Assignment 2: Policy Gradient

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Collaborators: `Write the Andrew IDs of your collaborators here (if any).`
NOTE: Please do **NOT** change the sizes of the answer blocks or plots.

5 Small-Scale Experiments

5.1 Experiment 1 (Cartpole) – [25 points total]

5.1.1 Configurations

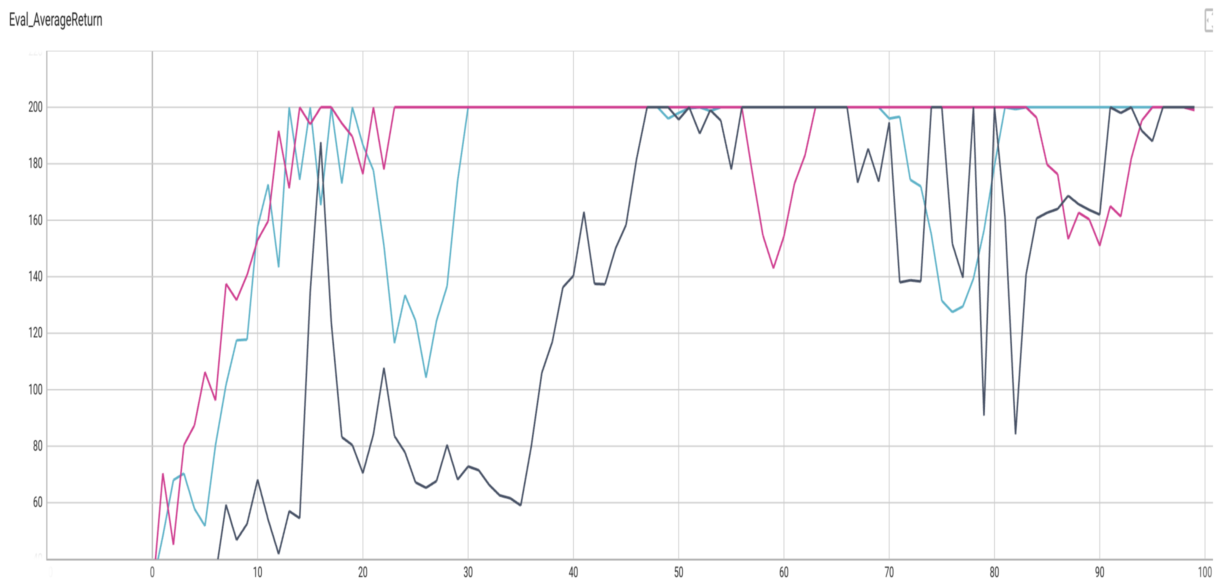
Q5.1.1

```
python rob831/scripts/run_hw2.py --env_name CartPole-v0 -n 100 -b 1000 \
    -dsa --exp_name q1_sb_no_rtg_dsa

python rob831/scripts/run_hw2.py --env_name CartPole-v0 -n 100 -b 1000 \
    -rtg -dsa --exp_name q1_sb_rtg_dsa

python rob831/scripts/run_hw2.py --env_name CartPole-v0 -n 100 -b 1000 \
    -rtg --exp_name q1_sb_rtg_na

python rob831/scripts/run_hw2.py --env_name CartPole-v0 -n 100 -b 5000 \
    -dsa --exp_name q1_lb_no_rtg_dsa

python rob831/scripts/run_hw2.py --env_name CartPole-v0 -n 100 -b 5000 \
    -rtg -dsa --exp_name q1_lb_rtg_dsa

python rob831/scripts/run_hw2.py --env_name CartPole-v0 -n 100 -b 5000 \
    -rtg --exp_name q1_lb_rtg_na
```

