```
import os
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))
```

```
/kaggle/input/d/sobhanmoosavi/us-accidents/US_Accidents_Dec20_Updated.csv
```

US Accidents Analysis

Importing Required Libraries

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import missingno as mn
import plotly.graph_objects as go
```

Data Handeling

Loading Dataset into Pandas Dataframe

```
data_filepath = "/kaggle/input/d/sobhanmoosavi/us-accidents/US_Accidents_Dec20_Updated.csv"
data = pd.read_csv(data_filepath)
data
```

	ID	Severity	Start_Time	End_Time	Start_Lat	Start_Lng	End_Lat	End_Lng	Dista
0	A-1	2	2019-05-21 08:29:55	2019-05-21 09:29:40	34.808868	-82.269157	34.808868	-82.269157	
1	A-2	2	2019-10-07 17:43:09	2019-10-07 19:42:50	35.090080	-80.745560	35.090080	-80.745560	
2	A-3	2	2020-12-13 21:53:00	2020-12-13 22:44:00	37.145730	-121.985052	37.165850	-121.988062	
3	A-4	2	2018-04-17 16:51:23	2018-04-17 17:50:46	39.110390	-119.773781	39.110390	-119.773781	
4	A-5	3	2016-08-31 17:40:49	2016-08-31 18:10:49	26.102942	-80.265091	26.102942	-80.265091	
...	...	...	...	...	...	...	...	...	
2906605	A-2906606	2	2018-06-28 08:49:01	2018-06-28 09:18:51	29.813824	-95.399437	29.813824	-95.399437	
2906606	A-2906607	2	2019-01-10 02:01:01	2019-01-10 02:30:32	34.068890	-117.342010	34.068890	-117.342010	
2906607	A-2906608	2	2020-11-23 12:52:00	2020-11-24 00:47:37	25.702200	-80.335556	25.703040	-80.334099	
2906608	A-2906609	2	2019-12-29 22:38:00	2019-12-29 23:38:00	40.660140	-111.952460	40.660140	-111.952460	
2906609	A-2906610	2	2018-03-26 13:35:03	2018-03-26 14:39:00	38.831749	-104.748161	38.831749	-104.748161	

2906610 rows × 47 columns

Information

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2906610 entries, 0 to 2906609
Data columns (total 47 columns):
 #   Column                 Dtype
---  ------                 -----
 0   ID                     object
 1   Severity               int64
```

```
 2   Start_Time             object
 3   End_Time               object
 4   Start_Lat              float64
 5   Start_Lng              float64
 6   End_Lat                float64
 7   End_Lng                float64
 8   Distance(mi)           float64
 9   Description            object
 10  Number                 float64
 11  Street                 object
 12  Side                   object
 13  City                   object
 14  County                 object
 15  State                  object
 16  Zipcode                object
 17  Country                object
 18  Timezone               object
 19  Airport_Code           object
 20  Weather_Timestamp      object
 21  Temperature(F)         float64
 22  Wind_Chill(F)          float64
 23  Humidity(%)            float64
 24  Pressure(in)           float64
 25  Visibility(mi)         float64
 26  Wind_Direction         object
 27  Wind_Speed(mph)        float64
 28  Precipitation(in)      float64
 29  Weather_Condition      object
 30  Amenity                bool
 31  Bump                   bool
 32  Crossing               bool
 33  Give_Way               bool
 34  Junction               bool
 35  No_Exit                bool
 36  Railway                bool
 37  Roundabout             bool
 38  Station                bool
 39  Stop                   bool
 40  Traffic_Calming        bool
 41  Traffic_Signal         bool
 42  Turning_Loop           bool
 43  Sunrise_Sunset         object
 44  Civil_Twilight         object
 45  Nautical_Twilight      object
 46  Astronomical_Twilight  object
dtypes: bool(13), float64(13), int64(1), object(20)
memory usage: 790.0+ MB
```

Columns in dataframe

```
data.columns
```

```
Index(['ID', 'Severity', 'Start_Time', 'End_Time', 'Start_Lat', 'Start_Lng',
       'End_Lat', 'End_Lng', 'Distance(mi)', 'Description', 'Number', 'Street',
       'Side', 'City', 'County', 'State', 'Zipcode', 'Country', 'Timezone',
       'Airport_Code', 'Weather_Timestamp', 'Temperature(F)', 'Wind_Chill(F)',
       'Humidity(%)', 'Pressure(in)', 'Visibility(mi)', 'Wind_Direction',
       'Wind_Speed(mph)', 'Precipitation(in)', 'Weather_Condition', 'Amenity',
       'Bump', 'Crossing', 'Give_Way', 'Junction', 'No_Exit', 'Railway',
       'Roundabout', 'Station', 'Stop', 'Traffic_Calming', 'Traffic_Signal',
       'Turning_Loop', 'Sunrise_Sunset', 'Civil_Twilight', 'Nautical_Twilight',
       'Astronomical_Twilight'],
      dtype='object')
```

Statistical Description of each column

```
data.describe().T
```

	count	mean	std	min	25%	
Severity	2906610.0	2.288649	0.554162	1.000000	2.000000	2.0
Start_Lat	2906610.0	36.530271	5.013964	24.555269	33.664527	36.0
Start_Lng	2906610.0	-96.426758	17.754125	-124.623833	-117.823219	-91.1
End_Lat	2623789.0	36.517333	5.016609	24.555269	33.646589	36.0
End_Lng	2623789.0	-96.203669	17.659713	-124.623833	-117.701990	-91.0
Distance(mi)	2906610.0	0.398054	1.592556	0.000000	0.000000	0.0
Number	1014938.0	6789.727574	16972.246955	0.000000	965.000000	3093.0
Temperature(F)	2839386.0	60.988730	18.452580	-89.000000	48.900000	63.0
Wind_Chill(F)	1722751.0	54.990478	22.195422	-89.000000	39.000000	58.0
Humidity(%)	2835340.0	65.377577	22.878537	1.000000	49.000000	68.0
Pressure(in)	2849702.0	29.656850	0.909413	0.000000	29.590000	29.9
Visibility(mi)	2834532.0	9.116766	2.837271	0.000000	10.000000	10.0
Wind_Speed(mph)	2599447.0	7.818111	5.431171	0.000000	4.600000	7.0
Precipitation(in)	1605284.0	0.011195	0.154081	0.000000	0.000000	0.0

