STUTERN

Feature Engineering (2)

SGA07_DATASCI

4th Febraury 2020

Module Overview

- Data Integration & Reduction
- Data Transformation & Discretisation

Book Keeping

- Peer Reviews
- Guest Lectures
- Sort into 3 Groups
- Catch up on Tasks/Practice Labs so far

Outcome

After this Module, you will;

- Overview of data integration and reduction as part of the preprocessing tasks.
- Explore some techniques for data integration and reduction: Attribute matching and correlation analysis
- Overview of data transformation and discretisation as concluding part of preprocessing tasks
- Explore how to write a custom function for equal-width approach to discretisation

Data Integration

- Attribute matching
- Correlation analysis
- Tuple duplication
- Data Value detection

> This step can help to reduce and avoid redundancies as well as inconsistencies in your data as well improve accuracy and speed of other steps in the data science process.

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Attribute Matching

Data integration can be done by referring to the metadata of various sources to effectively match attributes from various sources.

Jss 1 Science

Student_ID	Height
3	167
8	148
15	135

Jss 1 Art

ID	Height
1	165
2	135
5	176

Jss 1

Student_ID	Height
1	165
2	135
3	167
5	176
8	148
15	135

Correlation Analysis

- Nominal Data
- Numeric Data

> Correlation analysis enables the detection of redundancy in your data, when one attribute is derived from another with implicit rules attached

Nominal Correlation Analysis

> The chi-square or Pearson Statistic is used to evaluate correlation relationship between two nominal attributes

$$\tilde{\chi}^2 = \sum_{i=1}^{n} \sum_{j=1}^{m} \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

A	B
a1	b3
A3	b2
A4	B4
A1	B1
A2	B3
A3	B2
A2	b4
A4	b1
A3	B2

	B1	B2	B3	B4	Total
A1	1		1		2
A2			1	1	2
A3		3			3
A4	1			1	2
	2	3	2	2	9

Numeric Correlation Analysis

> The correlation coefficient or Pearson's product moment coefficient is used to evaluate correlation relationship between two numeric attributes

$$r = \frac{\sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n} (x_i - \bar{x})^2} \sqrt{\sum_{i=1}^{n} (y_i - \bar{y})^2}}$$

Data Reduction

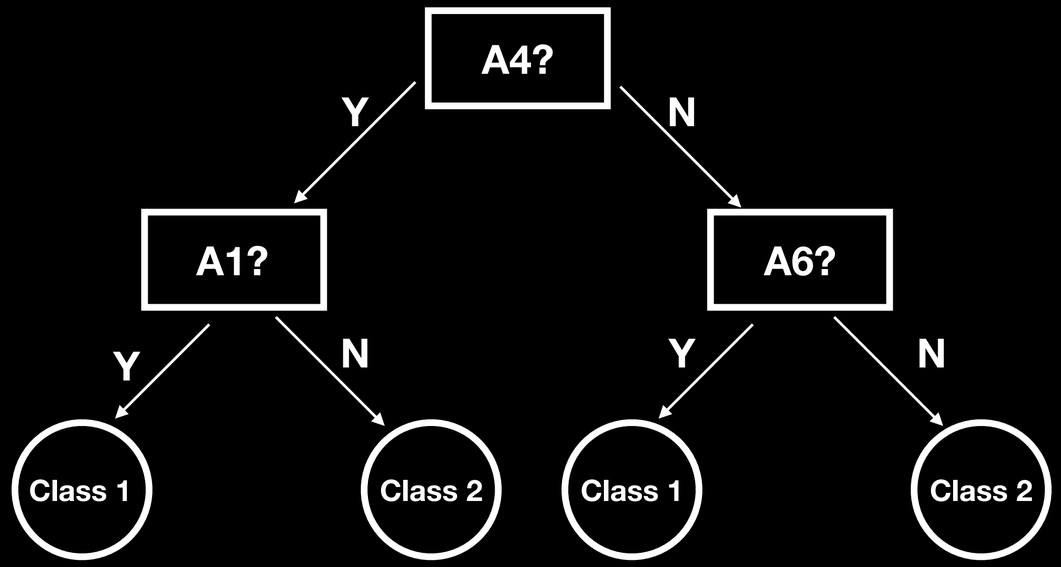
- Attribute Subset Selection
- Wavelet Transforms
- Principal Component Analysis

> This step helps to obtain a representation of the data set that is much smaller in volume, yet maintains the integrity of the original data..

Attribute Subset Selection

> Reduces the data set size by removing irrelevant or redundant attributes (or dimensions).

Initial Attribute Set $(A1, A2, A3, A4, A5, A6)$



Reduced Attribute Set $(A1, A4, A6)$

Principal Component Selection

- The input data are normalised, so that each attribute falls within the same range.
- PCA computes k orthonormal vectors that provide a basis for the normalised input data.
- The principal components are sorted in order of decreasing "significance" or strength.
- Because the components are sorted in decreasing order of "significance," the data size can be reduced by eliminating the weaker components, that is, those with low variance.

> PCA searches for k n-dimensional orthogonal vectors that can best be used to represent the data, where $k \leq n$.

Practice Lab

Quick Examples of Data Integration and Reduction

Use the following Instructions:

- Use the merge package in R to join two data frames together
- Use the chisq.test package in R to explore correlation relationship between gender and selected ice-cream

Data Transformation

- Smoothing
- Feature Engineering
- Data Aggregation
- Normalisation
- Discretisation

> Transform the data so that the resulting mining process may be more efficient, and the patterns found may be easier to understand.

Normalisation

> Help avoid dependence on the choice of measurement units, the data should be normalised or standardised, transforming the data to fall within a smaller or common range such as [−1,1] or [0.0, 1.0].

Min-Max Normalisation

$$v_i' = \frac{v_i - min_A}{max_A - min_A}$$

Jss 1

Student_ID	Height
1	165
2	135
3	167
5	176
8	148
15	135

Jss 1-1

Student_ID	Height
1	0.73
2	0.00
3	0.78
5	1.00
8	0.32
15	0.00

Discretisation

- Discretisation by binning
- Discretisation by histogram analysis
- Discretisation by correlation analysis
- Discretisation by decision tree

> Raw values of a numeric attribute (e.g. age) are replaced by interval labels (e.g., 0–10, 11–20, etc.) or conceptual labels (e.g., youth, adult, senior).

Discretisation by Binning

- Get maximum value
- Get minimum value
- Create width interval based on specified bin value
- Create cut value based on width interval between max and min values
- For each numeric value replace with minimus cut value

> Binning is a top-down splitting technique based on a specified number of bins.

Practice Lab

Quick Example of Data Discretisation

Use the following Instructions:

- Create a custom function to discretise a numeric attributes using equal-width approach

Recap/Summary

At the end of this Module, you should understand;

- Overview of data integration and reduction as part of the preprocessing tasks.
- Explore some techniques for data integration and reduction: Attribute matching and correlation analysis
- Overview of data transformation and discretisation as concluding part of preprocessing tasks
- Explore how to write a custom function for equal-width approach to discretisation

Suggested Material

- Data Mining Concepts and Techniques (3rd Edition) by Jiawei Han, Micheline Kamper and Jian Pei: Chapter 3 - Data Preprocessing
- https://uc-r.github.io/pca
- http://www.dataintegration.ninja/data-integration-techniques-and-its-challenges/
- http://www.programmingr.com/tutorial/left-join-in-r/
- https://en.wikipedia.org/wiki/Data_integration