A Communication Network Perspective of Social Networks

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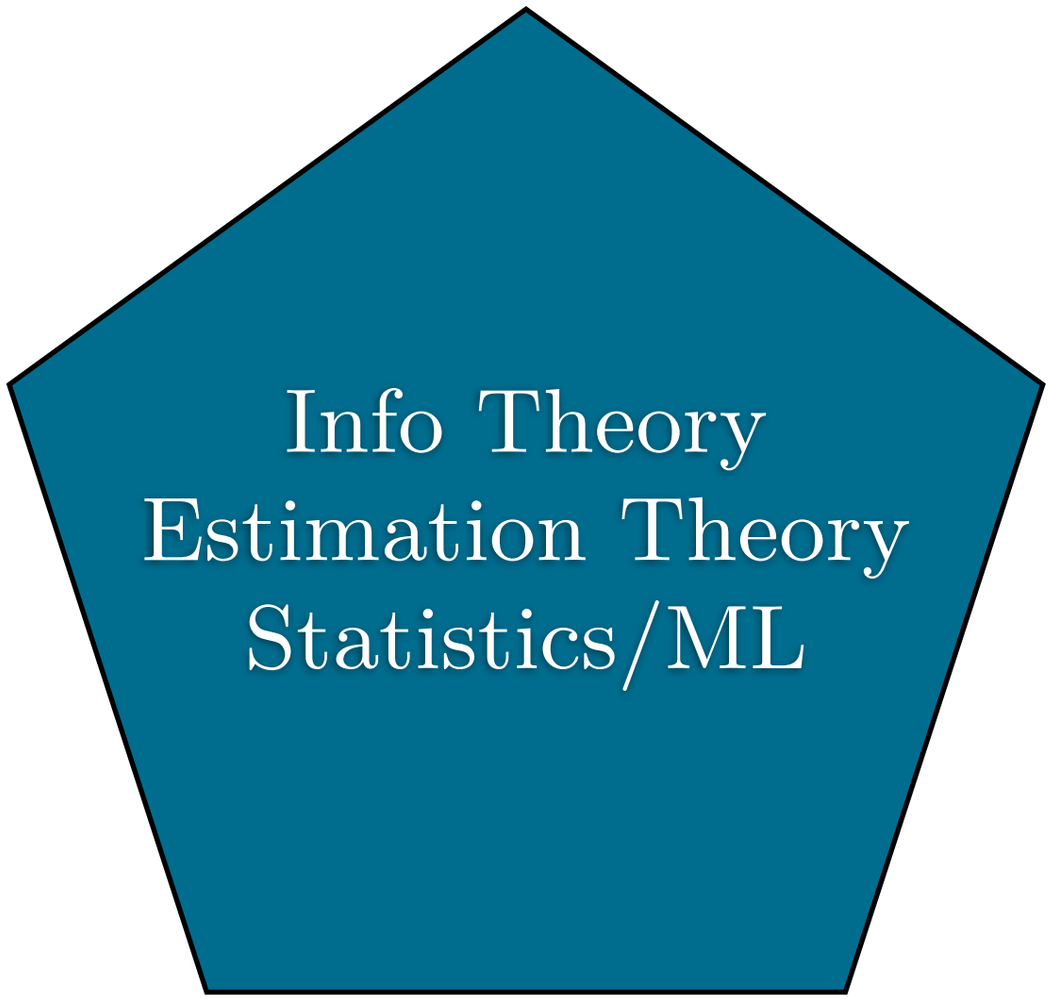
Recent Works



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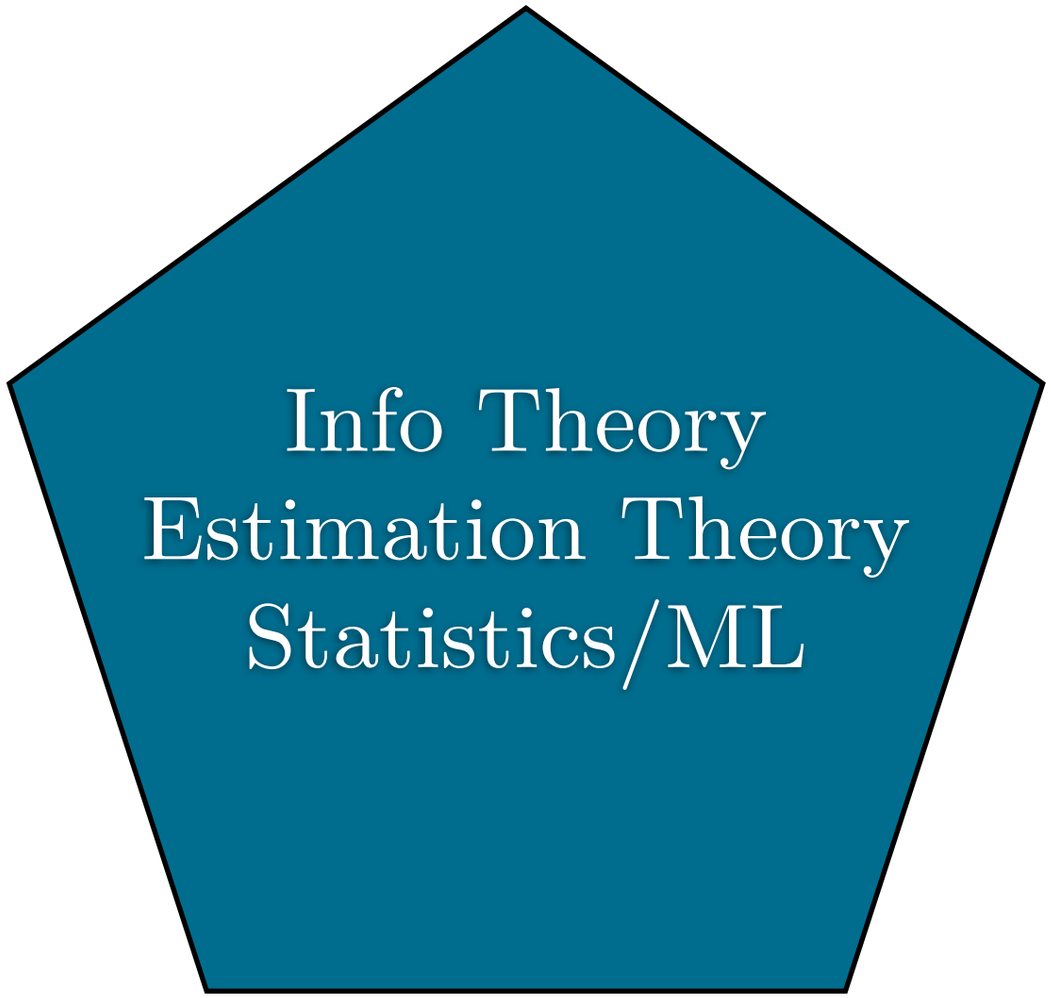

