

ANALYSIS OF TORONTO FIRE INJURIES AND FATALITIES



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Dataset from the City of Toronto Open Data Catalogue at:

<https://www.toronto.ca/city-government/data-research-maps/open-data/open-data-catalogue/#e3d443bb-2593-2615-4972-20e24c0ab876>

Dataset provides information similar to the data sent to the Ontario Fire Marshal relating to all incidents to which the Toronto Fire Services (TFS) responds.

Included is the response time intervals (dispatch, enroute, arrive and clear), event type, cross streets, responding units, property type, civilian and firefighter injuries and fatalities, number of people rescued.

FIRESTATIONS IN TORONTO

 Search 🔍

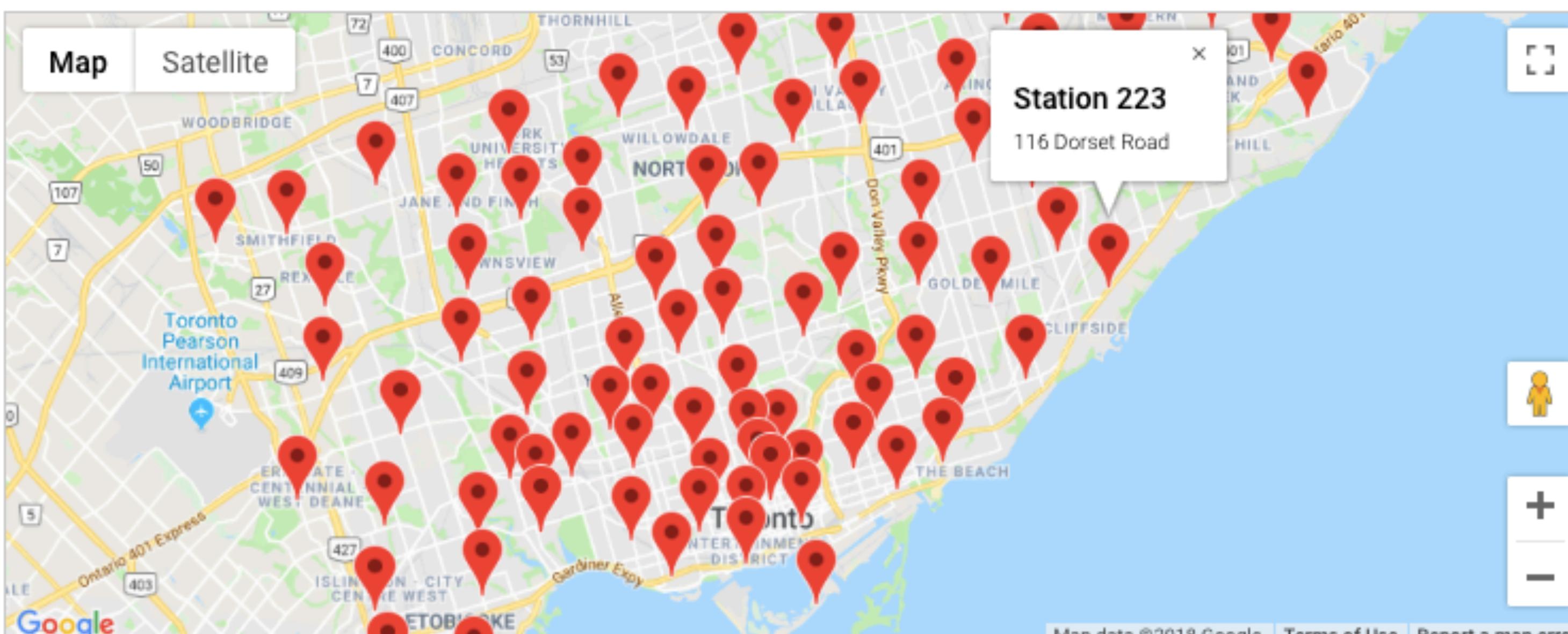
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Fire Station Locations

Services available at the Toronto Fire Halls:

- [Book a Fire Station Tour or Fire Truck Visit](#)
- Toronto Fire Stations accepts non perishable food donations for [Daily Bread Food Bank](#) ↗



Map Satellite

Station 223
116 Dorset Road

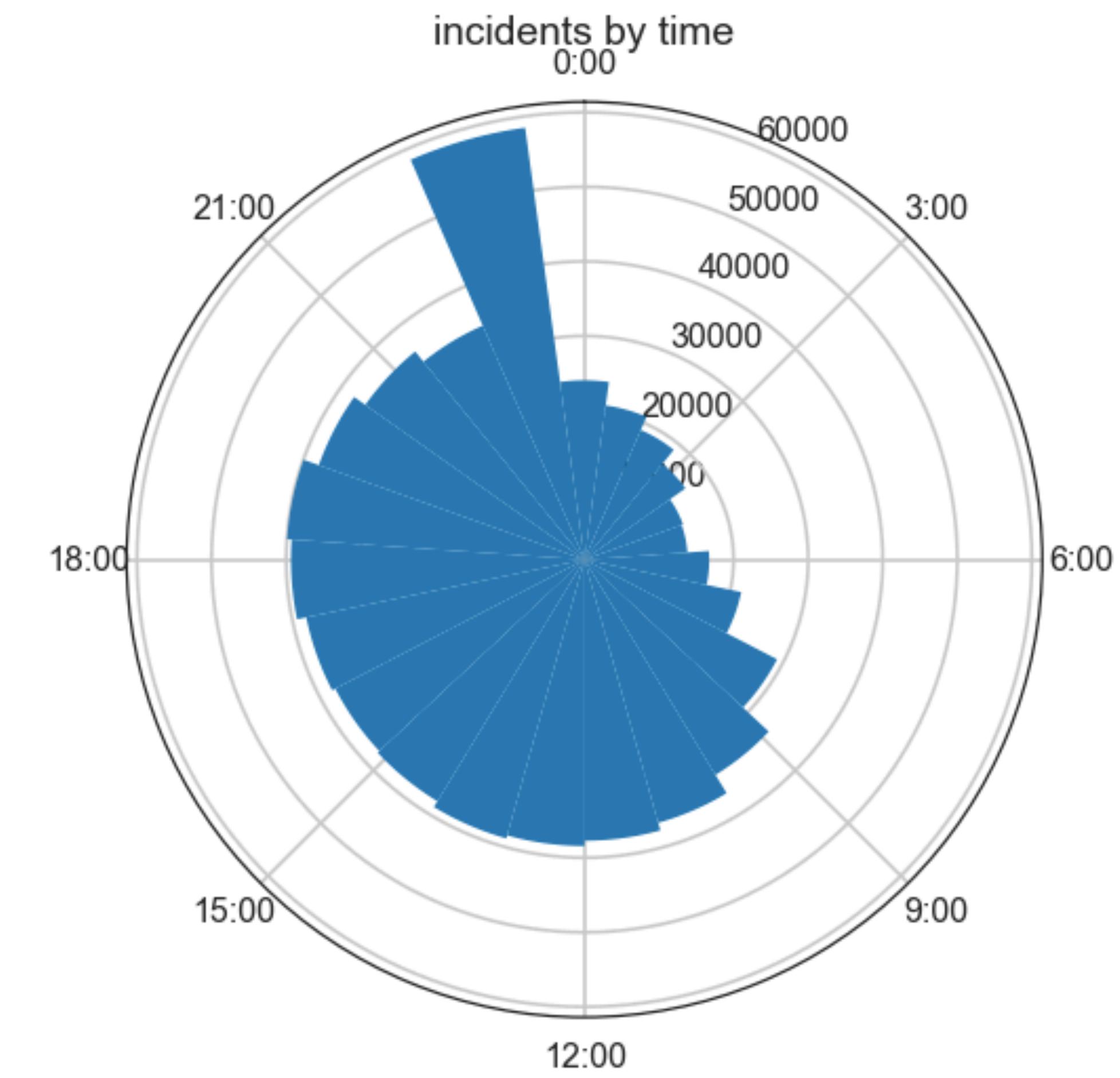
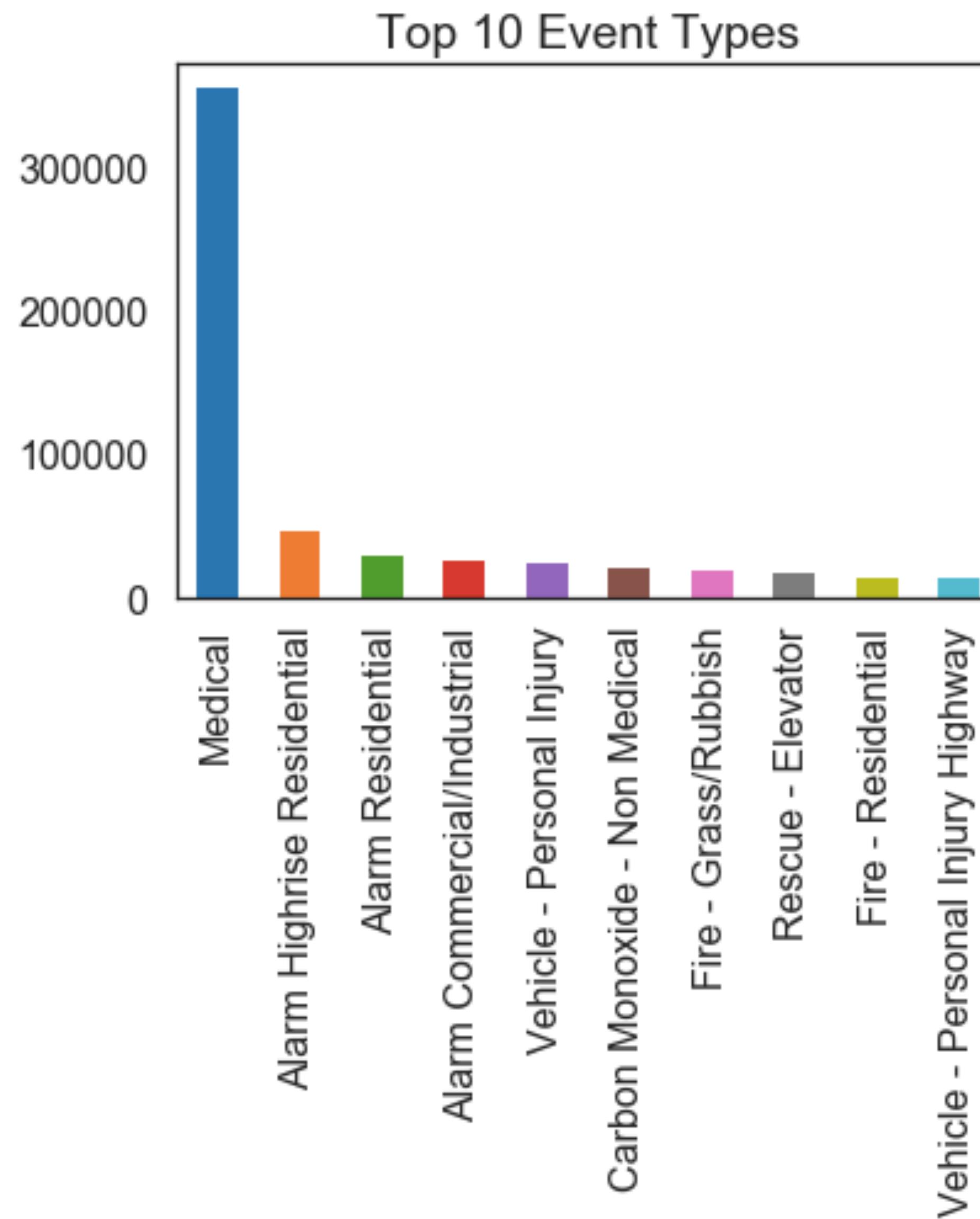
Map data ©2018 Google | Terms of Use | Report a map error

- ▶ 82 Fire Stations (2017)
- ▶ 3,174 personnel

Dataset (shape 720370, 103) merged from 6 XML files(2011-2016).

