

Intelligent Non-Player Character with Deep Learning

Meng Zhixiang, Zhang Haoze

Supervised by Prof. Michael Lyu

CUHK CSE FYP Term 1



Background

We all know the results...



Agenda

- Background
- Motivation & Objective
- Methodologies
- Design & Implementation
- Results & Discussion
- Conclusion

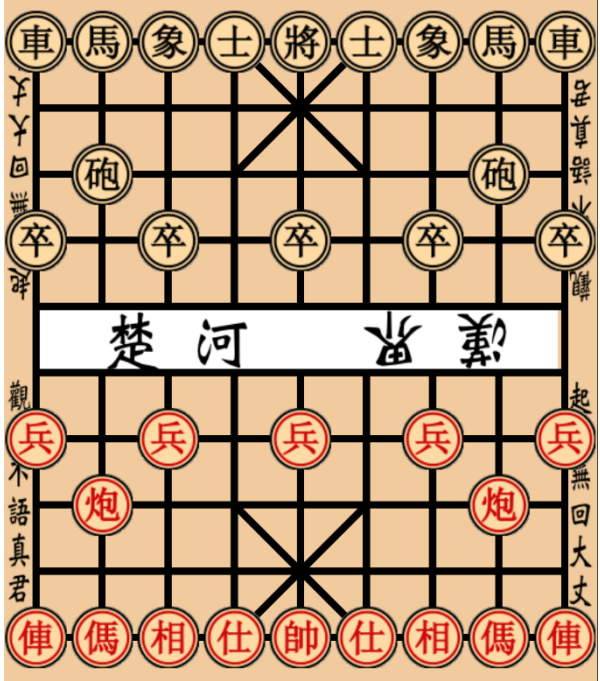
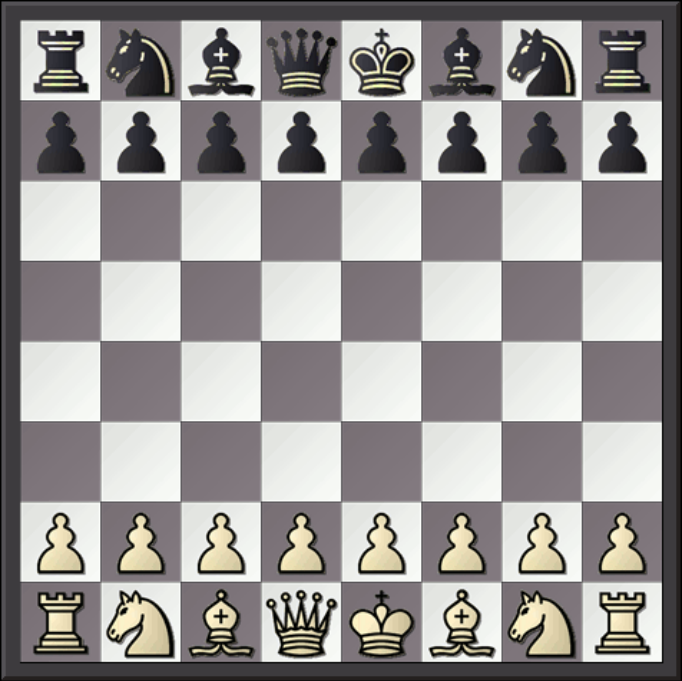
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- Background
 - Development of AI in Go, Chess and Chinese Chess
 - Difference among Go, Chess and Chinese Chess
- Motivation & Objective
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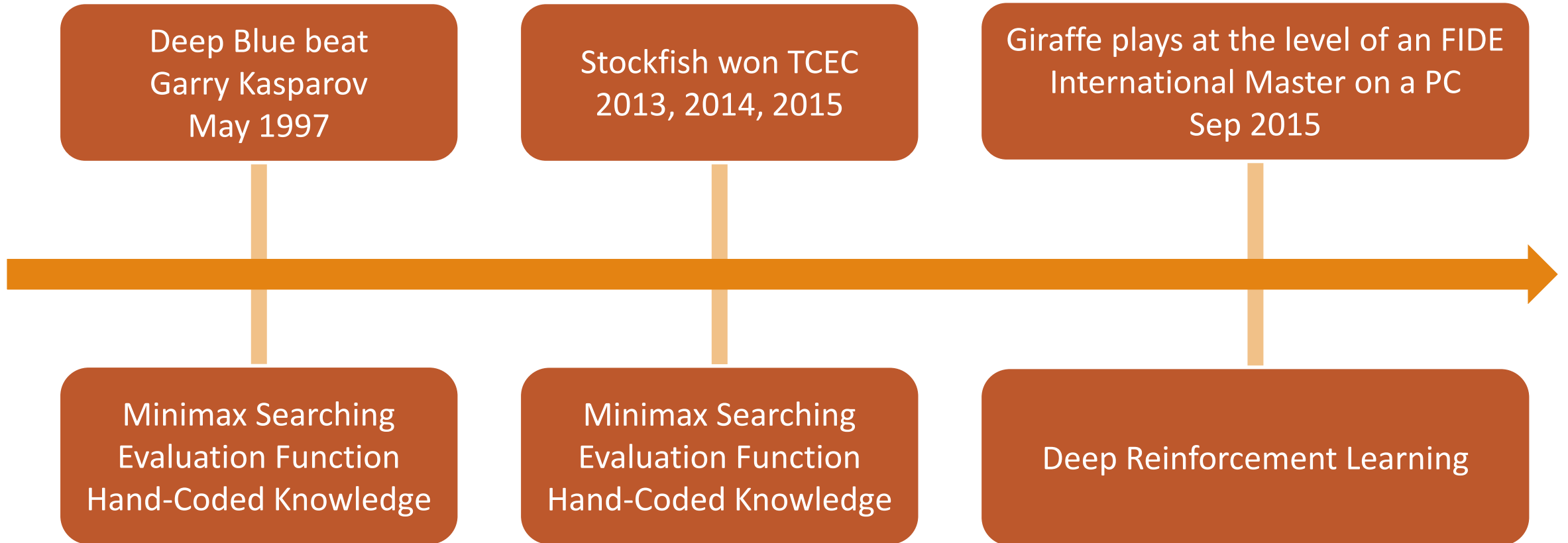
Development of AI in Go



Difference between Go and Chess/Chinese Chess

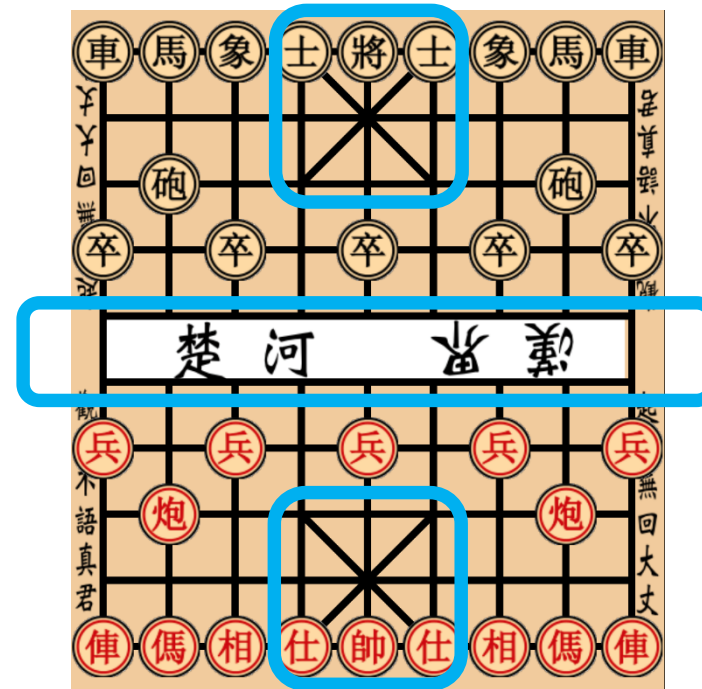
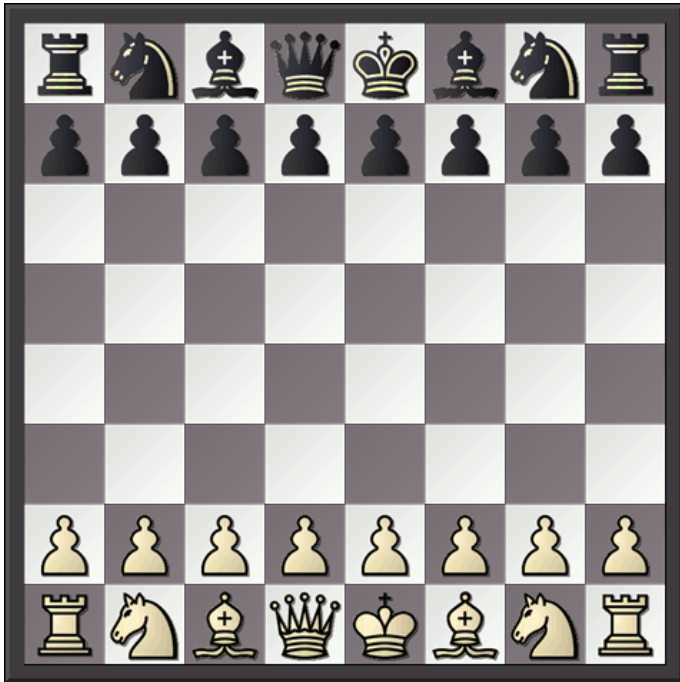


