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Network Effect on Loyalty for Service Systems

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Abstract: Customer loyalty is always an important index for service providers to consider in service systems. It represents the probability of repurchasing. The paper focuses on the study of loyalty in the networked environment. We propose one mathematical model to describe satisfaction and analyze how satisfaction and switching cost influence loyalty by using the catastrophe model. Comparing with previous studies, the proposed study considers the influence factors, such as word-of-mouth and past experience, reflects one's preference when facing othersresponse, and especially strengthens the effect of interaction between customers on loyalty. Utilizing a scale-free network, simulation experiments also show that customer interactions play an important role on loyalty.

1. INTRODUCTION

Service system is a complex one. It includes many different roles, relations and interactions. Many key factors and their relationship in service systems have been emphasized, such as loyalty, satisfaction, switching cost, and trust et al. Because of popularization of Internet, information is shared widely. So it is more necessary to consider the network effect on the above indexes in service systems.

Customer loyalty and his repeated purchase intention are related closely (Wang et al [2005]), so service providers always pay great attention on it and want to hold a large amount of loyal customers. Numerous studies also studied the principle of loyalty and some conceptual models have been proposed(Yang et al. [2004]). Among them, the phenomenon of positive influence of satisfaction on loyalty is widely known. Customer satisfaction has always been treated as a determinant component in many customer retention programs. However, recent studies found that although satisfaction is a necessary component of loyal or secure customers, the mere quality of being satisfied does not necessarily make customers loyal(Wang et al [2005]). On one hand, a loyal customer is not likely to change his choice because of once dissatisfaction with the service. On the other hand, a satisfied service experience doesnt mean the customer will choose the service again. How satisfaction affects loyalty is not clear. While Oliva et al.(Oliva et al. [1992]) made a contribution to it. He utilized the catastrophe theory to describe the relation between satisfaction and loyalty, taking switching cost as a mediator.

Catastrophe Theory was proposed by Thom (Thom [1975]) in 1975 and developed by Zeeman (Zeeman [1977]). It describes how small and continuous changes in independent variables can have sudden and discontinuous effect on a dependent variable. Catastrophe theory has been applied in many researches, such as physics, biology, and finance, social sciences, work and organization behavior. For example, cusp catastrophe model was studied not only in loyalty in services (Oliva et al. [1992]), but also in explaining job turnover of employees (Trocchia [1995]).

Based on the work of Oliva et al.(Oliva et al. [1992]),this study will further the research on loyalty. Different from Oliva et al. (Oliva et al. [1992]), we will combine the analysis of catastrophe with complex network and control theory to show how satisfaction and switching cost affect loyalty, especially in today when customers can communicate with each other more easily via popular networks. First, we will propose one method to model satisfaction based on its definition. The model can reflect the factors of past experience, personal preference and work-of-mouth. Then we will show how satisfaction and thus loyalty is affected by the customer network. The interactions between customers in a networked environment was researched a lot from different aspects, and many social networks have scale-free effect(William. [2001], Birke et al. [2005]). So we will use a scale-free network to represent the customer network. In simulation part, the paper will show the result of the network with different size, customers with different degrees, and customers with different preference. It shows that because of the customers interaction, loyalty will not change very large. So judging ones loyalty is not only limited in ones own behavior, but also affected by his surroundings largely.

The paper is arranged as follows. As the basis of the work, the loyalty model based on catastrophe theory is introduced in Section 2. The proposed satisfaction model and the description of switching cost are given in Section 3. Analysis of the network effect on loyalty is presented in Section 4. Utilizing a scale-free network, Section 5 does some simulations to show the effect in detail. Conclusion is given finally.