Haptics

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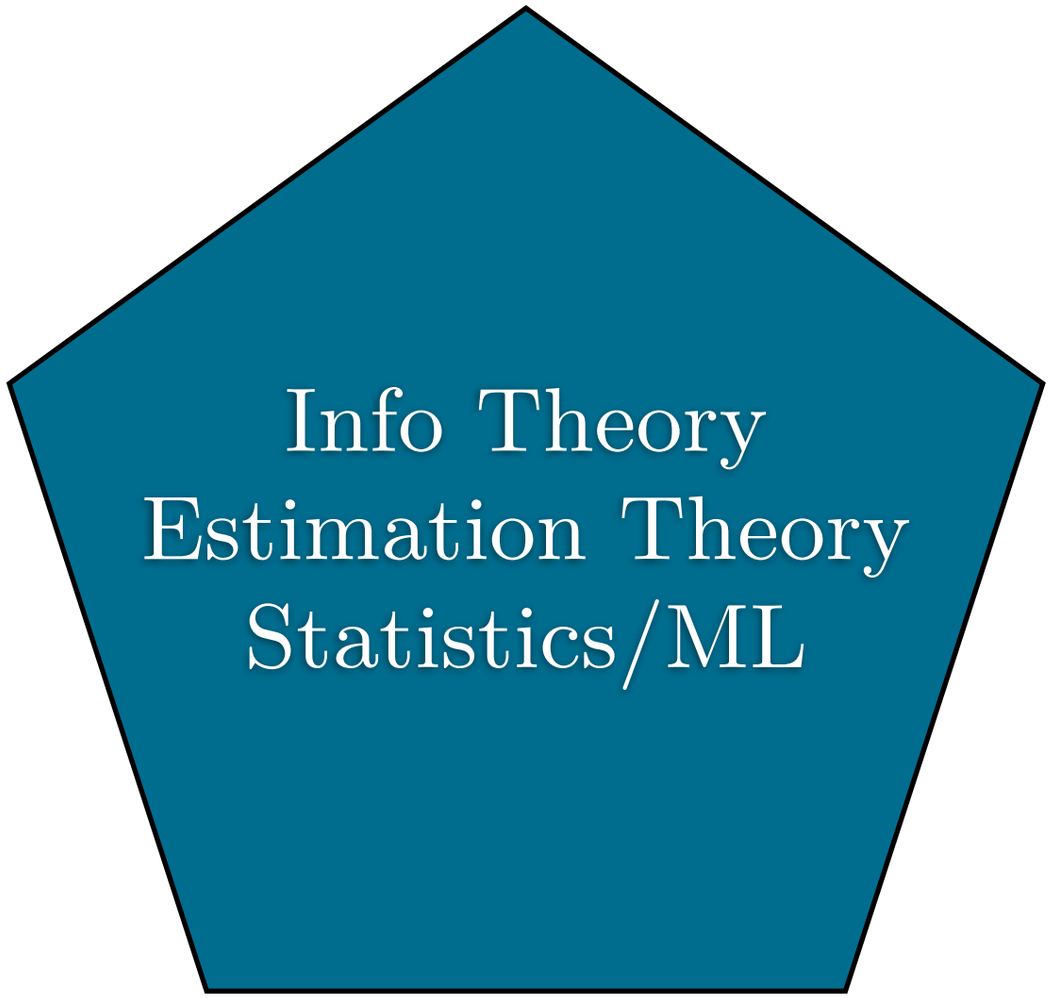

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- Controls - message display, connection recommendations, etc.
- **Goal:** Learn models for network, design optimal control, test and refine

Campaigns Over Twitter

The Problem

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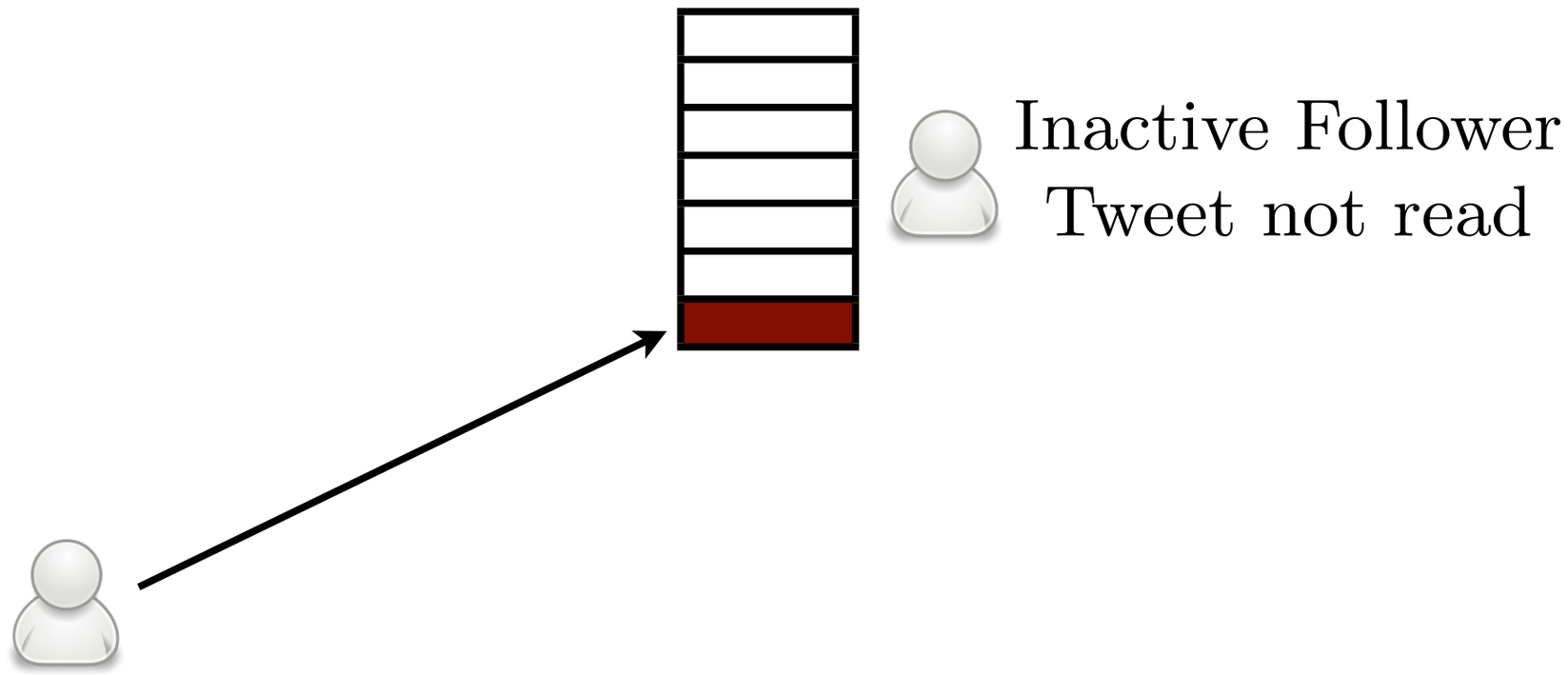

