Aim

1. This notebook is aimed towards doing bi-variate and multivariate analysis
2. as number of combinations for bi-variate analysis are high selecting a few variables to do bi-variate analysis on

In [1]:
```
import os

import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import seaborn as sns
```

In [2]:
```
DATA_ROOT = "../data"
```

In [3]:
```
df = pd.read_csv(f"{DATA_ROOT}/eda/clean-data.csv")
df.head(2)
```

Out[3]:

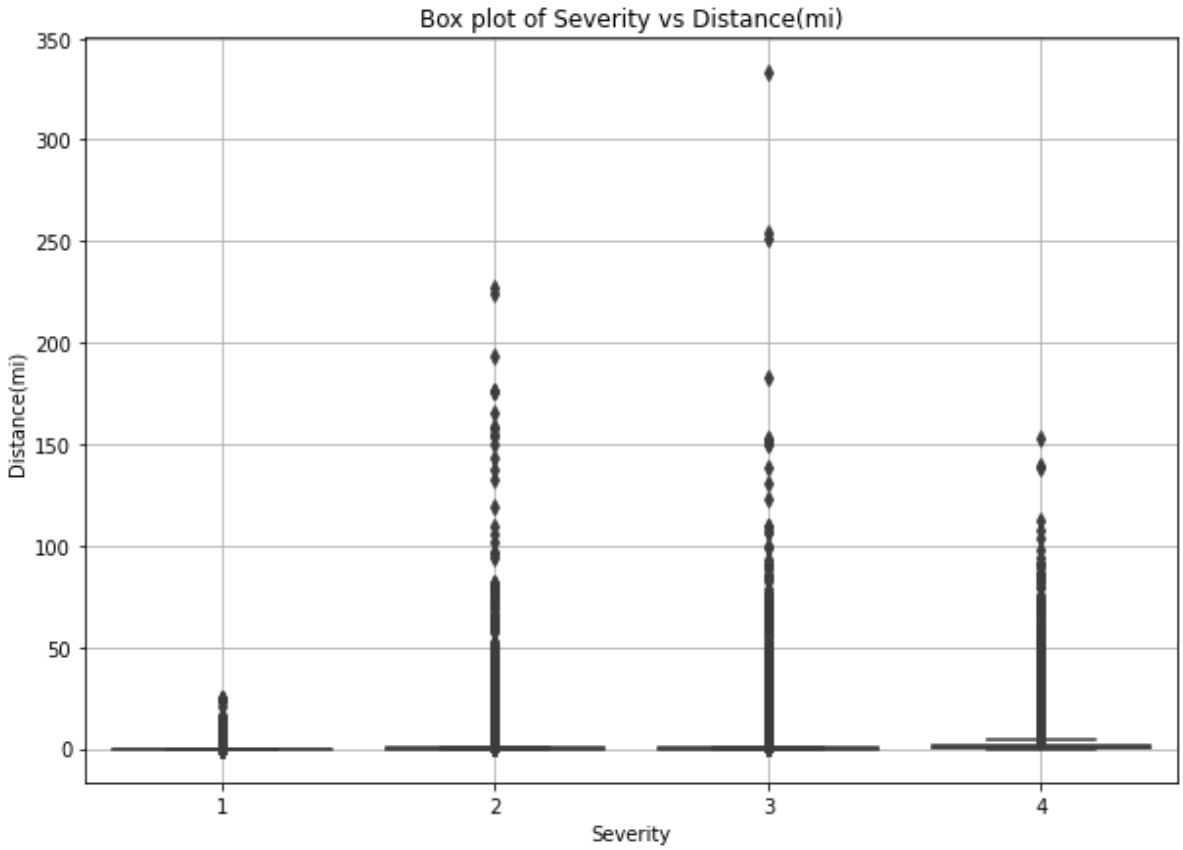
	ID	Source	TMC	Severity	Start_Time	End_Time	Start_Lat	Start_Lng	Distance(m
0	A-1	MapQuest	201.0	3	2016-02-08 05:46:00	2016-02-08 11:00:00	39.865147	-84.058723	0.
1	A-2	MapQuest	201.0	2	2016-02-08 06:07:59	2016-02-08 06:37:59	39.928059	-82.831184	0.

2 rows × 45 columns

Bivariate analysis

Severity - Distance(mi)

In [20]:
```
_ = df[["Distance(mi)", "Severity"]]

plt.figure(figsize=[10, 7])
plt.title("Box plot of Severity vs Distance(mi)")
sns.boxplot(x="Severity", y="Distance(mi)", data=_)
plt.grid()
plt.show()
```



1. Distance of road affected by different severities of accidents show long tailed distribution
2. We can see that accidents of severity 3 have the longest tail

Severity - Side

In [10]:
```
df["Side"].value_counts().reset_index()
```

Out[10]:

	index	Side
0	R	2879797
1	L	633819
2		1

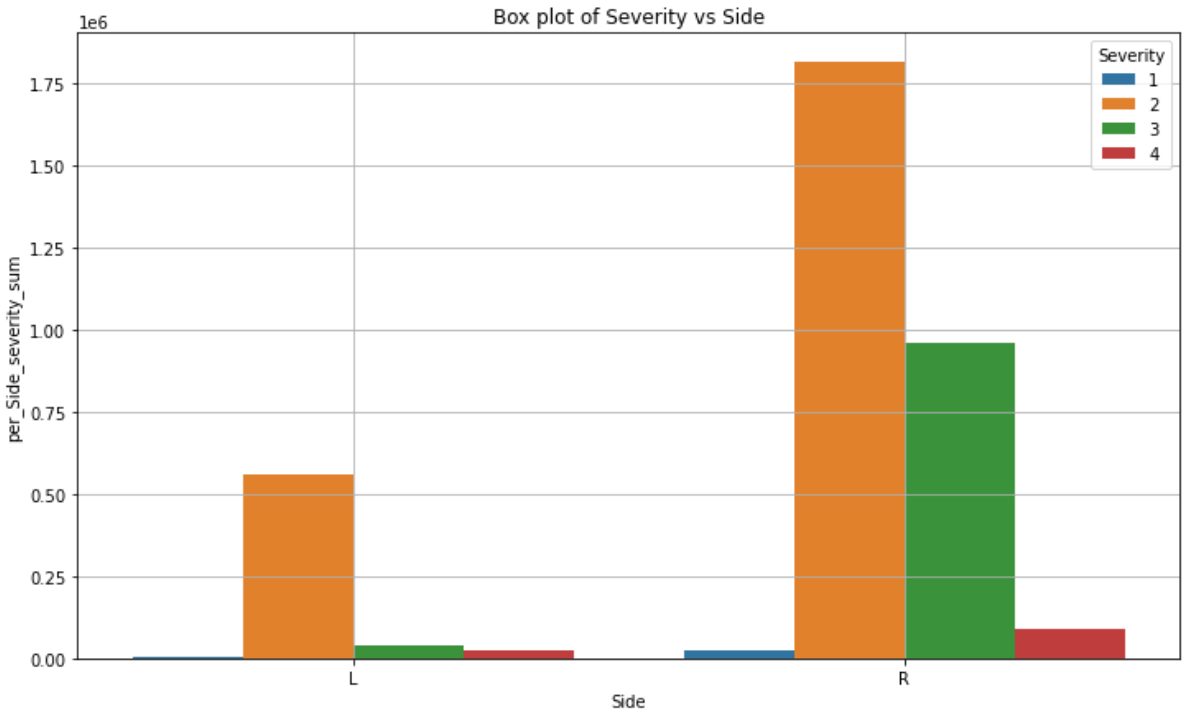
In [31]:
```
pd.options.mode.chained_assignment = None
ix = df[df["Side"] == " "].index

# filling with mode (as only one value is empty)
df.loc[ix, "Side"] = "R"
```

In [32]:
```
df_temp = df[["Side", "Severity"]]
df_temp["per_Side_severity_sum"] = 1
df_temp = df_temp.groupby(["Side", "Severity"], as_index=False).sum()
df_temp
```

Out[32]:

	Side	Severity	per_Side_severity_sum
0	L	1	6252
1	L	2	561020
2	L	3	41486
3	L	4	25061
4	R	1	22922
5	R	2	1812190
6	R	3	957427
7	R	4	87259

In [33]:
```
plt.figure(figsize=[12, 7])
plt.title("Box plot of Severity vs Side")
sns.barplot(
    y="per_Side_severity_sum", x="Side", data=df_temp, hue="Severity",
)
plt.grid()
plt.show()
```



