Minerunner

組員: 許瑋哲 、林揚森、林穎沛、陳宥翔

Introduction

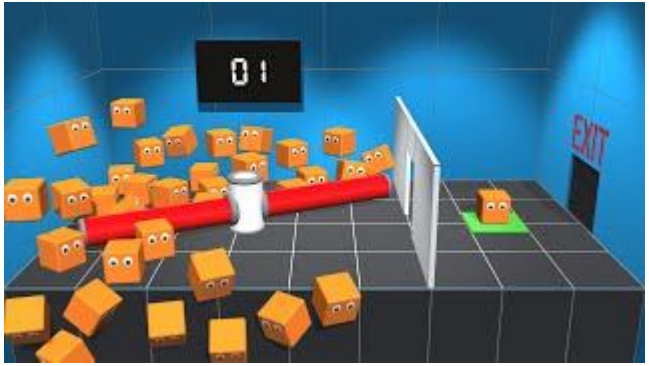
- 3D-world of Minecraft to simulate real world.
- AI exploring the specific map in Minecraft.
- Use QL & DQN & CNN to train

Introduction-Why this problem is important?

1. Generalize exploration system .
2. Pushing it to the real world .
3. Manually efficient.

Related work

- Malmo
- MineDojo
- MineRL
- AI learns to escape



Malmo

Platform

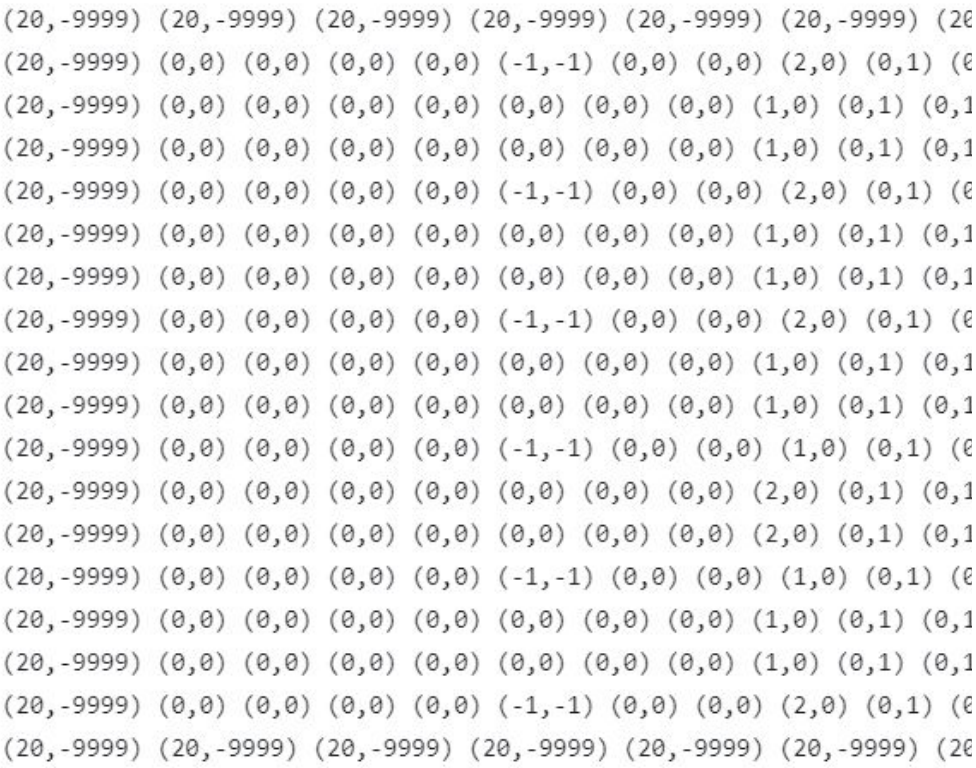
- Platform
  - Minecraft
  - Malmo

Dataset

- Store the information about maps in a metrix
  - We take 9 blocks around us as observation.
  - Each block has 2 feature: (h_d, block_type)
- h_d: height difference with block and initial spawn point(height = 0)
- block_type: Serial number of each block

