Who says what to whom on Twitter

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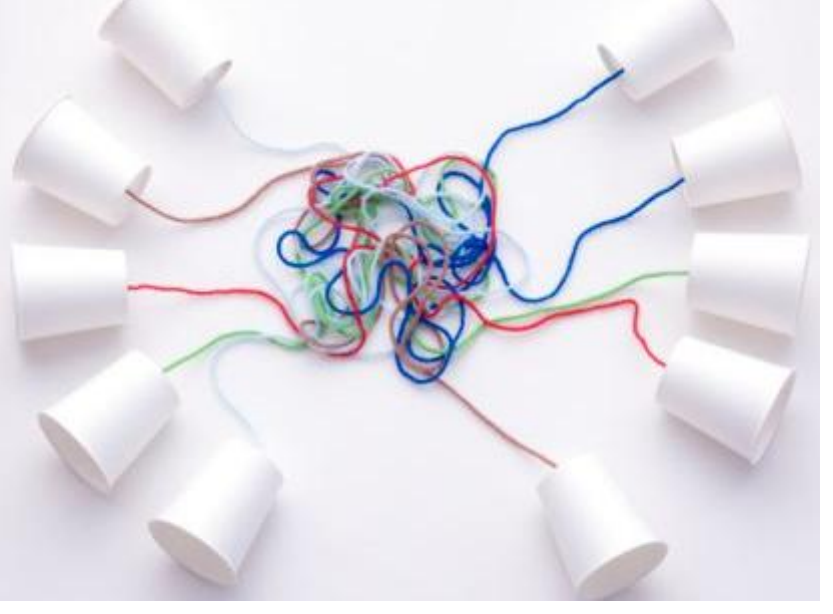
Motivation

- Lasswell's maxim (1948)
  - "Who says what to whom in what channel with what effect"
    - Hard to observe information flow in large population
    - Different channels have different attributes and effects



Twitter: a new platform for studying the pattern of communications

- Advantages
  - Represents the full spectrum of communications
    - *Mass media*: CNN, NYTimes, organizations, governments
    - *“Masspersonal”*: celebrities, bloggers, journalists, experts
    - *Interpersonal*: friends and acquaintances
  - Enables easy tracking of information flow
    - URL shortening services (e.g. bit.ly, tinyurl)
- Limitations
  - Twitter is merely one communication channel
  - Hard to observe the “real” effect (e.g., behavior change, opinion forming)

Data

- Twitter Firehose Corpus
  - 223 days (7/28/2009 – 3/8/2010)
  - 5B tweets, 260M (~5%) containing bit.ly URLs
- Follower graph (Kwak et al 2010)
  - Twitter as observed by 7/31/2009
  - 42M users, 1.5B following relationships

- Who is whom? (user classification)
- Who listens to whom?
- Who says what?

Who is whom on Twitter

mass media
(Katz and Lazarsfeld 1955)
(Gitlin 1978)

“masspersonal”
(Walther et al 2010)

