Swansea University
Prifysgol Abertawe

Predicting COVID-19 Mortality Using Machine Learning and Regression Analysis Based on Nutrition Factors

Abdullah Sharaf

Supervisor: Dr. Alma Rahat

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Problem Statement

The COVID-19 pandemic has severely impacted over 200 countries, COVID-19 has evolved into a major healthcare industry concern as well as a public health emergency. The World Health Organization estimates that COVID-19 has caused over 7 million deaths, or about 0.09% of the 8 billion global population, so stressing the extreme damage the epidemic has done on human life.

Project Methodology

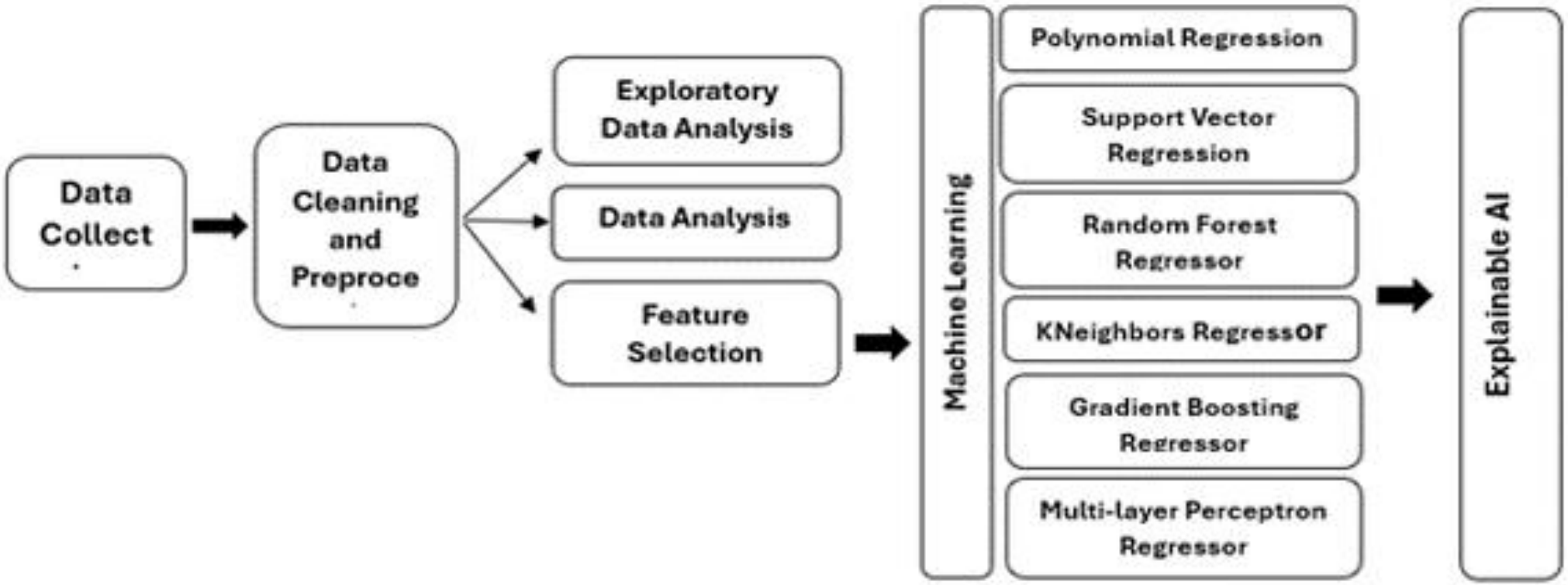


Figure 3.1: Methodology

Summary of Cross-sectional Study Data Analysis Part

- Introduction
- Methodology(Regression Analysis)
- Key finding
- recommendation

INTRODUCTION

Project Objective The primary objective of this data analysis project is to identify the **most significant factors**—such as **nutrition**—that influence **COVID-19 Case mortality** rates across different countries.

Public Health Goals: Use data-driven insights to refine **public health decision-making** strategies, improving the effectiveness of **change behaviors at schools.**

Hypotheses:

H_0: Nutrition does not influence COVID-19 case mortality rates β1=0.

H_1: Nutrition influences COVID-19 case mortality rates $\beta_1 \neq 0$

DATA COLLECTION

Dataset	Open Source	Features
Nutrition.csv	Kaggle – COVID-19 Healthy Diet Dataset	Country, Animal Products, Animal Fats, Cereals (excluding beer), Eggs, Fish, Seafood, Fruits (excluding wine), Meat, Milk (excluding butter), Miscellaneous Items, Offals, Oilcrops, Pulses, Spices, Starchy Roots, Stimulants, Sugar & Sweeteners, Treenuts, Vegetal Products, Vegetable Oils **(2020),** Case Fatality Rate **(2021)**

DATA Concept

- Checking Data type
- Handling missing values
- Handling Duplicate Data
- Handling Outliners
- Standardization

