

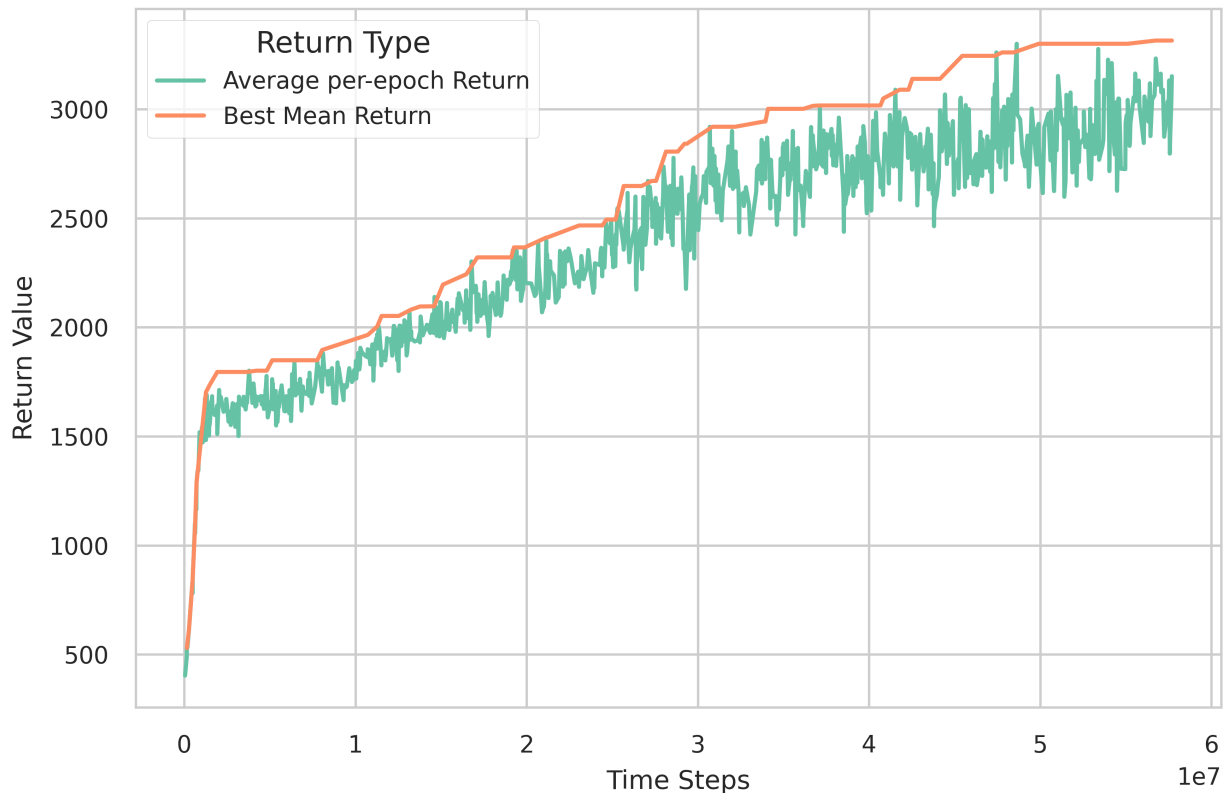
## Homework 3

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### 1 Part 1: Q-Learning

#### Question 1: basic Q-learning performance (DQN)

##### Results



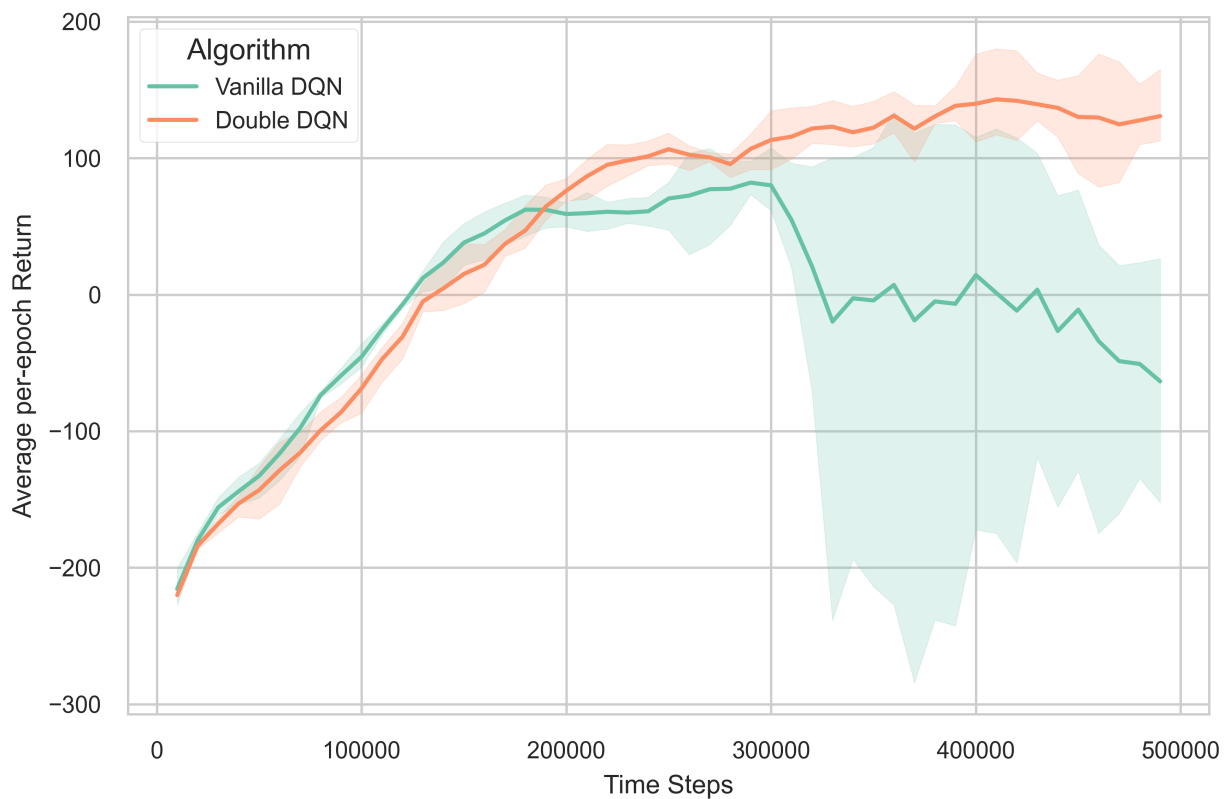
**Figure 1.** DQN performance on Ms. Pac-Man in average per-epoch return (cyan curve) and best mean return (red curve) versus number of time steps. Performance of the algorithm shows a step increasing trend. However, the average per-epoch return variances are also increasing.

##### Codes

```
python cs285/scripts/run_hw3_dqn.py --env_name MsPacman-v0 --exp_name q1 -gpu_id $1
```

## Question 2: double Q-learning (DDQN)

### Results



**Figure 2.** Average training per-epoch return with respect to vanilla (green curve) and double (orange curve) DQN. The double DQN successfully prevents rewards from decreasing after around 30,000 training steps and achieves a higher score.