interpersonal

Media — CNN

Organizations — yahoo

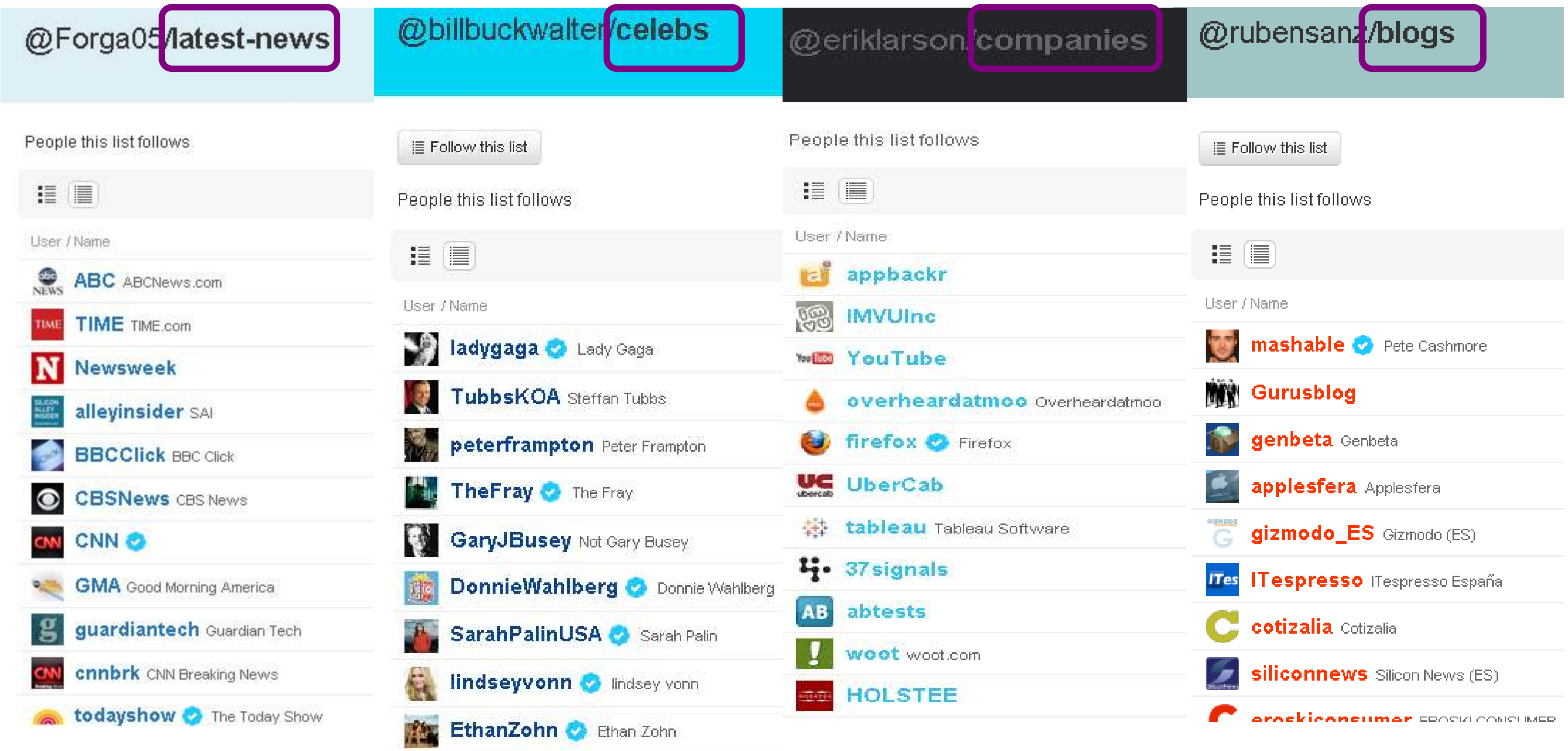
Celebrities —  ladygaga

Bloggers —  mashable

Other

Twitter Lists as Folksonomy of users

- Twitter Lists: Feature launched on 11/2/2009
- Use the name of a list as a tag of users it contains
- Very time-consuming to crawl all lists

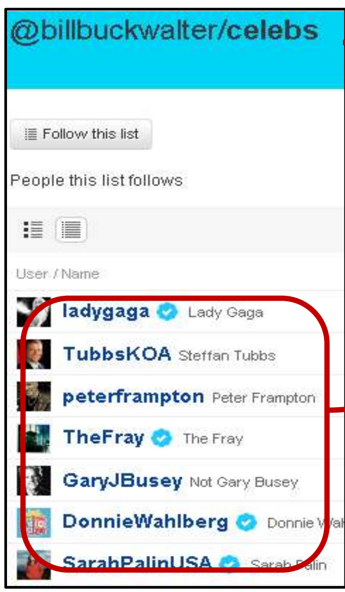


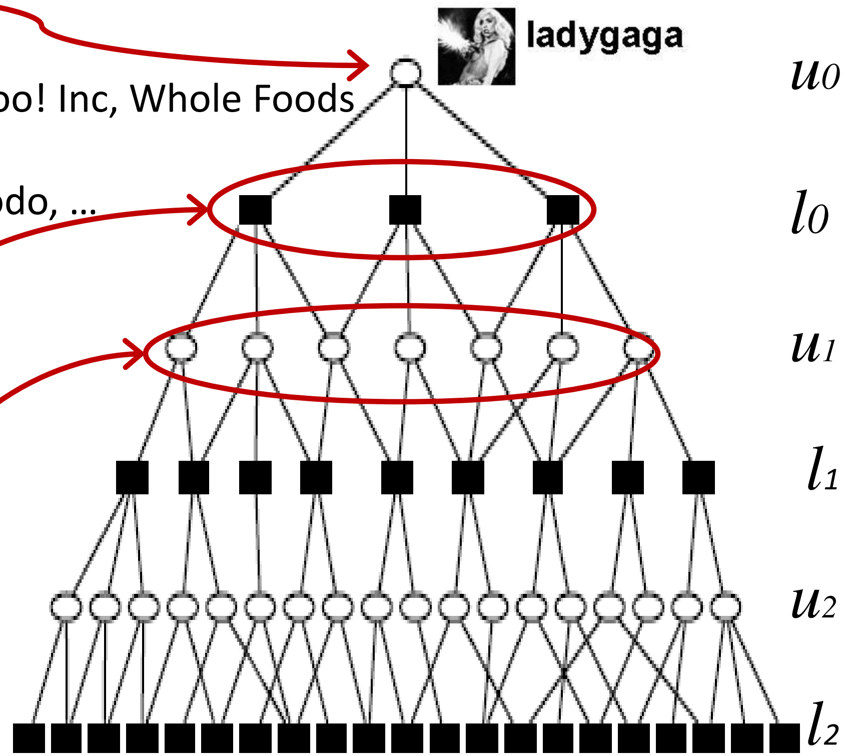
Twitter List Examples

Snowball sample of Twitter lists (I)

Manually selected seeds

- **Media**: CNN, New York Times
- **Organizations**: Amnesty International, WWF, Yahoo! Inc, Whole Foods
- **Celebrities**: Barak Obama, Lady Gaga, Paris Hilton
- **Blogs**: BoingBoing, mashable, Chrisbrogan, Gizmodo, …





