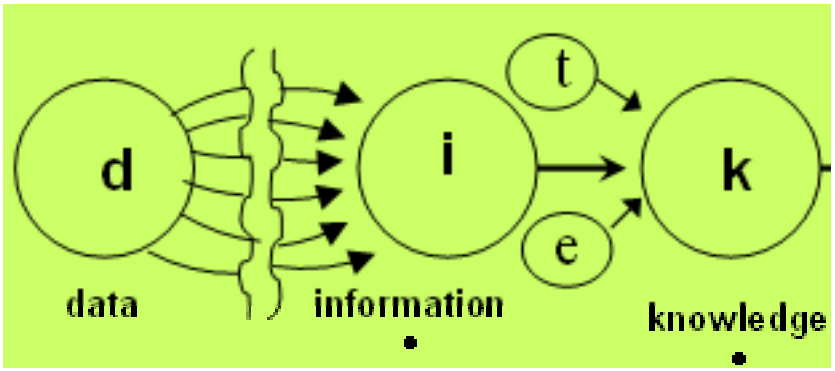
Introduction to Knowledge management

What is Knowledge?

- From data to Knowledge



Description: What **Instruction: How to**

- Data: tree, 20$, oil, etc.
- Information: "The price of crude oil is $96 per barrel"
- Knowledge: "When crude oil prices go up by $10 per barrel, it's likely that petrol prices will rise by 2p per litre"

Knowledge management
Introduction to Ontology

Introduction to Ontologies

- Definition
- Motivation
- Concepts of Ontologies
- Developing an Ontology
- Upper ontologies
- Exercise

Limitations of the “syntactic” Web

- What is the Web?
  - HTTP (how to transfer data)

    GET /index.html
  - URI (how to address data)

    http://www.deri.org/
  - HTML (how to mark up data for human reader)

    <html><head><title>.....
- Billions of diverse documents online; problems in:
  - Retrieving documents
  - Extracting relevant data from retrieved documents
  - Combining information from different sources to achieve a particular goal

Limitations of the “syntactic” Web – extracting information

Which book
Is about the Web?

Limitations of the “syntactic” Web – extracting information

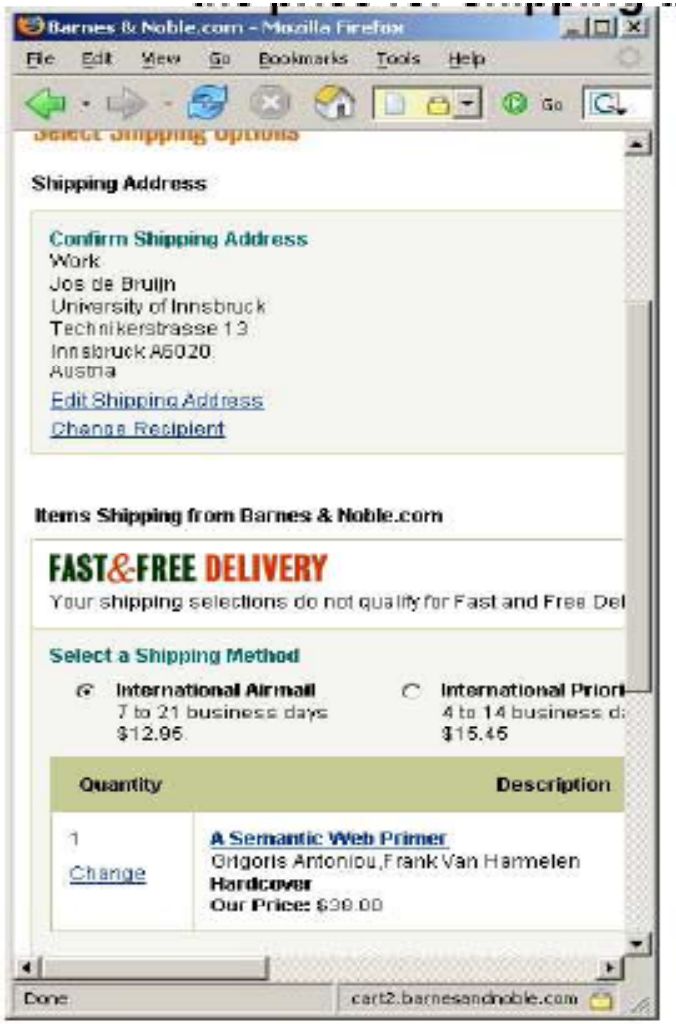
What is the price of the book?

