FORECASTING 911 CALLS (CITY OF CINCCINNATI)

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Contents

1.1 Background

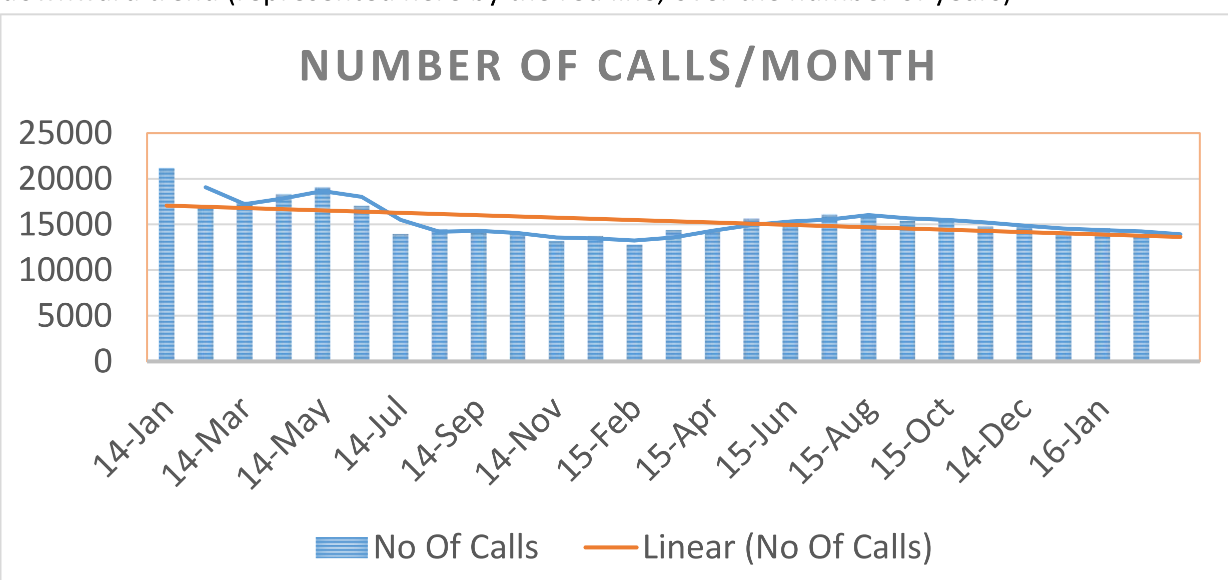
- The city of Cincinnati wants to overhaul the current emergency response mechanism.
- No prediction mechanism is in place to predict the expected number of 911 emergency calls on a monthly/yearly basis.
- No seasonal trend taken into account to assist in resource scheduling and optimization.
- Often the responses are not aligned with seasonal trends/requirements.

1.2 Purpose

- Produce quarterly predictions for EMS services.
- Categorize and identify high risk areas
- Identify Fire stations which will be impacted by high risk areas

2. Data – The data used for the analysis was collected by the City Of Cincinnati from January 2014 to February 2016.

3. Exploratory Analysis – Exploratory Analysis reveals that the data has a gradual linear downward trend (represented here by the red line, over the number of years)



4. Model- A Forecasting model was created to forecast the number of calls monthly/quarterly.

And the expected number of calls were forecasted from March 2016 to February 2018.

