Criminal_sentencing

Algorithmic Bias in Criminal Sentencing

Following is an example of data science in Journalism. The purpose of the project is to shed light on how the criminal sentencing by **Correctional Offender Management Profiling for Alternative Sanctions(COMPAS)** is racially biased. The purpose of Journalism is to give voice and by use of such projects it exactly does that.

```
#loading libraries
library(tidyverse)
```

```
-- Attaching packages --------------------------------------- tidyverse 1.3.2 --
v ggplot2 3.3.6      v purrr   0.3.4
v tibble  3.1.8      v dplyr   1.0.10
v tidyr   1.2.0      v stringr 1.4.0
v readr   2.1.2      v forcats 0.5.1
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
```

```
library(readr)
library(dplyr)
library(ggplot2)
library(grid)
library(gridExtra)
```

```
Attaching package: 'gridExtra'

The following object is masked from 'package:dplyr':

    combine
```

```r
library(caTools)
```

```
Warning: package 'caTools' was built under R version 4.2.2
```

```r
library(pROC)
```

```
Type 'citation("pROC")' for a citation.

Attaching package: 'pROC'

The following objects are masked from 'package:stats':

    cov, smooth, var
```

```r
library(caret)
```

```
Warning: package 'caret' was built under R version 4.2.2

Loading required package: lattice

Attaching package: 'caret'

The following object is masked from 'package:purrr':

    lift
```

```r
library(psych)
```

```
Warning: package 'psych' was built under R version 4.2.2


Attaching package: 'psych'

The following objects are masked from 'package:ggplot2':

    %+%, alpha
```

For the purpose of the project I have taken the dataset from **ProPublica of criminal justice records from Broward County, Florida** and created own risk assessment model.

```r
crime<-read.csv("https://raw.githubusercontent.com/propublica/compas-analysis/master/compa

head(crime)
```

```
  id               name  first        last compas_screening_date  sex
1  1   miguel hernandez miguel   hernandez            2013-08-14 Male
2  3        kevon dixon  kevon       dixon            2013-01-27 Male
3  4           ed philo     ed       philo            2013-04-14 Male
4  5        marcu brown  marcu       brown            2013-01-13 Male
5  6 bouthy pierrelouis bouthy pierrelouis            2013-03-26 Male
6  7       marsha miles marsha       miles            2013-11-30 Male
         dob age          age_cat             race juv_fel_count decile_score
1 1947-04-18  69 Greater than 45            Other             0            1
2 1982-01-22  34          25 - 45 African-American             0            3
3 1991-05-14  24    Less than 25 African-American             0            4
4 1993-01-21  23    Less than 25 African-American             0            8
5 1973-01-22  43          25 - 45            Other             0            1
6 1971-08-22  44          25 - 45            Other             0            1
  juv_misd_count juv_other_count priors_count days_b_screening_arrest
1              0               0            0                      -1
2              0               0            0                      -1
3              0               1            4                      -1
4              1               0            1                      NA
5              0               0            2                      NA
6              0               0            0                       0
            c_jail_in          c_jail_out c_case_number c_offense_date
1 2013-08-13 06:03:42 2013-08-14 05:41:20 13011352CF10A     2013-08-13
2 2013-01-26 03:45:27 2013-02-05 05:36:53 13001275CF10A     2013-01-26
3 2013-04-13 04:58:34 2013-04-14 07:02:04 13005330CF10A     2013-04-13
4                                         13000570CF10A     2013-01-12
5                                         12014130CF10A
6 2013-11-30 04:50:18 2013-12-01 12:28:56 13022355MM10A     2013-11-30
  c_arrest_date c_days_from_compas c_charge_degree
1                                1               F
2                                1               F
3                                1               F
4                                1               F
5    2013-01-09                 76               F
6                                0               M
                  c_charge_desc is_recid r_case_number r_charge_degree
1   Aggravated Assault w/Firearm        0
2 Felony Battery w/Prior Convict        1 13009779CF10A            (F3)
```

```
3         Possession of Cocaine        1 13011511MM10A            (M1)
4        Possession of Cannabis        0
5         arrest case no charge        0
6                       Battery        0
  r_days_from_arrest r_offense_date              r_charge_desc  r_jail_in
1                 NA
2                 NA     2013-07-05 Felony Battery (Dom Strang)
3                  0     2013-06-16 Driving Under The Influence 2013-06-16
4                 NA
5                 NA
6                 NA
  r_jail_out violent_recid is_violent_recid vr_case_number vr_charge_degree
1                       NA                0
2                       NA                1  13009779CF10A             (F3)
3 2013-06-16            NA                0
4                       NA                0
5                       NA                0
6                       NA                0
  vr_offense_date              vr_charge_desc type_of_assessment decile_score.1
1                                             Risk of Recidivism              1
2      2013-07-05 Felony Battery (Dom Strang) Risk of Recidivism              3
3                                             Risk of Recidivism              4
4                                             Risk of Recidivism              8
5                                             Risk of Recidivism              1
6                                             Risk of Recidivism              1
  score_text screening_date v_type_of_assessment v_decile_score v_score_text
1        Low     2013-08-14     Risk of Violence              1          Low
2        Low     2013-01-27     Risk of Violence              1          Low
3        Low     2013-04-14     Risk of Violence              3          Low
4       High     2013-01-13     Risk of Violence              6       Medium
5        Low     2013-03-26     Risk of Violence              1          Low
6        Low     2013-11-30     Risk of Violence              1          Low
  v_screening_date in_custody out_custody priors_count.1 start  end event
1       2013-08-14 2014-07-07  2014-07-14              0     0  327     0
2       2013-01-27 2013-01-26  2013-02-05              0     9  159     1
3       2013-04-14 2013-06-16  2013-06-16              4     0   63     0
4       2013-01-13                                     1     0 1174     0
5       2013-03-26                                     2     0 1102     0
6       2013-11-30 2013-11-30  2013-12-01              0     1  853     0
  two_year_recid
1              0
2              1
3              1
```

```
4                    0
5                    0
6                    0
```

