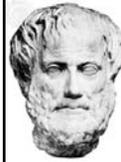


# Lecture 1

## Ontology as a Branch of Philosophy

### A brief history of ontology



Aristotle (384 BC – 322 BC)  
 Realist theory of categories  
 Intelligible universals extending across all domains  
 Central role of organisms



Medieval scholastics: Aquinas, Scotus, Ockham, ... (1200 – 1600)  
 Aristotelianism as *philosophia perennis*  
 Common panscientific ontology and controlled vocabulary (Latin)

2

### A brief history of ontology



Descartes (1596 – 1650)  
 Sceptical doubt initiates subversion of metaphysics, rise of epistemology  
 Central role of mind  
 Dualism of mind and matter



Kant (1724 – 1804)  
 Reality is unknowable  
 Metaphysics is impossible  
 We can only know the quasi-fictional domains which we ourselves create

3

### A brief history of ontology



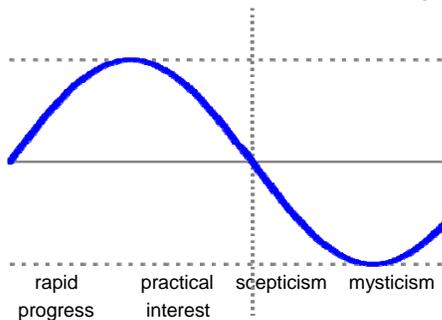
Brentano (1838 – 1917)  
 Rediscovery of Aristotle  
 Methods of philosophy and of science are one and the same



Husserl (1859 – 1938)  
 Inventor of formal ontology as a discipline distinct from formal logic  
 Showed how philosophy and science had become detached from the 'life world' of ordinary experience

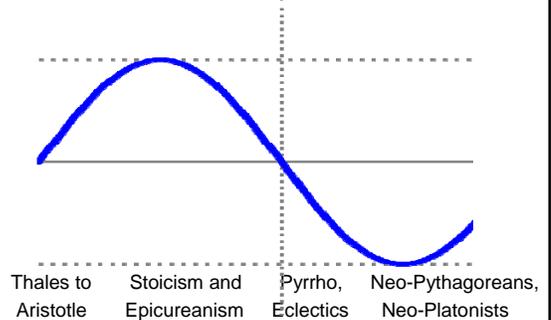
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### The Four Phases of Philosophy

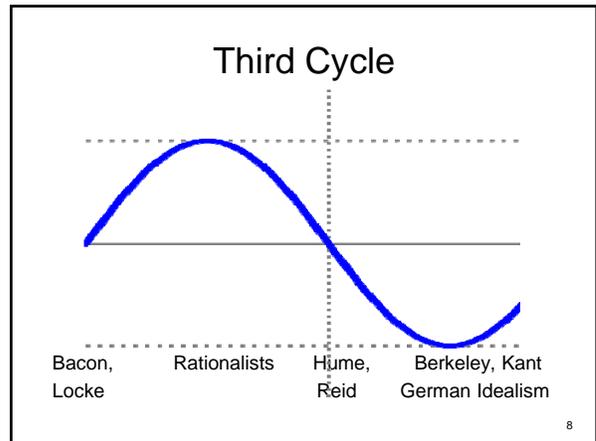
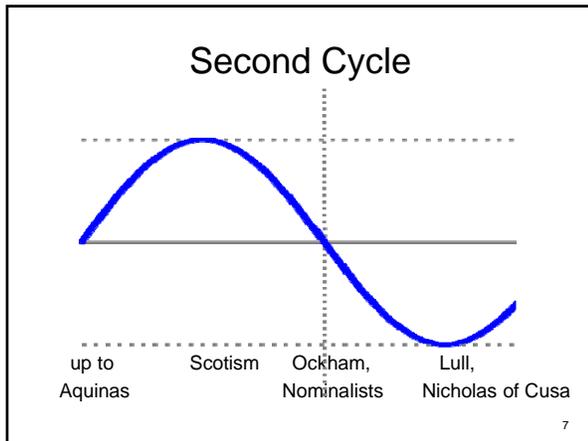


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### First Cycle



6



### A brief history of ontology

	Wittgenstein 1 (ca. 1910 – 1918) Author of <i>Tractatus</i> Bases ontology on formal logic in reductionistic atomism
	Vienna Circle (1922 – ca. 1938) Schlick, Neurath, Gödel, Carnap, Gustav Bergmann ... Centrality of logic to philosophy Construction of philosophy from either physics or sensations as base
	

9

### A brief history of ontology

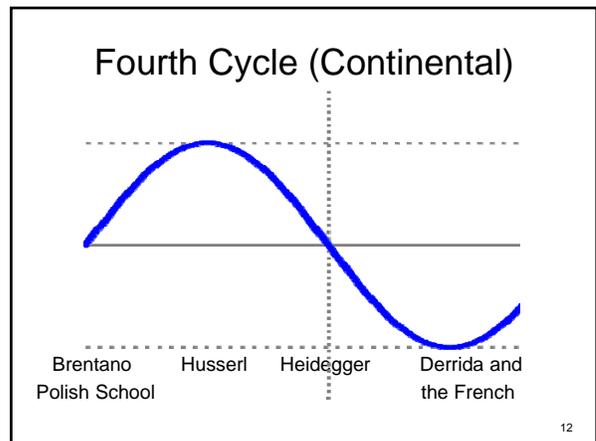
	Wittgenstein 2 (ca. 1930 – 1951) Centrality of language and of language games Metaphysics = language goes on holiday
	British Ordinary Language philosophy Philosophical problems to be solved by the study of the workings of language Speech Act Theory (J. L. Austin, 1911-1960)

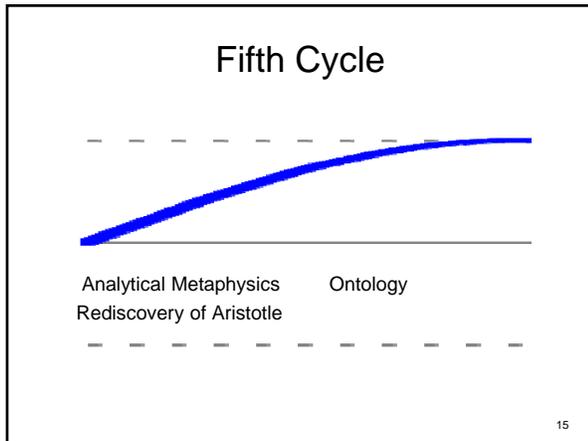
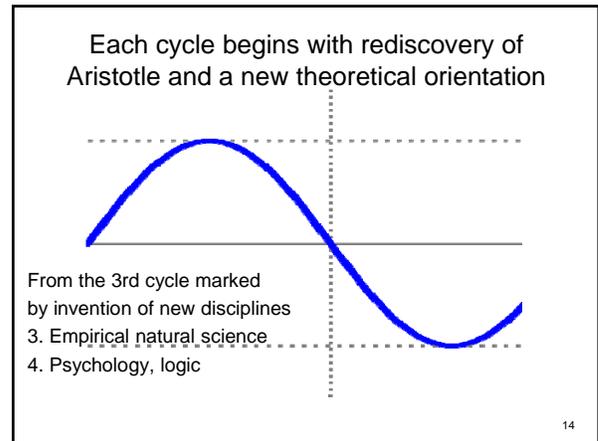
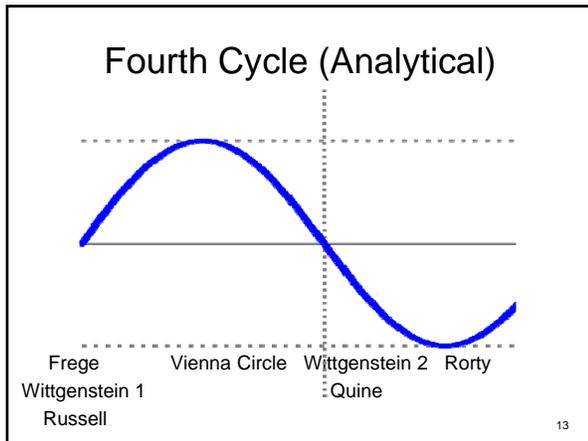
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### A brief history of ontology

	Quine (ca. 1930 – 1951) Ontological commitment (study not: <i>what there is</i> , but: what sciences believe there is when logically formalized)
	Analytical metaphysics (from ca. 1980): Chisholm, Lewis, Armstrong, Fine, Lowe, ... beginnings of a rediscovery of metaphysics as first philosophy
What next?	

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### An example of a practical problem

Increasingly, publishers are exploring ways to tag scientific literature in ways designed to make their contents more easily accessible to computers

For maximal effect, a single set of terms should be used for tagging all literature published in a given domain

How do we select the set of terms ('ontology') for each domain?

16

turn all highlighting on | data | disease | habitat | institution | organism | person | place | protein | taxon

SEMANTICALLY ENHANCED VERSION OF A RESEARCH ARTICLE FROM PLOS NEGLECTED TROPICAL DISEASES

### Impact of Environment and Social Gradient on *Leptospira* Infection in Urban Slums

document summary

Renato B. Reis <sup>1,2</sup>, Guilherme S. Ribeiro <sup>1,2</sup>, Ridalva D. M. Felzenburgh <sup>1</sup>, Francisco S. Santana <sup>1,2</sup>, Sharif Mohr <sup>1</sup>, Astrid X. T. O. Melendez <sup>1</sup>, Adriano Queiroz <sup>1</sup>, Andréa C. Santos <sup>1</sup>, Romy R. Ravines <sup>3</sup>, Wagner S. Tassinari <sup>3,4</sup>, Marília S. Carvalho <sup>3</sup>, Mittermayer G. Reis <sup>1</sup>, Albert I. Ko <sup>1,5</sup>

<sup>1</sup> Centro de Pesquisas Gonçalo Moniz, Fundação de Amparo à Pesquisa do Estado de Bahia, Salvador, Brazil, <sup>2</sup> Secretaria Estadual de Saúde de Bahia, Salvador, Brazil, <sup>3</sup> Escola Nacional de Saúde Pública, Fundação de Amparo à Pesquisa do Estado de Bahia, Salvador, Brazil, <sup>4</sup> Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil, <sup>5</sup> Division of International Medicine and Infectious Diseases, Weil Medical College of Cornell University, New York, New York, United States of America

Abstract from: <http://www.ploscompbiol.org/doi/pcbi.1000361>

Background

Leptospirosis has become an urban health problem as slum settlements have expanded worldwide. Efforts to identify interventions for urban leptospirosis have been hampered by the lack of population-based information on *Leptospira* transmission determinants. The aim of the study was to estimate the prevalence of *Leptospira* infection and identify risk factors for infection in the urban slum setting.

Methods and Findings

We performed a community-based survey of 3,171 slum residents from Salvador, Brazil. *Leptospira* agglutinating antibodies were measured as

turn all highlighting off | data | disease | habitat | institution | organism | person | place | protein | taxon

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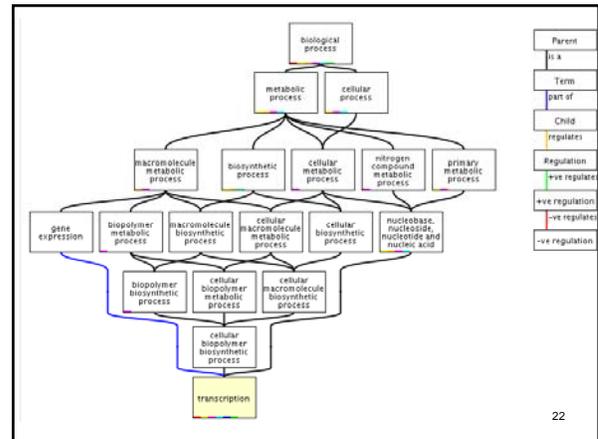
We performed a community-based survey of 3,171 slum residents from Salvador, Brazil. *Leptospira* agglutinating antibodies were measured as

Most successful ontology venture thus far

\$100 mill. invested in literature and database curation using the Gene Ontology (GO) over 11 million annotations relating gene products (proteins) described in the UniProt, Ensembl and other databases to terms in the GO

GO provides a controlled system of representations for use in annotating data and literature that is

- multi-species
- multi-disciplinary
- multi-granularity, from molecules to population



The GO and its sister ontologies are structured representations of the domains of molecules, cells, diseases ... which can be used by researchers in many different disciplines who are focused on one and the same biological reality

The goal: virtual science

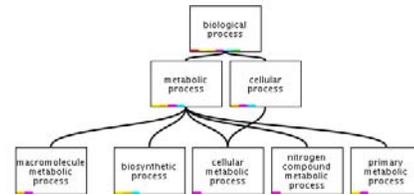
- consistent (non-redundant) annotation
  - cumulative (additive) annotation
- yielding, by incremental steps, a virtual map of the entirety of reality that is accessible to computational reasoning

This goal is realizable if we have a common ontology framework

- data is retrievable
- data is comparable
- data is integratable

only to the degree that it is annotated using a common controlled vocabulary – compare the role of seconds, meters, kilograms ... in unifying science

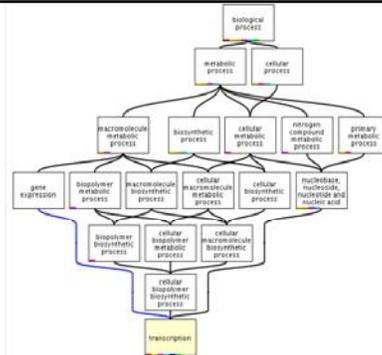
To achieve this end we have to engage in something like philosophy



is this the right way to organize the top level of this portion of the GO?  
how does the top level of this ontology relate to the top levels of other, neighboring ontologies?

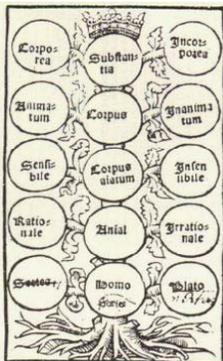
## Aristotle's Metaphysics

The world is organized via types/universals/categories which are hierarchically organized

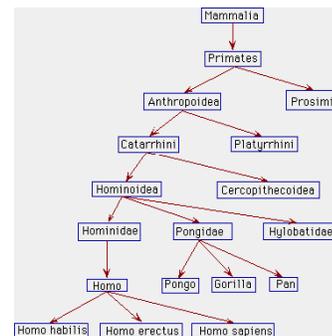


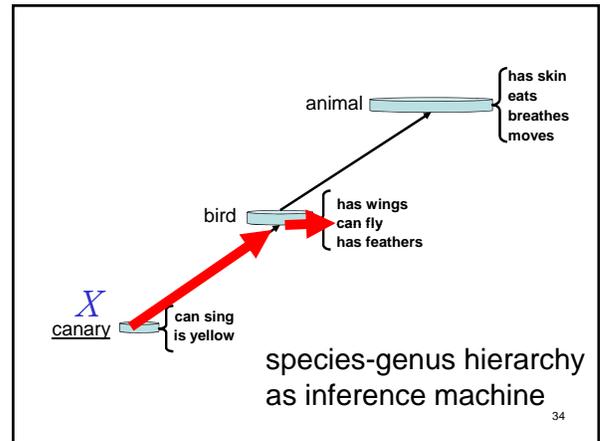
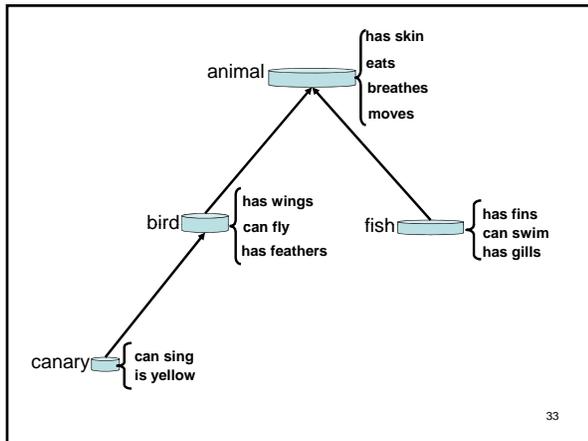
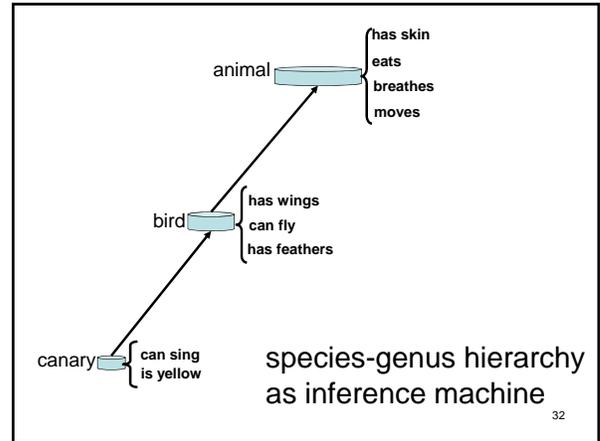
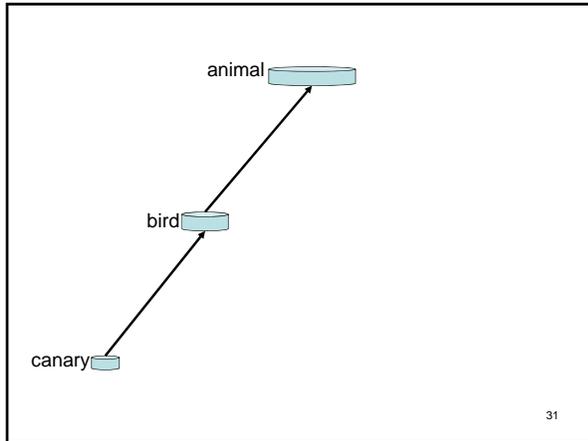
This holds, too, of the biological world

## Porphyrian Hierarchy



## Linnaean Hierarchy

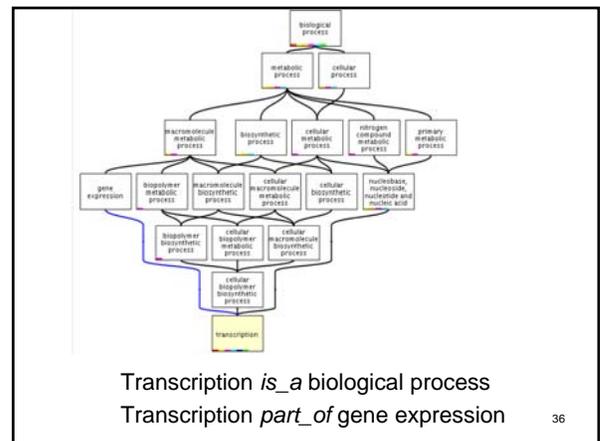




Question: Why are species-genus hierarchies good ways to represent the world for purposes of reasoning?

Answer: They capture the way the world is (Aristotelian realism)

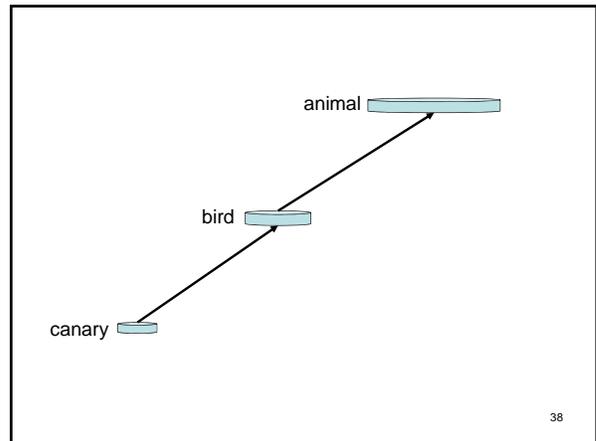
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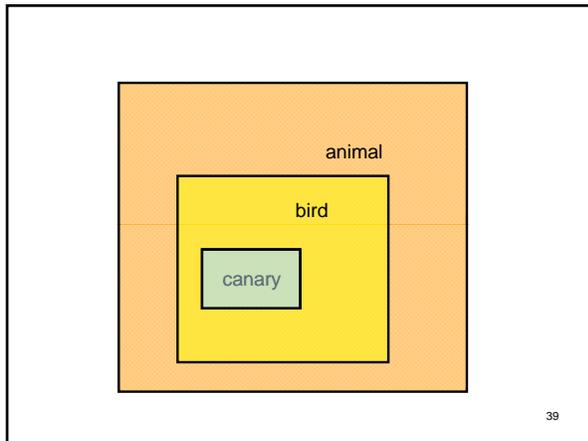
Species-genus trees can be represented also as map-like **partitions**

If Aristotelian realism is right, then such partitions, when correctly built are **transparent** to the reality beyond

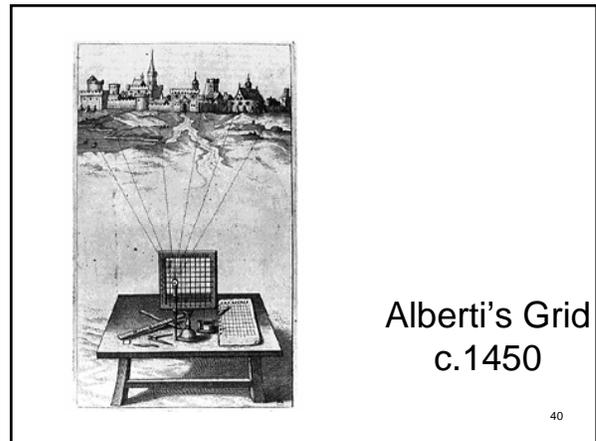
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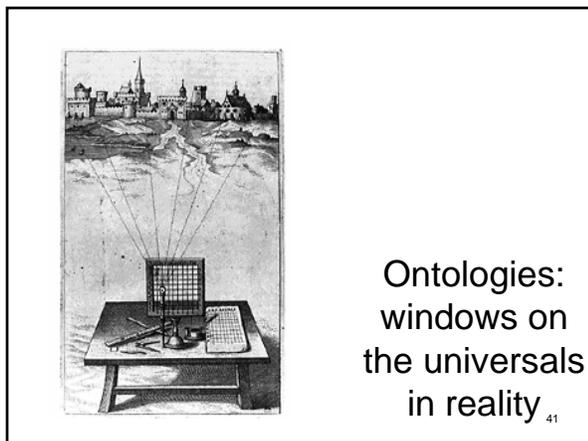
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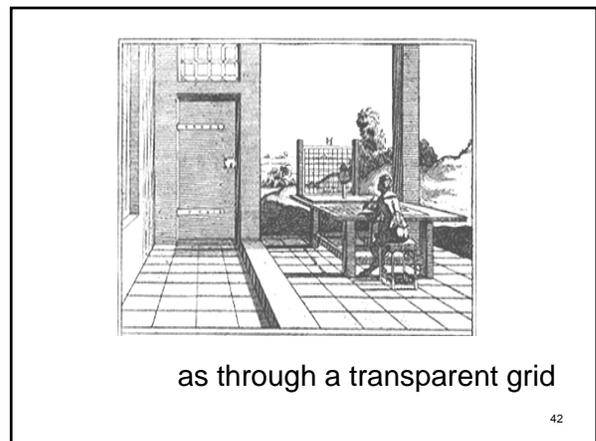
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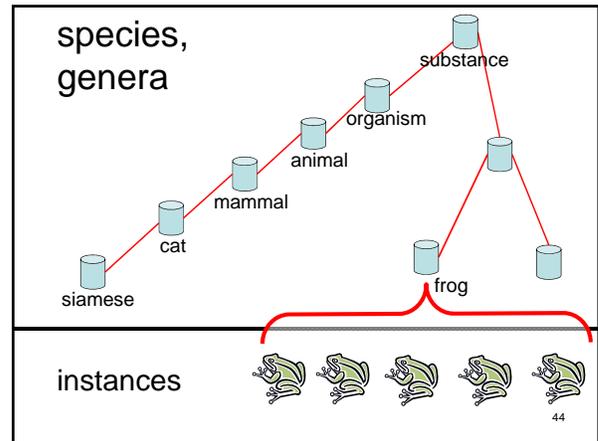
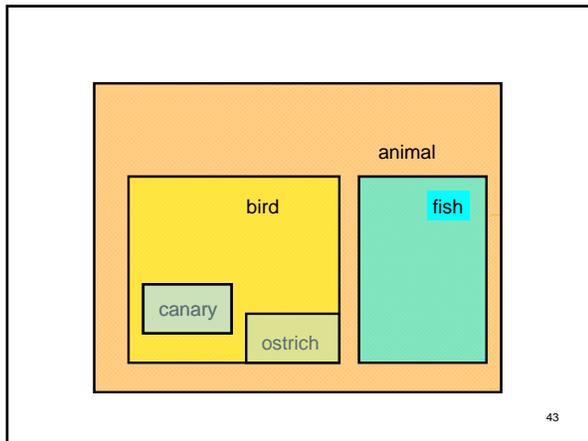
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41



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Aristotle's *Metaphysics* is focused on *objects (things, substances, organisms)*

The most important universals in his ontology are substance universals

*cow man rock planet*

which pertain to *what* a thing is at all times at which it exists

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For Aristotle, the world contains also accidents

which pertain to *how* a thing is at some time at which it exists:

*red hot suntanned spinning*

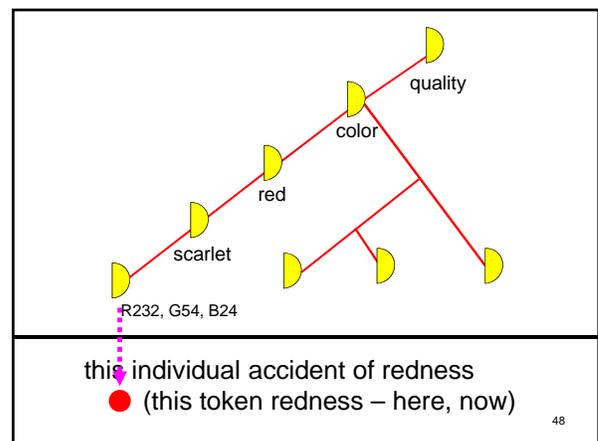
= what holds of a substance *per accidents*

46

**Accidents, too, instantiate genera and species**

Thus accidents, too, form trees of greater and lesser generality

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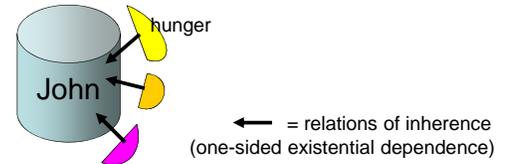


## Nine Accidental Categories

<i>quid?</i>	substance
<i>quantum?</i>	quantity
<i>quale?</i>	quality
<i>ad quid?</i>	relation
<i>ubi?</i>	place
<i>quando?</i>	time
<i>in quo situ?</i>	status/context
<i>in quo habitu?</i>	habitus
<i>quid agit?</i>	action
<i>quid patitur?</i>	passion

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## Substances are the *bearers* of accidents



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## Aristotle 1.0

an ontology recognizing:  
 substance tokens  
 accident tokens  
 substance types  
 accident types

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## Aristotle's Ontological Square

	Substantial	Accidental
Universal	Second substance <i>man</i> <i>cat</i> <i>ox</i>	Second accident <i>headache</i> <i>sun-tan</i> <i>dread</i>
Particular	First substance <i>this man</i> <i>this cat</i> <i>this ox</i>	First accident <i>this headache</i> <i>this sun-tan</i> <i>this dread</i>

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Some philosophers accept only  
 part of this four category  
 ontology

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## Standard Predicate Logic – F(a), R(a,b) ...

	Substantial	Accidental
Universal		Attributes F, G, R
Particular	Individuals <i>a, b, c</i> <i>this, that</i>	

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## Bicategorical Nominalism

	Substantial	Accidental
Universal		
Particular	First substance <i>this man</i> <i>this cat</i> <i>this ox</i>	First accident <i>this headache</i> <i>this sun-tan</i> <i>this dread</i>

55

## Process Metaphysics

	Substantial	Accidental
Universal		
Particular		Events Processes "Everything is flux"

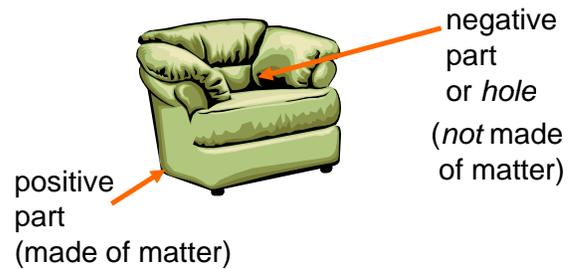
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In fact however we need more than the ontological square

Not everything in reality is either a substance or an accident

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## Positive and negative parts



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60

Niches, environments are holes



61



62

Places are holes



63

### Nine Accidental Categories

<i>quid?</i>	substance
<i>quantum?</i>	quantity
<i>quale?</i>	quality
<i>ad quid?</i>	relation
<i>ubi?</i>	place
<i>quando?</i>	time
<i>in quo situ?</i>	status/context
<i>in quo habitu?</i>	habitus
<i>quid agit?</i>	action
<i>quid patitur?</i>	passion

64

For Aristotle the **place** of a substance is the interior boundary of the surrounding body  
(for example the interior boundary of the surrounding water where it meets a fish's skin)

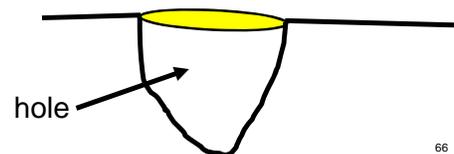
For holes, we need an extension of Aristotle's metaphysics

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### A hole in the ground

Solid physical boundaries at the floor and walls

but with a lid that is not made of matter:



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## Holes involve two kinds of boundaries

bona fide boundaries *which exist independently of our demarcating acts*

fiat boundaries *which exist only because we put them there*

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## Examples

### of bona fide boundaries:

an animal's skin, the surface of the planet

### of fiat boundaries:

the boundaries of postal districts and census tracts

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## Mountain

bona fide upper boundaries  
with a fiat base:



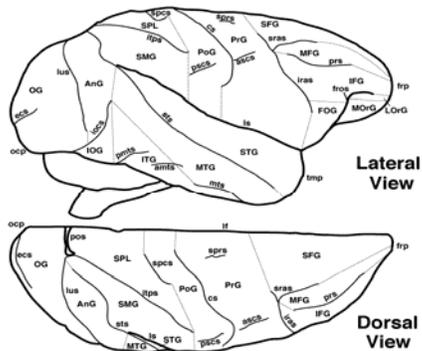
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where does the mountain start ?



