

Joint Graphical Models in Timeline Summarization

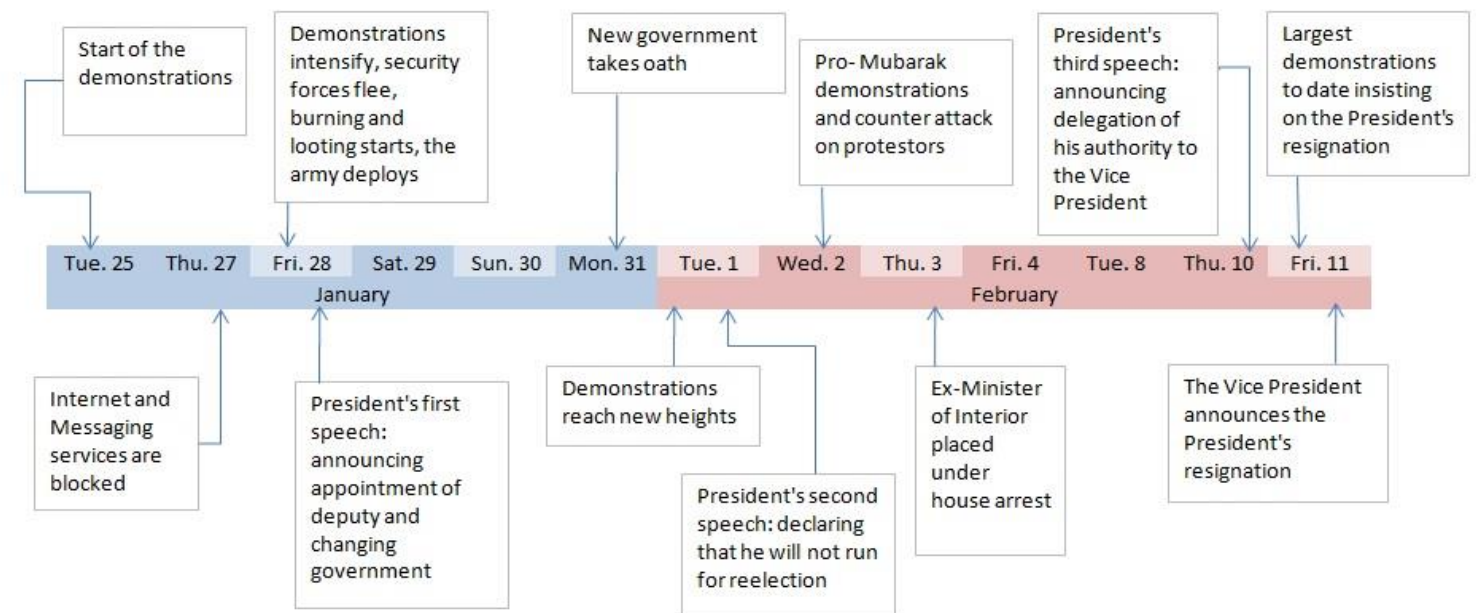
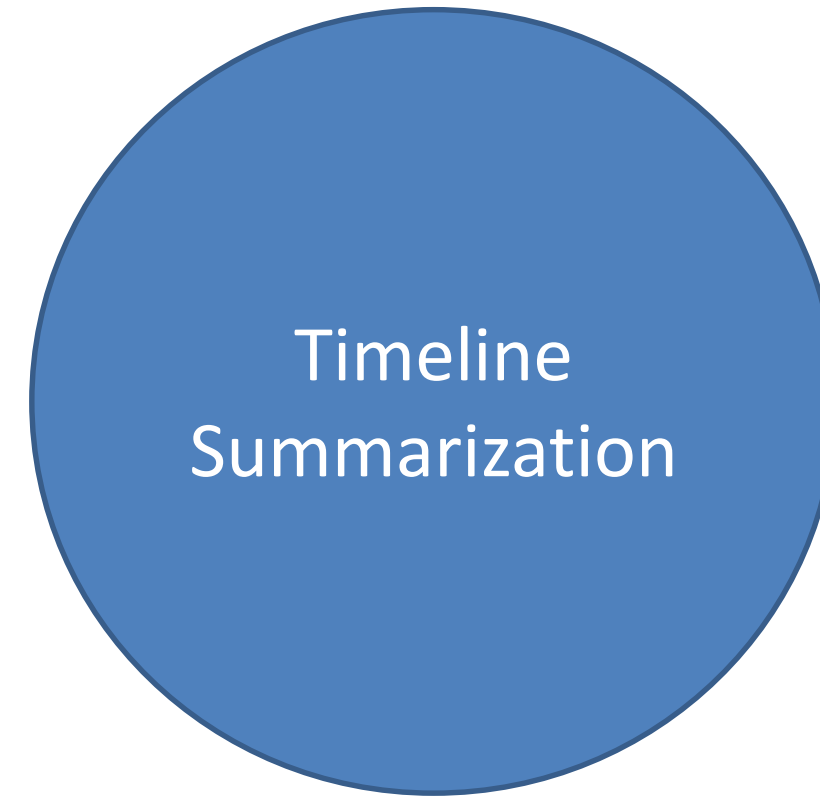
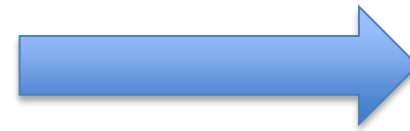
- ◆ **Giang Tran**, ◆ **Eelco Herder**,
- ❖ ◆ **Katja Markert**, ◆ **Mohammad Alrifai**
- ◆ **L3S Research Center & University of Hannover, Germany**
 - ❖ **School of Computing, University of Leeds**



Summarization of an ongoing event



Arab Spring



from Wikipedia, the free encyclopedia

This article may be **too long to read and navigate comfortably**. Please consider **splitting** content into sub-articles or **condensing** it. (November 2013)

The **Syrian Civil War**, also known as the **Syrian Uprising**,^[72] is an armed conflict in **Syria** between forces loyal to the **Ba'ath** government, which took power in 1963, and those seeking to oust it. The unrest started as a civil uprising that were part of the wider North African and Middle Eastern protest movements known as the **Arab Spring**, with Syrian protesters at first demanding democratic and economic reform within the framework of the existing government. The uprising began with protests in March 2011 in **Daraa**, but a violent response from the government and subsequent clashes left dozens of opposition protesters and at least





How to make a timeline summary

AP

2011-01-25
 2011-01-26
 2011-01-27
 2011-01-28
 2011-01-29
 2011-01-30
 2011-01-31
 2011-02-01
 2011-02-02
 2011-02-03
 2011-02-04
 2011-02-05
 2011-02-06
 2011-02-07
 2011-02-08
 ...
 2012-04-20
 2012-04-21
 2012-04-22

 2013-07-01
 2013-07-02
 2013-07-03

Date Selection

ACL 2015



a1) 2011-01-25

Egyptians hold nationwide demonstrations against the authoritarian rule of Hosni Mubarak, who has led the country for nearly three decades.

a2) 2011-01-26

A large security force moves into Cairo's Tahrir Square

a3) 2011-01-28

Protesters burn down the ruling party's headquarters, and the military is deployed.

a4) 2011-02-11

Mubarak steps down and turns power over to the military.

a5) 2011-03-19

In the first post Mubarak vote, Egyptians cast ballots on constitutional amendments ..., including scheduling the first parliamentary and presidential elections

(a8) 2012-04-20

The presidential campaign officially begins.

