Link prediction in the Greek Web

1.
The problem

Let’s start by describing the problem

Link prediction

The setting involves a directed graph which nodes correspond to webpages and edges represent a link from one page to another

Edge Classification

Since our task is to predict edges we will use edges as observations to extract meaningful features. An edge consists of two nodes and the directed link between these two.

Dataset

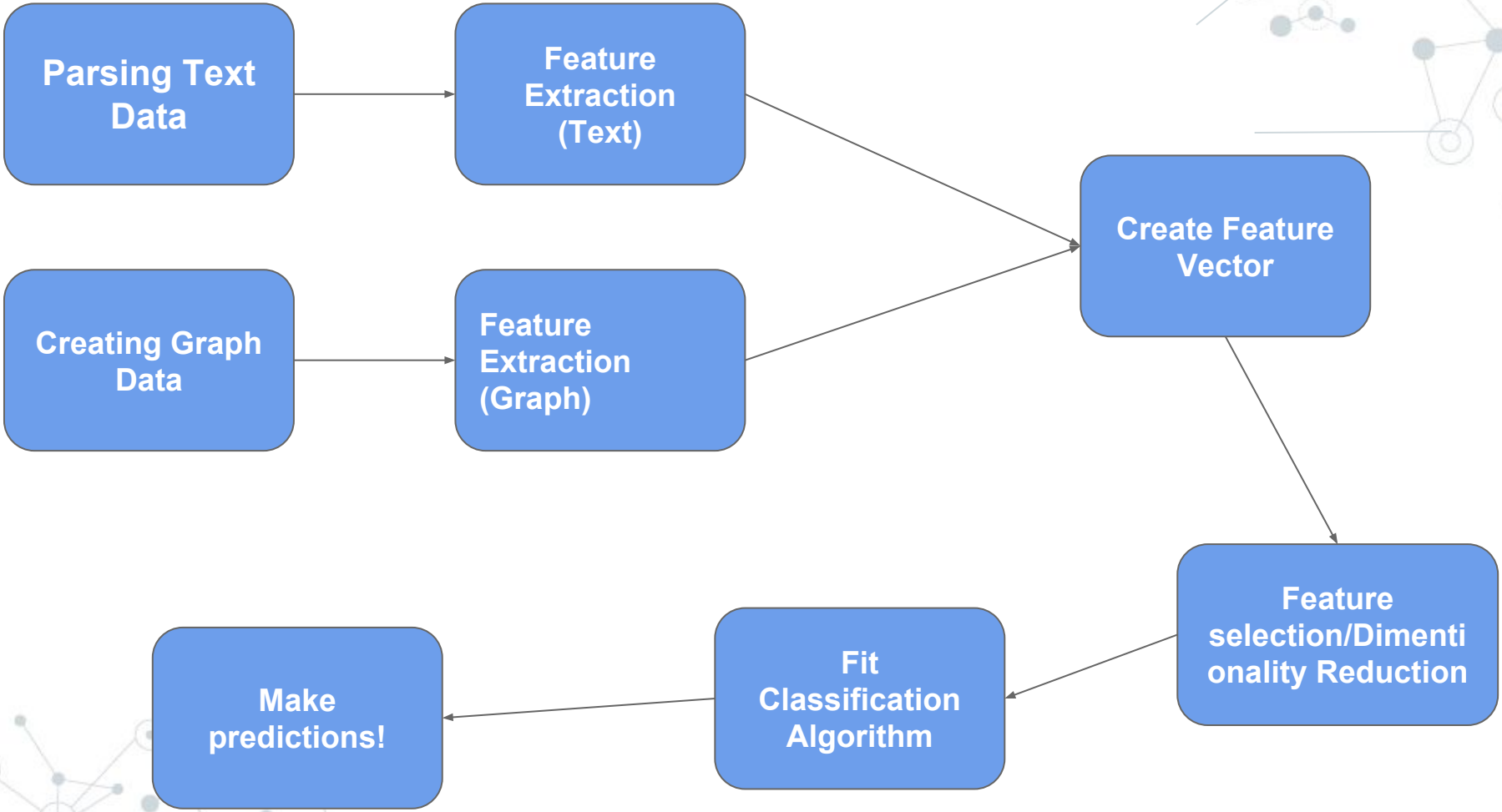
Graph Data

We have 2683 edges between that show links between 2041 webpages.

