Overview of this lecture

- Introduction to knowledge engineering
- Knowledge-based systems
- Different types of Knowledge representation

Software development: conventional systems and KBS

Standard model of the software development life cycle. It is likely to be something like this:

→ Feasibility study

→ Analysis

→ Requirements definition

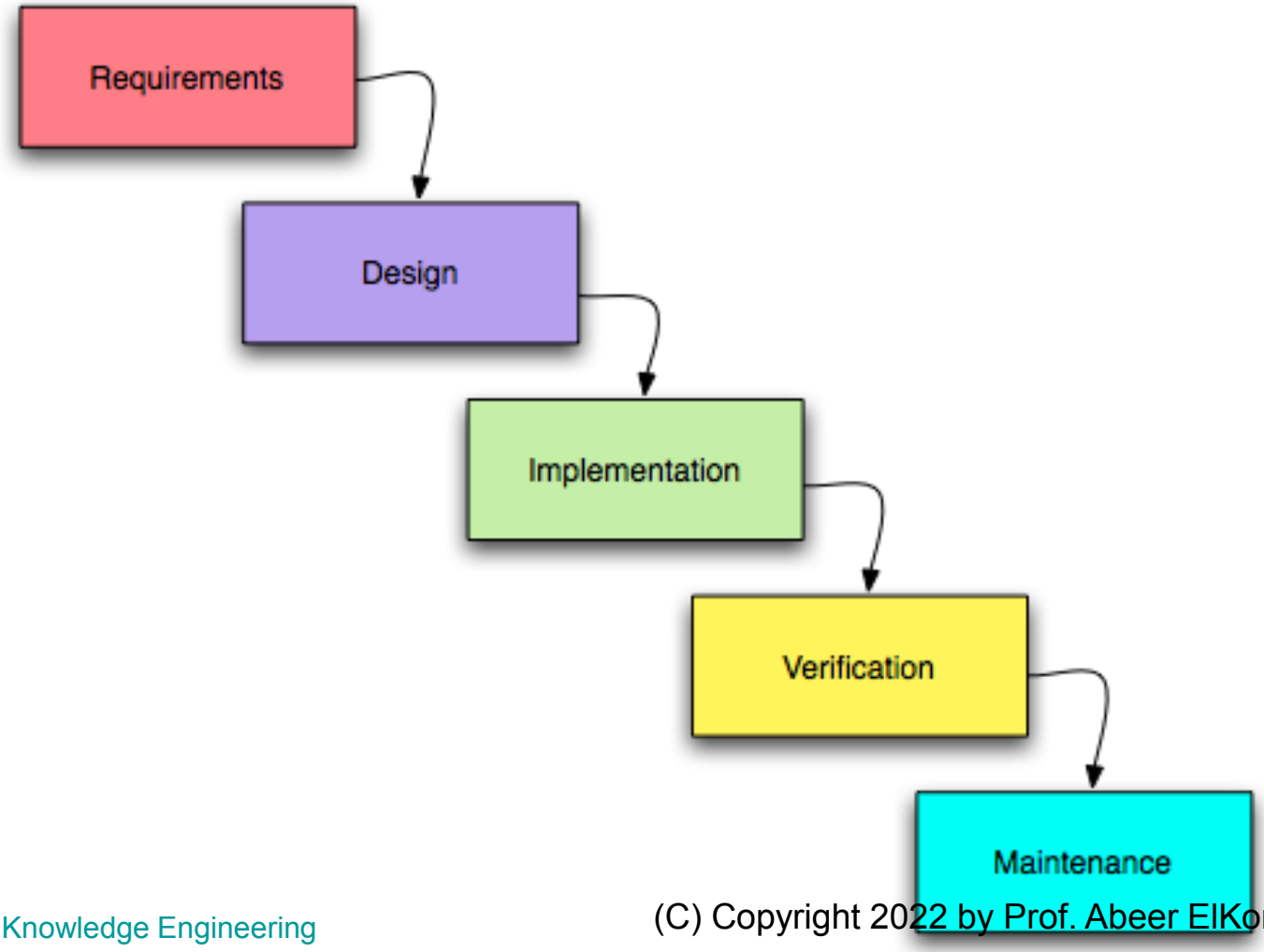
→ Design

→ Implementation

→ Testing

→ Maintenance & review

The software engineering process: waterfall model



Knowledge Engineering

- An engineering discipline that involves integrating knowledge into computer systems in order to solve complex problems normally requiring a high level of human expertise (Feigenbaum and Pamela, 1983)

- It normally involves five distinct steps in transferring human knowledge into some form of knowledge based systems (KBS)

