Multimodal Evolution Model of Internet Public Opinion Based on Cellular Automata

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Received 9 February 2015; Revised 19 February 2015; Accepted 9 March 2015

Abstract. These Based on the analysis of recent patents, the evolution regularity of the published article number and features of internet public opinion events, it was put forward that multimodal evolution model of cellular automata by using multi-agents simulation technology and given simulations about a peak event of internet public opinion of hunan university professional title evaluation bribery, and secondary peak event of xiangtan vice director who was the generation after 90s. The simulation results well represented public opinion evolution process of events. Finally, it showed that the credibility of local government performance played an important guiding role in internet public opinion evolution by adjusting the parameter of it.

Keywords: RFID multimodal model, cellular automata, internet public opinion evolution, Multi-agents simulation, scenario deduction

1 Introduction

With the popularity of Internet in the past few years, the network media has been increasingly powerful, and, meanwhile, Internet public opinion (IPO) has been a social issue that cannot be ignored. So the appropriate instruction and standardized management of IPO are urgent problems to be solved [1-4].

Nowadays, the relative researches cover two aspects, i.e. IPO theory and model. IPO model includes some mathematical models and simulation models, such as, small-world network, cellular automata model (CA model) and Markov Model, etc. The work team led by Qiong Wu has analyzed the definition [5], characteristics and harmfulness of Internet messages. And the research group led by Wei Wang [6], taking the event of Influenza A (H1N1) for example, discussed the way of responding IPO of emergencies. Jianhua Dai [7], integrating the traditional CA model and the views of fuzzy inference system(FIS), put forward CA propagation model of network public opinion under the fuzzy rules. Guobiao Jia[8] depicted the dissemination process of net-message by applying small-world network model in the complex network into his research. According to the basic features of small-world network, the research group led by Xiaojian Chen [9] constructed a complex network model of information dissemination of public crisis. On the basis of small-world effect of netizen relationship and network topology, Gensheng Wang [10,11] brought about the orientation-switching rules of netizens' opinions. Likewise, he, in light of small-world network matrix representation of IPO and netizen relationship, constructed evolution and migration model of IPO. Accordingly, by an empirical analysis of the scale-free feature of IPO evolution, he, on one hand, proposed that IPO evolution can be divided into two stages, namely, the viewpoint formation stage and the viewpoint interactive stage. On the other hand, he built up the BA model and put forward the evolution and migration model of IPO characterized by free scale. Wei Fang [12], by considering cell state transition, put forward the majority rule formula and the cell moving traversal algorithm of cell stability in March 2010. In the process of discussing simulation results, she defined four parameters i.e. orientation intensity, orientation aggregation, cellular peak value and cellular orientation mode, and she also respectively analyzed the evolutionary process, pattern and significance of cells, which are of different stability and states, i.e. stable or dynamic, based on the iteration results of those cells' state calculation. Through this analysis, Wei Fang concluded that special attention should be paid to the public opinion dissemination process of stability-featured cellular moving traversal. Wei Fang [13], presented an extended CA model, namely, synergistic CA model, and its algorithm in February 2012. The simulation results show that the order-variable parameter of society adaptability can reflect the herd mentality of IPO subjects, whose change can influence magnetic susceptibility converting towards the majority opinions. However, the order-variable parameter of preference makes tendency propagation as a whole close to the direction of preference rapidly. Contemporarily, Wei Fang [14] conducted a research on the forecasting model and algorithm for the positive/negative propagations of general emotion, and then worked out the law affecting mounting and perishing of such tendency propagations by simulation. The starting point of modeling lies in the construction of synergistic Markov model by means of considering public opinion propagation as a Markov chain by time series and utilizing collaborative probability supplied by Haken's synergetics theory as the one-step transition probability of Markov chain and finally altering each parametric variable in collaborative probability in the experiment of simulation in order to retrieve the distinctive IPO evolution process curves varying with propagating time. Hailin Xiao[15] established the CA consensus model for the purpose of studying ,to what extent, the transfers of personnel and the existing of people with firm attitude within the IPO system can make a difference on the formation and evolution of public opinion.

To summarize what has been mentioned above, different models in the research of IPO have examined and weighed IPO evolution process from different point of view, which contributes practical and heuristic significance to this kind of study. This thesis brings forward the CA-based peak model aiming at constructing and presenting a simulation model which can better reflect the actual outbreak process of IPO and fit the evolution process of uni-modal and bimodal IPO events. This thesis, on the other hand, based on instance modeling, further touches upon the function of credibility of local government.

2 Model Construction

2.1 An Analysis of the Characteristics of IPO Events and Model Elements

The paper Through empirical investigation on numerous IPO events, it has been found that they share some common features which can be summarized as the following statements: (i) these IPO events burst out unexpectedly and come to climax within one day; (ii) the total time is short, only lasting for few days, or up to ten days at the most; (iii) propagation individuals hold the traits of short incubation and out-break period. On the basis of these features, this thesis extracts critical elements and regards them as the important parameters of model construction. Here is an analogical model between characteristics of IPO events and model elements.

Table 1. Characteristics of Internet public opinion events compare with model elements

Reality System	Simulation System
netizen scale	system space M
Netizen individuals	Cell Agent
Netizen state (attention, posting, no attention)	Cellular state state
Duration of netizen's paying attention to events	Cellular incubation q
Duration of paying attention + duration of posting	Cell gene N(A) Sequence length L(A)
Number of articles posted by netizens	Cell gene N(A) Change of position value
Reciprocal dissemination rate among netizens	Transmitting efficiency of cell p0
Dissemination capacity of netizens	Transmitting effect of cell Cij
Total number of posted articles by netizens	Number of state-released cells F
Reporting media of IPO events	Agent which changs cell state
Credibility of local governments	Factors which weaken cellular transmission effect
Dilution effect on events by time	Time pt

Public opinion events' out-break originates from media reportings, which attract netizens' attention and lead to their massive posts on the Internet. The quantity of articles increases sharply within a short period of time, which will fluctuate if those media keep close track of the development of events, or words and deeds of the local governments. It is possible that the declining attention rate will ascent once again.

Additionally, the evolution of individual cell gives rise to the alteration of the overall state of system. The possible states during the performance of simulation system are as similar as those happening in the real condition. The specific illustration is shown in the following Table 2.

Table 2. Emergency state analysis

Reality System	Simulation System
netizen scale	system space M
Netizen individuals	Cell Agent
Netizen state (attention, posting, no attention)	Cellular state state
Duration of netizen's paying attention to events	Cellular incubation q
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2.2 Design of Agent

Number As a result of the peculiarities of public opinion event, the quantity of posting behavior will fluctuate repeatedly with the follow-up reports by media. To simplify the model, there will be two situations to be discussed: (i) the quantity of articles reaches the peak value once; (ii) the quantity of articles reaches the peak value twice.

The computerized model in this thesis puts swarm2.2-installed multi-agent platform into application. Marvin Minsky initiated the concept of Agent in his book, The Society of Mind. It is an self-adaptive and autonomous entity for understanding and simulating the intelligent behavior of human beings, whose formalized definition is, Agent：= { Sm, Agi } (Sm represent the internal state of Agent and Agi stands for its function and external interactive action) [16]. The main part of model construction is shown on Table 3.

Table 3. Mapping table about Internet public opinion events system with Agents of the model

	state	Posting cycle	interactivity	Individual cycle
Cell A	Cellular state	Gene length	Cell possesses transitive property in both attention state and posting state. The more 1 in $N_{(A)}$, the stronger transitive effect is.	In $N_{(A)}$, 0 and 1 represent stabilization and disorder respectively. The more 1 $N_{(A)}$ contains , the larger the quantity of posted articles is.
Netizen individuals	No attention, attention, posting	the number of days from no attention state to cure or death state	Both the individual who pay attention and the one who posts articles own transitive property. The latter has stronger transitive property than the former.	Attention, posting, repeated posting

Table 4. Comparison between individual in Internet public opinion events and cellular A

IPO Events System	Active Defense System
Event-population network	Environment Agent
Population individual	Agent
Monitoring bodies	Observer Agent
event evolution	Model Agent

Afterwards, there is the construction of simulation algorithm according to transfer operator and evolution operator. By doing this, energy transmission takes place within cell A itself and between its internal contents. Besides, the eruption process of emergencies can be simulated. The simulation process is illustrated as follow:

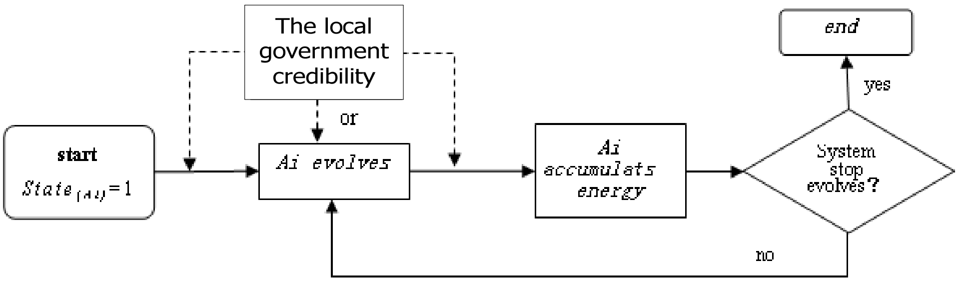

Fig. 1. Flow chart of simulation

2.3 Project of Cellular Modal Model

Providing that each cell is both a disseminators and one that is disseminated, the energy of adjacent cells will be activated gradually in the process of transmission, and additionally, the total energy will accumulate increasingly to the critical state. When a vast amount of cells break out intensively at a certain point, they are reduced into the disorder state from the critical state and finally public opinion events take place. Cell A stands for a particular individual among the events. The concrete explanation is shown in the Table 4.

2.3.1 Uni-modal Model

(1) components of system

This system is composed of cell A, whose quantity is M, and grid space where cell A lies. The number of unites in grid space is expressed as M=world$X$ × world$Y$ (world$X$ and world$Y$ are space boundaries). The spatial coordinate position of each cell is indicated by (x, y). Every unit of grid space has one and only one cell A. The initiative state（t=0）is that a random point is in attention state and the other cells are all in on-attention state.

(2) parameter of state

Cell Ai is a dynamics subsystem with some energy, whose state parameters include cellular gene $N_{(A)}$, energy value $E_{(A)}$, and current state $state_{(A)}$. $N_{(A)}$ is a binary number with certain length $L_{(A)}$. The positional value 0 and 1 represent stabilization and disorder respectively. The alteration of positional value signifies the evolutionary strategy cell takes in the current periodic evolution. The set state is:

$$N_{(A)} = \begin{cases} 00000 & \text{no attention（state=1）} \\ 10000 & \text{attention（state=2）} \\ 11100 & \text{posting（state=3）} \end{cases} \quad (1)$$

If observation starts from the second position of cellular gene and the positional value change from 0 to 1, an article is posted. It will not end until all positional values are turned into 1.

The energy value of each cell is determined by the number of 1 in $N_{(A)}$. Farther n stands for every positional value of cellular gene $N_{(A)}$, which is 0.1. The minimum value of $E_{(A)}$ is 0, and the maximum value of it is 0.1 $L_{(A)}$.

$$E_{(A)} = \sum(0.1n) \quad n = 0 \text{ or } 1 \quad (2)$$

The total energy of system is：

$$\sum E_{(A)} = \sum\sum(0.1n) \quad (3)$$

(3) evolution rules

The initiative state is that, because of the effect of Agent, a portion of cells change its state from no-attention to attention state, and then from attention state to posting state. Those cells in posting state can arouse those in no-attention state and turn them into the state of attention. All of cells in attention state can change into posting state. The effect between cells is affected by transmission efficiency, time and credibility of local governments.

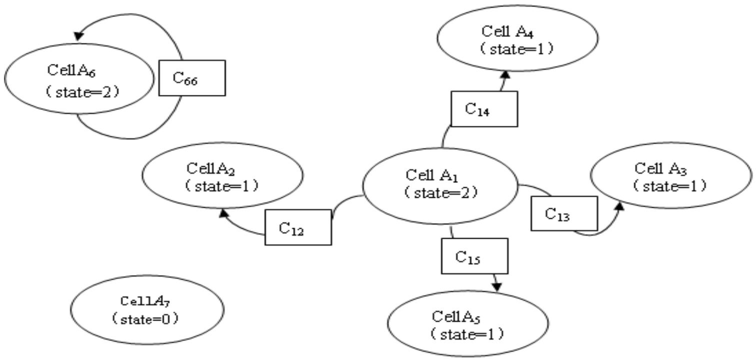

Fig. 2. Evolution structure of cellular automaton

This model includes other Agents, except cell A. Table 5 lists the main parameters of Agent and their interactivity.

Table 5. Interaction rules of the agents in model system

Agent	Parameter Instruction	Interactivity
Cell A	evolutionary state state$_{(A)}$, evolutionary strategy $N_{(A)}$, individual energy $E_{(A)}$, incubation period q, total running time of out-break, sequence length $L_{(A)}$ of $N_{(A)}$	transmission effect of cells, C_{ij} and C_{ii}
Model Agent	transmission efficiency p_0, evolutionary cycle, out-break value of system, total energy of system	interactive model of cell A, energy accumulation model, observation model of out-break value
Observer Agent	graph of system out-break value, graph of the total energy of system, control panel	demonstration of observations，control of system progress
Environment Agent	system space M =world$X$×world$Y$, initiative state of system, cellular field	supply of spatial scale for interactive action of cell A

2.3.2 Bimodal Model

What differentiates uni-modal model from bimodal model is that Agent functions not only in initiative state, but also in mid-late period of model evolution, which turns those cells already in posting state back into the cells in attention state, further in posting state, transmitting effects all around. The other evolutionary rules is similar to those of uni-modal model.

3 Simulation Analysis and Scenario Deduction

3.1 Uni-modal Event

This simulation experiment is based on the IPO of professional title evaluation bribery event in Hunan Province. This event lasted about seven to eight days from beginning to end. The number of posting reached a climax on the second day, and afterwards, it continued to descend till the end. These statistical data are retrieved from Media Opinion Monitoring Office By People's Daily Online.

Referring to these facts, basic parameter settings are completed. Assumed that model running a cycle takes 24 hours, taking the peak value of posting and the maximum number of posting in one day, system space can be described as, M = world$X$ × world$Y$ = 80×80 = 6400(the number of people) .

Public opinion events fades with time and the factor of time is set as p_t = 0.8 (decreasing 0.1 in every cycle).
Since netizens' comments spread fast, transmission efficiency is set up as, p_0=1.
The weaker credibility of the local governments is, the stronger the factor lowering the effect of cellular transmission is. Therefore, the factor lowering the effect of cellular transmission is expressed as, p_j =0.9.

Considering that the time which is taken to attract netizen's attention to events is short, they can react to these events immediately. Hence, the length of cyclic process of cellular movement from no-attention state to attention state is indicated as, q=1 .

Observation value under simulation system is denoted as the posting number (*f*), which is the total quantity of posting by the present cyclic cell A. Simulation outcome is illustrated by Figure 3.

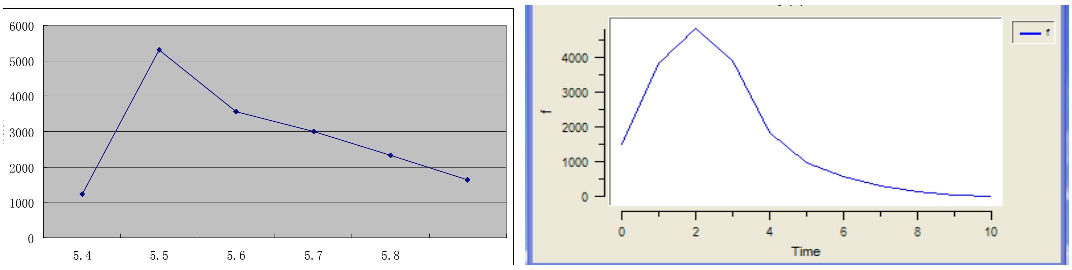

Fig. 3. Real and simulation chart about public opinion direction on the event of human university professional title evaluation bribery

This simulation model basically reflects the trend of public opinion and its general tendency. Both peak point and duration are more or less the same as that of the real event.

3.2 Bimodal Event

This simulation is based on the event of post-90s vice-director in Xiang Tan. After reaching the first peak point, this event comes to another climax because media report how local government deals with it. Duration at this time lasts evidently longer than that of the first peak for ten days in total.

The process of setting model and parameters resembles the uni-modal model. The only difference is that when the number of posting reaches the relatively low level, Agent, which triggers the change of cellular state, will functions again, whose state is 3. Those cells, of which every $N_{(A)}$ value is 1 change into state 2 again, thus contributing to bimodal event. The time of bimodal event is defined as 0.7. The simulation result is shown by Figure 4.