Development of AI in Chess

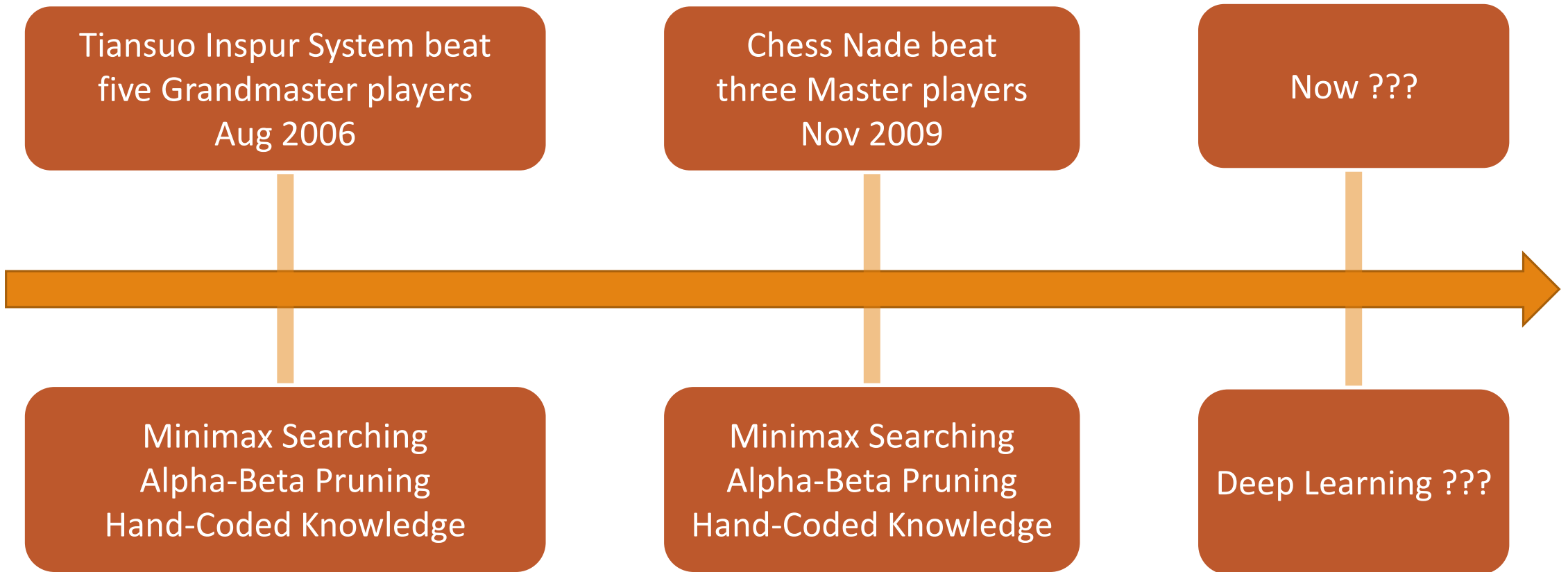


TCEC: Top Chess Engine Championship
FIDE: World Chess Federation

Difference between Chess and Chinese Chess



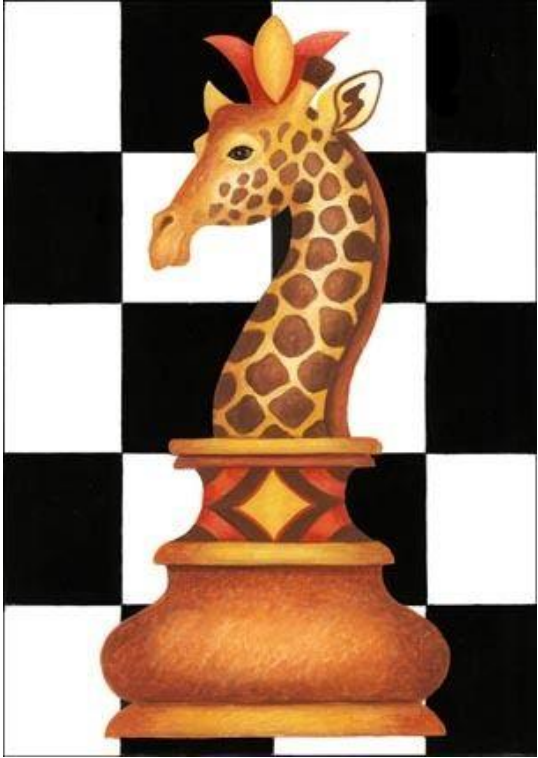
Development of AI in Chinese Chess



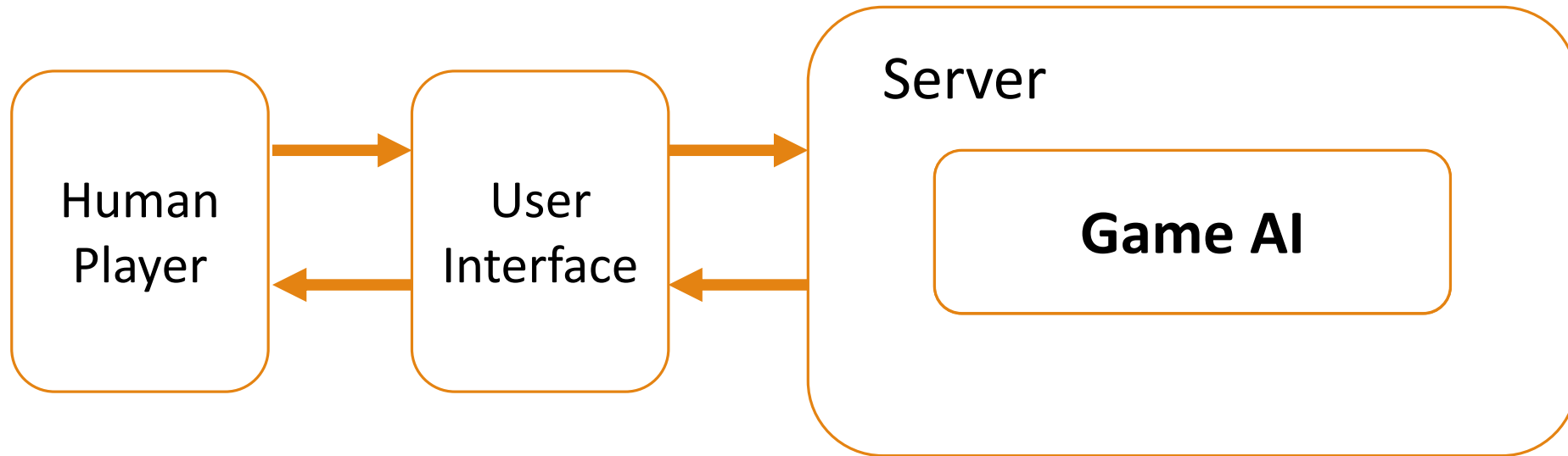
Motivation



AlphaGo



Objective

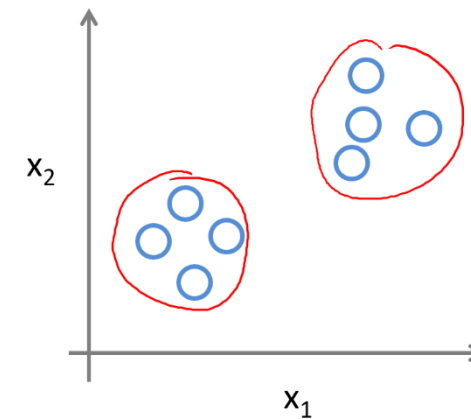
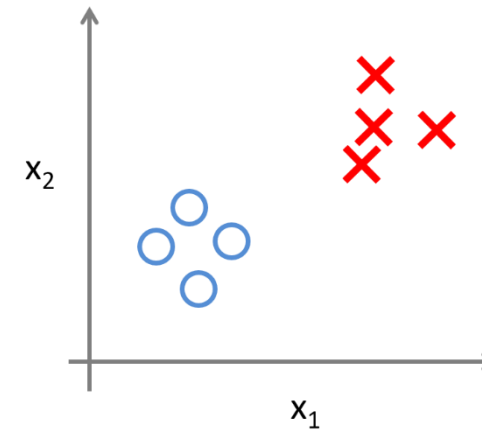


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- Methodologies
 - Supervised Learning
 - Convolutional Neural Network
- Design & Implementation
- Results & Discussion
- Conclusion

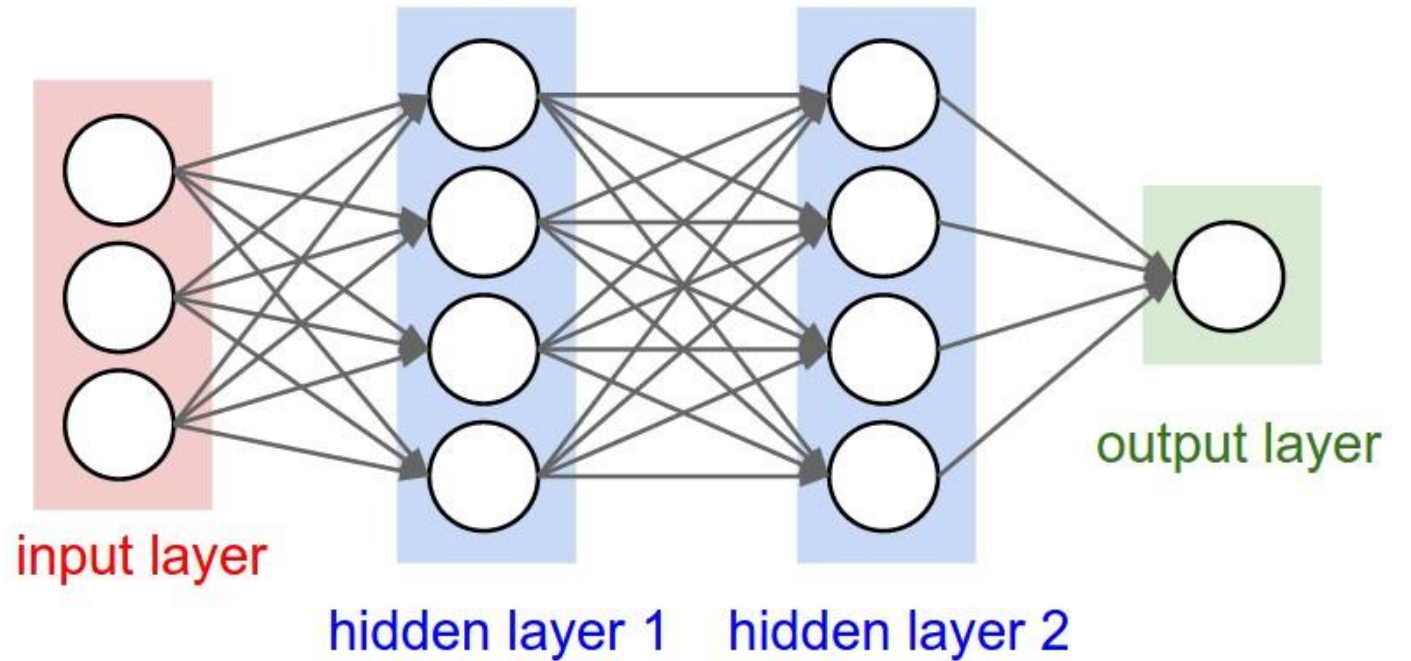
Supervised Learning

- Supervised Learning
 - the “right answer” is given
 - Regression Problem & Classification Problem
- Unsupervised Learning
 - no “right answer” is given
 - Clustering Problem



