# # 911 call Analysis

# Introduction - Description of the problem

**911.csv contains the call details to 911 from different locations. Provide as many insights as possible which will assist first responders for prioritizing their focus. First responders would like to know which area had maximum calls and see whether there is any modeling possible**

**Description of the data and how it will be used to solve the problem.**
**Please review the Results and Discussion after every analysis below**

# Description of the data and how it will be used to solve the problem.

```
Data - 911.csv, Dataset source - www.Kaggle.com

    lat : String variable, Latitude
    lng: String variable, Longitude
    desc: String variable, Description of the Emergency Call
    zip: String variable, Zipcode
    title: String variable, Title
    timeStamp: String variable, YYYY-MM-DD HH:MM:SS
    twp: String variable, Township
    addr: String variable, Address
    e: String variable, Dummy variable (always 1)
```

# Methodology

Below are the different steps that will be showcased in this project Exploratory analysis 1. of the data

1. Visualization of data using sea born
2. Identification of a major spike and visualizations
3. Data Summarization and visualization using Seaborn and WordCloud
4. Visualization of the Townships from where calls originated using Folium
5. Identification of the different neighborhoods using Foursquare API
6. Logistic regression on the data and analysis
7. Clustering of the data
8. Conclusion

# Results section

In [1]:
```
# Import the required libraries
import pandas as pd
import numpy as np
from bs4 import BeautifulSoup
import requests
```

In [2]:
```
# Import KMeans and graphic libraries
from sklearn.cluster import KMeans
import matplotlib.pyplot as plt
import seaborn as sns
```

In [3]:
```
import folium
```

In [4]:
```
CLIENT_ID='ZOO51K0TRLO3V1BXETAEBMWHHIO2C0DXTW05UWSNGTBS5G0E'
CLIENT_SECRET='ODKWIW1VFAKDYQ1PQNNJQU1RQDCA2QMV0UNTHXJHPBCR422B'
VERSION='20181511'
LIMIT=30
```

In [5]:

In [6]:

Out[6]:
```
Index(['lat', 'lng', 'desc', 'zip', 'title', 'timeStamp', 'twp', 'addr', 'e'], dty
pe='object')
```

In [7]:
```
# find out the size of the dataset
```

Out[7]:
```
(423909, 9)
```

In [8]:

Out[8]:

| | lat | lng | desc | zip | title | timeStamp | twp | addr | e |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 40.297876 | -75.581294 | REINDEER CT & DEAD END; NEW HANOVER; Station ... | 19525.0 | EMS: BACK PAINS/INJURY | 2015-12-10 17:10:52 | NEW HANOVER | REINDEER CT & DEAD END | 1 |
| **1** | 40.258061 | -75.264680 | BRIAR PATH & WHITEMARSH LN; HATFIELD TOWNSHIP... | 19446.0 | EMS: DIABETIC EMERGENCY | 2015-12-10 17:29:21 | HATFIELD TOWNSHIP | BRIAR PATH & WHITEMARSH LN | 1 |
| **2** | 40.121182 | -75.351975 | HAWS AVE; NORRISTOWN; 2015-12-10 @ 14:39:21-St... | 19401.0 | Fire: GAS-ODOR/LEAK | 2015-12-10 14:39:21 | NORRISTOWN | HAWS AVE | 1 |
| **3** | 40.116153 | -75.343513 | AIRY ST & SWEDE ST; NORRISTOWN; Station 308A;... | 19401.0 | EMS: CARDIAC EMERGENCY | 2015-12-10 16:47:36 | NORRISTOWN | AIRY ST & SWEDE ST | 1 |
| **4** | 40.251492 | -75.603350 | CHERRYWOOD CT & DEAD END; LOWER POTTSGROVE; S... | NaN | EMS: DIZZINESS | 2015-12-10 16:56:52 | LOWER POTTSGROVE | CHERRYWOOD CT & DEAD END | 1 |

In [9]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 423909 entries, 0 to 423908
Data columns (total 9 columns):
lat           423909 non-null float64
lng           423909 non-null float64
desc          423909 non-null object
zip           371780 non-null float64
title         423909 non-null object
timeStamp     423909 non-null object
twp           423750 non-null object
addr          423909 non-null object
e             423909 non-null int64
dtypes: float64(3), int64(1), object(5)
memory usage: 21.0+ MB
```

In [10]:
```
# Column title is in the format <short code> : <description>. Creating a new column sc
```

In [11]:

Out[11]:

| | lat | lng | desc | zip | title | timeStamp | twp | addr | e |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 40.297876 | -75.581294 | REINDEER CT & DEAD END; NEW HANOVER; Station ... | 19525.0 | EMS: BACK PAINS/INJURY | 2015-12-10 17:10:52 | NEW HANOVER | REINDEER CT & DEAD END | 1 |
| **1** | 40.258061 | -75.264680 | BRIAR PATH & WHITEMARSH LN; HATFIELD TOWNSHIP... | 19446.0 | EMS: DIABETIC EMERGENCY | 2015-12-10 17:29:21 | HATFIELD TOWNSHIP | BRIAR PATH & WHITEMARSH LN | 1 |
| **2** | 40.121182 | -75.351975 | HAWS AVE; NORRISTOWN; 2015-12-10 @ 14:39:21-St... | 19401.0 | Fire: GAS-ODOR/LEAK | 2015-12-10 14:39:21 | NORRISTOWN | HAWS AVE | 1 |
| **3** | 40.116153 | -75.343513 | AIRY ST & SWEDE ST; NORRISTOWN; Station 308A;... | 19401.0 | EMS: CARDIAC EMERGENCY | 2015-12-10 16:47:36 | NORRISTOWN | AIRY ST & SWEDE ST | 1 |
| **4** | 40.251492 | -75.603350 | CHERRYWOOD CT & DEAD END; LOWER POTTSGROVE; S... | NaN | EMS: DIZZINESS | 2015-12-10 16:56:52 | LOWER POTTSGROVE | CHERRYWOOD CT & DEAD END | 1 |

In [12]:
```
# twp apparently is Township. Just renaming the column to give it better sense
```

In [13]:
```
#Convering the zip to String removing and removing the decimal value
# Change nan to Not available to make it move readable
df['zip'] = df['zip'].astype(str)
df['zip'] = df['zip'].apply(lambda x : str(x).split('.')[0])
```

In [14]:

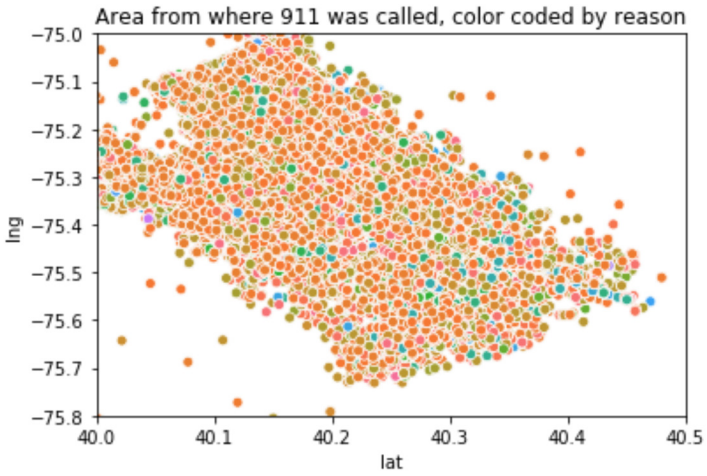
Out[14]:

| | lat | lng | desc | zip | title | timeStamp | Township | addr | e |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 40.297876 | -75.581294 | REINDEER CT & DEAD END; NEW HANOVER; Station ... | 19525 | EMS: BACK PAINS/INJURY | 2015-12-10 17:10:52 | NEW HANOVER | REINDEER CT & DEAD END | 1 |
| **1** | 40.258061 | -75.264680 | BRIAR PATH & WHITEMARSH LN; HATFIELD TOWNSHIP... | 19446 | EMS: DIABETIC EMERGENCY | 2015-12-10 17:29:21 | HATFIELD TOWNSHIP | BRIAR PATH & WHITEMARSH LN | 1 |
| **2** | 40.121182 | -75.351975 | HAWS AVE; NORRISTOWN; 2015-12-10 @ 14:39:21-St... | 19401 | Fire: GAS-ODOR/LEAK | 2015-12-10 14:39:21 | NORRISTOWN | HAWS AVE | 1 |
| **3** | 40.116153 | -75.343513 | AIRY ST & SWEDE ST; NORRISTOWN; Station 308A;... | 19401 | EMS: CARDIAC EMERGENCY | 2015-12-10 16:47:36 | NORRISTOWN | AIRY ST & SWEDE ST | 1 |
| **4** | 40.251492 | -75.603350 | CHERRYWOOD CT & DEAD END; LOWER POTTSGROVE; S... | Not Available | EMS: DIZZINESS | 2015-12-10 16:56:52 | LOWER POTTSGROVE | CHERRYWOOD CT & DEAD END | 1 |

**Lets start analyzing the data. Lets have a high level view on how the 911 calls are scattered, is it focused on a particular area or just scattered through out. Just to make it interesting , lets color code it based on the different title**

In [15]:
```
sns.scatterplot(x='lat',y='lng',hue='title',data=df,legend=False)
plt.ylim(-75.8, -75)
plt.xlim(40, 40.5)
```

Out[15]: Text(0.5,1,'Area from where 911 was called, color coded by reason')




**Looks like this does not help. Though it gives a general idea on the spread, it does not help in making any decisions. This is a crowded graph and is causing over plotting. Note that the legend is purposefully removed to make the graph visible**

**Lets get in to the dataset and find out moe about the data. Below table indicates that the maximum calls came from LOWER MERION. Below table shows the top 5 and bottom 5 Townships from where the calls originated**

In [16]:
```
print('911 calls - Top 5 Townships')
print(df['Township'].value_counts().head(5))
print(' ')
print('911 calls - Bottom 5 Townships')
```

```
911 calls - Top 5 Townships
LOWER MERION    36441
ABINGTON        25835
NORRISTOWN      23883
UPPER MERION    22694
CHELTENHAM      19629
Name: Township, dtype: int64

