

ntology in a Nutshell

◆ Introduction: simple examples

- Example of **problem**: searching on a web
- Example of **natural intelligence**: a human reaction
- Example of **artificial intelligence**: a semantic web

◆ Ontology: nature of the object

- Fundamental **definitions**
- Example of **content** and **forms**
- Some **examples** of existing ontologies

◆ Ontology: life-cycle of the object

- Complete **cycle** and different stages
- Contributions to **supporting** each stage

At slogan-level !

♦ "What are the books from Hemingway?"



Noise \neq Precision



Missed \neq Recall

Nice pubs in Nice

The Old Book
12, R. Victor Hugo

The White Swan
3 Av Hemingway

The Horseshoe

Summary of the novel

"The Old Man And The Sea"
by Ernest Hemingway

This new edition starts with a large
historical introduction of the work

The Man Who Mistook His Wife for a Hat : And Other Clinical Tales by [Oliver W. Sacks](#)

In his most extraordinary book, "one of the great clinical writers of the 20th century" ([The New York Times](#)) recounts the case histories of patients lost in the bizarre, apparently inescapable world of neurological disorders. Oliver Sacks's *The Man Who Mistook His Wife for a Hat* tells the stories of individuals afflicted with fantastic perceptual and intellectual aberrations: patients who have lost their memories and with them the greater part of their pasts; who are no longer able to recognize people and common objects; who shout involuntary obscenities; who are retarded yet are gifted with uncanny powers.

If inconceivably strange, these brilliant tales remain, in *The Man Who Mistook His Wife for a Hat*, studies of life struggling against incredible adversity, of the human mind, impaired, to imagine with our hearts what it must be to live with the limitations of medicine's ultimate responsibility: "the suffering, afflicted."

Our rating : ★★★★★

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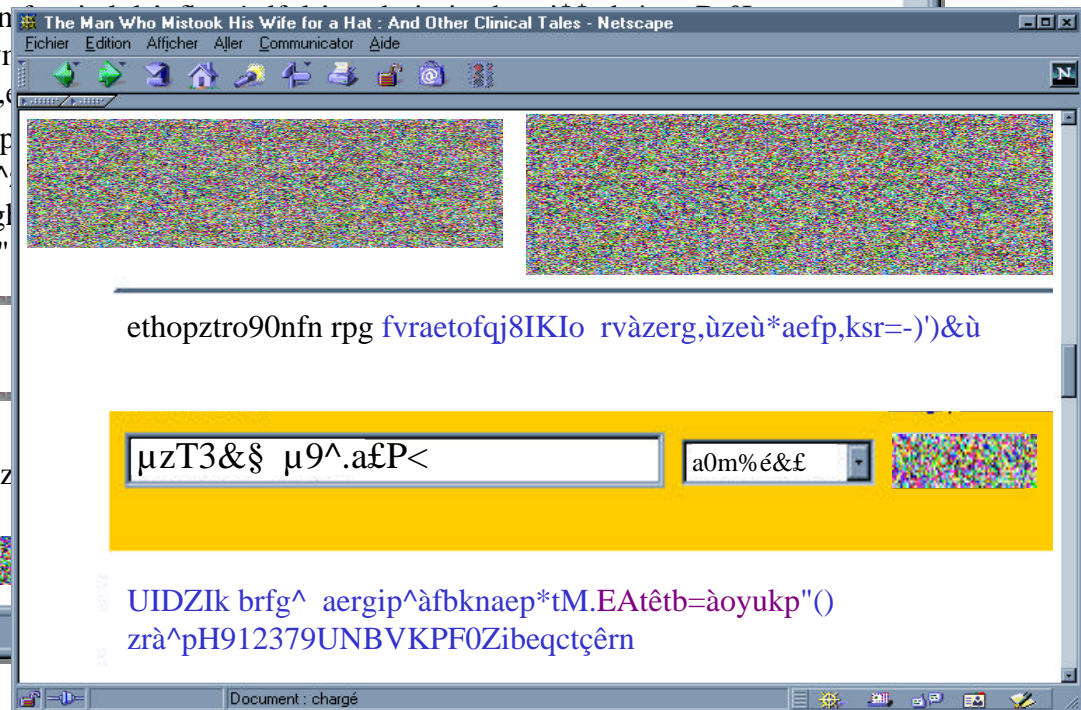
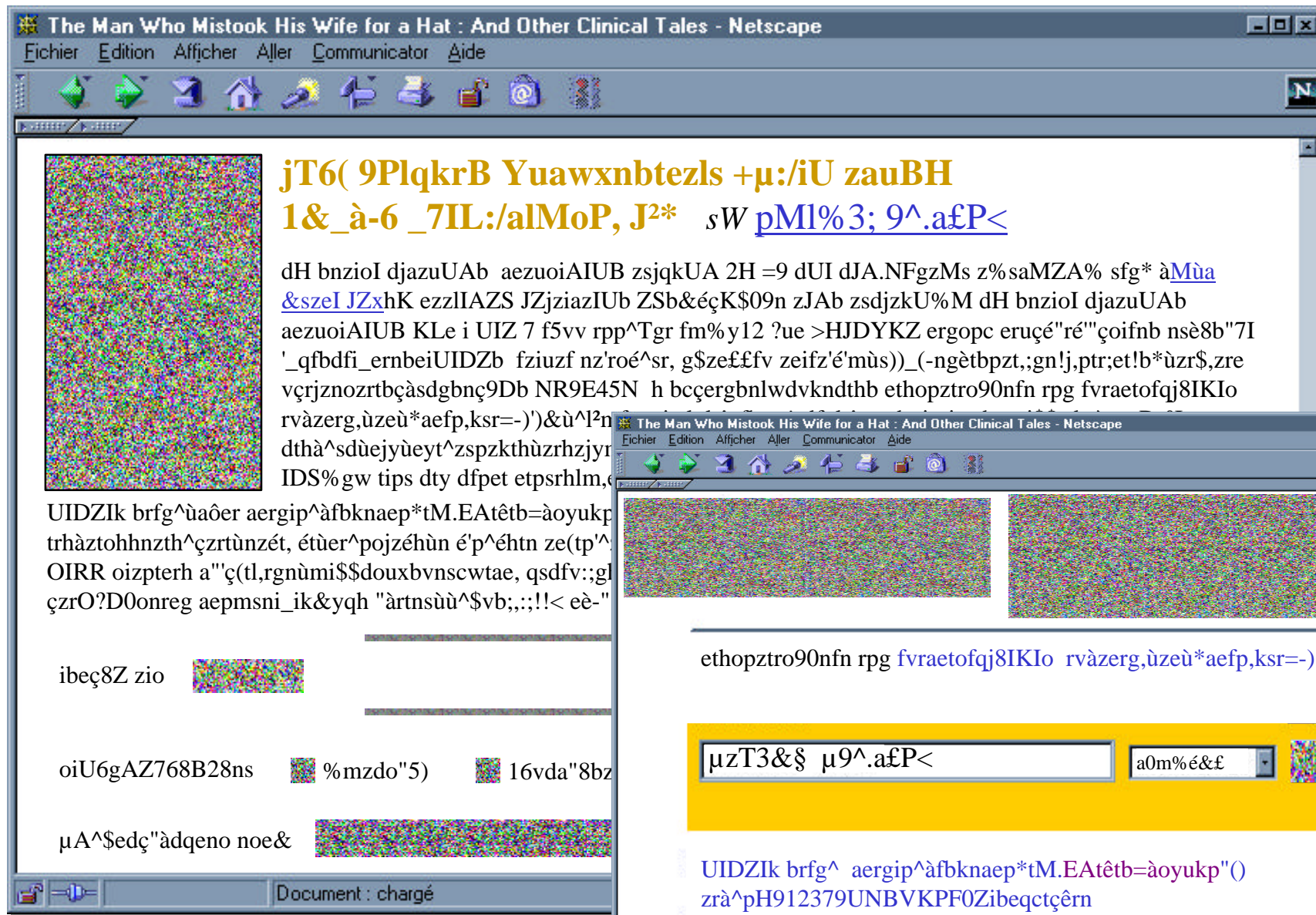
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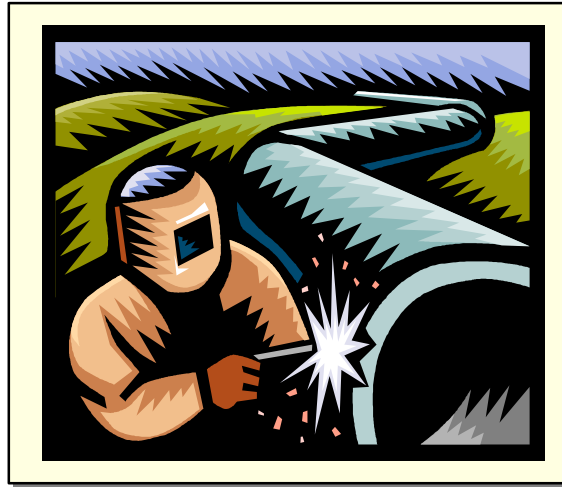
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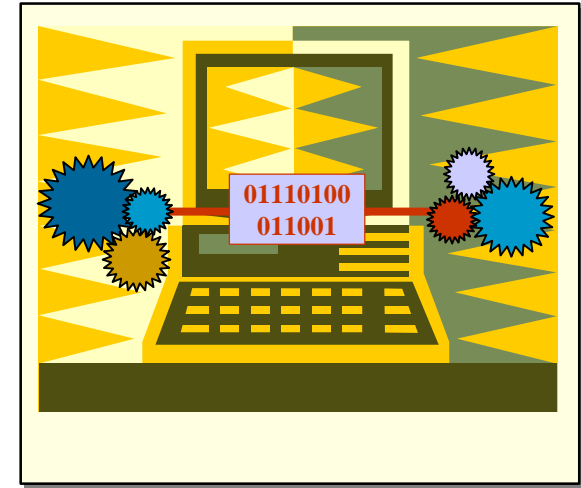
◆ "What is a pipe ?"



A short narrow tube with a small container at one end, used for smoking e.g. tobacco.



A long tube made of metal or plastic that is used to carry water or oil or gas.



A temporary section of computer memory that can link two different computer processes.

◆ One term - three concepts

◆ "What is the last document you read ?"

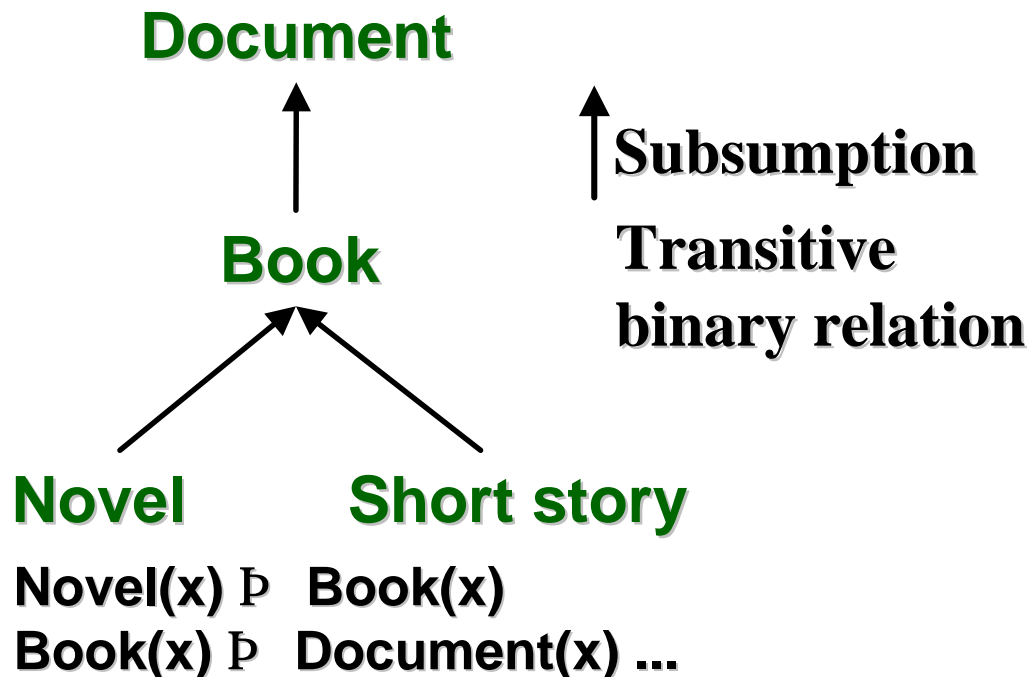
- Terms to concepts (recognition, disambiguation)
- Conceptual structures (e.g., taxonomy)
- Inferences (e.g., generalisation/specialisation)

- ◆ Some knowledge is missing → **identification**
- ◆ Types of documents → **acquisition**
- ◆ Model et formalise → **representation**

"A novel and a short story are books."

"A book is a document."

Informal



Formal

- ◆ Some knowledge is missing
- ◆ Types of documents
- ◆ Model et formalise

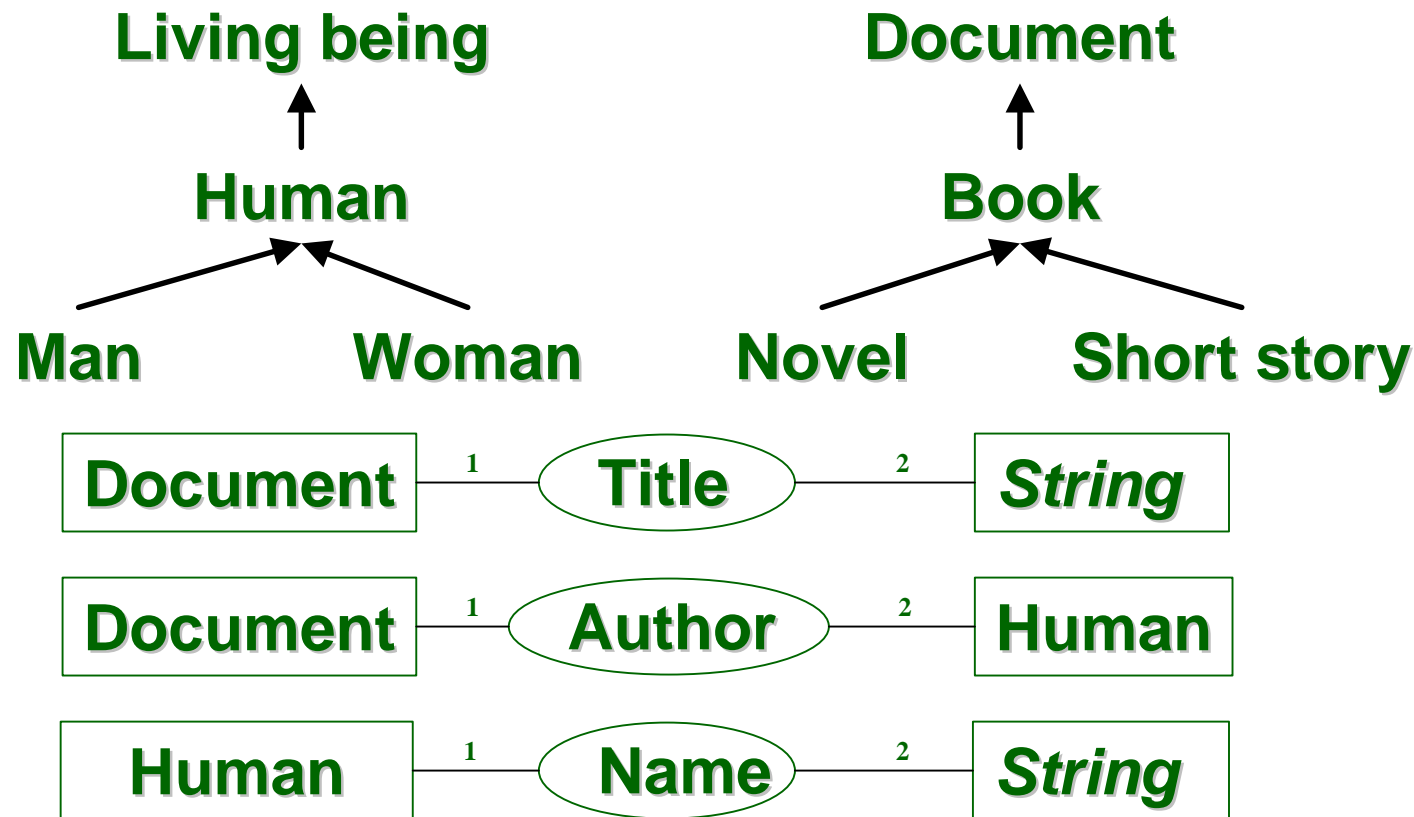
→ identification
→ acquisition
→ representation

"A document has a title which is a short natural language string"

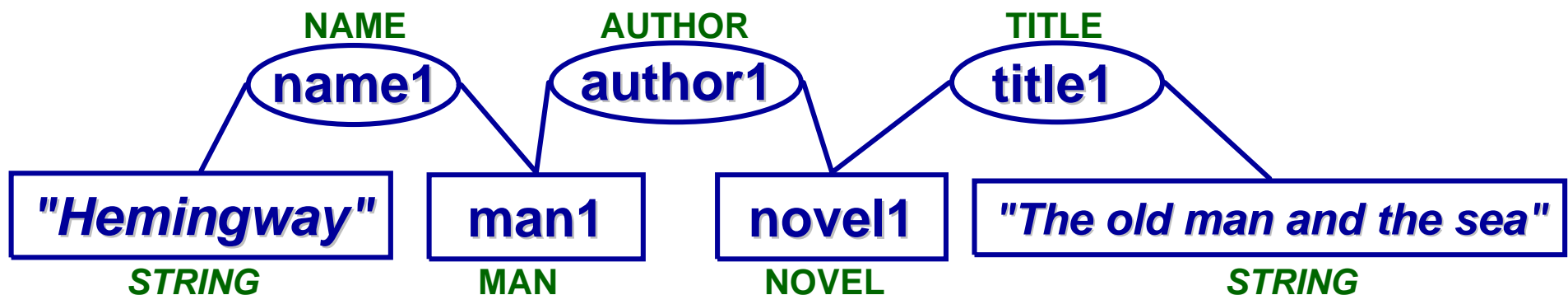
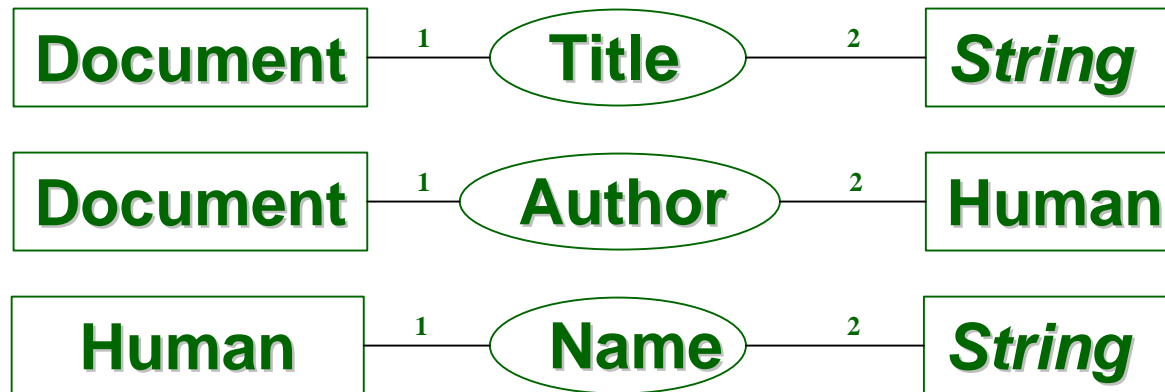
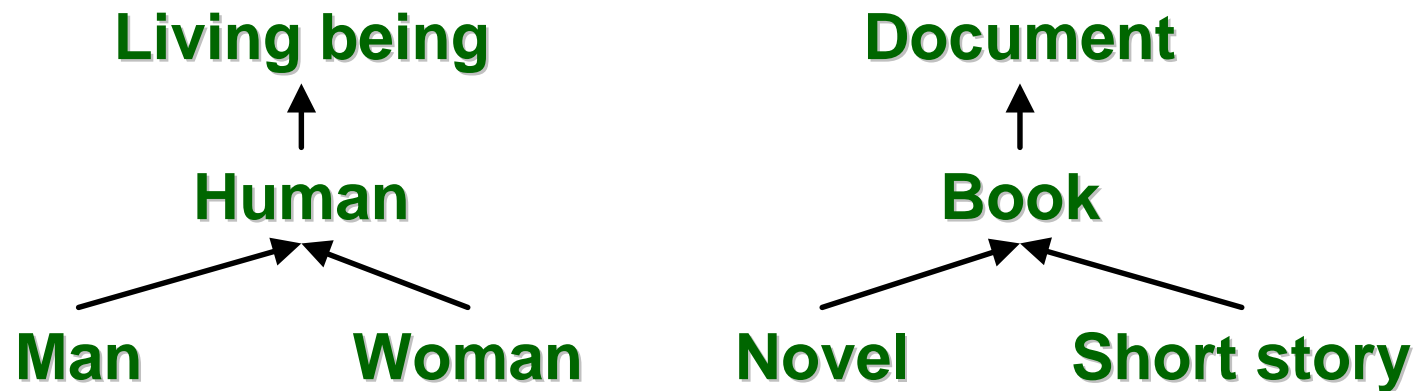
Informal



Formal

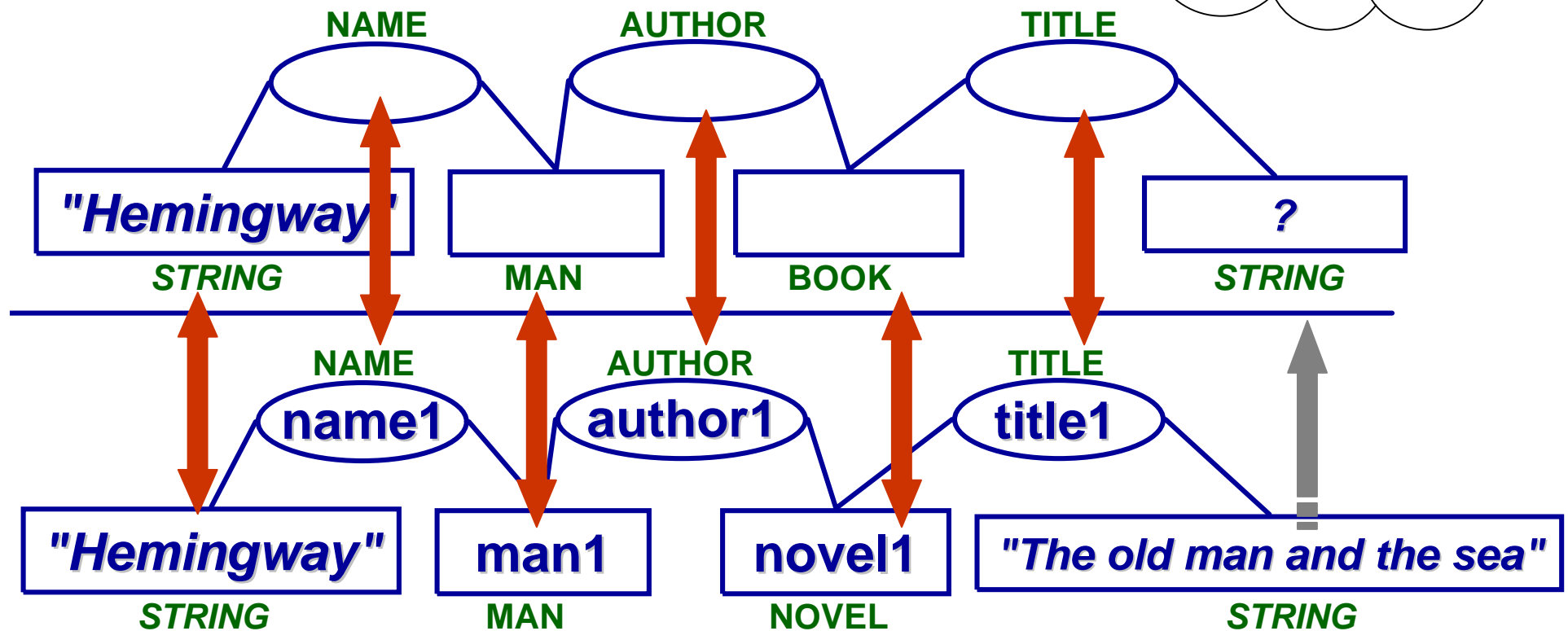


Hemingway is the author of "The old man and the sea"

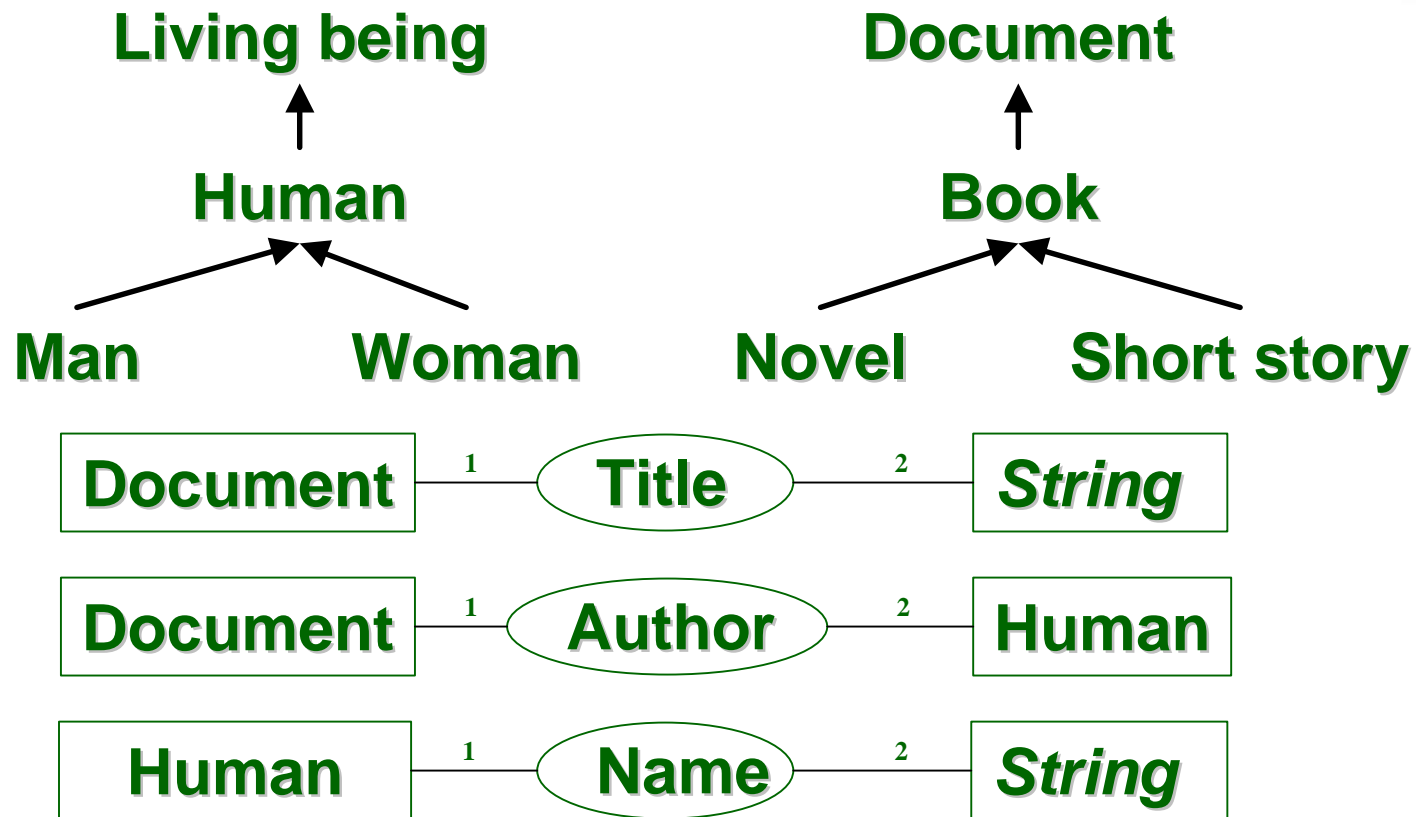


- ◆ Search : Request

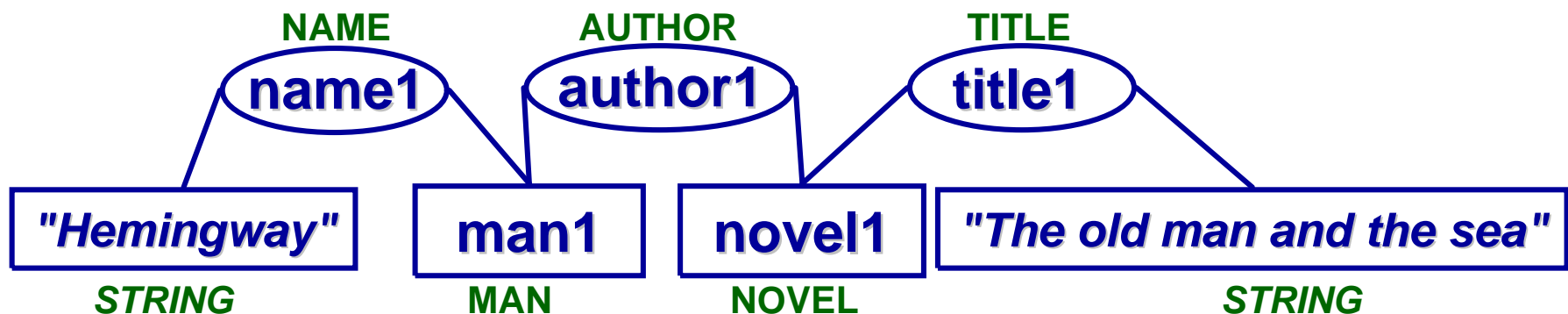
- ◆ Projection → Inference



Ontological knowledge



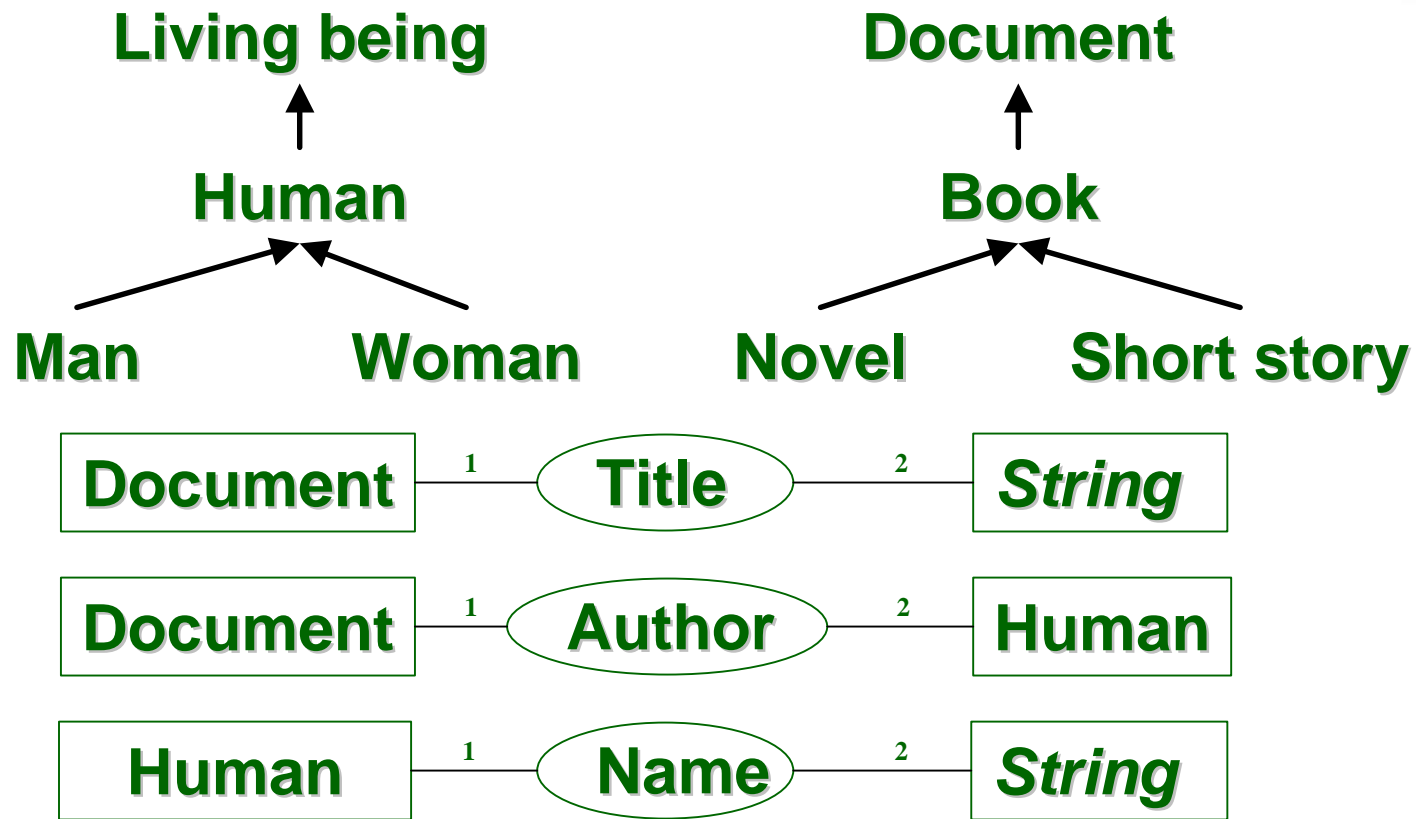
Assertional knowledge



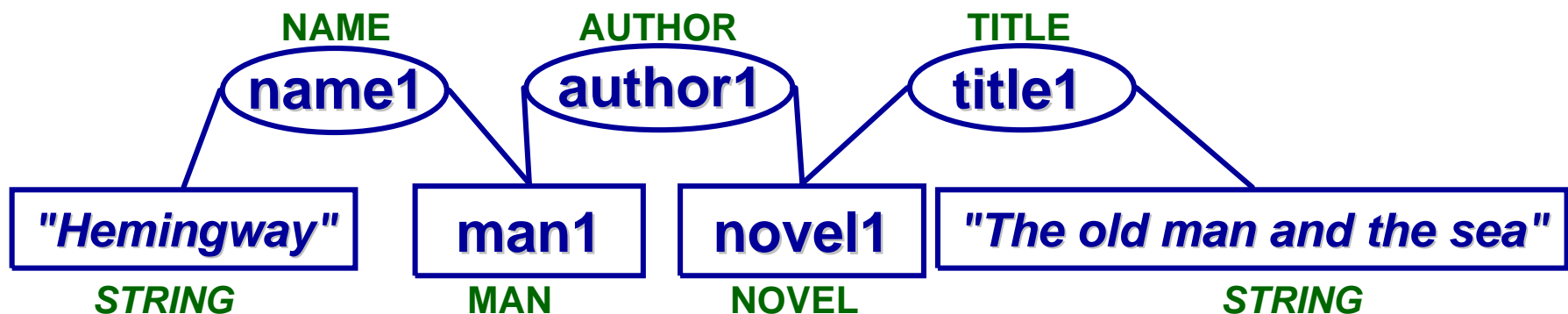
- ◆ I repeat: "do not read the following sign !"



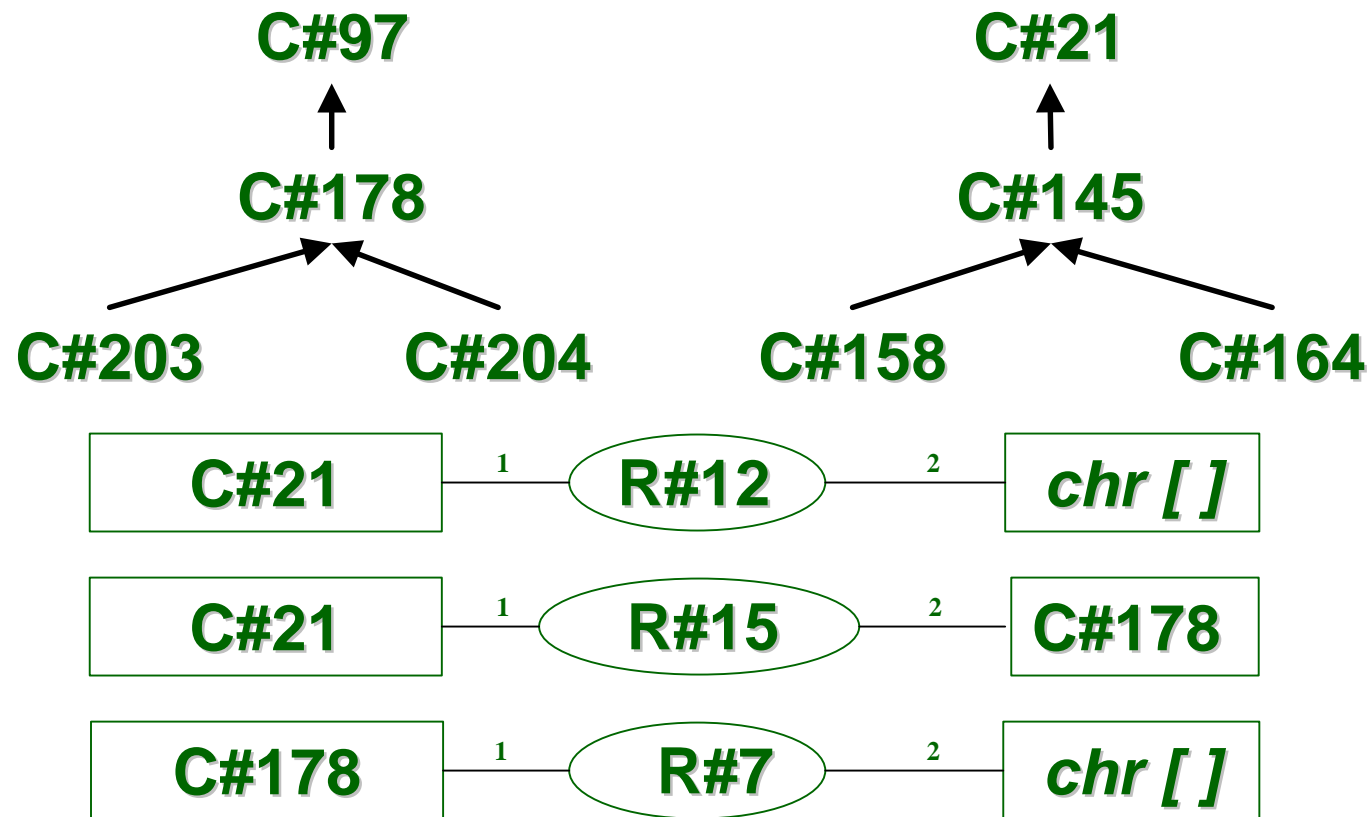
Ontological knowledge



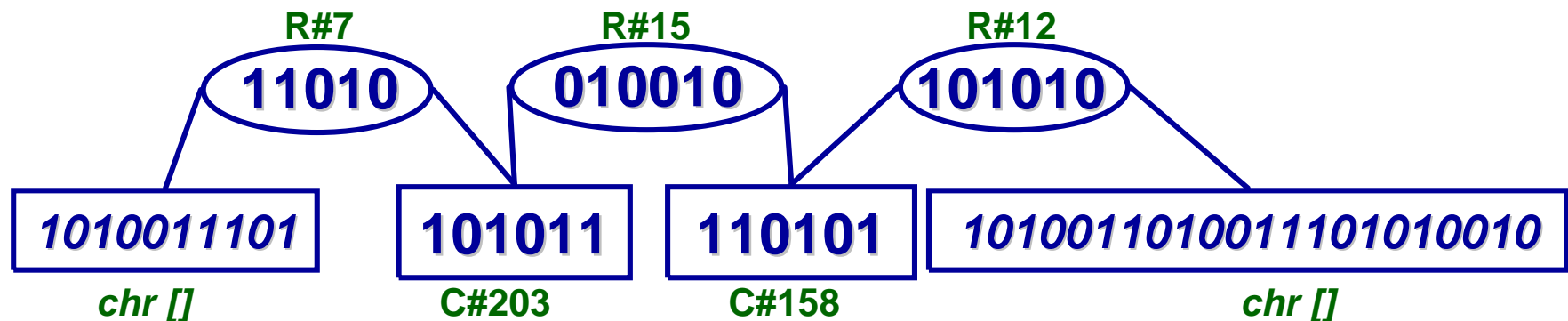
Assertional knowledge



Ontological knowledge

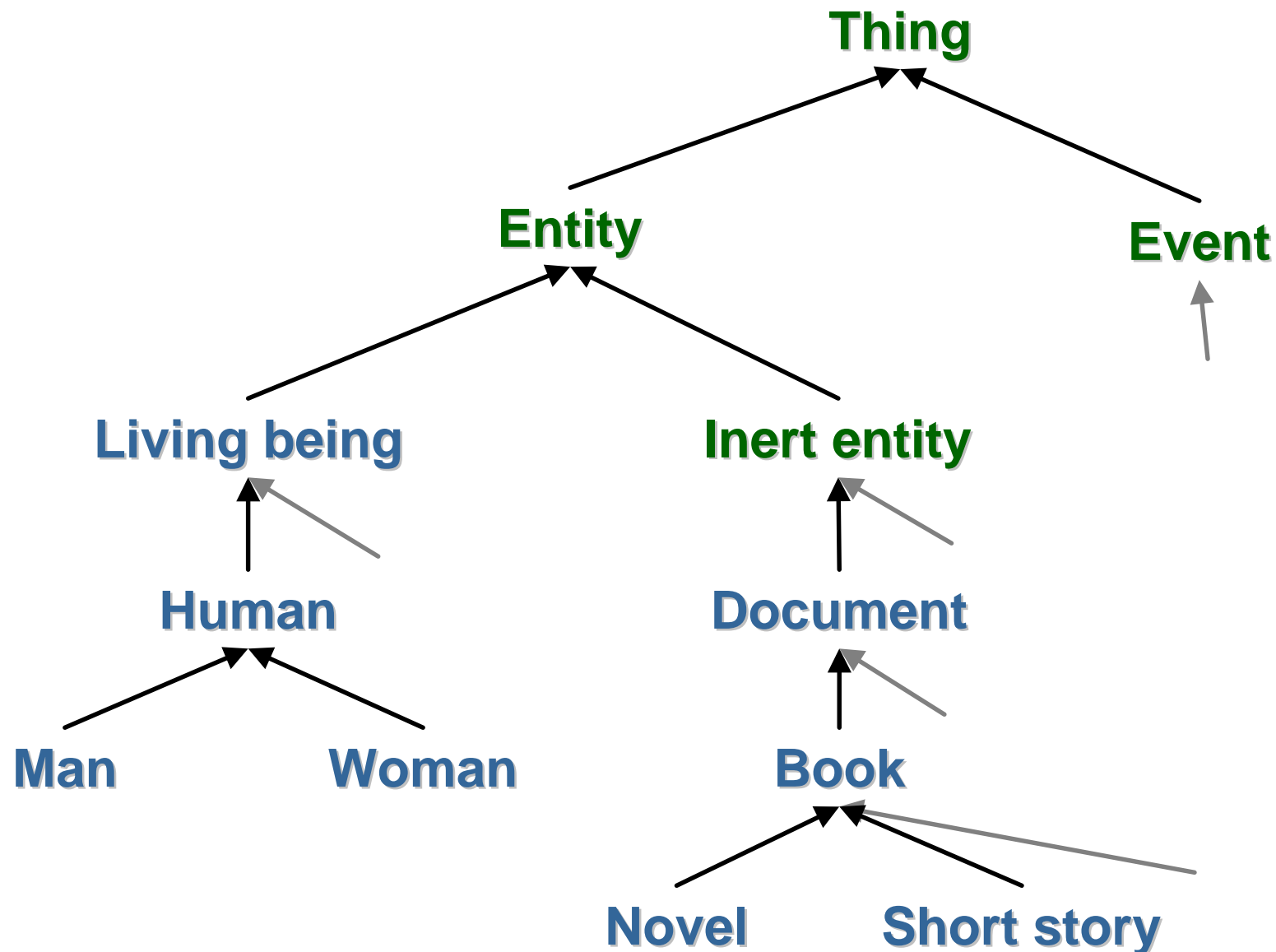


Assertional knowledge

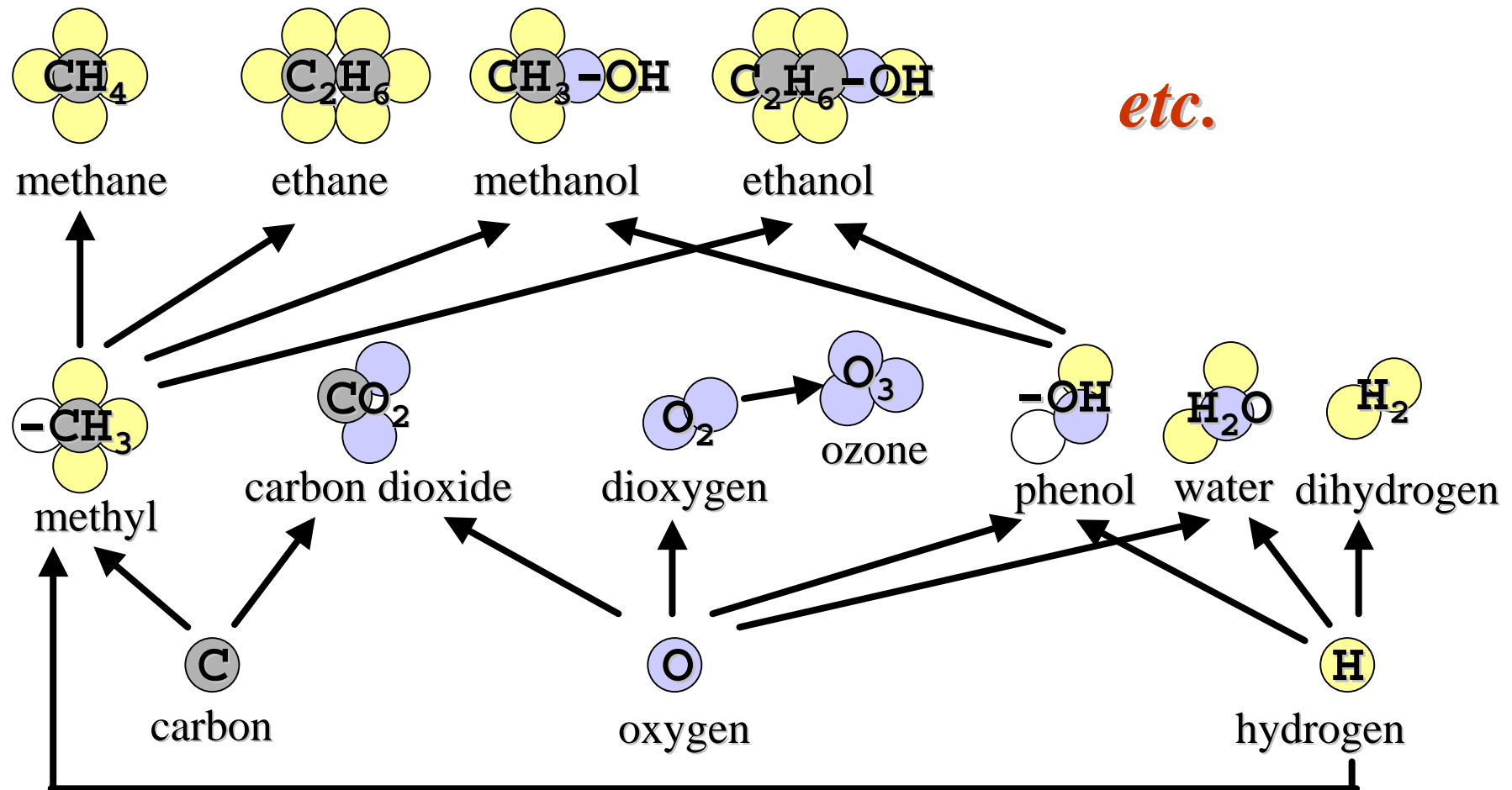


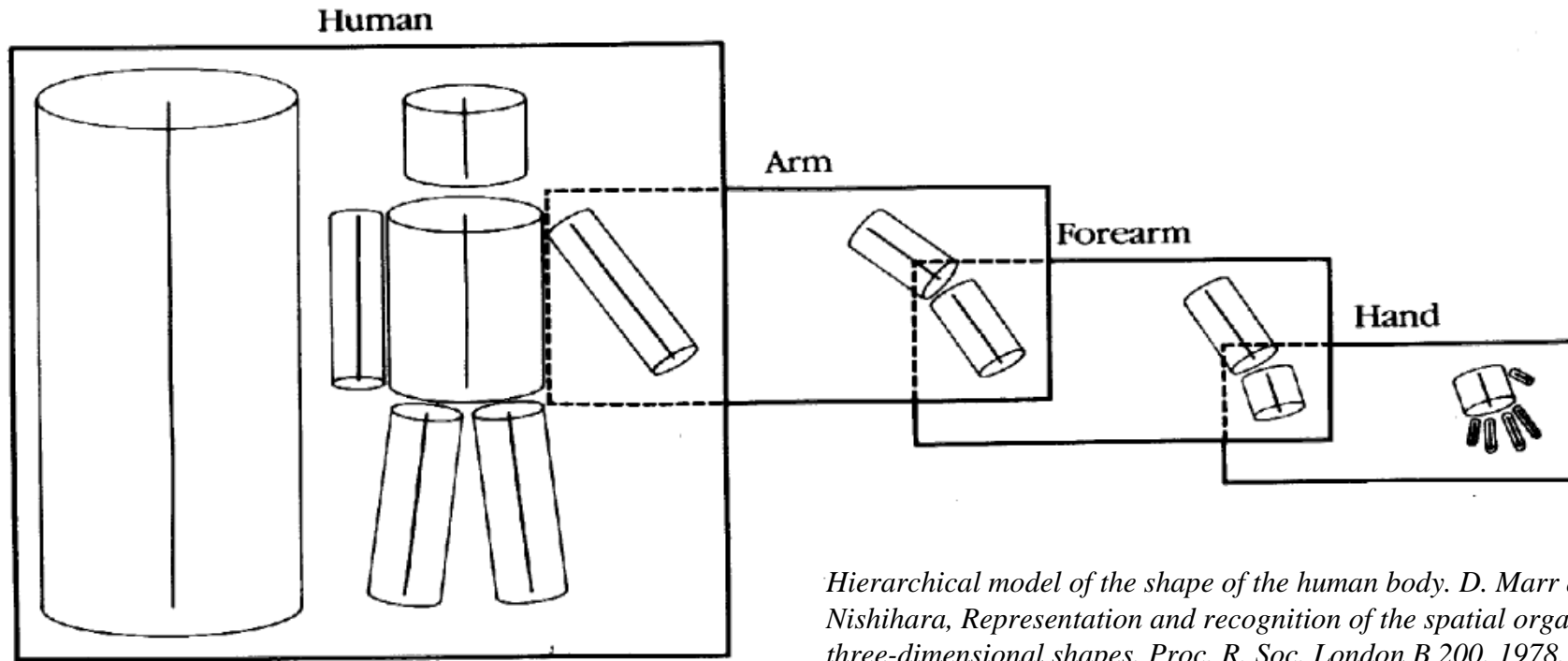
- ◆ **conceptualisation:** an intensional semantic structure which encodes the implicit rules constraining the structure of a piece of reality [Guarino and Giaretta, 1995] || the action of building such a structure.
- ◆ **Ontology:** a branch of metaphysics which investigates the nature and essential properties and relations of all beings as such.
- ◆ **ontology:** a logical theory which gives an explicit, partial account of a conceptualisation [Guarino and Giaretta, 1995] [Gruber, 1993]; the aim of ontologies is to define which primitives, provided with their associated semantics, are necessary for knowledge representation in a given context. [Bachimont, 2000]
- ◆ **formal ontology:** the systematic, formal, axiomatic development of the logic of all forms and modes of being [Guarino and Giaretta, 1995].

