

Introduction to Knowledge Engineering

What is Knowledge Engineering?
History & Terminology

Data, information & knowledge

- Data

- “raw signals”

... - - - ...

- Information

- meaning attached to data

S O S

- Knowledge

- attach purpose and competence to information
 - potential to generate action

emergency alert → start rescue operation

Knowledge engineering

process of

- eliciting,
- structuring,
- formalizing,
- operationalizing

information and knowledge involved in a
knowledge-intensive problem domain,
in order to construct a program that can perform a
difficult task adequately

Problems in knowledge engineering

- complex information and knowledge is difficult to observe
- experts and other sources differ
- multiple representations:
 - textbooks
 - graphical representations
 - heuristics
 - skills

Importance of proper knowledge engineering

- Knowledge is valuable and often outlives a particular implementation
 - knowledge management
- Errors in a knowledge-base can cause serious problems
- Heavy demands on extendibility and maintenance
 - changes over time

A Short History of Knowledge Systems

**general-purpose
search engines
(GPS)**

**first-generation
rule-based systems
(MYCIN, XCON)**

**emergence of
structured methods
(early KADS)**

**mature
methodologies
(CommonKADS)**

1965

1975

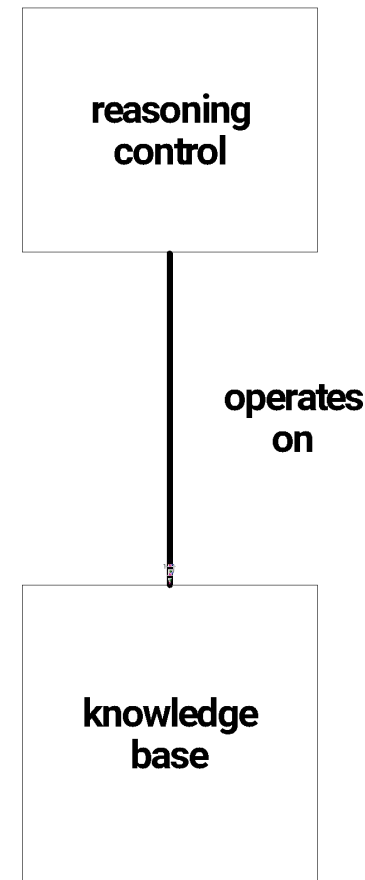
1985

1995

=> from art to discipline =>

First generation “Expert” Systems

- shallow knowledge base
- single reasoning principle
- uniform representation
- limited explanation capabilities



Transfer View of KE

- Extracting knowledge from a human expert
 - “mining the jewels in the expert’s head”
- Transferring this knowledge into KS.
 - expert is asked what rules are applicable
 - translation of natural language into rule format

Problems with transfer view

The knowledge providers, the knowledge engineer and the knowledge-system developer should share

- a common view on the problem solving process and
- a common vocabulary

in order to make knowledge transfer a viable way of knowledge engineering

Rapid Prototyping

- Positive
 - focuses elicitation and interpretation
 - motivates the expert
 - (convinces management)
- Negative
 - large gap between verbal data and implementation
 - architecture constrains the analysis hence: distorted model
 - difficult to throw away

Methodological pyramid

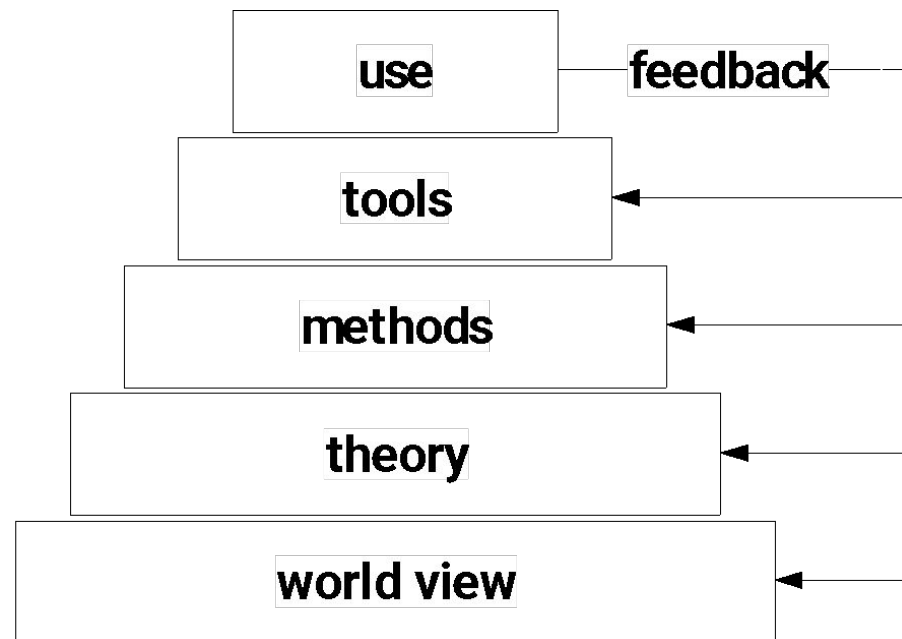
*case studies
application projects*

*CASE tools
implementation environments*

*life-cycle model, process model,
guidelines, elicitation techniques*

*graphical/textual notations
worksheets, document structure*

*model-based knowledge engineering
reuse of knowledge patterns*



World view: Model-Based KE

- The knowledge-engineering space of choices and tools can to some extent be controlled by the introduction of a number of models
- Each model emphasizes certain aspects of the system to be built and abstracts from others.
- Models provide a decomposition of knowledge-engineering tasks: while building one model, the knowledge engineer can temporarily neglect certain other aspects.

