

# Activity Intensity in Social Network Communities: a case study

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## Analysis of the Activity in a Social Network

**The Anatomy of a Scientific Rumor**, M. De Domenico et al.  
*Nature, Scientific Reports*, 2013

- Study of user activity at a global level

**Principal Pattern on Graphs:  
discovering coherent structures in dataset**, K. Benzi et al. *IEEE Transactions on Signal and Information Processing over Networks*, 2016

- Study of activity pattern and communities dynamics

Study of the activity at a local level

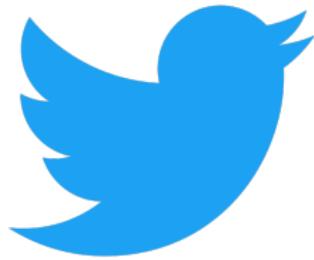
## Goal of the study

Analyze the difference in **activity intensity**  
between **small** and **large** communities

- Type of interaction between communities
- Type of interaction between users

# Context

- **Social Network:** Twitter  
following/followers relationships
- **Communities** of Users
- Study of community **activity** during  
**extraordinary event**
  - Discovery of the Higgs Boson



# Higgs Dataset

Twitter activity during the announcement of the discovery of the Higgs Boson on July 12th 2012

- **Time interval**

From July 11th 00:00 to July 12th  
23:59

- **Directed following/followers network**

450000 users and 14 million edges

userID → userID

- **Timestamped interactions**

500000 events

userID userID timestamp Retweet

userID userID timestamp Mention

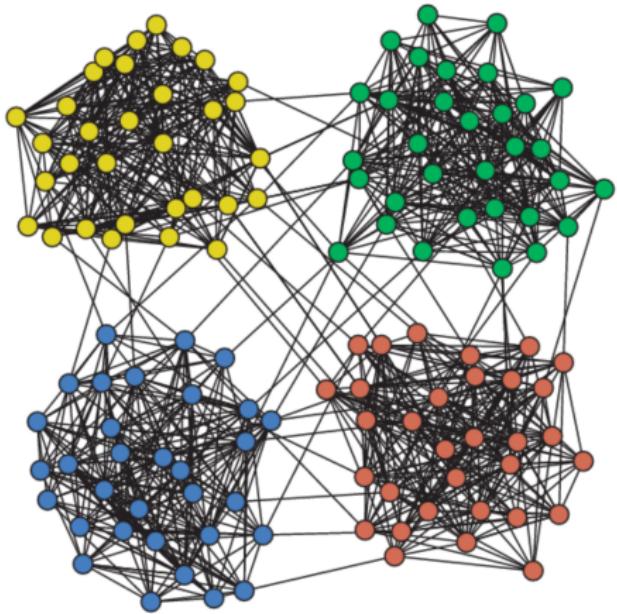


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Source: SNAP Datasets, Stanford Large Network Dataset Collection

# What defines a community?

- Very dense connections between users within community
- Very sparse connection coming in and going out community



Guimera, R., & Amaral, L. (2005). Functional cartography of complex metabolic networks. *Nature*, 433, p. 896

# User Activity: Retweet, Mentions and Replies

## TWEET



CERN  
@CERN

#CMS: "we have observed a new boson with  
a mass of  $125.3 \pm 0.6$  GeV at 4.9 sigma  
significance." Thunderous applause. #Higgs  
#ICHEP2012

Reply Retweet Favorite

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Reply Retweet Favorite

## RETWEET



EXCITED USER  
@EXCITED\_USER

Awesome news from #CERN #HIGGS

CERN @CERN

#CMS: "we have observed a new boson with a mass of  $125.3 \pm 0.6$  GeV at 4.9 sigma significance." Thunderous applause. #Higgs #ICHEP2012

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## MENTION



EXCITED USER  
@EXCITED\_USER

@CERN has announced that a new boson has been observed. What do you think @DUBIOUS\_USER ?  
#CERN #Higgs #Boson

