Publications

Barry Smith

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Books

1. Barry Smith (ed.), *Structure and Gestalt: Philosophy and Literature in Austria-Hungary and Her Successor States*, Amsterdam: John Benjamins, 1981, x + 348pp.
> Reviews:
> P. M. Simons, *Conceptus*, 17 (1983), 131–134.
> J. Shearmur, *Free Life*, 3/2 (1983), 16–17.
> W. Stock, "Österreichische Philosophie", *Philosophischer Literaturanzeiger*, 37 (1984), 93–96.
> R. Cardinal, *Explorations in Knowledge*, 2 (1985), 68–69.

2. Barry Smith (ed.), *Parts and Moments. Studies in Logic and Formal Ontology*, Munich: Philosophia, 1982, reprinted 2001, 564pp.

Reviews:
V. Muñoz Delgado, *Estudios Filosoficos*, (1982) 38, 611–613.
I. Niiniluoto, *Zentralblatt für Mathematik*, (1983) 489, 15–16.
D. P. Henry, *History and Philosophy of Logic*, (1983) 4, 228–229.
F. G. Asenjo, *Rivista Latinoamericana de Filosofía*, (1983) 9, 174–177.
U. Charpa, "Neues zur Lehre von den Ganzen und Teilen", *Philosophische Rundschau*, 1/2 (1984), 52–59.
J.M. Salanskis, "Parties, Moments et Modalités", *Critique*, 443 (1984), 290–296.
R. Sokolowski, *Review of Metaphysics*, 38 (1984), 140–142.
B. Schuwey, *Philosophy and Phenomenological Research*, 45 (1985), 474–476.
G. Berger, *Noûs*, (1986) 20, 115–121.
J. Woleński, "Czeski i momenty", *Studia Filozoficzne*, 1–2/242–243 (1986), 191–195.
D. Münch, *Philosophischer Literaturanzeiger*, 39 (1986), 272–276.
R. Casati, "Laboratorio husserliano", *Fenomenologia e scienze dell'uomo*, 2/1 (1986), 283–287.
R. Tragesser, *Husserl Studies*, 5 (1988), 169–173.
N. Hentschel, *Zeitschrift für Ganzheitsforschung*, 32 (1988), 137–139.
G. Schenk, *Wissenschaftliche Zeitschrift der Universität Halle*, 39 (1990), 116–118.

3. Wolfgang Grassl and Barry Smith (eds.), *Austrian Economics: Historical and Philosophical Background*, New York: New York University Press, London/Sydney: Croom Helm, 1986, x + 250pp. Reprint, London: Routledge, 2010.

Reviews:
A. W. Dnes, *Scottish Journal of Political Economy*, 33 (1986), 391–395.
B. J. Loasby, *Economic Journal*, 96 (1986), 1165–1166.
J. Vint, *Journal of Interdisciplinary Economics,* 1 (4), January 1987.
R. Ebeling, "The Roots of Austrian Economics", *Market Process*, 5 (1987), 20–22, repr. in S. C. Littlechild, ed., *Austrian Economics,* vol. 1, Aldershot/Brookfield VT: Edward Elgar, 38–40.
J. Walker, *Journal of Economic Studies*, 14 (1987), 67–68.
M. Rothbard, *Journal of Applied Philosophy, 4 (1987), 248–250*.
J. A. Tucker, *Austrian Economics Newsletter*, (Fall 1988), 10–11.

4. Barry Smith (ed.), *Foundations of Gestalt Theory*, Munich and Vienna: Philosophia, 1988, 495pp.

Reviews:
J. Schulte, *Lingua e Stile*, 23 (1988).
V. Fano, "Gestalt e genesi precategoriale", *Annali*, 9 (1988), 165–181.
J. L. Gardies, *Revue philosophique de la France et de l'Etranger*, 179 (1989), 119.
V. MuZoz-Delgado, *Estudios*, 46 (1990), 134–135.
C. G. Allesch, *Conceptus* 24 (1990), 106–107.
C. Porebski, *Philosophischer Literaturanzeiger*, 43 (1990), 176–178.
D. Münch, *History and Philosophy of Logic*, 11 (1990), 238–240.
C. G. Allesch, *Zeitschrift für klinische Psychopathologie und Psychotherapie*, 37 (1989), 476–477.
J. M. Salanskis, "Le concept de Gestalt et la situation contemporaine de la philosophie des sciences", *Les Etudes philosophiques*, 4 (1990), 519–536.
J. Wolenski, *Ruch Filozoficzny*, 17 (1990), 162–164.
E. and J. Dölling, *Deutsche Literaturzeitung*, 112 (1991), 189–192.

5. J. C. Nyíri and Barry Smith (eds.), *Practical Knowledge: Outlines of a Theory of Traditions and Skills*, London/Sydney/New York: Croom Helm, and Routledge and Kegan Paul, 1988, ix + 213pp.

Reviews:
T. Whittock, *British Journal of Aesthetics*, 29 (1989), 191–192.
F. Adams, *Canadian Philosophical Reviews*, 9, (1989), 283–285.

J. M. Heaton, *Journal of the British Society for Phenomenology*, 21 (1990), 299–300.
R. T. Allen, *Tradition and Discovery*, 17 (1990/91), 36–38.

6. Adolf Reinach, *Sämtliche Werke. Kritische Ausgabe mit Kommentar*, Band I: *Die Werke*, Teil I: *Kritische Neuausgabe (1905–1914)*, Teil II: *Nachgelassene Texte (1906–1917)*; Band II: *Kommentar und Textkritik*, Munich/Hamden/Vienna: Philosophia, 1989, critical edition with commentary by Karl Schuhmann and Barry Smith, 2 vols., xx + 848pp.

Reviews:
U. H. D., *Bibliographie de la Philosophie*, 36 (1989), 147.
M. Crespo, *Diálogo Filosófico,* 6 (1990), 274.
J. Seifert, *Prima Philosophia*, 3 (1990), 408–415.
B. Waldenfels, *Philosophische Rundschau,* 37 (1990), 348.
J. Machnacz, *Zycie katolickie*, (1990), 147–150.
V. Munoz Delgado, *Estudios*, 46 (1990), 161–162.
J. Seifert, *Philosophischer Literaturanzeiger*, 44 (1991), 24–29.
N. Duxbury, "Apriori Philosophy and Legal Ontology", *Archiv für Rechts- und Sozialphilosophie*, 77 (1991), 262–266.
P. Gorner, *Journal of the British Society for Phenomenology*, 25(3), (1994), 309-311.

7. Hans Burkhardt and Barry Smith (eds.), *Handbook of Metaphysics and Ontology*, 2 vols., Munich/Philadelphia/Vienna: Philosophia, 1991, reprinted 2001, xxv + 1,005pp.

Reviews:
J. M. Perreault, *Choice*, (April 1992), 38–39.
A. C. Grayling, *Times Literary Supplement*, (17 April 1992), 26.
S. Scharnagl, *Bayernkurier*, (24 October 1992).
Guillermo Hurtado, *Tópicos*, vol. II, núm. 3, (1992).
O. R. Scholz, *Frankfurter Allgemeine Zeitung*, (15 September 1992).
Roberto Poli, *History and Philosophy of Logic*, 24 (1992), 258–260.
James DuBois, *Review of Metaphysics*, 47 (1993), 391–392.
Roberto Poli, *Axiomathes*, 1 (1993), 140–142.
John Haldane, Philosophical Quarterly, 43 (1993), 130.
Michele Marsonet, *Epistemologia*, 16 (1993), 345–347.
M. Moors, *Tijdschrift voor Filosofie*, 56 (1994), 161–162.
Fran Mau, *Philosophischer Literaturanzeiger*, 47 (1994), 54–56.
Timothy Joseph Day, *Minds and Machines*, 5 (1995), 131–134.
Stanley Paulson, *Philosophical Books*, 44: 2 (2003), 135–153.

8. Barry Smith (ed.), *Philosophy and Political Change in Eastern Europe* (The Monist Library of Philosophy), La Salle: The Hegeler Institute, 1993, vi + 192pp.

Reviews:
D. Cross, *Small Press*, (Winter 1994/95).
A. R. Brunello, *Choice*, (December 1994).
Nebojsa Kujundzic, *Dialogue,* 36 (1997), 648–650.
T. Sunic, *CLIO*, 24 (1995), 440–443.

9. C. Eschenbach, C. Habel and B. Smith (eds.), *Topological Foundations of Cognitive Science,* Hamburg: Graduiertenkolleg Kognitionswissenschaft Hamburg, Bericht 37, November 1994.

10. Barry Smith, *Austrian Philosophy: The Legacy of Franz Brentano*, La Salle and Chicago: Open Court, 1994, xiii + 381pp. Paperback edition: 1996.

Reviews:

Terry Skeats, *Library Journal*, 119 (1 September 1994), 185.
J. Barker, *Choice*, 32 (March 1995), 1136.
Ulf Höfer, *Nachrichten*. *Forschungsstelle und Dokumentationszentrum für Österreichische Philosophie*, 6 (1995), 55–58.
Kurt R. Fischer, *Vienna Circle Institute Yearbook*, 3 (1995), 303–304.
S. Gandon, "La philosophie autrichienne", *Critique*, 51 (October 1995), 794–796.
David Gordon, "Why the Austrian School is Austrian", *The Mises Review,* 1:4 (1995), 18–21.
Winfried Löffler, *Kontroversen in der Philosophie*, 8 (1995), 99–107.
Susan Krantz, *Brentano Studien*, 6 (1995/96), 325-327.
Richard Beach, *Canadian Philosophical Reviews*, 16 (1996), 62–64.
Werner Diederich and Eva Picardi, *Erkenntnis*, 45 (1996), 123–127.
Francis Dunlop, *Journal of the British Society for Phenomenology*, 27 (1996), 330–332.
Sonja Rinofner-Kreidl, *Grazer* Philosophische *Studien*, 52 (1996/97), 191–220.
Robin D. Rollinger, *Journal of the History of Philosophy*, 35 (1997), 314–315.
Kelley, L. Ross, *The Proceedings of the Friesian School*, 4 (1998).
Pierre Keller, *Modern Austrian Literature*, 29 (1996), 180–184.
Gisela Kubon-Gilke, *Gestalt Theory* (1996), 157–158.
Johannes Brandl, *Philosophy and Phenomenological Research*, 57 (1997), 697–702.
Manuel Durand-Barthez, *Revue de Metaphysique et de Morale* (1999), 3, 427-428.

11. Barry Smith (ed.), *European Philosophy and the American Academy* (The Monist Library of Philosophy), La Salle: The Hegeler Institute, 1994, viii + 226pp.

Reviews:
Barry Gross, *Academic Questions*, 8 (1995), 88–93.
David C. Jacobs, *Teaching Philosophy*, 19 (1996), 306–310.

12. Barry Smith and David W. Smith (eds.), *The Cambridge Companion to Husserl*, Cambridge and New York: Cambridge University Press, 1995, x + 519pp. Reprinted 1996.

Reviews:
Michel Bourdeau, "Les nouveaux habits du Professeur Husserl", *Critique*, 593 (1996), 893–907.
Brice R. Wachterhauser, *Ethics* 107 (October 1996), 198.
J. A. Bell, *Choice* 33 (February 1996), 961.
P. Buckley, *Tijdschrift voor Filosofie*, 58 (1996), 768–769.
Paul S. MacDonald, *Philosophical Writings*, 2 (1996), 109-110.
R. P. Buckley, *Canadian Philosophical Reviews*, 16 (1996), 294–296.
Michael Inwood, *International Philosophical Quarterly* 36/4 (1996), 490–493.
Paul Gorner, *The Philosophical Quarterly*, 48 (1998), 419–422.
Wojciech Zelaniec, *Brentano Studien*, 6 (1997), 334–339.
M. J. Larrabee, *Philosophical Review*, 106 (1997), 283–286.
Guillermo E. Rosado Haddock, "Edmund Husserl: A Philosopher for all Seasons?" *Modern Logic*, 7 (1997), 380–395.
Jonathan Barnes, "Just a Swipe at Edmund", *Dialectica*, 53: 2 (1999), 151–154.

13. Balázs Mezei and Barry Smith, *The Four Phases of Philosophy* (Studien zur österreichischen Philosophie), Amsterdam / Atlanta: Rodopi (with appendix: "The Four Phases of Philosophy" by Franz Brentano, translated from the German by Balász Mezei and Barry Smith), 1999, iv + 122pp.

Reviews:
Wolfgang Huemer, *Philosophy in Review* (*Comptes rendus philosophiques*), 20 (2000), 206–209.

14. Barry Smith (ed.), *Liberal Education in a Knowledge Society,* Chicago and La Salle, IL: Open Court, 2002, x + 294 pp.

Review:
Ed Brandon, *Metapsychology,* Jan 19, 2004

15. Barry Smith (ed.), *John Searle,* Cambridge and New York: Cambridge University Press, 2003, 312 pp.

Reviews:
Constantine Sandis, *Metapsychology, 8 (4), 2004*.
Rodych, Victor, *Philosophy in Review (Comptes rendus philosophiques)*, 24(5), (2004), 365-367.
Richard De Blacquière-Clarkson, *Philosophical Writings*, 26 (2004), 75-77.
Briggs, Richard S. *Heythrop Journal: A Bimonthly Review of Philosophy and Theology*, 46(2), (2005), 270-272.
P. Madigan "John Searle", *Heythrop Journal: Quarterly Review of Philosophy and Theology* 47 (2), 2006, 335-337.

16. Aurel Kolnai, *On Disgust*, Barry Smith and Carolyn Korsmeyer (eds.), Chicago: Open Court, 2003, viii + 120 pp.

Abstract: Kolnai made a breakthrough in the phenomenology of aversion when he showed the "double intentionality" of emotions like fear, focusing on both the object of fear and the subjects' concern for his own well-being, this being one of the ways in which fear differs from disgust. In a surprising yet persuasive move, Kolnai argues that disgust is never related to inorganic or non-biological matter, and that its arousal by moral objects has an underlying similarity with its arousal by organic material: a particular combination of life and death. Kolnai gives an analytic list of various kinds of disgusting objects (which should not be read just before lunch) and shows how disgust relates to the five senses.

Review:
Francis Raven, *Journal of Aesthetics and Art Criticism,* 2004, 62 (4): 408-409.

17. Barry Smith, David Mark and Isaac Ehrlich (eds.), *The Mystery of Capital and the Construction of Social Reality*, Chicago: Open Court, 2008, xxiv + 360 pp.

Reviews:
Wolfgang Grassl, *Journal of Markets and Morality*, 11(2), 2008, 343-345.
Maksymilian Del Mar, *Dialectica*, 63(3), 2009, 365-368

18. Katherine Munn and Barry Smith (eds.), *Applied Ontology: An Introduction* (free download as e-book), Frankfurt/Lancaster: ontos/Walter de Gruyter, 2008, 342 pp.

Reviews:
Peter Simons, "Ontology Meets Ontologies: Philosophers as Healers", *Metascience*, 18(3), 2009, 469-473.
Joshua Gordon, *Education for Information*, 27(4), 2009, 231-234.
Sanfilippo E. M., *Rivista Italiana di Filosofia Analitica Junior*, 2:2 (2011), 137-40.

19. Ludger Jansen and Barry Smith (eds.), *Biomedizinische Ontologie. Wissen strukturieren für den Informatik-Einsatz* (UTB Forum), Zurich: vdf, 2008, 252 pp. As e-book (revised): Zürich: vdf, 2011. Now open access.

20. Robert Arp, Barry Smith and Andrew Spear, *Building Ontologies with Basic Formal Ontology*, Cambridge, MA: MIT Press, August 2015, xxiv + 220pp.

Chinese translation, 基于基本形式化本体的本体构建, Beijing: 人民卫生出版社 (People's Medical Publishing House), October 2020, translated by Yan Zhu and Yongqun He, assisted by Jie Zheng, Xiaoying Li, Xiaolin Yang.

MIT Press Scholarship Online

Abstract: In the era of "big data," science is increasingly information driven, and the potential for computers to store, manage, and integrate massive amounts of data has given rise to new

disciplinary fields such as biomedical informatics. Applied ontology offers a strategy for organizing scientific information in computer-tractable form, drawing on concepts not only from computer and information science but also from linguistics, logic, and philosophy. This book provides an introduction to the field of applied ontology that is of particular relevance to bio-medicine, covering theoretical components of ontologies, best practices for ontology design, and examples of biomedical ontologies in use. After defining an ontology as a representation of the types of entities in a given domain, the book distinguishes between different kinds of ontologies and taxonomies, and shows how applied ontology draws on more traditional ideas from metaphysics. It presents the core features of the Basic Formal Ontology (BFO) now used by over 100 ontology projects throughout the world, and offers examples of domain ontologies that utilize BFO. The book also describes the Web Ontology Language (OWL), a common framework for Semantic Web technologies. Throughout, the book provides concrete recommendations for the design and construction of domain ontologies.

Reviews:
Neil Mcnaughton, Oil IT Journal, 3, 2016.
Martin Frické, *Journal of the Association for Information Science and Technology*, 68, 3 (March 2017), 801–804.

21. Jobst Landgrebe and Barry Smith, *Why Machines Will Never Rule the World: Artificial Intelligence Without Fear*, Abingdon, UK: Routledge, 2022, xii+342pp.

Reviews:

Bert Gambini "Book: AI is cool, but nowhere near human capacity, *Futurity*, Aug. 12, 2022

Ken Archer, "Why Machines Will Never Rule the World", September 14, 2022

"Computer takeover won't happen, say a scientist and philosopher", *Mind Matters*, October 4, 2022

Walid S. Saba, "Why Machines Will Never Rule the World", *Journal of Knowledge Structures & Systems*, 3 (4), Oct./Dec. 2022, 38-41

Aditya Aswani, "Will AI Actually Surpass Human Intelligence?", *Less Wrong*, December 29, 2023

Fabian Nicolay, "Der Mythos von der Künstlichen Intelligenz", *Achgut*, January 14, 2023

Hawley, Jeff (2022). The robots are coming: What's happening in philosophy, *Philosophynews.com*, August 22, 2022

Ken Archer, Post, September 24, 2022

Irrlichter und Fixsterne: Matthias Matussek im Gespräch mit Jobst Landgrebe, *Matussek Kontrafunk No 15*, January 2023

Matt Duckham, Why machines will never rule the world, *The Hat Cupboard,* March 19, 2023

William J. Rapaport, "Is Artificial General Intelligence Impossible?", May 2023

"New Routledge Book on AI: It Won't Take Us Over", Mind Matters, May 2023

Agnieszka Lekka-Kowalik, Recenzja, Why Machines Will Never Rule the World, Ethos (Lublin), 36 (3), May 2023, in Polish; in English

Interview with Jobst Landgrebe, Reality Check Radio, May 23, 2023

Atle Ottesen Søvik, "Kan maskiner få generell intelligens? En kritisk drøfting av Landgrebe og Smiths bok Why Machines Will Never Rule the World", *Norsk filosofisk tidsskrift*, 58(2-3), 12 September 2023, 141–152.

Astral Codex Ten, Thomas Jefferson Snodgrass, Why Machines Will Never Rule the World, November 14, 2023, finalist in the Astral Codex Ten Book Review Contest

Reddit. Your book review (Comments on Astral Codex X). August 2023

Daniel Kelly, The Supposed Looming Specter of Artificial General Intelligence, CATT Blog, October 18, 2023

Peter Gärdenfors, Why Machines Won't Take Over the World, March 2024, originally published in Swedish as Varför AI inte kommer att ta över världen, *Sans,* 2024, 2

In Dubio, KO durch K.I.?, Interview with Jobst Landgrebe, April 21, 2024

Breaking Latest News, Artificial Intelligence Will not Dominate the World, April 27, 2024

Jack G. Nestell, Why Machines Will Never Rule the World"-Exploring the Future of Artificial Intelligence with Dr. Jobst Landgrebe & Dr. Barry Smith, N&A, May 16, 2024

Alberto Magnani, "The Limitations of AI", *Law and Liberty*, May 20, 2024

Atle Ottesen Søvik, "Vil kunstig intelligens i nær fremtid føre til dommedag for enneskeheten?", *Kirke og Kultur*, 129 (1), 26-37, 25 March, 2024

Cosmos+Taxis, 12 (5+6): Symposium, edited by Janna Hastings, on Jobst Landgrebe and Barry Smith, *Why Machines Will Never Rule the World: Artificial Intelligence without Fear. Includes:*

> In Our Own Image: What the Quest for Artificial General Intelligence Can Teach Us About Being Human**,** Janna Hastings
>
> Is Artificial General Intelligence Impossible?**,** William J. Rapaport
>
> Is Intelligence Non-Computational Dynamical Coupling?**,** Jonathan A. Simon
>
> What is a machine? Exploring the meaning of 'artificial' in 'artificial intelligence'**,** Stefan Schulz and Janna Hastings
>
> Complexity and Particularity: An Argument for the Impossibility of Artificial Intelligence**,** Emanuele Martinelli
>
> Computers will not acquire general intelligence, but may still rule the world**,** Ragnar Fjelland
>
> Semi-Autonomous Godlike Artificial Intelligence (SAGAI) is conceivable but how far will it resemble Kali or Thor?**,** Robert West
>
> Back to Evolutionary Intelligence: Reading Landgrebe and Smith**,** Kirill Krinkin
>
> Conversational AI for Psychotherapy and Its Role in the Space of Reason**,** Jana Sedlakova
>
> Every dog has its day: An in-depth analysis of the creative ability of visual generative AI**,** Maria M. Hedblom
>
> Intelligence. And what computers still can't do**,** Jobst Landgrebe and Barry Smith

Jobst Landgrebe and Barry Smith, *Why Machines Will Never Rule the World: Artificial Intelligence Without Fear*, Second, revised and expanded edition, Abingdon, UK: Routledge, May 1, 2025, xii+434pp.

> Ulrich Schödlbauer. "Warum Maschinen nie die Welt regieren werden. Und warum die Botschaft schmallippig bleibt" (Why Machines Will Never Rule the World — And Why No One Dares to Say So), *Globkult*, May 17, 2025.
>
> Emil O. W. Kirkegaard, Is it impossible to build general artificial intelligence? Review of Why Machines Will Never Rule the World, Aug 29, 2025

Edited Conference Proceedings

1. Roberto Casati, Barry Smith and Graham White (eds.), *Philosophy and the Cognitive Sciences*, Vienna: Hölder-Pichler-Tempsky 1994, viii + 682pp.

2. Berit Brogaard and Barry Smith (eds.), *Rationality and Irrationality*, Vienna: öbv&hpt, 2001, 411 pp.

3. Christopher Welty and Barry Smith (eds.), *Formal Ontology in Information Systems*, New York: ACM Press, 2001, xvi + 348 pp.

4. Pierre Grenon, Christopher Menzel and Barry Smith (eds.), *Proceedings of the KI 2003 Workshop on Reference Ontologies and Application Ontologies*, Hamburg, Germany, September 16, 2003. CEUR Workshop Proceedings 94.

5. Mitsuhiro Okada and Barry Smith, *Interdisciplinary Ontology. Proceedings of the First Interdisciplinary Ontology Meeting* (Tokyo, Japan, February 26-27, 2008), Tokyo: Keio University Press, 2008.

6. Mitsuhiro Okada and Barry Smith (eds.), *Interdisciplinary Ontology. Proceedings of the Second Interdisciplinary Ontology Meeting* (Tokyo, Japan, February 28-March 1, 2009), Tokyo: Keio University Press, 2009, iv + 166 pp.

7. Barry Smith (ed.) *ICBO 2009: Proceedings of the First International Conference on Biomedical Ontology* (Buffalo, NY, July 24-26, 2009). Buffalo: National Center for Ontological Research, 2009.

8. Barry Smith, Riichiro Mizoguchi and Sumio Nakagawa (eds.), *Interdisciplinary Ontology. Proceedings of the Third Interdisciplinary Ontology Meeting* (Tokyo, Japan, February 27-28, 2010), Tokyo: Keio University Press, 2010.

9. Mitsuhiro Okada and Barry Smith (eds.), *Interdisciplinary Ontology. Proceedings of the Fifth Interdisciplinary Ontology Meeting* (Tokyo, Japan, February 23-24, 2012), Tokyo: Keio University Press, 2012, iv + 159 pp.

Journal Special Issues

1. Barry Smith and Richard Scheuermann (eds.), *Ontologies for Clinical and Translational Research* (Special issue of the *Journal of Biomedical Informatics)*, Amsterdam: Elsevier, 2011, 176 pp.

> **Abstract:** A collection of original papers focusing on the ways in which biomedical ontologies are being used in attempts to break down the barriers between the many different sorts of information relevant to the understanding and treatment of disease, ranging from information deriving from experimental biology and model organism research to clinical trial data and information of the sort contained in electronic health records. The contributions represent both the state of the art and works in progress, and they reveal how far we still have to go if we are to reach the level of domain coverage and semantic consistency sought by those engaged in information-driven clinical and translational research.

2. Stefano Borgo, Riichiro Mizoguchi and Barry Smith (eds.) *The Ontology of Functions* (Special issue of the journal *Applied Ontology*), Amsterdam: IOS Press, 6 (2), 2011, 64 pp.

> **Abstract:** This special issue of *Applied Ontology* is devoted to the foundation, the comparison and the application of functional theories in all areas, with particular attention to the biological and engineering domains. It includes theoretical and technical contributions related to the description, characterization, and application of functions.

3. Andreas Tolk and Barry Smith (eds.), *Command and Control Ontology* (Special issue of the *International Journal of Intelligent Defence Support Systems), 4* (3), 2011, 98 pp.

> **Abstract:** Intelligent defence support systems are confronted with the need to manage ever-increasing floods of data in a way that raises significant challenges because the data are described and presented using different terminologies and formats. How, on this basis, is it possible to reach a common understanding of the information content of these data among

people and software agents? How is it possible to ensure that domain knowledge is reused in consistent fashion in a way that makes this information available for integration and analysis? How can we support the identification, selection, composition, and orchestration of services based on such diverse data providing homogeneous support by a service-oriented architecture? This collection is devoted to the use of ontologies to answer questions such as these.

4. Sonia Kamińska and Barry Smith (eds.), *The Philosopher Franz K* (Special issue of the *Polish Journal of Aesthetics*) 53 (2), 2019.

5. Gloria Sansò & Barry Smith (eds.), *Ontology of Finance*, Rosenberg & Sellier (forthcoming).

Abstract: One famous scene in *The Wolf of Wall Street* (2013) is the dialogue between the young Jordan Belfort (Leonardo DiCaprio) and the expert trader Mark Hanna (Matthew McConaughey). Hanna is complaining that the stock market is unpredictable; it's "fugazi … it's fairy dust. It doesn't exist. It's never landed. It is not matter. It's not on the element chart. It's not real". But the fact that something is unpredictable and non-physical does not imply that it does not exist. On the other hand, its unpredictability, non-physicality, and the fact that the stock market trend is largely determined by investors' beliefs, do make its nature difficult to grasp. This special issue of Rivista di Estetica aims to explore the financial sector from an ontological point of view. While the ontology of money has been extensively studied, few scholars have focused on the stock market and, more generally, on those entities belonging to the investment landscape. Matters are made more complicated by the fact that the financial sector is characterized by an ever-increasing use of digital technology, including software elements that trade in the market themselves. We believe that a careful study of this phenomenon may help us better to understand the role of artificial agents in the social world.

Refereed Articles in Scholarly Journals

1. Barry Smith, "The Ontogenesis of Mathematical Objects", *Journal of the British Society for Phenomenology*, 6 (1975), 91–101.

Abstract: Mathematical objects are divided into (1) those which are autonomous, i.e., not dependent for their existence upon mathematicians' conscious acts, and (2) intentional objects, which are so dependent. Platonist philosophy of mathematics argues that all objects belong to group (1), Brouwer's intuitionism argues that all belong to group (2). Here we attempt to develop a dualist ontology of mathematics (implicit in the work of, e.g., Hilbert), exploiting the theories of Meinong, Husserl and Ingarden on the relations between autonomous and intentional objects. In particular we develop a phenomenology of mathematical works, which has the stratified intentional structure discovered by Ingarden in his study of the literary work.

2. Barry Smith, "Frege and Husserl: The Ontology of Reference", *Journal of the British Society for Phenomenology*, 9 (1978), 111–125.

Abstract: Analytic philosophers apply the term 'object' both to concreta and to abstracta of certain kinds. The theory of objects which this implies is shown to rest on a dichotomy between object-entities on the one hand and meaning-entities on the other, and it is suggested that the most adequate account of the latter is provided by Husserl's theory of noemata. A two-story ontology of objects and meanings (concepts, classes) is defended, and Löwenheim's work on class-representatives is cited as an indication of how the need for higher types may be obviated, even in mathematical contexts. The paper concludes with a sketch of the taxonomy of the object realm which results from the above.

3. Barry Smith, "An Essay in Formal Ontology", *Grazer Philosophische Studien*, 6 (1978), 39–62.

Abstract: This paper is both a working introduction to the realist ontological theory put forward by the Polish phenomenologist Roman Ingarden and also a development of Ingarden's views in the light of current tendencies in analytic philosophical logic. The central theme of the paper is the ontological analysis of states of affairs, and in particular of negative states of affairs, a topic which is of some specific interest in forming a connecting link between the Brentano-Meinong-

Husserl tradition to which Ingarden belonged, and the (Frege)-Russell-Wittgenstein tradition which gave rise to modern philosophical logic.

4. Barry Smith, "Law and Eschatology in Wittgenstein's Early Thought", *Inquiry*, 21 (1978), 425–441.

Abstract: The paper investigates the role played by ethical deliberation and ethical judgment in Wittgenstein's early thought in the light of twentieth-century German legal philosophy. In particular the theories of the phenomenologists Adolf Reinach, Wilhelm Schapp and Gerhart Husserl are singled out, as resting on ontologies which are structurally similar to that of the *Tractatus*. In each case it is actual and possible *Sachverhalte* which constitute the prime ontological category. The study of the relationship between the states of affairs depicted, e.g., in the sentences of a legal trial and prior fact-complexes to which these may correspond suggests one possible connecting link between the logical and ontological sections of the *Tractatus* and the ethical reflections appearing at the end. It is argued that the latter can best be understood in terms of the idea of a "last judgment" (with its associated ethical rewards and punishments) which would relate to the world as a whole as a penal trial relates to individual complexes of facts.

5. Barry Smith, "Ingarden vs. Meinong on the Logic of Fiction", *Philosophy and Phenomenological Research*, 16 (1980), 93–105.

Abstract: For Meinong, familiarly, fictional entities are not created, but rather merely discovered (or picked out) from the inexhaustible realm of Aussersein (beyond being and non-being). The phenomenologist Roman Ingarden, in contrast, offers in his *Literary Work of Art* of 1931 a constructive ontology of fiction, which views fictional objects as entities which are created by the acts of an author (as laws, for example, are created by acts of parliament). We outline the logic of fiction which is implied by Ingarden's approach, showing how it distinguishes the *properties* possessed by fictional objects (for instance of having been created by such and such an author in such and such a work) from *characteristics* (for instance of smoking a pipe, of living in Baker Street) which are merely associated with such objects.

Polish translation as: "Ingarden versus Meinong o logice fikcji", in Z. Muszyński (ed.), *Z badań nad prawdą i poznaniem*, Lublin: Wydawnictwo UMC-S (1998), 283–296.

6. Barry Smith, "Logic, Form and Matter", *Proceedings of the Aristotelian Society*, *Supplementary Volume* 55 (1981), 47–63.

Abstract: It is argued on the basis of ideas derived from Wittgenstein's *Tractatus* and Husserl's *Logical Investigations* that the formal comprehends more than the logical. More specifically: that there exist certain formal-ontological constants (part, whole, overlapping, etc.) which do not fall within the province of logic. A two-dimensional directly depicting language is developed for the representation of the constants of formal ontology, and means are provided for the extension of this language to enable the representation of certain materially necessary relations. The paper concludes with a discussion of the relationship between formal logic, formal ontology and mathematics.

7. Barry Smith, "Osztrák és magyar filozófia: Wittgenstein és Pauler logikájáról", *Magyar Filozófiai Szemle* (1981), 139–144.

8. Barry Smith and Kevin Mulligan, "Framework for Formal Ontology", *Topoi*, 3 (1983), 73–85.

Abstract: We draw on the distinction first expounded by Husserl between formal logic and formal ontology. The former concerns itself with (formal) meaning-structures; the latter with formal structures amongst objects and their parts. The paper attempts to show how, when formal ontological considerations are brought into play, contemporary extensionalist theories of part and whole, and above all the mereology of Leniewski, can be generalised to embrace not only relations between concrete objects and object-pieces, but also relations between what we shall call dependent parts or moments. A two-dimensional formal language is canvassed for the resultant ontological theory, a language which owes more to the tradition of Euler, Boole and Venn than to the quantifier-centred languages which have predominated amongst analytic

philosophers since the time of Frege and Russell. Analytic philosophical arguments against moments, and against the entire project of a formal ontology, are considered and rejected.

9. Barry Smith, "Weininger und Wittgenstein", in B. F. McGuinness and A. Gargani (eds.), *Wittgenstein and Contemporary Philosophy* (*Teoria*, 5), Pisa: ETS (1984), 156–165.

Abstract: The paper seeks to show how Weininger's interpretations of Kant and Schopenhauer help us to understand some of the peculiar reflections on the will, on happiness and unhappiness, and on the problems of life, which are to be found in Wittgenstein's *Notebooks*. It seeks to explain, above all, why Wittgenstein should wish to reject the basic ethical axiom of "love thy neighbor." There follows a sketch of one possible Kantian interpretation of the *Tractatus* along Weiningerian lines. The conclusion is drawn, however, that, while in the *Notebooks* many of Weininger's views are still accepted, by the time of the *Tractatus* Wittgenstein has moved to a position in which a thinker like Weininger must be conceived as propounding so much more "ethical nonsense." Wittgenstein adopts in the *Tractatus* a wholly new conception of the ethical, a form of logical individualism or quietism.

Romanian translation in *Revista de filosofie,* 49, (2002), 233-246.

10. Barry Smith, "Acta cum fundamentis in re", *Dialectica*, 38 (1984), 157–178.

Abstract: The paper defends a theory of mind according to which certain sorts of acts are 'real material relations' and compares this theory to causal theories of reference and perception. All mental acts are dependent for their existence upon the subject (person, organism) whose acts they are. Relational acts are dependent also on intended objects in the world. The relational theory thus implies a rejection of the Cartesian thesis to the effect that we could in principle have exactly the same thoughts even though the objects of these thoughts did not exist. It implies thereby also a rejection of Husserlian phenomenology. Husserl's earlier work on the formal ontology of part, whole and dependence nevertheless provides a framework which can allow a precise formulation of the relational theory.

11. Barry Smith, "Ten Conditions on a Theory of Speech Acts", *Theoretical Linguistics*, 11 (1984), 311–330.

Abstract: It is now generally recognized that figures such as Reid, Peirce, and Reinach formulated theories of speech acts avant la lettre of Austin and Searle, in Reid and Reinach's cases under the heading 'theory of social acts'. Here we address the question as to what conditions would have to be satisfied for such theories to count as 'theories of speech acts' in the now familiar sense.

12. Kevin Mulligan, Peter M. Simons and Barry Smith, "Truth-Makers", *Philosophy and Phenomenological Research*, 44 (1984), 287–321.

Abstract: A realist theory of truth for a class of sentences holds that there are entities in virtue of which these sentences are true or false. We call such entities 'truthmakers' and contend that those for a wide range of sentences about the real world are moments (dependent particulars). Since moments are unfamiliar, we provide a definition and a brief philosophical history, anchoring them in our ontology by showing that they are objects of perception. The core of our theory is the account of truthmaking for atomic sentences, in which we expose a pervasive 'dogma of logical form', which says that atomic sentences cannot have more than one truthmaker. In contrast to this, we uphold the mutual independence of logical and ontological complexity, and the authors outline formal principles of truthmaking taking account of both kinds of complexity. We conclude by suggesting how to overcome the problem of negation faced by an account of truth in keeping with Wittgenstein's *Tractatus*.

Reprinted in Jean-Maurice Monnoyer, *Metaphysics and Truthmakers*, Frankfurt/Lancaster/New Brunswik: Ontos, 9-50.

Reprinted in E. J. Lowe and A. Rami (eds.), *Truth and Truth-Making*, Chesham: Acumen (2009), 59-86.

German translation as: "Wahrmacher", in L. Bruno Puntel (ed.), *Der Wahrheitsbegriff. Neue Explikationsversuche* (a collection of readings on

modern theories of truth), Darmstadt: Wissenschaftliche Buchgesellschaft (1987), 210–255.

Als zu Beginn des Jahrhunderts der Realismus wieder ernst genommen wurde, gab es viele Philosophen, die sich mit der Ontologie der Wahrheit befaßten. Unabhängig von der Bestimmung der Wahrheit als Korrespondenzbeziehung wollten sie herausfinden, inwieweit zur Erklärung der Wahrheit von Sätzen besondere Entitäten herangezogen werden müssen. Einige dieser Entitäten, so zum Beispiel Bolzanos 'Sätze an sich', Freges 'Gedanken' oder die 'propositions' von Russell und Moore, wurden als Träger der Eigenschaften Wahrheit und Falschheit aufgefaßt. Einige Philosophen jedoch, wie Russell, Wittgenstein im ›Tractatus‹ und Husserl in den ›Logischen Untersuchungen‹, argumentierten, zusätzlich zu den Wahrheitsträgern bzw. an ihrer Stelle müßten Entitäten angenommen werden, auf Grund deren Sätze und/oder 'Propositionen' wahr sind. Solchen Entitäten gab man verschiedene Namen, insbesondere 'fact', 'Tatsache', 'state of affairs' und 'Sachverhalt'. 1 Wir wollen einer Entscheidung über die Angebrachtheit dieser Ausdrücke nicht vorgreifen und daher zunächst eine neutralere Terminologie verwenden: Alle Entitäten, die für diese zweite Rolle in Frage kommen, wollen wir 'Wahrmacher' nennen.

French translation as "Vérificateurs", *Études de philosophie*, no. 9-10, 2008-2011 (published August 2011), translated by B. Langlet and J.-F. Rosecchi, 104-138.

Lors du renouveau réaliste des premières années de ce siècle, des philosophes de divers horizons s'impliquèrent dans la recherche d'une ontologie de la vérité. Que le point de vue de la vérité-correspondance ait été retenu ou non, ils s'y intéressèrent dans la mesure où il était requis de supposer l'existence d'entités jouant un rôle pour rendre compte de la vérité des phrases. Certaines de ces entités, comme les *Sätze an sich* de Bolzano, les *Gedanken* de Frege, ou les *Propositions* de Russell et Moore, étaient conçues comme porteurs des propriétés de vérité et de fausseté. Cependant, quelques penseurs comme Russell, Wittgenstein dans le *Tractatus* ou Husserl dans les *Recherches logiques*, arguèrent qu'en plus ou à la place de ces porteurs de vérité, il fallait supposer l'existence de certaines entités en vertu desquelles les phrases ou les propositions sont vraies. Plusieurs noms ont été utilisés pour désigner ces entités, comme « *fait* », « S*achverhalt* », et « *état de choses* ». Afin de ne pas préjuger de la pertinence de ces termes, nous allons employer une terminologie plus neutre et appeler *vérificateurs* toutes les entités candidates pour ce rôle.

13. Barry Smith, "De la modification de la sensibilité: l'esthétique de l'Ecole de Graz", *Revue d'Esthétique*, 9 (1985), 19–37.

14. Barry Smith, "Ontologische Aspekte der Husserlschen Phänomenologie", *Husserl Studies*, 3 (1986), 115–130.

Abstract: A study of the background of Husserl's early thinking in the perceptual psychology of Carl Stumpf and of the implications of Stumpfian ideas for an understanding of Husserl's phenomenology. Other topics treated include the ontology of part, whole and dependence; gestalt theory; and Husserl's notion of the synthetic a priori.

15. Barry Smith, "The Substitution Theory of Art", *Grazer Philosophische Studien*, 25/26 (1986), 533–557.

Abstract: In perceptual experience we are directed towards objects in a way which establishes a real relation between a mental act and its target. In reading works of fiction we enjoy experiences which manifest certain internal similarities to such relational acts, but which lack objects. The substitution theory of art attempts to provide a reason why we seek out such experiences and the artifacts which they generate. Briefly, we seek out works of art because we enjoy the physiology and the phenomenology of, for example, the experience of love or mountain climbing, and works of art serve as props for the promotion of substitutes for the corresponding genuine feelings. Art arose, or came to be separated out from other, related phenomena, through the discovery that the experience of substitute emotions can be pleasurable.

Italian translation as: "La teoria sostituzionale dell'arte", in E. Pulcini (ed.), *Teorie delle passioni* (Supplementi di Topoi), 3 (1989), 186–209.

16. Kevin Mulligan and Barry Smith, "A Relational Theory of the Act", *Topoi*, 5/2 (1986), 115–130.

Abstract: The paper defends a view of perceptual acts as real relations of a subject to an object. To make this view coherent, a theory of different types of relations is developed, resting on ideas on formal ontology put forward by Husserl in his *Logical Investigations* and on the theory of relations sketched in Smith's "Acta cum fundamentis in re". The theory is applied to the notion of a Cambridge change, which proves to have an unforeseen relevance to our understanding of perception.

17. Kevin Mulligan and Barry Smith, "Husserl's Logical Investigations", *Grazer Philosophische Studien*, 27 (1986), 199–207.

Abstract: The magisterial analyses of logic and meaning advanced in Husserl's *Logical Investigations* of 1900/01 have for a number of reasons been neglected by analytical philosophers in subsequent decades. This state of affairs has to do, in part, with the history of the editions and translations of Husserl's writings. Findlay's readable but imperfect translation appeared seventy years after the work itself was first published, and the editors and translators and expositors of Husserl's works have reflected the prevailing philosophical atmosphere on the Continent by concentration their energies on Husserl's later writings. Now, however, over eighty years after the appearance of Husserl's one true masterpiece, a critical edition of the work is at last available in completed form. We here analyze the structure and content of this new edition, published as part of the Husserliana series by the Husserl Archive in Louvain.

18. Kevin Mulligan and Barry Smith, "A Husserlian Theory of Indexicality", in *Grazer Philosophische Studien*, 28 (1986), 133–163.

Abstract: It is well known that Husserl's *Logical Investigations* contain the beginnings of an account of the meanings of indexical expressions, expressions whose meanings depend essentially on some sort of explicit or implicit pointing or indication [*Anzeigen*], and therefore on some contribution by the surroundings of speaker and hearer. Husserl in fact speaks explicitly of 'occasional expressions', that is of expressions like 'this' and 'that' whose meanings depend on features of the occasion of use, but it is possible to gauge the full implications of his explicit remarks on the problem of indexical or occasional meanings only if these are read in conjunction with what he says elsewhere in the Investigations, especially on the subject of perceptual judgments and proper names. Moreover, Husserl's deliberations on indication, perception and naming, as also what he has to say on demonstrative pronouns, spatial and temporal adverbs and tenses, must themselves be understood – like everything else in this work – as applications of a very general theory of meaning and of structure or dependence. In what follows we shall set out Husserl's account of indexicality and develop it in various ways. Unlike Husserl himself – who retrospectively described his own account as an 'act of violence' – we are strongly of the opinion that this effort is worthwhile.

19. Barry Smith, "The Substance of Brentano's Ontology", *Topoi*, 6/1 (1987), 39–49.

Abstract: This paper is a study of Brentano's ontology, and more specifically of his theory of substance and accident as put forward toward the end of his life in the materials collected together as the *Kategorienlehre* or *Theory of Categories*. Here Brentano presents an auditious (re-)interpretation of Aristotle's theory of substance and accidence. We show that on the Brentano initially defends, it is space which serves as the single substance upon which all other entities depend as accidents of space. In an appendix, however, Brentano puts forward an even more radical suggestion, inspired by the physics of Kelvin. According to this final view, space itself is an accident of a deeper substance: the present time.

20. Barry Smith, "The Ontology of Epistemology", *Reports on Philosophy*, 11 (1987), 57–66.

Abstract: Ingarden's puzzle is: how can we come to know what is essentially involved in an act of knowing? As starting point he takes what he holds to be a particular good candidate example of such an act, namely an act of perceiving an apple. Here we have act and object standing in a certain first-level relation to each other. We now in a second level act of reflection, make this first-level relation into an object, and strive to apprehend this object as an instantiation of the essence knowledge. But how, on this basis, could we ever establish that we had indeed grasped this essence, and that this is indeed the appropriate essence? Surely, through some third-level

act of reflection on this second-level act. We expound from an ontological point of view Ingarden's idea as to how this regress can be avoided.

Polish translation as: "Ontologia epistemologii", in W. Strozewski and A. Wegrzecki (eds.), *W Kregu Filozofii Romana Ingardena*, Warsaw/Cracow: PWN, 1995, 111–119.

21. Barry Smith, "Zalai Béla és a tiszta lét Metafizikája", *Magyar Filozófiai Szemle* (1987/3), 584–593.

Abstract: Between 1910 und 1915 the Hungarian philosoper Der ungarische Philosoph Béla Zalai (1882-1915) developed his "comparative metaphysics of systems", which had a significant influence on both the young Georg Lukács and also on Karl Mannheim. Through an analysis of Zalai's approach to metaphysics, we show how he served to mediate between the realist Austrian philosophy of Meinong and of the early Husserl on the one side, and the German (idealistic, Kantian) philosophy then dominant in Hungary.

German version: "Bela Zalai und die Metaphysik des reinen Seins", *Brentano Studien*, 5 (1994), 59–68.

22. Karl Schuhmann and Barry Smith, "Questions: An Essay in Daubertian Phenomenology", *Philosophy and Phenomenological Research*, 47 (1987), 353–384.

Abstract: This is a historical study of the logical, psychological and linguistic dimensions of the act of questioning, with special reference to the work of the Munich school of phenomenology and of E. Husserl. The essay is a contribution to recent work on anticipations by the Munich school of the theory of speech acts.

23. Barry Smith, "The Soul and Its Parts: A Study in Aristotle and Brentano", *Brentano–Studien*, 1 (1988), 75–88.

Abstract: The piece of wax takes on the form of the seal; but this occurs in a way that is largely indifferent to the particular constitution of the seal. Similarly, Aristotle says, 'the sense is affected by what is coloured or flavoured or sounding, but it is indifferent as to what in each case the substance is'. We show that Brentano takes this Aristotelian account of the relation between sense and its objects as the basis for his theory of mind in the *Psychology from an Empirical Standpoint*.

24. Barry Smith, "The Primacy of Place: An Investigation in Brentanian Ontology", *Topoi*, 8 (1989), 43–51.

Abstract: In his later writings Brentano defended a peculiar doctrine to the effect that the substances of the material world are three-dimensional places. The paper presents the psychological origins of this view and shows how the issue as to the nature of substance can throw light not only on Brentanian and Aristotelian ontology but also on a spectrum of views ranging from Quine, Kotarbinski and Lesniewski to Twardowski and Meinong.

25. Barry Smith, "Logic and the *Sachverhalt*", *The Monist*, 72 (1989), 52–69.

Abstract: Logic is often conceived as a science of propositions, or of relations between propositions. There is an alternative view, however, defended by Meinong, Pfänder, Reinach and others, which sees logic as a science of "Sachverhalte" or states of affairs. A consideration of this view, which was defended especially by thinkers within the tradition of Brentano, throws new light on the problems of intentionality and of mental content. It throws light also on the development of logic in Poland. Here the influence of Brentano's student Kasimir Twardowski is especially important, and the paper concludes with a new interpretation of Tarski's work on truth against the background of Twardowski's thinking.

Revised version in: L. Albertazzi, M. Libardi and R. Poli (eds.), *The School of Franz Brentano*, Dordrecht/Boston/Lancaster: Kluwer (1996), 323–341.

Italian translation as: "Dalla psicologia del giudizio all'ontologia dello stato di cose" in *Discipline Filosofiche*, 7: 2 (1997), 7–28.

26. Barry Smith, "On the Origins of Analytic Philosophy", *Grazer Philosophische Studien*, 35 (1989), 153–173.

Abstract: Analytic philosophers have until recently been reluctant to pursue historical investigations into the Central European roots of their own philosophical tradition. The most recent book by Michael Dummett, however, entitled *Origins of Analytic Philosophy*, shows how fruitful such investigations can be, not only as a means of coming to see familiar philosophical problems in a new light, but also as a means of clarifying what, precisely, 'analytic philosophy' might mean. As Dummett points out, the newly fashionable habit of referring to analytic philosophy as 'Anglo-American' leads to a 'grave historical distortion'. If, he says, we take into account the historical context in which analytic philosophy developed, then such philosophy 'could at least as well be called "Anglo-Austrian"' (p. 7). We here show the implications of this assertion for a more adequate understanding of the relations between analytic and Continental philosophy.

27. Barry Smith, "Aristotle, Menger, Mises: An Essay in the Metaphysics of Economics", *History of Political Economy*, Annual Supplement to vol. 22 (1990), 263–288; published simultaneously in B. Caldwell (ed.), *Carl Menger and His Economic Legacy*, Durham and London: Duke University Press, 1990).

Abstract: There are, familiarly, a range of distinct and competing accounts of the methodological underpinnings of Menger's work. These include Leibnizian, Kantian, Millian, and even Popperian readings; but they include also readings of an Aristotelian sort. I argue tha the historical situation in which Menger found himself points to the inevitability of the Aristotelian reading and that this reading fits also very naturally to the text of Menger's works. At the same time I will explain why the diversity of interpretations is not, however, entirely surprising. Menger broke new ground in economic theory in part by fashioning new linguistic instruments not easily open to unambiguous interpretation.

Reprinted in: E. Younkins (ed.), *Philosophers of Capitalism: Menger, Mises, Rand, and Beyond*, New York: Lexington Books, 2005, 199-222.

Reprinted in: *The Methodology of Carl Menger: A Symposium on the Philosophical Foundations of Austrian Economics*, London: Department of History and Philosophy of Science, Kings College, 1990.

28. Karl Schuhmann and Barry Smith, "Elements of Speech Act Theory in the Work of Thomas Reid", *History of Philosophy Quarterly*, 7 (1990), 47–66.

Abstract: Historical research has recently made it clear that, prior to Austin and Searle, the phenomenologist Adolf Reinach (1884-1917) developed a full-fledged theory of speech acts under the heading of what he called "social acts". He we consider a second instance of a speech act theory *avant la lettre*, which is to be found in the common sense philosophy of Thomas Reid (1710-1796). Reid's s work, in contrast to that of Reinach, lacks both a unified approach and the detailed analyses of pertinent examples. But his writings leave no doubt that he is acutely aware of the very problems concerning language structure and use out of which contemporary speech act theory has evolved and that he goes a good way towards solving these problems in the spirit of the modern theory.

29. Barry Smith, "Textual Deference", *American Philosophical Quarterly*, 28 (1991), 1–13.

Abstract: Works of philosophy written in English have spawned a massive secondary literature dealing with ideas, problems or arguments. But they have almost never given rise to works of 'commentary' in the strict sense, a genre which is however a dominant literary form not only in the Confucian, Vedantic, Islamic, Jewish and Scholastic traditions, but also in relation to more recent German-language philosophy. Yet Anglo-Saxon philosophers have themselves embraced the commentary form when dealing with Greek or Latin philosophers outside their own tradition. The paper seeks to establish the reasons for this peculiar asymmetry by examining those factors which might be conducive to the growth of a commentary literature in a given culture.

Danish translation as: "Textlig Œrbødighed", *Kritik*, 116 (1995), 89–99.

Italian translation as: "Deferenza testuale", *Divus Thomas*, 24/3 (1999), 92–116.

Russian translation as: "Проблема перевода", *Logos* 5 (2000), 124–139.

30. Barry Smith, "German Philosophy: Language and Style", *Topoi*, 10 (1991), 155–161.

Abstract: The paper addresses the apparent asymmetry as between German and English philosophical texts, turning on the fact that translations from the former into the latter language are typically much more easily obtained than in the reverse direction. A range of factors are shown to be involved, both stylistic and sociological. Most important, however, is a difference in the conception of what philosophy is in the two cultures.

31. Barry Smith, "La verità trionfa: Da T. G. Masaryk a Jan Patočka", *Discipline Filosofiche*, 2 (1991), 207–227.

Abstract: Thomas Garrigue Masaryk, later founder and President of the Republic of Czechoslovakia, studied philosophy in the University of Vienna from 1872 to 1876, where he came under the powerful influence of Franz Brentano. We survey the role of Brentano's philosophy, and especially of his ethics, in Masaryk's life and work.

German version as: "Von T. G. Masaryk bis Jan Patočka. Eine philosophische Skizze", in J. Zumr and T. Binder (eds.), *T. G. Masaryk und die Brentano-Schule*, Graz/Prague: Czech Academy of Sciences (1993), 94–110.

32. Karl Schuhmann and Barry Smith, "Neo-Kantianism and Phenomenology: The Case of Emil Lask and Johannes Daubert", *Kant-Studien*, 82 (1991), 303–318.

Abstract: Johannes Daubert he was an acknowledged leader, and in some respects the founder, of the early phenomenological movement, and was considered – as much by its members as by Husserl himself – the most brilliant member of the group. In Daubert's unpublished writings we find a series of reflections on Lask, and on Neo-Kantianism, which form the subject-matter of this paper. They range over topics such as the ontology of the '*Sachverhalt*' or state of affairs, truth-values (*Wahrheitswerte*) and the value of truth, negative judgments and the copula, and the relation between perception and judgment.

33. Barry Smith, "Zum Wesen des Common Sense: Aristoteles und die naive Physik", *Zeitschrift für philosophische Forschung*, 46 (1992), 508–525.

Abstract: The paper relates classical treatments of physics and metaphysics to contemporary work on common sense in the field of artificial intelligence (J. Hobbs, P. Hayes, *et al.*). It defends the universality (and truth) of certain basic principles of common-sense physics and shows why these basic principles must leave certain issues undetermined.

Revised version as: "Räumliche Entitäten: Örter, Löcher, Grenzen", in L. Jansen and B. Smith (eds.), *Biomedizinische Ontologie. Philosophie – Lebenswissenschaften – Informationstechnik* (UTB Forum), Zurich: vdf, 2008, 113-126.

34. Barry Smith, "The Soul and Its Parts, II: Varieties of Inexistence", *Brentano-Studien*, 4 (1992/93), 35–51.

Abstract: From the point of view of Brentano's philosophy, contemporary philosophy of mind presupposes an over-crude theory of the internal structures of mental acts and states and of the corresponding types of parts, unity and dependence. We here describe Brentano's own account of the part-whole structures obtaining in the mental sphere, and show how it opens up new possibilities for mereological investigation. One feature of Brentano's view is that the objects of experience are themselves parts of mind, so that there is a sense in which for him (as e.g. for Leibniz) ontology is a proper part of rational or descriptive psychology.

Romanian translation in: *Revista de Filosofie*, 49(3-4), (2002), 233-246.

35. Barry Smith, "Putting the World Back into Semanticsᵥ", *Grazer Philosophische Studien*, 44 (1993), 91–109.

Abstract: To what in reality do true logically simple sentences with empirical content correspond? Two extreme positions can be distinguished in this regard: 'Great Fact' theories, such as are defended by Davidson; and trope-theories, which see such sentences being made true simply by those events or states to which the relevant main verbs correspond. A position

midway between these two extremes is defended, one according to which sentences of the given sort are made true by what are called 'dependence structures', or in other words by certain complex concrete portions of reality between the parts of which relations of dependence are defined. Principles governing such dependence-structures are laid down, principles of an ontologically motivated sort which serve as basis for a "topological semantics" conceived as an alternative to standard set-theoretic approaches to semantics of the Tarskian sort. These principles are then used to resolve certain puzzles generated by the (semantically motivated) theory of events put forward by Davidson.

Reprinted in Peer F. Bundgaard and Frederik Stjernfelt (eds.), *Semiotics* (Critical Concepts in Linguistics Series), London: Routledge (2010).

Russian translation in: *Ophyr*, n.d.

36. Barry Smith, "An Essay on Material Necessity", P. Hanson and B. Hunter (eds.), *Return of the A Priori* (*Canadian Journal of Philosophy,* Supplementary Volume 18), (1993), 301–322.

Abstract: Where Humeans rule out the possibility of material or non-logical necessity, and thus of any associated knowledge *a priori*, the German legal philosopher Adolf Reinach defends the existence of a wide class of material necessities falling within the domain of what can be known *a priori,* for example in fields such as color and shape, rational psychology, law and economics. Categories such as promise or claim or obligation are, in Reinach's view, exist as nodes in a system of necessary relations, so that anyone who has experience of relevant instances of these categories is implicitly aware also of a corresponding family of relations to certain other categories – as for example that every promise implies a mutually correlated claim and obligation.

Midway between the two extremes of Hume and Reinach stands Searle, who accepts necessary relations of the mentioned sorts, but sees them as human creations, following from 'constitutive rules' analogous to the rules of chess. We seek to demonstrate that Searle does not occupy a stable and acceptable half-way house between Hume and Reinach; that he, too, if he is to do justice to the very constitutive rules which form the center of his approach, must on pain of circularity embrace something like the Reinachian position.

37. Karl Schuhmann and Barry Smith, "Two Idealisms: Lask and Husserl", *Kant-Studien*, 83 (1993), 448–466.

Abstract: Neo-Kantianism is common conceived as a philosophy 'from above', excelling in speculative constructions – as opposed to the attitude of patient description which is exemplified by the phenomenological turn 'to the things themselves'. When we study the work of Emil Lask in its relation to that of Husserl and the phenomenologists, however, and when we examine the influences moving in both directions, then we discover that this idea of a radical opposition is misconceived. Lask himself was influenced especially by Husserl's *Logical Investigations*, and Husserl, especially in his later writings, was in some respects closer to Kant than were the Neo-Kantians. The contrast between the two philosophers can be illustrated by looking at their view of the objects of judgment; for Lask, as for Kant, judgment can relate to the thing as such only in an indirect way. The world of judgment is a collection of 'imitations holding a secondary position'. It is cut apart from the plain world of real things by what Lask calls a 'chasm of artificiality and imagery'. For Husserl, in contrast, the object of judgment is a '*Sachverhalt*' or state of affairs, something ontologically 'positive' in the sense that it is an entity in its own right and does not point beyond itself in the manner of a mere sign or proxy for something else.

Polish translation as: "Dwa oblicza idealizmu: Lask a Husserl", in A. J. Norasa and D. Kuboka (eds.), *Miedzy kantyzmem a neokantyzmem*, Katowice: Wydawnictwo Uniwersyteto Slaskiego (2002), 130–156.

38. Barry Smith and Roberto Casati, "Naive Physics: An Essay in Ontology", *Philosophical Psychology*, 7/2 (1994), 225–244.

Abstract: The project of a naive physics has been the subject of attention in recent years above all in the artificial intelligence field, in connection with work on common-sense reasoning, perceptual representation and robotics. The idea of a theory of the common-sense world is however much older than this, having its roots not least in the work of phenomenologists and

Gestalt psychologists such as Köhler, Husserl, Schapp and Gibson. This paper seeks to show how contemporary naive physicists can profit from a knowledge of these historical roots of their discipline, which are shown to imply above all a critique of the set-theory-based models of reality typically presupposed by contemporary work in common-sense ontology.

French version: "La physique naïve: un essai d'ontologie", *Intellectica*, 17 (1993), 173–197.

Polish translation: "Naive Fizyka: Esej w ontologii", *Science Blog*, December 2018.

39. Barry Smith, "Zur Kognition räumlicher Grenzen: Eine mereotopologische Untersuchung", *Kognitionswissenschaft*, 4 (1995), 177–184.

Abstract: The perception of spatial bodies is at least in part a perception of bodily boundaries or surfaces. The usual mathematical conception of boundaries as abstract constructions is, however, of little use for cognitive science purposes. The essay therefore seeks a more adequate conception of the ontology of boundaries building on ideas in Aristotle and Brentano on what we may call the coincidence of boundaries. It presents a formal theory of boundaries and of the continua to which they belong, of a sort which allows a resolution of certain Zeno-style paradoxes. The theory proves to be applicable not only in the cognitive science field but also in regard to problems relating to the ontology of geographical and geopolitical boundaries.

40. Barry Smith, "Formal Ontology, Common Sense, and Cognitive Science", *International Journal of Human-Computer Studies*, 43 (1995), 641–667.

Abstract: Common sense is on the one hand a certain set of processes of natural cognition – of speaking, reasoning, seeing, and so on. On the other hand common sense is a system of beliefs (of folk physics, folk psychology and so on). Over against both of these is the world of common sense, the world of objects to which the processes of natural cognition and the corresponding belief-contents standardly relate. What are the structures of this world? How does the scientific treatment of this world relate to traditional and contemporary metaphysics and formal ontology? Can we embrace a thesis of common-sense realism to the effect that the world of common sense exists uniquely? Or must we adopt instead a position of cultural relativism which would assign distinct worlds of common sense to each group and epoch? The present paper draws on recent work in computer science (especially in the fields of naive and qualitative physics), in perceptual and developmental psychology, and in cognitive anthropology, in order to consider in a new light these and related questions and to draw conclusions for the methodology and philosophical foundations of the cognitive sciences.

Condensed version in: *AI*IA Notizie. Periodico dell'Associazione Italiana per l'Intelligenze Artificiale*, 7 (1994), 11–18.

Italian translation as: "L'ontologia del senso commune", in E. Agazzi (ed.), *Valore e Limiti del Senso Comune*, Milan: FrancoAngeli (2004), 261–284.

41. Barry Smith, "More Things in Heaven and Earth", *Grazer Philosophische Studien*, 50 (1995), 187–201.

Abstract: Philosophers in the field of analytic metaphysics have begun gradually to come to terms with the fact that there are entities in a range of categories not dreamt of in the set-theory and predicate-logic-based ontologies of their forefathers. Examples of such "entia minora" would include: boundaries, places, events, states holes, shadows, individual colour- and tone-instances (tropes), together with combinations of these and associated simple and complex universal species or essences, states of affairs, judgment-contents, and myriad abstract structures of the sorts which are studied by the mathematical sciences. How, as hunter-gatherer ontologists, are we to bring order into this vast array? How are we to gauge the ontological merits of given candidate entities, and how are we to understand their relation to entities of more humdrum sorts? Meinong, it turns out, offers a very simple answer to all of these questions.

42. Barry Smith, "The Structures of the Commonsense World", *Acta Philosophica Fennica*, 58 (1995), 290–317.

Abstract: The paper seeks to show how the world of everyday human cognition might be treated as an object of ontological investigation in its own right. The paper is influenced by work on affordances and prototypicality of psychologists such as Gibson and Rosch, by work on cognitive universals of the anthropologist Robin Horton, and by work of Patrick Hayes and others on 'naive' or 'qualitative physics'. It defends a thesis to the effect that there is, at the heart of common sense, a theoretical core of true propositions pertaining to mesoscopic objects, and that the latter are to be understood as relating mereologically to the objects studied by physical science.

Preprinted in: S. Poggi (ed.), *Gestalt Psychology. Its Origins, Foundations and Influence*, Florence: Olschky (1994), 209–232.

Italian translation as: "Le strutture del mondo del senso commune", in *Iride* (Florence), 9 (1992), 22–44. Partially reprinted as "Ontologia ecologia" in M. Ferraris (ed.), *Ontologia*, Naples: Guida (2003), 146–151.

German translation as: "Die Struktur der Common-Sense Welt", *Logos,* N. F. 1 (1994), 422–449.

Russian translation

43. Barry Smith, "Mereotopology: A Theory of Parts and Boundaries", *Data and Knowledge Engineering*, 20 (1996), 287–303.

Abstract: The paper is a contribution to formal ontology. It seeks to use topological means in order to derive ontological laws pertaining to the boundaries and interiors of wholes, to relations of contact and connectedness, to the concepts of surface, point, neighbourhood, and so on. The basis of the theory is mereology, the formal theory of part and whole, a theory which is shown to have a number of advantages, for ontological purposes, over standard treatments of topology in set-theoretic terms. One central goal of the paper is to provide a rigorous formulation of Brentano's thesis to the effect that a boundary can exist as a matter of necessity only as part of a whole of higher dimension which it is the boundary of. It concludes with a brief survey of current applications of mereotopology in areas such as natural-language analysis, geographic information systems, machine vision, naive physics, and database and knowledge engineering.

44. Barry Smith, "On Substances, Accidents and Universals: In Defence of a Constituent Ontology", *Philosophical Papers*, 26 (1997), 105–127.

Abstract: The essay constructs an ontological theory designed to capture the categories instantiated in those portions or levels of reality which are captured in our common sense conceptual scheme. It takes as its starting point an Aristotelian ontology of "substances" and "accidents", which are treated via the instruments of mereology and topology. The theory recognizes not only individual parts of substances and accidents, including the internal and external boundaries of these, but also universal parts, such as the "humanity" which is an essential part of both Tom and Dick, and also "individual relations", such as Tom's promise to Dick, or their current handshake.

Russian translation

45. Barry Smith, "Ontologie des Mesokosmos: Soziale Objekte und Umwelten", *Zeitschrift für philosophische Forschung,* 52 (1998), 521–540.

Abstract: Erst in neuester Zeit haben sich analytische Philosophen vorbehaltlos dem Bereich der Metaphysik gewidmet. Unter den interessantesten Ergebnissen dieser ‚analytischen Metaphysik' ist John Searles neues Buch zur Ontologie der sozialen Gegenstände (Die Konstruktion der gesellschaftlichen Wirklichkeit. Zur Ontologie sozialer Tatsachen, Hamburg: Rowohlt, 1997). Was sind Staaten, Gemeinschaften, Gesetze? Nach Searle sind diese Gegenstände Korrelate einer ‚kollektiven Intentionalität'. Searle vertritt m.a.W. eine kognitive Theorie von sozialen Gegenständen. Ein Problem bei einer solchen Theorie ist, daß wir Analogien zu bestimmten sozialen Gebilden auch bei Tieren begegnen, die den begrifflichen Apparat einer kollektiven Intentionalität nicht besitzen. Um dieses Problem zu umgehen, liegt es nahe, die biologischen Lehren von tierischen Umwelten, die etwa durch von Uexküll entwickelt wurden, auszunutzen. Von Uexkülls Umweltlehre ist jedoch eine Art organische Monadologie: jedes Tier, jeder Mensch, ist in seiner eigenen spezifischen Umwelt beheimatet, und es wird also schwer verständlich, wie das Verhalten zwischen Tieren überhaupt möglich ist. Der vorliegende Beitrag

bietet eine Lösung dieses Problems, durch die wir auch eine verbesserte Auffassung der Ontologie sozialer Gegenstände überhaupt gewinnen. Als Grundlage dieser Auffassung dient die realistische Theorie menschlicher Umwelten, die in der ökologischen Psychologie J. J. Gibsons und Roger Barkers entwickelt wurde.

46. Barry Smith, "Boundaries: A Brentanian Theory", *Brentano-Studien* 8 (1998/99), 107–114.

Abstract: We outline Brentano's theory of boundaries, for instance between two neighboring subregions within a larger region of space. Does every such pair of regions contain points in common where they meet? Or is the boundary at which they meet somehow pointless? On Brentano's view, two subregions such do not overlap; rather, along the line where they meet there are two sets of points which are not identical but rather spatially coincident. We outline Brentano's theory of coincidence, and show how he uses it to resolve a number of Zeno-like paradoxes.

47. Barry Smith, "Truthmaker Realism", *Australasian Journal of Philosophy*, 77 (3) (1999), 274–291.

Abstract: We take as our starting point a thesis to the effect that, at least for true judgments of many varieties, there are parts of reality which make such judgments true. We argue that two distinct components are involved in this truthmaker relation. On the one hand is the relation of *necessitation,* which holds between an object x and a judgment p when the existence of x entails the truth of p. On the other hand is the dual notion of *projection*, which holds between a judgment p and an object x when the truth of p entails the existence of x. A truthmaker for a judgment p is then a necessitator for p which satisfies the further constraint that it is part of p's projection. We offer a formal theory of the truthmaker relation thus defined, exploiting ontological tools of basic mereology and the theory of dependence. We then apply the theory to a range of problems connected with generic expressions, ellipsis, vagueness, and indexical and perceptual judgments.

48. Barry Smith and Achille Varzi, "The Niche", *Nous*, 33:2 (1999), 198–222.

Abstract: The categories of object and attribute, substance and accident, continuant and occurrent, have long enjoyed a dominant position in the history of metaphysics. The concept of niche (environment, setting, habitat), on the other hand, has been almost entirely neglected, in spite of the wide application of this and similar concepts in a variety of disciplines, from evolutionary biology to context-based semantics. The paper presents a theory of the niche, a theory of *objects in their settings*. It defends a view of niches as special sorts of parts of reality and builds upon existing work exploiting the resources of mereology (or the theory of part and whole) as an instrument of realist ontology. The theory will be illustrated above all by means of simple biological examples, but the concept of niche should be understood as being, like concepts such as part, boundary and location, a formal concept, one that is applicable in principle to a wide range of different domains.

Extended abstract published as: "Mereology, Topology, Ecology: A Formal Theory of Organism-Niche Relations", in J. Cachro and K. Kijania-Placek (eds.), *11th International Congress of Logic, Methodology and Philosophy of Science. Volume of Abstracts*, Cracow: Jagiellonian University (1999), p. 351.

Polish translation as: "Nisza," *Filozofia Nauki*, 8: 3/4 (2000), 5–30.

49. Barry Smith and David Mark, "Ontology with Human Subjects Testing: An Empirical Investigation of Geographic Categories", *American Journal of Economics and Sociology*, 58: 2 (April 1999), 245–272.

Abstract: Ontology, since Aristotle, has been conceived as a sort of highly general physics, a science of the types of entities in reality, of the objects, properties, categories and relations which make up the world. At the same time ontology has been for some two thousand years a speculative enterprise. It has rested methodologically on introspection and on the construction and analysis of elaborate world-models and of abstract formal-ontological theories. In the work of Quine and others this ontological theorizing in abstract fashion about the world was supplemented by the study, based on the use of logical methods, of the ontological commitments or presuppositions embodied in scientific theories. In recent years both types of

ontological study have found application in the world of information systems, for example in the construction of frameworks for knowledge representation and in database design and translation. As ontology is in this way drawn closer to the domain of real-world applications, the question arises as to whether it is possible to use empirical methods in studying ontological theories. More specifically: can we use empirical methods to test the ontological theories embodied in human cognition? We set forth the outlines of a framework for the formulation and testing of such theories as they relate to the specific domain of geographic objects and categories.

50. Barry Smith and Achille Varzi, "Fiat and Bona Fide Boundaries", *Philosophy and Phenomenological Research,* 60: 2 (March 2000), 401–420.

Abstract: We argue that the basic typology of spatial boundaries involves an opposition between bona fide (or physical) boundaries on the one hand, and fiat boundaries on the other, the latter being exemplified especially by boundaries induced through human demarcation, for example in the geographic realm. The classical metaphysical problems connected with the notions of adjacency, contact, separation and division can be resolved in an intuitive way by recognizing this two-sorted ontology of boundaries. Bona fide boundaries yield a notion of contact that is effectively modeled by classical topology; the analogue of contact involving fiat boundaries calls, however, for a different account, based on the intuition that fiat boundaries do not support the open/closed distinction on which classical topology is based. In the presence of this two-sorted ontology it then transpires that mereotopology—topology erected on a mereological basis—is more than a trivial formal variant of classical point-set topology.

Revised version of Barry Smith and Achille Varzi, "The Formal Ontology of Boundaries", *Electronic Journal of Analytic Philosophy*, 5: 5 (1997).

Russian translation by Alexey Shukhov: "Онтология границ", *Общество философскихисследований и разработок* (online publication), 2001.

51. Barry Smith, "Les objets sociaux," *Philosophiques,* 26/2 (1999), 315–347.

Abstract: One reason for the renewed interest in Austrian philosophy, and especially in the work of Brentano and his followers, turns on the fact that analytic philosophers have become once again interested in the traditional problems of metaphysics. It was Brentano, Husserl, and the philosophers and psychologists whom they influenced, who drew attention to the thorny problem of intentionality, the problem of giving an account of the relation between acts and objects or, more generally, between the psychological environments of cognitive subjects and the different sorts of external (physical, geographical, social) environments which they inhabit. The present essay addresses this environmental version of the problem of intentionality. It draws not only on the work of Husserl and Scheler but also on the Gestalt psychological writings of Kurt Koffka and Kurt Lewin. It considers the influential subjective idealist theory of animal environments put forward by J. von Uexküll and contrasts this with a realist theory of organism-environment interaction based on the work of the ecological psychologists J. J. Gibson and Roger Barker. This realist theory is then exploited as a basis for an ontology of social objects of a range of different sorts.

English version

Russian version

52. Werner Ceusters, Ignace Desimpel, Barry Smith and Stefan Schulz, "Using Cross-Lingual Information to Cope with Underspecification in Formal Ontologies", *Studies in Health Technology and Informatics*, 95 (2003), 391–396.

Abstract: Description logics and other formal devices are frequently used as means for preventing or detecting mistakes in ontologies. Some of these devices are also capable of inferring the existence of inter-concept relationships that have not been explicitly entered into an ontology. A prerequisite, however, is that this information can be derived from those formal definitions of concepts and relationships which are included within the ontology. In this paper, we present a novel algorithm that is able to suggest relationships among existing concepts in a formal ontology that are not derivable from such formal definitions. The algorithm exploits cross-lingual information that is implicitly present in the collection of terms used in various languages to denote the concepts and relationships at issue. By using a specific experimental design, we

are able to quantify the impact of cross-lingual information in coping with underspecification in formal ontologies.

53. Barry Smith and John Searle, "The Construction of Social Reality: An Exchange", *American Journal of Economics and Sociology,* 62: 2 (2003), 285-309.

Abstract: Part 1 of this exchange consists in a critique by Smith of Searle's *The Construction of Social Reality* focusing on Searle's use of the formula 'X *counts as* Y in context C'. Smith argues that this formula works well for social objects such as dollar bills and presidents where the corresponding X terms (pieces of paper, human beings) are easy to identify. In cases such as debts and prices and money in a banks computers, however, the formula fails, because these are cases of what he calls 'free-standing Y terms', since there is here no X which can *count as* the corresponding Y. In his response in Part 2, Searle argues that Smith's critique rests on three misunderstandings: 1. in wrongly presupposing that Searle is trying to analyze the nature of what he calls "social objects", rather than of social facts; 2. in thinking that the *counts as* formula is intended as a definition, rather than as a mere mnemonic; and 3. in neglecting the naturalism of Searle's account.

