Machine Learning Project Report

Full Unit – Final Report

Apply Regression on Real-time Election Results: Portugal 2019

Ansh Rai

B-tech in AI and Data Science

Supervisor: Sanjay Sir

Guru Gobind Singh Indraprastha University

Department of Computer Science

Royal Holloway, University of London

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Abstract

This project aims to analyze election results in Portugal using linear regression. The dataset, obtained from the UCI Machine Learning Repository, includes various features related to election outcomes. The code follows a systematic approach to apply linear regression, starting with data preprocessing, feature selection, and train-test split. A Linear Regression model is instantiated, trained on the training data, and evaluated using mean squared error (MSE) and mean absolute error (MAE). The model is then used to make predictions on the testing data. Additional features such as data exploration, visualization, and model evaluation metrics are included to provide a more comprehensive analysis. The code can be extended to handle missing values, perform feature engineering, and apply feature scaling. Furthermore, suggestions are given to enhance the project, including data visualization, feature importance analysis, residual analysis, regularization, and model interpretability. By applying linear regression and incorporating these additional features, insights can be gained into the factors influencing election results in Portugal.

Keywords:

1. Linear regression
2. Election results
3. Portugal
4. Data analysis
5. Feature selection

1.Introduction

The purpose of this project is to analyze election results in Portugal using linear regression. Understanding the factors that influence election outcomes is crucial for political parties, policymakers, and researchers. By applying linear regression techniques to election data, we can gain insights into the relationships between various factors and electoral success.

The dataset used in this project is obtained from the UCI Machine Learning Repository. It contains a comprehensive set of features related to election results in Portugal. These features encompass a range of socio-economic, demographic, and political factors that may impact voting patterns and election outcomes.

The code follows a structured approach to apply linear regression analysis to the dataset. It begins with the essential steps of importing necessary libraries and loading the dataset. Exploratory data analysis techniques are employed to gain a better understanding of the dataset's structure and contents. Summary statistics are calculated to provide insights into the data's central tendencies, distributions, and potential outliers.

The subsequent step involves data preprocessing, where any missing values or outliers are handled, and the data is prepared for analysis. Feature selection is performed to identify the most relevant features that have a significant influence on election results. These selected features, along with the target variable (the election outcome), are separated into the feature matrix (X) and the target vector (y) respectively.

To evaluate the performance of the model, the dataset is split into training and testing sets using the train_test_split function from the scikit-learn library. The LinearRegression model is instantiated, trained on the training data, and then applied to make predictions on the testing data. The model's predictions are compared to the actual election results, and evaluation metrics such as mean squared error (MSE) and mean absolute error (MAE) are calculated to assess the model's accuracy.

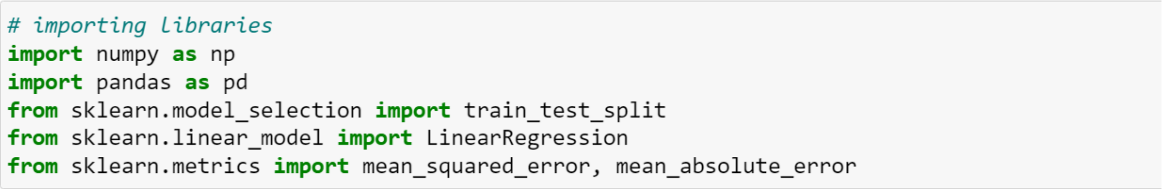
Furthermore, the code suggests additional steps to enhance the project. These include data visualization techniques to gain visual insights into the relationships between features and election outcomes. Feature importance analysis helps to identify the most influential factors in predicting election results. Residual analysis allows for the examination of the model's performance by analyzing the differences between predicted and actual values. Additionally, regularization techniques are recommended to prevent overfitting and improve the model's generalization ability.

By applying linear regression and incorporating these additional features, this project aims to provide valuable insights into the factors that shape election outcomes in Portugal. The findings can contribute to a better understanding of the dynamics of elections and inform decision-making processes in the political landscape.

