2018

Finding the safest area for the new house in Montgomery County, MD

FINAL PROJECT - DSS 665 - R PROGAMMING

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Introduction

The idea for this project came out of a conversation between me and my girlfriend regarding our plans to purchase a house. We both agreed upon priorities and concluded that determining factor in our decision-making process will be safety of the area. Taking into account that we have to commute to Washington DC every day for our jobs, I decided to start this project and visually present the safest location in Montgomery County.

I started the project by collecting data from the website Data.gov. I derived my data set from reported crimes classified according to the National Incident-Based Reporting System (NIBRS) of the Criminal Justice Information Services (CJIS) Division Uniform Crime Reporting (UCR) Program and documented by approved police incident reports in the Montgomery County, Maryland. The information contained herein include all founded crimes reported after July 1st, 2016.

The project is delivered using R Programming version 3.5.1.

For this project I have selected the following libraries:

1. library(tidyverse) - is the package that load all four libraries:
    1.1. library(readr)
    1.2. library(tidyr)
    1.3. library(dplyr)
    1.4. library(ggplot2)
2. library(ggmap) - is the package to pull the real-time roadmaps from GoogleMaps
3. library(caTools) - running easy statistics on the data
4. library(ggthemes) - additional themes, scales and geoms for the ggplot2

Loading Data

To load my data, I have used the simple command " file.choose()" a select my Crime.csv dataset. The first seven rows of the data show that my dataset contains a different type of data.

```
> crime.data <- read.csv(file.choose(), header = T)
> head(crime.data)
  Incident.ID Offence.Code CR.Number     Dispatch.Date.Time NIBRS.Code Victims           Crime.Name1
1   201087096         2399  16033231 07/01/2016 12:21:16 AM        23H       1 Crime Against Property
2   201087097         2303  16033232 07/01/2016 12:04:56 AM        23C       1 Crime Against Property
3   201087097         5202  16033232 07/01/2016 12:04:56 AM        520       1  Crime Against Society
4   201087097         5707  16033232 07/01/2016 12:04:56 AM        90J       1  Crime Against Society
5   201087100         1315  16033233 07/01/2016 12:32:17 AM        13A       1   Crime Against Person
6   201087102         3562  16033238 07/01/2016 12:58:05 AM        35A       1  Crime Against Society
              Crime.Name2                 Crime.Name3 Police.District.Name          Block_Address          City State
1        All other Larceny   LARCENY (DESCRIBE OFFENSE)           GERMANTOWN 19600  CRYSTAL ROCK DR    GERMANTOWN    MD
2              Shoplifting        LARCENY - SHOPLIFTING              WHEATON 13700  CONNECTICUT AVE SILVER SPRING    MD
3    Weapon Law Violations           WEAPON - CONCEALED              WHEATON 13700  CONNECTICUT AVE SILVER SPRING    MD
4 Trespass of Real Property                TRESPASSING              WHEATON 13700  CONNECTICUT AVE SILVER SPRING    MD
5       Aggravated Assault ASSAULT - AGGRAVATED - OTHER           GERMANTOWN    19700  FREDERICK RD    GERMANTOWN    MD
6 Drug/Narcotic Violations  DRUGS - MARIJUANA - POSSESS        SILVER SPRING 900  SILVER SPRING AVE SILVER SPRING    MD
  Zip.Code Agency                      Place Sector Beat PRA Address.Number        Start.Date.Time          End.Date.Time
1    20874   MCPD  Residence - Apartment/Condo      N  5N1 595          19600 07/01/2016 12:22:00 AM
2    20906   MCPD               Retail - Other      K  4K2 337          13700 07/01/2016 12:04:00 AM
3    20906   MCPD Retail - Drug Store/Pharmacy      K  4K2 337          13700 07/01/2016 12:04:00 AM
4    20906   MCPD Retail - Drug Store/Pharmacy      K  4K2 337          13700 07/01/2016 12:04:00 AM
5    20876   MCPD            Convenience Store      M  5M1 468          19700 07/01/2016 12:32:00 AM
6    20910   MCPD         Parking Lot - County      G  3G1 093            900 07/01/2016 12:58:00 AM 07/01/2016 12:58:00 AM
  Latitude Longitude Police.District.Number                                Location
1 39.17799 -77.26171                   5D (39.177993504815994, -77.261713770478252)
2 39.07891 -77.08079                   4D (39.078907345412624, -77.080791908039089)
3 39.07891 -77.08079                   4D (39.078907345412624, -77.080791908039089)
4 39.07891 -77.08079                   4D (39.078907345412624, -77.080791908039089)
5 39.17854 -77.23849                   5D (39.178541261093216, -77.238492567560044)
6 38.99170 -77.02410                   3D (38.991700529905174, -77.024095691199292)
>
```

