# Opportunity in Cities and Suburbs in the US

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## Introduction

This analysis is centered around an exploration in the opportunity in different parts of the US. Opportunity can be a hard thing to define and changes drastically from culture to culture. The data set that we found for opportunity comes datadiversity.org specifically the childhood opportunity index with each individual observation being a census tract in 2015 that relates to a neighborhood. From the data we have decided that we will explore opportunities in three main facets: Livability, Economics, and Education. Trying to answer various questions from the perspective of the entire continental United States would be a daunting challenge. Many academics try to focus on this overwhelming task. Our analysis could help to provide a starting point. As such, we have decided to look at how opportunity varies among some of largest and most cultural important cities in the United States: Los Angeles, Philadelphia, New York, and Houston. These three main categories will be broken down into smaller sub-categories to more accurately depict the variance among the four major cities and their surrounding suburbs.

Life quality in a city is difficult hard to measure and tends to vary from person to person. While quality of life might seem like an extraneous variable, it is linked to success even if it is not always in an obvious manner. Unfortunately, our study is focused more on the educational and economic indicators of success in a city. However, the data as mentioned is still exceptionally important, so while not the main focus of the analysis, it is still worth including.

Economic status as a general rule of thumb is tied intimately to money. However, while an important part of any economic indicator is income, there are other important factors to consider such as skilled labor, college degrees, and home ownership. Oftentimes these factors help to indicate a healthier economic status as they are intrinsically connected to the success of individuals in that society. All of these factors are needed for a society to continuously thrive in a gainful manner. The last measure that will be examined in the paper is education.

Education is arguably the hardest variable to successfully isolate and examine because education generally refers to intellectual competence. As Einstein said, “if you measure a fish's ability to climb a tree, you will think all fish are stupid”. However, trying to gauge a society’s ability to raise and retain skilled and intelligent members is an important part of its success. As such, we have decided to examine education from the perspective of the measure of third grade test scores, AP classes enrollment, and high school graduation rates.

**Livability**

The first topic we decided to analyze was the livability aspect of a city and its suburbs. In this Livability indicates the sum of the factors that add up to a community's quality of life. With cities being so densely populated, and suburbs being more spread out, our purpose with livability is to examine how the access and proximity to certain necessities vary among these cities and suburbs. There are a lot of factors that need to be considered, and there are many ways to measure and compare residential environment. We decided to combine three variables together to measure this.

Here, green space indicates the percentage of land that is partly or completely covered with grass, trees, shrubs or other vegetation. It includes parks, community gardens, and playgrounds. This measurement is a huge factor for residents of the area, specifically those with children, as two main benefactors of a green space are mental and physical health. The second factor is "Near Supermarket," which shows how many households have access to a supermarket within a half-mile from their house. Having a supermarket within a close proximity to a person's residence is a convenient attribute to have as a majority of the population makes multiple grocery trips a week. The last one is "Walkability." Walkability explains how friendly the area is to pedestrian activity of traveling by foot. Wheelchair users, skateboarders, and roller-bladers are all counted as pedestrian foot activity. The more walkable an environment is, the more livable it is. By combining these three factors, a better overall index of livability was created.

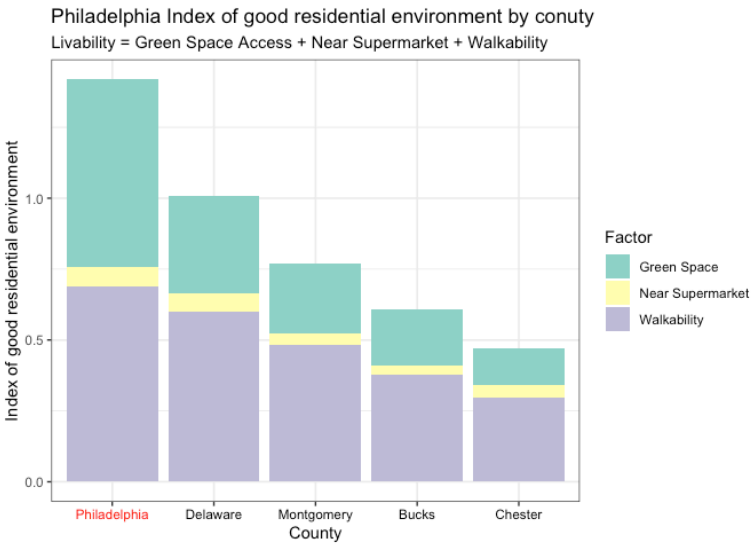
Each of the three variables have a different scale in the raw dataset. The range of "Green Space" is (0,100), "Near Supermarket" is (0, 96.3), and "Walkability" is (1,20). It is inappropriate to compare and combine different variables with different scales because a variable which has a big scale can have a higher contribution to the combined variable "livability," and skew the results. To ensure that the three factors have the same weight on livability, we normalized the three variables. Among many normalization methods, we selected "Min-max normalization." For every feature, the minimum value of that feature gets transformed into a 0, the maximum value gets transformed into a 1, and every other value gets transformed into a decimal between 0 and 1. By using the normalization method, we can compare not only each factor, but also the sum of three factors as livability together without worrying about offsetting between positive and negative values.

$$x_{scaled} = \frac{x - x_{min}}{x_{max} - x_{min}}$$

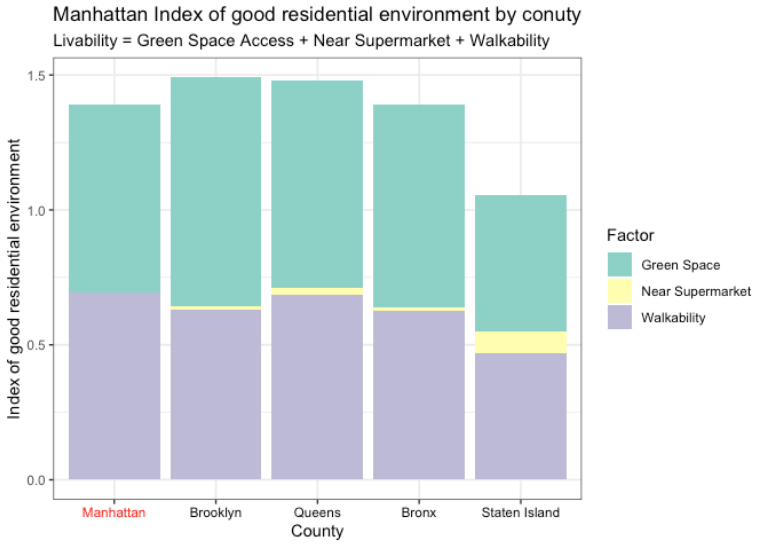
**[feature scaling] Min-max normalization**

The first major city we are going to analyze along with its suburbs is Los Angeles. The city of Los Angeles shows the highest livability among the surrounding five counties. Orange, Kern, Ventura, and San Bernardino are following in order. One can see that what makes up Los Angeles' livability score is not "Near Supermarket", but "Green Space" and "Walkability". The common belief is that since Los Angeles is a big city, the density of the supermarket is higher than any other suburb area. However, we can see that rather, one of the suburb areas, Kern has the highest density of supermarket among these five counties. Moreover, even though Los Angeles is a big city that has a lot of buildings, it has a huge green space that does not fall behind any other suburb areas. Also, Los Angeles has a good environment for pedestrians. By being the most populated city, it has a lot of money to allocate to enhance the city's environmental green space.

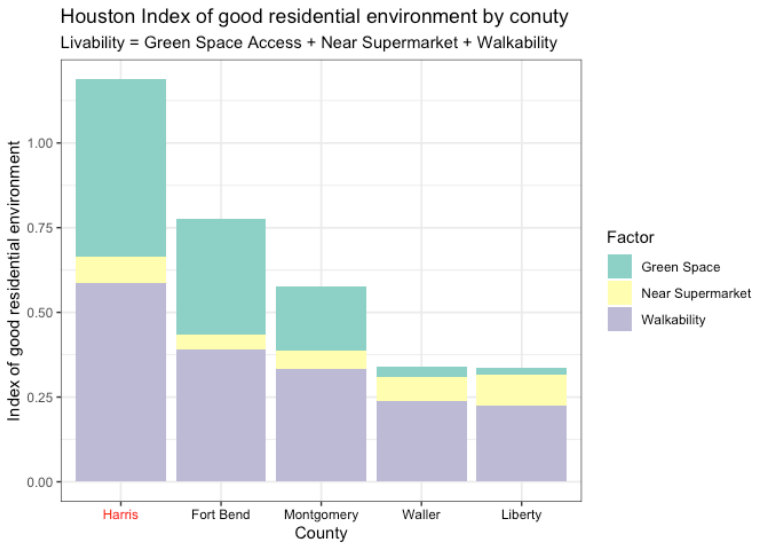

The next major city that will be analyzed is Philadelphia. Like Los Angeles, the city, Philadelphia, has the highest livability index also. Delaware, Montgomery, Bucks, and Chester are following in order. The interesting point here is that the sequences of all factors are the same as Los Angeles. In other words, when we order the amount of each factor in descending order, the sequences of Green Space, Near Supermarket, and Walkability are the same. Moreover, Pennsylvania area has a similar percentage of the Near Supermarket variables no matter the county. Even Chester, which has the lowest density of population among the counties has similar percentage of near supermarket as others.



