

Crime Investigation in Fairfax County, Virginia, United States

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1. Introduction

Fairfax County is a county located in the Commonwealth of Virginia in the United States. Part of Northern Virginia, Fairfax County borders both the City of Alexandria and Arlington County and forms part of the suburban ring of Washington, D.C. The county is thus predominantly suburban in character, with some urban and rural pockets.

As of 2018, the population was 1,150,795, and the growth rate has increased every year since 1840 (<https://worldpopulationreview.com/us-counties/va/fairfax-county-population/>). The county is the most populous jurisdiction in the Washington-Arlington-Alexandria, DC-VA-MD-WV Metropolitan Statistical Area, with around 20% of the MSA population, as well as the larger Washington-Baltimore-Arlington, DC-MD-VA-WV-PA Combined Statistical Area, with around 13% of the CSA population.

In 2019, Amazon announced the second headquarters (HQ2) development in Arlington, Virginia, which will take over 6 million square feet of office space and bring at least 25,000 new jobs to the region by the mid-2030s. In the same year, Virginia Tech announced that it would be building a new 1-million-square foot innovation campus in Alexandria, Virginia, positioning the area to better reap the rewards of the forthcoming Amazon HQ2. Being adjacent to Arlington and Alexandria, Fairfax county is home to the headquarters of intelligence agencies such as the Central Intelligence Agency, National Geospatial-Intelligence Agency, and National Reconnaissance Office, as well as the National Counterterrorism Center and Office of the Director of National Intelligence.

With the increase of population in North Virginia, crime information is one of the main considerations when potential residents determine the neighborhood which they want to live when they move to this area. This project investigates the crime information of the neighborhoods in Fairfax County. In addition, the neighborhood in Fairfax County are also investigated using the Foursquare location data. The results of this project not only benefit both current and potential residents in Fairfax County to find their next home in a safer neighborhood but also provide venue information of the neighborhood they are interested in.

2. Data Description

The crime reports are obtained from the Fairfax County website (<https://www.fairfaxcounty.gov/police/downloadcenter>). This project uses the weekly crime data from April 23rd to April 30th, 2020.

After dropping incidents with missing information and selecting five fields required in this project, there are 1367 cases in the data, where the first five rows are shown in Table 1.

Table1. First five rows from the original data

Crime	Description	Date	Neighborhood	State	Zip_code
DEST-290-2	DESTRUCTION - PRIVATE PROPERTY	2020-04-24	FALLS CHURCH	VA	22043
SUSP-1	SUSPICIOUS - EVENT	2020-04-24	SPRINGFIELD	VA	22150
FRAUD-26C-1	FRAUD - IMPERSONATION	2020-04-25	ALEXANDRIA	VA	22309
FRAUD-26C-1	FRAUD - IMPERSONATION	2020-04-25	FAIRFAX	VA	22032
DRUG-35A-4	DRUGS - MARIJUANA POSSESSION	2020-04-25	ALEXANDRIA	VA	22309

In addition, the population of each city in Virginia is also included in this study. The population information is obtained from World Population Review (<https://worldpopulationreview.com/zip/virginia/>), where the first five rows are shown in Table 2. Only cities in Fairfax County are merged into the data.

Table 2. First five rows of the population data

City	Population	Zip_code
Virginia Beach	62321	23464
Woodbridge	60216	22193
Chesapeake	51229	23322
Virginia Beach	50900	23454
Virginia Beach	49874	23452

3. Methodology

3.1 Data cleaning

The original crime report contains the crime code (Crime) and the description of each incident. To simplify the crime category, the first element of each crime code is extracted, as shown in Table 3. There are 30 unique crime categories in the data.

Table 3.

