Competitive Game of Life

Comp390 Demonstration

Hang Yang

Overview

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Introduction of the Project

Conway’s Game of Life represents the birth, survival and death of individual cells on a 2D surface.

I developed a two-player competitive version of Conway’s Game of Life, and I trained reinforcement learning agent (AI) to play against with human player.

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Motivation and Progress I made

- At the beginning of the project, instead of developing a game based on Conway's Game of Life, I was trying to put up with a mathematical model of Artificial life which can also survive, die, evolve, etc. The idea of Emergency catch me and I tried study two possible models myself: a model inspired by DNA and a model inspired by Taichi. (Not done)

- After that I turn to focus on Reinforcement Learning which is exciting and it's detailed in my project proposal. I try to train an agent that can deal with chaos which is unpredictable by human's intuition.(Done, see details in next slide)

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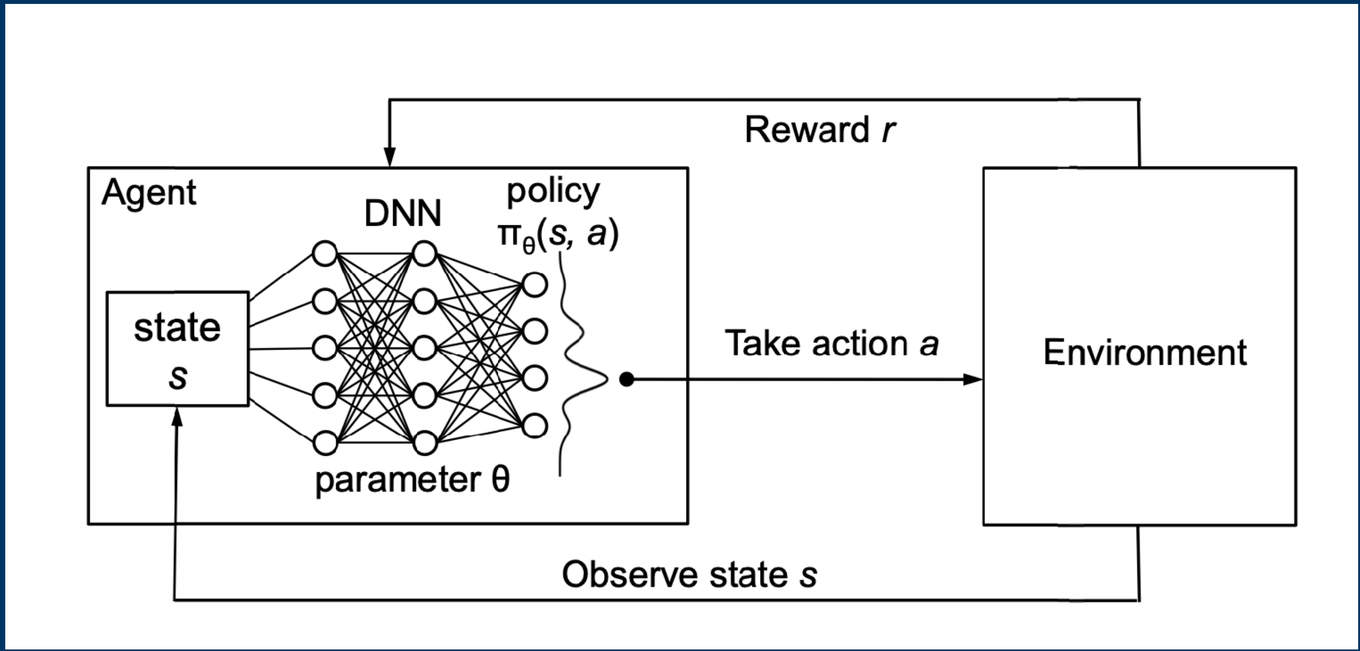
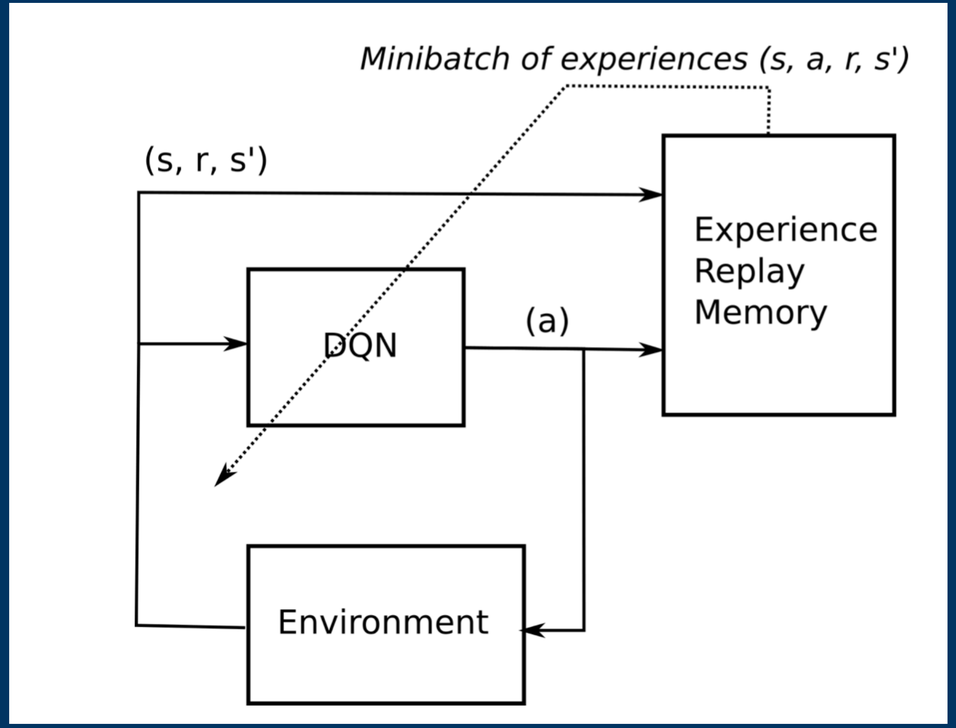
Reinforcement Learning

