Computational Models for Social Influence and Diffusion

Yang Yang and Jie Tang

Zhejiang University

Tsinghua University

Homepage: http://yangy.org   http://keg.cs.tsinghua.edu.cn/jietang/

Part I:
Learning User Behavior Influence in Large-Scale Social Networks

Networked World

facebook

- **1.65 billion** MAU
- **2.5 trillion** minutes/month

twitter

- **255 million** MAU
- **Peak: 143K** tweets/s

amazon.com

- **304 million** active users
- **14 billion** items/year

WeChat
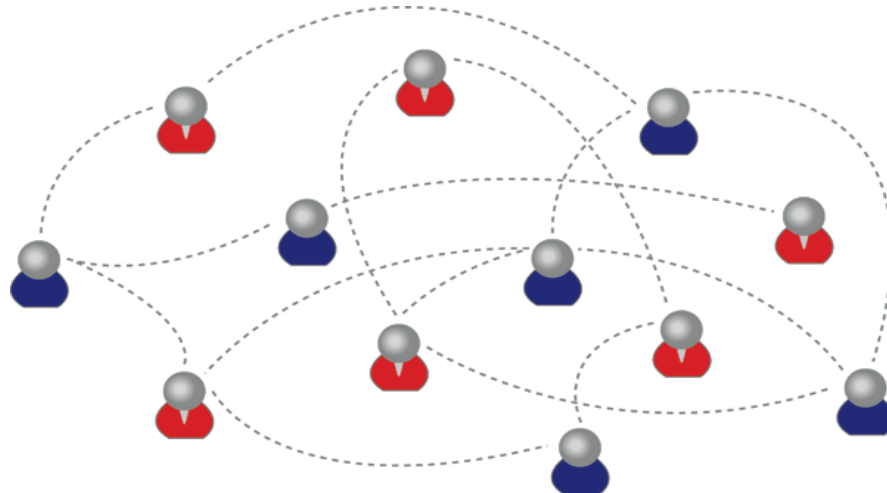
- QQ: **800 million** MAU
- **WeChat: 700 million** MAU

新浪微博 weibo.com

- **220 million** users
- **influencing** our daily life

Alibaba Group 阿里巴巴集团

- **~700 million** trans. (alipay)
- **120.7 billion** on 11/11

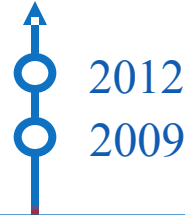# What is a social network?

- A social network is:
  - a **graph** made up of :
  - a set of **individuals**, called "nodes", and
  - tied by one or more **interdependency**, such as friendship, called "edges".
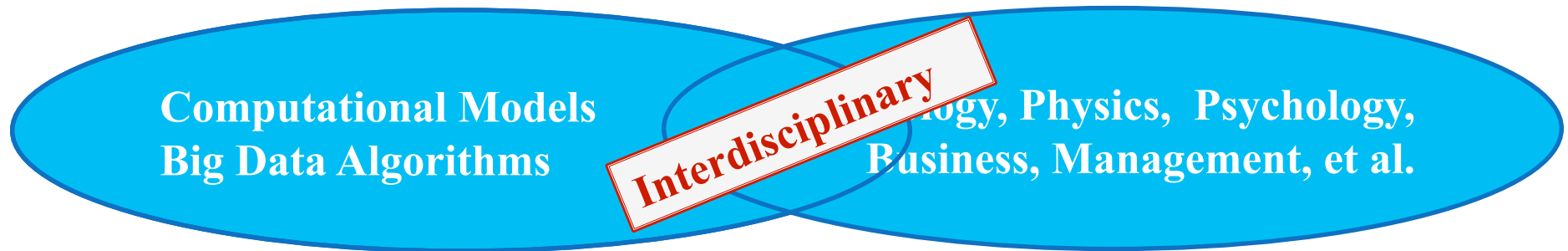
Computational Social Science

Computational Social Science [Giles]　　　　2012

Computational Social Science [Lazer et al.]　　2009

"A field is emerging that leverages the capacity to collect and analyze **data at a scale** that may reveal patterns of *individual* and *group behaviors*."

