Segmenting and Clustering Neighborhoods in Novi, MI

Applied Data Science Capstone Project Report

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1. Introduction to the Opportunity in Novi

1.1 Background
Novi is a city in Oakland County in the U.S. state of Michigan. The city is located approximately 25 miles northwest of the center of Detroit. Novi was originally a township organized in 1832, but it continues to be one of the fastest growing cities in Michigan today.

1.2 Problem
As the city grows and develops, it becomes increasingly important to examine and understand it quantitiatively. The city of Novi provides open data for everyone and encourages entrepreneurial use to develop services for the benefit of its citizens.

Developers, investors, policy makers and city planners have an interest in answering the following questions as the need for additional services:

- ***Whether the population increases continuously since Novi is the one of the fastest growing cities in Michigan?***
- ***Is population increasing correlated to economy?***
- ***How is crime incident today in Novi?***
- ***Where is the best place to open another coffee shop?***

2. Data

2.1 Data Sources
Most data and information about the City of Novi can be found in the City of Novi Open Data Center:
- https://www.opendatanetwork.com/entity/1600000US2659440/Novi_MI/
- Novi Developers Access to venue data: https://foursquare.com/

2.2 Data Selection
Normally, we can use the following data sets to indicate the growing status and economy healthy situatin of the city:
1. Population changing information
2. Residents' earning and education degree
3. The debt and revenue of the city
4. Crime incident information of the city

In the case, we can select and focus on the following data sets from the city Open Data Center:

- The City demographic data will show us the population changing rate, it will also show the residents' earning and education information.
- Economy and finance data will enable us to conclude economy statuation of Novi.
- The public safety data will let us to compare the population density and crime.
- Neighborhoods and location data can let us to capture venues information, so we can determine where to open another coffee shop.

3. Methodology

All steps are referenced below in the Appendix: Analysis Section.

3.1 Data Cleaning

Data scraped and downloaded from multiple sources were in all different type (ie. HTML, XML, xlsx), and it was in a mess and unreadable.

I used *Beautiful Soup* to pull data out of HTML and XML files, and parsed data in order to find ways of navigating and searching the useful information. Then I used *json* library to convert those parsed data into lists or dictionaries.

After that, I combined some related lists and dictionaries into different DataFrame or tables by using *Pandas* library. However, there were a lot of missing values in the DataFrame. I use *Pandas* to clean, fill those missing values and reorganize some DataFrame.
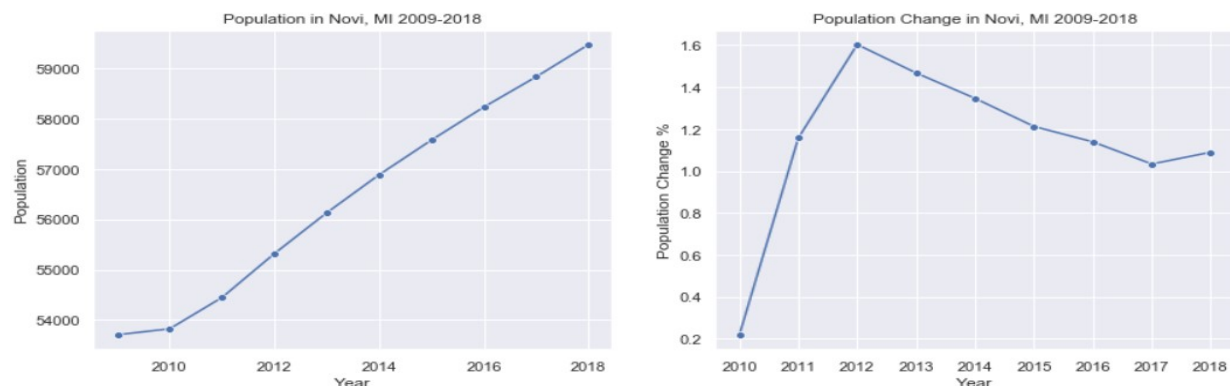
3.2 Exploratory Data Analysis

In order to determine the living condition of Novi, I explore and analyzed the each data set to see how does data affect to the city. I also studied and understood the correlation between population, economy and crimes in the city. Then I performed statistical analysis on each data, created summary tables and figures to show how those data affects the city.

3.2.1 Relationship between population changing and city growing

In general, more population means more business opportunities and more tax income to the city. I captured the population changing information of Novi from 2009 – 2010, and also calculated and plot the rate change of the population.