Data Cleaning for the final model i have selected features most relevant for analysis that includes Sex,Race,Prior count, Juvenile felony Count, Juvenile misdemeanor count, Juvenile other count, charge degree, and two year recidivism. Age at charge was calculated from difference of their date of birth and date when they went to jail. The age was categorized to five categories and length of stay at jail was counted by subtracting c_jail_out and c_jail_in. All the NA values were dropped.

```
clean<-crime%>%select("sex","race","priors_count","juv_fel_count","juv_misd_count","juv_ot
clean<-clean%>%select(-c("c_jail_out","c_jail_in","dob"))
```

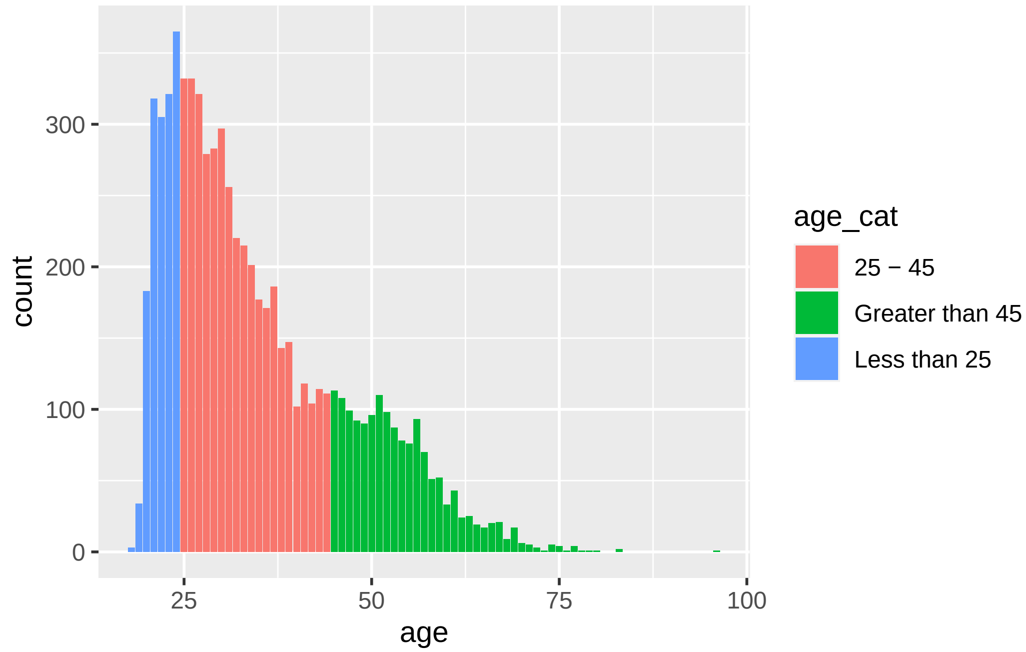
```
for(i in (1:range(nrow(clean)))){
  if (clean$age[i]>16 & clean$age[i]<25){clean$age[i]="[17,24]"}
  if (clean$age[i]>24 & clean$age[i]<32){clean$age[i]="(24,31]"}
  if (clean$age[i]>31 & clean$age[i]<43){clean$age[i]="(31,42]"}
  if (clean$age[i]>42 & clean$age[i]<81){clean$age[i]="(42,80]"}
  if(clean$age[i]>80){clean$age[i]="older"}
}
```

```