To find how many variables, what type of data and how big is my dataset I am running glimpse() function on my data.

```
> glimpse(crime.data)
Observations: 118,309
Variables: 26
$ Incident.ID           <int> 201087096, 201087097, 201087097, 201087097, 201087100, 201087102, 201087104, 201087108, 2...
$ Offence.Code          <fct> 2399, 2303, 5202, 5707, 1315, 3562, 5311, 1313, 5707, 2602, 9199, 3550, 2903, 3512, 9106,...
$ CR.Number             <int> 16033231, 16033232, 16033232, 16033232, 16033233, 16033238, 16033235, 16033248, 16033252,...
$ Dispatch.Date.Time    <fct> 07/01/2016 12:21:16 AM, 07/01/2016 12:04:56 AM, 07/01/2016 12:04:56 AM, 07/01/2016 12:04:...
$ NIBRS.Code            <fct> 23H, 23C, 520, 90J, 13A, 35A, 90C, 13B, 90J, 26A, 90Z, 35B, 290, 35A, 90Z, 35A, 35A, 90C,...
$ Victims               <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,...
$ Crime.Name1           <fct> Crime Against Property, Crime Against Property, Crime Against Society, Crime Against Soci...
$ Crime.Name2           <fct> All other Larceny, Shoplifting, Weapon Law Violations, Trespass of Real Property, Aggrava...
$ Crime.Name3           <fct> LARCENY (DESCRIBE OFFENSE), LARCENY - SHOPLIFTING, WEAPON - CONCEALED, TRESPASSING, ASSAU...
$ Police.District.Name  <fct> GERMANTOWN, WHEATON, WHEATON, WHEATON, GERMANTOWN, SILVER SPRING, ROCKVILLE, GERMANTOWN, ...
$ Block_Address         <fct> 19600  CRYSTAL ROCK DR, 13700  CONNECTICUT AVE, 13700  CONNECTICUT AVE, 13700  CONNECTICU...
$ City                  <fct> GERMANTOWN, SILVER SPRING, SILVER SPRING, SILVER SPRING, GERMANTOWN, SILVER SPRING, ROCKV...
$ State                 <fct> MD, MD, MD, MD, MD, MD, MD, MD, MD, MD, MD, MD, MD, MD, MD, MD, MD, MD, MD, MD, MD, M...
$ Zip.Code              <int> 20874, 20906, 20906, 20906, 20876, 20910, 20850, 20874, 20850, 20852, 20852, 20910, 20912...
$ Agency                <fct> MCPD, MCPD, MCPD, MCPD, MCPD, MCPD, RCPD, MCPD, RCPD, MCPD, MCPD, MCPD, MCPD, RCPD, MCPD,...
$ Place                 <fct> Residence - Apartment/Condo, Retail - Other, Retail - Drug Store/Pharmacy, Retail - Drug ...
$ Sector                <fct> N, K, K, K, M, G, A, N, A, D, D, G, H, A, K, H, H, G, G, P, N, A, E, A, N, N, H, N, E, H,...
$ Beat                  <fct> 5N1, 4K2, 4K2, 4K2, 5M1, 3G1, 1A3, 5N1, 1A3, 2D4, 2D4, 3G1, 3H1, 1A2, 4K2, 3H1, 3H1, 3G1,...
$ PRA                   <fct> 595, 337, 337, 337, 468, 093, 277, 702, 277, 187, 187, 094, 129, 299, 334, 126, 126, 671,...
$ Address.Number        <int> 19600, 13700, 13700, 13700, 19700, 900, 1, 19600, 300, 11800, 11800, 8500, 900, 13000, 33...
$ Start.Date.Time       <fct> 07/01/2016 12:22:00 AM, 07/01/2016 12:04:00 AM, 07/01/2016 12:04:00 AM, 07/01/2016 12:04:...
$ End.Date.Time         <fct> , , , , , 07/01/2016 12:58:00 AM, 07/01/2016 01:00:00 AM, , 07/01/2016 05:30:00 AM, , , ,...
$ Latitude              <dbl> 39.17799, 39.07891, 39.07891, 39.07891, 39.17854, 38.99170, 39.08047, 39.17689, 39.08664,...
$ Longitude             <dbl> -77.26171, -77.08079, -77.08079, -77.08079, -77.23849, -77.02410, -77.15281, -77.27311, -...
$ Police.District.Number <fct> 5D, 4D, 4D, 4D, 5D, 3D, 1D, 5D, 1D, 2D, 2D, 3D, 3D, 1D, 4D, 3D, 3D, 3D, 3D, 6D, 5D, 1D, 2...
$ Location              <fct> (39.177993504815994, -77.261713770478252), (39.078907345412624, -77.080791908039089), (39...
>
```

From the given output I can see that my dataset has 26 variables and 118,309 observations (has 4550 rows of data). The majority of my data has a factor data type.

I can see that some of the variables are repeated, and I will choose only variables that will have importance for my project.

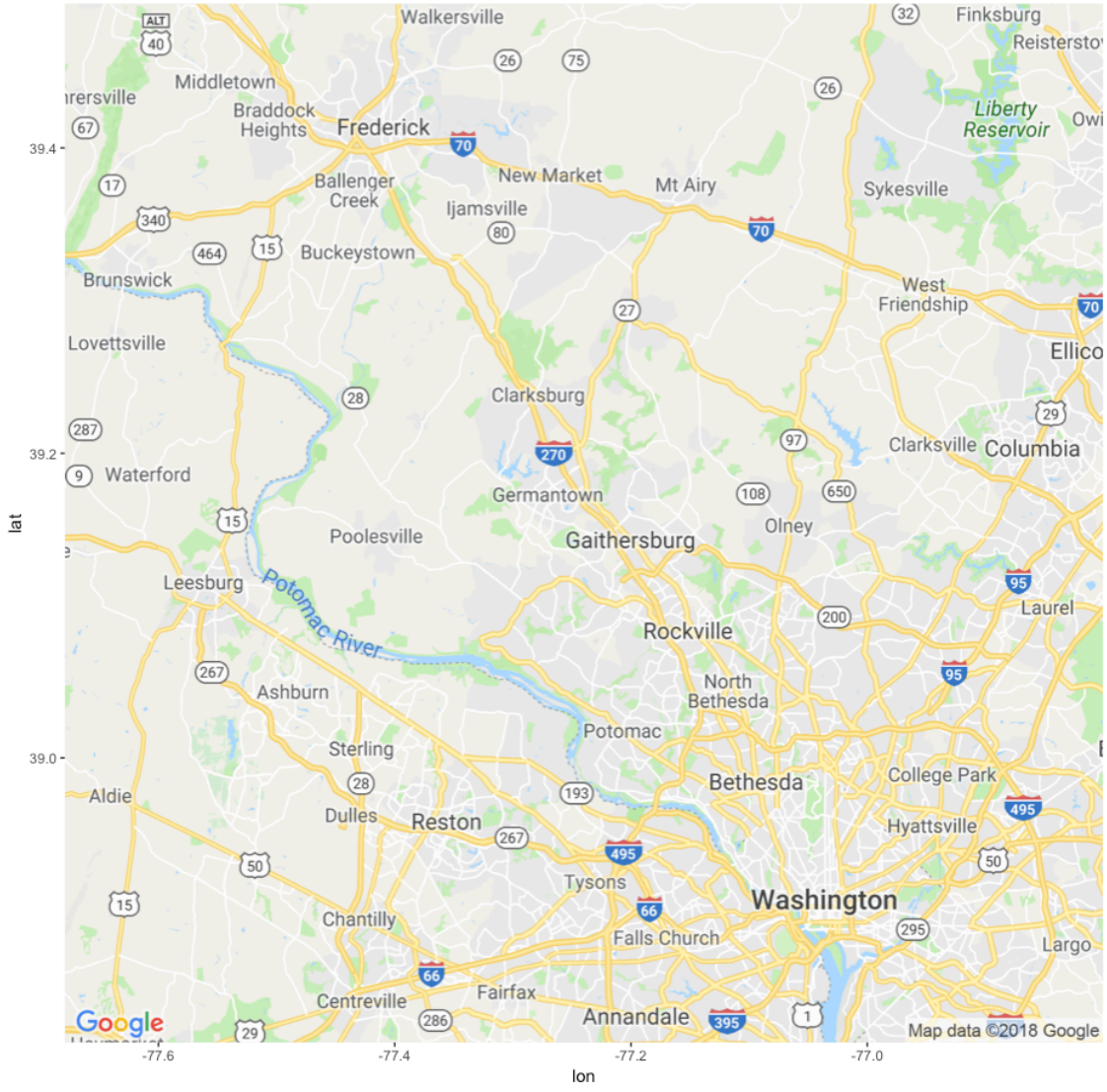
```
> crime.project <- crime.data[c(4, 6, 8, 10, 14,23,24)]
> glimpse(crime.project)
Observations: 118,309
Variables: 7
$ Dispatch.Date.Time   <fct> 07/01/2016 12:21:16 AM, 07/01/2016 12:04:56 AM, 07/01/2016 12:04:56 AM, 07/01/2016 12:04:56...
$ Victims              <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1...
$ Crime.Name2          <fct> All other Larceny, Shoplifting, Weapon Law Violations, Trespass of Real Property, Aggravate...
$ Police.District.Name <fct> GERMANTOWN, WHEATON, WHEATON, WHEATON, GERMANTOWN, SILVER SPRING, ROCKVILLE, GERMANTOWN, RO...
$ Zip.Code             <int> 20874, 20906, 20906, 20906, 20876, 20910, 20850, 20874, 20850, 20852, 20852, 20910, 20912, ...
$ Latitude             <dbl> 39.17799, 39.07891, 39.07891, 39.07891, 39.17854, 38.99170, 39.08047, 39.17689, 39.08664, 3...
$ Longitude            <dbl> -77.26171, -77.08079, -77.08079, -77.08079, -77.23849, -77.02410, -77.15281, -77.27311, -77...
```

