COMP318: Ontology based Information Systems

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Dr Valentina Tamma

Room: Ashton 2.12

Dept of computer science

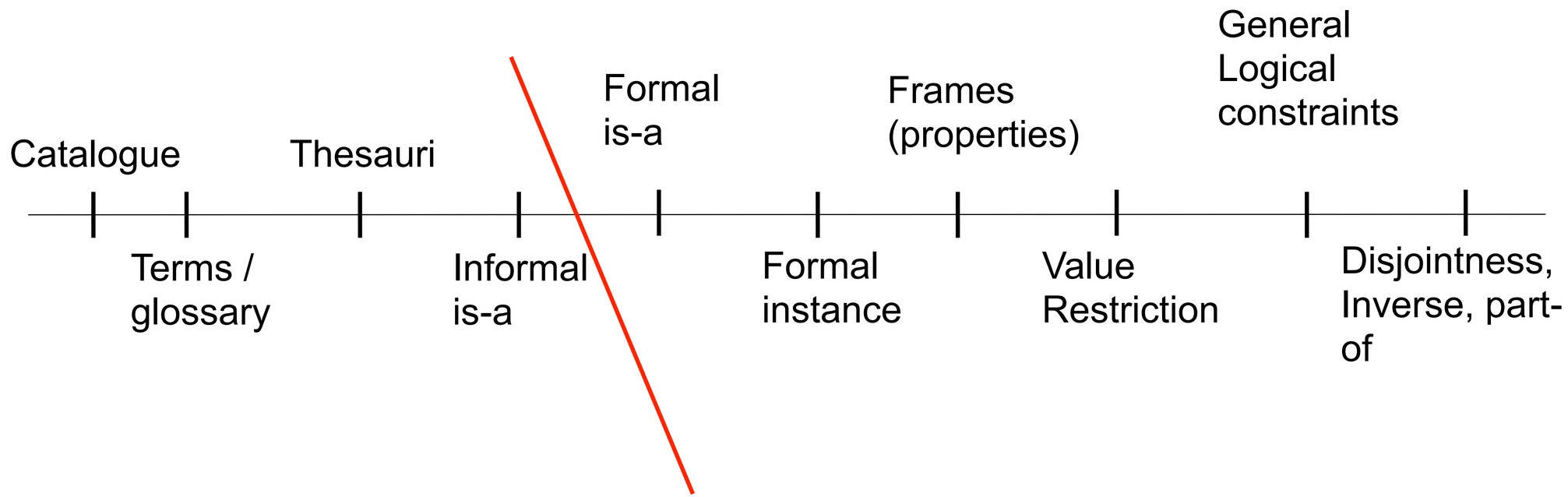
University of Liverpool

V.Tamma@liverpool.ac.uk

Where were we

- Motivation behind the need for ontologies
  - Data - Information - Knowledge - Wisdom model
  - Making knowledge explicit:
    - Concepts, relationships and constraints
- Definition of ontology in Computer Science
- Types of ontologies