Crime	Description	Date	Neighborhood	State	Zip_code	Crime_Category
DEST-290-2	DESTRUCTION - PRIVATE PROPERTY	2020-04-24	FALLS CHURCH	VA	22043	DEST
SUSP-1	SUSPICIOUS - EVENT	2020-04-24	SPRINGFIELD	VA	22150	SUSP
FRAUD-26C-1	FRAUD - IMPERSONATION	2020-04-25	ALEXANDRIA	VA	22309	FRAUD
FRAUD-26C-1	FRAUD - IMPERSONATION	2020-04-25	FAIRFAX	VA	22032	FRAUD
DRUG-35A-4	DRUGS - MARIJUANA POSSESSION	2020-04-25	ALEXANDRIA	VA	22309	DRUG

3.2 Descriptive Statistics

The frequency tables by crime category, by date, and by neighborhood are summarized in this project. The folium library is used to display the crime map in Fairfax County. Furthermore, linear regression is adopted in this project to investigate the causes of higher/lower crimes in the neighborhood in Fairfax County. The independent variable is population, and the dependent variable is the number of crimes in each neighborhood.

3.4 Use Foursquare to further explore a neighborhood

There are 19 neighborhoods in the data. This project uses Foursquare to further explore the venues in these 19 neighborhoods in Fairfax County.

4. Results

The Crime_Category field contains 26 categories, and the frequencies range from 1 to 685. The bar chart is displayed in Figure 1, and the frequency table is summarized in Appendix A. Service type of incidents, such as police phone reports, has the highest frequency in the week of April 23rd to April 30th, 2020. Figure 2 presents the frequencies by neighborhood. There are 19 neighborhoods in the data, and Alexandria has much higher number of incidents. Figure 3 further summarizes the frequency by date. As expected, April 25th, which is Saturday, has more incidents than the other dates. To visualize the incidents in each neighborhood, Figure 4 displays the incidents on the map.

