A Distributed Arabic Text Classification Approach Using Latent Semantic Analysis for Big Data

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Abstract

- Big data have special concerns from researchers
- Latent Semantic Analysis (LSA) deals with the semantics of the words.
- LSA has an effective performance in classification
- A distributed text classification approach based on LSA and Cosine Similarity proposed in this paper
- The proposed approach can be applied on big data

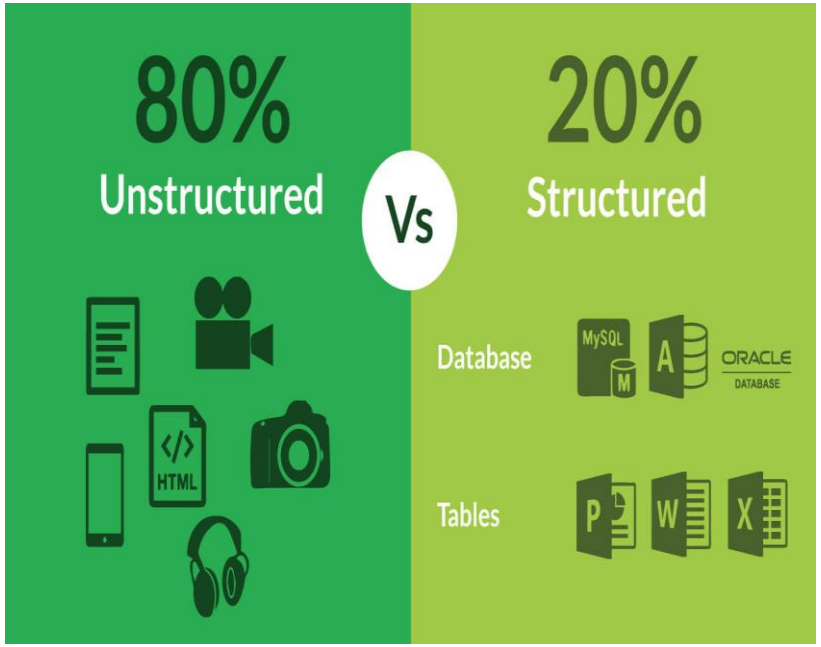
Introduction

- The term big data refer to the large amount of data that can be characterized by the 3V; Volume, Velocity, and Variety
- Big data contains valuable information that can be used in decision making, finance, marketing, etc.
- Many techniques have been proposed to extract valuable information from big data
- Text classification is one of the problems that has been widely studied in information retrieval, data mining, database, and machine learning

Text Classification

- The aim of the text classification is assigning an unlabeled set of documents into predefined categories in an automatic manner
- the process started with a set of documents (training set) that are labeled with class's l∈L manually
- Text classification has been solved using several techniques; vector space model, Naïve Bayes, support vector machine, Neural Network, etc.
- LSA used with a cosine similarity measure for text classification, gives better results than other techniques, but:
  - LSA requires intensive time complexity and computational memory

Big Data



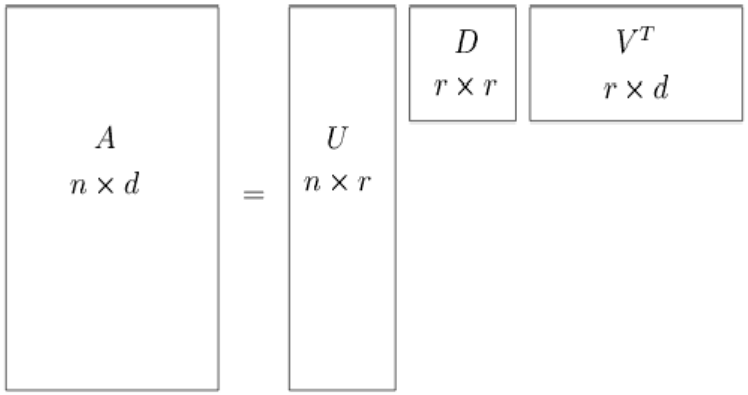
If the value gained from the structured data is useful, then there is a massive potential value gained from unstructured data

LSA

- A technique used for representing documents as a vector
  - ✓ Helps in finding similarities between documents by calculating the distance between vectors
- LSA represent a text as a matrix
  - ✓ The rows represent the terms
  - ✓ The columns represent the documents
  - ✓ The intersection between term and document have a value calculated using Term Frequency-Inverse Document Frequency (TF-IDF)
- TF-IDF reflect how important a word regarding a document

Singular Value Decomposition (SVD)

- LSA uses SVD to refine the Term Document Matrix (TDM)
- The SVD decomposes the TDM into three matrices in order to emphasize the strong relations between words and documents, and remove the noise
- The decomposition expose all the important properties and features of the matrices



Distributed Arabic Text Classification Approach

- The proposed distributed classification approach consist of two phases; learning phase, and testing phase
- **Learning phase:**
  - ✓ A sample of documents is selected randomly from a set of documents, and classified manually
  - ✓ The manually classified sample are distributed among machines
  - ✓ Every machine takes only a single class in order to speed up the process

Learning Phase

- Each machine is supposed to do the following:
  - ✓ Preprocessing the data by removing stop words, normalization, and stemming.
  - ✓ Next, the documents are converted into vectors.
  - ✓ Apply SVD on the TDM, the result of this step will be terms matrix.
  - ✓ Each machine sends the corresponding terms matrix, and documents matrix to all other machines.
- Now, all the machines have the results of the SVD of each class

Testing phase

- Select a documents from the set of the manually classified documents
- compare the results returned from the proposed system with manually results
- Every document is converted to a vector by the following equation

$$\vec{d} = \frac{\vec{t_1} + \vec{t_2} + \cdots + \vec{t_n}}{n}$$

Where is the document vector, and is the term vector from the TDM.

Testing phase ...

- Cosine similarity is used to find relativity between the document and each class
  - ✓ The document will be classified to the class that has the highest value of cosine similarity
  - ✓ If the results are no satisfying, then the number of documents used in training phase must be increased

$$Cosine\ Similarity = \frac{A.B}{||A||||B||}$$

Results and Discussion

- The dataset contains 4000 documents for 10 different categories
- The training set contains 400 documents, 40 document for each category
- The proposed distributed method compared with the work done by [11] and evaluated in terms of precision, recall, and time complexity

Precision Results

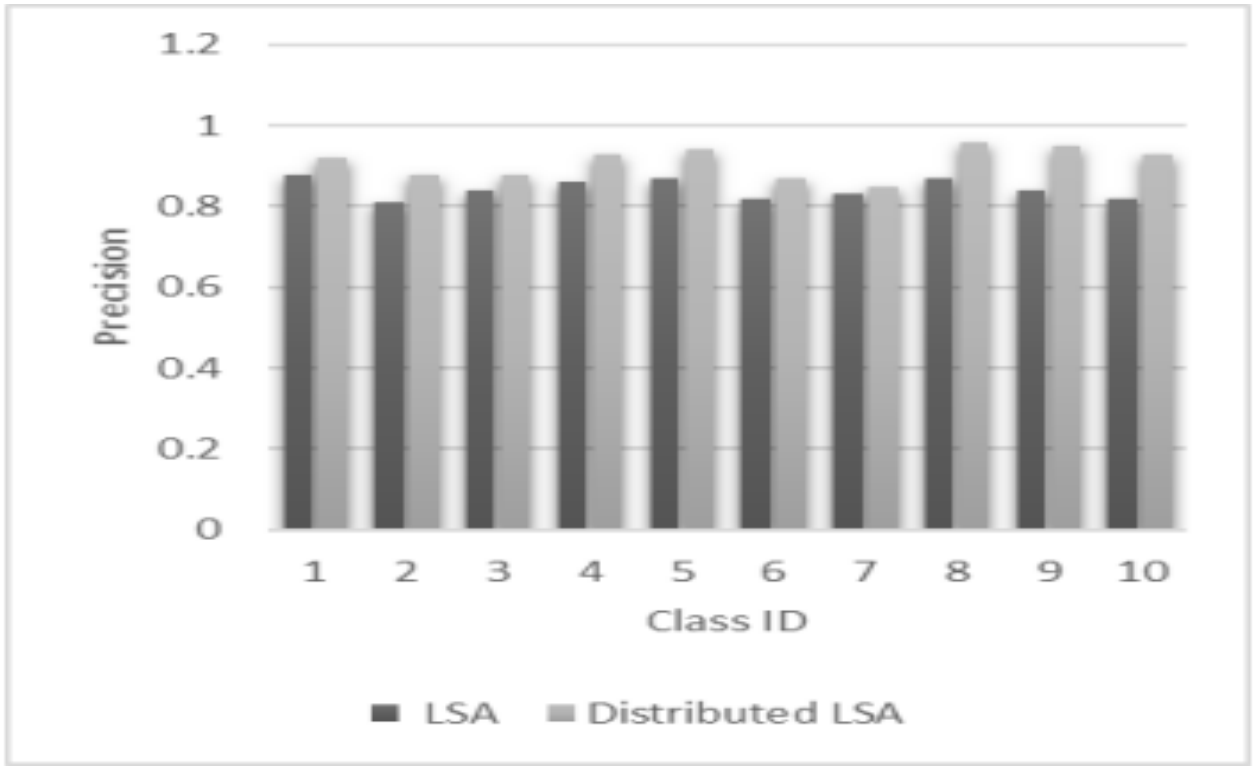


Fig 1: Precision Results for each class

Recall Results

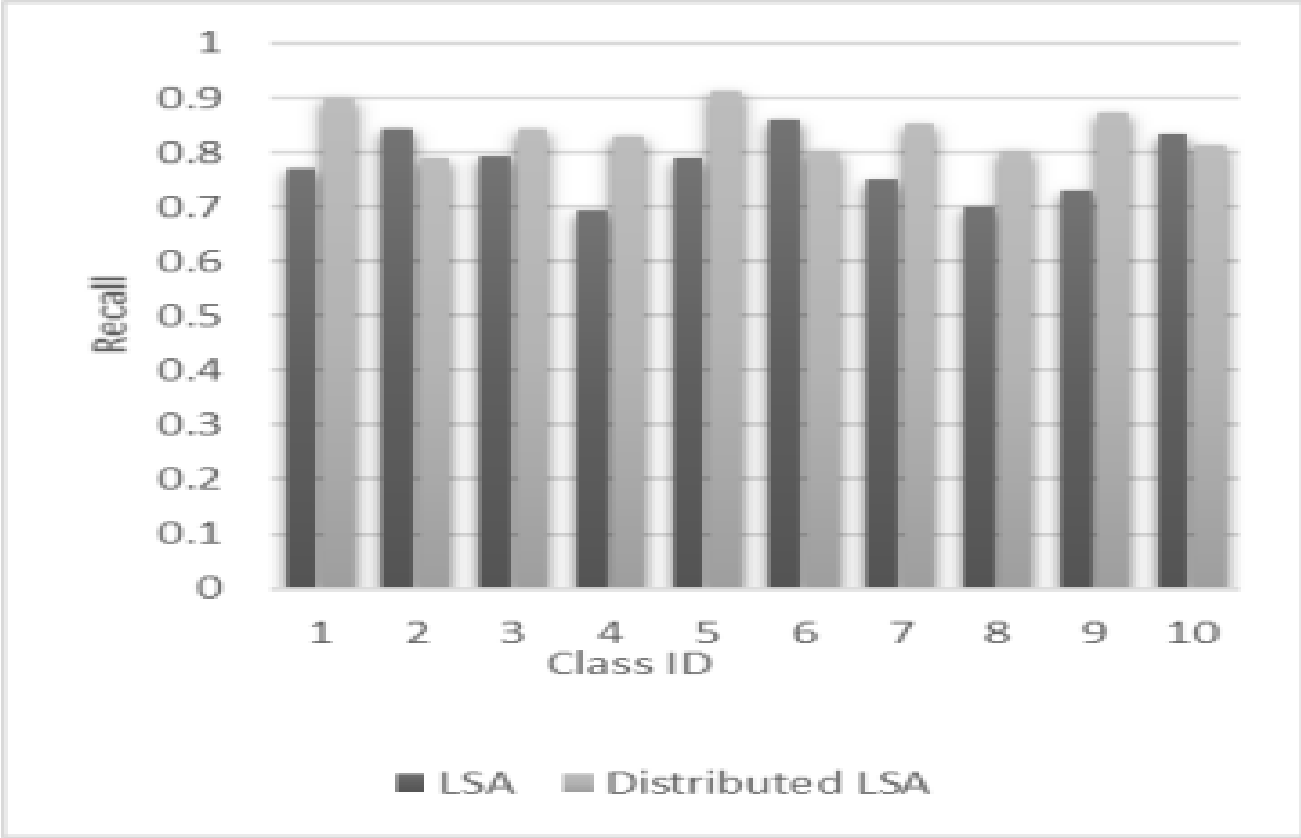


Fig 2: Recall Results for each class

Time Complexity Results

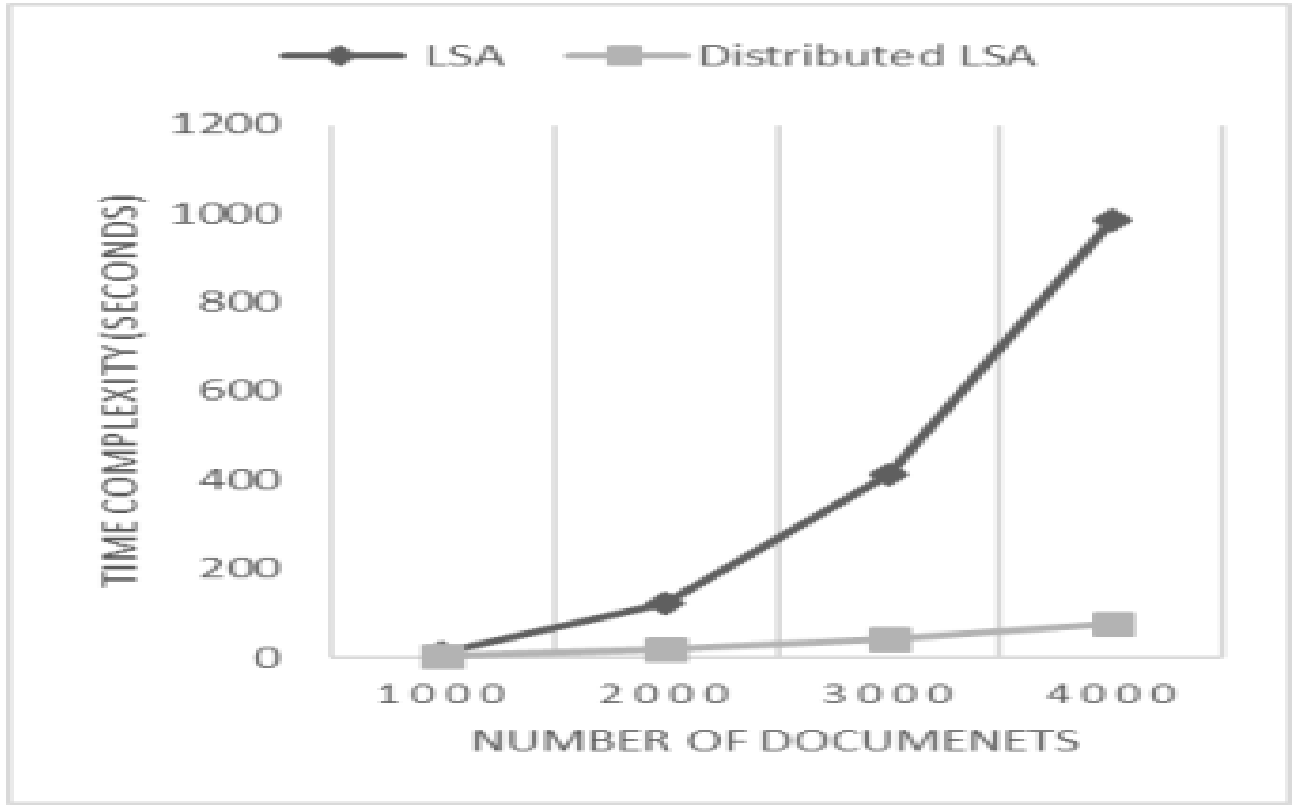


Fig 3: Time Complexity for different datasets

Conclusion

- LSA is a powerful technique for text classification
- A distributed classification method using LSA and cosine similarity proposed based on the method proposed in related works
- The proposed approach aims to reduce the time complexity of the LSA classifier in order to deal with big data
- The proposed approach reduced the time required for classification, and outperform the related works in terms of precision, and recall

Question?