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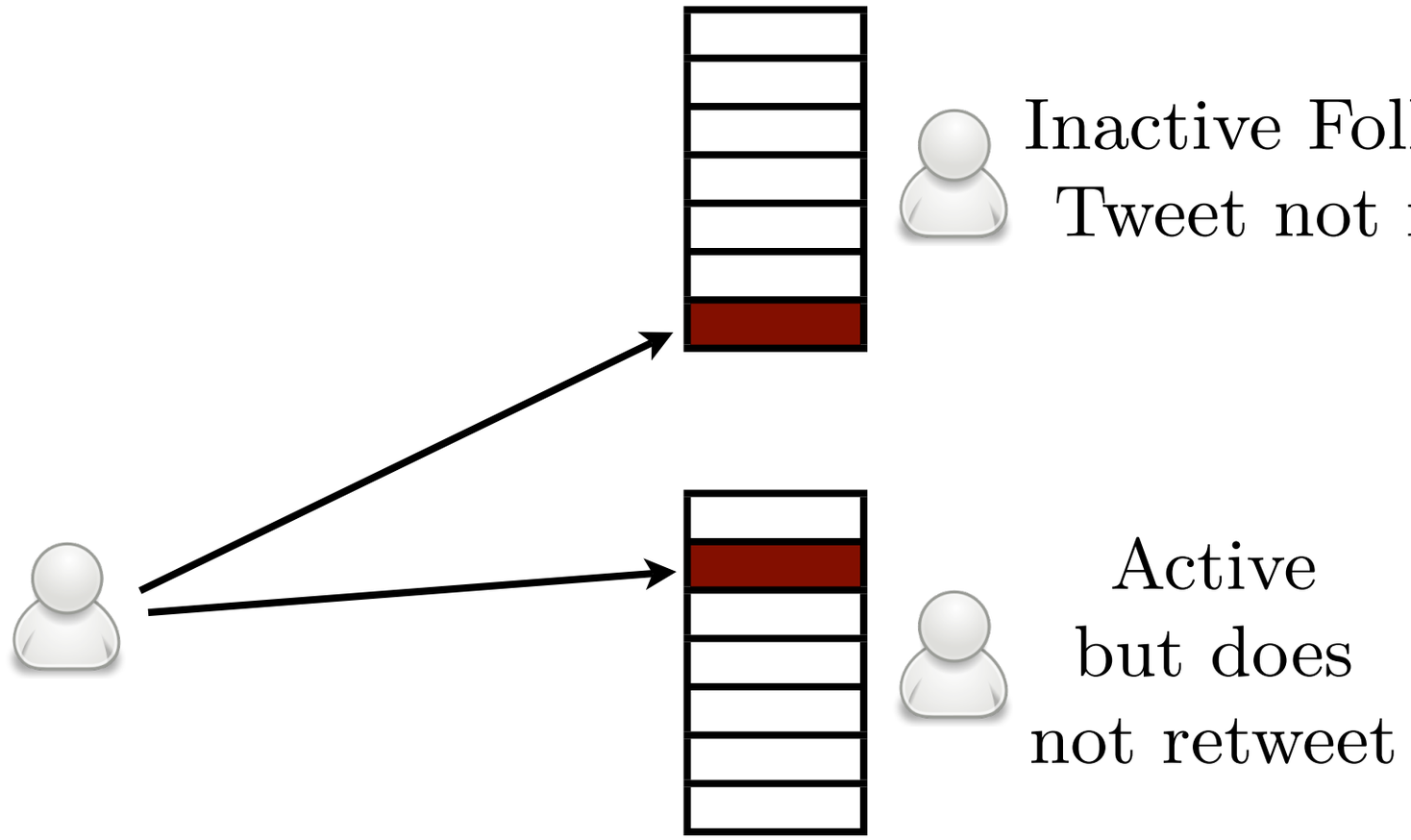
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