Now when I have my data set ready, I can continue the project and start the visualizations of my data.

Visualization

My visualization starts with finding the coordinates for the area of interest and pulling the map from Google Maps. Montgomery County in Maryland has Longitude = -77.24052 and Latitude = 39.15474. My zoom parameter for this map is set to 10.

```
> geocode("Montgomary County")
Information from URL : http://maps.googleapis.com/maps/api/geocode/json?address=Montgomary%20County&sensor=false
        lon      lat
1 -77.24052 39.15474
> mapMontCount <- get_map(location = c(-77.24052, 39.15474), source = "google", zoom = 10, maptype = "roadmap")
Map from URL : http://maps.googleapis.com/maps/api/staticmap?center=39.15474,-77.24052&zoom=10&size=640x640&scale=2&maptype=roadma
p&language=en-EN&sensor=false
> ggmap(mapMontCount)
>
```



Montgomery County by Google Maps

Now when I have my map, I am going to check what type of crimes I have in my dataset by putting all data into a table. The data is organized from the most repeated offense to the least repetitive offense. Following the crime table, I plugged all crimes on the Montgomery County map.

```
> sort(table(crime.project$Crime.Name2), decreasing = T)
```

All Other Offenses	Drug/Narcotic Violations	Theft From Motor Vehicle
26206	12408	9918
Simple Assault	Destruction/Damage/Vandalism of Property	Driving Under the Influence
7605	7197	6771
Shoplifting	All other Larceny	Theft from Building
5575	5282	4633
Liquor Law Violations	Burglary/Breaking and Entering	Disorderly Conduct
3762	3572	2714
Motor Vehicle Theft	False Pretenses/Swindle/Confidence Game	Trespass of Real Property
1977	1910	1835
Theft of Motor Vehicle Parts or Accessories	Credit Card/Automatic Teller Machine Fraud	Robbery
1740	1594	1484
Impersonation	Runaway	Aggravated Assault
1468	1422	1414
Identity Theft	Drug Equipment Violations	Counterfeiting/Forgery
1414	1066	977
Weapon Law Violations	Forcible Rape	Fondling
838	416	408
Family Offenses, NonViolent	Pocket/picking	Intimidation
331	265	211
Forcible Fondling	Embezzlement	Bad Checks
161	152	147
Purse-snatching	Not Mapped	Arson
145	126	123
Forcible Sodomy	Stolen Property Offenses	NOT NIBRS CODE
122	119	106
Extortion/Blackmail	Prostitution	Sexual Assault With An Object
97	96	89
Wire Fraud	Pornography/Obscene Material	Drunkenness
74	67	58
Peeping Tom	Murder and Nonnegligent Manslaughter	Kidnapping/Abduction
38	36	32
Curfew/Loitering/Vagrancy Violations	From Coin/Operated Machine or Device	
25	25	23
Human Trafficking, Commercial Sex Acts	Assisting or Promoting Prostitution	Negligent Manslaughter
18	15	1
Operating/Promoting/Assisting Gambling		
1		

```
> ggmap(mapMontCount) + geom_point(aes(x = Longitude, y = Latitude, colour = `Crime.Name2`),
+                                  size = 1, data = crime.project)
```

All crimes committed in MC after July 1st, 2016

Conclusion after this map is that I have a lot of data and a lot of different crimes.

