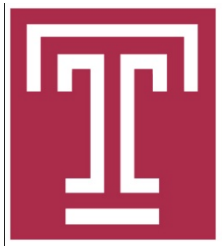



# Active Opinion-Formation in Online Social Networks

Wenjun Jiang[a] and Prof. Jie Wu[b]

[a] Hunan University
[b]Temple University

# Hunan University

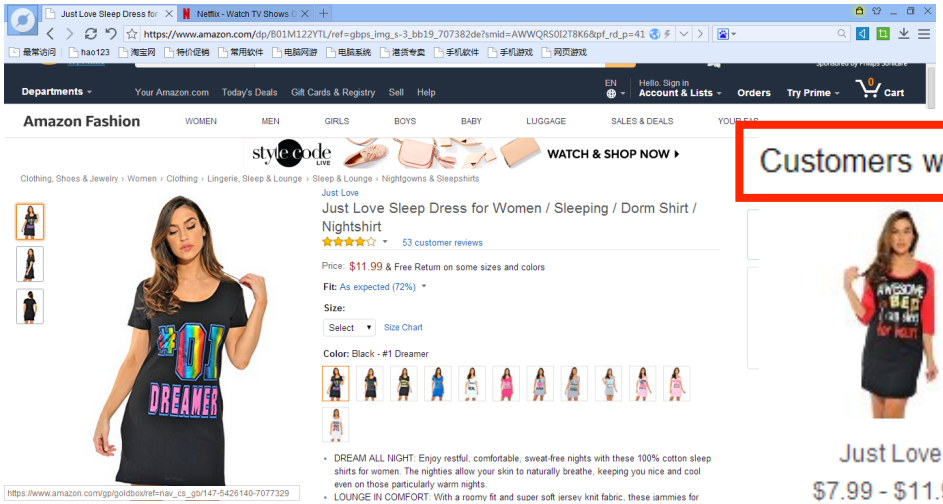
## —oriented from Yuelu Academy


# Outline

1. Background & Motivation
2. Related Work
3. Problem
4. Solution & Analysis
5. Experimental Evaluation
6. Conclusion & Future Work

# 1.1 Background

## -Personalized Recommendation




**Customers who viewed this item also bought**


**Customers who bought this item also bought**

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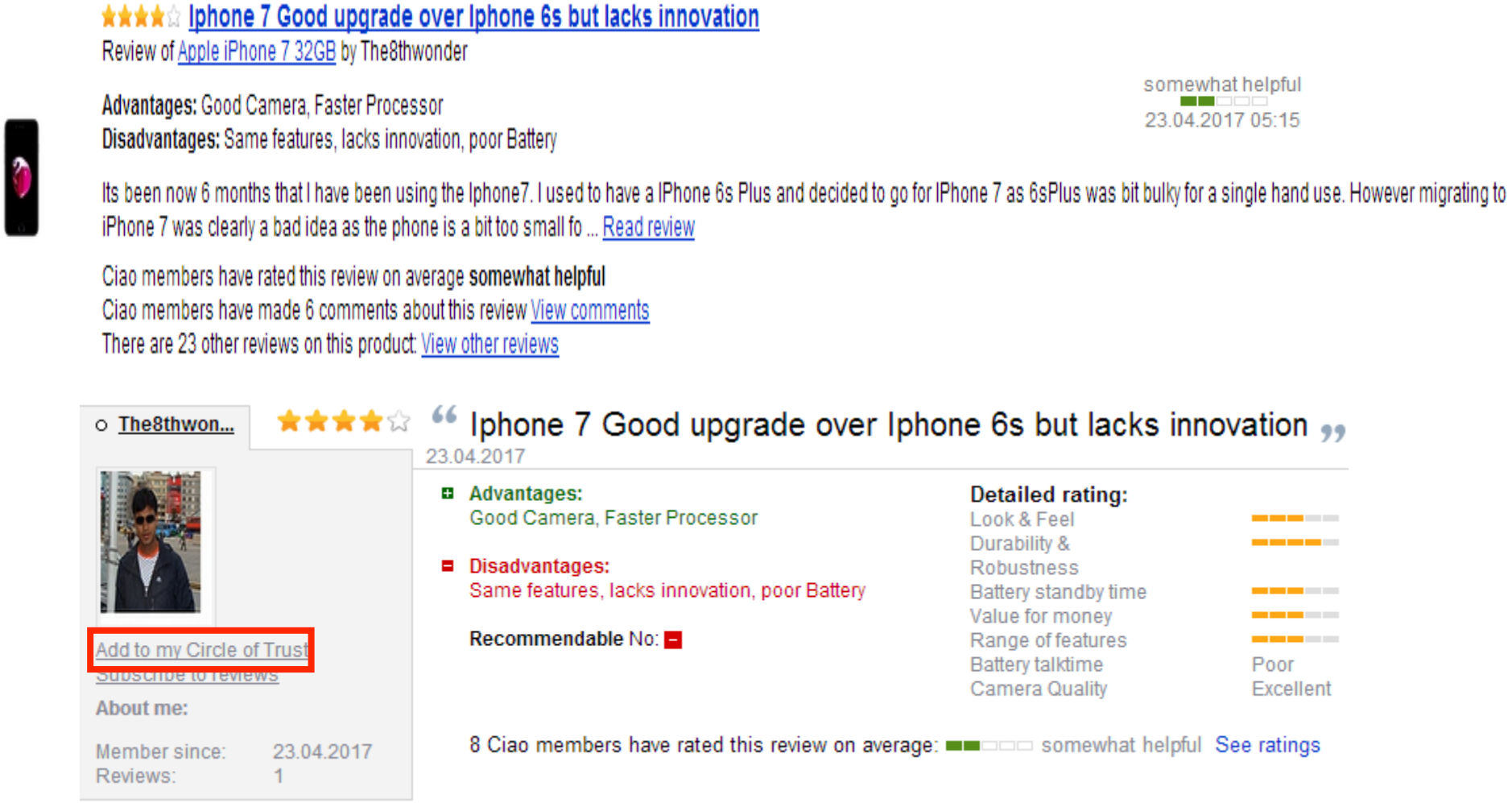
# 1.1 Background