... a mountain is not a substance

70



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## Aristotle 1.5

an ontology of  
substances + accidents  
+ holes (and other  
entities not made of matter)  
+ fiat and bona fide boundaries  
+ artefacts and environments

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## Question

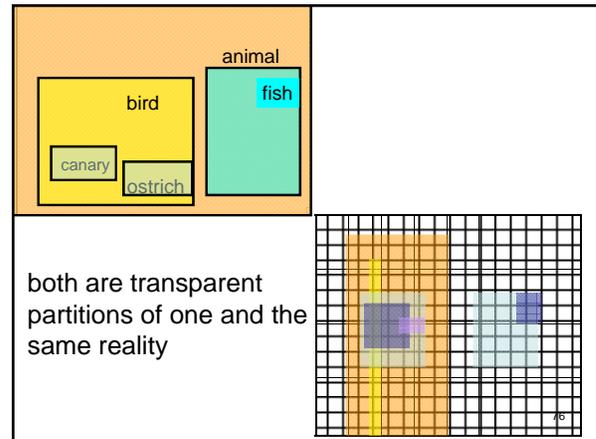
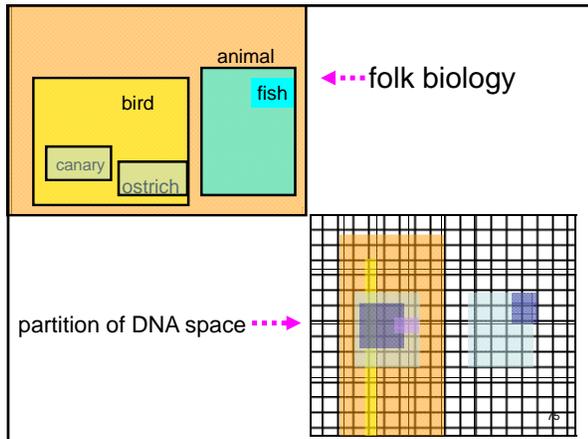
How do those parts and dimensions of reality which we encounter in our everyday experience relate to those parts and dimensions of reality which are studied by science?

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# Aristotle 2010

scientific realism coupled with realism about the everyday world

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- An organism is a totality of atoms
- An organism is a totality of molecules
- An organism is a totality of cells
- An organism is a single unitary substance
- ... all of these express **veridical partitions**

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## Multiple transparent partitions

at different levels of granularity

operating with species-genus hierarchies and with an ontology of substances and accidents along the lines described by Aristotle

substances and accidents reappear in the microscopic and macroscopic worlds of e.g. of chemistry and evolutionary biology

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we do not assert

that every level of granularity is structured in substance-accident form -- perhaps there are pure process levels, perhaps there are levels structured as fields

# Perspectivalism

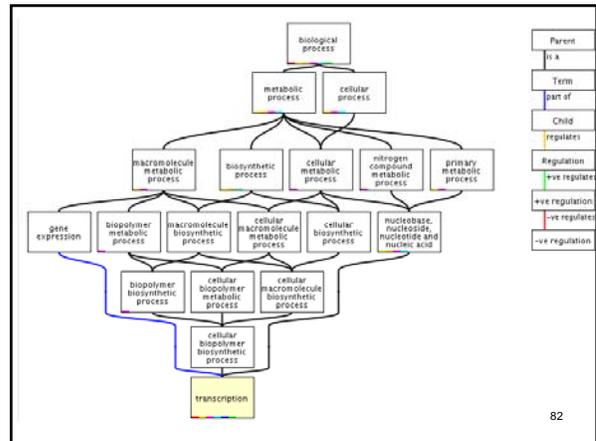
Different partitions may represent cuts through the same reality which are skew to each other

Not all need be structured in substance-accident terms – perhaps there are pure process levels, perhaps there are levels structured as fields

**Periodic Table of Elements**

Legend - click to find out more...

- H - gas
- Li - solid
- Br - liquid
- Tc - synthetic
- Non-Metals
- Transition Metals
- Rare Earth Metals
- Halogens
- Alkali Metals
- Alkali Earth Metals
- Other Metals
- Inert Elements



## Scientific partitions like the Periodic Table or the Gene Ontology

are transparent to the hierarchical order of an associated domain of objects

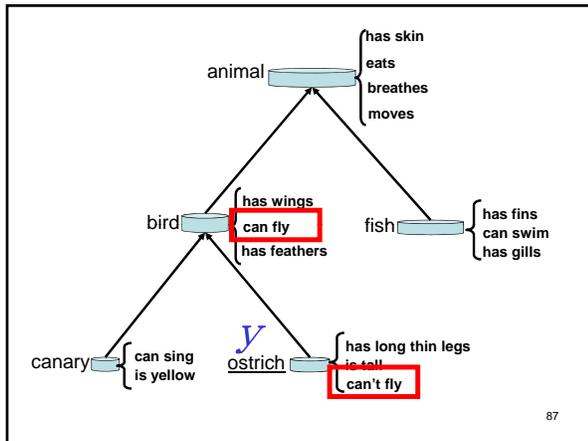
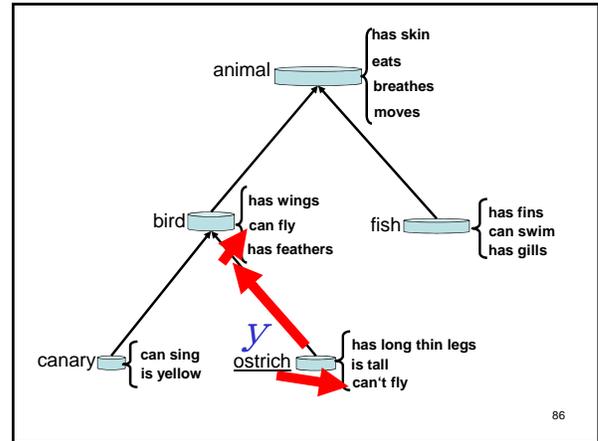
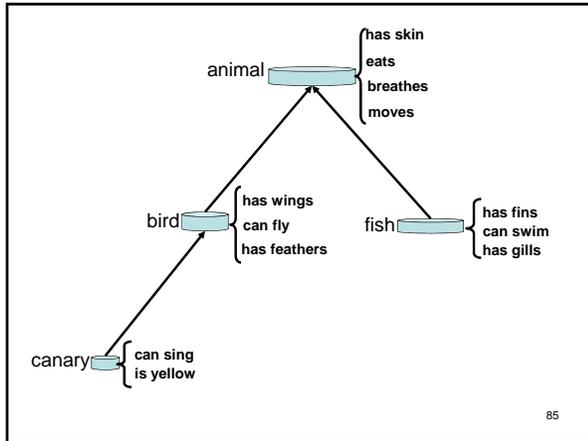
they capture reality at different levels of granularity

cellular constituents are visible to the GO, molecular constituents not

# Perspectivalism

Different partitions may represent cuts through the same reality which are skew to each other

Different partitions may capture reality in ways which involve different degrees of vagueness



How can ■ ■ ■ ■-based conceptualizations be transparent, if the world is shaped like this

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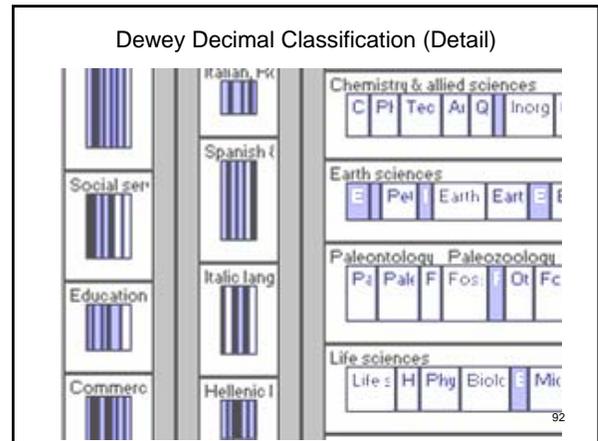
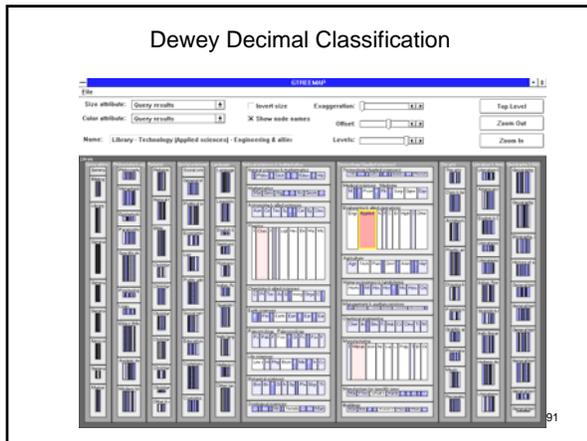
Observe that no such problems arise for the closed worlds constructed in information systems

hierarchies as reasoning tools work very well for the closed worlds of database engineers

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whether a file is in a given folder on your hard-drive is completely determinate:

90



No borderline cases in the closed world of a database

Every book is assigned a determinate Dewey Classification Number at birth

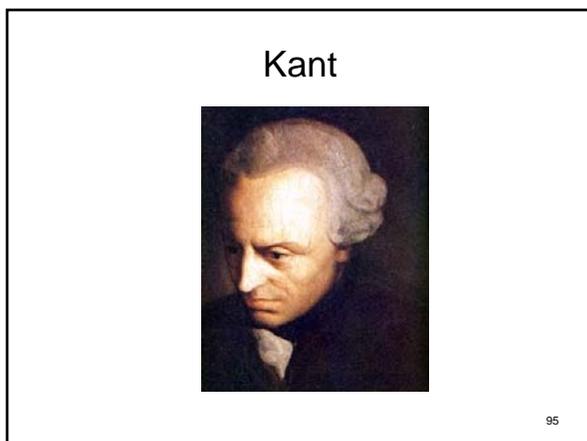
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this yields a classification that is completely *crisp*

... and always up-to-date

*To be a book* = to have a reference number in the Catalogue System

Each of the ontologies produced by ontological engineers deals with objects which are constructed (Kant would say "constituted") by the database itself



### Sharpness of database reality vs. vagueness of flesh and blood reality

How to deal with the problem of vagueness of our representations?

How to create adequate representations beyond the quasi-Kantian realm of database engineers

## Kantian Constructivism

There are no species-genus hierarchies in reality *unless we put them there*

The world – insofar as it is accessible to us through our concepts at all – is a *closed system* tailored by us to fit those concepts

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## Kantianism seems to work very well for the closed worlds of database environments

There Midas-touch epistemology is appropriate

If our database recognizes only two genders, then the world represented in the database is a world in which there are only two genders

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**Kantianism:** we constitute/shape (empirical) reality in such a way that it corresponds to our categories

**Aristotelianism:** reality in itself is messy, but our categories fit nonetheless

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## For Aristotelians

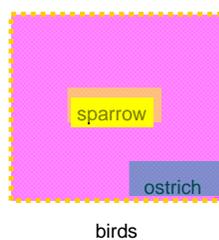
when we apply general terms to reality we are aware that we may have to deal with an opposition

... between standard or focal or **prototypical** instances of the corresponding universals

... and non-standard or '**fringe**' instances

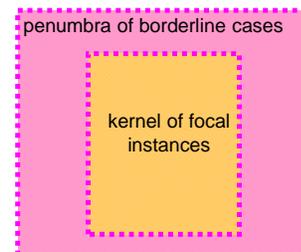
100

Natural categories have *borderline cases*

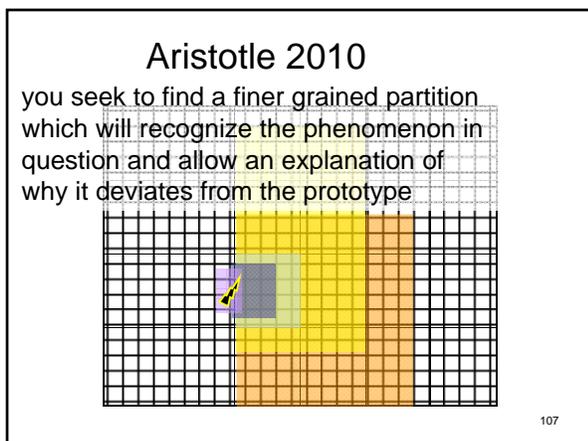
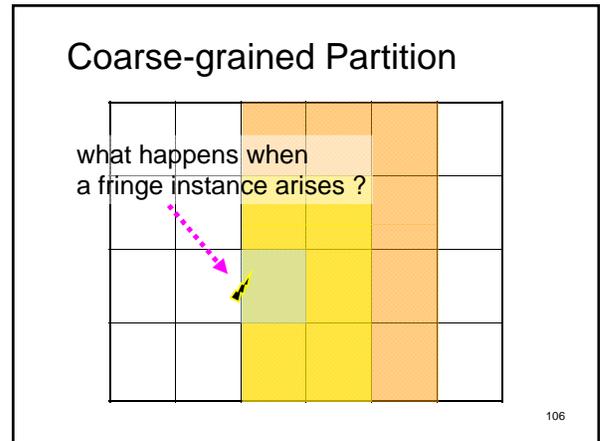
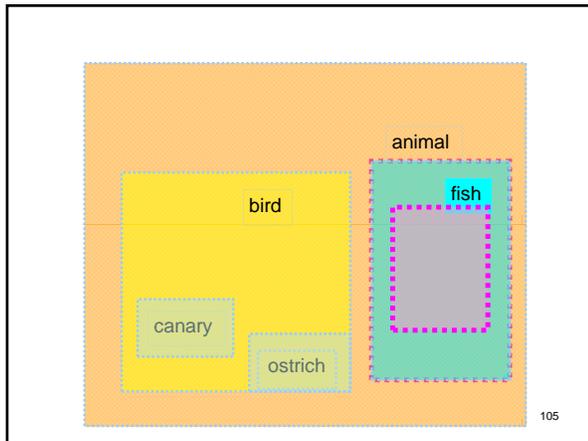
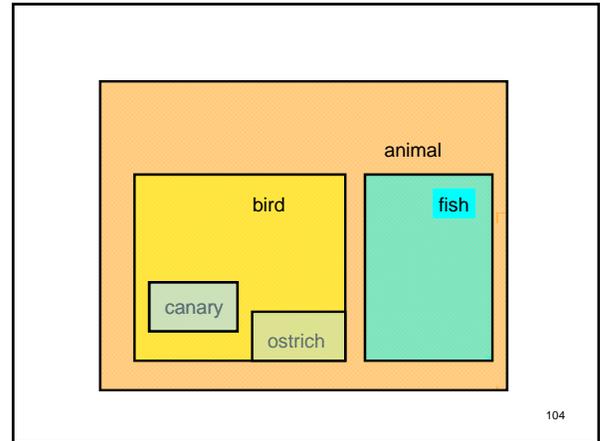
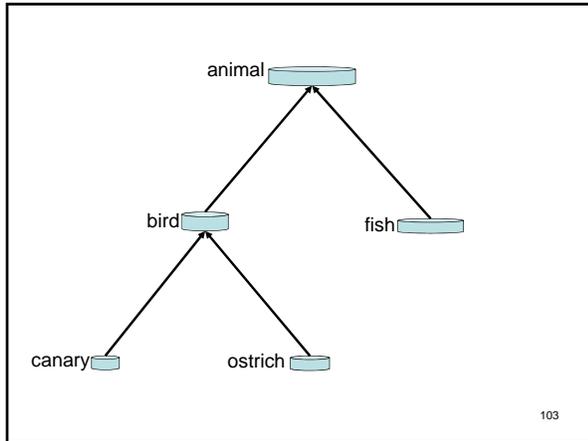


101

... they have a kernel/penumbra structure



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### The advance of science

is not an advance away from Aristotle towards something better.

Provided Aristotle is interpreted aright, it is a rigorous demonstration of the correctness of his ontological approach

108



## propositional logic

$p \ \& \ q$   
 $p \ \vee \ q$   
 $p \ \rightarrow \ q$   
 $\sim p$   
 $\sim p \ \rightarrow \ (q \ \vee \ (r \ \& \ \sim s))$

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## Predicate logic

atomic sentences:  $F(a), R(a,b), \dots$

molecular sentences:

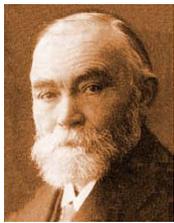
$F(a) \ \& \ G(b)$

$F(a) \ \rightarrow \ \text{for some } x, R(a, x)$

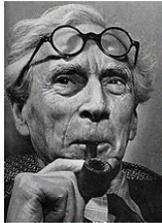
for all  $x (P(x) \ \rightarrow \ \text{for some } y, L(x, y))$

this syntax inspired by the mathematical symbolism of function and argument

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Frege



Russell



Wittgenstein

as a result of their work, the language of predicate logic came to be awarded a special role in the practice of philosophy

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## David Armstrong



spreadsheet ontology

118

	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
a																	
b																	
c																	
d																	
e																	
f																	
g																	
h																	
i																	
j																	
k																	

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	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
a			x		x					x	x	x					
b																	
c																	
d																	
e																	
f																	
g																	
h																	
i																	
j																	
k																	

120

	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
a			x		x				x	x	x						
b		x	x								x	x					x
c																	
d																	
e																	
f																	
g																	
h																	
i																	
j																	
k																	

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	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
a			x		x				x	x	x						
b		x	x								x	x					x
c		x	x											x	x	x	
d						x											x
e																	
f																	
g																	
h																	
i																	
j																	
k																	

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## Fantology

The doctrine, usually tacit, according to which 'Fa' (or 'Rab') is the key to the ontological structure of reality

The syntax of first-order predicate logic is a mirror of reality (a Leibnizian *universal characteristic*)

(Fantology a special case of **linguistic Kantianism**: the structure of language is they key to the structure of [knowable] reality)

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## Formal Ontology vs. Formal Logic

**Formal ontology** deals with the interconnections of *things* with *objects* and *properties*, *parts* and *wholes*, *relations* and *collectives*

**Formal logic** deals with the interconnections of *truths* with *consistency* and *validity*, or and *not*

124

## Formal Ontology vs. Formal Logic

Formal ontology deals with **formal ontological structures**

Formal logic deals with **formal logical structures**

'formal' = obtain in all material spheres of reality

125

Entails is a *logical* relation  
Part-whole is an *ontological* relation

First mistake of fantology:  
All form is logical form

126

## Semantic background of fantology

'F' stands for a property

'a' stands for an individual

properties belong to something like the Platonic realm of forms

or

properties are sets of those individuals a for which  $F(a)$  is true

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## For the fantologist

" $F(a)$ ", " $R(a,b)$ " ... is *the* language for ontology

This language reflects the structure of reality

The fantologist sees reality as being made up of atoms plus abstract (1- and  $n$ -place) 'properties' or 'attributes'

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## Fantology

Fa

All generality belongs to the predicate 'F'

'a' is a mere name

Contrast this with the way *scientists* use names:

DNA-binding requirement of the yeast protein Rap1p as selected *in silico* from ribosomal protein gene promoter sequences

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For extreme fantologists 'a' leaves no room for ontological complexity

From the fact that predicate logic can (by assumption) be used to represent reality

It follows that: reality is made of atoms

(See Wittgenstein, *Tractatus Logico-Philosophicus*)

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For extreme fantologists 'a' leaves no room for ontological complexity

From this it follows:

that fantology cannot do justice to the existence of different levels of granularity of reality

more generally, that fantology is conducive to **reductionism** in philosophy

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## Fantology

Tends to make you believe in some future state of 'total science'

when the values of 'F' and 'a', all of them, will be revealed to the elect

All true ontology is the ontology of a future perfected physics of ultimate atoms

132

## The application of the fantological approach

to a subject-domain thus presupposes the isolation of some basic level of atoms but then brings the additional task of simulation of all structures appearing on higher levels by means of logical constructions. (Cf. Carnap's *Aufbau*)

133

## Fantology

Fa

The particular corresponds to a 'bare name', leading to a noumenal view of 'bare particulars'

Cf. Wittgenstein's *Tractatus* doctrine of simples – and his inability to name even one example

But then in virtue of what could it be the case that Fa, rather than  $\sim$ Fa

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## Properties are abstract entities

They are timeless (they do not change)  
How can they be connecting up with the real entities with which they are in different ways associated.

135

## Fantology

All form is logical form

All necessity is logical necessity

Cf. Wittgenstein's doctrine of the independence of states of affairs

also the Wittgenstein/Armstrong view that all probability is combinatoric

136

	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
a			x		x				x	x	x						
b	x	x									x	x					x
c													x				
d										x							
e	x								x								
f						x											
g				x	x	x				x	x	x				x	
h	x						x	x						x			x
i					x	x	x			x	x			x			
j	x			x		x			x					x			
k	x	x	x														

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## Fantology

Fa

To understand *properties* is to understand *predication*

(effectively in terms of functional application à la Frege)

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## Contrast Aristotle

Predication in the category of substance:

John is a man, Henry is an ox

Predication in the category of accident:

John is hungry, Henry is asleep

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## For Fantology

no predication in the category of substance (or the two types of predication are confused)

Armstrong: property universals are all we need

no need for kind universals

(Armstrong's four-dimensionalism implies that there are no substances)

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## the same form $F(a)$

can be used to express more or less any kind of content

- *a is a human being*
- *a is negatively charged*
- *a is remote from Witwatersrand*
- *a swims regularly*
- *a is distinct from b*
- 

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## Confusion of universals and properties

The fantological doctrine of properties arises when we assume that to every predicate a property corresponds.

This doctrine of properties is ontologically empty

142

There is only one form of states of affairs

Fa

thus no distinction between, for example, predication in the category of substance and predication in the category of accident

John is human

John is suntanned

143

## Fantology

Fa:

This should be the form of laws of nature (things + universal powers)

(not, for instance, differential equations)

Therefore, again, a noumenal view of science

Armstrong not able to name even one example of a really existing universal

or of a really existing particular

Compare again Wittgenstein

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## Fantology

leads not only to Armstrong's atoms + properties view of the basic ingredients of reality

but also to trope bundle views

(where the *a* is deleted, and the *F*, *G*, *H*... are seen as having particularity)

Compare: Leibniz's monadology (each monad is a bundle of concepts)

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## Fantology

Fa

How to deal with time?

Can *simple* particulars gain and lose properties?

If not, how is change possible?

146

## Fantology

(given its roots in mathematics)

has no satisfactory way of dealing with time

hence leads to banishment of time from the ontology

(as in one or other version of four-dimensionalism)

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## For Aristotelians, universals are parts of reality

If redness is a universal, and squareness is a universal, this does not imply that there exist universals

not-redness

redness or squareness

redness and squareness

if exemplifies redness, then exemplifies squareness

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## Booleanism

if *F* stands for a property and *G* stands for a property

then

*F*&*G* stands for a property

*F*∨*G* stands for a property

not-*F* stands for a property

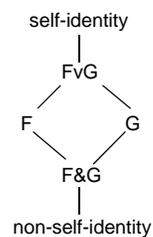
*F*→*G* stands for a property

and so on

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## Strong Booleanism

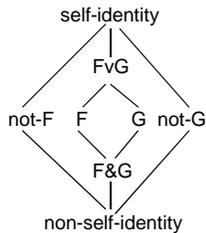
There is a complete lattice of properties:



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## Strong Booleanism

There is a complete lattice of properties, which exactly parallels the structure of the world of sets



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Fantology implies a poor treatment of relations

$R(a,b)$   
in terms of *adicity*

What is the adicity of your headache (A relation between your consciousness and various processes taking place in an around your brain) ?

152

Fantology implies a poor treatment of environments

John kisses Mary  
always in some environment  
(= roughly, in some spatial region: a room, a car ...)  
Spatial regions are, like substances, three-dimensional continuants

153

Fantology leads you to talk nonsense about family resemblances



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## The limitations of fantology

lead one into the temptations of possible world metaphysics

Definition: A possible world  $W$  is a pair  $(L,D)$  consisting of a set of first-order propositions  $L$  and a set of ground-level assertions  $D$ . ... (John Sowa)

155

## A better view

In order to do justice to time we need to recognize both qualities and processes at the level of both universals and instances  
Processes, too, are dependent on substances  
One-place processes:  
    getting warmer, getting hungrier  
Relational processes:  
    kissings, thumpings, conversations, dances

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### The (Aristotelian) Ontological Sextet

	Substances	Quality entities	Processes
Universals	Substance-universals	Quality-universals	Process-universals
Particulars	Individual Substances	Quality-instances (Tropes...)	Process-instances

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### Trope nominalism

	Substances	Qualities	Processes
Universals			
Particulars		Tropes, bundles	

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### The fantological view:

	Substances	Quality entities	Processes
Universals		Properties	
Particulars	Particulars		

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### The set-theoretical view

	Substances	Quality entities	Processes
Universals		Sets	
Particulars	Elements		

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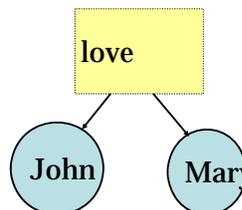
### one-place Quality... entities

tropes, individual properties  
(‘abstract particulars’)

- a blush
- my knowledge of French
- the whiteness of this cheese
- the warmth of this stone

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### relational Quality... entities



stand in relations of one-sided dependence to a plurality of substances simultaneously

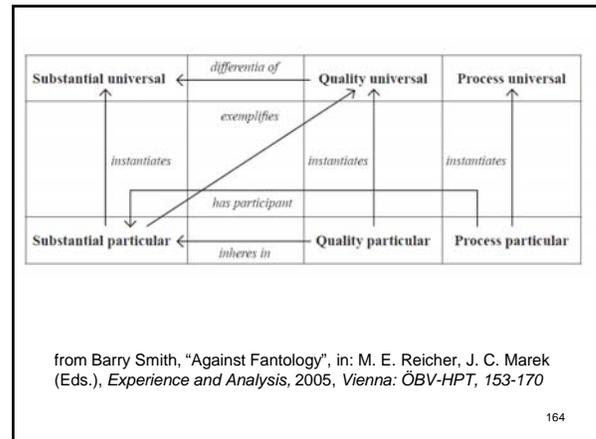
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## The alternative to fantology

must take the spatiality and materiality and modular complexity of substances seriously

A formal theory of parts and wholes and of spatial regions; individual variables and constant terms ('a') typically refer to something that is complex

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The 6 categories of entity are related together

via formal relations such as  
 instantiation  
 part-whole  
 exemplification  
 inherence  
 participation

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## A better syntax

variables x, y, z ... range over  
 universals and particulars in all 6 categories  
 predicates stand only for one or other of these  
 relations such as instantiates, part-of,  
 connected-to, is-a-boundary-of, is-a-niche-for,  
 etc.

the formal relations are not extra ingredients of  
 being

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This suggests a new syntax:

=(x,y)  
 Part(x,y)  
 Inst(x,y)  
 Dep(x,y)  
 Isa(x,y)

John is wise: Inst(John, wisdom)  
 John is a man: Isa(John, man)

<sup>167</sup> FOLWUT (first order logic with universal terms)

## Compare the syntax of first order logic with identity

The interpretation of identity is fixed  
 (does not vary with semantics)

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Compare the syntax of set theory

$\in(x,y)$

$=(x,y)$

two (formal) primitive relational predicates  
plus further defined predicates such as

$\subset(x,y)$

$\subseteq(x,y)$

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New syntax:

$=(x,y)$

Part(x,y)

Inst(x,y)

Dep(x,y)

Compare Davidson's treatment of events

Did(John,e)

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## Types of Formal Relation

Intracategorical

- Part\_of
- Boundary\_of
- Dependent\_on

Intercategorical

- Inheres\_in
  - Located\_in
  - Participates\_in
  - Transcendental
- Identity

Barry Smith, *et al.*, "Relations in Biomedical Ontologies", *Genome Biology* (2005), 6 (5), R46.

