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ShanghaiTech University

Deep Q-network Development and Validation based on Interactive 2D Video Games

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Outline



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- Introduction of Interactive 2D Video Games
- Structure of Deep Q-Network for Metroidvania Games
- Evaluation for Game AI Performance
- Future Works



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1. Introduction of Interactive 2D Video Games



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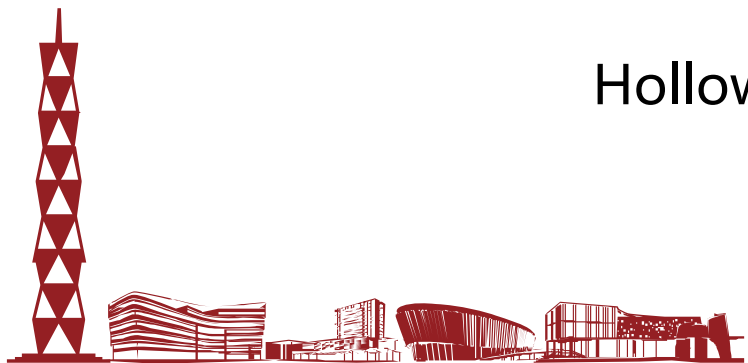
- Metroidvania Games



Hollow Knight



Celeste



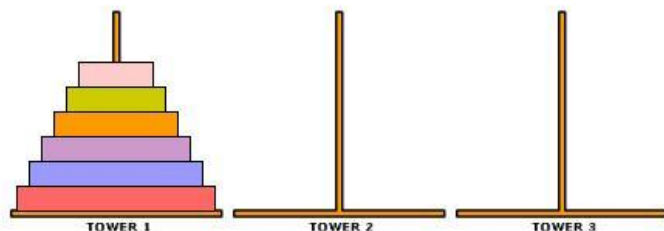
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1. Introduction of Interactive 2D Video Games

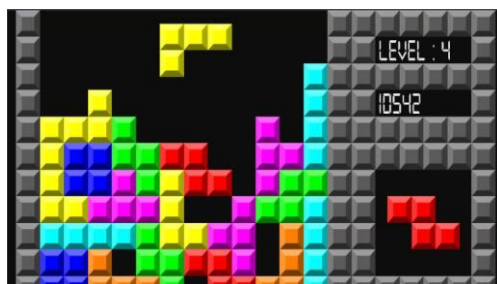


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- Common methods for game AI:
 - traditional SOTA algorithm



Hanoi



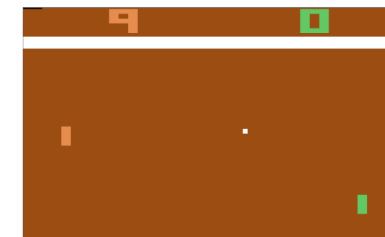
Tetris

- deep learning algorithms
 - convolutional neural network(CNN)

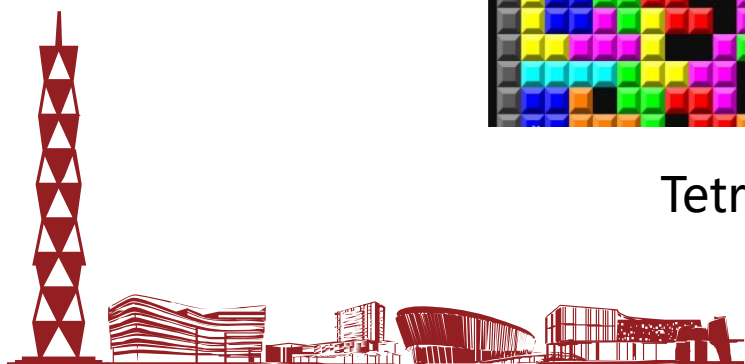


Mahjong

- deep Q-network(DQN)



Pong

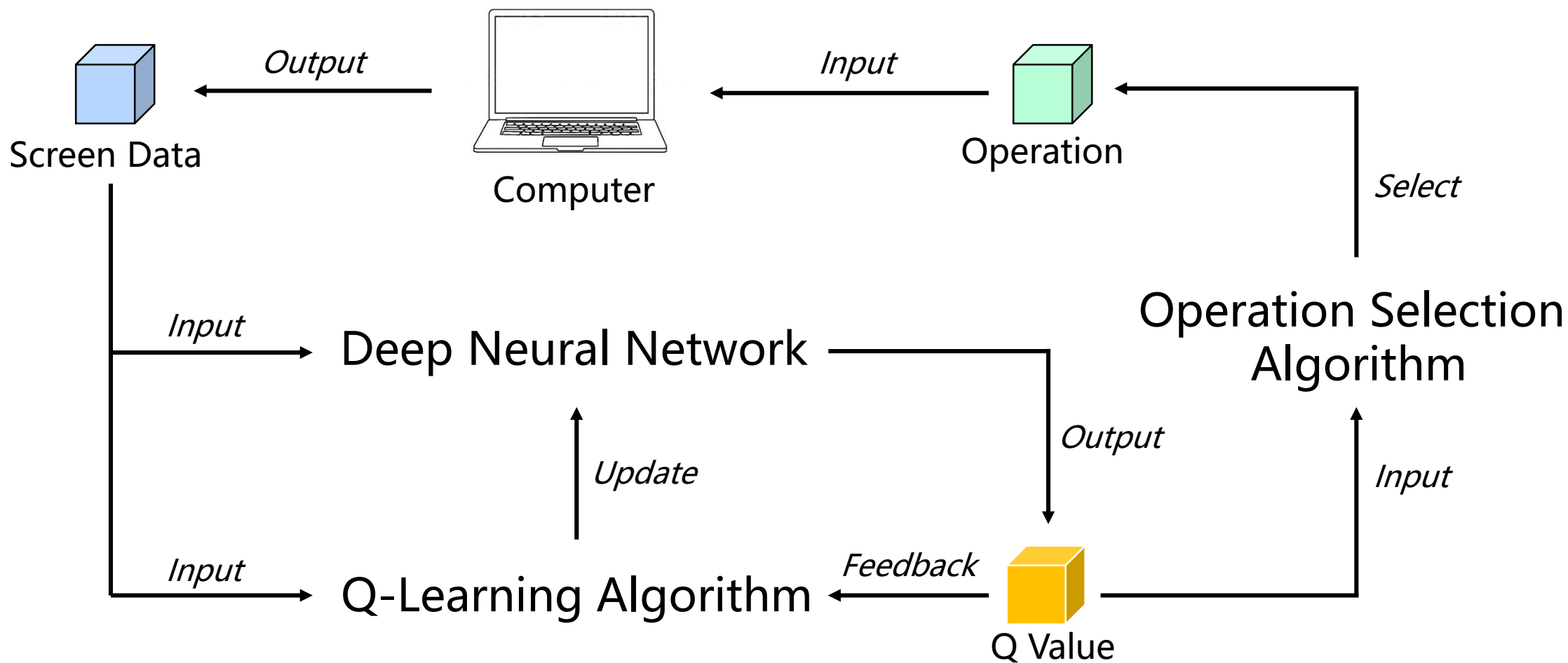


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2. Structure of Deep-Q-Network for Metroidvania Games



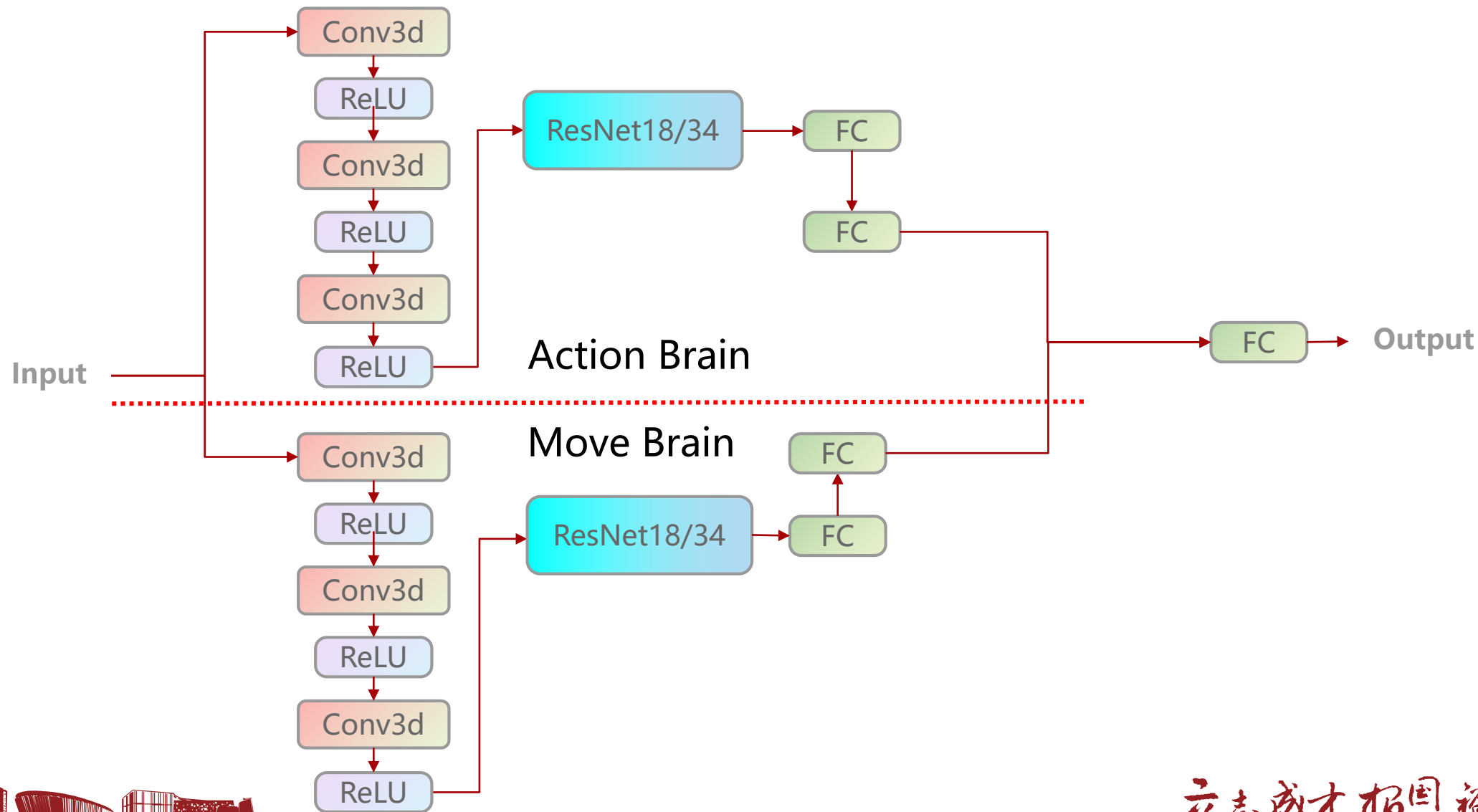
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2.1 Deep Neural Network in DQN



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2.2 Q-Learning Algorithm in DQN



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$$Q(s_{t+1}, a_{t+1}) = \underbrace{Q(s_t, a_t)}_{\text{old value}} + \underbrace{\alpha}_{\text{learning rate}} (\underbrace{r}_{\text{reward}} + \underbrace{\gamma}_{\text{discount}} \underbrace{\max_{a'} Q(s', a')}_{\text{optimal future value}}) - \underbrace{Q(s_t, a_t)}_{\text{old value}}$$

- **reward:** add the differences of reward for different operations at different locations to accelerate toward optimal solutions
- **discount:** reduce discount to prioritize current benefits



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2.3 Operation Selection in DQN



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- **ϵ -greedy policy of action selection**
 - if $\text{random}() < \epsilon$:
 - select *random action*
 - else:
 - select $\underset{a}{\operatorname{argmax}} Q(s_t, a)$
- We define some basic knowledge to constrain *random action*, thereby increasing learning efficiency



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3. Evaluation for Game AI Performance



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- Hollow Knight

	resNet18	resNet34
Clearance Rate	18.22%	22.49%
Total Average of Life	0.28	0.3
Average Life of Pass	1.53	1.33
Average time of Pass	57.12s	62.33s



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4. Future Works



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- Experiments for **validation**
 - check whether the model can pass under several circumstances
 - speed up
 - shelter
 - ban certain operations
 - ...
- Experiments for **more games**
 - Ori and the Will of the Wisps



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Thanks for listening!