In [1]:
```
%matplotlib inline
import numpy as np
import pandas as pd
import geopandas as gpd
from geopandas import GeoDataFrame
import matplotlib.pyplot as plt
import seaborn as sns
import re
from shapely.geometry import Polygon
import folium
import shapely.wkt
from shapely.wkt import loads
from shapely.geometry import Point, Polygon
import math
```

Load back DataFrames from part 1

In [2]:
```
grid_df = pd.read_csv('grid_df.csv')
incident_df = pd.read_csv('incident_df.csv')
speed_df = pd.read_csv('speed_df.csv')
volume_df = pd.read_csv('volume_df.csv')
# cast geometry column back to GeoDataFrame
grid_df['geometry'] = grid_df['geometry'].apply(shapely.wkt.loads)
grid_gdf = gpd.GeoDataFrame(grid_df, geometry = 'geometry')

speed_df['multiline'] = speed_df['multiline'].apply(shapely.wkt.loads)
speed_gdf = gpd.GeoDataFrame(speed_df, geometry = 'multiline', crs='eps
g:4326')

# volume_df['multilinestring'] = volume_df['multilinestring'].apply(shap
ely.wkt.loads)
# volume_gdf = gpd.GeoDataFrame(volume_df, geometry = 'multilinestring',
crs='epsg:4326')
```

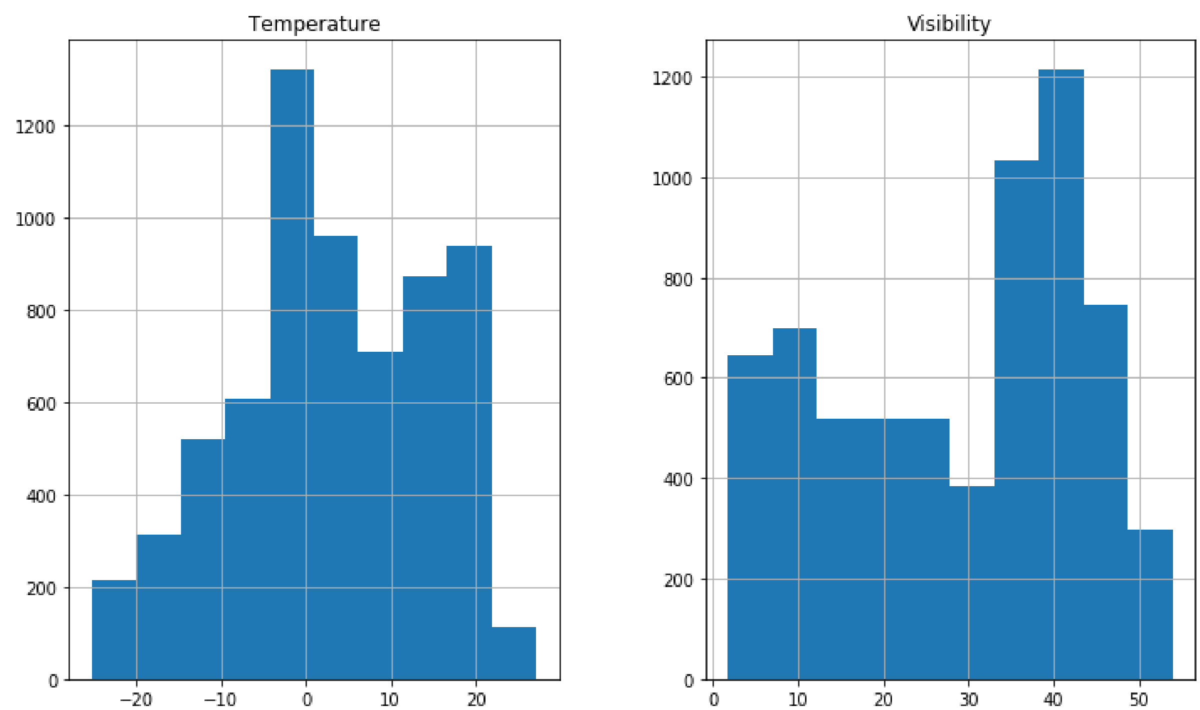
3. Correlation Analysis between features and Traffic Accidents

3.1 Daily Temperature and Visibility Influence on Traffic Accident

The histogram of Accident counts vs Temperature shows no relations between accident counts and temperature. Similarly, Accident counts vs Visibility scatter plot also indicates no relation between those two parameters.

However, by observing the distribution pattern, account count peaked at temperature range (-5, 0), which may indicating that when road just start to freeze, slippery road condition will create more tranffic accidents than any other temperature range.

In [3]:
```
fig, ax = plt.subplots(1, 2, figsize=(12,7))
# sns.scatterplot(x="Temperature", y="Accidents", ax=ax[0], data=inciden
t_df)
# sns.scatterplot(x="Visibility", y="Accidents", ax=ax[1], data=incident
_df)
incident_df.hist("Temperature", ax=ax[0])
incident_df.hist("Visibility", ax=ax[1])
plt.show()
```