The third city is Manhattan in New York. This state was the most interesting state among the four states we selected. The first takeaway is that Manhattan, a city, has a lower livability score compared to the boroughs of Queens and Brooklyn, while the other cities in California, Texas, and Pennsylvania, has the highest livability. The order of livability is Brooklyn, Queens, Manhattan, Bronx, and Staten Island. Another takeaway is that Manhattan has the smallest Near Supermarket value. This is because especially, Manhattan is the main drag for business and travel sites. For this reason, there are fewer supermarkets compared to any other city and suburb areas. However, Manhattan has Central Park in the middle of the city, which the size is 843 acres (SOURCE), so it still has a high livability score.



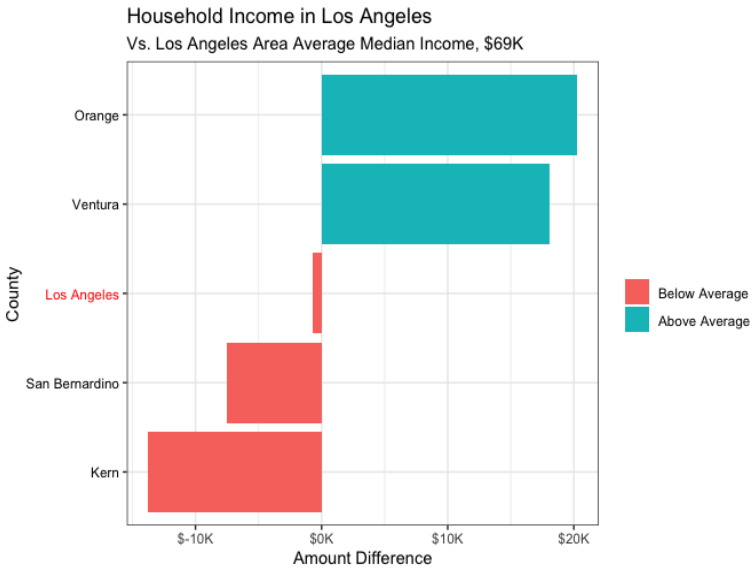

The area we are going to analyze next is Houston and the suburbs surrounding it in Texas. Houston shows the highest livability index among the counties. Fort Bend, Montgomery, Waller and Liberty are following in order. Waller and Liberty show very small green space value compared to other counties in Texas. This is because there are much more people in the city, Harris, than the suburbs, Waller and Liberty, so many people-friendly places such as parks are developed in the city, which increased the green space value in Harris. All near supermarket values are similar in every county in Texas.



**Economics**

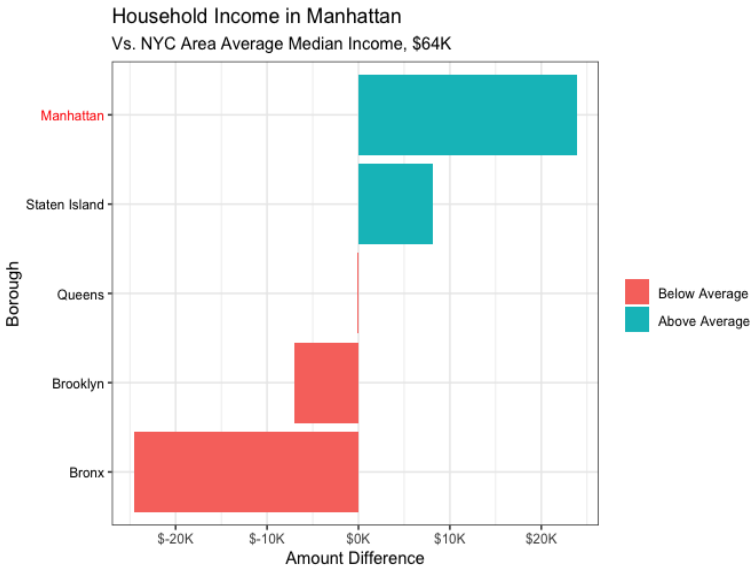
The next topic to be discussed is economics, specifically median income and how it affects other aspects of life. These elements will be evaluated on a city-suburb basis, which then will allow comparisons to be made. An additional factor to consider when using median income as the unit of analysis is the cost-of-living difference between all the different counties. Such differences can cause inflation and misinterpretation of how median income affects economic success and opportunity. To offset this type of bias, there is a mixture of baseline comparisons using both the area averages, along with the national averages.

To start off, the first graphical analysis is a basic comparison of median income by county and how it deviates from the specified area's median income. The graph on the right showcases by how much the Los Angeles area counties deviate from the area's median income. One may have assumed that Los Angeles might have the highest average income compared to the other counties, but while LA contains some of Southern California's wealthiest neighborhoods, it also contains some of the poorest.

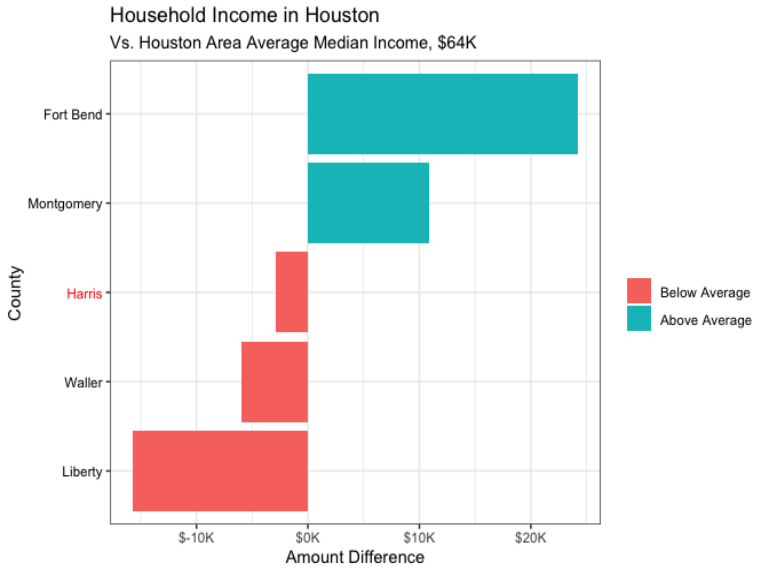



When comparing Philadelphia household income to the rest of the suburbs average, it scored over $30,000 less. This is a substantial amount of money since it is almost half of the average household income. Various sections of Philadelphia have poverty rates up to 25% resulting in a total of over 60%, as most employment are service jobs with low wages and an uncertain future. On the flip side, Chester County is booming with a median income of almost $20,000 dollars over the average, which is just shy of $100,000. An explanation for this is the county's increased employment rates in the scientific, technical and healthcare services, which in general have a higher income compared to other industries (1).

From the graphic on the right, the two standouts are Manhattan and the Bronx, but for opposite reasons. Manhattan seems to have more economic success and the Bronx seems to be struggling. As the financial center of the world, it does not come as a surprise to Manhattan's success. However, given the proximity of the Bronx to Manhattan, the reason for the Bronx's struggle is not as clear. In fact, the difference in NYC is one of the starkest in the entire world (source). This is something that might be caused by systemic issues or access to education.

