UNIVERSITETI I EVROPËS JUGLINDORE

УНИВЕРЗИТЕТ НА ЈУГОИСТОЧНА ЕВРОПА

SOUTH EAST EUROPEAN UNIVERSITY

A Model for Recommending Research Articles: A Case Study in Computer Science, Neuroscience and Biology

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Outline

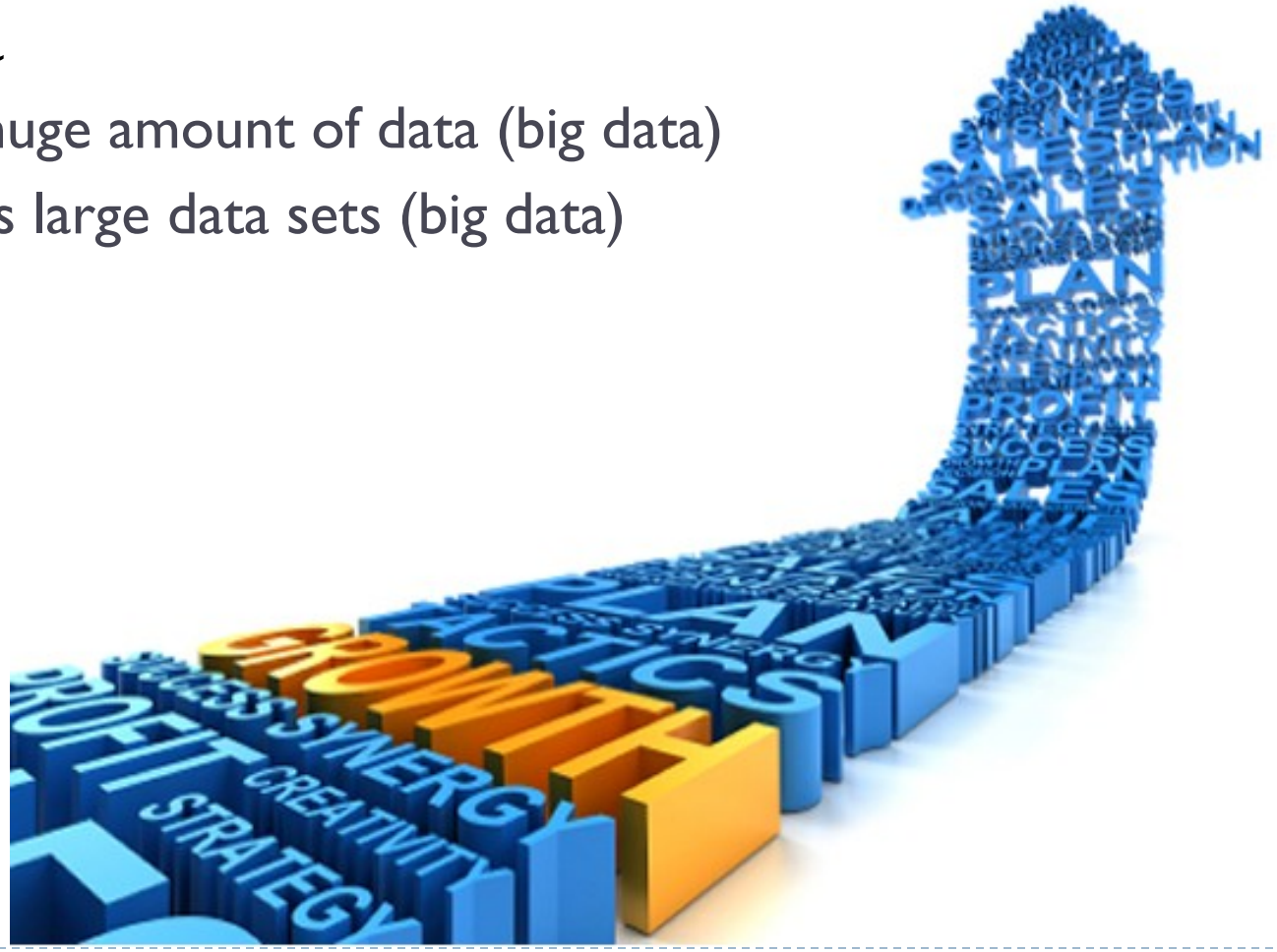
- Introduction
- Research Problem
- The Proposed Model
- A Case Study in Computer Science, Neuroscience and Biology
- Future Work
- Conclusion

Introduction

1. Why big data matters?
2. How to extract meaningful information from unstructured data, textual data?
3. What machine learning algorithms are used to analyze textual documents (textual data)?
4. Traditional vs. Parallel/Distributed machine learning algorithms for text analysis.
5. What kind of solutions have been proposed for recommending research articles to researchers.