Figure 1. Frequency table by crime categories

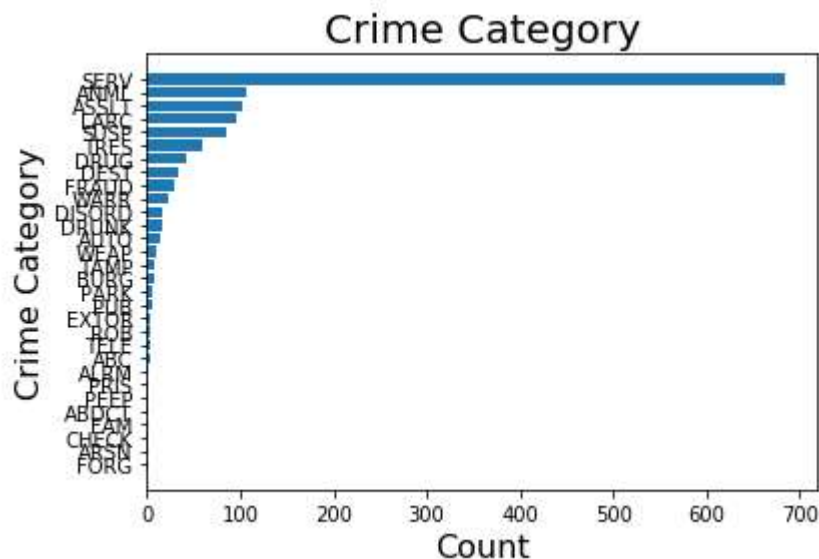


Figure 2. Frequency table by neighborhood

