Chapter 134

A Review of Microblogging Marketing Based on the Complex Network Theory

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Abstract Microblogging marketing which is based on the online social network with both small-world and scale-free properties can be explained by the complex network theory. Through systematically looking back at the complex network theory in different development stages, this chapter reviews literature from the microblogging marketing angle, then, extracts the analytical method and operational guide of microblogging marketing, finds the differences between microblog and other social network, and points out what the complex network theory cannot explain. In short, it provides a theoretical basis to effectively analyze microblogging marketing by the complex network theory.

Keywords Complex network · Microblogging · Marketing · Social network

Introduction

As a newly emerging marketing model, microblogging marketing has drawn the domestic academic interests in the recent years, but the relevant papers are scattered and inconvenient for a deep research. On the microblog, every ID can be seen as a node, and the connection between the different nodes can be seen as an edge. These nodes, edges, and relationships inside form the social network on microblog which belongs to a typical complex network category. Therefore, reviewing the literature from the microblogging marketing angle by the complex network theory can provide a systematic idea to the microblogging marketing research. In short, it provides a theoretical basis to effectively analyze microblogging marketing by the complex network theory.

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The Microblogging Marketing Concept in the Original Complex Network Theory

The start of the complex network theory dates from the birth of small-world and scale-free network model. These two models provide the network analysis tools and information dissemination interpretation to the microblogging marketing.

Small-World Network Model

“Six degrees of separation” found by Stanley Milgram and other empirical studies show that the real network has a network structure of high clustering coefficient and short average path length [1]. Watts and Strogatz creatively built the small-world network model with this network structure (short for WS model), reflecting human interpersonal circle focus on acquaintances to form the high clustering coefficient, but little exchange with strangers to form the short average path length [2]. Every ID in microblog has strong ties with acquaintance and weak ties with strangers, which matches the WS model, but individuals can have a large numbers of weak ties in the internet so that the online microblog has diversity with the real network.

Scale-Free Network Model

Barabási and Albert built a model by growth mechanism and preferential connection mechanism to reflect that the real network has degree distribution following the exponential distribution and power-law. Because power-law has no degree distribution of the characteristic scale, this model is called the scale-free network model (short for BA model) [3]. Exponential distribution exposes that most nodes have low degree and weak impact while a few nodes have high degree and strong impact, confirming “Matthew Effect” in sociology and satisfying the microblog structure that celebrities have much greater influence than grassroots, which the small-world model cannot describe.

In brief, the complex network theory pioneered by the small-world and scale-free network model overcomes the constraints of the network size and structure of regular network and random network, describes the basic structural features of high clustering coefficient, short average path length, power-law degree distribution, and scale-free characteristics. The existing literature analyzing microblogging marketing by the complex network theory is less, which is worth further study.

The Microblogging Marketing Concept in the Evolving Complex Network Theory

The complex network theory had been evolved from the small-world scale-free model to some major models such as the epidemic model and game model. The diffusion behavior study on these evolutionary complex network models is valuable and can reveal the spread of microblogging marketing concept in depth.

Epidemic Model

Epidemic model divides the crowd into three basic types: susceptible (S), infected (I), and removed (R), and build models according to the relationship among different types during the disease spread in order to analyze the disease transmission rate, infection level, and infection threshold to control the disease. Typical epidemic models are the SIR model and the SIS model. Differences lie in that the infected (I) in the SIR model becomes the removed (R) after recovery, so the SIR model is used for immunizable diseases while the infected (I) in the SIS model has no immunity and only becomes the susceptible (S) after recovery. Therefore, the SIS model is used for unimmunizable diseases. These two models developed other epidemic model: SIR model changes to SIRS model when the removed (R) has been the susceptible (S); SIS model changes to SI model presenting the disease outbreaks in a short time when the infected (I) is incurable. Epidemic model can be widely seen in the complex network, such as the dissemination of computer virus [4], information [5], knowledge [6]. Guimerà et al. finds the hierarchical and community structure in the social network [7]. Due to the hierarchical structure, Barthélemy et al. indicate that the disease outbreak followed hierarchical dissemination from the large-node degree group to the small-node degree group [8]. Due to the community structure, Liu et al. indicate the community structure has a lower threshold and greater steady-state density of infection, and is in favor of the infection [9]; Fu finds that the real interpersonal social network has a positive correlation of the node degree distribution, but the real interpersonal social network has negative [10]. The former expresses circles can be formed in celebrities except grassroots, but the latter expresses contacts can be formed in celebrities and grassroots on the microblog.

