Indian Institute of Technology Delhi

ELL 880 - Social Network Analysis

Assignment 3

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1 Problem statement

Q.1 The Information Cascade model that we studied is very simplified. In real-life there will be many more parameters we need to consider.

i) State a parameter that will be required in the real world and justify why will it be required.

ii) Rework the cascade model determining the probabilities for both the individual decision and multiple signals using this additional parameter.

2 Information Cascade Problem

2.1 Part 1

1. **State a parameter that will be required in the real world and justify why it will be required.**

Parameter: Information Source Credibility and Verification Mechanisms

In today's interconnected digital world, the spread of information is profoundly influenced by the perceived credibility of sources and the presence of verification mechanisms. As people navigate vast amounts of information across multiple platforms, cues that signal the trustworthiness of a source—such as verification badges, institutional endorsements, or historical accuracy—become essential. These credibility markers play a pivotal role in determining how quickly and widely information cascades through networks.

Why This Parameter is Required?

1) **Trust and Source Credibility:** Credibility markers, such as blue verification badges on social media or endorsements by reputable organizations, signal reliability to users. These markers often mean the difference between an idea gaining traction or being disregarded. When information is perceived as credible, users are more likely to engage with and share it, fuelling information cascades.

2) **Shield Against Misinformation:** As misinformation becomes a significant societal concern, credibility markers help users discern trustworthy information from unreliable sources. This parameter helps filter out unverified content, reducing the likelihood of misinformation cascades.

3) **Endorsements and Network Influence:** Information endorsed by authoritative figures or organizations has a higher chance of propagating, as endorsements act as implicit trust signals. A credible source's endorsement can amplify information, causing it to reach broader audiences and increasing the cascade's intensity.

4) **Reputation and Historical Reliability:** Sources with a track record of reliability are more likely to be trusted. Users rely on past credibility as a guide, favouring information from consistently accurate sources. This cumulative trust factor strengthens the influence of such sources on cascade dynamics.

5) **Platform-Specific Verification Mechanisms:** Different platforms have unique verification mechanisms (e.g., trending labels, trusted badges) that influence user perception. These mechanisms create a platform-driven bias that can significantly impact the speed and reach

of cascades on specific networks.

Key Components of the Parameter

1) **Verification Signals:** Verification mechanisms, such as badges or certifications, visually convey a source's authenticity. Users interpret these signals as indicators of reliability, making them more inclined to accept, engage with, and spread the information. In platforms where verification is scarce, cascades may occur more cautiously and selectively.

2) **Influencer and Authority Endorsements:** Endorsements by well-known figures or institutions often lead to widespread information adoption. Influencers or respected professionals lend credibility to information, accelerating its spread within and beyond their follower networks.

3) **Trustworthiness Score or Rating:** Platforms could assign trust scores based on a source's reliability history. Users tend to share content more when it comes from sources with high trust scores, fostering cascades from sources perceived as credible while minimizing the influence of less reputable ones.

4) **Content-Dependent Verification:** Certain types of information, like health data or financial news, may require additional verification processes. These contextual checks increase the perceived accuracy of the information, making users more likely to propagate it.

5) **Audience-Specific Credibility:** The credibility of a source can vary depending on the audience. For example, scientific communities may prioritize peer-reviewed journals, while the general public may rely on mainstream news outlets. Audience-aligned credibility markers enhance cascade precision within different demographic groups.

Importance of the Parameter in Real-World Information Cascades

1) **Rapid Spread of High-Credibility Information:** Information from verified or credible sources spreads more swiftly due to a higher initial trust level. In crises (e.g., natural disasters), people quickly adopt and share information from credible sources, amplifying its reach and impact.

2) **Suppression of Misinformation:** By emphasizing credible sources, this parameter acts as a barrier to misinformation, allowing verified content to gain prominence over potentially harmful, unverified information.

3) **Increased Cascade Depth:** Information from credible sources doesn't just spread widely; it tends to sustain itself longer. Users often share credible information repeatedly, reinforcing the cascade across multiple network layers and creating a more enduring impact.

4) **Differentiation of Cascades by Topic:** Some content areas (like medical advice or financial updates) are more credibility-sensitive. Users may only propagate information in these areas if it comes from verified sources, creating topic-dependent cascades influenced by source credibility.

5) **Trust-Building within Digital Communities:** Verified information from reputable sources strengthens trust within communities, making future cascades more effective. Users become conditioned to trust certain information channels, enhancing the speed of cascades when new, similarly credible information emerges.

Example Applications of Information Source Credibility and Verification Mechanisms

1) **Social Media News Dissemination:** Platforms like Twitter and Facebook use verification badges for trusted accounts. News shared by these verified accounts often achieves rapid and wide cascades, as users perceive it as credible and immediately relevant.

2) **Influencer Product Recommendations:** When influencers endorse products, especially those with verification badges, their followers view these endorsements as credible. This creates rapid cascades where product recommendations quickly spread across the network of followers, often spilling into broader audiences.

3) **Crisis and Emergency Communication:** During health crises or natural disasters, verified information from official channels (e.g., government health departments) spreads rapidly and reliably. In these situations, the credibility of the source is critical to public compliance and cascade effectiveness.

4) **Educational Campaigns:** For topics requiring public awareness, such as vaccination campaigns, endorsement by credible figures or organizations enhances cascade reach and intensity. The trustworthiness of these sources prompts individuals to adopt and share the information widely, accelerating campaign success.

2.2 Part 2

2. **Rework the cascade model determining the probabilities for both the individual decision and multiple signals using this additional parameter.**

Incorporating **Information Source Credibility** into the cascade model involves adjusting probabilities to account for the perceived trustworthiness of the information source. This means that individuals will weigh the credibility of a source when deciding whether to adopt and share information. Let's denote the credibility level as C, with values ranging from 0 (unverified or low credibility) to 1 (high credibility or verified).

Probability of an Individual Decision Based on Credibility

The probability that an individual will choose to adopt information (i.e., participate in the cascade) based on the source's credibility can be modelled as follows:

Individual Decision Probability Formula

Let:

- p: the base probability that the information is accurate or beneficial, without factoring in credibility.
- C: the credibility level of the source ($0 \leq C \leq 1$).

The modified probability of an individual adopting the information based on the credibility parameter, denoted as $Pr(\text{Adopt} \mid S,C)$, can be expressed as:

$$Pr(\text{Adopt} \mid S,C) = p * C + (1-p) * (1-C)$$

Here:

- When C is high (close to 1), individuals are more likely to trust the information, and the adoption probability aligns closely with the base probability p.
- When C is low (close to 0), individuals are less likely to adopt, and the probability skews away from p, reflecting scepticism toward low-credibility sources.

Probability with Multiple Signals and Credibility

In cases where individuals receive information from multiple sources, each with its own credibility level, we can define a weighted average to determine the overall probability of adopting based on all received signals.

Assume n signals from sources with differing credibility level C_1, C_2, ..., C_n, the probability of adoption given multiple signals can be calculated as follows:

$$Pr(\text{Adopt} \mid S,C) = \frac{\sum_{i=1}^{n}(p * C_i + (1-p) * (1-C_i))}{n}$$

This formula takes the credibility-weighted probability of each signal and averages it over all signals received:

- Higher-credibility sources (C_i closer to 1) will contribute more to the final probability, increasing the likelihood of adoption.

- Lower-credibility sources (C_i closer to 0) will reduce the probability, reflecting the damping effect of less trustworthy signals.

Example Application

Suppose three signals come from sources with credibility levels of 0.9, 0.7, and 0.3, and the base probability p is 0.8. We calculate the individual contribution of each signal:

i) For $C_1 = 0.9$:

$$Pr(\text{Adopt} \mid S,C_1) = 0.8 * 0.9 + (1 - 0.8) * (1 - 0.9) = 0.74$$

ii) For $C_2 = 0.7$

$$Pr(\text{Adopt} \mid S,C_2) = 0.8 * 0.7 + (1 - 0.8) * (1 - 0.7) = 0.62$$

iii) For $C_3 = 0.3$

$$Pr(\text{Adopt} \mid S,C_3) = 0.8 * 0.3 + (1 - 0.8) * (1 - 0.3) = 0.38$$

The overall probability of adoption across all signals is:

$$Pr(\text{Adopt} \mid S,C) = \frac{(0.74 + 0.62 + 0.38)}{3} = 0.58$$

This weighted approach demonstrates how the cascade model is adjusted by the credibility of each source, allowing the model to reflect realistic decision-making where individuals assess the trustworthiness of multiple sources.

Conclusion

Integrating Information Source Credibility into the cascade model enables more accurate predictions of information spread. By adjusting for source credibility, this reworked model captures the nuanced impact of trust and verification on individual and collective decisions in information cascades.