171

## FOLWUT

is still first order logic

but it allows quantification over universals  
exactly analogous to traditional  
quantification over individuals (and to  
Davidsonian quantification over events)

in this way it can simulate some of the  
expressive power of second order logic

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## Lecture 3 The Ontology of Social Reality

John Searle



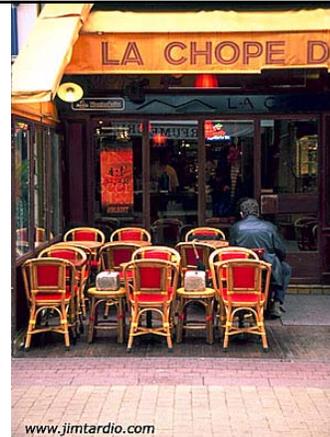
174

## Speech Acts (1969)

requesting, promising, commanding,  
baptising, marrying, apologizing, insulting,  
charging, forgiving, condemning,  
sentencing ...

Social acts which are performed in the act  
of speaking and which change the world

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## The Construction of Social Reality

- I go into a café in Paris and sit in a chair at a table.
- The waiter comes and I utter a fragment of a French sentence.
- I say, 'un demi, Munich, pression, s'il vous plaît.'
- The waiter brings the beer and I drink it.
- I leave some money on the table and leave.
  
- THIS SCENE HAS A 'HUGE INVISIBLE ONTOLOGY'

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## Social Reality

- the waiter did not actually own the beer he gave me, but he is *employed* by the restaurant which owned it.
- The restaurant is *required* to post a list of the *prices* of all the boissons.
- The *owner* of the restaurant is *licensed* by the French government to *operate* it.
- As such, he is *subject* to a thousand *rules* and *regulations* I know nothing about.
- I am *entitled* to be there in the first place *only* because I am a *citizen* of the *United States*, the *bearer* of a *valid passport*, and I have *entered France legally*.

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## Searle does not provide a definition of 'social object'

He is more interested in *social facts*

If the price of my stock rises, this is a social fact, but (Searle says) it is not a fact about some special sort of object called a social object

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## Nevertheless

we can extract a definition of social object from Searle's work:

x is a social object =def x *counts* as a y in context C

where 'y' is a term like 'president', 'cathedral', 'driver's license'

= cognitive theory of social objects

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**For example**

x is a president =def x counts as a president in political contexts

x is a cathedral =def x counts as a cathedral in religious contexts

x is a driver's license =def x counts as a driver's license in legal contexts

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## Social objects are physical objects + special kinds of beliefs

Searle's naturalism: x and y are one and the same part of physical reality (the only reality there is)

- a human being, a building, a piece of plastic -

but x is such as to *fall under different descriptions*: 'president', 'cathedral', 'drivers license'

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## PROBLEM FOR SEARLE

There are important provinces of social reality for which Searle's definition does not work because there is no underlying x term

The y term is in such cases *free-floating*; it exists, but it is not a part of physical reality

The y term exists because there are *documents* which record its existence

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## y = money in a bank account

There is no x term here

Rather the money in your bank account is merely *represented* by blips in the bank's computer

To understand these matters properly we need to pay careful attention to the role of **documents** and **representations** in the architecture of social and institutional reality

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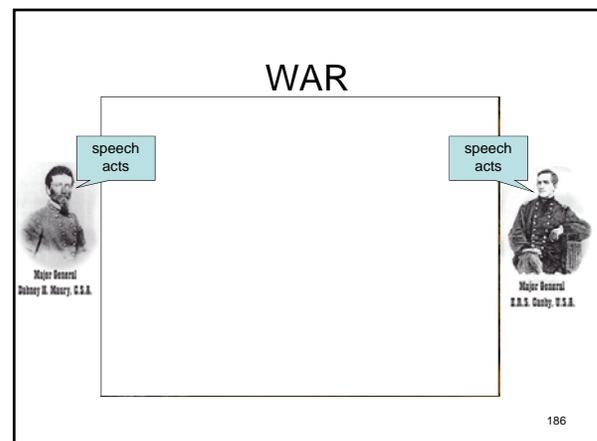
## MAIN THESIS

There are important provinces of social reality for which Searle's definition does not work because there is no underlying x term

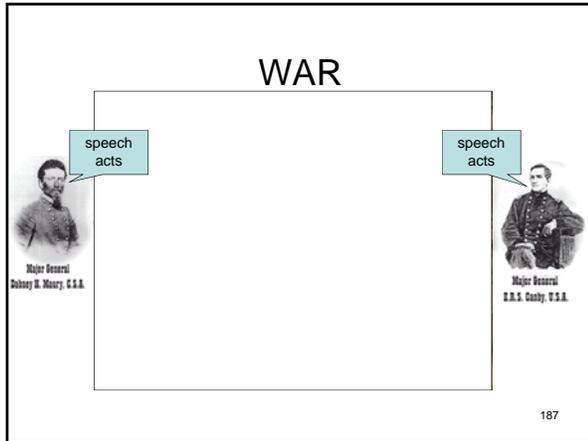
The y term is in such cases *free-floating*; it exists, but it is not a part of physical reality

The y term exists because there are *documents* which record its existence

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186



War is an essentially two-leveled affair  
(speech acts plus physical actions)

contrast wrestling:

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## The Ontology of Chess

(Searle: chess is war in attenuated form)

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## A Game of Chess

- physical
- movements
- of physical
- pieces of
- wood

190

## A Game of Chess

thoughts

- physical
- movements
- of physical
- pieces of
- wood

191

## A Game of Chess

thoughts

thoughts

records

- physical
- movements
- of physical
- pieces of
- wood

representations

192

## A Game of Chess



- physical
- movements
- of physical
- pieces of
- wood

193

## A Game of Blind Chess



194

## A Game of Blind Chess

thoughts



records



thoughts



representations

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## but surely:

A normal chess game doesn't consist of movements of pieces on a board, but of two alternating sequences of acts on the part of the players.

These are (intentional) acts of moving pieces on a board.

A game of blind chess also consists of such alternating sequences of acts

– but now these are speech acts which merely *represent* moves of pieces on a board.

Representing the movements takes the place of actually carrying out the movements.

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## The idea:

A normal chess game doesn't consist of movements of pieces on a board, but of two alternating sequences of acts on the part of the players.

NOTE THAT A SIMILAR ONTOLOGICAL ASSAY COULD NOT BE APPLIED IN THE CASE OF WAR

(there could be no such thing as blind war)

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This essay would imply that every game of chess was ontologically comparable to a game of blind chess

It would be a something non-physical – maybe a sequence of thoughts?

The movements of the pieces would not matter

But the thoughts in the minds of the players and their successive utterances are surely not *parts of the game*

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## A Normal Game of Chess

is something that is both physical and psychological and historical  
it is a physical pattern of movements of pieces tied to specific interrelated players's intentions as realized on a specific historical occasion  
which exists because there are physical acts of moving pieces on the part of the parties involved

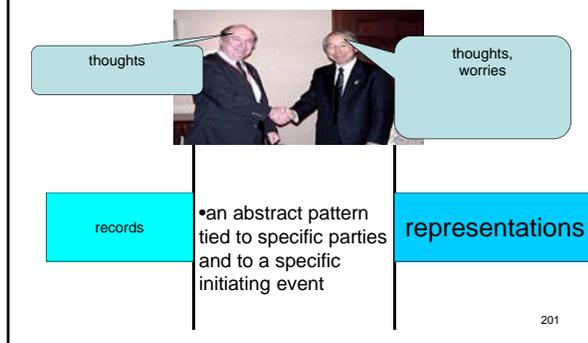
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## A Game of Blind Chess

is something that is both abstract and psychological and historical  
it is an analogous abstract pattern of successive states of the chess board that is analogously tied to specific players and their interrelated intentions as realized on a specific historical occasion  
which exists because there are corresponding speech acts on the part of the parties involved

200

## A Debt



201

## Searle's *Speech Acts* (1969)

- Regulative Rules
  - regulate antecedently existing forms of behavior
  - as rules of polite table behavior regulate eating

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## Constitutive rules

- create new forms of behavior
- as the rules of chess *create the very possibility of* our engaging in the type of activity we call playing chess;
- they have the basic form:

- x counts as y in context c

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## Examples

x = a certain arm movement

y = a signalling to turn left

- x = an utterance of the form
- 'I promise to mow the lawn'
- y = putting yourself under a corresponding obligation

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## Searle:

When you perform a speech act then you create an institutional fact

= a fact whose existence presupposes the existence of certain systems of constitutive rules called 'institutions'

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## Examples of institutions:

- money
- property
- marriage
- government
- chess
- baseball

•Searle's challenge is to develop an ontology of such phenomena that is both realist and naturalistic

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## Realism

social reality exists  
it is not a mere fiction

## Naturalism

- Searle: There is one world, and everything in it is governed by the laws of physics (sometimes also by the laws of biology, neurology, ...)

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## Social Reality

- \_ By acting in accordance with constitutive rules
- \_ we are able to impose certain special rights, duties, obligations
- \_ - 'deontic powers' -
- \_ on our fellow human beings and on the reality around us.

**\_Searle: this 'involves a kind of magic'**

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## Institutional facts

- = social facts involving a deontic component;
- ... they are facts which arise when human beings collectively award **status functions** to parts of reality,
- which means: functions those parts of reality could not perform exclusively in virtue of their physical properties.

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This works always via constitutive rules:

**x counts as y in context c**

- But then naturalism implies that both the x and the y terms in Searle's formula range in every case over token physical entities

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## Social Reality

- By exchanging vows before witnesses
- a man and a woman bring a husband and a wife into being
- (out of x terms are created y terms with new status and powers).

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A President



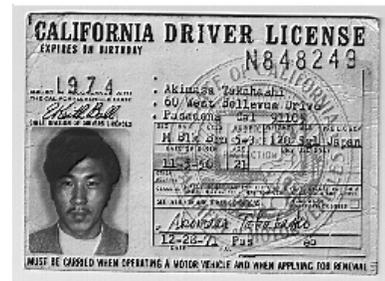
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A Cathedral



213

A Driving License



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## A Wife and A Husband



215

x counts as y, y counts as z

– ... a y term can itself play the role of a new x term in iterations of the formula:

- status functions can be imposed upon physical reality as it has been shaped by earlier impositions of status function

216

–

– but, because of naturalism, this imposition of function gives us nothing ontologically new

- Barack Obama is still Barack Obama even when he *counts as* President;
- Miss Anscombe is still Miss Anscombe even when she *counts as* Mrs Geach
- Contrast non-naturalism of Tibetan Buddhism

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## Social Objects

- While each y term is in a sense a new entity – President Clinton did not, after all, exist before his Inauguration – this new entity is from the physical perspective the same old entity as before.
- What has changed is the way the entity is treated in given contexts and the descriptions under which it falls.

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## Not Turtles All the Way Down

- Searle: wherever a status-function is imposed there has to be something it is imposed upon
- Eventually the hierarchy must bottom out in phenomena whose existence is not a matter of human agreement.

219

## Objects and events

- The range of x and y terms includes not only individual *substances (objects, things)* such as you and me but also *events*
- as when an act of uttering counts as the making of a promise.
- Here the event itself does not physically change; no new event comes into being – merely: the event with which we start is *treated in a special way*.

220

## A Problem for Naturalism

- This works when the y term exists simultaneously with the corresponding x term (e.g. utterance and promise)
- but how can an event which lasts for just 2 seconds be the bearer, the ontological support, the physical foundation, of deontic powers (e.g. claims, obligations) which continue to exist for several months or years?

221

## Searle's response:

- “my analysis originally started with speech acts, and the whole purpose of a speech act such as promising
- “is to create an obligation that will continue to exist after the original promise has been made.
- “I promise something on Tuesday, and the act of uttering ceases on Tuesday, but the obligation of the promise continues to exist over Wednesday, Thursday, Friday, etc.”

222

## Searle admits free-standing y terms:

- “that is not just an odd feature of speech acts, it is characteristic of the deontic structure of institutional reality.
- “So, think for example, of creating a corporation. Once the act of creation of the corporation is completed, the corporation exists.
- *“It need have no physical realization, it may be just a set of status functions.”*

223

## Searle’s response:

- “The whole point of institutional facts is that once created they continue to exist as long as they are recognized.
- “You do not need the x term once you have created the y status function.
- “At least you do not need it for such abstract entities as obligations, responsibilities, rights, duties, and other deontic phenomena, and these are, or so I maintain, the heart of the ontology of institutional reality.”

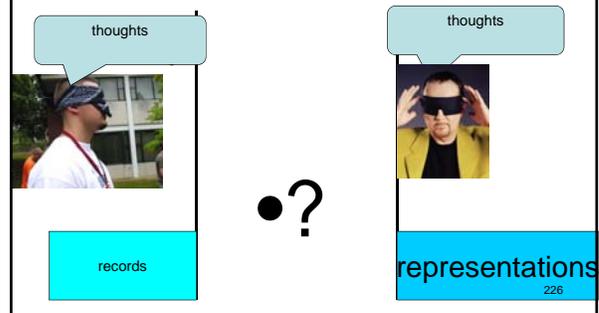
224

## The Problem for Naturalism

- How can Searle sustain naturalism AND accept free-standing y terms?
- how can obligations, responsibilities, rights, duties, corporations – **and blind chess games** – exist *in the very same reality* that is described by physics and biology?

225

## A game of blind chess



226

## Institutional reality

includes not only physical objects and events but also certain **abstract but also historical entities**:

- corporations
- obligations
- debts
- abstract patterns of successive chess-board states

– which have **documentations** but *coincide with no parts of physical reality*

227

## Objects vs. Representations

- Mental acts do not *count as* obligations, any more than blips in computers *count as* money.
- Mental acts do not *count as* moves in chess games
- Worries do not *count as* debts
- Rather, all of these things belong to the domain of records and registrations
- Blips in computers merely represent money
  - Title deeds merely register the existence of a property right

228

## A New View of the Ontology of Social Reality

ground floor = social entities (lawyers, doctors, traffic signs; speeches, coronations, weddings) which coincide with physical objects or events.

these form a physical web of institutional facts

in the interstices of this web are free-standing y terms, which are sustained in being by records and representations

229

## Free-Standing y Terms

are entities of a third kind:

there are neither real, physical entities nor abstract, Platonic entities existing outside time and space

but abstract entities tied to history and to specific contexts of human behavior

230

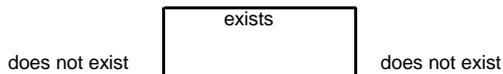
## Free-Standing y Money

does not tarnish

does not burn

is not subject to physical processes

its existence in time rather has the form:



231

## Towards an Ontology of Documents, of Document Acts and of Document-Created Entities

232



**Hernando de Soto**

Institute for Liberty and Democracy,  
Lima, Peru

Bill Clinton:

“The most promising anti-poverty initiative in the world”

233

We are interested in time-sensitive,  
transactional documents

identification documents

commercial documents

legal documents

Thus: not in novels, recipes, diaries ...

234

Yellow = examples in scope

Made of paper	Not made of paper
novel textbook newspaper advertising flier recipe map business card	<div style="background-color: yellow; padding: 5px;">             license              degree certificate              deed              contract              will              bill              statement of accounts              consent form           </div> <div style="background-color: yellow; padding: 5px;">             clay tablet recording outcome of litigation              e-document              electronic health record              credit card              stock market ticker              car license plate           </div> advertising hoarding gravestone hallmarked silver plate film credits exterior signage on buildings

235

- ### Scope of document act theory
- the social and institutional (deontic, quasi-legal) *powers* of documents
  - the sorts of things we can *do* with documents
  - the *social interactions* in which documents play an essential role
  - the *enduring institutional systems* to which documents belong
- 236

- ### Basic distinctions
- document as stand-alone entity vs. document with all its different types of proximate and remote attachments
  - document template vs. filled-in document
  - document vs. the piece of paper upon which it is written/printed
  - authentic documents vs. copies, forgeries
- 237

- ### What happens when you *sign* your passport?
- you initiate the validity of the passport
  - you attest to the truth of the assertions it contains (autographic)
  - you provide a sample pattern for comparison (allographic)
- Three document acts for the price of one
- 238

### Passport acts

I use my passport to prove my identity  
 You use my passport to check my identity  
 He renews my passport  
 They confiscate my passport to initiate my renunciation of my citizenship

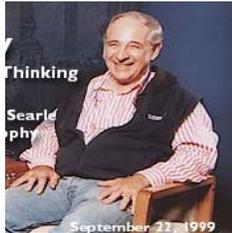
239

### Documents belong to the domain of administrative entities

entities such as organizations, rules, prices, debts, standardized transactions ..., which we ourselves *create*  
 But what does 'create' mean ?

240

- **The Searle thesis:**  
the performance of speech acts brings into being claims and obligations and deontic powers



241

appointings, marryings, promisings  
change the world

... provided certain *background conditions* are satisfied:

- valid formulation
- legitimate authority
- acceptance by addressees

We perform a speech act ... the world changes, instantaneously

242

but speech acts are evanescent entities: they are *events*, which exist only in their executions

we perform a speech act

a new entity comes into being, which survives for an extended period of time in such a way as to contribute to the coordination of the actions of the human beings involved.

what is the physical basis for the temporally extended existence of its products and for their enduring power to serve coordination?

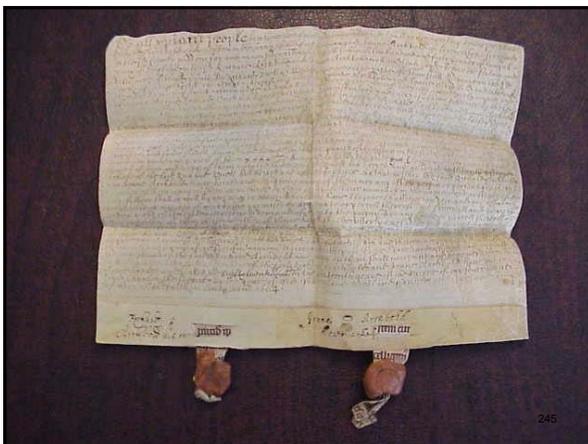
243

## Answer

In small societies: the memories of those involved

In large societies: documents – documents create and sustain permanent re-usable deontic powers

244



245

## Differences between document acts and speech acts

document acts can serve multiple ends (three-for-the-price-of-one)

documents are continuant objects, which endure self-identically through time, and so can create traceable liability

documents can be attached together, creating new complexes whose structure mirrors relations among the human beings involved (of husband to wife, debtor to creditor)

246

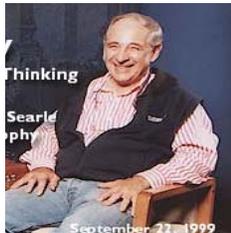
## Differences between document acts and speech acts

- speech acts are normally self-validating (they wear their provenance on their face)
- documents need technological devices (official stamps, special watermarks, signatures, countersignatures, seals, ...)

247



- **The Searle thesis:**  
the performance of speech acts brings into being claims and obligations and deontic powers



249

- **The de Soto thesis:**  
documents and document systems are mechanisms for creating the institutional orders of modern societies



*The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else*,  
New York: Basic Books, 2000

250

## The Mystery of Capital and the Construction of Social Reality



Edited by  
Barry Smith, David Mark, and Isaac Ehrlich

251

## The creative power of documents

- title deeds *create* property
- stock and share certificates *create* capital
- examination documents *create* PhDs
- marriage licenses *create* bonds of matrimony
- bankruptcy certificates *create* bankrupts
- statutes of incorporation *create* business organizations
- charters *create* universities, cities, guilds

252

## The creative (and destructive) power of documents

- restraining order
- prohibition
- summons
- divorce decree
- injunction
- restrictive covenant
- liquidation order

253

## Identity documents

- create identity (and thereby create the possibility of identity theft)
- what is the ontology of identity (and of identity theft)?
- what is the epistemology of identity (of the technologies of identification)?

254

## Things you can do with a document

Sign it  
Stamp it  
Witness it  
Fill it in  
Revise it  
Nullify it  
Realize (interrupt, abort ...) actions mandated by it  
Deliver it (*de facto*, *de jure*)  
Declare it active/inactive  
Display it (price list)  
Register it  
Archive it  
Anchor it to reality

255

## Anchoring

fingerprint  
official stamp  
photograph  
bar code  
cow brand-mark  
car license plate  
*cross-reference* other documents  
attach to other documents

256

## Anchoring is different from aboutness

A clinical laboratory test result is anchored to the laboratory, the sample, the technician, the instrument, ...

It is *about* certain chemical qualities of a certain patient ...

257

## The ontology of signatures

- documents needing signatures
- signed/not signed/incorrectly signed/
- fraudulently signed/signed and stamped
- signed by proxy
- with a single/with a plurality of signatories

258

## The ontology of names

- a baptism ceremony creates a new sort of cultural object called a name
- names, too, belong to the domain of administrative (= created) entities
- this is an abstract yet time-bound object, like a nation or a club
- it is an object with parts (your first name and your last name are parts of your name, in something like the way in which the first movement and the last movement are parts of Beethoven's 9th Symphony)

259

## The ontology of (credit card) numbers

Credit card numbers are not mathematical (not informational) entities – they are 'thick' (historical) numbers, special sorts of cultural artefacts

They are information objects with provenance: abstract-historical keys fitting into a globally distributed abstract-historical lock

260

## The Worlds of Finance: Mathematical Provinces of Institutional Reality

- We often take advantage of the abstract (non-physical) status of free-standing terms in order to manipulate them in quasi-mathematical ways:
  - we pool and collateralize assets
  - we securitize loans
  - we consolidate debts
- But these creative mysteries of capital work only if those involved follow rules of good documentation

261

The screenshot shows the top portion of a Newsweek article. At the top, there are navigation links for 'NATION · POLITICS · WORLD · BUSINESS/TECH · CULTURE · LIFE'. Below this is the Newsweek logo and a search bar. A quote from Brazil's president is visible: "It is time to address that imbalance." Below the search bar are links for 'LOGIN · REGISTER · SUBSCRIBE NOW' and 'BLOGS: THE GAGGLE · WEALTH OF NATIONS · POP VOX · HUMAN CONDITION'. The article is categorized under 'WORLD' and 'FINANCE'. The title is 'TOXIC Paper' and the sub-headline is 'The Obama administration must tackle a problem that has bedeviled the emerging markets for years.' The author is 'Hernando De Soto | NEWSWEEK'. The article was published on Feb 21, 2009, and is from the magazine issue dated Mar 2, 2009. The main text begins with 'Wall Street harshly judged U.S. Treasury Secretary Timothy Geithner's proposals for saving the banks. His televised remarks in mid-February were supposed to reassure watchers by outlining Obama administration's plan for fixing the financial markets, but the market plunged as he said Wall Street was wrong. The lack of details in Geithner's presentation doesn't really matter right now. More important is the fact that the administration has finally focused the U.S. on the primary cause of the current economic crisis: the trillions of dollars of "toxic paper" on the balance sheets of financial institutions. This poisonous paper is scaring off potential creditors and investors who lack the...

## de Soto on the Credit Crunch

Wall Street Journal, March 25, 2009

"... derivatives are the root of the credit crunch. Why? Unlike all other property paper, derivatives are not required by law to be recorded, continually tracked and tied to the assets they represent. Nobody knows precisely how many there are, where they are, and who is finally accountable for them."

263

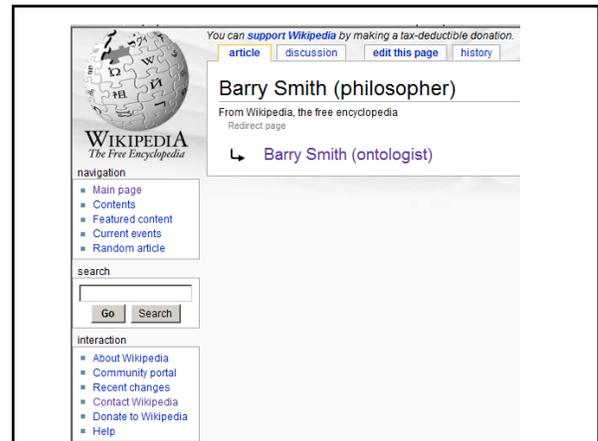
## de Soto on the Credit Crunch

Wall Street Journal, March 25, 2009

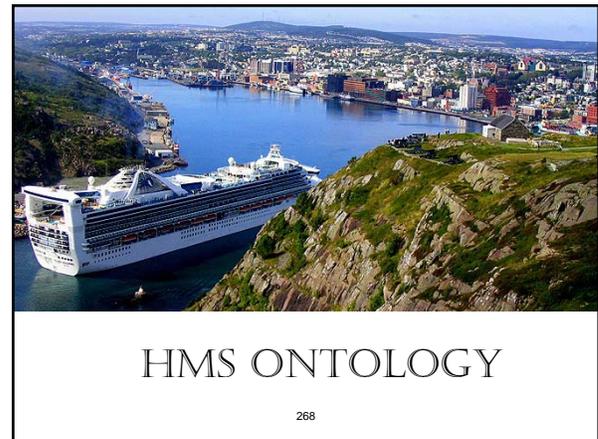
"All documents and the assets and transactions they represent or are derived from must be recorded in publicly accessible registries. It is only by recording and continually updating such factual knowledge that we can detect the kind of overly creative financial and contractual instruments that plunged us into this recession."

264

# Lecture 4 Why I am Not a Philosopher, or Ontologists Leaving the Philosophical Mother Ship



“Why I am not a philosopher”  
October 11, 2006



## Preamble

How, in the 19th century,  
psychologists left the  
philosophical mother ship

## 1866

Franz Brentano:

“Vera philosophiae methodus nulla alia  
nisi scientiae naturalis est.”

1874

Franz Brentano publishes *Psychology from an Empirical Standpoint*

Psychology is the hub and anglepoint of philosophy

“Vera philosophiae methodus nulla alia nisi scientiae naturalis est.”

271

1879

Wilhelm Wundt establishes the world's first psychological laboratory at the University of Leipzig

272

1883

The first laboratory of psychology in America established at Johns Hopkins

University authorities give Wundt's Leipzig laboratory formal recognition

*Tonpsychologie*, vol. I, published by Carl Stumpf

Wundt establishes a journal to publish the results of his laboratory (title is: *Philosophische Studien*)

273

1889

First International Congress of Psychology

Alexius Meinong founds Laboratory of Psychology in University of Graz

First Chinese translation of a Western psychology book, by Joseph Raven, called *Mental Philosophy*

274

1892

**The American Psychological Association founded, with 42 members**

275

1894

Stumpf called to serve as professor of philosophy in Berlin with the explicit task of establishing there an institute of psychology

276

## Stumpf's Berlin Institute

Gestaltists

Wertheimer, Köhler, Koffka, Rubin, Michotte

Twardowski, ein weiterer Brentano-Schüler, gründete das erste psychologische Laboratorium in Polen.

277

Wundt

Meinong

Twardowski

Stumpf

and many initial members of the American Psychological Association were professors of philosophy

When was psychology born as a science?

278

## typical reasons for founding a new discipline

feelings of chaos, deadenedness, triviality inside philosophy

new methods for tackling philosophical problems

empirical results

increasing intersection with other disciplines

increasing need for cross-disciplinary collaboration

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## Stumpf

One reason why German idealism failed was a matter of scientific organisation

'philosophy became fixated on a single personality (Kant) and on his ... "habitus" of thought, which set fundamental barriers to mutual understanding, division of labor, mutual criticism and correction, and mutual recognition ... and gives rise to a kind of dogmatic intolerance'

This habitus is 'alien to science, which rests on the principle of cooperation'

280

## typical reactions to the founding of a new discipline

struggle for resources

fearful reaction from within philosophy

1913 "Erklärung von Dozenten der Philosophie in Deutschland gegen die Besetzung Philosophischer Lehrstühle mit Vertretern der experimentellen Psychologie"

281

## Carnap:

If one is interested in the relations between fields which, according to customary academic divisions, belong to different departments, then he will not be welcomed as a builder of bridges, as he might have expected, but will rather be regarded by both sides as an outsider and troublesome intruder.

"My Work in Philosophy Begins" (in the Carnap Schilpp volume).

