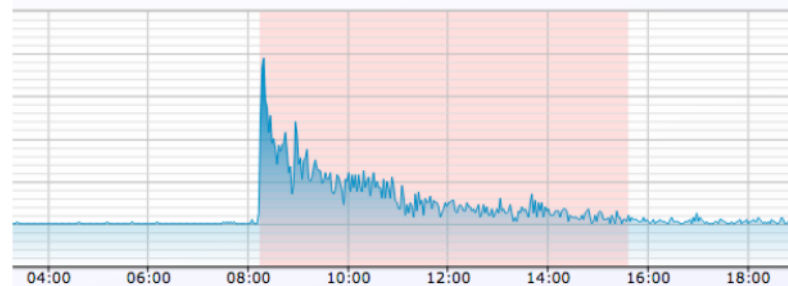




EARS (Earthquake Alert and Report System): a Real Time Decision Support System for Earthquake Crisis Management



Stefano Cresci, IIT-CNR, Italy

Maurizio Tesconi, IIT-CNR, Italy

Marco Avvenuti, University of Pisa, Italy

Andrea Marchetti, IIT-CNR, Italy

Carlo Meletti, INGV, Italy

Big Data

Google+

2011



Instagram

Pinterest

2010

2009

foursquare

2008

tumblr.

2007

bado



reddit

<https://about.twitter.com/company>

271 million monthly active users
500 million tweets per day
2.1 billion queries per day
125 countries
33 languages

twitter

2006

NETLOG

slideshare
Present Yourself

last.fm

2005

You Tube

facebook

2004

digg

flickr

LinkedIn

2003

myspace

delicious

2002

friendster.

2001



WIKIPEDIA
The Free Encyclopedia

SOCIAL MEDIA TIMELINE



<https://about.twitter.com/company>

271 million monthly active users
500 million tweets per day
2.1 billion queries per day
125 countries
33 languages

twitter 

You  Tube

A circular graphic containing a map of Italy. The map is light gray with white outlines for regions and cities. Several blue Twitter bird icons are scattered across the map, primarily in the northern and southern regions. The text "Social Sensing: people as sensors" is overlaid in the center of the map in a bold, black, sans-serif font.

Social Sensing: people as sensors

Disasters in the Age of New Media and Social Sharing:



How the VIRTUAL World Responds

Natural disasters have become entirely too frequent in recent years: the Indian Ocean tsunami in 2004; Hurricane Katrina in 2005; Myanmar's Cyclone Nargis in 2008; the 2010 Pakistan floods; and major earthquakes in Haiti, Chile, New Zealand, and

Social Media



TWITTER

The term "social media" has grown to cover a lot of territory, but the most widely used of these communications phenomena have also become the default means of **sharing news**, making **donations**, and even **saving lives** in the wake of earthquakes and other disasters.


When Japan's phone system was knocked offline by the 9.0 earthquake, **TWITTER QUICKLY BECAME THE PRIMARY MEANS OF COMMUNICATION IN JAPAN.**



Prezi



In the hours after the earthquake, Tweet-O-Meter recorded as many as **1,200 TWEETS PER MINUTE** out of Tokyo alone.



The Tokyo Electric Power Company set up a Twitter account to keep people informed and updated about radiation leaks, blackouts, and repairs.

During the aftermath of **Haiti's 7.7** earthquake in 2010, many people used Twitter as a place to **LEARN AND SHARE NEWS**.

People **TWEETED PICTURES** of missing friends and family and provided links, photos, and advice.