## RETWEET



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## REPLY



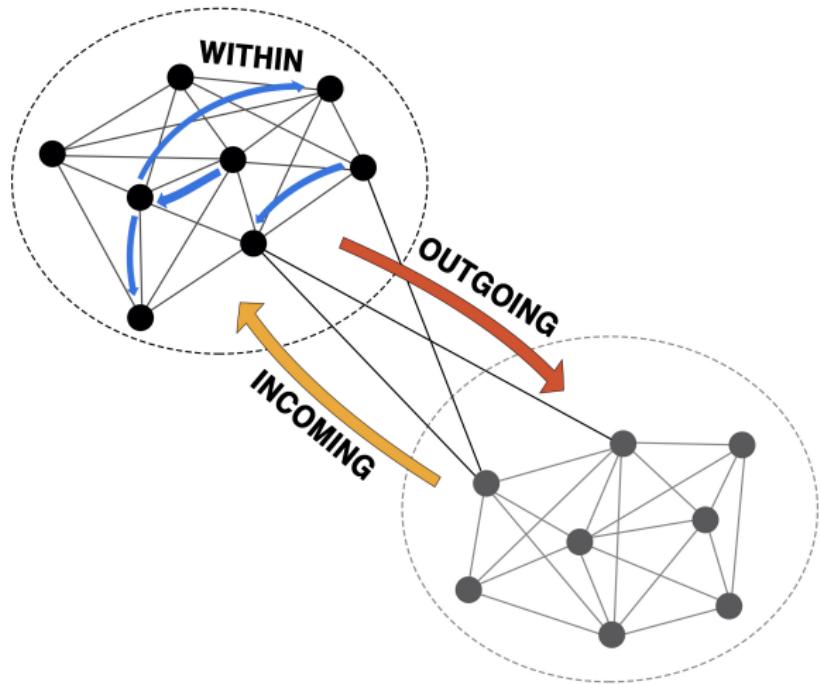
DUBIOUS USER  
@DUBIOUS\_USER

@EXCITED\_USER I'm still skeptical. I don't think the data is precise enough yet.

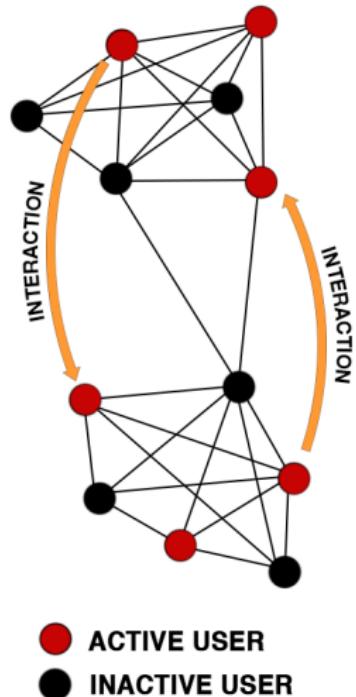
# Community Activity

Community activity is divided into:

- Within (active)
- Outgoing (active)
- Incoming (passive)



# Activity Classification: Index of Activity



For each community we compute:

- Number of Interactions
- Number of Active Users

and define the **Index of Activity** as

$$\frac{\text{Number of Interactions}}{\text{Number of Active Users}}$$

# Community Detection Algorithm

Choosing the right **community detection algorithm** is a crucial step of the network analysis.

## CONSTANT POTTS MODEL [1]

- Able to unveil small sub-communities
- Resolution parameter for smallest community size

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[1] Traag, V. A., Dooren, P. Van, Nesterov, Y. (2011). Narrow scope for resolution-limit-free community detection.

