**ML Internship Task 7**

**Objective:**

The goal of this task is to explore and implement Explainable AI (XAI) techniques to interpret regression models trained on numeric datasets from the EU and USA networks. You will apply XAI methods to understand the decision-making process of these models and assess the effectiveness of XAI in providing insights into model behavior. The task also involves comparing the insights provided by XAI with those obtained from traditional models.

**Datasets:**

* **EU Network Dataset** (numeric data for regression tasks)
* **USA Network Dataset** (numeric data for regression tasks)

**Requirements:**

1. **Understanding Explainable AI (XAI):**
   * **Research and Study:**
     + Learn about Explainable AI (XAI) techniques, focusing on their application to regression problems. Consult reliable sources such as academic papers, textbooks, and reputable online articles.
     + Understand key concepts such as feature importance, partial dependence plots (PDPs), Individual Conditional Expectation (ICE) plots, SHAP values, and LIME (Local Interpretable Model-agnostic Explanations).
2. **Data Preparation:**
   * **Dataset Preparation:**
     + Use the EU and USA datasets provided.
     + Preprocess the datasets as necessary (e.g., handling missing values, normalization).
3. **Regression Model Implementation:**
   * **Model Training:**
     + Train regression models on the EU and USA datasets separately.
     + Use appropriate regression models such as Linear Regression, Random Forest Regressor, or Neural Networks for the task.
     + Evaluate the models using standard regression metrics (e.g., Mean Absolute Error (MAE), Mean Squared Error (MSE), R-squared).
4. **Explainable AI Implementation:**
   * **Apply XAI Techniques:**
     + Implement XAI techniques to interpret the trained regression models. Use tools like SHAP, LIME, PDPs, and ICE plots to explain model predictions.
     + For each dataset (EU and USA), analyze how features influence the model's predictions and assess the interpretability of the models.
   * **Insights Extraction:**
     + Compare the insights gained from XAI techniques with the original regression model predictions. Evaluate the effectiveness of these techniques in explaining the model behavior.
     + Use visualizations to illustrate feature importance, partial dependencies, and individual prediction explanations.
5. **Model Training and Evaluation:**
   * **Performance Evaluation:**
     + Train and evaluate regression models on both the EU and USA datasets separately.
     + Use XAI techniques to assess model interpretability and compare these insights with the model's performance using traditional regression metrics.
   * **Comparison:**
     + Compare the performance of regression models with and without XAI techniques in terms of interpretability, accuracy, and reliability of insights.
6. **Documentation:**
   * **Report Preparation:**
     + Provide a detailed report documenting the XAI implementation, evaluation results, and comparisons with traditional regression models.
     + Include code snippets, relevant plots, and a discussion of the XAI strategies used.
     + Provide insights and recommendations based on your findings.

**Deliverables:**

1. **Results Report:** Include performance comparisons, visualizations, and a detailed discussion of XAI versus traditional regression model approaches.
2. **Code:** Well-documented and organized codebase for XAI implementation on regression models.
3. **Final Model:** The trained regression models and XAI insights saved in a format that can be loaded and used for future analysis.

**Deadline to Report:** [31st Augst 2024]