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TIME-DECAY-BASED REPUTATION METHOD FOR BUYERS MAKING DECISIONS IN ONLINE SHOPPING

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Abstract

Trust and reputation is considered a significant part of the Internet marketing. Internet transactions or interactions involve anonymity of participants, which are more risky on account of uncertainty about the quality of service or identity of service providers. Reputation system is a mechanism to determine who is trustworthy and induce Internet marketing's participants to maintain a good reputation while performing Internet activities. We consider that the evaluation of service provider's reputation or participant's honesty and responsibility constrained in some way by three factors, they are service quality, transaction time, and dollar value involved in the transaction(s), we called them as triple constraint. Very little research had done to pinpoint the relationship between trust and reputation with this triple constraint, especially when trust decay and time decay factors involved in the reputation evaluation process. We propose and investigate a novel dynamic trust and reputation framework based on the three factors mentioned above to reflect the more realistic reputation of the service providers in the Internet market.

Keyword: *time decay, feedback, reputation, trust, online shopping*

Introduction

The Internet is profoundly affecting almost all businesses and commerce paradigms [14]. It not only provides the opportunity for companies switching from "brick-and-mortar" traditional behaviour to "brick-and-clicks" businesses style, but also opens up new opportunities to provide quality products and improved customers services in the most efficient way as traditional businesses provide. In addition, Internet marketing also offers several benefits such as timing, immediacy, less expensive, targeting and scalability. Some studies have showed that people worldwide are making greater and more diverse use of the Internet meanwhile Internet sales continue to grow up [16][20]. According to Statistics Canada report, that more Canadian used the Internet to purchase goods and services in 2007, which totally worth $12.8 billion of orders, up 61% from 2005 [21]. Internet has become a supplement to traditional retail shopping more than a substitute. In fact, Internet marketing has become an essential part of today's electronic business since its core value is its ability to promote productivity and efficiency.

For doing successful business on the Internet, effective marketing strategies and necessary evaluation procedures must be established and one of them is the implementing feedback mechanism or reputation system. Reputation system is considered a significant part of the Internet business. Since Internet transactions involve anonymity of participants, which are more risky on account of uncertainty about the service of quality or identity of service providers, people would like to deal with honest merchants and reputation system is how to determine who is trustworthy. We consider that that the evaluation of service provider's reputation or participant's honesty and responsibility constrained in some way by three factors, they are service quality, transaction time, and dollar value involved in the transaction(s), we called them as triple constraint.

Since Internet marketing is prosperous growing up, fraud on the Internet is also developing into a major threat for consumers, business and governments [8]. We consider that Internet market and frauds as well as being developed or used reputation systems are close combined together, it is necessary and worthy to treat them as a whole while doing study to gain a significant understanding from the reputation system.

Trust and Reputation Systems

Trust and reputation are considered pure abstract concepts. They can become more meaningful only after applying to certain physical participants or entities. Trust and reputation are tightly coupled and platform-independent components that allows communications being carried out during processes between participants. They have led to a new breed of systems, which are quickly becoming an indispensable component of every successful online trading community: online feedback mechanisms [4], also known as reputation systems [17]. Reputation system provides a virtual platform which combining these two components together to address individual participant' past behaviour and to predict future behaviour.

The Internet marketing have created numerous opportunities to interact with strangers; these processes are also obviously raising a number of challenges such as lack of quality of services or even fraud during transactions, which may form asymmetric information flowing and lead up to the lemon problem [1] and finally only the lowest quality goods are traded and thus opportunities to achieve better profits from trading high quality goods are forgone [23].

The concept of trust is generally considered having broad-based meaning and varies between disciplines. Therefore, researchers in psychology, sociology, history, political science, economics and information technology area have done lots of research work to create suitable definitions for this abstract and crucial concept.