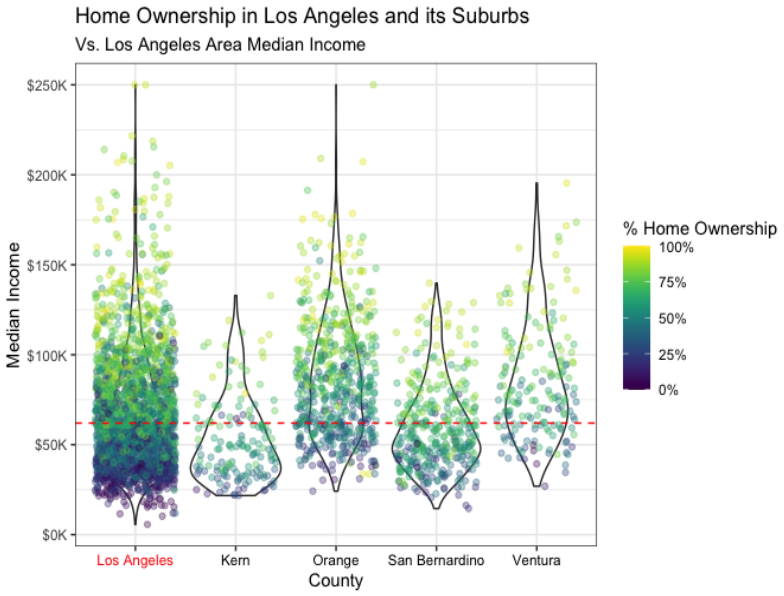



Interestingly, the city Houston is not listed as the highest income among its suburb counties, and actually is below the median income. Fort Bend is listed as the largest income county. Fort Bend shows the biggest income gap, and has become Texas's wealthiest county, with a median household income of $95,389 and a median family income of $105,944. The income of Fort Bend and Montgomery are the only counties above the area average. Other counties, Harris, Liberty, and Waller have a below average. Liberty has the lowest income and the gap between Fort Bend's income and Liberty's is almost $40,000.

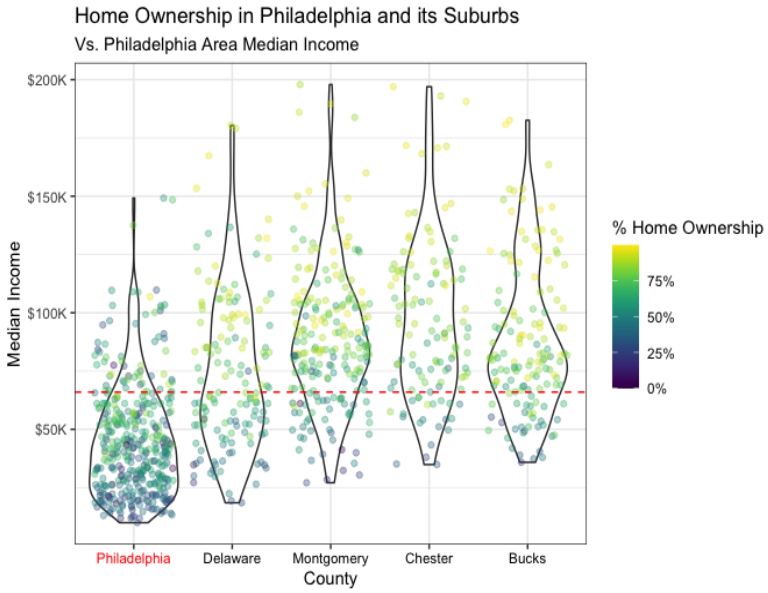


The next topic of discussion is the effect median income has on a resident's ability to own a home. Purchasing a home is often a person' most important financial decision and the home also tends to be the biggest financial asset a person has.

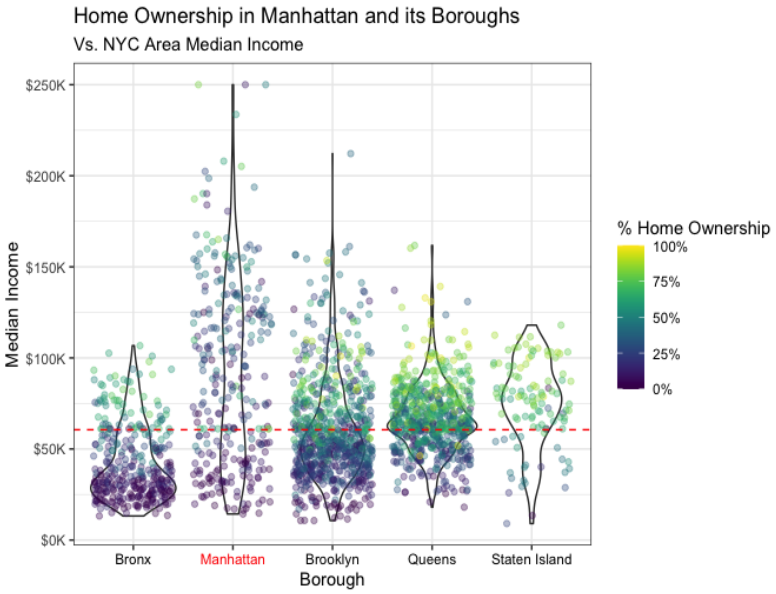
The illustration on the left shows us that in Los Angeles, as families start to make over the national average income, the percent of home ownership increases dramatically. Los Angeles and Orange counties have a very wide spread of the distribution, while the other counties are more compact. There also seems to be more outliers towards a high median income and high percentage of homeownership, than the other tail end.



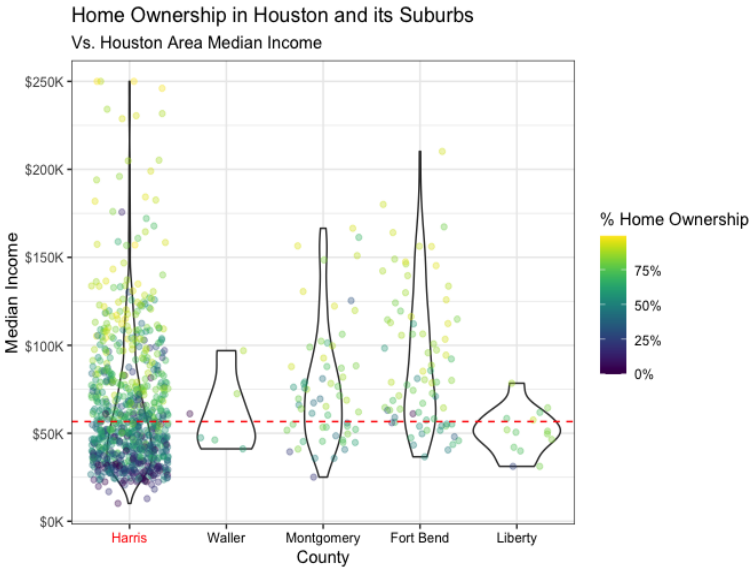

When evaluating how median income affects a person's ability to own a home in the Philadelphia area, it is pretty clear if a person earns over the area median income, that they are most likely to own a home. In Philadelphia's case, since it has a high population density below the national median income average, they also have a low number of residents who do not own a home. Due to the low income, many residents within the city live in and rent Section 8, low-income Federal housing. However, even the higher income residents are more likely to rent within the city limits rather than purchasing a home.



While one might expect Manhattan to have the largest number of homes, it is apparent this is not the case until you progress into the upper echelon of wealth. One can assume this is because of the price of real estate in Manhattan compared to other cities the median asking price in Manhattan was $1.4 million compared to $900K in Brooklyn(source).



