The Battle of Neighborhoods in Phoenix
(as a New Metro)

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1. INTRODUCTION

Based on Wikipedia[1] and an article published in 2017 on AZ Central[2], Phoenix is one of the fastest growing metro areas within recent years and earned "two national distinctions with the U.S. Census Bureau numbers released Thursday [June 8, 2017]: Fifth-largest city and fastest-growing city." However, due to its vast land mass within the Metropolitan Statistical Area (MSA) boundaries, this got some thinking it to be rather atypical of a "true city," like New York City. Key neighborhoods being miles apart don't fit together well for people seeking a traditional sense of one big city. Having been in the area a short while, I find that the uniqueness of the area is very much appreciated in recent urban developments that have injected pieces of the real city in many neighborhoods surrounding the urban core.

2. PROBLEM STATEMENT

Is Phoenix a true city? If naysayers' opinions about the city of Phoenix as described above remains pervasive, it may discourage some city seekers like new families and young professionals to dismiss the opportunities that lies within Arizona. One way to help new prospects better appreciate the area is to explore the various neighborhoods with geolocation data from Foursquare and supplemental local datapoints to illuminate the social composition of top activities, popular venues, and businesses within key neighborhoods. We can then compare these areas to those within a big city like New York City for context. With growth, comes economic development and increased business opportunities. Any similarities/differences found during the exploration could be leveraged to help identify potential pockets of opportunities. Let's see what the data can tell us during this data exploration exercise.

3. DATA DESCRIPTION

a. Objectives

- Gain better insight into Phoenix and the local neighborhoods of Maricopa county.
- Compare/Contrast Phoenix's mix of popular venue preferences focusing on Maricopa county versus those of a more established city, NYC's Manhattan borough (county equivalent).
- Based on similarities/differences to Manhattan, are there potential business opportunities for the Phoenix metro area neighborhoods.

b. Sources

- Foursquare[3] geolocation data for mid-February 2019 will be used to pull sample sets of top venues within the radius of the main metro areas. Categories of these venues will be used to cluster like activities and provide some contextual understanding within each neighborhood based on matches to the dataset with neighborhoods and their identified lat/long coordinates.

    - Phoenix (County: Maricopa)
    - New York City (Borough: Manhattan)
- US state-county[4] latitutude/longitude dataset will provide the set of county ZIP codes along with their lat/long coordinates that are needed to match to the Foursquare data.
- Supplemental manual neighborhood identification lookups will provide name identification of Phoenix neighborhoods since a set list is not readily available online. Any additional local statistics if pertinent to the analysis may be included from Phoenix local government sites.
    - US ZIP code lookups[5] for neighborhood names
    - Local AZ demographics data[6]
- United States Census Bureau[7] will provide some national census related business statistics at the zip code level that may be pertinent to the evaluation exercise.
    - Business Statistics
- Given the shorten timeframe to turn around this analysis, supplemental location intelligence produced by Esri[8] (an expert in geographic science and the builder of ArcGIS, a powerful mapping and spatial analytics software) will be used to help fill in characteristics about certain neighborhood segments within this study.
    - Esri's Tapestry Segmentation provides community lifestyle and demographic information

4. METHODOLOGY

GitHub was used as the main collaborative repository with a web based graphical interface to host the files for this project. The majority of the processing will be conducted from a Python notebook on the IBM Watson platform. The base geolocation files will be built off of publicly available neighborhood latitude/longitude for each area.

a. Pre Processing

For Manhattan, data sourced from a site used during the Coursera coursework was downloaded and processed. For Phoenix, there was not a dataset already formed at the county and neighborhood level to retrieve on a public site. Therefore, I had to comb several sites for ZIP code level datasets to scrape, download, and form my master dataset to merge with Foursquare geolocation venue data in a similar format to Manhattan in order to set up properly for comparisons of these two regions.