# Computational Aspects: Tools

- **Community Detection**



- **Community Analysis**

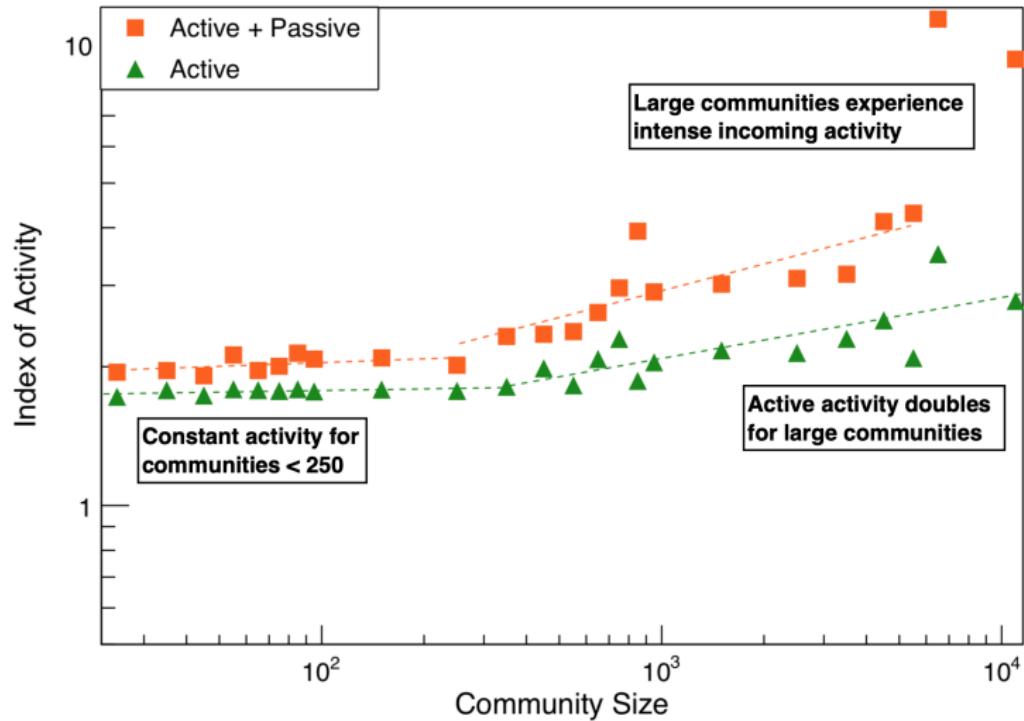


- **Plots and fits**



# Total Activity (Active and Passive)

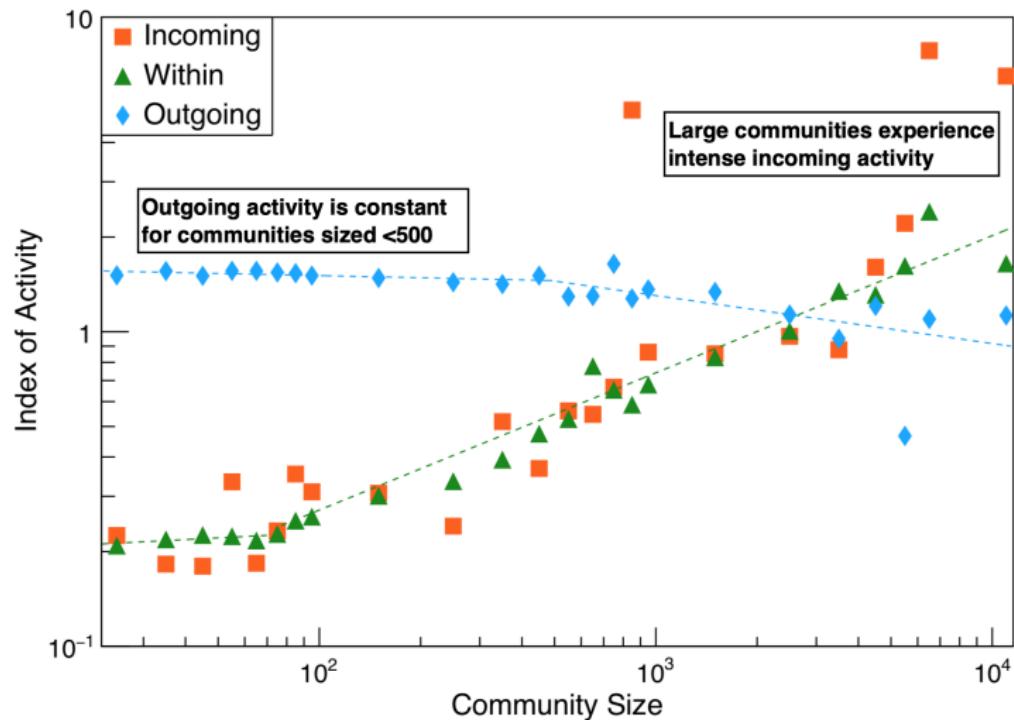
■ Activity is constant for small communities