5.1.2 Plots

5.1.2.1 Small batch – [5 points]

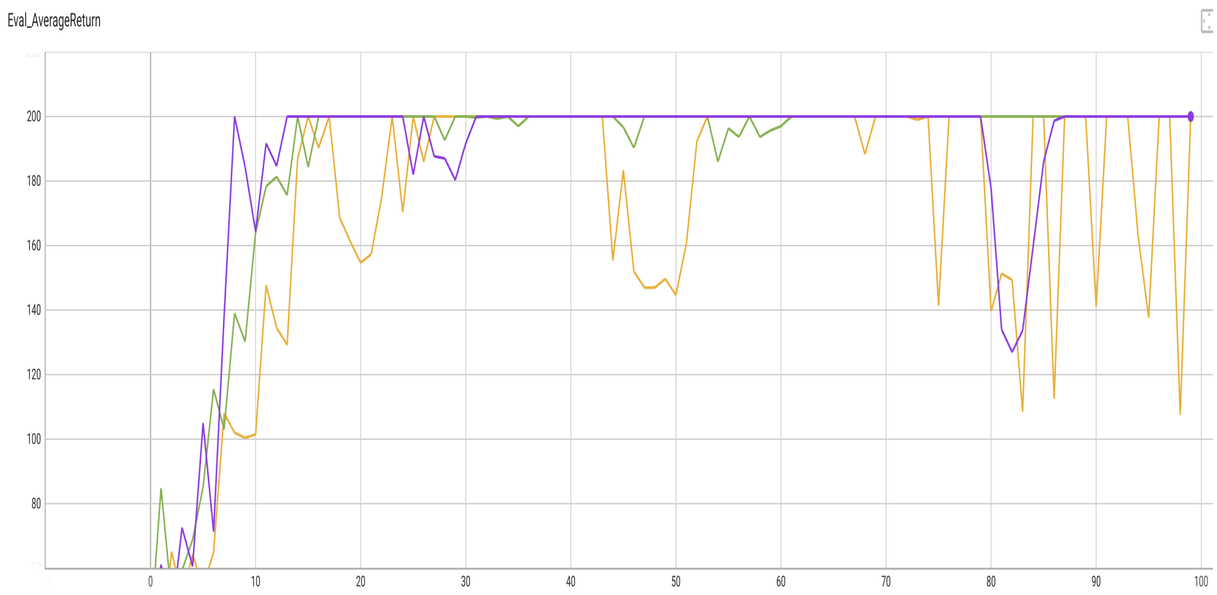
Q5.1.2.1



The gray curve is no reward-to-go and no-standardized-advantage, light-blue curve is with reward-to-go but no-standardized-advantage, pink curve is with reward-to-go and with-standardized-advantage

5.1.2.2 Large batch – [5 points]

Q5.1.2.2



The brown curve is no reward-to-go and no-standardized-advantage, light-green curve is with reward-to-go but no-standardized-advantage, purple curve is with reward-to-go and with-standardized-advantage

5.1.3 Analysis

5.1.3.1 Value estimator – [5 points]

Q5.1.3.1

The reward-to-go always gives faster convergence in both small and large batch size case

5.1.3.2 Advantage standardization – [5 points]

Q5.1.3.2

The standardized advantaged mainly helps on reduce the variance: training with it will has less variation after first time reach 200 eval-averagereturn.

5.1.3.3 Batch size – [5 points]

Q5.1.3.3

The batch size helps to speed up convergence, but not very obviously.

5.2 Experiment 2 (InvertedPendulum) – [15 points total]

5.2.1 Configurations – [5 points]

Q5.2.1

```
python rob831/scripts/run_hw2.py --env_name InvertedPendulum-v4 \
    --ep_len 1000 --discount 0.9 -n 100 -l 2 -s 64 -b <b*> -lr <r*> -rtg \
    --exp_name q2_b<b*>_r<r*>
```

5.2.2 smallest b* and largest r* (same run) – [5 points]