Reprinted in David Koepsell and Laurence S. Moss (eds.), *John Searle's Ideas about Social Reality: Extensions, Criticisms, and Reconstructions*, Oxford: Wiley-Blackwell (2003).

French translation as: "L'ontologie de la realité sociale", in P. Livet and R. Ogien (eds.), *L'Enquête ontologique, du mode de l'existence des objets sociaux*, Paris: Editions EHESS (2000), 185–208.

54. Barry Smith, "Philosophie, Politik und wissenschaftliche Weltauffassung: Zur Frage der Philosophie in Österreich und Deutschland", *Grazer Philosophische Studien* 58/59 (2000), 241–262.

Abstract: One of the most remarkable philosophical phenomena of the last 20 years is the rise of so-called 'Continental Philosophy' (C.P.), a creation above all of the North American university. Lectures under the heading of 'Continental Philosophy' are offered every year in Anglo-Saxon universities to many thousands of philosophy students, a practice which appears questionable not least for the reason that the lectures in question deal not with philosophy in Continental Europe as a whole, but rather only with a certain narrow segment of Franco-German philosophy, in which Heidegger seems to serve as the sole fixed point. Around him are assembled a progression of Paris-based thinkers expounding progressively more nonsensical claims concerning the 'end' of philosophy (or of the 'modern', of 'the author', of 'man', of 'identity', and so forth). In all of this the later Husserl is sometimes taken into account as C.P.-precursor, his teacher Franz Brentano however not at all. Other prominent German philosophers of the 20th century such as Ernst Cassirer or Nicolai Hartmann are likewise totally ignored, and so also are French philosophers in the tradition of Poincaré, Bergson or Gilson, as well as Polish, Scandinavian or Czech philosophers. The essay offers an explanation of these peculiar facts, which has to do with the different roles of politics and science in the different parts of Europe.

55. Barry Smith, "The Chinese Rune argument", *Philosophical Explorations*, 4 (2), 2001, 70-75, with Searle's response, 75–77.

Abstract: Searle's tool for understanding culture, law and society is the opposition between brute reality and institutional reality, or in other words between: observer-independent features of the world, such as force, mass and gravitational attraction, and observer-relative features of the world, such as money, property, marriage and government. The question posed here is: under which of these two headings do moral concepts fall? This is an important question because there are moral facts – for example pertaining to guilt and responsibility – which hover uncomfortably close to the boundary between the observer-relative and the observer-independent. By means of a thought experiment involving an imagined Chinese society in which guilt is determined by the random throwing of sticks, I seek to show that moral concepts threaten the foundations of Searle's philosophy of social reality.

56. Barry Smith and Berit Brogaard, "Living High and Letting Die", *Philosophy*, 76 (2001), 435–442 (published under the pseudonym Nicola Bourbaki).

Abstract: You wake up one morning in a hospital operating theater and learn that a glitch in the hospital's computer has brought it about that a tiny radio has been attached to your stomach. The radio is transmitting to an unconscious violinist who has been found to have a rare and fatal kidney ailment in virtue of which his brain is no longer able to send signals to his kidneys. If you remove the radio, the violinist will die. But never mind, it is only for nine months. By then he will have recovered from his ailment, and the radio can safely be removed. Are you morally obliged to agree to this situation?

57. Barry Smith and David M. Mark, "Geographical Categories: An Ontological Investigation", *International Journal of Geographical Information Science*, 15: 7 (2001), 591–612.

Abstract: This paper reports the results of a series of experiments designed to establish how non-expert subjects conceptualize geospatial phenomena. Subjects were asked to give examples of geographical categories in response to a series of differently phrased elicitations. The results yield an ontology of geographical categories—a catalogue of the prime geospatial concepts and categories shared in common by human subjects independently of their exposure to scientific geography. When combined with nouns such as feature and object, the adjective geographic elicited almost exclusively elements of the physical environment of geographical scale or size, such as mountain, lake and river. The phrase things that could be portrayed on a map, on the other hand, produced many geographical scale artefacts (roads, cities, etc.) and fiat objects (states, countries, etc.), as well as some physical feature types. These data reveal considerable mismatch as between the meanings assigned to the terms 'geography' and 'geographic' by scientific geographers and by ordinary subjects, so that scientific geographers are not in fact studying geographical phenomena as such phenomena are conceptualized by naive subjects. The data suggest, rather, a special role in determining the subject-matter of scientific geography for the concept of what can be portrayed on a map. This work has implications for work on usability and interoperability in geographical information science, and it throws light also on subtle and hitherto unexplored ways in which ontological terms such as 'object', 'entity' and 'feature' interact with geographical concepts.

Reprinted in: Peter Fisher (ed.), *Classics from the International Journal of Geographical Information Science*, London: Taylor and Francis, 2006, 481–506, with Postscript.

58. Barry Smith, "Fiat Objects", *Topoi*, 20: 2 (September 2001), 131–148.

Abstract: Extended entities have boundaries of two different sorts: those that do, and those that do not correspond to physical discontinuities. Call the first sort (coastlines, the surface of your nose) bona fide boundaries; and the second (the boundary of Montana, the boundary separating your upper from your lower torso) fiat boundaries. Fiat boundaries are found especially in the geographic realm, but are involved wherever language carves out portions of reality in ways which do not reflect physical discontinuities. These ideas are applied to the treatment of cognitive categorization, of the semantics of vagueness, of Quine's indeterminacy thesis, and of standard ontological problems such as Tibbles' tail.

Italian translation as: "Oggetti Fiat", *Rivista di Estetica,* 20/2 (2002), 58–87.

59. Barry Smith and Leonardo Zaibert, "The Metaphysics of Real Estate", *Topoi*, 20: 2 (September 2001), 161–172.

Abstract: The parceling of land into real estate is more than a simple geometrical affair. Real estate is a historical product of interaction between human beings, political, legal and economic institutions, and the physical environment. And while many authors, from Jeremy Bentham to Hernando de Soto, have drawn attention to the ontological (metaphysical) aspect of property in general, no comprehensive analysis of landed property has been attempted. The paper presents such an analysis and shows how landed property differs from other types of property in a way which implies a special role for political and economic philosophy of property rights in land.

Chinese translation as "房地产的形而上学" in Francesco Di Iorio and Jun Hu (eds.), 能动性与社会动力学——经济学哲学与社会科学哲学论文集 (*Agency and Social Dynamics: Essays in the Philosophy of Economics and the Social Sciences*, Beijing: Nankai University Press, December 2021, 164-185.

60. Barry Smith, "Husserlian Ecology", *Human Ontology* (Kyoto), 7 (2001), 9–24.

Abstract: While Husserl sought to find room in his later writings for the surrounding world of human practical experience, and while similar efforts were made also by later phenomenologists such as Heidegger, and Sartre, and Merleau-Ponty, in none of these authors do we find sustained attempts to grapple with the interactions between the world of human thought, feeling and action on the one hand and the surrounding environment as this is described by physics and biology on the other. Some attempts were made in this regard by Gestalt psychologists such as Wertheimer, Köhler, Koffka, and Lewin, and Koffka and Lewin in their turn influenced two American psychologists J. J. Gibson and Roger Barker, both of whom (independently) conceived their work under the banner of 'ecological psychology.' It is against this background that the term 'Husserlian ecology' is to be understood in what follows.

Japanese translation, 25-41.

61. Barry Smith, "Truthmaker Realism: Response to Gregory", *Australasian Journal of Philosophy*, 80 (2) (2002), 231–234.

Abstract: Standard definitions of the truthmaker relation in terms of necessitation fail. This is because there exist malignant necessitators (every contingent object is a malignant necessitator for every necessary truth). In my "Truthmaker Realism" (*Australasian Journal of Philosophy*, 77, 1999) I show that these standard definitions can be repaired by adding a second factor, in some ways the dual of necessitation, which I call 'projection'. Projection imposes on the relation between truths and truthmakers the additional requirement of relevance or aboutness. In his "Smith on Truthmakers" (Australasian Journal of Philosophy, 79, 2001), Dominic Gregory attempts to show that this attempt to prune the abundance of malignant necessitators fails. His argument reveals the existence of some unclarities in the prose commentary to the formal theory of my original paper. Here, however, I show that it does not undermine this formal theory itself.

62. Barry Smith and Achille Varzi, "Surrounding Space: The Ontology of Organism-Environment Relations", *Theory in Biosciences*, 121 (2002), 139–162.

Abstract: The history of evolution is a history of development from less to more complex organisms. This growth in complexity of organisms goes hand in hand with a concurrent growth in complexity of environments and of organism-environment relations. It is a concern with this latter aspect of evolutionary development that motivates the present paper. We begin by outlining a theory of organism-environment relations. We then show that the theory can be applied to a range of different sorts of cases, both biological and non-biological, in which objects are lodged or housed within specific environments, or niches. Biological science is interested in types—for example in genotypes, phenotypes and environment types—and in regularities that can serve as the basis for the formulation of laws or general principles. Types, however, can exist only through their corresponding tokens. Our theory of token environments is meant to plug this gap and to provide a first step towards a general theory of causally relevant spatial volumes.

63. Barry Smith and Berit Brogaard, "Quantum Mereotopology", *Annals of Mathematics and Artificial Intelligence*, 35/1–2 (2002), 153–175.

Abstract: Mereotopology is an extension of mereology (the formal theory of part-whole relations) which includes also relations of boundary, countinuity and contact. Mereotopology faces problems when its methods are applied to objects which lose and gain parts yet preserve their identities over time. We offer a new solution to these problems, based on a theory of partitions of reality of finite grain. This theory is extended to a theory of coarse- and fine-grained histories (or finite sequences of partitions evolving over time), drawing on machinery developed within the framework of the so-called 'consistent histories' interpretation of quantum mechanics.

Shorter version in: *Spatial and Temporal Granularity. Papers from the AAAI Workshop* (AAAI Technical Report WS-00-08), Menlo Park: AAAI Press (2000), 25–31.

64. Barry Smith and Berit Brogaard, "A Unified Theory of Truth and Reference", *Logique et Analyse,* No. 169-170 (2000, published 2003), 49–93.

Abstract: The truthmaker theory rests on the thesis that the link between a true judgment and that in the world to which it corresponds is not a one-to-one but rather a one-to-many relation. An analogous thesis in relation to the link between a singular term and that in the world to which it refers is already widely accepted. This is the thesis to the effect that singular reference is marked by vagueness of a sort that is best understood in supervaluationist terms. In what follows we show that the supervaluationist approach to singular reference, when wedded to the truthmaker idea, yields a framework of surprising power, which offers a uniform set of solutions to a range of problems regarding identity, reference and knowledge, problems which have hitherto been dealt with on an ad hoc basis.

French translation: "Une théorie unifiée de la vérité et de la référence" in J. M. Monnoyer (ed.), *La Structure du Monde: Objets, Propriétés, États du choses*, Paris: Vrin (2004), 141–184.

Russian translation

65. Barry Smith and David M. Mark, "Do Mountains Exist? Towards an Ontology of Landforms", *Environment and Planning B* (*Planning and Design*), 30(3) (2003), 411–427.

Abstract: Do mountains exist? The answer to this question is surely: yes. In fact, 'mountain' is the example of a kind of geographic feature or thing most commonly cited by English speakers (Mark, *et al*., 1999; Smith and Mark 2001), and this result may hold across many languages and cultures. But whether they are considered as individuals (tokens) or as kinds (types), mountains do not exist in quite the same unequivocal sense as do such prototypical everyday objects as chairs or people.

66. Barry Smith and Berit Brogaard, "Sixteen Days", *The Journal of Medicine and Philosophy*, 28 (2003), 45–78.

Abstract: When does a human being begin to exist? We argue that it is possible, through a combination of biological fact and philosophical analysis, to provide a definitive answer to this question. We lay down a set of conditions for being a human being, and we determine when, in the course of normal fetal development, these conditions are first satisfied. Issues dealt with along the way include: modes of substance-formation, twinning, the nature of the intra-uterine environment, and the nature of the relation between fetus and mother.

German translation as: "Sechzehn Tage: Wann beginnt ein menschliches Leben?", in G. Imaguire and Christine Schneider (eds.), *Untersuchungen zur Ontologie*, Munich: Philosophia, 2006, 3–40.

Revised version as "Die Ontologie des Embryos", in L. Jansen and B. Smith (eds.), *Biomedizinische Ontologie. Philosophie – Lebenswissenschaften - Informationstechnik* (UTB Forum), Zurich: vdf, 2008, 199-228.

67. Thomas Bittner and Barry Smith "Vague Reference and Approximating Judgements", *Spatial Cognition and Computation*, 3: 2 (2003), 137–156.

Abstract: We propose a new account of vagueness and approximation in terms of the theory of granular partitions. We distinguish different kinds of crisp and non-crisp granular partitions and we describe the relations between them, concentrating especially on spatial examples. We describe the practice whereby subjects use regular grid-like reference partitions as a means for tempering the vagueness of their judgments, and we demonstrate how the theory of reference partitions can yield a natural account of this practice, which is referred to in the literature as 'approximation'.

Russian translation

68. Pierre Grenon and Barry Smith, "SNAP and SPAN: Towards Dynamic Spatial Ontology", *Spatial Cognition and Computation*, 4: 1 (March 2004), 69–103.

Abstract: We propose a modular ontology of the dynamic features of reality. This amounts, on the one hand, to a purely spatial ontology supporting snapshot views of the world at successive instants of time and, on the other hand, to a purely spatiotemporal ontology of change and

process. We argue that dynamic spatial ontology must combine these two distinct types of inventory of the entities and relationships in reality, and we provide characterizations of spatiotemporal reasoning in the light of the interconnections between them.

69. Barry Smith and Anand Kumar, "Controlled Vocabularies in Bioinformatics: A Case Study in the Gene Ontology", *BIOSILICO: Drug Discovery Today*, 2 (2004), 246–252.

Abstract: The automatic integration of information resources in the life sciences is one of the most challenging goals facing biomedical informatics today. Controlled vocabularies have played an important role in realizing this goal, by making it possible to draw together information from heterogeneous sources secure in the knowledge that the same terms will also represent the same entities on all occasions of use. One of the most impressive achievements in this regard is the Gene Ontology (GO), which is rapidly acquiring the status of a de facto standard in the field of gene and gene product annotations and whose methodology has been much intimated in attempts to develop controlled vocabularies for shared use in different domains of biology. As the GO Consortium has recognized, however, its controlled vocabulary is as currently constituted marked by a number of problematic features which are characteristic of much recent work in bioinformatics and which are destined to raise increasingly serious obstacles to the automatic integration of biomedical information in the future. Here we survey some of these problematic features, focusing especially on issues of compositionality and syntactic regimentation.

70. Thomas Bittner, Maureen Donnelly and Barry Smith, "Endurants and Perdurants in Directly Depicting Ontologies", *AI Communications*, 13: 4 (2004), 247–258.

Abstract: We propose an ontological theory that is powerful enough to describe both complex spatio-temporal processes and the enduring entities that participate therein. For this purpose we introduce the notion a directly depicting ontology. Directly depicting ontologies are based on relatively simple languages and fall into two major categories: ontologies of type SPAN and ontologies of type SNAP. These represent two complementary perspectives on reality and employ distinct though compatible systems of categories. A SNAP (snapshot) ontology comprehends enduring entities such as organisms, geographic features, or qualities as they exist at some given moment of time. A SPAN ontology comprehends perduring entities such as processes and their parts and aggregates as they unfold themselves through some temporal interval. We give an axiomatic account of the theory of directly depicting ontologies and of the core parts of the metaontological fragment within which they are stembedded.

71. Jean-Luc Verschelde, Mariana Casella Dos Santos, Tom Deray, Barry Smith and Werner Ceusters, "Ontology-Assisted Database Integration to Support Natural Language Processing and Biomedical Data-Mining", *Journal of Integrative Bioinformatics*, 1 (2004), 1-10. Reprinted in: *Yearbook of Bioinformatics* (2004), 39–48.

Abstract: Successful biomedical data mining and information extraction require a complete picture of biological phenomena such as genes, biological processes and diseases as these exist on different levels of granularity. To realize this goal, several freely available heterogeneous databases as well as proprietary structured datasets have to be integrated into a single global customizable scheme. We will present a tool to integrate different biological data sources by mapping them to a proprietary biomedical ontology that has been developed for the purposes of making computers understand medical natural language.

72. Barry Smith and Pierre Grenon, "The Cornucopia of Formal-Ontological Relations", *Dialectica* 58: 3 (2004), 279–296.

Abstract: We present a new method for generating typologies of formal-ontological relations. The guiding idea is that formal relations are those sorts of relations which hold between entities which are constituents of distinct ontologies. We provide examples of ontologies (in the spirit of Zemach's classic "Four Ontologies" of 1970), and show how these can be used to give a rich typology of formal relations in a way which also throws light on the opposition between three and four-dimensionalism.

73. Anand Kumar, Barry Smith and Daniel Novotny, "Biomedical Informatics and Granularity", *Comparative and Functional Genomics*, 5 (2004), 501–508. PMC2447428

Abstract: An explicit formal ontological representation of entities existing at multiple levels of granularity is an urgent requirement for biomedical information processing. We discuss some fundamental principles which can form a basis for such a representation. We also comment on some of the implicit treatments of granularity in currently available ontologies and terminologies (GO, FMA, SNOMED CT).

74. Barry Smith and Bert R. E. Klagges, "Philosophie und biomedizinische Forschung", *Allgemeine Zeitschrift für Philosophie*, 30: 1 (2005), 5–26.

Abstract: The pathbreaking scientific advances of recent years call for a new philosophical consideration of the fundamental categories of biology and its neighboring disciplines. Above all, the new information technologies used in biomedical research, and the necessity to master the continuously growing flood of data that is associated therewith, demand a profound and systematic reflection on the systematization and classification of biological data. This, however, demands robust theories of basic concepts such as kind, species, part, whole, function, process, fragment, sequence, expression, boundary, locus, environment, system, and so on. Concepts which belong to the implicit stock of knowledge of every biologist. They amount to a dimension of biological reality which remains constant in the course of biological evolution and whose theoretical treatment requires contemporary analogues of the tools developed in traditional Aristotelian metaphysics. To provide the necessary theories and definitions is a task for philosophy, which is thus called upon to play an important role as intermediary between biology and informatics.

Revised version in L. Jansen and B. Smith (eds.), *Biomedizinische Ontologie. Philosophie – Lebenswissenschaften - Informationstechnik* (UTB Forum), Zurich: vdf, 2008, 17-30.

English version as "Bioinformatics and Philosophy", in K. Munn and B. Smith (eds.), *Applied Ontology: An Introduction*, Frankfurt/Lancaster: ontos, 2008, 17-30.

75. Barry Smith, Werner Ceusters, Bert Klagges, Jacob Köhler, Anand Kumar, Jane Lomax, Chris Mungall, Fabian Neuhaus, Alan Rector and Cornelius Rosse, "Relations in Biomedical Ontologies", *Genome Biology* (2005), 6 (5), R46. PMC1175958

Abstract: To enhance the treatment of relations in biomedical ontologies we advance a methodology for providing consistent and unambiguous formal definitions of the relational expressions used in such ontologies in a way designed to assist developers and users in avoiding errors in coding and annotation. The resulting Relation Ontology can promote interoperability of ontologies and support new types of automated reasoning about the spatial and temporal dimensions of biological and medical phenomena.

76. Werner Ceusters, Barry Smith and Louis Goldberg, "A Terminological and Ontological Analysis of the NCI Thesaurus", *Methods of Information in Medicine*, 44 (2005), 498–507.

Abstract: *Objective*: The National Cancer Institute Thesausus is described by its authors as "a biomedical vocabulary that provides consistent, unambiguous codes and definitions for concepts used in cancer research" and which "exhibits ontology-like properties in its construction and use". We performed a qualitative analysis of the Thesaurus in order to assess its conformity with principles of good practice in terminology and ontology design. *Materials and methods*: We used both the on-line browsable version of the Thesaurus and its OWL-representation (version 04.08b, released on August 2, 2004), measuring each in light of the requirements put forward in relevant ISO terminology standards and in light of ontological principles advanced in the recent literature. *Results*: We found many mistakes and inconsistencies with respect to the term-formation principles used, the underlying knowledge representation system, and missing or inappropriately assigned verbal and formal definitions. *Conclusion*: Version 04.08b of the NCI Thesaurus suffers from the same broad range of problems that have been observed in other biomedical terminologies. For its further development, we recommend the use of a more principled approach that allows the Thesaurus to be tested not just for internal consistency but also for its degree of correspondence to that part of reality which it is designed to represent.

77. <u>Barry Smith</u>, Werner Ceusters, Anand Kumar and Cornelius Rosse, "On Carcinomas and Other Pathological Entities", *Comparative and Functional Genomics*, vol. 6, issue 7/8, 2005, 379–387. PMC2447494

Abstract: Tumors, abscesses, cysts, scars, fractures are familiar types of what we shall call pathological continuant entities. The instances of such types exist always in or on anatomical structures, which thereby become transformed into pathological anatomical structures of corresponding types: a fractured tibia, a blistered thumb, a carcinomatous colon. In previous work on biomedical ontologies we showed how the provision of formal definitions for relations such as is_a, part_of and transformation_of can facilitate the integration of such ontologies in ways which have the potential to support new kinds of automated reasoning. We here extend this approach to the treatment of pathologies, focusing especially on those pathological continuant entities which arise when organs become affected by carcinomas. Includes a classification of biomedical entities which revises the classification provided in Rosse, *et al*.

78. Berit Brogaard and Barry Smith, "On Luck, Responsibility and the Meaning of Life", *Philosophical Papers¸* 34(3), 2005, 443–458.

Abstract: A life we view as an ordered sequence of actions and events of a special kind. We then defend the thesis that a *meaningful* life is a life upon which some sort of valuable pattern has been imposed—a pattern which relates not merely to what goes on inside the person's head, but which involves also, in serious ways, the person having an effect upon the world. Meaningfulness is then a special kind of value which a human life can bear. More specifically, it is a kind of intrinsic value – something that we value for its own sake. We then argue that it is crucial that, if such an imposed shape or pattern is to contribute to meaningfulness, then it must be the result of the person's own efforts and of his or her own decisions.

79. Ingvar Johansson, <u>Barry Smith</u>, Katherine Munn, Nikoloz Tsikolia, Kathleen Elsner, Dominikus Ernst, and Dirk Siebert, "Functional Anatomy: A Taxonomic Proposal", *Acta Biotheoretica*, 53(3), 2005, 153–166.

Abstract: It is argued that medical science requires a classificatory system that (a) puts functions in the taxonomic center and (b) does justice ontologically to the difference between the processes which are the realizations of functions and the objects which are their bearers. We propose formulae for constructing such a system and describe some of its benefits. The arguments are general enough to be of interest to all the life sciences.

80. Jonathan Simon, James Fielding and Barry Smith, "Formal Ontology for Natural Language Processing and the Integration of Biomedical Databases", *International Journal of Medical Informatics,* 75 (3-4), 2006, 224-231.

Abstract: The central hypothesis of the collaboration between Language and Computing (L&C) and the Institute for Formal Ontology and Medical Information Science (IFOMIS) is that the methodology and conceptual rigor of a philosophically inspired formal ontology greatly benefits application ontologies. To this end r®, L&C's ontology, which is designed to integrate and reason across various external databases simultaneously, has been submitted to the conceptual demands of IFOMIS's Basic Formal Ontology (BFO). With this project we aim to move beyond the level of controlled vocabularies to yield an ontology with the ability to support reasoning applications. Our general procedure has been the implementation of a meta-ontological definition space in which the definitions of all the concepts and relations in LinKBase® are standardized in a framework of first-order logic. In this paper we describe how this standardization has already led to an improvement in the LinKBase® structure that allows for a greater degree of internal coherence than ever before possible. We then show the use of this philosophical standardization for the purpose of mapping external databases to one another, using LinKBase® as translation hub, with a greater degree of success than possible hitherto. We demonstrate how this offers a genuine advance over other application ontologies that have not submitted themselves to the demands of philosophical scrutiny. LinKBase® is one of the world's largest applications-oriented medical domain ontologies, and BFO is one of the world's first philosophically driven reference ontologies. The collaboration of the two thus initiates a new phase in the quest to solve the so-called "Tower of Babel".

81. Anand Kumar, Barry Smith, Domenica Pisanelli, Aldo Gangemi and Mario Stefanelli, "Clinical Guidelines as Plans: An Ontological Theory", *Methods of Information in Medicine*, 45 (2), 2006, 204-210.

Abstract: *Objective*: Clinical guidelines are special types of plans realized by collective agents. We provide an ontological theory of such plans that is designed to support the construction of a framework in which guideline-based information systems can be employed in the management of workflow in health care organizations. *Method*: The framework we propose allows us to represent in formal terms how clinical guidelines are realized through the actions of individuals organized into teams. We provide various levels of implementation representing different levels of conformity on the part of health care organizations. *Result*: Implementations built in conformity with our framework are marked by two dimensions of flexibility that are designed to make them more likely to be accepted by health care professionals than are standard guideline-based management systems. They do justice to the fact (1) that responsibilities within a health care organization are widely shared, and (2) that health care professionals may on different occasions be noncompliant with guidelines for a variety of well justified reasons. *Conclusion*: The advantage of the framework lies in its built-in flexibility, its sensitivity to clinical context, and its ability to use inference tools based on a robust ontology. One disadvantage lies in the complication of its implementation.

82. Anand Kumar, Yum Lina Yip, <u>Barry Smith</u> and Pierre Grenon, "Bridging the Gap between Medical and Bioinformatics: An Ontological Case Study in Colon Carcinoma", *Computers in Biology and Medicine* 2006; 36, (7-8): 694-711.

Abstract: Ontological principles are needed in order to bridge the gap between medical and biological information in a robust and computable fashion. This is essential in order to draw inferences across the levels of granularity which span medicine and biology, an example of which include the understanding of the roles of tumor markers in the development and progress of carcinoma. Such information integration is also important for the integration of genomics information with the information contained in the electronic patient records in such a way that real time conclusions can be drawn. In this paper we describe a large multi-granular datasource built by using ontological principles and focusing on the case of colon carcinoma.

83. Barry Smith, "From Concepts to Clinical Reality: An Essay on the Benchmarking of Biomedical Terminologies", *Journal of Biomedical Informatics*, 2006; 39(3): 288-298.

Abstract: It is only by fixing on agreed meanings of terms in biomedical terminologies that we will be in a position to achieve that accumulation and integration of knowledge that is indispensable to progress at the frontiers of biomedicine. Standardly, the goal of fixing meanings is seen as being realized through the alignment of terms on what are called 'concepts'. Part I addresses three versions of the concept-based approach – by Cimino, by Wüster, and by Campbell and associates – and surveys some of the problems to which they give rise, all of which have to do with a failure to anchor the terms in terminologies to corresponding referents in reality. Part II outlines a new, realist solution to this anchorage problem, which sees terminology construction as being motivated by the goal of alignment not on concepts but on the universals (kinds, types) in reality and thereby also on the corresponding instances (individuals, tokens). We outline the realist approach, and show how on its basis we can provide a benchmark of correctness for terminologies which will at the same time allow a new type of integration of terminologies and electronic health records. We conclude by outlining ways in which the framework thus defined might be exploited for purposes of diagnostic decision-support.

Revised version as "New Desiderata for Biomedical Terminologies", in K. Munn and B. Smith (eds.), *Applied Ontology: An Introduction*, Frankfurt/Lancaster: ontos/de Gruyter, 2008, 83-108.

84. Christiane Fellbaum, Udo Hahn and Barry Smith, "Towards New Information Resources for Public Health – From WordNet to Medical WordNet", *Journal of Biomedical Informatics*, 2006; 39(3): 321-332.

Abstract: In the last two decades, WORDNET has evolved as the most comprehensive computational lexicon of general English. In this article, we discuss its potential for supporting the creation of an entirely new kind of information resource for public health, viz. MEDICAL WORDNET. This resource is not to be conceived merely as a lexical extension of the original WORDNET to medical terminology; indeed, there is already a considerable degree of overlap between WORDNET and the vocabulary of medicine. Instead, we propose a new type of repository, consisting of three large collections of (1) medically relevant word forms, structured along the lines of the existing Princeton WORDNET; (2) medically validated propositions, referred to here as medical facts, which will constitute what we shall call MEDICAL FACTNET; and (3) propositions reflecting laypersons' medical beliefs, which will constitute what we shall call the MEDICAL BELIEFNET. We introduce a methodology for setting up the MEDICAL WORDNET. We then turn to the discussion of research challenges that have to be met in order to build this new type of information resource.

85. Werner Ceusters and Barry Smith, "Strategies for Referent Tracking in Electronic Health Records", *Journal of Biomedical Informatics*, 2006; 39(3): 362-378.

Abstract: The goal of referent tracking is to create an ever-growing pool of data relating to the entities existing in concrete spatiotemporal reality. In the context of Electronic Healthcare Records (EHRs) the relevant concrete entities are not only particular patients but also their parts, diseases, therapies, lesions, and so forth, insofar as these are salient to diagnosis and treatment. Within a referent tracking system, all such entities are referred to directly and explicitly, something which cannot be achieved when familiar concept-based systems are used in what is called "clinical coding". In this paper we describe the components of a referent tracking system in an informal way and we outline the procedures that would have to be followed by healthcare personnel in using such a system. We argue that the referent tracking paradigm can be introduced with only minor – though nevertheless ontologically important – technical changes to existing EHR infrastructures, but that it will require a radically different mindset on the part of those involved in clinical coding and terminology development from that which has prevailed hitherto.

86. Rubin DL, Lewis SE, Mungall CJ, Misra S, Westerfield M, Ashburner M, Sim I, Chute CG, Solbrig H, Storey MA, Smith B, Richter JD, Noy NF and Musen MA, "National Center for Biomedical Ontology: Advancing Biomedicine through Structured Organization of Scientific Knowledge", *Omics: A Journal of Integrative Biology*, 10(2), 2006, 185-198.

Abstract: The National Center for Biomedical Ontology is a consortium that comprises leading informaticians, biologists, clinicians, and ontologists, funded by the National Institutes of Health (NIH) Roadmap, to develop innovative technology and methods that allow scientists to record, manage, and disseminate biomedical information and knowledge in machine-processable form. The goals of the Center are (1) to help unify the divergent and isolated efforts in ontology development by promoting high quality open-source, standards-based tools to create, manage, and use ontologies, (2) to create new software tools so that scientists can use ontologies to annotate and analyze biomedical data, (3) to provide a national resource for the ongoing evaluation, integration, and evolution of biomedical ontologies and associated tools and theories in the context of driving biomedical projects.

87. Patricia L. Whetzel, Ryan R. Brinkman, Helen C. Causton, Liju Fan, Jennifer Fostel, Gilberto Fragoso, Mervi Heiskanen, Tina Hernandez-Boussard, Norman Morrison, Helen Parkinson, Philippe Rocca-Serra, Susanna-Assunta Sansone, Daniel Schober, Barry Smith, Robert Stevens, Chris Stoeckert, Chris F. Taylor, Joe White, "Development of FuGO – An Ontology for Functional Genomics Experiments", *Omics: A Journal of Integrative Biology*, 10(2), 2006, 199-204. PMC2783628

Abstract: The development of the Functional Genomics Experiment Ontology (FuGO) is a collaborative, international effort which will provide a resource for annotating functional genomics experiments, including the study design, protocols and instrumentation used, the data generated and the types of analysis performed on the data. FuGO will contain terms that are both universal to functional genomics experiments and those that are domain specific. In this way, the ontology will serve as the 'semantic glue' to provide a common understanding of data

across these disparate data sources. In addition, FuGO will reference out to existing mature ontologies in order to avoid the need to duplicate these resources, but in such a way as to enable their ease of use in annotation. This project is in the beginning stages of development and the paper will describe the efforts to initiate the project, the scope and organization of the project, the work accomplished to date and the challenges encountered as well as describe future plans.

88. Jacob Köhler, Katherine Munn, Alexander Rüegg, Andre Skusa, <u>Barry Smith</u>, "[Quality Control for Terms and Definitions in Ontologies and Taxonomies](#)", *BMC Bioinformatics*, 2006, 7: 212, PMC1482721

Abstract: Ontologies and taxonomies are among the most important computational resources formolecular biology and bioinformatics. A series of recent papers has shown that the Gene Ontology (GO), the most prominent taxonomic resource in these fields, is marked by flaws of certain characteristic types, which flow from a failure to address basic ontological principles. As yet, no methods have been proposed which would allow ontology curators to pinpoint flawed terms or definitions in ontologies in a systematic way. We present computational methods that automatically identify terms and definitions which are defined in a circular or unintelligible way. We further demonstrate the potential of these methods by applying them to isolate a subset of 6001 problematic GO terms. By automatically aligning GO with other ontologies and taxonomies we were able to propose alternative synonyms and definitions for some of these problematic terms. This allows us to demonstrate that these other resources do not contain definitions superior to those supplied by GO. Our methods provide reliable indications of the quality of terms and definitions in ontologies and taxonomies. Further, they are well suited to assist ontology curators in drawing their attention to those terms that are ill-defined. We have further shown the limitations of ontology mapping and alignment in assisting ontology curators in rectifying problems, thus pointing to the need for manual curation.

89. Kevin Mulligan, Peter Simons and Barry Smith, "[What's Wrong with Contemporary Philosophy?](#)", *Topoi*, 25 (1-2), 2006, 63-67.

Abstract: Abstract Philosophy in the West divides into three parts: Analytic Philosophy (AP), Continental Philosophy (CP), and History of Philosophy (HP). But all three parts are in a bad way. AP is sceptical about the claim that philosophy can be a science, and hence is uninterested in the real world. CP is never pursued in a properly theoretical way, and its practice is tailor-made for particular political and ethical conclusions. HP is mostly developed on a regionalist basis: what is studied is determined by the nation or culture to which a philosopher belongs, rather than by the objective value of that philosopher's work. Progress in philosophy can only be attained by avoiding these pitfalls.

Finnish translation as "Mikä nykyfilosofiassa on vialla?", (published with commentary by Tuomas E. Tahko (76-78), Pauliina Remes (80-82) and Susanna Lindberg (85-90).

Portuguese translation as "[Ce se întâmplă cu filosofia contemporană?](#)", *Rivista de filosofie*, 62 (6), 2015, 759-765.

Turkish translations as "[Çağdaş Felsefede Yanlış Olan Ne?](#)", *Önkül* 6 (10), 2024, 110-119.

90. Leo Obrst, Patrick Cassidy, Steve Ray, <u>Barry Smith</u>, Dagobert Soergel, Matthew West and Peter Yim, "[The 2006 Upper Ontology Summit Joint Communiqué](#)", *Applied Ontology*, 1 (2), 2006, 203-211.

Abstract: On March 14-15, 2006, at the US National Institute of Standards and Technology (NIST) in Gaithersburg, MD there took place the first Upper Ontology Summit (UOS). This was a convening of custodians of several prominent upper ontologies, key technology participants, and interested other parties, with the purpose of finding a means to relate the different ontologies to each other. The result is reflected in a joint communiqué, directed to the larger ontology community and the general public, and expressing a joint intent to build bridges among the existing upper ontologies in ways designed to increase and rationalize their utilization and to enhance their semantic interoperability.

91. Olivier Bodenreider, Barry Smith, Anand Kumar, Anita Burgun, "Investigating Subsumption in SNOMED CT: An Exploration into Large Description Logic-Based Biomedical Terminologies", *Artificial Intelligence in Medicine*, 2007, 39, 183-195. PMC2442845

Abstract: Formalisms based on one or other flavor of Description Logic (DL) are sometimes put forward as helping to ensure that terminologies and controlled vocabularies comply with sound ontological principles. The objective of this paper is to study the degree to which one DL-based biomedical terminology (SNOMED CT) does indeed comply with such principles. We defined seven ontological principles (for example: each class must have at least one parent, each class must differ from its parent) and examined the properties of SNOMED CT classes with respect to these principles. Our major results are: 31% of these classes have a single child; 27% have multiple parents; 51% do not exhibit any differentiae between the description of the parent and that of the child. The applications of this study to quality assurance for ontologies are discussed and suggestions are made for dealing with the phenomenon of multiple inheritance. The advantages and limitations of our approach are also discussed.

92. Werner Ceusters and Barry Smith, "Referent Tracking for Treatment Optimisation in Schizophrenic Patients: A Case Study in Applying Philosophical Ontology to Diagnostic Algorithms", *Journal of Web Semantics*, 2006; (4)3, 229-236. PMC203705415

Abstract: The IPAP Schizophrenia Algorithm was originally designed in the form of a flow chart to help physicians optimise the treatment of schizophrenic patients in within a framework of guideline-based medicine. We take this algorithm as our starting point in investigating how artifacts of this sort can benefit from the facilities of high-quality ontologies. The IPAP algorithm exists thus far only in a form suitable for use by human beings. We draw on the resources of Basic Formal Ontology (BFO) in order to show how such an algorithm can be enhanced in such a way that it can be used in Semantic Web and related applications. We found that BFO provides a framework that is able to capture in a rigorous way all the types of entities represented in the IPAP schizophrenia algorithm in way which yields a computational tool that can be used by software agents to perform monitoring and control of schizophrenic patients. We discuss the issues involved in building an application ontology for this purpose, issues which are important for any Semantic Web application in the life science and healthcare domains.

Long version with supplementary data.

93. Werner Ceusters and Barry Smith "Referent Tracking for Digital Rights Management," *International Journal of Metadata, Semantics and Ontologies*, 2(1), 2007, 45-53.

Abstract: Digital Rights Management covers the description, identification, trading, protection, monitoring and tracking of all forms of rights over both tangible and intangible assets, including management of relationships between rights holders in a digital environment. The Digital Object Identifier (DOI) system provides a framework for the persistent identification of content in its broadest interpretation. Although the system has been very well designed to manage object identifiers, some important questions related to the assignment of identifiers are left open. The paradigm of a referent tracking system (RTS) recently advanced in the healthcare and life sciences environment is able to fill these gaps. This is demonstrated by pointing out inconsistencies in the DOI models and by showing how they can be corrected using an RTS.

94. Werner Ceusters, Peter Elkin and Barry Smith, "Negative Findings in Electronic Health Records and Biomedical Ontologies: A Realist Approach", *International Journal of Medical* Informatics 2007; 76: 326-333. PMC2211452.

Abstract: A substantial fraction of the observations made by clinicians and entered into patient records are expressed by means of negation or by using terms which contain negative qualifiers (as in "absence of pulse" or "surgical procedure not performed"). This seems at first sight to present problems for ontologies, terminologies and data repositories that adhere to a realist view and thus reject any reference to putative non-existing entities. Basic Formal Ontology (BFO) and Referent Tracking (RT) are examples of such paradigms. The purpose of the research here described was to test a proposal to capture negative findings in electronic health record

systems based on BFO and RT. *Methods*: We analysed a series of negative findings encountered in 748 sentences taken from 41 patient charts. We classified the phenomena described in terms of the various top-level categories and relations defined in BFO, taking into account the role of negation in the corresponding descriptions. We also studied terms from SNOMED-CT containing one or other form of negation. We then explored ways to represent the described phenomena by means of the types of representational units available to realist ontologies such as BFO. *Results*: We introduced a new family of 'lacks' relations into the OBO Relation Ontology in terms of which we were able to accommodate nearly all occurrences of negative findings in the sample studied.

95. Barry Smith, Michael Ashburner, Cornelius Rosse, Jonathan Bard, William Bug, Werner Ceusters, Louis J. Goldberg, Karen Eilbeck, Amelia Ireland, Christopher J Mungall, The OBI Consortium, Neocles Leontis, Philippe Rocca-Serra, Alan Ruttenberg, Susanna-Assunta Sansone, Richard H Scheuermann, Nigam Shah, Patricia L. Whetzel, Suzanna Lewis, "The OBO Foundry: Coordinated Evolution of Ontologies to Support Biomedical Data Integration", *Nature Biotechnology*, 25 (11), November 2007, 1251-1255. PMC2814061

Abstract: The value of any kind of data is greatly enhanced when it exists in a form that allows it to be integrated with other data. One approach to integration is through the annotation of multiple bodies of data using common controlled vocabularies or 'ontologies'. Unfortunately, the very success of this approach has led to a proliferation of ontologies which itself creates obstacles to integration. The Open Biomedical Ontologies (OBO) consortium has set in train a strategy to overcome this problem. Existing OBO ontologies, including the Gene Ontology, are undergoing a process of coordinated reform and new ontologies being created on the basis of an evolving set of shared principles governing ontology development. The result is an expanding family of ontologies designed to be interoperable, logically well-formed, and to incorporate accurate representations of biological reality. We describe the OBO Foundry initiative, and provide guidelines for those who might wish to become involved.

96. Darren A. Natale, Cecilia N. Arighi, Winona Barker, Judith Blake, Ti-Cheng Chang, Zhangzhi Hu, Hongfang Liu, Barry Smith, and Cathy H. Wu, "Framework for a Protein Ontology", *BMC Bioinformatics*, Nov. 2007, 8(Suppl. 9): S1. PMC2217659

Abstract: Biomedical ontologies are emerging as critical tools in genomic and proteomic research, where complex data in disparate resources need to be integrated. A number of ontologies describe properties that can be attributed to proteins. For example, protein functions are described by the Gene Ontology (GO) and human diseases by SNOMED CT or ICD10. There is, however, a gap in the current set of ontologies—one that describes the protein entities themselves and their relationships. We have designed the PRotein Ontology (PRO) to facilitate protein annotation and to guide new experiments. The components of PRO extend from the classification of proteins on the basis of evolutionary relationships to the representation of the multiple protein forms of a gene (products generated by genetic variation, alternative splicing, proteolytic cleavage, and other post-translational modifications). PRO will allow the specification of relationships between PRO, GO and other ontologies in the OBO Foundry. Here we describe the initial development of PRO, illustrated using human and mouse proteins involved in the transforming growth factor-beta and bone morphogenetic protein signaling pathways (http://pir.georgetown.edu/pro).

97. Chris F Taylor, Dawn Field, Susanna-Assunta Sansone, Rolf Apweiler, Michael Ashburner, Catherine A Ball, Pierre-Alain Binz, Alvis Brazma, Ryan Brinkman, Eric W Deutsch, Oliver Fiehn, Jennifer Fostel, Peter Ghazal, Graeme Grimes, Nigel W Hardy, Henning Hermjakob, Randall K Julian, Jr., Matthew Kane, Eugene Kolker, Martin Kuiper, Nicholas Le Novère, Jim Leebens-Mack, Suzanna E Lewis, Ruth McNally, Alexander Mehrle, Norman Morrison, John Quackenbush, Donald G Robertson, Philippe Rocca-Serra, Barry Smith, Jason Snape, Peter Sterk, Stefan Wiemann, "Promoting Coherent Minimum Reporting Requirements for Biological and Biomedical Investigations: The MIBBI Project", *Nature Biotechnology,* 26 (2008), 889-896. PMC2771753

Abstract: Throughout the biological and biomedical sciences there is a growing need for, prescriptive 'minimum information' (MI) checklists specifying the key information to include when reporting experimental results are beginning to find favor with experimentalists, analysts, publishers and funders alike. Such checklists aim to ensure that methods, data, analyses and results are described to a level sufficient to support the unambiguous interpretation, sophisticated search, reanalysis and experimental corroboration and reuse of data sets, facilitating the extraction of maximum value from data sets them. However, such 'minimum information' MI checklists are usually developed independently by groups working within representatives of particular biologically- or technologically-delineated domains. Consequently, an overview of the full range of checklists can be difficult to establish without intensive searching, and even tracking thetheir individual evolution of single checklists may be a non-trivial exercise. Checklists are also inevitably partially redundant when measured one against another, and where they overlap is far from straightforward. Furthermore, conflicts in scope and arbitrary decisions on wording and sub-structuring make integration difficult. This presents inhibit their use in combination. Overall, these issues present significant difficulties for the users of checklists, especially those in areas such as systems biology, who routinely combine information from multiple biological domains and technology platforms. To address all of the above, we present MIBBI (Minimum Information for Biological and Biomedical Investigations); a web-based communal resource for such checklists, designed to act as a 'one-stop shop' for those exploring the range of extant checklist projects, and to foster collaborative, integrative development and ultimately promote gradual integration of checklists.

98. David P. Hill, Barry Smith, Monica S. McAndrews-Hill, Judith A. Blake, "Gene Ontology Annotations: What they mean and where they come from", *BMC Bioinformatics*, 2008; 9(Suppl 5): S2. PMC2367625

Abstract: The computational genomics community has come increasingly to rely on the methodology of creating annotations of scientific literature using terms from controlled structured vocabularies such as the Gene Ontology (GO). We here address the question of what such annotations signify and of how they are created by working biologists. Our goal is to promote a better understanding of how the results of experiments are captured in annotations in the hope that this will lead to better representations of biological reality through both the annotation process and ontology development, and in more informed use of the GO resources by experimental scientists.

99. David Koepsell, Robert Arp, Jennifer Fostel and Barry Smith, "Creating a Controlled Vocabulary for the Ethics of Human Research: Towards a Biomedical Ethics Ontology", *Journal of Empirical Research on Human Research Ethics*, Vol. 4, No. 1, 2009, 43-58. PMC2725426

Abstract: Ontologies describe reality in specific domains in ways that can bridge various disciplines and languages. They allow easier access and integration of information that is collected by different groups. Ontologies are currently used in the biomedical sciences, geography, and law. A Biomedical Ethics Ontology would benefit members of ethics committees who deal with protocols and consent forms spanning numerous fields of inquiry. There already exists the Ontology for Biomedical Investigations (OBI); the proposed BMEO would interoperate with OBI, creating a powerful information tool. We define a domain ontology and begin to construct a BMEO, focused on the process of evaluating human research protocols. Finally, we show how our BMEO can have practical applications for ethics committees. This paper describes ongoing research and a strategy for its broader continuation and cooperation.

100. Thomas Bittner, Maureen Donnelly and Barry Smith, "A Spatio-Temporal Ontology for Geographic Information Integration", *International Journal for Geographical Information Science,* 23 (6), 2009, 765-798.

Abstract: This paper presents an axiomatic formalization of a theory of top-level relations between three categories of entities: individuals, universals, and collections. We deal with a variety of relations between entities in these categories, including the sub-universal relation among universals and the parthood relation among individuals, as well as cross-categorial relations such as instantiation and membership. We show that an adequate understanding of the formal properties of such relations – in particular their behavior with respect to time – is critical for geographic information processing. The axiomatic theory is developed using Isabelle,

a computational system for implementing logical formalisms. All proofs are computer verified and the computational representation of the theory is available online.

101. Daniel Schober, <u>Barry Smith</u>, Suzanna E Lewis, Waclaw Kusnierczyk, Jane Lomax, Chris Mungall, Chris F Taylor, Philippe Rocca-Serra and Susanna-Assunta Sansone, "[Survey-based naming conventions for use in OBO Foundry ontology development](#)", *BMC Bioinformatics*, 2009 (June), 10:125. PMC2684543

Abstract: A wide variety of ontologies relevant to the biological and medical domains are available through the OBO Foundry portal, and integration of these ontologies is extremely desirable. However, heterogeneities in naming conventions pose serious obstacles to such integration. We summarize a review of existing naming conventions and highlight certain disadvantages with respect to their general applicability in the biological domain. We also present the results of a survey carried out to establish which naming conventions are currently employed by OBO Foundry ontologies and to determine what their special requirements regarding the naming of entities might be. Lastly, we propose an initial set of typographic, syntactic and semantic conventions for labelling classes in OBO Foundry ontologies.

102. Cecilia Arighi, Hongfang Liu, Darren Natale, Winona Barker, Harold Drabkin, Zhangzhi Hu, Judith Blake, <u>Barry Smith</u> and Cathy Wu, "[TGF-beta Signaling Proteins and the Protein Ontology](#)", *BMC Bioinformatics*, 10: Art. No. S3 Suppl. 5, May 16 2009. PMC2679403

Abstract: The Protein Ontology (PRO) is designed as a formal and principled Open Biomedical Ontologies (OBO) Foundry ontology for proteins. The components of PRO extend from a classification of proteins on the basis of evolutionary relationships at the homeomorphic level to the representation of the multiple protein forms of a gene, including those resulting from alternative splicing, cleavage and/or post-translational modifications. Focusing specifically on the TGF-beta signaling proteins, we describe the building, curation, usage and dissemination of the Protein Ontology.

103. Anna M. Masci, Cecilia N. Arighi, Alexander D. Diehl, Anne E. Lieberman, Chris Mungall, Richard H. Scheuermann, <u>Barry Smith</u> and Lindsay G. Cowell, "[An improved ontological representation of dendritic cells as a paradigm for all cell types](#)", *BMC Bioinformatics*, February 2009, 10:70. PMC2662812

Abstract: The Cell Ontology (CL) is designed to provide a standardized representation of cell types for data annotation. Currently, the CL employs multiple is_a relations, defining cell types in terms of histological, functional, and lineage properties, and the majority of definitions are written with sufficient generality to hold across multiple species. This approach limits the CL's utility for cross-species data integration. To address this problem, we developed a method for the ontological representation of cells and applied this method to develop a dendritic cell ontology (DC-CL). DC-CL subtypes are delineated on the basis of surface protein expression, systematically including both species-general and species-specific types and optimizing DC-CL for the analysis of flow cytometry data. This approach brings benefits in the form of increased accuracy, support for reasoning, and interoperability with other ontology resources.

104. Barry Smith, "[Toward a Realistic Science of Environments](#)", *Ecological Psychology,* 2009, 21 (2), April-June, 121-130.

Abstract: The perceptual psychologist J. J. Gibson embraces a radically externalistic view of mind and action. We have, for Gibson, not a Cartesian mind or soul, with its interior theater of contents and the consequent problem of explaining how this mind or soul and its psychological environment can succeed in grasping physical objects external to itself. Rather, we have a perceiving, acting organism, whose perceptions and actions are always already tuned to the parts and moments, the things and surfaces, of its external environment. We describe how on this basis Gibson sought to develop a realist science of environments which will be 'consistent with physics, mechanics, optics, acoustics, and chemistry'.

105. Holger Stenzhorn, Stefan Schulz, Martin Boeker and Barry Smith, "[Adapting Clinical Ontologies in Real-World Environments](#)", *Journal of Universal Computer Science*, 14 (22), 2009, 3767-3780. PMC2853050

Abstract: The desideratum of semantic interoperability has been intensively discussed in medical informatics circles in recent years. Originally, experts assumed that this issue could be sufficiently addressed by insisting simply on the application of shared clinical terminologies or clinical information models. However, the use of the term 'ontology' has been steadily increasing more recently. We discuss criteria for distinguishing clinical ontologies from clinical terminologies and information models. Then, we briefly present the role clinical ontologies play in two multicentric research projects. Finally, we discuss the interactions between these different kinds of knowledge representation artifacts and the stakeholders involved in developing interoperational real-world clinical applications. We provide ontology engineering examples from two EU-funded projects.

106. Stefan Schulz, Holger Stenzhorn, Martin Boekers and Barry Smith, "Strengths and Limitations of Formal Ontologies in the Biomedical Domain", *Electronic Journal of Communication, Information and Innovation in Health* (Special Issue on Ontologies, Semantic Web and Health), 3 (1), 2009, 31-45. PMC2904529

Abstract: We propose a typology of representational artifacts for health care and life sciences domains and associate this typology with different kinds of formal ontology and logic, drawing conclusions as to the strengths and limitations for ontology in a description logics framework. The four types of domain representation we consider are: (i) lexico-semantic representation, (ii) representation of types of entities, (iii) representations of background knowledge, and (iv) representation of individuals. We advocate a clear distinction of the four kinds of representation in order to provide a more rational basis for using ontologies and related artifacts to advance integration of data and enhance interoperability of associated reasoning systems. We highlight the fact that only a minor portion of scientifically relevant facts in a domain such as biomedicine can be adequately represented by formal ontologies as long as the latter are conceived as representations of entity types. In particular, the attempt to encode default or probabilistic knowledge using ontologies so conceived is prone to produce unintended, erroneous models.

Portuguese translation as "Vantagens e limitações das ontologias formais na área biomedical", *Reciis: Revista Electronica de Comunicacao Informacao, Inovacao em Saude*, March 2009, March 2009, Vol. 3, N 1, 33-48.

107. Gunnar O. Klein and Barry Smith, "Concept Systems and Ontologies: Recommendations for Basic Terminology", *Transactions of the Japanese Society for Artificial Intelligence*, 25, 2010, 433-441. PMC3034144.

Abstract: This essay concerns the problems surrounding the use of the term 'concept' in current ontology and terminology research. It is based on the constructive dialogue between realist ontology on the one hand and the world of formal standardization of health informatics on the other, but its conclusions are not restricted to the domain of medicine. The term "concept" is one of the most misused in literature and documentation of technical standards in the computer and information technology domains. In this paper we propose to use the term "concept" in the context of producing defined professional terminologies with one specific and consistent meaning, which we then propose for adoption as the agreed meaning of the term in future terminological research, and specifically in the development of formal terminologies to be used in computer systems. We also discuss and propose new definitions of a set of cognate terms. We describe the relations governing the realm of concepts, and compare these to the richer and more complex set of relations obtaining between entities in the real world. On this basis we also summarize an associated terminology for ontologies as representations of the real world and a partial mapping between the world of concepts and the world of reality.

Japanese translation in *Journal of the Japanese Society for Artificial Intelligence*, 25 (3), 2010, 317-325.

108. David R. Karp, Nishanth Marthandan, Steven G. E. Marsh, Chul Ahn, Frank C. Arnett, Lindsay Cowell, David S. DeLuca, Alexander D. Diehl, Raymond Dunivin, Karen Eilbeck, Michael Feolo, Paula A. Guidry, Wolfgang Helmberg, Suzanna Lewis, Maureen D. Mayes, Chris Mungall, Darren A. Natale, Bjoern Peters, Effie Petersdorf, John D. Reveille, Barry Smith, Glenys Thomson, Matthew J. Waller, Richard H.

Scheuermann, "Novel Sequence Feature Variant Type Analysis of the HLA Genetic Association in Systemic Sclerosis", *Human Molecular Genetics*, 2010 Feb 15;19(4):707-19. PMC2807365

Abstract: Significant associations have been found between specific human leukocyte antigen (HLA) alleles and organ transplant rejection, autoimmune disease development, and the response to infection. Traditional searches for disease associations have conventionally measured risk associated with the presence of individual HLA alleles. However, given the high level of HLA polymorphism, the pattern of amino acid variability, and the fact that most of the HLA variation occurs at functionally important sites, it may be that a combination of variable amino acid sites shared by several alleles (shared epitopes) are better descriptors of the actual causative genetic variants. Here we describe a novel approach to genetic association analysis in which genes/proteins are broken down into smaller sequence features and then variant types defined for each feature, allowing for independent analysis of disease association with each sequence feature variant type. We have used this approach to analyze a cohort of systemic sclerosis patients and show that a sequence feature composed of specific amino acid residues in peptide binding pockets 4 and 7 of HLA-DRB1 explains much of the molecular determinant of risk for systemic sclerosis.

109. Barry Smith and Mathias Brochhausen, "Putting Biomedical Ontologies to Work", *Methods of Information in Medicine*, 49 (2), 135-40. (Published September 2010) PMC3116518

Abstract: Biomedical ontologies exist to serve integration of clinical and experimental data, and it is critical to their success that they be put to widespread use in the annotation of data. How, then, can ontologies achieve the sort of user-friendliness, reliability, cost-effectiveness, and breadth of coverage that is necessary to ensure extensive usage? Methods: Our focus here is on two different sets of answers to these questions that have been proposed, on the one hand in medicine, by the SNOMED CT community, and on the other hand in biology, by the OBO Foundry. We address more specifically the issue as to how adherence to certain development principles can advance the usability and effectiveness of an ontology or terminology resource, for example by allowing more accurate maintenance, more reliable application, and more efficient interoperation with other ontologies and information resources. Results: SNOMED CT and the OBO Foundry differ considerably in their general approach. Nevertheless, a general trend towards more formal rigor and cross-domain interoperability can be seen in both and we argue that this trend should be accepted by all similar initiatives in the future. Conclusions: Future efforts in ontology development have to address the need for harmonization and integration of ontologies across disciplinary borders, and for this, coherent formalization of ontologies is a prerequisite.

German version as "Biomedizinische Ontologien für die Praxis", *European Journal for Biomedical Informatics*, 1 (2009).

110. Jiye Ai, Barry Smith, and David Wong, "Saliva Ontology: An ontology-based framework for a Salivaomics Knowledge Base", *BMC Bioinformatics*, (2010) 11:302. PMC2898059

Abstract: The Salivaomics Knowledge Base (SKB) is designed to serve as a computational infrastructure that can permit global exploration and utilization of data and information relevant to salivaomics. SKB is created by aligning (1) the saliva biomarker discovery and validation resources at UCLA with (2) the ontology resources developed by the OBO (Open Biomedical Ontologies) Foundry, including a new Saliva Ontology (SALO). We define the Saliva Ontology (SALO) as a consensus-based controlled vocabulary of terms and relations dedicated to the salivaomics domain and to saliva-related diagnostics following the principles of the OBO (Open Biomedical Ontologies) Foundry. The Saliva Ontology is an ongoing exploratory initiative. The ontology will be used to facilitate salivaomics data retrieval and integration across multiple fields of research together with data analysis and data mining. The ontology will be tested through its ability to serve the annotation ('tagging') of a representative corpus of salivaomics research literature that is to be incorporated into the SKB.

111. Barry Smith and Werner Ceusters, "Ontological Realism as a Methodology for Coordinated Evolution of Scientific Ontologies", *Applied Ontology*, 5 (2010), 139–188. PMC3104413

Abstract: Since 2002 we have been testing and refining a methodology for ontology development that is now being used by multiple groups of researchers in different life science domains. Gary Merrill, in a recent paper in this journal, describes some of the reasons why this methodology has been found attractive by researchers in the biological and biomedical sciences. At the same time he assails the methodology on philosophical grounds, focusing specifically on our recommendation that ontologies developed for scientific purposes should be constructed in such a way that their terms are seen as referring to what we call universals or types in reality. As we show, Merrill's critique is of little relevance to the success of our realist project, since it not only reveals no actual errors in our work but also criticizes views on universals that we do not in fact hold. However, it nonetheless provides us with a valuable opportunity to clarify the realist methodology, and to show how some of its principles are being applied, especially within the framework of the OBO (Open Biomedical Ontologies) Foundry initiative.

112. Werner Ceusters and Barry Smith, "Foundations for a Realist Ontology of Mental Disease", *Journal of Biomedical Semantics*, 2010, 1:10, 1-23. PMC3017014

Abstract: While classifications of mental disorders have existed for over one hundred years, it still remains unspecified what terms such as 'mental disorder', 'disease' and 'illness' might actually denote. While ontologies have been called in aid to address this shortfall since the GALEN project of the early 1990s, most attempts thus far have sought to provide a formal description of the structure of some pre-existing terminology or classification, rather than of the corresponding structures and processes on the side of the patient. We here present a view of mental disease that is based on ontological realism and which follows the principles embodied in Basic Formal Ontology (BFO) and in the application of BFO in the Ontology of General Medical Science (OGMS). We analyzed statements about what counts as a mental disease provided (1) in the research agenda for the DSM-V, and (2) in Pies' model. The results were used to assess whether the representational units of BFO and OGMS were adequate as foundations for a formal representation of the entities in reality that these statements attempt to describe. We then analyzed the representational units specific to mental disease and provided corresponding definitions. Our key contributions lie in the identification of confusions and conflations in the existing terminology of mental disease and in providing what we believe is a framework for the sort of clear and unambiguous reference to entities on the side of the patient that is needed in order to avoid these confusions in the future.

113. Albert Goldfain, Barry Smith and Lindsay G. Cowell, "Towards an Ontological Representation of Resistance: The Case of MRSA", *Journal of Biomedical Informatics*, 2011 (Feb.), 44:1, 35-41. PMC2930208.

Abstract: This paper addresses a family of issues surrounding the biological phenomenon of resistance and its representation in realist ontologies. The treatments of resistance terms in various existing ontologies are examined and found to be either overly narrow, internally inconsistent, or otherwise problematic. We propose a more coherent characterization of resistance in terms of what we shall call blocking dispositions, which are collections of mutually coordinated dispositions which are of such a sort that they cannot undergo simultaneous realization within a single bearer. A definition of 'protective resistance' is proposed for use in the Infectious Disease Ontology (IDO) and we show how this definition can be used to characterize the antibiotic resistance in Methicillin-Resistant Staphylococcus aureus (MRSA). The ontological relations between entities in our MRSA case study are used alongside a series of logical inference rules to illustrate logical reasoning about resistance. A description logic representation of blocking dispositions is also provided. We demonstrate that our characterization of resistance is sufficiently general to cover two other cases of resistance in the infectious disease domain involving HIV and malaria.

114. Pierre Grenon and Barry Smith, "Foundations of an Ontology of Philosophy", *Synthese*, 2011, 182 (2), 185-204.

Abstract: We describe an ontology of philosophy that is designed to help navigation through philosophical literature, including literature in the form of encyclopedia articles and textbooks

and in both printed and digital forms. The ontology is designed also to serve integration and structuring of data pertaining to the philosophical literature, and in the long term also to support reasoning about the provenance and contents of such literature, by providing a representation of the philosophical domain that is orientated around what philosophical literature is about.

Preprint version

115. Werner Ceusters, Maria Capolupo, Georges De Moor, Jos Devlies, Barry Smith, "An Evolutionary Approach to Realism-Based Adverse Event Representations", *Methods of Information in Medicine*, 50 (1): 62-73, 2011. PMC2829617

Abstract: Background: Part of the ReMINE project involved the creation of an ontology enabling computer-assisted decision support for optimal adverse event management. Objectives: The ontology had to satisfy the following requirements: (1) to be able to account for the distinct and context-dependent ways in which authoritative sources define the term 'adverse event', (2) to allow the identification of relevant RAPS information on the basis of the disease history of a patient as documented in electronic health records, and (3) to be compatible with present and future ontologies developed under the OBO Foundry framework. *Methods*: We used as feeder ontologies the Basic Formal Ontology, the Foundational Model of Anatomy, the Ontology of General Medical Science, the Information Artifact Ontology and the Ontology of Mental Health. We further used relations defined according to the pattern set forth in the OBO Relation Ontology. In light of the use of the ontology for the representation of adverse events that actually occurred and therefore are registered in a database, we also applied the principles of Referent Tracking. *Results*: We merged the upper portions of the feeder ontologies and introduced 22 additional representational units of which 13 are generally applicable in biomedicine and 9 in the adverse event context. We provided for each representational unit a textual definition that can be translated into equivalent formal definitions. Conclusion: The resulting ontology satisfies all requirements set forth. Merging the existing ontologies, although all designed under the OBO Foundry principles, brought new insight into what the representational units of such ontologies actually denote.

116. Darren A. Natale, Cecilia N. Arighi, Winona C. Barker, Judith A. Blake, Carol J. Bult, Michael Caudy, Harold J. Drabkin, Peter D'Eustachio, Alexei V. Evsikov, Hongzhan Huang, Jules Nchoutmboube, Natalia V. Roberts, Barry Smith, Jian Zhang, Cathy H. Wu, "The Protein Ontology: A Structured Representation of Protein Forms and Complexes", *Nucleic Acids Research* 2011, 39 (Database Issue), D539-545. PMC3013777

Abstract: The Protein Ontology (PRO) provides a formal, logically-based classification of specific protein classes including structured representations of protein isoforms, variants and modified forms. Initially focused on proteins found in human, mouse and Escherichia coli, PRO now includes representations of protein complexes. The PRO Consortium works in concert with the developers of other biomedical ontologies and protein knowledge bases to provide the ability to formally organize and integrate representations of precise protein forms so as to enhance accessibility to results of protein research. PRO (http://pir.georgetown.edu/pro) is part of the Open Biomedical Ontologies (OBO) Foundry.

117. Carol J. Bult, Harold Drabkin, Alexei Evsikov, Darren Natale, Cecilia Arighi, Natalia Roberts, Alan Ruttenberg, Peter D'Eustachio, Barry Smith, Judith A. Blake, Cathy Wu, "The Representation of Protein Complexes in the Protein Ontology (PRO)", *BMC Bioinformatics*, September 2011, 12:371. PMC3189193

Abstract: Representing species-specific proteins and protein complexes in ontologies that are both human- and machine-readable facilitates the retrieval, analysis, and interpretation of genome-scale data sets. Although existing protein-centric informatics resources provide the biomedical research community with well-curated compendia of protein sequence and structure, these resources lack formal ontological representations of the relationships among the proteins themselves. The Protein Ontology (PRO) Consortium is filling this informatics resource gap by developing ontological representations and relationships among proteins and their variants and modified forms. Because proteins are often functional only as members of stable protein complexes, the PRO Consortium, in collaboration with existing protein and pathway databases, has launched a new initiative to implement logical and consistent representation of protein

complexes. We describe here how the PRO Consortium is meeting the challenge of representing species-specific protein complexes, how protein complex representation in PRO supports annotation of protein complexes and comparative biology, and how PRO is being integrated into existing community bioinformatics resources. Conclusion: PRO is a unique database resource for species-specific protein complexes. PRO facilitates robust annotation of variations in composition and function contexts for protein complexes within and between species.

118. Mark A. Musen, Natalya F. Noy, Nigam H. Shah, Patricia L. Whetzel, Christopher G. Chute, Margaret-Anne Story, Barry Smith, and the NCBO team, "The National Center for Biomedical Ontology", *Journal of the American Medical Informatics Association*, 19 (2), 2012, 190-195. PMC3277625

Abstract: The National Center for Biomedical Ontology is now in its seventh year. The goals of this National Center for Biomedical Computing are to: create and maintain a repository of biomedical ontologies and terminologies; build tools and web services to enable the use of ontologies and terminologies in clinical and translational research; educate their trainees and the scientific community broadly about biomedical ontology and ontology-based technology and best practices; and collaborate with a variety of groups who develop and use ontologies and terminologies in biomedicine. The centerpiece of the National Center for Biomedical Ontology is a web-based resource known as BioPortal. BioPortal makes available for research in computationally useful forms more than 270 of the world's biomedical ontologies and terminologies, and supports a wide range of web services that enable investigators to use the ontologies to annotate and retrieve data, to generate value sets and special-purpose lexicons, and to perform advanced analytics on a wide range of biomedical data.

119. Barry Smith, "How to Do Things with Documents", *Rivista di Estetica*, 50 (2012), 179-198.

Abstract: This essay is a contribution to social ontology, drawing on the work of John Searle and of Hernando de Soto. At the center of the argument is the proposition advanced by de Soto in his *Mystery of Capital* to the effect that many of the entities which structure our contemporary social reality are entities which exist in virtue of the fact that there are (paper or digital) documents which support their existence. I here develop de Soto's argument further, focusing specifically on the ontological problems raised by a family of new types of social phenomena – exemplified most dramatically in the domain of finance for example in the form of what are called 'structured investment vehicles' – made possible as a result of the employment of computer technology in entity creation. I address also Searle's most recent work on social ontology, and conclude with an appendix on the theory of documentality advanced by Maurizio Ferraris.

120. Jiye Ai, Barry Smith and David Wong, "Bioinformatics Advances in Saliva Diagnostics", *International Journal of Oral Science*, (2012) 4, 85–87. PMC3412667

Abstract: A knowledge base to retrieve, integrate and analyze multiple data types collected from saliva samples promises to transform healthcare. Saliva is ideally suited to non-invasive detection and monitoring of disease. However, the absence of a free resource that cross-references disease-based changes in the levels of biomolecules has hamstrung progress in identifying biomarkers of specific illnesses. To address this issue, a team led by Ji-Ye Ai and David Wong at the University of California in Los Angeles are spearheading the creation of the Salivaomics Knowledge Base (SKB), a data management system and web resource to facilitate the discovery of saliva biomarkers using systems biology. The researchers first defined a common and structured vocabulary to describe the diverse data types; now, they are creating a common interface to integrate protein, RNA and metabolite data from multiple independent databases.

121. Ramona L. Walls, Balaji Athreya, Laurel Cooper, Justin Elser, Maria A. Gandolfo, Pankaj Jaiswal, Christopher J. Mungall, Justin Preece, Stefan A. Rensing, Barry Smith, Dennis W. Stevenson, "Ontologies as Integrative Tools for Plant Science", *American Journal of Botany*, 99(8): 1–13, 2012. PMC3492881

Abstract: Bio-ontologies are essential tools for accessing and analyzing the rapidly growing pool of plant genomic and phenomic data. Ontologies provide structured vocabularies to support

consistent aggregation of data and a semantic framework for automated analyses and reasoning. They are a key component of the Semantic Web. This paper provides background on what bio-ontologies are, why they are relevant to botany, and the principles of ontology development. It includes an overview of ontologies and related resources that are relevant to plant science, with a detailed description of the Plant Ontology (PO). We discuss the challenges of building an ontology that covers all green plants (Viridiplantae). Key results: Ontologies can advance plant science in four keys areas: 1. comparative genetics, genomics, phenomics, and development, 2. taxonomy and systematics, 3. semantic applications and 4. education. Conclusions: Bio-ontologies offer a flexible framework for comparative plant biology, based on common botanical understanding. As genomic and phenomic data become available for more species, we anticipate that the annotation of data with ontology terms will become less centralized, while at the same time, the need for cross-species queries will become more common, causing more researchers in plant science to turn to ontologies.

122. Barry Smith, "Classifying Processes: An Essay in Applied Ontology", *Ratio*, 25:4 (2012), 463-488. PMC 3718480

Abstract: We begin by describing recent developments in the burgeoning discipline of applied ontology, focusing especially on the ways ontologies are providing a means for the consistent representation of scientific data. We then introduce Basic Formal Ontology (BFO), a top-level ontology that is serving as domain-neutral framework for the development of lower level ontologies in many specialist disciplines, above all in biology and medicine. BFO is a bicategorial ontology, embracing both three-dimensionalist (continuant) and four-dimensionalist (occurrent) perspectives within a single framework. We examine how BFO-conformant domain ontologies can deal with the consistent representation of scientific data deriving from the measurement of processes of different types, and we outline on this basis the first steps of an approach to the classification of such processes within the BFO framework.

Reprinted in D. Oderberg (ed.), *Classifying Reality*, Oxford: Wiley-Blackwell, 2013, 101-126.

123. Barry Smith, Tatiana Malyuta, David Salmen, William Mandrick, Kesny Parent, Shouvik Bardhan, Jamie Johnson, "Ontology for the Intelligence Analyst", *CrossTalk: The Journal of Defense Software Engineering*, November/December 2012, 18-25.

Abstract: As available intelligence data and information expand in both quantity and variety, new techniques must be deployed for search and analytics. One technique involves the semantic enhancement of data through the creation of what are called 'ontologies' or 'controlled vocabularies.' When multiple different bodies of heterogeneous data are tagged by means of terms from common ontologies, then these data become linked together in ways which allow more effective retrieval and integration. We describe a simple case study to show how these benefits are being achieved, and we describe our strategy for developing a suite of ontologies to serve the needs of the war-fighter in the ever more complex battlespace environments of the future.

124. Laurel Cooper, Ramona L. Walls, Justin Elser, Maria A. Gandolfo, Dennis W. Stevenson, Barry Smith, Justin Preece, Balaji Athreya, Christopher J. Mungall, Stefan Rensing, Manuel Hiss, Daniel Lang, Ralf Reski, Tanya Z. Berardini, Donghui Li, Eva Huala, Mary Schaeffer, Naama Menda, Elizabeth Arnaud, Rosemary Shrestha, Yukiko Yamazaki, Pankaj Jaiswal, "The Plant Ontology as a Tool for Comparative Plant Anatomy and Genomic Analyses", *Plant and Cell Physiology*, 54 (2) (Database Issue), Feb. 2013, 1-23 (PMC3583023)

Abstract: The Plant Ontology (PO; http://www.plantontology.org/) is a publicly-available, collaborative effort to develop and maintain a controlled, structured vocabulary ("ontology") of terms to describe plant anatomy, morphology and the stages of plant development. The goals of the PO are to link (annotate) gene expression and phenotype data to plant structures and stages of plant development, using the data model adopted by the Gene Ontology. From its original design covering only rice, maize and *Arabidopsis*, the scope of the PO has been expanded to include all green plants. The PO was the first multi-species anatomy ontology developed for the annotation of genes and phenotypes. Also, to our knowledge, it was one of

the first biological ontologies that provides translations (via synonyms) in non-English languages such as Japanese and Spanish. There are about 2.2 million annotations linking PO terms to over 110,000 unique data objects representing genes or gene models, proteins, RNAs, germplasm and Quantitative Traits Loci (QTLs) from 22 plant species. In this paper, we focus on the *plant anatomical entity* branch of the PO, describing the organizing principles, resources available to users, and examples of how the PO is integrated into other plant genomics databases and web portals. We also provide two examples of comparative analyses, demonstrating how the ontology structure and PO-annotated data can be used to discover the patterns of expression of the *LEAFY (LFY)* and terpene synthase (*TPS*) gene homologs.

125. Darren A. Natale, Cecilia N. Arighi, Judith A. Blake, Carol J. Bult, Karen R. Christie, Julie Cowart, Peter D'Eustachio, Alexander D. Diehl, Harold J. Drabkin, Olivia Helfer, Hongzhan Huang, Anna Maria Masci, Jia Ren, Natalia V. Roberts, Karen Ross, Alan Ruttenberg, Veronica Shamovsky, Barry Smith, Meher Shruti Yerramalla, Jian Zhang, Aisha AlJanahi, Irem Celen, Cynthia Gan, Mengxi Lv, Emily Schuster-Lezell, Cathy H. Wu, "Protein Ontology: a controlled structured network of protein entities", *Nucleic Acids Research*, 2013, 42(1): D415-21.

Abstract: The Protein Ontology (PRO) formally defines protein entities and explicitly represents their major forms and interrelations. Protein entities represented in PRO corresponding to single amino acid chains are categorized by level of specificity into family, gene, sequence and modification metaclasses, and there is a separate metaclass for protein complexes. All metaclasses also have organism-specific derivatives. PRO complements established sequence databases such as UniProtKB, and interoperates with other biomedical and biological ontologies such as the Gene Ontology (GO). PRO relates to UniProtKB in that PRO's organism-specific classes of proteins encoded by a specific gene correspond to entities documented in UniProtKB entries. PRO relates to the GO in that PRO's representations of organism-specific protein complexes are subclasses of the organism-agnostic protein complex terms in the GO Cellular Component Ontology. The past few years have seen growth and changes to the PRO, as well as new points of access to the data and new applications of PRO in immunology and proteomics. Here we describe some of these developments.