Numerical Columns to deal with

```
# int, float and boolean data
print(data.count(numeric_only=True))
print("Total No. of Numerical Columns:", len(data.count(numeric_only=True)))
```

```
Severity            2906610
Start_Lat           2906610
Start_Lng           2906610
End_Lat             2623789
End_Lng             2623789
Distance(mi)        2906610
Number              1014938
Temperature(F)      2839386
Wind_Chill(F)       1722751
Humidity(%)         2835340
Pressure(in)        2849702
Visibility(mi)      2834532
Wind_Speed(mph)     2599447
Precipitation(in)   1605284
Amenity             2906610
Bump                2906610
Crossing            2906610
Give_Way            2906610
Junction            2906610
No_Exit             2906610
Railway             2906610
Roundabout          2906610
Station             2906610
Stop                2906610
Traffic_Calming     2906610
Traffic_Signal      2906610
Turning_Loop        2906610
dtype: int64
```

```
Total No. of Numerical Columns: 27
```

Percentage of Missing Values

```
missing_values = data.isna().sum().sort_values(ascending=False)
missing_percentage = missing_values[missing_values!=0]/len(data)*100
print(" Percentage of Missing Values \n", missing_percentage)
```

```
 Percentage of Missing Values
 Number                   65.081728
Precipitation(in)        44.771263
Wind_Chill(F)            40.729888
Wind_Speed(mph)          10.567740
End_Lat                   9.730270
End_Lng                   9.730270
Visibility(mi)            2.479796
Weather_Condition         2.471986
Humidity(%)               2.451997
Temperature(F)            2.312797
Wind_Direction            2.183781
Pressure(in)              1.957882
Weather_Timestamp         1.614148
Airport_Code              0.227344
Timezone                  0.118007
Zipcode                   0.038326
Sunrise_Sunset            0.003784
Civil_Twilight            0.003784
Nautical_Twilight         0.003784
Astronomical_Twilight     0.003784
City                      0.003716
dtype: float64
```

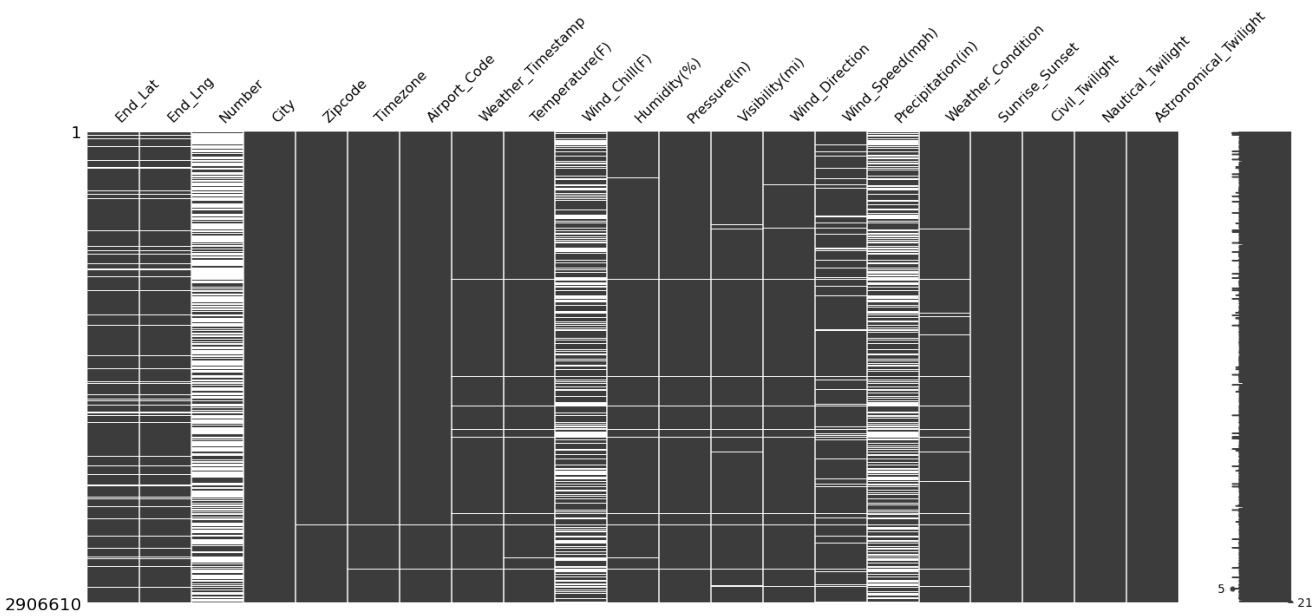
Getting List of Columns Having Null Values

```
null_cols = [i for i in data.columns if data[i].isnull().any()]
print(null_cols)
```

```
['End_Lat', 'End_Lng', 'Number', 'City', 'Zipcode', 'Timezone', 'Airport_Code', 'Weather_Timestamp',
```

Checking Missing Values Pattern in Dataframe

```
mn.matrix(data[null_cols]);
```



Drop Four Columns [End_Lng, End_Lat, Number, TMC] having high no. of Missing Values

```
new_data_a = data.drop(columns=["End_Lng", "End_Lat", "Number"], axis=0)
```