Data Exploration

Data Types

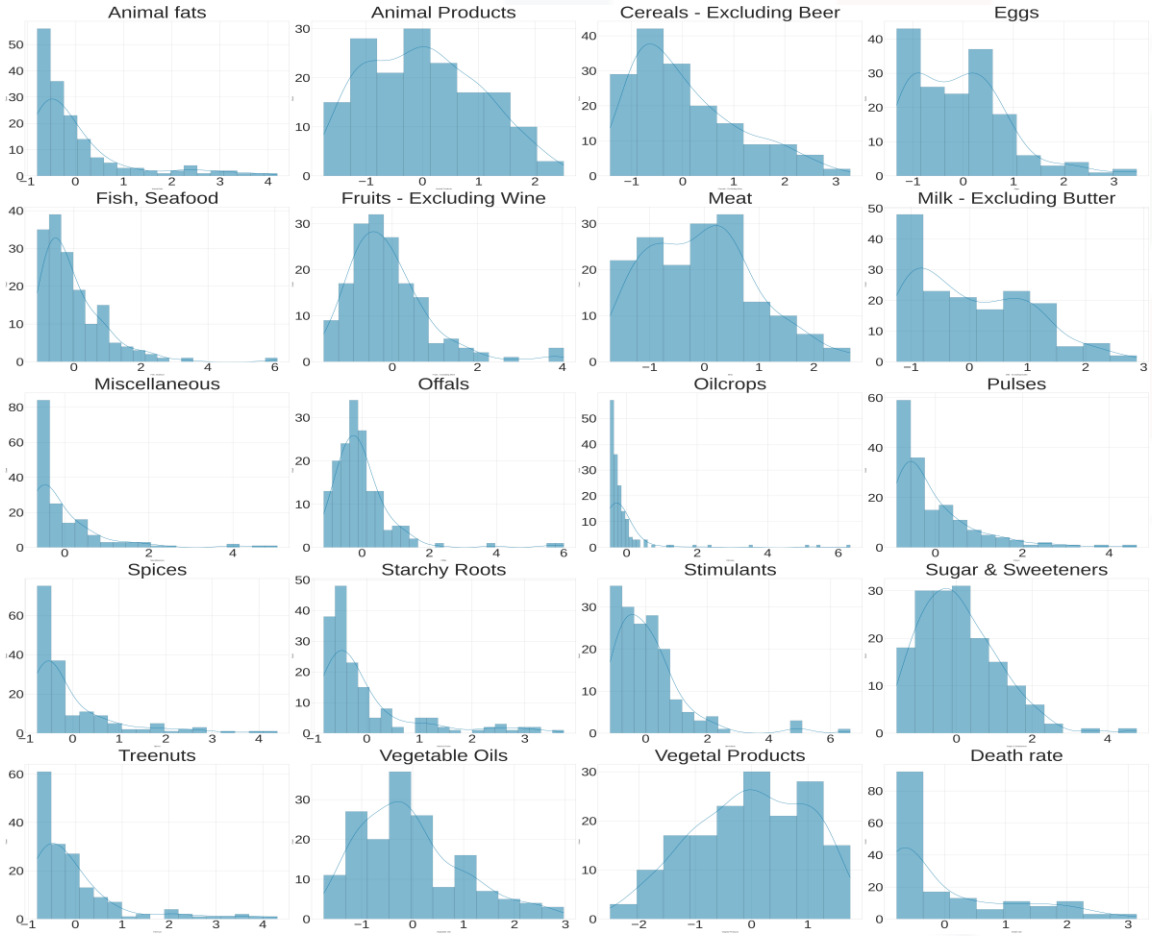
```
Data columns (total 21 columns):
 #   Column                    Non-Null Count  Dtype
---  ------                    --------------  -----
 0   Country                   164 non-null    object
 1   Animal fats               164 non-null    float64
 2   Animal Products           164 non-null    float64
 3   Cereals - Excluding Beer  164 non-null    float64
 4   Eggs                      164 non-null    float64
 5   Fish, Seafood             164 non-null    float64
 6   Fruits - Excluding Wine   164 non-null    float64
 7   Meat                      164 non-null    float64
 8   Milk - Excluding Butter   164 non-null    float64
 9   Miscellaneous             164 non-null    float64
 10  Offals                    164 non-null    float64
 11  Oilcrops                  164 non-null    float64
 12  Pulses                    164 non-null    float64
 13  Spices                    164 non-null    float64
 14  Starchy Roots             164 non-null    float64
 15  Stimulants                164 non-null    float64
 16  Sugar & Sweeteners        164 non-null    float64
 17  Treenuts                  164 non-null    float64
 18  Vegetable Oils            164 non-null    float64
 19  Vegetal Products          164 non-null    float64
 20  Death rate                164 non-null    float64
dtypes: float64(20), object(1)
memory usage: 28.2+ KB
```