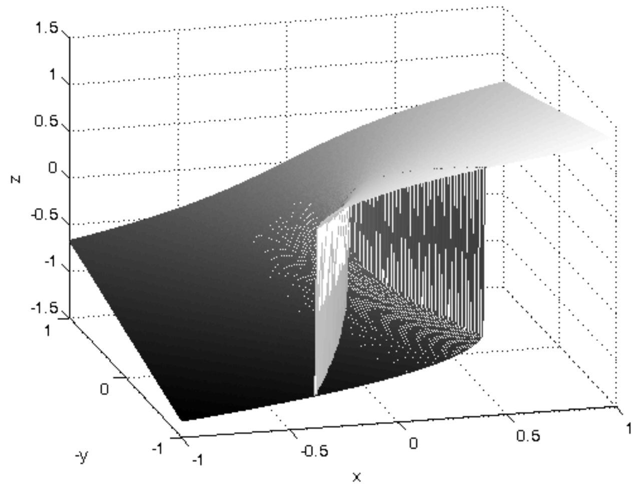

Fig. 1. Cusp catastrophe model

2. LOYALTY MODEL BASED ON CATASTROPHE THEORY

2.1 Overview of Catastrophe Theory

Issues surrounding nonlinearities, discontinuities, and multi-value have presented difficult problems for researchers. Catastrophe theory is such a technique for estimating a class of nonlinear dynamic systems. Elementary catastrophe theory focuses on seven models and the cusp catastrophe model is widely used. The cusp catastrophe model is

$$z^3 + yz - x = 0, \tag{1}$$

where z represents the dependent variable, and x and y are the independent variables. The surface defined by (1) is shown in Fig. 1.

In Fig. 1, x can move in the right and left direction, y can move back and front, and z can move in vertical direction. Changing the control variables x and y can affect the dynamic of z. If y is large, smooth change of z occurs and it is proportional to that of x. If y is small, change of x will produce only a relatively small change of z. Until x reached a threshold value, then z will have a sudden discontinuous shift. When x is increasing and z is at the bottom of the surface, z will not increase quickly and will keep moving at the bottom but not the upper part until x is large enough. When x is decreasing and z is at the top, z will stay at the top just with a little decreasing. Until x drops low enough, z will fall suddenly to the bottom and decreases as x does. So the dynamics of z is controlled by x and y . z cant change fluently and there are some values that it cant approach when y is large.

2.2 Loyalty Model of Catastrophe

The loyalty model based on cusp catastrophe model was defined as (1). z,x and $-y$ represent customer loyalty, customer satisfaction degree and switching cost respectively.

The model can explain the loyalty effectively, because sudden and discontinuous shifts are very familiar phenomena in the reality. For example, a customers emotional response may change from one side to the opposite side without intermediate process. And once the sudden shift occurs, it is difficult to return to the former state. And the relationship between customer satisfaction degree and customer loyalty is stronger for customers with higher switching cost than for those with lower switching cost.

3. SATISFACTION AND SWITCHING COST

3.1 Satisfaction Degree

Most researches relating satisfaction degree focused on conceptual model. To detail the influence of satisfaction degree on loyalty, we will estimate the satisfaction degree by combining its definition.

As defined by Hahm (Hahm et al. [1997]), customers satisfaction degree can be explained as the difference between the levels of service performance expected and perceived by the customer. The perceived service performance is positive relative with the service quality provided by the service provider. While the expected service is influenced by word-of- mouth, personal needs and past experience, which was proposed by Parasuraman (Parasuraman et al. [1985]) and popularly recognized by most of the researchers. So based on the definition in Hahm et al. [1997], we give its quantitive description

$$S = S_P - S_E, \tag{2}$$

where S_E is expected service, S_P is perceived service, and S is satisfaction degree.

Expected Service (S_E) is influenced by Past Experience (P_E), Word-of-Mouth (WOM) and Personal Need (P_N). Suppose the function is (3).

$$S_E = f_{es}(P_E, P_N, W_{OM}) \tag{3}$$

Both Expected Service (S_E) and Perceived Service S_P are the psychological results of customers. Considering that service evaluation is the difference between them, we propose a quantitative method to calculate satisfaction degree, based on the framework of control system. That is, the satisfaction degree can be thought as the degree of Personal Need(P_N) being satisfied. P_N is influenced by Past Experience and Word-of-Mouth. Satisfaction degree is an accumulation variable (Hahm et al. [1997]), so the influence of past experience can be viewed as an integral part. The integration result is averaged and influenced by Word-of-Mouth.

According to the satisfaction degree, the service provider will make improvement and provide service to satisfy the customer's requirement. Then a service cycle is presented in such control framework.

