PRIVACY IN ONLINE SOCIAL NETWORKS

Part 2

Outline

- Trust transitivity analysis.
- Combining trust and reputation.
- Trust derivation based on trust comparisons.

TRUST TRANSITIVITY ANALYSIS

What is Trust Transitivity Analysis?

- Assume two agents A and B where A trusts B, and B believes that proposition x is true.
- Then by **transitivity**, **agent A will also believe that proposition x is true.**
- In our approach, **trust** and **belief** are formally expressed as **opinions**.
- **The transitive linking of these two opinions consists of discounting B's opinion about x by A's opinion about B, in order to derive A's opinion about x.**

Representation of trust and difficulties in TTA

- The **solid** arrows represent initial **direct trust**.
- The **dotted** arrow represents derived **indirect trust**.
- **Trust transitivity**, as trust itself, is a **human mental phenomenon**

- **<u>Disadvantages:</u>**

1) The first is related to the **effect of A disbelieving that B** will give a good advice.
2) The second difficulty relates to the **effect of base rate trust in a transitive path**.

First Problem

1. Uncertainty Favoring Trust Transitivity

- A's disbelief in the recommending agent B ⟶ A thinks that B ignores the truth value of x.
- As a result A also ignores the truth value of x.

Fig. 22.3 Principle of trust transitivity

First Problem explained

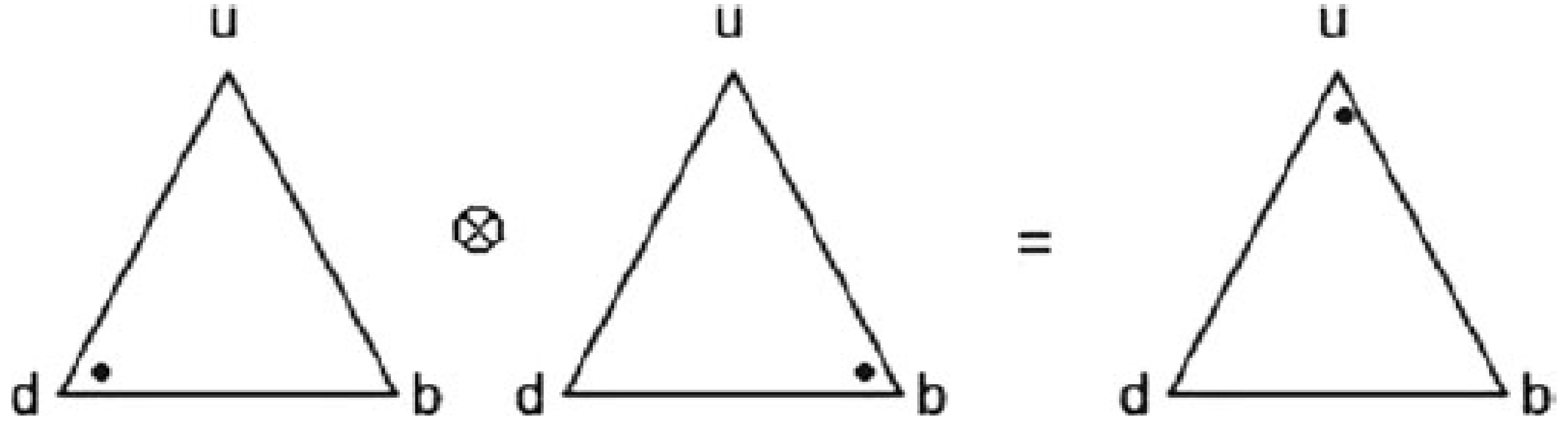

Fig. 22.4 Example of applying the discounting operator for independent opinions

Definition 22.1 (Uncertainty Favoring Discounting). Let A and B be two agents where A's opinion about B's recommendations is expressed as $\omega_B^A = \{b_B^A, d_B^A, u_B^A, a_B^A\}$, and let x be a proposition where B's opinion about x is recommended to A with the opinion $\omega_x^B = \{b_x^B, d_x^B, u_x^B, a_x^B\}$ Let $\omega_x^{A:B} = \{b_x^{A:B}, d_x^{A:B}, u_x^{A:B}, a_x^{A:B}\}$ be the opinion such that:

First Problem explained

$$\begin{cases} b_x^{A:B} = b_B^A b_x^B \\ d_x^{A:B} = d_B^A d_x^B \\ u_x^{A:B} = d_B^A + u_B^A + b_B^A u_x^B \\ a_x^{A:B} = a_x^B \end{cases}$$

then $\omega_x^{A:B}$ is called the uncertainty favoring discounted opinion of A. By using the symbol $\otimes$ to designate this operation, we get $\omega_x^{A:B} = \omega_B^A \otimes \omega_x^B$.

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First Problem explained

Your enemy's enemy is your friend

2. Opposite Belief Favoring

- A's disbelief in the recommending agent B means that A thinks that B consistently recommends the opposite of his real opinion about the truth value of x.

Definition 22.2 (Opposite Belief Favoring Discounting). Let A and B be two agents where A's opinion about B's recommendations is expressed as $\omega_B^A = \{b_B^A, d_B^A, u_B^A, a_B^A\}$, and let x be a proposition where B's opinion about x is recommended to A as the opinion $\omega_x^B = \{b_x^B, d_x^B, u_x^B, a_x^B\}$. Let $\omega_x^{A:B} = \{b_x^{A:B}, d_x^{A:B}, u_x^{A:B}, a_x^{A:B}\}$ be the opinion such that:

$$\begin{cases} b_x^{A:B} = b_B^A b_x^B + d_B^A d_x^B \\ d_x^{A:B} = b_B^A d_x^B + b_B^A d_x^B \\ u_x^{A:B} = u_B^A + (b_B^A + d_B^A) u_x^B \\ a_x^{A:B} = a_x^B \end{cases}$$

then $\omega_x^{A:B}$ is called the opposite belief favoring discounted recommendation from B to A. By using the symbol $\otimes$ to designate this operation, we get $\omega_x^{A:B} = \omega_B^A \otimes \omega_x^B$.

Second Problem explained

3. Base Rate Sensitive Transitivity

- A scenario!!!!!!!!!
- Imagine a stranger coming to a town which is know for its citizens being honest.
- The stranger is looking for a car mechanic, and asks the first person he meets to direct him to a good car mechanic.
- The stranger receives the reply that there are two car mechanics in town, David and Eric.
- David is cheap but does not always do quality work
- Eric might be a bit more expensive, but he always does a perfect job.
- Translated into the formalism of subjective logic, **the stranger has no other info about the person he asks than the base rate that the citizens in the town are honest.**

Definition 22.3 (Base Rate Sensitive Discounting). The base rate sensitive discounting of a belief $\omega_x^B = \{b_x^B,\ d_x^B,\ u_x^B,\ a_x^B\}$ by a belief $\omega_B^A = \{b_B^A,\ d_B^A,\ u_B^A,\ a_B^A\}$ produces the transitive belief $\omega_x^{A:B} = \{b_x^{A:B},\ d_x^{A:B},\ u_x^{A:B},\ a_x^{A:B}\}$ where

$$\begin{cases} b_x^{A:B} = E\left(\omega_B^A\right) b_x^B \\ d_x^{A:B} = E\left(\omega_B^A\right) d_x^B \\ u_x^{A:B} = 1 - E\left(\omega_B^A\right)\left(b_x^B + d_x^B\right) \\ a_x^{A:B} = a_x^B \end{cases}$$

where the probability expectation value $E\left(\omega_B^A\right) = b_B^A + a_B^A u_B^A$.

Second Problem explained

4. Mass Hysteria

- **Mass hysteria** can be caused by **people not** being **aware of dependence between opinions**.
- Let’s take for example; person A recommend an opinion about a particular statement x to a group of other persons.
- Without being aware of the fact that the opinion came from the same origin, these persons can recommend their opinions to each other as illustrated in Figure below.

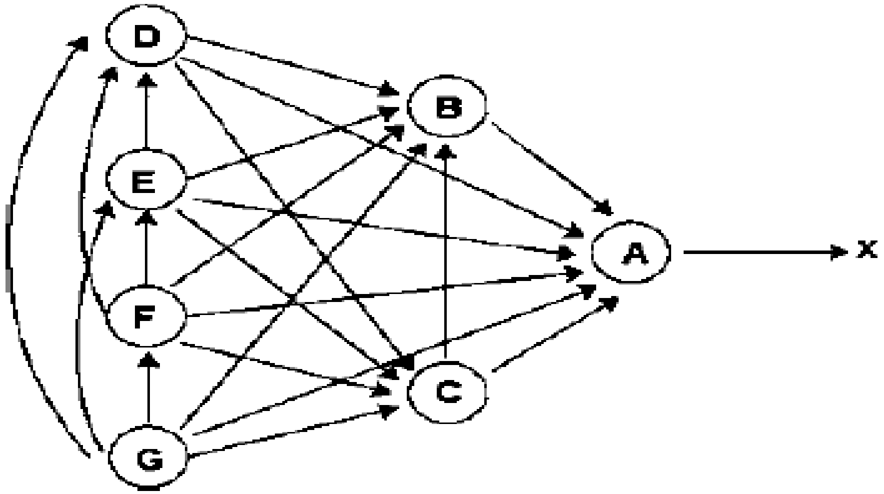

Fig. 22.5 The effects of unknown dependence

Second Problem explained

- ***<u>Problem with Mass Hysteria:</u>***
- The arrows represent trust so that for example B → A can be interpreted as saying that B trusts A to recommend an opinion about statement x.
- It can be seen that A recommends an opinion about x - 6 other agents, and that G receives six recommendations in all.
- If G assumes the recommended opinions to be independent and takes the consensus between them, his opinion can become abnormally strong and in fact even stronger than A’s opinion.

Second Problem explained

Solution for Mass Hysteria:

- Taking all the possible recommendations into account, we should first create a relatively complex trust graph.
- Analyzing the whole graph of dependent paths, as if they were independent.
- Retain only the non-redundant edges.
- If there are edges like $G \rightarrow B \rightarrow A$, $G \rightarrow C \rightarrow A$ and $G \rightarrow A$, retain only the edge $G \rightarrow A$.