Network Intervention to Limit Misinformation Spread on Reddit

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For CPSC 534L

Fall 2025

Outline

- ★ Motivation & Background
- ★ Graph Properties
- ★ Edge probabilities & Competitive IC
- ★ Results
    1. Seed selection
    2. Competitive IC
    3. User Removal
- ★ Conclusion

Motivation & Background

Social media is the leading source of information

Social media overtakes TV as Americans' top news source (Reuters Institute, 2025):

- 54% use social media/video for news
- 50% use TV
- First time (2025) social media leads
- Younger audiences (18-29) especially rely on social platforms

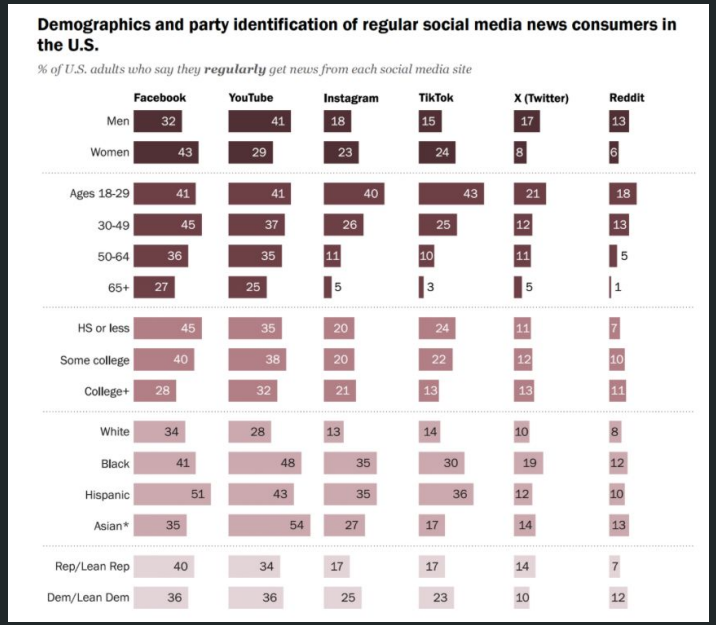


Figure 1. Social medias vs. party identification in the U.S. (Pew Research Center, 2025)

Misinformation

- Misinformation can be unintentional
- People are worried, but awareness alone is not enough
- In fact, people often retreat to news sources that confirm their own beliefs (echo chambers) (Harris et al., 2024)

➜ Better intervention strategies are needed!

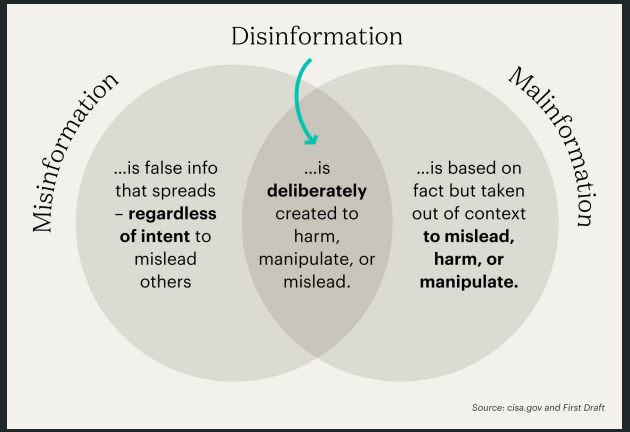


Figure 2. Misinformation, Disinformation, and Malinformation (Wentworth Institute of Technology, 2024)

Social Media Platform: Reddit

- Reddit is a forum social media platform, users can submit content et react to content
- Posts are organized by subject (subreddits)
- Redditors can upvote or downvote posts, submission with more upvotes appear towards the top of their subreddit
- Due to its nature, Reddit encourages debate