David Lazer, Alex Pentland, Lada Adamic, Sinan Aral, Alber-Laszlo Barabasi, et al. from *Departments of Sociology, Computer Science, Physics, Business, Government,* etc. at *Harvard, MIT, Northeastern, Northwestern, Columbia, Cornell, etc.*

**Computational Models
Big Data Algorithms**

Interdisciplinary

...ogy, Physics, Psychology, Business, Management, et al.**

1. **David Lazer et al. Computational Social Science. *Science* 2009.**
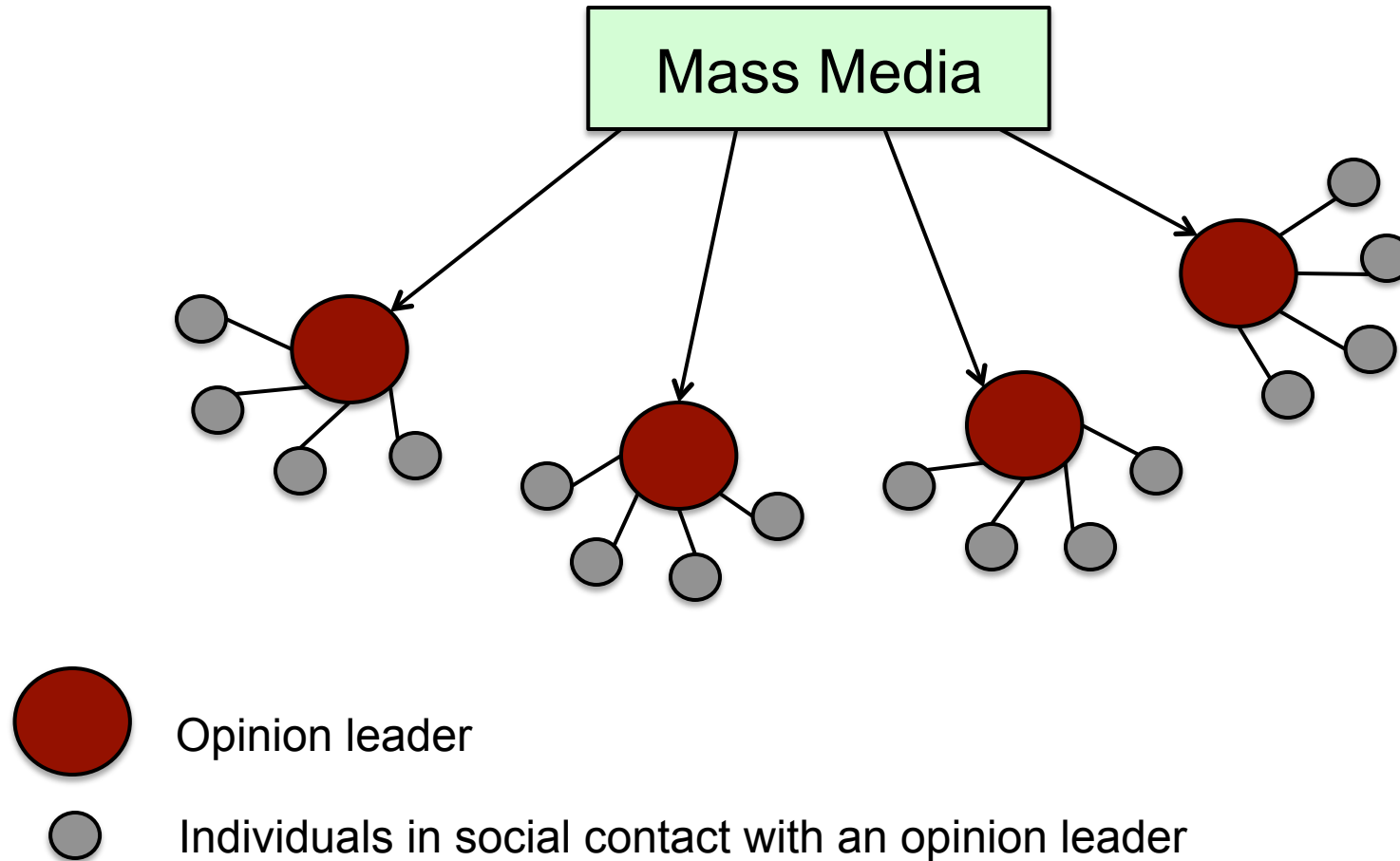2. James Giles. Computational Social Science: Making the Links. **Nature** 2012.

What is Social Influence?

- Social influence occurs when one's opinions, emotions, or behaviors are affected by others, intentionally or unintentionally.[1]

  – Peer Pressure

  – Opinion leadership

  – Conformity

  – …

[1] http://en.wikipedia.org/wiki/Social_influence

Two-step Flow Theory

The theory of "Three Degree of Influence"

Six degree of separation[1]

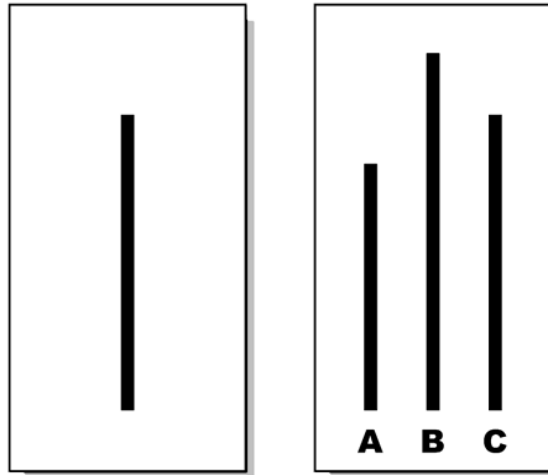Dario de Judicibus Personal Network

Three degree of Influence[2]

You are able to **influence** up to >1,000,000 persons in the world, according to the Dunbar's number[3].

