Ontologies and Description Logics

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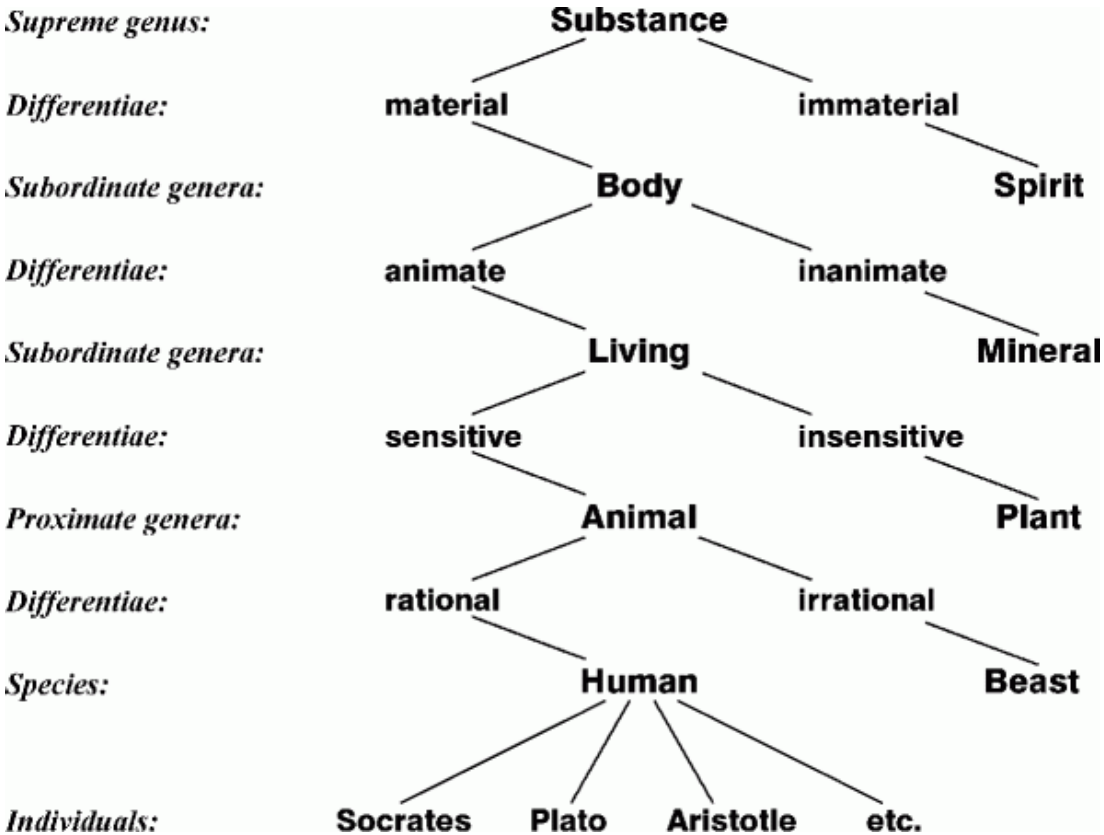
Outline

Ontologies

in Philosophy

- Ontology = "Study of being"



Ontologies

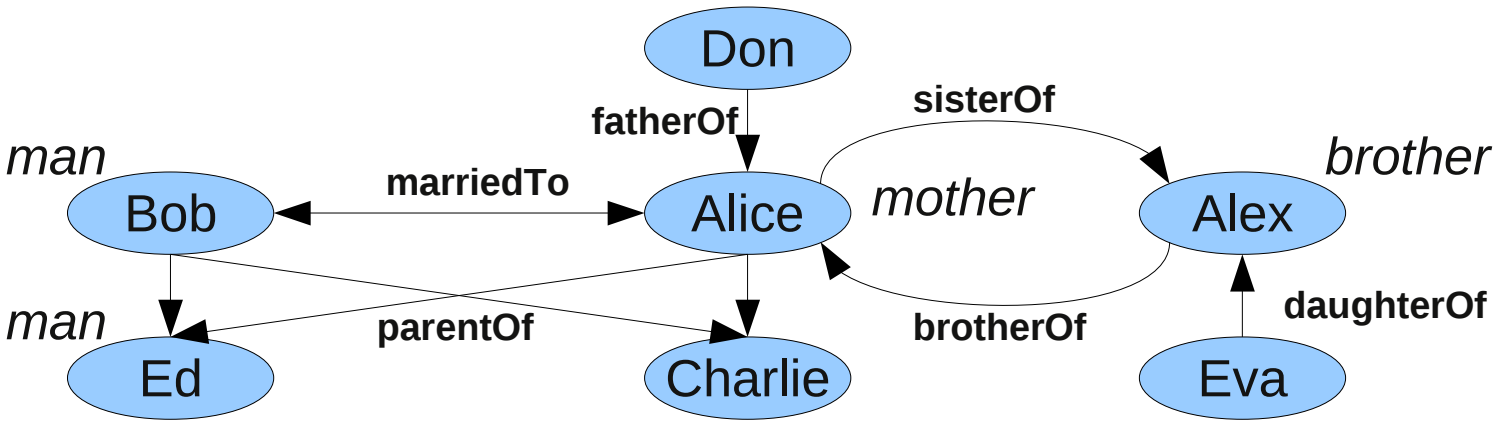
in Computer Science

- Formal specification of a domain of discourse
- Entities, classes, relationships

- Vocabulary for data exchange
- Automatic reasoning

Example: family members

- Entities: individual people
- Classes: man, woman, parent, father, mother, brother, sister, uncle, aunt, cousin, married, adult...
- Relations: parentOf, childOf, marriedTo, siblingOf, stepBrotherOf, sisterInLawOf...



Example: family members

Laws

- Everyone is either a man or a woman
- Mother is a woman who has a child
- Father is a man who has a child
- Parent is anyone who has a child

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- Everyone has exactly one father
- Everyone has exactly one mother
- Your grandparent is a parent of your parent

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- Your grandparent is a parent of your parent

$\Rightarrow$ Everyone has between 2 and 4 grandparents.

Common reasoning tasks

- Computing class hierarchy (uncle $\sqsubseteq$ brother $\sqsubseteq$ man)
- Identifying unsatisfiable classes (orphan)

Applications

- AI and Linguistics
- Medicine
  - Standardization
  - Machine readability
  - Expert Systems
- Semantic Web

Semantic Wikipedia

- The United Kingdom is a constitutional monarchy and unitary state consisting of four countries: England, Northern Ireland, Scotland and Wales. It is governed by a parliamentary system with its seat of government in London, the capital.

- Monarchy(UK)
- PartOf(England, UK)
- PartOf(Scotland, UK)
- Capital(UK, London)
- etc

Description Logic $\mathcal{ALC}$

- Attributive concept Language (with Complement)
- Class constructors
  - Top $\top$
  - Bottom $\bot$
  - Conjunction $C \sqcap D$
  - Disjunction $C \sqcup D$
  - Negation $\neg C$
  - Value restriction $\forall R.C$
  - Existential restriction $\exists R.C$
- TBox: Class inclusions $C \sqsubseteq D$
- ABox: Assertions $C(a)$, $R(a, b)$

Extensions of $\mathcal{ALC}$

- $\mathcal{I}$ Inverse roles
- $\mathcal{Q}$ Number restrictions $(\leq n)R.C$, $(\geq n)R.C$
- Role hierarchy, transitivity, symmetry...

Trade-off between expressivity and complexity of reasoning