Drop Rows w.r.t to columns having least percentage of missing values (do not effect much to data with 4.2 million records)

```
new_data_b = new_data_a.dropna(subset = ['Visibility(mi)','Weather_Condition','Humidity(%)','Temperature
```

```
new_data_b.isnull().sum()
```

```
ID                          0
Severity                    0
Start_Time                  0
End_Time                    0
Start_Lat                   0
Start_Lng                   0
Distance(mi)                0
Description                 0
Street                      0
Side                        0
City                        0
County                      0
State                       0
Zipcode                     0
Country                     0
Timezone                    0
Airport_Code                0
Weather_Timestamp           0
Temperature(F)              0
Wind_Chill(F)         1090741
Humidity(%)                 0
Pressure(in)                0
Visibility(mi)              0
Wind_Direction              0
Wind_Speed(mph)        229916
Precipitation(in)     1228285
Weather_Condition           0
Amenity                     0
Bump                        0
```

```
Crossing                       0
Give_Way                       0
Junction                       0
No_Exit                        0
Railway                        0
Roundabout                     0
Station                        0
Stop                           0
Traffic_Calming                0
Traffic_Signal                 0
Turning_Loop                   0
Sunrise_Sunset                 0
Civil_Twilight                 0
Nautical_Twilight              0
Astronomical_Twilight          0
dtype: int64
```

```
final_data = new_data_b.drop(columns = 'ID', axis=0)
```

```
final_data.isnull().sum()
```

```
Severity                       0
Start_Time                     0
End_Time                       0
Start_Lat                      0
Start_Lng                      0
Distance(mi)                   0
Description                    0
Street                         0
Side                           0
City                           0
County                         0
State                          0
Zipcode                        0
Country                        0
Timezone                       0
Airport_Code                   0
Weather_Timestamp              0
Temperature(F)                 0
Wind_Chill(F)            1090741
Humidity(%)                    0
Pressure(in)                   0
Visibility(mi)                 0
Wind_Direction                 0
Wind_Speed(mph)           229916
Precipitation(in)        1228285
Weather_Condition              0
Amenity                        0
Bump                           0
Crossing                       0
Give_Way                       0
Junction                       0
No_Exit                        0
Railway                        0
Roundabout                     0
Station                        0
Stop                           0
Traffic_Calming                0
Traffic_Signal                 0
Turning_Loop                   0
Sunrise_Sunset                 0
Civil_Twilight                 0
Nautical_Twilight              0
Astronomical_Twilight          0
dtype: int64
```

Exploratory Data Analysis

Location

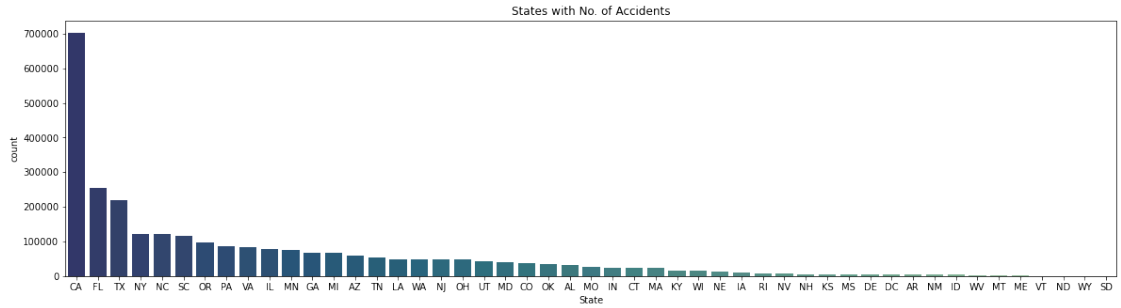
```
state_counts = final_data["State"].value_counts()
fig = go.Figure(data=go.Choropleth(locations=state_counts.index, z=state_counts.values.astype(float), loca
fig.update_layout(title_text="Number of Accidents for each State", geo_scope="usa")
fig.show()
```

```
print("State Code: ", final_data.State.unique())
print("Total No. of State in Dataset: ", len(final_data.State.unique()))
```

```
State Code:  ['SC' 'NC' 'CA' 'NV' 'FL' 'CO' 'TN' 'NY' 'TX' 'AZ' 'NJ' 'MI' 'GA' 'VA'
 'IN' 'LA' 'PA' 'MN' 'OH' 'CT' 'IL' 'MD' 'MO' 'OR' 'NE' 'OK' 'UT' 'WA'
 'AL' 'WI' 'MA' 'DC' 'MS' 'KY' 'ME' 'IA' 'KS' 'WV' 'AR' 'ID' 'RI' 'WY'
 'NM' 'MT' 'NH' 'DE' 'ND' 'SD' 'VT']
Total No. of State in Dataset:  49
```

- Total No. of State in Dataset: 49
- There are 50 states in US
- New York not in dataset

```
fig, ax = plt.subplots(figsize = (20,5))
c = sns.countplot(x="State", data=final_data, orient = 'v', palette = "crest_r", order = final_data['Sta
c.set_title("States with No. of Accidents");
```



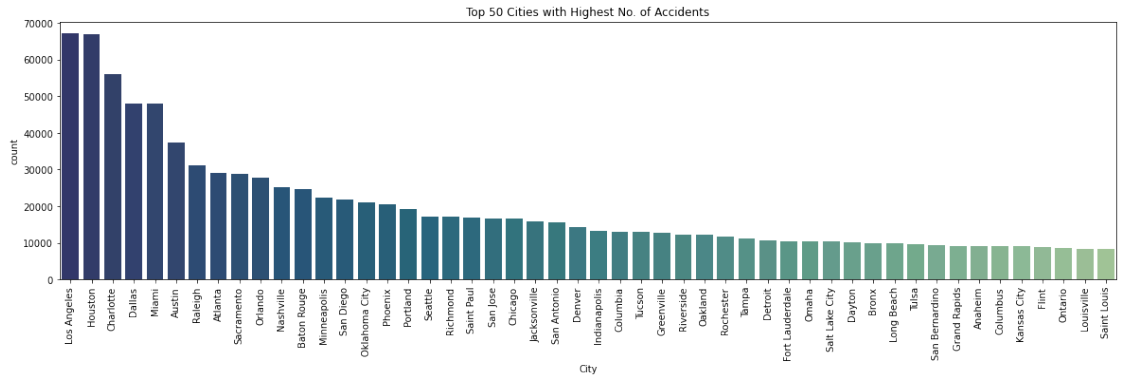
- California (CA) is the 3rd most largest state of US after Texas (TX) and Alaska (AL)
- Also California (CA) is the most populated among all, followed by Texas (TX)
- Alaska (AL) is the largest state but least populated state at 48th rank

```
print("City Code: ", final_data.City.unique())
print("Total No. of Cities in Dataset: ", len(final_data.City.unique()))
```

```
City Code:  ['Greenville' 'Charlotte' 'Los Gatos' ... 'Allons' 'Adolphus' 'Gowanda']
Total No. of Cities in Dataset:  11537
```

- Total No. of Cities in Dataset: 11537
- There were 19,502 incorporated places registered in the United States

```
fig, ax = plt.subplots(figsize = (20,5))
c = sns.countplot(x="City", data=final_data, order=final_data.City.value_counts().iloc[:50].index, orien
c.set_title("Top 50 Cities with Highest No. of Accidents")
c.set_xticklabels(c.get_xticklabels(), rotation=90)
plt.show()
```



Timestamp

```
final_data.Start_Time = pd.to_datetime(final_data.Start_Time)
final_data.Start_Time[0]
```