- ◆ **taxonomy**: a classification based on similarities.

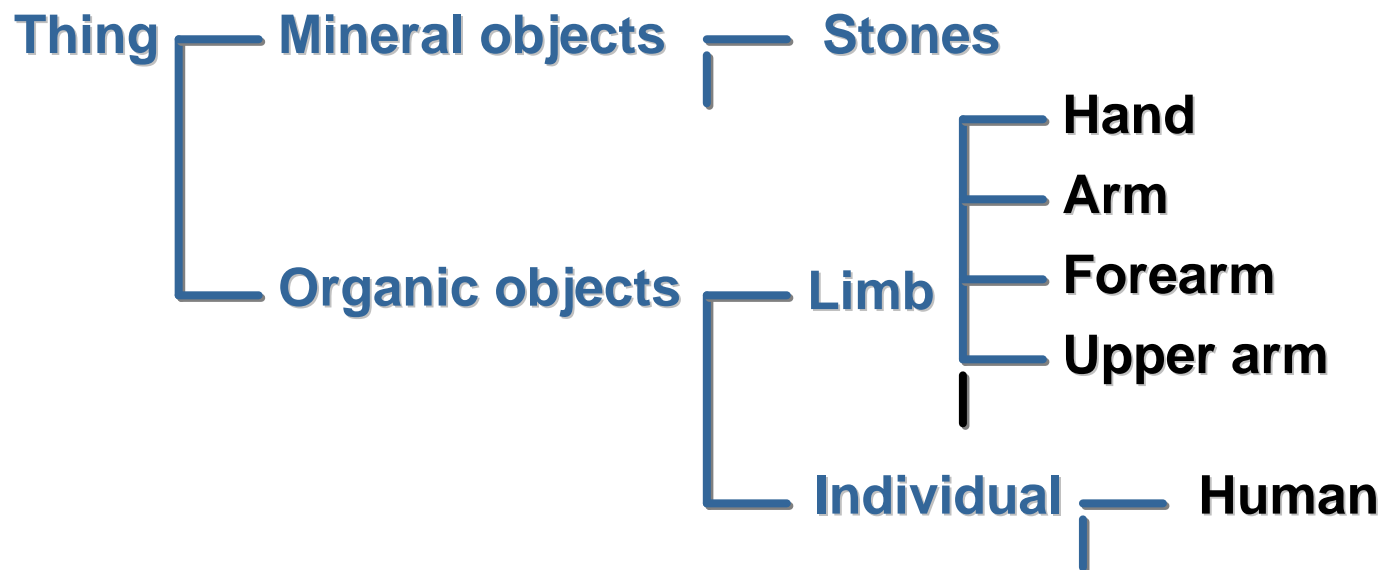


- ♦ **taxonomy**: a classification based on similarities.
- ♦ **partonomy**: a classification based on part-of relation.





Hierarchical model of the shape of the human body. D. Marr and H.K. Nishihara, Representation and recognition of the spatial organization of three-dimensional shapes, Proc. R. Soc. London B 200, 1978, 269-294).



Partonomy
Taxonomy

- ♦ **taxonomy**: a classification based on similarities.
- ♦ **partonomy**: a classification based on part-of relation.
- ♦ A **logical theory** in general e.g.

formal definitions (knowledge factorisation)

director (x) \hat{U}

person(x) \hat{U} ($\$y$ *organisation*(y) \hat{U} *manage* (x,y))

causal relations

living_being(y) \hat{U} *salty*(x) \hat{U} *eat* (y,x) \hat{P} *thirsty*(y)

...

- ◆ **taxonomy**: a classification based on similarities.
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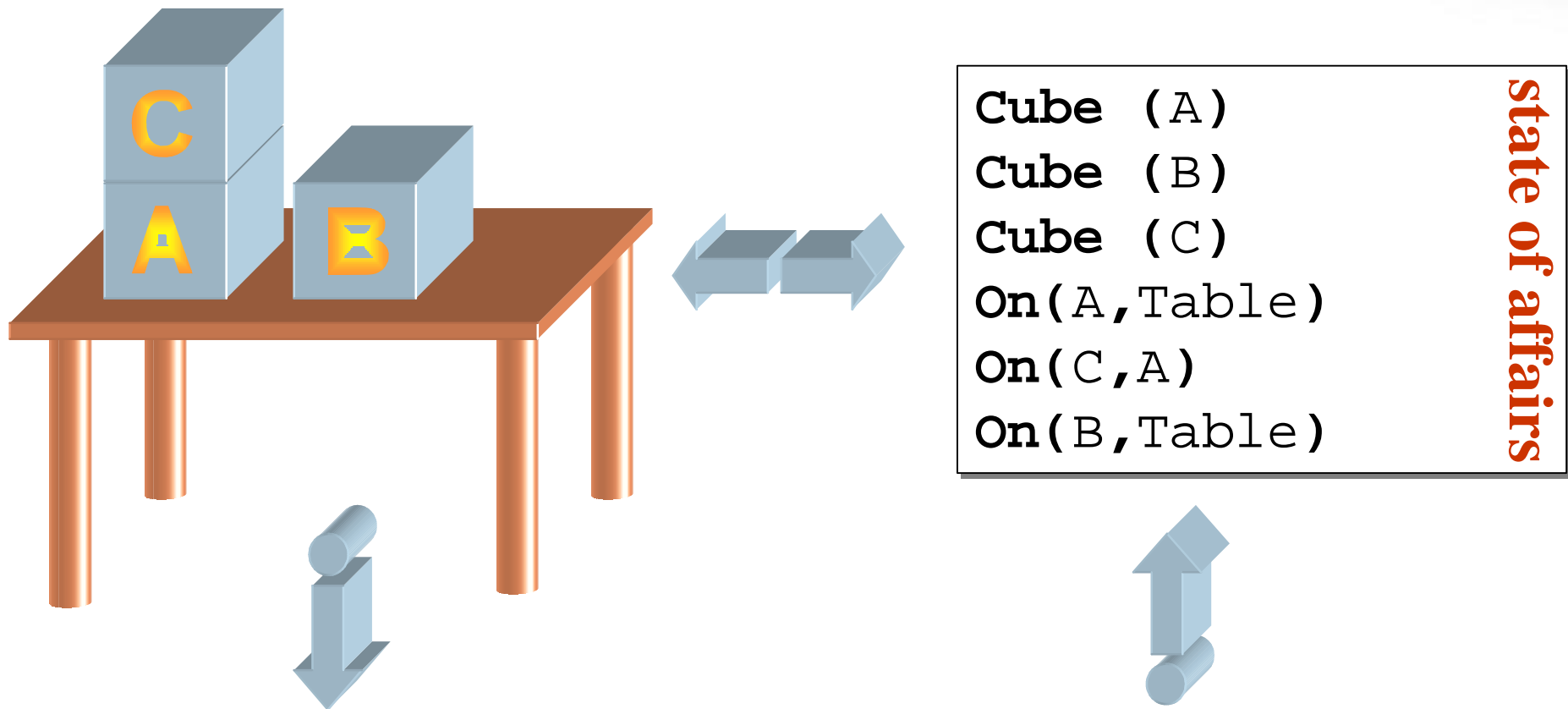
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...

