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Maggie Yu

Homicides Report

Description of Project Goals

The primary goal of this project is to investigate homicides in major cities in the United States over the last decade. Specifically, we want to know if we can predict where the Federal Government should allocate resources for homicide prevention and investigation.

The dataset is very interesting because we are able to examine the frequency of homicides in these cities, demographics about the victims, and the status of the disposition i.e. whether the case was closed with an arrest or is still open with no arrest made. This allows us to see relationships between these factors and gain important insights that may aid in preventing future homicides.

If we can decrease the number of homicides by allocating more law enforcement resources in cities most in need, we can benefit society and save lives. By allocating more investigative resources in places where homicide cases are still open, we can solve more of these cases and catch the murderers, thus benefiting the community and leading to a safer society.

Exploratory Analysis

For our analysis we obtained data from the Washington Post which they claim is more specific than the data released annually by the FBI. In addition, we used population data from the US census and state crime rate statistics from the FBI.

The data contains information about 52,179 homicides in 50 American cities since 2007 and includes 14 variables per homicide including:

- Reported date
- Victim first and last name
- Victim age, race, and sex
- City and state
- Latitude and longitude (where homicide occurred)
- State-wise population for every year
- City-wise population from 2010
- Crime rate of every state
- Disposition, which consisted of three options:
 - "Open/No Arrest"
 - "Closed by arrest"

- “Closed without arrest” - According to the Washington Post, “these are cases in which there is sufficient evidence but an arrest is not possible, for example, if the suspect has died.”

We first took a broad look at the total number of homicides over time, in what areas they occurred most frequently, and the proportion which were classified as each disposition. From there, we attempted to discern patterns in age, race, and sex demographics.

We observed a steady rise in homicides committed annually¹ with 2016 containing the greatest number², approximately 1,000 more than the years preceding and following it. Further research shows that there wasn’t anything particularly unique that caused this. Rather, there was simply an astonishing increase in already high-crime metropolises such as Chicago and Baltimore.

Homicides occurred least frequently³ in February, in part we’re assuming because it has the fewest days of any month. Homicides then begin to accumulate at an increasing rate until July where they are most frequent. From August until December, the rate decreases steadily and slightly.

We continued by plotting⁴ the amount of homicides per region⁵ and state⁶. We observed that California and Texas were the states with the greatest number of homicides. However, we found that Missouri had the highest homicide rates after adjusting for population differences. We thought this was unique, but Missouri also had the highest crime rate adjusted by population as well. We decided not to pursue this information further. First, the data represents just 50 cities, so there is the possibility that certain larger areas could be over or underrepresented in the data. Second, we believe that greater impact can be made at more local levels. We will explore this more in the Solutions & Insights portion of the report.

In terms of disposition⁷, 44.4% remained “Open/No arrest,” 47.8% were “Closed by Arrest”, and 7.8% were “Closed without arrest.” We weren’t sure whether or not to be surprised by the amount of homicide cases that remained open, but we were certainly disappointed, and it reevaluated the importance of our goal.

When examining demographic information, a clear pattern emerged. Young, African American males are the most likely by far to be homicide victims. 22.7% of victims in the data were African American males in their 20s. That number increases to 32.8% if you also include African American males in their teens.

Overall, 63.94% of homicide victims were African American⁸, 13.23% were Hispanic, 12.14% were White, 8.05% were of Unknown race, and other races were less than 2% each.⁹

78% of victims were Male¹⁰, 13.82% were Female, and 8.11% of unknown sex.¹¹

Finally, 34.5% of victims were in their 20s, 18.9% were in their 30s, 18.1% were between the ages of 40 and 60, and 15.6% were teens.¹²

Solution and Insights

When evaluating how to allocate federal resources, we wanted to consider two different metrics. First, where are homicides occurring most frequently? It is in these areas that we hope to make an effect via prevention. Second, where are homicide cases not being solved? Here is where we can make a significant improvement in investigation and closure. To gauge both of these metrics, we will focus on cities. As previously stated, the data isn't completely reliable for states and regions, and we believe the greatest effect can be made at a micro level.

To evaluate frequency, we simply looked at where the most homicides have been committed. There were six cities with greater than 2,200 homicides reported (with no other city above 1,600):¹³

- Chicago - 5535
- Philadelphia - 3037
- Houston - 2942
- Baltimore - 2827
- Detroit - 2519
- Los Angeles - 2257

When adjusting for population, the order changes slightly, but it is consistent with frequency in general. The cities with the highest homicide *rate* were:

- Kansas City
- Baltimore
- Detroit
- Philadelphia
- Houston
- Chicago
- Los Angeles

To evaluate effectiveness, we judged cities based on a measure we refer to as "Closure Rate."¹⁴ Closure Rate is the proportion of a city's homicides that were closed (whether by arrest or without arrest). There were 14 cities with a Closure Rate of 0.5 or below¹⁵ (with no other city below 0.53 but 9 cities above 0.70).¹⁶ Of those 14, we found 4 that also had a considerable quantity of homicides:¹⁷

- Chicago - 0.33
- Baltimore - 0.41
- Detroit - 0.41
- Los Angeles - 0.50

These four cities alone account for 25% of the total homicides¹⁸ and 34% of the total open cases in the data.¹⁹ It makes sense that there would be some overlap, especially at the extreme end of the frequency list. If a city has an exceptional number of homicide victims, they will have fewer resources (money, time, manpower) per victim to solve the case. Rather than being an issue of collinearity that would discount either measure, though, the relationship can almost be viewed as a multiplier and as further evidence that these are the areas deserving federal assistance.

When examining the demographics of each city, they are generally in line with the demographics of the data as a whole, but there are a couple exceptions. Victims in Detroit²⁰ and Los Angeles²¹ in their 40s - 60s are represented slightly more frequently than average. Also, the proportion of Hispanic victims is much higher in Los Angeles, most likely because the Hispanic population is proportionately much greater in Los Angeles (roughly 47%) than other cities and the nation as a whole.²² However, when considering that African Americans make up only about 10% of the total population in Los Angeles, that group is still being killed at the highest rate, consistent with the other cities we examined.

After narrowing down the cities, we wanted to predict the number of homicides for the year 2018 so that we could advise the federal government accordingly. We used a time series forecasting model called ARIMA(Autoregressive Integrated Moving Average). We can anticipate the following trends in each city:

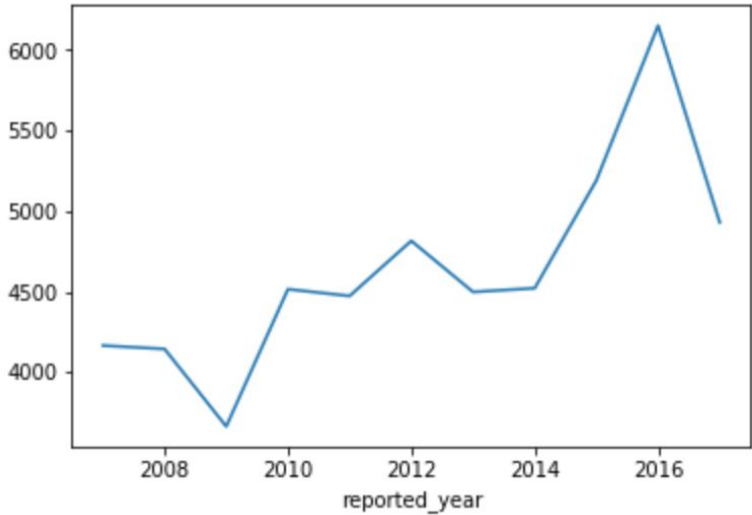
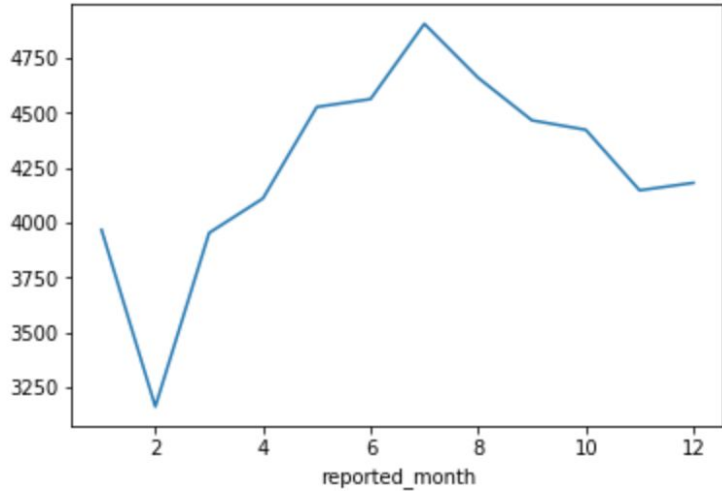
- Chicago²³ - Increased homicides, particularly in the last quarter
- Detroit²⁴ - Increased homicides, again rising in the last quarter
- Los Angeles²⁵ - Very consistent with 2017
- Baltimore²⁶ - Steadier rate of homicides per month (no dramatic spikes and dips like 2016)

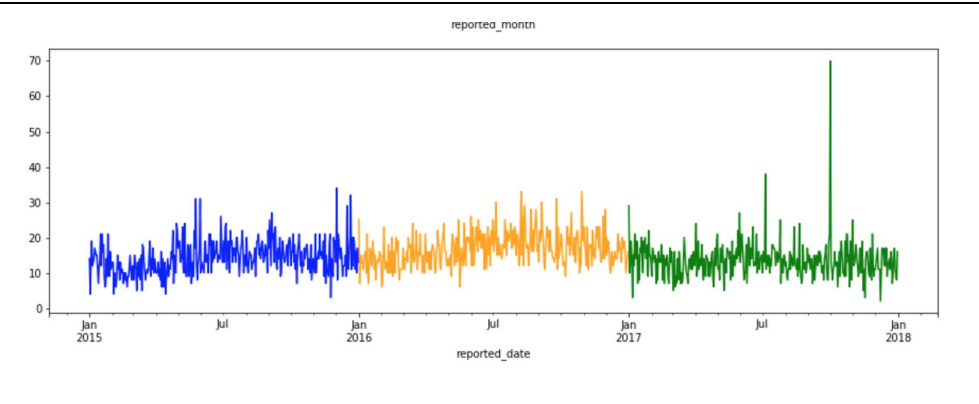
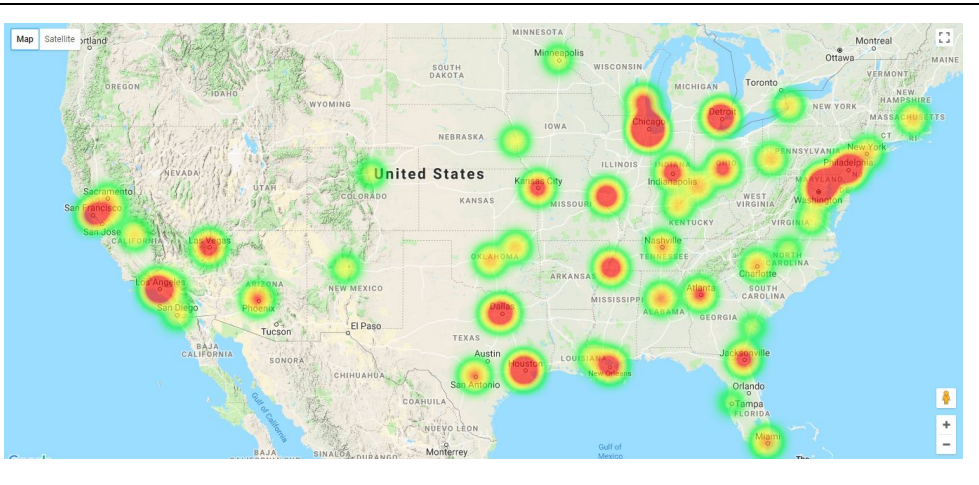
As a whole this analysis supports what already might have been expected. The areas with the greatest number of homicides and the lowest rate of cases being closed are those that are predominantly low-income and African-American. With this in mind, we would make the following suggestions:

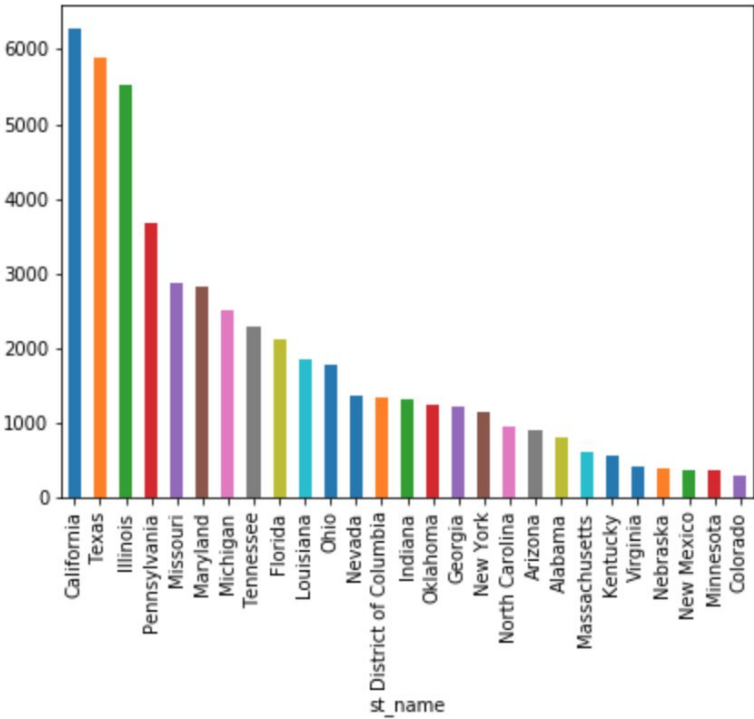
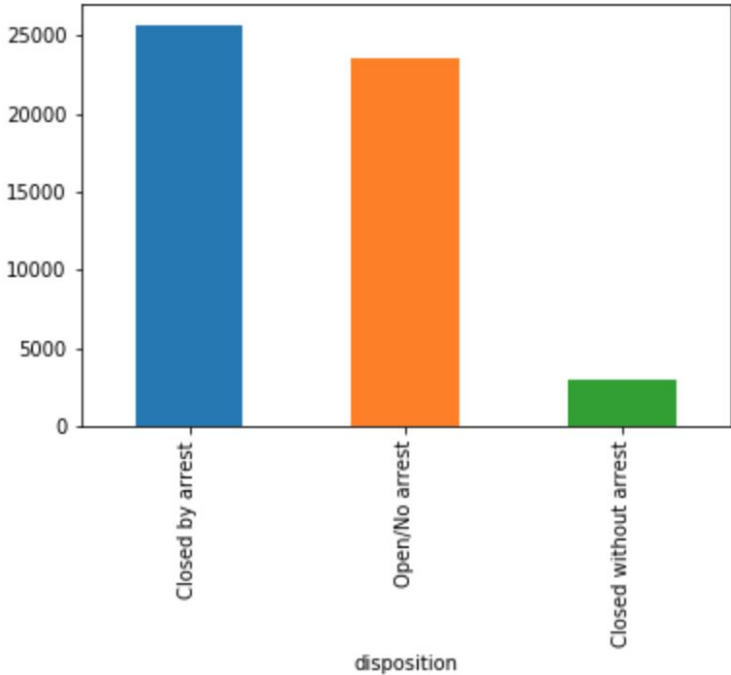
1. Expedite distribution to help prevent the anticipated rise in homicides in the next 2 months (and final quarter) of 2018
2. Prioritize allocation of resources meant to to mitigate gang violence
3. Funnel resources and advanced forces / manpower to specific neighborhoods with the worst economic conditions in each city

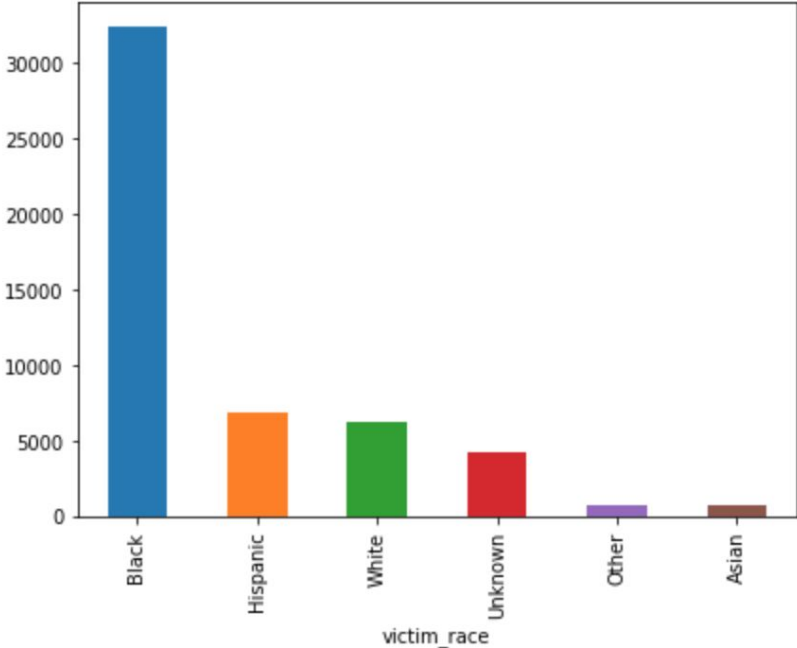
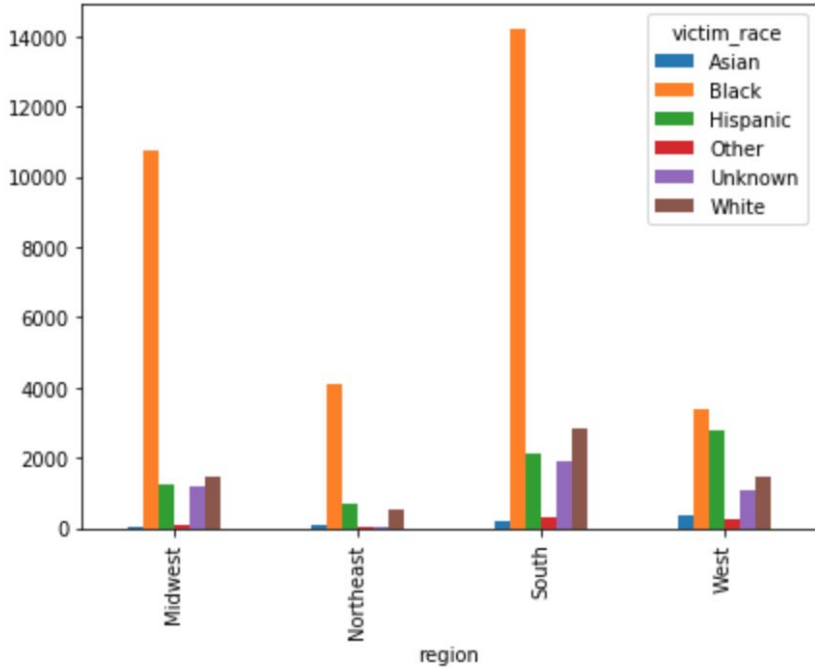
Appendix

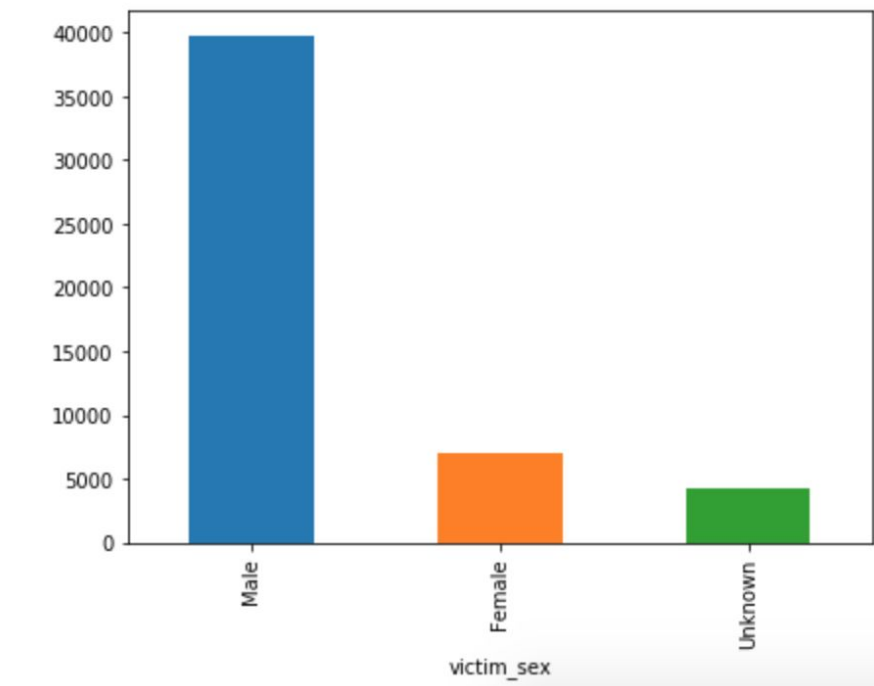
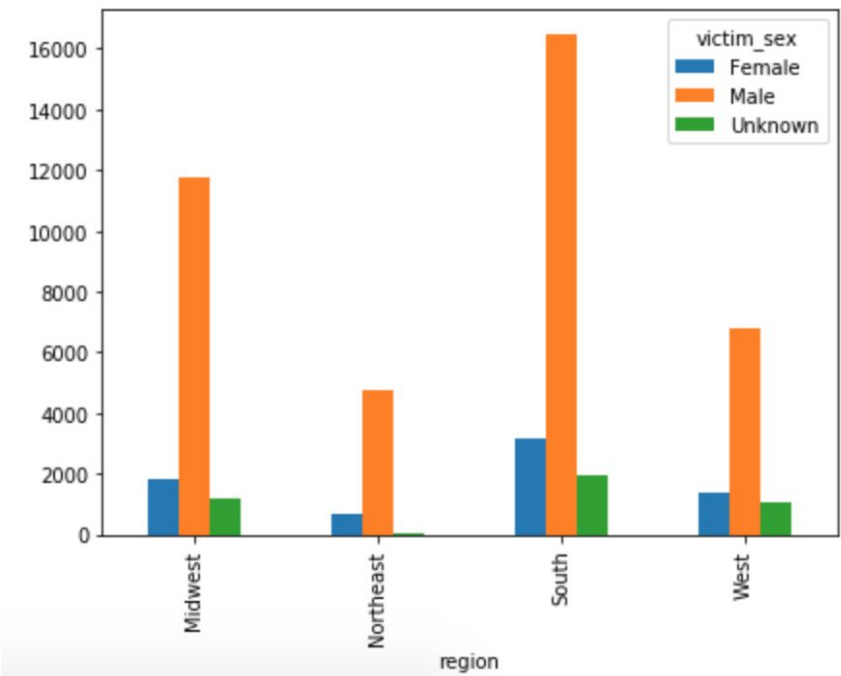
Original Data: <https://github.com/washingtonpost/data-homicides>

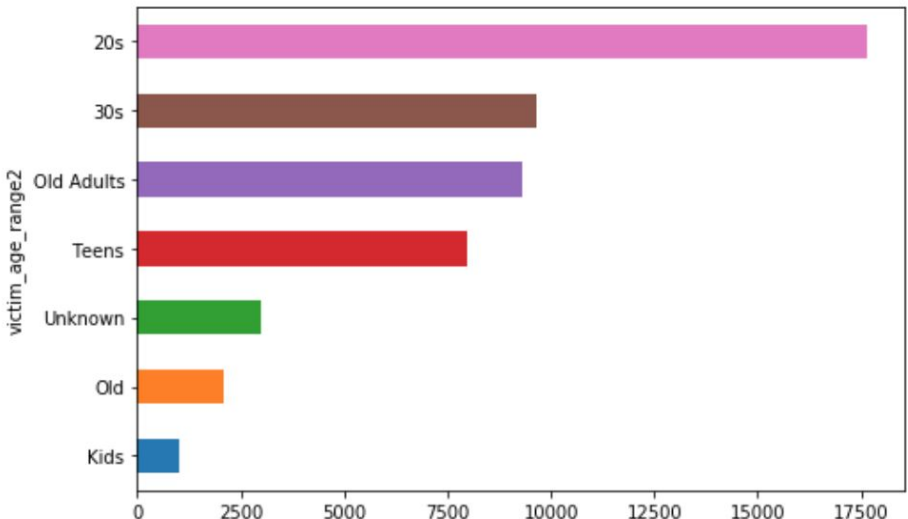
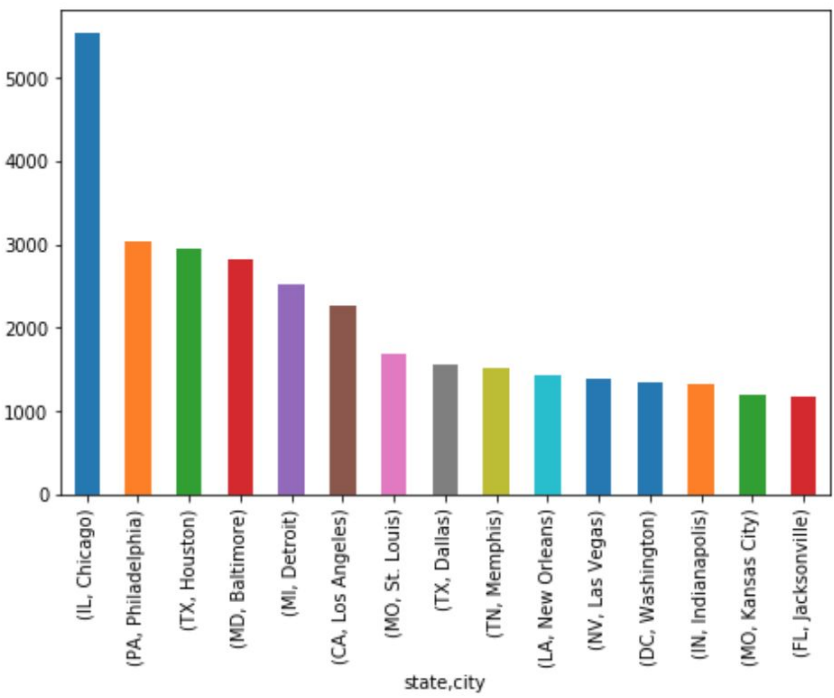
1	Homicides per year	 <table border="1"><thead><tr><th>reported_year</th><th>Homicides</th></tr></thead><tbody><tr><td>2007</td><td>4150</td></tr><tr><td>2008</td><td>4150</td></tr><tr><td>2009</td><td>3750</td></tr><tr><td>2010</td><td>4500</td></tr><tr><td>2011</td><td>4450</td></tr><tr><td>2012</td><td>4800</td></tr><tr><td>2013</td><td>4500</td></tr><tr><td>2014</td><td>4500</td></tr><tr><td>2015</td><td>5200</td></tr><tr><td>2016</td><td>6100</td></tr><tr><td>2017</td><td>4900</td></tr></tbody></table>	reported_year	Homicides	2007	4150	2008	4150	2009	3750	2010	4500	2011	4450	2012	4800	2013	4500	2014	4500	2015	5200	2016	6100	2017	4900		
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3	Homicides - Last 3 years											
4	National Heat Map											
5	Homicides per region	 <table><tr><th>region</th><th>Homicides</th></tr><tr><td>South</td><td>21000</td></tr><tr><td>Midwest</td><td>14500</td></tr><tr><td>West</td><td>9000</td></tr><tr><td>Northeast</td><td>5500</td></tr></table>	region	Homicides	South	21000	Midwest	14500	West	9000	Northeast	5500
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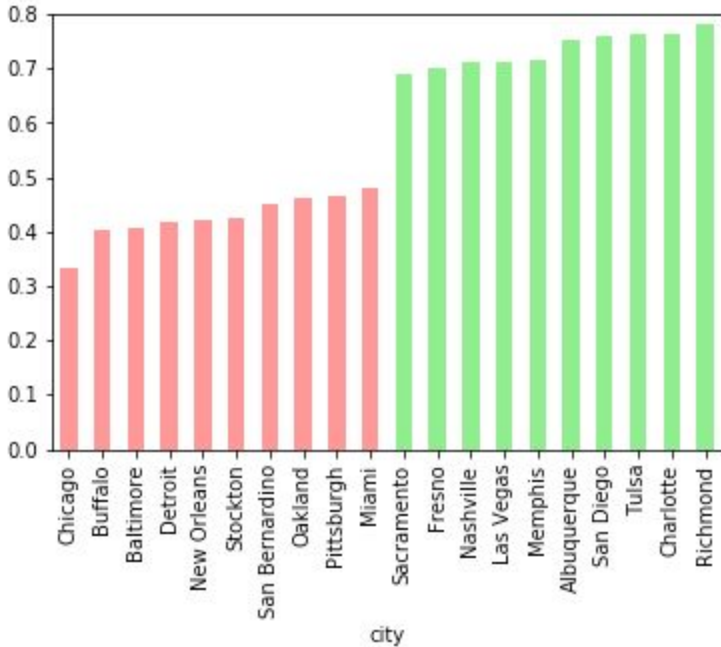
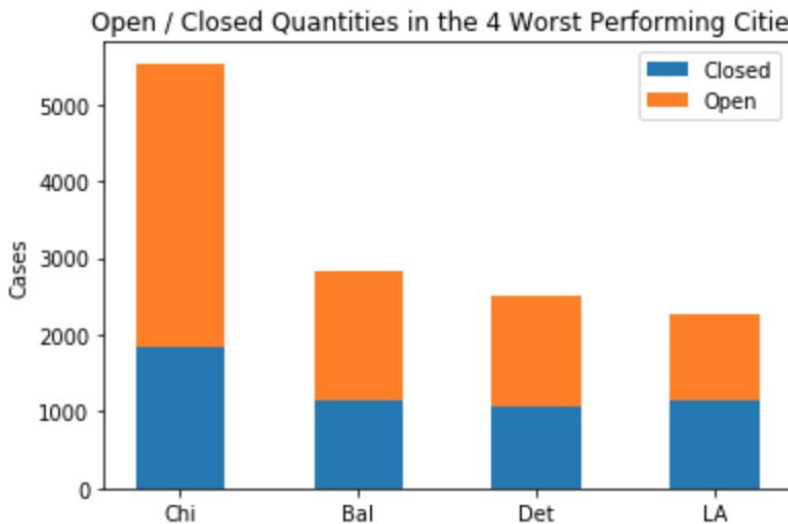
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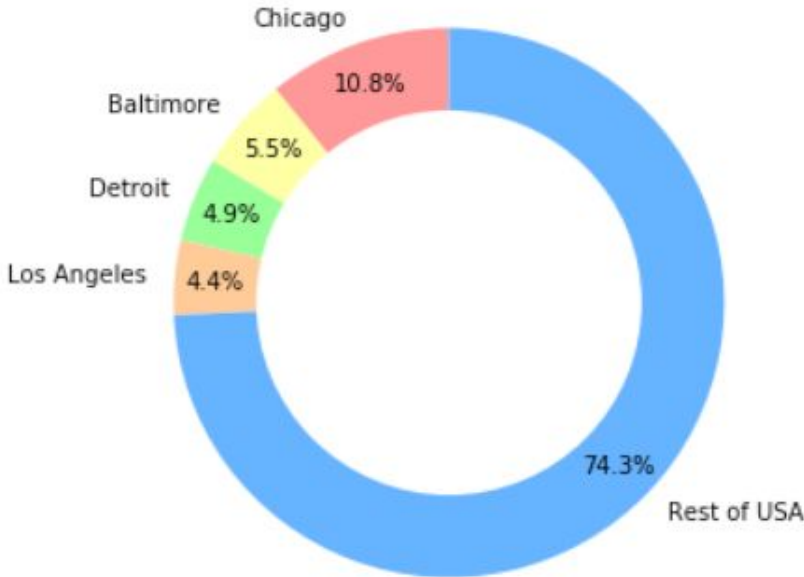
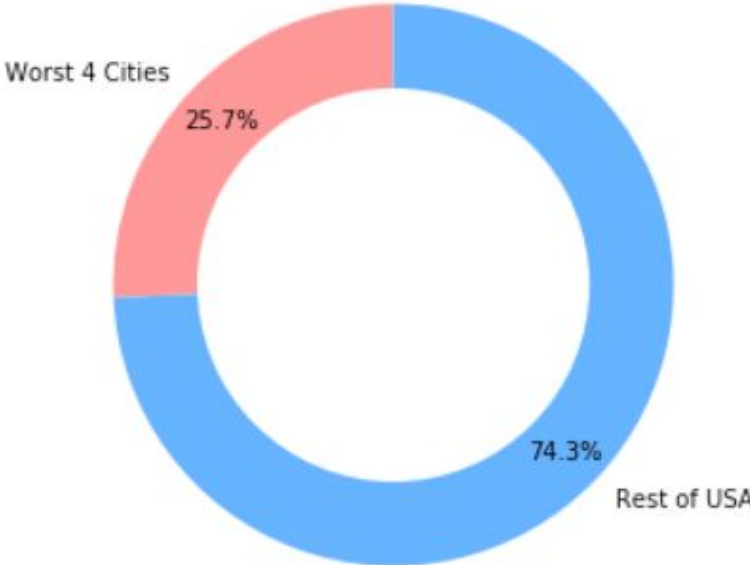
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12	Homicides by age	 <table><thead><tr><th>Age Group</th><th>Homicides (approx.)</th></tr></thead><tbody><tr><td>20s</td><td>17,500</td></tr><tr><td>30s</td><td>9,500</td></tr><tr><td>Old Adults</td><td>9,000</td></tr><tr><td>Teens</td><td>8,000</td></tr><tr><td>Unknown</td><td>3,000</td></tr><tr><td>Old</td><td>2,000</td></tr><tr><td>Kids</td><td>1,000</td></tr></tbody></table>	Age Group	Homicides (approx.)	20s	17,500	30s	9,500	Old Adults	9,000	Teens	8,000	Unknown	3,000	Old	2,000	Kids	1,000																
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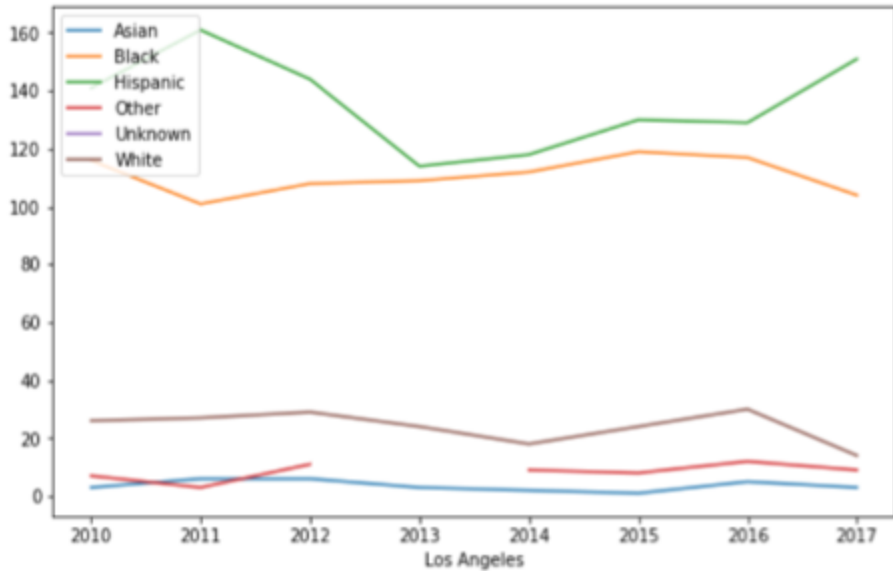
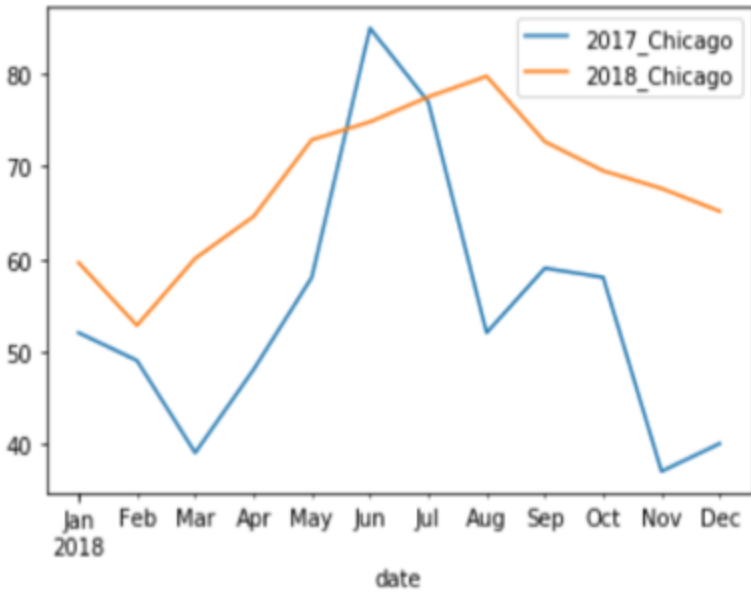
		<div><div>Chicago5535</div><div>Philadelphia3037</div><div>Houston2942</div><div>Baltimore2827</div><div>Detroit2519</div><div>Los Angeles2257</div><div>St. Louis1677</div><div>Dallas1567</div><div>Memphis1514</div><div>New Orleans1434</div><div>Las Vegas1381</div><div>Washington1345</div><div>Indianapolis1322</div><div>Kansas City1190</div><div>Jacksonville1168</div><div>Columbus1084</div><div>Atlanta973</div></div>																												
14	Closure rate by city (worst)	<div><div><div><div>0.8</div><div>0.7</div><div>0.6</div><div>0.5</div><div>0.4</div><div>0.3</div><div>0.2</div><div>0.1</div><div>0.0</div></div><div><div><div>Chicago</div><div>Buffalo</div><div>Baltimore</div><div>Detroit</div><div>New Orleans</div><div>Stockton</div><div>San Bernardino</div><div>Oakland</div><div>Pittsburgh</div><div>Miami</div><div>St. Louis</div><div>San Francisco</div><div>Boston</div><div>Los Angeles</div></div><div>city</div></div></div><table><tr><td>Chicago</td><td>0.33</td></tr><tr><td>Buffalo</td><td>0.40</td></tr><tr><td>Baltimore</td><td>0.40</td></tr><tr><td>Detroit</td><td>0.42</td></tr><tr><td>New Orleans</td><td>0.42</td></tr><tr><td>Stockton</td><td>0.43</td></tr><tr><td>San Bernardino</td><td>0.45</td></tr><tr><td>Oakland</td><td>0.46</td></tr><tr><td>Pittsburgh</td><td>0.46</td></tr><tr><td>Miami</td><td>0.48</td></tr><tr><td>St. Louis</td><td>0.48</td></tr><tr><td>San Francisco</td><td>0.49</td></tr><tr><td>Boston</td><td>0.49</td></tr><tr><td>Los Angeles</td><td>0.51</td></tr></table></div>	Chicago	0.33	Buffalo	0.40	Baltimore	0.40	Detroit	0.42	New Orleans	0.42	Stockton	0.43	San Bernardino	0.45	Oakland	0.46	Pittsburgh	0.46	Miami	0.48	St. Louis	0.48	San Francisco	0.49	Boston	0.49	Los Angeles	0.51
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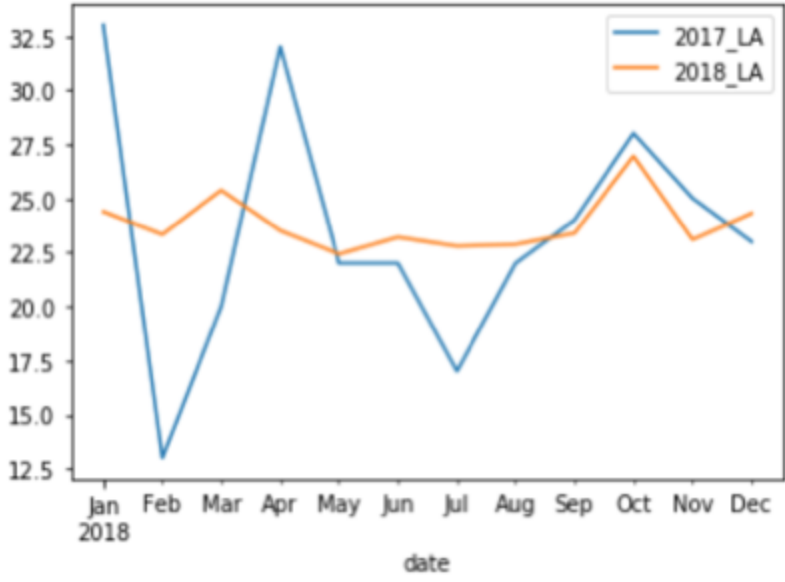
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18	Proportion of Homicides - 4 worst cities vs USA	 <table><thead><tr><th>City</th><th>Proportion</th></tr></thead><tbody><tr><td>Chicago</td><td>10.8%</td></tr><tr><td>Baltimore</td><td>5.5%</td></tr><tr><td>Detroit</td><td>4.9%</td></tr><tr><td>Los Angeles</td><td>4.4%</td></tr><tr><td>Rest of USA</td><td>74.3%</td></tr></tbody></table>	City	Proportion	Chicago	10.8%	Baltimore	5.5%	Detroit	4.9%	Los Angeles	4.4%	Rest of USA	74.3%
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19	Proportion of Open Cases - 4 worst vs USA	<p>A donut chart comparing the proportion of open cases between the 'Worst 4 Cities' and the 'Rest of USA'. The 'Worst 4 Cities' segment is red and represents 34.2% of the total. The 'Rest of USA' segment is grey and represents 65.8% of the total.</p> <table><tr><th>Category</th><th>Proportion</th></tr><tr><td>Worst 4 Cities</td><td>34.2%</td></tr><tr><td>Rest of USA</td><td>65.8%</td></tr></table>	Category	Proportion	Worst 4 Cities	34.2%	Rest of USA	65.8%												
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20	Age Distribution of Homicide Victims - Detroit	<p>A horizontal bar chart showing the age distribution of homicide victims in Detroit. The x-axis represents the number of victims (0 to 600). The y-axis lists age groups: Kids, Teens, 20s, late 20s, 30s, Old Adults, Old, and Unknown. The bars are color-coded: Kids (red), Teens (olive), 20s (green), late 20s (blue), 30s (purple), Old Adults (pink), Old (olive), and Unknown (green).</p> <table><tr><th>Age Group</th><th>Count (approx.)</th></tr><tr><td>Kids</td><td>20</td></tr><tr><td>Teens</td><td>320</td></tr><tr><td>20s</td><td>540</td></tr><tr><td>late 20s</td><td>390</td></tr><tr><td>30s</td><td>520</td></tr><tr><td>Old Adults</td><td>580</td></tr><tr><td>Old</td><td>110</td></tr><tr><td>Unknown</td><td>20</td></tr></table>	Age Group	Count (approx.)	Kids	20	Teens	320	20s	540	late 20s	390	30s	520	Old Adults	580	Old	110	Unknown	20
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21	Age Distribution of Homicide Victims - Los Angeles	<p>A horizontal bar chart showing the age distribution of homicide victims in Los Angeles. The x-axis represents the number of victims (0 to 500). The y-axis lists age groups: Kids, Teens, 20s, late 20s, 30s, Old Adults, Old, and Unknown. The bars are color-coded: Kids (red), Teens (olive), 20s (green), late 20s (blue), 30s (purple), Old Adults (pink), Old (olive), and Unknown (green).</p> <table><tr><th>Age Group</th><th>Count (approx.)</th></tr><tr><td>Kids</td><td>10</td></tr><tr><td>Teens</td><td>360</td></tr><tr><td>20s</td><td>400</td></tr><tr><td>late 20s</td><td>340</td></tr><tr><td>30s</td><td>460</td></tr><tr><td>Old Adults</td><td>510</td></tr><tr><td>Old</td><td>120</td></tr><tr><td>Unknown</td><td>70</td></tr></table>	Age Group	Count (approx.)	Kids	10	Teens	360	20s	400	late 20s	340	30s	460	Old Adults	510	Old	120	Unknown	70
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22	Race Distribution of Homicide Victims - Los Angeles	 <p>Los Angeles</p> <table><tr><th>Year</th><th>Asian</th><th>Black</th><th>Hispanic</th><th>Other</th><th>Unknown</th><th>White</th></tr><tr><td>2010</td><td>5</td><td>110</td><td>155</td><td>8</td><td>2</td><td>28</td></tr><tr><td>2011</td><td>8</td><td>102</td><td>162</td><td>3</td><td>5</td><td>28</td></tr><tr><td>2012</td><td>7</td><td>108</td><td>145</td><td>12</td><td>5</td><td>30</td></tr><tr><td>2013</td><td>4</td><td>110</td><td>115</td><td>5</td><td>2</td><td>25</td></tr><tr><td>2014</td><td>3</td><td>112</td><td>118</td><td>10</td><td>2</td><td>18</td></tr><tr><td>2015</td><td>3</td><td>120</td><td>130</td><td>8</td><td>2</td><td>25</td></tr><tr><td>2016</td><td>6</td><td>118</td><td>128</td><td>12</td><td>2</td><td>30</td></tr><tr><td>2017</td><td>4</td><td>105</td><td>152</td><td>10</td><td>2</td><td>15</td></tr></table>	Year	Asian	Black	Hispanic	Other	Unknown	White	2010	5	110	155	8	2	28	2011	8	102	162	3	5	28	2012	7	108	145	12	5	30	2013	4	110	115	5	2	25	2014	3	112	118	10	2	18	2015	3	120	130	8	2	25	2016	6	118	128	12	2	30	2017	4	105	152	10	2	15
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24	ARIMA Forecast - Detroit	 <p>The chart displays the monthly values for Detroit in 2017 and the forecast for 2018. The 2017 data shows a peak in August (approx. 27) and a low in October (approx. 18). The 2018 forecast follows a similar pattern, peaking in August (approx. 28.5) and dipping in October (approx. 20.5).</p> <table border="1"> <thead> <tr> <th>Month</th> <th>2017_Detroit</th> <th>2018_Detroit</th> </tr> </thead> <tbody> <tr><td>Jan</td><td>22.0</td><td>18.8</td></tr> <tr><td>Feb</td><td>21.0</td><td>16.5</td></tr> <tr><td>Mar</td><td>26.0</td><td>17.5</td></tr> <tr><td>Apr</td><td>21.0</td><td>22.5</td></tr> <tr><td>May</td><td>24.0</td><td>24.5</td></tr> <tr><td>Jun</td><td>19.0</td><td>24.5</td></tr> <tr><td>Jul</td><td>25.0</td><td>26.0</td></tr> <tr><td>Aug</td><td>27.0</td><td>28.5</td></tr> <tr><td>Sep</td><td>26.0</td><td>24.0</td></tr> <tr><td>Oct</td><td>18.0</td><td>20.5</td></tr> <tr><td>Nov</td><td>19.0</td><td>22.5</td></tr> <tr><td>Dec</td><td>18.0</td><td>24.0</td></tr> </tbody> </table>	Month	2017_Detroit	2018_Detroit	Jan	22.0	18.8	Feb	21.0	16.5	Mar	26.0	17.5	Apr	21.0	22.5	May	24.0	24.5	Jun	19.0	24.5	Jul	25.0	26.0	Aug	27.0	28.5	Sep	26.0	24.0	Oct	18.0	20.5	Nov	19.0	22.5	Dec	18.0	24.0
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25	ARIMA Forecast - Los Angeles	 <p>The chart displays the monthly values for Los Angeles in 2017 and the forecast for 2018. The 2017 data shows a high peak in April (approx. 32) and a low in February (approx. 13). The 2018 forecast shows a peak in March (approx. 25.5) and a low in July (approx. 23).</p> <table border="1"> <thead> <tr> <th>Month</th> <th>2017_LA</th> <th>2018_LA</th> </tr> </thead> <tbody> <tr><td>Jan</td><td>33.0</td><td>24.5</td></tr> <tr><td>Feb</td><td>13.0</td><td>23.5</td></tr> <tr><td>Mar</td><td>20.0</td><td>25.5</td></tr> <tr><td>Apr</td><td>32.0</td><td>24.0</td></tr> <tr><td>May</td><td>22.0</td><td>23.0</td></tr> <tr><td>Jun</td><td>22.0</td><td>23.5</td></tr> <tr><td>Jul</td><td>17.0</td><td>23.0</td></tr> <tr><td>Aug</td><td>22.0</td><td>23.0</td></tr> <tr><td>Sep</td><td>24.0</td><td>23.5</td></tr> <tr><td>Oct</td><td>28.0</td><td>26.5</td></tr> <tr><td>Nov</td><td>25.0</td><td>23.0</td></tr> <tr><td>Dec</td><td>23.0</td><td>24.5</td></tr> </tbody> </table>	Month	2017_LA	2018_LA	Jan	33.0	24.5	Feb	13.0	23.5	Mar	20.0	25.5	Apr	32.0	24.0	May	22.0	23.0	Jun	22.0	23.5	Jul	17.0	23.0	Aug	22.0	23.0	Sep	24.0	23.5	Oct	28.0	26.5	Nov	25.0	23.0	Dec	23.0	24.5
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Nov	25.0	23.0																																							
Dec	23.0	24.5																																							

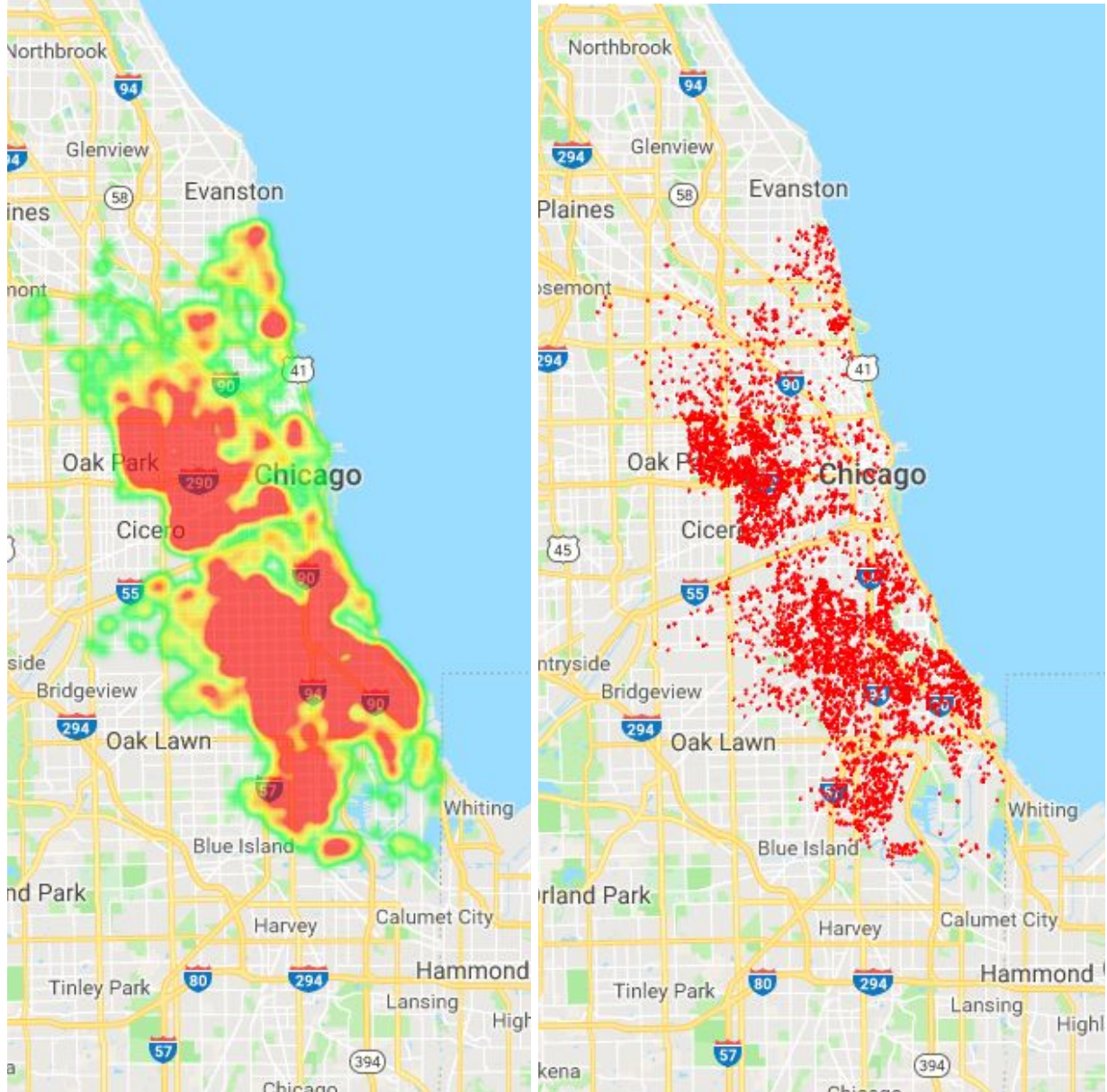
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**ARIMA
Forecast -
Baltimore**

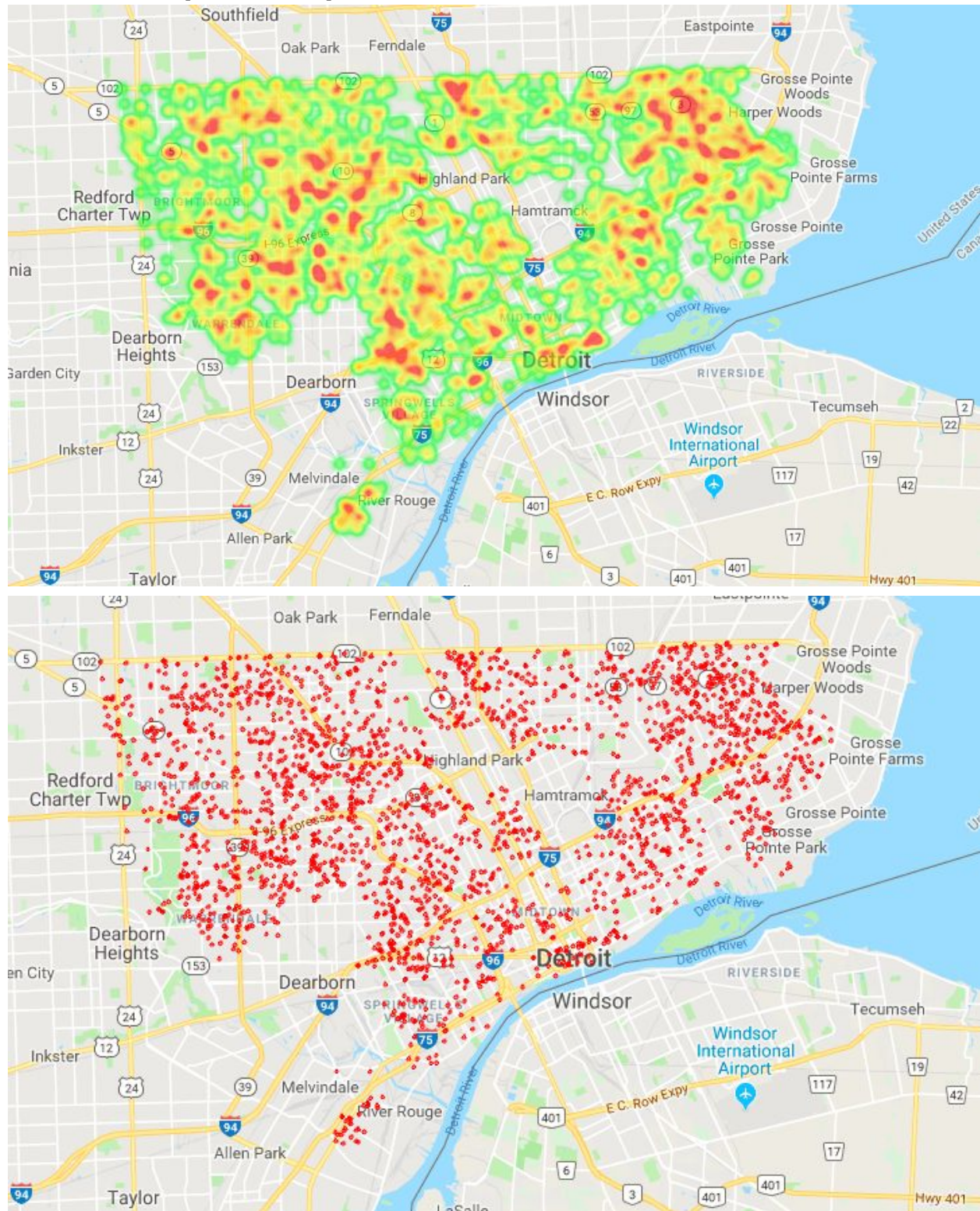


Heat Maps for each city (4 worst)

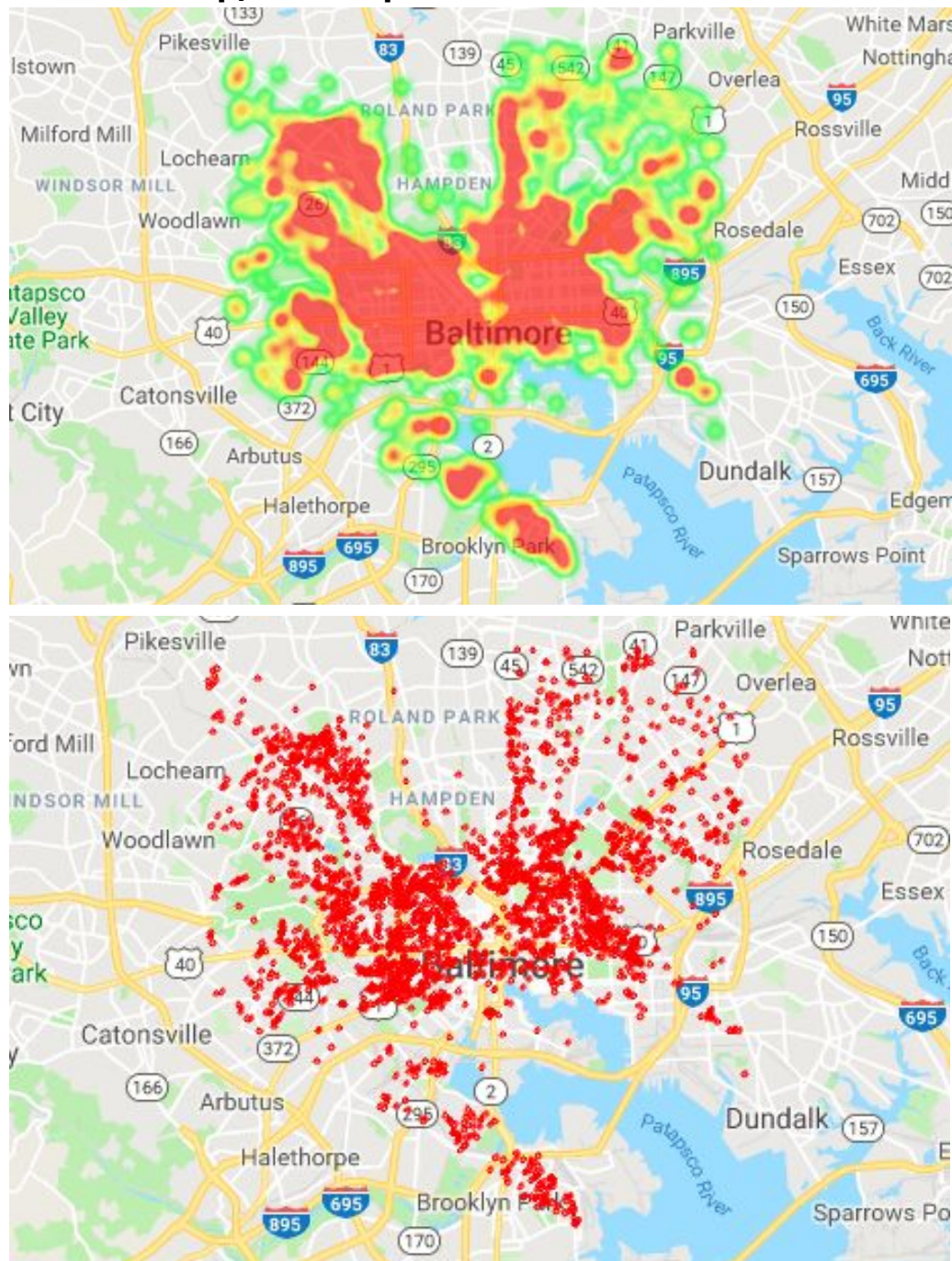
27.1 Heatmap/scatter plot for Chicago



27.2 Heatmap/scatter plot for Detroit



27.3 Heatmap/scatter plot for Baltimore



27.4 Heatmap/scatter plot for Los Angeles