CommonKADS principles

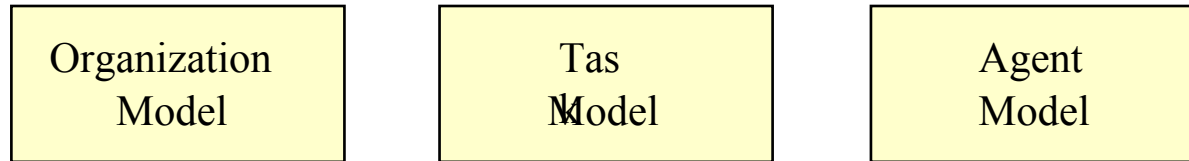
- Knowledge engineering is not some kind of 'mining from the expert's head', but consists of constructing different aspect models of human knowledge
- The knowledge-level principle: in knowledge modeling, first concentrate on the conceptual structure of knowledge, and leave the programming details for later
- Knowledge has a stable internal structure that is analyzable by distinguishing specific knowledge types and roles.

CommonKADS theory

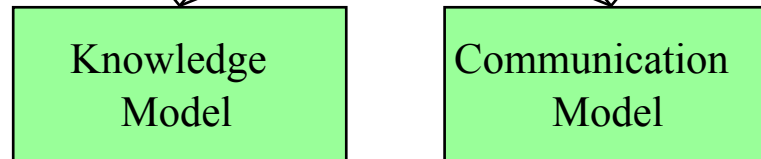
- KBS construction entails the construction of a number of models that together constitute part of the product delivered by the project.
- Supplies the KBS developer with a set of model templates.
- This template structure can be configured, refined and filled during project work.
- The number and level of elaboration of models depends on the specific project context.

CommonKADS Model Set

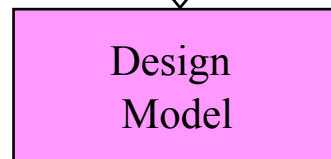
Context



Concept



Artefact



Model Set Overview (1)

- Organization model
 - supports analysis of an organization,
 - Goal: discover problems, opportunities and possible impacts of KBS development.
- Task model
 - describes tasks that are performed or will be performed in the organizational environment
- Agent model
 - describes capabilities, norms, preferences and permissions of agents (agent = executor of task).

Model Set Overview (2)

- Knowledge model
 - gives an implementation-independent description of knowledge involved in a task.
- Communication model
 - models the communicative transactions between agents.
- Design model
 - describes the structure of the system that needs to be constructed.

Principles of the Model Set

- Divide and conquer.
- Configuration of an adequate model set for a specific application.
- Models evolve through well defined states.
- The model set supports project management.
- Model development is driven by project objectives and risk.
- Models can be developed in parallel.

Models exist in various forms

- Model template
 - predefined, fixed structure, can be configured
- Model instance
 - objects manipulated during a project.
- Model versions
 - versions of a model instance can exist.
- Multiple model instances
 - separate instances can be developed
 - example: "current" and "future" organization

The Product

- Instantiated models
 - represent the important aspects of the environment and the delivered knowledge based system.
- Additional documentation
 - information not represented in the filled model templates (e.g. project management information)
- Software

Roles in knowledge-system development

- knowledge provider
- knowledge engineer/analyst
- knowledge system developer
- knowledge user
- project manager
- knowledge manager

N.B. many-to-many relations between roles and people

Knowledge provider/specialist

- “traditional” expert
- person with extensive experience in an application domain
- can provide also plan for domain familiarization
 - “where would you advise a beginner to start?”
- inter-provider differences are common
- need to assure cooperatio

Knowledge engineer

- specific kind of system analyst
- should avoid becoming an "expert"
- plays a liaison function between application domain and system

Knowledge-system developer

- person that implements a knowledge system on a particular target platform
- needs to have general design/implementation expertise
- needs to understand knowledge analysis
 - but only on the “use”-level
- role is often played by knowledge engineer

Knowledge user

- Primary users
 - interact with the prospective system
- Secondary users
 - are affected indirectly by the system
- Level of skill/knowledge is important factor
- May need extensive interacting facilities
 - explanation
- His/her work is often affected by the system
 - consider attitude / active tole