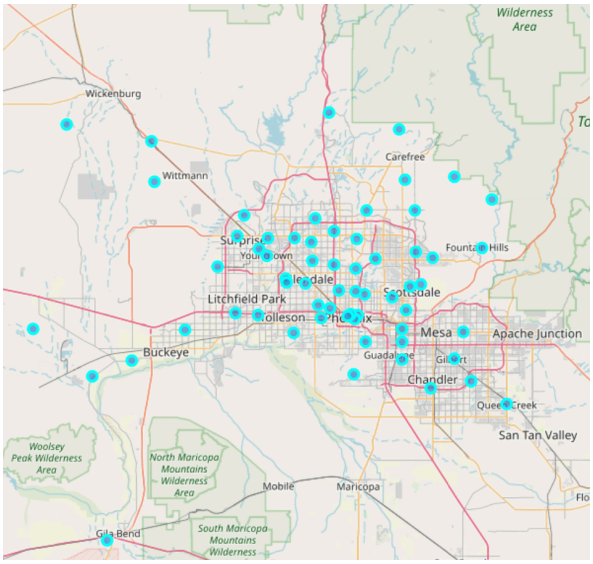
	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Marble Hill	40.876551	-73.91066	Arturo's	40.874412	-73.910271	Pizza Place
1	Marble Hill	40.876551	-73.91066	Bikram Yoga	40.876844	-73.906204	Yoga Studio
2	Marble Hill	40.876551	-73.91066	Tibbett Diner	40.880404	-73.908937	Diner
3	Marble Hill	40.876551	-73.91066	Sam's Pizza	40.879435	-73.905859	Pizza Place
4	Marble Hill	40.876551	-73.91066	Loeser's Delicatessen	40.879242	-73.905471	Sandwich Place

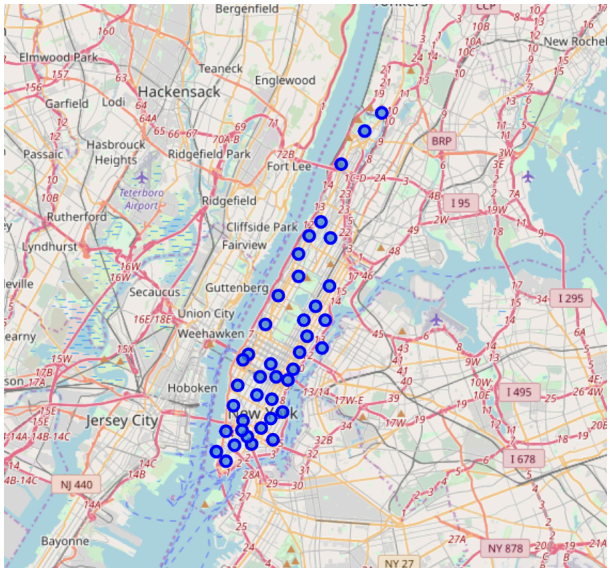
	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Ahwatukee Foothills	33.315767	-112.061267	Telegraph Pass Trailhead	33.317698	-112.066606	Trail
1	Ahwatukee Foothills	33.315767	-112.061267	Desert Foothills Park	33.305099	-112.059412	Park
2	Ahwatukee Foothills	33.315767	-112.061267	Yoasis Self-Serve Frozen Yogurt	33.306392	-112.055019	Frozen Yogurt Shop
3	Ahwatukee Foothills	33.315767	-112.061267	YMCA	33.296694	-112.059854	Gym
4	Ahwatukee Foothills	33.315767	-112.061267	Dobbins Lookout	33.345169	-112.058435	Scenic Lookout

To note, I did encounter a few challenges in the acquisition of ZIP code neighborhood data as well as the completeness of key indicators at the ZIP code level for the Maricopa neighborhoods. This took a lot of set up time to structure the master datasets before any exploration could be conducted for the area.

b. Exploratory Data Analysis

In reviewing the neighborhoods within each county/borough limits, you can clearly see the tightly situated neighborhoods in NYC versus Phoenix. Given that the neighborhoods in Phoenix are more wide spread, I used a wider radius of 5,000 meters (as opposed to 800 meters) to make the Foursquare API call to try and achieve approximately 100 data points for each neighborhood.





