Predicting Accident Severity based on environmental factors, accident location and collision type

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Introduction

- Accidents are preventable
- With limited resources, high severity accidents would be priority for policy makers
- Data on various factors that affect accident severity would provide key inputs to the policy makers

Data Description

- The base data is taken from the example dataset provided in the course.
- Data contains information about 194673 accidents on 37 attributes including accident severity, location, collision type, environmental conditions etc.

	SEVERITYCODE	X	Y	OBJECTID	INCKEY	COLDETKEY	REPORTNO	STATUS	ADDRTYPE	INTKEY	...	ROADCOND	LIGHTCOND	PEDROWNOTGRNT	SDOTCOLNUM
0	2	-122.323148	47.703140	1	1307	1307	3502005	Matched	Intersection	37475.0	...	Wet	Daylight	NaN	NaN
1	1	-122.347294	47.647172	2	52200	52200	2607959	Matched	Block	NaN	...	Wet	Dark - Street Lights On	NaN	6354039.0
2	1	-122.334540	47.607871	3	26700	26700	1482393	Matched	Block	NaN	...	Dry	Daylight	NaN	4323031.0
3	1	-122.334803	47.604803	4	1144	1144	3503937	Matched	Block	NaN	...	Dry	Daylight	NaN	NaN
4	2	-122.306426	47.545739	5	17700	17700	1807429	Matched	Intersection	34387.0	...	Wet	Daylight	NaN	4028032.0

Feature Selection

Based on primary understanding of the data available, following variables were selected as explanatory variables:

1. 'ADDRTYPE': A catagorical variable representing the type of location where incident took place. It may take the values of 'Intersection', 'Block' etc.
2. 'COLLISIONTYPE': A categorical variable indicating the type of collision such as head-on, angle etc.
3. 'PERSONCOUNT': An integer representing number of persons involved in the collision.
4. 'PEDCOUNT': An integer representing number of pedestrians involved in the collision.
5. 'PEDCYLCOUNT': An integer representing the number of bicycles involved in the collision.
6. 'VEHCOUNT': An integer representing the number of vehicles involved in the collision.
7. 'WEATHER': A categorical variable describing whether the weather was cloudy or rainy etc. at the time of collision
8. 'ROADCOND': A categorical variable describing condition of the road i.e. dry or wet
9. 'LIGHTCOND': A categorical variable describing the lighting condition at the time of collision.

Feature Selection

The sample data after selecting the features:

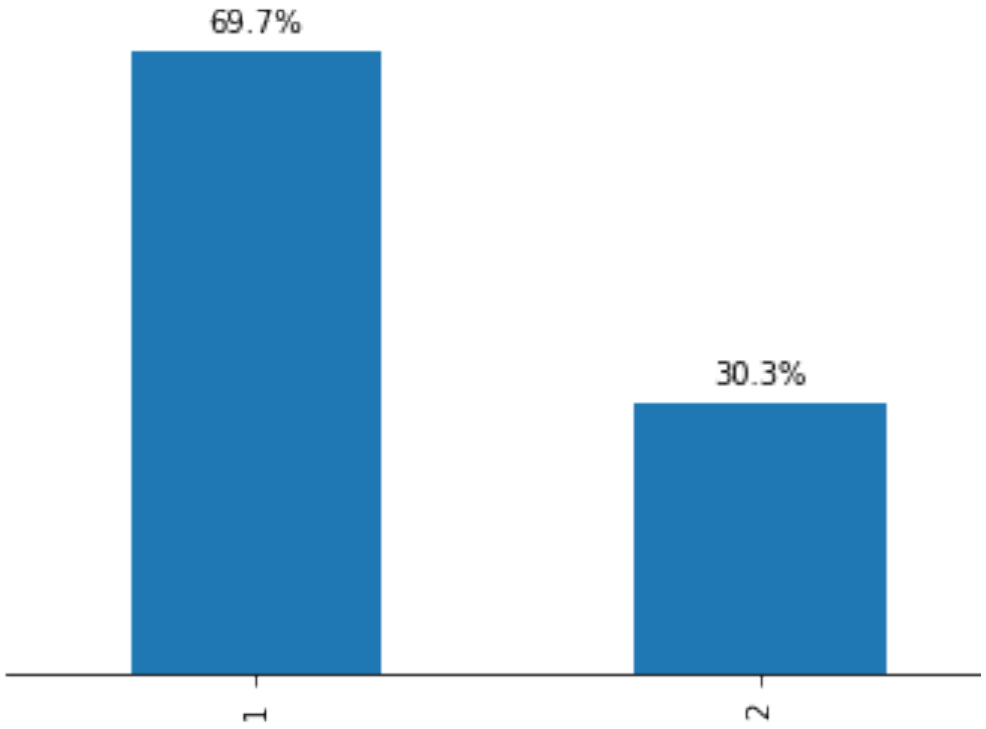
	SEVERITYCODE	ADDRTYPE	COLLISIONTYPE	PERSONCOUNT	PEDCOUNT	PEDCYLCOUNT	VEHCOUNT	WEATHER	ROADCOND	LIGHTCOND
0	2	Intersection	Angles	2	0	0	2	Overcast	Wet	Daylight
1	1	Block	Sideswipe	2	0	0	2	Raining	Wet	Dark - Street Lights On
2	1	Block	Parked Car	4	0	0	3	Overcast	Dry	Daylight
3	1	Block	Other	3	0	0	3	Clear	Dry	Daylight
4	2	Intersection	Angles	2	0	0	2	Raining	Wet	Daylight

Exploratory data analysis

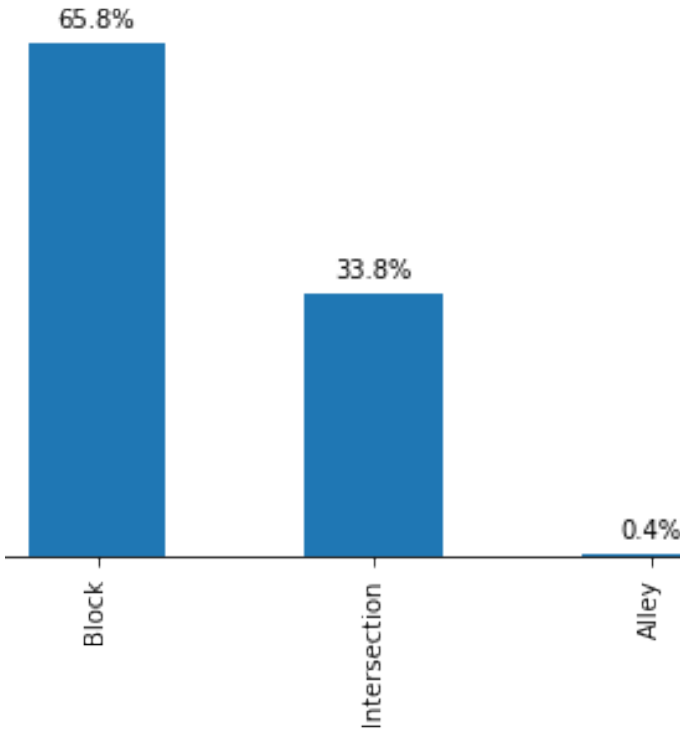
Distribution of Accident Severity

- As is evident from the bar chart, 69.7% of all accidents have been of severity 1 i.e. only property damage whereas remaining 30.3% accidents resulted in some human injury as well.

This is on expected lines as we expect more accidents of less severity.