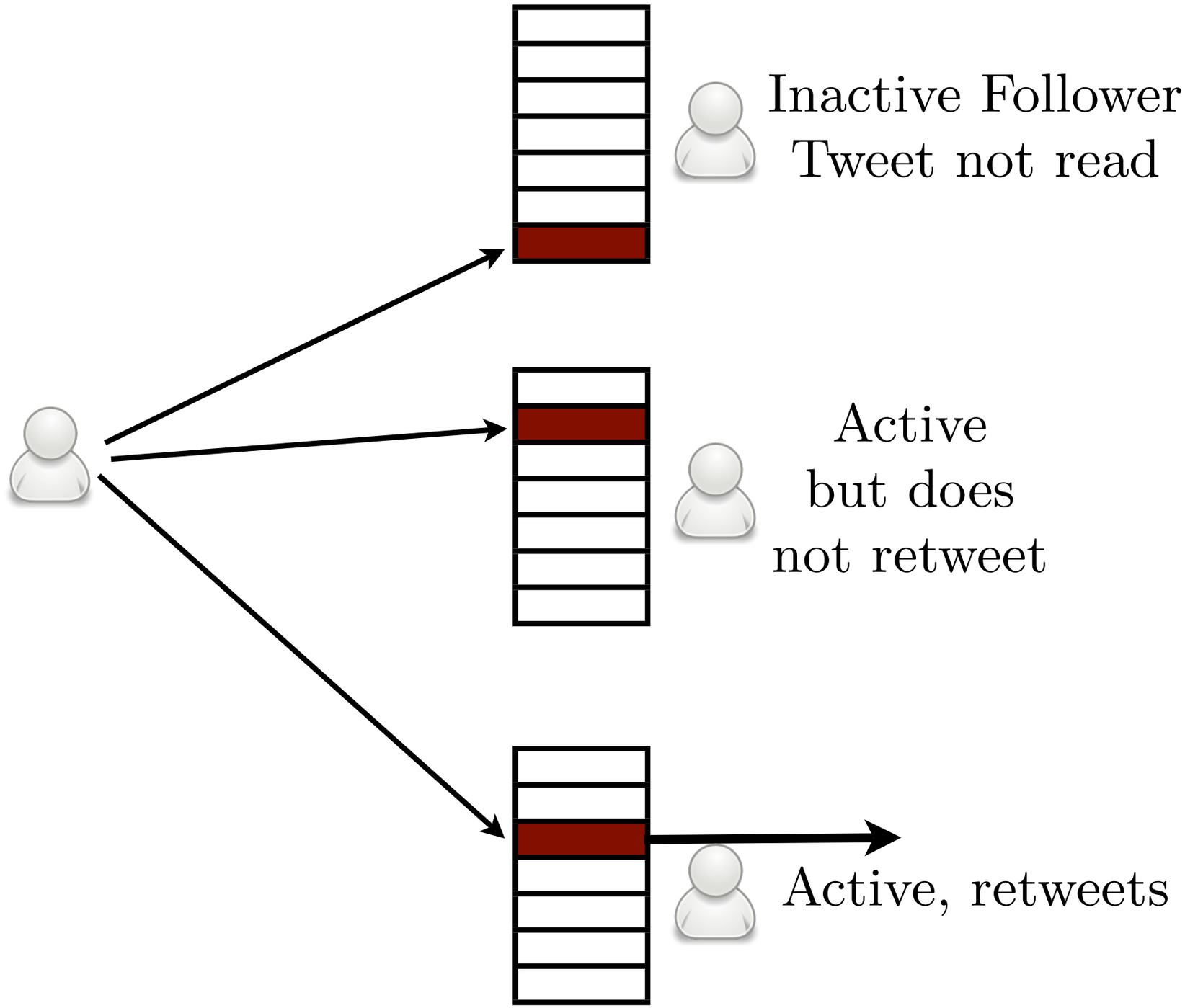
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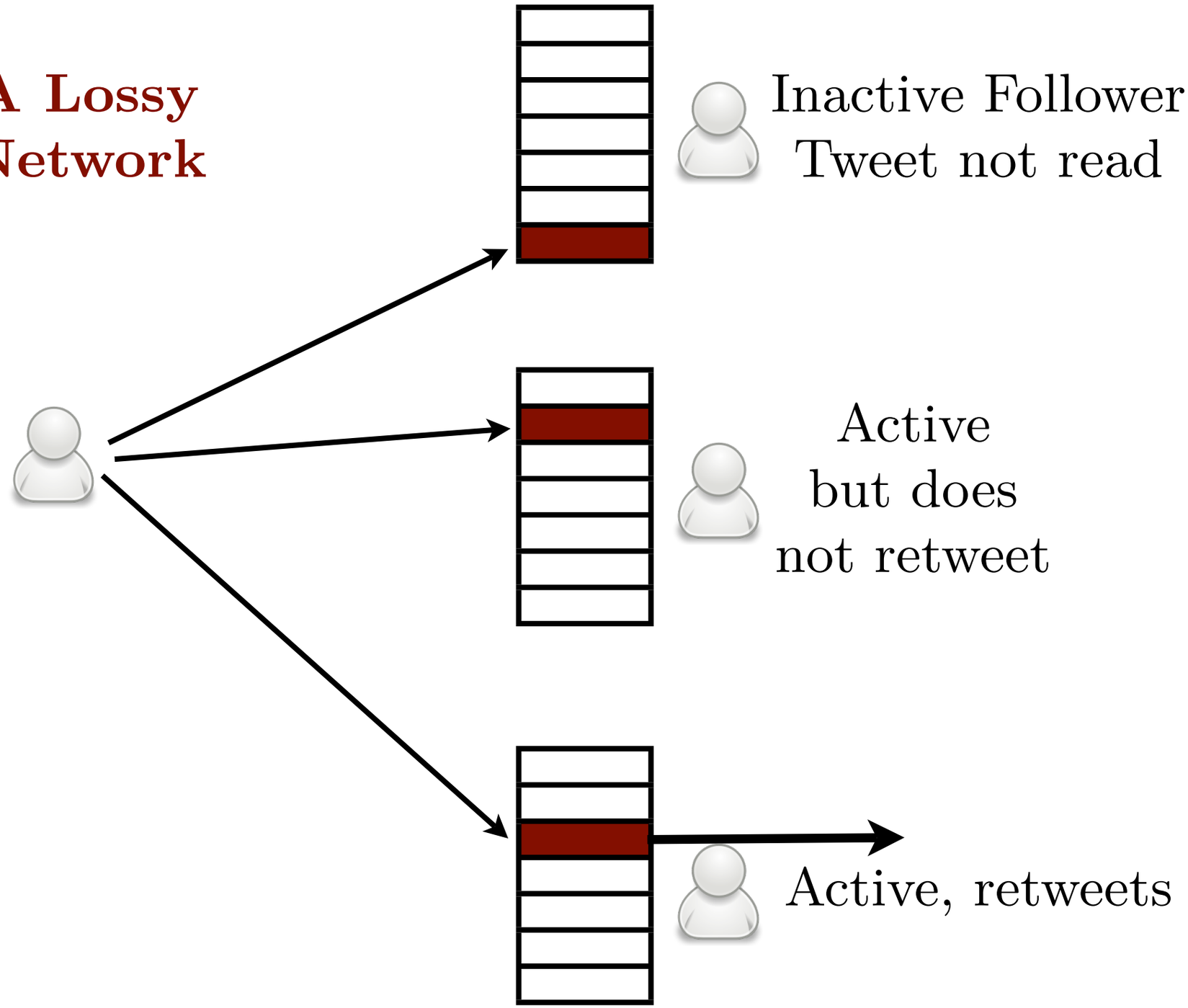