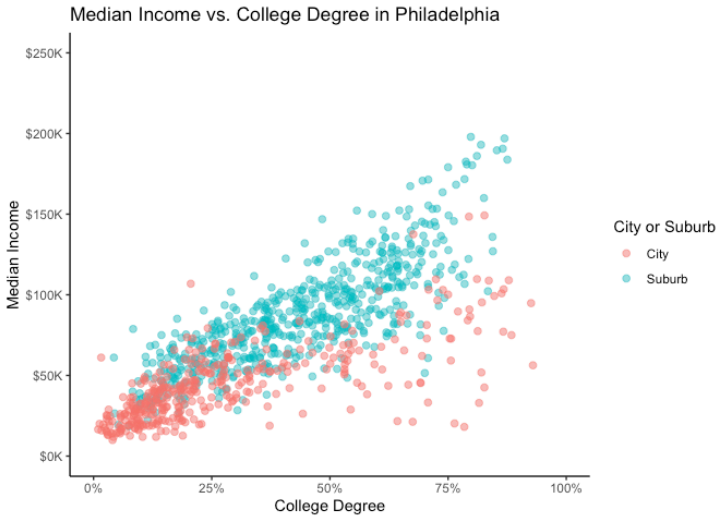

The Houston area seems to follow the general trend of the wealthier families owning homes. This is unsurprising because similar to the cities earlier, not all incomes can afford to buy a home. Most of Harris's residents seem to live with below the national average income, and roughly 40%-60% of the people around the national average income own a home. Additionally, most of Harris's residents earn less than six figures, there is a large group of outliers the extend to a quarter of a million dollars

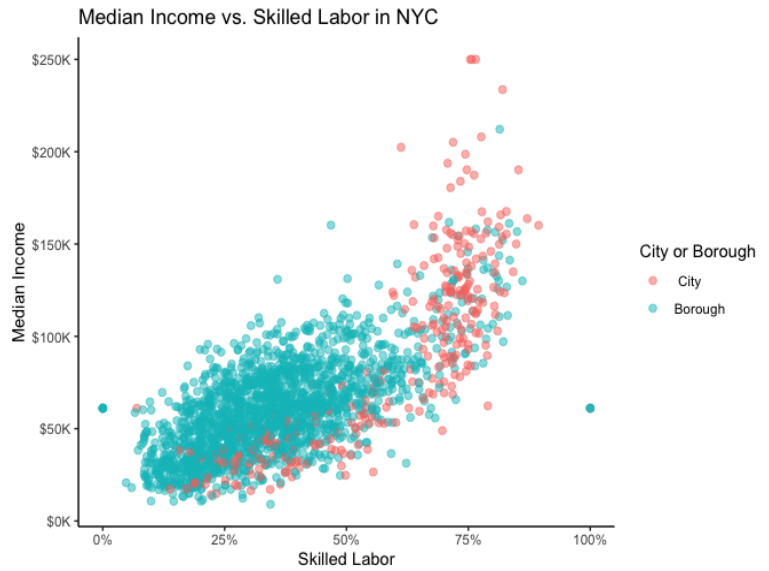



After seeing how income drives home ownership, we then wanted to see what drives median income. First, we will look at skilled labor jobs. The data dictionary defines high skill as Percent individuals ages 16 and over employed in management, business, financial, computer, engineering, science, education, legal, community service, health care practitioner, health technology, arts and media occupations (ACS).


The graphic on the left displays the positive relationship between skilled labor jobs and median income in Los Angeles. The relationship is more exponential than linear once skilled labor reaches about 70%. However, with the city has the most variability again.

After seeing how Philadelphia suburbs' median incomes were affected by the type of high earning employment present, we decided to examine how these high skill jobs translated to income. Unlike LA, Philadelphia has a more linear trend, but the suburbs have a somewhat exponential growth once skilled labor goes above the 50% mark. Philadelphia populates in the bottom-right indicating less high-skilled workers earning a lower median income.



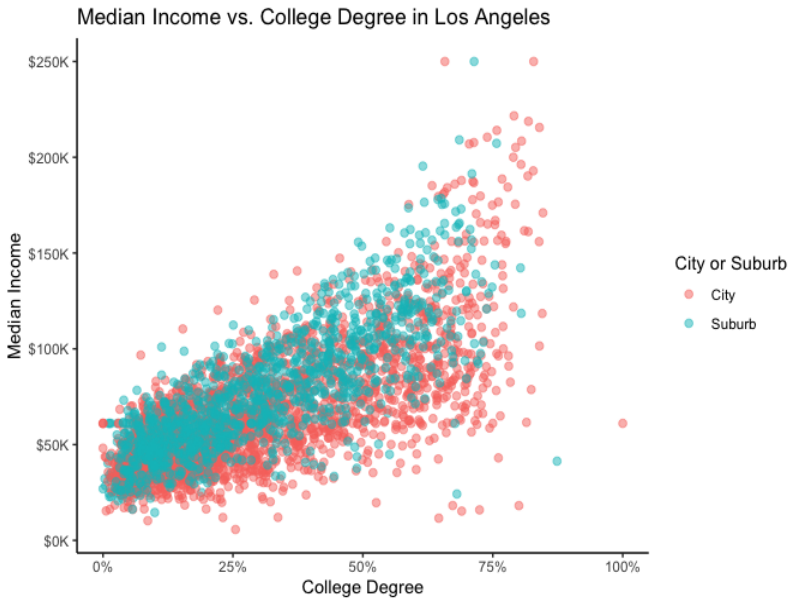




The interesting thing to note about this graph of New York City is the beginning of an exceptional relationship as skill gets higher wages seem to disproportionately increase, especially in Manhattan. As such, given that Manhattan is the financial capital of the US might explain part of the difference.

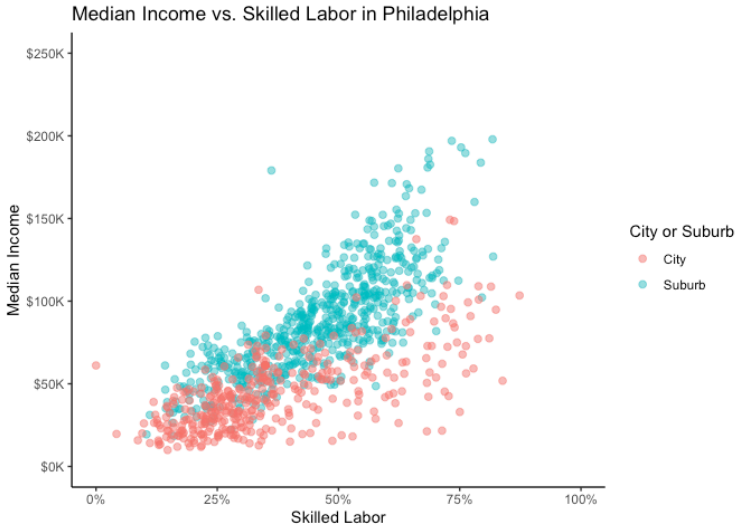

Even in the Houston area, the percentage of individuals with high skill has a positive linear relationship with median income. This means there is a tendency that people with high skill make more money than someone without high skills. The city, Harris (Houston), has the widest spread, but has a high density near low levels.

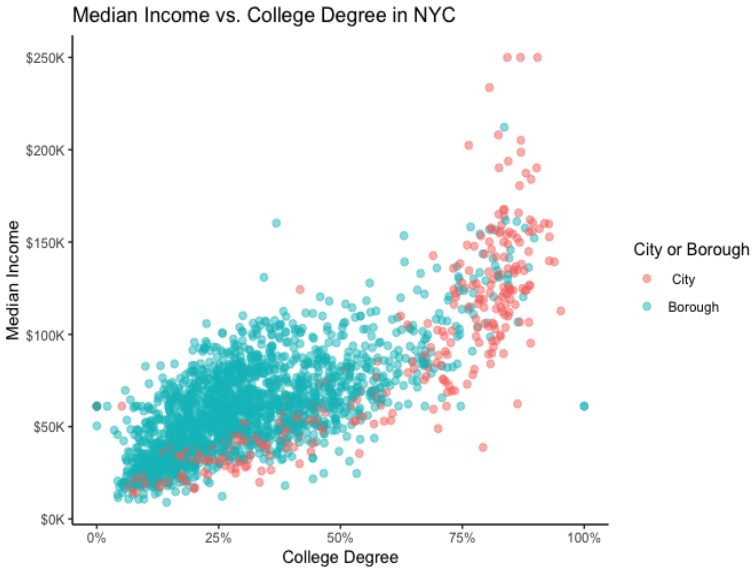
After analyzing high skilled jobs, the next thought was to observe how a college degree drives median income. According to Northeastern University someone with a bachelor's degree will earn nearly 19k more a year (source) than someone who does not have one.

Unsurprisingly, in the Los Angeles are, the higher the percentage of students with a college degree in each of the sub-areas of the counties, the higher the income is. We see a relatively even distribution of the counties, with Los Angeles having the highest variability. There is a cluster around 0% to 25% of students at a given school moving on to obtain a higher education degree and earning anywhere between $20,000 to about $75,000.



