Agenda • Day 1

• Introduction: What is an ontology and what is it useful for?

• **Basic Formal Ontology:** An upper-level ontology to support scientific research

• Open Biomedical Ontologies (OBO) and the Web Ontology Language (OWL)

• The OBO Relation Ontology
Ontology

the science of the kinds and structures of objects, properties, events, processes and relations in every domain of reality
World’s first ontology
(from Porphyry’s *Commentary on Aristotle’s Categories*)
Linnaean Ontology
Contemporary top-level ontologies

DOLCE = Domain Ontology for Linguistic and Cognitive Engineering

SUMO = Suggested Upper Merged Ontology

BFO = Basic Formal Ontology
Each of these ontologies

is not just a system of categories
but a *formal theory*

with definitions, axioms, theorems
designed to provide the resources for
reference ontologies built to represent the
entities in specific domains

of sufficient richness that terminological
incompatibilities can be resolved
intelligently rather than by brute force
BFO is a very small ontology to support integration of scientific research data

SUMO contains many portions which are more properly conceived of as domain ontologies (airports, bacteria, ...)

DOLCE is tilted towards objects of general thought and communication (fiction, mythology, ...)

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Basic Formal Ontology

- a true upper level ontology
- no interference with domain ontologies
- no interference with issues of cognition
- no negative entities
- no putative fictions
- a small subset of DOLCE but with more adequate treatment of instances, universals, relations and qualities

http://www.ifomis.org/bfo/
Groups and Organizations using BFO

AstraZeneca - Clinical Information Science
BioPAX-OBO
BIRN Ontology Task Force (BIRN OTF)
Computer Task Group Inc.
Duke University Laboratory of Computational Immunology
Dumontier Lab
INRIA Lorraine Research Unit
Kobe University Graduate School of Medicine
Language and Computing
National Center for Multi-Source Information Fusion
Ontology Works
Science Commons - Neurocommons
University of Texas Southwestern Medical Center
Ontologies using BFO

BioTop: A Biomedical Top-Domain Ontology
Common Anatomy Reference Ontology (CARO)
Foundational Model of Anatomy (FMA)
  Gene Ontology (GO)
Infectious Disease Ontology
Ontology for Biomedical Investigations (OBI)
Ontology for Clinical Investigations (OCI)
Phenotypic Quality Ontology (PaTO)
Protein Ontology (PRO)
RNA Ontology (RnaO)
Senselab Ontology
Sequence Ontology (SO)
Subcellular Anatomy Ontology (SAO)
Vaccine Ontology (VO)
Realist Perspectivalism: The philosophical basis of BFO

There is a multiplicity of ontological perspectives on reality, all equally veridical i.e. transparent to reality

Ontologies are windows on reality
The Time Problem

The tumor developed in John’s lung over 25 years
The Problem

___ developed in _____ over 25 years

process

state
The Problem

The tumor developed in the lung over 25 years

substances
things
objects
continuants
The Problem

The tumor developed in the lung over 25 years.

What is it that participates in this process of tumor development?

Parthood here not determinate.
The Problem

The tumor developed in the lung over 25 years.

Substances

Process

Gluing these two types of entities together yields ontological monsters.
Continuants vs occurrents

In preparing an inventory of reality we keep track of these two different kinds of entities in two different ways.
BFO: the very top

Continuant

Independent Continuant

Dependent Continuant

Occurrent (always dependent on one or more independent continuants)
An alternative approach: Fourdimensionalism

- only processes (occurrences) exist
- time is just another dimension, analogous to the three spatial dimensions
- substances are analyzed away as worms/fibers within the four-dimensional plenum
- fourdimensionalism brings benefits especially for computational purposes
There are no substances

Bill Clinton does not exist

Rather: there exists within the four-dimensional plenum a continuous succession of processes which are similar in a Billclintonizing way
Fourdimensionalism ("everything is flow") is right in everything it says