obsidian	sandStone	diamond	lapis_block
-1	0	0	-1

Matrix for maps



```
(20,-9999) (20,-9999) (20,-9999) (20,-9999) (20,-9999) (20,-9999) (2
(20,-9999) (0,0) (0,0) (0,0) (0,0) (-1,-1) (0,0) (0,0) (2,0) (0,1) (0
(20,-9999) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (1,0) (0,1) (0,1
(20,-9999) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (1,0) (0,1) (0,1
(20,-9999) (0,0) (0,0) (0,0) (0,0) (-1,-1) (0,0) (0,0) (2,0) (0,1) (0
(20,-9999) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (1,0) (0,1) (0,1
(20,-9999) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (1,0) (0,1) (0,1
(20,-9999) (0,0) (0,0) (0,0) (0,0) (-1,-1) (0,0) (0,0) (2,0) (0,1) (0
(20,-9999) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (1,0) (0,1) (0,1
(20,-9999) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (1,0) (0,1) (0,1
(20,-9999) (0,0) (0,0) (0,0) (0,0) (-1,-1) (0,0) (0,0) (1,0) (0,1) (0
(20,-9999) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (2,0) (0,1) (0,1
(20,-9999) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (2,0) (0,1) (0,1
(20,-9999) (0,0) (0,0) (0,0) (0,0) (-1,-1) (0,0) (0,0) (1,0) (0,1) (0
(20,-9999) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (1,0) (0,1) (0,1
(20,-9999) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (0,0) (1,0) (0,1) (0,1
(20,-9999) (0,0) (0,0) (0,0) (0,0) (-1,-1) (0,0) (0,0) (2,0) (0,1) (0
(20,-9999) (20,-9999) (20,-9999) (20,-9999) (20,-9999) (20,-9999) (2
```

Cristina tried to swim in lava
Received mission: Cliff walking mission based on Sutton and Barto.
Source: kubernetes.docker.internal
19...

Baseline - Q learning with CNN

- Input state
- Convolutional layer
  - conv1
- Fully connected layer
  - fc1
  - fc2
- Output q value

Baseline - Q learning with CNN

```python
class Net(nn.Module):
    def __init__(self, num_actions, hidden_layer_size=128):
        super(Net, self).__init__()
        # input_shape is 2 * 3 * 3
        self.input_state = (2, 3, 3)  # the dimension of state space
        self.num_actions = num_actions  # the dimension of action space

        # Convolutional layers
        # 讓圖片可以資訊完整被輸入進去
        self.conv1 = nn.Conv2d(in_channels=2, out_channels=6, kernel_size=1)
        # output shape is 6 * 3 * 3
        self.conv2 = nn.Conv2d(in_channels=6, out_channels=12, kernel_size=2)
        # output shape is 12 * 2 * 2
        # Fully connected layers
        self.fc1 = nn.Linear(12 * 2 * 2, hidden_layer_size)
        self.fc2 = nn.Linear(hidden_layer_size, num_actions)

    def forward(self, x):
        x = F.relu(self.conv1(x))
        print(f'size after conv 1: {x.size()}')
        x = F.relu(self.conv2(x))
        print(f'size after conv 2: {x.size()}')
        x = torch.flatten(x, 1)
        print(f'size after flatten: {x.size()}')
        x = F.relu(self.fc1(x))
        q_values = self.fc2(x)
        return q_values
```

Baseline - DQN

```python
class Net(nn.Module):
    def __init__(self,  num_actions, hidden_layer_size=80):
        super(Net, self).__init__()
        self.input_state = 4  # the dimension of state space
        self.num_actions = num_actions  # the dimension of action space
        self.fc1 = nn.Linear(self.input_state, 32)  # input layer
        self.fc2 = nn.Linear(32, hidden_layer_size)  # hidden layer
        self.fc3 = nn.Linear(hidden_layer_size, num_actions)  # output layer

    def forward(self, states):
        x = F.relu(self.fc1(states))
        x = F.relu(self.fc2(x))
        q_values = self.fc3(x)
        return q_values
```

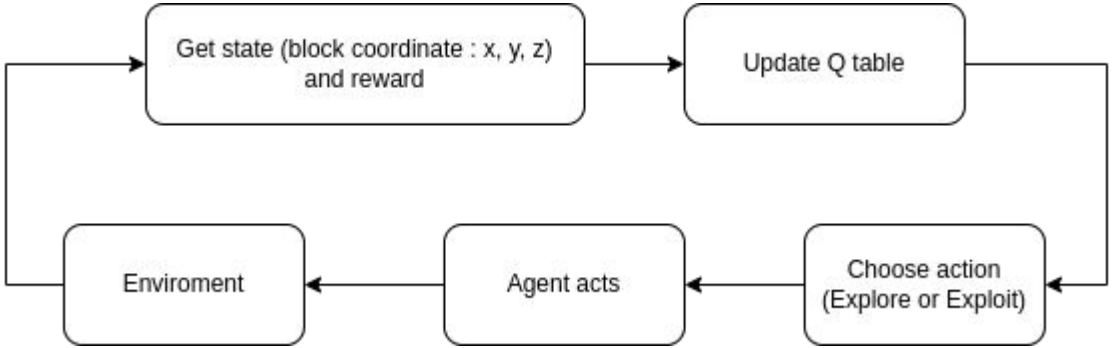
- Input state
- Full connected layer
  - fc1
  - fc2
  - fc3
- Output q value