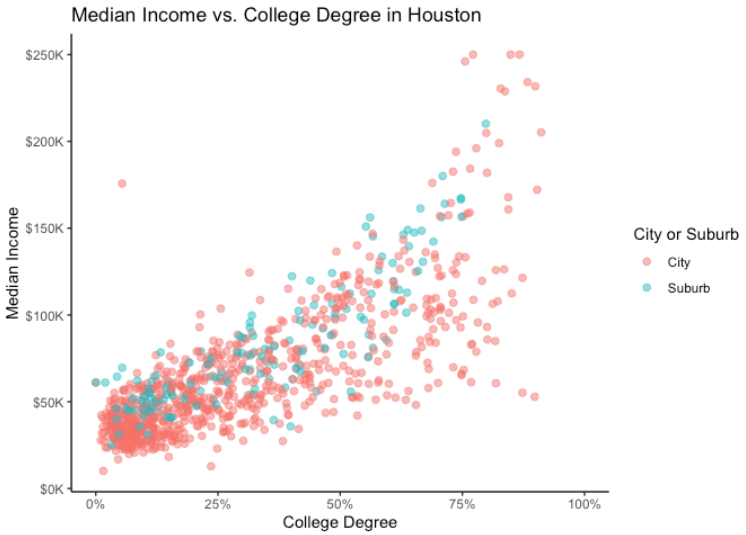
The Philadelphia area also seems to exhibit a strong, positive linear relationship between a college degree and an increase in income. First, the cluster of red points in the lower left-hand corner implying that the city has less college graduates who therefore earn less money. However, even as the percentage of college graduates increases within the city, the median income does not increase at the same rate as the suburban counties.



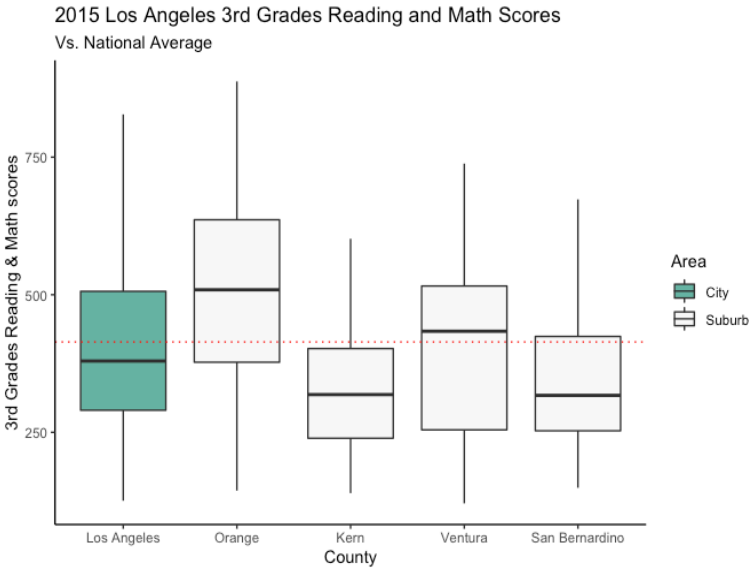

This graph of New York City portrays a different trend than the previous ones we have seen. Manhattan has the most college degrees and highest financial success. Then, there is an abrupt increase in median income in Manhattan once the college degree percentage exceeds 80%. It almost resembles a perfect horizontal trend.

The Houston area shows a cluster of the data at the bottom left, meaning many of the city's residents don't earn a college degree and don't make more than $50,000 a year. When analyzing Harris' data, while it is true that Harris has the highest percentage of college degree holders, it still has a median low income compared to other counties despite a big city.



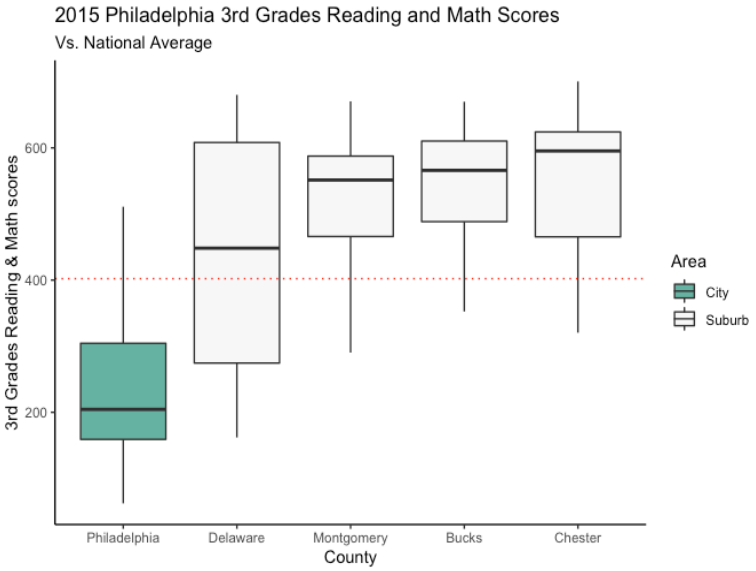
**Education**

Moving from each city's economic information, we can look at its educational achievements, and how it compares with national averages. We will start by analyzing primary school education then secondary school and see how each city compares with not only its surrounding suburbs but also with each other. Starting with primary school education, we can see how each county compares in its third graders academic score. Third grade is a good middle ground in primary school, which is why we picked that year. The academic score consists of adding a mathematical academic score with a reading score, both scored on a scale of 0 to 400. The scores were data from an examination participating schools in the area conducted to its students.

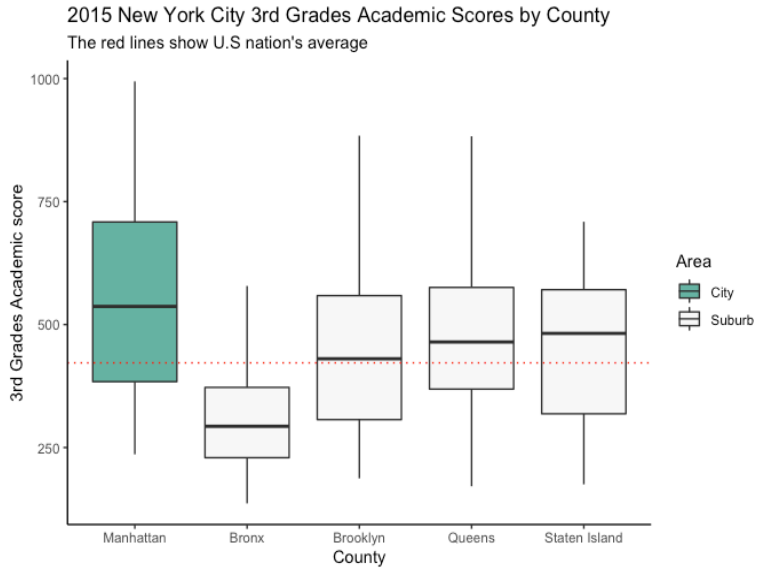



The first city we will look at is Los Angeles. Ventura and Orange counties fall below the national average, which interestingly are the two cities that have a higher average income than the area average. In fact, the order of the county's 3rd grade academic score averages follow the order of average household income, with Orange county being the top on both criteria, and Kern being the last of both.

Next, we look at Philadelphia Metropolitan Area. In the plot there is one outlier, Philadelphia. This follows suit, as it is recognized across the county that inter-city schools are subpar, with high teacher turnover compared to the rest of the country. Something odd is the large interquartile range of Delaware County. Upon further research there were no specific reasons as to why this is besides a wide-ranging success of schools.

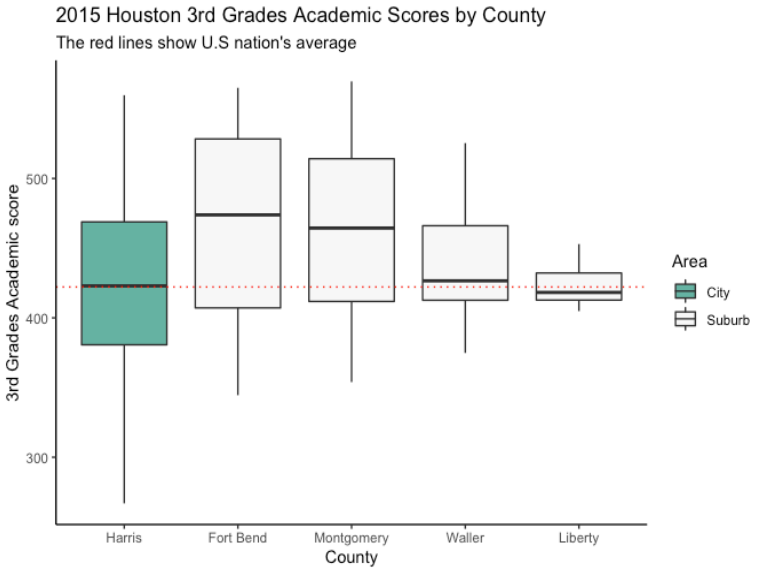


Next is New York City. As one can see, Manhattan has by far the best education scores in the New York City area. This is the first city so far where the main city is above the national average.