Why big data matters?

- Data on the Web is increasing rapidly.
- Big Data
  - Store huge amount of data (big data)
  - Process large data sets (big data)



Research Problem

IMPROVING THE PROCESS OF RECOMMENDING RESEARCH ARTICLES TO RESEARCHES.

EASE THE PROCESS OF LITERATURE REVIEW?

Related Work

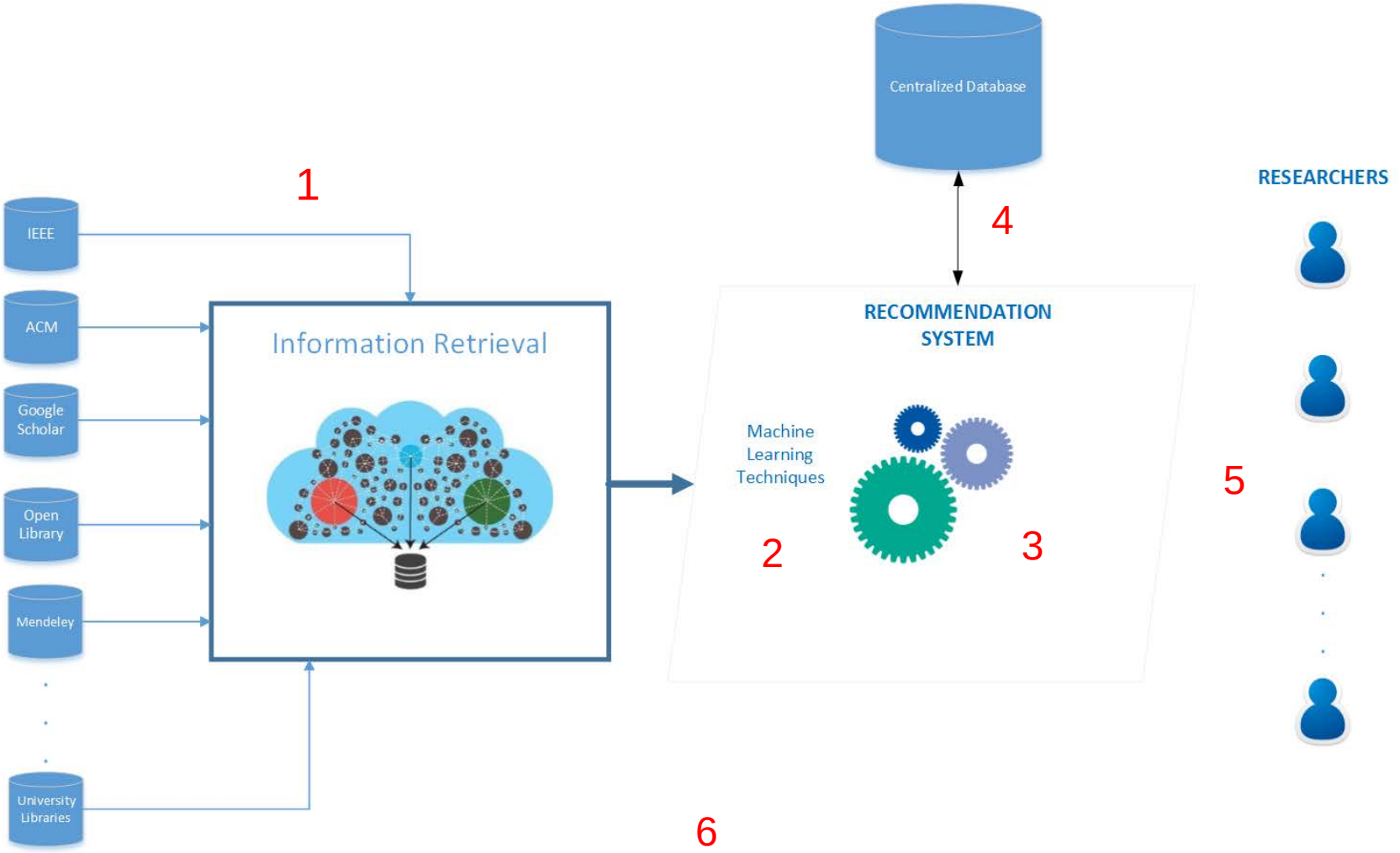
- Mendeley and CiteULike [1] [2]
  - Reference Management
  - Collaborative Filtering (User Filtering)
- Altimetric-Driven approach [3]
  - Enhance performance for research paper recommender systems.
- Topic-Modeling approach [4]
  - Exclude the keyword and focus on the topic

Our Study

- The aim of our study is to collect/retrieve and analyze research/scientific articles by applying machine learning techniques in order to recommend **research articles or/and research gaps** to researchers based on their research fields.

