Detecting Sentiment Change in Twitter Streaming Data

Albert Bifet, Geoff Holmes, Bernhard Pfahringer and Ricard Gavaldà

University of Waikato
Hamilton, New Zealand

Laboratory for Relational Algorithmics, Complexity and Learning **LARCA**
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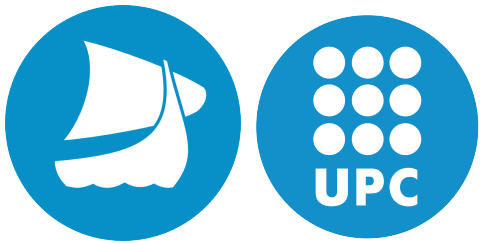

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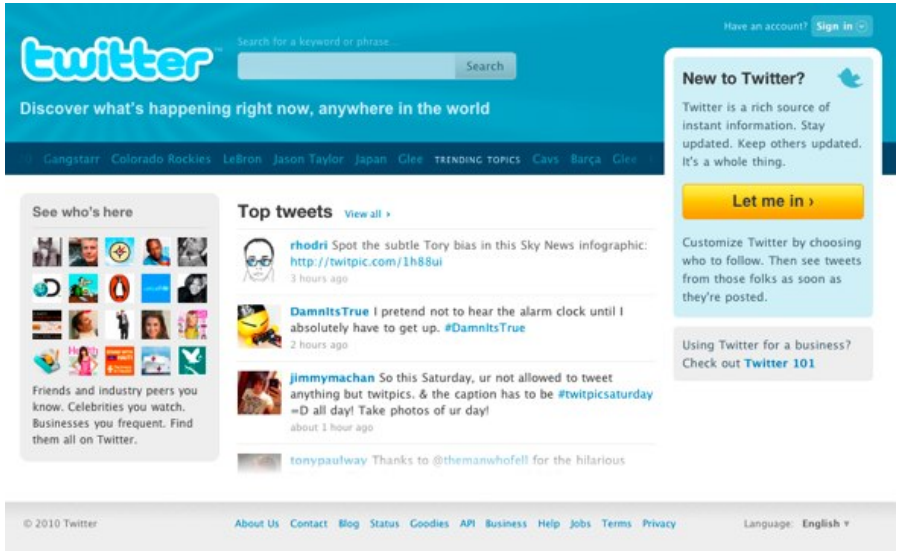

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Twitter is a micro-blogging service built to discover what is happening **now** anywhere

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Problem: How to analyze Twitter data on real time

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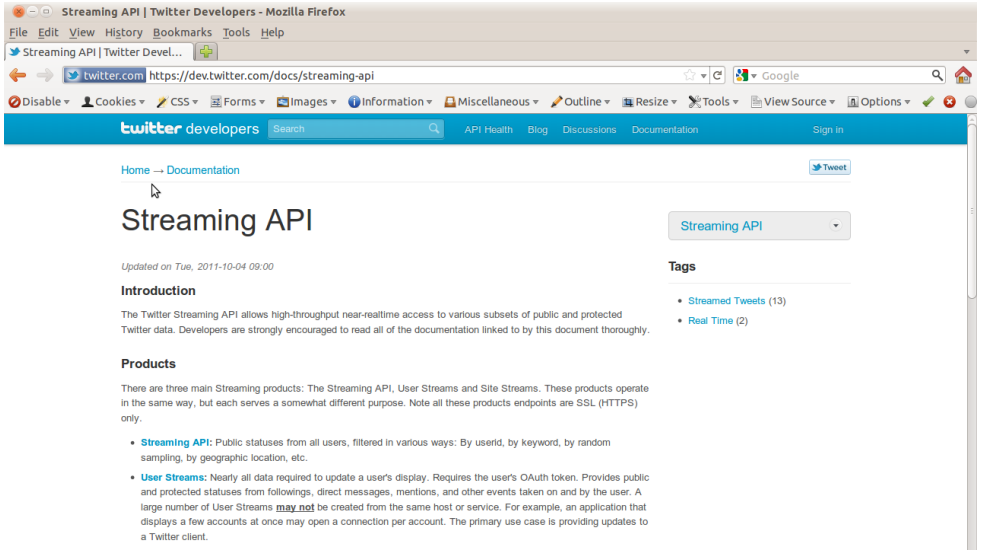

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Twitter Streaming API: API for accessing Twitter in real-time

