Experimental Setup

Hyper Parameters

```yaml
sizes:
  size_of_action_space: 2
  size_of_state_space: 3
  size_of_observation_space: 3
  horizon_len: 4
  num_episode: 2000
  confidence_level: 0.2
  risk_sensitivity_factor: 1.0 (default, later scanned in -5.0,-3.0,-1.0,1.0,3.0,5.0)
```

Environment Setting

Initial distribution:

$$\mu(\cdot) = [1, 0, 0]$$

we start from state 0 almost surely.

```
mu_true=torch.tensor([1,0,0])
```

Transition Matrices

We assume stationary transition. The transition law is almost deterministic.

```
T_true=torch.stack([torch.tensor([[0.03,0.04,0.89],
                                  [0.95,0.02,0.10],

[0.02,0.94,0.01]]).to(torch.float64).unsqueeze(-1).repeat(1,1,2)
                    for for _ in range(H)])
T_true=Normalize_T(T_true)
```

Emission Matrices

We assume stationary emission. In the experiments we consider both partially observable environment, when the emission is random, and the fully observable setting, in which the emission matrices are identity matrices that reveals the hidden states directly.

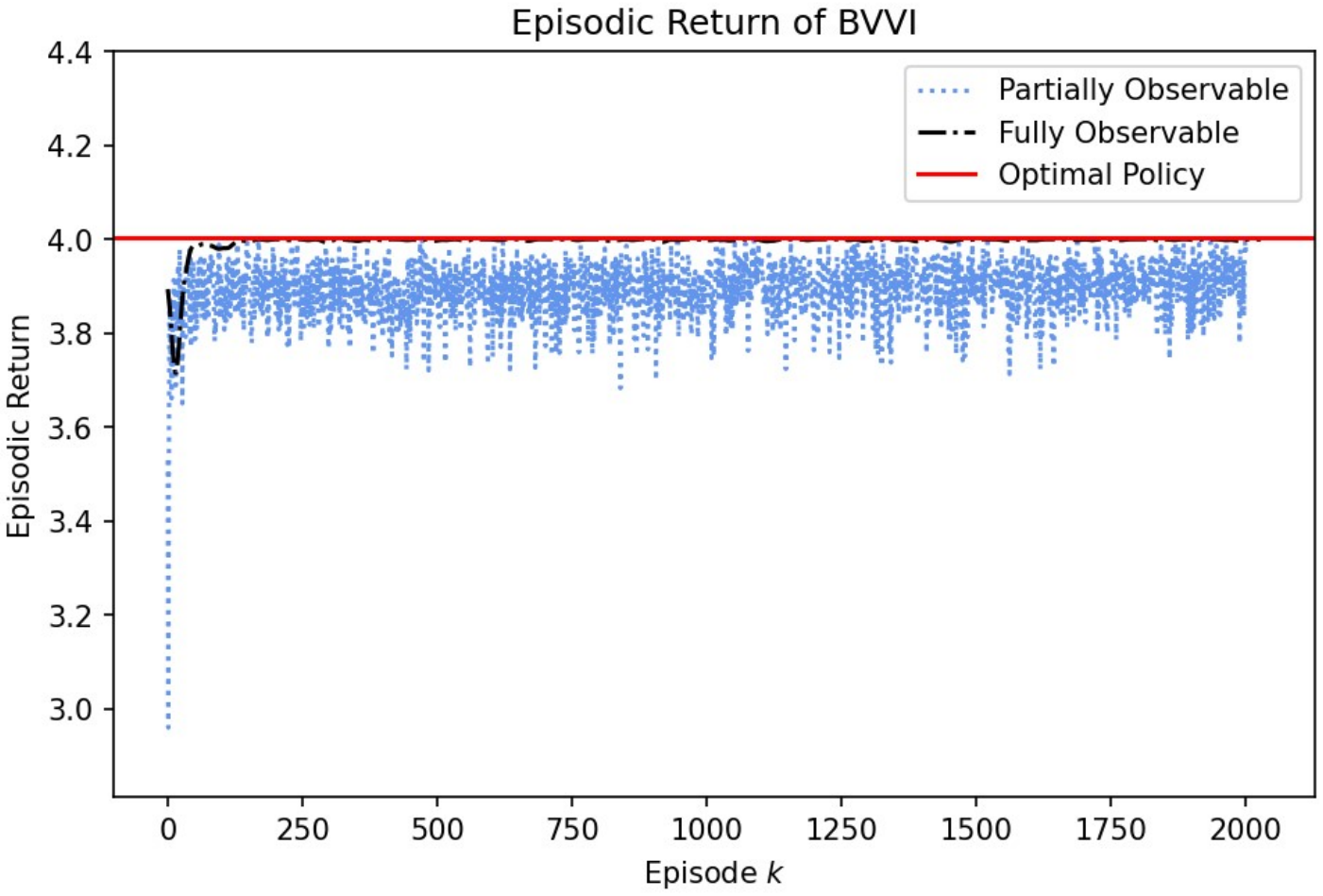
```
if identity_emission==False:
    O_true=torch.stack([
        torch.tensor([[0.83,0.05,0.02],
                      [0.08,0.79,0.09],
                      [0.09,0.06,0.89]]).to(torch.float64).transpose(0,1).repeat(1,1)
        for _ in range(H+1)])
    O_true=Normalize_O(O_true)
else:
    O_true=torch.eye(3).unsqueeze(0).repeat(H+1,1,1)
```

