

INRIA-EPFL Workshop 2016

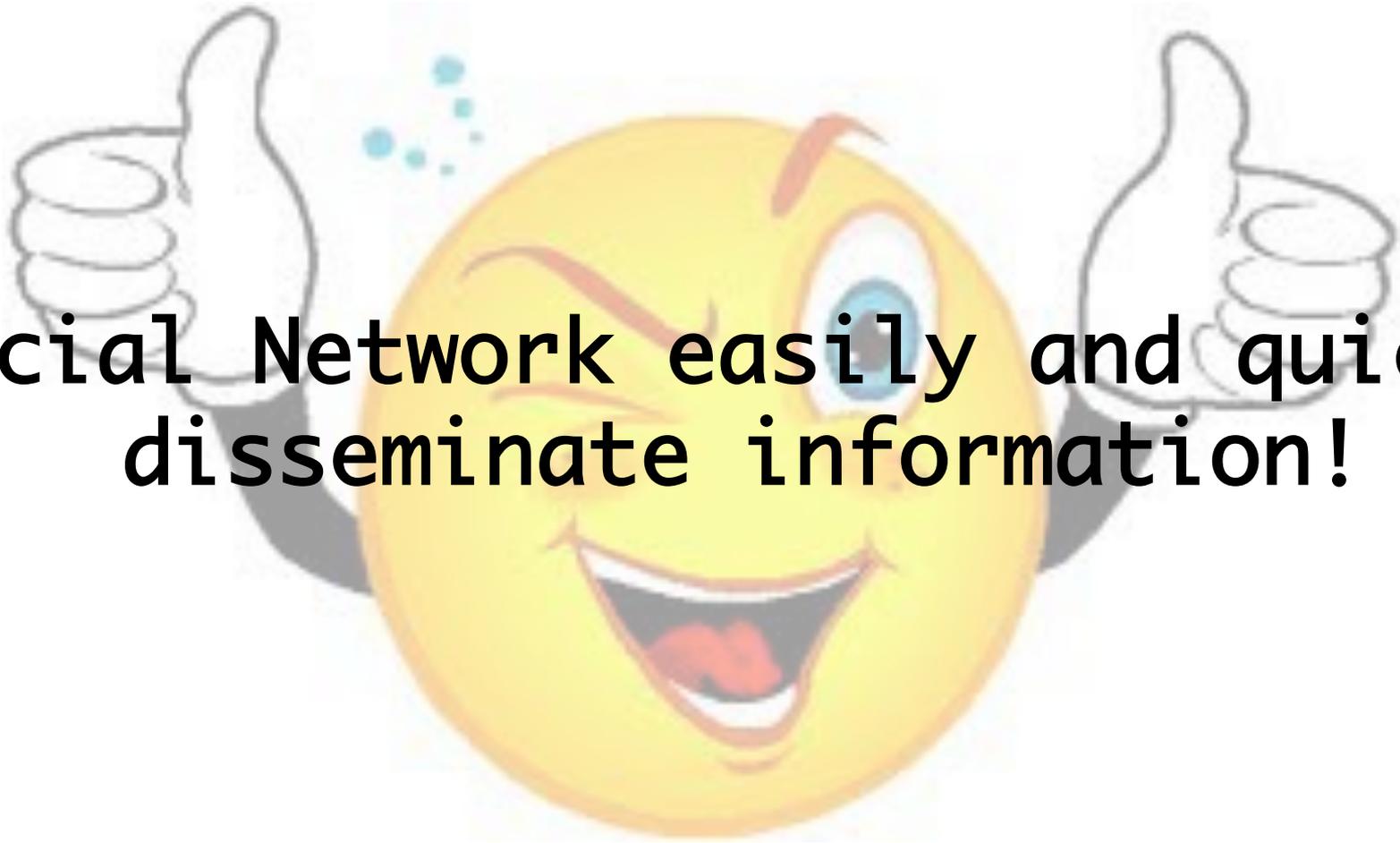
Privacy-Conscious Information Diffusion in Social Networks

