Machine Learning for Human-Robot Interaction

We welcome applications of PhD students in the domain of **human-robot interaction** with a focus on **machine learning** in its widest sense to enable social interactions between humans and robots.

One previous line of work within the Adaptive Systems Research Group focussed mostly on robotic language acquisition, which we are seeking to extend towards social interaction more generally. Listed below are two exemplary research topics of interest. However, any applicant with a serious interest in enabling genuine social interaction between robots and humans are encouraged to contact Dr Frank Förster in order to discuss ideas.
Topics will likely revolve around human-robot interaction (HRI) experiments acting as testbed for evaluating potential new algorithms and will likely involve the iCub humanoid robot. However, other robots are available too.
As indicated by the topics below, the research is highly interdisciplinary, connecting different research areas within robotics and computer science - human-robot interaction, machine learning, natural language processing, cognitive and developmental robotics, signal processing, and affective computing – as well as having links to linguistics, philosophy of language and mind, psychology, and sociology (conversation analysis).

Topic 1: Socially driven Machine Learning in Robotic Language Acquisition

We developed a language acquisition system that associates words extracted from human speech with sensorimotor-affective data originating from a small humanoid robot (**symbol grounding**). Learning was largely driven by interactional regularities between the human tutors and the humanoid robot iCub (see Förster et al 2017 & 2019).
We hypothesize that learning could be dramatically improved by making use **of (social) reinforcement signals**. This topic would involve the investigation of means by which different types of reinforcing signals could be made utilisable by the overarching acquisition algorithm.
Other aspects of interest in this context involve real-time prosody recognition in order to move the acquisition algorithm online (⟶ **social signal processing**). The topic also provides links to **affective computing**.

Topic 2: Repair Mechanisms in Interaction

Human interaction, whether by speech or otherwise, is partially enabled through robust repair mechanisms some of which have been documented in the conversation analytical literature. To our knowledge no machine learning or artificial intelligence techniques exist that would implement these mechanisms. The lack of these mechanisms in human-machine interaction systems, be it dialogue systems or other, renders these systems comparatively brittle and prone to interactional breakdowns. We would therefore strongly encourage any attempt to implement repair mechanisms to render future interaction systems more resilient with respect to interactional breakdowns. Research under this topic may employ a number of state-of-the art ML techniques with **counterfactual and causal reasoning** being one potential candidate.

Independently, and in addition to the above two topics we have just obtained membership of Homebank and Darcle, the former being a collection of various speech corpora of child- and child-directed speech. Research comparing and/or connecting robotic with human language acquisition could be an additional aspect of the proposed research. Interaction and potential collaborations with

students or researchers from developmental psychology or psycholinguistics would be strongly encouraged.

Background / Person Profile

Applicants should optimally have a background in computer science or a similar field. However, given the interdisciplinary nature of the topics, applicants with a background in psychology or philosophy will be considered too. Any applicant will need a strong background in at least one programming language – existing implementations were written in Python and/or C++. Interest in languages, language acquisition, and human interaction more generally is a plus, knowledge of the later Wittgenstein a big plus.

Useful skills and knowledge on the computer science side include signal processing, knowledge of robotic middleware such as ROS or YARP, experience in robotic software development, knowledge of speech processing in general, and prosody recognition in particular (including tools such as PRAAT or EmoVoice), machine learning more generally, or knowledge of dialogue system design. Useful skills and knowledge outside of computer science side include speech act theory, pragmatics, and conversation analysis, or other methods of behaviour coding.

Contact

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References

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