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Topic Identification of Noisy Arabic Texts Using Graph Approaches

Key Words :

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Talk Outline

1. Background
2. Corpus
3. Preprocessing
4. Topic Identification based Graph Approaches
5. Experimental results
6. Summary

What is Topic Identification ?

Topic Identification is the task of automatically recognizing the **subject** or the **theme** in which the text is written.

Automatic text categorization by attributing one or more labels from a **predefined** set of topics.

Applications of Topic Categorization

- **Newswires:** news are organized and archived by subject categories *(e.g. Politics, Economy, Sports, etc.);*
- **Academic articles:** papers are classified by domains and sub-areas;
- **Emails routing:** directing received emails to a specific mailbox depending on the topic;
- **Civil security:** predicting manifestations and/or terrorists' plots by automatically analyzing on-line conversations;

Motivation

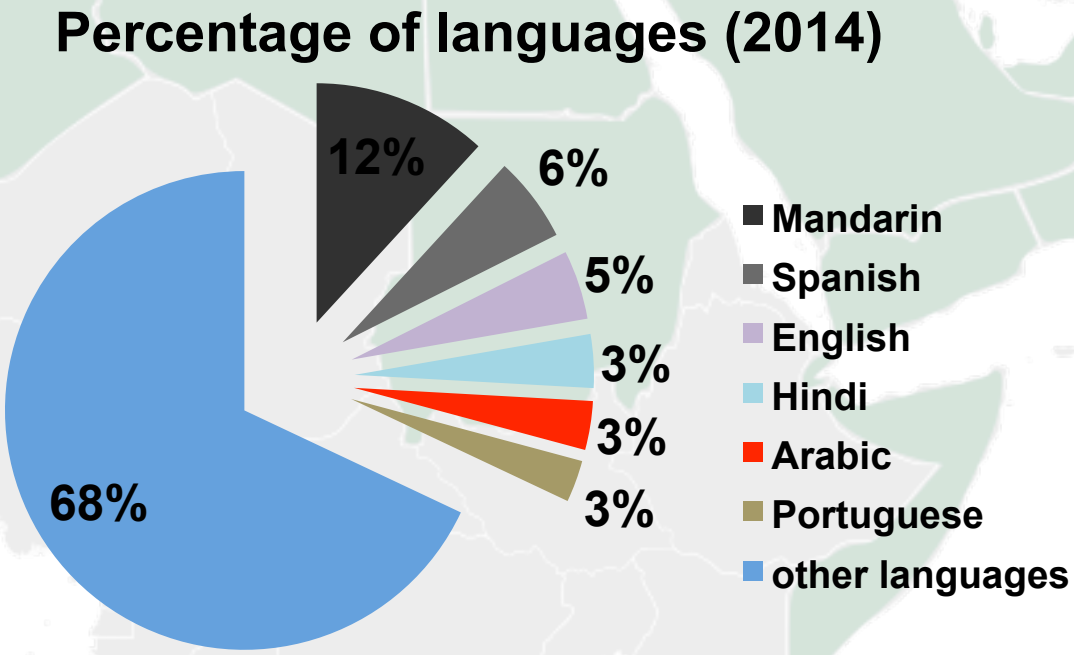
❖Many Topic Identification researches have been evaluated on **long** and **well written** texts (e.g. Scientific papers and Newspaper articles).

❖Many researches have been undergone on European languages and Asian languages, except the Arabic language (**few works**).

❖**Arabic language** is the more difficult one having a **complex** morphology and a **large** vocabulary.

Statistics (1)

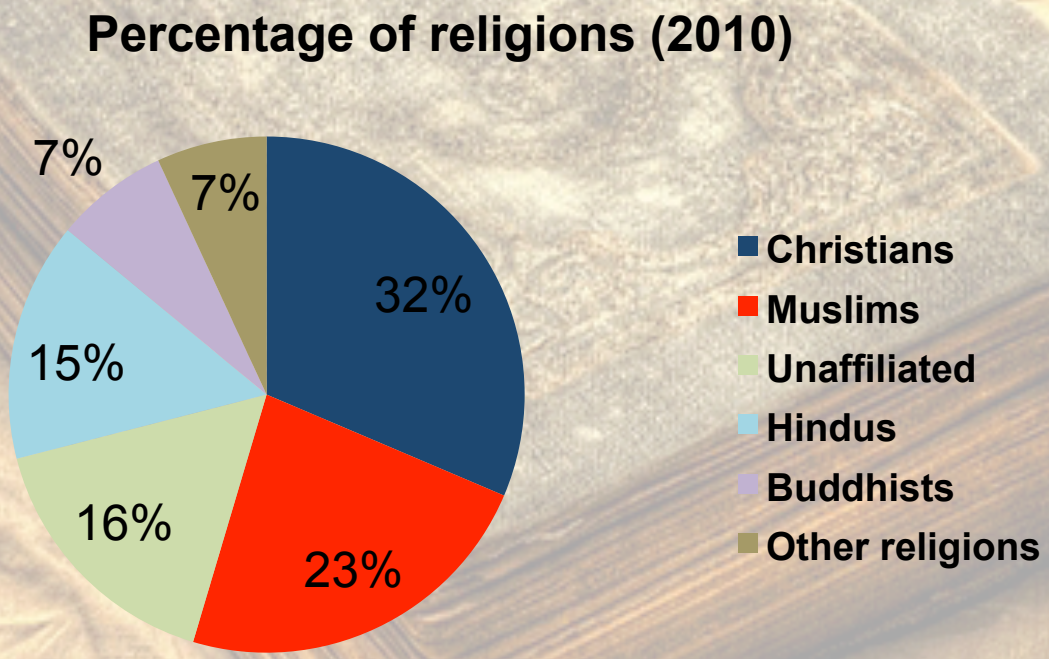
Arabic was the 5th most widely-spoken language, and is the tongue language of 422 million people in 22 countries.



https://www.cia.gov/library/publications/the-world-factbook/

Statistics (2)

As the religious language of the Quran (7th century), it was rapidly expanded during the rise of Islam in the 8th century



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Arabic language characteristics

❖Alphabet set consists of **28 main letters** with other forms taken by some characters (e.g. *Alif* "ألف", *Yaa* "ياء" and *Taa* "تاء").

❖There is **no capitalization** in Arabic (i.e. capital and small letters)

❖Letter can have different shapes depending on its location in the word.

separated	end	middle	beginning
ي	ـي	ـيـ	يـ

❖Word **meaning** is often determined by **diacritics** (or vowels).

كِلَامْ	كَلَامْ
(wound)	(speech)

❖Letter repetition twice is replaced by ***Shadda*** character "ّ"

❖Some conjunctions like "و" (*AND*) are welded to the following word, which makes the preprocessing quite difficult.

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ANTSIX Corpus

Text length ranges between 32 and 318 words

Difficulty

Main difficulty = Noisy texts (discussion forum texts)

- **Citations in other languages**
- **URLs**
- **Typing errors**
- **Tags** (e.g. hash tags, user tags...)
- **Insignificant characters** (e.g. emoticons)
- **Abbreviations**
- **Letters mistakenness** (e.g. the letter "ظ" and the letter "ض")

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Text preprocessing (step 1)

- Read the text as UTF-8 text.
- Strip some characters:
  - insignificant characters.
  - French and English characters.
  - Arabic diacritics.
- Separate contracted words (i.e. Replace "/" and "-" with white spaces).
- Strip multiple word delimiters (i.e. white space, "\n" and "\r").
- Normalize some letters:
  - ✓Replace *Alif* with different forms ("إ" ,"أ" and "آ") by *Alif* bare ("ا").
  - ✓Replace *Alif MaqSura* ("ى") by *Yaa* ("ي").

Text preprocessing (step 2)

- Extract a list of words.
- Remove stop words (**600 stop words**).
- Stem the rest of words (remove prefixes and suffixes).

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Approaches of topic identification

- Three graph approaches
  - **LIGA**
  - **TIGA1**
  - **TIGA2**
- **Nodes** represent the **word weights** and **edges** represent **word successions**
- The graph is represented by the following quintuple $G_i = (V_i, E_i, \mathcal{L}_i, W_{vi}, W_{ei})$
  - V_i and E_i are respectively a set of nodes and a set of edges.
  - $\mathcal{L}_i : V_i \rightarrow T$ Function used to assign vertices to the graph.
  - $W_{vi} : V_i \times T \rightarrow \mathbb{N}$ Function to assign weights to vertices.
  - $W_{ei} : E_i \times T \rightarrow \mathbb{N}$ Function to assign weights to edges.
- **Resultant graphs can be easily interpreted by human (visual analytics)**

LIGA approach (*training*)

Training doc $\in t_i$ → A list of words *W*

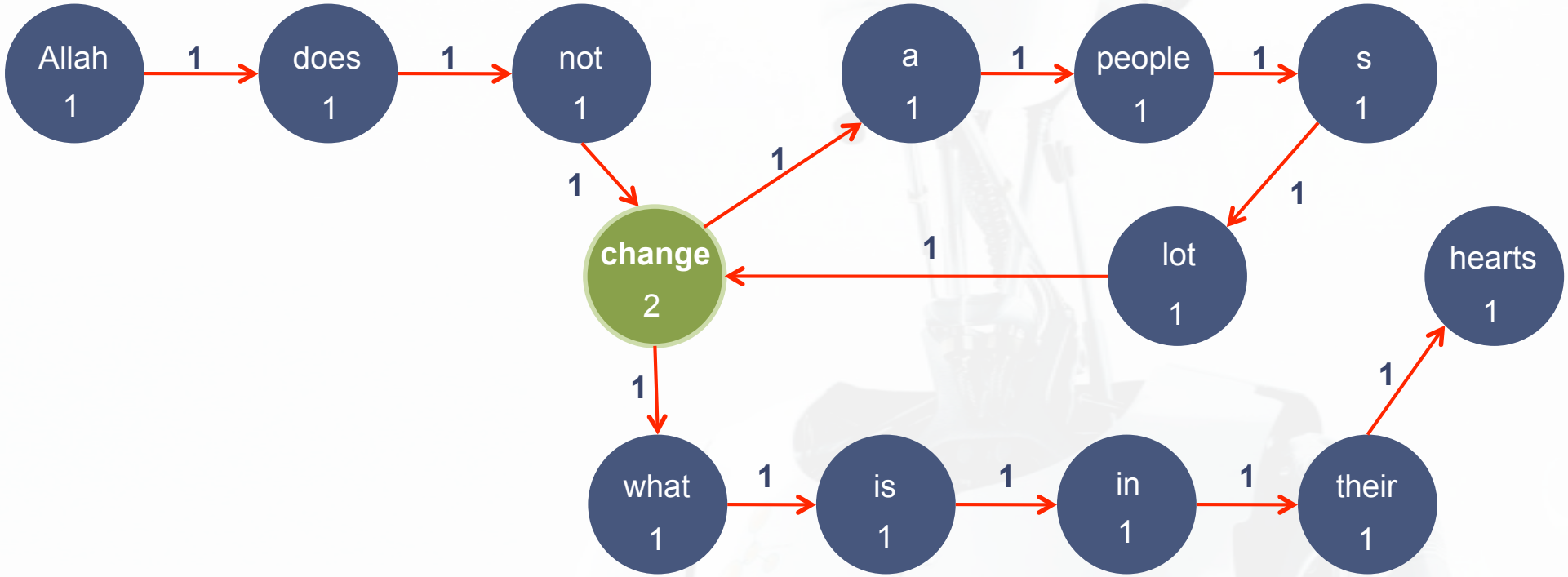
$$\forall w \in W \rightarrow \begin{cases} W_{vi}(v,t_i) = W_{vi}(v,t_i) + 1 & \text{if } v \in V_i \\ \mathcal{L}_i(v) = w \wedge W_{vi}(v,t_i) = 1 & \text{otherwise} \end{cases}$$

$$\forall w_j, w_{j+1} \in W \rightarrow \begin{cases} W_{ei}(e,t_i) = W_{ei}(e,t_i) + 1 & \text{if } e \in E_i \\ \text{edge } e \text{ is created} \wedge W_{ei}(e,t_i) = 1 & \text{otherwise} \end{cases}$$

Training example

"Allah does not change a people´s lot unless they change what is in their hearts"

[Allah] [does] [not] [**change**] [a] [people] [s] [lot] [unless] [they] [**change**] [what] [is] [in] [their] [hearts]



LIGA approach (*classification*)

Unlabeled text → path of words π (***consecutive words***)

Similarity = path matching function

$$\forall t_i \rightarrow PM(t_i) = 0$$

$$\forall w \in \pi \rightarrow PM(t_i) = \begin{cases} PM(t_i) + W_{vi}(v, t_i) & if\ v \in G_i \\ PM(t_i) & else \end{cases}$$

$$\forall w_j, w_{j+1} \in \pi \rightarrow PM(t_i) = \begin{cases} PM(t_i) + W_{ei}(e, t_i) & if\ e \in G_i \\ PM(t_i) & else \end{cases}$$

$$topic = argmax_{t_i \in T}(PM(t_i))$$

TIGA1

TIGA1 → Biasing the **LIGA** **node** weights using **TF-IDF** method.

$$tfidf(v,t_i) = W_{vi}(v,t_i) * idf_v$$

$W_{vi}(v,t_i)$ is the weight of the node v in the graph

idf_v is the inverse graph frequency

$$idf_v = \log(^{n}/_{M_v})$$

TIGA2

TIGA2 → Biasing the **TIGA1** **edge** weights using **TF-IDF** method.

$$tfidf(e,t_i) = W_{ei}(e,t_i) * idf_e$$

$W_{ei}(e,t_i)$ is the weight of the edge e in the graph

idf_e is the inverse graph frequency

$$idf_e = \log(n / M_e)$$

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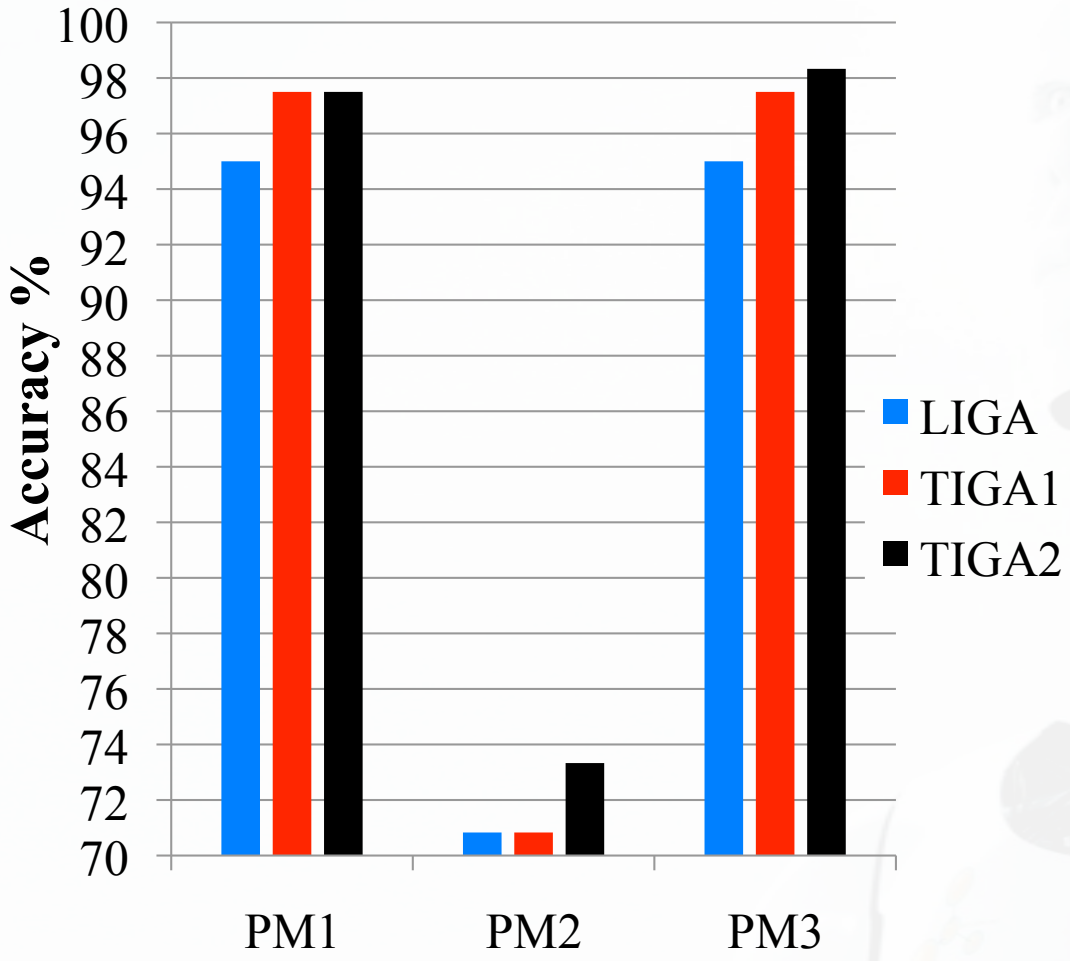
Experiment setup

- ANTSIX corpus:
  - 60% was used in the training.
  - 40% was reserved for the test.

- **Three** path matching functions are used:
  - PM1: uses only node weights.
  - PM2: uses only edge weights.
  - PM3: uses node and edge weights both.

Results (accuracies)



- **LIGA** is **worse** than **TIGA1** and **TIGA2**.
- **TIGA2** **is more accurate** than the two others (achieved the best accuracy).
- **PM2** produced **worse** performances comparing to **PM1** and **PM3**.
- **LIGA** and **TIGA1** can be **optimized** by using **PM1** instead of the original **PM3**.

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Conclusion

- Several experiments of **topic identification** were conducted on **noisy Arabic forum texts**.

- **Contributions**
  - ❖ **ANTSIX corpus**
    - ✓300 **noisy** Arabic texts
    - ✓6 different topics
  - ❖ **Preprocessing**
    - ✓Characters removing and normalizing
    - ✓Stop words removing(600 stop words)
    - ✓Words stemming
  - ❖ **Three approaches**
    - ✓LIGA
    - ✓Two improvements (i.e. TIGA1 and TIGA2)

- **Comparison** between **3 PM** functions
  - ✓TIGA1 and TIGA2 **outperformed** LIGA
  - ✓TIGA2 is the **more accurate**
  - ✓Original PM (PM3) can be **optimized** as PM1
  - ✓PM2 is not suitable in noisy Arabic texts

Perspective

- Benchmark the proposed approaches
  - ❖ **Evaluate TIGA1 and TIGA2 on a large corpus**
  - ❖ **Compare the two algorithms with other well known tools**
- Test other techniques of weighting instead TF-IDF

Thank you

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