

A Bilattice-Based Trust Model for Personalizing Recommendations

Patricia Victor, Chris Cornelis, Martine De Cock

Computational Web Intelligence
Ghent University, Belgium

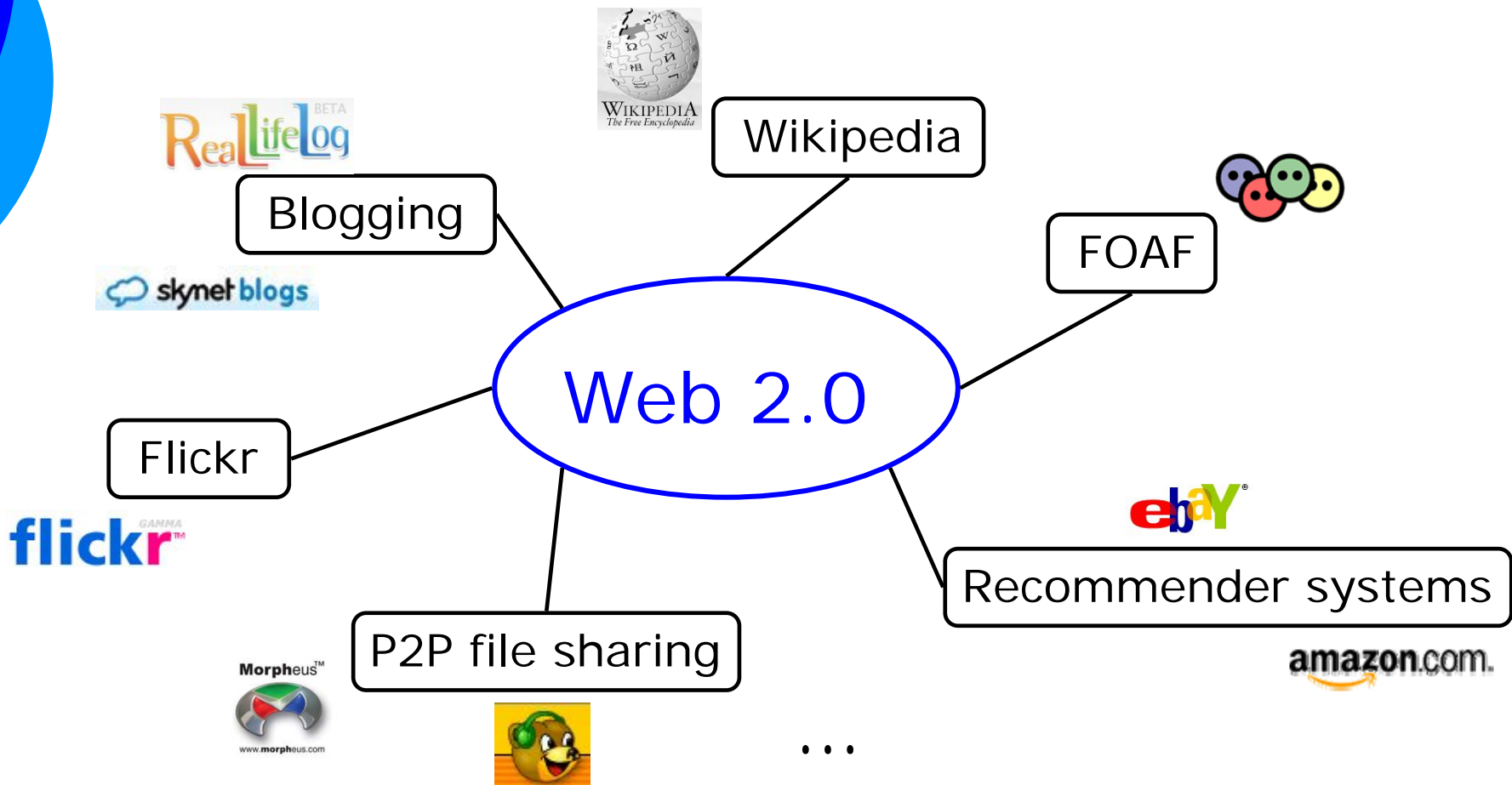




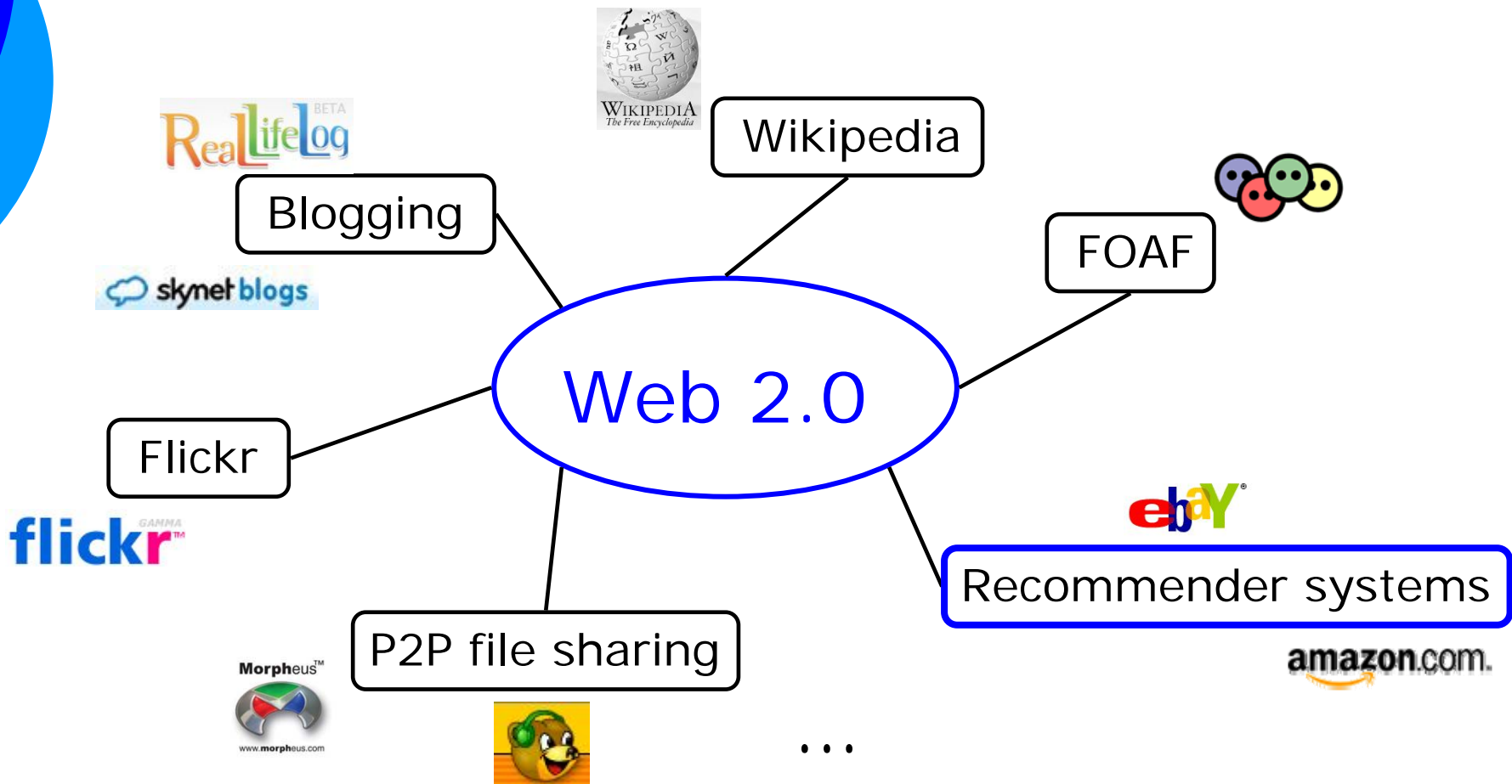
Outline

- Social Networks on the Web
- Trust Networks
- Bilattice-Based Trust Model
- Trust Propagation