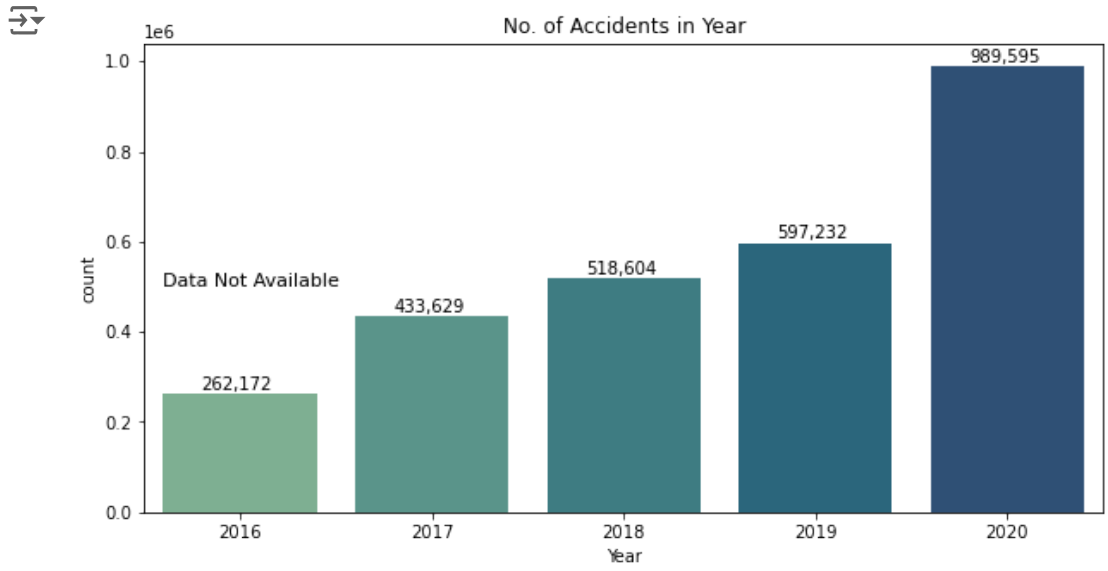
```
Timestamp('2019-05-21 08:29:55')
```

```
final_data['Month'] = final_data['Start_Time'].dt.month
```

```
final_data['Year'] = final_data['Start_Time'].dt.year
final_data['Hour'] = final_data['Start_Time'].dt.hour
final_data['Weekday'] = final_data['Start_Time'].dt.weekday
#yearly data subset
data_2016 = final_data[final_data.Start_Time.dt.year == 2016]
data_2017 = final_data[final_data.Start_Time.dt.year == 2017]
data_2018 = final_data[final_data.Start_Time.dt.year == 2018]
data_2019 = final_data[final_data.Start_Time.dt.year == 2019]
data_2020 = final_data[final_data.Start_Time.dt.year == 2020]
data_2017_2019 = final_data[(final_data["Year"] >= 2017) & (final_data["Year"] <= 2019)]
```

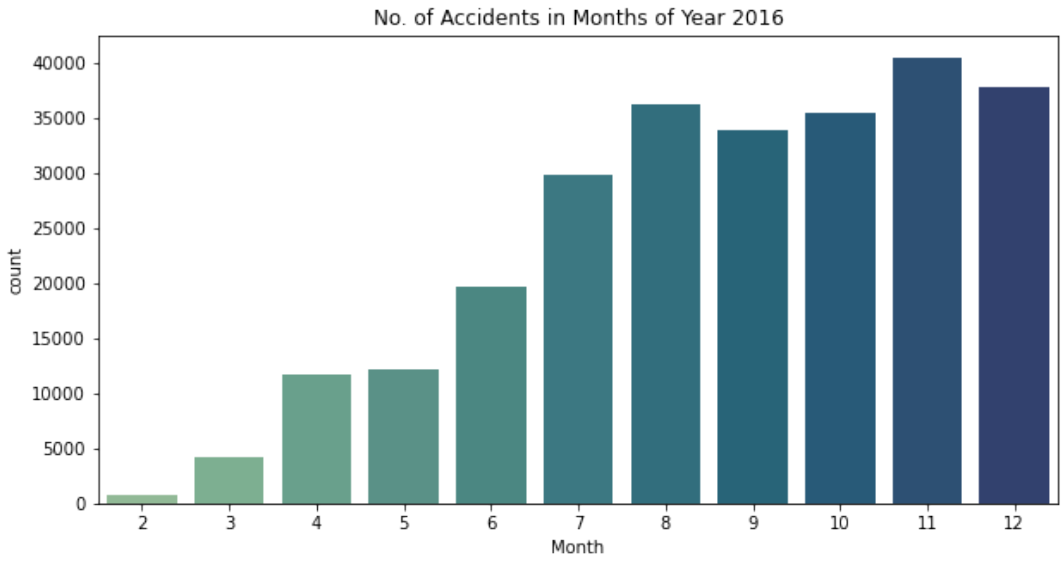
Yearly

```
fig, ax = plt.subplots(figsize = (10,5))
c = sns.countplot(x="Year", data=final_data, orient = 'v', palette = "crest")
plt.annotate('Data Not Available',xy=(-0.4,500000), fontsize=11)
c.set_title("No. of Accidents in Year")
for i in ax.patches:
    count = '{:,.0f}'.format(i.get_height())
    x = i.get_x()+i.get_width()-0.60
    y = i.get_height()+10000
    ax.annotate(count, (x, y))
plt.show()
```

