

AI METHODS AND DOU DI ZHU

XUESONG LUO

AI ARTICLE OF DOU DI ZHU

- Airticle: "THE DESIGN AND IMPLEMENTATION OF A COMPUTER GAME ALGORITHM OF DO DIZHU"
 - Author: Renzhi Wu, Shuai Liu, Shuqin Li, Meng Ding
 - Published 2017
- Airticle: "COMBINATIONAL Q-LEARNING FOR DOU DI ZHU"
 - Author: YANG YOU, LIANGWEI LI, BAISONG GUO, WEIMING WANG, CEWU LU
- Article: "FIGHT THE LANDLORD (DOU DI ZHU)"
 - Author: Zhennan Yan, Xiang Yu, Tinglin Liu, Xiaoye Han

RULE BASE OF DOU DI ZHU

- THE DESIGN AND IMPLEMENTATION OF A COMPUTER GAME ALGORITHM OF DO DIZHU
- SPLITTING STRATEGIES
- BIDDING STRATEGIES
- PLAYING STRATEGIES

SPLITTING STRATEGIES

Definition of Weights of Suit Patterns

Suit Pattern	Weight
Single	1
Pair	2
Triple	3
Single Sequence (Every card in addition then weight+1)	4
Double Sequence (Every pair in addition then weight +2)	5
Triple Sequence (Every triplet in addition then weight +3)	6
Bomb(Including Rocket)	7

SPLITTING STRATEGIES

- 1. Define the weight of the suit patterns.
- 2. Isolate the independent patterns from the hand and then isolate the cards with the same points.
- 3. Isolate all the bombs, triplets and pairs, which form a set $a = \{\text{bombs, triplets, pairs}\}$
- 4. Select a set b and put the elements of $a-b$ in the rest of cards.
- 5. Find the longest single sequence from the smallest point to the biggest from the rest of cards. The length of the single sequence should be equal or greater than 5.
- 6. Isolate all other cards left as singles.
- 7. Record the result of splitting in set $s_i = \{b, \text{single sequence, single}\}$, and calculate the weight and the hand of the result.
- 8. Repeat step 4 to step 6 until all the elements in $p(a)$ has been selected.



- Joker, 2 and A are independent suit patterns. Then find out their same cards: {Joker, 222, AA}
- Next, isolate all the Bombs, Triplets and Pairs, that is $A = \{QQQ, 66, 44\}$.
- First, choose "QQQ" from A, so $B = \{QQQ\}$, and the result set will be {QQQ, 45678910J, 4, 6}. We can get hands number and weight number.
- Then if $B = \{QQQ, 66\}$, and the result set will be {QQQ, 66, 78910J, 5, 44}. We can get hands number and weight number.
- If $B = \{QQQ, 66\}$
- So on.
- Compare each method, choose the highest weight and minimum hands number.

BIDDING STRATEGIES

- Rockets, Bombs, Jokers and 2 can be seen as major suits.
- Rule:
 - Assume the weight of Rocket is 8, Red Joker is 4, Black Joker is 3, and Single 2 is 2.
 - So if the total weight of these patterns is:
 - Equal or greater than 7, bid for 3 points;
 - Equal or greater than 5, bid for 2 points;
 - Equal or greater than 3, bid for 1 point;
 - Not bidding if less than 3.

PLAYING STRATEGIES

- Base on the Rule Base:
 - Strategy of play
 - For Pair: check the amount of Triplets and Triplet Sequences, if $\text{Sum (Triplets, Triple Sequences)} \leq \text{Pairs} + \text{Singles} - 2$, play Pair, otherwise pass this turn.
 - For Single: check the amount of Triplets and Triple Sequences, if $\text{Sum (Triplets, Triple Sequences)} \leq \text{Pairs} + \text{Singles} - 2$, play Single, otherwise pass this turn
 - STRATEGY OF FOLLOW
 - CARD 2 COULD BE PLAYED AS SINGLES, PAIRS OR TRIPLETS.
 - Check if there's Pairs, max Pair of 4-Card-Double-Sequence, Triplets, Double Sequence, Triple Sequences, Bombs in the above sequence, then split for an appropriate Pair to follow. If there's not, pass.