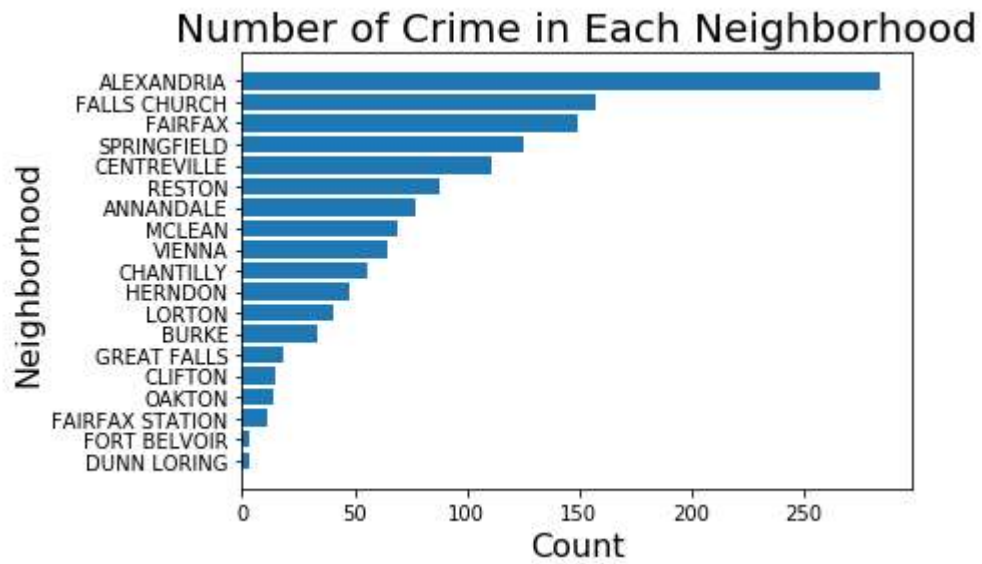


Figure 2. Frequency table by date

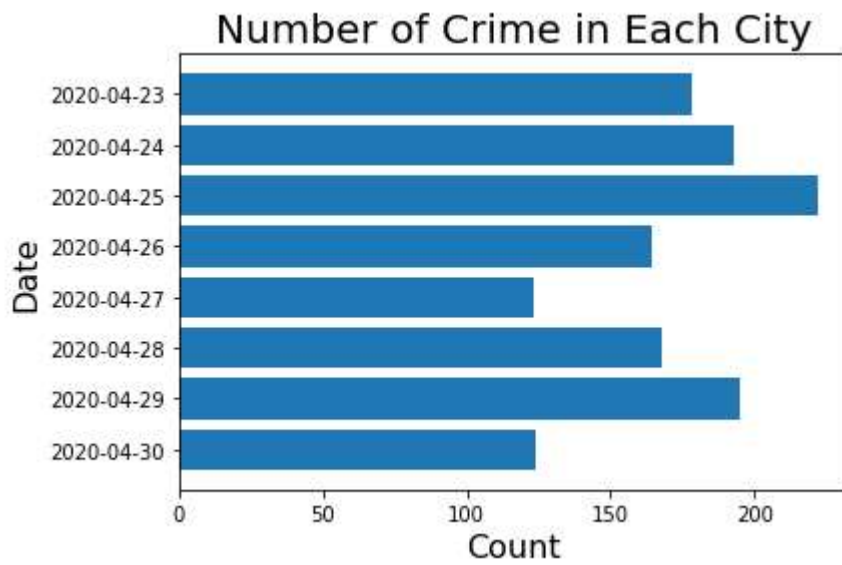
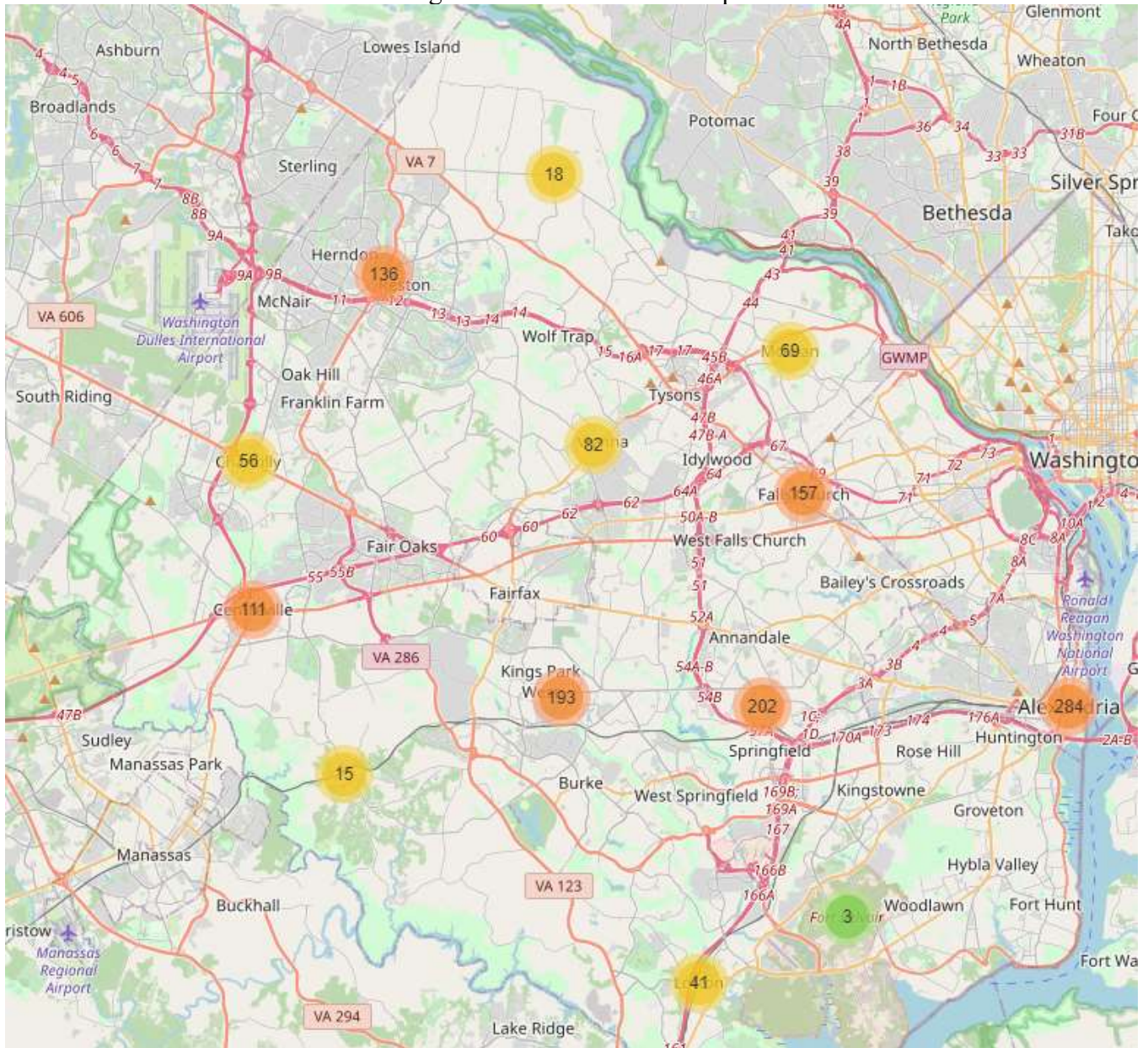


