Population on Gentrification

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0.1 Acknowledgements

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Chapter 1

Introduction

1.1 Project Idea

The project's main focus is on understanding and expressing in mathematical terms how gentrification affects neighborhoods and forces groups of people emigrate from one place to another.

In order for us to begin our project, we looked into California's different cities. Since there are over four hundred cities in California, our focus will be on just three cities. The cities we will examine closely are San Francisco, Santa Monica, and Van Nuys. We chose these three because they differed greatly in the extent of how affected they have been by gentrification.

It needs to be two cities that have factors differently from each other. The definition of a factor is a variable that plays a role as a data and would show changes in its model. We wanted some of the factors in each city to be the cost of living, economic differences, age groups, and race,

The variables or factors we will be looking at are ethnicity, wealth, and education. Since there are many levels to each of these factors, we decided to combine them into more compact representations. More specifically, we compressed them into binomial variables. We did this in order to use logistic regression to build a potentially predictive model.

1.2 Gentrification

The term *gentrification* was founded in 1964 by a British sociologist named Ruth Glass (Solomon, 2014). It refers to the process of middle and upper class people moving into less prosperous areas and displacing the original residents.

Throughout history, the root word "gentry" has generally referred to people of higher socioeconomic status. Glass' new word spun *gentry* in a different way. It placed more emphasis on the overall effects resulting from the displacement of working class citizens by those considered higher in socioeconomic standing. This process of change is known as gentrification and any area, such as a town or city, that has undergone significant change by this manner is labeled as gentrified.
Gentrification is the process of middle and higher class residents moving into a poor or a working class neighborhood, subsequently displacing the original residents and drastically altering the area(s) constitution. Gentrification occurs everywhere and has become a highly debated topic amongst activists, historians, mathematicians, etc., in past, as well as, recent years. The topic of gentrification is very interesting as we get to model the affects it has on cities; it also demonstrates the factors that contribute to the changes within these cities.
It is basically replacing the poor people with wealthy people. The term gentrification will be talked about in sections and chapters to help readers have an understanding what gentrification is and its impacts.

1.3 Location

Since gentrification is such a broad topic, where do we start? We decided to choose three places to compare with. The three places are San Francisco, Van Nuys, and Santa Monica. We chose these three places because Van Nuys is considered ungentrified, Santa Monica is in the process of gentrification, and San Francisco is gentrified. Additional cities within those areas may be added to have a stronger data model.

Gentrification is happening practically everywhere with widespread effects making it a very interesting phenomenon to study.

Chapter 2

History

2.1 San Francisco

San Francisco is located on the west coast shore bordering along the Pacific ocean. San Francisco has many nicknames such as "San Fran", "Fog City", "the City by the Bay", and many others. The Fog city was founded in the year of 1776. The people of San Francisco were mainly whites from the east coast until the early 1800 hundreds. Over the years, San Francisco has been heavily populated by Whites and Asians. In 2021, Whites and Asians make up the majority of this city.

On the next page the data illustrates the population and ethnicity table of San Francisco:

	San Francisco	
Years	Population by Metro	Average Growth Rate = $\frac{N+N_{1+N_2+N_k}}{k}$
2021	3,313,000	0.81%
2020	3,314,000	0.82%
2019	3,318,000	0.84%
2018	3,325,000	0.85%
2017	3,320,000	0.86%
2016	3,315,000	0.87%
2015	3,309,000	0.88%
2014	3,304,000	0.89%
2013	3,298,000	0.90%
2012	3,293,000	0.92%
2011	3,288,000	0.93%
2010	3,283,000	0.94%
2009	3,277,000	0.95%
2008	3,272,000	0.97%
2007	3,267,000	0.98%
2006	3,261,000	1.00%
2005	3,256,000	1.01%
2004	3,251,000	1.03%
2003	3,246,000	1.04%
2002	3,240,000	1.06%
2001	3,235,000	1.08%
2000	3,230,000	1.09%
1999	3,207,000	1.10%
1998	3,179,000	1.11%
1997	3,151,000	1.11%
1996	3,123,000	1.12%
1995	3,095,000	1.12%
1994	3,068,000	1.13%
1993	3,041,000	1.13%
1992	3,014,000	1.14%
1991	2,987,000	1.14%
1990	2,961,000	1.15%
1989	2,930,000	1.15%
1988	2,899,000	1.15%
1987	2,867,000	1.15%
1986	2,836,000	1.16%
1985	2,805,000	1.16%
1984	2,775,000	1.16%
1983	2,745,000	1.16%
1982	2,715,000	1.16%
1981	2,685,000	1.16%

	San Francisco	
Years	Population by Metro	Average Growth Rate = $\frac{N+N_{1+N_2+N_k}}{k}$
1980	2,656,000	1.17%
1979	2,640,000	1.18%
1978	2,627,000	1.21%
1977	2,615,000	1.24%
1976	2,602,000	1.26%
1975	2,590,000	1.29%
1974	2,578,000	1.33%
1973	2,565,000	1.36%
1972	2,553,000	1.40%
1971	2,541,000	1.44%
1970	2,529,000	1.49%
1969	2,499,000	1.50%
1968	2,464,000	1.51%
1967	2,429,000	1.51%
1966	2,395,000	1.52%
1965	2,361,000	1.52%
1964	2,328,000	1.53%
1963	2,295,000	1.53%
1962	2,263,000	1.54%
1961	2,231,000	1.55%
1960	2,200,000	1.56%
1959	2,164,000	1.55%
1958	2,127,000	1.53%
1957	2,091,000	1.51%
1956	2,056,000	1.48%
1955	2,021,000	1.44%
1954	1,987,000	1.39%
1953	1,953,000	5.19%
1952	1,920,000	1.16%
1951	1,887,000	0.86%
1950	1,855,000	0.00%

San Francisco		
Race	Population	Percentage
White	351,010	47.20%
Asian	304721	40.98%
Two or more races	35,825	4.82%
Black or African American	46063	6.19%
Other Race	3548	0.48%
Native	2465	0.33%

As you can see in the table above, the neighborhood is mostly made up of Caucasians compared to the rest of the ethnicity. This lets us determine that those who are rich and Caucasian (white) or Asian, often live in affluent areas such as San Francisco.