Nupur Mittal, Inria Rennes

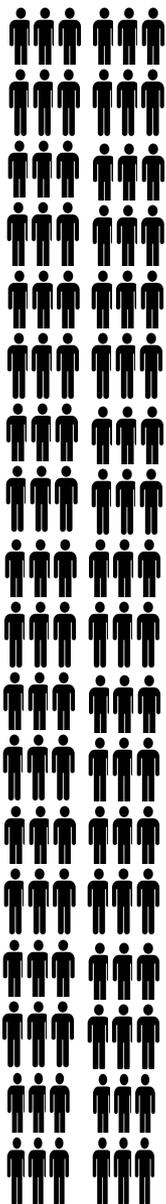
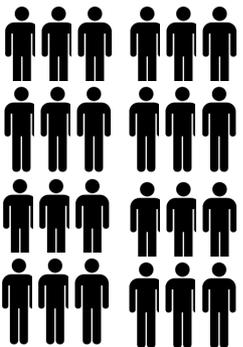
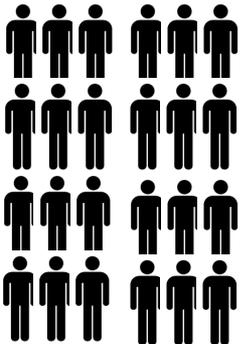
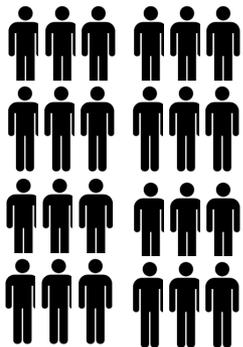
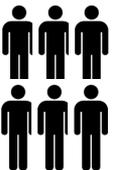
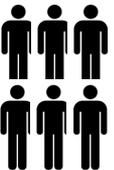
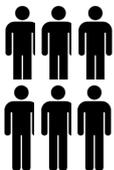
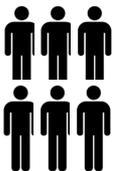
In collaboration with

George Giakkoupis, Rachid Guerraoui, Arnaud Jegou, Anne-Marie Kermarrec





**Social Network easily and quickly
disseminate information!**





BUT THE STAKES ARE TOO HIGH

Arrested for Retweeting North Korea in the South?



After very public arrest of blogger in South Korea, local court finds that no law was broken by photographer who was retweeting North Korea propaganda

DAILY POST

Home News Gossip Features ENews Editorial Sports Love Jokes Forum Jobs Advice County Other

Home / Entertainment News, Featured Articles, Gossip and Drama / SHOCK as blogger is arrested for retweeting PHOTOS of KINUTHIA MBUGUA's rotten daughter

SHOCK as blogger is arrested for retweeting PHOTOS of KINUTHIA MBUGUA's rotten daughter

The Kenyan DAILY POST Entertainment News, Featured Articles, Gossip and Drama 06:38



Nakuru based blogger and former journalist with *The Star* and *People Daily* publication, Elijah Kinyanjui Maina, has been arrested.

Kinyanjui was arrested early today after CID detectives found him at his home after tracing him for days.

He was arrested for allegedly re-posting photos of a lady alleged to be the daughter of Nakuru County Governor, Kinuthia Mbugua, in a story carried on the *Daily Post* in October

last year showing her enjoying shisha in a social place.



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Thai man arrested for Facebook 'like' of doctored royal photo

Man faces up to 32 years' prison for sedition and insulting the king after criticising corruption scandal



📷 Thai army officials celebrate King Bhumibol Adulyadej's 88th birthday in Bangkok last week. Photograph: Jorge Silva/Reuters

A Thai man has been arrested for “liking” a doctored photo of the king and sharing an infographic on Facebook about a growing corruption scandal, as prosecutions burgeon under draconian royal defamation laws.

The arrest, announced on Thursday, came as the US ambassador to [Thailand](#) faces a police investigation for royal defamation over a speech he made last month, in which he expressed concern over lengthy sentences handed to civilians for lese-majeste.



Garry Kasparov ✓

@Kasparov63



Russian man arrested for retweeting photo of a flyer with content deemed "extremist". Same day as Twitter IPO! RT this at your own risk!

9:12 PM - 9 Nov 2013



Kashyap Kompella

@indMgr

9 Nov 13

@Kasparov63 I am curious - do they allocate a huge budget for building jails in Russia?

[View conversation](#) ·



Bernie King

@BernardKingIII

9 Nov 13

@Kasparov63 - He should've said "RT's not endorsements" in his Twitter bio.

[View conversation](#) ·



Jeremy

@Gofer2OSU

9 Nov 13

@Kasparov63 Dare I favorite? Baby steps..

[View conversation](#) ·

Chinese Activist Detained for Retweeting News of Unrest in Xinjiang Province

keywords: Hu Jia arbitrary detention Censorship weibo

Chinese police **detained activist** Liu Linna for **"retweeting" news** of unrest in Xinjiang province on Weibo, China's equivalent of Twitter. She is currently being held in an administrative detention facility in Henan province.

