BIG DATA FOR AUTOMATIC RELATION EXTRACTION IN NATURAL LANGUAGE PROCESSING

Using Word Embedding and Word2vec

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MASTER THESIS

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GOALS

- **Extract relations** from raw corpus **pairs of words** (« Paris - France ») using **Word2Vec.**
- **Generate new pairs** with the same **relation type** given in input.
- **Evaluate** and **measure** the **reliability** of the retrieved pairs.
- Focus on **improving the precision** of the retrieved pairs.
- Improve the **computation time.**

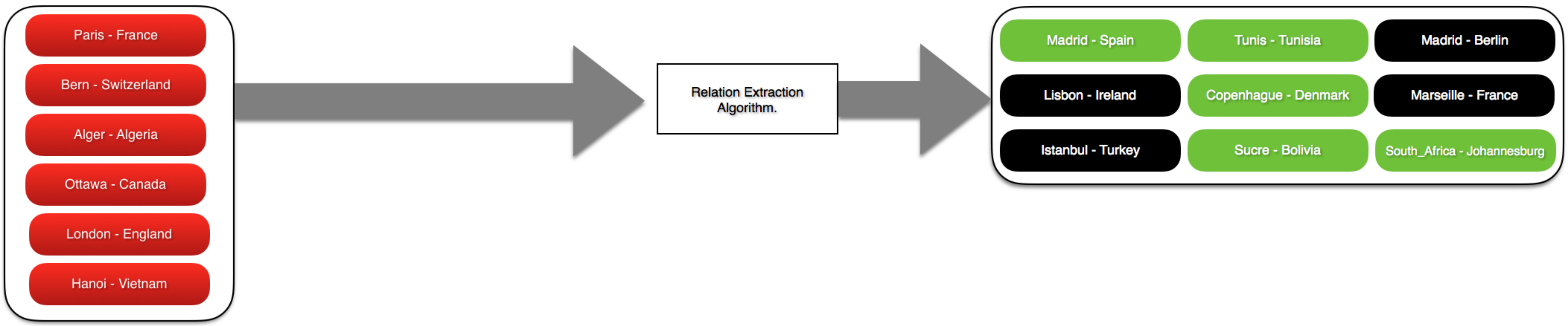
CHALLENGES

- Extract relation from unlabeled big data corpus.
- Starting from an existing undocumented program(Matúš Pikuliak) which runs on **a single machine.**
- Using **words embedding** for extracting pair relations.
- **Work in a distributed environment**

OUTLINE

- **Pre-process** a big data corpus from "Wikipedia dump" (General Field).
- Use the pre-processed corpus in order to **create a Word2Vec Model.**
- **Deploy the relation extraction** program from Gensim to Spark
- **Select the pairs in input** of the RE program with our new selection methods.
- **Extract relations with our algorithm using the Word2Vec model.**
- **Evaluate** the relations in an **automatic** way with a **Knowledge Base(KB).**
- Measure scores of the results(precision/nDCG) of these relations and compare them.
- Compare the **execution time.**

INTRODUCTION



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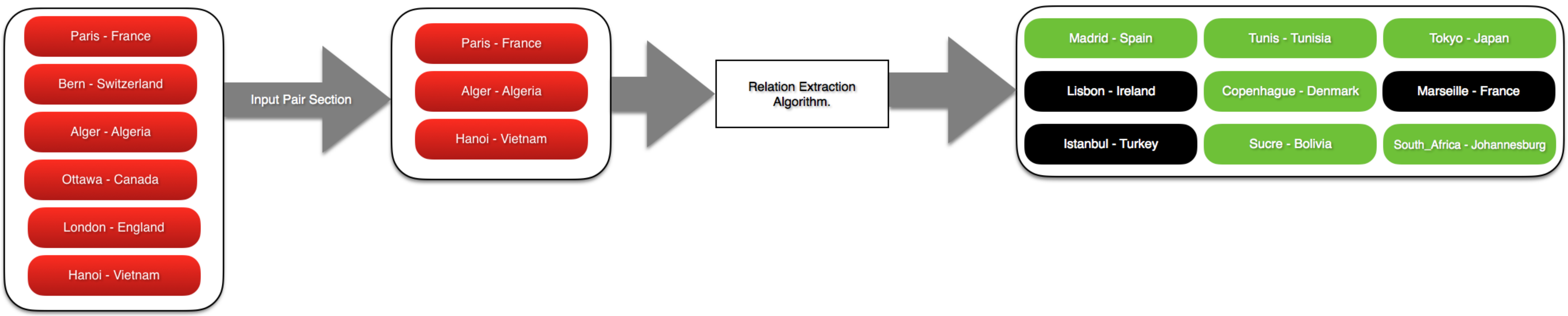

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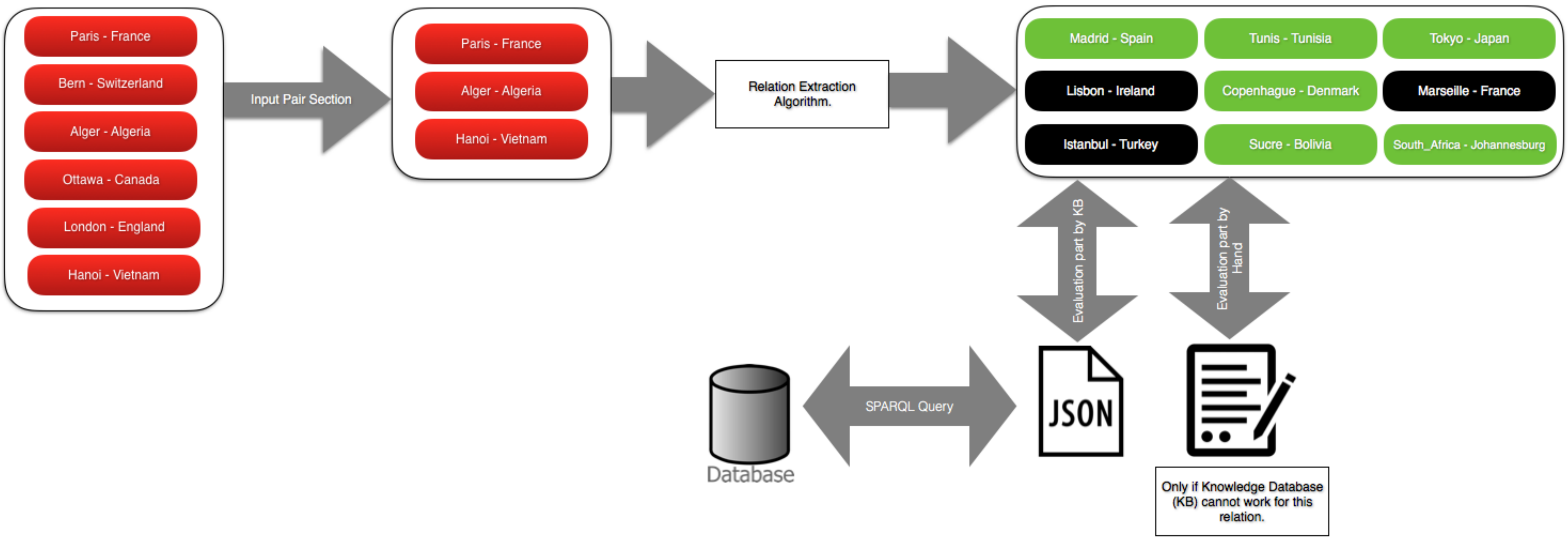

