Artificial Intelligence Project: AI Poker

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Introduction

Poker is a type of card game, using a standard 52-card deck, in which players bet on the value of the card combination ("hand") in their possession, by placing a bet into a central pot. The winner of the pot is the non-folded player who holds the hand with the highest value according to an established hand rankings hierarchy (rare card combinations are more valuable than common).

AI Poker is a poker game where the players are autonomous computer programs. The variant of poker used by AI Poker is called five-card draw[1]. Note that this is not the same as Texas Hold´Em, the currently most popular poker variant.

The objective of this project is to develop AI poker agents for the five-card draw poker game. You will be using knowledge learned in the course and lab exercises.

Requirements

AI Poker requires that a minimum of three programs run simultaneously; one server and two clients. The server controls the whole game while the clients participate in the game, playing against each other. A maximum of five clients (players) can be connected to the server at the same time, playing against each other. This is explained in more detail in the following chapters.

The project material includes:

- The poker server application, i.e. "PokerServerGui.jar", can be found within the folder "PokerServerGUI";
- An example random agent can be found within the folder "PokerClientRandom", in which "PokerGame.py" facilities the poker game, "Client.py" defines the behavior of the agent.

Playing the game

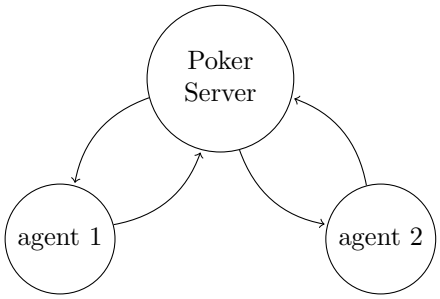
In simple terms, AI Poker works like this: The server application allows clients to connect to it, and once all clients are connected the game starts. The game is controlled by the server. When a player needs to make a decision, the server sends a query to the player. The communication is carried out in a client-server fashion, see Figure 1a. Before the server starts hosting a poker game, the game setting needs to be configured, an example is available in Figure 1b. After the server starts hosting, agents are allowed to connect the game.

Once started, the game goes in a loop until only a single player remains (has chips left), real-time feedback of the game is available in GUI (Figure 1c) and in text output(Figure 1d). The loop, controlled by the server, performs these actions each playing round:

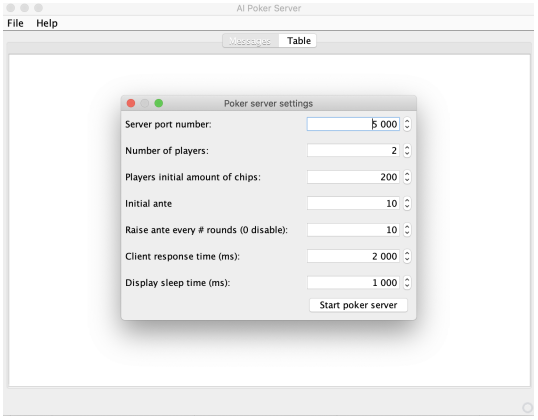
[1] See e.g. http://en.wikipedia.org/wiki/Five-card_draw.

1. The server informs all the players how many chips each player has.
2. The players receive five cards each from the server.
3. A forced bet (ante) is drawn from each player and put into the pot.
4. The first betting round[2].
5. The draw phase, in which each player is offered to discard some of the cards on hand and receive new cards as replacement for the discarded. The player chooses the what cards to discard (if any).
6. The second betting round.
7. The showdown, which determines the winner of the round. The winner receives the contents of the pot. (In case of multiple winners, the pot is split.)

Each betting round starts with a player making an opening action: "check", which is to not place a bet (the opportunity to open moves to the next player); "open", which is to make the first bet; or going "all-in", which is to open with all the players remaining chips. Once the round has been opened each player may "fold", which is to drop out of the hand losing any bets they have already made (but not risking any more); "call", which is to match the highest bet so far made; "raise", which is to increase the previous high bet; or go "all-in", which is to put all the players remaining chips in the pot.

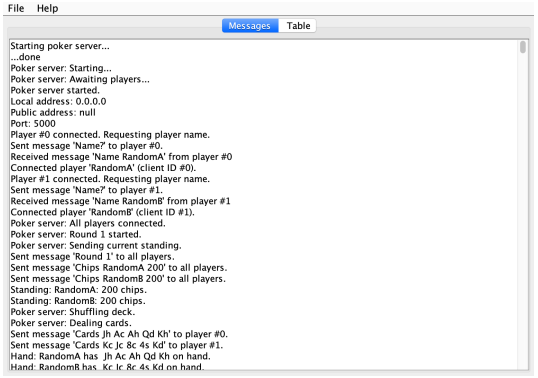


(a) Client-server communication between the Poker Server with two poker agents programs



(b) an example of poker game configuration

(c) GUI with two agents play against each other



(d) example text output of a poker game

Figure 1: Poker Server

[2]For information about betting in poker, see e.g. http://en.wikipedia.org/wiki/Betting_(poker).

AI Poker Rules

Players in AI Poker act in turn, in clockwise rotation.

The game starts by forcing each player to bet an ante (a forced bet). Once the bet has been set, each player will receive five cards from the server.

When it is a player's turn to act, the first action he takes binds him to his choice of action and changing his action after seeing how other players react to his initial action is not permitted. Once each player has received five cards the round can start. The first player can then choose to make one of a few specific actions:

- Until the first bet is made each player in turn may "check", which is to not place a bet, or "open", which is to make the first bet.
- After the first bet each player may "fold", which is to drop out of the hand losing any bets they have already made; "call", which is to match the highest bet so far made; or "raise", which is to increase the previous high bet.

Each game, every player will receive a specified amount of chips[3] which they can use for betting. The maximum amount of chips during a game, the amount the winner will have when the game is over, are the sum of all players initial amount of chips.

Six different types of chips exist:

- A "1-coin" chip.
- A "5-coins" chip.
- A "10-coins" chip.
- A "25-coins" chip.
- A "50-coins" chip.
- A "100-coins" chip.

Game flows and actions

Each round in the AI Poker game goes through a number of different steps. These steps are as follows:

1. Ante is set and cards are distributed.
2. The first betting round is made.
3. If any players remain in the game, then each player can choose to change cards.
4. The second betting round is made.
5. Showdown, where the players hands are compared and the winner(s) will receive the pot (or part of the pot, in case of multiple winners).

A betting round ends when each none-broke player has either bet an amount equal to the maximum bet, folded or gone all-in. If no opponents call a player's bet or raise, the player wins the pot.

[3]The default amount of chips is 200.

Open

The act of making the first voluntary bet in a betting round is called opening the round. On the first betting round, it is also called opening the pot.

Call

To call is to match a bet or a raise.

Check

If no one has yet opened the betting round, a player may pass or check. When checking, a player declines to make a bet; this indicates that he does not wish to open, but does wish to keep his cards and retain the right to call or raise later in the same round if an opponent opens. If all players check, the betting round is over with no additional money placed in the pot other than the ante (the forced bet) from each player.

Raise

To raise is to increase the size of the bet required to stay in the pot, forcing all subsequent players to at least call the new amount if they want to stay in the round. The act of opening is a special case of raising, done when no other player has raised yet. A player making the second (not counting the open) or subsequent raise of a betting round is said to re-raise. In AI Poker the raise must be at least as high as the previous raise (if any).

If, due to an open or raise action, a bet has been placed that the player in-turn cannot match, then unless that player chooses to go all-in, he must fold. A player must at least match the bet and cannot check or call with a lesser amount.

Fold

To fold is to discard one's hand and forfeit interest in the current pot. No further bets are required by the folding player, but the player cannot win.

Ante

An ante is a forced bet in which each player places an equal amount of money or chips into the pot before the deal begins.

Hands

In AI Poker, players construct hands of five cards according to predetermined rules. These hands are compared using a standard ranking system, and the player(s) with the highest-ranking hand wins that particular deal.
The strength of a hand is increased by having multiple cards of the same rank, all the cards being from the same suit, or having all the cards with consecutive values. The position of the various possible hands is based on the probability of being randomly dealt such a hand from a well-shuffled deck.
The following general rules apply to evaluating poker hands in AI Poker:
There are 311,875,200 ways ("permutations") of being dealt five cards from a 52-card deck, but since the order of cards does not matter there are 2,598,960 possible distinct hands ("combinations").

- Individual cards are ranked A (high), K, Q, J, 10, 9, 8, 7, 6, 5, 4, 3, 2, A. Aces only appear low when part of an A-2-3-4-5 straight or straight flush.

- Suits have no value. The suits of the cards are mainly used in determining whether a hand fits a certain category (specifically the flush and straight flush hands). If two players have hands that are identical except for suit, then they are tied and split the pot.
- A hand always consists of five cards.
- Hands are ranked by category, and even the lowest qualifying hand in a certain category defeats all hands in all lower categories. The smallest two pair hand, for example, defeats all hands with just one pair or high card.

These are standard poker hands in descending order[4]:

1. There are 40 possible straight flushes (five consecutive cards of the same suit), including the four Royal Flushes (ace to ten in the same suit). The probability of being dealt a straight flush is 40/2,598,960 = 0.0015%.
2. There are 624 possbile hands including four of a kind (four cards of the same value in different suits); the probability of being dealt one is 0.024%.
3. There are 3,744 possible full houses (three cards of one value, two cards of another value, regardless of suit); the probability of being dealt one in five-card hand is 0.14%.
4. There are 5,148 possible flushes (five cards of the same suit), of which 40 are also straight flushes; the probability of being dealt a flush in a five-card hand is 0.20%.
5. There are 10,240 possible straights (five consecutive cards), of which 40 are also straight flushes; the probability of being dealt a straight in a five-card hand is 0.39%.
6. There are 54,912 possible three of a kind hands (three cards of the same value) which are not also full houses; the probability of being dealt one in a five-card hand is 2.1%.
7. There are 123,552 possible two pair hands (two cards of one value, two other cards of another value) that are not also full houses; the probability of being dealt one in a five-card hand is 4.75%.
8. There are 1,098,240 possible one pair hands (two cards of the same value); the probability of being dealt one in a five-card hand is 42.26%.
9. Of the 2,598,960 possible hands, 1,302,540 do not contain any pairs and are neither straights nor flushes. As such, the probability of being dealt "high card" in a five-card hand is 50.12%. The value of the hand is the highest individual value of the cards in the hand.

Pots and Sidepots

Normally, each players bet are put into the main pot and the player with the best hand wins the pot. If several players have hands of the same rank, the pot is split equally between them. A player cannot win more from each of the other players when he himself has bet, so if a player has to few chips to call and goes all-in, a side-pot is created. Each player the all-in amount of chips from the main pot into the side pot (or all money if the player has folded), keeping the remaining amount of chips in the main pot. During the showdown, the best player(s) contributing to the side pot wins the side pot, while the best player(s) contributing to the main pot (this excludes the player that won all-in) wins the main pot. If several players go all-in, several side-pots can be created.

Due to side-pots, it is possible to have several winners in a round even if they have hands of different ranks.

[4] https://en.wikipedia.org/wiki/List_of_poker_hands

Task and reporting

Your task is to implement agents of different types to play the five-card draw poker game. The five-card draw poker game is more complicated compared to the one in the lab exercises. A new feature in this poker game is the "card exchange phase", which is placed after the first betting round. A rational decision made in this phase shall, conventionally, lead to a better hand. An example of an agent is provided in "Client.py", you can use it as a starting point of your implementation. To complete the project, a report and the corresponding code of an agent are required to be submitted. The report shall contain the following content:

- Abstract: a general description of what you have achieved:
  - What type of agent have you implemented?
  - What is the underlying strategy?
  - How well does it perform?
- Introduction: a short description of the project
  - The poker game, rules, and settings
  - What types of agent and AI methods can be applied?
  - Are any relevant work being applied to this problem?
- Method
  - Strategy and methods employed
  - PEAS description
  - Expected behavior
- Experiment and tournament result
  - What have you observed when playing against a random agent or any agent you have developed?
  - Does the result match your expectations?
  - Observation from the (pre-)tournament
- Conclusion

Grading Criteria

- Grade 3: a reflex agent that takes its own hand and/or the opponent's action into account is implemented.
- Grade 4: in addition to a reflex agent, an agent with learning capability in-built, utilizing historical data, is implemented.
- Grade 5: an agent with sophisticated learning capability and shall achieve good results in the tournament. The approach shall be well-motivated, explained (based on observations from the experiments conducted), and documented.