[1] S. Milgram. The Small World Problem. Psychology Today, 1967, Vol. 2, 60–67

[2] J.H. Fowler and N.A. Christakis. The Dynamic Spread of Happiness in a Large Social Network: Longitudinal Analysis Over 20 Years in the Framingham Heart Study. British Medical Journal 2008; 337: a2338

[3] R. Dunbar. Neocortex size as a constraint on group size in primates. Human Evolution, 1992, 20: 469–493.

Asch's Experiment

Which line matches the first line, A, B, or C?

74% of the participants followed the majority judgment on at least one trial, even when the majority was wrong.

Does Social Influence Really Matter?

- ## Case 1: Social influence and political mobilization[1]
  - – Will online political mobilization really work?

A controlled trial (with 61M users on FB)

- Social msg group: was shown with msg that indicates one's friends who have made the votes.

- Informational msg group: was shown with msg that indicates how many other.

- Control group: did not receive any msg.

a Informational message

Today is Election Day   What's this? • close

VOTE   Find your polling place on the U.S. Politics Page and click the "I Voted" button to tell your friends you voted.   0 1 1 5 5 3 7 6 People on Facebook Voted

I Voted

Social message

Today is Election Day   What's this? • close

VOTE   Find your polling place on the U.S. Politics Page and click the "I Voted" button to tell your friends you voted.   0 1 1 5 5 3 7 6 People on Facebook Voted

I Voted

Jaime Settle, Jason Jones, and 18 other friends have voted.

[1] R. M. Bond, C. J. Fariss, J. J. Jones, A. D. I. Kramer, C. Marlow, J. E. Settle and J. H. Fowler. A 61-million-person experiment in social influence and political mobilization. Nature, 489:295-298, 2012.
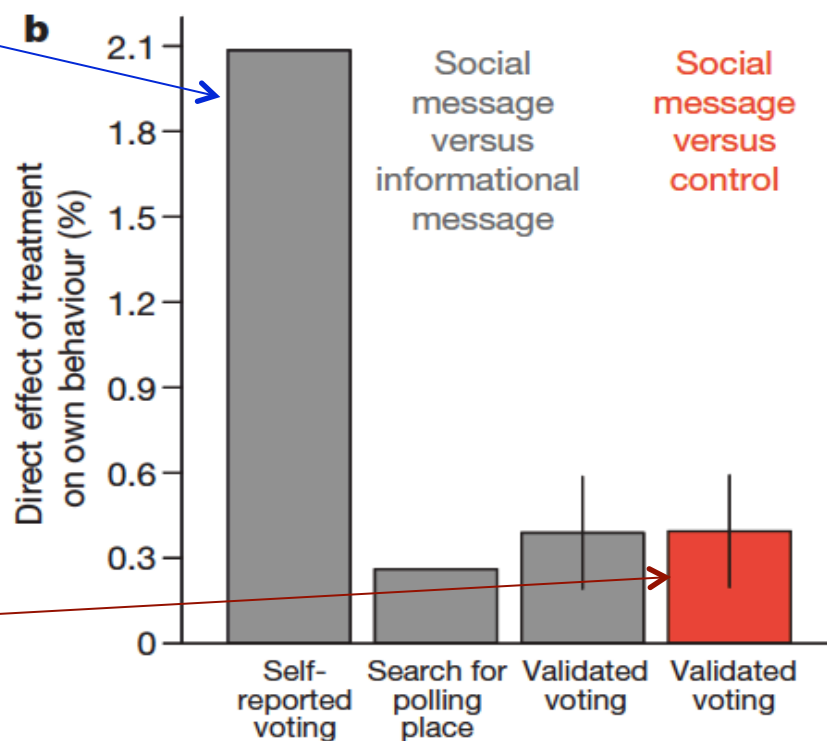
Does Social Influence Really Matter?