Severity - City

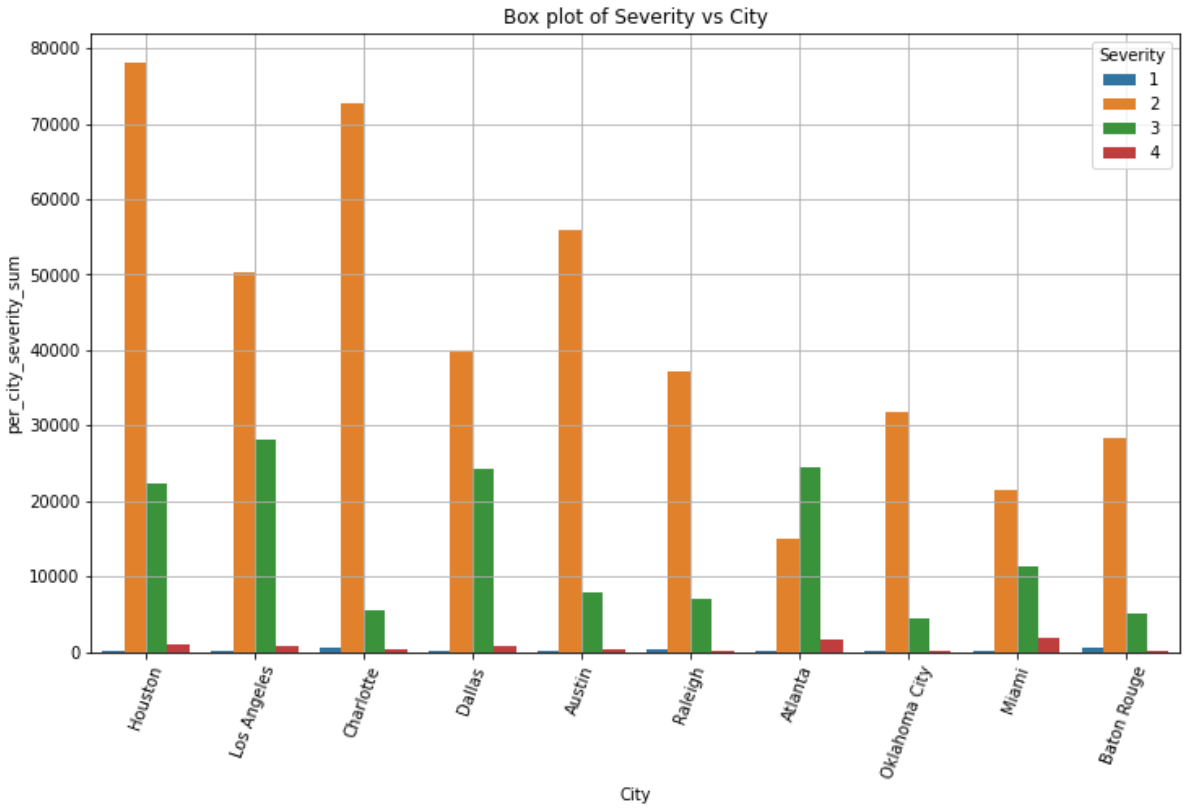
In [53]:
```
topk = 10
df_temp = df[["Severity", "City"]]
topk_cities = df_temp["City"].value_counts().head(topk).reset_index()["index
df_temp = df_temp[df_temp["City"].isin(topk_cities)]

df_temp["per_city_severity_sum"] = 1

df_temp = df_temp.groupby(["City", "Severity"], as_index=False).sum()
df_temp.head()
```

Out[53]:

	City	Severity	per_city_severity_sum
0	Atlanta	1	121
1	Atlanta	2	14950
2	Atlanta	3	24422
3	Atlanta	4	1633
4	Austin	1	17

In [54]:

```
plt.figure(figsize=[12, 7])
plt.title("Box plot of Severity vs City")
sns.barplot(
    y="per_city_severity_sum", x="City", data=df_temp, hue="Severity", order
)
plt.grid()
plt.xticks(rotation=70)
plt.show()
```



1. In top 10 cities Houston has maximum numbers of Severity 2 accidents
2. Severity 4 accidents are comparitively lower in these top 10 cities as compared to other severities

Severity - State

In [81]:

```
topk = 10
df_temp = df[["Severity", "State"]]
topk_states = df_temp["State"].value_counts().head(topk).reset_index()["inde
df_temp = df_temp[df_temp["State"].isin(topk_cities)]

df_temp["per_state_severity_sum"] = 1
```

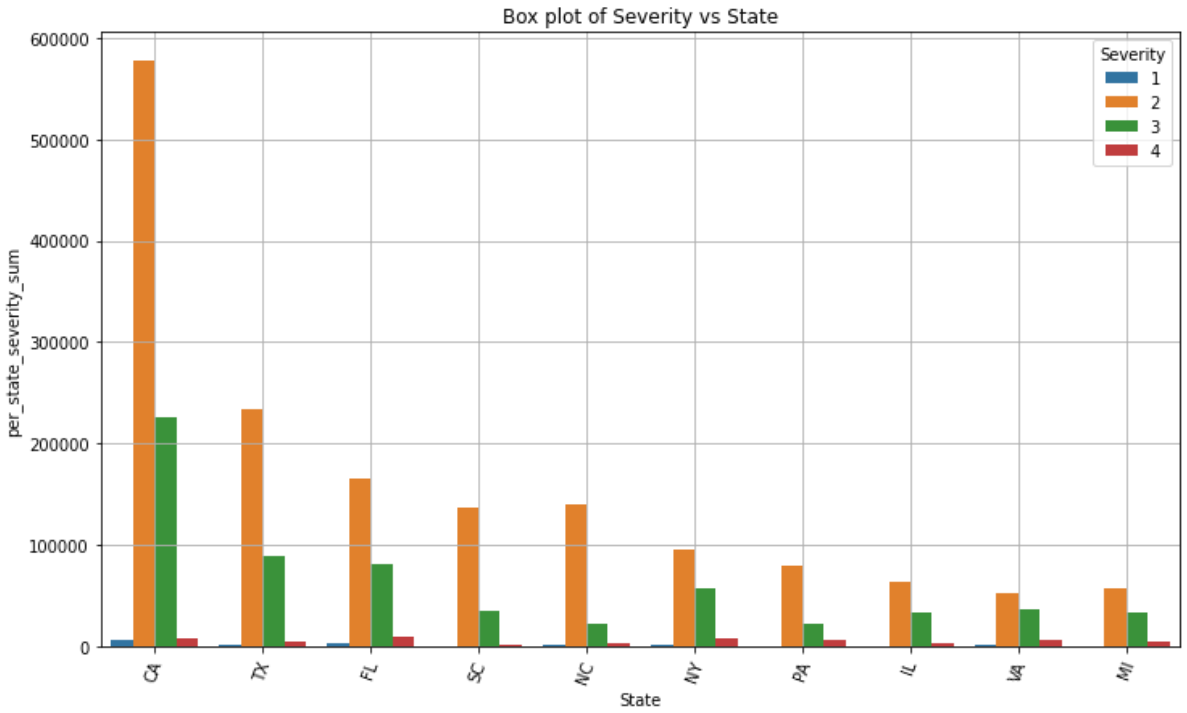
```
df_temp = df_temp.groupby(["State", "Severity"], as_index=False).sum()
df_temp.head()
```

Out[81]:

	State	Severity	per_state_severity_sum
0	CA	1	5801
1	CA	2	576742
2	CA	3	225820
3	CA	4	8462
4	FL	1	3014

In [82]:

```
plt.figure(figsize=[12, 7])
plt.title("Box plot of Severity vs State")
sns.barplot(
    y="per_state_severity_sum",
    x="State",
    data=df_temp,
    hue="Severity",
    order=topk_states,
)
plt.grid()
plt.xticks(rotation=70)
plt.show()
```



1. California has highest number of severity 2 accidents
2. Severity 2 cases are high in top 10 states of most occuring accidents
3. Severity 3 and 4 accidents are comparitively lower in these top 10 states

Severity - Temperature

In [71]:

```
pd.options.mode.chained_assignment = None  # default='warn'
df_temp = df[["Temperature(F)", "Severity"]]
df_temp["Temperature(C)"] = (df_temp["Temperature(F)"] - 32) / 1.8
df_temp
```

