# Python Assignment Report

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Repository Link

## 1 Methodology

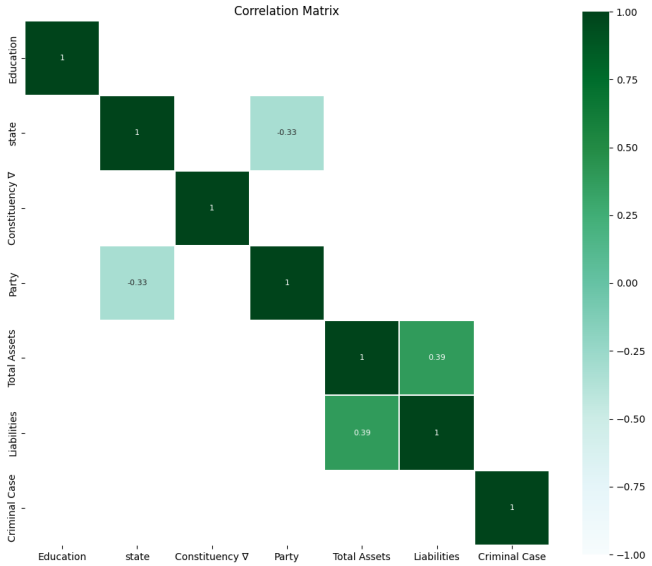
### 1.1 Data Preprocessing Steps

Basic Preprocessing[1] was carried out on the data. This included steps like:

1. The Total Assets and Liabilities, present as categorical values with various suffixes (Thou+, Hund+, Lac+, Crore+), were converted to their numerical counterpart.
2. Other categorical values such as Party, state, Education, and Constituency were label encoded.
3. No duplicates were found. Also, there were no missing values in the train data.

### 1.2 Feature Engineering

1. Useless Features like ID and Candidate Names were dropped. Constituencies were also unique in most of the data but were retained in the feature vector.



2. The difference between the Total Assets and Liabilities was also incorporated as a new feature. This was done after a positive correlation of around 0.39, which suggested a moderate positive linear relation was revealed.

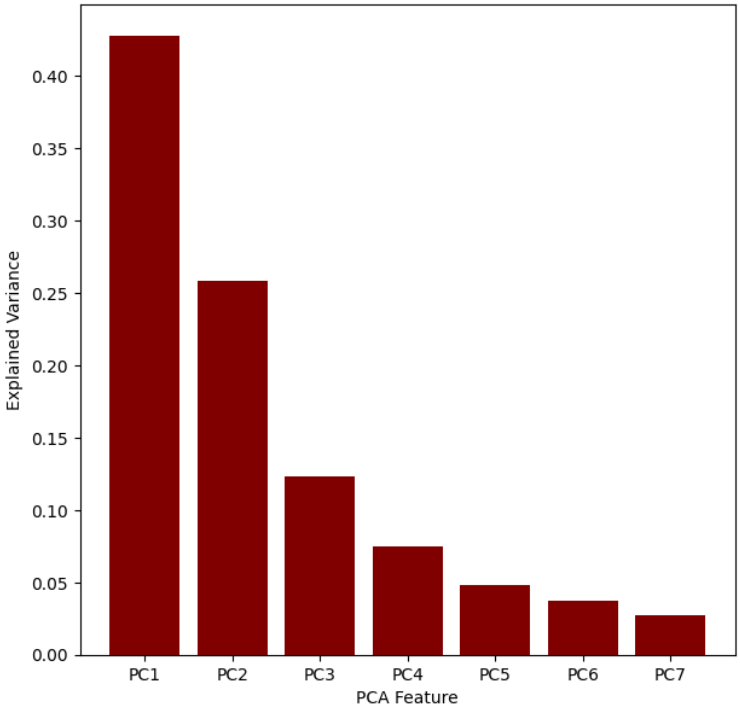
### 1.3 Identifying Outliers

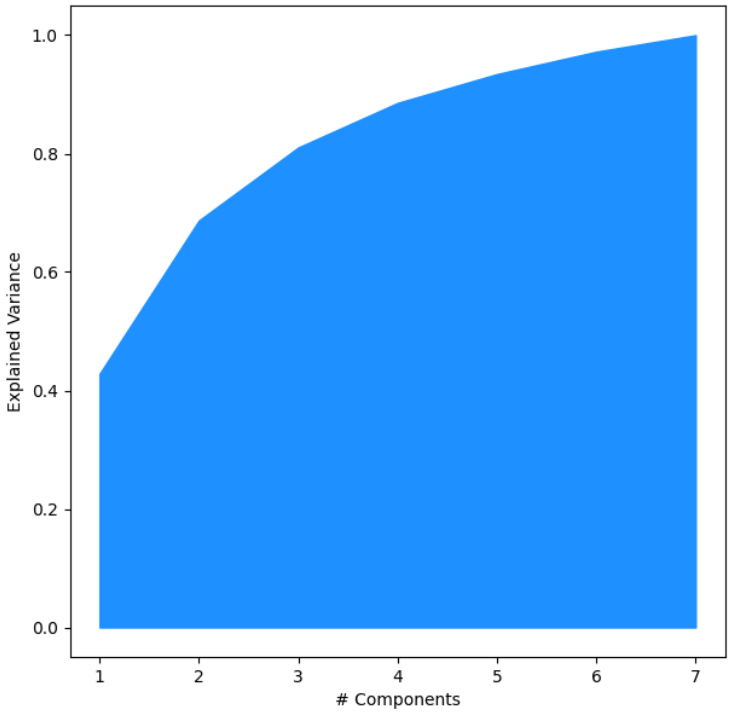
Z-Score Normalization was used to identify outliers. The Z-score Normalization (which standardizes the data by subtracting the mean and dividing by the standard deviation) score for Criminal Records, Assets, and Liabilities was calculated. However, this did not help improve the model's accuracy on the test set, so this normalization was discarded.

### 1.4 Dimensionality Reduction Techniques

Principal Component Analysis was used to find the principle components that explained most of the variance in the data.

PC1: Constituency
PC2: Party
PC3: Criminal Case
PC4: Total Assets
PC5: Liabilities
PC6: state
PC7: Wealth






### 1.5 Normalization, Standardization, or Transformation Used

Criminal Cases, Total Assets, and Liabilities values were highly right-skewed. Logarithmic transformation was applied to these features to reduce this skewness.

### 1.6 Other

Along with preprocessing, `StratifiedShuffleSplit` was used for splitting data into train and test sets while maintaining the same class distribution in both sets. This was done to handle the class imbalance. The oversampling technique ADASYN was tried, and synthetic data generators like CTGAN were used, although they did not improve the F1 score.

## 2 Experiment Details

### 2.1 Models Used[2]

In most of the Submissions, `RandomForestClassifier` was trained on the test data set. The best hyper-parameters for the model were found using `GridSearchCV`, which were as follows:

| | |
|---|---|
| max_depth | 20 |
| min_samples_leaf | 3 |
| min_samples_split | 5 |
| n_estimators | 400 |

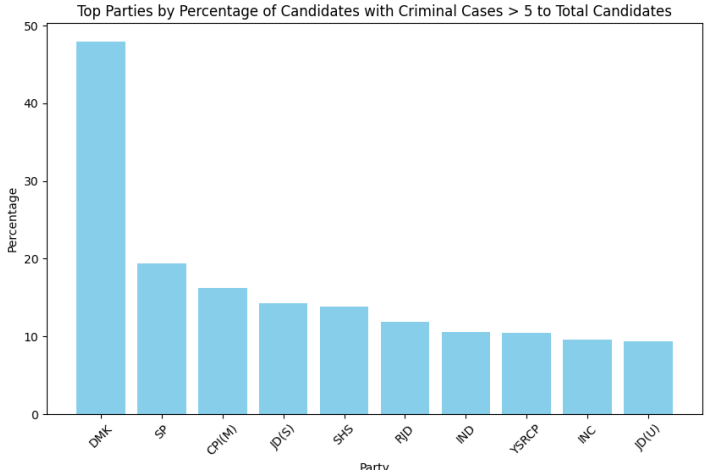
Some of the submissions also used other classifiers, such as XGBoost, SVC, and BernoulliNB, though their accuracy was less than that of RandomForest. The final submission used RandomForestClassifier.

5-Fold-Cross-Validation was also used to measure the model's performance and prevent the model from overfitting.

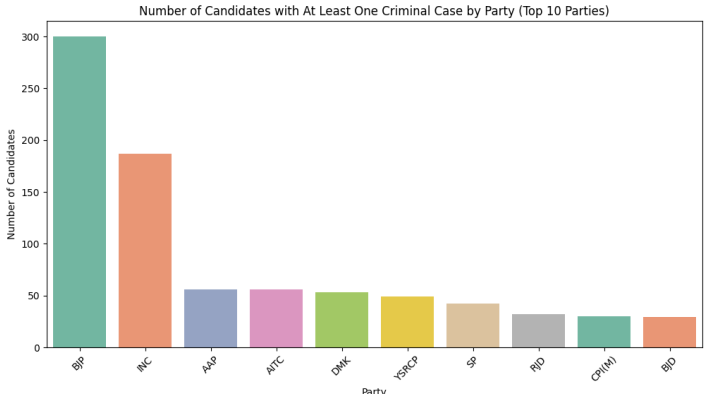
## 3 Data Insights

### 3.1 Parties and Criminal Cases

Here, I have plotted the percentage among the candidates of a party with more than 5 Criminal Cases against them. As we can see, DNK has the highest percentage of such candidates.

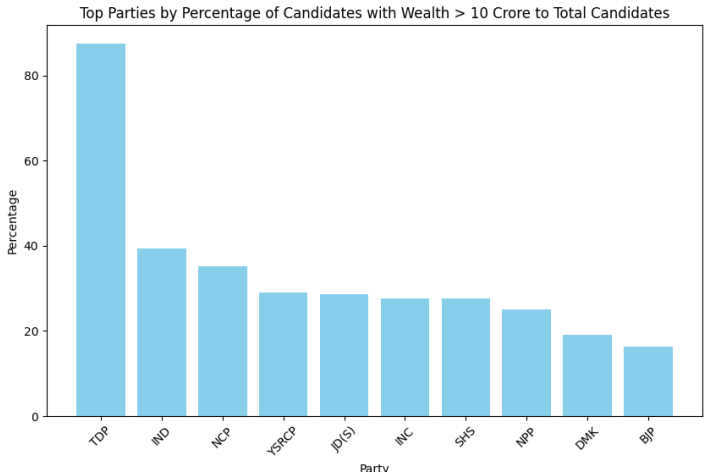



Next, I have plotted the number of candidates having criminal backgrounds present in the party. As we can see, the BJP has the highest number of such candidates. This can also be attributed to the fact that BJP has the highest number of candidates.



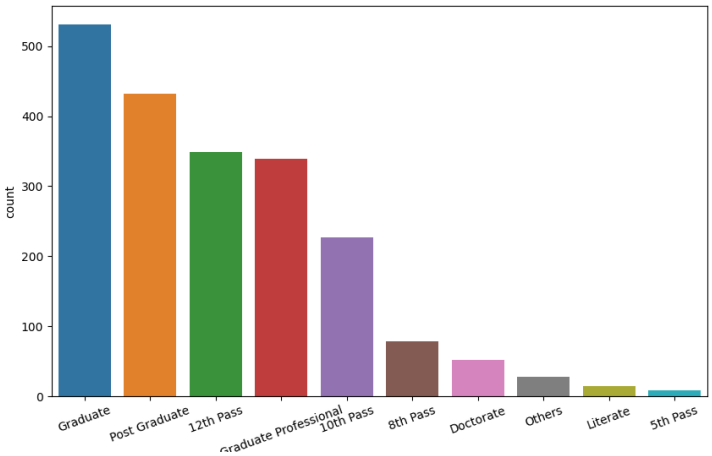

### 3.2 Wealth and Parties

Wealth is defined as assets minus Liabilities; we get the following plot: the number of Candidates having a wealth of more than 10 Crore versus their Political Party.

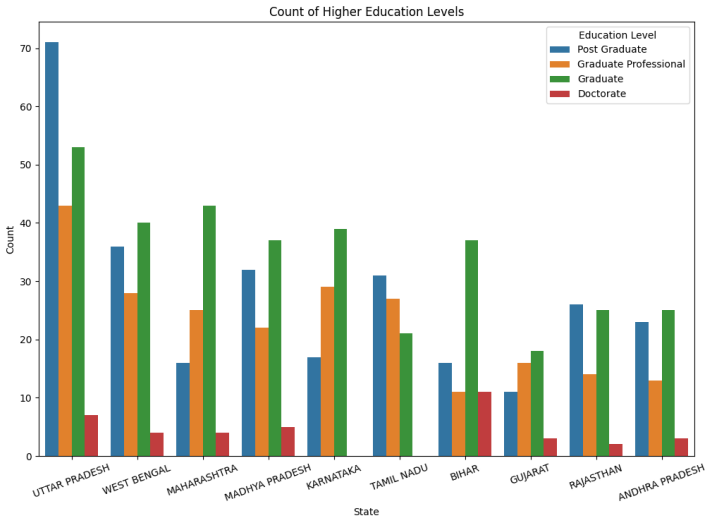


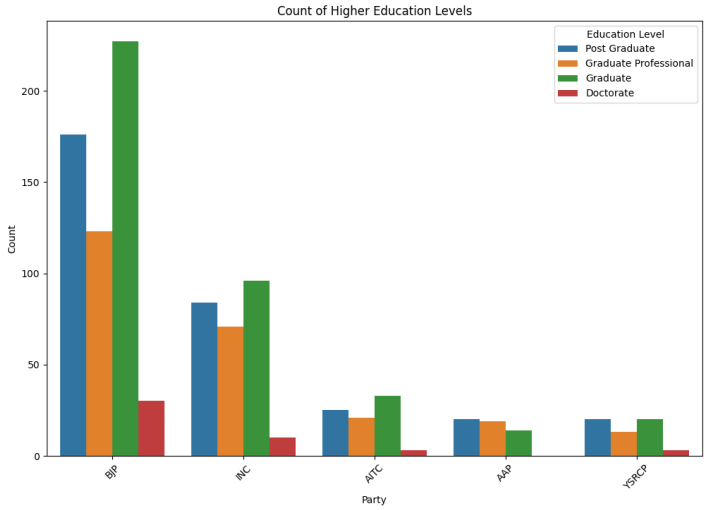

### 3.3 Additional Plots

The highest Number of Candidates are Graduates, followed by Post Graduates. This plot also shows us the imbalance present in the data. This can be handled using the `StratifiedShuffleSplit` for the train-test split, oversampling techniques like ADASYN, or by generating synthetic data CTGAN.




Plots showing the distribution of Education Levels in different States and Parties can also be plotted. This helps us understand the frequency of a particular label in a state/Party and can help better predict the Education for unseen data.






## 4 Results

The final F1 Score (public) is **0.24303**, and the private is **0.23175**.
The public leaderboard Rank is 87, and the private leaderboard rank is 114.

## 5 References

[1] 6.3. Preprocessing data — sci-kit-learn 1.4.2 documentation

[2] 1.12. Multiclass and multioutput algorithms

[3] Multi-Class Classification

Kaggle Feature Engineering

**REPO LINK**: https://github.com/SmartCheese22/CS253-Python-Assignment