Social msg group v.s. Info msg group

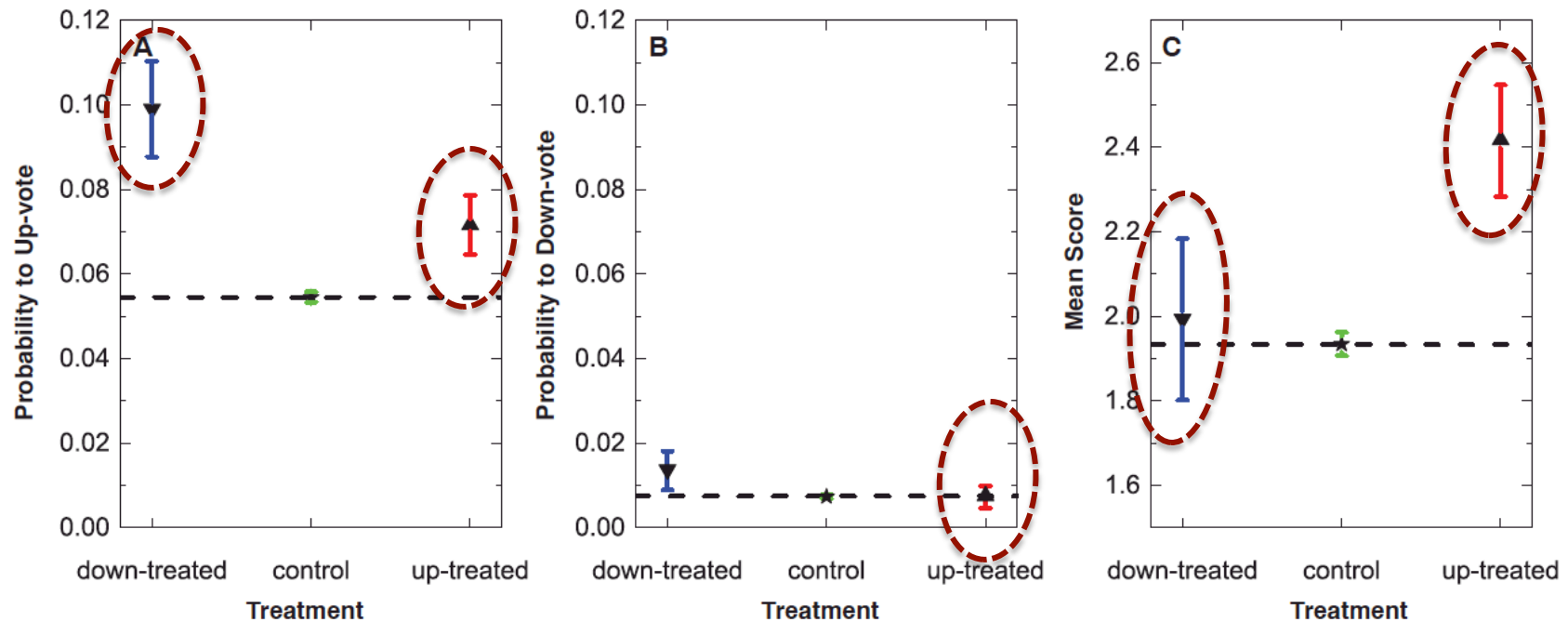**Result:** The former were 2.08% (*t*-test, *P*<0.01) more likely to click on the "I Voted" button

Social msg group v.s. Control group

Result: The former were 0.39% (*t*-test, *P*=0.02) more likely to **actually vote** (via examination of public voting records)

[1] R. M. Bond, C. J. Fariss, J. J. Jones, A. D. I. Kramer, C. Marlow, J. E. Settle and J. H. Fowler. A 61-million-person experiment in social influence and political mobilization. Nature, 489:295-298, 2012.
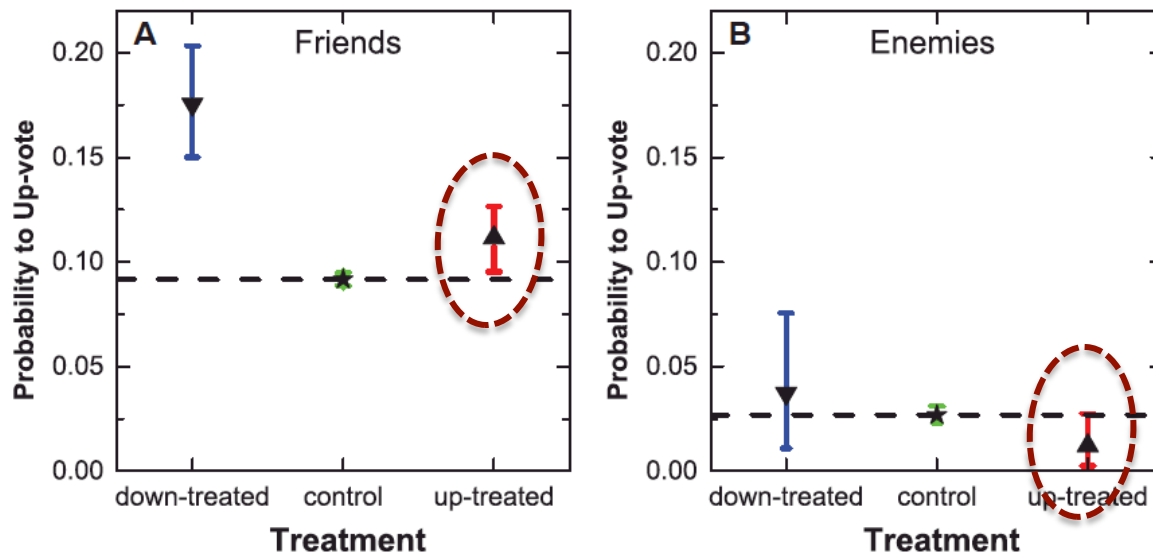
Does Social Influence Really Matter?