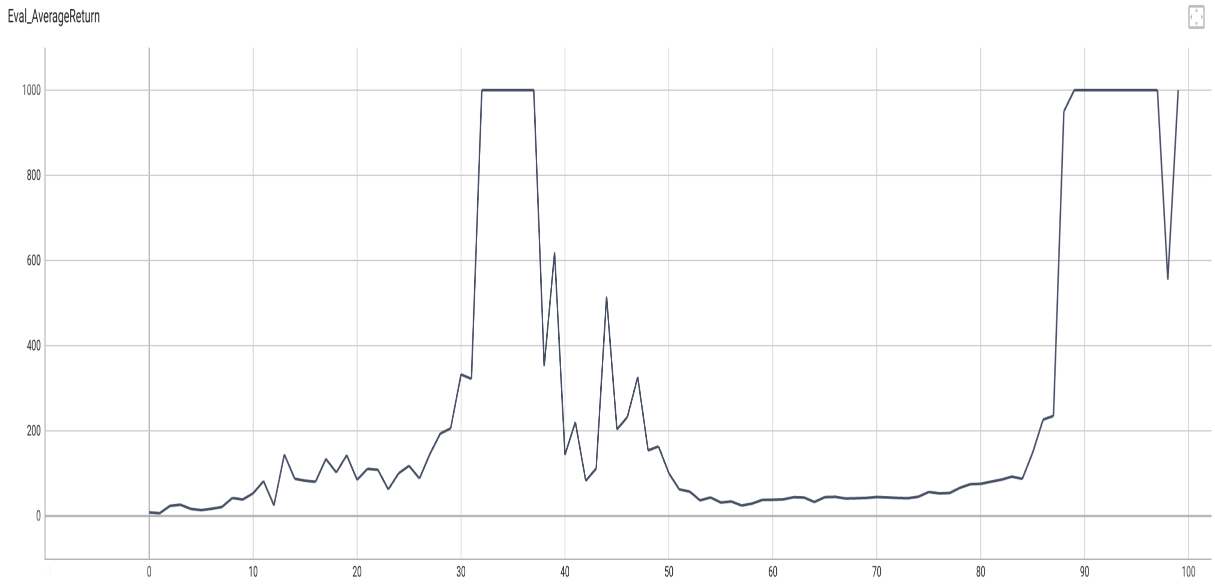
Q5.2.2

smallest batch size: 1000; largest learning rate: 9e-2
command:

```
python rob831/scripts/run_hw2.py --env_name InvertedPendulum-v4 --ep_len 1000 --discount 0.9 -n 100 -l 2 -s 64 -b 1000
↪  -lr 9e-2 -rtg --exp_name q2_b_1000_r_9e-2
```