Limitations of the “syntactic” Web – combining information

I want the cheapest copy of “A semantic Web Primer”.

Limitations of the “syntactic” Web – combining information

I want the cheapest copy of “A semantic Web Primer” taking into account the price for shipping the book.

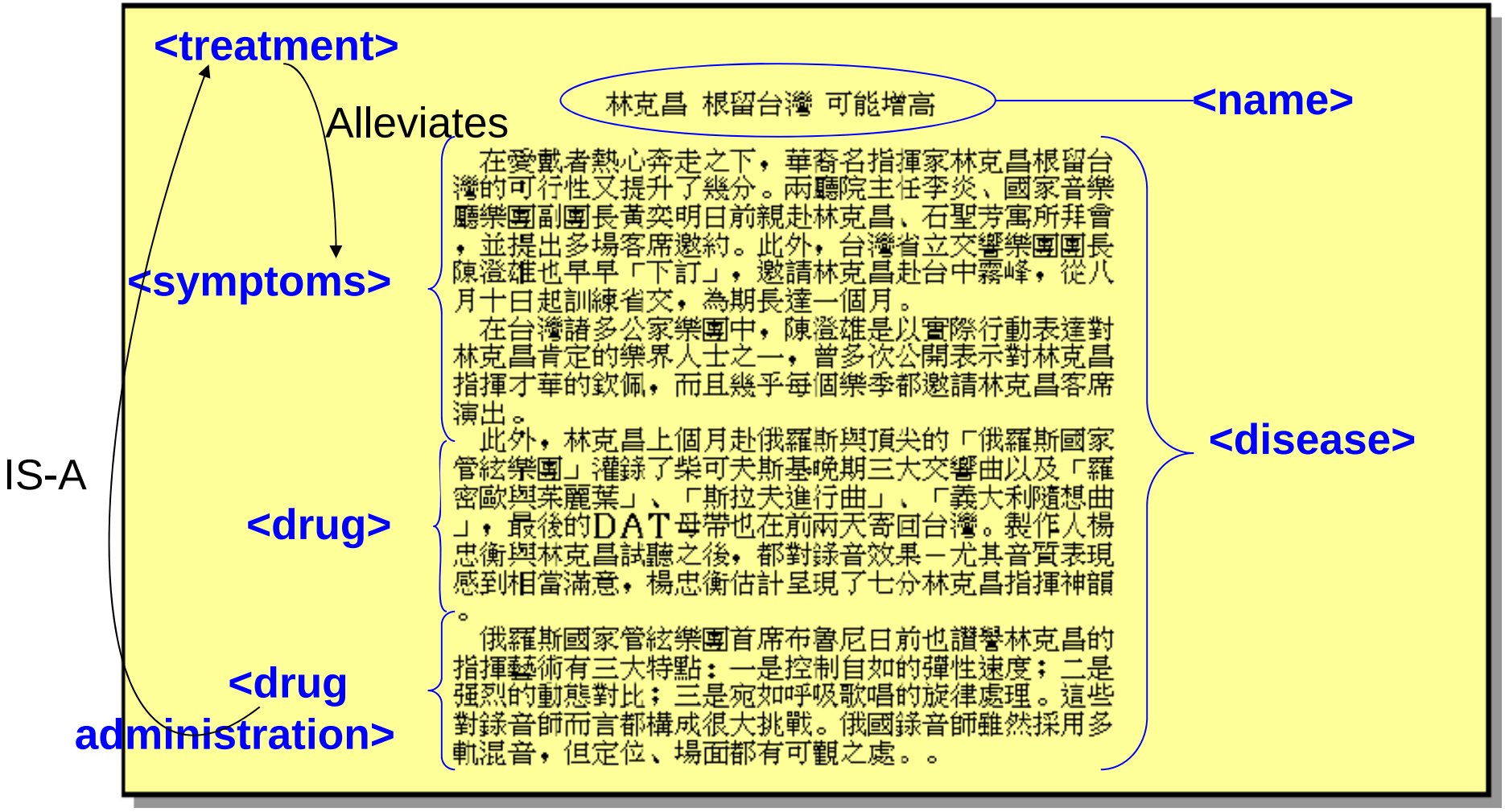


On average 10 clicks to find out what the Shipping rate is!

Semantic Web – solution principles

- Making Web-content machine processable
  - Turning the Internet from a huge, world wide Web repository of information for **human consumption** **into a device** for distributed, automated information **processing**
- Instead of publishing natural language, publish machine-processable data!
- Publish information in terms understandable for a machine
- Ask questions in terms understandable for a machine
- And: make sure all machines understand your terms!

What it's like to be a machine on the Web



Slide originally presented by Frank van Harmelen

http://www.cs.vu.nl/%7Efrankh/spool/SemWebSlides/SemWeb-tour-Brussels.ppt

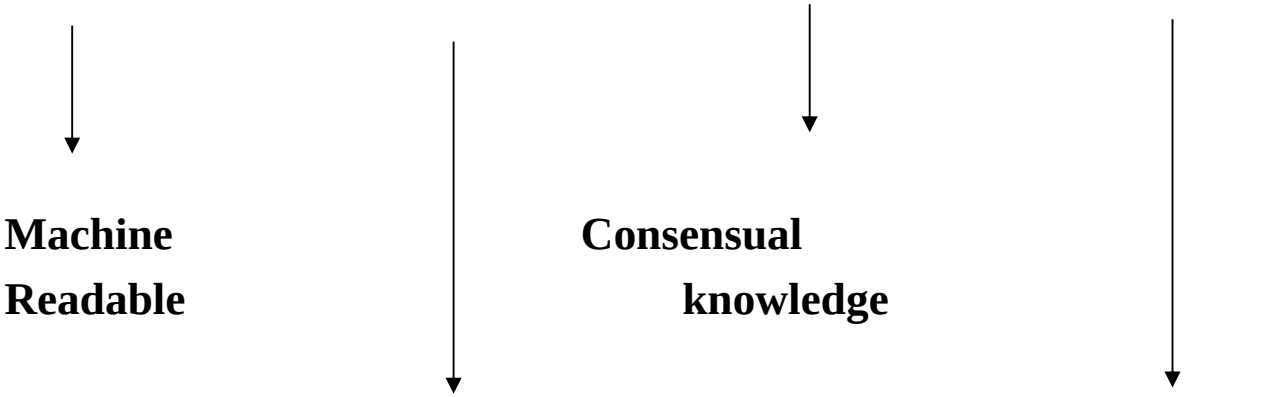
Definitions

- An ontology is:
  - a specification of a Conceptualization [Gruber, 93]
  - shared understanding of some domain of interest. [Uschold, Gruninger, 96]

What is an ontology?

Studer (98)