126. Pier Luigi Buttigieg, Norman Morrison, Barry Smith, Christopher J Mungall, Suzanna E Lewis and the ENVO Consortium, "The Environment Ontology: Contextualizing Biological and Biomedical Entities", *Journal of Biomedical Semantics* 2013, 4:43.

Abstract: As biological and biomedical research increasingly reference the environmental context of the biological entities under study, the need for formalisation and standardisation of environment descriptors is growing. The Environment Ontology (ENVO; www.environmentontology.org) is a community-led, open project which seeks to provide an ontology for specifying a wide range of environments relevant to multiple life science disciplines and, through an open participation model, to accommodate the terminological requirements of all those needing to annotate data using ontology classes. This paper summarises ENVO's motivation, content, structure, adoption, and governance approach.

127. Mark Jensen, Alexander P. Cox, Naveed Chaudhry, Marcus Ng, Donat Sule, William Duncan, Patrick Ray, Bianca Weinstock-Guttman, Barry Smith, Alan Ruttenberg, Kinga Szigeti, Alexander D. Diehl, "The Neurological Disease Ontology", *Journal of Biomedical Semantics*, 2013, 4:42.

Abstract: We are developing the Neurological Disease Ontology (ND) to provide a framework to enable representation of aspects of neurological diseases that are relevant to their treatment and study. ND is a representational tool that addresses the need for unambiguous annotation, storage, and retrieval of data associated with the treatment and study of neurological diseases. ND is being developed in compliance with the Open Biomedical Ontology Foundry principles and builds upon the paradigm established by the Ontology for General Medical Science (OGMS) for the representation of entities in the domain of disease and medical practice. Initial applications of ND will include the annotation and analysis of large data sets and patient records for Alzheimer's disease, multiple sclerosis, and stroke.

128. Schiffman E., Ohrbach R., Truelove E., Look J., Anderson G., Goulet J.-P., List T., Svensson P., Gonzalez Y., Lobbezoo F., Michelotti A., Brooks S.L., Ceusters W., Drangsholt M., Ettlin D., Gaul C., Goldberg L., Haythornthwaite J., Hollender L., Jensen R., John M.T., deLaat A., deLeeuw R., Maixner W., van der Meulen M., Murray G.M., Nixdorf D.R., Palla S., Petersson A., Pionchon P., Smith B., Visscher C.M., Zakrzewska J., Dworkin S.F., "Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for Clinical and Research Applications: Recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group," *Journal of Oral and Facial Pain and Headache*, 28 (2014), 6–27.

Abstract: *Aims*: The Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) Axis I diagnostic algorithms were demonstrated to be reliable but below target sensitivity and specificity. Empirical data supported Axis I algorithm revisions that were valid. Axis II instruments were shown to be both reliable and valid. An international consensus workshop was convened to obtain recommendations and finalization of new Axis I diagnostic algorithms and new Axis II instruments. *Methods*: A comprehensive search of published TMD diagnostic literature was followed by review and consensus via a formal structured process by a panel of experts for revision of the RDC/TMD. Results: The recommended Diagnostic Criteria for TMD (DC/TMD) Axis I protocol includes both a valid screener for pain diagnoses and valid criteria for the most common pain-related TMDs and for one intra-articular disorder. The Axis II protocol retains selected RDC/TMD screening instruments augmented with new instruments to better assess the interactions between pain and psychosocial functioning. A comprehensive classification system is also presented. Conclusion: The recommended evidence-based DC/TMD protocol is appropriate for use in both the clinical and research settings. Simple Axis I and II screening tests augmented by validated Axis I and Axis II instruments allow for identification of simple to complex TMD patients.

129. R. L. Walls, J. Deck, R. Guralnick, S. Baskauf, R. Beaman, S. Blum, S. Bowers, P. L. Buttigieg, N. Davies, D. Endresen, M. A. Gandolfo, R. Hanner, A. Janning, L. Krishtalka, A. Matsunaga, P. Midford, N. Morrison, É. Ó Tuama, M. Schildhauer, B. Smith, B. J. Stucky, A. Thomer, J. Wieczorek, J. Whitacre, and J. Wooley, "Semantics in Support of Biodiversity Knowledge Discovery: An Introduction to the Biological Collections Ontology and Related Ontologies", *PLoS One*, March 3, 2014, 10.1371/journal.pone.0089606 (PMC3940615)

Abstract: The study of biodiversity spans many disciplines and includes data pertaining to species distributions and abundances, genetic sequences, trait measurements, and ecological niches, complemented by information on collection and measurement protocols. A review of the current landscape of metadata standards and ontologies in biodiversity science suggests that existing standards such as the Darwin Core terminology are inadequate for describing biodiversity data in a semantically meaningful and computationally useful way. Existing ontologies, such as the Gene Ontology and others in the Open Biological and Biomedical Ontologies (OBO) Foundry library, provide a semantic structure but lack many of the necessary terms to describe biodiversity data in all its dimensions. In this paper, we describe the motivation for and ongoing development of a new Biological Collections Ontology, the Environment Ontology, and the Population and Community Ontology. These ontologies share the aim of improving data aggregation and integration across the biodiversity domain and can be used to describe physical samples and sampling processes (for example, collection, extraction, and preservation techniques), as well as biodiversity observations that involve no physical sampling. Together they encompass studies of: 1) individual organisms, including voucher specimens from ecological studies and museum specimens, 2) bulk or environmental samples (e.g., gut contents, soil, water) that include DNA, other molecules, and potentially many organisms, especially microbes, and 3) survey-based ecological observations. We discuss how these ontologies can be applied to biodiversity use cases that span genetic, organismal, and ecosystem levels of organization. We argue that if adopted as a standard and rigorously applied and enriched by the biodiversity community, these ontologies would significantly reduce barriers to data discovery, integration, and exchange among biodiversity resources and researchers.

130. David Koepsell and Barry Smith, "Beyond Paper", *The Monist*, 97 (2), April 2014, 222–235.

Abstract: The authors outline the way in which documents as social objects have evolved from their earliest forms to the electronic documents of the present day. They note that while certain features have remained consistent, processes regarding document authentication are seriously complicated by the easy reproducibility of digital entities. The authors argue that electronic documents also raise significant questions concerning the theory of 'documentality' advanced by Maurizio Ferraris, especially given the fact that interactive documents seem to blur the distinctions between the static documents (or 'inscriptions') which form Ferraris's starting point, and dynamic software processes. The authors argue further that the Ferraris view as applied to legal documents is flawed because of the fact that courts may treat contractual obligations as enduring even in spite of a complete absence of enduring inscriptions. Finally, the authors note that traces in brains, another important family of inscriptions (as Ferraris conceives them), differ significantly from genuinely documentary inscriptions by their lack of public inspectability.

131. Janna Hastings, Gwen Alexandra Frishkoff, Barry Smith, Mark Jensen, Russell A Poldrack, Jane Lomax, Anita Bandrowski, Fahim T. Imam, Jessica A Turner and Maryann E Martone, "Interdisciplinary perspectives on the development, integration and application of cognitive ontologies", *Frontiers in Neuroinformatics*, 8:62, 2014.

Abstract: We discuss recent progress in the development of cognitive ontologies and summarize three challenges in the coordinated development and application of these resources. Challenge 1 is to adopt a standardized definition for cognitive processes. We describe three possibilities and recommend one that is consistent with the standard view in cognitive and biomedical sciences. Challenge 2 is harmonization. Gaps and conflicts in representation must be resolved so that these resources can be combined for mark-up and interpretation of multi-modal data. Finally, Challenge 3 is to test the utility of these resources for large-scale annotation of data, search and query, and knowledge discovery and integration. As term definitions are tested and revised, harmonization should enable coordinated updates across ontologies. However, the true test of these definitions will be in their community-wide adoption which will test whether they support valid inferences about psychological and neuroscientific data.

Polish translation as: "Interdyscyplinarne perspektywy rozwoju, integracji i zastosowań ontologii poznawczych", *Avant*, 8(3), 2016, 101-117.

132. Yongqun He, Sirarat Sarntivijai, Yu Lin, Zuoshuang Xiang, Abra Guo, Shelley Zhang, Desikan Jagannathan, Luca Toldo, Cui Tao and Barry Smith, "OAE: The Ontology of Adverse Events", *Journal of Biomedical Semantics*, July 2014, 5:29.

Abstract: A medical intervention is a medical procedure or application intended to relieve or prevent illness or injury. Examples of medical interventions include vaccination and drug administration. After a medical intervention, adverse events (AEs) may occur which lie outside the intended consequences of the intervention. The representation and analysis of AEs are critical to the improvement of public health. The Ontology of Adverse Events (OAE) has been developed to standardize and integrate data relating to AEs and to support computer-assisted reasoning over such data. OAE has over 3,000 terms with unique identifiers, including terms imported from existing ontologies and more than 1,800 OAE-specific terms. In OAE, the term 'adverse event' denotes a pathological bodily process in a patient that occurs after a medical intervention. Causal adverse events are defined as those events that are causal consequences of a medical intervention. OAE has been used in the analysis of both vaccine and drug adverse event data, for example, using the influenze vaccine data extracted from the Vaccine Adverse Event Reporting System (VAERS)

133. Andrew R. Deans, Suzanna E. Lewis, Eva Huala, Sallvatore S. Anzaldo, Michael Ashburner, James P. Balhoff, David C. Blackburn, Judith A. Blake, J. Gordon Burleigh, Bruno Chanet, Laurel D. Cooper, Mélanie Courtot, Sándor Csösz, Hong Cui, Wasila Dahdul, Sandip Das, T. Alexander Dececchi, Agnes Dettai, Rui Diogo, Robert E. Druzinsky, Michel Dumontier, Nico M. Franz, Frank Friedrich, George V. Gkoutos, Melissa Haendel, Luke J. Harmon, Terry F. Hayamizu, Yongqun He, Heather M. Hines, Nizar Ibrahim, Laura M. Jackson, Pankaj Jaiswal, Christina James-Zorn, Sebastian

Köhler, Guillaume Lecointre, Hilmar Lapp, Carolyn J. Lawrence, Nicolas Le Novère, John G. Lundberg, James Macklin, Austin R. Mast, Peter E. Midford, István Mikó, Christopher J. Mungall, Anika Oellrich, David Osumi-Sutherland, Helen Parkinson, Martín J. Ramírez, Stefan Richter, Peter N. Robinson, Alan Ruttenberg, Katja S. Schulz, Erik Segerdell, Katja C. Seltmann, Michael J. Sharkey, Aaron D. Smith, Barry Smith, Chelsea D. Specht, R. Burke Squires, Robert W. Thacker, Anne Thessen, Jose Fernandez-Triana, Mauno Vihinen, Peter D. Vize, Lars Vogt, Christine E. Wall, Ramona L. Walls, Monte Westerfeld, Robert A. Wharton, Christian S. Wirkner, James B. Woolley, Matthew J. Yoder, Aaron M. Zorn, Paula Mabee, "Finding Our Way through Phenotypes", *PLoS Biology*, January 2015, 13 (1).

Abstract: Despite a large and multifaceted effort to understand the vast landscape of phenotypic data, their current form inhibits productive data analysis. The lack of a community-wide, consensus-based, human- and machine-interpretable language for describing phenotypes and their genomic and environmental contexts is perhaps the most pressing scientific bottleneck to integration across many key fields in biology, including genomics, systems biology, development, medicine, evolution, ecology, and systematics. Here we survey the current phenomics landscape, including data resources and handling, and the progress that has been made to accurately capture relevant data descriptions for phenotypes. We present an example of the kind of integration across domains that computable phenotypes would enable, and we call upon the broader biology community, publishers, and relevant funding agencies to support efforts to surmount today's data barriers and facilitate analytical reproducibility.

134. Cecilia Arighi, Veronica Shamovsky, Anna Maria Masci, Alan Ruttenberg, Barry Smith, Darren A Natale, Cathy Wu, Peter D'Eustachio ,"Toll-Like Receptor signaling in vertebrates: Testing the integration of protein, complex, and pathway data in the Protein Ontology framework", *PLoS One*, April 2015, PONE-D-14-45784R2.

Abstract: The Protein Ontology (PRO) supports annotation of species-specific protein complexes in an ontology framework that relates them both to their components and to species-independent families of complexes. Here, we describe extensions of this ontology framework to link complexes to their subcellular locations, molecular functions, and roles in biological processes as defined by the Gene Ontology, using terms from the Relation Ontology. To demonstrate the feasibility of this approach we have annotated the early events of innate immune signaling mediated by Toll-Like Receptor 3 and 4 complexes in human, mouse, and chicken. The resulting ontology has allowed us to identify species-specific gaps in experimental data and possible functional differences between species, and employ structural and functional relationships inferred from the ontology to suggest plausible resolutions of these discrepancies and gaps.

135. Barry Smith, Sivaram Arabandi, Mathias Brochhausen, Michael Calhoun, Paolo Ciccarese, Scott Doyle, Bernard Gibaud, Ilya Goldberg, Charles E. Kahn, Jr., James Overton, John Tomaszewski, Metin Gurcan, "Biomedical Imaging Ontologies: A Survey and Proposal for Future Work", *Journal of Pathology Informatics*, 2015, 6:37. PMC4485195

Abstract: Ontology is one strategy for promoting interoperability of heterogeneous data through consistent tagging. An ontology is a controlled structured vocabulary consisting of general terms (such as 'cell' or 'image' or 'tissue' or 'microscope') that form the basis for such tagging. These terms are designed to represent the types of entities in the domain of reality that the ontology has been devised to capture; the terms are provided with logical definitions thereby also supporting reasoning over the tagged data. This paper provides a survey of the biomedical imaging ontologies that have been developed thus far. It outlines the challenges, particularly faced by ontologies in the fields of histopathological imaging and image analysis, and suggests a strategy for addressing these challenges in the example domain of quantitative histopathology imaging. The ultimate goal is to support multiscale understanding of disease that comes from using interoperable ontologies to integrate imaging data with clinical and genomics data.

136. Jingshan Huang, Fernando Gutierrez, Harrison J. Strachan, Dejing Dou, Weili Huang, Barry Smith, Judith A. Blake, Karen Eilbeck, Darren A. Natale, Yu Lin, Bin Wu, Nisansa de Silva, Xiaowei Wang, Zixing Liu, Glen Borchert, Mnig Tan, Alan Ruttenberg, "OmniSearch: A semantic search system based on the Ontology for MIcroRNA Target (OMIT) for microRNA-target gene interaction data", *Journal of Biomedical Semantics*, 7:24, May 4, 2016.

Abstract: In recent years, sequencing technologies have enabled the identification of a wide range of non-coding RNAs (ncRNAs). Unfortunately, annotation and integration of ncRNA data has lagged behind their identification. Given the large quantity of information being obtained in this area, there emerges an urgent need to integrate what is being discovered by a broad range of relevant communities. To this end, the Non-Coding RNA Ontology (NCRO) is being developed to provide a systematically structured and precisely defined controlled vocabulary for the domain of ncRNAs, thereby facilitating the discovery, curation, analysis, exchange, and reasoning of data about structures of ncRNAs, their molecular and cellular functions, and their impacts upon phenotypes. The goal of NCRO is to serve as a common resource for annotations of diverse research in a way that will significantly enhance integrative and comparative analysis of the myriad resources currently housed in disparate sources. It is our belief that the NCRO ontology can perform an important role in the comprehensive unification of ncRNA biology and, indeed, fill a critical gap in both the Open Biological and Biomedical Ontologies (OBO) Library and the National Center for Biomedical Ontology (NCBO) BioPortal. Our initial focus is on the ontological representation of small regulatory ncRNAs, which we see as the first step in providing a resource for the annotation of data about all forms of ncRNAs. The NCRO ontology is free and open to all users, accessible at: http://purl.obolibrary.org/obo/ncro.owl.

137. Anita Bandrowski, Ryan Brinkman, Mathias Brochhausen, Matthew H. Brush, Bill Bug†, Marcus C. Chibucos, Kevin Clancy, Mélanie Courtot, Dirk Derom, Michel Dumontier, Liju Fan, Jennifer Fostel, Gilberto Fragoso, Frank Gibson, Alejandra Gonzalez-Beltran, Melissa A. Haendel, Yongqun He, Mervi Heiskanen, Tina Hernandez-Boussard, Mark Jensen, Yu Lin, Allyson L. Lister,Phillip Lord, James Malone, Elisabetta Manduchi, Monnie McGee, Norman Morrison, James A. Overton, Helen Parkinson, Bjoern Peters, Philippe Rocca-Serra, Alan Ruttenberg, Susanna-Assunta Sansone, Richard H. Scheuermann, Daniel Schober, Barry Smith, Larisa N. Soldatova, Christian J. Stoeckert Jr., Chris F. Taylor, Carlo Torniai, Jessica A. Turner, Randi Vita, Patricia L. Whetzel, Jie Zheng. "The Ontology for Biomedical Investigations", *PLoS ONE*, 11(4): e0154556, April 29, 2016.

Abstract: The Ontology for Biomedical Investigations (OBI) is an ontology that provides terms with precisely defined meanings to describe all aspects of how investigations in the biological and medical domains are conducted. OBI re-uses ontologies that provide a representation of biomedical knowledge from the Open Biological and Biomedical Ontologies (OBO) project and adds the ability to describe how this knowledge was derived. We here describe the state of OBI and several applications that are using it, such as adding semantic expressivity to existing databases, building data entry forms, and enabling interoperability between knowledge resources. OBI covers all phases of the investigation process, such as planning, execution and reporting. It represents information and material entities that participate in these processes, as well as roles and functions. Prior to OBI, it was not possible to use a single internally consistent resource that could be applied to multiple types of experiments for these applications. OBI has made this possible by creating terms for entities involved in biological and medical investigations and by importing parts of other biomedical ontologies such as GO, Chemical Entities of Biological Interest (ChEBI) and Phenotype Attribute and Trait Ontology (PATO) without altering their meaning. OBI is being used in a wide range of projects covering genomics, multi-omics, immunology, and catalogs of services. OBI has also spawned other ontologies (Information Artifact Ontology) and methods for importing parts of ontologies (Minimum information to reference an external ontology term (MIREOT)). The OBI project is an open cross-disciplinary collaborative effort, encompassing multiple research communities from around the globe. To date, OBI has created 2366 classes and 40 relations along with textual and formal definitions. The OBI Consortium maintains a web resource (http://obi-ontology.org) providing details on the

people, policies, and issues being addressed in association with OBI. The currentrelease of OBI is available at http://purl.obolibrary.org/obo/obi.owl.

138. Jingshan Huang, Karen Eilbeck, Barry Smith, Judith A. Blake, Dejing Dou, Weili Huang, Darren A. Natale, Alan Ruttenberg, Jun Huan, Michael T. Zimmermann, Guoqian Jiang, Yu Lin, Bin Wu, Harrison J. Strachan, Yongqun He, Shaojie Zhang, Xiaowei Wang, Zixing Liu, Glen M. Borchert and Ming Tan, "The Non-Coding RNA Ontology (NCRO): a comprehensive resource for the unification of non-coding RNA biology", *Journal of Biomedical Semantics*, 2016, 7:24, 4 May 2016

Abstract: In recent years, sequencing technologies have enabled the identification of a wide range of non-coding RNAs (ncRNAs). Unfortunately, annotation and integration of ncRNA data has lagged behind their identification. Given the large quantity of information being obtained in this area, there emerges an urgent need to integrate what is being discovered by a broad range of relevant communities. To this end, the Non-Coding RNA Ontology (NCRO) is being developed to provide a systematically structured and precisely defined controlled vocabulary for the domain of ncRNAs, thereby facilitating the discovery, curation, analysis, exchange, and reasoning of data about structures of ncRNAs, their molecular and cellular functions, and their impacts upon phenotypes. The goal of NCRO is to serve as a common resource for annotations of diverse research in a way that will significantly enhance integrative and comparative analysis of the myriad resources currently housed in disparate sources. It is our belief that the NCRO ontology can perform an important role in the comprehensive unification of ncRNA biology and, indeed, fill a critical gap in both the Open Biological and Biomedical Ontologies (OBO) Library and the National Center for Biomedical Ontology (NCBO) BioPortal. Our initial focus is on the ontological representation of small regulatory ncRNAs, which we see as the first step in providing a resource for the annotation of data about all forms of ncRNAs. The NCRO ontology is free and open to all users, accessible at: http://purl.obolibrary.org/obo/ncro.owl.

139. Andrew D. Spear, Werner Ceusters, Barry Smith, "Functions in Basic Formal Ontology", *Applied Ontology*, 11 (2), (2016), 103-128.

Abstract: The notion of function is indispensable to our understanding of distinctions such as that between *being broken* and *being in working order* (for artifacts) and between *being diseased* and *being healthy* (for organisms). A clear account of the ontology of functions and functioning is thus an important desideratum for any top-level ontology intended for application in domains such as engineering or medicine. The benefit of using top-level ontologies in applied ontology can only be realized when each of the categories identified and defined by a top-level ontology is integrated with the others in a coherent fashion. Basic Formal Ontology (BFO) has from the beginning included *function* as one of its categories, exploiting a version of the etiological account of function that is framed at a level of generality sufficient to accommodate both biological and artifactual functions. This account has been subjected to a series of criticisms and refinements. We here articulate BFO's account of function, provide some reasons for favoring it over competing views, and defend it against objections.

140. Jingshan Huang, Karen Eilbeck, Barry Smith, Judith A. Blake, Dejing Dou, Weili Huang, Darren A. Natale, Alan Ruttenberg, Jun Huan, Michael T. Zimmermann, Guoqian Jiang, Yu Lin, Bin Wu, Harrison Strachan, Nisansa de Silva, Mohan Vamsi Kasukurthi, Vikash Kumar Jha, Yongqun He, Shaojie Zhang, Xiaowei Wang, Zixing Liu, Glen Borchert, Ming Tan, "The Development of Non-Coding RNA Ontology", *International Journal of Data Mining and Bioinformatics*, 15 (3), June 25, 2016. DOI: 10.1504/IJDMB.2016.077072.

Abstract: Identification of non-coding RNAs (ncRNAs) has been significantly improved over the past decade. On the other hand, semantic annotation of ncRNA data is facing critical challenges due to the lack of a comprehensive ontology to serve as common data elements and data exchange standards in the field. We developed the Non-Coding RNA Ontology (NCRO) to handle this situation. By providing a formally defined ncRNA controlled vocabulary, the NCRO aims to fill a specific and highly needed niche in semantic annotation of large amounts of ncRNA biological and clinical data.

141. Jie Zheng, Marcelline R. Harris, Anna Maria Masci, Yu Lin, Alfred Hero, Barry Smith and Yongqun He, "The Ontology of Biological and Clinical Statistics (OBCS) for Standardized and Reproducible Statistical Analysis", *Journal of Biomedical Semantics*, 14 September 2016, 7(1): 53.

Abstract: Statistics play a critical role in biological and clinical research. However, most reports of scientific results in the published literature make it difficult for the reader to reproduce the statistical analyses performed in achieving those results because they provide inadequate documentation of the statistical tests and algorithms applied. The Ontology of Biological and Clinical Statistics (OBCS) is put forward here as a step towards solving this problem. The terms in OBCS cover the major types of statistical processes used in basic biological research and clinical outcome studies. OBCS is aligned with the Basic Formal Ontology (BFO) and extends the Ontology of Biomedical Investigations (OBI), an OBO (Open Biological and Biomedical Ontologies) Foundry ontology supported by over 20 research communities. We discuss two examples illustrating how the ontology is being applied. In the first (biological) use case, we describe how OBCS was applied to represent the high throughput microarray data analysis of immunological transcriptional profiles in human subjects vaccinated with an influenza vaccine. In the second (clinical outcomes) use case, we applied OBCS to represent the processing of electronic health care data to determine the associations between hospital staffing levels and patient mortality.

142. Selja Seppälä, Alan Ruttenberg, Yonatan Schreiber, Barry Smith, "Definitions in Ontologies", *Cahiers de Lexicologie*, 109, 2 (2016), 175-207.

Abstract: Definitions vary according to context of use and target audience. They must be made relevant for each context to fulfill their cognitive and linguistic goals. This involves adapting their logical structure, type of content, and form to each context of use. We examine from these perspectives the case of definitions in ontologies.

143. Metin N. Gurcan, John Tomaszewski, James A. Overton, Scott Doyle, Alan Ruttenberg, Barry Smith, "Developing the Quantitative Histopathology Image Ontology (QHIO): A case study using the hot spot detection problem", *Journal of Biomedical Informatics*, 66 (2017) 129–135. PMC5316345

Abstract: Interoperability across data sets is a key challenge for quantitative histopathological imaging. There is a need for an ontology that can support effective merging of pathological image data with associated clinical and demographic data. To foster organized, cross-disciplinary, information-driven collaborations in the pathological imaging field, we propose to develop an ontology to represent imaging data and methods used in pathological imaging and analysis, and call it Quantitative Histopathological Imaging Ontology – QHIO. We apply QHIO to breast cancer hot-spot detection with the goal of enhancing reliability of detection by promoting the sharing of data between image analysts.

144. Darren A Natale, Cecilia N Arighi, Judith A Blake, Jonathan Bona, Chuming Chen, Sheng-Chih Chen, Karen R Christie, Julie Cowart, Peter D'Eustachio, Alexander D Diehl, Harold J Drabkin, William D Duncan, Hongzhan Huang, Jia Ren, Karen Ross, Alan Ruttenberg, Veronica Shamovsky, Barry Smith, Qinghua Wang, Jian Zhang, Abdelrahman El-Sayed, Cathy H Wu, "Protein Ontology (PRO): Enhancing and scaling up the representation of protein entities", *Nucleic Acids Research* 45 (D1), 2017, D339-D346.

Abstract: The Protein Ontology (PRO; http://purl.obolibrary.org/obo/pr) formally defines and describes taxon-specific and taxon-neutral protein-related entities in three major areas: proteins related by evolution; proteins produced from a given gene; and protein-containing complexes. PRO thus serves as a tool for referencing protein entities at any level of specificity. To enhance this ability, and to facilitate the comparison of such entities described in different resources, we developed a standardized representation of proteoforms using UniProtKB as a sequence reference and PSI-MOD as a post-translational modification reference. We illustrate its use in facilitating an alignment between PRO and Reactome protein entities. We also address issues of scalability, describing our first steps into the use of text mining to identify protein-related entities, the large-scale import of proteoform information from expert curated resources, and

our ability to dynamically generate PRO terms. Web views for individual terms are now more informative about closely-related terms, including for example an interactive multiple sequence alignment. Finally, we describe recent improvement in semantic utility, with PRO now represented in OWL and as a SPARQL endpoint. These developments will further support the anticipated growth of PRO and facilitate discoverability of and allow aggregation of data relating to protein entities.

145. José M Parente de Oliveira, Barry Smith, "A visual representation of part-whole relationships in BFO-conformant ontologies", *Recent Advances in Information Systems and Technologies* (Advances in Intelligent Systems and Computing, 569), 2017, 184-194.

Abstract: In the visual representation of ontologies, in particular of part-whole relationships, it is customary to use graph theory as the representational background. We claim here that the standard graph-based approach has a number of limitations, and we propose instead a new representation of part-whole structures for ontologies, and describe the results of experiments designed to show the effectiveness of this new proposal especially as concerns reduction of visual complexity. The proposal is developed to serve visualization of ontologies conformant to the Basic Formal Ontology. But it can be used also for more general applications, particularly in the biomedical domain.

146. Selja Seppälä, Alan Ruttenberg, Barry Smith, "Guidelines for writing definitions in ontologies", *Ciência da Informação*, 46 (1), 2017, 73-88.

Abstract. Ontologies are being used increasingly to promote the reusability of scientific information by allowing heterogeneous data to be integrated under a common, normalized representation. Definitions play a central role in the use of ontologies both by humans and by computers. Textual definitions allow ontologists and data curators to understand the intended meaning of ontology terms and to use these terms in a consistent fashion across contexts. Logical definitions allow machines to check the integrity of ontologies and reason over data annotated with ontology terms to make inferences that promote knowledge discovery. Therefore, it is important not only to include in ontologies multiple types of definitions in both formal and in natural languages, but also to ensure that these definitions meet good quality standards so they are useful. While tools such as Protégé can assist in creating well-formed logical definitions, producing good definitions in a natural language is still to a large extent a matter of human ingenuity supported at best by just a small number of general principles. For lack of more precise guidelines, definition authors are often left to their own personal devices. This paper aims to fill this gap by providing the ontology community with a set of principles and conventions to assist in definition writing, editing, and validation, by drawing on existing definition writing principles and guidelines in lexicography, terminology, and logic.

147. Sanchita Bhattacharya, Patrick Dunn, Cristel Thomas, Barry Smith, Henry Schaefer, Jieming Chen, Zicheng Hu, Kelly Zalocusky, Ravi Shankar, Shai Shen-Orr, Elizabeth Thomson, Jeff Wiser, and Atul J. Butte, "ImmPort: Toward repurposing of open access immunological assay data for translational and clinical research", *Scientific Data*, 5:180015, February 2018, DOI: 10.1038/sdata.2018.15.

Abstract: Immunology researchers are beginning to explore the possibilities of reproducibility, reuse and secondary analyses of immunology data. Open-access datasets are being applied in the validation of the methods used in the original studies, leveraging studies for meta-analysis, or generating new hypotheses. To promote these goals, the ImmPort data repository was created for the broader research community to explore the wide spectrum of clinical and basic research data and associated findings. The ImmPort ecosystem consists of four components– Private Data, Shared Data, Data Analysis, and Resources—for data archiving, dissemination, analyses, and reuse. To date, more than 300 studies have been made freely available through the Shared Data portal (immport.org/immportopen), which allows research data to be repurposed to accelerate the translation of new insights into discoveries.

148. Cooper, Laurel; Meier, Austin; Laporte, Marie; Mungall, Chris; Elser, Justin; Sinn, Brandon; Cavaliere, Dario; Carbon, Seth; Dunn, Nathan; Qu, Botong; Smith, Barry; Preece, Justin; Zhang, Eugene; Todorovic, Sinisa; Gkoutos, Georgios;

Doonan, John; Stevenson, Dennis; Arnaud, Elizabeth; Jaiswal, Pankaj, "The Planteome Database: An Integrated Resource for Reference Ontologies, Plant Genomics and Phenomics", *Nucleic Acids Research,* January 2018, gkx1152, https://doi.org/10.1093/nar/gkx1152.

Abstract: The Planteome project provides a suite of reference and species-specific ontologies for plants and annotations to genes and phenotypes. Ontologies serve as common standards for semantic integration of a large and growing corpus of plant genomics, phenomics and genetics data. The reference ontologies include the Plant Ontology, Plant Trait Ontology, and the Plant Experimental Conditions Ontology developed by the Planteome project, along with the Gene Ontology, Chemical Entities of Biological Interest, Phenotype and Attribute Ontology, and others. The project also provides access to species-specific Crop Ontologies developed by various plant breeding and research communities from around the world. We provide integrated data on plant traits, phenotypes, and gene function and expression from 95 plant taxa, annotated with reference ontology terms.

148. Prodromos Kolyvakis, Alexandros Kalousis, Barry Smith and Dimitris Kiritsis, "Biomedical Ontology Alignment: An Approach Based on Representation Learning", *Journal of Biomedical Semantics*, (August 2018) 9:21.

Abstract: While representation learning techniques have shown great promise in application to a number of different NLP tasks, they have had little impact on the problem of ontology matching. Unlike past work that has focused on feature engineering, we present a novel representation learning approach that is tailored to the ontology matching task. Our approach is based on embedding ontological terms in a high-dimensional Euclidean space. This embedding is derived on the basis of a novel phrase retrofitting strategy through which semantic similarity information becomes inscribed onto fields of pre-trained word vectors. The resulting framework also incorporates a novel outlier detection mechanism based on a denoising autoencoder that is shown to improve performance. An ontology matching system derived using the proposed framework achieved an F-score of 94% on an alignment scenario involving the Adult Mouse Anatomical Dictionary and the Foundational Model of Anatomy ontology (FMA) as targets. This compares favorably with the best performing systems on the Ontology Alignment Evaluation Initiative anatomy challenge. We performed additional experiments on aligning FMA to NCI Thesaurus and to SNOMED CT based on a reference alignment extracted from the UMLS Metathesaurus. Our system obtained overall F-scores of 93.2% and 89.2% for these experiments, thus achieving state-of-the-art results.

149. Erik Thomsen and Barry Smith, "Ontology-Based Fusion of Sensor Data and Natural Language", *Applied Ontology*, 13 (4), 2018, 295-333.

Abstract: We describe a prototype ontology-driven information system (ODIS) that exploits what we call Portion of Reality (POR) representations. The system takes both sensor data and natural language text as inputs and composes on this basis logically structured POR assertions. The goal of our prototype is to represent both natural language and sensor data within a single framework. The framework should support not only axiomatic reasoning but also computation. It should also be capable of discovering and representing new kinds of situations and thematic roles (for example roles such as agent, patient and instrument) on the basis of new compositions of existing representations. We applied our prototype in an intelligence analysis use case to test the hypothesis that a framework of this sort can produce usefully structured information from combined natural language and sensor data inputs. We further tested our hypothesis by adding an enhanced US Air Force ontology framework to our ODIS in order to (1) process a collection of sensor data, intel reports, and mission plans; (2) build composite POR representations from these data; and (3) machine analyze the fused results to infer mission threats.

150. Munira Mohd Ali, Rahul Rai, J. Neil Otte, Barry Smith, "A Product Life Cycle Ontology for Additive Manufacturing", *Computers in Industry*, 105 (2019) 191-203.

Abstract: The manufacturing industry is evolving rapidly, becoming more complex, more interconnected, and more geographically distributed. Competitive pressure and diversity of consumer demand are driving manufacturing companies to rely more and more on improved knowledge management practices. As a result, multiple software systems are being created to support the integration of data across the product life cycle. Unfortunately, these systems

manifest a low degree of interoperability, and this creates problems, for instance when different enterprises or different branches of an enterprise interact. Common ontologies (consensus-based controlled vocabularies) have proved themselves in various domains as a valuable tool for solving such problems. In this paper, we present a consensus-based Additive Manufacturing Ontology (AMO) and illustrate its application in promoting re-usability in the field of dentistry product manufacturing.

151. Thomas J. Hagedorn, Barry Smith, Sundar Krishnamurty, Ian Grosse, "Interoperability of disparate engineering domain ontologies using Basic Formal Ontology", *Journal of Engineering Design*, published online: 14 June 2019, 625-654 https://doi.org/10.1080/09544828.2019.1630805.

Abstract: As engineering applications require management of ever larger volumes of data, ontologies offer the potential to capture, manage, and augment data with automated reasoning and semantic querying ontoloy. Unfortunately, considerable barriers hinder wider deployment of ontologies in engineering. Key among these is lack of a shared top-level ontology to unify and organize disparate aspects of the field and coordinate co-development of orthogonal ontologies. As a result, many engineering ontologies are limited to their original scope, and functionally difficult to extend or interoperate. This paper demonstrates how the use of a top-level ontology, specifically the Basic Formal Ontology (BFO), greatly facilitates interoperability of multiple engineering-related ontologies. We constructed a system of formal linked ontologies by re-engineering legacy ontologies to be conformant with BFO and developing new BFO-conformant ontologies to reflect engineering design, enterprise, human factors, manufacturing, and application domain knowledge. The resulting Integrated Framework for Additively Manufactured Products (IFAMP) and knowledge instantiated in it serves as the basis for a proposed Design with Additive Manufacturing Method, which supports the design of innovative products with semantically enhanced ideation tools and application domain knowledge. The method and its facilitation with the ontological framework are then demonstrated using a case study in medicine.

152. J. Neil Otte, Dimitris Kiritsis, Munira Binti Mohd Ali, Ruoyu Yang, Binbin Zhang, Ron Rudnicki, Rahul Rai, Barry Smith, "An ontological approach to representing the product life cycle", *Applied Ontology*, 14(2), May 2019, 155-177.

Abstract: The ability to access and share data is key to optimizing and streamlining any industrial production process. Unfortunately, the manufacturing industry is stymied by a lack of interoperability among the systems by which data are produced and managed, and this is true both within and across organizations. In this paper, we describe our work to address this problem through the creation of a suite of modular ontologies representing the product life cycle and its successive phases, from design to end of life. We call this suite the Product Life Cycle (PLC) Ontologies. The suite extends proximately from The Common Core Ontologies (CCO) used widely in defense and intelligence circles, and ultimately from the Basic Formal Ontology (BFO), which serves as top level ontology for the CCO and for some 300 further ontologies. The PLC Ontologies were developed together, but they have been factored to cover particular domains such as design, manufacturing processes, and tools. We argue that these ontologies, when used together with standard public domain alignment and browsing tools created within the context of the Semantic Web, may offer a low-cost approach to solving increasingly costly problems of data management in the manufacturing industry.

153. Ramona Lynn Walls, Laurel Cooper, Justin Lee Elser, Maria Alejandra Gandolfo, Christopher J. Mungall, Barry Smith, Dennis William Stevenson, Pankaj Jaiswal, "The Plant Ontology facilitates comparisons of plant development stages across species", *Frontiers in Plant Science*, June 4, 2019.

Abstract: The Plant Ontology (PO) is a community resource consisting of standardized terms, definitions, and logical relations describing plant structures and development stages, augmented by a large database of annotations from genomic and phenomic studies. This paper describes the structure of the ontology and the design principles we used in constructing PO terms for plant development stages. It also provides details of the methodology and rationale behind our revision and expansion of the PO to cover development stages for all plants, particularly the land plants (bryophytes through angiosperms). As a case study to illustrate the general approach, we examine variation in gene expression across embryo development stages in

Arabidopsis and maize, demonstrating how the PO can be used to compare patterns of expression across stages and in developmentally different species. Although many genes appear to be active throughout embryo development, we identified a small set of uniquely expressed genes for each stage of embryo development and also between the two species. Evaluating the different sets of genes expressed during embryo development in Arabidopsis or maize may inform future studies of the divergent developmental pathways observed in monocotyledonous versus dicotyledonous species. The PO and its annotation database (http://www.planteome.org) make plant data for any species more discoverable and accessible through common formats, thus providing support for applications in plant pathology, image analysis, and comparative development and evolution.

154. Yongqun He, Haihe Wang, Jie Zheng, Daniel P. Beiting, Anna Maria Masci, Hong Yu, Kaiyong Liu, Jianmin Wu, Jeffrey L. Curtis, Barry Smith, Alexander V. Alekseyenko, Jihad S. Obeid, "OHMI: The Ontology of Host-Microbiome Interactions", *Journal of Biomedical Semantics*, 10: 25 (2019). doi: 10.1186/s13326-019-0217-1.

Abstract: Host-microbiome interactions (HMIs) are critical for the modulation of biological processes and are associated with several diseases, and extensive HMI studies have generated large amounts of data. We propose that the logical representation of the knowledge derived from these data and the standardized representation of experimental variables and processes can foster integration of data and reproducibility of experiments and thereby further HMI knowledge discovery. A community-based Ontology of Host-Microbiome Interactions (OHMI) was developed following the OBO Foundry principles. OHMI leverages established ontologies to create logically structured representations of microbiomes, microbial taxonomy, host species, host anatomical entities, and HMIs under different conditions and associated study protocols and types of data analysis and experimental results.

155. Yongqun He, Hong Yu, Edison Ong, Yang Wang, Yingtong Liu, Anthony Huffman, Hsin-hui Huang, John Beverley, Junguk Hur, Xiaolin Yang, Luonan Chen, Gilbert S. Omenn, Brian Athey, Barry Smith, "CIDO, a community-based ontology for coronavirus disease knowledge and data integration, sharing, and analysis", *Scientific Data*, June 2020, 7(181).

Ontologies, as the term is used in informatics, are structured vocabularies comprised of human- and computer-interpretable terms and relations that represent entities and relationships. Within informatics fields, ontologies play an important role in knowledge and data standardization, representation, integration, sharing and analysis. They have also become a foundation of artificial intelligence (AI) research. In what follows, we outline the Coronavirus Infectious Disease Ontology (CIDO), which covers multiple areas in the domain of coronavirus diseases, including etiology, transmission, epidemiology, pathogenesis, diagnosis, prevention, and treatment. We emphasize CIDO development relevant to COVID-19.

156. Barry Smith, Olimpia Giuliana Loddo & Giuseppe Lorini, "On credentials", *Journal of Social Ontology* 6:1 (2020), 47-67.

Abstract: Credentials play an important role in all modern societies, but the analysis of their nature and function has thus far been neglected by social philosophers. We present a view according to which the function of credentials is certify the identity and the institutional status (including the rights) of individuals. More importantly, credentials enable rights-holders to exercise their rights, so that for a particular right to be exercisable the right-holder should possess, carry and sometimes, show to an authority a document of a specific kind. Driving licenses, identity cards, passports, boarding passes, library passes, credit cards, ATM cards, health insurance cards are all examples of credentials in this sense. Credentials have in every case a bearer, and the bearer should be able to carry them easily on his or her person. Credentials should also be inspectable – not least because credentials can be forged. The authors analyse several historical and contemporary examples of credentials, focusing on the credentials carried by the pilgrims of the Way of Saint James.

Italian translation as "Le credenziali: parole, disegni e poteri deontici", *Teoria e Critica della Regolazione Sociale*, 1 (20), 2020, 59-73.

157. Linda Elmhadhbi, Mohamed-Hedi Karray, Bernard Archimède, J. Neil Otte, Barry Smith, "PROMES: An ontology-based messaging service for semantically interoperable information exchange during disaster response", *Journal of Contingencies and Crisis Management,* 29 September 2020, 28 (3), 324-338.

Abstract: Disaster response requires the cooperation of multiple emergency responder organizations (EROs). However, after-action reports relating to large-scale disasters identity communication difficulties among EROs as a major hindrance to collaboration. On the one hand, the use of two-radio communication, based on multiple orthogonal frequencies and uneven coverage, has been shown to degrade inter-organization communication. On the other hand, because they reflect different areas of expertise, EROs use differing terminologies, which are difficult to reconcile. These issues lead to ambiguities, misunderstandings, and inefficient exchange of data and information among those involved, which can impede the response process and slow decision making. We, therefore, hypothesize that promoting semantic interoperability across ERO information systems might improve information exchange among stakeholders and thereby allow a more coherent response to the disaster. We propose an ontology-based messaging service on the basis of the Emergency Data Exchange Language (EDXL) standards. The parties involved will continue to use the terminologies to which they are accustomed, but the system will resolve inconsistencies and thereby enhance mutual understanding among EROs by ensuring semantic translation of the exchanged information. The evaluation of the semantic translation demonstrated the effectiveness and accuracy of the proposed service.

158. David Limbaugh, Jobst Landgrebe, David Kasmier, Ronald Rudnicki, James Llinas and Barry Smith, "Ontology and cognitive outcomes"*, Journal of Knowledge Structures and Systems*, 1:1 (2020), 3-22*.*

Abstract: The term 'intelligence' as used in this paper refers to items of knowledge collected for the sake of assessing and maintaining national security. The intelligence community (IC) of the United States (US) is a community of organizations that collaborate in collecting and processing intelligence for the US. The IC relies on human-machine-based analytic strategies that 1) access and integrate vast amounts of information from disparate sources, 2) continuously process this information, so that, 3) a maximally comprehensive understanding of world actors and their behaviors can be developed and updated. Herein we describe an approach to utilizing outcomes-based learning (OBL) to support these efforts that is based on an ontology of the cognitive processes performed by intelligence analysts. Of particular importance to the Cognitive Process Ontology is the class Representation that is Warranted. Such a representation is descriptive in nature and deserving of trust in its veridicality. The latter is because a Representation that is Warranted is always produced by a process that was vetted (or successfully designed) to reliably produce veridical representations. As such, Representations that are Warranted are what in other contexts we might refer to as 'items of knowledge'.

159. Munira Mohd Ali, Ruoyu Yang, Binbin Zhang, Francesco Furini, Rahul Rai, J. Neil Otte & Barry Smith, "Enriching the Functionally Graded Materials (FGM) Ontology for digital manufacturing", *International Journal of Production Research*, September 2021, 59(18), 5540-5557 https://doi.org/10.1080/00207543.2020.1787534.

Abstract: Functionally graded materials (FGMs) have been used in many different kinds of applications in recent years and have attracted significant research attention. However, we do not yet have a commonly accepted way of representing the various aspects of FGMs. Lack of standardised vocabulary creates obstacles to the extraction of useful information relating to pertinent aspects of different applications. A standard resource is needed for describing various elements of FGMs, including existing applications, manufacturing techniques, and material characteristics. This motivated the creation of the FGM Ontology (FGMO) in 2016. Here, we present a revised and expanded version of the FGM Ontology, which includes enrichments along four dimensions: (1) documenting recent FGMs applications; (2) reorganising the framework to incorporate an updated representation of types of manufacturing processes; (3) enriching the axioms of the ontology; and (4) importing mid-level ontologies from the Common Core Ontologies (CCO) and Product Life Cycle (PLC) Ontologies. The work is being carried out within the framework of the Industry Ontology Foundry (IOF), and the ontology is conformant to Basic Formal Ontology (BFO).

160. Jobst Landgrebe and Barry Smith, "Making AI meaningful again", *Synthese,* 198 (March 2021), 2061-2081*.*

Abstract: Artificial intelligence (AI) research enjoyed an initial period of enthusiasm in the 1970s and 80s, but this enthusiasm was tempered by a long interlude of frustration when genuinely useful AI applications failed to be forthcoming. Today, we are experiencing once again a period of enthusiasm, fired above all by the successes of the technology of deep neural networks or deep machine learning. In this paper we draw attention to what we take to be serious problems underlying current views of artificial intelligence encouraged by these successes, especially in the domain of language processing. We then show an alternative approach to language-centric AI, in which we identify a role for philosophy.

161. Shane Babcock, John Beverley, Lindsay G. Cowell, Barry Smith, "The Infectious Disease Ontology in the age of COVID-19", *Journal of Biomedical Semantics*, 12 (13), July 8, 2021.

Background: Effective response to public health emergencies, such as we are now experiencing with COVID-19, requires data sharing across multiple disciplines and data systems. Ontologies offer a powerful data sharing tool, and this holds especially for those ontologies built on the design principles of the Open Biomedical Ontologies Foundry. These principles are exemplified by the Infectious Disease Ontology (IDO), a suite of interoperable ontology modules aiming to provide coverage of all aspects of the infectious disease domain. At its center is IDO Core, a disease- and pathogen-neutral ontology covering just those types of entities and relations that are relevant to infectious diseases generally. IDO Core is extended by disease and pathogen-specific ontology modules.

Results: To assist the integration and analysis of COVID-19 data, and viral infectious disease data more generally, we have recently developed three new IDO extensions: IDO Virus (VIDO); the Coronavirus Infectious Disease Ontology (CIDO); and an extension of CIDO focusing on COVID-19 (IDO-COVID-19). Reflecting the fact that viruses lack cellular parts, we have introduced into IDO Core the term acellular structure to cover viruses and other acellular entities studied by virologists. We now distinguish between infectious agents – organisms with an infectious disposition – and infectious structures – acellular structures with an infectious disposition. This in turn has led to various updates and refinements of IDO Core's content. We believe that our work on VIDO, CIDO, and IDO-COVID-19 can serve as a model for yielding greater conformance with ontology building best practices.

Conclusions: IDO provides a simple recipe for building new pathogen-specific ontologies in a way that allows data about novel diseases to be easily compared, along multiple dimensions, with data represented by existing disease ontologies. The IDO strategy, moreover, supports ontology coordination, providing a powerful method of data integration and sharing that allows physicians, researchers, and public health organizations to respond rapidly and efficiently to current and future public health crises.

162. Rebecca C Jackson, Nicolas Matentzoglu, James A Overton, Randi Vita, James P Balhoff, Pier Luigi Buttigieg, Seth Carbon, Melanie Courtot, Alexander D Diehl, Damion Dooley, William Duncan, Nomi L Harris, Melissa A Haendel, Suzanna E Lewis, Darren A Natale, David Osumi-Sutherland, Alan Ruttenberg, Lynn M Schriml, Barry Smith, Christian J Stoeckert, Nicole A Vasilevsky, Ramona L Walls, Jie Zheng, Christopher J Mungall, Bjoern Peters, "OBO Foundry in 2021: Operationalizing open data principles to evaluate ontologies", *Database,* 2021/10/26

Abstract: Biological ontologies are used to organize, curate, and interpret the vast quantities of data arising from biological experiments. While this works well when using a single ontology, integrating multiple ontologies can be problematic, as they are developed independently, which can lead to incompatibilities. The Open Biological and Biomedical Ontologies (OBO) Foundry was created to address this by facilitating the development, harmonization, application, and sharing of ontologies, guided by a set of overarching principles. One challenge in reaching these goals was that the OBO principles were not originally encoded in a precise fashion, and interpretation was subjective. Here we show how we have addressed this by formally encoding the OBO principles as operational rules and implementing a suite of automated validation checks and a dashboard for objectively evaluating each ontology9s compliance with each principle. This

entailed a substantial effort to curate metadata across all ontologies and to coordinate with individual stakeholders. We have applied these checks across the full OBO suite of ontologies, revealing areas where individual ontologies require changes to conform to our principles. Our work demonstrates how a sizable federated community can be organized and evaluated on objective criteria that help improve overall quality and interoperability, which is vital for the sustenance of the OBO project and towards the overall goals of making data FAIR.

163. Elmhadhbi, Linda, Mohamed-Hedi Karray, Bernard Archimède, J. N. Otte, and Barry Smith, "An ontological approach to enhancing information sharing in disaster response", *Information* 12 (10), 2021: 432. https://doi.org/10.3390/info12100432

Abstract. Managing complex disaster situations is a challenging task because of the large number of actors involved and the critical nature of the events themselves. In particular, the different terminologies and technical vocabularies that are being exchanged among Emergency Responders may lead to misunderstandings. Maintaining a shared semantics for exchanged data is a major challenge. To help to overcome these issues, we elaborate a modular suite of ontologies called POLARISCO that formalizes the complex knowledge of the ERs. Such a shared vocabulary resolves inconsistent terminologies and promotes semantic interoperability among ERs. In this work, we discuss developing POLARISCO as an extension of Basic Formal Ontology and the Common Core Ontologies. We conclude by presenting a real use-case to check the efficiency and applicability of the proposed ontology.

164. Justine Flore Tchouanguem, Mohamed Hedi Karray, Bernard Kamsu Foguem, Camille Magniont, F. Henry Abanda, Barry Smith, "BFO-based ontology enhancement to promote interoperability in BIM", *Applied Ontology*, 16(4), October 2021, 1-27.

Abstract. Building Information Modelling (BIM) is a process for managing construction project information in such a way as to provide a basis for enhanced decision-making and for collaboration in a construction supply chain. One impediment to the uptake of BIM is the limited interoperability of different BIM systems. To overcome this problem, a set of Industry Foundation Classes (IFC) has been proposed as a standard for the construction industry. Building on IFC, the ifcOWL ontology was developed in order to facilitate representation of building data in a consistent fashion across the Web by using the Web Ontology Language (OWL). This study presents a critical analysis of the ifcOWL ontology and of the associated interoperability issues. It shows how these issues can be resolved by using Basic Formal Ontology (ISO/IEC 21838-2) as top-level architecture. A set of competency questions is used as the basis for comparison of the original ifcOWL with the enhanced ontology, and the latter is used to align with a second ontology — the ontology for building intelligent environments (DOGONT) — in order to demonstrate the added value derived from BFO by showing how querying the enhanced ifcOWL yields useful additional information.

165. Barry Smith, "Making space: The natural, cultural, cognitive and social niches of human activity", *Cognitive Processing – International Quarterly of Cognitive Science*, 22 (supplementary issue 1):77-87 (2021).

Abstract: This paper is in two parts. Part 1 examines the phenomenon of making space as a process involving one or other kind of legal decision-making, for example when a state authority authorizes the creation of a new highway along a certain route or the creation of a new park in a certain location. In cases such as this a new abstract spatial entity comes into existence – the route, the area set aside for the park – followed only later by concordant changes in physical reality. In Part 2 we show that features identified in studying this phenomenon of legal spacemaking can be detected in other spheres of human activity, for example in planning (where spacemaking is projected into the future), and in reasoning about history (where spacemaking is projected back through time). We shall see that these features display themselves in especially complex ways in our everyday use of language, and we conclude by examining the implications of this complexity for attempts to create an artificial intelligence that would enjoy a mastery of language that would be equivalent to that of human beings.

166. Linda Elmhadhbi, Mohamed-Hedi Karray, Bernard Archimède, J. Neil Otte and Barry Smith, "Ontology-driven multicriteria decision support for victim evacuation", *International Journal of Information Technology and Decision Making*, 21 (1), 2022, 243-272. https://doi.org/10.1142/S021962202150053X

Abstract: In light of the complexity of unfolding disasters, the diversity of rapidly evolving events, the enormous amount of generated information, and the huge pool of casualties, emergency responders (ERs) may be overwhelmed and in consequence poor decisions may be made. In fact, the possibility of transporting the wounded victims to one of several hospitals and the dynamic changes in healthcare resource availability make the decision process more complex. To tackle this problem, we propose a multicriteria decision support service, based on the Analytic Hierarchy Process (AHP) method, that aims to avoid overcrowding and outpacing the capacity of a hospital to effectively provide the best care to victims by finding out the most appropriate hospital that meets the victims' needs. The proposed approach searches for the most appropriate healthcare institution that can effectively deal with the victims' needs by considering the availability of the needed resources in the hospital, the victim's wait time to receive the healthcare, and the transfer time that represents the hospital proximity to the disaster site. The evaluation and validation results showed that the assignment of hospitals was done successfully considering the needs of each victim and without overwhelming any single hospital.

167. Barry Smith, "The birth of ontology", *Journal of Knowledge Structures and Systems*, January 2022, 3 (1), 57-66.

Abstract. This review focuses on the *Ogdoas scholastica* by Jacob Lorhard, published in 1606. The importance of this document turns on the fact that it contains what is almost certainly the first published occurrence of the term "ontology." The body of the work consists in a series of diagrams called "diagraphs." Relevant features of these diagraphs are: 1. that they do not in fact contain the word "ontology," and 2. that Lorhard himself was not responsible for their content.

168. William Mandrick & Barry Smith "Philosophical foundations of intelligence collection and analysis: a defense of ontological realism", *Intelligence and National Security*, DOI: 10.1080/02684527.2022.2076330, vol. 37 (6), May 2022, 809–819.

Abstract: There is a common misconception across the Intelligence Community (IC) to the effect that information trapped within multiple heterogeneous data silos can be semantically integrated by the sorts of meaning-blind statistical methods employed in much of artificial intelligence (AI) and natural language processlng (NLP). This leads to the misconception that incoming data can be analysed coherently by relying exclusively on the use of statistical algorithms and thus without any shared framework for classifying what the data are about. Unfortunately, such approaches do not yield sustainable results where we are dealing with widely distributed, highly heterogeneous and often changing bodies of data. We argue here that the needed integration requires the use of what we call an lntegrating Semantic Framework (ISF), which provldes a consistent set of categories and relationships that can be reused over and over again to tag successive bodies of data in ways which foster more coherent representation and reasoning.

169. Yongqun He, Hong Yu, Anthony Huffman, Asiyah Yu Lin, Darren A. Natale, John Beverley, Ling Zheng, Yehoshua Perl, Zhigang Wang, Yingtong Liu, Edison Ong, Yang Wang, Philip Huang, Long Tran, Jinyang Du, Zalan Shah, Easheta Shah, Roshan Desai, Hsin-hui Huang, Yujia Tian, Eric Merrell, William D. Duncan, Sivaram Arabandi, Lynn M. Schriml, Jie Zheng, Anna Maria Masci, Liwei Wang, Hongfang Liu, Fatima Zohra Smaili, Robert Hoehndorf, Zoë May Pendlington, Paola Roncaglia, Xianwei Ye, Jiangan Xie, Yi-Wei Tang, Xiaolin Yang, Suyuan Peng, Luxia Zhang, Luonan Chen, Junguk Hur, Gilbert S. Omenn, Brian Athey and Barry Smith, "A comprehensive update on CIDO: the community-based Coronavirus Infectious Disease Ontology", *Journal of Biomedical Informatics*, 3, 25, October 2022.

The current COVID-19 pandemic and the previous SARS/MERS outbreaks of 2003 and 2012 have resulted in a series of major global public health crises. We argue that in the interest of developing effective and safe vaccines and drugs and to better understand coronaviruses and associated disease mechenisms it is necessary to integrate the large and exponentially growing body of heterogeneous coronavirus data. Ontologies play an important role in standard-based knowledge and data representation, integration, sharing, and analysis. Accordingly, we initiated

the development of the community-based Coronavirus Infectious Disease Ontology (CIDO) in early 2020.

As an Open Biomedical Ontology (OBO) library ontology, CIDO is open source and interoperable with other existing OBO ontologies. CIDO is aligned with the Basic Formal Ontology and Viral Infectious Disease Ontology. CIDO has imported terms from over 30 OBO ontologies. For example, CIDO imports all SARS-CoV-2 protein terms from the Protein Ontology, COVID-19-related phenotype terms from the Human Phenotype Ontology, and over 100 COVID-19 terms for vaccines (both authorized and in clinical trial) from the Vaccine Ontology. CIDO systematically represents variants of SARS-CoV-2 viruses and over 300 amino acid substitutions therein, along with over 300 diagnostic kits and methods. CIDO also describes hundreds of host-coronavirus protein-protein interactions (PPIs) and the drugs that target proteins in these PPIs. CIDO has been used to model COVID-19 related phenomena in areas such as epidemiology. The scope of CIDO was evaluated by visual analysis supported by a summarization network method. CIDO has been used in various applications such as term standardization, inference, natural language processing (NLP) and clinical data integration. We have applied the amino acid variant knowledge present in CIDO to analyze differences between SARS-CoV-2 Delta and Omicron variants. CIDO's integrative host-coronavirus PPIs and drug-target knowledge has also been used to support drug repurposing for COVID-19 treatment.

CIDO represents entities and relations in the domain of coronavirus diseases with a special focus on COVID-19. It supports shared knowledge representation, data and metadata standardization and integration, and has been used in a range of applications.

170. Linda Elmhadhbi, Mohamed-Hedi Karray, Bernard Archimède, J. Neil Otte, Barry Smith, "A Semantics-Based Common Operational Command System for multiagency disaster response", *IEEE Transactions on Engineering Management*, 69(6), 3887-3901, December 2022. https://doi.org/10.1109/TEM.2020.3013109

Abstract: Disaster response is a highly collaborative and critical process that requires the involvement of multiple emergency responders (ERs), ideally working together under a unified command, to enable a rapid and effective operational response. Following the 9/11 and 11/13 terrorist attacks and the devastation of hurricanes Katrina and Rita, it is apparent that inadequate communication and a lack of interoperability among the ERs engaged on-site can adversely affect disaster response efforts. Within this context, we present a scenario-based terrorism case study to highlight the challenges of operational disaster command and response. In this article, which is based on the French emergency response doctrine, we outline a semantics-based common operational command system that is designed to guarantee an efficient information flow among ERs. Our focus is on offering to all ERs, a real-time operational picture of the situation in order to enable multilevel coordination among firefighters, police, healthcare units, public authorities, and other stakeholders. Our approach consolidates information to promote timely sharing of data among ERs. The proposed system is based on an ontology that has been developed to represent the different types of knowledge on the part of ERs, providing a shared vocabulary that covers a variety of interoperability concerns.

171. Hong Yu, Li Li, Anthony Huffman, John Beverley, Junguk Hur, Eric Merrell, Hsin-hui Huang, Yang Wang, Yingtong Liu, Edison Ong, Liang Cheng, Tao Zeng, Jingsong Zhang, Pengpai Li, Zhiping Liu, Zhigang Wang, Xiangyan Zhang, Xianwei Ye, Samuel K. Handelman, Jonathan Sexton, Kathryn Eaton, Gerry Higgins, Gilbert S. Omenn, Brian Athey, Barry Smith, Luonan Chen and Yongqun He, "A new framework for host-pathogen interaction research", *Frontiers in Immunology*, (December 2022) 13:1066733. doi: 10.3389/fimmu.2022.1066733

Abstract: COVID-19 often manifests with different outcomes in different patients, highlighting the complexity of the host-pathogen interactions involved in manifestations of the disease at the molecular and cellular levels. In this paper, we propose a set of postulates and a framework for systematically understanding complex molecular host-pathogen interaction networks. Specifically, we first propose four host-pathogen interaction (HPI) postulates as the basis for understanding molecular and cellular host-pathogen interactions and their relations to disease outcomes. These four postulates cover the evolutionary dispositions involved in HPIs, the dynamic nature of HPI outcomes, roles that HPI components may occupy leading to such

outcomes, and HPI checkpoints that are critical for specific disease outcomes. Based on these postulates, an HPI Postulate and Ontology (HPIPO) framework is proposed to apply interoperable ontologies to systematically model and represent various granular details and knowledge within the scope of the HPI postulates, in a way that will support AI-ready data standardization, sharing, integration, and analysis. As a demonstration, the HPI postulates and the HPIPO framework were applied to study COVID-19 with the Coronavirus Infectious Disease Ontology (CIDO), leading to a novel approach to rational design of drug/vaccine cocktails aimed at interrupting processes occurring at critical host-coronavirus interaction checkpoints. Furthermore, the host-coronavirus protein-protein interactions (PPIs) relevant to COVID-19 were predicted and evaluated based on prior knowledge of curated PPIs and domain-domain interactions, and how such studies can be further explored with the HPI postulates and the HPIPO framework is discussed.

172. Lin AY, Arabandi S, Beale T, Duncan WD, Hicks A, Hogan WR, Jensen M, Koppel R, Martínez-Costa C, Nytrø Ø, Obeid JS. De Oliveira JP, Ruttenberg A, Seppälä S, Smith B, Soergel D, Zheng J, Schulz S, "Improving the Quality and Utility of Electronic Health Record Data through Ontologies", *Standards*, 3(3), September 15, 2023, 316-40.

The translational research community, in general, and the Clinical and Translational Science Awards (CTSA) community, in particular, share the vision of repurposing EHRs for research that will improve the quality of clinical practice. Many members of these communities are also aware that electronic health records (EHRs) suffer limitations of data becoming poorly structured, biased, and unusable out of original context. This creates obstacles to the continuity of care, utility, quality improvement, and translational research. Analogous limitations to sharing objective data in other areas of the natural sciences have been successfully overcome by developing and using common ontologies. This White Paper presents the authors' rationale for the use of ontologies with computable semantics for the improvement of clinical data quality and EHR usability formulated for researchers with a stake in clinical and translational science and who are advocates for the use of information technology in medicine but at the same time are concerned by current major shortfalls. This White Paper outlines pitfalls, opportunities, and solutions and recommends increased investment in research and development of ontologies with computable semantics for a new generation of EHRs.

173. S. Clint Dowland, Barry Smith, Matthew A. Diller, Jobst Landgrebe & William R. Hogan, "Ontology of language, with applications to demographic data", *Applied ontology,* 18(3), 239-262, 7 November 2023.

Abstract: Here we present what we believe is a novel account of what languages are, along with an axiomatically rich representation of languages and language-related data that is based on this account. We propose an account of languages as aggregates of dispositions distributed across aggregates of persons, and in doing so we address linguistic competences and the processes that realize them. This paves the way for representing additional types of language-related entities. Like demographic data of other sorts, data about languages may be of use to researchers in a number of areas, including biomedical research. Data on the languages used in clinical encounters are typically included in medical records, and capture an important factor in patient-provider interactions. Like many types of patient and demographic data, data on a person's preferred and primary languages are organized in different ways by different systems. This can be a barrier to data integration. We believe that a robust framework for representing language in general and preferred and primary language in particular – which has been lacking in ontologies thus far – can promote more successful integration of language-related data from disparate data sources.

174. John Beverley, Shane Babcock, Gustavo Carvalho, Lindsay G. Cowell, Sebastian Duesing, Yongqun He, Regina Hurley, Eric Merrell, Richard H. Scheuermann, Barry Smith, "Coordinating virus research: The Virus Infectious Disease Ontology", *PLoS ONE*, January 18, 2024, https://doi.org/10.1371/journal.pone.0285093.

Abstract: The COVID-19 pandemic prompted immense work on the investigation of the SARS-CoV-2 virus. Rapid, accurate, and consistent interpretation of generated data is thereby of fundamental concern. Ontologies––structured, controlled, vocabularies––are designed to support consistency of interpretation, and thereby to prevent the development of data silos.

This paper describes how ontologies are serving this purpose in the COVID-19 research domain, by following principles of the Open Biological and Biomedical Ontology (OBO) Foundry and by reusing existing ontologies such as the Infectious Disease Ontology (IDO) Core, which provides terminological content common to investigations of all infectious diseases. We report here on the development of an IDO extension, the Virus Infectious Disease Ontology (VIDO), a reference ontology covering viral infectious diseases. We motivate term and definition choices, showcase reuse of terms from existing OBO ontologies, illustrate how ontological decisions were motivated by relevant life science research, and connect VIDO to the Coronavirus Infectious Disease Ontology (CIDO). We next use terms from these ontologies to annotate selections from life science research on SARS-CoV-2, highlighting how ontologies employing a common upper-level vocabulary may be seamlessly interwoven. Finally, we outline future work, including bacteria and fungus infectious disease reference ontologies currently under development, then cite uses of VIDO and CIDO in host-pathogen data analytics, electronic health record annotation, and ontology conflict-resolution projects.

176. Sonia Sharma, Gary Slade, Hanna Grol-Prokopczyk, D. Brad Rindal, Paul Durham, Werner Ceusters, Barry Smith, Richard Ohrbach, "Rates of Injury Across the Disease Course of a Chronic Overlapping Pain Condition", *The Journal of Pain*, Volume 29, Supplement 104830, April 2025.

Abstract: Tissue damage is central to the definition of pain, and injury is a plausible locus for nociceptive, inflammatory, or both types of pain. We previously reported that rates of painful temporomandibular disorder (TMD) incidence were significantly higher among individuals who experienced jaw injuries (5.37/100-person-years; 95%CL=4.19-6.87) than those who did not (3.44; 2.8-4.14). Here, we used data from a 24-month prospective study, concurrent with the below-listed TMD histories, assessing injury at 3-month intervals to estimate rates (per-person-months (95%CL)) of 1) extrinsic event exposure, such as tooth extraction, oral intubation, or motor vehicle accidents; 2) extrinsic jaw injury, attributed to extrinsic events; and 3) intrinsic jaw injury, attributed to yawning and sustained mouth opening. Rates were calculated for four mutually-exclusive groups of adults classified according to TMD history of disease chronicity, each compared to a non-TMD reference group. Rates of extrinsic events were not significantly higher in any TMD group versus those who never had TMD. Rates of extrinsic and intrinsic injury were significantly higher in the following groups compared to those who never had TMD [extrinsic=0.48 (0.25-0.83); intrinsic=0.55 (0.3-0.93)]: 1) Individuals with only prior painful TMD [intrinsic=2.39 (1.27-4.09)], 2) individuals whose TMD pain had not resolved 30days after first-onset [extrinsic=1.95 (1.09-3.21); intrinsic=4.02 (2.73-5.71)], and 3) individuals with chronic painful TMD [extrinsic=1.41 (0.88-2.13)]; intrinsic=5.89 (4.75-7.22)]. In summary, intrinsic injury is reported at increasing rates as TMD history shifts from prior to persistent, which may reflect both greater susceptibility to injury due to disease progression and injury's contribution to disease progression.

176. Shailendran Poyyamozhi, Ruoyu Yang, Venkat Krovi, Rahul Rai, Barry Smith and David Kasmier, "Ontology Foundation for the Self-Driving Software Stack." Submitted February 5, 2025. https://ssrn.com/abstract=5129199 and http://dx.doi.org/10.2139/ssrn.5129199

Abstract: An autonomous driving system is an extremely complex system comprising several subsystems rather than a single technology. An autonomous vehicle's ability to communicate information about its surroundings is critical to its successful operation. The main challenge is efficiently organizing and storing the information while taking into account the data and network layers of Vehicle to Everything (V2X). Unfortunately, the current autonomous system exhibits limited interoperability among various subsystems of an autonomous driving system, which poses a difficulty for large volumes of time-sensitive data streaming from multi-sensory platforms. This paper proposes the Connected Autonomous Vehicle Ontology (CAVO) as a solution to the interoperability problem found in CAV. CAVO is built as an extension of the Common Core Ontology (CCO) suite that takes Basic Formal Ontology (BFO) as its foundational top-level ontology. The research delves into the intricate process of mapping and retrieving big data from the CAV ontology through SPARQL queries. The study highlights the CAV ontology's adaptability across various self-driving applications and proposes improvements in data management to meet current and future needs. These enhancements aim to make data operations more efficient, reliable, and scalable in response to advancements in self-driving technologies.

177. Ludger Jansen and Barry Smith, "Categories in Top-Level Ontologies: Revisiting the Aristotelian Background", *Advances in Knowledge Representation,* 5 (3), September 2025.

Abstract: In the field of applied ontology, it is now commonplace to refer to a top-level ontology, and the Basic Formal Ontology (BFO) has even been recognized as an ISO standard. Like other contemporary top-level ontologies, BFO makes use of distinctions that have been developed in philosophy, many of which are already to be found in Aristotele. In this essay, we revisit Aristotele's metaphysics and discuss the similarities and differences with BFO.

178. Emanuele Martinelli and Barry Smith, "Artificial Intelligence and the Creativity of Human Entrepreneursv", SSRN, 19 Nov 2025 (Preprint).

Non-Refereed Articles in Scholarly Journals and Invited Talks

1. Barry Smith, "Historicity, value and mathematics", *Analecta Husserliana*, 4 (1975), 219–239.

Abstract: At the beginning of the present century, a series of paradoxes were discovered within mathematics which suggested a fundamental unclarity in traditional mathematical methods. These methods rested on the assumption of a realm of mathematical idealities existing independently of our thinking activity, and in order to arrive at a firmly grounded mathematics different attempts were made to formulate a conception of mathematical objects as purely human constructions. It was, however, realised that such formulations necessarily result in a mathematics which lacks the richness and power of the old 'platonistic' methods, and the latter are still defended, in various modified forms, as embodying truths about self-existent mathematical entities. Thus there is an idealism-realism dispute in the philosophy of mathematics in some respects parallel to the controversy over the existence of the experiential world to the settlement of which Ingarden devoted his life. The present paper is an attempt to apply Ingarden's methods to the sphere of mathematical existence. This exercise will reveal new modes of being applicable to non-real objects, and we shall put forward arguments to suggest that these modes of being have an importance outside mathematics, especially in the areas of value theory and the ontology of art.

2. Barry Smith, "Matematyka a ontologiczna estetyka Ingardena", *Studia Filozoficzne*, 1/122 (1976), 51–56.

Abstract: Outlines a theory of how the existence of mathematical objects can be explained using the aesthetic and ontological conceptual apparatus developed by Roman Ingarden in his *The Controversy over the Existence of the World* and *The Literary Work of Art*.

3. Karl Schuhmann and Barry Smith, "Against idealism: Johannes Daubert vs. Husserl's *Ideas* I", *Review of Metaphysics*, 38 (1985), 763–793.

Abstract: In manuscripts of 1930-1 Johannes Daubert, principal member of the Munich board of realist phenomenologists, put forward a series of detailed criticisms of the idealism of Husserl's *Ideas I*. The paper provides a sketch of these criticisms and of Daubert's own alternative conceptions of consciousness and reality, as also of Daubert's views on perception, similar, in many respects, to those of J. J. Gibson.

Reprinted in: Karl Schuhmann, *Selected Papers in Phenomenology*, C. Leijenhorst and P. Steenbakkers (eds.), Dordrecht, Boston and London: Kluwer (2004), 35–59.

4. Kevin Mulligan and Barry Smith, "Franz Brentano on the ontology of mind" (Review article on Brentano's *Deskriptive Psychologie*), *Philosophy and Phenomenological Research*, 45 (1985), 627–644.

Abstract: We provide a detailed exposition of Brentano's descriptive psychology, focusing on the unity of consciousness, the modes of connection and the types of part, including separable

parts, distinctive parts, logical parts and what Brentano calls modificational quasi-parts. We also deal with Brentano's account of the objects of sensation and the experience of time.

5. Wolfgang Grassl and Barry Smith, "The politics of national diversity", *The Salisbury Review*, 5 (1987), 33–37.

Reprinted in: R. Scruton (ed.), *Conservative Thoughts*, London: Claridge Press (1988), 101–114.

6. Kevin Mulligan, Peter Simons and Barry Smith, "Drei Briten in Kakanien", interview by Axel Bühler in *Information Philosophie*, 3 (1987), 22–33. English translation (June 19, 2025).

The three young philosophers Kevin Mulligan, Peter Simons and Barry Smith have become well-known in the last few years especially in German-speaking analytical philosophy and phenomenology circles. This is on the one hand as a result of their historical and systematic philosophical work; but it is also because of the provocative way in which they represent their philosophy. Because they often appear in threes, they have become known as the "gang of three" or "three musketeers" or even – and this in an admiring sense – "mafiosi" (Rescher). They are known primarily for the small workshops they have been organizing in uncomplicated Anglo-Saxon manner all over Europe. Their goal has been to show that analytic philosophy as it has been pursued up to now is in need of reform and also that the history of scientific philosophizing is not identical to the history of Anglo-Saxon analytic philosophy. Above all, they have tried to make more well known the Austrian tradition of scientific philosophy, and they can be given credit for having done much to promote the current interest in this tradition, which means: the history of Austrian philosophy of the 19th and early 20th centuries and its historical context in the Austro-Hungarian Empire.

7. Johannes Marek and Barry Smith, "Einleitung zu A. Martys 'Elemente der deskriptiven Psychologie'", *Conceptus*, 21 (1987), 33–48, editors' introduction to extracts from Marty's lectures (*ibid*., 49–66).

Abstract: Anton Marty delivered courses on descriptive psychology at regular intervals in the University of Prague. The content of these courses follows closely the ideas of Marty's teacher Franz Brentano, though with some interesting divergences and extrapolations. The present work is a historical and systematic introduction to an extract from notes taken of Marty's lecture, with some discussion of the work of Dilthey on similar topics, and of Marty's influence on Franz Kafka and on the Gestalt psychologist Max Wertheimer.