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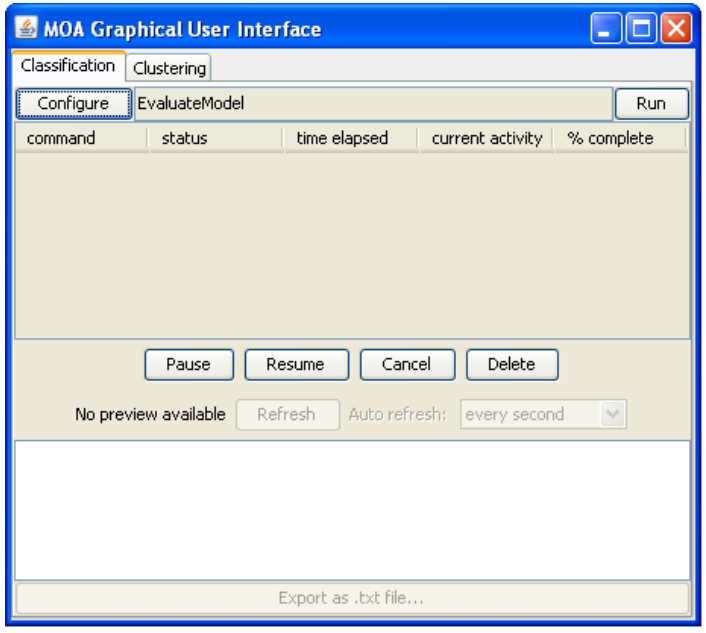

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MOA is an open source project for data stream mining, for analyzing big data on real time

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Sentiment analysis: analyze tweets with positive :) or negative :(tweets

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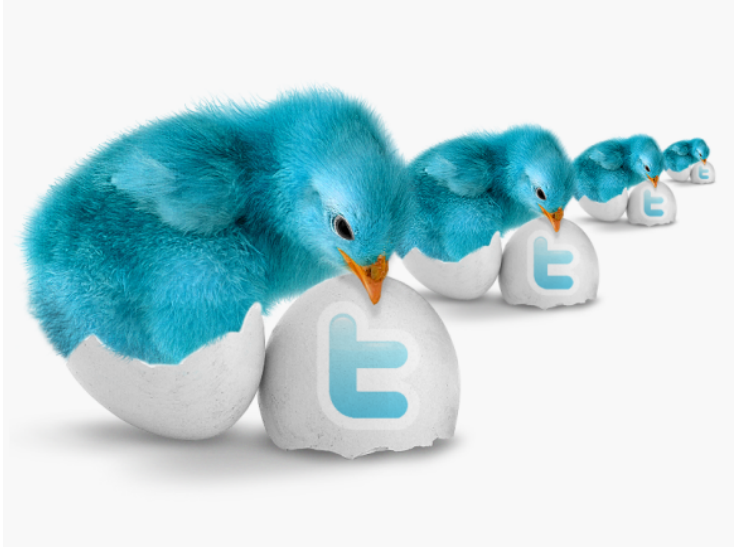

Problem: We need to convert tweet texts in sparse vector of features on real-time

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Real-time means (i) change adaption
(ii) fast: can not store tweets on memory

