ECE 590D-001, Reinforcement Learning at Scale

Jay Hineman, Ph.D.

Geometric Data Analytics

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Description

This course consist of three parts. The first part will focus on machine learning at scale using modern tools such as Docker, GitLab with CI/CD, cloud computing, and Kubernetes. The second part will focus on reinforcement learning (RL) for single-and multi- agent environments and include topics such as Q-learning, policy gradients, and their deep learning extensions. The third part will combine the first two topics and focus on scaling DeepRL methods to attack large problems such as the Atari-57 benchmark and the StarCraft Multi-Agent Challenge.

Details

- ► The Syllabus.
- Other resources:
 - Lecture notes
 - Bibliography (including books, articles, lecture notes from other course, projects)
- How I'm approaching this course as an instructor:
 - Collect and distill resources that allow students to understand recent advances in RL. To this end I will make connections with applications.
 - Develop experiments that illustrate the execution of recent advances in RL.
 - ▶ I am interested in the technical details (mathematician), but I think intuition about the field as a whole is more valuable.
 - ▶ I think problems and their solution is the best way to develop theory.

- ▶ How I'd like you to approach this course as a student:
 - Be curious—there will ample additional reading beyond what I can cover in-class.
 - Try things—learning by doing is critical and there many exciting places to apply RL.
 - Realize that the programming and implementation parts are likely as valuable (if not more) than the theory. It's essentially like steady hands in the lab.

Caveat Lector

- ► I try to clarify which statements are my opinions and which I can support by data or proof. I will not always succeed at this.
- ► These notes are essentially a draft and will like contain typos, errors, and other forms of mis-information. I'd rather they not, so please send corrections and comments to me via email.
- ▶ I will be version controlling the notes via git+github.

Some very brief history (more in later lectures)

- ▶ Reinforcement learning is other than you might think; it starts with Bellman in the 1950s (if not Von Neumann). Here the approach was using dynamic programming (DP) to solve exactly (by specifying a policy or value function). DP does not scale well.
- Reinforcement learning, Approximate dynamic programming, and Neuro-dynamic programming are all essentially interchangeable and try to solve the same problem, but by approximate policy or value functions.
- ▶ A number of advances were made in the 1980s and 1990s, but were limited by computational power. See also the Wikipedia article on *AI Winters*.

Some very brief history (more in later lectures)

- One way to approximate a policy or value function is using an deep neural network—this is part of the recent surge of research activity in RL.
- ▶ RL will often contain a generative component that can be sampled in a parallel or distributed sense. The price, availability, and user tools for distributed computing have also driven the RL surge.
- As a result of using new approximation methods (or practicality of such methods), new RL updates are currently active research topic.

Where to start ...

- There are some very nice books (see the Syllabus).
- ► There are also piles of journal articles (bibliography forthcoming).
- There is also digging into code!
 - Spinning Up: Docs, Code
 - Ray: Docs, Code
 - ChainerRL: Docs, Code
 - Horizon: Docs, Code
 - Open Al Baselines and stable baselines: Docs, Code

Spinningup

- Spinning Up is an introductory guide to (deep) reinforcement learning written by Joshua Achiam (OpenAl Research Scientist).
 - Gets to the good stuff quick and mixes theory and implementation well.
 - Uses standard tools (python, tensorflow, mpi)
 - Open-ended and flexible—we'll mix it together with other resources.

Docker

- De facto standard for containerization
- ► Starting place for rapidly building distributed architectures with orchestration like Kubernetes.
- Starting place: containerize requirements and code for Spinning Up (this will be written formally as a homework assignment).
- ► ¡¡demo!!

https://hub.docker.com/r/continuumio/anaconda/