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Social Physics: An Interdisciplinary Way to Explore the Mechanism of Public Opinion

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1. Introduction

After Conde put forward the idea of social physics nearly 200 years ago, the discipline has experienced such three development phases as classical social physics, modern social physics and contemporary social physics. As an interdisciplinary field, contemporary social physics uses the concepts, principles and methods of natural science to explore, simulate, export, explain and find out social behavior rules and economic operation orders with efficiently extending, properly integrating and rationally modifying (Fan et al., 2006). During the last 50 years, great progress has been achieved in this field.

Public opinion reflects the public on certain social reality and phenomenon in different historical stages, the integration of mass consciousness, ideas and emotion. The subject of opinion is the general public, the object is a particular focus of the community, and the ontology is the tendentious comments or remarks of this focus. "Public opinion comes before the unrest" has become consensus. Before any major social changes happen, there is always an aura from public opinion. During the changes, some oscillations will be caused on public opinion. After the changes, some public opinions will be persisted to guide new social changes as experience, preparation and reference. Public opinion can be viewed as a social behavior of the public and presentation of forming legal or moral restriction. It's helpful to build harmonious society. In contrast, it can also induce social trouble. Therefore, it's very significant to find out rule of opinion formation and evolvement and then guide opinion infection.

Social physics insisted that mechanism of opinion formation and evolution, same as process of common incident, involves latent period, active period and close period. Three main theories, social combustion theory, social shock wave theory and social behavior entropy theory are involved in social physics. When large-scale individuals or group discuss some incident together, it enters active period from latent period of opinion. That indicates that opinion is built step by step and formed at last by integration of local viewpoints with key points from opinion leader. The level of opinion formation during different stages can be quantitatively decided by number, scale and intensity. In the following parts, social physics with three main theories will be applied to study the mechanism of public opinion. Part 2 will briefly review the state of art by focusing on a wide list of disciplines ranging from

sociology, psychology, politics, journalism communication, mathematics, physics and system science. Three theories of social physics will be introduced in part 3. In part4, social combustion theory will be used to study mechanism of opinion formation, social shock wave theory is used for exploring process of opinion evolution, and social behavior entropy theory is used to analyze behavior of participants, mainly opinion leader, in opinion 'Ba' which means a virtual or reality environment.

2. Review of the public opinion under different disciplines

This part will firstly introduce the existing research on public opinion under Social Sciences & Natural Sciences. Social science puts more emphasis on straightforward analysis of social observation and investigation with qualitative description methods. In contrast, natural science focuses more on the mathematics or physics mechanism of opinion with quantitative methods. The latter ways produce more abstract results and may detach research from the actual media events.

2.1 Research on public opinion in the field of social sciences

2.1.1 Research on public opinion from sociological perspective

Sociology is a comprehensive course for studying the social structure, function, occurrence and development through social relations and social behavior (Chen, 1999). From the sociological perspective, research on opinion relates to the effect on the opinion formation from the process of socialization, the impact on the individual opinions from social organizations and social economic structures, and so on. Sociology concerns about the phenomenon of social life (the object of opinion) directly related to people (the subject of opinion), advocates to scan these phenomenon through the integrated and comprehensive perspective (the ontology of opinion). Therefore, there is an essential relationship between opinion research and sociology.

2.1.2 Research on public opinion from social psychology perspective

Social psychology is a branch of psychology to study the social and psychological phenomena of individuals and groups (Sha, 2002). Some scholars directly interpret opinion as the people's social and political attitudes. This definition limits opinion in the scope of research on the society or social activities. Only the subject and ontology of opinion are involved. Research on opinion also concerned about the various social phenomena and problems (the object of opinion) associated with the social and political attitudes besides the above two concerns. That is, different scopes are respectively owned by opinion research and social psychology which focus mainly on psychological development of the social groups.

2.1.3 Research on opinion from politics perspective

Politics concentrates on countries, political parties, classes, the political system, political democracy, political power distribution etc. and explores some regular essence (Wang, 2005). Opinion is defined as the social political attitude, which means that politics can guide social attitude of the civil society (ontology of opinion) and object of opinion is viewed as

the social phenomena and problems of politics. It can be more properly described as that opinion is people's direct or indirect attitude towards government. Opinion reflects the support or opposition of people and affects people's actions and the development of the situation. Politicians usually build a situation in favor of themselves and against the competitors with different opinions. Progressive opinion is often the precursor of the revolution.

2.1.4 Research on public opinion from journalism communication perspective

Communication is a science to study all human communication, development rules and the relationship between communication and society. In short, communication is majoring in how people exchange information with some symbols. Journalism media is very important for reflecting, forming and guiding opinion. To different subject of opinion, media can provide respective help. It accelerates the process of formation and evolution of opinion for the public, and helps to supervise, guide and control opinion for government. "Public opinion", as a classic in communication field, presents a panoramic view for opinion first time and lets people realize the various internal and external relationships among all kinds of opinion phenomena (Lippman, 2006).

2.2 Research on public opinion in the field of natural sciences

2.2.1 Research on public opinion from mathematics perspective

Usually, researchers build some mathematical models and then try to describe, explain, forecast or find out some rules based on analysis of these models. An early formulation of such a mathematical model was given by J.R.P. French in 1956 in order to understand the complexity of group's activity (French, 1956). In 1974, De Groot M. applied Delphi method to build consensus (De Groot, 1974). Lehrer & Wagner regarded rational theory as fundamental condition of modeling for social opinion from justice level to epistemology level in 1981 (Lehrer & Wagner, 1981). Especially, Abelson R., Friedkin N. & Johnsen E. investigated how to achieve consensus or form social opinion from divergent thinking (Friedkin & Johnsen, 1999). This solution can be described concretely as following.

Let n be the number of agents in the group under consideration. Each agent i will not blindly accept or reject another opinion but consider other opinions totally and then form owned viewpoint. That is, opinion of each agent can be modeled by regarding other opinions with different weight value w.

French Model: with discrete conditions, weight value w is constant.

