Action Oriented Adaptive Language Games

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1. Extended Abstract

In a recent article (Lindblom and Ziemke, 2002) the authors argue much of the work in epigenetic robotics and related fields has either direct or indirect inspiration from the work of the Psychologist and theoretician L. S. Vygotsky. And yet despite much interest in what a Vygotsky inspired robotics might look like, and theoretical schemes where Vygotskian ideas play a central role - e.g. (Zlatev, 1999) - there has been little in the way of implemented systems (either robotic or simulated) that demonstrate the practicality of this endeavour.

At least one implemented system: Vygovorotsky (Kulakov and Stojanov, 2002), does aim to build a developmental architecture along the lines of some of Vygotsky's ideas. But, although this architecture might plausibly be a basis for a future Vygotskian robotics, the authors candidly admit that until a language component is incorporated in the architecture - which is no trivial matter - Vygovorotsky's name is rather a promissory note suggesting the way for future work.

One reason for this difficulty is that Vygotsky's principal interest was in the development of higher psychological functions and these entailed both the use of signs and the internalisation of speech. For Vygotsky "the most significant moment in the course of intellectual development, which gives birth to the purely human forms of practical and abstract intelligence, occurs when speech and practical activity, two previously completely independent lines of development converge." (Vygotsky, 1978). To judge by current research both in humanoid robotic and simulated agent research, it might be considered beyond the current state of the art to incorporate such concerns. However, the framing of recent work such as the above around Vygotsky's ideas suggests that many believe this type of research to be both necessary and plausible. The question is how to pursue it?

Work in the related fields of the evolution of language using multi-agent systems - some of which is collected in (Cangelosi and Parisi, 2002) - has shown the viability of new techniques for studying many aspects of language and language development based on symbol grounding (Cangelosi et al., 2000), and the iterated learning model (Kirby and Hurford, 2002) . In most of this work, however, the job of learning a language is abstracted away from any other type of psychological process or situated activity. For Vygotsky the development of language could only be properly understood through the development of joint social and practical activity. This raises the question of whether it might be possible, with models similar to those currently being used to understand the evolution of language, to instead model language development and its relationship to the development of other higher cognitive processes. To put this in more Vygotskian terms, can we use some of these techniques to model the involvement of language-like systems in the development of higher practical activity?[1]

This poster illustrates a model which extends contemporary approaches to simulating language learning dynamics. It details a multi-agent system featuring symbol grounding which takes elements from (Cangelosi et al., 2000) particularly in regard to the agent's internal architecture. The world in which the agents are situated resembles in conception the talking heads scenario of (Steels, 1999) except our agents not only talk about the objects in the world but act upon them. We also propose extensions to the theoretical model of the Adaptive Language Game (hereafter ALG) framework (Steels, 2000) which aims to show how this model can be extended for modelling the shifting interrelationship between cognition and communication in a neo-Vygotskian manner.

Building upon the ALG framework we elaborate the design for a new multi-agent system which examines specifically how communicative agents might autonomously develop grounded, compositional communication systems ('languages') to mediate, extend and filter their collective behavioural repertoire. We make three novel additions to the existing frame-

[1] One groundbreaking study with a single robotic agent (Sugita and Tani, 2002) does begin to address how an agent may be entrained to map action-states onto linguistic commands in a context a context dependent manner. This model shares many features with our own approach.

work. Firstly, our Agents are designed to take an active stance toward the world. They can operate on the world both directly with an effector ('hand') with which they can move objects around; and indirectly by influencing the behaviour of other agents who can also act upon the world in a similar way. These language games therefore hinge around changing the world, not just each other's internal structure. Secondly our agents have a map of the world that serves as a plan for action. They are reinforced insofar as they are able to make the world conform to this map either directly or instrumentally using a conspecific's behaviour via the language game. Thirdly we use a fitness function that explicitly rewards social behaviour.

The new agent architecture can be argued to follow an epigenetic trajectory in the sense developed by Sinha (Sinha, 2001), i.e. the environmental factors, both the world, and the activity of other agents - the social world - are constructive of the organisation of each agent's activity. Unlike the models developed by Steels and his collaborators we use an architecture based on a coupled planning system, and neural network based communication system. Crucial to the model is that both the communication system and the agents' activity develop as they attempt to make the world conform to a pre-existing plan which is projected from each game scenario. Language games develop not just in terms of naming the features of objects, but in order to facilitate particular action plans. The modelled language games are therefore action oriented in a way not previously explored with this type of approach.

Vygotsky argued that "the child's system of activity is determined at each specific stage both by the child's degree of of organic development and by his mastery of tools." One of the principal tools he has in mind here was the sign. We argue that this augmented form of the Adaptive Language Game allows us a route to the understanding of how signs might mediate activity. Specifically, to explore the transition between an innate (the pre-given world model) and constructed representational architecture (the action-oriented communication system). Or, to put it in more contemporary terms, the trading of representational spaces between language and cognition (Clark and Thornton, 1997).

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