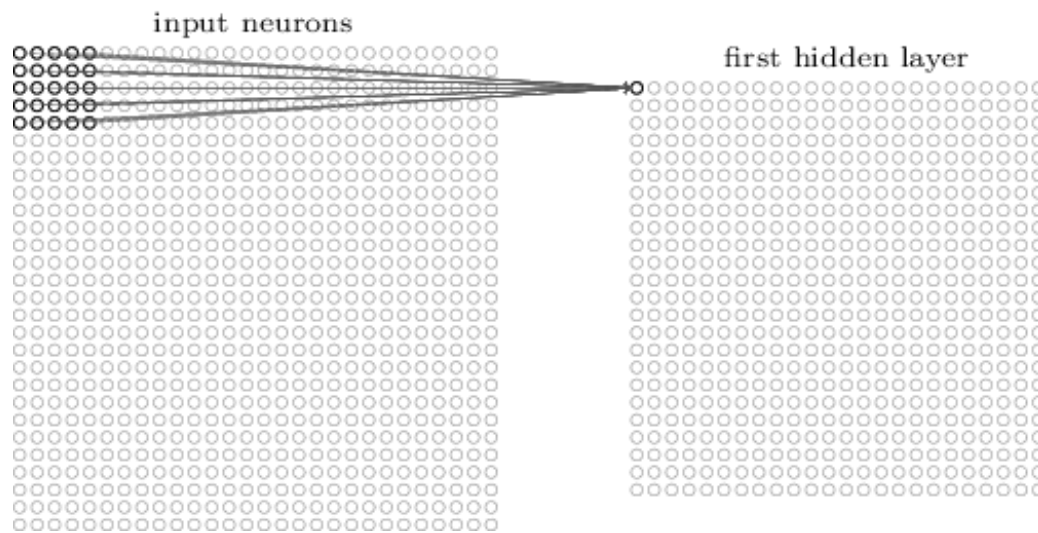
Neural Network

- Non-linear Hypotheses
- Neurons and Brain
- Backpropagation

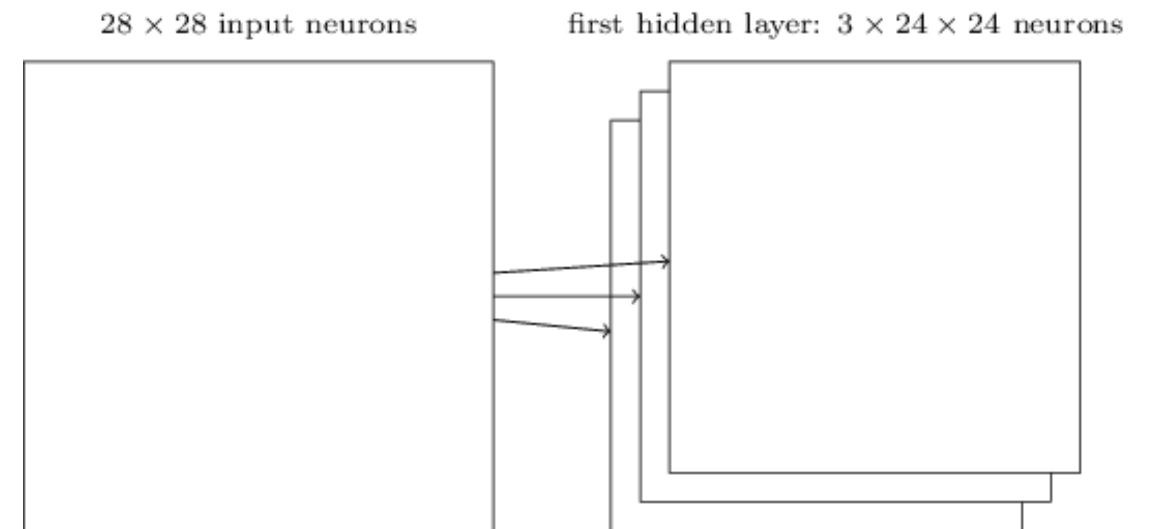


Convolutional Neural Network

- Feed-forward
- Organization of Animal Visual Cortex
- Image Recognition



Local Receptive Fields

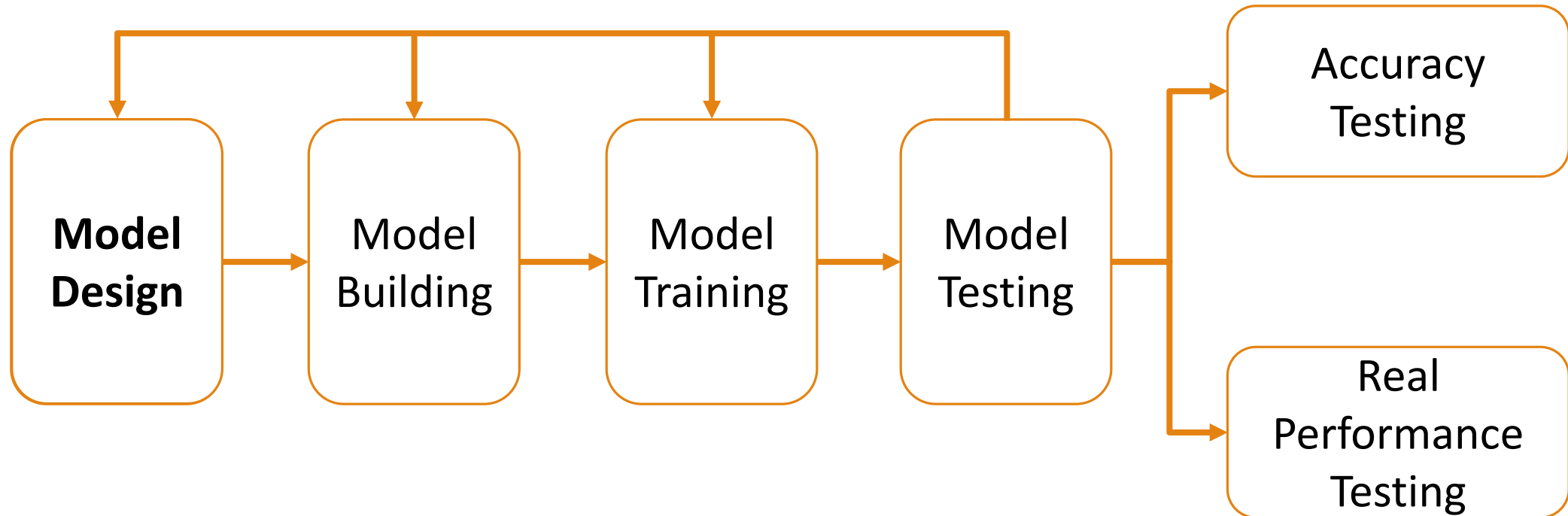


Shared Weights and Biases

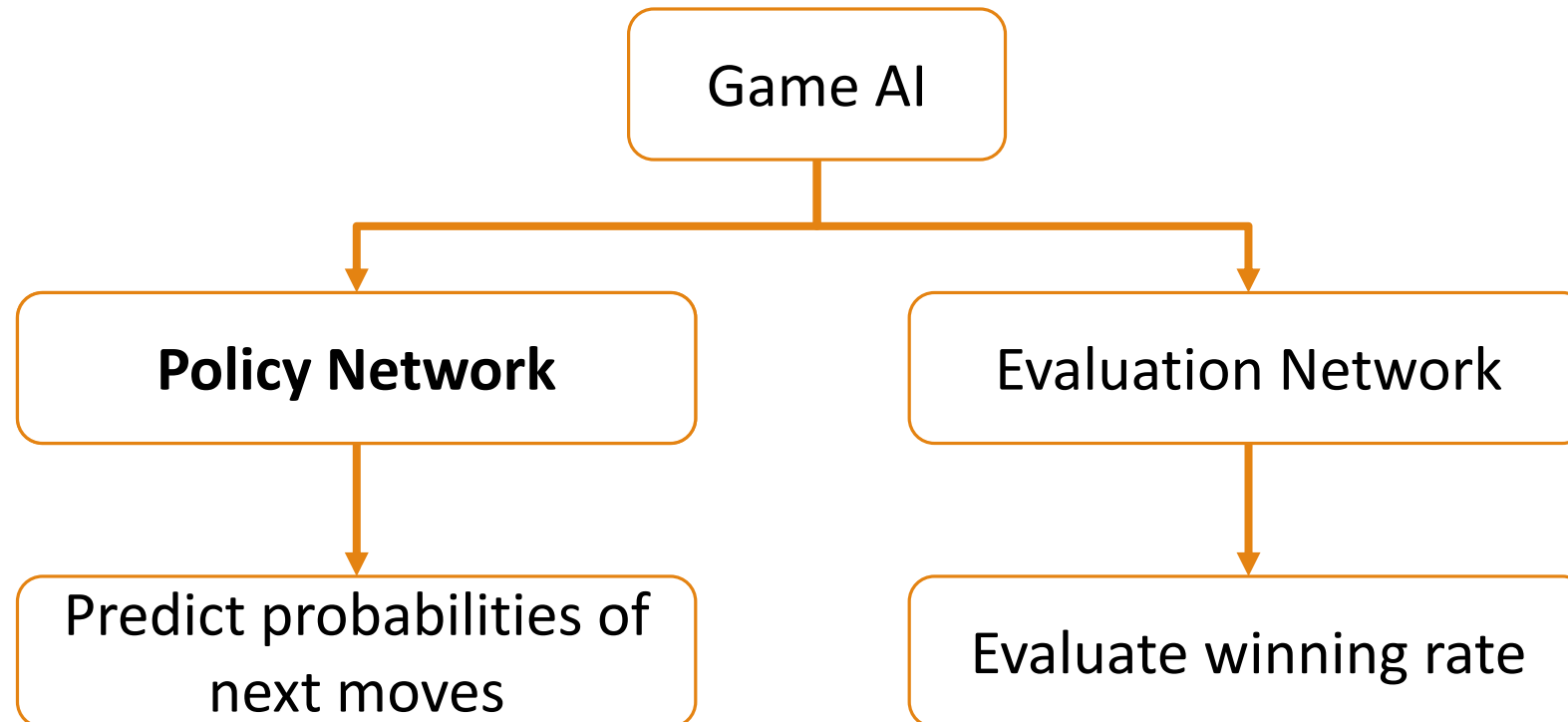
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- Methodologies
- **Design & Implementation**
 - Project Workflow
- Results & Discussion
- Conclusion

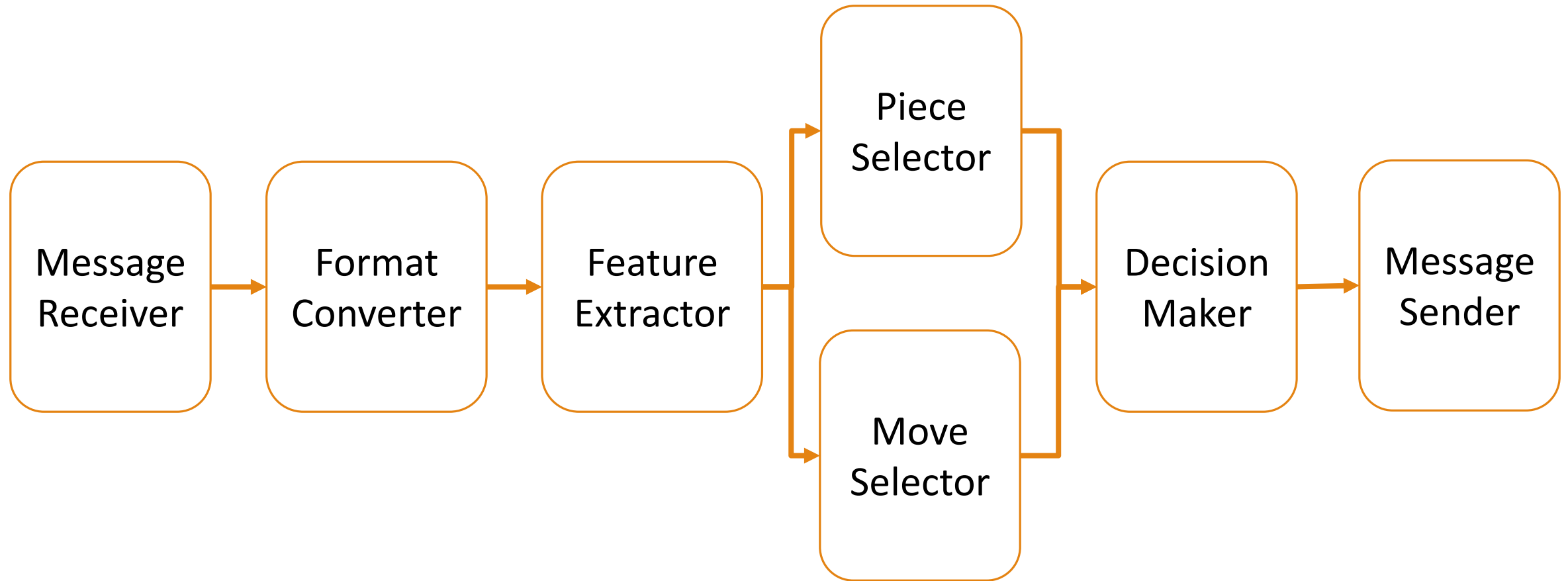
Project Workflow



Design Overview



Game AI Structure



Feature Channels

Feature Channel 1	Pieces belonging to different sides
Feature Channel 2	Pieces of Advisor type
Feature Channel 3	Pieces of Bishop type
Feature Channel 4	Pieces of Cannon type
Feature Channel 5	Pieces of King type
Feature Channel 6	Pieces of Knight type
Feature Channel 7	Pieces of Pawn type
Feature Channel 8	Pieces of Rock type
Feature Channel 9 (only for Move Selector)	Valid moves for the selected piece

Feature Channels

r	n	b	a	k	a	b	n	r
c							c	
p		p		p		p		p
P		P		P		P		P
C							C	
R	N	B	A	K	A	B	N	R

Chessboard Status

-1	-1	-1	-1	-1	-1	-1	-1	-1
0	0	0	0	0	0	0	0	0
0	-1	0	0	0	0	0	-1	0
-1	0	-1	0	-1	0	-1	0	-1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	0	1	0	1	0	1	0	1
0	1	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1

1st Feature Channel

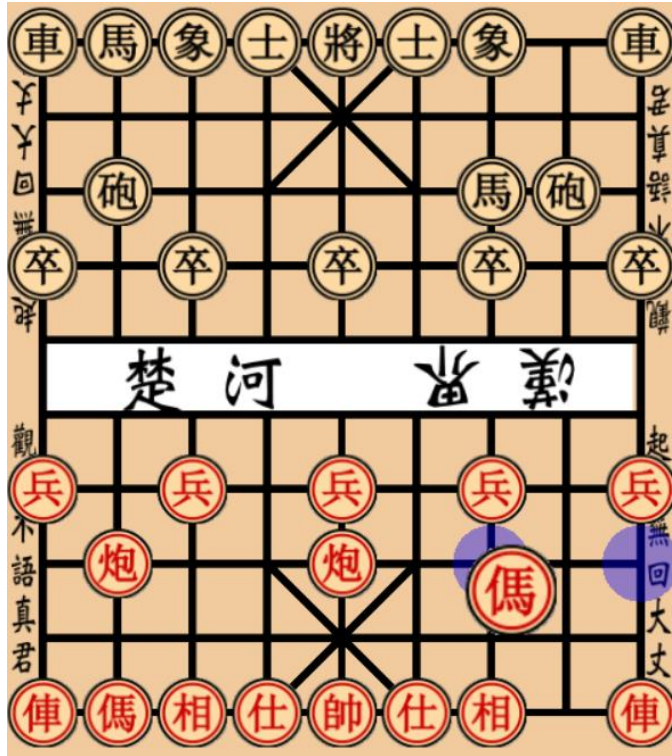
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	-1	0	0	0	0	0	-1	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

4th Feature Channel

-1	-1	-1	-1	-1	-1	-1	1	-1
-1	-1	-1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	1	-1
-1	-1	-1	-1	-1	-1	-1	1	-1
-1	-1	-1	-1	-1	-1	-1	1	-1
-1	-1	-1	-1	-1	-1	-1	1	-1
-1	-1	1	1	1	1	1	2	1
-1	-1	-1	-1	-1	-1	-1	1	-1
-1	-1	-1	-1	-1	-1	-1	-1	-1

9th Feature Channel

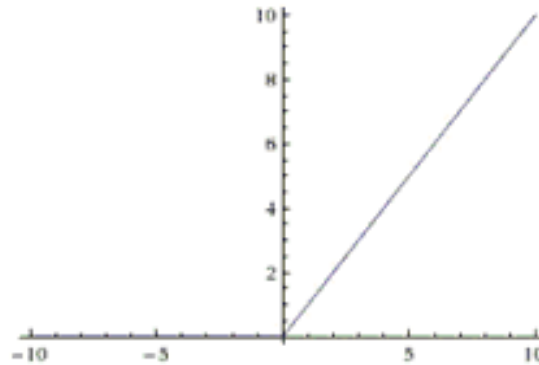
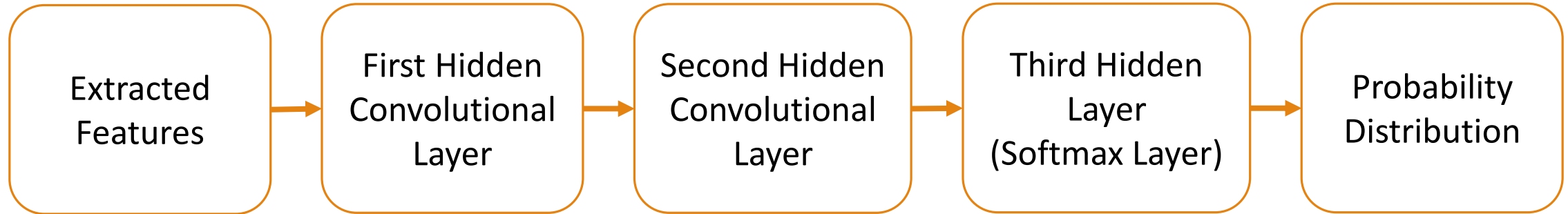
Piece Selector & Move Selector



r	n	b	a	k	a	b		r
	c					n	c	
p		p		p		p		p
P		P		P		P		P
	C			C				
R	N	B	A	K	A	B	N	R

r	n	b	a	k	a	b		r
	c					n	c	
p		p		p		p		p
P		P		P		P		P
	C			C				
R	N	B	A	K	A	B	N	R

Piece Selector & Move Selector



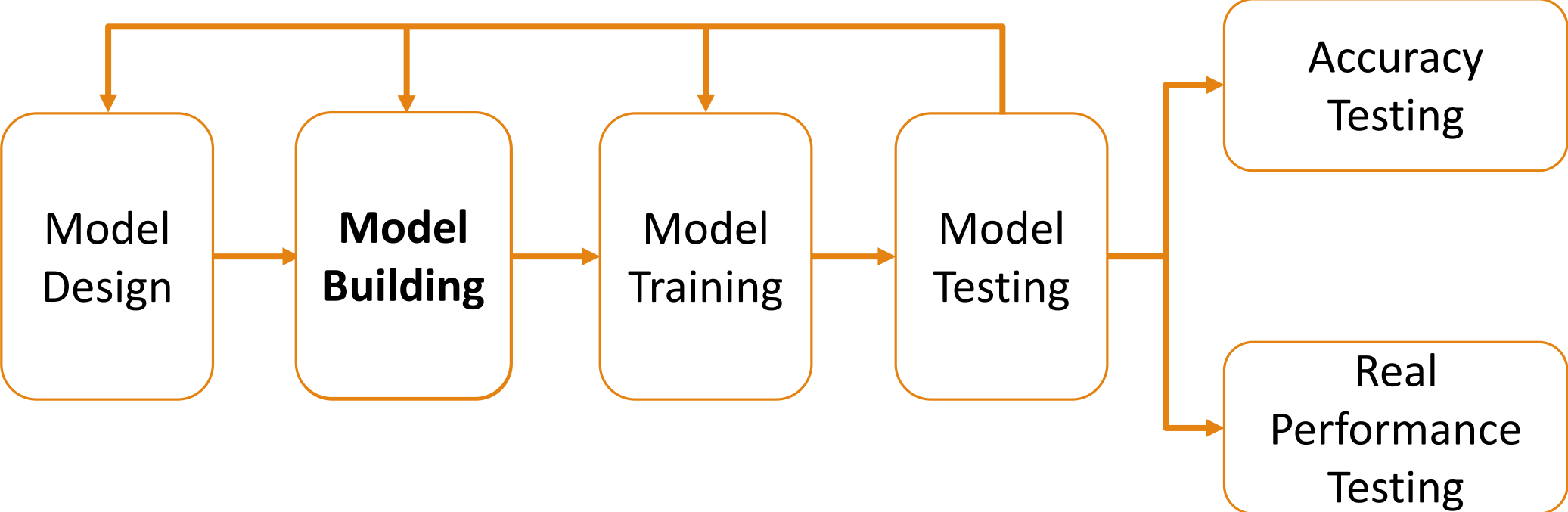
Rectified Linear Unit (ReLU)

Selection Strategy

- Strategy 1:
 - Select the piece with highest possibility given by Piece Selector
 - Select the destination of that piece with highest possibility given by Move Selector

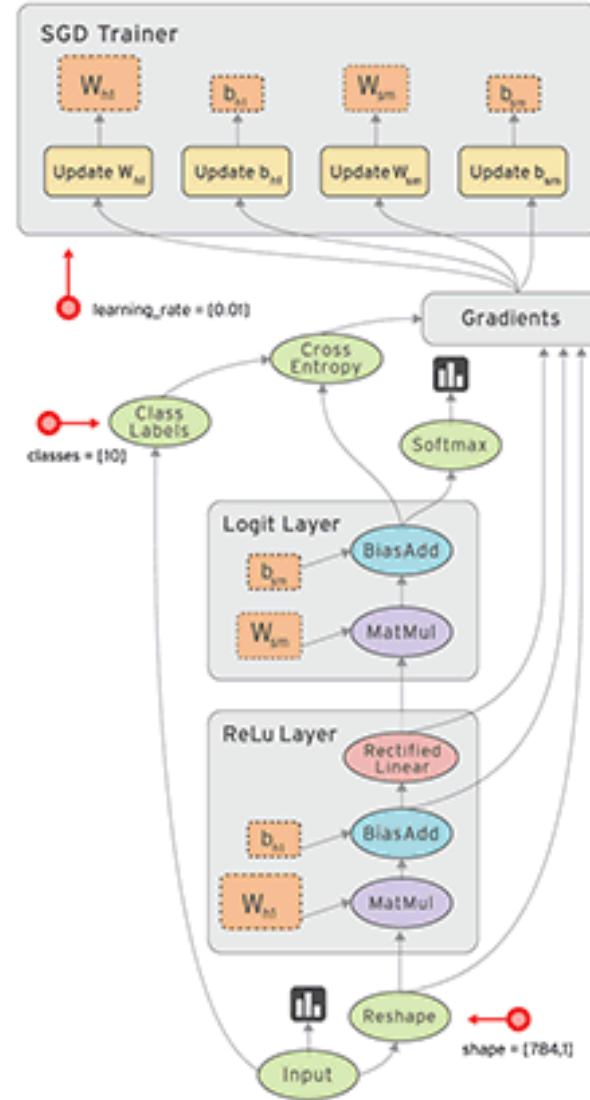
- Strategy 2:
 - Calculate the probability of moving a piece * the probability of a destination of that piece
 - Select the combination with highest probability

Project Workflow

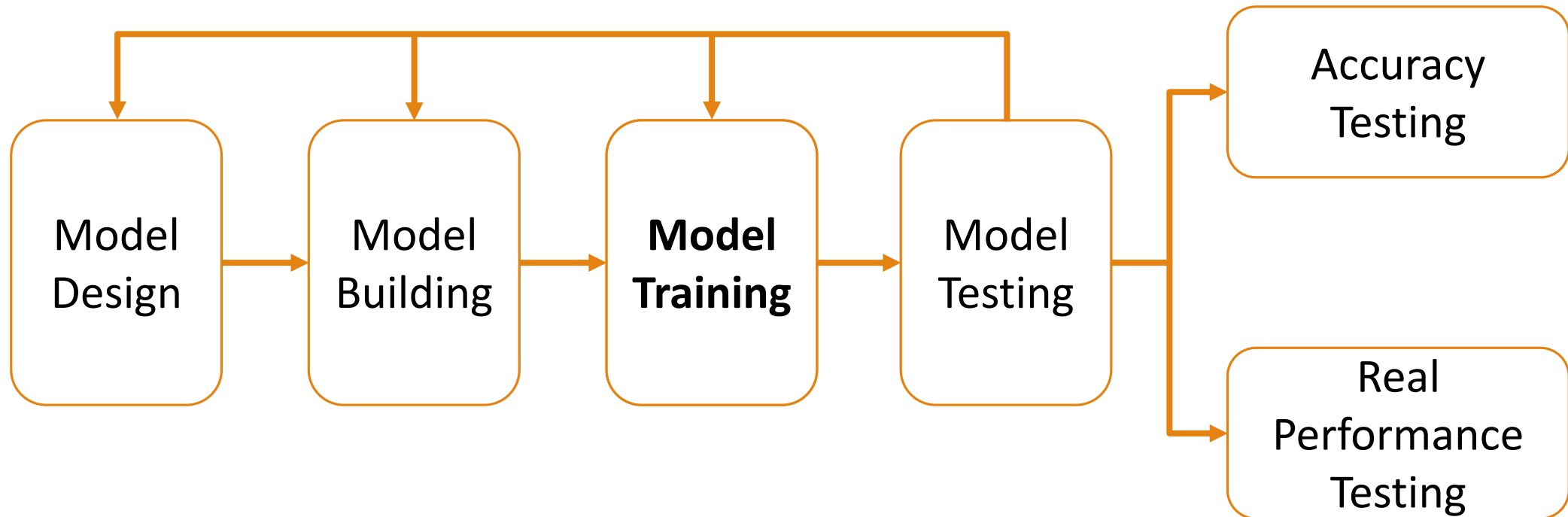


TensorFlow

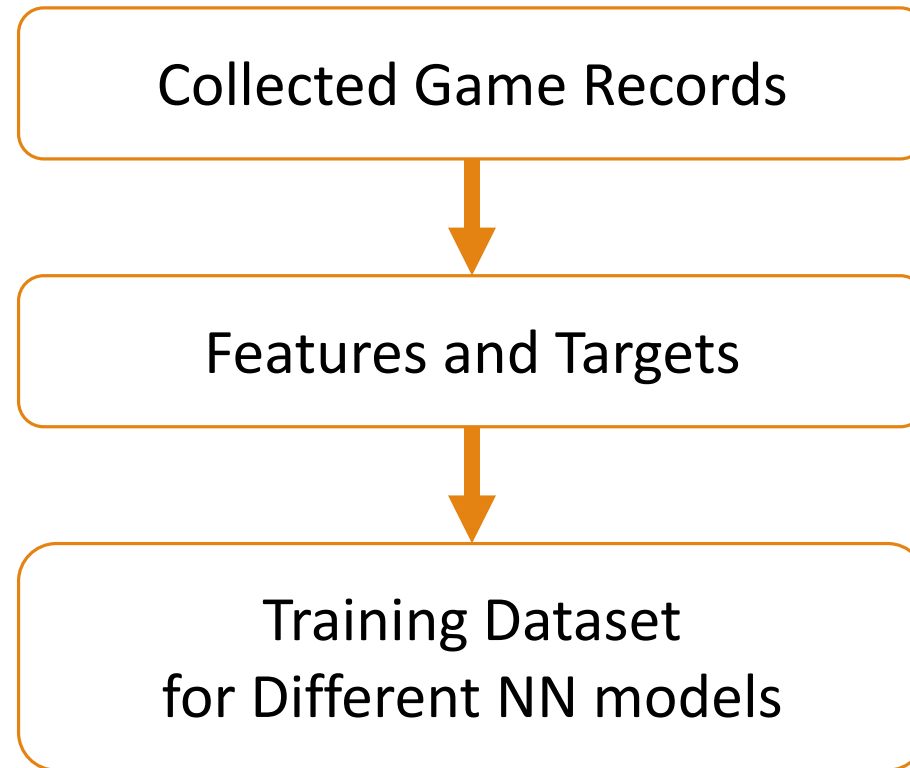
- an open source software library
- for numerical computation
- using data flow graphs
- flexibility and portability



