The Data Analysis of Traffic Accidents in Camden County, New Jersey (2017-2019)

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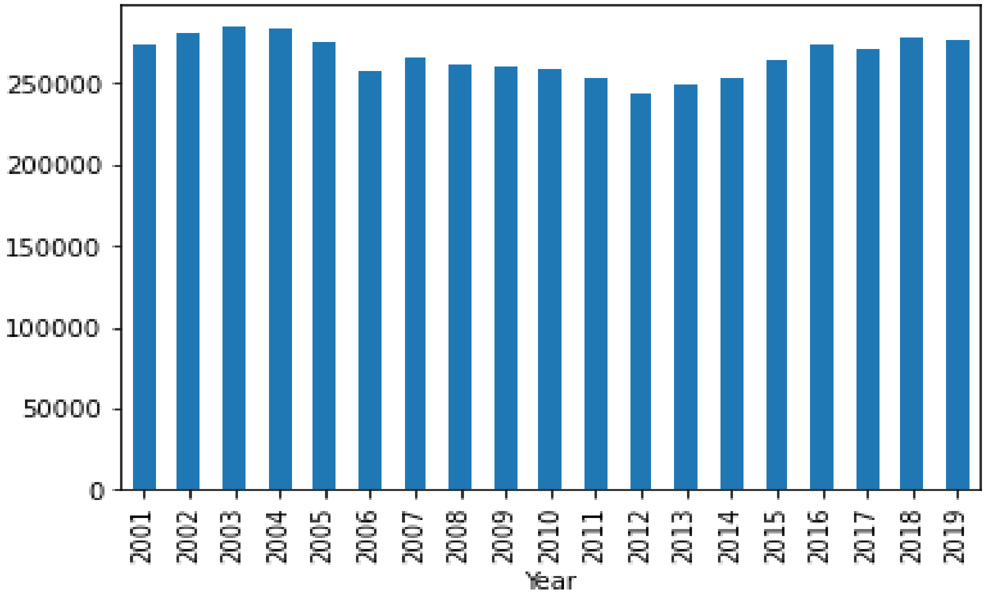
Data Source of Traffic accidents in New Jersey: Department of Transportation

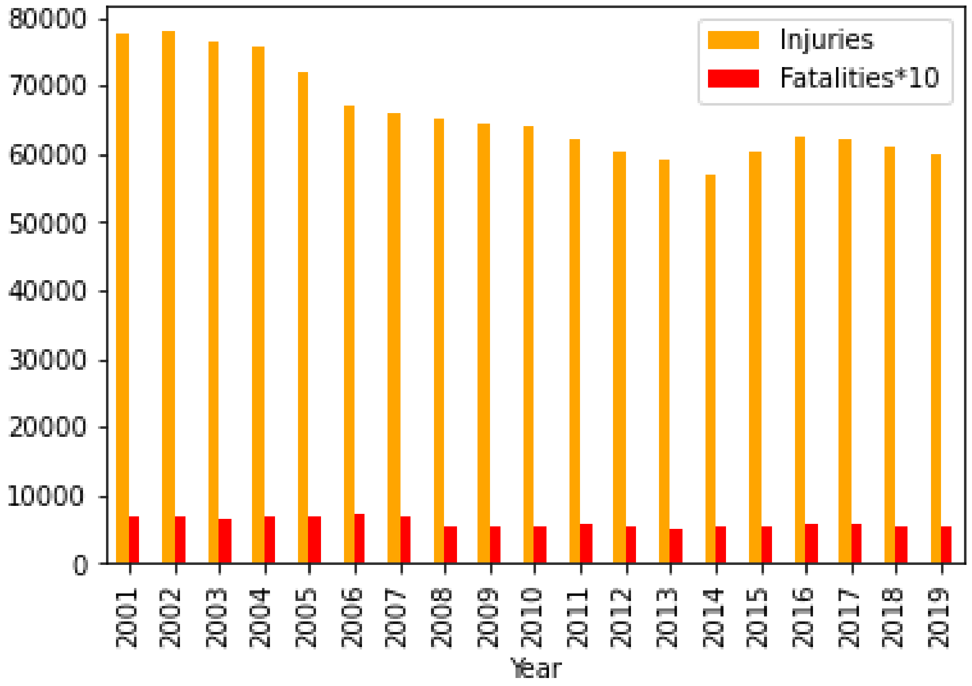
https://www.state.nj.us/transportation/refdata/accident/crash_statistics.shtm

Total Crashes 2001-2019



Year 2001: 274,110
Year 2019: 276,861

Total Injuries and Fatalities 2001-2019



Year 2001: 77,397 injuries, 667 fatalities
Year 2019: 59,850 injuries, 524 fatalities

The Problems with the Kaggle Dataset:

The Kaggle website provides a 3 million traffic accidents of US from February 2016 to December 2020 at https://www.kaggle.com/sobhanmoosavi/us-accidents

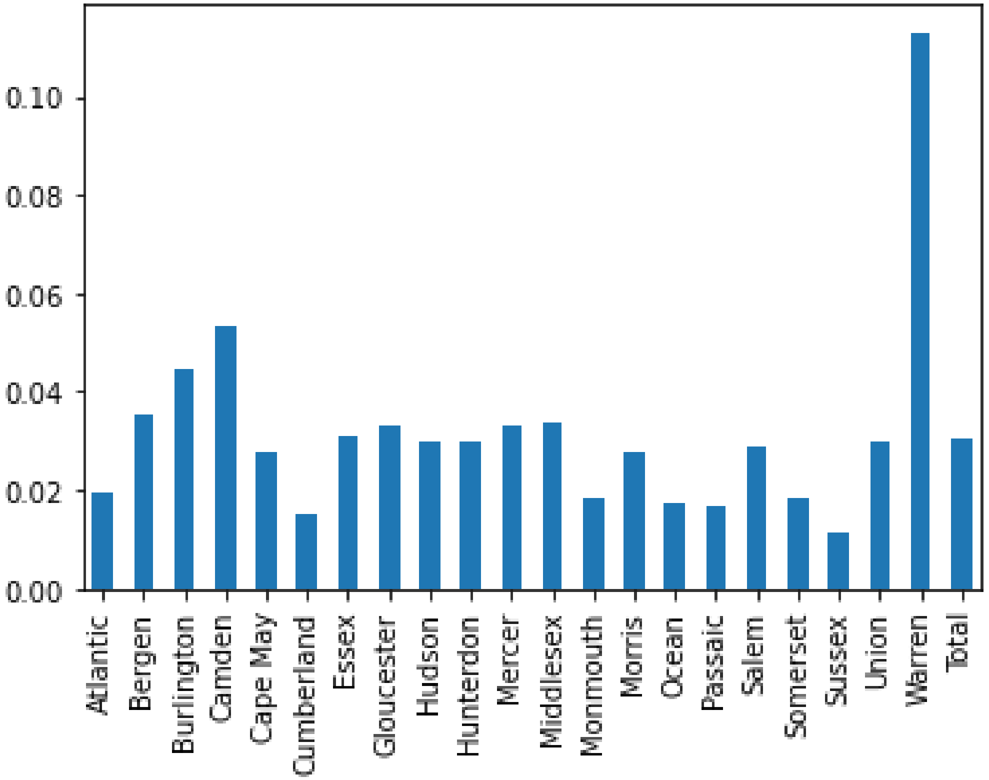
Problems:

1. It is estimated by the NHTSA that 6 million car accidents happen in the U.S. each year. (https://cdan.nhtsa.gov/tsftables/National%20Statistics.pdf)

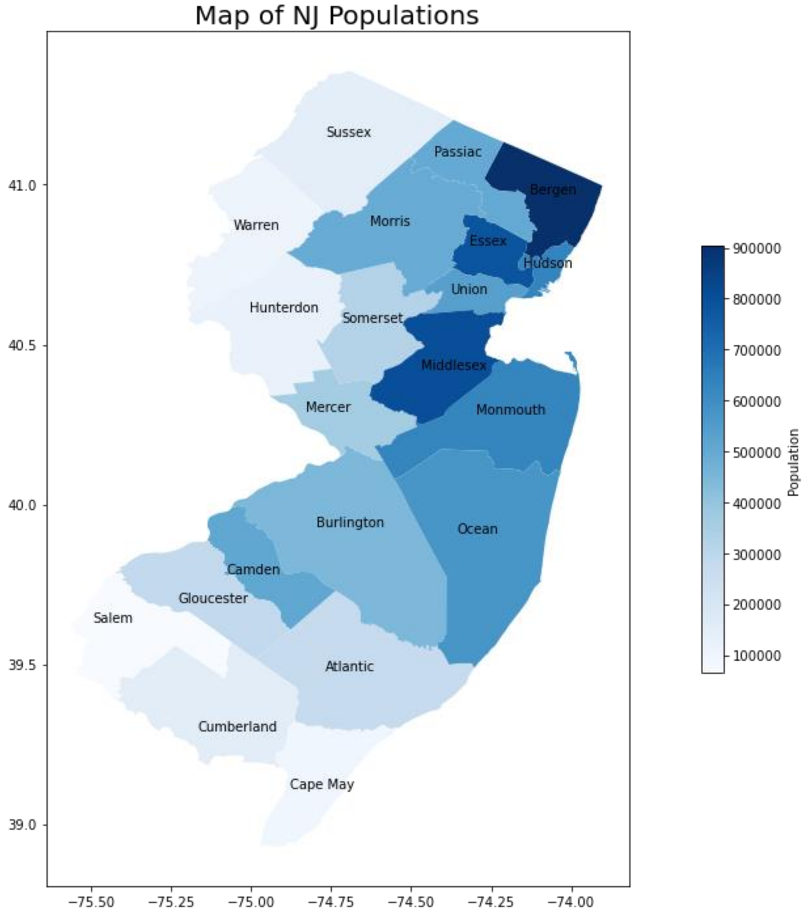
2. In Year of 2019 alone, NJ DOT reported 276,861 traffic accidents. The Kaggle dataset only has 8,435 cases. The sampling ratio is only 3.05% .

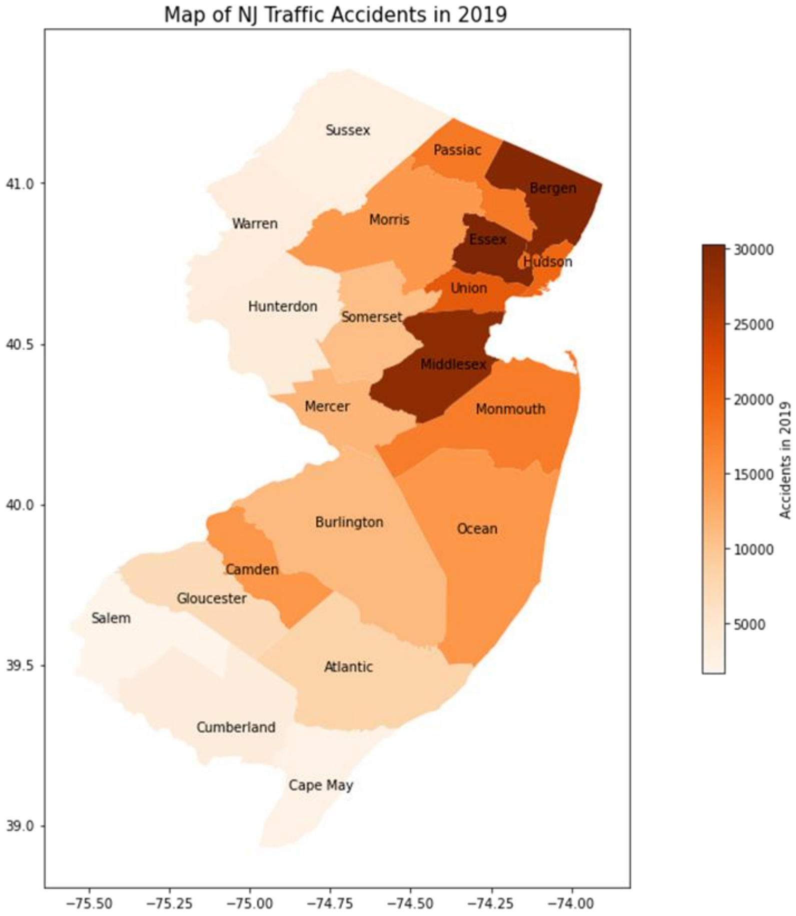
3. The sampling ratios of each county vary significantly. There are 21 counties in NJ. The highest (Warren) is 11.3% while the lowest (Sussex) is only 1.15%.