## -Reviews & Helpfulness

# 1.1 Background

## -Reviews, Helpfulness, & Trust relations



Iphone 7 Good upgrade over Iphone 6s but lacks innovation

Review of Apple iPhone 7 32GB by The8thwonder

somewhat helpful
23.04.2017 05:15

**Advantages:** Good Camera, Faster Processor
**Disadvantages:** Same features, lacks innovation, poor Battery

Its been now 6 months that I have been using the Iphone7. I used to have a IPhone 6s Plus and decided to go for IPhone 7 as 6sPlus was bit bulky for a single hand use. However migrating to iPhone 7 was clearly a bad idea as the phone is a bit too small fo ... Read review

Ciao members have rated this review on average **somewhat helpful**
Ciao members have made 6 comments about this review View comments
There are 23 other reviews on this product: View other reviews

The8thwon...

Add to my Circle of Trust
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About me:

Member since: 23.04.2017
Reviews: 1

"Iphone 7 Good upgrade over Iphone 6s but lacks innovation"
23.04.2017

**Advantages:**
Good Camera, Faster Processor

**Disadvantages:**
Same features, lacks innovation, poor Battery

**Recommendable** No:

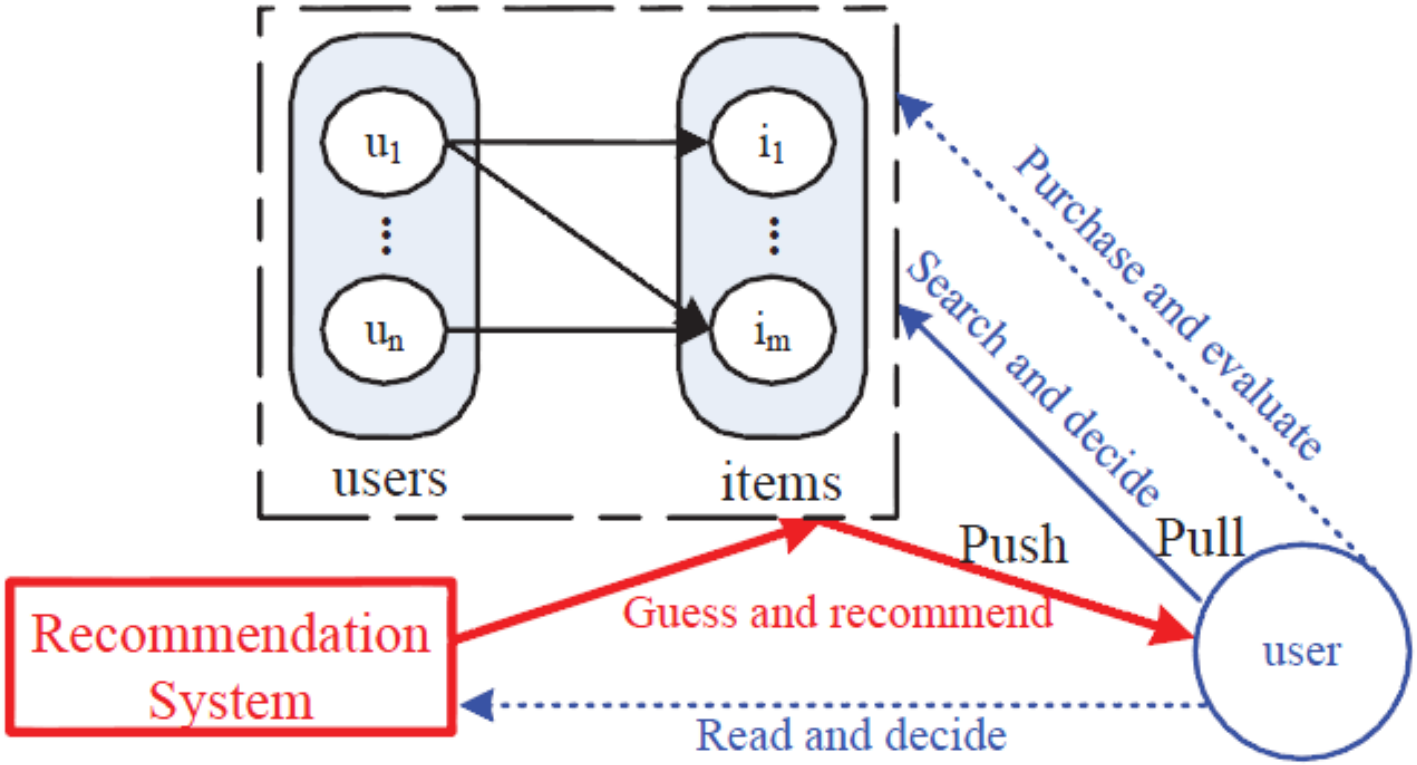
**Detailed rating:**

| | |
|---|---|
| Look & Feel | |
| Durability & Robustness | |
| Battery standby time | |
| Value for money | |
| Range of features | |
| Battery talktime | Poor |
| Camera Quality | Excellent |

8 Ciao members have rated this review on average: somewhat helpful See ratings

# 1.1 Background

## -Recommendation: work or not




individuals usually form their own opinion by themself

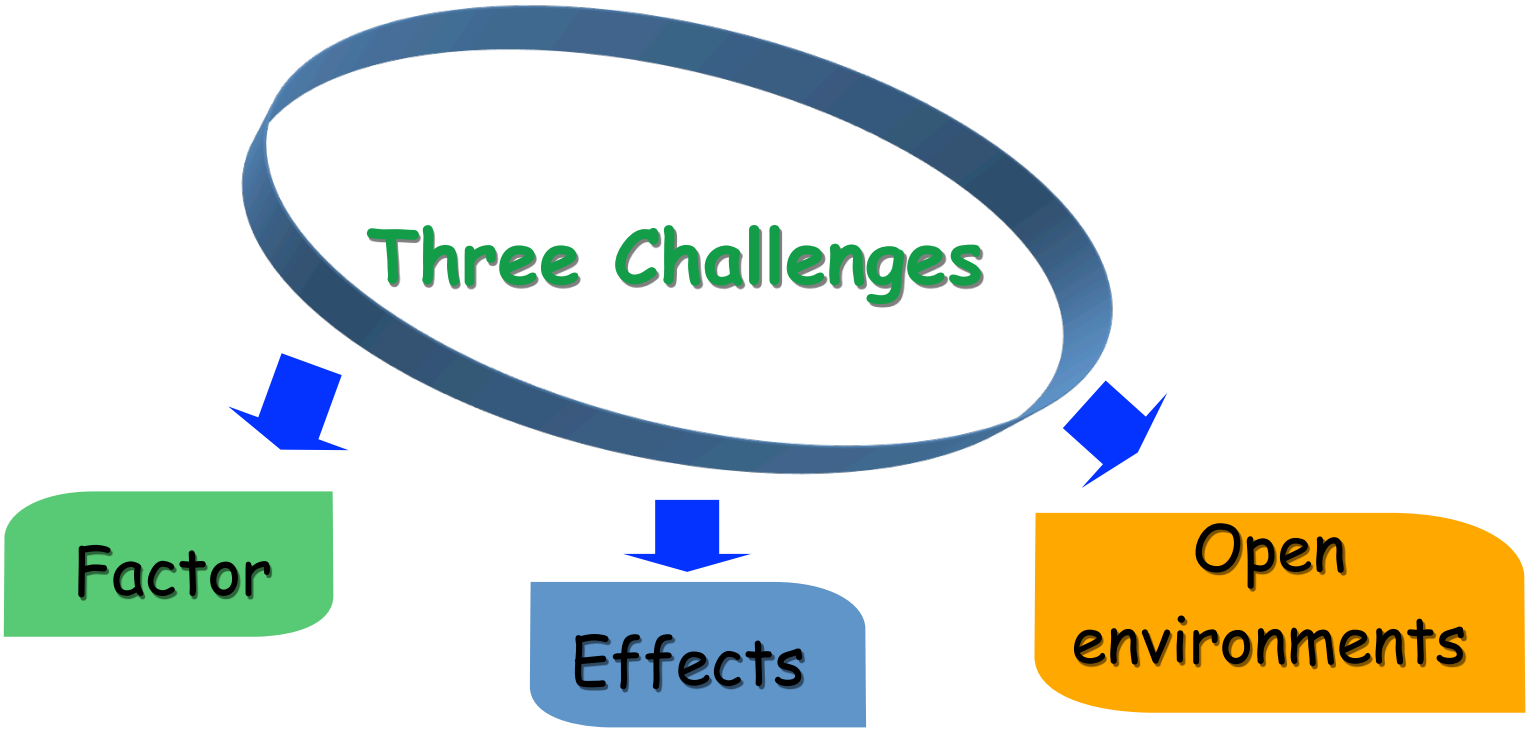
Lee D, Hosanagar K. When do Recommender Systems Work the Best?: The Moderating Effects of Product Attributes and Consumer Reviews on Recommender Performance[C]//Proc. **WWW** 2016: 85-97.

