TECHNISCHE UNIVERSITÄT MÜNCHEN
NEUROWISSENSCHAFTLICHE SYSTEMTHEORIE
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A D V A N C E D S E M I N A R

Cognitive Concepts: Computational Representations and Learning

Problem description:

Concepts or mental representations are often defined as internal cognitive symbols that represent external reality. We as humans learn and develop these representations mainly during infancy [1]. To find computational models and representations of cognitive concepts is currently an open research question [2, 5]. One suggested computational framework to represent and manipulate concepts or cognitive symbols is the Semantic Pointer Architecture (SPA) [2, 3], a part of the Neural Engineering Framework (NEF) [4]. In this seminar, the student is expected to research relevant literature regarding computational representations and frameworks of cognitive concepts. The student should give an overview of computational frameworks and compare them to the SPA by summarizing advantages and disadvantages. Finally, the student should research the current state-of-the art of how concepts and relations between them can be learned and what possibilities the chosen computational frameworks offer in this regard.

This seminar requires the student to

- introduce the theoretical background of cognitive concepts
- give an overview of current research regarding concepts and conceptual learning
- summarize computational frameworks for concept representation and compare them to the SPA
- write down the results in text form (report)
- present an overview of the results in oral form (presentation)

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Bibliography:

[1] N. Althaus and D. Mareschal. Modeling Cross-Modal Interactions in Early Word Learning. *IEEE Transactions on Autonomous Mental Development*, 5(4):288–297, Dec 2013.

[2] P. Blouw, E. Solodkin, P. Thagard, and C. Eliasmith. Concepts as Semantic Pointers: A Framework and Computational Model. *Cognitive Science*, 40(5):1128–1162, 2016.

[3] C. Eliasmith. *How to build a brain: A neural architecture for biological cognition*. Oxford University Press, New York, NY, 2013.

[4] C. Eliasmith and C. H. Anderson. *Neural Engineering : Computation, Representation, and Dynamics in Neurobiological Systems*. Computational neuroscience. Cambridge, Mass. MIT Press, 2003.

[5] A. Lieto. A computational framework for concept representation in cognitive systems and architectures: Concepts as heterogeneous proxytypes. *Procedia Computer Science*, 41:6 – 14, 2014.