After scrubbing and scrutinizing the data a bit, I ended up with 50 neighborhoods for Maricopa County and 40 for Manhattan with approximately 50-100 matched venues per neighborhood retrieved from Foursquare API. 13 neighborhoods along the outer skirts of the county boundaries were dropped from Maricopa after low venue counts were discovered. Maricopa produced 4,748 venue activities with 286 unique categories of venues. Manhattan ended up with 3,887 venue activities in 325 unique categories. Purely observing these numbers alone seems to indicate there's room for growth in categories of businesses to serve the Phoenix market.

Top trending venue categories did differ a bit between the two regions. Potentially fancier restaurants appear for Manhattan as opposed to fast food joints and quick eateries in Phoenix.

Venue Category	Maricopa Avg
Mexican Restaurant	0.056866
Pizza Place	0.056866
Coffee Shop	0.049495
American Restaurant	0.032013
Sandwich Place	0.031171
Fast Food Restaurant	0.028644
Grocery Store	0.027591
Convenience Store	0.022746
Burger Joint	0.022115
Italian Restaurant	0.020219
Pharmacy	0.018534
Breakfast Spot	0.016639
Bar	0.015375
Hotel	0.014532
Park	0.014322
Chinese Restaurant	0.014111
Gym	0.013479
Trail	0.012216
Sushi Restaurant	0.011584
Ice Cream Shop	0.011373

Venue Category	Manhattan Avg
Italian Restaurant	0.040134
Coffee Shop	0.039877
Pizza Place	0.026241
American Restaurant	0.022897
Park	0.022640
Bakery	0.021868
Café	0.020581
Mexican Restaurant	0.019552
Gym	0.018781
Hotel	0.018009
Gym / Fitness Center	0.016722
Cocktail Bar	0.016208
Chinese Restaurant	0.015693
Sandwich Place	0.014664
Japanese Restaurant	0.014664
Sushi Restaurant	0.013892
Ice Cream Shop	0.013892
Wine Shop	0.013892
Bar	0.013378
French Restaurant	0.013121

Additional data points at the ZIP code level was gathered for the Phoenix Maricopa county neighborhoods since this is my target area to evaluate. If data wasn't so difficult to gather at the ZIP level, I would've applied it to the Manhattan dataset as well and conducted the analytics and segmentation from the ground up with raw data. Alas, I have to make due to complete this quicker. The added feature set for Maricopa looked like this:

	neighborhood	rent	total_pop	no_of_homes	bus_estab	avg_hh_income	avg_hh_sz	diversity_index	own	median_age	rent_pct	own_pct
0	Ahwatukee Foothills	13080	85609	36894	1830	126801	2.600	53.90	21822	38.633333	0.354529	0.591478
1	Alhambra	29071	142673	58805	3224	59891	2.786	78.56	20340	33.620000	0.494363	0.345889
2	Arcadia	20497	79337	46626	4004	90040	2.040	56.05	18550	37.850000	0.439605	0.397847
3	Arlington	85	667	295	10	71147	2.950	80.60	141	36.100000	0.288136	0.477966
4	Avondale	10643	84087	28573	779	72639	3.285	83.55	14890	31.400000	0.372485	0.521121

c. Clustering

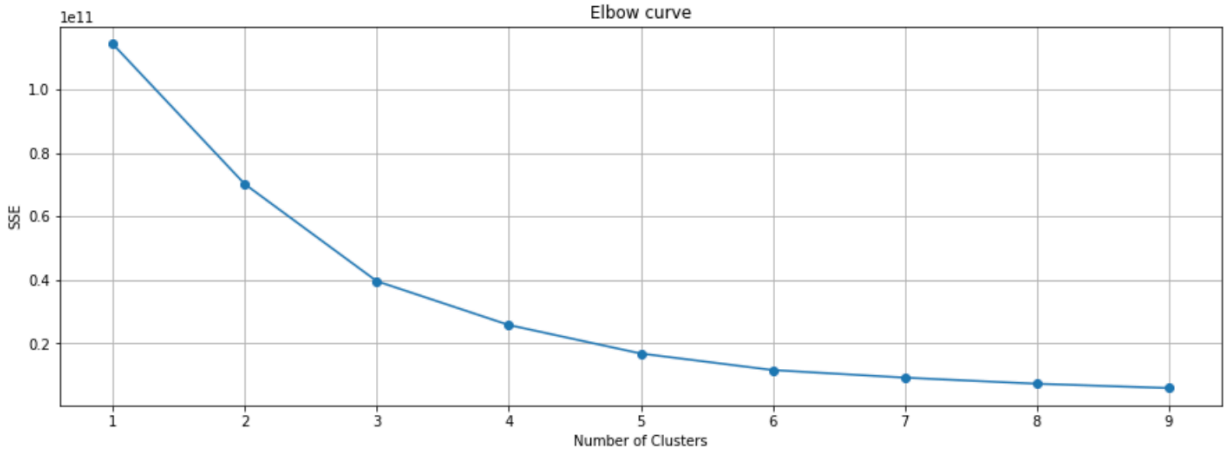
A simple clustering exercise employing K-means algorithms will first be conducted on Foursquare social networking data to compare top activities within Phoenix versus those within New York City for observations of basic behavior differences. Key points of differentiation from Manhattan will be leveraged to further build out segmentation for the Phoenix Maricopa area to help identify pockets of potential opportunity within like neighborhoods with some demographics overlay for context.