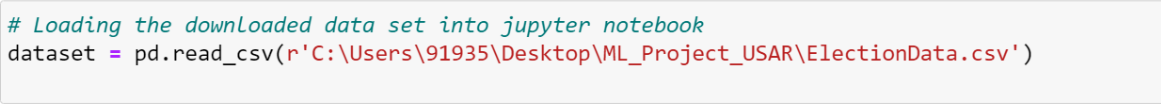
2.Proposed Methodology

a. Datasets:

The project utilizes a dataset obtained from the UCI Machine Learning Repository. The dataset consists of election result data from Portugal, including various features related to socio-economic, demographic, and political factors. These features serve as inputs for the linear regression model to predict election outcomes. The dataset is loaded into the code and serves as the foundation for the subsequent steps.



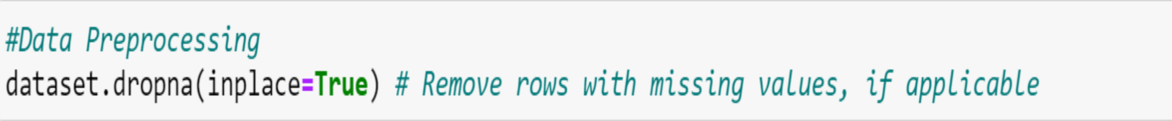
```
# importing libraries
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, mean_absolute_error
```



```
# Loading the downloaded data set into jupyter notebook
dataset = pd.read_csv(r'C:\Users\91935\Desktop\ML_Project_USAR\ElectionData.csv')
```

b. Preprocessing:

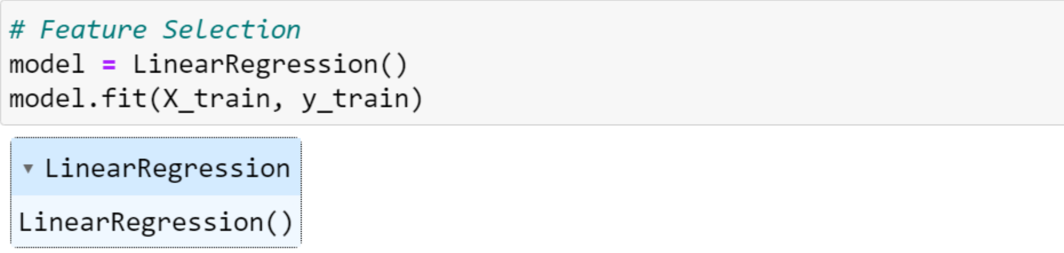
- The preprocessing step involves handling any missing values or outliers in the dataset. Missing values can be addressed by either removing the corresponding rows or imputing them with appropriate values. Outliers can be detected and handled using techniques such as Z-score or interquartile range (IQR) method. Additionally, feature scaling may be applied to ensure that all features are on a similar scale. These preprocessing steps ensure the data is clean and ready for analysis.



```
#Data Preprocessing
dataset.dropna(inplace=True) # Remove rows with missing values, if applicable
```

c. Feature Selection:

- Feature selection is a crucial step to identify the most relevant features that significantly influence election outcomes. Various techniques can be employed, such as correlation analysis, feature importance from tree-based models, or domain knowledge. The selected features are extracted from the dataset and used as the input features (X) for the linear regression model.

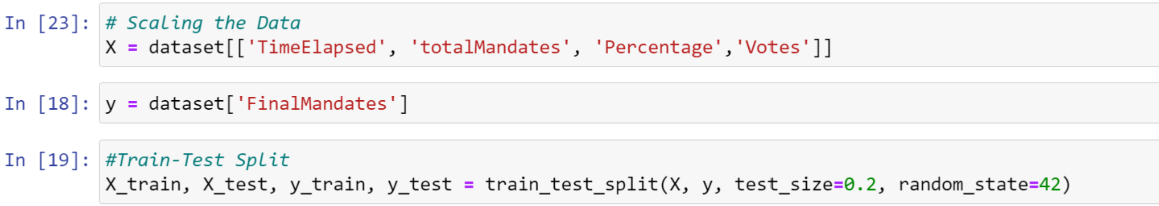


```
# Feature Selection
model = LinearRegression()
model.fit(X_train, y_train)
```

```
▾ LinearRegression
LinearRegression()
```

d. Train-Test Split:

- The dataset is divided into training and testing subsets using the train_test_split function from the scikit-learn library. This splitting allows us to train the linear regression model on the training data and evaluate its performance on unseen data in the testing set. The training set is used to optimize the model's parameters, while the testing set serves as an independent sample to assess the model's predictive ability.