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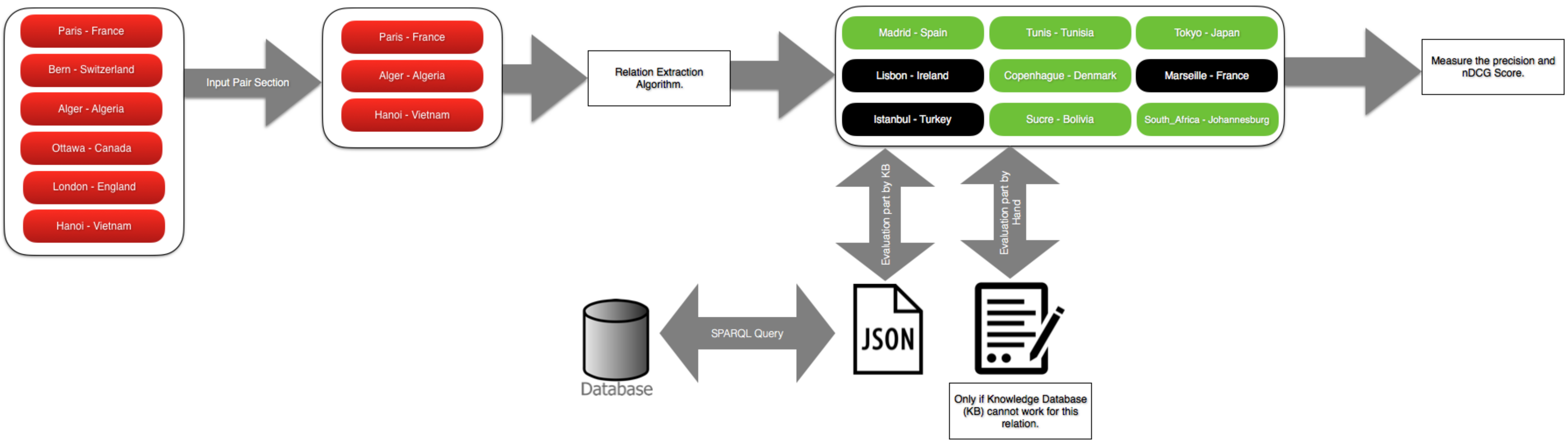

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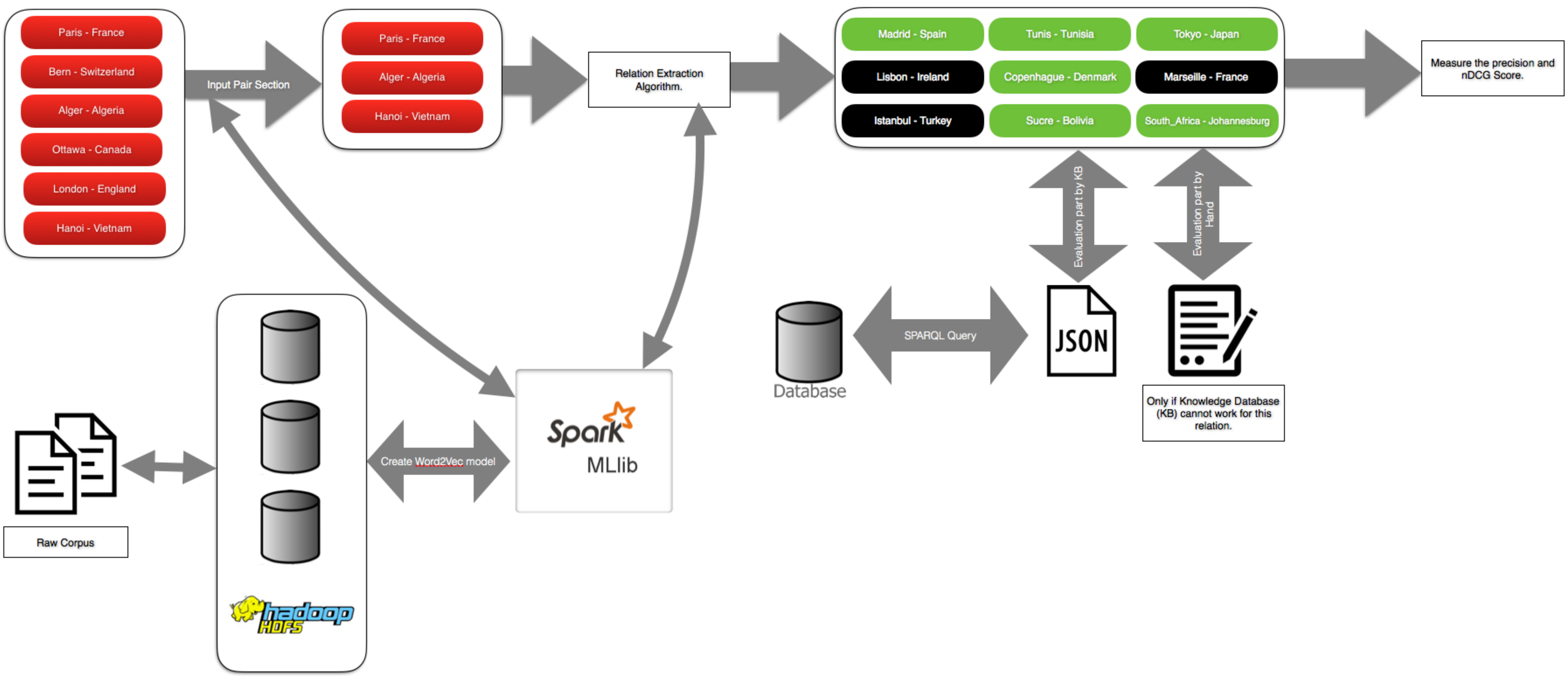
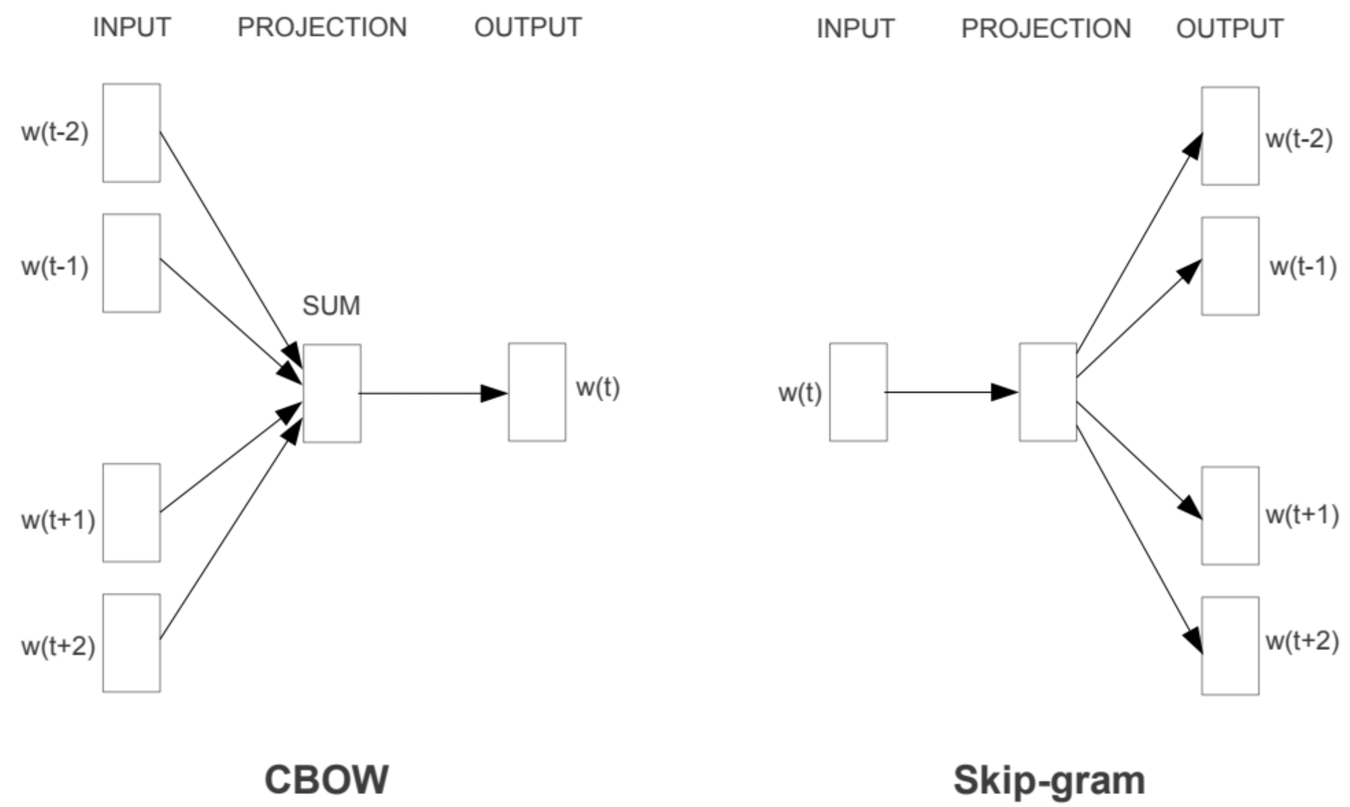