MOA-TweetReader

Solution: MOA-TweetReader, a package to connect MOA with Twitter

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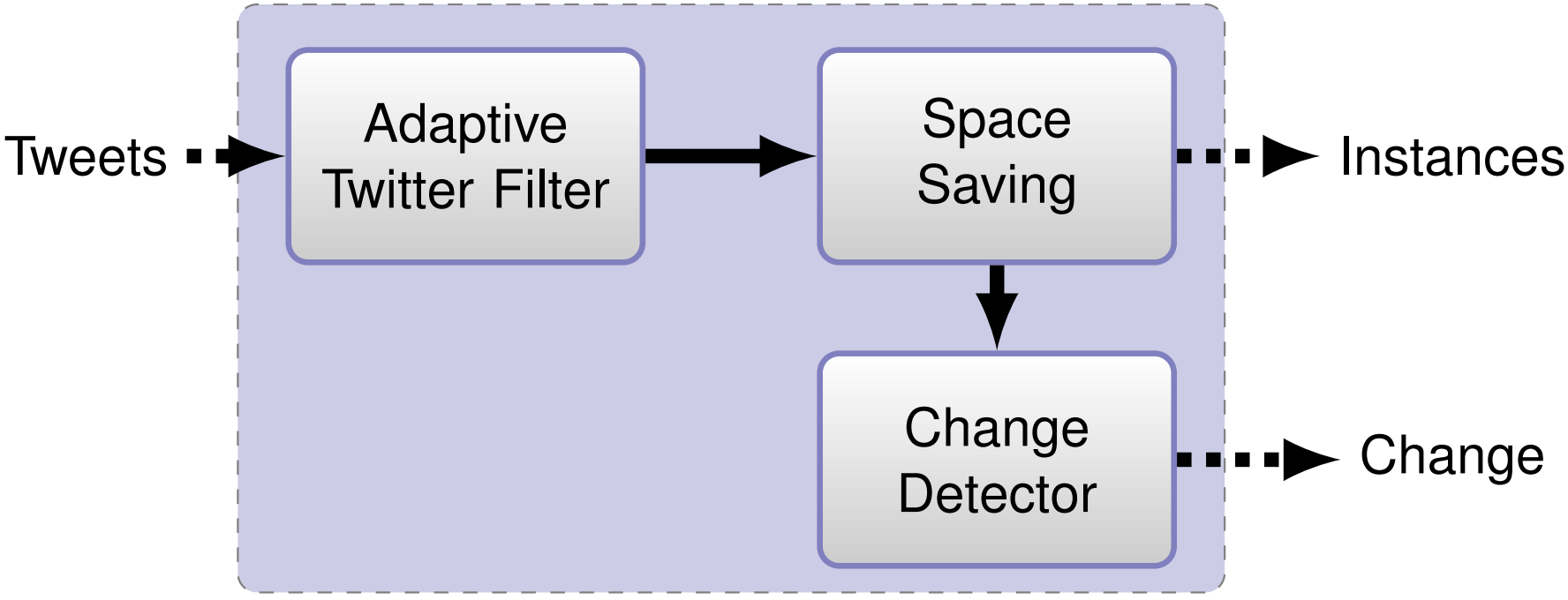

MOA-TweetReader consists in (i) Adaptive Twitter filter (ii)Frequent item miner (iii) Change Detector

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$$f_{i,j} = \frac{\text{freq}_{i,j}}{\sum_\ell \text{freq}_{\ell,j}} \quad \text{(number of times a word appears in the document)}$$

$$idf_i = \log \frac{N}{n_i} \quad \text{(inverse frequency of the word in the corpus)}$$

$$w_{i,q} = f_{i,j} \cdot idf_i$$

MOA-TweetReader Adaptive Twitter filter: online tf-idf

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SPACE SAVING (METWALLY ET AL.)

```
1   T ← ∅
2   for every term i
3       do if i ∈ T
4           then freq[i] ← freq[i] +1
5           else if |T| < k
6                   then ▷ Add a new item
7                        T ← T ∪ {i}
8                        freq[i] ← 1
9                   else ▷ Replace the item with lower freq.
10                       j ← arg min_{j∈T} freq[j]
11                       T ← T ∪ {i} \ {j}
12                       freq[j] ← freq[j] +1
```

MOA-TWEETREADER Frequent item miner :
SPACE SAVING

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SPACE SAVING (METWALLY ET AL.)

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```

SPACE SAVING is the frequent item algorithm for streams with best performance results

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SPACE SAVING EXPONENTIALLY DECAYED (CORMODE ET AL)

```
1  T ← ∅
2  for every term i with timestamp t_i
3       do if i ∈ T
4            then freq[i] ← freq[i] + exp(λ t_i)
5            else if |T| < k
6                 then ▷ Add a new item
7                      T ← T ∪ {i}
8                      freq[i] ← 1
9                 else ▷ Replace the item with lower freq.
10                     j ← arg min_{j∈T} freq[j]
11                     T ← T ∪ {i} \ {j}
12                     freq[j] ← freq[j] + exp(λ t_i)
```

Improvement to SPACE SAVING: space saving with exponential decay, or using ADWIN

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ADWIN: ADAPTIVE WINDOWING ALGORITHM

1 Initialize Window W
2 **for** each $t > 0$
3 **do** $W \leftarrow W \cup \{x_t\}$ (i.e., add x_t to the head of W)
4 **repeat** Drop elements from the tail of W
5 **until** $|\hat{\mu}_{W_0} - \hat{\mu}_{W_1}| < \varepsilon_c$ holds
6 for every split of W into $W = W_0 \cdot W_1$
7 output $\hat{\mu}_W$

