

# Developing Strategies for the Bidding Card Game 'Diamonds' with GenAI.

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## 1 Introduction

This report explores GenAI's ability to understand a completely new game of cards, 'Diamond Bids', think of strategies to win the said game and provide a python code simulating a game play.

## 2 Problem Statement

The original prompt given to Gemini was:

"This game can be played between two players and three players. In a typical three player game diamond is the trump suit and is set aside. Each player is given one of the remaining families of cards...i.e. heart, spades and clubs. now out of the diamonds suit one card is taken and everyone sees what card it is. This is the prize card. Everyone bids one card from their deck in a closed bid i.e. no one else knows what you are bidding. After the bids are revealed the prize card is distributed among players with the highest bids (i.e. if the diamond card was a 5 and two players had the highest bids among the three then both of them get 2.5 points). In case of two players the rules don't change but we simply remove the spades deck while playing. You can assume spades, decks and clubs are equivalent. At the end the player with the largest points wins."

## 3 Teaching GenAI the Game

### 3.1 Observations

- Gemini was interested in learning the game and gave questions for the user to answer in order to properly explain the game, especially when told the game was different from the ones it already knew.
- Gemini was able to understand almost the entirety of the game, except a point or two, which, when re-explained, it was able to catch on to.

### 3.2 Final Understanding of Game

**Players:** 2 or 3

**Cards:** Standard deck of 52 cards, with some modifications:

- **Diamonds:** Used one at a time as the prize card for each round.
- **Suits:** Each player receives one of the remaining three suits (hearts, clubs, spades) depending on the number of players.
  - For 3 players: all three suits are used.
  - For 2 players: spades are removed from play (essentially treating hearts and clubs as equivalent).

**Gameplay: Number of Rounds:** The game is played over as many rounds as there are diamond cards in the deck (13).

**Rounds:** In each round:

1. One diamond card is revealed as the prize card for that round.

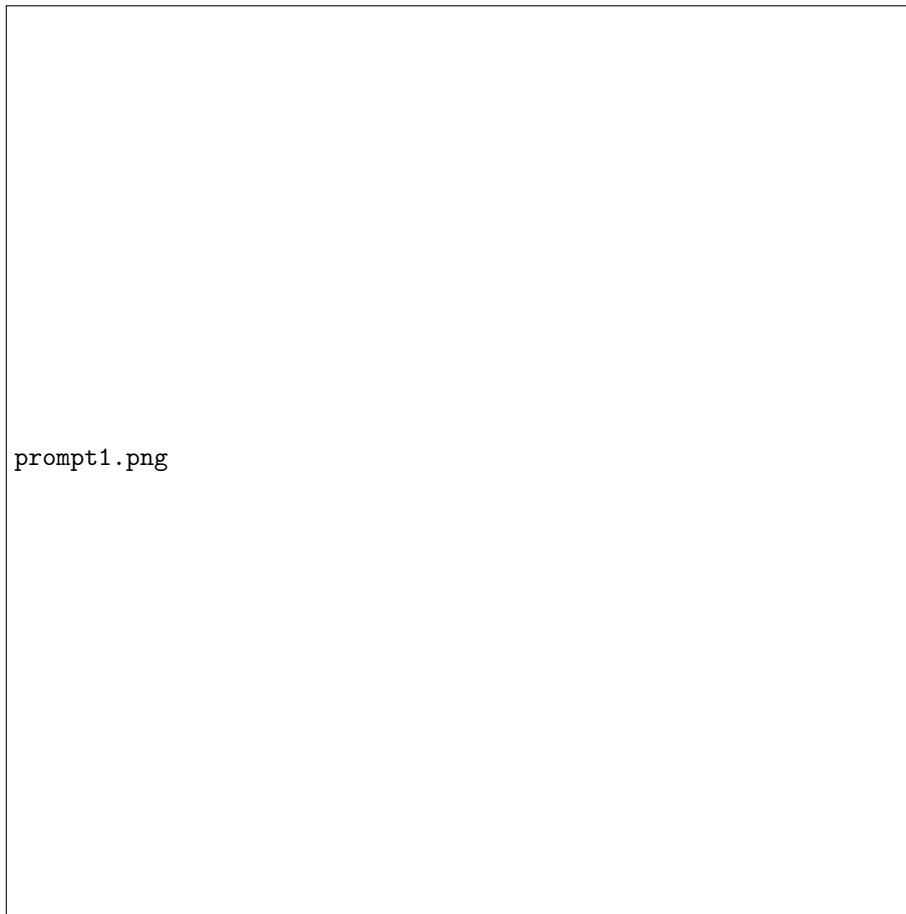


Figure 1: Prompt 1

2. Players bid one card from their assigned suit in a closed bid.
3. The player(s) with the highest bid win the prize card's face value in points (e.g., a 7 diamond wins 7 points).
4. In case of a tie for the highest bid:
  - For 3 players: Tied players split the prize card value.
  - For 2 players: Tied players also split the prize card value.

**Scoring:** Players accumulate points throughout the game by winning prize cards. The player with the most points at the end of the game (after all diamonds have been played) wins.

**Point System:**

The point value of a prize card is directly tied to its face value (2 for a 2, 10 for a 10, etc.) with face cards (J, Q, K) having values of 11, 12, and 13 respectively, and the Ace being worth 14 points.

**Similarities to Other Games:**

Similar to auction games and trick-taking games, players use bidding to win something valuable (prize card points).

**Possible Variations:**

- Award a bonus for the player who wins the most diamonds throughout the game.
- Introduce a limited number of card swaps between players during the game.

## 4 Iterating upon strategy

### 4.1 Observations

- Gemini was able to come up with relevant strategies for the game and was able to remember crucial points about the game which were important while giving these strategies.
- Gemini also tried giving specific strategies depending on number of players involved in the game.
- An interesting point is that it somehow related our game to a game of 'Poker' while strategizing.
- When prompted with some strategies of my own, Gemini analysed each of them and did not necessarily speak well for them. It had its reasonable reservations for some of them which was refreshing to see. It also gave some additional strategies which were a combination of the two.

### 4.2 Initial Strategies

**Know your deck:** Be familiar with the point distribution of your assigned suit (hearts, clubs, spades). This helps you understand the potential value of your cards relative to the prize card.

**Consider the average:** Since the point value directly reflects the card value, aim to bid slightly above the average value of your deck (around 7-8 for a 3-player game, slightly higher for a 2-player game).

**Bidding for high-value diamonds:** For high-value prize cards (10, J, Q, K, A), be more aggressive with your bids, especially if you hold high cards in your suit.

**Bidding wars:** If you're locked in a bidding war with another player, consider if the potential points gained outweigh the risk of losing points on your bid.

### 4.3 Initial Strategies (continued)

cards for a later round can be a better strategy.

**Forming temporary alliances:** In a 3-player game, you could potentially form an unspoken alliance with another player by strategically bidding lower on certain rounds to weaken a particularly dominant player. However, be cautious as this can backfire.

#### 4.3.1 Strategies for 2-Player Game (with Spades removed)

**Bidding becomes more crucial:** Since ties result in split points, precise bidding is even more important. Aim to bid just enough to win without overspending points on your bid card.

**Analyze opponent's play:** Since there's only one opponent, closely observe their bidding patterns and adjust your bids accordingly. If they consistently overbid, capitalize by bidding slightly lower for high-value diamonds.

### 4.4 Assessing User's Strategies and More

Your strategies are interesting and can definitely be effective in the Diamond Bidding Game! Here's a breakdown of your thoughts and some additional insights:

- **Remembering Opponent Bids:**

This is a very strong strategy, especially in a 3-player game. By remembering past bids, you can gain valuable information about your opponents' remaining cards. For example, if a player consistently bids high for high-value diamonds, you can deduce they likely don't have many high cards left in their suit.

- **Bidding Low for High-Value Aces:**

This is a clever strategy for Aces! Since Aces are the highest value card, bidding an Ace might lead to a tie. Bidding a lower card, especially a 2 (the lowest value) can be a good way to secure some points even if you don't win the full value.