2.2 Los Angeles

The city of L.A. is known as a place to pursue your dreams and to try to make it to Hollywood so you can become a star. Although that may be true for some, for others in L.A. it is a different reality. For those who live within urban areas of Los Angeles like some areas in the valley, it means that they need to survive life instead of dreaming of becoming a star. However, the population of Los Angeles continues to grow and continues to diversify. In the next page you will find a data table of Los Angeles' population and ethnicity:

Years	Population by Metro	Growth Rate = $\frac{N+N_1}{N_1}$	Average Growth Rate = $\frac{N+N_{1+N_2+N_k}}{k}$
2021	12,459,000	0.10%	1.59%
2020	12,447,000	-0.01%	1.61%
2019	12,448,000	-0.08%	1.63%
2018	12,458,000	0.31%	1.65%
2017	12,420,000	0.30%	1.67%
2016	12,383,000	0.31%	1.69%
2015	12,345,000	0.30%	1.72%
2014	12,308,000	0.30%	1.74%
2013	12,271,000	0.30%	1.76%
2012	12,234,000	0.30%	1.78%
2011	12,197,000	0.30%	1.81%
2010	12,160,000	0.31%	1.83%
2009	12,123,000	0.30%	1.86%
2008	12,087,000	0.31%	1.88%
2007	12,050,000	0.30%	1.91%
2006	12,014,000	0.30%	1.94%
2005	11,978,000	0.30%	1.97%
2004	11,942,000	0.30%	2.00%
2003	11,906,000	0.30%	2.03%
2002	11,870,000	0.30%	2.06%
2001	11,834,000	0.31%	2.10%
2000	11,798,000	0.69%	2.13%
1999	11,717,000	0.83%	2.16%
1998	11,621,000	0.82%	2.19%
1997	11,526,000	0.82%	2.22%
1996	11,432,000	0.82%	2.25%
1995	11,339,000	0.83%	2.28%
1994	11,246,000	0.82%	2.31%
1993	11,154,000	0.81%	2.34%
1992	11,064,000	0.83%	2.38%
1991	10,973,000	0.83%	2.41%
1990	10,883,000	1.23%	2.45%
1989	10,751,000	1.37%	2.48%
1988	10,606,000	1.38%	2.51%
1987	10,462,000	1.37%	2.54%
1986	10,321,000	1.38%	2.57%
1985	10,181,000	1.36%	2.61%
1984	10,044,000	1.37%	2.64%
1983	9,908,000	1.37%	2.68%
1982	9,774,000	1.37%	2.72%
1981	9,642,000	1.37%	2.76%

Years	Population by Metro	Growth Rate = $\frac{N+N_1}{N_1}$	Average Growth Rate = $\frac{N+N_{1+N_2+N_k}}{k}$
1980	9,512,000	1.31%	2.81%
1979	9,389,000	1.27%	2.86%
1978	9,271,000	1.27%	2.91%
1977	9,155,000	1.28%	2.97%
1976	9,039,000	1.27%	3.03%
1975	8,926,000	1.28%	3.10%
1974	8,813,000	1.28%	3.17%
1973	8,702,000	1.27%	3.25%
1972	8,593,000	1.28%	3.34%
1971	8,484,000	1.27%	3.43%
1970	8,378,000	2.23%	3.54%
1969	8,195,000	2.55%	3.60%
1968	7,991,000	2.57%	3.66%
1967	7,791,000	2.55%	3.72%
1966	7,597,000	2.55%	3.79%
1965	7,408,000	2.56%	3.86%
1964	7,223,000	2.56%	3.95%
1963	7,043,000	2.56%	4.05%
1962	6,867,000	2.55%	4.16%
1961	6,696,000	2.54%	4.30%
1960	6,530,000	4.38%	4.46%
1959	6,256,000	4.95%	4.47%
1958	5,961,000	4.97%	4.41%
1957	5,679,000	4.95%	4.34%
1956	5,411,000	4.99%	4.26%
1955	5,154,000	4.95%	4.13%
1954	4,911,000	4.98%	3.97%
1953	4,678,000	4.96%	14.87%
1952	4,457,000	4.97%	3.30%
1951	4,246,000	4.94%	2.47%
1950	4,046,000	0.00%	0

According to the data, you see that the growth rate is still growing for Los Angeles. Places that are gentrified like San Francisco do not have a positive growth rate or a consistent growth rate. Los Angeles is not gentrified so it has more diverse ed people coming into the area. Unlike San Francisco, it has more people leaving the area due to high costs.