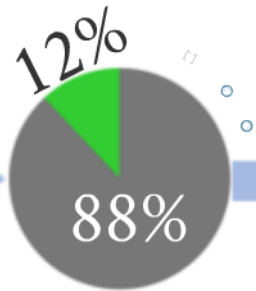


Goal



- Development of a real time decision support system for earthquake crisis management

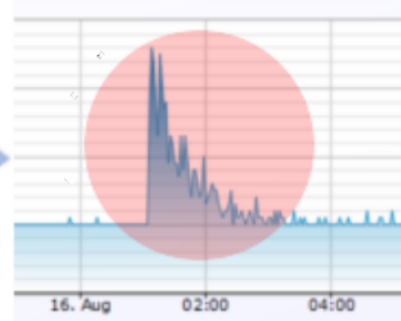
Data acquisition



Data filtering



Event detection

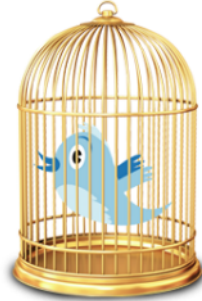


Damage assessment



Dissemination

Collected Data



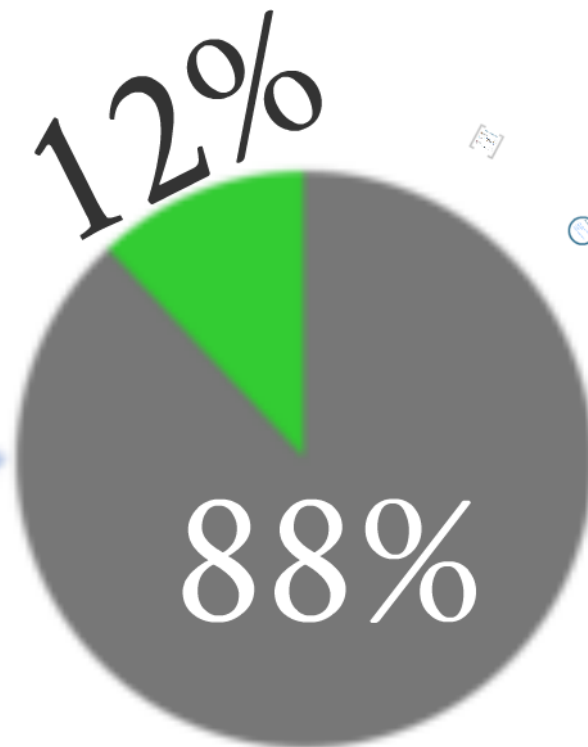
- data **completeness** and data **specificity**
- initial set of 9 keywords
- progressively restricted to final set of 2 keywords

Collected Data

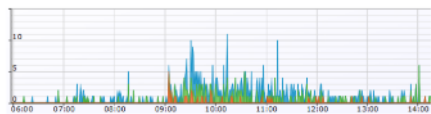
(over 70 days)



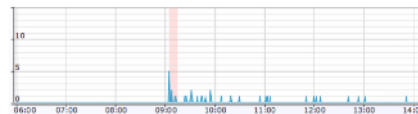
- 1,5 million tweets
- 1,9 million entities
(pictures, URLs, hashtags, etc.)
- 330.000 accounts



Data filtering

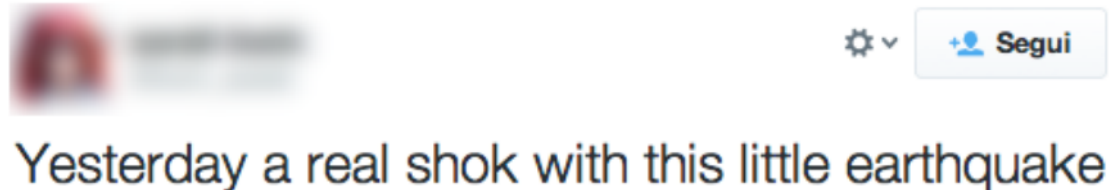
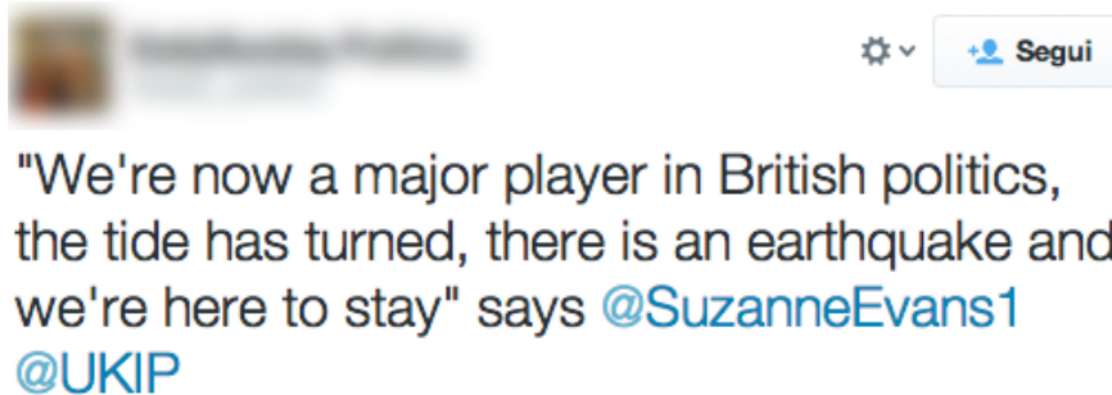