- Scientific Article
  - **Title**
  - Author/s
  - **Year**
  - **Abstract**
  - **Keywords**
  - Content
  - Contribution
  - Results
  - Future Work
  - Importance
  - Related articles

Proposed Solution



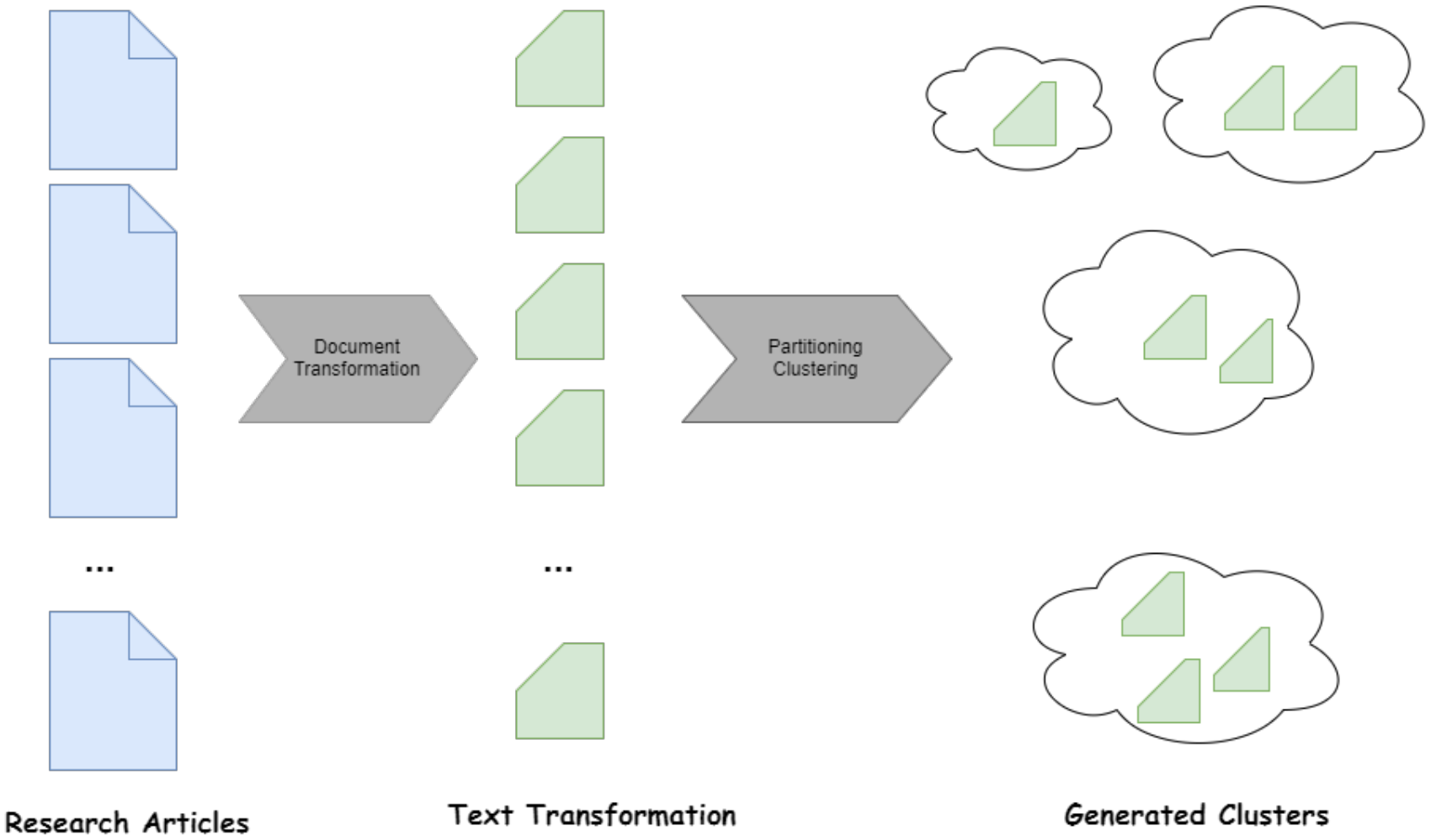
Research Questions - Model

- What is the best document representation in text mining?
- Which are the most efficient clustering algorithms used recently?
- What classification techniques are used to build the most accurate models in text mining?
- What is the difference between Neural Networks and traditional classification techniques?
- Which is the best hierarchical clustering technique for textual documents?

