Artificial Intelligence Project: Hierarchy Deep Q-Learning

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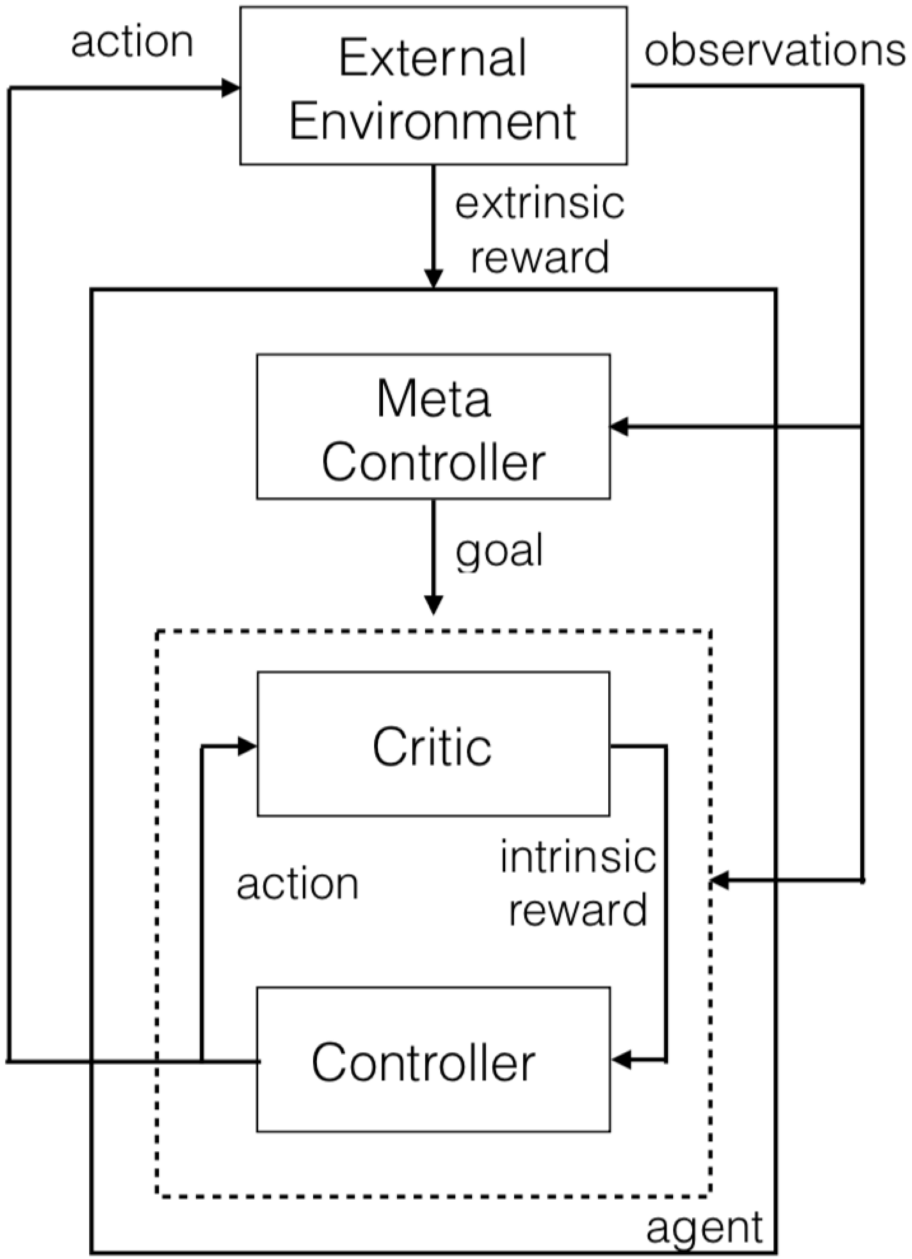
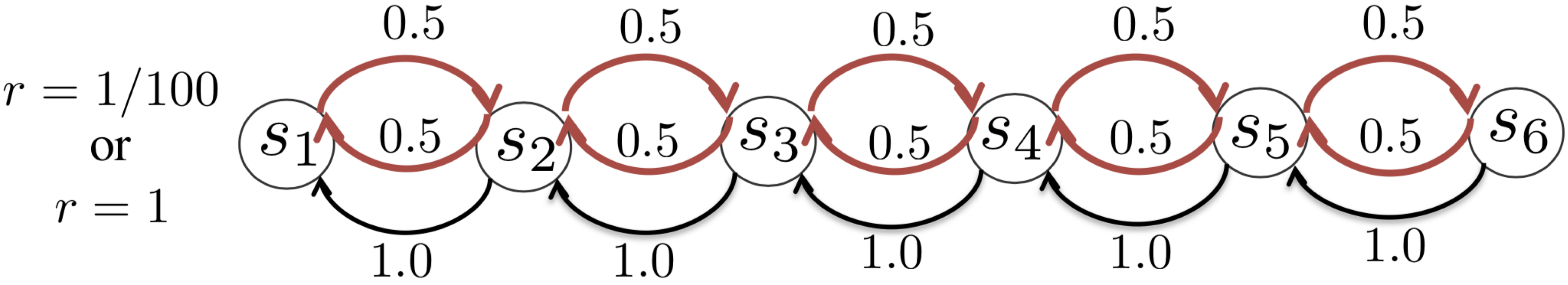
Introduction