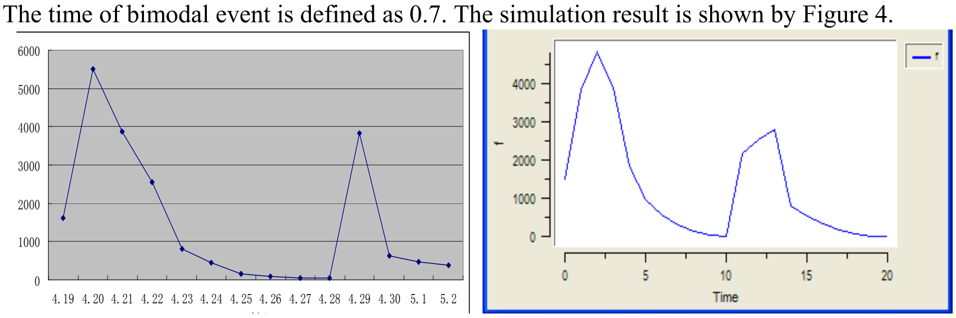

Fig. 4. Public opinion attention chart and simulation chart on the event of xiangtan vice director who was the generation after 90s

Simulation outcome is basically consistent with the trend of actual event. There exists a possibility that there has been continual attention to the event and peak value appears for several times. If so, it is mainly because new development occurs at a certain time, consequently, attracting new attention. Whereas, the following peak value will not surpass the first one.

3.3 The Effect of Credibility of the Local Governments

Under the condition of keeping other parameters unchanged, what has to be adjusted is to strengthen credibility of the local governments. The factor enhancing cellular transmission is defined as, p_j =0.5 and p_j =0.1. Thereafter, there comes the simulation project for uni-modal event. The outcome is shown in Figure 5.

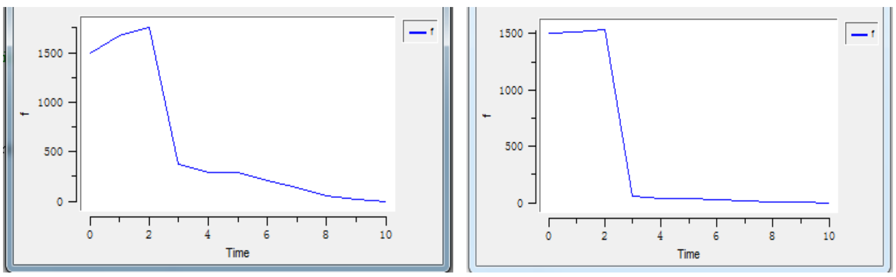

Fig. 5. Simulation chart after improvement the credibility of local government (p_j =0.5 OR p_j =0.1)

Credibility of local governments exerts great effect on the late stage of out-break period of public opinion events, which can effectively decrease the peak value of posting number and shorten event's cycle. In short, credibility of local governments holds the barrier effect on public opinion events.

4 Conclusion

Based on the construction of multimodal evolution model of cellular automata, uni-modal event and bimodal event are appropriately simulated, and meanwhile, credibility parameter of local governments is observed. In the end, this thesis draws the following conclusion:

(1) In uni-modal event, netizens spend relatively short time paying attention to event. The whole event rapidly develops from low point to climax. Comparatively, the rate of declining is relatively slow. Owing to the absence of other exogenic actions, public opinion comes to relief very soon.

(2) Bimodal event and multimodal event are more hazardous. This hazard is manifested as repeatedly rising trend of posting number, putting public opinion event into hard-to-tackle situation. This state of affairs is attributed to dereliction of duty of the local governments, exposal of decision-making mistakes and high spirits of netizens.

(3) In order to avoid multimodal event and restrict the level of netizens'concern within controllable limits, credibility of local governments and media hold considerable impact. If the local governments improve their credibility and media expose the truth of event and governments' treatment process to this event, public opinion event will receive positive influence.

Acknowledgement

This work was supported in part by the Chinese National Natural Science Foundation (No. 71371148); China postdoctoral Fund Projects (No. 2013 M542080); China postdoctoral Fund Special projects (No.2014T70750) and Hubei province: humanities and social science project(No. 14G524).

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