Text Data

We also have some raw texts from each webpage.

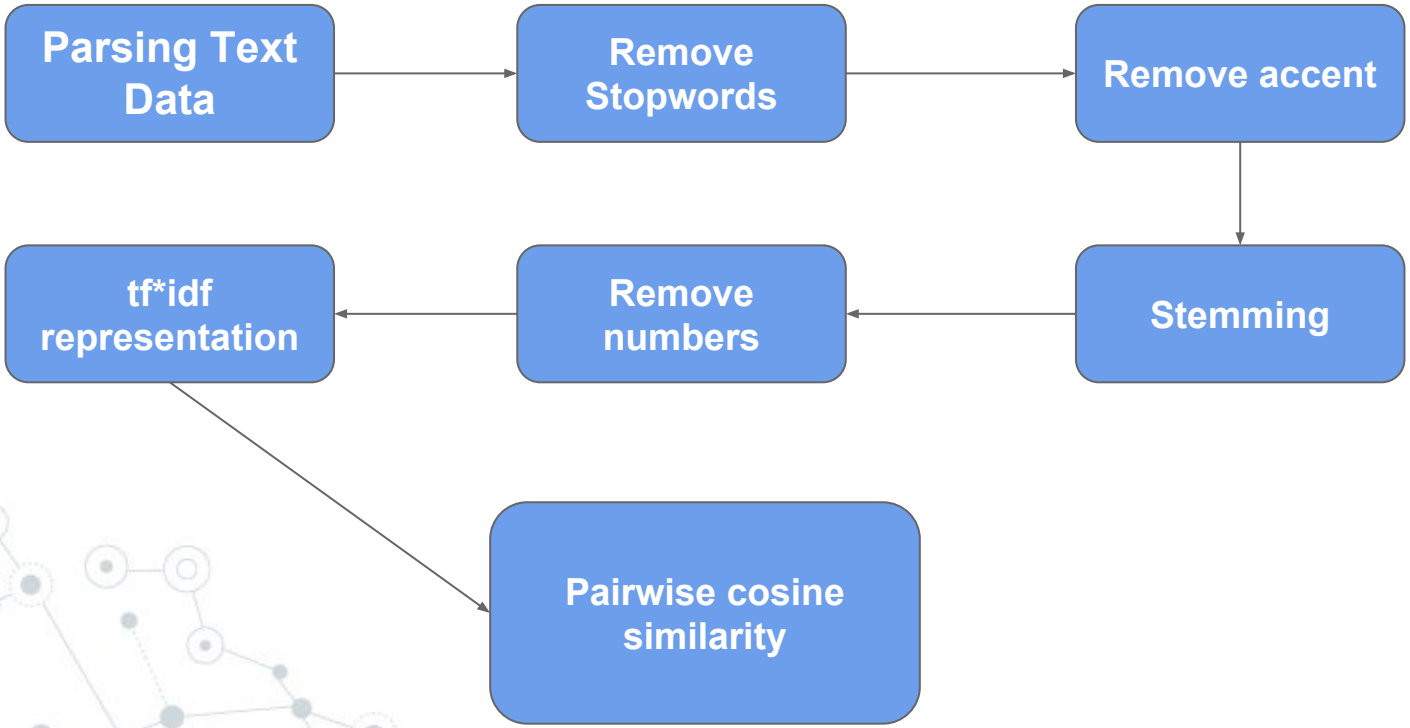
Classification pipeline



2.
Feature Extraction

Text Similarity

We compute text similarity between each pair of nodes



Graph Features

- Source out-degree
- Destination in-degree
- # common neighbors
- # of second neighbors

Graph Features: Centrality Measures

- Pagerank
- Eigenvector
- Betweenness
- Closeness
- Katz

Graph Features

- K-cores
- # of triangles
- Simrank
- Adamic adar
- Jaccard coefficient
- Preferential Attachment
- Resource allocation index

Graph Features: Community Detection

After applying the louvain method on the graph we obtain 605 communities. By exploring them we deal with some interesting communities like the following:

1: techgear.gr , prasinanea.gr , news247.gr , 24media.gr , oneman.gr , sport24.gr , huffingtonpost.gr , macuser.gr , ladylike.gr , contra.gr , redplanet.gr , olapaok.gr

2: arkadiapress.gr , arcadia-news.gr , arcadiaportal.gr , spartakos-dei.gr , kafeneio-megalopolis.gr , e-gortynia.gr

3:shootandgoal.com , briefingnews.gr , ikypros.com , tothemaonline.com , riknews.com.cy , lay-out.gr , dialogos.com.cy , onlycy.com , cyprusnet.gr , pafospress.com , sae.gr , cyprusrodos.gr , offsite.com.cy , cyprusnews.eu

Graph Features: Community Detection

We use 2 features that have to do with the extracted communities

- # of common neighbors in dst/src communities
- If src/dst co-exist in a community (boolean)

3.
Feature Selection

Feature Selection

We want to select the smallest subset of features that that better describe our data. These features better describe the variation in the response (if an edge should exist or not).
We are interested in examining the information gain of each candidate to answer the following:

How much does it help to reduce our uncertainty about the correct class?

Feature Selection

There are four approaches that can be followed for feature selection:

- Manual Feature Selection. We calculate statistics about each feature (min-max values, mean, variance). We discard features with very low variance(up to a threshold).Afterwards we also calculate the pearson correlation between each pair of features and choose to remove one of the features in each pair that shows a high correlation. High correlation between two features can make our model really unstable.

Feature Selection

- Use the feature_selection package available in scikit learn to do feature selection.
- Use a model that provides feature importance (eg Random Forests).
- Do no feature selection and use all features in a neural network or a tree based model

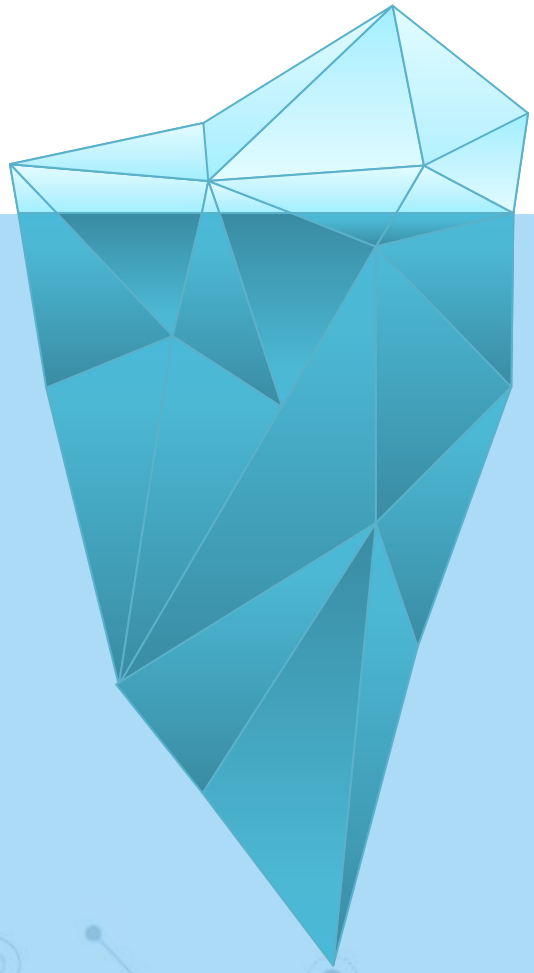
Considerations

Feature collinearity

Good feature subsets contain features highly correlated with the classification, yet uncorrelated to each other

Imbalanced dataset

We have a big number of non existing edge, opposed to the ones that actually exist



Complexity

We could examine other features like edge betweeness by adding and removing a candidate edge each time, but it would be too time-cosuming!

The Real World

Although we may find high similarity between two nodes eg. by examining text features, in the real world it would be unlikely for example that news247.gr has a link to newsit.gr!