# 1.1 Background: Opinion & Reference

- *Two* types of opinion
  - Internal opinion
  - Expressed opinion
- *Three* types of references
  - Internal opinion
  - Friends
  - Public channels

How do people form their expressed opinions in online systems?

# 1.2 Motivation




Three types of references

From passive to active

Incremental Approach

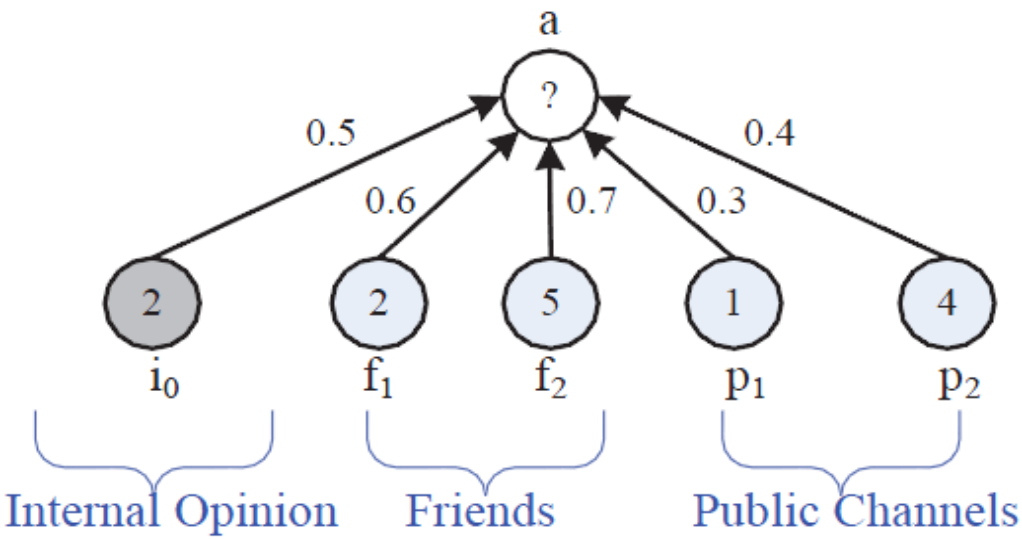
# 2. Related Work

- *Ising model*
  - *Spin: user opinion;*
  - *Spin coupling: user interactions*
  - Magnetic field: external information
- DeGroot's averaging model
  - individuals simultaneously update opinions using the weighted average of their own opinion and their neighbors
- Biased assimilation model
  - individuals weigh "confirming" evidence more heavily
- Fluid dynamics model
  - Container: user;
  - fluid: user opinion;
  - fluid exchange: influence

# 3. Problem

## System setting: Reference network

- Nodes
  - internal opinion
  - friends
  - public channels
  - sink
- Edges
  - Influence relations
  - can be converted from trust relations
  - from references to sink



# 3. Active Opinion-Formation Problem (AOFP)

- Given a reference network $G = (V, E)$
- Tasks
  - identify essential elements
  - select a proper subset of references
  - explore the way those channels take effect
  - incrementally incorporate selected channels
- Objective
  - simulate the process with which $a$ forms his expressed opinion $O_a$, and thus, to predict it accurately.
  - goal: minimize the prediction error with a given budget.

# 3. Problem Hardness

- Theorem1: Task 2 of the AOFP problem is NP-complete.
  - Convert the scenario of $a$'s expressed opinion formation to be: the selected references in $R_0$ are trying to answer "what is the rating of $a$?"
  - Simplify the question to be "is $a$'s expressed opinion a positive one?" (Jury selection problem as in Ref. [16])
  - Reduce to a $m$th-order Knapsack Problem

[16] C. Cao, J. She, Y. Tong, and L. Chen. Whom to ask? jury selection for decision making tasks on micro-blog services. Proc. VLDB, 5(11):1495-1506, 2012.

# 4. Solution
## - task 1: elements identification

- Basic idea
  - Identify useful empirical evidence to support elements identification.
  - Treat each reference independently
  - Two elements for each reference
    - The value of reference's opinion on item i ($O_{i0i}$, $O_{fi}$, $O_{pi}$)
    - The influence strength to sink ($w_{i0a}$, $w_{fa}$, $w_{pa}$)

# 4. Solution
## - task 1: elements identification

- Empirical evidence

1. Influence from a friend usually weighs more than that from a public channel (two theories of conformity and biased assimilation)
    - 1.1 *Higher interaction frequency indicates more influence* ("mere-exposure effect" in psychology )
    - 1.2 *More common friends indicates more influence*

2. Influence of a negative opinion usually weighs more than that of a positive one (the brilliant-but-cruel hypothesis )

3. Helpfulness indicates confidence.

# 4. Solution

## - task 1: elements identification

- Internal Opinion on item i

$$O_{i_0 i} = \bar{r}_i + \sum_{i \in I_a} d_{ai} / |I_a| \quad \text{where} \quad d_{ai} = r_{ai} - \bar{r}_i$$

$$w_{i_0 a} = 0.5$$

Self confidence

- Friends channels

$$O_{fi} = r_{fi} \qquad w_{fa} = \lambda w^1_{fa} + (1-\lambda) w^2_{fa}, \lambda \in [0,1]$$

$$w^1_{fa} = |I_{fa}| / \max\{I_{fa}, f \in F\} \quad w^2_{fa} = |F_a \cap F_f| / \max\{|F_a \cap F_f|, f \in F_a\}$$