Kaggle Sampling Ratios of NJ Counties



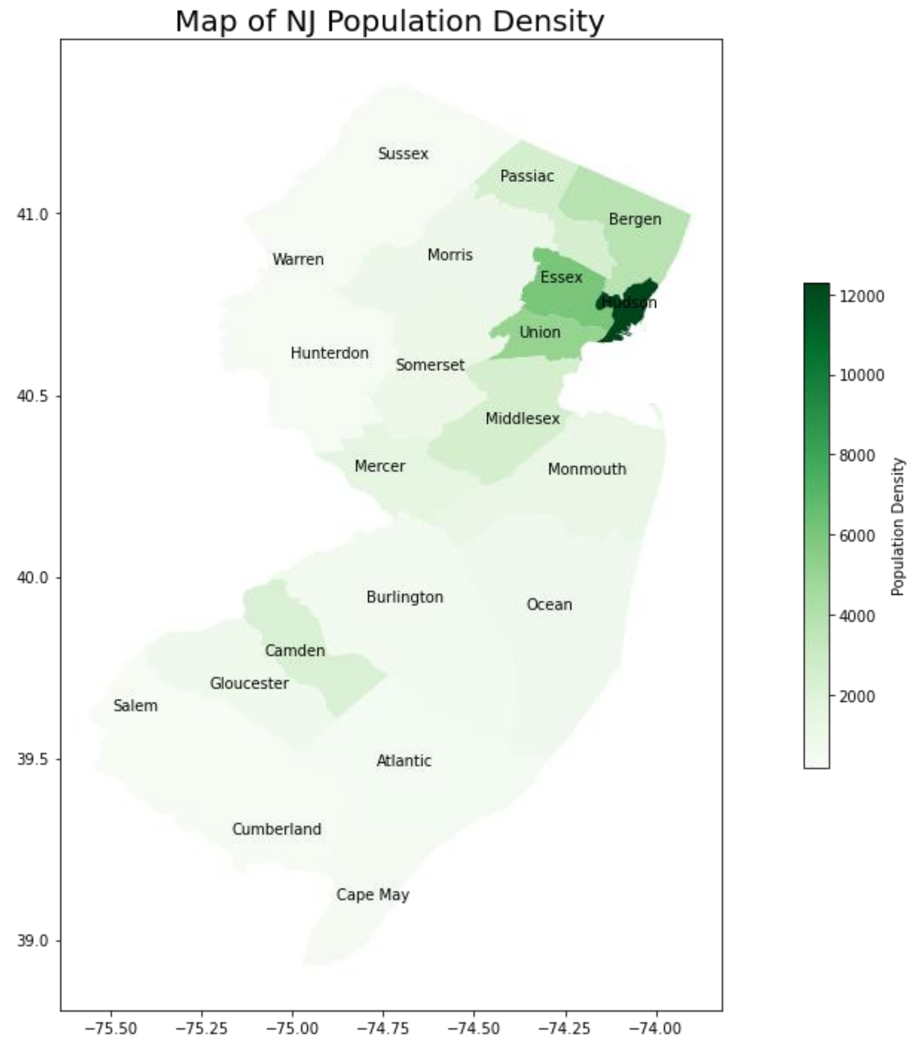
NJ Population and Traffic Accidents

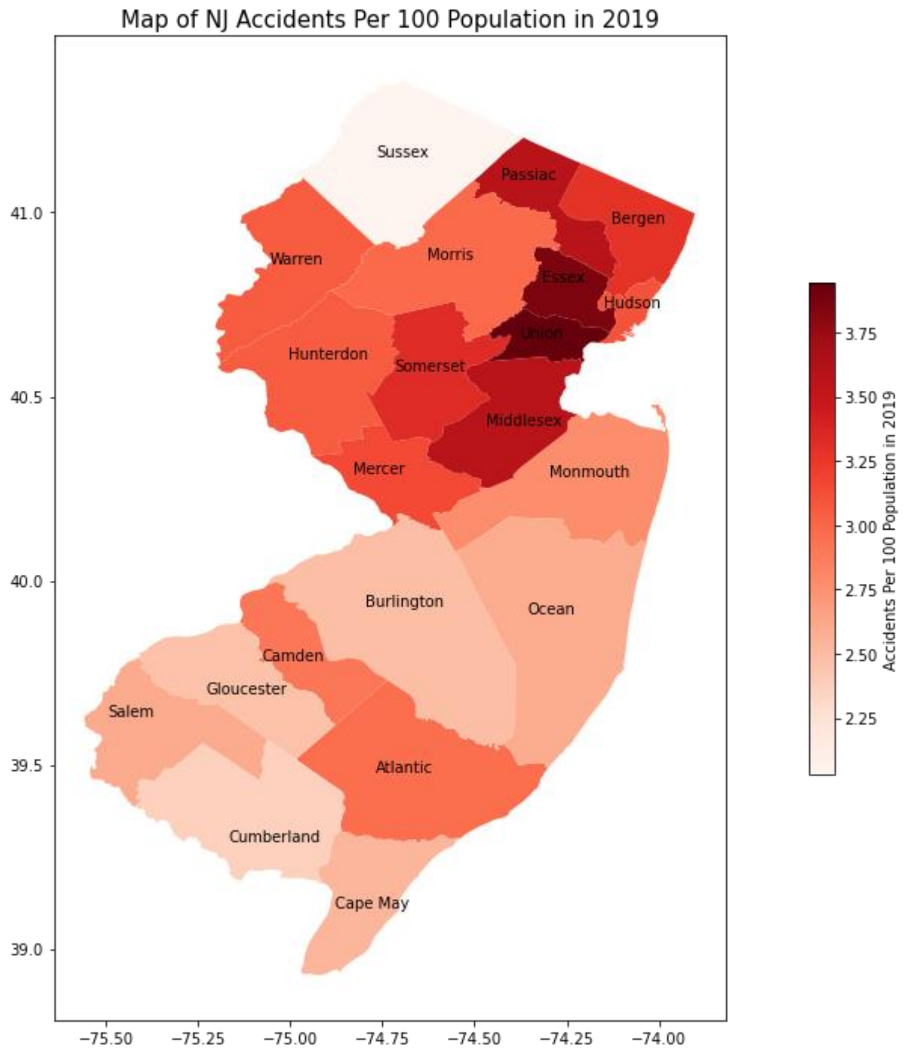




NJ has a population of 9 millions and an area of 8722 square miles (22,588 square kilometers), making it the most densely populated state in US.

Population Density and Accidents per 100 Populations

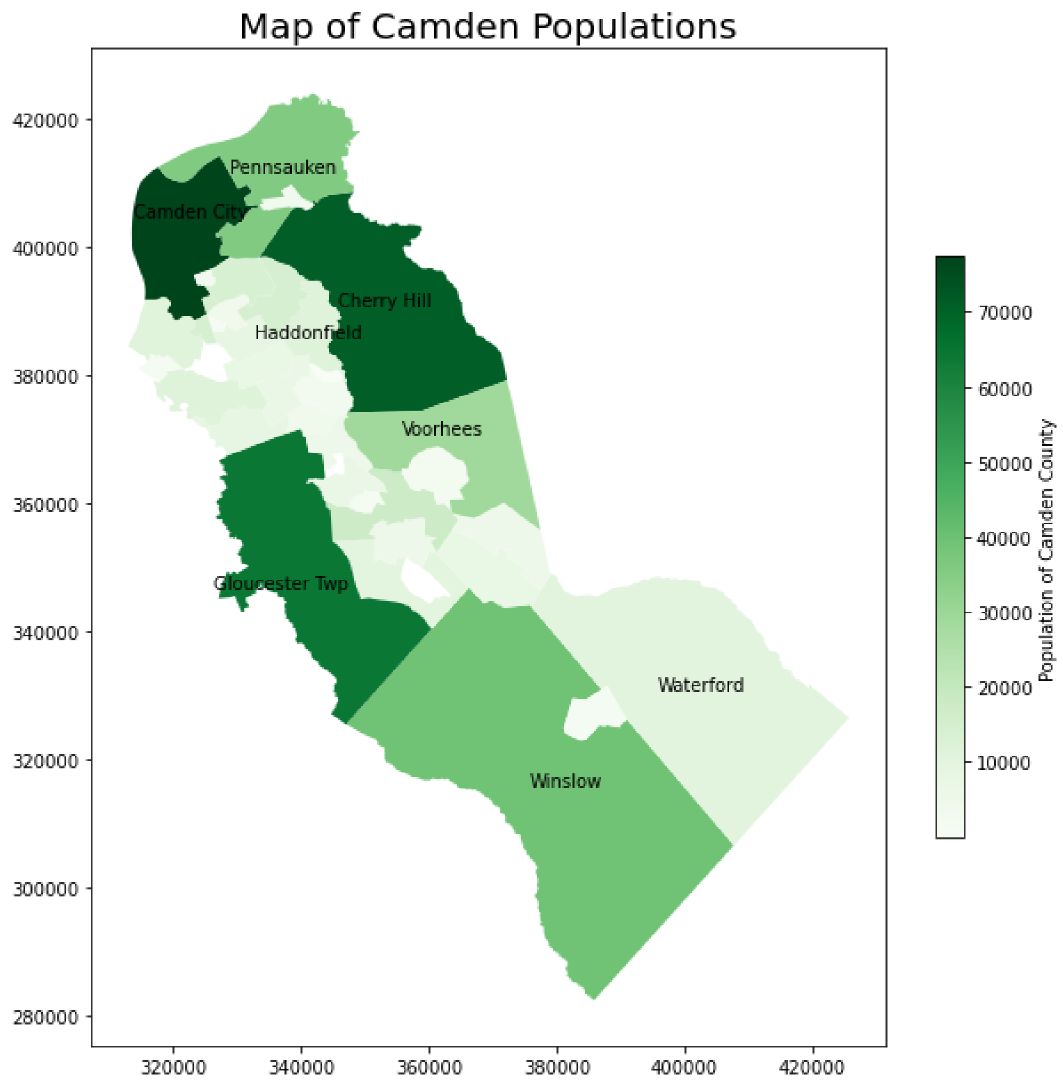

Map of NJ Population Density


Map of NJ Accidents Per 100 Population in 2019

Highest: Hudson 14000 per sq. miles
Lowest: Salem 188 per sq. miles
Camden: 2290 per sq miles

