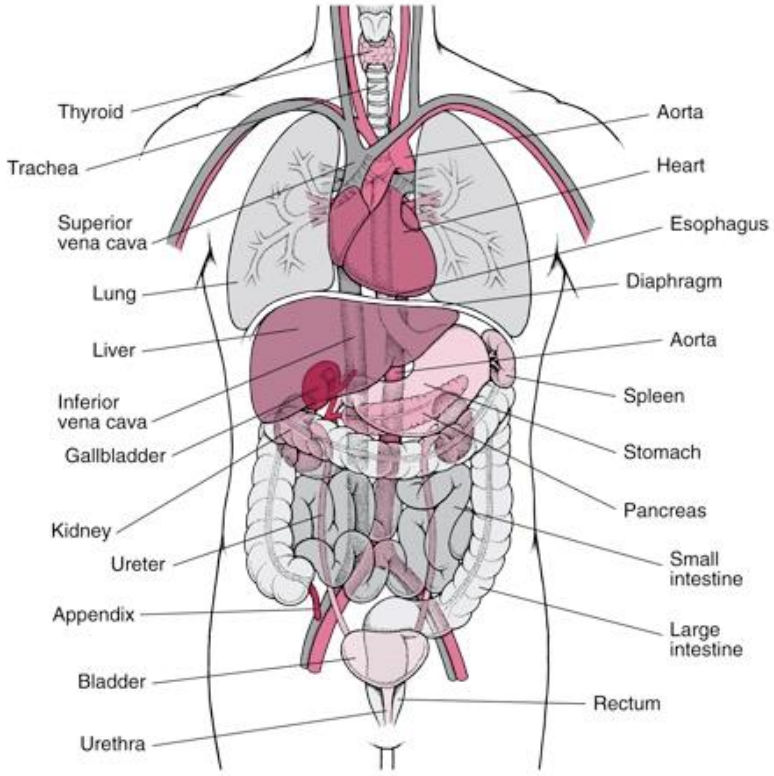
What is an Ontology?

A model of (some aspect of) the world

- Introduces **vocabulary** relevant to domain, e.g.:
  - Anatomy



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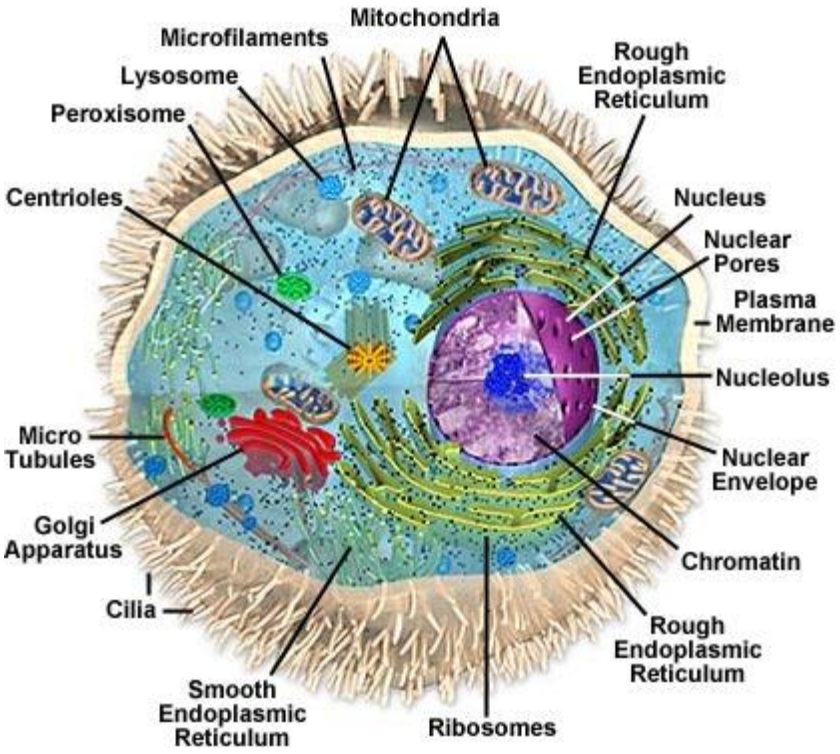