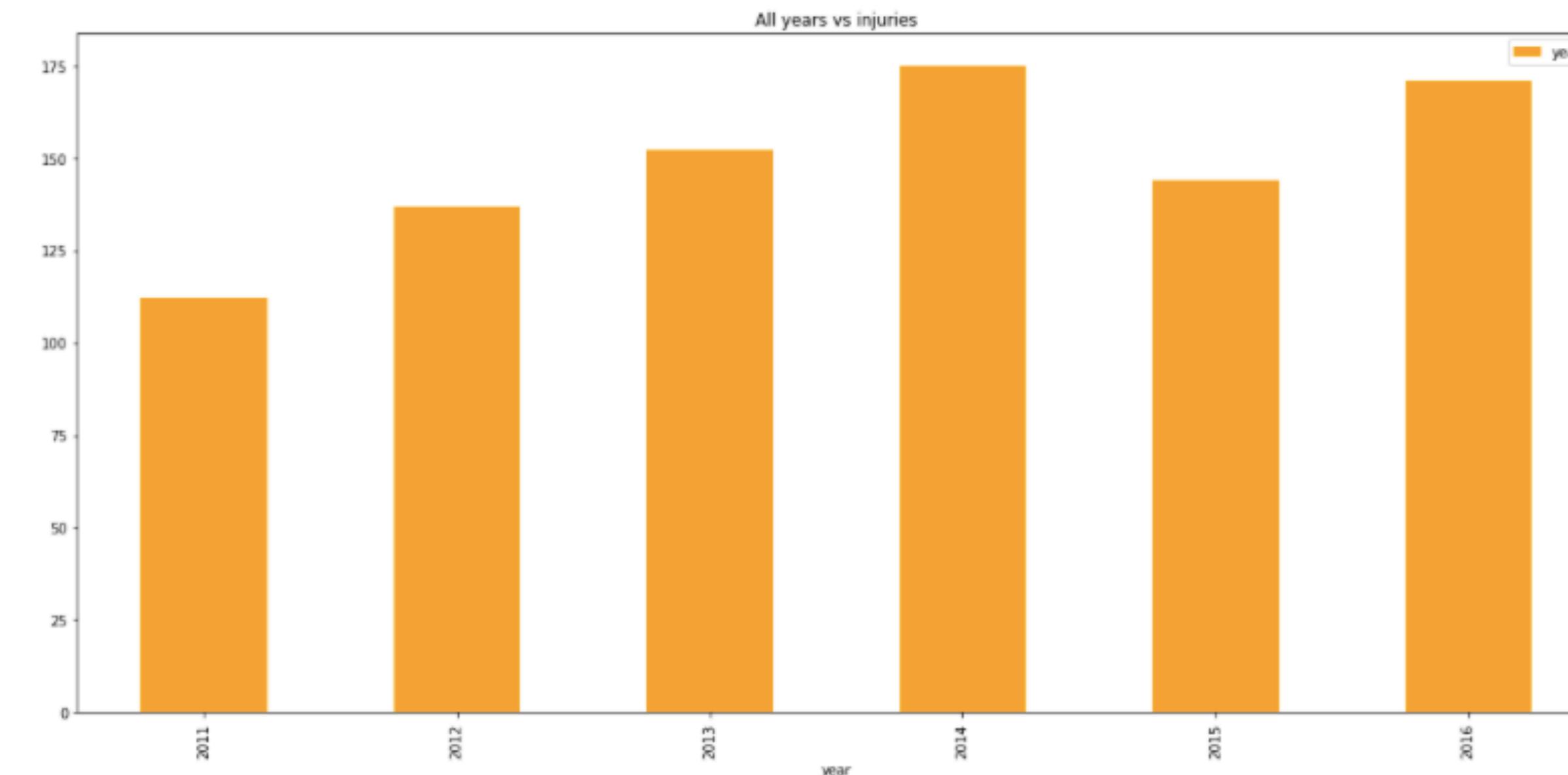
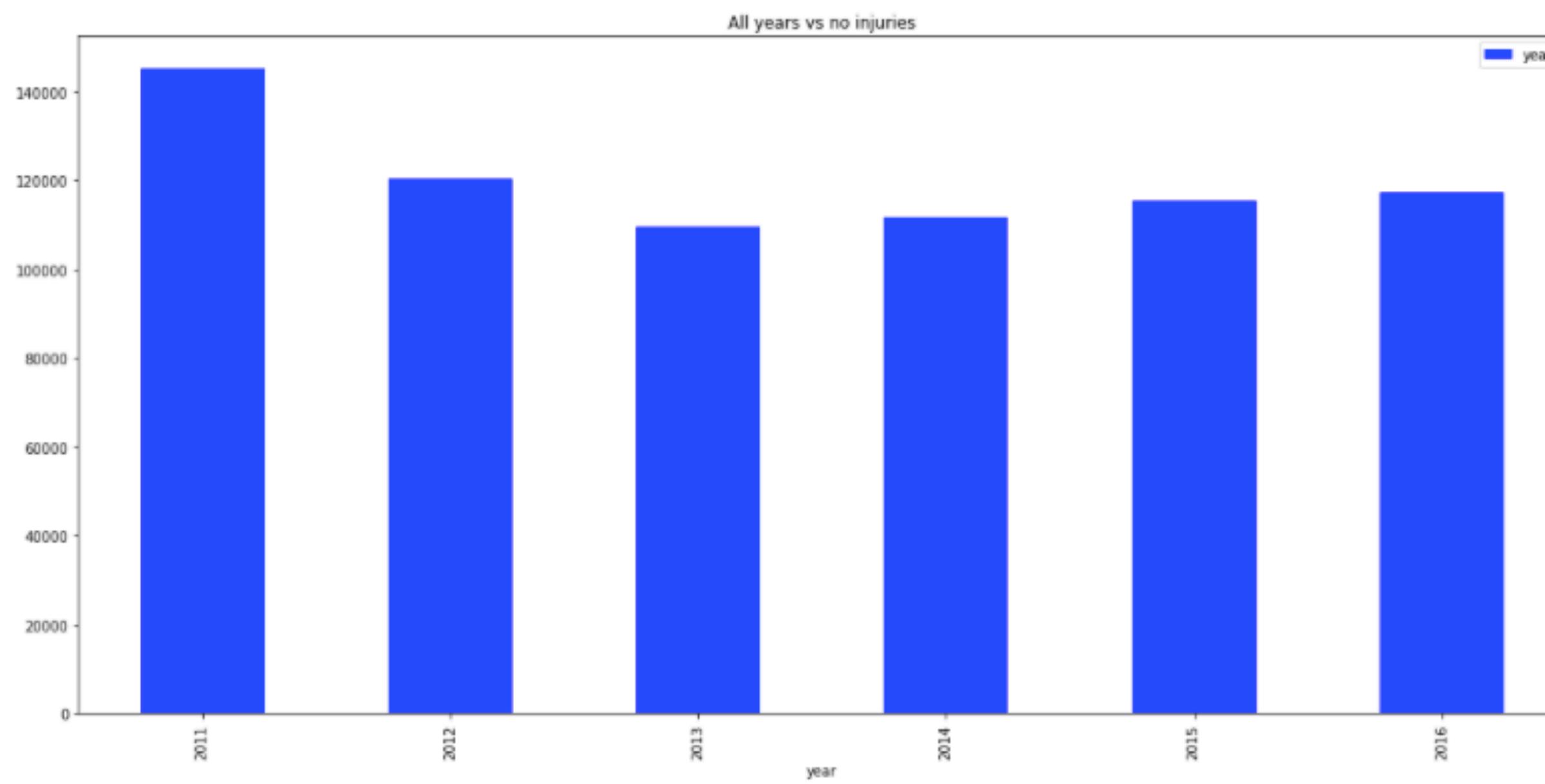
- ▶ Some discrete features: building height, alarm-level
- ▶ Some features with distinct values (0,1):
 - ▶ EMS, MOE, MOL, OFM, OPP, Gas, Hydro > Agencies contacted
- ▶ Some categorical features:
 - ▶ Almost 350 property types (church, pet shop, opera house, bus shelter)
 - ▶ Almost 100 response types (animal rescue, fire, medical, malicious intent)
 - ▶ 100+ event types (Rescue - Elevator, Hazmat Level 1, Vehicle Fire)

- ▶ Columns with more than 90% data as Nan were removed, leaving a dataset shape of (720370, 57)
- ▶ All NaN values were filled with the mean of the column.



EXPLORATORY CHARTS - INJURIES BY YEAR

7

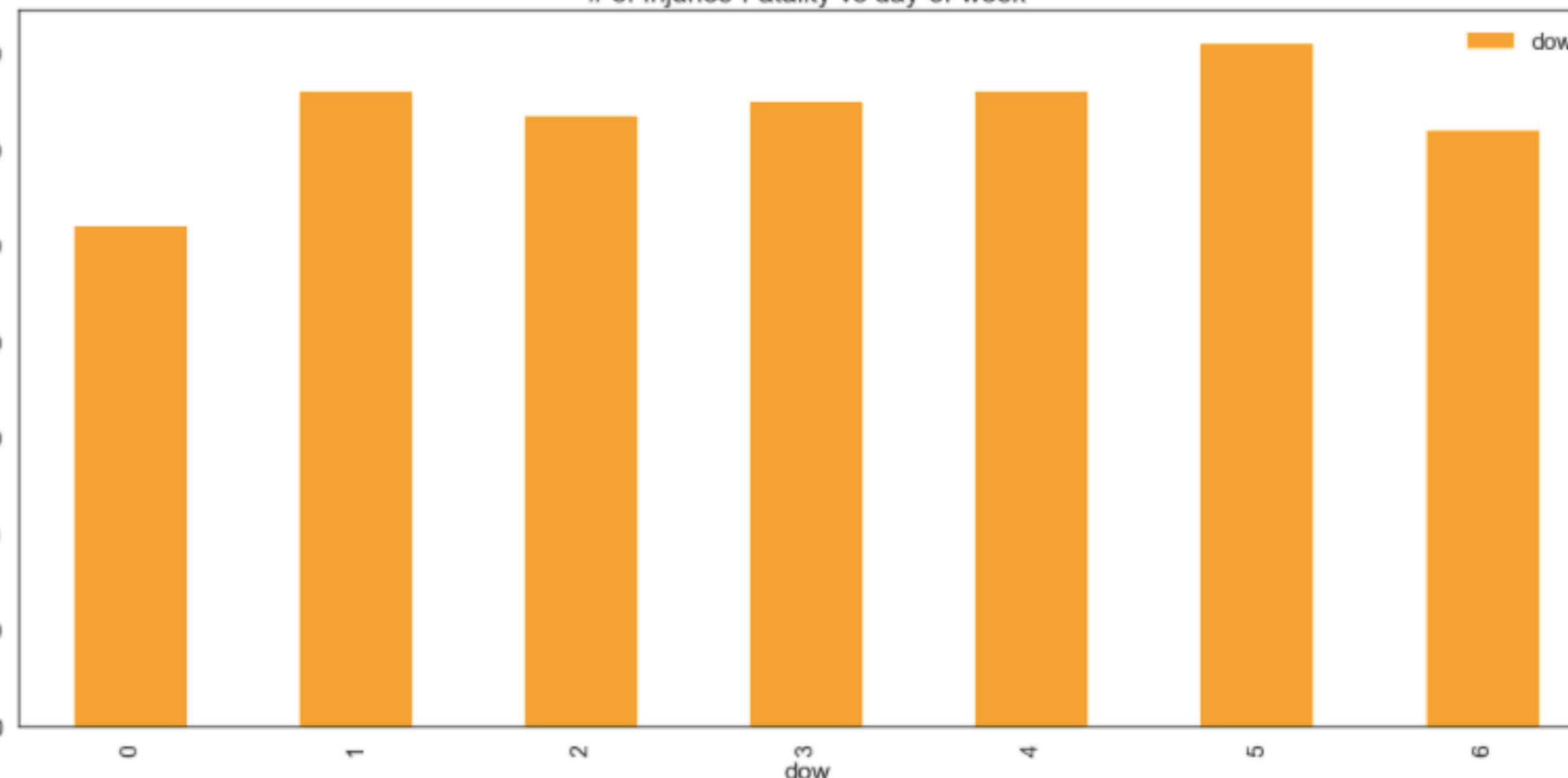
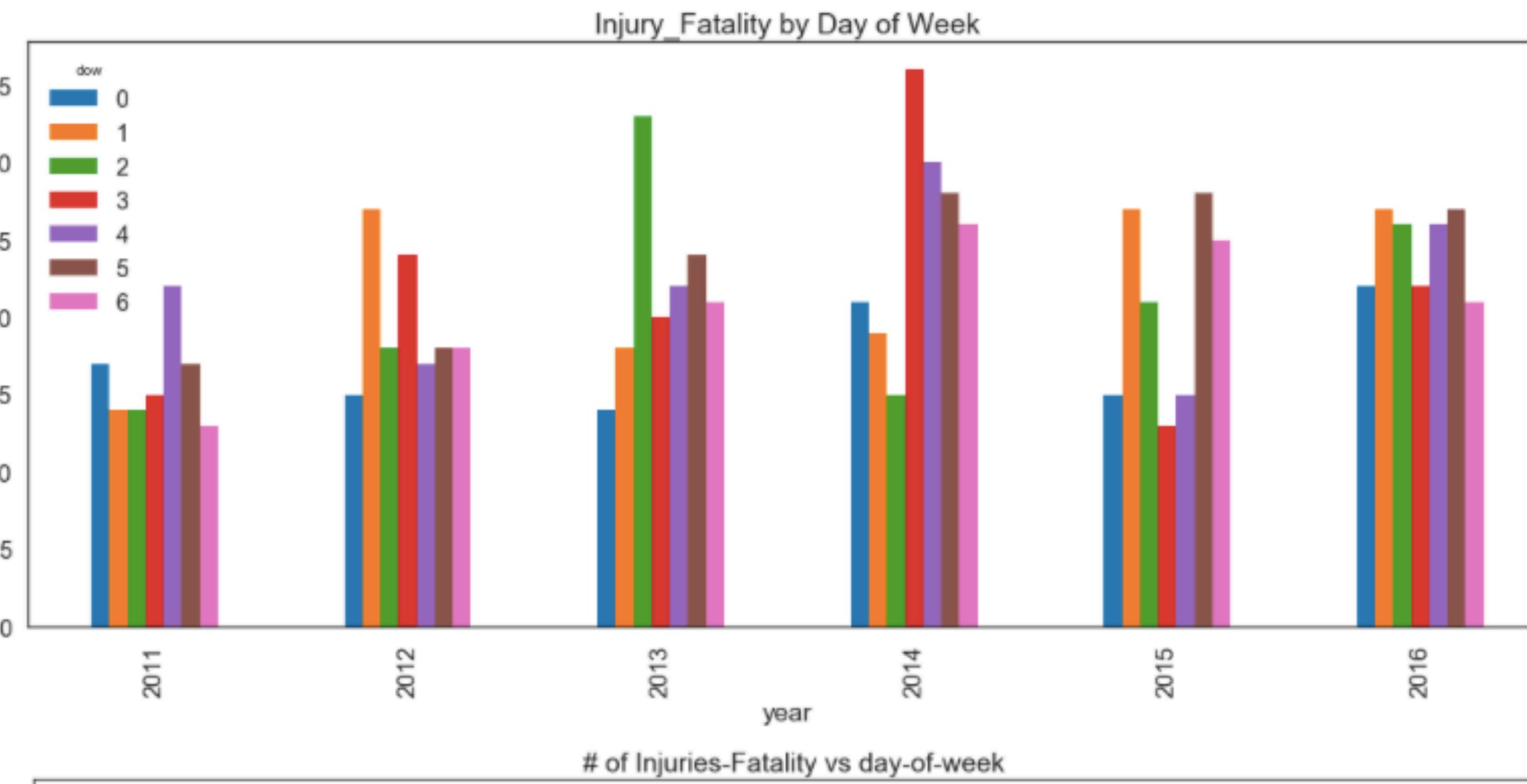


- ▶ Higher injuries in 2014 and 2016.