3.2 Switching Cost

Switching cost is the cost involved in changing from one service to another. As a lock-in method, switching cost help prevent customers from switching. So it is very important for service providers to manage switching cost, especially in the competitive environment.

How to evaluate switching cost is difficult which has been shown in many articles. First, switching cost is the collective result of economic, psychological and physical. Second, different kinds of service have different features.

We have done some research on modelling switching cost mathematically in other papers. Here the value of switching cost is simplified.

4. LOYALTY IN THE NETWORKED ENVIRONMENT

Today, massive quantities of data on large social networks are available. The customers will communicate information with each other through many ways, such as face to face talking, blogs, social-networking sites, newsgroups, chat rooms and so on. Any evaluation about one service or some service providers can be easily searched or spread. Thus most of the customers can easily know othersopinion; and the opinion of a customer is not only made by him, but also influenced by others. So managing customer loyalty is much difficult than before.

In this study, we attribute the customers interaction to word-of- mouth, and will study its influence on loyalty. Word-of-mouth is a pervasive and intriguing phenomenon (Goldenberg et al. [2001]). Both satisfied and dissatisfied consumers tend to spread positive and negative WOM respectively regarding the services they use.

People will show different attitude against othersevaluation. Some may trust the others more, some may believe themselves more, and some may prone to evenly balance their opinion with others. So, basically three types of customers are classified.

Here, we choose the following functions for the customer network. In the network, each customer is a node. Its state is influenced by the adjacent nodes that have connection with it.

$$y_i(k+1) = w_i \cdot \left(\sum_{j=1}^{N_i} q_{ji} y_j(k) \right) \Bigg/ \left(\sum_{j=1}^{Ni} q_{ji} \right) + (1 - w_i) \cdot y_i(k) \tag{4}$$

$y_i(k)$ represents the satisfaction degree of ith node at step k. N_i is the number of nodes connecting with node i . $q_j i$ shows the influence degree of node j on the node i . Each neighbor may have different influence on the neighbor, some are strong, such as good friends, and some are weak, such as new ones known from the website. $\left(\sum_{j=1}^{N_i} q_{ji} \cdot y_j(k) \right) \Big/ (\sum_{j=1}^{N_i} q_{ji})$ denotes the average influence of conjoint nodes. w_i is the weight on other's state. It is used to describe the characteristic of each node. The larger w_i is, the more the nodes rely on the others' opinions.

5. SIMULATION

In this section, we will show the dynamics of loyalty of different customers in a customer network related to one service providers service. To show the dynamic of loyalty, we give the following rules for satisfaction, switching cost and choice function before simulations.

Switching cost is $C_i, -1 \leq C_i \leq 1$. The smaller C_i is, the larger switching cost is paid. In each step, If the customer i keeps choosing this service, the switching cost is generated randomly a positive value, or $C_i(k)$ is negative.

In each step, the degree $s_{0i}(k), s_{0i}(k) \in [-1, 1]$ is the personal need being satisfied. Processed by (2), (3) and (4), $s_{0i}(k)$ becomes the satisfaction of this step $S_i(k)$. If the customer switches, $S_i(k)$ keeps the same as the last time. If the customer keeps choosing the service, $s_{0i}(k)$ is given a random value.

We choose a scale-free network as the customer network. To represent the customers feature, three types of nodes are defined. Type 1 includes the node that will rely more on his judgement, Type 2 includes the node that will rely more on other nodesstates and Type 3 includes the node that can well combine the othersstates with his.

In the following, we will describe the loyalty in several aspects, such as different types customers, the customer with maximal degree and minimal degree, the phase plane of loyalty. Because of lot of nodes but limited lines or marker types, we use different colors to represent the traces of the customers.

First, we show how the interaction between nodes will influence loyalty. Fig. 2 to Fig. 6 are the results of network with size $N = 40$.

