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Research on Time Distribution of Social Network Based on Tourist Preferences

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ABSTRACT. *People often make travel plans through various network platforms. Based on the data collected on the network, this paper studies the law of interactive time distribution according to the time distribution of interactions on social networks, and verifies it.*

KEYWORDS: *Travel; Interactive time distribution; Social networks*

1. Introduction

Today, people's lives have been surrounded by various social networks. The social networking of human society is a double-edged sword. On the one hand, it brings great convenience to commercial activities in human society, such as personalized recommendation, network marketing and advertising; On the other hand, it also brings some negative impacts, such as rumor spreading. However, whether it is the spread of information in business activities or the spread of rumors in emergencies, it is inseparable from human interaction.

With the Increase in Per Capita Income and the Improvement of the Tourism Market, China's Tourism Market Demand Expands Continuously and Grows Steadily. It is Estimated That by 2022, the Total Domestic Tourism Consumption Will Reach 5.5 Trillion Yuan, the Urban and Rural Residents Will Travel 4.5 Times a Year, and the Added Value of Tourism Accounts for More Than 5% of Gdp. as of June 2019, the Number of Online Travel Booking Users in China Reached 418 Million, an Increase of 8.14 Million over the End of 2018, Accounting for 48.9% of the Total Netizens. [1] People Usually Customize Travel Routes Online and Make Travel Strategies through Feedback from Online Travelers.

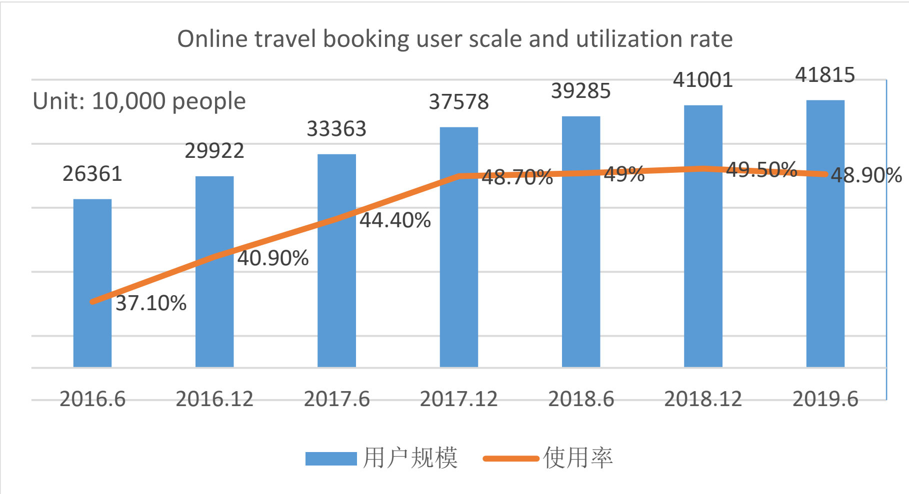

Figure.1 Online Travel Booking User Scale and Utilization Rate in 2016.6-2019.6

2. Research on Information Communication on Social Networks

The dynamic behavior of information dissemination on social networks can be accurately characterized by infectious disease models. There are three types of nodes in the infectious disease model, namely, Susceptible, Infected, and Removed. According to the state of the infected node, the main types of infectious disease models

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are SI, SIS, SIR and so on.[2] It is well known that node degrees on social networks obey power-law distribution, that is, most nodes in the network have fewer neighbor nodes, and a few nodes have more neighbor nodes. Therefore, based on the SIR model, this study analyzes the information dissemination model in small-scale networks.

2.1 Information Dissemination Based on Small World Network Structure

The small world network refers to a class of networks with shorter average path lengths and higher clustering coefficients. It`s information dissemination mechanism is: the susceptible node is infected once it contacts the infected node, and the infected node becomes an immune node after contacting the immune node or the infected node. The degree distribution of nodes in a small world network is uniformly distributed.

However, with the development of Internet technology, many scholars have analyzed the moderate distribution of social networks such as Email and research cooperation networks. It has been found that the degree distribution follows the power-law distribution, that means, the social network is a non-uniform network with scale-free.

2.2 Information Dissemination Based on Scale-Free Network Structure

The feature of a scale-free network is that most nodes in the network are only connected to a small number of nodes, and only a few nodes are connected to a large number of nodes, so it`s degree distribution follows the power-law distribution.

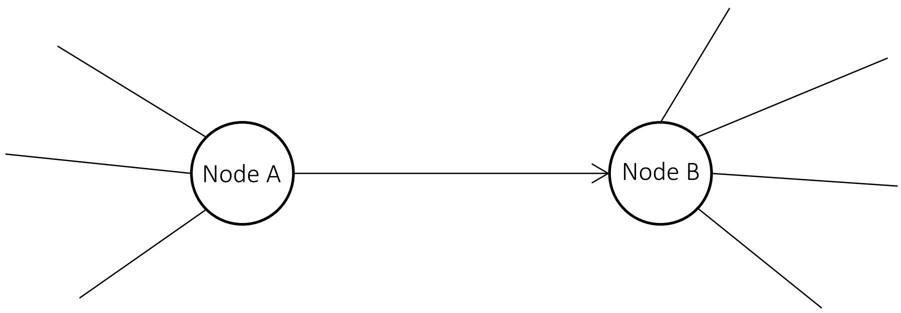

Figure.2 Information Dissemination on Scale-Free Network[3]

3. Time Distribution of Interactions on Social Networks

When information or rumors spread in a social network, the driving force is driven by the interaction of individuals in the network. Therefore, it is necessary to describe the temporal distribution of human interaction quantitatively to analyze the dynamic process of information dissemination or rumor diffusion. Based on the relationship between the arrival rate and the execution rate of interaction behavior, this paper analyzes the distribution of time interval of interaction behavior under different relationship situations. With the priority-based queuing model, the convection-diffusion equation is constructed, and the time distribution law of human interaction behavior is systematically demonstrated.

3.1 Construction and Solution of Convective Flow Diffusion Equation

The convection-diffusion equation is a basic equation of motion used to describe the law of mass transfer in a flow system. The basic idea is that the amount of substance A entering system B, plus its own increment in system B, minus its outflow, is the cumulative amount of substance B in system A.[4] By solving the convection-diffusion equation, the distribution state of substance A in the system square can be known.

Based on the above description, we propose the following three hypotheses: (1) Any one of the interaction behaviors with priority $x(0 \le x \le 1)$ per unit time, the arrival rate of the system entering the system is λ; (2) The priority satisfies the uniform distribution, and its distribution function is $p(x) = 1$; (3) In the unit time, the individual handles the highest priority interaction behavior in the system according to the priority of the

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interaction behavior, and the execution rate is μ . It is known that the probability that the waiting execution time of any one interaction with priority x is τ is:

$$P(\tau)=\sum_{n=0}^{\infty}\int_{0}^{1}dx\tilde{Q}(n,x)G(n,x,\tau), \tag{3.1}$$

Among it, the waiting execution time refers to the time interval between entering the system and being executed. $G(n,x,\tau)$ denotes the distribution probability of the interactive behavior with priority x being the following two conditions. First, an interaction with priority x, waiting time for execution is τ . Second, when the interaction behavior with priority x enters the system, the interaction amount higher than priority x is n . $\tilde{Q}(n,x)$ indicates the probability that the interaction amount with priority higher than x in the system is n when the system is in a stable state.

3.2 Distribution Law of Interaction Behavior

In this section, we will analyze the temporal distribution of human interaction behavior from the relationship of the interaction behavior between the arrival rate λ and the execution rate μ . The arrival rate refers to the percentage of recipients of the disseminated information as a percentage of all transmitted objects in the communication activities. The execution rate is the efficiency of information dissemination in communication activities. In order to evaluate the time pattern of human interaction behavior comprehensively, the following is divided into three situations.

(1) $\mu=\lambda$

In this case, the arrival rate of the interaction behavior is equal to the execution rate. It is known from the formula 3.21 in the literature[5] that $j(l,x)\geq 0$, and $h(l,x)=O(lx)$, $j(l,x)=O(l^2)$ when l,x is sufficiently small.

According to the following formula:

$$P(\tau)=\sum_{n=0}^{\infty}\int_{0}^{1}dx\tilde{Q}(n,x)G(n,x,\tau), \tag{3.2}$$

the right side of the equal sign is equal to $\tau^{-3/2}$ multiplied by the value of the double integral function with $\tilde{l},\tilde{x}$ as the integral variable, resulting in

$$P(\tau)\sim\tau^{-\alpha},\alpha=3/2 \tag{3.3}$$

(2) $\mu>\lambda$

In this case, the arrival rate of the interaction behavior is less than the execution rate. Similarly, from equation (3.21), $j(l,x)\geq 0$, where l,x is sufficiently small, $j(l,x)=j^{'}(l,x)+1/\tau_0$. Among it,

$$\begin{gathered}P(\tau)\sim\tau^{-\alpha},\alpha=3/2\\ 1/\tau_0=(\mu-\lambda)^2/4\mu(1-\lambda)\end{gathered} \tag{3.4}$$

When $\tau>\tau_0$, $h(l,x)=O(l), j^{'}(l,x)=O(l)$. To eliminate the variable τ in the definite integral function $\int_0^{1}dxh(l,x)e^{-\tau j^{'}(l,x)}$ in equation (3.19), let $(l,x)=\tau^{-1}(\tilde{l},\tilde{x})$, which can be derived,

$$P(\tau)\sim e^{-\tau/\tau_0}\tau^{-5/2} \tag{3.5}$$

When $\tau<\tau_0$, $h(l,x)=O(lx), j^{'}(l,x)=O(l^2)$, let $(l,x)=\tau^{-1/2}(\tilde{l},\tilde{x})$, which can be derived,

$$P(\tau)\sim e^{-\tau/\tau_0}\tau^{-3/2} \tag{3.6}$$

(3) $\mu<\lambda$

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In this case, the arrival rate of the interaction behavior is greater than the execution rate, which means that the amount of interaction behavior waiting to be executed in the system will increase with the continuation of time, that is, the amount of interaction behavior waiting to be executed is $(\lambda-\mu)t$.

When the arrival rate is greater than the execution rate, the waiting execution time distribution of the interaction behavior is biased toward the distribution pattern specified by Equation 3.3, that is, $P(\tau)\sim\tau^{-\alpha},\alpha=3/2$.

4. Verification of the Time Distribution Law of Interactions

It is necessary to collect large-scale experimental data to check the temporal distribution rule of tourist interaction. This study selects the data of Baidu Poster of Ctrip for verification. Ctrip is an online ticketing service company, whose business scope covers hotel reservation, air ticket reservation, vacation reservation, ticket reservation, travel management and so on. Baidu post bar is the largest Chinese online communication platform in the world. It is a keyword-based topic communication community, which enables people who are interested in the same topic to facilitate communication and mutual assistance.

4.1 Sample Information Collection

This study collected the user interaction behavior data of Baidu Poster of Ctrip within 3 months, and checked the distribution law of waiting execution time, the basic information of the sample is shown in Table 1.

Table 1 the Basic Information of the Sample Group

Type	Sample size
Air tickets	24613
High-speed rail	14587
Hotel	22654
Specialized car	15118

4.2 Estimation of Parameter Values for Arrival Rate and Execution Rate

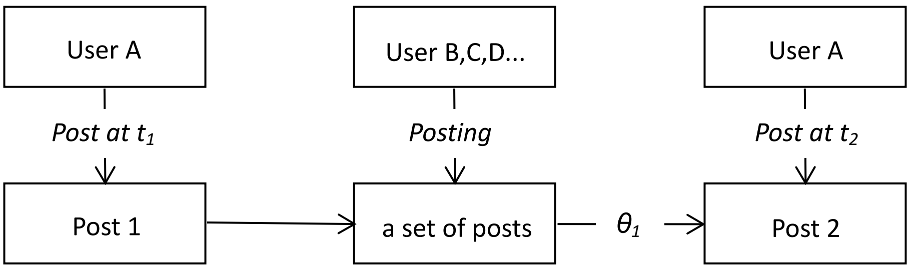

Figure.3 Cycle Diagram

In this study, the period from user Posting to reply is one cycle, as shown in figure 3. The θ_1 represents the time when the user replies to a post, that is, the execution time, and $1/E(\theta_1)$ is the execution rate μ of the interactive behavior, where $E(\theta_1)$ is the mathematical expectation of θ_1. $\theta_2=(t_2-t_1)/(n_1+1)$ represents the average time interval of two adjacent posts in the period, that is, the arrival time, and $1/E(\theta_2)$ is the arrival rate λ of the interaction behavior, where $E(\theta_2)$ is the mathematical expectation value of θ_2 .

Figure 3 shows that the User A posts a post, Referred to as Post 1, at the time t_1, and then the user group (B,C,D...) replies to Post 1 to generate a set of replies of number M_1. After the time θ_1, User A responds to a set of replies at time t_2, generating Post 2. The execution time and arrival time of the interactive behavior shown in the sample data are shown in Figure 4.

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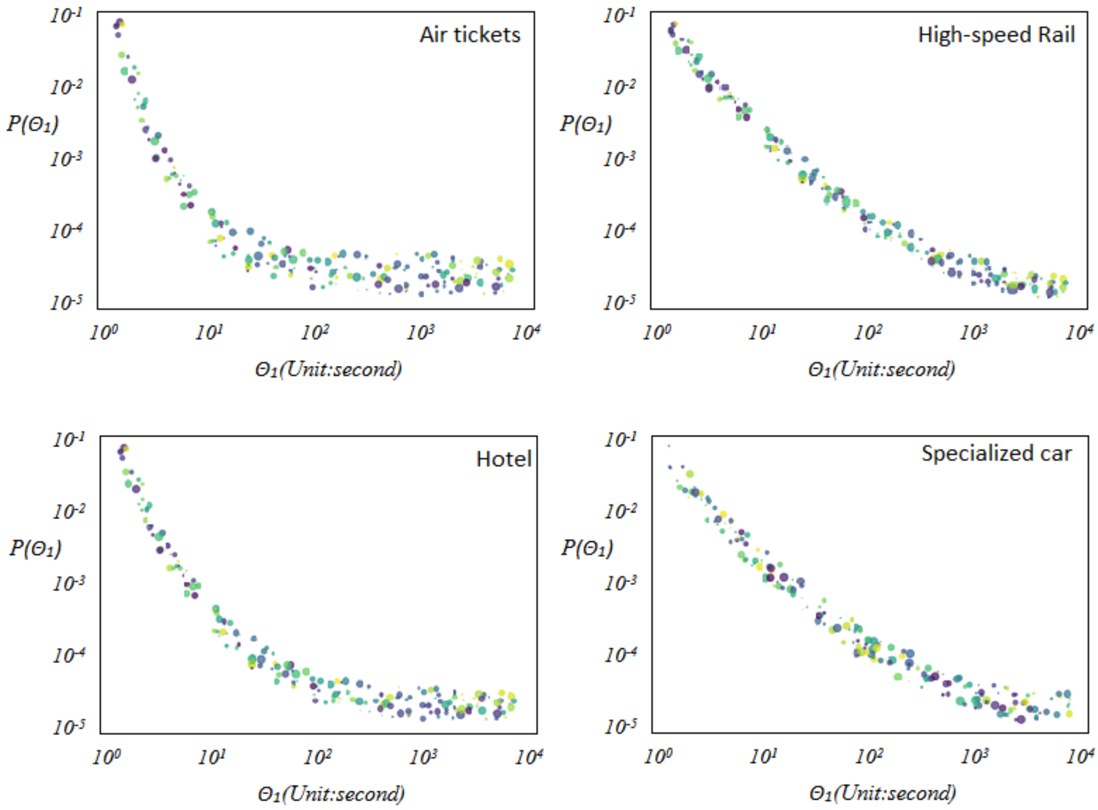

Figure.4 The Behavior Execution Time and Arrival Time in the Sample Group

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