Robotic Language Acquisition and Dialogue Systems

We welcome applications of PhD students in the domain of **robotic language acquisition**, with potential links to dialogue systems research. Listed below are two research topics of interest. However, applicants are encouraged to look at previous work by Dr Frank Förster and should contact him prior to making an application to discuss ideas for these as well as alternative topics or if they need further information.
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

In past research, 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). While a reasonable level of success in acquiring words and word meanings was achieved, one of the simplest machine learning algorithms, k-nearest neighbour (kNN), was used as the core learning algorithm forming part of a larger multi-step acquisition process.
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** in these sense that affective expressions of the robot have played an important part in the interactive acquisition process within past research as well as being used within the symbol grounding process itself.

Topic 2: Linking Language Acquisition with Dialogue Systems Research

Historically, robotic language acquisition was largely restricted to the developmental robotics community. Only recently, symbol grounding, as one of the central techniques in this strand of research, has been picked up by the much larger computer vision and dialogue systems communities. We believe that dialogue systems could benefit from insights won within language acquisition research. In particular the affective symbol grounding techniques we have developed within the Adaptive Systems Research Group, the grounding of non-referential words, and the discovery of strong interactional regularities in asymmetric speaker dyads could be of potentially major importance to “guide” dialogue systems on the pragmatic level.
The interface between these two areas of research has so far not been explored, and we would encourage any applicant who were to take up this topic to take “brave steps” into this void.

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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