Lewicki and Bunker (1996) based on previous researchers' work [2][19] consider trust development to be an iterative process and a dynamic phenomenon that takes on a different character in the early, developing and mature stages of a relationship with each participant involved [12]. Wang and Vassileva (2003) define trust as a peer's belief in another peer's capabilities, honesty and reliability based on its own direct experiences [22]. Dillon, Chang, and Hussain (2004) also consider that trust has a dynamic aspect in the virtual world [6].

In information technology field, Marsh (1994) is among the first to introduce a computational model for trust in the distributed artificial intelligence [13]. His model is complex, but draws on many relevant real world phenomenons based on social and psychological factors. He defines trust in three categories which are basic trust, general trust and situational trust. Although his work is widely cited, but the model is theoretical and often considered too difficult to practically implement [9][15].

Sabater and Sierra (2001) define reputation as the opinion or view about something [18]. This opinion can be updated direct interactions or indirect experiences from other members while Resnick *et al.* (2000) point out that reputation to be the community opinion of a subject's standing [17]. Jøsang, Ismail and Boyd (2007) define reputation as generally said or believed about a person's or thing's character or standing [11].

Reputation system collects, distributes, and aggregates feedback about participants' past behaviour [17]. Generally, in order to operate reputation system effectively and to provide incentives for honest and trustworthy behaviour, several properties must be taken into account [7][17], they are:

1. Entities are long-lived, so that there are chances of future interaction;

2. Feedback about current interactions is recorded and distributed, such information must be visible in the future;
3. The costs for submitting and distributing feedback should be reasonable low;
4. Feedback information must be aggregated and presented in a suitable way to guide trust decisions;
5. Showing clear guidelines on how the rating system operates and how potential conflicts can be resolved;
6. The reputation system provider itself must be reputable and trustworthy.

The most significant feature of Internet market is that it has implemented the reputation system or feedback system. The Internet market's giant, eBay firstly introduced reputation system into the Internet market and enables its online auction system. This revolutionary pioneering spirit has been greatly absorbed by many other companies since then and significantly promotes the healthy development of Internet market. Several literature or books have tried to establish methods or framework to make comparisons possible between these reputation systems current in use in the Internet market. Based on previous researches [3][5][10], Table 1 at the end of this paper summarizes several noteworthy examples of Internet market reputation systems in use today

Time-Decay Trust Function

As described previously, trust and reputation are crucial to a service participant or a service provider's success. Service providers closely work with service participants and the other people involved in certain reputation system to meet individual goals and vice versa.

Every service provider or participant's reputation is often considered consisting of a series of discrete points or values and constrained in different ways by several factors, such as quality of service, transaction time, and dollar value involved in evaluating process of provider or participant's honesty and responsibility. We call these three factors as the triple constraint. To create a successful reputation system and give a reasonable result, quality, time and dollar value must be reflected in the reputation system.

Here, we give their operational definitions which will be frequently used in our dynamic trust and reputation framework described below.

1. **Definition 1** (Quality of service): The satisfaction level of unique product or service received by service participant from committed service providers. Normally, it involved two dimensional evaluation criteria,

i.e., product itself and service provided after receiving that product.

2. **Definition 2** (Transaction time): It denotes the time period during which a transaction take place. Since our model especially focuses on decay, the date after service participant receives product or service will play an important role, because it would affect reputation of the service provider in the future.

3. **Definition 3** (Dollar value or Transaction value): The amount of money spent for the product or to complete the service.

Due to the page limit, in this paper, we propose and investigate a new dynamic trust and reputation framework based on the two factor mentioned above for improving rating service to reflect the more realistic reputation of the service providers in the Internet market. Actually time factor will play an important role on the obtaining the reputation of service providers at different length of time windows.

The level of trust relationship between service provider(s) and participants after each transaction or interaction can be represented numerically or linguistically by different scale systems. Sometimes these representations can be mutually exchangeable. It is reported that eBay provides three scales such as positive, neutral, and negative (i.e. 1, 0, -1) to allow buyer and seller to rate each other. The advantage of eBay's mechanism is that it is simple and easy to be understood by average users. However, due to its primitive, this led to a vague image of the service provider's reputation [11]. Amazon and Elance use five scale rating system to evaluate the seller's trustworthiness through buyer while ignore seller's feedback on ratings. The latter approach is a step further to detail ratings scale than eBay's method. Apparently, a reputation system with five scale levels is better than a system with three levels. However, it doesn't mean the more scale levels the better. In our proposed model, we also use five scale rating system, the difference is that our defined rating levels are distributed over the most positive aspects as listed in Table 2.

Since we want to quantify representing the trustworthiness of the service provider, it is unavoidable that we mathematically calculate the trust values. The value of trustworthiness is computed based on past experiences given by the service participants for a specific service provider and it can be converted into five scale star system. Therefore, we also give the corresponding reputation levels versus the values of trustworthiness. These calculated numerical values called trust values that ranges from [1...5] can be interchanged to linguistic

representations such as "Excellent", "Very Good", "Good", "Fair" and "Poor".

The reason that we leave only one scale to represent the reputation level "Poor" is that, in Internet market, people would like to deal with honest merchants or in other words, no one would like to conduct business with service provider(s) only having 50% possibility or even lower success rate. Therefore, there is no point to define extra scale ratings such as "Very poor" or "Extremely poor". Since most transactions involved in the Internet market are participants with anonymity, there are certainly possibilities that uncertainty and risk accompanying online trading course. We encourage people to deal with only the service providers with higher reputations to reduce these potential risks to the minimum level.

The reputation of the service provider is considered consisting of a series of discrete numeric values given by the service participants in the reputation model. These values can change from time to time. They are accumulated together at a given length of time to generate an average value which is used to determine the trustworthiness of the service provider. For each individual transaction, the given value of trustworthiness of service provider may not in a stable stage which means it might go up or down after this transaction. We call this as trust shifts or trust transient phenomenon as Figure 1 shows.

In business environment, once the service provider accumulate enough "trust" from service participants and keep momentum on good customers service, their reputation will maintain certain level or even go to upper level. However, this process can go in the opposite direction if service provider loses confidence from service participants, their reputation level will go down.
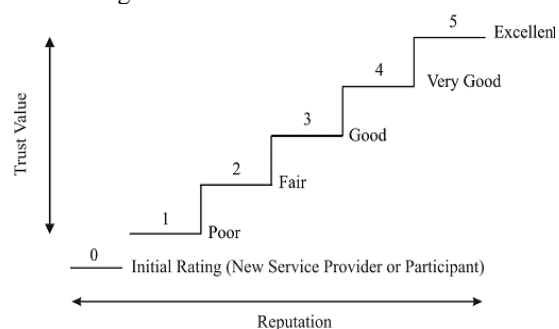

Figure 1. Trust shifts or trust transient phenomenon.

In order to quantify the trustworthiness of the service provider and give it an adequate value, in addition to the quality of service or product received which will be used to evaluate the trustworthiness of the service provider, there is also another important factor which may affect the evaluation of reputation of service provider – decay. For example, trust decay may

occur when trust value become outdated due to the lack of fresh transactions or interactions. This may led to the question about the realistic trustworthiness about the reputation of service provider.

Time based decay function is a concept which can be used to model trust decay phenomena and leading in designing realistic trust environments. Actually, trust decay is the tendency for trust to weaken or disappear over certain period of time. For instance, if customer John trusts restaurant A at level B based on personal experience ten years ago, the trust level today is very likely to be lower or to be faded from his mind unless he has provoked one or more return visits to his venerable one since then. In this research, we introduced time stamp into the decay function to enhance trust aggregation and reputation representation.

In reality, the decay process may take either exponential or linear format. In our research, we use simple linear depreciating function which decays the trust value by passed months relative to current month. The decay rate based on time R_{time} can be represented as following:

R_{time} = desired percentage of decayed rating changed/ (number of months involved – 1)

For instance, we consider that the desired decay rate after one year decay is one star (20 percentage of rating change based on five star rating scale levels), and there are 11 months (current month does not have any contribution to the decay process) for one year run, the decay rate would be calculated as: R_{time} = 0.2/11 or 1/55.

Once we have decided to consider decay factor in obtaining the trustworthiness of reputation, furthermore, we also consider the time weighting factor and assign different weight to different time slot's feedbacks. Where, time slot is a period of time that corresponds to an academic cycle, and during which various feedbacks can be collected. We assign equal weight to all transactions' feedbacks at the same time slot. Different time slot may have different period of time. The more recent time slot, the more weigh for feedbacks.

Conclusions

In this paper, a novel application of dynamic trust and reputation system framework is presented for Internet marketing. The algorithm takes into account three factors or called the triple constraints, i.e., quality of service, transaction time, and transaction value which are involved in evaluating process of provider or participant's honesty and responsibility; therefore, the system can give more reliable and reasonable trustworthiness value of the service providers or participants. The core idea of the framework's algorithm is to express quantitatively representing the trustworthiness of the service providers or service participants.

There is still some work needs to be done to make this feasible system in practical in Internet market environments. Those are:
1. Consider the third factor, transaction amount, when design the time-decay trust function;
2. Evaluate the performance of the proposed system framework with realistic data; and,
3. A further refine work related to decay algorithms may be modified. Since we adopt the linear depreciating function in this paper, exponential depreciating function may also be used if applicable.

The proposed dynamic trust and reputation system framework will be helpful and an alternative approach to overcome some limitations of reputation systems or feedback mechanisms currently in use and give more realistic trustworthiness value to reflect the reputation of the service providers.

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Appendix

Table 1. Examples of Internet Market Reputation Systems

Business Name	Summary of Reputation System	Format of Solicited Feedback	Format of Published Feedback
eBay[1]	Buyers and sellers rate one another following transactions; PowerSeller: 98% total positive feedback in terms of consistent sales volume and customer satisfaction;	Positive, negative or neutral rating plus short comment; Rated party may post a response	Sums of positive, negative and neutral ratings received in the last 1, 6, and 12 months; Members can be authorized colored star based on earned feedback score from yellow star (at least 10) all the way to a red shooting star (above 100,000)
Elance[2]	Business employer and service provider rate one another following transactions	Numerical rating from one to five plus comment based on the satisfaction received by business employer; Service provider may post a response	Rating calculated based on same criteria with different weighed factor; Average of ratings received during past six months and lifetime
Epinions[3]	Users write reviews about a variety of different products/services; Other members can also rate the usefulness of reviews	Users rate multiple aspects of reviewed items typically on a scale of one to five; Readers rate reviews based on a scale of four ratings, from very useful to useless, etc.	Averages of item ratings; % of readers who found a review "useful"
BizRate[4]	Users write reviews and rate products; Offering "Customer Certified" identification logo based on some criteria	Four BizRate Smiley Scale about a store's capabilities; Five star rating about a product; 16 quality ratings applied to evaluate the produce and service	Store Ratings and Reviews updated on a weekly basis and based on last 90 days data;

[1]eBay. http://www.ebay.com   [2]Elance. http://www.elance.com
[3]Epinions. http://www.epinions.com   [4]BizRate. http://www.bizrate.com

Table 2. Schematic Diagram of Trust Value and Its Star Rating

Trust Value (%)	Stars Rating	Reputation
5 (95 ~ 100)	★ ★ ★ ★ ★	Excellent
4 (85 ~ 94.9)	★ ★ ★ ★	Very Good
3 (70 ~ 84.9)	★ ★ ★	Good
2 (50 ~ 69.9)	★ ★	Fair
1 (0.1 ~ 49.9)	★	Poor
0	No Rating	New Service Provider or Participant