Social Networks on the Web



Social Networks on the Web



Social Networks in RSs

amazon.com

ebay®


Epinions.com

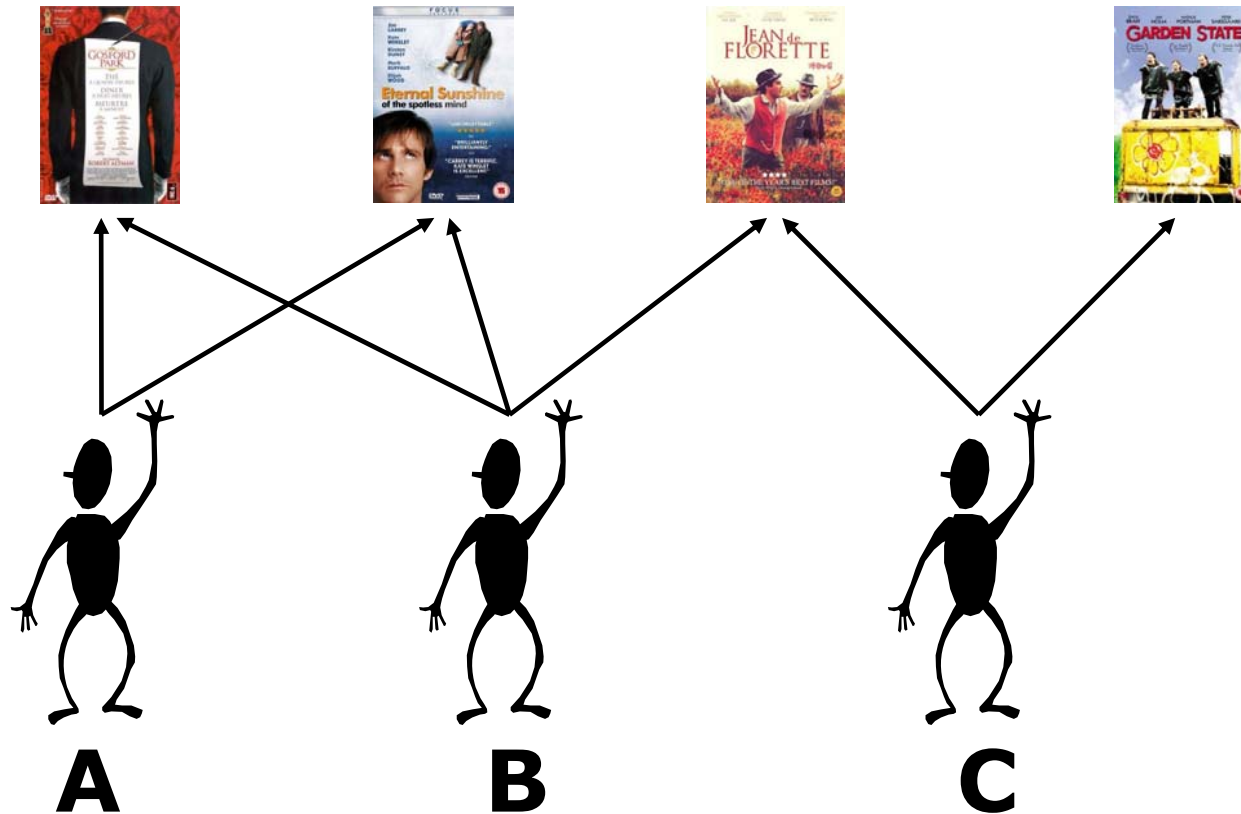


Problems in RSs (1)

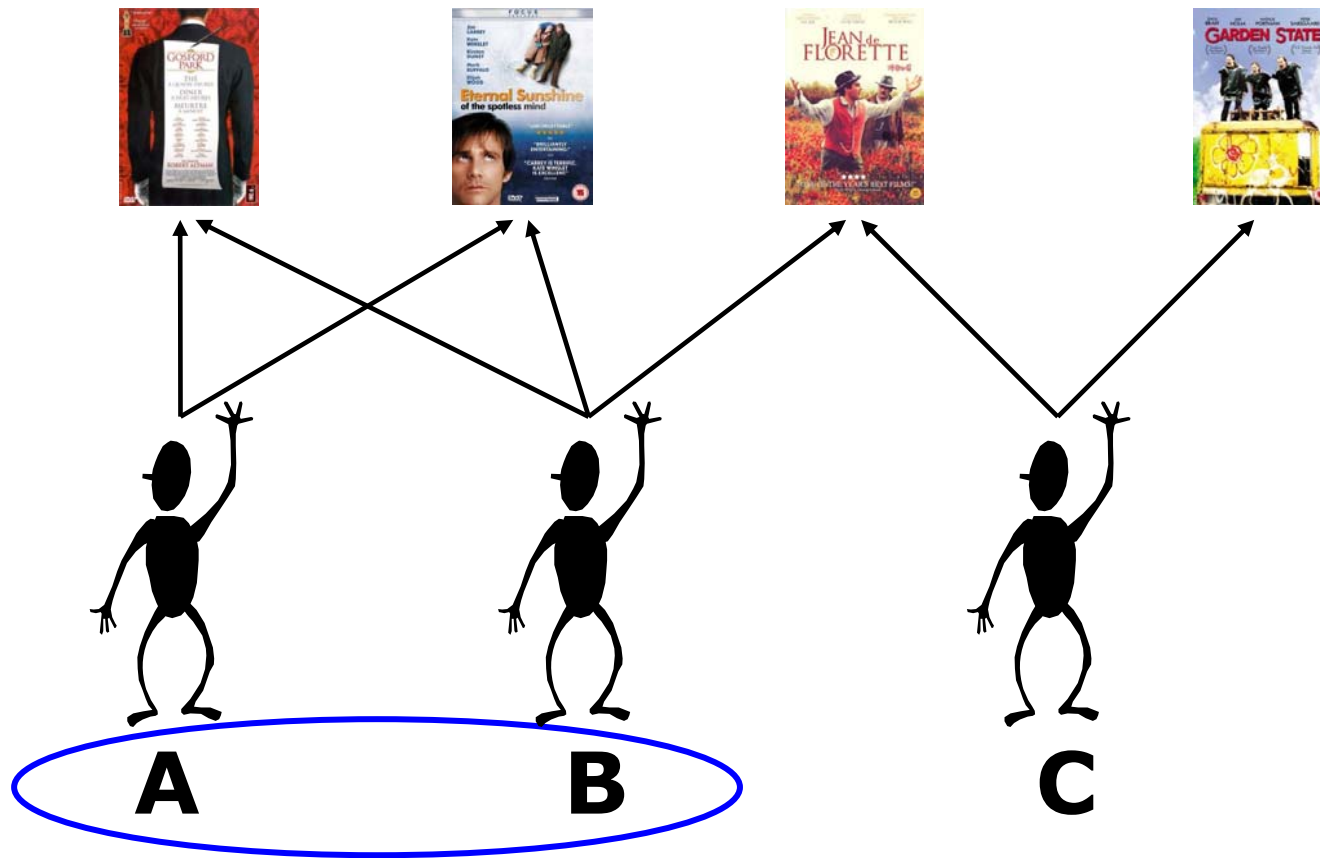
KEY PROBLEMS

- Malicious users (intruders)
- Sparsity of the dataset
- Cold start (new) users

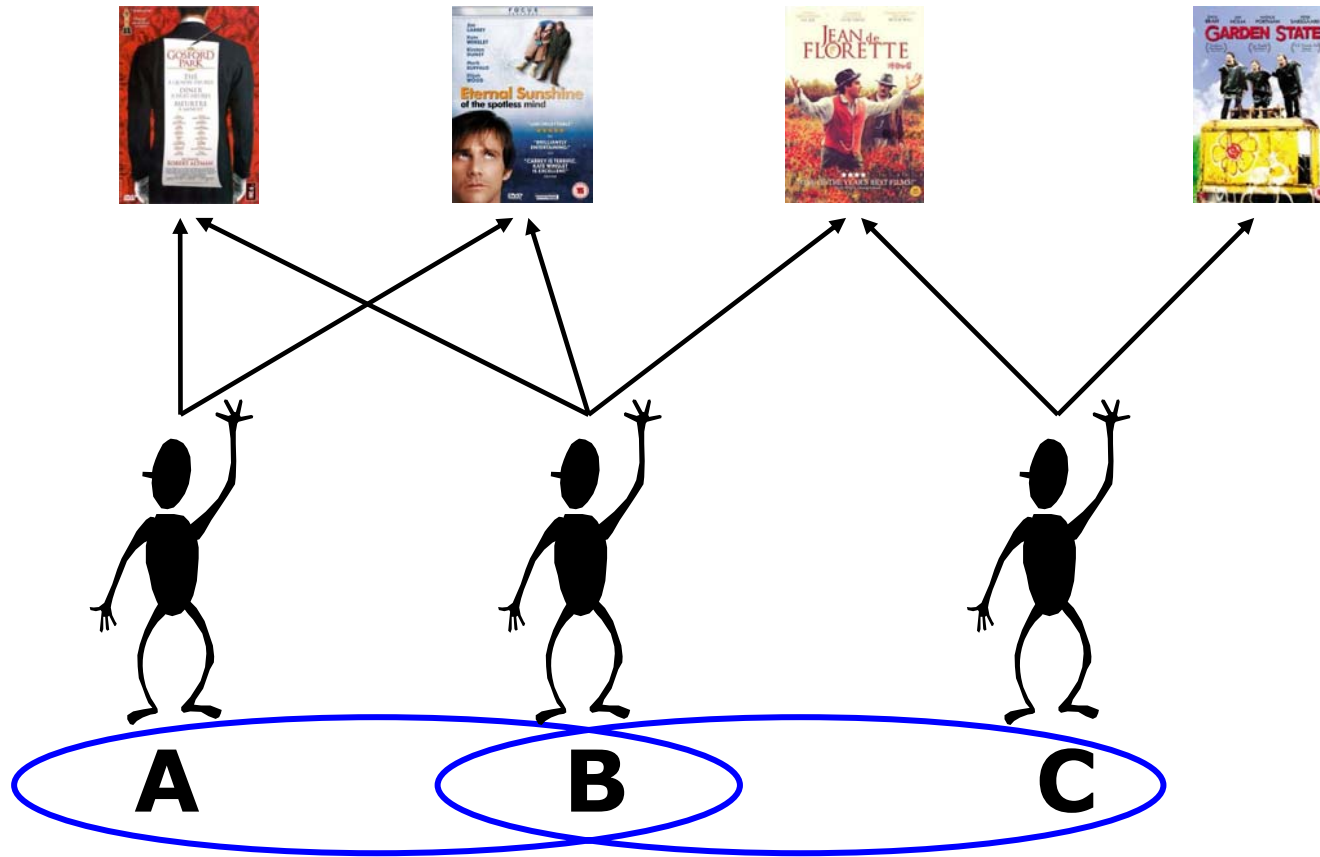
Problems in RSs (2)