911 calls - Bottom 5 Townships
HATFIELD BORO    865
BRYN ATHYN       835
GREEN LANE       259
PHILA COUNTY     172
LEHIGH COUNTY     95
Name: Township, dtype: int64
```

**Lets start exploring the data. As one can see the 911 calls happen majorly for Vehicle accidents. As you can see top 2 reasons are related to Vehicles**

In [183]:
```
df['title'] = df['title'].astype(str)
print("Top 5 ")
print(df['title'].value_counts().head(5))
print("Bottom 5 ")
```

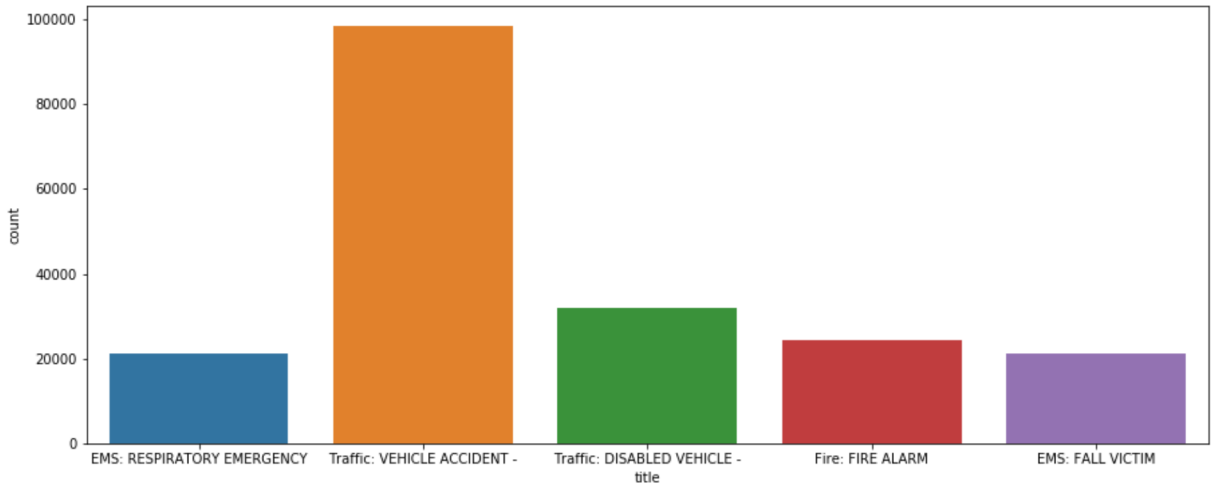
```
Top 5
Traffic: VEHICLE ACCIDENT -    98401
Traffic: DISABLED VEHICLE -    31871
Fire: FIRE ALARM               24380
EMS: FALL VICTIM               21253
EMS: RESPIRATORY EMERGENCY     21158
Name: title, dtype: int64
Bottom 5
EMS: HIT + RUN                 1
Fire: POISONING                1
Fire: UNRESPONSIVE SUBJECT     1
EMS: PUBLIC SERVICE            1
Fire: PRISONER IN CUSTODY      1
Name: title, dtype: int64
```

In [18]:
```
top5titles = ['Traffic: VEHICLE ACCIDENT -','Traffic: DISABLED VEHICLE -','Fire: FIRE
df_top5titles = df[df['title'].isin(top5titles)]
df_top5titles.head()
```

Out[18]:

| | lat | lng | desc | zip | title | timeStamp | Township | addr |
|---|---|---|---|---|---|---|---|---|
| **7** | 40.217286 | -75.405182 | COLLEGEVILLE RD & LYWISKI RD; SKIPPACK; Stati... | 19426 | EMS: RESPIRATORY EMERGENCY | 2015-12-10 16:17:05 | SKIPPACK | COLLEGEVILLE RD & LYWISKI RD |
| **9** | 40.102398 | -75.291458 | BLUEROUTE & RAMP I476 NB TO CHEMICAL RD; PLYM... | 19462 | Traffic: VEHICLE ACCIDENT - | 2015-12-10 17:35:41 | PLYMOUTH | BLUEROUTE & RAMP I476 NB TO CHEMICAL RD |
| **10** | 40.231990 | -75.251891 | RT202 PKWY & KNAPP RD; MONTGOMERY; 2015-12-10 ... | Not Available | Traffic: VEHICLE ACCIDENT - | 2015-12-10 17:33:50 | MONTGOMERY | RT202 PKWY & KNAPP RD |
| **11** | 40.084161 | -75.308386 | BROOK RD & COLWELL LN; PLYMOUTH; 2015-12-10 @ ... | 19428 | Traffic: VEHICLE ACCIDENT - | 2015-12-10 16:32:10 | PLYMOUTH | BROOK RD & COLWELL LN |
| **12** | 40.174131 | -75.098491 | BYBERRY AVE & S WARMINSTER RD; UPPER MORELAND;... | 19040 | Traffic: VEHICLE ACCIDENT - | 2015-12-10 17:15:49 | UPPER MORELAND | BYBERRY AVE & S WARMINSTER RD |

In [19]:
```
# Visualize the 911 calls for the top 5 titles
plt.figure(figsize=(15,6))
sns.countplot(x='title',data=df_top5titles)
```



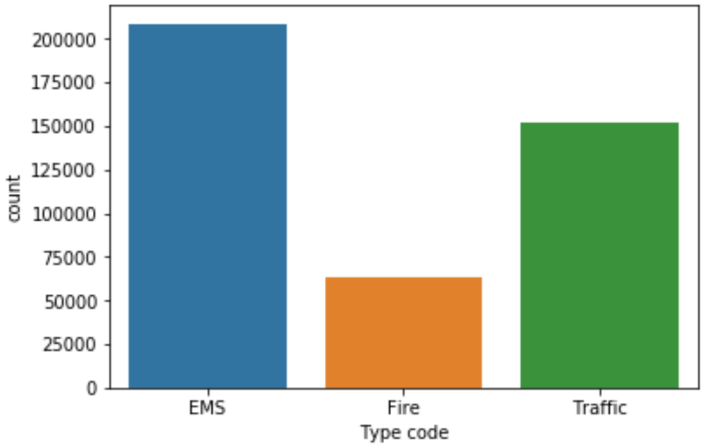

**Looks like there are three different type codes available for the title..**

1. **EMS**
2. **Fire**
3. **Traffic**

**Below is the viualization of the 911 calls against these three categories**

In [20]:

Out[20]: <matplotlib.axes._subplots.AxesSubplot at 0xfcd0d90>




**Lets explore the calls based on different time parameters.. Note that the type needs to be changed before moving ahead**

In [21]:

In [22]:

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 423909 entries, 0 to 423908
Data columns (total 10 columns):
lat           423909 non-null float64
lng           423909 non-null float64
desc          423909 non-null object
zip           423909 non-null object
title         423909 non-null object
timeStamp     423909 non-null datetime64[ns]
Township      423750 non-null object
addr          423909 non-null object
e             423909 non-null int64
Type code     423909 non-null object
dtypes: datetime64[ns](1), float64(2), int64(1), object(6)
memory usage: 22.6+ MB
```

In [23]:

```
#Create three different columns to capture Hour, month and Week day seperately
df['Hour'] = df['timeStamp'].apply(lambda x: x.hour)
df['Month'] = df['timeStamp'].apply(lambda x: x.month).map({1:'Jan',2:'Feb',3:'Mar',4:
                                                            7:'Jul',8:'Aug',9:'Se
df['Week Day'] = df['timeStamp'].apply(lambda x: x.dayofweek).map({0:'Mon',1:'Tue',2:'
```

In [24]:

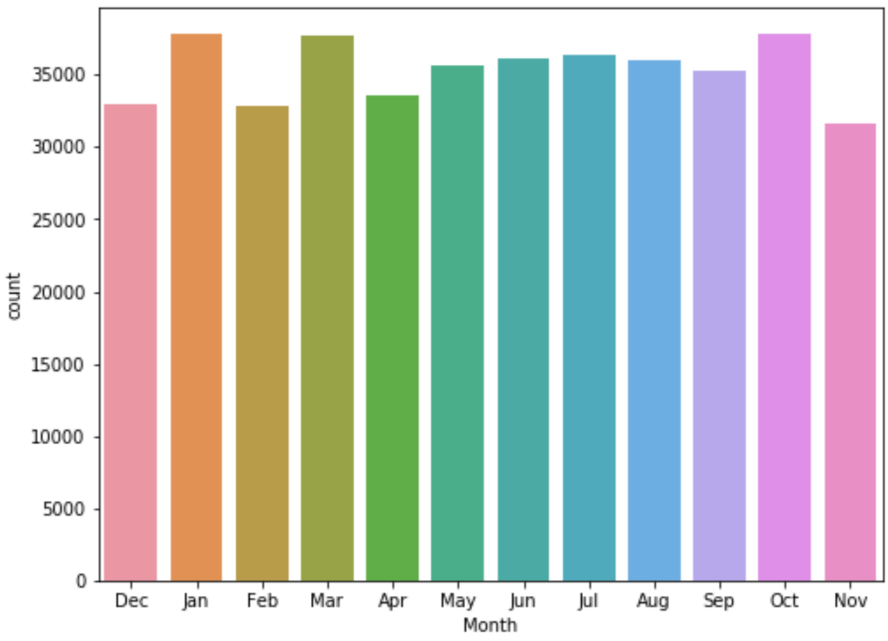
Out[24]:

| | lat | lng | desc | zip | title | timeStamp | Township | addr | e | Type code |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 40.297876 | -75.581294 | REINDEER CT & DEAD END; NEW HANOVER; Station ... | 19525 | EMS: BACK PAINS/INJURY | 2015-12-10 17:10:52 | NEW HANOVER | REINDEER CT & DEAD END | 1 | EMS |
| **1** | 40.258061 | -75.264680 | BRIAR PATH & WHITEMARSH LN; HATFIELD TOWNSHIP... | 19446 | EMS: DIABETIC EMERGENCY | 2015-12-10 17:29:21 | HATFIELD TOWNSHIP | BRIAR PATH & WHITEMARSH LN | 1 | EMS |