K-means is one of the simplest and popular unsupervised machine learning clustering algorithms meant to derive common themes based on inputs or features with unlabeled or

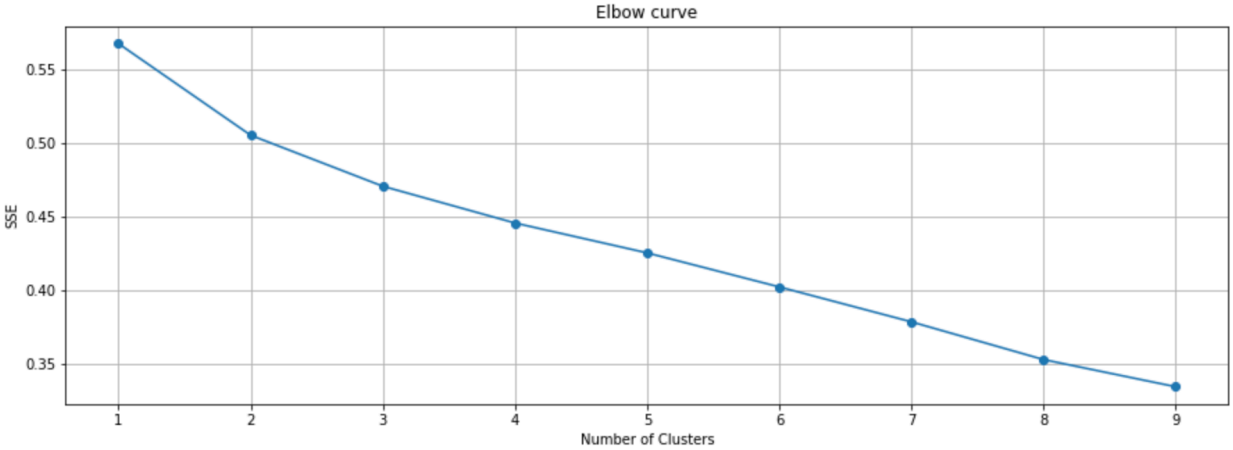
unknown outcomes. I used this to cluster the Foursquare neighborhood activities in hopes of deriving common themes to better understand the preferences of people within each region. Since the data to be clustered were unlabeled, first objective is to determine the best number of clusters or 'k' to kick off the unsupervised modeling process. Typically, the elbow method and silhouette scores could be employed to help pick the best 'k'. However, these are not fool proof methods, especially if the data points are fairly homogenous or doesn't cluster well into distinct groups.

Both the Elbow method and Silhouette scoring provided minimal assistance in selecting the optimum k using Foursquare venue category data. As you can see here, after several iterations, a definitive bend was not found in either the Maricopa or Manhanttan charts during the investigation.

