Poker Project - Team 15

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1 Introduction

This project implements a poker player AI agent that acts as one of the two players in Limit Texas Hold'em. The fundamental idea of implementation is using reinforcement learning to build a heuristic evaluation function, which measures the expected reward of each action and make the decision that maximizes the return. Hand strength, current bet and opponent's bet were the three components that make up the evaluation function. The evaluation function is a linear function that sum up the product of the numerical value of each component and their corresponding weight. To decide the weight of the three components, online training was conducted. The weight for each component reflects the expected influence that the component has on the final result of one round of game. The agent's decision and final result were feed into the online training at the end of every round, and weight for each component was adjusted. Different from current bet and opponent's bet which can be obtained directly from game state, the numerical value of hand strength was computed by evaluating hole cards and revealed community cards. A list of poker features, such as high card and pair value was selected to determine the hand strength. Similar to the evaluation function, the function that calculates hand strength is also a linear function that sums up the value of the product of weight and feature. The weight of each feature was determined from our offline training. Traditional approach of poker game agent, like listing preflop chart, is computationally expensive and space consuming. To improve the efficiency while not reducing accuracy, we choose to implement a reinforcement learning based agent. Our agent is able to learn from opponent's behavior and adjust evaluation function according to opponent's characteristic. To improve the accuracy of decision making, we trained the hand strength evaluation function of agent offline with large amount of data before playing game with others. In this report, we will explain how we implement the poker agent and discuss how the agent can make optimal decisions. In section 2, we will review a few approaches in past research and analysis their strength and weaknesses. In section 3, we will elaborate our agent's play strategy, and explain the implementation details and training methods. In section 4, we will discuss the training results and show merits and limitation of our approach. Lastly, we will go into the conclusion and future direction.

2 Past research

The core of the implementation of an AI poker player agent is to decide the next action it should take giving the information of the environment. Utility maximization and regret minimization are two approaches that have been well explored regarding next action decision. The most traditional method to optimize the utility is to list out results for all possible solutions in each round and select the action that gives highest utility. This method is precise and easy to implement but computational expansive. To reduce the computational effort, some researchers proposed heuristics that evaluate the return of the game and use decision trees to model the next actions that should be take. With sufficient and reasonable training, this method can yield good results. Regret minimization is another popular approach. Regret is defined to be the loss in utility taking this action suffers for not having selected the single best deterministic strategy and the single best deterministic strategy can only be known in hindsight. The approach aims to minimize the regret value. In 2015, Bowling and other 3 scientists announced that they weakly solved Heads-up limit Texas hold'em by using a technique called counterfactual regret minimization which is based on regret minimization. Since we discussed minimax algorithm during class and we are more familiar with the utility maximization approach, we adopted the utility maximization approach. We generate a decision tree at each step and the agent will take the action that gives the highest numeric value of the evaluation function. Evaluation function is another key element of our implementation. From past research, hand strength and pot money are two of the most widely-used factors when constructing the evaluation function. Reinforced learning is also proposed by some researchers to adjust the evaluation function based on information that cannot be got in advance, such as opponent's behavior.

3 Implementation

3.1 Agent strategy

In Limit Taxas Holdem Game, each player start as small To play the poker game, our agent estimates the expected quality of each action in current state and choose the optimal action among "fold" "raise" and "call". "Optimal" action refers to the action which maximizes the expected winning result

at one round of game. The heuristic evaluation function to evaluate action is a linear combination of X criteria: (1) expected hand strength (2) ....

3.2 Training method

Offline training

Online training

4 Training Result and analysis

5 Conclusion

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```
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Citations within the text should include the author's last name and the year of publication, for example [Gottlob, 1992]. Append lowercase letters to the year in cases of ambiguity. Treat multiple authors as in the following examples: [Abelson *et al.*, 1985] or [Baumgartner *et al.*, 2001] (for more than two authors) and [Brachman and Schmolze, 1985] (for two authors). If the author portion of a citation is obvious, omit it, e.g., Nebel [2000]. Collapse multiple citations as follows: [Gottlob *et al.*, 2002; Levesque, 1984a].

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Acknowledgments

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A LaTeX and Word Style Files

The LaTeX and Word style files are available on the IJCAI–18 website, `http://www.ijcai-18.org/`. These style files implement the formatting instructions in this document.

The LaTeX files are `ijcai18.sty` and `ijcai18.tex`, and the BibTeX files are `named.bst` and `ijcai18.bib`. The LaTeX style file is for version 2e of LaTeX, and the BibTeX style file is for version 0.99c of BibTeX (*not* version 0.98i). The `ijcai18.sty` file is the same as the `ijcai07.sty` file used for IJCAI–07.

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These Microsoft Word and LaTeX files contain the source of the present document and may serve as a formatting sample.

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[3] Note the line separating these footnotes from the text.