The knowledge engineering process: general methodology

Identify the task

Assemble the relevant knowledge

Decide on a vocabulary of predicates, functions and constants

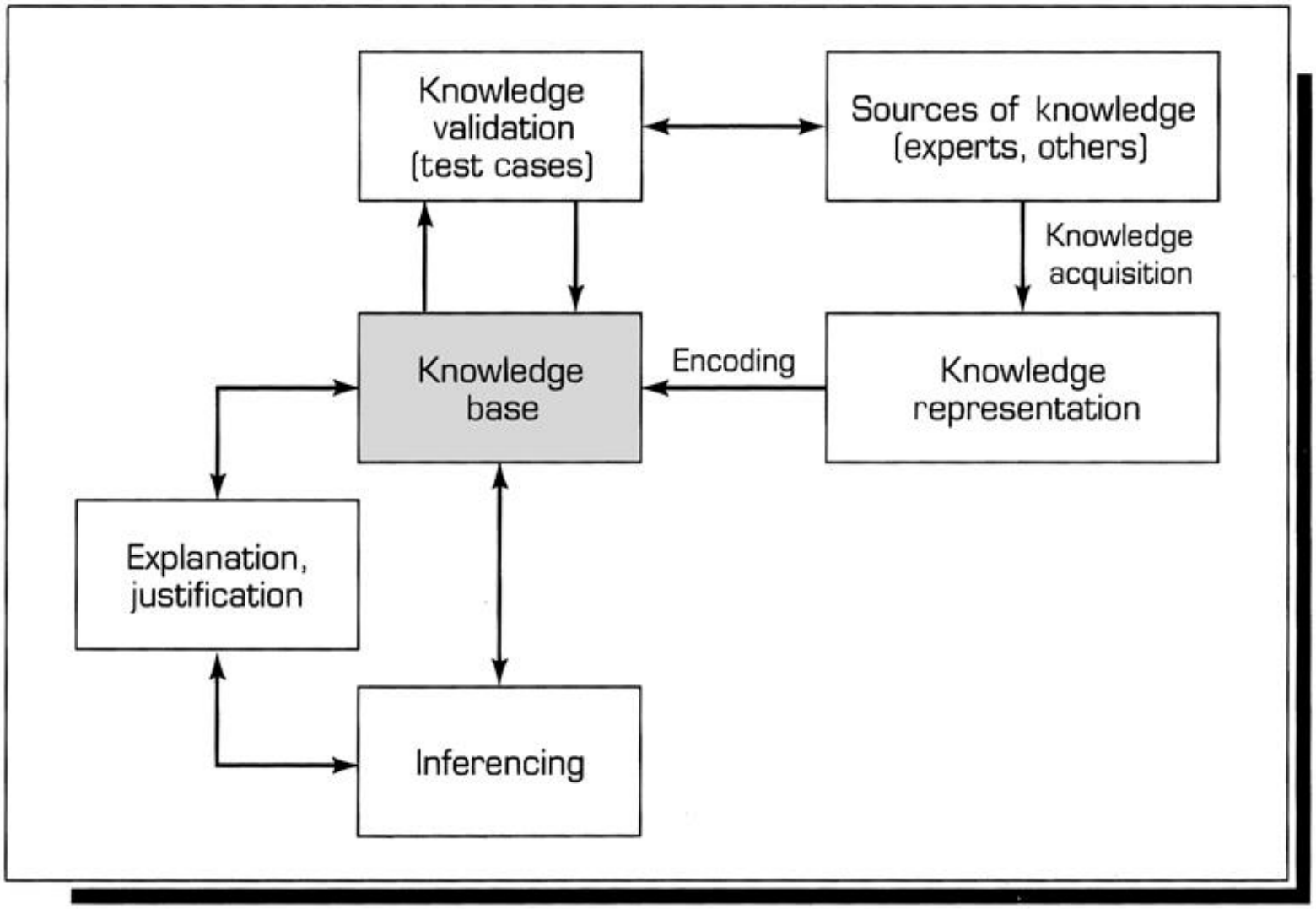
Encode general knowledge about the domain

Encode a description of the specific problem instance

Pose queries to the inference procedure and get answers

Debug the knowledge base

Figure 11.1 Process of Knowledge Engineering



Knowledge Engineering Process

- Acquisition of knowledge
  - General knowledge or metaknowledge
  - From experts, books, documents, sensors, files
- Knowledge representation
  - Organized knowledge
- Knowledge validation and verification
- Inferences
  - Software designed to pass statistical sample data to generalizations
- Explanation and justification capabilities

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
- knowledge system (KS)
  - system that solves a real-life problem using knowledge about the application domain and the application task

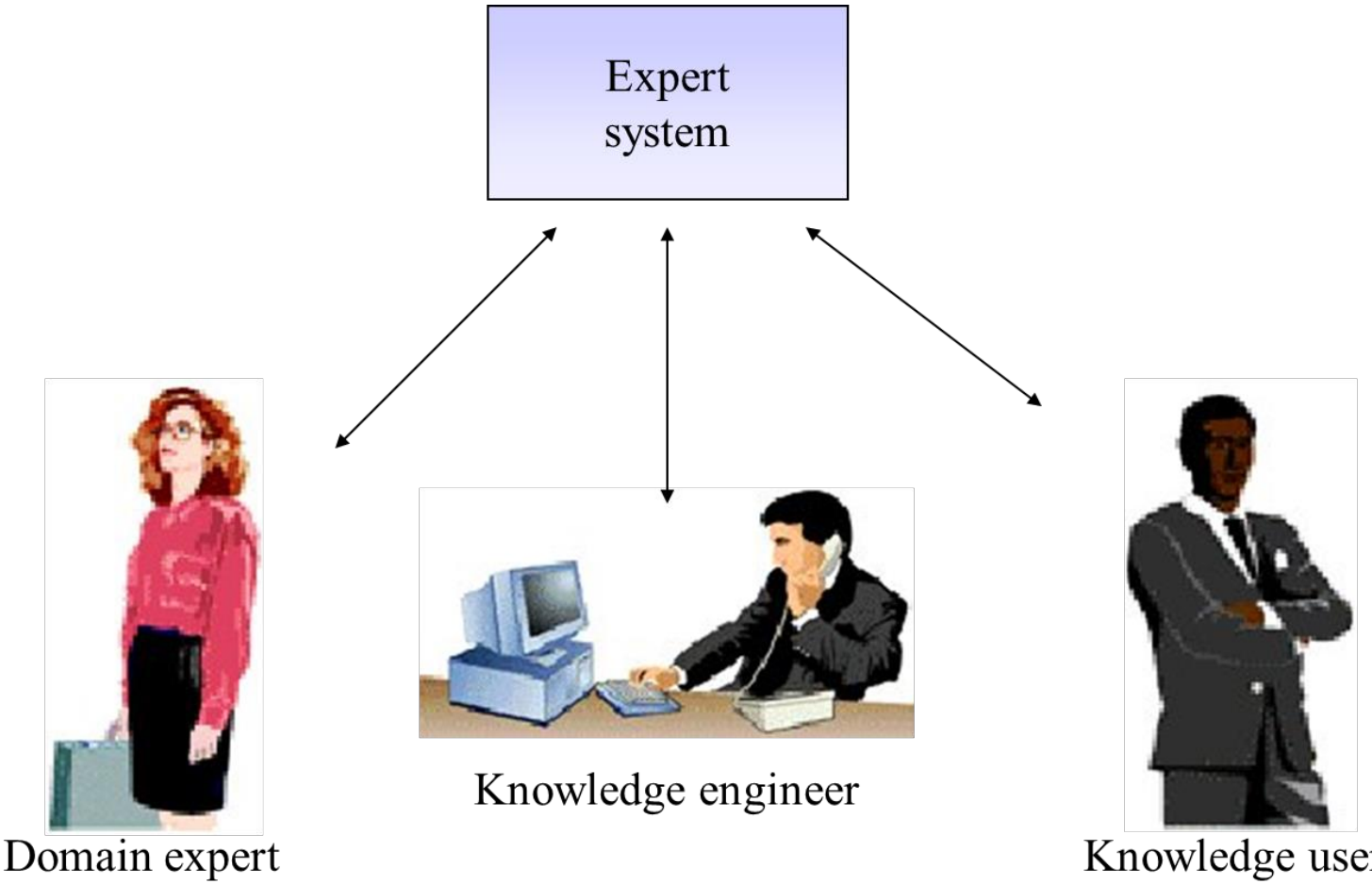
KBS Stockholders

- Domain expert
  - The individual or group whose expertise and knowledge is captured for use in an expert system
- Knowledge user
  - The individual or group who uses and benefits from the expert system
- Knowledge engineer
  - Someone trained or experienced in the design, development, implementation, and maintenance of an expert system

Knowledge engineering

- Knowledge engineering is a process for developing *special-purpose* knowledge bases:
  - whose **domain** is carefully defined
- A knowledge engineer is someone who:
  - Investigates a particular domain
  - Learns what concepts are important in that domain
  - Creates a formal representation of the objects and relations in the domain

Knowledge Engineering



Participants in Expert Systems Development and Use

- Domain expert
  - The individual or group whose expertise and knowledge is captured for use in an expert system
- Knowledge user
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- Knowledge engineer
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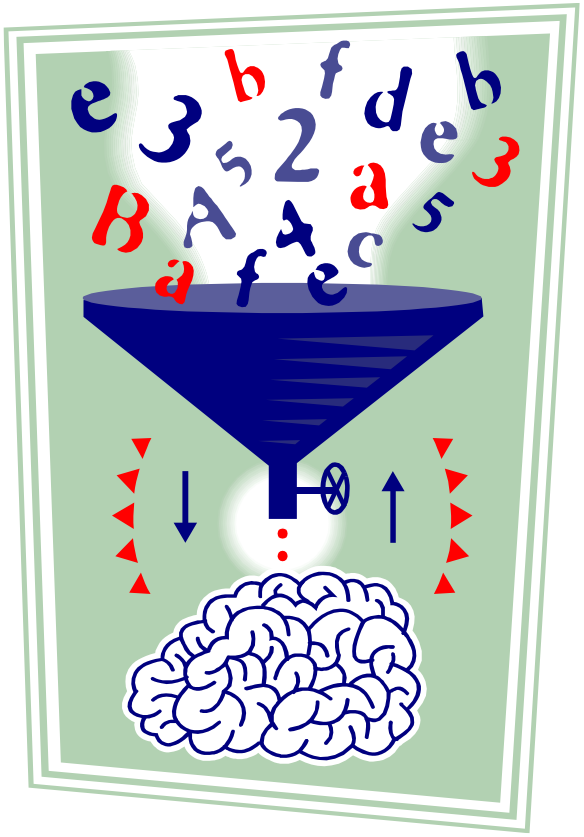
What is Knowledge

- The facts, feelings, or experiences known by a person or group of people.
- Knowledge includes:
  - facts, concepts, procedures, models, heuristics, examples.
- Knowledge may be:
  - specific or general
  - exact or fuzzy
  - procedural or declarative

Data, Information, and Knowledge

- **Data:** Unorganized and unprocessed facts; static; a set of discrete facts about events
- **Information:** Aggregation of data that makes decision making easier
- **Knowledge** is derived from information in the same way information is derived from data; it is a person's range of information

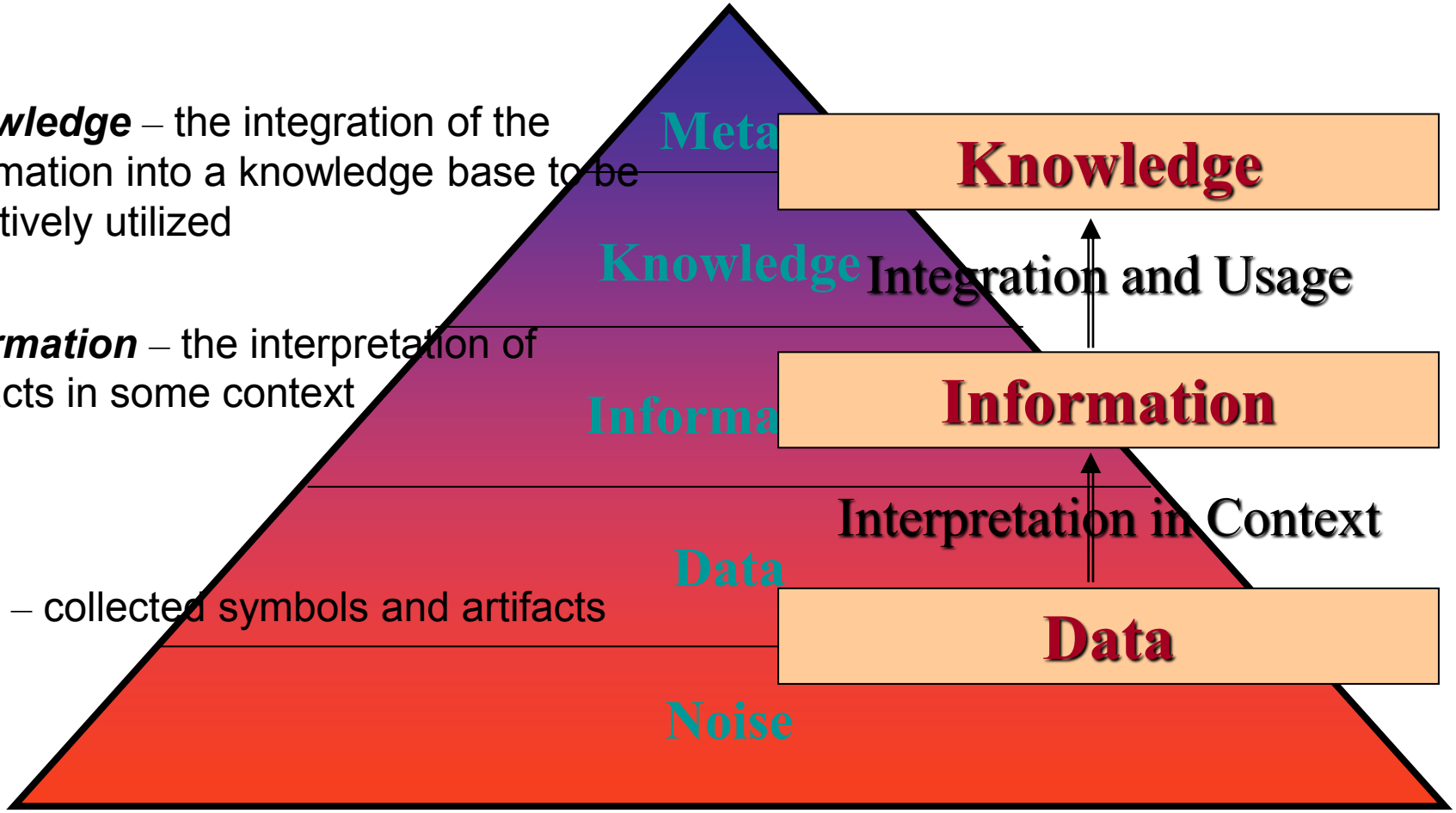


Knowledge Pyramid

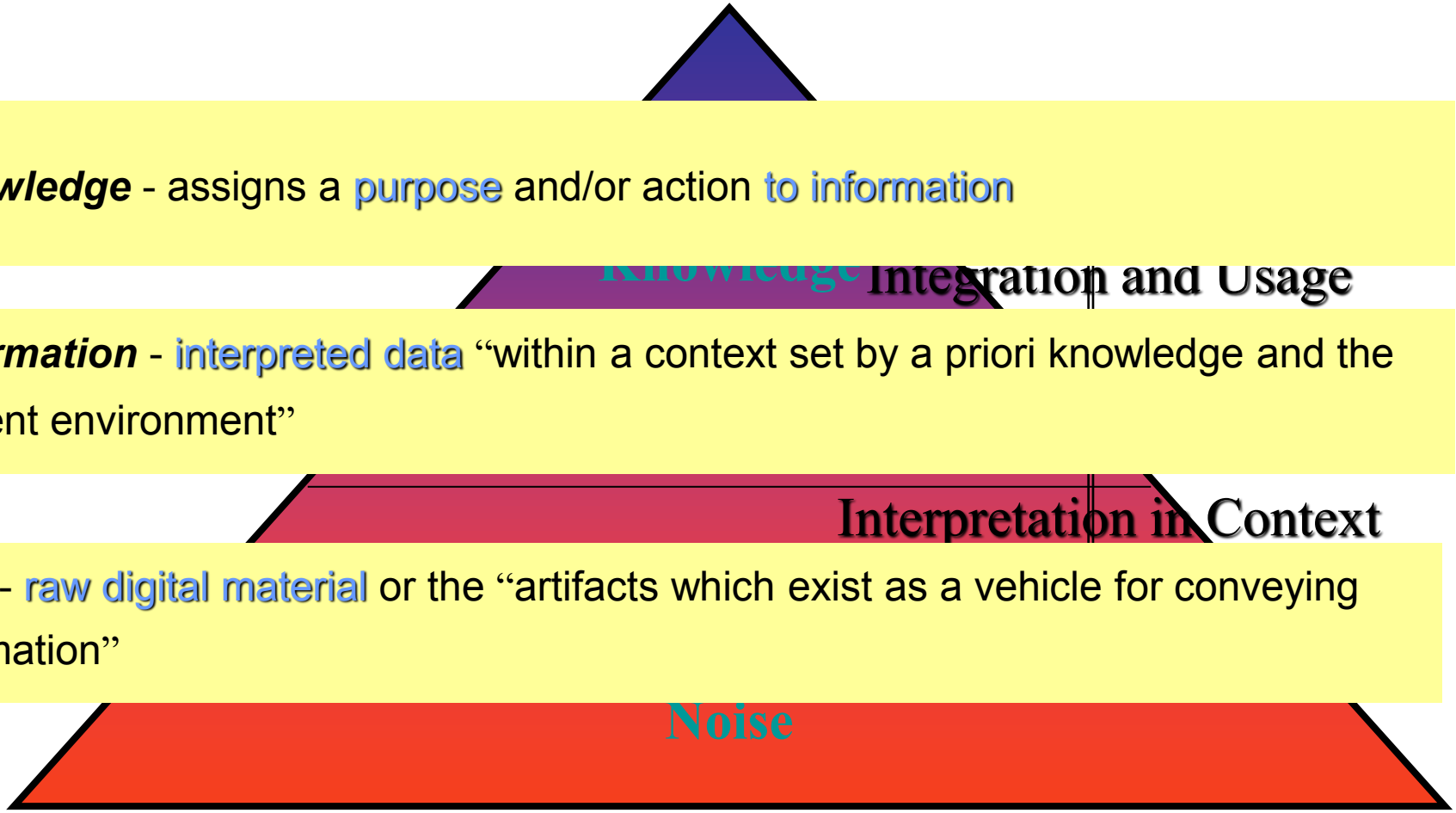
Knowledge – the integration of the information into a knowledge base to be effectively utilized

Information – the interpretation of artifacts in some context

Data – collected symbols and artifacts



Knowledge Pyramid

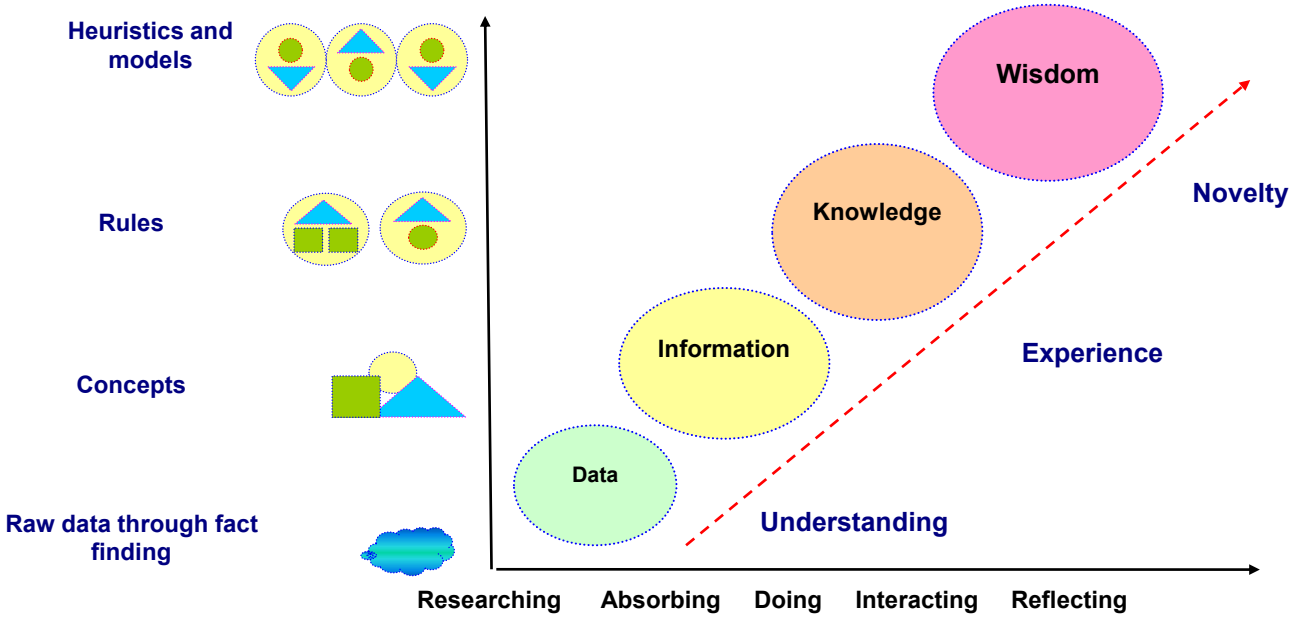


Knowledge - assigns a purpose and/or action to information

Information - interpreted data "within a context set by a priori knowledge and the current environment"

Data - raw digital material or the "artifacts which exist as a vehicle for conveying information"

Data Pyramid and Computer Based Systems



Convergence from data to intelligence

Quiz

- Data/information/knowledge

A. A second language in which you are fluent.

B. The content of a television news program.

C. A close friend.

D. Name of AI instructor

E. A company's annual report.

F. The weather on the other side of the world

Knowledge & KBS

- What is knowledge?
  - Knowledge is the sort of information that people use to solve problems.

- What is a knowledge-based system?
  - A system which is built around a knowledge base. i.e. a collection of knowledge, taken from a human, and stored in such a way that the system can *reason* with it.

KBS is …

- Software system, which ***represents*** (explicit, declarative description of knowledge) and ***uses*** this ***knowledge*** to accomplish a ***task*** within the context of a certain ***application***
- Behaves intelligent
- Automation and reuse of knowledge

Knowledge-based Systems: A definition

- A system that draws upon the knowledge of human experts captured in a knowledge-base to solve problems that normally require human expertise.

  - Heuristic rather than algorithmic
  - Specific domain knowledge

- Knowledge is separated from how it is used

  KBS = knowledge-base + inference engine

KBS Applications

- Medicine
  - diagnosis & solution
  - discovery & analysis
- Geology
  - analysis of data
- Justice
- Scheduling tasks
- Education and Training
- Decision Support Systems
  - less emphasis on autonomy

Main types of KBS:

- Expert systems
- Neural networks.
- Case-based reasoning.
- Genetic algorithms
- Intelligent agents
- Data mining
- Intelligent Tutoring systems.

Taxonomies of Knowledge

Five Types of Knowledge

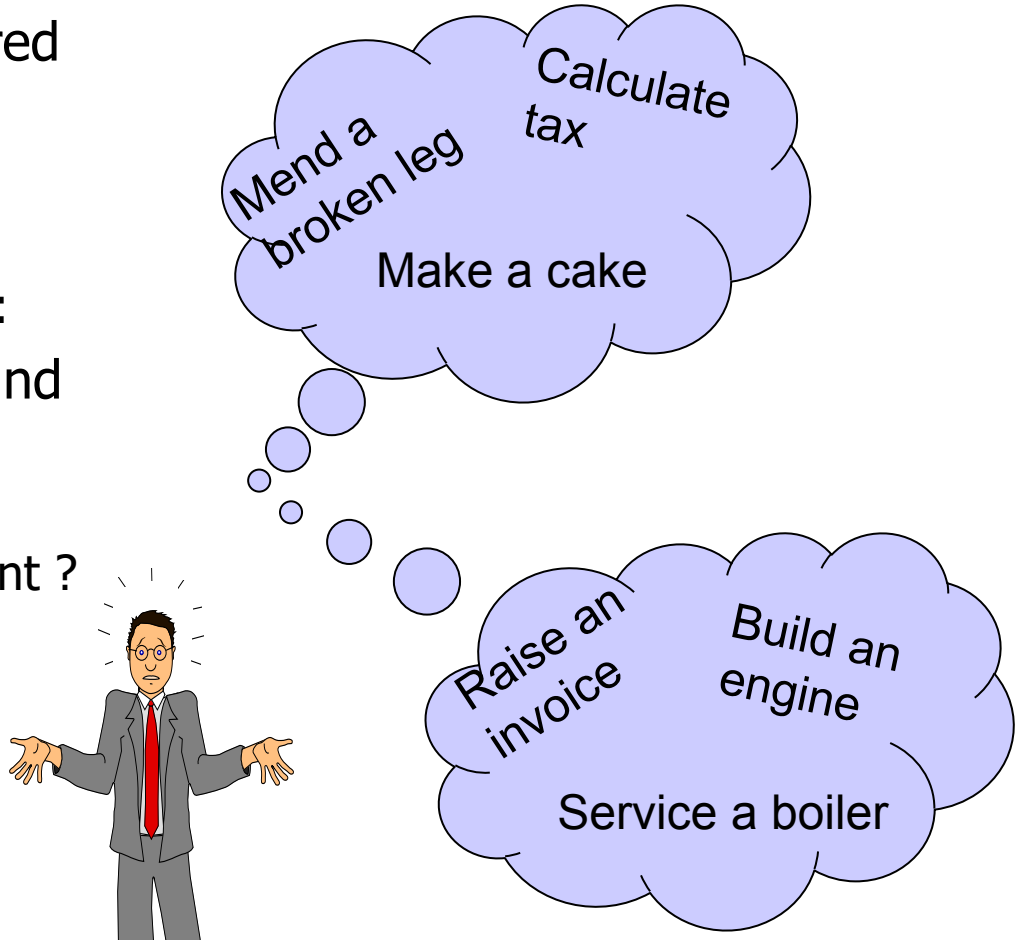
- Declarative knowledge Know-about
- Procedural knowledge Know-how
- Causal knowledge Know-why
- Conditional knowledge Know-when
- Relational knowledge Know-with

 Meta-knowledge

Knowledge about knowledge

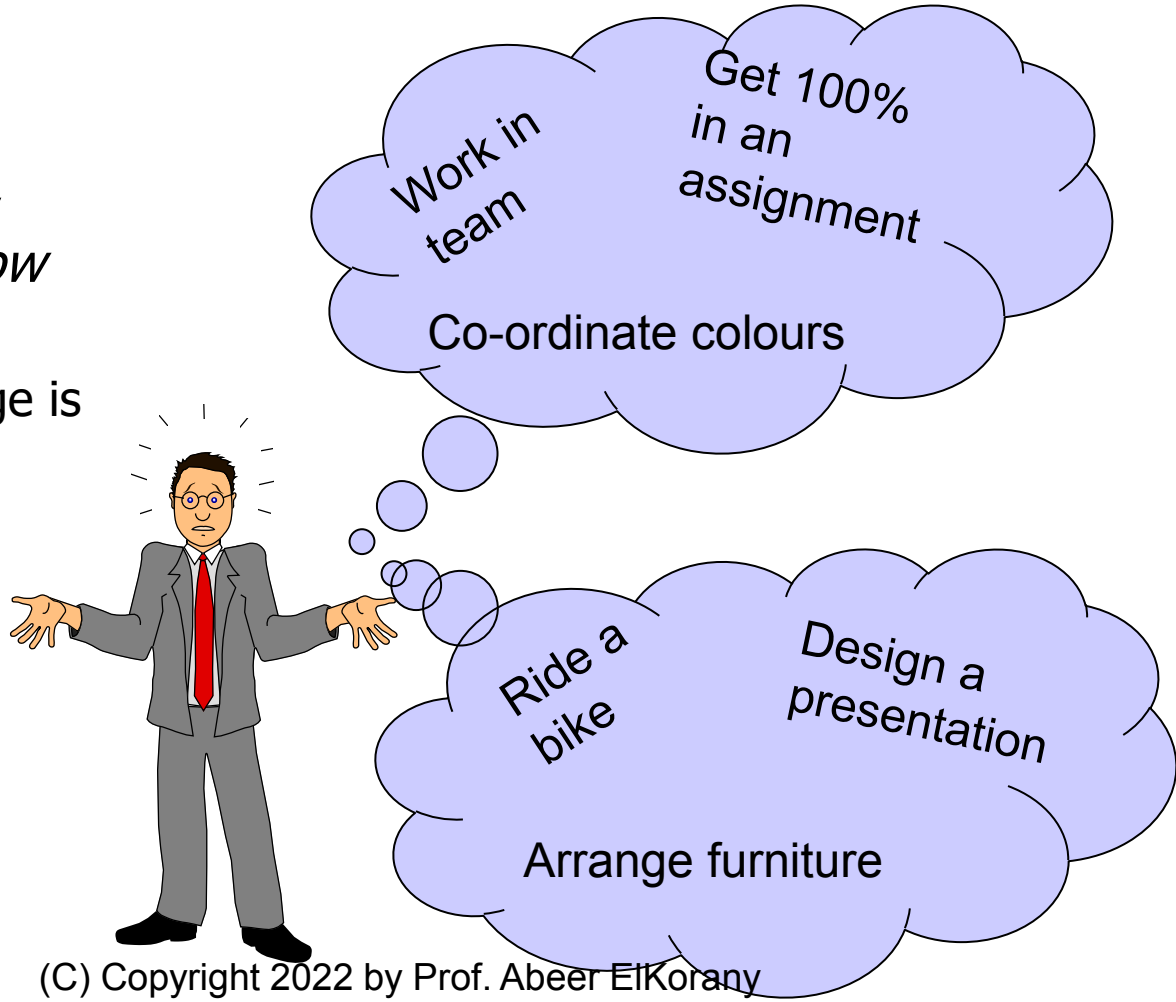
Explicit Knowledge

- Formal and systematic:
  - easily communicated & shared in product specifications, scientific formula or as computer programs;
- Management of explicit knowledge:
  - management of processes and information
- Are the activities to the right information or knowledge dependent ?



Tacit Knowledge Examples

- Highly personal:
  - hard to formalise;
  - difficult (but not impossible)to articulate;
  - often in the form of *know how*.
- Management of tacit knowledge is the management of people:
  - how do you extract and disseminate tacit knowledge.



Learning

- **Learning by experience**:

a function of time and talent

- **Learning by example**:

more efficient than learning by experience (case-based reasoning)

- **Learning by sharing (education)**.
- **Learning by discovery**: explore a problem area.

Problems in knowledge engineering

- Complex information and knowledge is difficult to observe
- Experts and other sources differ
- Multiple representations:
  - textbooks
  - graphical representations
  - heuristics
  - skills