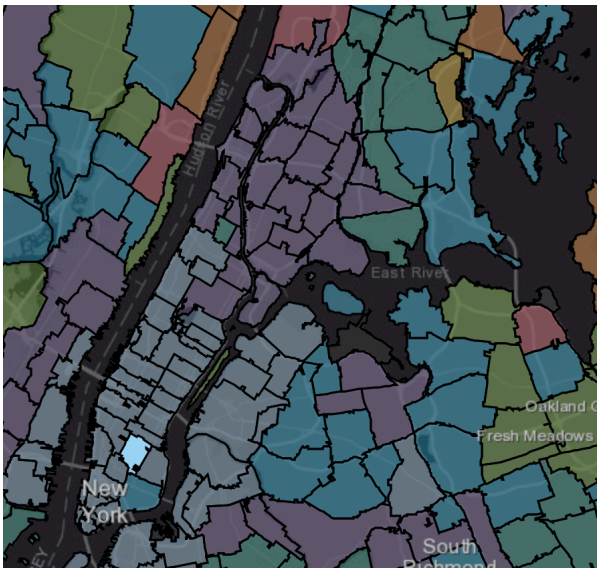
Maricopa

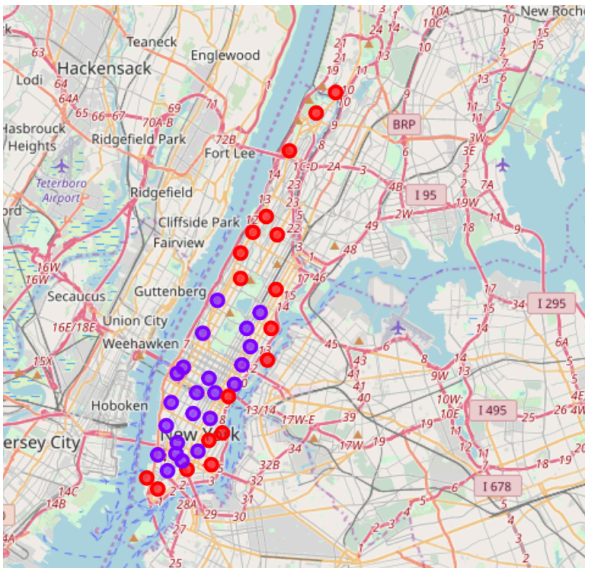


Manhattan

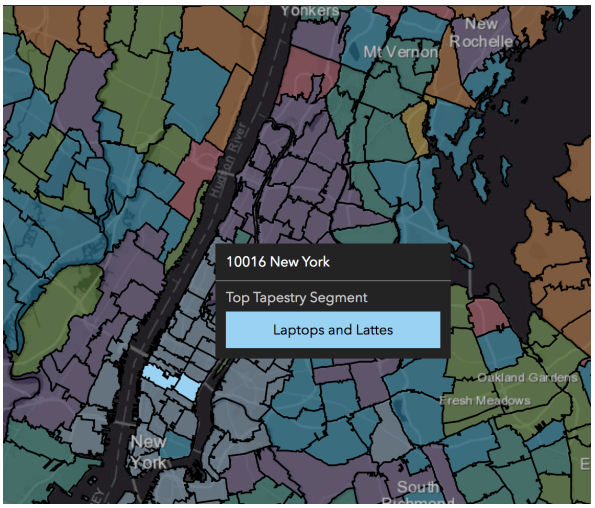


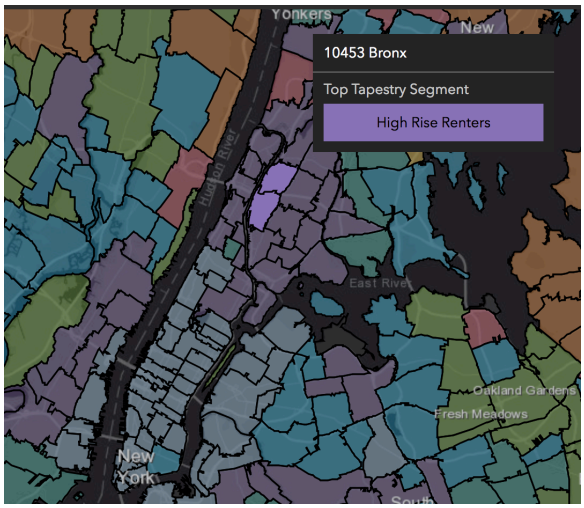
In this case, with limited time and stubborn data points, I did have to seek additional insight from Esri's Tapestry Segmentation to determine which groupings and how many are more viable for this study. For the Manhattan area, there appears to be two main segments so I followed suit in breaking Manhattan into two clusters based on just venue category data and plotted them. While observing the visualization of the Foursquare segmented venue clusters for Manhattan, they do to a certain degree, resemble the shapes of the Tapestry Segmentation (pictured below). With the limited amount of time for this study, I took advantage of this alignment and applied the basic demographics findings from Esri to help explain the additional nuances of our newly formed venue based segments.