Statistical Summery

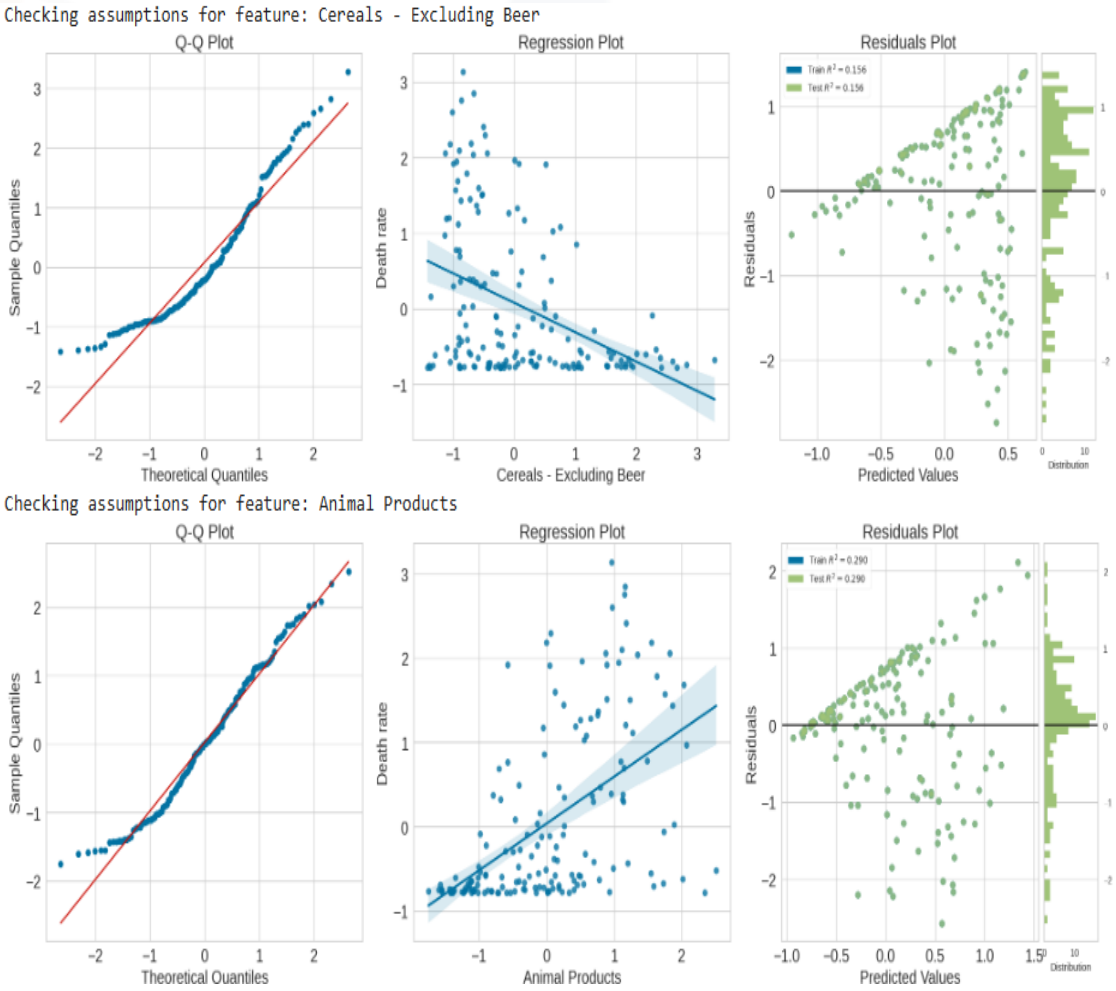
	Animal fats	Animal Products	Cereals - Excluding Beer	Eggs	Spices	Starchy Roots	Stimulants	Sugar & Sweeteners	Treenuts	Vegetable Oils	Vegetal Products	Death rate
count	164.0	164.0	164.0	164.0	164.0	164.0	164.0	164.0	164.0	164.0	164.0	164.0
mean	0.0	0.0	0.0	-0.0	-0.0	-0.0	0.0	0.0	-0.0	-0.0	-0.0	0.0
std	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
min	-1.0	-2.0	-1.0	-1.0	-1.0	-1.0	-1.0	-2.0	-1.0	-2.0	-3.0	-1.0
25%	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
50%	-0.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-1.0
75%	0.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0	1.0
max	4.0	3.0	3.0	3.0	4.0	4.0	7.0	5.0	4.0	3.0	2.0	3.0