Los Angeles				
Race	Population	Percentage	In Poverty	Poverty Rate
White	69539	75.94%	4980	7.16%
Asian	9299	10.15%	1628	17.51%
Two or more races	5385	5.88%	1030	19.13%
Black or African American	4100	4.48%	743	18.12%
Other Race	2869	3.13%	595	20.74%
Native	385	0.42%	95	24.68%
Overall	91577	100.00%	9071	107.33%

2.2.1 Santa Monica

A little history about Santa Monica is that the city was named after the Saint Monica. The city was populated with Spanish Conquistadores, until it was later on transferred to Mexican territory, and then American territory. Santa Monica is known for its luxurious beaches, its beach houses, as well as its pier. It is a very touristic place were it is filled with opportunities for the people who live within that community. The following data will demonstrate how wealth, ethnicity, and education have all contributed towards the flourish of this city.

On the next page there is a data table of Santa Monica's Population and ethnicity:

Years	Population	Growth Rate = $\frac{N+N_1}{N_1}$	Average Growth Rate = $\frac{N+N_{1+N_2+N_k}}{k}$
2021	88,991	-0.79%	14.66%
2020	89,696	-0.79%	15.30%
2019	90,401	-0.78%	16.00%
2018	91,106	-0.70%	16.77%
2017	91,747	-0.47%	17.60%
2016	92,176	-0.27%	18.50%
2015	92,422	0.36%	19.49%
2014	92,087	0.04%	20.55%
2013	92,050	0.79%	21.76%
2012	91,327	0.93%	23.07%
2011	90,476	0.79%	24.54%
2010	89,759	6.32%	26.24%
2000	84,084	-3.35%	27.77%
1990	86,905	-1.62%	30.37%
1980	88,314	0.03%	33.28%
1970	88,289	5.71%	36.60%
1960	83,249	14.00%	40.03%
1950	71,595	25.27%	43.29%
1940	53,500	30.57%	45.86%
1930	37,146	58.94%	48.41%
1920	15,252	48.55%	46.30%
1910	7,847	61.04%	45.74%
1900	3,057	48.32%	40.64%
1890	1,580	73.61%	36.80%
1880	417	0.00%	0.00%

Santa Monica				
Race	Population	Percentage	In Poverty	Poverty Rate
White	69539	75.94%	4980	7.16%
Asian	9299	10.15%	1628	17.51%
Two or more races	5385	5.88%	1030	19.13%
Black or African American	4100	4.48%	743	18.12%
Other Race	2869	3.13%	595	20.74%
Native	385	0.42%	95	24.68%
Overall	91577	100.00%	9071	107.33%

2.2.2 Van Nuys

Van Nuys is also a city that is located near the San Fernando Valley. Fun fact of Van Nuys is that back in the year 1911, a man named Isaac Van Nuys owned a piece of land in where he created a pathway for people to travel in and out of different cities by using a train. Although the pathway helped many go in

and out of the city, many people began to purchase land and build the town of Van Nuys. Now Van Nuys is a very well populated, however it is made up of minorities and poverty stricken families. The community has a lack of resources such as education, healthcare, and economic resources, etc.

Van Nuys	
Year	Population
1970	43,524
1980	49,463
1990	66,400
2000	80,240
2010	80,547

Van Nuys		
Race	Population	Percentage
White	25.1k	20.9%
Hispanic	67.2k	65.7%
Asian	7421	7.1%
Two or more races	1105	1.1%
Black or African American	4610	4.5%
Other Race	771	0.8%

The mathematical model equation that our group will present in this paper demonstrates the ethnicity, economical wealth, and educational opportunities that this community has received. The data below will portray the following factors that were previously listed, so that we can picture how these factors effected this community.

Chapter 3

Math Models

There are many different techniques and models available to more closely examine the factors that contribute to gentrification. Furthermore, once a greater understanding is obtained, predictive models may be developed. These models could potentially produce information to help prepare for and minimize the negative impact of gentrification on affected neighborhoods.

The goal is to make a model that collects all of the cities that we have chosen by portraying there data and applying the data into the model to determine if it is gentrified or not gentrified. First, we need to determine what gentrification is and the variables that determine if it is gentrified or untouched.

3.1 Discrete Model

The first model we will discuss is the discrete model. Since gentrification occurs largely in tandem with changing dynamics in a population's wealth, a discrete model would best suit this type of investigation. In the paper, "Modeling Gentrification: an Agent-Based, Amenities-Driven Approach", Avishai Halev presents a discrete model used for the changing distribution of wealth, as well as spatial factors, within a given community. At its base, the model is given by:

$$A_s(t + \delta t) = A_s(t)(1 - \omega\delta t) + \phi W_s(t)\delta t$$

The parameters are as follows:

Parameter	Definition
$W_s(t)$	Wealth
$A_s(t)$	Amenities
ω	Wealth and amenities decay rate
δt	Time step size
ϕ	Rate of amenities increase per dollar

ω and $\delta t > 0$

Halev's model then goes more in depth, adding a logistic component to model external investment as a result of increased wealth, and the subsequent distribution of said wealth to neighboring areas. Simultaneously, the model accounts for a decay in the value of amenities given a halt in investments. Analysis then reveals the equilibria at which the wealth of an area becomes unsustainable or achieves stability. This reportedly occurs when the wealth and amenities decay rate equals the wealth growth rate and produces a transcritical bifurcation.

3.2 Logistic Growth

Havlev's model incorporates a logistic component to represent the rate of reinvestment. In other words, investment by outside parties such as the government or philanthropists. This component takes the form:

$$r(W_s) = \tilde{r}(1 - \frac{W_s}{M})$$

where

Parameter	Definition
r	Wealth growth rate
$\tilde{r}$	Constant wealth growth rate
M	Wealth regulating factor (carrying capacity)

In context of investment, this component is expected to increase at times of low wealth until a certain threshold is attained. At this point, influx of wealth is predicted to stop and decay may take its place.