8. Barry Smith, "On the Austrianness of Austrian Economics", *Critical Review*, 4, 1-2 (1990), 212–238.

Abstract: Much recent work on the intellectual background of Austrian economics reveals an unfortunate lack of awareness of the distinct nature of the Austrian contribution to philosophy, from which the Austrian economists drew many of their ideas. The present essay offers a sketch of this contribution, contrasting Austrian philosophy especially with the modes of philosophy dominant in Germany. This makes it possible to throw new light on the relations on Mises, Kant and the Vienna circle, and it allows us also to establish the extent to which Austrian economics might properly be seen as being allied to the German hermeneutic tradition of Dilthey, Gadamer, et al. The essay concludes with a criticism of the hermeneutic relativism recently canvassed by some Austrian economists, concentrating especially on the work of Don Lavoie, whose writings are treated as symptomatic of a wider and somewhat regrettable trend.

Partially reprinted as "The philosophy of Austrian Economics: Principles and Provocations", in S. C. Littlechild (ed.), *Austrian Economics*, vol. I, Aldershot/Brookfield VT: Edward Elgar, 1990, 527–538.

9. Barry Smith, "The question of apriorism", *Austrian Economics Newsletter*, (Fall 1990), 1–5.

Abstract: We defend a view according to which Austrian economics rests on what can most properly be called an Aristotelian methodology. This implies a realist perspective, according to which the world exists independently of our thinking and reasoning activities; an essentialist

perspective, according to which the world contains certain simple essences or natures which may come together in law-like ways to form more complex static and dynamic wholes, and an apriorist perspective, according to which given essences and essential structures are intelligible, in the sense that they ca be grasped non-inductively in our thinking. We show the consequences of this view for an analysis of the thinking of Mises and Hoppe, both of which – we claim – incorporate what we believe to be foreign mixtures of Kantianism in their account of the foundations of Austrian economics.

Reprinted in *Rothbard e neo-hayekiani nella Scuola austriaca di economia* (Special issue of *Nuova Civiltà delle Macchine*), Dario Antiseri, Enzo Di Nuoscio, Francesco Di Iorio (eds.), June 2011, 59–68.

Czech translation: "Apriorizmus v ekonómii"

10. Barry Smith, "Puntel on truth, Or: Old idealistic wine in new semantic bottles", *Ethik und Sozialwissenschaften. Streitforum für Erwägungskultur*, 3 (1992), 166–169.

11. Barry Smith, "No philosophy. no transformation. no theses" [peer commentary on Herta Nagl-Docekal, "The Feminist Transformation of Philosophy"], *Ethik und Sozialwissenschaften. Streitforum für Erwägungskultur*, 4 (1992), 571–573.

12. Barry Smith, "Report on the International Brentano Conference. Graz, 25–26 May 1990", in *Nachrichten der Forschungsstelle und des Dokumentationszentrums für Österreichische Philosophie*, 2 (1990), 9–12.

13. Barry Smith, "First International Summer Institute in Cognitive Science held at UB", *UB International*, 3/2 (1994), 4, 7.

14. Barry Smith, "On feminist nomadism", *Free Inquiry*, 15/2 (1995), 30–31.

15. Ellen Klein and Barry Smith, "Philosophy and Feminist Politics: A Brief Guide", *Free Inquiry*, 16/1 (1995/96), 60–61.

16. Barry Smith, "Questionnaire on Cognitive Science", *Kog-Bit. Journal aus dem Graduiertenkolleg Kognitionswissenschaft der Universität Hamburg*, 13 (1996), 12.

17. Barry Smith and Peter Baumann, "Von Kant über Pol Pot zu Derrida", *KogBit. Journal aus dem Graduiertenkolleg Kognitionswissenschaft der Universität Hamburg*, 14 (1996), 8–11.

Revised version as "The worst cognitive performance in history", *Noûsletter*, 1997, 13–15.

18. Barry Smith, "Bringing the humanities down to Earth", *Academic Questions*, 10 (4), 1997, 58-62.

Abstract: The phenomenon known as 'Pascal's syndrome', familiar to those who work with adolescents, affects a significant fraclion of adolescents who, in striving to establish themselves as independent adults, pass lhrough a phase in which they make utterances that amount lo a radical negation of everything their parents think or believe. Such rebellion may express itself in political, religious, economic, or sexual terms. In some cases, however, it leads co what can only be described as an ontological rebellion, expressing itself in utterances such as 'Reality does not exist,' or 'The world is a gigantic conspiracy,' and so forth. A very small minority of sufferers from such ontological rebellion become philosophers. We address the implications of this phenomenon for the present-day state of the humanities disciplines.

19. Barry Smith, "Applied ontology: A new discipline is born", *Philosophy Today*, vol. 12, number 29 (1998), 5–6.

Italian translation as "Ontologo, il mestiere del futoro: È nata l'ontologia applicata", in: *Il Sole 24 Ore* (May 24, 1998), p. 35.

20. Barry Smith, "Qu'est-ce qu'une niche? Biologie et Ontologie formelle", *Biofutur. Le Mensuel européen de Biotechnologie*, 181 (September 1998), 13.

21. Barry Smith, "Presidential Teaching Tool", *Nousletter* (Buffalo), (July 1999), 3–4.

22. Reinhild Steingröver-McRae and Barry Smith, "The last days of the human race", *Austria Kultur*, 9: 5 (September/October 1999), 16–17.

23. Barry Smith, "Revisiting the Derrida Affair," interview by J. Sims, *Sophia*, 38: 2 (October 1999).

Abstract: In 1992 the proposal to award an honorary degree to Jacques Derrida exposed Cambridge University to the scrutiny of the academic world as well as to the press. The original proposal led four senior dons in Cambridge to announce a 'non-placet' vote. Barry Smith then authored a letter to The Times published on 9 May, 1992 along with eighteen other signatures from renowned philosophers, calling into doubt Derrida's qualifications for such an honor. The interview here reproduced describes the background and motivation of the letter, and of Derrida's response.

24. Barry Smith, "Obiektywnosc percepcji zmyslowej", *Roczniki Filozoficzne* 49: 1 (2001), 63–75.

Abstract: There is an old problem in philosophy: the problem of how we pass from the mental theater of our representations to the external realm of concrete physical objects. This problem arises against the background of representationalist theories of the relation between mind and its objects which are marked by the following three features: 1. The perceiving subject is idealized. It is conceived as lying outside any context or environment and in abstraction from any goal-directed behavior. 2. Perception is seen as beginning with raw or bare sensations. Then, by a process of inference, there arise beliefs about external physical objects. 3. Physical objects are assumed to be out there in the world, but to be inaccessible to direct experience. This representationalist theory lives on in the computational theories of the mind and in the doctrines of methodological solipsism embraced by contemporary cognitive scientists. But by making perception dependent on sensation, and by making sensations the direct objects of experience, it has matters exactly upside down. The paper draws on the ecological psychology of J. J. Gibson and Roger Barker in order to provide the metaphysical principles of a more adequate theory.

25. Barry Smith, "from classical metaphysics to medical informatics", *Humboldt-Kosmos*, 79 (July 2002), 31–32.

Italian translation as: "Dalla metafisica classica all'informatica medica" in Maurizio Ferraris (ed.), *Ontologia*, Naples: Guida (2003), 154–158.

26. Barry Smith, "Groups, sets, and wholes", *Revista di estetica*, N.S. 24/3 (2003), 129–130.

27. Barry Smith and Werner Ceusters, "Towards industrial strength philosophy: how analytical ontology can help medical informatics", *Interdisciplinary Science Reviews*, 28 (2003), 106–111.

Abstract: Initially the problems of data integration, for example in the field of medicine, were resolved in case by case fashion. Pairs of databases were cross-calibrated by hand, rather as if one were translating from French into Hebrew. As the numbers and complexity of database systems increased, the idea arose of streamlining these efforts by constructing one single benchmark taxonomy, as it were a central switchboard, into which all of the various classification systems would need to be translated only once. By serving as a lingua franca for database integration this benchmark taxonomy would ensure that all databases calibrated in its terms would be automatically compatible with each other. We describe one strategy for creating such a lingua franca, in which philosophical ontology plays a central role.

Italian translation as: "Verso una filosofia al servizio dell'industria: l'utilità dell'ontologia analitica per l'informatica medica", *Sistemi Intelligenti*, 15: 3 (2003), 407–417.

28. Barry Smith, "The measure of civilizations", *Academic Questions*, 16: 1 (2002/03), 16–22.

Abstract: Is it possible to compare civilizations one with another? Is it possible, in other words, to construct some neutral and objective framework in terms of which we could establish in what respects one civilization might deserve to be ranked more highly than its competitors? Morality will surely provide one axis of such a framework (and we note in passing that believers in Islam might quite reasonably claim that their fellow-believers are characteristically more moral than are many in the West). Criteria such as material well-being will need to play a role, too, as also will happiness or pleasure (and again we note that it is not clear a priori that there is more happiness in the West than there is in other civilizations). But even happiness (pace some proponents of the utilitarian philosophy) comes in different types, and to count in the civilization stakes the happiness involved would presumably need to be of the right kind. We explore what this might mean in terms of the idea of a self-chosen life plan.

Russian translation

29. Barry Smith, "Il senso della vita, oltre ogni nichilismo", *Il Domenicale* (3 May 2003), 5.

30. Barry Smith, "Soldi, elezioni e molecole", *Il Sole 24 Ore* (7 December 2003), 37.

31. Barry Smith and Berit Brogaard, "E il 16º giorno nacque un nuovo individuo", *Il Sole 24 Ore* (21 December 2003).

32. Barry Smith and Enrico Berti, "Le prime cellule non sono già umane? No, altrimenti saremmo nati due volte", *Il Sole 24 Ore* (28 December 2003).

33. Barry Smith and Dirk Siebert, "Warum benutzen Ärzte keine Computer?", *Deutsches Ärzteblatt/Praxis Computer* (January 2004), 18–20.

34. Barry Smith, "Die ganze Welt ist eine Bühne", *Interdisziplinäre Phänomenologie / Interdisciplinary Phenomenology* (Kyoto), 1 (2004), 31–44.

Abstract: Die klassische bikategoriale Ontologie von Substanzen und Akzidentien ist für die Festlegung der Strukturen menschlichen und tierischen Verhaltens nicht hinreichend, da die Umwelten dieses Verhaltens sich nicht in dieses klassische System einfügen. Wir bieten dementsprechend den Grundriß einer Theorie der besonderen Gebilde, die die Alltagswelten menschlicher und tierischer Verhalten konstituieren. Die Ausgangsüberlegung ist die folgende, Wir sind alle (Schau)spieler, und diese brauchen eine Bühne. Unsere Bühne ist die jeweilige Umwelt, in der wir leben und handeln. Der Terminus 'Umwelt' wird hierbei in Analogie zu Husserls Begriff der Lebenswelt verwendet. Er bezeichnet dementsprechend einen strukturierten Teil der Welt, in den sich ein Lebewesen, z.B. ein Mensch, einpaßt. Die Umwelt ist, wenn man so will, demnach die Bühne, auf welcher sich unser Verhalten abspielt. Der Versuch, das Wesen solcher Umwelten ontologisch festzulegen, bringt allerdings ein schwieriges Problem mit sich - ein Problem so alt wie Platons Höhlengleichnis und so neu wie gegenwärtige Reflexionen amerikanischer Philosophen zur Metaphysik der virtuellen Realität und zum Gedankenexperiment des Gehirns im Tank. Es gibt nämlich in manchen Fällen grobe Inkonsistenzen zwischen (1) der Umwelt, wie wir sie uns gerade vorstellen, und (2) der Umwelt als Bestandteil der wirklichen Welt. Das Problem, zwischen diesen beiden Umweltklassen einen Ausgleich zu finden, wird im letzten Teil behandelt.

35. Barry Smith, Werner Ceusters and Dirk Siebert, "Was die philosophische Ontologie zur biomedizinischen Informatik beitragen kann", *Information: Wissenschaft und Praxis*, 55: 3 (2004), 143–146.

36. Barry Smith, Maurizio Ferraris and Leonardo Zaibert, "La costituzione ontologica", *Il sole 24 Ore* (27 June 2004).

37. Barry Smith, "Niente è più sicuro della morte e delle tasse", *Il sole 24 Ore* (7 December 2004).

38. James J. Cimino and Barry Smith, "Introduction: International Medical Informatics Association Working Group 6 and the 2005 Rome Conference", *Journal of Biomedical Informatics*, 2006; 39(3): 249–251.

39. Barry Smith, "Philosophical flaws in standardization", *The Risks of Freedom Briefing*, 26 (2006), 3.

40. Thaddeus H. Grasela, Jill Fiedler-Kelly, Brenda Cirincione, Darcy Hitchcock, Kathleen Reitz, Susanne Sardella, and Barry Smith, "Informatics: the fuel for pharmacometric analysis", *AAPS Journal*, 2007; March, 9(1), E84–E91*. PMC2751306

Abstract: The current informal practice of pharmacometrics as a combination art and science makes it hard to appreciate the role that informatics can and should play in the future of the discipline and to comprehend the gaps that exist because of its absence. The development of pharmacometric informatics has important implications for expediting decision-making and for improving the reliability of decisions made in model-based development. We argue that well-defined informatics for pharmacometrics can lead to much needed improvements in the efficiency, effectiveness and reliability of the pharmacometrics process. The purpose of this paper is to provide a description of the pervasive yet often poorly appreciated role of informatics in improving the process of data assembly, a critical task in the delivery of pharmacometric analysis results. First, we provide a brief description of the pharmacometric analysis process. Second, we describe the business processes required to create analysis-ready datasets for the pharmacometrician. Third, we describe selected informatic elements required to support the pharmacometrics and data assembly processes. Finally, we offer specific suggestions for performing a systematic analysis of existing challenges as an approach to defining the next generation of pharmacometric informatics.

41. Barry Smith, "The Open Biomedical Ontologies (OBO) Foundry in 2008", *MMHCC (Mouse Models of Human Cancer Consortium) Newsletter,* March 2008, 1–2.

42. Robert Arp and Barry Smith, "Ontologies of cellular networks", *Science Signalling*, Vol. 1, Issue 50 (December 2008), 1-3, DOI: 10.1126/scisignal.150mr2.

Abstract: As part of a series of workshops on different aspects of biomedical ontology sponsored by the National Center for Biomedical Ontology (NCBO), a workshop titled "Ontologies of Cellular Networks" took place in Newark, New Jersey, on 27 to 28 March 2008. This workshop included more than 30 participants from various backgrounds in biomedicine and bioinformatics. The goal of the workshop was to provide an introduction to the basic tools and methods of ontology, as well as to enhance coordination between groups already working on ontologies of cellular networks. The meeting focused on three questions: What is an ontology? What is a pathway? What is a cellular network?

43. Barry Smith, Louis J. Goldberg, Alan Ruttenberg and Michael Glick, "Ontology and the future of dental research informatics", *The Journal of the American Dental Association*, October, 141 (10), 2010, 1173–75.

Abstract: How do we find what is clinically significant in the swarms of data being generated by today's diagnostic technologies? As electronic records become ever more prevalent – and digital imaging and genomic, proteomic, salivaomics, metabalomics, pharmacogenomics, phenomics and transcriptomics techniques become commonplace – fdifferent clinical and biological disciplines are facing up to the need to put their data houses in order to avoid the consequences of an uncontrolled explosion of different ways of describing information. We describe a new strategy to advance the consistency of data in the dental research community. The strategy is based on the idea that existing systems for data collection in dental research will continue to be used, but proposes a methodology in which past, present and future data will be described using a consensus-based controlled structured vocabulary called the Ontology for Dental Research (ODR).

44. Barry Smith and Richard H. Scheuermann, "Ontologies for Clinical and Translational Research", *Journal of Biomedical Informatics*, 44:1 (2011), 3–7.

45. Barry Smith, Louis J. Goldberg, Alan Ruttenberg and Michael Glick, "Ontology and research: Authors' response", *The Journal of the American Dental Association*, 142(3), 2011, 252–54.

46. Fabian Neuhaus, Elizabeth Florescu, Antony Galton, Michael Gruninger, Nicola Guarino, Leo Obrst, Arturo Sánchez-Ruíz, Amanda Vizedom, Peter Yim and Barry Smith, "Creating the ontologists of the future", *Applied Ontology* 6 (2011), 91–98.

Abstract: The goal of the Ontology Summit 2010 was to address the current shortage of persons with ontology expertise by developing a strategy for the education of ontologists. To achieve this goal we studied how ontologists are currently trained, the requirements identified by organizations that hire ontologists, and developments that might impact the training of ontologists in the future. We developed recommendations for the body of knowledge that should be taught and the skills that should be developed by future ontologists; these recommendations are intended as guidelines for institutions and organizations that may consider establishing a program for training ontologists. Further, we recommend a number of specific actions for the community to pursue.

47. Barry Smith, "Guest Editorial: caBIG has another fundamental problem: it relies on 'incoherent' messaging standard", *The Cancer Letter*, 37: 16, April 22, 2011, 1 and 5–6.

48. Stefano Borgo, Riichiro Mizoguchi and Barry Smith, "On the ontology of functions", *Applied Ontology*, 6 (2011), 99–104.

49. Andreas Tolk and Barry Smith, "Editors' Introduction to Special Issue on Command and Control Ontology", *International Journal of Intelligent Defence Support Systems,* 4 (3), 2011, 209–214.

50. Dipak Kalra, Mark Musen, Barry Smith, Werner Ceusters, "Policy Brief on Semantic Interoperability", *Interoperability Reviews: ARGOS Trans-Atlantic Observatory Policy Briefs*, Washington, DC: American Medical Informatics Association, Summer 2011, Vol. 2 No. 1.

51. Georg Fuellen, Melanie Boerries, Hauke Busch, Aubrey de Grey, Udo Hahn, Thomas Hiller, Andreas Hoeflich, Ludger Jansen, Georges E. Janssens, Christoph Kaleta, Anne C. Meinema, Sascha Schäuble, Paul N. Schofield, Barry Smith, Jürgen Sühnel, Julio Vera, Wolfgang Wagner, Eva C. Wonne, Daniel Wuttke, "In-Silico-Approaches and the Role of Ontologies in Aging Research", *Rejuvenation Research*, 2013 Dec;16(6):540-6.

Abstract: The 2013 Rostock Symposium on Systems Biology and Bioinformatics in Aging Research was again dedicated to dissecting the aging process using in silico means. A particular focus was on ontologies, as these are a key technology to systematically integrate heterogeneous information about the aging process. Related topics were databases and data integration. Other talks tackled modeling issues and applications, the latter including talks focussed on marker development and cellular stress as well as on diseases, in particular on diseases of kidney and skin.

52. Barry Smith, "It Usually Begins with the Gene Ontology", *Methods of Information in Medicine*, 2013, 52 (6), 559-60.

Comment on P. L. Elkin, S. H. Brown and G. Wright, "Biomedical Informatics: We Are What We Publish", *Methods of Information in Medicine*, 2013, 52 (6), 538-546.

53. Carolyn Korsmeyer and Barry Smith, "Comment: Kolnai's Disgust", *Emotion Review*, 6 (3), 2014, 221–222.

Abstract: In his *The Meaning of Disgust*, Colin McGinn employs elements of the phenomenological theory of disgust advanced by Aurel Kolnai in his "On Disgust" of 1929. Kolnai's treatment of what he calls "material" disgust and of its primary elicitors—putrefying organic matter, bodily wastes and secretions, sticky contaminants, vermin—anticipates more recent scientific treatments of this emotion as a mode of protective recoil. In her review of McGinn's book, Nina Strohminger charges McGinn with neglecting such scientific studies. We here attempt to show how Kolnai goes beyond experimental findings in his careful description of the phenomenological differences between disgust and other emotions of forceful disapproval.

54. "[The curious case of the complicated border: The story of Baarle](#)," *Dutch International Society Magazine*, 47 (4), 2016, 11-17.

55. Sonia Kamińska and Barry Smith, "[How many Kafka's are there?](#)", *Polish Journal of Aesthetics,* 53 (2), 2019.

The aim of this volume is to present Kafka not as a writer, or not only as a writer, but as a philosopher. However, even after narrowing the scope of our interest down, there will still be several Kafka's left on the table. Themes treated in the volume include: the so-called Brentano School in Prague, Kafka's affiliation to the Louvre Circle, Kafka and existentialist philosophy, Kafka's Jewish heritage, his love of Nietzsche and Meister Eckhart and—last but not least, since he was such an exceptional writer—his aesthetics.

56. Barry Smith, "[The bridge between philosophy and information-driven science](#)", *Journal of Knowledge Structures and Systems* 2 (2): 47-55. 2021.

Abstract: This essay is a response to Luis M. Augusto's intriguing paper on the rift between mainstream and formal ontology. I will show that there are in fact two questions at issue here: 1. concerning the links between mainstream and formal approaches within philosophy, and 2. concerning the application of philosophy (and especially philosophical ontology) in support of information-driven research for example in the life sciences.

57. Jobst Landgrebe & Barry Smith, "[Intelligence. And what computers still can't do](#)", *[Cosmos+Taxis](#),* 12 (5+6):104-114. June 4 (2024)

Abstract: We comment on the collection of papers inspired by our book Why Machines Will Never Rule the World published in volume 12 (5+6) of the journal Cosmos+Taxis. We summarize the arguments made by the contributors about what we say in the book, and then show where we disagree.

58.

Chapters in Books

1. Barry Smith, "[Roman Ingarden: Ontological Foundations for Literary Theory](#)", in J. Odmark (ed.), *Language, Literature and Meaning I: Problems of Literary Theory*, Amsterdam: Benjamins, 1979, 373–390.

Abstract: The paper seeks to apply the work of the Polish phenomenologist Roman Ingarden to certain problems in literary theory; contrasts the notions of ontological and epistemological incompleteness of the represented objects of a literary work and considers the question of the nature of such objects. The paper concludes by analyzing some of the degrees of freedom possessed by the readings of literary work in relation to the work itself.

2. Barry Smith, "Kafka and Brentano: A Study in Descriptive Psychology", in Barry Smith (ed.), *Structure and Gestalt: Philosophy and Literature in Austria-Hungary and Her Successor States*, Amsterdam: John Benjamins, 1981, 113–161.

Abstract: There is a narrow thread in the vast literature on Kafka which pertains to Kafka's knowledge of philosophy, and more precisely to Kafka's use in his fictional writings of some of the main ideas of Franz Brentano. Kafka attended courses in philosophy at the Charles University given by Brentano's students Anton Marty and Christian von Ehrenfels, and was for several years a member of a discussion-group organized by orthodox adherents of the Brentanian philosophy in Prague. The present essay summarizes what is known about Kafka's relations to the

Brentanist movement. It draws on Brentanian ideas on the evidence of inner perception, on oblique consciousness, on active introspection, on correct and incorrect judgment, and on consciousness as a species of inner tribunal, in order to throw light on central features of Kafka's writings, including stylistic features. Special attention is directed towards *Die Verwandlung* and *Der Prozess,* and a reading of the latter is offered according to which the trial of Joseph K. occurs entirely within the mind of K. himself.

Revised version as: "Brentano and Kafka", *Axiomathes*, 8 (1997), 83–104.

French translation as: "Kafka et Brentano", *Philosophiques,* 26/2 (1999), 349–371.

3. Barry Smith, "The Production of Ideas: Notes on Austrian Intellectual History from Bolzano to Wittgenstein", in Barry Smith (ed.), *Structure and Gestalt: Philosophy and Literature in Austria-Hungary and Her Successor States*, Amsterdam: John Benjamins, 1981, 211–234.

Abstract: This paper takes the form of a series of sketches of 19th century Austrian political and intellectual history, allied with a number of more general reflections designed to contribute to our understanding of some of the peculiar characteristics of Austrian thought, particularly Austrian philosophy and economics, in theperiod in question.

4. Barry Smith and Kevin Mulligan, "Pieces of a theory", in Barry Smith (ed.), *Parts and Moments. Studies in Logic and Formal Ontology*, Munich: Philosophia, 1982, 15–109.

Abstract: A survey of theories of part, whole and dependence from Aristotle to the Gestalt psychologists, with special attention to Husserl's Third Logical Investigation "On the Theory of Parts and Wholes".

5. Barry Smith, "Introduction to Adolf Reinach, 'On the Theory of the Negative Judgment'", in Barry Smith (ed.), *Parts and Moments. Studies in Logic and Formal Ontology*, Munich: Philosophia, 1982, 289–313.

Abstract: Reinach's essay of 1911 establishes an ontological theory of logic, based on the notion of Sachverhalt or state of affairs. He draws on the theory of meaning and reference advanced in Husserl's Logical Investigations and at the same time anticipates both Wittgenstein's Tractatus and later speech act theorists' ideas on performative utterances. The theory is used by Reinach to draw a distinction between two kinds of negative judgment: the simple negative judgment, which is made true by a negative state of affairs; and the polemical negative judgment, which is a performative utterance in which the truth of some earlier judgment – typically a judgment made by some other person – is denied.

6. Barry Smith, "Meinen und Vorstellen in der literarischen Gegenstandskonstitution", in G. Wolandt (ed.), *Kunst und Kunstforschung. Beiträge zur Ästhetik*, Bonn: Bouvier, 1983, 49–61.

Abstract: Material things have material (spatial) parts. Acts, events, occurrences, have phases, which we can view as their temporal parts. Spatial surfaces and volumes, stretches of time, they all have parts again; they can all be considered "extended". Entities, on the other hand, such as directions, numbers, temperatures, colors, tones, fictional characters, prices, numbers, values, ideologies, goals, are all unextended; they are partless. Let us call such non-extended objects "nodes", in order to express the fact that we have a tendency to grasp them as pure correlates of our thinking, often at the same time viewing them effectively as placeholders within systems of coordinates in various intellectual and social domains. My aim, here, is to clarify this rough idea of "node" for the purpose of providing a corresponding clarification of Ingarden's idea of a *purely intentional object*. I first consider purely intentional objects in general, and then focus in particular on fictional examples.

7. Barry Smith, "Summaries and Note: On the Political Economy of Karl Wittgenstein", in J. C. Nyíri (ed.), *Karl Wittgenstein: Politico-Economic Writings*, Amsterdam: John Benjamins, 1984, 197–227.

8. Barry Smith, "Wittgenstein und das ethische Gesetzv", in D. Birnbacher and A. Burkhardt (eds.), *Sprachspiel und Methode. Zum Stand der Wittgenstein-Diskussion*, Berlin/New York: de Gruyter, 1985, 191–211.

Abstract: Der vorliegende Aufsatz stellt den Versuch dar, die normative Seite von Wittgensteins Frühwerk herauszuarbeiten und dabei an seinem Ansatz insofern Kritik zu üben, als gezeigt wird, wie sehr dessen Implikationen mit unseren üblichen ethischen Vorstellungen in Konflikt stehen. Die Arbeit hat aber auch einen etwas wohlwollenderen Aspekt: Sie versucht zu zeigen, wie Wittgensteins scheinbar widersinnige Ansichten so formuliert werden können, daß sie zumindest begreifbar erscheinen. Zu diesem Zweck beginnen wir mit der Untersuchung des demjenigen Wittgensteins erstaunlich ähnlichen ethischen Ansatzes, wie er von einem seiner frühen väterlichen Freunde vertreten wurde, nämlich von Karl Kraus.

9. Barry Smith, "Preface: Austrian Economics from Menger to Hayek", in Wolfgang Grassl and Barry Smith (eds.), *Austrian Economics: Historical and Philosophical Background*, New York: New York University Press, London/Sydney: Croom Helm, 1986, v–viii.

10. Barry Smith, "Austrian economics and Austrian philosophy", in Wolfgang Grassl and Barry Smith (eds.), *Austrian Economics: Historical and Philosophical Background*, New York: New York University Press, London/Sydney: Croom Helm, 1986, 1–36, reprinted in the series Routledge Revivals, London: Routledge, 2010.

Abstract: Austrian economics starts out from the thesis that the objects of economic science differ from those of the natural sciences because of the centrality of the economic agent. This allows a certain *a priori* or essentialistic aspect to economic science of a sort which parallels the *a priori* dimension of psychology defended by Brentano and his student Edmund Husserl. We outline these parallels, and show how the theory of a priori dependence relations outlined in Husserl's *Logical Investigations* can throw light on the Austrian account of entrepreneurship, especially as this is formulated by Israel Kirzner.

11. Barry Smith, "The theory of value of Christian von Ehrenfels", in R. Fabian (ed.), *Christian von Ehrenfels: Leben und Werk*, Amsterdam: Rodopi, 1986, 150–171.

Abstract: Christian von Ehrenfels was a student of both Franz Brentano and Carl Menger and his thinking on value theory was inspired both by Brentano's descriptive psychology and by the subjective theory of economic value advanced by Menger, the founder of the Austrian school of economics. Value, for Ehrenfels, is a function of desire, and we ascribe value to those things which we either do in fact desire, or would desire if we were not convinced of their existence. He asserts that the needed theoretical understanding of values is to be achieved by generalizing economic laws of valuation to apply to value in general. The law of marginal utility, for example, is a law to the effect that the n+1st sample of a good which I receive is *ceteris paribus* less valuable than the nth sample (imagine that the samples in question are, for example, a series of identical ham sandwiches). The essay describes how Ehrenfels provides on this basis an account of the different types of values, both intrinsic and non-intrinsic. It outlines also Ehrenfels views on the problem of interpersonal value-comparisons and on the struggle for survival between different values of different types.

12. Kevin Mulligan and Barry Smith, "Mach und Ehrenfels: Über Gestaltqualitäten und das Problem der Abhängigkeit", in R. Fabian (ed.), *Christian von Ehrenfels: Leben und Werk*, Amsterdam: Rodopi, 1986, 85–111.

Abstract: Ernst Mach's atomistic theory of sensation faces problems in doing justice to our ability to perceive and remember complex phenomena such as melodies and shapes. Christian von Ehrenfels attempted to solve these problems with his theory of "Gestalt qualities", which he sees as entities depending one-sidedly on the corresponding simple objects of sensation. We explore the theory of dependence relations advanced by Ehrenfels and show how it relates to the views on the objects of perception advanced by Husserl and by the Gestalt psychologists.

Revised and expanded English version as: "Mach and Ehrenfels: The Foundations of Gestalt Theory", in Barry Smith (ed.), *Foundations of Gestalt Theory*, Munich and Vienna: Philosophia, 1988, 124–157.

Romanian translation as: "Mach şi Ehrenfels. Fundamentele teoriei gestaltiste", in Constantin Stoenescu, Ion Tănăsescu (eds.), *Filosofia Austriacă*, Bucharest: Pelican, 2005, 262–294.

13. Barry Smith, "Materials towards a history of speech act theory", in A. Eschbach (ed.), *Karl Bühler's Theory of Language*, Amsterdam: John Benjamins, 1987, 125–152.

Abstract: Provides a survey of the development of speech act theory from Aristotle through Reid and Peirce to Edmund Husserl, Anton Marty, Johannes Daubert, Adolf Reinach, and finally to Austin and Searle. A special role is played by Husserl's theory of objectifying acts (meaning, roughly, acts of naming or stating) and of the efforts by his followers to extend this theory to cover phenomena such as questioning and commanding. These efforts culminated in the work of Adolf Reinach, who developed the first systematic theory of speech acts in connection with his monograph of 1913 on "The A Priori Foundations of the Civil Law".

Revised and expanded version as: "Towards a history of speech act theory", in A. Burkhardt (ed.), *Speech Acts, Meanings and Intentions. Critical Approaches to the Philosophy of John R. Searle*, Berlin/New York: de Gruyter, 1990, 29–61.

Italian translation as: "Per una storia della teoria degli atti linguistici", in: *Il realismo fenomenologico. Sulla filosofia dei circoli di Monaco e Gottinga*, Stefano Besoli e Luca Guidetti (eds.), Macerata: Quodlibet, 2000, 385–418.

Spanish translation as: "Una breve historia de la teoría de los actos de habla", in *Pragmática: Desarrollos teóricos y debates*, translated by Jorge Gómez, Quito: Edicion Abya-Yala, 2002, 13–82.

14. Barry Smith, "Husserl, Language and the Ontology of the Act", in D. Buzzetti and M. Ferriani (eds.), *Speculative Grammar, Universal Grammar, and Philosophical Analysis of Language*, Amsterdam: John Benjamins, 1987, 205–227.

Abstract: The ontology of language is concerned with the relations between uses of language, both overt and covert, and other entities, whether in the world or in the mind of the thinking subject. We attempt a first survey of the sorts of relations which might come into question for such an ontology, including: relations between referring uses of expressions and their objects, relations between the use of a (true) sentence and that in the world which makes it true, relations between mental acts on the one hand and underlying mental states (attitudes, beliefs), on the other, relations between my acts and states, associated uses of language and overt actions on my part and on the part of those other subjects with whom I communicate.

15. Barry Smith, "On the cognition of states of affairs", in K. Mulligan (ed.), *Speech Act and Sachverhalt: Reinach and the Foundations of Realist Phenomenology*, Dordrecht/Boston/Lancaster: Nijhoff, 1987, 189–225.

Abstract: The theory of speech acts put forward by Adolf Reinach in his "The A Priori Foundations of the Civil Law" of 1913 rests on a systematic account of the ontological structures associated with various different sorts of language use. One of the most original features of Reinach's account lies in hIs demonstration of how the ontological structure of, say, an action of promising or of commanding, may be modified in different ways, yielding different sorts of non-standard instances of the corresponding speech act varieties. The present paper is an attempt to apply this idea of standard and modified instances of ontological structures to the realm of judgement and cognition, and thereby to develop a Reinachian theory of how intentionality is mediated through language in acts of thinking and speaking.

Italian translation as: "Adolf Reinach e la fondazione della fenomenologia realistica", *Paradigmi*, 5 (1987), 229–241 and 6 (1987), 485–507.

16. Karl Schuhmann and Barry Smith, "Adolf Reinach: An Intellectual Biography", in K. Mulligan (ed.), *Speech Act and Sachverhalt: Reinach and the Foundations of Realist Phenomenology*, Dordrecht/Boston/Lancaster: Nijhoff, 1987, 1–27.

Abstract: The essay provides an account of the development of Reinach's philosophy of "Sachverhalte" (states of affairs) and on problems in the philosophy of law, leading up to his discovery of the theory of speech acts in 1913. Reinach's relations to Edmund Husserl and to the Munich phenomenologists are also dealt with.

17. Barry Smith, "Austrian Origins of Logical Positivism", in B. Gower (ed.), *Logical Positivism in Perspective*, London/Sydney: Croom Helm, 1987, Totowa: Barnes and Noble, 1988, 35–68.

Abstract: Recent work on Austrian philosophy has revealed, hitherto, unsuspected links between Vienna circle positivism on the one hand, and the thought of Franz Brentano and his circle on the other. the paper explores these links, casting light also on the Polish analytic movement, on the development of Gestalt psychology, and on the work of Schlick and Neurath.

Reprinted in: K. Szaniawski (ed.), *The Vienna Circle and the Lvov-Warsaw School*, Dordrecht/Boston/Lancaster: Kluwer, 1989, 19–53.

18. Barry Smith, "Gestalt Theory: An Essay in Philosophy", in Barry Smith (ed.), *Foundations of Gestalt Theory*, Munich and Vienna: Philosophia, 1988, 11–81.

Abstract: The Austrian philosopher Christian von Ehrenfels published his essay "On 'Gestalt Qualities'" in 1890. The essay initiated a current of thought which enjoyed a powerful position in the philosophy and psychology of the first half of this century and has more recently enjoyed a minor resurgence of interest in the area of cognitive science, above all in criticisms of the so-called 'strong programme' in artificial intelligence. The theory of Gestalt is of course associated most specifically with psychologists of the Berlin school such as Max Wertheimer, Wolfgang Köhler and Kurt Koffka. We shall see in what follows, however, that an adequate philosophical understanding of the Gestalt idea and of Ehrenfels' achievement will require a close examination not merely of the work of the Berlin school but also of a much wider tradition in Austrian and German philosophy in general.

19. Barry Smith, "Knowing How vs. Knowing That", in J. C. Nyíri and Barry Smith (eds.), *Practical Knowledge. Outlines of a Theory of Traditions and Skills*, London/Sydney/New York: Croom Helm, 1988, 1–16.

Abstract: A sketch of the history of the opposition between propositional and practical knowledge is followed by a brief account of the relevant ideas of Merleau-Ponty, Polanyi, and H. and S. Dreyfus (on expertise and artificial intelligence). The paper concludes with a discussion of the work of Ryle on the notion of a 'discipline', drawing implications for a theory of traditions.

20. Barry Smith, "Practices of Art", in J. C. Nyíri and Barry Smith (eds.), *Practical Knowledge. Outlines of a Theory of Traditions and Skills*, London/Sydney/New York: Croom Helm, 1988, 172–209.

Abstract: Starting out from the ontology of human work set out by Marx in *Das Kapital*, the paper seeks to analyse the relations between the artist and his actions and aims, the work of art he produces, and the audience for this work. The paper concludes with a discussion of the problem of creativity in the arts, drawing on ideas of Roman Ingarden and other phenomenologists.

21. Barry Smith, "Logic and Formal Ontology", in J. N. Mohanty and W. McKenna (eds.), *Husserl's Phenomenology: A Textbook*, Lanham: University Press of America, 1989, 29–67.

Abstract: Logic for Husserl is a science of science, a science of what all sciences have in common in their modes of validation. Thus logic deals with universal laws relating to truth, to deduction, to verification and falsification, and with laws relating to theory as such, and to what makes for theoretical unity, both on the side of the propositions of a theory and on the side of the domain of objects to which these propositions refer. This essay presents a systematic overview of Husserl's views on these matters as put forward in his Logical Investigations. It shows how

Husserl's theory of linguistic meanings as species of mental acts, his formal ontology of part, whole and dependence, his theory of meaning categories, and his theory of categorial intuition combine with his theory of science to form a single whole. Finally, it explores the ways in which Husserl's ideas on these matters can be put to use in solving problems in the philosophy of language, logic and mathematics in a way which does justice to the role of mental activity in each of these domains while at the same time avoiding the pitfalls of psychologism.

Revised version in: *Manuscrito*, 23: 2, 2000, 275–323.

Italian translation as: "Logica e ontologia formale nelle *Logische Untersuchungen* di Edmund Husserl", *Rivista di Filosofia*, 83, 1991, 53–70.

Spanish translation as: "Lógica y ontología formal", Grupo de Acción Filosófica (GAF), Buenos Aires, Argentina, 2004.

Russian translation

22. Barry Smith, "Kasimir Twardowski: An Essay on the Borderlines of Psychology, Ontology and Logic", K. Szaniawski (ed.), *The Vienna Circle and the Philosophy of the Lvov-Warsaw School*, Dordrecht/Boston/Lancaster: Kluwer, 1989, 313–373.

Abstract: The influence of Kasimir Twardowski on modern Polish philosophy is all-pervasive. As is well known, almost all important 20th century Polish philosophers went through the hard training of his courses in Lvov. Twardowski instilled in his students an enduring concern for clarity and rigour. He taught them to regard philosophy as a collaborative effort, a matter of disciplined discussion and argument. And he encouraged them to work together with scientists from other disciplines — above all with psychologists, and also with mathematicians — so that the Lvov school of philosophy would gradually evolve into the Warsaw school of logic.

Revised version as: "Kasimir Twardowski: On Content and Object ", chapter 6 of Barry Smith, *Austrian Philosophy: The Legacy of Franz Brentano*, La Salle and Chicago: Open Court, 1994, 160-200.

23. Barry Smith, "Constraints on Correspondence" in *Traditionen und Perspektiven der analytischen Philosophie. Festschrift für Rudolf Haller*, H. Rutte, W. Sauer and W. Gombocz (eds.), Vienna: Hölder/Pichler/Tempsky, 1989, 415–430.

Abstract: My aim is to lay down some constraints on a correspondence theory of truth for empirical sentences of a natural language on the basis of a theory according to which that to which a true empirical sentence of such a language corresponds is a part of the natural world. The problem is to find some means of delineating those portions of the world which serve as correspondents, portions of reality otherwise called 'truthmakers'.

24. Barry Smith, "Logica Kirchbergensis", in P. Klein (ed.), *Praktische Logik. Traditionen und Tendenzen*, Abhandlungen eines Seminars beim 13. Internationalen Wittgenstein-Symposium, Kirchberg am Wechsel 1988 (Veröffentlichungen der Joachim-Jungius Gesellschaft Hamburg, 61), Göttingen: Vandenhoeck & Ruprecht, 1989, 123–145.

Abstract: In der klassischen Logik von Aristoteles bis Wolff findet sich eine durchgängige Parallelität von logischen (einschließlich grammatikalischen und psychologischen) und ontologischen Gebilden. Der Logiker beschäftigt sich mit Subjekt und Prädikat, aber gleichzeitig auch z.B. mit Substanz und Akzidenz als Entitäten in der Welt. Nach Kant begann für die Logik eine Phase, in der diese ontologische oder objektbezogene Seite verloren ging. Gegen Ende des 19. Jahrhunderts beginnt man dann aber wieder über die ontologischen Korrelate des Denkens und des Urteilens zu sprechen. Wir zeigen, dass diese Wiederbelebung der alten Logik mit der Einführung des Terminus 'Sachverhalt' in die Sprache der Philosophie verbunden ist.

25. Karl Schuhmann and Barry Smith, "Vorwort", editors' forward to vol. I of Adolf Reinach, *Sämtliche Werke. Kritische Ausgabe mit Kommentar*, Karl Schuhmann and Barry Smith (eds.), Munich/Hamden/Vienna: Philosophia, 1989, XIV–XVIII.

26. Karl Schuhmann and Barry Smith, "Adolf Reinach (1884-1917)", editors' introduction to vol. II of Adolf Reinach, *Sämtliche Werke. Kritische Ausgabe mit Kommentar*, Karl Schuhmann and Barry Smith (eds.), Munich/Hamden/Vienna: Philosophia, 1989, 613–626.

27. Karl Schuhmann and Barry Smith, "Kommentar und Textkritik", critical apparatus to vol. II of Adolf Reinach, *Sämtliche Werke. Kritische Ausgabe mit Kommentar*, Karl Schuhmann and Barry Smith (eds.), Munich/Hamden/Vienna: Philosophia, 1989, 627–829.

28. Barry Smith, "Brentano and Marty: An Inquiry into Being and Truth", in K. Mulligan (ed.), *Mind, Meaning and Metaphysics: The Philosophy and Theory of Language of Anton Marty*, Dordrecht/Boston/Lancaster: Kluwer, 1990, 111–149.

Abstract: A study of the concepts of reality and existence in the work of Franz Brentano and his student Anton Marty. Topics dealt with include: Aristotle's concept of being in the sense of being true; operationally defined concepts; Brentano's reism; things and states of affairs.

Revised version as: "Anton Marty: On Being and Truth", chapter 4 of Barry Smith, *Austrian Philosophy: The Legacy of Franz Brentano*, La Salle and Chicago: Open Court, 1994.

29. Barry Smith, "On the Phases of Reism", in J. Wolenski, ed., *Kotarbinski: Logic, Semantics and Ontology*, Dordrecht/Boston/London: Kluwer, 1990, 137–184.

Abstract: Kotarbiński is one of the leading figures in the Lvov-Warsaw school of Polish philosophy. We summarize the development of Kotarbiński's thought from his early nominalism and 'pansomatistic reism' to the later doctrine of 'temporal phases'. We show that the surface clarity and simplicity of Kotarbiński's writings mask a number of profound philosophical difficulties, connected above all with the problem of giving an adequate account of the truth of contingent (tensed) predications. The paper will examine in particular the attempts to resolve these difficulties on the part of Leśniewski. It will continue with an account of the relations of Kotarbińskian reism to the ontology of things or entia realia defended by the later Brentano. Kotarbiński's identification of Brentano as a precursor of reism is, it will be suggested, at least questionable, and the paper will conclude with a more careful attempt to situate the Brentanian and Kotarbińskian ontologies within the spectrum of competing ontological views.

Reprinted in: *Actions, Products, and Things. Brentano and Polish Philosophy*, A. Chrudzimski and D. Łukasiewicz (eds.), Frankfurt: ontos, 2006, 115–176.

30. Jean Petitot and Barry Smith, "New Foundations for Qualitative Physics", in J. E. Tiles, G. T. McKee and C. G. Dean (eds.), *Evolving Knowledge in Natural Science and Artificial Intelligence*, London: Pitman Publishing, 1990, 231–249.

Abstract: Modern physics is not the science of some ultimate bedrock of reality. Rather (crudely speaking) it is a science which deals with a limited number of ways in which matter manifests itself in qualitative reality. It deals with these manifestations not, however, as denizens of the qualitative world, but in purified form, as quantities or magnitudes. Physics seeks to use mathematical devices to explain the given manifestations by showing how they are subject to formal laws or principles. We describe a variety of such manifestations and show how qualitative reality is preserved, in the physicists' view of reality, but filtered through structures of a quantitative sort.

Russian translation

31. Barry Smith, "Grundlegung eines fallibilistichen Apriorismus", in N. Leser, J. Seifert and K. Pflitzner (eds.), *Die Gedankenwelt Sir Karl Poppers. Kritischer Rationalismus im Dialog*, Heidelberg: Carl Winter Universitätsverlag, 1991, 393–411.

Abstract: We assume a position of scientific realism to the effect (i) that the world exists and (ii) that through the working out of ever more sophisticated theories our scientific picture of reality will approximate ever more closely to the world as it really is. Against this background consider, now, the following question: 1. Do the empirical theories with the help of which we

seek to approximate a good or true picture of reality rest on any non-empirical presuppositions? One can answer this question with either a 'yes' or a 'no'. 'No' is the preferred answer of most contemporary methodologists – Murray Rothbard is one distinguished counterexample to this trend – who maintain that empirical theories are completely free of non-empirical ('a priori') admixtures and who see science as a matter of the gathering of pure 'data' obtained through simple observation. From such data scientific propositions are then supposed to be somehow capable of being established.

English translation as: "In Defense of Extreme (Fallibilistic) Apriorism", *Journal of Libertarian Studies* 12 (1996), 179–192.

Russian translation

32. Barry Smith, "Relevance, Relatedness and Restricted Set Theory", in G. Schurz and G. J. W. Dorn (eds.), *Advances in Scientific Philosophy. Essays in Honour of Paul Weingartner*, Amsterdam/Atlanta: Rodopi, 1991, 45–56.

Abstract: What sort of set theory results when restrictions are placed on the sorts of elements which may form a set? Given an arbitrary relevance relation, one can formulate a notion of set which will apply only to totalities of mutually relevant entities. Relevance might signify for example: exists at the same time as, belongs to the same body as, is less than a certain distance from, etc. The resultant theory, which embodies topological constraints, can then be used as the basis for an account of relevance between propositions which is in the tradition of the relevant logics of analytic implication studied by M. Dunn and W. T. Parry.

33. Barry Smith, "Characteristica Universalis", in K. Mulligan (ed.), *Language, Truth and Ontology* (Philosophical Studies Series), Dordrecht/Boston/London: Kluwer, 1992, 48–77.

Abstract: Recent work in formal philosophy has concentrated overwhelmingly on the logical problems pertaining to epistemic shortfall - which is to say on the various ways in which partial and sometimes incorrect information may be stored and processed. A directly depicting language, in contrast, would reflect a condition of epistemic perfection. It would enable us to construct representations not of our knowledge but of the structures of reality itself, in much the way that chemical diagrams allow the representation (at a certain level of abstractness) of the structures of molecules of different sorts. A diagram of such a language would be true if that which it sets out to depict exists in reality, i.e. if the structural relations between the names (and other bits and pieces in the diagram) map structural relations among the corresponding objects in the world. Otherwise it would be false. All of this should, of course, be perfectly familiar. (See, for example, Aristotle, *Metaphysics*, 1027 b 22, 1051 b 32ff.) The present paper seeks to go further than its predecessors, however, in offering a detailed account of the syntax of a working universal characteristic and of the ways in which it might be used.

Characteristica Universalis (Danish translation) in: *Almen Semiotik*, 14 (1998), 158–187.

34. Barry Smith, "Austrian Philosophy and Austrian Economics", in J. Lee Auspitz, *et al*. (eds.), *Praxiologies and the Philosophy of Economics,* New Brunswick and London: Transaction Publishers, 1992, 245–272.

35. Barry Smith, "Ontology and the Logistic Analysis of Reality", in N. Guarino and R. Poli (eds.), *Proceedings of the International Workshop on Formal Ontology in Conceptual Analysis and Knowledge Representation,* Padova: Institute for Systems Theory and Biomedical Engineering of the Italian National Research Council, 1993, 51–68.

Abstract: I show how mereology, taken together with certain topological notions, can yield the basis for future investigations in formal ontology. I shall attempt to show also how the mereological framework here advanced can allow the direct and natural formulation of a series of theses – for example pertaining to the concept of boundary – which can be formulated only indirectly (if at all) in set-theoretic terms.

Polish translation as: "[Ontologia i logiczna analiza rzeczywistosci](...)", in *Filozofia Nauki*, 2 (1994), 5–22.

36. Barry Smith, "[The New European Philosophy](...)" in Barry Smith (ed.), *Philosophy and Political Change in Eastern Europe*, La Salle: The Hegeler Institute, 1993, 165–170 and 191–192.

Abstract: The paper seeks to indicate ways in which the crude distinction between Anglo-Saxon and Continental philosophy may have to be amended in light of recent developments in Eastern Europe. As is well known, the philosophy of science is to no small part a product of the universities of the Habsburg Empire (in Vienna, Prague, Lemberg/Lwow, etc.). Logic, too, has played a more significant role in Eastern Europe (not least in Poland) than in the philosophical cultures of Germany or France. For these and other reasons, a shift in the center of gravity of Continental philosophy is currently being realized, as younger Eastern European philosophers in newly liberalized institutions begin to return to their roots in their native pre-Communist intellectual traditions.

37. Barry Smith, "[Husserl's Theory of Meaning and Reference](...)", in L. Haaparanta (ed.), *Mind, Meaning and Mathematics. Essays on the Philosophy of Husserl and Frege*, Dordrecht/Boston/Lancaster: Kluwer, 1994, 163–183.

Abstract: This paper is a contribution to the historical roots of the analytical tradition. As Michael Dummett points out in his *Origins of Analytic Philosophy*, many tendencies in Central European thought contributed to the early development of analytic philosophy. Dummett himself concentrates on just one aspect of this historical complex, namely on the relationship between the theories of meaning and reference developed by Frege and by Husserl in the years around the turn of the century. It is to this specific issue that the present essay is devoted, though we attempt a more sympathetic reading of Husserl's views on these matters than is to be found in Dummett's work. Topics covered include Husserl's theory of intentionality, his view of meanings as types or essences of mental acts, of the relation between meaning and expression, of states of affairs, and of indexicality.

38. Barry Smith, "[Filozofia Austriacka](...)" in T. Lubowiecki and A. Rojszczak (eds.), *Filozofia Austriacka (Principia* VIII–IX), Cracow: Aureus S.C., 1994, 19–50. Polish translation of Chapter 1 of Barry Smith, *Austrian Philosophy: The Legacy of Franz Brentano*, La Salle and Chicago: Open Court, 1994.

39. Josef Seifert and Barry Smith, "[The Truth about Fiction](...)", in W. Galewicz, E. Ströker and W. Strozewski (eds.), *Kunst und Ontologie. Für Roman Ingarden zum 100. Geburtstag*, Amsterdam/Atlanta: Rodopi, 1994, 97–118.

40. Barry Smith and David W. Smith, "[Introduction](...)" to Barry Smith and David W. Smith (eds.), *The Cambridge Companion to Husserl*, Cambridge and New York: Cambridge University Press, 1995, 1–44.

Husserl's philosophy, by the usual account, evolved through three stages: 1. development of an anti-psychologistic, objective foundation of logic and mathematics, rooted in Brentanian descriptive psychology; 2. development of a new discipline of "phenomenology" founded on a metaphysical position dubbed "transcendental idealism"; transformation of phenomenology from a form of methodological solipsism into a phenomenology of intersubjectivity and ultimately (in his Crisis of 1936) into an ontology of the life-world, embracing the social worlds of culture and history. We show that this story of three revolutions can provide at best a preliminary orientation, and that Husserl was constantly expanding and revising his philosophical system, integrating views in phenomenology, ontology, epistemology and logic with views on the nature and tasks of philosophy and science as well as on the nature of culture and the world in ways that reveal more common elements than violent shifts of direction. We argue further that Husserl is a seminal figure in the evolution from traditional philosophy to the characteristic philosophical concerns of the late twentieth century: concerns with representation and intentionality and with problems at the borderlines of the philosophy of mind, ontology, and cognitive science.

41. Barry Smith, "Common Sense", in Barry Smith and David W. Smith (eds.), *The Cambridge Companion to Husserl*, Cambridge and New York: Cambridge University Press, 1995, 394–436.

Abstract: Can there be a theory-free experience? And what would be the object of such an experience. Drawing on ideas set out by Husserl in the "Crisis" and in the second book of his "Ideas", the paper presents answers to these questions in such a way as to provide a systematic survey of the content and ontology of common sense. In the second part of the paper Husserl's ideas on the relationship between the common-sense world (what he called the 'life-world') and the world of physical theory are subjected to a critical evaluation. The relation of Husserl's ideas to current work in folk psychology and naive physics and to the direct realism of J. J. Gibson are also treated.

42. Barry Smith, "The Neurath–Haller Thesis: Austria and the Rise of Scientific Philosophy", in K. Lehrer and J. C. Marek (eds.), *Austrian Philosophy Past and Present* (Boston Studies in the Philosophy of Science), Dordrecht/Boston/Lancaster: Kluwer, 1996, 1–20.

Abstract: The term 'Continental philosophy' designates not philosophy on the continent of Europe as a whole, but rather a selective slice of Franco-German philosophy. Through a critical analysis of the arguments advanced by Otto Neurath, the paper addresses the issue of why Austrian philosophers in particular are not counted in the pantheon of Continental philosophers. Austrian philosophy is marked by the predominance of philosophical analysis and of the philosophy of science. The paper concludes that it is not Austria which is the special case when seen against the background of contemporary mainstream philosophy, but rather Germany and France.

Reprinted as: "Austria and the Rise of Scientific Philosophy", in A. Chrudzimski and W. Huemer (eds.), *Phenomenology and Analysis. Essays on Central European Philosophy*, Frankfurt and Lancaster: ontos / de Gruyter, 2004, 33–56.

French version as: "L'Autriche et la naissance de la philosophie scientifique", *Actes de la Recherche en Sciences Sociales* (Paris), 109 (1995), 61–71.

43. Barry Smith, "Foreword" to Wojciech Zelaniec, *The Recalcitrant Synthetic A Priori*, Lublin: Artom, 1996, 7–8.

44. Barry Smith and Leonardo Zaibert, "Prolegomena to a Metaphysics of Real Estate", in Roberto Casati (ed.), *Shadows and Socio-Economic Units. Foundations of Formal Geography,* Department of Geoinformation, Technical University of Vienna, 1996, 151–155.

Abstract: As an object in which property rights can be invested, land is a peculiar hybrid structure that comprehends both spatial and non-spatial aspects. Even in its purely spatial aspect land is treated differently from culture to culture, thus for example in the degree to which property rights in land are held to relate to vague or precisely delineated parcels and to portions of space above and below the surface of the earth. When we examine the non-spatial aspects of landed property, however, the dimensions of variability across cultures are multiplied tremendously. The goal is to provide a general framework for comparison of different socio-legal ontologies of land. The relevance of this project turns on the fact that without land (or real estate) it is difficult (perhaps impossible) to obtain credit; without credit it is difficult for nations to develop. Thus, if land is treated in a radically different way from one nation to another, this will surely exert an effect upon the development of nations.

45. Barry Smith, "Pleasure and Its Modifications: Stephan Witasek and the Aesthetics of the Grazer Schule", in L. Albertazzi (ed.), *The Philosophy of Alexius Meinong* (*Axiomathes VII,* nos. 1–2), 1996, 203–232.

Abstract: The most obvious varieties of mental phenomena directed to non-existent objects occur in our experiences of works of art. The task of applying the Meinongian ontology of the non-existent to the working out of a theory of aesthetic phenomena was however carried out

not by Meinong by his disciple Stephan Witasek in his *Grundzüge der allgemeinen Ästhetik of* 1904. Witasek shows in detail how our feelings undergo certain sorts of structural modifications when they are directed towards what does not exist. He draws a distinction between genuine mental phenomena and what he calls 'phantasy-material', asserting that 'the job of the aesthetic object, whether it is a work of art or a product of nature, is to excite and support the actualisation of phantasy-material in the experiencing subject'. We might think of such phantasy-material as a matter of *Ersatz*-emotions or emotional 'slop'. We could then see Witasek's aesthetics as an elaborate taxonomy of the various different sorts of ersatz-emotions which the subject allows to be stimulated within himself in his intercourse with works of art, and see works of art themselves as machines for the production of ever more subtle varieties of such phantasy-material in the perceiving subject.

46. Barry Smith, "The Connectionist Mind: A Study of Hayekian Psychology", in S. F. Frowen (ed.), *Hayek: Economist and Social Philosopher: A Critical Retrospect*, London: Macmillan, 1997, 9–29.

Abstract: In his *The Sensory Order* of 1952 Hayek develops a connectionist view of the mind that is similar to the view developed by Donald Hebb in 1949. The paper presents the details of Hayek's theory in the light of subsequent developments in connectionist psychology. It expands on Hayek's comparison between the mind and the price system of the market order, and it concludes with a series of criticisms of Hayek's views in particular and of connectionism in general, focusing on the issues of active, deliberate thinking, on mental causality, and on the stability of human cognitive categories.

Reprinted in: *Cognitive Economics*, M. Egidi and S. Rizzello (eds.), Cheltenham: Edward Elgar Publishing, 2004, 148-168.

French translation as: "L'esprit connexionniste: une étude de la psychologie de Hayek", *Intellectica,* 28: 1, 1999, 93–115.

47. Jean Petitot and Barry Smith, "Physics and the Phenomenal World", in R. Poli and P. M. Simons (eds.), *Formal Ontology*, Dordrecht/Boston/Lancaster: Kluwer, 1997, 233–254.

Abstract: The paper challenges the assumption, common amongst philosophers, that the reality described in the fundamental theories of microphysics is all the reality we have. It will be argued that this assumption is in fact incompatible with the nature of such theories. It will be shown further that the macro-world of three-dimensional bodies and of such qualitative structures as colour and sound can be treated scientifically on its own terms, which is to say not only from the perspective of psychology but also ontologically. A new sort of emergentist position will be defended, one which yields the basis of a method for describing the perceptually salient macroscopic world in mathematical terms. Broadly, it will be argued that the macroscopic world exists in virtue of certain specific sorts of boundary-patterns in the field of what is captured by the theories of microphysics.

Russian translation in: *Ophyr*, n.d.

48. Barry Smith, "Boundaries: An Essay in Mereotopology", in L. H. Hahn (ed.), *The Philosophy of Roderick Chisholm* (Library of Living Philosophers), Chicago and LaSalle: Open Court, 1997, 534–561.

Abstract: How can two neighboring spheres be in contact, given that, between any two points of the continuum, an infinity of further points must be admitted? Chisholm proposed a solution to this paradox, which rests on a theory of the coincidence of boundaries drawn from the work of Franz Brentano. For Brentano, a boundary can never exist except in connection with other boundaries and except as belonging to a continuum of higher dimension. Taking Chisholm's formalizations of Brentano's ideas as its starting point, the present paper seeks to develop a general theory of topology based on mereology.

49. Barry Smith, "Truth and the Visual Field", in *Naturalizing Phenomenology. Issues in Contemporary Phenomenology and Cognitive Science,* edited by J. Petitot, F. J. Varela, B. Pachoud and J. M. Roy, Stanford: Stanford University Press, 1999, 317–329.

Abstract: The paper uses the tools of mereotopology (the theory of parts, wholes and boundaries) to work out the implications of certain analogies between the 'ecological psychology' of J. J Gibson and the phenomenology of Edmund Husserl. It presents an ontological theory of spatial boundaries and of spatially extended entities. By reference to examples from the geographical sphere it is shown that both boundaries and extended entities fall into two broad categories: those which exist independently of our cognitive acts (for example, the planet Earth, its exterior surface); and those which exist only in virtue of such acts (for example: the equator, the North Sea). The visual field, too, can be conceived as an example of an extended entity that is dependent in the sense at issue. The paper suggests extending this analogy by postulating entities which would stand to true judgments as the visual field stands to acts of visual perception. The judgment field is defined more precisely as that complex extended entity which comprehends all entities which are relevant to the truth of a given (true) judgment. The work of cognitive linguists such as Talmy and Langacker, when properly interpreted, can be shown to yield a detailed account of the structures of the judgment fields corresponding to sentences of different sorts. A new sort of correspondence-theoretic definition of truth for sentences of natural language can then be formulated on this basis.

Preprint in: Carola Eschenbach and Wolfgang Heydrich (eds.), *Parts and Wholes. Integrity and Granularity*, Hamburg: Graduiertenkolleg Kognitionswissenschaft, 1995, 109–118.

Italian translation as: "La verità e il campo visivo", *Paradigmi*, 17, 1999, 48–62.

French translation as : "La vérité et le champ visuel", in *Naturaliser la phénoménologie: Husserlianisme et science cognitive*, Paris: CNRS Editions, 2002, 411–426.

50. Artur Rojszczak and Barry Smith, "Urteilstheorien und Sachverhalte", in Otto Neumaier (ed.), *Satz und Sachverhalt*, Sankt Augustin: Academia Verlag, 2000, 9–72.

51. "Zeno's Paradox for Colours", in Robert Dostal, Lester Embree, Joseph J. Kockelmans, J. N. Mohanty, and Olav K. Wiegand (eds.), *Phenomenology on Kant, German Idealism*, *Hermeneutics*, *and Logic*, Dordrecht: Kluwer (2000), 201–207.

52. Barry Smith, "Objects and Their Environments: From Aristotle to Ecological Psychology", in Andrew Frank, Jonathan Raper and Jean-Paul Cheylan (eds.), *The Life and Motion of Socio-Economic Units* (GISDATA 8), London: Taylor and Francis, 2001, 79–97.

Abstract: The essay is divided into four main parts: the first sketches basic dichotomy of substances (objects, things, persons), on the one hand, and accidents (events, qualities, actions) at the heart of Aristotelian ontology. The second outlines some of the subtypes falling under these two headings. The third concerns the Aristotelian ontology of what is extended in space, including in particular a sketch of Aristotle's theory of places. The fourth and final part then goes beyond Aristotle to give an account of the ontology of the environments which constitute the everyday world of human action.

German version as: "Gegenstände und ihre Umwelten: Von Aristoteles zur ökologischen Ontologie", in Barbara Boisits and Sonja Rinofner-Kreidl (eds.), *Einheit und Vielheit. Organologische Denkmodelle in der Moderne*, Vienna: Passagen Verlag, 2000, 35–64.

53. Barry Smith, "Aristoteles, Kant und die Quantenphysik", in Ruth Hagengruber (ed.), *Philosophie und Wissenschaft*, Würzburg: Königshausen und Neumann, 2002, 79–97.

54. Gerald J. Erion and Barry Smith, "In Defense of Truth: Skepticism, Morality, and The Matrix", in W. Irwin (ed.), *Philosophy and The Matrix*, La Salle and Chicago: Open Court, 2002, 16–27.

> Portuguese translation as: "Ceticismo, moralidade e Matrix", in W. Irwin (ed.), *Matrix: Bem-Vindo ao Deserto do Real*, São Paulo: Madras, 2003, 62-79.

> Italian translation as: "Scetticismo, moralità e Matrix", *Pillole rosse: Matrix e la filosofia,* Milan: Tascabili Bompiani, 22-35.

> **Abstract:** *The Matrix* exposes us to the uncomfortable worries of philosophical skepticism in an especially compelling way. However, with a bit more reflection, we can see why we need not share the skeptic's doubts about the existence of the world. Such doubts are appropriate only in the very special context of the philosophical seminar. When we return to normal life we see immediately that they are groundless. Furthermore, we see also the drastic mistake that Cypher commits in turning his back upon reality and re-entering the matrix. Not only does reason compel us to admit the existence of the external world, it also requires us to face this world, to build for ourselves meaningful lives within it, and to engage, as adults, in the serious business of living.

55. Harold Henderson and Barry Smith. "Introduction: A New Definition of Liberal Education", *Liberal Education in a Knowledge Society,* Barry Smith (ed.), Chicago, Open Court Publishing, 2002, 1-9.

56. Barry Smith, *The Meaning of Life and the Measure of Civilizations* (Brochure 9 in the series The History of Liberalism in Europe), Paris: CREA/CREPHE, 2002, 22 pp.

> **Abstract:** In what respects is Western civilization superior or inferior to its rivals? In raising this question we are addressing a particularly strong form of the problem of relativism. For in order to compare civilizations one with another we would need to be in possession of a framework based on principles of evaluation which would be acceptable, in principle, to all human beings. Morality will surely provide one axis of such a framework (and we note in passing that believers in Islam might quite reasonably claim that their fellow-believers are characteristically more moral than are many in the West). Criteria such as material wellbeing, too, will need to play a role, as also will happiness or pleasure. Even happiness (pace some proponents of the utilitarian philosophy) comes in different types, and to count in the civilization stakes the happiness involved would presumably need to be of the right kind. We propose a specification for what this 'right kind' of happiness might be.

> French translation as "La signification de la vie, et comment il convient d'évaluer les civilisations", in *Histoire du Libéralisme en Europe*, Philippe Nemo and Jean Petitot (eds.), Paris: Presses Universitaires de France, 2006, 1399–1411.

> Italian translation as "Il significato della vita: come valurare una civiltà" in P. Nemo and J. Petitot (eds.), *Storia del liberalismo in Europa*, Soveria Mannelli: Rubbettino, 2013, 1225–1234.

57. Artur Rojszczak and Barry Smith, "Theories of Judgment", in Thomas Baldwin (ed.), *The Cambridge History of Philosophy 1870-1945*, Cambridge: Cambridge University Press, 2003, 157–173.

> **Abstract:** The dominant theory of judgment in 1870 was one or other variety of combination theory: the act of judgment is an act of combining concepts or ideas in the mind of the judging subject. In the decades to follow a succession of alternative theories arose to address defects in the combination theory, starting with Bolzano's theory of propositions in themselves, Brentano's theory of judgment as affirmation or denial of existence, theories distinguishing judgment act from judgment content advanced by Brentano's students Twardowski, Husserl and Meinong, and finally, Adolf Reinach's addition of a linguistic dimension to the Brentano-Husserlian theory of judgment – an account of judgments as ways of doing things with words in what Reinach called 'social acts'.

58. Barry Smith, "John Searle: From Speech Acts to Social Reality", in Barry Smith (ed.), *John Searle*, Cambridge: Cambridge University Press, 2003, 1–33.

Abstract: We provide an overview of Searle's contributions to speech act theory and the ontology of social reality, focusing on his theory of constitutive rules. In early versions of this theory, Searle proposed that all such rules have the form 'X counts as Y in context C' formula – as for example when Barack Obama (X) counts as President of the United States (Y) in the context of US political affairs. Crucially, the X and the Y terms are here identical. A problem arises for this theory for cases involving 'free-standing Y terms', as for example in the case of money in a computerized bank account. Here there is no physical X to which a status function might be attached. We conclude by arguing that Searle's response to this problem creates difficulties for his naturalistic framework.

Polish translation as: "John Searle: Od aktów mowy do rzeczywistości społecznej", *Roczniki Filozoficzne*, 51: 1, 2003, 265–292.

Italian translation as: "Un'aporia nella costruzione della realtà sociale. Naturalismo e realismo in John R. Searle", in: Paolo Di Lucia (ed.), *Ontologia sociale: Potere deontico e regole costitutive*, Macerata: Quodlibet, 2003, 137-152. This translation appeared in a partial version also in *Il Sole-24 Ore*, Sunday, 7 December 2003, n. 335, p. 32.

Russian translation

59. Barry Smith and Leo Zaibert, "Real Estate: Foundations of the Ontology of Property", in Heiner Stuckenschmidt, Erik Stubjkaer and Christoph Schlieder (eds.), *The Ontology and Modelling of Real Estate Transactions*, Aldershot: Ashgate, 2003, 51–67.

Abstract: Suppose you own a garden-variety object such as a hat or a shirt. Your property right then follows the ageold saw according to which possession is nine-tenths of the law. That is, your possession of a shirt constitutes a strong presumption in favor of your ownership of the shirt. In the case of land, however, this is not the case. Here possession is not only not a strong presumption in favor of ownership; it is not even clear what possession is. Possessing a thing like a hat or a shirt is a rather straightforward affair: the person wearing the hat or shirt possesses the shirt or the hat. But what is possession in the case of land? This essay seeks to provide an answer to this question in the form of an ontology of landed property.

60. Barry Smith, "Aristoteles 2002", in T. Buchheim, H. Flashar and R. A. H. King (eds.), *Kann man heute noch etwas anfangen mit Aristoteles?*, Hamburg: Meiner, 2003, 3–38.

Abstract: The essay surveys recent developments in ontology and defends a strategy for improvement of ontologies based on ontological realism. As a thought experiment, we consider central theses of Aristotelian metaphysics, and show how they fall short of what we believe to be the requirements of ontology today. Above all, Aristotle provides us with no strategy for the reconciliation of common-sense realism and scientific realism where these diverge. We focus specifically on shortfalls in Aristotle's treatment of individual accidents, especially in regard to the category of place. We then show how Aristotle's metaphysics needs to be supplemented by a theory of holes, of fiat boundaries, of granularity, and of vagueness.

61. Thomas Bittner and Barry Smith, "A Theory of Granular Partitions", *Foundations of Geographic Information Science*, Matthew Duckham, Michael F. Goodchild and Michael F. Worboys (eds.), London: Taylor & Francis, 2003, 117–151.

Abstract: We have a variety of different ways of dividing up, classifying, mapping, sorting and listing the objects in reality. The theory of granular partitions presented here seeks to provide a general and unified basis for understanding such phenomena in formal terms that is more realistic than existing alternatives. Our theory has two orthogonal parts: the first is a theory of classification; it provides an account of partitions as cells and subcells; the second is a theory of reference or intentionality; it provides an account of how cells and subcells relate to objects in reality. We define a notion of well-formedness for partitions, and we give an account of what

it means for a partition to project onto objects in reality. We continue by classifying partitions along three axes: (a) in terms of the degree of correspondence between partition cells and objects in reality; (b) in terms of the degree to which a partition represents the mereological structure of the domain it is projected onto; and (c) in terms of the degree of completeness with which a partition represents this domain.

Revised version in K. Munn and B. Smith (eds.), *Applied Ontology: An Introduction*, Frankfurt/Lancaster: ontos, 2008, 125–158.

Revised German version as "Granulare Partitionen", in L. Jansen and B. Smith (eds.), *Biomedizinische Ontologie. Philosophie – Lebenswissenschaften – Informationstechnik* (UTB Forum), Zurich: vdf, 2008, 67–84.

62. Barry Smith, "The Ecological Approach to Information Processing", in Kristóf Nyíri (ed.), *Mobile Learning: Essays on Philosophy, Psychology and Education*, Vienna: Passagen Verlag, 2003, 17–24.

Abstract: Imagine a 5-stone weakling whose brain has been loaded with all the knowledge of a champion tennis player. He goes to serve in his first match – Wham! – His arm falls off. The 5-stone weakling just doesn't have the bone structure or muscular development to serve that hard. There are, clearly, different types of knowledge/ability/skill, only some of which are a matter of what can be transferred simply by passing signals down a wire from one brain (or computer) to another. Sometimes it is the body (the hardware) which knows.

Hungarian translation: "Az adatfeldolgozás ökológiai megközelítése", *Proceedings of the Conference on Philosophy, Psychology, Culture*, held in the Hungarian Academy of Sciences, Budapest, 29-30 November 2002.

63. Barry Smith, "Ontology", in Luciano Floridi (ed.), *Blackwell Guide to the Philosophy of Computing and Information*, Oxford: Blackwell, 2003, 155–166.

Abstract: Ontology as a branch of philosophy is the science of what is, of the kinds and structures of objects, properties, events, processes and relations in every area of reality. 'Ontology' in this sense is often used by philosophers as a synonym of 'metaphysics' (a label meaning literally: 'what comes after the Physics'), a term used by early students of Aristotle to refer to what Aristotle himself called 'first philosophy'. But in recent years, in a development hardly noticed by philosophers, the term 'ontology' has gained currency in the field of computer and information science, and in information-driven research in bioinformatics and related areas. We examine these new developments in applied ontology, and show what lessons they might have for both philosophers and information scientists.

Reprinted in Guillermo Hurtado and Oscar Nudler (eds.), *The Furniture of the World. Essays in Ontology and Metaphysics* (Rodopi Studies in Philosophy, vol. 9), Amsterdam: Rodopi, 2012, 47–68.

Spanish translation as: "Ontología" in G. Hurtado and O. Nudler (eds.), *El mobiliario del mundo. Ensayos de ontología y metafísica*, Mexico: Universidad Autónoma de México, 2007, 47–71.

Italian translation as: "Ontologia e sistemi informativi" in: *Networks*, 6, 2006, 137–164.

64. Barry Smith, "Kraus on Weininger, Kraus on Women, Kraus on Serbia" in Wolfgang Huemer and Marc-Oliver Schuster (eds.): *Writing the Austrian Traditions: Relations Between Philosophy and Literature,* Edmonton: University of Alberta Press and Frankfurt/Lancaster: Ontos, 2003, 81–100.

Abstract: Otto Weininger's *Sex and Character* interprets Kant's categorical imperative in a way which takes it to imply that all human relations, including human sexual relations, are immoral; it is thus in a certain sense impossible to lead a moral life on this earth. We discuss Weininger's ideas on man, woman, value and intellect, and describe their influence among the Central European intellectuals of his day, including Wittgenstein, and also including Karl Kraus.

65. Barry Smith, "Kamikaze – und der Westen", in Geog Meggle (ed.), *Terror und der Krieg gegen ihn: Öffentliche Reflexionen*, Paderborn: Mentis, 2003, 107–118.