Improvement to SPACE SAVING: space saving with exponential decay, or using ADWIN

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SPACE SAVING ADWIN

```
1   T ← ∅
2   for every term i with timestamp t_i
3       do if i ∈ T
4           then  Insert 1 into ADWIN[i] and 0 to other ADWINs
5           else if |T| < k
6                   then ▷ Add a new item
7                        T ← T ∪ {i}
8                        Init ADWIN[i]
9                        Insert 1 into ADWIN[i] and 0 to other ADWINs
10                  else ▷ Replace the item with lower freq.
11                       j ← arg min_{j∈T} freq[j]
12                       T ← T ∪ {i} \ {j}
13                       Insert 1 into ADWIN[j] and 0 to other ADWINs
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Improvement to SPACE SAVING: space saving with exponential decay, or using ADWIN

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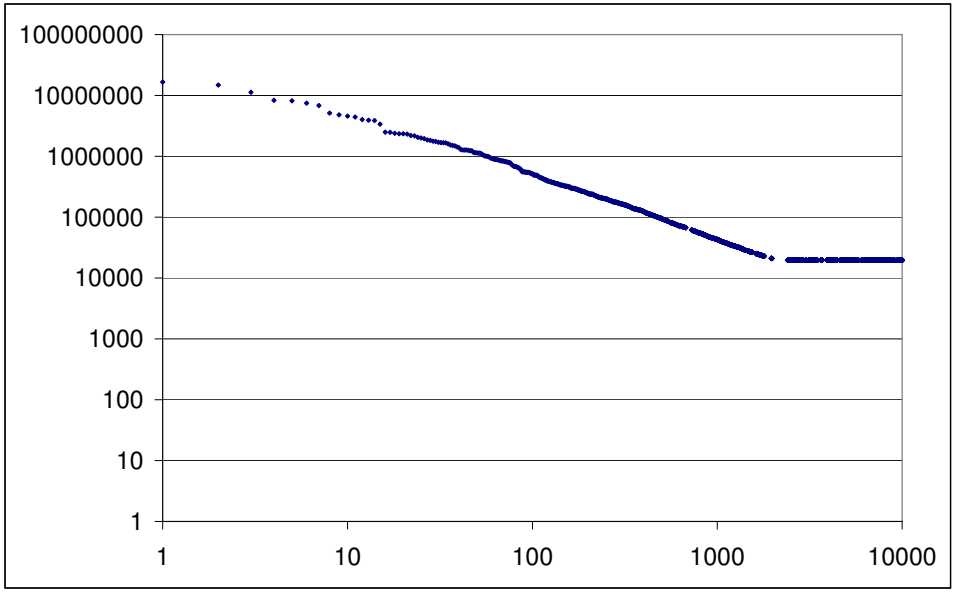

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Experiments: Frequency and ranking of twitter data follows a Zipf distribution

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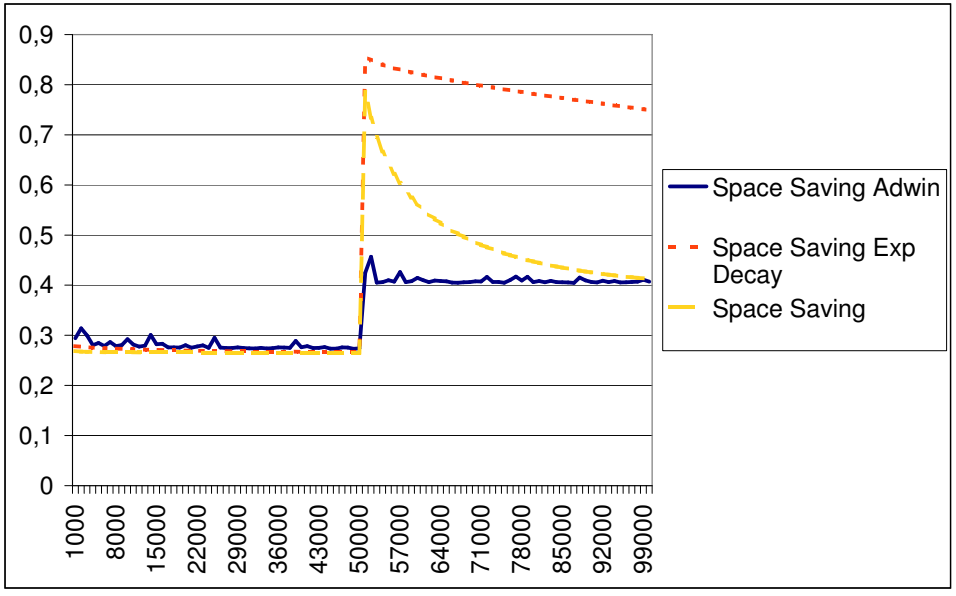

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SPACE SAVING ADWIN is able to adapt automatically

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Toyota crisis: during end of 2009 and beginning of 2010 Toyota had problems with accelerator pedals and had to recall millions of cars

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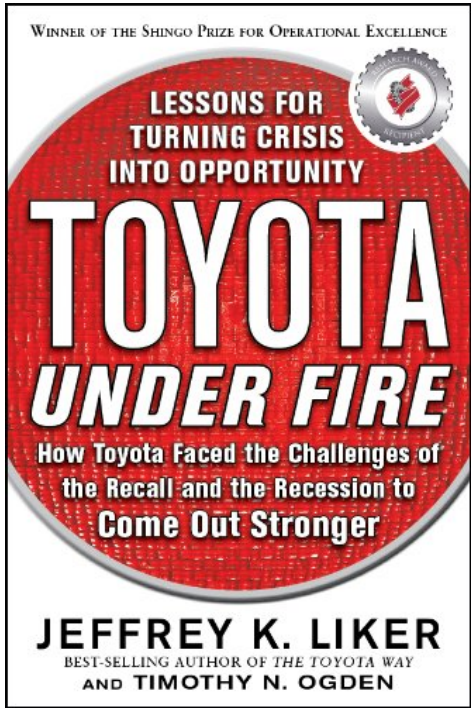