- Public channels

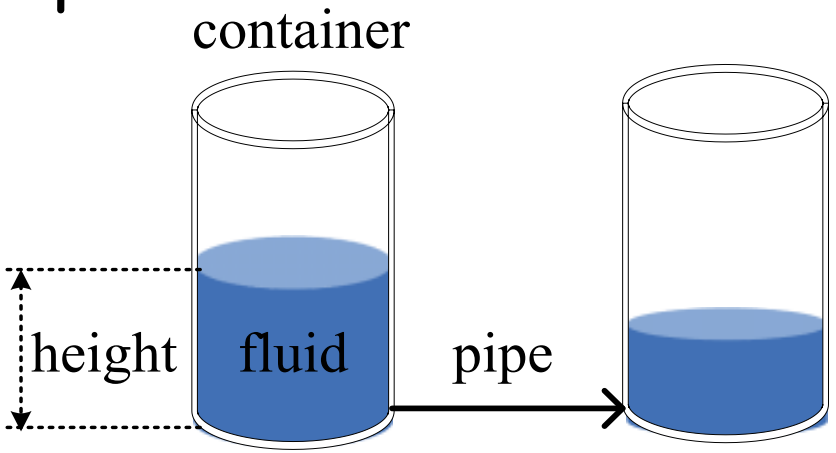
$$O_{pi} = r_{pi} \qquad w_{pa} = r^r_{pi} / \max H$$

# 4. Solution
## - task 2: reference selection

- NP-hardness
- Heuristic solution
  - Individual's prediction error rate decreases when a reference having more close relation
  - Determine selection order with
    - Internal opinion first
    - Friends second
    - Public channels last

# 4. Solution
## - task 3&4: incorporate channels

- OpinionFormer: three components
  - Container: user
  - Pipe: influence relation
  - Fluid: recommendation
    - Temperature as rating
    - Height as persistency




- Influnece: two micro steps
  - Compare persistency (fluid height)
  - Fluid flowing from a reference to sink

# 4. Solution
## - task 3: differentiate effects

- Differentiate 3 types of channels
  - Internal opinion reference level
  - Friends channels reference level
  - Public channels lower than reference level
- Differentiate 2 types of opinion
  - Positive opinion reference level
  - Negative opinion higher than reference level

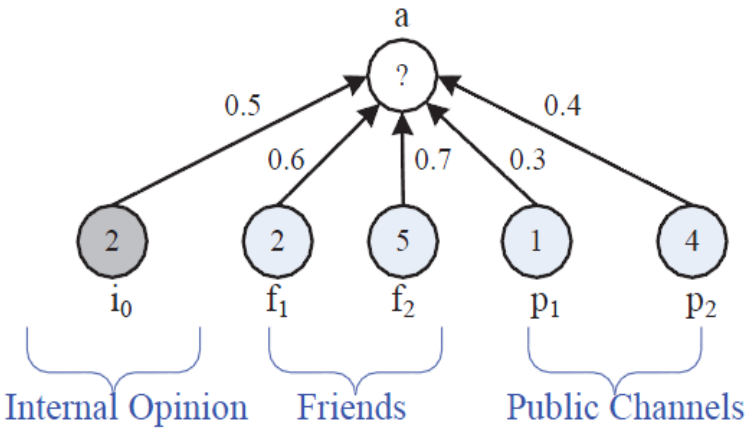
$h_\Delta$

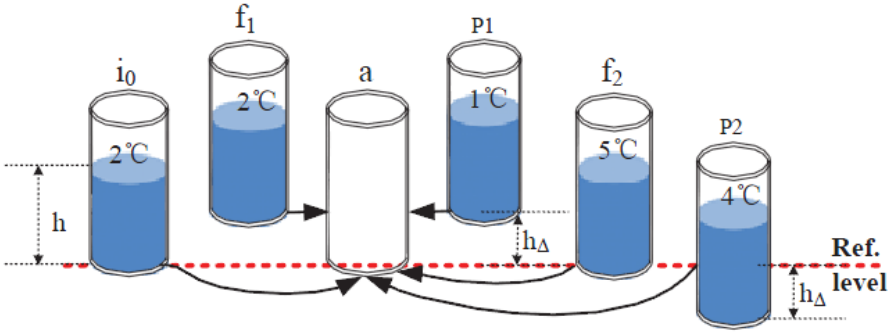
Height difference w.r.t Ref. Level

# 4. Solution

## - task 3&4: incorporate channels

- OpinionFormer
  - From reference network to fluid dynamics system




reference network

fluid dynamics system

# 4. Solution
## - task 3&4: incorporate channels

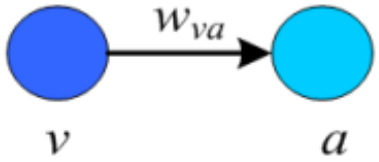
- OpinionFormer: 3 steps
  - Fluid Updating Preparation (from a ref. to sink)
    - Calculate the fluid volume that will flow
  - Fluid Updating Execution (from a ref. to sink)
    - Let fluid flow and mix
  - Confidence Refinement (sink)
    - When meeting different opinions
    - Decrease confidence/fluid height