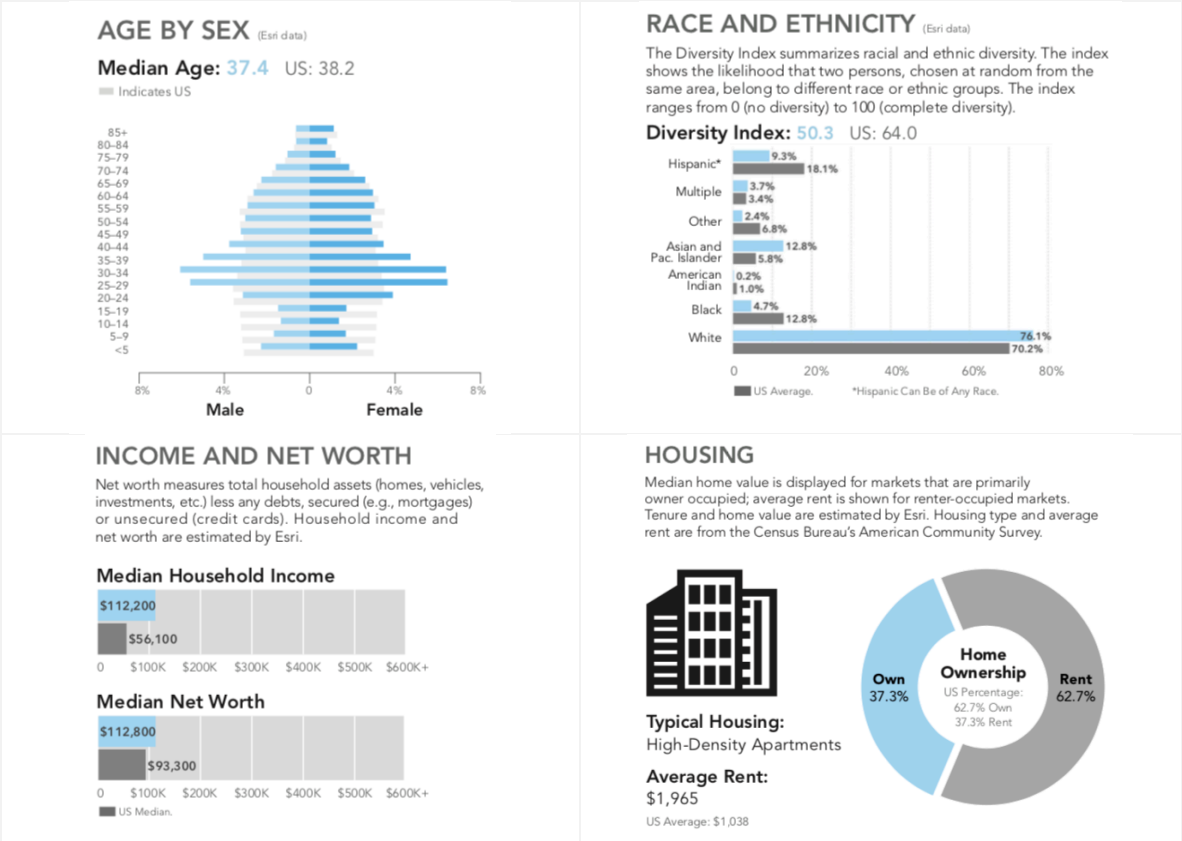


As you can see, the plotted clusters above aligned fairly well with those of the Esri Tapestry segments in Manhattan for Laptops and Lattes (light blue blocks) and High Rise Renters (purple blocks). Cluster 1 (red pins) appeared to match more so to the High Rise Renters. Cluster 2 (purple pins) mapped more to the Laptops and Lattes .