Warning in 1:range(nrow(clean)): numerical expression has 2 elements: only the
first used
```

```
clean<-clean%>%rename(age.cat=age)
```

Exploratory Data Analysis

```
crime%>%ggplot(mapping = aes(x = age, fill=age_cat)) + geom_bar()
```



Frome the original dataset we can conclude that most recidivism activity was found for 27-40s age group.

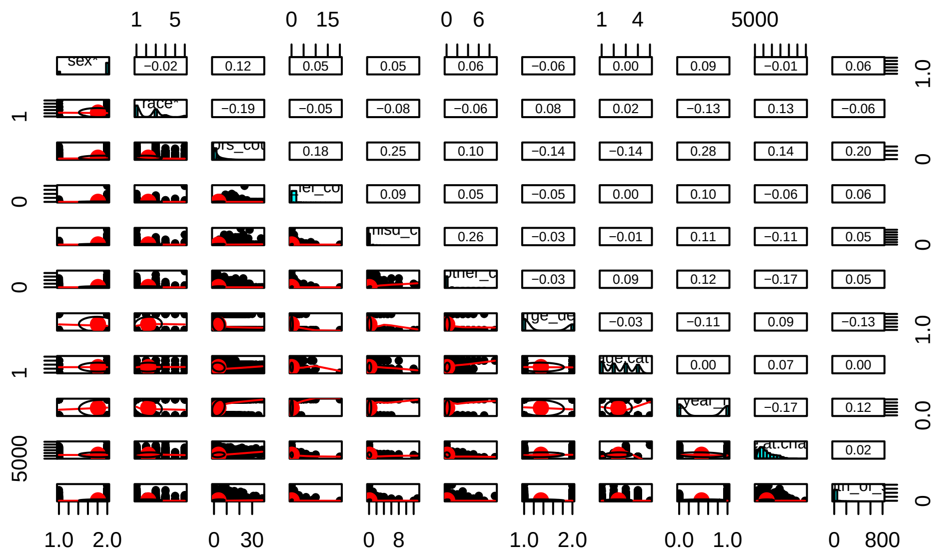
```
c1<-clean %>%ggplot(mapping = aes(x = race, fill=as.factor(two_year_recid))) + geom_bar()+

c2<-clean%>%filter(sex=="Female")%>%ggplot(aes(x=race,fill=as.factor(two_year_recid)))+geo

c3<-clean%>%filter(sex=="Male")%>%ggplot(aes(x=race,fill=as.factor(two_year_recid)))+geom_

grid.arrange(c1, c2,c3, ncol = 1,nrow=3)
```

Above graphs represents the analysis of two year recidivism and it is can be clearly concluded that overall more African american have recidivism score than any other races and so is true while doing gender wise analysis. Although difference between second most and first race i.e. Caucasian and African american is less for females when compare to males.