(a) Before filtering



(b) After filtering

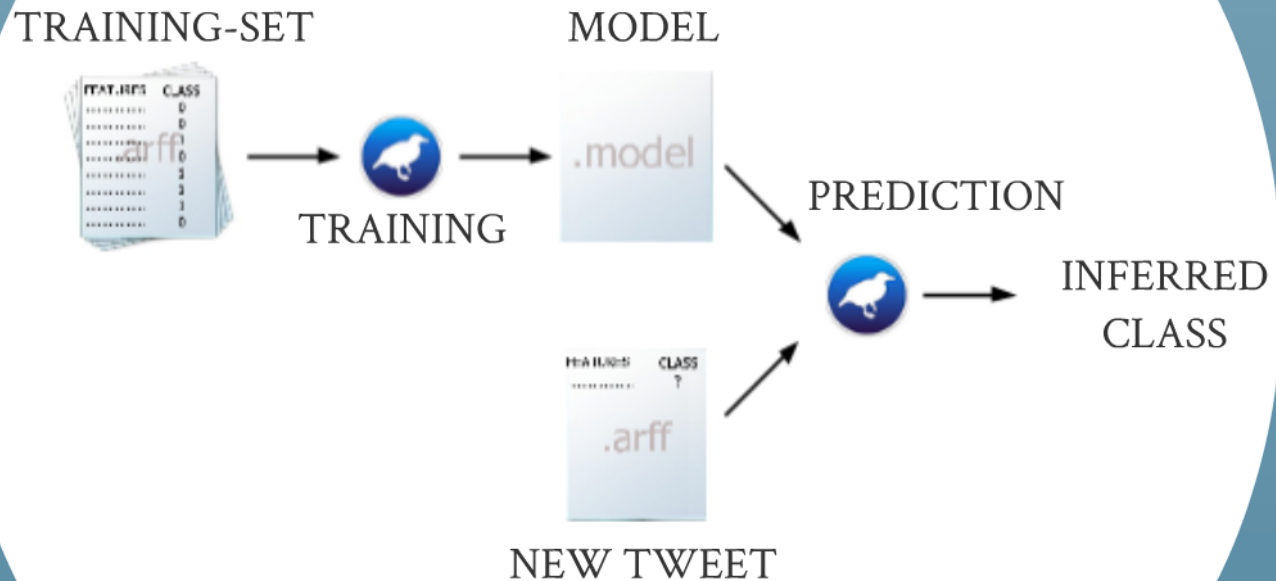
Noise in collected data

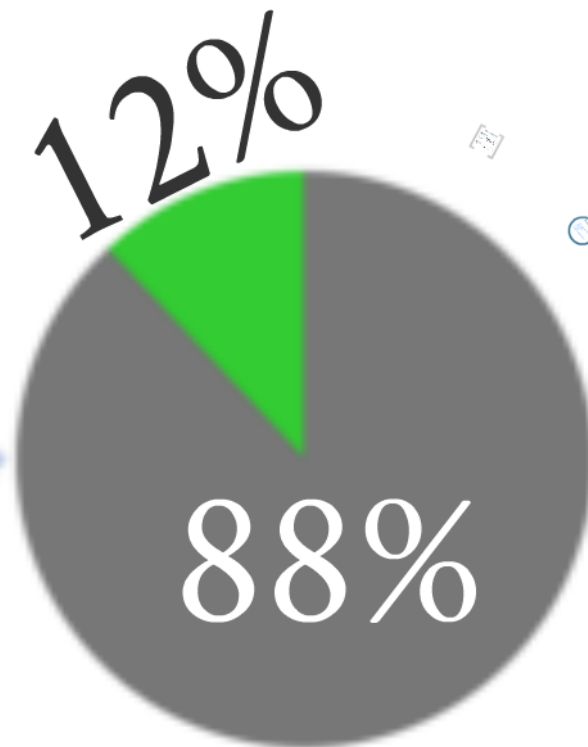


Pre-filtering

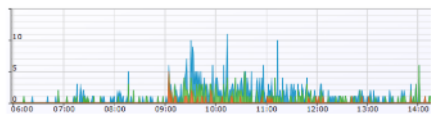
- Official news agencies
- Retweets
- Replies
- Fakes / Spams / Bots

