



Demoralize the Fake Review in Business by Using Game Theory

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Abstract

The application of mathematics in our everyday routines is becoming more common, particularly in business. The main purpose of this study is to help the vendor and the buyer to gain profit with both their action and decision through the game theory. The use of a review system in an online selling platform leads to a profitable business model. The impacts of favorable and negative evaluations on product success have been extensively researched in the literature. Consequently, it is very meaningful for the vendors to secure a positive review for their product. There, exist vendors that are willing to pay incentives to the buyer in return the buyer has to write and release a fake positive review of their product on the online selling platform. Fake review system (FRS) generates fake reviews intentionally to mislead readers to believe false data that makes it tough and non-trivial to discover supported content. In this study, we come up with a game-theory-based strategy to demoralize the above-mentioned counterfeit business model. Using a contract agreement is a practical approach to accomplish this strategy. Firstly, we use the sequential game as the reference for the current business model and we list some conditions making FRS beneficial. Secondly, we recommend computing a contemporary approach to the review system. We implemented the solution and decided the best way for both vendor and the buyer to gain profit from both decisions.

Keywords: game theory; fake review system (FRS); sequential game.

1. Introduction

Several e-commerce platforms offer users the possibility to release reviews on the products on sale. Both buyers and vendors receive benefits from these reviews. For the buyers, they represent a useful tool for decision making about whether or not to buy the product. On the other hand, for the vendors, positive reviews represent a way to effectively and cheaply advertise the quality of their products. Consequently, the e-commerce platforms have the interest in offering a review system (RS) to incentive the use of the platform itself. Several studies show the introduction of an RS leads to a higher number of sales and use of the platform (Chong et. al., 2018).

As a side effect, some vendors decide to pay an incentive to the buyers in exchange for fake positive reviews of their products. In this case, we say that the buyers and the vendors adhere to the fake review system (FRS). Usually, in this system, the vendors put up a low-quality product for sale at a high price and obtain good reviews from intrigued buyers. The goal is to deceive unaware users about the quality of the product and its actual value. On the other hand, the gain of colluding buyers is represented by the incentive provided by vendors.

Therefore, FRS is realistic as both vendors and buyers obtain advantages (i.e., it is a win-win situation). As a matter of fact, there are many existing FRSs instances in the major e-commerce

platforms. Clearly, in the long term, users tend not to trust the reviews and this discourages the use of the e-commerce platform. Therefore, it is very important to adopt mechanisms against the FRS.

2. Literature Review

2.1. Fake Reviews

A basic approach to fake review detection is to analyse reviews manually. This approach is based on the premise that humans can detect when other humans behave in fraudulent ways. For example, knowledge of the “psychology of lie” (DePaulo et al., 1996) the advantage of careful perusing of fake reviews is that it affords developing heuristic rules that can be understood and interpreted. For example, Costa et al. (2019) identified a set of rules to distinguish between incentivized and non-incentivized reviews, including the review’s length, sentiment, and helpfulness rate. Jindal and Liu (2008) identified general patterns in online reviews, such as only a small number of reviews per user and product, and that the reviews rarely garner much feedback. If a review differs from these patterns, it may have a higher probability of being fake. Filieri (2016) investigated how humans assess the trustworthiness of an online review and found factors, such as the review’s content and writing style, including the presence of pictures, length, degree of detail, and extreme positivity or negativity.

A fake review is a review written or generated without any actual experience of the product or service being reviewed (Lee et al., 2016). Because it is “written” or “generated,” a fake review can be created manually by a human writer or automatically by a computer program. As such, technological progress is a major enabler of fake reviews, as it creates both opportunities and incentives for manipulating consumer decisions (Ahmed et al., 2018). On the one hand, advances in natural language generation (Floridi and Chiriatti, 2020) provide opportunities for large-scale production of fake reviews – technology may be reaching the pinnacle in which it becomes virtually impossible for human readers to detect if a given piece of text is written by a real person. On the other hand, online platforms provide a distribution channel for large-scale diffusion of fake reviews. As literally millions of consumers read online reviews at any given moment, there is an incentive to exploit this route of persuasion at scale. Therefore, fake reviews potentially benefit from economies of scale and scope, which accentuates the challenge of developing contrary measures for this type of misinformation.

2.2. Datasets

Ott et al. (2011) developed a dataset with 800 fake reviews and 800 truthful reviews. The truthful reviews were collected from TripAdvisor, representing the 20 most popular hotels in an American city. The fake reviews were written by 400 crowd workers recruited via Amazon Mechanical Turk. The workers were asked to make either a positive or a negative review for a given hotel that they had no experience with. The given hotels included the same 20 hotels as in the truthful reviews. Despite representing a considerable step forward in understanding fake reviews, the dataset by Ott et al. (2011) has two major limitations. First, the dataset size ($n = 1600$ reviews in total) is small for training effective text classifiers. Second, the researchers omitted reviews with less than 150 characters and those with less than five stars (maximum score) when collecting the dataset. However, as mentioned previously, fake reviews are not necessarily positive ones, and so the exclusion of reviews with less than five stars may not be appropriate. Similarly, the length distribution of fake reviews may extend to under 150 characters.

Yoo and Gretzel (2009) collected 42 fake and 40 truthful hotel reviews and compared psycholinguistic differences among those reviews. Again, the dataset is too small for training effective ML classifiers to detect fake reviews at scale. Sandulescu and Ester (2015) obtained a dataset containing 9000 reviews labeled as fake or real reviews. The dataset was shared by an online company called Trustpilot, and the dataset includes four- and five-star reviews from 130 companies, limited to one-time reviewers only. Yet, the dataset has not been made publicly available, which hinders replication and

further development. Moreover, this dataset is biased to positive reviews at the expense of detecting negative fake reviews.

2.3. Game Theory

Game theory is a social science theory that uses a mathematical model to predict the possible outcomes of a scenario. People in professions such as political science, business, and poker frequently utilize it to forecast possible outcomes for scenarios in their fields. Game theory uses sequential games to mimic a series of real-life strategic events to forecast how people or organizations will conduct. The most common strategy is for a player to make the choice that benefits them the most, but the ideal reaction is usually to collaborate to achieve the most favorable, symmetric conclusion for all players.

2.4. Type of the strategy

Pure strategy and mixed strategy are the two sorts of player strategies. A pure strategy game is one in which no randomization occurs, whereas a mixed strategy game is one in which at least one person uses a randomized method. Switching to a new strategy will not raise the projected payoff. Players, the scenario, and strategic options that can be made are always present in a strategic game, as are all the possible outcomes or payoff matrices for each decision. In-game theory, there are a few sorts of games that can be applied to the business world (Masterclass, 2021).

2.4.1. Sequential Games

In this section, we give some background taken from game theory,

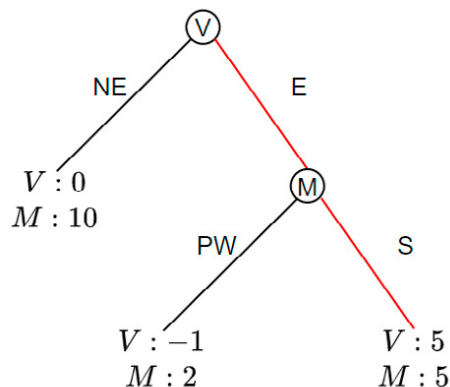


Figure 1 Game Tree for the Entry Game

A sequential game is one in which players take turns making movements. A sequential game has perfect knowledge if, at each turn, when a player must make a choice, she or he is aware of all prior occurrences. The term payoff refers to the outcome of a game that is determined by the sequence of decisions made by the participants.

An example for the sequential game with pure data is the Entry Game. A conceivable vendor must decide whether to enter (E) or not enter (NE) a monopolist-controlled market (M). If vendor (V) enters, M has to decide whether to start a price war (PW) with V or share the market (S).

Assume the corresponding payoffs are as follows.

- If V does not enter, then V gains 0 and M gains 10.
- If V enters and M starts a price war, then V gains -1 and M gains 2.
- If V enters and M shares the market, then V gains 5 and M gains 5.

A sequential game can be represented by a Game Tree where the nodes are the points of a decision of the players and the edges are the possible moves. The Game Tree associated with the Entry Game is illustrated in Figure 1.

In a finite sequence game with pure data, it is feasible to obtain a Subgame perfect Nash equilibrium by using backward induction and assuming that the players take the optimal choice to maximise their payoff at each phase of the game. Using this method, we may deduce a series of optimum actions for the participants.

In figure 1 has illustrated how the Entry Games works. It is started by considering the choice of M will be the last choice of the game. Obviously, the perfect option for M is the edge of S since she or he gains 5 while the edge of PW, M only gains 2. Thus, it is possible to associate the payoff (V:5, M:5) with the edge E. Next, the decision of V needs to consider. The ideal option for V is the edge of E since she or he gains 5 by assuming that M in the next move will choose S.

In consequence, the sequence of optimal actions for the players is (E-S) highlighted as red in the figure above. The main idea is that M being rational by not start the price war so that V can enter the monopolist-controlled market surely without risking obtaining a payoff of (-1).

Unfortunately, backward induction cannot be used to solve games with incomplete data, when one player may be unaware of the other player's prior choices.

3. Methodology

3.1. Research Design

The research design is intended to provide an appropriate framework for a study. A very significant decision in research design process is the choice to be made regarding research approach since it determines how relevant information for a research study will be obtained.

3.2. Operational Framework



Figure 2 Operational Framework

3.3.1 Identify Research Problem

A preparatory reading is required, which can supplement existing knowledge of the subject. Find relevant articles and works on the subject and needed field to help you grasp the situation better. The literature study conducted in Chapter 2 is utilized to determine the appropriate game theory model and discover a viable strategy as a solution that can be employed in the fake review system.

3.3.2 Data Collection

Gather all the data about the problem such as the definition of game theory, how to apply game theory in the subject that we want to do the research. Apart from that, there are various business planning that also use game theory. Fake review system is used in almost every online platform, so it is important as a preparation for analysis of the data.

3.3.3 Development of Game Theory

The two players identified in this game are the vendor and the buyer. The strategy of the vendor is to give incentive is denoted by 1, do not give incentive denoted by 2. While the buyer strategies are to give an honest review of a product denoted by 1 and give the fake review of a product denoted by 2. The payoffs of the vendor and buyer are assigned with the letter V and B respectively, with the action adopted by the vendor taking the first subscript and the buyer taking the second subscript. The payoffs result is given as shown in Table 1.

Table 1 Payoff's representation for the vendor (V) and the buyer (B)

Payoff of Vendor	Payoff of Buyer	Description
V_{11}	B_{11}	Vendor gives incentive and the buyer gives an honest review of a product
V_{12}	B_{12}	Vendor gives incentive and the buyer gives the fake review of a product
V_{21}	B_{21}	Vendor does not give incentive and the buyer gives an honest review of a product
V_{22}	B_{22}	Vendor does not give incentive and the buyer gives a fake review of a product

3.1. Results and discussion

4.1 Game Theory Model

In the forthcoming discussion about the decision between the vendor side and the buyer side, we assume that both vendor and buyer will have an equal chance to make the decision. During the process of buying and selling, the vendors as the first decision maker need to decide whether to put their product on sale or not sell any of their product. Next, after the decision is made by the vendor it comes to the turn of the buyer the choose their own decision which is to buy and release a positive review or not buy any or buy and release a negative review.

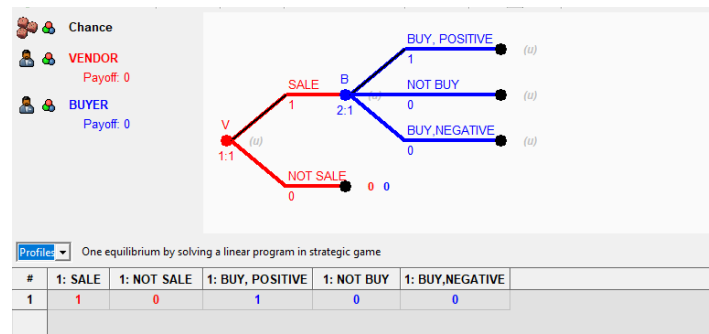


Figure 3 Interaction between vendor and buyer

Next, it is time for the vendor to decide whether to pay the incentives or not pay the incentives due to the review released by the buyer. Here are two different situations in which the vendor pays an incentive to the buyer that releases either a negative or positive review. Then, the buyer that receives the incentives need to make the move which is to return the product or not return the product. On the other hand, the buyer that does not receive the incentives also had to make the decision whether to return or not return the product. In Figure 4 will show the full interaction between the vendor and the buyer and all the possibilities by using extensive form for the game.

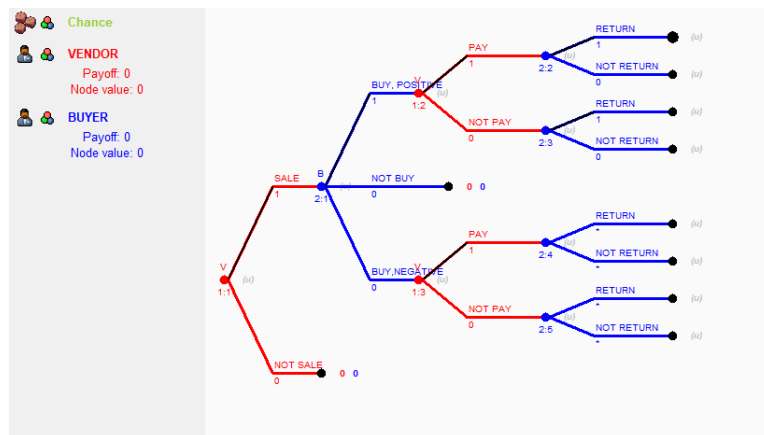


Figure 4 Decision Tree between vendor and buyer

Analyze Tree Diagram

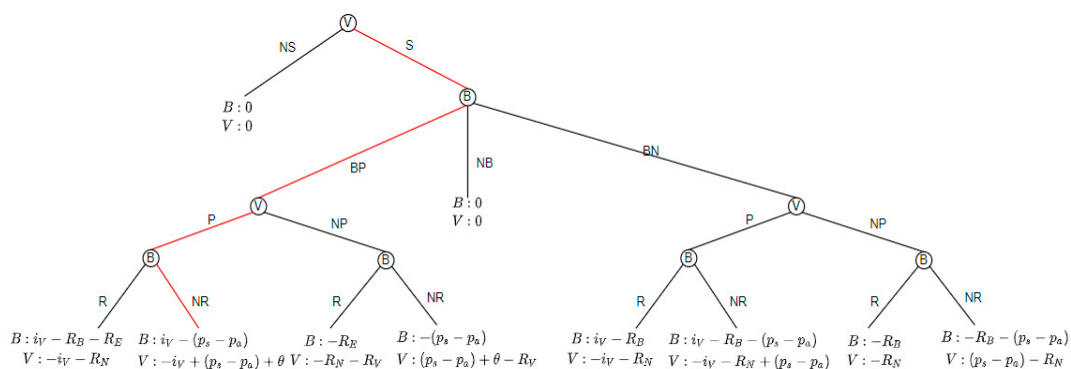


Figure 5 Game Tree for the payoffs of the game

- **Path NS:** V decided to not put the product up for sale, the payoffs are (B:0, C:0)

- **Path S-BP-P-R:** For this path, V put up the product for sale and B buy the product and release a positive review, V pays the incentive i_V to the buyer but B choose to return the product.

In this case, B gains the incentive i_V , but loses the reputation R_B with respect to the FRS and the reputation R_E with respect to the community of E (since he/she first release a positive review and successively returns the product). Apart from that, V loses the incentive i_V and the reputation R_N with respect to the community of E since B has returned the product. Therefore, the associate payoffs are $(B : i_V - R_B - R_E, V : -i_V - R_N)$.

- **Path S-BP-P-NR:** For this path, V put the product for sale and B buy the product and released a positive review, V pays the incentive i_V to the buyer but B choose to not return the product.

In this case, B and V adhere to the FRS. Regarding the payoffs, B gains the incentive i_V , but loses the difference between the selling price and the actual price $p_s - p_a$ of the product. V loses the incentive i_V but gains the difference $p_s - p_a$ and the reputation where denoted by θ with respect to the community of E. Therefore, the payoffs are $(B: i_V - (p_s - p_a), V: -i_V + (p_s - p_a) + \theta)$.

- **Path S-BP-NP-R:** In this path, V choose to put the product for sale and B buy the product and released the positive review, V does not pay incentive i_V to the buyer but B choose to return the product.

In this case, B loses the reputation R_E with respect to the community E. V loses the reputation R_N with respect to the community E and loses the reputation R_V with respect to the FRS. This happened due to buyer give positive review and the vendor do not give the incentive then buyer returned the product. Therefore, the payoffs are $(B: -R_E, V: -R_N - R_V)$.

- **Path S-BP-NP-NR:** Following this path, V put the product for sale and B buy the product then release the positive review, V does not pay the incentive i_V to the buyer but the B choose to not return the product.

For this case, B loses the difference between the selling price and the actual price $p_s - p_a$ of the product. V gains the difference between the selling price and the actual price $p_s - p_a$ and the reputation where denoted by θ with respect to the community E but loses the reputation R_V with respect to the FRS. Therefore, the payoffs are $(B: -(p_s - p_a), V: (p_s - p_a) + \theta - R_V)$.

- **Path S-NB:** As the figure above showed, when B does not buy the product, the payoffs become $(B; 0, V: 0)$.

- **Path S-BN-P-R:** For this path, V decided to put the product for sale, B buy the product and release the negative review. V pays the incentive i_V but B returned the product.

In this case, B gains the incentive i_V from the vendor but loses the reputation R_B with respect to the FRS. V loses the incentive i_V and loses the reputation R_N with respect to the community E. This happened when the buyer gives negative review or returned the product. Therefore, the payoffs are $(B: i_V - R_B, V: -i_V - R_N)$.

- **Path S-BN-P-NR:** In this path, V put the product for sale, B decided to buy the product and release the negative review. V pays the incentive i_V to the buyer but B choose to not return the product.

For this case, B gains the incentive i_V but loses the reputation R_B with respect to the FRS and loses the difference between the selling price and the actual price $p_s - p_a$ of the product. V loses the incentive i_V

and the reputation R_N with respect to the community E but gains the difference between the selling price and the actual price $p_s - p_a$ of the product. This happened because the buyer releases the negative review for the product. Therefore, the payoffs are (B: $i_V - R_B - (p_s - p_a)$, V: $-i_V - R_N + (p_s - p_a)$).

- **Path S-BN-NP-R:** For this path, V put the product on sale, B buy the product and release the negative review. V does not pay the incentive i_V to the buyer and B decided to return the product.

In this case, B loses the reputation of buyer R_B with respect to the FRS. Meanwhile, V loses the reputation of vendor R_N with respect to the community E. This happened because the buyer gives the negative review and returned the product even though the vendor pays the incentive i_V to the buyer. Therefore, the payoffs are (B: $-R_B$, V: $-R_N$).

- **Path S-BN-NP-NR:** Following this path, V decided to put the product for sale, B buy the product and release the negative review. V does not pay the incentive i_V to the buyer and B choose to not return the product.

For this case, B loses the reputation of buyer R_B with respect to the FRS. B also loses the difference between the selling price and the actual price $p_s - p_a$ of the product. Meanwhile, V gains the difference between the selling price and the actual price $p_s - p_a$ to the product but loses in reputation of vendor R_N with respect to the community E. therefore, the payoffs are (B: $-R_B - (p_s - p_a)$, V: $(p_s - p_a) - R_N$).

Conclusion

In this research, the objectives were achieved since the interaction between a potential dishonest vendor and a potential dishonest buyer had been modeled. Apart from that, both vendor and buyer behavior had been identified when adhering to the fake review system (FRS). Lastly, the best strategy that give the beneficial for vendor and buyer had been obtained.

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