From the above graphs overall recidivism activity was most implicated for people between 24-31 age

Creating correlation matrix

```
pairs.panels(clean)
```



From the correlation matrix we can implicate that the features does not have any significant correlation which is good sign for our model

Creating training and testing datasets Divide train and test in 80-20 ratio

```
index.doc<-sample(x=nrow(crime), size=0.80*nrow(crime))
train_crime<-clean[index.doc,]
test_crime<-clean[-index.doc,]
```

Logistic Regression Model Output variable is taken as two year recidivism score

```
crime_glm<-glm(train_crime$two_year_recid~ .,data=train_crime,family = binomial)
summary(crime_glm)
```

```
Call:
glm(formula = train_crime$two_year_recid ~ ., family = binomial,
    data = train_crime)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-2.9152  -0.9907  -0.6507   1.0922   2.1251
```

```
Coefficients:
                      Estimate Std. Error z value Pr(>|z|)    
(Intercept)          2.284e-01  2.255e-01   1.013 0.311084    
sexMale              2.639e-01  7.563e-02   3.490 0.000483 ***
raceAsian           -6.581e-01  4.936e-01  -1.333 0.182417    
raceCaucasian       -6.027e-02  6.697e-02  -0.900 0.368120    
raceHispanic        -2.402e-01  1.095e-01  -2.194 0.028256 *  
raceNative American  1.555e-01  6.505e-01   0.239 0.811017    
raceOther           -1.640e-01  1.348e-01  -1.216 0.223878    
priors_count         1.503e-01  8.491e-03  17.699  < 2e-16 ***
juv_fel_count        1.934e-01  9.894e-02   1.954 0.050677 .  
juv_misd_count       6.885e-02  8.571e-02   0.803 0.421813    
juv_other_count      2.365e-01  7.483e-02   3.161 0.001574 ** 
c_charge_degreeM    -9.238e-02  6.323e-02  -1.461 0.144021    
age.cat(31,42]      -2.299e-01  1.049e-01  -2.190 0.028496 *  
age.cat(42,80]       6.057e-02  2.095e-01   0.289 0.772504    
age.cat[17,24]       2.745e-01  9.292e-02   2.955 0.003132 ** 
age.catolder         1.433e+01  1.970e+02   0.073 0.942016    
age.at.charge       -9.611e-05  2.224e-05  -4.321 1.55e-05 ***
length_of_stay       2.533e-03  6.586e-04   3.846 0.000120 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 7632.4  on 5530  degrees of freedom
Residual deviance: 6742.9  on 5513  degrees of freedom
  (240 observations deleted due to missingness)
AIC: 6778.9

Number of Fisher Scoring iterations: 10
```

Predicting the recidivism score using model on testing dataset

```
predict_crime<-predict(crime_glm,test_crime,type='response')
```

using the sigmoid concept

```
predicted<-ifelse(predict_crime>0.50,1,0)
```

Confusion Matrix

```r
confusionMatrix(as.factor(test_crime$two_year_recid),as.factor(predicted))
```

```
Confusion Matrix and Statistics

          Reference
Prediction   0   1
         0 550 175
         1 298 353

               Accuracy : 0.6562
                 95% CI : (0.6305, 0.6814)
    No Information Rate : 0.6163
    P-Value [Acc > NIR] : 0.00118

                  Kappa : 0.3038

 Mcnemar's Test P-Value : 2.028e-08

            Sensitivity : 0.6486
            Specificity : 0.6686
         Pos Pred Value : 0.7586
         Neg Pred Value : 0.5422
             Prevalence : 0.6163
         Detection Rate : 0.3997
   Detection Prevalence : 0.5269
      Balanced Accuracy : 0.6586

       'Positive' Class : 0
```

Sensitivity or True positive rate which is true positive rate the percentage of individuals the model correctly predicted . Here Sensistivity is low that means that model did not correctly predicted the recidivism score i.e. people who should be have high recidivism shouldnt have low recidivism score.