Game Model

The game theory combined with the complex network theory can explain the interpersonal microlevel interaction such as tweet release, reply, and retweet because it can analyze the complex dynamic process between individuals such as the game learning model, dynamic evolutionary game model, local interaction model, etc. (1) *Game learning model*: Individuals make the best decision by learning from others

in the network. Learning is a critical point to decision-making and game behavior, and equilibrium is the long-term process of seeking the optimal results by irrational individuals [11]. Bala and Goyal draw the “neighbor effect” showing the optimal decision-making process based on the historical information from individuals and neighbors [12]. (2) *Dynamic evolutionary game model*: The formation of the social network seems to be a dynamic outcome due to the strategic choice behavior between edge-breaking and edge-connecting based on the individual evolutionary game [13]. Fu et al. add reputation to the dynamic evolutionary game model and find individuals are more inclined to cooperate with reputable individuals in order to form a stable reputation-based network [14]. (3) *Local interaction model*: Local network information dissemination model based on the strong interactivity in local community is more practical to community microblogging marketing. Li et al. restrain preferential connection mechanism in a local world and propose the local world evolutionary network model [15]. Burke et al. construct a local interaction model and find individual behavior presents the coexistence of local consistency and global decentrality [16].

Generally speaking, microblog has characteristics of the small-world, scale-free, high clustering coefficient, short average path length, hierarchical structure, community structure, and node degree distribution of positive and negative correlation. On one hand, the epidemic model offers the viral marketing principles to microblogging marketing, such as the SIRS model can be used for the long-term brand strategy and the SI model can be used for the short-term promotional activity; on the other hand, the game model tells microblogging marketing how to find opinion leaders in different social circles to develop strategies for the specific community to realize neighbor effect and local learning to form global microblog coordination interaction. Rationally making use of these characteristics can preset effective strategies and solutions for microblogging marketing.

The Microblogging Marketing Concept in the Domestic Complex Network Theory

The complex network theory is applied to biological, technological, economic, management, social, and many other fields by domestic scholars. Zhou Hui proves the spread of SARS rumors has a typical small-world network features [17]. Duan Wenqi studies new products synergy diffusion in the internet economy by the complex network theory to promote innovation diffusion [18]. Wan Yangsong (2007) analyzes the dynamic network of banking crisis spread and proposes the interbank network immunization and optimization strategy [19]. Although papers explaining microblogging marketing by the complex network theory have not been found, these studies have provided the heuristic method, such as the study about the online community. Based on Fu’s study on Xiao Nei SNS network [10], Hu Haibo et al. carry out a case study on Ruo Lin SNS network and conclude that the online interpersonal social network not only has almost the same network characteristics as the real interpersonal social

network, but also has a negative correlation of the node degree distribution while the real interpersonal social network has positive. This is because the online interpersonal social network is more easier for strangers to establish relationships so that that small influence people can reach the big influence people and make weak ties in plenty through breaking the limited range of real world [20]. These studies can be used to effectively develop marketing strategies and control the scope and effectiveness of microblogging marketing. There will be a great potential to research on the emerging microblog network platform by the complex network theory.

Conclusions

Analytical Method that Complex Network Theory Provides to Microblogging Marketing

The complex network theory describes micro and macro models analyzing the marketing process to microblogging marketing. The complex network characteristics of the small-world, scale-free, high clustering coefficient, short average path length, hierarchical structure, community structure, node degree distribution of positive and negative correlation and its application in various industries provide theoretical and practical methods to conduct and implement microblogging marketing. The basic research idea is: extract the network topology of microblog by the complex network theory; then, analyze the marketing processes and dissemination mechanism by the epidemic model, game model, or other models while taking into account the impact of macro and micro factors; finally, find out measures for improving or limiting the marketing effect in order to promote the beneficial activities and control the impedimental activities for enterprises' microblogging marketing.