Liu's detention follows the detention of a 16 year-old boy who was arrested in Gansu province for retweeting information. The teenager was the first target of China's latest crackdown on online rumors. New laws make it an offense to engage in online "rumor mongering," defined as posting a message that is viewed at least 5,000 or retweeted over 500 times.

Accueil > Economie

Maroc : prison et forte amende dans le projet de loi sur le code numérique

15 décembre 2013

8

58

0

Tweeter

J'aime

g+1

Le projet de loi sur le code numérique fait polémique au Maroc. Le texte prévoyant des peines allant jusqu'à cinq ans de prison et 100.000 DH d'amende à l'encontre des éditeurs de sites internet, ou de moyens de communication

numériques, reconnus coupables d'avoir détourné, espionné ou stocké des communications privées, sera examiné la semaine prochaine par le gouvernement.



WOMAN ARRESTED FOR SHARING PICTURES OF NEIGHBOR'S ABUSED DOG ON FACEBOOK

November 9, 2015 by Jacquelyn Gray



A Texas woman is confused as to why she was arrested for documenting the possible abuse of a nearby dog.

Amber Cammack took pictures of a dog that had been confined to a porch in a diaper, with a string tied around its muzzle. What she got was a 14-hour stint in jail for harassment and including personal information in the Facebook posts.

According to [Click 2 Houston](#), the six-month-old mixed-breed pup named June was staying with Cammack's neighbor, Karess Buckman, for that week. Buckman told the station that no neighbor *"attempted to knock on the door, ask about the dog, inquire about the dog or any of the above."*

You are here: Home » Comment »

Where the crime of retweeting can land you in jail

September 29, 2013

☆ Read later

Adam Minter



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Email article

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'Anyone whose message is re-tweeted more than 500 times on Chinese microblogs or is seen by more than 5000 online users can be subject to jail for up to three years if the original post turns out to be false.' *Photo: Reuters*

Two weeks ago, Yang Hui was summoned from class by his school's vice-principal, according to an account the student provided to the *Beijing News*. The 16-year-old quickly learnt that he was in serious trouble. Three plainclothes and a uniformed police officer were waiting in the principal's office. They asked for his phone, interrogated him, conveyed him to the police station for further questioning and then locked him up in a detention centre.

His apparent crime? He was retweeted.

PROBLEM STATEMENT

Spread information in a social network **without revealing** user's opinion about it.

Plausible Deniability

MOTIVATION

- Using pseudonyms & different IP address ^{[1] Wulf et. al}
- Cryptographic techniques: “anonymlike” ^{[2] Alvis et. al}

Randomized Response Techniques ^{[3] Quercia et. al}

RRT

- Increase the validity of responses.
- Tell responder to lie with p_{lie} .

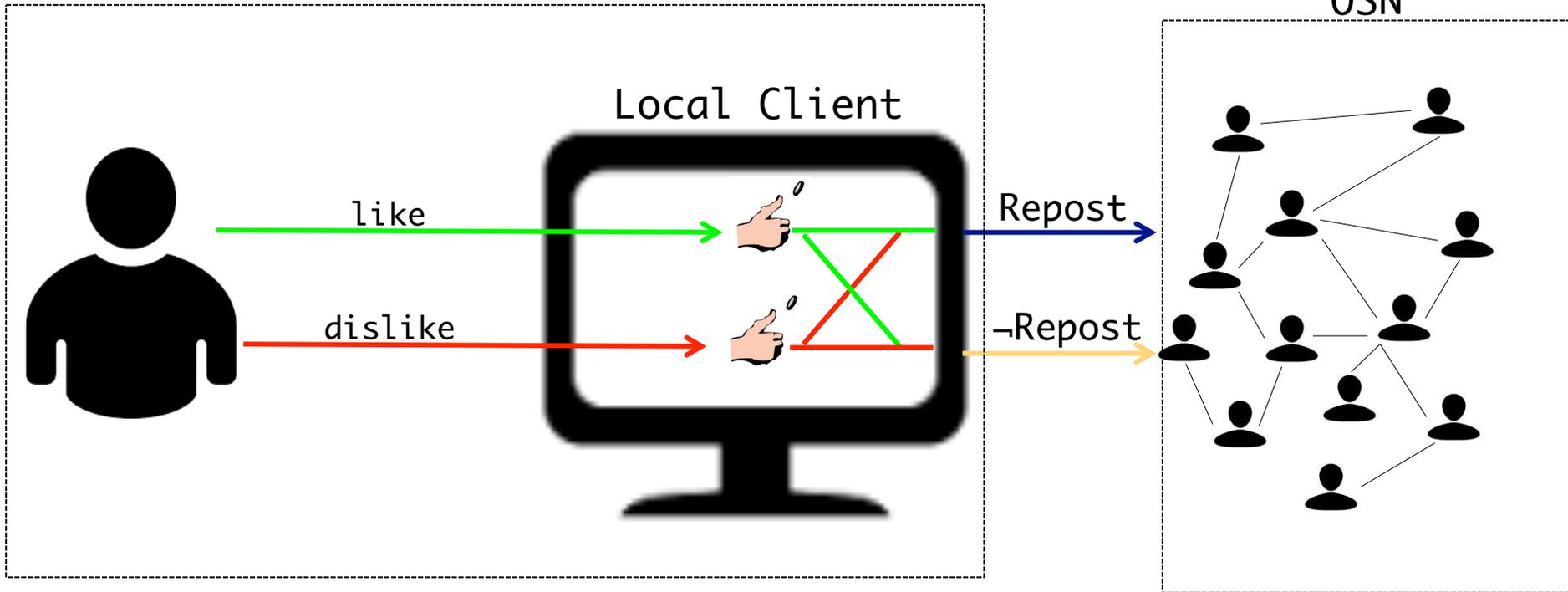
Roll a die and lie whenever it shows 1 or 2
 $P_{\text{lie}} = 1/3$
- Accurate estimations of only aggregate results can be extracted.
- Individual's answers are always plausible deniable.