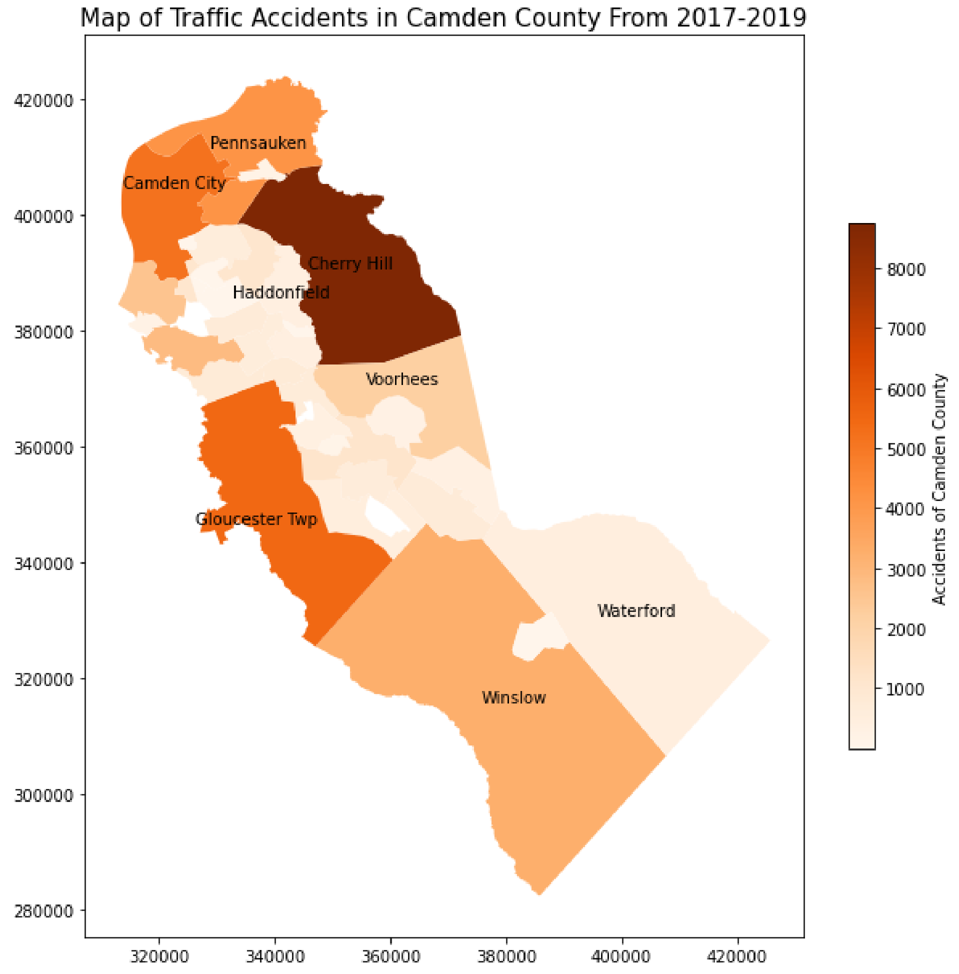
Highest: Union 3.95
Lowest: Sussex, 2.03
Camden: 2.91, Hudson: 3.11

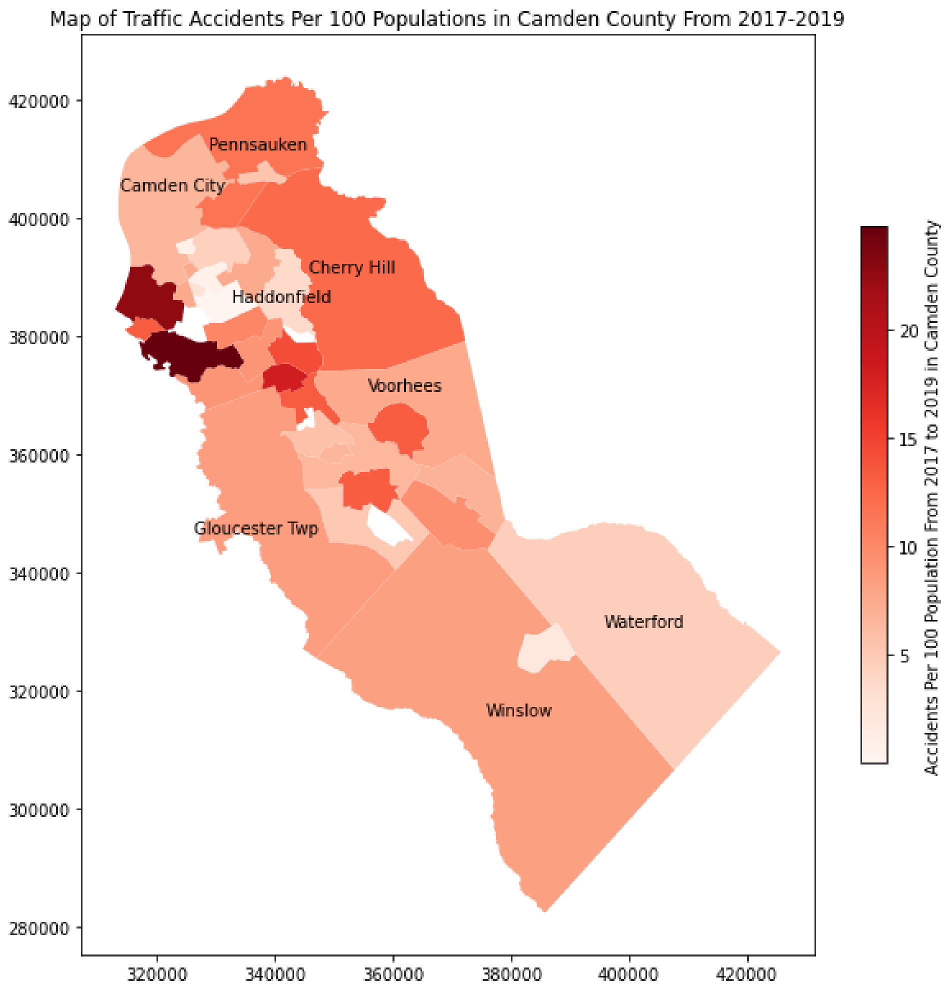
Camden County of NJ:



Camden County has a population of 506,471, an area of 227.293 sq mi (588.69 km^2).
Camden City (pop.: 77,000), Cherry Hill (pop.: 71,000) and Gloucester Twp (pop.: 64,000) are 3 largest municipalities.

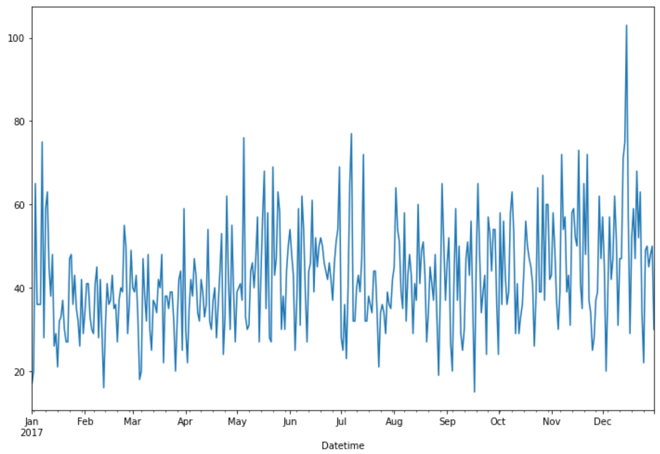
Traffic Accidents in Camden County:

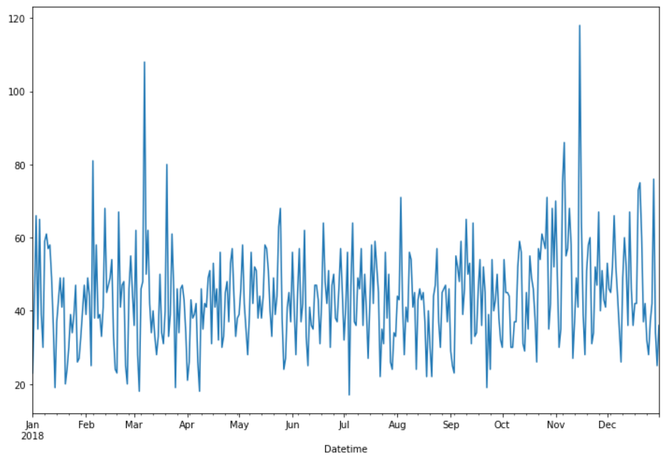


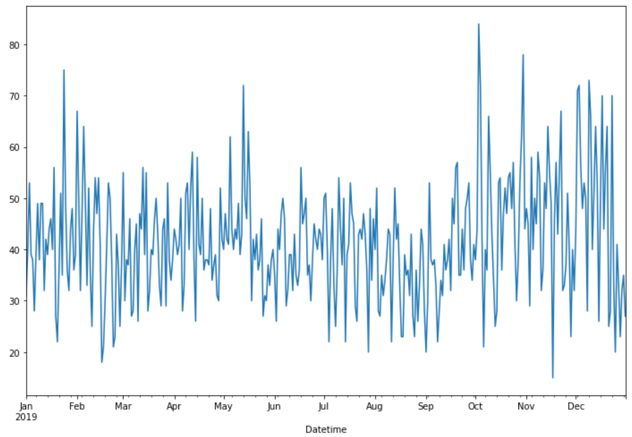


The total accidents of Camden County during 2017-2019 are 15, 176, 15,755 and 14950.
The traffic injurie cases are 4003, 4088 and 37,84 while fatal cases are 40, 42 and 45.

Daily Accidents in Camden County:







Counted from the dataset from NJ DOT: 46519 cases from 2017-2018

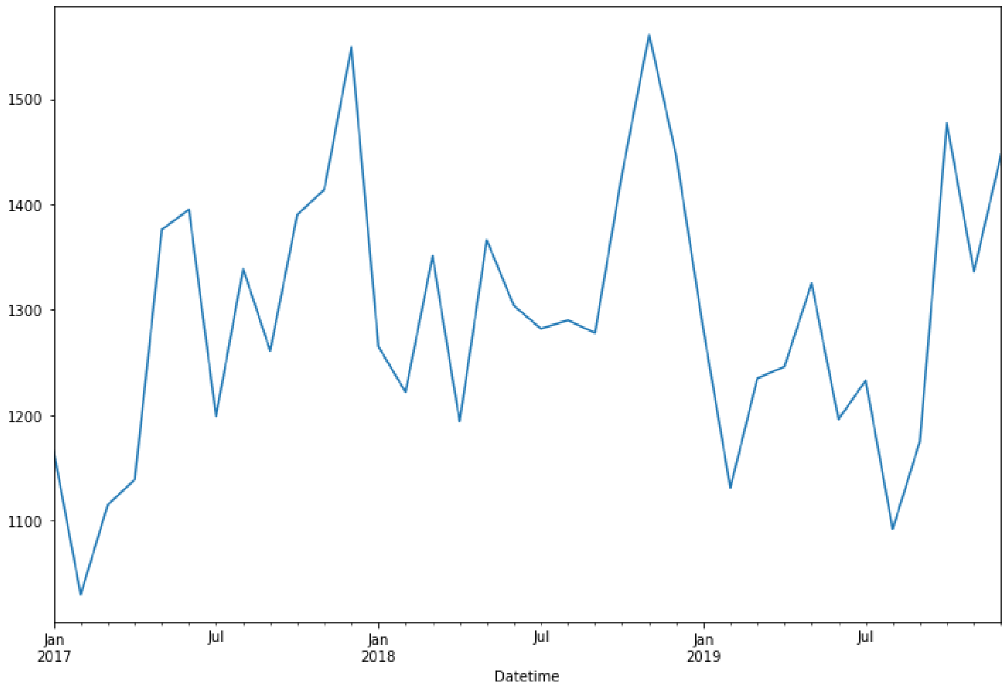
Daily Average: 42.5 per day

Highest 3 days during 2017-2019:   2017-12-15: 103,   2018-03-07: 108,   2018-11-15: 118
Most of the cases reported snow conditions.