(a10) 2012-06-24

Election officials declare Morsi the winner

a26) 2013-07-03

Egypt's military chief says Morsi has been replaced by Adly Mansour, the chief justice of constitutional court.

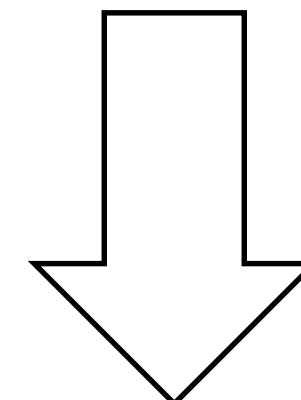
Daily Summarization

ECIR 2015

Problem Setup



From T1
To T2



Input:

1. Set of dates within given $[T1, T2]$ time range
2. A news corpus about one ongoing event
3. N – the number of dates in the timeline

Output:

- Ranked list of top N dates
(to be selected into a timeline)

Existing approaches

Kessler et al. (ACL 2012), Tran et al. (WWW 2013)

Supervised Machine Learning with date feature extraction

- Published documents/sentences
- Frequency of date references....

- Relevance score of the date by Lucene (max, average)
- Date distance from returned answers....

Dates are scored individually

Timeline Summary as A Set of Substories

**There are
Substories**

(a1) 2011-01-25

Egyptians hold nationwide demonstrations against the authoritarian rule of Hosni Mubarak, who has led the country for nearly three decades.

(a2) 2011-01-26

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(a3) 2011-01-28

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AP

Assumption

◆ *Events are related*

➤ ... A substory happens as a chain of (strongly) related events



◆ *Joint modeling may work better than scoring dates individually*

◆ *Substories are reflected in date references*

- **Simplification:** Date references are a proxy for relations among events

- On **January 25**, an uprising of Egyptians erupted calling for Mubaraks resignation as president. Protests continued to grow . . .
- (CBS Detroit, **2011-02-11**)

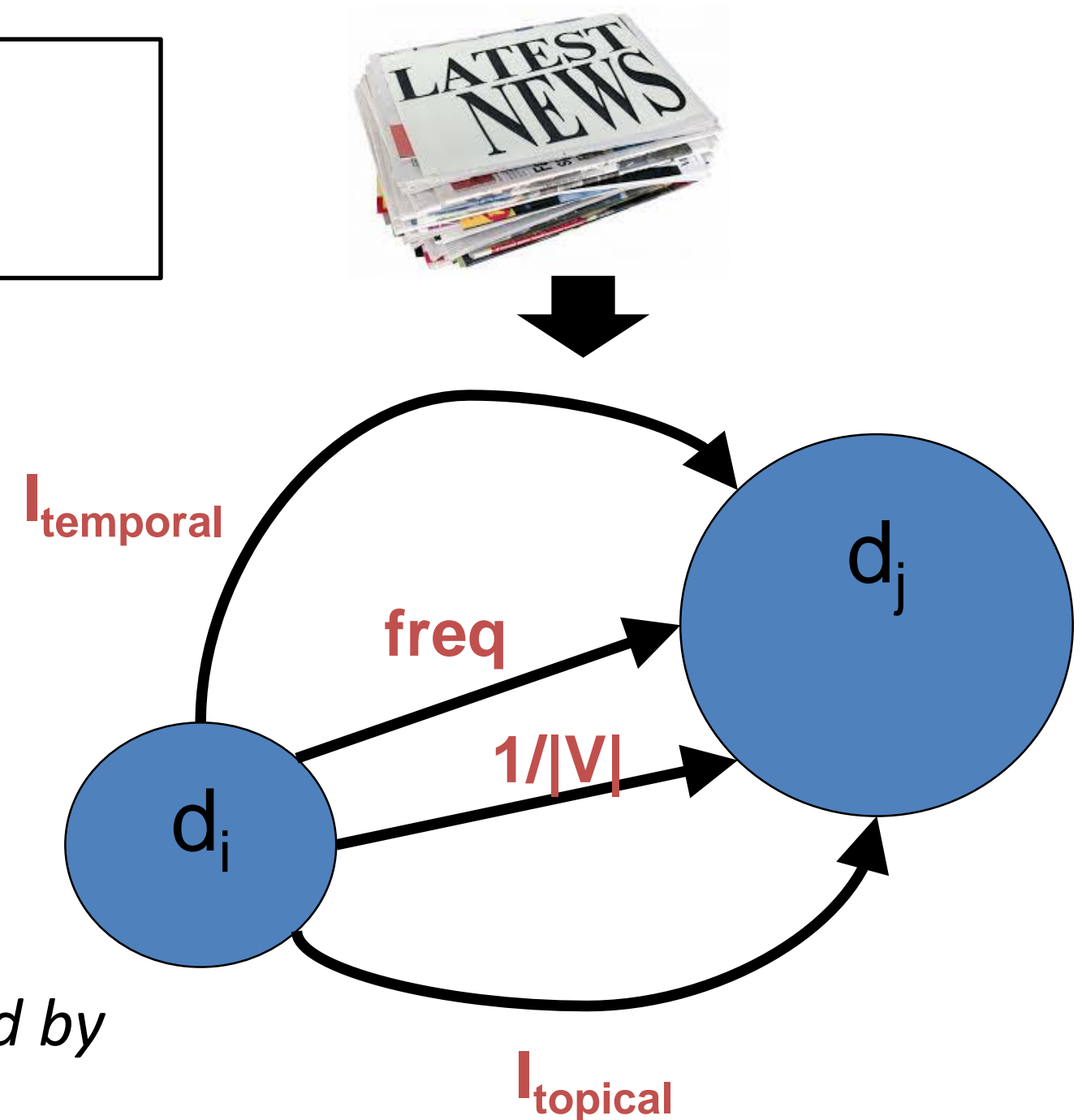
Our Approach: Influence-based Random Walk Model

Modeling date references
 by Date Reference Graph (DRG)