**Visualize the count of calls originated based on Month, week day and hour**

In [25]:
```
plt.figure(figsize=(8,6))
```

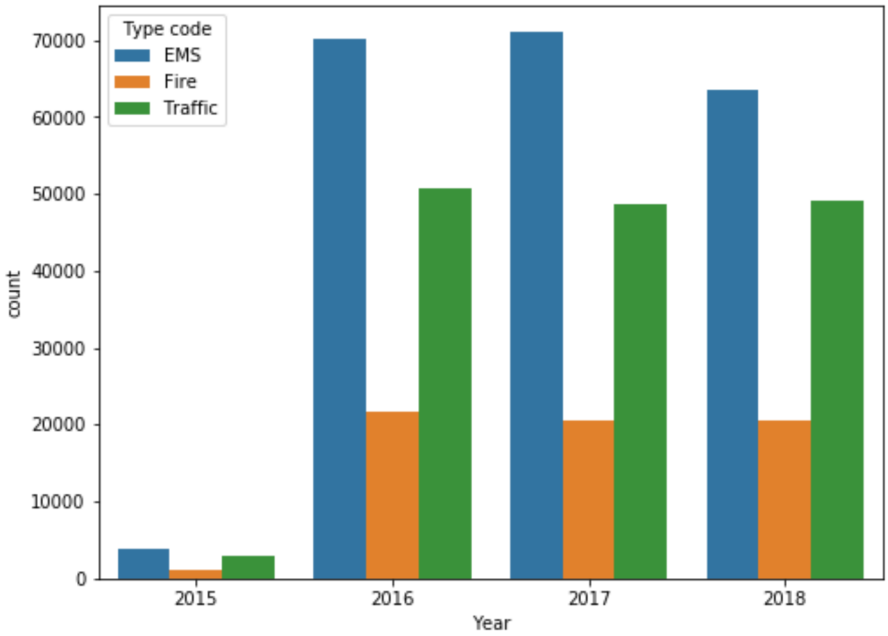
Out[25]: <matplotlib.axes._subplots.AxesSubplot at 0x4b12610>




**No definite pattern seen. Jan, Mar and Oct seems to be the highest hitters.. Other than that, no obvious pattern is seen. Lets move forward**

In [26]:
```
plt.figure(figsize=(8,6))
```

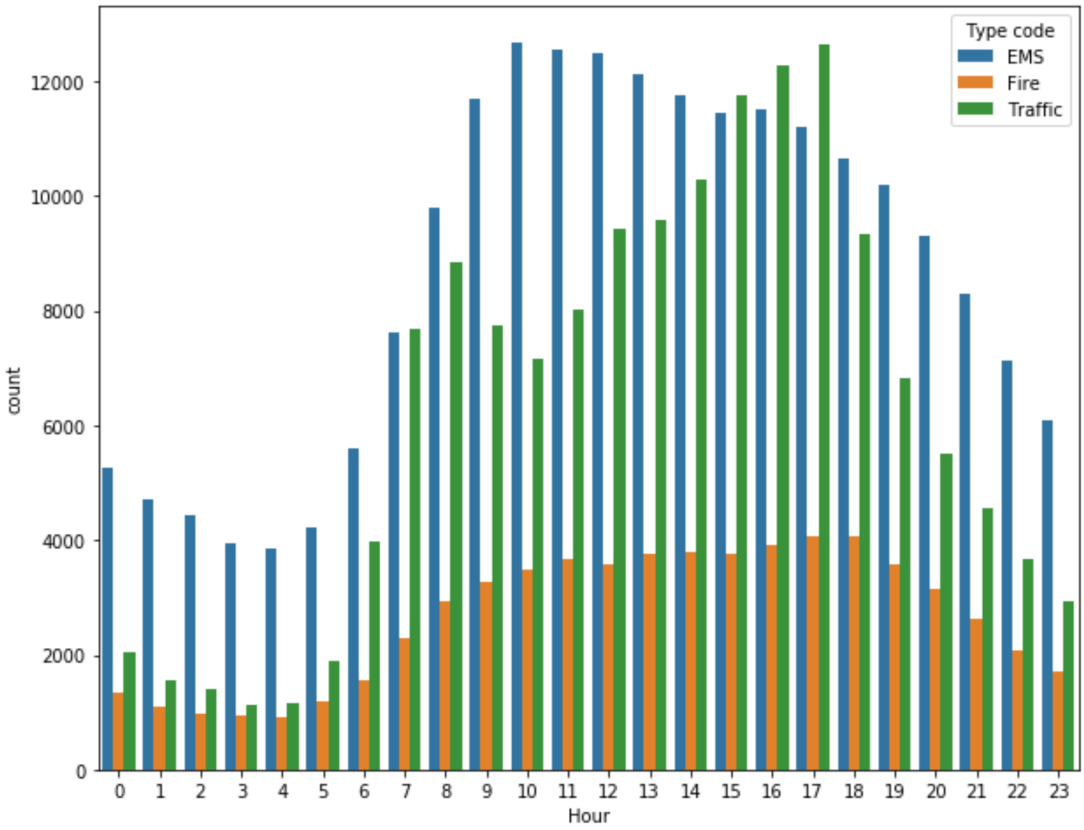
Out[26]:
```
<matplotlib.axes._subplots.AxesSubplot at 0xffc18d0>
```




**There seems to be a substantial jump in the number of call from 2015 to 2016.. This might be an anomaly. For all the years, the pattern seems to be the same for all three type codes, EMS type code is at the top , followed by Traffic and Fire**

In [27]:
```
plt.figure(figsize=(10,8))
```

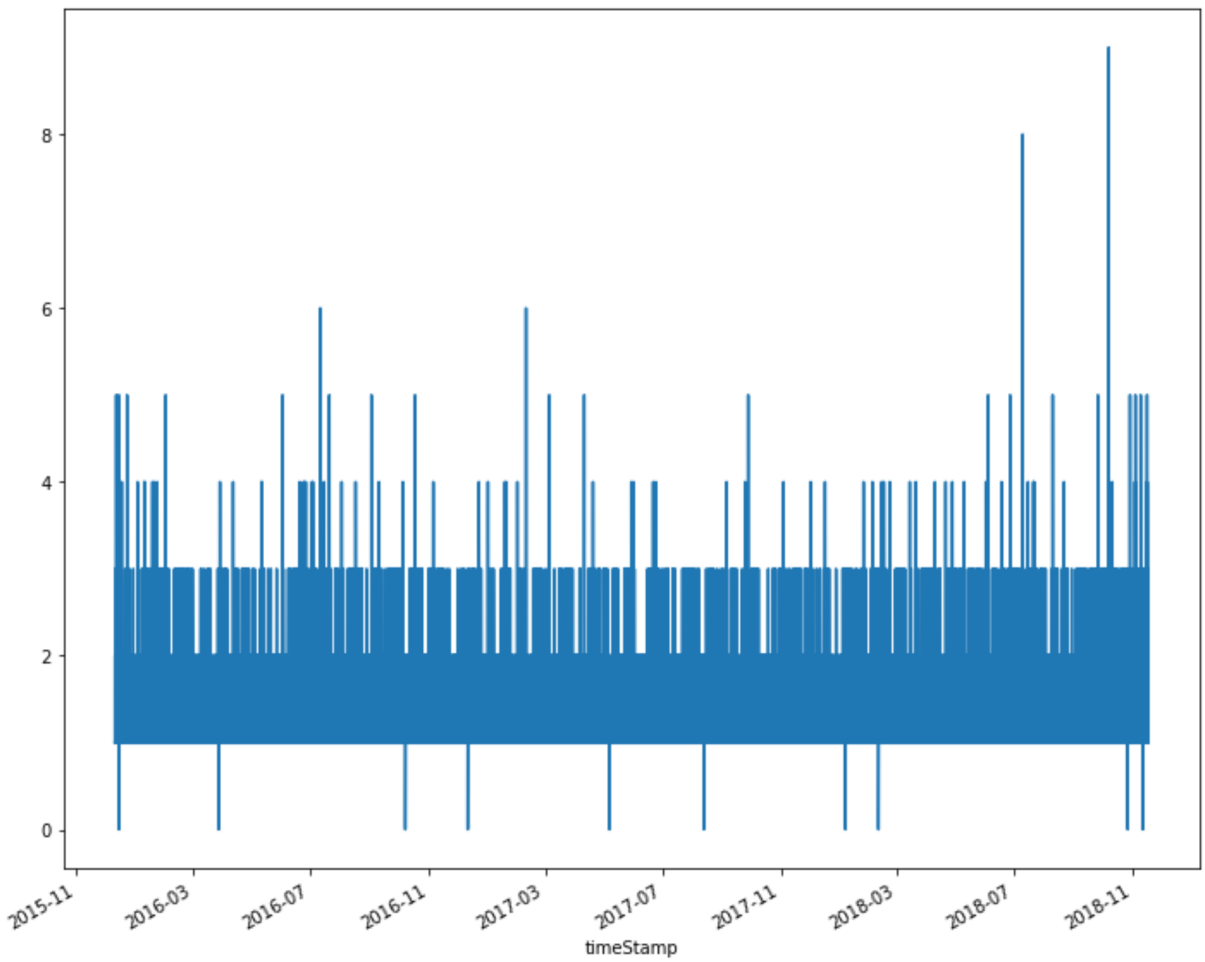
Out[27]:
```
<matplotlib.axes._subplots.AxesSubplot at 0xfcbcd70>
```




**1. Its interesting to note that, maximum calls happened between 4 PM and 6 PM for Traffic. May be because, that is the time when folks were rushing home**
**2. EMS related calls peaked at 09:00 AM and 10:00 AM and reducing as day progr eses**
**3. Fire related calls happened primariy during the business hours, reducing sh arply after 06:00 PM**