Main Approach

- Q-learning
  - Q-table
  - DQN
  - CNN

Main Approach-Q-Learning

- Q-table

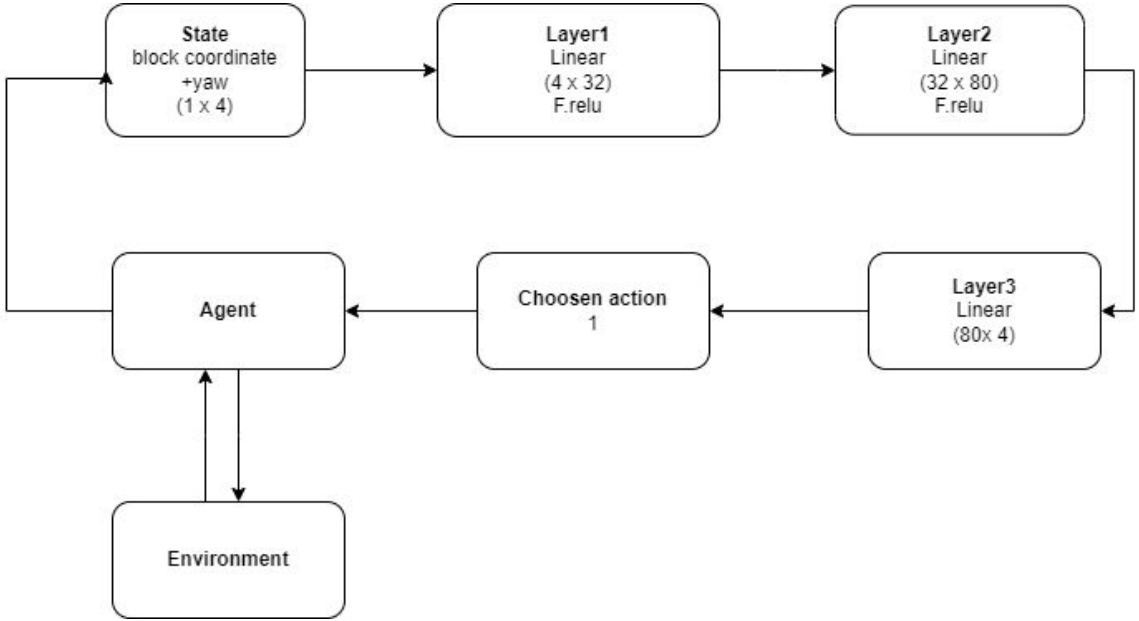


The formula for updating the Q table:

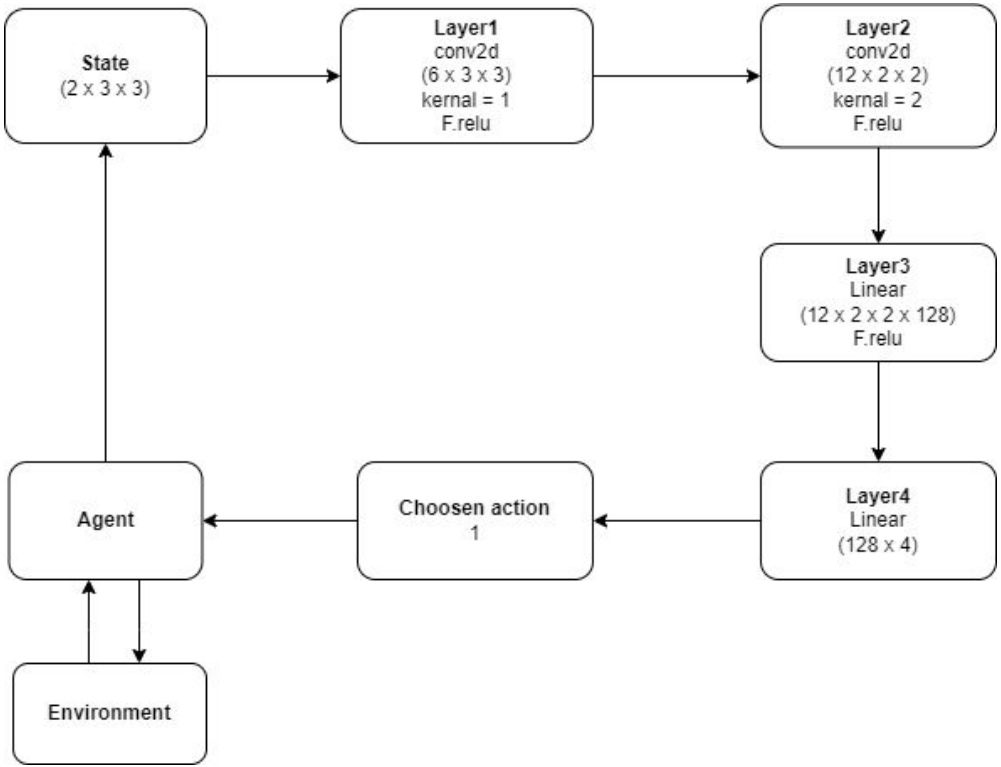
new_q = old_q + learning_rate * (reward - old_q)

