Master Thesis Proposal 2020 - All for one and one for all

Arend Hintze

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1 Introduction

The state of the art machine learning technique to optimize neural network AI controllers (agents) is back-propagation and deep learning. This methods assumes that solutions and examples for such solutions are known. A different approach to this is evolutionary computation and genetic algorithms. Instead of rewarding proper responses to specific situations and hoping for proper generalization, a genetic algorithm uses an objective function. This objective function evaluates the total performance of a system and can select controllers that perform better. Over many generations such system optimizes controllers, often finds more creative solutions [5], and most importantly does not require knowledge about specific actions but only the desired outcome.

This method works well when optimizing individual controllers as their objectives do not conflict with the objectives of other controllers. When agents need to interact or work in teams [4], the situation becomes much more complicated, and often the goals of the individual are contrary to the success of the group. Imagine self driving cars. Optimizing them to reach their goal as fast as possible might induce negative side effects. How to overcome such issues?

Group level selection plays an important role in evolution. Often individuals do not act alone, but in groups. As such they can achieve together more than alone. Collaborative hunting is one of those examples, where individuals are not selected individually but as a group [2]. This group level selection scheme typically pools the resources the group collected and redistributes them back equally, which implies that groups are evaluated by their average performance.

What if this scheme is altered? Imagine a group is rewarded according to the performance of its best individual (*all for one*) or its worst performer (*one for all*)?

In the *all for one* case, you would pool all resources on one individual, and in the case of the *one for all* you would distribute the resources as fairly as possible. The big question is, which of the two groups collected the most resources in total?

This research will use neuro-evolution where agents are simulated in a virtual environment and controlled by so called Markov Brains. Group level selection regimes such as the ones described above will be tested with respect to their effect on individual and group level performance.

2 Aims and Purpose

This research seeks to improve the way we train groups of AI controllers (agents) to perform better individually and in teams at the same time. While this is a basic research question in optimization of neural networks using genetic algorithms, it has direct applications to robotics and other autonomous AI decision making systems that need to work in groups.

3 Method

This research will use the MABE (C++ Modular Agent Based Evolution Framework [1]) to implement virtual test environments. Agents are controlled using Markov Brains [3] which are a particular evolvable type of neural network. After replicate evolutionary experiments are completed, data will be analyzed and visualized.

4 Supervisor

Arend Hintze

References

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