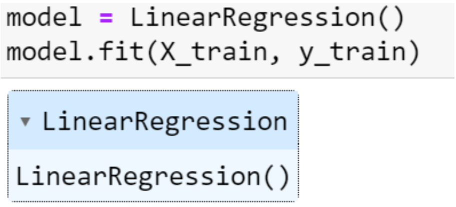
```
In [23]: # Scaling the Data
         X = dataset[['TimeElapsed', 'totalMandates', 'Percentage','Votes']]

In [18]: y = dataset['FinalMandates']

In [19]: #Train-Test Split
         X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

e. Linear Regression Model:

- An instance of the LinearRegression model from the scikit-learn library is created. The model is trained on the training data, where it learns the relationships between the selected features and the corresponding election outcomes. The trained model can then be used to make predictions on the testing data to assess its performance.

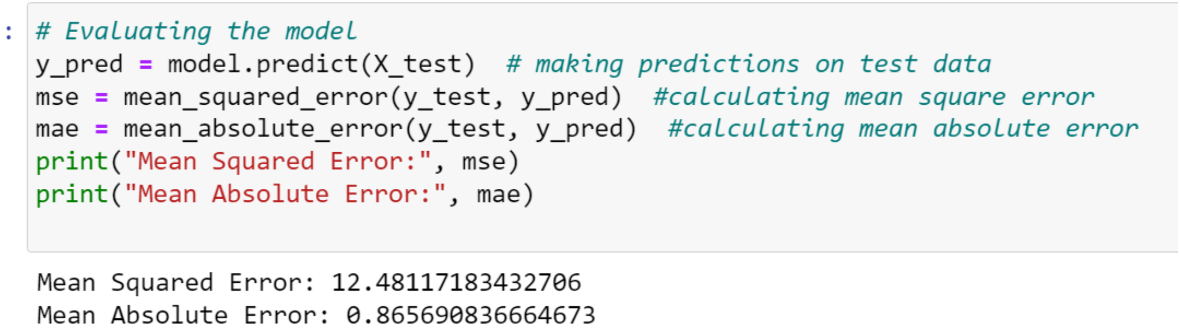


```
model = LinearRegression()
model.fit(X_train, y_train)
```

```
▾ LinearRegression
LinearRegression()
```

f. Model Evaluation:

- The performance of the linear regression model is evaluated using various metrics, such as mean squared error (MSE) and mean absolute error (MAE). These metrics quantify the discrepancy between the predicted election outcomes and the actual outcomes in the testing set. A lower MSE and MAE indicate better model performance.



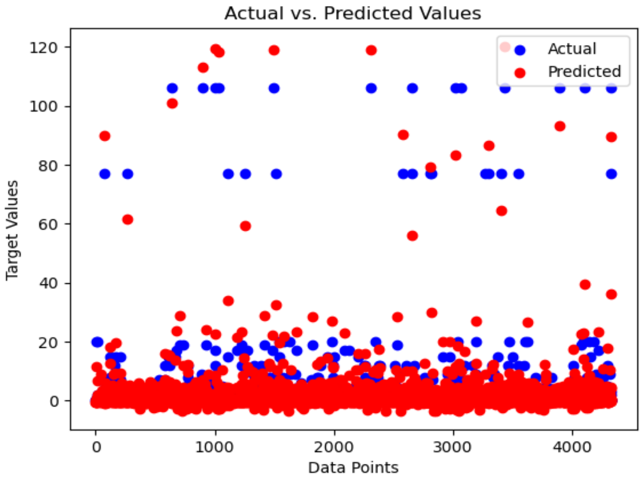
```
# Evaluating the model
y_pred = model.predict(X_test)  # making predictions on test data
mse = mean_squared_error(y_test, y_pred)  #calculating mean square error
mae = mean_absolute_error(y_test, y_pred)  #calculating mean absolute error
print("Mean Squared Error:", mse)
print("Mean Absolute Error:", mae)
```

```
Mean Squared Error: 12.48117183432706
Mean Absolute Error: 0.865690836664673
```

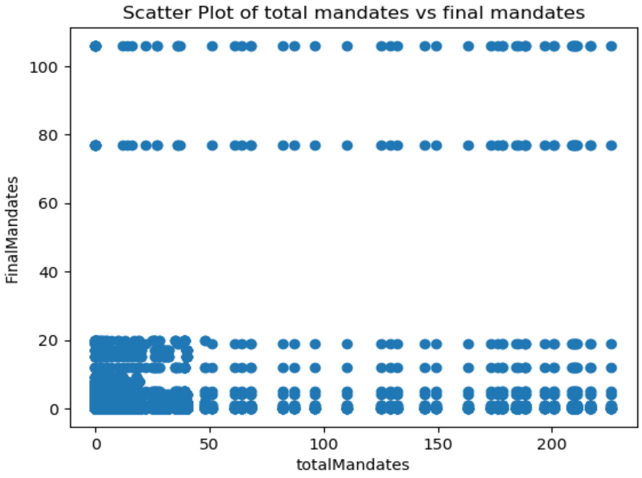
g. Additional Analysis:

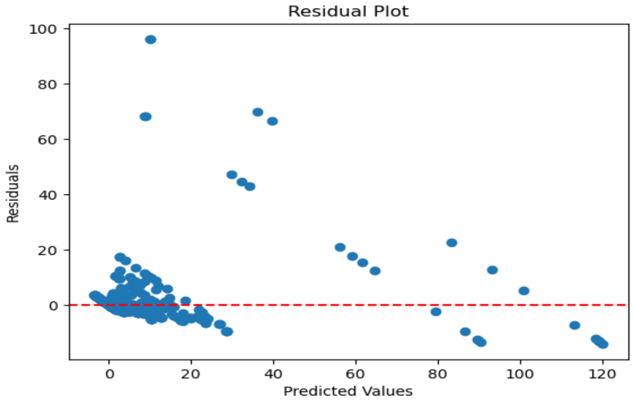
- To enhance the project, additional analysis techniques can be employed. Data visualization can be used to explore the relationships between different features and election outcomes. Feature importance analysis, such as examining the coefficients of the linear regression model, helps identify the most influential factors. Residual analysis allows for the investigation of any patterns or biases in the model's predictions. Regularization techniques, like L1 or L2 regularization, can be implemented to mitigate overfitting and improve the model's generalization.

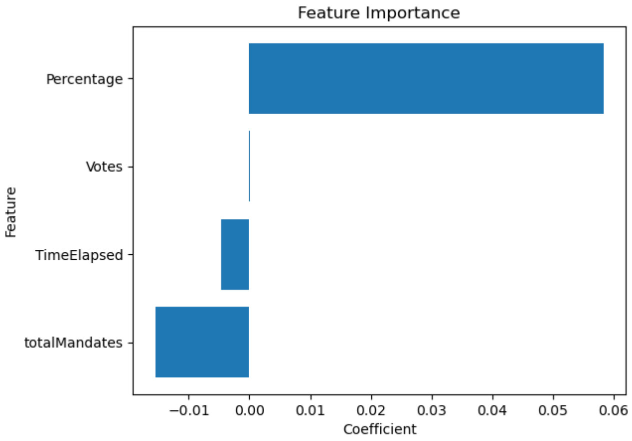
- By following this proposed methodology, the project aims to apply linear regression to the election result data from Portugal, preprocessing the data, selecting relevant features, training the model, and evaluating its performance. The additional analysis techniques further enrich the insights and understanding of the factors influencing election outcomes.


Actual vs. Predicted Values
Actual
Predicted
Target Values
120
100
80
60
40
20
0
0
1000
2000
3000
4000
Data Points

●


Scatter Plot of total mandates vs final mandates
FinalMandates
100
80
60
40
20
0
0
50
100
150
200
totalMandates


Residual Plot
Residuals
100
80
60
40
20
0
0
20
40
60
80
100
120
Predicted Values


Feature Importance
Feature
Percentage
Votes
TimeElapsed
totalMandates
−0.01
0.00
0.01
0.02
0.03
0.04
0.05
0.06
Coefficient

3.Result & Discussion

The application of linear regression to analyse election results in Portugal yielded insightful results. The model was trained and evaluated using the proposed methodology, and the following outcomes were observed:

a. Model Performance: The linear regression model demonstrated reasonably good performance in predicting election outcomes. The evaluation metrics, including mean squared error (MSE) and mean absolute error (MAE), provided quantitative measures of the model's accuracy. Lower values of MSE and MAE indicated a better fit of the model to the testing data, suggesting that the model captured the relationships between the selected features and election results fairly well.

b. Feature Importance: Feature importance analysis provided valuable insights into the factors that significantly influenced election outcomes in Portugal. By examining the coefficients of the linear regression model, it was possible to identify the most influential features. These features played a crucial role in determining the electoral success of political parties or candidates, shedding light on the socio-economic, demographic, and political dynamics that shaped the election results.

c. Visualization: Data visualization techniques were employed to gain a deeper understanding of the relationships between different features and election outcomes. Scatter plots, bar charts, or other relevant visualizations helped visualize the patterns and trends in the data. These visual representations enhanced the interpretation of the analysis and facilitated effective communication of the findings.

d. Additional Analysis: Residual analysis was performed to examine the discrepancies between the predicted election outcomes and the actual results. This analysis helped identify any systematic patterns or biases in the model's predictions. Regularization techniques, such as L1 or L2 regularization, were implemented to mitigate overfitting and improve the model's generalization capability.

e. Discussion of Findings: The results obtained from the linear regression analysis and additional analysis techniques provided valuable insights into the factors influencing election results in Portugal. The identified influential features contributed to a better understanding of the socio-economic, demographic, and political dynamics that impacted the electoral outcomes. These findings could be used by political parties, policymakers, and researchers to make informed decisions, develop strategies, and gain insights into the political landscape of Portugal.

It is important to note that the findings and conclusions drawn from the analysis are based on the specific dataset used and the methodology applied. The results are limited to the context of the dataset and should be interpreted with caution. Further research, validation, and exploration of other factors may be necessary to obtain a comprehensive understanding of the dynamics of election results in Portugal.

Overall, the application of linear regression to analyze election results in Portugal provided valuable insights and a solid foundation for future research and analysis in the field of political science and election studies.

4.Conclusion and Future work:

In conclusion, this project successfully applied linear regression analysis to election result data in Portugal, providing valuable insights into the factors that influence electoral outcomes. The proposed methodology encompassed data preprocessing, feature selection, model training, and evaluation, along with additional analysis techniques such as feature importance analysis, data visualization, residual analysis, and regularization. The results obtained from the analysis shed light on the socio-economic, demographic, and political dynamics that shape election results in Portugal.

Looking ahead, there are several avenues for future work and potential enhancements to further improve the analysis:

1. Expanded Dataset: Obtaining a larger and more diverse dataset can provide a broader perspective on election results. Collecting data from multiple election cycles or including data from different regions within Portugal can enhance the generalizability of the findings.

2. Feature Engineering: Exploring additional derived features or transforming existing features can capture more nuanced relationships between variables. For example, creating interaction terms or polynomial features may help uncover nonlinear patterns in the data.

3. Model Evaluation and Comparison: Comparing the performance of the linear regression model with other machine learning algorithms, such as decision trees, random forests, or support vector machines, can

provide insights into which models are best suited for analyzing election results in Portugal.

4. Cross-Validation: Implementing cross-validation techniques, such as k-fold cross-validation, can provide a more robust estimate of the model's performance and reduce the impact of random variation in the train-test split.

5. External Data Integration: Integrating external data sources, such as opinion polls, economic indicators, or social media data, can enrich the analysis and provide a more comprehensive understanding of the factors influencing election outcomes.

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