# 4. Solution

## - task 3&4: incorporate channels

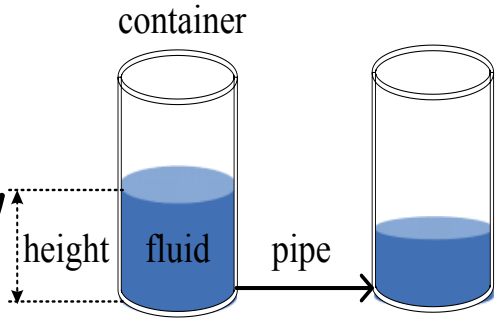
- Step 1: Fluid Updating Preparation
  - The speed of efflux: Torricelli's law

$$\upsilon_{va} = \sqrt{2gh_v}$$




  - The volume of fluid that will flow

$$s_{va} = \sqrt{2gh_v} \cdot w_{va} \cdot \Delta$$




  - The temperature of fluid that will flow

$$O_{va} = O_v$$

# 4. Solution

## - task 3&4: incorporate channels

- Step 2: Fluid Updating Execution
  - The updated volume

$$s_a(k+1) = s_a(k) + s_{va}$$

  - The updated temperature

$$O_a(k+1) = \frac{O_a(k) \cdot s_a(k) + O_v \cdot s_{va}}{s_a(k+1)}$$

# 4. Solution

## - task 3&4: incorporate channels

- Step 3: Confidence Refinement
  - When meeting different opinions

$$h_a^* = h_a \cdot (1-\eta)$$

Confidence decreasing ratio

# 4. Solution

## - task 3&4: incorporate channels

- (Sink) Iteratively considers several references until he reaches his confidence threshold or no more references.

The quantitative change and the qualitative change

- Possible extensions and variances
  - Different orders
  - Non-uniform time slots
  - Multiple considerations on one reference

# 4. Solution

## - Analysis: convergence

- *Theorem 2:* $h_a \leq h_{max.}$
  - In OpinionFormer, *a*'s fluid height, $h_a$, will not be larger than the upper-bound $h_{max}$ in a reference set.
- *Theorem 3:* $h_a \rightarrow h_{max.}$
  - In OpinionFormer, suppose sink *a* continuously listens to the references' opinions. Then, after a sufficient time period of opinion refinement, *a*'s fluid height will be equal to the upper-bound $h_{max}$ in the reference set.

# 4. Solution

## - Analysis: advantages & desirable properties

- *Advantages*
  - OpinionFormer *comprehensively incorporates three types of channels into a fluid system.*
  - OpinionFormer *simulates the opinion formation process naturally and flexibly.*
- *Desirable properties*
  - *Evolution compatibility.*
  - *Incremental treatment.*

# 5. Experimental Evaluation
## - basic settings

- Data set: Epinions and Ciao!
- Test method: Leave-one-out
- Metrics: Precision, Recall, Fscore, and RMSE

$$P_h = \frac{A_h \cap B_h}{B_h} \qquad P_l = \frac{A_l \cap B_l}{B_l}$$

$$R_h = \frac{A_h \cap B_h}{A_h} \qquad R_l = \frac{A_l \cap B_l}{A_l}$$

$$F_h = \frac{2R_hP_h}{R_h + P_h} \qquad F_l = \frac{2R_lP_l}{R_l + P_l}$$

$$RMSE = \sqrt{\sum (r_{u,i} - \hat{r}_{u,i})^2} / D$$

# 5. Experimental Evaluation
## - data set statistics

- Data set: Epinions and Ciao!

TABLE III
STATISTICS OF DATA SETS.

| | #U | #P | #C | #R | #TR | $\overline{R}$ | $\overline{H}$ |
|---|---|---|---|---|---|---|---|
| **Epinions** | 22,166 | 296,277 | 27 | 922,267 | 355,813 | 3.97 | 1.94 |
| **Ciao** | 2,378 | 16,861 | 6 | 36,065 | 57,544 | 4.22 | 1.43 |

