# **Separating Fact from Fear: Tracking Flu Infections on Twitter** Alex Lamb, Michael Paul, Mark Dredze

# Flu Monitoring via Twitter



✓ Intuition: people tweet when they get sick

I've been struck down by some sort of evil flu. Expand < Reply 13 Retweet \* Favorite \*\*\* More

O Can aggregate flu tweets to estimate population rate

O Why? Potential for early outbreak detection

 A number of papers have shown influenza can be accurately tracked in Twitter

 Culotta 2010; Lampos et al 2010; Paul and Dredze 2011; Aramaki et al 2011; Sadilek et al 2012; Doan et al 2012

### Calls to censor details of potential killer flu



### Alison Caldwell

Updated December 22, 2011 08:43:08

The suppression of breakthrough research into deadly bird flu strains has been labelled scientific censorship by some, but others say it is a necessary step to prevent a possible biological attack.

Last month researchers in the Netherlands discovered that the H5N1 influenza virus, or bird flu, could develop into a dangerous virus that can spread between humans.

The H5N1 strain of bird flu is fatal in 60 per cent of human cases but only 350 people have so far died from the disease largely because it cannot be spread by sneezing or coughing.

But by using ferrets in a lab, the researchers proved it was possible to change H5N1 into an aerosol-transmissible virus that can be easily spread rapidly through the air.

March

The H5N1 strain of bird flu is fatal in 60 per cent of human cases

June

NIN

Related Story: Flu scare sparks mass Hong Kong chicken cull Map: United States

May

The genetic mutations could trigger deadly epidemics in humans, and the scientists behind the research have now agreed to remove key details of their work from publication.

April

The research - known as the Erasmus study - alarmed the National Science Advisory Board for Biosecurity (NSABB), a US government science committee.



### Challenges

People tweet about the flu in different contexts

- "Michael Jordan's 'flu game' is on NBATV right now."
- "going over to a friends house to check on her son. he has the flu and i am worried about him"
- Hypothesis: some contexts will predict flu rates better than others
- Approach: use rich features to differentiate these types of tweets

## **Categorization of Flu Tweets**

### ⊘ 3 classifiers:

- O Related vs Unrelated
- O Infection vs Awareness
- ✓ Self vs Others
- Annotations using Mechanical Turk:
  - ⊘ 11,900 tweets each labeled by 3 annotators
  - We discarded low quality annotators (on gold standard)
  - ⊘ We hand-corrected 14% of the labels after majority vote

### Learning and Classification

✓ MaxEnt model, L2 regularization

Ø Features: n-grams + more (next slide)

✓ Two-stage classification:

⊘ 1<sup>st</sup> stage:

⊘ related vs unrelated

⊘ 2<sup>nd</sup> stage ('related' tweets only):

⊘ infection vs awareness

### Features

### ⊘ 8 manually created word classes

| Infection                | getting, got, recovered, have, having, had, has, catching, catch, cured, infected |  |  |
|--------------------------|---|--|--|
| Disease                  | bird, the flu, flu, sick, epidemic  |  |  |
| Concern                  | afraid, worried, scared, fear, worry, nervous, dread, dreaded, terrified          |  |  |
| Treatment/<br>Prevention | vaccine, vaccines, shot, shots, mist, tamiflu, jab,<br>nasal spray                |  |  |
|                          | •••   |  |  |

### Features

**⊘** Stylometry

retweets, user mentions
links/URLs
emoticons (positive or negative)

### Features

- ⊘ Part of Speech templates
  - O (subject,verb,object) tuples
  - o pronoun/noun pairings ("my son has the flu")
  - O whether phrases begin with a verb ("getting the flu")
  - ⊘ numeric references
  - O whether "flu" is a noun or adjective
  - ⊘ and more see paper!

### **Results - Classification**

⊘ F1-score:

- O Related/Unrelated: 0.77
- O Awareness/Infection: 0.80
- ⊘ Self/Others: 0.86
- Feature ablation experiments

O Word class features helped the most for aware./inf.
O Stylometry features helped the most for self/others







### Influenza Surveillance

⊘ 2 data sets from 2009-2010 and 2011-2012

- ✓ Weekly flu rate:

(# flu tweets from US in week) / (# all tweets in week)

Compare to US government weekly estimates

Normalized # hospital admissions for flu symptoms
 source: Centers for Disease Control and Prevention (CDC)
 Metric: Pearson correlation coefficient

### **Results - Influenza**

| Data    | System         | 2009-2010 | 2011-2012 |
|---------|----------------|-----------|-----------|
| Google  | Flu Trends     | .9929     | .8829     |
| Twitter | ATAM           | .9698     | .5131     |
|         | Keywords       | .9771     | .6597     |
|         | All Flu        | .9833     | .7247     |
|         | Infection      | .9897     | .7987     |
|         | Infection+Self | .9752     | .6662     |



### Conclusion

 We showed that we can mine real-world trends through social media feeds

 Even though we are aggregating many tweets, we gained improvements by modeling individual tweets with rich features

Takeaway: deeper content analysis matters!
 Our annotated data will be available soon

### **Thank You**

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human language technology