The following figures show the population increases continuously while the city is growing from 2009-18
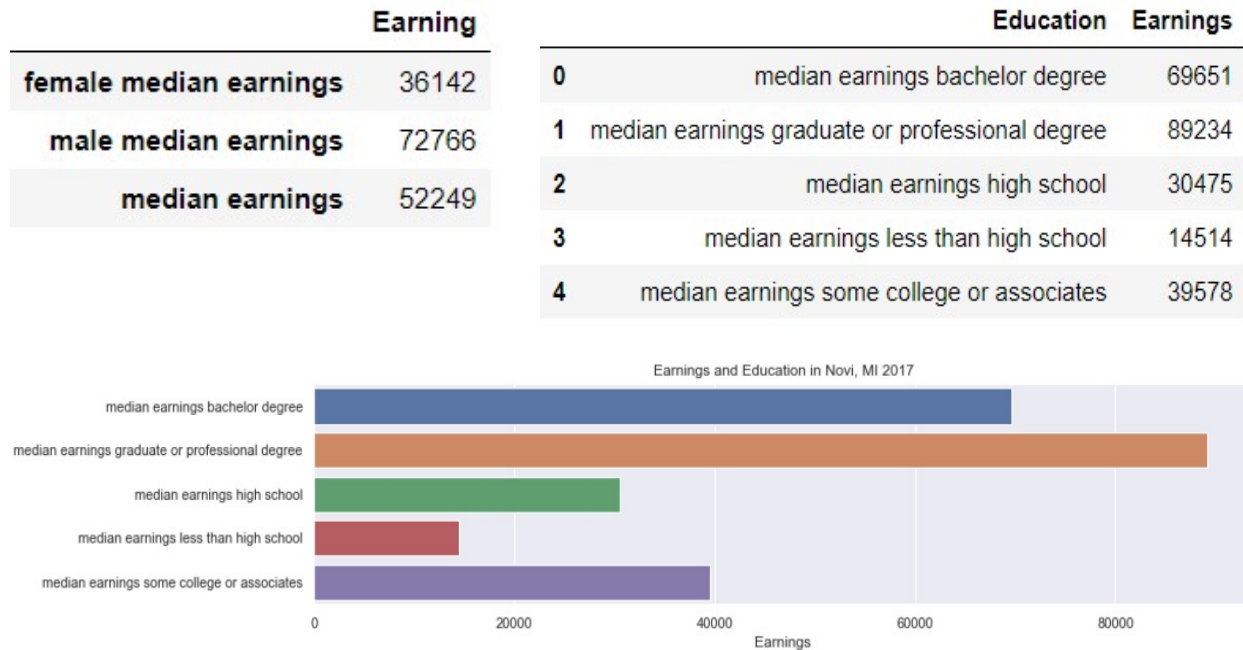
3.2.2 What kind of people move to Novi

This will help the city to have more business opportunities if people who live in Novi have high income. More shopping mall, groceries, supermarkets, stores will occur and provide more tax to the city, then the city will have sufficient resource to develop.

Also, the people who have high education degree will make the city living condition and school district to be better.

The following table and figure show people who come to Novi have high earning and education degree.

	Earning
female median earnings	36142
male median earnings	72766
median earnings	52249

