Knowledge Management and Information Systems

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INTRODUCTION

Information systems (IS) and management of knowledge are often discussed either as separate entities or alternatively as analogies. But what is the gap between information processed with IS and human information or knowledge? Is the gap insurmountable, or can the subspecies be analysed and selected, so that section of these two sets will be found or so that the union of information and knowledge complete each other?

IS and users share information, which is why it is in this context more important than data, as the basis for systems, but human knowledge is the final aim. As a background there is a philosophical classification of knowledge. Positivism, post-positivism and critical theory are briefly presented. This presentation is assuming constructivism as the most appropriate viewpoint to knowledge.

There are various species of information, which are analysed more deeply. ICT consists of information processing and communication technologies. From philosophy, there can be the same main streams found. Information theory gives us quantitative classes based on probability. Semantics leads us to qualitative information categories.

Information and communication theory live along with systems theory. Systems analysis is an engineering discipline based on this theory of the nature of systems. This analysis framework for studying and modifying the world is used for the examples about engineering, that are mainly from a project WISE - Web-enabled Information Services for Engineering. WISE is concerned with knowledge management (KM) in participatory design processes of complex products, putting the engineer in the centre of the overall picture. Main objective of the project is not on developing new specific KM tools and methods but rather to integrate and exploit existing state-of-the art approaches oriented towards the needs of industrial users. This research project will prototype a meta-system for different kinds of information sources. In this context, WISE can be an example to show what findings are observed from engineering knowledge.

INFORMATION AND KNOWLEDGE

Most definitions of KM share the perspective of collection and dissemination of knowledge to benefit organisation and its individuals. Typically knowledge is defined like ‘information that is relevant, actionable, and based at least partially on experience’. We must take a look at paradigms of philosophy and species of information to find out what is meaningful for KM.

Paradigms from Philosophy

The paradigms from philosophy can be distinguished by ontology, which (in philosophy) concerns beliefs about the form and nature of reality, and epistemology, which concerns the nature of knowledge and the relationship between those who know and knowing. Four main paradigms are 1) positivism, 2) post-positivism, 3) critical theory with a) postmodernism and b) post-structuralism, and 4) constructivism.

For *positivistic* ontology the reality can be apprehended, and there are observer independent data as facts. The positivistic epistemology is based on objectivity, a possibility to find universal truths.

Positivism is a simple belief in science in Western industrial history. The results are mechanistic science extended to behaviourism in psychology and naïve systemic thinking.

Post-positivistic ontology finds an objective reality that is apprehended imperfectly and probabilistically. The epistemology is confessing that only an approximate image of reality is possible. As an "engineering view" the observers can have their own perspective that can influence the way they see things. Observers have consciousness that (in extension to simple behaviourism) is seen to be a set of engineering processes converting information acquired as observation from "outside" into information implemented. People can be better or worse at this engineering process, and at least fuzzy optimisation becomes relevant. Mind is biased machine, reality is actually out there, and knowledge is objective.

The *critical theory* is based on the ontology that reality is virtual. Social, political, economic, ethnic, and other factors shape reality. The epistemology is subjectivist. Findings are value laden with respect to the worldview of an inquirer. Inquiry is value determined in both postmodernism and post-structuralism.

This presentation is on the level of *constructivism*, according to which there exists both local and specifically constructed realities. Ontology says that reality is relative phenomenon, and epistemological knowledge is created in interaction between inquirers and its participants in a situation. Subjectivist epistemology relates to created findings.

There are no observers, only viewers. Views, like behaviours are derived from worldview. Interaction of different worldviews occurs through a semantic communication process or interaction occurs in a framework, "lifeworld". *Cognitive* oriented constructivist theories emphasize the exploration and discovery on the part of each learner as explaining the learning process. Knowledge is still very much a symbolic, mental representation in the mind of the individual. In *socially* oriented theory the context is part of the knowledge. Knowledge is based on experience through worldviews, which are relative to the institutions that one is attached to in a given society, and they change as the institutional realities change.

Knowledge is not explicit. To derive knowledge from information means that much of knowledge is based on sensory or perceptual experience (a posteriori) but such knowledge can be used to understand new things (a priori). Knowledge by acquaintance is based on experience, but we can also recognise things without sensual experiences, which leads to a distinction between *direct* and *indirect* knowledge. Propositional knowledge tells us that earth goes around the sun and one plus one is two.

What then is explicit? Even IS functions, such as search, retrieval and filtering are effective as long as they are processing data. They are working when applied to appropriate tasks, such as sorting, comparing, or visualising data, but their capabilities are rather limited when applied to processing of any interpretation. The interpretation of information is always constructivist.

Information Species based on Probability

As the data, information and knowledge are separated, the middle layer remains crucial. The ***probability interpretation*** of information is giving us three categories of *physical*, *syntactic* and *semantic* information.

Physical information is the orientation degree of systems, opposite to entropy. It is the common denominator that can bring matter, energy and time into a single, unified framework of analysis. All matter-energy transformations are change of state information. Animate and inanimate objects - information condensations of matter-energy, e.g. DNA, atom, galaxy - are including the more information the more complicated they are. Actually, it’s impossible to say confidently of anything

that it could not be information. Physical information can further be classified as natural and man-made artefacts.

Syntactic information is attached to communication in any channel where messages are sent and received using some notation system. The amount of information is depending from the rarity of each notation string. The theory of syntax is very close to the statistical-mathematical information theory. However, when someone is creating or utilising syntactic information, there is always interpretation – even with completely automatic IS.