Fig. 2 gives the overall view of the relation among loyalty with satisfaction and switching cost of all the customers. Fig. 2-a is the catastrophe plot reflecting how loyalty is controlled by satisfaction and switching cost. Fig. 2-b and Fig. 2-c are the images of catastrophe model in the $x - z$ plane and $y - z$ plane respectively. Fig. 2-b shows the relation of loyalty with satisfaction and Fig. 2-c is the relation of loyalty with switching cost. Fig. 2 shows that with different switching cost, the dots pass different catastrophe loops. As shown in Fig. 2-c, the loyalty will not be very large when the switching cost is not large enough. Fig. 3 shows the relation between loyalty and satisfaction of three type's customers. Fig. 3-a is the customers of Type 1, Fig. 3-b is the customers of Type 2 and Fig. 3-c is the customers of Type 3. It shows that, because considering more on his neighbors' opinions, the satisfaction of Customer Type 2 will not change widely. Fig. 4 shows the relation among loyalty, satisfaction and switching cost of the nodes with maximal degree and those with minimal degree. Blue dots represent the nodes with maximal degree, and purple dots represent the nodes with minimal degree. It shows that the nodes that have few connections will not change his loyalty largely, but the nodes that hold more neighbors have a large range of satisfaction, switching cost and loyalty. Fig. 5 is the average loyalty. Fig. 5-a compares the average loyalty value of three types' customers. All the average loyalty of the customer is always changing. Customers of Type 1 change more frequently than the other two types. Fig. 5-b compares the loyalty between nodes with maximal degree with those minimal degree. The difference is obviously. The average loyalty of high-degree nodes will change frequently. The low-degree nodes will keep more steady loyalty. Fig. 6 plots the loyalty and its incensement in the phase plane. Fig. 6-a is of all the customers. Fig. 6-b is of the nodes with maximal and minimal degree. In four regions, the

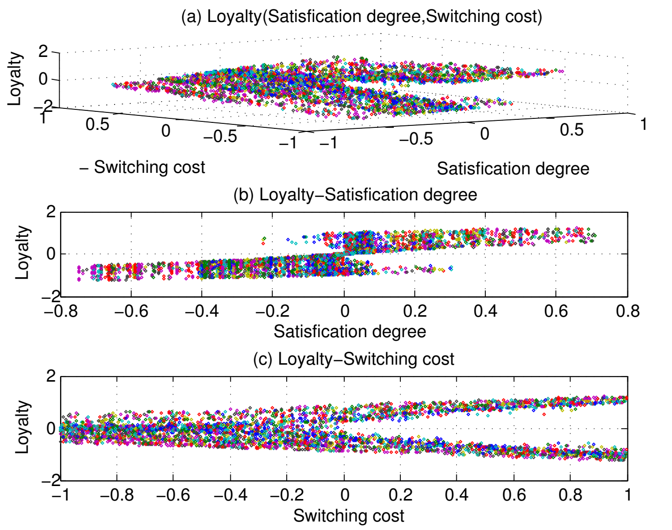

Fig. 2. Relation of loyalty, satisfaction and switching cost-all customers ($N = 40$)

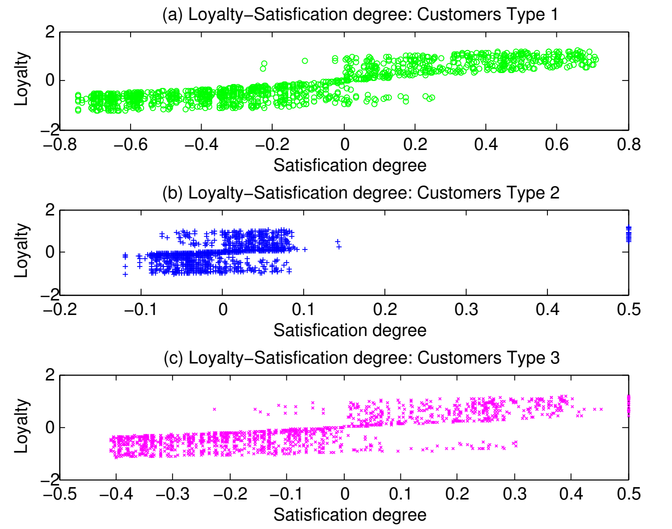

Fig. 3. Relation of loyalty and satisfaction -three type's customers ($N = 40$)

third regions attract more dots. It represents that, when customer is less loyal, the loyalty is easier to decline. Also, it shows that the dots concentrate more on the second and fourth regions. When the loyalty is low, it is prone to increase. When the loyalty is high, it is likely to decrease.