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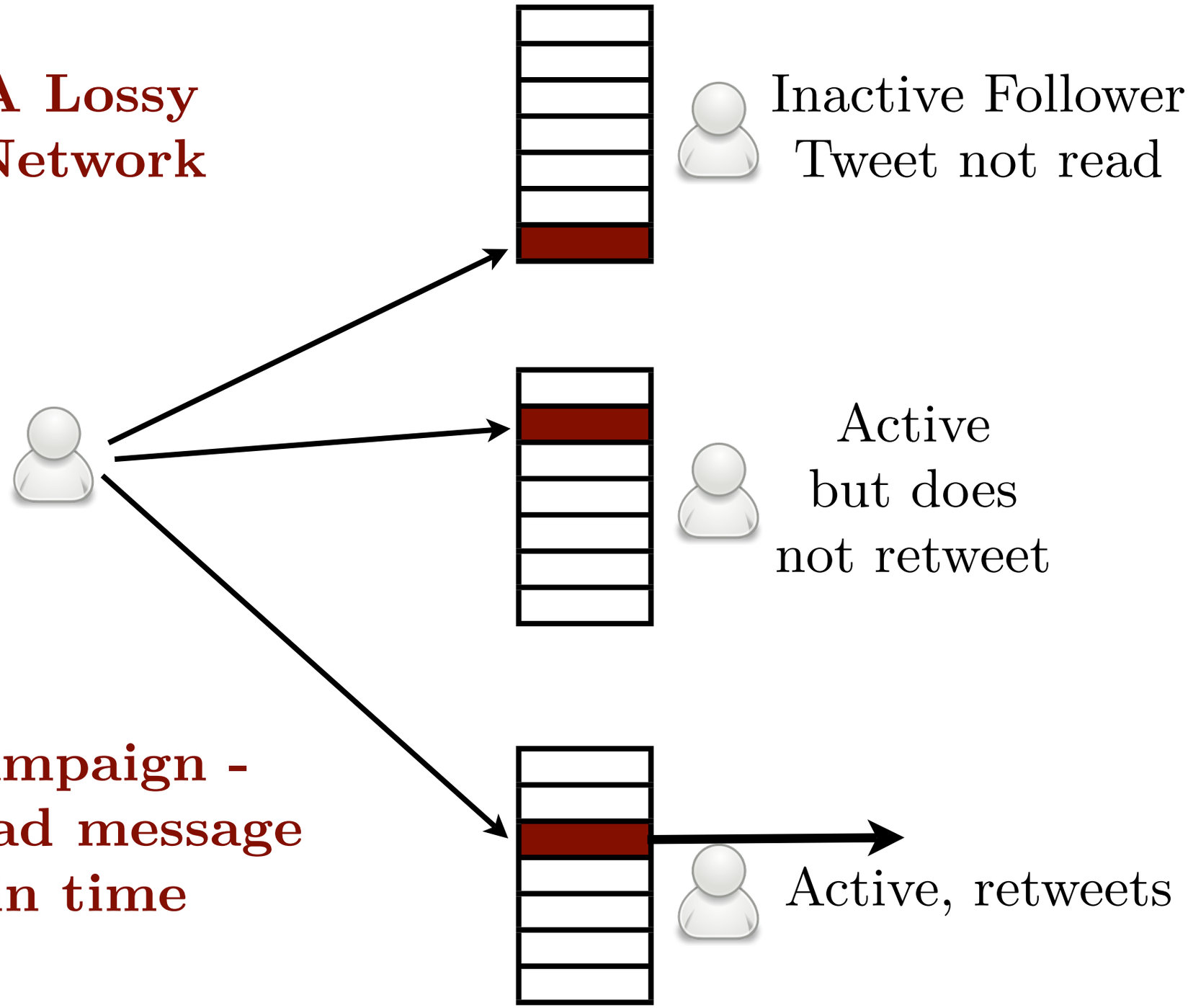
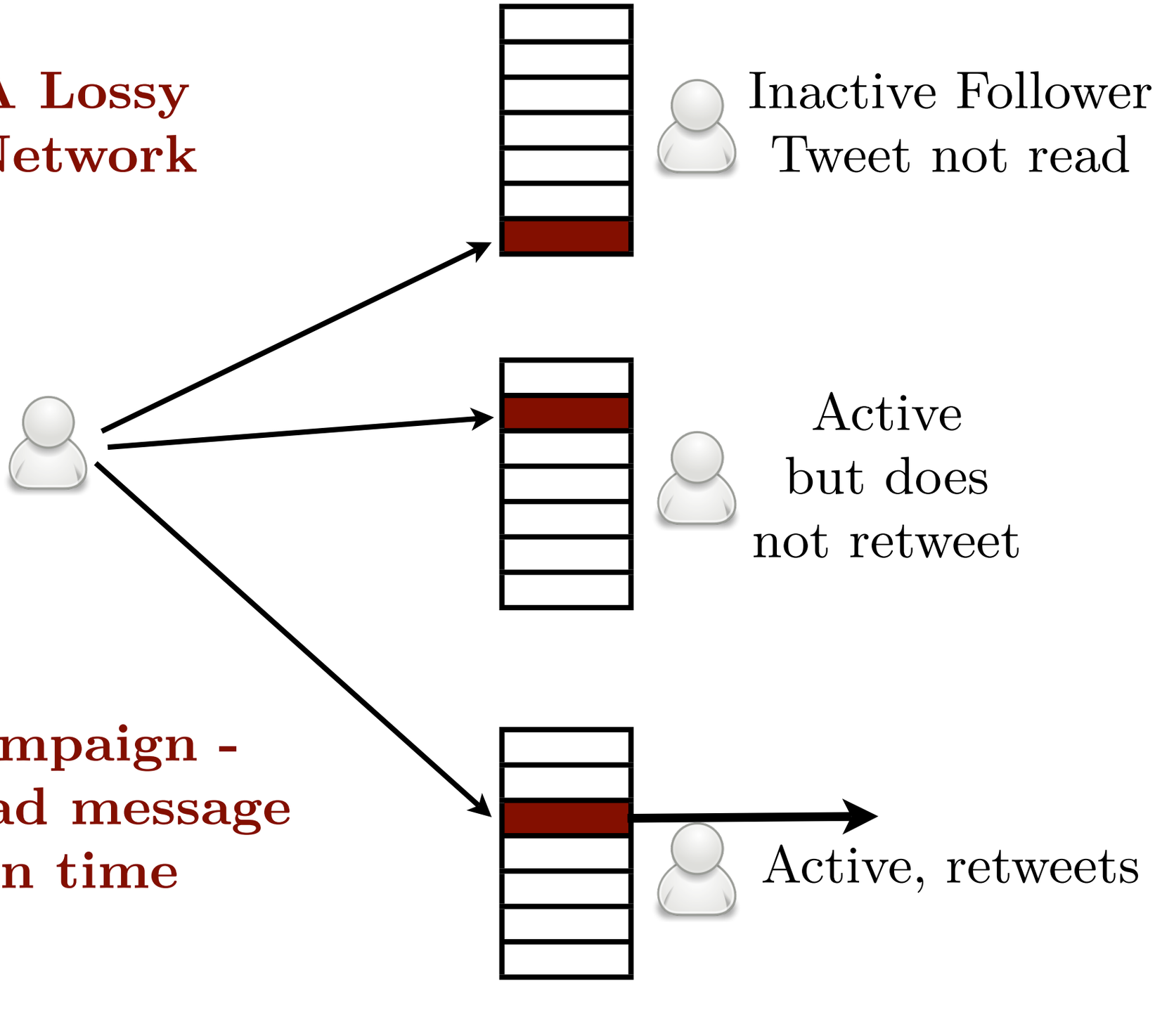


