

The School of Mathematics



THE UNIVERSITY
of EDINBURGH

Anomaly Detection with Bayesian Neural Networks

by

Theodoros Ladas

Dissertation Presented for the Degree of
MSc in Statistics with Data Science

July 2021

Supervised by
Dr Bruce Worton and Dr Daniel Paulin

Executive Summary

Here comes your executive summary ...

Acknowledgments

Here come your acknowledgments ...

University of Edinburgh – Own Work Declaration

This sheet must be filled in, signed and dated - your work will not be marked unless this is done.

Name:

Matriculation Number:

Title of work:

I confirm that all this work is my own except where indicated, and that I have:

- Clearly referenced/listed all sources as appropriate
- Referenced and put in inverted commas all quoted text (from books, web, etc)
- Given the sources of all pictures, data etc. that are not my own
- Not made any use of the report(s) or essay(s) of any other student(s) either past or present
- Not sought or used the help of any external professional academic agencies for the work
- Acknowledged in appropriate places any help that I have received from others (e.g. fellow students, technicians, statisticians, external sources)
- Complied with any other plagiarism criteria specified in the Course handbook

I understand that any false claim for this work will be penalised in accordance with the University regulations (<https://teaching.maths.ed.ac.uk/main/msc-students/msc-programmes/statistics/data-science/assessment/academic-misconduct>).

Signature

Date

Contents

1	Introduction	1
1.1	Motivation	1
1.2	Data Sources	1
1.3	Software	1
2	Exploratory Data Analysis	2
2.1	Univariate Analysis	2
2.2	Bivariate Analysis	2
2.3	Dimensionality Reduction	3
2.3.1	PCA	3
2.3.2	t-SNE	6
2.4	Multivariate Analysis	6
3	Methods	7
3.1	Base Neural Network	7
3.2	Bayesian Neural Network	7
3.3	Model Validation	7
3.4	Model Explanation	7
4	Results	8
4.1	Standard Deviation	8
4.2	Confidence Intervals	8
4.3	Entropy	8
5	Discussion	9
	Appendices	11
A	Appendix first topic	11
B	Appendix second topic	11

List of Tables

List of Figures

1	centered image	2
2	3
3	4
4	centered image	4
5	centered image	5
6	centered image	6
7	Look at this scenario tree with funny times t_1 and scenarios s_1 etc.	8

1 Introduction

1.1 Motivation

Anomaly detection is a very useful technique, leveraged (among others) by the banking sector in order to automatically block fraudulent transactions. This dissertation project is a detailed explanation of how an anomaly detection system could be implemented using Bayesian neural networks. This application, uses machine learning to train a model on a set of data, in order to predict an outcome of interest. Afterwards, the predictions are drawn many times (bootstrapped), in order to create an estimation of confidence about the prediction. The goal of the project is to automatically flag transactions that could be fraudulent, thus allowing a human to spend time in deep investigation of those transactions, rather than manually going through each transaction one by one.

This report is divided into the *Introduction*, *Exploratory Data Analysis*, *Methods*, and *Results* sections and a brief summary of each one is presented here. The rest of the *Introduction* section will explain the specific dataset used for the presentation of the problem, as well as all the software requirements to be able to reproduce the results. Next, the *Exploratory Data Analysis* section, presents a various aspects of the data, such as the distributions of the features, their correlations as well as a quick way to visually discover potential anomalies. On the *Methods* section, the specific architecture of all the neural networks models are presented, as well as the way the best model was selected (model validation). Finally, three related but different metrics are presented in the *Results* section of what constitutes as an anomaly, yet the specific threshold for those metrics, is arbitrarily set. In a real life application this is a business decision, that should be set by the stakeholders according to their criteria.