5.2.3 Plot – [5 points]

Q5.2.3



7 More Complex Experiments

7.1 Experiment 3 (LunarLander) – [10 points total]

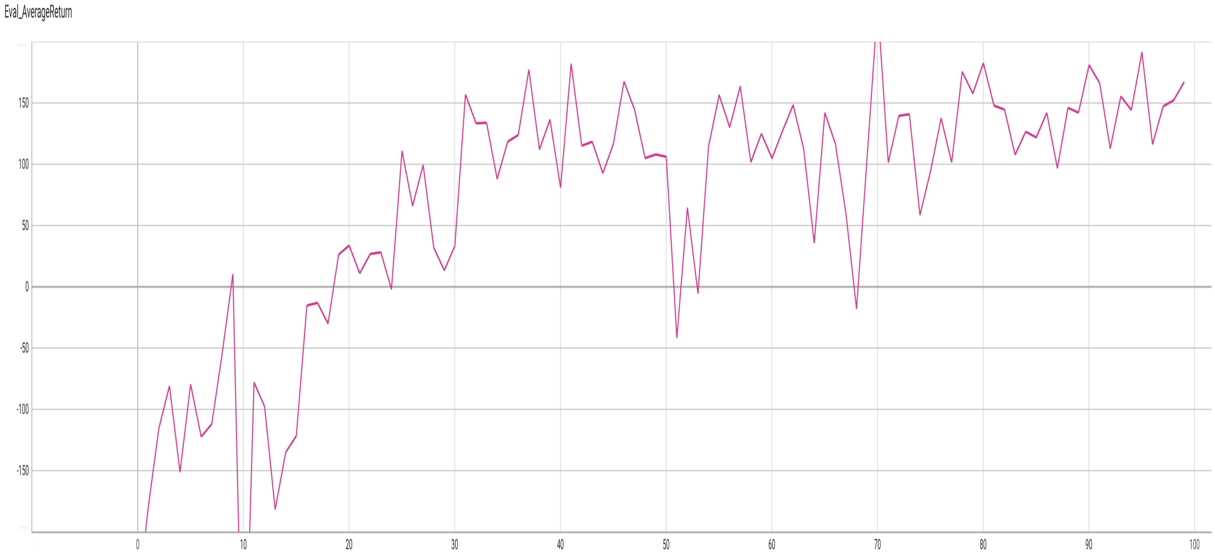
7.1.1 Configurations

Q7.1.1

```
python rob831/scripts/run_hw2.py \
    --env_name LunarLanderContinuous-v4 --ep_len 1000
    --discount 0.99 -n 100 -l 2 -s 64 -b 10000 -lr 0.005 \
    --reward_to_go --nn_baseline --exp_name q3_b10000_r0.005
```

