Mahjong AI

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***Abstract*— This report is mainly about the original AI we developed based on some open source projects and Tenhou Mahjong platform to realize identifying whether the opponents have been in the status of waiting.**

I. Introduction

Mahjong is a game that filled with random and strategy so it is actually very challenging. We cannot know the whole process and every game it is greatly different. The state space of mahjong can be greatly large. We need to work out proper methods simplifying it. In this work, we design a simple but cogent method not worse than the complex methods the best present mahjong AI and get great positive effects. We also finish corresponding API to the current mahjong platform Tenhou and design, modify the scrawler acquiring good data.

Fig. 1. Tenhou mahjong platform

II. Basic Rules of Mahjong

The AI we develop is based on Japanese Mahjong, which is a table game in which four players start with a score of 25,000 points and compete to achieve the highest score. One game of Mahjong usually consists of four or eight rounds. A player can win a round by completing a winning hand consisting of 14 tiles, and get a score according to the hand.

At each turn in a round, a player picks up a tile from the wall (a set of tiles shared by all players), or picks up a tile discarded by another player, which is called stealing. He then discards a tile or declares a win. When a player picks up a winning tile himself, it is called winning-from-the-wall, and the other three players share the responsibility of paying out the score. A player can call out ron when one of the other players discards a winning tile. It is called winning-by-a-discard, and the player who has discarded the tile pays the whole score to the winner.The final result will be a rank based on the points one have.The one with the most points will get the highest reward and the one with the least points will have the most strict punishment.Therefore, we need to greatly avoid becoming the last one.

Mahjong is played using 136 tiles, comprising 34 distinct kinds with four of each kind. One hundred and eight of them are number tiles. Each has a number from one to nine and one of three suits (numbers, balls, and sticks). The rest are honor tiles with no particular ordering. Honor tiles comprise wind tiles (east, south, west and north) and dragon tiles (white, green and red).

Each player usually tries to make a hand of four sets (melds) and one pair of tiles. There are two kinds of set, a pung, three identical tiles, and a chow, three consecutive tiles of the same suit.

There are three status concerning strategy and status we need to pay special attention to:

- Waiting A player is waiting if his hand needs only one tile to become complete.
- Riichi A player can declare riichi when he is waiting with no melds made by stealing. Once a player declares riichi, he must discard every tile he picks up except when it is a winning tile.
- Folding A player folds if he gives up to win and only tries to avoid discarding a winning tile for other players. Unlike poker, players do not explicitly declare a fold, and thus folding is not an action but a strategy in Mahjong

III. Algorithm Prediction I

A. Basic thinking

In the rules of mahjong,one cannot win by the tile he had discarded,which provides great space for people to decide whether to defend or take more active action.The timing

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and policy to decide which attitude you prefer will influence greatly the results.

In this process,the most important two points we think of are to judge whether other players in a waiting state and when we should take the mode of defence.Because once we decide to defend, the probability of winning, namely harvesting scores, would be greatly decreased. A nice judge for the conditions can provide great efficiency to avoid losing scores and win scores.

B. Scrawler and Data

The data we acquire are mainly from the site: http://archttpturus.su/tenhou/ranking/ . We mainly select the high levels(above 17 levels, namely only 18,19,20 levels, about top 0.1%) human game record.We approximately use 50000 games to realize our algorithms.

C. Algorithm I

We firstly use Naive Bayes based on Gaussian distribution to identify whether they are in the waiting status.

1.Load the data and divide them into training data and test data.

2.Identify the feature space.We select the features which seem to influence our judge mostly.They are separately the quantity of 1 and 9, the quantity of 2 to 8, the quantity of yakuhai(the special tile can independently satify winning), the quantity of wind tile but not yakuhai, the number of draws(we set three stages early, middle, late stage to represent the evolution of the game), the pung,kan,chi tiles.

3.Calculate the mean and standard error of each feature of data. we then suppose they obey to Gaussian distribution.

$$P(Y|F_1, F_2, ..., F_n) = \alpha P(F_1|Y)P(F_2|Y)...P(F_n|Y)P(Y)$$

We extract the conditional probability $P(F_i|Y)$ from the Gaussian distribution acquired from the data set.

4.Prediction by compare the value of probability of opponents in waiting status or not.

In this process, several important notes need to be mentioned. Firstly, the feature space we choose is based on the tendency that the middle number of the tile would be easier to form melds so that people tend to discard boundary tile. Then the melds and yakuhai contribute greatly to the winning results, we think they must also be considered.Besides, with the number of draws going, people have more complete tiles and winning with higher probability. These are the reason why we choose these several features.

Secondly,Because people always tend to discard the boundary tiles(number 1 and 9 tiles),they tend to form melds,and get yakuhai,though some special conditions actually appear,it doesn't influence much the distribution. They can be seen as repetitive and independent experiments for every game.We then can seen them obey to gaussian distribution approximately.

At last, we also want to use Q-learning or deep neural networks at first.However, the mahjong game has the portion of randomness, we cannot explore well and design a good algorithm that seems to have a good presentation. We think of regression, DNN, naive bayes. In fact, naive bayes is one of the easiest but powful tool. Furthermore, it has a good ability to generalize the situation and convenient to design the feature space that not too specific to overfit or too few to underfit.