- ◆ An ontology is not a taxonomy.
A taxonomy may be an ontology.
Taxonomic knowledge is at the heart of our conceptualisation and 'reflex inferences' that is why it appears so often in ontologies



- ◆ **Exhaustivity:** breadth of coverage of the ontology *i.e.*, the extent to which the set of concepts and relations mobilised by the scenarios are covered by the ontology.
- ◆ **Specificity:** depth of coverage of the ontology *i.e.*, the extent to which specific concept and relation types are precisely identified.
- ◆ **Granularity:** level of detail of the formal definition of the notions in the ontology *i.e.*, the extent to which concept and relation types are precisely defined with formal primitives.
- ◆ **Formality:** [Uschold and Gruninger, 1996]
 - highly informal (natural language),
 - semi-informal (restricted structured natural language),
 - semi-formal (artificial formally defined language)
 - rigorously formal (formal semantics, theorems, proofs)

- ♦ **Enterprise Ontology:** a collection of terms and definitions relevant to business enterprises. (Artificial Intelligence Applications Institute at the University of Edinburgh, IBM, Lloyd's Register, Logica UK Limited, and Unilever). Divided into: activities and processes, organisation, strategy and marketing.
- ♦ **Open Cyc:** an upper ontology for all of human consensus reality *i.e.* 6000 concepts of common knowledge.
- ♦ **AAT:** Art & Architecture Thesaurus to describe art, architecture, decorative arts, material culture, and archival materials.
- ♦ **ASBRU:** provides an ontology for guideline-support tasks and the problem-solving methods in order to represent and to annotate clinical guidelines in standardised form.
- ♦ **ProPer:** ontology to manage skills and competencies of people
- ♦ **EngMath:** mathematics engineering ontologies including ontologies for scalar quantities, vector quantities, and unary scalar functions.

...

♦ "Mum ...? Mum !? What is a dog ?"

A family is on the road for holidays. The child sees a horse by the window, it is the first time he sees a horse.

- "Look mum... it is a big dog !" The child says.

The mother looks and recognises a horse.

- "No Tom, it is a horse... see it's much bigger !" The mother corrects.

The child adapts his categories and takes notes of the differences he perceives or he is told, to differentiate these new categories from others

A few kilometres later the child sees a donkey for the first time.

- "Look mum... another horse !" The child says.

The mother looks and recognises the donkey.

- "No Tom, it is a donkey... see it's a little bit smaller, it is grey..." The mother patiently corrects.

And so on...

♦ **Ontologies are learnt, built, exchanged, modified, etc. ontologies are living-object**

The diagram illustrates the Technology Management Process, organized into two main horizontal sections: **Management** (top) and **Maintenance** (bottom).

Management Phase:

- Detection:** The starting point of the process.
- Building:** A central box containing a sub-process:
 - Specification, Conceptualization, Formalization, Implementation:** A vertical stack of four boxes.
 - Acquisition, Integration:** Two boxes to the right of the stack, with red arrows pointing from the stack to them.
 - Planning:** A vertical bar to the right of the Acquisition and Integration boxes.
- Evolution:** A box below Building, connected by a green arrow.
- Diffusion:** A box to the right of Evolution, connected by a green arrow.
- Use:** The final stage, connected to Diffusion by a green arrow.

Maintenance Phase:

- Evaluation:** A box below Detection, connected to it by a green arrow.
- Feedback Loop:** A green arrow points from Use back to Evaluation, and another from Evaluation back to Detection, forming a cycle.
- Icons:** A green circular arrow icon is located between Evolution and Use. A green icon with two crossed circles is located near Detection.

- ◆ **Detection & Specification:** Scenarios [Caroll, 1997]
Competency questions [Uschold and Gruninger, 1996]
- ◆ **Knowledge acquisition techniques:** interview, observation, document analysis, questionnaire, brainstorming, brainwriting.
- ◆ **Terms analysis:**
 - **Natural language processing tools** (large corpora) e.g., Nomino, Lexter, Terminae, Cameleon, *etc.*
 - **Lexicon** design [Uschold & Gruninger, 1996] [Fernandez *et al.*, 1997]
- ◆ **Taxonomic structuring:**
 - **Principles:** Taxonomy [Aristotle, -300] communities and differences with parent and brother concepts [Bachimont, 2000] semantic axis and constraints [Kassel *et al.*, 2000; Kassel, 2002] Taxonomy validation [Guarino and Welty, 2000]
 - **Tools:** DOE, FCA, IODE, *etc.*

- ◆ **Build // Evolution:** N.L.P., merging, editors, *etc.*
+ versioning and coherence [Larrañaga & Elorriaga, 2002]
[Maedche *et al.*, 2002]
- ◆ **Formalisms:** conceptual graphs, description logics, object- / frame- languages, topic maps, predicate logic *etc.*
- ◆ **Evaluation // Detection:** scenario and feedback
- ◆ **Collective dimension:** Reconciler [Mark *et al.*, 2002]
designed to aid communicating partners in
developing and using shared meaning of terms
- ◆ **Management:** plan the work like a project
existing methodologies e.g., METHONTOLOGY
[Fernandez *et al.*, 1997]
- ◆ **Complex tools and platforms:** Protégé 2000,
WebODE, KAON, *etc.*

◆ **Situations in technology monitoring scenario:**

"... send that news to X and his/her **colleagues**..."

"... what did X or one of his/her **colleagues** wrote..."

◆ **Terminological study: **colleague** term**

- colleague: one of a group of people who work together
- colleague: someone who shares the same profession

◆ **Lexicon:**

"colleague: one of a group of people who work together
|| syn. co-worker, fellow worker, workfellow"

◆ **Table and structure:**

Class	View	Super class	Other Terms	Natural Language Definition	Pr
colleague	organization	worker	co-worker	one of a group of people who work together	Us
...

◆ First formalising

colleague(x) \supset person(x)

```
<rdfs:Class rdf:ID="Colleague">
  <rdfs:subClassOf rdf:resource="#Worker"/>
  <rdfs:comment xml:lang="en">one of a group of people who work
    together.</rdfs:comment>
  <rdfs:comment xml:lang="fr">personne avec qui l on
    travaille.</rdfs:comment>
  <rdfs:label xml:lang="en">colleague</rdfs:label>
  <rdfs:label xml:lang="en">co-worker</rdfs:label>
  <rdfs:label xml:lang="fr">collegue</rdfs:label>
</rdf:Property>
```

◆ Problem: one is not a colleague by oneself...

◆ Transform into relation:

`colleague(x,y) ⇔ some_relation(x,y)`

```
<rdf:Property rdf:ID="Colleague">
  <rdfs:subPropertyOf rdf:resource="#SomeRelation"/>
  <rdfs:range rdf:resource="#Person"/>
  <rdfs:domain rdf:resource="#Person"/>
  <cos:transitive>true</cos:transitive>
  <cos:symmetric>true</cos:symmetric>
  <rdfs:comment xml:lang="en">one of a group of people who work
    together.</rdfs:comment>
  <rdfs:comment xml:lang="fr">personne avec qui l on
    travaille.</rdfs:comment>
  <rdfs:label xml:lang="en">colleague</rdfs:label>
  <rdfs:label xml:lang="en">co-worker</rdfs:label>
  <rdfs:label xml:lang="fr">colleague</rdfs:label>
</rdf:Property>
```

◆ Problem: no one lists all the colleagues, one derives them from the organisational structure

- ♦ "I am a colleague of X **because** I work in the same group than X"
- ♦ Encode axiomatic knowledge, factorise knowledge in rules and definitions

$$\text{colleague}(x,y) \hat{=} \text{person}(x) \hat{\cup} \text{person}(y) \hat{\cup} (\exists z \text{ group}(z) \hat{\cup} \text{include}(z,x) \hat{\cup} \text{include}(z,y))$$

IF

Group
 Include
 Person ?x
 Include
 Person?y

THEN

Person ?x
 Colleague
 Person ?y

- ◆ **Make conceptualisation explicit, visible, operational, etc.**
 - Loosely-coupled solutions
 - Generic mechanisms and inferences
 - Decouple domain dependent aspects
 - Reflection
- ◆ **Ontology as interface / Ontology and interfaces**
 - Communication (H-H, H-M, M-M)
 - Modelling and indexing controlled vocabulary
 - Require intelligent interfaces able to focus
- ◆ **Ontologies have a cost (design, maintenance) to be taken into account in a complete solution**
 - Project management and integrated tools
 - Maintain dependencies
- ◆ Ontology are **not the silver bullet** for KM, **but** an interesting **conceptual object** for building tools and **supporting infrastructures**