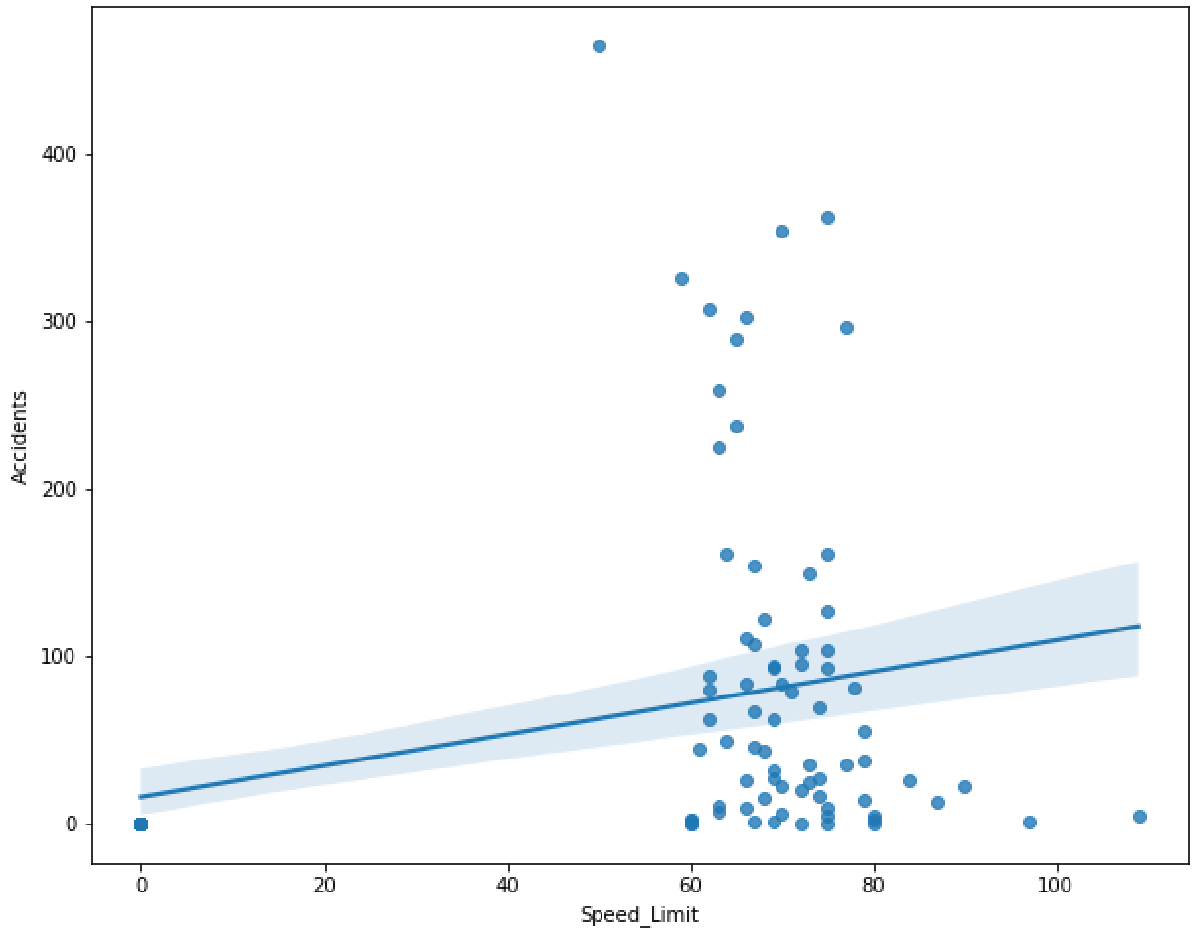
3.2 Other Features Influence on Traffic Accident

3.2.1 Correlation between Speed Limit and Traffic Accident

The linear regression plot of Accident counts vs Speed Limit shows a somewhat positive correlation between those two variables. However, most of the accidents can be seen within the speed limit range 60-80, which may indicates Expressways and Freeways within the city.

In [4]:
```
fig,ax=plt.subplots(figsize=(10,8))
sns.regplot(x='Speed_Limit',y='Accidents', ax=ax, data=grid_df, order=1)
```

Out[4]: <matplotlib.axes._subplots.AxesSubplot at 0x1a1660cd50>



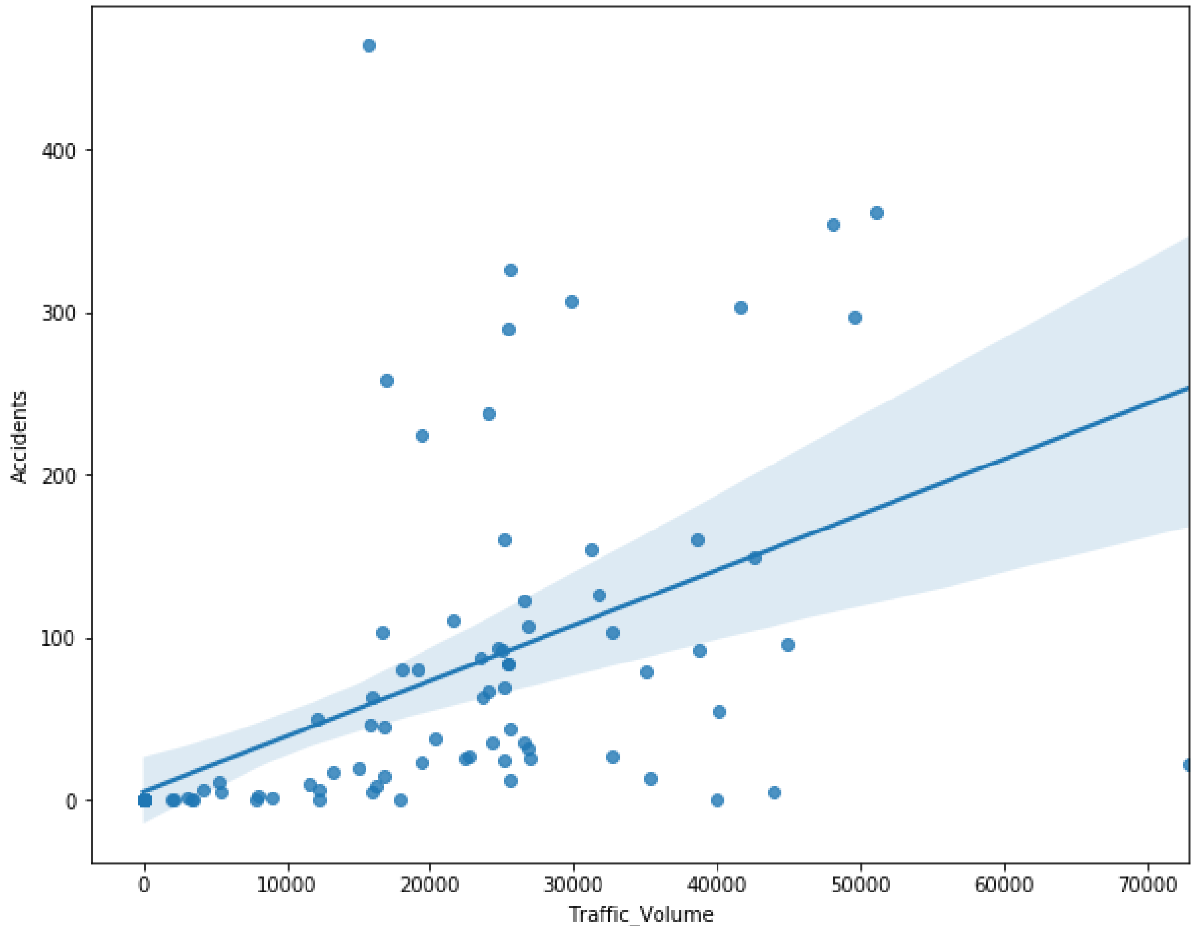
3.2.2 Correlation between Traffic Volume and Traffic Accident

The linear regression plot of Accidents Counts vs Traffic Volume indicates a positive correlation between them. This pattern is within anticipation statistically, as locations with higher traffic volume has the larger sample pool so are prone to have more traffic accidents.

