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

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

https://about.twitter.com/company
Social Sensing: people as sensors
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...
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.
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
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

12%

88%
Noise in collected data

"We're now a major player in British politics, the tide has turned, there is an earthquake and we're here to stay" says @SuzanneEvans1 @UKIP

Yesterday a real shok with this little earthquake
Pre-filtering

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

TRAINING-SET → TRAINING → .model

MODEL ← PREDICTION → INFERRRED CLASS

NEW TWEET ← .arff
Data filtering
Data filtering

(a) Before filtering

(b) After filtering
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
## System evaluation

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

Table 2: System evaluation against earthquakes that generated at least one report on Twitter
Figure 5: Geographical view: epicenter and spatial distribution of relevant messages

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Username</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014-01-20</td>
<td>08:30:28</td>
<td>Alex__Giordano</td>
<td>C'è mancava solo il terremoto di prima mattina</td>
</tr>
<tr>
<td>2014-01-20</td>
<td>08:30:28</td>
<td>__manuhappy</td>
<td>Ha cambiato in modo improvviso che io sto da giorni che trevo per il terremoto</td>
</tr>
<tr>
<td>2014-01-20</td>
<td>08:30:31</td>
<td>rinogargano</td>
<td>Se c'era dormivo, Davvero. #terremoto</td>
</tr>
<tr>
<td>2014-01-20</td>
<td>08:30:35</td>
<td>DavideRocco</td>
<td>Di nuovo terremoto al sud. Confermate? #terremoto</td>
</tr>
<tr>
<td>2014-01-20</td>
<td>08:30:39</td>
<td>Ilfuzz</td>
<td>E con questa scossa, #gennarodauria si conferma il Sommo Veghente del nostro cuore</td>
</tr>
<tr>
<td>2014-01-20</td>
<td>08:30:43</td>
<td>asollazzo98</td>
<td>E come terremoto per la prima volta a scuola. Mi sono messo in paura ye</td>
</tr>
<tr>
<td>2014-01-20</td>
<td>08:30:49</td>
<td>animaesiliata</td>
<td>Come fate a dormire ancora tuttii?? Non vi ha svegliati il #terremoto??</td>
</tr>
<tr>
<td>2014-01-20</td>
<td>08:30:53</td>
<td>Iaccio</td>
<td>Mappa del #terremoto di magnitudo 4.6 <a href="http://t.co/Igw1Mo3VXS">http://t.co/Igw1Mo3VXS</a></td>
</tr>
</tbody>
</table>
#Ferrara pic.twitter.com/UmB5lZWT

Torre di finale emilia sbucciata pic.twitter.com/HmBhHdK"

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

Torre dell'Orologio, #FinaleE. Fa impressione vedere l'orologio spaccato a metà... #Terremoto pic.twitter.com/Y7sJ5gQJ
Red Ronnie

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

06:03 - 20 mag 2012

Retweets
45

Favories
0

davide berti
@dvdberti

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

11:26 - 20 mag 2012

Retweets
37

Favories
2

Kaspo
@kasco

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

0 Retweet
0 Favorito
0 Altre
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