3.3 Logistic Regression

Logistic regression is used to model the probability of an event with two possible outcomes occurring. Since we compressed our variables into binomial form, we will use this structure for our model.

$$Y = \ln \frac{p}{1-p} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \epsilon_i$$

Parameter	Definition
Y	Probability of being classified as gentrified
βi	Regression coefficients
x_i	Indicator variables for each factor
ϵ_i	Error

The βi and x_i where $i = 1, 2, 3$ represent the regression coefficients and the values of the city being studied, respectively. x_i will take on values 0 or 1 depending on the threshold determined by the index of dissimilarity.

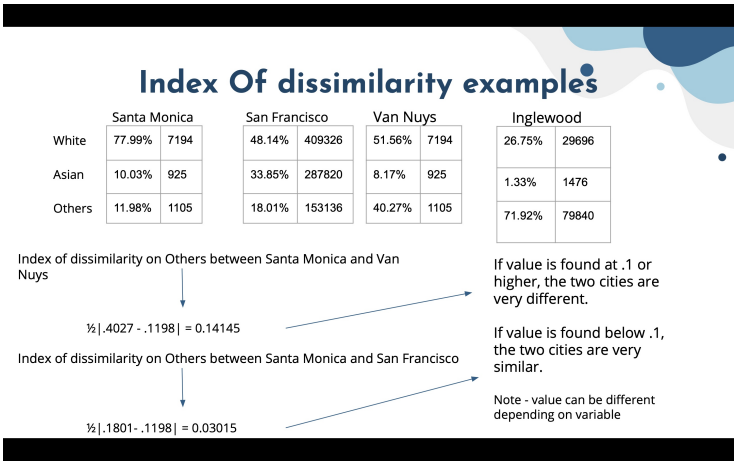
3.4 Index of Dissimilarity

In order to classify cities as gentrified or not, we utilized the index of dissimilarity to determine the threshold at which they would be divided within the variables.

[htbp!] $\frac{1}{2}\Sigma_{i=1}^{N}|\frac{b_i}{B} - \frac{w_i}{w}|$

Parameter	Definition
$a_i,\ b_i$	Number of observations possessing the specified quality
$A,\ B$	Total population of area

The index of dissimilarity is used as a measurement of the distribution of groups across populations. Using San Francisco, Santa Monica, and Van Nuys as our baseline reference, we use this index to determine the threshold for our definition of being gentrified.



We end up with a value of 0.1415 which can be written as 14.15%. What this means is that Santa Monica has 14.15% less non-Asian and non-white than Van Nuys. If Van Nuys wanted to become more gentrified, it would need 13.2% more whites to reach the average gentrified white percentage.
By these values, we can see patterns of what each value means. The higher the value is, the more different the two areas are. The lesser the value is, the less different the two areas are. According to the Index of Dissimilarity with gentrification, if the value is found to be 10% or higher, the two cities are different. If the value is found below 10% the two cities are very similar.
Since now we understand Index of Dissimilarity, and that San Francisco or Santa Monica are gentrified. We can use their data to compare with any city to find out if it is similar or not since we understand what each value means.

3.5 Graphs and Data

3.5.1 Education

Here is our data on education in a program named Excel:
n/a is for not gentrified
G is for gentrified

G	Pacific Heights
Avg. Test Score	53%
Finished Highschool	97.60%
Highschool	97.60%
Completed some college	94.20%
Completed Associates Degree	85.80%
Completed Bacherlors Degree	82.80%
Completed masters	37.00%
Completed professional degree	11.60%
Completed doctorate	3.50%

G	Noe Valley
Avg. Test Score	28%
Completed 8th grade	97.50%
Completed high school	97.40%
Completed some college	94.40%
Completed associate degree	83.50%
Completed bachelors	80.30%
Completed masters	43.90%
Completed professional degree	15.90%
Completed doctorate	7.50%

Now, we have the data we need. What we need to do next is plug our data into the model and code. Down below are our graphs and the outcomes from the tables.

Studio City	G	Santa Monica	G	San Francisco	G	Westwood Village
53%		61%		46%		61%
96.10%		94.30%		87.10%		96.60%
95.90%		93.90%		86.10%		96.10%
85.00%		86.00%		75.00%		90.00%
66.70%		72.00%		60.20%		77.20%
59.80%		67.00%		54.80%		72.30%
23.00%		28.20%		21.90%		37.60%
8.80%		12.90%		7.60%		17.80%
3.10%		4.60%		2.70%		6.30%

n/a	Inglewood		North Hollywood		Pacoima		Boyle Heights		Ocean Vie
Avg. Test Score	22%		27%		23%		22%		37%
Finished 8th grade	73.60%		72.10%		51.80%		45.20%		80.30%
Highschool	71.50%		70.00%		49.60%		42.80%		78.50%
Completed some college	52.70%		47.70%		25.10%		23.20%		59.40%
Completed Associates Degree	26.50%		29.60%		12.60%		10.90%		38.30%
Completed Bacherlors Degree	18.90%		23.00%		8.20%		7.50%		31.00%
Completed masters	6.20%		5.50%		2.00%		1.60%		9.50%
Completed professional degree	1.40%		1.40%		0.40%		0.40%		2.80%
Completed doctorate	0.50%		0.60%		0.10%		0.10%		1.10%