DRG is a *Multiplex graph of dates*

$e(d_i, d_j)$ d_i refers to d_j

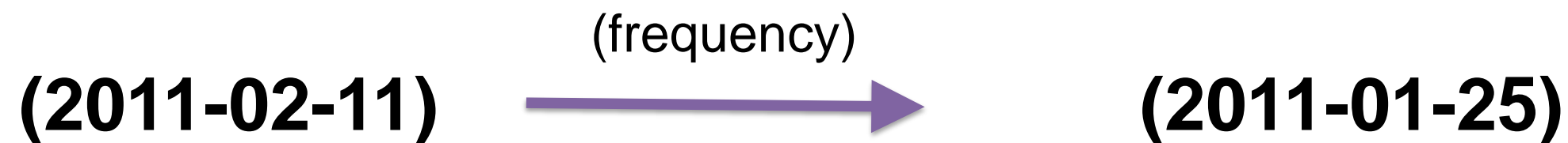
- $1/|V|$: uniform transitional probability
- $\text{Freq}(d_i, d_j)$: how frequently d_j is mentioned by documents in d_i
- $I_{\text{topical}}(d_i, d_j)$: topical influence of d_j on d_i
- $I_{\text{temporal}}(d_i, d_j)$: temporal influence of d_j on d_i



Frequency of references: $\text{freq}(d_i, d_j)$

Intuition:

- Important dates are referred to from future dates
- More references \rightarrow More important



- On **January 25**, an uprising of Egyptians erupted calling for Mubaraks resignation as president. Protests continued to grow . . .
(CBS Detroit, 2011-02-11)

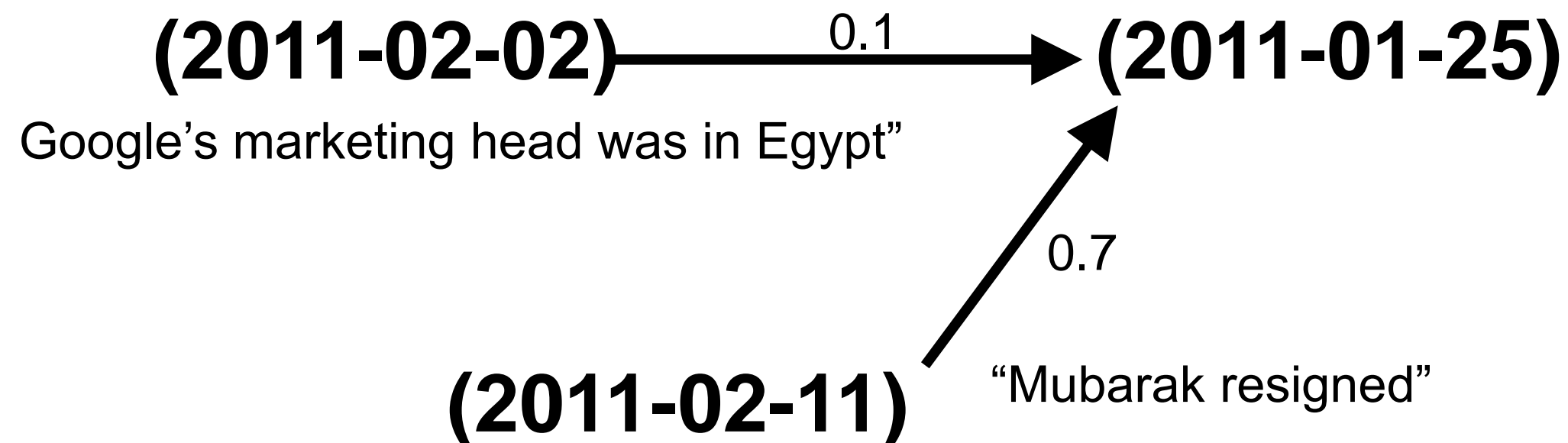
Topical Influence: $I_{\text{topical}}(d_i, d_j)$

Intuition:

References from topical sentences are more important

Mr Ghonim is Google's head of marketing for Middle East and North Africa and was in Egypt when the protests started on **Jan 25**

(DailyMail, 2011-02-02).



On **January 25**, an uprising of Egyptians erupted calling for Mubaraks resignation as president. Protests continued to grow . . .

(CBS Detroit, 2011-02-11)

Topical Influence

Compute on whole set of documents

Query (set of keywords)
by TextRank algorithm

$$I_{\max \text{ topical}}(d_i, d_j) = \max_{s_{ij} \in \mathcal{S}_{i \rightarrow j}} \text{BM25}(s_{ij}, Q)$$

$$I_{\text{freq*topical}}(d_i, d_j) = \sum_{s_{ij} \in \mathcal{S}_{i \rightarrow j}} \text{BM25}(s_{ij}, Q)$$

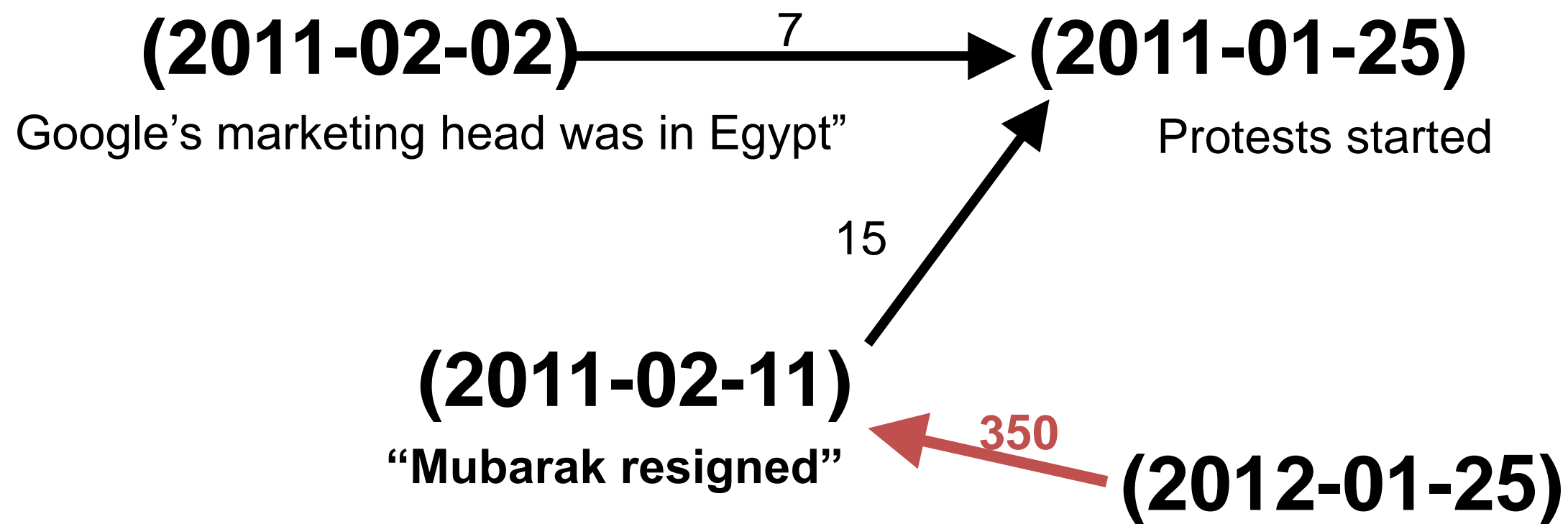
Set of sentences on d_i
but refers to d_j

Frequency can be integrated into *topical influence*

Temporal Influence: $I_{\text{temporal}}(d_i, d_j)$

Intuition:

Important events are more often referred to over long time frames



Military generals took over power from Mubarak when he stepped down on **February 11** last year.

