

# Topic Detection and Tracking

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# Topic Detection and Tracking

Wayne (1997) - *automatic techniques for finding topically related materials in streams of data*

- EMM NewsExplorer
- EMM NewsBrief

## Clustered news for Tuesday, June 4, 2013

Read more...



View with Google Earth

Turkey riot zone [20] ar bg da de es fa fr it nl no pl pt ro ru sl sv sw tr

cnn 3:35:00 PM CEST

Dramatic rescue as river strands truck in China [19] da de es fr it nl pl pt sv sl

telegraph 1:51:00 PM CEST

Dozens of NGO workers, including Americans, sentenced in Egypt [11] ar da de pt sv  
(CNN) -- An Egyptian court sentenced dozens of foreign workers, including several Americans, to prison after they were convicted on charges of illegal foreign funding, Egypt's state news agency reported Tuesday. The defendants received sentences of one to five years, MENA reported Tuesday.  
cnn 12:19:00 PM CEST

### Countries

United States (466)
United Kingdom (111)
China (64)
Syrian Arab Republic (56)
France (55)
India (51)
Mali (41)
Greece (39)
Russian Federation (35)
South Africa (32)
Turkey (31)
Germany (30)
Korea, Democratic
People's Republic Of (29)
Palestinian Territory, Occupied (27)
Japan (26)
Afghanistan (25)
Egypt (22)
Mexico (21)
Singapore (20)
Nigeria (19)
Ethiopia (18)

### People

Barack Obama
Xi Jinping
Recep Tayyip Erdogan
John Kerry
Bashar Assad
Oscar Pistorius
Kamla Persad-Bissessar
Reeva Steenkamp
Osama bin Laden
David Cameron

### This Week's New Stories

Chinese baby cut from 4in sewer will be returned to his mother

**May 28, 2013 - May 31, 2013**  
Armenia assumes chairmanship in the CoE Committee of Ministers with pretentious agenda: Armenia's NA Chairman

**May 31, 2013 - June 3, 2013**  
Judge in 'Blade Runner' Pistorius case warns of 'trial by media'

**May 31, 2013 - June 4, 2013**  
Nigerian MPs ban same-sex marriage

**May 29, 2013 - June 1, 2013**  
11 missing from Mexico City bar

**May 28, 2013 - June 4, 2013**  
BREAKING NEWS: Letters containing poisonous RICIN sent to New York Mayor

Read more...

### This Month's New Stories

Woolwich attack: Latest developments

**May 15, 2013 - June 3, 2013**  
How to help

**May 20, 2013 - June 3, 2013**  
Police hail rescued Ohio women

**May 7, 2013 - May 16, 2013**  
'IRS must apply the law in a fair and impartial way': Obama blasts tax agency

# Terminology

**Story** an article or news broadcast with an underlying focus

**Event** a unique thing that happens at some point in time

**Topic** a set of highly-related events

**Input** a continuous stream of real-time text (stories)

**Output** clusters organized by topic with a leading story

# Terminology



# Subtasks

- Topic Detection
  - 1st story
- Topic Tracking
  - Finding additional stories about a particular topic
  - Clustering

# Feature Selection

**Lexical** Words, Noun Phrases, Named Entities

**Syntactic** POS tagging (nouns, verbs, proper names)

**Semantic** Temporal language cues (verb tense and temporal NPs)(Makkonen and Ahonen-Myka, 2003)

**Metadata** Timestamps

# Similarity Measures and Model Selection

Similarity measures such as TF-IDF and language models such as smoothed Bayes are used to compare documents.

**Vector space** TF-IDF (Carbonell et al., 1999)

**Probabilistic** Chi-square (Swan and Allan, 1999)

**Graph-based** Edge weights from word cooccurrences (Saha and Sindhwani, 2012)

**Language Models** Probability of a story given a topic (Allan et al., 2000)

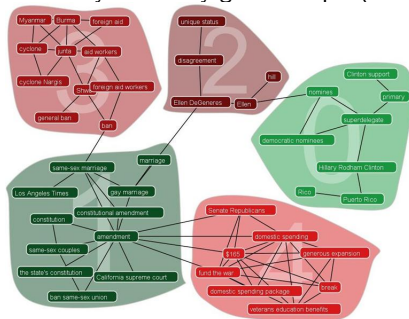
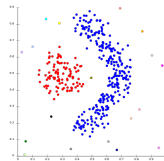
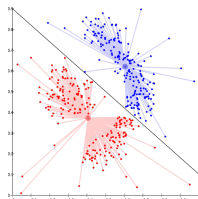