Campaign - spread message in time

The Problem

A Lossy Network



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- Can we measure 'irritation'?
- Tradeoff between reach and irritation?
  - Structure of optimal strategies?

A Model

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  - Response probability of each follower known

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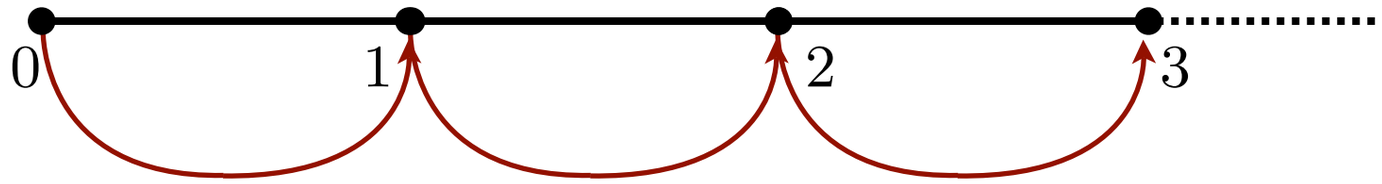

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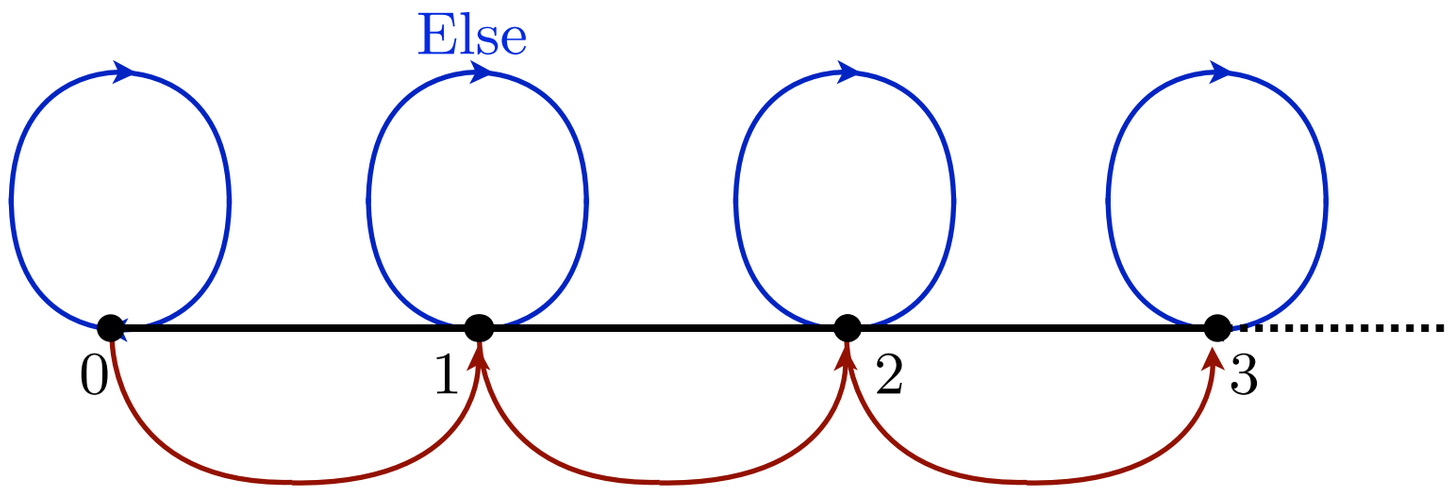

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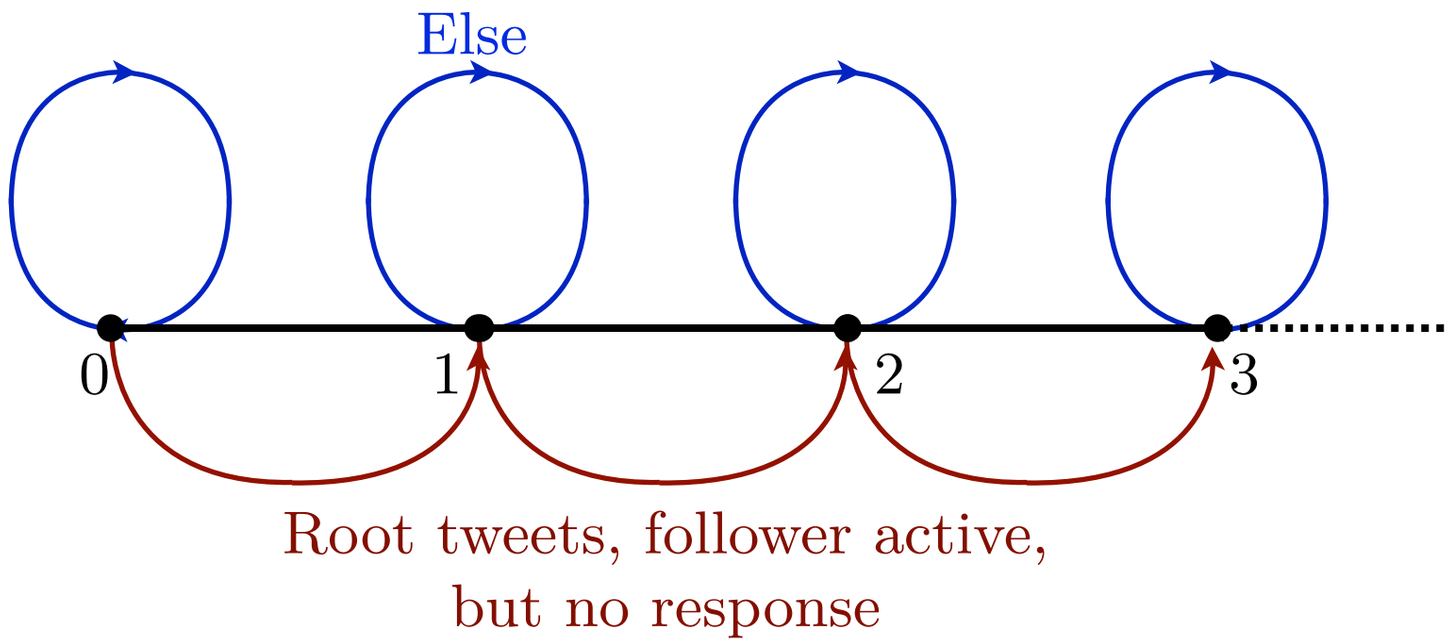

Response probability may depend on state

- **Optimistic Case:** State independent response prob.
- **Pessimistic Case:** No response under irritation

Data Collection and Parameter Estimation

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- 1 root node, 11916 followers, 6837 allow tweet collection
- 50+ accounts to get around rate limitation
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- Few months to few years
- Estimation of activity probabilities:
  - 26 most recent weeks
  - 24 x 7 time slots
  - # weeks with tweet in the slot/# weeks