- ## Case 2: Social influence distorts decision-making [1]
  - Two treatment groups and a control group:
    - Up-treated: comments were artificially given a +1 rating;
    - Down-treated: comments were given a -1 rating;

[1] L. Muchnik, S. Aral, S. J. Taylor. Social Influence Bias: A Randomized Experiment. Science, Vol. 341, Issue 6146, page 647-651, 2013.

Does Social Influence Really Matter?

- ## Case 2: Social influence distorts decision-making [1]
  - Define a user's "friends" and "enemies" according to they "like" or "dislike" her (a feature of the studied web site)
  - Friendship moderates the impact of social influence.

Friends were more likely to up-vote a comment than enemies (9.2% versus 2.7%).

Friends tend to herd on current positive ratings (0.122 versus 0.092).

[1] L. Muchnik, S. Aral, S. J. Taylor. Social Influence Bias: A Randomized Experiment. Science, Vol. 341, Issue 6146, page 647-651, 2013.

We applied social influence to help real applications

—in very big Tencent networks

Big Data Analytics in Game Data

- Online gaming is one of the largest industries on the Internet…

- Facebook
  - 250 million users play games monthly
  - 200 games with more than 1 million active users
  - 12% of the company's revenue is from games

- Tencent (Market Cap: ~150B $)
  - More than 400 million gaming users
  - 50% of Tencent's overall revenue is from games

[1] Zhanpeng Fang, Xinyu Zhou, Jie Tang, Wei Shao, A.C.M. Fong, Longjun Sun, Ying Ding, Ling Zhou, and Jarder Luo. Modeling Paying Behavior in Online Social Networks. **CIKM'14.**

Two games: DNF

- Dungeon & Fighter Online (DNF)
  - A game of melee combat between users and large number of underpowered enemies
  - 400+ million users, the 2nd largest online game in China
  - Users in the game can fight against enemies by individuals or by groups

Two games: QQ Speed

- QQ Speed
  - A racing game that users can partake in competitions to play against other users
  - 200+ million users
  - Users can race against other users by individuals or forma a group to race together
  - Some users may pay…