**Now lets try to plot the call on a time scale**

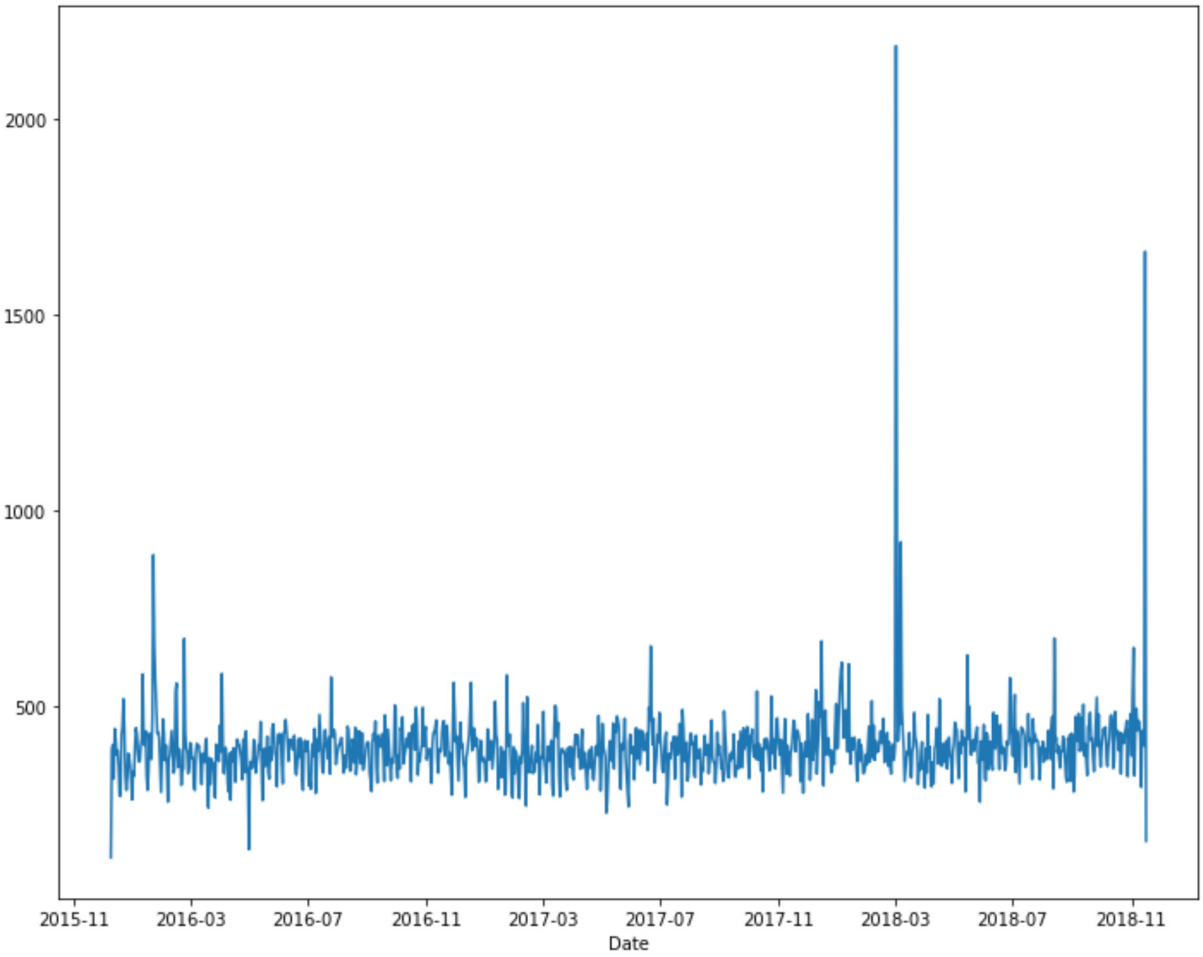
In [28]:
```
plt.figure(figsize=(10,8))
df.groupby('timeStamp').count()['Township'].plot()
```




The graph seems to be over crowded. Lets convert the timestamp to date and see whether the problem is getting sorted out

In [29]:

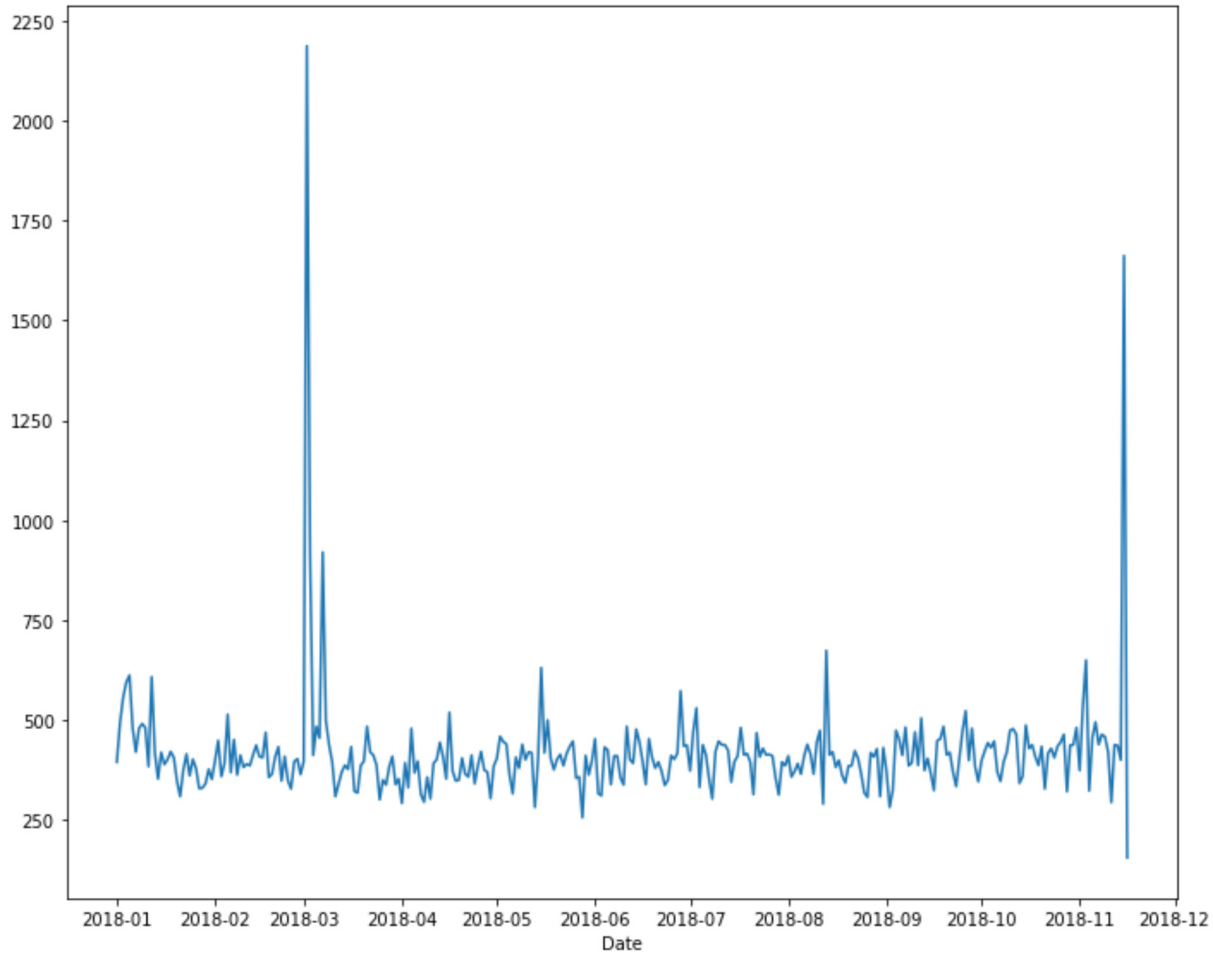
In [30]:
```
plt.figure(figsize=(10,8))
df.groupby('Date').count()['Township'].plot()
```




**What happened during the 2018 time frame why this spike.. Lets try to drill down a bit more and try to figure out**

In [31]:

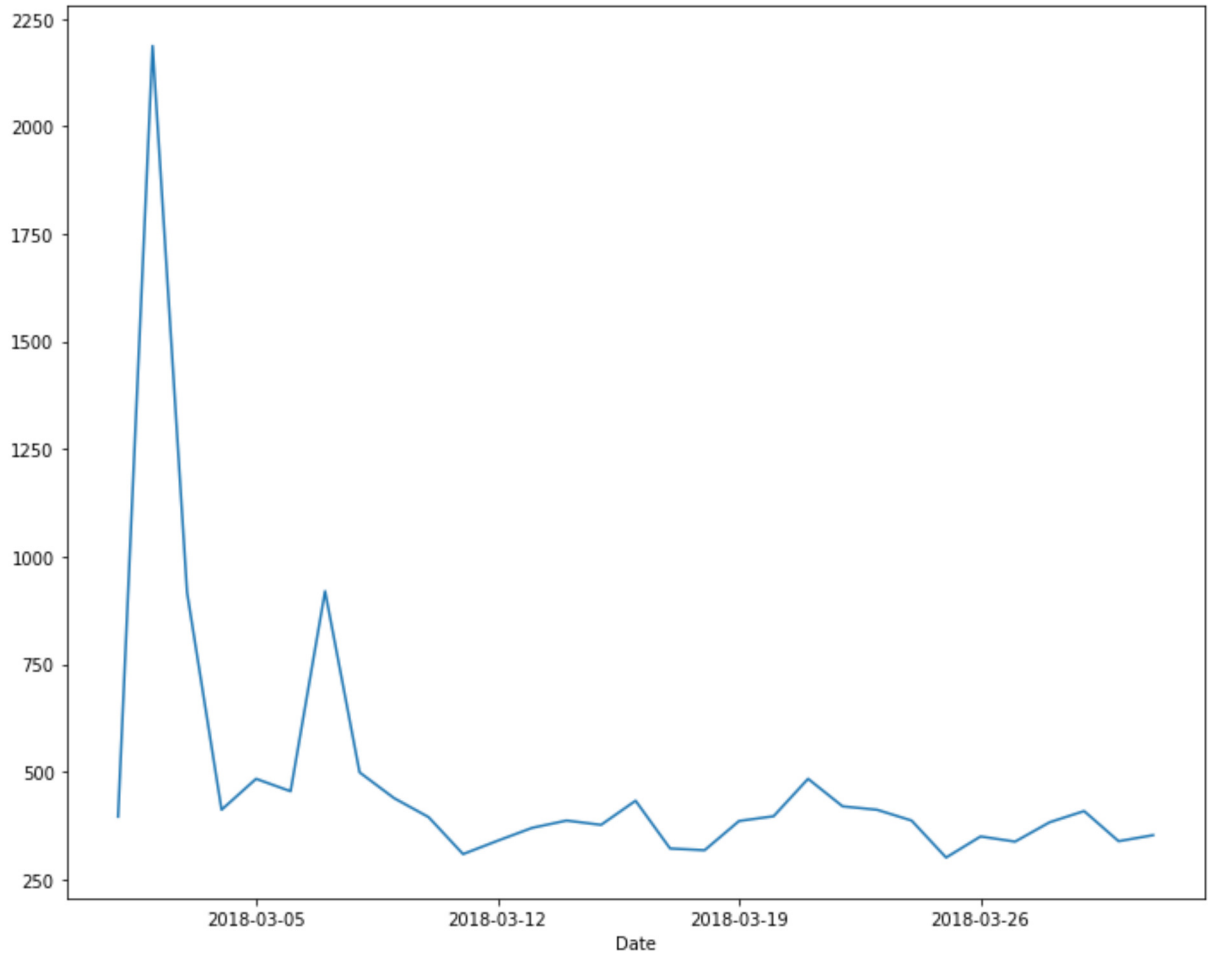
In [32]:
```
plt.figure(figsize=(10,8))
df_year2018.groupby('Date').count()['Township'].plot()
```