Main Approach-DQN

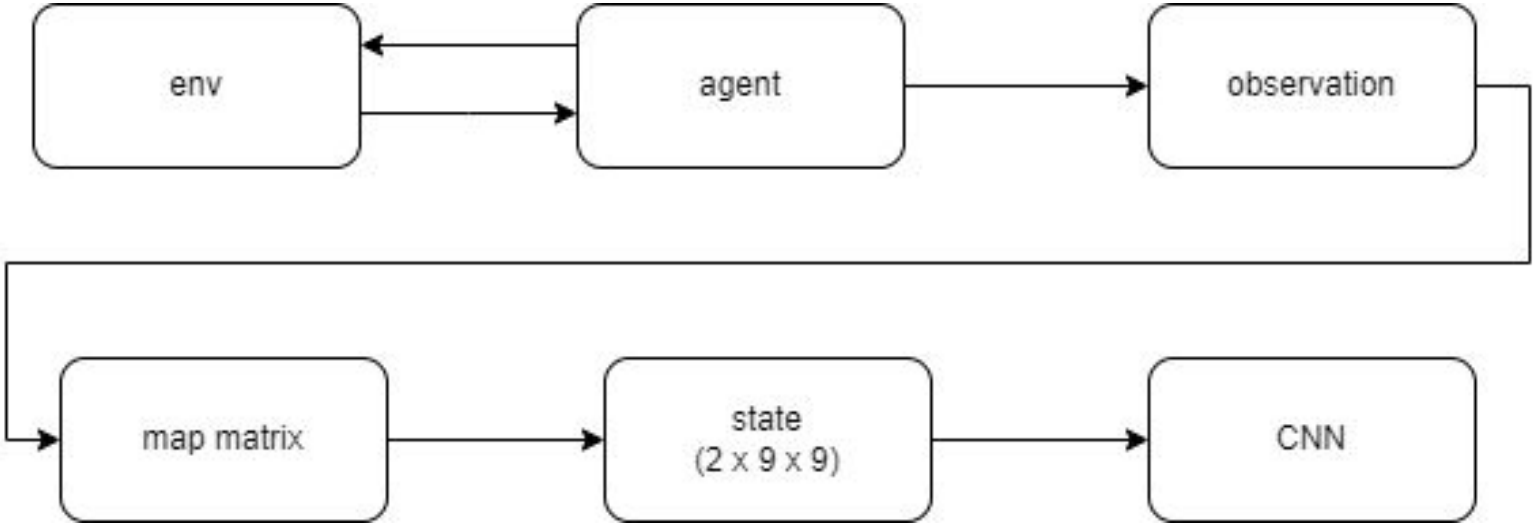
- DQN



Main Approach-CNN

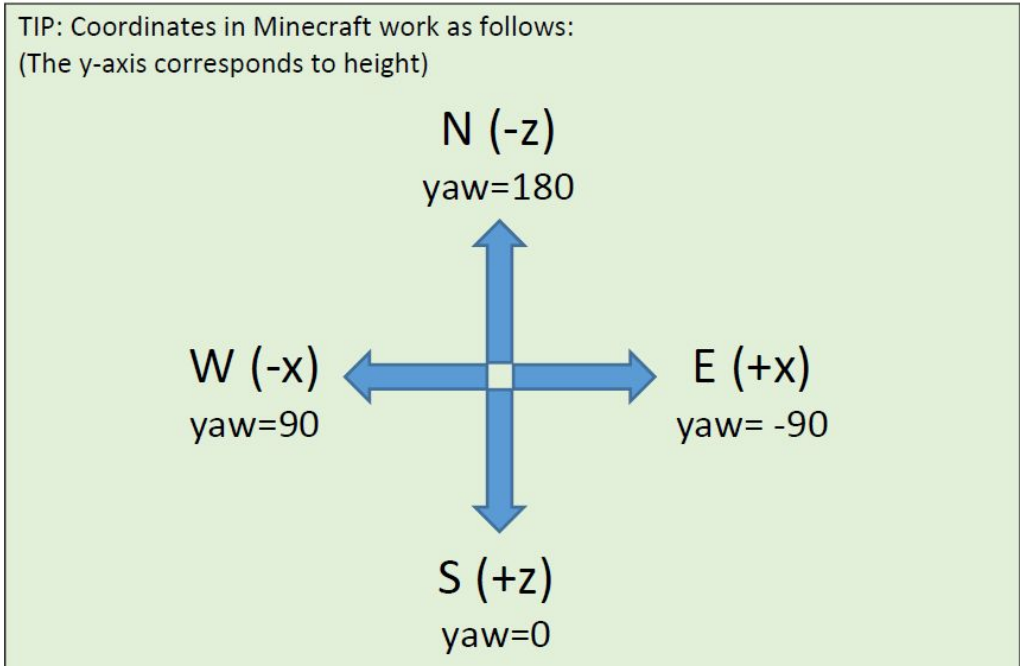


Main Approach-How to get state



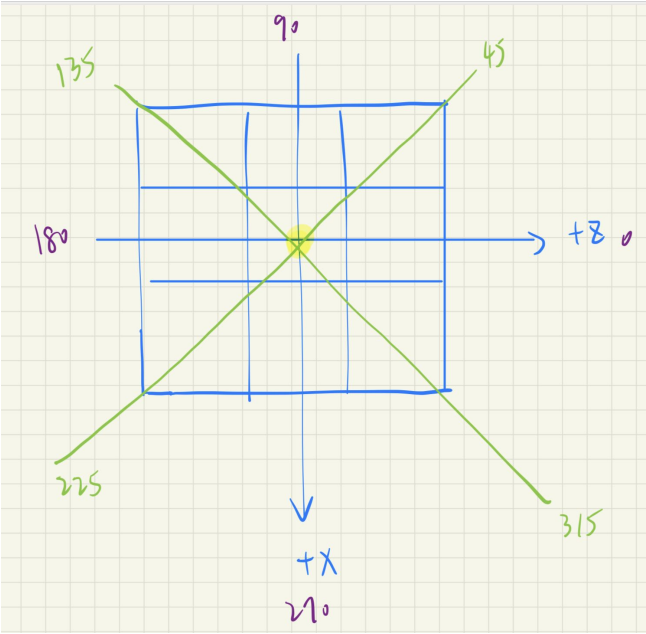
Main Approach-How to get state

- Coordination system in malmo



Main Approach-How to get state

- state transform from map matrix



Main Approach-How to get state

- Block order change based on different yaw

map matrix

1	2	3
4	5	6
7	8	9

45<=yaw<=135

7	8	9
4	5	6
1	2	3

135<=yaw<=225

9	6	3
8	5	2
7	4	1

225<=yaw<=315

3	2	1
6	5	4
3	2	1

0<=yaw<=45
or 315<=yaw<=360(0)

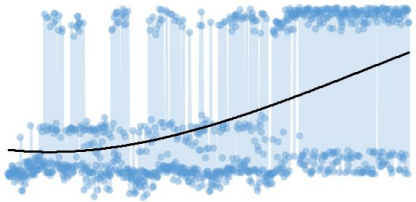
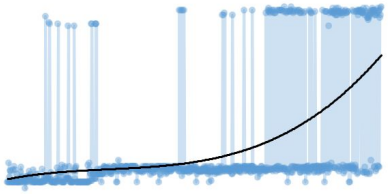
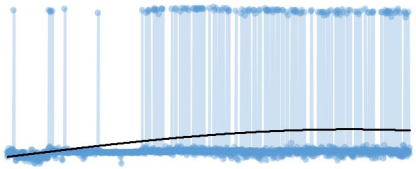
3	6	9
2	5	8
1	4	7

Main Approach-XML file

code > Train > new_map_xml > 20230605_2.xml

```xml
<AgentHandlers>
  <ContinuousMovementCommands/>
  <ObservationFromFullStats/>
  <RewardForTouchingBlockType>
    <Block reward="200.0" type="lapis_block" behaviour="onceOnly"/>
    <Block reward="-50" type="obsidian" behaviour="onceOnly"/>
    <Block reward="20.0" type="diamond_block" behaviour="onceOnly"/>
    <Block reward='2' type='sandstone' behaviour='oncePerBlock'/>
  </RewardForTouchingBlockType>
  <RewardForTimeTaken initialReward="0" delta="-0.1" density="PER_TICK"/>
  <RewardForSendingCommand reward="-2" />
  <RewardForMissionEnd rewardForDeath="-20.0">
    <Reward description="out_of_time" reward="0.0"/>
  </RewardForMissionEnd>
  <AgentQuitFromTouchingBlockType>
      <Block type="obsidian" />
      <Block type="lapis_block" />
  </AgentQuitFromTouchingBlockType>
</AgentHandlers>
</AgentSection>
```