Task

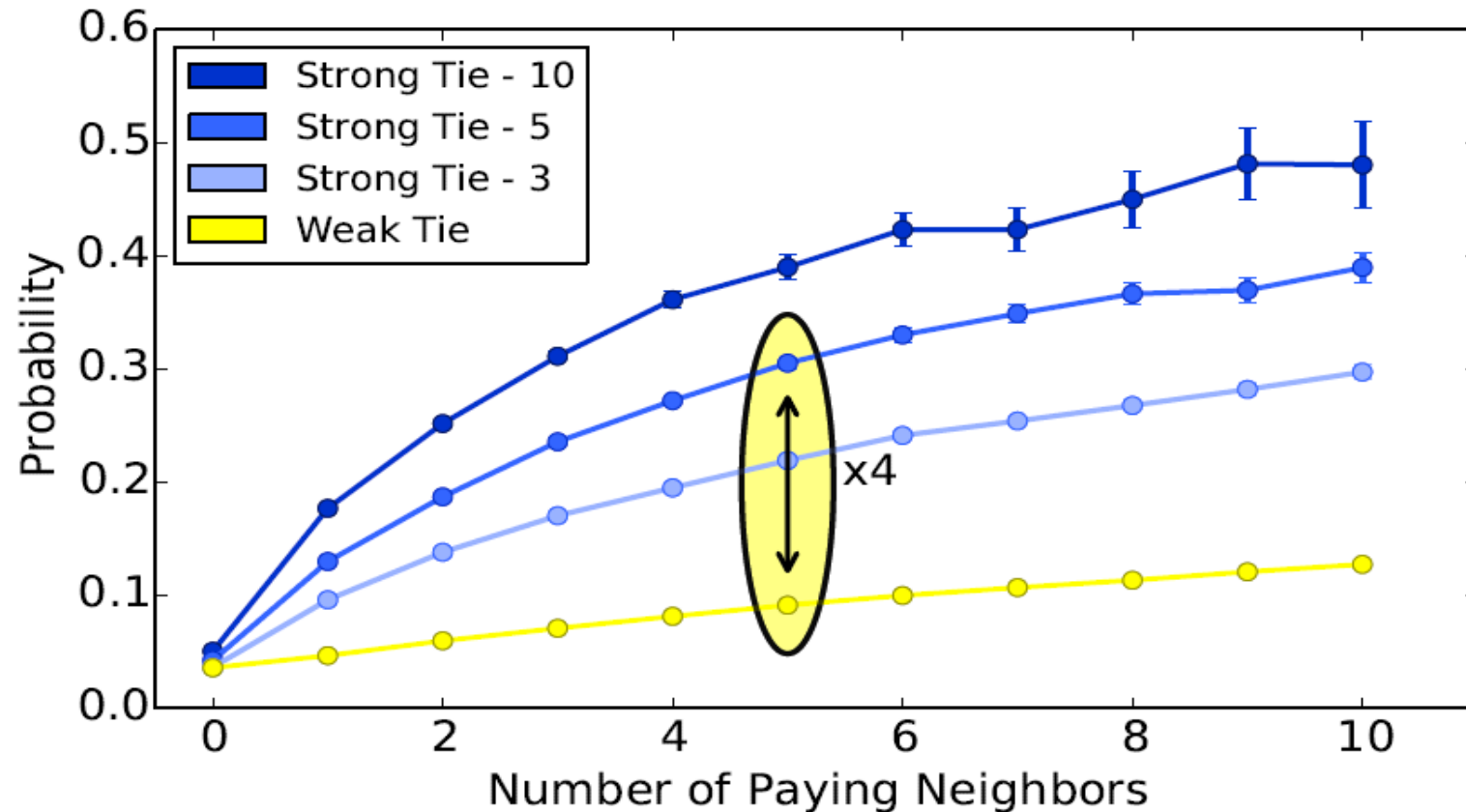- Given behavior log data and paying logs of online game users, predict

