Chapter 14

Knowledge translation and innovation using adaptive informatics

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14.1 Introduction

Knowledge translation can be defined as the process of supporting the uptake of research in a manner that improves the practices in the society and in industries through improved understanding, processes, services, products or systems. The term knowledge translation is used rather widely in health care: knowledge translation activities include: (1) research into the mechanisms of knowledge translation, and (2) evidence-based translation of knowledge (e.g., knowledge dissemination, technology transfer, knowledge management, knowledge utilization, synthesis of research results within a local or global context, development and application of consensus guidelines). Knowledge translation in any discipline requires a reciprocal relationship between research and practice. The goals of knowledge translation are to enhance competitiveness, innovation and quality of services and products. Adaptive informatics can provide tools for supporting knowledge translation and innovation.

14.2 Statistical machine learning systems as traveling computational models

In collaboration with the department of philosophy at University of Helsinki, we have considered statistical machine learning models from a more general level focusing on the question on what can be said about them as scientific methods and tools. This question has strategic interest when the use of these model is considered. Within science and technology studies, Dr. Tarja Knuuttila has for some time conducted research on studying scientific models as epistemic artifacts. Earlier her interest has focused on explicit models in computational linguistics such as parsers. Traditional linguistic models can be considered to be first-order models of language. Unsupervised learning methods, on the other hand, can be called second-order models: They do not model the phenomenon directly but through a process of emergence. In the following, the collaboration work is described more in detail based on [4] (see also [3]). We focus on neural network models and specifically on the Self-Organizing Map (SOM) [2]. The discussion, however, applies basically to any unsupervised statistical machine learning method.

Traditionally, it has been thought that models are primarily models of some target systems, since they represent partially or completely the target systems. Sometimes computational models not only have various roles within a scientific domain, but also travel across scientific disciplines. A travelling computational template is a computational method that has a variety of applications in different scientific domains [1]. Neural networks are good examples of such traveling templates. Initially, most of them were inspired by the idea of looking at brains as a model of a parallel computational device, but nowadays neural networks are applied in several different scientific domains, not all of which belong to the domain or neuroscience.

That a model can have so many and various applications, raises opinion some significant philosophical issues concerning the nature of models and how they give us knowledge. Both questions have been answered by philosophers of science by reverting to representation. On one hand models are considered to be representations, on the other hand they are thought to give us knowledge because they represent.

In the recent research in the philosophy of science it has been shown that neither isomorphism nor similarity can provide an adequate analysis of scientific representation. They lead to well-known problems. Firstly, the isomorphism view in fact assumes that there is no such thing as false representation, either the model and its target system are isomorphic, or then they are not, in which case there is no representation either. Secondly, both isomorphism and similarity are symmetric relations, which runs counter our intuitions about representation: we want a model to represent its target system but not vice versa. Both problems appear to be solved once the pragmatic aspects of representation are taken into account. The users' intentions create the directionality needed to establish a representative relationship; something is being used and/or interpreted as a model of something else. Taking into account human agency introduces also indeterminateness into the representative relationship: human beings as representers are fallible. Consequently, pragmatic approaches to representation solve many problems of the structuralist notion of representation-but this comes with a price. When representation is grounded primarily on the specific goals and representing activity of humans as opposed to the respective properties of the representative vehicle and its target system, nothing very substantive can be said about representation in general: There is nothing in the nature of the representation (the model) and its target system that guarantees the representational relationship between the two.

More importantly, even though the SOM were originally inspired by the neurophysiological structures of the cortex that does not explain their success in other domains. What is more, when SOMs are used in the fields of inquiry that lie quite afar from the neurophysiological research of the cortex, to conceive SOMs as representations becomes often vague. Instead, the SOM models reveal statistical structure in the data. To do this they rely on a "neurally inspired" algorithm, but this fact does not really make the SOM a representation of a neural representation of the domain of interest. If it represents anything, then it represents the data in a certain way. In this SOM models are alike simulation models on general, since often they are first and foremost appreciated for the output representations they produce. There was also a specific reason to consider the SOM as a sample of a neural network model rather than for instance, a backpropagation algorithm. Namely, as the SOM applies unsupervised learning paradigm, the end result of the analysis reflects relatively more the contents of the data than the supervised learning model sthat impose predetermined output categories on the analysis.