AM

EXPLORATORY CHARTS - INJURIES BY DAY OF WEEK

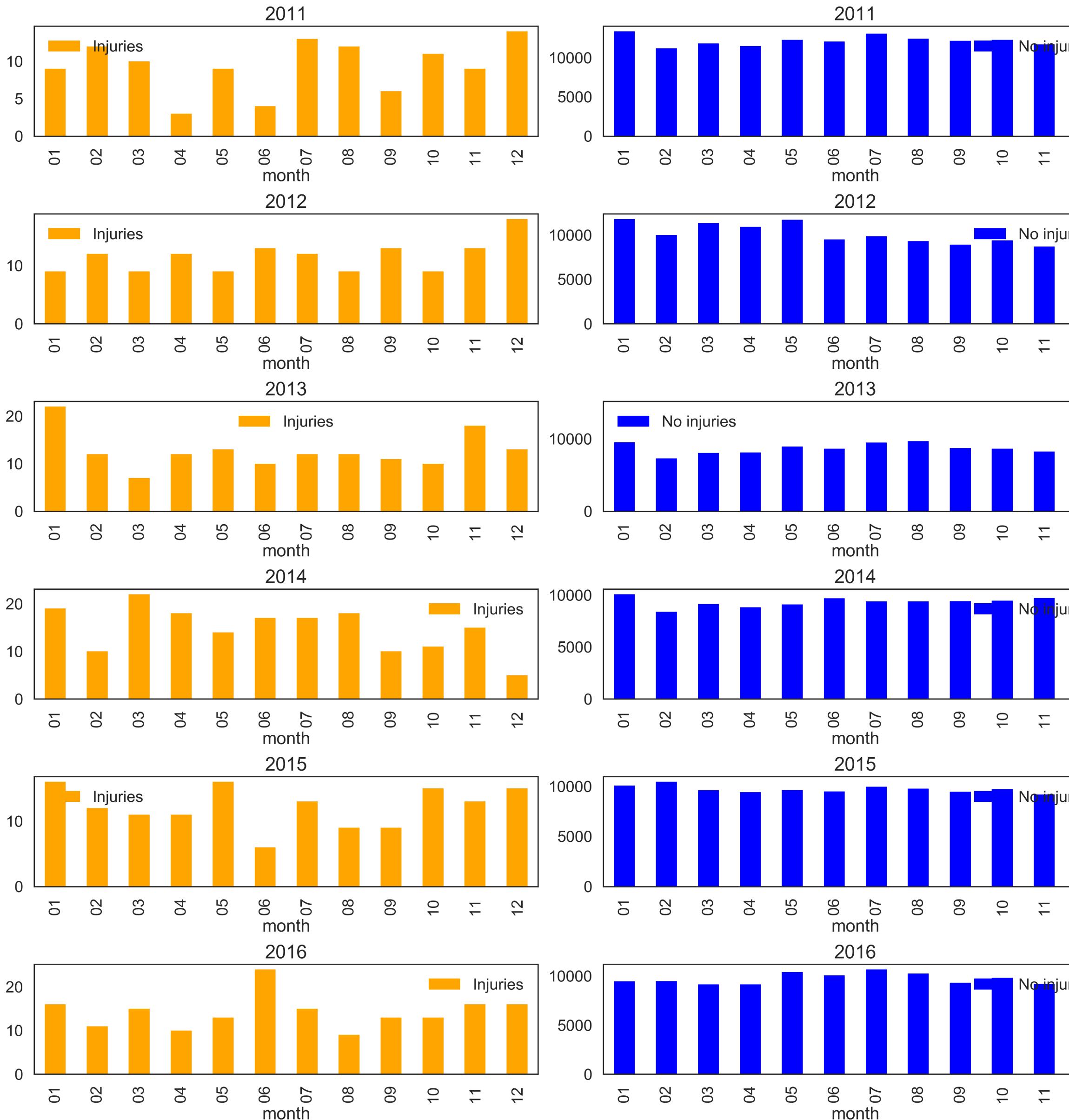
8



- ▶ No discernible day of week has the highest injuries, year on year.
- ▶ 2014 had the highest injury rate for a single day.
- ▶ Most injuries occurred on Saturday.

AM

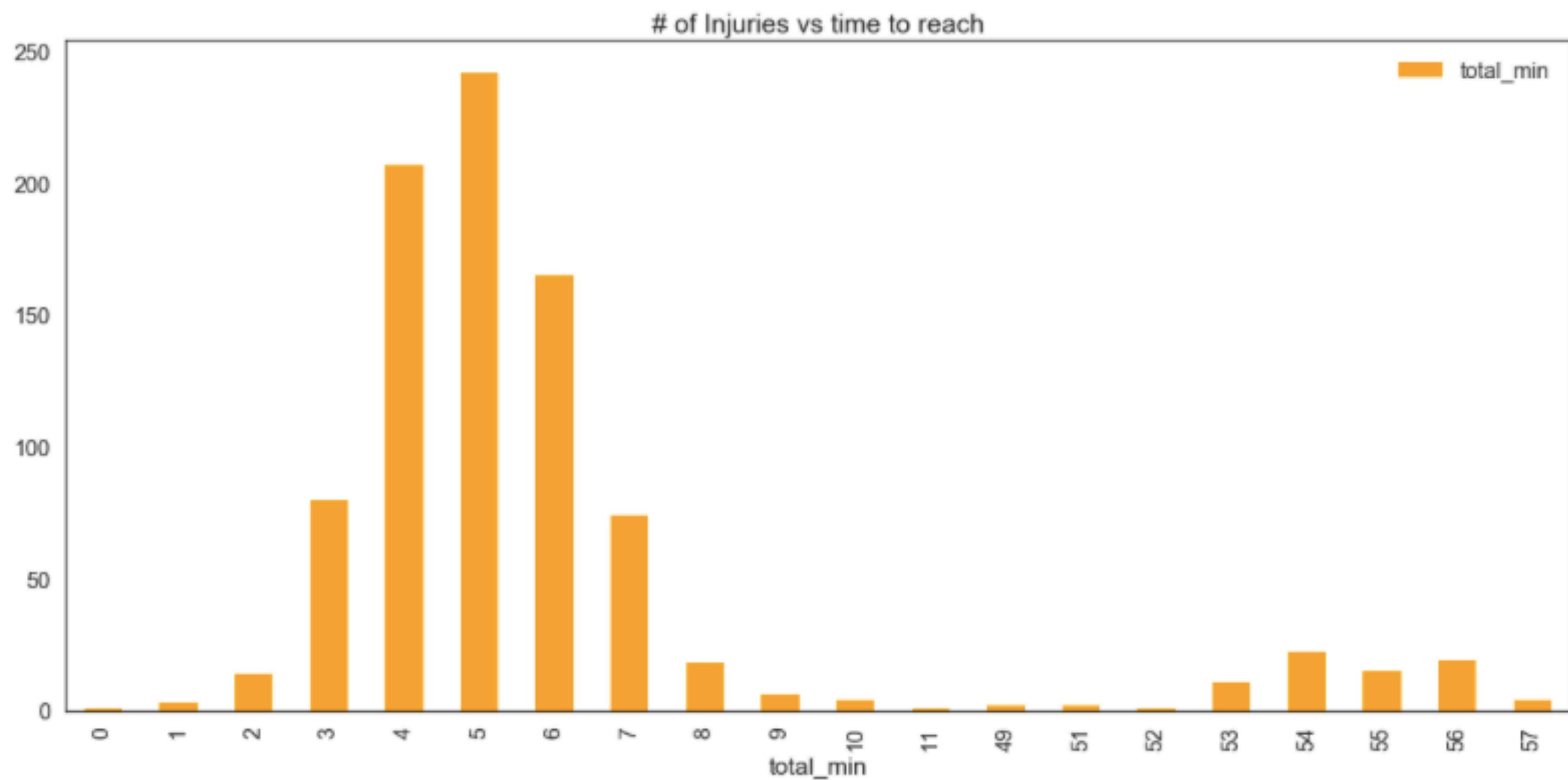
EXPLORATORY CHARTS - INJURIES BY MONTH



- ▶ There is no correlation between months and non-injuries.
- ▶ March 2014 Toronto ice storm
- ▶ June 2016 fiery multi-vehicle crash