282

### typical results of the founding of a new discipline

the new discipline initially lacks sophistication  
is dismissed by the philosophical mother-discipline as 'trivial'  
"Psychologismus", "Szientismus", "Materialismus"  
...  
rapidly acquires resources much larger than those available to the mother discipline  
conferences etc., are rapidly much larger than their philosophical counterparts

283

### Metaphysics (*phil.*)

The science of being

### Ontology (*phil.*)

A theory of the types of entities existing in reality, and of the relations between these types

284

### Ontologies (*tech.*)

Standardized classification systems which enable data from different sources to be combined

285

### Google hits Jan. 2004

ontology + Heidegger	58K
ontology + Aristotle	77K
ontology + philosophy	327K
ontology + software	468K
ontology + database	594K
ontology + information systems	702K

286

### Google hits Oct. 2009

ontology + Heidegger	1.62M
ontology + Aristotle	1.65M
ontology + philosophy	4.86M
ontology + software	6.91M
ontology + database	8.66M
ontology + information systems	9.37M

287

### Comparison 2004/2009

ontology + Heidegger	58K	1.62M
ontology + Aristotle	77K	1.65M
ontology + philosophy	327K	4.86M
ontology + software	468K	6.91M
ontology + database	594K	8.66M
ontology + information systems	702K	9.37M

288

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Web Timeline [Hide options](#) Results 1 - 100 of about 11,300 for ontology history

1600-2009 [Search other dates](#)

1501 1604 - He was more directly influenced by Clemens Templar of Heidelberg, whose *Metaphysicae systema methodicum* was published in Steyerl in 1604. Lorhard followed Templar by defining **ontology** as "the knowledge of the intelligible by which it is intelligible". This ... [Show more](#)  
From [Jacob Lorhard - Wikipedia, the free encyclopedia](#) - [Related web pages](#)  
[en.wikipedia.org/wiki/Jacob\\_Lorhard](http://en.wikipedia.org/wiki/Jacob_Lorhard)

1606 1606 - Abstract: Jacob Lorhard published his **ontology** in 1606. In this work the term **ontology** was used for the **first time** ever. In this paper, it is argued that Lorhard's **ontology** provides a useful key to the understanding of the early 17th-century world view ... [Show more](#)  
From [Jacob Lorhard, \*Optica Scholastica\* \(1606\), the first book on ontology](#) - [Related web pages](#)  
[www.formalontology.it/jacob-lorhard.htm](http://www.formalontology.it/jacob-lorhard.htm)

1613 1613 - In 1613, however, the term is also found in Rudolph Gocckel's *Lexicon philosophicum*. Here the word "ontologia" is only mentioned briefly as follows: "ontologia, philosophia de ente" (ie, "ontology, the philosophy of being"). It is very likely that Gocckel included ... [Show more](#)  
From [Both of a New Science, \*History of Ontology from Suarez to Kant\*](#) - [Related web pages](#)  
[www.formalontology.it/history.htm](http://www.formalontology.it/history.htm)

289

## National Center for Biomedical Ontology

\$18.8 mill. NIH Roadmap Center

- Stanford Medical Informatics
- The Mayo Clinic
- University at Buffalo Department of Philosophy

290

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Workshop on *Ontology of Diseases*  
November 8, 2008 - November 7, 2009 Johns Hopkins University, Baltimore, MD

Genetic

PATO Meeting  
November 30, 2006 - December 2, 2006 Clark Center, Stanford University, Stanford, CA

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National Center for Biomedical Ontology: Advancing Biology through the Structured Organization of Knowledge

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Results 1 - 10 of about 54,100,000 for ontology

**What is an Ontology?**  
Short and long answers from Tom Gruber of Stanford University, Knowledge Systems Lab.  
[www.kit.stanford.edu/ksh/what-is-an-ontology.html](http://www.kit.stanford.edu/ksh/what-is-an-ontology.html) - 7x - [Cached](#) - [Similar pages](#) - [Remove result](#)

**Ontology - Wikipedia, the free encyclopedia**  
Ontology thus has strong implications for conceptions of reality. ... According to this theory, then, **ontology** is the science of being inasmuch as it is ...  
[en.wikipedia.org/wiki/Ontology](http://en.wikipedia.org/wiki/Ontology) - 40k - [Cached](#) - [Similar pages](#) - [Remove result](#)

**Ontology (computer science) - Wikipedia, the free encyclopedia**  
First, unlike a philosophical **ontology**, a computer science **ontology** must, ... Using a foundation **ontology** to provide a common definition of core terms can ...  
[en.wikipedia.org/wiki/Ontology\\_\(computer\\_science\)](http://en.wikipedia.org/wiki/Ontology_(computer_science)) - 37k - [Cached](#) - [Similar pages](#) - [Remove result](#)

**The Gene Ontology**  
The Gene Ontology project provides a controlled vocabulary to describe gene and gene ... The Gene Ontology Consortium is supported by an P41 grant from the ...  
[www.geneontology.org/](http://www.geneontology.org/) - 15k - [Cached](#) - [Similar pages](#) - [Remove result](#)

**Ontology: A resource guide for philosophers**  
An extensive resource site on the development of **ontology**, especially in the twentieth century.  
[www.formalontology.it/](http://www.formalontology.it/) - 61k - 1 May 2006 - [Cached](#) - [Similar pages](#) - [Remove result](#)

**W3C Web Ontology (WebOnt) Working Group (OWLI) [Closed]**  
[www.w3.org/2002/07/owl/](http://www.w3.org/2002/07/owl/) - 10k - 1 May 2006 - [Cached](#) - [Similar pages](#) - [Remove result](#)

**UB** University at Buffalo  
The State University of New York

national center for ontological research

founded October 2005

292

## NCOR

established to:

- advance ontology as science
- advance ontology education
- develop measures of quality for ontologies and to establish best practices

<http://ncor.us>

Main activities:

- initiated Ontology for the Intelligence Community (OIC) series: <http://ncor.us/OICseries>
- ontology contributions to Army Net-Centric Data Strategy

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## Ontology (science)

The science which develops theories of the types of entities existing in given domains of reality, and of the relations between these types

including: ways of testing such theories, ways of using such theories, e.g. in supporting reasoning about empirical data collected by other sciences

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## Examples of Ontology (Science) Projects funded by National Institutes of Health

NIH / NHGRI	GO: Gene Ontology
NIH / NIGMS	PRO: Protein Ontology
NIH / NIAID	IDO: Infectious Disease Ontology
NIH / NIAID	Major Histocompatibility Complex (MHC) Ontology
NIH / NHGRI	SO: Sequence Ontology
NIH / NLM	FMA: Foundational Model of Anatomy
NIH / NHGRI	CL: Cell Ontology

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## NIH funding for ontology (science)

NIH / NHLBI

James Brinkley (Seattle)

Realizing the potential of reference ontologies for the semantic web

NIH / National Library of Medicine

Werner Ceusters (Buffalo)

Realism-based versioning for biomedical ontologies

297

## OBO Foundry Project

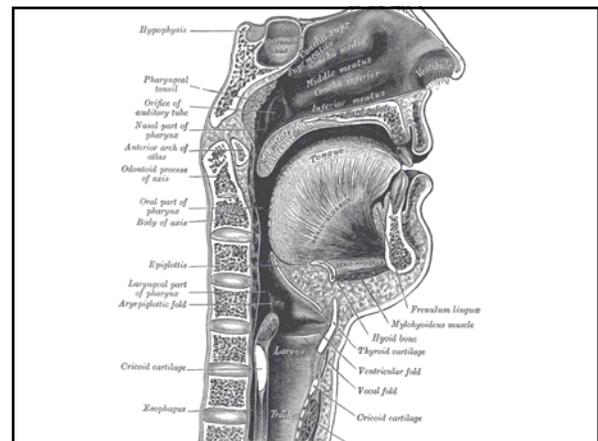
ontology developers in the life sciences have agreed in advance to accept a growing set of best practices in ontology development, these best practices to be determined empirically

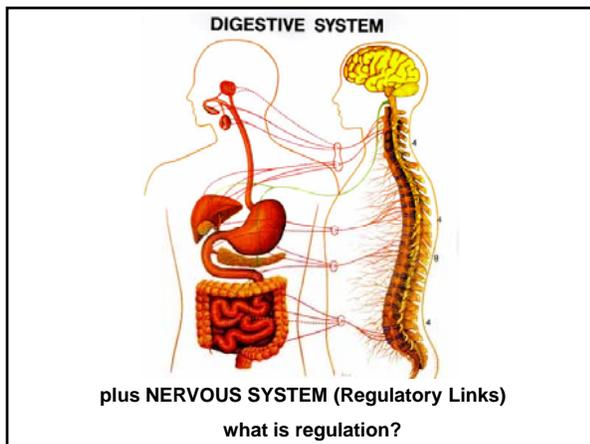
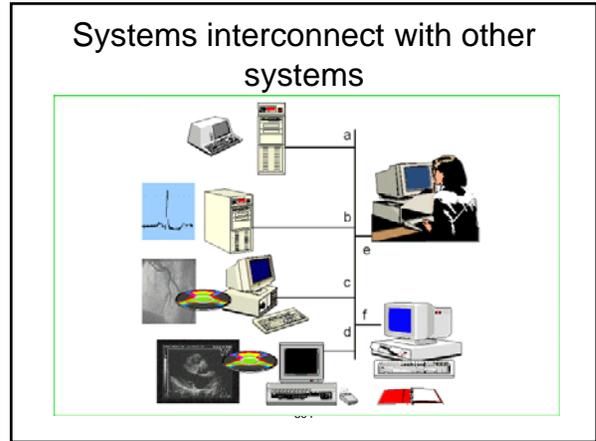
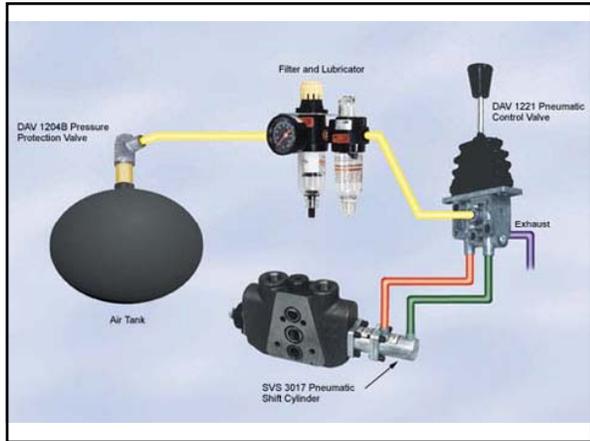
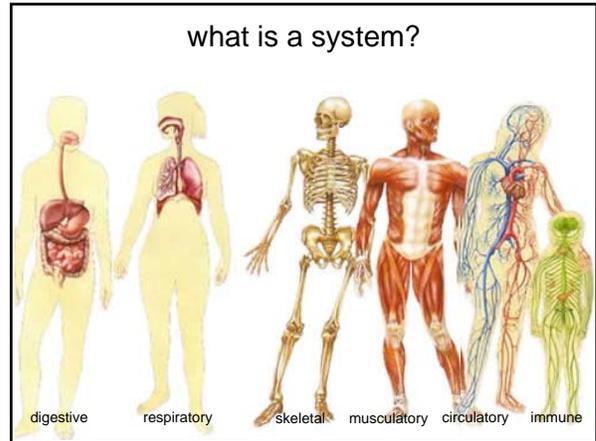
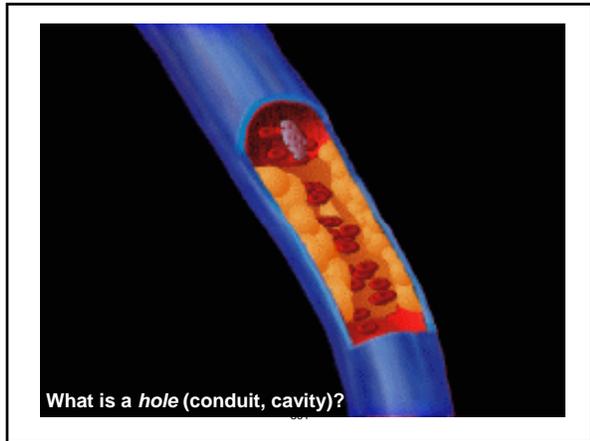
<http://obofoundry.org>

298

RELATION TO TIME	CONTINUANT				OCCURRENT
	INDEPENDENT		DEPENDENT		
ORGAN AND ORGANISM	Organism (NCBI Taxonomy?)	Anatomical Entity (FMA, CARO)	Organ Function (FMP, CPRO)	Phenotypic Quality (PaTO)	Organism-Level Process (GO)
CELL AND CELLULAR COMPONENT	Cell (CL)	Cellular Component (FMA, GO)	Cellular Function (GO)		Cellular Process (GO)
MOLECULE	Molecule (ChEBI, SO, RnaO, PrO)		Molecular Function (GO)		Molecular Process (GO)

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**Systems**

have functions  
can malfunction

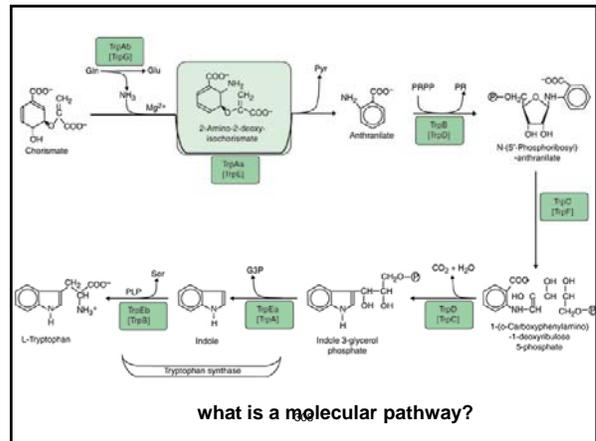
what is disease?  
what is death?

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## Aristotle 2010

an ontology of  
 substances,  
 + qualities  
 + processes  
 + holes (conduits, cavities)  
 + systems, networks  
 + functions, malfunctions

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## Problems with a popular slogan

philosophy should not interfere with the positive sciences

But today, the problem is that computer scientists are interfering with these sciences all the time, and the result is sometimes a disaster.

309

Ontology (*tech.*) often marked by intellectual confusions – above all by the confusion of use and mention

Gruber: 'For AI systems what "exists" is what can be represented'

Microsoft Healthvault: 'An allergy episode is ... a single unit of data that is recorded in Microsoft Healthvault'

310

## Ontology (*science*)

is not a job for software engineers  
 but it is not a job for philosophers, either,  
 e.g. where ontology is playing an increasing role in supporting interdisciplinary communication between human beings – for example in improving communication between Federal government departments

311

## Typical reasons for founding a new discipline

feelings of chaos, deadendedness, triviality inside the mother discipline  
 new methods for tackling problems of the mother discipline  
 new kinds of empirical methods and results  
 increasing need for cross-disciplinary collaboration – e.g. marked by multi-authorship

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**nature biotechnology**

Journal home > Archive > Research > Perspective > Full Text

Journal content Perspective

Journal home  
 Advance online publication  
 Current issue  
 Archive  
 Conferences  
 Focuses and Supplements  
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Journal information  
 Guide to authors  
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 Permissions  
 For referees

Nature Biotechnology **25**, 1251 - 1255 (2007)  
 Published online: 7 November 2007 | doi:10.1038/nbt1346

**The OBO Foundry: coordinated evolution of ontologies to support biomedical data integration**

Barry Smith<sup>1</sup>, Michael Ashburner<sup>2</sup>, Cornelius Rosse<sup>3</sup>, Jonathan Bard<sup>4</sup>, William Bug<sup>5</sup>, Werner Ceusters<sup>6</sup>, Louis J Goldberg<sup>7</sup>, Karen Eilbeck<sup>8</sup>, Amelia Ireland<sup>9</sup>, Christopher J Mungall<sup>10</sup>, The OBI Consortium<sup>11</sup>, Neocles Leontis<sup>12</sup>, Philippe Rocca-Serra<sup>9</sup>, Alan Ruttenberg<sup>13</sup>, Susanna-Assunta Sansone<sup>9</sup>, Richard H Scheuermann<sup>14</sup>, Nigam Shah<sup>15</sup>, Patricia L Whetzel<sup>16</sup> & Suzanna Lewis<sup>10</sup>

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 is pursuing a strategy to overcome this problem. Existing OBO ontologies, including the Gene Ontology, are undergoing coordinated reform, and new ontologies are being created

**nature biotechnology**

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Genome Biology

Workflow and Forms Engine  
 Business Process Mgmt

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Method

**Relations in biomedical ontologies**

Barry Smith<sup>1,2</sup>, Werner Ceusters<sup>3</sup>, Bert Klagges<sup>4</sup>, Jacob Köhler<sup>5</sup>, Anand Kumar<sup>1</sup>, Jane Lomax<sup>6</sup>, Chris Mungall<sup>7</sup>, Fabian Neuhaus<sup>1</sup>, Alan L Rector<sup>8</sup> and Cornelius Rosse<sup>9</sup>

<sup>1</sup>Institute for Formal Ontology and Medical Information Science, Saarland University, D-66041 Saarbrücken, Germany  
<sup>2</sup>Department of Philosophy, University at Buffalo, Buffalo, NY 14260, USA  
<sup>3</sup>European Centre for Ontological Research, Saarland University, D-66041 Saarbrücken, Germany  
<sup>4</sup>Department of Genetics, University of Leipzig, D-04103 Leipzig, Germany  
<sup>5</sup>Rothamsted Research, Harpenden, AL5 2JQ, UK  
<sup>6</sup>European Bioinformatics Institute, Hinxton, CB10 1SD, UK  
<sup>7</sup>HIMI, Department of Molecular and Cellular Biology, University of California, Berkeley, CA 94729, USA  
<sup>8</sup>Department of Computer Science, University of Manchester, M13 9PL, UK  
<sup>9</sup>Department of Biological Structure, University of Washington, Seattle, WA 98195, USA  
 Correspondence: Barry Smith. Email: phsmith@buffalo.edu

Genome Biology 2005, 6:R46 doi:10.1186/gb-2005-6-5-r46

Subject areas: Bioinformatics, Genome studies

The electronic version of this article is the complete one and can be found online at: <http://www.genomebiology.com/2005/6/5/r46>

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Genome Biology 2005, 6:R46 doi:10.1186/gb-2005-6-5-r46

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what is needed to found a new discipline

- journals
- conferences
- institutes
- societies
- industrial applications
- subject-matter
- methods
- cumulative results
- teaching
- career path (inside and outside the university)

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## Journals

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Applied  
Ontology

An interdisciplinary journal on  
ontological analysis and  
conceptual modeling

An Interdisciplinary Journal of Ontological Analysis and Conceptual Modeling

Soon to be published by BioMed Central

 JOURNAL OF  
BIOMEDICAL SEMANTICS

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Dietrich Rebholz-Schuhmann, European Bioinformatics Institute, United Kingdom  
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Journal of Biomedical Semantics is an open access, peer-reviewed online journal soon to be launched by [BioMed Central](#).

Journal of Biomedical Semantics encompasses all aspects of semantic resources (e.g. ontologies, taxonomies, terminologies, data, knowledge and service repositories, literature, reasoning systems) and their use in data integration, mining, modeling, interpretation and exploitation in biomedical research.

The journal aims to provide the community of biomedical semantics specialists and general researchers a forum for communication on knowledge representations and on the results of semantics driven analyses.

Journal of Biomedical Semantics will publish high quality research focused on the biomedical domain, addressing computational methods, infrastructure and resources needed to support semantic mining and enrichment. It will serve researchers who exploit semantic resources and reasoning to facilitate data and knowledge integration into the biomedical research infrastructure. The journal will also provide a place for dissemination of results on the semantic web research in the domain of life sciences. As an interdisciplinary forum, the journal will address practical and theoretical advances in applying knowledge-based and semantics-driven approaches to biomedical research.

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Objectives  
» Objectives  
» Publishing  
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» Editorial Board  
» Specific Notes for Authors  
» Sample Issue

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## Conferences

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**FOIS 2006**

**FOIS-2006**  
International Conference on Formal Ontology in Information Systems



Johns Hopkins University's Gilman Hall; picture courtesy of JHU Conference Services

**November 9-11, 2006**  
Baltimore, Maryland (USA)

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NEWS  
CONFERENCE DESCRIPTION  
ORGANIZING COMMITTEE  
TOPICS  
IMPORTANT DATES  
SUBMISSIONS  
PROGRAMME COMMITTEE  
WEBPAGE

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**International Conference on Biomedical Ontology**  
University at Buffalo, NY • July 24-26, 2009

**CONFERENCE PROCEEDINGS**

Registered Conference Participants    Conference Logistics

POSTER    PROGRAM    AREA HOTELS    REGISTRATION

Call for Papers    Submission Guidelines    Employment Opportunities

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THE NATIONAL CENTER FOR ONTOLOGICAL RESEARCH (NCOR) PRESENTS:



**OIC 2009**  
GMU, Fairfax, Virginia • October 21 - 23, 2009

**ONTOLOGY FOR THE INTELLIGENCE COMMUNITY**  
Towards Effective Exploitation and Integration of Intelligence Resources

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**Japanese Centre For Ontology Research**  
http://abelard.fes.fuo.ac.jp/ontology/index.php/JapaneseCentreForOntologyResearch

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**Menu**

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- Program2006
- Program2006 (30 items)
- Program2004
- Program2004 (30 items)
- Okada Lab
- Cite
- Link

**000200**

**2006-09-27**

- JapaneseCenterForOntologyResearch

**2006-09-26**

- OntologyForumJapan
- The 3rd Ontology Forum is to take place in March 2007.
- The 2nd Ontology Forum (Mar. 2006)
- The 1st Ontology Forum (Dec. 2004)

**2006-09-25**

- Program2006
- The Intersiplinary Workshop on Ontology (Nov. 2001)

The Japan Ontology Forum aims at bringing together ontology researchers in Japan from various fields, including philosophy, logic, AI, ontology-engineering, bio-informatics, medical science, biology, taxonomy, policy-management, e-commerce, semantic web, etc.

The idea of such an interdisciplinary forum was first conceived at the workshop on formal ontology organized by a group of philosophers, logicians, AI researchers and ontology engineers at the 34th Annual Conference of the Philosophy of Science Society, Japan in 2001, and has been materialized as a series of academic conferences.

In particular, the interdisciplinary Ontology Forum has been held annually (in the Japanese academic year) since 2004.

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**Toward Principles for the Design of Ontologies Used for Knowledge Sharing**

*Revision: August 23, 1993*

**Thomas R. Gruber**  
Stanford Knowledge Systems Laboratory  
701 Welch Road, Building C  
Palo Alto, CA 94304  
gruber@ksl.stanford.edu

Presented at International Workshop on Formal Ontology, March 1993, Padua, Italy – Organized by LADSEB

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**Research Institutes**

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In *Formal Ontology in Conceptual Analysis and Knowledge Representation*, edited by Nicola Guarino and Roberto Poli, Kluwer Academic Publishers, in press. Substantial revision of paper presented at the International Workshop on Formal Ontology, March, 1993, Padova, Italy.

Organized by LADSEB (Institute for Systems Science and Biomedical Engineering), where a research group on "Conceptual Modeling and Knowledge Engineering" has been active since 1991.

Under the leadership of Nicola Guarino this group gained an international reputation for its interdisciplinary approach focused on the role of philosophical ontology in the foundations of knowledge representation, ... In 2003 Guarino's group moved to Trento to form the Laboratory for Applied Ontology.

<http://www.istc.cnr.it/about/history.shtml>

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## The Metaphysics Research Lab

**Center for the Study of Language and Information**  
Cordura Hall 202  
Stanford University  
Stanford, CA 94305-4115  
founded 1994

Welcome to the web pages of the Metaphysics Research Lab. Whereas physics is the attempt to discover the laws that govern fundamental concrete objects, metaphysics is the attempt to discover the laws that systematize the fundamental abstract objects presupposed by physical science, such as natural numbers, real numbers, functions, sets and properties, physically possible objects and events, to name just a few. The goal of metaphysics, therefore, is to develop a formal ontology, i.e., a formally precise systematization of these abstract objects. Such a theory will be compatible with the world view of natural science if the abstract objects postulated by the theory are conceived as patterns of the natural world.

In our research lab, we have developed such a theory: the axiomatic theory of abstract objects and relations. In many ways, this theory is like a machine for detecting abstract objects (hence the name 'research lab'), for among the recursively enumerable theorems, there are statements which assert the existence of the abstract objects mentioned above. Moreover, the properties of these abstracts can be formally derived as consequences of the axioms. The theory systematizes ideas of philosophers such as Plato, Leibniz, Frege, Meinong, and Mally. Our results are collated in the document *Principia Metaphysica*, which is authored by Edward N. Zalta (Ph.D. Philosophy), a Senior Research Scholar at CSLI. An online version of *Principia Metaphysica* can be found by following the link to **The Theory of Abstract Objects** (see below). In published work, the theory has been applied to problems in the philosophy of language, intensional logic, the philosophy of mathematics, and the history of philosophy.

**Welcome Message (272K sound file)** ([.mp3](#), [.au](#), or [.wav](#))  
(Recorded December 1, 1994)

<http://mally.stanford.edu/>



*Since 1999, Laboratory for Ontology*

Department of Philosophy, University of Turin, Via Sant'Ottavio, 20 10124 Turin

October 6, 2009

**Labont.it**

The Laboratory for Theoretical and Applied Ontology (Labont) of the University of Turin is a center of study and research member of the CTAO. The research activity of LABONT focuses on Social Ontology.

» **Description**

» **Research**

» **Publications**

- » [Collana di Ontologia](#)
- » [Rivista di Estetica](#)

» **Peoile**

**Members of Labont** founded 1999 <http://www.labont.it/>

Professors and Researchers:  
[Maurizio Ferraris](#), [Pietro Kobau](#), [Tiziana Andina](#), [Cristina Becchio](#), ...

# IFOMIS

Institute for Formal Ontology and Medical Information Science  
Saarland University

The Institute for Formal Ontology and Medical Information Science (IFOMIS) was founded in April 2002 utilizing a grant of the Alexander von Humboldt Foundation. IFOMIS comprehends an interdisciplinary research group, with members from Philosophy, Computer and Information Science, Logic, Medicine, and Medical Informatics, focusing on theoretically grounded research in both formal and applied ontology. Its goal is to develop a formal ontology that will be applied and tested in the domain of medical and biomedical information science. Inquiries regarding long- and short-term research visits are welcome.

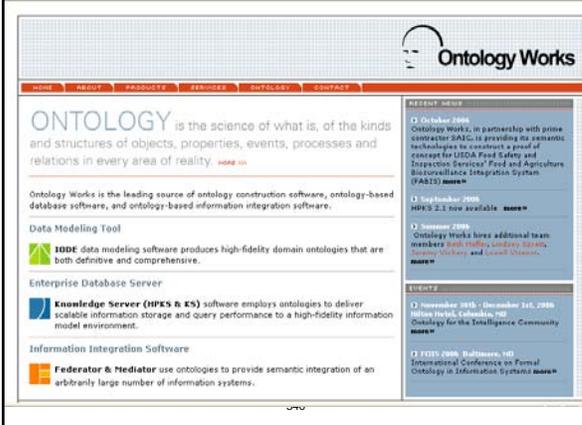
**Main Topics:**  
 Advancing Clinico-Genomic Trials on Cancer (ACGT)  
 Basic Formal Ontology (BFO)  
 OBO Foundry  
 European Patients Smart Open Services (epSOS)

**Book Publications:**  
 L. Jansen, B. Smith (eds.) "Biomedizinische Ontologien. Wissen strukturieren für den Informatik-Einsatz"

Founded 2002

## Industrial applications

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**Ontology Works**

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**ONTOLOGY** is the science of what is, of the kinds and structures of objects, properties, events, processes and relations in every area of reality. [more info](#)

Ontology Works is the leading source of ontology construction software, ontology-based database software, and ontology-based information integration software.

**Data Modeling Tool**

**IDDE** data modeling software produces high-fidelity domain ontologies that are both definitive and comprehensive.

**Enterprise Database Server**

**Knowledge Server (HPKS & KS)** software employs ontologies to deliver scalable information storage and query performance to a high-fidelity information model environment.

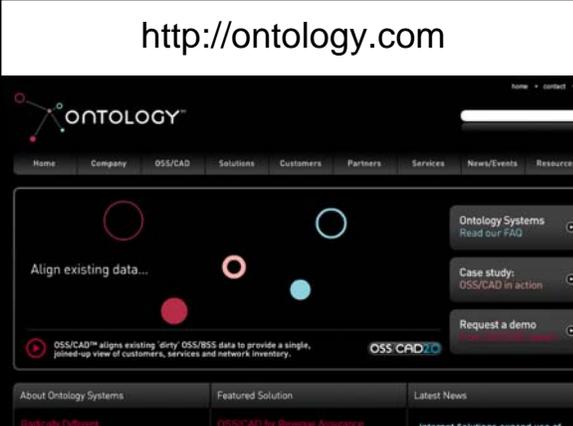
**Information Integration Software**

**Federator & Mediator** use ontologies to provide semantic integration of an arbitrarily large number of information systems.

**RECENT NEWS**

- 12 October 2006  
Ontology Works, in partnership with prime contractor SAIC, is providing its semantic technologies to construct a proof of concept for USDA Food Safety and Inspection Service' Food and Agriculture Bio-surveillance Integration System (FABSIS) [more»](#)
- 12 September 2006  
HPKS 2.1 now available [more»](#)
- 12 November 2005  
Ontology Works hires additional team members [David Taylor, Andrew J. Jones, Jeremy Wilkley, and Laurel Orsman](#) [more»](#)
- 12 November 2005 - December 31st, 2006  
Ontology Works joins the [Ontology for the Intelligence Community](#) [more»](#)
- 12 2005 2006  
Publication: 140 International Conference on Formal Ontology in Information Systems [more»](#)

<http://ontology.com>



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OSS/CAD™ aligns existing 'dirty' OSS/BSS data to provide a single, joined-up view of customers, services and network inventory.