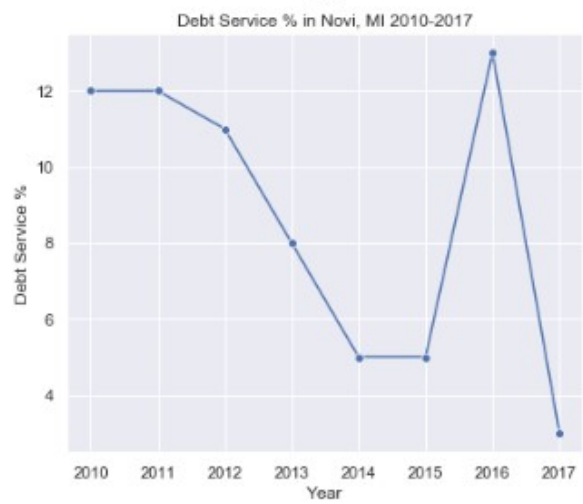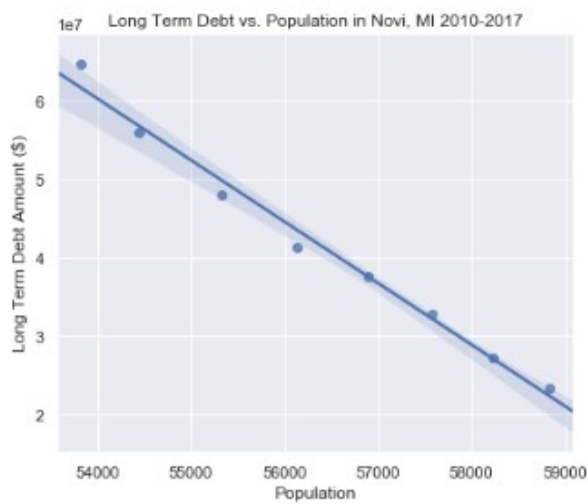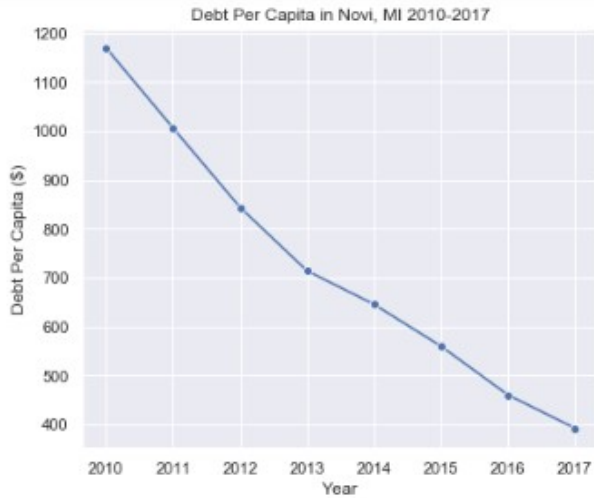|	Education	Earnings
0	median earnings bachelor degree	69651
1	median earnings graduate or professional degree	89234
2	median earnings high school	30475
3	median earnings less than high school	14514
4	median earnings some college or associates	39578

Earnings and Education in Novi, MI 2017

3.2.3 Check the city debt and revenue information

Since Novi is the one of the fastest growing cities in Michigan. I assumed the revenue of the city should increase and the debt should decrease due to more and more high income people move to Novi.

The following table and figures show debt decreases and revenue increases in Novi from 2010 – 2017.

- Debt refers to the total amount of outstanding dollars owed by a government entity.
- Debt Per Capita is the amount of outstanding debt per resident.
- Long Term Debt is the unmatured principal of bonds, or other forms of noncurrent or long-term obligation indebtedness.
- Debt Service Ratio is the percentage of annual revenues committed to paying back debts.
- Debt as a Percentage of Taxable Value is the amount of long term debt compared to taxable value.
- Long Term Debt Revenue is the ratio of outstanding long term debts to revenues.

	Year	Long Term Debt	Population	Debt Per Capita	Debt Service %	Debt % of Taxable value	Debt % Revenue
0	2010	64613290	53823.0	1170.02	12.0	2.000000	76.0
1	2011	55925472	54446.0	1006.16	12.0	1.000000	66.0
2	2012	48022654	55319.0	843.80	11.0	1.000000	60.0
3	2013	41379833	56131.0	713.93	8.0	1.000000	49.0
4	2014	37695000	56887.0	645.28	5.0	1.000000	40.0
5	2015	32870000	57577.0	559.74	5.0	1.000000	32.0
6	2016	27235000	58233.0	459.96	13.0	0.825766	23.0
7	2017	23400000	58835.0	391.86	3.0	0.678238	24.0