D. Results

After complete training, the accuracy of our judge of the opponents waiting status converge to about 74%, we then compare it with the newest mahjong AI based on Adam gradient and FOBOS algorithm.They choose more than one thousand features and use complex loss function to optimize. Their accuracy is about 77%, only slightly higher than us. The plot we draw present the tendency of convergence of our accuracy with respect to the number of traning data.

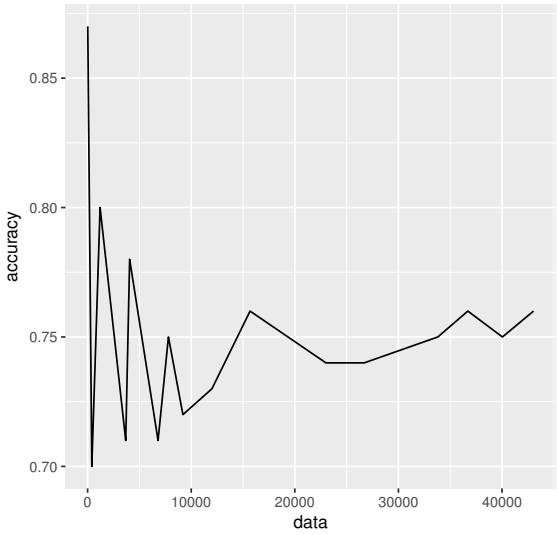

Fig. 2. Data-Accuracy plot

E. Features modification

We think to optimize further, we can modify the feature space chosen.

Firstly When the boundary tiles we choose 1,9,2,8(previously we only choose 1,9), it at last converges 76%,which is a little better than before. Secondly when we change the draws.Previously, we set the draws three stages, but we change it as totally specific number.The result lifts up to about 77%.

IV. Algorithm Prediction II

We also consider the current players' rank and the two scores with others to decide whether we take defence or take active strategy. To be convenient, we also use the previous classification mathod, naive bayes. Besides the two features mentioned, we also add draws.

The result is beyond our expectations.The accuracy is only

about 38%. We then try changing the two scores as the scores gap.The result is still only about 45%. We don't have enough energy to try a new method,which has further space to improve.

According to our analysis, the gap between your scores and the upper and lower rank one has relationship with your action. For example, if the gap is small and is rank 2, you can sure take active strategy and strive for rank 1. However, if you have small gap with the third one and large gap with the first one, you may choose defence more possibly!

The failure reason we think may be firstly when check the test set, the defence and active behavior may be not so easy to judge.We only consider the shanten number(the tiles need to be changed to win)tendency. The other reason may be that the relationship actually is not so strong. Other machine learning algorithms may contribute to better behavior, we don't have much time to go deeper. To make it be able to play with real man opponents, as the AI bot becomes the fourth rank,we let it always take active strategy, because it won't be worse.

V. Results and Conclusions

A. Results

We construct API connected with Tenhou and creat an AI ShTecBot and it now gets level 6. We also design a chinese-friendly hint so that it's more comfortable to observe.

From the data plot we can see we actually avoid 4th ranking effectively.And after one night, it levels up to 2nd grade(The grade is from 10th to 2nd decreasingly with you winning more)

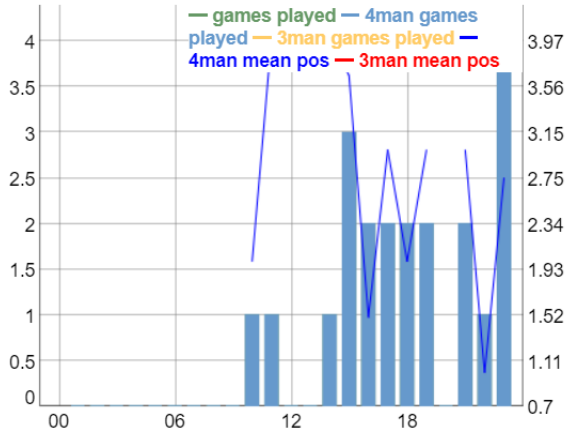

Fig. 3. Results I

B. Conclusions

Naive Bayes can be powerful sometimes but it also has time no use.The feature space we choose has great relationship with the results so we can try many features to select the best.Mahjong is a relatively challenging game concerning great randomness and activeness.The newest mahjong AI also still have great challenges, some aspects of our AI can get pretty good behavior compared with them. There are still

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2019-01-18 15:11:48 INFO: 退出游戏
2019-01-18 15:11:49 INFO: 人工智能：初音未来，V2
2019-01-18 15:11:50 INFO: 达到新的段位！
 認定段位/級位     :     2級

ShTecBot 殿

貴殿は天鳳において卓越した技能を遺憾なく発揮され優秀な
成績をおさめられました。今後もさらなる雀力向上に精進され
ますようここに段位/級位を認定し栄誉を称えます。

2019年01月18日
天鳳段位認定協会
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Fig. 4. Results II

future works we can work on like trying to use regression and Deep neural networks to train the model of Algorithm prediction II. To conclude, we think this is a fun project and the bot we have done is interesting,

References

https://github.com/erreurt/MahjongKit
https://github.com/MahjongRepository/mahjong