GAME THEORY

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INTRODUCTION

This is a research-based project centred around game theory, where we shall analyse experimental data which will be obtained using two auction games that are designed by us.

AUCTION AND ITS TYPES

An auction is a sales event wherein potential buyers place competitive bids on assets or services either in an open or closed format.

TYPES OF AUCTION -
- ❏ The Ascending Bid (or English Auction)
- ❏ The Descending Bid (or Dutch Auction)
- ❏ The first-price, sealed-bid Auction
- ❏ The second-price, sealed-bid Auction (or Vickrey Auction)

AUCTION THEORY

ENGLISH AUCTION

English auction refers to the process or method of the sale of a single quantity of a product where the bidding starts with the starting price, which is set by the seller of the product and increases with the continuous bidding from the different buyers until the price is reached at a level above which there is no further bidding. This price will be the selling price of the product under the auction.

DUTCH AUCTION

A Dutch auction (also called a descending price auction) refers to a type of auction in which an auctioneer starts with a very high price, incrementally lowering the price until someone places a bid. That first bid wins the auction (assuming the price is above the reserve price), avoiding any bidding wars. This price may not necessarily be the highest price.

GAME 01

TRI-CARD BID : ENGLISH AUCTION

Objective:
Tri-Card Bid is a strategic card game where players use their wits, cards, and money to outmaneuver their opponents. The goal is to either force all other players to fold, securing victory, or to reveal the best pair of cards among the remaining players' hands to claim the prize.

Setup:
- ❏ Players: 3 or more
- ❏ Deck: A well-shuffled deck of cards containing numbered cards from 7 to 13 in four suits (Spades, Hearts, Diamonds, Clubs).
- ❏ Money: Each player is given $1000 at the beginning.
- ❏ Hierarchy:
    I. Sum - The Hand with the highest Sum
    II. Highest Number - If the sum of the hands is same, then the card, maximum of the three, is compared. The hand with greater number wins.
    III. Suits - If the highest number of hand is also same then the Suit of the higher number is compared in the order ~ Spade > Heart > Diamond > Club.

GAMEPLAY

➢ **Card Distribution:** Each player is dealt three cards from the deck. These cards remain concealed from opponents.
➢ **Initial Bidding:** Players examine their cards and begin the game by bidding in a turn-based manner. Bidding starts at a predetermined minimum amount of 10 dollars. The rate of increasing bid is constant for all players in multiples of 10.
➢ **Bidding Strategy:** Players evaluate their cards' value and potential for creating a winning pair. Based on their assessment, they decide to bid, fold, or strategize for the later stages.
➢ **Folding:** At any point during bidding, a player can choose to fold if they believe their cards are not strong enough to win. A folded player drops out of the current round and cannot win the prize.
➢ **Double-and-Show:** If a player feels confident in their cards and wants to expedite the game, they can opt for a "Double-and-Show" move. This involves doubling the current bid and revealing all players' concealed cards.

DETERMINING THE WINNER

If a "Double-and-Show" move is made, the player with the best pair of cards wins the game and the accumulated prize money. If all players except one fold, the remaining player wins the prize.

Pair Ranking: Pairs are ranked based on the hierarchy of cards

STRATEGY

The sum of the cards in hand should fall under the following three cases:

IF SUM > 34

The chances of winning is quite high so the player should increase the bid in every turn.

IF 28 < SUM < 34

- Increase the bid safely and watch opponent's moves.
- If the player has a card numbered greater than 11 then the chance of winning the hand increases.

IF SUM < 28

The chances of winning is very low so the better option is to fold and play safe.

Link for the Game Data:
https://docs.google.com/spreadsheets/d/1HVLZj0EMsx0A8WseTjwfk94cjnknIPKzn3WvFNB-Lo8/edit#gid=0

Link for the Code:
https://colab.research.google.com/drive/1l7dlyHoKgAHAJ1BvsN-SlJmeP2lLwdEG?usp=sharing

GOLF BATTLE : DUTCH AUCTION

Objective: This is similar to the traditional golf game and the objective of the game is still to complete the course by putting the ball into the hole in as few shots as possible. However, in this version of the game, players also need to consider the distance from which they start each hole.

Setup:

- ❏ Course: Set up a standard golf course with holes and fairways.
- ❏ Starting Distance: Before each hole, players decide from what distance they want to start their shots. This distance can vary from player to player and from hole to hole. Players can choose any distance they believe will give them the best chance of putting the ball in the hole in the fewest shots. The distance ranges from 1000 to 5000 m.

GAME PLAY

DATA ANALYSIS ~
INITIALIZATION:
[Par is a golf term that refers to how many strokes it should take a scratch golfer to complete a single golf hole or a round of golf]

Bogey – This is when the number of strokes is one over par.

Birdie – This is where the golfer's score is one under par on an individual hole.

Eagle – This is where the score is two under par on an individual hole.

Player Skill Grouping:
Players are categorized into three skill levels: Advanced (A), Intermediate (I), and Beginner (B) based on their skill ratios. These ratios are calculated using the number of Eagles, Birdies, and Bogeys a player makes.

DETERMINING THE WINNER

The player with the lowest overall ratio across all the holes at the end of the game is considered the winner.

RATIO = (no. of shots taken to put the ball in hole) / (Distance from hole)

Link For The Code
https://colab.research.google.com/drive/1fVrBmf9IRea6_eI0HJshWhfdk38RmGCU

STRATEGY

Advanced

Intermediate

Beginner

4000-5000 m

Advanced player can choose a greater distance as he/she is skilled to finish in minimum shots, thus reducing the ratio.

2000-4000 m

The number of shots taken by an intermediate player is highly uncertain so he/she is recommended to choose a mediocre distance.

1000-2000 m

Beginner payer can maximize the chance of winning only by choosing a smaller distance.

Thank You!