Abstract: Against the background of a taxonomy of types of suicide advanced by Durkheim we propose an analysis of the phenomenon of terrorist suicide attacks. We argue that suicide of this sort is a specifically non-Western phenomenon. The significant difference between the strategy of Western terrorist groups and those terrorist groups engaged in suicide attacks is rooted in a peculiar feature of the history and character of the West extending back to the Middle Ages.

Vor dem Hintergrund einer von Durkheim ausgehenden Selbstmordarten-Typologie wird das Phänomen von terroristischen Selbstmordattentaten untersucht: Diese scheinen ein spezifisch nicht-westliches Phänomen zu sein. Der deutliche Unterschied zwischen der Strategie westlicher Terrorgruppen und solchen Terrorgruppen, die Selbstmordattentate ausüben, geht auf ein besonderes Merkmal der Geschichte und der Eigenart des Westens zurück; und dies wiederum ist tief im Mittelalter verwurzelt.

66. Artur Rojszczak and Barry Smith, "Truthmakers, Truthbearers and the Objectivity of Truth", in J. Hintikka, *et al*. (eds.), *Philosophy and Logic: In Search of the Polish Tradition*, Dordrecht/Boston/Lancaster: Kluwer, 2003, 229–268.

Abstract: The aim of this paper is to show that the account of objective truth taken for granted by logicians at least since the publication in 1933 of Tarski's "The Concept of Truth in Formalized Languages" arose out of a tradition of philosophical thinking initiated by Bolzano and Brentano. The paper shows more specifically that certain investigations of states of affairs and other objectual correlates of judging acts, investigations carried out by Austrian and Polish philosophers around the turn of the century, formed part of the background of views that led to standard current accounts of the objectivity of truth. It thus lends support to speculations on the role of Brentano and his heirs in contemporary logical philosophy advanced by Jan Woleński in his masterpiece of 1989 on the Logic and philosophy in the Lvov-Warsaw School of 1989.

67. Arkadiusz Chrudzimski and Barry Smith, "Brentano's Ontology: From Conceptualism to Realism", in Dale Jacquette (ed.), *The Cambridge Companion to Brentano*, Cambridge: Cambridge University Press, 2004, 175–194.

Abstract: It is often claimed that the beginnings of Brentano's ontology were Aristotelian in nature; but this claim is only partially true. Certainly the young Brentano adopted many elements of Aristotle's metaphysics, and he was deeply influenced by the Aristotelian way of doing philosophy. But he always interpreted Aristotle's ideas in his own fashion. He accepted them selectively, and he used them in the service of ends that would not have been welcomed by Aristotle himself. The present paper is an exposition of the development of Brentano's ontology, beginning with the Lectures on Metaphysics first delivered by Brentano in Würzburg in 1867 and concluding with his late work from 1904–1917.

Reprinted in *Brentano* (Major Works series), Cambridge University Press and Routledge, in press.

68. Carolyn Korsmeyer and Barry Smith, "Visceral Values: Aurel Kolnai on Disgust," in Aurel Kolnai, *On Disgust,* Chicago and La Salle: Open Court Publishing Company, 2004, 1–23.

Abstract: In 1929 when Aurel Kolnai published his essay "On Disgust" in Husserl's *Jahrbuch* he could truly assert that disgust was a "sorely neglected" topic. Now, however, this situation is changing as philosophers, psychologists, and historians of culture are turning their attention not only to emotions in general but more specifically to the large and disturbing set of aversive emotions, including disgust. We here provide an account of Kolnai's contribution to the study of the phenomenon of disgust, of his general theory of emotions and of the phenomenological methodology he employed in his work.

69. Barry Smith, "Carving Up Reality", in M. Gorman and J. Sanford (eds.), *Categories: Historical and Systematic Essays*, Washington: Catholic University of America Press, 2004, 225–237.

Abstract: If Mont Blanc is a vague object, then its vagueness will depend on the context in which reference is made. In a geological context the mountain might include only rock, perhaps together with a certain amount of air in the crevices and tunnels which have been formed beneath its surface. In a context of soil chemistry we might include also a surrounding thin layer of organic matter. In a skiing context we might include some snow. This essay sketches in informal terms the theory of granular partitions, which is designed to do justice to this context-dependence of vagueness by means of what might be described as a contextualized supervaluationism. Granularity and vagueness, it is argued, are two sides of a single coin: what is vague at one level of granularity may appear crisp at another. The resultant theory can be shown to resolve certain problems in our description of perceptual content, for example when John says that he sees the wall, but that he does not see the molecules by which the wall is constituted.

Spanish translation as "Tallando la realidad", in Juan González (ed.), *Perspectivas contemporáneas sobre la cognición: percepción, categorización y conceptualización*, Madrid: Siglo XXI Editores, 2006, 53-68.

70. David M. Mark and Barry Smith, "A science of topography: From Qualitative Ontology to Digital Representations", in Michael P. Bishop and John F. Shroder (eds.), *Geographic Information Science and Mountain Geomorphology*, Chichester, England: Springer-Praxis, 2004, 75–100.

Abstract: The shape of the Earth's surface, its topography, is a fundamental dimension of the environment, shaping or mediating many other environmental flows or functions. But there is a major divergence in the way that topography is conceptualized in different domains. Topographic cartographers, information scientists, geomorphologists and environmental modelers typically conceptualize topographic variability as a continuous field of elevations or as some discrete approximation to such a field. Pilots, explorers, anthropologists, ecologists, hikers and archeologists, on the other hand, typically conceptualize this same variability in terms of hills and valleys, mountains and plains, barrows and trenches, that is, as (special sorts of) objects, with locations, shapes, and often names of their own. In this chapter, we sketch an approach to bridging this fundamental gap in geographic information infrastructure.

71. David Mark, Barry Smith, Max Egenhofer, Stephen Hirtle, "UCGIS Emerging Research Themes: Ontological Foundations for Geographic Information Science", in: R. B. McMaster and E. L. Usery (eds.), *A Research Agenda for Geographic Information Science*, Boca Raton, Florida: CRC Press, 2004, 335–350.

Abstract: We propose as a UCGIS research priority the topic of "Ontological Foundations for Geographic Information." Under this umbrella we unify several interrelated research subfields, each of which deals with different perspectives on geospatial ontologies and their roles in geographic information science. While each of these subfields could be addressed separately, we believe it is important to address ontological research in a unitary, systematic fashion, embracing conceptual issues concerning what would be required to establish an exhaustive ontology of the geospatial domain, issues relating to the choice of appropriate methods for formalizing ontologies, and considerations regarding the design of ontology-driven information systems. This integrated approach is necessary, because there is a strong dependency between the methods used to specify an ontology, and the conceptual richness, robustness and tractability of the ontology itself. Likewise, information system implementations are needed as testbeds of the usefulness of every aspect of an exhaustive ontology of the geospatial domain. None of the current UCGIS research priorities provides such an integrative perspective, and therefore the topic of "Ontological Foundations for Geographic Information Science" is unique.

72. Barry Smith, "Why Polish Philosophy Does Not Exist", J. J. Jadacki and J. Pasniczek (eds.), *The Lvov-Warsaw School: The New Generation* (Poznan Studies in the Philosophy of the Sciences and the Humanities, vol. 89), 2006, 19–39.

Abstract: Why have Polish philosophers fared so badly as concerns their admission into the pantheon of Continental Philosophers? Why, for example, should Heidegger and Derrida be included in this pantheon, but not Ingarden or Tarski? Why, to put the question from another side, should there be so close an association in Poland between philosophy and logic, and between

philosophy and science? We distinguish a series of answers to this question, which are dealt with under the following headings: (a) the role of socialism; (b) the disciplinary association between philosophy and mathematics; (c) the influence of Austrian philosophy in general and of Brentanian philosophy in particular; (d) the serendipitous role of Twardowski; (e) the role of Catholicism. The conclusion of the paper is that there is no such thing as 'Polish philosophy' because philosophy in Poland is philosophy *per se*; it is part and parcel of the mainstream of world philosophy, simply because, in contrast to French or German philosophy, it meets international standards of training, rigour, professionalism and specialization.

Polish translation: "Dlaczego nie istnieje filozofia polska?", *Filozofia Nauki*, 5 (1997), 5–15.

73. Barry Smith and Wolfgang Grassl, "On Creativity and the Philosophy of the Supranational State", in Tamás Demeter (ed.), *Essays on Wittgenstein and Austrian Philosophy: In Honour of J. C. Nyíri*, Amsterdam/New York: Rodopi, 2004, 25–39.

Abstract: Building on the writings of Wittgenstein on rule-following and deviance, Kristóf Nyíri advanced a theory of creativity as consisting in a fusion of conflicting rules or disciplines. Only such fusion can produce something that is both intrinsically new and yet capable of being apprehended by and passed on to a wider community. Creativity, on this view, involves not the breaking of rules, or the deliberate cultivation of deviant social habits, but rather the acceptance of enriched systems of rules, the adherence to which presupposes simultaneous immersion in disciplines hitherto seen as being unrelated. The paper presents a demonstration of the fruitfulness of this theory by means of an account of some of the political, cultural and intellectual peculiarities of the Habsburg Monarchy.

74. Barry Smith and David Mark, "Geographical Categories: An Ontological Retrospective", in Peter Fisher (ed.), *Classics from the International Journal of Geographical Information Science*, London: Taylor and Francis, 2006, 507–512.

75. Leo Obrst, Werner Ceusters, Inderjeet Mani, Steve Ray, Barry Smith, "The Evaluation of Ontologies: Toward Improved Semantic Interoperability", in C. Baker and K.-H. Cheung, ed., *Semantic Web: Revolutionizing Knowledge Discovery in the Life Sciences*, New York: Springer Verlag, 2007, 139–158.

Abstract: Recent years have seen rapid progress in the development of ontologies as semantic models intended to capture and represent aspects of the real world. There is, however, great variation in the quality of ontologies. If ontologies are to become progressively better in the future, more rigorously developed, and more appropriately compared, then a systematic discipline of ontology evaluation must be created to ensure quality of content and methodology. Systematic methods for ontology evaluation will take into account representation of individual ontologies, performance (in terms of accuracy, domain coverage and the efficiency and quality of automated reasoning using the ontologies) on tasks for which the ontology is designed and used, degree of alignment with other ontologies and their compatibility with automated reasoning. A sound and systematic approach to ontology evaluation is required to transform ontology engineering into a true scientific and engineering discipline. This chapter discusses issues and problems in ontology evaluation, describes some current strategies, and suggests some approaches that might be useful in the future.

76. Barry Smith and Jonathan Simon, "Truthmaker Explanations", in: Jean-Maurice Monnoyer, *Metaphysics and Truthmakers*, Frankfurt/Lancaster/New Brunswik: Ontos, 2007, 79-98.

Abstract: This paper is a fresh attempt to articulate the role of a theory of truthmakers. We argue that truthmaker theory constitutes a cornerstone of good methodology in metaphysics, but that a conflation of truthmaker theory with the theory of truth has been responsible for certain excesses associated with truthmaker-based approaches in the recent literature. If truthmaker theory is not a component of a theory of truth, then truthmaker maximalism – the view that every truth has a truthmaker – loses its primary motivation. More generally, if the task of truthmaker theory is not to provide a definition or account of truth in truthmaker terms, there is no pressing need for hard, a priori principles stating which truths have truthmakers and which do not.

French translation: "[Explications vérifactionnistes](#)" in *Philosophiques,* 38 (1), 2011, 277–194.

Résumé: Le présent article est une tentative nouvelle d'articuler le rôle d'une théorie des vérifacteurs. Nous soutenons que la théorie de la vérifaction constitue une pierre angulaire dans une bonne méthodologie en métaphysique, mais que l'amalgame entre la théorie de la vérifaction et la théorie de la vérité a été responsable de certains excès associés aux approches vérifactionnistes dans la littérature récente. Nous montrons que la théorie de la vérifaction conserve son attrait comme instrument d'investigation métaphysique, et ce, malgré notre accord avec les doctrines défl ationnistes telles que celles défendues par Ayer, Quine, Field et Horwich (ou, du moins, malgré notre neutralité à leur égard). Nous soutenons en outre que les intuitions sous-jacentes à la théorie de la vérifaction s'éclairent quand nous les dissocions d'une théorie de la vérité et, par-dessus tout, de la tentative de fournir une défi nition de la vérité.

77. Leo Zaibert and Barry Smith, "[The Varieties of Normativity: An Essay on Social Ontology](#)", in Savas L. Tsohatzidis (ed.), *Intentional Acts and Institutional Facts: Essays on John Searle's Social Ontology*, Dordrecht: Springer, 2007, 155–174.

Abstract: For much of the first fifty years of its existence, analytic philosophy shunned discussions of normativity and ethics. Ethical statements were considered as pseudo-propositions, or as expressions of pro- or con-attitudes of minor theoretical significance. Nowadays, in contrast, prominent analytic philosophers pay close attention to normative problems. Here we focus our attention on the work of Searle, at the same time drawing out an important connection between Searle's work and that of two other seminal figures in this development: H.L.A. Hart and John Rawls. We show that all three thinkers tend to assume that there is but one type of normativity within the realm of social institutions – roughly, the sort of normativity that is involved in following the results of chess – and that they thereby neglect features that are of crucial significance for an adequate understanding of social reality.

78. Barry Smith and Werner Ceusters, "[Ontology as the Core Discipline of Biomedical Informatics: Legacies of the Past and Recommendations for the Future Direction of Research](#)", in *Computing*, *Information, Cognition*, Gordana Dodig Crnkovic and Susan Stuart (eds.), Newcastle: Cambridge Scholars Press, 2007, 104–122.

Abstract: The automatic integration of rapidly expanding information resources in the life sciences is one of the most challenging goals facing biomedical research today. Controlled vocabularies, terminologies, and coding systems play an important role in realizing this goal, by making it possible to draw together information from heterogeneous sources – for example pertaining to genes and proteins, drugs and diseases – secure in the knowledge that the same terms will also represent the same entities on all occasions of use. In the naming of genes, proteins, and other molecular structures, considerable efforts are under way to reduce the effects of the different naming conventions which have been spawned by different groups of researchers. Electronic patient records, too, increasingly involve the use of standardized terminologies, and tremendous efforts are currently being devoted to the creation of terminology resources that can meet the needs of a future era of personalized medicine, in which genomic and clinical data can be aligned in such a way that the corresponding information systems become interoperable.

79. Werner Ceusters and Barry Smith, "[Referent Tracking for Corporate Memories](#)", in P. Rittgen (ed.), *Handbook of Ontologies for Business Interaction*, Hershey, New York and London: Information Science Reference, 2007, 34–46.

Abstract: For corporate memory and enterprise ontology systems to be maximally useful, they must be freed from certain barriers placed around them by traditional knowledge management paradigms. This means, above all, that they must mirror more faithfully those portions of reality which are salient to the workings of the enterprise, including the changes that occur with the passage of time. The purpose of this chapter is to demonstrate how theories based on philosophical realism can contribute to this objective. We discuss how realism-based ontologies (capturing what is generic) combined with referent tracking (capturing what is specific) can play a key role in building the robust and useful corporate memories of the future.

80. Barry Smith and Bert R. E. Klagges, "[Ontologie des menschlichen Lebewesens: Substanz und Funktion](#)", in L. Honnefelder, M. C. Schmidt (eds.), *Naturalismus als*

Paradigma – Wie weit reicht die naturwissenschaftliche Erklärung des Menschen?, Berlin: Berlin University Press, 2007, 61-75.

81. Barry Smith and Berit Brogaard, "Ontologie des Embryos: Wann beginnt menschliches Leben?", in L. Honnefelder, M. C. Schmidt (eds.), *Naturalismus als Paradigma - Wie weit reicht die naturwissenschaftliche Erklärung des Menschen?*, Berlin: Berlin University Press, 2007, 196-204.

Abstract: Der Abschluß der Gastrulation, der gleichzeitig auch den Anfang der Neurulation bedeutet, ist die zeitliche Grenze, die Beginn eines menschlichen Individuums markiert. Oft wird behauptet, daß jegliche natürliche Veränderung stetig ist. Wie ist es dann aber möglich, eine zeitliche Grenze auszuzeichnen, an der ein menschliches Lebewesen zu existieren beginnt? Man beachte, was geschieht, wenn wir vom Thema zeitlicher Unstetigkeit zum räumlichen übergehen. Lebewesen haben räumliche Grenzen (wie sie durch ihre Haut geformt wird). Die letzteren sind genuine Diskontinuitäten, auch angesichts der Kontinuität der Materie in der physikalischen Welt. Und ebenso müssen wir schließen: Das Leben menschlicher Lebewesen hat zeitliche Grenzen - seinen Beginn und sein Ende - die auch angesichts der Kontinuität physikalischer, chemischer und biologischer Prozesse, in die sie involviert sind, echte Diskontinuitäten sind.

82. Pierre Grenon and Barry Smith, "Persistence and Ontological Pluralism", in C. Kanzian (ed.), *Persistence*, Frankfurt/Lancaster: ontos, 2008, 33-48.

Abstract: We aim to provide the ontological grounds for an adequate account of persistence. We defend a perspectivalist, or moderate pluralist, position, according to which some aspects of reality can be accounted for in ontological terms only via partial and mutually complementary ontologies, each one of which captures some relevant aspect of reality. Our thesis here is that this is precisely the sort of ontological account that is needed for the understanding of persistence, specifically an account involving two independent ontologies, one for continuants, and one for occurrents.

83. Fabian Neuhaus and Barry Smith, "Modelling Principles and Methodologies: Relations in Anatomical Ontologies", in: Albert Burger, Duncan Davidson and Richard Baldock (eds.), *Anatomy Ontologies for Bioinformatics: Principles and Practice*, New York: Springer, 2008, 289-305.

Abstract: It is now increasingly accepted that many existing biological and medical ontologies can be improved by adopting tools and methods that bring a greater degree of logical and ontological rigor. In this chapter we will focus on the merits of a logically sound approach to ontologies from a methodological point of view. As we shall see, one crucial feature of a logically sound approach is that we have clear and functional definitions of the relational expressions such as 'is a' and 'part of'.

84. Melissa A. Haendel, Fabian Neuhaus, David Osumi-Sutherland, Paula M. Mabee, José L. V. Mejino Jr., Chris J. Mungall, Barry Smith, "CARO: The Common Anatomy Reference Ontology", in: Albert Burger, Duncan Davidson and Richard Baldock (eds.), *Anatomy Ontologies for Bioinformatics: Principles and Practice*, New York: Springer, 2008, 327-349.

Abstract: The Common Anatomy Reference Ontology (CARO) is being developed to facilitate interoperability between existing anatomy ontologies for different species, and will provide a template for building new anatomy ontologies. CARO has a structural axis of classification based on the top-level nodes of the Foundational Model of Anatomy. CARO will complement the developmental process sub-ontology of the GO Biological Process ontology, using it to ensure the coherent treatment of developmental stages, and to provide a common framework for the model organism communities to classify developmental structures. Definitions for the types and relationships are being generated by a consortium of investigators from diverse backgrounds to ensure applicability to all organisms. CARO will support the coordination of cross-species ontologies at all levels of anatomical granularity by cross-referencing types within the cell type ontology (CL) and the Gene Ontology (GO) Cellular Component ontology. A complete cross-species CARO could be utilized in other ontologies for cross-product generation.

85. Barry Smith, "Searle and de Soto: The New Ontology of the Social World", Barry Smith, David Mark and Isaac Ehrlich (eds.), *The Mystery of Capital and the Construction of Social Reality*, Chicago: Open Court, 2008, 35-51.

Abstract: Consider a game of blind chess between two chess masters that is recorded in some standard chess notation. The recording is a representation of the game. But what is the game itself? This question is, we believe, central to the entire domain of social ontology. We argue that the recorded game is a special sort of quasi-abstract pattern, something that is: (i) like abstract entities such as numbers or forms, in that it is both nonphysical and nonpsychological; but at the same time, (ii) through its association with specific players and a specific occasion, tied to time and history. We discover other abstract patterns of this sort especially in the domains of law and commerce. This essay draws on the work in social ontology, and specifically on the attempts of Hernando de Soto and of John Searle to develop an ontology of the social world based on an analysis of the peculiar interdependence between quasi-abstract patterns and their representations in documents of different sorts.

Preliminary version as "The Foundations of Social Coordination: John Searle and Hernando de Soto", in N. Psarros (ed.), *Facets of Sociality*, Frankfurt: Ontos, 2007, 3-22.

86. Barry Smith and Mathias Brochhausen, "Establishing and Harmonizing Ontologies in an Interdisciplinary Health Care and Clinical Research Environment", in: B. Blobel P. Pharow and M. Nerlich (eds.), *eHealth: Combining Health Telematics, Tele-medicine, Biomedical Engineering and Bioinformatics on the Edg*e (Global Expert Summit Textbook, Studies in Health, Technology and Informatics, 134), IOS Press, Amsterdam, 2008, 219-234.

Abstract: Ontologies are being ever more commonly used in biomedical informatics and we provide a survey of some of these uses, and of the relations between ontologies and other terminology resources. In order for ontologies to become truly useful, two objectives must be met. First, ways must be found for the transparent evaluation of ontologies. Second, existing ontologies need to be harmonised. We argue that one key foundation for both ontology evaluation and harmonisation is the adoption of a realist paradigm in ontology development. For science-based ontologies of the sort which concern us in the eHealth arena, it is reality that provides the common benchmark against which ontologies can be evaluated and aligned within larger frameworks. Given the current multitude of ontologies in the biomedical domain the need for harmonisation is becoming ever more urgent. We describe one example of such harmonisation within the ACGT project, which draws on ontology-based computing as a basis for sharing clinical and laboratory data on cancer research.

87. Mathias Brochhausen, Gabriele Weiler, Luis Martín, Cristian Cocos, Holger Stenzhorn, Norbert Graf, Martin Dörr, Manolis Tsiknakis, and Barry Smith, "Applications of the ACGT Master Ontology on Cancer", R. Meersman, Z. Tari, and P. Herrero (Eds.): *Proceedings of 4th International IFIP Workshop On Semantic Web and Web Semantics* (*OTM 2008: Workshops*), LNCS 5333, 2008, 1046–1055.

Abstract: We present applications of the ACGT Master Ontology (ACGT MO), which is a new terminology resource for a transnational network providing data exchange in oncology, emphasizing the integration of both clinical and molecular data. The development of a new ontology was necessary due to problems with existing biomedical ontologies in oncology. The ACGT MO is a test case for the application of best practices in ontology development. This paper provides an overview of the application of the ontology within the ACGT project thus far.

88. Barry Smith, "Informatica", in M. Ferraris (eds.), *Storia dell'Ontologia*, Milan: Bompiani, 2008, 503-530.

89. Barry Smith, "Realitätsrepräsentation: Das Ziel der Ontologie", in L. Jansen and B. Smith (eds.), *Biomedizinische Ontologie. Philosophie – Lebenswissenschaften - Informationstechnik* (UTB Forum), Zurich: vdf, 2008, 31-46.

90. Barry Smith and Bert Klagges, "Philosophy and biomedical information systems", in K. Munn and B. Smith (eds.), *Applied Ontology: An Introduction*, Frankfurt/Lancaster: ontos/Walter de Gruyter, 2008, 21-38.

Abstract: Recent years have seen the development of new applications of the ancient science of philosophy, and the new sub-branch of applied philosophy. A new level of interaction between philosophy and non-philosophical disciplines is being realized. Serious philosophical engagement, for example, with biomedical and bioethical issues increasingly requires a genuine familiarity with the relevant biological and medical facts. The simple presentation of philosophical theories and arguments is not a sufficient basis for future work in these areas. Philosophers working on questions of medical ethics and bioethics must not only familiarize themselves with the domains of biology and medicine, they must also find a way to integrate the content of these domains in their philosophical theories.

91. Barry Smith, "New Desiderata for Biomedical Terminologies", in K. Munn and B. Smith (eds.), *Applied Ontology: An Introduction*, Frankfurt/Lancaster: ontos/de Gruyter, 2008, 83-108.

The terminologies used in biomedical research, clinical practice, and health information management today grew out of the medical dictionaries of an earlier era. Such dictionaries, of course, were created to be used by human beings, and the early steps towards standardization of terminologies in the 1930s were designed, above all, to enable clear understanding of terms in different languages; for example, on the part of those engaged in gathering data on an international scale. With the increasing importance of computers, however, came the recognition that standardization of terminology must go beyond the needs of humans, and it is especially in the biomedical domain – with terminologies such as SNOMED (see SNOMED 2007) and controlled vocabularies such as the Gene Ontology (see Gene Ontology 2007) – that the power of formal representation of terminological knowledge has been explored most systematically. The need for such formal, computer-processable representations becomes all the more urgent with the enormous increase in the amounts and varieties of data with which biomedical researchers are confronted, data which can no longer be surveyed without the aid of powerful informatics tools.

92. Barry Smith "The Benefits of Realism: A Realist Logic with Applications", in K. Munn and B. Smith (eds.), *Applied Ontology: An Introduction*, Frankfurt/Lancaster: ontos/Walter de Gruyter, 2008, 109-124.

Abstract: We propose a formalization of a realist ontology using first order logic with identity and allowing quantification over terms representing both individuals and universals. In addition to identity, the ontology includes also relational predicates such as subtype, instantiation, parthood, location, and inherence. Inspired in part by Davidson's treatment of events, the ontology includes also various relations linking events to their participants and to the times at which they occur. The approach allows a simulation of some of the features of second order logic within a classical first order framework, as outlined in my "Against Fantology" (2005), above.

93. Ulf Schwarz and Barry Smith, "Ontological Relations", in K. Munn and B. Smith (eds.), *Applied Ontology: An Introduction*, Frankfurt/Lancaster: ontos, Bonn: Walter de Gruyter, 2008, 219-234.

Abstract: During our discussion of the ontological sextet and the associated classification of reality in Chapter 8, we saw that the classical Aristotelian square can be extended to encompass both particulars and universals, and both continuants and occurrents, to yield a total of six categories. We had postulated very specific relations among the entities in these categories, such as the relations of inherence, participation, instantiation, exemplification, and characterization. In this chapter, we will discuss how to characterize the relations among the entities in these categories more precisely and to define the relational expressions used in ontologies in a more rigorous and unambiguous way

German version "Ontologische Relationen", in L. Jansen and B. Smith (eds.), *Biomedizinische Ontologie. Philosophie – Lebenswissenschaften - Informationstechnik* (UTB Forum), Zurich: vdf, 2008, 155-172.

Abstract: In Kapitel 5 dieses Buches wurde mit dem ontologischen Sextett eine Klassifizierung

der Realität vorgestellt, die das klassische Aristotelische Viereck erweitert, indem sie Einzeldinge und Universalien in insgesamt sechs Kategorien umfaßt. Zwischen den Entitäten dieser Kategorien sind bestimmte Beziehungen postuliert worden, wie zum Beispiel Inhärenz, Partizipation, Instantiierung, Exemplifizierung und Charakterisierung. In diesem Kapitel soil der Frage nachgegangen werden, wie eben diese Beziehungen zwischen den Entitäten dieser Kategorien genauer charakterisiert und die sie bezeichnenden relationalen Ausdrücke eindeutig formal definiert werden konnen.

94. Richard H. Scheuermann, Megan Kong, Carl Dahlke, Jennifer Cai, Jamie Lee, Yu Qian, Burke Squires, Patrick Dunn, Jeff Wiser, Herb Hagler, Barry Smith, David Karp, "Ontology-Based Knowledge Representation of Experiment Metadata in Biological Data Mining", *Biological Data Mining,* Jake Chen and Stefano Lonardi (eds.), Boca Raton: Chapman Hall / Taylor and Francis, September 2009, 529-559.

Abstract: According to the PubMed resource from the U.S. National Library of Medicine, over 750,000 scientific articles have been published in the ~5000 biomedical journals worldwide in the year 2007 alone. The vast majority of these publications include results from hypothesis-driven experimentation in overlapping biomedical research domains. Unfortunately, the sheer volume of information being generated by the biomedical research enterprise has made it virtually impossible for investigators to stay aware of the latest findings in their domain of interest, let alone to be able to assimilate and mine data from related investigations for purposes of meta-analysis. While computers have the potential for assisting investigators in the extraction, management and analysis of these data, information contained in the traditional journal publication is still largely unstructured, free-text descriptions of study design, experimental application and results interpretation, making it difficult for computers to gain access to the content of what is being conveyed without significant manual intervention. In order to circumvent these roadblocks and make the most of the output from the biomedical research enterprise, a variety of related standards in knowledge representation are being developed, proposed and adopted in the biomedical community. In this chapter, we will explore the current status of efforts to develop minimum information standards for the representation of a biomedical experiment, ontologies composed of shared vocabularies assembled into subsumption hierarchical structures, and extensible relational data models that link the information components together in a machine-readable and human-useable framework for data mining purposes.

95. Lindsay Grey Cowell and Barry Smith, "Infectious Disease Ontology", in Vitali Sintchenko (ed.), *Infectious Disease Informatics*, New York: Springer, December 2009, 373-395.

Abstract: Technological developments have resulted in tremendous increases in the volume and diversity of the data and information that must be processed in the course of biomedical and clinical research and practice. Researchers are at the same time under ever greater pressure to share data and to take steps to ensure that data resources are interoperable. The use of ontologies to annotate data has proven successful in supporting these goals and in providing new possibilities for the automated processing of data and information. In this chapter, we describe different types of vocabulary resources and emphasize those features of formal ontologies that make them most useful for computational applications. We describe current uses of ontologies and discuss future goals for ontology-based computing, focusing on its use in the field of infectious diseases. We review the largest and most widely used vocabulary resources relevant to the study of infectious diseases and conclude with a description of the Infectious Disease Ontology (IDO) suite of interoperable ontology modules that together cover the entire infectious disease domain.

96. Barry Smith, "Signs and Meanings", *Signs and Meanings: Five Questions*, Peer Bundgaard and Frederik Stjernfelt (eds.), Copenhagen: Automatic Press, September 2009, 199-206.

97. Barry Smith, "Metaphysics", *Metaphysics: Five Questions*, Asbjørn Steglich-Petersen (ed.), Copenhagen: Automatic Press, July 2010, 143-158.

Abstract: An attempt to trace a unifying thread of ontological realism extending through: 1. my early writings on Frege, Brentano, Husserl, Wittgenstein, Ingarden and (with Kevin Mulligan and Peter Simons) truthmakers; 2. work on formal (especially mereotopological) theories of the

common-sense world, on fiat objects, geographical categories, and environments (with David Mark, Roberto Casati and Achille Varzi); 3. work (with John Searle) on social ontology and (inspired by Hernando de Soto) on the theory of document acts; and 4. current work on applied ontology in biology and medicine, and on the ontology of document acts and of information artifacts.

98. Werner Ceusters and Barry Smith, "Switching Partners: Dancing with the Ontological Engineers", in Thomas Batcherer and Roderick Coover (eds.), *Switching Codes. Thinking through Digital Technology in the Humanities and the Arts*, Chicago and London: University of Chicago Press, 2011, 103-124.

Abstract: Ontologies are today being applied in almost every field to support the alignment and retrieval of data of distributed provenance. Here we focus on new ontological work on dance and on related cultural phenomena belonging to what UNESCO calls the "intangible heritage." Currently data and information about dance, including video data, are stored in an uncontrolled variety of ad hoc ways. This serves not only to prevent retrieval, comparison and analysis of the data, but may also impinge on our ability to preserve the data that already exists. Here we explore recent technological developments that are designed to counteract such problems by allowing information to be retrieved across disciplinary, cultural, linguistic and technological boundaries. Software applications such as the ones envisaged here will enable speedier recovery of data and facilitate its analysis in ways that will assist both archiving of and research on dance.

99. Barry Smith, "Preface", in G. Sartor, et al. (Eds.), *Approaches to Legal Ontologies. Theories, Domains, Methodologies*, New York: Springer, 2011, p. 5.

100. Dipak Kalra, Mark Musen, Barry Smith, Werner Ceusters, Georges De Moor, "ARGOS Policy Brief on Semantic Interoperability", in: G. De Moor (ed.), *Transatlantic Cooperation Surrounding Health Related Information and Communication Technology* (Studies in Health Technology and Informatics 170), 2011, 1-15.

Abstract: Semantic interoperability is one of the priority themes of the ARGOS Trans-Atlantic Observatory. This topic represents a globally recognised challenge that must be addressed if electronic health records are to be shared among heterogeneous systems, and the information in them exploited to the maximum benefit of patients, professionals, health services, research, and industry. Progress in this multi-faceted challenge has been piecemeal, and valuable lessons have been learned, and approaches discovered, in Europe and in the US that can be shared and combined. Semantic interoperability requires the use of standards, not only for EHR data to be transferred and structurally mapped into a receiving repository, but also for the clinical content of the EHR to be interpreted in conformity with the original meanings intended by its authors. Wide-scale engagement with professional bodies, globally, is needed to develop these clinical information standards. Accurate and complete clinical documentation, faithful to the patient's situation, and interoperability between systems, require widespread and dependable access to published and maintained collections of coherent and quality-assured semantic resources, including models such as archetypes and templates that would (1) provide clinical context, (2) be mapped to interoperability standards for EHR data, (3) be linked to well specified multi-lingual terminology value sets, and (4) be derived from high quality ontologies.

101. Barry Smith and Wojciech Żełaniec, "Laws of Essence or Constitutive Rules? Reinach vs. Searle on the Ontology of Social Entities", in *Eidetica del Diritto e Ontologia Sociale. Il Realismo di Adolf Reinach,* Francesca De Vecchi (ed.), Milan: Mimesis, 2012, 83-108.

Abstract: Amongst the entities making up social reality, are there necessary relations whose necessity is not a mere reflection of the logical connections between corresponding concepts? We distinguish three main groups of answers to this question, associated with Hume and Adolf Reinach at opposite extremes, and with Searle who occupies a position somewhere in the middle. We first set forth Reinach's views on what he calls 'material necessities' in the realm of social entities. We then attempt to show that Searle has not identified a sustainable position somewhere between the Humean and the Reinachian extremes. This is because Searle's position is threatened by circularity, and to steer clear of that danger it must incorporate at least some elements of Reinach's essentialism.

102. Barry Smith, Lowell Vizenor and Werner Ceusters, "Human Action in the Healthcare Domain: A Critical Analysis of HL7's Reference Information Model" in C. Svennerlind, J. Almäng, R. Ingthorsson (eds.), *Johanssonian Investigations. Essays in Honour of Ingvar Johansson on His Seventieth Birthday*, Berlin / New York: de Gruyter, 2013, 554-573.

Abstract: If we are to develop efficient, reliable and secure means for sharing information across healthcare systems and organizations, then a careful analysis of human actions will be needed. To address this need, the HL7 organization has proposed its Reference Information Model (RIM), which is designed to provide a comprehensive representation of the entire domain of healthcare centered around the phenomenon of human action. Taking the Basic Formal Ontology as our starting point, we examine the RIM from an ontological point of view, describing how it fails to provide a representation of the healthcare domain which would enjoy the sort of clarity, coherence, rigor and completeness that is claimed on its behalf.

103. Barry Smith, "Austrian and Hungarian Philosophy: On the Logic of Wittgenstein and Pauler", in Anne Reboul (ed.), *Mind, Values and Metaphysics. Philosophical Papers Dedicated to Kevin Mulligan*, Vol. 1, New York: Springer, 2014, 387-486.

Abstract: As Kevin Mulligan, more than anyone else, has demonstrated, there is a distinction within the philosophy of the German-speaking world between two principal currents: of idealism or transcendentalism, characteristic of Northern Germany, on the one hand; and of realism or objectivism, characteristic of Austria and the South, on the other. We explore some of the implications of this distinction with reference to the influence of Austrian (and German) philosophy on philosophical developments in Hungary, focusing on the work of Ákos von Pauler, and especially on Pauler's reading of Wittgenstein's *Tractatus*.

Hungarian translation as: "Osztrák és magyar filozófia: Wittgenstein és Pauler logikájáról", *Századvég*, 17 (65), 2012, 5-30.

104. Barry Smith, "Document Acts", in Anita Konzelmann Ziv and Hans Bernhard Schmid (eds.), *Institutions, Emotions, and Group Agents. Contributions to Social Ontology*, Dordrecht: Springer, 2014, 19-31.

Abstract: The theory of document acts is an extension of the more traditional theory of speech acts advanced by Reinach, Austin and Searle. It is designed to do justice to the ways in which documents can be used to bring about a variety of effects in virtue of the fact that, where speech is evanescent, documents are continuant entities. This means that documents can be preserved in such a way that they can be inspected and modified at successive points in time and grouped together into enduring document complexes. We outline some components of a theory of document acts, and show how it can throw light on certain problems in Searle's ontology of social reality.

Italian translation as: "Atti Documentali", in: *Verità, immagine, normatività*, edited by Pier Luigi Lecis, Giuseppe Lorini, Vinicio Busacchi, Pietro Salis, Olimpia G. Loddo, Macerata: Quodlibet, 2017, 369-390.

105. Barry Smith, "The Relevance of Philosophical Ontology to Information and Computer Science", *Philosophy, Computing and Information Science*, Ruth Hagengruber and Uwe Riss (eds.), London: Pickering and Chatto, 2014, 75-83.

Abstract: The discipline of ontology has enjoyed a checkered history since 1606, with a significant expansion in recent years. We focus here on those developments in the recent history of philosophy which are most relevant to the understanding of the increased acceptance of ontology, and especially of realist ontology, as a valuable method also outside the discipline of philosophy.

106. Barry Smith, "Values in Contexts: An Ontological Theory", *Inherent and Instrumental Values. Excursions in Value Inquiry,* G. John M. Abbarno (ed.), Lanham, MD: University Press of America, 2015, 17-29.

Abstract: Values exist not in isolation, but in complex wholes. Values are what they are because of the complex wholes in which they are situated. To do justice to this thesis will require a holistic ontology, a theory according to which many types of entities exist only as inseparable parts or moments of wider contexts or environments. An ontological theory of environments – with roots in Gestalt psychology and the ecological psychology of J. J. Gibson and Roger Barker, and which is related also to the theory of motivation sketched by Edmund Husserl as part of his theory of the lifeworld or *Lebenswelt* – will help us to understand the ontology of values. It will help us also to understand what values are. It will not, however, tell us what is good or bad. From facts of ontology, no value propositions follow.

107. Barry Smith, "Towards a Science of Emerging Media", *Philosophy of Emerging Media: Understanding, Appreciation and Application*, edited by J. E. Katz and J. Floyd, Oxford: Oxford University Press, December 2015, 29-48.

Abstract: If media studies are to become established as a genuine science, then it needs to be determined what the subject matter of this science is to be. I propose a specification of this subject matter as consist In his Untimely Meditations on the Relations between Self and Non-Self, Bozzi considers two popular approaches to answering ing in: 1. the new sorts of digital entities that have been added to social reality through the invention of the digital computer, and 2. the new sorts of interactions involving human beings which such entities make possible. I support this proposal by examining examples of some of the ways in which the digital products of emerging media differ from entities of other sorts. I then draw consequences from this examination to demonstrate how these products mark out a new realm within the larger domain of social ontology.

108. Robert Kelly and Barry Smith, "Comments on Bozzi's Untimely meditations on the relation between self and non-self", *Paolo Bozzi's Experimental Phenomenology*, Ivana Bianchi and Richard Davies (eds.), London and New York: Routledge, 2019, 125-129.

Abstract: In his Untimely Meditations on the Relations between Self and Non-Self, Paolo Bozzi considers two popular approaches to answering the question of how it is possible, given the nature of our experience, that we can delimit what we take to be ourselves from what we take to be outside of ourselves. He considers two popular approaches to answering this question— one rooted in the discussion of personal identity in Hume's *Treatise on Human Nature*, the other rooted in the origins of constructivism in psychology. We show how Bozzi uses these two approaches to set the stage for his own account, which is at the same time realist and also rooted in experimental phenomenology and Gestalt theory. Bozzi's conclusions are, first, that against at least one reading of Hume there really is a self. And second—against the extreme constructivist position, —that the self can be distinguished ontologically from the objects of the external world.

109. Barry Smith, "Drawing Boundaries", in: T. Tambassi T. (ed.), *The Philosophy of GIS*, 2019, New York: Springer, 137-158.

Abstract: In "On Drawing Lines on a Map" (1995), I suggested that the different ways we have of drawing lines on maps open up a new perspective on ontology, resting on a distinction between two sorts of boundaries: *fiat* and *bona fide*. "Fiat" means, roughly: human-demarcation-induced. "Bona fide" means, again roughly: a boundary constituted by some real physical discontinuity. I presented a general typology of boundaries based on this opposition and showed how it generates a corresponding typology of the different sorts of objects which boundaries determine or demarcate. In this paper, I describe how the theory of fiat boundaries has evolved since 1995, how it has been applied in areas such as property law and political geography, and how it is being used in contemporary work in formal and applied ontology, especially within the framework of Basic Formal Ontology.

110. Barry Smith, "本体：广谱的知识集成工具" (Ontology: Tool for Broad Spectrum Knowledge Integration), Foreword to 基于基本形式化本体的本体构建 (Chinese translation of Robert Arp, Barry Smith and Andrew Steele, *Building Ontologies with Basic Formal Ontology*), People's Medical Publishing House, October 2020), 4-8.

111. "Neural Chitchat", in: *The Sherry Turkle Miracle*, Papers from a Hungarian Academy of Sciences online workshop, Budapest, May 27, 2021, 39-43.

Abstract: A constant theme in Sherry Turkle's work is the idea that computers shape our social and psychological lives. This idea is of course in a sense trivial, as can be observed when walking down any city street and noting how many of the passers-by have their heads buried in screens. In *The Second Self*, however, Turkle makes a stronger claim to the effect that where people confront machines that seem to think this suggests a new way for us to think – about human thought, emotion, memory, and understanding and thereby affects the way we think and see ourselves as humans. I here attempt here to throw a sceptical light on claims of this sort by examining the Chinese chatbot "Xiǎoice", which is described by its authors as "the most popular social chatbot in the world".

112. Jobst Landgrebe and Barry Smith, "Unsterblichkeit 2.0", in: Ludger Jansen and Rebekka A. Klein (eds.), *Seele digital*? *Mind uploading, virtuelles Bewusstsein und christliche Auferstehungshoffnung*, Regensburg: Verlag Friedrich Pustet, August 2022, 69-83.

Das in diesem Aufsatz vorgebrachte Argumentationsmuster hat folgende Schritte:

1. Der menschliche Geist ist vom Körper nicht trennbar, sie bilden ein Kontinuum.
2. Unser Bewusstsein und alle darauf aufbauenden geistigen Phänomene sind die Emanation eines materiellen Prozesses, den ein komplexes System verursacht.
3. Komplexe Systeme lassen sich mathematisch nicht modellieren und nicht kausal verstehen.
4. Computer sind Turing-Maschinen. Sie können nur mathematische Modelle berechnen. Es wird niemals Hyper-Turing Maschinen geben, und wenn es sie gäbe, könnten sie auch nur mathematische Modelle berechnen.
5. Es ist nicht möglich, den Geist den Körper als Substrat des Geistes durch einen Computer zu ersetzen.

Die digitale Unsterblichkeit ist demzufolge ein Ding der Unmöglichkeit.

113. Jobst Landgrebe and Barry Smith, "Sam Harris and the Myth of Artificial Intelligence", in Sandra Woien, ed. *Sam Harris. Critical Responses*, Chicago, Open Universe, January 2023, 153-161.

Sam Harris is a contemporary illustration of the difficulties standing in the way of coherent interdisciplinary thinking in an age where science and the humanities have drifted so far apart. We are here with Harris's views on AI, and specifically with his view according to which, with the advance of AI, there will evolve a machine superintelligence with powers that far exceed those of the human mind. This he sees as something that is not merely possible, but rather a matter of inevitability. If, however, we look carefully at what intelligence is, and at how computers really work on the basis of mathematical models, then we can see that it is forever impossible to emulate inside a computer even the intelligence of crows or rabbits, let alone that of human beings.

114. Barry Smith, "The Future of Ontologies", in Peter Elkin, ed., *Terminology, Ontology and their Implementations*, Cham: Springer Nature Switzerland AG, July 20, 2023, 573-577.

115. Barry Smith, "Biomedical Ontologies", Peter Elkin, ed., *Terminology, Ontology and their Implementations*, Springer Nature Switzerland AG, July 20, 2023, 125-169.

Abstract: We begin at the beginning, with an outline of Aristotle's views on ontology and with a discussion of the influence of these views on Linnaeus. We move from there to consider the data standardization initiatives launched in the nineteenth century and then turn to investigate how the idea of computational ontologies developed in the AI and knowledge representation communities in the closing decades of the twentieth century. We show how aspects of this idea, particularly those relating to the use of the term "concept" in ontology development, influenced SNOMED CT and other medical terminologies. Against this background, we then show how the Foundational Model of Anatomy, the Gene Ontology, Basic Formal Ontology, and other OBO

Foundry ontologies came into existence and discuss their role in the development of contemporary biomedical informatics.

116. Barry Smith, "Thinking Like an Austrian", in Cavallo, J.A., Block, W.E. (eds), *Libertarian Autobiographies*, Cham: Palgrave, September 2023, 41-45.

Abstract: I was introduced to libertarianism and Austrian economics as an undergraduate in Oxford, and I began to explore the links between philosophers and economists in the former Austria-Hungary. I was led also to the phenomenological movement founded by Edmund Husserl, more specifically to the Munich branch of the movement whose members sought to apply Husserl's methods to the study of extra-philosophical topics such as law, language, the state, and religion. Between 1976 and (roughly) 2000, I focused my work on these Austro-German themes, co-founding an organization by the name of the Seminar for Austro-German Philosophy which attempted to familiarize other philosophers in the English-speaking world with the contributions of thinkers such as Menger, Hayek, Brentano, Reinach, and Ingarden.

117. "ChatGPT: Not intelligent", in: G. Molnar and K. Nyíri, *AI: From Robotics to Philosophy. Proceedings of the Hungarian Academy of Sciences Workshop on The Intelligent Robots of the Future – Or Human Evolutionary Development Based on AI Foundations*, Proceedings of the Hungarian Academy of Sciences Workshop, 2023, 52-56.

Abstract: In our book, *Why Machines Will Never Rule the World*, Jobst Landgrebe and I defend an argument to the effect that we can engineer machines that can emulate the behaviours only of simple systems. This means: only of those systems whose behaviour we can predict mathematically. The human brain is an example of a complex system, and thus its behaviour cannot be emulated by a machine. We use this argument to debunk the claims of those who believe that large language models such as ChatGPT are poised to achieve a level of intelligence that will equal or even surpass that of the human brain.

Papers in Refereed Conference Proceedings

1. Barry Smith, "Wittgenstein and the Background of Austrian Philosophy", in E. Leinfellner, *et al*. (eds.), *Wittgenstein and His Impact on Contemporary Thought*, Vienna: Hölder-Pichler-Tempsky, Dordrecht: Reidel, 1978, 31–35.

Abstract: Surveys the evidence for an influence of Austrian philosophers – specifically Brentano, Meinong, Husserl, Twardowski and Mach – on the early Wittgenstein. Such influence might either have been direct, for instance through Wittgenstein's reading of Mach, or indirect, through the mediation of Russell and Moore. The paper concludes by addressing the possible influence of Stumpf and Reinach on Wittgenstein's technical usage of the term '*Sachverhalt'* in the *Tractatus*.

2. Barry Smith, "On Tractarian Law", in H. Berghel, *et al*. (eds.), *Wittgenstein, the Vienna Circle and Critical Rationalism*, Vienna: Hölder-Pichler-Tempsky, Dordrecht: Reidel, 1979, 31–35.

Abstract: 'It is clear', wrote Wittgenstein in the *Tractatus*, 'that ethics has nothing to do with punishment and reward in the usual sense of the terms' (6.422). But he insisted also that there must be some kind of ethical punisment and reward; 'the reward,' he tells us, 'must be something pleasant, and the punishment something unpleasant'. I attempt to interpret Wittgenstein's intentions here as a modification of ethico-legal views we find in Schopenhauer, Kierkegaard, and Weininger. 'Reward' and 'punishment' are conceived as elements in an ideal legal system, of which existing penal law and the divine law would be special cases.

3. Barry Smith, "On Making Sense of Ingarden", in Maria Gołaszewska (ed.), *Crisis of Aesthetics*, Cracow: Jagiellonian University, 1979, 283–289.

4. Barry Smith, "It", in R. Haller and W. Grassl (eds.), *Language, Logic and Philosophy*, Vienna: Hölder-Pichler-Tempsky, Dordrecht: Reidel, 1980, 342–345.

Abstract: A brief study of the logical, linguistic, psychological and ontological problem of 'impersonalia', which is to say of assertions such as 'it's raining' or '*es blitzt*' which seem to have no subject. Such assertions cause problems not only for defenders of traditional subject-predicate views of assertive sentences, but also for those, such as Frege, who defended a view in terms of functions and arguments.

5. Barry Smith, "Some Formal Moments of Truth", in W. Leinfellner, *et al*. (eds.), *Language and Ontology*, Vienna: Hölder-Pichler-Tempsky, Dordrecht: Reidel, 1982, 186–190.

Abstract: A preliminary statement of the formal theory of the truthmaker relation advanced in the paper "Truth-makers" (Mulligan, Simons and Smith) in 1984. Correspondence theories of truth have. I give a brief account of some more or less obvious formal characteristics of this almost forgotten basic truthmaker relation. I then attempt to show how this account may be extended to provide elements of a theory of truth which is in keeping with the spirit of Wittgenstein's *Tractatus*.

6. Barry Smith, "Acts and their Objects", in P. Weingartner and H. Czermak (eds.), *Epistemology and Philosophy of Science*, Vienna: Hölder-Pichler-Tempsky, Dordrecht: Reidel, 1983, 38–41.

7. Barry Smith, "Logical and Philosophical Remarks on Parts and Wholes", in P. Sällström (ed.), *An Inventory of Present Thinking about Parts and Wholes*, vol. I, Stockholm: Forskningsradsnämnden, 1983, 123–128.

8. Barry Smith, "Reflections on Dependence", in P. Sällström (ed.), *An Inventory of Present Thinking about Parts and Wholes*, vol. II, Stockholm: Forskningsradsnämnden, 1984, 29–42.

9. Barry Smith, "How not to talk about what does not exist", in R. Haller (ed.), *Aesthetics*, Vienna: Hölder-Pichler-Tempsky, Dordrecht: Reidel, 1984, 194–196.

Abstract: Defends a view of intentional directedness according to which those seemingly object-directed acts – involved for example in reading works of fiction – which lack existing objects as targets, are not intentional (thus: not directed towards any object). Rather, each such act seems to its subject as if it were so directed because it is associated with a belief of a certain special sort, whose intentional directedness is not towards any putative external object but rather towards the very act itself with which the belief is associated.

10. Barry Smith, "On the Structures of Perceptual *Gestalten*", in R. M. Chisholm, *et al*. (eds.), *Philosophy of Mind. Philosophy of Psychology*, Vienna: Hölder-Pichler-Tempsky, 1985, 301–304.

Abstract: The Gestalt tradition was initiated in 1890 by Christian von Ehrenfels with his essay "On Gestalt Qualities". We describe how Ehrenfels and other thinkers in the tradition stretching from Brentano, Meinong and Ehrenfels to Benussi, held different views of the the way in which the organized structure which is the object of perception – for example a melody or pattern of colors – relates to the physiological processing on the side of the perceiver on the one hand, and to the objects in the world – for example single tones or patches of color. We focus particularly on the problem of the objectivity of perceptual Gestalten and on the contrast between the so-called Graz school of Meinong and Benussi and the Berlin school of Wertheimer, Köhler and Koffka.

11. Wolfgang Grassl and Barry Smith, "A Theory of Austria", in J. C. Nyíri (ed.), *From Bolzano to Wittgenstein: The Tradition of Austrian Philosophy*, Vienna: Hölder-Pichler-Tempsky, Dordrecht: Reidel, 1986, 11–30.

Abstract: The present essay seeks, by way of the Austrian example, to make a contribution to what might be called the philosophy of the supranational state. More specifically, we shall attempt to use certain ideas on the philosophy of Gestalten as a basis for understanding some aspects of that political and cultural phenomenon which was variously called the Austrian Empire, the Habsburg Empire, the Danube Monarchy or Kakanien.

12. Barry Smith, "Wittgensteinian Philosophy and the Culture of the Commentary", in R. Haller and J. Brandl (eds.), *Wittgenstein: Towards a Re-Evaluation*, Vienna: Hölder-Pichler-Tempsky, 1990, vol. 2, 247–254.

Abstract: The commentary is a form of literature that once predominated in all major philosophical cultures, from classical China to Renaissance Italy. Commentaries on the writings of German thinkers such as Kant, Hegel, Marx and Heidegger have kept the form alive to some extent in recent centuries; but among contemporary philosophers in the analytic mainstream it is a form that is almost never used. Why then, among philosophers in the analytic tradition, should the writings of Wittgenstein have spawned the growth of a commentary literature? What are the marks of an author, and of the surrounding culture, which spawn such growth?

13. "Zur Nichtübersetzbarkeit der deutschen Philosophie", in D. Papenfuss and O. Pöggeler (eds.), *Zur philosophischen Aktualität Heideggers*, vol. 3, *Im Spiegel der Welt: Sprache, Übersetzung, Auseinandersetzung*, Frankfurt: Klostermann, 1992, 125–147.

Abstract: Warum hat sich die deutsche Philosophie so sehr und so langanhaltend an Autoritäten und Texte gebunden gefühlt, fast als ob man – wie die alten Iatrophilologen – Wissen aus bloßen Worten herauspressen wollte? Warum haben sich in Deutschland so häufig philosophische Sprachstile entwickelt, die ein Hindernis fur das Verständnis der entsprechenden Texte sind?

Russian translation: "К непереводимости немецкой философии", *Социологос* [*Sociologos*]. No. 5-6, 124-139.

14. Barry Smith, "Über die Grenzen der Übersetzbarkeit", in Armin Paul Frank, Kurt–Jürgen Maass, Fritz Paul and Horst Turk (eds.), *Übersetzen. Verstehen. Brücken bauen. Geisteswissenschaftliches und literarisches Übersetzen im internationalen Kulturaustausch* (Göttinger Beiträge zur Internationalen Übersetzungsforschung, 8/1), Berlin/Bielefeld/Munich: Erich Schmidt Verlag, 1994, 295–301.

15. Barry Smith, "Philosophieren und Kommentieren: Überlegungen zu ihrem Verhältnis", in H. F. Fulda and Rolf-Peter Horstmann (eds.), *Vernunftbegriffe in der Moderne. Stuttgarter Hegel-Kongress 1993*, Stuttgart: Klett Cotta, 1994, 857–868.

Shorter version as: "Worin unterscheiden sich deutsche und angelsächsische Philosophie?", *Information Philosophie,* 2/1994, 30–38.

16. Barry Smith, "Fiat Objects", in N. Guarino, L. Vieu and S. Pribbenow (eds.), *Parts and Wholes: Conceptual Part-Whole Relations and Formal Mereology, 11th European Conference on Artificial Intelligence, Amsterdam, 8 August 1994*, Amsterdam: European Coordinating Committee for Artificial Intelligence, 1994, 15–22.

Abstract: Human cognitive acts are directed towards entities of a wide range of different types. What follows is a new proposal for bringing order into this typological clutter. The starting point for our categorial scheme is the concept of extended entity. Two sorts of extended entity are initially distinguished: objects, which are extended in space; and processes, which are extended in time. Examples of objects are: you and I. Objects are possessed of divisible bulk: they can be divided, in reality or in thought, into spatial parts. Examples of processes are: your life and my current headache. It is unproblematic that both objects and processes have outer boundaries: the exterior surface of your skin; the beginning and the ending of your life. Here however we focus on what we can think of as inner boundaries – the boundary dividing your upper and lower torso? Or the boundary dividing your life before from your life after your fourteenth birthday?

17. Barry Smith, "Topological Foundations of Cognitive Science", in C. Eschenbach, C. Habel and B. Smith (eds.), *Topological Foundations of Cognitive Science,* Hamburg: Graduiertenkolleg Kognitionswissenschaft, 1994, 3–22.

Abstract: The paper introduces the concepts at the heart of *point-set-topology* and of *mereotopology* (topology founded in the non-atomistic theory of parts and wholes) in an

informal and intuitive fashion. It will then seek to demonstrate how mereotopological ideas can be of particular utility in cognitive science applications. The prehistory of such applications (in the work of Husserl, the Gestaltists, of Kurt Lewin and of J. J. Gibson) will be sketched, together with an indication of the field of possibilities in linguistics, perceptual psychology, categorization and geographic information systems. Topological structures will be shown to play a central role in studies of naive physics not least in virtue of the fact that even well-attested departures from true physics on the part of common sense leave the topology and vectorial orientation of the underlying physical phenomena invariant: our common sense would thus seem to have a veridical grasp of the topology and broad general orientation of physical phenomena, both static and dynamic, even where it illegitimately modifies the relevant shape and metric properties. The implications of this and related insights for the methodology of psychology will be explored.

Danish translation as: "Kognitionsforskningens topologiske grundlag", in *Semikolon,* 3 (7), 2003, 91-105, also published as Peer F. Bundgaard, Jesper Egholm & Martin Skov (eds.), *Dynamisk semiotik. Kognition, sprog, ontologi*, Copenhagen: Gyldendal.

18. Barry Smith, "On Drawing Lines on a Map", in Andrew U. Frank and Werner Kuhn (eds.), *Spatial Information Theory. A Theoretical Basis for GIS* (Lecture Notes in Computer Science 988), Berlin/Heidelberg/New York, etc.: Springer, 1995, 475–484.

Abstract: The paper is an exercise in descriptive ontology, with specific applications to problems in the geographical sphere. It presents a general typology of spatial boundaries, based in particular on an opposition between *bona fide* or physical boundaries on the one hand, and *fiat* or human-demarcation-induced boundaries on the other. Cross-cutting this opposition are further oppositions in the realm of boundaries, for example between: crisp and indeterminate, complete and incomplete, enduring and transient, symmetrical and asymmetrical. The resulting typology generates a corresponding categorization of the different sorts of *objects* which (complete) boundaries determine or demarcate. The theory is applied first of all in the areas of geography and of administrative and property law. Indications are then given as to how the typology may be applied also in other fields where physical and fiat boundaries are at work, including the field of cognitive linguistics and the related field of the ontology of truth.

19. Barry Smith, "Towards an Ontology of Common Sense", in Jaakko Hintikka and Klaus Puhl (eds.), *The British Tradition in Twentieth-Century Philosophy*, Vienna: Hölder-Pichler-Tempsky, 1995, 300–309.

Abstract: Just as some have argued that the folk-psychological ontology of beliefs, desires, etc. yields the best explanation we can have of the order of cognitive phenomena conceived from the perspective of first-person experience, so we argue here that (1) the commonsensical ontology of folk physics yields the best explanation we can have of our externally directed cognitive experience and that (2) an ontology of mesoscopic things, events and processes must play a role, in particular, in our best scientific theory of human action.

20. Barry Smith, "The Cognitive Geometry of War", in Peter Koller and Klaus Puhl (eds.), *Current Issues in Political Philosophy: Justice in Society and World Order,* Vienna: Hölder-Pichler-Tempsky, 1997, 394–403.

Abstract: Why does 'ethnic cleansing' occur? Why does the rise of nationalist feeling in Europe and of Black separatist movements in the United States often go hand in hand with an upsurge of anti-Semitism? Why do some mixings of distinct religious and ethnic groups succeed, where others (for example in Northern Ireland, or in Bosnia) fail so catastrophically? Why do phrases like 'balkanisation', 'dismemberment', 'mutilation', 'violation of the motherland' occur so often in warmongering rhetoric? All of these questions are, it will turn out, connected. To understand how they are connected we we will need to examine how human beings acquire a relationship to specific chunks of land, a relationship that is emotionally so strong that they are prepared to die – or kill – to protect that land for themselves or to win it back from others. Territoriality, the biologically rooted predisposition to defend core areas of home ranges against intruders, is a near-universal phenomenon amongst animals of all species. But the ways in which defended territories are conceived and demarcated differ widely from species to species and from group

to group. By coming to an understanding of the geometry of these differences we can come to understand also some of the factors which give rise to interethnic conflict.

French translation as: "La géométrie cognitive de la guerre", in Bernard Baertschi and Kevin Mulligan (eds.), *Les Nationalismes*, Paris, PUF, 2002, 199–226.

Romanian translation in *Nationalismele*, Bucharest: Nemira, 2010

21. Barry Smith and Achille Varzi, "Fiat and Bona Fide Boundaries: Towards an Ontology of Spatially Extended Objects", in S. C. Hirtle and A. U. Frank (eds.), *Spatial Information Theory. International Conference COSIT '97. Laurel Highlands, Pennsylvania, October 1997* (Lecture Notes in Computer Science 1329)*,* Berlin/New York: Springer Verlag, 103–119.

Abstract: Human cognitive acts are directed towards objects extended in space of a wide range of different types. What follows is a new proposal for bringing order into this typological clutter. The theory of spatially extended objects should make room not only for the objects of physics but also for objects at higher levels, including the objects of geography and of related disciplines. It should leave room for different types of boundaries, including both the bona fide boundaries which we find in the physical world and the fiat (or human-demarcation-induced) boundaries with which much of geography has to deal. Two distinct axiomatic theories of boundaries are accordingly presented, and the need for both is examined in some detail. The resultant dual framework is shown to have application above all for our understanding of issues involving contact, division, and separation, issues which have posed serious difficulties for the ontological theories of boundaries that have been proposed hitherto.

22. Barry Smith, "Basic Concepts of Formal Ontology", in Nicola Guarino (ed.), *Formal Ontology in Information Systems*, Amsterdam, Oxford, Tokyo, Washington, DC: IOS Press (Frontiers in Artificial Intelligence and Applications), 1998, 19–28.

Abstract: The term 'formal ontology' was first used by the philosopher Edmund Husserl in his *Logical Investigations* to signify the study of those formal structures and relations – above all relations of part and whole – which are exemplified in the subject-matters of the different material sciences. We follow Husserl in presenting the basic concepts of formal ontology as falling into three groups: the theory of part and whole, the theory of dependence, and the theory of boundary, continuity and contact. These basic concepts are presented in relation to the problem of providing an account of the formal ontology of the mesoscopic realm of everyday experience, and specifically of providing an account of the concept of individual substance.

Polish translation as "Podstawowe pojęcia ontologii formalnej", *Lectiones & Acroases Philosophicae*, 8, 2 (2015), 141-161.

23. Roberto Casati, Barry Smith and Achille Varzi, "Ontological Tools for Geographic Representation", in Nicola Guarino (ed.), *Formal Ontology in Information Systems* Amsterdam, Oxford, Tokyo, Washington, DC: IOS Press (Frontiers in Artificial Intelligence and Applications), 1998, 77–85.

Abstract: This paper is concerned with certain ontological issues in the foundations of geographic representation. It sets out what these basic issues are, describes the tools needed to deal with them, and draws some implications for a general theory of spatial representation. Our approach has ramifications in the domains of mereology, topology, and the theory of location, and the question of the interaction of these three domains within a unified spatial representation theory is addressed. In the final part we also consider the idea of non-standard geographies, which may be associated with geography under a classical conception in the same sense in which non-standard logics are associated with classical logic.

"地理的表象のための存在論的ツール", Japanese translation by Y. Yamashita, *InterCommunication,* 45, Summer 2003, 80–91.

Casati, R., Smith, B., & Varzi, A. C. (2003). 地理的表象のための存在論的ツール. *Inter communication*= インターコミュニケーション, *12*(3), 80-91.

24. Barry Smith and David M. Mark, "Ontology and Geographic Kinds", in T. Poiker and N. Chrisman (eds.), *Proceedings of the 8th International Symposium on Spatial Data Handling (SDH '98)*, Vancouver: International Geographic Union, 1998, 308–320.

Abstract: Cognitive categories in the geographic realm appear to manifest certain special features as contrasted with categories for objects at surveyable scales. We have argued that these features reflect specific ontological characteristics of geographic objects. This paper presents hypotheses as to the nature of the features mentioned, reviews previous empirical work on geographic categories, and presents the results of pilot experiments that used English-speaking subjects to test our hypotheses. Our experiments show geographic categories to be similar to their non-geographic counterparts in the ways in which they generate instances of different relative frequencies at different levels. Other tests, however, provide preliminary evidence for the existence of important differences in subjects' categorizations of geographic and non-geographic objects, and suggest further experimental work especially with regard to the role in cognitive categorization of different types of object-boundaries at different scales.

Reprinted in Yaser Bishr and Werner Kuhn (eds.), *The Role of Ontology in Modelling Geospatial Feature*s, Institut für Geoinformatik, Westfälische Wilhelms-Universität, Münster: Formatik, 1999.

25. Barry Smith, "Agglomerations", in C. Freksa, and David M. Mark (eds.), *Spatial Information Theory. Cognitive and Computational Foundations of Geographic Information Science* (Springer Lecture Notes in Computer Science 1661), 1999, 267–282.

Abstract: Where some have attempted to apply cognitive methods to the study of geography, the present paper is designed to serve as a starting point for applying methods of geographic ontology to the phenomena of cognition. Agglomerations are aggregates of entities that are dispersed through space on geographic scales. Examples include: plagues, biological species, major world religions. The paper applies standard mereotopological theories of spatial regions to agglomerations in this sense. It offers the beginnings of a general theory of the relations between social, cultural, ethnic and religious agglomerations on the one hand and territorially demarcated spatial objects on the other. In this way it serves as the basis for a general ontological theory of types of human groups and also of types of conflict between these groups. At the same time it provides ontological foundations for the epidemiological study of cognitive phenomena, and especially of cognitive phenomena in the sociopolitical realm.

26. David Mark, Barry Smith and Barbara Tversky "Ontology and Geographic Objects: An Empirical Study of Cognitive Categorization," in C. Freksa and David M. Mark (eds.), *Spatial Information Theory. Cognitive and Computational Foundations of Geographic Information Science* (Lecture Notes in Computer Science 1661), 1999, 283–298.

Abstract: Cognitive categories in the geographic realm appear to manifest certain special features as contrasted with categories for objects at surveyable scales. We have argued that these features reflect specific ontological characteristics of geographic objects. This paper presents hypotheses as to the nature of the features mentioned, reviews previous empirical work on geographic categories, and presents the results of pilot experiments that used English-speaking subjects to test our hypotheses. Our experiments show geographic categories to be similar to their non-geographic counterparts in the ways in which they generate instances of different relative frequencies at different levels. Other tests, however, provide preliminary evidence for the existence of important differences in subjects' categorizations of geographic and non-geographic objects, and suggest further experimental work especially with regard to the role in cognitive categorization of different types of object-boundaries at different scales.

27. Barry Smith and Achille C. Varzi, "The Formal Structure of Ecological Contexts," in P. Bouquet, P. Brezillon, L. Serafini, M. Beneceretti, F. Castellani (eds.), *CONTEXT '99: Modeling and Using Context*. *Proceedings of the Second International and Interdisciplinary Conference* (Lecture Notes in Artificial Intelligence, 1688), Berlin and Heidelberg: Springer-Verlag, 1999, 339–350.

Abstract: This paper presents the outline of a formal ontology of contexts. More specifically, it deals with the ontology of ecological contexts (niches, habitats, environments, ambients) and of the relations between organisms, niches, and the spatial regions they occupy. The first part sets out the basic conceptual background. The second part outlines a semi-formal theory which builds upon notions and principles of mereology, topology, and the theory of spatial location.

28. David M. Mark, Barry Smith, Berit Brogaard-Pedersen, "Ontology of Common Sense Geographic Phenomena: Foundations for Interoperable Multilingual Geospatial Databases", 3rd AGILE Conference on Geographic Information Science – Helsinki/Espoo, Finland, May 25–27, 2000, 32-34.

Abstract: Information may be defined as the conceptual or communicable part of the content of mental acts. The content of mental acts includes sensory data as well as concepts, particular as well as general information. An information system is an external (non-mental) system designed to store such content. Information systems afford indirect transmission of content between people, some of whom may put information into the system and others who are among those who use the system. In order for communication to happen, the conceptual systems of the originators and users of the information must be sufficiently similar. A formal conceptual framework that can provide the basis for exchange of information is termed an ontology. In its most fundamental form, ontology studies the most basic constituents of reality. Traditionally, ontology seeks to reflects structures that are independent of thought and cognition. The term ontology is used more broadly in artificial intelligence and software engineering, to refer to the conceptual basis for an information system.

29. Barry Smith, "On Forms of Communication in Philosophy", in *Proceedings of the 20th World Congress of Philosophy,* Volume X: *Philosophy of Science*, Editor: Tian Yu Cao, Bowling Green: Philosophy Documentation Center, 2001, 73–82.

30. Barry Smith and Achille C. Varzi, "Environmental Metaphysics", in U. Meixner (ed.), *Metaphysics in the Post-Metaphysical Age. Proceedings of the 22nd International Wittgenstein-Symposium*, Vienna: öbv&hpt, 2001, 231–239.

Abstract: We propose the beginnings of a general theory of environments, of the parts or regions of space in which organisms live and move. We draw on two sources: on the one hand on recent work on the ontology of space; and on the other hand on work by ecological scientists on concepts such as territory, habitat and niche.

Japanese translation by S. Kajitani: "環境の形而上学" (Kankyo no Keijijyogaku), *理想* (*The Riso/Risosha* (Tokyo), 669, 2002, 170–180.

31. Barry Smith, "True Grid", in Daniel Montello (ed.), *Spatial Information Theory. Foundations of Geographic Information Science, Proceedings of COSIT 2001,* Morro Bay, California, September 2001 (Lecture Notes in Computer Science 2205), Berlin/New York: Springer, 14–27.

Abstract: The Renaissance architect, moral philosopher, cryptographer, mathematician, Papal adviser, painter, city planner and land surveyor Leon Battista Alberti provided the theoretical foundations of modern perspective geometry. Alberti's work on perspective exerted a powerful influence on painters of the stature of Albrecht Dürer, Leonardo da Vinci and Piero della Francesca. But his Della pittura of 1435–36 contains also a hitherto unrecognized ontology of pictorial projection. We sketch this ontology, and show how it can be generalized to apply to representative devices in general, including maps and spatial and non-spatial databases.

Revised version as: "Pictures, Maps and Other Cognitive Artifacts", *Visio*, 6: 2-3, 2001, 163–176.

32. David M. Mark, Andre Skupin and Barry Smith, "Features, Objects, and Other Things: Ontological Distinctions in the Geographic Domain", in Daniel Montello (ed.), *Spatial Information Theory. Foundations of Geographic Information Science, Proceedings of COSIT 2001, Morro Bay, California, September 2001* (Lecture Notes in Computer Science 2205), Berlin/New York: Springer, 488–502.

Abstract: Two hundred and sixty-three subjects each gave examples for one of five geographic categories: geographic features, geographic objects, geographic concepts, something geographic, and something that could be portrayed on a map. The frequencies of various responses were significantly different, indicating that the basic ontological terms feature, object, etc., are not interchangeable but carry different meanings when combined with adjectives indicating geographic or mappable. For all of the test phrases involving geographic, responses were predominantly natural features such as mountain, river, lake, ocean, hill. Artificial geographic features such as town and city were listed hardly at all for geographic categories, an outcome that contrasts sharply with the disciplinary self-understanding of academic geography. However, geographic artifacts and fiat objects, such as roads, cities, boundaries, countries, and states, were frequently listed by the subjects responding to the phrase something that could be portrayed on a map. In this paper, we present the results of these experiments in visual form, and provide interpretations and implications for further research.

33. Thomas Bittner and Barry Smith, "A Taxonomy of Granular Partitions", Daniel Montello (ed.), *Spatial Information Theory. Foundations of Geographic Information Science,* Proceedings of COSIT 2001*, Morro Bay, California, September 2001* (Lecture Notes in Computer Science 2205), Berlin/New York: Springer, 28–43.

Abstract: In this paper we propose a formal theory of partitions (ways of dividing up or sorting or mapping reality) and we show how the theory can be applied in the geospatial domain. We characterize partitions at two levels: as systems of cells (theory A), and in terms of their projective relation to reality (theory B). We lay down conditions of well-formedness for partitions and we define what it means for partitions to project truly onto reality. We continue by classifying well-formed partitions along three axes: (a) degree of correspondence between partition cells and objects in reality; (b) degree to which a partition represents the mereological structure of the domain it is projected onto; and (c) degree of completeness and exhaustiveness with which a partition represents reality. This classification is used to characterize three types of partitions that play an important role in spatial information science: cadastral partitions, categorical coverages, and the partitions involved in folk categorizations of the geospatial domain.

34. Barry Smith and Christopher Welty, "Ontology: Towards a New Synthesis", editors' introduction to: Christopher Welty and Barry Smith (eds.), *Formal Ontology in Information Systems*, New York: ACM Press, 2001, iii-ix.

Abstract: This introduction to the Second International Conference on Formal Ontology in Information Systems presents a brief history of ontology as a discipline spanning the boundaries of philosophy and information science. We sketch some of the reasons for the growth of ontology in the information science field, and offer a preliminary stocktaking of how the term 'ontology' is currently used. We conclude by suggesting some grounds for optimism as concerns the future collaboration between philosophical ontologists and information scientists.

35. Thomas Bittner and Barry Smith, "Granular Partitions and Vagueness" in Christopher Welty and Barry Smith (eds.), *Formal Ontology in Information Systems*, New York: ACM Press, 2001, 309–321.

36. Wolfgang Degen, Barbara Heller, Heinrich Herre and Barry Smith, "GOL: A General Ontological Language", in D (eds.), *Formal Ontology in Information Systems*, New York: ACM Press, 2001, 34–46. Preprint version with the title "GOL: Towards an Axiomatized Upper-Level Ontology*,* IMISE Report, University of Leipzig, 2001.

Abstract: Every domain-specific ontology must use as a framework some upper-level ontology which describes the most general, domain-independent categories of reality. In the present

paper we sketch a new type of upper-level ontology, which is intended to be the basis of a knowledge modelling language GOL (for: 'General Ontological Language'). It turns out that the upper-level ontology underlying standard modelling languages such as KIF, F-Logic and CycL is restricted to the ontology of sets. Set theory has considerable mathematical power and great flexibility as a framework for modelling different sorts of structures. At the same time it has the disadvantage that sets are abstract entities (entities existing outside the realm of time, space and causality), and thus a set-theoretical framework should be supplemented by some other machinery if it is to support applications in the ripe, messy world of concrete objects. In the present paper we partition the entities of the real world into sets and urelements, and then we introduce several new ontological relations between these urelements. In contrast to standard modelling and representation formalisms, the concepts of GOL provide a machinery for representing and analysing such ontologically basic relations.