In fact, Manhattan has the highest average income, then followed by Staten Island, Queens, Brooklyn, then the Bronx, which is also the order of the 3rd graders academic scores! The direct correlation between income and academic performance in NYC could be due to city funding, access to tutors, and high teacher salaries. The Bronx is also the only borough that is below the national average.

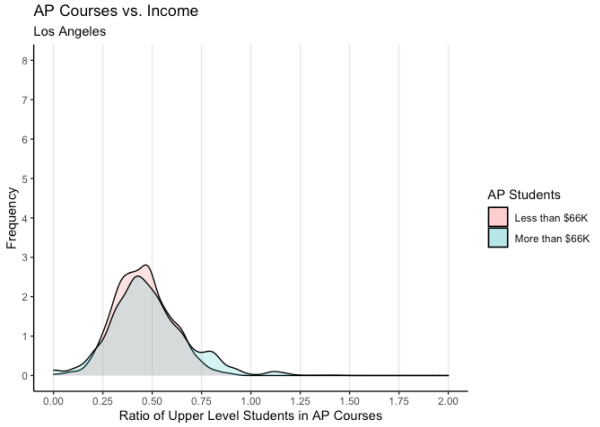
The average of 3rd grader's academic score in Harris (Houston) is right on par with the U.S. nation's average. In contrast to New York City, income does not seem to affect children's education level. For example, Waller's median income is lower than that of Harris's, yet Waller's students tend to have better academic achievement scores in third grade. Harris also has the widest spread in its distribution of scores, while Fort Bend has the widest distribution of the median.

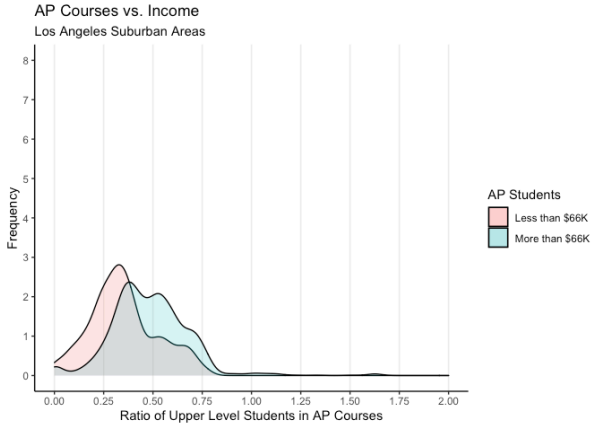



This was a common trend in all four of the regions that the big cities have a wide spread of the data, if not the widest. This is due to the main cities having high population, in this case third graders, resulting in the biggest variance. Income rates have a generally effect third grade academic achievement.

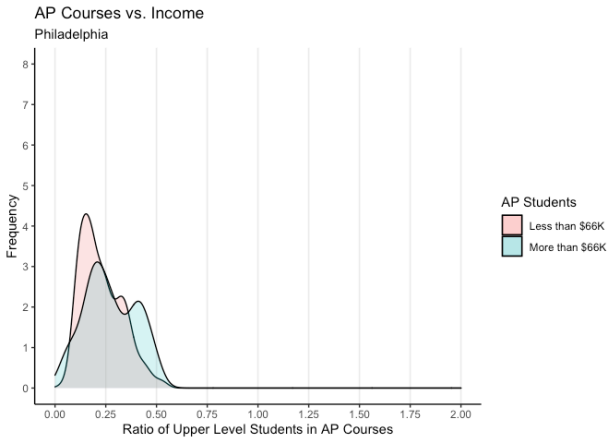
Next, we examine secondary school education and how income affects a student's ambition in the classroom. While there are many ways to access ambition, enrolling in AP classes is one of the more concrete ways to do so. The graphs show the frequency of the ratio of students in at least one Advanced Placement course to the number of 11th and 12th graders. The pink density plots represent the schools where the student's households earn less than $66,000/year while the blue density plots are the schools whose students' households earn at least $66,000/year 66K is the mean income across the areas allowing us to compare across cities.

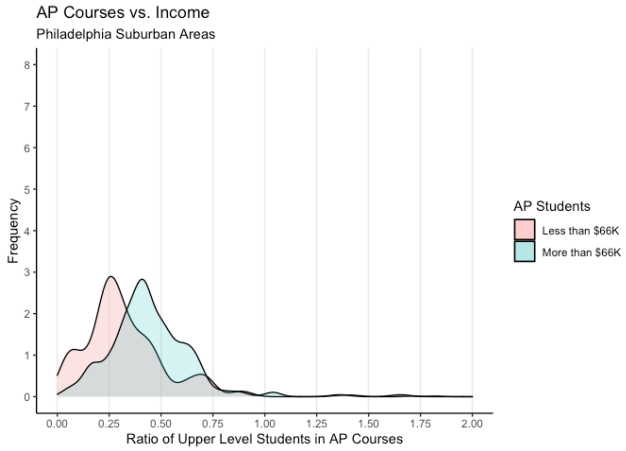
In LA and its surrounding counties, the ratio tends to be greater in schools with high earning families. In the LA suburbs, schools with wealthier students peak at 1 student in at least one AP class to 2 upperclassmen at the school (0.5), while lower-earning schools are about 1:4. Los Angeles, however, also sees the same increase, but is much more minimal. Both types of schools in LA peak at a ratio of just under 1:2, around 4:9.



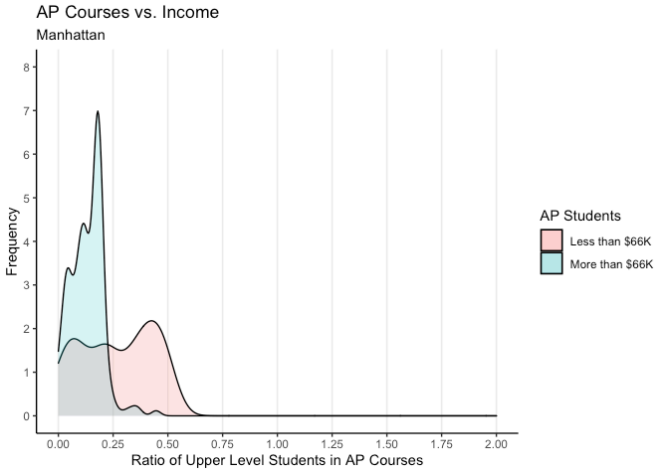



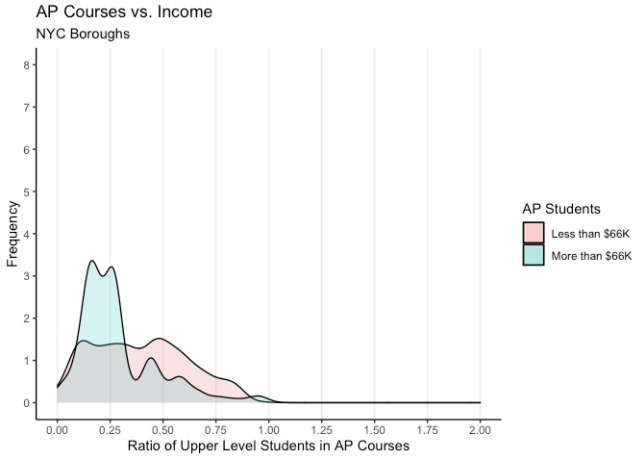

Below is Philadelphia, where students from families of higher incomes take more AP classes, with the ratio peaking once at 1:5 and again at 2:5. Philadelphia's suburbs follow a similar trend, with the wealthier students most frequently around 1:2, and the lower-income schools around 1:4.