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**ISB** International Society for Biocuration

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Welcome to the ISB

Welcome to the International Society for Biocuration (ISB). The ISB is a non-profit organisation for biocurators, developers, and researchers with an interest in biocuration. The society promotes the field of biocuration and provides a forum for information exchange through meetings and workshops.

For questions or comments, please email [the ISB helpdesk](mailto:the ISB helpdesk).

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typical reactions to the founding of a new discipline

- struggle for resources
- resistance from within philosophy

typical results of the founding of a new discipline

1. the new discipline initially lacks sophistication
2. is dismissed by the philosophical mother-discipline as 'trivial'
3. typically acquires resources much larger than those available to the mother discipline itself
4. conferences etc., are much larger than their philosophical counterparts

### typical results of the founding of a new discipline

- intensified international cooperation
- genuine cooperative work with clear deadlines and goals
- shorter deadlines for publication of research results

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### Why found a new discipline

The needs of Wundt and his psychologist colleagues for trained psychologists could not be met within the then existing curricular and incentive structures of philosophy,

So the world's exploding need for trained ontologists cannot be met with the existing curricular and incentive structures maintained by departments of philosophy today.

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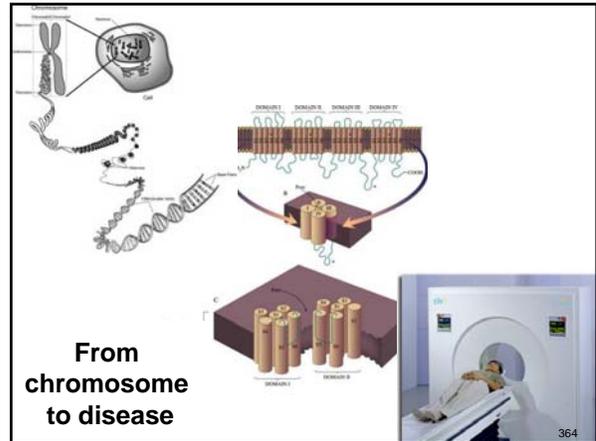
### what is needed to found a new discipline

- journals
- conferences
- institutes
- societies
- industrial applications
- subject-matter
- methods
- cumulative results
- teaching
- career path (inside and outside the university)

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# Lecture 5

## Why computer science needs philosophy



genomics  
 proteomics  
 reactomics  
 metabonomics  
 phenomics  
 behavioromics  
 connectomics  
 toxicopharmacogenomics

... legacy of Human Genome Project

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a vast new problem of data unification

chemistry data  
 biochemical disease pathway data  
 biomedical image data  
 electronic health record data  
 hospital management data  
 hospital insurance data  
 public health data

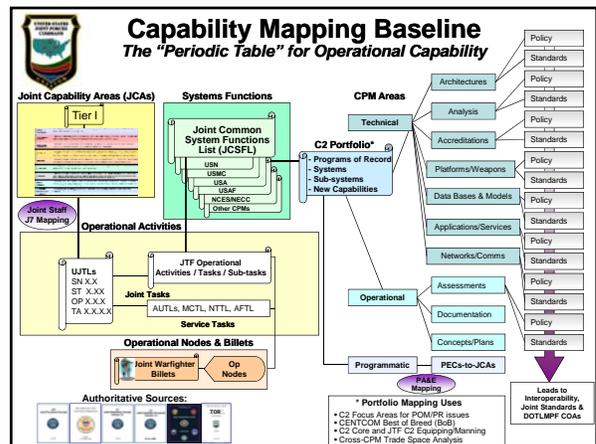
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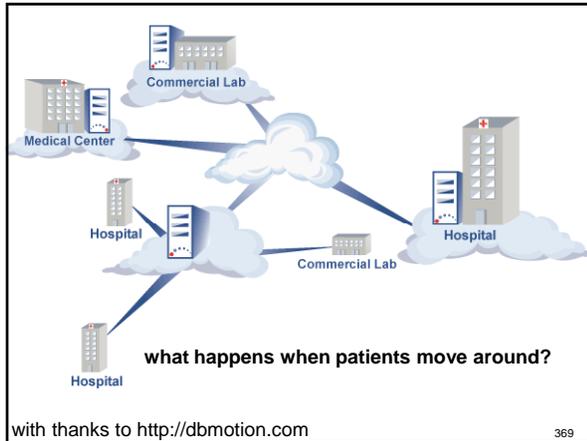
and not only in the world of biology and medicine

### Joint Architectures as a Driver for Common Lexicons

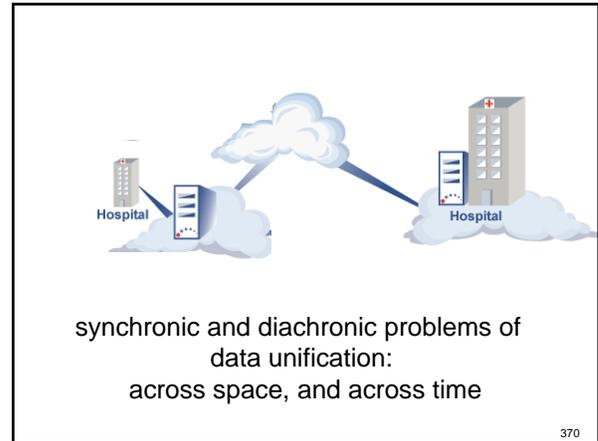
Presented to the Command and Control Ontology Exchange Meeting  
 Buffalo 15 Jan 2009

M. Kim Frisby  
 US Joint forces Command  
 J89 Joint Architectures &  
 Capability Engineering Division  
 757-836-7702  
 margery.frisby@jcom.mil





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## The Data Model That Nearly Killed Me

by Joe Bugajski  
<http://tiny.cc/S1HWo>

“If data cannot be made reliably available across silos in a single EHR, then this data cannot be made reliably available to a huge, heterogeneous collection of networked systems.”

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## Are Health IT designers, testers and purchasers trying to kill people?

by Scot M. Silverstein  
<http://tiny.cc/CKIW1>

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### Sample problem presentation page generated via autopopulation in an EHR

Name	Latest
Abdominal pain (3)	Mar 12, 2006
<b>Atrial fibrillation</b> (2) - ???	Jan 3, 2009
Diabetes mellitus (12)	Jun 3, 2007
Diabetes mellitus type I (14)	Jun 3, 2007
Diabetes mellitus type II (13)	Jun 5, 2007
Dizziness/Vertigo (1)	Mar 13, 2008
Gynecological Exam, routine	Sep 2, 2006
HYPERTENSION, ESSENTIAL (1)	Jun 3, 2007
Hypercholesterolemia (4)	Mar 12, 2006
Hyperlipidemia, mixed (2)	Jun 6, 2007
Hypertension benign (4)	Jun 3, 2009
Hypertension, essential (1)	1/12/2000
Medication use, long term (1)	1/12/2000
Screening for diabetes mellitus	Jun 5, 2007
Screening for breast cancer	Jun 6, 2007
Urinary retention	1/13/2000
Alphabetic condition ...	Date
Alphabetic condition ...	Date
Alphabetic condition ...	Date

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### Problem List for Mary Jones

Name	Latest
Abdominal pain (3)	Mar 12, 2006
<b>Atrial fibrillation</b> (2) - ???	Jan 3, 2009
Diabetes mellitus type I (14)	Jun 3, 2007
Diabetes mellitus type II (13)	Jun 5, 2007
Dizziness/Vertigo (1)	Mar 13, 2008
Gynecological Exam, routine	Sep 2, 2006
HYPERTENSION, ESSENTIAL (1)	Jun 3, 2007
Hypercholesterolemia (4)	Mar 12, 2006
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Hypertension benign (4)	Jun 3, 2009
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Medication use, long term (1)	1/12/2000
Screening for diabetes mellitus	Jun 5, 2007
Screening for breast cancer	Jun 6, 2007
Urinary retention	1/13/2000
Alphabetic condition ...	Date
Alphabetic condition ...	Date
Alphabetic condition ...	Date

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## Problem List for Mary Jones

Name	Latest
Abdominal pain (3)	Mar 12 2006
<b>Atrial fibrillation - ???</b>	<b>Jan 3, 2009</b>
Diabetes mellitus type I (14)	Jun 3 2007
Diabetes mellitus type II (13)	Jun 5 2007
Dizziness/Vertigo (1)	Mar 13 2008
Gynecological Exam, routine	Sep 2, 2006
HYPERTENSION, ESSENTIAL (1)	Jun 4, 2007

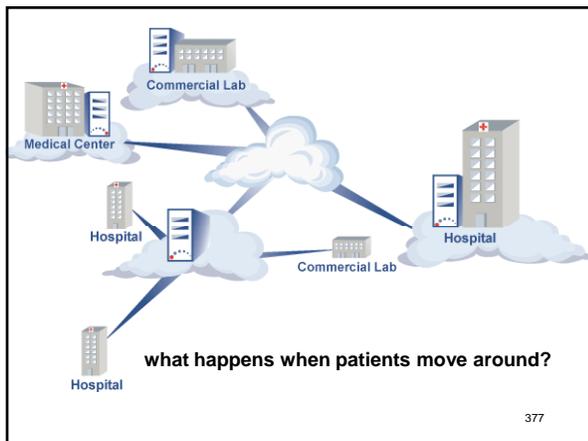
"This entry was auto-populated when a nurse ordered a blood clotting test and erroneously entered the reason for the test as 'atrial fibrillation' (a common reason, just not the case here) to expedite the order's completion. ... I am told it takes going back to the vendor to have this erroneous entry permanently removed. ..."

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## Redundant, Alphabetical Problem List for Mary Jones

Abdominal pain (3)	Mar 12 2006
<b>Atrial fibrillation - ???</b>	Jan 3, 2009
Diabetes mellitus (12)	Jun 3 2007
Diabetes mellitus type I (14)	Jun 3 2007
Diabetes mellitus type II (13)	Jun 5 2007
Dizziness/Vertigo (1)	Mar 13 2008
Gynecological Exam, routine	Sep 2, 2006
HYPERTENSION, ESSENTIAL (1)	Jun 3, 2007
Hypercholesterolemia (4)	Mar 12, 2006
Hyperinodemia, mixed (2)	Jun 6, 2007
Hypertension benign (4)	Jun 3, 2009
Hypertension, essential (1)	1/12/2000
Medication use, long term (1)	1/12/2000
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Screening for breast cancer	Jun 6, 2007
Urinary retention	1/13/2000
Alphabetic condition ...	Date
Alphabetic condition ...	Date
Alphabetic condition ...	Date

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To solve the problem of unifying data, what we need is an 'information model'



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## HL7 Reference Information Model

### Definition of Entity

Entity =def. A physical thing, group of physical things or an organization capable of participating in Acts, while in a role.

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### States of Entity

- active: The state representing the fact that the Entity is currently active.
- inactive: The state representing the fact that an entity can no longer be an active participant in events.
- normal: The "typical" state. Excludes "nullified", which represents the termination state of an Entity instance that was created in error
- nullified: The state representing the termination of an Entity instance that was created in error.

380

## HL7: Persons are Entities

What does 'active' and 'inactive' mean as applied to Person?

Is there a special kind of death-through-nullification in the case of these instances of Person who were created in error?

(The definitions of 'active' and 'inactive' provide no assistance in this regard.)

381

## HL7: Persons are Entities

What does 'active' and 'inactive' mean as applied to Person?

Is there a special kind of death-through-nullification in the case of these instances of Person who were created in error?

(The definitions of 'active' and 'inactive' provide no assistance in this regard.)

382

**HL7 Watch**

HL7 (Health Level 7) is a collection of standards and proposals for healthcare-specific data computer applications. Considerable efforts are being invested by governments and industrial health IT projects. Many claims are made on behalf of HL7 by its advocates. The goal is to investigate the merits of these claims, and to provide some needed independent perspectives.

**About Me**

 Barry Smith

Barry Smith is Julian Park Distinguished Professor of Philosophy in the University at Buffalo (New York, USA) and Research Scientist in the New York State Center of Excellence in Bioinformatics and Life Sciences. He is Director of the National Center for Ontological Research, a principal scientist of the National Center for Biomedical Ontology and a Coordinating Editor of the Open Biomedical Ontologies (OBO) Foundry.

Thursday, October 09, 2008

### Does the emperor have clothes?

This [set of slides](#) from a recent presentation by Eric Brown provides some reassurance that the arguments I have been product of my own ignorance. Summary: "Basing clinical info severely flawed. It is too complex; the underlying principles, leads to bad models, glacial progress, compromised quality and..."

Postscript: Feb. 15, 2009  
A more recent post by Eric Brown documenting problems with HL7.

Posted by Barry Smith at Thursday, October 09, 2008

<http://hl7-watch.blogspot.com/>

383

## What is going on here?

'Person', for HL7, refers not to persons, but to objects in information systems – entities created through processes of data entry.

They undergo not: processes such as being treated, falling ill, being born, dying

...

but: processes of being revised, reactivated, nullified

384

 **Knowledge Systems Laboratory  
Stanford University**

### Abstract: Ontology Development 101: A Guide to Creating Your First Ontology

Ontologies have become core components of many large applications yet the training material has not kept pace with the growing interest. This paper addresses the issues of why one would build an ontology and presents a methodology for creating ontologies based on declarative knowledge representation systems. It leverages the two authors' experiences building and maintaining ontologies in a number of ontology environments including Protégé-2000, Ontologus, and Chamaera. It presents the methodology by example utilizing a tutorial versus knowledge base example. While it is aimed at users of frame-based systems, it can be useful for building ontologies in any object-centered system.

Nils F. Nitz and Deborah K. McGuinness: "Ontology Development 101: A Guide to Creating Your First Ontology". Stanford Knowledge Systems Laboratory Technical Report KSL-01-05 and Stanford Medical Informatics Technical Report SMI-2001-080, March 2001.

The full paper is available in [pdf](#), [word](#), and [html](#) format.

The Guide is also available in other languages:  
A [French](#) version is available. It was translated by A. Angioli from the Bibliothèque Nationale de France.  
A [Russian](#) version is available. It was translated by A. Fityaz from the Eastern European subgroup of the International Forum on Educational Technologies and Society.

385

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Ontologies have become core components of many large applications yet the training material has not kept pace with the growing interest. This paper addresses the issues of why one would build an ontology and presents a methodology for creating ontologies based on declarative knowledge representation systems.

386

## Ontology Development 101: A Guide to Creating Your First Ontology (2001)

“An ontology together with a set of individual instances of classes constitutes a knowledge base. In reality, there is a fine line where the ontology ends and the knowledge base begins.”

387

## Classes

“Classes are the focus of most ontologies. Classes describe concepts in the domain. For example, a class of wines represents all wines. Specific wines are instances of this class. **The Bordeaux wine in the glass in front of you ... is an instance of the class of Bordeaux wines.**”

388

## From the Protégé glossary:

“**Instance:** Concrete occurrence of information about a domain that is entered into a knowledge base. For example, Fran Smith might be an instance for a Name slot. An instances is entered via a form generated by Protégé-2000.”

389

## From the Protégé glossary:

“... individual bottles of each wine may become individual instances = in our knowledge base.”

390

## Instances

“we can create an individual instance Chateau-Morgon-Beaujolais to represent a specific type of Beaujolais wine. Chateau-Morgon-Beaujolais is an instance of the class Beaujolais”

391

## An instance or a class?

“Deciding whether a particular concept [e.g. the Bourgogne region] is a class in an ontology or an individual instance depends on what the potential applications of the ontology are.”

392

## Wines are the instances?

“Individual instances are the most specific concepts represented in a knowledge base: if we are only going to talk about pairing wine with food we will not be interested in the specific physical bottles of wine. ... the Wine class is [then] a collection not of individual bottles of wines but rather of the specific wines produced by specific wineries.”

393

## Glasses, then? Or bottles?

“On the other hand, if we would like to maintain an inventory of wines in the restaurant ... individual bottles of each wine may become individual instances in our knowledge base.”

394

## Only

“If concepts form a natural hierarchy, then we should represent them as classes. Consider the wine regions. Initially, we may define main wine regions, such as France, United States, Germany, and so on, as classes and specific wine regions within these large regions as instances. For example, Bourgogne region is an instance of the French region class.”

395

## Rules

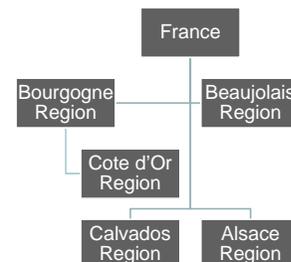
Only classes have subclasses  
Only classes have instances  
All hierarchical relations in a knowledge base are subclass relations

396

## All regions are classes

we would also like to say that the Cotes d'Or region is a Bourgogne region. Therefore, Bourgogne region must be a class ... However, making Bourgogne region a class and Cotes d'Or region an instance of Bourgogne region seems arbitrary: it is very hard to clearly distinguish which regions are classes and which are instances. Therefore, we define all wine regions as classes.”

397



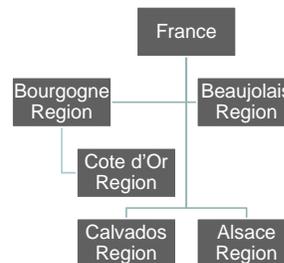
all of these things are classes

398

## The Alsace region does not exist

“Only classes can be arranged in a hierarchy – knowledge-representation systems do not have a notion of sub-instance. Therefore, if there is a natural hierarchy among terms, ..., we should define these terms as classes even though they may not have any instances of their own.”

399



400



401

## Instances

“we can create an individual instance *Chateau-Morgon-Beaujolais* to represent a specific type of Beaujolais wine.

*Chateau-Morgon-Beaujolais* is an instance of the class *Beaujolais*”

How can you *create* an instance?

402

## An instance or a class?

“Deciding whether a particular concept [e.g. the Bourgogne region] is a class in an ontology or an individual instance depends on what the potential applications of the ontology are.”

403

## Wines are the instances?

Or bottles are the instances?

Or vintages?:

“Similarly, if we would like to record different properties for each specific vintage of the Sterling Vineyards Merlot, then the specific vintage of the wine is an instance in a knowledge base and Sterling Vineyards Merlot is a class containing instances for all its vintages.

404

## Or bottles

“On the other hand, if we would like to maintain an inventory of wines in the restaurant in addition to the knowledge base of good wine-food pairings, individual bottles of each wine may become individual instances in our knowledge base.”

405

## The Alsace region does not exist

“Only classes can be arranged in a hierarchy – knowledge-representation systems do not have a notion of sub-instance. Therefore, if there is a natural hierarchy among terms, ..., we should define these terms as classes even though they may not have any instances of their own.”

406

## From the Protégé glossary:

“... individual bottles of each wine may become individual instances = **concrete occurrences of information** in our knowledge base.”

407

## Microsoft Healthvault

from list of Healthvault's [Health Item Types](#):

*Allergic Episode* = def. *an occurrence of an allergy which is defined by the Allergy type.symptoms*

*Allergic Episode* inherits *Health Record Item*,

*Health Record Item* = def. *a single piece of data in a health record that is accessible through the HealthVault service.*

408

## Microsoft Healthvault

an Allergic Episode = (a) a single piece of data, that is (b) in a health record that is (c) accessible through Microsoft Healthvault?

Other Health Record Items: *a blood pressure measurement, an exercise session, an insurance claim.*

409

## The Pizza Ontology

### Exercise 22: Create an AmericanHotPizza and a SohoPizza

An AmericanHotPizza is almost the same as an AmericanaPizza, but has Jalapeno peppers on it — create this by cloning the class AmericanaPizza and adding an existential restriction along the hasTopping property with a filler of JalapenoPepperTopping.

410

## The Use-Mention Confusion

Swimming is healthy  
Swimming has eight letters

8 is the square root of 64  
8 is the output on my measuring device

Software engineers are allowed to  
commit use-mention errors, because  
they know what they are doing

411

## The standard engineering methodology

Pragmatics ('usefulness') is everything  
Usefulness = we get to write software  
which runs on our machines

It is easier to write software if we deal not  
with reality, but with simple models

("...We can't know what reality is like in any  
case; we only have our concepts...")

412

## Arguments for Ontology as Conceptual Modeling

**Ontology is hard.**

**Life is short.**

**Let's do conceptual modeling instead**

413

programming real ontology into computers  
is *hard*

**therefore:**

**we will simplify ontology  
and not care about reality at all**

414



Painting the Emperor's Palace is

***hard***

415

therefore

we will not try to paint the *Palace* at all

... we will be satisfied instead with a  
grainy snapshot of **some other building**

## Each information system/ontology/conceptual model

uses its own terminology and its own way of dividing up its domain of objects  
the same terms are used to mean different things in different information systems  
different terms are used to mean the same thing  
no calibration from one system to the next

417

## An alternative approach

## Why build *scientific* ontologies

“There are many ways to create ontologies ...”

Multiple ontologies simply make our unification problems worse

We need to constrain ontologies so that they converge

Just as bad scientific theories must die, so also bad ontologies must die

419

## Science-based ontology development

Q: What is to serve as constraint in order to avoid silo creation ?

A: Reality, as revealed, incrementally, by experimentally-based science

420

## Ontological realism

Find out what the world is like (= by doing science)

Build representations adequate to this world, not to some simplified model in your laptop

421

## Ontology (Science)

Experimental results are being described in algorithmically useful ways with the help of ontologies like the GO

Such ontologies are authored and maintained by scientists to support the sharing, retrieval, integration and analysis of their data

Thesis: these ontologies are *part of science*.

422

## Ontologies like the Gene Ontology are *part of science*

They must be associated with computer implementations (with engineering artifacts)

But the ontologies are not themselves engineering artifacts

The same ontology can be associated with multiple engineering artifacts

423

## Ontologies like the GO are comparable to

- scientific theories
- scientific databases
- scientific journal publications

424

## Ontologies like the GO are being used by scientific journal publications

- to provide more useful access to article content via controlled structured keyword lists
- to provide a basis for creating formally structured versions of journal articles themselves

425

## Benefits of ontology peer review

1. will provide an impetus to the improvement of scientific knowledge over time
2. brings benefits to readers, since they need only absorb and collate vetted ontologies, as opposed to all the ontologies available e.g. on the Semantic Web

426

## Peer review creates incentives for investment of effort in ontology work

It gives career-related credit to both authors and reviewers (university promotions and funding based on peer review credit)

Supports creation of a professional career path for ontologists

It gives credit to *scientific experts* for investment of *scientific expertise*

It allows measurement of *citations* of ontologies

It magnifies the motivating potential of the factor of influence

427

## For engineers, ontologies

1. can be bought and sold
2. need have no well-demarcated scientific domains
3. need not be subject to further maintenance
4. can be stand-alone products
5. are typically tied to one specific implementation

**Ontology (engineering) thereby makes the silo problem worse**

428

## Ontologies created to serve scientific purposes

1. are developed to be common resources (thus they cannot be bought or sold)
2. for representation of well-demarcated scientific domains
3. subject to constant maintenance by domain experts
4. designed to be used in tandem with other, complementary ontologies
5. maximally independent of format and implementation

429

## Background assumptions

Scientific hypotheses should be formulated by scientists

Scientific experiments should be carried out by scientists

Scientific databases should be developed and maintained by scientists

Scientific textbooks should be written by scientists

430

## We need to annotate our data

to allow retrieval and integration of

- sequence and protein data for pathogens
- case report data for patients
- clinical trial data for drugs, vaccines
- epidemiological data for surveillance, prevention
- ...

Goal: to make data deriving from different sources comparable and computable

431

## Goals of ontology (science)

1. to determine, empirically, the consensus core of ontology (science) – which high-level principles work best?
2. to train a community of ontology experts who will be in a position to apply and to extend this core in their scientific work.
3. to establish ontology development as being, like statistics, a recognized part of the scientific enterprise.

432

## Goals of ontology (science)

4. to establish empirical methods of ontology evaluation
5. to establish a system of expert peer review for ontologies
6. to work with journals to institute publishing of peer-reviewed ontologies
7. to create an established set of non-overlapping ontology modules to be recommended for use in all data and literature annotation

433

## Benefits of this approach

1. will provide an alternative to the existing computer (manufacturing) based approach, according to which: the more ontologies the better
2. will provide an impetus to the improvement of scientific knowledge over time
3. brings benefits to readers, since they need only absorb and collate vetted ontologies, as opposed to all the ontologies available e.g. on the semantic web.

434

such filtering especially needed in biomedical ontology

**Bill Bug:** Until there is a reliable vetting procedure, we cannot expect to re-use existing ontologies effectively for the purpose of bringing like data together in novel ways .... Without vetting, we cannot expect to provide other developers with clear advice on what are the reliable ontological shoulders to build on.

435

## Benefits of orthogonality

helps those new to ontology to find what they need  
provides models of good practice  
ensures mutual consistency of ontologies (trivially)  
and thereby ensures *additivity* of annotations

436

## More benefits of orthogonality

it rules out simplification and partiality  
brings an obligation on the part of ontology developers to commit to scientific accuracy and domain-completeness

437

## More benefits of orthogonality

helps to eliminate redundancy  
serves the division of ontological labor: allows experts to focus on their own domains of expertise  
makes possible the establishment of clear lines of authority

438

## The goal of orthogonality is a basic goal of science

it is a pillar of the scientific method that scientists should strive always to seek out and resolve conflicts between competing theories

439

## is there a problem with orthogonality?

what if I need my own ontology of cellular membranes to meet my own special purposes?  
strategy of application ontologies should be developed from the start using terms whose definitions employ the resources of orthogonal ontologies like those within the Foundry  
any other approach creates silos

440

Better to have one consensus ontology serving multiple purposes imperfectly

because multiple ontologies addressing the same domain, whether they are good ones or bad ones, create **silos**

441

For engineers, ontologies need possess none of these features

1. they can be bought and sold
2. they need have no well-demarcated scientific domains
3. they need not be subject to further maintenance
4. they can be stand-alone products
5. they are typically tied to one specific implementation

**Ontology (engineering) thereby makes the silo problem worse**

442

The special features of ontologies created to serve scientific purposes:

1. they are developed to be common resources (thus they cannot be bought or sold)
2. for representation of well-demarcated scientific domains
3. subject to constant maintenance by domain experts
4. designed to be used in tandem with other, complementary ontologies
5. independent of format and implementation

443

### Shimon Edelman's Riddle of Representation

two humans, a monkey, and a robot are looking at a piece of cheese;  
what is common to the representational processes in their visual systems?

444

**Answer:**

The cheese, of course



445

## Lecture 6 Ontology and the Semantic Web

## The problem of ontology

human beings can integrate highly heterogeneous information inside their heads

447

## Consider how the human mind

cope with complex phenomena in the social realm (e.g. speech acts of promising) which involve:

- experiences (speaking, perceiving)
- intentions (including potentially conflicting or disguised intentions)
- language
- action (and tendencies to action)
- deontic powers, obligations, claims, authority ...
- background habits
- mental competences
- records and representations

448

understanding how computers can effect the same sort of integration is a difficult problem

449

## A new silver bullet



450

## The Semantic Web

designed to integrate the vast amounts of heterogeneous online data and services

via dramatically better support at the level of metadata that will yield the ability to query and integrate across different conceptual systems

451

## Tim Berners-Lee, inventor of the internet

“sees a more powerful Web emerging, one where documents and data will be annotated with special codes allowing computers to search and analyze the Web automatically. The codes ... are designed to add meaning to the global network in ways that make sense to computers”

452

## Tim Berners-Lee:

hyperlinked vocabularies, called 'ontologies' will be used by Web authors "to explicitly define their words and concepts as they post their stuff online.

"The idea is the codes would let software 'agents' analyze the Web on our behalf, making smart inferences that go far beyond the simple linguistic analyses performed by today's search engines."

453

## Exploiting tools such as:

XML (Extensible Markup Language)  
RDF (Resource Descriptor Framework)  
OWL (Ontology Web Language – a fragment of First Order Logic with nice computational properties)

Often, in Semantic Web circles, an ontology is identified as any artifact that is formulated using the OWL language

454

## Ebiquity Publication Ontology

<http://ebiquity.umbc.edu/ontology/publication.owl>

```
- <owl:ObjectProperty rdf:ID="author">
  <rdfs:label>Resource Author</rdfs:label>
  <rdfs:domain rdf:resource="#Resource" />
  <rdfs:range
    rdf:resource="http://ebiquity.umbc.edu/ontology/person.owl#Person" />
- <owl:DatatypeProperty rdf:ID="chapter">
  <rdfs:label>Publication Chapter</rdfs:label>
  <rdfs:domain rdf:resource="#Publication" />
  <rdfs:range
    rdf:resource="http://www.w3.org/2001/XMLSchema#string" />
```

what sort of string is a chapter?

