Multiagent Behaviors in Neural Network

Jimmy Lin
Barry Feigenbaum

Prof. Risto Miikkulainen

Department of Computer Science
The University of Texas At Austin

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Recap

- What we currently have?
  - Commitee Machine
  - Reinforcement Learning
  - Neuro-evolution
  - High-level Behaviors

Motivation

- Most of works so far has focused exclusively on single agents we can extend reinforcement learning straightforwardly to multiple agents if they are all independent.
- Intuitive idea: Multiple agents together will outperform any single agent due to the fact that they have more resources and a better chance of receiving rewards.
- Today, we will touch a really broad area

"Multiagent System" (M.A.S.).

Introduction

- What is multiple agent system?
  - Unfortunately, it is not formally defined by M.A.S. community.
  - Employment of multiple agents (10 to thousands).
  - Intelligent mechanisms to address interactions between agents.
- When is it proposed?
  - a relatively new sub-field of computer science
  - has only been studied since about 1980
  - only gained widespread recognition since about the mid-1990s

Applications/Simulations

- Crowd Simulation / Crowd Collision Avoidance
- Clear Path

Independent v.s. Cooperative Agents

Using independent agents as a benchmark, Tang Ming (1993) [**1**] studied performance of cooperative agents and concluded that:

- Additional sensation from another agent is beneficial if it can be used efficiently
- Sharing learned policies or episodes among agents speeds up learning at the cost of communication
- For joint tasks, agents engaging in partnership can significantly outperform independent agents although they may learn slowly in the beginning.

M.A.S. Environments

The agents in a multi-agent system have several important characteristics:

- Autonomy: the agents are at least partially independent, self-aware, autonomous.
- Local views: no agent has a full global view of the system, or the system is too complex for an agent to make practical use of such knowledge.
- Decentralization: there is no designated controlling agent (or the system is effectively reduced to a monolithic system).

Active Research Areas

List of Multiagent Behaviors:

- communication
- cooperation and coordination
- negotiation
- distributed problem solving
- multi-agent learning
- fault-tolerance

Simulations

- ..

Reinforcement learning

- Barry, here u go.

Questions, Suggestions or Some Other Ideas?

Our Research Project

- Motivations
- Mechanisms
- Suggestions

Further Readings: Books

- W. Michael. *An introduction to multiagent systems*. John Wiley & Sons, 2009.
- S. Yoav, and K. L. Brown. *Multiagent systems: Algorithmic, game-theoretic, and logical foundations*. Cambridge University Press, 2008.
- W, Gerhard, ed. *Multiagent systems: a modern approach to distributed artificial intelligence*. MIT press, 1999.

Further Readings: Courses and Labs

- Stanford CS224M: Multi Agent Systems (Spring 2013-14). HERE
- MIT CPSC689: Special Topics in Multi-Agent Systems (Spring 2006). HERE
- Stanford Multiagent Research Group. HERE
- CMU Advanced Agent-Robotics Technology Lab. HERE
- MIT Robust Open Multi-Agent Systems (ROMA) Research Group. HERE

References

[tan1993multi] Tan, Ming. "Multi-agent reinforcement learning: Independent vs. cooperative agents." *Proceedings of the Tenth International Conference on Machine Learning*. Vol. 337. 1993.