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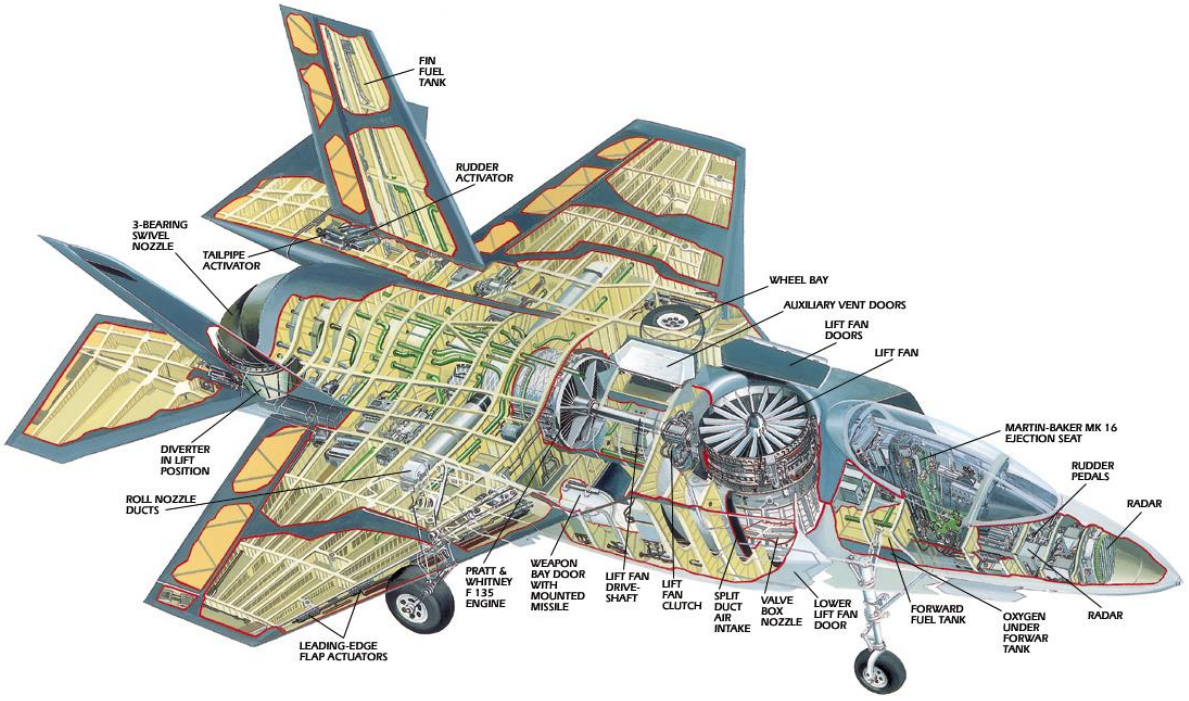

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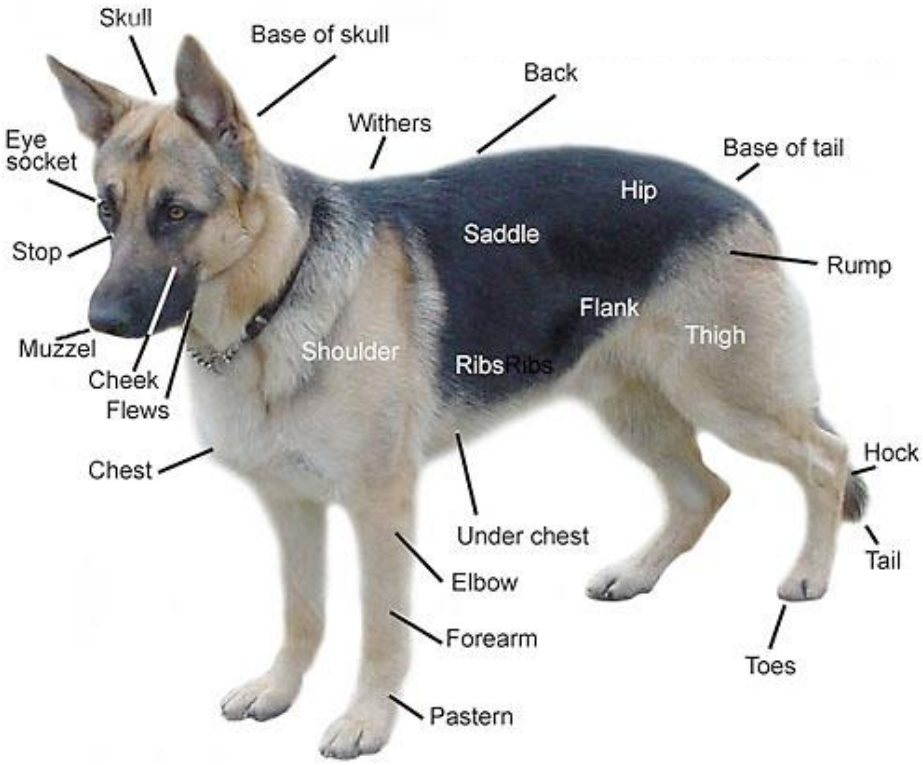
  - Dogs