MAIN TECHNOLOGIES USED

- **Hadoop** for the Distributed File system HDFS.
- **Yarn** for the resource management (included in hadoop).
- **Spark** for the execution of our algorithms in a distributed environment (using hdfs).
- **Gensim** framework for the pre-processing tools.
- **Word2Vec** with **Spark** (MLLIB) and the Gensim implementation.
- **Wikidata** is a Free Knowledge Database (KB), more precisely a document-oriented database for Semantic Web.

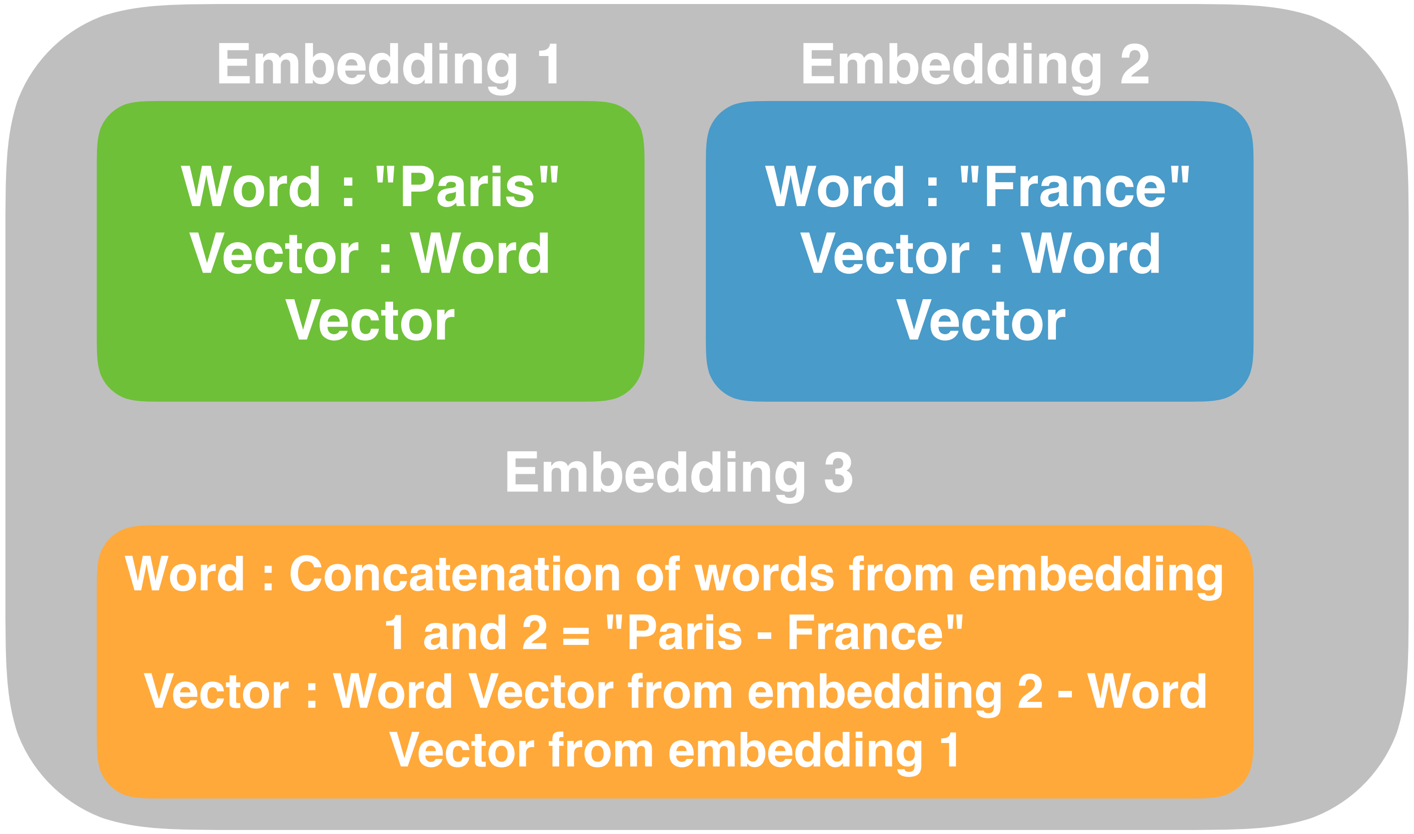
WORD2VEC QUICK OVERVIEW

- This algorithm produces word embeddings.
- Words from corpus are mapped to vectors in multi-dimensional space of real numbers. Each word is positioned in function of its context in the corpus.
- CBOW and Skip-gram architecture models.



PAIR STRUCTURE

- A pair is composed of 3 embedding instances.
- An embedding instance is composed of one word and its vector representation.



APPROACH

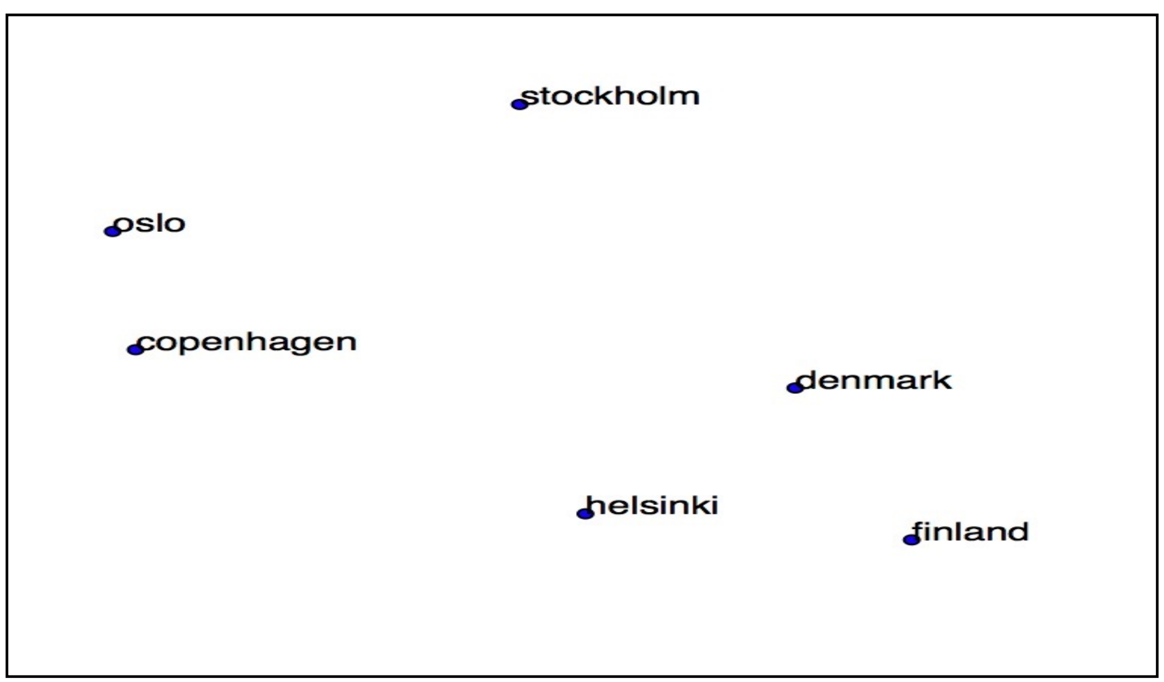
- Pre-processing
- Fitting the Word2Vec model
- Input Pair Selection Methods
- Relation extraction
- Evaluation
- Results comparison