EXPLORATORY CHARTS - TIME TO REACH

10

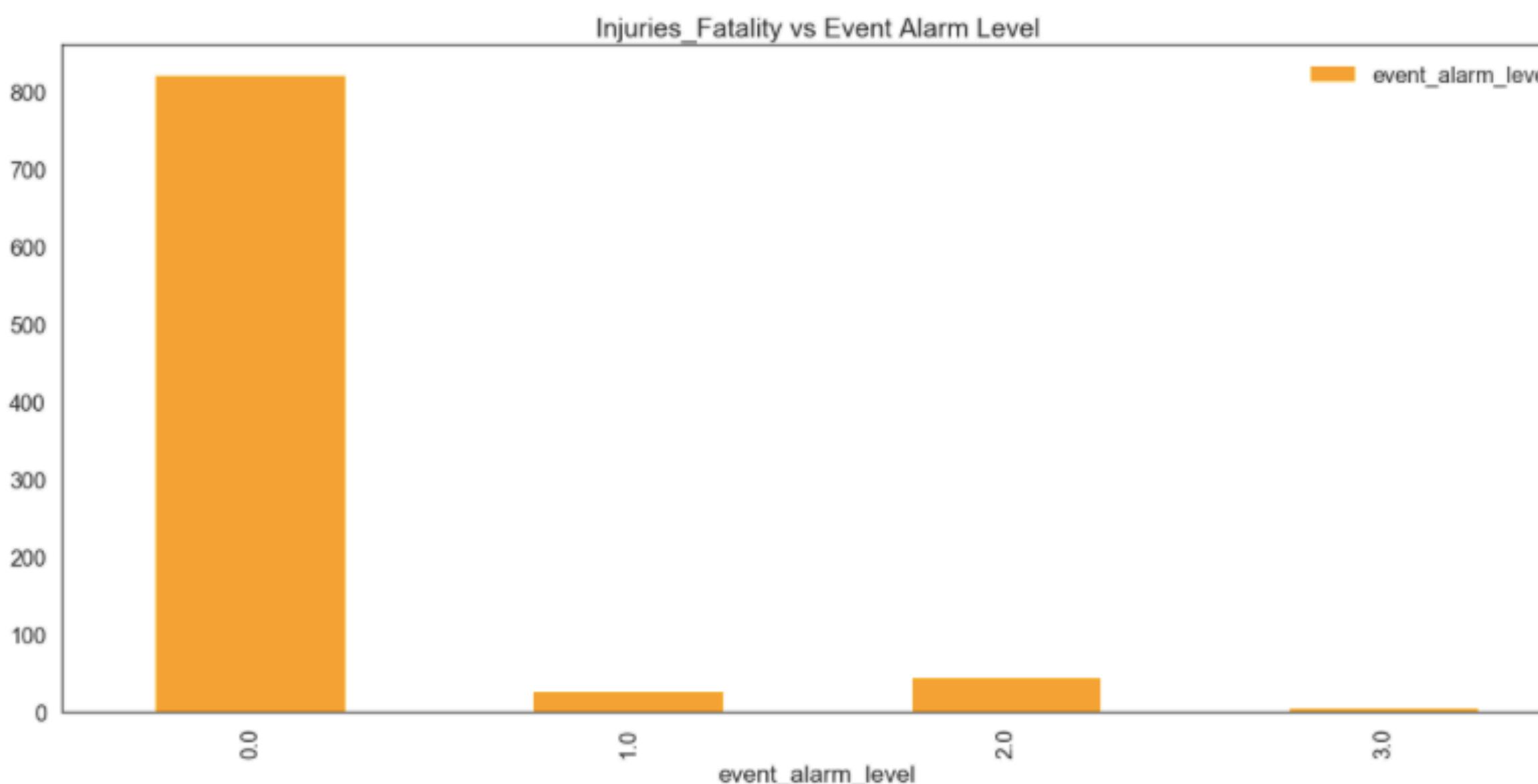
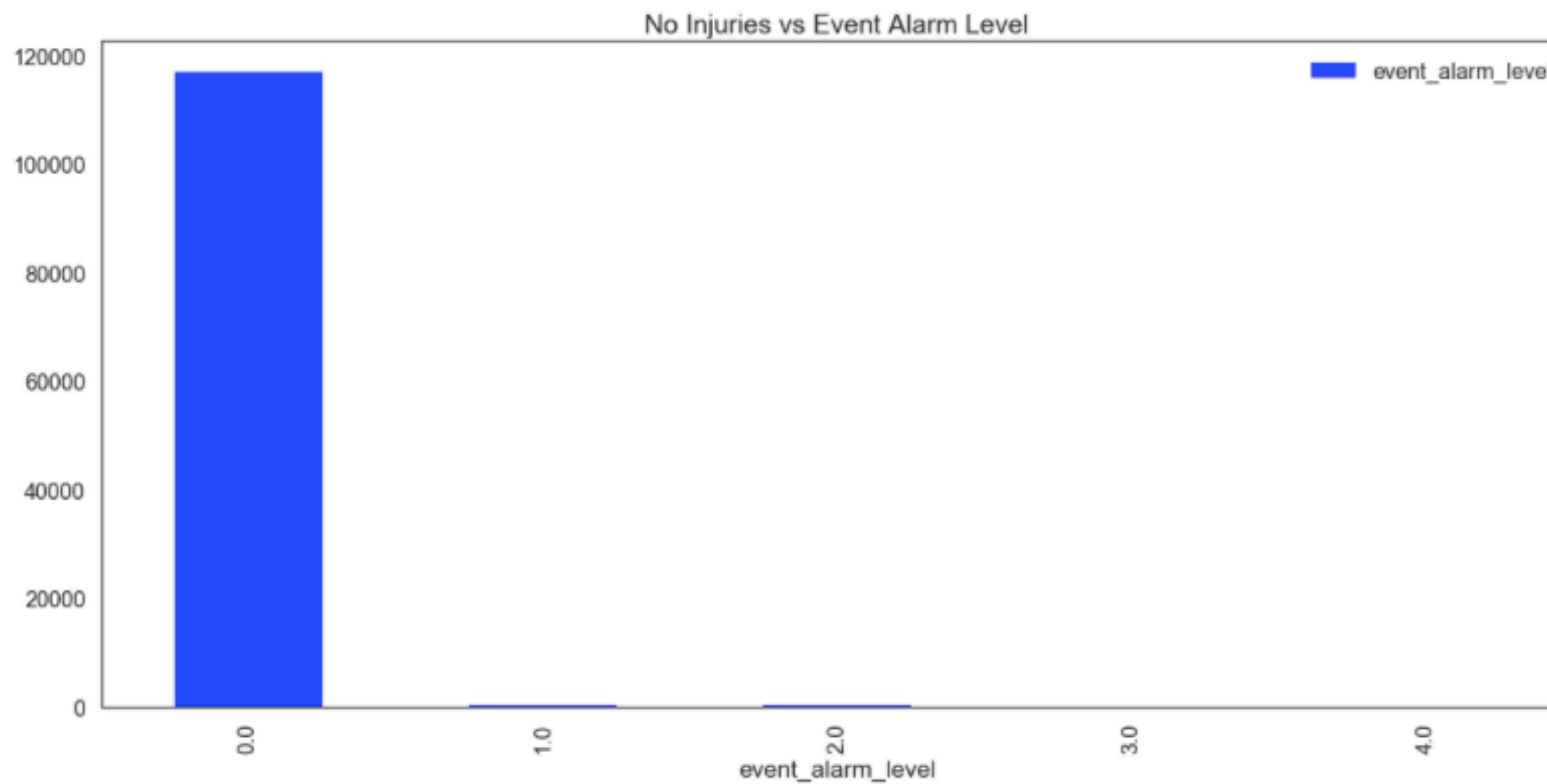


- ▶ Higher injuries occurred when the time to reach was 6 minutes or less.

AL

EXPLORATORY CHARTS - ALARM LEVEL

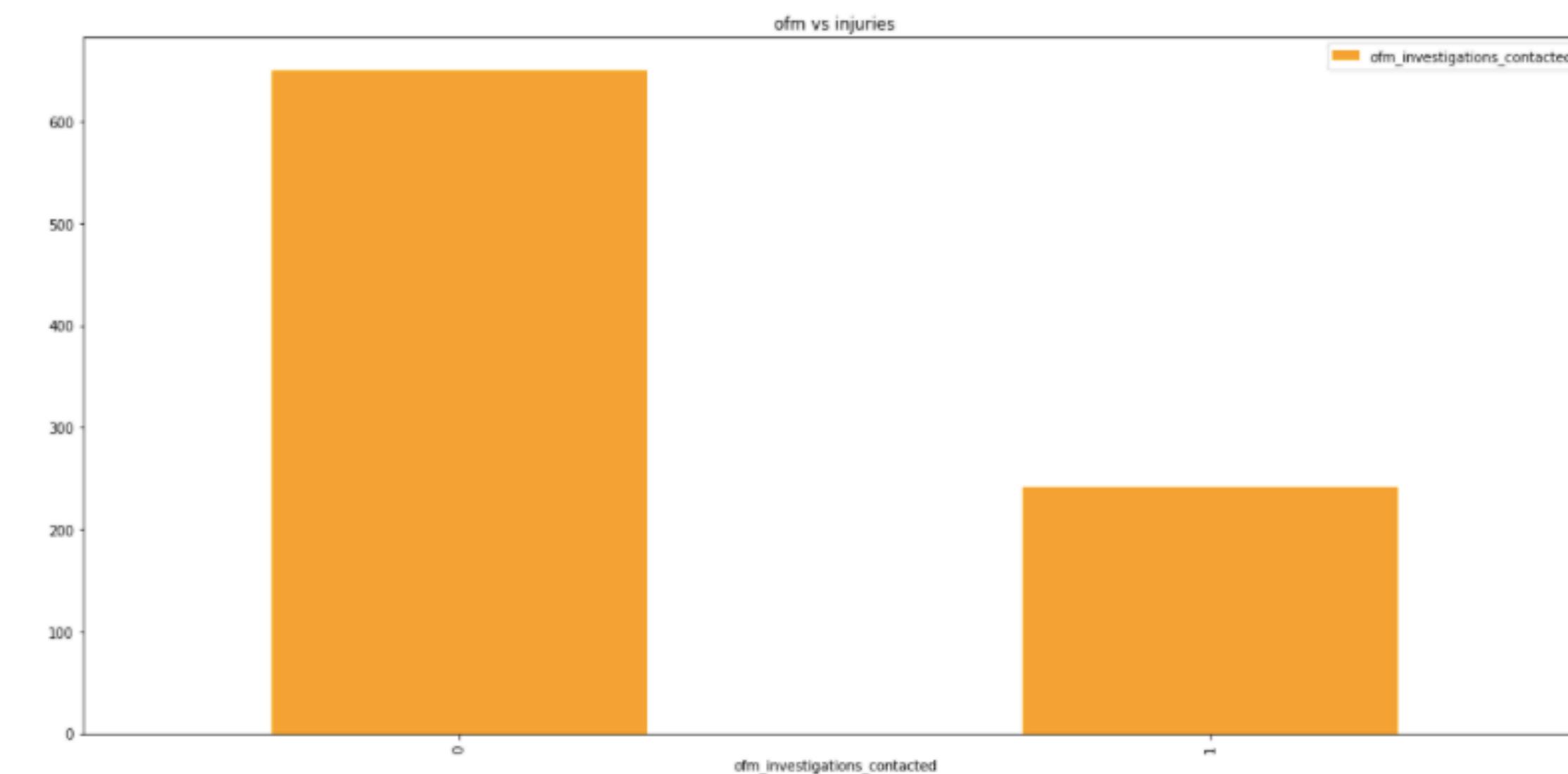
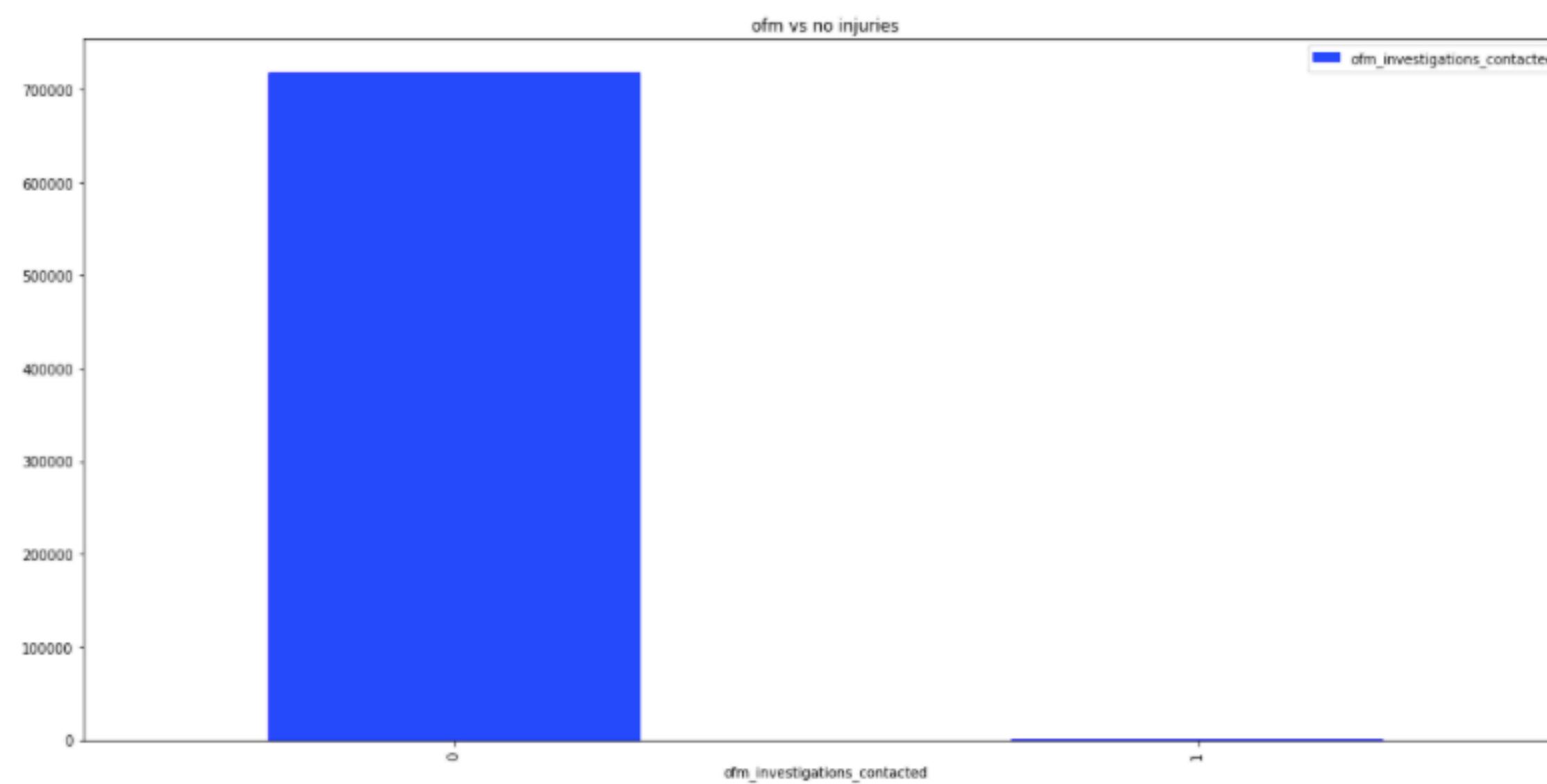
11



- ▶ High majority of injury_fatalities occur at Alarm Level 0.