1.2 Data Sources

The dataset used in this project, was given by the University of Edinburgh in the context of the dissertation project and it is the wine dataset. It is an especially clean and very well known real-life dataset for prototype creation. The basic assumption is that if the algorithm manages to capture anomalies on this dataset, it is in principal possible to productionise a variant of the architecture for an application of interest. More specifically it is a 4898 (rows) \times 12 (columns) matrix, with no missing values and no duplicated rows. Each row represents one wine and the columns are the various features of each wine, such as its degrees of *alcohol*, the *acidity* of the wine, the *pH* level wich measures how acidic or basic the solution etc. The problem this dissertation is going to try to solve, is a classification problem, of the *type* of the wine, according to all other features. The variable *type* is either 1, 2, or 3 and the classes are almost perfectly balance thus making easier the preprocessing stage of the problem, and focusing more on the architecture and the interpretation of the algorithm as well as its results. Thus, the only preprocessing steps needed are the centering and scaling of the data matrix, to ensure that variables can potentially have the same impact regardless of the scale they are measured in and one-hot encoding the *quality* feature, since its also not a numeric variable, but a factor one. Lastly, The dataset is split into train (80%), validation (25%) and test (25%) sets to ensure that no algorithm overfits the given dataset.

1.3 Software

A combination of the programming languages R and Python are used to produce this report. The use of both languages is in no way binding. R is used for the exploration of the dataset, as well as for the dimensionality reduction plots, while Python is used in combination with `tensorflow`, `tensorflow-probability`, and `keras` to build, validate, and test the neural networks. These packages can also be used from the R ecosystem, yet the setup process is more complicated and thus avoided. The reason R is selected for the EDA, is due to the `ggplot2` package, wich is a very powerfull and easy package for creating complicated plots.

2 Exploratory Data Analysis

In this section a basic overview of the dataset and its properties is going to be presented. Firstly, various statistics regarding the dataset are presented in the form of graphs, in univariate, bivariate and multivariate analysis. Afterwards, the dataset is reduced in dimensions with two techniques (a linear and a non-linear) in order to be able to plot it with a two-dimensional graph. This is also a quick way to identify potential anomalies as well visually. The reason of the extended EDA, is to understand what preprocessing steps could be needed in order for the future models to work correctly. Also, the knowledge gained from this exploration of the dataset will help in the explanation of the model in the *Model Validation* section.

2.1 Univariate Analysis

The dataset, consist of twelve feature variables, out of which only one (*quality*) is categorical, while all the others are numeric. The target variable (*type*) is also a target variable with three levels *type*=1, *type*=2, *type*=3. There are no missing values.