Solution

- Why Hybrid solution?
  - The reason why we consider this model as hybrid solution is because it is built on top of combination of supervised and unsupervised learning algorithms.

Model – Phase 1



Model – Phase 1.1

Bag of Words vs Word2Vec Document Representation

- Terms
- Bag of Words
- Term Frequency
- **Term Frequency Inverse Document Frequency**
- **Enhanced TF-IDF models**
- Word Sequences
- Graph Structure
- **Word2Vec**
  - Word Embeddings
  - NLP
  - Extract Linguistic Context of Words
  - Latent Semantic Analysis (LSA)

Model – Phase 1 Results

- Phase 1:
  - Validate the Input Data Set
  - Distance between Clusters
  - Total number of Clusters
  - Outliers
  - **Cluster Labels**
  - **Cluster List of Labels (Keywords)**
- The quality of the generated training dataset will be dependent on three key factors:
  - The input dataset
  - The text representation model
  - The applied clustering algorithm

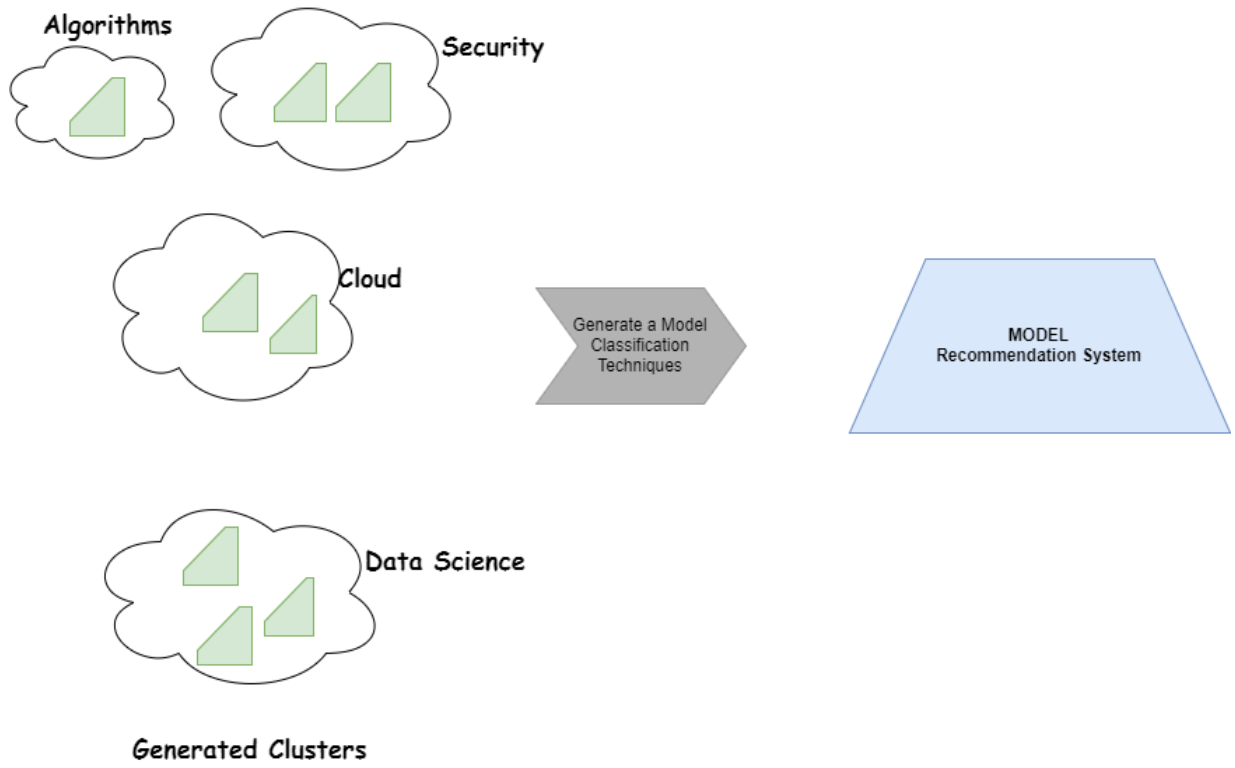
Model – Phase 1 (Important)

1. **How we are going to define the number of clusters?**
   - The Silhouette Coefficient

2. **How we will measure the accuracy of the clustering algorithm?**
   - Since it was difficult for us to have concrete measurements for the first phase we had to use an already labeled textual dataset with sports news articles. [5]

[5] Nuhi Besimi, Betim Çiço, **A Model for Recommending Research Articles**, 7th Information & Communication Technologies at Doctoral Student Conference 2018 (DSC), Thesaloniki, Greece.

