A Simulation Study on Rumor Propagation in Online Social Networks like Twitter

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1. Problem statement

A lot has been studied in rumor spreading field, some of which build numeric models to describe the spreading procedure. Those models are mostly simulating the rumor spreading through word-of-mouth in real society. The rumor spreads locally in a region and spills over out of the region where it has never been spread with movement of people and information.

Compared to other social network sites like Facebook, people use Twitter mostly to broadcast news and their status within 140 words. One of the characteristic of Twitter is that there are two kinds of relationship between users instead of one-follow each other, or follow in one direction. This characteristic makes it different when transmitting information through users.

We often observe that a rumor or a popular topic can be spread with a high rapid. However, in this kind of network, not all users hear from each other, thus the rumor spreading will result in different ways. Hence, studying the model of like twitter network is interesting and meaningful to abstract the complicated social network.

2. Hypothesis

2.1 Directed network

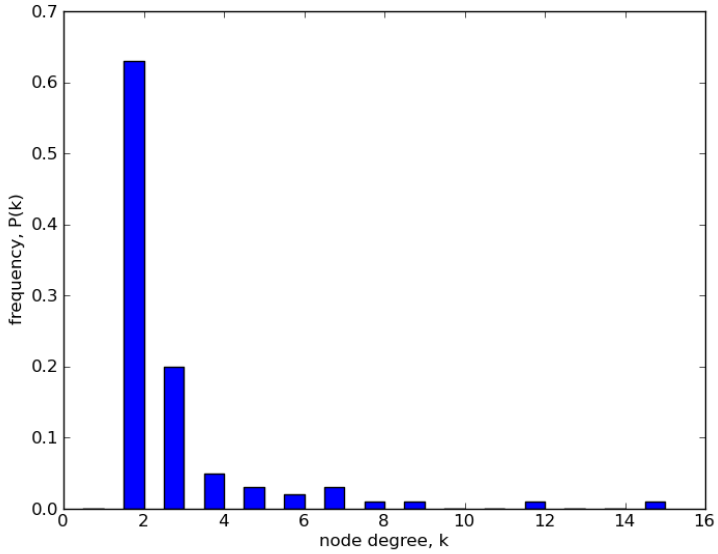
Twitter-like network is a directed network, in which users always searching for those who have more influence. In order to gain more attention and more influence, those users who have many followers usually follow back. So there are two relationships in the network:

1) Friendship
   Two users follow each other
2) Followership
   One user follows the other, but the other does not follow back.

2.2 Scale-free network

When you decide to follow someone in Twitter, you may consider how many people are following him/her. **The more followers he/she has, the more likely you reasons for them to make the same decision**. As a result, there should be a few people who have more followers above the average. Therefore it is reasonable to assume that these people have more influence on others when they spread some information or broadcast their options.

The network described above is called scale-free network. A scale free network is a network whose **degree distribution** has the "long tail" phenomenon.



The fraction P(k) of nodes in network having k connections to other nodes goes for large values of k as

P(k)~k^{-r}, where r is a parameter whose value is typically in the range 2 < r < 3.

2.3 Rumor spreading model

Suppose that we build the rumor spreading model in a scale-free network. People are divided into three different groups: **Igorant**, **Spreader** and **Stifer**

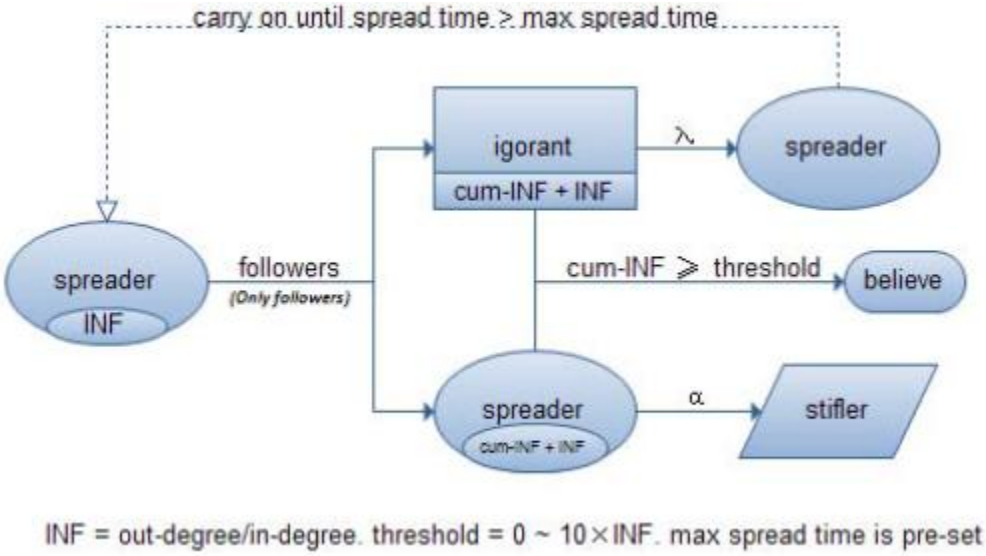
- **Igorant**
  Have never heard of the rumor.
- **Spreader**
  Spread the rumor.
- **Stifer**
  Know about the rumor but don't spread it.