NOTION

Flip a coin and change (or not) the user's original opinion.

- Ask user her opinion
- Lie with probability $p_{\text{lie}} = \delta / (\delta + \lambda)$
- If the answer is yes, repost it with $(\lambda + \delta) / s$

ALGORITHM



- Local Algorithm
- Graph $G = (V, E)$, with $|V| = n$ nodes.
- Global parameters $\delta < 1$ and $\lambda > 1$

OBJECTIVES

- Dissemination Algorithm
- User's **opinion** about an item is **concealed**
- **“Popular”** items spread more
- **“Unpopular”** items spread less

Riposte

- User's Opinion
- Upper Bound on the number of user's followers*
- Global parameters δ and λ

RIPOSTE

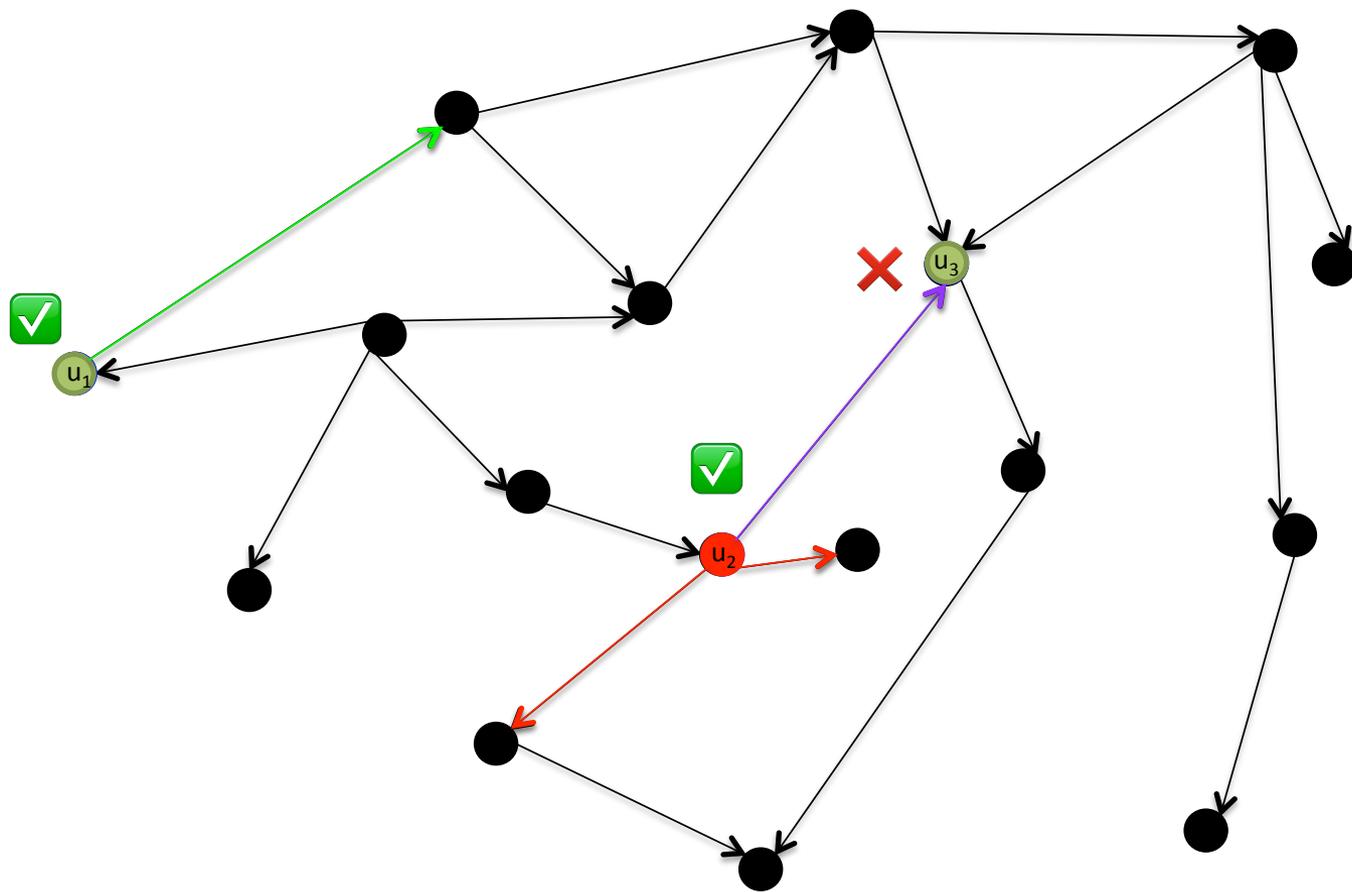
- if u likes the item

$$r_{like}(s) := \begin{cases} \lambda/s & \text{if } s \geq \lambda + \delta, \\ 1 - \frac{\delta(s - \delta)}{\lambda s} & \text{if } 0 < s < \lambda + \delta; \end{cases}$$

- if u does not like the item

$$r_{dislike}(s) := \frac{\delta}{s} \quad \text{if } s > 0$$

s : followers of user u who haven't received the item yet



DISSEMINATION

Fraction of users receiving an item should reflect the users' overall opinion on the item .



- Information liked by a large fraction of users should be received by a lot of users.
- Less interesting information should be received by lesser people.

Popularity of an item

- p_t : Popularity of an item
- Probability that u likes $t \rightarrow p_t$
- Independent of other user's opinion about t

p_t is the expected fraction of users that like t

POPULARITY THRESHOLD : p^*

Probability for Riposte to repost, when u likes an item with probability p , if $s > 0$ $\equiv p \cdot r_{like}(s) + (1-p)r_{dislike}(s)$

If $s \geq \lambda + \delta$, $\equiv p \cdot (\lambda/s) + (1-p)(\delta/s)$

If s is the number of followers of u who have not received the item yet, the expected number of new users that learn the item from u $\equiv p \cdot \lambda + (1-p) \cdot \delta$

- p^* is the probability p for which the expected number of new users to learn the item from u is 1 .

- $p^* = \frac{1-\delta}{\lambda-\delta}$

POPULAR AND UNPOPULAR ITEMS

- $p_t > p^* \rightarrow$ Popular & $p_t < p^* \rightarrow$ Unpopular
- p^* is fixed according to the values of λ & δ