Formal,explicit specification of a shared conceptualization



Machine Readable

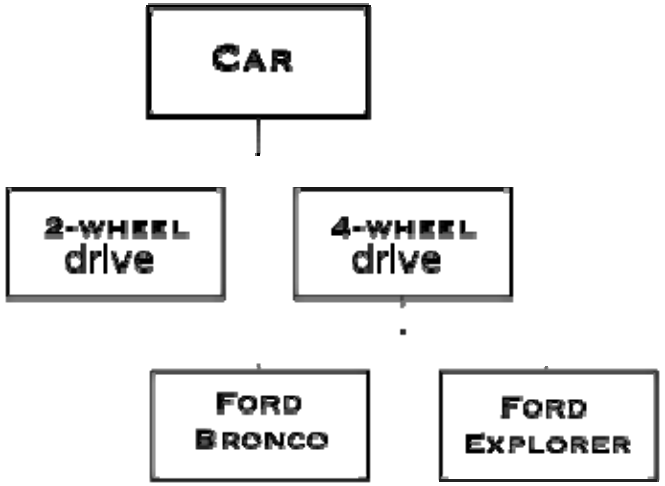
Concepts, properties, functions, axioms are explicitly defined

Consensual knowledge

Abstract model of some phenomena in the world

What is an ontology?

- An ontology is an explicit description of a domain:
  - concepts
  - properties and attributes of concepts
  - constraints on properties and attributes
  - Individuals *(often, but not always)*
- An ontology defines
  - a common vocabulary
  - a shared understanding



Why Use Ontologies?

- **Labeling**: If I say “car” and you say “Auto” how do we know we mean the same thing?
- **Semantics**: If I say “vehicle”, how do you know if this includes buses, powered motorcycles
- Knowledge sharing and reuse

➔ Need to be able to create definitions of terms in a machine-understandable format

  – Systematic categorisation and computation requires systematic representation
  – Systematic representation = an ontology

Upper Ontologies: Motivation

- Ontologies may have different names for the same things
  - **type** – a relation between a class and an instance
  - **instance** – a relation between a class and an instance
  - **isa** – a relation between a class and an instance
  - …
- Ontologies may have the same name for different things
  - **before** – a relation between two time points
  - **before** – a relation between two time intervals
- Either use the same upper ontology, or at least map to a common upper ontology