Free users -> Paying users

- Will social influence play an important role in this task?
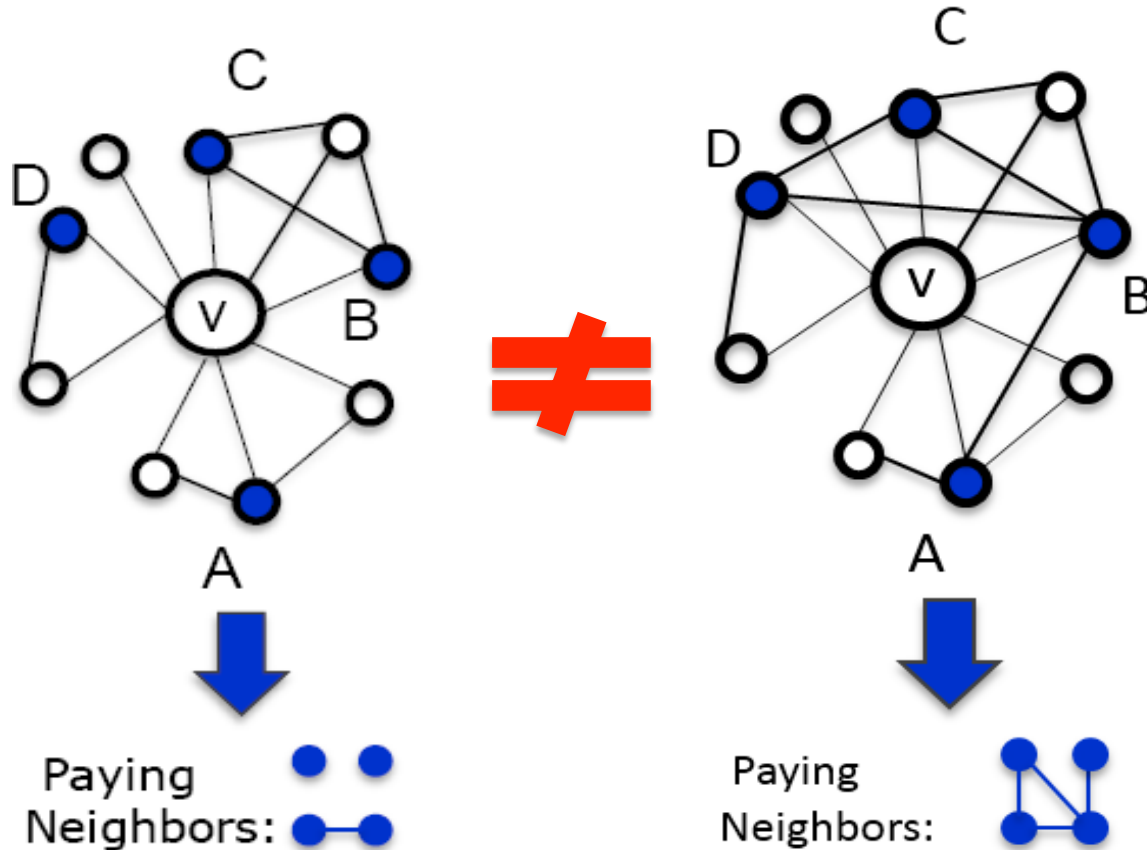
Social Influence
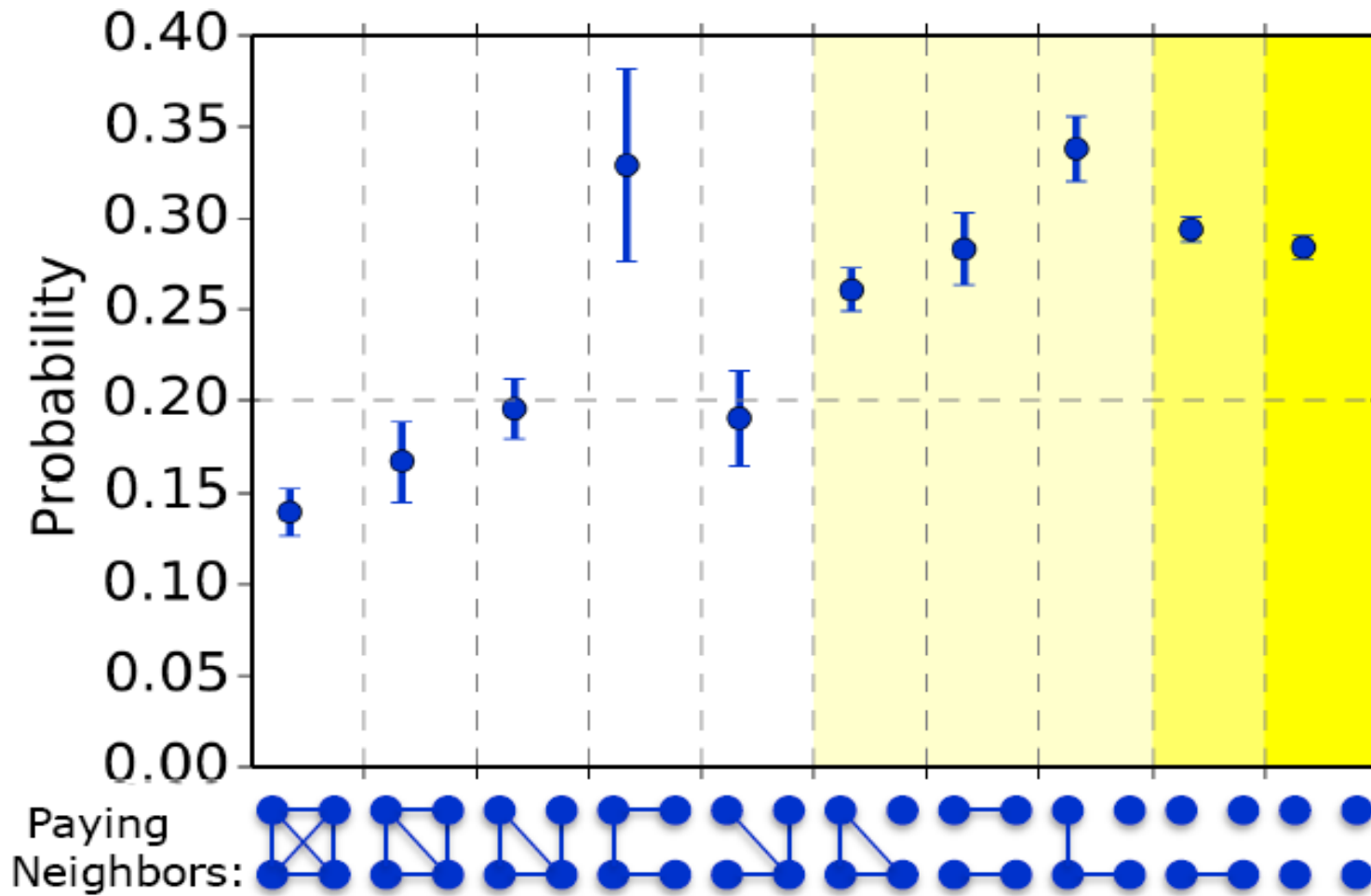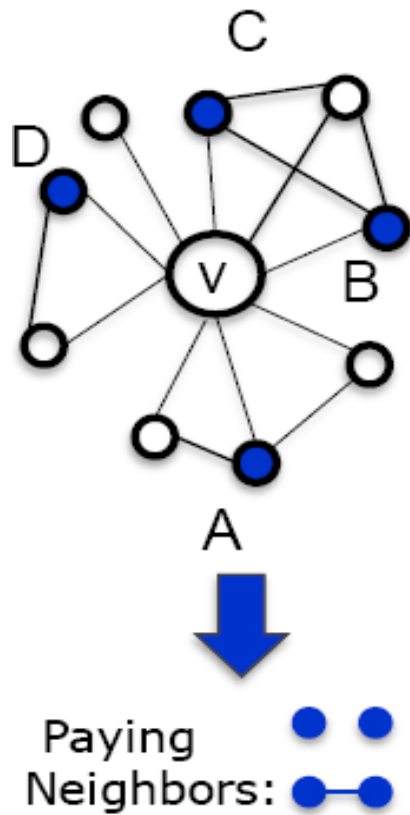
Influence + Tie Strength