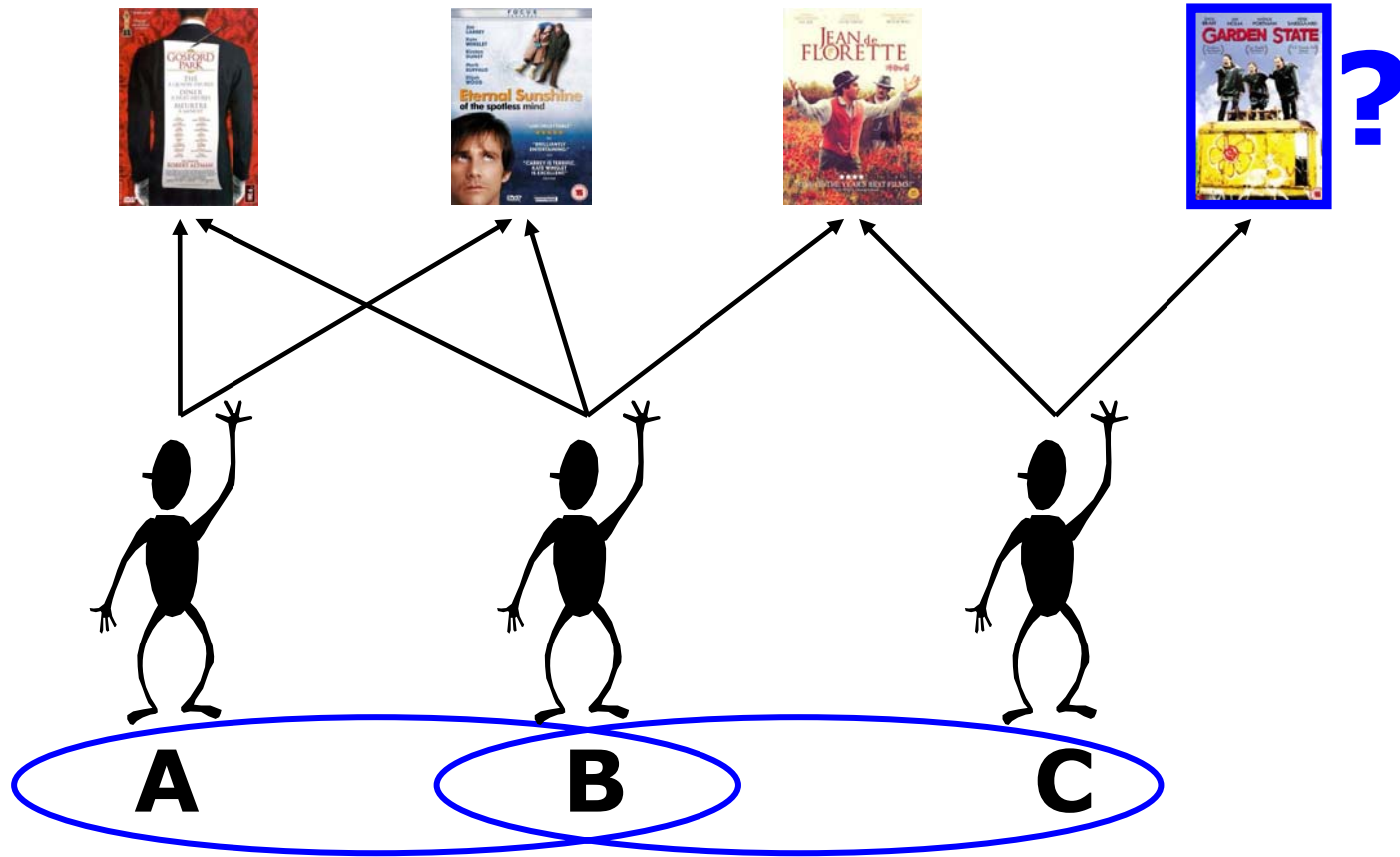
Problems in RSs (2)



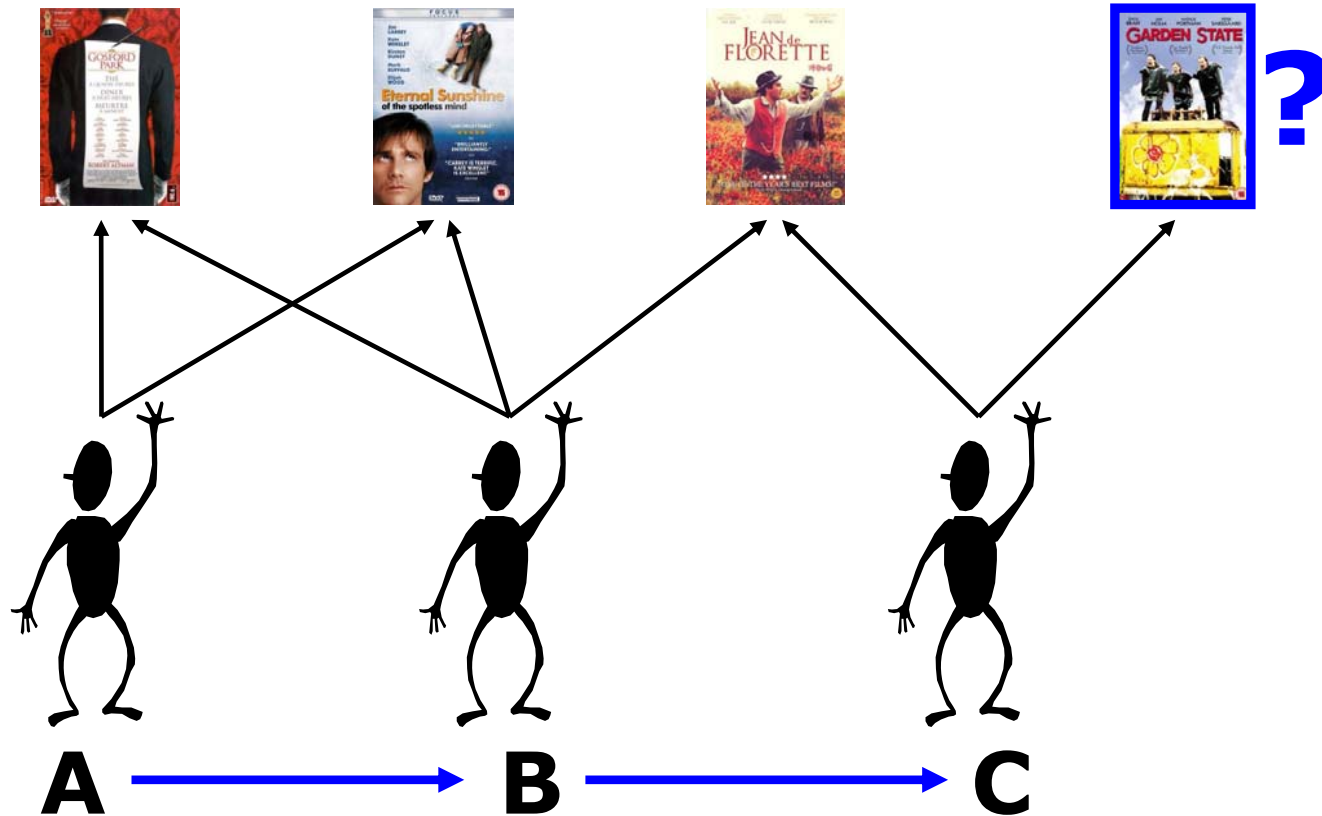
Problems in RSs (2)



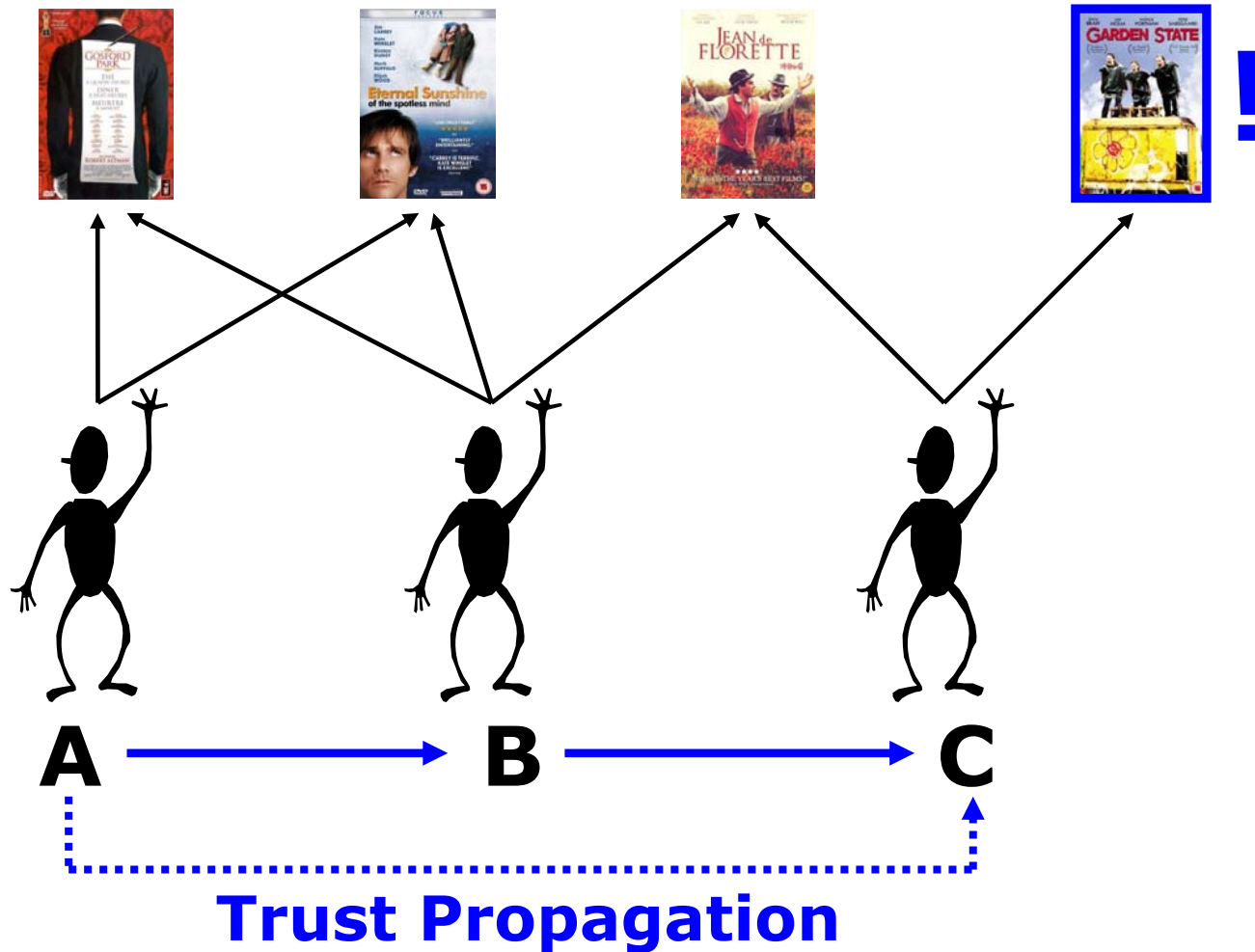
Problems in RSs (2)



Solution: Trust Networks in RSs



Solution: Trust Networks in RSs





Trust Model (1)

BINARY

ONLY TRUST



Trust Model (1)

BINARY

... But what about:

"I trust him *very much*" /

"*Rather low* trust" / ...