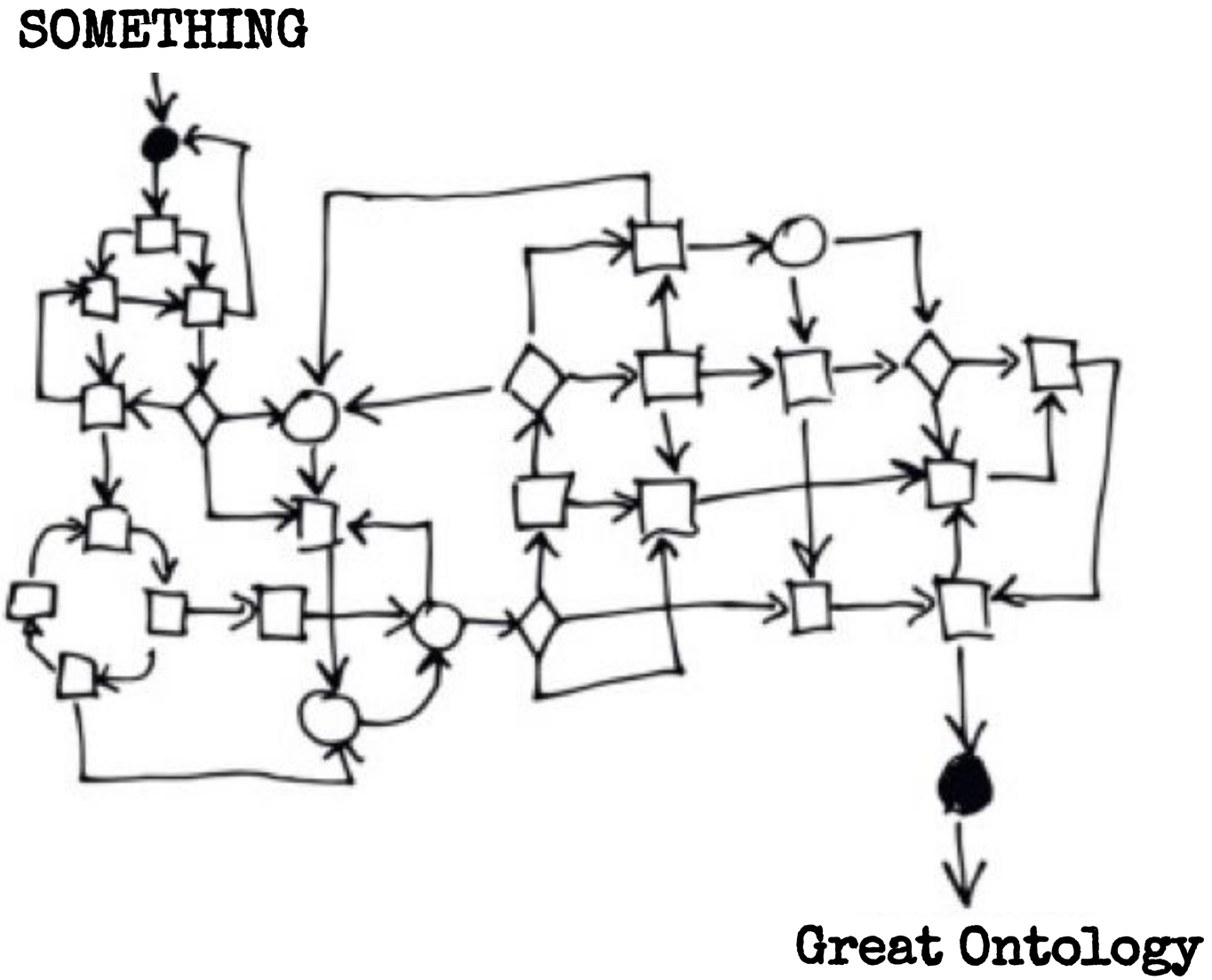
Level of Granularity



Level of Granularity

- An ontology specifies a rich description of the:
  - Terminology, concepts, vocabulary
  - Properties explicitly describing concepts
  - Relations among concepts
  - Rules distinguishing concepts,
    - refining definitions and relations (constraints, restrictions, regular expressions) relevant to a particular domain or area of interest.

Ontology development process



Ontology Engineering

"*The set of activities that concern the ontology development process, the ontology life cycle, and the methodologies, tools and languages for building ontologies*"

Gomez-Perez et al, 2004

Ontology Engineering

- Defining terms in the domain and relations among them
  - Defining concepts in the domain (**classes**)
  - Arranging the concepts in a hierarchy (**subclass-superclass hierarchy**)
  - Defining which attributes and properties classes can have
    - and constraints on their values
  - Defining individuals and filling in property values

Methodological questions

- What part of the domain do we need to model?
- What are the constraints on the use of this knowledge?
- How can tools and techniques best be applied?
- Which languages and tools should be used in which circumstances, and in which order?
- What about issues of quality control and resource management?
  - Many of these questions for ontology engineering have been studied in other contexts
    - E.g. software engineering, object-oriented design, and knowledge engineering