But it is incomplete
Realist Perspectivalism

There is a multiplicity of ontological perspectives on reality, all equally veridical = transparent to reality

Fourdimensionalism is one veridical perspective among others

Cf. particle vs. wave ontologies used in quantum mechanics
Continuants and Occurrents
Two Orthogonal, Complementary Perspectives

stocks and flows
commodities and services
product and process

anatomy and physiology
Continuant entities
- have continuous existence in time
- preserve their identity through change
- exist *in toto* if they exist at all

Occurrent entities
- have temporal parts
- unfold themselves phase by phase
- exist only in their phases/stages
You are a substance

Your *life* is a process

*You* are 3-dimensional

Your *life* is 4-dimensional
Many SNAPshot Ontologies

Here time exists outside the ontology, as an index or time-stamp.
mereology works without restriction
(parthood is everywhere determinate) in
every SNAP ontology

Note that, while, the *views* are
instantaneous, the *objects viewed* endure
Three kinds of continuant entities

1. Substances (Independent)
2. SNAP Dependent Entities
3. Spatial regions, contexts, niches, environments, settings
Dependent continuants:

one-place:

your temperature, color, height
my knowledge of French
the whiteness of this cheese
relational dependent continuants

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

love

John

Mary

specific dependence
Dependent continuants

Functions, qualities, roles …
dispositions, plans, shapes, diseases …
The world of processes
Occurrents

here time exists as part of the domain of the ontology
mereology works without restriction everywhere here and boundaries are mostly fiat
Processes, too, are dependent on substances

One-place vs. relational processes

One-place processes:
  your getting warmer
  your getting hungrier
Examples of relational processes

kissings, thumpings, conversings, dancings, ...
join their carriers together into *collectives* of greater or lesser duration
Two kinds of occurrent entities

1. Processes (including events, beginnings, endings = process-boundaries)
2. Spatio-temporal regions
How do you know whether an entity is a continuant or an occurrent?
problem cases

forest fire
the Olympic flame
epidemic
hurricane
traffic jam
ocean wave
forest fire

a process

a pack of monkeys jumping from tree to tree and eating up the trees as they go

(anthrax spores are little monkeys)
The Epidemic
(Continuant)

The Spread of an Epidemic
(Occurrent)
Three dichotomies

• instance vs. universal
• continuant vs. occurrent
• dependent vs. independent

• universals exist in reality *through their instances*
BFO

Continuant

Independent Continuant

(molecule, cell, organ, organism)

Dependent Continuant

(quality, function, disease)

Occurrent (Process)

Functioning

Side-Effect, Stochastic Process, ...
BFO

all terms included in the ontology are intended to designate universals in reality

in conformity with the basic principle of science-based ontology

science-based ontologies are windows on reality
Phenotype Ontology

Continuant

Occurrent (Process)

Independent Continuant

(molecule, cell, organ, organism)

PATO phenotypic quality ontology

Functioning

Side-Effect, Stochastic Process, …
An example of a quality

- The particular redness of the left eye of a single individual fly
  - An instance of a quality universal
- The color ‘red’
  - A quality universal
- Note: the eye does not instantiate ‘red’

- PATO represents quality universals: color, temperature, texture, shape …
Qualities are *dependent* entities

- Qualities require (depend on) *bearers*, which are independent continuants
  
  Example:
  - A shape requires a physical object as its bearer
  - If the physical object ceases to exist (e.g. it decomposes), then the shape ceases to exist
the universal *red*

instantiates

the particular case of redness (of a particular fly eye)

has_bearer

an instance of an eye (in a particular fly)

the universal eye

instantiates

the universal eye
What a quality is NOT

• Qualities are not measurements
  – Instances of qualities exist independently of their measurements
  – Qualities can have zero or more measurements

• These are not the names of qualities:
  – percentage
  – process
  – abnormal
  – high

• Open problem: how relate qualities such as length to measurement values?