Specificity or true negative rate the percentage of individuals the model correctly predicted would have low risk. For the above model the specificity is low i.e. people who have low recidivism shouldnt have low recidivism score.

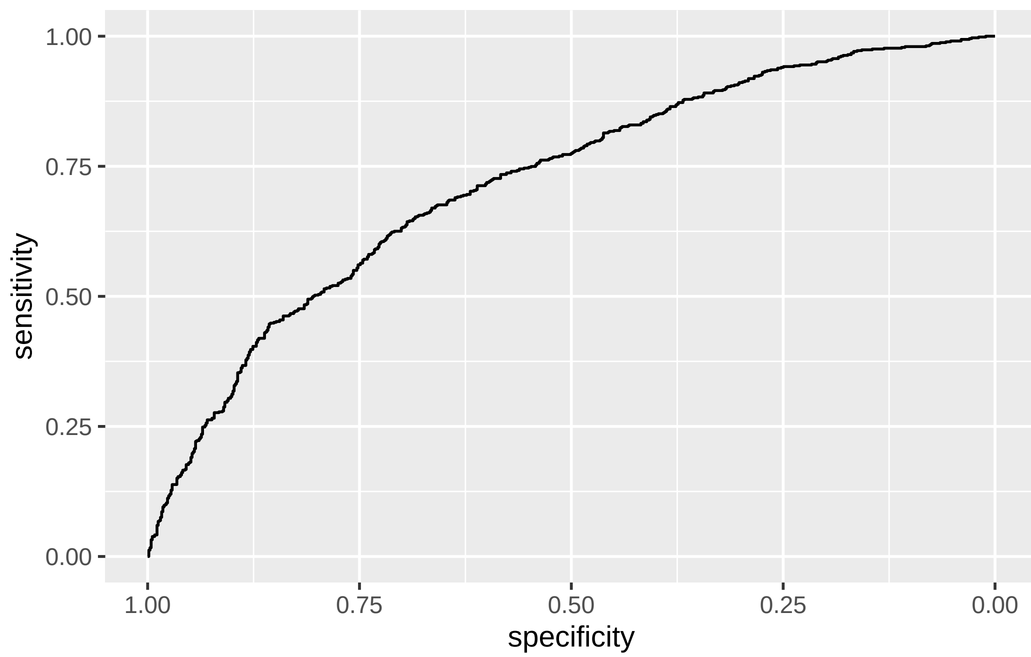
The model also have low accuracy

ROC Curve

```r
ggroc(roc(test_crime$two_year_recid,predict_crime))
```

```
Setting levels: control = 0, case = 1
```

```
Setting direction: controls < cases
```



The ROC Curve of our classification model is bad. A poor classifier will not properly distinguish between the two classes.

Algorithmic Bias

From the evaluation of model it is clearly indicated that the dataset is biased because people of certain race were implicated to higher risk score by model wrongfully, since race and sex are one of the inputs of the dataset as well. To remove the algorithmic bias the basis to train the model should not be such factors.

Conclusion

The model is clearly biased because it takes race and sex as one of it's features. As there is lot of history behind wrongfully conviction and supression of one race by another having such factors in training the model is ethically wrong. Also, the evaluation of model suggests that sizeable people who have low risk score should have high risk score and visa a versa. With such a model in implementation in real life people can be wrongfully convicted and those who should be convicted just because they belong to certain race are out of consideration.