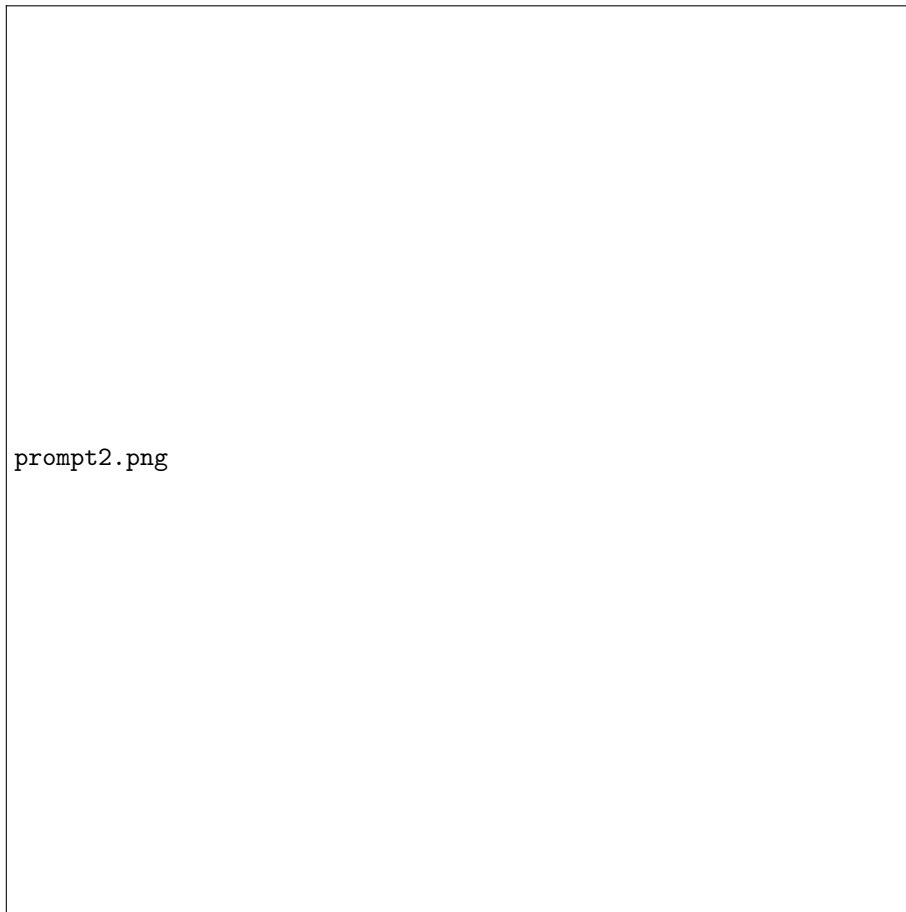


Figure 2: User's suggestion for strategies

- **Bidding Patterns (Low-High-Low-High):**

This strategy can be effective in some situations, but it requires careful consideration. Bidding low early on can be risky if your opponents are also bidding low, as you might miss out on valuable early points. Similarly, bidding high later can be risky if you've depleted your high cards earlier.

Here's a more nuanced approach to consider:

- **Early Rounds (1-3):**

You can bid slightly lower than average in these rounds, especially if the prize card value is low. This allows you to conserve your high cards and potentially bait opponents into overbidding.

- **Middle Rounds (4-7):**

This is where you can strategically use your high cards, especially if you have a good understanding of your opponents' remaining cards based on past bids.

- **Late Rounds (8-13):**

As the game progresses, high-value diamonds become more frequent. Be prepared to use your remaining high cards to compete for these valuable points.

**Combining Strategies:**

The best approach is to combine these strategies based on the situation. Here are some additional tips:

- Observe your opponents' reactions: Pay attention to how your opponents react to your bids. Are they surprised? Do they adjust their bidding accordingly?

- Adapt your strategy: Don't be afraid to adapt your strategy as the game progresses. If your initial approach isn't working, try something different based on the information you've gathered.
- Balance risk and reward: Every bid involves some risk (losing points on your bid card) and potential reward (winning the prize card). Aim to find a balance that maximizes your points while minimizing risk.

By combining your observations, these strategies, and a bit of luck, you can become a formidable Diamond Bidding Game player!

## 5 Pseudocode

Gemini surprisingly gave a very apt pseudocode for simulating the game play at it's first try.

An interesting thing to note is that it did a decent job at functional decomposition but did not go for OOPS, something that would have been very efficient for this kind of problem.

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### Algorithm 1 Diamond Bidding Game Pseudocode

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1: Define number of players (2 or 3)
2: num_players ← INPUT("Enter number of players (2 or 3): ")
3: Define suits based on player count
4: suits ← ["hearts", "clubs", "spades"]                                ▷ For 3 players
5: if num_players == 2 then
6:   suits.remove("spades")                                             ▷ For 2 players, remove spades
7: end if
8: procedure SHUFFLE_AND_DEAL(deck)                                   ▷ Function to shuffle and deal cards
9: end procedure
10: procedure GET_HIGHEST_BID(bids)                                     ▷ Function to get highest bid
11: end procedure
12: procedure CALCULATE_POINTS(bid_values)                             ▷ Function to calculate points based on bid values
13: end procedure
14: procedure PLAY_ROUND(round_number, players)                         ▷ Main function to play a round
15:   Input: Round number, list of player objects
16:   Output: Updated player objects with points
17:   prize_card ← DRAW_PRIZE_CARD
18:   for each player in players do
19:     player.bid ← GET_BID(player)
20:   end for
21:   highest_bid ← GET_HIGHEST_BID(bids)
22:   bid_values ← CALCULATE_POINTS(highest_bid)
23:   for each player in players do
24:     player.points ← player.points + bid_values[player]
25:   end for
26:   return players
27: end procedure

```

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## 6 Conclusion

In conclusion, GenAI demonstrated a remarkable ability to grasp the rules and strategies of the Diamond Bidding Game. Through iterative teaching and feedback, it was able to develop sophisticated strategies and provide insightful analysis. The pseudocode provided lays a solid foundation for implementing the game in Python, with room for further refinement and optimization. Overall, this project showcases the potential of AI to learn and excel in complex strategic environments.