Deep Gaming

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1 Describe what has been done, learned and tested

The goal of Deep Gaming is to use Deep Q Learning to play Atari-style games, from pixels, meaning it will have to learn to play in a similar manner to people learning to play these games.

1.1 Caffe .prototxt to Tensorflow Parser

In the interest of being able to easily test a number of different architectures, we have written a .prototxt to Tensorflow architecture parser. In general, it is able to parse a .prototxt file, and create each of the layers needed to implement it. Because Caffe has different capabilities than Tensorflow, not all existing Caffe architectures will be directly portable to Tensorflow. This system will allow us to easily share and adapt architectures as we try to find ones that work well.

1.2 Deep Learning Framework Exploration

Many opensource frameworks are currently available and one of our first task was to determine which would be the best choice for our application. UC San Diego's Data Science/Machine Learning Platform (DSMPL) provides access to Docker containers with many different frameworks installed (such as PyTorch, Tensorflow, Theano, Caffe, etc.). Our group members had the most experience with the Tensorflow and Caffe frameworks and both frameworks have been proven to switch easily between CPU and GPU computation; these were chosen for out initial framework exploration.

The first issue we ran into was installation. While merely an inconvenience, Caffe needed to be built from source on our local machines; installation of Tensorflow was done with a simple pip command. The second comparison we did was look at pre-trained models; we found Caffe's model zoo provides access to a large amount of pre-trained models, though most were for image classification and not of much use to use. While Tensorflow did not have as many pre-trained models, coding in Python is simple. The third criteria was GPU support and we found Tensorflow's GPU support was easy to use (all done through tf.device()) and had a very flexible architecture (multiple GPUs on a single model), while Caffe was more limiting. The last criteria we judged was layer-wise design. Caffe treats each node in the neural networks as a layer whereas in Tensorflow each node is a tensor operation and a layer can be defined as a composition of those operation. Tensorflow was found to be more flexible since we were limited to pre-defined layers in Caffe.

Overall, Caffe was found to be better for image analysis (such as CNNs or RCNNs) and image classification tasks. Tensorflow was found to be easier to use, easier to interface with, and inherently use a smaller building block; which means that it offers more flexibility. The seamless interface, better documentation, higher flexibility led us to our final decision of choosing Tensorflow over Caffe.

2 Describe what are the difficulties you are facing

2.1 Difficulties with Snake

Originally, our goal was to learn Snake, due to its ease of implementation and display we thought a CNN would be able to learn it well. However, because snake requires pixel accurate information, and can often be ambiguous, even when multiple frames are examined simultaneously. Because of this, no architecture we developed learned to survive long enough to collect more than a minimal number of points. Additionally, because the amount of time between collecting points was often very long (could be as high as 100,000 time-steps between rewards), the reinforcement learning aspect had a lot of trouble finding any good patterns. We do not believe a CNN is the right approach for Snake.

3 Describe what is left to do, what is your planning and how tasks will be split between the team members

We believe we are close to an architecture that will work on a few games. At this point we hope to have the architecture assembled and trained on a few games for demonstration. Bryan currently has a few training sessions running which appear to indicate performance is improving. Edward and Samuel are both focusing on implementing this architecture within different frameworks. By next week we expect to have two games performing well as well as have data collected for change in performance over time.

4 Describe your preliminary results

4.1 OpenAI Gym

OpenAI Gym is a toolkit for developing and comparing reinforcement learning algorithms. Gym provides a variety of Atari environments that can be used for training our Deep-Q Networks [DQN]. After installing Gym we were successfully able to simulate several Atari environments (see below).

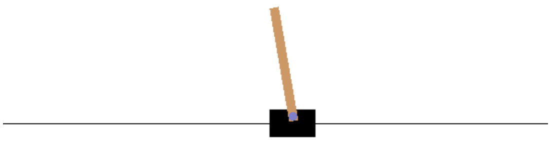

Figure 1: CartPole-v0.

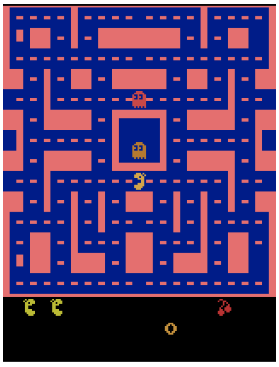

Figure 2: MsPacman-v0.

4.2 CartPole-v0

We decided to start by training an artificial network to beat Cartpole. CartPole is a game in which a pole is attached by an un-actuated joint to a cart. The cart moves along a frictionless track and the goal is to balance the pendulum on the cart and prevent it from falling over.

We implemented a neural network with two fully connected hidden layers. The input to the network was the carts position, carts velocity, poles angle, and poles velocity at tip. The output of our network was push the cart to left or right. At first our network was scoring very low at about 14 points. After only 5 minutes the network was able to learn enough to score 500 points consistently! Although the result was very good, we found that this particular network would not generalize to other games for various reasons.

4.3 MsPacman-v0

Our next task was to train our network on more complicated environments. MsPacman offers many more challenges for the system. Two challenges worth highlighting are:

1. We must train our network to learn from images.

2. It is much more difficult for the system to remember, or know, which moves led towards a successful result.

We modified our architectures input to accept 88x80 images and to output an action space suited for the game. We quickly realized that our current network was not capable of beating MsPacman. We are currently developing a multi-layer convolutional neural network (CNN) which hopefully can beat MsPacman and other similar games.