Non-Liner Problem

Nutrition Distribution

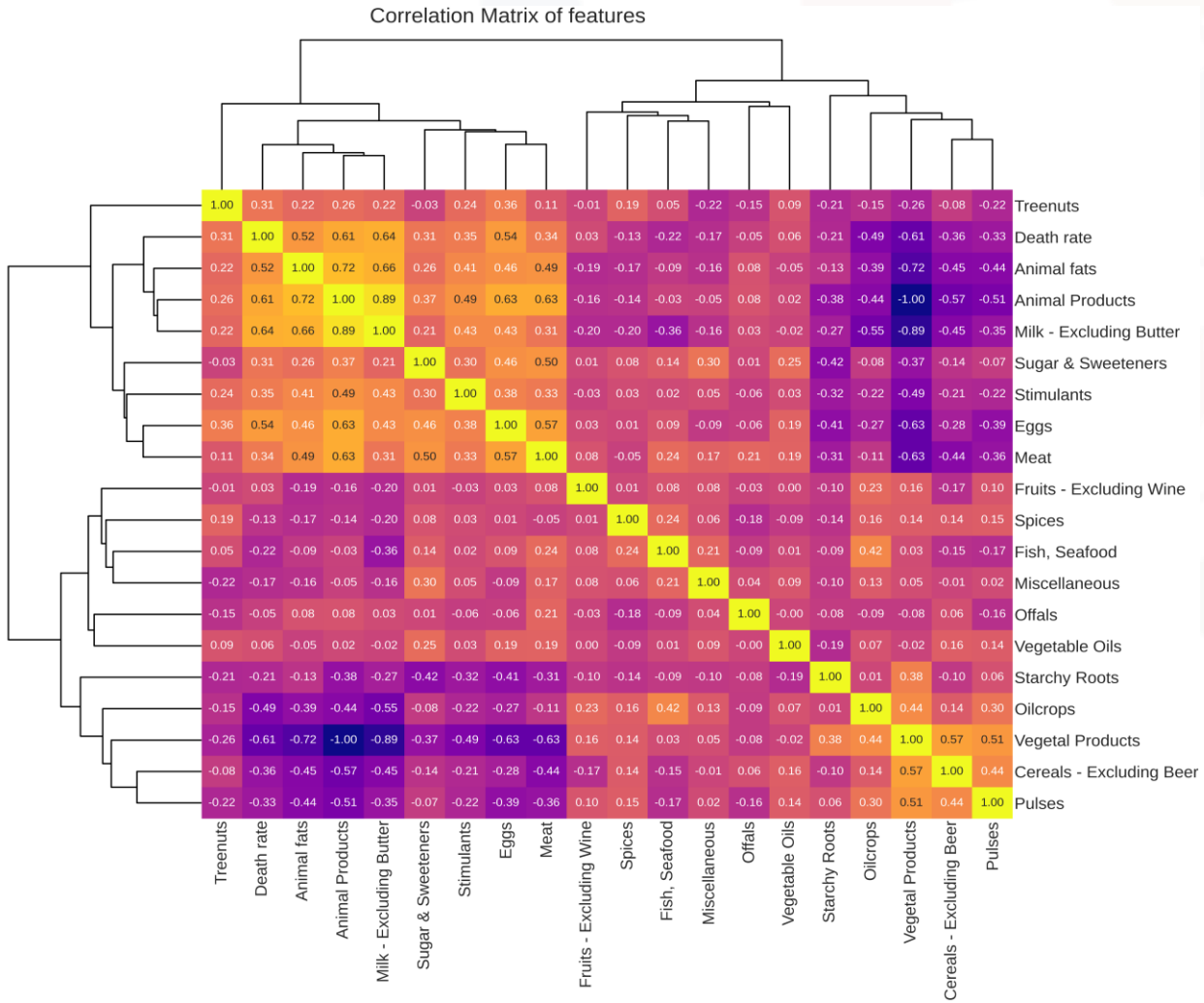


Normality Test

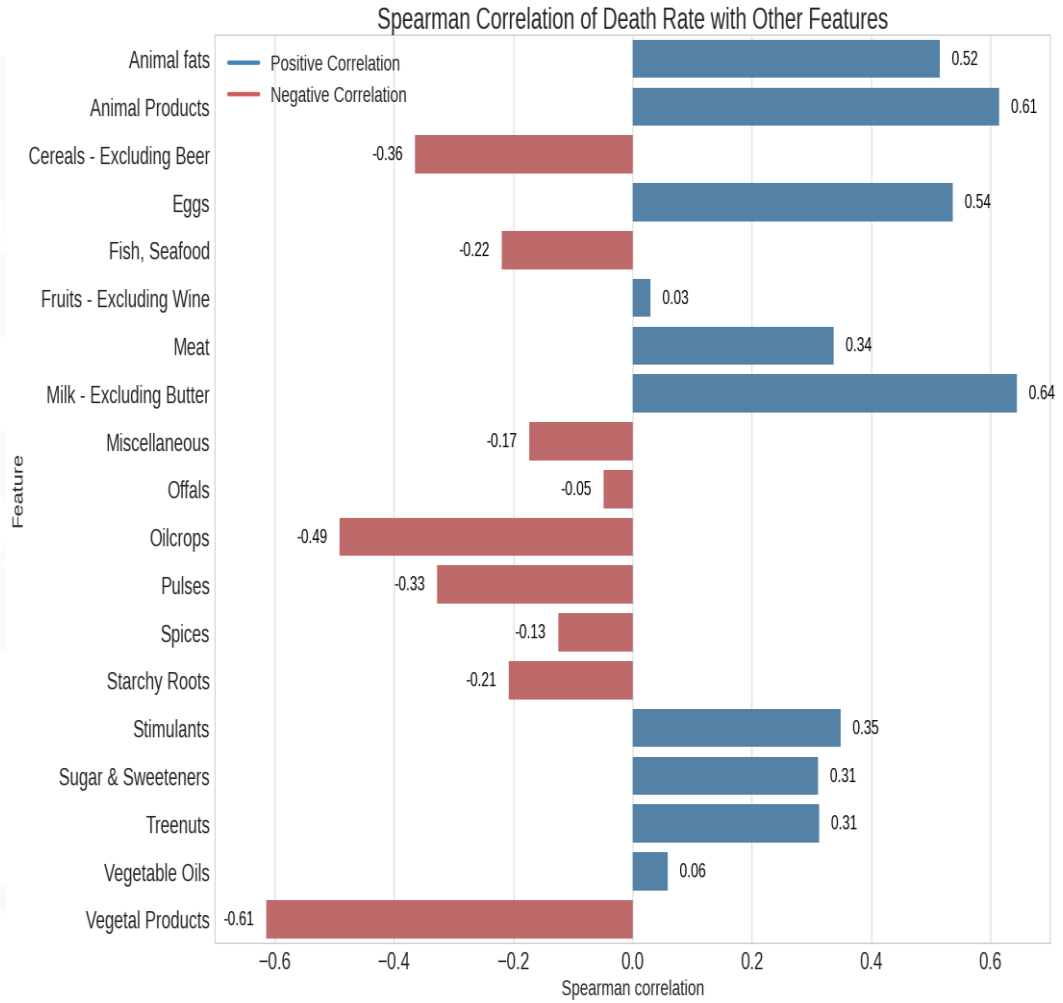


Data Analysis

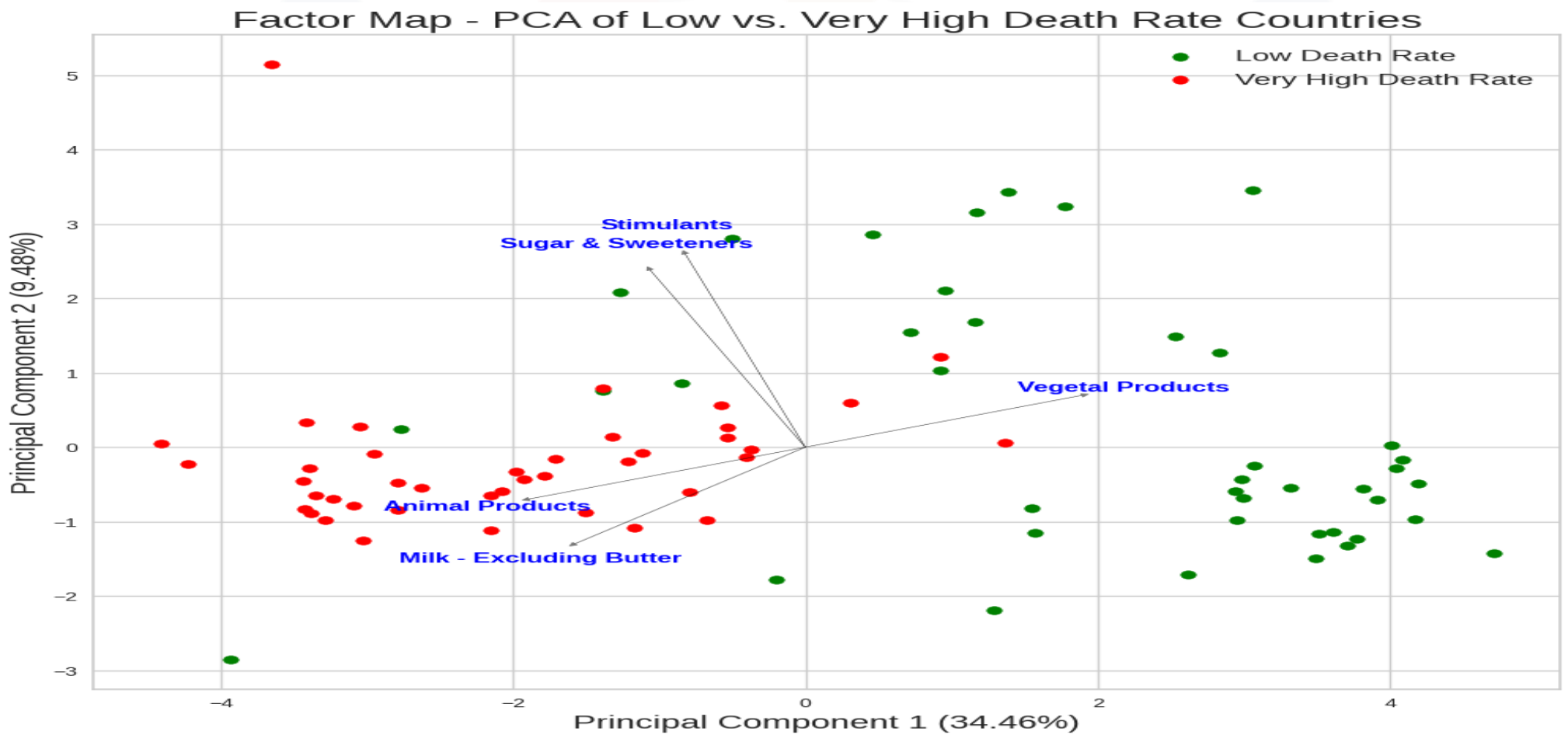
Spearman Correlation matrix



Case Death rate VS Nutrition



Factor Map - PCA



Non-Parametric Test (Spearman, Kendall's Tau)

Feature	Spearman Correlation	Spearman p-value	Kendall's Tau	Kendall p-value
Animal Products	0.614041	2.264509e-18	0.433793	1.769582e-16
Milk - Excl. Butter	0.643527	1.500912e-20	0.452816	8.114807e-18
Vegetal Products	-0.614095	2.244723e-18	-0.433793	1.769582e-16

Confidence Interval: 99% (α = 0.01)

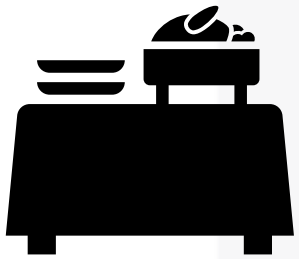
Based on the analysis, we identified that the most influential features affecting the COVID-19 case death rate were statistically significant. As a result, we **rejected the null hypothesis** and **accepted the alternative hypothesis**.

Alternative Hypothesis (N1):

Nutritional factors have a significant influence on COVID-19 case mortality rates.

$$\beta_1 \neq 0$$

Key finding



Higher consumption of **Animal products and Milk** linked to increased mortality, while a balanced diet with sufficient **plant-based** foods is crucial for reducing health risks.

Animal Products: Aquatic Animals, Others; Aquatic Plants; Bovine Meat; Butter, Ghee; Cephalopods; Cream; Crustaceans;
Vegetal Products: Apples and products; Bananas; Barley and products; Beans.

Recommendation
Primary Schools(Behavioral Change)

Intervention	Behavior or Aspect Targeted	Method of Influence / Notes
Difficult-to-open animal product packaging. easy-to-open packaging 	Natural tendency to save effort 	Kids tend to choose the easier-to-opern option; leveraging 'productive laziness' in favor of healthy choices.
Appealing names like ..Hero Salad" + cartoon images 	Identity and imagination (I'm a hero = I eat veggies) 	Connecting vegetarian food to the child's identity as a lovable hero through appealing names.
Reward cards (stickers, stars) 	Positive reinforcement after desired behavior 	Kids see an immediate outcome of their good choice, motivating them to repeat the behavior.
Device that makes a playful sound only for choosing a vegetarian dish 	Instant gratification and auditory response 	Building a positive group habit and linking it to team spirit and group pride. 
Replace high-fat milk with low-fat milk	Default bias and availability 	

Encourage behavior change starting from an early age to support long-term healthy habits.

Data Science Part

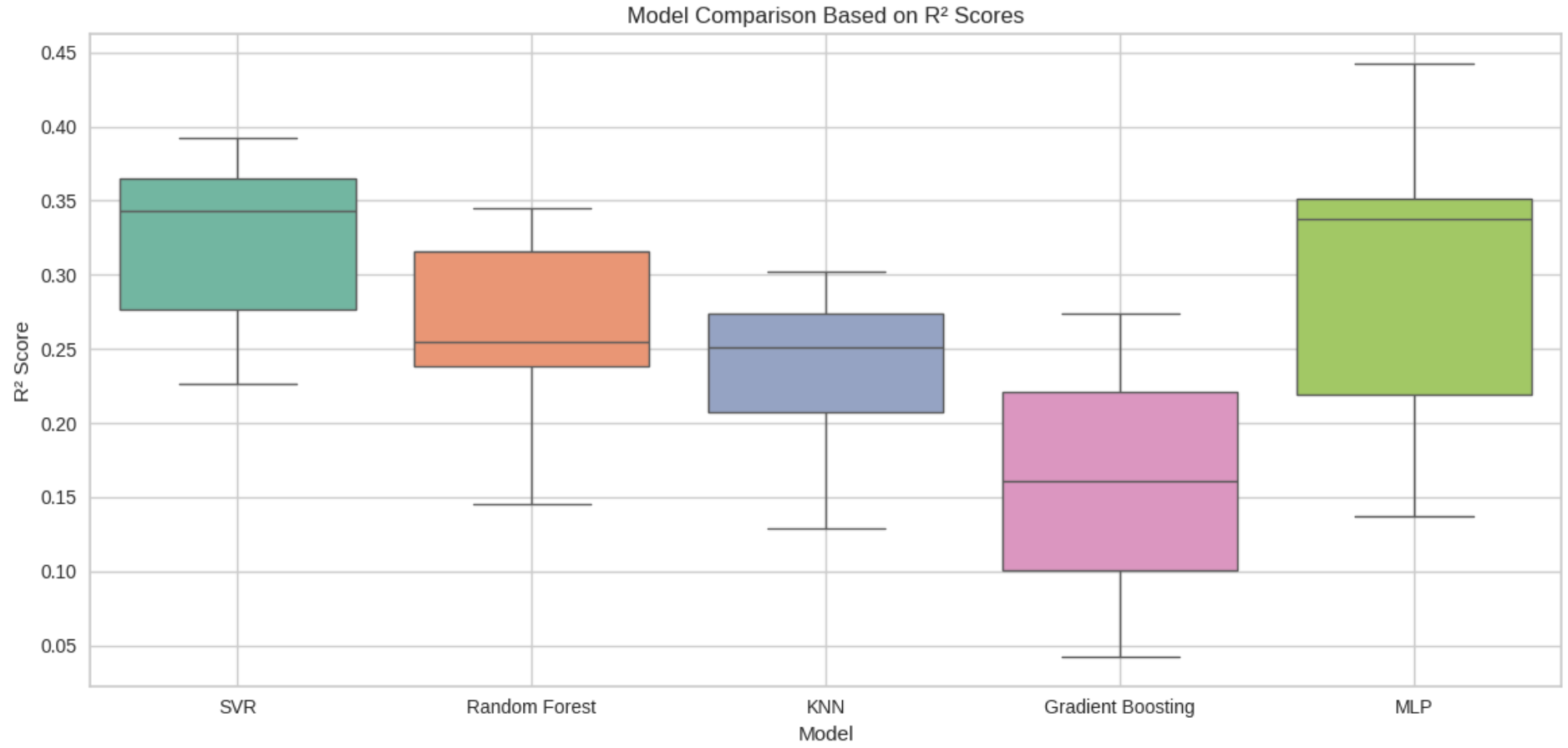
Summary of Cross-sectional Study
Data Science Part

