CONCHAMO 4:

Modeling Conceptual Change

Hanasaari Congress Hotel, 20-22.02 2013

PROGRAM

Wednesday 20.02 2013

12.00-13.00 *Lunch* (Restaurant Johannes)

13.00-13.30 Ismo Koponen: Welcome and the introduction of the workshop

13.30-14.30 *Theme Session 1*: Modeling Conceptual Change

Paul Thagard: Concepts, Conceptual Change, and Explanatory Identities

Timo Honkela: Lessons learned in computational modeling of language learning and conceptual change

14.45-15.15 *Coffee*

15.15-16.15 *Theme Session 1*: Discussion. Discussant: Terhi Mäntylä

16.15-16.30 *Break*

16.30-17.30 *Theme discussion 1*: Conceptual Change - Bayes or Connectionism?

18.00-20.00 *Dinner* (Restaurant Johannes)

Thursday 21.02 2013

09.00-10.15 *Theme Session 2*: On Modeling Conceptual Change

Andrea A. DiSessa: Modeling Conceptual Change at the Knowledge Level

David Danks: Changing Concepts for Causal Coherence

10.15-10.30 *Coffee*

10.30-11.00 Peter Gärdenfors: Conceptual change as dimensional change: conceptual spaces applied to the dynamics of empirical theories

11.00-11.30 Antonio Lieto: Concepts, (Formal) Ontologies and Conceptual Change

11.30-11.40 *Break*

11.40 - 12.30 *Theme Session 2:* Discussion. Discussant: Ismo Koponen

12.30-13.30 *Lunch* (Restaurant Johannes)

13.30-14.30 *Theme Session 3:* Empirical and Methodological Interlude.

Organizers: Otto Lappi, Henri Kauhanen, Tommi Kokkonen

14.30-14.45 *Coffee*

14.45-16.15 *Theme Session 3:* Empirical and Methodological Interlude

Group work

16.15-17.30 *Discussion*

18.30- *Dinner at Downtown.* Transportation leaves at 18.30 (the main doors).

Friday 22.02 2013

09.00-10.45 *Theme Session 4:* Making sense of empirical data

Organizer: Ismo Koponen

10.45-11.00 *Coffee*

11.00-12.00 *Theme Session 4*: Discussion. Discussant: Timo Honkela

12.00-12.45 *The results of the survey and wrapping up the workshop:* Timo Honkela

12.45- *Lunch* (Restaurant Johannes)

ABSTRACTS

Wednesday 20 February

13.30-14.30 Theme Session 1: Modeling Conceptual Change

Concepts, Conceptual Change, and Explanatory Identities

Paul Thagard, University of Waterloo

A theory of conceptual change requires a theory of concepts, but current accounts of concepts are explanatorily inadequate. A theory of concepts is being developed as part of the new synthesis in cognitive science accomplished by Chris Eliasmith's Semantic Pointer Architecture. This architecture integrates insights about cognitive structures and processes found in symbolic, neural network, and embodiment traditions. Concepts are semantic pointers, which are patterns of firing in neural populations that can function as symbols but can also be expanded into sensory-motor representations. This account of concepts can explain the findings used to support prototype, exemplar, and explanation-based theories of concepts, and applies well to scientific concepts such as force, water, and cell.

This talk will show the relevance of the semantic pointer theory of concepts for understanding the conceptual changes that have taken place in 15 familiar concepts: air, blood, cloud, earth, electricity, fire, gold, heat, light, lightning, magnetism, salt, star, thunder, and water. All of these have undergone major conceptual changes as the result of explanatory identities established by scientific theories. For example, air is a mixture of gases, water is H20, and fire is rapid oxidation. The semantic pointer theory of concepts can accommodate both (1) conceptual shifts resulting from reclassification as different kinds and (2) conceptual continuity resulting from sensory processes.

Blouw, P., Solodkin, E., Eliasmith, C., & Thagard, P. (forthcoming). Concepts as semantic pointers: A theory and computational model. Unpublished manuscript, University of Waterloo.

Eliasmith, C. (in press). How to build a brain. Oxford: Oxford University Press.

Eliasmith, C., et al., (2012). A large-scale model of the functioning brain. Science, 338, 1202-1205.

Thagard, P. (2012). The cognitive science of science: Explanation, discovery, and conceptual change. Cambridge, MA: MIT Press.