(Daily Mail, 2012-01-25).

Temporal Influence

$$I_{|temporal|}(d_i, d_j) = \Delta t = |d_i - d_j|$$

$$I_{freq*temporal}(d_i, d_j) = freq(d_i, d_j) \cdot |d_i - d_j|$$

Again, **frequency** can be integrated into *temporal influence*

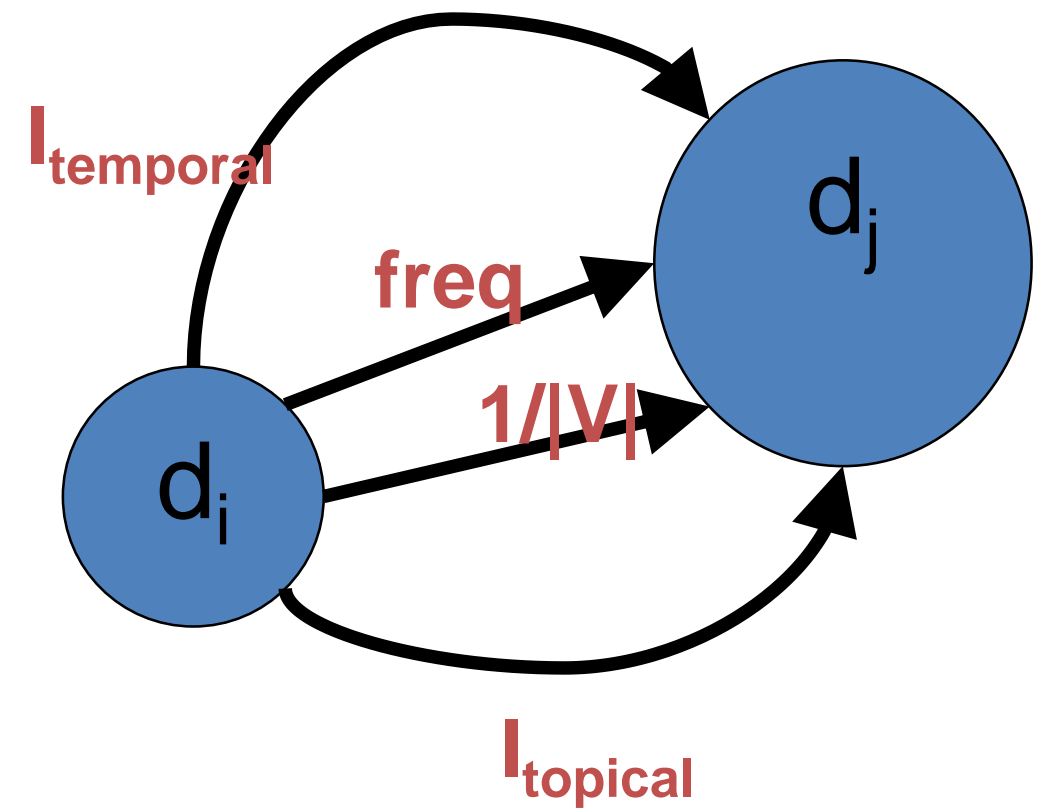
Putting things together: IRW

$$x_t(j) = \alpha \sum_{i \in L_j^-} M_{ij} x_{t-1}(i) + (1 - \alpha)v_j,$$

$$x_t(j) = \alpha \sum_{i \in L_j^-} \mathcal{I}(i, j) \cdot M_{ij} \cdot x_{t-1}(i) + (1 - \alpha)v_j$$

Convergence proof
 in the paper

$\mathcal{I}(i, j)$: Influence between (d_i, d_j)
 M_{ij} : Stochastic Transitional Probability (d_i, d_j)



Multiplex IRW

Different combinations of *freq*, $I_{temporal}$, $I_{topical}$

$$\begin{aligned}
 x_t(j) = & \alpha\omega \sum_{i \in L_j^-} W_1(i, j) \cdot M_{ij} \cdot x_{t-1}(i) \\
 & + \alpha(1 - \omega) \sum_{i \in L_j^-} W_2(i, j) \cdot M_{ij} \cdot x_{t-1}(i) \\
 & + (1 - \alpha)v_j
 \end{aligned}$$

W(i,j) is normalized value of I(i,j)

Unsupervised model

- $\omega = 0$: Only temporal influence
- $\omega = 1$: Only topical influence

With and without Frequency

Supervised model

ω is learnt automatically

Dataset

News articles

Story	Time Range	#News
Egypt	2011/01/11 - 2013/11/10	3869
Libya	2011/02/16 - 2013/07/18	3994
Syria	2011/11/17 - 2013/07/26	4071
Yemen	2011/01/15 - 2013/07/25	3600

GroundTruth Timelines from major news agencies

Note:

Strict Setting: dates appear in *at least 2 ground-truth timelines*

Relaxed Setting: dates appear in *at least 1 ground-truth timeline*

Relaxed Setting

Strict Setting

Input
Time range

Story	#TL	#atLeastOnce	#atLeastTwice	avgL		Time Range	#dates
Egypt	4	122	18	36		2011/01/01 - 2013/07/07	918
Libya	7	118	56	34		2011/02/14 - 2011/11/22	281
Syria	5	106	17	60		2011/03/15 - 2013/07/06	844
Yemen	5	81	26	24		2011/01/22 - 2012/02/27	401

Evaluation

Baselines

System	strict setting				relaxed-setting			
	MAP@5	MAP@10	MAP@15	MAP@20	MAP@5	MAP@10	MAP@15	MAP@20
Document Frequency	0.312	0.303	0.299	0.299	0.509	0.550	0.564	0.560
MaxLength	0.349	0.335	0.311	0.287	0.647	0.594	0.566	0.533
Date Frequency	0.555	0.498	0.457	0.427	0.597	0.626	0.625	0.613

Existing Supervised Models

(Kessler et al., 2012)	0.567	0.546	0.519	0.491	0.790	0.740	0.723	0.704
(Kessler et al., 2012) (Pub)	0.701	0.620	0.571	0.524	0.912	0.807	0.759	0.731
(Tran et al., 2013a)	0.668	0.565	0.522	0.488	0.740	0.717	0.700	0.673
(Tran et al., 2013a) (Pub)	0.710	0.601	0.551	0.506	0.792	0.771	0.746	0.716

