Data Mining:

Individual project

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# Introduction

The answers to a questionnaire answered by the students of this year’s Data Mining course has been published and given this data it is wanted to perform data mining techniques to be able to classify, recognize patterns and cluster the data points.

This report and implementation focuses on the implementations of the algorithms. They should be generic and able to handle any data points given to them if they conform to certain standards. Furthermore, for classification and clustering two different implementations have been given to be able to access and compare their effectivity and correctness.

The implemented algorithms and the examined questions are the following:

* K-Nearest Neighbors and ID3
  + *Can the gender of a participant be predicted from an Answer?*
* Apriori
  + *Is it possible to recognize patterns in which programming languages the participants are proficient in?*
* K-Means and K-Medoids
  + *Does answers cluster on which degree the participant is pursuing?*

The program can be run from the main of IndividualProjectRunner class and every result shown in this report has been created using seed value 1 which can be provided as the first command line argument.

# Pre-processing

Several techniques are used in the preprocessing phase.

## Data Cleaning

Certain rules have been put up for the dimensions of the data points. For example, for the numeric attribute “age” the value must be between 18 and 65 to be able to handle faulty entries(one entry had value 999 which does not seem likely). If the data point does not abide the rules then the data point is not added. This is a very strict policy and could entail bias in the results.

Furthermore, most multiple choice answers have been converted to Enums and the answer given in the “other” option have been discarded. For the given dataset, the approach seem fine since only two people have entered values in the other option. Should the dataset change it would be necessary to study the new data points to see if any new answers have been added. I

The question about which languages the participant was proficient in had no premade choices and the answers were explored. To match the same answer written in different ways multiple matches map to the same Enum result. The “Gender” attribute has been matched to a binary nominal attribute for either Male or Female which matches all the answers.

Several attributes have been disregarded due to time issues with fitting them to the data structures.

Most of the data cleaning can be seen in the class AnswerDataLoader.

## Aggregated Data

The three data types which consists of multiple answers, proficient languages, commute means, and games played are also represented in another attribute describing the amount of these values. This allows us to remove the sequences in some of the algorithms while still having some reduction of the same data.

## Normalization

Both the only original numeric value “age” and the aggregated attributes are normalized after the outliers have been removed to ensure less skewed results. Normalization can be seen in the class Normalizer.

# Classification

To be able to classify a data point a specific attribute is picked as the classification attribute. To compare and assess KNN and ID3 the gender attribute has been picked. Since it is a binary nominal value a confusion matrix can be created for both methods. All attributes are used for both of these methods and a training sample size of 48, and test size of 17 is used.

|  |  |  |
| --- | --- | --- |
|  | **K-Nearest neighbors** | **ID3** |
| True positives(female) | 3 | 0 |
| False positives | 1 | 4 |
| True negatives (male) | 13 | 13 |
| False negatives | 0 | 0 |
| Accuracy | 94.1% | 76.4% |
| Error rate | 5.88% | 23.5% |
| Sensitivity | 75.0% | 0.0% |
| Specificity | 100% | 1.0% |
| Precision | 75.0% | 0.0% |
| F-score | 75.0% | NAN |

ID3 does not seem to ever categories data points as females, but by picking other sample sizes and different seeds did show some flexibility in the model. Generally K-nearest neighbors performs the best but it is difficult to assess anything with the small sample sizes.

# Pattern mining:

Apriori is implemented to do pattern mining. Specifically a support threshold of 10% and a confidence threshold of 80% is used. All data points and all attributes of the data points are used.

* AssociationRule: [[FSharp] => [CSharp, Java]] with confidence: 84%
* AssociationRule: [[Cpp] => [CSharp, Java]] with confidence: 82%

These values have a high support in the data set and furthermore a high confidence which does seem entail that participants who know F# or C++ also know Java and C#

# Clustering

K-Means and K-Medoids are used as clustering algorithms. All data is used but for K-Means any sequence attribute (which games, proficient languages and commute means) are omitted. To measure, compare and answer the hypothesis, the percentage of the most common “degree” of a cluster is calculated. The amount of clusters was decided experimenting and k=4 seemed to provide the best results.

|  |  |  |
| --- | --- | --- |
| **Cluster** | **K-Means** | **K-Medoids** |
| Most common: SDT-DT | 42.8% | 64.7% |
| Most common: SDT\_DT | 66.6% | 66.6% |
| Most common: SDT\_SE | 57.1% | 43.3% |
| Most common: Games-T | 83.3% | 40.0% |

The two methods seem equally bad at clustering the data points, this is probably due to the high dimensionality of the data points and might prove better if only the “Games played”, “Proficient Languages” and “Age” attributes were used.

# Conclusion

Generally, the algorithms do seem to pick up some patterns, but they struggle due to the low volume of data and its high dimensionality. One could reduce the number of dimension by looking at correlations among certain attributes and then use only those. To accumulate more data, several years of questionnaires could be combined.