Meta Controller:
(Higher Hierarchy)
Interact with External Environment (extrinsic reward), set goals for Controller;

Controller:
(Lower Hierarchy)
Try to achieve goals, receive intrinsic reward from Meta Controller.



Problem Setting

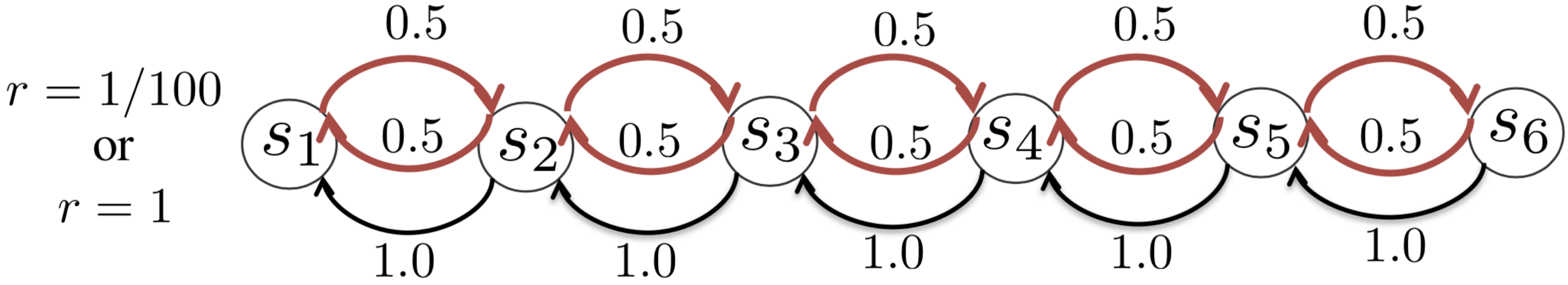


Reward: if s6 is visited, reward = 1; else, reward = 0.01

Actions: 1: move to left with probability 1;

2: move to right with probability 0.5; otherwise, move to left;