### Codes

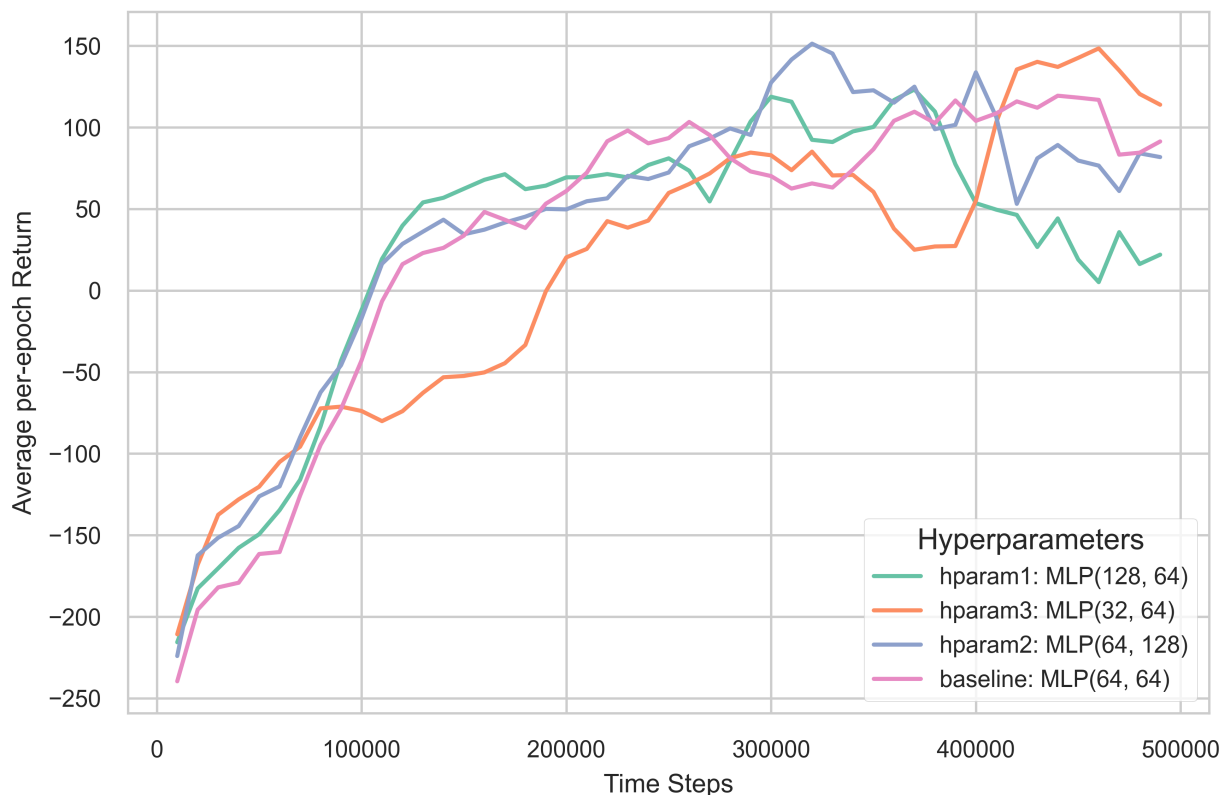
```
echo "Running Homework 3 Question 2";
python $1 --env_name LunarLander-v3 --exp_name q2_dqn_1 --seed 1 -gpu_id $2;
python $1 --env_name LunarLander-v3 --exp_name q2_dqn_2 --seed 2 -gpu_id $2;
python $1 --env_name LunarLander-v3 --exp_name q2_dqn_3 --seed 3 -gpu_id $2;

python $1 --env_name LunarLander-v3 --exp_name q2_doubledqn_1 --double_q --seed 1 -gpu_id $2;
python $1 --env_name LunarLander-v3 --exp_name q2_doubledqn_2 --double_q --seed 2 -gpu_id $2;
python $1 --env_name LunarLander-v3 --exp_name q2_doubledqn_3 --double_q --seed 3 -gpu_id $2;
echo "Question 2 Done!"
```

### Question 3: experimenting with hyperparameters

#### Results

For this question I explore the influence of different `hidden_size` settings of the Q-function network on the training process. Intuitively, higher number of neurons yields better ability to represent non-linear relationships, which explains why performance under `hparam3` are lower compared to the others at the earlier stage of the training. But with sufficient training, all network structures converge to a similar performance level.



**Figure 3.** Average per-epoch training returns with respect to training time steps given different Q-function neural network structures.