Debt Per Capita in Novi, MI 2010-2017

Long Term Debt in Novi, MI 2010-2017

Long Term Debt vs. Population in Novi, MI 2010-2017

Debt Service % in Novi, MI 2010-2017

Debt as % of Taxable Value in Novi, MI 2010-2017
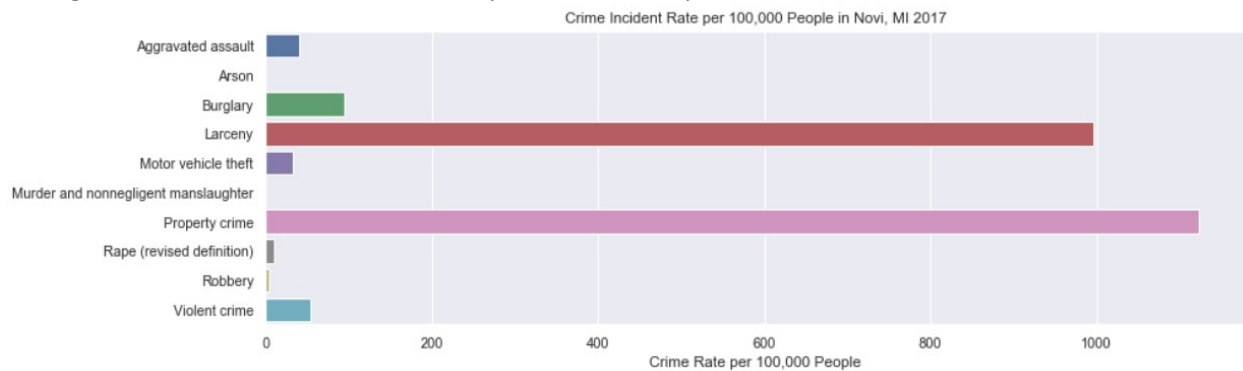

Long Term Debt to Revenue in Novi, MI 2010-2017

3.2.4 How about the crime incident since more population come to Novi

I summaried all crime occurred in Novi in 2017, sorted and listed them with crime name and count number. In order to explore the relationship between population density and crime, I calculated and created a bar chart to display the crime incident rate per 100,000 People in Novi.

The following table shows the number of crime occurs in Novi in 2017.

	Crime	Count
0	Aggravated assault	24
1	Arson	0
2	Burglary	56
3	Larceny	586
4	Motor vehicle theft	19
5	Murder and nonnegligent manslaughter	0
6	Property crime	661
7	Rape (revised definition)	6
8	Robbery	2
9	Violent crime	32

The figure shows the crime incident rate per 100,000 People in Novi.

Crime Incident Rate per 100,000 People in Novi, MI 2017

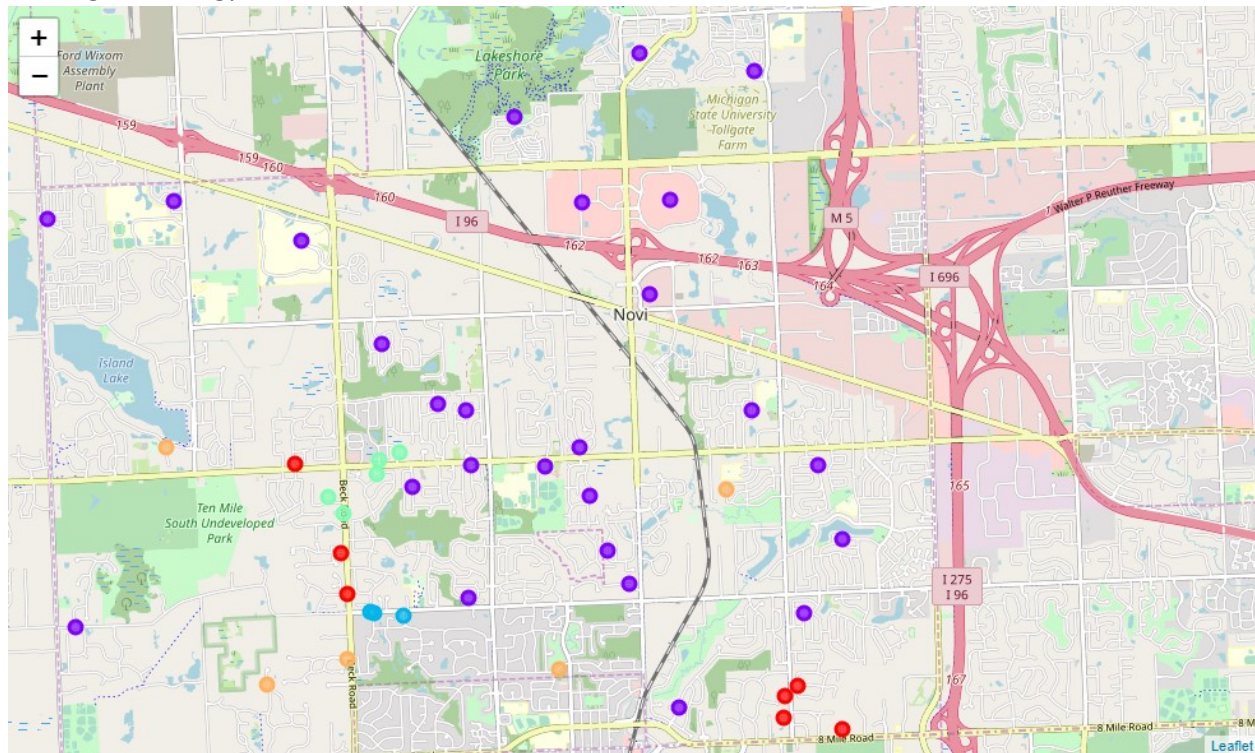### 3.2.5 Explore and Cluster the Neighborhoods in Novi