37. Barry Smith and Leo Zaibert, "The Metaphysics of Real Estate", in Christoph Schlieder, Erik Stubkjaer and Heiner Stuckenschmidt (eds.), *Von der Theorie zur Praxis: Entwicklung und Transfer von Informatik-Technologien. Papers of the Kick-Off Meeting of the COST Action G9 "Modeling Real-Property Transactions', Bremen, Nov. 1-3, 2001,* University of Bremen, Fachbereich Mathematik/Informatik, 2001, 19–21.

Abstract: The parceling of land into real estate is more than a simple geometrical affair. Real estate is a historical product of interaction between human beings, political, legal and economic institutions, and the physical environment. And while many authors, from Jeremy Bentham to Hernando de Soto, have drawn attention to the ontological (metaphysical) aspect of property in general, no comprehensive analysis of landed property has been attempted. The paper presents such an analysis and shows how landed property differs from other types of property in a way which implies a special role for political and economic philosophy of property rights in land.roduct of interaction between human beings, political, legal and economic institutions, and the physical environment. And while many authors, from Jeremy Bentham to Hernando de Soto, have drawn attention to the ontological (metaphysical) aspect of property in general, no comprehensive analysis of landed property has been attempted. The paper presents such an analysis and shows how landed property differs from other types of property in a way which implies a special role for political and economic philosophy of property rights in land.

38. Thomas Bittner and Barry Smith, "A unified theory of granularity, vagueness and approximation", Proceedings of COSIT Workshop on Spatial Vagueness, Uncertainty and Granularity (2001).

Abstract: We propose a view of vagueness as a semantic property of names and predicates. All entities are crisp, on this semantic view, but there are, for each vague name, multiple portions of reality that are equally good candidates for being its referent, and, for each vague predicate, multiple classes of objects that are equally good candidates for being its extension. We provide a new formulation of these ideas in terms of a theory of granular partitions. We show that this theory provides a general framework within which we can understand the relation between vague terms and concepts and the corresponding crisp portions of reality. We also sketch how it might be possible to formulate within this framework a theory of vagueness which dispenses with the notion of truth-value gaps and other artifacts of more familiar approaches. Central to our approach is the idea that judgments about reality involve in every case (1) a separation of reality into foreground and background of attention and (2) the feature of granularity. On this basis we attempt to show that even vague judgments made in naturally occurring contexts are not marked by truth-value indeterminacy. We distinguish, in addition to crisp granular partitions, also vague partitions, and reference partitions, and we explain the role of the latter in the context of judgments that involve vagueness. We conclude by showing how reference partitions provide an effective means by which judging subjects are able to temper the vagueness of their judgments by means of approximations.

38. Maureen Donnelly and Barry Smith "Layers: A New Approach to Locating Objects in Space", in W. Kuhn, M. F. Worboys, and S. Timpf (eds.), *Spatial Information Theory: Foundations of Geographic Information Science* (Lecture Notes in Computer Science 2825), Berlin: Springer, 2003, 50–65.

Abstract: Standard theories in mereotopology focus on relations of parthood and connection among spatial or spatio-temporal regions. Objects or processes which might be located in such regions are not normally directly treated in such theories. At best, they are simulated via appeal to distributions of attributes across the regions occupied or by functions from times to regions. The present paper offers a richer framework, in which it is possible to represent directly the relations between entities of various types at different levels, including both objects and the regions they occupy. What results is a layered mereotopology, a theory which can handle multiple layers (analogous to the layers of a lasagna) of spatially or spatiotemporally coincident but mereologically non-overlapping entities.

39. Daniel Cohnitz and Barry Smith, "Assessing Ontologies: The Question of Human Origins and Its Ethical Significance", in C. Kanzian and E. Runggaldier (eds.), *Persons: An Interdisciplinary Approach*, Vienna: hpt&öbv, 2003, 243–59.

Abstract: In their paper "Sixteen Days" Barry Smith and Berit Brogaard try to answer the question: when does a human being begin to exist? In this paper we will address some methodological issues connected with this exercise in ontology. We shall begin by sketching the argument of "Sixteen Days". We shall then attempt to characterize what is special about the ontological realism of "Sixteen Days" as contrasted to the linguistic constructivism which represents the more dominant current in contemporary analytic philosophy. This will allow us to infer guidelines for assessing the quality of ontological theories of various types. We shall argue that ontological parsimony, groundedness, faithfulness to ordinary language, consistency with science, coherence, and fruitfulness are at least part of the adequacy criteria for such theories. These criteria will then be applied to the theory presented in "Sixteen Days", and they will lead us to some revisions of this theory as well as to some reflections on its ethical implications.

40. Anand Kumar and Barry Smith "Ontology for Task-Based Clinical Guidelines and the Theory of Granular Partitions", *Proceedings of the 9th Conference on Artificial Intelligence in Medicine* (Lecture Notes on Artificial Intelligence 2780), Berlin: Springer, 2003, 71–75.

Abstract: The theory of granular partitions (TGP) is a new approach to the understanding of ontologies and other classificatory systems. The paper explores the use of this new theory in the treatment of task-based clinical guidelines as a means for better understanding the relations between different clinical tasks, both within the framework of a single guideline and between related guidelines. We used as our starting point a DAML+OIL-based ontology for the WHO guideline for hypertension management, comparing this with related guidelines and attempting to show that TGP provides a flexible and highly expressive basis for the manipulation of ontologies of a sort which might be useful in providing more adequate Computer Interpretable Guideline Models (CIGMs) in the future.

41. Barry Smith, Igor Papakin and Katherine Munn, 2003, "Bodily Systems and the Modular Structure of the Human Body", *Proceedings of the 9th Conference on Artificial Intelligence in Medicine* (Lecture Notes on Artificial Intelligence 2780), Berlin: Springer, 2003, 86–90.

Abstract: Medical science conceives the human body as a system comprised of many subsystems at a variety of levels. At the highest level are bodily systems proper, such as the endocrine system, which are central to our understanding of human anatomy, and play a key role in diagnosis and in dynamic modeling as well as in medical pedagogy and computer visualization. But there is no explicit definition of what a bodily system is; such informality is acceptable in documentation created for human beings, but falls short of what is needed for computer representations. Our analysis is intended as a first step towards filling this gap.

42. Werner Ceusters, Barry Smith and Jim Flanagan 2003, "Ontology and Medical Terminology: Why Description Logics Are Not Enough", in *Proceedings of the Conference: Towards an Electronic Patient Record* (TEPR 2003), San Antonio 10-14 May 2003, Boston, MA: Medical Records Institute (CD-ROM publication).

Abstract: Ontology is currently perceived as the solution of first resort for all problems related to biomedical terminology, and the use of description logics is seen as a minimal requirement

on adequate ontology-based systems. Contrary to common conceptions, however, description logics alone are not able to prevent incorrect representations; this is because they do not come with a theory indicating what is computed by using them, just as classical arithmetic does not tell us anything about the entities that are added or subtracted. In this paper we shall show that ontology is indeed an essential part of any solution to the problems of medical terminology – but only if it is understood in the right sort of way. Ontological engineering, we shall argue, should in every case go hand in hand with a sound ontological theory.

43. Barry Smith, Jennifer Williams and Steffen Schulze-Kremer, 2003, "The Ontology of the Gene Ontology", in *Biomedical and Health Informatics: From Foundations to Applications*, Proceedings of the Annual Symposium of the American Medical Informatics Association, Washington DC, November 2003, 609–613. PMC1480173

Abstract: The rapidly increasing wealth of genomic data has driven the development of tools to assist in the task of representing and processing information about genes, their products and their functions. One of the most important of these tools is the Gene Ontology (GO), which is being developed in tandem with work on a variety of bioinformatics databases. An examination of the structure of GO, however, reveals a number of problems, which we believe can be resolved by taking account of certain organizing principles drawn from philosophical ontology. We shall explore the results of applying such principles to GO with a view to improving GO's consistency and coherence and thus its future applicability in the automated processing of biological data.

44. Anand Kumar and Barry Smith, 2003, "The Universal Medical Language System and the Gene Ontology: Some Critical Reflections", in A. Günter, R. Kruse and B. Neumann (eds.), *KI 2003: Advances in Artificial Intelligence* (Lecture Notes in Artificial Intelligence 2821), Berlin: Springer, 2003, 135–148.

Abstract: The Unified Medical Language System and the Gene Ontology are among the most widely used terminology resources in the biomedical domain. However, when we evaluate them in the light of simple principles for well-constructed ontologies we find a number of characteristic inadequacies. Employing the theory of granular partitions, a new approach to the understanding of ontologies and of the relationships ontologies bear to instances in reality, we provide an application of this theory in relation to an example drawn from the context of the pathophysiology of hypertension. This exercise is designed to demonstrate how, by taking ontological principles into account we can create more realistic biomedical ontologies which will also bring advantages in terms of efficiency and robustness of associated software applications.

45. Barry Smith, "Ontology in Biomedicine", E. Papp, A. G. Beck-Sickinger and S. Eichler (eds.), *2. Biotechnologie-Tag*, Leipzig: University of Leipzig, 2003, 294–296.

46. Anand Kumar and Barry Smith, "A Framework for Protein Classification", *Proceedings of the 2003 German Conference on Bioinformatics,* Vol. II, 2003, 55–57.

Abstract: It is widely understood that protein functions can be exhaustively described in terms of no single parameter, whether this be amino acid sequence or the three-dimensional structure of the underlying protein molecule. This means that a number of different attributes must be used to create an ontology of protein functions. Certainly much of the required information is already stored in databases such as Swiss-Prot, Protein Data Bank, SCOP and MIPS. But the latter have been developed for different purposes and the separate data-structures which they employ are not conducive to the needed data integration. When we attempt to classify the entities in the domain of proteins, we find ourselves faced with a number of cross-cutting principles of classification. Our question here is: how can we bring together these separate taxonomies in order to describe protein functions? Our proposed answer is: via a careful top-level ontological analysis of the relevant principles of defeTclassification, combined with a new framework for the simultaneous manipulation of classifications constructed for different purposes.

47. Anand Kumar, Barry Smith, Mario Stefanelli, Silvana Quaglinia and Matteo Piazza, "Implementing Clinical Guidelines in an Organizational Setup", *Proceedings of the Workshop on Model-Based and Qualitative Reasoning in Biomedicine*, AIME 2003, 39–44. See also supplementary paper here.

Abstract: Outcomes research in healthcare has been a topic much addressed in recent years. Efforts in this direction have been supplemented by work in the areas of guidelines for clinical practice and computer-interpretable workflow and careflow models.In what follows we present the outlines of a framework for understanding the relations between organizations, guidelines, individual patients and patient-related functions. The derived framework provides a means to extract the knowledge contained in the guideline text at different granularities, in ways that can help us to assign tasks within the healthcare organization and to assess clinical performance in realizing the guideline. It does this in a way that preserves the flexibility of the organization in the adoption of the guidelines.

48. Thomas Bittner and Barry Smith, "Granular Spatio-Temporal Ontologies", *AAAI Symposium: Foundations and Applications of Spatio-Temporal Reasoningv* (FASTR), AAAI Press, 2003, 12–17.

Abstract: We propose an ontological theory that is powerful enough to describe both complex spatio-temporal processes (occurrents) and the enduring entities (continuants) that participate therein. The theory is divided into two major categories of sub-theories: (sub-) theories of type SPAN and (sub-)theories of type SNAP. These theories represent two complementary perspectives on reality and result in distinct though compatible systems of categories. In SNAP we have enduring entities such as substances, qualities, roles, functions; in SPAN we have perduring entities such as processes and their parts and aggregates. We argue that both kinds of ontological theory are required in order to give a non-reductionism account of complex domains of reality.

49. David M Mark, Werner Kuhn, Barry Smith, Andrew G. Turk, "Ontology, natural language, and information systems: Implications of cross-linguistic studies of geographic terms", *6th Annual Conference of the Association of Geographic Information Laboratories for Europe* (AGILE), 45-50.

Abstract: Ontology has been proposed as a solution to the 'Tower of Babel' problem that threatens the semantic interoperability of information systems constructed independently for the same domain. In information systems research and applications, ontologies are often implemented by formalizing the meanings of words from natural languages. However, words in different natural languages sometimes subdivide the same domain of reality in terms of different conceptual categories. If the words and their associated concepts in two natural languages, or even in two terminological traditions within the same language, do not have common referents in the real world, an ontology based on word meanings will inherit the 'Tower of Babel' problem from the languages involved, rather than solve it. In this paper we present evidence from a preliminary comparison of landscape terms in English with those in the Yindjibarndi language of northwestern Australia demonstrating that this problem is not just hypothetical. Some possible solutions are suggested.

50. Istvan-Tibor Nébel, Barry Smith, Ralf Paschke, "A User Profiling Component with the Aid of User Ontologies", *Proceedings of Learning – Teaching – Knowledge – Adaptivity* (LLWA), University of Karlsruhe (2003).

Abstract: What follows is a contribution to the field of user modeling for adaptive teaching and learning programs especially in the medical field. The paper outlines existing approaches to the problem of extracting user information in a form that can be exploited by adaptive software. We focus initially on the so-called stereotyping method, which allocates users into classes adaptively, reflecting characteristics such as physical data, social background, and computer experience. The user classifications of the stereotyping method are however ad hoc and unprincipled, and they can be exploited by the adaptive system only after a large number of trials by various kinds of users. We argue that the remedy is to create a database of user ontologies from which readymade taxonomies can be derived in such a way as to enable associated software to support a variety of different types of users.

51. Barry Smith, Jakob Köhler and Anand Kumar, "On the Application of Formal Principles to Life Science Data: A Case Study in the Gene Ontology", in *Proceedings of* DILS 2004 *(Data Integration in the Life Sciences*), (Lecture Notes in Bioinformatics 2994), Berlin: Springer, 2004, 79–94.

Abstract: Formal principles governing best practices in classification and definition have for too long been neglected in the construction of biomedical ontologies, in ways which have important negative consequences for data integration and ontology alignment. We argue that the use of such principles in ontology construction can serve as a valuable tool in error-detection and also in supporting reliable manual curation. We argue also that such principles are a prerequisite for the successful application of advanced data integration techniques such as ontology-based multi-database querying, automated ontology alignment and ontology-based text-mining. These theses are illustrated by means of a case study of the Gene Ontology, a project of increasing importance within the field of biomedical data integration.

52. Werner Ceusters, Barry Smith and James Matthew Fielding, "LinkSuite™: Software Tools for Formally Robust Ontology-Based Data and Information Integration", in *Proceedings of* DILS 2004 *(Data Integration in the Life Sciences*), (Lecture Notes in Bioinformatics, 2994), Berlin: Springer, 2004, 124–139.

Abstract: The integration of information resources in the life sciences is one of the most challenging problems facing bioinformatics today. We describe how Language and Computing nv, originally a developer of ontology-based natural language understanding systems for the healthcare domain, is developing a framework for the integration of structured data with unstructured information contained in natural language texts. L&C's LinkSuite™ combines the flexibility of a modular software architecture with an ontology based on rigorous philosophical and logical principles that is designed to comprehend the basic formal relationships that structure both reality and the ways humans perceive and communicate about reality.

53. Werner Ceusters, Barry Smith and Martin Van Mol, "Using Ontology in Query Answering Systems: Scenarios, Requirements and Challenges," in R. Bernardi and M. Moortgat (eds.) *Questions and Answers: Theoretical and Applied Perspectives, Proceedings of the 2nd CoLogNET-Elsnet Symposium*, December 2003, Amsterdam, 5–15.

Abstract: Equipped with the ultimate query answering system, computers would finally be in a position to address all our information needs in a natural way. In this paper, we describe how Language and Computing nv (L&C), a developer of ontology-based natural language understanding systems for the healthcare domain, is working towards the ultimate Question Answering (QA) System for healthcare workers. L&C's company strategy in this area is to design in a step-by-step fashion the essential components of such a system, each component being designed to solve some one part of the total problem and at the same time reflect well-defined needs on the prat of our customers. We compare our strategy with the research roadmap proposed by the Question Answering Committee of the National Institute of Standards and Technology (NIST), paying special attention to the role of ontology.

54. Werner Ceusters, Barry Smith, Anand Kumar and Christoffel Dhaen, "Mistakes in Medical Ontologies: Where Do They Come From and How Can They Be Detected?", in D. M. Pisanelli (ed.), *Ontologies in Medicine*: *Proceedings of the Workshop on Medical Ontologies, Rome October 2003* (*Studies in Health and Technology Informatics*, 102 (2004)), Amsterdam: IOS Press, 2004, 145–164.

Abstract: We present the details of a methodology for quality assurance in large medical terminologies and describe three algorithms that can help terminology developers and users to identify potential mistakes. The methodology is based in part on linguistic criteria and in part on logical and ontological principles governing sound classifications. We conclude by outlining the results of applying the methodology in the form of a taxonomy different types of errors and potential errors detected in SNOMED-CT.

55. Pierre Grenon, Barry Smith and Louis Goldberg, "Biodynamic Ontology: Applying BFO in the Biomedical Domain", in D. M. Pisanelli (ed.), *Ontologies in Medicine*: *Proceedings of the Workshop on Medical Ontologies, Rome October 2003* (*Studies in Health and Technology Informatics*, 102), Amsterdam: IOS Press, 2004, 20–38.

Abstract: We propose a modular formal ontology of the biomedical domain with two components, one for biological objects, corresponding broadly to anatomy, and one for biological

processes, corresponding broadly to physiology. The result constitutes what might be described as a joint venture between two perspectives – of so-called three-dimensionalism and four-dimensionalism – which are normally regarded as incompatible. We outline an approach which allows them to be combined together, and provide examples of its application in biomedicine.

56. Barry Smith, Igor Papakin and Katherine Munn, "Bodily Systems and the Spatial-Functional Structure of the Human Body", in D. M. Pisanelli (ed.), *Ontologies in Medicine*: *Proceedings of the Workshop on Medical Ontologies, Rome October 2003* (*Studies in Health and Technology Informatics*, 102 (2004)), Amsterdam: IOS Press, 2004, 39–63.

Abstract: The human body is a system made of systems. The body is divided into bodily systems proper, such as the endocrine and circulatory systems, which are subdivided into many sub-systems at a variety of levels, whereby all systems and subsystems engage in massive causal interaction with each other and with their surrounding environments. Here we offer an explicit definition of bodily system and provide a framework for understanding their causal interactions. Medical sciences provide at best informal accounts of basic notions such as system, process, and function, and while such informality is acceptable in documentation created for human beings, it falls short of what is needed for computer representations. In our analysis we will accordingly provide the framework for a formal definition of bodily system and of associated notions.

57. Anand Kumar, Paolo Ciccarese, Barry Smith and Matteo Piazza, "Context-Based Task Ontologies for Clinical Guidelines", in D. M. Pisanelli (ed.), *Ontologies in Medicine*: *Proceedings of the Workshop on Medical Ontologies, Rome October 2003* (*Studies in Health and Technology Informatics*, 102 (2004)), Amsterdam: IOS Press, 2004, 81–94.

Abstract: Evidence-based medicine relies on the execution of clinical practice guidelines and protocols. A great deal of of effort has been invested in the development of various tools which automate the representation and execution of the recommendations contained within such guidelines and protocols by creating Computer Interpretable Guideline Models (CIGMs). Context-based task ontologies (CTOs), based on standard terminology systems like UMLS, form one of the core components of such a model. We have created DAML+OIL-based CTOs for the tasks mentioned in the WHO guideline for hypertension management, drawing comparisons also with other related guidelines. The advantages of CTOs include: contextualization of ontologies, providing ontologies tailored to specific aspects of the phenomena of interest, dividing the complexity involved in creating ontologies into different levels, providing a methodology by means of which the task recommendations contained within guidelines can be integrated into the clinical practices of a health care set-up.

58. Anand Kumar, Barry Smith, Domenico M. Pisanelli, Aldo Gangemi and Mario Stefanelli, "An Ontological Framework for the Implementation of Clinical Guidelines in Health Care Organizations," in D. M. Pisanelli (ed.), *Ontologies in Medicine*: *Proceedings of the Workshop on Medical Ontologies* (Rome October 2003), Amsterdam: IOS Press, 2004, 95–107.

Abstract: The paper presents the outlines of an ontology of plans and guidelines, which is then used as the basis for a framework for implementing guideline-based systems for the management of workflow in health care organizations. The framework has a number of special features, above all in that it enables us to represent in formal terms assignments of work-items both to individuals and to teams and to tailor guideline to specific contexts of application in health care organizations. It is designed also to enable implementations to do justice to the fact that the processes carried out in health care organizations may deviate in different ways from the norms set forth in corresponding guideline definitions. This means that implementations built in conformity with the framework will be marked by a type of flexibility that might make them more likely to be accepted by healthcare professionals than are standard guideline-based management systems.

59. Werner Ceusters, Barry Smith, Anand Kumar and Christoffel Dhaen, "Ontology-Based Error Detection in SNOMED-CT", in M. Fieschi, *et al*. (eds.), *Medinfo 2004*, Amsterdam: IOS Press, 482–486.

Abstract: Quality assurance in large terminologies is a difficult issue. We present two algorithms that can help terminology developers and users to identify potential mistakes. We demonstrate the methodology by outlining the different types of mistakes that are found when the algorithms are applied to SNOMED-CT®. On the basis of the results, we argue that both formal logical and linguistic tools should be used in the development and quality-assurance process of large terminologies.

60. Barry Smith and Cornelius Rosse, "The Role of Foundational Relations in the Alignment of Biomedical Ontologies", in M. Fieschi, *et al*. (eds.), *Medinfo 2004*, Amsterdam: IOS Press, 444–448.

Abstract: The Foundational Model of Anatomy (FMA) symbolically represents the structural organization of the human body from the macromolecular to the macroscopic levels, with the goal of providing a robust and consistent scheme for classifying anatomical entities that is designed to serve as a reference ontology in biomedical informatics. Here we articulate the need for formally clarifying the *is-a* and *part-of* relations in the FMA and similar ontology and terminology systems. We diagnose certain characteristic errors in the treatment of these relations and show how these errors can be avoided through adoption of the formalism we describe. We then illustrate how a consistently applied formal treatment of taxonomy and partonomy can support the alignment of ontologies.

61. Jonathan Simon, James Matthew Fielding and Barry Smith, "Using Philosophy to Improve the Coherence and Interoperability of Applications Ontologies: A Field Report on the Collaboration of IFOMIS and L&C", in Gregor Büchel, Bertin Klein and Thomas Roth-Berghofer (eds.), *Proceedings of the First Workshop on Philosophy and Informatics. Deutsches Forschungszentrum für künstliche Intelligenz*, Cologne: 2004 (CEUR Workshop Proceedings 112), 65–72.

Abstract: The collaboration of Language and Computing nv (L&C) and the Institute for Formal Ontology and Medical Information Science (IFOMIS) is guided by the hypothesis that quality constraints on ontologies for software applications purposes closely parallel the constraints salient to the design of sound philosophical theories. The extent of this parallel has been poorly appreciated in the informatics community, and it turns out that importing the benefits of philosophical insight and methodology into applications domains yields diverse improvements. L&C's LinKBase® is one of the world's largest medical domain ontologies. Its current primary use pertains to natural language processing applications, but it also supports intelligent navigation through a range of structured medical and bioinformatics information resources, such as UMLS, SNOMED, Swiss-Prot, and the Gene Ontology (GO). In this report we discuss how and why philosophical methods improve both the internal coherence of LinKBase®, and its capacity to serve as a translation hub, improving the interoperability of the ontologies it embeds.

62. Anand Kumar and Barry Smith, "Towards a Proteomics Meta-Classification", *IEEE Fourth Symposium on Bioinformatics and Bioengineering,* Taichung, Taiwan. IEEE Press, 2004, 419–427.

Abstract: There is a recognized need for a meta-classification that can serve as a foundation for more refined ontologies in the field of proteomics. Standard data sources classify proteins in terms of just one or two specific aspects. Thus SCOP (Structural Classification of Proteins) is described as classifying proteins on the basis of structural features; SWISS-PROT annotates proteins on the basis of their structure and of parameters like post-translational modifications. Such data sources are connected to each other by pairwise term-to-term mappings. However, there are obstacles which stand in the way of combining them together to form a robust meta-classification of the needed sort. We discuss some formal ontological principles which should be taken into account within the existing datasources in order to make such a metaclassification possible, taking into account also the Gene Ontology (GO) and its application to the annotation of proteins.

63. James M. Fielding, Jonathan Simon, Werner Ceusters and Barry Smith, "Ontological Theory for Ontological Engineering: Biomedical Systems Information Integration", *Proceedings of the Ninth International Conference on the Principles of Knowledge Representation and Reasoning* (KR2004), Whistler, BC, 2-5 June 2004, 114–120.

Abstract: Software application ontologies have the potential to become the keystone in state-of-the-art information management techniques. It is expected that these ontologies will support the sort of reasoning power required to navigate large and complex terminologies correctly and efficiently. Yet, there is one problem in particular that continues to stand in our way. As these terminological structures increase in size and complexity, and the drive to integrate them inevitably swells, it is clear that the level of consistency required for such navigation will become correspondingly difficult to maintain. While descriptive semantic representations are certainly a necessary component to any adequate ontology-based system, so long as ontology engineers rely solely on semantic information, without a sound ontological theory informing their modeling decisions, this goal will surely remain out of reach. In this paper we describe how Language and Computing nv (L&C), along with The Institute for Formal Ontology and Medical Information Sciences (IFOMIS), are working towards developing and implementing just such a theory, combining the open software architecture of L&C's LinkSuiteTM with the philosophical rigor of Basic Formal Ontology. In this way we aim to move beyond the more or less simple controlled vocabularies that have dominated the industry to date.

64. Olivier Bodenreider, Barry Smith, Anand Kumar and Anita Burgun, "Investigating Subsumption in DL-Based Terminologies: A Case Study in Snomed-CT", in U. Hahn, S. Schulz and R. Cornet (eds.), *Proceedings of the First International Workshop on Formal Biomedical Knowledge Representation* (KR-MED 2004), 12–20.

Abstract: Formalisms such as description logics (DL) are sometimes expected to help terminologies ensure compliance with sound ontological principles. The objective of this paper is to study the degree to which one DL-based biomedical terminology (SNOMED CT) complies with such principles. We defined seven ontological principles (for example: each class must have at least one parent, each class must differ from its parent) and examined the properties of SNOMED CT classes with respect to these principles. Our major results are: 31% of the classes have a single child; 27% have multiple parents; 51% do not exhibit any differentiae between the description of the parent and that of the child. The applications of this study to quality assurance for ontologies are discussed and suggestions are made for dealing with multiple inheritance.

65. Anand Kumar, Barry Smith and Christian Borgelt, "Dependence Relationships between Gene Ontology Terms based on TIGR Gene Product Annotations", *Proceedings of CompuTerm 2004: 3rd International Workshop on Computational Terminology*, Sophia Ananadiou and Pierre Zweigenbaum (eds.), Geneva: Coling, 31–38.

Abstract: The Gene Ontology is an important tool for the representation and processing of information about gene products and functions. It provides controlled vocabularies for the designations of cellular components, molecular functions, and biological processes used in the annotation of genes and gene products. These constitute three separate ontologies, of cellular components), molecular functions and biological processes, respectively. The question we address here is: how are the terms in these three separate ontologies related to each other? We use statistical methods and formal ontological principles as a first step towards finding answers to this question.

66. Barry Smith and Christiane Fellbaum, "Medical WordNet: A New Methodology for the Construction and Vfalidation of Information Resources for Consumer Health", *Proceedings of Coling: The 20th International Conference on Computational Linguistics*, Geneva 23-27 August 2004, 371–382.

Abstract: A consumer health information system must be able to comprehend both expert and non-expert medical vocabulary and to map between the two. We describe an on-going project

to create a new lexical database called Medical WordNet (MWN), consisting of medically relevant terms used by and intelligible to non-expert subjects and supplemented by a corpus of natural-language sentences that is designed to provide medically validated contexts for MWN terms. The corpus derives primarily from online health information sources targeted to consumers, and involves two sub-corpora, called Medical FactNet (MFN) and Medical BeliefNet (MBN), respectively. The former consists of statements accredited as true on the basis of a rigorous process of validation, the latter of statements which non-experts believe to be true. We summarize the MWN / MFN / MBN project, and describe some of its applications.

67. Olivier Bodenreider Barry Smith and Anita Burgun, "The Ontology-Epistemology Divide: A Case Study in Medical Terminology", Achille Varzi and Laure Vieu (eds.), *Formal Ontology in Information Systems. Proceedings of the Third International Conference (FOIS 2004)*, Amsterdam: IOS Press, 2004, 185–195.

Abstract: Medical terminology collects and organizes the many different kinds of terms employed in the biomedical domain both by practitioners and also in the course of biomedical research. In addition to serving as labels for biomedical classes, these names reflect the organizational principles of biomedical vocabularies and ontologies. Some names represent invariant features (classes, universals) of biomedical reality (i.e., they are a matter for ontology). Other names, however, convey also how this reality is perceived, measured, and understood by health professionals (i.e., they belong to the domain of epistemology). We analyze terms from several biomedical vocabularies in order to throw light on the interactions between ontological and epistemological components of these terminologies. We identify four cases: 1) terms containing classification criteria, 2) terms reflecting detectability, modality, uncertainty, and vagueness, 3) terms created in order to obtain a complete partition of a given domain, and 4) terms reflecting mere fiat boundaries. We show that epistemology-loaded terms are pervasive in biomedical vocabularies, that the "classes" they name often do not comply with sound classification principles, and that they are therefore likely to cause problems in the evolution and alignment of terminologies and associated ontologies. This paper introduces the idea of *epistemological intrusion* into the study of medical ontologies.

68. Barry Smith, "Beyond Concepts: Ontology as Reality Representation", Achille Varzi and Laure Vieu (eds.), *Formal Ontology in Information Systems. Proceedings of the Third International Conference (FOIS 2004)*, Amsterdam: IOS Press, 2004, 73–84.

Abstract: There is an assumption commonly embraced by ontological engineers, an assumption which has its roots in the discipline of knowledge representation, to the effect that it is concepts which form the subject-matter of ontology. The term 'concept' is hereby rarely precisely defined, and the intended role of concepts within ontology is itself subject to a variety of conflicting (and sometimes intrinsically incoherent) interpretations. It seems, however, to be widely accepted that concepts are in some sense the products of human cognition. The present essay is devoted to the application of ontology in support of research in the natural sciences. It defends the thesis that ontologies developed for such purposes should be understood as having as their subject matter, not concepts, but rather the universals and particulars which exist in reality and are captured in scientific laws. We outline the benefits of a view along these lines by showing how it yields rigorous formal definitions of the foundational relations used in many influential ontologies, illustrating our results by reference to examples drawn from the domain of the life sciences.

69. Fabian Neuhaus, Pierre Grenon and Barry Smith, "A Formal Theory of Substances, Qualities, and Universals", Achille Varzi and Laure Vieu (eds.), *Formal Ontology in Information Systems. Proceedings of the Third International Conference (FOIS 2004)*, Amsterdam: IOS Press, 2004, 49–58.

Abstract: One of the tasks of ontology in information science is to support the classification of entities according to their kinds and qualities. We hold that to realize this task as far as entities such as material objects are concerned we need to distinguish four kinds of entities: substance particulars, quality particulars, substance universals, and quality universals. These form, so to speak, an ontological square. We present a formal theory of classification based on this idea, including both a semantics for the theory and a provably sound axiomatization.

70. Thomas Bittner, Maureen Donnelly and Barry Smith, "Individuals, Universals, Collections: On the Foundational Relations of Ontology", in Achille Varzi and Laure Vieu (eds.), *Formal Ontology in Information Systems. Proceedings of the Third International Conference (FOIS 2004)*, Amsterdam: IOS Press, 2004, 37–48.

Abstract: This paper provides an axiomatic formalization of a theory of foundational relations between three categories of entities: individuals, universals, and collections. We deal with a variety of relations between entities in these categories, including the is-a relation among universals and the part-of relation among individuals as well as cross-category relations such as instance-of, member-of, and partition-of. We show that an adequate understanding of the formal properties of such relations – in particular their behavior with respect to time – is critical for formal ontology. We provide examples to support this thesis from the domain of biomedicine.

71. Thomas Bittner and Barry Smith, "Normalizing Medical Ontologies Using Basic Formal Ontology", *Kooperative Versorgung, Vernetzte Forschung, Ubiquitäre Information,* Proceedings of GMDS 2004, Niebüll: Videel OHG, 199–201.

Abstract: Description Logics are nowadays widely accepted as formalisms which provide reasoning facilities which allow us to discover inconsistencies in ontologies in an automatic fashion. Where ontologies are developed in modular fashion, they allow changes in one module to propogated through the system of ontologies automatically in a way which helps to maintain consistency and stability. For this feature to be utilized effectively, however, requires that domain ontologies be represented in a normalized form.

72. Barry Smith, "Ontologie-basierte Qualitätssicherung medizinischer Terminologien", *Kooperative Versorgung, Vernetzte Forschung, Ubiquitäre Information,* Proceedings of GMDS 2004, Niebüll: Videel OHG, 193–195.

Abstract: Die medizinische Ontologie soll helfen, die Flut medizinischer Information soweit zu kanalisieren, dass sie ohne Vereinfachungen oder Verzerrungen computergestützt verarbeitet werden kann. Nach ontologischen Kriterien aufbereitete Terminologiesysteme sollen darüber hinaus die Integration von Daten aus heterogenen Quellen unterstützen.

73. Lowell Vizenor and Barry Smith, "Speech Acts and Medical Records: The Ontological Nexus", *Proceedings of the International Joint Meeting EuroMISE 2004*, Jana Zvarova, *et al.* (eds.), Prague, EuroMISE 2004, p.61. Expanded version.

Abstract: Despite the recent advances in information and communication technology that have increased our ability to store and circulate information, the task of ensuring that the right sorts of information gets to the right sorts of people remains. We argue that the many efforts underway to develop efficient means for sharing information across healthcare systems and organizations would benefit from a careful analysis of human action in healthcare organizations. This in turn requires that the management of information and knowledge within healthcare organizations be combined with models of resources and processes of patient care that are based on a general ontology of social interaction.

74. James Mathew Fielding, Jonathan Simon and Barry Smith, "Formal Ontology for Biomedical Knowledge Systems Integration", *Proceedings of the International Joint Meeting EuroMISE 2004*, Jana Zvarova, *et al.* (eds.), Prague, EuroMISE 2004, 62-66.

Abstract: The central hypothesis of the collaboration between Language and Computing (L&C) and the Institute for Formal Ontology and Medical Information Science (IFOMIS) is that the methodology and conceptual rigor of a philosophically inspired formal ontology will greatly benefit software application ontologies. To this end LinKBase®, L&C's ontology, which is designed to integrate and reason across various external databases simultaneously, has been submitted to the conceptual demands of IFOMIS's Basic Formal Ontology (BFO). With this, we aim to move beyond the level of controlled vocabularies to yield an ontology with the ability to support reasoning applications.

75. Barry Smith, "The Logic of Biological Classification and the Foundations of Biomedical Ontology", in Petr Hájek, Luis Valdés-Villanueva and Dag Westerståhl

(ed.), *Logic, Methodology and Philosophy of Science. Proceedings of the 12th International Conference*, London: King's College Publications, 2005, 505–520.

Abstract: Biomedical research is increasingly a matter of the navigation through large computerized information resources deriving from functional genomics or from the biochemistry of disease pathways. To make such navigation possible, controlled vocabularies are needed in terms of which data from different sources can be unified. One of the most influential developments in this regard is the so-called Gene Ontology, which consists of controlled vocabularies of terms used by biologists to describe cellular constituents, biological processes and molecular functions, organized into hierarchies via the relation of class subsumption. Here we seek to provide a rigorous account of the logic of classification that underlies GO and similar biomedical ontologies. Drawing on Aristotle, we develop a system of axioms and definitions for the treatment of biological classes and instances.

76. Anand Kumar and Barry Smith, "Enhancing GO for the Sake of Clinical Bioinformatics", *Proceedings of Bio-Ontologies Workshop,* Intelligent Systems for Molecular Biology (ISMB 2004), Glasgow, July 30.

Abstract: Recent work on the quality assurance of the Gene Ontology (GO, Gene Ontology Consortium 2004) from the perspective of both linguistic and ontological organization has made it clear that GO lacks the kind of formalism needed to support logic-based reasoning. At the same time it is no less clear that GO has proven itself to be an excellent terminological resource that can serve to combine together a variety of biomedical database and information systems. Given the strengths of GO, it is worth investigating whether, by overcoming some of its weaknesses from the point of view of formalontological principles, we might not be able to enhance a version of GO which can come even closer to serving the needs of the various communities of biomedical researchers and practitioners. It is accepted that clinical and bioinformatics need to find common ground if the results of data-intensive biomedical research are to be harvested to the full. It is also widely accepted that no single method will be sufficient to create the needed common framework. We believe that the principles-based approach to life-science data integration and knowledge representation must be one of the methods applied. Indeed in dealing with the ontological representation of carcinomas, and specifically of colon carcinomas, we have established that, had GO (and related biomedical ontologies) followed some of the basic formal-ontological principles we have identified (Smith et al. 2004, Ceusters et al. 2004), then the effort required to navigate successfully between clinical and bioinformatics systems would have been reduced. We point here to the sources of ontologicallyrelated errors in GO, and also provide arguments as to why and how such errors need to be resolved.

77. Barry Smith and Anand Kumar, "On the Proper Treatment of Pathologies in Biomedical Ontologies", *Proceedings of Bio-Ontologies Workshop*, Intelligent Systems for Molecular Biology (ISMB 2005), Detroit, 22–23.

Abstract: In previous work on biomedical ontologies we showed how the provision of formal definitions for relations such as *is_a* and *part_of* can support new types of automated reasoning about biomedical phenomena. We here extend this approach to the *transformation_of* characteristic of pathologies.

78. Barry Smith, "Against Fantology", in Johann C. Marek and Maria E. Reicher (eds.), *Experience and Analysis*, Vienna: HPT&ÖBV, 2005, 153–170.

Abstract: The analytical philosophy of the last one hundred years has been heavily influenced by a doctrine to the effect that one can arrive at a correct ontology by paying attention to certain superficial (syntactic) features of first-order predicate logic as conceived by Frege and Russell. More specifically, it is a doctrine to the effect that the key to the ontological structure of reality is captured syntactically in the 'Fa' (or, in more sophisticated versions, in the 'Rab') of first-order logic, where 'F' stands for what is general in reality and 'a' for what is individual. Hence "f(a)ntology". Because predicate logic has exactly two syntactically different kinds of referring expressions – 'F', 'G', 'R', etc., and 'a', 'b', 'c', etc. – so reality must consist of exactly two correspondingly different kinds of entity: the general (properties, concepts) and the particular (things, objects), the relation between these two kinds of entity being revealed in the predicate-argument structure of atomic formulas in first-order logic.

79. Anand Kumar and Barry Smith, "Oncology Ontology in the NCI Thesaurus", *AIME 2005* (*Artificial Intelligence in Medicine Europe*), (Lecture Notes in Computer Science 3581), 213–220.

Abstract: The National Cancer Institute's Thesaurus (NCIT) has been created with the goal of providing a controlled vocabulary which can be used by specialists in the various sub-domains of oncology. It is intended to be used for purposes of annotation in ways designed to ensure the integration of data and information deriving from these various sub-domains, and thus to support more powerful cross-domain inferences. In order to evaluate its suitability for this purpose, we examined the NCIT's treatment of the kinds of entities which are fundamental to an ontology of colon carcinoma. We here describe the problems we uncovered concerning classification, synonymy, relations and definitions, and we draw conclusions for the work needed to establish the NCIT as a reference ontology for the cancer domain in the future.

80. Barry Smith, Werner Ceusters and Rita Temmerman, "Wüsteria"*, Medical Informatics Europe* (MIE 2005), Geneva, *Studies in Health Technology and Informatic,* 116 (2005), 647–652.

Abstract: The last two decades have seen considerable efforts directed towards making Electronic Health Records interoperable through improvements in medical ontologies, terminologies and coding systems. Unfortunately, these efforts have been hampered by a number of influential ideas inherited from the work of Eugen Wüster, the father of terminology standardization and the founder of ISO TC 37. We here survey Wüster's ideas – which see terminology work as being focused on the classification of concepts in people's minds – and we argue that they serve still as the basis for a series of influential confusions. We argue further that an ontology based unambiguously, not on concepts, but on the classification of entities in reality can, by removing these confusions, make a vital contribution to ensuring the interoperability of coding systems and healthcare records in the future.

81. Werner Ceusters and Barry Smith, "Tracking Referents in Electronic Health Records", *Medical Informatics Europe* (MIE 2005), Geneva, *Studies in Health Technology and Inform*atics 116 (2005), 71–76.

Abstract: Electronic Health Records (EHRs) are organized around two kinds of statements: those reporting observations made, and those reporting acts performed. In neither case does the record involve any direct reference to what such statements are actually about. They record not: what is happening on the side of the patient, but rather: what is said about what is happening. While the need for a unique patient identifier is generally recognized, we argue that we should now move to an EHR regime in which all clinically salient particulars – from the concrete disorder on the side of the patient and the body parts in which it occurs to the concrete treatments given – should be uniquely identified. This will allow us to achieve interoperability among different systems of records at the level where it really matters: in regard to what is happening in the real world. It will also allow us to keep track of particular disorders and of the effects of particular treatments in a precise and unambiguous way. We discuss the ontological and epistemological aspects of our claim and describe a scenario for implementation within EHR systems.

82. Anand Kumar, Y. Lina Yip, Barry Smith, Dirk Marwede and Daniel Novotny, "An Ontology for Carcinoma Classification for Clinical Bioinformatics", *Medical Informatics Europe* (MIE 2005), *Studies in Health Technology and Informatics*, 116, (2005) 635-40.

Abstract: There are a number of existing classifications and staging schemes for carcinomas, one of the most frequently used being the TNM classification. Such classifications represent classes of entities which exist at various anatomical levels of granularity. We argue that in order to apply such representations to the Electronic Health Records one needs sound ontologies which take into consideration the diversity of the domains which are involved in clinical bioinformatics. Here we outline a formal theory for addressing these issues in a way that the ontologies can be used to support inferences relating to entities which exist at different anatomical levels of granularity. Our case study is the colon carcinoma, one of the most common carcinomas prevalent within the European population.

83. Louis J. Goldberg, Werner Ceusters, John Eisner and Barry Smith, "The Significance of SNODENT", *Medical Informatics Europe* (MIE 2005), Geneva, *Studies in Health Technology and Informatics*, vol. 116, 2005, 737–742.

Abstract: SNODENT is a dental diagnostic vocabulary incompletely integrated in SNOMED-CT. Nevertheless, SNODENT could become the de facto standard for dental diagnostic coding. SNODENT's manageable size, the fact that it is administratively self-contained, and relates to a well-understood domain provides valuable opportunities to formulate and test, in controlled experiments, a series of hypothesis concerning diagnostic systems. Of particular interest are questions related to establishing appropriate quality assurance methods for its optimal level of detail in content, its ontological structure, its construction and maintenance. This paper builds on previous software-based methodologies designed to assess the quality of SNOMED-CT.

84. Barry Smith, Jose L.V. Mejino Jr., Stefan Schulz, Anand Kumar and Cornelius Rosse, "Anatomical Information Science", in A. G. Cohn and D. M. Mark (eds.), *Spatial Information Theory. Proceedings of COSIT 2005* (Lecture Notes in Computer Science 3693), Berlin/Heidelberg/New York: Springer, 149–164.

Abstract: The Foundational Model of Anatomy (FMA) is a map of the human body. Like maps of other sorts – including the map-like representations we find in familiar anatomical atlases – it is a representation of a certain portion of spatial reality as it exists at a certain (idealized) instant of time. But unlike other maps, the FMA comes in the form of a sophisticated ontology of its object-domain, comprising some 1.5 million statements of anatomical relations among some 70,000 anatomical kinds. It is further distinguished from other maps in that it represents not some specific portion of spatial reality (say: Leeds in 1996), but rather the generalized or idealized spatial reality associated with a generalized or idealized human being at some generalized or idealized instant of time. It will be our concern in what follows to outline the approach to ontology that is represented by the FMA and to argue that it can serve as the basis for a new type of anatomical information science. We also draw some implications for our understanding of spatial reasoning and spatial ontologies in general.

85. Stephan Schulz, Philipp Daumke, Barry Smith and Udo Hahn, "How to Distinguish Parthood from Location in Bioontologies", *Proceedings of the AMIA Symposium 2005*, Washington DC, 669–673. PMC1560856

Abstract: The pivotal role of the relation *part-of* in the description of living organisms is widely acknowledged. Organisms are open systems, which means that in contradistinction to mechanical artifacts they are characterized by a continuous flow and exchange of matter. A closer analysis of the spatial relations in biological organisms reveals that the decision as to whether a given particular is *part-of* a second particular or whether it is only *contained-in* the second particular is often controversial. We here propose a rule-based approach which allows us to decide on the basis of well-defined criteria which of the two relations holds between two anatomical objects, given that one spatially includes the other. We discuss the advantages and limitations of this approach, using concrete examples from human anatomy.

86. Barry Smith and Werner Ceusters, "An Ontology-Based Methodology for the Migration of Medical Terminologies to Electronic Health Records", *Proceedings of AMIA Symposium 2005*, Washington DC, 704–708. PMC1560617

Abstract: Biomedical terminologies are focused on what is general, Electronic Health Records (EHRs) on what is particular, and it is commonly assumed that the step from the one to the other is unproblematic. We argue that this is not so, and that, if the EHR of the future is to fulfill its promise, then the foundations of both EHR architectures and biomedical terminologies need to be reconceived. We accordingly describe a new framework for the treatment of both generals and particulars in biomedical information systems that is designed: 1) to provide new opportunities for the sharing and management of data within and between healthcare institutions, 2) to facilitate interoperabilityforms among different terminology and record systems, and thereby 3) to allow new kinds of reasoning with biomedical data.

87. Cornelius Rosse, Anand Kumar, Jose Leonardo V. Mejino, Daniel L. Cook, Landon T. Detwiler and Barry Smith, "A Strategy for Improving and Integrating Biomedical

Ontologies", *Proceedings of AMIA Symposium 2005,* Washington DC, 639–643. PMC1560467

Abstract: The integration of biomedical terminologies is indispensable to the process of information integration. When terminologies are linked merely through the alignment of their leaf terms, however, differences in context and ontological structure are ignored. Making use of the SNAP and SPAN ontologies, we show how three reference domain ontologies can be integrated at a higher level, through what we shall call the OBR framework (for: Ontology of Biomedical Reality). OBR is designed to facilitate inference across the boundaries of domain ontologies in anatomy, physiology and pathology.

88. Werner Ceusters and Barry Smith, "Requirements for natural language understanding in referent-tracking based electronic health records", *Computer Science and IT with/for Biology*, C. Maria Keet and Enrico Franconi (eds.), Free University of Bolzano, 2005, 43-46.

Abstract: Most electronic patient records contain identifiers to uniquely identify entities such as the patient, the physician, and the healthcare facility. None, however, contains thus far identifiers that uniquely identify the particular disorders patients have, the symptoms they experienced, the actual treatments that have been applied, and so forth. Referent tracking has been introduced as a paradigm to make this also a standard procedure. In this talk, we discuss how natural language understanding can contribute to this.

89. Barry Smith and Werner Ceusters, "HL7 RIM: An Incoherent Standard" (MIE 2006), *Studies in Health Technology and Informatics*, vol. 124, 133–138. (This issue also published as *Ubiquity: Technologies for Better Health in Aging Societies. Proceedings of MIE2006*, edited by Arie Hasman, Reinhold Haux, Johan van der Lei, Etienne De Clercq, Francis Roger-France, Amsterdam: IOS Press, 2006.)

Abstract: The Health Level 7 Reference Information Model (HL7 RIM) is lauded by its authors as 'the foundation of healthcare interoperability'. Yet even after some 10 years of development work, the RIM is still subject to a variety of logical and ontological flaws, which has placed severe obstacles in the way of those who are called upon to develop implementations. We offer evidence that these obstacles are insurmountable and that the time has come to abandon an unworkable paradigm.

90. Werner Ceusters, Peter Elkin and Barry Smith "Referent Tracking: The Problem of Negative Findings" (MIE 2006), *Studies in Health Technology and Informatics*, vol. 124, 741–6. (This issue also published as *Ubiquity: Technologies for Better Health in Aging Societies. Proceedings of MIE2006*, edited by Arie Hasman, Reinhold Haux, Johan van der Lei, Etienne De Clercq, Francis Roger-France, Amsterdam: IOS Press, 2006.)

Abstract: The paradigm of referent tracking is based on a realist presupposition which rejects so-called negative entities (congenital absent nipple, and the like) as spurious. How, then, can a referent tracking-based Electronic Health Record deal with what are standardly called 'negative findings'? To answer this question we carried out an analysis of some 748 sentences drawn from patient charts and containing some form of negation. Our analysis shows that to deal with these sentences we need to introduce a new ontological relationship between a particular and a universal, which holds when no instance of the universal has a specific qualified ontological relation with the particular. This relation is found to be able to accommodate nearly all occurrences of negative findings in the examined sample, in ways which involve no reference to negative entities.

91. Werner Ceusters and Barry Smith, "A Realism-Based Approach to the Evolution of Biomedical Ontologies", *Proceedings of the Annual AMIA Symposium*, Washington DC, 2006, 121-125. PMC1839444.

Abstract: We present a novel methodology for calculating the improvements obtained in successive versions of biomedical ontologies. The theory takes into account changes both in reality itself and in our understanding of this reality. The successful application of the theory rests on the willingness of ontology authors to document changes they make by following a

number of simple rules. The theory provides a pathway by which ontology authoring can become a science rather than an art, following principles analogous to those that have fostered the growth of modern evidence-based medicine. Although in this paper we focus on ontologies, the methodology can be generalized to other sorts of terminology-based artifacts, including Electronic Patient Records.

92. Barry Smith, "Against Idiosyncrasy in Ontology Development", in B. Bennett and C. Fellbaum (Eds.), *Formal Ontology in Information Systems* (FOIS 2006), Amsterdam: IOS Press, 2006, 15-26.

Abstract: The world of ontology development is full of mysteries. Recently, ISO Standard 15926 ("Lifecycle Integration of Process Plant Data Including Oil and Gas Production Facilities"), a data model initially designed to support the integration and handover of large engineering artefacts, has been proposed by its principal custodian for general use as an upper-level ontology. As we shall discover, ISO 15926 is, when examined in light of this proposal, marked by a series of quite astonishing defects, which can however provide general lessons for the developers of ontologies in the future.

Russian translation

93. Barry Smith, Waclaw Kusnierczyk, Daniel Schober, Werner Ceusters, "Towards a Reference Terminology for Ontology Research and Development in the Biomedical Domain", O. Bodenreider, ed., *Proceedings of KR-MED* (CEUR, 222), 2006, 57-66.

Abstract: Ontology is a burgeoning field, involving researchers from the computer science, philosophy, data and software engineering, logic, linguistics, and terminology domains. Many ontology-related terms with precise meanings in one of these domains have different meanings in others. Our purpose here is to initiate a path towards disambiguation of such terms. We draw primarily on the literature of biomedical informatics, not least because the problems caused by unclear or ambiguous use of terms have been there most thoroughly addressed. We advance a proposal resting on a distinction of three levels too often run together in biomedical ontology research: 1. the level of reality; 2. the level of cognitive representations of this reality; 3. the level of textual and graphical artifacts. We propose a reference terminology for ontology research and development that is designed to serve as common hub into which the several competing disciplinary terminologies can be mapped. We then justify our terminological choices through a critical treatment of the 'concept orientation' in biomedical terminology research.

94. Darren A. Natale, Cecilia N. Arighi, Winona Barker, Judith Blake, Ti-Cheng Chang, Zhangzhi Hu, Hongfang Liu, Barry Smith, and Cathy H. Wu, "Framework for a Protein Ontology", *Proceedings of the 1st International Workshop on Text Mining in Bioinformatics*, 2006, 29-36. Journal version.

95. Barry Smith, "On Place and Space: The Ontology of the Eruv", in C. Kanzian (ed.), *Cultures: Conflict – Analysis – Dialogue*, Frankfurt: Ontos Verlag, 2007, 403-416.

Abstract: 'Eruv' is a Hebrew word meaning literally 'mixture' or 'mingling'. An eruv is an urban region demarcated within a larger urban region by means of a boundary made up of telephone wires or similar markers. Through the creation of the eruv, the smaller region is turned symbolically (halachically = according to Jewish law) into a private domain. So long as they remain within the boundaries of the eruv, Orthodox Jews may engage in activities that would otherwise be prohibited on the Sabbath, such as pushing prams or wheelchairs, or carrying walking sticks. There are eruvim in many towns and university campuses throughout the world. There are five eruvim in Chicago, five in Brooklyn, twenty three in Queens and Long Island, and at least three in Manhattan. The US Supreme Court is (like most other major US Federal Government buildings) located within the eruv of Washington DC. In many cases, not all of those living within or near the area of an actual or proposed eruv will themselves be Orthodox Jews, and this has sometimes led to protests against eruv creation. It is such protests which triggered the writing of this essay.

96. Ceusters W, Smith B. "Referent Tracking and its Applications", *Proceedings of the Workshop WWW2007 Workshop i³: Identity, Identifiers, Identification (Workshop on*

Entity-Centric Approaches to Information and Knowledge Management on the Web), Banff, Canada, May 8, 2007, http://ceur-ws.org/Vol-249/.

Abstract: Referent tracking (RT) is a new paradigm, based on unique identification, for representing and keeping track of particulars. It was first introduced to support the entry and retrieval of data in electronic health records (EHRs). Its purpose is to avoid the ambiguity that arises when statements in an EHR refer to disorders or other entities on the side of the patient exclusively by means of compound descriptions utilizing general terms such as 'pimple on nose' or 'small left breast tumor'. In this paper, we describe the theoretical foundations of this paradigm and show how it is being applied to the solution of analogous problems of ambiguous identification in the fields of digital rights management, corporate memories and decision algorithms.

97. Blake J, Hill DP, Smith B. "Gene Ontology annotations: What they mean and where they come from", *Proceedings of the Bio-Ontologies Workshop*, ISMB/ECCB, Vienna, July 20, 2007, 79-82. Journal version.

98. Daniel Schober, Waclaw Kusnierczyk, Suzanna E Lewis, Jane Lomax, Members of the MSI, PSI Ontology Working Groups, Chris Mungall, Philippe Rocca-Serra, Barry Smith and Susanna-Assunta Sansone, "Towards naming conventions for use in controlled vocabulary and ontology engineering", *Proceedings of the Bio-Ontologies Workshop*, ISMB/ECCB, Vienna, July 20, 2007, 87-90. Journal version.

Abstract: For most people, the term 'standard' generates an immediate impulse to run in the opposite direction. We all know that this means someone is bent upon the 'one, true capitalization style', thereby fomenting an instantaneous rebellion. While it is somewhat audacious to propose standards, the adoption of a few shared simple conventions is an important strategy to improve quality in controlled vocabularies and ontologies we build. Ontologies should not only satisfy computational requirements, but also meet the needs of human readers who are trying to understand them. When confronted by the full complexity of an ontology, logical coherence and predictable naming is important, then our guesses about where something may be found, or what it is called, are right more often than wrong. Conforming to naming conventions in ontology construction will help consumers more readily understand what is intended and avoid the introduction of faults, and it is here where its value lies.

99. Werner Ceusters, Kent Spackman and Barry Smith, "Would SNOMED-CT Benefit from Realism-Based Ontology Evolution?", *Proceedings of the Annual Symposium of the American Medical Informatics Association*, Chicago, IL, 2007, 105-109. PMC2655780

Abstract: If SNOMED-CT is to serve as a biomedical reference terminology, then steps must be taken to ensure comparability of information formulated using successive versions. New releases are therefore shipped with a history mechanism. We assessed the adequacy of this mechanism for its treatment of the distinction between changes occurring on the side of entities in reality and changes in our understanding thereof. We found that these two types are only partially distinguished and that a more detailed study is required to propose clear recommendations for enhancement along at least the following lines: (1) explicit representation of the provenance of a class; (2) separation of the time-period during which a component is stated valid in SNOMED-CT from the period it is (or has been) valid in reality, and (3) redesign of the historical relationships table to give users better assistance for recovery in case of introduced mistakes.

100. Ron Rudnicki, Werner Ceusters, Shahid Manzoor and Barry Smith, "What Particulars are Referred to in EHR Data? A Case Study in Integrating Referent Tracking into an Electronic Health Record Application", *Proceedings of the Annual Symposium of the American Medical Informatics Association*, Chicago, IL, 2007, 630-634. PMC2655819.

Abstract: The Referent Tracking paradigm, which advocates the use of instance unique identifiers to refer to the entities comprising the subject matter of patient health records, promises many benefits to those who use health record data to improve patient care. To further the adoption of the paradigm we provide an illustration of how data from an EHR application

needs to be decomposed to make it accord with the tenets of Referent Tracking. We describe the ontological principles on which such decomposition needs to be based in order to allow integration efforts to be applied to other EHR applications by interested parties. We find that an ordinary statement from an EHR reveals a surprising amount of 'hidden' data that is revealed by its decomposition according to these principles.

101. Terry Janssen, Herbert Basik, Mike Dean, Barry Smith, "A Multi-INT Semantic Reasoning Framework for Intelligence Analysis Support", *Proceedings of Ontology for the Intelligence Community, Columbia MD, November 2007*, 27-32.

Abstract: The volume of data available to intelligence agencies and the complexity of the national security environment are increasing so quickly as to overwhelm a finite workforce of analysts. Machines must augment human cognitive capacity in order to achieve the needed level of situational awareness. We describe the state of the art in ontology-based approaches to addressing these problems as they arise in other domains, and outline the results of a Lockheed Martin IRAD project to address some of the specific challenges confronting integration of the data generated by multiple intelligence agencies.

Reprinted as "A Multi-INT Semantic Reasoning Framework for Intelligence Analysis Support", in: L. Obrst, T. Janssen, W. Ceusters (eds.), *Ontologies and Semantic Technologies for the Intelligence Community* (Frontiers in Artificial Intelligence and Applications), Amsterdam: IOS Press, 2010, 57-69.

102. Stefan Schulz, Holger Stenzhorn, Martin Boeker, Rudiger Klar, Barry Smith, "Clinical Ontologies Interfacing the Real World", *Third International Conference on Semantic Technologies* (i-semantics 2007), Graz, Österreich, September 2007, 356-363.

Abstract: The desideratum of semantic interoperability has been intensively discussed in medical informatics circles in recent years. Originally it was assumed by many that this issue could be addressed simply by insisting on the application of shared clinical terminologies. More recently however the use of the term 'ontology' has been steadily growing. We here address the issue of the degree to which the use of ontologies represents any real advance on the road to semantic interoperability.

103. Anand Kumar and Barry Smith, "The Ontology of Processes and Functions: A Study of the International Classification of Functioning Disability and Health", In: *Sharing Knowledge through the ICF: 13th Annual North American WHO Collaborating Center Conference on the ICF*, Niagara Falls, June 7, 2007. North American WHO Collaborating Center (2007)

Abstract: The International Classification of Functioning, Disability and Health provides a classification of human bodily functions, which, while exhibiting non-conformance to many formal ontological principles, provides an insight into which basic functions such a classification should include. Its evaluation is an important first step towards such an adequate ontology of this domain

104. Mitsuhiro Okada, Barry Smith, and Yutaro Sugimoto, "Remarks on Logic for Process Descriptions in Ontological Reasoning: A Drug Interaction Ontology (DIO) Case Study", *InterOntology. Proceedings of the First Interdisciplinary Ontology Meeting*, Tokyo, Japan, 26-27 February 2008, 127-138.

Abstract: We present some ideas on logical process descriptions, using relations from the DIO (Drug Interaction Ontology) as examples and explaining how these relations can be naturally decomposed in terms of more basic structured logical process descriptions using terms from linear logic. In our view, the process descriptions are able to clarify the usual relational descriptions of DIO. In particular, we discuss the use of logical process descriptions in proving linear logical theorems. Among the types of reasoning supported by DIO one can distinguish both (1) basic reasoning about general structures in reality and (2) the domain-specific reasoning of experts. We here propose a clarification of this important distinction between

(realist) reasoning on the basis of an ontology and rule-based inferences on the basis of an expert's view.

105. Barry Smith, "The Evaluation of Ontologies: Editorial Review vs. Democratic Ranking", *Proceedings of InterOntology 2008* (Tokyo, Japan, 26-27 February 2008), 127-138.

Abstract: Increasingly, the high throughput technologies used by biomedical researchers are bringing about a situation in which large bodies of data are being described using controlled structured vocabularies—also known as ontologies—in order to support the integration and analysis of this data. Annotation of data by means of ontologies is already contributing in significant ways to the cumulation of scientific knowledge and, prospectively, to the applicability of cross-domain algorithmic reasoning in support of scientific advance. This very success, however, has led to a proliferation of ontologies of varying scope and quality. We define one strategy for achieving quality assurance of ontologies—a plan of action already adopted by a large community of collaborating ontologists—which consists in subjecting ontologies to a process of peer review analogous to that which is applied to scientific journal articles.

106. Cecilia Arighi, Hongfang Liu, Darren Natale, Winona Barker, Harold Drabkin, Zhangzhi Hu, Judith Blake, Barry Smith and Cathy Wu, "TGF-beta Signaling Proteins and the Protein Ontology", *Proceedings of Bio-Ontologies Workshop,* Intelligent Systems for Molecular Biology (ISMB 2008), Toronto, 25-28. Journal version.

Abstract: The Protein Ontology (PRO) addresses the need for a formal description of proteins and their evolutionary relationships. PRO is authored via manual curation on the basis of content derived automatically from various data sources. Curation is needed to ensure correct representations of relationships both internally (between PRO nodes) and externally (to other ontologies). Focusing specifically on the TGF-beta signaling proteins, we describe how this ontology can be used for multiple purposes, including annotation, representation of objects in pathways, data integration, and the representation of biological system dynamics and of disease etiology.

107. Robert Arp and Barry Smith, "Function, Role, and Disposition in Basic Formal Ontology", *Proceedings of the Bio-Ontologies Workshop*, Intelligent Systems for Molecular Biology (ISMB 2008), Toronto, 45-48. Revised version (2011).

Abstract: Numerous research groups are now utilizing Basic Formal Ontology (BFO) as an upper-level framework to assist in the organization and integration of biomedical information. This paper provides elucidation of the three existing BFO subcategories of realizable entity, namely function, role, and disposition. It proposes one further sub-category of tendency, and considers the merits of recognizing two sub-categories of function for domain ontologies, namely, artifactual and biological function. The motivation is to help advance the coherent ontological treatment of functions, roles, and dispositions, to help provide the potential for more detailed classification, and to shed light on BFO's general make-up and use.

108. Barry Smith, "Ontology (Science)", in C. Eschenbach and M. Grüninger (eds.), *Formal Ontology in Information Systems. Proceedings of the Fifth International Conference (FOIS 2008)*, Amsterdam: IOS Press, 21-35.

Abstract: Increasingly, in data-intensive areas of the life sciences, experimental results are being described in algorithmically useful ways with the help of ontologies. Such ontologies are authored and maintained by scientists to support the retrieval, integration and analysis of their data. The proposition to be defended here is that ontologies of this type – the Gene Ontology (GO) being the most conspicuous example – are a part of science. Initial evidence for the truth of this proposition (which some will find self-evident) is the increasing recognition of the importance of empirically-based methods of evaluation to the ontology development work being undertaken in support of scientific research. The ontologies created by scientists must, of course, be associated with implementations satisfying the requirements of software engineering. But these ontologies are not themselves engineering artifacts, and to conceive them as such brings grievous consequences. Rather, we shall argue, ontologies such as the GO are comparable to scientific theories, to scientific databases, or to scientific journal publications. Such a view implies a radically new conception of what is involved in the authoring, maintenance

and application of ontologies in scientific contexts, and therewith also a radically new approach to the evaluation of ontologies and to the training of ontologists.

109. Richard H. Scheuermann, Werner Ceusters, and Barry Smith, "Toward an Ontological Treatment of Disease and Diagnosis", *Proceedings of the 2009 AMIA Summit on Translational Bioinformatics*, 2009, 116-120.

Abstract: Many existing biomedical vocabulary standards rest on incomplete, inconsistent or confused accounts of basic terms pertaining to diseases, diagnoses, and clinical phenotypes. Here we outline what we believe to be a logically and biologically coherent framework for the representation of such entities and of the relations between them. We defend a view of disease as involving in every case some physical basis within the organism that bears a disposition toward the execution of pathological processes. We present our view in the form of a list of terms and definitions designed to provide a consistent starting point for the representation of both disease and diagnosis in information systems in the future.

110. Werner Ceusters and Barry Smith, "What do Identifiers in HL7 Identify? An Essay in the Ontology of Identity", *Proceedings of InterOntology 2009* (Tokyo, Japan, February 27-March 1, 2009), 77-86.

Abstract: Health Level 7 (HL7) is an organization seeking to provide universal standards for the exchange of healthcare information. In a document entitled 'HL7 Version 3 Standard: Data Types', the HL7 organization advances descriptions of data types recommended for use as identifiers. We will argue that the descriptions supplied provide insufficient guidance as to what exactly the entities are which these data types uniquely identify. Are they real things, such as persons or pieces of equipment? Or are they representations of such real things in information artifacts? We here outline the problems faced by HL7 in providing answers to such questions, problems which arise because of the lack of anything like a coherent ontology in the HL7 standard, and we make some recommendations for future improvements.

111. Werner Ceusters, Maria Capolupo, Barry Smith, Georges De Moor, "An Evolutionary Approach to the Representation of Adverse Events", *Medical Informatics Europe* (MIE 2009), Sarajevo, *Studies in Health Technology and Informatics*, 150 (2009) 537-541. PMC2829617

Abstract: One way to detect, monitor and prevent adverse events with the help of Information Technology is by using ontologies capable of representing three levels of reality: what is the case, what is believed about reality, and what is represented. We report on how Basic Formal Ontology and Referent Tracking exhibit this capability and how they are used to develop an adverse event ontology and related data annotation scheme for the European ReMINE project.

112. Bernd Blobel, Dipak Kalra, Marc Koehn, Ken Lunn, Peter Pharow, Pekka Ruotsalainen, Stefan Schulz, Barry Smith, "The Role of Ontologies for Sustainable, Semantically Interoperable and Trustworthy EHR Solutions", *Medical Informatics Europe* (MIE 2009), Sarajevo, *Studies in Health Technology and Informatics*, 150 (2009), 953-957.

Abstract: As health systems around the world turn towards highly distributed, specialized and cooperative structures to increase quality and safety of care as well as efficiency and efficacy of delivery processes, there is a growing need for supporting communication and collaboration of all parties involved with advanced ICT solutions. The Electronic Health Record (EHR) provides the information platform which is maturing towards the eHealth core application. To meet the requirements for sustainable, semantically interoperable, and trustworthy EHR solutions, different standards and different national strategies have been established. The workshop summarizes the requirements for such advanced EHR systems and their underlying architecture, presents different strategies and solutions advocated by corresponding protagonists, discusses pros and cons as well as harmonization and migration strategies for those approaches. It particularly highlights a turn towards ontology-driven architectures. The workshop is a joint activity of the EFMI Working Groups "Electronic Health Records" and "Security, Safety and Ethics".

113. Barry Smith, Kristo Mietinnin and William Mandrick, The Ontology of Command and Control, *Proceedings of the 14th International Command and Control Research and Technology Symposium* (ICCRTS), Washington DC, Jun 15-17, Arlington, VA: The Command and Control Research Program, 2009.

Abstract: The goal of the Department of Defense Net-Centric Data Strategy is to improve data sharing throughout the DoD. Data sharing is a critical element of interoperability in the emerging system-of-systems. Achieving interoperability requires the elimination of two types of data heterogeneity: differences of syntax and differences of semantics. This paper builds a path toward semantic uniformity through application of a disciplined approach to ontology. An ontology is a consensus framework representing the types of entities within a given domain and the relations between them. The construction of an ontology begins when a Community of Interest (COI) identifies its authoritative data sources (ADS), which are usually manifest in relevant doctrinal publications, glossaries, data dictionaries, and logical data models. The identified terms are then defined in relation to a common logical framework that has been designed to ensure interoperability with other ontologies created on the basis of the same strategy. As will be described, the Command and Control (C2) Ontology will include representations of a substantial number of entities within the Command and Control (C2) domain. If domain ontologies (e.g. Strike and Counterinsurgency) semantically align with the C2 Ontology, then a substantial barrier to systems interoperability is thereby crossed.

114. Albert Goldfain, Lindsay G. Cowell, Barry Smith, "Towards an Ontological Representation of Resistance: The Case of MRSA", *ICBO 2009: Proceedings of the First International Conference on Biomedical Ontology*, 61-64.

Abstract: This paper addresses a family of issues surrounding the biological phenomenon of resistance and its representation in realist ontologies. Resistance terms from various existing ontologies are examined and found to be either overly narrow, inconsistent, or otherwise problematic. We propose a more coherent ontological representation using the antibiotic resistance in Methicillin-Resistant Staphylococcus aureus (MRSA) as a case study.

115. Barry Smith, Lowell Vizenor and James Schoening, "Universal Core Semantic Layer", *Ontology for the Intelligence Community*, Proceedings of the Third OIC Conference, George Mason University, Fairfax, VA, October 2009, CEUR Workshop Proceedings, vol. 555.

Abstract: The Universal Core (UCore) was a central element of the US National Information Sharing Strategy supported by multiple U.S. Federal Government Departments, by the intelligence community, and by a number of other national and international institutions. The goal of the UCore initiative is to foster information sharing by means of an XML schema providing consensus representations for four groups of universally understood terms under the headings who, what, when, and where. We here describe a project to create an ontology-based supporting layer for UCore, entitled 'Universal Core Semantic Layer' (UCore SL), and describe how UCore SL can be applied to further UCore's information sharing goals.

116. Shahid Manzoor, Werner Ceusters and Barry Smith, "Referent Tracking for Command and Control Messaging Systems", *Proceedings of Ontology for the Intelligence Community*, George Mason University, Fairfax, VA, October 2009, CEUR Workshop Proceedings, vol. 555.

Abstract: The Joint Battle Management Language (JBML) is an XML-based language designed to allow Command and Control (C2) systems to interface easily with Modeling and Simulation (M&S) systems. While some of the XML-tags defined in this language correspond to types of entities that exist in reality, others are mere syntactic artifacts used to structure the messages themselves. Because these two kinds of tags are not formally distinguishable, JBML messages in effect confuse data with what the data represent. In this paper we show how a realism-based ontology combined with a rule language can be used to make these distinctions explicit. The approach allows storage of the contents of JBML messages in a Referent Tracking System in a format that mimics the structure of reality thereby providing an aid to message validation.

117. Werner Ceusters and Barry Smith, "Malaria Diagnosis and the Plasmodium Life Cycle: The BFO Perspective", in *Interdisciplinary Ontology. Proceedings of the Third Interdisciplinary Ontology Meeting* (Tokyo, Japan, February 27-28, 2010), Tokyo: Keio University Press, 2010, 25-34.

Abstract: Definitive diagnosis of malaria requires the demonstration through laboratory tests of the presence within the patient of malaria parasites or their components. Since malaria parasites can be present even in the absence of malaria manifestations, and since symptoms of malaria can be manifested even in the absence of malaria parasites, malaria diagnosis raises important issues for the adequate understanding of disease, etiology and diagnosis. One approach to the resolution of these issues adopts a realist view, according to which the needed clarifications will be derived from a careful representation of the entities on the side of the patient which form the ultimate truthmakers for clinical statements. We here address a challenge to this realist approach relating to the diagnosis of malaria, and show how this challenge can be resolved by appeal to Basic Formal Ontology (BFO) and to the Ontology for General Medical Science (OGMS) constructed in its terms.

118. Werner Ceusters and Barry Smith, "A Unified Framework for Biomedical Terminologies and Ontologies", *Proceedings of Medinfo 2010,* Cape Town, South Africa, Amsterdam: IOS Press, 12-15 September 2010 (*Studies in Health Technology and Informatics* 2010, 160) 1050-1054. PMC3104298

Abstract: The goal of the OBO (Open Biomedical Ontologies) Foundry initiative is to create and maintain an evolving collection of non-overlapping interoperable ontologies that will offer unambiguous representations of the types of entities in biological and biomedical reality. These ontologies are designed to serve non-redundant annotation of data and scientific text. To achieve these ends, the Foundry imposes strict requirements upon the ontologies eligible for inclusion. While these requirements are not met by most existing biomedical terminologies, the latter may nonetheless support the Foundry's goal of consistent and non-redundant annotation if appropriate mappings of data annotated with their aid can be achieved. To construct such mappings in reliable fashion, however, it is necessary to analyze terminological resources from an ontologically realist perspective in such a way as to identify the exact import of the 'concepts' and associated terms which they contain. We propose a framework for such analysis – based on the analysis of configurations and groups of entities in reality – that is designed to maximize the degree to which legacy terminologies and the data coded with their aid can be successfully used for information-driven clinical and translational research.

119. Albert Goldfain, Barry Smith and Lindsay G. Cowell, "Dispositions and the Infectious Disease Ontology", in Antony Galton and Riichiro Mizoguchi (eds.), *Formal Ontology in Information Systems. Proceedings of the Sixth International Conference (FOIS 2010)*, Amsterdam: IOS Press, 2010, 400-413.

Abstract: This paper addresses the use of dispositions in the Infectious Disease Ontology (IDO). IDO is an ontology constructed according to the principles of the Open Biomedical Ontology (OBO) Foundry and uses the Basic Formal Ontology (BFO) as an upper ontology. After providing a brief introduction to disposition types in BFO and IDO, we discuss three general techniques for representing combinations of dispositions under the headings blocking dispositions, complementary dispositions, and collective dispositions. Motivating examples for each combination of dispositions is given along with a specific use case in IDO. Description logic restrictions are used to formalize statements relating to these combinations.

120. Kerry Trentelman, Alan Ruttenberg, Barry Smith, "An Axiomatisation of Basic Formal Ontology with Projection Functions", *Advances in Ontologies*, *Proceedings of the Sixth Australasian Ontology Workshop (AOW 2010), Adelaide, 7 December 2010*, Kerry Taylor, Thomas Meyer and Mehmet Orgun (eds.), 2010, Sydney: ACS, 71-80.