Trend lines are for guidance only

# Total Activity by Community Interaction

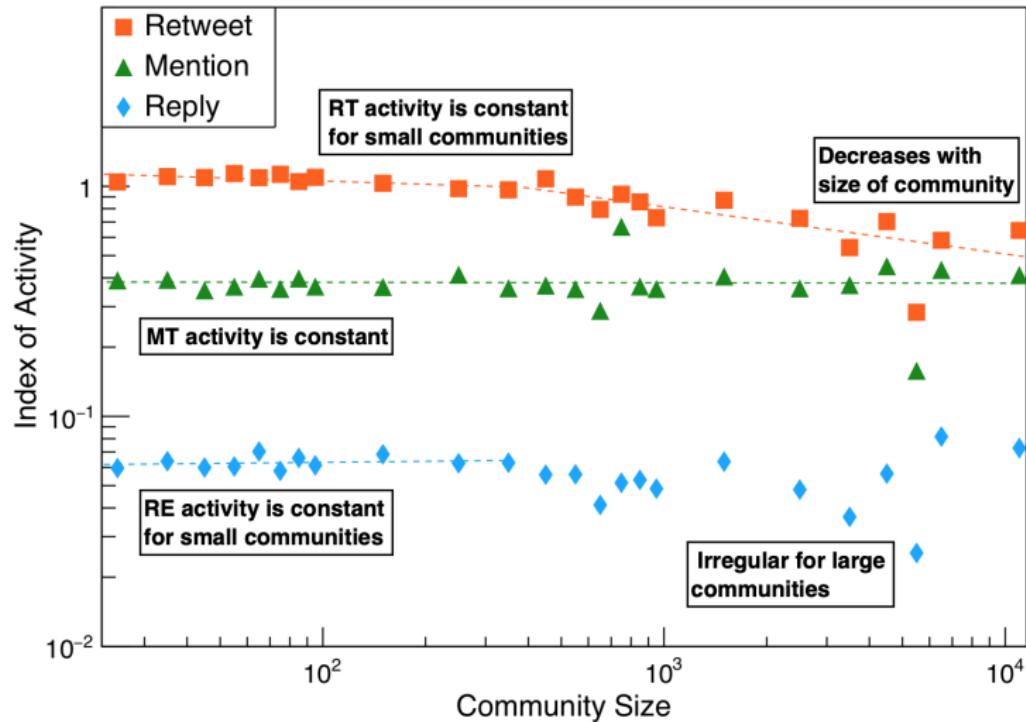
- Outgoing activity decreases with cluster size



Trend lines are for guidance only

# Outgoing Activity by Type of User Interaction

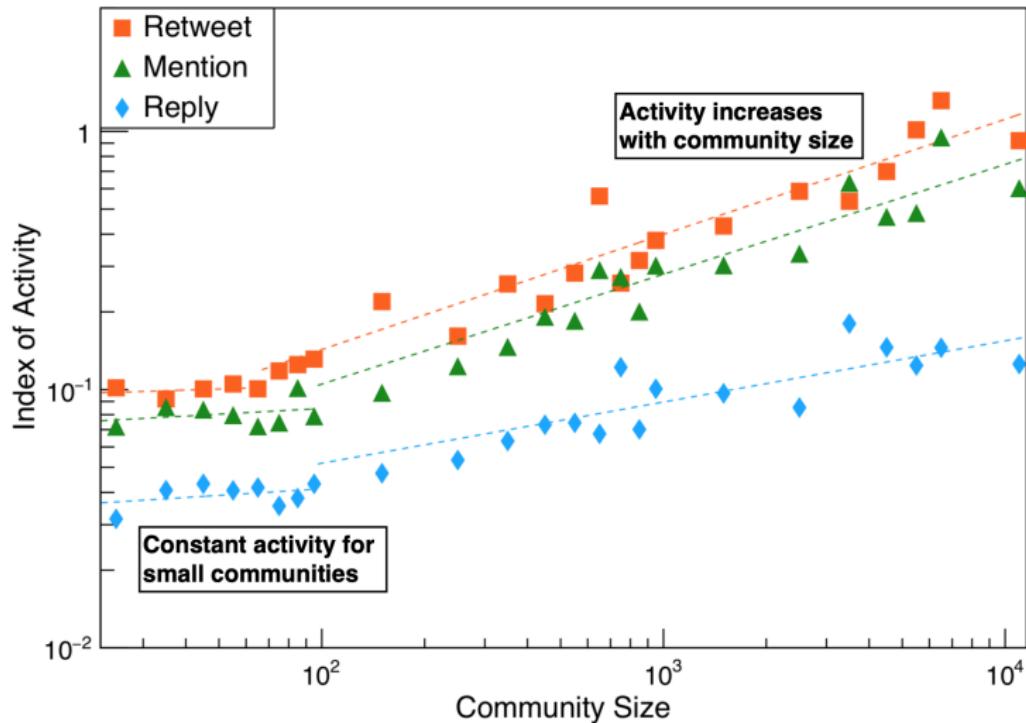
■ Mention activity is constant



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# Within Activity by Type of User Interaction

