

Two-Player No-Limit Texas Hold'em Competition

Game Theory (2020 Spring)

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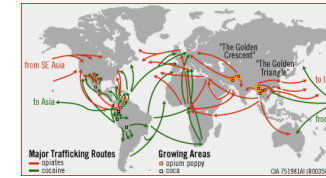
Outline

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Introduction

- **Texas hold 'em** (also known as **Texas holdem**, **hold 'em**, and **holdem**) is one of the most popular variants of the card game of [poker](#). Two cards, known as hole cards, are dealt face down to each player, and then five [community cards](#) are dealt face up in three stages.
- Players have [betting](#) options to call, raise, or fold. Rounds of betting take place before the flop is dealt and after each subsequent deal. The player who has the best hand and has not folded by the end of all betting rounds wins all of the money bet for the hand, known as the pot.
- Useful references:
 - <https://www.pokerlistings.com/poker-rules-texas-holdem>
 - https://en.wikipedia.org/wiki/Texas_hold_%27em

Imperfect-Information Games



Perfect-Information Games



Most of the
successes in multi-
agent AI research



No-Limit Texas Hold'em Poker

- The main ***benchmark and challenge problem*** in AI for imperfect-information games
- 10^{161} decision points
- Determines the winner of the World Series of Poker Main Event
- Featured in *Casino Royale* and *Rounders*
- No prior AI was able to beat top humans



2017 Brains vs AI

- Libratus (our 2017 AI) against four of the **best** heads-up no-limit Texas Hold'em poker pros



- 120,000 hands over 20 days in January 2017
- \$200,000 divided among the pros based on performance
- Won with 99.98% statistical significance
- Each human lost individually to Libratus

Rules

- 13 cards: 2, 3, 4, 5, 6, 7, 8, 9, T, J, Q, K, A
- 4 suits: s, h, d, c
- 4 rounds: pre-flop round (2 * 2 private cards), flop round (3 public cards), turn round (1 public card), river round (1 public card)



Rules

- Stack for each player is 20000. It is reinitialized after each hand.
- Before one hand begins, player at position 0 puts in 100 (big blind), player at position 1 puts in 50 (small blind).
- Actions:
 - **Fold:** Pay nothing to the pot and throw away their hand, waiting for the next deal to play again.
 - **Call:** Match the amount of the other player's larger bet.
 - **Raise:** Raise the bet.
- A Texas Hold'em round ends when two conditions are met:
 - 1.All players have had a chance to act.
 - 2.All players who haven't folded have bet the same amount of money for the round.

Rules

- player 1 (small blind) acts first in the pre-flop round.
 - call, raise, fold are valid actions.
- player 0 (big blind) acts first in the remaining rounds.
 - raise, call are valid actions. fold is not valid since it is dominated by call.
- Hand values:
- royal flush > straight flush > four of a kind > full house > flush > straight > three of a kind > two pairs > pair > highcard
- <https://www.pokerlistings.com/poker-hand-ranking>

Rules for raise

- if nobody has raised in the current **ROUND**:
 - $\text{min_raise_size} = \text{big_blind}$
 - else:
 - $\text{min_raise_size} = \text{size of last raise in this ROUND}$
- $\text{min_raise_bet} = \text{highest_bet} + \text{min_raise_size}$

steps	min_raise_size	min_raise_bet	raise size picked	representation	after raise
[100, 50]	100	200	100	r200	[100, 200]
[100 , 200]	100	300	100	r300	[300, 200]
[300, 200]	100	400	350	r650	[300, 650]
[300 , 650]	350	1000	550	r1200	[1200, 650]
[1200, 650]	550	1750	-	c	[1200, 1200]
go to next round...					
[1200 , 1200]	100	1300			

Project

- We provide a poker server, which hosts a poker game, sends state information to poker clients, and simulates poker games given actions responded by clients.
- You can implement your poker client with any language.
 - For C++/Python3 users, we already have implemented code frameworks for you. You only need to fulfill an 'act' function to realize your poker strategy.
 - For others, you need to communicate with the server via socket.
- Find much more details in the documents provided along with the source code!
 - The project needs Linux or macOS. Please make sure your client is able to be compiled and run properly in macOS, Ubuntu, etc.

Submission

- Deadline: by the end of the 16th week
- source code + report (how do you implement your poker strategy)
- Details of competition:
 - group stage + knockout stage
 - Each match consists of 1000 hands. (Fewer hands is possible if faced with long responding time)
 - Agents' performance is measured with milli-big-blinds per game (mbb/g), which is a standard measurement in annual computer poker competition (acpc).
 - In general, your poker agent should return each action in less than 7 seconds (same as acpc) while running on a common PC.
 - Timeouts, responding with illegal messages shall be treated as giving up.
- If you find bugs, we appreciate it if you could contact TAs.