BOUNDS ON DISSEMINATION

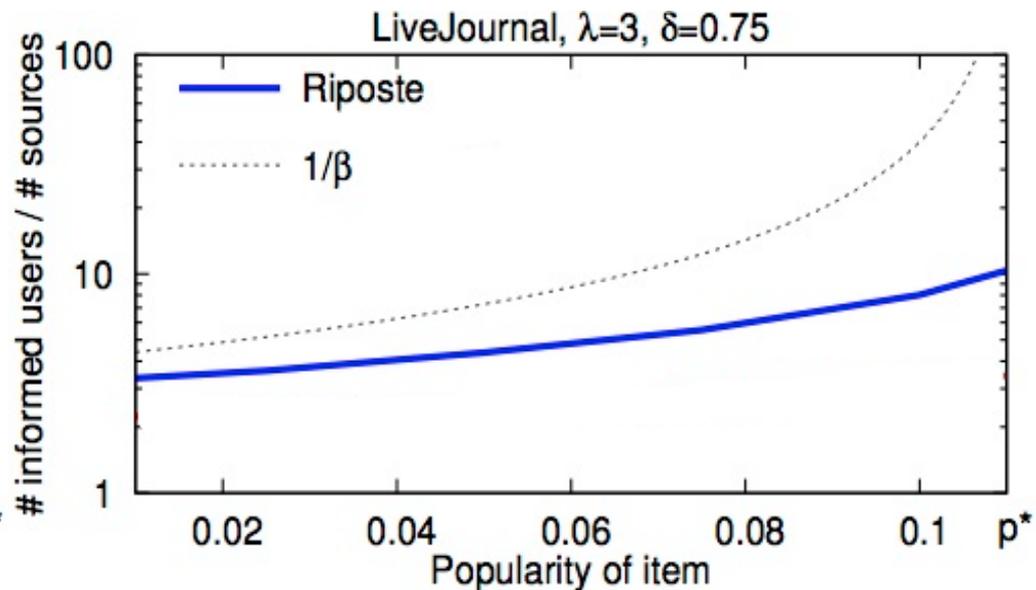
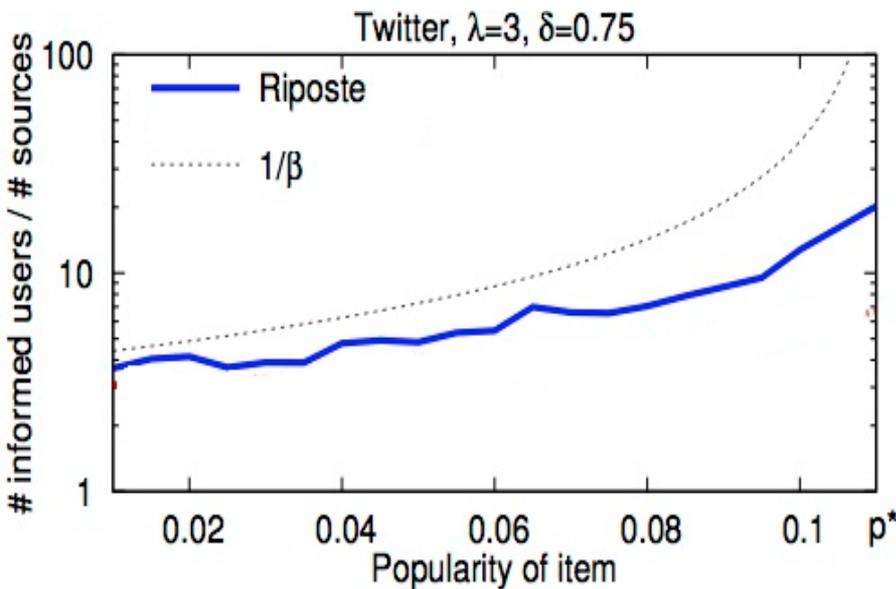
Unpopular Items

- Intuition : When $p < p^*$, the expected number of new users receiving the news after each step is < 1 .
- Unpopular item disseminate to at most a constant factor larger than the users exposed to it initially.
 - Popularity of the item
 - Parameters λ and δ



Riposte guarantees that an item with popularity $p < p^*$ starting from any set S of users is received by an expected total of at most $|S|/\beta$ users;