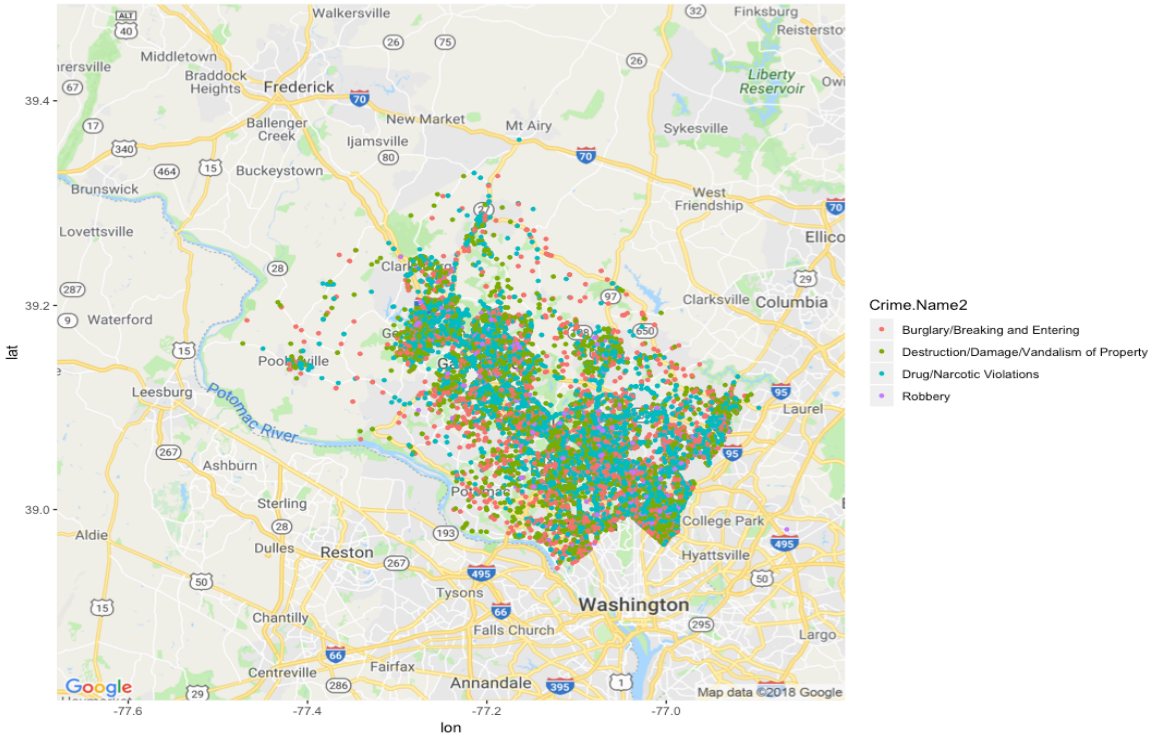
To better present data and achieve desired outcome I am limiting crimes data to four crimes:

1. Drug/Narcotic Violations
2. Destruction/ Damage/ Vandalism of Property
3. Burglary / Breaking and Entering
4. Robbery.

```
filt.crime.project <- filter(crime.project,
                             Crime.Name2 == "Drug/Narcotic Violations" |
                                    Crime.Name2 == "Destruction/Damage/Vandalism of Property" |
                                    Crime.Name2 == "Burglary/Breaking and Entering" |
                                    Crime.Name2 == "Robbery")
sort(table(filt.crime.project$Crime.Name2), decreasing = T)
```

```
Drug/Narcotic Violations    Destruction/Damage/Vandalism of Property
                   12408                                        7197
Burglary/Breaking and Entering                              Robbery
                    3572                                        1484
```

The rest of the data will remain "zero" in the further analysis. Going back to the map and add only filtered crimes.



Filtered crimes committed in MC after July 1st, 2016

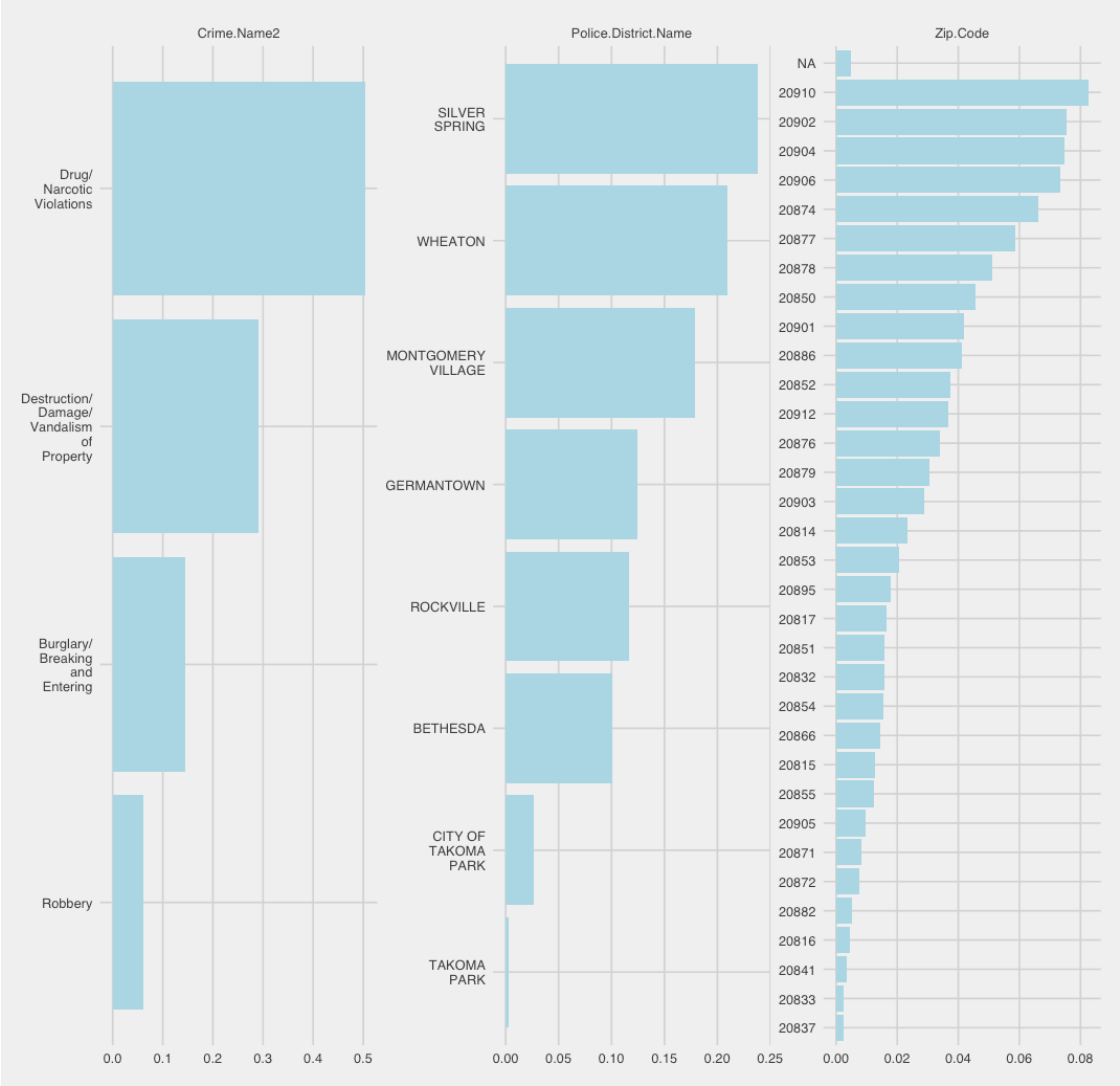
I can see on the map that there are some areas where the crime level is on the high level and also some areas where crime level is not that high.