They should rather be conceptualized as multifunctional epistemic artifacts. More generally, the traditional philosophical view according to which models are first and foremost representations of some pre-defined target systems does not capture what seems to us the characteristic feature of modeling: the use of inherently cross-disciplinary computational templates.

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14.3 Modeling and simulating practices

In collaboration with Prof. Mika Pantzar (Helsinki School of Economics, on leave from National Consumer Research Centre), we have been developing a simulation model called *Pracsim*[3]. The systems demonstrates the basic concepts of practice theory. The theory is developed by Pantzar in collaboration with Prof. Elizabeth Shove (Lancaster University). In the theory, it is assumed that practices consist of three basic elements: material (materials, technologies and tangible, physical entities), image (domain of symbols and meanings), and skill (competence, know-how and techniques) [1]. Practices come into existence, persist and disappear when links between these foundational elements are made, sustained or broken: material, image and skill co-evolve. For instance, in the case of Nordic walking, Walking sticks are integrated to produce a proper Nordic Walking technique (linking material objects with skills). Furthermore, images of safety, fitness and nature can be integrated into the sticks themselves (linking image and material object) [2]. The basic motivation in considering practices as an application domain for adaptive informatics methods raises from its richness and complexity. The dynamics and conceptual content related to the phenomena of everyday practices sets a clear challenge for methodology development.

Theories on human action are often constructed either in such a way that the emphasis is on the social or on the individual level. Practice theory aims to build a bridge between these points of view. Based on the theory, Pracsim simulation system consists of two main parts: Simulation of practice dynamics and simulation of associated human population, the members of which adopt practices based on a variety of principles. Pracsim is an example of social simulation that refers to a general class of strategies for understanding social dynamics using computers to simulate social systems.

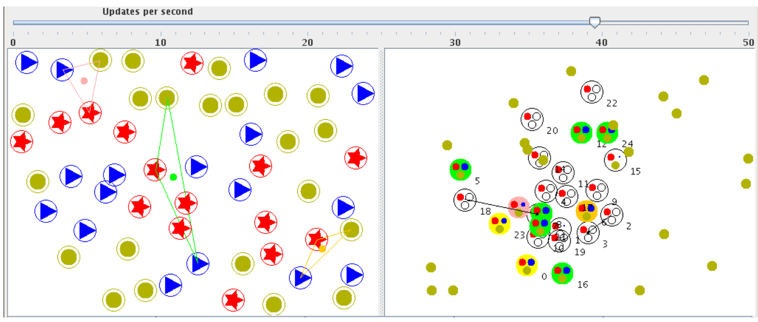

Figure 14.1: A screenshot of the Pracsim simulation. The symbols on the left hand side of the screen refers to the three different elements in the practice theory. The groups of three elements that are linked form a living practice. The right hand side of the screen includes a number of individuals, some of which have adopted a practice. Communication and diffusion within the community of agents is visualized with the links between the individuals. Small items in the "world" are instances of some material.

The pracsim simulation environment consists of a "world" in which a collection of items interact with each other. Following the practice theory, the items are either material, image and skill. Practices can be linked together into systems of practices. These systems are visualized by links between the participating practices. [3]

Pracsim system is applied in a Tekes project called Kulta that develops and applies methods that can be used in understanding, conceptualizing and anticipating the changing needs of consumers. The conceptual models of the practice theory are applied to analyze changes in the consumer society. These models are applied in the context of developing the business models of different kinds of companies. The data gained in this research and developing process are then analyzed and modeled using adaptive informatics methods. The research is focused on the strategic decision making within companies, and how new modeling techniques can be used in these processes. We have also been studied the usability of the modeling and simulation methods.

References

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14.4 Analysis of interdisciplinary Text Corpora

We have presented means for analyzing text documents from various areas of expertise to discover groups of thematically similar texts with no prior information about the topics. These results show how a relatively simple keyword analysis combined with a SOM projection can be very descriptive in terms of analyzing the contextual relationships between documents and their authors.

Our analysis of text documents attempts to extract information about the area of expertise of the document using a set of keywords which are extracted from the documents automatically. To extract relevant keywords for each text document the frequency of each word is examined as an indicator of relevance. As the word frequency distribution for any source of natural language has a Zipf'ian form, special care has to be taken to filter out words, which occur frequently in all documents but are irrelevant in describing the topics. After the keyword extraction phase the documents are analyzed using a SOM projection of the keyword usage of the documents.