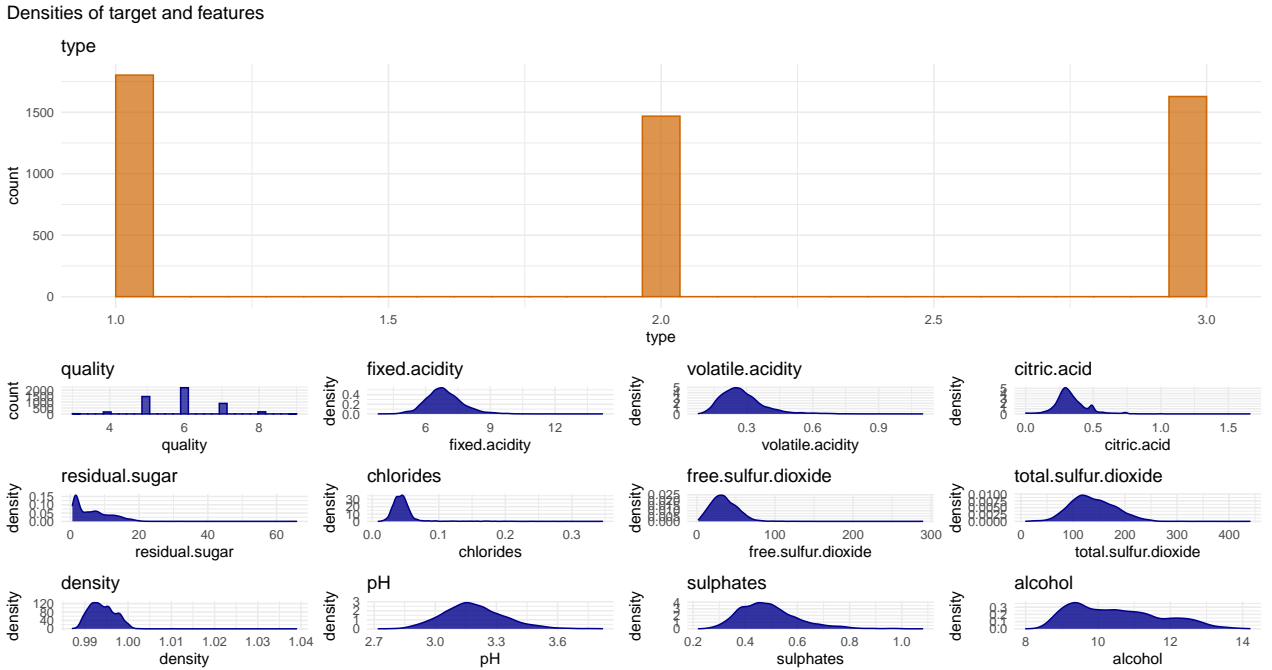


Figure 1: centered image

In Figure 1, the target variable *type* is represented by the orange barplot. The number of rows in each class is balanced therefore no preprocessing to upsample (downsample) the underrepresented (overrepresented) classes is needed. On the variable *quality*, the majority of cases are $(quality \geq 5) \vee (quality \leq 7)$, which would make the very poor and very good wines difficult to predict. Finally, evidently the features, are measured in vastly different scales. For example *pH* is ranging from 2.7 to 3.6, while *free.residual.dioxide* is ranging from 0 to 300. This means that centering and scaling the data matrix is crucial for any algorithm to work properly.

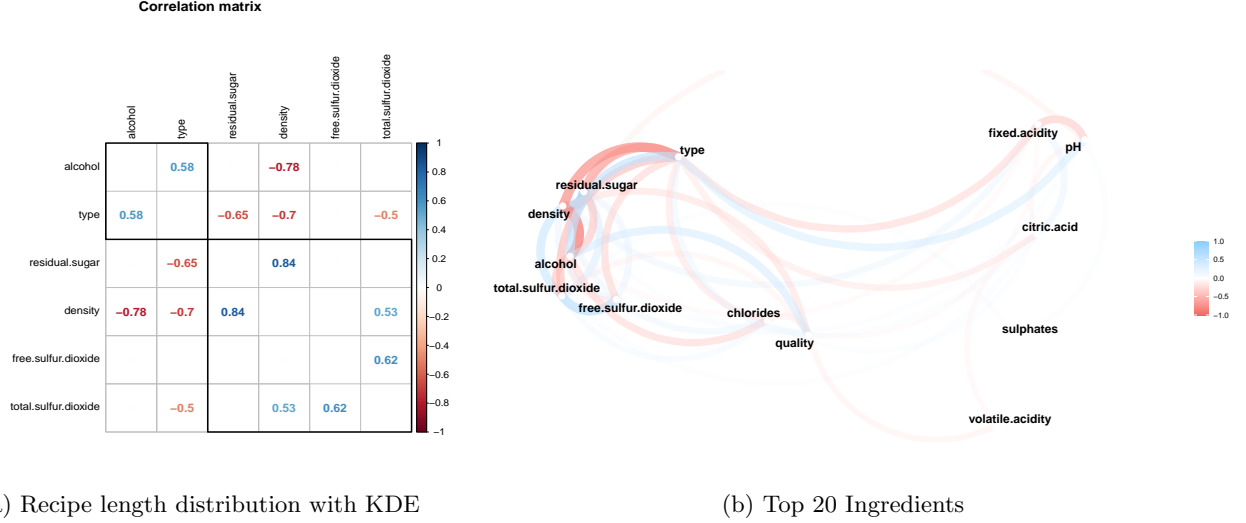
2.2 Bivariate Analysis

Extending the univariate analysis of the previous subsection, the bivariate analysis reveals how the feature correlate to each other. Figure 2 (a) and Figure 2 (b) are both producing the same information but presented differently. On Figure 2 (a) the exact values of the linear relationships are shown, while

on Figure 2 (b) clear clusters of high and low linear correlation are formed. Out of these clusters that are present in Figure 2 (b) some are expected but others are not.

