Ad-hoc teamwork in the pursuit domain

Supervisor: Panayiotis Danassis

November 9, 2016

1 The Story

Mr. & Ms. Pac-Man have evaded capture for too long. Blinky, Pinky, Inky and Clyde from the G.H.O.S.T. association have requested the assistance of the Artificial Intelligence Laboratory in order to better equip themselves in their pursuit. Since they sometimes moonlight in a thrill ride at the local amusement park, they would like an agent to assume the role of the forth member of their team from time to time. As they have no time to train the new agent in their tactics, you are tasked to build an ad-hoc agent that is able to engage in ad-hoc teamwork in the pursuit domain and efficiently cooperate with the other ghosts, without a prior agreed protocol.

2 Project Overview

Ad-hoc multi-agent coordination is a relatively new research area, recently introduced in the seminal work of Stone et al. [1]. As technology evolves, the number of autonomous agents in society grows, and so does the need for them to interact with other agents efficiently. However, due to the differences between the agents in terms of origin, robustness, knowledge of their environment, and perceptual and actuation capabilities, such teamwork must take place without any prior defined coordination protocol or even, in some cases, any form of explicit communication. This is in contrast to most of the prior research done on multi-agent teamwork, which often requires explicit coordination protocols, and/or shared assumptions.

This project aims to investigate the problem of ad-hoc team work, where an agent interacts with other (unknown) agents on a set of collaborative tasks. The agent must efficiently coordinate with the other agents towards the completion of the given task, without the use of a prior defined protocol [2]. The project will focus on the pursuit domain [3].

The pursuit domain is a common benchmark in the multi-agent literature. In the classical formulation, four predators must capture a moving prey. The prey is captured if surrounded on all four sides by the predators. Both predators and prey can move in any of the four directions in a toroidal grid world environment. The ad-hoc agent must coordinate with the other predators in order to capture the prey.

3 Goal Description

The focus of this project is to acclimate the student in the field of ad-hoc multi-agent teamwork. To this end, the student is required to implement a planning algorithm for

ah-hoc coordination and a framework for evaluating and comparing the performance of the ad-hoc agents. Towards this goal, a simple PAC-MAN-like game will be developed, consisting of three 'dummy' predator agents and one ad-hoc, whose goal is to capture their pray in the minimum number of steps.

4 Project Steps

- Model the world and define the state representation.
- Design and implement the platform.
- Implement simple agents to demonstrate how the platform functions.
- Implement the planning algorithm for determining the actions of the ad-hoc agent (such as a Monte Carlo Tree Search (MCTS) [4]).
- Run simulations comparing the efficiency of the ad-hoc agent as part of different predator teams.

5 Required Skills

Good programming skills are required.
Having taken an AI course is preferable, although not required.
Being passionate about the topic and good English skills are a must.

References

[1] P. Stone, G. A. Kaminka, S. Kraus, and J. S. Rosenschein, "Ad hoc autonomous agent teams: Collaboration without pre-coordination," in *Proceedings of the Twenty-Fourth Conference on Artificial Intelligence*, July 2010.

[2] P. Stone, G. A. Kaminka, and J. S. Rosenschein, *Leading a Best-Response Teammate in an Ad Hoc Team*. Berlin, Heidelberg: Springer Berlin Heidelberg, 2010, pp. 132–146. [Online]. Available: http://dx.doi.org/10.1007/978-3-642-15117-0_10

[3] S. Barrett, P. Stone, and S. Kraus, "Empirical evaluation of ad hoc teamwork in the pursuit domain," in *The 10th International Conference on Autonomous Agents and Multiagent Systems - Volume 2*, ser. AAMAS '11. Richland, SC: International Foundation for Autonomous Agents and Multiagent Systems, 2011, pp. 567–574. [Online]. Available: http://dl.acm.org/citation.cfm?id=2031678.2031698

[4] Wikipedia, "Monte carlo tree search — wikipedia, the free encyclopedia," 2016. [Online]. Available: https://en.wikipedia.org/w/index.php?title=Monte_Carlo_tree_search&oldid=746587300