The quantified correlation with be studied at the end of this chapter.

In [5]:
```
fig,ax=plt.subplots(figsize=(10,8))
sns.regplot(x='Traffic_Volume',y='Accidents', ax=ax, data=grid_df, order
=1) # pointplot x vs y
```

Out[5]: <matplotlib.axes._subplots.AxesSubplot at 0x1a16bab650>

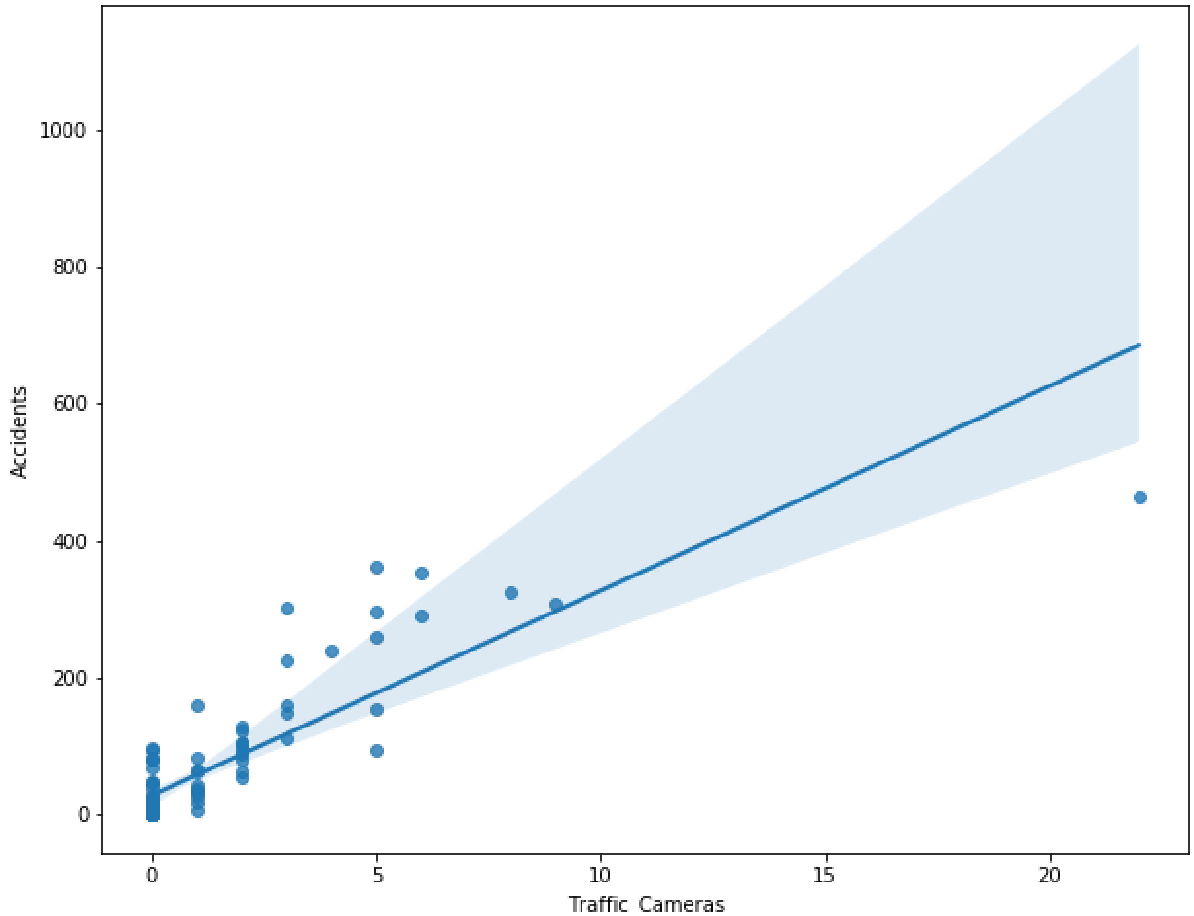


3.2.3 Correlation between Traffic Camera Counts and Traffic Accident

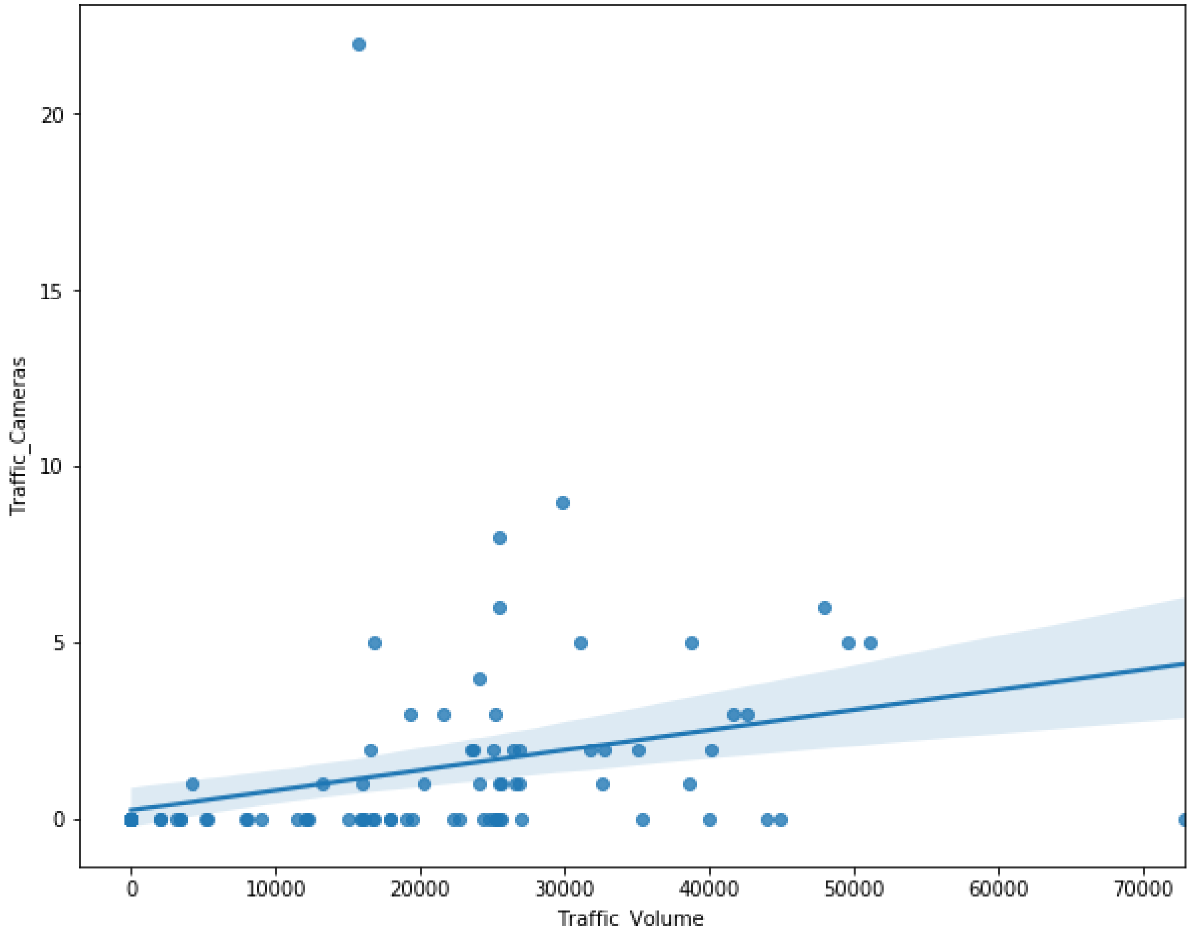
The regression plot of Traffic Accident counts vs Traffic Camera counts indicates a positive correlation between them. This effect may also because of the traffic volume, since the Traffic Cameras count vs Traffic Volume plot indicates a positive correlation between them.