Principles for the design of an ontology

- **Clarity:**
  - To communicate the intended meaning of defined terms
    - An ontology should communicate **effectively** the intended meaning of defined terms.
    - Definitions should be objective and should be stated with formal axioms.
    - A complete definition (defined by necessary and sufficient conditions) is preferred over a partial definition (defined by only necessary or sufficient conditions)
- **Coherence:**
  - To sanction inferences that are consistent with definitions
    - If a sentence that can be inferred from the axioms contradicts a definition or example given informally, then the ontology is incoherent.
- **Extendibility:**
  - To anticipate the use of the shared vocabulary
    - define new terms for special uses based on the existing vocabulary, in a way that does not require the revision of the existing definitions.
- **Minimal Encoding Bias:**
  - To be independent of the symbolic level
    - The conceptualization is specified at the knowledge level without depending on a particular symbol-level encoding.
- **Minimal Ontological Commitments:**
  - To make as few claims as possible about the world
    - ontological commitment is based on the consistent use of the vocabulary,
    - ontological commitment can be minimised by specifying the weakest theory and defining only those terms that are essential to the communication of knowledge consistent with the theory.

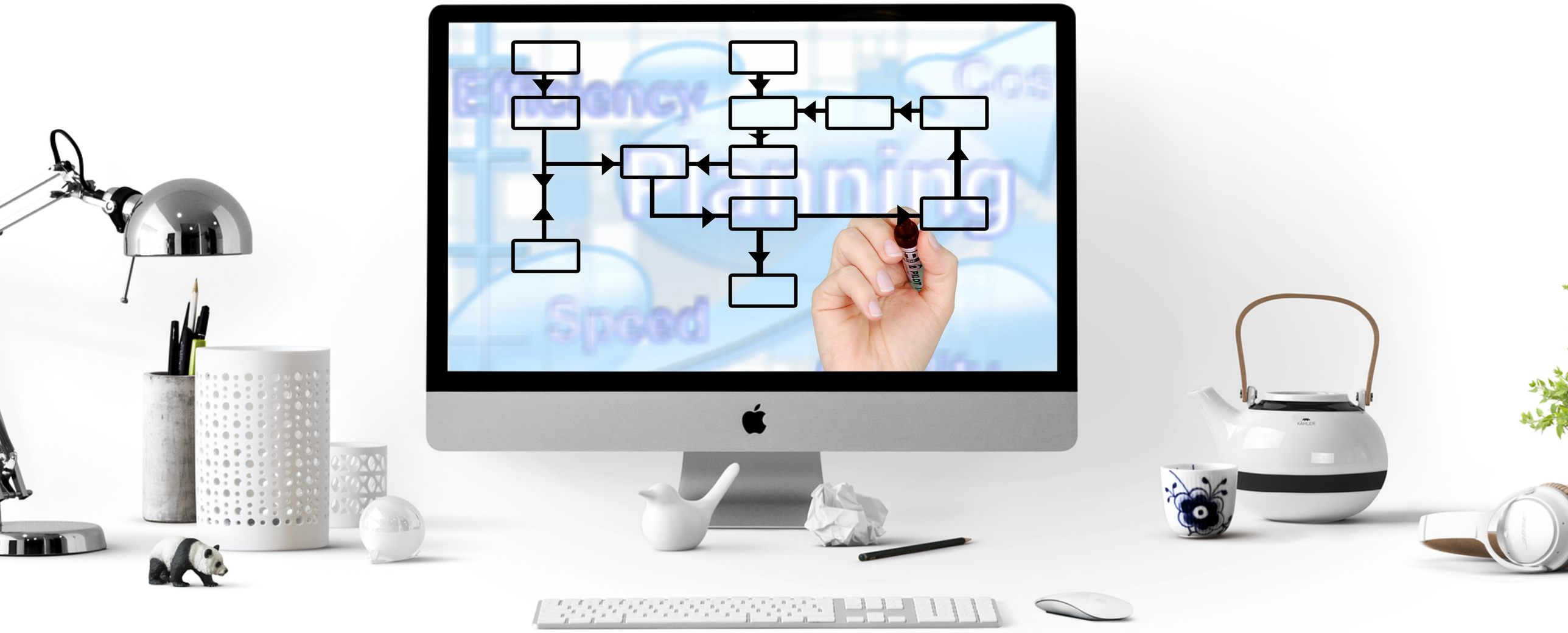
Gruber, T.; *Towards Principles for the Design of Ontologies.* KSL-93-04. Knowledge Systems Laboratory. Stanford University. 1993

Ontological Commitment

- Agreements to use the vocabulary in a coherent and consistent manne
  - An agent commits (conforms) to an ontology if it “acts” consistently with the definitions