Classifier filtering

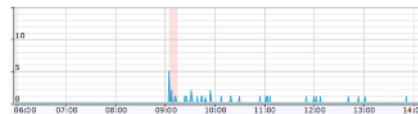




Data filtering

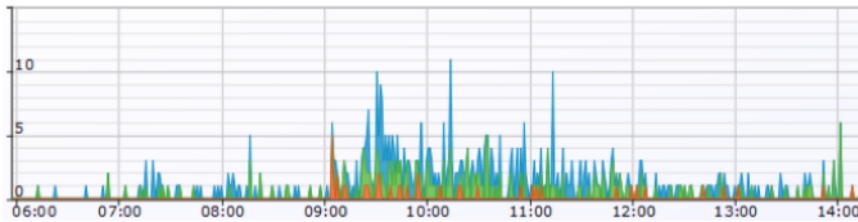


(a) Before filtering

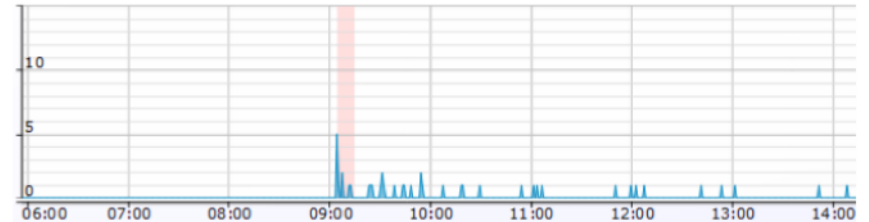


(b) After filtering

Data filtering

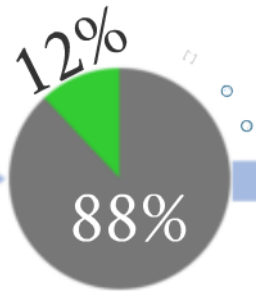


(a) *Before filtering*



(b) *After filtering*

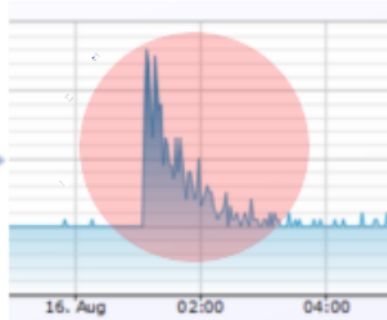
Data acquisition