AL

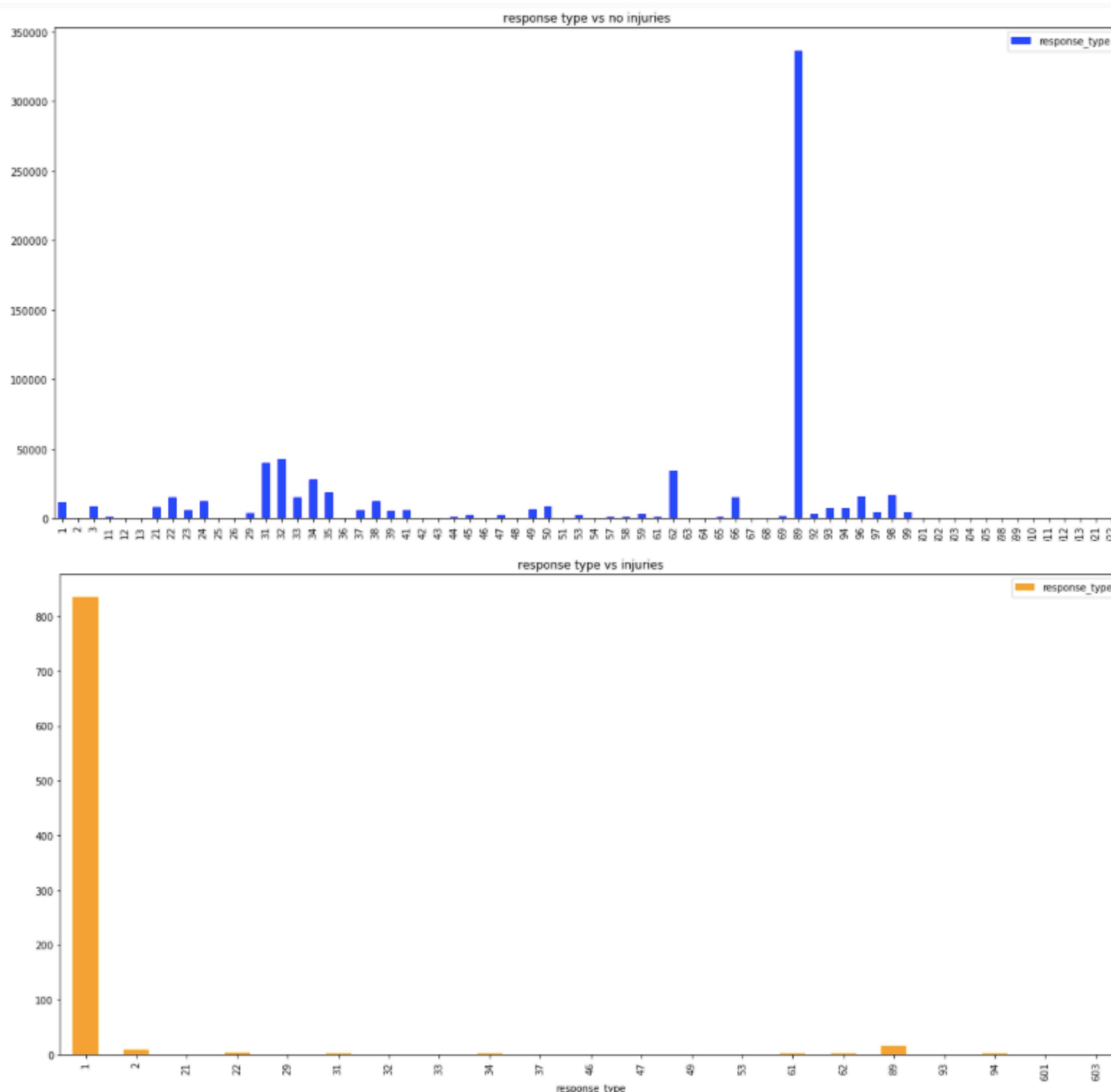
EXPLORATORY CHARTS - OFM



- ▶ In most incidents the Office of the Fire Marshall (OFM) is not contacted.
- ▶ Injuries and fatalities are higher when the OFM is not contacted.
- ▶ This feature is not a good predictor for injuries.

EXPLORATORY CHARTS - RESPONSE TYPE

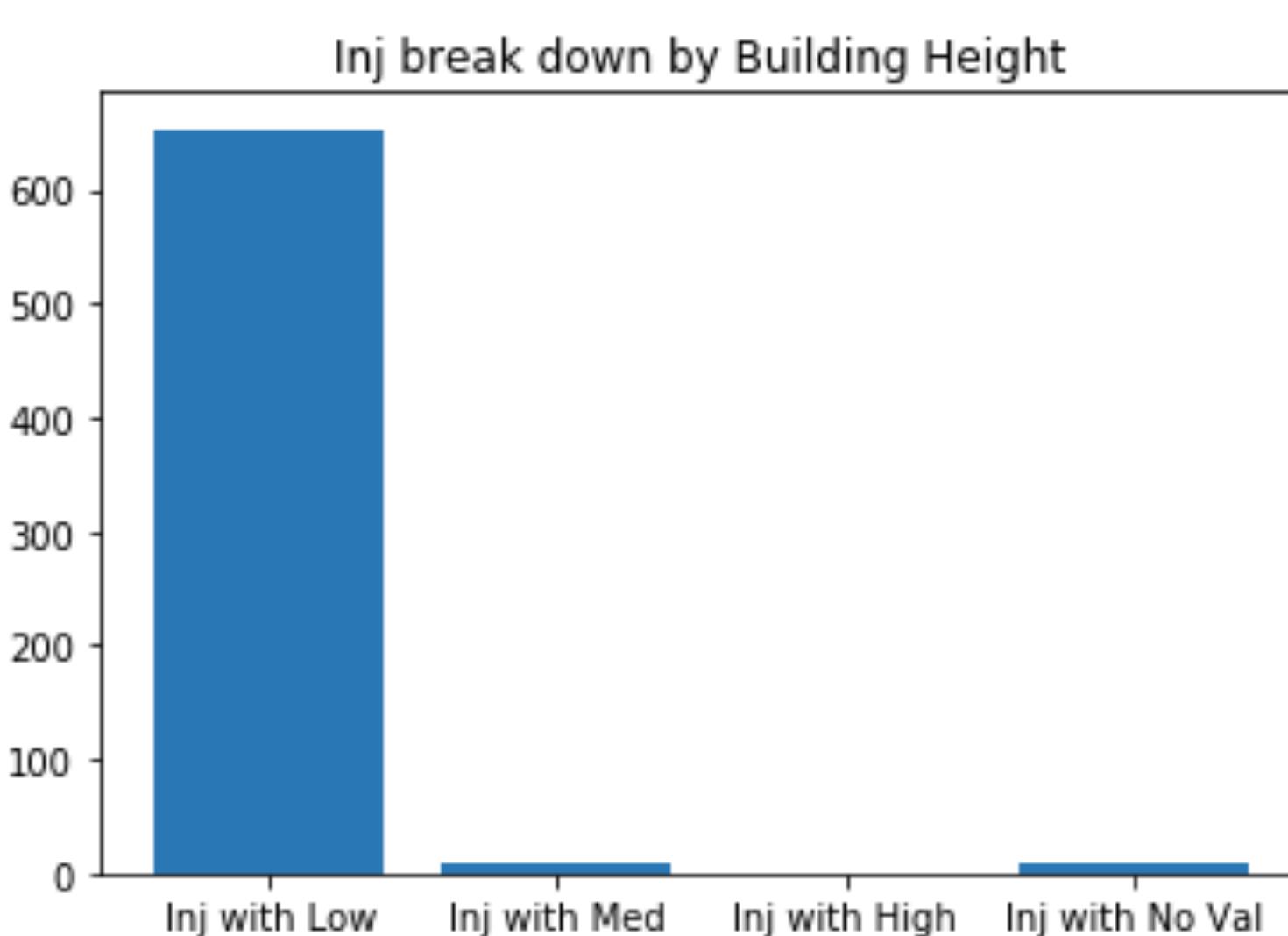
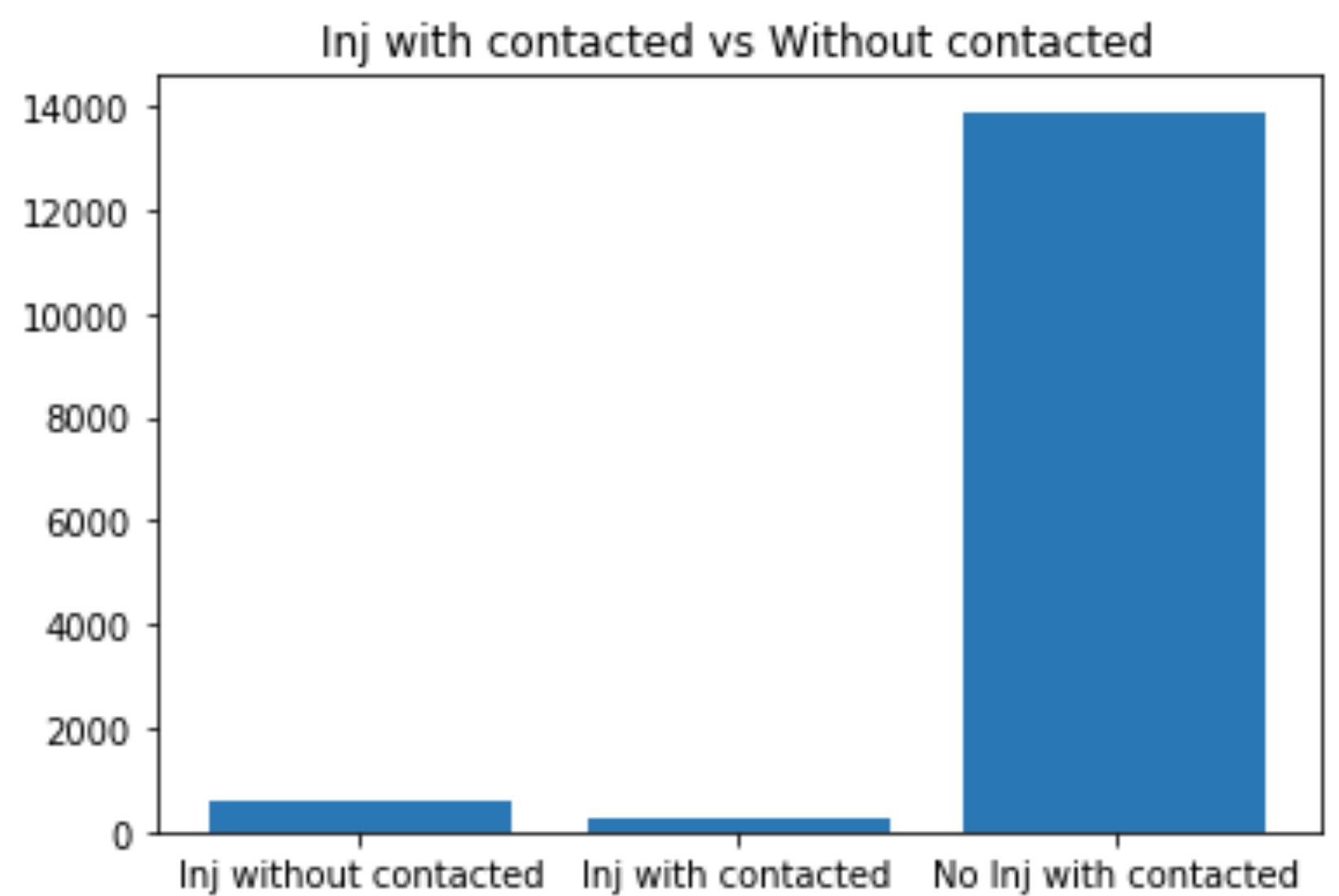
13



- ▶ In most incidents, response type 89 - Other Medical/Resuscitator Call, reports the highest non_injuries and fatalities.
- ▶ Response type 1-Fire Injuries has the highest rate of injuries and fatalities.
- ▶ This is also not a good predictor.

AV

EXPLORATORY CHARTS



- ▶ Combination of various contact agencies are contacted, yet they do not predict injuries.
- ▶ High majority of injuries are at low building heights.

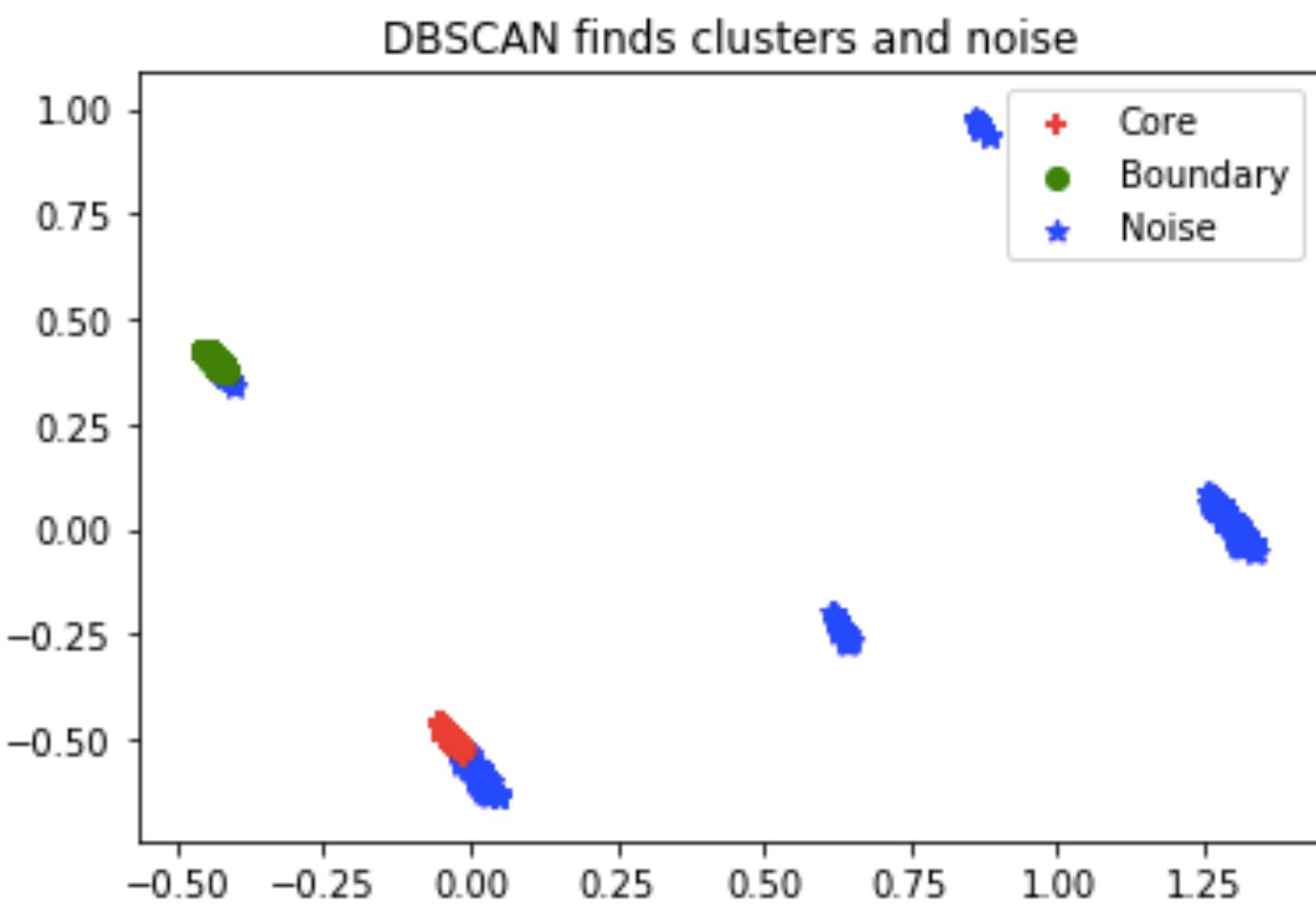
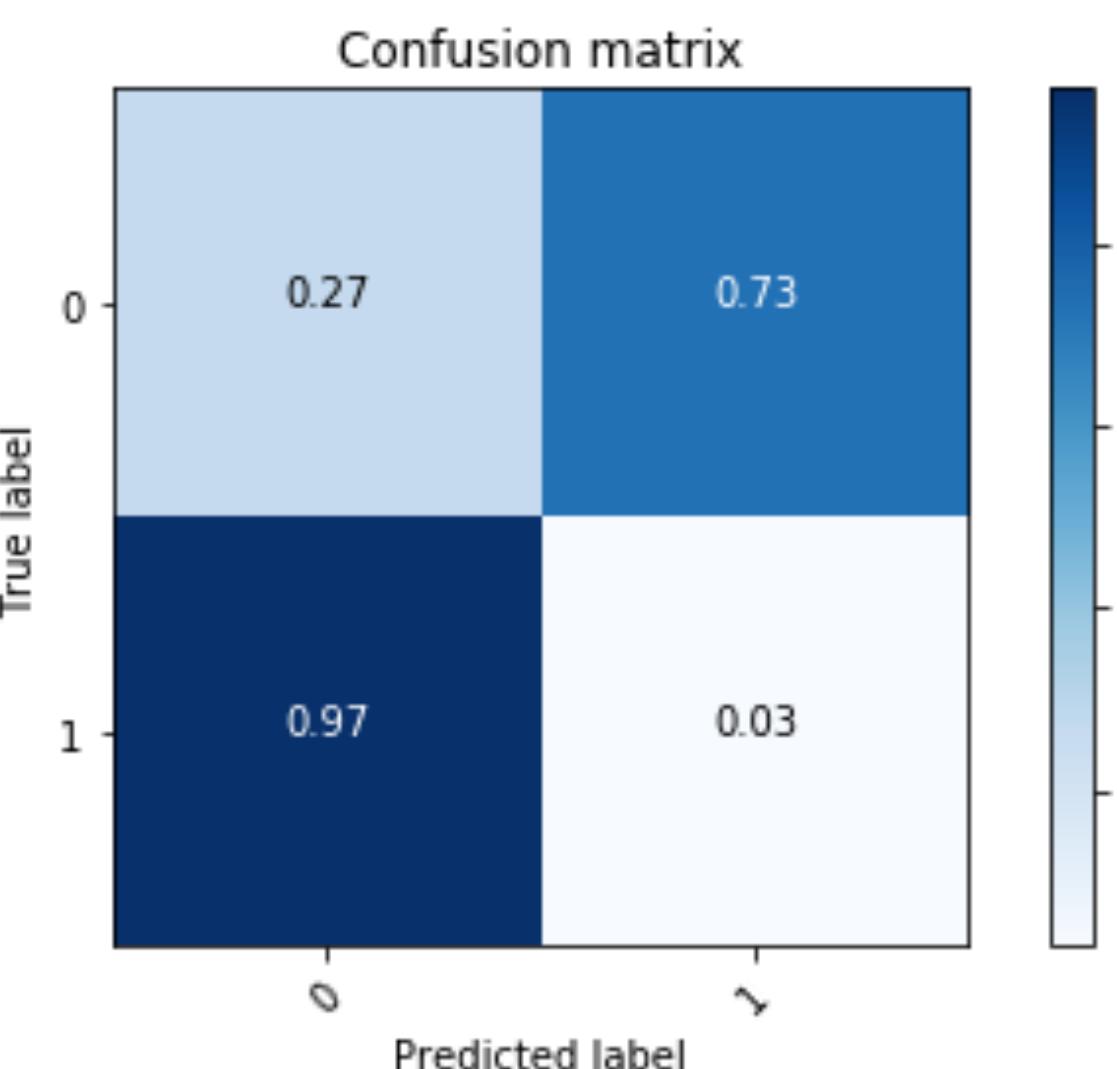
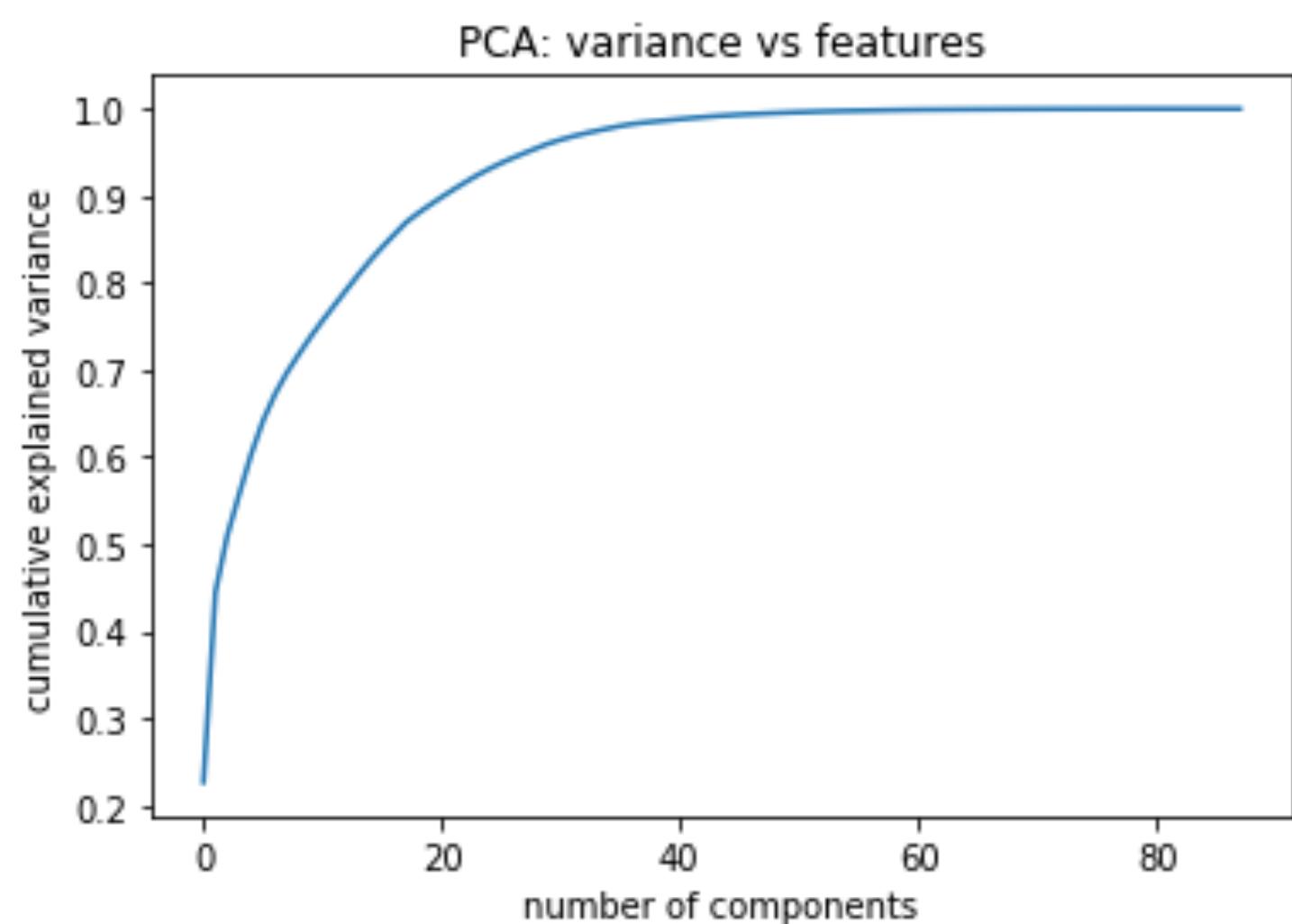
▶ FEATURE EXTRACTION

- ▶ **Total_Inj_and_Fatalities** feature combines civilian and firefighter injuries and fatalities into a single value 0 (no) or 1 (yes), used as TARGET variable.
- ▶ **Contacted** feature is a combination of all the agencies contacted into a single variable.
- ▶ **Mins_to_Reach** feature is a calculation of the time it took to reach the incident.

▶ ONE-HOT ENCODING

- ▶ Response_Type , Alarm_Level, Building_Height,

KMEANS, DBSCAN AND PCA



	precision	recall	f1-score	support
0	1.00	0.27	0.42	143896
1	0.00	0.03	0.00	178
avg / total	0.99	0.27	0.42	144074

KMeans

DBScan

- ▶ PCA shows that 13 features explain 80% of the variance.
- ▶ KMeans shows that true positives are 3%.
- ▶ DBScan identified injuries as outliers. Success rate was less than 2%.
- ▶ Clustering is not a good method of identifying injuries.

KNN AND SVC RESULTS ON SCALED AND UNSCALED DATA

Mean 0.9984916513254847
STD 3.729121211015762e-05
[0 0 0 ... 0 0 0]

KNN-Scaled

Mean 0.9989701474713678
STD 0.0001194183560079276
[0 0 0 ... 0 0 0]

KNN-Unscaled

Mean 0.9987796464382107
STD 4.135013539885878e-06
[0 0 0 ... 0 0 0]

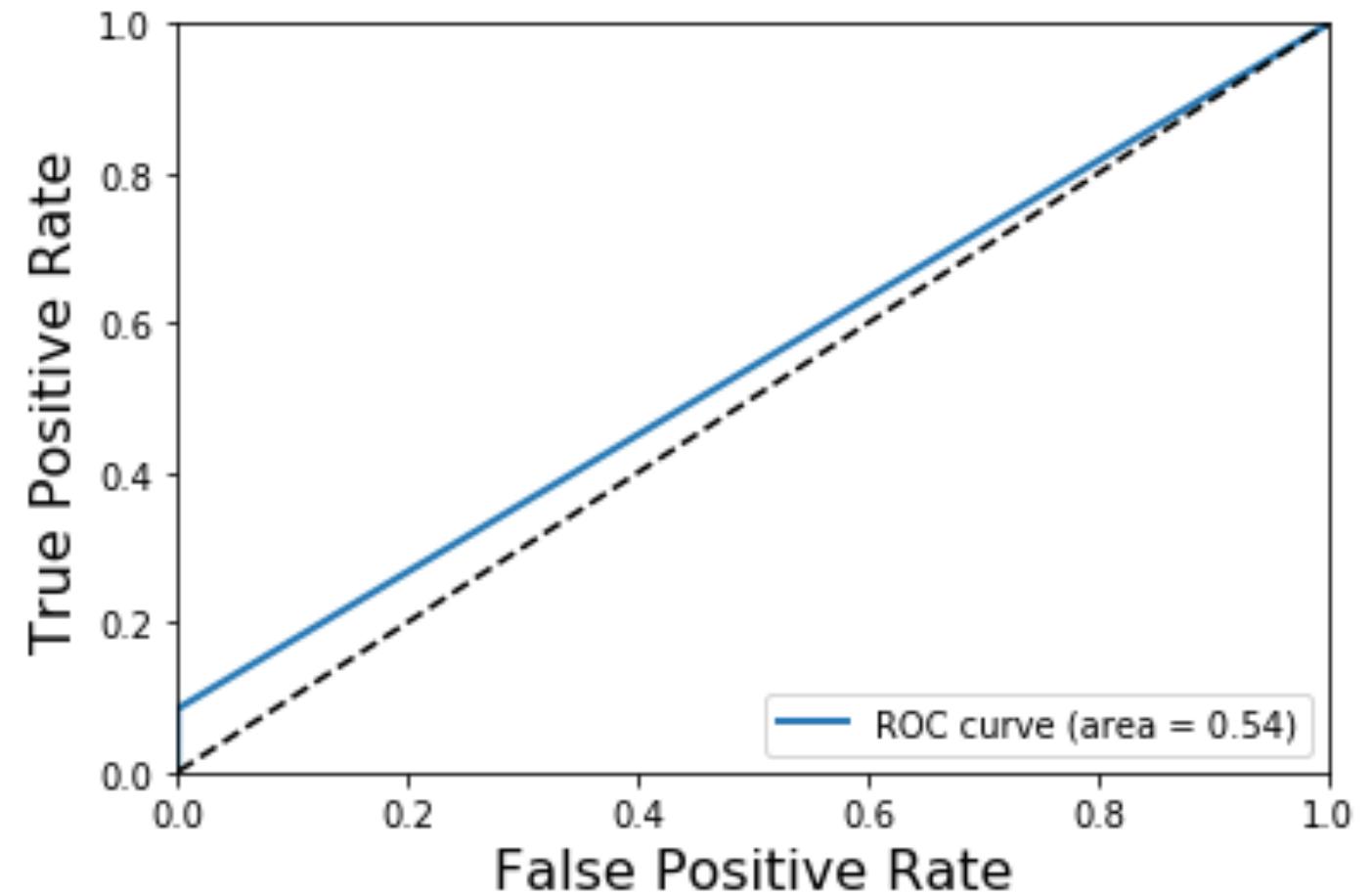
SVC-Scaled

Mean 0.9991567172528182
STD 5.0600609897574254e-05
[0 0 0 ... 0 0 0]

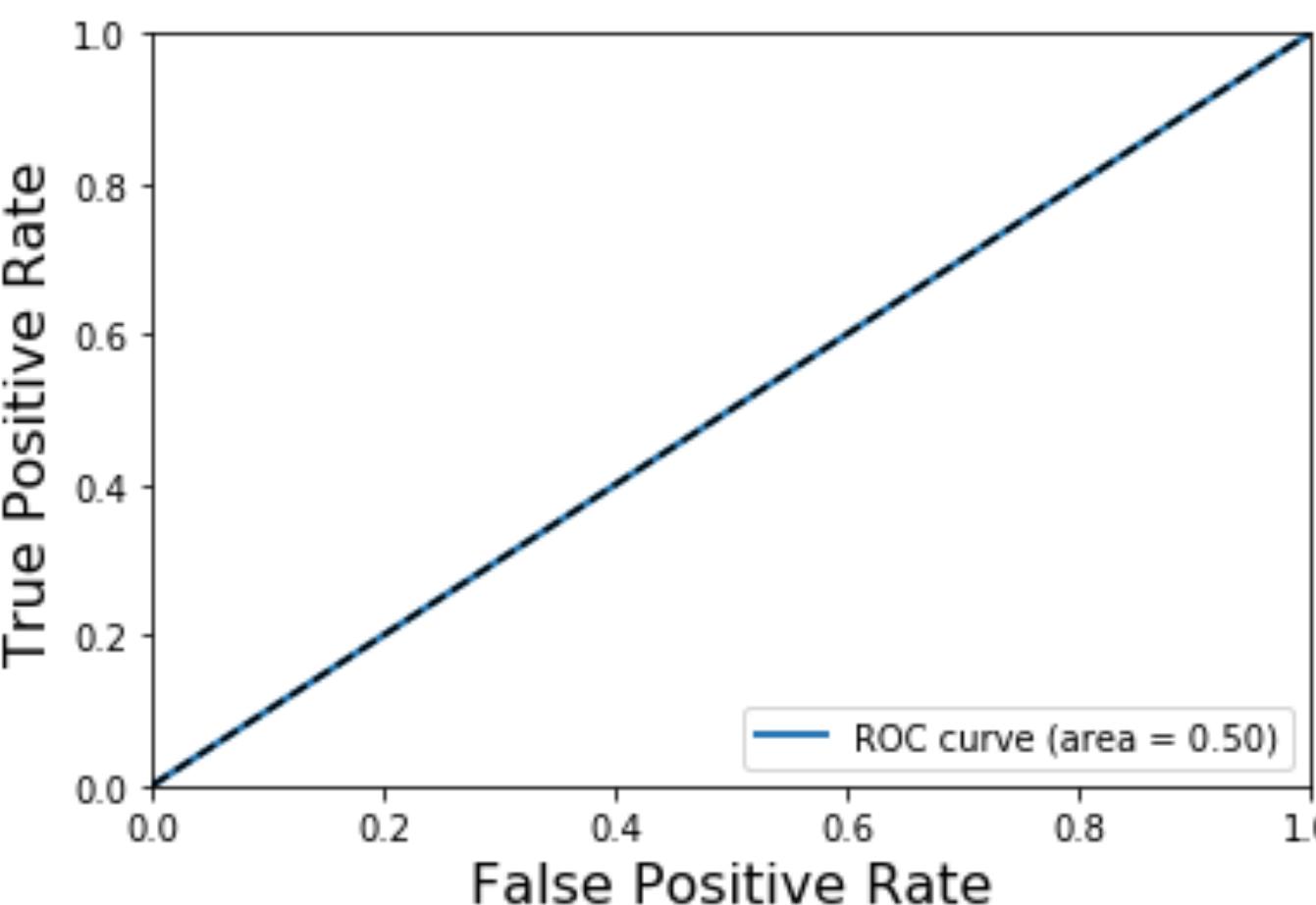
SVC-Unscaled

- ▶ Shows the accuracy scores of the predictions with KNN and SVC.

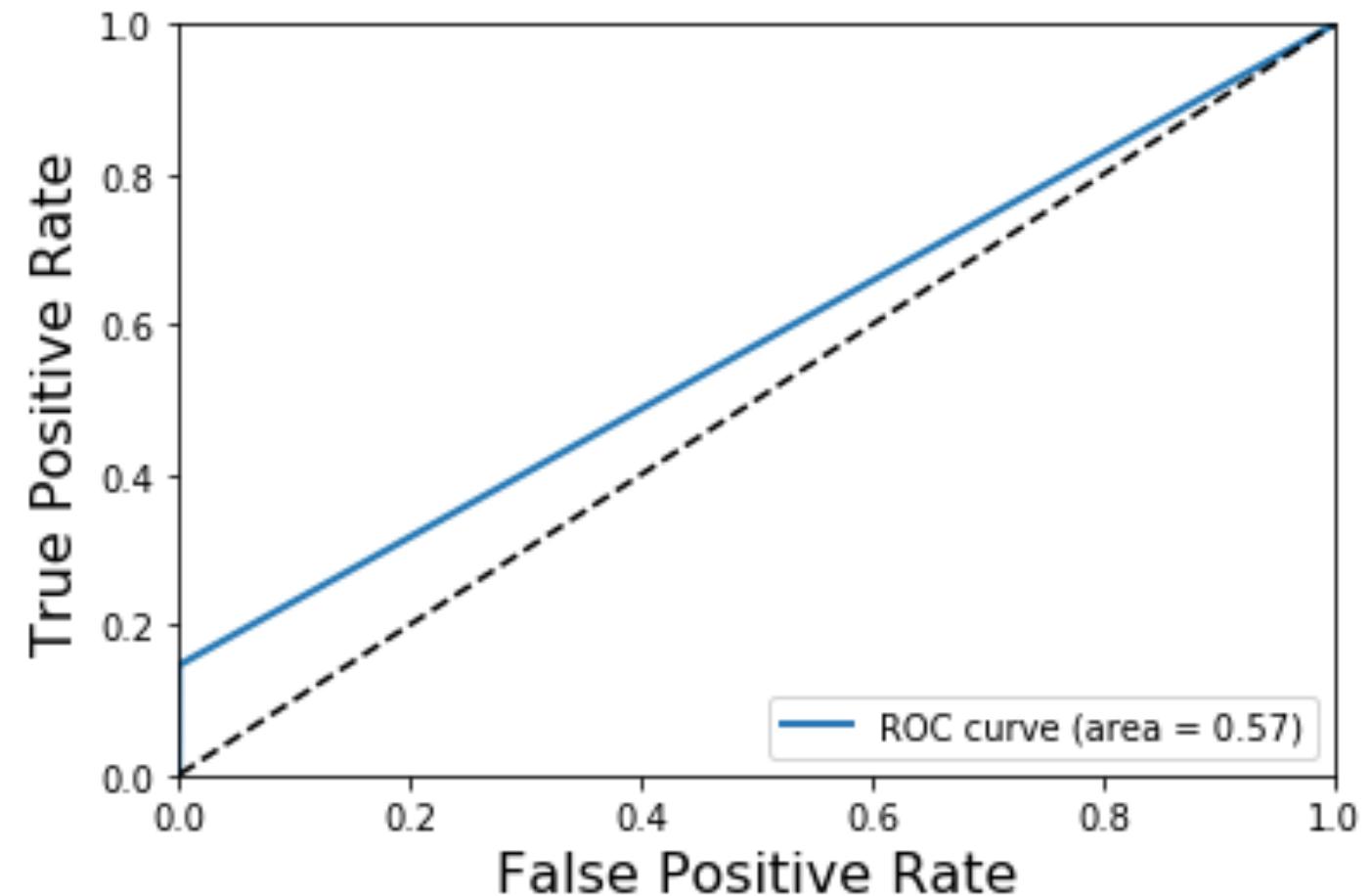
RANDOM FOREST - ROC CURVE



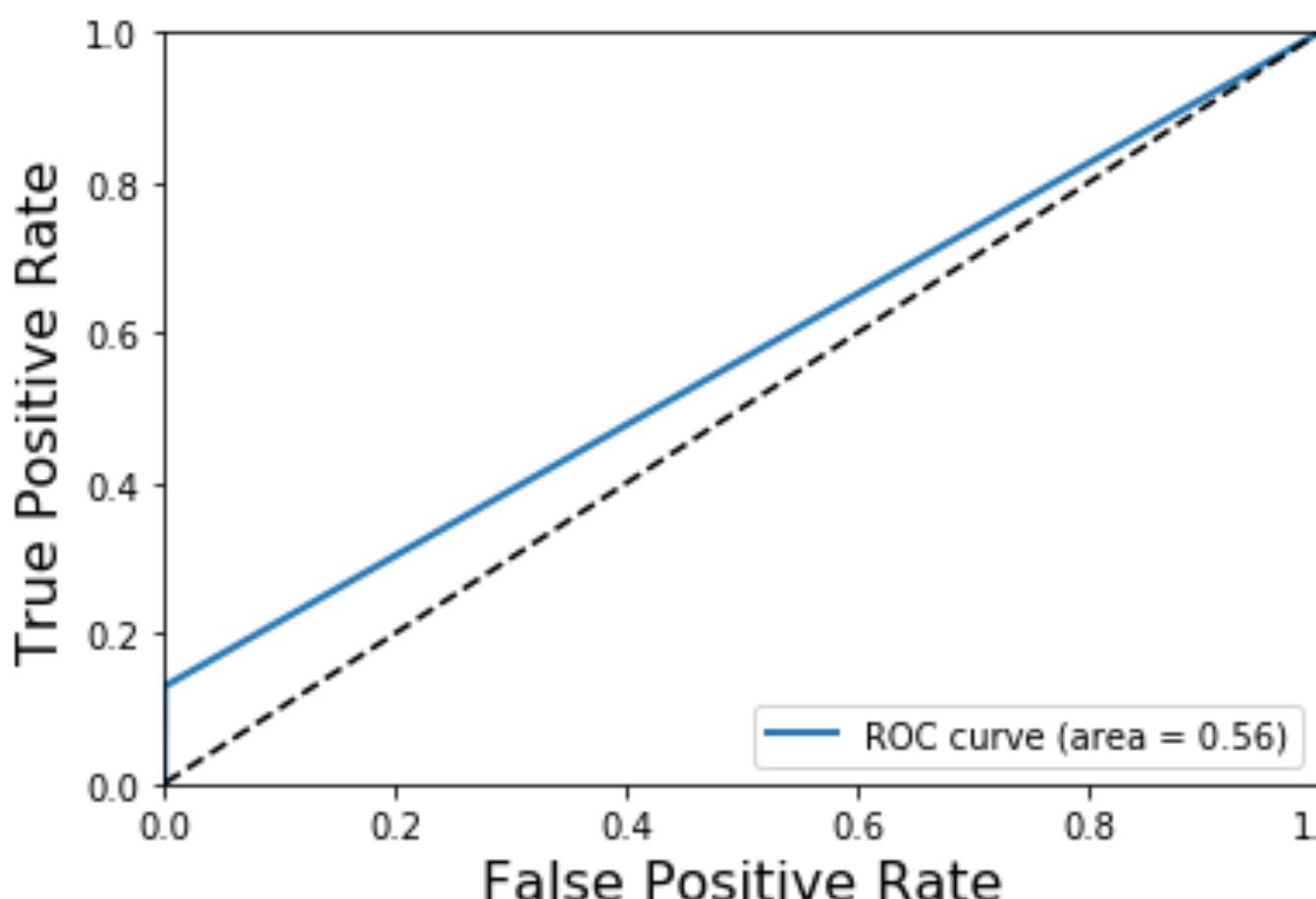
Un-Scaled



Scaled with RandomSearchCV

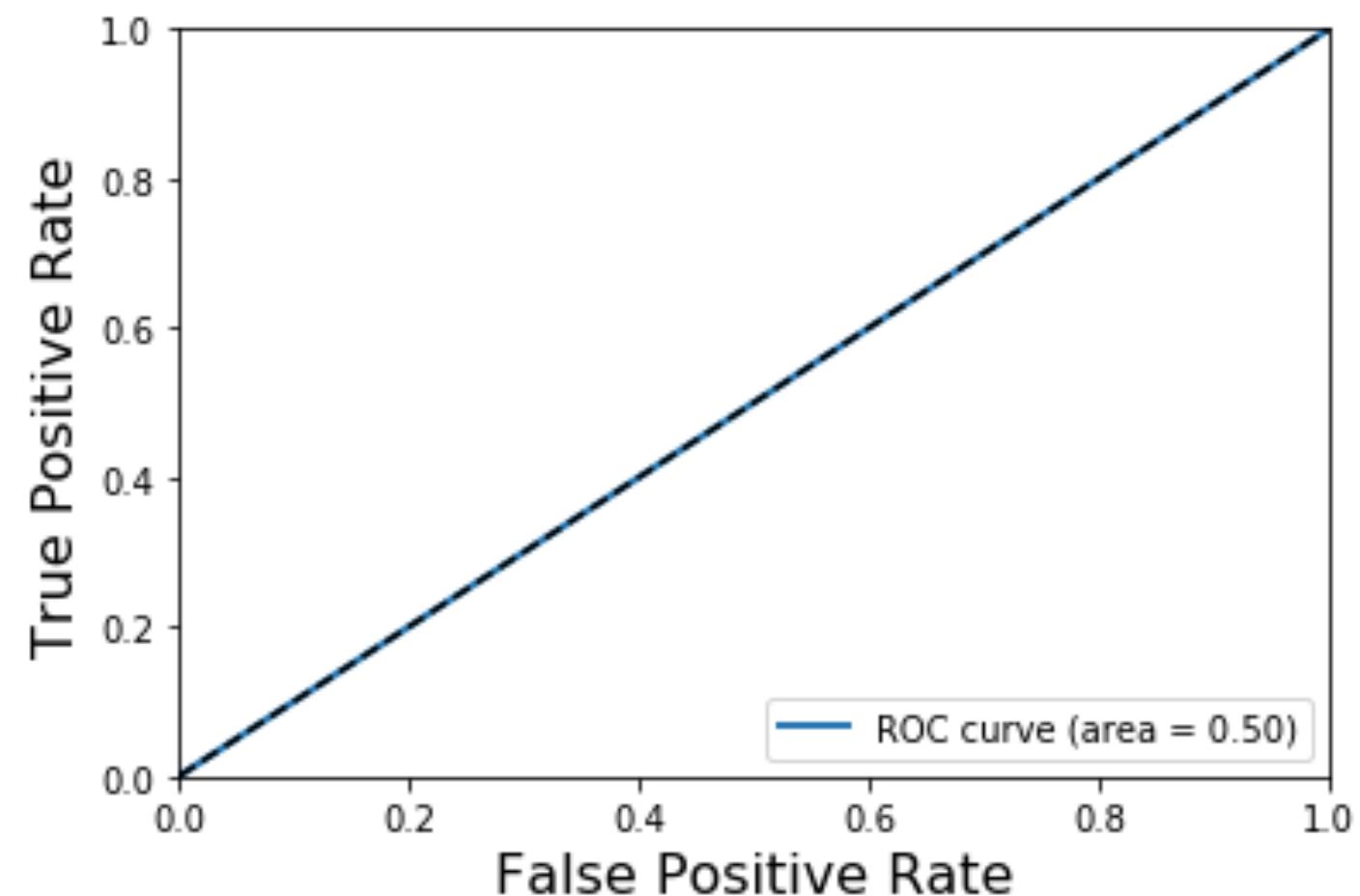


Un-Scaled with RandomSearchCV

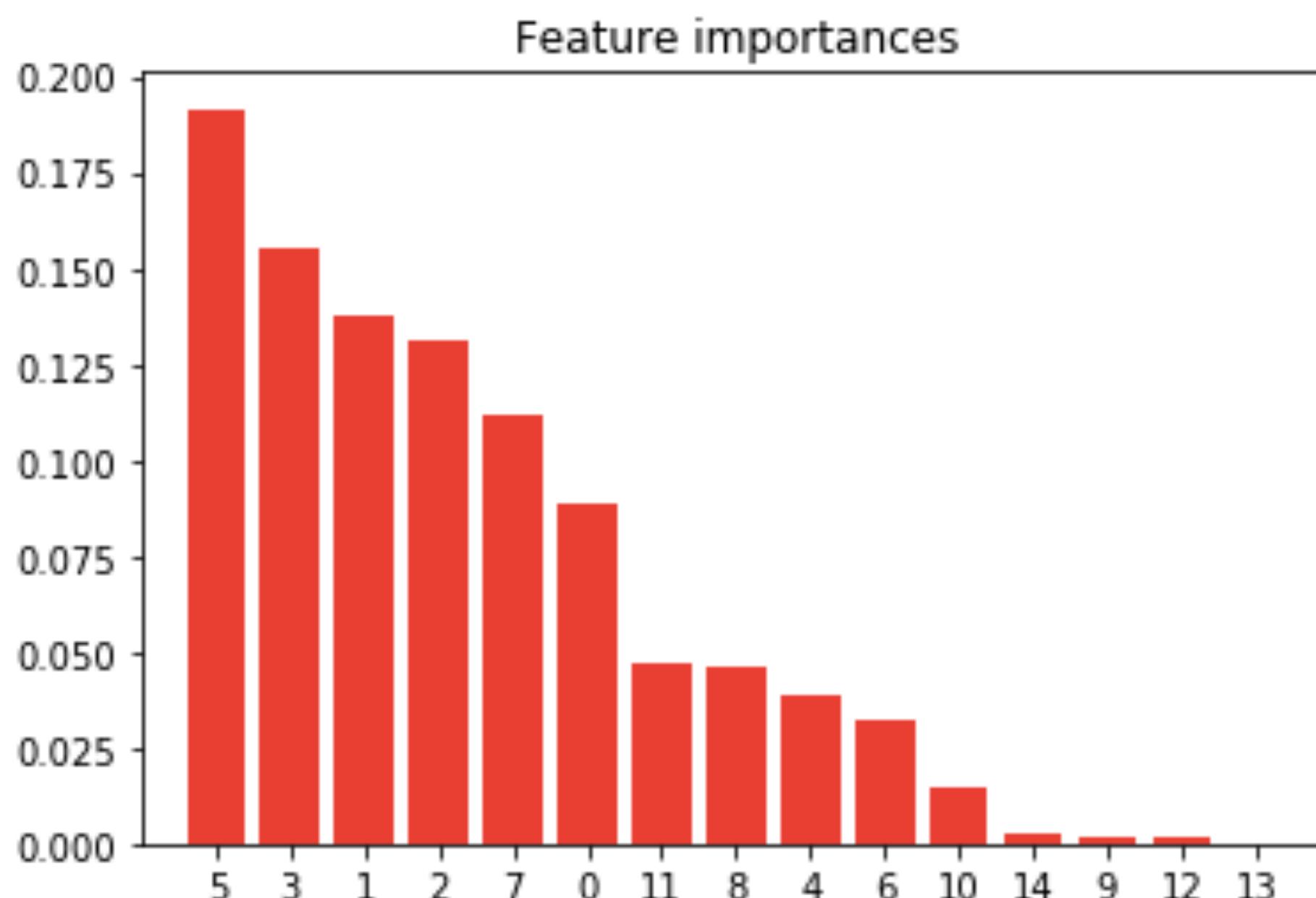


Scaled with Best Parameters

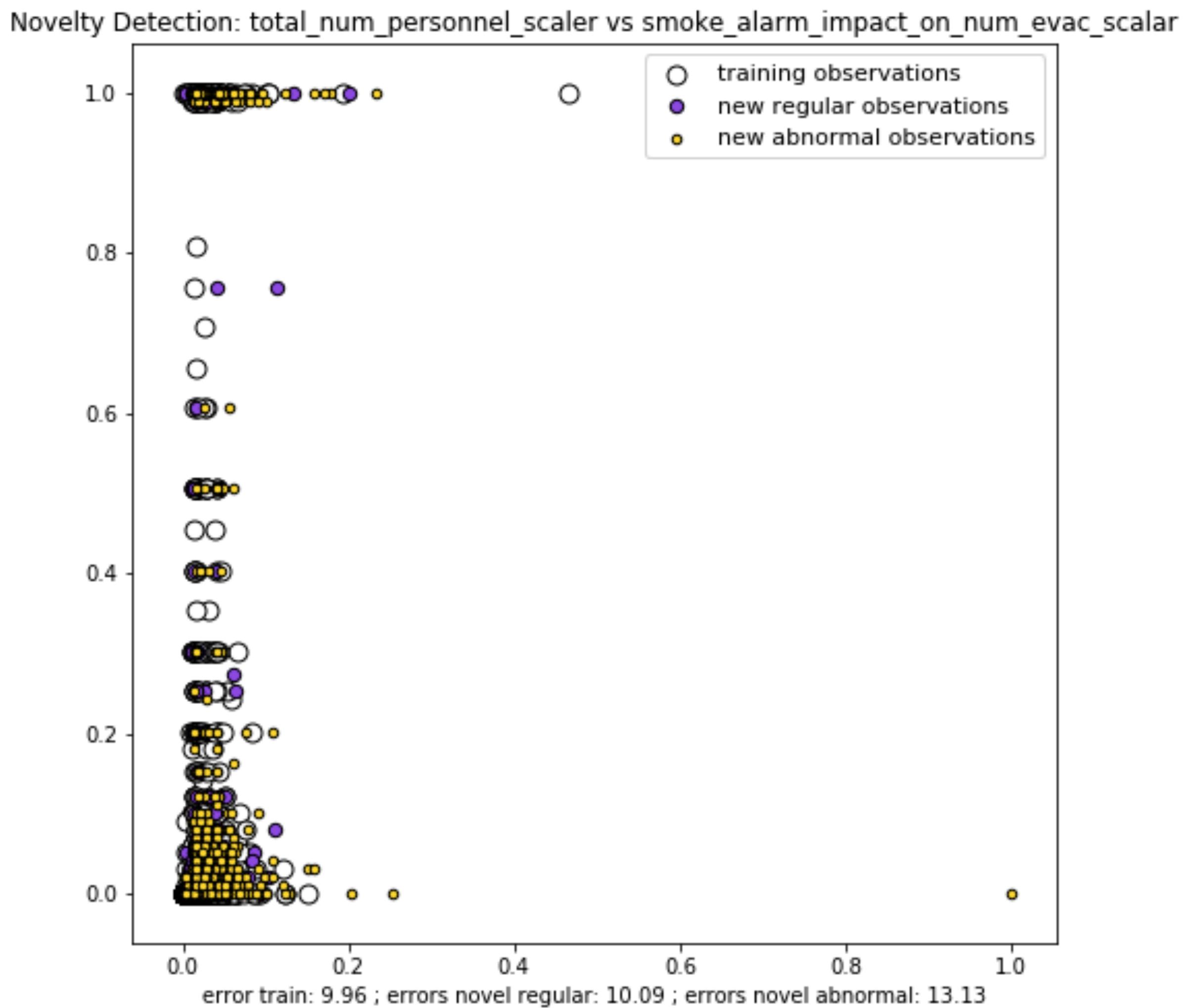
- ▶ Un-scaled, the AUC is around 0.54 which is almost random.
- ▶ Un-scaled with GridCV AUC is slightly better at 0.57.
- ▶ Overall scaled results were poorer compared to un-scaled.
- ▶ Cross-validation with best randomized (not shown) did not fare any better.



Scaled



- ▶ Neural-net gave the same score as other classifiers - as expected.



- ▶ Finding outliers in anomaly detection.

- Data is skewed - only 0.12% of recorded incidents have injuries and fatalities.
- Data is sparse with lots of thinly spread out values across 700,000 records.
- None of the models did a good job of predicting injuries and fatalities.

Future-Recommendations:

A feature to add might be the 911 calls subscripts (natural language).

A feature for if the patient was transported to hospital.

Any feature that include weather, traffic, road-conditions.

ANY QUESTIONS?



On February 14, 2017 a massive 6-alarm fire broke out the Badminton and Racquet Club at the intersection of Yonge and St. Clair. It took more than 100 firefighters over five hours just to contain the blaze, with no major injuries reported.

Photos (front and back): M. Baehr via the Toronto Professional Fire Fighters' Association