The quantified correlation with be studied at the end of this chapter.

In [6]:
```
fig,ax=plt.subplots(figsize=(10,8))
sns.regplot(x="Traffic_Cameras", y="Accidents", ax=ax, data=grid_df)
plt.show()
```



In [7]:
```
fig,ax=plt.subplots(figsize=(10,8))
sns.regplot(x="Traffic_Volume", y="Traffic_Cameras", ax=ax, data=grid_df
)
plt.show()
```

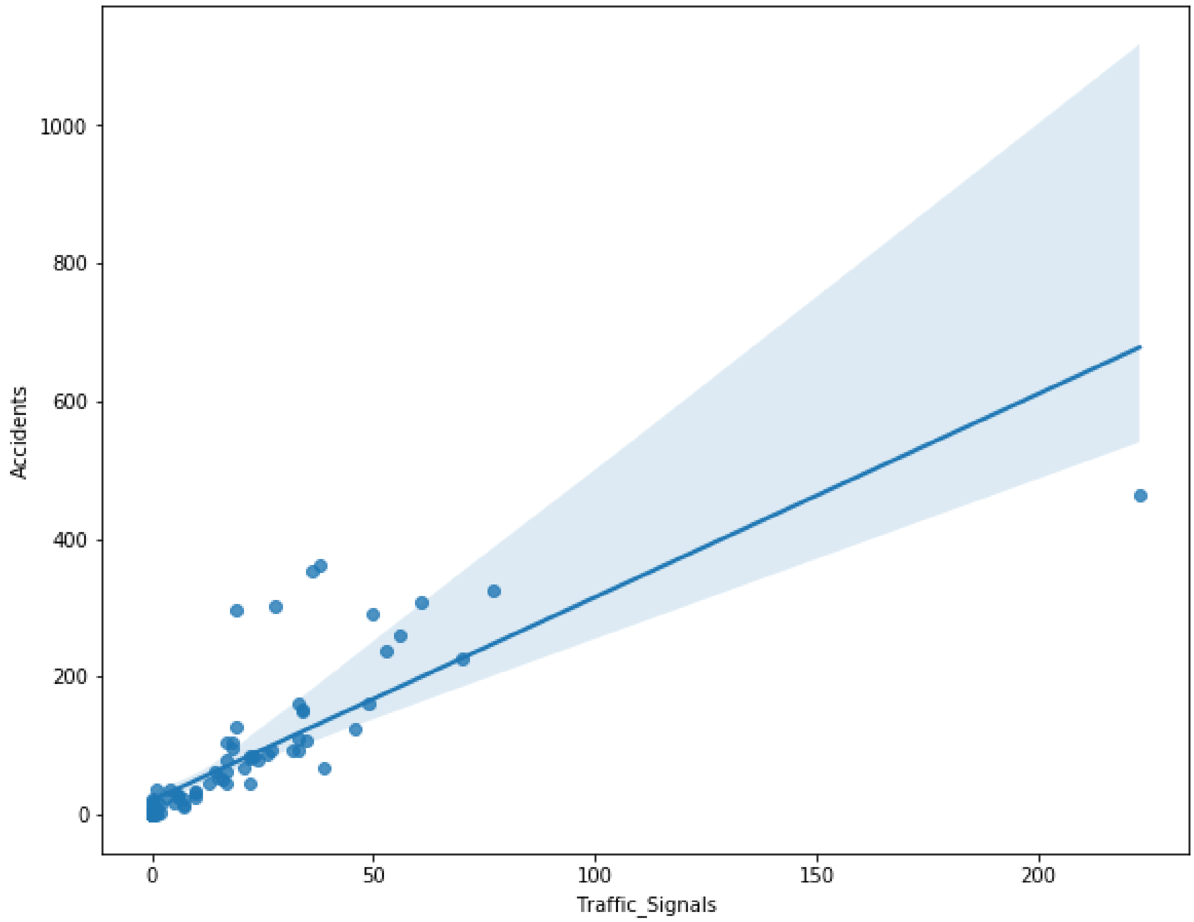


3.2.4 Correlation between Traffic Signal Counts and Traffic Accident

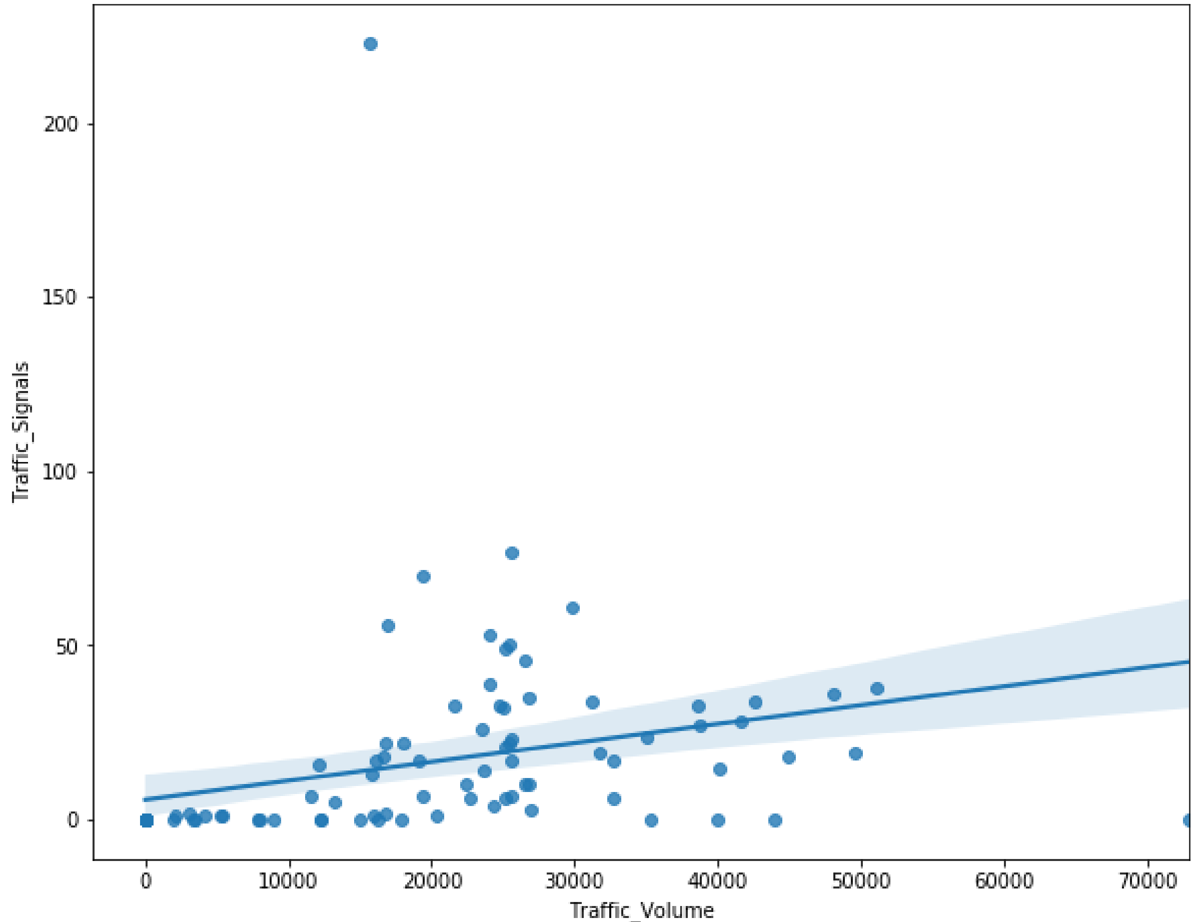
The regression plot of Traffic Accident counts vs Traffic Signal counts indicates a positive