For measuring the correlation, the *Pearson's correlation coefficient* is used, which measures the covariance of two random variables, X and Y , and normalizes it with the product of their standard deviations, or:

$$\rho(x, y) = \frac{\text{cov}(x, y)}{\text{std}(x)\text{std}(y)} \quad (2.1)$$



(a) Recipe length distribution with KDE

(b) Top 20 Ingredients

Figure 2

For example, Figure 2 (a) shows a strong positive relationship between *free.sulfur.dioxide* and *total.sulfur.dioxide*, which is expected, as *total.sulfur.dioxide* is the *free.sulfur.dioxide* plus other sulfur dioxides from other ingredients. Interestingly, the same is not true regarding *volatile.acidity*, *fixed.acidity* and *citric.acid*. The feature with the most strong correlations however, is *density*, as it strongly correlates, both positively or negatively with *alcohol*, *type*, *residual.sugar* and *total.sulfur.dioxide*.

In general we identify two clusters. One with strong correlations containing *type*, *residual.sugar*, *density*, *alcohol*, *total.sulfur.dioxide* and *free.sulfur.dioxide*, and a second one with low correlations containing *fixed.acidity*, *pH*, *citric.acid*, *sulphates* and *volatile.acidity*. The model is going to leverage this relationships in order to predict the outcome.

2.3 Dimensionality Reduction

In the exploration of the dataset, two different techniques were used in order to reduce the dimensions and visualize it with plots. The first method is the Principal Component Analysis (PCA), which is a singular value decomposition (SVD) of the centered, data matrix. The SVD of an $m \times n$ matrix A is the factorization of the matrix into USV^T . Secondly, a more advanced nonlinear dimensionality reduction method, called t-distributed Stochastic Neighbor Embedding (t-SNE) was tried, to cross evaluate the results of PCA. This method works by finding a way to project the high dimensional data into a lower dimension, while preserving the clustering of the higher dimension.

2.3.1 PCA

Using the singular value decomposition to factorize the data matrix X , we produce, three matrixes, U , S and V , each carrying information about the dataset in some aspect. First of all, we can create the following graph of the percentage of variance explained by each principal component.