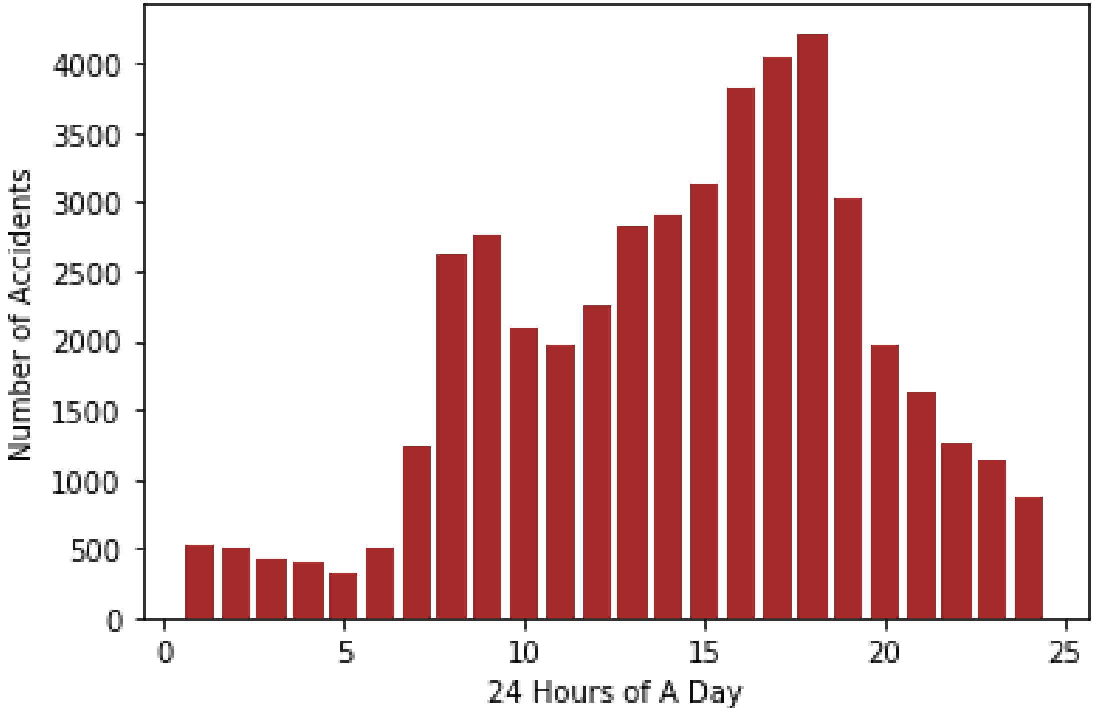
Lowest 4 days during 2017-2019:   2017-09-17 (Monday, 15 cases), 2019-11-17 (Sunday, 15)
2017-01-01 (17), 2018-07-04 (17)

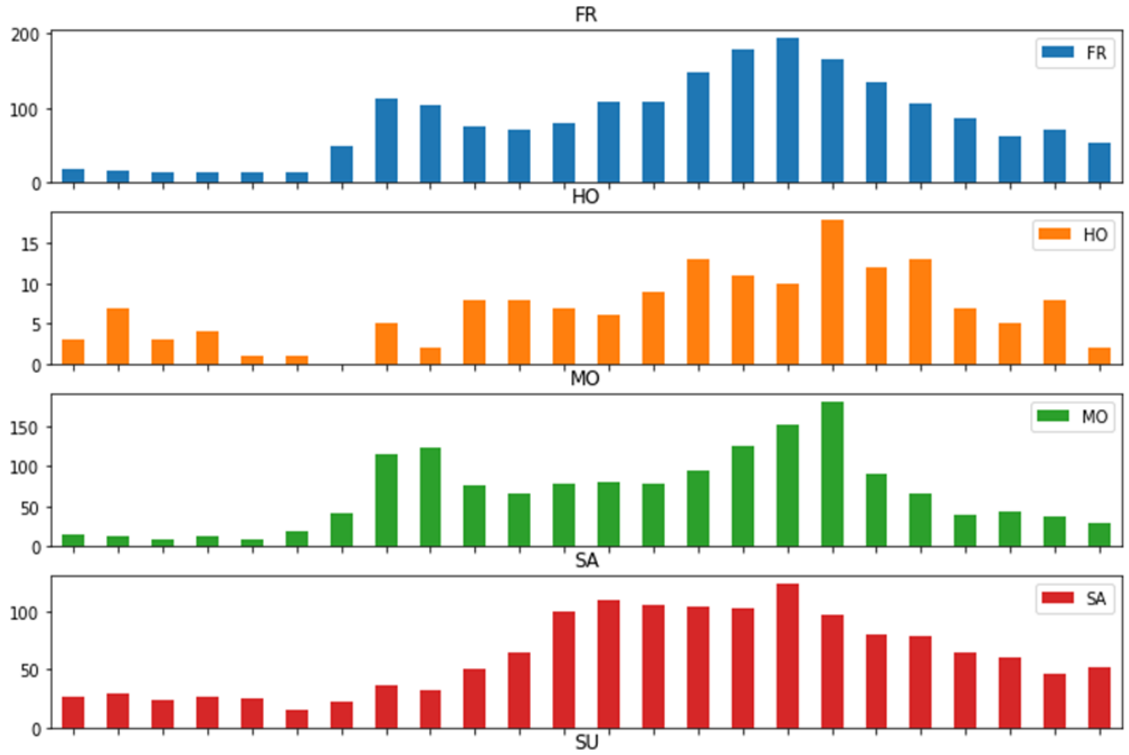
Accidents vs. Time

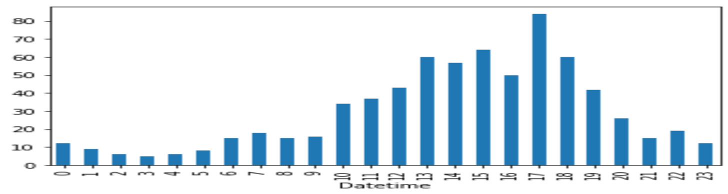
Accident Numbers in Each Month during 2017-2019



Total Accidents in Each Hour During 2017-2019




FR
200
100
0
FR
HO
15
10
5
0
HO
MO
150
100
50
0
MO
SA
100
50
0
SA
SU


80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
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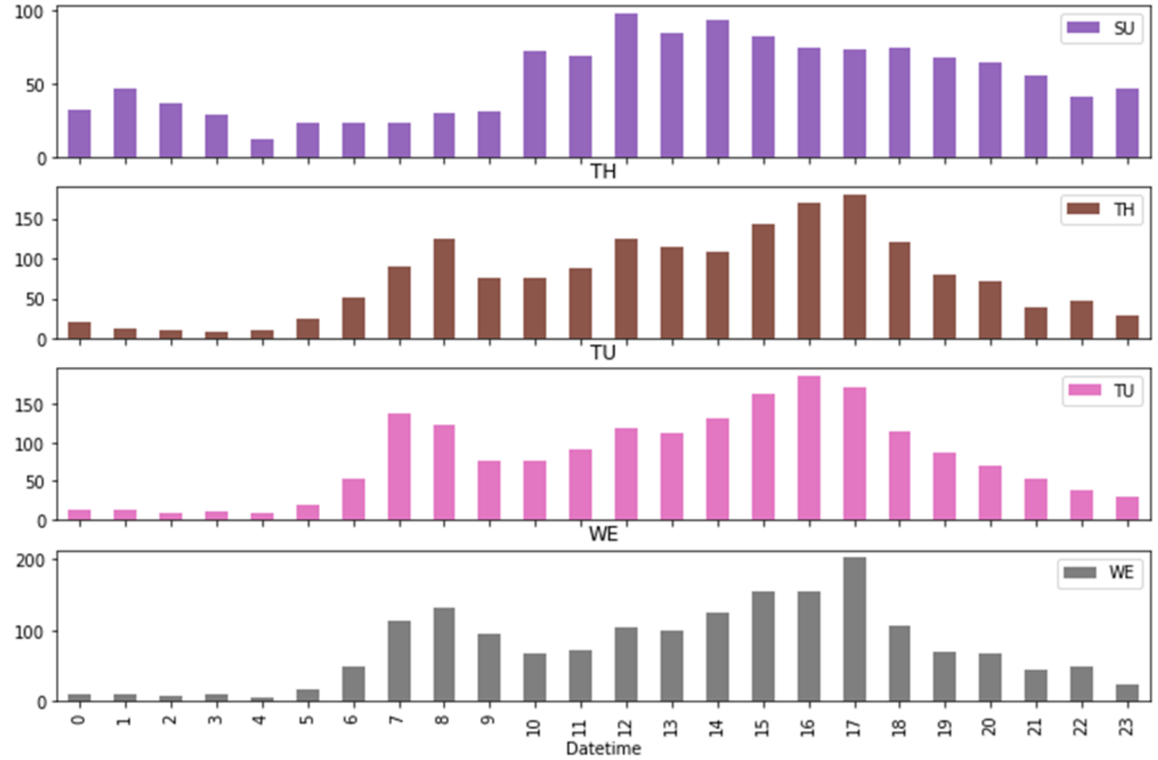
11
12
13
14
15
16
17
18
19
20
21
22
23
Datetime


100
50
0
SU
TH
150
100
50
0
TH
TU
150
100
50
0
TU
WE
200
100
0
WE
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Datetime

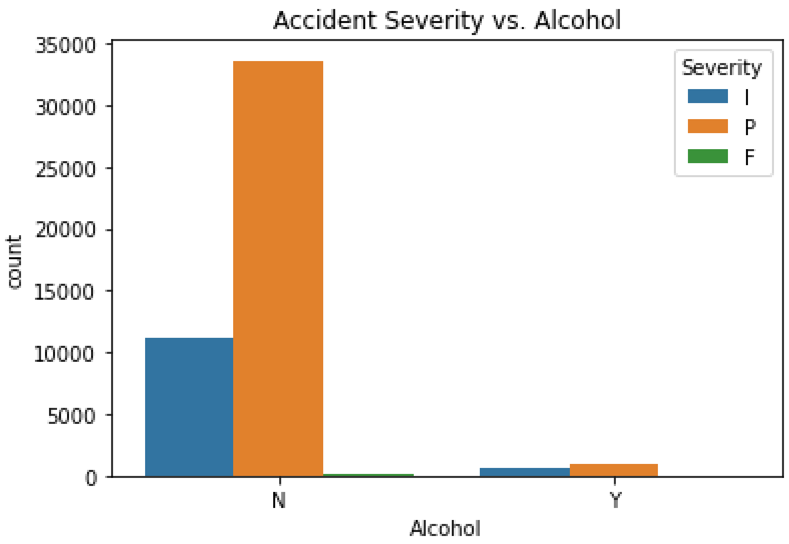
Crash Severity Research

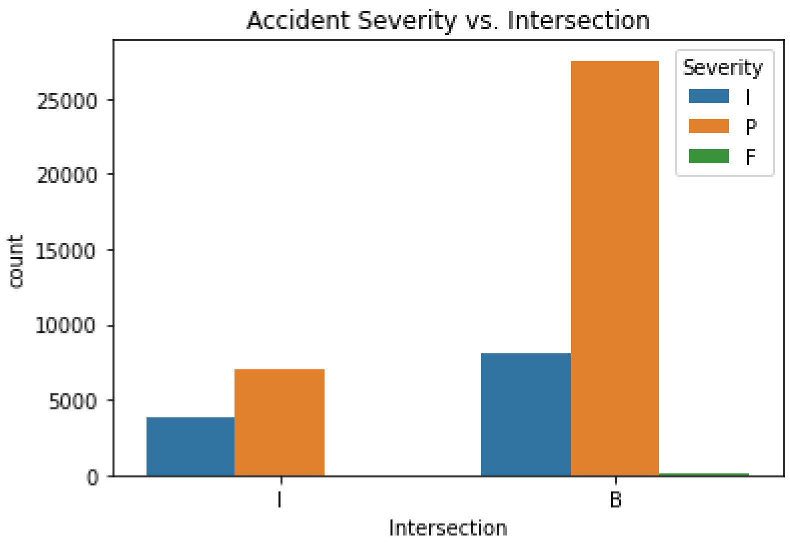
- During 2017-2019, among 46536 cases:

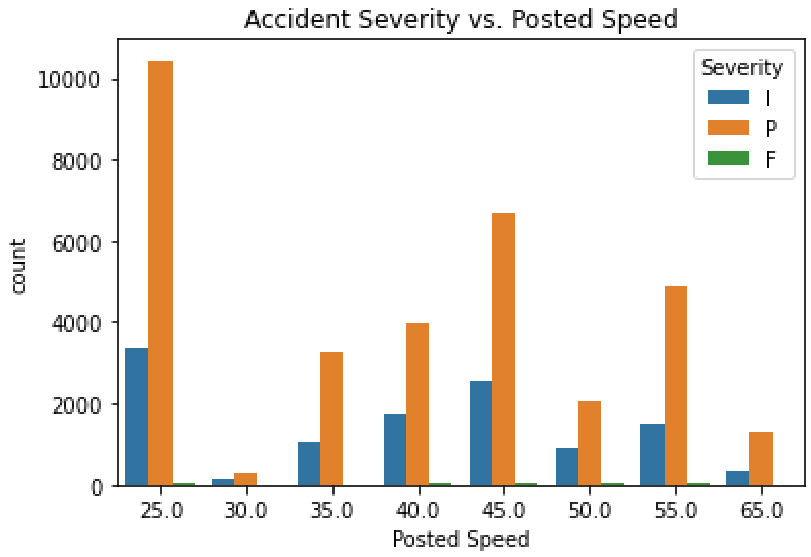
• Property Damage (P) :	34543
• Injury (I):	11853
• Fatality (F):	140

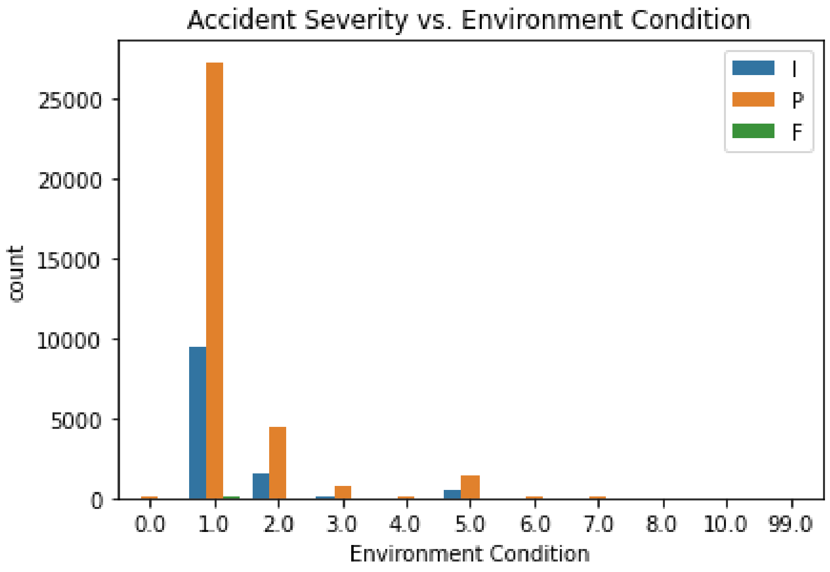
Need to understand which factors can more likely cause injuries or fatalities

Impact Factors

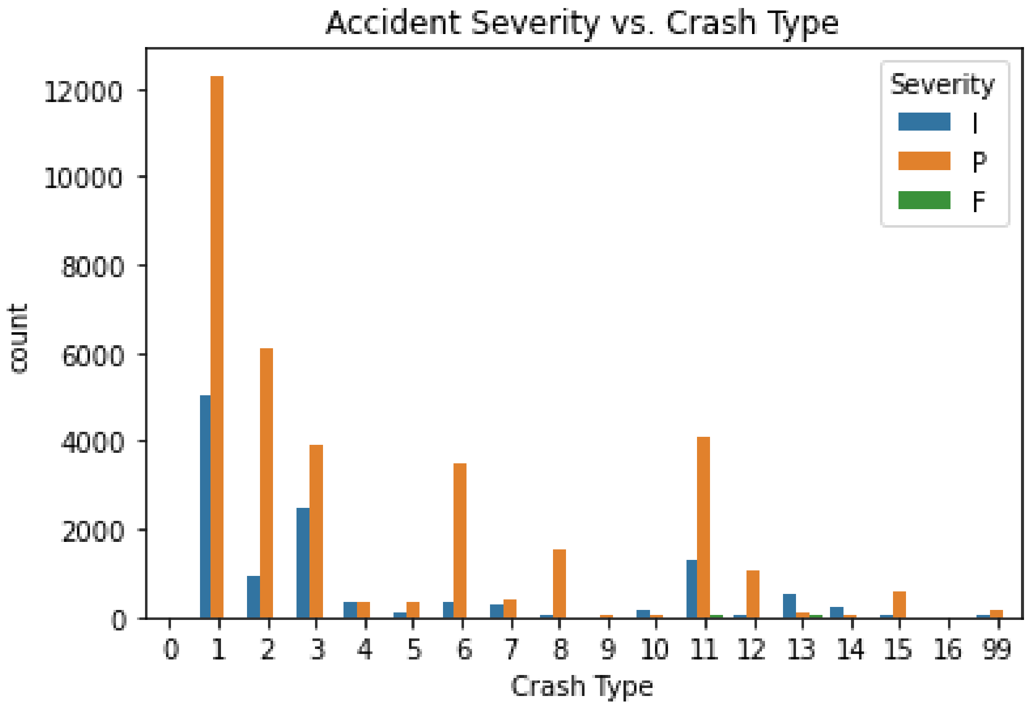


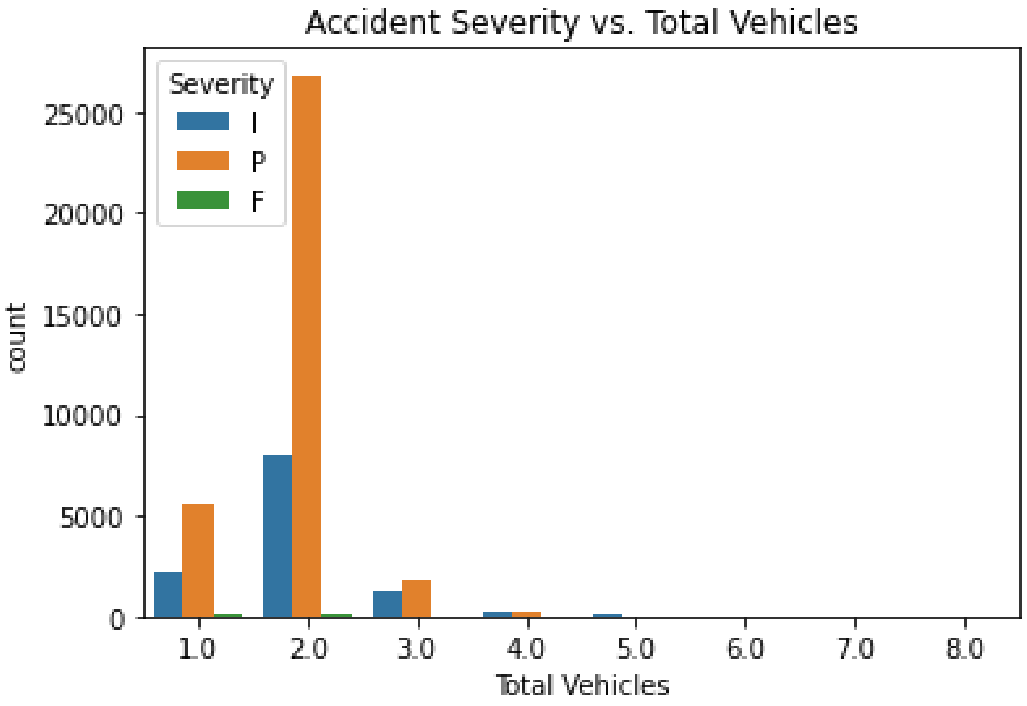




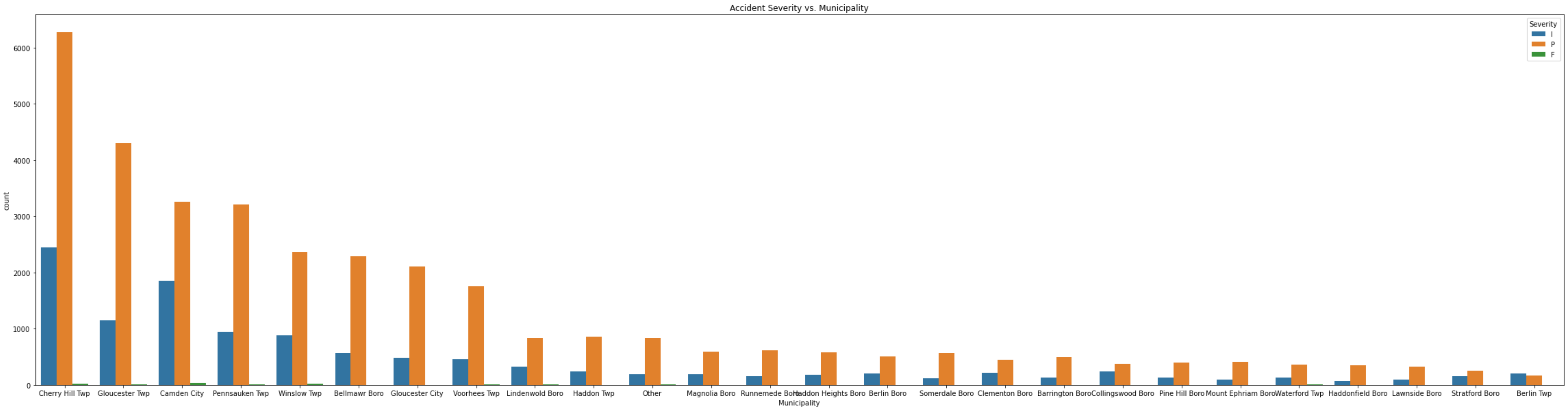


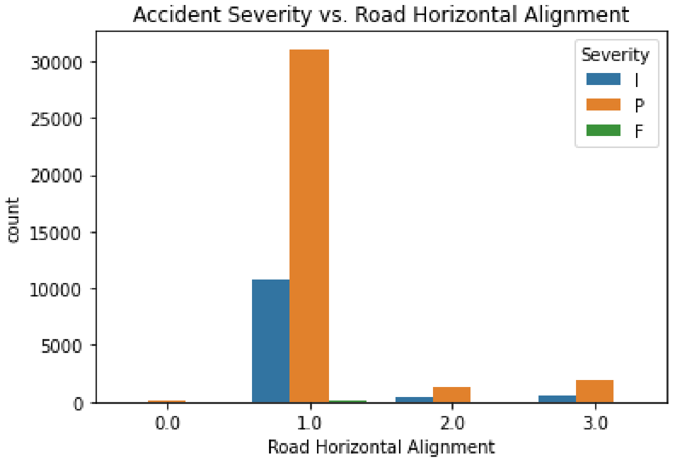
Factors Obviously Matter

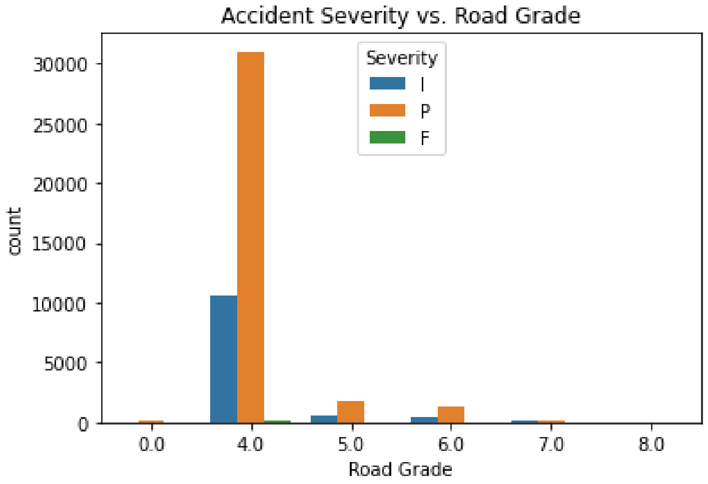


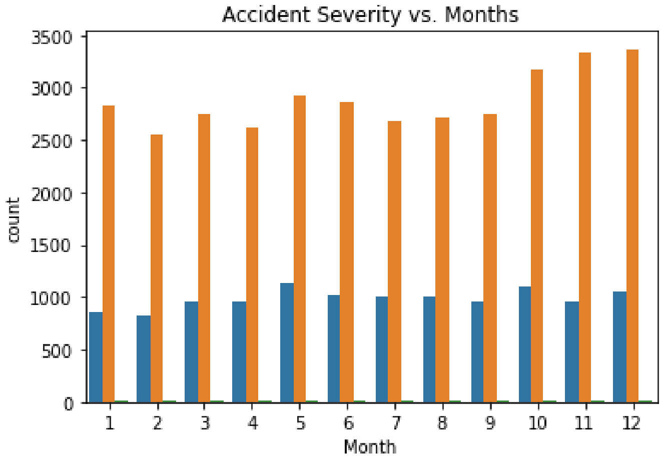


1. Same direction (Rear end)
2. Same direction (Side swipe)
3. Right Angle
4. Opposite Direction(Head on, Angular)
7. Left Turn, U Turn
8. Backing
12. Animal
13. Pedestrain
14. Pedalcyclist