Q-LEARNING OF DOU DI ZHU

- COMBINATIONAL Q-LEARNING FOR DOU DI ZHU

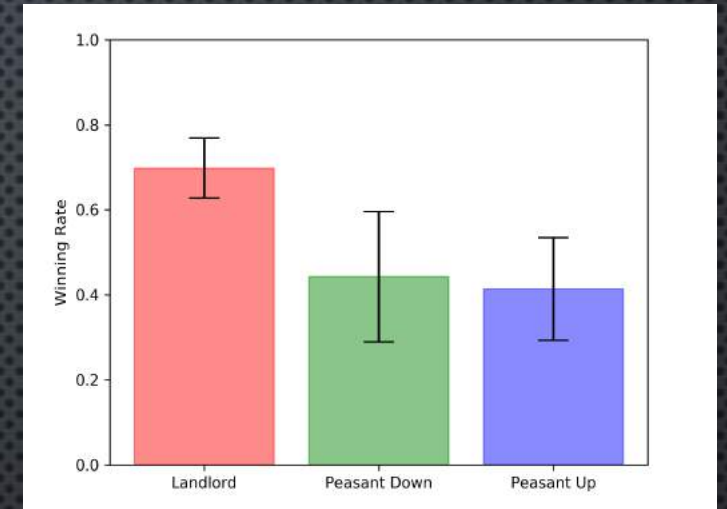
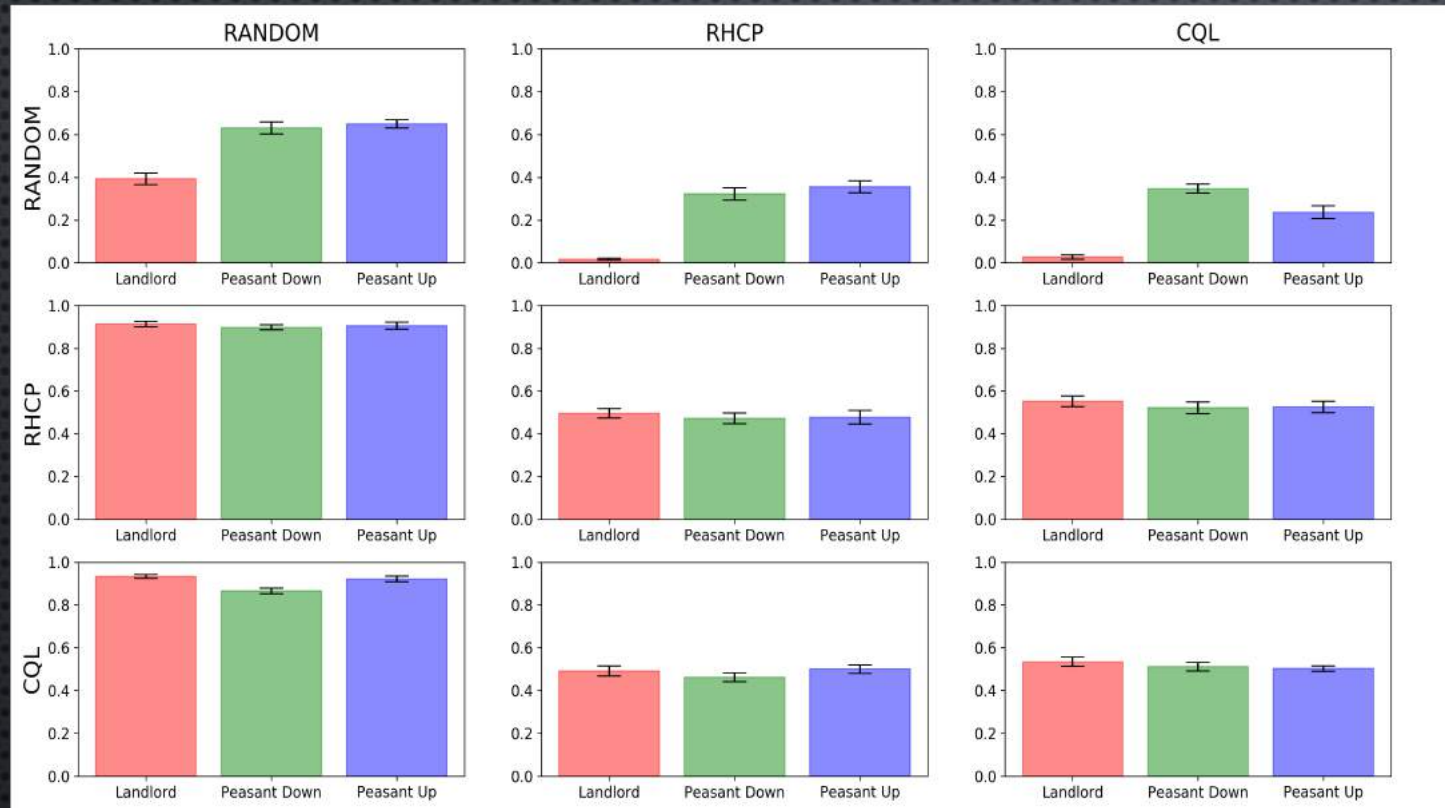
COMBINATIONAL Q-LEARNING

- It depend on the current handled card, to make the new strategy.
- Before each step to play the card, AI need to prepare the newest strategy depend on the right now handle cards. It is defined as 2 state: \mathbf{c} and \mathbf{f} .
- When in $\mathbf{S_c}$ (state c), agents choose the best decomposition, and then in $\mathbf{S_f}$ (state c), agents choose the best final move within previously selected decomposition. At each stage, a new set of actions need to be defined, $\mathbf{A_c}$ and $\mathbf{A_f}$ respectively.
- $\mathbf{A_c} := \{\mathbf{A^{(1)}_f}, \mathbf{A^{(2)}_f}, \dots, \mathbf{A^{(D)}_f}\}$ $\mathbf{A^{(i)}_f} := \{\mathbf{C^1_{(i)}}, \mathbf{C^2_{(i)}}, \dots, \mathbf{C^k_{(i)}}\}$
- D is the number of possible decompositions given current handheld cards and K is the number of card groups within each decomposition.

THE TWO STATES

- 2 state:
- S_c and S_f
- In S_c , agents choose the best decomposition.
- In S_f , agents choose the best final move within previously selected decomposition.

CONCLUSION



Winning rates of human players against our agents.

Winning rates of different models playing against each other.

FIGHT THE LANDLORD (DOU DI ZHU)

- There are four different level AI agent.
 - Random Agent
 - Simple Agent
 - Advanced Agent
 - Predictive Agent

FOUR AGENTS

- Random Agent: believes the playing is stochastic process, plays valid cards randomly,
- doesn't consider cooperation, doesn't remember history, doesn't plan for future
- • Simple Agent: plans for future, plays the low-ranking valid card(s) first if possible
- • Advanced Agent: analyzes different contexts, and plays conditionally according to
 - decision tree and sometimes probabilities.
- • Predictive Agent: remembers cards played and related context, predicts the possible
- remaining cards in other players' hands, plays card(s) as optimal as possible