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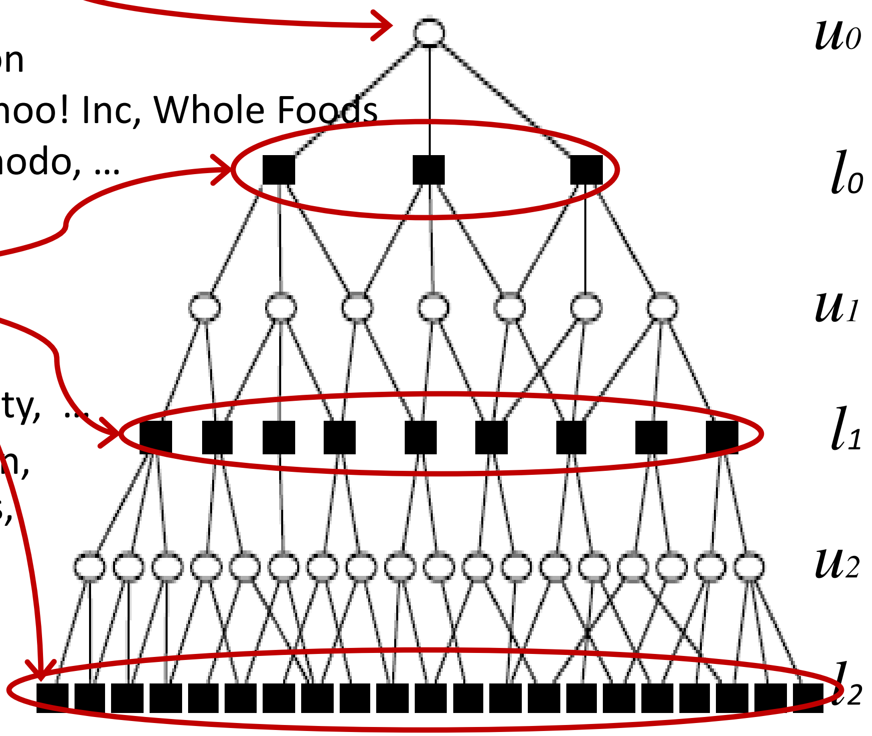
Keyword-pruned lists

- **Media**: news, media, news-media
- **Celebrities**: star, stars, hollywood, celebs, celebrity, …
- **Organizations**: company, companies, organization, organizations, organisations, corporation, brands, products, ngo, charity, …
- **Blogs**: blog, blogs, blogger, bloggers



Resolve ambiguity (e.g. Oprah Winfrey in both "celebrity" and "media")

- Define *membership score*: wic = nic/Nc (nic - # of lists in category c that contain user i, Nc – total # of lists in category c)
- Assign user i to the category with highest membership score

Activity sample Twitter lists

all users who tweeted **at least once every week** during entire observation period (750K users)

Keyword-pruned lists

- Total 5M lists, 113,685 after pruning

85% also appear in snow-ball sample

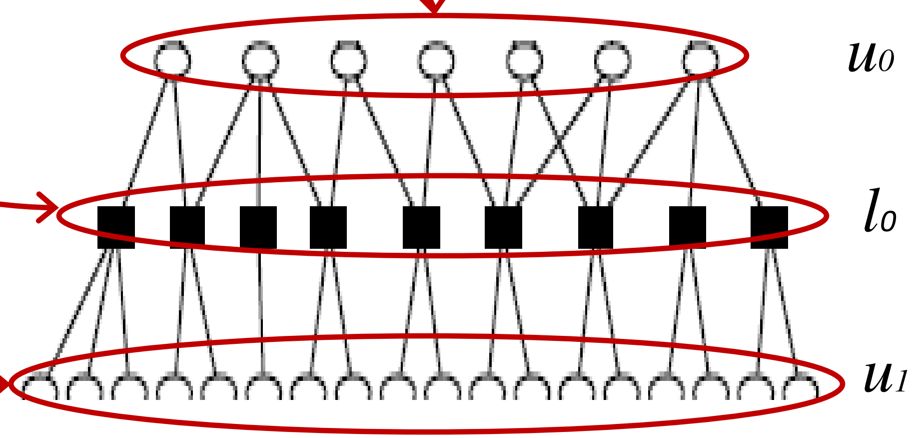


Table 1: Distribution of users over categories

category	Snowball Sample		Activity Sample	
	# of users	% of users	# of users	% of users
celeb	82,770	15.8%	14,778	13.0%
media	216,010	41.2%	40,186	35.3%
org	97,853	18.7%	14,891	13.1%
blog	127,483	24.3%	43,830	38.6%
total	524,116	100%	113,685	100%