During the period of March, calls seems to have spiked.. Interesting. Lets drill down a bit more , this time with a hue on Type code

In [33]:

In [34]:
```
plt.figure(figsize=(10,8))
df_year2018_march.groupby('Date').count()['Township'].plot()
```




In [35]:
```
df_year2018_march['Dayno'] = df_year2018_march['Date'].apply(lambda x : x.day )
```

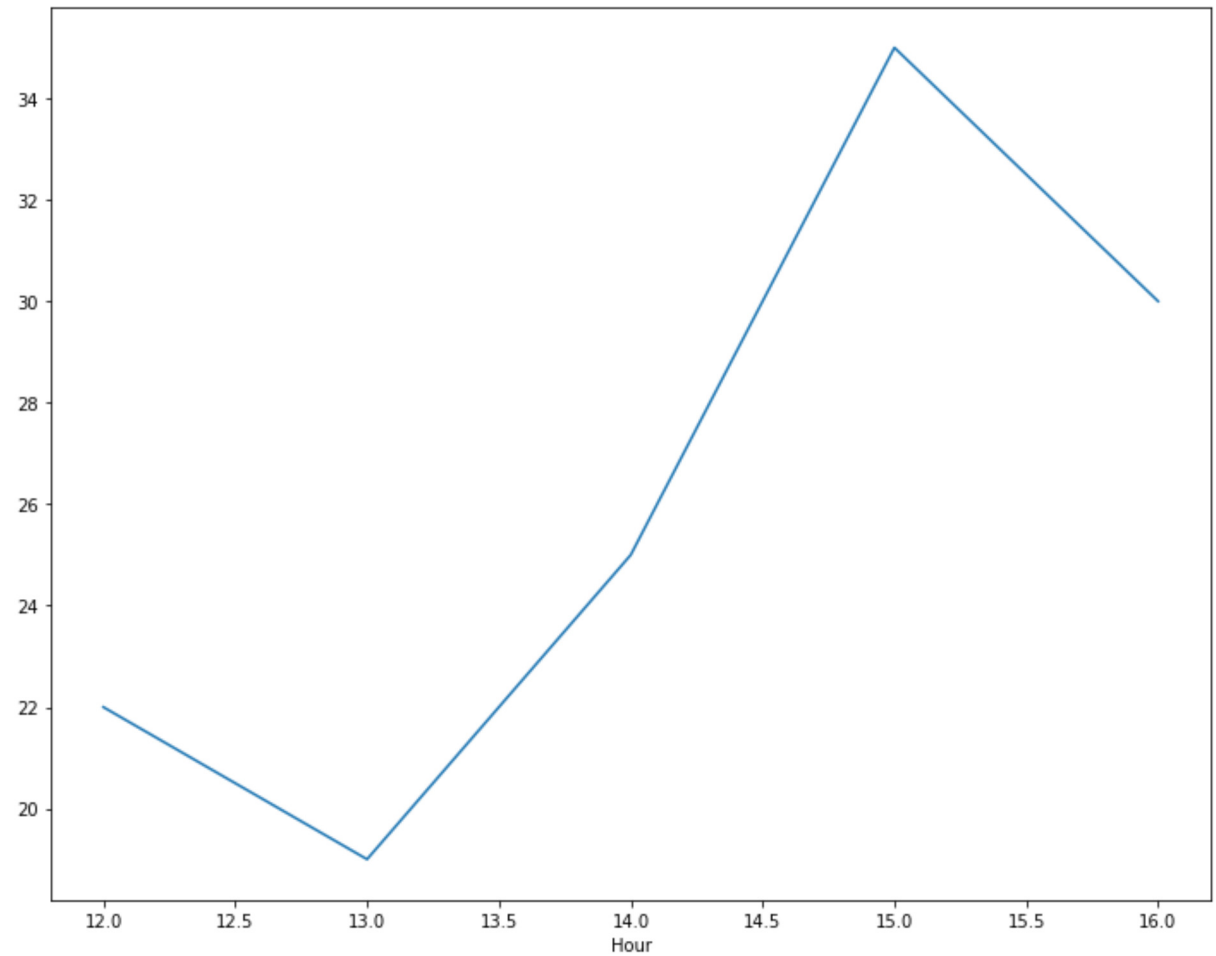
```
c:\users\ibm_admin\appdata\local\programs\python\python36-32\lib\site-packages\ipy
kernel_launcher.py:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/
indexing.html#indexing-view-versus-copy (http://pandas.pydata.org/pandas-docs/stab
le/indexing.html#indexing-view-versus-copy)
  """Entry point for launching an IPython kernel.
```

In [36]:
```
plt.figure(figsize=(8,8))
df_year2018_march_df.groupby('Hour').count()['Township'].plot()
```


In [37]:

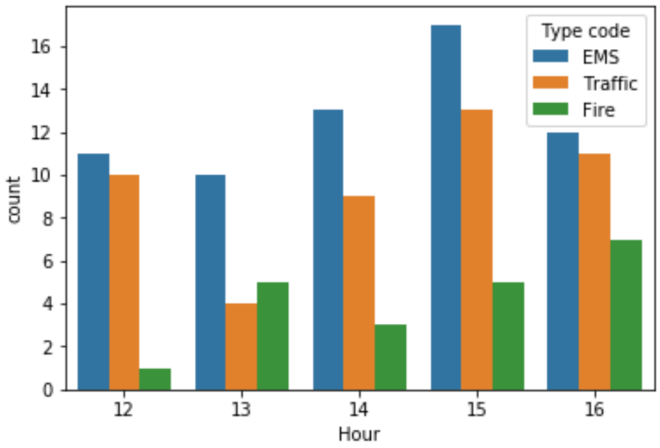
In [38]:
```
plt.figure(figsize=(10,8))
df_year2018_march_df_spiked.groupby('Hour').count()['Township'].plot()
```



**Call spiked at 1:15:31**

In [39]:

Out[39]: <matplotlib.axes._subplots.AxesSubplot at 0x1c9893f0>




Above are the different calls that happened during the piked period

In [40]:

Out[40]:

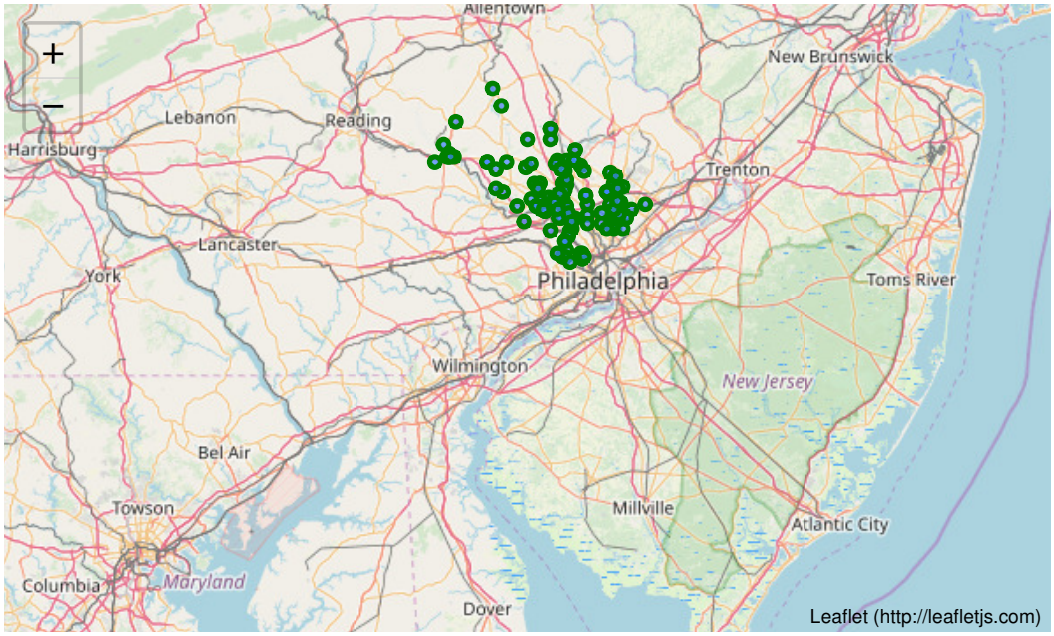
| | lat | lng | desc | zip | title | timeStamp | Township | addr | e | T c |
|---|---|---|---|---|---|---|---|---|---|---|
| **315040** | 40.236172 | -75.278918 | PENN ST & PARK DR; LANSDALE; Station 345; 201... | 19446 | EMS: ALLERGIC REACTION | 2018-03-01 12:00:10 | LANSDALE | PENN ST & PARK DR | 1 | E |
| **315043** | 40.148557 | -75.332151 | W GERMANTOWN PIKE & SCENIC RD; EAST NORRITON; ... | 19403 | Traffic: VEHICLE ACCIDENT - | 2018-03-01 12:01:49 | EAST NORRITON | W GERMANTOWN PIKE & SCENIC RD | 1 | Tra |

In [41]:
```
address = 'Philadelphia,USA'
geolocator = Nominatim()
location = geolocator.geocode(address)
latitude = location.latitude
longitude = location.longitude
print(latitude,longitude)

mymap = folium.Map(location = [latitude, longitude],zoom_start=10)
for lat,long,name in zip(df_year2018_march_df_spiked['lat'],df_year2018_march_df_spike
    label = '{}'.format(name)
    label = folium.Popup(label, parse_html=True)
    folium.CircleMarker(
          [lat, long],
          radius=3,
          popup=label,
          color='green',
          fill=True,
          fill_color='#4186FF',
          fill_opacity=0.7).add_to(mymap)
mymap
```

```
39.9524152 -75.1635755
```