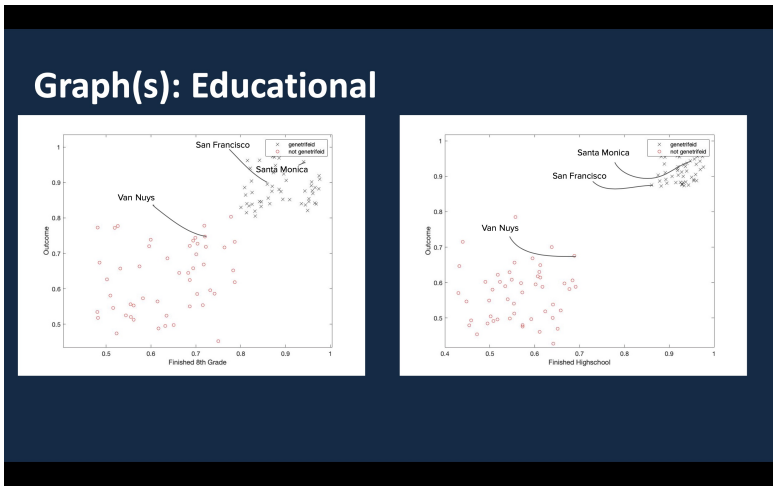


Figure 3.2: Finished 8th grade and High school Graphs

It shows the graph of 8th grade and High school. We see that Van Nuys is not too far apart from San Francisco and Santa Monica percentage-wise. We see that Van Nuys has students finishing 8th grade around 78% and high school at 70%. San Francisco and Santa Monica have a completion over at least 90%. The small gap from not gentrified and gentrified areas.

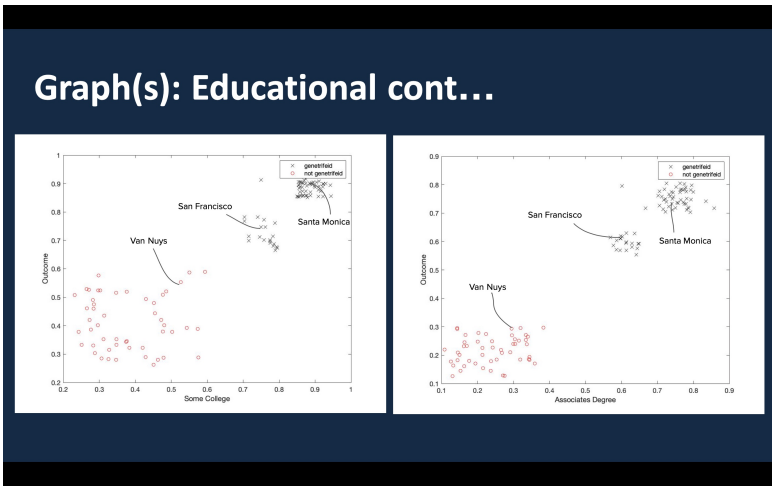


Figure 3.3: Some College and Associates Degree Graphs

Shows small changes where Van Nuys is slowly drifting away from Santa Monica and San Francisco as each degree gets higher.

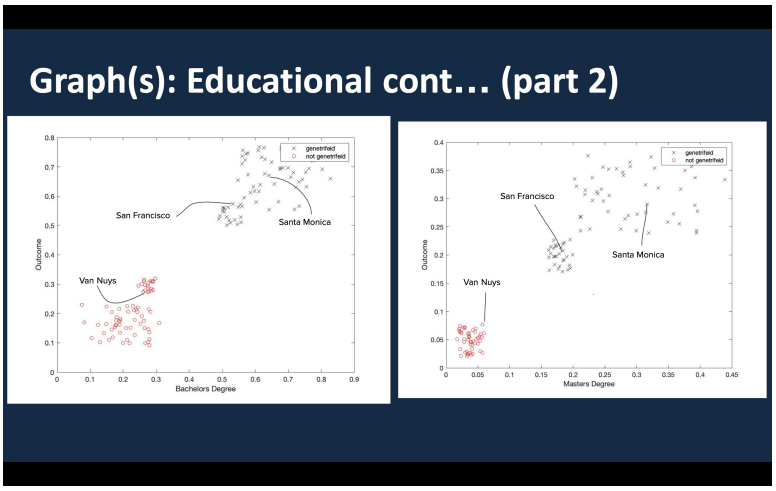


Figure 3.4: Bachelors and Masters Degree Graphs

The figure displays drifting in the bachelor's graph between Van Nuys and Santa Monica is slowly getting faster and dramatic. If we were to plug in a city or area into the graph of a bachelor's degree, it will be determined its label. If the city has a percentage of 40% or lower of completing a bachelor's degree, then it would be in the not gentrified area. If it was over 50%, then it would be gentrified.

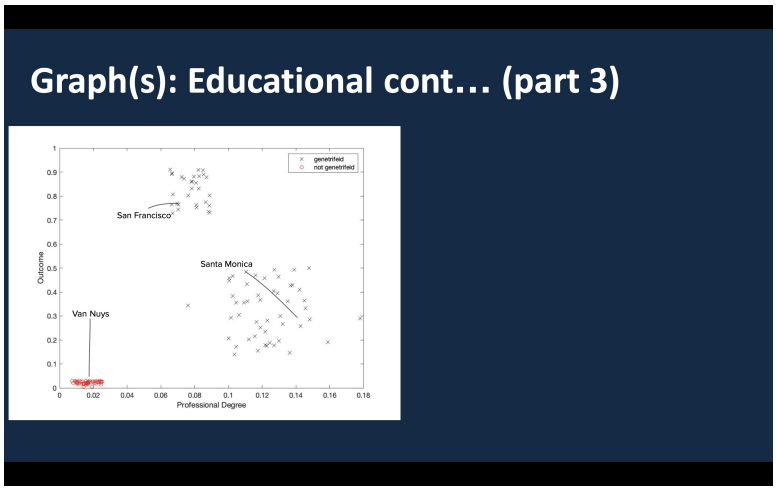


Figure 3.5: Professional Degree

Figure 3.5 shows the professional degree and it shows a huge gap. Starting from 8th grade to a professional degree is very different, but if you look closely at the y and x-axis. The value is very small. A small percentage is very small where we view it as unnecessary data.

3.5.2 Ethnicity

Here is our data from excel on Ethnicity:
n/a is for not gentrified
G is for gentrified

G	Studio City			Santa Monica			Echo Park	
Population	100%	48533		100%	92247		100.00%	31774
White	80.45%	39045		77.99%	71943		52.03%	16532
Asian	7.48%	3630		10.03%	9252		21.15%	6720
Others	12.07%	5858		11.98%	11051		26.82%	8522

G	Pacific Heights		Neo Valley		San Francisco	
Population	100%	19716	100%	21074	100%	850282
White	76.79%	15140	76.02%	16020	48.14%	409326
Asian	16.18%	3190	13.06%	2752	33.85%	287820
Others	7.03%	1386	10.92%	2301	18.01%	153136

n/a	Van Nuys		Inglewood		North Hollywood	
Population	100%	127440	100%	111012	100%	158,322
White	51.56%	65708	26.75%	29696	64.96%	102846
Asian	8.17%	10412	1.33%	1476	6.25%	9895
Others	40.27%	51320	71.92%	79840	28.79%	45581

n/a	Pacoima			Boyle Heights			Ocean View	
Population	100%	55,999		100%	79029		100%	30,618
White	60.45%	33851		67.45%	53305		21.74%	6656
Asian	2.58%	1445		0.98%	774		52.92%	16203
Others	36.97%	20703		31.57%	24949		25.34%	7759

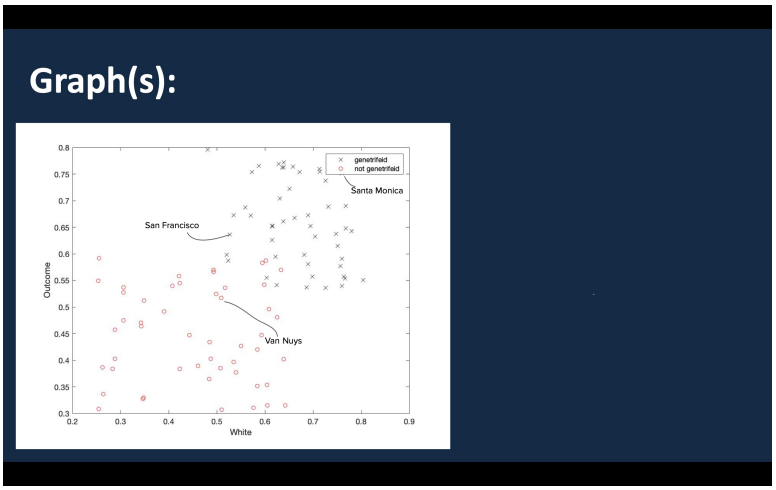


Figure 3.6: Percentage of White

According to our data, Van Nuys has around 48% of whites. We can see that many of the non-gentrified areas like Van Nuys do not have lots of whites, unlike Santa Monica. Santa Monica and gentrified areas have at least 65% whites will have a higher outcome of becoming gentrified.

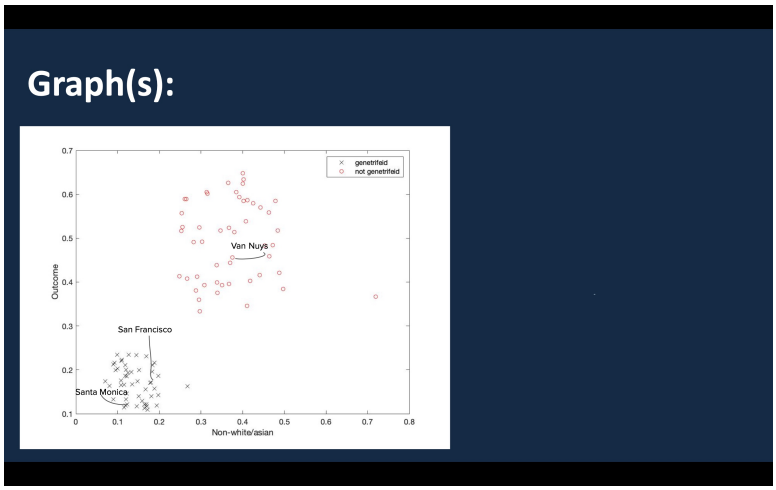


Figure 3.7: Percentage of non-Asian and non-White

Asians are separate from others due to many reasons. According to the data, Asian Americans have the highest income in the states. However, they also have a high rate of poverty. Asians are a diverse group where all Asian groups have dissimilar data. For example, Nepalese Americans have a median household income of $56,000. Indian Americans have a median household income of $125,000. Huge gap. Either found well off or in poor, or middle-classed. Look at San Francisco, which is in the middle of the graph where it could land in the non-gentrified or gentrified. So we will separate Asians and Whites from other races.
In Figure 3.7, if the city or area has more than 20% of non-Asian and non-White, then it would have a higher probability of not becoming gentrified. Van Nuys has a higher percentage of non-Asian and non-White where maybe in the future it will have it reduce to transit to a gentrified city.