Using our dataset, I am looking for the city that is going to be our possible choice. Sorting crime in the table I can see that Takoma Park is the area with only 73 committed crimes. Comparing to Silver Spring with 5874 crimes or Wheaton with 5174 committed crimes, Takoma Park has a much lower crime rate.

```
> sort(table(filt.crime.project$Police.District.Name), decreasing = T)

      SILVER SPRING             WHEATON  MONTGOMERY VILLAGE          GERMANTOWN           ROCKVILLE
               5874                5174                4419                3079                2876
 BETHESDA CITY OF TAKOMA PARK         TAKOMA PARK               OTHER
               2484                 652                  73                  30
```

Double checking the data by making bar plots to confirm that Takoma Park is the right choice.

```
crime.frequency <-  filt.crime.project [c(3,4,5)]  %>%
        gather("var", "value") %>%
        group_by(var) %>%
        count(var, value) %>%
        mutate(prop = prop.table(n)) %>%
        filter(prop > .02)

crime.plot <-
        ggplot(data = crime.frequency,
               aes(x = reorder(stringr::str_wrap(value, 10), prop),
                   y = prop)) +
        geom_bar(stat = "identity", fill = "lightblue") +
        coord_flip() +
        facet_wrap(~var, ncol = 3, scales = "free") +
        ggthemes::theme_fivethirtyeight()

crime.plot
```



Bar presentation of the crime rate for different variable

Bar presentation confirmed that Takoma Park is for now the best possible choice. I will perform the data visualization to check the area.

Takoma Park Visualization

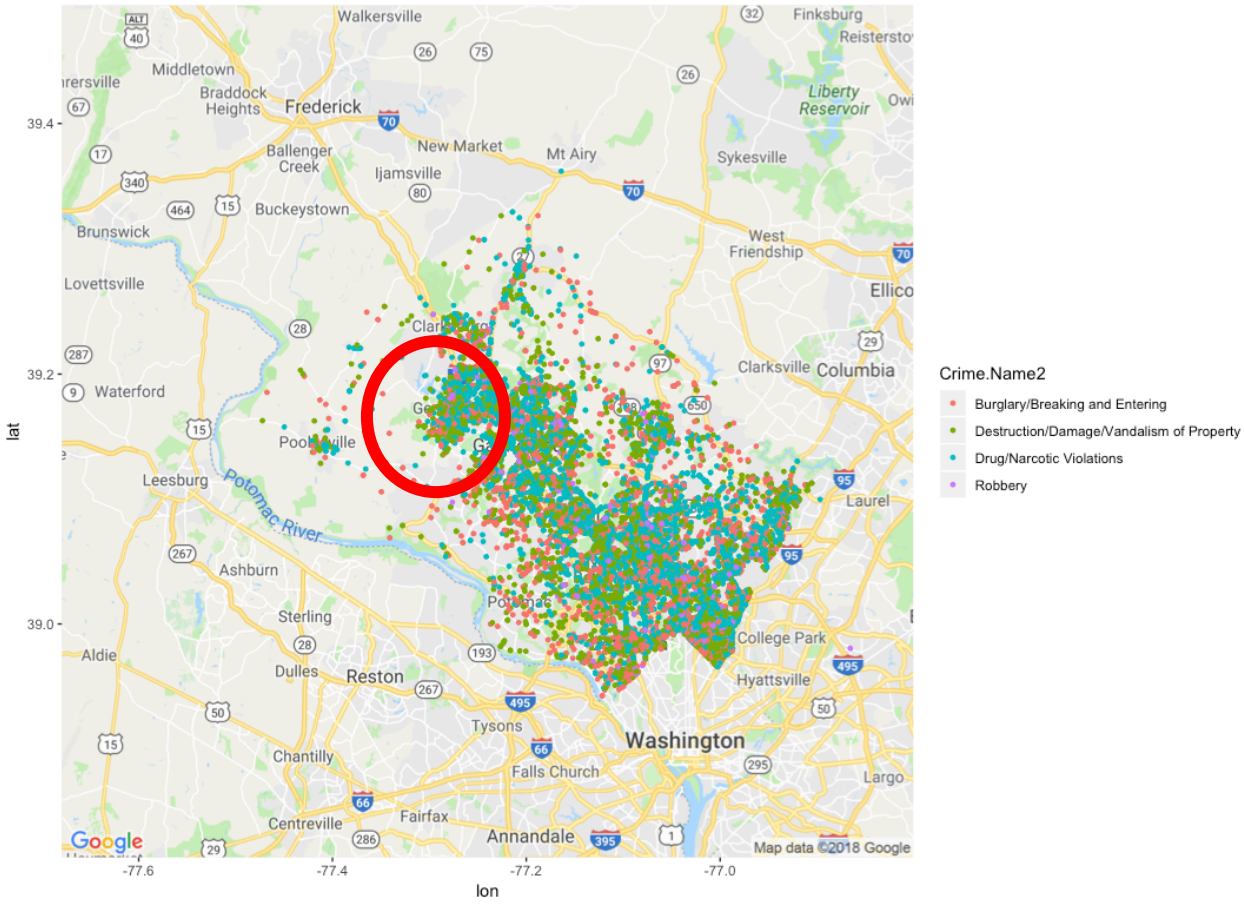
First, I found the Longitude and Latitude for Takoma Park area. Next, I imported the crime data in the Takoma Park Google Map to help me visualize the data. The zoom for the map is set to 15 so that I can have a closer look to data.

```
> geocode("Takoma Park")
Information from URL : http://maps.googleapis.com/maps/api/geocode/json?address=Takoma%20Park&sensor=false
        lon      lat
1 -77.00748 38.97789
> mapTakoma <- get_map(location = c(-77.00748, 38.97789), source = "google", zoom = 15, maptype = "roadmap")
Map from URL : http://maps.googleapis.com/maps/api/staticmap?center=38.97789,-77.00748&zoom=15&size=640x640&scale=2&ma
ptype=roadmap&language=en-EN&sensor=false
> ggmap(mapTakoma)
> ggmap(mapTakoma) + geom_point(aes(x = Longitude, y = Latitude, colour = `Crime.Name2`),
+                               size = 2, data = filt.crime.project)
```

Filtered crimes committed in Takoma Park after July 1st, 2016

Get back to my girlfriend with the explanation what this visualization presents, and her first comment was that this area looks like "Crime on every corner". Looking at the map, it seems like that the crime is happening on almost every corner.

From here I decided to go back to the original Montgomery County Crime map and try to find the spot on the map that is "clean" but also not too far from the urban city areas.



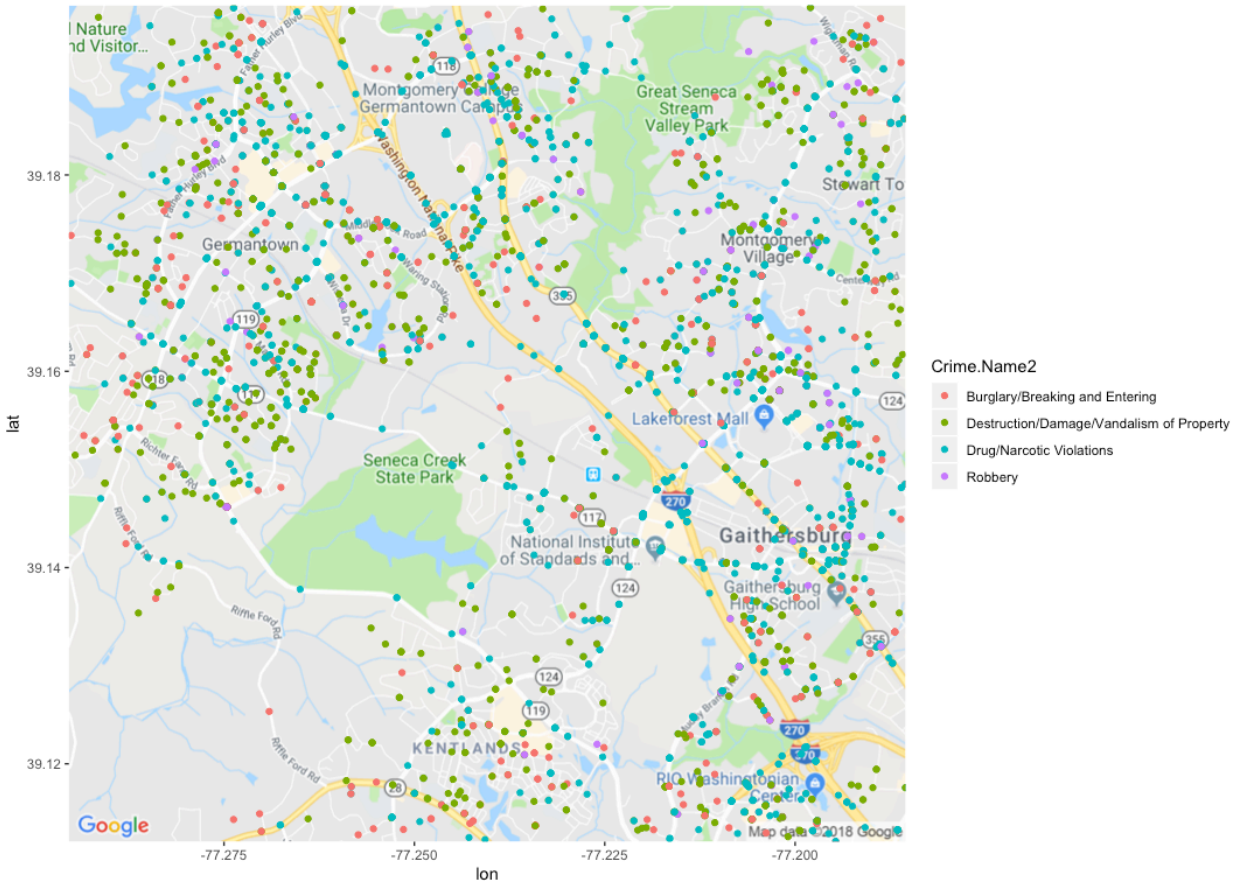
Filtered crimes committed in MC after July 1st, 2016

Looking at the map, I decided to check the red circled area because it seems like a part that does not have a lot of dots (crimes). Also, this is close to the urban city area which is one of the priorities in our choice.

Montgomery County crime on the zoomed map

Changing zoom to 13 allows me to have a better view of this area after I insert the crime data.

```
> mapMontCount <- get_map(location = c(-77.24052, 39.15474), source = "google", zoom = 13, maptype = "roadmap")
Map from URL : http://maps.googleapis.com/maps/api/staticmap?center=39.15474,-77.24052&zoom=13&size=640x640&scale=2&maptype=roadmap&language=en-EN&sensor=false
> ggmap(mapMontCount)
>
> ggmap(mapMontCount) + geom_point(aes(x = Longitude, y = Latitude, colour = `Crime.Name2`),
+                                  size = 1.5, data = filt.crime.project)
```