Figure 4. Incidents on the map



Population is usually considered as a main reason to have higher crime rate. To further investigate the relationship between the number of crimes vs. the population in the neighborhood in Fairfax County, Figure 5 shows the scatter plot by neighborhood, which shows a moderate positive correlation between these two variables (correlation = 0.53, as shown in Figure 6). Figure 7 further shows the regression plot and the estimated slope and intercept between these two variables. From the regression result we can have the following equation for the relationship between population vs. number of crimes:

$$\hat{Y}_i = 6.35875 + 0.0011X_i, i = 1, \dots, 19.$$

Figure 5. Scatter plot between population and number of crimes

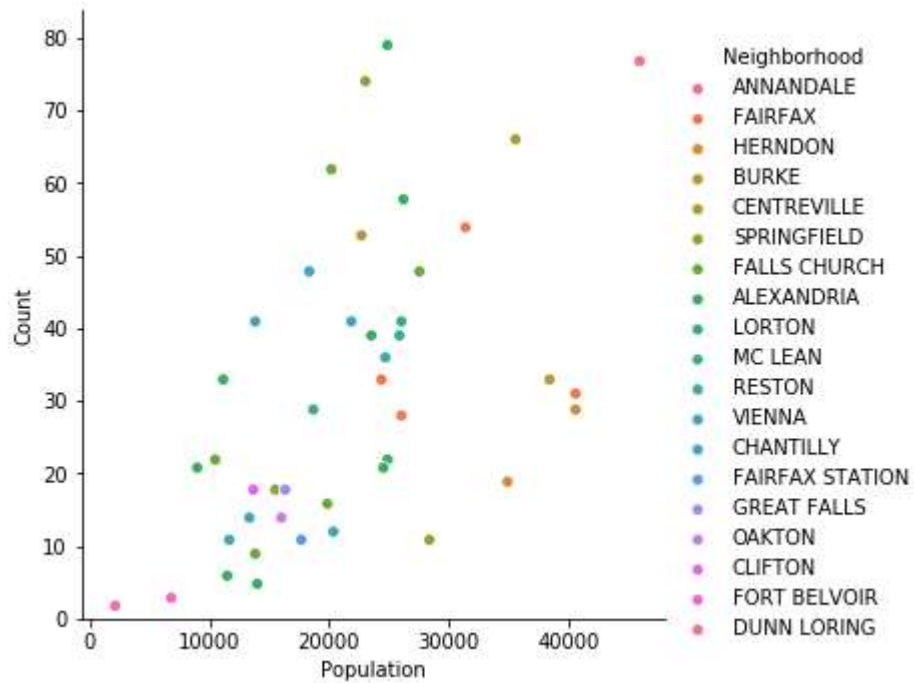


Figure 6. Correlation between population and number of crimes

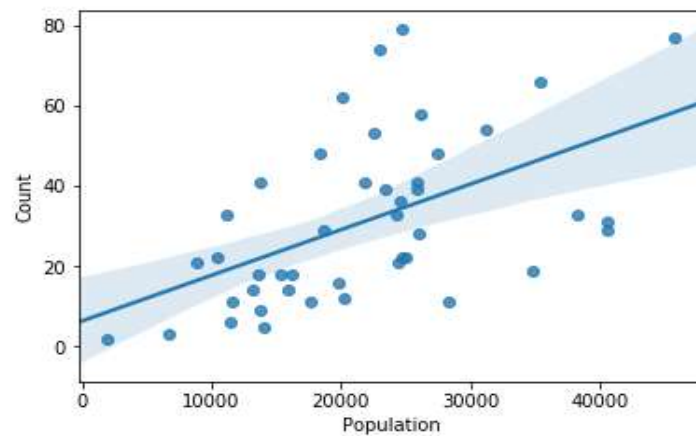
	Count	Population
Count	1.000000	0.528677
Population	0.528677	1.000000

Figure 7. Correlation between population and number of crimes

The intercept is 6.358745986751504

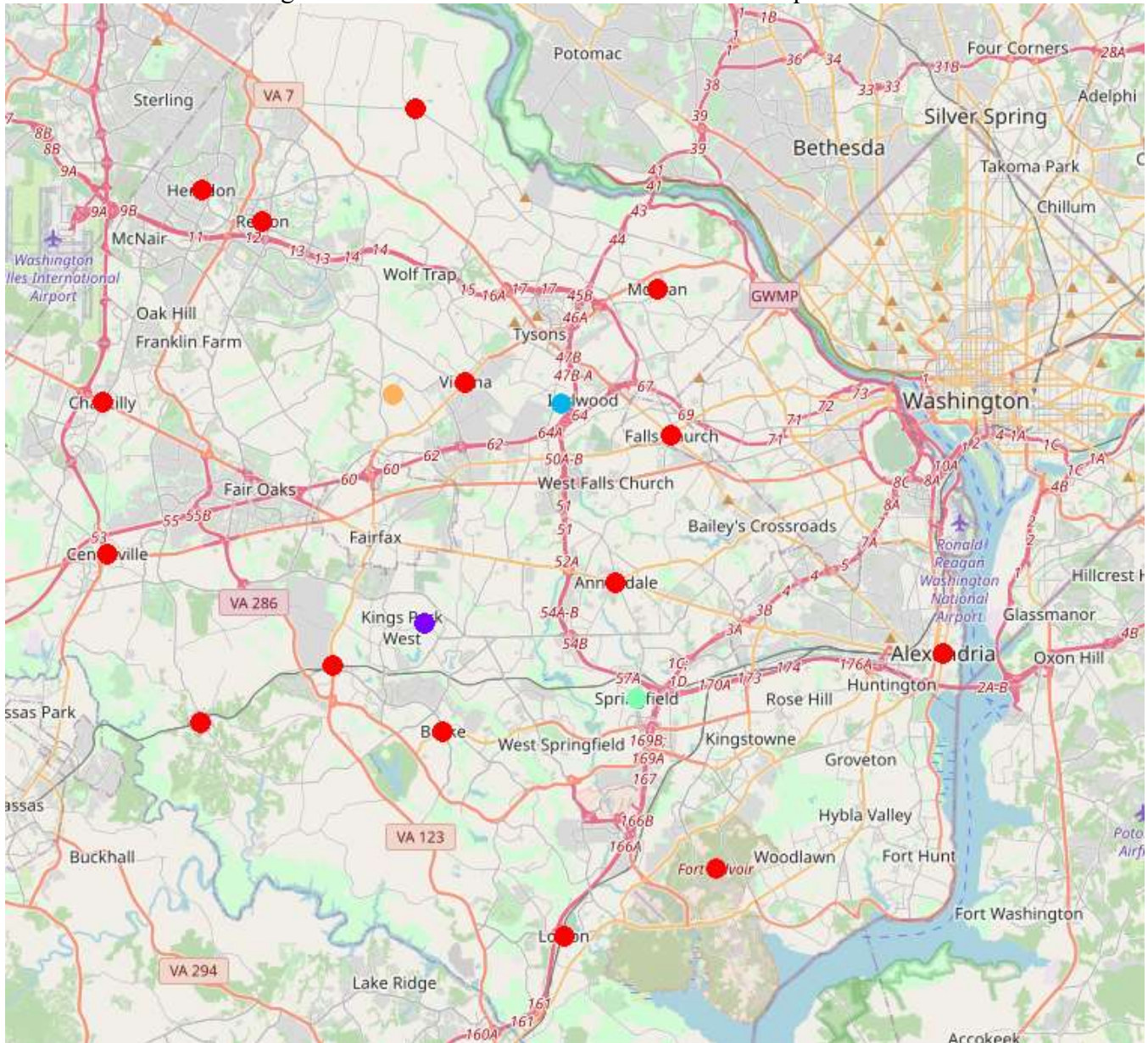
The slope is [0.00113532]