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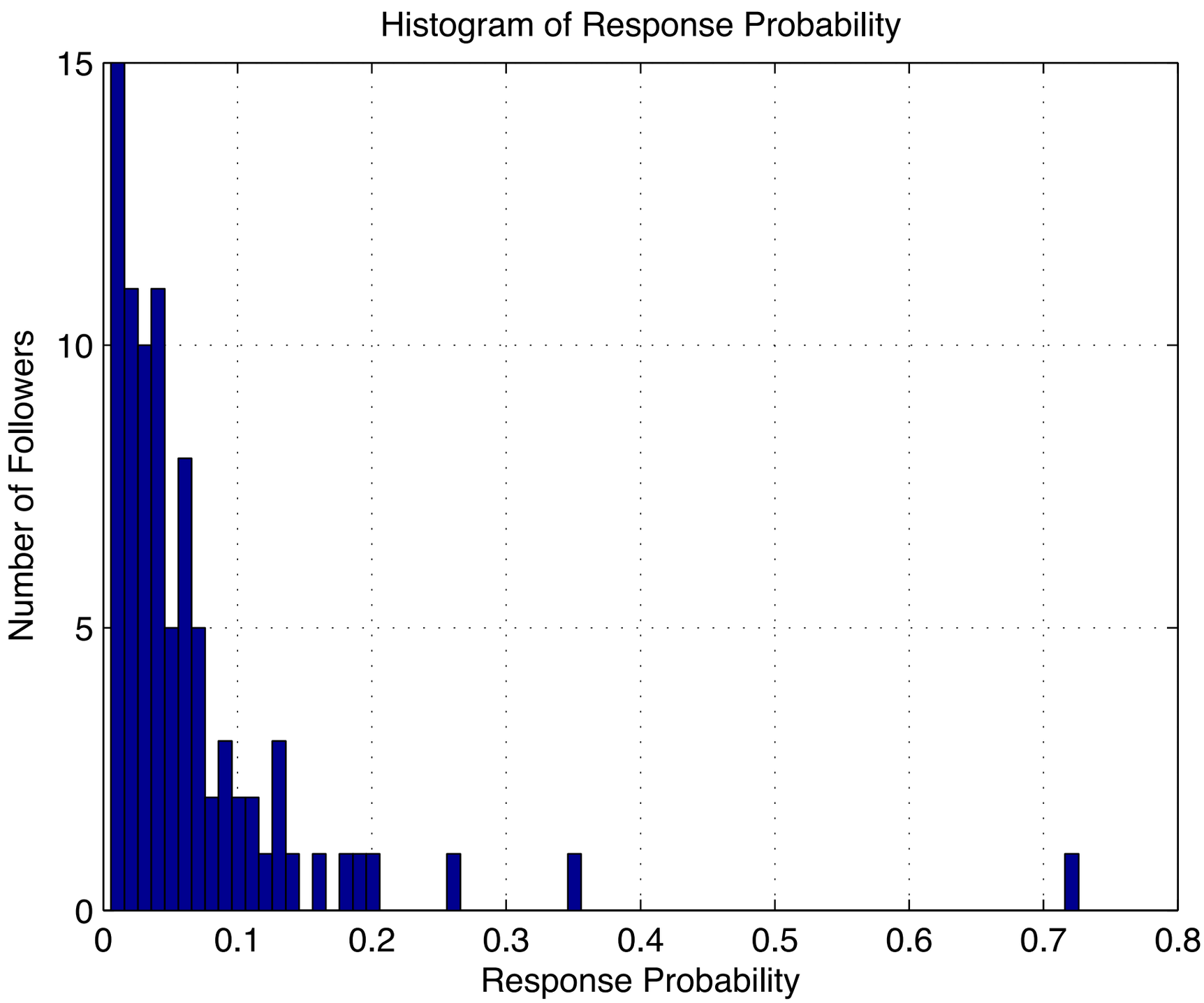
- Confidence interval: pick only those followers with good estimates
- Only 84 followers have non-zero response probability

Response Probability



The Markov Decision Process (Finite Horizon)

Markov Chain and Its Control

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- **State:** Vector of irritation states of all users
  - Independent activity across followers
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  - Conditioned on current state, the response is independent of the past
- **Control:** The decision to transmit in the slot or not
  - May depend on the state; root needs to follow followers
  - State independent for many policies we consider

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- Passive consumers
  - Many consume information but retweet rarely
  - # Active followers
  - A reward just to reach followers

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- Net irritation in campaign
  - Campaign ends in a fixed time
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- Human resource
  - # Tweets in campaign
  - Fewer tweets, lesser human effort in constructing novel tweets in campaign