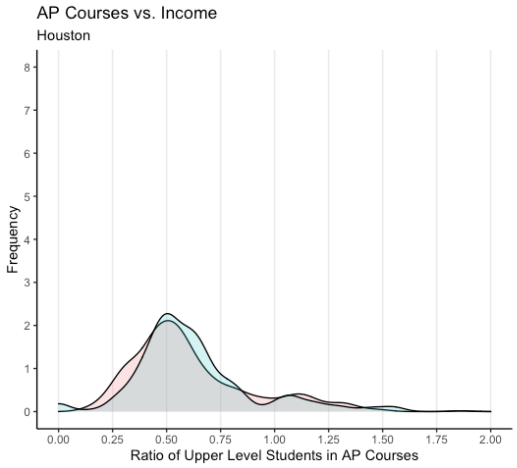



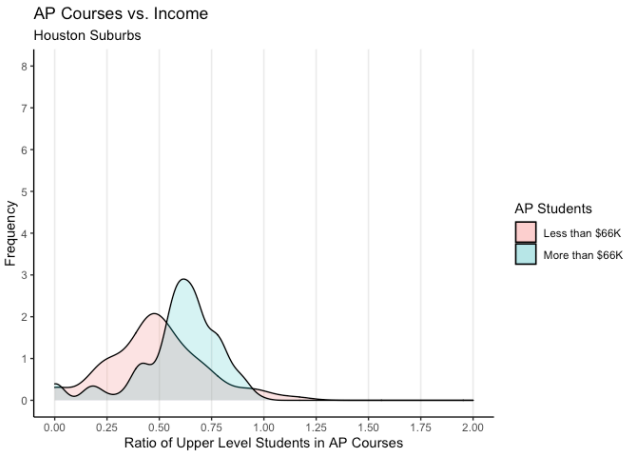
The next city to analyze is the Big Apple, New York City. Most of Manhattan's wealthier schools have 1 student in at least 1 AP class for every 5 upperclassmen, while the less wealthy schools seem to have a more even distribution. The trend in the schools in the four other boroughs of Brooklyn, Staten Island, and The Bronx exhibit a similar distribution. Both types of students peak around 1:5, then have a drastic dip and finally stretch out to an even 1:1 ratio (right tail end). This could be due to a few things; perhaps a social normalcy of highly competitive high school environments pressuring students to enroll in at least one AP class.



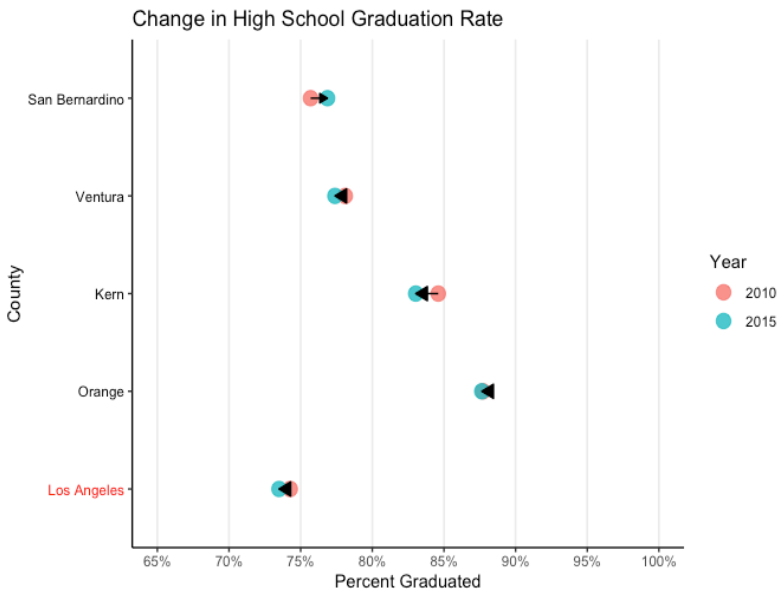




In the Houston area, it is quickly apparent the schools of the Houston metropolitan area follow the same trend as the first city, Los Angeles and its suburbs. In the suburbs of Houston, most of the wealthier schools have a ratio of 3:5, and most of the non-wealthy schools have a ratio of 2:5. The schools of Houston seem to follow the same distribution as the schools of Los Angeles, in that while more students in wealthier schools tend to take AP classes, the difference is very minimal. It is possible the increase is much smaller in the city because the competition in the high schools is still very similar, despite a students' background.



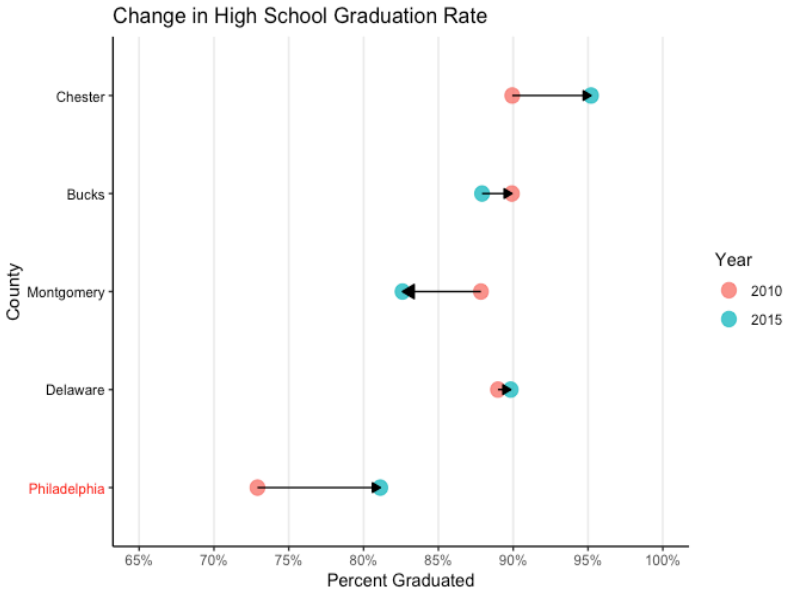



To conclude our analysis of secondary education, we want to look at is the change in graduation rate from 2010 to 2015. This is an interesting variable to analyze so we can see if there are identifiable trends, whether it is increases in graduations rates, decreases, and where one is more common than the other.



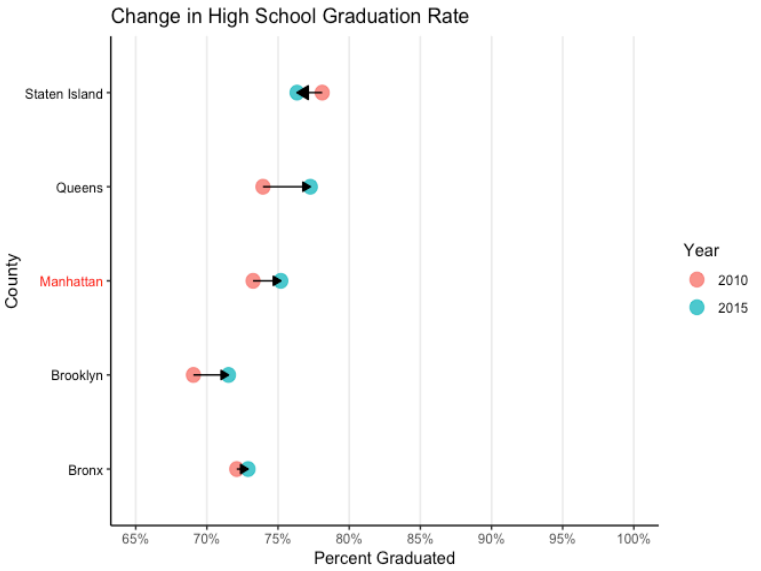

On the left, we see the changes from five counties of Southern California. There is a small decrease in graduation rates in every county but San Bernardino. It is nearly impossible to know if this is standard variance or due to a more significant problem. The graduate rates lie between 75% to 87% across all counties in both years, with Los Angeles having the lowest in both years.

In the Philadelphia area, Philadelphia had the largest change, a jump of about 8%. Philadelphia's drastic increase in graduation rate could be attributed to a few factors. First, in the recent years the city has built a number of new high schools in order to create smaller classrooms for more interactive learning. Second, the city created a reengagement center to help former dropouts get back in school and graduate. And third, the city has upgraded and expanded its technical school to offer a wider range of certifications available to achieve a high school diploma.

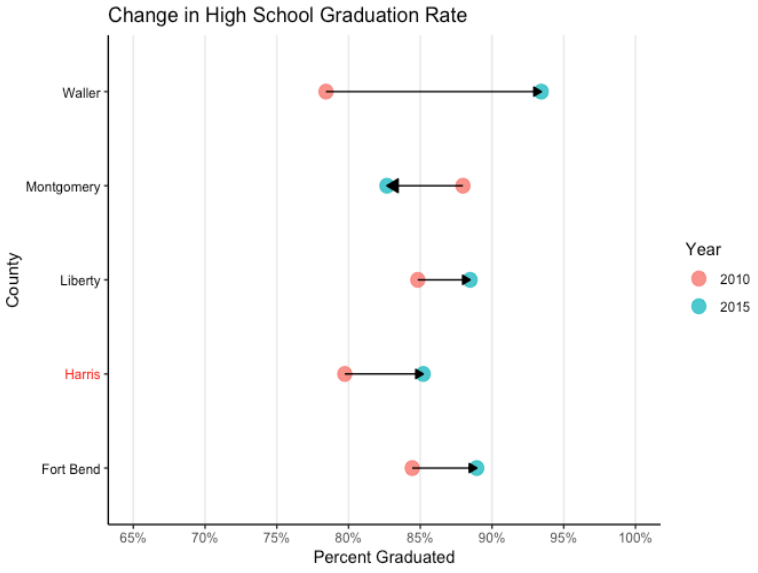



Despite the big increase, just like Los Angeles, it has the lowest graduation rates of all five counties in both years!

Moving on to New York City, the graduation rates are increasing slightly across the board except in Staten Island. This goes against what would be expected given that in the other education categories Staten Island tends to do well. As such, it might be due to other factors such as social pressures. To further investigate this discrepancy, one would need more data specifically how high school dropouts are viewed between the boroughs and what opportunities there are in each area if one lacks a diploma. Unlike Philadelphia and Los Angeles, Manhattan's rates are not the lowest, rather right in the middle.



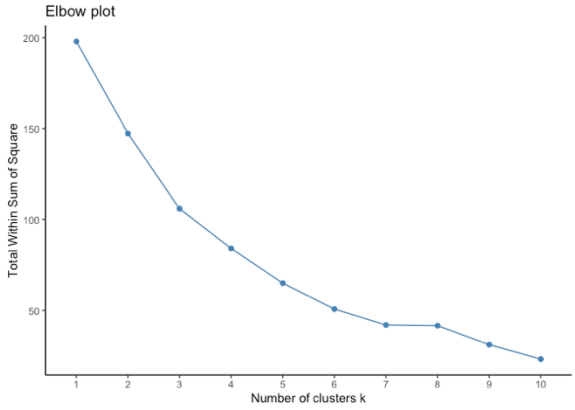

In the Houston area, Waller had a dramatic increase in graduation rate from about 78% to 94%- more than a 15% increase! Harris, Liberty, and Fort Bend also show an increase in high school graduation rates of about four to six percent. Montgomery seems to be the only county to have a decreased change in high school graduation rate. Other than Waller, all the counties seem to have similar percentages or change.

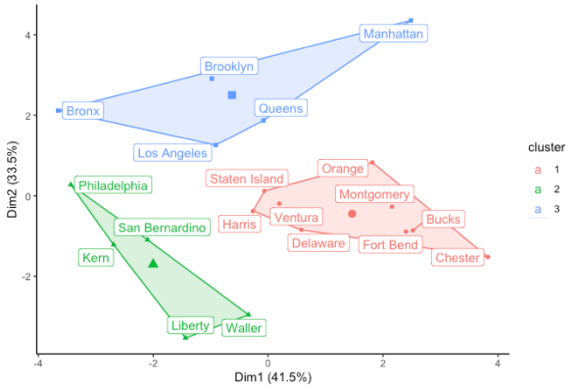



In 2015 the Los Angeles, Philadelphia, and Houston areas had a wide range of high school graduation rates, 73%-83%, 81%-95%, and 73% to 84%, respectively. While those cities range at least 10%, NYC had the smallest range at 3%, 72% to 75%. It also seemed to be a common trend that the big cities of each of the four regions, had one of the lower rates when compared to its surrounding counties.

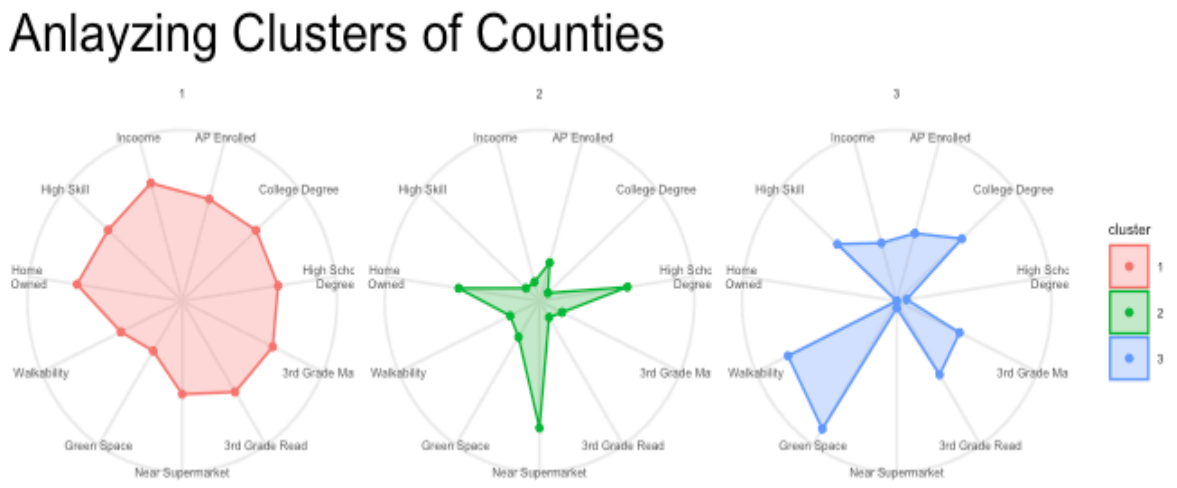
## Clustering

We analyzed and compared some counties in California, Philadelphia, New York, and Texas for livability, economics and education. Before we analyzed the variables, such as home ownership and median income, our assumption was that all the cities would show the similar characteristics, while all the suburb counties show the same with each other as well. We checked this assumption using k-means clustering.




Before running this cluster, one could have assumed the clusters would have been cut across two major axes either by being a big city or the big city that it is near. However, that is not the case. In order to further investigate, we used a radar plot to analyze the clusters' cluster.
We found that the blue cities are not grouped strongly on economic and educational variables but by the livability variables. The Bronx, Brooklyn, LA, Queens, and Manhattan are clustered together due to the high scores in walkability and access to green space. The green clusters, Philadelphia, San Bernardino, Kern, Liberty, and Waller are together because of high similar access to supermarkets and high school. The red cluster containing Orange, Staten Island, Harris, Ventura, Delaware, Montgomery, Fort Bend, Bucks, and Chester is the most balanced. This cluster seemed to group on similarities of nearly every category.



**Ethics**

This analysis could be used to see which parts of the United States need more attention in terms of funding for various components of everyday life, particularly education in this case. For example, the Bronx in New York City was the only borough where its third graders performed below the national average. The city could use this information to supply the schools in that area with more opportunities of academic achievement. We also saw a consistent trend of less students from low-income families enrolling in Advanced Placement classes than those from wealthier families. Thus, schools could make more of an effort to enroll students from low-income households in more AP classes. While these are examples of the positive outcomes that could result from this research, with any exploratory analysis project, there will inevitably be some ethical concerns embedded in it.

There are always concerns about data confidentiality, security, and consent. The research we conducted was for secondary data analysis, meaning the data was collected to answer a different set of questions first. Misuse of this data could lead to misinterpretation and the spread of misinformation. For example, in the economics section of this research, there was a general trend of suburban residents with a college degree out earning the city residents with a college degree. This issue with this, however, is white flight, which could potentially then lead to gentrification. People will notice that college graduates can earn more in the suburbs, want to move there, which will ultimately drive up the cost of living and housing in those areas. Further, it is important to have informed consent when conducting data collection. But with the data from the third graders scores, it is likely that the nine and ten-year old students do not understand what they are consenting.

**Conclusion**

We compared and contrasted four of the six biggest cities in the United States on the basis of livability, economics, and education. We found that the main cities of the Philadelphia area, New York City, Los Angeles area, and Houston area scored higher in livability than their surrounding suburbs. While there was a general trend of suburban residents with a college degree out earning the city residents with a college degree, we couldn't identify a common pattern in terms of median income, whether the city earns more than its suburbs. Other than Manhattan, the main cities of each region had its 3rd graders underperform in academics than both the national average and its surrounding counties. Further, household income seemed to have an effect on a high schooler's ambition in the classroom- measured by number of AP classes enrolled in- with New York City being the outlier again. LA was the only big city that did not see an increase in graduation rates from 2010 to 2015, and the LA area was also the only region where more than one county saw a decrease in graduation rates. In conclusion, these big cities greatly vary on lifestyles and academic, economic, and livability infrastructure.

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