ONLY TRUST

Trust Model (1)

BINARY

... But what about:

"I trust him *very much*" /

Rather low trust" / ...

ONLY TRUST

... But what about:

No trust? Caused by ...

Distrust / lack of knowledge

Trust Model (1)

BINARY

... But what about:

"I trust him *very much*" /

"*Rather low* trust" / ...



ONLY TRUST

... But what about:

No trust? Caused by ...

Distrust / lack of knowledge



GRADUAL TRUST AND DISTRUST



Trust Model (2)

- 1. Large networks:
Many agents do not know each other**

**** IGNORANCE ****

Trust Model (2)

1. Large networks:
Many agents do not know each other

**** IGNORANCE ****

- *B distrusts D* \rightarrow *trust=0*
- *C does not know D* \rightarrow *trust=0*

Trust Model (2)

1. Large networks: Many agents do not know each other

** IGNORANCE **

- *B distrusts D* → $trust=0$
C does not know D → $trust=0$
- *B trusts C 0.5 and distrusts C 0.2*
 - $trust=0.5?$
 - $trust=0.5-0.2=0.3?$ (Guha et al.)

Trust Model (3)

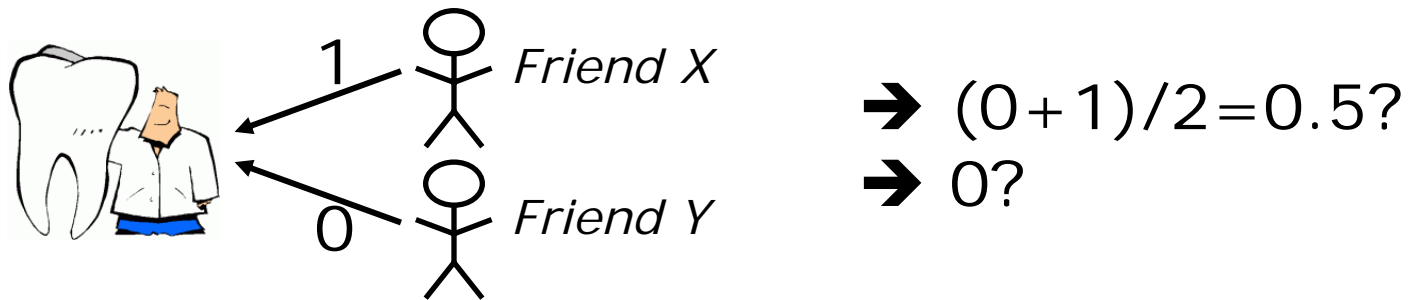
**2. Lack of central authority:
Agents may provide different
and/or contradictory information**

**** INCONSISTENCY ****

Trust Model (3)

**2. Lack of central authority:
Agents may provide different
and/or contradictory information**

**** INCONSISTENCY ****





Trust Model (4)

- “Trust problem” caused by:
 - presence of distrust
=> untrustworthy agents
 - lack of knowledge
=> unknown agents

- “Knowledge problem” caused by:
 - too little information
 - too much, contradictory information

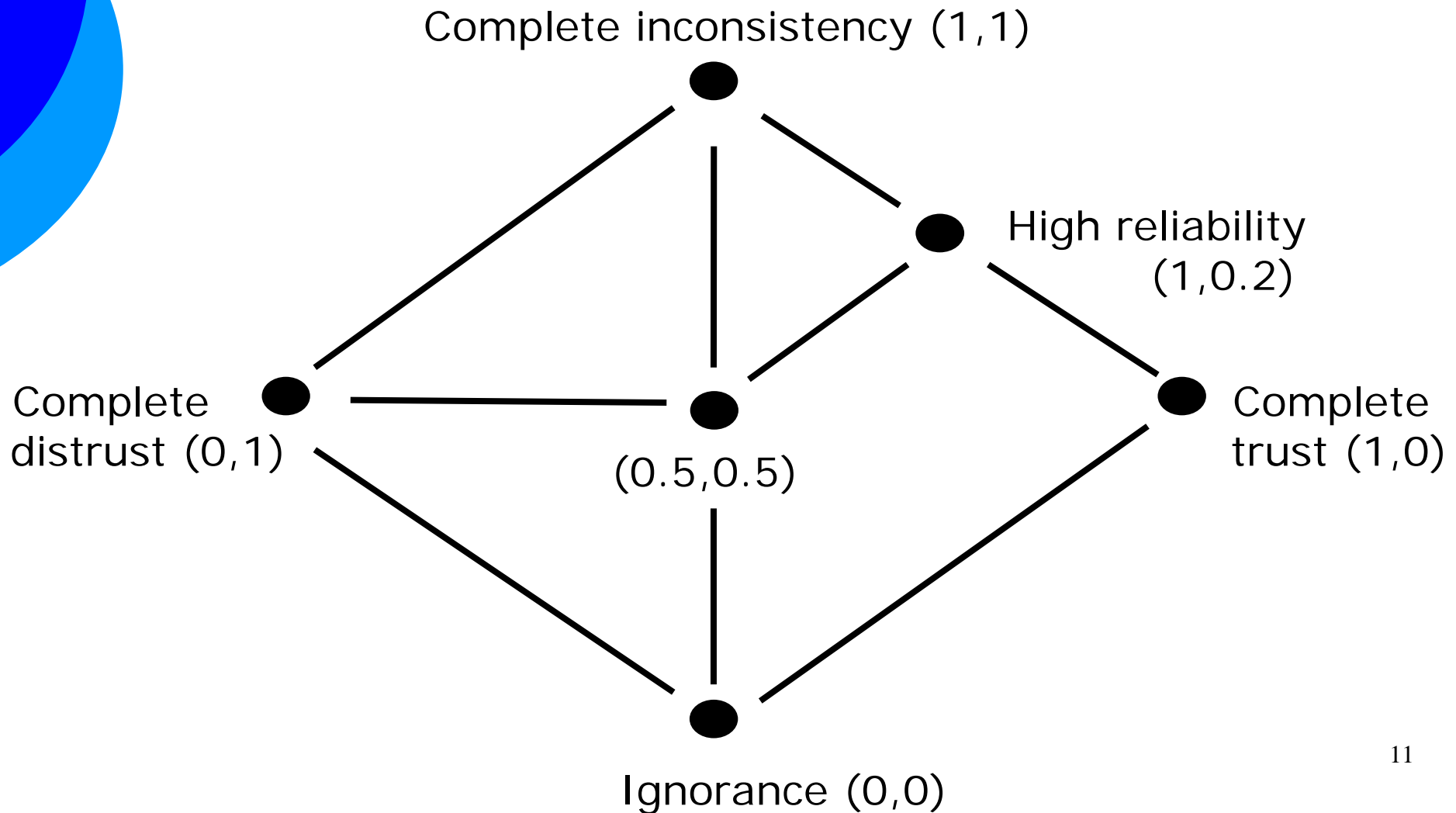
Trust Model (4)

- “Trust problem” caused by:
 - presence of distrust
=> untrustworthy agents
 - lack of knowledge
=> unknown agents

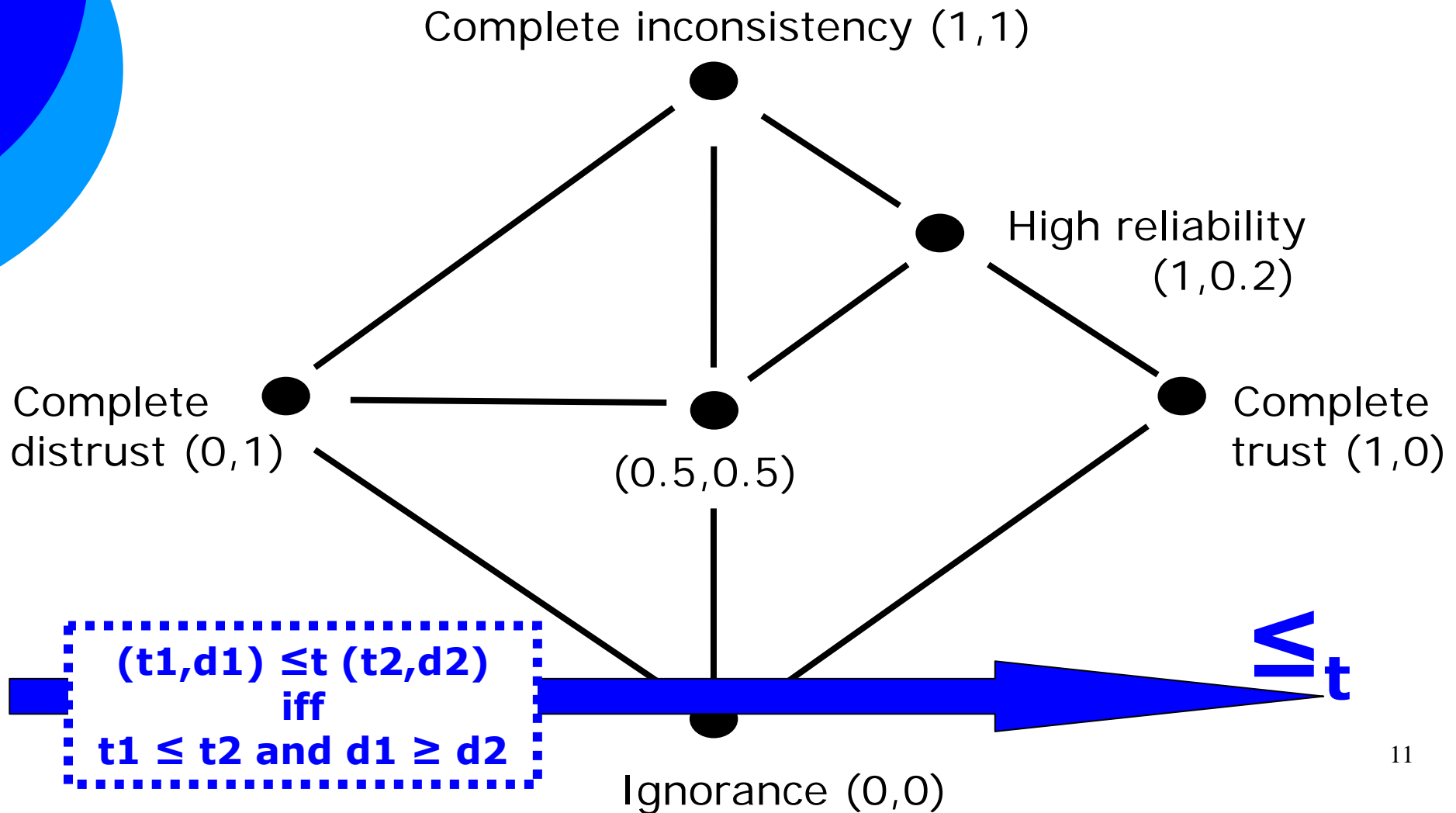
- “Knowledge problem” caused by:
 - too little information
 - too much, contradictory information

 **Trust score space BL^{\square}**

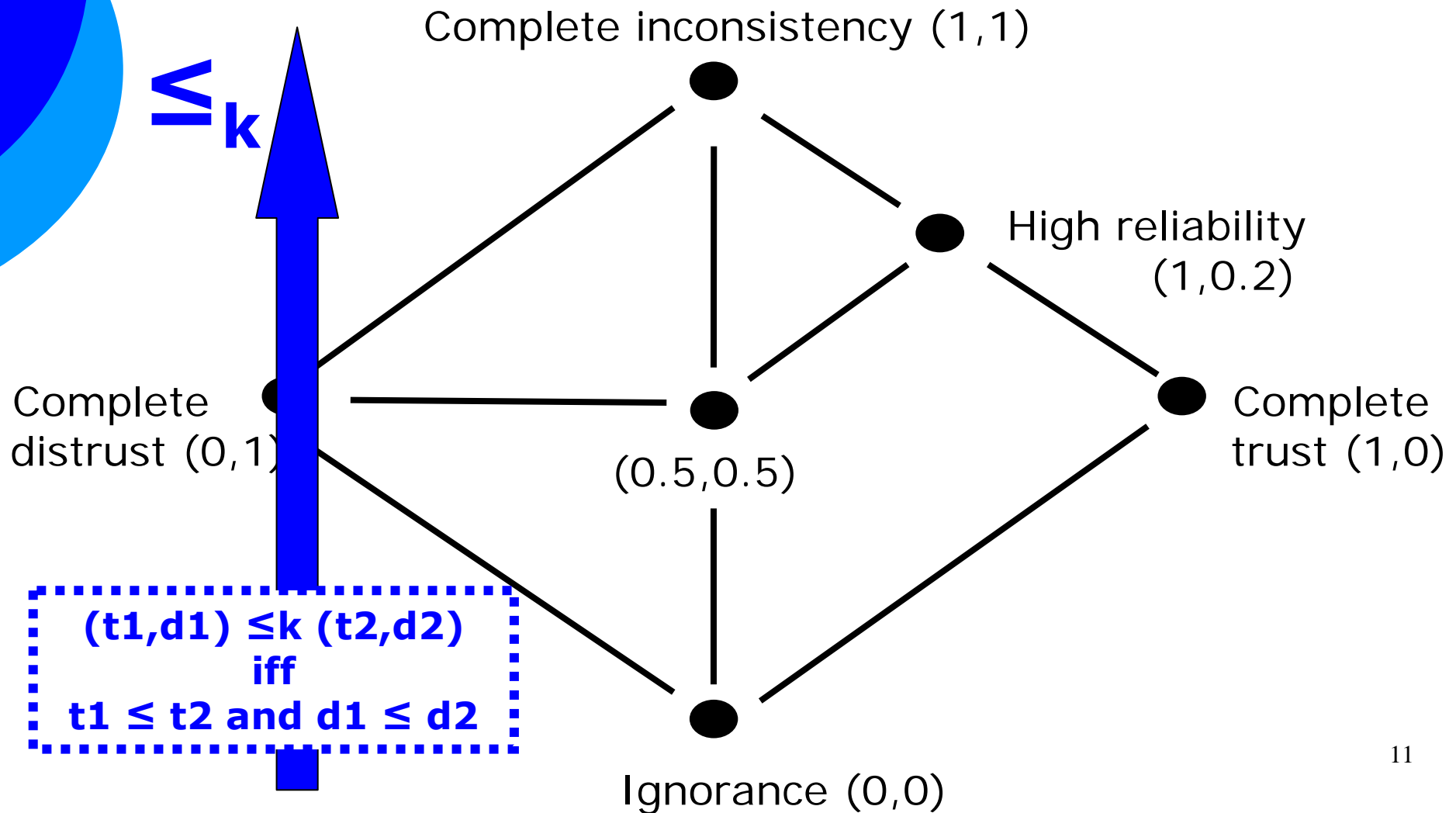
Trust score space $BL^{\square} = ([0,1]^2, \leq t, \leq k)$



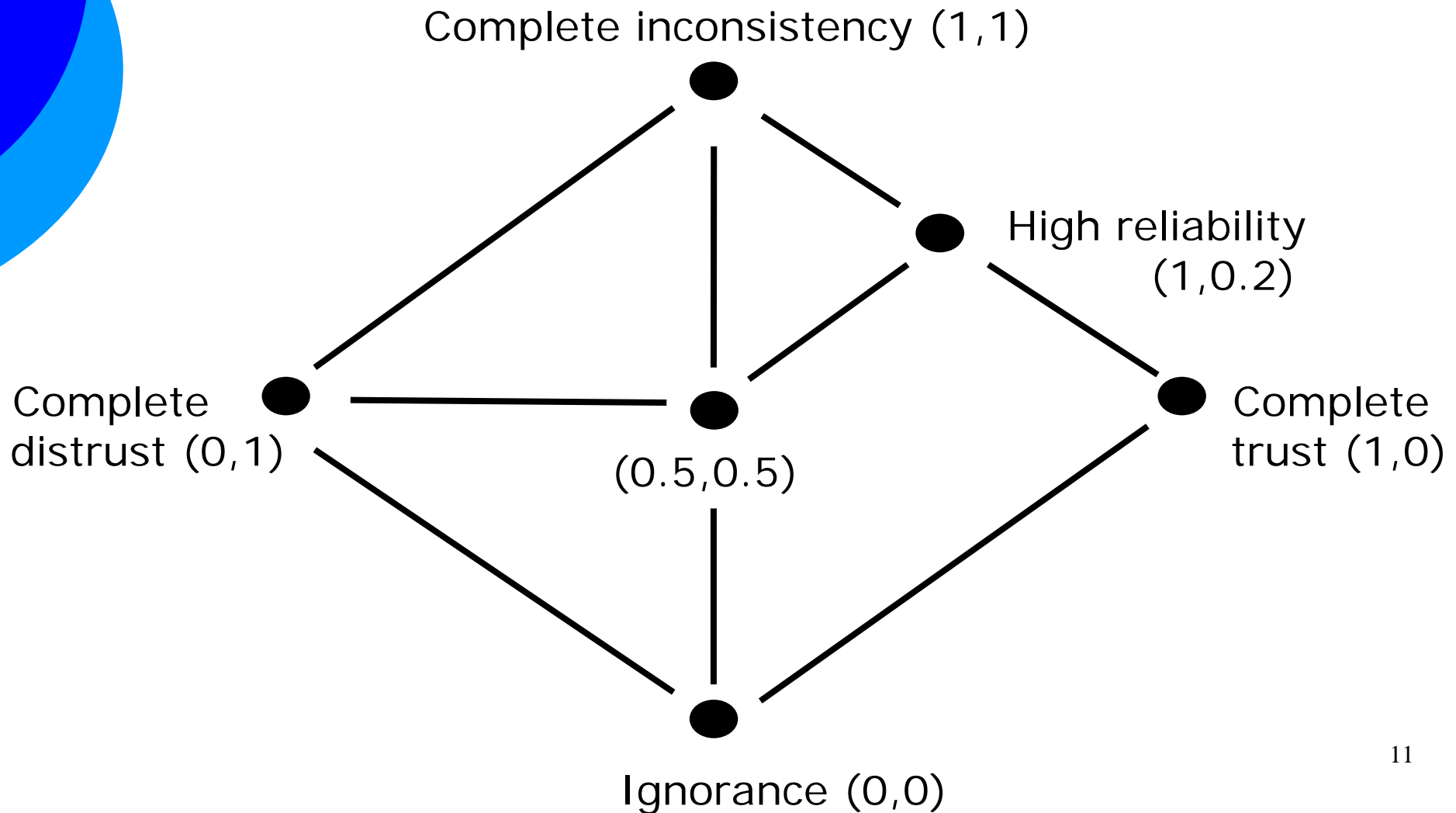
Trust score space $BL^{\square} = ([0,1]^2, \leq_t, \leq_k)$



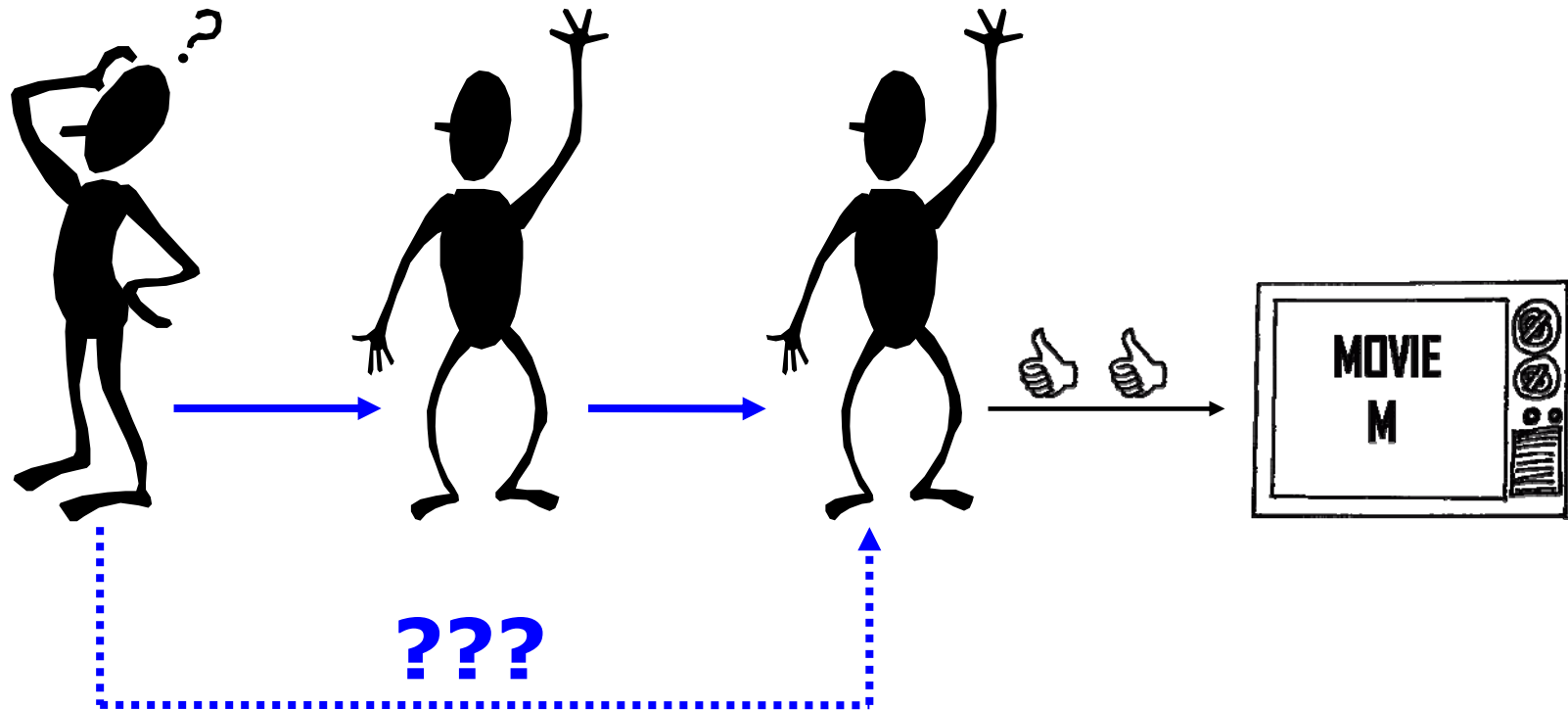
Trust score space $BL^{\square} = ([0,1]^2, \leq_t, \leq_k)$



Trust score space $BL^{\square} = ([0,1]^2, \leq t, \leq k)$



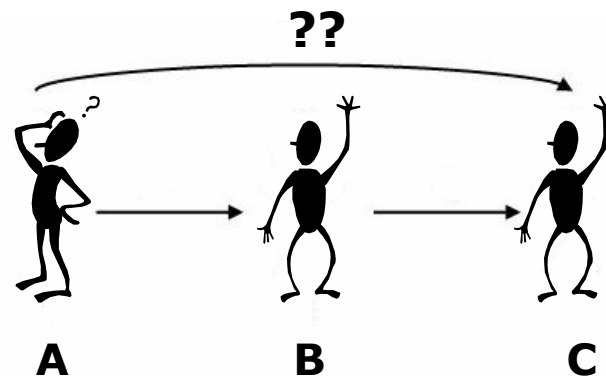
Trust Propagation



Trust Propagation: Experiment (1)

Experiment: How do people act when receiving information from a (dis)trusted acquaintance or from a stranger?

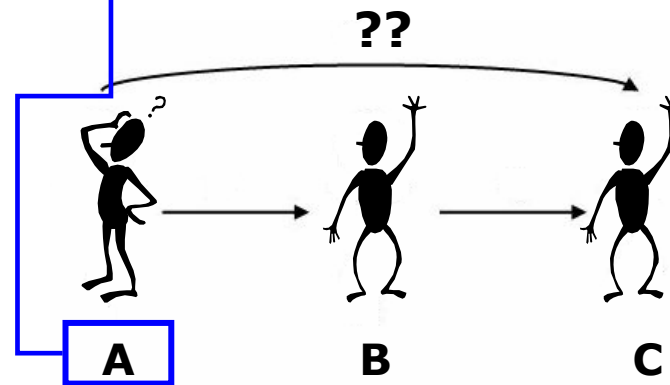
Question 1/20 : You hear a *complete stranger* talking to his friend: "Personally, I don't know anything about movie M, but I asked *some guy I don't know* if he had seen the movie, and he said he liked M a lot, and greatly recommended it to me".



Trust Propagation: Experiment (1)

Experiment: How do people act when receiving information from a (dis)trusted acquaintance or from a stranger?

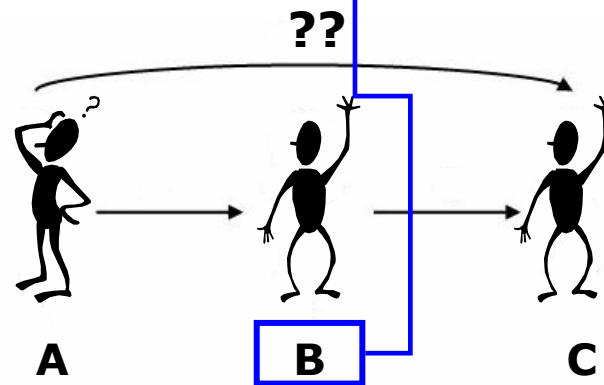
Question 1/20 : You hear a *complete stranger* talking to his friend: "Personally, I don't know anything about movie M, but I asked *some guy I don't know* if he had seen the movie, and he said he liked M a lot, and greatly recommended it to me".



Trust Propagation: Experiment (1)

Experiment: How do people act when receiving information from a (dis)trusted acquaintance or from a stranger?

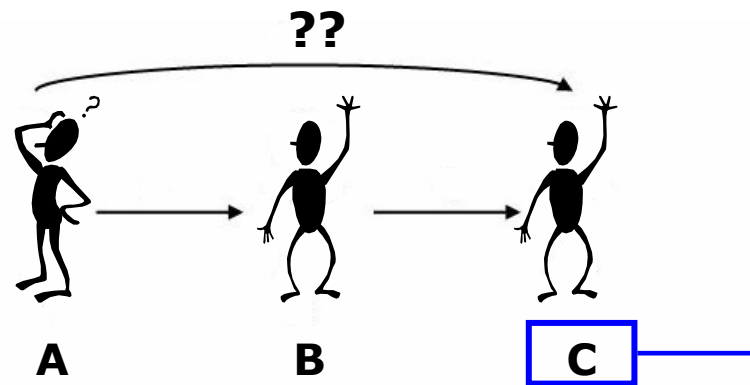
Question 1/20 : You hear **a complete stranger** talking to his friend: "Personally, I don't know anything about movie M, but I asked *some guy I don't know* if he had seen the movie, and he said he liked M a lot, and greatly recommended it to me".



Trust Propagation: Experiment (1)

Experiment: How do people act when receiving information from a (dis)trusted acquaintance or from a stranger?

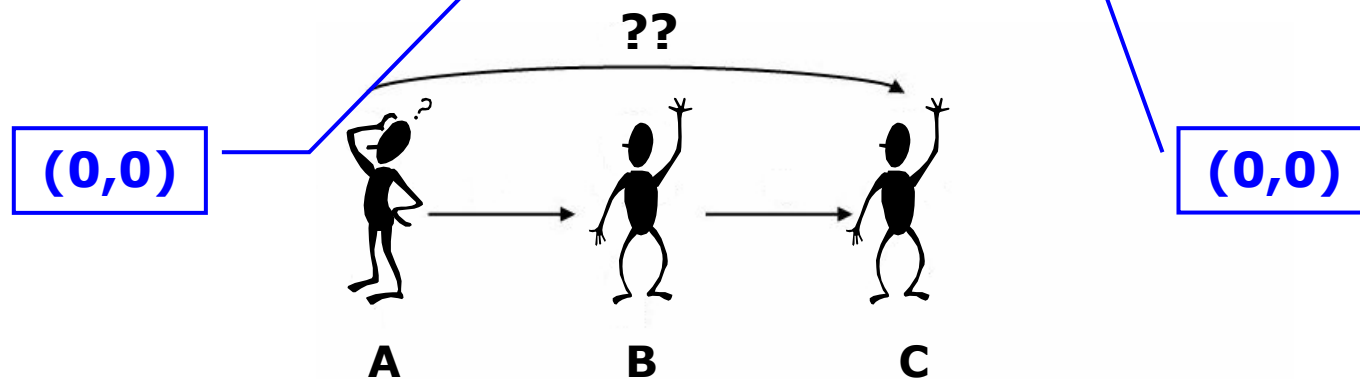
Question 1/20 : You hear a *complete stranger* talking to his friend: "Personally, I don't know anything about movie M, but I asked **some guy I don't know** if he had seen the movie, and he said he liked M a lot, and greatly recommended it to me".



Trust Propagation: Experiment (1)

Experiment: How do people act when receiving information from a (dis)trusted acquaintance or from a stranger?

Question 1/20 : You hear **a complete stranger** talking to his friend: "Personally, I don't know anything about movie M, but I asked **some guy I don't know** if he had seen the movie, and he said he liked M a lot, and greatly recommended it to me".

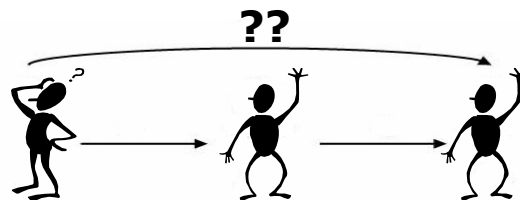


Trust Propagation: Experiment (2)

Question 1/20: You hear a *complete stranger* talking to his friend: 'Personally, I don't know anything about movie M, but I've just asked *some guy I don't know* if he had seen the movie, and he said he liked M a lot, and greatly recommended it to me'.

What do you do with this advice?

- Fully accept. You accept the advice wholeheartedly. Unless an even better recommendation comes along, you'll choose M.
- Rather accept. You accept the recommendation as mild (non-compelling) evidence in favour of M. In case this is the only information (about any movie) you obtained, you'd probably go for M.
- Ignore. It doesn't have an influence on your decision whether to watch M or not.
- Rather reject. You don't have much faith in this recommendation; it actually makes M a less attractive alternative.
- Fully reject. You will definitely not watch M.
- Don't know. This recommendation confuses you: it gives you reasons both to see M, and not to see it.

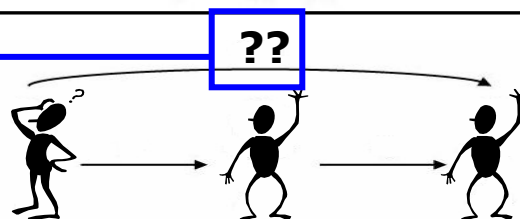


Trust Propagation: Experiment (2)

Question 1/20: You hear a *complete stranger* talking to his friend: 'Personally, I don't know anything about movie M, but I've just asked *some guy I don't know* if he had seen the movie, and he said he liked M a lot, and greatly recommended it to me'.

What do you do with this advice?

- Fully accept. You accept the advice wholeheartedly. Unless an even better recommendation comes along, you'll choose M.
- Rather accept. You accept the recommendation as mild (non-compelling) evidence in favour of M. In case this is the only information (about any movie) you obtained, you'd probably go for M.
- Ignore. It doesn't have an influence on your decision whether to watch M or not.
- Rather reject. You don't have much faith in this recommendation; it actually makes M a less attractive alternative.
- Fully reject. You will definitely not watch M.
- Don't know. This recommendation confuses you: it gives you reasons both to see M, and not to see it.



Trust Propagation: Experiment (2)

Question 1/20: You hear a *complete stranger* talking to his friend: 'Personally, I don't know anything about movie M, but I've just asked *some guy I don't know* if he had seen the movie, and he said he liked M a lot, and greatly recommended it to me'.

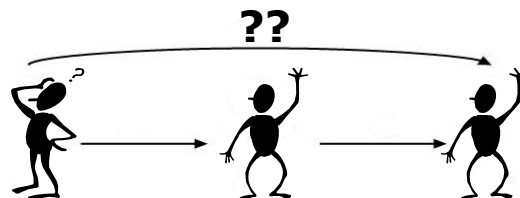
What do you do with this advice?

(1,0)

(0,0)

(0,1)

- Fully accept. You accept the advice wholeheartedly. Unless an even better recommendation comes along, you'll choose M.
- Rather accept. You accept the recommendation as mild (non-compelling) evidence in favour of M. In case this is the only information (about any movie) you obtained, you'd probably go for M.
- Ignore. It doesn't have an influence on your decision whether to watch M or not.
- Rather reject. You don't have much faith in this recommendation; it actually makes M a less attractive alternative.
- Fully reject. You will definitely not watch M.
- Don't know. This recommendation confuses you: it gives you reasons both to see M, and not to see it.



Trust Propagation: Experiment (2)

Question 1/20: You hear a *complete stranger* talking to his friend: 'Personally, I don't know anything about movie M, but I've just asked *some guy I don't know* if he had seen the movie, and he said he liked M a lot, and greatly recommended it to me'.

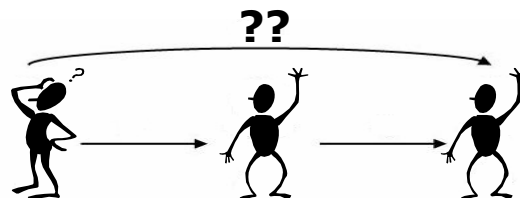
What do you do with this advice?

- Fully accept. You accept the advice wholeheartedly. Unless an even better recommendation comes along, you'll choose M.
- Rather accept. You accept the recommendation as mild (non-compelling) evidence in favour of M. In case this is the only information (about any movie) you obtained, you'd probably go for M.
- Ignore. It doesn't have an influence on your decision whether to watch M or not.
- Rather reject. You don't have much faith in this recommendation; it actually makes M a less attractive alternative.
- Fully reject. You will definitely not watch M.
- Don't know. This recommendation confuses you: it gives you reasons both to see M, and not to see it.

(0.5,0)

(0,0.5)

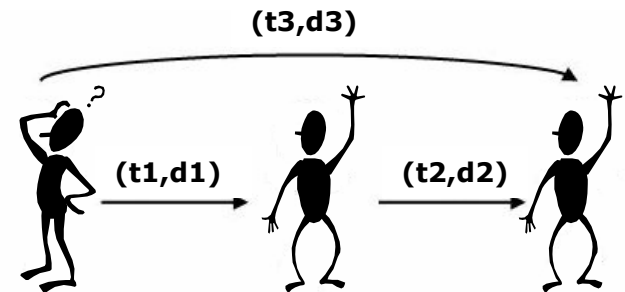
(0.5,0.5)



Propagation Operators (1)

PROFILE I:

- * The friend of your enemy is your enemy
- * The enemy of your enemy is your friend



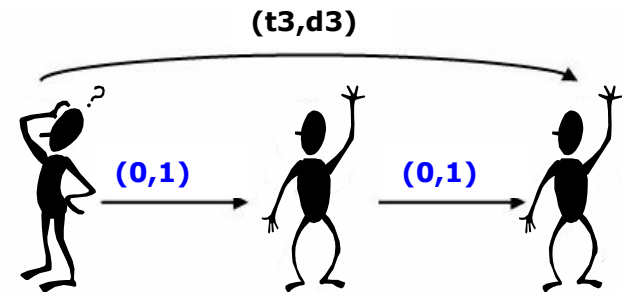
Trust of A in C: $t3 = S(T(t1,t2), T(d1,d2))$

Distrust of A in C: $d3 = S(T(t1,d2), T(d1,t2))$

Propagation Operators (1)

PROFILE I:

- * The friend of your enemy is your enemy
- * The enemy of your enemy is your friend



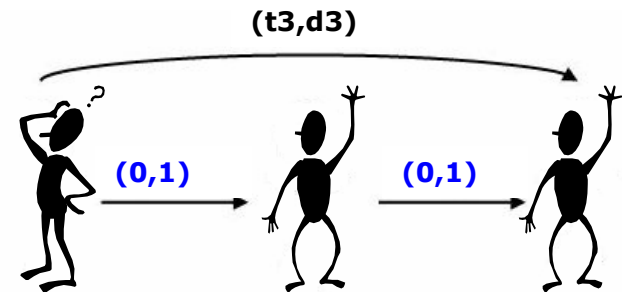
Trust of A in C: $t3 = S(T(t1,t2), T(d1,d2))$

Distrust of A in C: $d3 = S(T(t1,d2), T(d1,t2))$

Propagation Operators (1)

PROFILE I:

- * The friend of your enemy is your enemy
- * The enemy of your enemy is your friend



Conjunction

t-norm T : $\min(x,y), xy, \dots$

Trust of A in C:

$$t3 = S(T(t1,t2), T(d1,d2))$$

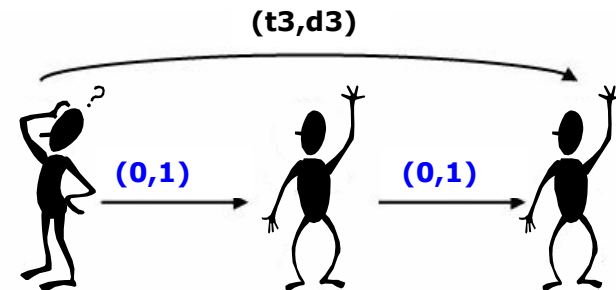
Distrust of A in C:

$$d3 = S(T(t1,d2), T(d1,t2))$$

Propagation Operators (1)

PROFILE I:

- * The friend of your enemy is your enemy
- * The enemy of your enemy is your friend



Disjunction

t-conorm **S**: $\max(x,y), x+y-xy, \dots$

Conjunction

t-norm **T**: $\min(x,y), xy, \dots$

Trust of A in C:

$$t3 = \mathbf{S}(\mathbf{T}(t1,t2), \mathbf{T}(d1,d2))$$

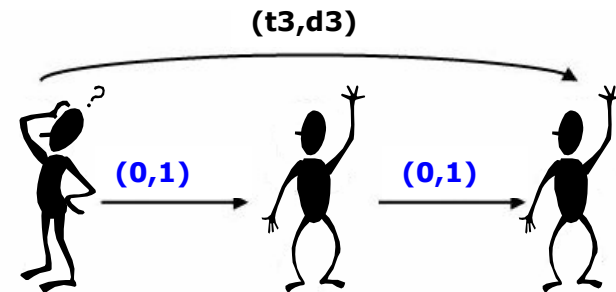
Distrust of A in C:

$$d3 = \mathbf{S}(\mathbf{T}(t1,d2), \mathbf{T}(d1,t2))$$

Propagation Operators (1)

PROFILE I:

- * The friend of your enemy is your enemy
- * The enemy of your enemy is your friend



Disjunction

t-conorm **S**: $\max(x,y), x+y-xy, \dots$

Conjunction

t-norm **T**: $\min(x,y), xy, \dots$

Trust of A in C:

$$t3 = S(T(0,0), T(1,1))$$

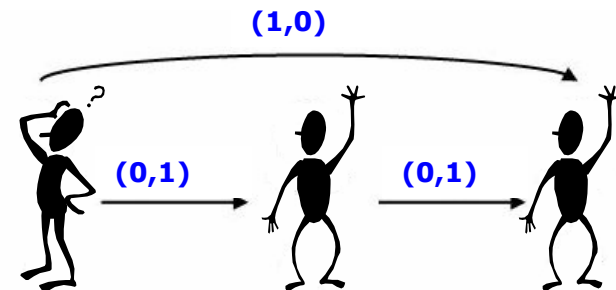
Distrust of A in C:

$$d3 = S(T(0,1), T(1,0))$$

Propagation Operators (1)

PROFILE I:

- * The friend of your enemy is your enemy
- * The enemy of your enemy is your friend



Disjunction

t-conorm **S**: $\max(x,y), x+y-xy, \dots$

Conjunction

t-norm **T**: $\min(x,y), xy, \dots$

Trust of A in C:

$$\mathbf{1} = \mathbf{S}(\mathbf{T}(\mathbf{0},\mathbf{0}),\mathbf{T}(\mathbf{1},\mathbf{1}))$$

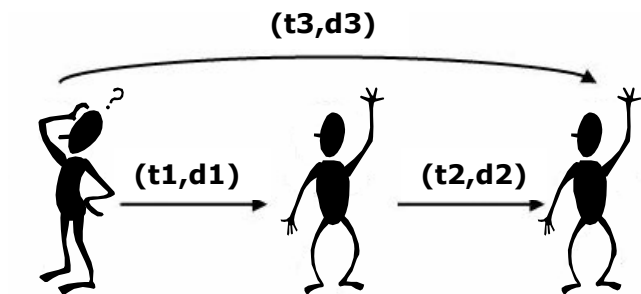
Distrust of A in C:

$$\mathbf{0} = \mathbf{S}(\mathbf{T}(\mathbf{0},\mathbf{1}),\mathbf{T}(\mathbf{1},\mathbf{0}))$$

Propagation Operators (2)

PROFILE II:

- * The friend of your enemy is your enemy
- * The enemy of your enemy is NOT your friend



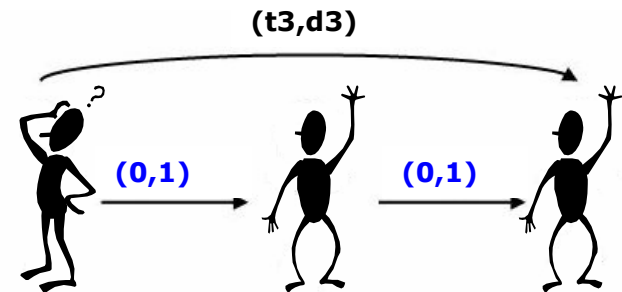
Trust of A in C: $t3 = T(t1, t2)$

Distrust of A in C: $d3 = S(T(t1, d2), T(d1, t2))$

Propagation Operators (2)

PROFILE II:

- * The friend of your enemy is your enemy
- * The enemy of your enemy is NOT your friend



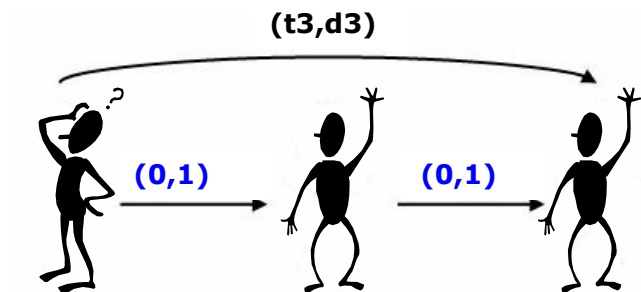
Trust of A in C: $t3 = T(t1,t2)$

Distrust of A in C: $d3 = S(T(t1,d2),T(d1,t2))$

Propagation Operators (2)

PROFILE II:

- * The friend of your enemy is your enemy
- * The enemy of your enemy is NOT your friend



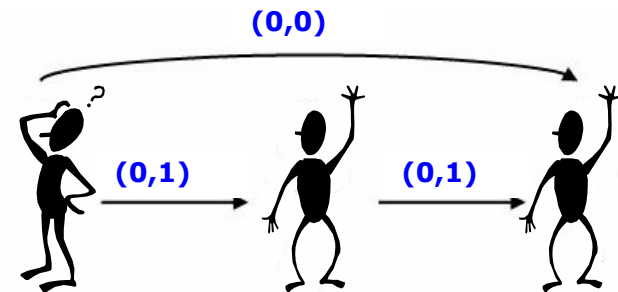
Trust of A in C: $t3 = T(0,0)$

Distrust of A in C: $d3 = S(T(0,1), T(1,0))$

Propagation Operators (2)

PROFILE II:

- * The friend of your enemy is your enemy
- * The enemy of your enemy is NOT your friend



Trust of A in C: $\mathbf{0} = \mathbf{T}(\mathbf{0},\mathbf{0})$

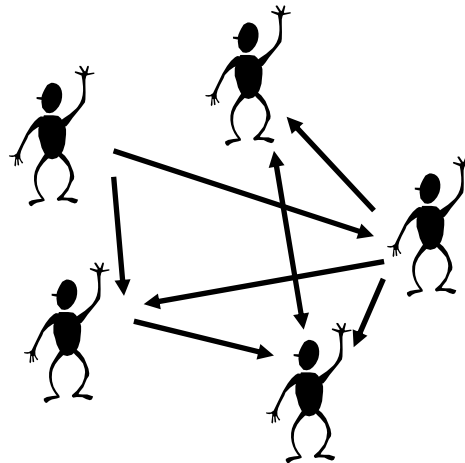
Distrust of A in C: $\mathbf{0} = \mathbf{S}(\mathbf{T}(\mathbf{0},\mathbf{1}),\mathbf{T}(\mathbf{1},\mathbf{0}))$

Future Work

1. Other propagation profiles??

- skeptical
- paranoid
- benefit of the doubt
- ...

2. Aggregation of trust scores??

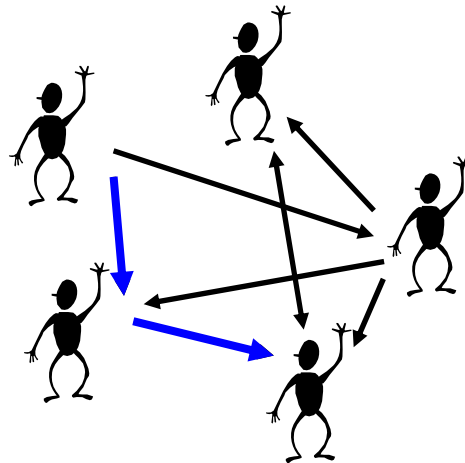


Future Work

1. Other propagation profiles??

- skeptical
- paranoid
- benefit of the doubt
- ...

2. Aggregation of trust scores??

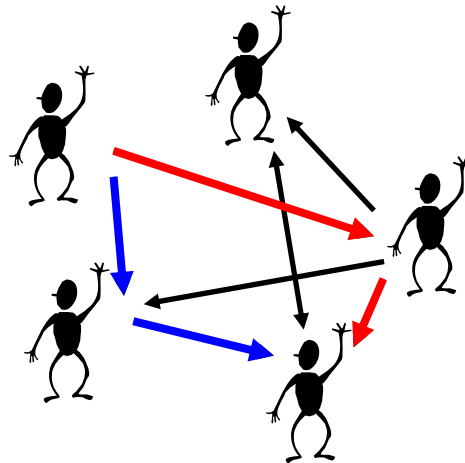


Future Work

1. Other propagation profiles??

- skeptical
- paranoid
- benefit of the doubt
- ...

2. Aggregation of trust scores??



Conclusions

Key problems in **RS**:

- sparsity
- cold start
- intruders



Trust Network
among the users

Conclusions

Key problems in **RS**:

- sparsity
- cold start
- intruders



Trust Network
among the users

**New
bilattice
Trust Model**

Full and Partial
Trust/Distrust/Ignorance
+ Inconsistency

Conclusions

Key problems in **RS**:

- sparsity
- cold start
- intruders



Trust Network
among the users

**New
bilattice
Trust Model**

Full and Partial
Trust/Distrust/Ignorance
+ Inconsistency

**Enriched
with
Operations**

Propagation → user dependent
→ 2 profiles ?
Aggregation → ? ? ?



Thank you
for listening!

<http://www.cwi.ugent.be/patricia.html>