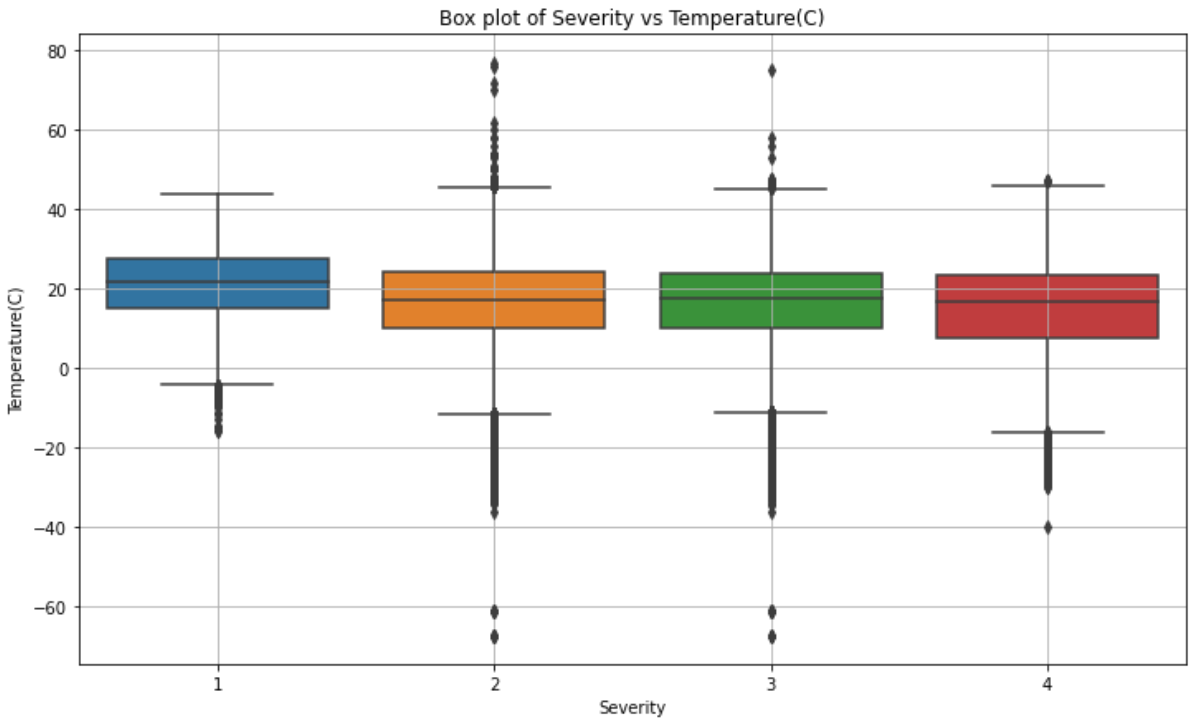
Out[71]:

	Temperature(F)	Severity	Temperature(C)
0	36.9	3	2.722222
1	37.9	2	3.277778
2	36.0	2	2.222222
3	35.1	3	1.722222
4	36.0	2	2.222222
...	...	...	...
3513612	86.0	2	30.000000
3513613	70.0	2	21.111111
3513614	73.0	2	22.777778
3513615	71.0	2	21.666667
3513616	79.0	2	26.111111

3513617 rows × 3 columns

In [72]:

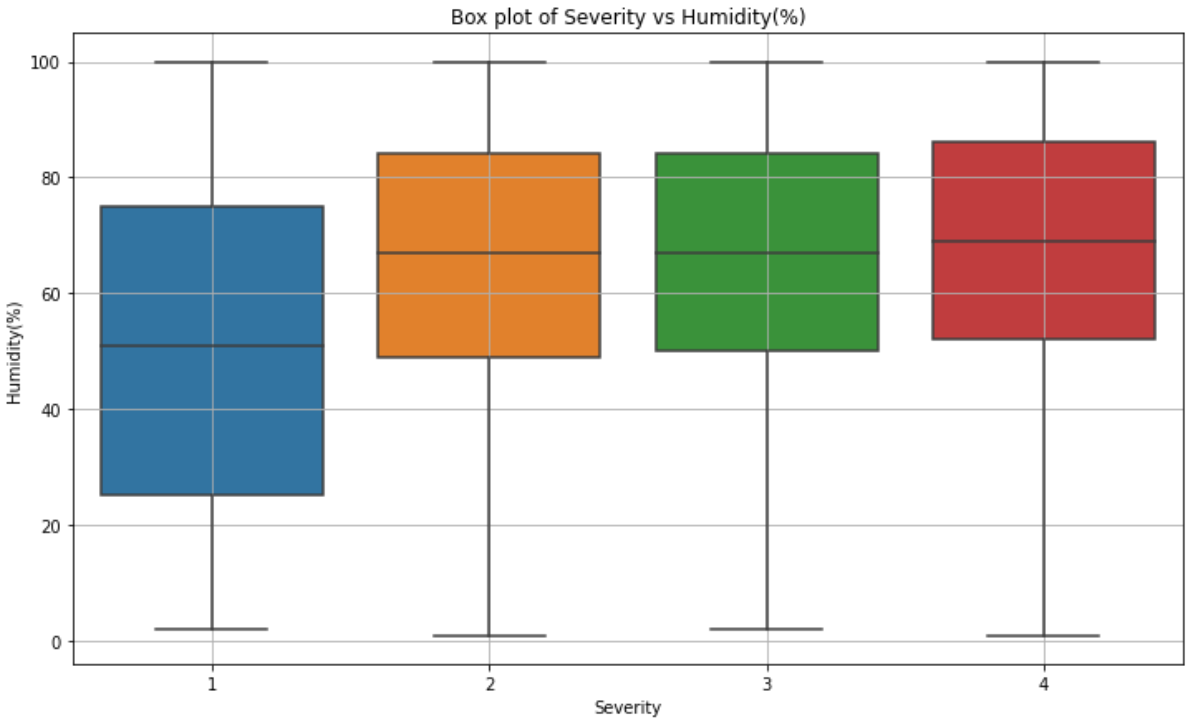
```
plt.figure(figsize=[12, 7])
plt.title("Box plot of Severity vs Temperature(C)")
sns.boxplot(
    y="Temperature(C)", x="Severity", data=df_temp,
)
plt.grid()
plt.show()
```



1. IQR of temperatures across all severities is more or less similar
2. Tails of box plots of severity 2 and 3 seem longer than others

Severity - Humidity

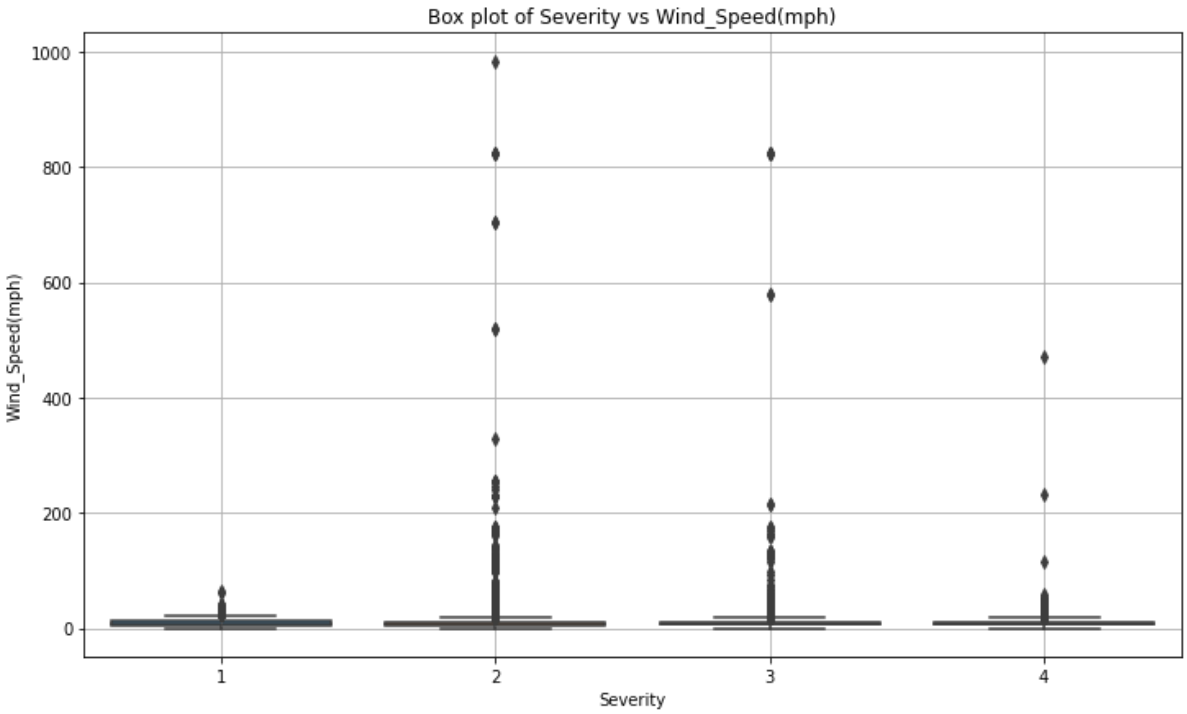
In [74]:
```
df_temp = df[["Humidity(%)", "Severity"]]

plt.figure(figsize=[12, 7])
plt.title("Box plot of Severity vs Humidity(%)")
sns.boxplot(
    y="Humidity(%)", x="Severity", data=df_temp,
)
plt.grid()
plt.show()
```