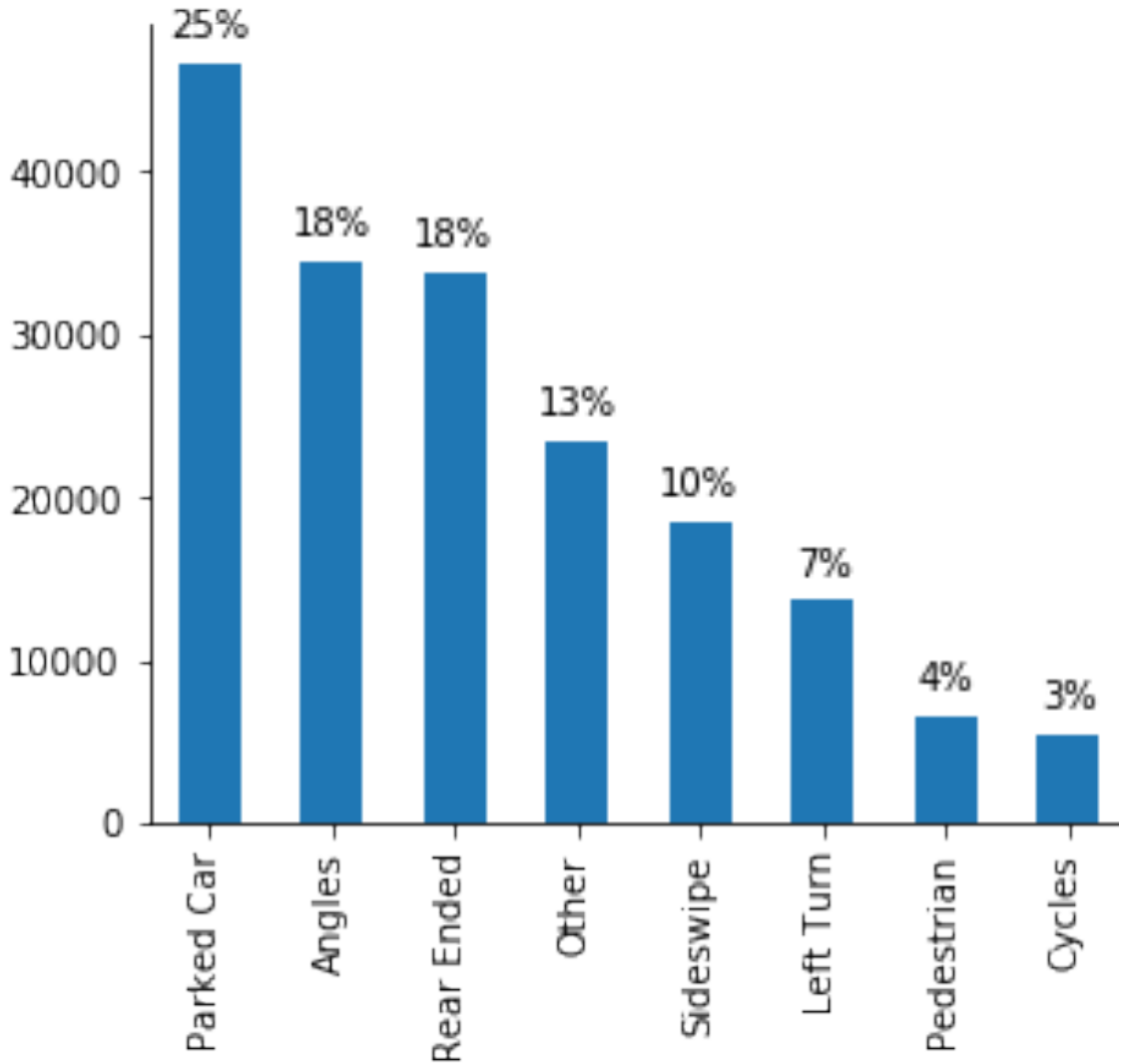
Location of Accidents



About two third of all accidents took place in blocks whereas about one third took place at intersections. Alleys, understandably, contributed negligible proportion of accidents.

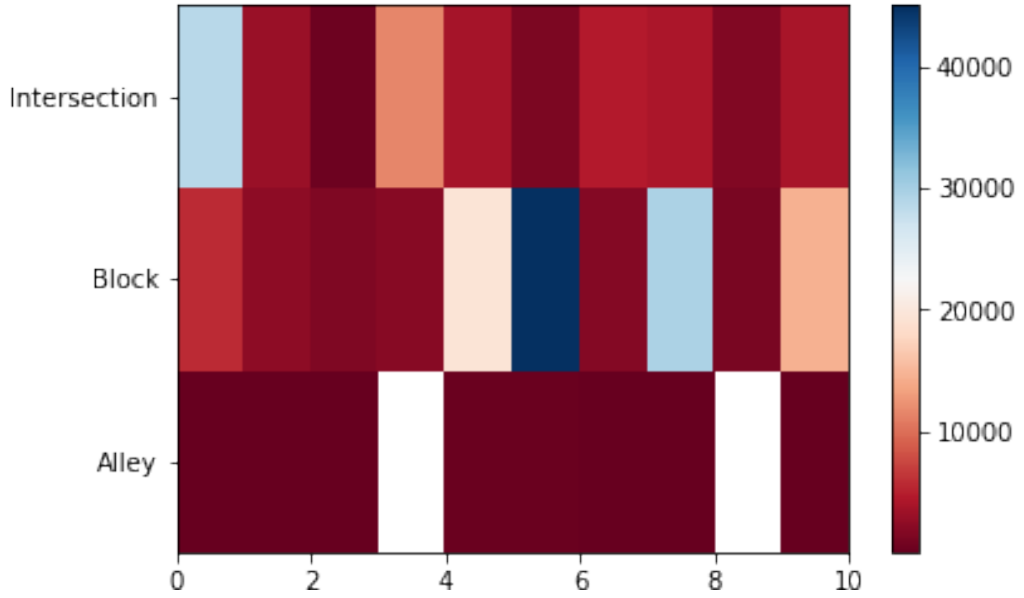
Distribution of Accidents by Collision Type