correlation between them. Like Traffic Cameras, this correlation may also because of the traffic volume, since the Traffic Signal count vs Traffic Volume plot indicates a positive correlation between them.

The quantified correlation with be studied at the end of this chapter.

In [8]:
```
fig,ax=plt.subplots(figsize=(10,8))
sns.regplot(x="Traffic_Signals", y="Accidents", ax=ax, data=grid_df)
plt.show()
```

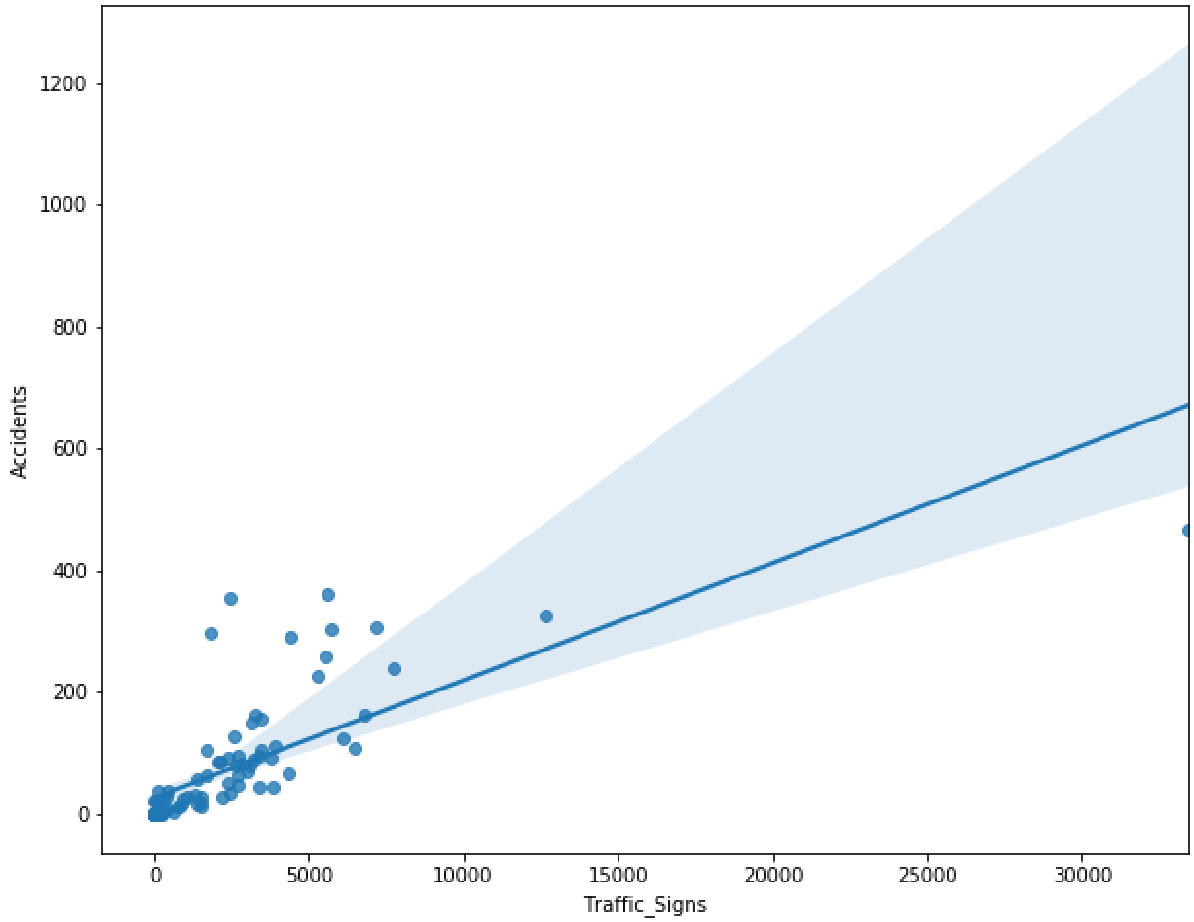


In [9]:
```
fig,ax=plt.subplots(figsize=(10,8))
sns.regplot(x="Traffic_Volume", y="Traffic_Signals", ax=ax, data=grid_df
)
plt.show()
```