$$\beta = (p^* - p)(\lambda - \delta)$$

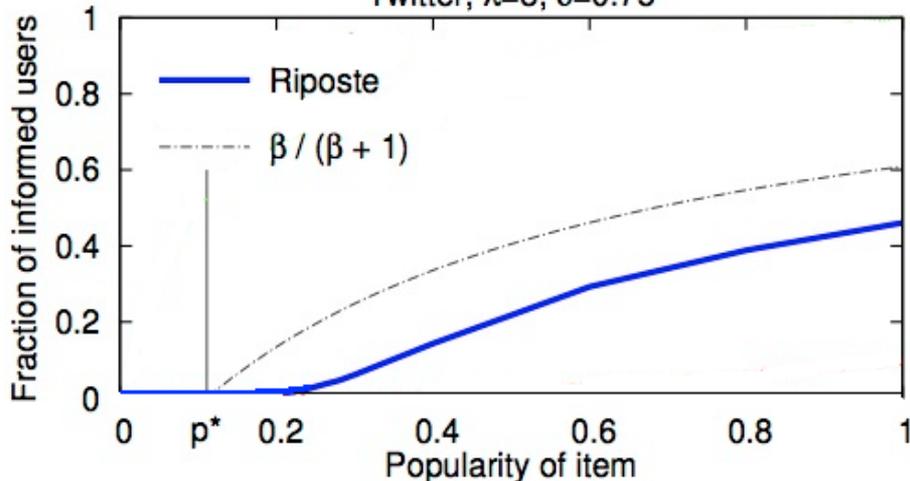


BOUNDS ON DISSEMINATION

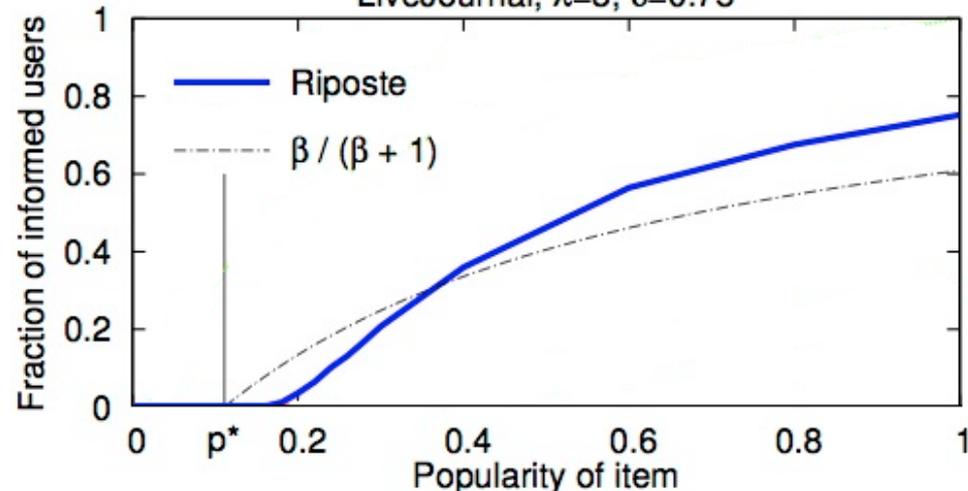
Popular Items

- Intuition : When $p > p^*$, the expected number of new users receiving the news after each step is > 1 .
- Popular items spread to at least some constant fraction of the network with constant or high probability depending on S [1].