Operational Guide that the Complex Network Theory Provides to Microblogging Marketing

Because the macro and micro complexity and uncertainty of online interpersonal social network, the previous static and dynamic marketing theory cannot give a reasonable explanation. Based on the strong ties and weak ties that lie in individuals of the complex network, Goldenberg et al. find: (1) After the external short-term promotion activity, strong ties and weak ties turn into the main force driving product diffusion; (2) Strong ties have strong local impact and weak transmission ability, while weak ties have strong transmission ability and weak local impact [21]. Therefore, the strong local impact of strong ties and strong transmission ability of weak ties are required to be rationally used for microblogging marketing. Through system simulation and data mining, the complex network theory can provide explanation

framework and mathematical tools to microblogging marketing as an operational guide.

Differences Between Microblog Platform and Other Social Networks

Microblogging marketing is based on online interpersonal social network, having difference with the nonpersonal social network and real interpersonal social network. Therefore, the corresponding study results cannot be simply mixed if involved with human factors. Pastor-Satorras et al. propose the target immunization solution to give protection priority to larger degree node according to SIS scale-free network model [22]. This suggests the importance of cooperation with the large influential IDs as opinion leaders in microblogging marketing. Remarkably, the large influential IDs are usually considered as large followers' IDs on the microblog platform that can be seen from the microblog database. The trouble is, as scarce resources, the large influential IDs have a higher cooperative cost, but the large followers' IDs are not all large influential IDs due to the online public relations behaviors such as follower purchasing and watering. This problem is more complicated than simply the epidemic model.

Existing Microblogging Marketing Problems Unsolved by the Complex Network Theory

The complex network theory can be applied in behavior dynamics, risk control, organizational behavior, financial markets, information management, etc.. Microblogging marketing can learn the analytical method and operational guide from these applications, but the complex network theory cannot solve all the problems of microblogging marketing, mainly:

1. The complexity and diversity of microblogging marketing process cannot completely be explained by the complex network theory. Unlike the natural life-like virus, individuals on microblog are bounded rational, therefore, the decision-making processes are impacted by not only the neighbor effect and external environment but also by individuals' own values, social experience, and other subjective factors. This creates a unique automatic filtering mechanism of microblogging information dissemination: information recipients reply and retweet the tweet or establish and cancel contact only dependent on their interests, leading to the complexity and diversity. Therefore, interaction-worthy topics are needed in microblogging marketing, and the effective followers' number and not the total followers' number of ID is valuable. This cannot be seen in disease infection.

2. There are differences in network characteristics between microblog network and the real interpersonal social network. On one hand, the interpersonal social network is different from the natural social network in six points: (1) Social network has smaller network diameter and average path length; (2) social network has higher clustering coefficient than the same-scale ER random network; (3) the degree distribution of social network has scale-free feature and follows power-law; (4) interpersonal social network has positive correlation of node degree distribution but natural social network has negative; (5) local clustering coefficient of the given node has negative correlation of the node degree in social network; (6) social network often has clear community structure [23]. Therefore, the results of the natural social network are not all fit for the interpersonal social network. On the other hand, as the online interpersonal social network, microblog has negative correlation of the node degree distribution which is opposite to the real interpersonal social network. This means the results of the real interpersonal social network are not all fit for microblogging marketing.
3. There is still a conversion process from information dissemination to sales achievement in microblogging marketing. Information dissemination on microblog can be explained by the complex network models such as the epidemic model, but the conversion process from information dissemination to sales achievement cannot be simply explained by the complex network theory, due to not only individual's external environment and neighborhood effect, but also consumer's psychology and willingness, payment capacity and convenience, etc.. According to the operational experience, conversion rate, retention rates, residence time, marketing topic design, target group selection, staged operation program, and other factors are needed to be analyzed by other theories.

Above all, microblogging marketing which attracts the booming social attention cannot be analyzed by regular research theories. However, the complex network theory can provide the analytical method and operational guide to microblogging marketing. It is believed that microblogging marketing on the complex network theory has a good study potential and prospect from both theoretical and practical point of view.

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