Machine Learning Project

Analysis on COMPAS Recidivism

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Introduction To Dataset

- One widely used criminal risk assessment tool, Correctional Offender Management Profiling for Alternative Sanctions (COMPAS; Northpointe, which rebranded itself to “equivalent” in January 2017), has been used to assess more than 1 million offenders since it was developed

- This software predicts a defendant’s risk of committing a misdemeanor or felony within 2 years of assessment from 137 features about an individual and the individual’s past criminal record.

How This Data Was Collected

- When most defendants are booked in jail, they respond to a COMPAS questionnaire. Their answers are fed into the COMPAS software to generate several scores including predictions of “Risk of Recidivism” and “Risk of Violent Recidivism.”
- Through a public records request, ProPublica obtained two years worth of COMPAS scores from the Broward County Sheriff’s Office in Florida
- 7000 individuals arrested in Broward County, Florida between 2013 and 2014.

Feature explanation

Past Record

- Juvenile felony count, Juvenile other count,
- Juvenile missed count
- Adult priors count
- Jail duration
- Custody duration

Crime Score

- Decile Score
- Violent Decile Score
- Is two recid

Demographics

- Sex
- Age
- Race

Current Charge

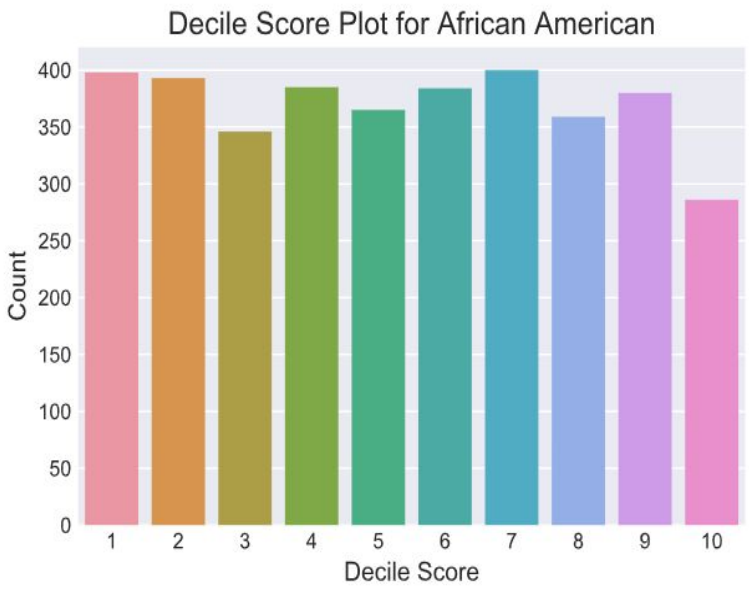
- Length of sentence
- Charge degree
- Charge category

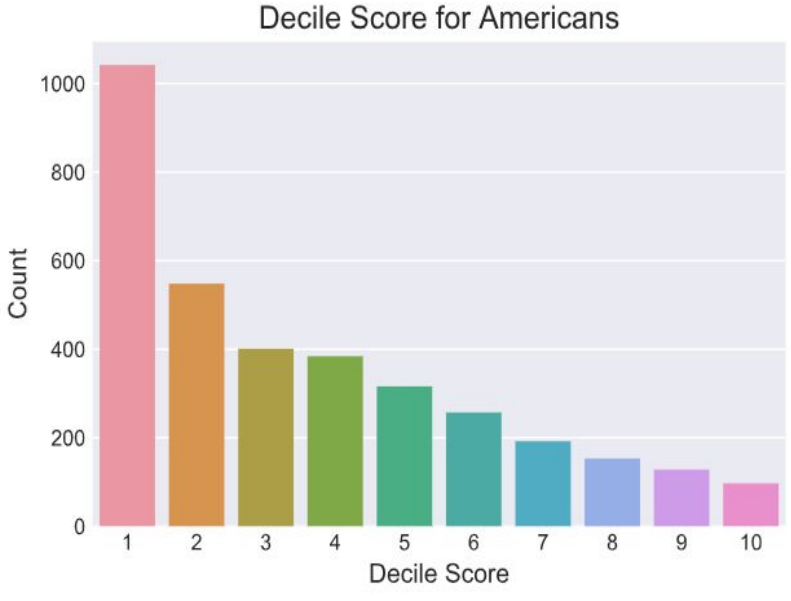
Analysis found in COMPAS

- COMPAS's overall accuracy for white defendants is 67.0% and for black defendants was 63.8%.
- Black defendants who did not recidivate were incorrectly predicted to reoffend at a rate of 44.9%, nearly twice as high as their white counterparts at 23.5%
- white defendants who did recidivate were incorrectly predicted to not reoffend at a rate of 47.7%, nearly twice as high as their black counterparts at 28.0%

Analysis found in COMPAS

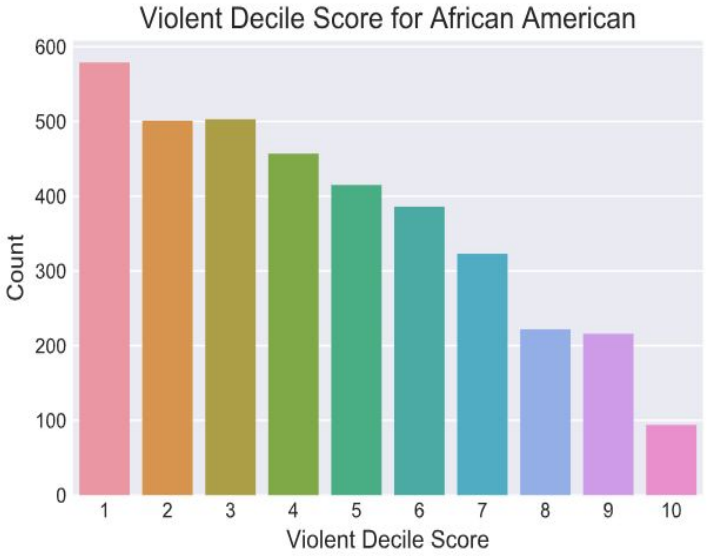
These histograms show that scores for white defendants were skewed toward lower-risk categories, while black defendants were evenly distributed across scores

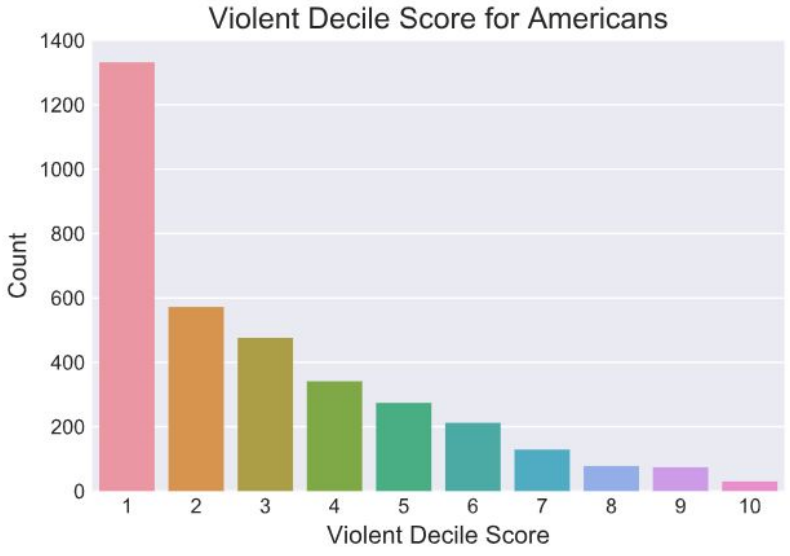




Analysis found in COMPAS

The histograms for COMPAS's violent risk score also show a disparity in score distribution between white and black defendants





Feature Engineering

- Total Number of rows: 7214 & Total Number of columns: 53
- There are a number of columns that have more than 50% missing data, hence we took them out from data set before our analysis.
- Columns like id, FirstName, Last Name and date related fields were removed
- Calculation: For keeping significance of date values like jail_in, jail_out, in_custody, out_custody, start and end, we calculated jail duration, custody duration and length of sentence respectively
- Columns that had only one value for all the rows were removed. Example: Type of Assessment and violent type of Assessment

Dataset for Classification Models

We applied Machine learning algorithms on two datasets:

a. All features -

- Dataset formed after retaining only valuable 25 features
- Features like Age, Gender, Race, Juvenile felony count, decile score, jail duration etc

b. Best features -

- Dataset devoid of demographic features like Race and Gender

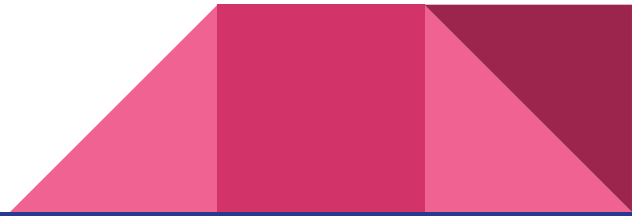
Outcome of interest:

Recidivism in 2 years - A person's relapse into criminal behaviour after 2 years

Classification Models Used

Below models are used on two datasets:

1. Probabilistic Model
    a. Logistic Regression
    b. Naive Bayes
2. Linear Model
    a. Support Vector Machine (SVM)
3. Decision Model
    a. Random Forest
4. Non-Linear Model
    a. KNN (K-Nearest Neighbour)



Logistic Regression

- All features
  - ROC Score : 0.98887
  - Accuracy Score: 0.98821
- Top 10 features
  - ROC Score : 0.9904
  - Accuracy Score: 0.9896
- **Analysis:** Our analysis on the model indicates that data set has little collinearities and it is linearly separable which results in to high accuracy and ROC-AUC scores

Naive Bayes

- All features
  - ROC Score : 0.9823
  - Accuracy Score: 0.9799
- Top 10 features
  - ROC Score : 0.98055
  - Accuracy Score: 0.9778
- **Analysis:** Our analysis on the model indicates that each feature contributes independently to the probability if the person commits a crime after two years regardless of any correlations between the features.

Support Vector Machine

- All features
  - ROC Score : 0.9896
  - Accuracy Score: 0.9889
- Top 10 features
  - ROC Score : 0.9910
  - Accuracy Score: 0.9902
- **Analysis:**Because of the less number of features there was no need to map data to a higher dimensional space. Using the linear kernel we achieved optimum performance pertaining to the linearly separable nature of the data

Random Forest

- All features
  - ROC Score : 0.9939
  - Accuracy Score: 0.9930
- Top 10 features
  - ROC Score : 0.9939
  - Accuracy Score: 0.9930
- **Analysis:** From our analysis on Random Forest, the most influential features seems to be the features related to criminal records rather than the demographic information. This indicates that criminal record is generally weighed more heavily than demographic information.

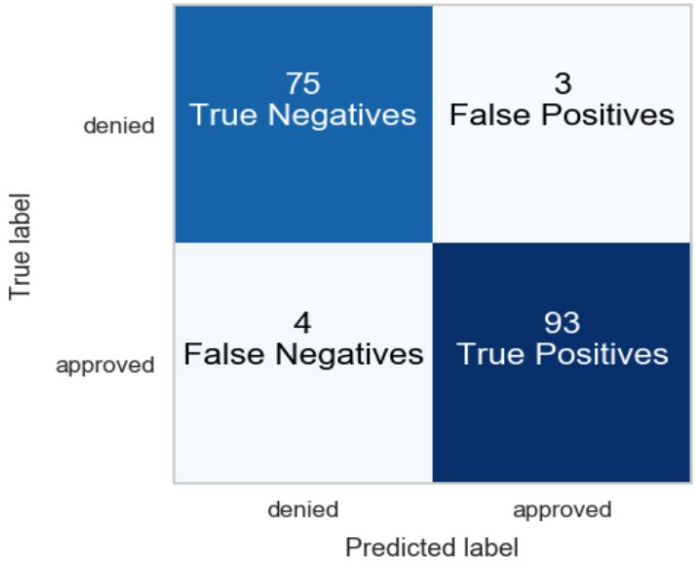
K-Nearest Neighbor

- All features
  - ROC Score : 0.8832
  - Accuracy Score: 0.8759
- Top 10 features
  - ROC Score : 0.8842
  - Accuracy Score: 0.8759
- **Analysis:** This model does not perform well as compared to the other models as the data is linearly separable.

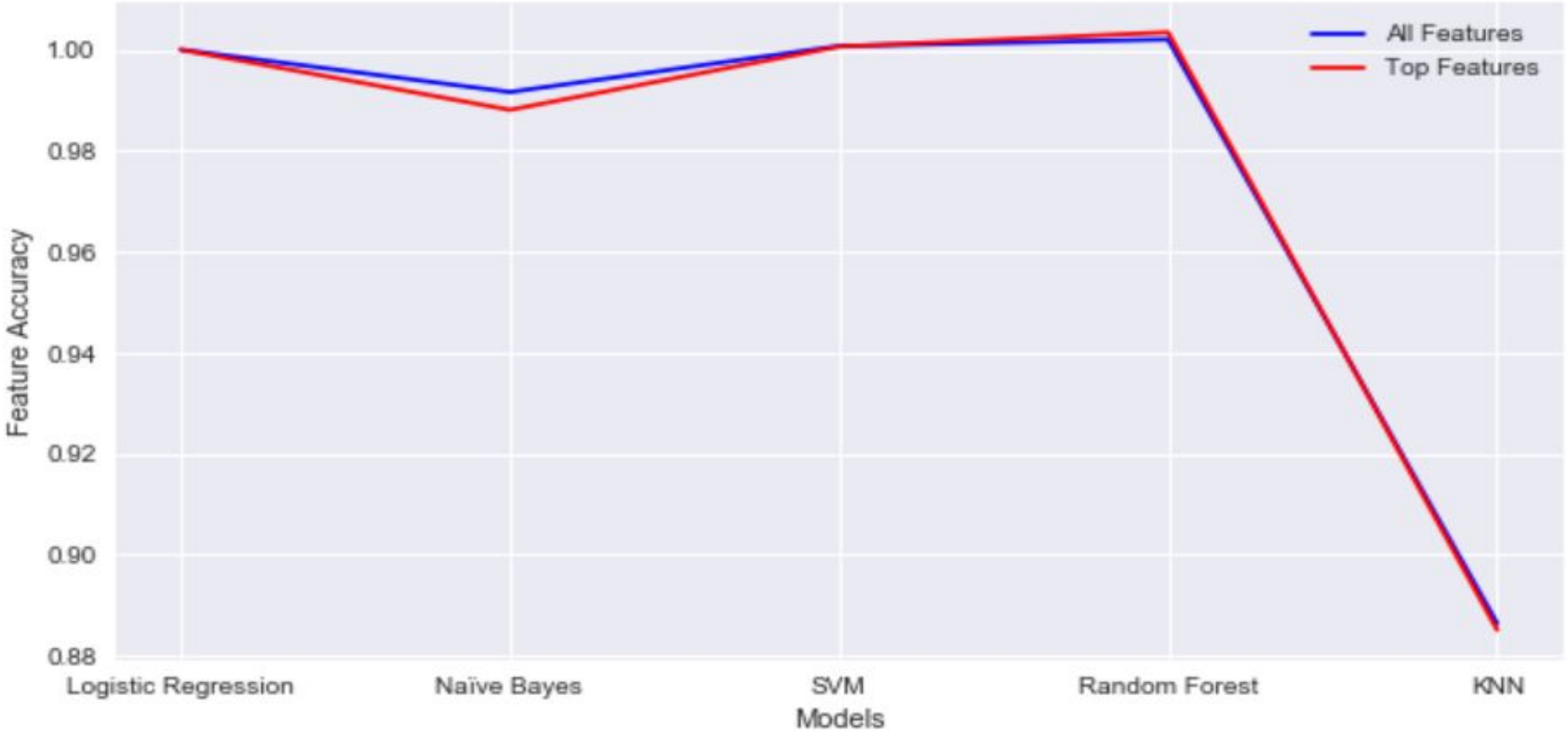
Classification Evaluation Metrics

Confusion Matrix: A table that describes the performance of a classification model on a set of test data for which the actual labels are known. It gives us True Negatives, False Positives, False Negatives and True Positives

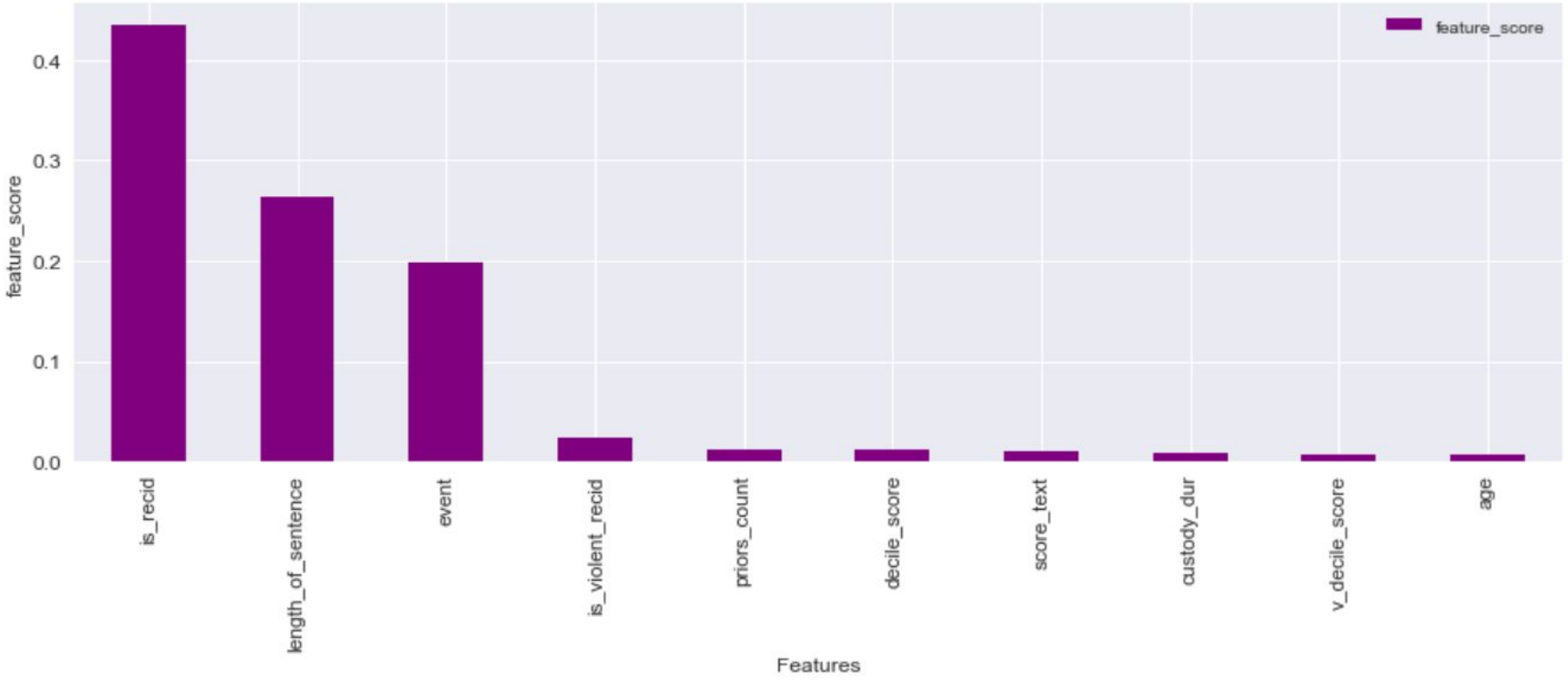
Accuracy: It is the ratio of number of correct predictions to the total number of input samples. For example- There were 5 total observations. For 4/5 observations, our model predicted a label equivalent to the actual label. 4/5 is 0.8. So we can say the accuracy score of this model is 0.8



Comparison Of Models on Accuracy



Best Features



Recommendation Of Model and Features

- ***Model Recommendation -*** *Random Forest* with Accuracy 0.9930
  Reason: We conclude that Random Forests is the best model to predict the criminal recidivism. The point of RF is to prevent overfitting.

- ***Features Recommendation -*** Focus on features based on criminal records

- **What factors should actually be considered for predicting Recidivism and why?**

  Factors such as demographic may serve as a proxy for race. Because these variables are highly correlated with race, they will likely have a racially disparate impact. As a public policy matter , we believe that "risk assessment" factors based on demographic background may not serve its intended goal of reducing incarcenation because they already have racially disparate impact, which means that existing COMPAS algorithms produce higher risk estimates, all other things equal, for subgroups whose members are already disproportionately incarcenated.