Accident Severity vs. Municipality
Severity
I
P
F
count
0
1000
2000
3000
4000
5000
6000
Cherry Hill Twp
Gloucester Twp
Camden City
Pennsauken Twp
Winslow Twp
Bellmawr Boro
Gloucester City
Voorhees Twp
Lindenwold Boro
Haddon Twp
Other
Magnolia Boro
Runnemede Boro
Haddon Heights Boro
Berlin Boro
Somerdale Boro
Clementon Boro
Barrington Boro
Collingswood Boro
Pine Hill Boro
Mount Ephriam Boro
Waterford Twp
Haddonfield Boro
Lawnside Boro
Stratford Boro
Berlin Twp
Municipality

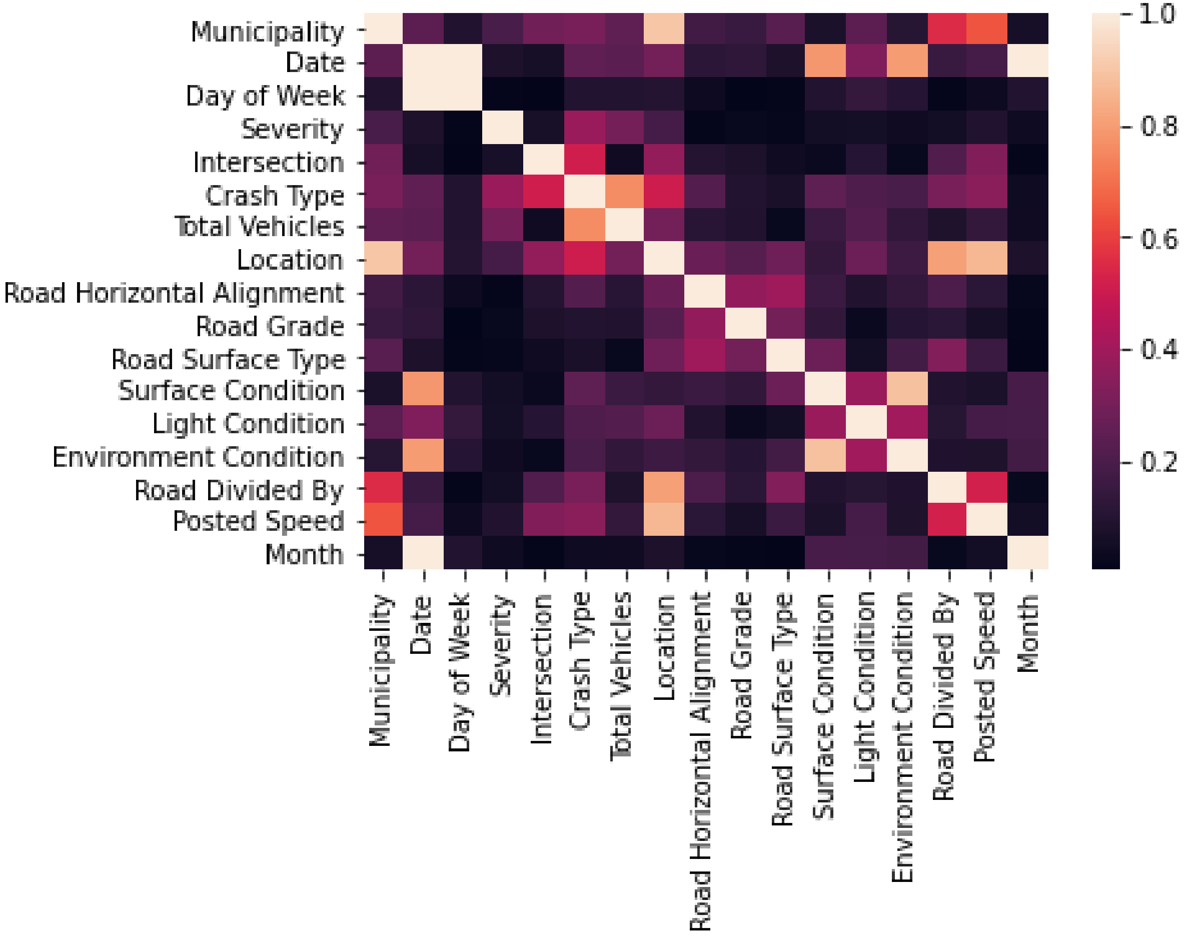

Accident Severity vs. Road Horizontal Alignment
Severity
I
P
F
count
0
5000
10000
15000
20000
25000
30000
0.0
1.0
2.0
3.0
Road Horizontal Alignment

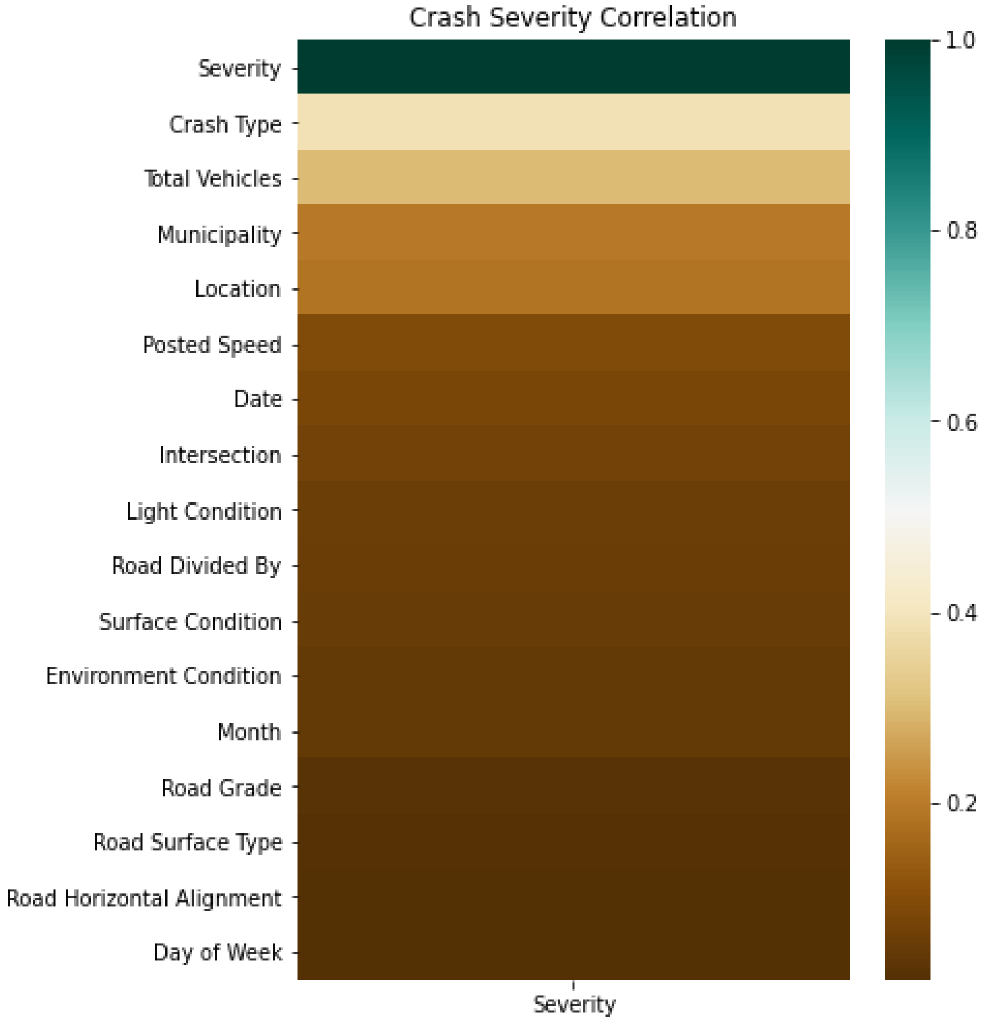

Accident Severity vs. Road Grade
Severity
I
P
F
count
0
5000
10000
15000
20000
25000
30000
0.0
4.0
5.0
6.0
7.0
8.0
Road Grade


Accident Severity vs. Months
count
0
500
1000
1500
2000
2500
3000
3500
1
2
3
4
5
6
7
8
9
10
11
12
Month