7.1.2 Plot – [10 points]

Q7.1.2



7.2 Experiment 4 (HalfCheetah) – [30 points]

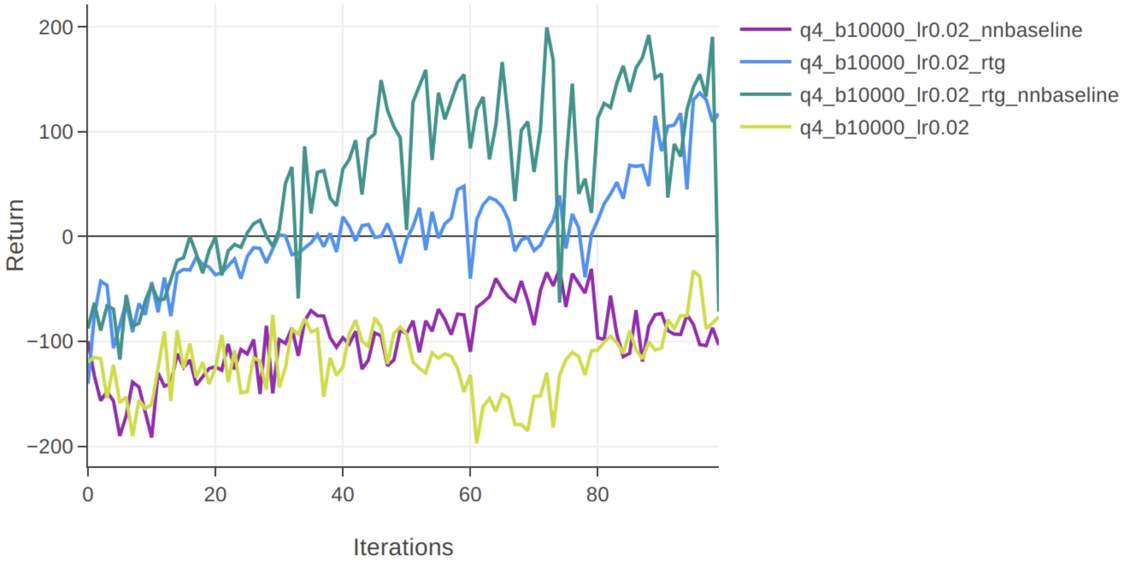
7.2.1 Configurations

Q7.2.1

```
python rob831/scripts/run_hw2.py --env_name HalfCheetah-v4 --ep_len 150 \
    --discount 0.95 -n 100 -l 2 -s 32 -b 10000 -lr 0.02 \
    --exp_name q4_search_b10000_lr0.02
python rob831/scripts/run_hw2.py --env_name HalfCheetah-v4 --ep_len 150 \
    --discount 0.95 -n 100 -l 2 -s 32 -b 10000 -lr 0.02 -rtg \
    --exp_name q4_search_b10000_lr0.02_rtg
python rob831/scripts/run_hw2.py --env_name HalfCheetah-v4 --ep_len 150 \
    --discount 0.95 -n 100 -l 2 -s 32 -b 10000 -lr 0.02 --nn_baseline \
    --exp_name q4_search_b10000_lr0.02_nnbaseline
python rob831/scripts/run_hw2.py --env_name HalfCheetah-v4 --ep_len 150 \
    --discount 0.95 -n 100 -l 2 -s 32 -b 10000 -lr 0.02 -rtg --nn_baseline \
    --exp_name q4_search_b10000_lr0.02_rtg_nnbaseline
```

7.2.2 Plot – [10 points]

Q7.2.2



7.2.3 (Optional) Optimal b* and r* – [3 points]

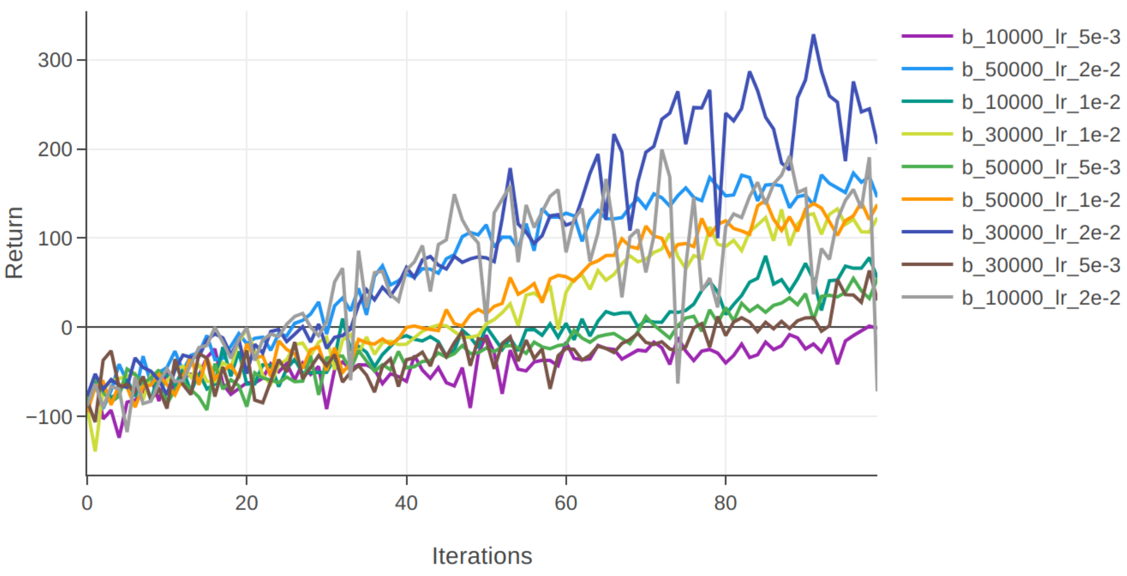
Q7.2.3

The best b and r is batch size of 30000 and learning rate of 2e-2.

```
python rob831/scripts/run_hw2.py --env_name HalfCheetah-v4 --ep_len 150 \
         --discount 0.95 -n 100 -l 2 -s 32 -b 30000 -lr 2e-2 -rtg --nn_baseline \
         --exp_name q4_search_b_30000_lr_2e-2_rtg_nnbaseline
```

7.2.4 (Optional) Plot – [10 points]

Q7.2.4



7.2.5 (Optional) Describe how b* and r* affect task performance – [7 points]

Q7.2.5

Within the range of experiemented data, larger learning rate gives faster convergence. Larger batch size tends to give high final return, but large batch size with large learning rate may result in low return.

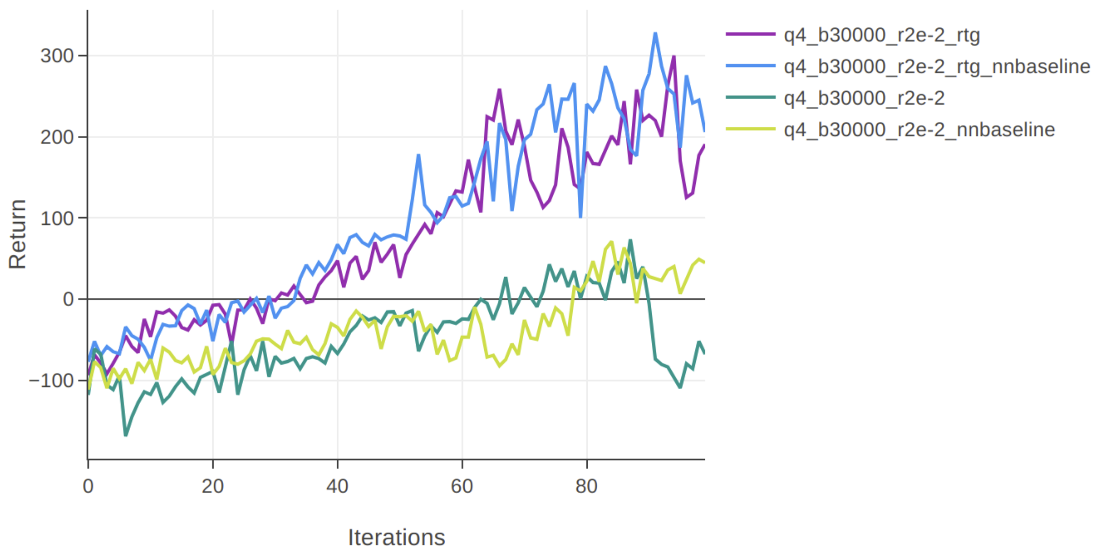
7.2.6 (Optional) Configurations with optimal b* and r* – [3 points]

Q7.2.6

```
python rob831/scripts/run_hw2.py --env_name HalfCheetah-v4 --ep_len 150 \
--discount 0.95 -n 100 -l 2 -s 32 -b 30000 -lr 2e-2 \
--exp_name q4_b30000_r2e-2

python rob831/scripts/run_hw2.py --env_name HalfCheetah-v4 --ep_len 150 \
--discount 0.95 -n 100 -l 2 -s 32 -b 30000 -lr 2e-2 -rtg \
--exp_name q4_b30000_r2e-2_rtg

python rob831/scripts/run_hw2.py --env_name HalfCheetah-v4 --ep_len 150 \
--discount 0.95 -n 100 -l 2 -s 32 -b 30000 -lr 2e-2 --nn_baseline \
--exp_name q4_b30000_r2e-2_nnbaseline

python rob831/scripts/run_hw2.py --env_name HalfCheetah-v4 --ep_len 150 \
--discount 0.95 -n 100 -l 2 -s 32 -b 30000 -lr 2e-2 -rtg --nn_baseline \
--exp_name q4_b30000_r2e-2_rtg_nnbaseline
```

7.2.7 (Optional) Plot for four runs with optimal b* and r* – [7 points]