Data filtering



Event detection

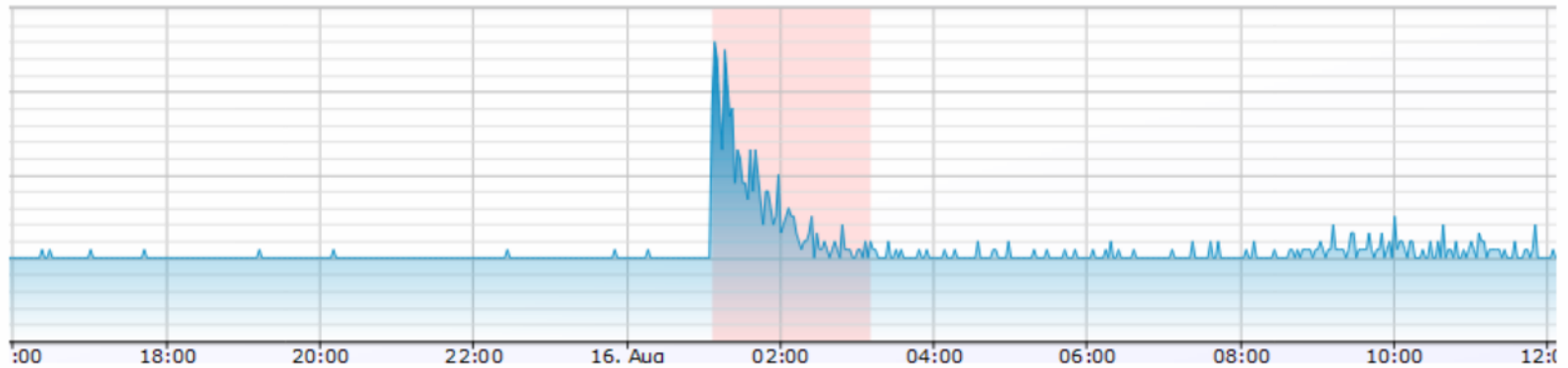


Damage assessment

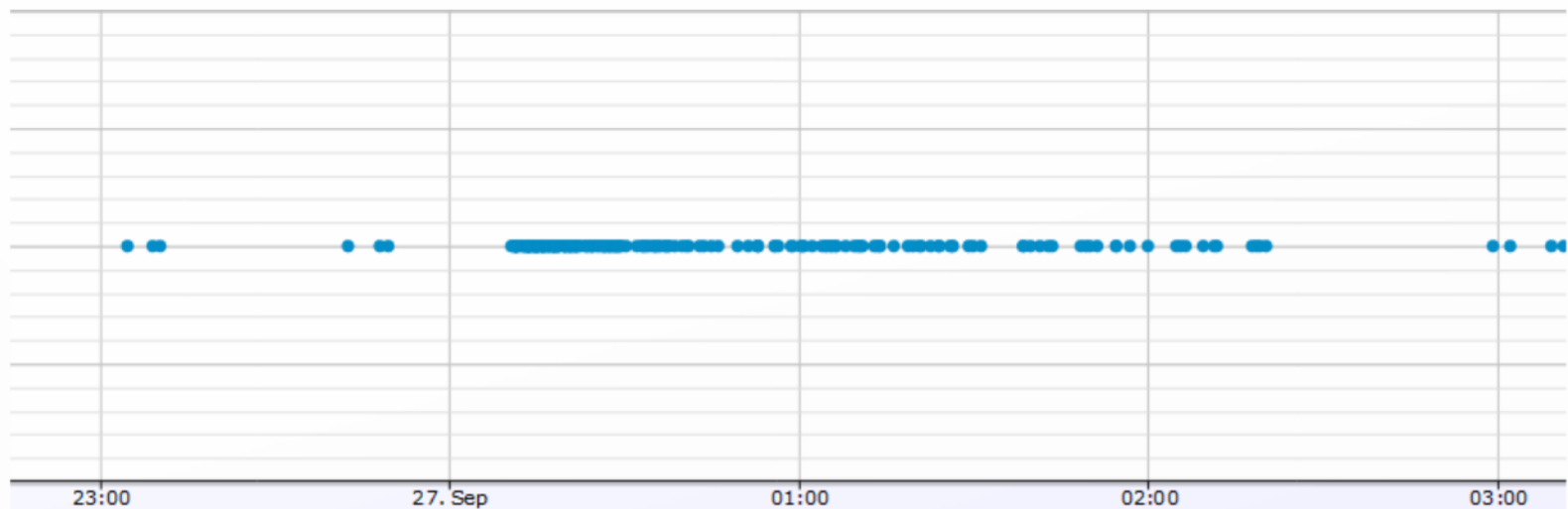


Dissemination

Peak in tweet frequency



Burst in tweet arrival times



Event detection techniques

- Bayesian statistics

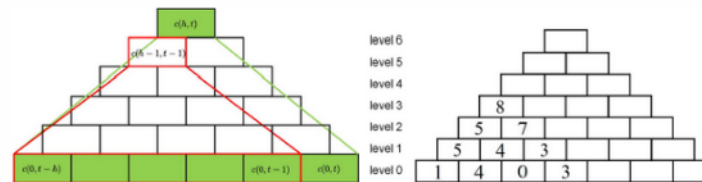
- Peak detection



- Corrected conditional entropy (CCE)

- Change detection

- Burst detection





Event detection techniques

- Bayesian statistics

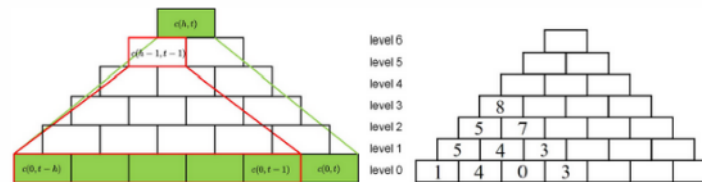
- Peak detection

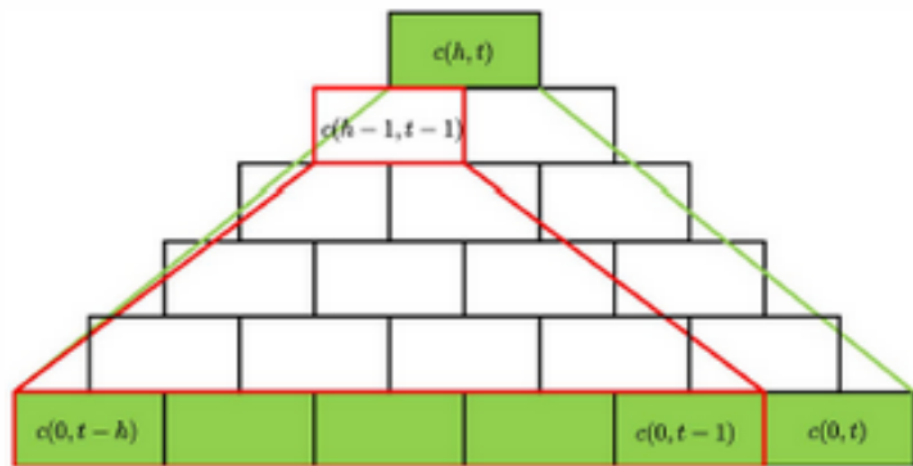


- Corrected conditional entropy (CCE)