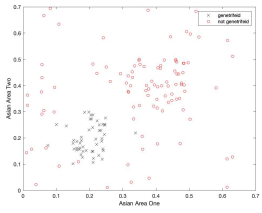


Figure 3.8: Graph of Asians

It is very clear where gentrified areas lie, but the non-gentrified areas are also in the area. So, therefore, this graph proves it is not a good source to use.

3.5.3 Wealth

Here is a table of our Wealth data:

G	Studio City		Santa Monica		Echo Park	
Population	100%	48533	100%	92247	100%	31774
Unemployment Rate	6.1%	2961	5.9%	5443	5%	1589
Median Household Income	$105,301		$82,123		$53,669	
Income per capita	$64,597		$62,874		$28,905	
poverty rate		N/A	10.70%	9870	N/A	
poverty level		N/A	11.30%	10424	N/A	

G	San Francisco		Pacific Heights		Noe Valley	
Population	100%	850282	100%	19716	100%	21074
Unemployment Rate	4%	34011	2.80%	552	3.70%	780
Median Household Income	$87,701		$147,213		$133,927	
Income per capita	$55,567		$110,078		$88,529	
poverty rate	11.70%		N/A		N/A	
poverty level	12.50%		N/A		N/A	

n/a	Pacoima		Boyle Heights		Ocean View	
Population	100%	55,999	100%	79029	100%	30,618
Unemployment Rate	7.50%	4200	5.30%	4189	6.60%	2021
Median Household Income	49893		35846		$78,895	
income per capita	14972		12775		$29,346	
poverty rate		N/A	n/a		N/A	
poverty level		N/A	n/a		N/A	

n/a	North Hollywood		Inglewood		Van Nuys	
Population	100%	158,322	100%	111012	100%	127440
Unemployment Rate	6.60%	10449	9%	9991	8%	10195
Median Household Income	48628		$44,377		$48,885	
income per capita	22010		$21,013		$24,359	
poverty rate	N/A		19.99%		21.50%	
poverty level	N/A		20.70%		N/A	

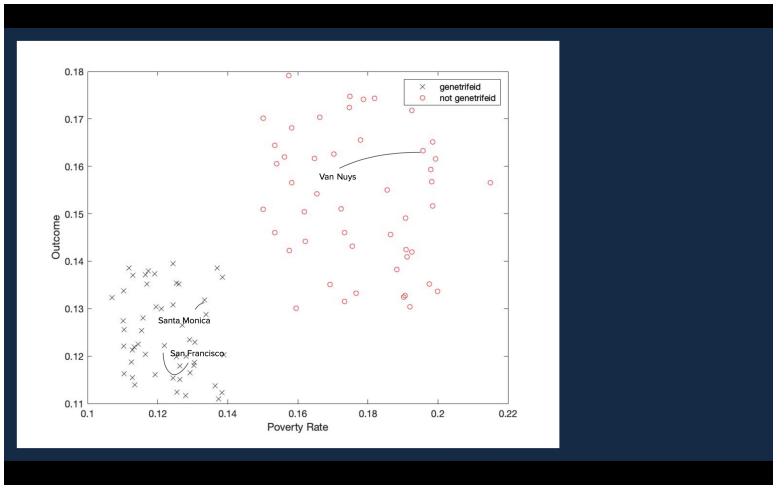


Figure 3.9: Poverty Rate

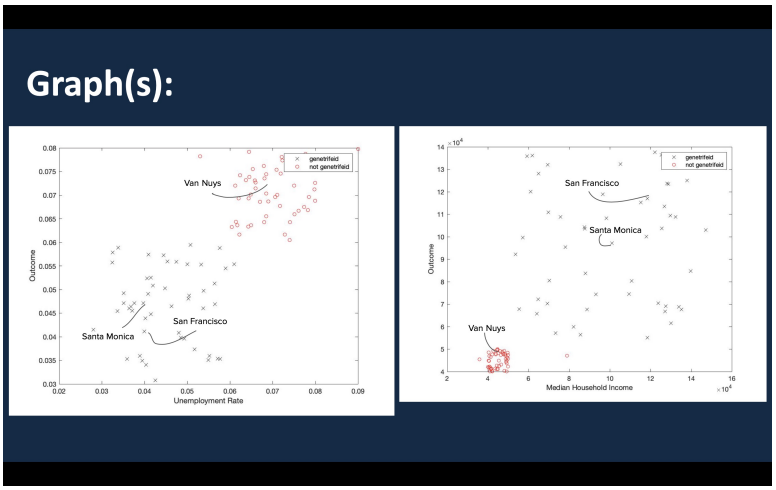


Figure 3.10: Unemployment Rate and Median Household Income

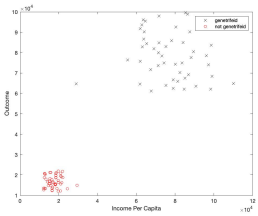


Figure 3.11: Income Per Capita

The difference and gap are huge. Gentrified areas make more money than the non-gentrified areas where this keeps a big gap from each other. This shows that this is an issue because it separates the poor and the rich. When you separate the poor and the rich, there are problems in the economy and its access to resources. So if we wanted to fix our economy, this is graph says it all what we need to fix.

3.6 Conclusion of Our Results

As we have seen in the data as well as the graphs above, the results illustrate how gentrification has an effect on cities such as Van Nuys, San Francisco, and Santa Monica. By comparing all three cities together we can see that often times people who live in affluent cities that is filled with opportunity and higher education tend to flourish and find opportunistic jobs, while other people who live in low poverty stricken areas tend to stop attending schools and remain in the same slate for the past year or so.

