MIE 1624 Assignment 3 Report
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Part 1: Data Collection and Cleaning

For this part, I scraped data containing several on-site and remote jobs, most of which were US postings. There is a total of 4 datasets merged into one final dataset. For the cleaning process, all elements in the data frame “Description” column are converted to the lower letter and generated a new “Description-Lower” column for part 2 expository data analysis.

Part 2: Exploratory data analysis and Feature engineering

After part 1 data cleaning, The NLTK stop words library was implemented for stop words, and several customized stop words were also added to process the job description better. And finally, the “Description-Lower” column was used toward generates several words cloud. The following words clouds are generated as key information:

-Words cloud for all skills
-Words cloud for hard skills
-Words cloud for soft skills

Part 3: Hierarchical clustering implementation

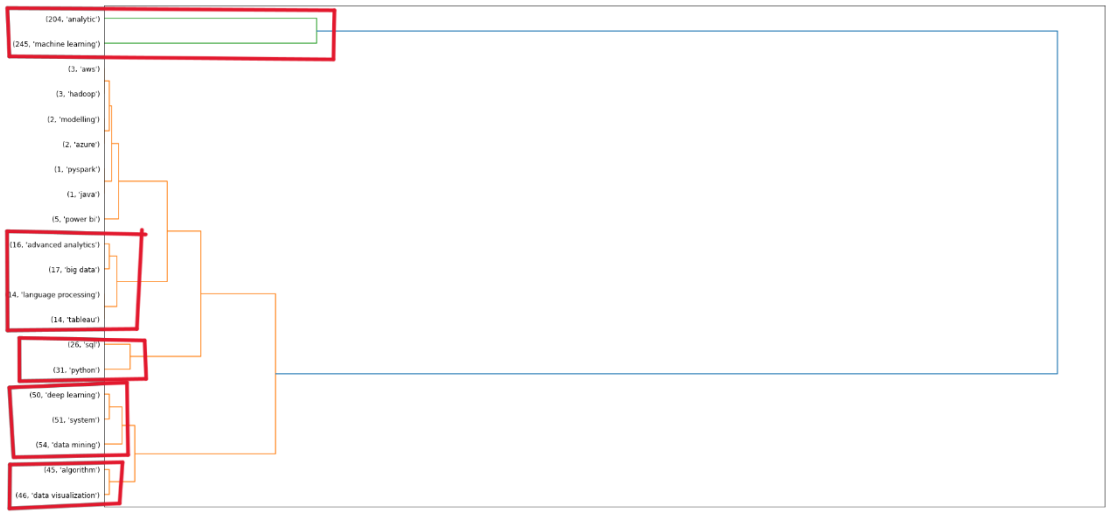
After part 2, the two lists of soft and hard(technical) skills are created to find essential skills employers require from candidates. For soft and hard skills, the program scraps the “Description-Lower” column, counts the total number of appearances for each word, puts it into one data frame, and normalizes it. After having two data frames,

Justification: Hierarchical clustering was implemented based on the count of skills keywords frequency. In that way, we can observe the most wanted skills and filter the skills demand by different clusters, which is more precise than visually inspecting the skill frequency bar plot. Clusters will be used to design electives and mandatory courses or create a new course that fits those skill clusters if those skills are relevant. Based on that thought, two dendrograms were generated for technical and business skills.

The skill dendrograms show that many skills clustered together are closely related. From the hard skill dendrograms, we choose the following clusters (rank by demand descending order):

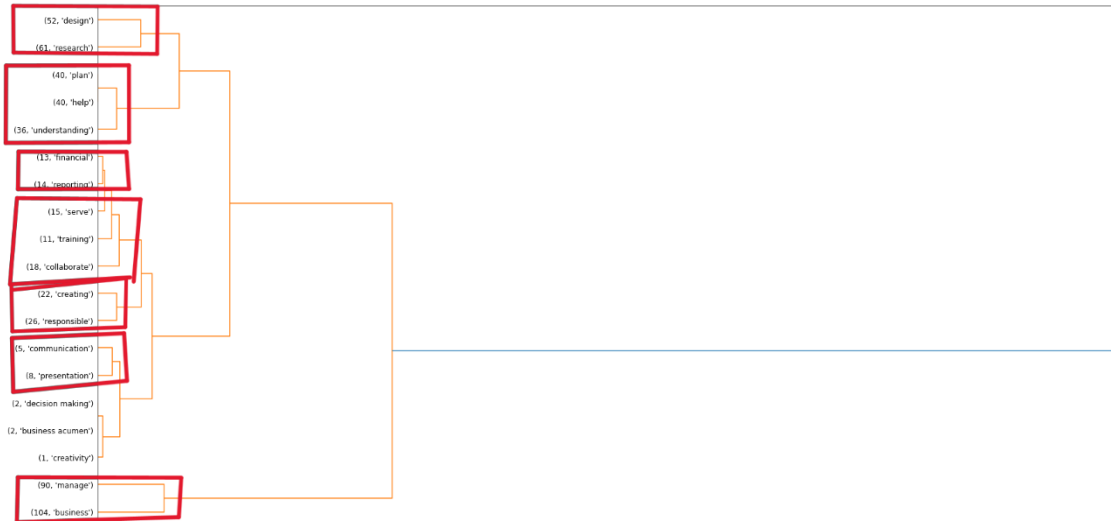
Analytic Skills	Analytic, Machine Learning
Artificial Intelligence Skills	Deep learning, System, Data Mining
Data Visualization and Algorithm	Algorithm, Data visualization

Design Skills	
Database Skills	SQL, Python
Advanced Data Processing and Visualization Skills	Advanced analytics, Big Data, Language processing, Tableau



The soft skills clusters are as follows.