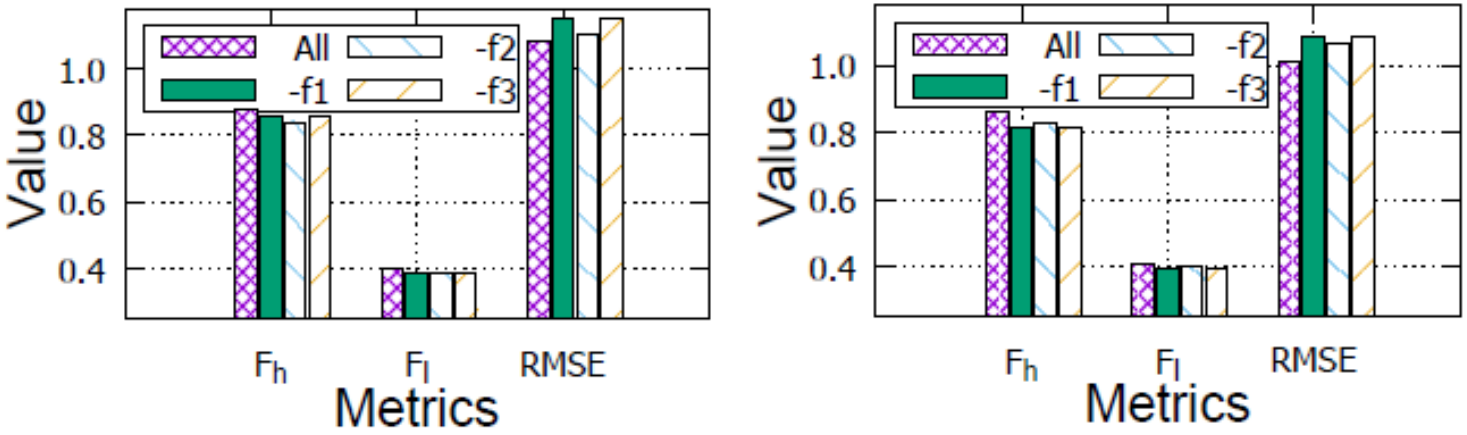
U: Users, P: Products, C: Category, R: Rating, TR: Trust relations,
$\overline{R}/\overline{H}$: Average Rating/Helpfulness

TABLE IV
PARAMETER SETTINGS.

| Parameter | Description | Range | Default |
|---|---|---|---|
| $\lambda$ | weight of interaction frequency | [0,1] | 0.5 |
| $h$ | fluid height | 10 | |
| $h_\Delta$ | height difference with ref. level | [1,10] | 5 |
| $k$ | number of rounds | [1, 100] | |
| $\Delta$ | time slot | 0.04 | |
| $\eta$ | confidence decrease ratio | [0,1] | 0.1 |

# 5. Experimental Evaluation
## - results (1)

- The effects of each type of channels

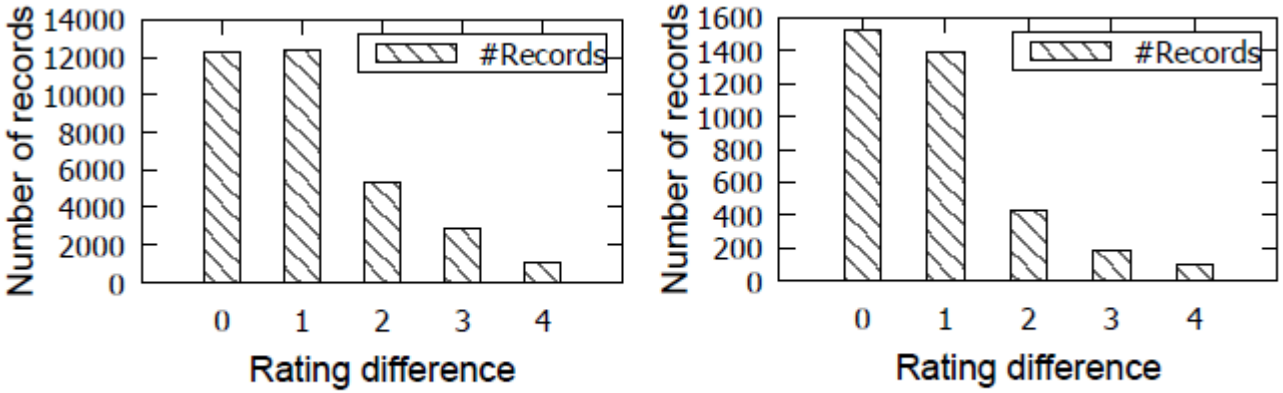



(a) Epinions (b) Ciao

- Each type of channel has its impact.
- The public channel has the largest impact, the internal opinion has the second, and the friend channel has the last. (a bit surprising)

# 5. Experimental Evaluation - results (1)

- The effects of each type of channels (reason)