1) If the receiver is an igorant, he will turn to be a spreader at the possibility of **λ**.

2) If the receiver is a stifler or also a spreader, the resource spreader will turn to be a stifler at the possibility of 1/α. Here α means the number of neighbor spreader or stifler one spreader may spread the rumor to.

3. Overview of method

Based on the above assumption, we build the model as following:



INF = out-degree/in-degree. threshold = 0 ~ 10×INF. max spread time is pre-set

The entire process consists of 7 steps:

1) Create a scale-free network that has a “long tail” degree distribution
2) Calculate each of every node’s INF
   INF = out-degree/in-degree
3) Start the rumor by making a few of nodes become spreaders
4) Define max-spread-time. Each spreader spread the rumor no more than the max time of time step.
5) Set threshold randomly between 0 and INF times the threshold multiplier
6) The rumor spread from the spreader to his neighbors. Assume A is one of them.
   - If A is an ignorant, he will have a chance of p to become a spreader.
   - If A is a spreader already, he will have a chance of r to become a stifler.
   - If A is a stifler, there is no chance that the rumor can reach to him.
7) Repeat the above 1-6 steps

4. Data to be used

- Solution 1:
  Co-author data from http://snap.stanford.edu/data/ca-GrQc.html which has been used in class and has a "long tail degree" distribution. We can do some modification for this case.
- Solution 2:
  Use some tools to generate scale free network such as Netlogo
- Solution 3:
  Generate data by adding "random" in regular graph like we did in class.