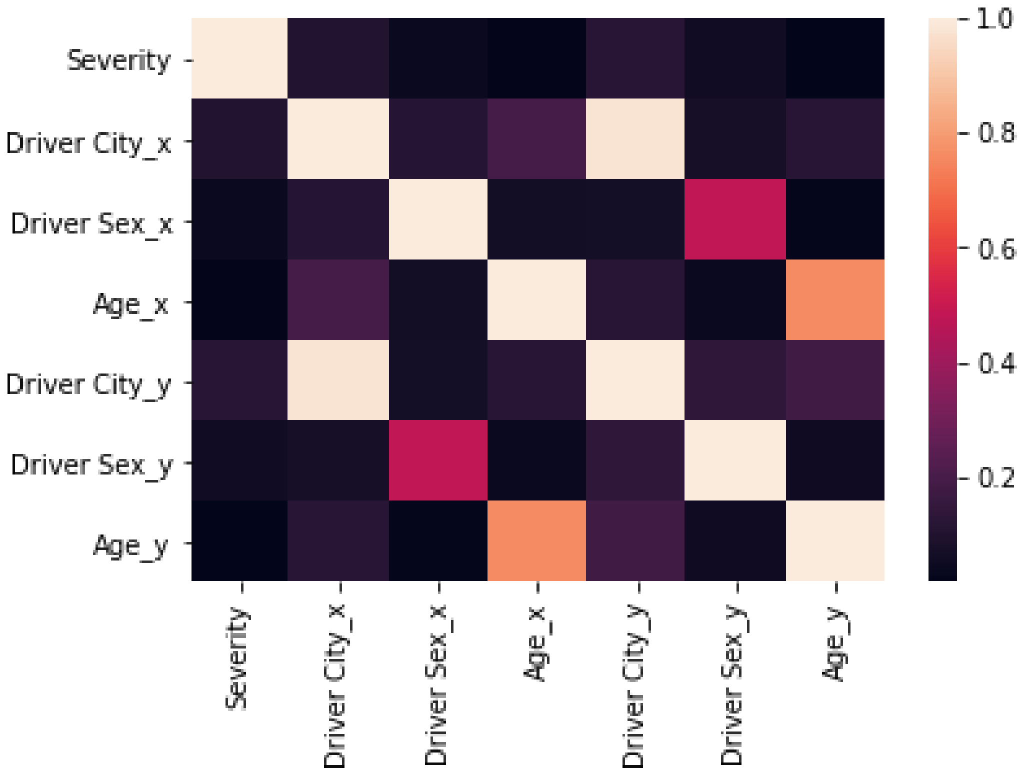
Phi_K Correlations

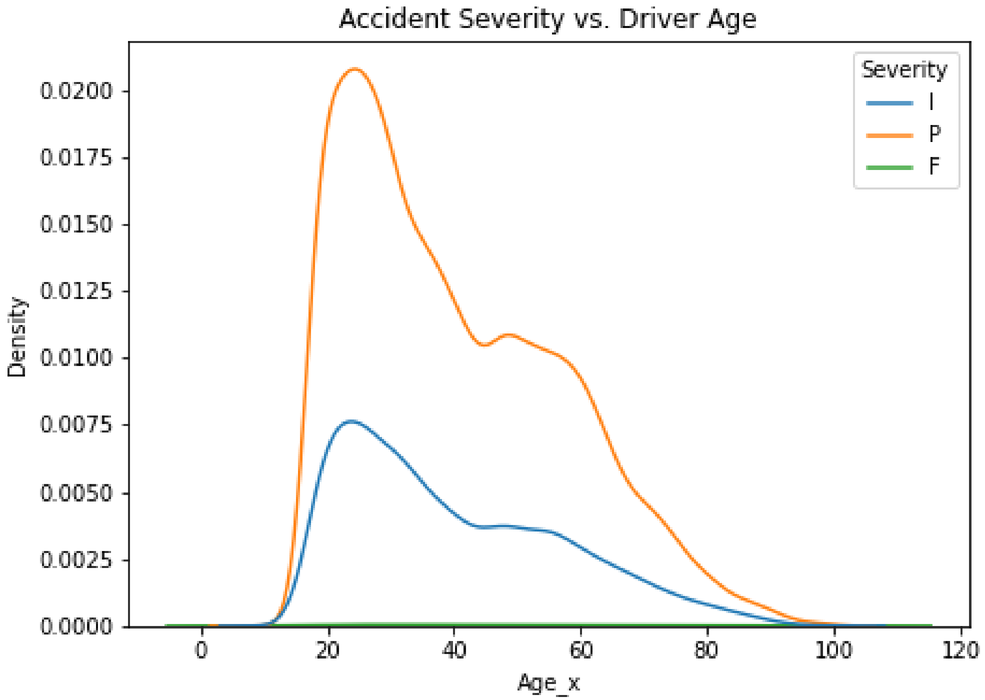
Assign accident severity of ‘P’ as 0, ‘I’ and ‘F’ as 1.





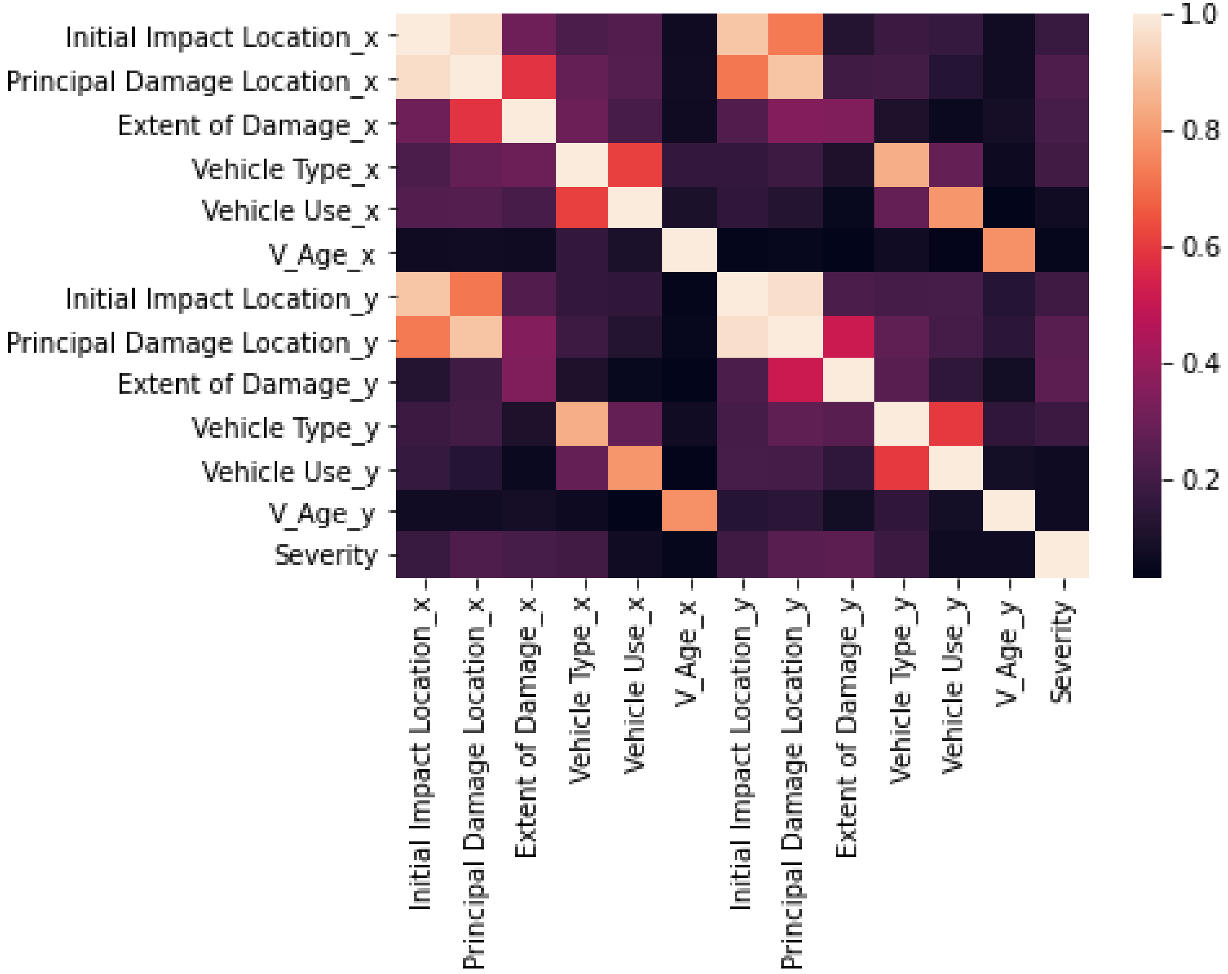
Drivers’ Features Correlations

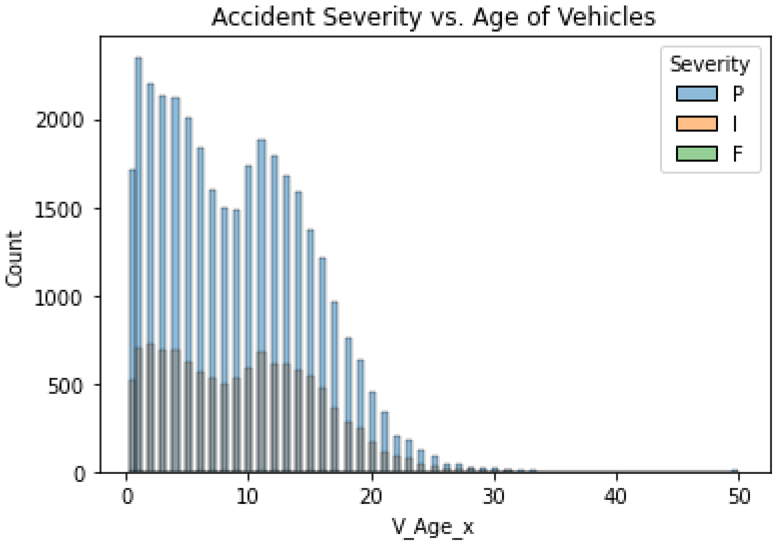


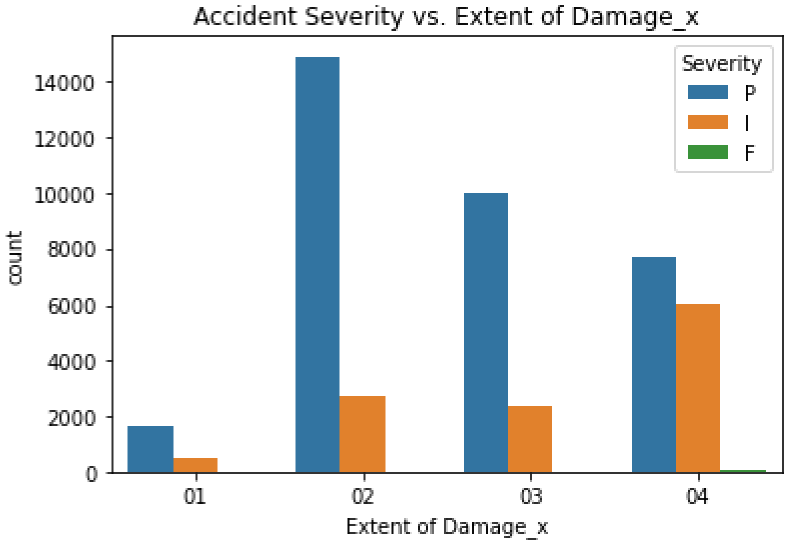


Drivers’ age is not significantly related to the accident severity

Vehicles’ Feature Correlations





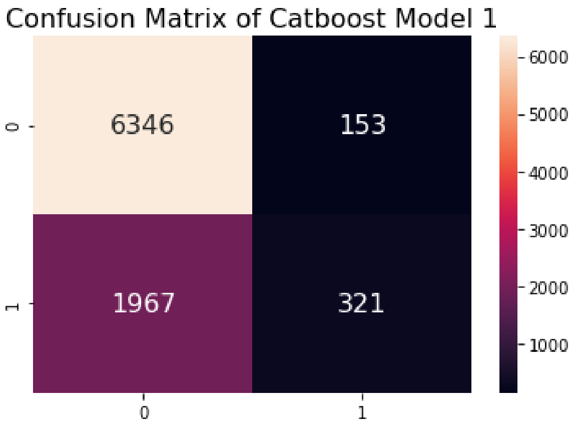


Machine Learning: Predict the Severity of the Traffic Accident

1. Catboost-1

Selected Features:
Categorical: 'Municipality’, 'Intersection', 'Crash Type’, 'Total Vehicles’
Numeric: Posted Speed, Month

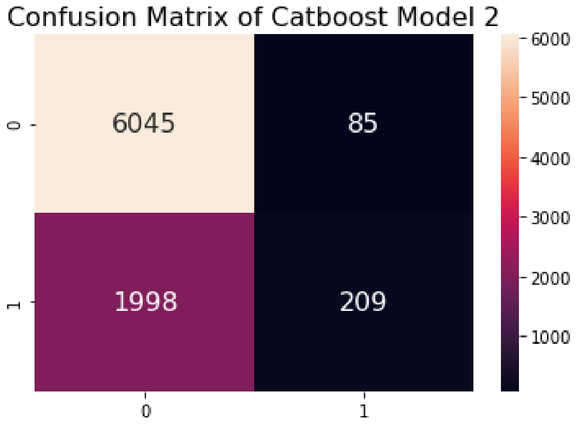
	Precision	Recall	F1-score	Support
0	0.76	0.98	0.86	6499
1	0.69	0.14	0.23	2288
Accuracy			0.76	8787
Macro average	0.73	0.56	0.54	8787
Weighted Average	0.74	0.76	0.69	8787



2. Catboost-2

Selected Features:
Categorical: 'Intersection', 'Crash Type’, 'Total Vehicles', 'Location’, 'Light Condition', 'Environment Condition’, 'Road Divided By’, 'Driver Sex_x’, 'Driver Sex_y”
Numeric: 'Posted Speed', 'Month', ‘ Driver Sex_x’, 'Age_x’, ‘Driver Sex_y’, 'Age_y'

