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MIE 1624 Introduction to Data Science and Analytics – Fall 2022

Assignment 3

Objective:

(1) To web scrape data and extract skills from job descriptions (indeed)

(2) Use hierarchical clustering and K means to cluster the extracted skills.

(3) design a course curriculum for a new "Master of Business and Management in Data Science and Artificial Intelligence" program

1. Data Collection and cleaning

Data is collected from indeed, I have improved the code provided to scrape data (used the concept of parallelization) to reduce the run time from ~3.5hrs to ~17mins for 1000 job scraping. As for cleaning the data, not much is done as I have used spacy and SkillNer NLP model.

2. Exploratory data analysis and feature engineering

- Used a NLP model called SkillNer to extract skills, SkillNer is an NLP module to automatically Extract skills and certifications from unstructured job postings, texts, and applicant's resumes.
- That said it was very new and far from complete, has non-exist docs, therefore after spending a while on their github figured out how to make use of it. (more information and examples in Python notebook)
- Once the skills are extracted they are our features, and if they exist in description, then it is 1 if not 0 value in given.
- Around ~4000 were extracted but ,uch cleaning was required as model was overfitting the data.
- Finally ended up with 127 skills in around 1137 descriptions.
- some visualisations are below.

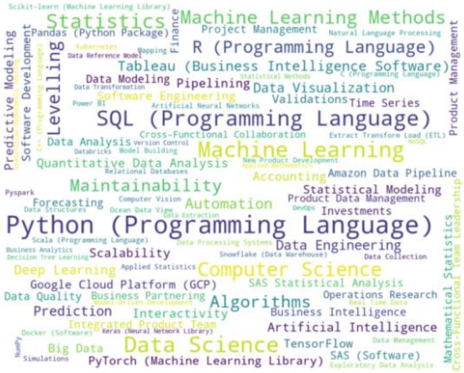


Figure 2 Hard skills WordCloud

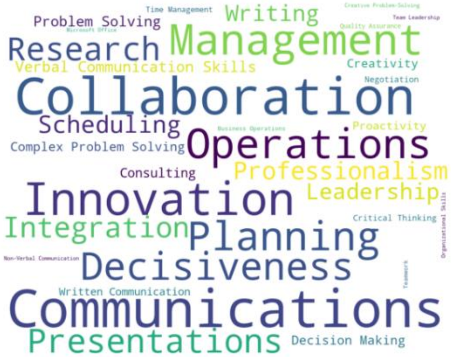


Figure 1 Soft Skills WordCloud

NOTE: Other visualizations such as all skills, salaries are available In python notebook

3. Hierarchical clustering Implementation

Distances plotted:

- cosine
- Euclidean
- Jaccard
- Hamming

Chosen: **Jaccard**

While all of these resulted in very similar dendrogram I have personally felt **Jaccard** distance one did better job.

Cosine is not suited as it is sensitive to repetitions of word (which we do not have any), same with Euclidean.

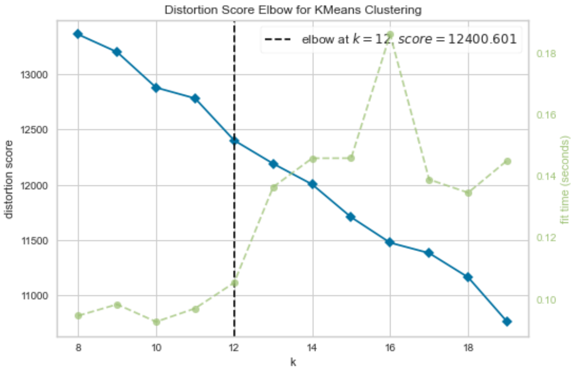
Hamming and **Jaccard** are suited for binary such as 1 and 0 in our case, Jaccard has advantage as it can work with any length whereas hamming expects the descriptions of be of same length.

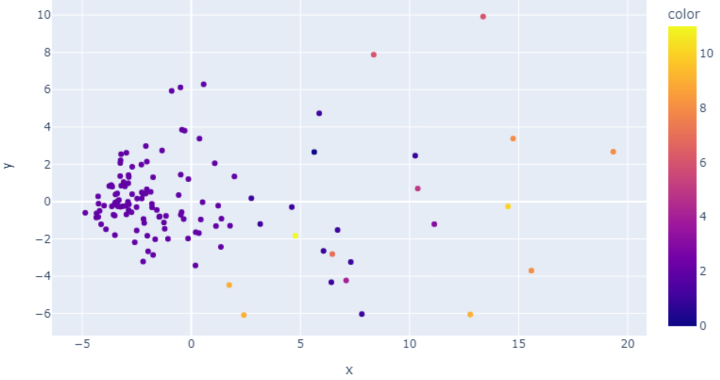
Clusters chosen 8, as we can see some of the clusters cannot lead to course by itself so looking all the courses, I believe.

All the graphs are available in Python Notebook. (they are very large to present here)

4. K-means clustering implementation:

After using elbow method I have got 12 clusters as the elbow point thus k means is done for 15 clusters, do note, the results when compared to Clustering are really bad, so I have did the k means again separately for hardskills and softskills, which made it slightly better but not better compared to hierarchical clustering.