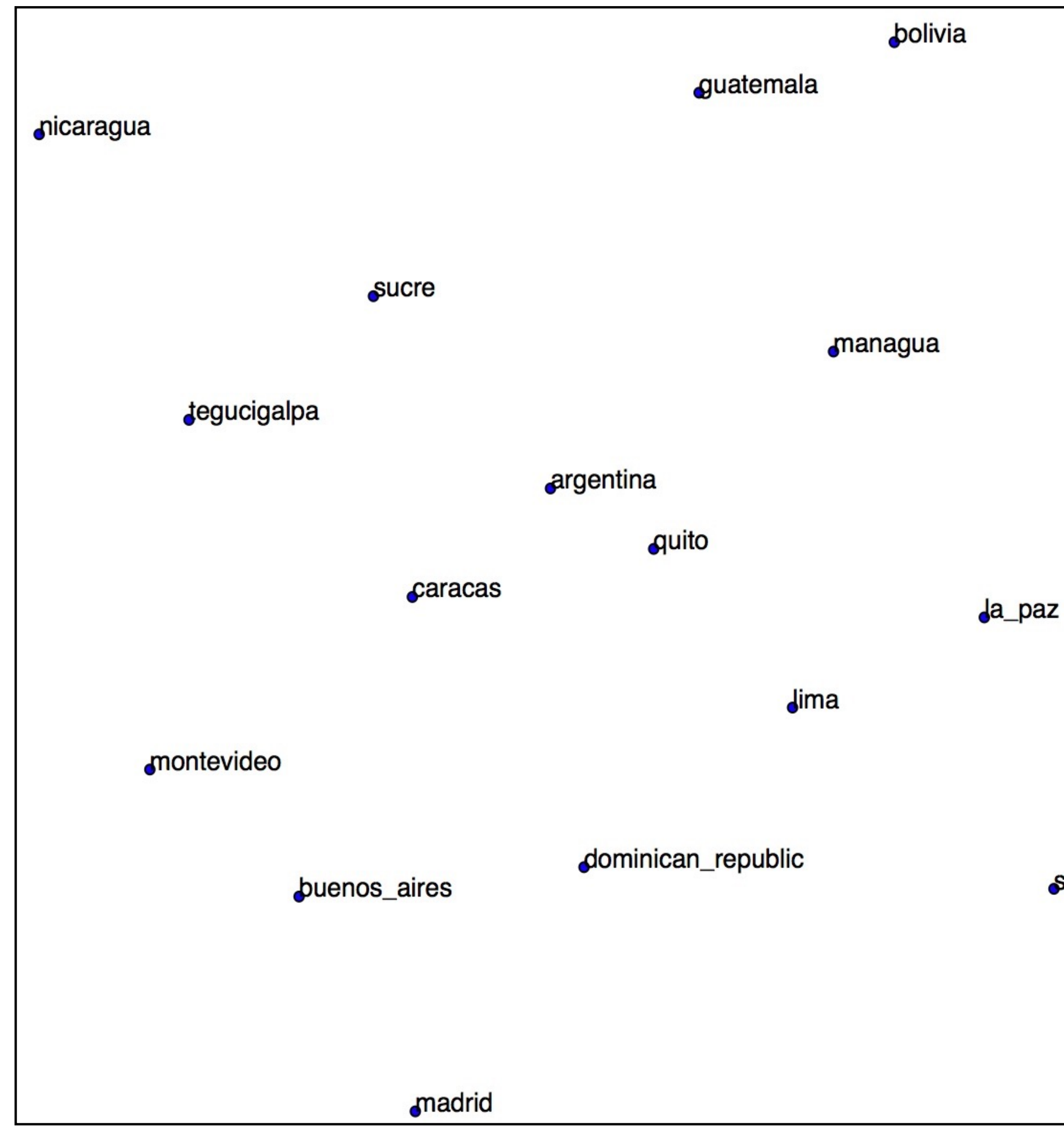
PRE-PROCESSING

- Select a global corpus from wikidata.
- Remove the XML Wikidata template.
- Transform upper case letters to lower case letters.
- Remove accent on letters.
- Remove non-ASCII characters.
- N-Gram (bi-gram, tri-gram and quadri gram).
- Stopword Lists .

FIT WORD2VEC MODEL

- Vector Size (Number of neurons)
- Min Count
- Window Size (Context)