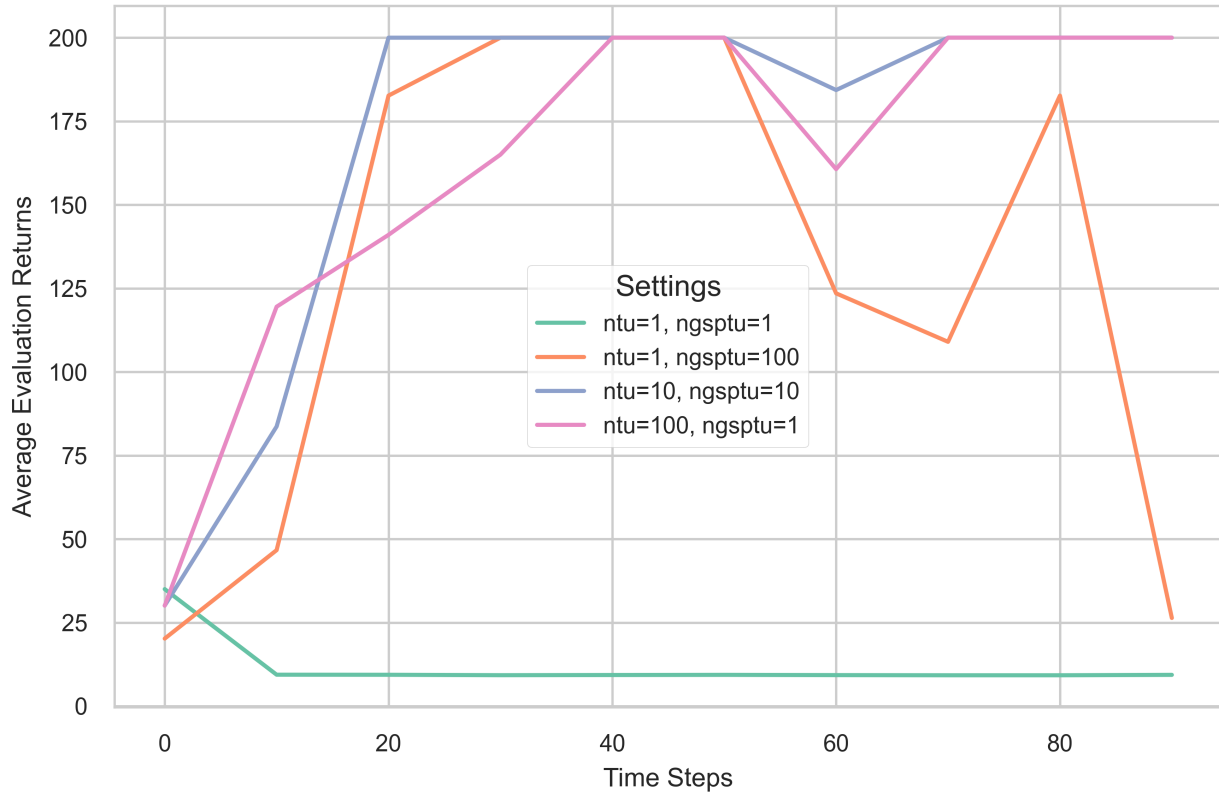
#### Codes

```
python cs285/scripts/run_hw3_dqn.py --env_name LunarLander-v3 --exp_name q3_hparam1 -gpu_id $1;
python cs285/scripts/run_hw3_dqn.py --env_name LunarLander-v3 --exp_name q3_hparam2 -gpu_id $1;
python cs285/scripts/run_hw3_dqn.py --env_name LunarLander-v3 --exp_name q3_hparam3 -gpu_id $1;
```

## 2 Part 2: Actor-Critic

### Question 4: sanity check with Cartpole-v0

#### Results



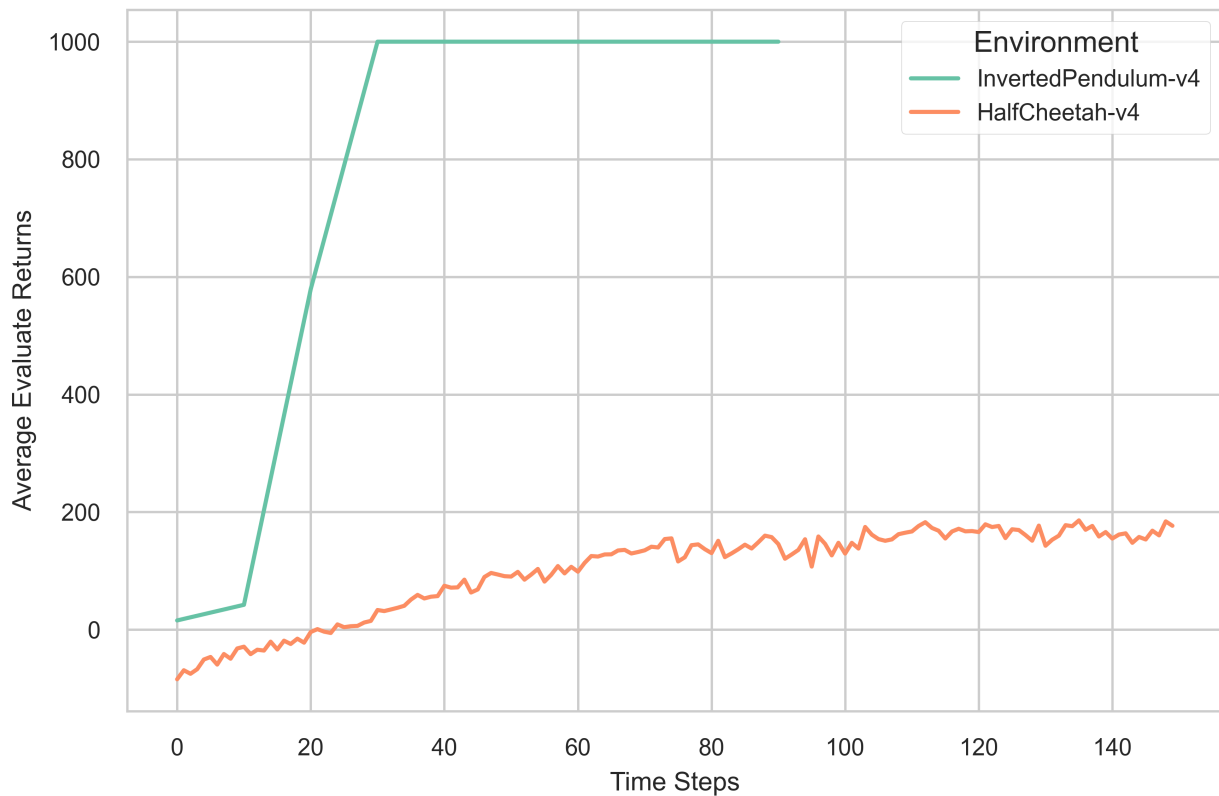
**Figure 4.** Average evaluation returns with respect to training time steps given different `ntu` and `ngsptu` settings. From the results, 10 target updates along with 10 gradient steps per target update yields the best results among the four different settings.

#### Codes

```
echo "Running Homework 3 Question 4..."
python $1 --env_name CartPole-v0 -n 100 -b 1000 --exp_name q4_ac_1_1 -ntu 1 -ngsptu 1 -gpu_id $2
python $1 --env_name CartPole-v0 -n 100 -b 1000 --exp_name q4_ac_100_1 -ntu 100 -ngsptu 1
-gpu_id $2
python $1 --env_name CartPole-v0 -n 100 -b 1000 --exp_name q4_ac_1_100 -ntu 1 -ngsptu 100
-gpu_id $2
python $1 --env_name CartPole-v0 -n 100 -b 1000 --exp_name q4_ac_10_10 -ntu 10 -ngsptu 10
-gpu_id $2
echo "Done!"
```

## Question 5: Run Actor-Critic with more difficult tasks

### Results



**Figure 5.** Average evaluation return with respect to training steps of running Actor-Critic algorithm with InvertedPendulum-v4 (green) and HalfCheetah-v4 (orange).

### Codes

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```
NTU=$2
NGSPTU=$3
GPUID=$4

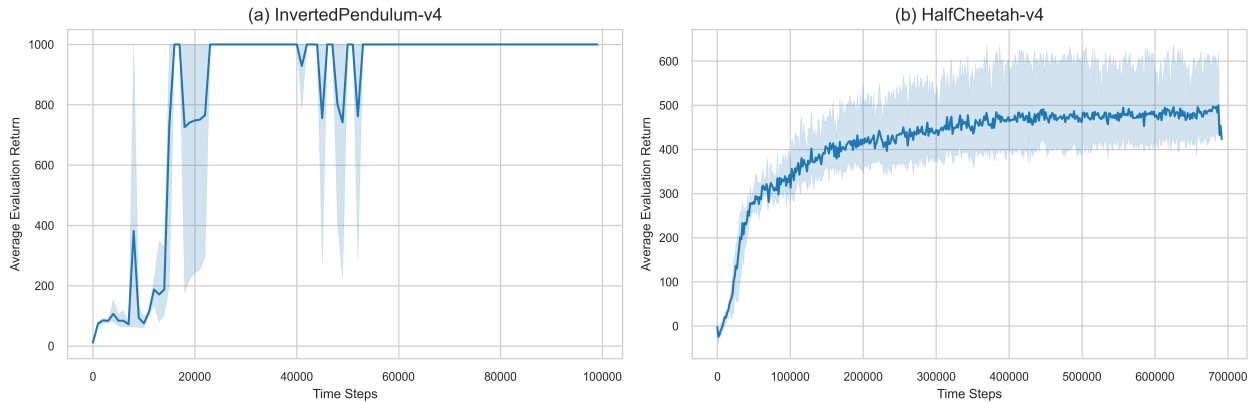
echo "Running Homework 3 Question 5";
python $1 --env_name InvertedPendulum-v4 --ep_len 1000 --discount 0.95 -n 100 -l 2 -s 64 -b 5000
-lr 0.01 --exp_name q5_${NTU}_${NGSPTU} -ntu $NTU -ngsptu $NGSPTU -gpu_id $GPUID;
python $1 --env_name HalfCheetah-v4 --ep_len 150 --discount 0.90 --scalar_log_freq 1 -n 150 -l 2
-s 32 -b 30000 -eb 1500 -lr 0.02 --exp_name q5_${NTU}_${NGSPTU} -ntu $NTU -ngsptu $NGSPTU
-gpu_id $GPUID
echo "Done!"
```

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### 3 Part 3: Soft Actor-Critic

#### Question 6: Run Soft Actor-Critic with more difficult tasks

##### Results



**Figure 6.** Average Evaluation Returns running Soft Actor-Critic on InvertedPendulum-v4 (left) and HalfCheetah-v4 (right). Average rewards on HalfCheetah-v4 reaches around 300 after 50,000 steps, and rewards on InvertedPendulum-v4 reaches 1,000 after 20,000 steps. However, results varies greatly with different seed settings. I only submit the best result for my submission.

##### Codes

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```
echo "Running Homework 3 Question 6";
for SEED in 1 2 3
do
    python cs285/scripts/run_hw3_sac.py --env_name InvertedPendulum-v4 --ep_len 1000 --discount
    0.99 --scalar_log_freq 1000 -n 100000 -l 2 -s 256 -b 1000 -eb 2000 -lr 0.0003
    --init_temperature 0.1 --exp_name q6a_sac_InvertedPendulum_seed_${SEED} --seed $SEED
    -gpu_id $1;
    python cs285/scripts/run_hw3_sac.py --env_name HalfCheetah-v4 --ep_len 150 --discount 0.99
    --scalar_log_freq 1500 -n 2000000 -l 2 -s 256 -b 1500 -eb 1500 -lr 0.0003
    --init_temperature 0.1 --exp_name q6b_sac_HalfCheetah_seed_${SEED} --seed $SEED -gpu_id $1
done
echo "Done!"
```

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