Model – Phase 2



Model – Phase 2 Results

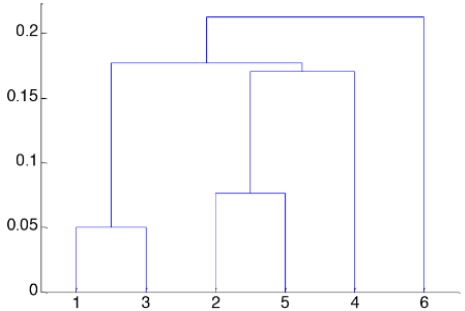
- Phase 2:
  - Model (Decision Tree, Probabilistic Model, Centroids, Neural Network)
- Our aim is to select the most efficient model based on the literature review and the experiments. This model will help us to solve tasks like:
  - Classify new research articles based on their content.
  - Recommend research articles based on search criteria.
  - Query the input dataset for potential research gaps and trend research fields recently.

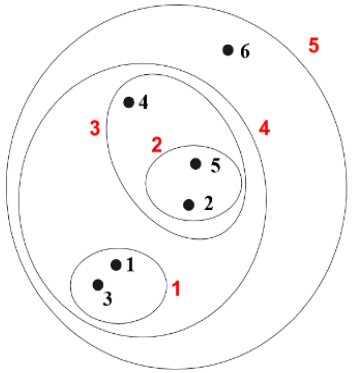
Model – Phase 2 (Important)

- **How we are going to measure the efficiency of the model?**

Model – Phase 3

- Finally, we can apply hierarchical clustering on the generated clusters to extract different levels of details for specific research fields. This step will be used to extract the trend topics and to increase the accuracy of the recommendation system.





Case Study Computer Science, Neuroscience, and Biomedical.

- Open Research Corpus
  - Over 39 million published research papers in Computer Science, Neuroscience and Biomedical.
  - http://labs.semanticscholar.org/corpus/

- Waleed Ammar et al. 2018. Construction of the Literature Graph in Semantic Scholar. NAACL. https://www.semanticscholar.org/paper/09e3cf5704bcb16e6657f6ceed70e93373a54618

Dataset

- 36GB in JSON Format
- Computer Science, Neuroscience, Biomedical
- Attributes
  - Id, title, paperAbstract, entities, s2Url, s2PdfUrl, pdfUrls, authors, inCitations, outCitations, year, venue, journalName, journalVolume, journalPages, sources.

Processing

- GCE
  - Machine type: custom (2 vCPUs, 16 GB memory)
  - Storage: 100GB (SSD persistent disk)
  - OS: Ubuntu 16.04

