Group Members

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Problem Description

Many games these days have what is called a ‘drafting phase’ in which players in the game take turns spending resources to attain game pieces which will be later used during the actual ‘playing phase’. This framework is most notably seen in popular games like DoTA 2, Magic the Gathering, fantasy sports, and others. However, we propose that this is in fact an instance of what we are calling an ‘Adversarial Resource Allocation Game’ that, more generally, can extrapolate to problems faced in many other games such as politics, venture capitalism, military operations, and more.

Specifically, in this project, we aim to formulate the ‘drafting phase’ of DoTA 2 as an adversarial resource allocation game and train a deep reinforcement learning agent to play this game (note: we are not training an agent to play the game DoTA 2 itself which has incredibly high complexity). To do this, we will use an already existing, extensive database of game drafts and results from DoTA 2 to train our drafting agent.

Methods and Algorithms

We plan to use a combination of deep reinforcement learning and classic game theory. For the deep RL component, we expect to use embedding layers to learn representations of the various heroes in DoTA 2, and a sequential model (either transformer or LSTM) to learn a representation and expected value of the current game state. We could potentially use a second sequential model to help the game theory component anticipate opponent behavior. The exact RL algorithm we use is still undecided, but we anticipate some variant of MCTS (e.g. UCT) will perform well due to the generative nature of the sequential models.

Reading List

- The Mysteries of Security Games: Equilibrium Computation Becomes Combinatorial Algorithm Design - Haifeng Xu
- Adversarial Reasoning and Resource Allocation: the LG Approach - Stilman et al.
- Silver, David, et al. "Mastering chess and shogi by self-play with a general reinforcement learning algorithm." *arXiv preprint arXiv:1712.01815* (2017).

Evaluations

For final evaluation, we plan to run our drafting strategy against the built in drafting in DoTA2, using identically skilled “bots” to play the actual game. This provides a level playing field, so we can conclusively measure the effects of our model’s drafting strategy on the outcome of the game.

We also plan on doing a qualitative evaluation of the system’s strategies by comparing its behavior with well established domain knowledge (i.e., certain heroes in DoTA 2 are designed to counteract others - does it learn these matchups?)

Member Responsibilities

While we are not sure who will end up doing exactly which part of the project, we have established what seems like a rough natural division of labor. Both of us are experienced in reinforcement learning, so we will share the responsibilities of designing the system, architecture, and the game itself. Ben has prior experience working with neural networks, and is comfortable with PyTorch, so he will lead the actual coding of the neural network component. Connor has a stronger game theory and math background, and will lead the development of the algorithm and theory components. Both of us have engineering skills. Ben has experience in Python and data collection, so will develop the framework for initial data collection of historical DoTA 2 games. Connor has a stronger background in c++, so he will work on the DoTA 2 simulator, which we will use for the final evaluation.