Identify "Elite" Users

- Rank users by the frequency of being listed in each category

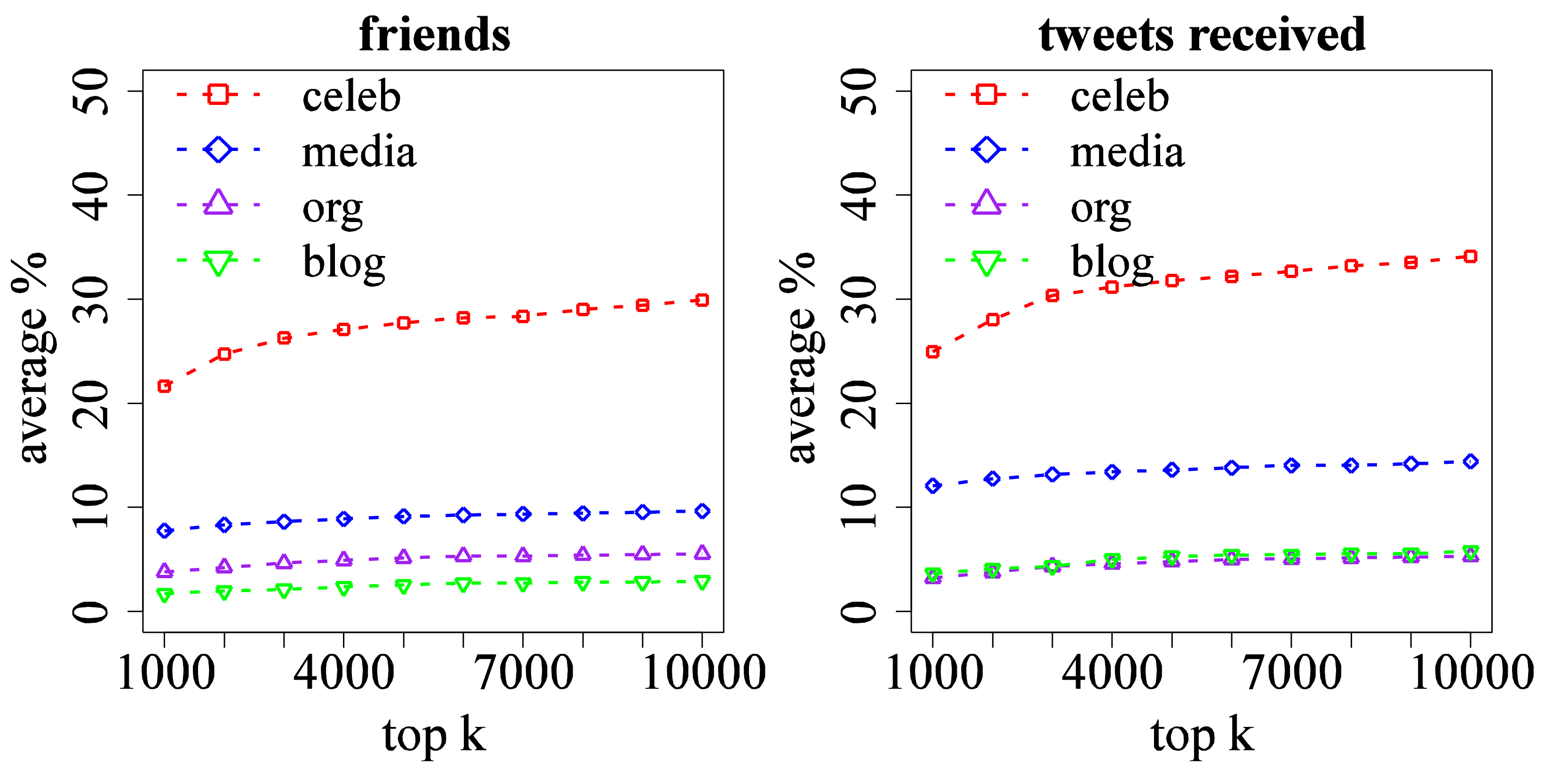
Table 3: Top 5 users in each category

Celebrity	*Media*	*Org*	*Blog*
aplusk	cnnbrk	google	mashable
ladygaga	nytimes	Starbucks	problogger
TheEllenShow	asahi	twitter	kibeloco
taylorswift13	BreakingNews	joinred	naosalvo
Oprah	TIME	ollehkt	dooce

- Take the top *k* users in each category as "elite" users
- Leave all the rest as "ordinary" users

How to set the cutoff value k?

- For each value of k measure the prominence of each category
  - randomly sample 100K ordinary (i.e. unclassified) users, calculate:
    - % of accounts they follow among the top k users
    - % of tweets they receive from the top k users



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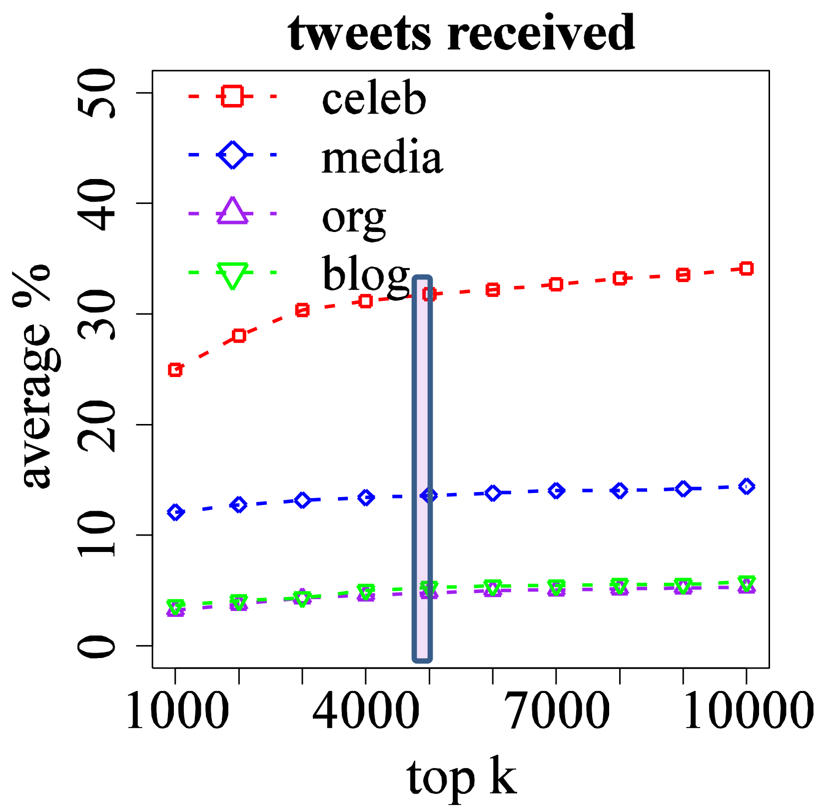
High concentration of attention on a small set of "elite" users:

- *~30% tweets from celebs*
- *~15% from media*
- *~5% from orgs and blogs*



- Who is whom? (user classification)
- Who listens to whom?
- Who says what?