Management Skills	Business, Manage
Research and Creativity Skills	Design, Research
Fundamental Social Skills	Plan, Help, Understanding
Design Skills	Creating, Responsible
Teamwork Skills	Serve, Training, Collaborate
Financial Skills	Financial, Reporting
Communication Skills	Communication, Presentation



From the above clusters, we may consider their frequencies to determine the core, major and elective courses. The pro of this approach is that we can find

top-demanded skills separately, and the curriculum can reflect technical and business skills. The cons are that soft and hard skills courses are designed independently, and we need newly designed courses that combine soft and hard skills.

Part 4: K-mean clustering

For this part, the elbow method using distortion was implemented to determine the best k for k mean clustering. From the plot, we observed that when k=11, the decreasing distortion rate tends to flatter. Therefore, the k value will be set to 11. The clustering method will combine hard and soft skills to see if the curriculum can recommend courses without separating technical and business courses. Therefore, the two data frames obtained from part 2 were combined into one for k means clustering to see if high-demand hard and soft skills can be integrated into a new course.

Clustering Result:

Skills	Cluster
Business, Analytics	1
System, Deep Learning, Research, Lead	2
PowerBI, Hadoop, AWS, Azure, Reporting, Financial, Training, Presentation.	3
Modelling, Java, Pyspark, Communication, Business acumen, Decision marking.	4
Algorithm, help	5
Tableau, Language Processing, Collaborate, Serve	6
Python, SQL, Plan, Understanding	7
Advanced Analytics, Creating	8
Data Mining, Managing	9
Big Data, Responsible	10
Machine Learning, Learning	11

The above clusters show that top-demanded soft and hard skills are viewed as one cluster, an advantage that helps design new courses that can target and combine those skills. However, it may also cause that all courses are business oriented, but some technical courses only sometimes need business skills.

Part 5: Interpolation of result and Final Curriculum

Hierarchical Clustering course curriculum

After hierarchical algorithm clusters, many essential skills related to data science are determined. We want to design most skills clusters as courses. Fortunately, the University of Toronto already offers most courses for those skills. The new course will be implemented when designing the curriculum for some clusters that current courses cannot fulfil.

Master of Business and Management in Data Science and Artificial Intelligence

Technical Courses:

Course Title	Topics
MIE1624: Introduction to Data Science and Analytics	Analytics, Machine Learning, Python
MIE1517: Introduction to Deep Learning	Deep learning
INF1343: Data Modelling and Database design	SQL
CSC2537: Information Visualization	Data Visualization
CHE1147: Data Mining in Engineering	Data Mining

MIE 1624 can be replaced by APS 1070: Foundation of Data Analytics and Machine Learning

Business Skills:

STA2453: Data Science Methods, Collaborations, and Communication	Communication, Collaboration
MIE1622: Computational Finance and Risk Management	Financial

Electives (Both technical and business skill):

RSM1282: Statistics for Management	Management
APS1070: Foundation of Data Analytics	Analytics, Machine Learning, Python

K-means Clustering course curriculum.

Due to substantial irreverent skills, some soft and hard skills in one cluster cannot be combined into one course. But to fill this gap, the curriculum can be designed with more business courses or take courses from other university departments.

Master of Business and Management in Data Science and Artificial Intelligence

Course Title	Topics Related Clusters from Part 4
MIE1624: Introduction to Data Science and Analytics	10
MIE1517: Introduction to Deep Learning	2
INF1343: Data Modelling and Database design	7
MIE1622: Computational Finance and Risk Management	3,11
RSM1282: Statistics for Management	9,10
CSC2537: Information Visualization	3
New Course 1: Applied Data Science in Financial Sector	3
New Course 2: Business Programming Application	4

Combining two curriculums as Final Curriculum

From those two curriculums, we can find that the curriculum from K-means is more business-oriented. Still, in general, both curriculums are similar, and it is unlikely to combine some soft and hard skills as one course. In conclusion, Curriculum from Hierechicial Clustering will be modified for students who have more interest in Business. We can create a specialization in Business and develop additional courses for those students to earn that specialization.

Final Course Curriculum combined from Part 4 and Part 5:
Master of Business and Management in Data Science and Artificial Intelligence

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APS1070: Foundation of Data Analytics	Analytics, Machine Learning, Python

Optional Business Specialization Courses (Choose two of three to earn specialization):

New Course 1: Applied Data Science in Financial Sector	Big Data, Financial
New Course 2: Business Programming Application	Business, Java, Python, Pyspark
APS1088: Business Planning and Executions for Canadian Entrepreneurs	Business, Planning