455

## Example: The Enterprise Ontology

A Sale is an agreement between two Legal-Entities for the exchange of a Product for a Sale-Price.

A Strategy is a Plan to Achieve a high-level Purpose.

A Market is all Sales and Potential Sales within a scope of interest.

456

## Assumptions

Communication / compatibility problems should be solved *automatically* (by machine)

Hence ontologies must be *applications* running in real time

457

## Computational tractability

Semantic Web Ontologies are computer artifacts subject to severe constraints on expressive OWL DL (for Description Logic) a maximum fragment of first order logic for which a complete inference procedure and a decision procedure are known to exist

Brings considerable benefits in building ontologies – you can check your ontology for consistency

Good for capturing static combinatorial information (pizzas, family relations ...); less good when it comes to dealing with *time* and *instances*

458

## Philosophical issues about classes and instances

SARS is NOT

**Severe Acute Respiratory Syndrome**

it is THIS collection of instances of

**Severe Acute Respiratory Syndrome**

associated with THIS coronavirus and ITS mutations

459

## Clay Shirky

The Semantic Web is a machine for creating syllogisms.

Humans are mortal

Greeks are human

Therefore, Greeks are mortal

460

## Lewis Carroll

- No interesting poems are unpopular among people of real taste
  - No modern poetry is free from affectation
  - All your poems are on the subject of soap-bubbles
  - No affected poetry is popular among people of real taste
  - No ancient poetry is on the subject of soap-bubbles
- Therefore: All your poems are bad.

461

## the promise of the Semantic Web

it will improve all the areas of your life where you currently use syllogisms

462

most of the data we use in our everyday lives is not amenable to recombination in syllogistic form

because it is partial, inconclusive, context-sensitive

So we guess, extrapolate, intuit, we do what we did last time, we do what we think our friends would do ... but we almost never use syllogistic logic.

463

## The Semantic Web Initiative

The Web is a vast edifice of heterogeneous data sources

Needs the ability to query and integrate across different data systems

464

## How resolve incompatibilities?

The Semantic Web idea:

create terminological compatibility via standardized term hierarchies, with standardized definitions of terms, which

1. satisfy the needed logical constraints
2. are applied as meta-tags to the content of websites

(Tim Berners-Lee: we need to do this without losing the sorts of freedoms exemplified by the existing html-based web)

465

## Merging Databases

In the brave new world of the Semantic Web, "Merging databases simply becomes a matter of recording in RDF somewhere that "Person Name" in your database is equivalent to "Name" in my database, and then throwing all of the information together and getting a processor to think about it." [\[http://infomesh.net/2001/swintro/\]](http://infomesh.net/2001/swintro/)

Is your "Person Name = John Smith" the same person as my "Name = John Q. Smith"? Who knows? Not the Semantic Web

466

## XML-syntax does not help

```
<BUSINESS-CARD>
  <FIRSTNAME>Jules</FIRSTNAME>
  <LASTNAME>Deryck</LASTNAME>
  <COMPANY>Newco</COMPANY>
  <MEMBEROF>XTC Group</MEMBEROF>
  <JOBTITLE>Business Manager</JOBTITLE>
  <TEL>+32(0)3.471.99.60</TEL>
  <FAX>+32(0)3.891.99.65</FAX>
  <GSM>+32(0)465.23.04.34</GSM>
  <WEBSITE>www.newco.com</WEBSITE>
  <ADDRESS>
    <STREET>Dendersesteeweg 17</STREET>
    <ZIP>2630</ZIP>
    <CITY>Aartselaar</CITY>
    <COUNTRY>Belgium</COUNTRY>
  </ADDRESS>
</BUSINESS-CARD>
```

467

## XML-syntax does not help

```
<BUSINESS-CARD>
  <FIRSTNAME>Jules</FIRSTNAME>
  <LASTNAME>Deryck</LASTNAME>
  <COMPANY>Newco</COMPANY>
  <MEMBEROF>XTC Group</MEMBEROF>
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  <TEL>+32(0)3.471.99.60</TEL>
  <FAX>+32(0)3.891.99.65</FAX>
  <GSM>+32(0)465.23.04.34</GSM>
  <WEBSITE>www.newco.com</WEBSITE>
  <ADDRESS>
    <STREET>Dendersesteeweg 17
  </STREET>
```

468

## even with correct XML-syntax:

```
<BUSINESS-CARD>
  <FIRSTNAME>Jules</FIRSTNAME>
  <LASTNAME>Deryck</LASTNAME>
  <COMPANY>Newco</COMPANY>
  <MEMBEROF>XTC Group</MEMBEROF>
  <JOBTITLE>Business Manager</JOBTITLE>
  <TEL>+32(0)3.471.99.60</TEL>
  <FAX>+32(0)3.891.99.65</FAX>
  <GSM>+32(0)465.23.04.34</GSM>
  <WEBSITE>www.newco.com</WEBSITE>
  <ADDRESS>
    <STREET>Dendersesteeweg 17</STREET>
    <ZIP>2630</ZIP>
    <CITY>Aartselaar</CITY>
    <COUNTRY>Belgium</COUNTRY>
  </ADDRESS>
</BUSINESS-CARD>
```

 Is "Jules" the first name of the person, or of the business-card?

469

## even with correct XML-syntax:

```
<BUSINESS-CARD>
  <FIRSTNAME>Jules</FIRSTNAME>
  <LASTNAME>Deryck</LASTNAME>
  <COMPANY>Newco</COMPANY>
  <MEMBEROF>XTC Group</MEMBEROF>
  <JOBTITLE>Business Manager</JOBTITLE>
  <TEL>+32(0)3.471.99.60</TEL>
  <FAX>+32(0)3.891.99.65</FAX>
  <GSM>+32(0)465.23.04.34</GSM>
  <WEBSITE>www.newco.com</WEBSITE>
  <ADDRESS>
    <STREET>Dendersesteeweg 17</STREET>
    <ZIP>2630</ZIP>
    <CITY>Aartselaar</CITY>
    <COUNTRY>Belgium</COUNTRY>
  </ADDRESS>
</BUSINESS-CARD>
```

 Is Jules or Newco the member of XTC Group?

470

even with correct XML-syntax:

```
<BUSINESS-CARD>
<FIRSTNAME>Jules</FIRSTNAME>
<LASTNAME>Deryck</LASTNAME>
<COMPANY>Newco</COMPANY>
<MEMBEROF>XTC Group</MEMBEROF>
<JOBTITLE>Business Manager</JOBTITLE>
<TEL>+32(0)3.471.99.60</TEL>
<FAX>+32(0)3.891.99.65</FAX>
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<ZIP>2630</ZIP>
<CITY>Aartselaar</CITY>
<COUNTRY>Belgium</COUNTRY>
</ADDRESS>
</BUSINESS-CARD>
```

Do the phone numbers and address belong to Jules or to the business?

use of OWL-DL syntax in many cases similar

471

Clay Shirkey:

“The Semantic Web’s philosophical argument – the world should make more sense than it does – is hard to argue with. The Semantic Web, with its neat ontologies and its syllogistic logic, is a nice vision. However, like many visions that project future benefits but ignore present costs, it requires too much coordination and too much energy to be effective in the real world ...

“A world of exhaustive, reliable metadata would be a utopia.”

472

### Problem 1: People lie

Meta-utopia is a world of *reliable* metadata.

But poisoning the well can confer benefits to the poisoners

Metadata exists in a competitive world.

Some people are crooks.

Some people are cranks.

Some people are French philosophers.

Who will police the coding?

473

### Problem 2: People are lazy

How many pages on the web are titled: “Please title this page”

474

### Problem 3: People are stupid

The vast majority of the Internet’s users (even those who are native speakers of English)

cannot spell or punctuate

Will internet users learn to accurately tag their information with whatever DL-hierarchy they’re supposed to be using?

475

### Problem 4: Multiple descriptions

“Requiring everyone to use the same vocabulary denudes the cognitive landscape, enforces homogeneity in ideas.”

(Cary Doctorow)

476

## Problem 5: Ontology Impedance

= semantic mismatch between ontologies being merged

Solution 1: treat it as inevitable, and learn to find ways to cope with the disturbance which it brings\*

Solution 2: resolve the impedance problem by hand on a case-by-case basis

477

## Both solutions fail

1. treating mismatches as 'impedance' ignores the problem of error propagation (and is inappropriate in critical areas like medicine or finance)
2. resolving impedance on a case-by-case basis defeats the very purpose of the Semantic Web

478

## Clay Shirkey: Let a million lite ontologies bloom

"Much of the proposed value of the Semantic Web is coming, but it is not coming because of the Semantic Web. The amount of meta-data we generate is increasing dramatically, and it is being exposed for consumption by machines as well as, or instead of, people. But it is being designed a bit at a time, out of self-interest and without regard for global ontology."

479

## Early Days of the Web (2002)

- MusicBrainz Metadata Vocabulary
- Musical Baton Vocabulary
- Beer Ontology
- Kissology
- Pet Profile Ontology
- ...

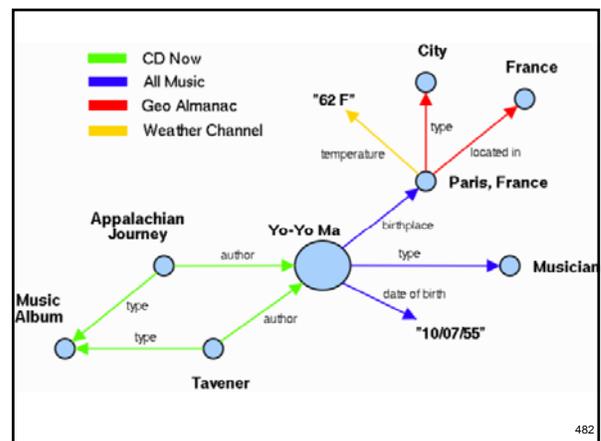
Schemaweb ontologies  
(originally at <http://www.w3.org/>)

480

## blooming lite ontologies good for some things; but

- they often do not generalize ...
- repeat work already done by others
- are not glueable together (expensive to map, hard to keep mappings up-to-date)
- resist progressive improvement
- reproduce the silo problems which ontology was designed to solve
- are often used in sloppy ways

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482

from *Handbook of Ontology*  
(*Semantic Web* approach)

RetailPrice hasA Denomination InstanceOf  
Dollar (p. 101)

SI-Unit instanceof System-of-Units (p. 40)

483

from: *Ontological Engineering*  
(*Semantic Web* approach)

location =def. a spatial point identified by a name  
(p. 12)

arrivalPlace =def. a journey ends at a location (p.  
13)

facet =def. ternary relation that holds between a  
frame, a slot, and the facet (p. 51)

484

We will be able to use ontologies  
to help us share data only if

they are ontologically coherent  
(intelligible to a human user)

and logically coherent

and computationally tractable

and work well together

- evolve together
- created according to the tested rules

485

A new approach

prospective standardization based on  
objective measures of what works

bring together selected groups to  
agree on and commit to good  
terminology / annotation habits  
(traffic laws) preemptively

486

Compare science

1. scientific theories must be common  
resources (cannot be bought or sold)
2. must be intelligible to a human being
3. they must use open publishing venues
4. they must constantly evolve to reflect  
results of scientific experiments  
("evidence-based")
5. must be synchronized
  - use common SI system of units
  - common mathematical theories (built by  
adults)

487

Semantic Web: moving in the right  
direction

1. recognition that creating many local ad hoc  
(‘lite’) ontologies will not somehow magically  
meld into an intelligent end result
2. Schemaweb Musicbeanz OWL ontologies now  
removed from W3C website; gradually being  
supplanted by serious science-driven efforts,  
for example in the healthcare domain\*
3. (some) recognition of the need for coordination  
(the end of html-inspired anarchy?)

\*see e.g. <http://tinyurl.com/ydc514o>

488

## Goal:

where OWL-DL constraints  
ontology developers in their use of  
'is\_a'  
to inhibit ontological impedance the  
Semantic Web needs to foster use  
of a rigorously tested common  
upper level ontology which goes  
much further than this

489

## the needed upper level ontology

will be not just a system of categories  
but a *formal theory*  
with definitions, axioms, theorems  
designed to allow building of ontologies for  
specific domains by populating downwards  
from a shared common core  
the latter should be of sufficient richness that  
terminological incompatibilities can be  
resolved intelligently rather than by brute  
force

490

## alternative frameworks

OBO Format

<http://oboedit.org/>

OWL DL

<http://www.co-ode.org/resources/papers/OBO2OWL.pdf>

Common Logic

<http://cl.tamu.edu/>

[http://www.berkeleybop.org/people/cjm/Mungall-bib.html#mungall\\_experiences\\_2009](http://www.berkeleybop.org/people/cjm/Mungall-bib.html#mungall_experiences_2009)

491

## the goal is to reach a situation

where it is not arbitrary how entities of a  
given type are to be treated – there is very  
little discretion / freedom of choice on the  
part of the ontology builder as concerns  
use of *part\_of*, *located\_at*, *earlier\_than* ...

492

## Candidate Upper-Level Integrating Ontologies

(Upper) CYC

SUMO

DOLCE

BFO

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## The Background of Cyc

- axiomatic representation of the entirety of human common sense
- gigantic investment 25 years
- “a large and broad ontology, knowledge base, and inference engine”
- ontology = a representation of knowledge
- assumed to allow contradictory information
- thus: use of microtheories to screen against contradictions

494

## Some problems with Cyc

- CLASSIFICATION OF HUMAN-TYPE-BY-CUP-SIZE
- cup size a = instance of human type by cup size
- instance of partially tangible type by non-numeric size
- subtype of homo sapiens
- disjoint with cup size b
- the collection of people with female breast cup size a
- human type by cup size is an instance of collection with an event-like order

495

## Some problems with Cyc

•A collection of collections. Each instance of `CollectionWithAnEventLikeOrder` is a collection whose instances are conventionally regarded as being ordered by some relation `RELN`, where `RELN` orders the members of `COL` in the manner in which events are ordered in linear time.

•For example, the instances of `Distance` are conventionally regarded as being ordered by the relation greater than, and this ordering is event-like. So `Distance` is a collection with an event-like order.

•

496

## Some problems with Cyc

- biology microtheory is an instance of general microtheory
- general microtheory is an instance of microtheory type
- microtheory type is an instance of second order collection
- second order collection is an instance of collection type type
- collection type type is an instance of collection type
- collection type is an instance of collection type by disjointness
- collection type by disjointness is an instance of collection type [!]
- collection type type subsumed by collection type [!]
- collection type subsumed by collection [!]
- collection is an instance of collection type

497

## Some problems with Cyc

- plant is an instance of biological kingdom
- plant is a subset of vegetable matter
- plant is the collection of all individual plants
- cell is an instance of clarifying collection type
- cell is an instance of biology (topic)
- flower (botanical part) is the collection of all reproductive organs of angiosperm plants. may or may not look like conventional 'flowers'

•

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## Some problems with Cyc upper level

•`#$Configuration` A specialization of both `#$StaticSituation` and `#$SpatialThing-Localized`. Each instance of `#$Configuration` is a static situation consisting of two or more `#$PartiallyTangible` things of certain types standing in a certain type of spatial relationship (or set of relationships). This (set of) spatial relationship(s) characterizes the `#$Configuration's` `_type_` in the sense that any group of objects of the appropriate types standing in that relationship (or those relationships) correspond to a `#$Configuration` of that type; and each of these objects, in turn, is said to be configured (see `#$ObjectConfigured`) in the (individual) `#$Configuration`.

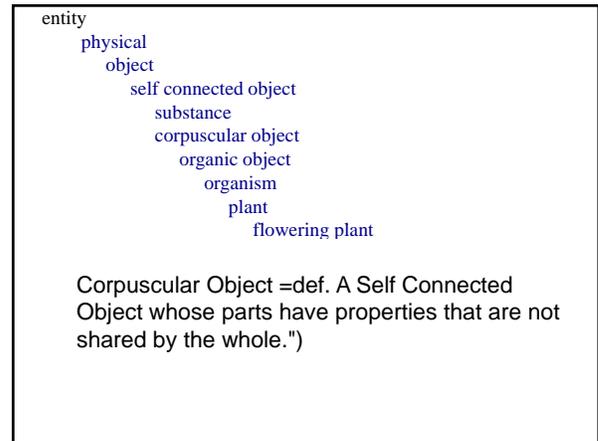
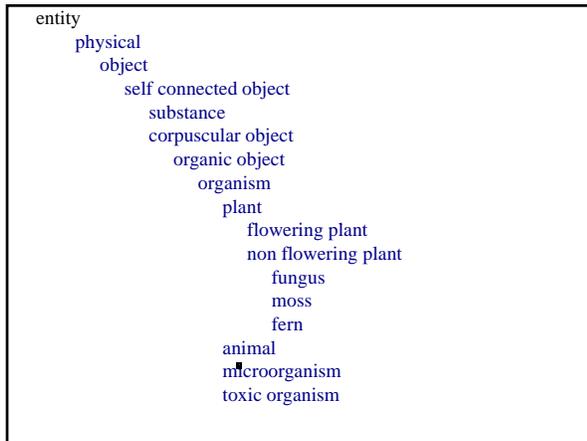
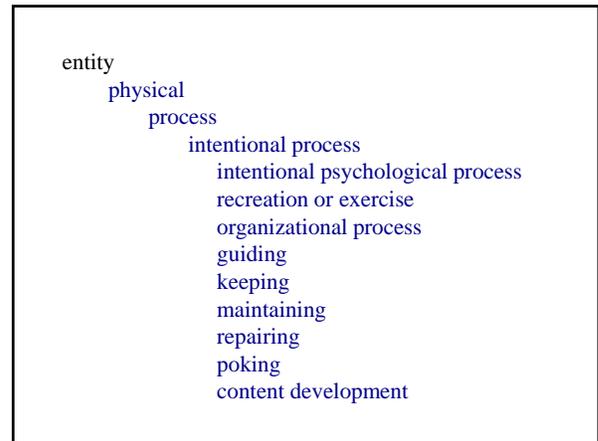
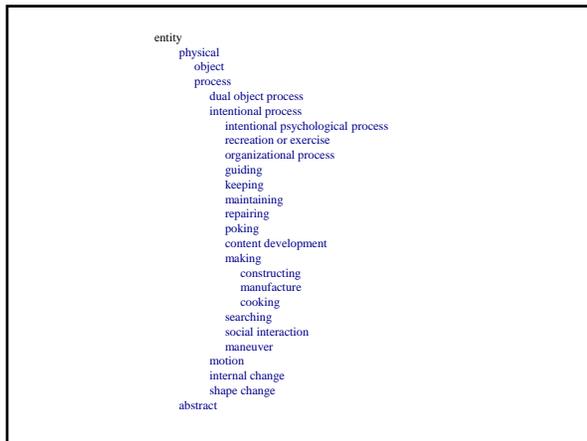
499

## why Cyc cannot do the job of providing a shared upper level

- it has no progressive cumulation from an established core
- it has too little concern for consistency with basic science (common sense should not wear the trousers)
- it has no perspicuous policies for updating
- it is largely unintelligible to outsiders

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## Advantages of SUMO

- fully axiomatized in First Order Logic (FOL)
- clear logical infrastructure: too expressive for decidability, more intuitive (human friendly) than e.g. OWL
- much more coherent than e.g. CYC upper level
- good web support
- public domain

## Problems with SUMO

- it contains its own tiny biology ('protein', 'crustacean', 'body-covering', 'fruit-Or-vegetable' ...)
- it is overwhelmingly an ontology for abstract entities (sets, functions in the mathematical sense, ...)
- not yet clear treatment of relations between instances vs. relations between types

# DOLCE: Descriptive Ontology for Linguistic and Cognitive Engineering

Strong cognitive/linguistic bias:

- **descriptive** (as opposite to *prescriptive*) attitude
- Categories mirror cognition, common sense, and the lexical structure of natural language.

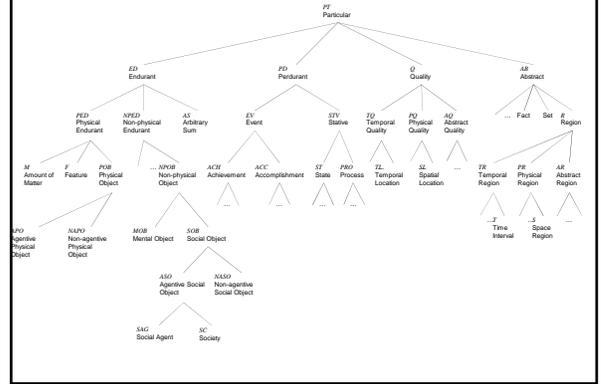
Categories as **conceptual containers**: no "deep" metaphysical implications

## Rich axiomatization

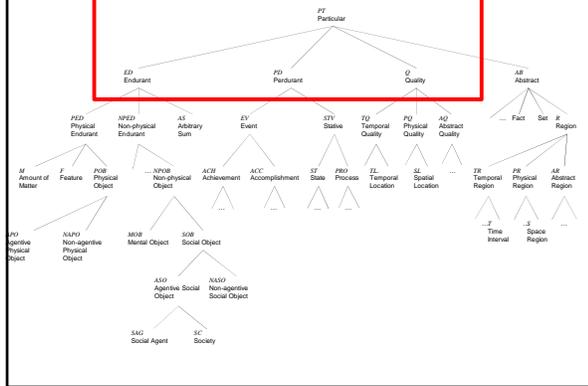
- 37 basic categories
- 7 basic relations
- 80 axioms, 100 definitions, 20 theorems

Rigorous quality criteria and extensive documentation

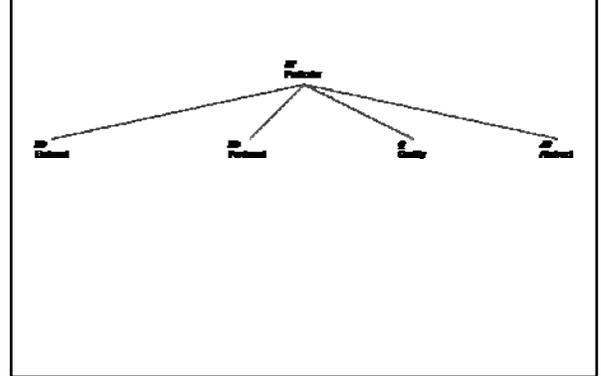
## DOLCE taxonomy



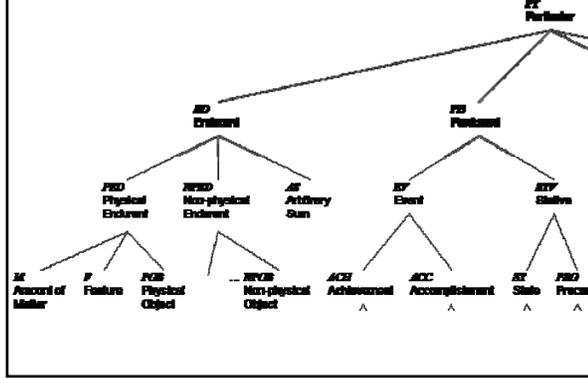
## DOLCE taxonomy



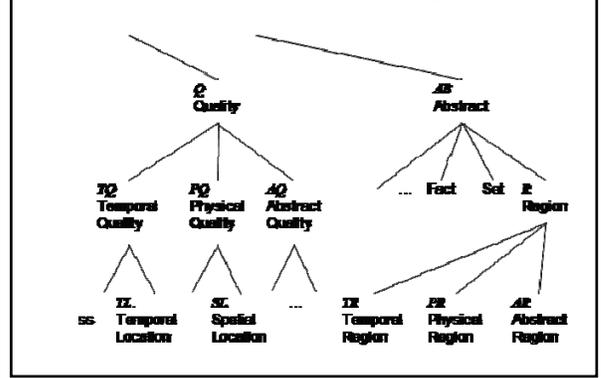
## DOLCE taxonomy



## DOLCE taxonomy



## DOLCE taxonomy



## 1 - The physical view (= one of many views)

Basic **qualities** ascribed to atomic spacetime regions (e.g., mass, electric charge...)

physical processes are spatiotemporal distributions of qualities

## 2 - The *cognitive view*

Humans isolate **relevant invariances** on the basis of:

- Perception (as resulting from evolution)
- Cognition and cultural experience
- Language

A set of **atomic percepts** is associated to each situation

is this consistent with common sense?

## DOLCE's Multiplicative Ontology

The statue and the lump of clay here on my desk

The human being and the collection of molecules here behind my desk

They have different histories

Based on DOLCE's Linguistic View

## Substitutivity Tests

I am talking here

\*This bunch of molecules is talking

\*What's here now is talking

This statue is looking at me

\*This piece of marble is looking at me

This statue has a strange nose

\*This piece of marble has a strange nose

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## DOLCE embraces abstract (non-physical) entities

= entities with no inherent spatial localization

Dependent on agents

- mental (depending on singular agents)
- social (depending on communities of agents)

Agentive: a company, an institution

Non-agentive: a law, the Divine Comedy, a linguistic system

## Advantages of DOLCE

clear logical infrastructure (FOL) – beyond computability

much more coherent than e.g. CYC upper level

successful applications in a number of research projects

## Problem with DOLCE

not sure if it is an ontology of reality or an ontology of concepts

ontology of molecules, light, sexual dimorphism in plants, etc.

or:

ontology of concepts = part of the ontology of psychology, of language (etc.)