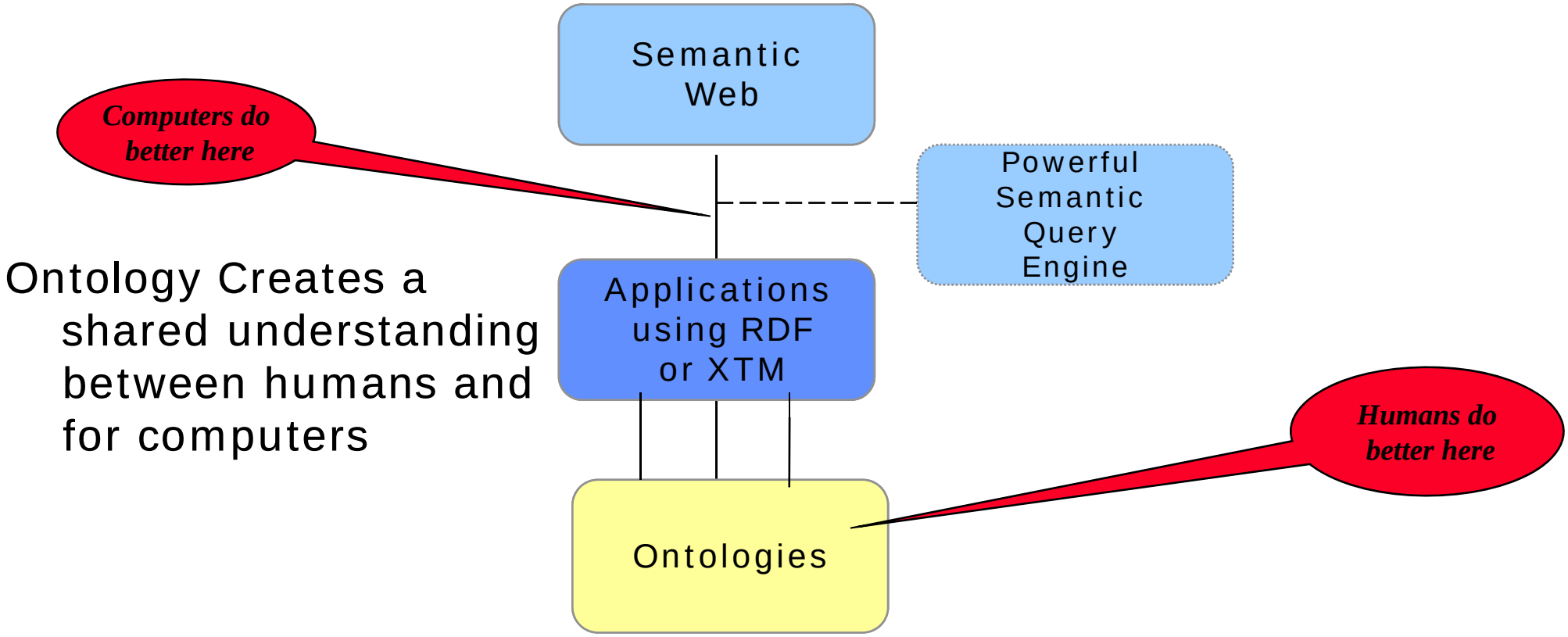
Many Ways to Use Ontology

- As an information engineering tool
  - Create a database schema
  - Map the schema to an upper ontology
  - Use the ontology as a set of reminders for additional information that should be included

- As more formal comments
  - Define an ontology that is used to create a DB or OO system
  - Use a theorem prover at design time to check for inconsistencies

Many Ways to Use Ontology

- To create a semantic Web



Ontology Creates a shared understanding between humans and for computers

Components of an Ontology

