Honors Thesis Proposal:
Evolving Languages
for Robotic Foraging Tasks

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Language is easily one of the most fascinating phenomena, yet very little is known of how it came about. Researchers observe that communication between individuals arises in environments where cooperation and coordination are essential factors for survival. However, the connection between primitive forms of communication, such as that in ant colonies, and the complex structured language of humankind is almost a complete mystery.

In order to shed some light on the processes involved in the creation of a language, two cutting edge fields, evolutionary linguistics and behavioral robotics, have come together. Inspired by nature, researchers from those fields are set out to simulate the emergence and evolution of a communication system between autonomous agents.

The goal of this project is to make a contribution to the ongoing research by better understanding the influence of the environment and properties of a group of autonomous agents on the creation and evolution of a language in that group. Additionally properties of the language that evolves will be examined as well as the effect of the language on overall performance of the group.

The robots will be given a survival task to perform in a simulated ecosystem. The project will involve evolving controllers for real robots to perform a cooperative foraging task using language to coordinate their actions. Three Khepera robots (http://www.k-team.com/) will be used, equipped with IR and visible light sensors, a dedicated channel for communication, as well as effecters to grasp and pick up objects. The setup for the experiment will be a small, obstacle free, uniform colored, square environment, a meter to two meters wide. Three bins, as well as small objects for gathering, will be placed in the environment. The bins will be marked with different light sources so that they can be detected by the light sensor of the robots. The robots will be required to keep all the bins full in order to survive, the hypothesis being that effective communication between robots will greatly increase their chance of survival. A good approach in this situation is to implement the controller for the robots as a reinforcement learner that chooses a predefined high-level behavior, such as scouting and homing to execute based on the input from the sensors (Mitri, 2006). For the language evolution part of the experiment a modified version of a language game described in the literature (Vogt, 1997) will be used: at every decision step the agent utters the behavior that it has chosen and in the decision process the agent takes into account the last utterance it has heard (Mitri,

2006). A version of the Iterated Learning Model (Kirby, 2002) will be used for the evolution of the language. Initially the robots will be evolved in simulation using the Khepera simulator (http://diwww.epfl.ch/lami/team/michel/khep-sim/) and then the controller will be transferred to real robots and further evolved.

References

Kirby, S., and J. Hurford. *The Emergence of Linguistic Structure: An Overview of the Iterated Learning Model*. Springer Verlag, London, 2002, ch. 6, pp. 121–148.

Mitri, S. and P. Vogt, *Co-evolution of Language and Behaviour in Autonomous Robots*, in Proceedings of the sixth international conference on the Evolution of Language (Evolang6), Rome, April, 2006

Steels, L. and P. Vogt. *Grounding adaptive language games in robotic agents*. In Proceedings of ECAL'97,pages 473--484, 1997.