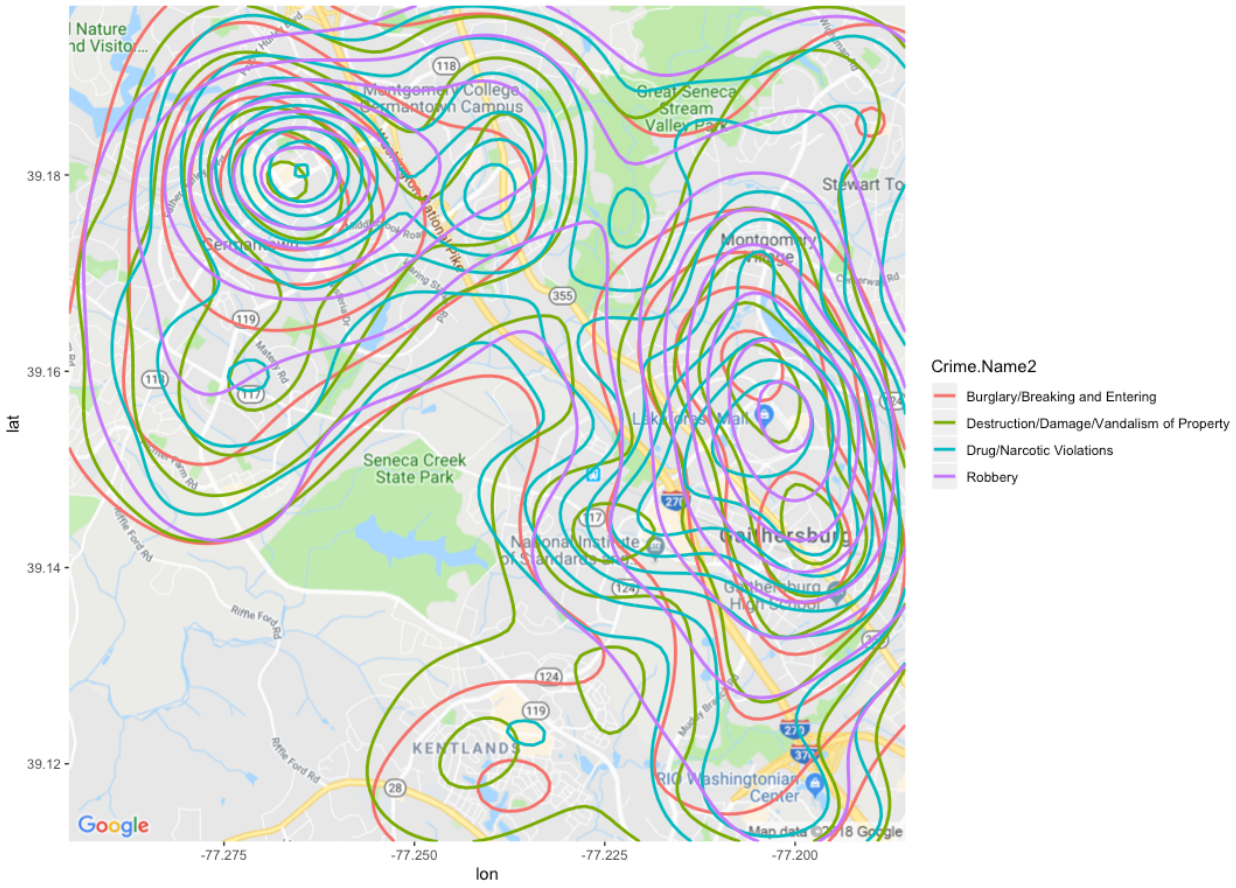


Filtered crimes committed in part of MC after July 1st, 2016

On the first look, this area looks like place that has high crime volume. I decided to go into the more in-depth visual analysis and see the density of the crime in the area.

Density of all crime in the chosen area will show me the concertation of the crime.

```
ggmap(mapMontCount) + geom_density2d (aes(x = Longitude, y = Latitude, colour = `Crime.Name2`),
                                      size = 1, data = filt.crime.project)
```



Density of the Filtered crimes after July 1st, 2016

The density presentation looks a little bit messy, but I can see that small town called Kentlands has a much lower density of the crime compared to the rest of the map.