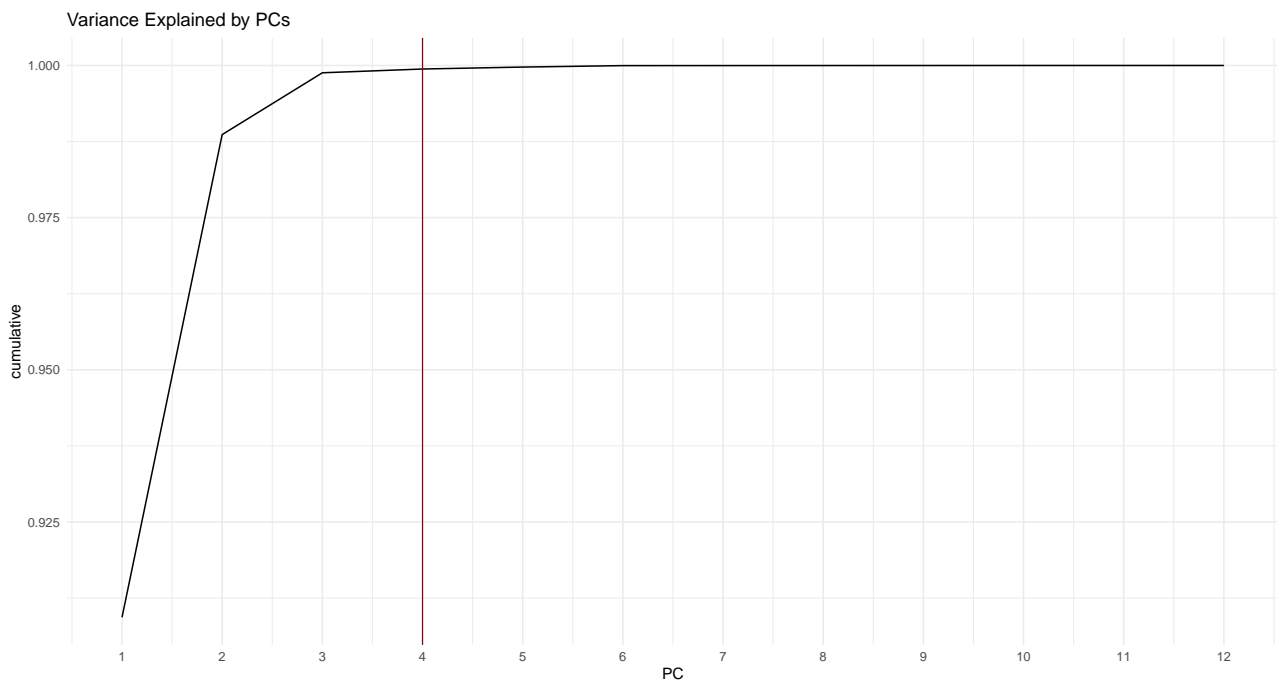


Figure 3

In Figure 3, we can see the cummalative variance explained by each additional principal component. This is a very important graph as we can reduce the dimension of the data matrix by selecting a threshold (for example, 99% of the variance). In this example, it is clear that with only the first four principal components, that threshold is surpassed.

The principal components are a linear compination of all the columns of the dataset, and each one is perpendiclar to the previous one. We can continue the exploration by visualizing the weights (loadings) of these four principal components and try to understand wheather these components make sense according to our knowledge on the topic.