- The assignment of the meaning to the terms in the ontology vocabulary

Ontology engineering methodologies



Methodologies

- Various methodologies have been proposed to formalise the development process, or even some of its phases
  - Uschold & King
  - Gruninger & Fox
  - Methontology (Gomez Perez et al)
  - Ontology Design Patterns (Gangemi et al)
  - Ontology 101 (Noy & McGuinness)

Uschold & King

- Identify purpose
- Build ontology
  - **Capture**
  - **Coding**
  - **Integrating**
- Evaluation
- Documentation

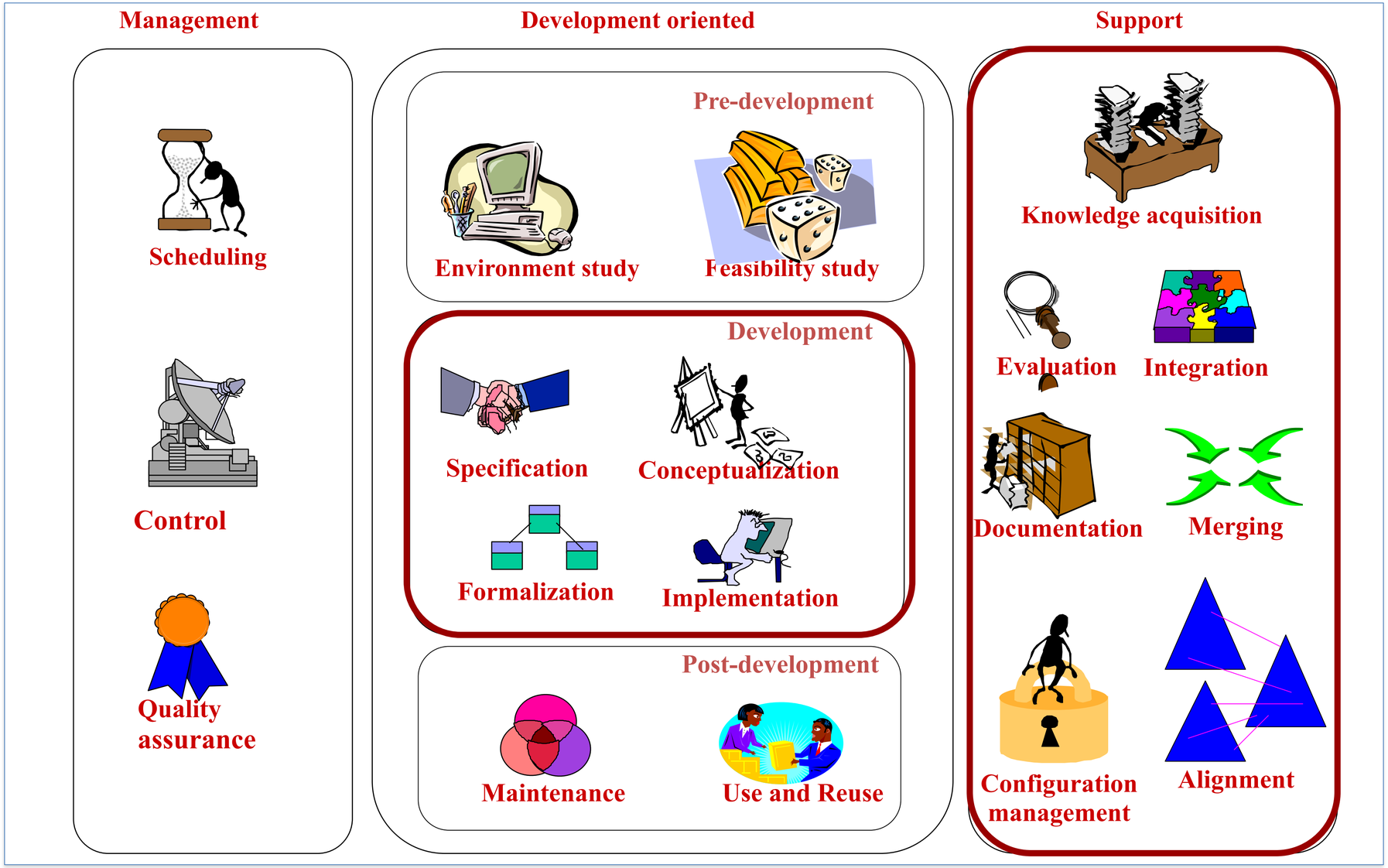
Gruninger & Fox

- Identify motivating scenarios
- Elaborate informal competency questions
- Specify terminology in FOL
  - Identify objects
  - Identify predicates
- Formal competency questions
- Specify axioms in FOL
- Specify completeness theorems

