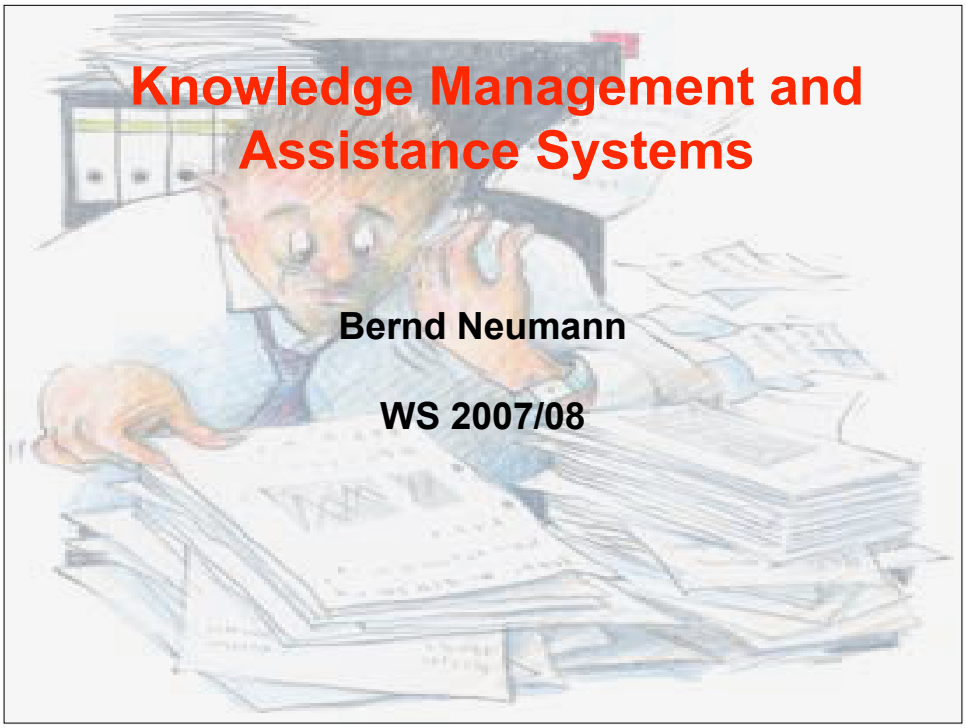

Knowledge Management and Assistance Systems

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WS 2007/08

Topics

Introduction
Applications of Knowledge-based Systems
Role of Knowledge Management

Knowledge Representation Techniques
Semantic Networks
Relational Structures
Frame-based Knowledge Representation
Rule-based Systems
Case-based Reasoning

Assistance Systems
Rule-based Diagnosis Systems
Model-based Configuration
Model-based Simulation
Model-based Diagnosis

Semantic Web
OWL
Description Logics
Protégée
Web-Services

Ontologies
Linguistic Ontologies
Domain Ontologies

Knowledge Management in Organizations
Document Management
Content Management
Knowledge Networks

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Organizational Issues

This course is part of the module "Grundlagen der Wissensverarbeitung" (GWV):

18.240 Vorlesung GWV - Wissensbasierte Systeme
18.241 Vorlesung Wissensmanagement und Assistenzsysteme
18.242 Grundlagen der Wissensverarbeitung

Slide copies and information related to this course will be available at

http://kogs.informatik.uni-hamburg.de/~neumann/WMA-WS-2007/

The lab course 18.242 will also contain exercises and practice assignments related to this course and must be attended, see

http://www.informatik.uni-hamburg.de/WSV/teaching/vorlesungen/GwvVL_WiSe07.php

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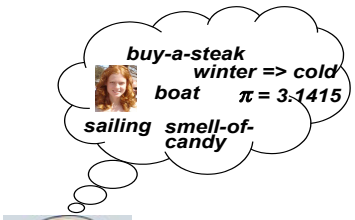
What is Knowledge?



information and skills acquired by education and experience

π = 3,14159 26535 89793 23846

IF winter THEN cold

marietta.jpg

http://best-steakhouse.com

information and processing methods acquired by programming and machine learning

Clarification of Terms?

Websters New Encyclopaedic Dictionary

Data:
Factual information (e.g. measurements or statistics) used as a basis for calculation, discussion or reasoning.

Information:
1. **Communication or reception of knowledge**
2. **Knowledge obtained fom investigation, study or instruction**
   Knowledge of a particular event (news)
   Coded knowledge put out by a machine

Knowledge:
1. **Understanding gained by actual experience**
2. **Awareness of information**
3. **Perception of truth**
4. **Something learnt and kept in mind**

These introductory slides are inspired by the the lecture "Wissensmanagement"of Rudi Studer et al., University of Karlsruhe http://www.aifb.uni-karlsruhe.de/Lehre/Sommer2006/WM/

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Semiotic View

Data:
Syntactic phenomena, e.g. numbers, bitcodes

Information:
Contains syntax and semantics (form and content).
E.g. HH-BU 151 denotes my car

Knowledge:
Contains a pragmatic version in addition to syntax and semantics.
Linked to usage or a purpose.

Knowledge is linked to knowledge usage!
Information which does not include ways how to use it is useless.

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Knowledge in Humans

Tacit knowledge:
- difficult to communicate
- stored in the brain
- embodied knowledge
- difficult to formalize

Tacit knowledge can be transported through socialisation or externalised via analogies, metaphors, models.

Explicit knowledge:
- can be communicated
- can be formalised at different levels of abstraction
- can be stored in different media
- often disembodied knowledge

Explicit knowledge can be combined with other explicit knowledge.
It can (must) be internalized to become tacit knowledge.

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Knowledge Management in Organizations

Knowledge is an essential asset of organizations (companies, institutions).
- Knowledge and know-how of employees are vital for the economical success of an organization.
- Methods for preserving, enhancing and communicating knowledge are in high demand.
- Externalization of tacit knowledge and formalizing human knowledge is the main topic of "Knowledge Management in Organizations" ("Wissensmanagement in Betrieben").

This course mainly deals with computational aspects of knowledge representation, knowledge use and knowledge management.

Organizational aspects are addressed in the last part of the course.

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Knowledge-based Systems

Systems which exploit knowledge (in analogy to human knowledge) for problem solving

Examples:

Public traffic information systems
- knowledge of timetable
- search of best connection

Expert system for car repairs
- cause-effect knowledge
- rule-based inferencing

Case-based building design
- Database of design problems and solutions
- Intelligent case retrieval to solve new problems

Chess-playing system
- Large library of start and end games
- Expert position evaluation
- Fast game-tree exploration

Content and organisation of system knowledge may be different from human knowledge

System knowledge processing methods may be different from human knowledge processing methods

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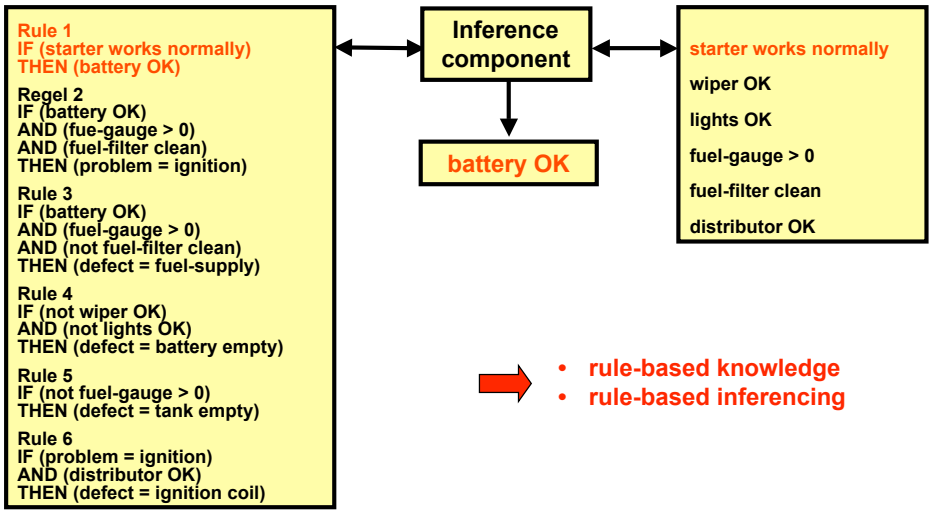
Expert System for Car Repair



- **rule-based knowledge**
- **rule-based inferencing**

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Logic-based Information System

- **Facts and rules are represented in a logic-based formal language**

  "Cottage ´Happy-Fisherman´ is situated at Lake Ontario"

  cottage(happy-fisherman)
  lake(lake-ontario)
  at(happy-fisherman, lake-ontario)

  "all cottages close to a lake have mosquitos"

  $$(\forall X)(\forall Y)\{\ [\text{cottage}(X) \wedge \text{lake}(Y) \wedge \text{close-to}(X,Y)] \Rightarrow [\text{has-mosquitos}(X)]\ \}$$

  " 'at' also means 'close-to' "

  $$(\forall X)(\forall Y)\{\ \text{at(X,Y)} \Rightarrow \text{close-to}(X,Y)\ \}$$

- **A question "Are there mosquitos at the cottage ´Happy-Fisherman´?" can be answered automatically:**

  `has-mosquitos(happy-fisherman)`

  "Cottage ´Happy-Fisherman´ has mosquitos"

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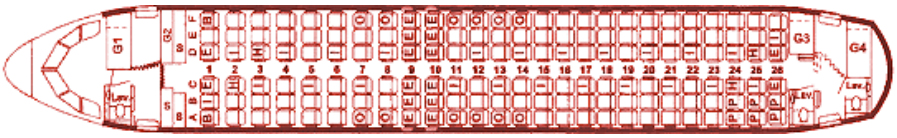
Cabin Layout for Passenger Aircraft



Optimal selection and placement of cabin equipment (seats, galleys, toilets, etc.) respecting:

- **customer wishes**
- **technical constraints**
- **legal constraints**
- **optimality criteria**

Effort for human experts: **several days**
Effort for interactive expert system: **ca. 2 hours**

➡ **knowledge-based configuration systems**

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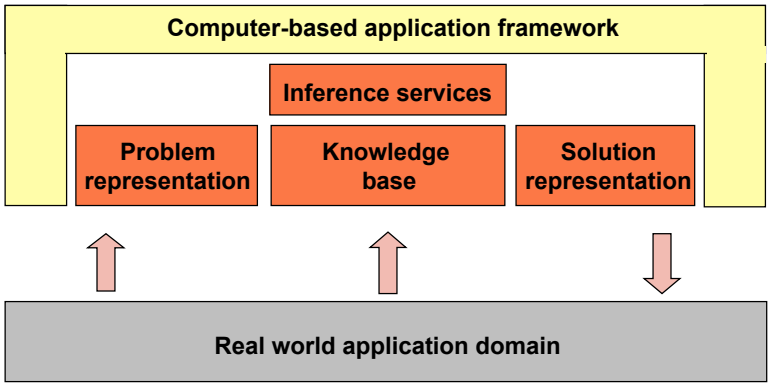
General Scheme for Knowledge-based Assistance Systems



Mapping between real world and computer may or may not require human help - give examples!

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Characteristics of Knowledge-Based Assistance Systems

- **Relevant knowledge about application domain is represented in a declarative format (as opposed to a procedural format)**
  - enhances readability
  - facilitates change maintenance
- **Domain knowledge and problem-specific knowledge may be separated**
- **Inference services may have general validity and proven correctness**
  - validity of logic-based inferences is well-understood
  - validity of rule-based and handcrafted inferences must be doubted
- **Separation of data and control**
  - enables data-driven processing
  - not cleanly realized in rule-based systems
- **Domain knowledge must be acquired and modelled**
  - "knowledge-acquisition bottleneck"

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