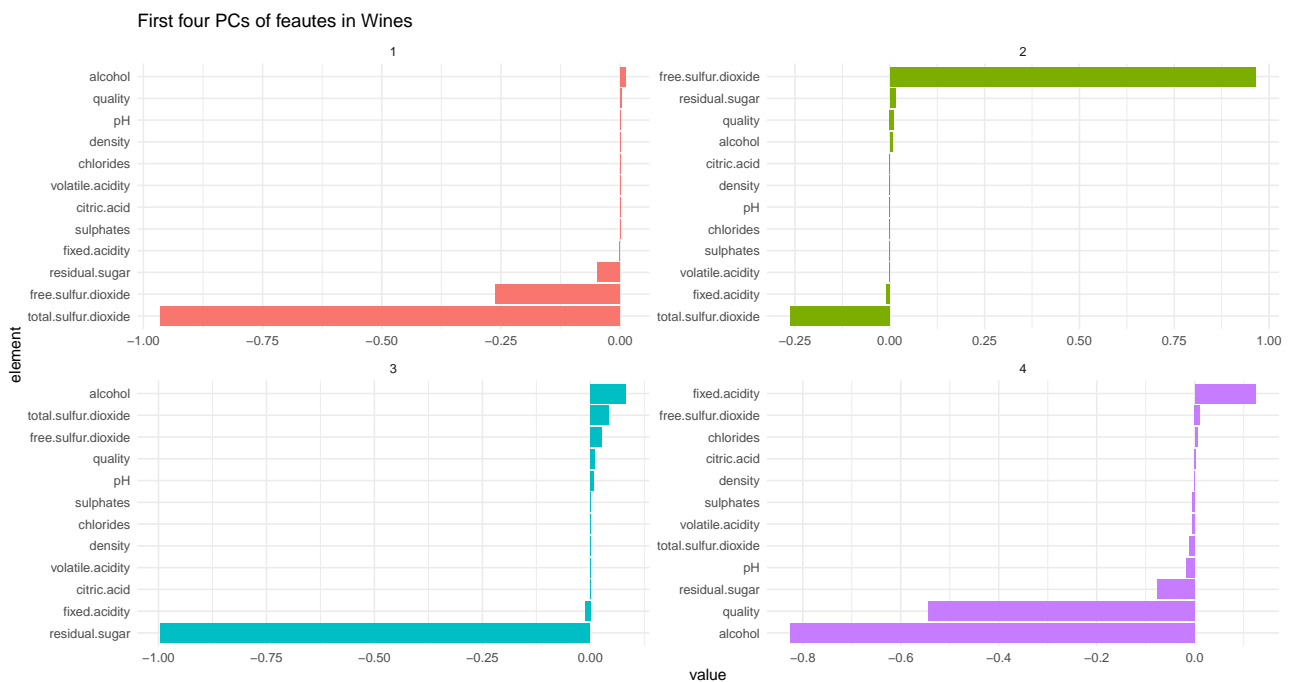


Figure 4: centered image

In ?? the first four principal components are visualized along with the loadings of each columns. By on the two most extreme positive and negative values of the loadings, we can interpret the components into new kinds of variables.

- PC1: Alcohol vs Sulfur Dioxide (free and total)
- PC2: Free Sulfur Dioxide vs Total Sulfur Dioxide
- PC3: Alcohol vs Sugar
- PC4: Alcohol vs Acidity

It is clear that this dimensionality reduction technique produces results that reflect the real word. Sulfure Dioxide is a vital component in wine making as it regulates bacteria growth among other important tasks, yet, it also gives unpleasent oddors and tastes to the wine. PCA immidiately captures that reality by assigning the two biggest negative loadings on sulfure dioxide concentration (both free and total) to the first pricipal component. In addition to that, the second most important component in order to classify the wines, is the origin of that Sulfure Dioxide. The total Sulfure Dioxide is the Free Sulfure Dioxide plus Sulfure Dioxide that is bound to other ingredients such as sugars etc. After investigating how much SO2 a wine has, as well as were it comes from (free vs total), the next most important factors have to do with the specific taste of the wine, mainly how sweet and how acidic the taste the wine has.

We can now visualize the first two pricipal components on a plot, while also coloring the datapoint according to their *type*, the target variable. It is immidiately clear by Figure 5 that *type* classes two

