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RESEARCH REVIEW

Balint Toth

Overview

My review is about a research paper titled Multiagent Bidirectionally-Coordinated Nets for Learning to Play StarCraft Combat Games. The document describes the design of an AI - called *BiCNet* - that uses two bidirectional recurrent neural networks to play combats in the famous real-time strategy game called Starcraft. The challenge of this game is that the player has to control a lot of heterogenous units against the different units of the opponent and the terrain of the battle is also quite diverse.

Techniques introduced

The first main idea is to use bidirectional recurrent neural networks. Recurrent networks - unlike traditional feed-forward ones - have memory that makes it possible to develop tactics that work over time. The units / agents use the same variables and share observation so it is possible to teach the network using a small number of agents and scale it up without a lot of extra computation. The next action of an agent is determined by bidirectional communication in the hidden layers of the network which is simpler to handle than making each agent actions' to be dependent on the actions of all others, but still make it possible to propagate the effects to all units. It is also worth to note that action space is treated continuous as a discrete model would be too big to handle for a lot of agents.

The second main idea is to use an actor and a critic neural network. The actor or policy network determines the actions of each agent and the critic network calculates a value for the outcome. The critic network provides a local value for each agent and then combines it to a global 'score'. Since Starcraft is the game the valuation function is based on the health points of the units.

Results

The authors of the paper have created a few combat scenarios each with different number and type of units. Some of the scenarios were pretty simple with just 10-15 total units while the most complex one had 50.

BiCNet was competing against rule based AIs and other neural networks. The best rule based one was the StarCraft built-in AI, the other two followed quite simple logic *Attack the Weakest* and *Attack the Closest*. The neural network opponents were different in how the agents communicate to each other ranging from fully individual to fully connected solutions.

The combat simulation results show that BiCNet was the best performing AI aside from the most simple combat scenario. Its win margin grows with more and more units being involved in the fight. Furthermore the BiCNet network learned quicker than the other neural networks.

Aside from having good results in combat situations, BiCNet has developed several tactics that are pretty similar to how expert human players play:

- The agents performed coordinated moves without colliding into each other.
- Hit and run tactics where units attack when safe, but move away when in danger.
- The units also performed cover attacks which means one of them draw the attention of the opponents while the others could cause more damage.

All in all the paper has successfully showed that a neural network with well designed architecture and communication can perform successfully in a complex multi-agent environment. That said the research does not address how such an AI would handle the higher level aspects of real-time strategy games like building bases and armies and working toward game winning objectives.