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Summary Sheet

Nowadays, the appearance of multimedia accelerates the flow of information. Finding out the relationship between the speed of information and its inherent value through different medium is important to understand the functionality of society's networks. Up to now, WS small-world-networks and BA scale-free networks are two common model used to analyze the function of networks. However, they cannot be used to analyze the flow of information between two or more groups.

Based on the factors influencing the flow of information: the value of information, the individual attitude towards the information, the social networks of individual, the change of public interest, the coverage rate of medium in different countries, and the period for medium to publish the information, a model is built to explore the flow of information according to its inherent value. A C++ program is used to help the simulation of the model. Another model is built to determine the change of public opinion and interest. The result shows that the increasing number of people forms an “S” shaped line. Also, it shows that the higher the coverage rates of Internet, the more rapid the increase of the number of people who have known the news. This model also passes the test of its reliability and the prediction capability.

Using this model, a prediction of the communication networks’ relationships and capacities around the year 2050 can be made. Compared with current situation, the coverage rate of a piece of information will increase with respect to the same information value. Moreover, by the prediction of this model, a novel communication media will occur by 2050. To improve this model, more situations need to be taken into consideration.

Key Words: social networks, the flow of information, model

Social Network Model

—— The Flow of Information

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Contents

1 Introduction

1.1 Restatement of the problem

With the development of technology, information nowadays is spread more and more quickly. In 19 century, the most convenient way to spread information is by newspaper. When it came into 20 century, the appearance of radio and television accelerate the flow of information. Now, with the help of Internet, people can get news not only from websites, but also from their friends. In addition, the flow of information also depends on whether the inherent value of the information meets the need of people. As a result, finding out the relationship between the speed of information and its inherent value through different medium is important to understand the functionality of society's networks.

1.2 Background

Before the appearance of newspaper, people exchange information orally. However, those so called "current events" would spend very long time to be known by most people. Then those events are not news any more. Fortunately, the invention of newspaper, telegraph, television and Internet, which are called mass medium, makes it possible for people to get current events immediately regardless of the distance. Mass communication also has many functions: information function, interpretation functions, instructive functions, bonding functions and diversion functions [1].
However, people receiving information depend not only on the media, but also on their interest and public opinion, which makes society's networks become much more complicated.

1.3 Previous works

Up to now, there are 2 common models which simulate the networks: WS small-world-networks and BA scale-free networks. WS small-world-networks is that taking a connected graph or network with a high graph diameter and adding a very small number of edges randomly, the diameter tends to drop drastically [2].

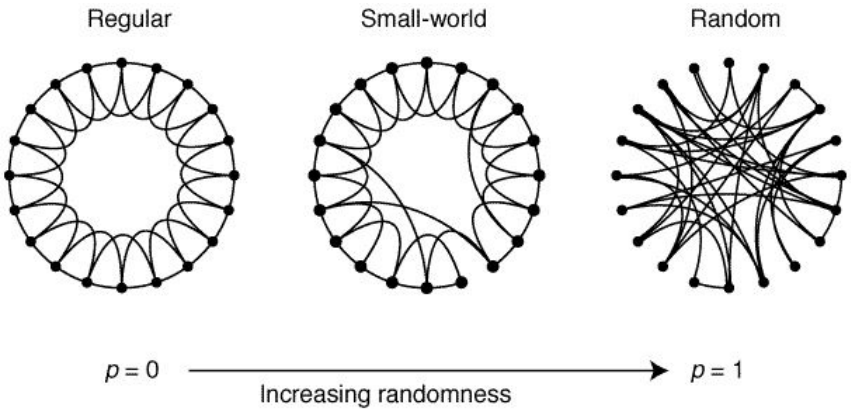


Figure 1: Collective Dynamics of "Small-world" Networks [3]

A scale-free network is a connected graph or network with the property that the number of

links k originating from a given node exhibits a power law distribution $P(k) \sim k^{(-\gamma)}$ [4]. Those two models are usually used to construct and simulate the networks.

2 The Description of the problem

2.1 How do we define the region of the investigation

According to the information we get on the Internet, we obtain the number of population of some famous countries such as American, Canada, China, and United Kingdom. Some of the rates of variety communication means are acquired from the data resource. Based on these data, we build several similar models to test the flow of the information in a district.

In the data resource, data can be acquired in the following way. Take America in 2006 as an example:

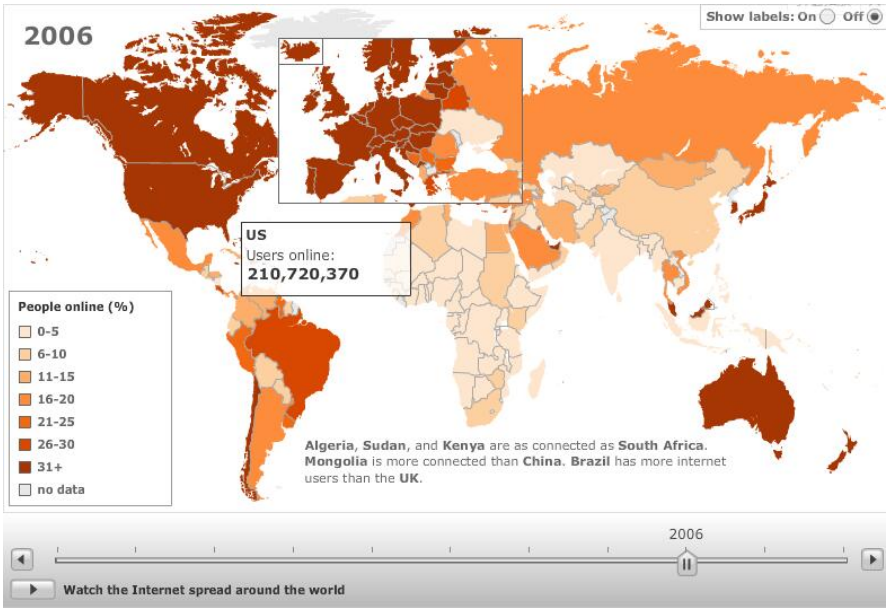


Figure 2: The defination of the investigated region.

2.2 What factors influence the flow of information

The flow range of a piece of information is caused by several reasons. The individual's preference will influence the information's transformation most. Suppose the individual has different degree of preference in various fields so that he or she will determine to deliver the information to another person or not.

Another important reason is the popularizing rate of communication means. Different means of transmission has different transmitting velocity, which indicates the time of a piece of information to spread everywhere. If one region has more advanced means to convey the information, larger range will be covered by this information.

Moreover, some certain ways to communicate may need media to finish the process. Therefore, when choosing the next individual to get the information, whether he or she has the tool will be concerned.

2.3 How do we define the coverage of a piece of information

By selecting individual randomly, different results will be obtained. In every test the total number of people is a constant, so that an average ratio of people get the information in a certain period of time can be acquired. Using the number of population we get from the Internet and the ratio, we define the total estimating number of people who receive the message as coverage.

2.4 What if there is no data available

The popularizing rate of communication tools in some main countries over the world are easy to find on the Internet. Some small countries' data are not available, however, the population of these countries is not that big and influences little in the whole model. Considering about that there is sensational news around the world and then such small countries can also get the information, which will change the results slightly.

3 Model of the Flow of Information vs the Value of Information

3.1 Definition and symbol

3.1.1 Symbols of the current events' value

1. C_1: The class of the factuality of the current event.
2. C_2: The class of the significance of the current event.
3. C_3: The class of the timeliness of the current event.
4. C_4: The class of the confidentiality of the current event.
5. C_5: The class of the freshness of the current event.

3.1.2 Symbols of one individual

1. A: One's attitude towards the news, where $A \in [-1, 1]$.
2. M: One's likelihood to believe others, where $M \in [0, 1]$.
3. W_1, W_2, W_3, W_4, W_5: Whether the one is covered by certain media, where "1" means covered, and "0" means not covered.
4. in_1, in_2, in_3, in_4: Whether the one is interested in the field of news, where "1" means interested, and "0" means not interested.
5. I_{inter}: Whether the one is interested in the foreign news, where "1" means interested, and "0" means not interested.
6. F: Individual has F friends in Internet connection.
7. Nei: The number of possible neighbors for each person.
8. Fri: The number of friends for each person.

3.1.3 Symbols of one country

1. Pop: The population of a country.
2. c_1, c_2, c_3, c_4, c_5: The coverage rate of certain media in the country.
3. ic_1, ic_2, ic_3, ic_4: The average interested in the field of news in the country.
4. ic_{inter}: The interested of the country to foreign news.
5. $I_1, I_2, ..., I_{2500}$: The 2500 test people in the country.

3.1.4 Symbols during the flow of the information

1. V: The value of the information, where $V \in [0, 1]$.
2. S_1, S_2, S_3, S_4, S_5: The different class of media.
3. $\text{con}_1, \text{con}_2, \text{con}_3, \text{con}_4, \text{con}_5$ Different countries.
4. R_1, R_2, R_3, R_4, R_5: The minimum ratio of people who know the news needed for some certain media to publish news, where $R_1, R_2, R_3, R_4, R_5 \in [0, 1]$.
5. P: The possibility for two people to communicate, where $P \in [0, 1]$.
6. T_1, T_2, T_3, T_4, T_5: Units of time needed for media to prepare news.
7. $tl_1, tl_2, tl_3, tl_4, tl_5$: Units of time left for the news to be published after decision.
8. t_{in}: Units of time needed for media to prepare news so that it will flow to foreign.
9. tl_{in}: Units of time left for the news to be published after decision in foreign country
10. N: Number of people who know the event.
11. N_t: After the message spreads in t units of time, the number of people who know the event.
12. N_{t-com}: When the message spreads in t units of time, the number of people who know the event by neighbor's communication.
13. $N_{t-media}$: When the message spreads in t units of time, the number of people who know the event by media.

3.1.5 Notation

1. Random 2500 people in one country are tested.
2. The subscript 1,2,3,4,5 for media represents for newspaper, telegraph, radio, television and Internet respectively.
3. The subscript 1,2,3,4 for interest represents for finance, policy, recreation, and science respectively.
4. The subscript 1,2,3,4,5 for country represents for America, China, Britain, Canada and India respectively.

3.2 Assumptions

1. This model considers five countries: America, China, Britain, India and Canada.
2. This model considers four categories of the events: financial, political, recreational, and scientific events.

3. The initial attitude towards the information for each person is given randomly. In addition, for each person the value that one's likelihood to believe others M is also given randomly, which means he or she believes himself or herself to some extent and believe others to some extent.
4. The person who holds which kind of medium will be given randomly at the beginning.
5. Whether medium will publish the information is determined by the percentage of people who have known this information and the value of the information. The medium will publish the information if the percentage of people who have known the news is larger than $\frac{R_i}{V}$.
6. Different medium needs different time to prepare the article to publish.
7. There is no directly communication between each country, which means the flow of information between country only by the communication of people or medium in each country.
8. People have six ways to receive information: talking, newspaper, telegraph, radio, television, and Internet. But people only have two ways to spread information to others: talking and Internet.
9. Only those people who are interest in the field of the information will receive the information; and only those people who are interest in foreign information will receive the news from another country.
10. Only those people whose attitude towards the information is positive will keep on passing the information.
11. This model assumes that people will only have possibility to talk to the eight neighbours around them.

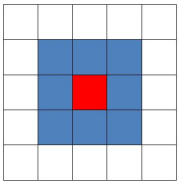


Figure 3: The way people talk to the neighbours.

12. This model assumes that people can communicate with other F_i people who have Internet randomly regardless of the distance.
13. When the information is published by the medium, it will have the probability of V to be published by foreign countries. The flow of information in the foreign countries will be delayed for tl_{in} unit times.
14. People who have known the event won't forget it.
15. This model ignore the influence of celephones, because nowadays, although people use celephones, they use Internet to receive and spread the information.

3.3 Decide the value of the event

When an event appear, people need to decide the value of the event quantitatively. In this model, the value of an event can be calculated from 5 aspects: the factuality of the event, the

Aspects	Proportion
Factuality	0.333
Significance	0.182
Timeliness	0.258
Confidentiality	0.164
Freshness	0.063

Table 1: Different Aspect and Their Proportion

significance of the event, the timeliness of the event, the confidentiality of the event, and the freshness of the event. According to the research of Liu Shuli [18], those aspects have different proportion in deciding the value of the event which are shown in Table 1.
Each aspect (except "Confidentiality") will have 5 classes, from high to low, corresponding 1 to 5 (which means the larger the number, the higher the class). For confidentiality, the smaller the number, the higher the class. Then, one can get the value of the event by

$$V = \frac{1}{5}(C_1 \times 0.333 + C_2 \times 0.182 + C_3 \times 0.258 + C_4 \times 0.164 + C_5 \times 0.063) \tag{1}$$

3.4 Decide the attitude of people and public interest

At beginning, different people holds different attitude to the event. In this model, people's attitude are quantified from -1 to 1: $-1 \sim 0$ means "don't believe", and $0 \sim 1$ means "believe". Only those people whose attitude is $0 \sim 1$ will keep on passing the information. Initially, the attitude of each person is random.
During the flow of information, people's opinion towards this event will change due to other's opinion. If the person i tells the person j the event by talking or Internet, both of their attitude will change to

$$A_i(t+1) = (1 - M_i) \times A_i(t) + M_i \times A_j(t) \tag{2}$$

$$A_j(t+1) = (1 - M_j) \times A_j(t) + M_j \times A_i(t) \tag{3}$$

In a group, people's interest will always change according to other's interest, which called herd mentality. If an event occurs and spreads out, people's interest towards this event will increase. Based on this theory, the initial public interest $I(0)$ on this event is

$$I(0) = \frac{\sum_{n=1}^{\psi} in_n(0)}{Pop} \tag{4}$$

After the flow of information, people will be more and more interest in the field of this event if the increase of the number of people who know this event is rapid. Otherwise, people will lose interest and calm down. Then one can get the public interest at moment $t+1$ by

$$I(t+1) = I(0) \times \left(\frac{N(t+1) - N(t)}{\psi} + 1\right) \tag{5}$$

3.5 The foundation of the model

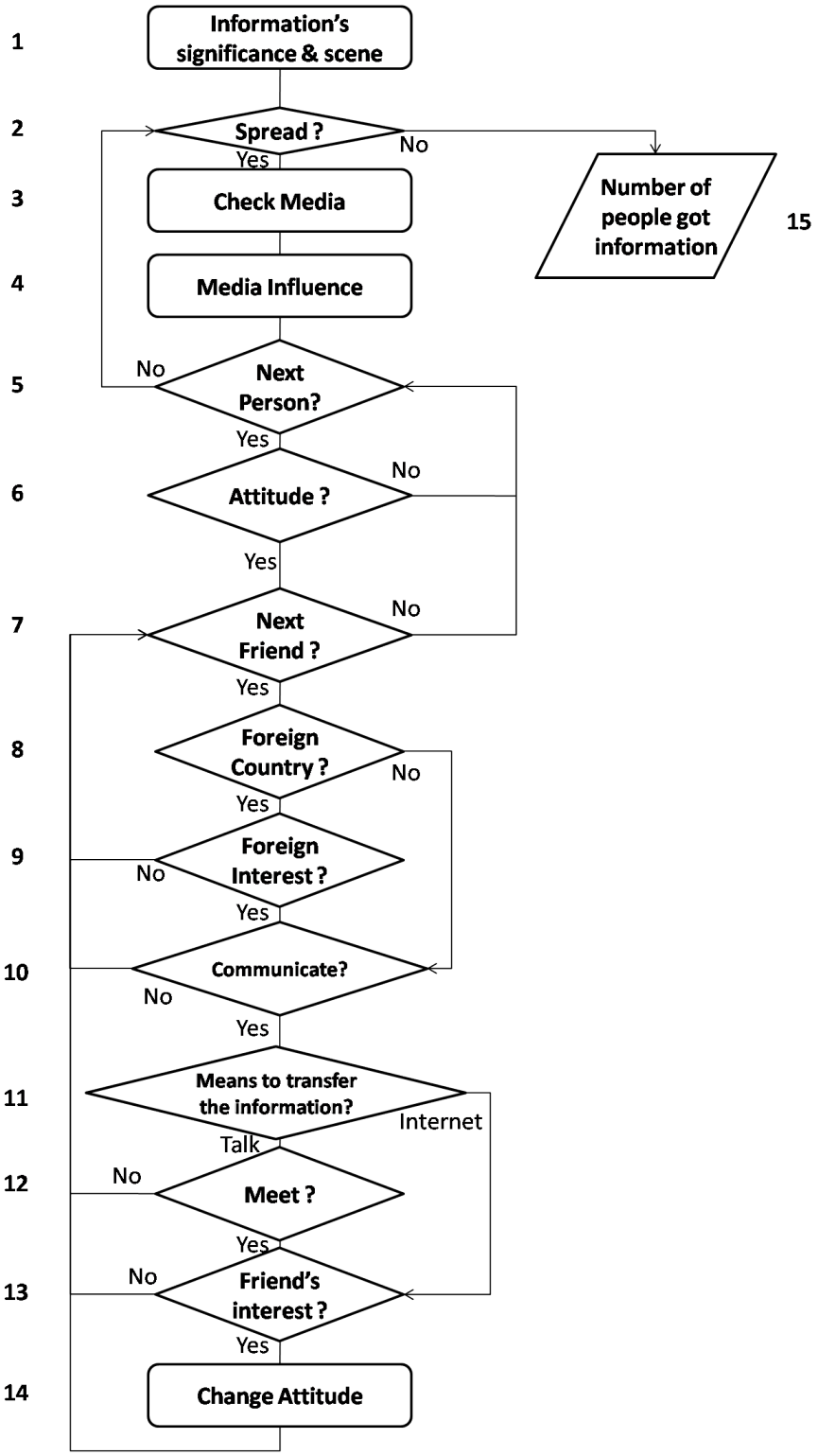


Figure 4: The flow diagram of this model.

1. At beginning, users need to input the value of the event, the country the event occurs, and the category of the event. The value of the event can be calculated using Eq(1).
2. The step 2 means the program has a circulation to decide the time the information has spread and whether it will continue spreading. During every circulation in the later calculation, the timer will decrease a unit of time. And as soon as the timer becomes 0, it means the information has spread some certain time we have set before and the results are considered as the coverage of the information.
3. If the information continues to spread, the model considers about the power of media. Checking whether the media will promote the information is the main step. Compare the current coverage of the information with the threshold value. The threshold value is calculated in the following formula:

$$\text{threshold value } = \frac{2500 \times R_i}{V} \tag{6}$$

4. It is easier for people to be influenced by medium such as newspaper, television, Internet and so on because those medium are more authoritative than communication between people by talking.
   (a) If the unit time left for one or some of the medium to be publish, which are $tl_1, tl_2, tl_3, tl_4, tl_5$, is 0, and this person get this news from the medium which $tl_i = 0$, this person will have ξ_1 percentage to receive the news, where ξ_1 is decided by the value of the information
   $$\xi_1 = P$$
   Once the person receive the news from the medium, the person will know the news and his attitude toward the news will change to 1.
   (b) Otherwise this person won't be influenced by medium.
5. After checking the media, traversing all people who are covered with some certain media (medium). The number of people who will be investigated is calculated in the following formula:

$$N_t = N_{t-1} + N_{t-com} + N_{t-media} \tag{7}$$

   i.e.

$$N_t = N_0 + \sum_{i=1}^{t} (N_{\text{i-com}} + N_{\text{i-media}}) \tag{8}$$

6. The attitude toward the message itself is very important. Define that if the individual holds a positive attitude to the information, he or she will try to propagate it to friends. Otherwise he or she will hold opinion and do nothing.
7. When the individual decides to deliver the information, we traverse all the friends to get the final attitude of the transmitter and change the number of people who know the event at some certain unit of time.
   (a) If this person has Internet, the number of friends are calculated in the following:
   $$\text{Fri}_\text{i} = \text{Nei}_\text{i} + \text{F} \tag{9}$$

(b) If this person does not have Internet, the number of friends are calculated in the following:

$$\mathrm{Fri_i} = \mathrm{Nei_i} \tag{10}$$

8. Check whether the information are spreading in the initial country where it happened or in the foreign country. If it is in the foreign country, the information's deliver will also depend on the receiver's attitude toward foreign message. Otherwise, the model will move on to step 10.
9. After knowing the information is delivering in the foreign country, there is a parameter I_{inter} to check the receiver's interest to the foreign information. If the parameter of the receiver is 0, then the receiver will not accept foreign information from person. Thus, the transmitter will pass this person and move on to the next friend.
10. Judge whether his or her friends have already know the news. The notation "No" means that the friend has already know, so the transmitter will move on to the next friend instead. After traversing all the friends, we change the transmitter to another one. And the notation "Yes" means the friend of the transmitter does not know the news, so those two people will try to communicate about this message.
11. When this person decides to transfer the information, he or she will have two ways to pass on this information: Internet or talking to others.
    (a) If this person has Internet, he or she will first use Internet to pass on the information to the friends. Then talking with eight of his or her neighbors about the event.
    (b) If this person doesn't have Internet, he or she will talking with eight of his or her neighbors about the event directly.
12. By talking, the transmitter will have ξ_2 percentage to exchange the news with his or her neighbors, where ξ_2 is decided by the percentage of meeting neighbors, the attitude of the transmitter, and the value of the information

$$\xi_2 = P \times A_i \times V \tag{11}$$

    the higher the ξ_2, the more the possibility that this person will convey the information to that neighbor.
    When sending the information to others by Internet, he or she will have ξ_3 percentage exchange the news with the friends, where ξ_3 is decided by the attitude of this person, and the value of the information

$$\xi_3 = A_i \times V \tag{12}$$

    the higher the ξ_3, the more the possibility that this person will convey the information to that friend (Whether this person will be told the news will be determined by the algorithm using random number which can be seen in the code of Appendix).
    The transmitter will keep on doing this until all of the friends are tried.
13. Whether the friend of the transmitter receive the news also depends on the friend's interest in the category.
    (a) If the friend has interest in the category of the news, he or she will receive the information.
    (b) Else, next person won't receive the information. Then the previous person will go back to step 7 to find the next person. He or she will keep on doing this until all of the friends are tried.

14. Then due to communication, those two person will exchange their idea, and their attitude towards this information will change according to Eq(2) and Eq(3).
15. After several units of time (determined by demands), the information will stop spreading. Then this model can check how many people have known the information in each country.

3.6 Simulative Results

Take America as an example. A recreation information in 2010 whose value is 0.8 delivers in the next 72 units of time. To make the concept more clearly, we mark that if the individual gets the information, he or she will be showed as a black square. At the beginning, everyone in the country is showed as a white square. Every three units of time, we plot a graph to observe the flow of information.

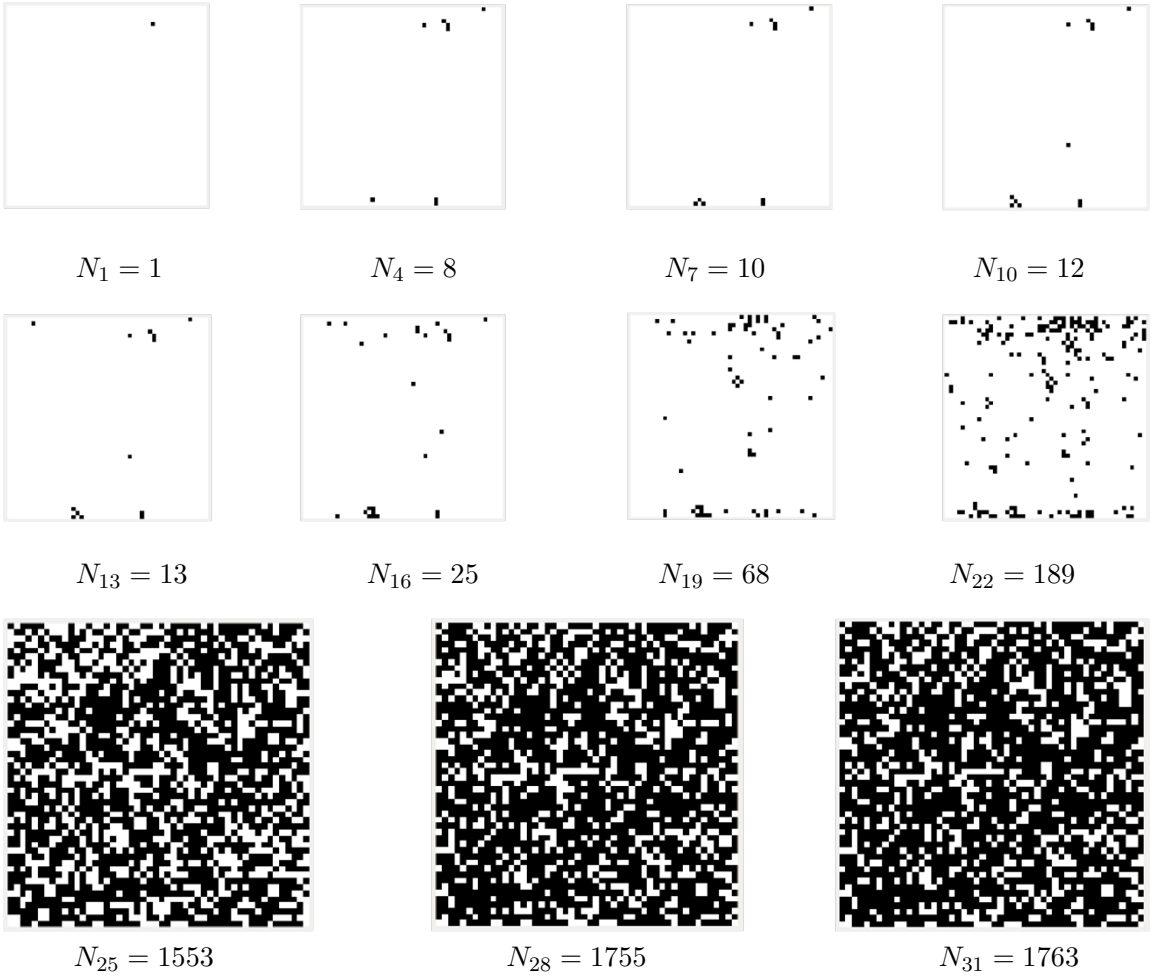


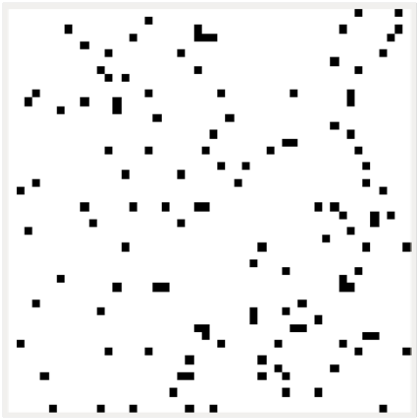
Figure 5: The flow of the test information in America.

From the figure we can see that the information flows at a slow speed at the beginning. However, the flow has a saltation after some time. It is because the media helps the information to convey to more people. Here we can see the strong power of media. After the publicity of media, the information flows in a low speed again and eventually becomes a constant. In

the example, the constant is about 1763, and the total test number is 2500. The popularizing rate is calculated as

$$\text{popularizing rate} = \frac{1763}{2500} = 70.52\%$$

It is a high rate so that the information will become a international news. According to the population of the United States from the Internet, the total number of American get the news is calculated as $70.52\% \times 309350000 = 218153620$. About 200 hundred of million Americans receive the information so that other foreign country's media will transmit the information as well. Take a foreign country China, as an example. The first news convey to China is at 28 unit time. And the flow figure are showed in the following:



$N_{28} = 125$

$N_{31} = 933$

$N_{34} = 1058$

$N_{37} = 1132$

Figure 6: The flow of the test information in China.

The popularizing rate in China is calculated as

$$\text{popularizing rate} = \frac{1132}{2500} = 45.28\%$$

From the results it shows that a nationwide news in America will deliver to about half of Chinese citizen. In today's environment, it is really possible. From the simulative process we can conclude that the flow of information is a bit like the virus. After some incubation period, which means time for media to prepare the news, the information can spread in a

striking speed and in every small period of time, quantities of people obtain the news from media. However, when the media let nearly every covered people know it, the step of spread of the information slows down. The mode of information transmission is in "low-high-low" pattern, which is similar to the truth.
On the other hand, the quality of the news can be reflected as the value of the information which given by the Eq.1. The information whose value is higher will spread in a high popularizing rate and quickly than the lower one.

4 Validation of the Model

4.1 The reliability of the model

To validate the reliability of this model, data in 2010 are used (Table 2).

		America	China	Britain	Canada	India
Population ($\times 10^4$)		30935	134091	6277	3401	120562
Coverage Percentage	Newspaper	0.6	0.5	0.9	0.7	0.2
	Telegraph	0.1	0.1	0.1	0.1	0.1
	Radio	0.15	0.10	0.15	0.10	0.10
	Television	0.23	0.12	0.24	0.19	0.06
	Internet	0.76	0.14	0.73	0.74	0.04
Interest	Financial	0.5	0.4	0.6	0.5	0.5
	Political	0.6	0.5	0.5	0.6	0.5
	Recreational	0.7	0.6	0.7	0.6	0.6
	Scientific	0.4	0.3	0.5	0.4	0.2

Table 2: Data used to simulate the flow of information in 2010 [2] [6] [7] [8] [9] [10].

Our team use C++ to write a program to realize the model. The code can be seen in Appendix. Some of data, for example "Interest" in different field are very difficult to find, so we made some assumptions in the model. The This model simulates the flow of information with value of 0.8 happened in America. Then we get the result of the number of people having know the news with respect to time shown in Figure 5.
In the figure the tendency of the increase of people form a shape of "S". This means that during the flow of information, the diffusion of the information becomes more and more rapid at first, then the speed of the diffusion goes down. Also, the figure shows that the higher the coverage percentage of Internet, the more rapid the information will spread if the information is published on Internet. Finally the increasing of people will reach saturation due to the percentage of people who are interested in the field of the information.
Compared with reality, this model works quite well. In reality, when an event happens, the flow of information is rapid at first and then slow down. Also, due to the convenience of Internet, the diffusion of information will be quicker if the coverage percentage of Internet becomes larger. As a result, this model is reliable.

4.2 The prediction capability of the model

To test the prediction capability of the model, we use an event happened in 2010 to test the prediction capability of the model. On 3^{rd} Aug, 2010, 8 people were killed by gun in a brewery

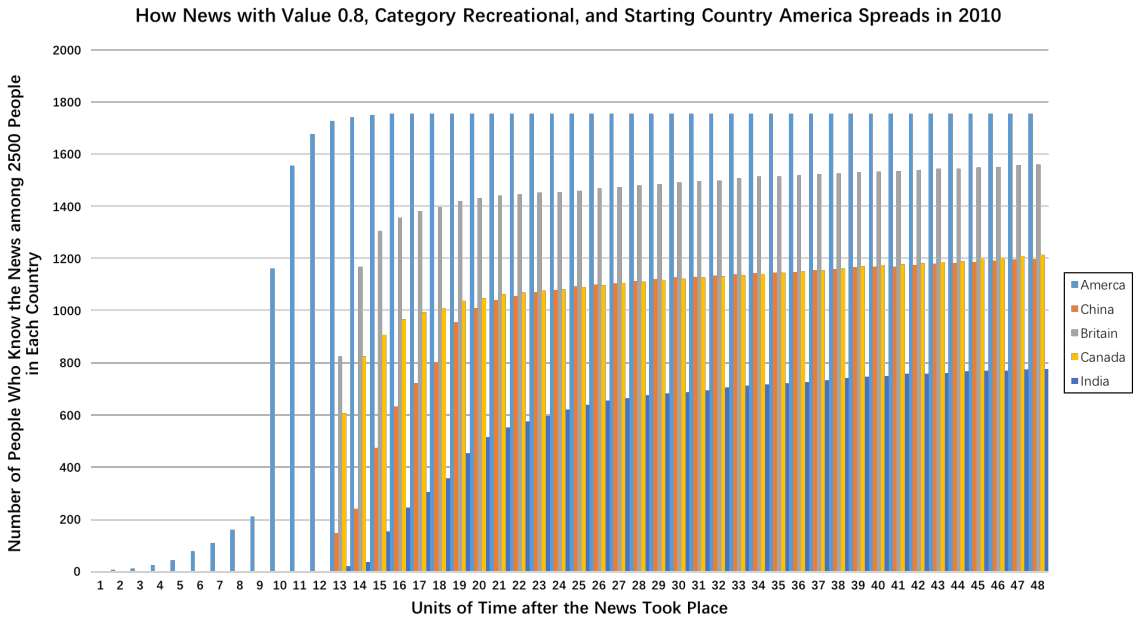


Figure 7: The number of people having known the news with respect to time

of Connecticut, America. The horrible event happens at 7:00 in the morning of America, and the average time this news coming to China by Internet is 8:12 on 4^{th} Aug of China (Table 3).

Website	Time(China)	Website	Time(China)
Caixin.com [11]	15:30	Enorth.com [12]	09:22
News.163.com [13]	02:00	Sohu.com [14]	12:15
Tencent.com [15]	04:02	Sznews.com [16]	07:21
Average		8:12	

Table 3: The average time for this information spread from America to China

It took about 13 hours to spread this news from America to China. Use Eq(1) we can get the value of this event,

$$V = \frac{1}{5}(4 \times 0.333 + 5 \times 0.182 + 3 \times 0.258 + 4 \times 0.164 + 1 \times 0.041) = 0.73$$

Also, we define that this event is a political event. Then use our model, we can predict the time needed to make this event spread from America to China. Data like population and the coverage percentage of medium are shown in Table 2. Then use this model, we can get the increase of number of people who have known this event with respect to time in China and America (Figure 8)
From Figure 8, China can get the shooting accident after 12 hours. In reality, it took 13 hours to spread this news from America to China, which shows that this model has a quite good prediction capability.

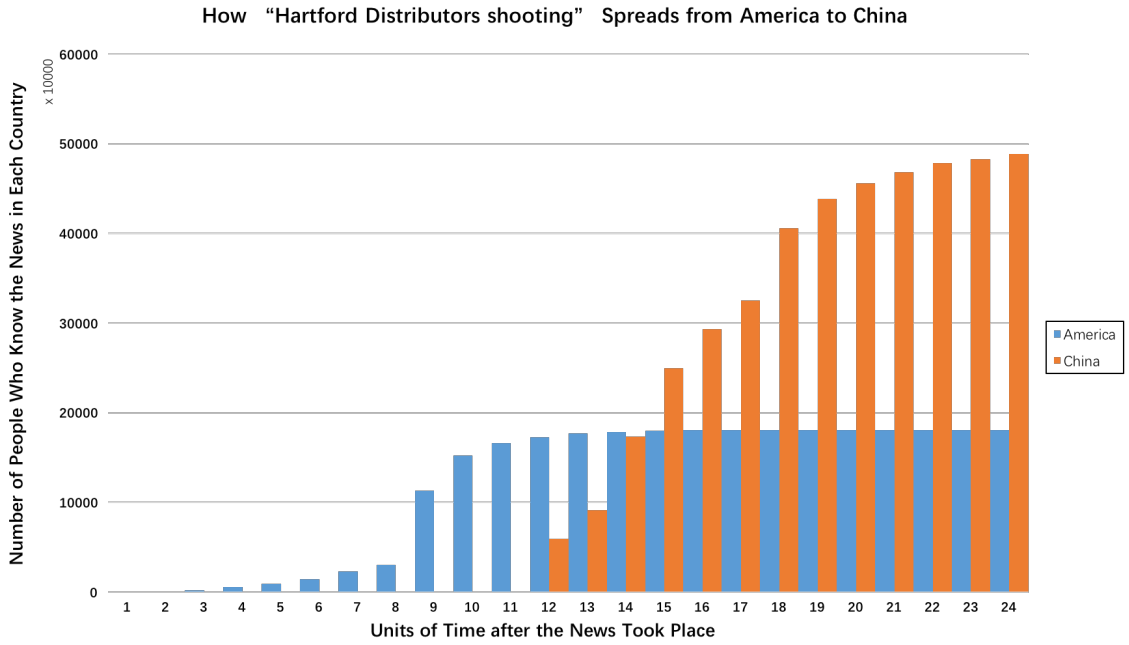


Figure 8: The increase of number of people who have known the shooting accident with respect to time.

5 Strength and Weakness

5.1 Strength

The model can give a random but reasonable result in the five chosen countries. The graph to represent the known condition is very straight forward. Meanwhile, the graph shows that the relationship between the test people. For example, in the figure 4 at the very beginning, the witness of the event try to transmit the information to his or her friends. However, not so many people believe on it, and this restrict the flow speed of the information which fits the reality.

Meanwhile, figure 10 concludes that after a long period of time, if the event is very important, no matter what condition is the media, nearly all people who are interested in it will know it. And the development of medium make the soar of the number of the known people in advanced, and that fit the reality well.

5.2 Weakness

It is difficult to find all the data in the model to fit for more countries. And to extend the range of application, more parameter and constant need to be add in the program. Meanwhile, the model miss a point that there is some foreign friends do not live his or her mother land. Hence the way to convey a piece of information abroad is not that limited.

6 Prediction

Use the model to calculate the information's flow condition in different times, and fit the curve to get a predictive value. Take 0.8 value, recreation information happens in America as an example again. The total coverage in worldwide is showed in the following:

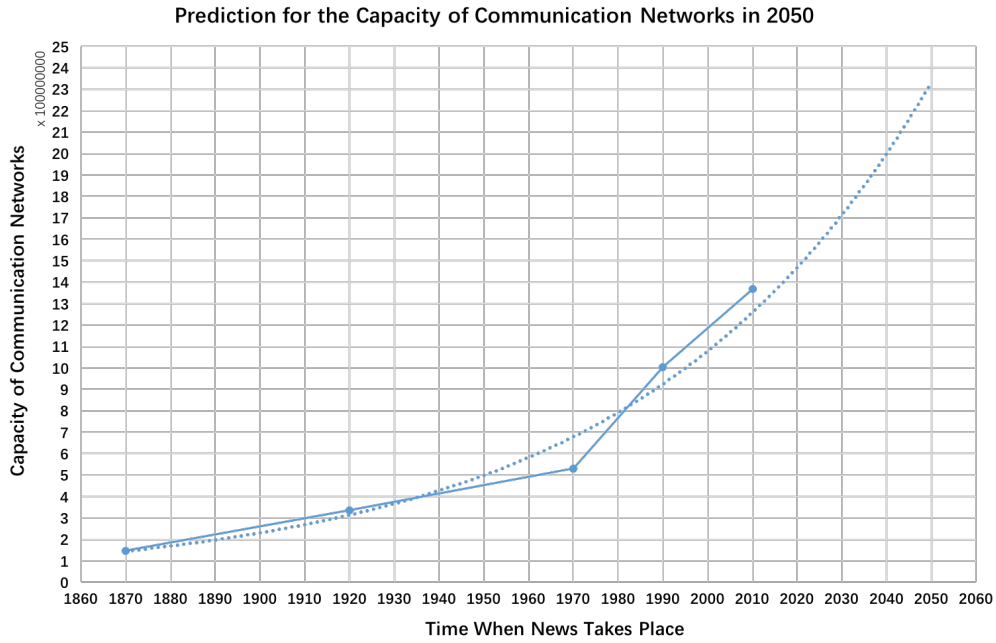


Figure 9: Prediction for the Capacity of Communication Network in 2050.

The function of the fitting curve is that

$$4.3 \times 10^{-5} \times e^{0.01543t} \tag{13}$$

where t is the year from D.C.

The results of the function represent for the quantity of covered rate of the information in the test five countries. Therefore, in 2050, the capacity of the network is 2.3×10^9. And the predictive population in 2050 is about 3.5×10^9. [19] The ratio is about 67% for the coverage of the information. Consider about the previous data, the ratio can be showed as following:

Years	America	China	Canada	Britain	India	Total	Known people	Ratio
1870	3856	35000	3100	363	20600	62918	14609	23.22
1920	10602	58260	4403	844	25100	99209	31601	31.85
1970	20321	69458	5593	2130	54816	152318	68354	44.88
1990	24871	113368	5744	2751	84642	231377	93065	40.22
2010	30875	133972	6318	3351	121019	295535	126709	42.87
2050	43901	130372	6398	4132	165655	350458	234885	67.02

Table 4: Network relationship from 1800 to 2050(predictive) [20] [21]

The number or people are in 10^4 unit. From the table we can see that the ratio of receiving the information are getting higher, and in 2050 it will reach a very high level. However, if there is no new approach to deliver the information, and assume that in 2050, the Internet covers everywhere around the world, we test the popularizing rate by our model. The result is as follows:

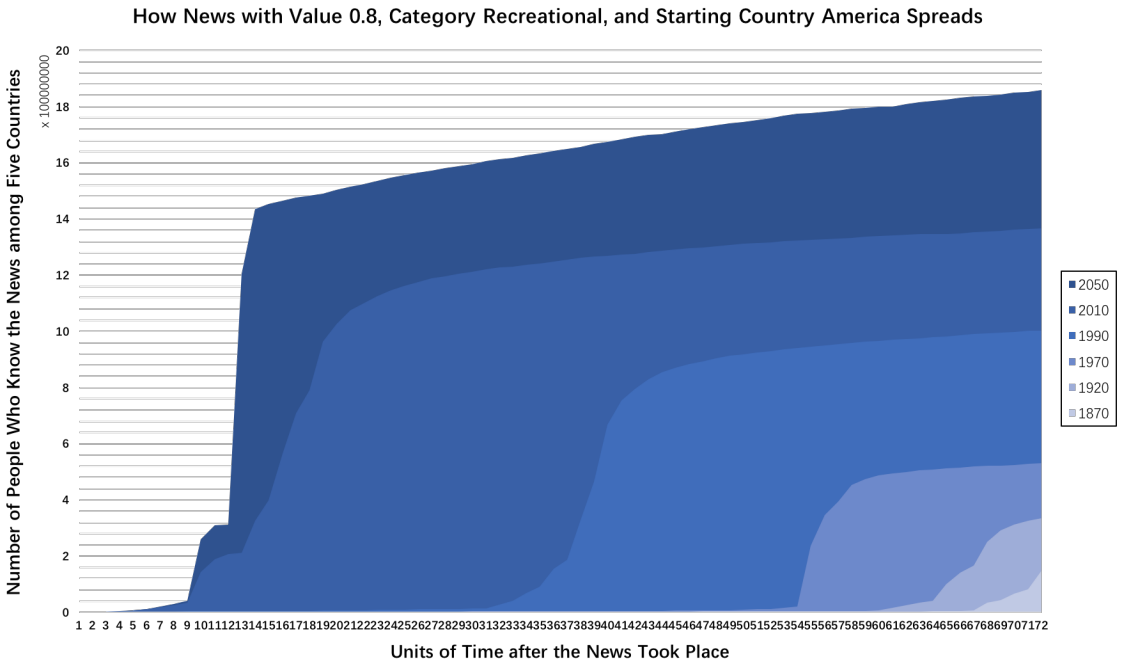


Figure 10: Prediction for the Relation of Communication Network in 2050.

In the figure we get that in 2050, by Internet the information can cover about 1.86×10^9, which is smaller than 2.3×10^9, the predictive value. Hence we conclude that there must be a new way to transmit the message, so that the message can deliver in an amazing speed and cover huge range of the world.

7 Future Work

Based on our model, several improvement can be done to make the model better:

1. To improve this model, more data needs collecting. Data about the coverage percentage of telegraph and television are lack.

2. We also need the data of interest in different fields of people. This can be obtained using questionnaire.

3. The time for medium to prepare article to publish needs further collecting.

4. In the model, we assume that people can only talk to their neighbors, however, it is not true in reality. It will be better if we can find a relationship radium which is closer to reality.

5. In our model, we only consider 6 kinds of medium, 5 countries and 4 categories of events, more situations need to be considered.

6. Moreover, we assume that there is no directly communication between countries, however, there are journalists staying in other countries who will send information to their countries directly.

7. People's interest can be influenced by the content of the news instead of just holding their own interest.

8. People's interest can be neutral or be interested to some extent.

In the future, we need to take this into consideration.

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Appendix

```
//
//  main.cpp
//  News
//


#include <iostream>
#include <random>
#include <time.h>
#include <stdio.h>
#include <stdlib.h>
#include "initialize.h"
#include "Class.h"

using namespace std;

#define P 0.2 //possibility for neighbors to meet in one unit of time

#define P_n 0.06 //minimum ratio of people who know the news needed for newspaper to
publish news
#define P_t 0.05 //minimum ratio of people who know the news needed for telegraph to
publish news
#define P_r 0.05 //minimum ratio of people who know the news needed for radio to publish
news
#define P_v 0.06 //minimum ratio of people who know the news needed for television to
publish news
#define P_i 0.04 //minimum ratio of people who know the news needed for internet to
publish news

#define T_inter 2 //units of time needed for news to transfer form one country to other
countries
#define T_n 10 //units of time needed for newspaper to prepare news
#define T_t 5 //units of time needed for telegraph to prepare news
#define T_r 5 //units of time needed for radio to prepare news
#define T_v 6 //units of time needed for television to prepare news
#define T_i 3 //units of time needed for internet to prepare news

bool d_n = 0, d_t = 0, d_r = 0, d_v = 0, d_i = 0; //whether each medium decides to
publish the news
int p_n = T_n, p_t = T_t, p_r = T_r, p_v = T_v, p_i = T_i; //units of time left for the
news to be published after decision

bool d_inter = 0; //whether the news is decided to be publish in foreign countries;
//units of time left for the news to be published in foreign countries after decision
int p_inter_n = T_n + T_inter, p_inter_t = T_t + T_inter, p_inter_r = T_r + T_inter,
p_inter_v = T_v + T_inter, p_inter_i = T_i + T_inter;

bool check_inter = 0; //whether foreign countries are checked

double value; //the value of the news
string category; //the category of the news
string country; //the starting country of the news



void check(Country *c, string name) {
    int i, j, s;
    s = 0;

    /*for(i = 1; i <= N; i ++) {
        for(j = 1; j <= N; j ++) {
            cout << (*c).a[i][j].i_inter << " ";
        }
        cout << endl;
    }
    cout<<endl;*/

    for(i = 1; i <= N; i ++) {
```

```
        for(j = 1; j <= N; j ++) {
            cout << (*c).a[i][j].w << " ";
            if((*c).a[i][j].w == 1) s++;
        }
        cout << endl;
    }
    cout << s << endl;

    //situation in the starting country
    if(name == country) {
        if(s >= N * N * P_n / value) d_n = 1;
        if(s >= N * N * P_t / value) d_t= 1;
        if(s >= N * N * P_r / value) d_r = 1;
        if(s >= N * N * P_v / value) d_v = 1;
        if(s >= N * N * P_i / value) d_i = 1;

        if(d_n == 1 && p_n > 0) p_n--;
        if(d_t == 1 && p_t > 0) p_t--;
        if(d_r == 1 && p_r > 0) p_r--;
        if(d_v == 1 && p_v > 0) p_v--;
        if(d_i == 1 && p_i > 0) p_i--;

        if(d_n == 1) cout<<"n decide"<<endl;
        if(d_t == 1) cout<<"t decide"<<endl;
        if(d_r == 1) cout<<"r decide"<<endl;
        if(d_v == 1) cout<<"v decide"<<endl;
        if(d_i == 1) cout<<"i decide"<<endl;

        if(p_n == 0) cout<<"n start"<<endl;
        if(p_t == 0) cout<<"t start"<<endl;
        if(p_r == 0) cout<<"r start"<<endl;
        if(p_v == 0) cout<<"v start"<<endl;
        if(p_i == 0) cout<<"i start"<<endl;
    }

    //situation in foreign countries
    else if (check_inter == 0) {
        if(p_n == 0 || p_v == 0 || p_i == 0) d_inter = 1;

        if(d_inter == 1 && p_inter_n > 0) p_inter_n--;
        if(d_inter == 1 && p_inter_t > 0) p_inter_t--;
        if(d_inter == 1 && p_inter_r > 0) p_inter_r--;
        if(d_inter == 1 && p_inter_v > 0) p_inter_v--;
        if(d_inter == 1 && p_inter_i > 0) p_inter_i--;

        if(d_inter == 1) cout<<"inter decide"<<endl;

        if(p_inter_n == 0) cout<<"n start"<<endl;
        if(p_inter_t == 0) cout<<"t start"<<endl;
        if(p_inter_r == 0) cout<<"r start"<<endl;
        if(p_inter_v == 0) cout<<"v start"<<endl;
        if(p_inter_i == 0) cout<<"i start"<<endl;

        check_inter = 1;
    }

    return;
}



void send(Country *c, int x, int y, int i, int j, string way, bool w) {

    //one would not receive the news if the one does not have interests in that category
    if(category == "financial" && (*c).a[x][y].i_f == 0) return;
    if(category == "political" && (*c).a[x][y].i_p == 0) return;
    if(category == "recreational" && (*c).a[x][y].i_r == 0) return;
    if(category == "scientific" && (*c).a[x][y].i_s == 0) return;

    //one in foreign countries would not receive the news if the one does not have
interests in foreign news
    if(w == 0 && (*c).a[x][y].i_inter == 0) return;
```

```
    //condition where people send news by talking
    if(way == "talk") {
        if(x != 0 && y != 0 && x != N+1 && y != N+1 && percent(P*(*c).a[i][j].b*value)
== 1 && (*c).a[x][y].w == 0 && (*c).a[i][j].b > 0) {
            (*c).a[x][y].w = 1;
            (*c).a[i][j].b = (1-(*c).a[i][j].m)*(*c).a[i][j].b + (*c).a[i]
[j].m*(*c).a[x][y].b;
            (*c).a[x][y].b = (1-(*c).a[x][y].m)*(*c).a[x][y].b + (*c).a[x]
[y].m*(*c).a[i][j].b;
        }
    }

    //condition where people send news though Internet
    if(way == "internet") {
        if(x != 0 && y != 0 && x != N+1 && y != N+1 && percent((*c).a[i][j].b*value) ==
1 && (*c).a[x][y].w == 0 && (*c).a[i][j].b > 0) {
            (*c).a[x][y].w = 1;
            (*c).a[i][j].b = (1-(*c).a[i][j].m)*(*c).a[i][j].b + (*c).a[i]
[j].m*(*c).a[x][y].b;
            (*c).a[x][y].b = (1-(*c).a[x][y].m)*(*c).a[x][y].b + (*c).a[x]
[y].m*(*c).a[i][j].b;
        }
    }
    return;
}



void spread(Country *c, string name) {
    int i, j, k;

    //situation in the starting country
    if(name == country) {
        for(i = 1; i <= N; i ++) {
            for(j = 1; j <= N; j ++) {

                //effect of individuals
                if((*c).a[i][j].w == 1) {

                    //eight neighbors
                    send(c,i-1,j-1,i,j,"talk",1);
                    send(c,i-1,j,i,j,"talk",1);
                    send(c,i-1,j+1,i,j,"talk",1);
                    send(c,i,j+1,i,j,"talk",1);
                    send(c,i+1,j+1,i,j,"talk",1);
                    send(c,i+1,j,i,j,"talk",1);
                    send(c,i+1,j-1,i,j,"talk",1);
                    send(c,i,j-1,i,j,"talk",1);

                    //M friends with internet connection
                    if((*c).a[i][j].w_i == 1)
                        for(k = 1; k <= M; k ++)
                            send(c,(*c).a[i][j].f[k][1],(*c).a[i][j].f[k]
[2],i,j,"internet",1);
                }

                //effect of media
                if(category == "financial" && (*c).a[i][j].i_f == 0) continue;
                if(category == "political" && (*c).a[i][j].i_p == 0) continue;
                if(category == "recreational" && (*c).a[i][j].i_r == 0) continue;
                if(category == "scientific" && (*c).a[i][j].i_s == 0) continue;

                if(p_n == 0 && (*c).a[i][j].w_n == 1 && percent(value) == 1) {
                    (*c).a[i][j].w = 1;
                    (*c).a[i][j].b = 1;
                }
                if(p_t == 0 && (*c).a[i][j].w_t == 1 && percent(value) == 1) {
                    (*c).a[i][j].w = 1;
                    (*c).a[i][j].b = 1;
                }
                if(p_r == 0 && (*c).a[i][j].w_r == 1 && percent(value) == 1) {
```

```
                    (*c).a[i][j].w = 1;
                    (*c).a[i][j].b = 1;
                }
                if(p_v == 0 && (*c).a[i][j].w_v == 1 && percent(value) == 1) {
                    (*c).a[i][j].w = 1;
                    (*c).a[i][j].b = 1;
                }
                if(p_i == 0 && (*c).a[i][j].w_i == 1 && percent(value) == 1) {
                    (*c).a[i][j].w = 1;
                    (*c).a[i][j].b = 1;
                }
            }
        }
    }

    //situation in foreign countries
    else {
        for(i = 1; i <= N; i ++) {
            for(j = 1; j <= N; j ++) {

                //effect of individuals
                if((*c).a[i][j].w == 1) {

                    //eight neighbors
                    send(c,i-1,j-1,i,j,"talk",0);
                    send(c,i-1,j,i,j,"talk",0);
                    send(c,i-1,j+1,i,j,"talk",0);
                    send(c,i,j+1,i,j,"talk",0);
                    send(c,i+1,j+1,i,j,"talk",0);
                    send(c,i+1,j,i,j,"talk",0);
                    send(c,i+1,j-1,i,j,"talk",0);
                    send(c,i,j-1,i,j,"talk",0);

                    //M friends with internet connection
                    if((*c).a[i][j].w_i == 1)
                        for(k = 1; k <= M; k ++)
                            send(c,(*c).a[i][j].f[k][1],(*c).a[i][j].f[k]
[2],i,j,"internet",0);
                }

                //effect of media
                if(category == "financial" && (*c).a[i][j].i_f == 0) continue;
                if(category == "political" && (*c).a[i][j].i_p == 0) continue;
                if(category == "recreational" && (*c).a[i][j].i_r == 0) continue;
                if(category == "scientific" && (*c).a[i][j].i_s == 0) continue;

                if(p_inter_n == 0 && (*c).a[i][j].w_n == 1 && percent((*c).a[i]
[j].i_inter * value) == 1) {
                    (*c).a[i][j].w = 1;
                    (*c).a[i][j].b = 1;
                }
                if(p_inter_t == 0 && (*c).a[i][j].w_t == 1 && percent((*c).a[i]
[j].i_inter * value) == 1) {
                    (*c).a[i][j].w = 1;
                    (*c).a[i][j].b = 1;
                }
                if(p_inter_r == 0 && (*c).a[i][j].w_r == 1 && percent((*c).a[i]
[j].i_inter * value) == 1) {
                    (*c).a[i][j].w = 1;
                    (*c).a[i][j].b = 1;
                }
                if(p_inter_v == 0 && (*c).a[i][j].w_v == 1 && percent((*c).a[i]
[j].i_inter * value) == 1) {
                    (*c).a[i][j].w = 1;
                    (*c).a[i][j].b = 1;
                }
                if(p_inter_i == 0 && (*c).a[i][j].w_i == 1 && percent((*c).a[i]
[j].i_inter * value) == 1) {
                    (*c).a[i][j].w = 1;
                    (*c).a[i][j].b = 1;
                }
            }
```

```
        }
    }
}

int main() {
    int i, start, x, y;
    Country America, China, Britain, Canada, India;
    //News news;
    initialize(&America, &China, &Britain, &Canada, &India);
    cin >> value >> category >> country;
    //cin >> value >> category;
    //news.s = s;

    //srand((unsigned)time(NULL));
    start = rand() % (N * N) + 1;
    x = start / N + 1;
    y = start % N;
    if(y == 0) y = N;

    if(country == "America") {
        America.a[x][y].b = 1;
        America.a[x][y].w = 1;
    }
    if(country == "China") {
        China.a[x][y].b = 1;
        China.a[x][y].w = 1;
    }
    if(country == "Britain") {
        Britain.a[x][y].b = 1;
        Britain.a[x][y].w = 1;
    }
    if(country == "Canada") {
        Canada.a[x][y].b = 1;
        Canada.a[x][y].w = 1;
    }
    if(country == "India") {
        India.a[x][y].b = 1;
        India.a[x][y].w = 1;
    }

    for(i = 1; i <= 48; i++) {
        check_inter = 0;
        check(&America, "America");
        cout<<"America"<<endl;
        check(&China, "China");
        cout<<"China"<<endl;
        check(&Britain, "Britain");
        cout<<"Britain"<<endl;
        check(&Canada, "Canada");
        cout<<"Canada"<<endl;
        check(&India, "India");
        cout<<"India"<<endl;


        spread(&America,"America");
        spread(&China,"China");
        spread(&Britain,"Britain");
        spread(&Canada,"Canada");
        spread(&India,"India");

        //getchar();
    }
    return 0;
}
```

```
//
//  Class.h
//  News
//


#ifndef Class_h
#define Class_h
#include "initialize.h"

#define M 5
#define N 50

/*class News{
public:
    double s; //importance of the news

};*/

class Individual{
public:
    double b; //one's attitude towards the news
    double m; //one's likelihood to believe others
    bool w; //whether the one know the news

    bool w_n; //whether the one covered by newspapers
    bool w_t; //whether the one covered by telegraph
    bool w_r; //whether the one covered by radio
    bool w_v; //whether the one covered by television
    bool w_i; //whether the one covered by internet
    //bool w_c; //whether the one has cellphone

    bool i_inter; //whether interested in news from foreign countries

    bool i_f; //whether interested in financial news
    bool i_p; //whether interested in political news
    bool i_r; //whether interested in recreational news
    bool i_s; //whether interested in scientific news

    int f[M+1][3]; //one's M friends with internet connection
};

class Country{
public:
    int population; //population of this country

    double newspaper; //coverage rate of newspapers
    double telegraph; //coverage rate of telegraph
    double radio; //coverage rate of radio
    double television; //coverage rate of televisions
    double internet; //coverage rate of internet
    //double cellphone; //coverage rate of cellphone

    double inter; //interests in news form foreign countries

    double financial; //interests in financial news
    double political; //interests in political news
    double recreational; //interests in recreational news
    double scientific; //interests in scientific news

    Individual a[N+2][N+2]; //condition of a part of individuals in this country
};

#endif /* Class_h */
```

```
//
//  initialize.h
//  News
//

#ifndef initialize_h
#define initialize_h
#include "Class.h"
#include <random>

using namespace std;


bool percent(double p) {
    random_device rd;
    mt19937 mt(rd());
    uniform_int_distribution<int> ran(0,100);
    if(ran(mt) / 100.0 <= p) return 1;
    else return 0;
}

void initialize(Country *America, Country *China,Country *Britain,Country
*Canada,Country *India) {
    int i,j,k,l,x,y,t,m,s;

    (*America).population = 309350000;
    (*America).newspaper = 0.6;
    (*America).telegraph = 0.1;
    (*America).radio = 0.5;
    (*America).television = 0.5;
    (*America).internet = 0.76;
    (*America).inter = 0.8;
    (*America).financial = 0.5;
    (*America).political = 0.6;
    (*America).recreational = 0.7;
    (*America).scientific = 0.4;

    (*China).population = 1340910000;
    (*China).newspaper = 0.7;
    (*China).telegraph = 0.1;
    (*China).radio = 0.6;
    (*China).television = 0.3;
    (*China).internet = 0.14;
    (*China).inter = 0.7;
    (*China).financial = 0.4;
    (*China).political = 0.5;
    (*China).recreational = 0.6;
    (*China).scientific = 0.3;

    (*Britain).population = 62770000;
    (*Britain).newspaper = 0.6;
    (*Britain).telegraph = 0.1;
    (*Britain).radio = 0.5;
    (*Britain).television = 0.4;
    (*Britain).internet = 0.73;
    (*Britain).inter = 0.8;
    (*Britain).financial = 0.8;
    (*Britain).financial = 0.6;
    (*Britain).political = 0.5;
    (*Britain).recreational = 0.7;
    (*Britain).scientific = 0.5;

    (*Canada).population = 34010000;
    (*Canada).newspaper = 0.6;
    (*Canada).telegraph = 0.1;
    (*Canada).radio = 0.5;
    (*Canada).television = 0.4;
    (*Canada).internet = 0.74;
    (*Canada).inter = 0.7;
```

```
(*Canada).financial = 0.5;
(*Canada).political = 0.6;
(*Canada).recreational = 0.6;
(*Canada).scientific = 0.4;

(*India).population = 1205620000;
(*India).newspaper = 0.5;
(*India).telegraph = 0.1;
(*India).radio = 0.4;
(*India).television = 0.3;
(*India).internet = 0.04;
(*India).inter = 0.5;
(*India).financial = 0.5;
(*India).political = 0.5;
(*India).recreational = 0.6;
(*India).scientific = 0.2;

for(i = 0; i <= N + 1; i++) {
    for(j = 0; j <= N + 1; j ++) {
        (*America).a[i][j].w = 0;
        (*China).a[i][j].w = 0;
        (*Britain).a[i][j].w = 0;
        (*Canada).a[i][j].w = 0;
        (*India).a[i][j].w = 0;
    }
}

random_device rd;
mt19937 mt(rd());
uniform_int_distribution<int> ran1(0,200);
uniform_int_distribution<int> ran2(0,50);


for(i = 1; i <= N; i ++) {
    for(j = 1; j <= N; j ++) {
        (*America).a[i][j].b = ran1(mt) / 100.0 - 1;
        (*China).a[i][j].b = ran1(mt) / 100.0 - 1;
        (*Britain).a[i][j].b = ran1(mt) / 100.0 - 1;
        (*Canada).a[i][j].b = ran1(mt) / 100.0 - 1;
        (*India).a[i][j].b = ran1(mt) / 100.0 - 1;

        (*America).a[i][j].m = ran2(mt) / 100.0;
        (*China).a[i][j].m = ran2(mt) / 100.0;
        (*Britain).a[i][j].m = ran2(mt) / 100.0;
        (*Canada).a[i][j].m = ran2(mt) / 100.0;
        (*India).a[i][j].m = ran2(mt) / 100.0;

        (*America).a[i][j].w_n = percent((*America).newspaper);
        (*America).a[i][j].w_t = percent((*America).telegraph);
        (*America).a[i][j].w_r = percent((*America).radio);
        (*America).a[i][j].w_v = percent((*America).television);
        (*America).a[i][j].w_i = percent((*America).internet);
        (*America).a[i][j].i_inter = percent((*America).inter);
        (*America).a[i][j].i_f = percent((*America).financial);
        (*America).a[i][j].i_p = percent((*America).political);
        (*America).a[i][j].i_r = percent((*America).recreational);
        (*America).a[i][j].i_s = percent((*America).scientific);

        (*China).a[i][j].w_n = percent((*China).newspaper);
        (*China).a[i][j].w_t = percent((*China).telegraph);
        (*China).a[i][j].w_r = percent((*China).radio);
        (*China).a[i][j].w_v = percent((*China).television);
        (*China).a[i][j].w_i = percent((*China).internet);
        (*China).a[i][j].i_inter = percent((*China).inter);
        (*China).a[i][j].i_f = percent((*China).financial);
        (*China).a[i][j].i_p = percent((*China).political);
        (*China).a[i][j].i_r = percent((*China).recreational);
        (*China).a[i][j].i_s = percent((*China).scientific);

        (*Britain).a[i][j].w_n = percent((*Britain).newspaper);
        (*Britain).a[i][j].w_t = percent((*Britain).telegraph);
        (*Britain).a[i][j].w_r = percent((*Britain).radio);
```

```
            (*Britain).a[i][j].w_v = percent((*Britain).television);
            (*Britain).a[i][j].w_i = percent((*Britain).internet);
            (*Britain).a[i][j].i_inter = percent((*Britain).inter);
            (*Britain).a[i][j].i_f = percent((*Britain).financial);
            (*Britain).a[i][j].i_p = percent((*Britain).political);
            (*Britain).a[i][j].i_r = percent((*Britain).recreational);
            (*Britain).a[i][j].i_s = percent((*Britain).scientific);

            (*Canada).a[i][j].w_n = percent((*Canada).newspaper);
            (*Canada).a[i][j].w_t = percent((*Canada).telegraph);
            (*Canada).a[i][j].w_r = percent((*Canada).radio);
            (*Canada).a[i][j].w_v = percent((*Canada).television);
            (*Canada).a[i][j].w_i = percent((*Canada).internet);
            (*Canada).a[i][j].i_inter = percent((*Canada).inter);
            (*Canada).a[i][j].i_f = percent((*Canada).financial);
            (*Canada).a[i][j].i_p = percent((*Canada).political);
            (*Canada).a[i][j].i_r = percent((*Canada).recreational);
            (*Canada).a[i][j].i_s = percent((*Canada).scientific);

            (*India).a[i][j].w_n = percent((*India).newspaper);
            (*India).a[i][j].w_t = percent((*India).telegraph);
            (*India).a[i][j].w_r = percent((*India).radio);
            (*India).a[i][j].w_v = percent((*India).television);
            (*India).a[i][j].w_i = percent((*India).internet);
            (*India).a[i][j].i_inter = percent((*India).inter);
            (*India).a[i][j].i_f = percent((*India).financial);
            (*India).a[i][j].i_p = percent((*India).political);
            (*India).a[i][j].i_r = percent((*India).recreational);
            (*India).a[i][j].i_s = percent((*India).scientific);

            for(k = 1; k <= M; k ++) {
                if((*America).a[i][j].w_i == 1)
                {
                    s = 0;
                    while(1) {
                        t = rand() % (N * N) + 1;
                        x = t / N + 1;
                        y = t % N;
                        if(y == 0) {
                            x--;
                            y = N;
                        }
                        while((*America).a[x][y].w_i == 0) {
                            t = rand() % (N * N) + 1;
                            x = t / N + 1;
                            y = t % N;
                            if(y == 0) {
                                x--;
                                y = N;
                            }
                        }
                        if(x == i && y == j) continue;
                        m = 1;
                        for(l = 1; l <= k - 1; l ++) {
                            if((*America).a[i][j].f[l][1] == x && (*America).a[i]
[j].f[l][2] == y) {
                                m = 0;
                                break;
                            }
                        }
                        if(m == 1) {
                            (*America).a[i][j].f[k][1] = x;
                            (*America).a[i][j].f[k][2] = y;
                            break;
                        }
                        if(s == 10) break;
                        s++;
                    }
                }

                if((*China).a[i][j].w_i == 1)
                {
```

```
                    s = 0;
                    while(1) {
                        t = rand() % (N * N) + 1;
                        x = t / N + 1;
                        y = t % N;
                        if(y == 0) {
                            x--;
                            y = N;
                        }
                        while((*China).a[x][y].w_i == 0) {
                            t = rand() % (N * N) + 1;
                            x = t / N + 1;
                            y = t % N;
                            if(y == 0) {
                                x--;
                                y = N;
                            }
                        }
                        m = 1;
                        for(l = 1; l <= k - 1; l ++) {
                            if((*China).a[i][j].f[l][1] == x && (*China).a[i][j].f[l][2]
== y) {
                                m = 0;
                                break;
                            }
                        }
                        if(m == 1) {
                            (*China).a[i][j].f[k][1] = x;
                            (*China).a[i][j].f[k][2] = y;
                            break;
                        }
                        if(s == 10) break;
                        s++;
                    }
                }

                if((*Britain).a[i][j].w_i == 1)
                {
                    s = 0;
                    while(1) {
                        t = rand() % (N * N) + 1;
                        x = t / N + 1;
                        y = t % N;
                        if(y == 0) {
                            x--;
                            y = N;
                        }
                        while((*Britain).a[x][y].w_i == 0) {
                            t = rand() % (N * N) + 1;
                            x = t / N + 1;
                            y = t % N;
                            if(y == 0) {
                                x--;
                                y = N;
                            }
                        }
                        m = 1;
                        for(l = 1; l <= k - 1; l ++) {
                            if((*Britain).a[i][j].f[l][1] == x && (*Britain).a[i]
[j].f[l][2] == y) {
                                m = 0;
                                break;
                            }
                        }
                        if(m == 1) {
                            (*Britain).a[i][j].f[k][1] = x;
                            (*Britain).a[i][j].f[k][2] = y;
                            break;
                        }
                        if(s == 10) break;
                        s++;
                    }
```

```
                }

                if((*Canada).a[i][j].w_i == 1)
                {
                    s = 0;
                    while(1) {
                        t = rand() % (N * N) + 1;
                        x = t / N + 1;
                        y = t % N;
                        if(y == 0) {
                            x--;
                            y = N;
                        }
                        while((*Canada).a[x][y].w_i == 0) {
                            t = rand() % (N * N) + 1;
                            x = t / N + 1;
                            y = t % N;
                            if(y == 0) {
                                x--;
                                y = N;
                            }
                        }
                        m = 1;
                        for(l = 1; l <= k - 1; l ++) {
                            if((*Canada).a[i][j].f[l][1] == x && (*Canada).a[i][j].f[l]
[2] == y) {
                                m = 0;
                                break;
                            }
                        }
                        if(m == 1) {
                            (*Canada).a[i][j].f[k][1] = x;
                            (*Canada).a[i][j].f[k][2] = y;
                            break;
                        }
                        if(s == 10) break;
                        s++;
                    }
                }

                if((*India).a[i][j].w_i == 1)
                {
                    s = 0;
                    while(1) {
                        t = rand() % (N * N) + 1;
                        x = t / N + 1;
                        y = t % N;
                        if(y == 0) {
                            x--;
                            y = N;
                        }
                        while((*India).a[x][y].w_i == 0) {
                            t = rand() % (N * N) + 1;
                            x = t / N + 1;
                            y = t % N;
                            if(y == 0) {
                                x--;
                                y = N;
                            }
                        }
                        m = 1;
                        for(l = 1; l <= k - 1; l ++) {
                            if((*India).a[i][j].f[l][1] == x && (*India).a[i][j].f[l][2]
== y) {
                                m = 0;
                                break;
                            }
                        }
                        if(m == 1) {
                            (*India).a[i][j].f[k][1] = x;
                            (*India).a[i][j].f[k][2] = y;
                            break;
```

```
                        }
                        if(s == 10) break;
                        s++;
                    }
                }
            }
        }
    }
}

#endif /* initialize_h */
```