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# A game theoretic approach to social media engagement

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# Explanation of game theory

## 1.1 What is Game Theory?

Game theory is the study of competition where players compete with each other, following a set of rules. It studies the best decisions one can make when in a competition, because one individual's decision affects the outcome of the other individuals. Game theory is then classified into the three following main categories of study :

- **Classical Game Theory** : This category focuses on optimal play, where more than one person must make a decision and the impact of that decision and everyone's decision is known.
- **Combinatorial Game Theory** : It focuses on optimal solutions between two players. Each player takes turns using strategies that are known before. An example of this category is the game of chess.
- **Dynamic Game Theory** : It analyses the game where players need to make a decision over time which will affect the outcome now.

## 1.2 Classification of games

In game theory, games can be classified according to certain significant features. For instance the number of people in the game. Therefore, a game can be a one-person, two-person or n-person game (where n is greater than 2) [4]. In these games there can be a game of perfect information, which is a game where players know everything about the game at all times. There can also be a game of imperfect information which is where the players do not know all of the other player's choices or possible strategies. Another way of classifying games is through the extent at which the goals of players conflict or coincide.

A constant-sum game is a game where there is only conflict in the game, the combined payoffs for the players stay the same even though it gets distributed during the playing. The players in this game have totally opposing interests[4].

A variable-sum game is a game where all players of the game can be winners or losers. Since it is a competition the players do have conflicting interests, but when they stop something bad from happening, they both benefit from that decision [4]. These games can be further distinguished

as cooperative or noncooperative. A cooperative game is a game where players can communicate and reach consensus. A noncooperative game on the other hand is a game where players can communicate but cannot make binding agreements. An example of a cooperative game would be a sales person and a customer when they agree on a price and sign a contract. A noncooperative game would be when people bid at auctions. They are playing a noncooperative game with the other bidders, even though the highest bidder would agree to make the purchase[4].

During the study of these games, the games have to be described so that it can be easy to understand and to see the way to reach an optimal. We can then describe them in one of the three ways : extensive, normal or characteristic-function form. Most games that progress step-by-step, one player at a time can be modelled using extensive form, such as a game tree where vertices would indicate each players turn and each branch showing the players' choices. The normal strategic form is used to describe a two-person game, where the game is represented by a payoff matrix with each row representing the strategy of one player and each column representing the strategy of the other player. The entry at the intersection of each row and column then gives off the outcome of each player choosing the corresponding strategy.

The characteristics-function form is used to model and analyze n-person games, where n is greater than two. It shows the minimum value that each temporary alliance for combined action of players can guarantee for itself when in conflict with the alliance for combined actions made for all the other players.

### 1.2.1 One-person Games

In a one-person game “games against nature”, there are no opponents, the player just chooses the optimal outcome from a list of available choices.

### 1.2.2 Two-person Games of perfect information

Games of perfect information are games that are determined by making use of all available information. Players can find optimal strategies, which make the outcome preordained. They have a saddle point, which is the outcome that a rational player would choose. It is the minimum of the row that is also the maximum of the column in a payoff matrix.

## 1.3 Uses of Game Theory in the past by other studies

Game theory has been used to measure vulnerability of stochastic networks. In this study the researchers come up with a method that looks to identify links or nodes whose failure would ruin the performance of the network the most. The study assumes that all links have costs; normal costs and failed cost and they are both traffic-independent [1]. The game is then modelled as a 2-player non cooperative, zero-sum game that is between a router seeking a least-cost path and a virtual network tester looking to maximize trip cost by failing one link. The study finds the equilibrium by solving a maximin problem which can be then recasted as a linear programming problem. In general, the game has no end, because each player always makes the same choice. When it ends, it means that the Nash equilibrium has been found; that is when both players have no better choice given the choice of the other. The following moves are made available for the players : The router can seek a least cost path through the undamaged network and the path with the least s-expected cost, The tester then fails the link which increases the s-expected cost of the trip the most [1].

## 1.4 Ways other social media projects have tackled this problem

### 1.4.1 Measuring the influence of online management response on customer satisfaction

In this particular article, the study measures the impact of management responses on customer satisfactions, by using data retrieved from an online agency in China. The study applied a panel model that controls for regression towards mean and heterogeneity to arrive at the conclusion that online management responses are effective among low satisfaction customers and have limited influence on other customers [2]. The aim of this study was to know how to respond to complaining customers in order to not lose them as customers, but also keeping in mind other customers that might be observing the complaints and how management responds to these complaints. The study therefore used data models to check how the complaining customers influence other customers and how the management influences the complaining customers and other customers. The study retrieved the data from review pages, then they responded to the reviews with the low ratings.

## 1.5 Uses of Game Theory in social media by other studies

### 1.5.1 Prediction of online social behaviour with a game theoretic approach

In this article game theory was used to cast two instagram users as players in a game where both the players are trying to get an optimal community, that is a community with higher amount of followers and no negativity [5]. The aim of these players is to be famous, widely known and have a large number of following. A loss to the players is said to be losing followers because of negativity. The study describes the variables of the game as being followers, number of likes on a recent post and negative comments as a percentage. It uses cost and payoff functions as functions of the game and defines them as cost being the amount of negativity in the community and the payoff function being the outreach, that is how much popularity the user gains. The game is modelled as a two-person cooperative game. The study then concludes that the number of comments does not have a link with negative comments percentage. Rather there is a positive correlation between the number of followers a user has and the number of comments on their posts [5].

### 1.5.2 Game theoretic model of information release in social media

As the popularity of online social networks continues to grow, a huge amount of sensitive and private information is consistently uploaded to these social networks [3]. Therefore this project uses a game theoretic approach to characterize social media users' willingness to release, withhold or lie about certain information. The study models the game as a graph and has classes of information. Then it has functions for returning a benefit for releasing a certain amount of information. The study's findings reveal that a social network user's tendency to lie is highly correlated with his or her desire to portray a successful social image and only weakly related to privacy concerns [3].





# Introduction

Online spaces have experienced growth in the recent years and the popularity of these networks continues to grow. As the number of users in these spaces increase, there are problems that also arise that the users have to deal with: negativity within the platforms. Such behaviours are associated with the number of followers a user has and how those followers engage on the users posts. These social network users are always competing with each other in these spaces, each one trying to get the largest amount of following than the other users and trying to maintain a positive community; that is a community with engagement, many likes and low percentage of negative comments on posts they make. This study uses game theory to cast Twitter users as players in a game where a player is trying to achieve an optimal community; that is a community with large following and positive engagement on posts. The purpose of this study is to learn how game theory can be used to predict and suggest strategies for Online spaces. The study defines the game as a variable-sum game because it assumes that all players of the game can be winners, since the users can obtain optimal communities both at the same time, independent of the other players. For example two users in Twitter can both have 100 thousand followers and have positive engagements on their posts at the same time. The study seeks to learn how the following strategies affect the game when made available to the users :

- Time the users make the post.
- The type of content the users posts.

The game is modeled as a characteristic-function form because this form of game theory modeling analyzes n-person games and shows the minimum value that each player can guarantee for themselves [4], which we will take as the minimum number of likes a user can settle for. To be able to fulfill the purpose of this study, data about the users tweets will be used. The study extracts the data from the Twitter API and uses a library called Tweepy and Python to extract certain aspects of interest from the information supplied by the twitter API. Through the API it is possible to extract tweets of users, randomly or through specifying the user wanted, this will enable the study to be able to get the number of likes, retweets and the number of following the user has to help with the analyzing of these users to be able to reach a conclusion that then answers the important question that we seek to answer which is, what strategies should a user use in order to get an optimal community? And possibly, what is the relationship between a user's following and the type of community that the user will have or has?



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