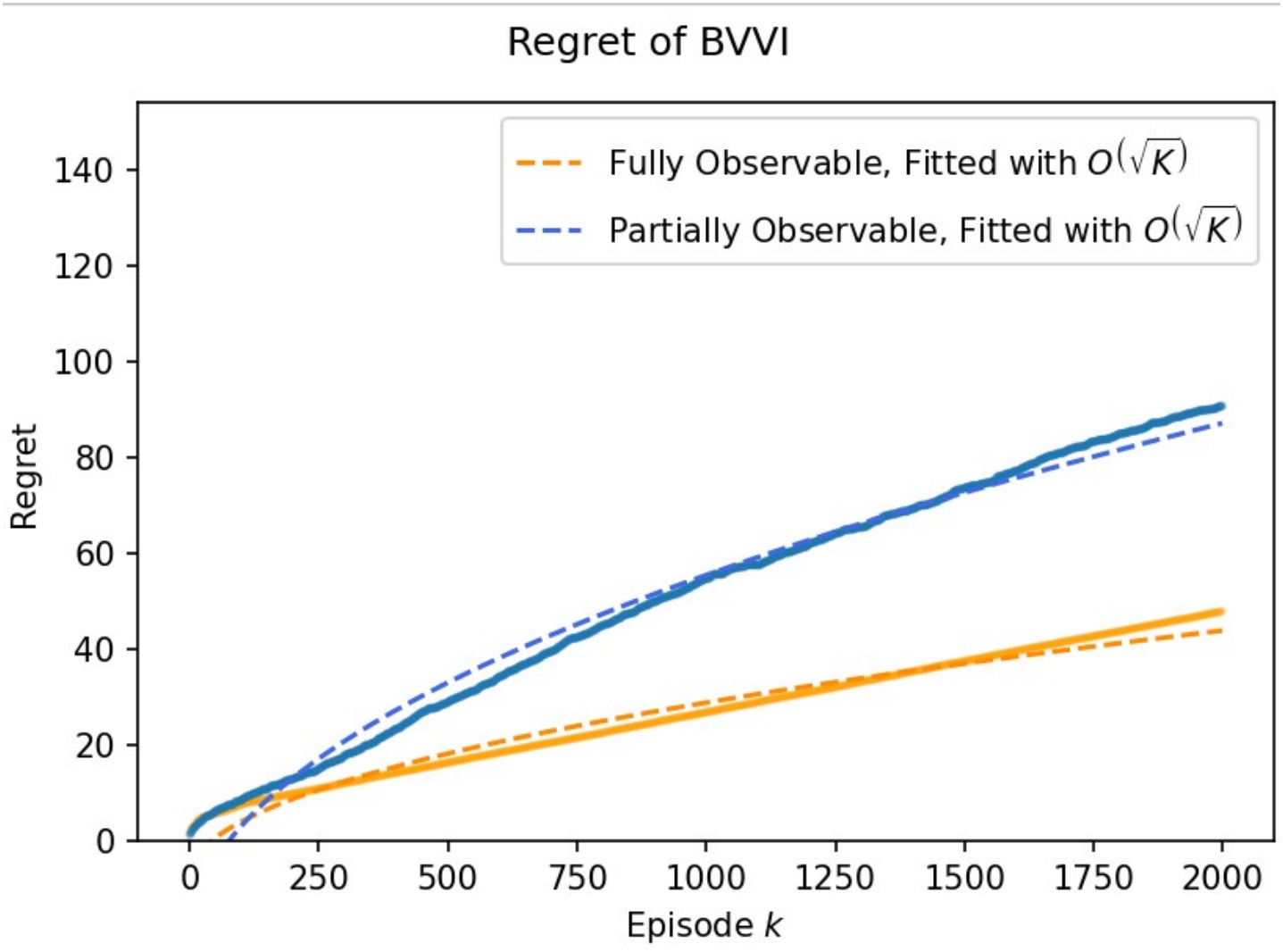
Rewards

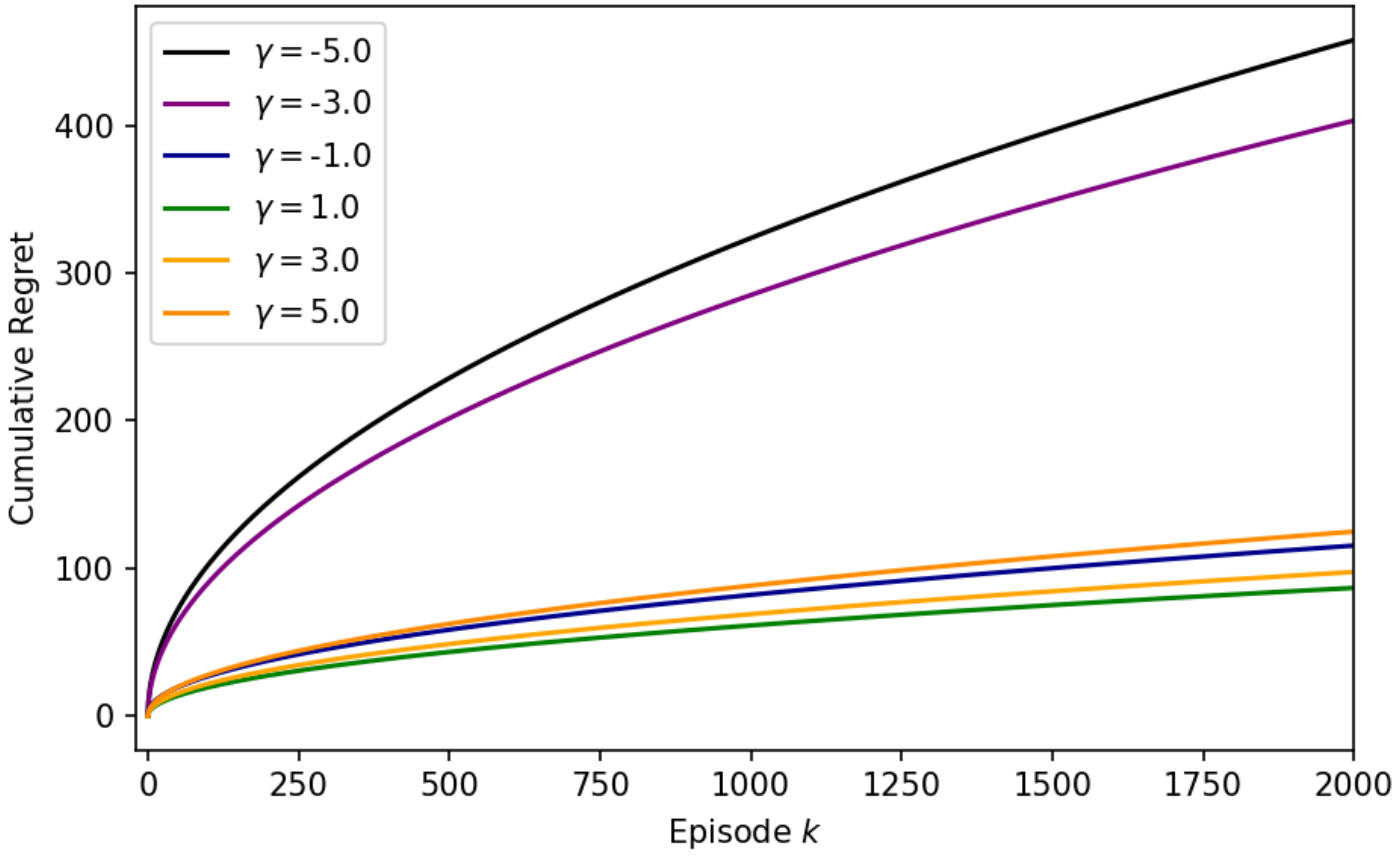
Rewards are functions of the hidden states and actions.

```
R_true=torch.tensor([[1,0],[0,1],[1,0]]).unsqueeze(0).repeat(H,1,1)
```

