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A Model Study on Emergency Information's Spread under Mobile Internet Environment

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Abstract. With public emergencies' frequent occurrences and mobile internet's fast developments, emergency information managements under mobile Internet environment become a hotspot of study.This paper applies the complex network theory to the study on emergency information's spread under mobile internet environment. This paper constructs the emergency information's spread model with different clustering coefficient under mobile internet environment to study emergency information's spread trend. The result shows that under mobile internet environment there is high relevance between the emergency information's spread trend and the topological network's clustering coefficient. Governments can adjust the clustering coefficient to improve the management of emergency information under mobile internet environment.

Introduction

The management of emergency information is one special kind of public management. Emergency information has the characters of urgency, changeability, radiation and devastate, to some extent. For the mobile terminals' characteristics of portability and users' identifiability(identified by position), the information's acquisition can be more precise and the information's access can be more efficient. The analysis of emergency information mechanism and the effective emergency information's spread management under mobile internet environment are valuable studying subjects.

When incident occurs, a large number of emergency information will be spread on mobile internet. The mobile internet users' contacting and their interaction's way have important effects to to the incident's evolution and control. If we use nodes to signify the individuals and use the sides to connect the individuals with contact or other interaction relations, then the mobile internet groups will be abstracted and characterized by social network availably[1].

Watts and Strogatz proposed WS small world model[2],which has high clustering properities, but the network's degree distribution does not obey the power-law distribution. Barabasi and Albert, proposed BA scale-free model[3-4],which obeys the power-law distribution, but its clustering coefficient is very low. Holme and Kim introduced variable clustering coefficient of scale-free network model and got the network model with power-law degree distribution and higher clustering coefficient meanwhile[5].

Qiang Yan and Huaying Shu conducted the study on internet topology and spreading dynamics model,.They also proposed both free and restricted spread model of harmful information on internet[6].

This paper applies the complex network theory to the study on emergency information's spread model under mobile internet environment, by constructing information's spread model with different clustering coefficient, discussing the influence to emergency information's spread, and the result can support for the effective control of emergency information's spread.

Scale-free Networks with Variable Clustering Coefficient

Definition of clustering coefficient:

There is a phenomenon in the network, that is if node a and node b are connected, and node b and node c are connected, then there exists a side between node a and node c in all probability. Clustering coefficient is used to describe the probability of the side's existence. Choose one node j in any network, assuming that the number of nodes directly connected with node j is kj, the real total number of sides between these nodes is Ej, the total number of possible existing sides is $C_{k_j}^2$,then node j's clustering coefficient will be defined as $C_j = \frac{2E_j}{k_j(k_j-1)}$. On mobile Internet, it indicates the probability of two friends of one person also knows each other .

One of the important spreading channel of emergency information is mobile internet media.Mobile internet has the characteristics of scale-free networks[7-10]. This paper proposes the simulation algorithm of emergency information's spread network under mobile internet environment, mainly based on the scale-free networks with variable clustering coefficient proposed by Holme and Kim.

When t= 0,there exists one node and no side,

Then each time step, execute the following steps:

(1) Add a new node, and the new nodes carrying with m pieces of sides ($m \le m_0$);

(2) For the new joining node, firstly connect once with top priority ;

(3)According to the probability Pt, connect triangularly and connect with priority according to the probability 1–Pt, until the m pieces of sides are added to the end.

Enter into the next cycle step to add new node, until the network contains N nodes.

Emergency Information's Spread Model under Mobile Internet Environment

This paper constructs the spread model of emergency information under mobile internet environment as follows: Consider one emergency information spread system composed of N individuals, each individual is in one of the three states: the ignorant (ignorant), communicators (spreader) and immune people (stifler). The ignorant refers to who has no defense to emergency information's spread and once he or she acquires the emergency information then he or she becomes one communicator in a certain probability.Communicator is who spreads the emergency information and immune refers to who is affected by the emergency information not at all.

The dynamic rules of emergency information's spread are as follows: assuming that i is one communicator, and he or she meets j, if j is ignorant, then j will believe the emergency information according to the probability of λ, and become one of communicator s. If j is a communicator or an immune person, then he or she will become a immune person according the probability of α.If use i (t), s (t) and r (t) to signify the propotion of the ignorant, communicator and immune separately[i (t) + s (t) + r (t) = 1].Considering that the mobile internet users' identity can be distinguished, users' position can be identified, and information can be acquired with more accuracy and efficiency. Under mobile internet environment the number of λ will have larger values comparing to that of traditional internet environment. The emergency information's spread under mobile internet environment can be described using the following differential equations:

$$\begin{cases} \frac{di(t)}{dt} = -\lambda i(t)s(t) \\ \frac{ds(t)}{dt} = \lambda i(t)s(t) - \alpha s(t)[s(t) + r(t)] \\ \frac{dr(t)}{dt} = \alpha s(t)[s(t) + r(t)] \end{cases} \tag{1}$$

On the earlier stage of emergency information's spread under mobile internet environment there are only a small amount of communicators and the others are all the ignorant, there is no immune person. Along with the further spread of emergency information, the number of immune person begins to increase and the number of spreaders begins to turn down.

Simulation and Results

This paper uses the matlab tool to simulate and analyse the propagation of the emergency information's spread under mobile internet environment. Firstly establish a scale-free network with variable clustering coefficient composed of N nodes. Each node represents a individual and which influences its connecting nodes only. When t=0, most of the nodes are know-nothings, and the rest few are communicators. When t=1,it begins to spread the emergency information. For the node which is in ignorant or immune state, it will not affect the nodes connecting with it. For the node which is in spreading state, it will spread according to the dynamic rules that has been mentioned above, and then affect the nodes connecting with it until the number of the communicator of the whole network becomes 0 and then comes to an end.

Through the generative process of the the front scale-free network with variable clustering coefficient, we can get the scale-free network with different clustering coefficient, and then we can study the emergency information's spread status' different clustering coefficients.

Figure 1 shows the s(t) and r(t) trend change with time under different α and λ parameters. Figure 2 shows the s(t) and r(t) trend change with time under different clustering coefficient parameters. From the simulation results,we can see that the greater the clustering coefficient is, the smaller the peak of s (t) throughout the evolution process is, and the smaller the corresponding final r (t) value is. Both indicate that the greater the clustering coefficient of the emergency information is, the less the information's spread affects. Also the less the clustering coefficient of the emergency information is, the greater the information's spread affects. The intensity of crowd communication has certain inhibition to the emergency information's spread.

Considering that the mobile internet users' identity can be distinguished, users' position can be identified, and the information can be acquired with more accuracy and efficiency. Under mobile internet environment, the number of λ will have larger values(the higher reliability to the information).

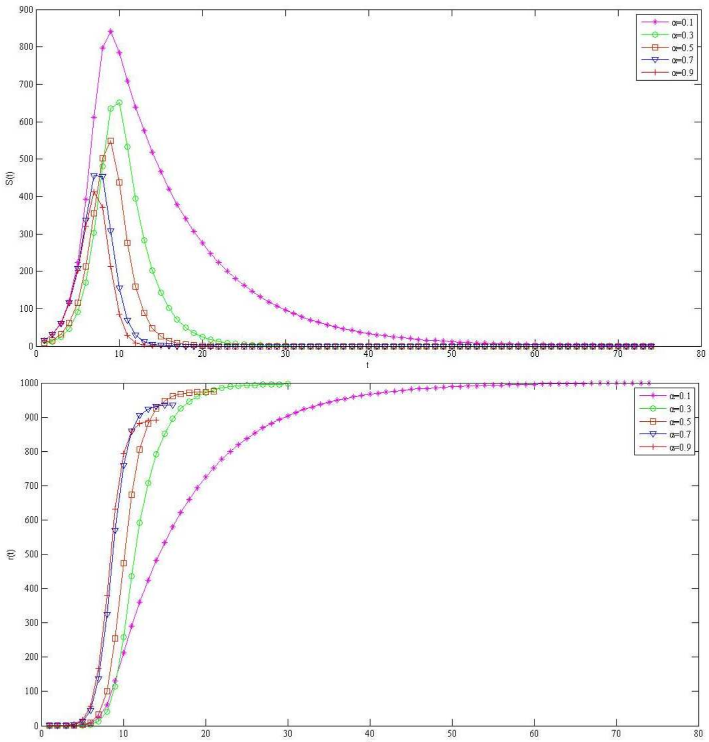

Figure 1 s(t) and r(t) trend chart changing with time under different α and λ parameters

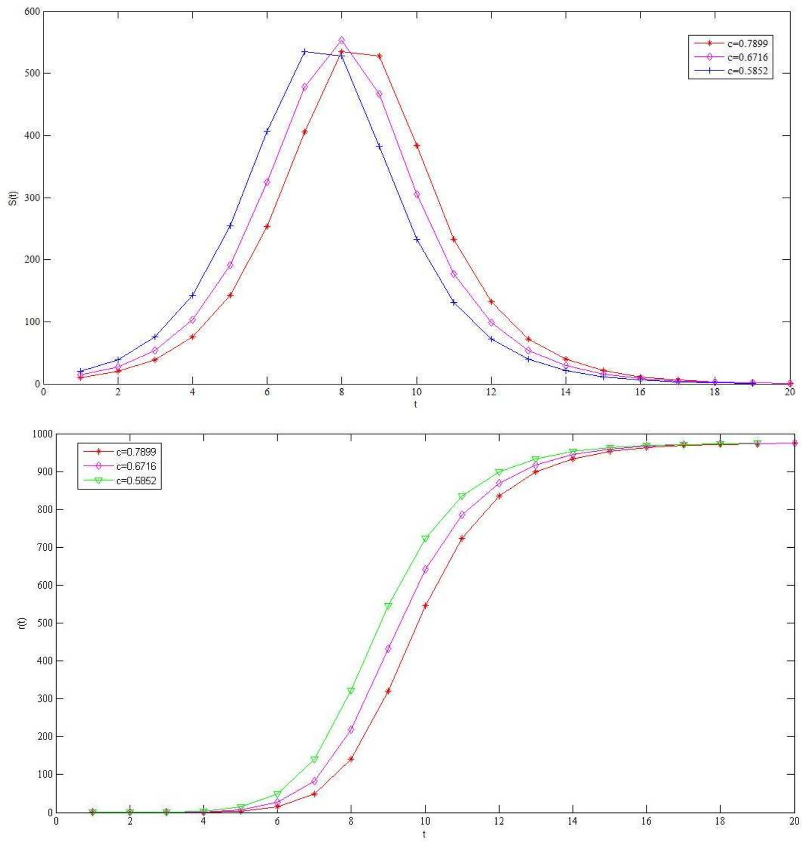

Figure 2 s(t) and r(t) trend chart changing with time under different clustering coefficient parameters

By adjusting the clustering coefficient of the emergency information's spread network can get the above simulation results. The greater the clustering coefficient is, the smaller the spread range is, eventually the scale of the immune is also smaller. That explains people's communication intensity has certain inhibition to emergency information's spread. This also tells us that it is important to keep the information channel's unblocking during the process of emergency information's spreading under mobile internet environment.

Conclusions

At present, one of the main international research direction of emergency information management is using dynamic quantitative analysis method, and combining computer modeling with simulation technologies [10].Compared with the overseas study, the research in this field of our country at present is still in developing stage. This paper is mainly studying from the clustering coefficient's angle of the emergency information spreading network under mobile internet environment.

Under mobile internet environment the clustering coefficient of the emergency information's spreading network has large influence to the information's spread. The change of clustering coefficient is closely related to the highly efficient communication between people (transparent communication between individuals increases the network's clustering coefficient). Through establishing the efficient communication mechanism, improve the mobile internet network's clustering coefficient, which can improve the emergency information's spread effectively

The model this paper has studied on the emergency information's spread under mobile internet environment can be used to analyze the other spreading network with different clustering coefficient, and also can be used to provide more specific support for emergency information management. Utilising the complex adaptive system theory, regarding each individual of the emergency information spreading system under mobile internet environment as adaptive body(agent), realizing the complexity simulation of emergency information's spreading process under mobile internet environment by designing different interaction rules among the agents is the emphasis in further study.

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