Twitter, $\lambda=3, \delta=0.75$



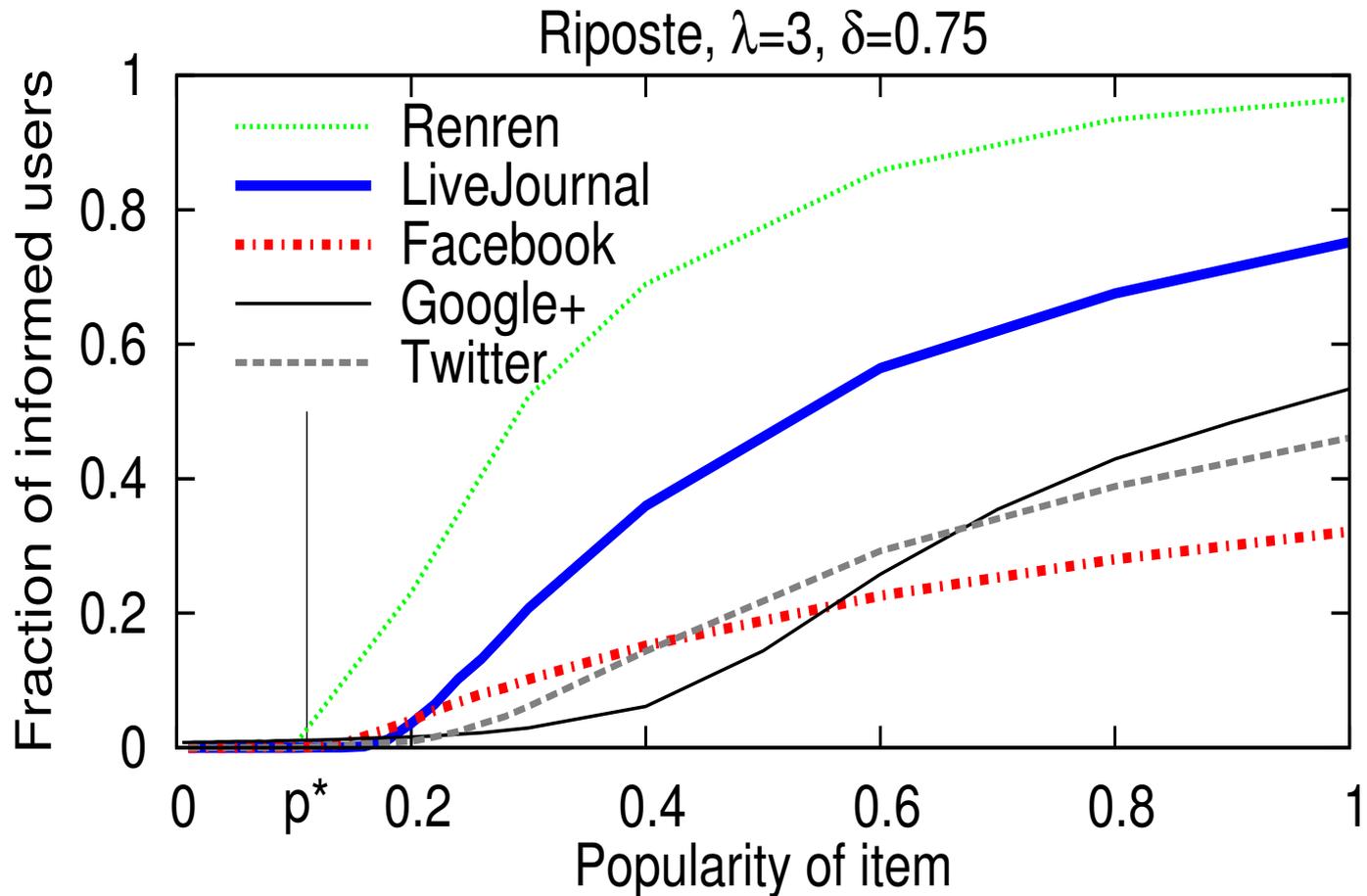
LiveJournal, $\lambda=3, \delta=0.75$



S is the number of users who receive the items initially.

Constant if $|S|$ is close to average degree and large if $|S|$ is $\log n$ times larger than the avg. degree

Dissemination



RIPOSTE – PROPERTIES

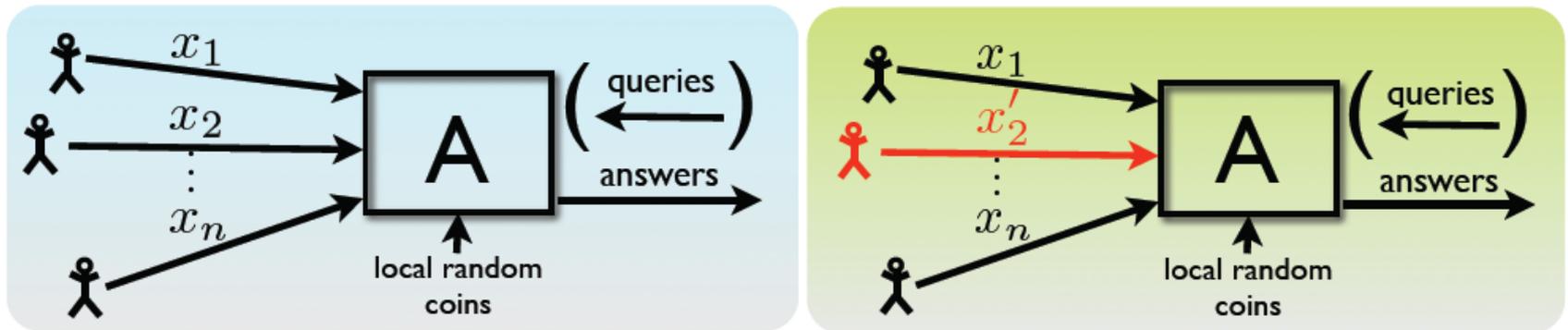
- Plausible Deniability
- Differential Privacy

RIPOSTE – PLAUSIBLE DENIABILITY

- Intuition
 - User's action of reposting (or not) does not reflect user's true opinion.
 - Randomness of the algorithm is responsible for user's action.
- Example: Let $\lambda=3$ and $\delta=.75$ and $s = 6$

The probability to repost an item if a user likes it under Riposte is $\lambda/s = 3/6 = .5$, where as without using Riposte, a user will repost it with probability 1.

QUANTIFICATION : DIFFERENTIAL PRIVACY



x' is a neighbor of x
if they differ in one row

For all neighboring databases x and x'

$$\Pr[A(x) \in Q] \leq e^\epsilon \Pr[A(x') \in Q]$$

Algorithm A is ϵ -differentially private if changing exactly one of its inputs changes the distribution of the output by at most an e^ϵ factor.

DIFFERENTIAL PRIVACY

Riposte is ϵ -differentially private, $\epsilon = \ln(\lambda/\delta)$

- $r_{\text{like}}(s) \leq (\lambda/\delta) \cdot r_{\text{dislike}}(s)$
- $1 - r_{\text{dislike}}(s) \leq (\lambda/\delta) \cdot (1 - r_{\text{like}}(s))$

- If user reposts an information *if and only if* she likes it
→ $\lambda = \text{max. degree}$, $\delta = 0$: **NO PRIVACY**
- $\lambda = \delta$ → probability of reposting doesn't depend on user's opinion : **PERFECT PRIVACY**

CONCLUSION

- Local Dissemination Algorithm.
- Bounded Dissemination reflects users' opinion.
- Equips a user with Plausible Deniability.
- Quantified in terms of Differential Privacy.