	Precision	Recall	F1-score	Support
0	0.75	0.99	0.85	2207
1	0.71	0.09	0.17	6130
Accuracy			0.75	8337
Macro average	0.73	0.54	0.51	8337
Weighted Average	0.74	0.75	0.69	8337



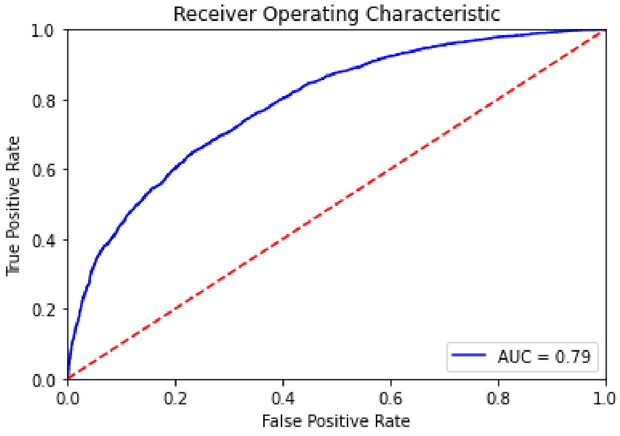
3. Catboost-3

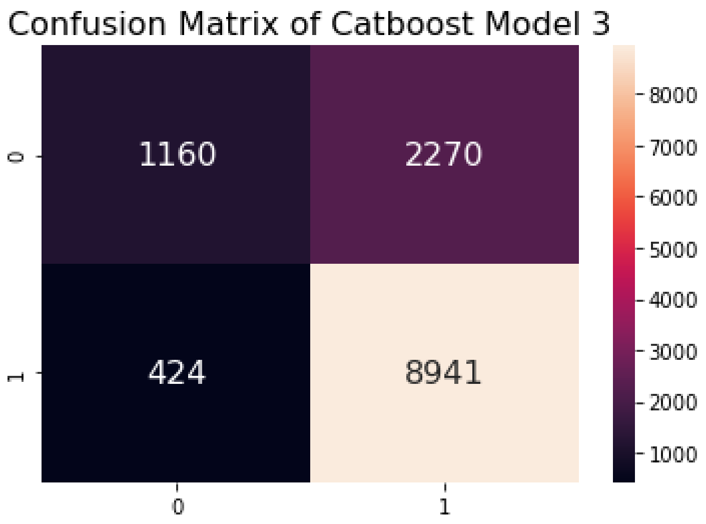
Selected Features:

Categorical: ‘Municipality’, 'Intersection', 'Crash Type', 'Total Vehicles', 'Environment Condition', 'Road Divided By', 'Initial Impact Location_x’, 'Principal Damage Location_x', 'Vehicle Type_x', 'Vehicle Use_x’, 'Initial Impact Location_y', 'Principal Damage Location_y', 'Vehicle Type_y', 'Vehicle Use_y’, 'Municipality’, 'Intersection', 'Crash Type’, 'Total Vehicles’.

Numeric: None

	Precision	Recall	F1-score	Support
0	0.80	0.95	0.87	3430
1	0.73	0.34	0.46	9365
Accuracy			0.79	12795
Macro average	0.76	0.65	0.67	12795
Weighted Average	0.78	0.79	0.76	12795



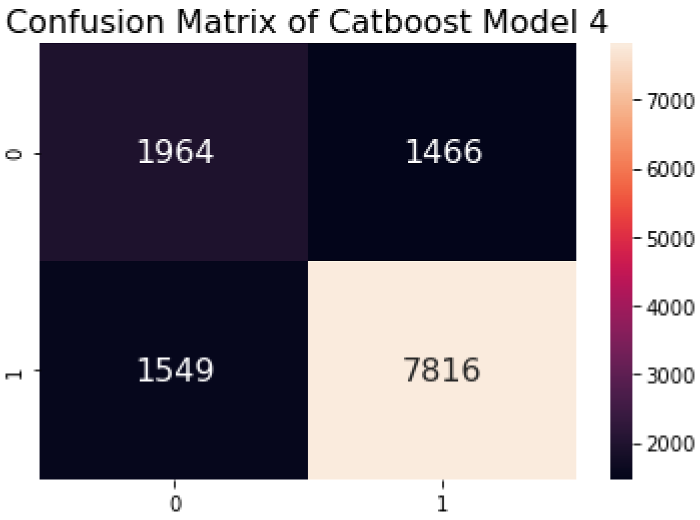


Solving the Data Imbalance Problem

Synthetic Minority Oversampling Technique (SMOTE)

0: 22187, 1 : 7667 → 0: 22187, 1 : 22187

	precision	recall	f1-score	support
I	0.56	0.57	0.57	3430
P	0.84	0.83	0.84	9365
accuracy			0.76	12795
macro avg	0.70	0.70	0.70	12795
weighted avg	0.77	0.76	0.77	12795



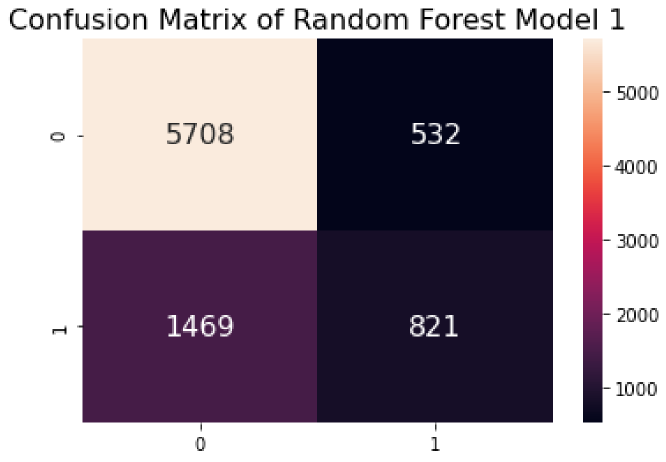
Random Forest Model

Train data : 0: 25312
1 : 8807

```
              precision    recall  f1-score   support

0               0.80      0.91     0.85      6240
1                0.61     0.36      0.45     2290

accuracy                           0.77      8530
macro avg       0.70      0.64     0.65     8530
weighted avg     0.74      0.77     0.74     8530
```

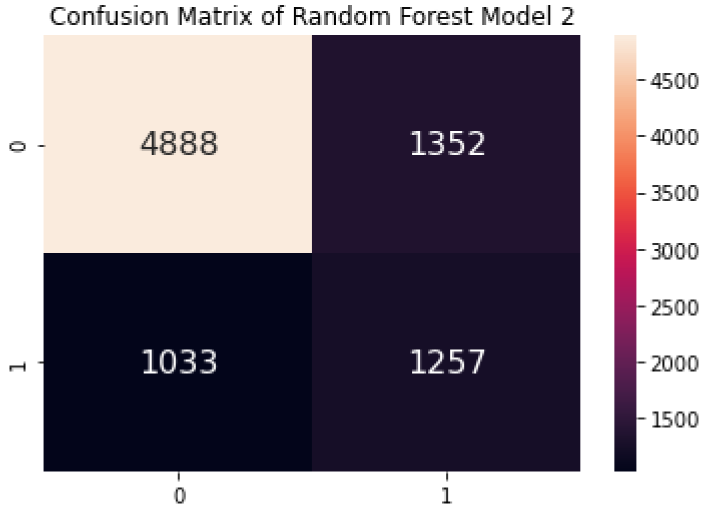


Train data after SMOTE: 0: 25312
1 : 25312

```
              precision    recall  f1-score   support

0               0.83      0.78      0.80      6240
1                0.48      0.55      0.51      2290

accuracy                            0.72      8530
macro avg       0.65      0.67      0.66      8530
weighted avg     0.73      0.72      0.73      8530
```



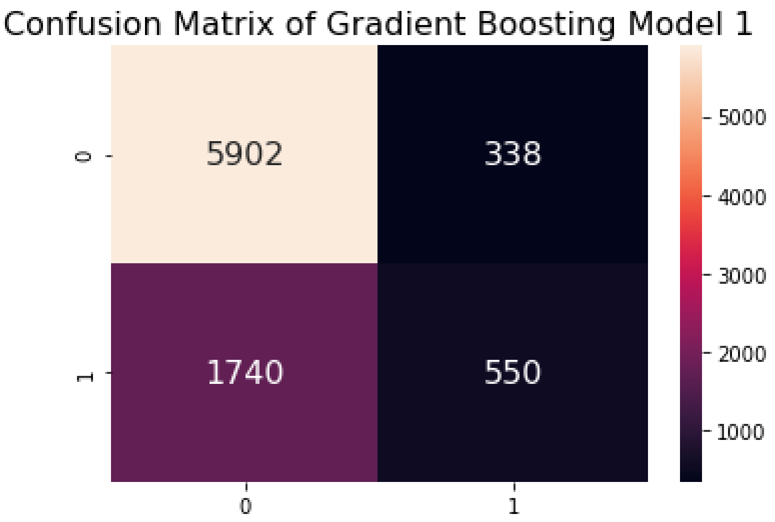
Gradient Boosting Model

Train data : 0: 25312
1 : 8807

```
              precision    recall  f1-score   support

       0          0.77      0.95      0.85      6240
       1          0.62      0.24      0.35      2290

 accuracy                             0.76      8530
 macro avg        0.70      0.59      0.60      8530
weighted avg      0.73      0.76      0.71      8530
```

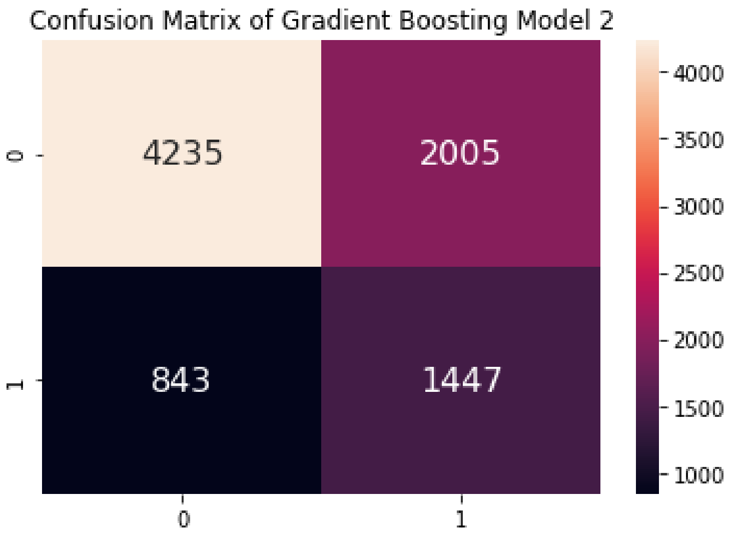

Confusion Matrix of Gradient Boosting Model 1

Train data after SMOTE: 0: 25312
1 : 25312

```
              precision    recall  f1-score   support

       0          0.83      0.68      0.75      6240
       1          0.42      0.63      0.50      2290

 accuracy                             0.67      8530
 macro avg        0.63      0.66      0.63      8530
weighted avg      0.72      0.67      0.68      8530
```


Confusion Matrix of Gradient Boosting Model 2

Summary

1. In the state of New Jersey, the total number of traffic crashes remain unchanged during the past 20 years, the injuries and deaths from traffic crashes declined.
2. The traffic accident occurrences vs. hours of a day, weekdays, holidays and months were studied.
3. A classification model to predict the severity (causing injury/death or just property damage) of a traffic accident were established. It can achieve close to 80% accuracy.
4. The features mostly likely influence injury or death are crash type, vehicle damage extent, vehicle impact location and municipality.
5. Due to too much missing data of the exact location of accidents and lack of the detailed weather conditions, I only use the municipality as the location feature and no weather feature, future study can focus more on the exact locations and the detailed weather conditions to find ways of better predictions.