- Concepts: Class of individuals
  - The concept Car and the individual (instance) `AUDITT'

- Relationships/Properties
  - **Parent of**
    - Concept A is a parent of concept B if every instance of B is also an instance of A
  - **Is-a** relationship forms a taxonomy
  - **is a part of** relationship gives further structure

Example : “is-a” and “part-of” relations

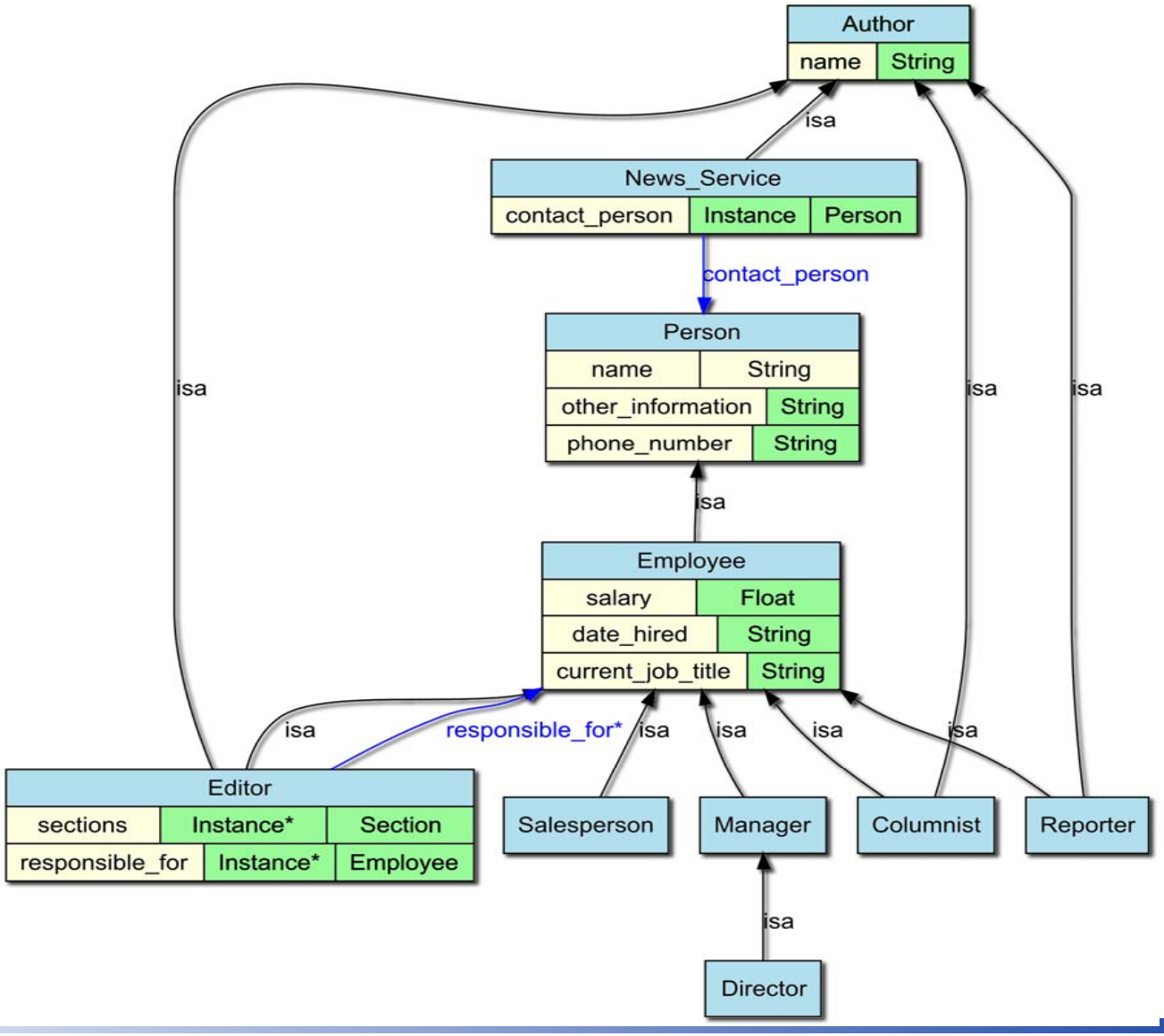
- Is-a
  - Computer
    MicroComputer
  - Parts of Computer
    CPU
    Pentium
  - Circuit Components
    Transistor
- Part-of
  - Microcomputer
    Mother_board
    CPU
    Transistor

Components of an Ontology

- **Constraints** and other **meta information** about **relations**
  - *Value type: Number*
  - *Domain: Car*
  - *Cardinality: At-Least 1*
  - *Range: 0 <= X <= 50*

- **Axioms** – Disjointness, covering, equivalence,…
  - *Car-speed > 240 Km/h are Racers*

Example of ontology

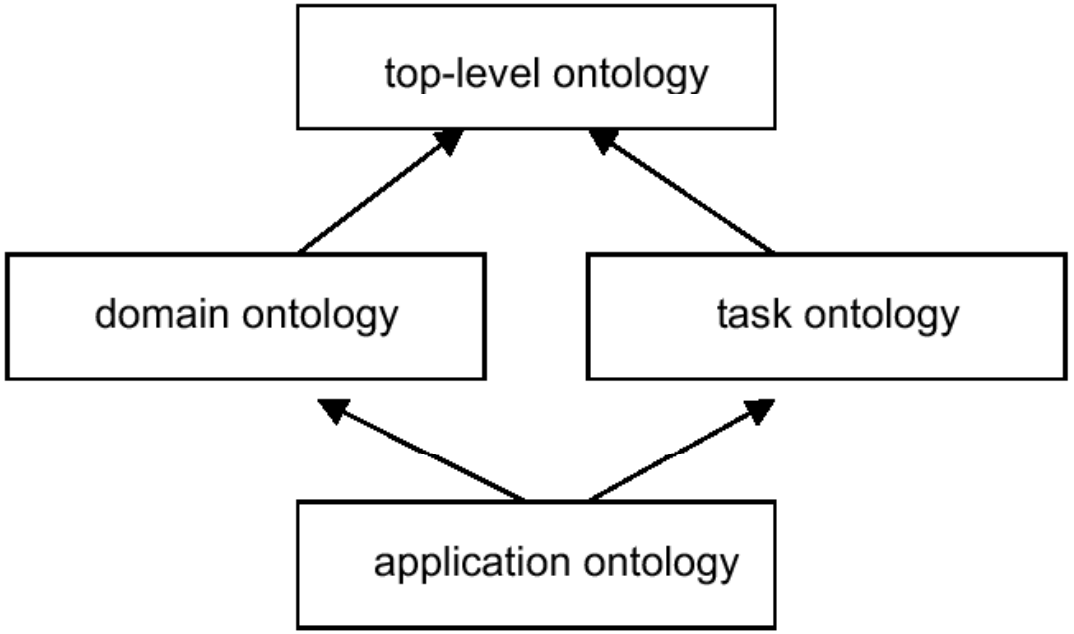


Types of ontologies

[Guarino, 98]

Describe **very general concepts** like space, time, event, which are independent of a particular problem or domain. It seems reasonable to have unified top-level ontologies for large communities of users.

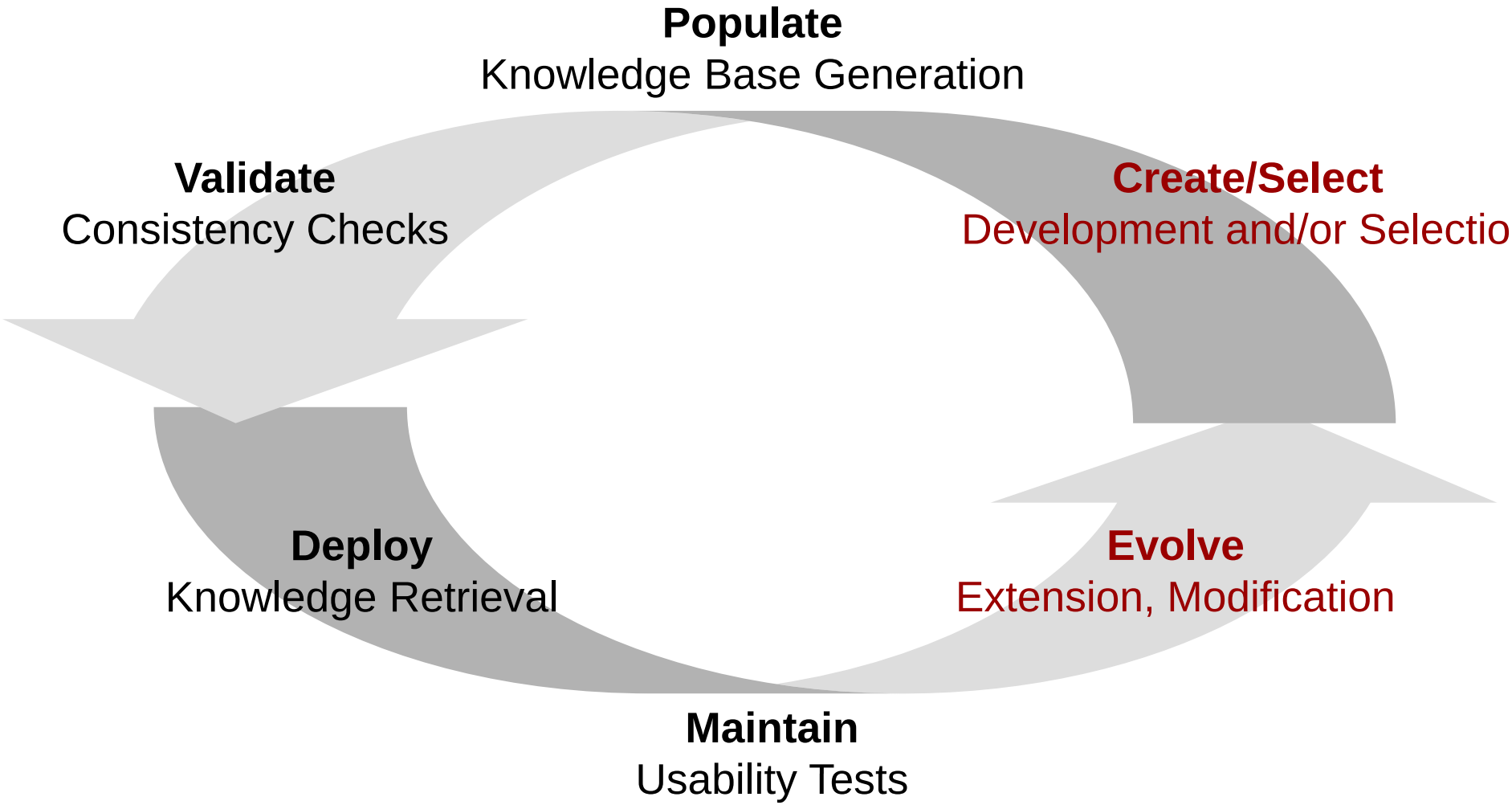
Describe the vocabulary related to a **generic domain** by specializing the concepts introduced in the top-level ontology.



Describe the vocabulary related to a **generic task or activity** by specializing the top-level ontologies.

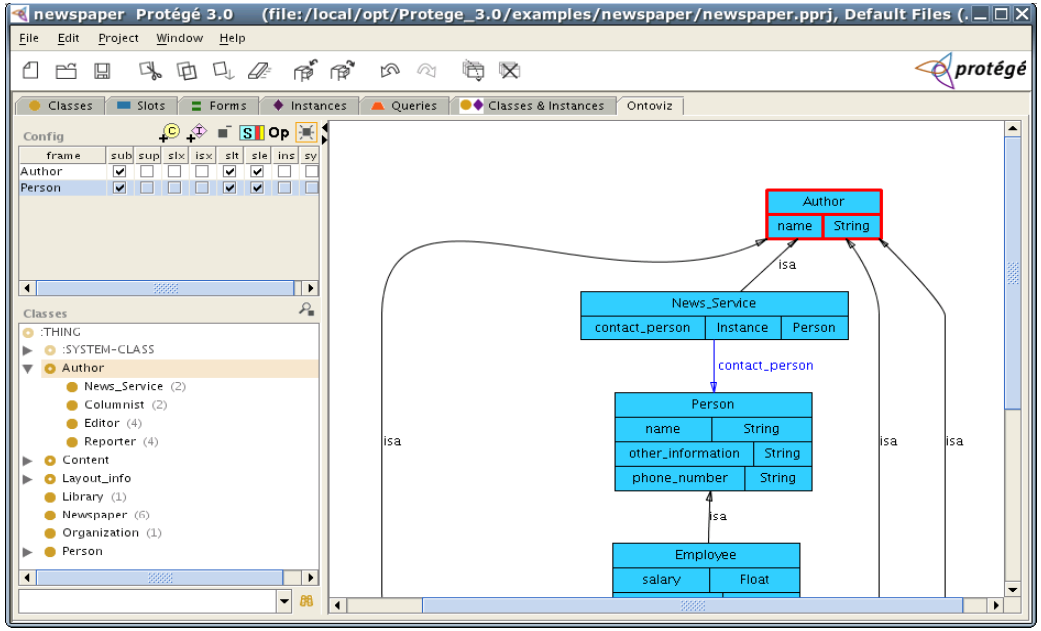
These are the most specific ontologies. Concepts in application ontologies often correspond to **roles played by domain entities while performing a certain activity**.

Lifecycle of ontologies



Tools

- APIs
  - Jena - Java
  - Redland – Pytho
  - RAP - PhP
- Editors
  - Protégé
  - OntoStudio
  - Triple20 - Prolog
- Storage
  - Sesame
  - OntoBroker



Exercise

- A bank description from the Web:
  - *A bank is a financial institution that has customers. Customers can be persons (retail customers) or companies (business customers). A customer can have a bank account which belongs to a bank.*

- Design a bank ontology according to that definition
  - *Hints*:
    - Start by extracting the different nouns and verbs from the definition
    - Add necessary attributes
    - You can use the following representation