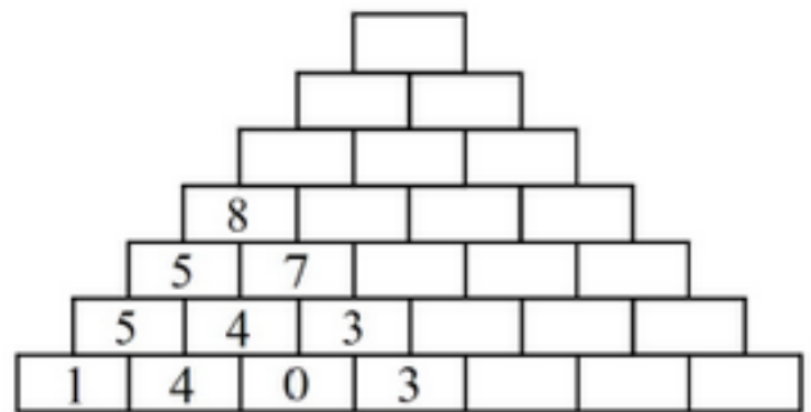
- Change detection

- Burst detection





level 6
level 5
level 4
level 3
level 2
level 1
level 0

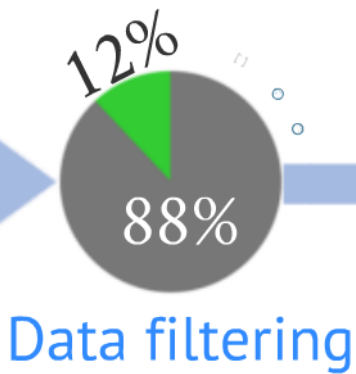


System evaluation

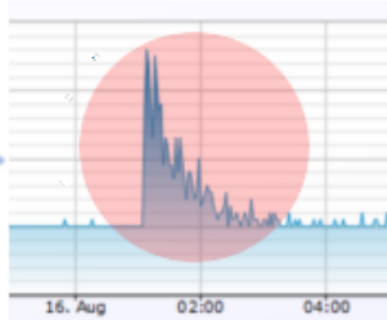
<i>Magnitude</i>	<i>Tweeted earthquakes</i>	<i>TP</i>	<i>FP</i>	<i>FN</i>	<i>Precision</i>	<i>Recall</i>	<i>F-Measure</i>
> 2.0	128	17	30	111	36.17%	13.28%	19.43%
> 2.5	55	16	30	39	34.78%	29.09%	31.68%
> 3.0	21	13	17	8	43.33%	61.90%	50.98%
> 3.5	9	9	3	0	75%	100%	85.71%
> 4.0	5	5	0	0	100%	100%	100%
> 4.5	2	2	0	0	100%	100%	100%

Table 2: System evaluation against earthquakes that generated at least one report on Twitter

Data acquisition



Event detection



Damage assessment



Dissemination

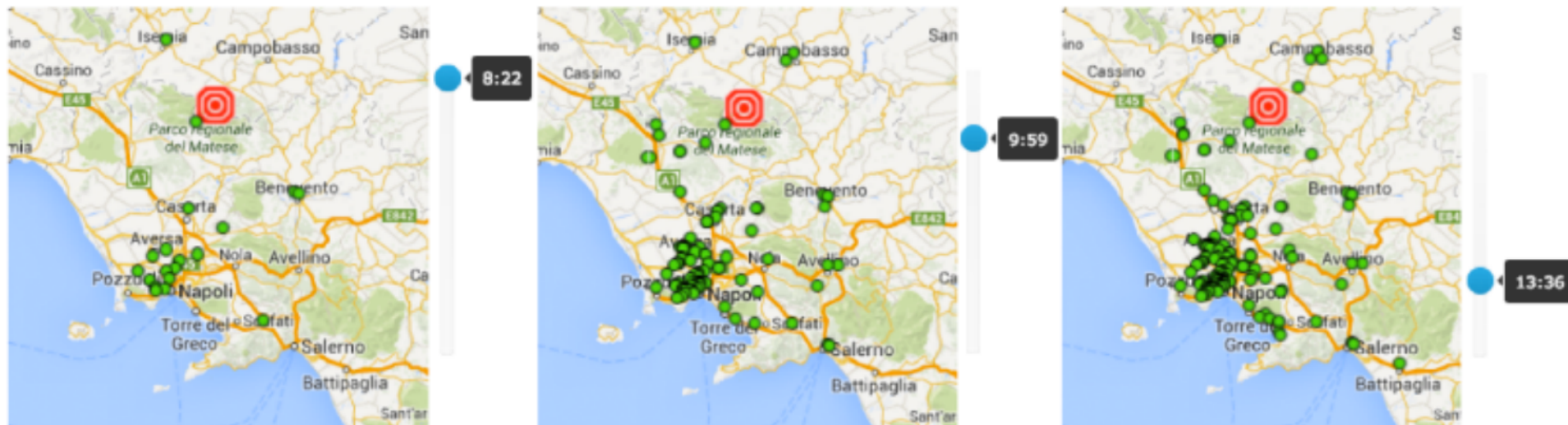





Figure 5: Geographical view: epicenter and spatial distribution of relevant messages

2014-01-20 08:30:28	Alex_Giordano: Ci mancava solo il terremoto di prima mattina	
2014-01-20 08:30:28	_manuhappy: No perché dovete sapere che io sto da giorni che tremo per il terremoto # terremoto	
2014-01-20 08:30:31	rinogargano: Se c'ero dormivo. Davvero. # terremoto	
2014-01-20 08:30:35	DavideRoccio: Di nuovo terremoto al sud. Confermate? # terremoto	
2014-01-20 08:30:39	ilfuzz: e con questa scossa , # gennarodauria si conferma il Sommo Vegente del nostro cuore	
2014-01-20 08:30:43	asollazzo98: Paradiso il terremoto per la prima volta a scuola. Mi son messo paura ye	
2014-01-20 08:30:49	animaesiliata: Come fate a dormire ancora tutti??? Non vi ha svegliati il # terremoto ??	
2014-01-20 08:30:53	laccio: mappa del # terremoto di magnitudo 4.6 http://t.co/Igw1Mo3VXS	