“Who listens to whom”

- Concentrated attention
  - 20K (0.05%) elite users account for 50% of all attention within Twitter

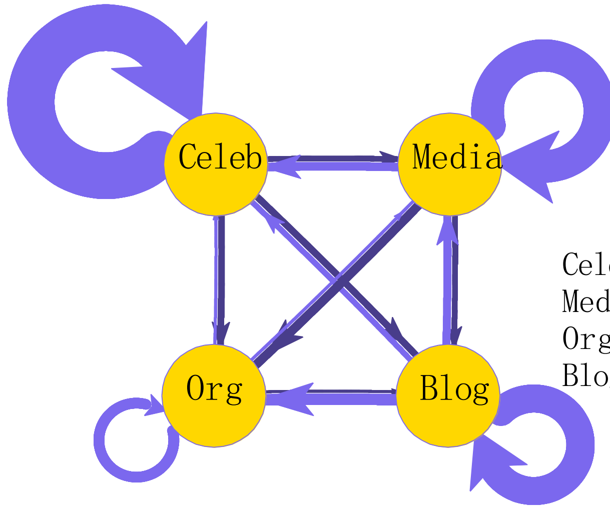
⇨ How do elite users listen to each other?

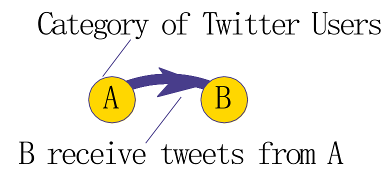
- Fragmented audience
  - Ordinary users receive information from thousands of distinct sources
  - Only 15% of information ordinary users receive directly from the media

⇨ How does information flow from the media to the masses?

How elite categories listen to each other

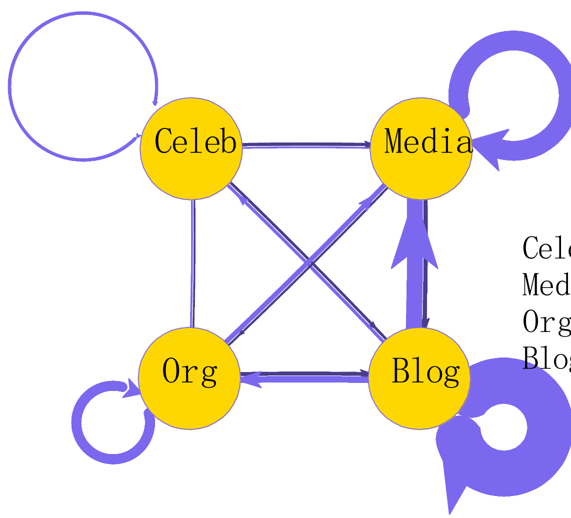
tweets received

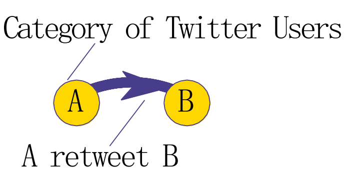




	% of tweets received from			
	Celeb	Media	Org	Blog
Celeb	38.27	6.23	1.55	3.98
Media	3.91	26.22	1.66	5.69
Org	4.64	6.41	8.05	8.70
Blog	4.94	3.89	1.58	22.55