## Advantages of BFO

a true upper level ontology

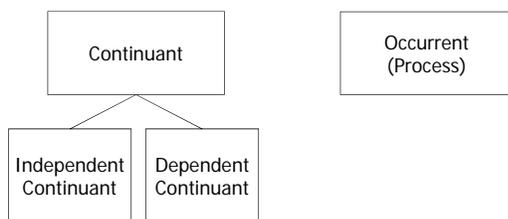
no interference with domain ontologies

no interference with physics / biology / cognition / mathematics

no abstracta

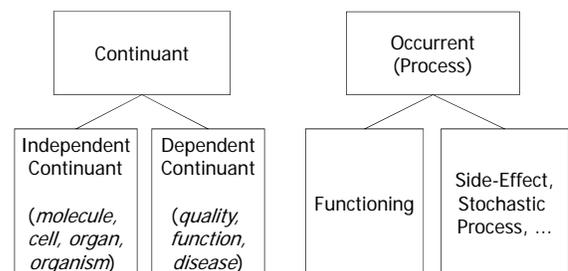
a small subset of DOLCE but with more adequate treatment of instances, types, relations and qualities

## BFO



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## BFO



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## Lecture 7 Towards a Standard Upper Level Ontology

## A shocking idea

Before we build a data model let's look at the reality we are trying to represent (= let's look at the best scientific theory we have of this reality)

Let's constrain our data models so that our databases are veridical representations of the world outside

530

## Scientific ontologies have special features

Every term in a scientific ontology must be such that the developers of the ontology believe it to refer to some entity\* in reality on the basis of the best current evidence

\*in first approximation: instances of a type

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For science, and thus for scientific ontologies,  
it is *generalizations* that are of prime importance = universals, types, kinds, species

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## For scientific ontologies

reusability, openness is crucial  
intelligibility to humans is crucial  
revisability is crucial  
there is always an open world assumption  
testability is crucial  
compatibility with neighboring scientific ontologies is crucial  $\therefore$  *it should not be too easy to add new terms to an ontology*

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## For scientific ontologies

the issue of how the ontology will be *used* is not a factor relevant for determining how entities are treated by the ontology

If this decision is made to reflect specific, local practical needs, this will thwart reusability of the data the ontology is used to annotate

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## BFO

A simple top-level ontology to support information integration in scientific research  
Defining a framework that will help to ensure consistency and non-redundancy of the ontologies created in its terms

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## Three Fundamental Dichotomies

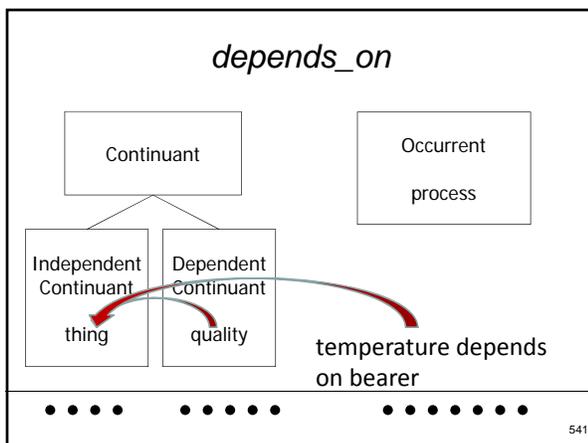
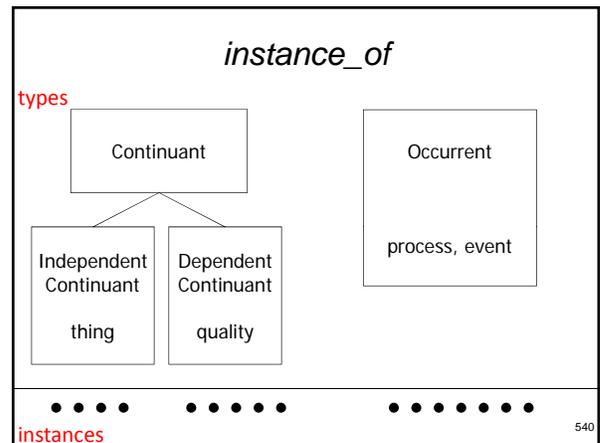
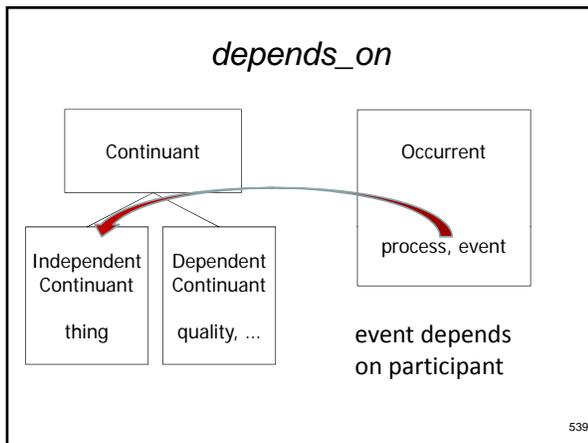
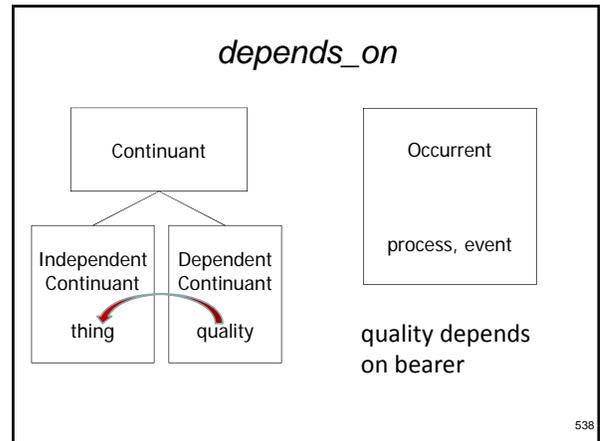
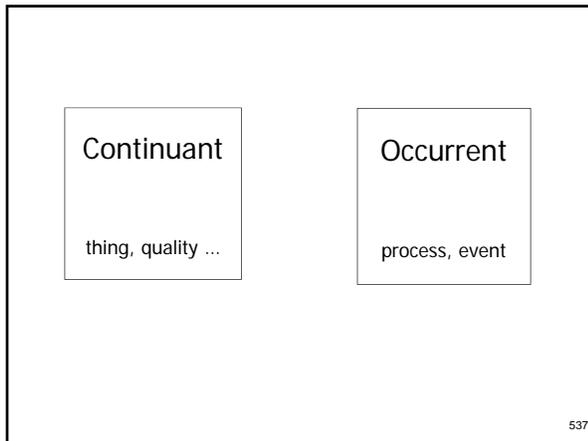
Continuant vs. occurrent

Dependent vs. independent

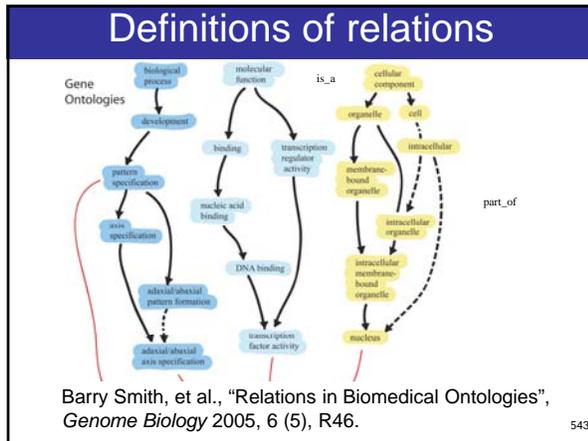
Type vs. instance

<http://ontology.buffalo.edu/bfo/>

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- ### 3 kinds of (binary) relations
- Between types
- *human is\_a mammal*
  - *human heart part\_of human*
- Between an instance and a type
- this human **instance\_of** the type *human*
  - this human **allergic\_to** the type *tamiflu*
- Between instances
- Mary's heart **part\_of** Mary
  - Mary's aorta **connected\_to** Mary's heart
- 542



Type-level relations presuppose the underlying instance-level relations

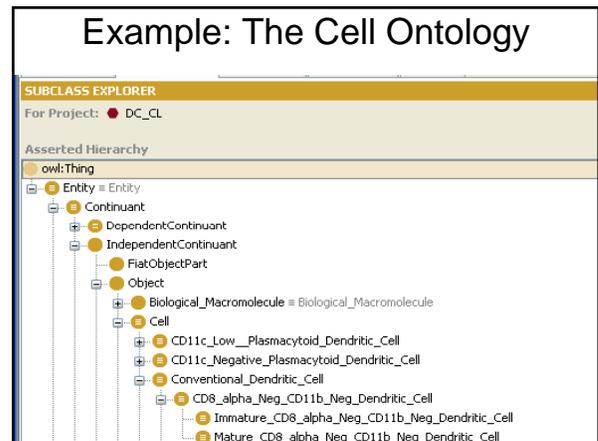
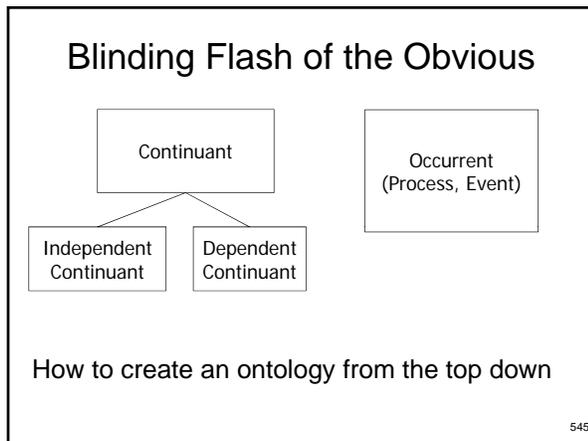
*A part\_of B* =def. All instances of *A* are instance-level-parts-of some instance of *B*

e.g. *human heart part\_of human*

*A has\_participant B* =def. All instances of *A* have an instance of *B* as instance-level participant

e.g. *cell binding has\_participant cell*

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## Benefits of coordination

- No need to reinvent the wheel
- Can profit from lessons learned through mistakes made by others
- Can more easily reuse what is made by others
- Can more easily inspect and criticize results of others' work (PATO)
- Leads to innovations (e.g. Mireot) in strategies for combining ontologies

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## Users of BFO

- PharmaOntology (W3C HCLS SIG)
- MediCognos / Microsoft Healthvault
- Cleveland Clinic Semantic Database in Cardiothoracic Surgery
- Major Histocompatibility Complex (MHC) Ontology (NIAID)
- Neuroscience Information Framework Standard (NIFSTD) and Constituent Ontologies

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## Users of BFO

Interdisciplinary Prostate Ontology (IPO)  
 Nanoparticle Ontology (NPO): Ontology for  
 Cancer Nanotechnology Research  
 Neural Electromagnetic Ontologies (NEMO)  
 ChemAxiom – Ontology for Chemistry  
 Ontology for Risks Against Patient Safety  
 (RAPS/REMINE) (EU FP7)  
 IDO Infectious Disease Ontology (NIAID)

549

## Users of BFO

National Cancer Institute Biomedical Grid  
 Terminology (BiomedGT)  
 US Army Universal Core Semantic Layer  
 (UCore SL)  
 US Army Biometrics Ontology  
 US Army Command and Control Ontology  
 Ontology for General Medical Science  
 (OGMS)

550

## Infectious Disease Ontology Consortium

MITRE, Mount Sinai, UTSouthwestern –  
 Influenza

IMBB/VectorBase – Vector borne diseases (*A. gambiae*, *A. aegypti*, *I. scapularis*, *C. pipiens*, *P. humanus*)

Colorado State University – Dengue Fever

Duke University – Tuberculosis, *Staph. aureus*,  
 HIV

Case Western Reserve – Infective  
 Endocarditis

University of Michigan – Brucellosis

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## OBO Open Biomedical Ontologies

- GO Gene Ontology
- CL Cell Ontology
- SO Sequence Ontology
- ChEBI Chemical Ontology
- PATO Phenotype (Quality) Ontology
- FMA Foundational Model of Anatomy
- ChEBI Chemical Entities of Biological Interest
- PRO Protein Ontology
- Plant Ontology
- Environment Ontology
- Ontology for Biomedical Investigations
- RNA Ontology

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RELATION TO TIME	CONTINUANT				OCCURRENT
	INDEPENDENT		DEPENDENT		
GRANULARITY					
ORGAN AND ORGANISM	Organism (NCBI Taxonomy)	Anatomical Entity (FMA, CARO)	Organ Function (FMP, CPRO)	Phenotypic Quality (PaTO)	Biological Process (GO)
CELL AND CELLULAR COMPONENT	Cell (CL)	Cellular Component (FMA, GO)	Cellular Function (GO)		
MOLECULE	Molecule (ChEBI, SO, RnaO, PrO)		Molecular Function (GO)		Molecular Process (GO)

The Open Biomedical Ontologies (OBO) Foundry

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## maintained by

Werner Ceusters, Buffalo  
 Pierre Grenon, Open University  
 Chris Mungall, Berkeley  
 Fabian Neuhaus, NIST  
 Holger Stenzhorn, IFOMIS, Saarland  
 University  
 Alan Ruttenberg, Science Commons

plus 103 other members of BFO Discussion Group:  
<http://groups.google.com/group/bfo-discuss?>

## inspired by

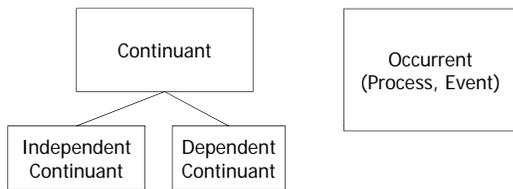
Aristotle  
 Husserl  
 Roman Ingarden  
 Ingvar Johansson  
 Kevin Mulligan, University of Geneva  
 Cornelius Rosse  
 Peter Simons, Trinity College, Dublin

Wittgenstein's *Tractatus* (picture theory of language)  
 Wolfgang Degen, Nicola Guarino, Patrick Hayes

## some important users

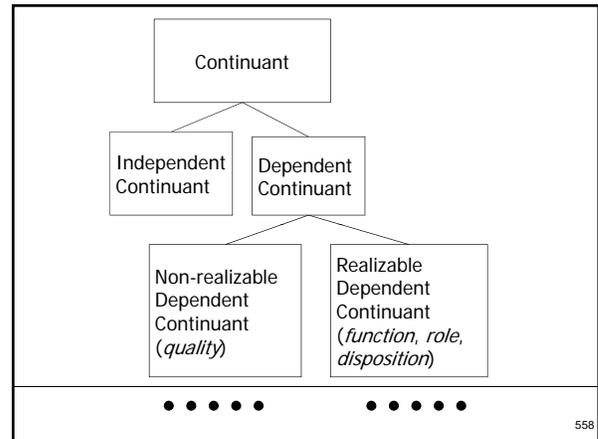
Bjoern Peters, University of California, San Diego  
 Mathias Brochhausen, IFOMIS  
 Lindsay Cowell, Duke University Medical Center  
 Albert Goldfain, University at Buffalo/Blue Highway  
 William Hogan, University of Pittsburgh  
 Ontology for Biomedical Investigations  
 Stephan Schulz, Freiburg University  
 Kent Spackman, SNOMED / IHTSDO

## Blinding Flash of the Obvious



How to create an ontology from the top down

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## Realizable dependent continuants

plan  
 function  
 role  
 disposition  
 capability  
 tendency

} **continuants**

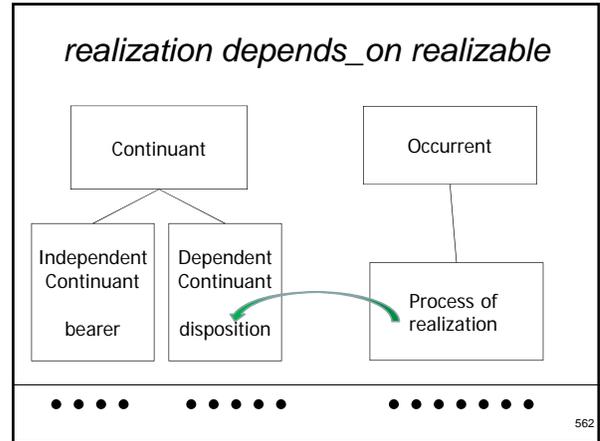
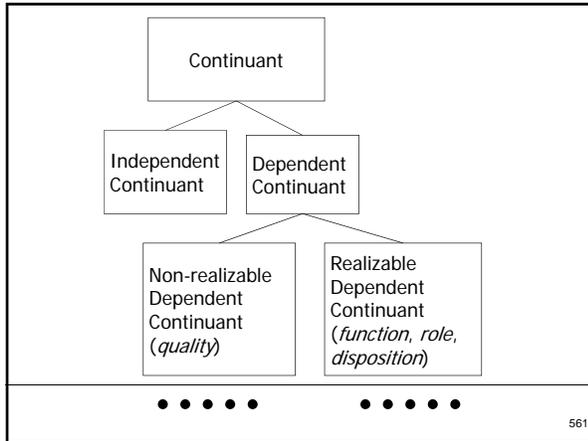
559

## Their realizations

execution  
 expression  
 exercise  
 realization  
 application  
 course

} **occurents**

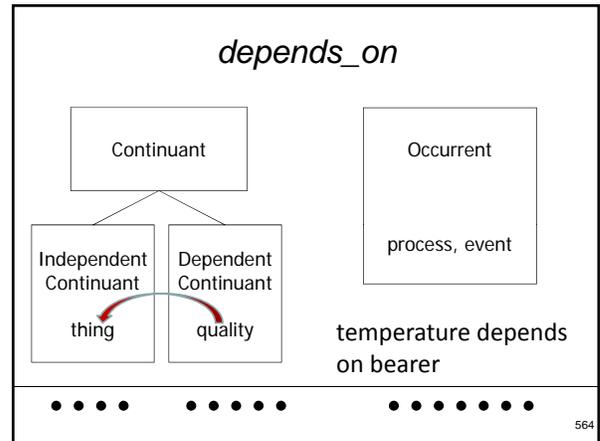
560



### Specific Dependence

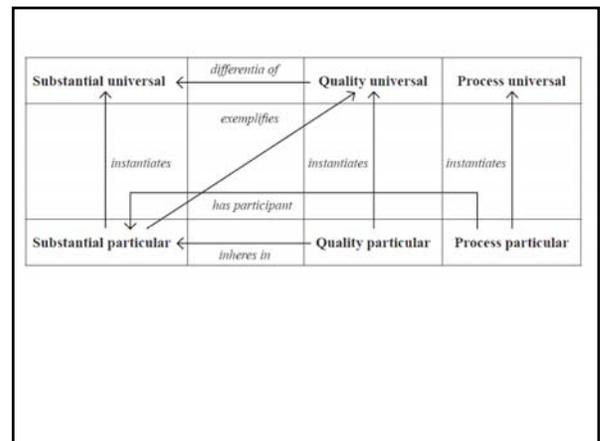
*on the instance level*  
**a depends\_on b** = def. *a* is necessarily such that if *b* ceases to exist than *a* ceases to exist

*on the type level*  
**A specifically\_depends\_on B** = def. for every instance *a* of *A*, there is some instance *b* of *B* such that *a* **depends\_on** *b*.



### The (Aristotelian) Ontological Sextet

	Substances	Quality entities	Processes
Universals	Substance-universals	Quality-universals	Process-universals
Particulars	Individual Substances	Quality-instances (Tropes...)	Process-instances



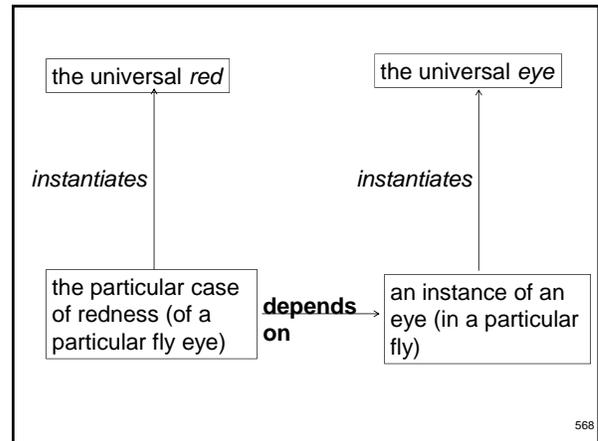
## Specifically dependent continuants

the *quality* of whiteness of this cheese

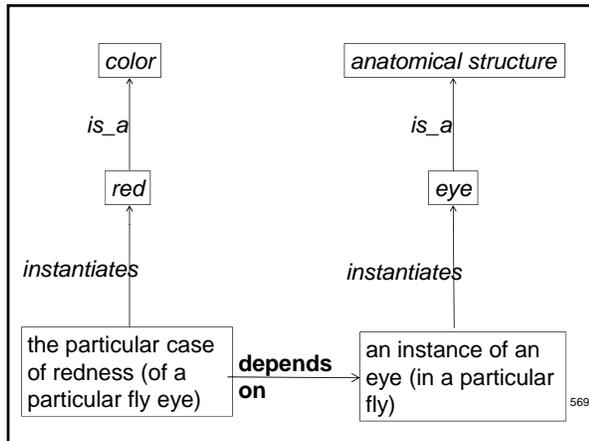
your *role* as lecturer

the *disposition* of this patient to experience diarrhea

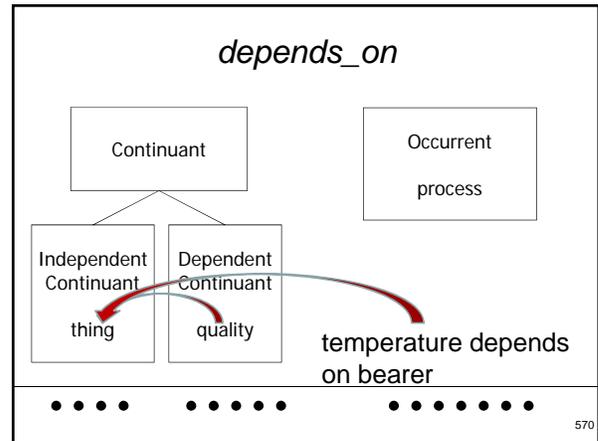
567



568

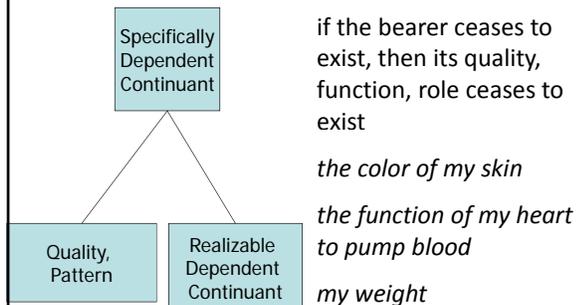


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## Specifically Dependent Continuants



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RELATION TO TIME	CONTINUANT				OCCURRENT
	INDEPENDENT		DEPENDENT		
GRANULARITY					
ORGAN AND ORGANISM	Organism (NCBI Taxonomy)	Anatomical Entity (FMA, CARO)	Organ Function (FMA, CPRO)	Phenotypic Quality (PaTO)	Biological Process (GO)
CELL AND CELLULAR COMPONENT	Cell (CL)	Cellular Component (FMA, GO)	Cellular Function (GO)		
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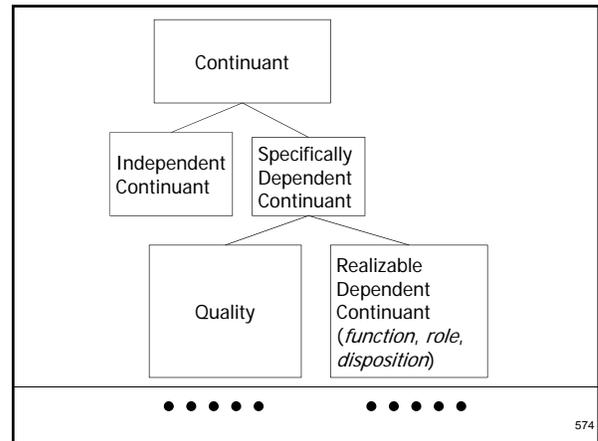
The Open Biomedical Ontologies (OBO) Foundry

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	CONTINUANT		OCCURRENT	
<b>RELATION TO TIME</b>	←		→	
	INDEPENDENT		DEPENDENT	
<b>GRANULARITY</b>				
ORGAN AND ORGANISM	Organism (NCBI Taxonomy)	Anatomical Entity (FMA, CARO)	Organ Function (FMP, CPRO)	Phenotypic Quality (PaTO)
CELL AND CELLULAR COMPONENT	Cell (CL)	Cellular Component (FMA, GO)	Cellular Function (GO)	
MOLECULE	Molecule (ChEBI, SO, RNAO, PRO)		Molecular Function (GO)	Molecular Process (GO)

rationale of OBO Foundry coverage

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### Specific Dependence

*on the instance level*  
 a **depends\_on** b =def. a is necessarily such that if b ceases to exist than a ceases to exist

*on the type level*  
 A **specifically\_depends\_on** B =def. for every instance a of A, there is some instance b of B such that a **depends\_on** b.

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### Generically Dependent Continuants

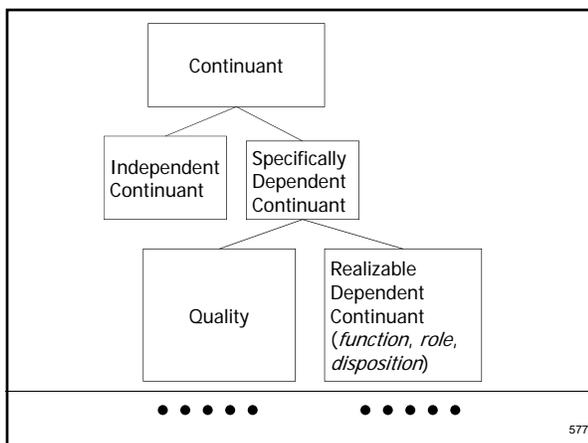
if one bearer ceases to exist, then the entity can survive, because there are other bearers  
 (copyability)

```

graph TD
    GDC[Generically Dependent Continuant] --> IO[Information Object]
    GDC --> GS[Gene Sequence]
  
```

*the pdf file on my laptop*  
*the DNA (sequence) in this chromosome*

576

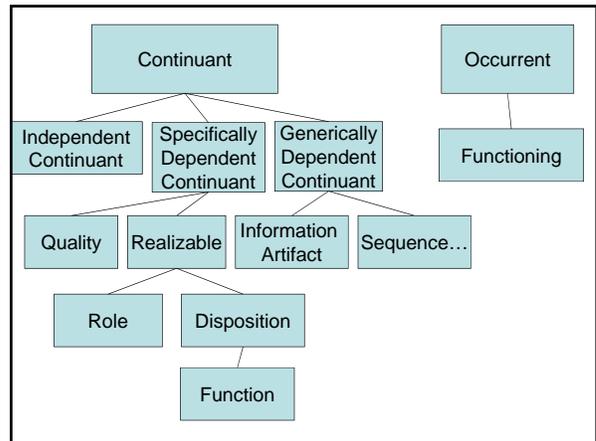
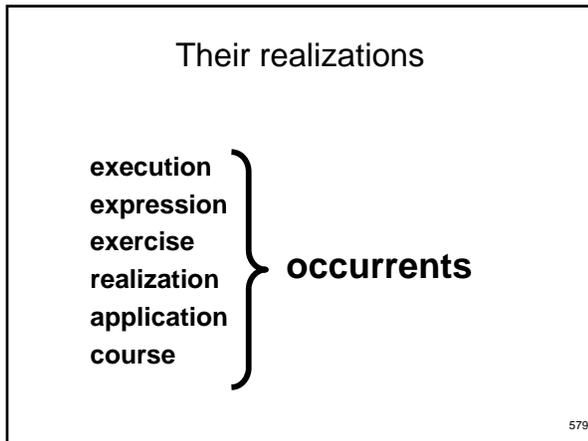


### Realizable dependent continuants

plan  
 function  
 role  
 disposition  
 capability  
 tendency

} **continuants**

578



### Role (Externally-Grounded Realizable Entity)

role =def. a realizable entity which exists because the bearer is in some special physical, social, or institutional set of circumstances in which the bearer does not have to be, and is not such that, if it ceases to exist, then the physical make-up of the bearer is thereby changed.

581

### Disposition (Internally-Grounded Realizable Entity)

*disposition* =def. a realizable entity which if it ceases to exist, then its bearer is physically changed, and whose realization occurs when this bearer is in some special physical circumstances, in virtue of the bearer's physical make-up

582

### Function (A Disposition Designed or Selected For)

*function* =def. a disposition that exists in virtue of the bearer's physical make-up, and this physical make-up is something the bearer possesses because it came into being, either through evolution (in the case of natural biological entities) or through intentional design (in the case of artifacts), in order to realize processes of a certain kind.

583

### The parts of the organism have functions

They have been selected for to ensure that the events transpiring inside the organism remain within the spectrum of allowed values and to respond when they move outside this spectrum of allowed values

584

## What is a Disease?

a state in which a function or part of the body is no longer in a healthy condition.

an illness

a process that is a hazard to health and/or longevity.

a pathological condition that is cross-culturally defined and recognized

585

## Four distinct classificatory tasks

1. of people (patients, carriers, ...)
2. of diseases (cases, instances, problems, ...)
3. of courses of disease (symptoms, ...)
4. of representations (data, diagnoses...)

586

## Four distinct BFO categories

1. person (patient, carrier, ...)  
– **independent continuant**
2. disease (case, instance, problem, ...)  
– **specifically dependent continuant**
3. course of disease (symptom, treatment...)  
– **occurrent**
4. representation (record, datum, diagnosis...)  
– **generically dependent continuant**

587

## Disposition

### Internally-Grounded Realizable Entity

A *disposition* is

a realizable entity which is such that

(1) if it ceases to exist, then its bearer is physically changed, and

(2) whose realization occurs, in virtue of the bearer's physical make-up, when this bearer is in some special physical circumstances

588

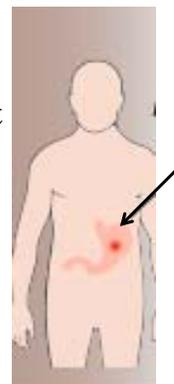
## Disorder

A *part* of an (extended) organism which serves as the bearer of a *disposition* of a certain sort

589

## Disorder

1. person  
– **independent continuant**  
objects  
fiat object part  
object aggregate



590

## Disorder

A *fiat object* part of an organism which serves as the bearer of a *disposition* of a certain sort

This fiat object part is part of the organism and in the case of progressive diseases typically grows larger through time

It is real, but it may have no determinate boundaries

591

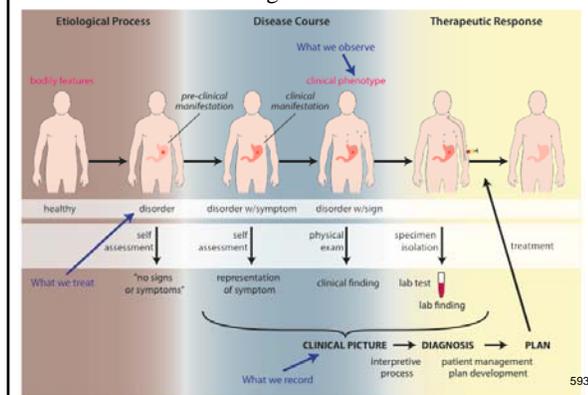


Where does Mount Everest begin and end?

Cf. Barry Smith and David M. Mark, "Do Mountains Exist?", *Environment and Planning B*, 30, 2003.

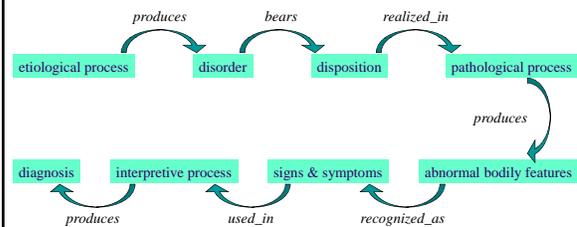
592

## Big Picture



593

A *disease* is a *disposition* rooted in a *physical disorder* in the organism and realized in *pathological processes*.



594

## Elucidation of Primitive Terms

'*bodily feature*' - an abbreviation for a physical component, a bodily quality, or a bodily process.

*disposition* - an attribute describing the propensity to initiate certain specific sorts of processes when certain conditions are satisfied.

*clinically abnormal* - some bodily feature that

- (1) is not part of the life plan for an organism of the relevant type (unlike aging or pregnancy),
- (2) is causally linked to an elevated risk either of pain or other feelings of illness, or of death or dysfunction, and
- (3) is such that the elevated risk exceeds a certain threshold level.\*

\*Compare: baldness

595

## Definitions - Foundational Terms

**Disorder =def.** - A physical component that is clinically abnormal.

**Pathological Process =def.** - A bodily process that is a realization of a disorder and is clinically abnormal.

**Disease =def.** - A disposition (i) to undergo pathological processes that (ii) exists in an organism because of one or more disorders in that organism.