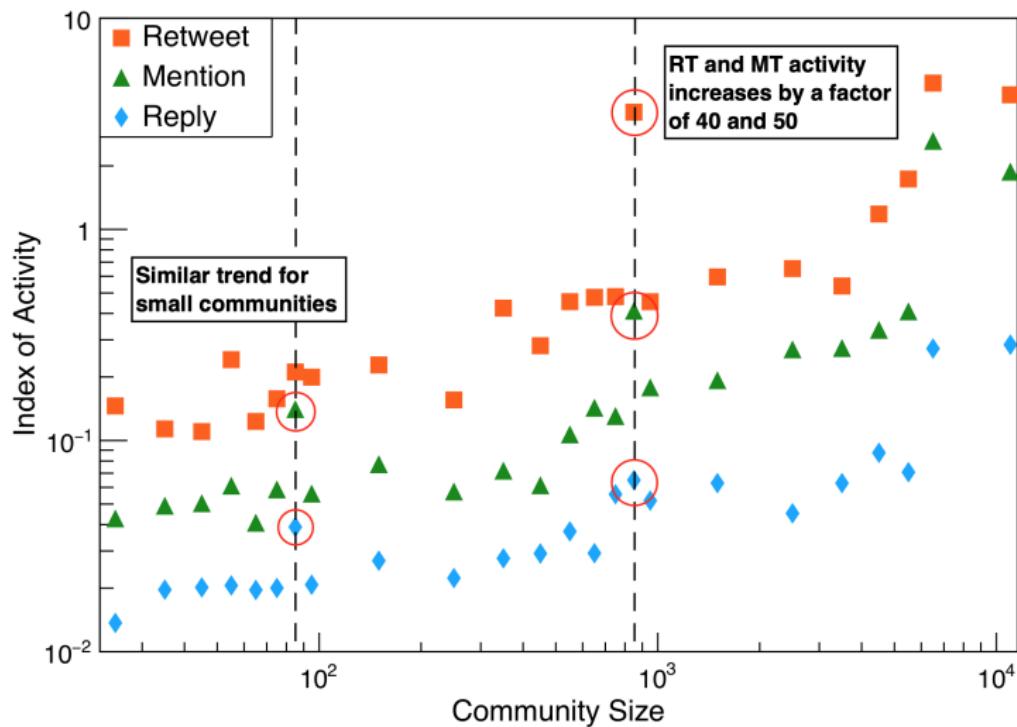
■ Retweet and Mention activity increase at the same rate



Trend lines are for guidance only

# Incoming Activity by Type of User Interaction

■ Activity increases with community size



## What do these results tell us?

- ① **Small** communities (less than 150-350 users) show similar activity, regardless of the type
- ② For **large** communities the activity increases/decreases with the community size
  - Increases for Within and Incoming Activity
  - Decreases for Outgoing Activity
  - **Exception:** Outgoing Mentions Activity is constant for all communities

# What do these results tell us?

**SMALL**

- **Less** activity **within** the community
- Very **little incoming** activity
- **More** activity is directed outside the community (**outgoing**)

**LARGE**

- **More** activity **within** the community
- **Less outgoing** activity
- Experience **intense incoming** activity

# Lessons Learned

- **Retweets** are the **most frequent** type of interaction, suggesting that the **news** is **shared** rather than discussed
- **Small communities** activity is **directed towards** other communities, probably of larger size
- During an **extraordinary event** the activity is **not contained** within the community, but spreads through the network

# Future Developments

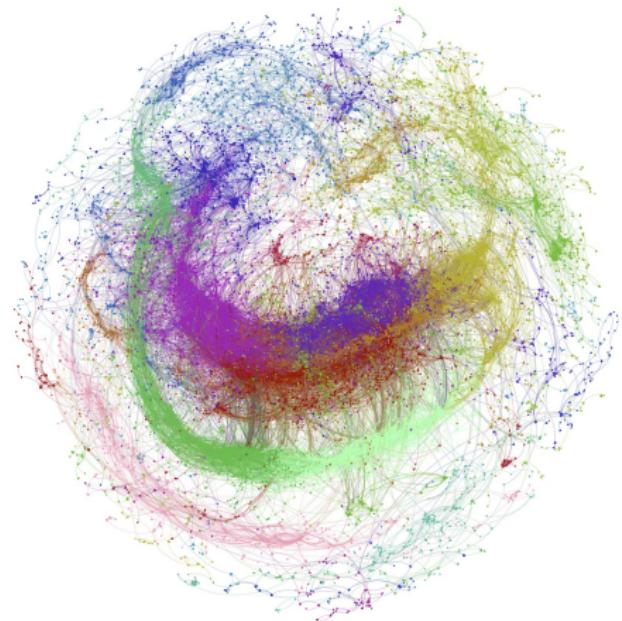
## ■ SPATIAL ANALYSIS

- Where is the outgoing activity directed to?

## ■ TEMPORAL ANALYSIS

- Burst of activity
- Time of activation

**Thanks for your attention**



Benzi, K., Ricaud, B., Vanderghenst, P., et Traitement, L. De.  
(2016). Principal Patterns on Graphs : Discovering Coherent  
Structures in Datasets, 119.