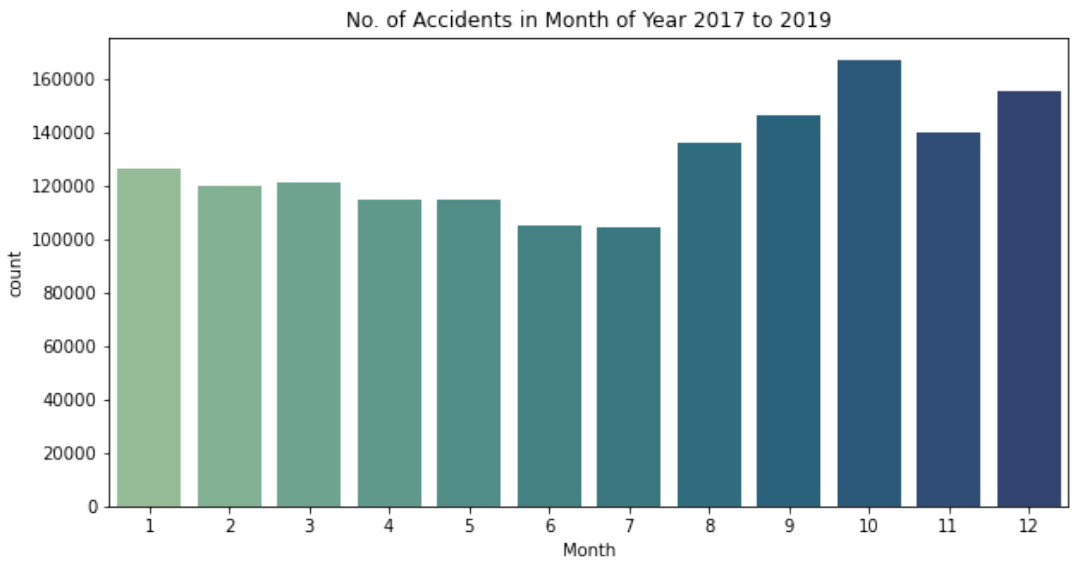


Monthly

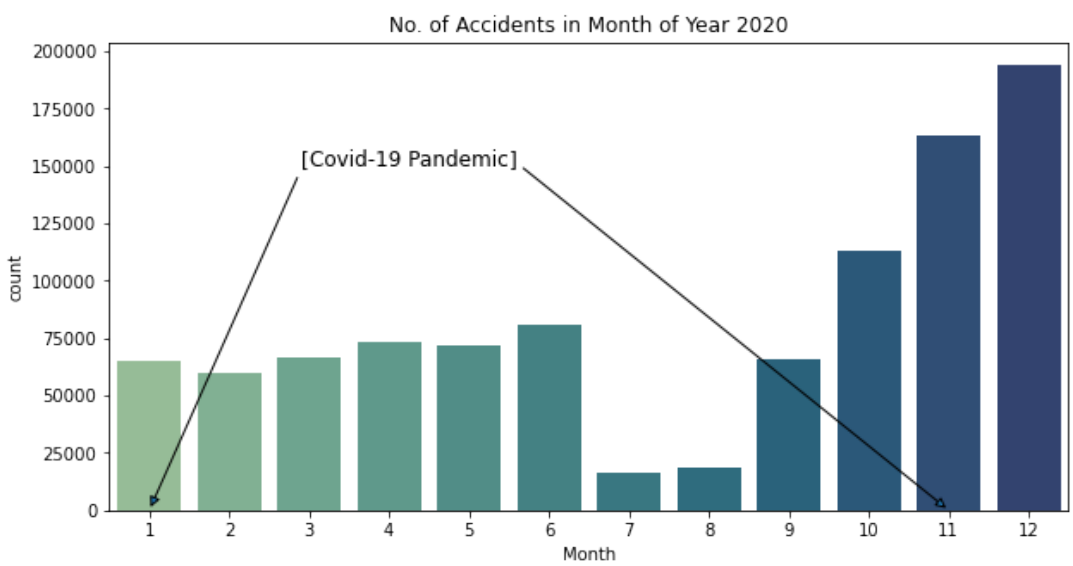
```
fig, ax = plt.subplots(figsize = (10,5))
c = sns.countplot(x="Month", data=data_2016, orient = 'v', palette = "crest")
plt.annotate('Data Not Available',xy=(2,50000), fontsize=11)
c.set_title("No. of Accidents in Months of Year 2016")
plt.show()
```




```
fig, ax = plt.subplots(figsize = (10,5))
c = sns.countplot(x="Month", data=data_2017_2019, orient = 'v', palette = "crest")
c.set_title("No. of Accidents in Month of Year 2017 to 2019")
plt.show()
```



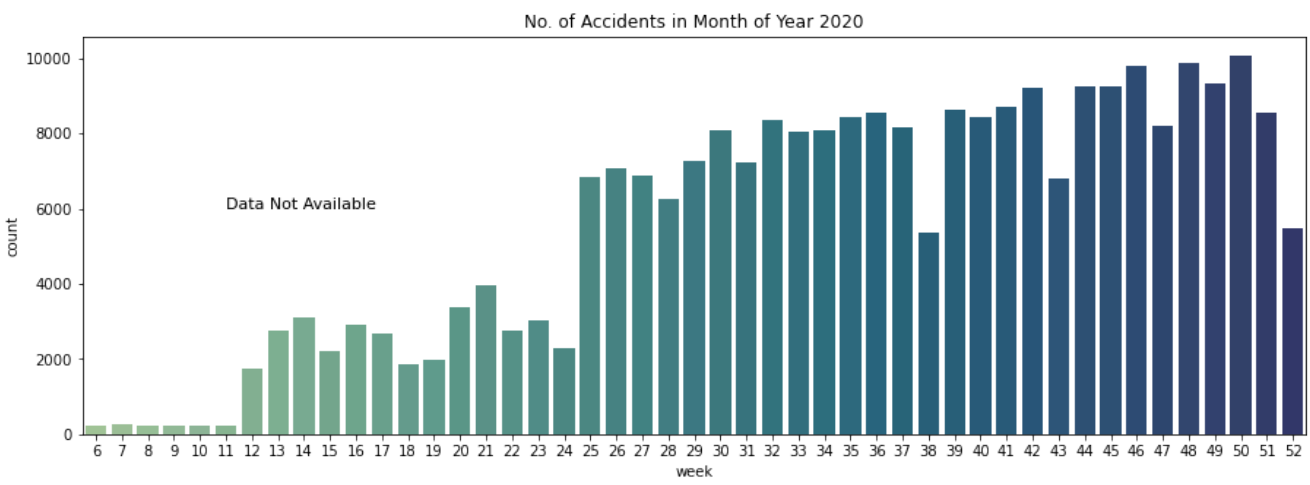

```
fig, ax = plt.subplots(figsize = (10,5))
c = sns.countplot(x="Month", data=data_2020, orient = 'v', palette = "crest")
plt.annotate('Covid-19 Pandemic',xy=(2,150000), fontsize=12)
plt.annotate("[",xy=(0,0),xytext=(1.9,150000),arrowprops={'arrowstyle':'-|>'}, fontsize=12)
plt.annotate("]",xy=(10,0),xytext=(4.5,150000),arrowprops={'arrowstyle':'-|>'}, fontsize=12)
c.set_title("No. of Accidents in Month of Year 2020")
plt.show()
```



Weekly

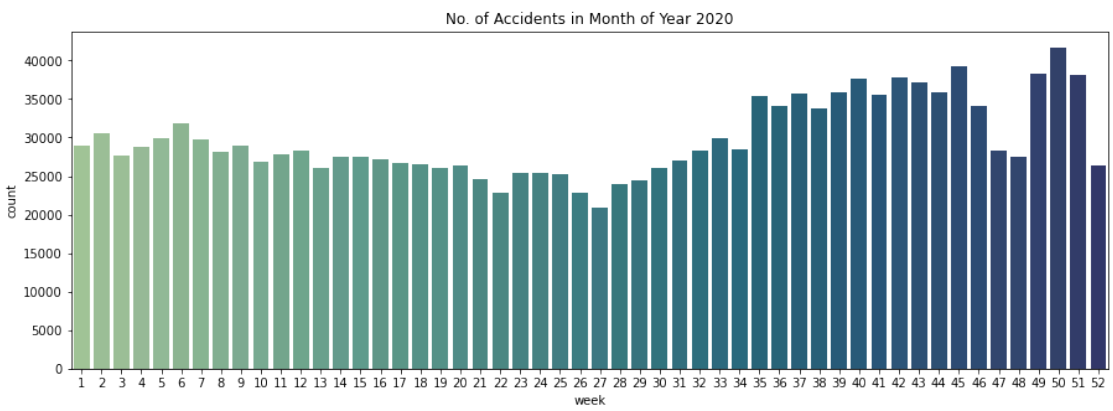
All Weeks of Year 2016

```
fig, ax = plt.subplots(figsize = (15,5))
c = sns.countplot(x=data_2016.Start_Time.dt.isocalendar().week, data=data_2016, orient = 'v', palette =
plt.annotate('Data Not Available',xy=(5,6000), fontsize=11)
c.set_title("No. of Accidents in Month of Year 2020")
plt.show()
```



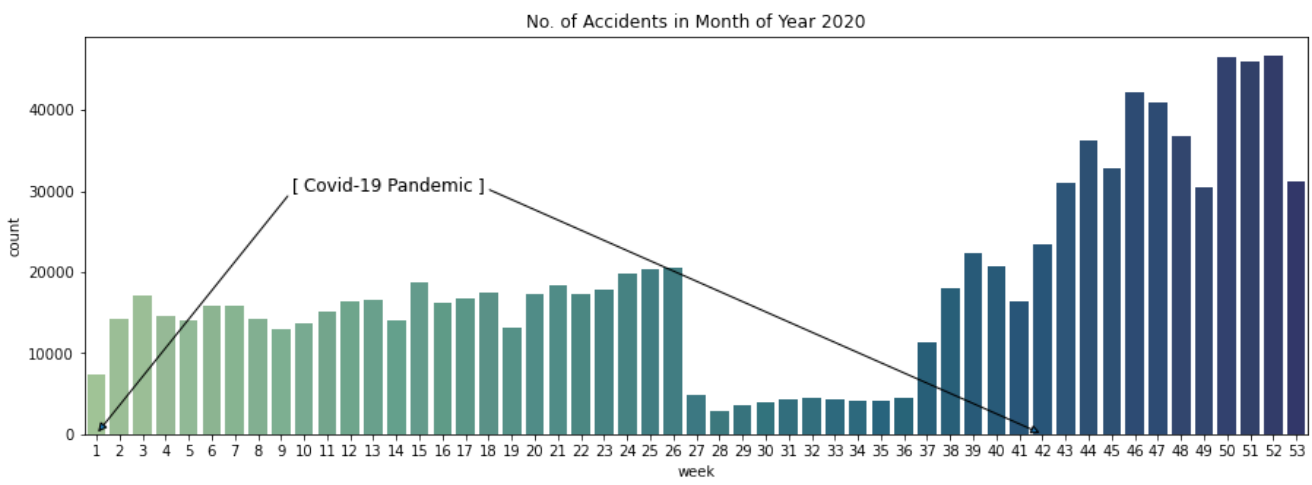
All Weeks of Year 2017 to 2019

```
fig, ax = plt.subplots(figsize = (15,5))
c = sns.countplot(x=data_2017_2019.Start_Time.dt.isocalendar().week, data=data_2017_2019, orient = 'v',
c.set_title("No. of Accidents in Month of Year 2020")
plt.show()
```



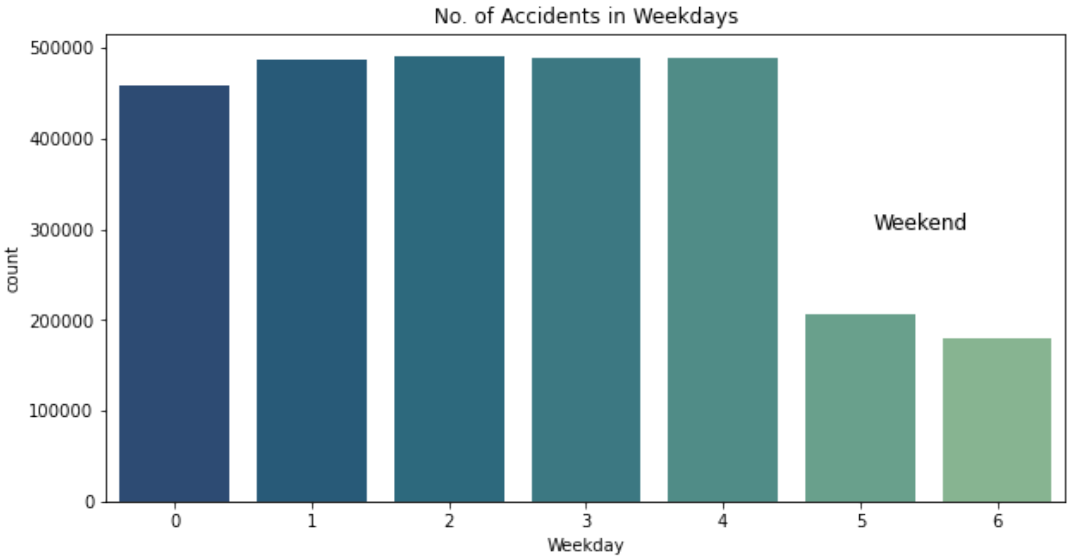
All Weeks of Year 2020

```
fig, ax = plt.subplots(figsize = (15,5))
c = sns.countplot(x=data_2020.Start_Time.dt.isocalendar().week, data=data_2020, orient = 'v', palette = "c
plt.annotate('Covid-19 Pandemic',xy=(9,30000), fontsize=12)
plt.annotate("[",xy=(0,0),xytext=(8.5,30000),arrowprops={'arrowstyle':'-|>'}, fontsize=12)
plt.annotate("]",xy=(41,0),xytext=(16.5,30000),arrowprops={'arrowstyle':'-|>'}, fontsize=12)
c.set_title("No. of Accidents in Month of Year 2020")
plt.show()
```

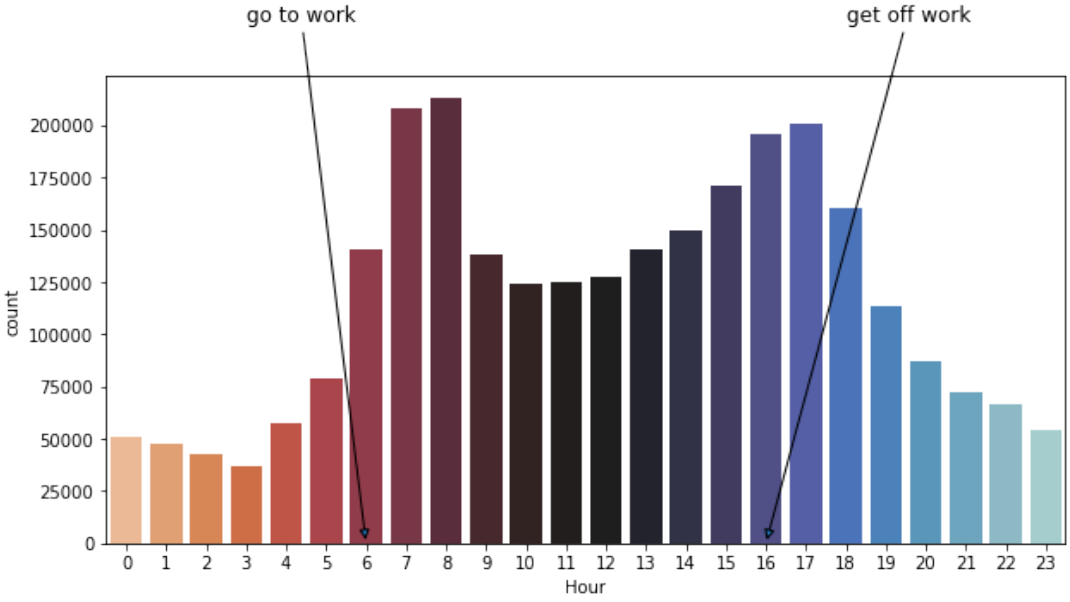


Weekdays

```
fig, ax = plt.subplots(figsize = (10,5))
c = sns.countplot(x="Weekday", data=final_data, orient = 'v', palette = "crest_r")
plt.annotate('Weekdays',xy=(2,728000), fontsize=12)
plt.annotate('Weekend',xy=(5.1,300000), fontsize=12)
c.set_title("No. of Accidents in Weekdays")
plt.show()
```

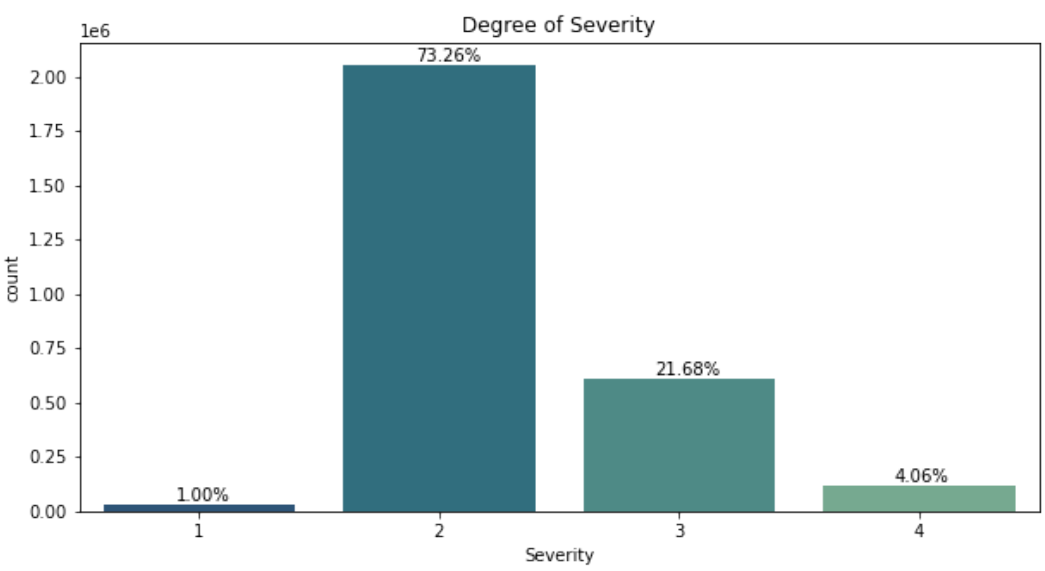



```
fig, ax = plt.subplots(figsize = (10,5))
sns.countplot(x="Hour", data=final_data, orient = 'v', palette = "icefire_r")
plt.annotate('Morning Peak',xy=(6,350000), fontsize=12)
plt.annotate('Afternoon Peak',xy=(15,350000), fontsize=12)
plt.annotate('go to work',xy=(6,0),xytext=(3,250000),arrowprops={'arrowstyle':'-|>'}, fontsize=12)
plt.annotate('get off work',xy=(16,0),xytext=(18,250000),arrowprops={'arrowstyle':'-|>'}, fontsize=12)
plt.show()
```

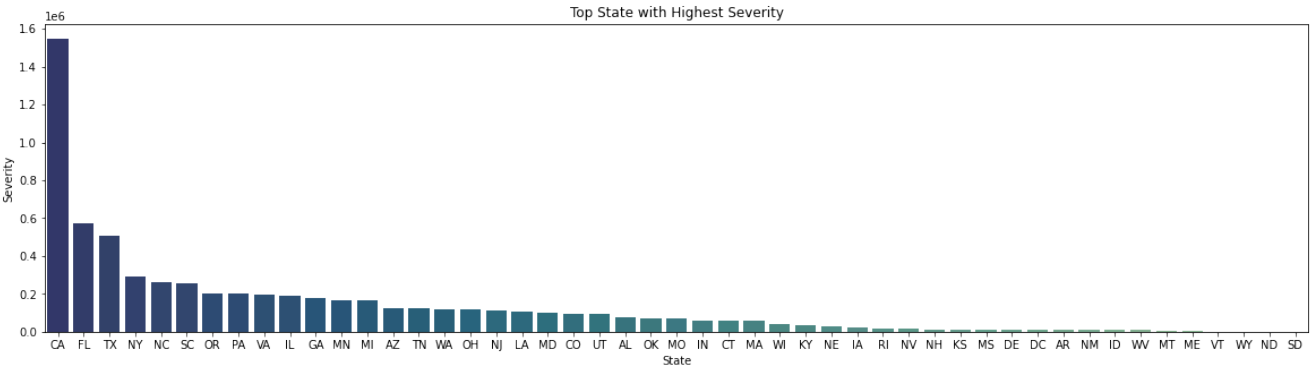


Severity

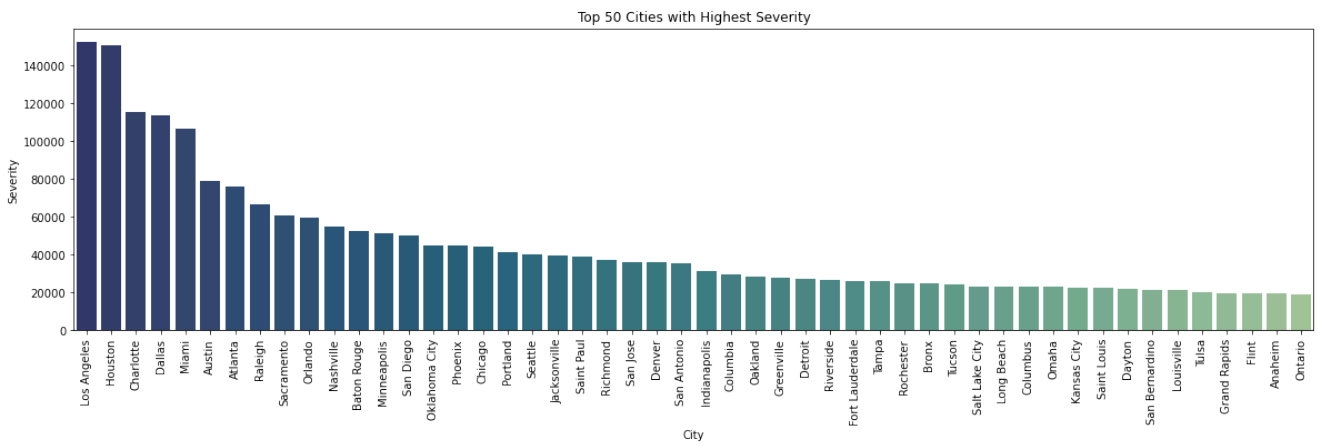
```
fig, ax = plt.subplots(figsize = (10,5))
c = sns.countplot(x="Severity", data=final_data, orient = 'v', palette = "crest_r")
c.set_title("Degree of Severity")
for i in ax.patches:
    count = "{:.2%}".format(i.get_height()/len(final_data.Severity))
    x = i.get_x()+i.get_width()-0.50
    y = i.get_height()+20000
    ax.annotate(count, (x, y))
plt.show()
```




```
df_state = final_data.groupby('State').sum('Severity')[['Severity']]
df_state = df_state.reset_index().sort_values('Severity', ascending = False)[:50]
fig, ax = plt.subplots(figsize = (20,5))
c = sns.barplot(x = 'State', y = 'Severity', data = df_state, orient = 'v', palette = "crest_r")
c.set_title("Top State with Highest Severity")
plt.show()
```




```
df_city = final_data.groupby('City').sum('Severity')[['Severity']]
df_city = df_city.reset_index().sort_values('Severity', ascending = False)[:50]
fig, ax = plt.subplots(figsize = (20,5))
c = sns.barplot(x = 'City', y = 'Severity', data = df_city, orient = 'v', palette = "crest_r")
c.set_title("Top 50 Cities with Highest Severity")
c.set_xticklabels(c.get_xticklabels(), rotation=90)
plt.show()
```



Weather Stimuli Impact

Related Columns

```
final_data.iloc[:10, 17:26]
```

	Temperature(F)	Wind_Chill(F)	Humidity(%)	Pressure(in)	Visibility(mi)	Wind_Direction	Wind_Sp
0	76.0	76.0	52.0	28.91	10.0	N	
1	76.0	76.0	62.0	29.30	10.0	VAR	
2	51.0	51.0	80.0	30.17	10.0	W	
3	53.6	NaN	16.0	30.16	10.0	SSW	
4	84.2	NaN	84.0	29.92	10.0	SSE	
5	73.4	NaN	33.0	30.17	10.0	NNW	
6	28.0	28.0	88.0	24.67	2.0	NE	
7	55.0	55.0	40.0	29.86	10.0	E	
8	87.1	NaN	43.0	30.04	10.0	NE	
9	57.0	57.0	77.0	29.08	5.0	VAR	

Location Impact

Related Columns

```
final_data.iloc[:10, 27:39]
```

	Bump	Crossing	Give_Way	Junction	No_Exit	Railway	Roundabout	Station	Stop	Traffic_Calming
0	False	False	False	False	False	False	False	False	False	False
1	False	False	False	False	False	False	False	False	False	False
2	False	False	False	False	False	False	False	False	False	False
3	False	False	False	False	False	False	False	False	False	False
4	False	False	False	True	False	False	False	False	False	False
5	False	False	False	False	False	False	False	False	False	False

```
f,ax=plt.subplots(4,3,figsize=(25,25))
ax[0,0] = final_data['Amenity'].value_counts().plot.pie(autopct='%1.1f%%',ax=ax[0,0],colors=["cornflower
ax[0,0].set_title("Amenity",fontweight ="bold")
ax[0,1] = final_data['Bump'].value_counts().plot.pie(autopct='%1.1f%%',ax=ax[0,1],colors=["cornflowerblu
```