We selected two sets of documents from two distinctive fields of expertise: the first corpus A was collected from scientific articles published in the proceedings of the AKRR'05 conference with the topics of the papers mainly in the fields of computer science, cognitive science, language technology and bioinformatics. Corpus B consists of a collection of articles published by the Laboratory of Environmental Protection at Helsinki University of Technology with the topics ranging from social sciences to environmental managing.

Our experiments have shown that a combination of an automatic keyword extraction scheme combined with a clustering algorithm can be effective in describing the mutual similarities of text documents. Our statistical approach to the task has the additional benefit of being independent of the language that is being processed as no prior information about the processed language syntax is encoded into the algorithm.

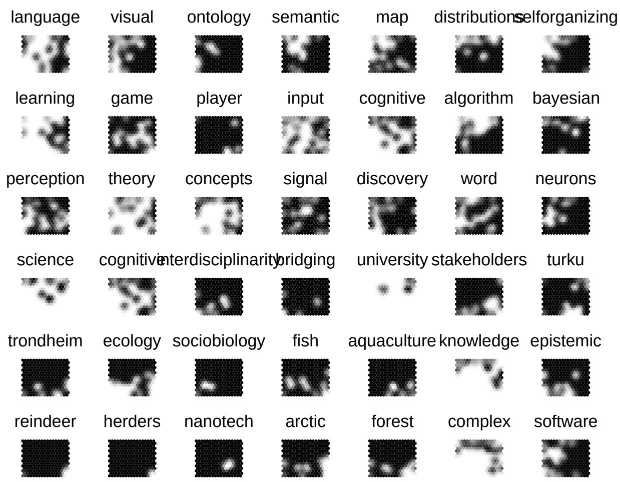

Figure 14.2: Component plane visualization of 42 keywords used in the analysis. Light shade corresponds to the occurrence of the keyword.

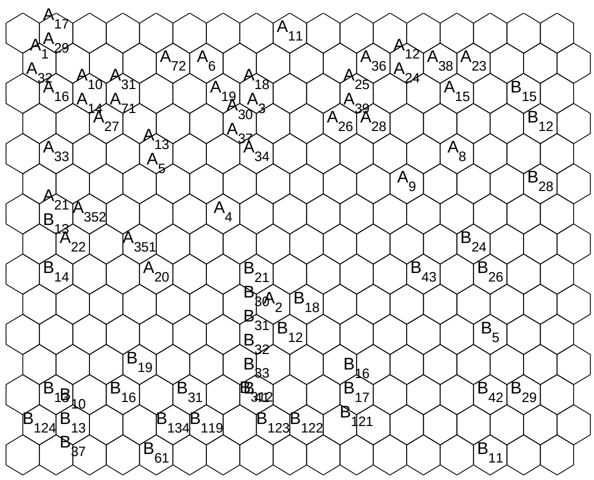

Figure 14.3: The documents of corpora A and B in a SOM projection. The two collections stem from the research of two different research groups which can clearly be seen in the clustering structure.

References

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14.5 Quality analysis of medical web content

As the number of medical web sites in various languages increases, it is more than necessary to establish specific criteria and control measures that give the consumers some guarantee that the health web sites they are visiting, meet a minimum level of quality standards and that the professionals offering the information on the web site are responsible for its contents and activities.

We are a partner in a EU-funded project called MedIEQ that develops methods and tools for the quality labelling process in medical web sites. MedIEQ will deliver tools that crawl the Web to locate medical web sites in seven different European languages (Spanish, Catalan, German, English, Greek, Czech, and Finnish) in order to verify their content using a set of machine readable quality criteria. MedIEQ tools will monitor already labelled medical sites alerting labelling experts in case the sitesâ content is updated against the quality criteria, thus facilitating the work of medical quality labelling agencies. The overall objective of MedIEQ is to advance current medical quality labelling technology, drawing on past and original research in the area. Our work on automatic keyphrase extraction is used as a component of the MedIEQ AQUA system where relevant terminology about the content of medical web sites is used to facilitate the work of the human expert.

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