3.6.1 San Francisco vs Santa Monica

The comparison between San Francisco and Santa Monica are very similar to each other. Although San Francisco does have many factors such as tourism and great economic stability, it also contains cities that are stricken by poverty. These areas have lower graduation averages and lower income, which causes a lack of resources for some people as well as a struggle to survive in their economy. However, Santa Monica is also a very prominent city made up of tourists and affluence. That city itself is very prominent compared to come parts of San Francisco that have low income areas.
If we compare the data between the two cities, we can see that some parts in San Francisco are beginning to transition into a more affluent environment because population begins to increase, since the population increases, the wealth of that city starts to increase causing resources such as having a higher education seem possible. As shown in the graphs above we can see how San Francisco is coming very close towards a full on gentrified city like Santa Monica. Although it seems like a good idea for a neighborhood or city to gentrify, often times the

consequences of gentrification leads people who come from a lower income, as well as who come from a minority background, to move outside of these cities. It causes people to have to move to cities such as Van Nuys in order to make a living.

3.6.2 Van Nuys vs San Francisco vs Santa Monica

The comparison between Van Nuys and San Francisco are very distinct from each other because Van Nuys is an ungentrified city. The city of Van Nuys is made up of minorities such as Latinas/os and African Americans that live in poverty. They have a lack of resources and support when it comes to finances and education. On the contrast, San Francisco and Santa Monica have many more opportunities and resources for the people that live within those communities. If we compare the data between these three cities we can determine how Van Nuys' population lacks in receiving an education. Some of the population tries to attain a high school degree, however once they do attain their high school degree, they rarely pursue a bachelor's let alone a Master's degree. The city of Van Nuys compared to Santa Monica and San Francisco is an example of the unfairness and consequences gentrification brings onto another community.

3.6.3 Lesson Learned

After looking at the results and comparing the cities towards each other we can see how the three factors all intertwine to create the following environments for each of these cities. Examining their wealth, education, and ethnicity has helped us understand the huge gap that there is between urban cities and gentrified cities. There is an inequality between these communities that push a group of people further back in society, while others are pushed forward and are capable of achieving things that some people who live in an urban society can only dream of. The results made us realize that gentrification is a problem in society, and if people are trying to create equal opportunities for every person no matter what their background may be, then the government or people wealth need to invest their capital into providing resources and opportunities for people who do not have the chance to do so. Overall, the topic of this project was very interesting because we were capable of applying mathematical equations that we learned in our math classes onto real life events that occur within our community. It helps us understand just how important mathematics contributes in portraying a solution to a problem as well as portray the effects of the problem that is already presented. Again we thank both Professor Jaime S. Cruz and Professor Jing Li for guiding us throughout this topic and for providing the resources that we needed to make this topic possible.

3.7 Appendix

Code of main.m:

```
%%initialize
clear;
close all;
clc;

%%load the data
data = load('data.txt');
X = data(:, 1:2);
y = data(:, 3);

%%plot the data
plotData(X,y);
legend('genetrifeid', 'not genetrifeid');
xlabel('Test Scores 1');
ylabel('Test Scores 2');

%%compute the cost and gradient
[m, n]=size(X);
initialTheta = zeros((n + 1), 1);
[J, grad] = computeCost(initialTheta, X, y);

%run the function optimization algorithm
options = optimset('GradObj', 'on', 'MaxIter', 400);
theta = fminunc(@(t)computeCost(t, X, y), initialTheta, options);


%%check the accuracy of the predictions
predictions = predict(theta, X);
accuracy = mean( double(predictions == y) * 100)
```

---

function [J, grad] = computeCost(Theta, X, y)
m = size(X, 1); X = [ones(m, 1) X];
h = sigmoid(X * Theta);
J = -(1 / m) * sum(y .* log(h) + (1 - y) .* log(1 - h));
grad = zeros(size(Theta, 1), 1); for i = 1 : size(grad), grad(i) = (1 / m) * sum((h - y)' * X(:, i)); end

---

Code of plotData.m: function plotData(X, y)
pos = find(y == 1); neg = find(y == 0);
plot(X(pos, 1), X(pos, 2), 'kx', 'MarkerSize', 5) hold on plot (X(neg, 1), X(neg, 2), 'ko', 'MarkerSize', 5, 'Color', 'r')
end

Code of predict.m:
function p = predict(theta, X)
m = size(X, 1); X = [ones(m, 1) X];

p = round(sigmoid(X * theta)); end Code of sigmoid.m: function g = sigmoid(z)
g = 1 ./ (1 + exp(-z));
end

3.8 Resources

North Hollywood Data:
https://www.point2homes.com/US/Neighborhood/CA/Los-Angeles/North-Hollywood-Demographics.html

Bay View Data:
https://www.areavibes.com/san+francisco-ca/bayview/demographics/

San Francisco Demographics 2010-2014:
https://default.sfplanning.org/publicationsreports/SFNGBDSocioEconomicProfiles/2010-2014ACSProfileNeighborhoodsv3AH.pdf
Data Sources: https://www.macrotrends.net/cities/23130/san-francisco/population
Solomon, Jane. https://www.kqed.org/news/136343/gentrification-a-word-from-another-place-and-time

Van Nuys:
https://vnnc.org/wp-content/uploads/2014/05/The-State-of-Van-Nuys.pdf
https://statisticalatlas.com/neighborhood/California/Los-Angeles/Van-Nuys/Race-and-Ethnicity