Second, we focus on analyzing the effect of network size. From Fig. 7 to Fig. 11, we give the results of network with size $N = 500$. The meanings of these figures correspond to that of Fig. 2 to Fig. 6.

With the incensement of network, the surfaces of Fig. 7 and Fig. 8 are denser than in Fig. 2 and Fig. 3, especially the brim are more covered. Comparing Fig. 9 with Fig. 4, the loyalty becomes more centralized in Fig. 9. Fig. 10-a shows that when the network is large, the customers average loyalty becomes more calmly for all three types customers. And the whole level of loyalty is lower than shown in Fig. 5-a. And it is obviously to see that the more one rely on other's opinions, the higher the loyalty can be kept. Also for different degree of nodes, the curves in

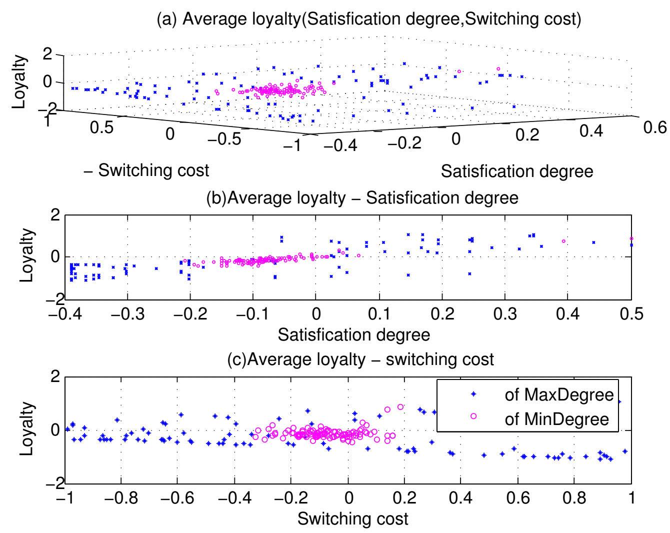

Fig. 4. Relation of loyalty, satisfaction and switching cost- nodes with max degree with nodes with min degree($N = 40$)

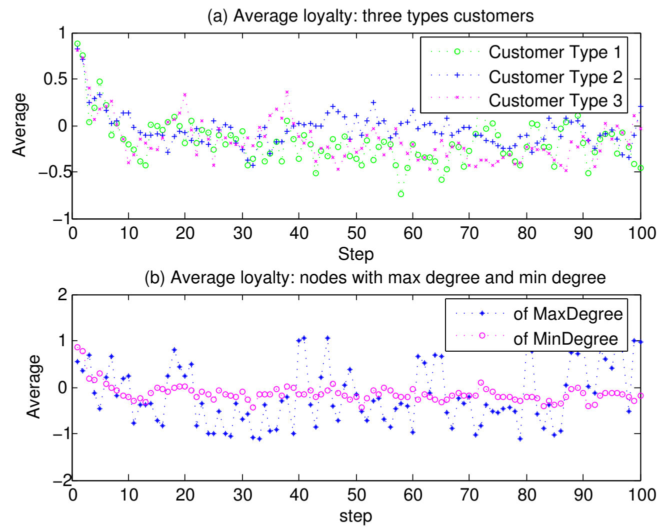

Fig. 5. Average loyalty ($N = 40$)

Fig. 10-b don't change as frequently as shown in Fig. 5-b, especially for those nodes with high degree. In Fig. 11-a, the phase plane is more dense than in Fig. 6-a. Fig. 11-b becomes more concentrate than in Fig. 6-b, especially for nodes with minimal degree.

From the above simulation results, we can get the following remarks.

(a) Interaction between customers has great effect on loyalty. Comparing with customers has little interaction, those customers with more connections show more active. Their loyalty also changes more largely. The size of the customer network plays an important role on interaction and thus loyalty. Because there are more connections, customers can communicate more widely. The larger the customer network is, the more likely a lower level of average loyalty is obtained. So for larger customer network, it is more difficult for service providers to control customers and evaluate their loyalty.