Total Reward

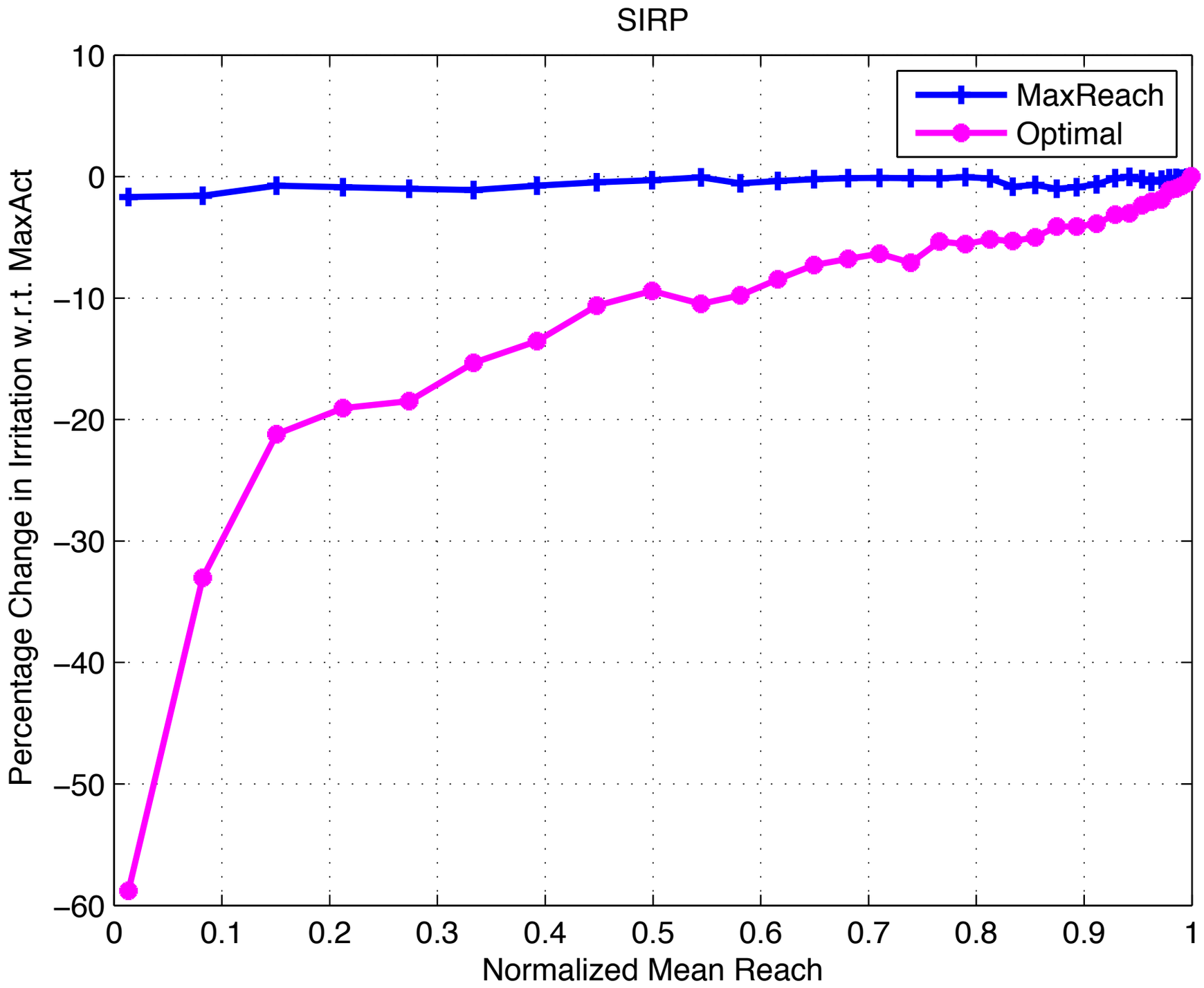
$$\lambda_1 \underbrace{\sum_{t=1}^{T}\sum_{n=1}^{N} w_n 1(n \text{ retweets at } t)}_{\textbf{Reach}} + \lambda_2 \underbrace{\sum_{t=1}^{T}\sum_{n=1}^{N} 1(n \text{ active at } t)}_{\textbf{\# Active}}$$

$$-\lambda_3 \underbrace{\sum_{n=1}^{N} w_n S_n(T)}_{\textbf{Net Irritation}} - \lambda_4 \underbrace{\sum_{t=1}^{T} 1(\text{Root tweets at } t)}_{\textbf{\# Tweets}}$$

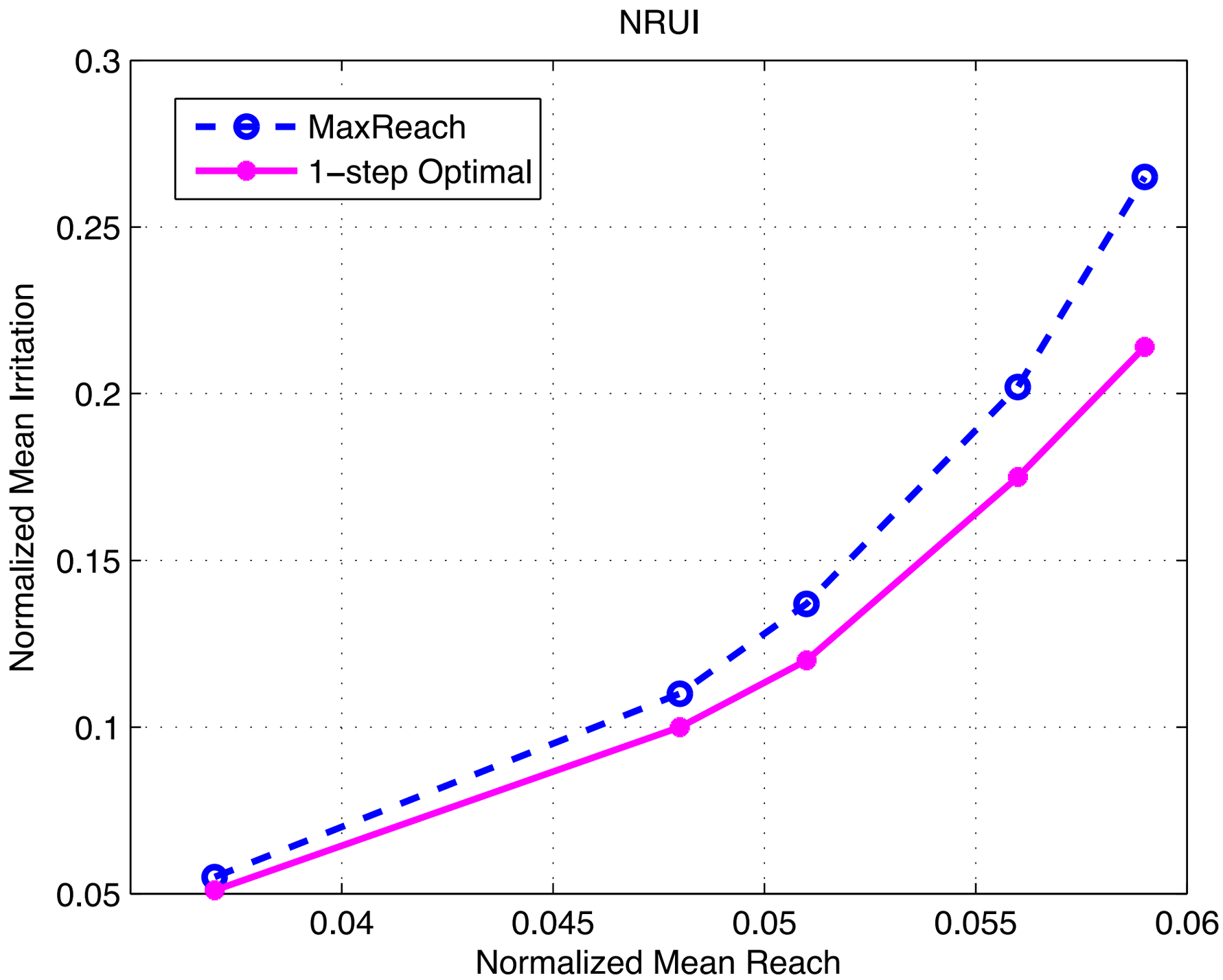
- Non-negative parameters
- **Goal:** Maximize expected reward
- In principle, optimal policy can be found by dynamic programming

Simulations

Optimistic Case



Pessimistic Case



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- MaxReach
  - Within 10-20% of best policy we have tried
- MaxAct
  - Reward for reaching passive followers

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- The general network with order of message display as control

Thanks!