I created data includes all neighborhoods with their latitude and longitude values in Novi, then I used *Foursquare API* to explore those neighborhoods, used the *explore function* to get the most common venue categories in each neighborhood.

Finally, I used the **k-means clustering algorithm** to group the neighborhoods into clusters, and use the *Folium library* to visualize the neighborhoods in Novi and their emerging clusters.

The following table shows the top 10 most common venues in Novi:

	Neighborhood	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
0	Addington Park	Intersection	Business Service	Food Court	Park	Seafood Restaurant	Insurance Office	Automotive Shop	Electronics Store	Fabric Shop	Art Gallery
1	Ascension Hospital	Coffee Shop	Spa	American Restaurant	Intersection	Gym / Fitness Center	Hot Dog Joint	Gas Station	Frozen Yogurt Shop	Medical Center	Mediterranean Restaurant
2	Autumn Park	Intersection	Bar	Golf Course	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop	Food
3	Barclay Estates	Intersection	Bar	Golf Course	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop	Food
4	Beckenham	Intersection	Baseball Field	Golf Course	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop	Food
5	Bella Terra	Park	Women's Store	Gift Shop	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop	Food
6	Bellagio	Bar	Gym / Fitness Center	Women's Store	Gift Shop	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop
7	Berkshire Pointe	American Restaurant	Fast Food Restaurant	Sandwich Place	Coffee Shop	Motel	Donut Shop	Spa	Sports Bar	Big Box Store	Grocery Store
8	Bradford of Novi	Bar	Women's Store	Golf Course	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop	Food
9	Briarwood	Massage Studio	Intersection	Pharmacy	Business Service	Gift Shop	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop
10	Broadmoor Park	Massage Studio	Intersection	Pharmacy	Food	Business Service	Gift Shop	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant
11	Brookland Farms	Intersection	Gym	Pharmacy	Japanese Restaurant	Chinese Restaurant	Sushi Restaurant	Furniture / Home Store	Frozen Yogurt Shop	Food Court	Flower Shop
12	Carriage Hill	Intersection	Dog Run	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop	Food	Food Court
13	Chase Farms	Ice Cream Shop	Gymnastics Gym	Pizza Place	Sandwich Place	Flower Shop	Tanning Salon	Juice Bar	Mexican Restaurant	Event Service	Wine Shop
14	Cheltenham Estates	Intersection	Electronics Store	Dog Run	Dry Cleaner	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop	Food	Food Court
15	Churchill Crossing	Indian Restaurant	Baseball Field	Pub	Cosmetics Shop	Chinese Restaurant	Breakfast Spot	Grocery Store	Liquor Store	Government Building	Kids Store
16	City Hall	Intersection	Food Court	Government Building	Chinese Restaurant	Baseball Field	Track	Park	Fast Food Restaurant	Flower Shop	Gastropub
17	Estates of Meadowbrook	Intersection	Golf Course	Ice Cream Shop	IT Services	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop
18	Greenwood Oaks	Intersection	Dog Run	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop	Food	Food Court
19	Iroquois Estates	Intersection	Trail	Massage Studio	Gift Shop	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop
20	Island Lake	Gym / Fitness Center	Pet Store	Flower Shop	Women's Store	Gift Shop	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant
21	Knightsbridge Gate	Pool	Recreation Center	Trail	Gastropub	Donut Shop	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant
22	Liberty Park	Pool	Residential Building (Apartment / Condo)	Gym	Bar	Playground	Event Service	Electronics Store	Fabric Shop	Gas Station	Dry Cleaner
23	Lochmoor Village	Pool Hall	Gift Shop	Donut Shop	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop	Food
24	Maybury Park Estates	Gym / Fitness Center	Women's Store	Gift Shop	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop	Food
25	Meadowbrook Glens	Pizza Place	Convenience Store	Pharmacy	Gift Shop	Clothing Store	Sandwich Place	Flower Shop	Sushi Restaurant	Grocery Store	Automotive Shop
26	Mirabella Estates	Intersection	Business Service	Gift Shop	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop	Food