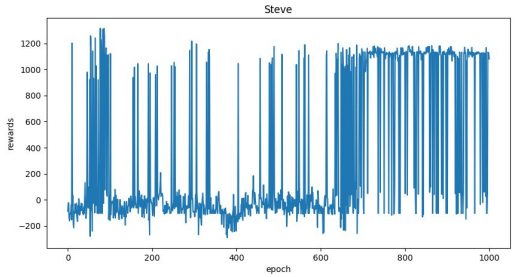
Evaluation metric

	Success Rate	Learning Curve
Q-table	0.372	
DQN	0.1916	
CNN	0.0752	

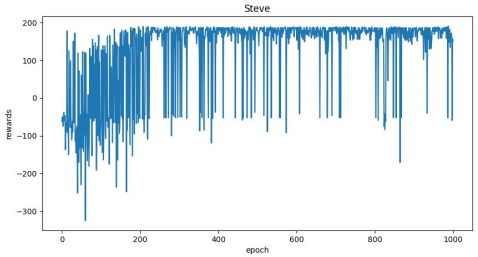
1. 任
2. 學
3. ~~平~~

Results & analysis & Others // Important

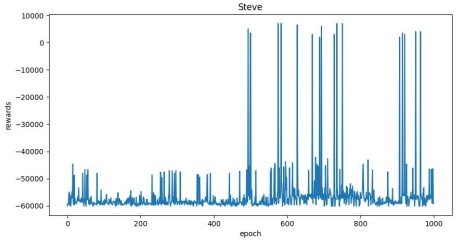
- Change learning rate



Large learning rate : 0.1



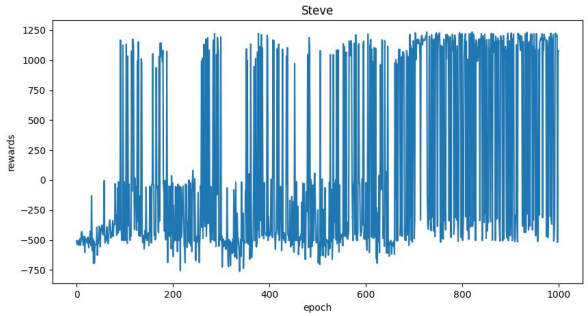
Medium learning rate : 0.01



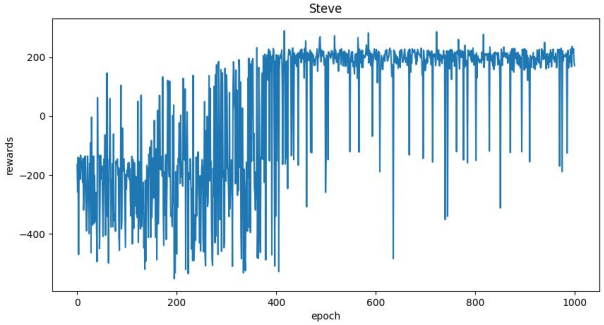
Small learning rate : 0.0001

Results & analysis & Others

- Change the epilson



High epilson : 0.99 -> 0.3

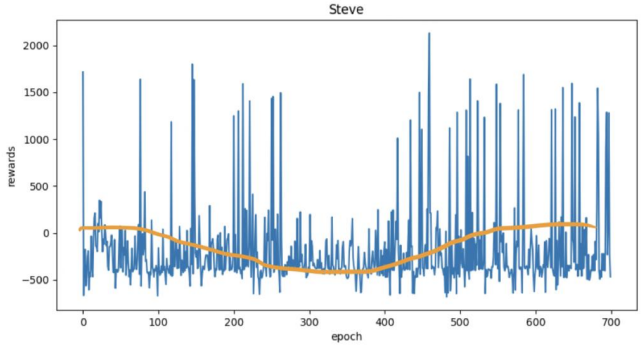


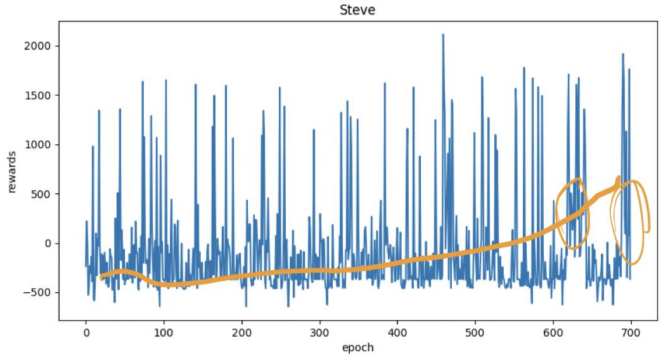
Decayed epilson : 0.99->0.01

Results & analysis & Others // Important

- The reward of the sand is too high

DQN-Map3





- Difference:

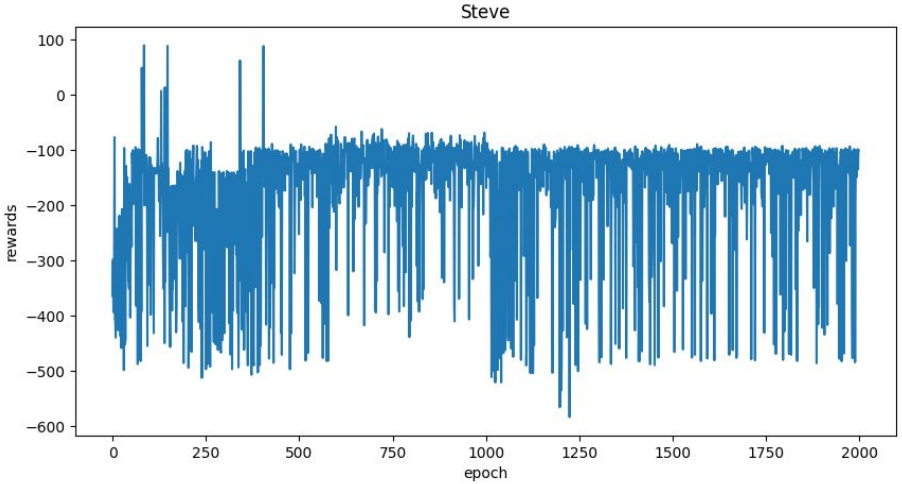
1. Added: increasing reward block

2. Added :time penalty & movement reward

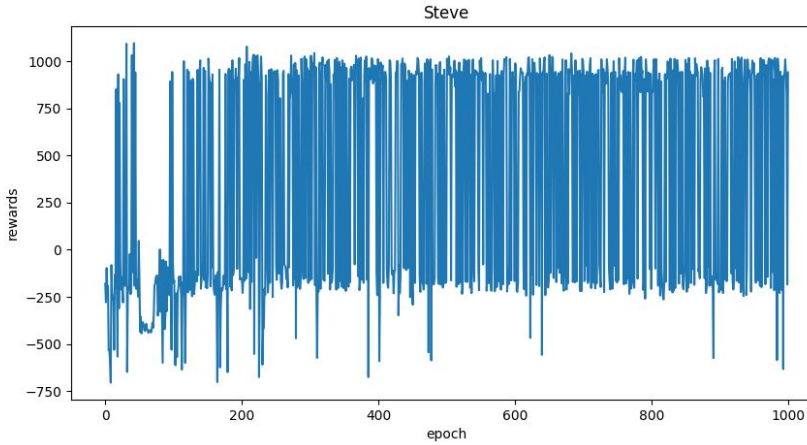
3.Result: Number of success increased!

Results & analysis & Others-CNN

- Change gamma rate



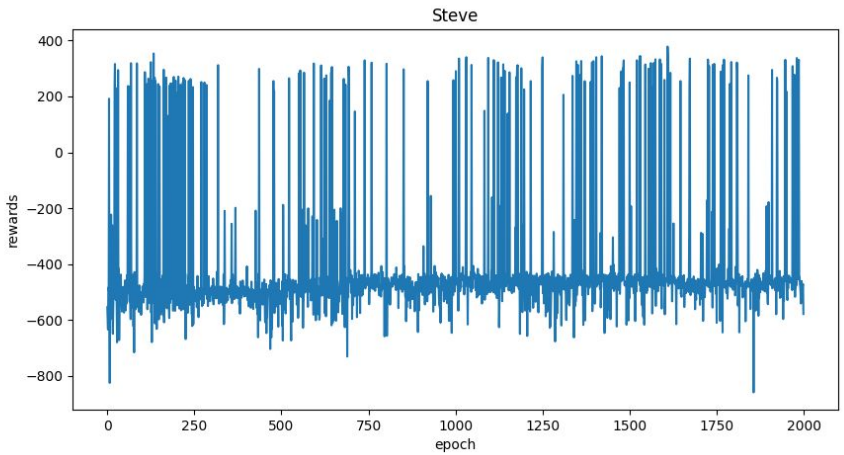
gamma = 0.15



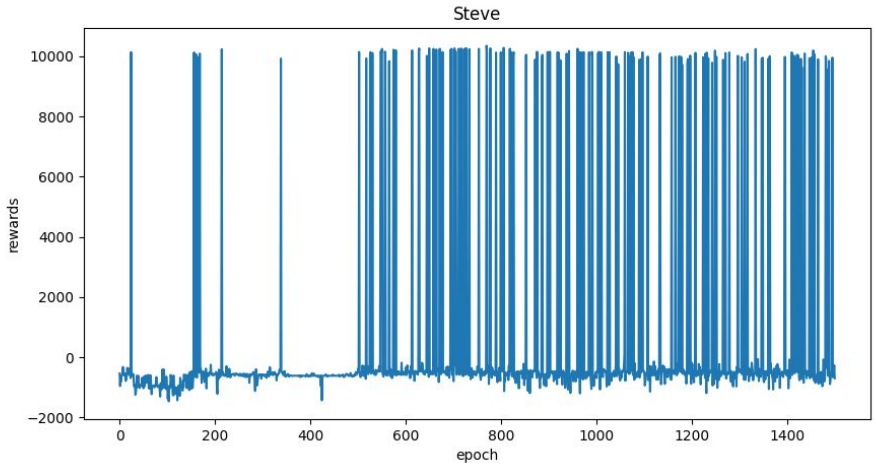
gamma = 0.99

Results & analysis & Others-CNN

- Change learning rate



learning rate: 0.1



learning rate: 0.001

Results & analysis & Others-Limitation

- input state
- movement
- q-learning algorithm with previous info and current info

Github link

https://github.com/zebra314/MineRunner

Reference

malmo : https://github.com/microsoft/malmo

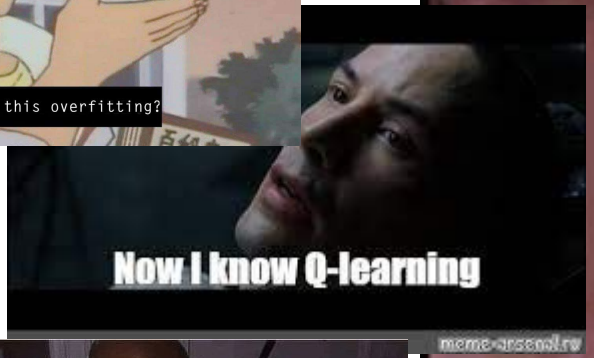
MineDojo : https://github.com/MineDojo/MineDojo

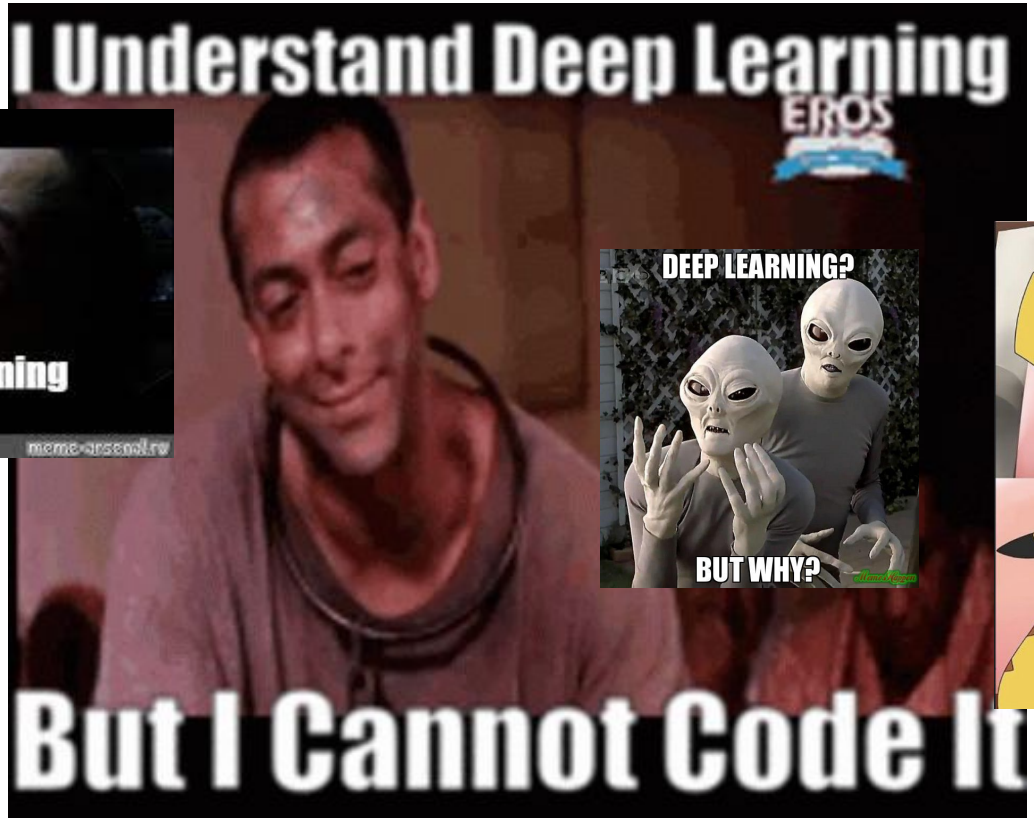
MineRL: https://github.com/minerllabs/minerl

AI learn to escape :https://www.youtube.com/watch?v=2tamH76Tjvw&t=20s

Main Contribution of each member

- 許瑋哲
  - 寫主要CNN演算法、 map file 變換成 input state、處理agent action
- 林穎沛
  - 影片剪輯、寫DQN演算法、Q_table
- 林揚森
  - 調整地圖xml檔、調整reward、數據分析
- 陳宥翔
  - 製作地圖及地圖資訊矩陣、研究xml檔、調整reward
- 共同工作
  - training、報告製作、錄製影片





Me: *uses machine learning*

Machine: *learns*

Me: