Ontology Summit 2021

Ontology Generation and Harmonization

Ontology Landscape
One View

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Ontology Landscape Dimensions



- * What is an Ontology – Definitions
- Uses of Ontology
- * Types of Ontologies
- Representation Languages
- Development Methodologies
- * Development Challenges
- Reasoners
- Knowledge Capture/Management
- Ontology Development – Who should develop them?
- Ontology Design Patterns
- Interoperability
- Quality of existing ontologies – ability for reuse
- Producing Organizations
- Proliferation of ontologies
- Infrastructure
- Deployment/Performance – Operationalization
- Commercial Support - Tools

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Ontology Landscape Over Time



- ***Knowledge Graphs*** - OntologySummit2020
- ***Explanations*** - OntologySummit2019
- ***Contexts in Context*** - OntologySummit2018
- ***AI, Learning, Reasoning, and Ontologies*** - OntologySummit2017
- ***Framing the Conversation: Ontologies within Semantic Interoperability Ecosystems*** - OntologySummit2016
- ***Internet of Things: Toward Smart Networked Systems and Societies*** - OntologySummit2015
- ***Big Data and Semantic Web Meet Applied Ontology*** - OntologySummit2014
- ***Ontology Evaluation Across the Ontology Lifecycle*** - OntologySummit2013
- ***Ontology for Big Systems*** - OntologySummit2012
- ***Making the Case for Ontology*** - OntologySummit2011
- ***Creating the Ontologists of the Future*** - OntologySummit2010
- ***Toward Ontology-based Standards*** - OntologySummit2009
- ***Toward An Open Ontology Repository*** - OntologySummit2008
- ***Ontology, Taxonomy, Folksonomy: Understanding the Distinctions*** - OntologySummit2007
- ***the Upper Ontology Summit*** - UpperOntologySummit (2006)

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(One) Purpose

- Ontologies are for **Communication**
  - Facilitating interoperability
- Types of Communication Paths
  - **People -to- People** Interface using natural language
  - **People -to- Machines** Interface using natural language translated (potentially lossy) to formal languages
  - **Machines -to- Machines**: Interface using formal languages, perhaps with translations or lossy
  - **People -to- Machines -to- People**: Interface using natural language to formal language and back to natural language with translations

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Communication Interface



- **An Ontology is an Interface for Communication**
- To communicate, information must be expressed
- Cannot assume recipient will share your/intended interpretation
- Listing (natural language) terms is insufficient
- Definitions are needed
  - Natural Language – for humans
  - Formal – for computation
- Track B will address definitions

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What is an Ontology?

- From Nicola Guarino

  An ontology **makes explicit *people's distinctions and assumptions*** about the nature and structure of a portion of the world (the domain of discourse)

  A computational ontology is an engineered artifact representing an intended interpretation of a **vocabulary** in a machine-readable form distinguishing and describing the ***nature*** and ***structure*** of a ***domain of discourse***

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Types of Ontology?

- One view provided in 2017 Ontology Summit - *Ontology, Taxonomy, Folksonomy: Understanding the Distinctions*

- By the phrase 'type of ontology' we have in mind a classification that can be viewed in terms of
  - the number of domains in which the ontology is applicable

  Or
  - the number of possible interpretations or models (an ontology has)

  Or
  - the number of (formal) distinctions made

- Using this 'view' there are four common 'types of ontology' usually recognized:
  - Application
  - Domain
  - Reference
  - Foundational

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Foundational Ontology

- **Foundational Ontologies** consist of notions (aka terms, concepts, relations) common across most all domains.
- They provide a minimal set of distinctions but provide important constructs and common semantics that support interoperability among the other types of ontologies (hence 'foundational').
- In particular they make very few ontological commitments (hence allow many models/interpretations).
- A starting point for reference, domain, and application ontologies.
- The most difficult to create and require extensive analysis.

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Reference Ontologies

- **Reference Ontologies** should be based on and can extend a foundational ontology providing a common basis for (consistent extension of) a single domain or 'support' one or more domains.
- They provide additional constructs and distinctions (adding to, or extending, those in a foundational ontology).
- There are (at least) two types of reference ontologies.
  - Ones that focus on a single subject but are applicable in (or to) many other domains - to some extent domain (of applicability) agnostic. Examples of these types of reference ontologies include ontologies for Time, Qualities, or Units of Measure.
  - And then those that provide a basis for consistent extension in a particular domain. Example domains include a particular branch of science, a field of engineering, or some portion of an industrial or commerce domain (e.g. maintenance or finance).

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Domain & Application Ontologies

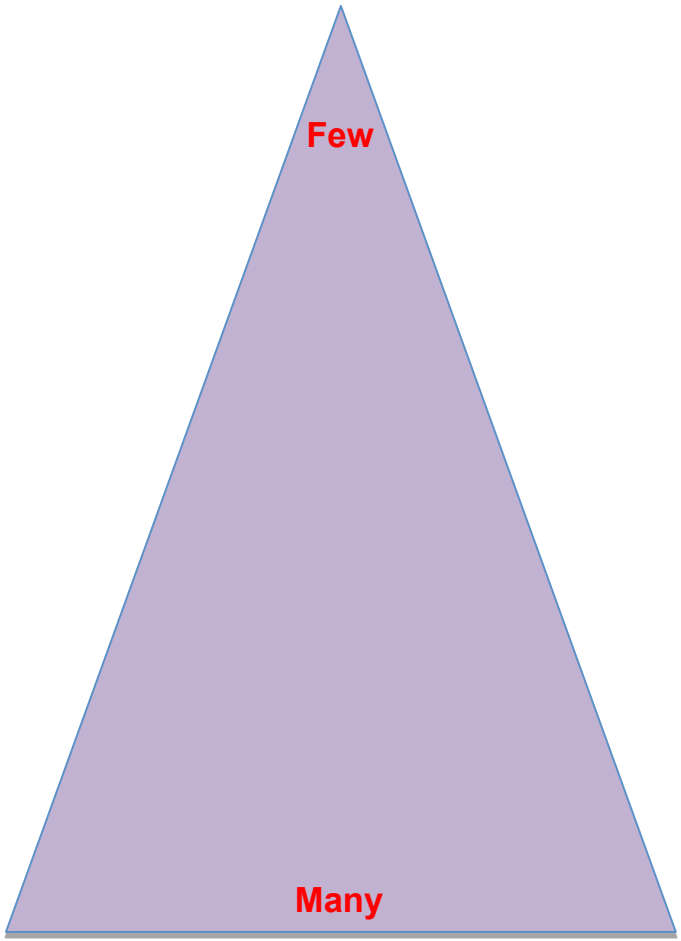


- **Domain Ontologies** are intended to represent those entities and their relations common to a particular domain with the intent that they provide a basis for more detailed extensions (into application ontologies).

- **Application Ontologies** are intended for specific applications, usually in information systems.
  - These ontologies have the largest number of (formal) distinctions.
  - Usually the least interoperable

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Interpretations vs. Distinctions



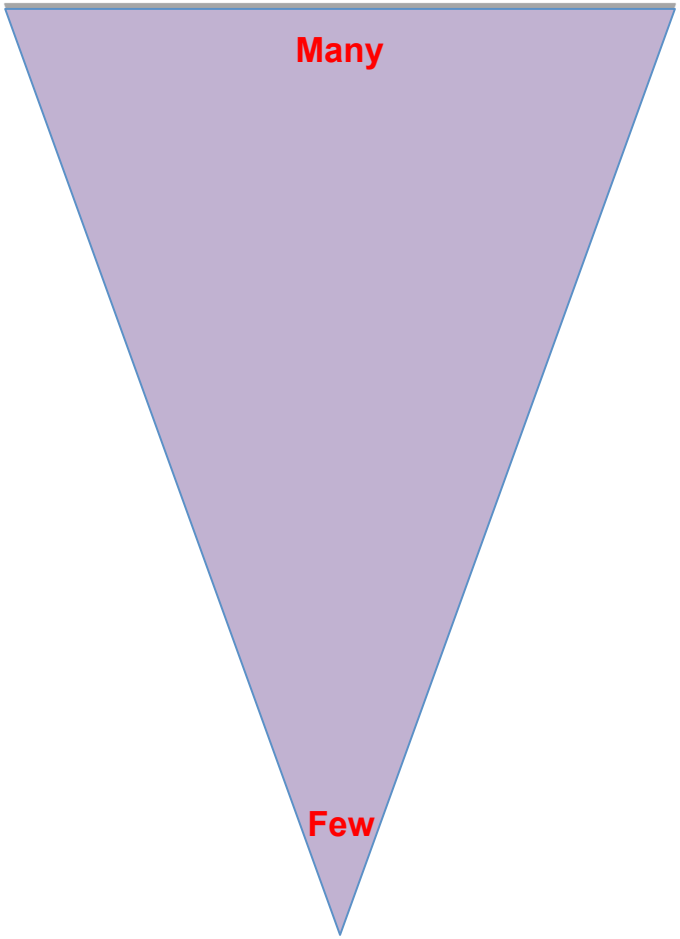
Ontology Type

Application

Domain

Reference

Foundational



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Symbols, Communication, Bias

$\Theta(x) \equiv \Lambda(x) \,\&\, \exists f\,[\Omega(f) \,\&\, \lambda(x,f) \,\&\, \forall y\,(\delta(y, f) \rightarrow \Pi(y))]$

Manufacturing Tool(x) ≡ Material-Entity(x) & ∃f (Function(f) & hasFunction(x,f) & ∀y (realizes(y, f) → Manufacturing Process (y)))

What are the differences between the first and second expressions?

For whom or what are there differences?

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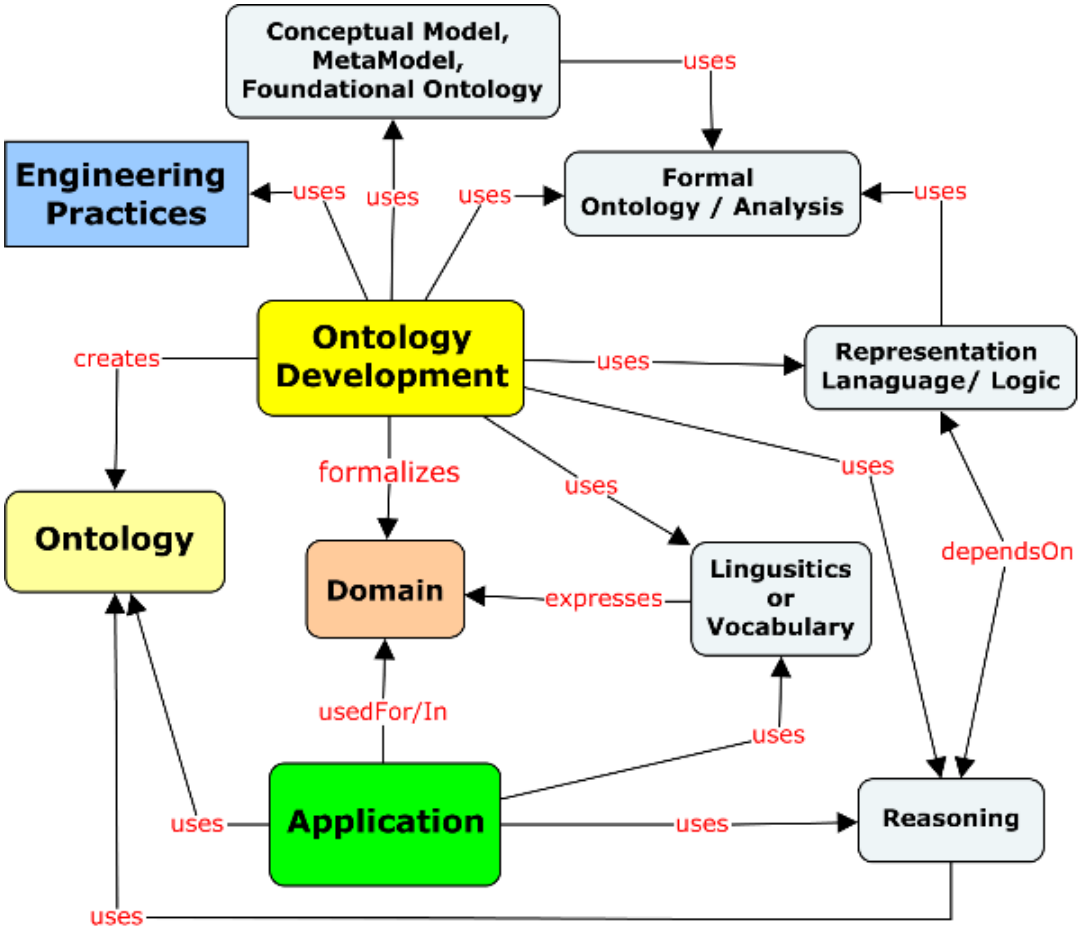
Ontology Development Challenges



- Using natural language terms and phrases as symbols in identifying entities
  - Computable ontologies use symbols (for relations and classes) in some logical system
- Overcoming (implicit) biases, assumptions and context(s) inherent in use of natural language terms and phrases (as symbols)
- Understanding the notion to be represented
  - Failing to distinguish a notion independent from its (domain) context(s)
- Developing 'useful' natural language definitions
- Avoiding ambiguous and polysemous notions/terms: e.g. part, component, subsystem
- Lack of understanding or use of ontological constructs & analysis techniques
- Effective use of foundational ontology
- Taxonomy seduction – Rush to placing an entity into a taxonomy without completing an analysis
- Constraints of representation languages, especially OWL
- Operational Performance Issues
- Ability/Inability to reuse existing ontologies
- Allowing subject matter experts to exert too much influence in development
- Creating interoperable ontologies

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Ontology Development Disciplines



Ontology development builds on, and makes use of, work in philosophy, cognitive science, linguistics and logic with the purpose of understanding, clarifying, making explicit and communicating people's distinctions and assumptions about the nature and structure of the world towards helping people understanding each other.

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Overlooked Analysis Tool

Natural Language Interrogatives

Who	Who Is interested in the entity and what is their context? Who Could Be (or not be) interested in the entity?
What	What Is the Entity? What Does the entity Do? What Is the entity Related to? What Does it Depend on?
Where	Where Does the entity Exist? What contexts? Where Can the entity Exist?
When	When Does the entity Exist? When Can the entity Exist?
Why	Why Does the entity Exist? Why Can the entity Exist?

Also need to consider the negatives of the questions

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Overlooked Landscape Aspects



- How are the ontologies expected to be used?
- How will changes to the ontology and entailments be rolled out?
  - Governance?
- How will ontologies be sustained? What does this entail?
  - Track D addresses this
- What is the architecture of the ontologies and associated constructs (e.g. queries)?
- What is the architecture of the information system that will use the ontologies?
- How will any transition (of the information system to using ontologies) be accomplished?
- Is there the financial wherewithal to sustain it (e.g. business model)?

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