Sentiment Classification Using Linear Regression

---

1. Introduction

Sentiment classification is a vital task in Natural Language Processing (NLP) that involves identifying the emotional tone behind text data. While classification models are typically used, this experiment explores the use of **Linear Regression** for predicting sentiment classes based on textual data. Using **TF-IDF** for feature extraction and **label encoding** for sentiment labels, the model aims to minimize prediction error and assess feasibility for classification tasks.

---

2. Methodology

2.1 Feature Extraction

- **Term Frequency-Inverse Document Frequency (TF-IDF)** was used to transform raw text into numerical features.
- This method reduces the weight of commonly used words and emphasizes rare but meaningful terms.

2.2 Label Encoding

- The sentiment labels were encoded numerically using **LabelEncoder**, converting classes such as positive, neutral, and negative into integers.

2.3 Regression Model

- A **Linear Regression** model was trained using the TF-IDF-transformed data and encoded sentiment labels.
- Despite being a regression model, predictions were **rounded and clipped** to the nearest valid class to simulate classification behavior.

2.4 Evaluation Metrics

To evaluate the regression model as a classifier:

- **Mean Squared Error (MSE)**
- **R^2 Score**
- **Approximate Accuracy** (after rounding predictions)
- Visuals:
    - Actual vs Predicted Scatter Plot
    - Residuals Histogram

- Residuals Line Plot

---

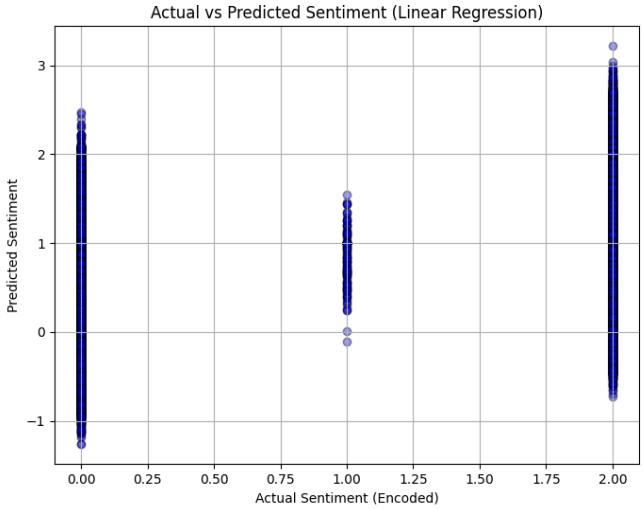
3. Results and Analysis

3.1 Performance Metrics

Metric	Value
Mean Squared Error	≈ 0.3496
R^2 Score	≈ 0.5167
Approx. Accuracy	≈ 68.42%

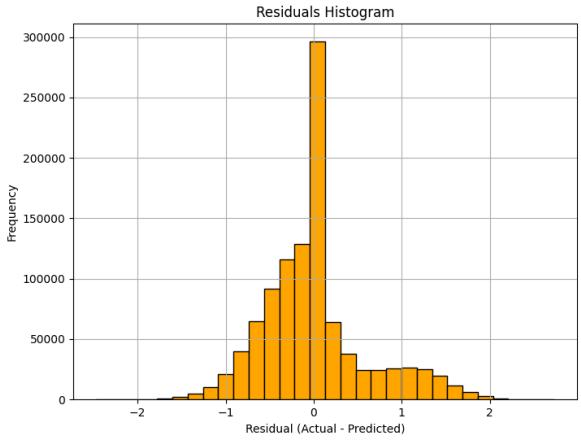
3.2 Scatter Plot: Actual vs Predicted

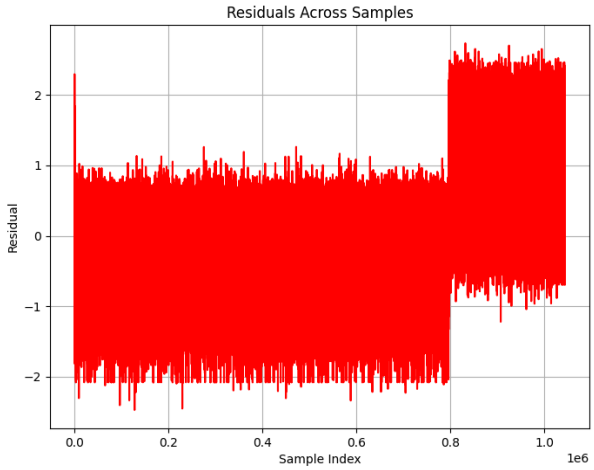
- The scatter plot indicates the spread of predicted values vs actual encoded classes.
- A tighter grouping along the diagonal suggests better fit and separability.



3.3 Residual Analysis

- **Histogram** of residuals shows the distribution of prediction errors.
- **Line plot** of residuals highlights systematic bias or trends over sample indices.





---

4. Conclusions and Recommendations

1. **Linear Regression**, while not a traditional choice for classification, can approximate sentiment classification reasonably well when predictions are post-processed.
2. The **MSE and R^2** provide insights into how well sentiment labels (as numeric values) were predicted.
3. The **rounded accuracy** gives a crude but useful benchmark for classification performance.
4. However, for production-ready classification tasks, using models like **Logistic Regression, SVM, or Random Forest** is **highly recommended** due to their inherent capability to deal with discrete target labels and probabilistic interpretation.