Given the same hypothesis, opinion vector can be denoted with continues condition at time t as

$$x(t) = (x_1(t), x_2(t), \cdots, x_n(t)) \tag{1}$$

Where, $x_i(t)$, opinion of agent i, is a real number. Let w_{ij} be weight of effect on agent i from agent j, then

$$x_i(t+1) = w_{i1}x_1(t) + w_{i2}x_2(t) + \cdots + w_{in}x_n(t) \tag{2}$$

w_{ij} is a variable of time. It relates to $x(t)$ at t.

$$W(t, x(t)) = (w_{ij}(t, x(t))) \tag{3}$$

That is:

$$x(t+1) = W(t, x(t))x(t) \tag{4}$$

This model can be simplified. Assume W is a constant random matrix, then:

$$x(t+1) = Wx(t) \tag{5}$$

The above procedure is the kernel process of social opinion modeling by De Groot and Lehrer.

Based on the model by De Groot and Lehrer, Friedkin and Johnsen consider opinion of agent i lies on two factors. The first one is insistence of owned opinion, described as g_i. The second one is effect from other opinions, described as $1 - g_i$. Formula (2) can be changed as

$$x_i(t+1) = g_i x_i(0) + (1 - g_i)(w_{i1}x_1(t) + w_{i2}x_2(t) + \cdots + w_{in}x_n(t)) \tag{6}$$

With matrix mode, it can be expressed as,

$$x(t+1) = Gx(0) + (1 - G)Wx(t) \tag{7}$$

This is Friedkin & Johnsen Model. The difference between this model and Abelson model is that differential equation instead of difference equation is involved in the latter on. These models often involve matrix theory, Markov chain and graph theory, etc.

2.2.2 Research on public opinion from physics perspective

The Ising model has been well-known to be a simple model providing profound physical significances, which is helpful for discovering principles in our physical world (Zhang, 2007). It has been not only conceived as a description of magnetism in crystalline materials, but also applied to various phenomena as diverse as the order-disorder transformation in alloys, the transition of liquid helium to its suprafluid state, the freezing and evaporation of liquids, the behavior of glassy substances, and even the folding of protein molecules into their biologically active forms.

We consider an Ising spins chain (S_i; $i = 1, 2, 3, \ldots N$) with the following dynamic rules:

if $S_i S_{i+1} = 1$, then S_{i-1} and S_{i+2} take the direction of the pair (i, $i+1$);

if $S_i S_{i+1} = -1$, then S_{i-1} takes the direction of S_{i+1}, and S_{i+2} takes the direction of S_i.

These rules describe the influence of a given pair on the decision of its nearest neighbors. When members of a pair have the same opinion, then their nearest neighbors agree with them. On the contrary, when members of a pair have different opinions, then the nearest neighbor of each member disagrees with him (her).

Deriving from the Ising model, Sznajd model (Stauffer, 2002a, 2002b), Krause-Hegselmann model, Deffuant model (Stauffer, 2005) and Galam model (Galam, 1990, 2003) have also been proposed for opinion dynamics.

2.2.3 Research on public opinion under system perspective

Systems Science focuses on the structure, function (including evolution, coordination and control) and general rules. China's famous scientist Qian Xuesen gathers up and unifies achievements from the different disciplines with a systemic perspective, reveals the general rules and nature of system, and then builds the theoretical basis for systems science. Objective of system science is various types of systems. According to amount of the elements and their different types, as well as degree of complexity of the relationships between different elements, systems are divided into simple system and complex system.

Some scientists have tried to study opinion from the perspective of systems science. For example, Haken H., a famous physicist, proposed viewpoints as order parameter of opinion formation and considered that change in the number of viewpoints (n_+, n_-) is a cooperative effect. Also, he insists that the formation of viewpoint will be affected by the same or the opposite viewpoint. Haken simply divides opinion into two contrary, positive and negative. That means, opinion is viewed as a simple system here.

3. Three theories of social physics

Social physics presents three main theories, social combustion theory, social shock wave theory and social behavior entropy theory (Niu, 2001). Social combustion theory focuses on mechanism of society stability. Social shock wave theory explores spatio-temporal distribution of society stability. Social behavior entropy theory is for essential research on society stability.

3.1 Social combustion theory

Social combustion theory, which carries a reasonable analogy between the natural burning phenomenon and social disorder, instability and turmoil, was proposed in 2001(Niu, 2001). In nature, burning involves not only physics process but also chemistry process. Physics process indicates physical balance conversation of energy, and chemistry process mainly indicates physical change and the related conditions. Burning occurred only if all three basic conditions, namely burning material, catalysis and the ignition temperature or the last straw, exist. That is, any of the three ones is indispensable. The mechanisms of combustion process in nature can also be used for reference during studying on social stability. In detail, the basic cause of social disorder, such as conflict between people and nature and the disharmony between persons, can be viewed as the burning material. The non-rational judgments, malicious attacks by hostile forces and deliberately one-sided interests of the chase will work as catalysis. When both of the above exist, even a small emergency become the ignition temperature or the last straw, thus result in mass incidents with a certain scale and some impact and then cause social instability and discord at last.

This research studies on the mechanism of opinion formation based on social combustion theory. There are wide ranges of attitudes, discussions and demands as a collection of

burning material. The hierarchical structure in ba of the public opinion will create more opportunities to move closer to consensus, which can be viewed as social "catalysis". What ultimately triggers the formation of public opinion is usually an unexpected incident or an authoritative source of speech. That is "the last straw".

3.2 Social shock wave theory

The shock wave is one of the most important phenomena in the high speed of gas movement process. It is the strong compression wave produced by strongly compressed gas, also known as strong inter-section. The thin interruption is called as shock wave(Zhi, 2003). In this thin layer, speed, temperature, pressure, and other physical quantities changes quickly from the wave front value to wave behind value. Also, the gradient of speed, pressure and temperature are great. Therefore, the shock wave theory is not very concerned about the flow in wave, but just explores changes of physical quantities after going through the shock wave.

At present, some ideas are absorbed from the shock wave theory to solve complex social problems (Niu, 2001), especially for those problems with wave phenomena, such as traffic, the flow of people, etc. The crowded can be viewed as a continual medium because any crowd disturbance is spread in the crowd with the form of waves. Besides, due to individual differences, non-linear distortion occurs on waves, which may result in the shock wave, crowded accident.

3.3 Social behavior entropy theory

Social behavior entropy is the essence of social unrest. The entropy theory in physics field is used for preference to explain the composing of group from individuals. There are six principles of social behavior entropy theory (Niu, 2001), namely 1) Universal 'minimal effort' principle, 2) Pursue 'Minimum entropy' principle, 3) Keep 'psychological balance' principle, 4) Sustain 'EQ resonance' principle, 5) social orientation 'was the trend-U' Principle, and 6) Long for social convention that limits any other people except himself.

During the process of public opinion formation and evolution, we may mainly concern with 'psychological balance' principle and sustain 'EQ resonance' principle.

'Psychological balance'principle. If the individual could calm down through persuasion and self-reflection after suffering some unfairness, great help can be provided for the building of a harmonious society. In other words, by persuading the participants can achieve self-acceptance, self-awareness, self-experience and self-control.

Sustain 'EQ resonance' principle. 'EQ resonance' means that only the people who own most respect, reputation or approbate is allowed to play a role for persuading. Whether to the public or to government leaders, an example is very significant.

Individuals always unconsciously follow some of the rules from social behavior entropy theory. Moreover, the above two principles indicate that the individuals prefer to seek the emotional support and the dependence on attitude from opinion leaders. This explained the indispensability of opinion leaders.

4. Studying on the mechanism of public opinion based on three theories of social physics

4.1 To determine formation of public opinion based on social combustion theory

Public opinion during the process of collection and formation is presented with two forms (Liu, 2002), view flow and action flow. With view flow, the public continually express their opinions on some of the social reality and problems to vent their unhappiness. If a high degree of consensus is achieved among the view flows and the demands of the people can not be met, view flow will upgrade to action flow. That is, the individual and unprompted actions become organized and purposeful campaign, to promote the mass outbreak of emergencies. The critical point of opinion formation is the moment when view flow upgrades to action flow.

Some of the social injustice invoked a psychological dissatisfaction of people, which plays an important role in preparation for the opinion formation. Those voices of appeal and cumulative negative effects, and so on, can be viewed as burn the material from the people's suffering. Besides, some sensitive words, such as 'the rich', 'money', 'official'' and 'corruption' etc. will work as catalysis of pricking up public discontent (Liu et al, 2008). With the above to preconditions, even a small event can play a role of the last straw. At this moment, the three conditions of opinion formation are in place and a consensus of opinion has been reached. Without active response, the mass incidents leading to crimes against property and social stability will eventually happen.

As a result, research on opinion formation should focus more on the mass incidents caused by the day-to-day events, analyze the opinions against social order and stability derived from public debate or views through continual friction and integration, and then give a correct guidance or even destroy this destructive force in a timely manner to avoid unexpected incidents and protect the security of the people and society property. As an important part of early warning system, public opinion research will take a prediction role through the grasp of opinion formation mechanism.

4.2 To simulation evolution of public opinion based on social shock wave theory

4.2.1 Concept modeling for qualitative analysis

Qualitative analysis produces scenarios or hypotheses for the complex problems, i.e. to expose some qualitative relations or structures of the concerned problems. Opinion represents diffusion of the explicit awareness and presents ups and downs state. According to the different ability of people, there are different reactions. Wave ups and downs are exhibited because of the gap produced from different strength of evolution. One conceptual model of opinion diffusion is proposed as below.

Hypothesis: there are N opinion subjects, each of them owns viewpoint o_i where $i = 1, 2, \cdots N$. The three basic elements of opinion infection involves {σ change of public behavior E environment of opinion infection t time of opinion infection}, as following,

$$Y = F(\sigma, E; t) \qquad (8)$$

where, Y is speed of opinion infection on some social phenomenon or event.

Opinion diffusion is the process of choosing or being persuaded of each individual. Participants (or part of them) get agree on behavior finally. Therefore, the law of gravity can be referred to reflect change of individual behavior between moment t and $t+1$ due to interaction. That can be expressed as,

$$\sigma_i = \sum_{j=1}^{N} k \frac{o_i \bullet o_j}{d_{ij}^{\alpha}} \tag{9}$$

where k is the constant coefficient, d_{ij}^{α} represents the distance between the individual i and individual j, α is the parameter of power, $o_i \bullet o_j$ describes the consistency between the individual i and individual j.

If $o_i \bullet o_j > 0$, individual i has the same viewpoint as individual j, then individual i will hold the original viewpoint.

If $o_i \bullet o_j < 0$, individual i has the opposite viewpoint to individual j, then, we can take following two conditions:

when $\sigma > 0$, individual i will hold the original viewpoint.

when $\sigma < 0$, individual i will change its proposition.

4.2.2 Multi-agent modeling for quantitative simulation

Of course, having an explicit concept model with mathematical expression does not mean at all that one has explicit mathematical answers. With the development of complex adaptive systems theory, artificial life and distributed artificial intelligence technology, MAS (Multi Agent Systems) provides a good approach to address these issues. Agent (intelligent subject) is abstracted from the study of specific entities, which has their own initiative behavior, and is a 'live' individual. Through establishing different decision-making rules for agents, a simulation model can be set up. In this paper, we use multi-based modeling to simulate the agents' behaviors with different interactive strategies to understand the dynamics of public opinion.

During opinion diffusion, the behaviors of the participants can be classified as 'conformity', 'power' and 'egoism'(Liu & Gu, 2008; Liu et al, 2009). In detail, 'conformity' involves more psychological factors. Participants are fear of loneliness and obey to majority. 'Power' mainly involves the moral values. Whether power or prestige is decisive factor, which is especially important in China. 'Egoism' is driven by people's values. For some benefit, people may even change their words and deeds. Therefore, the 'conformity', 'power' and 'egoism' are fundamental for the establishment of opinion infection simulation rules. Three transfer rules of opinion can be defined as following:

- The 'conformity' rule: ask all their neighbors for their opinion, and then follow the arithmetic average of them.
- The 'power' rule: convince all neighbors particularly if two neighboring agents have the same opinion.

- The 'egoism' rule: each agent select one discussion partner at one time step. If their opinions differ by less than the confidence bound, their two opinions mutually get closer without necessarily agreeing completely.

Simulation 1: Hypothesis, when $t = 0$, the number of opinion subject (agent) is $N = 10000$, there are $n = 5$ types of viewpoints, and the transfer probability is $p_{O_{ij}} = p_{O_{ji}} = 0.1$, a_{pi} is a random real number between 0 and 1. We require that only people with similar opinions talk to each other, namely, agents with viewpoint 1 can be talk with viewpoint 2, but can not be contact with viewpoint 3, 4, 5, if we defined the bounded is 1. The initial random spatial status can be described as figure 1.
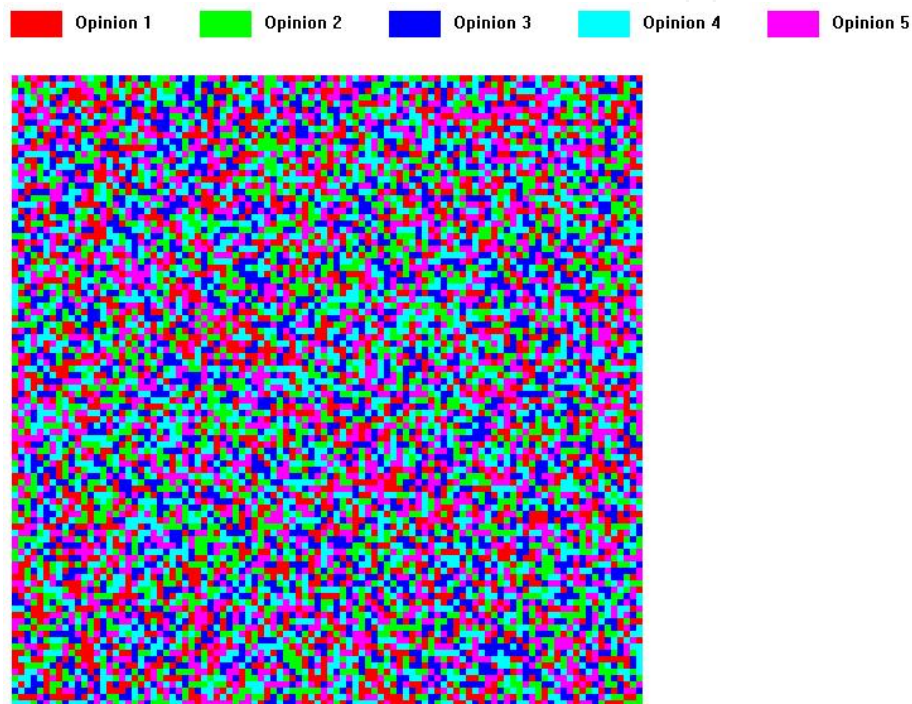
Fig. 1. Initial random spatial status of agents' distribution

According to the above conditions, with different rules of opinion transferring, respective results can be captured at $t = 5$ as shown in figure 2 (a), (b) and (c).
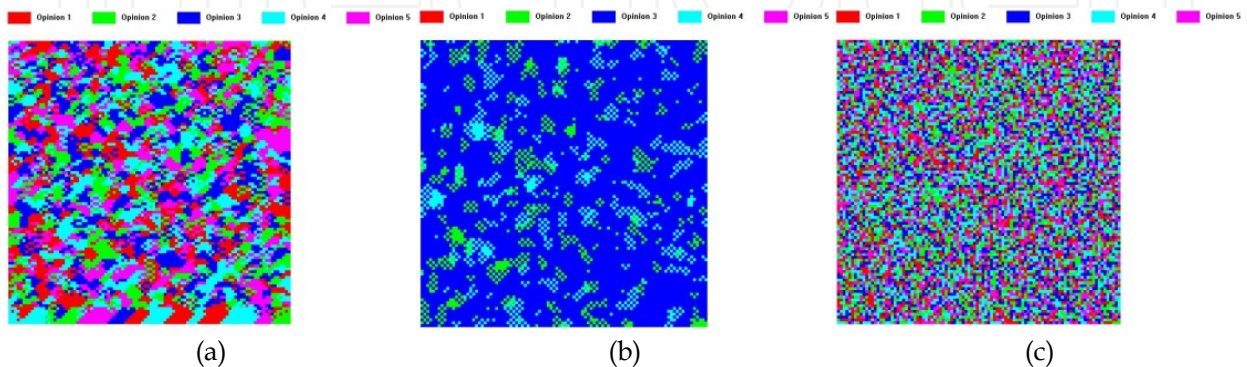

| (a) | (b) | (c) |

Fig. 2. when $t = 5$, (a) is the agents' distribution with "power" rule , (b) is with "conformity" rule and (c) is with "egoism" rule.

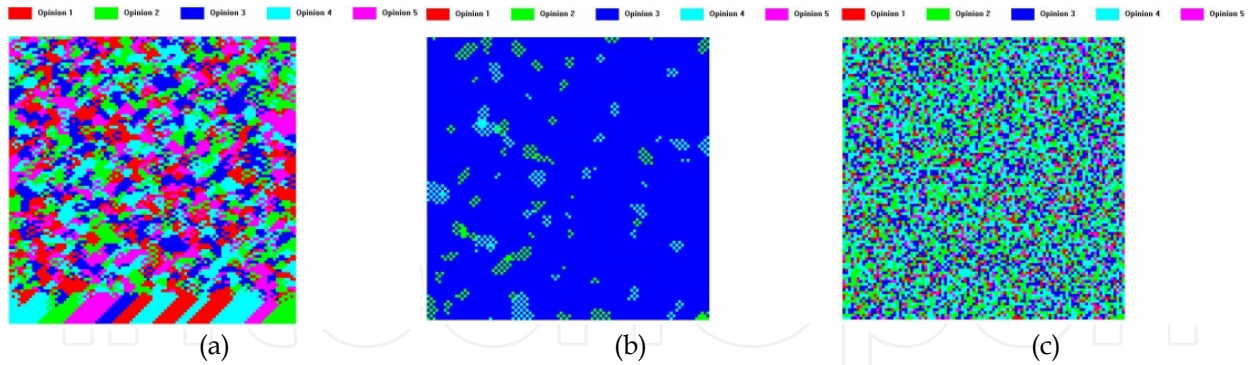When t =10, the corresponding status is described as figure 3 (a), (b) and (c).

(a)   (b)   (c)

Fig. 3. When t =10, (a) is the agents' distribution with "power" rule , (b) is with "conformity" rule and (c) is with "egoism" rule.

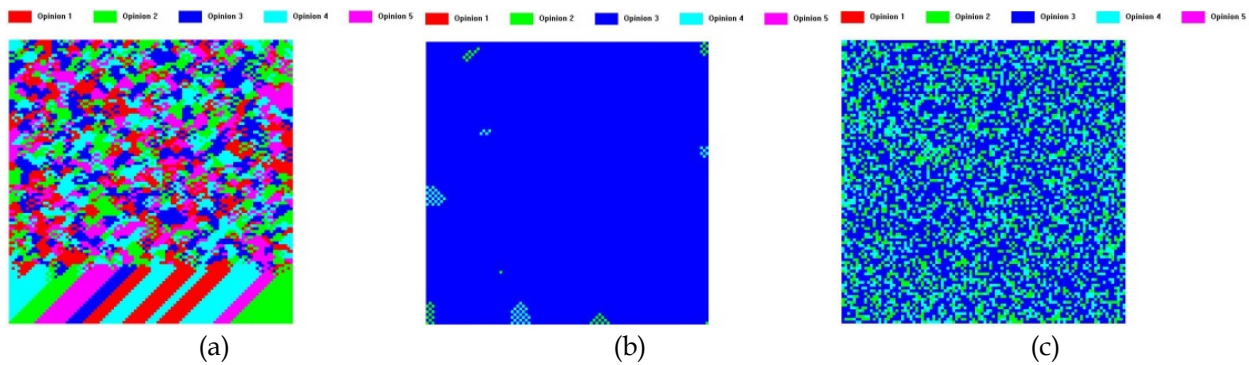When t =20, the corresponding result is shown as figure 4 (a), (b) and (c).

(a)   (b)   (c)

Fig. 4. When t =20, (a) is the agents' distribution with "power" rule , (b) is with "conformity" rule and (c) is with "egoism" rule.

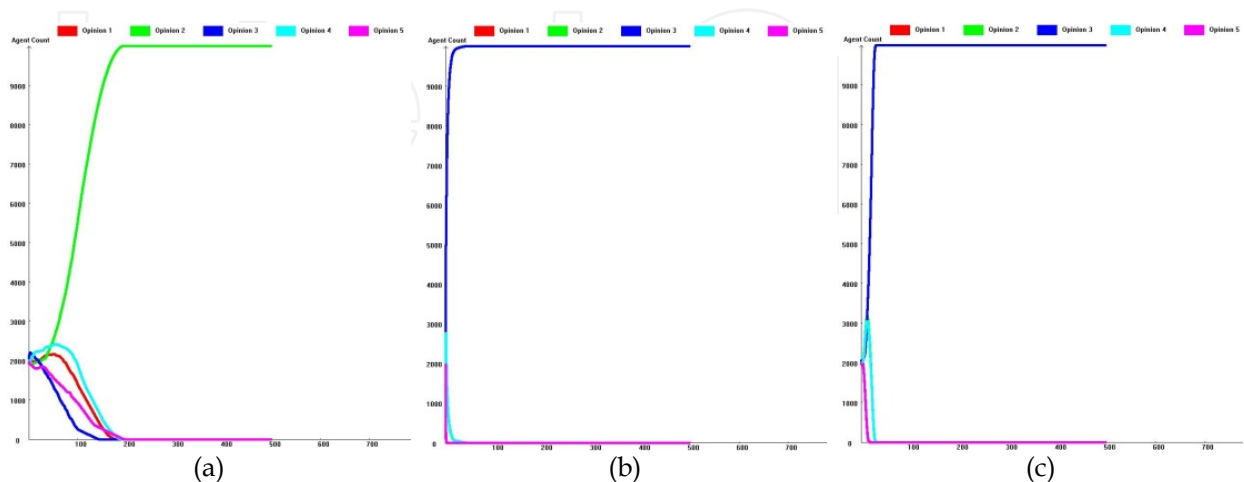Above are the opinions' spatial scenarios, figure 5 (a), (b) and (c) can be found whose temporal evolution process.

(a)   (b)   (c)

Fig. 5. From t =5 to t =20, five opinions temporal evolution process, (a) is the agents' distribution with "power" rule , (b) is with "conformity" rule and (c) is with "egoism" rule.

Simulation 2: Hypothesis, most conditions are same with the simulation 1, only in $N = 10000$ agents, triplicate individuals, namely $N_1 = 3333$, are prefer to "power" rule, $N_2 = 3333$ stand to "conformity" rule, rest of the N adhere to "egoism" rule. The initial random spatial status also be described as figure 1. Figure 6 (a) and (b) respectively show the spatial status when $t = 50$ and $t = 100$, consensus formation can be captured at $t = 500$ as shown in figure 7. Temporal evolution process can be seen in figure 8.

(a)   (b)
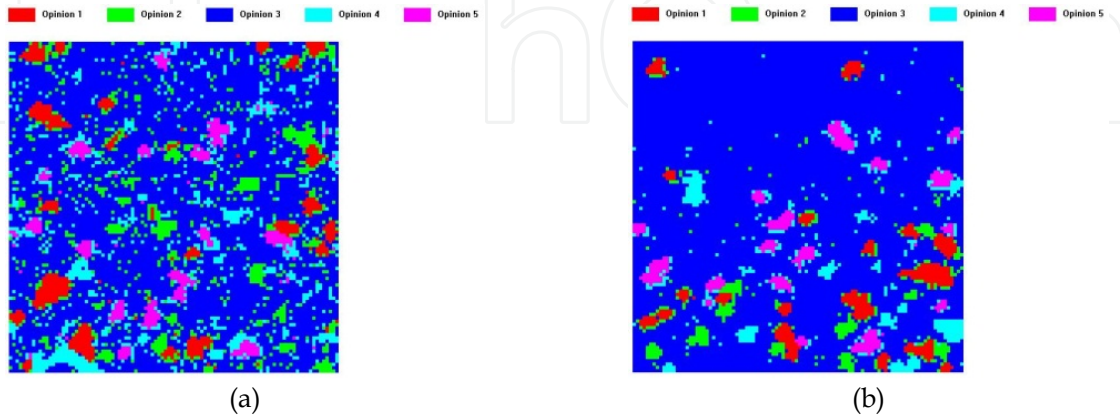
Fig. 6. (a) is the agents' distribution when $t = 50$, (b) is the agents' distribution when $t = 100$.
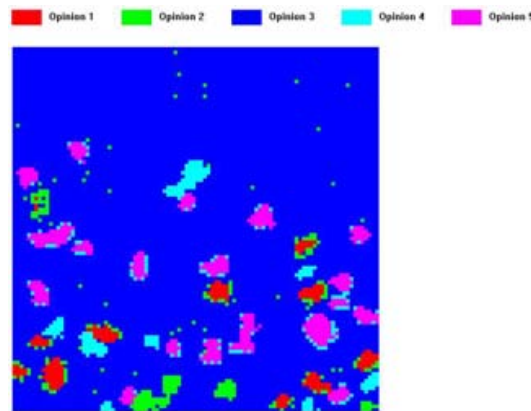

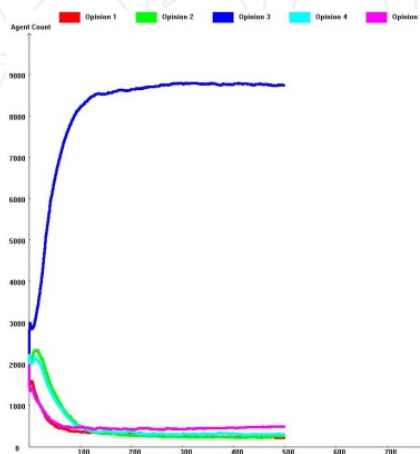Fig. 7. Agents' distribution when $t = 500$

Fig. 8. From $t = 50$ to $t = 500$, five opinions temporal evolution process

Based on the above simulations and analysis, some conclusions can be drawn as following.

For the simulation 1:

With the 'power' rule, given opinion subjects (agents) holding five viewpoints, the viewpoint supported initially by more agents will get agree among more and more participants during opinion dynamics. In the scenarios of this paper, the viewpoint 2 with green color dominates the process of opinion diffusion.

With the 'conformity' rule, an opinion subject (agent) will continuously get average value between the five viewpoints. Trend of opinion diffusion is able to be determined by viewpoint 3.

With the 'egoism' rule, viewpoint of each agent will be transferred depending on corresponding probability when meeting agents with same or different viewpoint. The process of evolution is slower than "conformity" rule in the same simulation steps.

For the simulation 2:

During the simulation steps, though viewpoint 3 is the consensus tendency in five viewpoints, but evolution speed is slowly than single preference by all the agents.

4.3 To recognize opinion leaders based on social behavior entropy theory

Hegselmann etc al. (Hegselmann & Krause, 2002) figured out that opinion can be formed in a group as small as a few experts or as large as in the whole society. Based on this viewpoint, 4.3.1 of this paper will use meta-synthetic approach (MSA) and expert mining (EM) to identify and judge "expert leaders" during the process of experts argumentation. In 4.3.2, social network analysis (SNA) will be involved to find out the "opinion leaders" during the opinion formation and evolution over network.

4.3.1 Recognizing opinion leaders in a group

4.3.1.1 Meta-synthetic approach and expert mining

Meta-synthetic Approach(MSA), proposed by a Chinese system scientist Qian Xuesen (Tsien HsueShen), is one of the system methodologies to tackle with open complex giant system (OCGS) problems from the view of systems in the early 1990s (Qian et al, 1990). Here, we regarded OCGS problems such as social public opinion as ill-structured or wicked problems. This approach expects to unite organically the expert group, data, all sorts of information, the computer technology, and even scientific theory of various disciplines and human experience and knowledge for proposing hypothesis and quantitative validating. Later it is evolved into Hall of Workshop for Meta-Synthetic Engineering (HWMSE) which emphasizes to make full use of breaking advances in information technologies (Gu & Tang, 2003, 2005).

Expert mining (EM), as a new mining method, is put forward based on the meta-synthetic approach (Gu et al, 2008). This method emphasizes expert experience, ideas and wisdom mining. It is not built on the basis of mass data but in a smaller group of samples based on the thinking of experts to conduct in-depth experience in mining. This method is also different from those based on artificial intelligence-based expert system because it focuses

more on people - machine, human-oriented to people's wisdom and the wisdom of the main groups. Mining expert system methodology, which combines science, scientific thinking and knowledge of scientific theories and makes full use of modern computer technology, is the development of the former theory and technology.

This section tries to identify and judge expert leaders by expert leader judgment module with guidance of MSA and EM.

4.3.1.2 Hall for workshop of expert argumentation and expert leader judgement module

Based on MSA, expert mining method and knowledge creation model, the Hall for Workshop of Expert Argumentation is to provide a distributed computer platform. On which, participants bring out new ideas and knowledge through communication and collaboration (Tang & Liu, 2004; Liu & Tang, 2005). The Hall integrates proposals and views from experts to build solution and compute quantitatively degree of centralization and consensus.

Aiming to the discussion topic, the Hall for Workshop of Expert Argumentation expresses the registered ID (shown in rectangular box) and keywords (shown in ellipse box) as a visualized two-dimensional map, as shown in Figure 9, The experts owning high degree of concerns will be centralized. This provides a new way to share knowledge and solve unstructured problems.

Discussion space is a joint thinking space for the participants. Via the 2-dimensional space, the idea association process to stimulate participants' thinking, idea generation, tacit knowledge surfacing and even wisdom emergence is exhibited based on the utterances and keywords from participants. The global structure and relationships between participants and their utterances are shared by all participants in the session. It helps the user acquire a general impression about each participant's contributions toward the discussing topic, and understand the relationships of each thinking structure about the topic between participants.