- Introduction
- Methodology(Supervised ML & XAI)
- Key finding

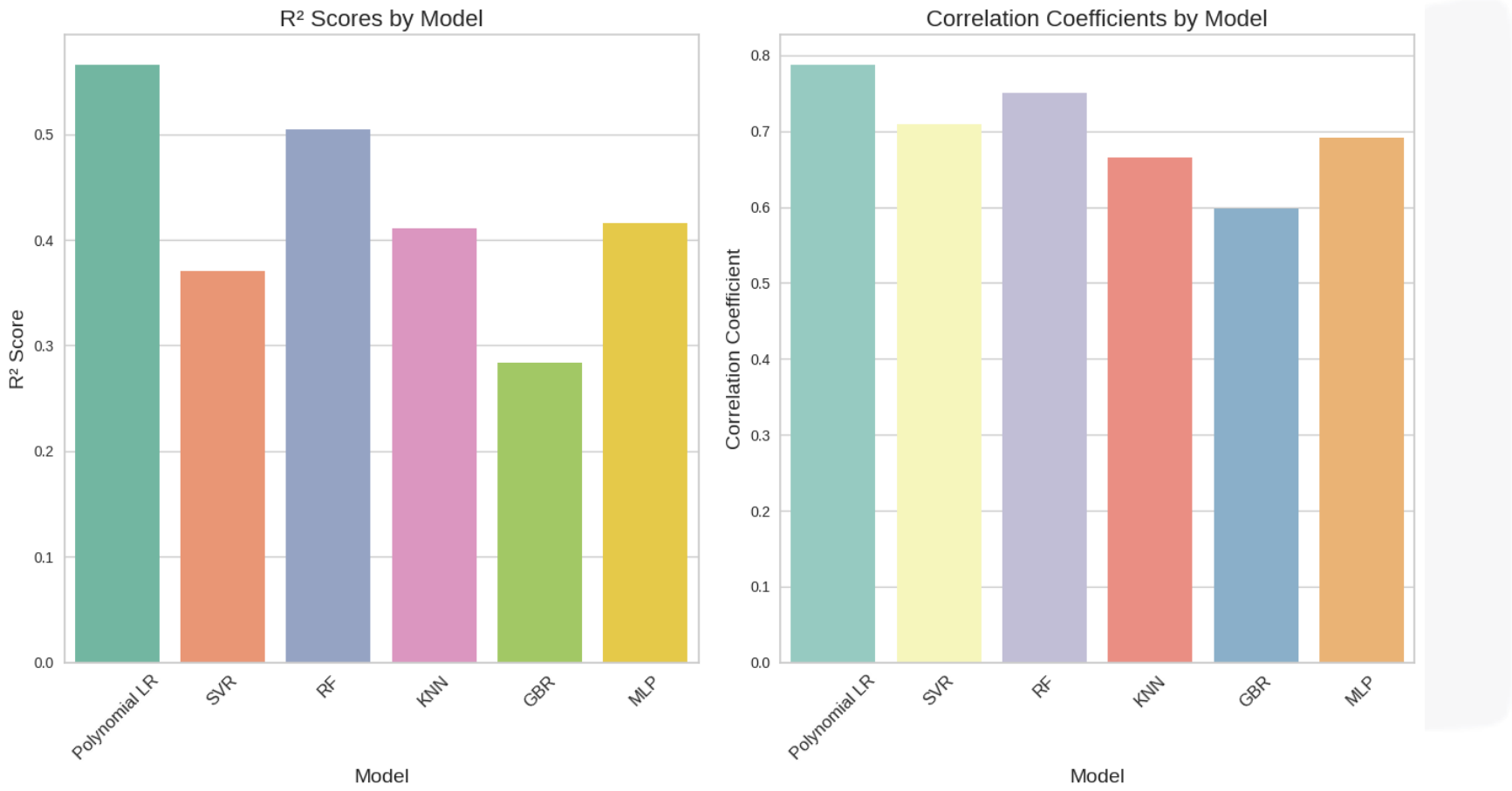
Data Concept

- Checking Data type
- Handling missing values
- Handling Duplicate Data
- Handling Outliners
- Train-Test Split(test 20%, training 80%)
- Standardization
- Feature Selection
    - Filter Method
    - Wrapper Method