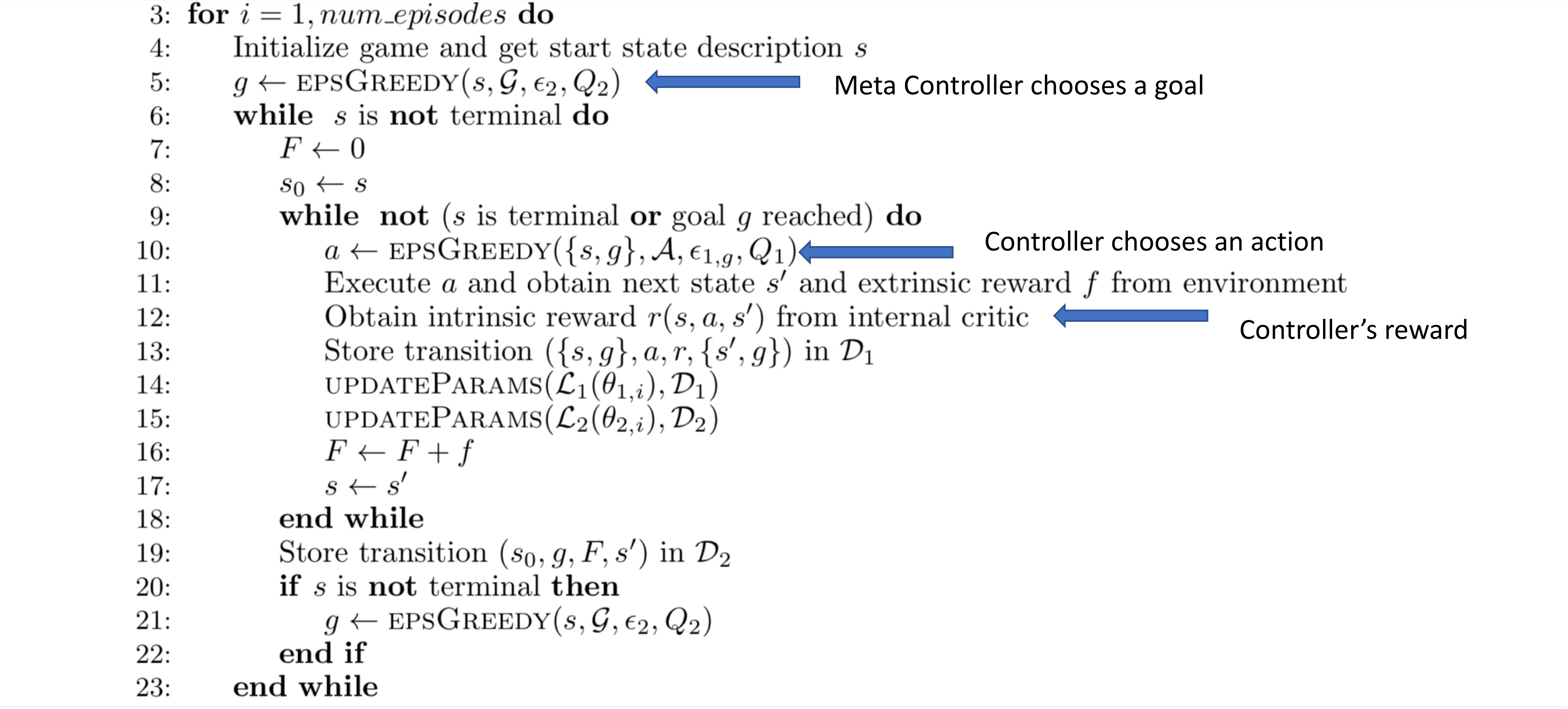
Difficulties



Hidden State: What if we have an additional state to indicate whether s6 is visited?

Search Efficiency: Can epsilon greedy agent keep taking action 2 for enough times?