The expert leader judgement module of the Hall for Workshop of Expert Argumentation constructs the consistent matrix based on the sameness and difference of keywords from all participants. The largest eigenvector will be computed to achieve sort of speaker. The sort can also be used to exhibit contribution of each participant. The matrix A can be expressed as,

$$a_{ii} = |U_i| \text{ and } a_{ij} = |U_i \cap U_j|, i \neq j . \tag{10}$$

Where, U_i represents the set of keywords from No. *i* participant.

After discussion, participants will be evaluated to help analyze quantitatively discussion result and try to find out key speaker based on effects on group from each participant. Those key speakers are "opinion leader".

Example: The Xiangshan Science Conference (XSSC, website: www.xssc.ac.cn), which is initiated in 1993 in similar to Gordon Research Conferences and denotes as the general designation of a series of small-scale academic meetings which bring together a group of scientists working at the frontier of research of a particular area and enable them to discuss

in depth all aspects of the most recent advances in the field and to stimulate new directions for research, is a top-level science forum for interdisciplinary and cutting-edge studies and can be viewed as a platform for knowledge sharing and creation in China. Next we apply our tool to analyze Xiangshan Science Conference.

Figure 9 shows the process and result map of analyzing 'the brain, consciousness and intelligence' topic with experts meeting system. Detail of design and development of the system will not be explained here. Figure 9(b) is different from Figure 9(a) because one new expert ('Pan Yunhe') is added into the discussion. But the two maps own the same character that the expert 'Wang Yunjiu' locates at the center of the discussion. That indicates that he actively involved in the 'brain' research field and relative meeting. This result can be verified by the record in text mode from Xiangshan Conference.
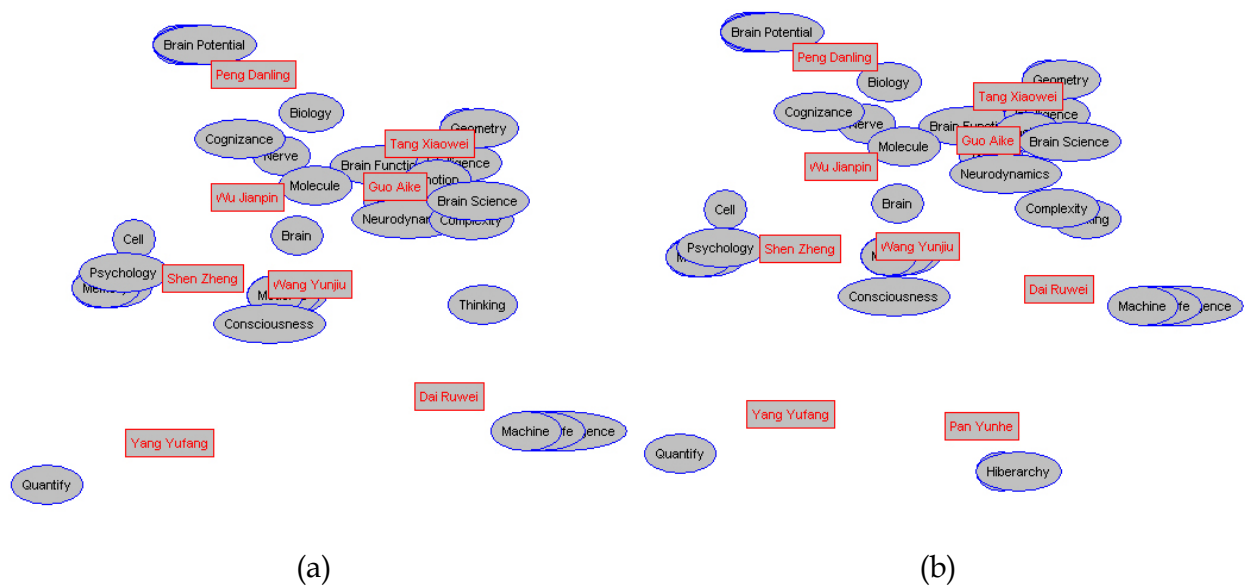

(a)   (b)

Fig. 9. Two-dimensional Distribution of Participants and Keywords

Table 1 lists the evaluation of participation based on agreement and discrepancy matrixes. It is shown that user 'Guo Aike' holds highest rank based on both eigenvectors, which may be justified by his active role as one of chairpersons or plenary speech contributors among those conferences, which furthermore exposes his big influence in neuroscience field in China.

Maximum eigenvector of agreement matrix:	(0.3761, 1.0914, 0.3082, 0.6179, 0.2522, 0.3618, 0.3125, 0.1937, 0.1092)
Rank of the top five participants:	Guo Aike > Wang Yunjiu > Tang Xiaowei > Peng Danling > Dai Ruwei

Table 1. Evaluction of 9 Participantions

Due to less staff and simple content, Prof. Guo Aike can not be defined as 'opinion leader'. Instead, 'leader expert' is better. However, such a new idea builds an important basis for research of identifying "opinion leader".

The social network analysis proposed in the following section of this article can be used to identify "opinion leaders" from a large scale of participants.

4.3.2 Detecting opinion leader in the society

4.3.2.1 Social network analysis

Social network analysis (SNA), as a new paradigm for sociological research (Scott, 2007), is proposed in 1930s and enhanced in 1970s. This article intends to detect the 'opinion leaders' by this method. In fact, the opinion leaders are those special individuals who appear during the formation of opinion from microcosmic individual actions to macroscopical group behavior.

'Social network' refers to the social actors and the collection of the relationship between different actors. That is, a social network is a collection of a number of points (social actors) and the connection between the points (the relationship between actors). "Social network" emphasizes that each actor has a certain extent relationship with other actors. Social network analysis build models for these relationships, try to describe the structure of relations between group members and study the effect on group and individual from this structure.

Social network analysis can be used to identify quantitatively the 'opinion leaders' because this approach has exactly described the relationship between the subjects of opinion in a very good way. In which, the social network position refers to a series of individual actors who have the similar characters in social activities, relationship and interaction located in the same relationship network, network factor refers to combination of relations to link the social positions and mode of the relation between the actors or positions.

Some other concepts such as point, edge, degree, betweenness, cutpoint, component, subgroup and centralization and so on are involved in SNA. During the formation and evolution of opinion, this article particularly concerns the 'cutpoint'.

4.3.2.2 Cutpoint in the SNA as the opinion leader

In graph theory, the only one point connecting two sub-graphs is called as cutpoint. The cutpoint is very important because its absence will divide network into independent segments named after block. Such a point is important to not only network but also the other point, that is, cutpoint plays the "opinion leaders" role among the subjects of opinion.

Example: A series of serious terrorist attacks occurred in the in the eastern part of United States at September 11, 2001. With this incident, World Trade Center in New York, the Pentagon where U.S. Department of Defense locates in Washington and some other important buildings had been attacked and heavy casualties were caused. By the later survey, this is an organized and purposeful terrorist activity against the interests of the people, the U.S. security and even world peace. After that, not only the United States governments but also experts around the world analyze this incident in-depth for getting more meaningful and valuable information and forecasting such terrorism. Figure 10 (website: http://www.orgnet.com/tnet.html) shows the social network analysis of key man of 9 • 11 terrorist events.
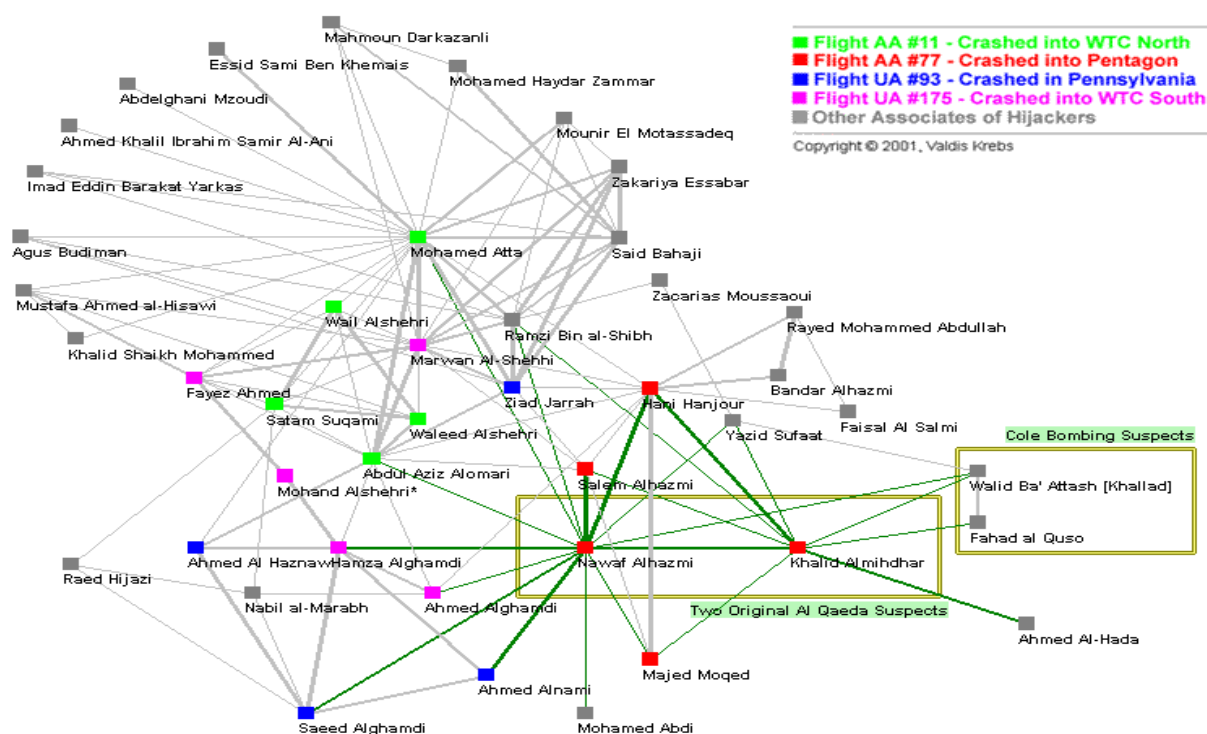
Fig. 10. Social network analysis of participants of 9 • 11 terrorist events

This case is involved here to indicate that social network analysis is a good method and technique to identify the "key persons". Analogously, opinion leader can be easily identified in a war of opinion through the "cut point" algorithm if the network topology of opinion subjects had been built out.

5. Conclusion

This paper tries to explore the mechanism of public opinion with perspective of social physics. Firstly, the research points out that public opinion are arisen by the herd behavior under the paroxysmal events, and then formed by the mass incidents based on social combustion theory. The development process is an important opportunity to catch essence of public opinion formation, which is useful for building a quantitative method to predict the herd behavior under the paroxysmal events and mass incidents. Then, opinion dynamics is explored and one kind of concept model and some simulate demonstrations based on social shock wave theory is produced. Such a kind of work aims to provide different perspectives for some systemic solutions instead of traditional ways toward social issues (topics about opinion). Forming of qualitative scenarios or hypotheses through concept modeling is the foundation for understanding the opinion's complex structure, simultaneously, multi-agent modeling as a core quantitative activity is also used to describe and analyze opinion's simulations based on assumptions. Finally, the public continually look for the emotional support and depend on opinion leaders due to the 'psychological balance' and 'emotional resonance' principles based on social behavior entropy theory. That is the root cause of generation of opinion leaders. MSA and SNA are studied to identify the

opinion leaders and master their behaviors and traces for further exploring the nature of opinion and then effectively controlling and guiding opinion.

According to result presented in this paper and previous research, it can be summarized that the key value of opinion is from its prediction and alert function as a way to guide opinion infection, to get full, harmony and sustainable development of society. Of course, lots of further works are still under exploration. This paper only proposed two scenarios, more detailed simulation will be strengthened, three rules will be further explored in-depth, and the simulation platform for opinion diffusion will be gradually improved, etc. All which aim to explore more new perspectives, methods and ideas on public opinion, and provide theoretical and methodological support for building harmonious opinion society.

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