Machine Learning with default Hyperparameters
Result of training Data



Machine Learning with hyperparameter tuning
Result of Testing Data



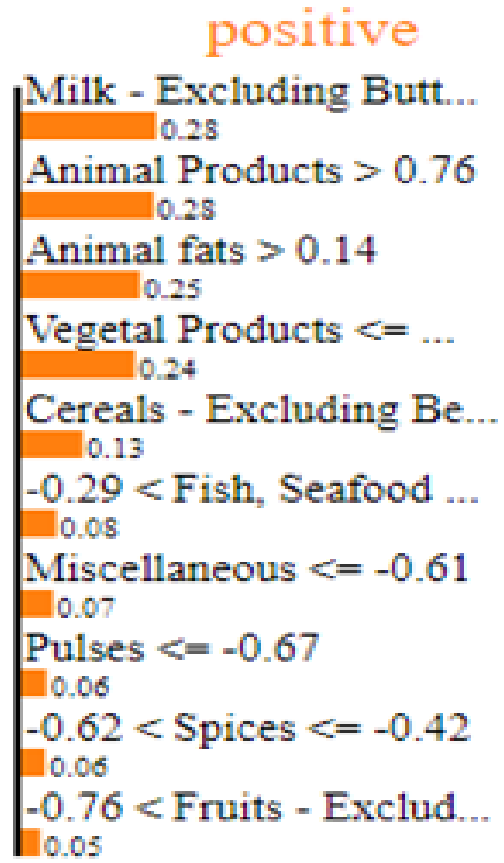
Explainable AI

Prediction_local [1.22172904]
Right: 1.3330868040274693
Country: Belgium

Predicted value

-8.58 (min) — 1.33 — 1.54 (max)

Feature	Value
Milk - Excluding Butter	1.05
Animal Products	0.96
Animal fats	2.35
Vegetal Products	-0.96
Cereals - Excluding Beer	-0.84
Fish, Seafood	-0.19
Miscellaneous	-0.65
Pulses	-0.71
Spices	-0.44
Fruits - Excluding Wine	-0.55

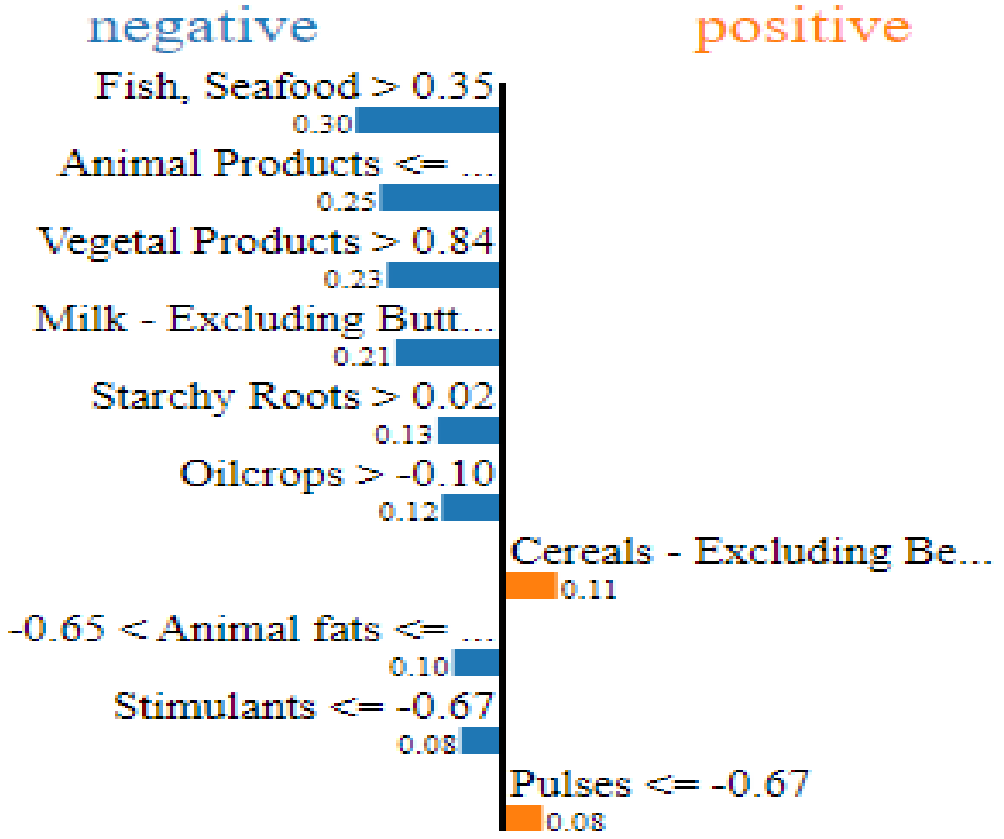


Prediction_local [-0.81452202]
Right: -0.6705301018960877
Country: Vanuatu

Predicted value

-8.90 (min) | -0.67 | 1.85 (max)

Feature	Value
Fish, Seafood	0.65
Animal Products	-0.93
Vegetal Products	0.93
Milk - Excluding Butter	-1.02
Starchy Roots	1.21
Oilcrops	6.34
Cereals - Excluding Beer	-0.88
Animal fats	-0.51
Stimulants	-0.99
Pulses	-0.89



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