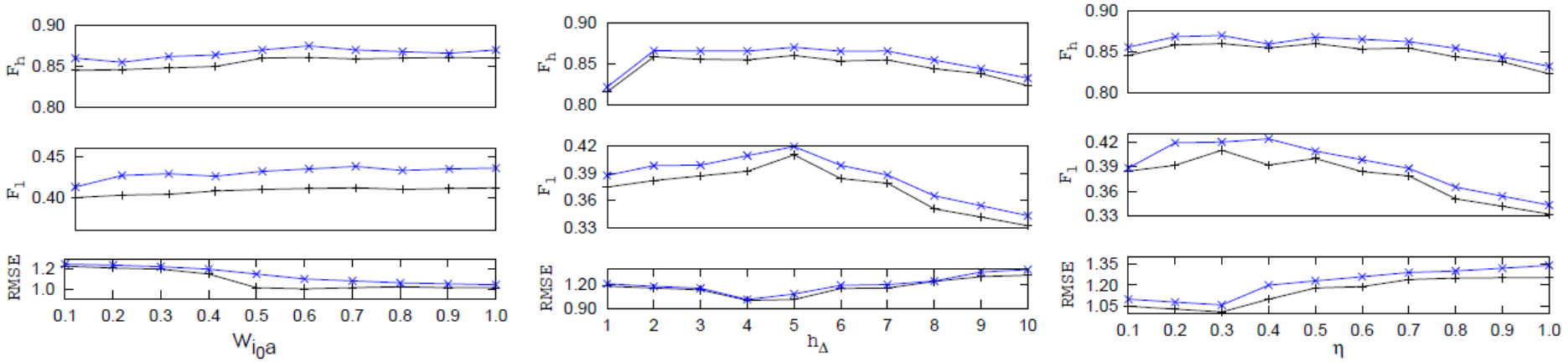



(a) Epinions (b) Ciao

- Observation 1: There do exist trust relations among users who have rated the same item, but it is quite sparse.
- Observation 2: Ratings of a user and their trustee on the same item are close to each other's; however, users' ratings are not always consistent with those of their trustees
- Moreover, if a user gives the same rating as their trustee, the two users usually have higher interaction frequency and share more common friends.

# 5. Experimental Evaluation - results (2)

- The effects of impact factors

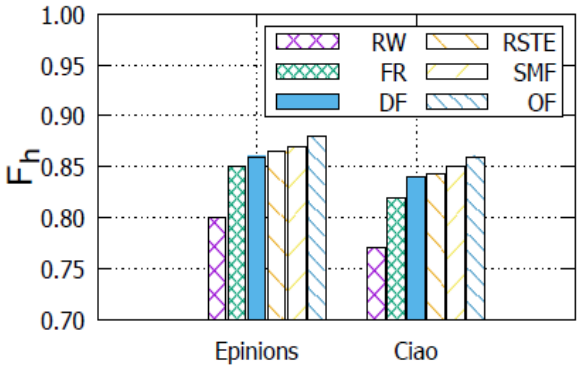



(a) Changing $w_{i_0 a}$ (b) Changing $h_\Delta$ (c) Changing $\eta$

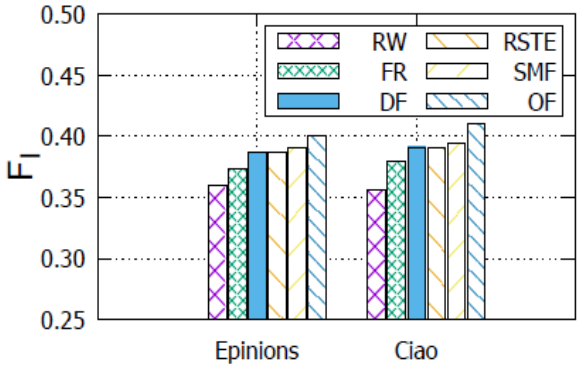
- A larger $w_{i0a}$ leads to a better performance. (internal opinion is important!)
- There is a turning point of $h_\Delta$. (weaken public channel and enhance negative opinion)
- $\eta$ (the confidence decrease ratio) cannot be too large. (even meeting different opinions, people will still hold most of their current ones)

# 5. Experimental Evaluation - results (3)

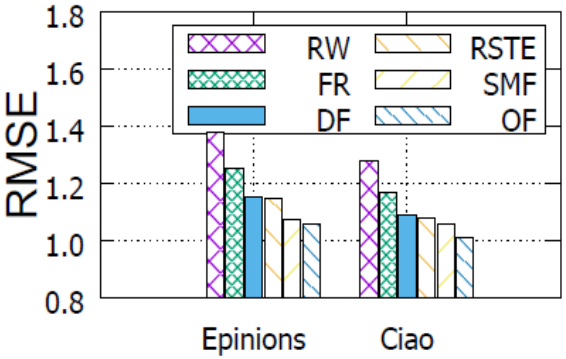
- Comparison of Multiple Methods




(a) $F_h$




(b) $F_l$




(c) RMSE

Findings: OpinionFormer beats others; w.r.t. Dyfluid,

- In Epinions, RMSE is 6.09% less,
  *$F_h$ &$F_l$ is 2.33% & 3.46% higher;*
- In Ciao, RMSE is 7.34% less,
  *$F_h$ &$F_l$ is 2.38% & 4.8% higher.*

# Summary of Experiments

- Validate the effects of each type of channels
- Test the effects of three key parameters
  - The influence strength of internal opinion
  - The height difference with reference level
  - The confidence decrease ratio when meeting inconsistent opinions
- Comparison study

# Conclusion & Future Work

- Conclusion
  - Study active opinion formation at the individual level
  - Consider three types of channels and differentiate their effects
  - Incrementally incorperate those channels
- Future work
  - Comprehensive study on reference selection order
  - Deep study on opinion refinements (especially when different opinion occurs)

# Thank you for your attentions!

Active Opinion Formation in Online Social Networks

Wenjun Jiang
Associate professor
Hunan Univeristy, P. R. China
Email: wenjj8a@163.com