RT behavior

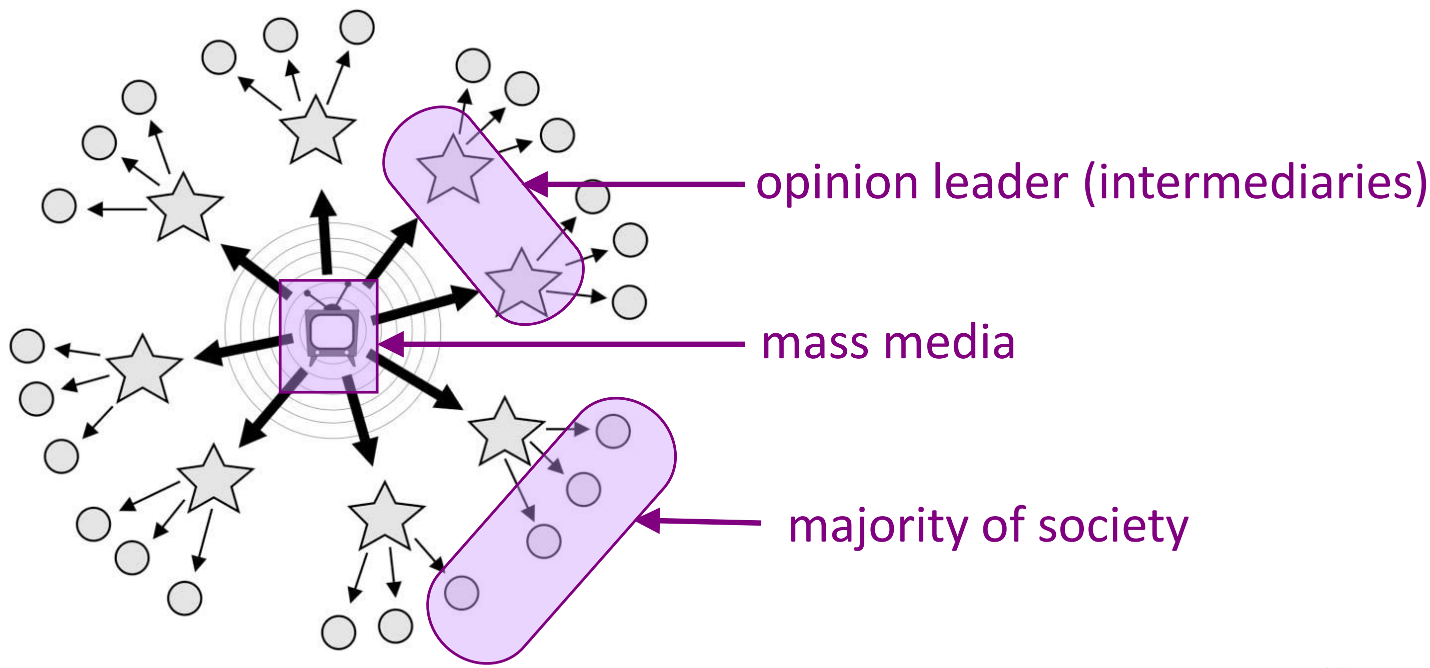




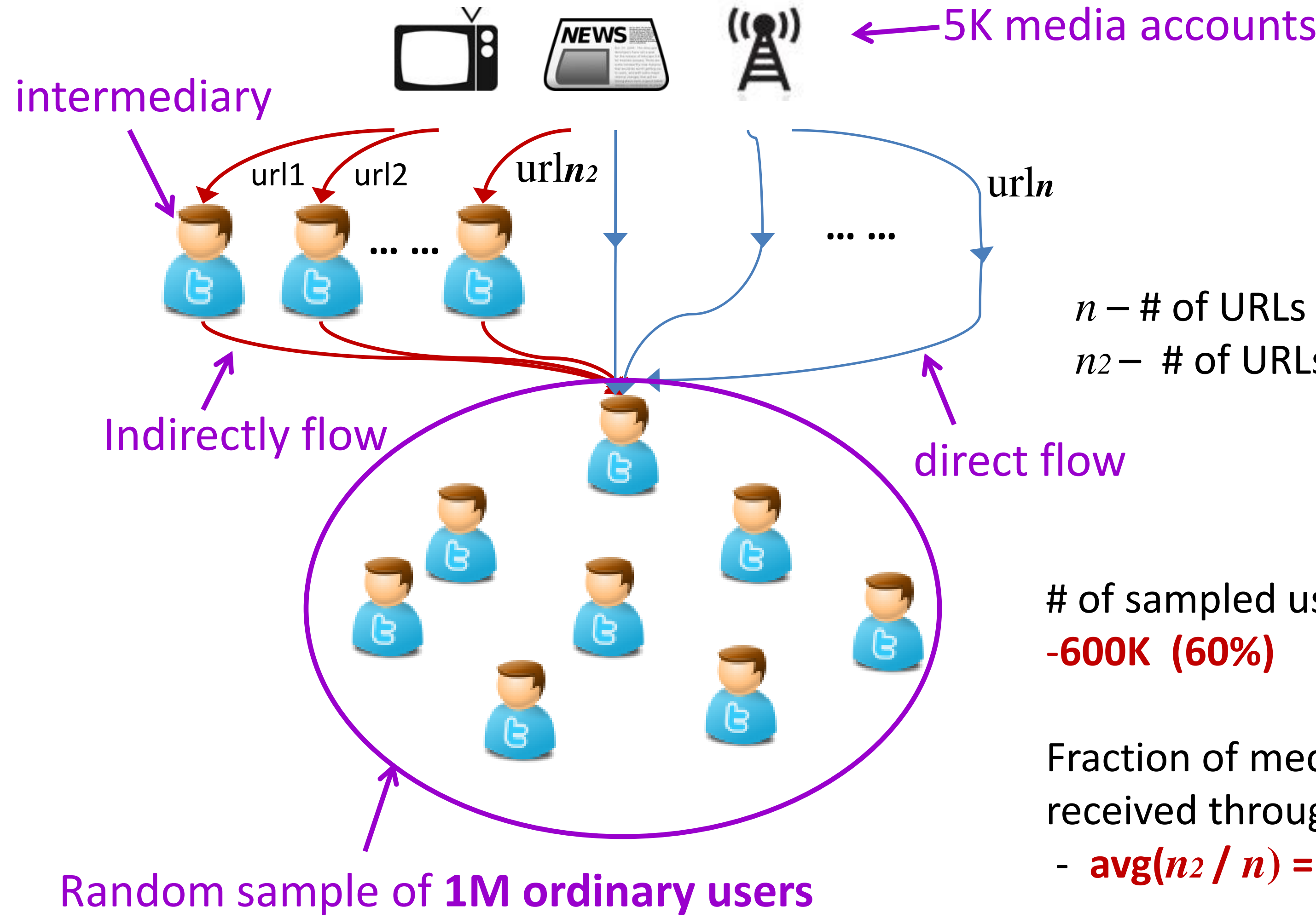
	# of retweets by			
	Celeb	Media	Org	Blog
Celeb	4,334	1,489	1,543	5,039
Media	4,624	40,263	7,628	32,027
Org	1,570	2,539	18,937	11,175
Blog	3,710	6,382	5,762	99,818