Our Unsupervised Models

IRW_{freq}	0.646	0.535	0.471	0.431	0.861	0.770	0.711	0.687
$IRW_{max\ topical}$	0.763	0.647	0.564	0.510	0.887	0.794	0.724	0.685
$IRW_{freq*topical}$	0.737	0.576	0.498	0.448	0.945	0.836	0.762	0.709
$IRW_{ temporal }$	0.724	0.587	0.522	0.484	0.699	0.597	0.570	0.564
$IRW_{freq*temporal}$	0.724	0.588	0.527	0.486	0.712	0.622	0.581	0.559

Our Supervised Models

$IRW_{max\ topical+freq*temporal}$	0.879	0.760	0.658	0.587	0.897	0.842	0.775	0.730
$IRW_{freq*topical+ temporal }$	0.818	0.677	0.596	0.536	0.928	0.866	0.801	0.745

First Conclusion

- ◆ Events often consist of several substories and related subevents, leading to references between dates
- ◆ Influence-based random walk on multiplex date reference graph
 1. *temporal references*
 2. *topical references*
 3. *frequency of references*
- ◆ Unsupervised version rivals (supervised) state-of-the-art
- ◆ Supervised version improves state-of-the-art

Joint scoring of dates improves date selection for timelines



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Here

Daily Summarization

ECIR 2015

Daily Summary Generation Challenges

- ***Select and represent*** most important events of a date?
 - Summarization techniques
 - Select relevant sentences from news articles' content
- Hard to select good sentences from ~100 news articles
- **Not easy to represent a daily summary**

Challenges

Good representation = *good understandability*

– Meaningful representation of selected sentences?

*(A.1) It will end as soon as the people vote on a constitution, **he** told state television...*

*(A.2) ...**President Mohamed Mursi** hopes will help to end a crisis..."*

Cross-document co-reference resolution is not easy

Example

(B.1) On Wednesday , two protesters were killed Aden , a southern port city.....

(B.2) On Thursday , dozens of people were reportedly injured in clashes.....

Time resolutions: even more challenging when no temporal expressions

Another example

-
- *(C.1) Anti-government protesters in Yemen have resumed demonstrations to try to force Ali Abdullah Saleh, the president, to quit,*
(C.2) The students, some of whom were also armed with batons, responded

Content In-coherence among sentences

Sentence ordering / Coherence measurement is challenging enough ...

Why not headlines?

-Meaningful, timely, self-contained information

-Short, comprehensive

...

- **2011-01-25**

- Antigovernment protests rock Egypt.
- Egyptian youth mobilise via the internet.

- **2012-05-23**

- Egyptians vote in first free presidential election.
- Egypt Election 2012: Policeman shot dead outside Cairo polling station

Technical Challenges

Selection of relevant headlines! Not an easy task

- Many headlines are about comments, reviews, ...
 - *Why Libya is not another Suez... or Iraq*
 - *John Graham: Egypt - A Time for Heroes*
- Many are not about major events of the date
 - *Egypt's government must work for its people*
 - *Israel could learn from the Egyptian syndrome*
 - *Washington has few strings to pull in Egyptian crisis*

Our solution

- **Many headlines are about comments, reviews, ...**
 - Informing headline detection
 - Machine learning model with linguistic features & trained on **WikiTimes corpus** - collection of highlighted events*
- **Many are not about major events of the date**
 - Spread aspect: major events spread around the world
 - **HuffingtonPost:** *Mubarak Steps Down Tahrir Square , Egypt Erupts In Cheers.*
 - **TheGuardian:** *Hosni Mubarak resigns and Egypt celebrates a new dawn.*
 - **CNN:** *Egypt's Mubarak resigns after 30-year rule.*
 - **NBC:** *'Egypt is free,'crowds cheer after Mubarak quits.*

Our solution (cont.)

– *Influence aspect: major events are influential to what will happen in the future*

- *The euphoria sparked by **Mubarak 's resignation on Feb. 11** has given way to mistrust and recrimination....*
- *Many Egyptians are angry at the slow pace of change since **President Hosni Mubarak resigned on February 11** after protests . . .*
- *Neighborhood residents point to small ways life has changed **since Mubarak stepped down on Feb. 11** . Some said police no longer stop them to demand cash .*

$$I(h)_u = \sum_{w \in h} p(w|\theta(h)) * p(w|\theta(\mathcal{E}_{V \rightarrow u}))$$

Influence-based Ranking

Random Walk model on duplication graph of headlines
Prioritizing headlines to their influences

$$R(j) = d \sum_i \frac{p_{ij}}{\sum_k p_{ik}} * R(i) + (1 - d) * \frac{I(h_j)}{\max_{h \in H} I(h)}$$