5. Related work

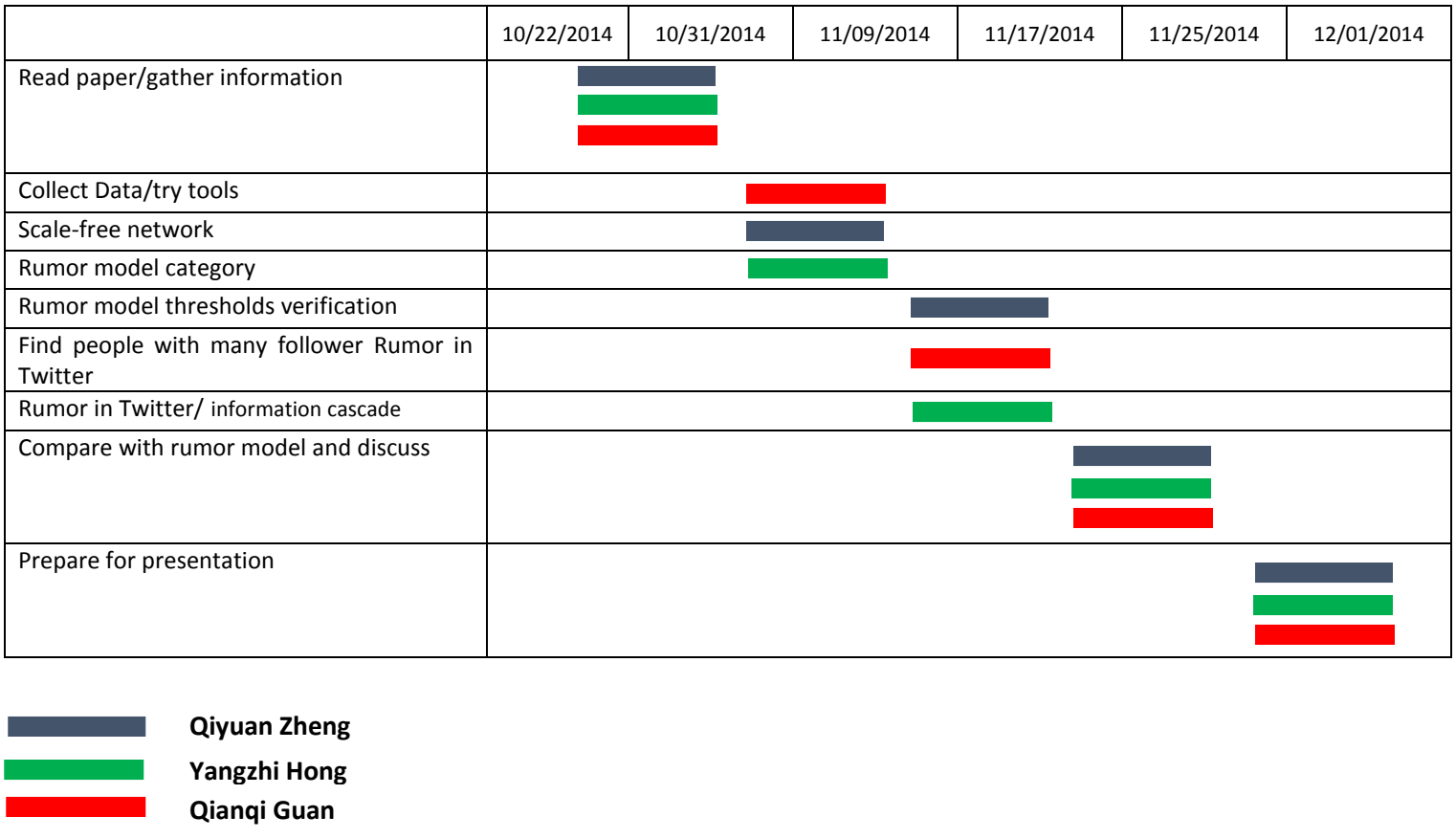
There are some existing researches about the rumor propagation models. The differences in our research as following:

1) The existing researches consider only undirected graph [1] [2]; however we plan to study based on a directed graph.
2) The existing researches don't include the mechanism for people to determine whether or not to believe the rumor [1] [2]; however we introduce a condition under which people believe the rumor, which is related to the rumor influence in reality.
3) **The existing researches [3] don't compare the model with the real information cascade in Twitter; however we will compare the model with real behavior of information cascade in Twitter.**

6. Project execution plan

ID	Task	Owner	Time
1	Read paper/gather information	Qiyuan Zheng Yangzhi Hong Qianqi Guan	10/22/2014-10/31/2014
2	Collect data/try some tools	Qianqi Guan	11/01/2014-11/08/2014
3	Build up scale-free network • P(k) • Degree distribution	Qiyuan Zheng	11/01/2014-11/08/2014
4	Build rumor model • Category • Try different thresholds	 Yangzhi Hong Qiyuan Zheng	 11/01/2014-11/08/2014 11/09/2014-11/16/2014
5	Behavior of rumor in Twitter • Find a people with many followers • Analysis rumor in Twitter/information cascade	 Qianqi Guan Yangzhi Hong	 11/09/2014-11/16/2014 11/09/2014-11/16/2014
6	Compare with the rumor model and discuss	Qiyuan Zheng Yangzhi Hong Qianqi Guan	11/17/2014-11/24/2014
7	Prepare for presentation	Qiyuan Zheng Yangzhi Hong Qianqi Guan	11/25/2014-12/01/2014

Timeline



References

[1] Fang, Z., S. Guang-ya, and L. Pi, A Survey for Rumor Propagation Models. Complex Systems and Complexity Science, 2009. 6(4): p. 1-11.

[2] Kawachi, K., et al., A rumor transmission model with various contact interactions. Journal of theoretical biology, 2008. 253(1): p. 55-60.

[3] Dechun, L., Xi Ch., Rumar Propagationin Online Social Networks Like Twitter. Third International Conference on Multimedia Information Networking and Security, 2011