1. accidents with severity 1 are seen in between humidity percentage of ≈25-75
2. accidents with severity 2,3,4 are observed between humidity percentage of ≈50-80

Severity - Wind_Speed(mph)

In [76]:
```
df_temp = df[["Severity", "Wind_Speed(mph)"]]

plt.figure(figsize=[12, 7])
plt.title("Box plot of Severity vs Wind_Speed(mph)")
sns.boxplot(
    y="Wind_Speed(mph)", x="Severity", data=df_temp,
)
plt.grid()
plt.show()
```



1. IQR of wind speed for severity 1,2,3,4 are in very similar ranges
2. whereas long tails are observed for wind speed across severity 2,3

Severity - POI variables

In [96]:
```
def poi_charts(df, poi_var):
    # prepare data
    df_temp = df[[poi_var, "Severity"]]
    var = f"per_{poi_var}_severity_sum"
    df_temp[var] = 1
    df_temp = df_temp.groupby([poi_var, "Severity"], as_index=False).sum()
    display(df_temp)

    # plot
    plt.figure(figsize=[8, 5])

    plt.title(f"Box plot of Severity vs {i}")
    sns.barplot(
        y=var, x=poi_var, data=df_temp, hue="Severity", order=[True, False],
    )
    plt.grid()
    plt.show()
```

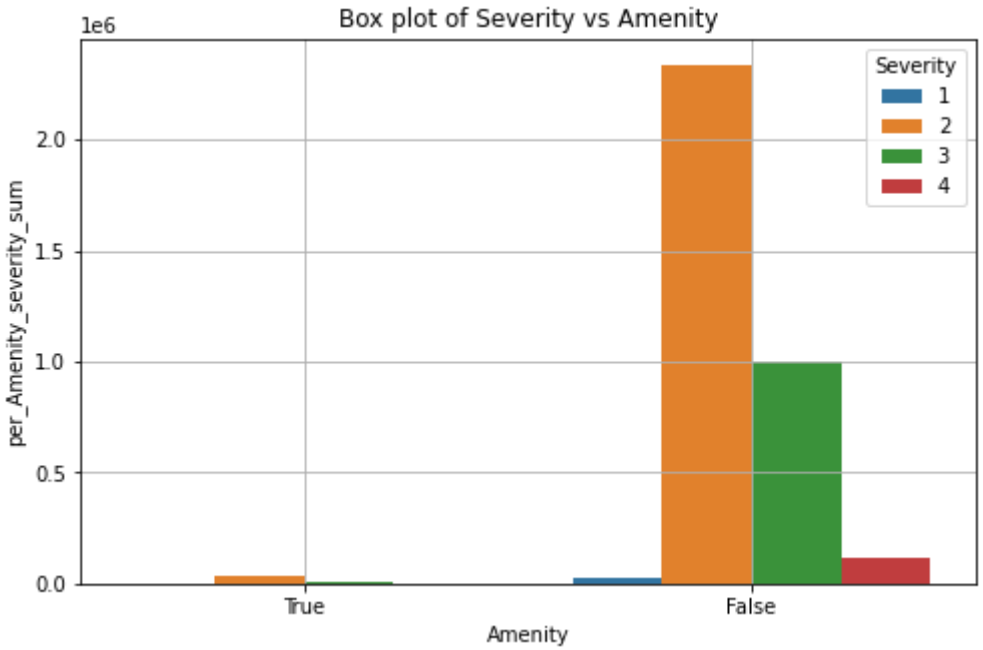
In [109…
```
poi_list = [
    "Amenity",
    "Bump",
    "Crossing",
    "Give_Way",
    "Junction",
    "No_Exit",
    "Railway",
    "Roundabout",
    "Station",
    "Stop",
    "Traffic_Calming",
    "Traffic_Signal",
```

```
    "Turning_Loop",
]
```

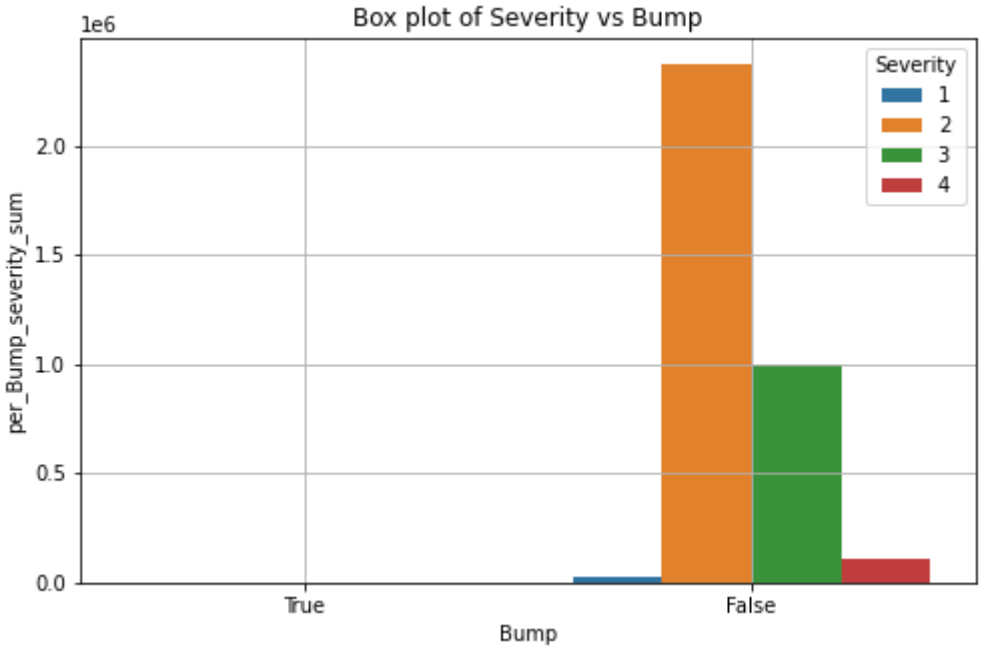
In [110…

```
for i in poi_list:
    poi_charts(df, i)
    print("\n\n")
```