Selection of c headlines for summaries

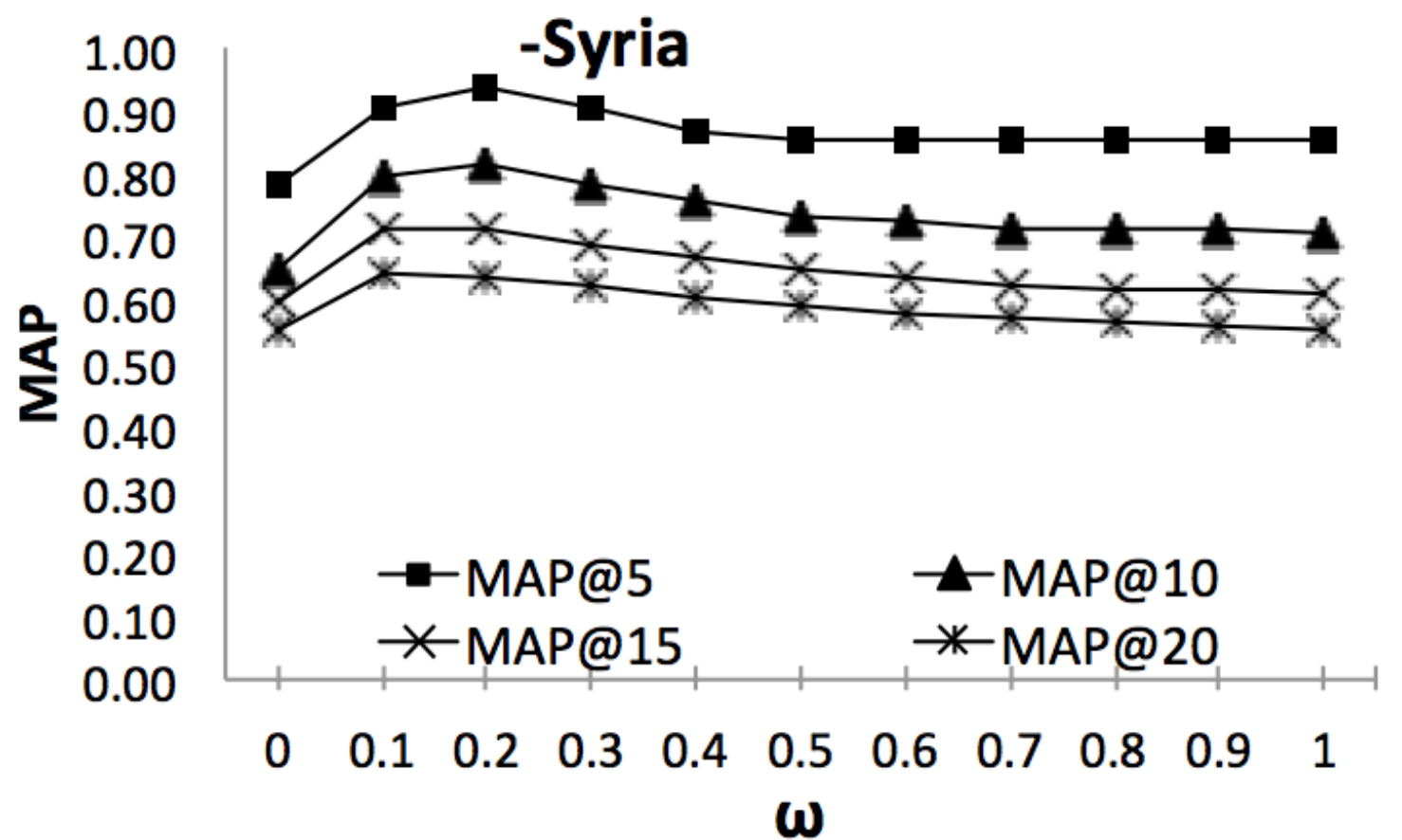
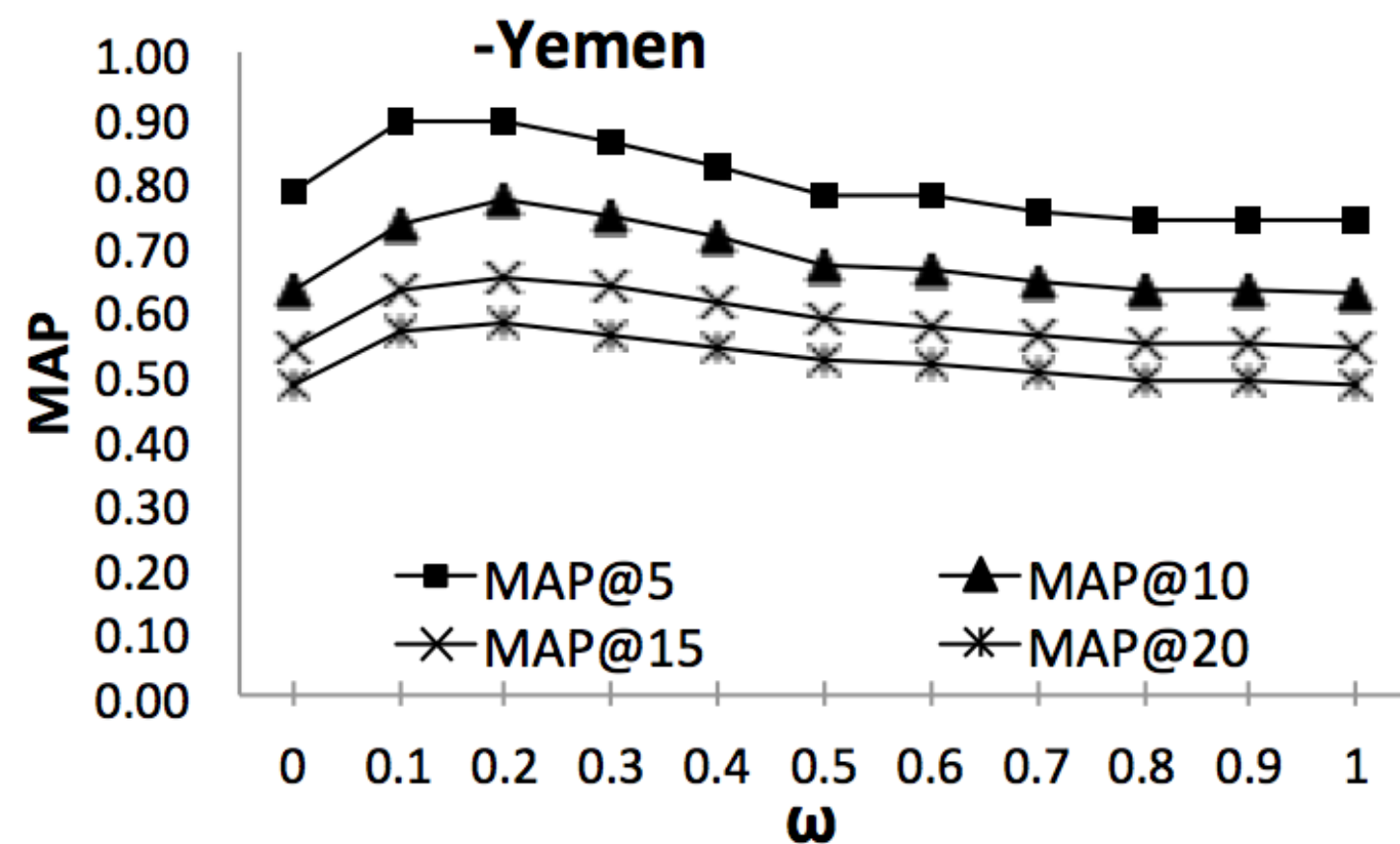
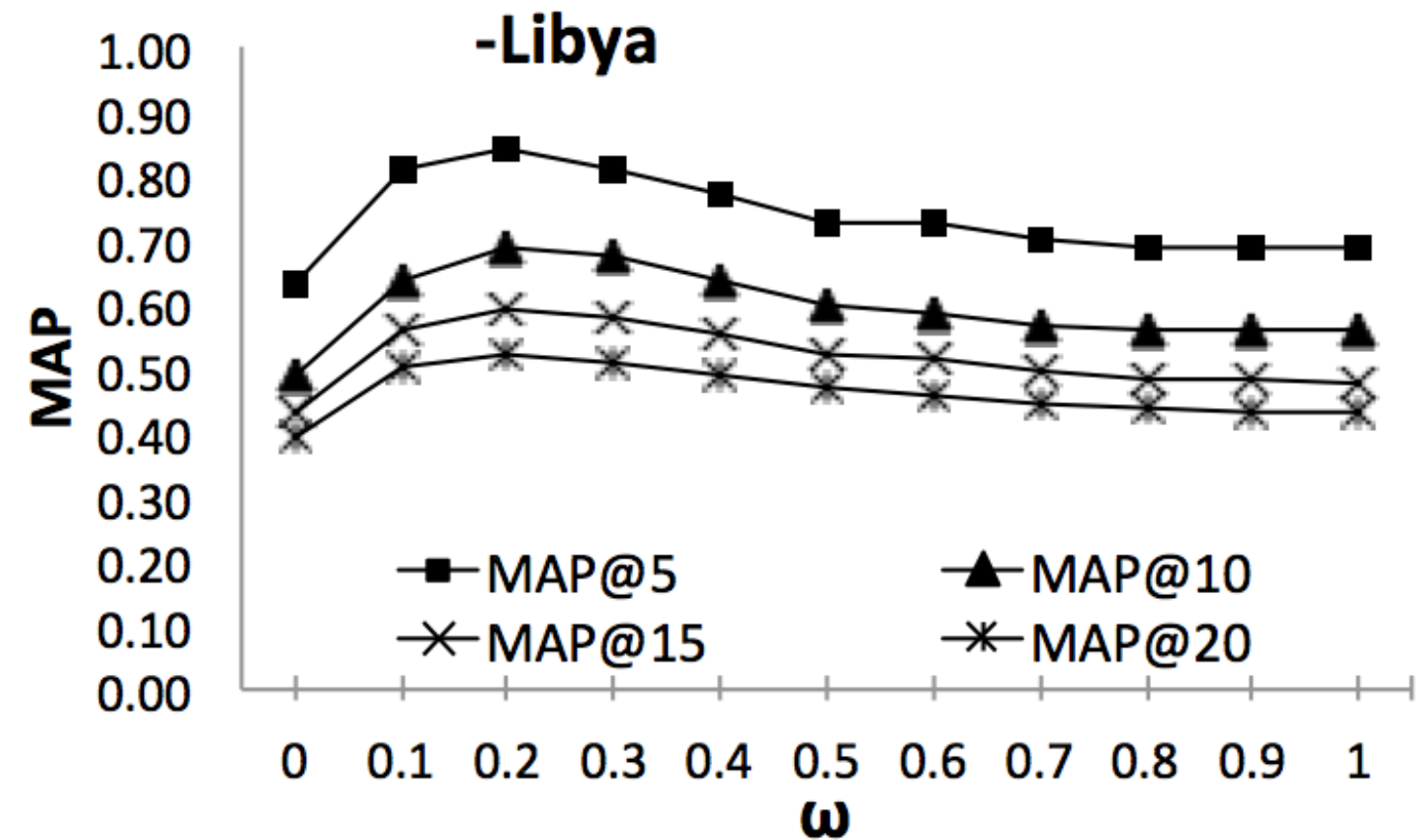
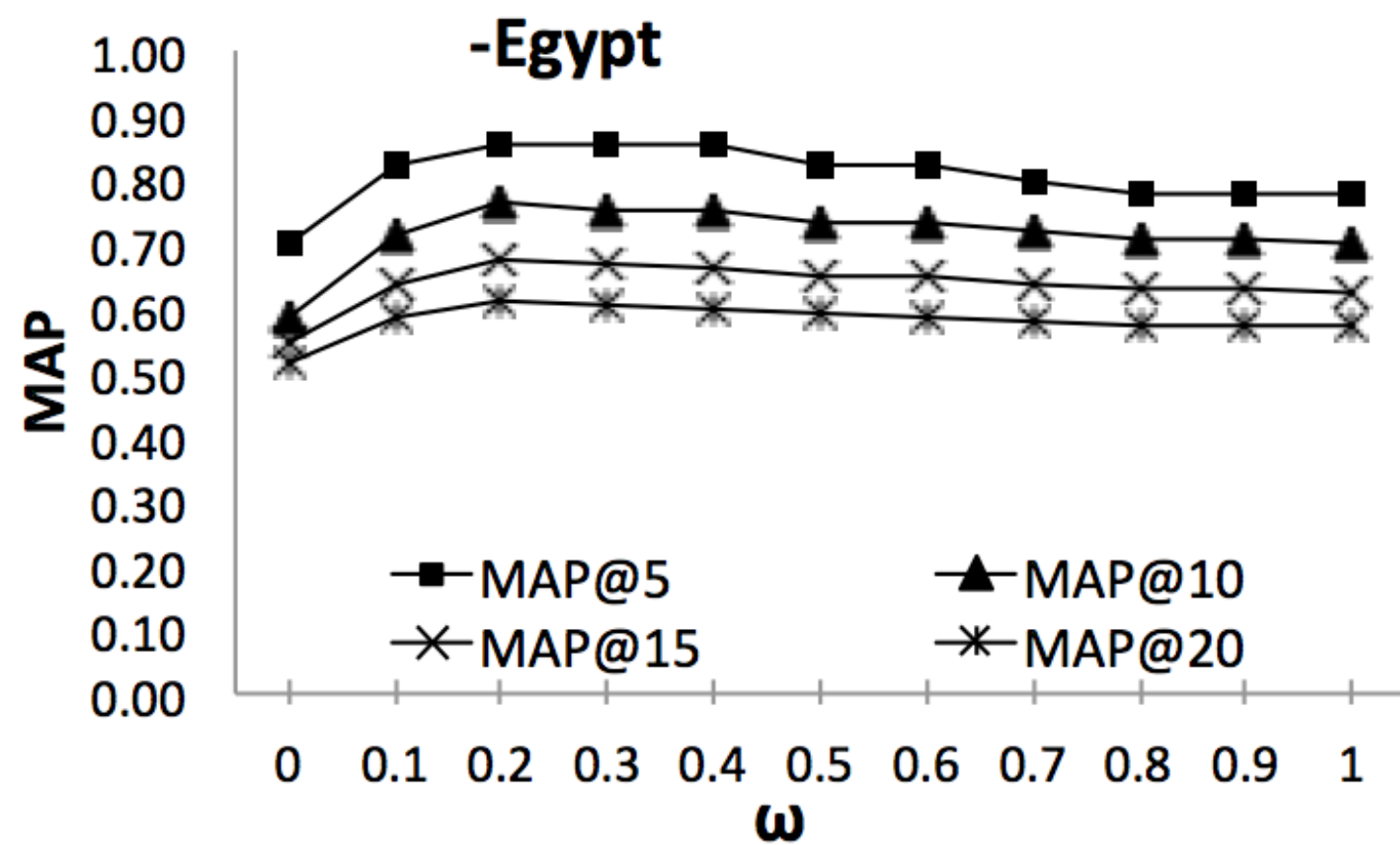
~Sub-modularity with budget c &
with **Informing** constraint $\geq \theta$

Future Work

- ◆ Combine the date selection model with the daily summarization model (37th ECIR, 2015)
- ◆ Analysis of differences in viewpoints between human-authored timelines (23rd UMAP, 2015)
- ◆ Consider a wider range of events and event types
- ◆ Various granularity levels of timepoints

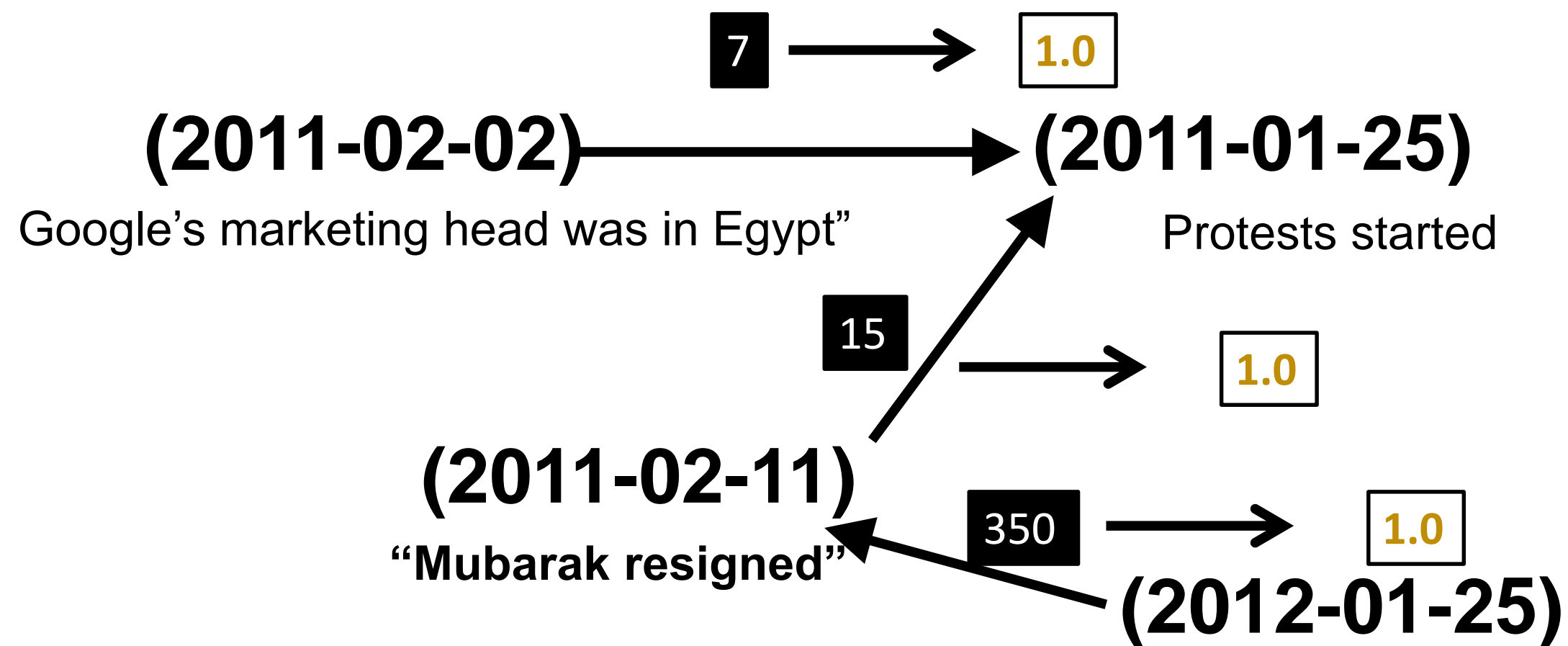
Q & A

Tuning (Training) hyper-parameter (4-folds)



Why not weighted pagerank?

- Transform $I * M$ into a stochastic matrix will destroy the global
- context of influence scores



Combination of Temporal and Topical Influence

$$\begin{aligned}
 x_t(j) = & \alpha\omega \sum_{i \in L_j^-} W_1(i, j) \cdot M_{ij} \cdot x_{t-1}(i) \\
 & + \alpha(1 - \omega) \sum_{i \in L_j^-} W_2(i, j) \cdot M_{ij} \cdot x_{t-1}(i) \\
 & + (1 - \alpha)v_j
 \end{aligned}$$

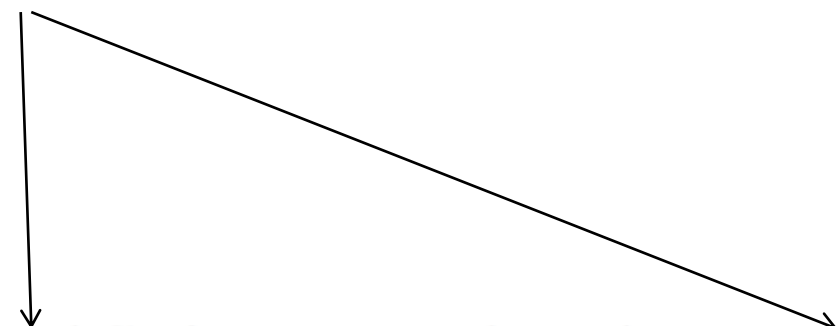
Scaled **I_topical** into [0, 1]

Hyper parameter ω in [0, 1]

Scaled **I_temporal** into [0, 1]

Graph Analysis

DRG is well connected
with a **good coverage**
of important dates



	#sent	#hasRef(%)	#nodes	#Edges	toStrict	reachStrict	toRelaxed	reachRelaxed
Egypt	143,096	26,428 (18.5)	939	2784	15.55%	100.00%	35.99%	89.34%
Libya	140,753	22,166 (15.7)	971	1797	33.78%	98.21%	56.98%	99.15%
Syria	162,305	26,992 (16.6)	812	1555	7.14%	88.24%	31.00%	73.58%
Yemen	140,156	21,606 (15.4)	1106	1608	18.28%	100.00%	37.00%	100.00%

Table 4: Interaction-based analysis on experimental news collections

Note:

Strict Setting: *dates appear in **at least 2 ground-truth timelines***

Relaxed Setting: *dates appear in **at least 1 ground-truth timeline***

Stability

	Egypt	Libya	Syria	Yemen
<i>IRW</i> _{max topical} temporal				
MAP@5	0.960	1.000	0.713	0.843
MAP@10	0.738	0.969	0.598	0.735
MAP@15	0.600	0.854	0.503	0.676
MAP@20	0.520	0.776	0.433	0.619
Kessler et al. (2012) (100)				
MAP@5	0.703	0.843	0.257	1.000
MAP@10	0.566	0.759	0.203	0.952
MAP@15	0.507	0.697	0.187	0.894
MAP@20	0.450	0.659	0.171	0.816
Tran et al. (2013a) (100)				
MAP@5	0.960	0.910	0.257	0.713
MAP@10	0.803	0.836	0.224	0.541
MAP@15	0.665	0.799	0.227	0.514
MAP@20	0.569	0.758	0.212	0.484

Table 6: Stability of our systems vs. competitors

Daily Summarization from Relevant Headlines

- ECIR 2015
- **Problem:** *What are the most important events of a date?*
- Using **headlines** for summarization
 - Meaningful, timely, self-contained information
 - Short, comprehensive
- **2011-01-25**
 - Antigovernment protests rock Egypt.
 - Egyptian youth mobilise via the internet.
- **2012-05-23**
 - Egyptians vote in first free presidential election.
 - Egypt Election 2012: Policeman shot dead outside Cairo polling station

Wiketimes.l3s.de

Index of storylines which are collected from the Wikipedia crowds