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UNIVERSITY OF
BIRMINGHAM

School of Computer Science

Review of Habilitation Thesis of Dr. Martin Takáč

“Computational Structures for Knowledge Representation and Language Acquisition”

General comments:

Dr Martin Takáč has put together an impressive synthesis of some of his past work that appeared in the form of 6 publications. Overall, the thesis is very well written and shows deep understanding of the underlying issues in the fields of linguistics and mathematical modeling. Martin was one of the main driving forces behind the developments mapped in the thesis and managed to co-ordinate work with a team of international collaborators to the highest degree. The publications appeared in respectable venues and managed to attract healthy response from his scientific peers.

The main focus of Martin’s work is on connectionist modeling, in particular, connectionist models involving memory in the form of feedback loops. There has been a long established research stream on this topic, however, Martin’s work brought several fresh insights, which is a very commendable achievement.

Both research and teaching activities of Dr Martin Takáč show a rich and active progression, nicely aligned with his main research focus.

Detailed questions to be discussed during the habilitation meeting:

Paper A *“Autonomous construction of ecologically and socially relevant semantics”*

The method seems closely related to metric learning methods in Machine Learning, e.g. global, or local metric learning in prototype based classification/ordinal regression. Can you please explain the links between your dynamic kernel and those methods? In addition, since most (but not all) metric learning methods in Machine Learning are formulated in the framework of supervised learning, the metric updates follow in a principled manner from a clear, well formulated cost function related to the prediction task (e.g. shrink classes while maximizing inter-class distances). Can you comment on what are the main driving forces behind metric updates in your method?

Paper B *“What can Neighbourhood Density effects tell us about word learning? Insights*

Can you please explain the use of HMM in the coarse-grained analysis of the network's learning? The formulations seem to be related to (observable) Markov model, rather than a model with latent variables, such as HMM. Can you please elaborate on limitations of describing the behavior of continuous state space RNNs through coarse-grained state spaces?

Paper C: *"Mapping sensorimotor sequences to word sequences: A connectionist model of language acquisition and sentence generation"*

A very interesting study. I am curious, given the complexity of the overall architecture, how important for training is a good parameter initialization? How could the problem of vanishing error signal caused by the presence of latent temporal variables (in RNN embedded in the overall model) be effectively avoided?

Papers D-F: *"A Neural Network Model of Episode Representations in Working Memory"*, *"Working memory encoding of events and their participants: a neural network model with applications in sensorimotor processing and sentence generation"*, *"Mechanisms for storing and accessing event representations in episodic memory, and their expression in language: a neural network model"*

Can you please elaborate on possible use of other recurrent/recursive extensions of SOM in place of MergeSOM? MSOM can potentially lose vital information in the merging process; could other alternatives, such as RecSOM be viable candidates? Can you hypothesize to what degree do your conclusions depend on the particular choice of including memory in the SOM architecture?

Overall recommendation:

Dr Martin Takáč has fully fulfilled requirements for the habilitation process and without any hesitation I warmly recommend to award Dr Takáč the title "docent in informatics".

Kind regards,

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