Applied Machine Learning (ICS5110)

Project Specifications

Title:	Machine Learning Approaches to Ethical Analysis of Statistics
Deadline:	23rd January 2025
Contact person:	Dr Dylan Seychell (email: dylan.seychell@um.edu.mt)
Modality:	Groups between 3 and 5, at most. Equal contribution will be assumed

Preliminaries

Aim and Objectives

- This project aims to introduce you to machine learning (ML) techniques applied to real data sets. You are expected to:
  - Transform and analyse raw, tabular data from a statistics website.
  - Apply multiple machine-learning techniques to this data.
  - Investigate and document ethical and social implications.
  - Create a data project and analysis related to real-life statistics.

Deliverables per group

1. 20 Pages (Maximum) Document in the IEEE Access format[1].
2. Project GitHub Pages Webpage and a repository for the project
3. 10 Page (Maximum) Generative AI Usage Journal

Grading Criteria

- Quality of Data Preparation and Analysis: 20%
- Experiments with Machine Learning Techniques: 30%
- Ethical and Social Implications Analysis: 20%
- Web Tool Usability and Design: 10%
- Quality of Documentation: 10%
- Generative AI Journal: 10%

Plagiarism and Academic Integrity are taken very seriously, and you must cite any reference to third-party sources, including code from notebooks uploaded from Kaggle or other websites.

The examiners reserve the right to call the groups for an interview if any irregularities are perceived.

[1] https://ieeeaccess.ieee.org/wp-content/uploads/2023/03/ACCESS_latex_template_3.2023.zip

Specifications

These specifications are organised into three parts:

- The Key Tasks of the project leading to the deliverables.
- Guidelines for the Ethical Review
- Guidelines for the Generative AI Journal

Key Tasks

- **Data Extraction**
  - Acquire datasets or utilise web scraping techniques to collect data from statistics websites. Examples of such sources are the National Statistics Office (NSO)[2], OECD[3] or ProPublica[4].
  - It is advisable to find datasets that contain demographic information to facilitate experiments that are carried out later in this project.
  - The data has to be in text format. Do not use multimedia content.
- **Data Preparation**
  - Conduct data cleaning, transformation, and feature engineering to prepare the data for ML.
- **Implement and Evaluate Three ML techniques on the data:**
  - Each team member will be responsible for a technique.
    - These specifications assume a group of 3 students. If it is a group of 5 students, 5 techniques and so on will need to be completed accordingly.
  - Compare at least 3 machine learning techniques for the modelling and predicting data in the chosen dataset.
  - You may use any implementation of the techniques and customise them as necessary for effective integration in the project.
  - You are encouraged to use a Jupyter Notebook for the 3 techniques.
  - Evaluate the performance of the models using appropriate metrics and techniques.
  - Include ethical considerations in the evaluation process by, for example, assessing how a modification to a cost function can produce an output that impacts a demographic differently.
  - The project needs to have a GitHub repository that includes all the techniques and an appropriate readme.
- **Ethical Review**
  - Investigate and document potential biases, data privacy concerns, and other ethical considerations related to the data and its source.
- **Web Tool**

[2] https://nso.gov.mt/
[3] https://oecd.ai/en/data?selectedArea=ai-models-and-datasets
[4] https://www.propublica.org/datastore/

- Develop a web-based interactive tool, using GitHub Pages, that allows users to interact with the model and see its predictions using tools such as Gradio[5].

Documentation Outline

1. **Introduction**
    a. Explain the properties of the chosen data set and plan of analysis
    b. Mention the machine-learning techniques that you will be using

2. **Background**
    a. Demonstrate and describe the mechanics of the selected machine learning techniques.
    b. Describe what rescaling and normalisation are and why they are important.
    c. Describe what cross-validation is and how (if applicable) it was used.
    d. Describe what dimensionality reduction and feature selection methods are
    e. Explain the quantitative measurements that you will be using to quantify the results; e.g. accuracy rate

3. **Data Preparation**
    a. Describe the steps that you used to process the data set
    b. Discuss and explain the data cleaning, transformation, and feature engineering process to prepare the data for ML.

4. **Experiments**
    a. Describe the experiments that you carried out
    b. Describe the implementation of the ML techniques chosen
    c. Compare the results and insights from these models using the appropriate metrics.
    d. For each technique, assess individually how a modification in the parameters or cost function can affect the output with respect to a particular demographic.

5. **Ethical Review**
    a. Analyse, discuss and evaluate the ethical aspects of the data, the insights generated and the societal implications emerging from your project.

6. **Web Portal Usage Guide**
    a. Provide a brief user guide (maximum 2 pages) on how the data and insights can be explored from the web portal.

7. **References and List of Resources Used**

[5] https://www.gradio.app/

Sample Guiding Questions for the Ethical Review

Below are general guidelines and considerations that can be taken on board for the ethical review of this project.

- Data Source and Integrity
  - Is the data collected from a reputable source?
  - Are there any issues with data credibility or reliability?
- Data Bias
  - Is the data representative of the population it's supposed to serve?
  - Are there inherent biases in the data collection method?
- Data Privacy
  - Does the dataset include sensitive or personally identifiable information (PII)?
  - If so, what measures are taken to anonymise this data?
- Transparency and Accountability
  - How transparent is the data collection and machine learning process?
  - Who is accountable for the model's predictions?
- Fairness and Equity
  - Could applying your ML model result in unfair or unequal treatment of individuals or communities?
- Social Impact
  - What are the potential societal consequences, both positive and negative, of your model's deployment?
- Environmental Impact
  - Does the process of data collection, storage, or running the machine learning model have an environmental cost? Is it justifiable?
- Accessibility
  - Is the web tool designed in an accessible manner, following universal design principles?
- Consent and Opt-In
  - Does the model's deployment involve obtaining consent from the end-users for data collection or tracking?
- Long-term Effects
  - What could be the long-term societal impact of your model if it were deployed at scale?

Generative AI Journal Guidelines

The objective of this document is to critically examine and reflect on how generative AI models, like Gemini, Claude or ChatGPT, were used in this project. This documentation will focus on ethical considerations, the methodology employed, and the specific contributions of generative AI to improving your work. It is important to cite any references or resources you consulted about generative AI.

The document, which is separate from the technical paper, has a page limit of 10 pages, including references and should contain the following sections:

1. **Introduction**
    a. Briefly describe the generative AI models you chose to use and the rationale behind that choice. (Maximum of 1 page)

2. **Ethical Considerations**
    a. Discuss the ethical aspects of using generative AI in your project. This should include issues like data bias and privacy. (Maximum of 1 page)

3. **Methodology**
    a. Outline the methods and steps to integrate the generative AI model into your work. Which tools did you use, and in which sequence? Did you create your pipeline, or did you just use one tool? There is no wrong answer, and this journal aims for transparency and accountability.

4. **Prompts and Responses**
    a. List down the specific prompts that were used with the generative AI model and you found noteworthy. For each prompt, also include the generated response and explain how it contributed to improving your project. It is advisable to use screenshots for this part.

5. **Improvements, Errors and Contributions**
    a. Discuss the areas where generative AI contributed to enhancing your work or instances where the output contained errors. This can include but is not limited to data analysis, formulation of ethical considerations, literature review enhancement, or idea generation. Highlight specific cases where this happened.

6. **Individual Reflection**
    a. Reflect on your personal experience using generative AI in your project. Discuss what you learned, what surprised you, and how your perspective on using AI in academic projects has changed, if at all. Did Gen AI help you be more efficient? Do you feel you wasted more time when you used it? For which part was it most helpful? Literature review, debugging?

7. **References and List of Resources Used**

End of Project Specifications