- A quarter of all accidents involved a parked car. It is likely that these incidents are mostly happening in blocks rather than intersection. This may be one plausible reason why blocks have more accidents than intersections.
- This also provides an interesting policy question to address and regulate the parking in blocks to avoid these accidents.
- 'Angles', 'Rear Ended' and 'Sideswipe' are other prominent types of accidents.



Location of Accident & Collision Type

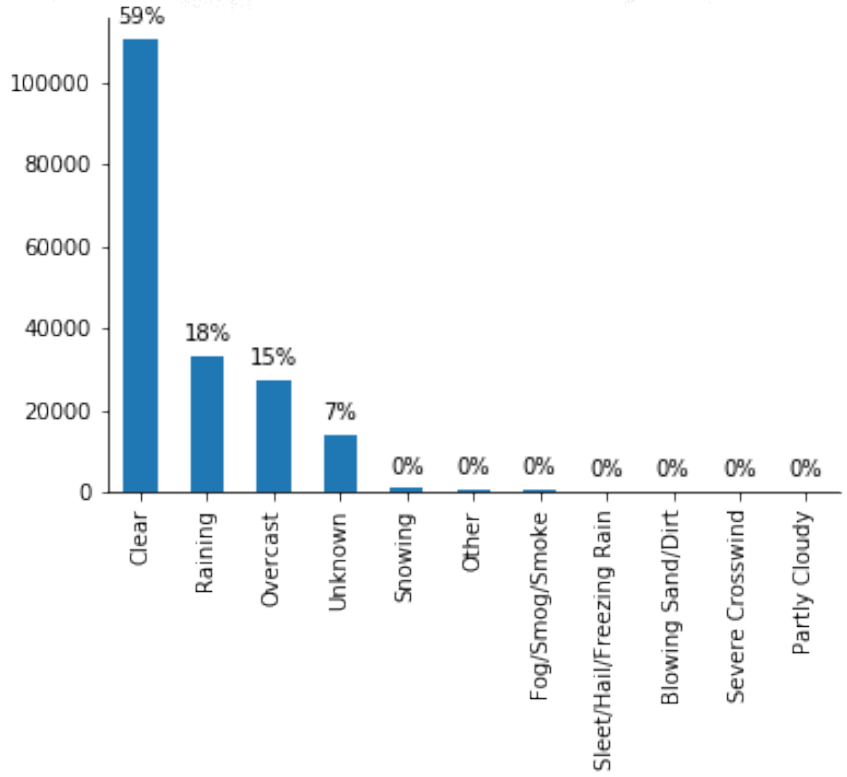
- parked car contributes a significant proportion of accidents reported in blocks.
- It is followed by the 'angle collision at intersections', 'sideswipe collision in blocks' and 'left turn collision at intersections’
- If these four issues could be addressed systematically, about 60% of the accidents can be avoided.



Weather & Accident Severity

- 59% of the accidents took place on clear days, 18% on rainy days and 15% on overcast days.
- On clear, rainy as well as overcast days, the ratio of severity 1 and severity 2 accidents appear to be similar indicating that the weather may not have significant effect on severity of the accidents.

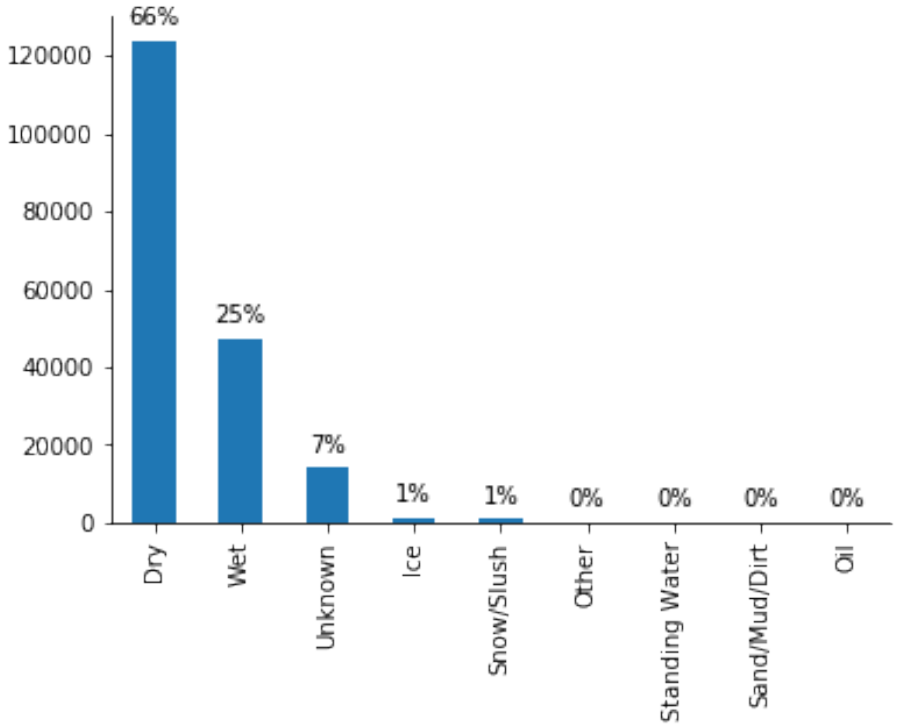
SEVERITYCODE	1	2
WEATHER		
Blowing Sand/Dirt	36	13
Clear	74775	35718
Fog/Smog/Smoke	377	186
Other	676	114
Overcast	18834	8711
Partly Cloudy	2	3
Raining	21835	11134
Severe Crosswind	18	7
Sleet/Hail/Freezing Rain	85	27
Snowing	729	167
Unknown	13267	790



Road Condition & Accident Severity

The proportion of wet among severity 2 accidents is slightly higher than the proportion of wet among all accidents. This may indicate a role of wet roads in increasing the severity of the accident which can be further evaluated using machine learning models.

SEVERITYCODE	1	2
ROADCOND		
Dry	83832	39898
Ice	923	269
Oil	40	24
Other	82	42
Sand/Mud/Dirt	51	22
Snow/Slush	827	165
Standing Water	82	29
Unknown	13276	729
Wet	31521	15692

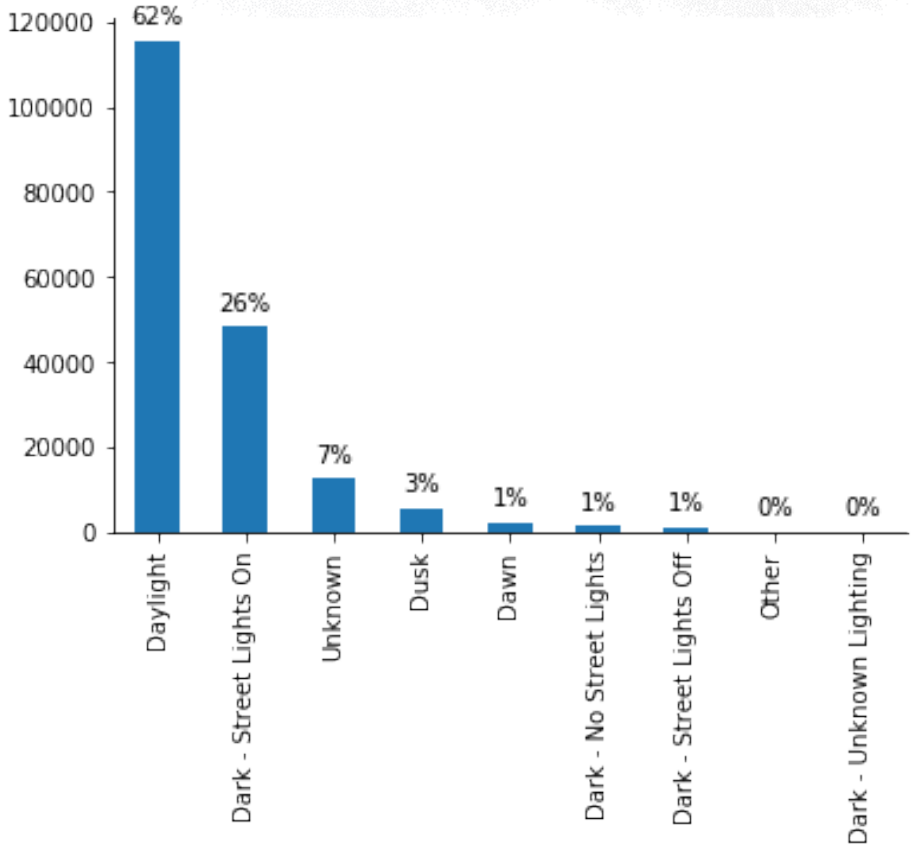


Light Condition & Accident Severity

Lights do not seem to be a problem as most of the accidents occurred in daylight or with street lights on.

The data does not point to any obvious relation between light condition and accident severity.

SEVERITYCODE	1	2
LIGHTCOND		
Dark - No Street Lights	1191	334
Dark - Street Lights Off	869	315
Dark - Street Lights On	33816	14417
Dark - Unknown Lighting	7	4
Dawn	1667	823
Daylight	76995	38400
Dusk	3906	1936
Other	175	52
Unknown	12008	589



Methodology

- To explore the predictability of accident severity based on the selected explanatory variables, we will train a classifier model on the data.
- We will follow the following steps to arrive at a classifier model:
  - First of all, we will create the dummy variables for the categorical variables.
  - Next, we will split the available dataset into training, cross-validation and test data sets. Training data will be used to train the models, cross validation data will be used to fine-tune the model by adjusting certain parameters, and the test data will be used to evaluate the performance of the models.
  - We will fit logistic regression model to the data and evaluate the accuracy.

Results

	Predictors	Coefficient
0	PERSONCOUNT	0.196347
1	PEDCOUNT	0.503117
2	PEDCYLCOUNT	0.557418
3	VEHCOUNT	0.177225
4	Block	0.384537
5	Intersection	0.464946
6	Angles	0.069204
7	Cycles	-0.034651
8	Head On	0.049831
9	Left Turn	0.044486
10	Parked Car	-0.807155
11	Pedestrian	0.139716
12	Rear Ended	0.153727
13	Right Turn	-0.084374
14	Sideswipe	-0.337537
15	Blowing Sand/Dirt	0.002608
16	Clear	0.172218
17	Fog/Smog/Smoke	0.017697
18	Overcast	0.105056
19	Partly Cloudy	0.014706
20	Raining	0.104690
21	Severe Crosswind	0.002489
22	Sleet/Hail/Freezing Rain	-0.011673
23	Snowing	0.015935
24	Dry	0.303440
25	Ice	0.042644
26	Oil	0.024158
27	Sand/Mud/Dirt	0.019980
28	Snow/Slush	0.020552
29	Standing Water	0.012825
30	Wet	0.276915
31	Dark - No Street Lights	0.038395
32	Dark - Street Lights Off	0.047863
33	Dark - Street Lights On	0.264161
34	Dark - Unknown Lighting	-0.002439
35	Dawn	0.073487
36	Daylight	0.289292
37	Dusk	0.114966

Discussions

- 'Parked car accidents' and 'Sideswipe accidents' have strong correlation with severity 1 accidents.
- The count of persons, pedestrians, cycles, and vehicles involved in accidents are all positively correlated with the severity 2 accidents
- accidents involving pedestrians and cyclists are more likely to be severity 2 accident than the accidents involving vehicles.
- 'Overcast' and 'raining' weather conditions contribute to severity 2 accidents. Positive coefficient for 'wet' road condition further validates this point.
- Among light conditions, 'Daylight' and 'Street Lights on' have highest positive coefficients, indicating that bad light had no significant impact in increasing the severity of the accident.

Conclusion

- The model provides significant insights into the factors that determined the severity of accidents. The insights also provide inputs for the policy-makers to avoid high severity accidents.
- However, data on more factors and data about higher severity accidents would provide more insights.