Abstract: This paper proposes a reformulation of the treatment of boundaries, at parts and aggregates of entities in Basic Formal Ontology. These are currently treated as mutually exclusive, which is inadequate for biological representation since some entities may simultaneously be at parts, boundaries and/or aggregates. We introduce functions which map

entities to their boundaries, at parts or aggregations. We make use of time, space and spacetime projection functions which, along the way, allow us to develop a simple temporal theory.

121. Barry Smith, Werner Ceusters, Louis J. Goldberg, Richard Ohrbach, "Towards an Ontology of Pain", in Mitsu Okada (ed.), *Proceedings of the Conference on Ontology and Analytical Metaphysics*, February 24-25, 2011, Tokyo: Keio University Press, 2011, 23-36.

Abstract: We present an ontology of pain and of other pain-related phenomena, building on the definition of pain provided by the International Association for the Study of Pain (IASP). Our strategy is to identify an evolutionarily basic canonical pain phenomenon, involving unpleasant sensory and emotional experience based causally in localized tissue damage that is concordant with that experience. We then show how different variant cases of this canonical pain phenomenon can be distinguished, including pain that is elevated relative to peripheral trauma, pain that is caused neuropathically (thus with no necessary peripheral stimulus), and pain reports arising through deception either of self or of others. We describe how our approach can answer some of the objections raised against the IASP definition, and sketch how it can be used to support more sophisticated discrimination of different types of pain resulting in improved data analysis that can help in advancing pain research.

Japanese translation: "痛みと痛み関連の現象のオントロジー (分類体系) に向けて (特集 痛むカラダ–当事者研究最前線)", 現代思想 (Contemporary Thought), 39 (11), 2011, 172-180.

Russian translation

122. Barry Smith, "The Ontology of Documents", in Mitsu Okada (ed.), *Proceedings of the Conference on Ontology and Analytical Metaphysics*, February 24-25, 2011, Tokyo: Keio University Press, 2011, 1-6.

Abstract: As is well known, speech acts such as acts of promising can have ontological consequences. For example an act of promising can give rise to a mutually correlated claim and obligation. Increasingly, speech acts in the narrow sense are being augmented by the use of documents of multiple different sorts. In this paper we analyze the results of this augmentation from the ontological point of view, considering especially the domains of law and commerce. We show how document acts are not isolated phenomena, but rather form large and complex systems with other entities, including occurrent entities such as acts of signing and inspecting, as well as speech acts for example of instructing people to sign or complete a document. The paper concludes with a consideration of some of the special problems associated with the use of digital documents, for example as concerns issues of security and provenance.

Russian translation

123. Janna Hastings, Werner Ceusters, Barry Smith, Kevin Mulligan, "Dispositions and Processes in the Emotion Ontology", *Proceedings of the 2nd International Conference on Biomedical Ontology*, Buffalo, NY, July 28-30, 2011 (CEUR Workshop Proceedings, 833), 71-78.

Abstract: Affective science conducts interdisciplinary research into the emotions and other affective phenomena. Currently, such research is hampered by the lack of common definitions of te rms used to describe, categorise and report both individual emotional experiences and the results of scientific investigations of such experiences. High quality ontologies provide formal definitions for types of entities in reality and for the relationships between such entities, definitions which can be used to disambiguate and unify data across different disciplines. Heretofore, there has been little effort directed towards such formal representation for affective phenomena, in part because of widespread debates within the affective science community on matters of definition and categorization. We describe our efforts towards developing an Emotion Ontology (EMO) to serve the affective science community. We here focus on conformity to the BFO upper ontology and disambiguation of polysemous terminology.

124. Jobst Landgrebe, Barry Smith, "The HL7 Approach to Semantic Interoperability", *Proceedings of the 2nd International Conference on Biomedical Ontology*, Buffalo, NY, July 28-30, 2011 (CEUR Workshop Proceedings, 833), 139-146.

Abstract: Health Level 7 (HL7) is an international standards development organisation in the domain of healthcare information technology. Initially the mission of HL7 was to enable data exchange via the creation of syntactic standards which supported point-to-point messaging. Currently HL7 sees its mission as one of creating standards for semantic interoperability in healthcare IT on the basis of its flagship "version 3" (v3). Unfortunately, v3 has been plagued by quality and consistency issues, and it has not been able to keep pace with recent developments either in semantics and ontology or in computer science and engineering. HL7's response has been to develop its "Services-Aware Interoperability Framework" (SAIF), which is intended to provide a foundation for work on all aspects of standardization in HL7 henceforth. We here summarise the major design principles that must be satisfied by a semantic interoperability framework – principles relating both to static semantics and to computational behaviour. We then assess the SAIF in light of these principles. We conclude that the SAIF is not in a position to support the needed reform of the HL7 v3 family of standards.

125. Jiye Ai, Mauricio Almeida, Andre Andrade, Alan Ruttenberg, David T.W. Wong, Barry Smith, "Towards a Body Fluids Ontology: A Unified Application Ontology for Basic and Translational Science", *Proceedings of the ICBO Workshop on Working with Multiple Biomedical Ontologies,* Buffalo, NY, July 26, 2011 (CEUR Workshop Proceedings, 833), 381-386.

Abstract: We describe the rationale for an application ontology covering the domain of human body fluids that is designed to facilitate representation, reuse, sharing and integration of diagnostic, physiological, and biochemical data, We briefly review the Blood Ontology (BLO), Saliva Ontology (SALO) and Kidney and Urinary Pathway Ontology (KUPO) initiatives. We discuss the methods employed in each, and address the project of using them as starting point for a unified body fluids ontology resource. We conclude with a description of how the body fluids ontology initiative may provide support to basic and translational science.

126. Albert Goldfain, Barry Smith, Sivaram Arabandi, Mathias Brochhausen, William R. Hogan, "Vital Sign Ontology", *Proceedings of the Workshop on Bio-Ontologies*, ISMB, Vienna, June 2011, 71-74.

Abstract: We introduce the Vital Sign Ontology (VSO), an extension of the Ontology for General Medical Science (OGMS) that covers the consensus human vital signs: blood pressure, body temperature, respiratory rate, and pulse rate. VSO provides a controlled structured vocabulary for describing vital sign measurement data, the processes of measuring vital signs, and the anatomical entities participating in such measurements. VSO is implemented in OWL-DL and follows OBO Foundry guidelines and best practices. If properly developed and extended, we believe the VSO will find applications for the EMR, clinical informatics, and medical device communities.

127. David Salmen, Tatiana Malyuta, Alan Hansen, Shaun Cronen, Barry Smith, "Integration of Intelligence Data through Semantic Enhancement", *Proceedings of the Conference on Semantic Technology in Intelligence, Defense and Security* (STIDS), George Mason University, Fairfax, VA, November 16-17, 2011, CEUR, Vol. 808, 6-13.

Abstract: We describe a strategy for integration of data that is based on the idea of semantic enhancement. The strategy promises a number of benefits: it can be applied incrementally; it creates minimal barriers to the incorporation of new data into the semantically enhanced system; it preserves the existing data (including any existing data-semantics) in their original form (thus all provenance information is retained, and no heavy preprocessing is required); and it embraces the full spectrum of data sources, types, models, and modalities (including text, images, audio, and signals). The result of applying this strategy to a given body of data is an evolving Dataspace that allows the application of a variety of integration and analytic processes to diverse data contents. We conceive semantic enhancement (SE) as a lightweight and flexible process that leverages the richness of the structured contents of the Dataspace without adding

storage and processing burdens to what, in the intelligence domain, will be an already storage- and processing-heavy starting point. SE works not by changing the data to which it is applied, but rather by adding an extra semantic layer to this data. We sketch how the semantic enhancement approach can be applied consistently and in cumulative fashion to new data and data-models that enter the Dataspace.

128. Janna Hastings, Werner Ceusters, Barry Smith, Kevin Mulligan, "The Emotion Ontology: Enabling Interdisciplinary Research in the Affective Sciences", in *CONTEXT '11, The Seventh International and Interdisciplinary Conference on Modeling and Using Context*, Karlsruhe, Germany, September 26-30, 2011, Berlin/Heidelberg: Springer, 119-123.

Abstract: Affective science conducts interdisciplinary research into the emotions and other affective phenomena. Currently, such research is hampered by the lack of common definitions of terms used to describe, categorise and report both individual emotional experiences and the results of scientific investigations of such experiences. High quality ontologies provide formal definitions for types of entities in reality and for the relationships between such entities, definitions which can be used to disambiguate and unify data across different disciplines. Heretofore, there has been little effort directed towards such formal representation for affective phenomena, in part because of widespread debates within the affective science community on matters of definition and categorization. To address this requirement, we are developing an Emotion Ontology.

129. Cecilia N. Arighi, Darren A. Natale, Judith A. Blake, Carol J. Bult, Michael Caudy, Alexander D. Diehl, Harold J. Drabkin, Peter D'Eustachio, Alexei Evsikov, Hongzhan Huang, Natalia V. Roberts, Alan Ruttenberg, Barry Smith, Jian Zhang, Cathy H. Wu, "Protein-Centric Connection of Biomedical Knowledge: Protein Ontology (PRO) Research and Annotation Tools", *Proceedings of the 2nd International Conference on Biomedical Ontology*, Buffalo, NY, July 28-30, 2011, 285-287.

Abstract: The Protein Ontology (PRO) web resource provides an integrative framework for protein-centric exploration and enables specific and precise annotation of proteins and protein complexes based on PRO. Functionalities include: browsing, searching and retrieving, terms, displaying selected terms in OBO or OWL format, and supporting URIs. In addition, the PRO website offers multiple ways for the user to request, submit, or modify terms and/or annotation. We will demonstrate the use of these tools for protein research and annotation.

130. Patricia L. Whetzel, Natasha Noy, Nigam Shah, Paul Alexander, Michael Dorf, Ray Fergerson, Margaret-Anne Storey, Barry Smith, Chris Chute, Mark Musen, "Bioportal: Ontologies and Integrated Data Resources at the Click of a Mouse", *Proceedings of the 2nd International Conference on Biomedical Ontology*, Buffalo, NY, July 28-30, 2011, 292-293.

Abstract: BioPortal is a Web portal that provides access to a library of biomedical ontologies and terminologies developed in OWL, RDF(S), OBO format, Protégé frames, and Rich Release Format. BioPortal functionality, driven by a service-oriented architecture, includes the ability to browse, search and visualize ontologies (Figure 1). The Web interface also facilitates community-based participation in the evaluation and evolution of ontology content.

131. Barry Smith, "On Classifying Material Entities in Basic Formal Ontology", in *Interdisciplinary Ontology. Proceedings of the Third Interdisciplinary Ontology Meeting,* Tokyo: Keio University Press, 2012, 1-13.

Abstract: Basic Formal Ontology (BFO) was created in 2002 as an upper-level ontology to support the creation of consistent lower-level ontologies, initially in the subdomains of biomedical research, now also in other areas, including defense and security. BFO is currently undergoing revisions in preparation for the release of BFO version 2.0. We summarize some of the proposed revisions in what follows, focusing on BFO's treatment of material entities, and specifically of the category object.

132. Janna Hastings, Nicolas Le Novère, Werner Ceusters, Kevin Mulligan and Barry Smith, "Wanting What We Don't Want to Want: Representing Addiction in Interoperable Bio-Ontologies", *Proceeedings of the Third International Conference on Biomedical Ontology* (CEUR 897), Graz, July 23-25, 2012, 56-60.

Abstract: Ontologies are being developed throughout the biomedical sciences to address standardization, integration, classification and reasoning needs against the background of an increasingly data-driven research paradigm. In particular, ontologies facilitate the translation of basic research into benefits for the patient by making research results more discoverable and by facilitating knowledge transfer across disciplinary boundaries. Addressing and adequately treating mental illness is one of our most pressing public health challenges. Primary research across multiple disciplines such as psychology, psychiatry, biology, neuroscience and pharmacology needs to be integrated in order to promote a more comprehensive understanding of underlying processes and mechanisms, and this need for integration only becomes more pressing with our increase in understanding of differecces among individuals and populations at the molecular level concerning susceptibility to specific illnesses. Substance addiction is a particularly relevant public health challenge in the developed world, affecting a substantial percentage of the population, often co-morbid with other illnesses such as mood disorders. Currently, however, there is no straightforward automated method to combine data of relevance to the study of substance addiction across multiple disciplines and populations.

In this contribution, we describe a framework of interlinked, interoperable bio-ontologies for the annotation of primary research data relating to substance addiction, and discuss how this framework enables easy integration of results across disciplinary boundaries. We describe entities and relationships relevant for the description of addiction within the Mental Functioning Ontology, Chemical Entities of Biological Interest Ontology, Protein Ontology, Gene Ontology and the Neuroscience Information Framework ontologies.

133. Ramona Walls, Barry Smith, Justin Elser, Albert Goldfain, Dennis W. Stevenson and Pankaj Jaiswal, "A Plant Disease Extension of the Infectious Disease Ontology", *Proceeedings of the Third International Conference on Biomedical Ontology* (CEUR 897), Graz, July 23-25, 2012, 1-5.

Abstract: Plants from a handful of species provide the primary source of food for all people, yet this source is vulnerable to multiple stressors, such as disease, drought, and nutrient deficiency. With rapid population growth and climate uncertainty, the need to produce crops that can tolerate or resist plant stressors is more crucial than ever. Traditional plant breeding methods may not be sufficient to overcome this challenge, and methods such as highOthroughput sequencing and automated scoring of phenotypes can provide significant new insights. Ontologies are essential tools for accessing and analysing the large quantities of data that come with these newer methods. As part of a larger project to develop ontologies that describe plant phenotypes and stresses, we are developing a plant disease extension of the Infectious Disease Ontology (IDOPlant). The IDOPlant is envisioned as a reference ontology designed to cover any plant infectious disease. In addition to novel terms for infectious diseases, IDOPlant includes terms imported from other ontologies that describe plants, pathogens, and vectors, the geographic location and ecology of diseases and hosts, and molecular functions and interactions of hosts and pathogens. To encompass this range of data, we are suggesting in-house ontology development complemented with reuse of terms from orthogonal ontologies developed as part of the Open Biomedical Ontologies (OBO) Foundry. The study of plant diseases provides an example of how an ontological framework can be used to model complex biological phenomena such as plant disease, and how plant infectious diseases differ from, and are similar to, infectious diseases in other organism.

134. Albert Goldfain, Barry Smith and Lindsay Cowell, "Constructing a Lattice of Infectious Disease Ontologies from a Staphylococcus aureus Isolate Repository", *Proceeedings of the Third International Conference on Biomedical Ontology* (CEUR 897), Graz, July 23-25, 2012.

Abstract: A repository of clinically associated Staphylococcus aureus (Sa) isolates is used to semi-automatically generate a set of application ontologies for specific subfamilies of Sa-related disease. Each such application ontology is compatible with the Infectious Disease Ontology (IDO)

and uses resources from the Open Biomedical Ontology (OBO) Foundry. The set of application ontologies forms a lattice structure beneath the IDO Core and IDO extension reference ontologies. We show how this lattice can be used to define a strategy for the construction of a new taxonomy of infectious disease incorporating genetic, molecular, and clinical data. We also outline how faceted browsing and query of annotated data is supported using a lattice application ontology.

135. Janna Hastings, Werner Ceusters, Mark Jensen, Kevin Mulligan and Barry Smith, "Representing Mental Functioning: Ontologies for Mental Health and Disease", *Towards an Ontology of Mental Functioning* (ICBO Workshop), *Third International Conference on Biomedical Ontology*, Graz, July 22, 2012.

Abstract: Mental and behavioral disorders represent a significant portion of the public health burden in all countries. The human cost of these disorders is immense, yet treatment options for sufferers are currently limited, with many patients failing to respond sufficiently to available interventions and drugs. High quality ontologies facilitate data aggregation and comparison across different disciplines, and may therefore speed up the translation of primary research into novel therapeutics. Realism-based ontologies describe entities in reality and the relationships between them in such a way that – once formulated in a suitable formal language – the ontologies can be used for sophisticated automated reasoning applications. Reference ontologies can be applied across different contexts in which different, and often mutually incompatible, domain-specific vocabularies have traditionally been used. In this contribution we describe the Mental Functioning Ontology (MF) and Mental Disease Ontology (MD), two realism-based ontologies currently under development for the description of humanmental functioning and disease. We describe the structure and upper levels of the ontologies and preliminary application scenarios, and identify some open questions.

136. Alexander P. Cox, Mark Jensen, William Duncan, Bianca Weinstock-Guttman, Kinga Szigeti, Alan Ruttenberg, Barry Smith and Alexander D. Diehl, "Ontologies for the Study of Neurological Disease", *Towards an Ontology of Mental Functioning* (ICBO Workshop), *Third International Conference on Biomedical Ontology*, Graz, July 22, 2012.

Abstract: We have begun work on two separate but related ontologies for the study of neurological diseases. The first, the Neurological Disease Ontology (ND), is intended to provide a set of controlled, logically connected classes to describe the range of neurological diseases and their associated signs and symptoms, assessments, diagnoses, and interventions that are encountered in the course of clinical practice. ND is built as an extension of the Ontology for General Medical Sciences — a high-level candidate OBO Foundry ontology that provides a set of general classes that can be used to describe general aspects of medical science. ND is being built with classes utilizing both textual and axiomatized definitions that describe and formalize the relations between instances of other classes within the ontology itself as well as to external ontologies such as the Gene Ontology, Cell Ontology, Protein Ontology, and Chemical Entities of Biological Interest. In addition, references to similar or associated terms in external ontologies, vocabularies and terminologies are included when possible. Initial work on ND is focused on the areas of Alzheimer's and other diseases associated with dementia, multiple sclerosis, and stroke and cerebrovascular disease. Extensions to additional groups of neurological diseases are planned. The second ontology, the NeuroPsychological Testing Ontology (NPT), is intended to provide a set of classes for the annotation of neuropsychological testing data. The intention of this ontology is to allow for the integration of results from a variety of neuropsychological tests that assay similar measures of cognitive functioning. Neuropsychological testing is an important component in developing the clinical picture used in the diagnosis of patients with a range of neurological diseases, such as Alzheimer's disease and multiple sclerosis, and following stroke or traumatic brain injury. NPT is being developed as an extension to the Ontology for Biomedical Investigations.

137. Janna Hastings, Werner Ceusters, Kevin Mulligan and Barry Smith, "Annotating affective neuroscience data with the Emotion Ontology", *Towards an Ontology of Mental Functioning* (ICBO Workshop), *Third International Conference on Biomedical Ontology*, Graz, July 22, 2012.

Abstract: The Emotion Ontology is an ontology covering all aspects of emotional and affective mental functioning. It is being developed following the principles of the OBO Foundry and Ontological Realism. This means that in compiling the ontology, we emphasize the importance of the nature of the entities in reality that the ontology is describing. One of the ways in which realism-based ontologies are being successfully used within biomedical science is in the annotation of scientific research results in publicly available databases. Such annotation enables several objectives, including searching, browsing and cross-database data integration. A key benefit conferred by realism-based ontology is that suitably annotated research results are able to be aggregated and compared in a fashion that is based on the underlying reality that the science is studying. This has the potential of increasing the power of statistical analysis and meta-analysis in data-driven science. This aspect has been fruitfully exploited in the investigation of the functions of genes in molecular biology. Cognitive neuroscience uses functional neuroimaging to investigate the brain correlates of areas of mental functioning such as memory, planning and emotion. The use of functional neuroimaging to study affective phenomena such as the emotions is called 'affective neuroscience'. BrainMap is the largest curated database of coordinates and metadata for studies in cognitive neuroscience, including affective neuroscience (Laird et al., 2005). BrainMap data is already classified and indexed using a terminology for classification, called the 'Cognitive Paradigm Ontology' (CogPO), that has been developed to facilitate searching and browsing. However, CogPO has been developed specifically for the BrainMap database, and the data are thus far not annotated to a realism-based ontology which would allow the discovery of interrelationships between research results across different databases on the basis of what the research is about. In this contribution, we describe ongoing work that aims to annotate affective neuroscience data, starting with the BrainMap database, using the Emotion Ontology. We describe our objectives and technical approach to the annotation, and mention some of the challenges.

138. Barry Smith, Tatiana Malyuta, William S. Mandrick, Chia Fu, Kesny Parent, Milan Patel, "Horizontal Integration of Warfighter Intelligence Data. A Shared Semantic Resource for the Intelligence Community", *Proceedings of the Conference on Semantic Technology in Intelligence, Defense and Security* (STIDS), George Mason University, Fairfax, VA, October 23-25, 2012, CEUR 996, 112-119.

Abstract: We describe a strategy that is being used for the horizontal integration of warfighter intelligence data within the framework of the US Army's Distributed Common Ground System Standard Cloud (DSC) initiative. The strategy rests on the development of a set of ontologies that are being incrementally applied to brcding about what we call the 'semantic enhancement' of data models used within each intelligence discipline. We show how the strategy can help to overcome familiar tendencies to stovepiping of intelligence data, and describe how it can be applied in an agile fashion to new data resources in ways that address immediate needs of intelligence analysts.

139. Barry Smith, "Diagrams, Documents, and the Meshing of Plans", in: András Benedek and Kristóf Nyíri (eds.), *How To Do Things With Pictures: Skill, Practice, Performance*, Frankfurt a. M.: Peter Lang Edition, 2013, 165-179.

Abstract: There are two important ways in which, when dealing with documents, we go beyond the boundaries of linear text. First, by incorporating diagrams into documents, and second, by creating complexes of intermeshed documents which may be extended in space and evolve and grow through time. The thesis of this paper is that such aggregations of documents are today indispensable to practically all complex human achievements from law and finance to orchestral performance and organized warfare. Documents provide for what we can think of as a division of intellectual, instructional, and deontic labour, allowing plans, orders, and obligations to be enmeshed together in a way that often involves the use of diagrammatic elements, as for example in a musical score.

Italian translation as "Diagrammi, documenti e l'intrecciarsi dei piani d'azione" in Tiziana Andina and Carola Barbero (eds.), *Ermeneutica, estetica, ontologia*, Bologna: Il Mulino, 2016, 249-266.

140. William R. Hogan, Mathias Brochhausen, Barry Smith, "A call to urgent action on standard ontologies for translational science", Presented at Translational Science

2013, Washington DC, April 18, 2013, *Clinical and Translational Science*, 6:2, 2013, 57 (Abstract).

Abstract: The Clinical and Translational Science Award (CTSA) Program has always emphasized data standards to promote sharing and comparison of data across the CTSA Consortium and beyond. Yet creation and adoption of such standards is still painfully slow. Urgent action remains necessary. History shows the high value of standard terms, definitions, and symbols (i.e. ontology) to science. But the creation and adoption of such standards often takes decades, as we show with two examples: chemical elements and units of measure. Translational science requires a consistent set of standard ontologies spanning all scales, from molecule to organism to population. But clinical terminologies at the macroscale – such as SNOMED and ICD – inhibit translational science. They are inconsistent with successful micro-scale ontologies such as the Gene Ontology, and they also cannot change rapidly with the advance of science. Translational science must settle on standards that evolve in a way that is closely tied to scientific advance. In the case of chemical symbols and SI Units adoption proceeded in three overlapping stages. First came widespread recognition and understanding of the problem. Second, influential stakeholders helped to develop, test, and select appropriate standards. Third, once scientifically useful standards emerged, the community enforced them via peer review. How can we accelerate progress on clinical ontologies through all three stages? The authors, all of whom are involved in the new CTS Ontology Affinity Group, sketch a plan for the Consortium to invest in and adopt standard clinical ontologies that are open and well disseminated, following the strategies of the Open Biomedical Ontologies Foundry, Neuroscience Information Framework, and eagle-i/VIVO/CTSAconnect communities.

141. Albert Goldfain, Min Xu, Jonathan Bona and Barry Smith, "Ontology based annotation of contextualized vital signs", *Proceedings of the Fourth International Conference on Biomedical Ontology* (ICBO), Montreal, July 8-9, 2013, CEUR, vol. 1060, 28-33.

Abstract: Representing the kinetic state of a patient (posture, motion, and activity) during vital sign measurement is an important part of continuous monitoring applications, especially remote monitoring applications. In contextualized vital sign representation, the measurement result is presented in conjunction with salient measurement context metadata. We present an automated annotation system for vital sign measurements that uses ontologies from the Open Biomedical Ontology Foundry (OBO Foundry) to represent the patient's kinetic state at the time of measurement. The annotation system is applied to data generated by a wearable personal status monitoring (PSM) device. We demonstrate how annotated PSM data can be queried for contextualized vital signs as well as sensor algorithm configuration parameters.

142. Barry Smith, "Introduction to the logic of definitions", *International Workshop on Definitions in Ontologies*, organized in conjunction with the Fourth International Conference on Biomedical Ontology (ICBO), Montreal, July 7, 2013, CEUR, vol. 1061, 1-2.

Abstract: What follows is a summary of basic principles pertaining to the definitions used in constructing an ontology. A definition is a statement of necessary and sufficient conditions. What this means in the simplest case can be understood as follows. To say that φ-ing is a necessary condition for being an A is just another way of saying that every A φ's; to say that φ-ing is a sufficient condition for being an A is just another way of saying that everything that φ's is an A. The goal in writing a definition is to specify a set of conditions of this sort which are all necessary, and which are jointly sufficient.

143. Barry Smith, Tatiana Malyuta, Ron Rudnicki, William Mandrick, David Salmen, Peter Morosoff, Danielle K. Duff, James Schoening, Kesny Parent, "IAO-Intel: An Ontology of Information Artifacts in the Intelligence Domain", *Proceedings of the Eighth International Conference on Semantic Technologies for Intelligence, Defense, and Security*, Fairfax, VA (STIDS 2013), CEUR, 1097, 33-40.

Abstract: We describe on-going work on IAO-Intel, an information artifact ontology developed as part of a suite of ontologies designed to support the needs of the US Army intelligence community within the framework of the Distributed Common Ground System (DCGS-A). IAO-

Intel provides a controlled, structured vocabulary for the consistent formulation of metadata about documents, images, emails and other carriers of information. It will provide a resource for uniform explication of the terms used in multiple existing military dictionaries, thesauri and metadata registries, thereby enhancing the degree to which the content formulated with their aid will be available to computational reasoning.

144. Werner Ceusters, Chiun Yu Hsu and Barry Smith, "Clinical Data Wrangling Using Ontology and Referent Tracking", *Proceedings of the Fifth* International Conference on Biomedical Ontology (ICBO), Houston, 2014, (CEUR, 1327), 27-32.

Abstract: Ontological realism aims at the development of high quality ontologies that faithfully represent what is general in reality and to use these ontologies to render heterogeneous data collections comparable. To achieve this second goal for clinical research datasets presupposes not merely (1) that the requisite ontologies already exist, but also (2) that the datasets in question are faithful to reality in the dual sense that (a) they denote only particulars and relationships between particulars that do in fact exist and (b) they do this in terms of the types and type-level relationships described in these ontologies. Using Referent Tracking as basis, we describe a strategy for addressing issue (2), which consists in creating for each dataset a template that, when applied to each particular record in the dataset, leads to the generation of a collection of Referent Tracking Tuples (RTT) built out of unique identifiers for the entities described by means of the data items in the record. The proposed strategy is based on (i) the distinction between data and what data are about, and (ii) the explicit descriptions of portions of reality which RTTs provide and which range not only over the particulars described by data items in a dataset, but also over these data items themselves. This last feature allows us to describe particulars that are only implicitly referred to by the dataset; to provide information about correspondences between data items in a dataset; and to assert which data items are unjustifiably or redundantly present in or absent from the dataset.

145. Albert Goldfain, Barry Smith, Lindsay Cowell, "Ontological Representation of CDC Active Bacterial Core Surveillance Case Reports", *Proceedings of the Fifth International Conference on Biomedical Ontology* (ICBO), Houston, 2014, (CEUR, 1327), 74-77.

Abstract: The Center for Disease Control and Prevention's Active Bacterial Core Surveillance (CDC ABCs) Program is a collaborative effort betweeen the CDC, state health departments, laboratories, and universities to track invasive bacterial pathogens of particular importance to public health. The year-end surveillance reports produced by this program help to shape public policy and coordinate responses to emerging infectious diseases over time. The ABC's case report form (CRF) data represents an excellent opportunity for data reuse beyond the original surveillance purposes. In this work, we focus on methicillin-resistant Staphylococcus aureus (MRSA), which has been tracked by the ABCs program since 2005. We use the Infectious Disease Ontology (IDO) Staphyloccocus aureus extension ontology (IDO-Staph), along with other ontologies following the principles of the Open Biomedical Ontologies Foundry (OBOF) to represent the entities referenced by the MRSA specific ABCs CRF. The goals of this effort are: (1) to demonstrate that infectious disease case report data can be positioned for reuse and linking to complementary data sources at the point of collection, (2) to identify any coverage gaps or limitations in the OBOF representation, and (3) to extend and reassess previous work in the ontology of infectious diseases.

146. Selja Seppälä, Barry Smith and Werner Ceusters, "Applying the Realism-Based Ontology-Versioning Method for Tracking Changes in the Basic Formal Ontology", *Formal Ontology in Information Systems. Proceedings of the Sixth International Conference (FOIS 2014)*, Amsterdam: IOS Press, 227-240.

Abstract: Changes in an upper level ontology have obvious consequences for the domain ontologies that use it at lower levels. It is therefore crucial to document the changes made between successive versions of ontologies of this kind. We describe and apply a method for tracking, explaining and measuring changes between successive versions of upper level ontologies such as the Basic Formal Ontology (BFO). The proposed change-tracking method extends earlier work on Realism-Based Ontology Versioning (RBOV) and Evolutionary Terminology Auditing (ETA). We describe here the application of this evaluation method to

changes between BFO 1.0, BFO 1.1, and BFO 2.0. We discuss the issues raised by this application and describe the extensions which we added to the original evaluation schema in order to account for changes in an ontology of this type. Our results show that BFO has undergone eight types of changes that can be systematically explained by the extended evaluation schema. Finally, we discuss problematic cases, possible pitfalls and certain limits of our study that we propose to address in future work.

147. Neil Otte, Brian Donohue and Barry Smith. "An Ontological Approach to Territorial Disputes", *Proceedings of the Conference on Semantic Technology in Intelligence, Defense and Security* George Mason University, Fairfax, VA, (STIDS 2014)*,* CEUR, vol. 1304, 2-9.

Abstract: Disputes over territory are a major contributing factor to the disruption of international relations. We believe that a cumulative, integrated, and continuously updated resource providing information about such disputes in an easily accessible form would be of benefit to intelligence analysts, military strategists, political scientists, and also to historians and others concerned with international disputes. We propose an ontology-based strategy for creating such a resource. The resource will contain information about territorial disputes, arguments for and against claims pertaining to sovereignty, proffered evidence for such claims, political and military motives (overt or hidden), and associated conflicts. Our approach is designed to address several issues surrounding the representation of geopolitical conflict, including the tracking and individuation of disputes and the validation of disseminated information.

148. Erik Thomsen, Fred Read, William Duncan, Tatiana Malyuta and Barry Smith, "Ontological Support for Living Plan Specification, Execution and Evaluation", *Proceedings of the Conference on Semantic Technology in Intelligence, Defense and Security*, George Mason Ujniversity, Fairfax, VA, *,* CEUR, vol. 1304 (STIDS 2014), 10-17.

Abstract: Maintaining systems of military plans is critical for military effectiveness, but is also challenging. Plans will become obsolete as the world diverges from the assumptions on which they rest. If too many ad hoc changes are made to intermeshed plans, the ensemble may no longer lead to well-synchronized and coordinated operations, resulting in the system of plans becoming itself incoherent. We describe in what follows an Adaptive Planning process that we are developing on behalf of the Air Force Research Laboratory (Rome) with the goal of addressing problems of these sorts through cyclical collaborative plan review and maintenance. The interactions of world state, blue force status and associated plans are too complex for manual adaptive processes, and computer-aided plan review and maintenance is thus indispensable. We argue that appropriate semantic technology can 1) provide richer representation of plan-related data and semantics, 2) allow for flexible, non-disruptive, agile, scalable, and coordinated changes in plans, and 3) support more intelligent analytical querying of plan-related data.

149. Werner Ceusters and Barry Smith, "Biomarkers in the Ontology for General Medical Science", *Digital Healthcare Empowering Europeans*, R. Cornet et al. (eds.), Amsterdam: IOS Press, 2015, 155-159.

Abstract: A great deal of recent work has been devoted to the topic of biomarkers as aids to diagnosis, prognosis and treatment evaluation. Basing our work on the Ontology for General Medical Science (OGMS) and on the specifications provided by the Institute of Medicine (IOM), we propose definitions for biomarkers of various types. These definitions provide a formal representation of what biomarkers are in a way that allows us to remove certain ambiguities and inconsistencies in the documentation provided by the IOM.

150. Werner Ceusters and Barry Smith, "Aboutness: Towards Foundations for the Information Artifact Ontology", *Proceedings of the Sixth International Conference on Biomedical Ontology* (ICBO), Lisbon, Portugal (CEUR 1515), 2015, 1-5.

Abstract: The Information Artifact Ontology (IAO) was created to serve as a domain-neutral resource for the representation of types of information content entities (ICEs) such as

documents, data-bases, and digital images. We identify a series of problems with the current version of the IAO and suggest solutions designed to advance our understanding of the relations between ICEs and associated cognitive representations in the minds of human subjects. This requires embedding IAO in a larger framework of ontologies, including most importantly the Mental Functioning Ontology (MFO). It also requires a careful treatment of the aboutness relations between ICEs and associated cognitive representa-tions and their targets in reality.

151. Jingshan Huang, Karen Eilbeck, Judith Blake, Dejing Dou, Darren Natale, Alan Ruttenberg, Barry Smith, Michael Zimmermann, Guoqian Jiang, Yu Lin, Bin Wu, Yongqun He, Shaojie Zhang, Xiaowei Wang, He Zhang, David Schmitt, and Ming Tan, "A domain ontology for the non-coding RNA field", *IEEE International Conference on Bioinformatics and Biomedicine* (IEEE BIBM 2015), 621-624.

Abstract: Identification of non-coding RNAs (ncRNAs) has been significantly enhanced due to the rapid advancement in sequencing technologies. On the other hand, semantic annotation of ncRNA data lag behind their identification, and there is a great need to effectively integrate discovery from relevant communities. To this end, the Non-Coding RNA Ontology (NCRO) is being developed to provide a precisely defined ncRNA controlled vocabulary, which can fill a specific and highly needed niche in unification of ncRNA biology.

152. Jingshan Huang, Fernando Gutierrez, Dejing Dou, Judith Blake, Karen Eilbeck, Darren Natale, Barry Smith, Yu Lin, Xiaowei Wang, Zixing Liu, Bin Wu, Ming Tan and Alan Ruttenberg, "A semantic approach for knowledge capture of microRNA-target gene interactions," *IEEE International Conference on Bioinformatics and Biomedicine* (IEEE BIBM 2015), 975-982.

Abstract: Research has indicated that microRNAs (miRNAs), a special class of non-coding RNAs (ncRNAs), can perform important roles in different biological and pathological processes. miRNAs' functions are realized by regulating their respective target genes (targets). It is thus critical to identify and analyze miRNA-target interactions for a better understanding and delineation of miRNAs' functions. However, conventional knowledge discovery and acquisition methods have many limitations. Fortunately, semantic technologies that are based on domain ontologies can render great assistance in this regard. In our previous investigations, we developed a miRNA domain-specific application ontology, Ontology for MIcroRNA Target (OMIT), to provide the community with common data elements and data exchange standards in the miRNA research. This paper describes (1) our continuing efforts in the OMIT ontology development and (2) the application of the OMIT to enable a semantic approach for knowledge capture of miRNA-target interactions.

153. Peter Morosoff, Ron Rudnicki, Jason Bryant, Robert Farrell, Barry Smith, "Joint Doctrine Ontology: A Benchmark for Military Information Systems Interoperability", *Semantic Technology for Intelligence, Defense and Security* (STIDS), 2015, CEUR vol. 1523, 2-9.

Abstract: When the U.S. conducts warfare, elements of a force are drawn from different Services and work together as a single team to accomplish an assigned mission on the basis of joint doctrine. To achieve such unified action, it is necessary that specific Service doctrines be both consistent with and subservient to joint doctrine. Two less commonly addressed requirements flow from the ways in which, in an age of ever increasing flows of heterogeneous network data, unified action involves not only live forces but also automated systems. First, the information technology that is used in joint warfare must be aligned with joint doctrine. Second, the separate information systems used by the different elements of a joint force must be interoperable in the sense that data and information that is generated by each element must be usable (understandable, processible) by all the other elements which need them. Currently, such interoperability is impeded by multiple inconsistencies among different data and software standards. We describe here the on-going project of creating a Joint Doctrine Ontology (JDO), which uses joint doctrine to provide shared computer-accessible content valid for any field of military endeavor, organization, and information system. JDO addresses the two above-mentioned requirements of unified action by providing a widely applicable benchmark for use by developers of information systems that would both guarantee alignment with joint doctrine and support interoperability.

154. Brian Donohue, Douglas Kutach, Amardeep Bhattal, Dave Braines, Geeth de Mel, Robert Ganger, Tien Pham, Ron Rudnicki and Barry Smith, "Controlled and Uncontrolled English for Ontology Editing", *Semantic Technology for Intelligence, Defense and Security* (STIDS), 2015, CEUR vol. 1523, 74-81

Abstract: Ontologies formally represent reality in a way that limits ambiguity and facilitates automated reasoning and data fusion, but is often daunting to the non-technical user. Thus, many researchers have endeavored to hide the formal syntax and semantics of ontologies behind the constructs of Controlled Natural Languages (CNLs), which retain the formal properties of ontologies while simultaneously presenting that information in a comprehensible natural language format. In this paper, we build upon previous work in this field by evaluating prospects of implementing International Technology Alliance Controlled English (ITACE) as a middleware for ontology editing. We also discuss at length a prototype of a natural language conversational interface application designed to facilitate ontology editing via the formulation of CNL constructs.

155. Francesco Furini, Rahul Rai, Giorgio Colombo, Barry Smith, Venkat Krovi, "Development of a Manufacturing Ontology for Functionally Graded Materials", *Proceedings of International Design Engineering Technical Conferences & Computers and Information in Engineering Conference* (IDETC/CIE 2016), August 21-24, 2016, Charlotte, NC

Abstract: The development of manufacturing technologies for new materials involves the generation of a large and continually evolving volume of information. The analysis, integration and management of such large volumes of data, typically stored in multiple independently developed databases, creates significant challenges for practitioners. There is a critical need especially for open-sharing of data pertaining to engineering design which together with effective decision support tools can enable innovation. We believe that ontology applied to engineering (OE) represents a viable strategy for the alignment, reconciliation and integration of diverse and disparate data. The scope of OE includes: consistent capture of knowledge pertaining to the types of entities involved; facilitation of cooperation among diverse group of experts; more effective ongoing curation, and update of manufacturing data; collaborative design and knowledge reuse. As an illustrative case study we propose an ontology focused on the representation of composite materials focusing in particular on the class of Functionally Graded Materials (FGM) in particular. The scope of the ontology is to provide information about the components of such materials, the manufacturing processes involved in creation, and diversity of application ranging from additive manufacturing to restorative dentistry. The ontology is developed using Basic Formal Ontology (BFO) and the Ontology for Biomedical Investigations (OBI).

156. Selja Seppälä, Alan Ruttenberg, Barry Smith, "The Functions of Definitions in Ontologies", *Formal Ontology in Information Systems. Proceedings of the Ninth International Conference* (FOIS 2016), Amsterdam: IOS Press, 2016, 37-50.

Abstract: To understand what ontologies do through their definitions, we propose a theoretical explanation of the functions of definitions in ontologies backed by empirical neuropsychological studies. Our goal is to show how these functions should motivate (i) the systematic inclusion of definitions in ontologies and (ii) the adaptation of definition content and form to the specific context of use of ontologies.

157. Niels Grewe, Ludger Jansen and Barry Smith, "Permanent Generic Relatedness and Silent Change", *Formal Ontology in Information Systems. Proceedings of the Ninth International Conference* (FOIS 2016) *Ontology Competition*, (CEUR 1660), 1-5.

Abstract: Given the assertion of a relation between two types such as: "Epidermis has part some Keratinocyte", we define silent change as any kind of change of the instance-relata of the relation in question that does not change the truth-value of the respective type-level assertion. Such assertions are notoriously difficult to model in OWL 2. To address this problem,

we distinguish different modes of type-level relatedness giving rise to this problem and describe a conservative extension to the BFO top-level ontology that allows expressing these modes.

158. Alexander P. Cox, Christopher K. Nebelecky, Ronald Rudnicki, William A. Tagliaferri, John L. Crassidis, Barry Smith, "The Space Object Ontology", *19th International Conference on Information Fusion* (FUSION 2016), Heidelberg, Germany, July 5-8, 2016.

Abstract: Achieving space domain awareness requires the identification, characterization, and tracking of space objects. Storing and leveraging associated space object data for purposes such as hostile threat assessment, object identification, and collision prediction and avoidance present further challenges. Space objects are characterized according to a variety of parameters including their identifiers, design specifications, components, subsystems, capabilities, vulnerabilities, origins, missions, orbital elements, patterns of life, processes, operational statuses, and associated persons, organizations, or nations. The Space Object Ontology provides a consensus-based realist framework for formulating such characterizations in a computable fashion. Space object data are aligned with classes and relations in the Space Object Ontology and stored in a dynamically updated Resource Description Framework triple store, which can be queried to support space domain awareness and the needs of spacecraft operators. This paper presents the core of the Space Object Ontology, discusses its advantages over other approaches to space object classification, and demonstrates its ability to combine diverse sets of data from multiple sources within an expandable framework. Finally, we show how the ontology provides benefits for enhancing and maintaining long-term space domain awareness.

159. Fernanda Farinelli, Mauricio B. Almeida, Peter Elkin and Barry Smith, "OntONeo: The Obstetric and Neonatal Ontology", Fernanda Farinelli, Mauricio Almeida, Peter Elkin, Barry Smith", *International Conference on Biological Ontology* (ICBO), CEUR 1747, 2016.

Abstract: This paper presents the Obstetric and Neonatal Ontology (OntONeo). This ontology has been created to provide a consensus representation of salient electronic health record (EHR) data and to serve interoperability of the associated data and information systems. More generally, it will serve interoperability of clinical and translational data, for example deriving from genomics disciplines and from clinical trials. Interoperability of EHR data is important to ensuring continuity of care during the prenatal and postnatal periods for both mother and child. As a strategy to advance such interoperability we use an approach based on ontological realism and on the ontology development principles of the Open Biomedical Ontologies Foundry, including reuse of reference ontologies wherever possible. We describe the structure and coverage domain of OntONeo and the process of creating and maintaining the ontology.

160. Fernanda Farinelli, Mauricio B. Almeida, Peter Elkin and Barry Smith, "Dealing with elements of medical encounters: an approach based on ontological realism", *International Conference on Biological Ontology* (ICBO), CEUR 1747, 2016

Abstract: Electronic health records (EHRs) serve as repositories of documented data collected in a health care encounter. An EHR records information about who receives, who provides the health care and about the place where the encounter happens. We also observe additional elements relating to social relations in which the healthcare consumer is involved. To provide a consensus representation of common data and to enhance interoperability between different EHR repositories we have created a solution grounded in formal ontology. Here, we present how an ontology for the obstetric and neonatal domain deals with these general elements documented in health care encounters. Our goal is to promote the interoperability of information among EHRs created in different specialties. To develop our ontology, we used two main approaches: one based on ontological realism, the other based on the principles of the OBO Foundry, including reuse of reference ontologies.

161. Laurel Cooper, Austin Meier, Justin Elser, Justin Preece, Xu Xu, Ryan Kitchen, Botong Qu, Eugene Zhang, Sinisa Todorovic, Pankaj Jaiswal, Marie-Angélique Laporte, Elizabeth Arnaud, Seth Carbon, Chris Mungall, Barry Smith, Georgios Gkoutos and John Doonan, "The Planteome Project", *International Conference on Biological Ontology* (ICBO), CEUR 1747, 2016.

Abstract: The Planteome project is a centralized online plant informatics portal which provides semantic integration of widely diverse datasets and with the goal of plant improvement. Traditional plant breeding methods for crop improvement may be combined with next-generation analysis methods and automated scoring of traits and phenotypes to develop improved varieties. The Planteome project (www.planteome.org) develops and hosts a suite of reference ontologies for plants associated with a growing corpus of genomics data. Data annotations linking phenotypes and germplasm to genomics resources are achieved by data transformation and mapping species-specific controlled vocabularies to the reference ontologies. Analysis and annotation tools are being developed to facilitate studies of plant traits, phenotypes, diseases, gene function and expression and genetic diversity data across a wide range of plant species. The project database and the online resources provide researchers tools to search and browse and access remotely via APIs for semantic integration in annotation tools and data repositories providing resources for plant biology, breeding, genomics and genetics.

162. William Duncan, Travis Allen, Jonathan Bona, Olivia Helfer, Barry Smith, Alan Ruttenberg and Alexander D. Diehl, "The ImmPort Antibody Ontology", *International Conference on Biological Ontology* (ICBO), CEUR 1747, 2016.

Abstract: Monoclonal antibodies are essential biomedical research and clinical reagents that are produced by companies and research laboratories. The NIAID ImmPort (Immunology Database and Analysis Portal) resource provides a long-term, sustainable data warehouse for immunological data generated by NIAID, DAIT and DMID funded investigators for data archiving and re-use. A variety of immunological data is generated using techniques that rely upon monoclonal antibody reagents, including flow cytometry, immunofluorescence, and ELISA. In order to facilitate querying, integration, and reuse of data, standardized terminology for describing monoclonal antibody reagents and their targets needs to be used for annotating data submitted to ImmPort.

163. Barry Smith, Mark Jensen, "The UNEP Ontologies and the OBO Foundry", *International Conference on Biological Ontology* (ICBO), CEUR 1747, 2016.

Abstract: It is now generally accepted that wherever we need to address multiple different kinds of data deriving from multiple different kinds of sources, a strategy is required to ensure interoperability across the various systems involved. The United Nations Environmental Program (UNEP) is developing an ontology for use in their knowledge management platform – the Sustainable Development Goals Interface Ontology (SDGIO). The UNEP approach to achieving interoperability is modeled on the OBO (Open Biomedical Ontologies) Foundry, an initiative of ontology developers working in a range of life science domains who have been working since 2004 to develop a suite of ontologies which would work together consistently in such a way as to advance the integration of data. To serve such integration the OBO Foundry members formulated and tested an evolving set of principles for ontology development which are now being used by ontology developers also in other areas, including manufacturing, geology, transport and security.

164. José M Parente de Oliveira, Barry Smith, "A diagrammatic representation for entities and mereotopological relations in ontologies", *Ontobras*, Brasilia, August 28-30, 2017 (CEUR 1908).

Abstract: In the graphical representation of ontologies, it is customary to use graph theory as the representational background. We claim here that the standard graph-based approach has a number of limitations. We focus here on a problem in the graph-based representation of ontologies in complex domains such as biomedical, engineering and manufacturing: lack of mereotopological representation. Based on such limitation, we proposed a diagrammatic way to represent an entity's structure and various forms of mereotopological relationships between the entities.

165. Anna Maria Masci, Shannon McCall, Alessandro Racioppi, Helena Judge Ellis, Jihad S. Obeid, Barry Smith, Christian Stoeckert and Jie Zheng, "Standardization of the Histopathology Cancer Report: An Ontological Approach", *Proceedings of the 9th International Conference on Biological Ontology* (ICBO 2018), Corvallis, OR, 2018.

Abstract: In recent years, the complexity of cancer pathology reporting has increased significantly. The pathology report covers not only general information such as the presence or absence of cancer, but includes a collection of specific parameters such as tumor size, grade, margin, lymphatic or vascular involvement as well as molecular testing. Soon, biomarkers and immune profiling will play an increasingly important role in determining the eligibility for particular therapies, along with genetic predisposition and social risk factors. The increased use of digital pathology, which allows streamlined sharing of images, has highlighted the importance of clear communication of the information displayed in the pathology report. In the past years, significant effort has been devoted to redefining the way that histopathology report information is recorded. The College of American Pathologists (CAP) introduced synoptic cancer reports, a structured checklist to standardize clinical documentation. Despite continuous improvement and generation of electronic reports, formal representation is still lacking. This lack of standardization limits the ability to integrate pathology information with other genomic and proteomic data and often results in loss of information.

166. Werner Ceusters and Barry Smith, "On defining bruxism", *Medical Informatics Europe*, Gothenberg, Sweden (*Studies in Health Technology and Informatics*, 247), 2018, 551-555.

Abstract: In a series of recent publications, orofacial researchers have debated the question of how 'bruxism'should be defined for the purposes of accurate diagnosis and reliable clinical research. Following the principles of realism-based ontology, we performed an analysis of the arguments involved. This revealed that the disagreements rested primarily on inconsistent use of terms, so that issues of ontology were thus obfuscated by shortfalls in terminology. In this paper, we demonstrate how bruxism terminology can be improved by paying attention to the relationships between (1) particulars and types, and (2) continuants and occurrents.

167. Evan Wallace, Dimitris Kiritsis, Barry Smith, Chris Will, "The Industrial Ontologies Foundry Proof-of-Concept Project", *APMS 2018: Advances in Production Management Systems. Smart Manufacturing for Industry 4.0* (IFIP International Conference on Advances in Production Management Systems, vol. 536), New York: Springer, 2018, 402-409.

Abstract: The current industrial revolution is said to be driven by the digitization that exploits connected information across all aspects of manufacturing. Standards have been recognized as an important enabler. Ontology-based information standard may provide benefits not offered by current information standards. Although there have been ontologies developed in the industrial manufacturing domain, they have been fragmented and inconsistent, and little has received a standard status. With successes in developing coherent ontologies in the biological, biomedical, and financial domains, an effort called Industrial Ontologies Foundry (IOF) has been formed to pursue the same goal for the industrial manufacturing domain. However, developing a coherent ontology covering the entire industrial manufacturing domain has been known to be a mountainous challenge because of the multidisciplinary nature of manufacturing. To manage the scope and expectations, the IOF community kicked-off its effort with a proof-of-concept (POC) project. This paper describes the developments within the project. It also provides a brief update on the IOF organizational set up.

168. Barry Smith, "Ontology as Product-Service System: Lessons Learned from GO, BFO and DOLCE", *Proceedings of the International Conference on Biomedical Ontology* (ICBO), University at Buffalo, Buffalo NY, 2019 (CEUR 2931, published 2021).

Abstract: This paper defends a view of the Gene Ontology (GO) and of Basic Formal Ontology (BFO) as examples of what the manufacturing industry calls product-service systems. This means that they are products bundled with a range of ontology services such as updates, training, help desk, and permanent identifiers. The paper argues that GO and BFO are contrasted in this respect with DOLCE, which approximates more closely to a scientific theory or a scientific publication. The paper provides a detailed overview of ontology services and concludes with a discussion of some implications of the product-service system approach for the understanding of the nature of applied ontology. Ontology developer communities are compared in this respect with developers of scientific theories and of standards (such as W3C). For each of these we can

ask: what kinds of products do they develop and what kinds of services do they provide for the users of these products?

169. David Limbaugh, Barry Smith and Werner Ceusters, "Warranted Diagnosis", *Proceedings of the International Conference on Biomedical Ontology* (ICBO), University at Buffalo, NY, 2019 (CEUR 2931, published August 2021)

Abstract: A diagnostic process is an investigative process that takes a clinical picture as input and outputs a diagnosis. We propose a method for distinguishing diagnoses that are warranted from those that are not, based on the cognitive processes of which they are the outputs. Processes designed and vetted to reliably produce correct diagnoses will output what we shall call 'warranted diagnoses'. The latter are diagnoses that should be trusted even if they later turn out to have been wrong. Our work is based on the recently developed Cognitive Process Ontology and further develops the Ontology of General Medical Science. It also has applications in fields such as intelligence, forensics, and predictive maintenance, all of which rely on vetted processes designed to secure the reliability of their outputs.

170. Eric Merrell, David Limbaugh, Alex Anderson and Barry Smith, "Mental Capabilities", *Proceedings of the International Conference on Biomedical Ontology* (ICBO), University at Buffalo, NY, 2019, (CEUR 2931, published August 2021).

Abstract: We propose capability as a universal or type intermediate between function and disposition. A capability is, broadly speaking, a disposition that is of a type whose instances can be evaluated on the basis of how well they are realized. A function, on the view we are proposing, is a capability the possession of which is the rationale for the existence of its bearer. To say for example that a water pump has the function to pump water is to say that the pump exists because something was needed that would pump water. A water pump may have many capabilities, including: to be weatherproof, to run without lubricant, to be transportable, and so forth. But its function is to pump water. We focus here on capabilities possessed by humans – such as piano playing or language using – and we explore the relation between capabilities of these sorts and structures in the brain.

171. David Kasmier, David Limbaugh and Barry Smith, "Foundation for a Realist Ontology of Cognitive Processes", *Proceedings of the International Conference on Biomedical Ontology* (ICBO), University at Buffalo, NY, 2019 (CEUR 2931, published August 2021).

Abstract: What follows is a first step towards an ontology of conscious mental processes. We provide a theoretical foundation and characterization of conscious mental processes based on a realist theory of intentionality and using BFO as our top-level ontology. We distinguish three components of intentional mental process: character, directedness, and objective referent, and describe several features of the process character and directedness significant to defining and classifying mental processes. We arrive at the definition of representational mental process as a process that is the bringing into being, sustaining, modifying, or terminating of a mental representation. We conclude by outlining some benefits and applications of this approach.

172. Barry Smith, Farhad Ameri, Hyunmin Cheong, Dimitris Kiritsis, Dusan Sormaz, Chris Will, and J. Neil Otte, "A First-Order Logic Formalization of the Industrial Ontologies Foundry Signature Using Basic Formal Ontology", *Proceedings of the Joint Ontology Workshops (*JOWO*)* 2019, Medical University of Graz, Austria (CEUR 2518).

Abstract. Basic Formal Ontology (BFO) is a top-level ontology used in hundreds of active projects in scientific and other domains. BFO has been selected to serve as top-level ontology in the Industrial Ontologies Foundry (IOF), an initiative to create a suite of ontologies to support digital manufacturing on the part of representatives from a number of branches of the advanced manufacturing industries. We here present a first draft set of axioms and definitions of an IOF upper ontology descending from BFO. The axiomatization is designed to capture the meanings of terms commonly used in manufacturing and is designed to serve as starting point for the construction of the IOF ontology suite.

173. Jonathan Vajda, Eric Merrell and Barry Smith, "Towards an Ontology of Commercial Exchange", SOLEE, *Proceedings of the Joint Ontology Workshops (*JOWO*)* 2019, Medical University of Graz, Austria (CEUR 2518)

Abstract. In this paper we propose an Ontology of Commercial Exchange (OCE) based on Basic Formal Ontology. OCE is designed for re-use in the Industrial Ontologies Foundry (IOF) and in other ontologies addressing different aspects of human social behavior involving purchasing, selling, marketing, and so forth. We first evaluate some of the design patterns used in the Financial Industry Business Ontology (FIBO) and Product Types Ontology (PTO). We then propose terms and definitions that we believe will improve the representation of contractual obligations, sales processes, and their associated documents. A commercial exchange, for instance, involves mutual agreement to reciprocate actions, such as transferring money, performing a service, or transferring goods.

174. Jeremy R Chapman, David Kasmier, David Limbaugh, Stephen R Gagnon, John L Crassidis, James Llinas, Barry Smith, Alexander P Cox, "Conceptual Space Modeling for Space Event Characterization", *IEEE 23rd International Conference on Information Fusion (FUSION)*, July 6, 2020, 1-8.

Abstract. A method for space event characterization using the framework of conceptual spaces will be illustrated in this paper. The focus of this paper is on estimating the likelihood of a collisions between space objects. Specifically, an approach is developed for anticipatory decision support for space operators so that preventative actions can be taken based on the assessment of relative risk. The conceptual space approach will draw on fusion of both hard and soft data into a single decision framework. The fusion-based approach presented in this paper for decision support extends the conceptual space framework with a set of ontologies by drawing on the space domain ontologies, which is a large system of ontologies designed to support aspects of space situational awareness. This framework is coupled with a mathematical optimization approach, providing a quantitative basis for ranking the potential for collision across multiple satellite pairs. The goal is to provide the broadest possible information foundation for critical assessments of collision likelihood.

175. Asiyah Yu Lin, Stephan Gebel, Qingliang Leon Li, Sumit Madan, Johannes Darms, Evan Bolton, Barry Smith, Martin Hofmann-Apitius, Yongqun Oliver He, Alpha Tom Kodamullil, "CTO: A Community-Based Clinical Trial Ontology and Its Applications in PubChemRDF and SCAIViewH", *Proceedings of the 11th International Conference on Biomedical Ontologies (ICBO) and 10th Workshop on Ontologies and Data in Life Sciences (ODLS)*, Bolzano, September 17, 2020.

Abstract. Driven by the use cases of PubChemRDF and SCAIView, we have developed a first community-based clinical trial ontology (CTO) by following the OBO Foundry principles. CTO uses the Basic Formal Ontology (BFO) as the top level ontology and reuses many terms from existing ontologies. CTO has also defined many clinical trial-specific terms. The general CTO design pattern is based on the PICO framework together with two applications. First, the PubChemRDF use case demonstrates how a drug Gleevec is linked to multiple clinical trials investigating Gleevec's related chemical compounds. Second, the SCAIView text mining engine shows how the use of CTO terms in its search algorithm can identify publications referring to COVID-19-related clinical trials. Future opportunities and challenges are discussed.

176. Jeremy R Chapman, John L Crassidis, David Kasmier, David Limbaugh, Stephen Gagnon, James Llinas, Barry Smith, Alexander P Cox, "Conceptual Spaces for Space Event Characterization via Hard and Soft Data Fusion", *American Institute of Aeronautics and Astronautics (Sensor Systems and Information Fusion) Proceedings* (AIAA 2021)*,* 4 January 2021, https://doi.org/10.2514/6.2021-1163.

Abstract: The overall goal of the approach developed in this paper is to estimate the likelihood of a given kinetic kill scenario between hostile spacebased adversaries using the mathematical framework of Complex Conceptual Spaces - Single Observation. Conceptual spaces are a cognitive model that provide a method for systematically and automatically mimicking human decision making. For accurate decisions to be made, the fusion of both hard and soft data into a single decision framework is required. This presents several challenges to this data fusion

framework. The first is the challenge involved in handling multiple complex terminologies, which is addressed by drawing on a set of Space Domain Ontologies. Another challenge is the complex combinatorics involved when considering all possible feature combinations. This can be mitigated by using integer linear programming optimization that is outlined by the Complex oConceptual Spaces - Single Observation mathematical model framework. A third challenge is the complicated physics that is involved in a spacecraft collision that must be addressed to obtain a better understanding of threat assessment. Overcoming these various challenges allows for a quantitative ranking for the potential of a kinetic kill collision across multiple spacecraft pairs. In addition to overcoming these challenges this paper will break down threat assessment into four domains and identify a ranking of threat both for each individual domain and for the four domains combined. Simulation results are shown to verify the developed concepts.

177. Mohamed H. Karray, Neil Otte, Rahul Rai, Farhad Ameri, Boonserm Kulvatunyou, Barry Smith, Dimitris Kiritsis, Chris Will, Rebecca Arista, "The Industrial Ontologies Foundry (IOF) perspectives", *Industrial Ontology Foundry (IOF) – Achieving Data Interoperability Workshop*, International Conference on Interoperability for Enterprise Systems and Applications, Tarbes, France, March 3, 2021 (CEUR 2900).

Abstract: In recent years there has been a number of promising technical and institutional developments regarding use of ontologies in industry. At the same time, however, most industrial ontology development work remains within the realm of academic research and is without significant uptake in commercial applications. In biomedicine, by contrast, ontologies have made significant inroads as valuable tools for achieving interoperability between data systems whose contents derive from widely heterogeneous sources. In this position paper, we present a set of principles learned from the successful Open Biomedical Ontologies (OBO) Foundry initiative to guide the design and development of the Industrial Ontologies Foundry (IOF), which is a counterpart to the OBO Foundry initiative for the manufacturing industry. We also illustrate the potential utility of these principles by sketching the conceptual design of a framework for sustainable IOF development.

178. Eric C. Merrell, Olivier Massin, Barry Smith, "Common Core Conformant Definitions for an Ontology of Commercial Exchange", *Proceedings of the 2nd International Workshop on the Ontology of Social, Legal and Economic Entities (SoLEE)*, Bolzano, September 11-18, 2021 (CEUR 2969), 1-8.

Abstract: In "Toward an Ontology of Commercial Exchange" [11], we proposed human readable definitions for terms that are central to an ontology of commercial exchange. This paper furthers that project in two ways. First, the definitions have been modified to be compatible with the Common Core Ontologies (CCO). CCO is used in a wide variety of domains including the industrial and military domains. Having a commerce ontology compatible with CCO allows data about the exchange of goods relevant to those domains to be tagged with compatible ontologies. Second, we propose preliminary formalizations of these definitions, with the aim of informing the creation of an ontology which can be used to assist in reasoning over business-related data.

179. Eric C. Merrell, Robert M. Kelly, David Kasmier, Barry Smith, Marc Brittain, Ronald Ankner, Evan Maki, Curtis W. Heisey, and Kevin Bush, "Benefits of Realist Ontologies to Systems Engineering", *8th International Workshop on Ontologies and Conceptual Modelling (OntoCom)*, September 11-18, 2021 (CEUR 2969), 1-10.

Abstract: Applied ontologies have been used more and more frequently to enhance systems engineering. In this paper, we argue that adopting principles of ontological realism can increase the benefits that ontologies have already been shown to provide to the systems engineering process. Moreover, adopting Basic Formal Ontology (BFO), an ISO standard for top-level ontologies from which more domain specific ontologies are constructed, can lead to benefits in four distinct areas of systems engineering: (1) interoperability, (2) standardization, (3) testing, and (4) data exploitation. Reaping these benefits in a model-based systems engineering (MBSE) context requires utilizing an ontology's vocabulary when modeling systems and entities within those systems. If the chosen ontology abides by the principles of ontological realism, a semantic standard capable of uniting distinct domains, using BFO as a hub, can be leveraged to promote greater interoperability among systems. As interoperability and standardization increase, so does the ability to collect data during the testing and implementation of systems. These data

can then be reasoned over by computational reasoners using the logical axioms within the ontology. This, in turn, generates new data that would have been impossible or too inefficient to generate without the aid of computational reasoners.

180. Alexander P. Cox, Christopher K. Nebelecky, Ron Rudnicki, William A. Tagliaferri, John L. Crassidis, Barry Smith, "The Space Domain Ontologies," *National Symposium on Sensor & Data Fusion* (NSSDF), Military Sensing Symposia (MSS), October 2021. Cox AP, Crassidis JL, Smith B, Nebelecky CK, Tagliaferri WA, and Rudnicki R. (2021) "The Space Domain Ontologies". MSS-JOINT-21-001 *Proceedings of the 2021 MSS Virtual Joint (BAMS and NSSDF) Conference, Volume 1*. Available from AnaVation, LLC, 5003 Westfields Blvd, #231837, Centreville, VA 20120. Classified. Available on https://www.dtic.mil.

Abstract: Achieving space situational awareness requires, at a minimum, the identification, characterization, and tracking of space objects. Leveraging the resultant space object data for purposes such as hostile threat assessment, object identification, and conjunction assessment presents major challenges. This is in part because in characterizing space objects we reference a variety of identifiers, components, subsystems, capabilities, vulnerabilities, origins, missions, orbital elements, patterns of life, operational processes, operational statuses, and so forth, which tend to be defined in highly heterogeneous and sometimes inconsistent ways. The Space Domain Ontologies are designed to provide a consensus-based realist framework for formulating such characterizations in a way that is both consistent and computable. Space object data are aligned with classes and relations in a suite of ontologies built around the existing Space Object Ontology. They are stored in a dynamically updated Resource Description Framework triple store, which can be queried to support space situational awareness and the needs of spacecraft operators and analysts. This paper provides an overview of the Space Domain Ontologies and their development and use. It presents the motivation for and advantages of the Space Domain Ontologies, including the benefits they provide for enhancing and maintaining long-term space situational awareness.

181. Jeremy R. Chapman, David Kasmier, John L. Crassidis, James Llinas, Barry Smith, Alexander P. Cox, "An Introduction to Hard and Soft Data Fusion via Conceptual Spaces Modeling for Space Event Characterization", *National Symposium on Sensor & Data Fusion* (NSSDF), Military Sensing Symposia (MSS), October 2021.

Abstract: This paper describes an AFOSR-supported basic research program that focuses on developing a new framework for combining hard with soft data in order to improve space situational awareness. The goal is to provide, in an automatic and near real-time fashion, a ranking of possible threats to blue assets (assets trying to be protected) from red assets (assets with hostile intentions). The approach is based on Conceptual Spaces models, which combine features from traditional associative and symbolic cognitive models. While Conceptual Spaces are revolutionary, they lack an underlying mathematical framework. Several such frameworks have attempted to represent Conceptual Spaces, but by far the most robust is the model developed by Holender. His model utilizes integer linear programming in order to obtain an overall similarity value between observations and concepts that support the formation of hypotheses. This paper will describe a method for building Conceptual Spaces models for threats that utilizes ontologies as a means to provide a clear semantic foundation for this inferencing process; in particular threat ontologies and space domain ontologies are developed and employed in this approach. A space situational awareness use-case is presented involving a kinetic kill scenario and results are shown to assess the performance of this fusion-based inferencing framework.

182. David Kasmier, Eric Merrell, Robert Kelly, Barry Smith, Curtis Heisey, Donald Maki, Marc Brittain, Ronald Ankner and Kevin Bush, "Ontology of Plays for Autonomous Teaming and Collaboration", *Proceedings of the 14th Seminar on Ontology Research in Brazil* (ONTOBRAS, November 2021), CEUR 3050, 9-22.

Abstract: We propose a domain-level ontology of plays for the facilitation of play-based collaborative autonomy among unmanned and manned-unmanned aircraft teams in the Army's Unmanned Aircraft System (UAS) mission domain. We define a play as a type of plan that

prescribes some pattern of intentional acts that are intended to reliably result in some goal in some competitive context, and which specifies one or more roles that are realized by those prescribed intentional acts. The ontology is well suited to be extended to other types of military and nonmilitary unmanned vehicle operations.

183. Jeremy R. Chapman, John L. Crassidis, James Llinas, Barry Smith, David Kasmier, Alexander P. Cox, "Implementing Dampster-Shafer Theory for property similarity in Conceptual Spaces modeling", Sensor Systems and Information Systems IV, American Institute of Aeronautics and Astronautics (AIAA) SCITECH Forum 2022, January 3-7, 2022, San Diego.

Abstract: Previous work has shown that the Complex Conceptual Spaces – Single Observation Mathematical framework is a useful tool for event characterization. This mathematical framework is developed on the basis of Conceptual Spaces and uses integer linear programming to find the needed similarity values. The work of this paper is focused primarily on space event characterization. In particular, the focus is on the ranking of threats for malicious space events such as a kinetic kill. To make the Conceptual Spaces framework work, the similarity values between the contents of observations on the one hand and the properties of the entities observed on the other needs to be found. This paper shows how to exploit Dempster-Shafer theory to implement a statistical approach for finding these similarities values. This approach will allow a user to identify the uncertainty involved in similarity value data, which can later be propagated through the developed mathematical model in order for the user to know the overall uncertainty in the observation-to-concept mappings needed for space event characterization.

184. Mohamed H. Karray, Neil Otte, Rahul Rai, Farhad Ameri, Boonserm Kulvatunyou, Barry Smith, Dimitris Kiritsis, Albert Jones, "Industrial Ontologies Foundry (IOF) Core", *FOMI 2022: 12th International Workshop on Formal Ontologies meet Industry*, September 12-15, 2022, Tarbes, France, CEUR, Vol. 3240.

Abstract: The Industrial Ontologies Foundry (IOF) was formed to create a suite of interoperable ontologies. Ontologies that would serve as a foundation for data and information interoperability in all areas of manufacturing. To ensure that each ontology is developed in a structured and mutually coherent manner, the IOF has committed to the tiered architecture of ontology building based on the Basic Formal Ontology (BFO) as top level. One of the critical elements of a successful tiered architecture build is the domain mid-level ontologies. However, thus far there has been no mid-level manufacturing ontology that is based on BFO. The IOF has recently released the IOF Core version 1 beta to fill this gap. This paper documents the development process and gives an overview of the current content of the IOF Core. Finally, the paper describes how the IOF Core can be used as the basis for a more domain-specific Supply Chain Ontology.

185. Charles Clark, Mayur Gosai, Terry Janssen, Melissa LaDuke, Jobst Landgrebe, Lawrence Pace, Barry Smith, "Quantum sensing and quantum engineering: a strategy for acceleration via metascience", *SPIE Quantum West Proceedings Volume 12447: Quantum Sensing, Imaging, and Precision Metrology* (February 2023), https://doi.org/10.1117/12.2650568.

186. Peter Koch and Barry Smith, "Beyond the Goods-Services Continuum", *Proceedings of the International Conference on Biomedical Ontologies*, Brasilia, Brazil, December 2023, 173-178.

Abstract: Governments standardly deploy a distinction between goods and services in assessing economic health and tracking national income statistics, of which medical goods and services carry significant importance. In what follows we draw on Basic Formal Ontology (BFO) to introduce a third kind of entity called *patterns*, which help capture the various ways in which goods and services are intertwined and help also to show how many services generate a new kind of non-goods-related products. Patterns are an overlooked yet essential features of many economic sectors including medicine. Studying patterns offers new insights into various components of economic analysis, including outcomes-oriented evaluations of medical services and the value of human capital in the medical sphere.

187. Barry Smith, "AlphaFold, AI and Ontologies", in: Alexander D. Diehl, William D. Duncan, Yongqun "Oliver" He (eds.), *ICBO 2022: International Conference on Biomedical Ontology*, Ann Arbor, Michigan, September 25-28, 2022, CEUR, P1-3 (published October 1, 2024).

188. John Beverley, Shane Babcock, Gustavo Carvalho, Lindsay Cowell, Sebastian Duesing, Regina Hurley, Barry Smith, "Coordinating Coronavirus Research: The COVID-19 Infectious Disease Ontology", *ICBO 2022: International Conference on Biomedical Ontology*, Ann Arbor, Michigan, September 25-28, 2022, CEUR, P1-3 (published October 2024).

Abstract: Rapidly, accurately and easily interpreting generated data is of fundamental concern. Ontologies – structured controlled vocabularies – support interoperability and prevent the development of data silos which undermine interoperability. The Open Biological and Biomedical Ontologies (OBO) Foundry serves to ensure ontologies remain interoperable through adherence by its members to core ontology design principles. For example, the Infectious Disease Ontology (IDO) Core includes terminological content common to investigations of all infectious diseases. Ontologies covering more specific infectious diseases in turn extend from IDOCore, such as the Coronavirus Infectious Disease Ontology (CIDO). The growing list of virus-specific IDO extensions has motivated construction of a reference ontology covering content common to viral infectious disease investigations: the Virus Infectious Disease Ontology (VIDO) (https://bioportal.bioontology.org/ontologies/VIDO). Additionally the present pandemic has motivated construction of a more specific extension of CIDO covering terminological contents specific to the pandemic: the COVID-19 Infectious Disease Ontology (IDO-COVID-19) (https://bioportal.bioontology.org/ontologies/IDO-COVID-19). We report here the development of VIDO and IDO-COVID-19. More specifically we examine newly minted terms for each ontology, showcase reuse of terms from existing OBO ontologies, motivate choice points for ontological decisions based on research from relevant life sciences, apply ontology terms to explicate viral pathogenesis, and discuss the annotating power of virus ontologies for use in machine-learning projects.

189. John Beverley, Francesco Franda, Hedi Karray, Dan Maxwell, Carter-Beau Benson, and Barry Smith, "Ontologies, arguments, and Large Language Models", *Joint Ontologies Workshops* (JOWO), University of Twente, Netherlands, July 15-19, 2024, 1-9.

Abstract: The explosion of interest in large language models (LLMs) has been accompanied by concerns over the extent to which generated outputs can be trusted, owing to the prevalence of bias, hallucinations, and so forth. Accordingly, there is a growing interest in the use of ontologies and knowledge graphs to make LLMs more trustworthy. This rests on the long history of ontologies and knowledge graphs in constructing human-comprehensible justification for model outputs as well as traceability concerning the impact of evidence on other evidence. Understanding the nature of arguments and argumentation is critical to each, especially when LLM output conflicts with what is expected by users. The central contribution of this article is to extend the Arguments Ontology (ARGO) - an ontology specific to the domain of argumentation and evidence broadly construed - into the space of LLM fact-checking in the interest of promoting justification and traceability research through the use of ARGO-based 'blueprints'.

190. John Beverley, David Limbaugh, Eric Merrell, Peter Koch, and Barry Smith Capabilities: An ontology, *Joint Ontologies Workshops* (JOWO), University of Twente, Netherlands, July 15-19, 2024, 1-14. Revised version, arxiv, August 16, 2024.

Abstract: In our daily lives, as in science and in all other domains, we encounter huge numbers of dispositions (tendencies, potentials, powers) which are realized in processes such as sneezing, sweating, shedding, melting. Among this plethora of what we can think of as 'mere dispositions' is a subset of dispositions in whose realizations we have an interest – a car responding well when driven on ice, a rabbit's lungs responding well when it is chased by a wolf, and so on. We call the latter 'capabilities' and we attempt to provide an ontological account of what capabilities are that is of sufficient generality to serve a variety of purposes, for example by providing a

useful extension to ontology-based research in areas where capabilities data are being collected in siloed fashion.

191. John Beverley, Giacomo De Colle, Mark Jensen, Carter-Beau Benson, Barry Smith, Middle architecture criteria, *Joint Ontologies Workshops* (JOWO), University of Twente, Netherlands, July 15-19, 2024, 1-12.