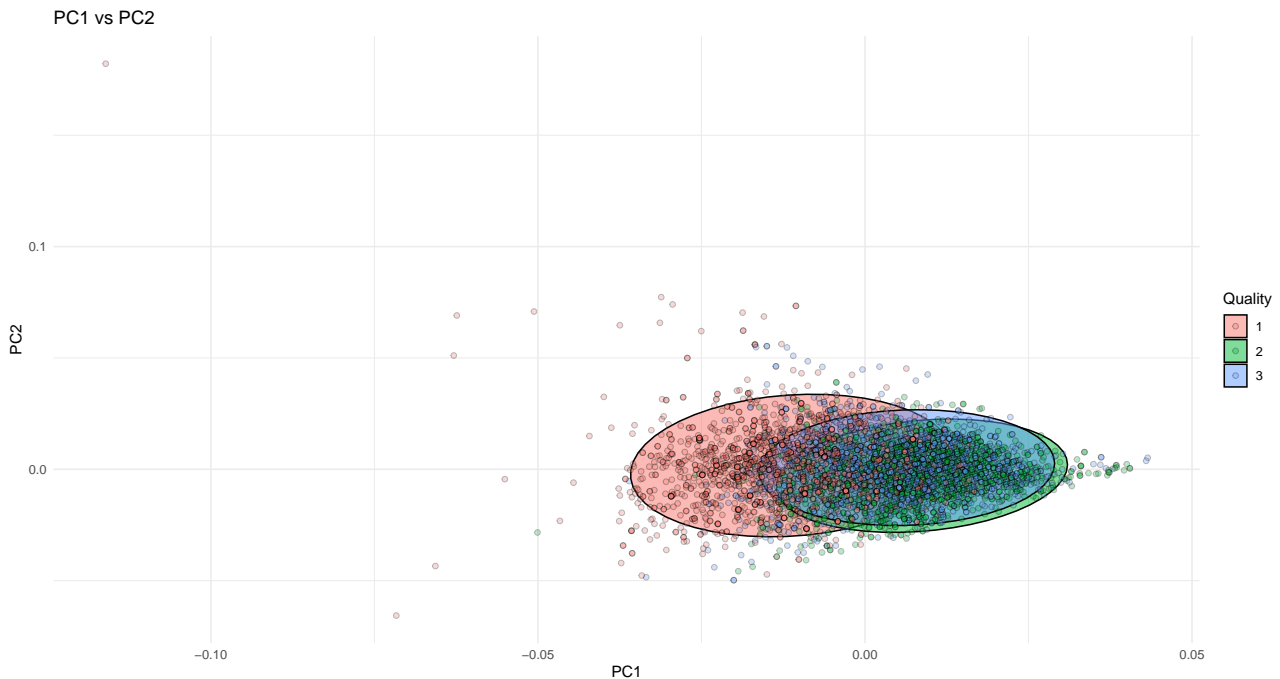


Figure 5: centered image

and three, have an extensive overlap in this graph. That is a useful information in the model evaluation, as we expect the model to "find it difficult" to distinguish a wine of type two from a wine of type three, while simultaneously having better accuracy in predicing class one. However, there a second major takeaway from *Figure 3*, and that is the existance of potential anomalies. While the majority of the points are centered around (0,0), some points are geometrically far away from the others of the same class.

2.3.2 t-SNE

Principal Component Analysis through singular value decomposition produced important findings and deepened our understanding of the dataset. However, it was clear by *Figure 3*, that it could not produce a clear enough separation between the classes. This could be because of the nature of the dataset, or it means that PCA is too simple to capture the complexity of the dataset, due to its linear nature.

Therefore, a second, non-linear technique was tried in order to produce the corresponding figure as *Figure 3*. This technique, is based on calculating the distances from each point to each neighbors and imposing a t-distribution on those values. It is an iterative algorithms that many times produces very good clustering. However, in *Figure 6*, it is clear that *type* classes two and three are still clustered together, while class one, is separated.

The main takeaway from this analysis is that the dataset, although clean and simple in nature to understand, is more complicated than it looks. This suggest that a simple model such as logistic regression might not be the model of choice. Neural Networks are a good candidate for such task due to their flexible nature.