Deep Q Network (DQN) [1]



Experience replay memory [2]



$$\mathcal{L}(\theta) = \mathbb{E}_\pi[(r_t + \gamma \max_{a'} Q_\theta(s', a') - Q_\theta(s, a))^2]$$

Loss function [2]

Reward function

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Reinforcement Learning

This game is symmetric:

```
episode:  990  and reward:  250
episode:  991  and reward:  90
episode:  992  and reward:  -100
episode:  993  and reward:  -100
episode:  994  and reward:  -100
episode:  995  and reward:  -100
episode:  996  and reward:  290
episode:  997  and reward:  190
episode:  998  and reward:  190
episode:  999  and reward:  -100
episode:  1000  and reward:  250
fianl wining: 0.496
(base) niceanyh@pc-68-253 dqn_keras_v2 %
```

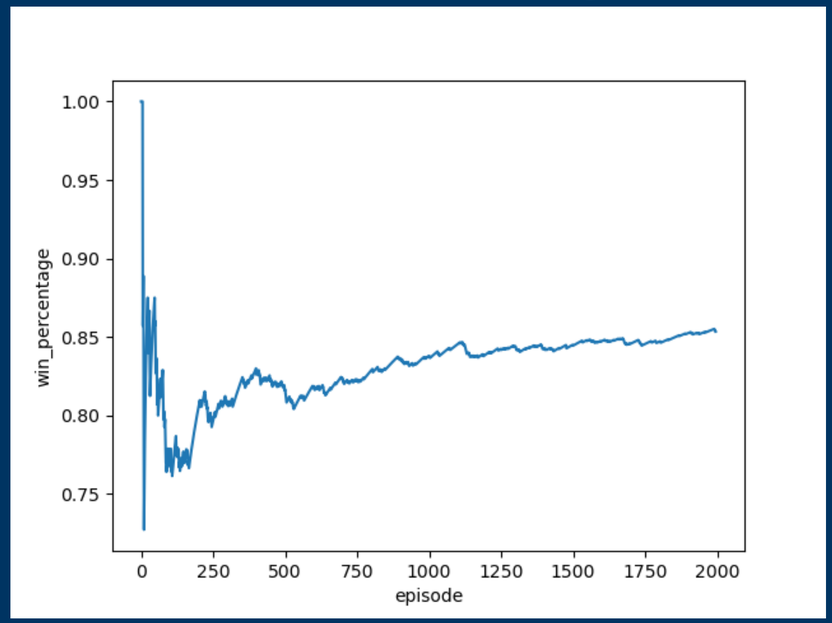
(Playing by two random-action players)

After Training:

```
episode:  990  and reward:  260
episode:  991  and reward:  160
episode:  992  and reward:  -100
episode:  993  and reward:  260
episode:  994  and reward:  -100
episode:  995  and reward:  180
episode:  996  and reward:  220
episode:  997  and reward:  -100
episode:  998  and reward:  250
episode:  999  and reward:  290
episode:  1000  and reward:  280
fianl wining: 0.854
(base) niceanyh@pc-68-253 dqn_keras_v2 %
```

(DQN agent play against random player)

Training curve
(accumulated wining rate)



- Currently model used: 5000 episodes playing against still life + 1000 episodes playing against random player.

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The Philosophy behind the project

- I try to imitate Monument Valley which is a game known for its minimalism.

- Inspired by a book called Sapiens: A Brief History of Humankind, I am quite into the idea of evolution, competition. A good game could also inspire people to think about that.

- The sound of life. Some patterns might have higher possibility to win (higher Q value), so can I train a classifier to let each state play piano. By listening to the sound of each state, we might find something interesting.

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Conclusion

The thing I'm most proud of is that I built a game environment and UI, defined the problem and developed Reinforcement Learning Agent, and the agent did a good job.

Knowing that a friend of mine' honour year project is to develop reinforcement learning models by using existing integrated game environments (gym)

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Reference

[1] H. Mao, M. Alizadeh, I. Menache, and S. Kandula, “Resource management with deep reinforcement learning,” in Proceedings of the15th ACM Workshop on Hot Topics in Networks, ser. HotNets ’16. New York, NY, USA: Association for Computing Machinery, 2016, p. 50–56. [Online]. Available: https://doi.org/10.1145/3005745.3005750

[2] J.Vitay “Deep Reinforcement Learning” [Online]. Available: https://julien-vitay.net/deeprl/Valuebased

Links

Github: https://github.com/Niceanyh/GoI_dqn_v2

Video: https://liverpool.instructuremedia.com/embed/75bcf9a1-edf9-436e-befd-7264b3f5fe69

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