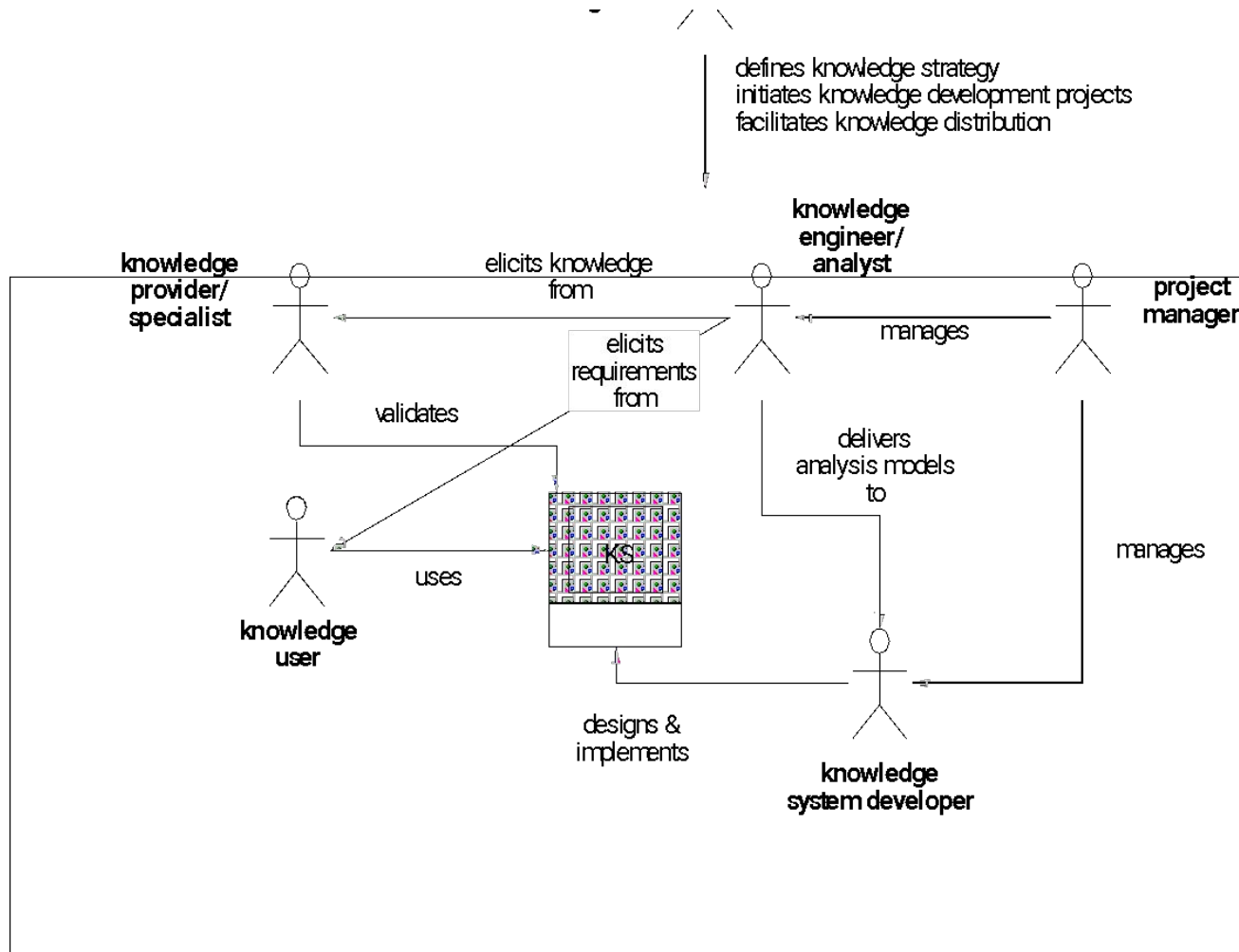
Project manager

- responsible for planning, scheduling and monitoring development work
- liaises with client
- typically medium-size projects (4-6 people)
- profits from structured approach

Knowledge manager

- background role
- monitors organizational purpose of
 - system(s) developed in a project
 - knowledge assets developed/refined
- initiates (follow-up) projects
- should play key role in reuse
- may help in setting up the right project team

Roles in knowledge-system development



Terminology

- Domain
 - some area of interest
banking, food industry, photocopiers, car manufacturing
- Task
 - something that needs to be done by an agent
monitor a process; create a plan; analyze deviant behavior
- Agent
 - the executor of a task in a domain
typically either a human or some software system

Terminology

- Application
 - The context provided by the combination of a task and a domain in which this task is carried out by agents
- Application domain
 - The particular area of interest involved in an application
- Application task
 - The (top-level) task that needs to be performed in a certain application

Terminology

- knowledge system (KS)
 - system that solves a real-life problem using knowledge about the application domain and the application task
- expert system
 - knowledge system that solves a problem which requires a considerable amount of expertise, when solved by humans.