How does Information flow from media to the masses

- Two-step flow theory (Katz and Lazarsfeld 1955)
  - Media exerts indirect influence on the masses via an intermediate layer of opinion leaders



Quantify 2-step flow on Twitter



n – # of URLs received

n_2 – # of URLs received indirectly

# of sampled users with $n > 0$

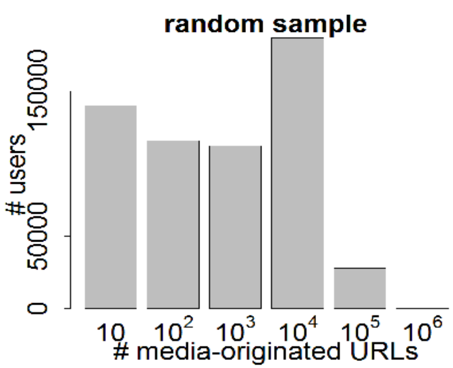
-600K (60%)

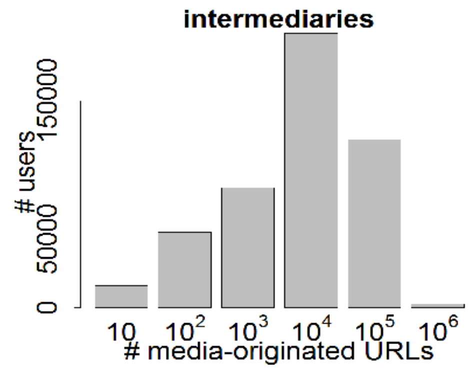
Fraction of media-originated URLs received through intermediaries

- **avg(n_2 / n) = 0.46**

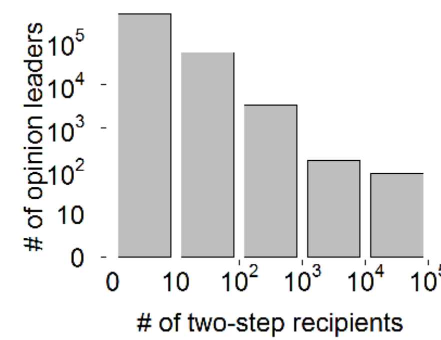
Who are the intermediaries?

- A large population (490K users) act as intermediaries for 600K users
  - Most (99%) are ordinary
  - Also receive information via two-step flows
  - More exposed to the media





- Opinion leadership is NOT a binary attribute



Findings consistent with the two-step theory.

- Who is whom? (user classification)
- Who listens to whom?
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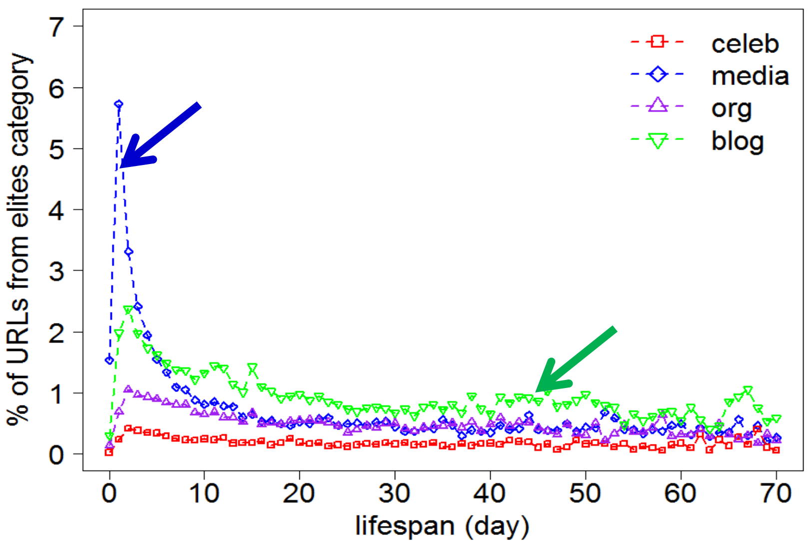
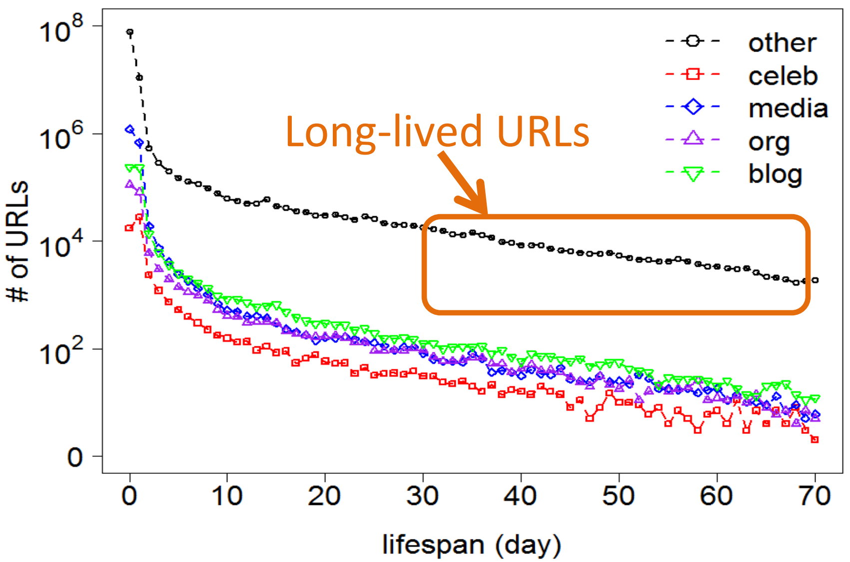
Lifespan of URLs

- URL lifespan
  - the time lag between the first and last appearance of a given URL on Twitter
- Lifespan of URLs introduced by different categories



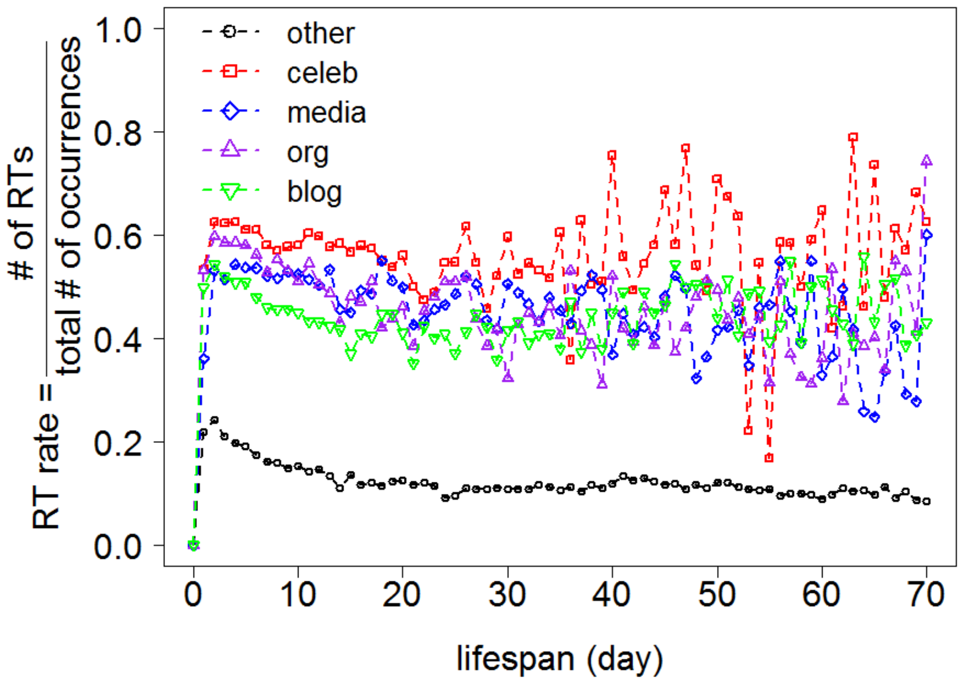


* lifespan = 0 means the URL only appeared once

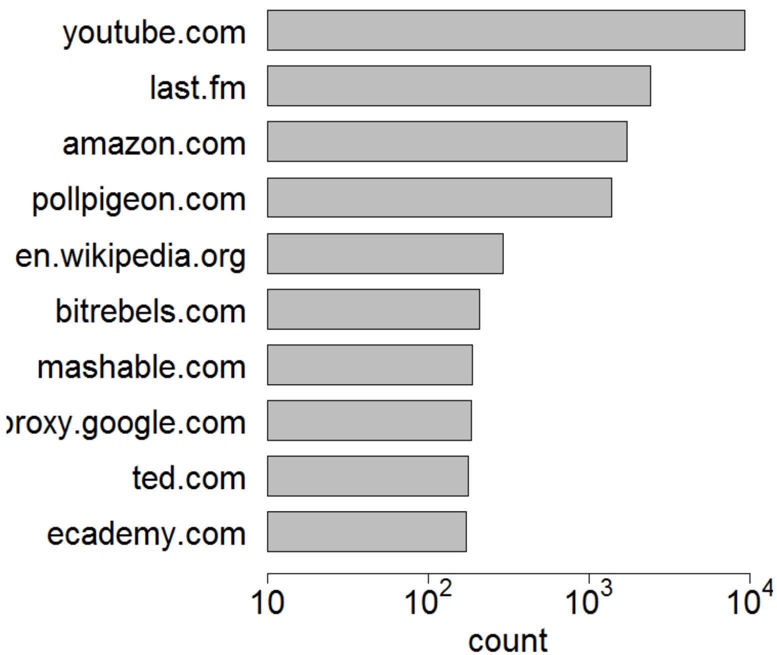
The mechanism for persistence

Content vs. Network structure

Average RT rate as a function of lifespan



Top 10 domains for URLs that lived more than 200 days



Conclusion

- Introduce a method for classifying users into “elite” and “ordinary” categories, using Twitter Lists
- Investigate the flow of information among categories
  – High concentration of attention on a minority of elites
  – A large population of intermediaries passing information from mass media to the masses
- Study the types of contents
  – Different types of content exhibit different characteristic lifespans
  – The persistence of information as a result of content, not structure