Methontology

- Development + Management Activities + Support in parallel
- Development
  - **Specification**
  - **Conceptualization**
  - **Formalization**
  - **Implementation**
  - **Maintenance**
- Focus on the conceputalization activity
  - Advantage: Integration of existing ontologies considered from early on.
- Conceptualization is evaluated early on, which prevents propagation of errors.

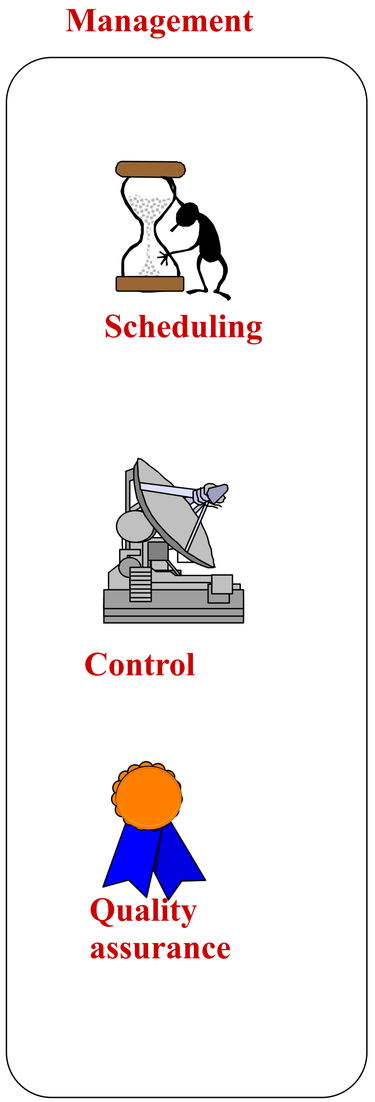
Ontology development process



Gomez-Perez et al, 2004

Management activities

- **Scheduling**
  - Identification of tasks/problems to solve
  - Arrangement/planning of tasks/problems to solve
  - Identification of required resources (time, memory, resources)
- **Control**
  - Ensuring the correct execution of tasks / problems to solve
- **Quality Assurance**
  - Ensuring the quality of all the artefacts produced during development
    - ontologies, software, and documentation