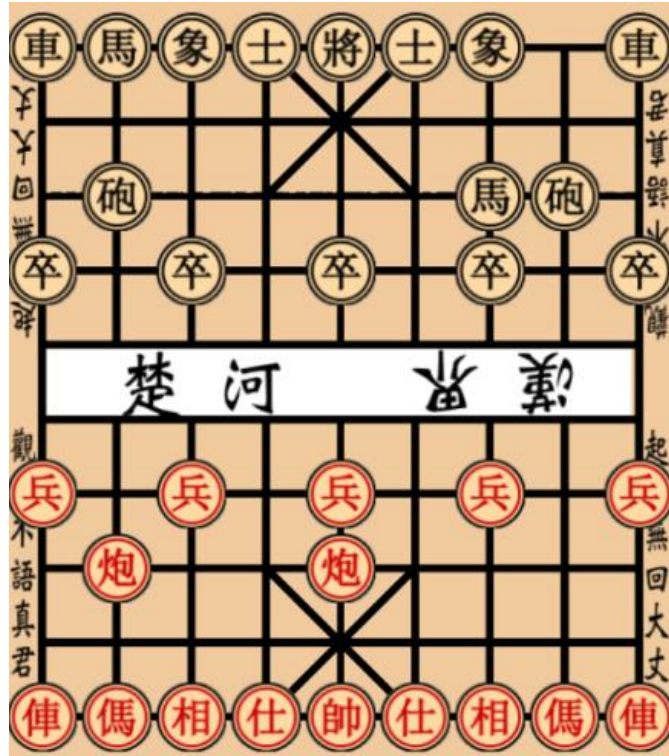
Project Workflow



Training Dataset



FEN Format

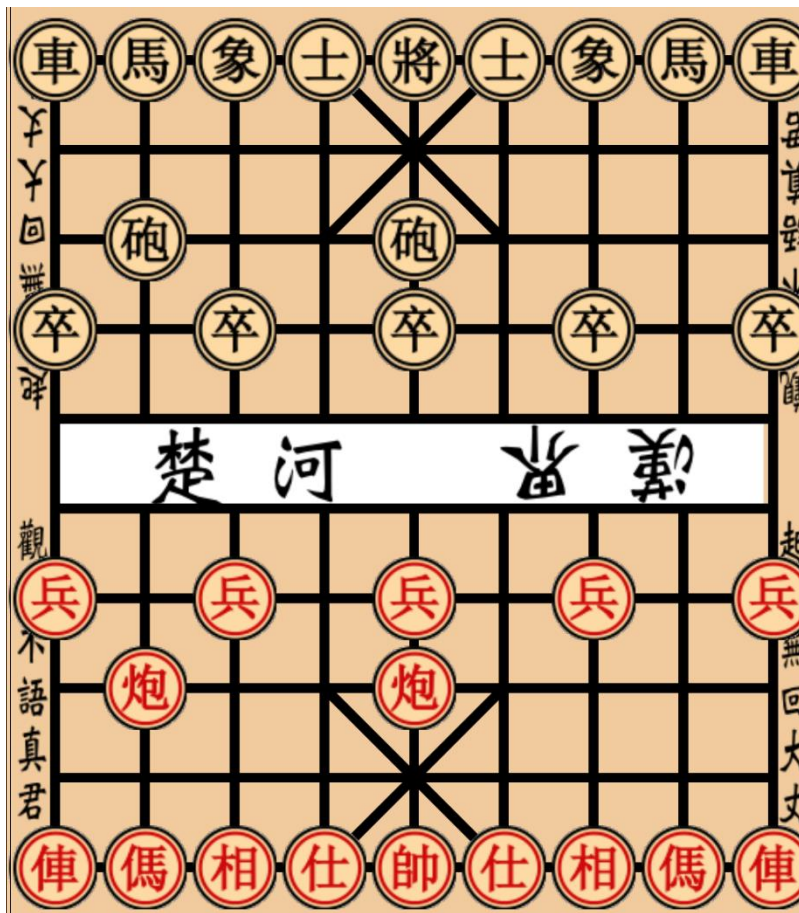


r	n	b	a	k	a	b		r
	c					n	c	
p		p		p		p		p
P		P		P		P		P
	C			C				
R	N	B	A	K	A	B	N	R

```
rnbakab1r/111111111/1c1111nc1/p1p1p1p1p/111111111/111111111/P1P1P1P1P/1C11C1111/111111111/RNBAKABNR, r
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Format Conversion

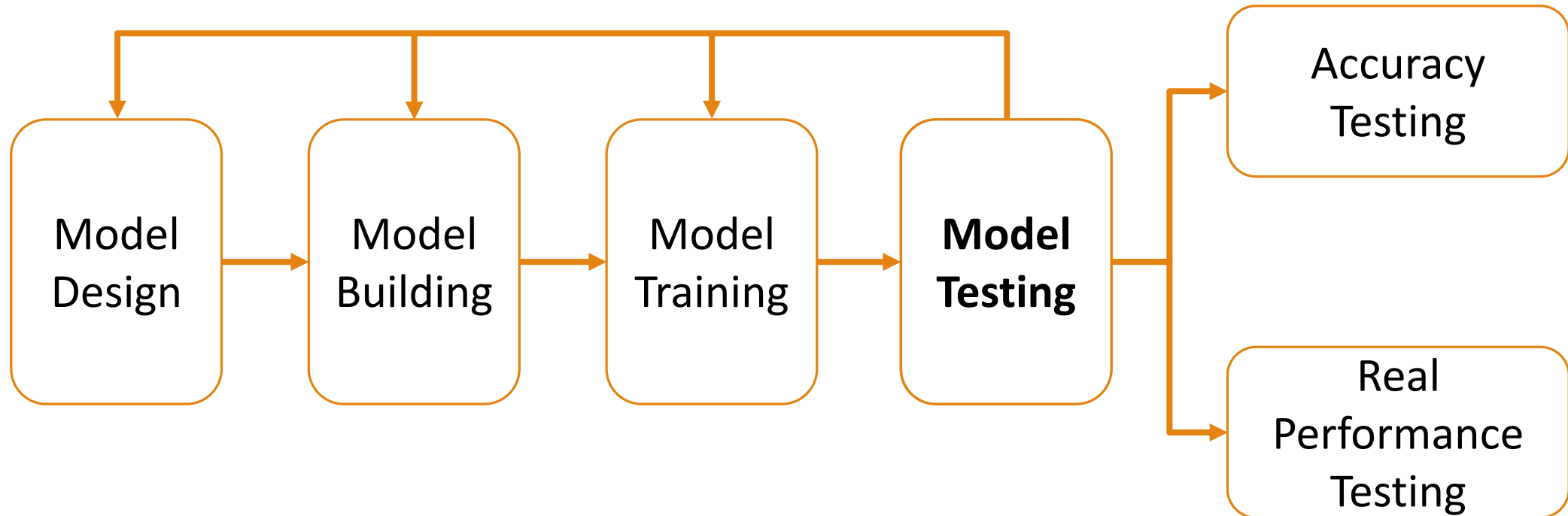
炮二平五	炮 8 平 5
马二进三	马 8 进 7
车一进一	车 9 平 8
车一平六	车 8 进 6
车六进七	马 2 进 1
车九进一	炮 2 进 7
炮八进五	马 7 退 8
炮五进四	士 6 进 5
车九平六	将 5 平 6
前车进一	士 5 退 4
车六平四	炮 5 平 6
车四进六	将 6 平 5
炮八平五	



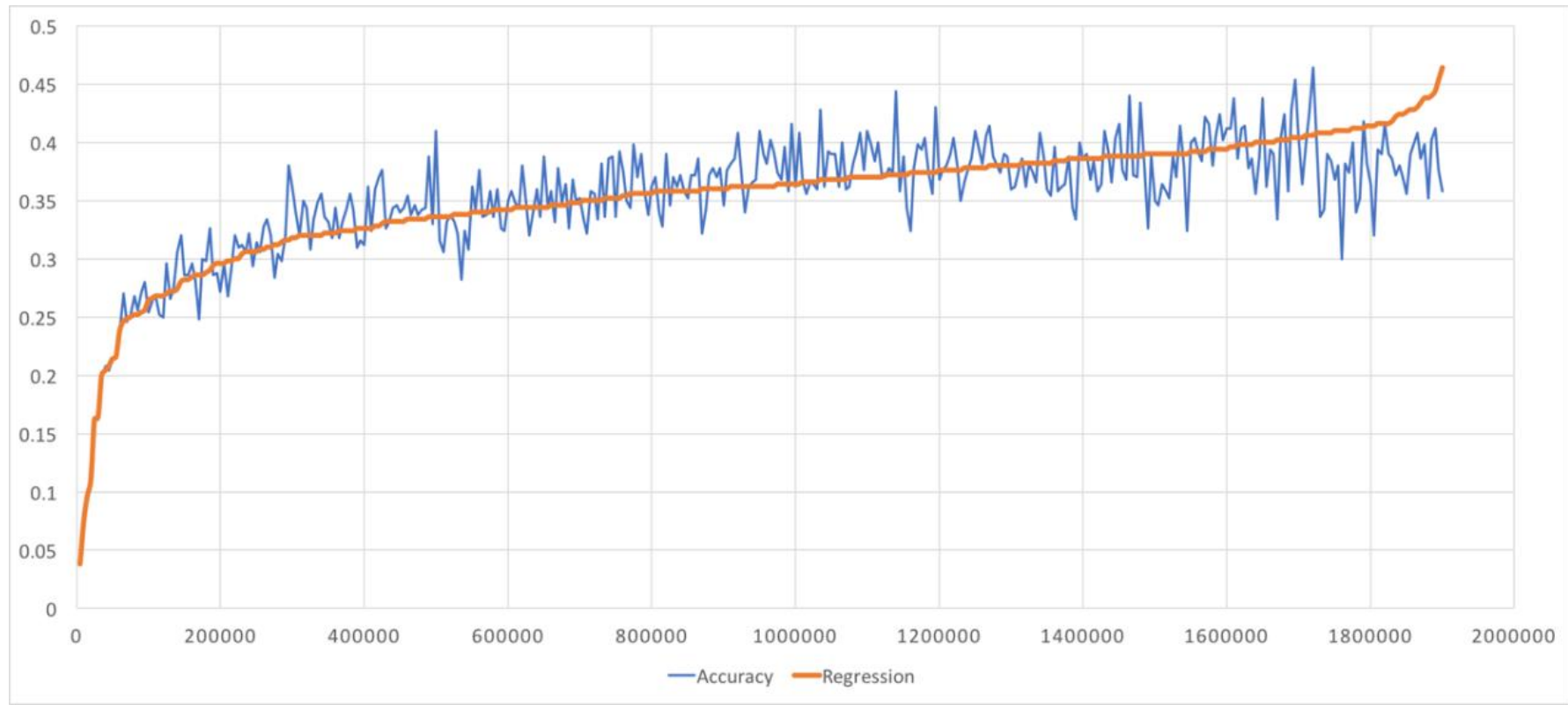
Training Strategy

- Piece Selector and Move Selector are trained separately
- Shuffle the training dataset containing over 1,600,000 moves
- Train the models batch by batch
- Test the accuracy along the process
- An untrained testing dataset containing over 80,000 moves

Project Workflow



Results

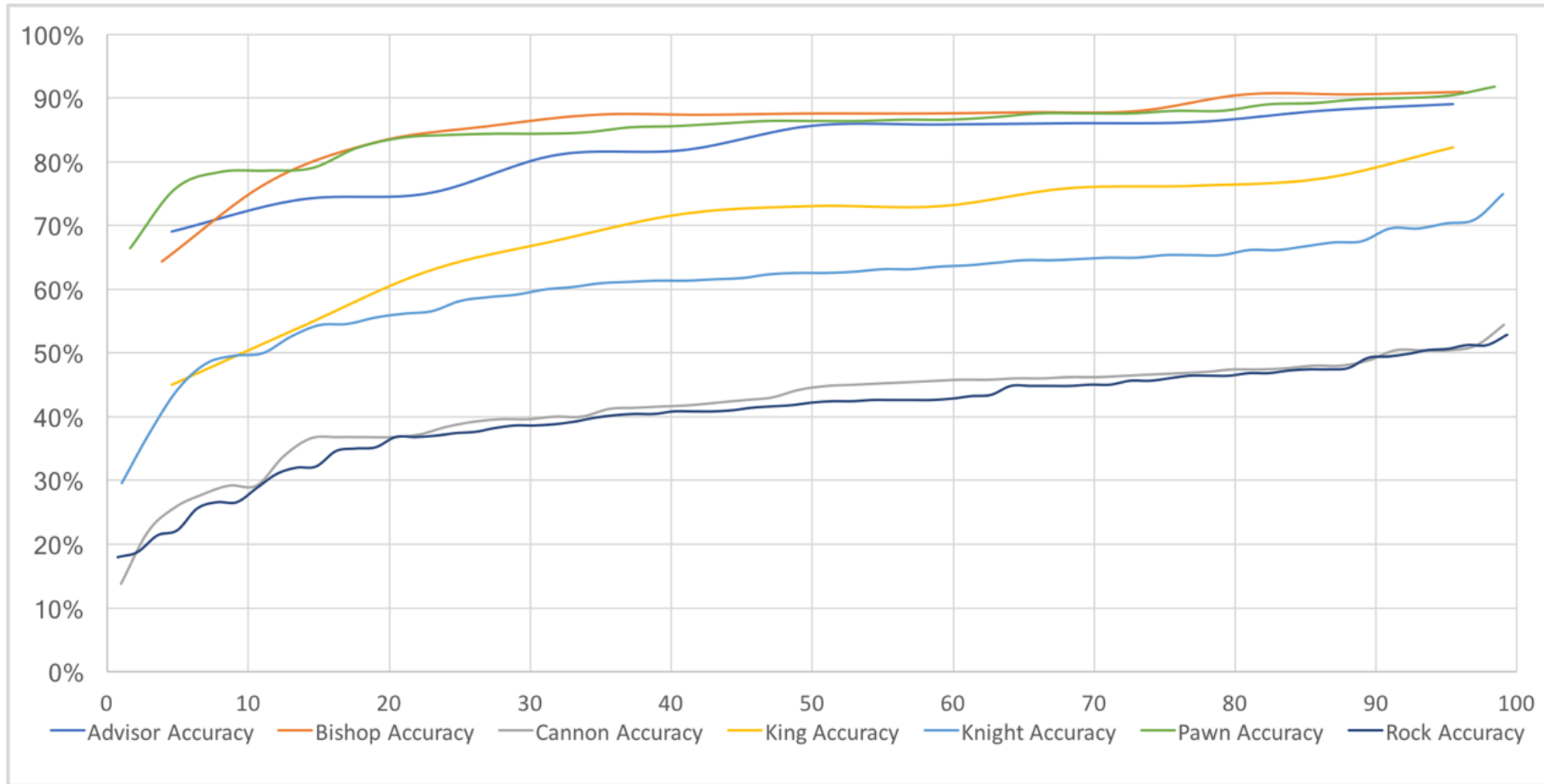


Piece Selector Accuracy

accuracy = # of correct predictions / total # of test cases

prediction: the choice with the highest probability

Results



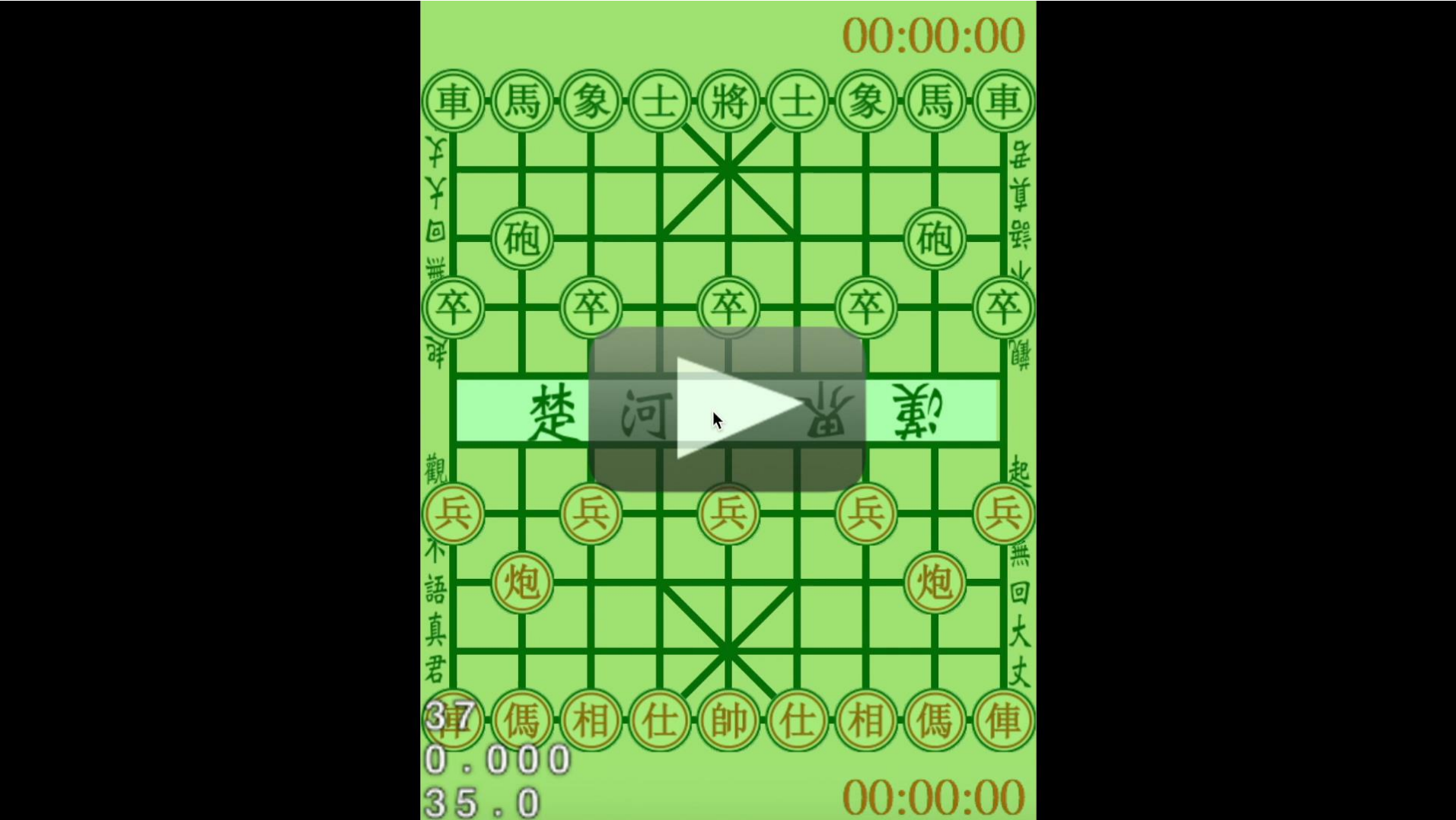
Move Selector Accuracy

Results

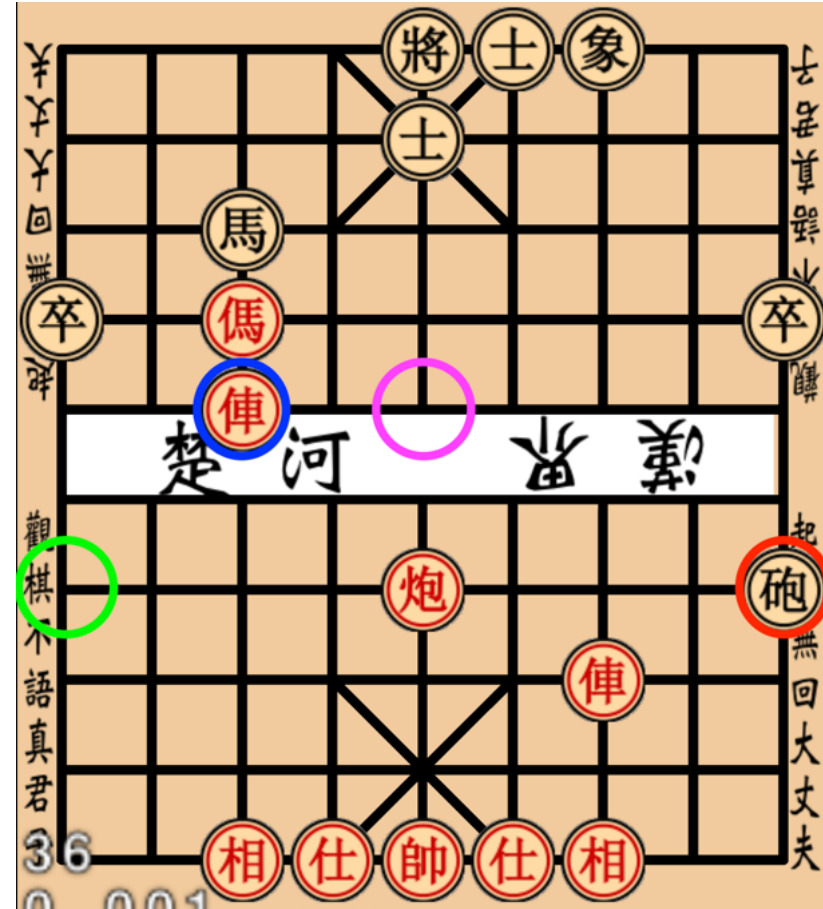
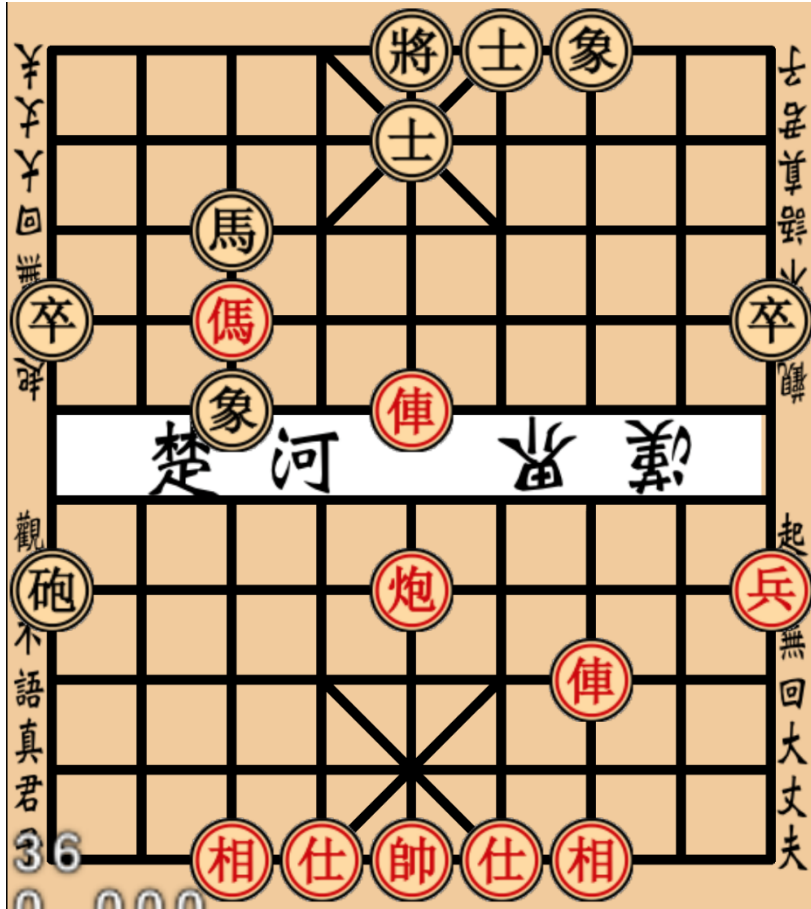
Move Selector	Accuracy
Advisor	89.8%
Bishop	91.2%
Cannon	54.1%
King	79.8%
Knight	70.1%
Pawn	90.4%
Rock	53.6%

Move Selector Accuracy

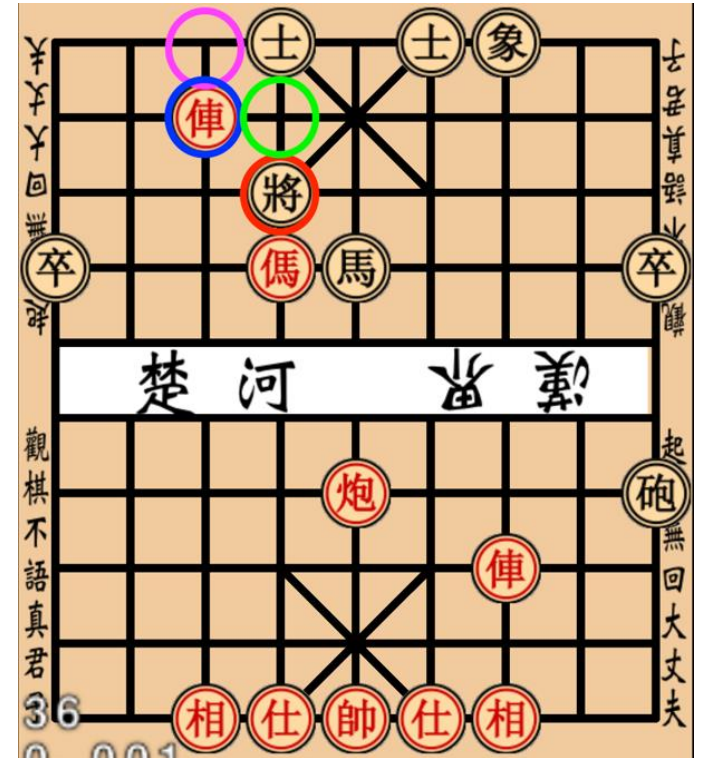
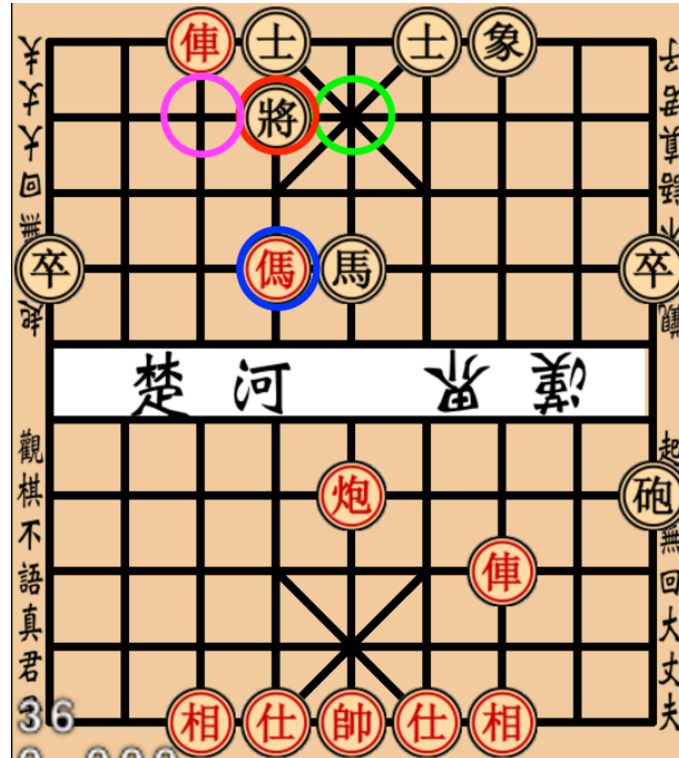
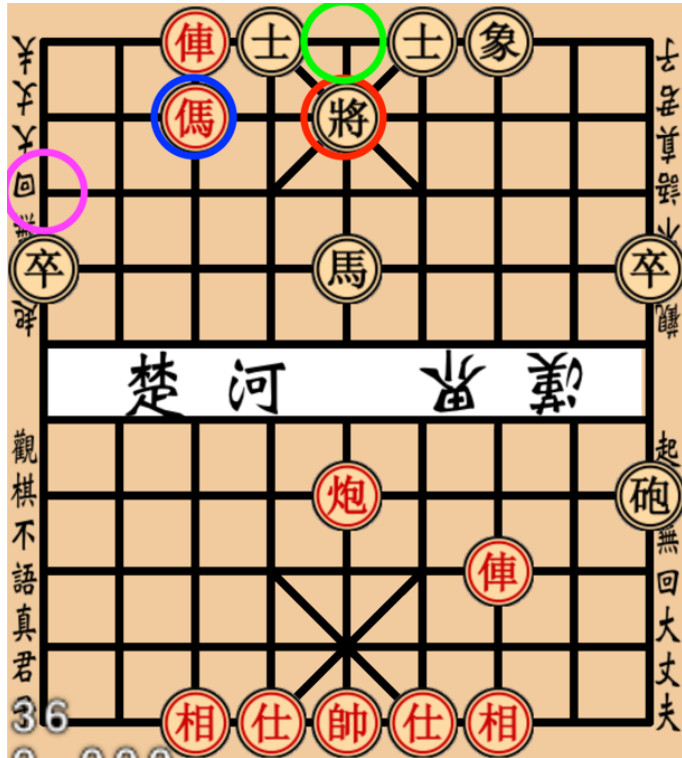
Results



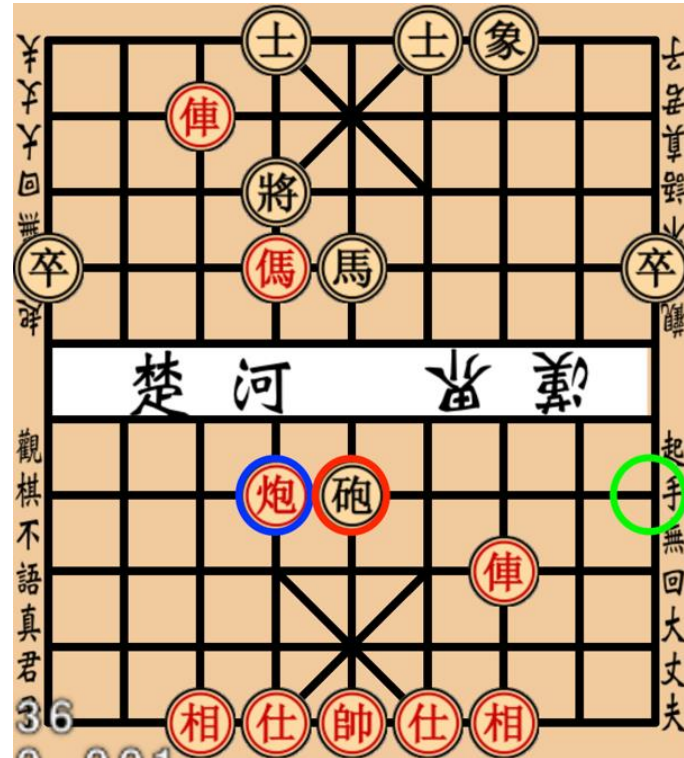
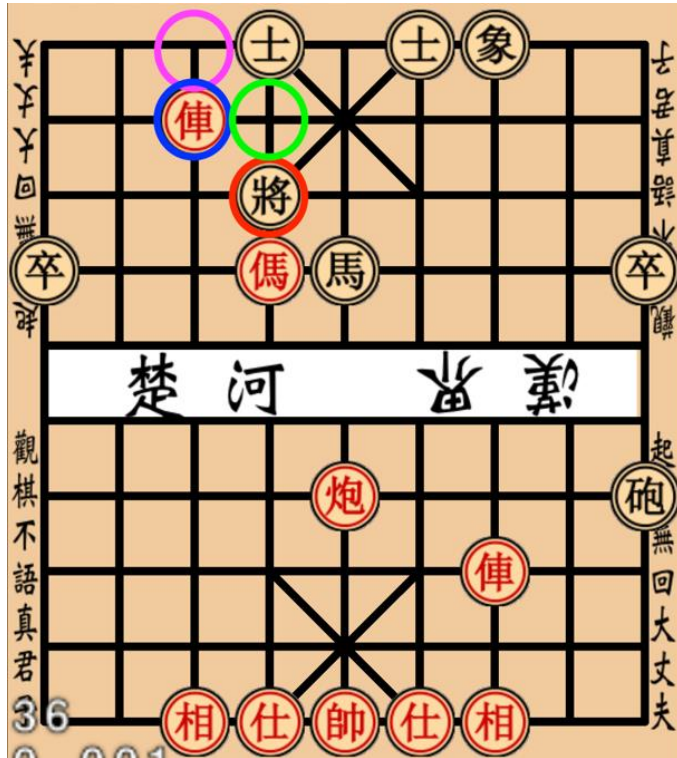
Results



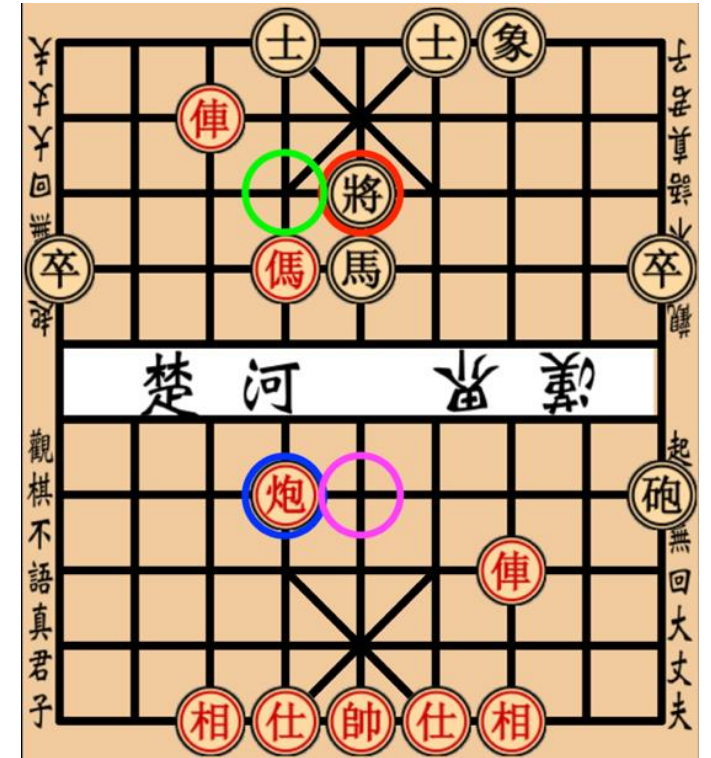
Results



Results



Selection Strategy 1



Selection Strategy 2

Discussion

- Possible Reasons:
 - CNN not deep enough
 - Training dataset not large enough
 - Records in training dataset may not be the optimal choices
 - For one chessboard status, there may be different move choices in training dataset
 - It's hard to judge which choice is better in current phase

Conclusion

- Achieved overall high accuracy
- Performed badly in some cases
- Need further improvement
 - Reinforcement Learning
 - Not limited by training dataset
 - Evaluation Network
 - To judge which move is better

Q&A