Reimplementation



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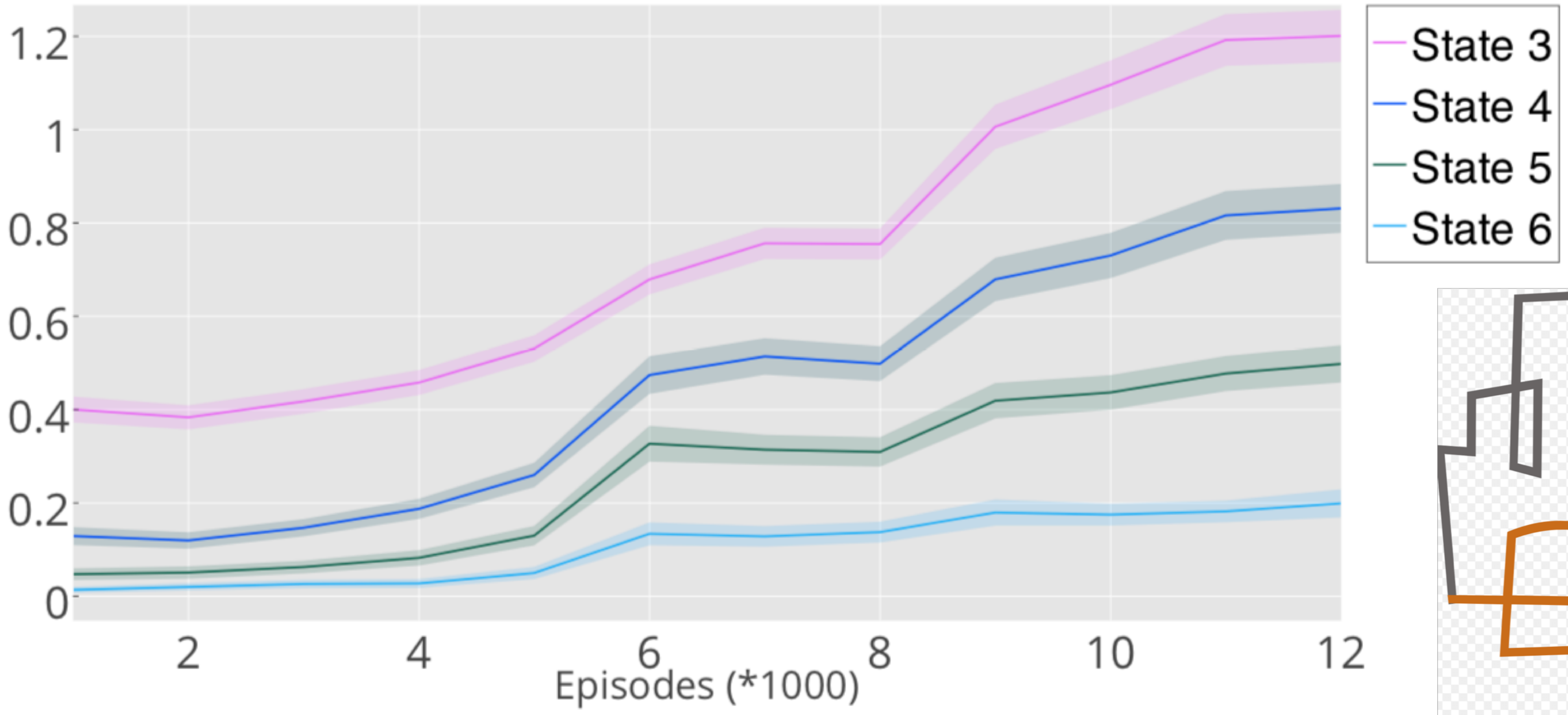
for $i = 1, num\_episodes$ do
    Initialize game and get start state description $s$
    $g \leftarrow \textsc{epsGreedy}(s, \mathcal{G}, \epsilon_2, Q_2)$
    while $s$ is not terminal do
        $F \leftarrow 0$
        $s_0 \leftarrow s$
        while not ($s$ is terminal or goal $g$ reached) do
            $a \leftarrow \textsc{epsGreedy}(\{s, g\}, \mathcal{A}, \epsilon_{1,g}, Q_1)$
            Execute $a$ and obtain next state $s'$ and extrinsic reward $f$ from environment
            Obtain intrinsic reward $r(s, a, s')$ from internal critic
            Store transition $(\{s, g\}, a, r, \{s', g\})$ in $\mathcal{D}_1$
            $\textsc{updateParams}(\mathcal{L}_1(\theta_{1,i}), \mathcal{D}_1)$
            $\textsc{updateParams}(\mathcal{L}_2(\theta_{2,i}), \mathcal{D}_2)$
            $F \leftarrow F + f$
            $s \leftarrow s'$
        end while
        Store transition $(s_0, g, F, s')$ in $\mathcal{D}_2$
        if $s$ is not terminal then
            $g \leftarrow \textsc{epsGreedy}(s, \mathcal{G}, \epsilon_2, Q_2)$
        end if
    end while
```

Meta Controller chooses a goal

Controller chooses an action

Controller's reward

Reimplementation



Authors' Result:

Ref: Hierarchical Deep Reinforcement Learning: Integrating Temporal Abstraction and Intrinsic Motivation

Reimplementation

Our result:

epoch	s1	s2	s3	s4	s5	s6
1	1	1.596	0.903	0.421	0.172	0.058
2	1	1.571	0.859	0.435	0.21	0.063
3	1	1.654	0.928	0.415	0.211	0.07
4	1	1.661	0.978	0.484	0.237	0.07
5	1	1.592	0.9	0.499	0.298	0.107
6	1	1.635	1.003	0.601	0.36	0.127
7	1	1.576	0.942	0.574	0.306	0.098

Ref: https://github.com/EthanMacdonald/h-DQN

Reimplementation

- Interesting Phenomena:

When goal is sited to s2, the controller often takes action 2…

Then it can visit s6…

Meta-Controller receives a big reward…

Meta-Controller tends to set s2 as the goal…

But, is this stable?

Maybe the experience of Controller is too volatile to train Meta Controller?

Quality input guarantees quality output…