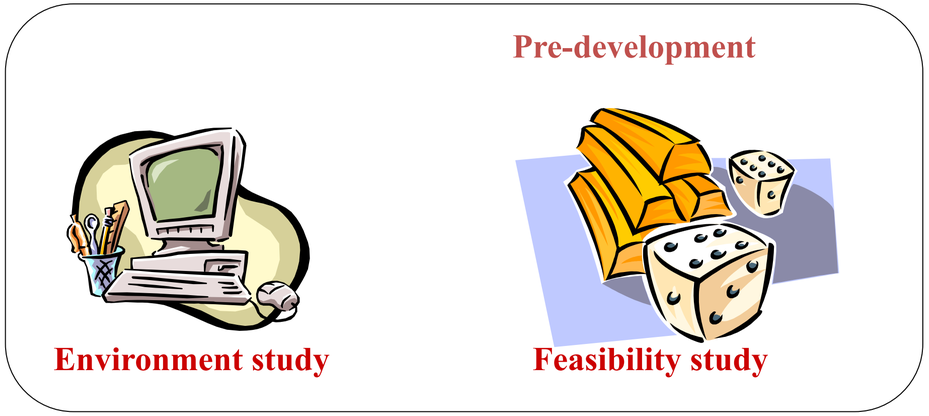


Development activities of the design process

- **Pre-Development**
- **Development**
- **Post-Development**
- **Support**

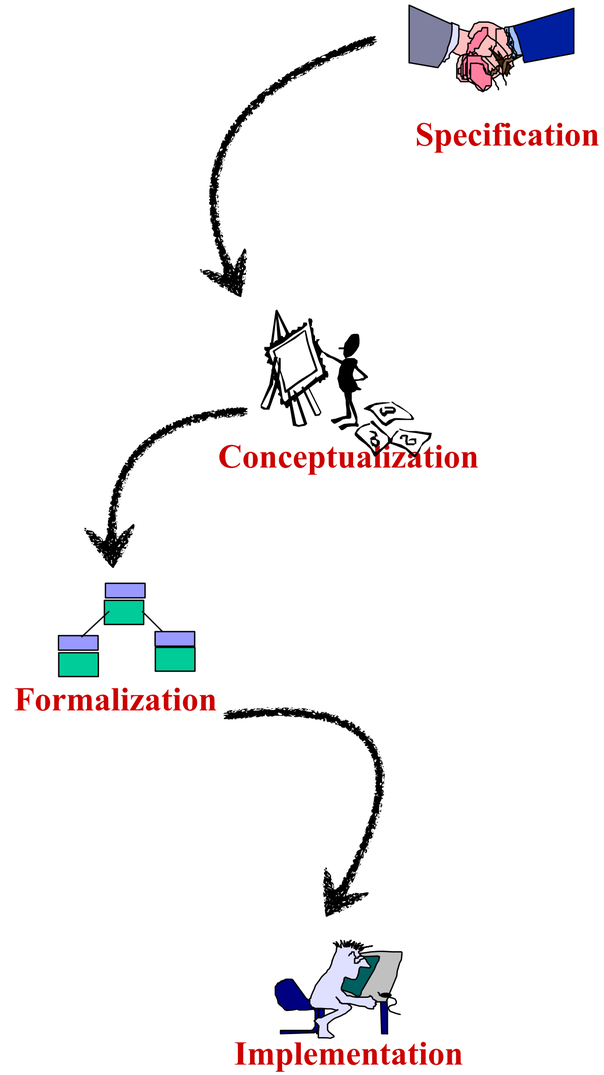
Pre-development activities

- **Environment study**
  - Determine the environment in which the ontology should operate:
    - What is the designated software platform for the ontology?
    - Which applications should use the ontology?
- **Feasibility study**
  - Assesses the feasibility and value of the ontology
    - Can the ontology really be developed?
    - Does it make sense to develop the ontology?



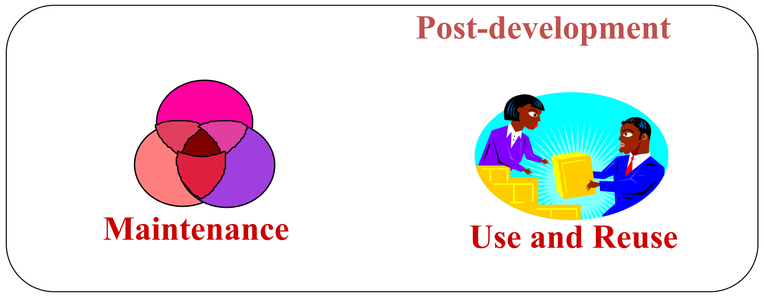
Development activities

- **Specification**
  - Use-cases and requirements
    - Why is the ontology developed, what is the benefit and who are the end-users?
    - What are the questions the ontology should answer?
- **Conceptualisation**
  - Generation of a conceptual model that provides an abstraction of the domain model
- **Formalisation**
  - Translation the conceptual model into a (semi) computable model
- **Implementation**
  - Construction of a of a computable model in an ontology representation language (e.g. RDFS, OWL)



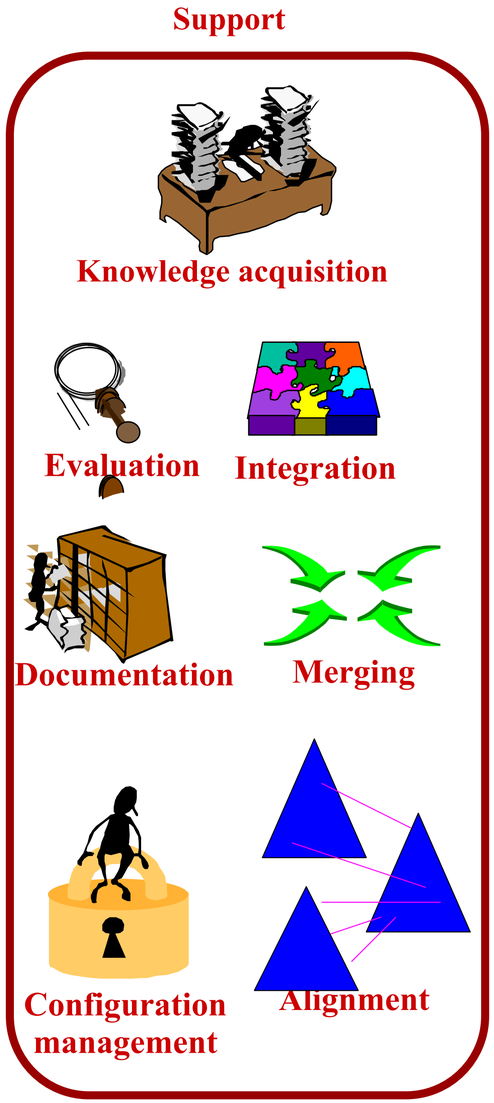
Post-Development Activities

- **Maintenance**
  - Update and amendment of the ontology (if necessary)
- **Use**
  - Usage of the ontology within the designated applications
- **Reuse**
  - Use of the ontology in novel, unplanned applications
    - very common for top level ontologies



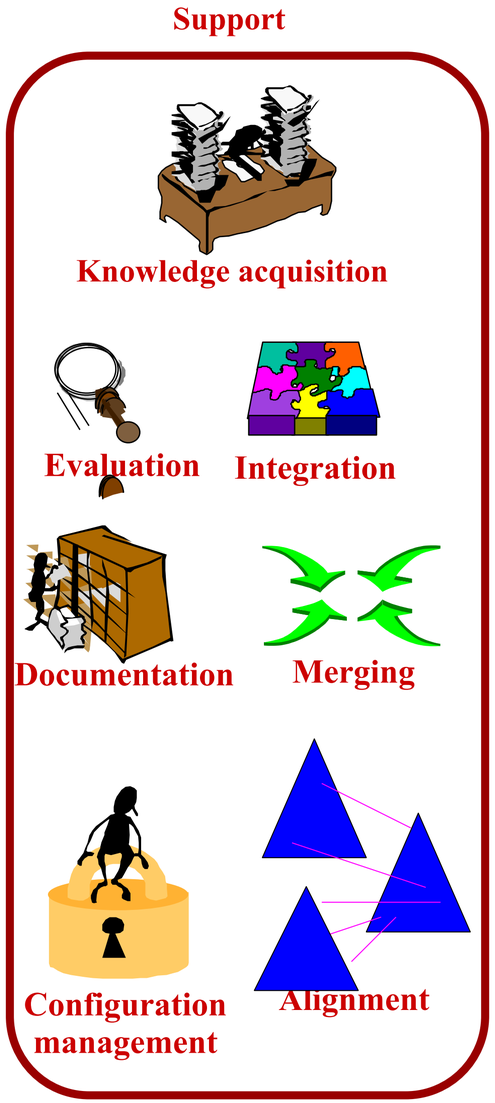
Support Activities

- **Knowledge Acquisition**
  - The process of eliciting (tacit) knowledge from domain expert
  - Learning semi-automatically the ontology from text
- **Evaluation**
  - Technical evaluation of the outcome of each step of the ontology development process
- **Documentation**
  - Accurate documentation of each step of the ontology development process
- **Configuration management**
  - Management of the different versions of the ontology produced and its documentatio
    - Versioning



Support Activities

- **Integration**
  - Integrating two ontologies through the definition of mappings between them
    - Definition of a global schema
- **Merging**
  - Ontology merging describes the process of integrating two (or more) ontologies into a single one.
- **Alignment**
  - Determine or apply mapping rules for reconciling the involved ontologies



Ontology design patterns

- Adapting a design idea originally from architecture
  - recurring modeling problems
  - providing a set of adaptable standard solutions
  - a “**pattern**” is a solution to a problem in a given context

Summary

- Types of ontology
- Ontology engineering principles
- Ontology engineering methodologies