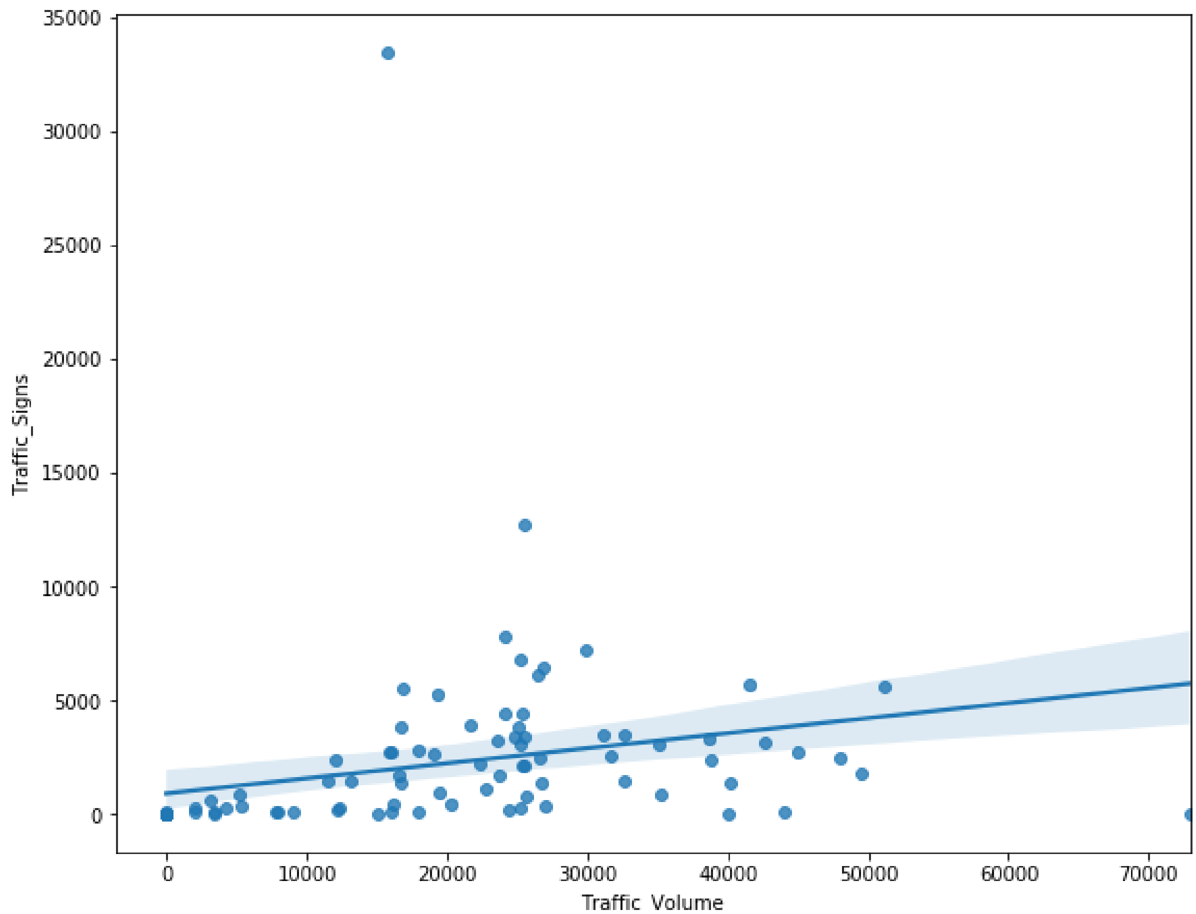


3.2.5 Correlation between Traffic Sign Counts and Traffic Accident

In [10]:
```
fig,ax=plt.subplots(figsize=(10,8))
sns.regplot(x="Traffic_Signs", y="Accidents", ax=ax, data=grid_df)
plt.show()
```



In [11]:
```
fig,ax=plt.subplots(figsize=(10,8))
sns.regplot(x="Traffic_Volume", y="Traffic_Signs", ax=ax, data=grid_df)
plt.show()
```



3.3 Quantitative Study of Factors Contribute to Traffic Accidents

Three quantitative correlation study(Pearson, Kendall, Spearman) have been performed in this section.

In all three studies, we are observing positive correlations between any or the features and accident counts. Amoung those, Traffic Sign counts and Traffic Signal counts are showing the strongest correlation to accidents.

3.3.1 Pearson Correlation Study

In [12]:
```
parameters=['Accidents', 'Speed_Limit','Traffic_Volume', 'Traffic_Camera
s', 'Traffic_Signals', 'Traffic_Signs']
grid_df[parameters].corr(method='pearson')
```

Out[12]:

	Accidents	Speed_Limit	Traffic_Volume	Traffic_Cameras	Traffic_Signals	Traffic_S
Accidents	1.000000	0.299831	0.528462	0.846082	0.818475	0.75
Speed_Limit	0.299831	1.000000	0.707985	0.168168	0.213830	0.19
Traffic_Volume	0.528462	0.707985	1.000000	0.311684	0.302962	0.26
Traffic_Cameras	0.846082	0.168168	0.311684	1.000000	0.919970	0.90
Traffic_Signals	0.818475	0.213830	0.302962	0.919970	1.000000	0.97
Traffic_Signs	0.757298	0.196862	0.261465	0.900012	0.972463	1.00

3.3.2 Kendall Correlation Study

In [13]:
```
grid_df[parameters].corr(method='kendall')
```

Out[13]:

	Accidents	Speed_Limit	Traffic_Volume	Traffic_Cameras	Traffic_Signals	Traffic_S
Accidents	1.000000	0.282082	0.633239	0.701243	0.835438	0.78
Speed_Limit	0.282082	1.000000	0.555923	0.138387	0.169990	0.20
Traffic_Volume	0.633239	0.555923	1.000000	0.473617	0.528490	0.53
Traffic_Cameras	0.701243	0.138387	0.473617	1.000000	0.695502	0.61
Traffic_Signals	0.835438	0.169990	0.528490	0.695502	1.000000	0.82
Traffic_Signs	0.788238	0.201583	0.537230	0.611603	0.825797	1.00

