29 points card game bot for Smartbots 2023

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Approach used

- Hard coded bidding logic
- ISMCTS(Information Set Monte Carlo Tree Search) to get a card
- Maximal Bipartite Matching for distributing cards

Bidding

- Determine the potential trump suit that will be chosen.
- Separate the cards into trump and non-trump cards.
- Find out the points of cards in both sets.
- With various conditions accordingly as the count of trump cards and total points of trump and non-trump cards, set the maximum bid.
- If the current bid doesn't exceed the maximum bid,
  - the bid is matched or raised.
  - else, the turn is passed.

Choosing Trump

- The cards are separated by their suits.
- The highest count of cards for any suits is determined.
- If a single suit has highest number of cards, it is chosen as trump.
- If the two suits compete with highest number of cards, the total points of their set of cards is determined.
- The suit with higher total points is chosen as trump.

ISMCTS details

- Infer opponents cards
- Distribute cards using Maximal Bipartite Matching
- On current determinization:
  - Select cards using UCB formula
  - Use historical data for simulation

Cards Inference

- Inference of unavailable suits

  This is the simplest type of inference. If a player cannot throw the running suit, then he has no cards of that suit.

- Inference of unavailability of low point cards

  Say an opponent throws a 9 of *Spades* on a losing hand. Then, it is highly probable they don't possess lower point cards of suit *Spades*. This probability is fixed to be 0.92 using observation from data.

Cards Inference (contd.)

- Inference of unavailability of low order cards

  Same as above but the inference is applied for order of cards instead of point. The probability of using this inference in given determinization is fixed to be 0.8.

- Inference of unavailability of trump cards

  If a player reveals trump and does not play trump card, then it is certain that they do not possess trump cards.

Distributing Cards

- Turn the problem of distributing cards to maximal bipartite matching problem.
- The two sets used for the bipartite matching are the set of players and the set of cards.
- An edge is drawn between them if a given player can receive a given card.
- Convert the maximal bipartite matching problem to a network flow maximization problem.
- Use Ford-Fulkerson algorithm to solve the flow maximization problem.

Using Historical Data in Simulation

- Separate available cards into winning and losing cards.
- Calculate point value of each card
- Use historical data to determine the probability that a given winning (or losing) card with given point will be played.
- Choose the given card with probability as dictated by historical data.
- Historical data used is derived from hundreds of thousands of P2P games

Thanks.