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  - Cellular biology
  - Aerospace
  - Dogs
  - Hotdogs
  - …

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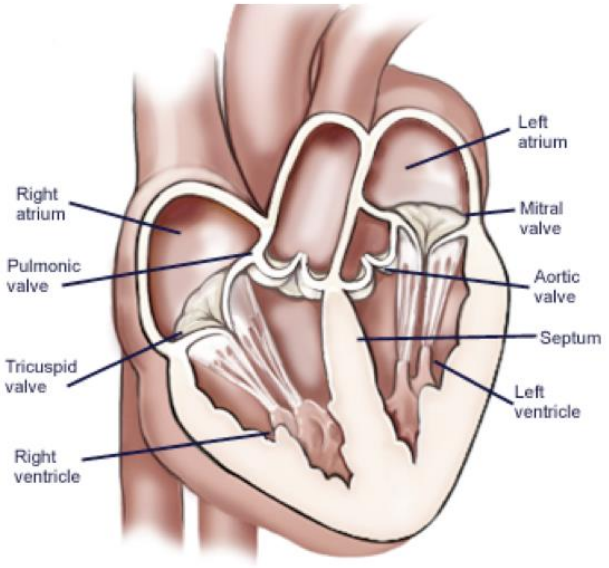
- Introduces **vocabulary** relevant to domain
- Specifies **meaning** (semantics) of terms

  Heart is a muscular organ that is part of the circulatory system



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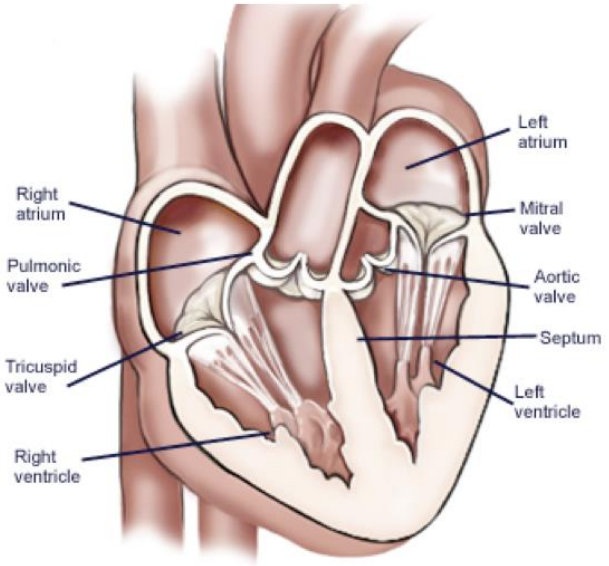
- **Formalised** using suitable logic

$$\forall x.[\mathsf{Heart}(x) \rightarrow \mathsf{MuscularOrgan}(x) \wedge \exists y.[\mathsf{isPartOf}(x,y) \wedge \mathsf{CirculatorySystem}(y)]]$$



Web Ontology Language OWL (2)

- W3C **recommendation(s)**
- Motivated by **Semantic Web** activity

  Requirement for standardised
  "web ontology language"
- Supported by **tools and infrastructure**
  - APIs (e.g., OWL API, Thea, OWLink)
  - Development environments
    (e.g., Protégé, Swoop, TopBraid Composer, Neon)
  - Reasoners & Information Systems
    (e.g., Pellet, Racer, HermiT, Quonto, …)
- Based on **Description Logics** (**SHOIN** / **SROIQ**)

Description Logics (DLs)

- Fragments of **first order logic** designed for KR
- Desirable computational properties
  - **Decidable** (essential)
  - Low complexity (desirable)
- Succinct and **variable free syntax**

$$\forall x.[\mathsf{Heart}(x) \rightarrow \mathsf{MuscularOrgan}(x) \wedge \exists y.[\mathsf{isPartOf}(x,y) \wedge \mathsf{CirculatorySystem}(y)]]$$

$$\mathsf{Heart} \sqsubseteq \mathsf{MuscularOrgan} \sqcap \exists \mathsf{isPartOf}.\mathsf{CirculatorySystem}$$

Description Logics (DLs)

DL **Knowledge Base** (KB) consists of two parts:

– Ontology (aka **TBox**) axioms define terminology (schema)

$$\begin{aligned} \mathsf{Heart} &\sqsubseteq \mathsf{MuscularOrgan} \sqcap \\ &\quad \exists \mathsf{isPartOf}.\mathsf{CirculatorySystem} \\ \mathsf{HeartDisease} &\equiv \mathsf{Disease} \sqcap \\ &\quad \exists \mathsf{affects}.\mathsf{Heart} \\ \mathsf{VascularDisease} &\equiv \mathsf{Disease} \sqcap \\ &\quad \exists \mathsf{affects}.(\exists \mathsf{isPartOf}.\mathsf{CirculatorySystem}) \end{aligned}$$

– Ground facts (aka **ABox**) use the terminology (data)

$$\begin{aligned} \mathsf{John} : \mathsf{Patient} &\sqcap \\ &\exists \mathsf{suffersFrom}.\mathsf{HeartDisease} \end{aligned}$$

Why Care About Semantics?

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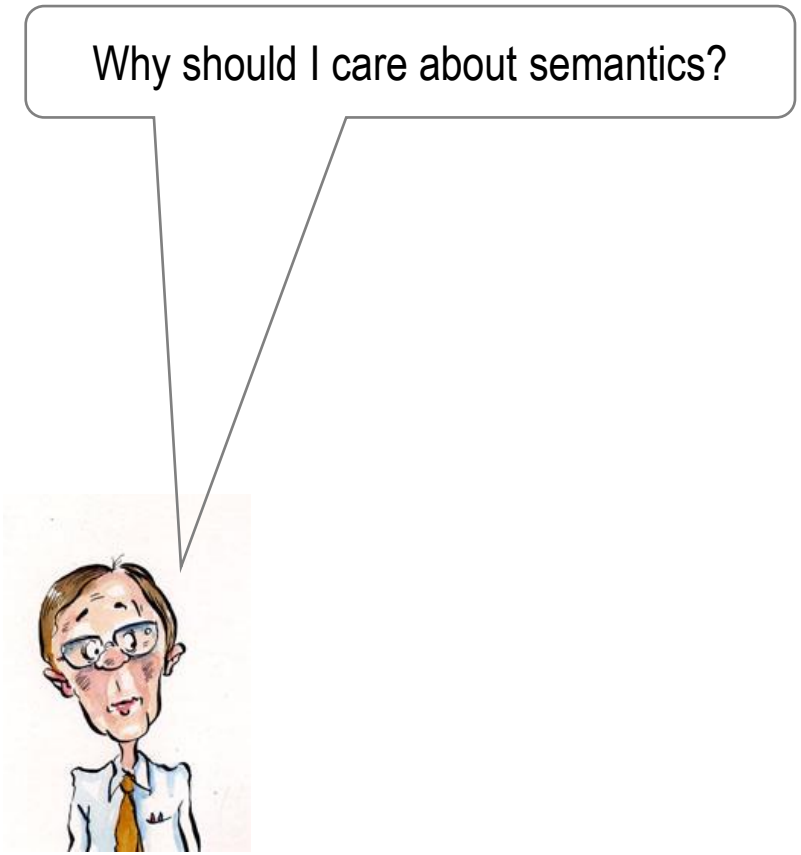

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Well, from a philosophical POV, we need to specify the relationship between statements in the logic and the existential phenomena they describe.

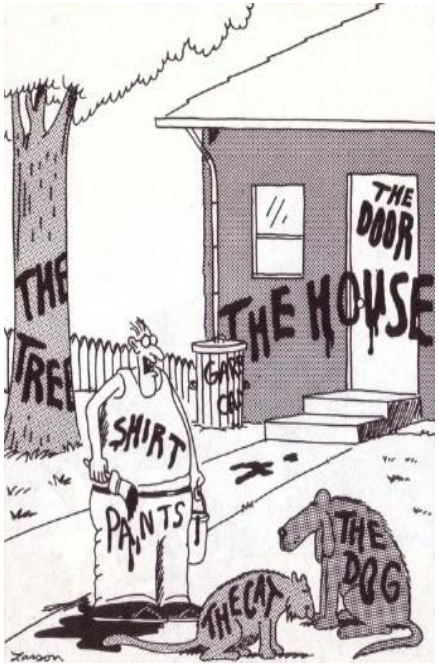
That's OK, but I don't get paid for philosophy.

From a practical POV, in order to specify and test (ontology-based) information systems we need to precisely define their intended behaviour

What are Ontologies Good For?

- Coherent **user-centric view** of domain
  - Help identify and resolve disagreements
- Ontology-based **Information Systems**
  - View of data that is independent of logical/physical schema
  - Answers reflect schema & data, e.g.:

    “Patients suffering from Vascular Disease”



Now... *that* should clear up a few things around here

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