Knowledge Engineering

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Lecture 1 – Introduction
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General information

- Lecturer: Michael Rovatsos (mrovatso@inf, AT 3.12)
- Lecture times: Tue/Fri 3-3:50 p.m. AT Lecture Theatre 3
- Assessment:
  - Two assessed practicals counting 15% each
  - Final exam paper counting 70%
- Module Web page:

  www.inf.ed.ac.uk/teaching/courses/ke
- Check Web page for announcements and materials

"Health warning"

- This course will cover formal material
- The slides are not a summary of the lecture (notion of "lecture" misleading)
- Making a KE DVD is much cheaper than this
  ➡ make use of opportunity for interaction!
- Idea: You do the work anyway, why not do as much as possible of it in class?
- If you want to come, be punctual and stay throughout

What is knowledge?

- **Knowledge** is a condensed presentation of information, which in turn is structured, contextualised raw data

	Characteristics	Example
Data	uninterpreted raw signal	· · · – – – · · ·
Information	data + context meaning	SOS
Knowledge	purpose attached generative for action creates new information	emergency start rescue

Different views

- Nature and purpose of knowledge:
  - theoretical: knowledge as "justified, true belief"
  - practical: knowledge as the "intellectual machinery" to achieve a problem-solving **goal**
- Symbol system vs. physical grounding hypothesis
  - Is inference on symbols representing the world sufficient to solve real-world problems ...
  - ... or are these symbolic representations irrelevant as long as the agent is successful in the physical world?
  - "Elephants don't play chess" (or do they?)

Classifying knowledge

- By knowledge source: **Empirical** vs. **theoretical** knowledge
- By knowledge orientation: **Object-level** vs. **meta-level**
- Other categories:
  - Global vs. local
  - Explicit vs. tacit
  - Complete vs. incomplete
  - Certain vs. uncertain
  - Accessible vs. inaccessible
  - Fixed vs. volatile
  - Declarative vs. procedural

Exercise

Consider the following statements.
What kinds of knowledge do they describe?

- John is a great pool player. He always wins against his mates.
- Mary is great at physics. Her understanding of quantum theory baffles her teachers.
- Man has proven capable of travelling to unexplored planets.
- Reuters news reports are always up to date with what is happening in the world.

Knowledge-based systems

- **Knowledge-based systems (KBS)** are **intelligent problem solvers** that represent and reason about domain knowledge
- **Intelligent problem solving** maps domain space onto solution space using knowledge and problem data
- Core of a KBS:
  - Data: specific, volatile & short-term information
  - Knowledge: general, stable & long-term information
- Symbolic AI view: knowledge is represented using symbols that can be manipulated by a computer program

Knowledge in KBS

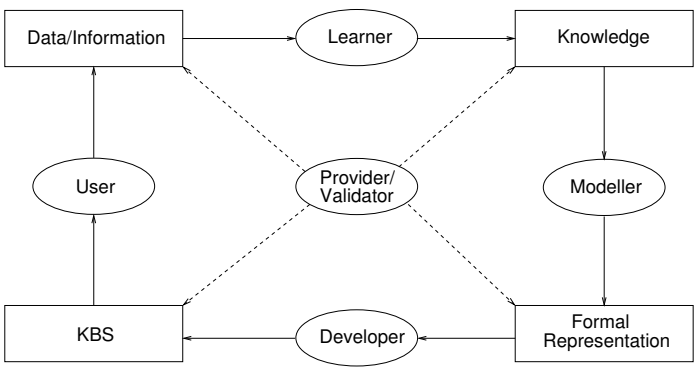
- Domain knowledge: knowledge about the domain of discourse
  - objects and relationships between them, domain facts, domain rules, domain types
- Inference knowledge: knowledge about reasoning operations on domain knowledge
- Task knowledge: goals of the KBS, their decomposition, control issues
- Example: Medical domain
  - Domain: e.g. symptoms and diseases
  - Inference: e.g. procedures "hypothesise" and "verify"
  - Task: e.g. diagnosis, clinical test

Knowledge Engineering

- **Knowledge Engineering (KE)** concerns the basic issues involved in building and using KBS, i.e.
  - acquisition
  - representation
  - explanation
  - validation

  of knowledge in a KBS

Knowledge Engineering Process

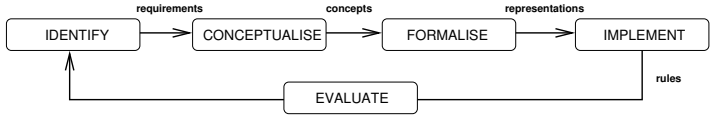


Central KE tasks

- **Learning:** Acquire knowledge from experts/examples (combined with prior knowledge?) with or without supervision
- **Modelling:** Represent knowledge in computer-readable format for which appropriate **inference** methods exist
- **Development:** Design/Implement a KBS that solves the problem at hand
- **Validation:** Test the performance of the system according to some performance measure

KE: The Human Interface

- Interaction btw. human and KE important in two stages: knowledge acquisition and explanation
- Knowledge acquisition:



- Explanation
  - Convince end user that reasoning is correct
  - Convince engineer that the system is working
- Two approaces: trace-based vs. logic-based (trade-off btw. control and clarity)

Exercise

What are the pros and cons of the KE endeavour?

+ Make use of knowledge in an organisation regardless of (fluctuating) individual human experts
+ Support discovery of new knowledge through automation
+ Create systems that are more comprehensible/natural for humans
+ Unbiased, rational "thinking" of KBS
– Great cost, esp. knowledge acquisition (bottleneck)
– No replacement of human intelligence (e.g. creativity)
– Dependence on technology

Course outline

1. Knowledge Acquisition
   - Inductive learning of symbolic knowledge
2. Knowledge Representation & Reasoning
   - Different AI-based methods for representing and reasoning about knowledge (logic, ontologies, uncertainty etc.)
3. Knowledge Synthesis
   - Closed systems view: knowledge-based software synthesis
   - Open systems view: Semantic Web, software agents & multiagent systems
4. Knowledge Evolution
   - Combining existing knowledge with new information
   - Knowledge engineering methodologies

Summary

- What is knowledge?
- What are knowledge-based systems?
- What is knowledge engineering?
- What are its most important aspects?
- Which of them will be dealt with in this course?