3.3.3 Spearman Correlation Study

In [14]:
```
grid_df[parameters].corr(method='spearman')
```

Out[14]:

	Accidents	Speed_Limit	Traffic_Volume	Traffic_Cameras	Traffic_Signals	Traffic_S
Accidents	1.000000	0.439067	0.803756	0.800618	0.940578	0.92
Speed_Limit	0.439067	1.000000	0.712159	0.193739	0.277248	0.36
Traffic_Volume	0.803756	0.712159	1.000000	0.590118	0.679468	0.71
Traffic_Cameras	0.800618	0.193739	0.590118	1.000000	0.792520	0.74
Traffic_Signals	0.940578	0.277248	0.679468	0.792520	1.000000	0.94
Traffic_Signs	0.929010	0.360214	0.714335	0.743034	0.943018	1.00

3.3.4 Weather conditions

As we are not seeing any correlations between weather conditions and accident counts, it may be helpful to confirm this conclusion by using quantitative tools as well.

As expected, all results from three methods are showing very weak correlations between weather conditions and traffic accident counts. However, on a sidenote, we can observe a somewhat positive correlation between temperature and visibility, which is also true by common sense.

In [15]:
```
parameters=['Accidents', 'Temperature', 'Visibility']
incident_df[parameters].corr(method='pearson')
```

Out[15]:

	Accidents	Temperature	Visibility
Accidents	1.000000	0.044856	0.037522
Temperature	0.044856	1.000000	0.229565
Visibility	0.037522	0.229565	1.000000

In [16]:
```
incident_df[parameters].corr(method='kendall')
```

Out[16]:

	Accidents	Temperature	Visibility
Accidents	1.000000	0.028576	0.024483
Temperature	0.028576	1.000000	0.157612
Visibility	0.024483	0.157612	1.000000

In [17]:
```
incident_df[parameters].corr(method='spearman')
```

Out[17]:

	Accidents	Temperature	Visibility
Accidents	1.000000	0.042133	0.036063
Temperature	0.042133	1.000000	0.230376
Visibility	0.036063	0.230376	1.000000

4. Visualization

4.1 Visualize the speed limit according to the roads. (5 Marks)

In [18]:
```
smap = folium.Map(location=[51.03011, -114.08529], zoom_start = 10)

style20 = {'fillColor': '#FAF9DF', 'color': '#FAF9DF'}
speed20_df = speed_gdf[(speed_gdf['SPEED']>=20) & (speed_gdf['SPEED']<35
)]
folium.GeoJson(speed20_df['multiline'], style_function=lambda x:style20)
.add_to(smap)

style30 = {'fillColor': '#FAF8B9', 'color': '#FAF8B9'}
speed30_df = speed_gdf[(speed_gdf['SPEED']>=30) & (speed_gdf['SPEED']<35
)]
folium.GeoJson(speed30_df['multiline'], style_function=lambda x:style30)
.add_to(smap)

style35 = {'fillColor': '#F7F265', 'color': '#F7F265'}
speed35_df = speed_gdf[(speed_gdf['SPEED']>=35) & (speed_gdf['SPEED']<40
)]
folium.GeoJson(speed35_df['multiline'], style_function=lambda x:style35)
.add_to(smap)

style40 = {'fillColor': '#E7E032', 'color': '#E7E032'}
speed40_df = speed_gdf[(speed_gdf['SPEED']>=40) & (speed_gdf['SPEED']<45
)]
folium.GeoJson(speed40_df['multiline'], style_function=lambda x:style40)
.add_to(smap)

style45 = {'fillColor': '#E7CF3A', 'color': '#E7CF3A'}
speed45_df = speed_gdf[(speed_gdf['SPEED']>=45) & (speed_gdf['SPEED']<60
)]
folium.GeoJson(speed45_df['multiline'], style_function=lambda x:style45)
.add_to(smap)

style60 = {'fillColor': '#D6A40A', 'color': '#D6A40A'}
speed60_df = speed_gdf[(speed_gdf['SPEED']>=60) & (speed_gdf['SPEED']<70
)]
folium.GeoJson(speed60_df['multiline'], style_function=lambda x:style60)
.add_to(smap)

style70 = {'fillColor': '#E0A536', 'color': '#E0A536'}
speed70_df = speed_gdf[(speed_gdf['SPEED']>=70) & (speed_gdf['SPEED']<80
)]
folium.GeoJson(speed70_df['multiline'], style_function=lambda x:style70)
.add_to(smap)

style80 = {'fillColor': '#E17515', 'color': '#E17515'}
speed80_df = speed_gdf[(speed_gdf['SPEED']>=80) & (speed_gdf['SPEED']<90
)]
folium.GeoJson(speed80_df['multiline'], style_function=lambda x:style80)
.add_to(smap)

style90 = {'fillColor': '#E14D15', 'color': '#E14D15'}
speed90_df = speed_gdf[(speed_gdf['SPEED']>=90) & (speed_gdf['SPEED']<10
0)]
folium.GeoJson(speed90_df['multiline'], style_function=lambda x:style90)
.add_to(smap)
```

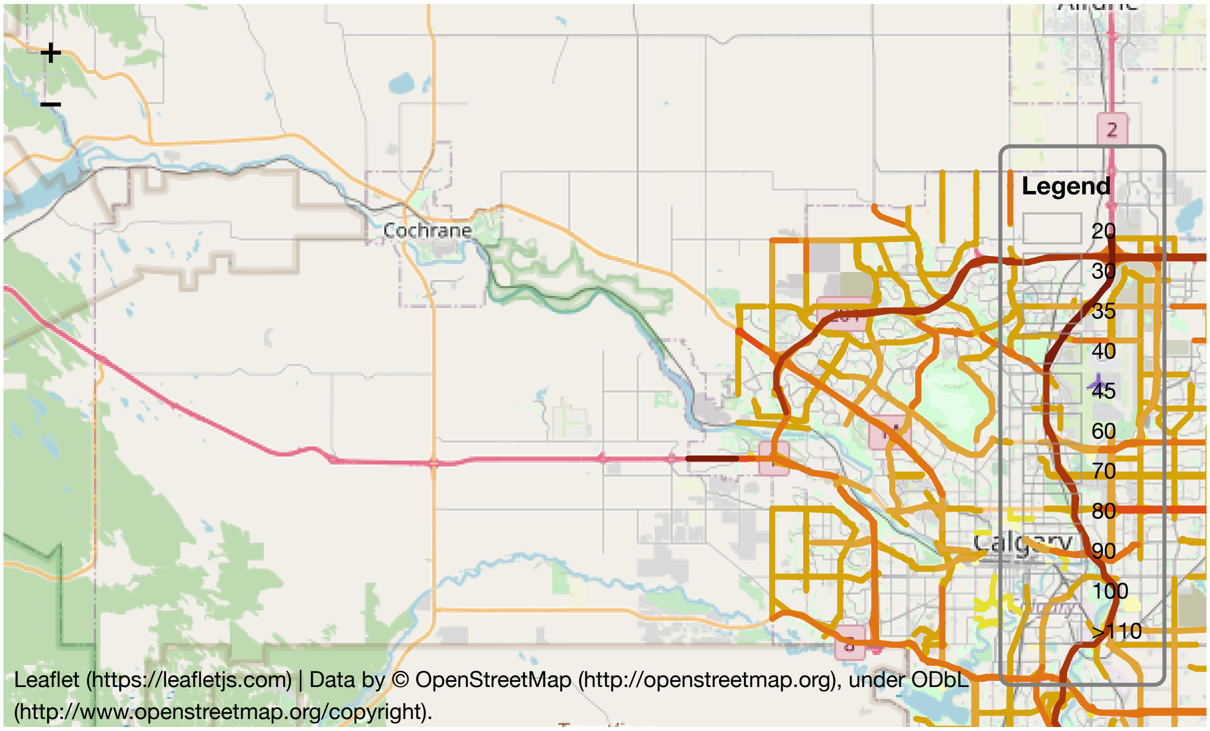
```
style100 = {'fillColor': '#AA370C', 'color': '#AA370C'}
speed100_df = speed_gdf[(speed_gdf['SPEED']>=100) & (speed_gdf['SPEED']<
110)]
folium.GeoJson(speed100_df['multiline'], style_function=lambda x:style10
0).add_to(smap)

style110 = {'fillColor': '#7B1C0B', 'color': '#7B1C0B'}
speed110_df = speed_gdf[(speed_gdf['SPEED']>=110)]
folium.GeoJson(speed110_df['multiline'], style_function=lambda x:style11
0).add_to(smap)
```

Out[18]: <folium.features.GeoJson at 0x1a179ac8d0>

In [19]:
```
# add legend info on to map and display
from branca.element import Template, MacroElement

template = """
{% macro html(this, kwargs) %}

<!doctype html>
<html lang="en">
<head>
  <meta charset="utf-8">
  <meta name="viewport" content="width=device-width, initial-scale=1">
  <title>jQuery UI Draggable - Default functionality</title>
  <link rel="stylesheet" href="//code.jquery.com/ui/1.12.1/themes/base/j
query-ui.css">

  <script src="https://code.jquery.com/jquery-1.12.4.js"></script>
  <script src="https://code.jquery.com/ui/1.12.1/jquery-ui.js"></script>

  <script>
  $( function() {
    $( "#maplegend" ).draggable({
                    start: function (event, ui) {
                        $(this).css({
                            right: "auto",
                            top: "auto",
                            bottom: "auto"
                        });
                    }
                });
});

  </script>
</head>
<body>


<div id='maplegend' class='maplegend'
    style='position: absolute; z-index:9999; border:2px solid grey; back
ground-color:rgba(255, 255, 255, 0.8);
     border-radius:6px; padding: 10px; font-size:14px; right: 20px; bott
om: 20px;'>

<div class='legend-title'>Legend</div>
<div class='legend-scale'>
  <ul class='legend-labels'>
    <li><span style='background:#FAF9DF;opacity:0.7;'></span>20</li>
    <li><span style='background:#FAF8B9;opacity:0.7;'></span>30</li>
    <li><span style='background:#F7F265;opacity:0.7;'></span>35</li>
    <li><span style='background:#E7E032;opacity:0.7;'></span>40</li>
    <li><span style='background:#E7CF3A;opacity:0.7;'></span>45</li>
    <li><span style='background:#D6A40A;opacity:0.7;'></span>60</li>
    <li><span style='background:#E0A536;opacity:0.7;'></span>70</li>
    <li><span style='background:#E17515;opacity:0.7;'></span>80</li>
    <li><span style='background:#E14D15;opacity:0.7;'></span>90</li>
    <li><span style='background:#AA370C;opacity:0.7;'></span>100</li>
    <li><span style='background:#7B1C0B;opacity:0.7;'></span>>110</li>
```

```
  </ul>
</div>
</div>

</body>
</html>

<style type='text/css'>
  .maplegend .legend-title {
    text-align: left;
    margin-bottom: 5px;
    font-weight: bold;
    font-size: 90%;
    }
  .maplegend .legend-scale ul {
    margin: 0;
    margin-bottom: 5px;
    padding: 0;
    float: left;
    list-style: none;
    }
  .maplegend .legend-scale ul li {
    font-size: 80%;
    list-style: none;
    margin-left: 0;
    line-height: 18px;
    margin-bottom: 2px;
    }
  .maplegend ul.legend-labels li span {
    display: block;
    float: left;
    height: 16px;
    width: 30px;
    margin-right: 5px;
    margin-left: 0;
    border: 1px solid #999;
    }
  .maplegend .legend-source {
    font-size: 80%;
    color: #777;
    clear: both;
    }
  .maplegend a {
    color: #777;
    }
</style>
{% endmacro %}"""

macro = MacroElement()
macro._template = Template(template)

smap.get_root().add_child(macro)

smap
```

Out[19]:



4.2 Show traffic heatmap of 2018. (5 Marks)

In [20]:
```
volume_points_df = pd.read_csv('volume_points_df.csv')
```

In [21]:
```
# create heat map  --hmap
```

In [22]:
```python
from folium import FeatureGroup, LayerControl, Map, Marker
from folium.plugins import HeatMap
hmap = folium.Map(location=[51.04011, -114.03529], zoom_start = 13,tiles
='cartodbpositron')
gradient = {.5: 'lightblue', .7: 'orange', .9:'red'}
hm_wide = HeatMap(list(zip(volume_points_df.latitude.values, volume_poin
ts_df.longitude.values, volume_points_df.volume)),
                    min_opacity=0.3,
                    gradient=gradient,
                    radius=8,
                    blur=2,
                    max_zoom=10
                )
hmap.add_child(hm_wide)
```

Out[22]: