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2016
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Summary Sheet

Information Flow Simulation Based on the Complex Network

Summary

With the rapid development of global internet, how to measure the evolution and influence in society's information network is becoming a hot issue. This paper aims to build models to analyze the evolution and relationship between spread speed and qualified news.

Task (a): a formula is given to define qualified news. ***Local Regions Network*** for early three periods and ***Global Network*** for lately two periods are build respectively to show the evolution process based on consideration of different features in these 5 periods.

Task (b): percent of different information sources in 2012 year is predicted by ***Time Series*** model. Based on global network model in (a), ***a Random Graphic model*** with formula for nodes and edges is constructed by Monte-Carlo simulation to predict today's communication situation, the relationship between spread speed and qualified news displays that the averaged relative error between reality and prediction is nearly 8.9%.

Task (c): ***Time Series model*** is used again to predict the ratio change of information sources in 2050. re-calculated the numbers of diffusive nodes and time, the network capacity to describe speed and qualified news can be obtained. In addition, two index of ***averaged shortest distance*** and ***connected strength*** in 2050 show that the communication capability increase 25.81% and 23.22% than in 2012.

Task (d): delivery probability for information with and without public guidance are formulated respectively. ***Degree of Approval***, defined as the proportion who agree with a piece of information, is used to measure the change caused by public interest. Curves shows that lower initial approval degree will tend to more less but higher initial approval degree will increase to 1.

Task(e): Four factors that we should discuss are divided into two classes. Using model in (b), we found three factors of information value, messageąŕs form and the topology of network would speed up the information spreading. Using model in (d), we found the factor people's initial bias would influence public opinions.

Keywords: Information network; Communication capability; Time series;

1 Introduction

1.1 Background

The communication was limited much when it was face-to-face in the past. And the appearance of mass communication as a newly-developing method transferring information marks the arrival of Mass Media era. The mass communication can not only overcome the physical limitations present in face-to-face communication, but also accelerate the speed of information transmission. Hence, as mass communication evolved from a mechanical process to electronic transmission, the speed of information transmission is becoming more and more quickly.

Technological advances made possible newer forms of media. And all the forms of media constitute the communication network that becomes more complex and advanced with the development of times. In addition, the communication network reflecting paths of information transmission implies the scientific and technological level of the age.

Therefore, it is necessary to build a Communication Network to reflect the process of information transmission. Moreover, the relationship between speed of information vs inherent value of information can be analyzed based on the network, which can be used to spread information and influence public opinion.

1.2 Problem Restatement and Analysis

From the global aspect, the supervisor requires writers to analyse the relationship between speed/flow of information vs inherent value of information based on consideration of 5 periods, which is the mainly assignment of this question.

From the partial aspect, the requirements of Task A are developing models to explore the flow of information and find what qualifies as news, which are actually to confirm the definition of speed of information and inherent value of information. With the definition confirmed, it is possible to analyse the relationship between speed and inherent value. Hence, the difficult points of Task A are how to confirm the indexes used to measure the inherent value and the speed of information.

Task B requires us to validate our model's prediction capability, for which the comparison between reality and prediction can be used. For the sake of confirming the prediction capability of our model more accuracy, the difficult point of this task is confirming what to be used to show the comparison result. The analysis of Task C is the same as Task B.

The assignment of Task D is to explore how public interest and opinion can be changed thought information networks in today's connected world. The key point of this task is the public interest and opinion should be added into the model already builded previous.

Task E needs us to determine how the factors involved can be used to spread information and influence public opinion. And the difficult point of this task is to confirm the way the factors use to spread information and influence public opinion.

2 Bold Assumptions

- Regardless of the technology innovation;
- Regardless of the people's birth or death in the information network;

- Regardless of the migration.

Under the bold assumptions proposed in the paper, the occupation distribution method and the multiplex model can be designed later.

3 Symbol Description

In the section, we define some symbols when constructing the model as follows.

Table 1: Symbol Description

Symbol	Description
$\omega(t)$	The inherent value of information.
β	The forwarding rates of information.
$v(t)$	The speed of information.
d	The average shortest instance.
w_{ij}	The connected strength.

P.s: Other symbol instructions will be given in the text.

4 Task A: News definition and information network construction

According to the requirements of Task A, finding what qualifies as news is actually confirming the inherent value of information. And the information with higher inherent value is more likely to be news. In addition, having considered about the possible connection between the speed of information and the inherent value of it, the inherent value should be confirmed at first.

4.1 The definition of the qualified value information

There are many kinds of information around us, but news not equals to information. Only the information with higher inherent value has the qualification as news. Hence, ***news can be defined as those information with high qualified value***.

When it comes to the qualified value of information, three important factors relating to it that is time, information capacity and the preference degree of people, should be taken into seriously account.

Firstly, timeliness is an important characteristic of news. For example, information about recent events is more likely to be news than what happened long ago. And the real situation is the longer transmitting time is, the less inherent value of information is. Hence, the relationship between time and inherent value can be described as the formula listed below:

$$D(t_0, t) = e^{-\alpha(t-t_0)} \tag{1}$$

where t denotes time; t_0 stands for the happening time of event; α means an adjustment coefficient.

Besides, there is a close connection between the inherent value of information and information capacity it contains. Referring to reference, information capacity[5] is described as the

formula:

$$I = -\log_2 P \tag{2}$$

where P represents the happening probability of the event within information.

Moreover, information involving events which have the preference of people has a bigger possibility to be news. Having considered about the appearance of the internet, *searching heart* based on the ***Google Trends*** is adopted to represent the preference degree of people for information.

Therefore, the inherent value of information can be defined by these three factors, namely, ***time, information capacity and the preference degree of people***. And its formula is listed as Equation 3.

$$\omega(t) = \frac{D(t) I}{R} \tag{3}$$

where D is the relationship between time and inherent value; I is information capacity; R is the preference degree of people, which is a given value during the diffusive process of information

4.2 The definition of spread speed

Only when there is the flow of information in the communication network, there will exist the speed of information. However, the speed of information depends on whether individuals receiving information transmit it to others or not. Therefore, before confirming the definition of the speed of information, the forwarding rates of information should be defined at first.

In the communication network established by considering individuals as nodes, the retransmission of information drives the flow of information within the network. For example, if a individual who receives a piece of information transmits it to other individuals, this information can continue to flow in the network, otherwise, it will stop at the individual and cannot flow in the whole network. This phenomenon can be demonstrated by **the forwarding rates of information**. And its calculation formula is listed below:

$$\beta = k\omega(t) \tag{4}$$

where k is an adjustment coefficient; $Value_{news}(t)$ is inherent value of information.

After the retransmission of information driving the flow of information, it is possible to explore the speed of information. Furthermore, the speed of information relates to the range it spreads in a certain time. Consequently, in networks with the same scale, that is to say, the number of nodes in the networks is identical, the speed of information can be described by the reciprocal of the consumption time when the range of information transmission reaches $C(t)$. And the equation of it is drawn below:

$$v(t) = \frac{C(t)}{t} \tag{5}$$

where t denotes the diffusion time when the range of information transmission reaches $C(t)$.

4.3 Local region network model for early periods

For sake of understanding the relationship between speed of information vs inherent value of information, the communication network model must be given at first. However, if the model is established by considering individuals as nodes, there will be billions of nodes in the

network, which goes against the analysis on the network. Moreover, having considered about the purpose, measuring the evolution and influence in society's information networks, it is reasonable to extract the mainly topology from the real information network to construct the communication network model needed.

Taking the characteristics belonging to the mass media in 5 periods into account, the communication network models of 5 periods can be divided into two types, one of which contains the previous three periods i.e. early periods from about 1870s to 1990s and the other contains the last two periods, ie. lately periods from 1990s to nowadays.

The mainly mass communications in the previous three periods are newspapers, radios and televisions. Having considered about the characteristics of these mass communications, a bold assumption that is not considering about the direct information transmission between two regions can be adopted into this model.

According to the network theory, the nodes are considered as individuals and information sources as well as using edges to describe the paths of information transmission. Although the communication networks in the previous three periods use same construction method, there are some differences in each specific network. For example, there is only one mainly information source belonging to the network in the first period while the network in the second period has two mainly information sources. And the number of users using each mass communication differs from each other in the three periods.

For simplicity, suppose there are $i\,(i = 1, 2, \cdots, m)$ regions involved in an information network, and there are $j\,(j = 1, 2, \cdots, n)$ individuals in every region. Therefore, we are considering a common information network with a size of $m * n$.

Afterwards, three networks are drawn in Figure 1.

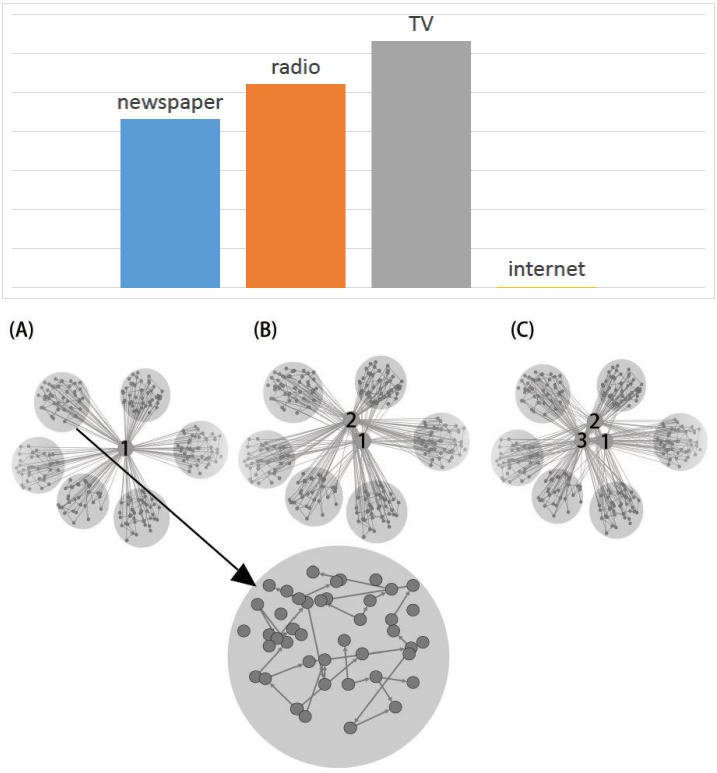

Figure 1: *Local region network model for the previous periods*

From Figure 1, the three charts describe the information communication situations in the previous three periods. Chart A is the communication network in the first period and newspaper is the only one information source in this network. Chart B is the communication network in the second period and the information sources of it are newspaper and radio. Chart C is the communication network in the third period and there are three information sources including newspaper, radio and television. Moreover, the quantitative relation of three medias is shown in the column chart. In addition, the edge between two nodes in each of the three charts shows the path transferring information. In addition, individuals in each region can receive information from the information sources and exchange their information to each other face-to-face in their region. Besides, the individuals receiving information from the information sources maybe not contain all individuals. Moreover, arbitrary two different regions cannot exchange information to each other and information sources are independent and have no information transmission.

4.4 Global network model for lately periods

With the rapid development of internet technology, the information is spread quickly from one point to any corner of the world by the way of current tech-connected communication network. Except the faster speed of information flow, the source of social media such as intelligent cell phones, wireless internet, Tv and so on becoming variety greatly. In addition, the new form of media in the last two periods allows the information transmission between arbitrary two different regions. that means, the original separated regions have been united to be a whole space, every person is possible to spread the news to the other one within this space at a certain probability.

However, the original mass communications still exist which make the network more complex and comprehensive in these two periods.

Having considered about the characteristics belonging to the mass communications, the communication networks in the last two periods are actually the evolution of that in the third period. Therefore, taking all the factors with respect to the mass communications in the last two periods into account, the communication networks in these two periods can be drawn in Figure 2.

From Figure 2, this chart reflect the global network model in the last two periods. The digits from 1 to 3 represent the connection between information resource and nodes in regions, which show the paths of information by newspaper,radio and TV. And the digit 4 stands for the connection between the regions, which shows the paths of information by the internet. Moreover, the quantitative relation of three medias is shown is the column chart.In addition, the communication networks are established by considering individuals and information sources as nodes while the connections between individuals and individuals as well as information sources are regarded as edges. Besides, there is no link in the information sources. Thus the edges reflect the information transmission paths in the network.

5 Task B: information communication situation prediction for today

5.1 The prediction of the usage rate belonging to each media

In this section, we use the data attached on this problem:
http://www.people-press.org/2012/09/27/section-1-watching-reading-and-listening-to-the-news-3/, to determine the use ratio of main social media. The data after process is shown in

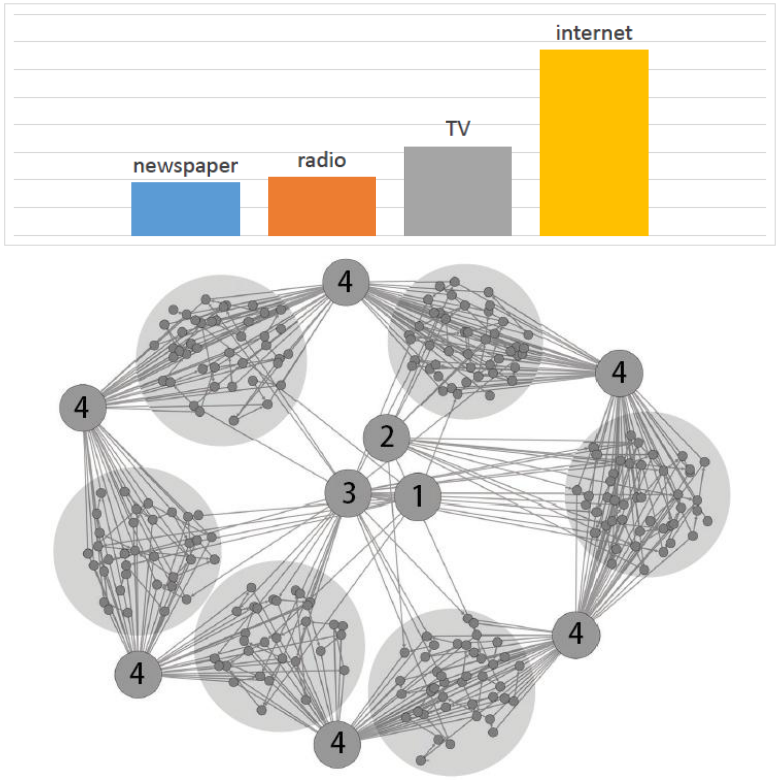

Figure 2: *Global network model for the last two periods*

Table 2, which tells us how much percentage of newspaper, radio, television and online phone to get news.

Table 2: The usage rates of radio, TV and newspaper in America

year	1991	1993	1996	1998	2000	2002	2004	2006	2008	2010
Radio	0.54	0.47	0.44	0.49	0.43	0.41	0.40	0.36	0.35	0.34
TV	0.68	0.72	0.59	0.59	0.56	0.54	0.60	0.57	0.57	0.58
Newspaper	0.56	0.49	0.50	0.47	0.47	0.41	0.42	0.40	0.34	0.31

The data provided by the website:
http://www.pewinternet.org/2014/02/27/part-1-how-the-internet-has-woven-itself-into-american-life/, to determine the use ratio of main social media. The data after process is shown in Table 3 and Table 4, which tells us how much percentage of computer and smart phone to get news.

Table 3: The usage rates of computer in America

year	1990	1995	2000	2005	2010	2014
Computer	0.42	0.55	0.62	0.72	0.77	0.81

The usage rate of each media determines the number of nodes connecting to the information source within the communication network. Hence, confirming the usage rate is very important to construct communication network.

The prediction of year 2012 based on the model already constructed is used to represent

Table 4: The usage rates of smart phone in America

year	2011	2012	2013	2014
Smart phone	0.35	0.45	0.56	0.58

that of today. ***Time series model*** is used for prediction. In addition, the Second Exponential Smoothing Method, a rule of thumb technique for smoothing time series data[6], is used to predict the usage rate of each media for the year 2012 based on the data already searched previous. And the calculation formulas are listed below:

$$\begin{cases} S_t^{(1)} = \alpha y_t + (1-\alpha) S_{t-1}^{(1)} \\ S_t^{(2)} = \alpha S_t^{(1)} + (1-\alpha) S_{t-1}^{(2)} \end{cases} \tag{6}$$

where $S_t^{(1)}$ denotes the smoothing value of one-time index; $S_t^{(2)}$ stands for the smoothing value of two-times index.

When the time series, $\{y_t\}$, has straight line trend from a period, the model of straight line trend which can be used to predict under the circumstance is listed below:

$$\hat{y}_{t+m} = a_t + b_t m, m = 1, 2, \cdots \tag{7}$$

$$\begin{cases} a_t = 2S_t^{(1)} - S \\ b_t = \frac{\alpha}{1-\alpha}\left(S_t^{(1)} - S_t^{(2)}\right) \end{cases} \tag{8}$$

Therefore, according to Equation (6) (7) (8), the result of the usage rate can be predicted. For the sake of validating the model's reliability, taking the real value and predictive value of usage rate into a same table shown in Figure 3.

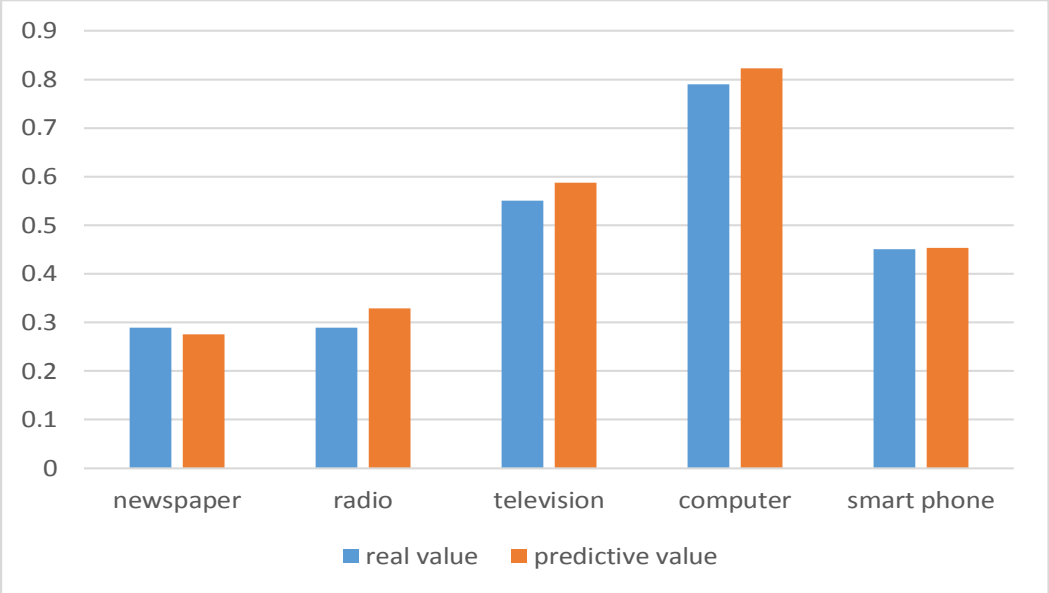

Figure 3: *The usage rate of each media in year 2012.*

From Figure 3, the predictive value and real value is very closely to each other. In addition, the average relative error between the real value and predictive value is 6.04% which means the model already constructed has a better prediction capacity.

5.2 Random Graphic model

The prediction capability of our model can be evaluated by comparing the predicting result with the reality of year 2012. For this reason, the communication network in year 2012 ought to be predicted at first.

The predictive usage rates shown in Figure 3 make it possible to construct the communication network. And the specific process to build the network can be divided into three steps.

- **Step One:** confirm the number of nodes in our global network. For simplicity, the global network we constructed with a size of $m * n$ individuals can be divided into 10^5 units, every unit can be regarded as a node, the following figure shows a simplified sketch diagram for global network.

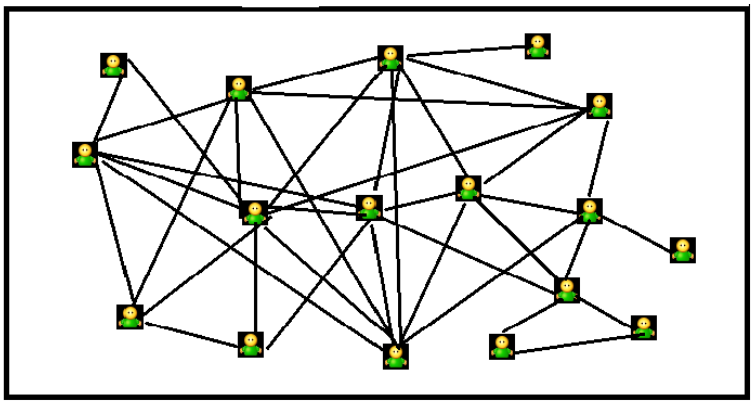

Figure 4: *simplified sketch diagram for Global network*

- **Step Two:** confirm the number of nodes connecting to each kind of information source according to the usage rates of each media, which results in the constructions of star coupled network with its center as information source.
- **Step Three:** construct the communication network with *the model of ER random graph*[7]based on the previous two steps, the formula of which is listed below:

$$Random \quad Graphic \quad model \begin{cases} G = (V, E) \\ NumV = n \times m \\ p\left(e_k = v_i v_j\right) = 0.0003 \\ v\left(t\right) = \frac{C(t)}{t} \\ \omega\left(t\right) = \frac{D(t)I}{R} \end{cases}$$

where V denotes all nodes in the network; E stands for edge of the network; e_k is the kth edge; $\omega\left(t\right)$ and $v\left(t\right)$ are defined in Equation (5) and Equation (3).

For the sake of validating the prediction capability of the model more clearly, the relationship between speed of information vs inherent value of information in the two networks,that is, the real communication network and the predictive communication network by the model, is adopted to describe it. And ***Monte Carlo Simulation***, a method to simulate dynamic process[8], is used to simulate the flow of information inside the communication network. The process of the simulation using ***Monte Carlo Simulation*** for one node is shown in Figure 5.

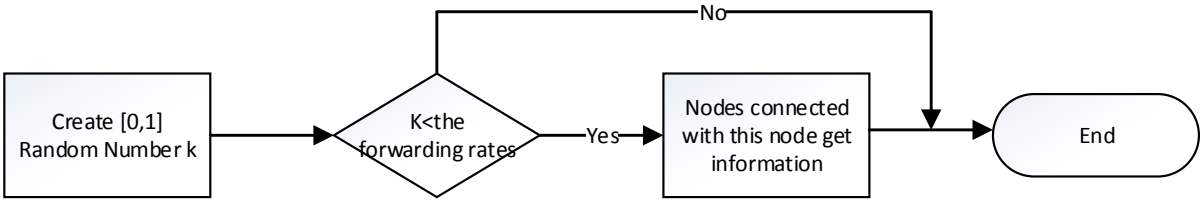

Figure 5: *The flow chart of the simulation using* **Monte Carlo Simulation** *for one node.*

From Figure 5, there will generate a random number at first in the ***Monte Carlo Simulation*** for one node, and only under the circumstance that the random number is less than forwarding rates can nodes connected with this node get information.

Applying ***Monte Carlo Simulation*** to the real and predictive communication network respectively, the relationship between the speed of information and its initial inherent value within these two networks can be drawn in a same figure shown in Figure 6.

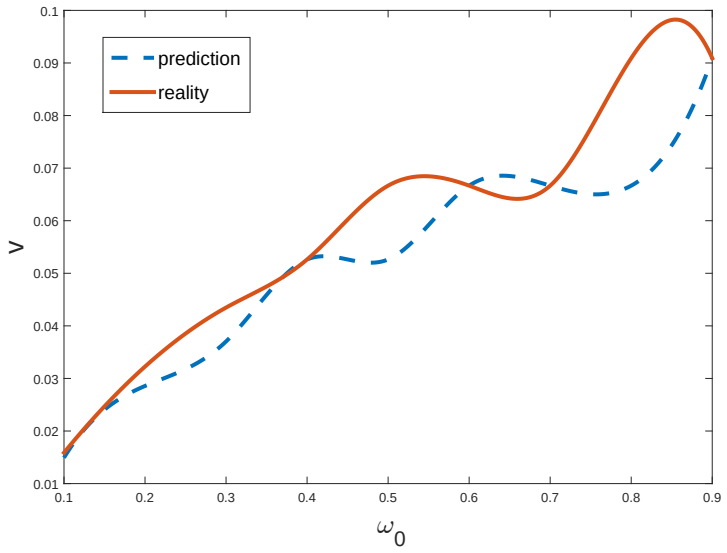

Figure 6: *Comparing graph between reality and prediction*

From Figure 6, v is the speed of information; ω_0 is the initial inherent value of information; $\omega_0 = \omega(t)|_{t=t_0}$. Moreover, the graph reflects the relationship between the speed of information and the initial inherent value of information in the real and predictive network in 2012

5.3 Comparation with the reality

From Figure 6, the higher the initial inherent value of information is, the more quickly the speed of information is. Besides, the average relative error between reality and prediction can be calculated as 8.9%, which validating the prediction capacity of our model is good.

6 Task C: The predictions of relationships and capacities of the network in 2025

6.1 The prediction of the relationships between communication networks

The relationships between communication networks are actually the relationship between speed of information vs inherent value of information. And the method to predict the relationship has been provided in solving Task B. Hence, the prediction of the relationship between communication networks around the year 2050 can be divided into several steps.

- **Step One:** predict the usage rate of each media with *Second Exponential Smoothing Method* in the network;
- **Step Two:** construct the communication network;
  - **Substep One:** confirm the number of nodes in the network, which can equal to ten thousand in the simulation;
  - **Substep Two:** confirm the number of nodes connecting to each kind of information source according to the usage rates of each media, which results in the constructions of star coupled network with its center as information source;
  - **Substep Three:** construct the communication network with *the model of ER random graph* based on the previous steps.
- **Step Three:** apply ***Monte Carlo Simulation*** to the predictive communication network in the year 2050, the relationship between the speed of information and its initial inherent value can be obtained.

There are some graphs which can be obtained in some of the steps above. In Step One, the trends of the usage rate of each media in the network can be obtained and shown in Figure 7. In addition, the relationship between the speed of information and its initial inherent value in Step Three can be described in Figure 8.

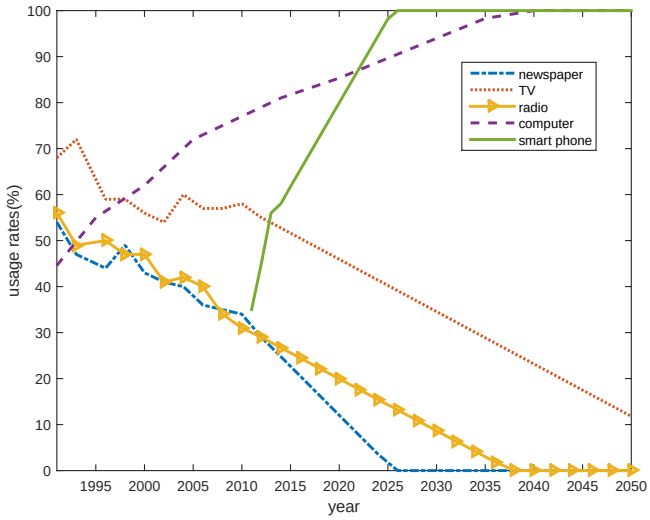

Figure 7: *Curves in this chart reflect the changing trends of usage rates along with time. With the increasing of time, there is some new media appear while there is some old media disappear. For example, smart phone appears in the 2010s and newspaper disappears in the 2025s.*

From Figure 7, with the increasing of time, the usage rates of newspaper, radio and TV show downtrend while that of computer and smart phone show an increasing. And in the year 2050, newspaper and radio have already disappear, the usage rate of TV is around 12% and that of computer and smart phone have reached to 100%. This phenomenon also shows that technology develops rapidly with the increasing of time.

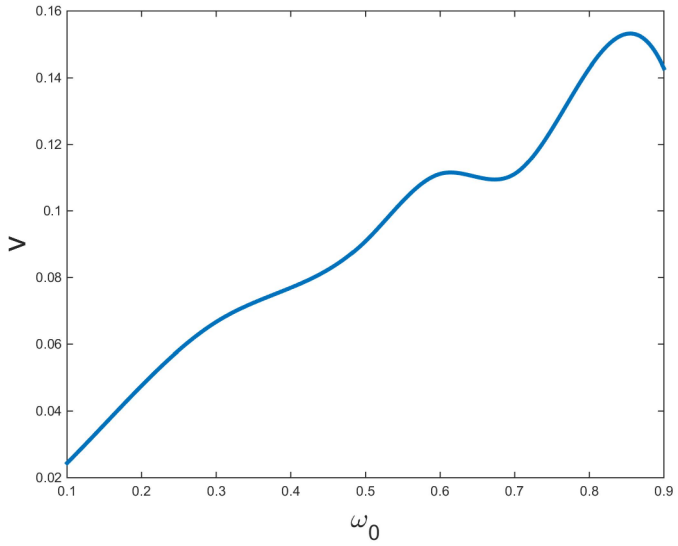

Figure 8: *The relationship between the speed of information and its initial inherent value*

From Figure 8, in this chart, abscissa is the initial inherent value of information, and ordinate is the speed of information. Curve in this chart reflects the relationship between the speed of information and its initial inherent value. From the global aspect, the lager the initial inherent value is, the quicker the speed of information is.

6.2 The prediction of the capacities of communication networks

The capacities of communication networks relate to two important factors, namely, the communication capability between two nodes and the tie strength of edge in the network. Hence, two index, that is, *the index of communication capability and the index of tie strength*, can be used to describe the capacities of communication networks around the year 2050.

6.2.1 The index of averaged shortest distance

The connections within the network can be described with average shortest distance which depicts the communication capability between two nodes in the network. Therefore, the specific process to define ***the index of communication capability*** can be divided into two steps.

- **Step One:** use ***the Floyd algorithm***, an algorithm to calculate the shortest distance between two nodes in graph theory[4], to obtain the shortest distance between arbitrary two nodes in the communication network.

- **Step Two:** define the average shortest distance with the formula below:

$$d = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} d_{ij}}{n\,(n-1)/2} \tag{9}$$

where d_{ij} is the shortest distance between the ith node and the jth node in the communication network; n is the number of nodes in the network.

Finishing the above two steps, the result of the average shortest distance in the communication network around the year 2050 is 6.495. According to the data of 2012, the result of the average shortest distance in the communication network in the year 2012 is 8.651. Comparing the two value, the value in 2050 is less than that in 2012 and the percentage about the increasing of communication capacity is 25.81%, which represent that communication capacity is increasing along with time.

6.2.2 The index of the connected strength

In the communication network, there is a tendency for individuals to follow other individuals to obtain more information. This phenomenon can be represented by a network in which there are directed weighted links pointing from followers to their leaders. What is noticeable is that the direction of information spreading is contrary to the follow relation. In addition, The initial weight of the edge from node A to B stands for the specific times. However, in real situation, the connected strength of edge actually represents the probability. Hence, it is necessary to normalize the connected strength. And the formula of normalized weight is listed below:

$$w_{ij} = \frac{f_{ij}}{\sum f_i^{out}} \tag{10}$$

where f_{ij} denotes the initial weight; $\sum f_i^{out}$ stands for the sum of initial weights of all out-links of node i.

The average connected strength is 0.246 in the year 2012 while that is 0.304 in the year 2050. And the percentage about the increasing of connected strength is 23.22%,

7 Task D: The changes of public interest and opinion

Information can be divided into two types, namely, *information with guiding characteristic and information without guiding characteristic*. And *information with guiding characteristic* means information which has emotional coloring, such as the negative news about public figures which always contain strong emotional coloring of criticism and disgust. However, *information without interest guidance* means information which is only the statement of facts, such as the promulgation of some policies which has no emotional coloring. Having considered that the two kinds of information have different effect on public, the way public interest and opinion changed through information networks in today's connected world should be researched from two situations.

7.1 The effect of information without interest guidance

In virtue of the objectivity of information without guiding characteristic, the opinion of individual about this kind of information is easily to be affected by the opinions of others around

him. For example, in terms of the same information without interest guidance, if majority of people who have connection with the individual have an optimistic opinion to it, it is more likely for the individual to have an optimistic opinion as well.

For understanding how public interest and opinion can be changed through information without interest guidance, it is necessary to make a rule for it. Taking the node A which represents a individual in the communication network as an example, the changing situation of this individual's opinion about a piece of information without interest guidance can be described by the formula below:

$$P_A = \begin{cases} 0, (m-b) \geq b \\ \frac{b}{m}, (m-b) < b \end{cases} \tag{11}$$

where P_A denotes the changing probability of the initial opinion the individual in node A has; m represents the number of the nodes which not contain information source connected with the node A; b stands for the number of the nodes where individuals take the opposite opinions with the individual in node A.

The confirming of the rule for the changing probability of the initial opinion makes it possible to explore the effect of information without guiding characteristic. Firstly, initializing the initial opinions for a piece of information without guiding characteristic in each node within the communication network in year 2012. Then, applying ***Monte Carlo Simulation*** to simulate the relationship between public interest and opinion and information network based on the rule confirmed previously. And the relationship between degrees of approval belonging to the public and time is shown in (A) of Figure 9.

7.2 The effect of information with interest guidance

Compared to information without interest guidance, information with interest guidance has a obvious emotional coloring. Hence, the opinions of the public for this kind of information not only relates to the opinions of other people, but also have a relationship with the times people receiving it. For example, if a individual receives a piece of information with interest guidance for many times, it is more likely for this individual to take the opinion with the same emotional coloring as information has.

It is necessary to make a rule for exploring the effect of information with interest guidance. However, this rule is not completely identical to that of information without interest guidance. Still taking the node A which represents a individual in the communication network as an example. Firstly, opinions of the public have a relationship with the times people receiving the piece of information. When individuals agree with information with interest guidance, the factor of times the individual receiving the piece of information has no effect on the initial opinions of this individual. And its specific formula is listed below:

$$P = \begin{cases} 0, (m-c) \leq c \\ \frac{m-c}{m}, (m-c) > c \end{cases} \tag{12}$$

where c denotes the number of the nodes where individuals have the same opinions with the individual in node A; m represents the number of the nodes which not contain information sources connected with the node A.

However, if individuals disagree with the piece of information, the times will be a very important factor which can not be ignored when confirming the changing probability of the initial opinion the individual has. Furthermore, it is more likely for the individual to change his initial opinion for information with the increasing of the times individual receiving information. This situation can be described with the formula of the changing probability below:

$$P = \frac{c}{m} z \tag{13}$$

where c denotes the number of the nodes where individuals have the same opinions with the individual in node A; m represents the number of the nodes which not contain information sources connected with the node A; z stands for the times the individual receiving information.

After confirming the rule for the changing probability of the initial opinion, it is possible to explore the effect of information with interest guidance. Firstly, initializing the initial opinions for a piece of information with interest guidance in each node within the communication network in year 2012. Then, applying ***Monte Carlo Simulation*** to simulate the relationship between public interest and opinion and information network based on the rule confirmed previously. And the relationship between degrees of approval belonging to the public and time is shown in (B) of Figure 9.

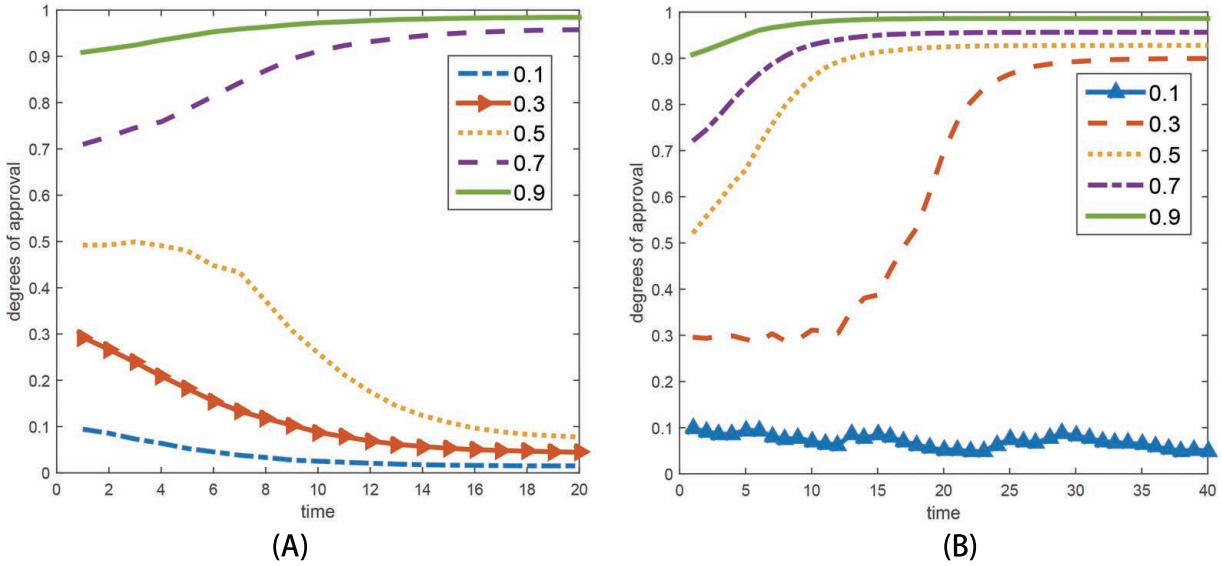

Figure 9: *Relationships between degrees of approval belonging to the public and time*

From Figure 9, Chart A describes the relationship between degrees of approval about information without interest guidance and time in a long enough period of time. Chart B describes the relationship between degrees of approval about information with interest guidance and time in a long enough period of time. In these two charts, degrees of approval means the proportion of people who agree with a piece of information among the all people in the communication network in year 2012. Besides, the digits from 0.1 to 0.9 denote the initial value of degrees of approval.

Comparing the two charts in Figure 9, curves in the two charts between degrees of approval and time will tend to a certain value in the end. In Chart A, curves with lower initial value will tend to zero while that with higher initial value will tend to one. However, in Chart B, only extremely low initial value leads to the curve tending to zero. And curves with higher initial values will tend to one. This phenomenon also reflects the transmission characteristic of information. The final intention of the information with interest guidance is to make the degrees of approval tend to one, which shows that the information with interest guidance has obvious emotional coloring while the information without interest guidance has strong objectivity.

8 Task E: The effects of factors on spreading information and influencing public opinion

Requirements of Task E can be divided into two subproblems, one of which is determining how the factors could be used to spread information, the other is determining how the factors could be used to influence public opinion. And the two subproblems can be solved respectively. Besides, taking America as an example to solve the subproblems in Task E.

8.1 The effects of factors on spreading information

There are four factors in the question of Task E, among which three factors, that is, *information value, the sources of message and the topology of information network* are associated with the spread of information. In addition, the spread of information can be reflected by the speed of information. Hence, according to the model we have constructed above as well as the data of America in the year 2012, the relationship between the speed of information and information value can be described in Figure 10.

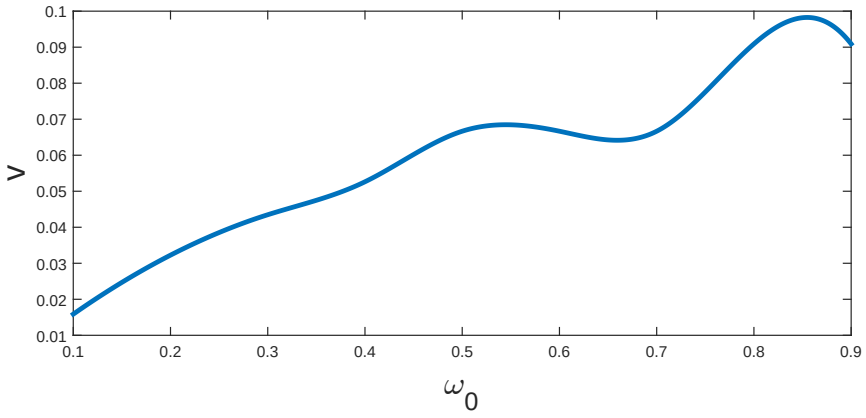

Figure 10: *The relationship between the speed and initial inherent value of information*

From Figure 10, in this chart, abscissa is the initial inherent value of information, and ordinate is the speed of information. Curve in this chart reflects the relationship between the speed of information and its initial inherent value. From the global aspect, the lager the initial inherent value is, the quicker the speed of information is.

The source of message and the topology of the information network have an effect on the speed of information, among which, the topology of the information network is the essential condition of the flow of information. In addition, the topology of the information network is changing along with time. However, information in the network comes from the sources of message. Hence, eliminating the effects from other factors should be the first thing to do. Here the internal quality of information can be confirmed as 0.3. Then, the relationship between the speed of information and the topology of information network corresponding to each kind of source of message can be described in Figure 11 by using the model already constructed previous.

From Figure 11, the three curves in the graph show the relationship between the speed of information and the topology of the information network with the source of message is TV, newspaper or radio. In addition, since the topology of the information network is changing along with time, the curves in the chart reflect the relationship between the speed of information

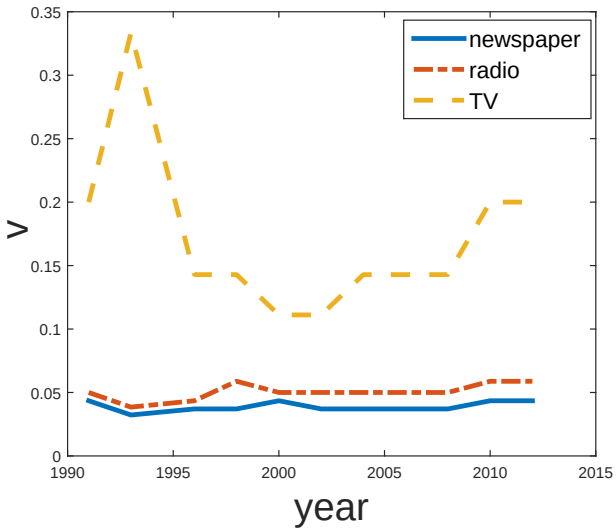

Figure 11: *The relationship between the source of message, the topology and the speed of information*

and the topology of the information network.

8.2 The effects of factors on influencing public opinion

Among the factors listed in the question of Task E, peopleą́s initial opinion and bias are associated with the public opinion, which has been confirmed in Task D. For information without interest guidance, curves reflecting the relationship between degrees of approval and time with lower initial value will tend to zero while that with higher initial value will tend to one. However, for information with interest guidance, only extremely low initial value leads to the curve tending to zero. And curves with higher initial values will tend to one. This phenomenon also reflects the transmission characteristic of information, which shows that the information with interest guidance has obvious emotional coloring while the information without interest guidance has strong objectivity.

9 Strengths and Weaknesses

Strengths:

- ***Monte carlo method*** can simulate the evolution of the complex network with simple rules.
- ***Dynamic simulation*** can simulate the detailed process for the flow of information, rather than just getting the result
- ***Time series model*** can predict future more accurate.

Weaknesses:

- There is no consideration about the emergence of new technology when constructing the models.
- The models we have constructed is not suitable for small networks.

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