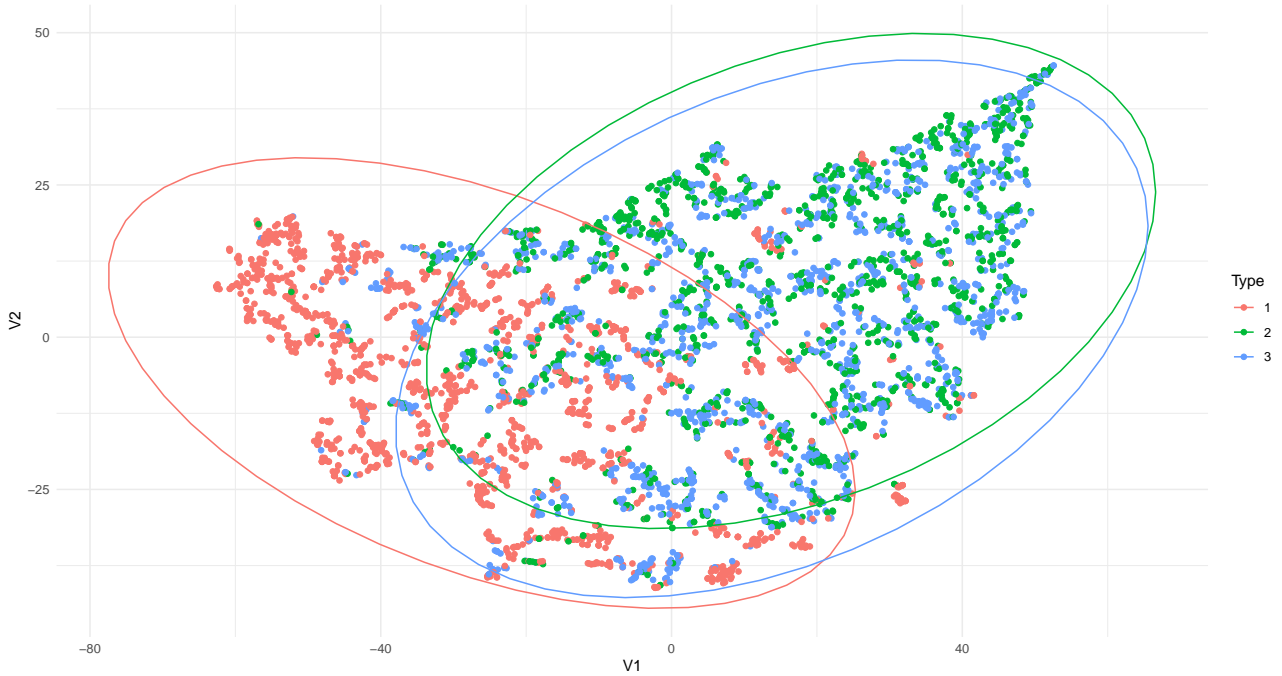


Figure 6: centered image

2.4 Multivariate Analysis

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

3 Methods

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

3.1 Base Neural Network

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

3.2 Bayesian Neural Network

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

3.3 Model Validation

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

3.4 Model Explanation

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

4 Results

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

4.1 Standard Deviation

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

4.2 Confidence Intervals

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

4.3 Entropy

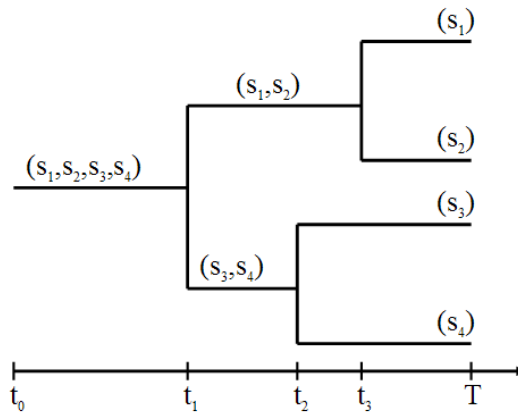


Figure 7: Look at this scenario tree with funny times t_1 and scenarios s_1 etc.

5 Discussion

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

References

- [1] N. Gröwe-Kuska and W. Römisch. *Stochastic unit commitment in hydro-thermal power production planning*. Preprints aus dem Institut für Mathematik. Humboldt-Universität zu Berlin, Institut für Mathematik, 2001.
- [2] T. Shiina and J. R. Birge. Stochastic unit commitment problem. *International Transactions in Operational Research*, 11(1):19–32, 2004.

Appendices

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

A Appendix first topic

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.

B Appendix second topic

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante. Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede. Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit. Ut porttitor. Praesent in sapien. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis fringilla tristique neque. Sed interdum libero ut metus. Pellentesque placerat. Nam rutrum augue a leo. Morbi sed elit sit amet ante lobortis sollicitudin. Praesent blandit blandit mauris. Praesent lectus tellus, aliquet aliquam, luctus a, egestas a, turpis. Mauris lacinia lorem sit amet ipsum. Nunc quis urna dictum turpis accumsan semper.