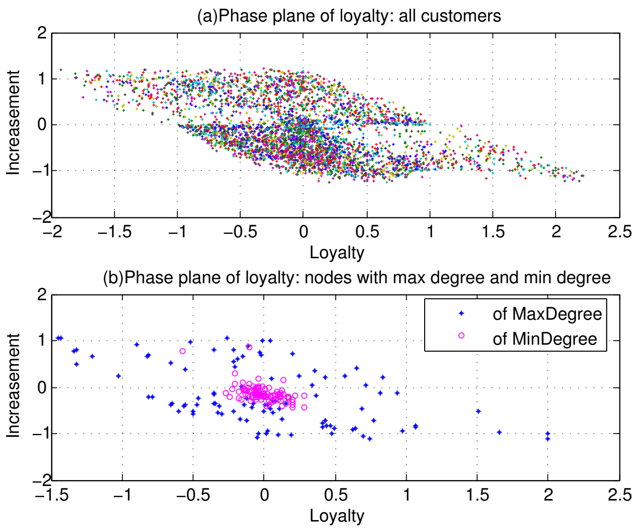

Fig. 6. Phase plane of loyalty ($N = 40$)

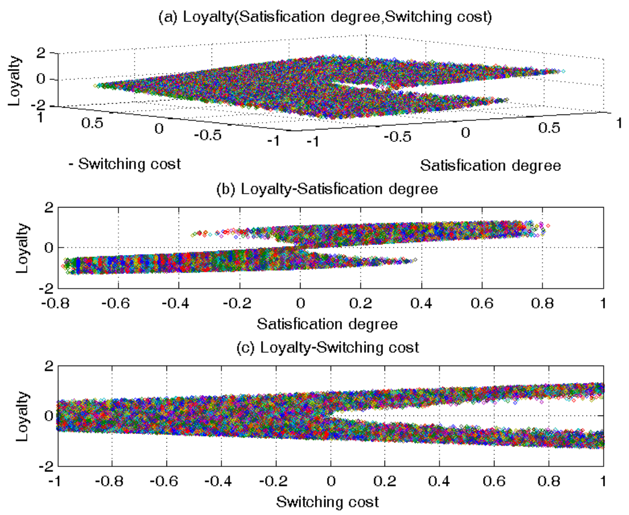

Fig. 7. Relation of loyalty, satisfaction and switching cost-all customers ($N = 500$)

(b) For different types of customers, those who are not influenced by other's opinions are more smoothly than the others. So these types of customer can easily become loyal with several satisfied service. But once he becomes not loyal, service providers must pay more to improve his satisfaction. Because employing word-of-mouth effect can't make sense. For the customers that can listen to others' opinions, utilizing customer interaction is a good method to increase his satisfaction degree and loyalty. While for those who are prone to make decision relying on others, introducing a group of some loyal customers to him is an easy way.

So service providers may consider well utilizing the network effect.

6. CONCLUSIONS

The loyalty is so important for service providers that it will influence the retention of customers to repurchase. With the increasing customer network, customer's loyalty

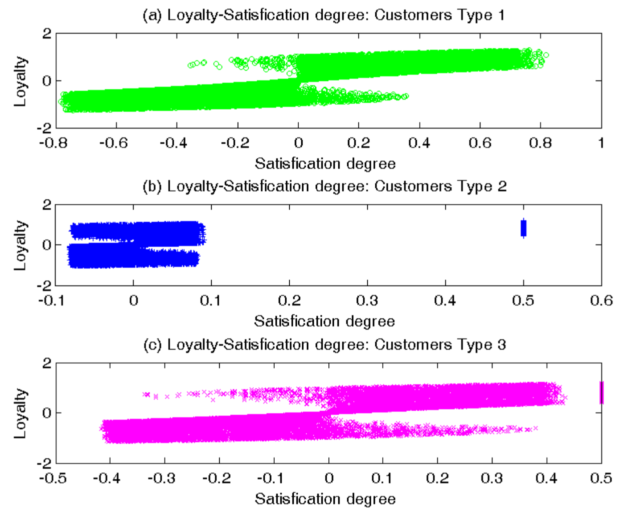

Fig. 8. Relation of loyalty and satisfaction -three type's customers ($N = 500$)

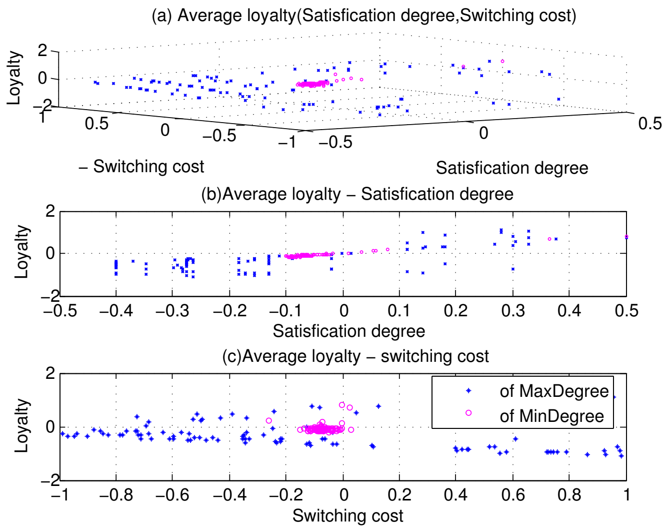

Fig. 9. Relation of loyalty, satisfaction and switching cost-nodes with max degree with nodes with min degree ($N = 500$)

shows different feature than before. The paper studied how customer interaction can affect loyalty. Basing on catastrophe model, we utilized customer network and customer's preference to analyze loyalty. Results showed that the network holds great effect on loyalty, especially when the network size is large. Understanding such complex model of customers will help service providers to predict the response of the delivered service among customers.

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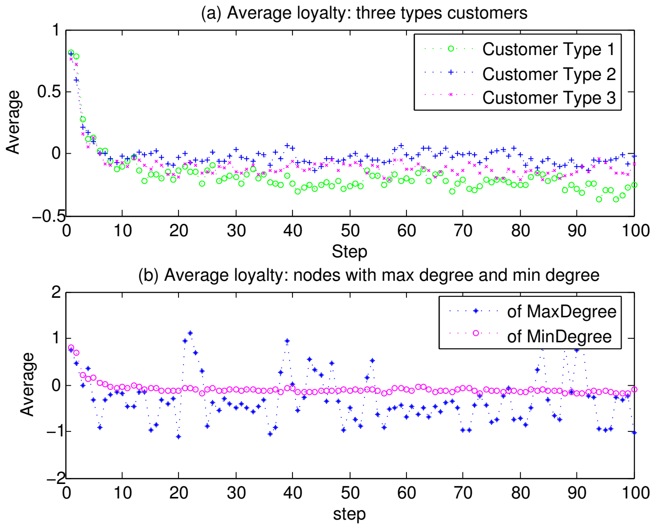

Fig. 10. Average loyalty ($N = 500$)

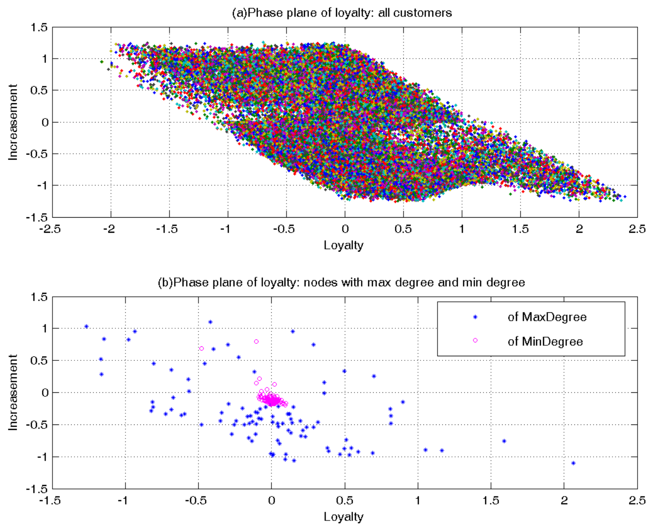

Fig. 11. Phase plane of loyalty ($N = 500$)

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