Experimental results(new)

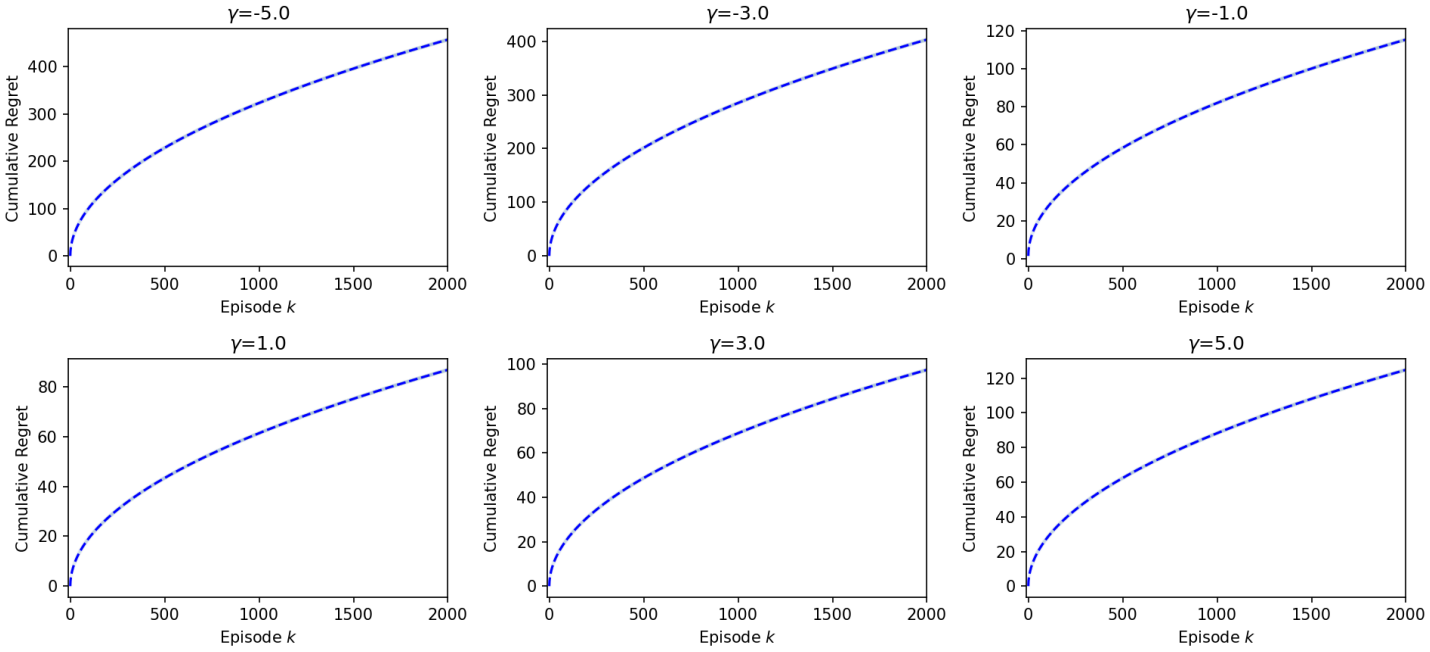



Regret of BVVI
Fully Observable, Fitted with $O(\sqrt{K})$
Partially Observable, Fitted with $O(\sqrt{K})$
Regret
Episode k
0
20
40
60
80
100
120
140
0
250
500
750
1000
1250
1500
1750
2000


$\gamma = -5.0$
$\gamma = -3.0$
$\gamma = -1.0$
$\gamma = 1.0$
$\gamma = 3.0$
$\gamma = 5.0$
Cumulative Regret
Episode k
0
100
200
300
400
0
250
500
750
1000
1250
1500
1750
2000

Regret of BVVI under Various Risk Levels

$$\text{Regret} = \tilde{O}\left(\frac{e^{|\gamma|H}-1}{|\gamma|H} H^2 \sqrt{KHS^2OA}\right)$$



PAC Guarantee of BVVI under Various Risk Levels

$$J(\pi^*; \mathcal{P}, \gamma) - \frac{1}{K}\sum_{k=1}^{K} J(\pi^k; \mathcal{P}, \gamma) = \tilde{O}\left(\frac{1}{\sqrt{K}} \frac{e^{|\gamma|H}-1}{|\gamma|H} H^2 \sqrt{HS^2OA}\right)$$