Google Cloud Platform

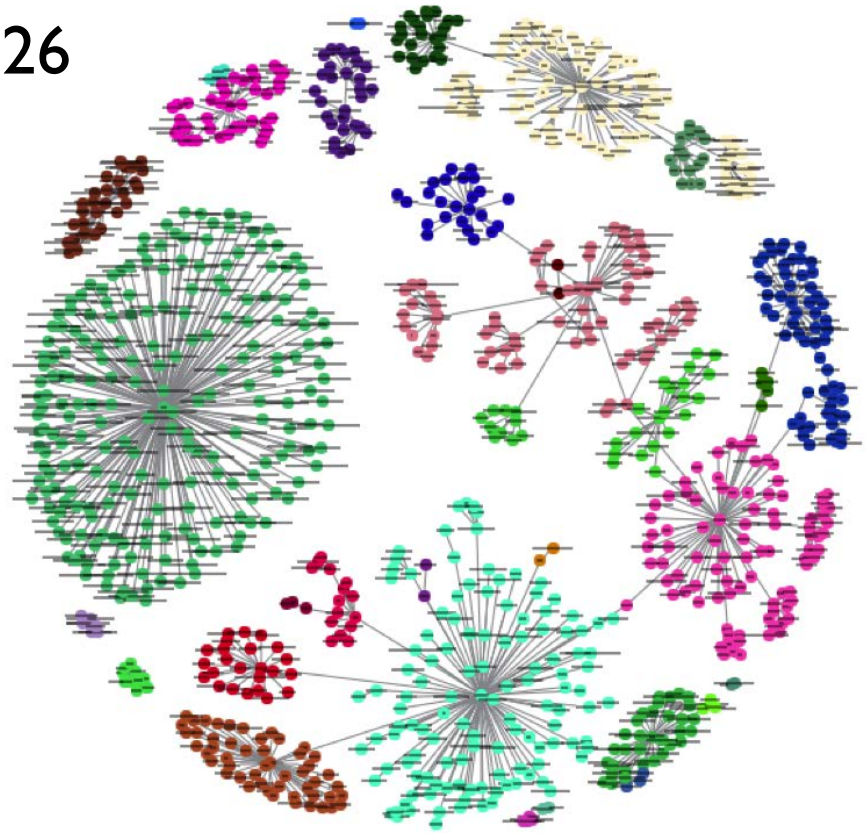
- MongoDB v4.0

- Scikit-learn
  - Machine Learning in Python. Simple and efficient tools for data mining and data analysis.

- NLTK
  - The Natural Language Toolkit, or more commonly NLTK, is a suite of libraries and programs for symbolic and statistical natural language processing for English written in the Python programming language.

Experiments

- Total number of papers: 10 000
- Total number of clusters: 37
- Number of valid clusters: 26
- Outliers: 11 clusters



Experiments

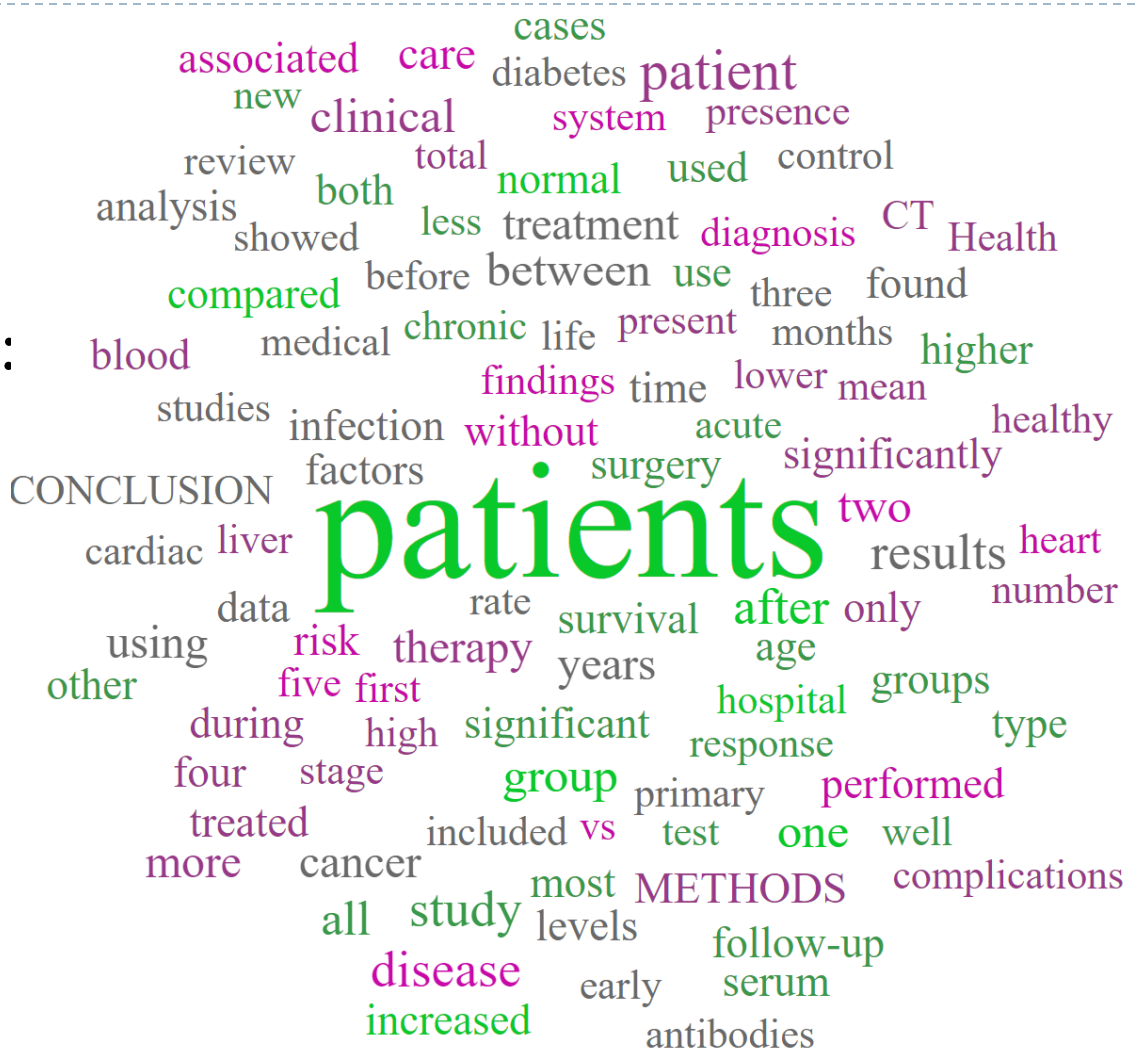
- Cluster 1
  - 1257 papers
- Top keywords:
  - der
  - health
  - disease
  - medical
  - evaluation
  - …