596

## Dispositions and Predispositions

All diseases are dispositions; not all dispositions are diseases.

A predisposition is a disposition.

### **Predisposition to Disease of Type X =def.**

– A disposition in an organism that constitutes an increased risk of the organism's subsequently developing the disease X.

597

## Cirrhosis - environmental exposure

Etiological process - phenobarbital-induced hepatic cell death

– produces

Disorder - necrotic liver

– bears

Disposition (disease) - cirrhosis

– realized\_in

Pathological process - abnormal tissue repair with cell proliferation and fibrosis that exceed a certain threshold; hypoxia-induced cell death

– produces

Abnormal bodily features

– recognized\_as

Symptoms - fatigue, anorexia

Signs - jaundice, splenomegaly

- Symptoms & Signs
  - used\_in
- Interpretive process
  - produces
- Hypothesis - rule out cirrhosis
  - suggests
- Laboratory tests
  - produces
- Test results - elevated liver enzymes in serum
  - used\_in
- Interpretive process
  - produces
- Result - diagnosis that patient X has a disorder that bears the disease cirrhosis

598

## Influenza - infectious

Etiological process - infection of airway epithelial cells with influenza virus

– produces

Disorder - viable cells with influenza virus

– bears

Disposition (disease) - flu

– realized\_in

Pathological process - acute inflammation

– produces

Abnormal bodily features

– recognized\_as

Symptoms - weakness, dizziness

Signs - fever

- Symptoms & Signs
  - used\_in
- Interpretive process
  - produces
- Hypothesis - rule out influenza
  - suggests
- Laboratory tests
  - produces
- Test results - elevated serum antibody titers
  - used\_in
- Interpretive process
  - produces
- Result - diagnosis that patient X has a disorder that bears the disease flu

But the disorder also induces normal physiological processes (immune response) that can result in the elimination of the disorder (transient disease course).

599

## Huntington's Disease - genetic

Etiological process - inheritance of >39

CAG repeats in the HTT gene

– produces

Disorder - chromosome 4 with abnormal mHTT

– bears

Disposition (disease) - Huntington's disease

– realized\_in

Pathological process - accumulation of mHTT protein fragments, abnormal transcription regulation, neuronal cell death in striatum

– produces

Abnormal bodily features

– recognized\_as

Symptoms - anxiety, depression

Signs - difficulties in speaking and swallowing

- Symptoms & Signs
  - used\_in
- Interpretive process
  - produces
- Hypothesis - rule out Huntington's
  - suggests
- Laboratory tests
  - produces
- Test results - molecular detection of the HTT gene with >39CAG repeats
  - used\_in
- Interpretive process
  - produces
- Result - diagnosis that patient X has a disorder that bears the disease Huntington's disease

600

## Benefits of coordination

No need to reinvent the wheel

Can profit from lessons learned through mistakes made by others

Can more easily reuse data collected by others

Can more easily resolve the silo problems created by multiple independent discipline-specific ontologies

601

## Why GO is so successful

Strategy of low hanging fruit

Lessons learned and disseminated as common guidelines – all developers in a large community are doing it the same way

Ontologies are built by domain experts

Ontologies based on *real thinking* (not for example on automatic extraction of terms from text)

## Benefits of BFO

small, simple, rigorously tested  
large community of users and maintainers  
top-down development methodology has  
been shown to work in many different  
domains  
humanly intelligible  
compatible with top-level of DOLCE  
a genuine top level

604



## Universal Core Semantic Layer (UCore SL)

An Ontology-Based Supporting Layer for  
UCore 2.0

October 11, 2009

Barry Smith

605



## Universal Core Semantic Layer (UCore SL)

An Ontology-Based Supporting Layer for  
UCore 2.0 sponsored by the US Army Net-  
Centric Data Strategy Center of Excellence

606

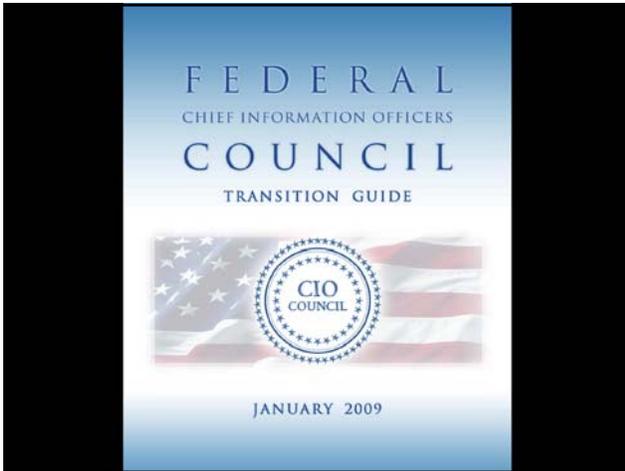


## DoD Net-Centric Data Strategy

*The DoD Net-Centric Data Strategy, issued by the DoD CIO May 9, 2003, is the plan to make the Department's information resources:*

<b>Visible</b>	Is an information resource discoverable by most users?
<b>Accessible</b>	Is it available on the network, and are tools readily available to use it?
<b>Understandable</b>	Can it be intelligibly used? Are the semantics well documented?
<b>Trusted</b>	Are the source, security level and access controls of the data available to users?
<b>Interoperable</b>	Can it be combined or compared with other information? Can it be mediated?
<b>Responsive</b>	Is the data what users need? Are robust user feedback mechanisms in place to improve it?

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## UCore Initiative

- The UCore initiative focused on improving national readiness and international security by developing a common technical approach and vocabulary that enable information sharing between Federal, state, regional, and local governments, along with civil and non-governmental organizations, and U. S. coalition partners and allies.

609

## UCore Initiative

- An XML schema was defined containing agreed-upon representations for the most commonly shared and universally understood concepts of who, what, when, and where in order to promote Federal information sharing.

610

### What is the Universal Core (UCore)?

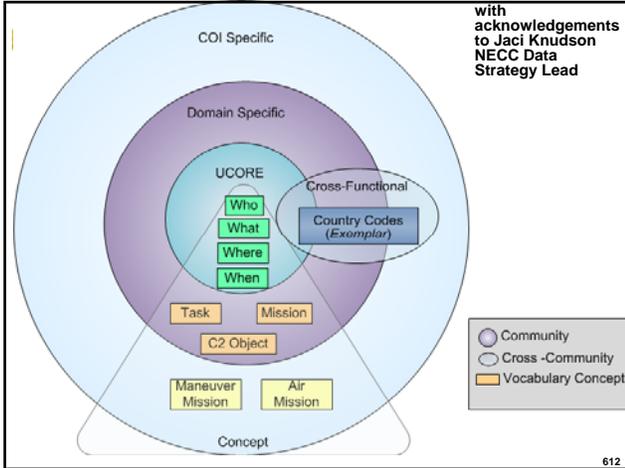
**U**niver  
**e**or

**An information exchange specification and Implementation profile**

- Vocabulary**
  - Of most commonly exchanged concepts: Who, What, When, Where
- XML representation** of the concepts
- Guidance for extension** to permit tailoring to specific mission areas
- Security markings** to permit controlled access electronic tear lines
- Messaging framework** to package and unpack the content consistently

**UCore V2.0 Conceptual Data Model**

**UCore is Common Point of Departure**



## UCore 2.0 Taxonomy

uc:Entity	uc:LivingThing	uc:Event	uc:LawEnforcementEvent
uc:Cargo	uc:Animal	uc:AlertEvent	uc:MigrationEvent
uc:CollectionOfThings	uc:Person	uc:CommunicationEvent	uc:MilitaryEvent
uc:CyberAgent	uc:MicroOrganism	uc:CriminalEvent	uc:NaturalEvent
uc:Document	uc:Plant	uc:CyberSpaceEvent	uc:ObservationEvent
uc:Environment	uc:Organization	uc:DisasterEvent	uc:PlannedEvent
uc:Equipment	uc:PoliticalEntity	uc:EconomicEvent	uc:PoliticalEvent
uc:Facility	uc:Sensor	uc:EmergencyEvent	uc:PublicHealthEvent
uc:FinancialInstrument	uc:Vehicle	uc:EnvironmentalEvent	uc:SecurityEvent
uc:GeographicFeature	uc:Aircraft	uc:EvacuationEvent	uc:SocialEvent
uc:GroupOfOrganizations	uc:GroundVehicle	uc:ExerciseEvent	uc:TerroristEvent
uc:GroupOfPersons	uc:Spacecraft	uc:FinancialEvent	uc:TransportationEvent
uc:InformationSource	uc:Watercraft	uc:HazardousEvent	uc:WeatherEvent
uc:Infrastructure		uc:HumanitarianAssistanceEvent	
		uc:InfrastructureEvent	

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## UCore SL

- An incremental strategy for achieving semantic interoperability
- Leaves UCore 2.0 as is, but provides a logical definition for each term in UCore 2.0 taxonomy and for each UCore 2.0 relation
- UCore SL is designed to work behind the scenes in UCore 2.0 application environments as a logical supplement to the UCore messaging standard

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## UCore SL

- Initiative of NCOR and Army Net-Centric Data Strategy Center of Excellence with contributions from the Intelligence Community and multiple Army COIs

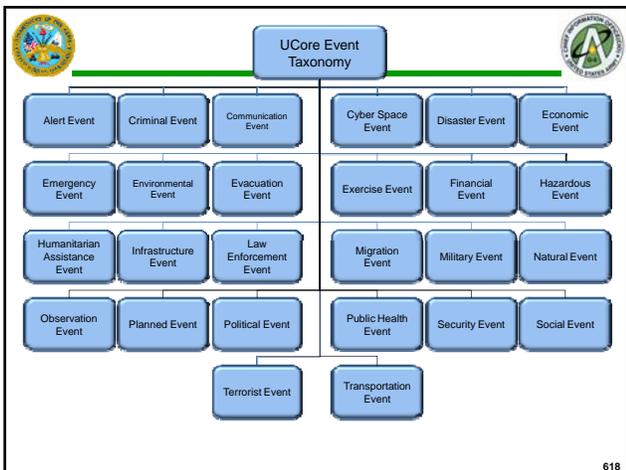
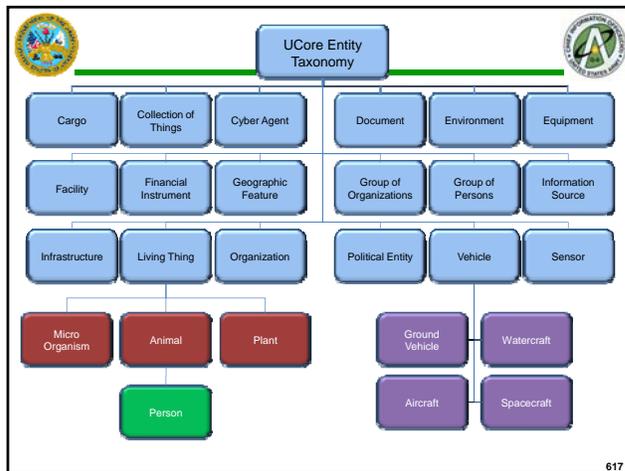
615

**XML vs. OWL DL**

XML → *syntactic interoperability*

OWL DL → *semantic interoperability*

616



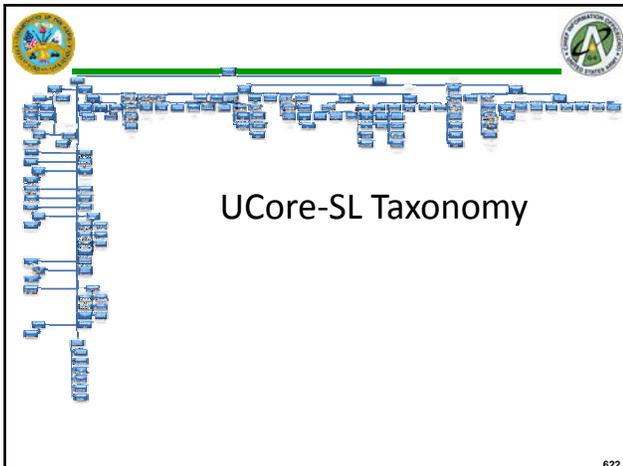
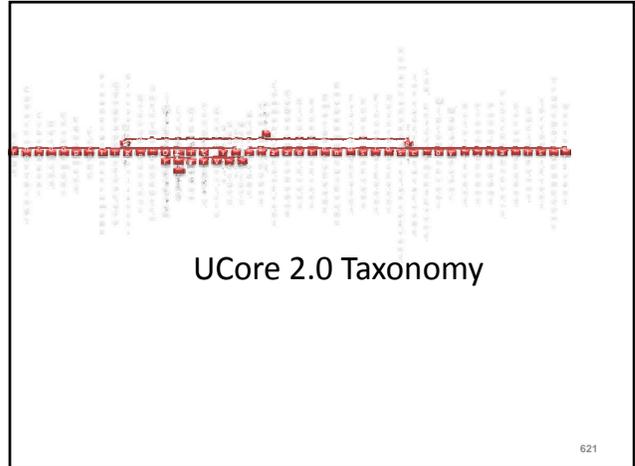
**fragment of UCore 2.0 Taxonomy**

<p><u>uc:Entity</u></p> <ul style="list-style-type: none"> <li><u>uc:Cargo</u></li> <li><u>uc:CollectionOfThings</u></li> <li><u>uc:CyberAgent</u></li> <li><u>uc:Document</u></li> <li><u>uc:Environment</u></li> <li><u>uc:Equipment</u></li> <li><u>uc:Facility</u></li> <li><u>uc:FinancialInstrument</u></li> <li><u>uc:GeographicFeature</u></li> <li><u>uc:GroupOfOrganizations</u></li> <li><u>uc:GroupOfPersons</u></li> <li><u>uc:InformationSource</u></li> </ul>	<p><u>uc:Event</u></p> <ul style="list-style-type: none"> <li><u>uc:AlertEvent</u></li> <li><u>uc:CommunicationEvent</u></li> <li><u>uc:CriminalEvent</u></li> <li><u>uc:CyberSpaceEvent</u></li> <li><u>uc:DisasterEvent</u></li> <li><u>uc:EconomicEvent</u></li> <li><u>uc:EmergencyEvent</u></li> <li><u>uc:EnvironmentalEvent</u></li> <li><u>uc:EvacuationEvent</u></li> <li><u>uc:ExerciseEvent</u></li> <li><u>uc:FinancialEvent</u></li> <li><u>uc:HazardousEvent</u></li> </ul>
--	---

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## fragment of UCore SL Taxonomy

sl:Entity	
sl:InformationContentEntity	sl:Infrastructure
sl:Analysis	sl:Materiel
sl:Objective	sl:Consumable
sl:ObjectiveSpecification	sl:Organization
sl:Opinion	sl:Government
sl:Plan	sl:PhysicalObject
sl:TaskSpecification	sl:LivingThing
sl:PhysicalEntity	sl:Animal
sl:Agent	sl:Person
sl:Artifact	sl:InfectiousOrganism
sl:ArtificialAgent	sl:MicroOrganism
sl:Equipment	sl:Plant
sl:Facility	sl:Vehicle
sl:Sensor	sl:SpaceRegion
sl:Environment	sl:Property
sl:GeographicFeature	sl:Capability
sl:GeospatialBoundary	sl:PhysicalProperty



OWL DL allows use of UCore SL

- To leverage UCore 2.0 by facilitating consistent merging with other OWL DL resources
- Provides logically articulated definitions
- To support use of W3C-standards-based software providing:
  - Enhanced reasoning with UCore message content
  - Enhanced quality assurance
  - Consistent evolution of UCore
  - Reliable and consistent extension modules

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## Provides Additional Logical Resources

Using UCore SL as a supporting layer makes it possible to identify that something cannot be both a Person and an Organization

Logically speaking, UCore 2.0 is too weak to detect simple inconsistencies.

624

## Potential Benefits for UCore 2.0

- Provide automatic warnings e.g. for potential ambiguities in UCore 2.0 terms and definitions
- Automatic consistency checking when extensions to UCore 2.0 are proposed
- Identify logical gaps in UCore 2.0 taxonomy and relations
- Allow integration of UCore 2.0 XML-based technology with W3C (Semantic Web) content

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## Potential Benefits for UCore Users

- Provide flexible refactoring of UCore 2.0 for different (DoD, IC, DoJ, ...) purposes, while preserving interoperability
- Allow development of standards-based tools to support and enhance verification of UCore messages for correctness
- Application of more powerful logic-based tools e.g. in identifying referents of terms using in messages
- Help UCore users work more effectively in retrieving and processing messages

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## What NCOR can do for UCore users

NCOR has several years experience applying semantic technology to terminology resources across multiple domains, including:

- Biosurveillance
- Geospatial information
- Multi-source data and information fusion
- Infectious disease
- Petrochemical industry
- Vaccine research

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## What NCOR can do for UCore users

NCOR offers services in three areas:

- ★ Training in use of semantic technology
- ★ Evaluation of terminology resources
- ★ Creating consistent extensions of core resources that work well across multiple domains
- ★ Use of semantic technology to support reasoning with data

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## Benefits of Coordination

Each new Community of Interest (COI):

- can profit from lessons learned at earlier stages and avoid common mistakes
- can more easily reuse tested software resources
- can collect data in forms which will make it automatically comparable with data already collected

No need to reinvent the wheel

629

## Example: Command and Control

- ★ The C2 Domain consists of 6 components:
  - Force Structure, Integration, Organization
  - Situational Awareness
  - Planning and Analysis
  - Decision Making and Direction
  - Operational Functions and Tasks
  - Monitoring Progress (Assessing)
- ★ C2 Core Ontology is based upon these elements
- ★ Vocabulary derived from Joint Doctrine

with thanks to Maj. Bill Mandrick

630

Unclassified

## C2 Core Ontology Doctrinal Sources...

- JP 5-0 Joint Operation Planning
- JP 1-02 DoD Dictionary of Military and Related Terms
- JP 3-13.1 Joint Doctrine for Command and Control
- JP 3-0 Joint Operations
- FM 3-0 Operations
- MCDP Command and Control

Unclassified

631

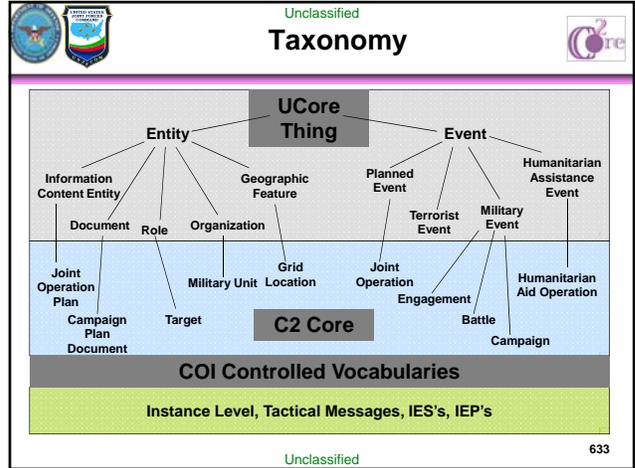
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## High-Frequency Terminology

- Getting to the Low-Hanging Fruit
  - Reliable Data Sources
  - Good C2 Models
  - C2 Experience
  - Apply 10/90 rule
  - Use "Best Practices"
  - SME Input

Unclassified

632



Unclassified

## C2 Information Content Entities

Doctrinal Definition: A clear, concise statement of what the force must do and the conditions the force must meet to succeed with respect to the enemy, terrain, and the desired end state (FM 3-0).

Unclassified

634

Unclassified

## C2 Core Ontology Events

Definitions based upon Joint Doctrine

Doctrinal Definition: A C2 Process whereby Combatant Commanders and subordinate joint force commanders translate national or theater strategy into operational concepts through the development of an Operation Plan for a Campaign. (JP 1-02)

Unclassified

635

Unclassified




## Example

- Net-Enabled Command Capability (NECC): Controlled Vocabulary Includes:
  - Geographic Locations
  - Information Entities
  - Plans
  - Operations
  - Information Requirements
  - Planning Processes
  - Observation and Analysis
  - Force Structures

Unclassified

636

Unclassified




## Extending UCore 2.0

- C2 Core Taxonomy is...
  - A powerful tool for organizing controlled vocabularies
  - With categories that extend from UCore 2.0
  - And acts as a middle (semantic) layer
  - Which connects UCore 2.0 with COI controlled vocabularies
  - Establishes a systematic way of organizing the terms, entities, and events
  - For any COI (controlled vocabulary) across the DoD enterprise
  - Using doctrinally sound terminology
- Some examples from NECC follow...

Unclassified

637

Unclassified




## Geospatial Location



**C2 Core Taxonomy "Entities"**

Definition: A geospatial region where an entity or event is located.

**NECC Terms**

- Air Force Equipment Locations
- Air Force Unit Locations
- Army Equipment Locations
- Navy Equipment Locations
- Navy Unit Locations
- SOF Equipment Locations
- SOF Unit Locations
- USMC Equipment Locations
- USMC Unit Locations
- Army Unit Locations

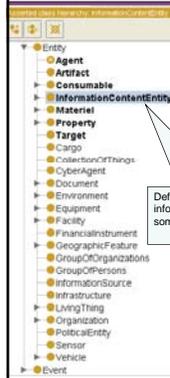
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638

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## Information Entities



Definition: An entity which consists of information and which inheres in some information bearing entity.

**NECC Terms**

- Air Force Unit Mobilization History
- Air Force Unit Readiness History
- Air\_Sea Port Information
- Passenger Movement Information
- Army Unit Mobilization History
- USMC Unit OPS Tempo History

Unclassified

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Unclassified

## Plans

NECC Terms

- Army Fires Plan
- Army Maneuver Plan
- Naval Fires Plan
- OPLAN
- USMC Fires Plan
- USMC Maneuver Plan
- Air Force Unit Planned Future Activities

Definition: An information content entity that is a specification of events that are to occur in order to obtain some objective.

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## Information Requirements

NECC Terms

- Army Combat Support Requirements
- USMC Combat Support Requirements
- USMC Unit Sustainment Requirements

Definition: All of the information elements that the commander and staff require to successfully conduct operations; that is, all elements necessary to address the factors of METT-TC (FM 6-0)

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Unclassified

## Operations

NECC Terms

C2 Core Taxonomy "Events"

- Medical Response
- Consequence Management
- Civil Military Operations
- Combat Search and Rescue

Definition: The process of carrying on combat, including movement, supply, attack, defense, and maneuvers needed to gain the objectives of any battle or campaign. (JP 1-02)

642

Unclassified

## Planning Processes

NECC Terms

C2 Core Taxonomy "Military Event"

- Computer Network Attack Planning
- Computer Network Defense Planning

Definition: The means by which the commander envisions a desired outcome, lays out effective ways of achieving it, and communicates to his subordinates his vision, intent, and decisions, focusing on the results he expects to achieve (FM 3-0).

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## Acts of Observation




Definition: An Act which has the Objective of obtaining information about some Entity or Event by observation (in contrast to hearsay or indirect report), and in which this Objective is achieved.

NECC Terms

Gray Track

Red Track

ActOfObservation

- Thing
- Entity
- Event
  - Act
    - ActOfAnalysis
    - ActOfObservation**
    - ControlMeasures
    - CollateralDamage
    - DecisionPoint
    - Effect
    - Operation
    - Task
      - AlertEvent
      - CommunicationEvent
      - CriminalEvent
      - CyberSpaceEvent
      - DisasterEvent
      - EconomicEvent
      - EmergencyEvent
      - EnvironmentalEvent
      - EvacuationEvent
      - ExerciseEvent
      - FinancialEvent
      - HazardousEvent
      - HumanitarianAssistanceEvent
      - InfrastructureEvent
      - LawEnforcementEvent

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## UCore 2.0 Federal Change Management Process



## UCore 2.0 Change Request

Changes to be proposed by U.S. Army Net-Centric Data Strategy Center of Excellence (ANCDS-COE) and the National Center for Ontological Research (NCOR) regarding

- Temporally Bounded Attributes
- Correct Subtyping



## UCore 2.0 Proposed Change #1

- UCore recognizes that **location** is a temporal attribute of an entity
- UCore does not recognize that other attributes stand in temporal relationships to their bearers
- The current UCore Entity hierarchy makes no distinction between entities that bear attributes and the attributes themselves
- For example:

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Leading Army Data Transformation

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### Entities and their Roles

Selected class hierarchy: InformationSource

- Thing
  - Entity
    - Cargo
    - CollectionOfThings
    - CyberAgent
    - Document
    - Environment
    - Equipment
    - Facility
    - FinancialInstrument
    - GeographicFeature
    - GroupOfOrganizations
    - GroupOfPersons
    - InformationSource ←
    - Infrastructure
    - LivingThing
      - Animal
        - Person ←
        - MicroOrganism
        - Plant
      - Organization
      - PoliticalEntity
      - Sensor
      - Vehicle



TSGT Jones is always a person, but he is an "Information Source" while on a mission

649

### Multiple Inheritance

Selected class hierarchy: Cargo

- Thing
  - Entity
    - Cargo ←
    - CollectionOfThings
    - CyberAgent
    - Document
    - Environment
    - Equipment
    - Facility
    - FinancialInstrument
    - GeographicFeature
    - GroupOfOrganizations
    - GroupOfPersons
    - InformationSource
    - Infrastructure
    - LivingThing
      - Organization
      - PoliticalEntity
    - Sensor
    - Vehicle
      - Aircraft
      - GroundVehicle ←
      - Spacecraft
      - Watercraft



This tank is always a type of "Ground Vehicle"  
At "Time T" it was also "Cargo"

As COI's extend UCore 2.0 to provide more specific coverage of their domains, entities will be sub-typed under multiple parent terms in order to accommodate the attributes they acquire during their participation in events.

Such multiple inheritance leads to difficulties when attempting to merge ontologies.

650

### Proposed Solution

- Entity
  - Object
  - Dependent Entity
    - Capability
    - Function
    - Property
    - Role
      - Command Role
      - Cargo Role ←
      - Information Source Role
      - Target Role



Photo from: <http://www.army.mil/news/2009/02/02/16332-innovation-saves-thousands-to-ship-damaged-track-vehicles/>

651

### Proposed Solution

- Entity
  - Object
  - Dependent Entity
    - Role
      - Command Role
      - Cargo Role
      - Information Source Role
      - Target Role ←



This building was an insurgent safe-house.

At the time this picture was taken it also took on the Role of a Target

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**Proposed Change**

- **Thing**
  - Entity
    - Geographic Feature
    - Group Of Organizations
    - Group Of Persons
    - Information Bearing Entity
    - Information Content Entity
    - Information Source

Definition: A Physical Entity in which some Information Content Entity inheres.

Definition: An entity which consists of information and which inheres in some information bearing entity.

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**UCore 2.0 Proposed Change # 3**

- **Title: Sub-Categories**
  - 1. Alert Event is a sub-category Communication Event.
  - 2. Weather Event is a sub-category of Natural Event.
  - 3. Exercise Event is a sub-category of Planned Event.
  - 4. Financial Event is a sub-category of Economic Event.
  - 5. Financial Instrument is a sub-category of Document.
  - 6. Cyber Agent is a sub-category of Agent.
    - The taxonomy should include Agent.
  - 7. Political Entity is a sub-category of Organization.

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**Document Sub-Type**

Financial Instrument is a sub-type of Document

A piece of written, printed, or electronic matter that provides information or evidence. [Verbatim from Concise Oxford English Dictionary, 11th Edition, 2008]

A document, real or virtual, having legal force and embodying or conveying monetary value. [Derived from: Deardorff's Glossary of International Economics (ISBN 978-981-256-628-7)]

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**Organization Sub-Type**

Political Entity is a sub-type of Organization

An organized body of people with a particular purpose, e.g. a business or government department. [Verbatim from Concise Oxford English Dictionary, 11th Edition, 2008]

An organized governing body with political responsibility in a given geographic region. [Derived from Concise Oxford English Dictionary, 11th Edition, 2008]

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**Entity with Proposed Changes**

The screenshot shows a software interface with a tree view on the left and a list view on the right. The tree view shows a hierarchy starting with 'Thing' and including various sub-entities like 'Cargo', 'CollectionOfThings', 'CyberAgent', etc. The list view shows a list of entities, including 'Entity', 'Agent', 'Cyber Agent', 'Cargo', etc. A blue box labeled "Entity with proposed changes" has arrows pointing to the 'Entity' entry in the list and the 'Entity' node in the tree view.

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**How UCore SL helps**

These proposed changes to UCore 2.0 were generated automatically via a very simple error-checking process based on the logical relations incorporated into UCore SL

As UCore 2.x grows larger, and the number of extensions continues to grow, this facility for quality assurance will become ever more important

In this way, as in biology and medicine, so also in government, logical and ontological rigor can contribute to the realization of the information sharing needs of the future.

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