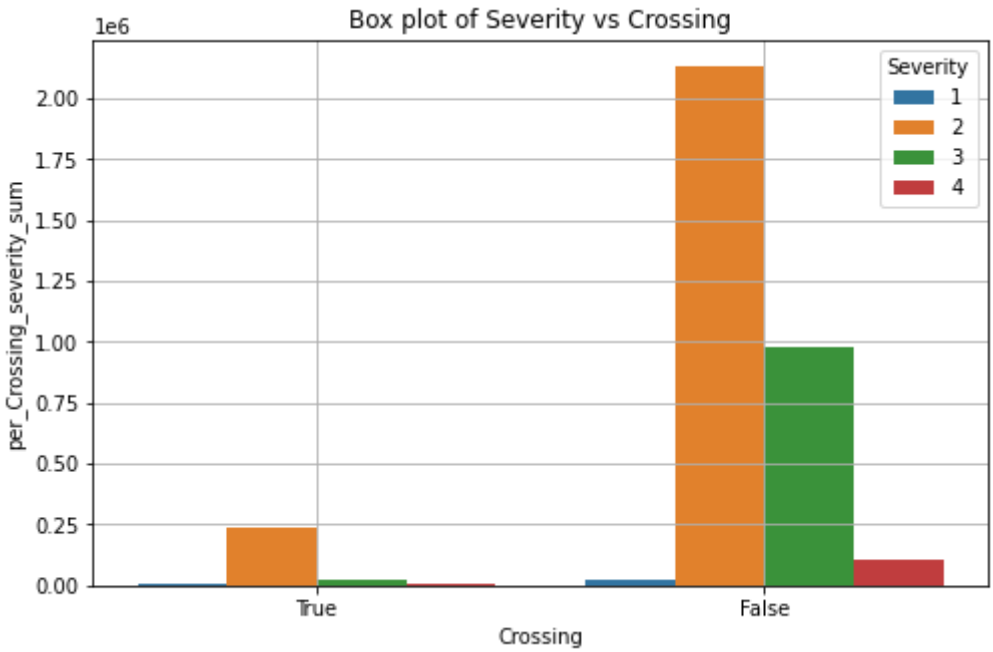
	Amenity	Severity	per_Amenity_severity_sum
0	False	1	28682
1	False	2	2335907
2	False	3	995745
3	False	4	111201
4	True	1	492
5	True	2	37303
6	True	3	3168
7	True	4	1119



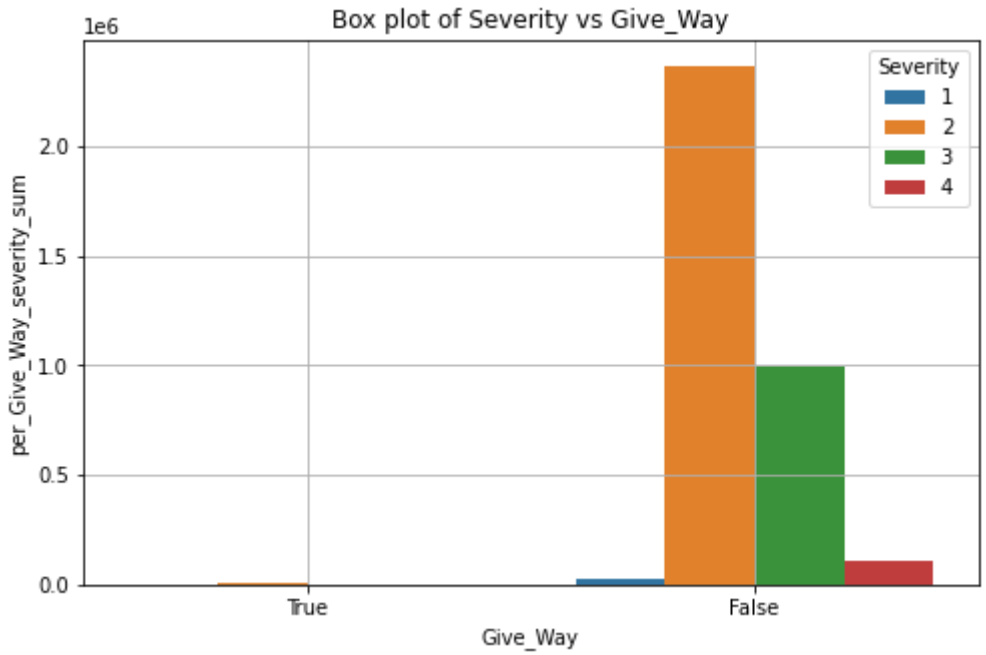
	Bump	Severity	per_Bump_severity_sum
0	False	1	29164
1	False	2	2372704
2	False	3	998830
3	False	4	112313
4	True	1	10
5	True	2	506
6	True	3	83
7	True	4	7



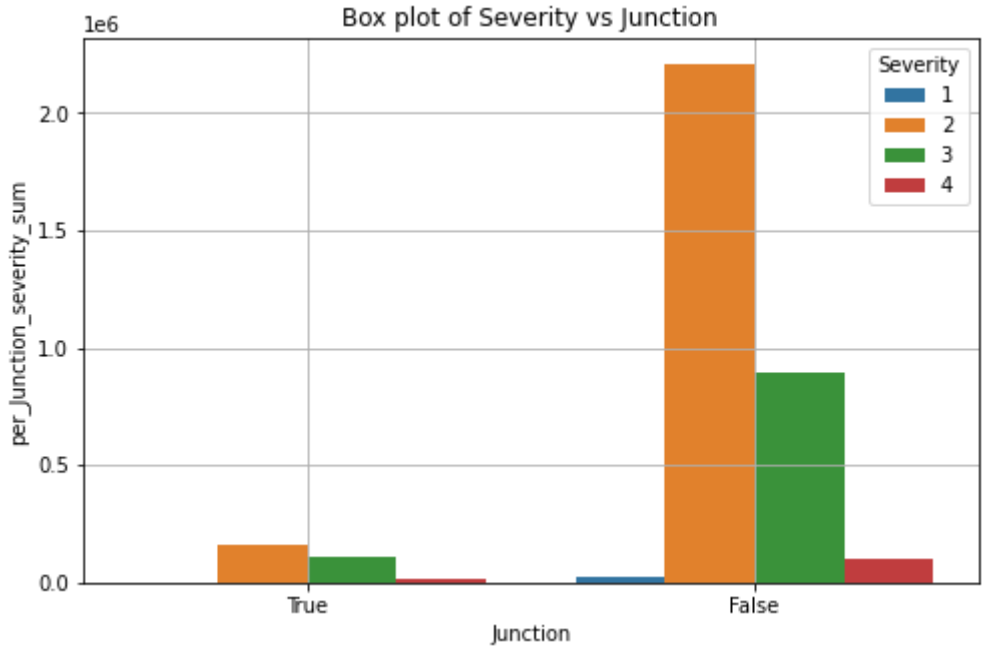
	Crossing	Severity	per_Crossing_severity_sum
0	False	1	20250
1	False	2	2132468
2	False	3	979387
3	False	4	106986
4	True	1	8924
5	True	2	240742
6	True	3	19526
7	True	4	5334



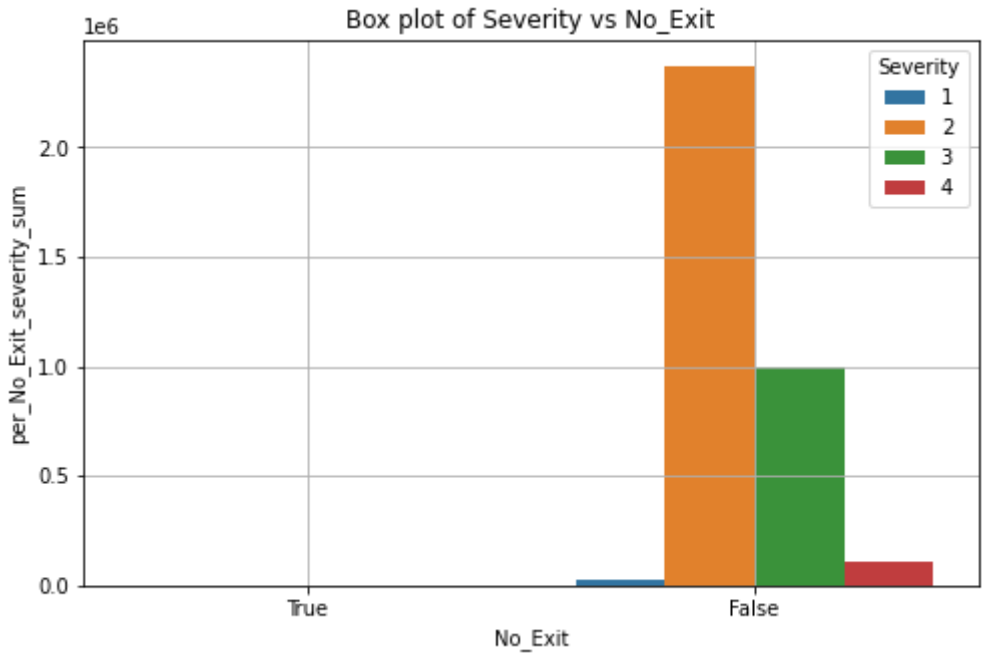
	Give_Way	Severity	per_Give_Way_severity_sum
0	False	1	29101
1	False	2	2365889
2	False	3	997114
3	False	4	111949
4	True	1	73
5	True	2	7321
6	True	3	1799
7	True	4	371



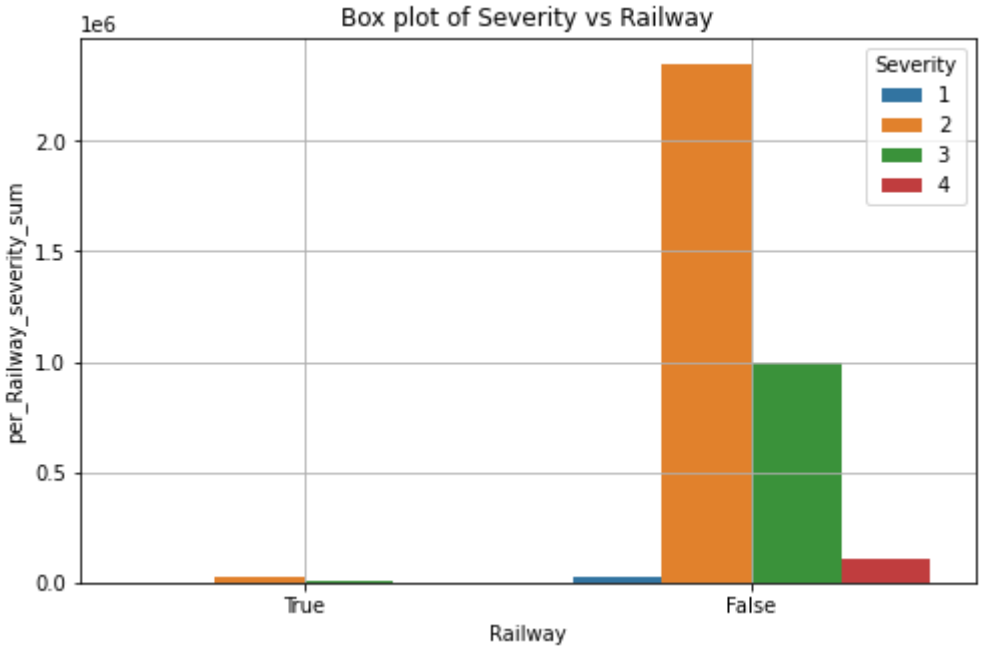
	Junction	Severity	per_Junction_severity_sum
0	False	1	26649
1	False	2	2209455
2	False	3	893591
3	False	4	99473
4	True	1	2525
5	True	2	163755
6	True	3	105322
7	True	4	12847



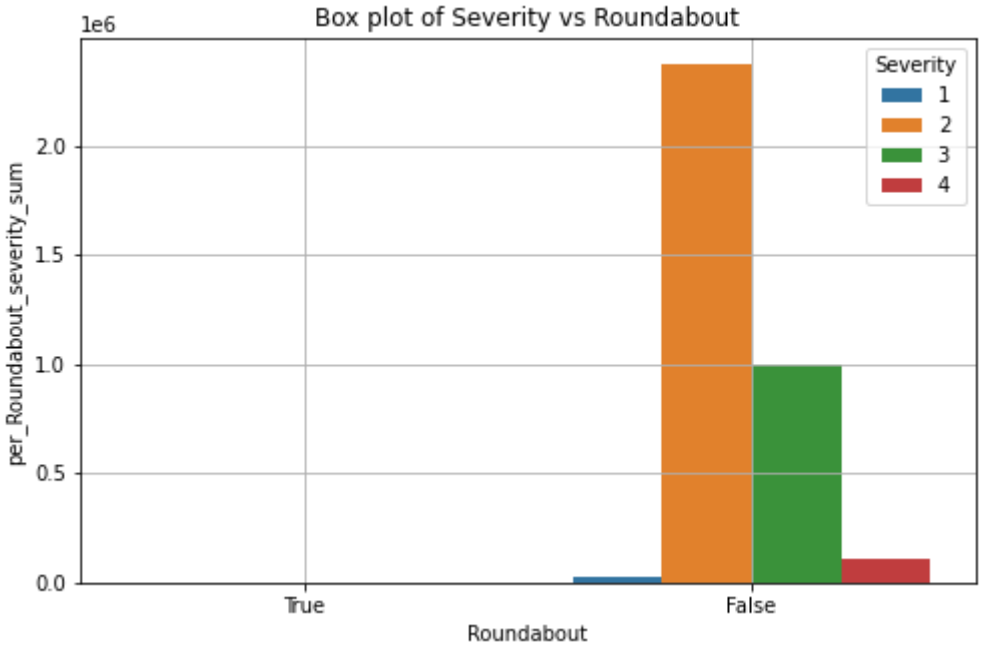
	No_Exit	Severity	per_No_Exit_severity_sum
0	False	1	29075
1	False	2	2369927
2	False	3	998039
3	False	4	112192
4	True	1	99
5	True	2	3283
6	True	3	874
7	True	4	128



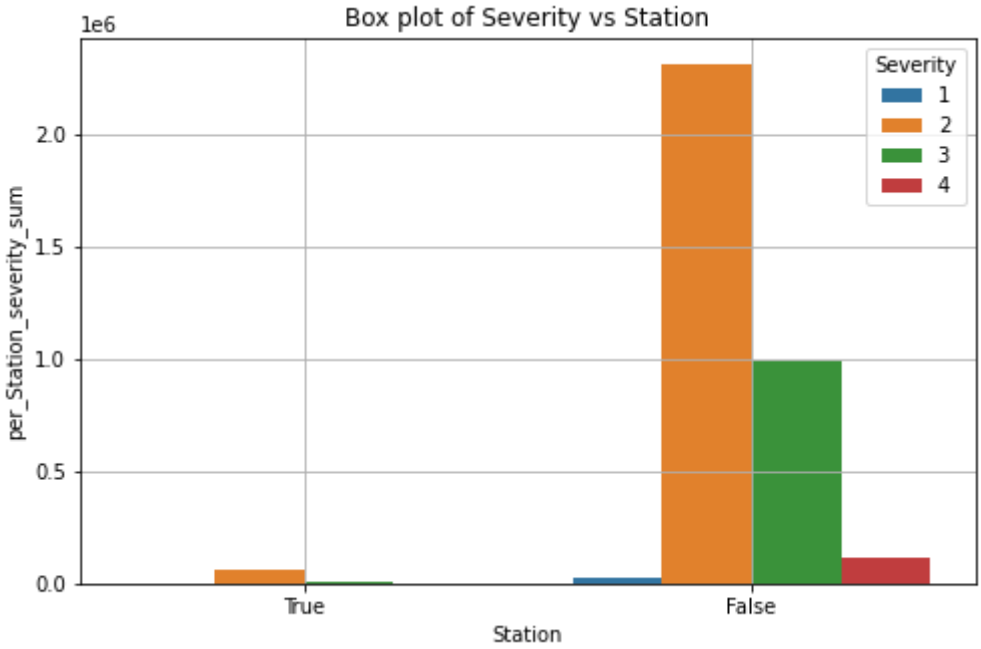
	Railway	Severity	per_Railway_severity_sum
0	False	1	28636
1	False	2	2348621
2	False	3	993678
3	False	4	111507
4	True	1	538
5	True	2	24589
6	True	3	5235
7	True	4	813



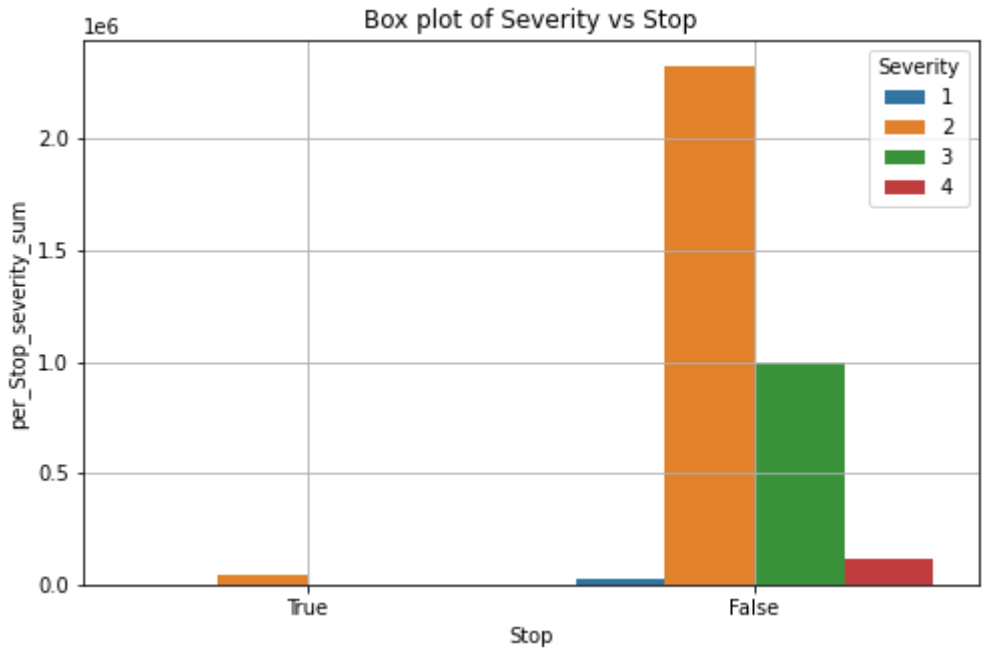
	Roundabout	Severity	per_Roundabout_severity_sum
0	False	1	29173
1	False	2	2373032
2	False	3	998911
3	False	4	112317
4	True	1	1
5	True	2	178
6	True	3	2
7	True	4	3



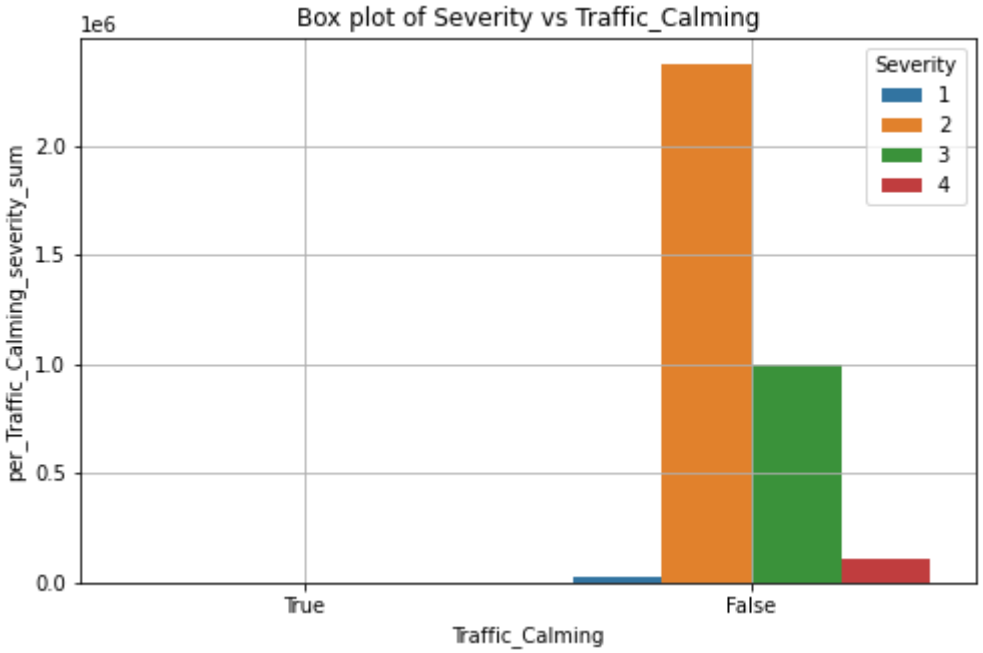
	Station	Severity	per_Station_severity_sum
0	False	1	28215
1	False	2	2314019
2	False	3	990321
3	False	4	110741
4	True	1	959
5	True	2	59191
6	True	3	8592
7	True	4	1579



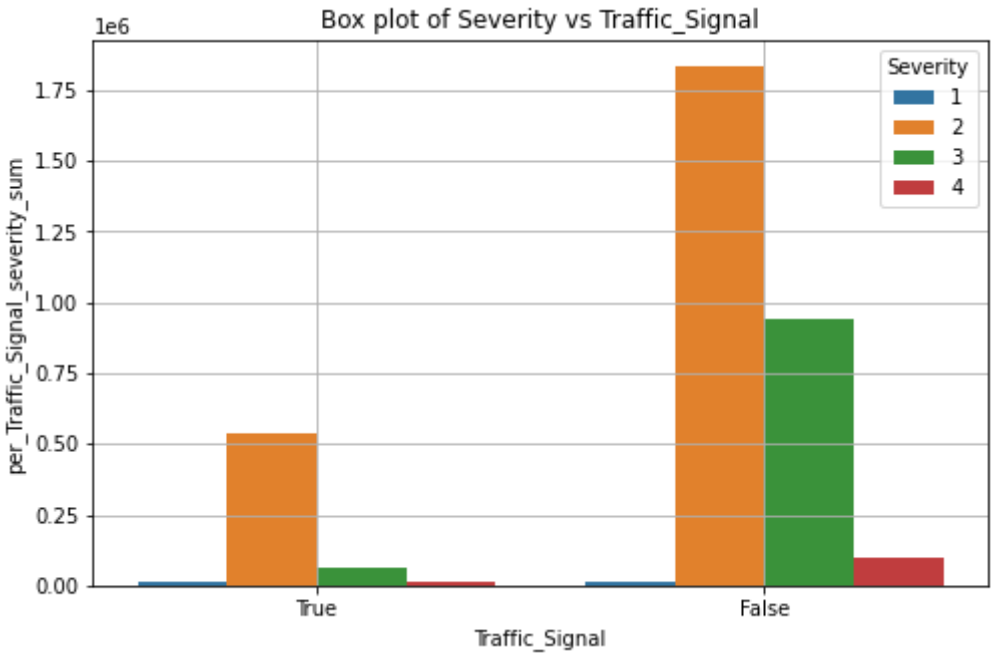
	Stop	Severity	per_Stop_severity_sum
0	False	1	28696
1	False	2	2325825
2	False	3	996302
3	False	4	110818
4	True	1	478
5	True	2	47385
6	True	3	2611
7	True	4	1502



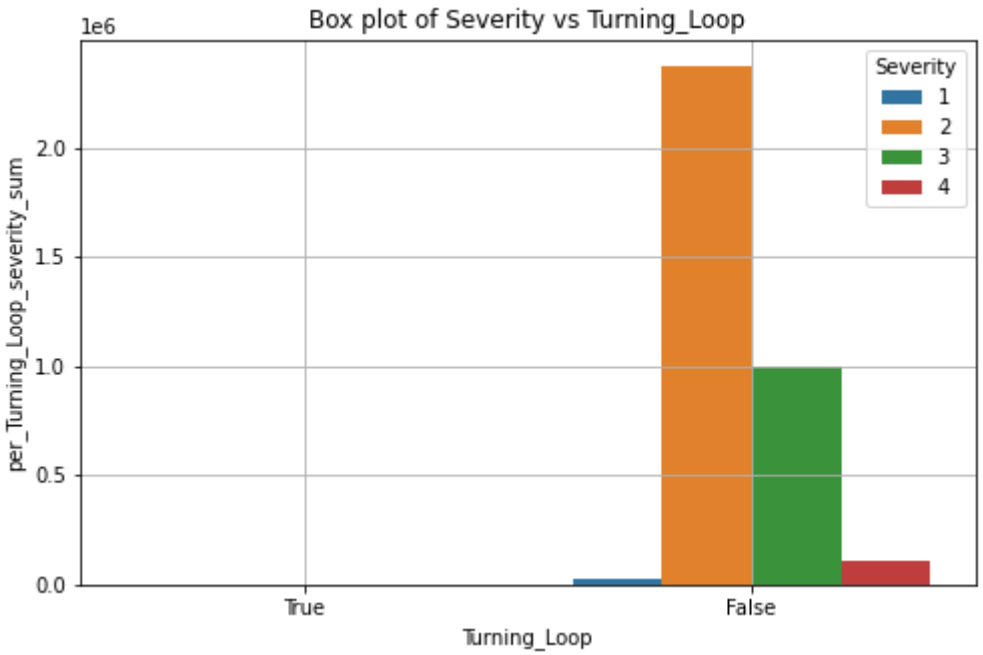
	Traffic_Calming	Severity	per_Traffic_Calming_severity_sum
0	False	1	29162
1	False	2	2372039
2	False	3	998730
3	False	4	112285
4	True	1	12
5	True	2	1171
6	True	3	183
7	True	4	35



	Traffic_Signal	Severity	per_Traffic_Signal_severity_sum
0	False	1	16717
1	False	2	1833400
2	False	3	938661
3	False	4	101216
4	True	1	12457
5	True	2	539810
6	True	3	60252
7	True	4	11104



	Turning_Loop	Severity	per_Turning_Loop_severity_sum
0	False	1	29174
1	False	2	2373210
2	False	3	998913
3	False	4	112320



Following observations can be made from severity - poi variables plots:

1. in most of the cases absence of POIs have more occurences of accidents of varying severity e.g:
   A. absence of traffic signal
   B. turning loop
   C. stop signs
2. in some of the cases even presence of POIs have some occurences of accidents of varying severity e.g:
   A. Traffic signal
   B. Crossing
   C. Junction
3. Accidents with severity 2 are most occuring accidents in all of the POIs

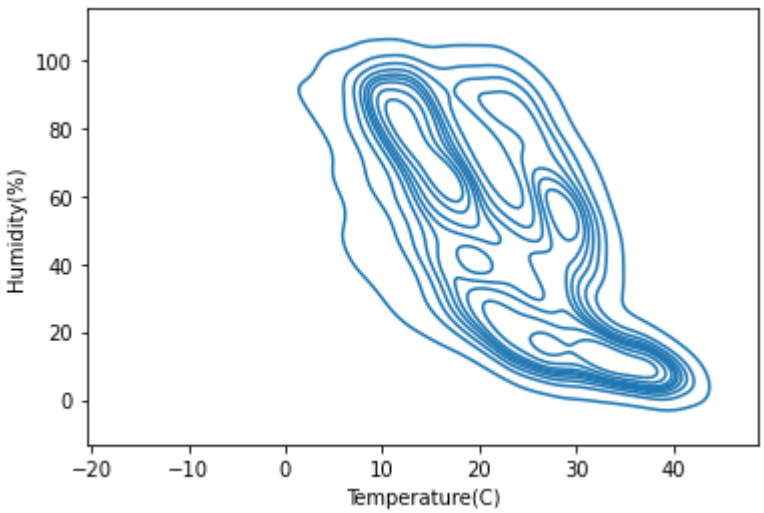
Multivariate analysis

Severity - Humidity - Temperature

In [115…
```
df_temp = df[["Severity", "Humidity(%)", "Temperature(F)"]]
df_temp["Temperature(C)"] = (df_temp["Temperature(F)"] - 32) / 1.8
```

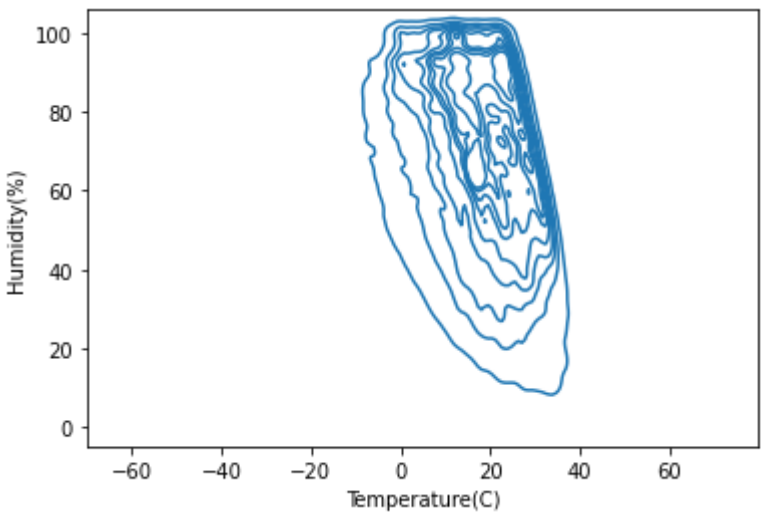
Contour plots of Humidity, Temperature with varying severity

In [120…
```
sns.kdeplot(
    data=df_temp[df_temp["Severity"] == 1], x="Temperature(C)", y="Humidity(
)
plt.show()
```



1. for severity of accidents 1
    - humidity % range between 0-20
    - and temperature(C) between 20-40
    - show high over lap
2. similar observation can be made for another fairly dense region
    - humidity % range between 60-90
    - and temperature(C) between 10-20
    - show high over lap

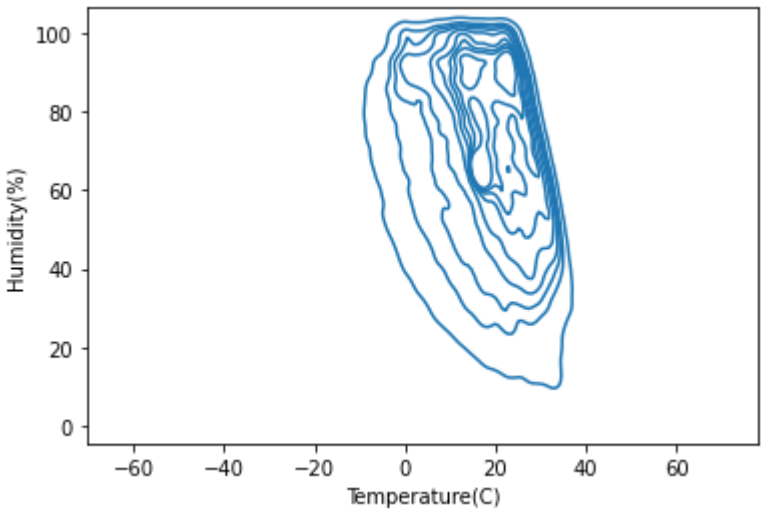
In [121…
```
sns.kdeplot(
    data=df_temp[df_temp["Severity"] == 2], x="Temperature(C)", y="Humidity(
)
plt.show()
```



1. for severity of accidents 2
    - humidity % range between 90-100
    - and temperature(C) between 0-30
    - show high over lap

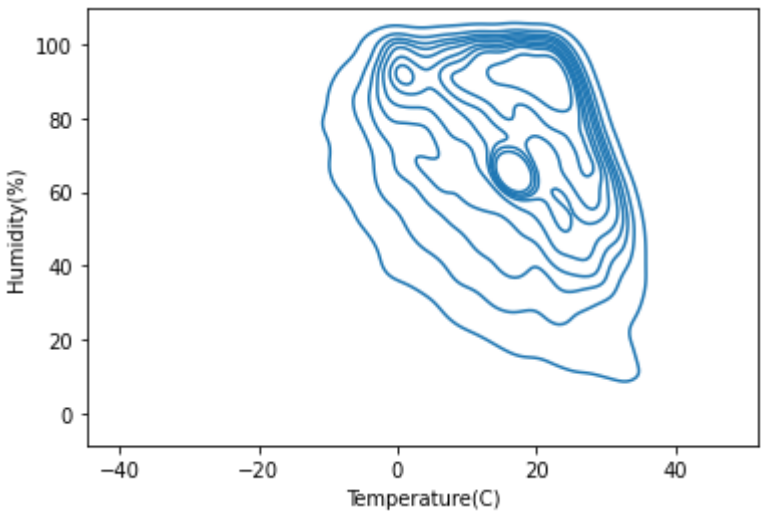
2. similar observation can be made for another dense region
    - humidity % range between 50-100
    - and temperature(C) between 25-35
    - show high over lap

In [122…
```
sns.kdeplot(
    data=df_temp[df_temp["Severity"] == 3], x="Temperature(C)", y="Humidity(
)
plt.show()
```



1. for severity of accidents 3
    - humidity % range between 90-100
    - and temperature(C) between 10-30
    - show high over lap
2. similar observation can be made for another dense region
    - humidity % range between 40-100
    - and temperature(C) between 20-35
    - show high over lap

In [123…
```
sns.kdeplot(
    data=df_temp[df_temp["Severity"] == 4], x="Temperature(C)", y="Humidity(
)
plt.show()
```



1. for severity of accidents 4
    - humidity % range between 90-100
    - and temperature(C) between 0-30
    - show high over lap
2. similar observation can be made for another dense region
    - humidity % range between 50-100
    - and temperature(C) between 20-35
    - show high over lap

Concluding EDA

1. There is a skew in distribution/ occurences of accidents across variables
2. Severities of accidents also has a skew across multiple variables
3. Interesting patterns can be observed w.r.t Weather variables and Severity
4. Combination of multiple POI variables might give some interesting results while modelling
5. Occurence of accidents across different cities and states vary
6. Text features such as description hold informative keywords which could be leveraged to build features