4.
Classification

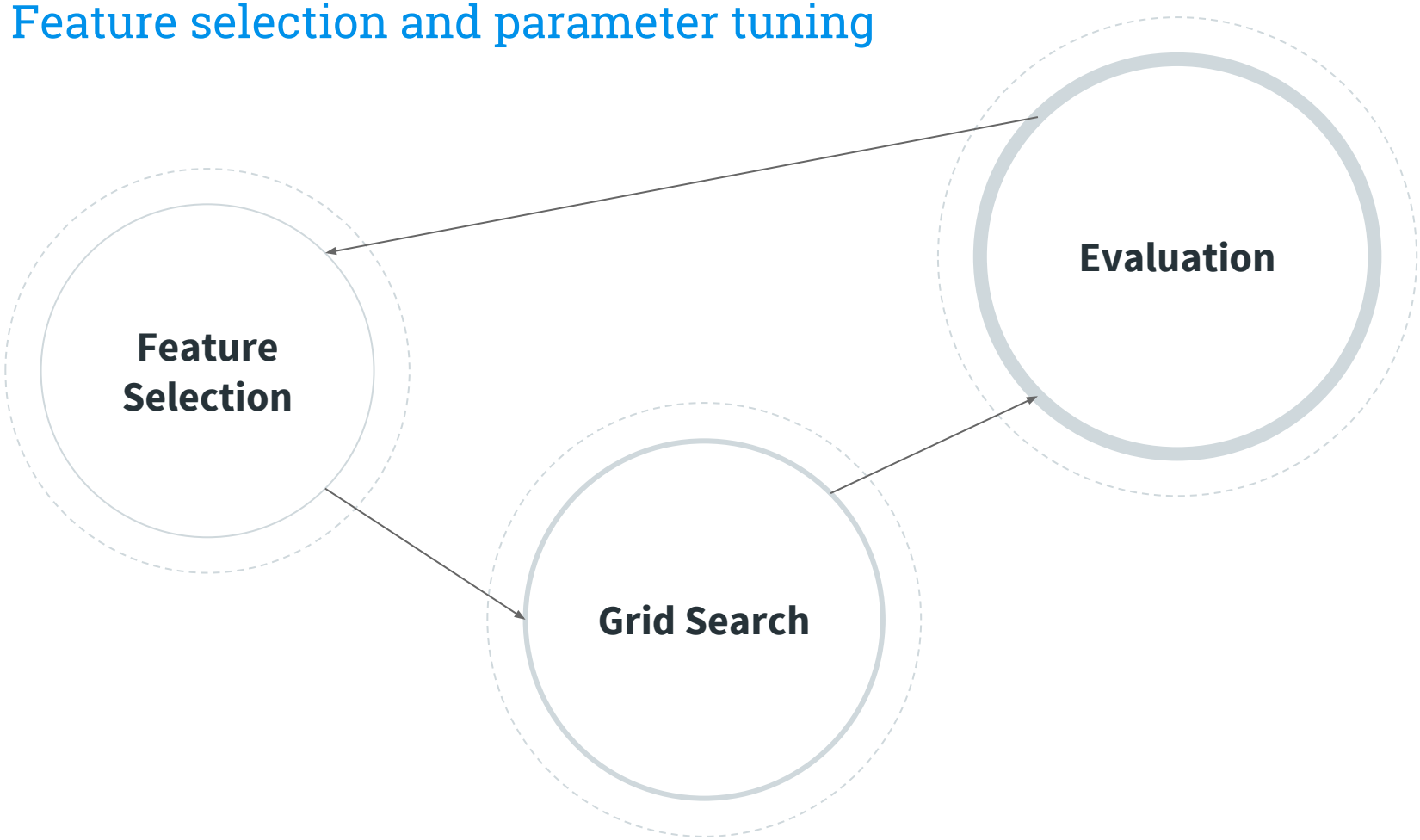
Classification Algorithms/Techniques

- Logistic Regression
- SVM
- Multilayer Perceptron
- XGBoost
- Random Forest
- Gradient Boosting Classifier
- Voting Classifier

Challenges

- Avoid overfitting (regularization)
- Hyper-parameter tuning (Grid Search)

Feature selection and parameter tuning



And tables to compare data

	Accuracy
Logistic Regression	**6.4%**
SVM	**8,6%**
XGBoost	**10,15%**
Random Forest	**10,31%**

Thanks!

Any questions?