Lessons learned in computational modeling of language learning and conceptual change

Timo Honkela, Aalto University School of Science

Computational modeling of cognitive processes related to language learning and conceptual change have taken a number of different forms, depending on the philosophical and methodological basis that the modelers have taken in their work. In many cases, symbolic logic is the starting point and resulting models focus on explaining conceptual change in linguistic terms.

In some other cases, a distinction between sets of discrete symbols and continuous high dimensional spaces grounded in multimodal perceptions is made. In this presentation, concepts and conceptual change are considered from different philosophical, theoretical and methodological points of view including symbolic logic, self-organizing maps, Bayesian modeling, and conceptual spaces. Attention is also paid to the issues of symbol grounding and subjectivity of conceptualization.

Thursday 21 February

09.00-11.30 Theme Session 2: On Modeling Conceptual Change

Modeling Conceptual Change at the Knowledge Level

Andrea A diSessa, Graduate School of Education, University of California at Berkeley

This talk describes an unusual hybrid agenda that builds on "classical" means of studying conceptual change, but that also links to the paradigm of cognitive modeling. Cognitive modeling has been influential and (arguably) successful in terms of studying problem solving and skill acquisition, but it has not obviously had great success or influence within the conceptual change community. "Modeling at the knowledge level" takes the goal of moment-by-moment study of human cognition, which is typical of cognitive modeling, much more seriously than most approaches to conceptual change. On the other hand, modeling at the knowledge level does not adhere to the principle that models should or must be tested by computer implementation.

In more detail, I will:

• motivate the hybrid agenda by identifying strengths and weaknesses of, on the one side, cognitive modeling, and, on the other, non-modeling approaches to conceptual change.

• explain, generally, (1) how this paradigm works, (2) how it combines elements of, but also how it differs from, progenitors, and (3) how it might be more productive, right now, than either of its progenitors.

• illustrate the program with some general remarks about some parts of my own research history concerning conceptual change.

• show some details of the program in action by using a recent analysis of how a classroom of students managed—almost without help—to construct a respectable version of Newton's laws of thermal equilibration.

Changing Concepts for Causal Coherence

David Danks, Carnegie Mellon University

Much of the literature on conceptual change focuses on conceptual reconfigurations to better predict or explain observed data. We might instead think about changing (or discovering) concepts to better capture causal regularities, particularly the outcomes of hypothetical actions. In this talk, I will first show that these two different perspectives --- predicting observational vs. interventional data --- can easily lead to different conceptual structures, even given exactly the same input data. The mathematics of conceptual change must thus be sensitive to "conceptual change for what purpose." Time permitting, I will then show that the problem gets even more complex: not only can different concepts cohere with different causal or predictive structures, but different sets of concepts can cohere with the very same structure, depending on the level of description of the dynamics. Conceptual change is beset by multiple layers of underdetermination that can (and must) be clearly disentangled mathematically and theoretically.

Conceptual change as dimensional change: conceptual spaces applied to the dynamics of empirical theories

Peter Gärdenfors, University of Lund

I present a new way of reconstructing conceptual change in empirical theories. Changes occur in terms of the structure of the dimensions—that is to say, the conceptual spaces—underlying the conceptual framework within which a given theory is formulated. Five types of changes are identified: (1) addition or deletion of special laws, (2) change in scale or metric, (3) change in the importance of dimensions, (4) change in the separability of dimensions, and (5) addition or deletion of dimensions. Given this classification, the conceptual development of empirical theories becomes gradual and rationalizable. The five types are exemplified and applied in a case study on the development within physics from the original Newtonian mechanics to special relativity theory.

Concepts, (Formal) Ontologies and Conceptual Change

Antonio Lieto, University of Turin

Formal Ontologies are widely known in the field of Artificial Intelligence as powerful concept-oriented knowledge representation systems. One of their main features regards the possibility of representing (and reasoning on) conceptual information expressed in forms of logical axioms (description logics, DL). In this talk I will briefly outline the pros and cons of the representational and reasoning capability of these systems by arguing that many problems, already pointed out in the philosophical and psychological studies about concepts, are still open (Frixione & Lieto 2012). Despite their limits, however, I will argue that formal ontologies could be very useful in the conceptual change research as an instrument for i) explicitly formalize a given theory T ii) semi-automatically detect the cases of “wrong” conceptualizations with respect to that theory T. For the latter task I will provide a list of “easily” recognizable misconceptions by using standard DL reasoners.