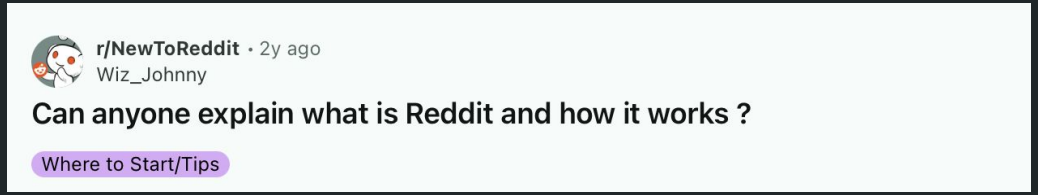


Figure 3. Post by redditor Wiz_Johnny in the subreddit NewToReddit. (Reddit, 2023)

Dataset: FACTOID

- FACTOID is a dataset for identifying misinformation spreaders and political bias (Reddit)
- Psycholinguistic features:
  - **Is misinformation spreader [true, false]**
  - factuality score (fd), political bias (pb), science belief (sb)
- Graph:
  - 4150 users
  - Edge = similarity between users, if they interact

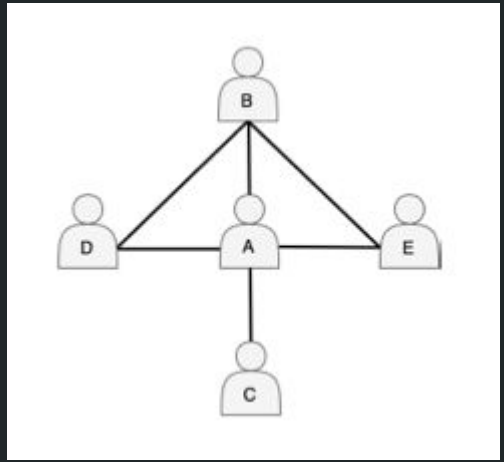


Figure 4. User Graph (Sakketou et al., 2022).

Research Questions

To stop misinformation, we must find the source or fight it!

1. **Which strategy is better to select seed nodes in the FACTOID social network?**
2. **Can we counter misinformation with a factual campaign?**
    a. Using the strategy from 1
3. **Are superspreaders solely responsible for misinformation?**
    a. Intuitively, we could remove “bigger” account (potential superspreaders), but it might be hard and controversial to remove: can we remove “smaller” users instead (minimal cost)?

Previous work

Limiting the spread of misinformation in social networks (Budak et al., 2011):

- Introduce competitive cascade model: “good” vs. “bad” campaigns (degree centrality)
- No removal: have more people adopt the factual campaign

Efficiently Block the Influence of Misinformation (Manouchehri et al., 2021):

- Influence blocking maximization (IBM)
- No removal: specific nodes block misinformation to stop spread

Countering Misinformation on Social Networks Using Graph Alterations (Bayiz & Topcu, 2022)

- Probabilistic edge dropout based on how aligned politically users are and their ability to discriminate between true and false
- No removal: drop connections to suppress misinformation

Graph Properties

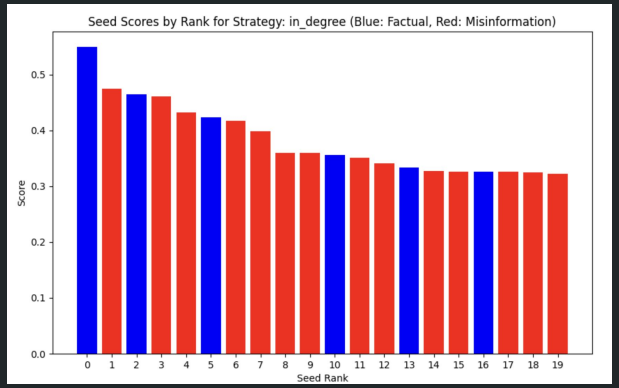
Graph Properties

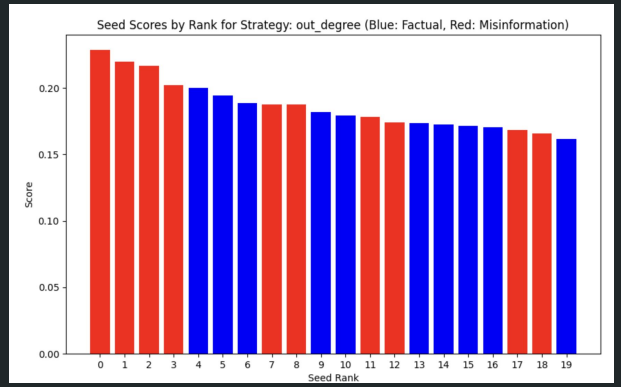
Basic Population Statistics

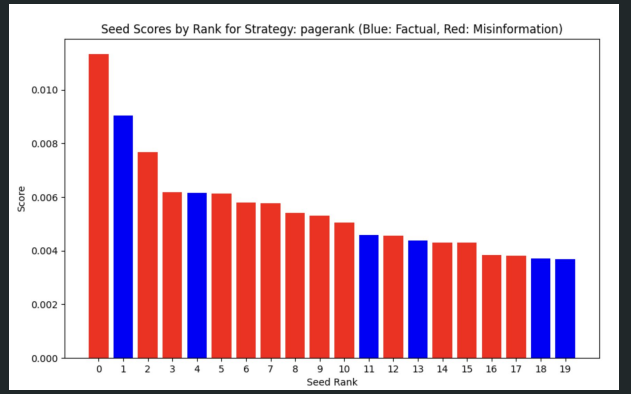
Number of nodes in graph: 4150
Number of edges in graph: 500276
Average degree: 241.10
Average in-degree/out-degree: 120.55
Number of fake news spreaders in graph: 1086

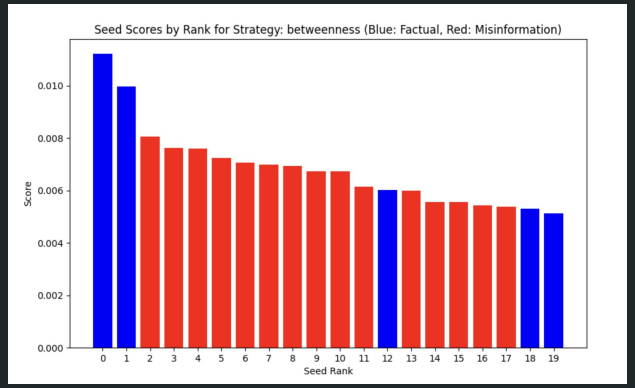
Graph Properties

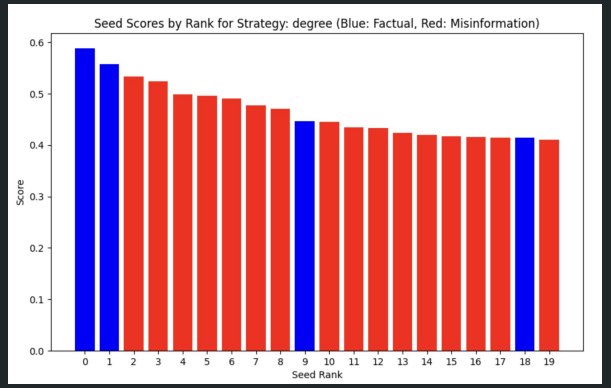
Seed Node Selection





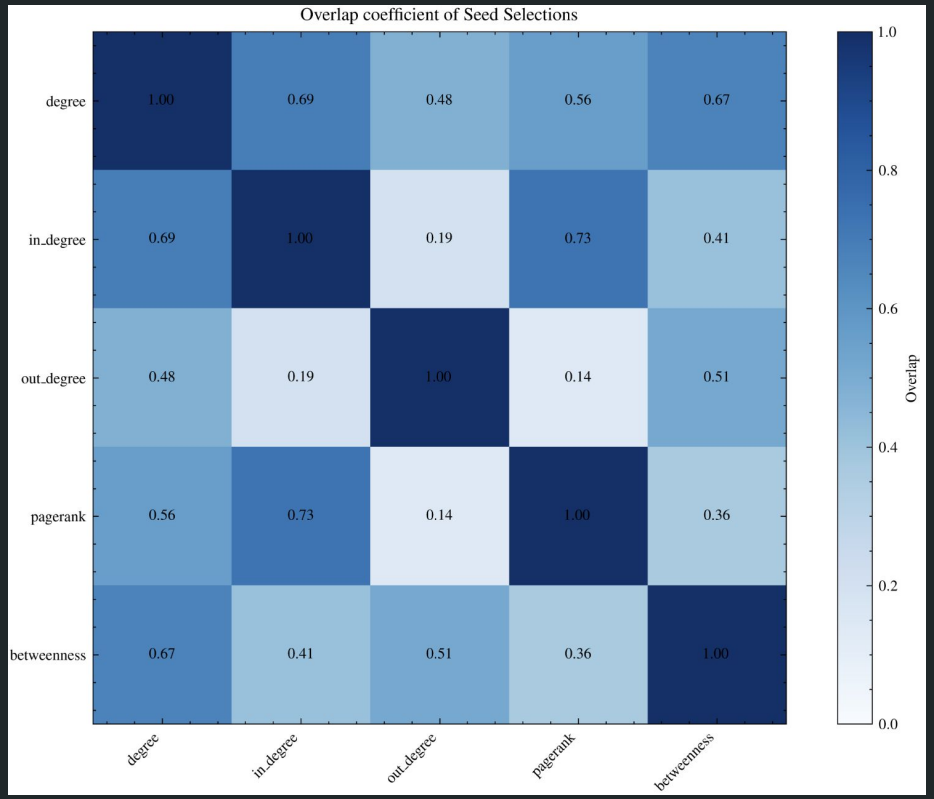






Graph Properties

Overlap between Seed Selection Methods



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Edge probabilities & Competitive IC

Methods

1. Calculating edge probabilities & Competitive IC
    a. Normalized interaction frequency
    b. Latent space similarity
    c. Baseline diffusion setup
2. Node Removal Based on Cost
    a. Greedy
    b. Knapsack

Calculating edge probabilities

Normalized interaction frequency

- For each edge, store the frequency of interaction for each direction
- Normalize the inward edges such that the sum is 1
- This is based on the assumption that if two users are more similar in ideology, they are more likely to influence each other

Calculating edge probabilities

Normalized interaction frequency

- For each edge, store the frequency of interaction for each direction
- Normalize the inward edges such that the sum is 1
- This is based on the assumption that if two users are more similar in ideology, they are more likely to influence each other

- This has a few issues
- Assumes uniform influence from all neighbours
- Does not account for the ***reason*** that the user replied to a post
    - I.e Even if the user disagreed, they would still have an equal probability of adopting a view given their *number* of replies are the same

Calculating edge probabilities

Latent Space Similarity

- For each user, gather the text content of all of their posts
- Run this through a sentence transformer and extract the embedding
- Now, for each user, we have an embedding that represents in some way their *views*
- Assign probability of propagation based on the cosine similarity of the vectors

- Result: No more uniformity and more accurate propagation probabilities
- Idea based on “Inf2Vec: Latent Representation Model for Social Influence Embedding”

Competitive IC

Baseline Diffusion Setup

We implement a competitive independent cascade model for two sets of seed nodes: Factual and Misinformation

In this model we assume that the speed of travel is equal for both sets of information, but if **the first set of seed nodes** (seed nodes A) reaches a node before the second set of seed nodes (see nodes B), then the node adopts A.

Results

Results

Experiment 1: Seed Selection Strategy Efficacy

Goal: Find which centrality metric produces the most effective seed nodes for viral spread

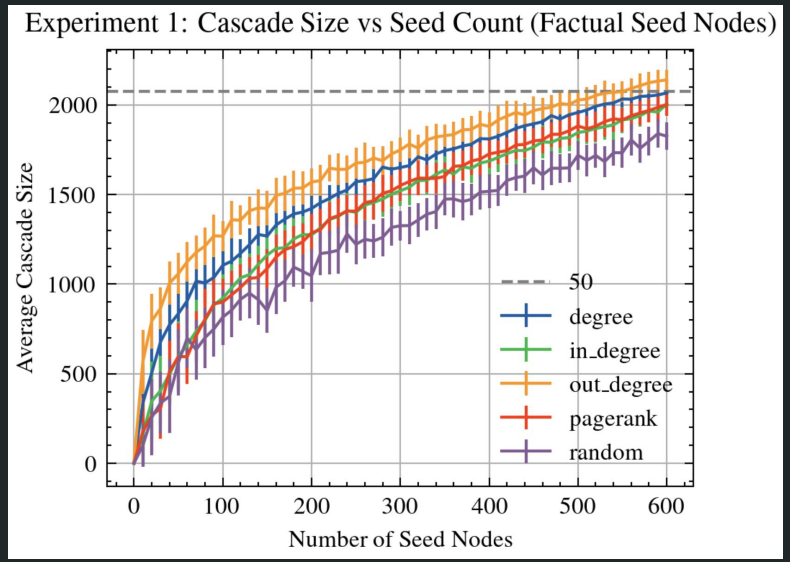
For each metric

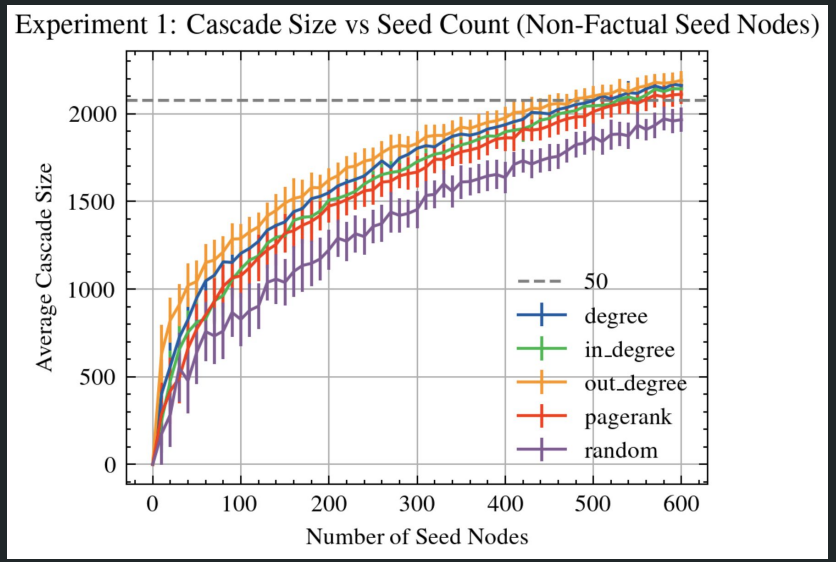
    For various seed set sizes:

        Run single-campaign IC simulations

Results

Experiment 1: Seed Selection Strategy Efficacy





Results

Experiment 2: Competitive Advantage & Resource Asymmetry

Goal: How do propagation priority and seed set size affect spread in competitive diffusion

When two nodes are both going to be successful in spreading to a node at the same time step, we need to break ties. We do this by giving priority to one of the two seed sets

This gives four scenarios based on our two choices of priority (Factual vs Misinfo) and our two choices of *which seed set to fix*

Results

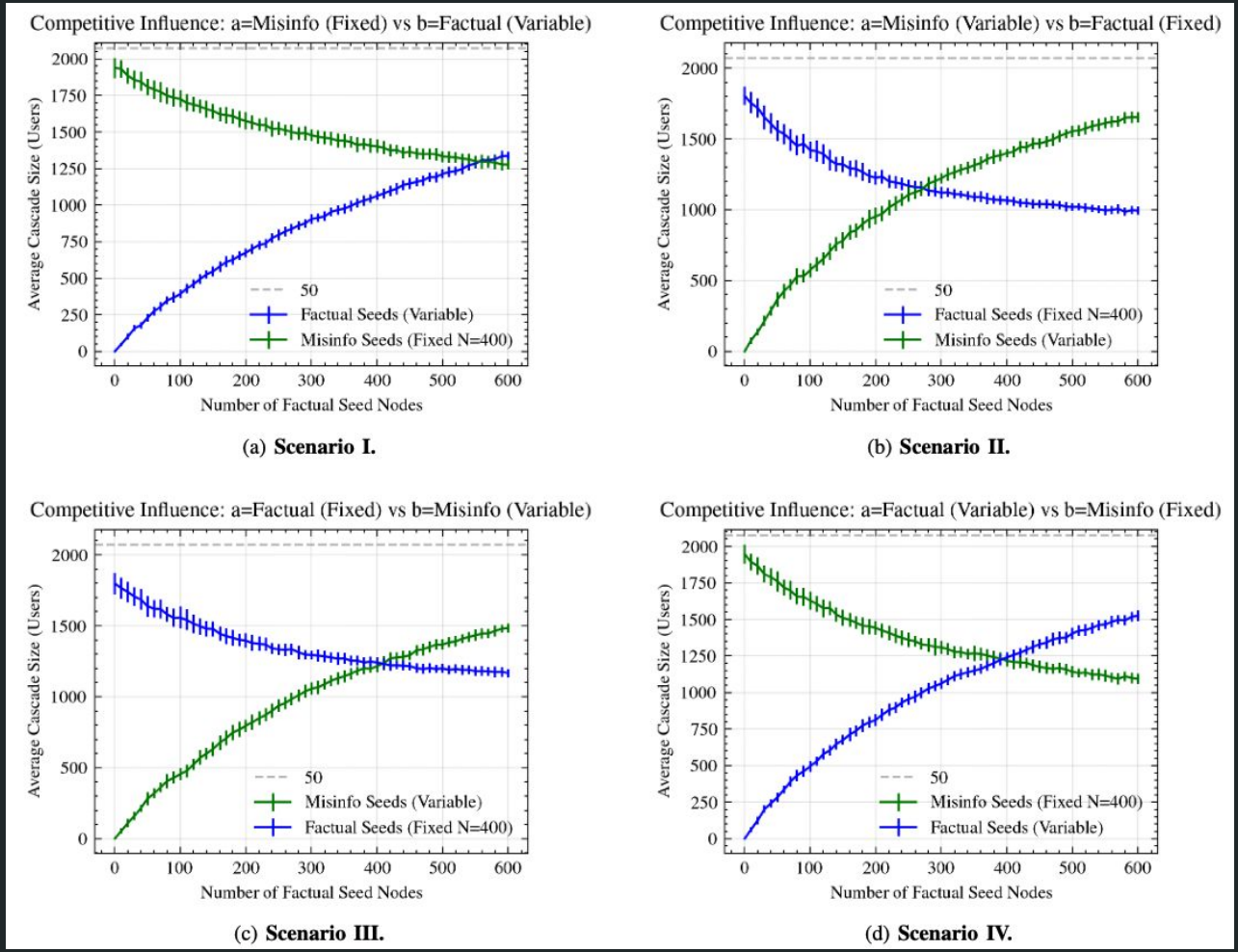
Experiment 2: Competitive Advantage & Resource Asymmetry

	Fix Misinfo Seeds Vary Factual Seeds	Vary Misinfo Seeds Fix Factual Seeds
Misinformation gets priority	**Scenario 1** *How many factual seeds are needed to match misinformation?*	**Scenario 2** *How cheaply can misinformation overwhelm a fixed defense?*
Factuality gets priority	**Scenario 4** *How efficient is a high-priority factual campaign?*	**Scenario 3** *How resilient is factual information with priority?*

Results

Experiment 2

The fixed seed set size is 400



Results

Experiment 3

Goal: See if it is more cost-effective to remove a few large users
or many small ones

High-degree users may be more controversial to remove, and their removal may also decrease the amount of genuine, constructive conversation being had

Define the cost of removal: **C(*u*) = floor(deg(*u*)^α)**

This is not an easy problem, since removing one node affects the degree of all of its neighbours

Results

Experiment 3

We try two strategies for removal

Strategy 1: **Greedy**

Iterativley, at each step:
if the budget allows for it, remove
the highest degree node
(and thus the highest cost)

Gives exclusively high degree nodes

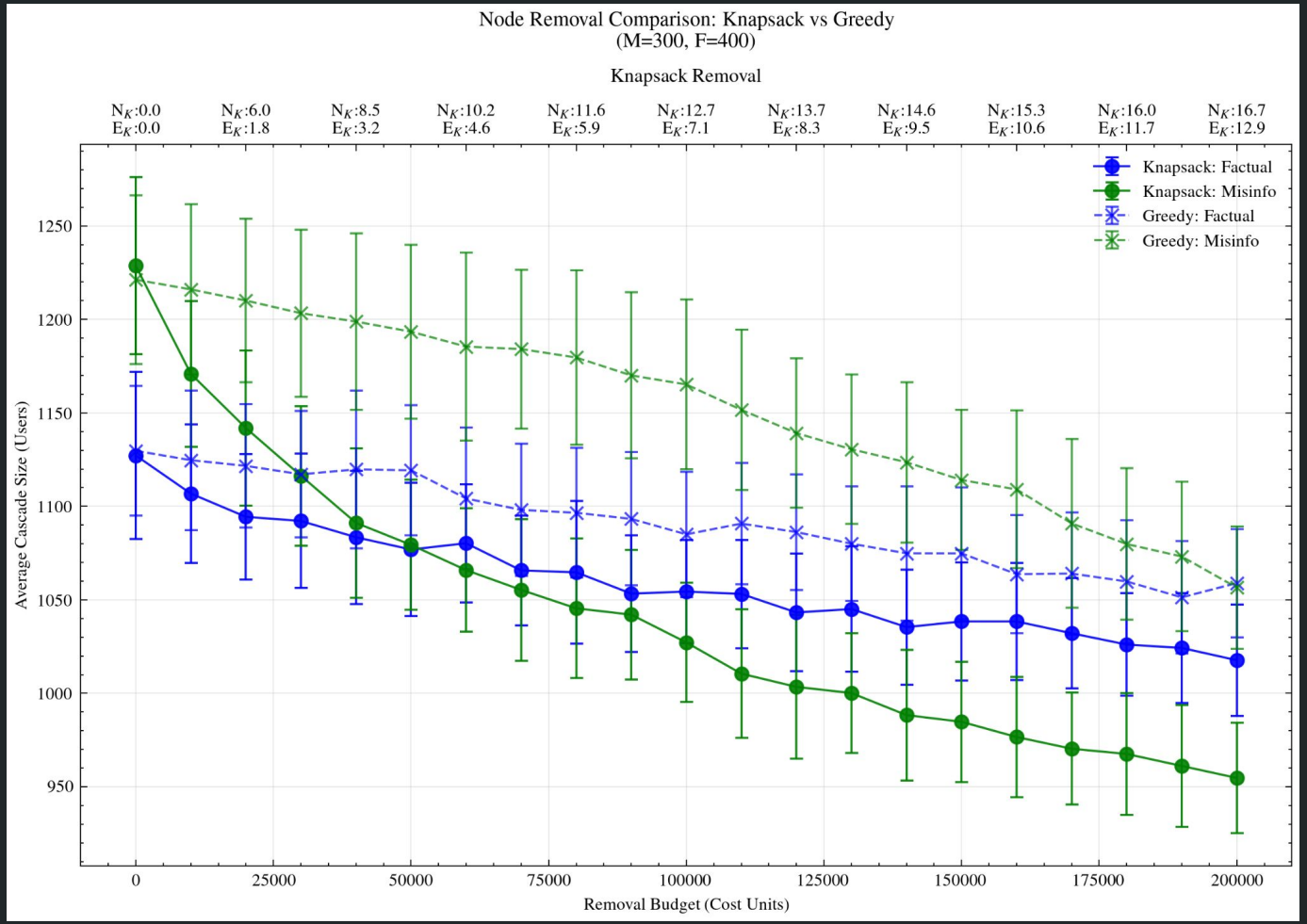
Strategy 2: **Knapsack**

0/1 Knapsack problem:
Weight = removal cost
Value = node degree

Can favour many small degree nodes

Results

Experiment 3



Conclusion

Conclusion

1. Out-degree is the preferred method for selecting seed users.
2. Independent of propagation priority, Misinformation possesses an intrinsic spreading advantage.
3. Removing a group of less moderately connected users can have more impact than a single highly connected user, given the same budget.
4. Removing users can act as a complementary mechanism alongside factual campaigns to neutralize misinformation spread.

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