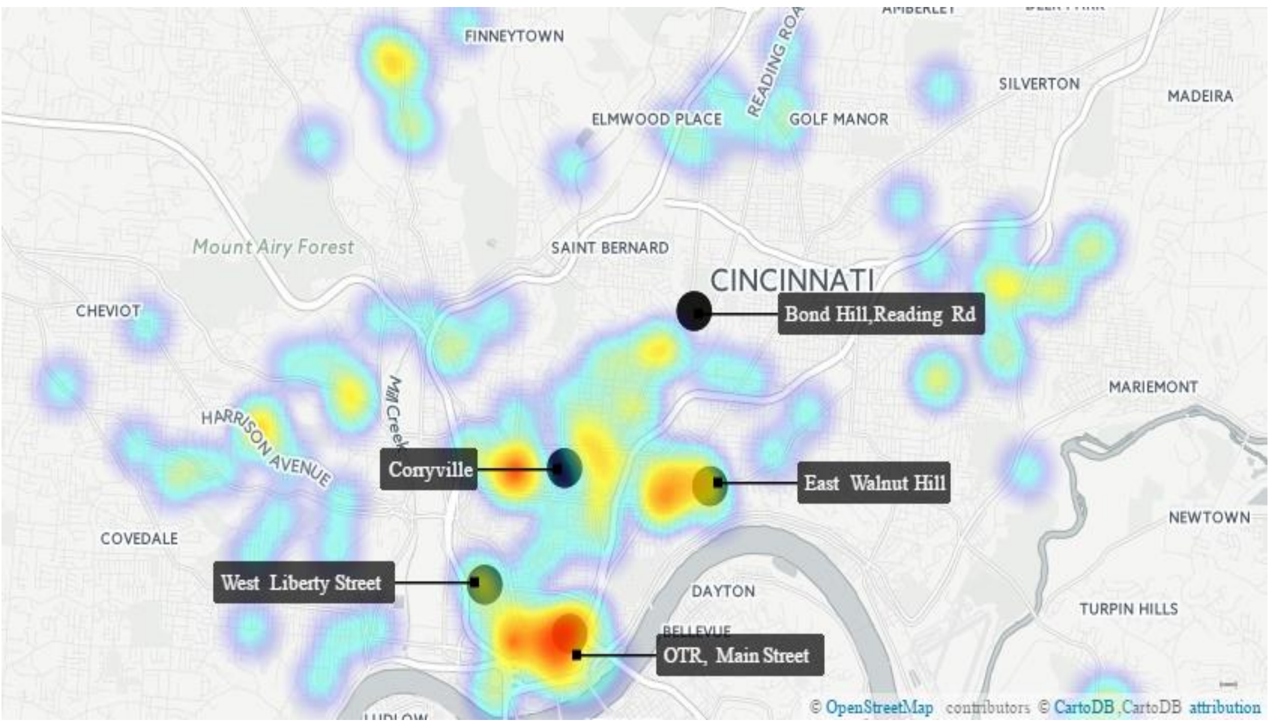
Month	Forecast
Mar-16	14810
Apr-16	15138
May-16	15465
Jun-16	15783
Jul-16	16085
Aug-16	16365
Sep-16	16616
Oct-16	16834
Nov-16	16615
Dec-16	16658
Jan-17	17260
Feb-17	17322
Mar-17	17343
Apr-17	17326
May-17	17273
Jun-17	17187
Jul-17	17073
Aug-17	16933
Sep-17	16774
Oct-17	16600
Nov-17	16416
Dec-17	16226
Jan-18	16037
Feb-18	15853

5. Predicting the Risky Zones- The following approach was used to predict the risky zones -:

- The geo codes from the addresses were obtained and the centroid was calculated using all the data where the number of repetitions for a quarter were more than 100.
- Then the Euclidean distances were calculated from the center to each of the fire stations, and the closest five fire stations were obtained and were marked as Primary Responders.

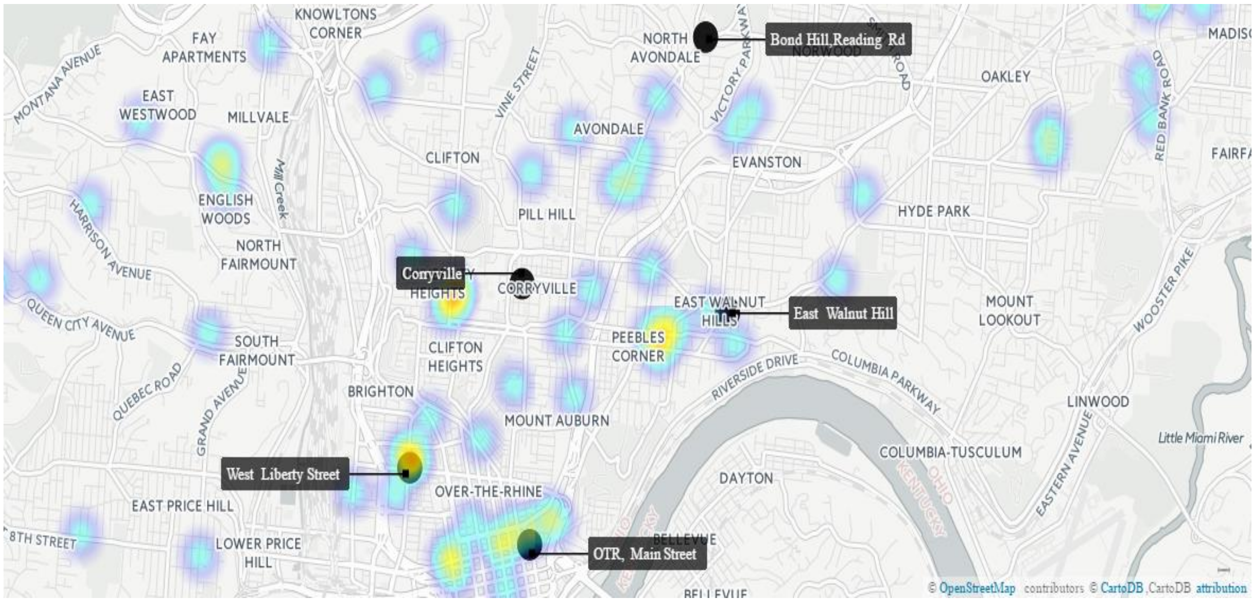
5.1 <u>Q1 High Risk Areas and fire stations</u>

The chart below represents a heat map of high risk areas for the first quarter. The stations listed here are the top five stations which are most likely to be impacted by high risk areas in this quarter.

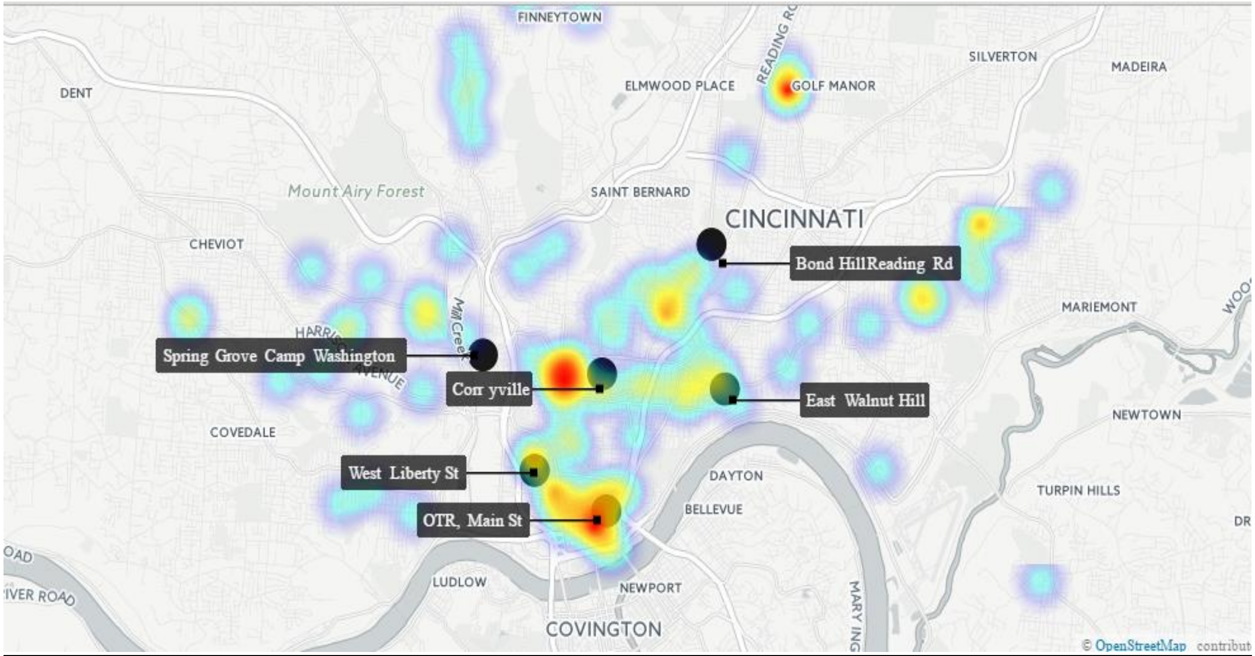


5.2 <u>Q2 High Risk Areas and Fire Stations</u>

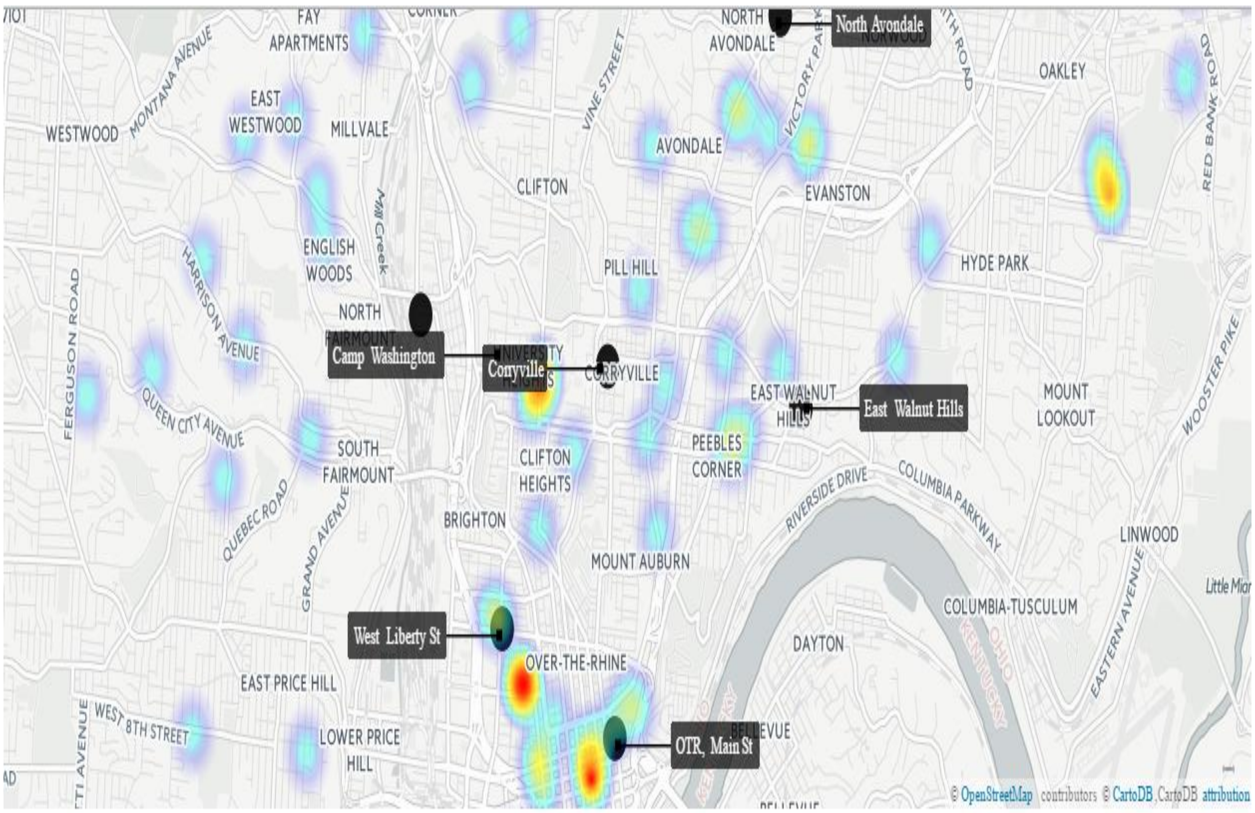
The chart below represents a heat map of high risk areas for the second quarter. The stations listed here are the top five stations which are most likely to be impacted by high risk areas in this quarter.



5.3 <u>Q3 High Risk Areas and Fire Stations</u>- The chart below represents a heat map of high risk areas for the third quarter. The stations listed here are the top five stations which are most likely to be impacted by high risk areas in this quarter.



5.4 Q4 High Risk Areas and Fire Stations - The chart below represents a heat map of high risk areas for the fourth quarter. The stations listed here are the top five stations which are most likely to be impacted by high risk areas in this quarter.



6. Further Analysis -

- An area wise model can be developed which can be more parsimonious when we have area wise demographic data.
- If the patient information were available, the percentage of ALS run which could be replaced with a BLS run can be obtained.

7. Appendix

```
Data data;
Input Calls Year $;
Cards;
21151 14-Jan
17000 14-Feb
17439 14-Mar
18283 14-Apr
19036 14-May
17018 14-Jun
13957 14-Jul
14434 14-Aug
14172 14-Sep
13979 14-Oct
13167 14-Nov
13737 15-Jan
12750 15-Feb
14367 15-Mar
14242 15-Apr
15627 15-May
15038 15-Jun
16053 15-Jul
15977 15-Aug
15363 15-Sep
15651 15-Oct
14783 15-Nov
14971 14-Dec
14164 15-Dec
;
run;
Proc Print Data= data;
Run;
Data DATA;
set data;
dcalls=dif(calls);
lcalls=lag(calls);
ldcalls=lag(dcalls);
run;
%let ylist = calls;
%let lylist = ldcalls;
%let dylist = dcalls;
%let time = Year;
* Plotting the data;
proc gplot data=data;
plot &ylist*&time;
plot &dylist*&time;
run;
proc reg data=data;
model &dylist = &lylist;
run;
* ARIMA identification/Dickey Fuller Test for Significance (Highly
Significant);
proc arima data=data;
identify var=&ylist stationarity=(adf);
run;
```

```
* ARIMA for differenced variable;
proc arima data=data;
identify var=&ylist(1) stationarity=(adf);
run;

* ARIMA(1,0,0) or AR(1);
proc arima data=data;
identify var=&ylist;
estimate p=1 method=ml;
forecast lead=12
run;
* ARIMA(2,0,0) or AR(2);
proc arima data=data;
identify var=&ylist;
estimate p=2;
run;
* ARIMA(0,0,1) or MA(1);
proc arima data=data;
identify var=&ylist;
estimate q=1;
run;
* ARIMA(3,0,1) or ARMA(1,1);
proc arima data=data;
identify var=&ylist;
estimate p=2 q=2;
forecast lead=12
run;
* ARIMA(1,1,0);
proc arima data=data;
identify var=&dylist;
estimate p=1;
run;
* ARIMA(0,1,1);
proc arima data=data;
identify var=&dylist;
estimate q=1;
run;
* ARIMA(1,1,1);
proc arima data=data;
identify var=&dylist;
estimate p=1 q=1;
run;
* ARIMA(1,1,3);
proc arima data=data;
identify var=&dylist;
estimate p=1 q=3;
run;
* ARIMA(2,1,3);
proc arima data=data;
identify var=&dylist;
estimate p=2 q=3;
run;
```