Experiments

- Cluster 2
  - 759 papers
- Top keywords:
  - treatment
  - brain
  - therapy
  - blood
  - disease
  - …

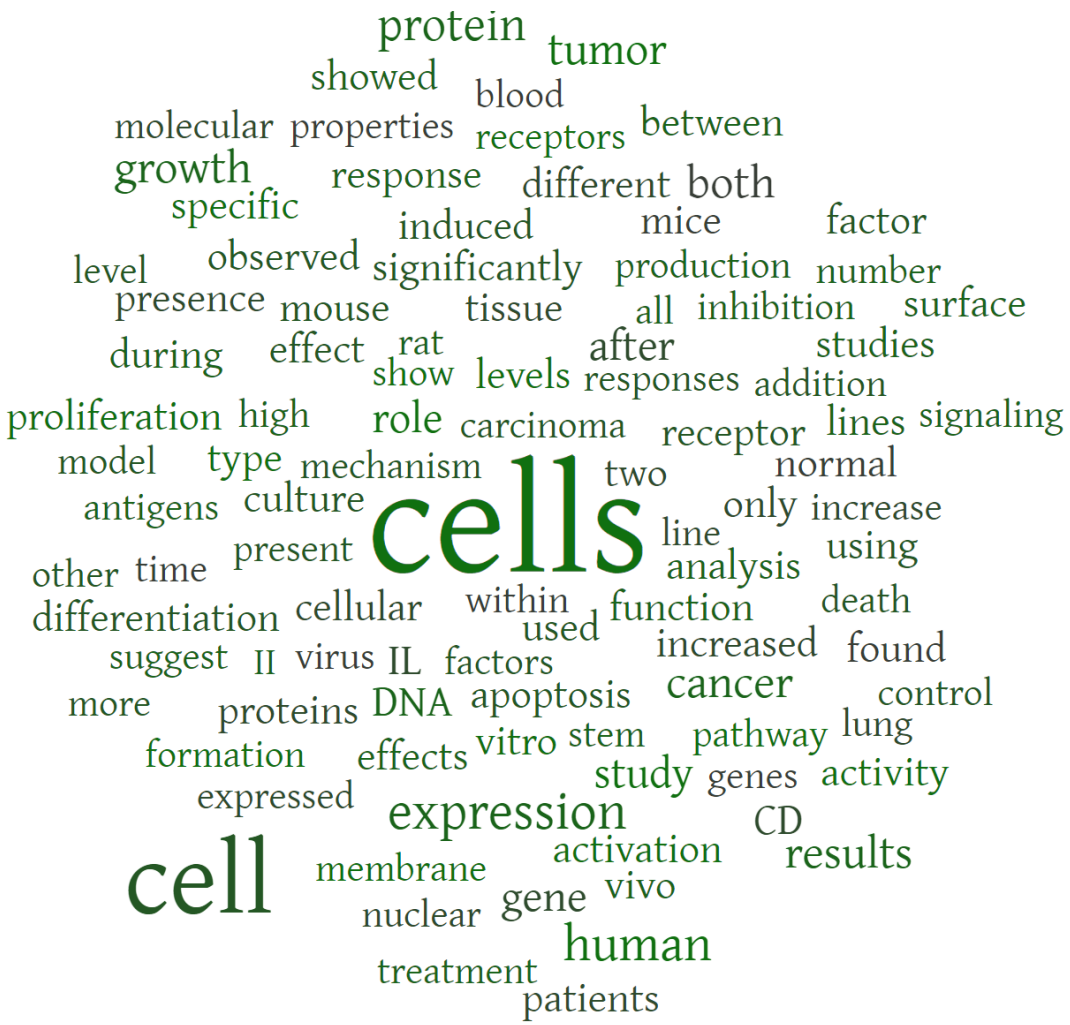
Experiments

- Cluster 3
  - 364 papers
- Top keywords:
  - patients
  - health
  - risk
  - cancer
  - compared
  - …



Experiments

- Cluster 4
  - 350 papers
- Top keyword
  - cell
  - human
  - cancer
  - tumor
  - dna
  - …

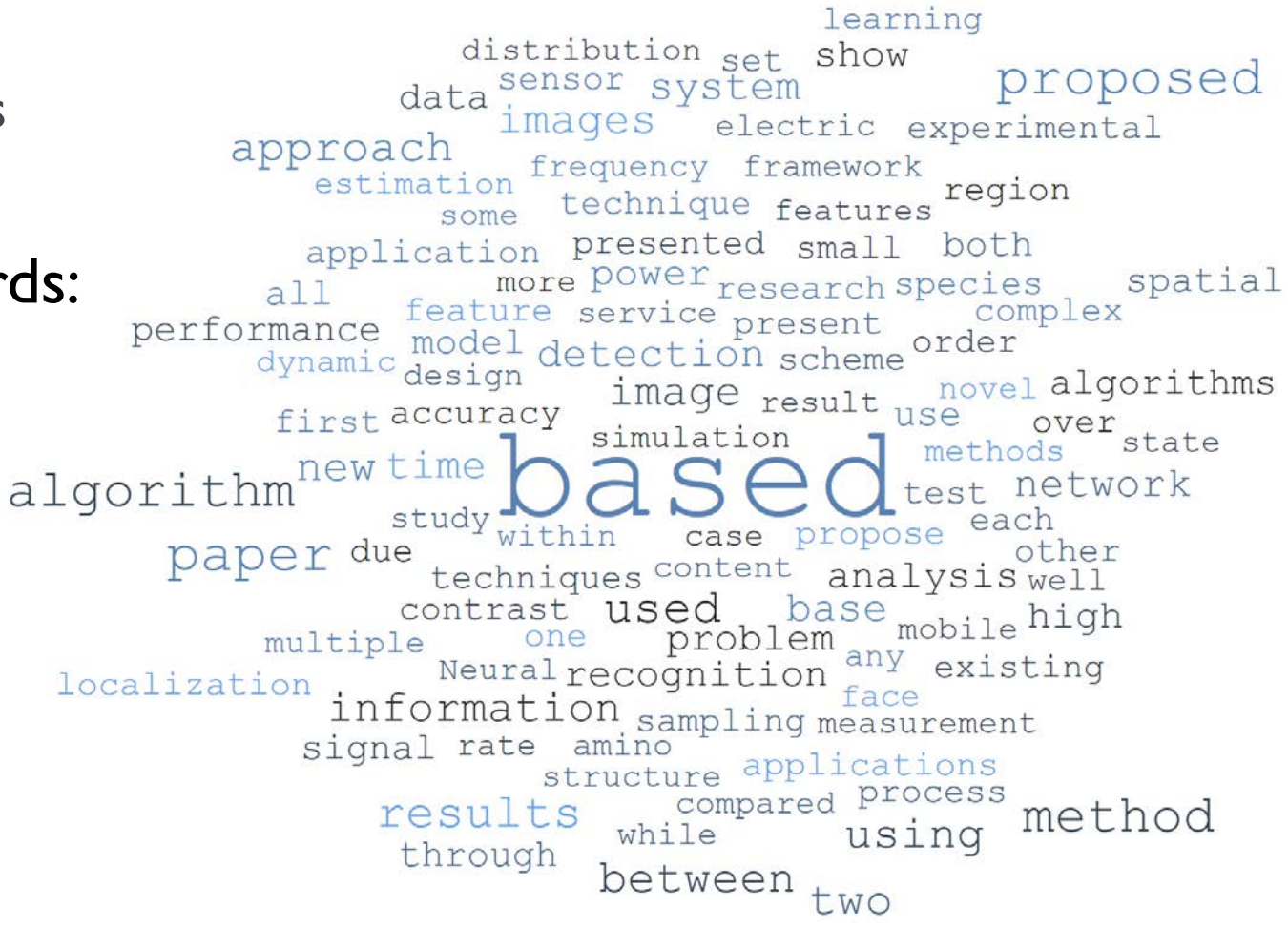


Experiments

- Cluster 5
  - 312 papers
- Top keywords:
  - system
  - information
  - query
  - strategy
  - user
  - …

Experiments

- Cluster 6
  - 171 papers
- Top keywords:
  - algorithm
  - paper
  - image
  - based
  - proposed
  - detection
  - …



Future Work

- Experiment with different textual documents representation and evaluate the models which produce high performance in accuracy.
- Generate models based on various classification techniques to identify the most proper techniques for this task.
- Make our solution Open Source

COMMENTS & RECOMMENDATIONS

?!

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