Figure: source: <http://www.cs.umd.edu/~sayyadi/keygraph.html>

# Cluster

Stories are grouped through clustering using distance metrics based on the model (probabilistic, cosine similarity, etc.):

- **K-means:**
  - Selecting small  $k$  with small variance
  - Centroid represents dominant features
- **Hierarchical agglomerative clustering:**
  - Provides a hierarchy of clusters
- **KeyGraph link based clustering:**
  - Network of features and relations
  - Topics are identified using network theory
- **Advanced Techniques:**
  - Latent Dirichlet Allocation (LDA)
  - Non-negative Matrix Factorization (NMF) (Sayyadi et al., 2009)

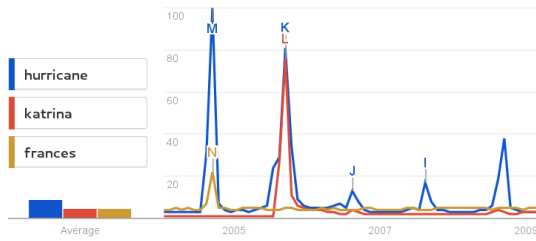




## Examples

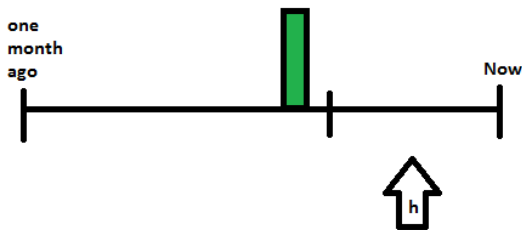
## Time-Span (Swan and Allan, 1999)

- Entities & noun phrases with overlapping time-spans constitute a topic.
- Calculate probabilities of time-span overlap for features if independence is assumed.
- Merge features, which are statistically dependent ( $\chi^2$ ) in terms of doc occurrence.



# Topic Tracking in Tweet Streams (Lin et al., 2011)

- High arrival rate (up to 4000+ tweets per second)
- Foreground model: tracks recent topic counts
  - History of  $h$  events
  - Smoothed with the background model
- Background model: long-term estimates of term distributions
  - Handles sparsity from limited history of foreground model
- Evaluation based off hashtags



# Conclusion

- Topic Detection
- Topic Tracking
- Implementation: Feature  $\rightarrow$  Model  $\rightarrow$  Cluster
- Current Application:
  - EMM
  - Google News

- James Allan, Victor Lavrenko, Daniella Malin, and Russell Swan. Detections, bounds, and timelines: Umass and tdt-3, URL <http://maroo.cs.umass.edu/pdf/IR-201.pdf>.
- Jaime Carbonell, Yiming Yang, John Lafferty, Ralf D Brown, Tom Pierce, and Xin Liu. Cmu report on tdt-2: Segmentation, detection and tracking, URL [http://www.cs.cmu.edu/afs/cs.cmu.edu/Web/People/jgc/publication/CMU\\_Approach\\_TDT\\_Segmentation\\_DARPA\\_1999.pdf](http://www.cs.cmu.edu/afs/cs.cmu.edu/Web/People/jgc/publication/CMU_Approach_TDT_Segmentation_DARPA_1999.pdf).
- Jimmy Lin, Rion Snow, and William Morgan. Smoothing techniques for adaptive online language models: topic tracking in tweet streams, URL <http://doi.acm.org/10.1145/2020408.2020476>.
- Juha Makkonen and Helena Ahonen-Myka. edition, URL [http://dx.doi.org/10.1007/978-3-540-45175-4\\_36](http://dx.doi.org/10.1007/978-3-540-45175-4_36).

Ankan Saha and Vikas Sindhwani. Learning evolving and emerging topics in social media: A dynamic nmf approach with temporal regularization, URL <http://people.cs.uchicago.edu/~ankans/Papers/wsdm227-saha.pdf>.

Hassan Sayyadi, Matthew Hurst, and Alexey Maykov. Event detection and tracking in social streams, URL [http://www.cs.umd.edu/~sayyadi/files/papers/9-sayyadi-EventDetection\\_KeyGraph\\_ICWSM09.pdf](http://www.cs.umd.edu/~sayyadi/files/papers/9-sayyadi-EventDetection_KeyGraph_ICWSM09.pdf).

Russell Swan and James Allan. Extracting significant time varying features from text, URL <http://doi.acm.org/10.1145/319950.319956>.