<matplotlib.axes._subplots.AxesSubplot at 0x7fbec5f04fd0>



Foursquare is used to further explore the crime types in the Fairfax County area. From Foursquare API there are 61196 venues, which are grouped into 162 unique categories. In addition, K-means clustering with five clusters is used to group these venues, and the visualization map is shown in Figure 8. The detailed information for each cluster can be found in *Crime in Fairfax VA.ipynb*.

Figure 8. Five Clusters of the venues from Foursquare API



5. Discussion

Among the 1367 crime incidents between April 23rd to April 30th, 2020, service type crime occurred in most of the incidents, followed by animal type, such as animal bites and license violation. In terms of crimes by neighborhood, Alexandria had the highest number of crimes in that week. The scatter plot showed a moderate positive correlation between population and the number of crimes. The

correlation result indicated that more independent variables can be considered in the regression model. For example, the neighborhoods of Annandale and Fairfax have smaller population than Alexandria, but they have fewer crimes. It is possible that they are farther to Washington, DC, and they are not close to the DC metro lines. Further analyses can consider more demographic information as independent variables.

In terms of the venues exploration in Fairfax County, there are five clusters in Fairfax County: (1) restaurant and entertainment, (2) scenic spots, (3) event services and trail, (4) business, and (5) art gallery. From the Foursquare results, 79% of the crime incidents occurred in cluster 1 – restaurant and entertainment. There are many restaurants in the Alexandria, which explains the high number of crimes in this neighborhood.

6. Conclusion

With the increase of population in Fairfax County, understanding crime information is essential for people who are interested in moving to an area. This report uses the crime data in a week. It is suggested to analyze the crime information using a larger data set, such as yearly data, or continuously investigate crime rate on the weekly or monthly bases. Furthermore, more variables, such as school rating and distance to Washington DC, can be included in the independent variables to provide a better regression prediction of crimes. A regression model with more variables can benefit current and potential residents to select the area they would like to live after considering all the variables.

Appendix A

Crime_Category	Count
SERV	685
ANML	107
ASSLT	102
LARC	95
SUSP	86
TRES	59
DRUG	43
DEST	34
FRAUD	29
WARR	23
DISORD	17
DRUNK	16
AUTO	13
WEAP	9
TAMP	8
BURG	8
PARK	6
PUB	5
EXTOR	4
ROB	4
TELE	3
ABC	3
PRIS	1
PEEP	1
ABDCT	1
FAM	1
CHECK	1
ARSN	1
ALRM	1
FORG	1