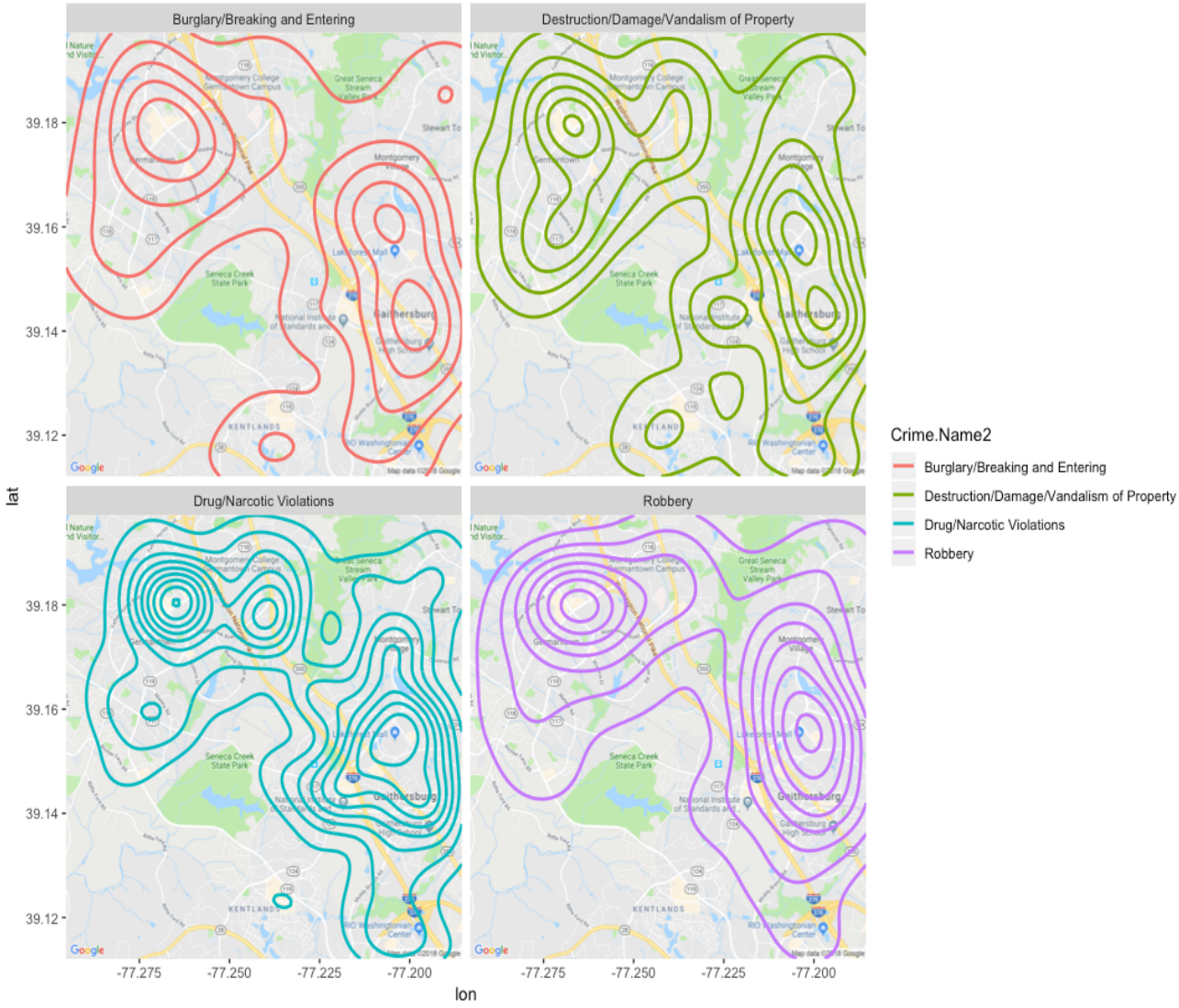
Splitting the map for each crime

My next goal is to split the map for every crime and check the density of the crime in the area for every crime separately.

```
> ggmap(mapMontCount) + geom_point(aes(x = Longitude, y = Latitude, colour = `Crime.Name2`),
+                                  size = 1, data = filt.crime.project) +
+         facet_wrap(~ `Crime.Name2`)
```

Split map for each crime after July 1st, 2016

Density for the map by crime shows us that the area around Kentlands has almost no Robbery crime and very low Drug / Narcotic Violations. The Destruction / Damage / Vandalism of Property and Burglary in Kentlands has much lower density comparing to the rest of the urban area of the map.

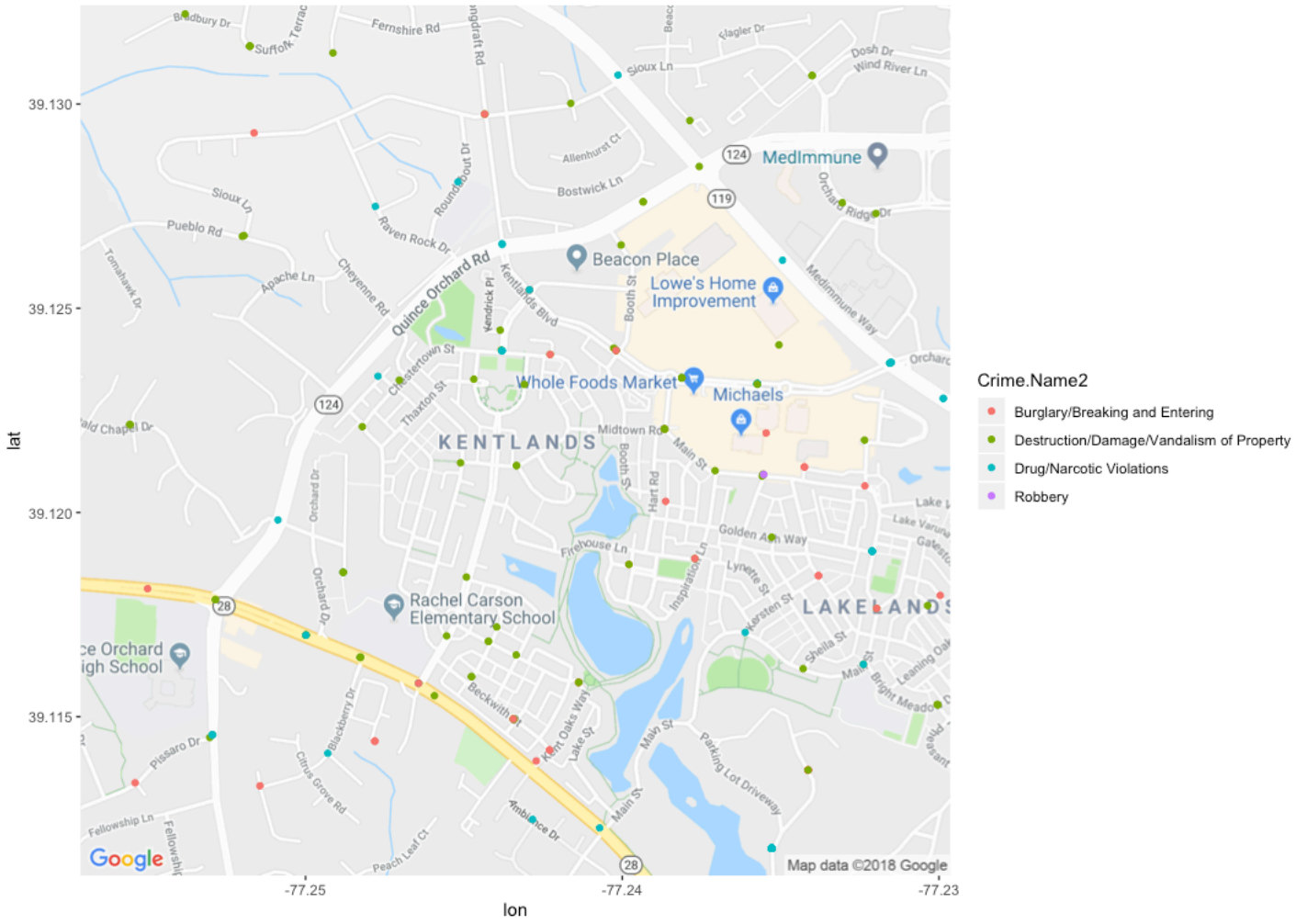


Split map for each crime density after July 1st, 2016

Kentlands Visualization

I plugged the crime data into Kentlands area for the visual comparison with Takoma Park. Note that I am using the same zoom = 15 for the map view as I did in Takoma Park.

```
> geocode("Kentlands")
Information from URL : http://maps.googleapis.com/maps/api/geocode/json?address=Kentlands&sensor=false
        lon      lat
1 -77.24339 39.12178
> ggmap(mapKentlands) + geom_point(aes(x = Longitude, y = Latitude, colour = `Crime.Name2`),
+                                  size = 1.5, data = filt.crime.project)
```



Filtered crimes committed in Kentlands after July 1st, 2016

Conclusion

My girlfriend looked at the map and loved the fact that the area has almost everything that we wanted. It has an elementary school, shopping center, small lakes around perfect for a morning run and the most important it has low crime frequency.

We made our decision.

We are going to contact our real estate agent and let him know that our wish is to look for the hour in the Kentlands, MD.

This project shows that R programming is an powerful language with a very broad usage in the real world problems.