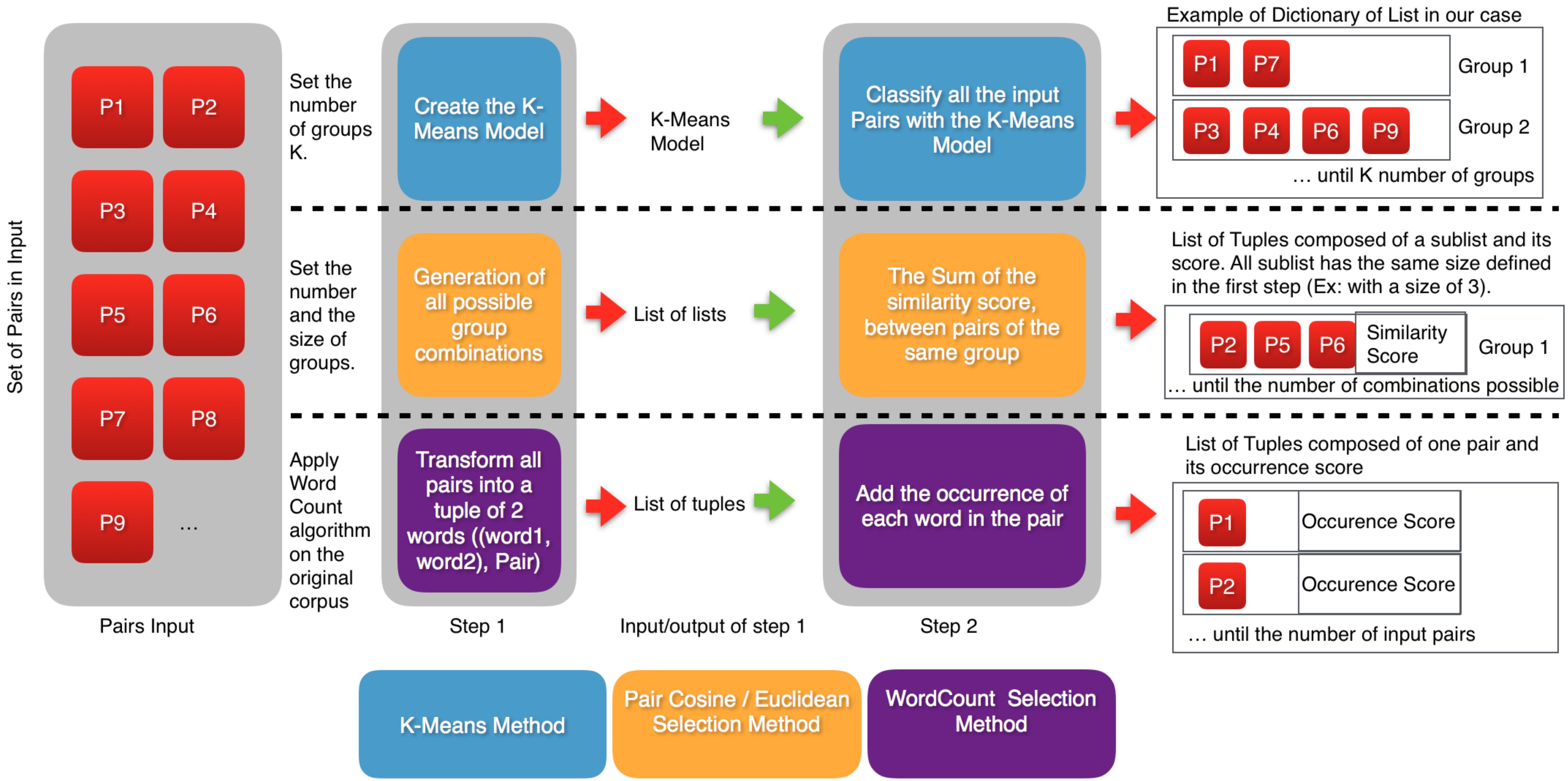




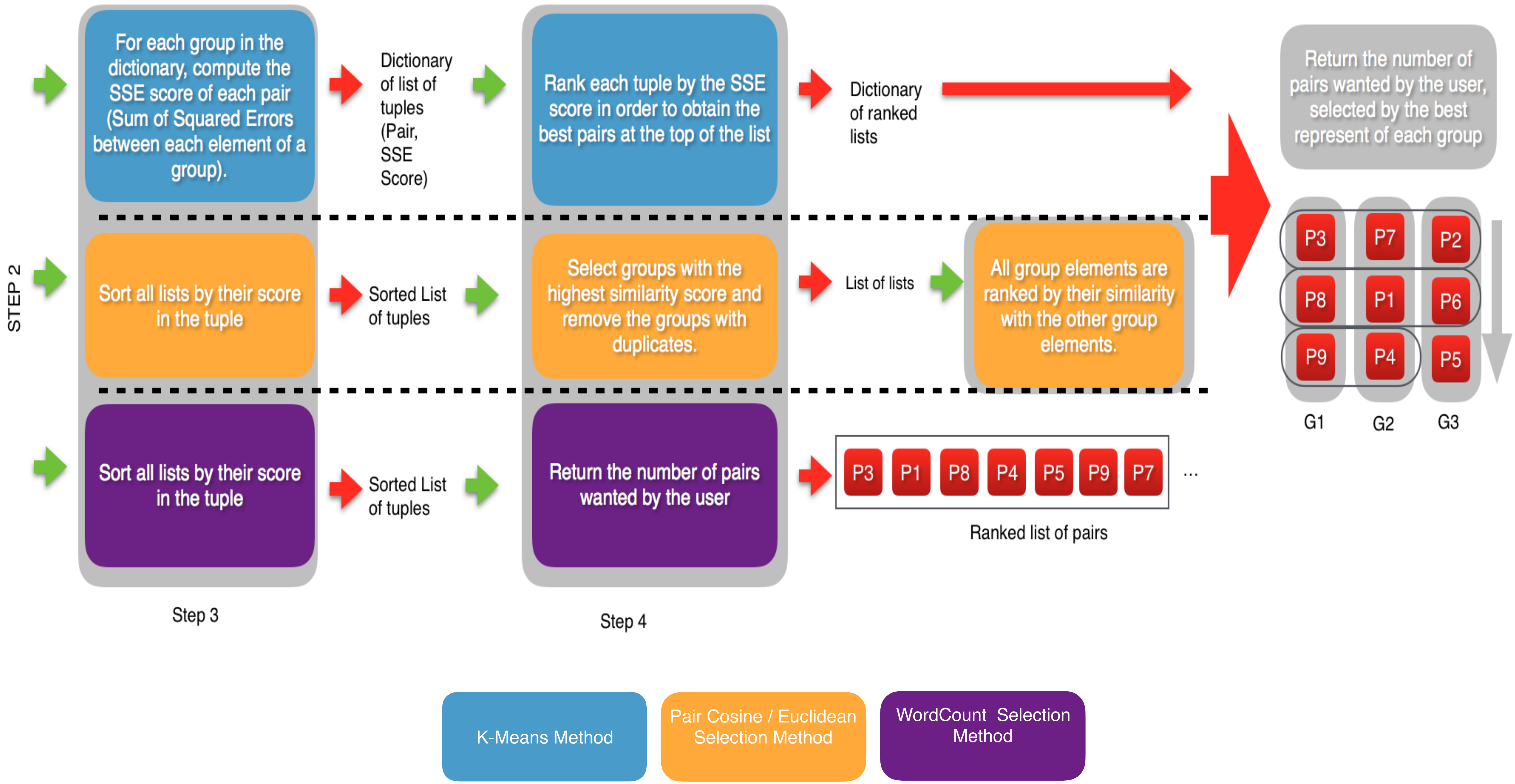
INPUT PAIR SELECTION

- Some input pairs are close in the multi-dimensional space.
- During the generation of neighbours we will obtain almost the same result for closest pairs.
- One of the objectives is to obtain a high precision and nDCG score with fewer input pairs as possible.
- 4 Methods :
  - **Word Count** Selection
  - **Cosine** and **Euclidean** Input Pair Selection
  - **K-Means** Selection