5. Interpretation of results, discussion, and final course curriculum:

I chose hierarchical clustering to provide better results thus course made from it was way better. Adobe Illustrator is

K means

Courses using k means are as follows: (clusters are printed in notebook)

Using plotly tree

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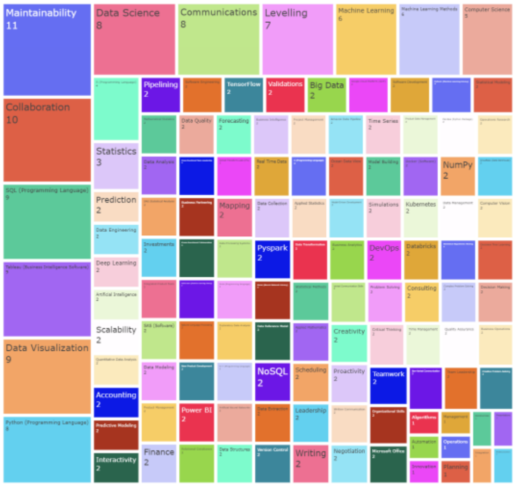

The numbers correspond to course:

1) Operations Management, 2)AI and Big Data, 3)Statistics for Data Scientists, 4) *R* for Data science, 5) Introduction to computer science, 6) Introduction to machine learning, 7) Highlighting yourself as leader, 8) Python for Data science, 9) Data Visualization, 10) Collaborations for engineers, 11) Maintainability in Data Science, 0)Research techniques for engineers

Note: High quality interactive plot for above is available in notebook, cannot bring it here without losing significant quality or consuming complete page, numbers in plot are the groups and match with numbers above

Hierarchical clustering

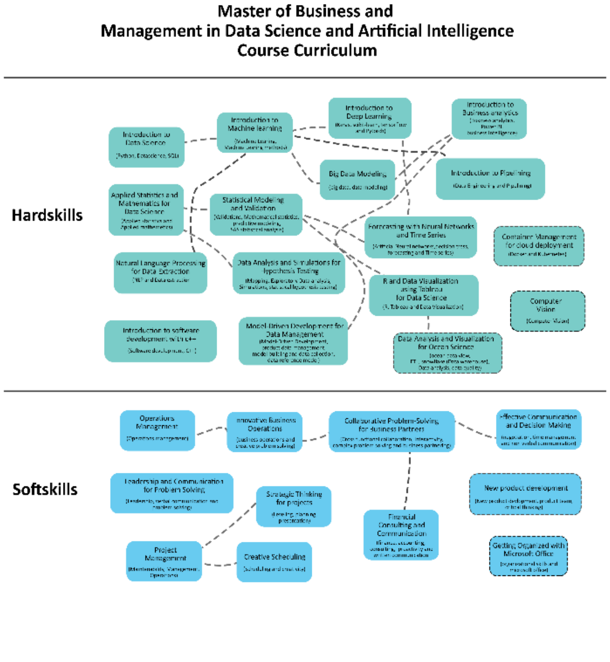
Master of Business and
Management in Data Science and Artificial Intelligence
Course Curriculum
Hardskills
Introduction to Data Science
Introduction to Machine learning
Introduction to Deep Learning
Introduction to Business analytics
Big Data Modeling
Introduction to Pipelining
Applied Statistics and Mathematics for Data Science
Statistical Modeling and Validation
Forecasting with Neural Networks and Time Series
Container Management for cloud deployment
Natural Language Processing for Data Extraction
Data Analysis and Simulations for Hypothesis Testing
R and Data Visualization using Tableau for Data Science
Computer Vision
Introduction to software development with C++
Model-Driven Development for Data Management
Data Analysis and Visualization for Ocean Science
Softskills
Operations Management
Innovative Business Operations
Collaborative Problem-Solving for Business Partners
Effective Communication and Decision Making
Leadership and Communication for Problem Solving
Strategic Thinking for projects
New product development
Financial Consulting and Communication
Project Management
Creative Scheduling
Getting Organized with Microsoft Office

Figure 4 For Bonus mark

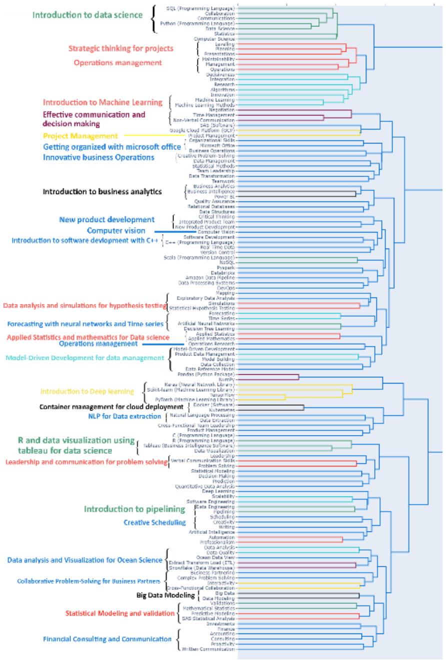

Figure 3 Hierarchial courses

Note: was trying to maintain the 3 pages limit, I will also upload (High quality) images independently