@barbiechenola

#Ferrara pic.twitter.com/Umb5LZWT

← Risposta ↻ Retweet ★ Preferito ⋮ Altro



RETWEETS 130 FAVORITES 4

05:09 - 20 mag 2012

Giulio Pierini @giulopierini

Torre di finale emilia sbriciolata pic.twitter.com/HrnBhHdK"

← Risposta ↻ Retweet ★ Preferito ⋮ Altro



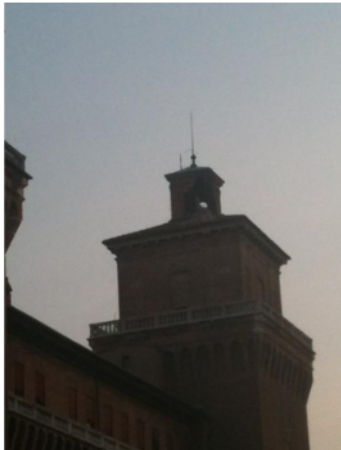
RETWEETS 112 FAVORITES 4

05:21 - 20 mag 2012

Valentina @barbiechenola

Crollata torretta Castello Estense #Ferrara pic.twitter.com/rTrdNwHf

← Risposta ↻ Retweet ★ Preferito ⋮ Altro



RETWEETS

Giacomo Monari @Arsenico13

Torre dell'Orologio, #FinaleE. Fa impressione vedere l'orologio spaccato a metà... - #Terremoto - pic.twitter.com/YteJ8gQJ

← Risposta ↻ Retweet ★ Preferito ⋮ Altro



RETWEETS FAVORITES

Red Ronnie @RedRonnie

Ecco la chiesa di Bonacompra (FE) per terremoto pic.twitter.com/WMOeFC6l

Retweets: 45

06:03 - 20 mag 2012



davide berti @dvdberti

#terremoto la chiesa del mulino dove si sposano i sanfeliciani completamente distrutta pic.twitter.com/oVIYQmrxr

Retweets: 37 Favorites: 2

11:26 - 20 mag 2012



Kaspo @kaspo

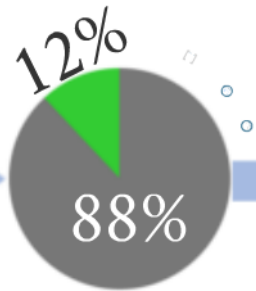
Casa danneggiata a Ferrara. #terremoto pic.twitter.com/JhGnEDCg

Retweets: 5

06:03 - 20 mag 2012



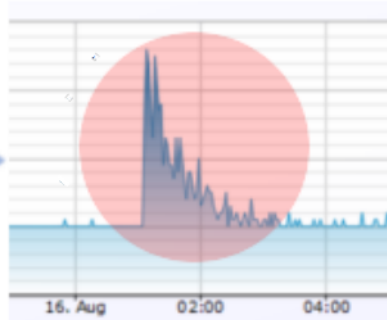
Data acquisition



Data filtering



Event detection



Damage assessment



Dissemination

Information dissemination

- Web application
- Automatic email reports
- Automatic Twitter direct messages

A practical example

2013-07-21 earthquake in Ancona, Italy

03:32:24 : earthquake strikes Ancona and Macerata

03:32:50 : first tweet about the event (26 seconds delay)



03:33:31 : earthquake detected by the system (1 minute, 7 seconds delay)

03:35:30 : first damage assessment report (3 minutes delay)

03:55:02 : INGV tweet (22 minutes delay)

10:51:00 : official news agencies reports (7 hours delay)





Questions?

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www.socialsensing.eu