27	Mission Pines	Intersection	Art Gallery	Golf Course	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop	Food
28	Mystic Forest	Pool	Gym	Gift Shop	Donut Shop	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop
29	North Hills	Gym / Fitness Center	Mobile Phone Shop	Women's Store	Gift Shop	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop
30	Novi Town Center	Sandwich Place	American Restaurant	Pizza Place	Burger Joint	Seafood Restaurant	Korean Restaurant	Salon / Barbershop	Noodle House	Mobile Phone Shop	Miscellaneous Shop
31	Orchard Hills West	Gym / Fitness Center	Café	Dog Run	Women's Store	Gastropub	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant
32	Orchard Ridge Estates	Baseball Field	IT Services	Government Building	Racetrack	Women's Store	Furniture / Home Store	Frozen Yogurt Shop	Food Court	Food	Fast Food Restaurant
33	Roma Ridge	Massage Studio	Pharmacy	Food	Women's Store	Gift Shop	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant
34	Royal Crown	Intersection	Cosmetics Shop	Beer Bar	Golf Course	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop	Food
35	Saratoga Circle	Bar	Hotel	Shoe Store	Park	Fast Food Restaurant	Convenience Store	Lake	Food	Furniture / Home Store	Frozen Yogurt Shop
36	Simmons Orchard	Mediterranean Restaurant	Train Station	Women's Store	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop	Food
37	Tollgate Woods	Playground	Residential Building (Apartment / Condo)	Gastropub	Donut Shop	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop
38	Turtle Creek	Intersection	Hill	Lake	Construction & Landscaping	Gift Shop	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop
39	Twelve Oak East	Cosmetics Shop	Department Store	Clothing Store	Lingerie Store	Soup Place	Gourmet Shop	Kitchen Supply Store	Electronics Store	Cupcake Shop	Pizza Place
40	Twelve Oak West	Furniture / Home Store	Sporting Goods Shop	Clothing Store	Pizza Place	Fabric Shop	Recreation Center	Racetrack	Plaza	Department Store	Discount Store
41	Valencia Estates	Massage Studio	Intersection	Pharmacy	Gift Shop	Dry Cleaner	Electronics Store	Event Service	Fabric Shop	Fast Food Restaurant	Flower Shop
42	Village Oaks	Park	Pool	Martial Arts Dojo	Pet Store	Sandwich Place	Women's Store	Flower Shop	Frozen Yogurt Shop	Food Court	Food
43	Willowbrook Farm	Pizza Place	Ice Cream Shop	Shopping Mall	Japanese Restaurant	Greek Restaurant	Gift Shop	Dry Cleaner	Pet Store	Convenience Store	Salon / Barbershop
44	Wintergreen Park	Optical Shop	Trail	Lake	Business Service	Fabric Shop	Fast Food Restaurant	Flower Shop	Event Service	Gift Shop	Food
45	Yorkshire Place	Mediterranean Restaurant	Train Station	Thai Restaurant	Food	Gastropub	Gas Station	Furniture / Home Store	Frozen Yogurt Shop	Food Court	Women's Store

The following figure shows the map of cluster neighborhoods in Novi after using k-means machine learning technology:

4. Result

In this study, I analyzed the relationship between Population, Residents' earning and education, Cities' Debt and Revenue and City Economy, Living condition.

Data shows more and more high income and education population come and live in Novi in the past 10 years. At the same time, more and more business opportunities occurrs, and the city has more revenue and less debt while the city is growing. Also, the high population does not increase the crime indicent significantly. The crime indicent per population density is still very low.

Overall, Novi is the one of the best city to live in Michigan and it is also the one of the fastest growing city. Better living condition, school district and safety will attract more high income and education people move to Novi, then those people will bring more benefit and opportunities to the city. It is a great virtuous cycle.

5. Discussion

There is more and more business opportunities in Novi. Based on the data analysis, machine learning and cluster visualization, we can see that maybe the best place to open a coffee shop will be at the section of Ten Mile Rd and Novi Rd.

The reason is : 1) The center of the city . 2) A lot of subdivisions locate around that section. 3) Close to the entry of the heavily used highway in Novi*.*