Structure Diversity

Different structures of a user's neighbors have different effects on the user's behavior[1]

[1] Ugander, J., Backstrom, L., Marlow, C., & Kleinberg, J. Structural diversity in social contagion. In PNAS'12.
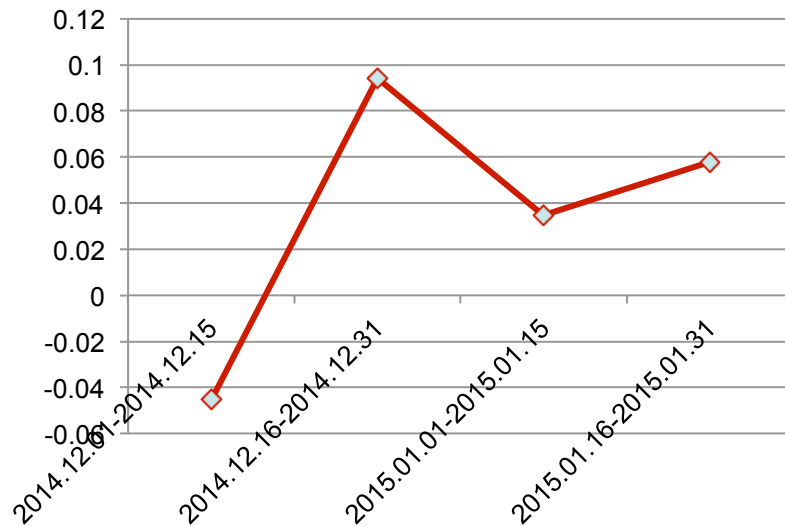
Structure Diversity

Online Test

- Test setting
  - Two groups: *test group* and *control group*
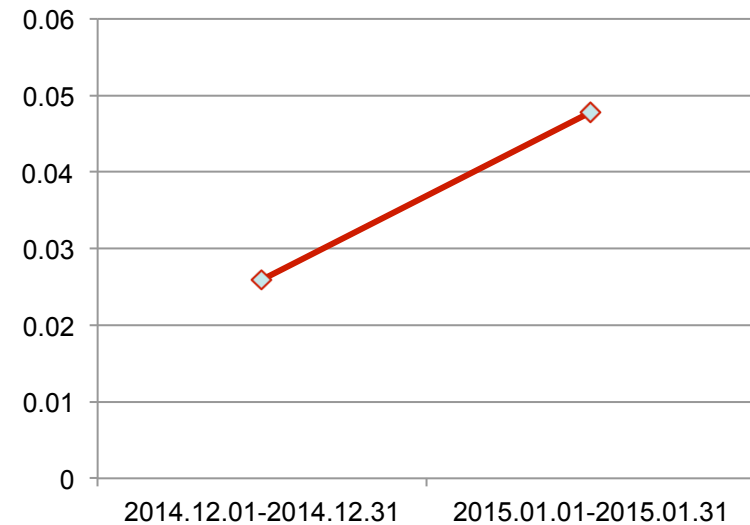 - Send msgs to invite the user to attend a promotion activity.

Group name	Online Test 1 2013.12.27 - 2014.1.3		Online Test 2 2014.1.24 - 2014.1.27		
	test group	control group	test group	test group2	control group
Group size	600K	200K	400K	400K	200K
#Message read	345K	106K	229K	215K	106K
Message read rate	57.50%	53.00%	57.25%	53.75%	53.00%
#Message clicked	47584	7466	23325	20922	6299
Message clicked rate	7.93%	3.73%	5.83%	5.23%	3.15%
Lift_Ratio	196.87%	0%	123.63%	73.40%	0%

Online Test

- Item Recommendation

Half-Month Improvement

Single-Month Improvement

Our social influence based recommendation algorithm in QQ Speed increased the item income by **9.4%** during December, 2014.