Semantics is the branch of semiotics, the philosophy of signs that deals with meaning. The other two branches are syntax and pragmatics. It's basically the study of the relationship between what an object is representing, and the object itself. *Semantic information* is attached to declarative sentences about states of affairs that have a linguistic meaning. Information is therefore eliminating ambivalence. The probability of a sentence is inversely proportional to its information. That is because information is the amount of ambivalence, which disappears when we get to know that the sentence is true. Pragmatic information, however, belong to qualitative interpretation.

Information Species based on Qualitative Interpretation

Qualitative interpretation consists of *1) communication*, 2) *presentation* and 3) *information processing* interpretations that are giving us species of *pragmatic (expressive and knowledge-related) epistemic, doxastic, modal, data-derived* and *meta* information.

All propositional knowledge is derived from causal connections. Causalities are retrospective (there has been this causality before) or prospective (this causality can be seen coming). Linked with truth-values there is a justification condition.

Pragmatic information is build into proposition and justification. It is related to the significance of information to the person receiving it in a particular situation. For communication it is the most important category. When converting it to an IS, it must be noted that pragmatic information is including together with the actual sentence the constructivist state of the surrounding world excluded from the sentence.

For IS, another aspect of pragmatic information emerges above others: novelty or newness. It is a crucial component when measuring value of information. Three kinds of novelty can be listed: 1) the amount of how meaningful or surprising the information is for the recipient, 2) the utility value of information, and 3) the exchange value for information sharing, i.e. how much others (co-workers) respect that information. Most of the characteristics of pragmatic information are describing the value, e.g. relevancy, accuracy, reliability, validity, readability and topicality.

Expressive information is covering assumptions, intuitions, beliefs, moods and non-linguistic expressions, like sounds, pictures and artefacts. Belief is regarded as a way of reducing doubt and uncertainty. Expressive information is obvious for engineering: 'this working method is good', or 'you must do this next'. Also questions, exclamations, advice, requests or orders that have not got any truth-value are belonging to expressive information. But *knowledge-related* expressive information has always got a truth-value.

An expression can be a communicated as verbal, aural, visual, based on sense of touch, or based on artefacts. *Presentation* is also important for IS. Common knowledge and scientific information are both platonic (*epistemic*) information. It has got a truth-value, but knowing the value is not a required. The truth-value of scientific information is heterogeneous; there are e.g. realist and instrumentalist view of science, as well as relativists and objectivist.

Truth-value and evidence are requirements for epistemic information. When there is a truth-value, but no evidence, we are talking about *doxastic* information, which is pertaining to belief, or to states sufficiently like beliefs (thoughts, judgments, opinions, desires, wishes, fears). We may know that something is so, and we may also believe that something is so. Believing may be based on facts, opinion or both, and may be true, erroneous or both.

Something may be true but we may not believe it, and we may believe something that isn't true. Beliefs, suppositions and hypotheses, have not necessarily got a truth-value. This kind of expressive information is named as *modal information*. In the modal information category there are absolute values or norms, commands, questions etc.

For IS the most obvious is *data* and datalogical or *data-derived* information. Raw data is converting to data-derived information when processed. This is traditionally divided into *procedural* information, which is a series of instructions following a specific algorithm or heuristics, whereas *declarative* information is passive, non-algorithmic description of world in a symbolic and explicit format. Data is finally *numerical*.

Meta-information management is nowadays a crucial component of organisational system strategy. It can be further divided to system-specific meta-information and data-specific information. The system information is about the media where the data is stored and retrieved, while the data-specific information is solely data about data.

All information categorisation is based on the same procedure where human notice patterns from environment, and, when the perception of these patterns leads to the interpretation of new information in the context of previous knowledge, the meaning occurs. This notion of dynamic meaning is an important aspect for ICT. There are many other issues of human knowledge not written here, such as the question of understanding and tacit knowledge.

DISCUSSION

ISs and KM are mainly based on other than constructivist philosophy. Tightly rationalistic KM is epistemologically impoverished, seemingly oblivious to the thousands years of vigorous and not concluded debate about the nature of human knowledge. Awareness of this is especially important when discussing about ISs *for* KM.

The syntactic, pragmatic and data-derived information species are useful for conceptual clarification of ICT. Information species based on probability are considered wrongly more crucial, although human interpretation is always needed for knowledge. ISs are representing something, and probabilities will be misleading without proper interpretation.

A categorisation of information is a presupposition for working IS. Usually KM systems are suffering from the information overload lacking the utility value. Best practices and lessons learned are working only with knowing the interpretation based on information species. It is often experienced error to deliver irrelevant data as a repetition.

The dynamic nature of new information is a big challenge for ISs. Human knowledge and information needs are dynamic. They are changing when new information is found. Moreover, knowledge is attached to person, it requires commitment, and is difficult to detach from the person. Knowledge is constructed both individually and socially.

Processes, like search and retrieval are working only in well-defined situations. Search engines are depending from the context or otherwise the results are mostly irrelevant. Information overload is not an absolute phenomenon. Knowledge-base expert systems and information filtering are good

examples in engineering, but even there we need user profiles for different users and their roles. Also other organisational processes like knowledge acquisition, retention and maintenance should be viewed through information species and context.

Discussion about ISs and KM continually follows the rationalistic paradigm. Human thinking with practical and strategic skills and the ability to learn are far from the knowledge model of ISs. KM systems are efficient and effective only when used right. IS content shall not be perceived as a substitute for human knowledge. Knowledge and information should not be managed in similar manners.

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