Lecture 1: Data, Information and Knowledge

Dr. Roman V Belavkin

BIS4410

Contents

1 Introduction to KM

Defining Knowledge

Definition 1 (Knowledge)**.** Justified *true* belief. Can be justified by facts (Nonaka & Takeuchi, 1995).

Definition 2 (Knowledge)**.** Information in *context*. Coherent with a larger system (rational) and can be useful in decision-making and problem solving (pragmatic).

Definition 3 (Knowledge)**.** *Understanding* based on experience.

Definition 4 (Knowledge)**.** *Capacity* for effective action.

Human Knowledge

- Human knowledge is encoded and communicated in a *natural language* (e.g. English, Chinese).

  Example 5. Shark is a dangerous fish. Fish live in water. They swim and breath using gills. Fish are animals. Other animals are birds, such as canary and ostrich. Birds have wings.

- Knowledge helps us to solve problems (e.g. finding food, avoid danger).

Question 1. *Is it possible to communicate knowledge to a computer? How should knowledge be represented?*

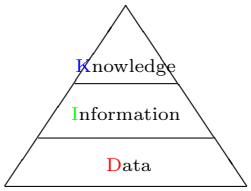
Knowledge Economy

- More than 50% of the cost of extracting oil is gathering, processing of data and information (Stewart, 1997).
- Knowledge-based service has been responsible for 65%–70% of the total added value of products in manufacturing industries (Quinn, 1992).
- Intellectual capital (IC) constitutes more than 70% of the total balance sheet of companies.
- Knowledge is a key enterprise resource.
- Knowledge management (KM), knowledge engineering (KE).

2 Knowledge Synthesis

Knowledge Synthesis

Question 2. *Where does knowledge come from?*

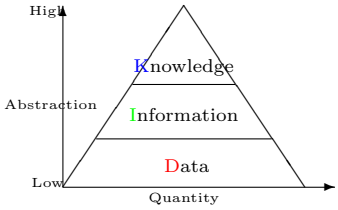


Data — measurements or records about events (prices, temperature, etc). Data can be numerical, alphabetical, images, sounds, etc.

Information — analysed and organised data such that we know its characteristics (average, range, variance, distributions, clusters, etc).

Knowledge — information put into a specific context (e.g. distribution of oil prices, a map of London, etc).

Quantity and Abstraction



- Data, Information and Knowledge can be classified by levels of abstraction and quantity.

- Knowledge is the most abstract and exists in the smallest quantity.
- Knowledge itself can have levels of abstraction: concrete (knowledge about the specific problem), domain specific (class of problems) and abstract (many classes of problems).

Explicit and Tacit Knowledge

Definition 6 (Tacit ('Background') knowledge)**.** Knowledge that cannot be expressed or described explicitly by those who possess it.

Definition 7 (Explicit knowledge)**.** Beliefs that can be expressed or communicated (e.g. using natural language).

Remark 1.
- *Some tacit knowledge can be made explicit (Polanyi, 1958; 1966).*
- *Some define implicit knowledge as the complement of knowledge that can be made explicit.*

Declarative and Procedural Knowledge

Cognitive scientists distinguish between two types of knowledge:

Declarative : these are propositions or facts describing the current state of the problem (e.g. which facts are known to be true).

Procedural : these are logical rules (implications $a \Rightarrow b$):

$$\text{IF} \quad \textit{condition} \quad \text{THEN} \quad \textit{action}$$

The rules are used to change a problem state (e.g. by inferring new facts). The IF part is called the *left-hand-side* (or the *antecedent*, *premise*). The THEN part is called the *right-hand-side* (or the *consequent*).

Remark 2. *Evidence suggests that these types of knowledge are encoded in different parts of the brain or even use different mechanisms. Procedural knowledge is usually difficult to describe, but also harder to forget.*

Encoding and Decoding Analogy

- Let X be the set of *signals*, and let Y be the set of *codes*.
- A process (a rule) $\kappa : x \mapsto \kappa(x) = y$ of mapping signals into codes is called *encoding*.
- The reverse process is called *decoding*:

$$\kappa^{-1}(y) = \{x : \kappa(x) = y\}$$

That is, decoding of code (or symbol) y is the set if all signals x, which can be encoded by it.

- If a code is not uniquely decodable, then decoding y can be ambiguous.
- Knowledge can be thought of as a process of encoding experiences.

The Knowledge Management Cycle

- Identify
- Plan
- Acquire / develop
- Distribute
- Foster use
- Control / maintain
- Dispose

D.I.K. Reading

- Chaim Zins (2007). Conceptual Approaches for Defining Data, Information, and Knowledge. Journal of the American Society for Information Science and Technology, 58(4):479493.
- Max Boisot & Agustí Canals (2004). Data, information and knowledge: have we got it right? J Evol Econ (2004) 14: 4367
- Hans Müller & Christiaan Maasdorp (2011). The data, information, and knowledge hierarchy and its ability to convince. Research Challenges in Information Science (RCIS).
- Andreas Nürnberger, Rudolf Seising, Constanze Wenzel (2009). On the Fuzzy Interrelationships of Data, Information, Knowledge and Wisdom. The 28th North American Fuzzy Information Processing Society Annual Conference (NAFIPS2009) Cincinnati, Ohio, USA - June 14 - 17, 2009

References

Firestone, J. M., & McElroy, M. W. (2003). *Key issues in the new knowledge management*. KMCI Press.

McElroy, M. W. (2003). *The new knowledge management: complexity, learning, and sustainable innovation*. KMCI Press.

Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company: How japanese companies create the dynamics of innovation*. Oxford University Press.

Passin, T. B. (2004). *Explorer's guide to the semantic Web*. Manning.

Schreiber, G., Hoog, R. de, Akkermans, H., Anjewierden, A., Shadbolt, N., Velde, W. V. de, et al. (1999). *Knowledge engineering and management: The CommonKADS methodology.* The MIT Press.