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Recommended reading “Toyota under fire”

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There was a gap between the time that our U.S. colleagues realised that this was an urgent situation and the time that we realised here in Japan that there was as urgent situation going on in the U.S. It took ***three months*** *for us to recognise that this had turned into a crisis. In Japan, unfortunately, until the middle of January we did not think that this was really a crisis.*

Akio Toyoda

Recommended reading “Toyota under fire”

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Term	Before	After	Diff
gas	0.122	0.484	0.363
pedals	0.129	0.438	0.309
wonder	0.017	0.214	0.198
problem	0.163	0.357	0.194
good	0.016	0.205	0.190
recalling	0.012	0.106	0.095
gm	0.011	0.089	0.077
#heard_on_the_street	0.040	0.113	0.072
social	0.031	0.099	0.068
sticking	0.070	0.125	0.055
fix	0.026	0.076	0.050
popularity	0.016	0.037	0.021
love	0.017	0.024	0.008

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Following twitter data sentiment, and changes in MOA-TweetReader it is possible to know faster when problem starts

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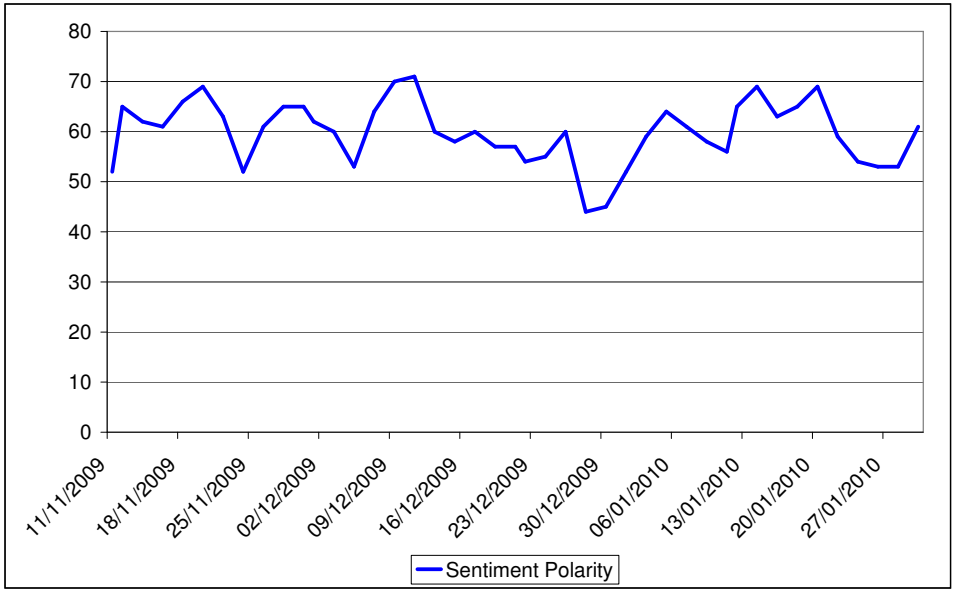

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A tool like MOA-TweetReader would have helped Toyota to understand the crisis sooner and to respond more appropiately

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CONCLUSIONS. Our goal: how to do real time analysis of twitter data. Our proposal: MOA-TweetReader