INPUT PAIR SELECTION – PART 1

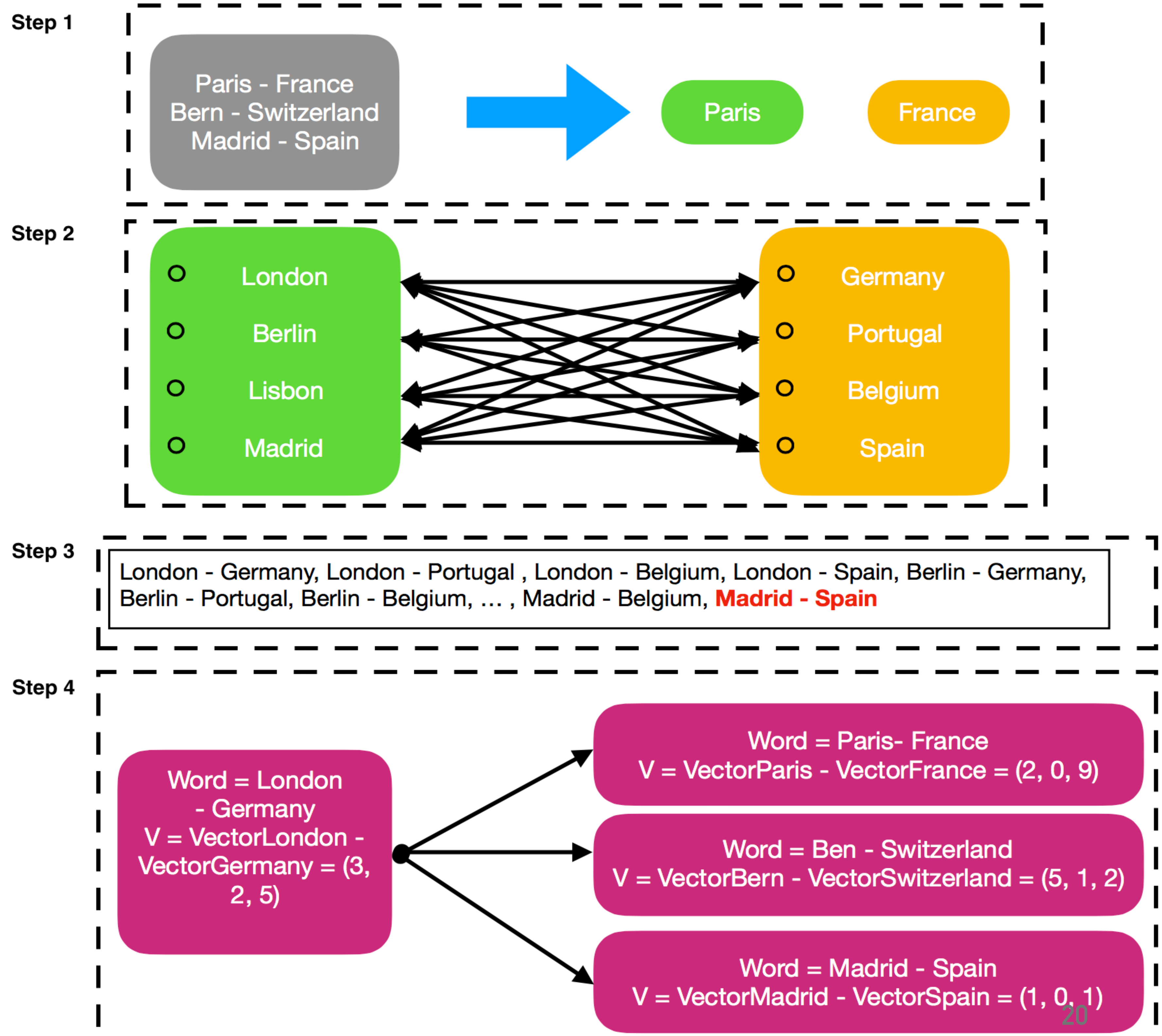


INPUT PAIR SELECTION – PART 2



PAIRS EXTRACTION

- Pairs used as Input for the algorithm
- Generate neighbours of each pair word and perform a Cartesian product between them.
- Each pair from the output list is compared to all the input pairs using a **Euclidian similarity.**



EVALUATION

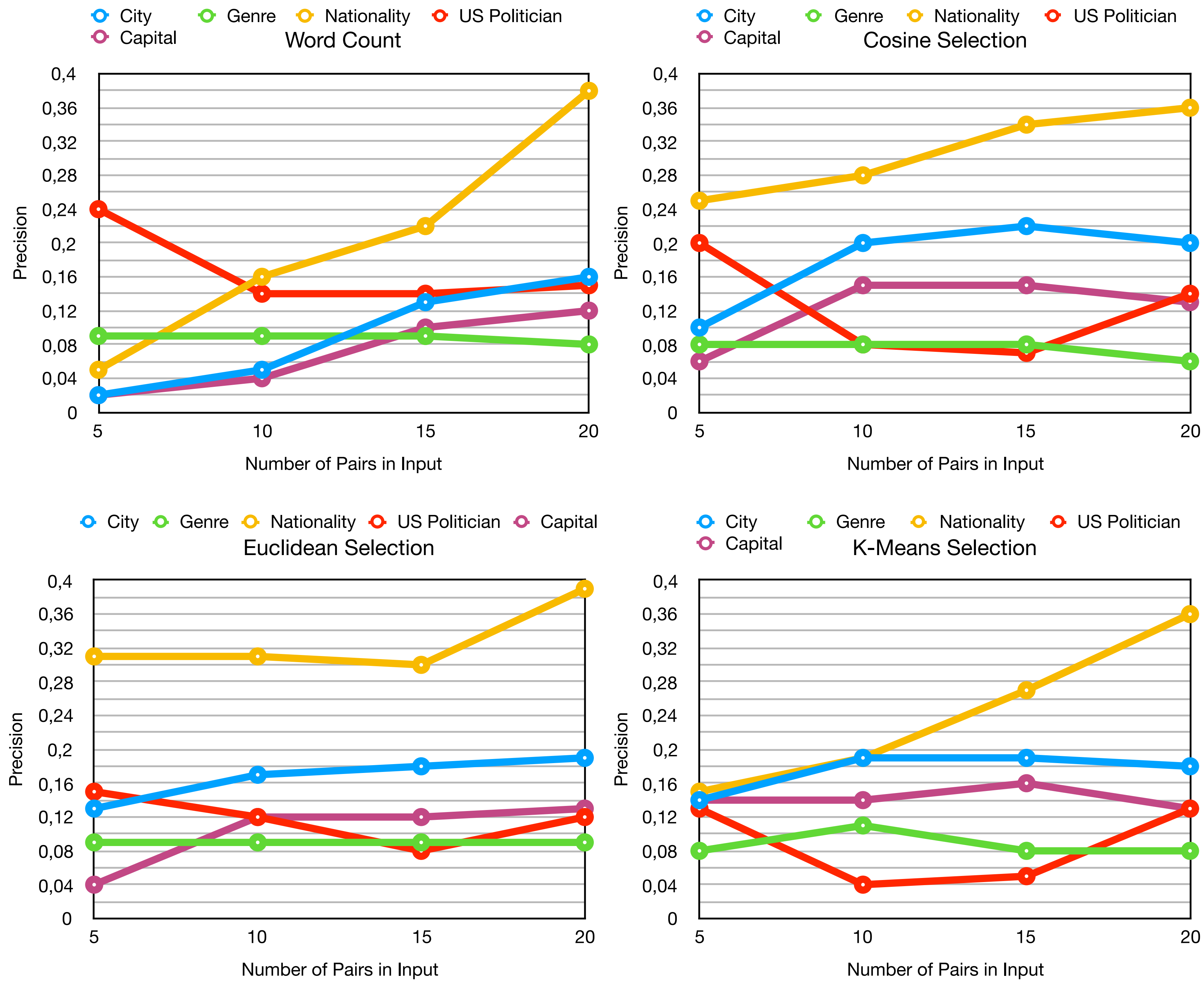
- Use a knowledge Base with Wikidata for binary evaluation
- Manual validation for more complex relation (e.g., Genre):
    - 2 : True relation (Barman - Waitress)
    - 1 : Half True relation (Bartender - Waitress)
    - 0 : False relation

NORMALIZED DISCOUNTED CUMULATIVE GAIN(NDCG)

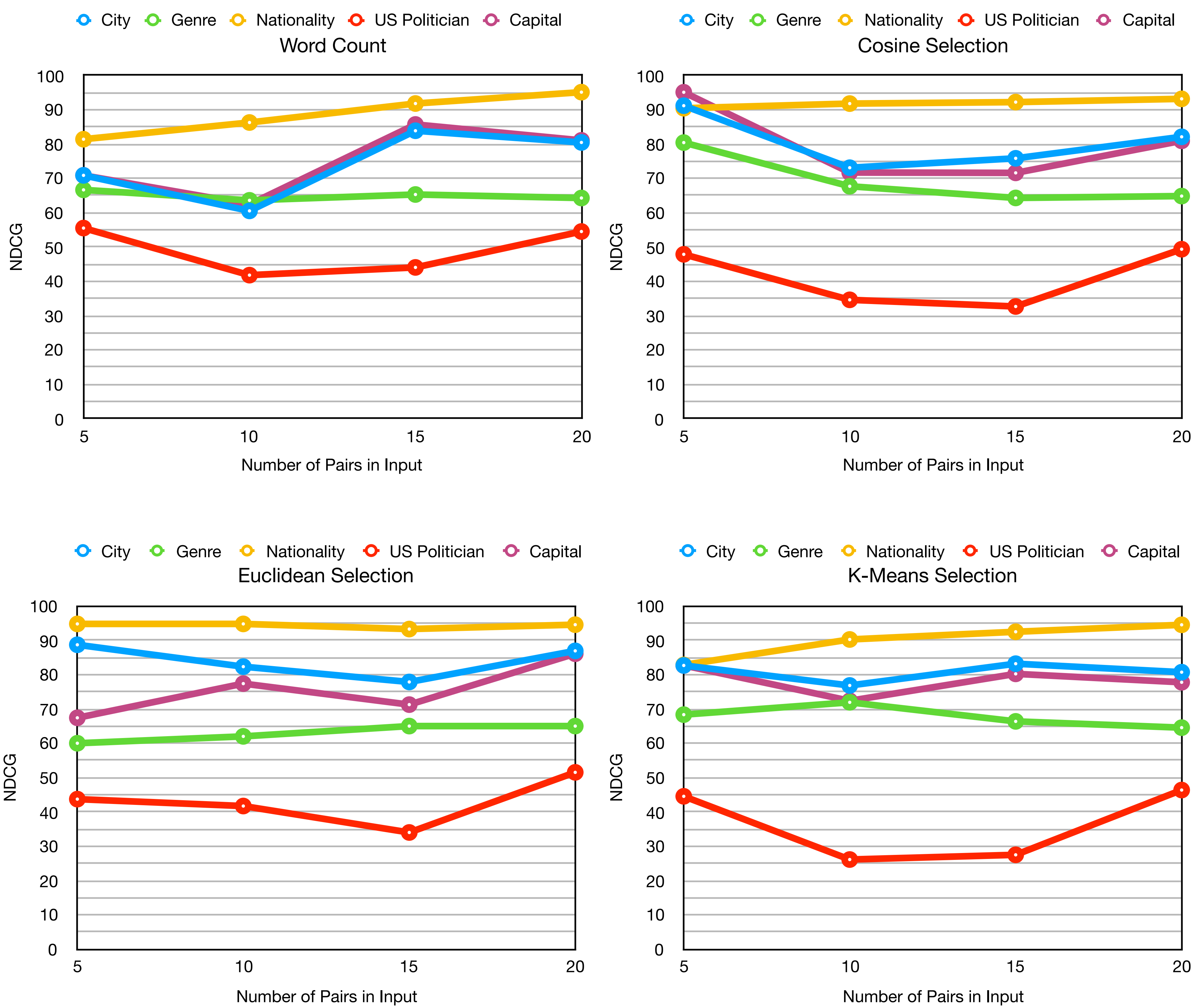
- Used to evaluate the extracted pairs(ranked).
- The nDCG score takes into account if a good candidate is correctly ranked.
- The DCG and the iDCG formulas are almost similar except for the rank order, in effect the iDCG formula sorts in descending order.
- **p** is the number of relations extracted and **rel** corresponds to the score of the relation **i.**

$$\mathrm{DCG_p} = \sum_{i=1}^{p} \frac{rel_i}{\log_2(i+1)} \qquad \mathrm{nDCG_p} = \frac{DCG_p}{IDCG_p}$$

PRECISION RESULT BETWEEN 4 METHODS

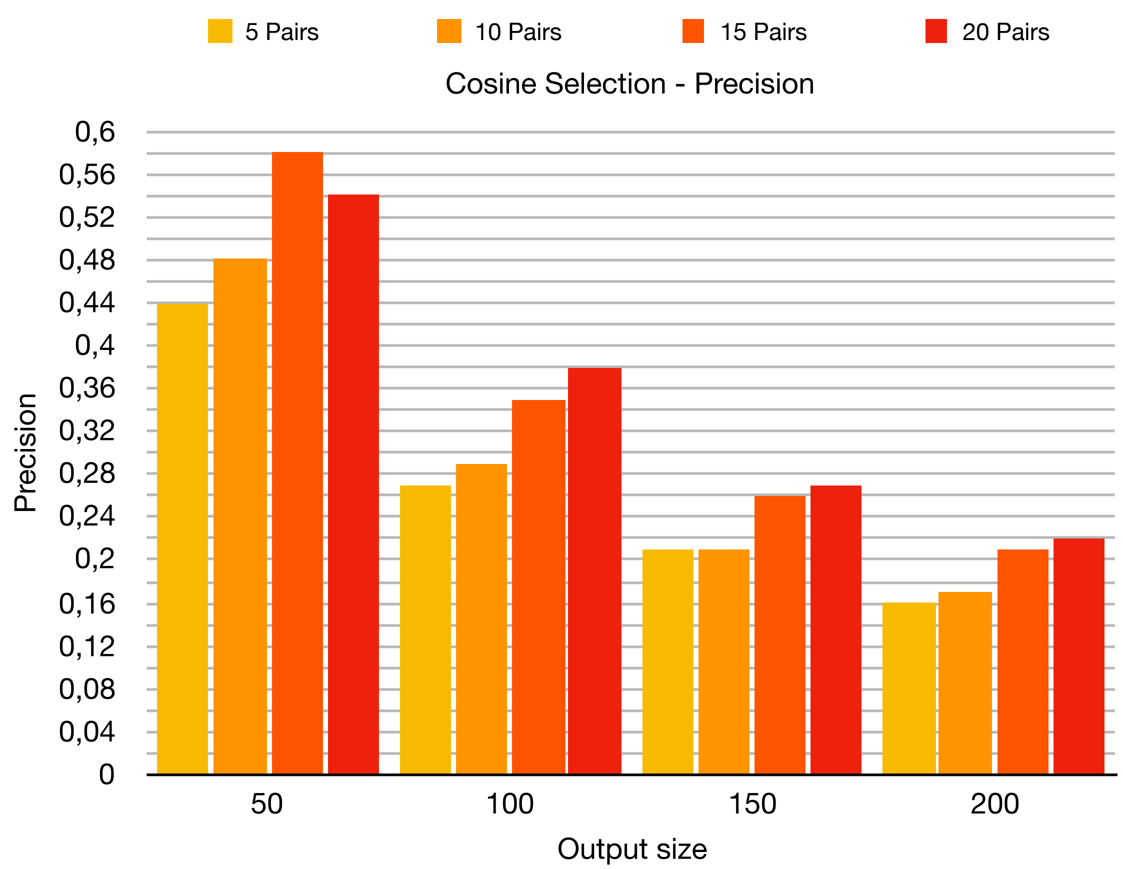


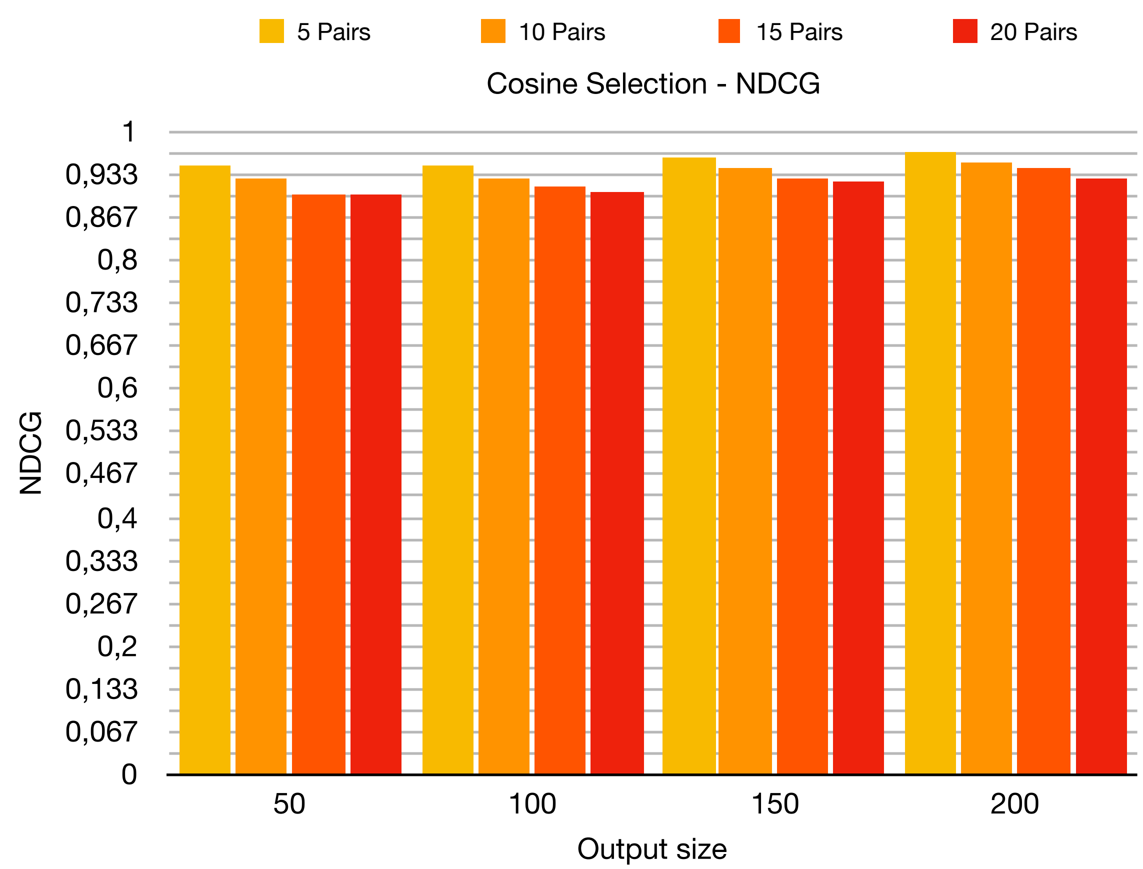
NDCG RESULT BETWEEN 4 METHODS



RESULT OF INCREASING THE NUMBER OF PAIRS RETURN

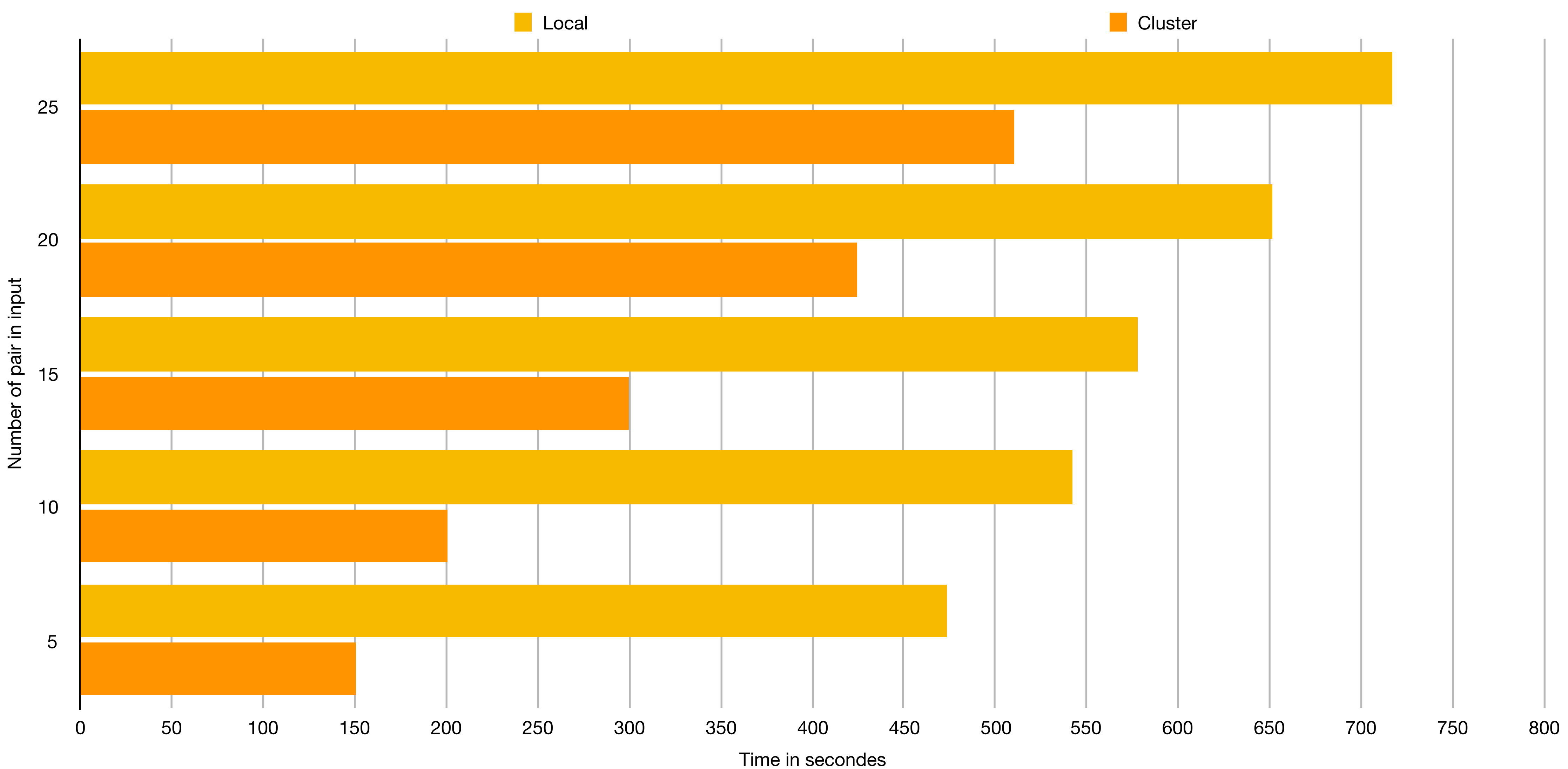
- For the precision we obtain almost the same « shape » with lower scores when the number of returned pairs increases.
- For the NDCG score the result is the same, so it is not affected by the number of pairs.





EXECUTION TIME

- We compare the Results with the original implementation
- Using fewer pairs in input (5 pairs instead of 20) can considerably reduce the execution time.



CONCLUSION

- This new implementation in distributed environment improves the computation time
- The corpus and the pairs chosen in input influence the extracted pairs.
- Input pairs selection methods improve the precision of the model with less pair in input.
- Evaluation can be done automatically.
- Word2Vec is very powerful for Relation Extraction.

FUTURE WORK

- Try our algorithms of « pair extraction » and our « input pair selection method » with other words embedding algorithms like GloVe from the Stanford NLP Group.
- One improvement can be to link the extracted information to a knowledge base of the type of relation, before the generation of similar words in the relation extraction part.

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