Abstract: Mid-level ontologies are used to integrate data across disparate domains using vocabularies more specific than top-level ontologies and more general than domain-level ontologies. There are no clear, defensible criteria for determining whether a given ontology should count as mid-level, because we lack a rigorous characterization of what the middle level of generality is supposed to contain. Attempts to provide such a characterization have failed, we believe, because they have focused on the goal of specifying what is characteristic of those single ontologies that have been advanced as mid-level ontologies. Unfortunately, single ontologies of this sort are generally a mixture of top- and mid-level, and sometimes even of domainlevel terms. To gain clarity, we aim to specify conditions for membership in what we call the middle architecture, which consists solely of mid-level ontologies

192. Barry Smith, LLMs and practical knowledge: What is intelligence?, in Kristof Nyíri (ed.), *Envisioning an Electrifying Future, 11th Budapest Visual Learning Conference*, Budapest: Hungarian Academy of Science, 2024, 19-26.

193. Barry Smith, Shame, embarrassment and social intelligence, Conference on the Occasion of the 200th Anniversary of the Hungarian Academy of Sciences, October 19,2025, 10-12.

STANDARDS

1. International Standard ISO/IEC 21838-1:2021(E), First edition, August 2021: Information technology — Top-level ontologies (TLO) — Part 1:Requirements

2. International Standard ISO/IEC 21838-2:2021(E), First edition, August 2021: Information technology — Top-level ontologies (TLO) — Part 2: Basic Formal Ontology (BFO)

3. International Standard ISO/IEC 21838-2:2021(E), Electronic Insert, November 2021.

PREPRINTS

1. Jobst Landgrebe and Barry Smith, "There is no General Artificial Intelligence", https://arxiv.org/pdf/1906.05833.pdf, November 28, 2019.

Abstract: The goal of creating Artificial General Intelligence (AGI) – or in other words of creating Turing machines (modern computers) that can behave in a way that mimics human intelligence – has occupied AI researchers ever since the idea of AI was first proposed. One common theme in these discussions is the thesis that the ability of a machine to conduct convincing dialogues with human beings can serve as at least a sufficient criterion of AGI. We argue that this very ability should be accepted also as a necessary condition of AGI, and we provide a description of the nature of human dialogue in particular and of human language in general against this background. We then argue that it is for mathematical reasons impossible to program a machine in such a way that it could master human dialogue behaviour in its full generality. This is (1) because there are no traditional explicitly designed mathematical models that could be used as a starting point for creating such programs; and (2) because even the sorts of automated models conzgenerated by using machine learning, which have been used successfully in areas such as machine translation, cannot be extended to cope with human dialogue. If this is so, then we can conclude that a Turing machine also cannot possess AGI, because it fails to fulfil a necessary condition thereof. At the same time, however, we acknowledge the potential of Turing machines

to master dialogue behaviour in highly restricted contexts, where what is called "narrow" AI can still be of considerable utility.

2. Rebecca C Jackson, Nicolas Matentzoglu, James A Overton, Randi Vita, James P Balhoff, Pier Luigi Buttigieg, Seth Carbon, Melanie Courtot, Alexander D Diehl, Damion Dooley, William Duncan, Nomi L Harris, Melissa A Haendel, Suzanna E Lewis, Darren A Natale, David Osumi-Sutherland, Alan Ruttenberg, Lynn M Schriml, Barry Smith, Christian J Stoeckert, Nicole A Vasilevsky, Ramona L Walls, Jie Zheng, Christopher J Mungall, Bjoern Peters, "OBO Foundry in 2021: Operationalizing Open Data Principles to Evaluate Ontologies", bioRxiv, Cold Spring Harbor Laboratory, January 1, 2021. Now published as https://doi.org/10.1093/database/baab069 (above).

Biological ontologies are used to organize, curate, and interpret the vast quantities of data arising from biological experiments. While this works well when using a single ontology, integrating multiple ontologies can be problematic, as they are developed independently, which can lead to incompatibilities. The Open Biological and Biomedical Ontologies (OBO) Foundry was created to address this by facilitating the development, harmonization, application, and sharing of ontologies, guided by a set of overarching principles. One challenge in reaching these goals was that the OBO principles were not originally encoded in a precise fashion, and interpretation was subjective. Here we show how we have addressed this by formally encoding the OBO principles as operational rules and implementing a suite of automated validation checks and a dashboard for objectively evaluating each ontology's compliance with each principle. This entailed a substantial effort to curate metadata across all ontologies and to coordinate with individual stakeholders. We have applied these checks across the full OBO suite of ontologies, revealing areas where individual ontologies require changes to conform to our principles. Our work demonstrates how a sizable federated community can be organized and evaluated on objective criteria that help improve overall quality and interoperability, which is vital for the sustenance of the OBO project and towards the overall goals of making data FAIR.

3. Jobst Landgrebe and Barry Smith, "An argument for the impossibility of machine intelligence", *arXiv*:2111.07765, October 20, 2021, 1-13.

Abstract: Since the noun phrase `artificial intelligence' (AI) was coined, it has been debated whether humans are able to create intelligence using technology. We shed new light on this question from the point of view of themodynamics and mathematics. First, we define what it is to be an agent (device) that could be the bearer of AI. Then we show that the mainstream definitions of `intelligence' proposed by Hutter and others and still accepted by the AI community are too weak even to capture what is involved when we ascribe intelligence to an insect. We then summarise the highly useful definition of basic (arthropod) intelligence proposed by Rodney Brooks, and we identify the properties that an AI agent would need to possess in order to be the bearer of intelligence by this definition. Finally, we show that, from the perspective of the disciplines needed to create such an agent, namely mathematics and physics, these properties are realisable by neither implicit nor explicit mathematical design nor by setting up an environment in which an AI could evolve spontaneously.

4. Jobst Landgrebe and Barry Smith, "Why machines do not understand: A response to Søgaard, *arXiv*: 2307.04766, July 7, 2023, 1-5.

Abstract: Some defenders of so-called 'artificial intelligence' believe that machines can understand language. In particular, Søgaard has argued in (Søgaard, 2022) for a thesis of this sort, on the basis of the idea (1) that where there is semantics there is also understanding and (2) that machines are not only capable of what he calls 'inferential semantics', but even that they can (with the help of inputs from sensors) 'learn' referential semantics. We show that he goes wrong because he pays insufficient attention to the difference between language as used by humans and the sequences of inert of symbols which arise when language is stored on hard drives or in books in libraries.

5. Jobst Landgrebe and Barry Smith, "Ontologies of common sense, physics and mathematics", 23 March, 2023, https://arxiv.org/abs/2305.01560

Abstract: The view of nature we adopt in the natural attitude is determined by common sense, without which we could not survive. Classical physics is modelled on this common-sense view of nature, and uses mathematics to formalise our natural understanding of the causes and effects we observe in time and space when we select subsystems of nature for modelling. But in modern physics, we do not go beyond the realm of common sense by augmenting our knowledge of what is going on in nature. Rather, we have measurements that we do not understand, so we know nothing about the ontology of what we measure. We help ourselves by using entities from mathematics, which we fully understand ontologically. But we have no ontology of the reality of modern physics; we have only what we can assert mathematically. In this paper, we describe the ontology of classical and modern physics against this background and show how it relates to the ontology of common sense and of mathematics.

6. John Beverley, David Limbaugh, Eric Merrell, Peter M. Koch, Barry Smith, Capabilities: An Ontology, arXiv preprint arXiv:2405.00183

Abstract: In our daily lives, as in science and in all other domains, we encounter huge numbers of dispositions (tendencies, potentials, powers) which are realized in processes such as sneezing, sweating, shedding dandruff, and on and on. Among this plethora of what we can think of as mere dispositions is a subset of dispositions in whose realizations we have an interest a car responding well when driven on ice, a rabbits lungs responding well when it is chased by a wolf, and so on. We call the latter capabilities and we attempt to provide a robust ontological account of what capabilities are that is of sufficient generality to serve a variety of purposes, for example by providing a useful extension to ontology-based research in areas where capabilities data are currently being collected in siloed fashion.

7. John Beverley, Giacomo De Colle, Mark Jensen, Carter Benson, Barry Smith, Middle architecture criteria, arXiv preprint arXiv:2404.17757

Abstract: Mid-level ontologies are used to integrate terminologies and data across disparate domains. There are, however, no clear, defensible criteria for determining whether a given ontology should count as mid-level, because we lack a rigorous characterization of what the middle level of generality is supposed to contain. Attempts to provide such a characterization have failed, we believe, because they have focused on the goal of specifying what is characteristic of those single ontologies that have been advanced as mid-level ontologies. Unfortunately, single ontologies of this sort are generally a mixture of top- and mid-level, and sometimes even of domain-level terms. To gain clarity, we aim to specify the necessary and sufficient conditions for a collection of one or more ontologies to inhabit what we call a mid-level architecture.

INVITED TALKS, INTERVIEWS AND PODCASTS

1. Interview with Barry Smith, *COSIT Features*, 2003 (on-line interview series on spatial information theory).

2. Barry Smith, "Die Ontologie als Grundlagenwissenschaft der Informatik", interview in *Information Philosophie*, 3 (2003), 120–123.

3. Barry Smith, "Ontocommons in the standardization environment", interview by Rita Giuffrida, *Ontocommons. Ontology-driven data integration for industry commons*, April 2022.

Abstract: Ontologies and standards are strongly interrelated and can often be seen as two sides of the same coin. Indeed, standards reflect consensus on the semantics of terms, though different standards might employ different ways to explain the same or very similar concepts semantically. Given the crucial role played by both aspects in OntoCommons, we have interviewed Barry Smith, SUNY Distinguished Professor of Philosophy at the University at Buffalo and one of the External Advisory Board (EAB) members of the OntoCommons project, to better understand what are the challenges and priorities to focus on in this context.

4. *An interview with the Editor of The Monist*, May 31, 2015, OUPblog.

5. "Faculty Interview: Barry Smith", NousLetter, 21, Summer 2015, 13-17.

6. "Conversation on Systems Engineering" with Dr Oliver Gao, Director, Systems Engineering, Cornell University, September 2, 2022.

7. Careers in Ontology: An Interview with Professor Barry Smith by Charlie Taben, American Philosophical Association Blog, September 15, 2022

8. APA Book Spotlight on *Why Machines Will Never Rule the World,* Interview with Charlie Taben, American Philosophical Association Blog, September 23, 2022

9. Why AI Will Never Rule the World, Interview with Luke Dormehl, *Digital Trends*, September 25, 2022.

10. Machines Will Never Rule Us!, podcast with David Ramsey Steele, *LocoFoco*, September 27, 2022

> Machines don't learn — "Machine learning" is a misnomer! Artificial General Intelligence is impossible — in the same way socialism is impossible! No physicist or mathematician or even AI specialist really believes that AI will become conscious and rule the world! So don't worry. But these aren't just assertions. Join host Timothy Virkkala and author David Ramsay Steele as they talk to Jobst Landegrebe and Barry Smith — experts who know something about the subject. A fascinating discussion, and a good occasion to revive the LocoFoco Netcast from its year of silence.

11. Interview with Walid Saba on *Why Machines Will Never Rule the World*, Machine Learning Street Talk, December 15, 2022 (review starts half way through)

12. Will Machines Rule the World? Interview with J. Scott Turner, National Association of Scholars *Restoring the Sciences Webinar Serie*s, October 4, 2022 Youtube

13. Luke Dormehl, Jobst Landgrebe and Barry Smith, "Why AI will never rule the world" (transcript), *Digital Trends* (September 2022)

14. Why Machines Will Never Rule the World – On AI and Faith*,* Conversation between Jobst Landgrebe, Barry Smith and Rev. Jamie Franklin, *Irreverend*, November 30, 2022

15. Interview with Jobst Landgrebe, ChatGPT, Kontrafunk Matussek, January 13, 2023

16. Why the Singularity Might Never Come. Interview with Richard Hanania, Center for the Study of Partisanship and Ideology, January 30, 2023. Twitter link

17. Jobst Landgrebe and Barry Smith, Interview with Alex Thomson, "Where there's no will there's no way," *UKCommons*, April 2023

18. Conversation with Jobst Landgrebe and Barry Smith, Why AI Won't Rule the World, The Pangburn Hangout, May 5, 2023

19. AI and ChatGPT: Should we be worried? Steven Peterson, Jobst Landgrebe and Barry Smith, National Association of Scholars, May 19, 2023

20. Jobst Landgrebe and Barry Smith, Interview with Kyle Polich, Why Machines Will Never Rule the World, Data Sceptic, May 29, 2023 (Youtube, Apple, Spotify)

21. Gerd Buurmann. K.O. durch K.I.? Interview with Jobst Landgrebe, May 2024

23. Jobst Landgrebe, Skynet Will Not Become Self-Aware, AGI Is Impossible!, *Geopolitics & Empire*, April 17, 2024

24. Pierangelo Soldavini, "L'intelligenza artificiale non dominerà il mondo", interview with Barry Smith, *Il sole de 24 ore*, April 27, 2024. English translation

22. Jobst Landgrebe and Barry Smith, Why Machines Will Never Rule the World, interview by Paolo Sironi, Bankers Bookshelf, August 12, 2024

25. Jobst Landgrebe, Why AI Will Never Become Conscious, Parallel Mike Podcast,

August 28, 2024

26. [Exploring Career Opportunities in Tech for Non-STEM Students](#), Techguide podcast, October 30, 2024

27. [Will Machines Rule the World?,](#) Brain in a Vat podcast, November 3, 2024

REPORTS

1. Barry Smith, "[Palaeontological Reflections on the Tractatus](#)", extended version of a paper presented at the Wittgenstein Colloquium of the Seminar for Austro-German Philosophy, held in Oxford in January 1978.

2. Barry Smith, *Foundations of Formal Geography*, Department of Geoinformation, Technical University of Vienna, 1995, 143pp.

3. Thomas Carroll and Barry Smith, *[SUNY's Core Curricula: The Failure to Set Consistent and High Academic Standards](#)*, New York: Empire :Foundation for Policy Research, 1996, xiv + 34pp.

4. Donna Peuquet, Barry Smith and Berit O. Brogaard, *[The Ontology of Fields](#): Report of the Specialist Meeting held under the auspices of the Varenius Project*, Bar Harbor, Maine, June 1998, Santa Barbara: NCGIA, vi + 42pp.

Abstract: In the specific case of geography, the real world consists on the one hand of physical geographic features (bona fide objects) and on the other hand of various fiat objects, for example legal and administrative objects, including parcels of real estate, areas of given soil types, census tracts, and so on. It contains in addition the beliefs and actions of human beings directed towards these objects (for example, the actions of those who work in land registries or in census bureaux), and the relations between these beliefs and actions and their targets.

5. [Applied Ontology. An International Conference on Law and Institutions in Society](#) (Proceedings), University at Buffalo, 1998

6. David Mark, Max Egenhofer, Stephen Hirtle and Barry Smith, *[UCGIS Emerging Research Theme: Ontological Foundations for Geographic Information Science](#)* (University Consortium for Geographic Information Science White Paper), 2000.

7. Barbara Heller, Heinrich Herre, Barry Smith, "[A Unified Framework for Building Ontological Theories with Application and Testing in the Field of Clinical Trials](#)", Institute for Formal Ontology and Medical Information Science (IFOMIS) Report No. 2, University of Leizpig, 2001.

Abstract: The objective of this research programme is to contribute to the establishment of the emerging science of Formal Ontology in Information Systems via a collaborative project involving researchers from a range of disciplines including philosophy, logic, computer science, linguistics, and the medical sciences. The researchers will work together on the construction of a unified formal ontology, which means: a general framework for the construction of ontological theories in specific domains. The framework will be constructed using the axiomatic-deductive method of modern formal ontology. It will be tested via a series of applications relating to on-going work in Leipzig on medical taxonomies and data dictionaries in the context of clinical trials. This will lead to the production of a domain-specific ontology which is designed to serve as a basis for applications in the medical field.

8. Thomas Bittner and Barry Smith, [Formal Ontologies for Space and Time](#), IFOMIS Reports, 2003.

Abstract: We propose an ontological theory that is powerful enough to describe both complex spatio-temporal processes (occurrents) and the enduring entities (continuants) that participate in such processes. For this purpose we distinguish between meta-ontology and token ontologies. Token ontologies fall into two major categories: ontologies of type SPAN and ontologies of type SNAP. These represent two complementary perspectives on reality and result in distinct though

compatible systems of categories. The meta-ontological level then describes the relationships between the different token ontologies. In a SNAP (snapshot) ontology we have enduring entities such as substances, qualities, roles, functions as these exist to be inventoried at a given moment of time. In a SPAN ontology we have perduring entities such as processes and their parts and aggregates. We argue that both kinds of ontological theory are required, together with the metaontology which joins them together, in order to give a non-reductionistic account of both static and dynamic aspects of the geospatial world.

9. Thomas Bittner and Barry Smith, "Directly Depicting Granular Ontologies", IFOMIS Reports, 2004. Published in revised and expanded form as Thomas Bittner, Maureen Donnelly and Barry Smith, "Endurants and Perdurants in Directly Depicting Ontologies", *AI Communications*, 13: 4 (2004), 247–258.

Abstract: We propose an ontological theory that is powerful enough to describe both complex spatio-temporal processes and the enduring entities that participate in such processes. For this purpose we distinguish between ontologies and metaontology. Ontologies are based on very simple directly depicting languages and fall into two major categories: ontologies of type SPAN and ontologies of type SNAP. These represent two complementary perspectives on reality and result in distinct though compatible systems of categories. In a SNAP (snapshot) ontology we have the enduring entities in a given domain as they exist to be inventoried at some given moment of time. In a SPAN ontology we have perduring entities such as processes and their parts and aggregates. We argue that both kinds of ontology are required, together with the meta-ontology which joins them together. On the level of meta-ontology we are able to impose constraints on ontologies of a sort which can support efficient processing of large amounts of data.

10. Werner Ceusters, Barry Smith, George De Moor, Ontology-Based Integration of Medical Coding Systems and Electronic Patient Records, IFOMIS Reports, 2004.

Abstract: In the last two decades we have witnessed considerable efforts directed towards making electronic healthcare records comparable and interoperable through advances in record architectures and (bio)medical terminologies and coding systems. Deep semantic issues in general, and ontology in particular, have received some interest from the research communities. However, with the exception of work on so-called 'controlled vocabularies', ontology has thus far played little role in work on standardization. The prime focus has been rather the rapid population of terminologies at the level of fine detail. In this paper, we argue that more efforts are needed on the side of both research and standardization to ensure that the coding systems used in electronic healthcare records enjoy a semantics that is coherent with the semantics of the record. We propose realist ontology as a method to bring about this coherence by means of a robust system of top-level ontological categories.

11. Anand Kumar, Matteo Piazza, Barry Smith, Silvana Quaglini, Mario Stefanelli, Formalizing UMLS Relations Using Semantic Partitions in the Context of a Task-Based Clinical Guidelines Model, IFOMIS Reports, 2004.

Abstract: An important part of the Unified Medical Language System (UMLS) is its Semantic Network, consisting of 134 Semantic Types connected to each other by edges formed by one or more of 54 distinct Relation Types. This Network is however for many purposes over-complex, and various groups have thus made attempts at simplification. Here we take this work further by simplifying the relations which involve the three Semantic Types – Diagnostic Procedure, Laboratory Procedure and Therapeutic or Preventive Procedure. We define operators which can be used to generate terms instantiating types from this selected set when applied to terms designating certain other Semantic Types, including almost all the terms specifying clinical tasks. Usage of such operators thus provides a useful and economical way of specifying clinical tasks. The operators allow us to define a mapping between those types within the UMLS which do not represent clinical tasks and those which do. This mapping then provides a basis for an ontology of clinical tasks that can be used in the formulation of computer-interpretable clinical guideline models.

12. Lowell Vizenor, Barry Smith and Werner Ceusters, Foundation for the Electronic Health Record: An ontological analysis of the HL7 Reference Information Model, IFOMIS Reports, 2004.

Abstract: Despite the recent advances in information and communication technology that have increased our ability to store and circulate information, the task remains of ensuring that the right sorts of information reach the right sorts of people. In what follows we defend the thesis that efforts to develop efficient means for sharing information across healthcare systems and organizations would benefit from a careful analysis of human action in healthcare organizations, and that the communication of healthcare information and knowledge needs to rest on a sound ontology of social interaction. We illustrate this thesis in relation to the HL7 RIM, which is one centrally important tool for communication in the healthcare domain.

13. Barry Smith, Anand Kumar, Thomas Bittner, Basic Formal Ontology for bioinformatics, IFOMIS Reports, 2005.

Abstract: Two senses of 'ontology' can be distinguished in the current literature. First is the sense favored by information scientists, who view ontologies as software implementations designed to capture in some formal way the consensus conceptualization shared by those working on information systems or databases in a given domain. [Gruber 1993] Second is the sense favored by philosophers, who regard ontologies as theories of different types of entities (objects, processes, relations, functions) [Smith 2003]. Where information systems ontologists seek to maximize reasoning efficiency even at the price of simplifications on the side of representation, philosophical ontologists argue that representational adequacy can bring benefits for the stability and resistance to error of an ontological framework and also for its extendibility in the future. In bioinformatics, however, a third sense of 'ontology' has established itself, above all as a result of the successes of the Gene Ontology (hereafter: GO), which is a tool for the representation and processing of information about gene products and their biological functions [Gene Ontology Consortium 2000]. We show how Basic Formal Ontology (BFO) has established itself as an overarching ontology drawing on all three of the strands distinguished above, and describe applications of BFO especially in the treatment of biological granularity.

14. Anand Kumar, Anita Burgun, Werner Ceusters, James J. Cimino, James Davis, Peter Elkin, Ira Kalet, Alan Rector, Jim Rice, Jeremy Rogers, Stephan Schulz, Kent Spackman, Davide Zaccagini, Pierre Zweigenbaum and Barry Smith, "Six questions on the construction of ontologies in biomedicine", assembled for the Workshop of the AMIA Working Group on Formal Biomedical Knowledge Representation in connection with AMIA Symposium, Washington DC, 2005.

Abstract: Best practices in ontology building for biomedicine have been frequently discussed in recent years. However there is a range of seemingly disparate views represented by experts in the field. These views not only reflect the different uses to which ontologies are put, but also the experiences and disciplinary background of these experts themselves. We asked six questions related to biomedical ontologies to what we believe is a representative sample of ontologists in the biomedical field and came to a number conclusions which we believe can help provide an insight into the practical problems which ontology builders face today.

15. Nicola Guarino and Barry Smith, Engineering Ontologies: Foundations and Theories from Philosophy and Logical Theory, Semantic Interoperability and Data Mining in Biomedicine (SemanticMining, European Union Network of Excellence 507505, Deliverable D.21.2), 2006.

16. Barry Smith, Mark Musen and Michael Schröder (eds.) Towards Interoperability of Biomedical Ontologies: Proceedings of the Dagstuhl Seminar Nr. 07132, Schloss Dagstuhl, Wadern, Germany, Mar 27-30, 2007.

17. L. Obrst, M. Musen, B. Smith, F. Neuhaus, F. Olken, M. Gruninger, M. Raymond, P. Hayes, R. Sharma (eds.), Towards an Open Ontology Repository. Communiqué. Ontology Summit 2008.

18. William Mandrick, James Schoening and Barry Smith, Command and Control (C2) Core Extended to Net-Enabled Command Capability, Briefing to Department of Defense (DoD) Net-Enabled Command Capability, September 14, 2009.

19. Bernard de Bono, Mathias Brochhausen, Sybo Dijkstra, Dipak Kalra, Stephan Keifer, Barry Smith, Biomedical Terminologies and Ontologies: Enabling Biomedical Semantic Interoperability and Standards in Europe, White Paper, ELSA (European Large Scale Action on Electronic Health) Consultation Meeting, September 29, 2009.

20. William Mandrick, James Schoening and Barry Smith, NATO Briefing on Command and Control (C2) Core Ontology, October 11, 2009.

21. Ron Rudnicki, James Schoening and Barry Smith, Aligning Legacy Data Models using UCore-SL, Department of Defense Briefing, November 2009.

22. James Schoening, Barry Smith and William Mandrick, UCore and UCore Semantic Layer. Briefing to US Army Training and Doctrine Command (TRADOC) HQ, November 9, 2009.

23. Barry Smith, James Schoening and Dan Brennan, UCore 2.0 Change Request, US Department of the Army, November 2009.

24. Werner Ceusters and Barry Smith, Semantic Interoperability in Healthcare: State of the Art in the US. A Position Paper with Background Materials, prepared for the European Union ARGOS Project: Transatlantic Observatory for Meeting Global Health Policy Challenges through ICT-Enabled Solutions, March 3, 2010.

Abstract: Semantic interoperability can be defined as the ability of two or more computer systems to exchange information in such a way that the meaning of that information can be automatically interpreted by the receiving system accurately enough to produce useful results to the end users of both systems. Several activities are currently being performed by a variety of stakeholders to achieve semantic interoperability in healthcare. Many of these activities are not beneficial, because they place too great a focus on business aspects and not enough on involvement of the right sorts of researchers, in particular those that are able to see how the data and information relate to the entities of concern on the side of the patient. The lack of a central focus on the patient, and the associated focus on 'concepts', have spawned a variety of mutually incompatible terminologies exhibiting non-resolvable overlap. The predominance of the healthcare IT industry in the writing and selection of semantic interoperability standards mitigates against the benefits that standards, when well designed, can bring about.

25. Fabian Neuhaus and Barry Smith, Ontology Summit 2010 Communiqué: Creating the Ontologists of the Future, Gaithersburg, MD: National Institute for Standards and Technology, March 2010.

Abstract: Increasingly, major national and international projects and systems centered on ontology technology are being developed and deployed by governments and by scientific and commercial organizations. This brings a growing need for ontology expertise and thus for new methods and organizations for the education and training of ontologists. The goal of the Ontology Summit 2010 was to develop a strategy for the education of ontologists. To achieve this goal we studied how ontologists are currently trained, the requirements by organizations that hire ontologists, and developments that might impact the training of ontologists in the future.

The main findings and results of the Ontology Summit 2010 are: (1) That there is already a large demand for trained ontologists, and the demand is expected to increase as ontology-based technologies become more successful and as the quantities and number of different types of data continues to expand. (2) That there are very few formal training opportunities for ontologists, and they often do not meet the needs of trainees or of those who would hire them. (3) That organizations wanting to hire ontologists often have difficulties in identifying qualified candidates since there are so few formal qualifications in ontology, and there is no professional organization that certifies ontologists.

We developed recommendations for the body of knowledge that should be taught and the skills that should be developed by future ontologists; these recommendations are intended as guidelines for institutions and organizations that may consider establishing a program for

training ontologists. Further, we recommend a number of specific actions for the community to pursue as a follow-up to the Ontology Summit 2010 that will improve the education of ontologists

26. Mark Phillips, Barry Smith, Lowell Vizenor, Scott Streit, Independent Review of Emerging Semantic Web Technologies Supporting the Defense Training Environment, United States Joint Forces Command, Joint Warfighting Center, September 2010, 27 pp.

27. Mark Phillips, Barry Smith, Lowell Vizenor, Scott Streit, White Paper: Realizing the Next Generation Defense Training Environment (DTE) through Semantic Web Technologies and Best Practices, United States Joint Forces Command, Joint Warfighting Center, November 2010, 60pp.

28. Barry Smith, Suzanne Lewis, Judith Blake, Chris Mungall, *Disease Ontology: Report of the Scientific Advisory Board*, February 2011.

29. Barry Smith, Tatiana Malyuta, and William Mandrick, Methodology for Semantic Enhancement of Intelligence Data, Intelligence and Information Warfare Directorate (I2WD), March 2013.

30. Barry Smith, Mauricio Almeida, Jonathan Bona, Mathias Brochhausen, Werner Ceusters, Melanie Courtot, Randall Dipert, Albert Goldfain, Pierre Grenon, Janna Hastings, William Hogan, Leonard Jacuzzo, Ingvar Johansson, Chris Mungall, Darren Natale, Fabian Neuhaus, James Overton, Anthony Petosa, Robert Rovetto, Alan Ruttenberg, Mark Ressler, Ron Rudniki, Selja Seppälä, Stefan Schulz, Jie Zheng, BFO 2.0 Specification and User's Guide, June 26, 2015

31. Ron Rudnicki, Barry Smith, Tanya Malyuta, William Mandrick, Best Practices of Ontology Development, CUBRC, October 2016

32. J. Neil Otte, Ron Rudnicki, and Barry Smith, Coordinated Holistic Alignment of Manufacturing Processes (CHAMP) Final Report, January 2018.

33. Neil Otte, Rahul Rai, Clare Paul & Barry Smith, Wind Turbine Analysis, Final Project Report, Digital Manufacturing and Design Innovation Institute (DMDII), May 2018.

> **Abstract:** The report describes an application of ontologies to the analysis of wind turbine manufacturing data. We show how applying ontologies to composite materials data may facilitate the discovery of optimum composite material designs that will deliver maximum wind turbine blade performance within environmental constraints.

34. Barry Smith, Ontologies for Space and Ground Systems, Ground System Architectures Workshop, Los Angeles, CA, March 2020.

35. Robert Kelly, David Limbaugh, and Barry Smith, Peer Review Report: "Ontologies relevant to behaviour change interventions: A method for their development", *Wellcome Open Research* 2020, 5:126, 39004.

> Version 1 DOI: 10.12688/wellcomeopenres.15908.3.

> Version 2 DOI: 10.21956/wellcomeopenres.18177.r41884.

> **Abstract:** In "Ontologies Relevant to behaviour change interventions: A Method for their Development" Wright, et al. outline a step by step process for building ontologies of behaviour modification – what the authors call the Refined Ontology Developmental Method (RODM) – and demonstrate its use in the development of the Behaviour Change Intervention Ontology (BCIO). RODM is based on the principles of good ontology building used by the Open Biomedical Ontology (OBO) Foundry in addition to those outlined in (Arp, Smith, and Spear 2015). BCIO uses as its top-level ontology Basic Formal Ontology (BFO). The methods outlined in Wright, et al. are a

valuable contribution to the field, especially the use of formal mechanisms for literature annotation and expert stakeholder review, and the BCIO will certainly play an important role in the extension of OBO Foundry ontologies into the behavioural domain.

POSTERS AND ABSTRACTS

1. Albert Goldfain, Barry Smith and Lindsay Cowell, "BFO Dispositions and their Bases: Two Shortcut Relations", *Seventh International Conference on Formal Ontology in Information Systems* (FOIS 2012).

2. Barry Smith, Anand Kumar and Steffen Schulze-Kremer, "Revising the UMLS Semantic Network," in M. Fieschi, *et al*. (eds.), *Medinfo* 2004, Amsterdam: IOS Press, 1700. Expanded version.

Abstract: The integration of standardized biomedical terminologies into a single, unified knowledge representation system has formed a key area of applied informatics research in recent years. The Unified Medical Language System (UMLS) is the most advanced and most prominent effort in this direction, bringing together within its Metathesaurus a large number of distinct source-terminologies. The UMLS Semantic Network, which is designed to support the integration of these source-terminologies, has proved to be a highly successful combination of formal coherence and broad scope. We argue here, however, that its organization manifests certain structural problems, and we describe revisions which we believe are needed if the network is to be maximally successful in realizing its goals of supporting terminology integration.

3. Lee Sam, Tara Borlawsky, Ying Tao, Jianrong Li, Barry Smith and Yves Lussier, "Information-Theoretic Classification of SNOMED Improves the Organization of Context-Sensitive Excerpts from Cochrane Reviews" (Poster), *Proceedings of the Annual Symposium of the American Medical Informatics Association*, Chicago, 2007, 645. PMC2655812

Abstract: The emphasis on evidence based medicine (EBM) has placed increased focus on finding timely answers to clinical questions in presence of patients. Using a combination of natural language processing for the generation of clinical excerpts and information theoretic distance based clustering, we evaluated multiple approaches for the efficient presentation of context-sensitive EBM excerpts.

4. Yongqun He, Zuoshuang Xiang, Boyang Zhao, David States, Brian Athey, Gil Omenn, Steve Qin, Harry Mobley, Howard Rush, Lindsay Cowell, Barry Smith, "Vaccine Ontology Development and its Application on Vaccine Data Standardization and Exchange", ISMB, Toronto, July 19-23, 2008.

5. Yongqun He, Lindsay Cowell, Alexander D. Diehl, Harry Mobley, Bjoern Peters, Alan Ruttenberg, Richard H. Scheuermann, Ryan R. Brinkman, Melanie Courtot, Chris Mungall, Zuoshuang Xiang, Fang Chen, Thomas Todd, Lesley Colby, Howard Rush, Trish Whetzel, Mark A. Musen, Brian D. Athey, Gilbert S. Omenn and Barry Smith. "VO: Vaccine Ontology", *ICBO 2009: Proceedings of the First International Conference on Biomedical Ontology*, 2009, 164.

6. Patricia L. Whetzel, Nigam H. Shah, Natalya F. Noy, Benjamin Dai, Michael Dorf, Nicholas B. Griffith, Clement Jonquet, Cherie H. Youn, Adrien Coulet, Chris Callendar, Daniel L. Rubin, Barry Smith, Margaret-Anne Storey, Christopher G. Chute, and Mark A. Musen. BioPortal: Ontologies and Integrated Data Resources at the Click of a Mouse", in *Bio-Ontologies: Knowledge in Biology, SIG*, Poster session, ISMB/ECCB, Stockholm, Sweden, July 2009.

7. Albert Goldfain, Lindsay Cowell and Barry Smith. "Clonal Complexes in Biomedical Ontologies", *ICBO 2009: Proceedings of the First International Conference on Biomedical Ontology*, 2009, 168.

8. Patricia L Whetzel, Nigam H. Shah, Natalya F. Noy, Benjamin Dai, Michael Dorf, Nicholas Griffith, Clement Jonquet, Cherie Youn, Adrien Coulet, Chris Callendar, Barry Smith, Margaret-Anne Storey, Christopher G. Chute, Daniel L. Rubin and Mark A. Musen. "BioPortal: Ontologies and Integrated Data Resources at the Click of the Mouse", *ICBO 2009: Proceedings of the First International Conference on Biomedical Ontology*, 2009, 197.

9. Bjoern Peters and the OBI Consortium, "Ontology for Biomedical Investigations". *Nature Precedings* (2009), First International Conference on Biomedical Ontology, 2009 doi:10.1038/npre.2009.3623.

Abstract: The goal of OBI is to enable a formal representation of biomedical investigations that captures the experimental evidence on which their findings are based. The scope of OBI includes: materials made in and produced for investigations, research objectives, experimental protocols, roles of people in investigations and processing and publication of data gathered in investigations. Use of OBI will allow comparison of experimental data from the wide array of scientific disciplines represented by domain experts in the OBI consortium. OBI follows the principles laid out by the OBO foundry, and integrates tightly with other foundry candidate ontologies, such as GO (www.geneontology.org) and ChEBI (www.ebi.ac.uk/chebi/) whose terms are used to describe biological reality. The use of OBI by the scientific community to represent or annotate their investigations within electronic data resources will facilitate interdisciplinary data synthesis, enable access to their data on the semantic web and improve third-party understanding of information related to life-science and clinical investigations.

10. He Y, Cowell L, Diehl AD, Mobley H, Peters B, Ruttenberg A, Scheuermann RH, Xiang Z, Athey BD, Omenn GS, Smith B. "Development of the Community-based Vaccine Ontology (VO)", *109th American Society of Microbiologists (ASM) General Meeting*. May 17-21, 2009, Philadelphia, PA, USA.

11. A. Patrice Seyed, Stuart C. Shapiro, and Barry Smith, "Integrating BFO with OntoClean: Towards a Method for Evaluating and Correcting Ontologies", Presented at Formal Ontology in Information Systems, Toronto, May 11-14, 2010.

12. Ramona L. Walls, Laurel D. Cooper, Justin Elser, Dennis W. Stevenson, Barry Smith, Chris Mungall, Maria A. Gandolfo, Pankaj Jaiswal, "The Plant Ontology: A Common Reference Ontology for Plants", *Proceedings of the Workshop on Bio-Ontologies*, ISMB, Boston, July, 2010.

13. Laurel D. Cooper, Justin Elser, Ramona Walls, Dennis W. Stevenson, Barry Smith, Chris Mungall, Maria A. Gandolfo, Pankaj Jaiswal, "The Plant Ontology: A Database for Plant Genomics", *Plant Biology 2010*, Montreal, July 30-August 4, 2010, P14010.

14. Robert Williams, A. Keith Dunker, Barry Smith, Darren Natale, An OBO Foundry ontology for intrinsically disordered proteins, *Pacific Symposium on Biocomputing*, 2011, P835.

15. Mauricio Almeida, Anna Barbara Proietti, Jiye Ai, Barry Smith, "The Blood Ontology: An Ontology in the Domain of Hematology", *Proceedings of the Second International Conference on Biomedical Ontology*, Buffalo, NY, July 28-30, 2011, (CEUR Workshop Proceedings, 833), 227-229.

16. Laurel Cooper, Ramona Walls, Justin Elser, Justin Preece, Barry Smith, Chris Mungall, Stefan A. Rensing, Manuel Hiss, Péter Szöevényi, Daniel Lang, Maria A. Gandolfo, Dennis W. Stevenson, Pankaj Jaiswal, "Expanding the Plant Ontology: Linking Plant Anatomy and Development to Genomics Across Plant Taxa" (Abstract), Plant Biology 2011, Minneapolis, MI.

17. Ramona L. Walls, Laurel D. Cooper, Justin Elser, Chris Mungall, Neeral Beladia, Justin Preece, Maria A. Gandolfo, Dennis W. Stevenson, Barry Smith, Pankaj Jaiswal,

"Using the Plant Ontology to improve the interoperability of genomic and phenomic data sets", Plant Genomes and Biotechnology: From Genes to Networks, Cold Spring Harbor Laboratories, November 30-December 3, 2011.

18. Laurel Cooper, Ramona Walls, Justin L. Elser, Justin Preece, Barry Smith, Chris Mungall Marie A. Gandolfo, Dennis W. Stevenson, Pankaj Jaiswal, The Plant Ontology: Linking Plant Anatomy and Development to Genomics Across Plant Taxa, *Proceedings of Plant and Animal Genome XX*, San Diego, California, 2012.

Abstract: The Plant Ontology (PO: http://www.plantontology.org) is a structured vocabulary and database resource for all plant scientists that links plant anatomy, morphology and development to the rapidly expanding field of plant genomics. The primary purpose of the PO is to facilitate cross-database querying and to foster consistent use of vocabularies in annotation. Originally designed to span the monocot-dicot divide in flowering plants, the PO has been redesigned to encompass a wider variety of angiosperm species, as well as gymnosperms, pteridophytes (ferns), lycophytes (lycopods) and bryophytes (liverworts, mosses and hornworts). Recent changes in the PO include the addition of more than 80 new terms to accommodate non-seed plants, with an emphasis on those needed to annotate gene expression from the *Physcomitrella patens* genome. An essential feature of the PO is the set of freely accessible web links from terms to associated annotations, which are structure- or development-specific genes, proteins and phenotypes sourced from numerous plant genomics datasets. Currently, the PO includes over 2 million such annotations associated with over 1,300 terms. Outreach activities include workshops, conference presentations and outreach booths. Also, image libraries are being created through PlantSystematics.org and linked to PO terms to provide reference images for plant structure terms. The PO is a valuable resource for both research and teaching that can be used as a guide to plant structures and growth and developmental landmarks in life cycles of plants across many taxa.

19. Walls RL, Elser JL, Preece J, Smith B, Mungall CJ, Rensing S, Hiss M, Szövényi P, Lang D, Gandolfo MA, Stevenson DW, Jaiswal P, "Annotating Gene Expression in *Physcomitrella patens* using the Plant Ontology: Facilitating Cross-Taxa Comparisons", *Proceedings of Plant and Animal Genome XX*, San Diego, California, 2012.

Abstract: The Plant Ontology is a structured vocabulary and database resource for all plant scientists that links plant anatomy, morphology and development to the rapidly expanding field of plant genomics. Recent changes in the PO include the addition of more than 80 new terms to accommodate non-seed plants, with an emphasis on those needed to annotate gene expression from the Physcomitrella patens genome. The primary purpose of the PO is to facilitate cross-database querying and to foster consistent use of vocabularies in annotation. The use of ontologies ensures consistent annotations within and across species, enabling both prediction of gene function and cross-species comparisons of gene expression. An essential, powerful feature of the PO is the set of links from terms to associated annotations, which are structure- or development-specific genes, proteins and phenotypes sourced from numerous plant genomics datasets. Currently, the PO includes over 2 million annotations associated with over 1,300 terms. We will give a brief tutorial on how to access the PO and associated data, and demonstrate the utility of linking Physcomitrella gene expression data to PO terms. The combination of ontology terms and the annotation of diverse gene expression and phenotype data sets facilitates diverse analyses, including assessing the similarity between genes of inter- or intra-specific origin and the exploration of structural homologies among organs, tissues and cell types.

20. Alexander C. Yu, Barry Smith, Stanley Schwartz, "Formal and Computable Representations of Allergic Diseases in the Electronic Health Record: An Approach Based on the Ontology of General Medical Science", 2012 Annual Meeting of the American College of Allergy, Asthma & Immunology (ACAAI), November 8-13, 2012, Anaheim, California (Poster).

21. Pankaj Jaiswal, Barry Smith, Ruth Bastow, Paul J. Kersey, Elizabeth Arnaud,

Laurel Cooper, Christopher Rawlings, "A Resource for a Common Reference Ontology for Plants", *Proceedings of Plant and Animal Genome XXI*, San Diego, CA, January 12, 2013 (Poster).

22. Brian Atkinson, Laurel Cooper, Laura Moore, Justin Preece, Justin Elser, Nikhil Lingutla, Sinisa Todorovic, Ramona Walls, Ruth Stockey, Gar Rothwell, Barry Smith, Maria A, Gandolfo, Dennis Stevenson, Pankaj Jaiswal, "Plant Ontology, A Controlled and Structured Plant Vocabulary for All Botanical Disciplines", *Botany 2013*, New Orleans, July 17-21, 2013.

Abstract: Recently, plant genome sequencing has expanded to different species of plants. This has dramatically expanded our knowledge of gene expression in plant structures and development, as well as plant evolution. However, due to the vast phylogenetic diversity within the plant kingdom some inconsistencies with terminology have occurred. These conflicting plant vocabularies challenge advancement in the plant sciences; therefore, it is important to have a consistent plant structure vocabulary that encompasses all green plants. The Plant Ontology (PO) has been constructed as a well-structured vocabulary whether the terms are anatomical or developmental. The PO also annotates gene expression data to a wide diversity of plant parts and stages of development, for example, terms can be linked with relevant genes that are expressed during the development of a certain structure. Terms are arranged in a hierarchical structure in which taxon-specific annotations occur; this provides the opportunity for users to compare gene expression in homologous structures across clades. This serves as a critical aid for plant scientists who incorporate large data sets to engage questions on genomics, development, and comparative genetics across different plant groups. The Plant Ontology also provides other resources for plant biologists to use such as the Annotation of Image Segments with Ontologies program (AISO), allowing users to annotate plant structures with relevant terminology and genes from images from digital photography or scanned copies.

23. Mark Jensen, Alexander P. Cox, Barry Smith, Alexander D. Diehl, "Representing Disease Courses: An Application of the Neurological Disease Ontology to Multiple Sclerosis Typology", *Proceedings of the Fourth International Conference on Biomedical Ontology* (ICBO), Montreal, July 8-9, 2013, (CEUR, 1060), 121.

24. Jie Zheng, Marcelline R. Harris, Anna Maria Masci, Yu Lin, Alfred Hero, Barry Smith and Yongqun He, "OBCS: The Ontology of Biological and Clinical Statistics", *Proceedings of the Fifth International Conference on Biomedical Ontology* (ICBO), Houston, 2014, (CEUR, 1327), 65.

Abstract: Statistics play a critical role in biological and clinical research. To promote logically consistent representation and classification of statistical entities, we have developed the Ontology of Biological and Clinical Statistics (OBCS). OBCS extends the Ontology of Biomedical Investigations (OBI), an OBO Foundry ontology supported by some 20 communities. Currently, OBCS contains 686 terms, including 381 classes imported from OBI and 147 classes specific to OBCS. The goal of this paper is to present OBCS for community critique and to describe a number of use cases designed to illustrate its potential applications.

25. Laurel D. Cooper, Justin Elser, Justin Preece, Elizabeth Arnaud, Dennis W Stevenson, Sinisa Todorovic, Eugene Zhang, Christopher J. Mungall, Barry Smith, Pankaj Jaiswal, "Common Reference Ontologies for Plant Biology: A Platform for Integrative Plant Genomics", *Proceedings of Plant and Animal Genome XXII*, San Diego, CA, 2014 (Poster).

Abstract: Around the world, a small number of plant species serve as the primary source of food for the human population, yet these crops are vulnerable to multiple stressors, such as diseases, nutrient deficiencies and unfavorable environmental conditions. Traditional breeding methods for plant improvement may be combined with next-generation methods such as automated scoring of traits and phenotypes to develop improved varieties. Linking these analyses to the growing corpus of genomics data generated by high-throughput sequencing, transcriptomics, proteomics, phenomics and genome annotation projects requires common, interoperable, reference vocabularies (ontologies) for the description of the data. The 'Common

Reference Ontologies for Plant Biology' (cROP) initiative is building the needed suite of reference ontologies, together with enhanced data storage and visualization technologies. The cROP will assume the further development of the existing Plant Ontology (PO), Plant Trait Ontology (TO), and Plant Environment Ontology (EO) and will develop the Plant Stress Ontology (PSO) for abiotic and biotic stresses. It will also include relevant aspects of ontologies such as Gene Ontology (GO), Cell Type (CL), Chemical Entities of Biological Interest (ChEBI), Protein Ontology (PRO) and the Phenotypic Qualities Ontology (PATO). It will include a centralized platform where reference ontologies for plants will be used to access cutting-edge data resources for plant traits, phenotypes, diseases, genomes and semantically-queried gene expression and genetic diversity data across a wide range of plant species. cROP will unify and streamline a fragmented semantic framework and will support allele discovery, advance the understanding of crop evolution, and facilitate crop development.

26. Pankaj Jaiswal, Laurel Cooper, Justin L. Elser, Austin Meier, Marie-Angélique Laporte, Christopher Mungall, Barry Smith, Ethan K. S. Johnson, Megan Seymour, Justin Preece, Xu Xu, Ryan S. Kitchen, Botong Qu, Eugene Zhang, Elizabeth Arnaud, Seth Carbon, Sinisa Todorovic and Dennis Wm. Stevenson, "Planteome: A resource for Common Reference Ontologies and Applications for Plant Biology", *Proceedings of Plant and Animal Genome XXIV,* 2016*.

Abstract: Around the world, a small number of plant species serve as the primary source of food for the human population, yet these crops are vulnerable to multiple stressors, such as diseases, nutrient deficiencies and unfavorable environmental conditions. Traditional breeding methods for plant improvement may be combined with next-generation methods such as automated scoring of traits and phenotypes to develop improved varieties. Linking these analyses to the growing corpus of genomics data generated by high-throughput sequencing, transcriptomics, proteomics, phenomics and genome annotation projects requires common, interoperable, reference vocabularies (ontologies) for the description of the data. The Planteome initiative (www.planteome.org) is developing the needed suite of common reference ontologies that describe anatomy and development in Plant Ontology (PO), Plant Trait Ontology (TO), and Plant Environment Ontology (EO) and the Plant Stress Ontology (PSO) for describing the abiotic and biotic stresses. The project will also host ontologies such as Gene Ontology (GO), Chemical Entities of Biological Interest (ChEBI), Protein Ontology (PRO) and the Phenotypic Qualities Ontology (PATO) developed by collaborators. The project database and the online resources will provide researchers tools to search and browse and remote access via APIs for semantic integration in annotation tools and data repositories providing resources for plant traits, phenotypes, diseases, genomes, gene expression and genetic diversity data across a wide range of plant species.

27. Edison Ong, Zuoshuang Xiang, Jie Zheng, Barry Smith and Yongqun He, "Ontobull and BFOConvert: Web-based programs to support automatic ontology conversion", *International Conference on Biological Ontology* (ICBO), CEUR 1747, 2016.

Abstract: When a widely reused ontology appears in a new version which is not compatible with older versions, the ontologies reusing it need to be updated accordingly. Ontobull (http://ontobull.hegroup.org) has been developed to automatically update ontologies with new term IRI(s) and associated metadata to take account of such version changes. To use the Ontobull web interface a user is required to (i) upload one or more ontology OWL source files; (ii) input an ontology term IRI mapping; and (where needed) (iii) provide update settings for ontology headers and XML namespace IDs. Using this information, the backend Ontobull Java program automatically updates the OWL ontology files with desired term IRIs and ontology metadata. The Ontobull subprogram BFOConvert supports the conversion of an ontology that imports a previous version of BFO. A use case is provided to demonstrate the features of Ontobull and BFOConvert.

28. Fernanda Farinelli, Mauricio B. Almeida, Peter L. Elkin, Barry Smith, "Interoperability Among Prenatal EHRs: A Formal Ontology Approach", *Proceedings AMIA Symposium 2017*. DOI10.13140/RG.2.2.16743.34729

29. Michael Grüninger, Alan Ruttenberg, Barry Smith", "Tutorial: ISO/IEC 21838", *Proceedings of the Joint Ontology Workshops 2019 (JOWO)*, Graz.

30. Barry Smith, "Ontologies for Space and Ground Systems", *Ground System Architectures Workshop*, Los Angeles, CA, March 2-5, 2020.

DATABASES AND ONTOLOGIES

1. Buffalo Norms for Geographic Categories, November 1999.
2. Basic Formal Ontology (BFO), May 2004.
3. Relation Ontology (RO), April 2006.
4. Common Anatomy Reference Ontology (CARO), September 2008.
5. Protein Ontology (PRO), with the University of Delaware, October 2009.
6. Infectious Disease Ontology (IDO), with Duke University, October 2009.
7. Information Artifact Ontology (IAO), November 2009
8. Ontology for General Medical Science (OGMS), November 2009.
9. Universal Core Semantic Layer (UCore SL), March 2010.
10. Biometrics Upper Ontology (US Army), March 2010.
11. Mental Functioning Ontology, 2009
12. Mental Disease Ontology, 2010
13. Document Act Ontology, September 2012
14. Joint Doctrine Ontology, 2015
15. Space Object Ontology, 2017
16. Manufacturing Ontology for Functionally Graded Materials, 2016
17. Cognitive Process Ontology, March 2019
18. Intel Cognitive Process Ontology, March 2019
19. Medical Cognitive Process Ontology, March 2019
20. Product Life Cycle Ontology, 2019
21. Injury Ontology

LETTERS TO EDITORS

1. "Derrida Degree: A Question of Honour", Letter to *The Times* (London) of 9 May 1992 on the award by Cambridge University of an honorary degree to Jacques Derrida. Co-signatories: Hans Albert (University of Mannheim), David Armstrong (Sydney), Ruth Barcan Marcus (Yale), Keith Campbell (Sydney), Richard Glauser (Neuchâtel), Rudolf Haller (Graz), Massimo Mugnai (Florence), Kevin Mulligan (Geneva), Lorenzo Peña (Madrid), Willard van Orman Quine (Harvard), Wolfgang Röd (Innsbruck), Karl Schuhmann (Utrecht), Daniel Schulthess (Neuchâtel), Peter Simons (Salzburg), René Thom (Burs-sur-Yvette), Dallas Willard (Los Angeles), Jan Woleński (Cracow).

> Reprinted *inter alia* in: *Silenus Laughed* (Sydney), July 1992; *The Cambridge Review*, October 1992 (special issue on "The Derrida Affair"), p. 138-139; J. Derrida, *Points ... Interviews, 1974–1994,* Stanford: Stanford University Press, 1995, 419-421; *English Studies* 94 (30), 2013; *Digressions&Impressions* (2016); *Metaphilosophy*, June 5, 2020

Italian translation in *La Stampa* (Milan), 12 May 1992

Chinese translation in 豆瓣小组, 22 August 2008

Czech translation in Filosofie Dnes, 8 (2), 2016.

See also Niall Gildea, *Jacques Derrida's Cambridge Affair*, Rowman & Littlefield, 2019; and also his "'Fanciful associations'. The Perverse Endurance of Derrida's [sic] 'logical phallusies'", in *v*, 34(1), March 2022.

2. Mark A. Musen, Suzanna Lewis and Barry Smith, "Wrestling with SUMO and bio-ontologies", *Nature Biotechnology*, 24, 1 (2006), p. 21. PMC2768033

3. Field, Dawn, Morrison, Norman, Glockner, Frank Oliver, Kottmann, Renzo, Cochrane, Guy, Vaughan, Robert, Garrity, George, Cole, Jim, Hirschman, Lynette, Schriml, Lynn, Mizrachi, Ilene, Federhen, Scott, Schindel, David, Miller, Scott, Hebert, Paul, Ratnasingham, Sujeevan, Hanner, Robert, Amaral-Zettler, Linda, Sogin, Mitchell, Ashburner, Michael, Lewis, Suzanna, Smith, Barry, "Working together to put molecules on the map", *Nature*, 453 (7198), June 2008, 978.

4. David Koepsell and Barry Smith, "Dealing with socially constructed concepts in an ontology", *Journal of Empirical Research on Human Research Ethics*, Vol. 4, No. 2, June 2009, 75-6.

4. Barry Smith, Louis J. Goldberg, Alan Ruttenberg and Michael Glick, Ontology and the Future of Dental Research Informatics, *The Journal of the American Dental Association* (JADA), 141 (10) October 2010, 1173-1175.

5. Barry Smith, Louis J. Goldberg, Alan Ruttenberg and Michael Glick, "Regarding Ontology and the Future of Dental Research Informatics", *The Journal of the American Dental Association (JADA)*, January 2011, 142 (1), 2011, 252-254.

ARTICLES IN DICTIONARIES AND IN ENCYCLOPEDIAS

1. "Art", in N. Ashford and S. Davies (eds., *A Dictionary of Conservative and Libertarian Thought*, London and New York: Routledge, 1991, 9–11, reprinted 2011.

Spanish translation in: *Diccionario del Pensamiento Conservador y Liberal*, Buenos Aires: Ediciones Nueva Vision, 1992, 22-24.

2. "Conservative Theory", in N. Ashford and S. Davies (eds.), *A Dictionary of Conservative and Libertarian Thought*, London and New York: Routledge, 1991, 49–51.

Spanish translation in: *Diccionario del Pensamiento Conservador y Liberal*, Buenos Aires: Ediciones Nueva Vision, 1992, 313-315.

3. "Nationalism", in N. Ashford and S. Davies (eds.), *A Dictionary of Conservative and Libertarian Thought*, London and New York: Routledge, 1991, 180–183.

Spanish translation in: *Diccionario del Pensamiento Conservador y Liberal*, Buenos Aires: Ediciones Nueva Vision, 1992, 229-233.

4. "Introduction" to Hans Burkhardt and Barry Smith (eds.), *Handbook of Metaphysics and Ontology*, Munich/Philadelphia/Vienna: Philosopia, 1991, xix–xxiii.

5. "Naive Physics", in Hans Burkhardt and Barry Smith (eds.), *Handbook of Metaphysics and Ontology*, Munich/Philadelphia/Vienna: Philosopia, 1991, 585–586.

6. "Meinong and the Graz School", in Hans Burkhardt and Barry Smith (eds.), *Handbook of Metaphysics and Ontology*, Munich/Philadelphia/Vienna: Philosopia, 1991, 519–522.

7. "Sachverhalt", Article in *Historisches Wörterbuch der Philosophie*, J. Ritter and K. Gründer (eds.), Stuttgart and Basel: Schwabe, vol. 8, 1992, 1102–1113.

Abstract: Both *'Sachverhalt'* and 'state of affairs' seem to have been derived from the juridical 'status' in the sense of 'status rerum' meaning: state or constitution of things. 'Status' signifies also in an extended sense 'the way things stand, the condition or peculiarity of a thing in regard to its circumstances, position, order'. We describe the history of usage of '*Sachverhalt'* from these beginnings, addressing the role of Goclenius, Lotze, Stumpf, Husserl and Adolf Reinach, whose theory of the relations between judgment and *Sachverhalt* served as one starting point for the development of Reinach's theory of speech acts in 1913.

Preprinted in: "Sachverhalt: eine begriffsgeschichtliche Untersuchung" (includes an extensive English summary), *Forschungsberichte und Mitteilungen des Forschungsinstituts Philosophie/Technik/Wirtschaft*, Universität Salzburg, 9 (1988), 41pp.

8. "Aristotelianism, apriorism, essentialism", in P. Boettke (ed.), *The Elgar Companion to Austrian Economics*, Cheltenham: Edward Elgar Publishing, 1994, 33–37.

9. "Brentano", in J. Kim and E. Sosa (eds.), *A Companion to Metaphysics*, Oxford: Blackwell, 1995, 61–63.

10. "Ingarden", in J. Kim and E. Sosa (eds.), *A Companion to Metaphysics*, Oxford: Blackwell, 1995, 241–242.

11. "Ontology", in J. Kim and E. Sosa (eds.), *A Companion to Metaphysics*, Oxford: Blackwell, 1995, 373–374.

12. Dallas Willard and Barry Smith, "British Moral Theory" in: L. Embree (ed.), *Encyclopedia of Phenomenology*, Dordrecht/Boston/London: Kluwer, 1997, 81-85.

Abstract: There is an inherent phenomenological tendency in British moral theory, especially from John Locke onward. The purpose of his *Essay* is to consider the discerning faculties of a man, as they are employed about the objects which they have to do with. This is language that might serve well in a general description of the work of Husserl and other phenomenologists.

13. "Realistic phenomenology", in L. Embree (ed.), *Encyclopedia of Phenomenology*, Dordrecht/Boston/London: Kluwer, 1997, 586–590.

Abstract: The tradition of realist phenomenology was founded in around 1902 by a group of students in Munich interested in the newly published *Logical Investigations* of Edmund Husserl. Initial members of the group included Johannes Daubert, Alexander Pfänder, Adolf Reinach and Max Scheler. With Reinach's move to Göttingen the group acquired two new prominent members – Edith Stein and Roman Ingarden. The group's method turned on Husserl's idea that we are in possession *a priori* (which is to say: non-inductive) knowledge of entities (for example, colors, tones, values, shapes) of a range of different sorts. Pfänder applied this method in his descriptive psychology of willing and motivation, Reinach (anticipating the later speech act theory) to what he called 'social acts', Stein to the ontology of communities, and Ingarden to works of art and aesthetic phenomena. The movement latter, through Ingarden, lived on in Poland, where it influenced the young Karol Wojtyła.

14. "Austria" in L. Embree (ed.), *Encyclopedia of Phenomenology*, Dordrecht/Boston/London: Kluwer, 1997, 43–48.

Abstract: Philosophy in the German-speaking world can be divided inlo two loose traditions, which we might refer to as the German and the Austrian (or Austro-Hungarian), respectively. The main line of the first begins with Kant, Fichte, Hegel and Scheling and ends with Heidegger

and his contemporary followers. The main line of the second embraces the philosophy of Prague, Lemberg (now Lwiv), and Cracow as much as that of Vienna and Graz. It begins with Bolzano, Mach, Brentano, Meinong and Twardowski and ends with Willgenstein, Neurath and Popper. Here we describe the evolution of this Austrian tradition, paying special attention to the role of phenomenology therein.

15. "Gestalt psychology" in Edward Craig (ed.), *Routledge Encyclopedia of Philosophy,* London: Routledge 1998, vol. 4, 51–54.

Abstract: An outline of the history of Gestalt psychology, beginning with Christian von Ehrenfels and Ernst Mach, the Austro-Italian school of Benussi, Musatti and Kanizsa, and concluding with the Berlin School of Stumpf, Wertheimer, Köhler and Koffka and the ontological theory of Gestalt morphologies advanced by Edwin Rausch.

16. "Reinach" in Edward Craig (ed.), *Routledge Encyclopedia of Philosophy*, London: Routledge, 1998, vol. 8, 180–182.

17. "Axiology" in Edward Craig (ed.), *Routledge Encyclopedia of Philosophy*, London: Routledge 1998, vol. 1, 608–612 (with Alan Thomas).

18. "Witasek", in Monika Betzler and Julian Nida-Rümelin (eds.), *Ästhetik und Kunstphilosophie von der Antike bis zur Gegenwart in Einzeldarstellungen,* Stuttgart: Alfred Kröner Verlag, 1998, 821–824.

19. "Ingarden", in Robert Audi (ed.), *The Cambridge Dictionary of Philosophy*, Cambridge: Cambridge University Press, 1999, p. 437.

20. "Brentano", in *MIT Encyclopedia of Cognitive Science*, Cambridge, MA: MIT Press, 1999, 94–95.

21. "Daubert", in *Powszechna Encyklopedia Filozofii*, Lublin: Polskie Towarzystwo Tomasza z Akwinu, 2001, 415-418. English version.

22. Steffen Schulze-Kremer and Barry Smith, "Ontologies for the Life Sciences", *Encyclopedia of Genetics, Genomics, Proteomics and Bioinformatics*, New York and London: John Wiley and Sons, vol. 4, 2005.

Abstract: Where humans can manipulate and integrate the information they receive in subtle and ever-changing ways from context to context, computers need structured and context-free background information of a sort which ontologies can help to provide. A domain ontology captures the stable, highly general and commonly accepted core knowledge for an application domain. The domain at issue here is that of the life sciences, in particular molecular biology and bioinformatics. Contemporary life science research includes components drawn from physics, chemistry, mathematics, medicine and many other areas, and all of these dimensions, as well as fundamental philosophical issues, must be taken into account in the construction of a domain ontology. Here we describe the basic features of domain ontologies in the life sciences and show how they can be used.

23. Barry Smith "John Searle", *Les sciences humaines*, ed. Patrick Savidan, Paris: Presses Universitaires de France, 2006, 1061-62.

24. James DuBois and Barry Smith, "Reinach", *Stanford Encyclopedia of Philosophy*, 2008.

25. Barry Smith, "Biometaphysics", *Routledge Companion to Metaphysics,* Robin Le Poidevin, *et al*. (eds.), London and New York: Routledge, 2009, 537-544.

Abstract: While Darwin is commonly supposed to have demonstrated the inapplicability of the Aristotelian ontology of species to biological science, recent developments, especially in the wake of the Human Genome Project, have given rise to a new golden age of classification in which ontological ideas – as for example in the Gene Ontology, the Cell Ontology, the Protein Ontology, and so forth – are once again playing an important role. In regard to species, on the other hand, matters are more complex. We provide a brief overview of recent proposals

concerning the ontology of species, dealing with species as sets, classes and as collections, the views of Ernst Mayr, and mereological views.

26. Alessandro Salice, James DuBois, Barry Smith, "Reinach" (revised version), *Stanford Encyclopedia of Philosophy*, 2024.

TRANSLATIONS

1. Translation of Adolf Reinach, "On the Theory of the Negative Judgment", in Barry Smith (ed.), *Parts and Moments. Studies in Logic and Formal Ontology*, Munich: Philosophia, 1982, 315–377.

2. Translation of Adolf Reinach, "William James and Pragmatism", in K. Mulligan (ed.), *Speech Act and Sachverhalt. Reinach and the Foundations of Realist Phenomenology*, Dordrecht/Boston/Lancaster: Nijhoff, 1987, 291–298.

3. Franz Brentano, *Philosophical Investigations on Space*, *Time and the Continuum*, English translation by Barry Smith, London/Sydney: Croom Helm, 1988, xxiv + 202pp. Reprinted Abingdon/New York: Routledge, 2010.

   Reviewed by J onathan Barnes, *Philosophy and Phenomenological Research*, 51 (2), 468-470.

4. Translation of Christian von Ehrenfels, "On 'Gestalt-Qualities'" and other writings on Gestalt theory, in Barry Smith (ed.), *Foundations of Gestalt Theory*, Munich and Vienna: Philosophia, 1988, 82–123.

5. "A Note on Brentano's Terminology", translator's preface to Franz Brentano, *Philosophical Investigations on Space, Time and the Continuum*, London/Sydney: Croom Helm, 1988, xxii–xxiv.

BIBLIOGRAPHIES

1. "Annotated Bibliography of Writings on Part-Whole Relations since Brentano", in Barry Smith (ed.), *Parts and Moments. Studies in Logic and Formal Ontology*, Munich: Philosophia, 1982, 481–552.

2. "Addenda to: Annotated Bibliography of Writings on Part-Whole Relations since Brentano", in P. Sällström (ed.), *An Inventory of Present Thinking about Parts and Wholes*, vol. III, Stockholm: Forskningsrådsnämnden, 1985, 74–86.

3. "Chronicle"/"Husserl Bibliography", cumulative bibliography of literature on and by Edmund Husserl, in *Husserl Studies*, triennially from issue 3/2 (1986) to 8/3 (1991).

4. "Adolf Reinach: An Annotated Bibliography", in K. Mulligan (ed.), *Speech Act and Sachverhalt*, Dordrecht/Boston/Lancaster: Nijhoff, 1987, 299–332.

   Abstract: Ever since its appearance in 1913, Reinach's work on a The A Priori Foundations of the Civil Law has served as the principal representative of phenomenological, aprioristic and ontological/realist approaches to the philosophy of law. This annotated bibliography provides an overview of the reception of Reinach's thinking, which has been of influence also in the realm of speech act theory.

5. "Gestalt Theory and Its Reception: An Annotated Bibliography", in Barry Smith (ed.), *Foundations of Gestalt Theory*, Munich and Vienna: Philosophia, 1988, 231–478.

6. "Bibliography" in Barry Smith and David W. Smith (eds.), *The Cambridge Companion to Husserl*, Cambridge and New York: Cambridge University Press, 1995, 487–508.

REVIEWS AND REVIEW ARTICLES

1. Roman Ingarden, The *Literary Work of Art* (Evanston 1973), *Journal of the British Society for Phenomenology*, 6 (1975), 141–144.

2. Reinhardt Grossmann, *Meinong* (London 1974), *Journal of the British Society for Phenomenology*, 4 (1976), 147–148.

3. Michael Dummett, *Truth and Other Enigmas* (London 1978), *Philosophischer Literaturanzeiger*, 32 (1979), 365–368 (in German).

4. Martin Heidegger, *Metaphysische Anfangsgründe der Logik* (Frankfurt 1978), *Annals of Science*, 36 (1979), 103–105.

5. Alexius Meinong, *Gesamtausgabe* (Graz 1971–79), *Annals of Science*, 36 (1979), 636–38. German version in *Philosophischer Literaturanzeiger*, 33 (1980), 236–240.

6. Jacques Derrida, *Edmund Husserl's 'Origins of Geometry.' An Introduction* (London 1979), *Annals of Science*, 36 (1979), 638–641.

7. R. M. Chisholm and R. Haller (eds.), *Die Philosophie Franz Brentanos* (Amsterdam 1978), *Journal of the British Society for Phenomenology*, 11 (1980), 194–199.

8. Alexius Meinong, *On Objects of Higher Order and Husserl's Phenomenology* (M. L. Schubert-Kalsi (ed.), The Hague 1978), *The Philosophical Quarterly*, 30 (1980), 252–254.

9. Edmund Husserl, *Aufsätze und Rezensionen 1890–1910* (The Hague 1979), *Philosophischer Literaturanzeiger*, 33 (1980), 313–315 (in German).

10. David Wiggins, *Sameness and Substance* (Oxford 1979), *History and Philosophy of Logic*, 2 (1981), 150–151.

11. Paul Gochet, *Outline of a Nominalist Theory of Propositions* (Dordrecht 1980), *Grazer Philosophische Studien*, 14 (1981), 216–217.

12. Edmund Husserl, *Phantasie, Bildbewußtsein, Erinnerung. Zur Phänomenologie der anschaulichen Vergegenwärtigung* (The Hague 1980), *Philosophischer Literaturanzeiger*, 35 (1982), 14–17 (in German).

13. Ludwig Landgrebe, *The Phenomenology of Edmund Husserl* (Ithaca 1981), *History and Philosophy of Logic*, 4 (1983), 111.

14. Roger Schmit, *Husserls Philosophie der Mathematik*. *Platonistische und konstruktivistische Momente in Husserls Mathematikbegriff* (Bonn 1981), *History and Philosophy of Logic*, 4 (1983), 230–234.

15. Kurt Lewin, *Wissenschaftstheorie I* (Bern/Stuttgart 1981), *History and Philosophy of Logic*, 4 (1983), 235–238.

16. "Phänomenologie und angelsächsische Philosophie" [Review article on recent publications in phenomenology], *Philosophischer Literaturanzeiger*, 37 (1984), 387–405.

17. Kevin Mulligan and Barry Smith, "Traditional vs. Analytic Philosophy" [Review article on E. Tugendhat, *Traditional and Analytic Philosophy*], *Grazer Philosophische Studien*, 21 (1984), 193–202.

Abstract: We review an influential series of lectures on analytic philosophy published in 1976 by the West German philosopher Ernst Tugendhat focusing on Tugendhat's treatment of Husserl, and particularly on issues connected with the notion of dependence or *Abhängigkeit* central to Husserl's philosophy. These issues are of interest not only because Tugendhat's work is one of the few contributions to contemporary analytic philosophy in which they are confronted explicitly, but also because what he has to say about Husserl and dependence illustrates well both the positive and the negative thrust of his argument.

19. Edmund Husserl, *Studien zur Arithmetik und Geometrie* (The Hague 1983), *History and Philosophy of Logic*, 5 (1985), 228–230.

20. P. Jaeger and R. Lüthe (eds.), *Distanz und Nähe. Reflexionen und Analysen zur Kunst der Gegenwart* (Würzburg 1983), *Journal of the British Society for Phenomenology*, 16 (1985), 320–322.

21. Harald Delius, *Self-Awareness: A Semantical Inquiry* (Munich 1981), *Philosophy and Phenomenological Research*, 46 (1985), 170–173.

> **Abstract:** The thesis of Delius's book is that statements of self-awareness such as "I am aware that I see a cat" possess what he calls 'Cartesian characteristics' of indubitability or absolute self-evidence. He argues that this is the case in virtue of the fact that such statements are not about anything independent of themselves. The book is described as a 'semantical inquiry', but it is not by any means a contribution to the philosophy of language of the predictable sort. Statements of self-awareness express what Delius calls 'egological experiences', and the subject of the book is most accurately described as consisting in the relations between egological statements and egological experiences, in a sense made clear in the course of the book.

22. J. N. Mohanty, *The Possibility of Transcendental Philosophy* (Dordrecht 1985), *Journal of the British Society for Phenomenology*, 18 (1987), 299–301.

23. Paul Gochet, *Ascent to Truth: A Critical Examination of Quine's Philosophy* (Munich/Vienna 1986), *Grazer Philosophische Studien*, 30 (1987), 212–213.

24. J. Macnamara, *A Border Dispute. The Place of Logic in Psychology* (Cambridge, Mass. 1987), *History and Philosophy of Logic*, 9 (1988), 126–128.

25. R. Bernet, I. Kern and E. Marbach, *Edmund Husserl. Darstellung seines Denkens* (Hamburg, 1989), *History and Philosophy of Logic,* 11 (1990), 260.

26. Edmund Husserl, *Aufsätze und Vorträge (1911–21)* (Dordrecht 1987), *Journal of the British Society for Phenomenology*, 21 (1990), 293–295 (with K. Schuhmann).

27. L. B. Puntel, *Grundlagen einer Theorie der Wahrheit* (Berlin/New York 1990), *Philosophy and Phenomenological Research*, 52 (1992), 494–496.

28. Mark A. Notturno, (ed.) *Perspectives on Psychologism* (Leiden 1989), *History and Philosophy of Logic,* 12 (1991), 249–251.

29. Felix Kaufmann, *L'infinito in matematica* (Gardolo di Trento 1990), *History and Philosophy of Logic*, 13 (1992), 131.

30. "The Philosophy of Austrian Economics" [Review article on David Gordon, *The Philosophical Origins of Austrian Economics* (Auburn 1993)], *Review of Austrian Economics*, 7 (1994), 127–132.

31. Ernest Davis, *Representations of Commonsense Knowledge* (San Mateo 1990), *Minds and Machines*, 4/2 (1994), 245–249.

32. Kenneth J. Perszyk, *Nonexistent Objects: Meinong and Contemporary Philosophy* (Dordrecht/Boston/London 1993), *History and Philosophy of Logic*, 16 (1995), 154–155.

33. Werner Stelzner (ed.), *Philosophie und Logik. Frege-Kolloquien Jena 1989/1991* (Berlin/New York 1993), *History and Philosophy of Logic*, 16 (1995), 155–156.

34. Edmund Husserl, *Briefwechsel* (10 volumes, Dordrecht/Boston/London 1994), *Husserl Studies*, 12 (1995), 98–104.

> **Abstract:** This edition of Husserl's correspondence comprises 10 volumes. Its philosophical core is contained in the first four volumes, which correspond to the four phases of Husserl's philosophical career: as follower of Brentano, as mentor of the realist phenomenologists in Munich (the founders of the

'phenomenological movement'), and as professor, successively, in Göttingen and Freiburg. The remaining five volumes pertain to HusserI's correspondence with philosophers and other scholars outside the inner circle of the phenomenological movement, with institutions and editors, and with family members and friends. Volume 10 comprises a masterly introduction to the edition by the editors, Karl and Elisabeth Schuhmann, together with chronological tables and seven separate indexes enabling the user to trace references in the letters to Husserl's own publications, manuscripts and lectures, as well as to persons, institutions and places.

35. Arnold Heidsieck, *The Intellectual Contexts of Kafka's Fiction: Philosophy*, *Law*, *Religion* (Columbia, SC 1994) in *Nachrichten der Forschungsstelle und des Dokumentationszentrums für Österreichische Philosophie*, 6 (1995), 47–49.

36. Gustav Bergmann, *New Foundations of Ontology* (Madison and London 1992), in *Vienna Circle Institute Yearbook*, 3 (1995), Dordrecht: Kluwer, 304–306.

37. Aurel Kolnai, *The Utopian Mind* (London 1995), *Journal of the British Society for Phenomenology*, 27/2 (1996), 208–210.

38. Steven S. Pollard and Norman M. Martin, *Closure Spaces and Logic* (Dordrecht 1996), *History and Philosophy of Logic*, 17 (1996), 176–177.

39. Peter A. Burrough and Andrew U. Frank (eds.), *Geographic Objects with Indeterminate Boundaries* (London and Bristol, PA. 1996), *Dialectica*, 55: 1 (2001), 72–74.

39. Peter A. Burrough and Andrew U. Frank (eds.), *Geographic Objects with Indeterminate Boundaries* (London and Bristol, PA. 1996), *Dialectica*, 55: 1 (2001), 72–74.