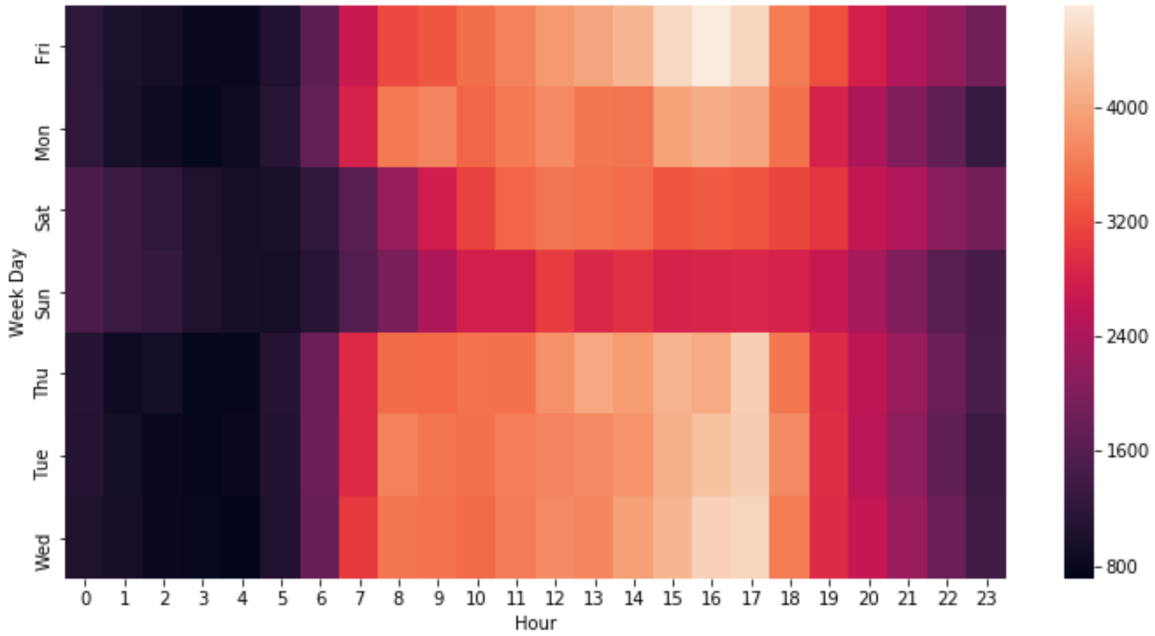
Out[41]:




**Above are the coordinates in the map from where the calls happened**

In [42]:
```
plt.figure(figsize=(12,6))
```

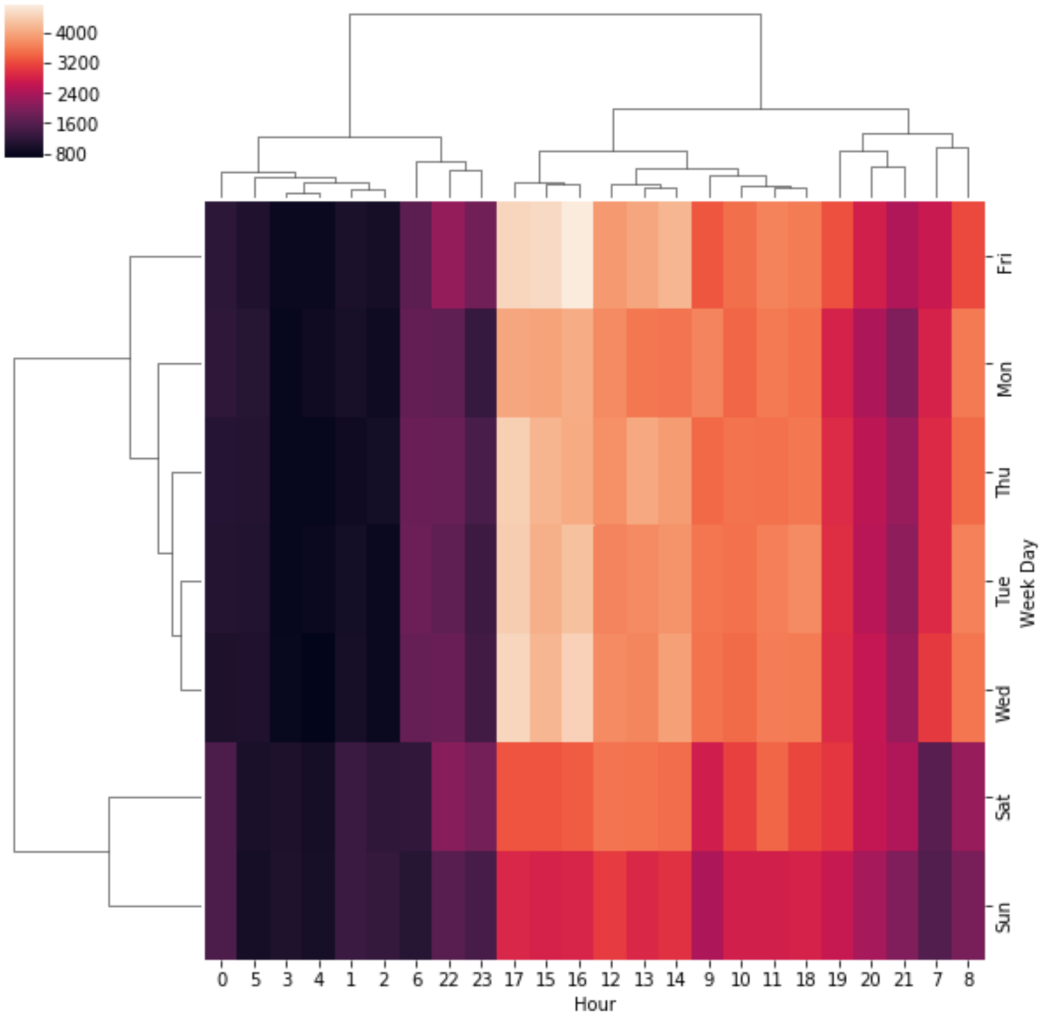
Out[42]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1c352930>
```




**Heat map on the 911 calls.. 17:00 during week days seems to be the time when most of the calls happen**

In [43]:

Out[43]: <seaborn.matrix.ClusterGrid at 0xfc967b0>




**Lets Generate a work cloud on the titles to see what pops up on the entire Dataset**

In [44]:
```
df['title'][4:].to_csv('title.csv')
```

In [45]:
```
from wordcloud import WordCloud, STOPWORDS
```

In [46]:
```
cat_wc = WordCloud(
    background_color='white',
    max_words=2000,
    stopwords=stopwords
```

In [47]:

Out[47]: <wordcloud.wordcloud.WordCloud at 0x1af3e0b0>

In [48]:
```
fig = plt.figure()
fig.set_figwidth(14) # set width
fig.set_figheight(18) # set height

# display the cloud
plt.imshow(cat_wc, interpolation='bilinear')
plt.axis('off')
```


**As expected , Vehicle accident and Traffic seems to be the one that is prominent**

**Now lets explore the venues around the areas when the spike happened. Above 2018 dataset is going to be the source**

In [54]:
```
df_2018 = pd.read_csv('Data/Montgomery_2018.csv')
df_2018.head()
```

Out[54]:

| | lat | lng | desc | zip | title | timeStamp | Township | |
|---|---|---|---|---|---|---|---|---|
| **315040** | 40.236172 | -75.278918 | PENN ST & PARK DR; LANSDALE; Station 345; 201... | 19446 | EMS: ALLERGIC REACTION | 2018-03-01 12:00:10 | LANSDALE | PENN S |
| **315043** | 40.148557 | -75.332151 | W GERMANTOWN PIKE & SCENIC RD; EAST NORRITON; ... | 19403 | Traffic: VEHICLE ACCIDENT - | 2018-03-01 12:01:49 | EAST NORRITON | W GERM PIKE & |
| **315044** | 40.116153 | -75.343513 | AIRY ST & SWEDE ST; NORRISTOWN; Station 308A;... | 19401 | EMS: CARDIAC EMERGENCY | 2018-03-01 12:05:52 | NORRISTOWN | A S\ |
| **315045** | 40.118073 | -75.355405 | LAFAYETTE ST & JAMISON ALY; NORRISTOWN; Stati... | 19401 | EMS: DIABETIC EMERGENCY | 2018-03-01 12:03:36 | NORRISTOWN | LAFAYE JAMI |

In [72]:
```
df_venue_all = pd.DataFrame()
venues = None
for lat,long,name  in zip(df_year2018_march_df_spiked['lat'],df_year2018_march_df_spik
    url = 'https://api.foursquare.com/v2/venues/search?client_id={}&client_secret={}&l
    results = requests.get(url).json()
    try:
        venues = results['response']['venues']
        df_venues = json_normalize(venues)
        #print(df_venues.shape)
        df_venues['Township'] = name
        df_venues['Latitude'] = lat
        df_venues['Longitude'] = long
        df_venue_all = df_venue_all.append(df_venues)
    except:
        pass
```

In [73]:

Out[73]:
```
Index(['Latitude', 'Longitude', 'Township', 'categories', 'delivery.id',
       'delivery.provider.icon.name', 'delivery.provider.icon.prefix',
       'delivery.provider.icon.sizes', 'delivery.provider.name',
       'delivery.url', 'events.count', 'events.summary', 'hasPerk', 'id',
       'location.address', 'location.cc', 'location.city', 'location.country',
       'location.crossStreet', 'location.distance',
       'location.formattedAddress', 'location.labeledLatLngs', 'location.lat',
       'location.lng', 'location.neighborhood', 'location.postalCode',
       'location.state', 'name', 'referralId', 'venuePage.id'],
      dtype='object')
```

In [74]:
```
df_venue_all.drop(['delivery.id',
       'delivery.provider.icon.name', 'delivery.provider.icon.prefix',
       'delivery.provider.icon.sizes', 'delivery.provider.name',
       'delivery.url', 'events.count', 'events.summary', 'hasPerk', 'id','location.cc'
        'location.formattedAddress', 'location.labeledLatLngs','location.state', 'refe
```

In [75]:

Out[75]:

| | Latitude | Longitude | Township | categories | location.address | location.crossStreet | location. |
|---|---|---|---|---|---|---|---|
| 0 | 40.236172 | -75.278918 | LANSDALE | [{'id': '4f4533814b9074f6e4fb0106', 'name': 'M... | 400 Penn St | NaN | |
| 1 | 40.236172 | -75.278918 | LANSDALE | [{'id': '4bf58dd8d48988d1e8941735', 'name': 'B... | NaN | NaN | |
| 2 | 40.236172 | -75.278918 | LANSDALE | [{'id': '4bf58dd8d48988d163941735', 'name': 'P... | 300 E. Main St. | NaN | |
| 3 | 40.236172 | -75.278918 | LANSDALE | [] | Broad street | NaN | |
| 4 | 40.236172 | -75.278918 | LANSDALE | [{'id': '4bf58dd8d48988d1fb941735', 'name': 'H... | NaN | Line St. & Penn St. | |

In [76]:
```
def get_category(row):
    category_list =  row['categories']
    if len(category_list)==0:
        return None
    else:
```

In [77]:
```
df_venue_all['categories'] = df_venue_all.apply(get_category,axis=1)
```

Out[77]:

| | Latitude | Longitude | Township | categories | location.address | location.crossStreet | location.distance | location |
|---|---|---|---|---|---|---|---|---|
| 0 | 40.236172 | -75.278918 | LANSDALE | Middle School | 400 Penn St | NaN | 46 | 40.235 |
| 1 | 40.236172 | -75.278918 | LANSDALE | Baseball Field | NaN | NaN | 35 | 40.236 |
| 2 | 40.236172 | -75.278918 | LANSDALE | Park | 300 E. Main St. | NaN | 43 | 40.236 |
| 3 | 40.236172 | -75.278918 | LANSDALE | None | Broad street | NaN | 598 | 40.241 |
| 4 | 40.236172 | -75.278918 | LANSDALE | Hobby Shop | NaN | Line St. & Penn St. | 204 | 40.237 |

In [78]:

Out[78]:
```
Township
LOWER MERION          450
NORRISTOWN            270
HORSHAM               270
ABINGTON              240
POTTSTOWN             180
UPPER GWYNEDD         180
WHITEMARSH            180
PLYMOUTH              180
CHELTENHAM            150
UPPER MORELAND        150
EAST NORRITON         150
MONTGOMERY            150
WHITPAIN              150
WEST NORRITON         120
WORCESTER             120
LIMERICK               90
AMBLER                 60
SOUDERTON              60
SPRINGFIELD            60
UPPER PROVIDENCE       60
LOWER PROVIDENCE       60
LOWER MORELAND         60
CHESTER COUNTY         60
UPPER DUBLIN           60
HATBORO                60
RED HILL               30
UPPER MERION           30
DOUGLASS               30
EAST GREENVILLE        30
JENKINTOWN             30
FRANCONIA              30
SKIPPACK               30
LANSDALE               30
WEST POTTSGROVE        30
WEST CONSHOHOCKEN      30
PERKIOMEN              30
LOWER SALFORD          30
Name: Latitude, dtype: int64
```

In [184]:

Out[184]:

| categories | |
|---|---|
| Office | 137 |
| Building | 108 |
| Doctor's Office | 84 |
| Automotive Shop | 66 |
| Gas Station | 59 |
| Church | 58 |
| Bank | 51 |
| Pizza Place | 46 |
| City | 46 |
| Medical Center | 43 |
| Bus Line | 41 |
| Gym | 41 |
| Dentist's Office | 41 |
| Intersection | 41 |
| Residential Building (Apartment / Condo) | 41 |
| Neighborhood | 40 |
| Salon / Barbershop | 40 |
| Other Great Outdoors | 39 |
| Park | 38 |
| Gym / Fitness Center | 36 |
| Miscellaneous Shop | 32 |
| Hotel | 29 |
| Mexican Restaurant | 28 |
| Nail Salon | 28 |
| Convenience Store | 28 |
| Café | 27 |
| Coffee Shop | 24 |
| Bar | 23 |
| American Restaurant | 22 |
| Fire Station | 22 |
| ... | ... |
| Fraternity House | 1 |
| Fountain | 1 |
| Market | 1 |
| Convention Center | 1 |
| Performing Arts Venue | 1 |
| Mattress Store | 1 |
| Outlet Mall | 1 |
| Other Repair Shop | 1 |
| Food Truck | 1 |
| Nursery School | 1 |
| Nightlife Spot | 1 |
| College Auditorium | 1 |
| Nature Preserve | 1 |
| Mountain | 1 |
| Motorcycle Shop | 1 |
| Motel | 1 |
| Mosque | 1 |
| College Quad | 1 |
| College Rec Center | 1 |
| Monument / Landmark | 1 |
| College Science Building | 1 |
| College Technology Building | 1 |
| Men's Store | 1 |
| Comic Shop | 1 |
| Community Center | 1 |
| Memorial Site | 1 |
| Meeting Room | 1 |
| Mediterranean Restaurant | 1 |
| Medical Supply Store | 1 |
| Yoga Studio | 1 |

**Most of the calls originated from LOWER MERION**

In [81]:

Out[81]:
```
Index(['lat', 'lng', 'desc', 'zip', 'title', 'timeStamp', 'Township', 'addr',
       'e', 'Type code', 'Hour', 'Month', 'Week Day', 'Year', 'Date', 'Y'],
      dtype='object')
```

In [80]:

In [98]:
```
X = df[['lat', 'lng','Hour', 'Month', 'Week Day', 'Year']]
Y = df['Y']
X['Month'] = X['Month'].map({'Jan':1,'Feb':2,'Mar':3,'Apr':4,'May':5,'Jun':6,
                             'Jul':7,'Aug':8,'Sep':9,'Oct':10,'Nov':11,'Dec':12})
```

```
c:\users\ibm_admin\appdata\local\programs\python\python36-32\lib\site-packages\ipy
kernel_launcher.py:4: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/
indexing.html#indexing-view-versus-copy (http://pandas.pydata.org/pandas-docs/stab
le/indexing.html#indexing-view-versus-copy)
  after removing the cwd from sys.path.
c:\users\ibm_admin\appdata\local\programs\python\python36-32\lib\site-packages\ipy
kernel_launcher.py:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/
indexing.html#indexing-view-versus-copy (http://pandas.pydata.org/pandas-docs/stab
le/indexing.html#indexing-view-versus-copy)
  """
```

In [99]:

In [100]:

In [101]:
```
from sklearn.linear_model import LogisticRegression
logmodel = LogisticRegression()
```

```
c:\users\ibm_admin\appdata\local\programs\python\python36-32\lib\site-packages\skl
earn\linear_model\logistic.py:432: FutureWarning: Default solver will be changed t
o 'lbfgs' in 0.22. Specify a solver to silence this warning.
  FutureWarning)
```

Out[101]:
```
LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
          intercept_scaling=1, max_iter=100, multi_class='warn',
          n_jobs=None, penalty='l2', random_state=None, solver='warn',
          tol=0.0001, verbose=0, warm_start=False)
```

In [102]:

In [103]:

In [104]:

```
              precision    recall  f1-score   support

           0       0.55      0.63      0.59     71013
           1       0.55      0.46      0.50     68877

   micro avg       0.55      0.55      0.55    139890
   macro avg       0.55      0.55      0.54    139890
weighted avg       0.55      0.55      0.55    139890
```

In [117]:

Out[117]:

```
0          NEW HANOVER
1    HATFIELD TOWNSHIP
2           NORRISTOWN
3           NORRISTOWN
4     LOWER POTTSGROVE
Name: Township, dtype: object
```

In [132]:

```
n = df['Township'].nunique()
t = df['Township'].unique()
tdict = {}
for i,tname in zip(range(n+1),t):
    tdict[tname] = i
tdict
```

In [143]:
```
df['Y'] = df['Type code'].apply(lambda x : 1 if x=='EMS' else 0)
X = df[['lat', 'lng','Hour', 'Month', 'Week Day', 'Year','nTownship']]
Y = df['Y']
X['Month'] = X['Month'].map({'Jan':1,'Feb':2,'Mar':3,'Apr':4,'May':5,'Jun':6,
                             'Jul':7,'Aug':8,'Sep':9,'Oct':10,'Nov':11,'Dec':12})
X['Week Day'] = X['Week Day'].map({'Mon':1,'Tue':2,'Wed':3,'Thu':4,'Fri':5,'Sat':6,'S
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
logmodel = LogisticRegression()
logmodel.fit(X_train,y_train)
predictions = logmodel.predict(X_test)
from sklearn.metrics import classification_report
```

```
c:\users\ibm_admin\appdata\local\programs\python\python36-32\lib\site-packages\ipy
kernel_launcher.py:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/
indexing.html#indexing-view-versus-copy (http://pandas.pydata.org/pandas-docs/stab
le/indexing.html#indexing-view-versus-copy)
  """
c:\users\ibm_admin\appdata\local\programs\python\python36-32\lib\site-packages\ipy
kernel_launcher.py:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/
indexing.html#indexing-view-versus-copy (http://pandas.pydata.org/pandas-docs/stab
le/indexing.html#indexing-view-versus-copy)

c:\users\ibm_admin\appdata\local\programs\python\python36-32\lib\site-packages\skl
earn\linear_model\logistic.py:432: FutureWarning: Default solver will be changed t
o 'lbfgs' in 0.22. Specify a solver to silence this warning.
  FutureWarning)
```

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| 0 | 0.55 | 0.63 | 0.59 | 71013 |
| 1 | 0.55 | 0.46 | 0.50 | 68877 |
| micro avg | 0.55 | 0.55 | 0.55 | 139890 |
| macro avg | 0.55 | 0.55 | 0.54 | 139890 |
| weighted avg | 0.55 | 0.55 | 0.55 | 139890 |

In [136]:
```
n = df['title'].nunique()
t = df['title'].unique()
tdict = {}
for i,tname in zip(range(n+1),t):
    tdict[tname] = i
tdict
```

In [138]:
```
df['Y'] = df['Type code'].apply(lambda x : 1 if x=='EMS' else 0)

X = df[['lat', 'lng','Hour', 'Month', 'Week Day', 'Year','nTownship','ntitle']]
Y = df['Y']
X['Month'] = X['Month'].map({'Jan':1,'Feb':2,'Mar':3,'Apr':4,'May':5,'Jun':6,
                             'Jul':7,'Aug':8,'Sep':9,'Oct':10,'Nov':11,'Dec':12})
X['Week Day'] = X['Week Day'].map({'Mon':1,'Tue':2,'Wed':3,'Thu':4,'Fri':5,'Sat':6,'S
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
logmodel = LogisticRegression()
logmodel.fit(X_train,y_train)
predictions = logmodel.predict(X_test)
from sklearn.metrics import classification_report,confusion_matrix
print(classification_report(y_test,predictions))
```

```
c:\users\ibm_admin\appdata\local\programs\python\python36-32\lib\site-packages\ipy
kernel_launcher.py:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/
indexing.html#indexing-view-versus-copy (http://pandas.pydata.org/pandas-docs/stab
le/indexing.html#indexing-view-versus-copy)
  """
c:\users\ibm_admin\appdata\local\programs\python\python36-32\lib\site-packages\ipy
kernel_launcher.py:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/
indexing.html#indexing-view-versus-copy (http://pandas.pydata.org/pandas-docs/stab
le/indexing.html#indexing-view-versus-copy)

c:\users\ibm_admin\appdata\local\programs\python\python36-32\lib\site-packages\skl
earn\linear_model\logistic.py:432: FutureWarning: Default solver will be changed t
o 'lbfgs' in 0.22. Specify a solver to silence this warning.
  FutureWarning)
              precision    recall  f1-score   support

           0       0.55      0.63      0.59     71013
           1       0.55      0.46      0.50     68877

   micro avg       0.55      0.55      0.55    139890
   macro avg       0.55      0.55      0.54    139890
weighted avg       0.55      0.55      0.55    139890

[[44976 26037]
 [37057 31820]]
```

In [145]:
```
```

Out[145]:
```
Index(['lat', 'lng', 'desc', 'zip', 'title', 'timeStamp', 'Township', 'addr',
       'e', 'Type code', 'Hour', 'Month', 'Week Day', 'Year', 'Date', 'Y',
       'nTownship', 'ntitle'],
      dtype='object')
```

In [150]:
```
n = df['desc'].nunique()
t = df['desc'].unique()
tdict = {}
for i,tname in zip(range(n+1),t):
    tdict[tname] = i
tdict
```

In [151]:
```
n = df['title'].nunique()
t = df['title'].unique()
tdict = {}
for i,tname in zip(range(n+1),t):
    tdict[tname] = i
tdict
```

In [160]:

In [161]:

Out[161]:
```
Index(['lat', 'lng', 'desc', 'zip', 'title', 'timeStamp', 'Township', 'addr',
       'e', 'Type code', 'Hour', 'Month', 'Week Day', 'Year', 'Date', 'Y',
       'nTownship', 'ntitle', 'ndesc'],
      dtype='object')
```

In [162]:

In [163]:
```
df_kmean['Month'] = df_kmean['Month'].map({'Jan':1,'Feb':2,'Mar':3,'Apr':4,'May':5,'J
                                'Jul':7,'Aug':8,'Sep':9,'Oct':10,'Nov':11,'Dec':12})
```

In [164]:

Out[164]:

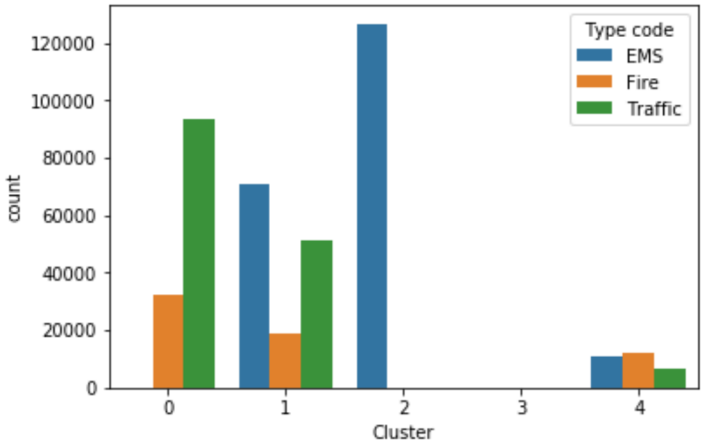
| | lat | lng | Hour | Month | Week Day | Year | Y | nTownship | ntitle | ndesc |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 40.297876 | -75.581294 | 17 | 12 | 4 | 2015 | 1 | 0 | 0 | 0 |
| **1** | 40.258061 | -75.264680 | 17 | 12 | 4 | 2015 | 1 | 1 | 1 | 1 |
| **2** | 40.121182 | -75.351975 | 14 | 12 | 4 | 2015 | 0 | 2 | 2 | 2 |
| **3** | 40.116153 | -75.343513 | 16 | 12 | 4 | 2015 | 1 | 2 | 3 | 3 |
| **4** | 40.251492 | -75.603350 | 16 | 12 | 4 | 2015 | 1 | 3 | 4 | 4 |

In [175]:
```
from sklearn.preprocessing import StandardScaler
df_kmean = StandardScaler().fit_transform(df_kmean)
c = 5

k_means = KMeans(init = "k-means++", n_clusters = c, n_init = 12)
k_means.fit(df_kmean)
```

In [181]:

Out[181]: <matplotlib.axes._subplots.AxesSubplot at 0x1af17d30>




In [178]:

Out[178]: 5

In [177]:

Out[177]:

| | lat | lng | desc | zip | title | timeStamp | Township | addr | e | Type code | ... |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **357795** | 22.986757 | 87.854975 | RT202 SB & RAMP RT202 SB TO I76 WB; UPPER MERI... | Not Available | Traffic: VEHICLE ACCIDENT - | 2018-06-11 16:59:29 | UPPER MERION | RT202 SB & RAMP RT202 SB TO I76 WB | 1 | Traffic | ... |
| **369428** | 26.820553 | 30.802498 | RAMP EGYPT RD TO RT422 EB & EGYPT RD; UPPER PR... | Not Available | Traffic: VEHICLE ACCIDENT - | 2018-07-10 08:10:38 | UPPER PROVIDENCE | RAMP EGYPT RD TO RT422 EB & EGYPT RD | 1 | Traffic | ... |
| **398440** | 0.000000 | 0.000000 | RAMP EGYPT RD TO RT422 & EGYPT RD; UPPER PRO... | Not Available | EMS: UNKNOWN MEDICAL EMERGENCY | 2018-09-20 07:07:49 | UPPER PROVIDENCE | RAMP EGYPT RD TO RT422 & EGYPT RD | 1 | EMS | ... |
| **398739** | 22.986757 | 87.854975 | RAMP RT202 SB TO I76 WB & RAMP N GULPH RD TO I... | Not Available | Traffic: DISABLED VEHICLE - | 2018-09-20 20:01:42 | UPPER MERION | RAMP RT202 SB TO I76 WB & RAMP N GULPH RD TO I... | 1 | Traffic | ... |
| **398740** | 22.986757 | 87.854975 | RAMP RT202 SB TO I76 WB & RAMP N GULPH RD TO I... | Not Available | Traffic: DISABLED VEHICLE - | 2018-09-20 20:02:29 | UPPER MERION | RAMP RT202 SB TO I76 WB & RAMP N GULPH RD TO I... | 1 | Traffic | ... |

5 rows × 21 columns

In [179]:

Out[179]:

| | lat | lng | desc | zip | title | timeStamp | Township | addr | e |
|---|---|---|---|---|---|---|---|---|---|
| **4** | 40.251492 | -75.603350 | CHERRYWOOD CT & DEAD END; LOWER POTTSGROVE; S... | Not Available | EMS: DIZZINESS | 2015-12-10 16:56:52 | LOWER POTTSGROVE | CHERRYWOOD CT & DEAD END | 1 |
| **10** | 40.231990 | -75.251891 | RT202 PKWY & KNAPP RD; MONTGOMERY; 2015-12-10 ... | Not Available | Traffic: VEHICLE ACCIDENT - | 2015-12-10 17:33:50 | MONTGOMERY | RT202 PKWY & KNAPP RD | 1 |
| **14** | 40.097222 | -75.376195 | SCHUYLKILL EXPY & CROTON RD UNDERPASS; UPPER M... | Not Available | Traffic: VEHICLE ACCIDENT - | 2015-12-10 17:09:49 | UPPER MERION | SCHUYLKILL EXPY & CROTON RD UNDERPASS | 1 |
| **23** | 40.143326 | -75.422819 | RT422 & PAWLINGS RD OVERPASS; LOWER PROVIDENC... | Not Available | Traffic: DISABLED VEHICLE - | 2015-12-10 18:00:38 | LOWER PROVIDENCE | RT422 & PAWLINGS RD OVERPASS | 1 |
| **24** | 40.153268 | -75.189558 | SUMMIT AVE & RT309 UNDERPASS; UPPER DUBLIN; 20... | Not Available | Traffic: VEHICLE ACCIDENT - | 2015-12-10 17:58:22 | UPPER DUBLIN | SUMMIT AVE & RT309 UNDERPASS | 1 |

5 rows × 21 columns

# Conclusion

1. **Data set has 423909 rows and 9 columns**
2. **maximum calls came from LOWER MERION, Least being LEHIGH COUNTY**
3. **Maximum calls happen due to Vehicle accidents**
4. **Calls belong to the below three categories**
   a. **EMS**
   b. **Fire**
   c. **Traffic**
5. **Calls under EMS category is the highest reason , followed by Fire and Traffic**
6. **Jan, Mar and Oct seems to be the highest hitters for the entire dataset**
7. **2015 data in the dataset seems to be having only a subset of the actual data. There seems to be a substantial jump in the number of call from 2015 to 2016.For all the years, the pattern seems to be the same for all three type codes, EMS type code is at the top , followed by Traffic and Fire**
8. **Maximum calls happened between 4 PM and 6 PM for Traffic**
9. **During March 2018 timeframe there has been a spike in the calls . Looking at the summary , looks like it is from LOWER MERION township that maximum calls originated Based on the different venues, looks like the calls originated which are near to Office building**
10. **Looking at the heat map, 17:00 during week days seems to be the time when most of the calls happen**
11. **Word cloud has Traffic accidents clearly standing out**
12. **Logitic regression does not yield good results, Probably the dataset does not have enough for logitic regression to work. Maximum accuracy that was achieved was just 55 %**
13. **Clustering algorithm, segrated all the records where the zip codes are not available.**
    a. **Cluster 0 - Maximum Traffic related calls**
    b. **Cluster 1 - Maximum EMS related calls**
    c. **Cluster 2 - Zip code is missing**
    d. **Cluster 3 - where the calls were at the minimum**

In [ ]: