SWE2032 – Knowledge Engineering

Pre requisite: SWE1001

Knowledge Engineering

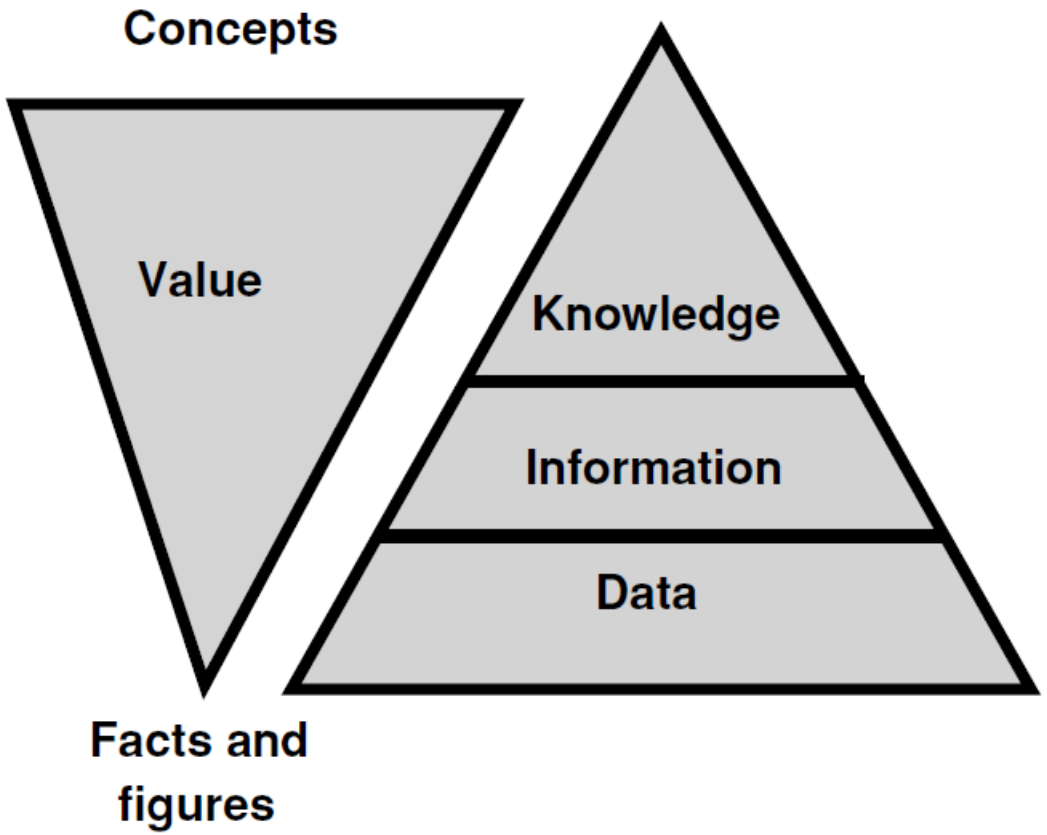
- Knowledge engineering is the process of developing knowledge based systems in any field, whether it be in the public or private sector, in commerce or in industry
- An engineering discipline that involves integrating knowledge into computer systems in order to solve complex problems normally requiring a high level of human expertise (Feigenbaum and Pamela, 1983)
- Knowledge is 'The explicit functional associations between items of information and/or data'
- Data are streams of raw facts representing events.
- Information is data that have been collected and processed into a meaningful form. Simply, information is the meaning we give to accumulated facts (data). Information is data in context

Example

- Temperature and humidity readings are taken from various locations around one city. These readings are taken four times each day, and the results collated in a central location.
- *Data*: Individual temperature and humidity readings, by themselves, are simply numbers, and therefore represent data.
- *Information*: Information on where the readings have been taken (e.g. at which point in the city) and at what time provides a trend to show how the temperature is currently changing. This information can be used by someone to make a decision.
- *Knowledge:* Knowing how the temperature and humidity are changing AND, knowing about how the weather can affect people living or working in the city will allow decisions to be made concerning the use of umbrellas, warm clothing, running a cricket or tennis match, etc. In this situation, two or more sets of information are related and can be processed to reach a decision.

- It is 5◦C—data.
- It is cold—information.
- It is cold outside AND if it is cold you should wear a warm coat—knowledge.
- From a knowledge engineering perspective, it is useful to consider knowledge as something that can be expressed as a rule or useful to assist a decision, i.e.,
- IF it is cold outside THEN wear a warm coat.

Data, Information and Knowledge



Example

It is cold – put on a warm coat.

It is cold outside.

The temperature outside is 5°C

Example 2

- 50 litres (*Data*)—e.g. the amount of petrol your car can hold

- *Information*?

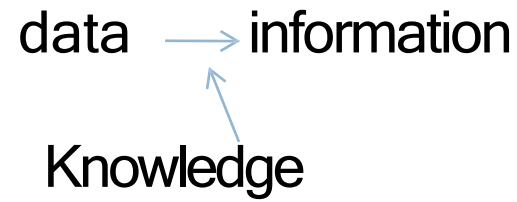
- Information : How many miles you can now travel (say 320 miles)
- Knowledge?

- Knowledge:

Mapping of several places you can visit within a 160 mile radius

Information Processing Views of Knowledge

- Hierarchical view: data → information → knowledge
  - Information is the input or raw material of new knowledge
  - Knowledge is authenticated/personalized information
- Reversed hierarchical view: knowledge → information → data
  - Knowledge must exist before information can be formulated and before data can be collected
- Non-hierarchical view:



  - Knowledge is needed in converting data into information
  - Knowledge is the accumulation of experiences vs. knowledge is created through conjectures and refutations.

Types of Knowledge

- Declarative knowledge tells us facts about things. For example, the statement ‘A light bulb requires electricity to shine’ is factually correct.
- Procedural knowledge provides alternative actions based on the use of facts to obtain knowledge. For example, an individual will normally check the amount of water in a kettle before turning it on; if there is insufficient water in the kettle, then more will be added.
- Meta-knowledge is knowledge about knowledge. It helps us understand how experts use knowledge to make decisions. For example, knowledge about planes and trains might be useful when planning a long journey and knowledge about footpaths and bicycles might be useful when planning a short journey.

Taxonomies of Knowledge

- Tacit vs. explicit
  - Explicit knowledge refers to knowledge that is transmittable in formal, systematic language
  - Tacit knowledge is deeply rooted in actions, experience, and involvement in a specific context. It consists of cognitive element (mental models) and technical element (know-how and skills applicable to specific work).
- Individual vs. social
  - Individual knowledge is created by and exists in the individual whereas social knowledge is created by and exists in the collective actions of a group.

Four Modes of Knowledge Conversion (Nonaka 1994)

From \ *To*	Tacit knowledge	Explicit knowledge
Tacit knowledge	Socialization	Externalization
Explicit knowledge	Internalization	Combination

Knowledge Processes

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

- Knowledge acquisition
- Knowledge validation
- Knowledge representation
- Inferencing
- Explanation and justification

- *Knowledge acquisition* involves obtaining knowledge from various sources including human experts, books, videos and existing computer sources of data such as databases and the Internet.
- In *knowledge validation*, knowledge is checked using test cases for adequate quality.
- *Knowledge representation* involves producing a map of the knowledge and then encoding this knowledge into the knowledge base.
- *Inferencing* means forming links (or inferences) in the knowledge in the computer software so that the KBS can make a decision or provide advice to the user.
- *Explanation and justification* involves additional computer program design, primarily to help the computer answer questions posed by the user and also to show how a conclusion was reached using knowledge in the knowledge base.

Two Main Views of Knowledge Engineering

- Transfer view – This is the traditional view. In this view, the key idea is to apply conventional knowledge engineering techniques to transfer human knowledge into the computerized system.
- Modeling view – In this view, the knowledge engineer attempts to model the knowledge and problem solving techniques of the domain expert into the computerized system.

Knowledge Engineering (KE) vs Knowledge Management (KM)

- KE is primarily concerned with constructing a knowledge-bases system while KM is primarily concerned with identifying and leveraging knowledge to the organization's benefit.
- KE and KM activities are inherently interrelated.
- Knowledge engineers are interested in what technologies are needed to meet the enterprise's KM needs.

Knowledge Engineer

- A knowledge engineer is responsible for obtaining knowledge from human experts and then entering this knowledge into some form of KBS.

Knowledge engineer will have to:

- acquire the knowledge from the expert to be used in the system
- use an appropriate method for representing knowledge in a symbolic, processable form.

- To begin with, a knowledge engineer must extract knowledge from people (human experts) that can be placed into knowledge based systems (KBSs).
- This knowledge must then be represented in some format that is understandable both to the knowledge engineer, the human expert and the programmer of the KBS.
- A computer program, which processes that knowledge or makes inferences, must be developed, and the software system that is being produced must be validated.
- The knowledge engineer may be involved in the development of the program, or this may be delegated to another person.
- In developing these systems the knowledge engineer must apply methods, use tools, apply quality control and standards.
- To undertake these activities, the knowledge engineer must plan and manage projects, and take into account human, financial and environmental constraints.

Skills required for Knowledge Engineer

- Knowledge representation
- Fact finding
- Human skills
- Visualisation skills
- Analysis
- Creativity
- Managerial

Knowledge representation	Being able to understand the information being provided by the expert and record this in some appropriate manner
Fact finding	Using tools such as interviews, questionnaires and observations to obtain knowledge from an expert
Human skills	Interviewing skill including how to acquire knowledge from an expert in a friendly and helpful manner
Visualisation skills	Being able to visualise the overall design of the system, prior to committing the ideas to paper
Analysis	Working through data and information to find the most appropriate method of representing it, and identifying links within the data and information
Creativity	Using new ideas or methods of representing data within the structure of the KBS
Managerial	Having good time management and delegation skills to help ensure that the data is recorded on time and within budget