Q7.2.7



8 Implementing Generalized Advantage Estimation

8.1 Experiment 5 (Hopper) – [20 points]

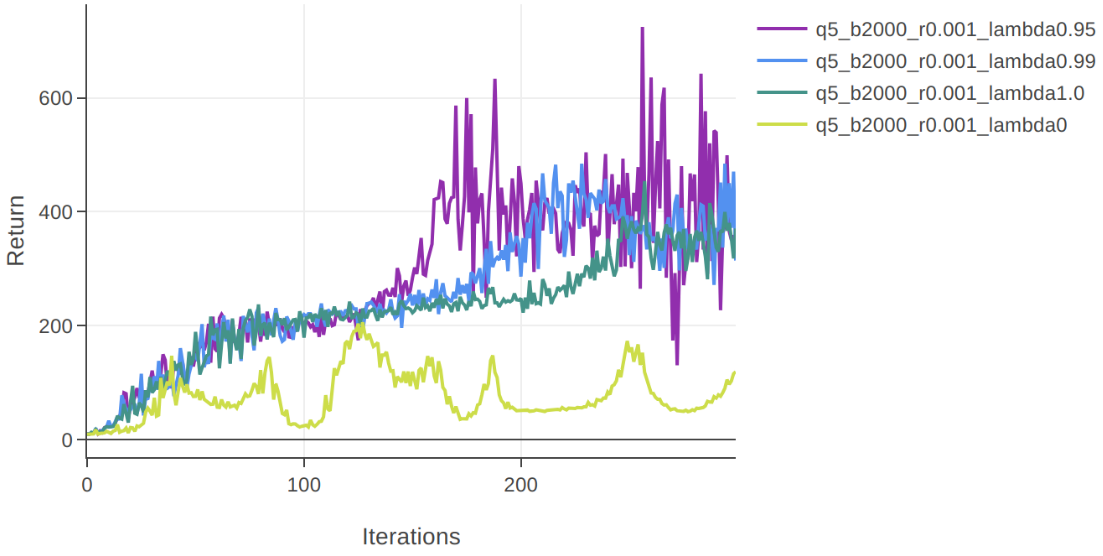
8.1.1 Configurations

Q8.1.1

```
# λ ∈ [0, 0.95, 0.99, 1]
% python rob831/scripts/run_hw2.py \
    --env_name Hopper-v4 --ep_len 1000
    --discount 0.99 -n 300 -l 2 -s 32 -b 2000 -lr 0.001 \
    --reward_to_go --nn_baseline --action_noise_std 0.5 --gae_lambda <λ> \
    --exp_name q5_b2000_r0.001_lambda<λ>
```

8.1.2 Plot – [13 points]

Q8.1.2



8.1.3 Describe how λ affects task performance – [7 points]

Q8.1.3

With λ increase, the convergence speed slower but more stable and has less variance.

9 Bonus! (optional)

9.1 Parallelization – [15 points]

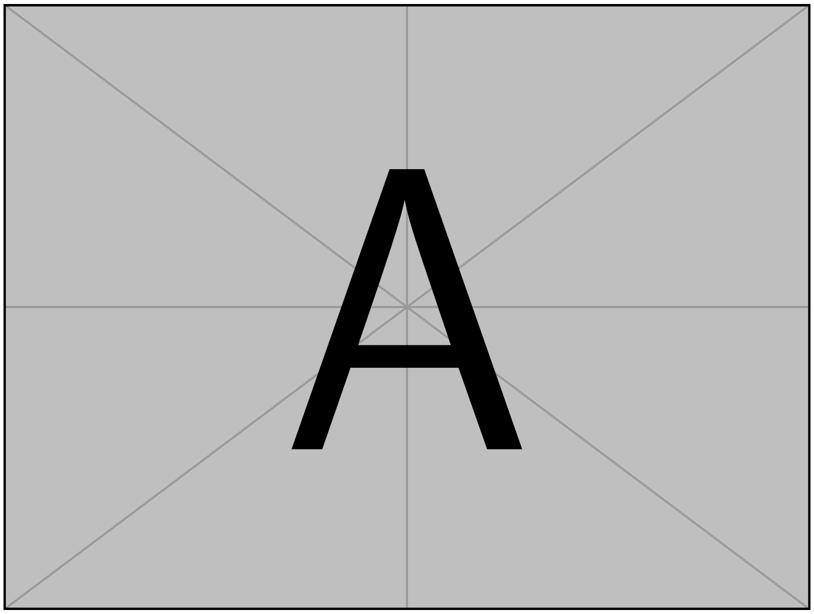
Q9.1

Difference in training time:

```
python rob831/scripts/run_hw2.py \
```

9.2 Multiple gradient steps – [5 points]

Q9.1



```
python rob831/scripts/run_hw2.py \
```