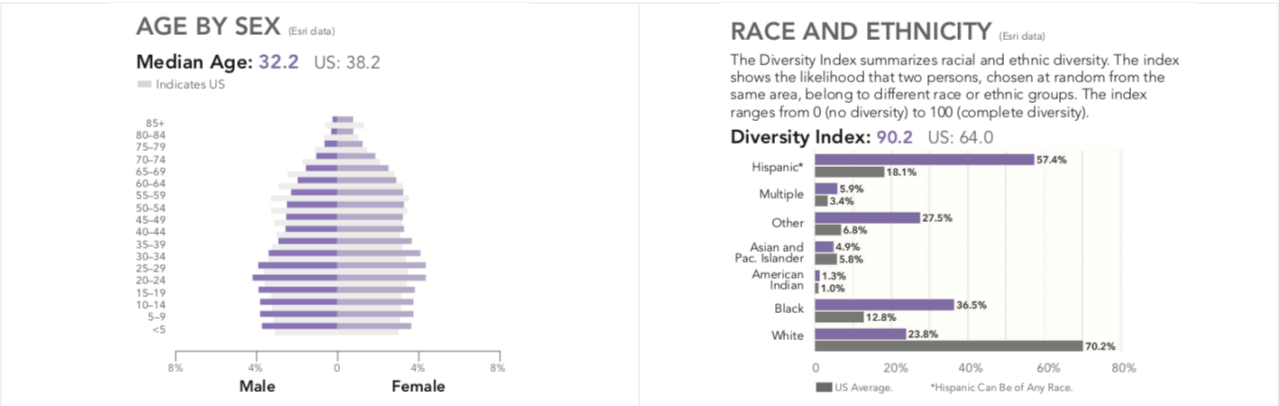


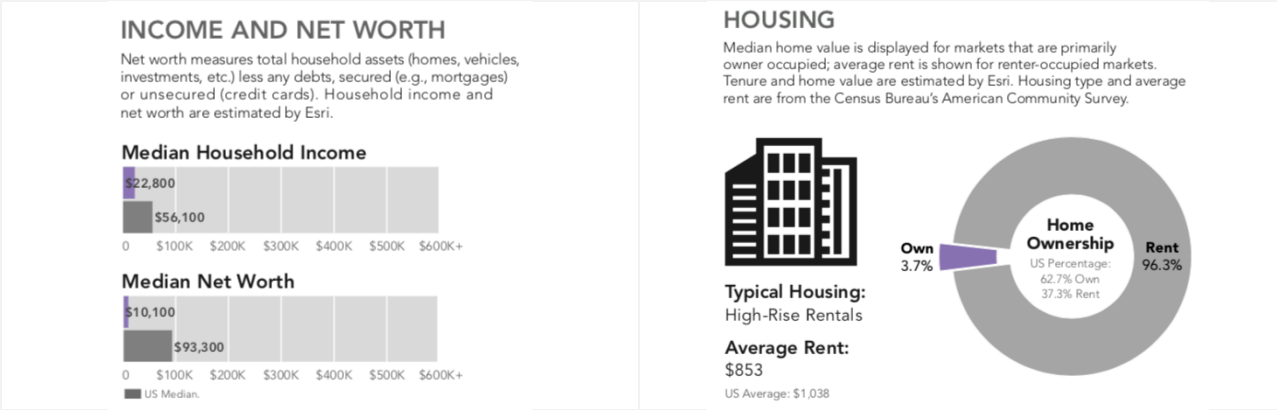


According to Esri, Laptops and Lattes folks are said to be more upscale, mid-career professionals, and likely to be single householders with an average household size of 1.87. These are health-conscious consumers, who exercise regularly and pay attention to the nutritional value of the food they purchase. Additional demographics to note:



The other dominant segment that is less of an interest for this study are the High Rise Renters. To round out observations, High Rise Renters are said to be less well off, more likely multicultural and multigenerational households with an average household size of 2.82. These are family oriented people, risk takers spending beyond their means to make ends meet and like to explore other interests to make life enjoyable. Additional demographics for comparison:





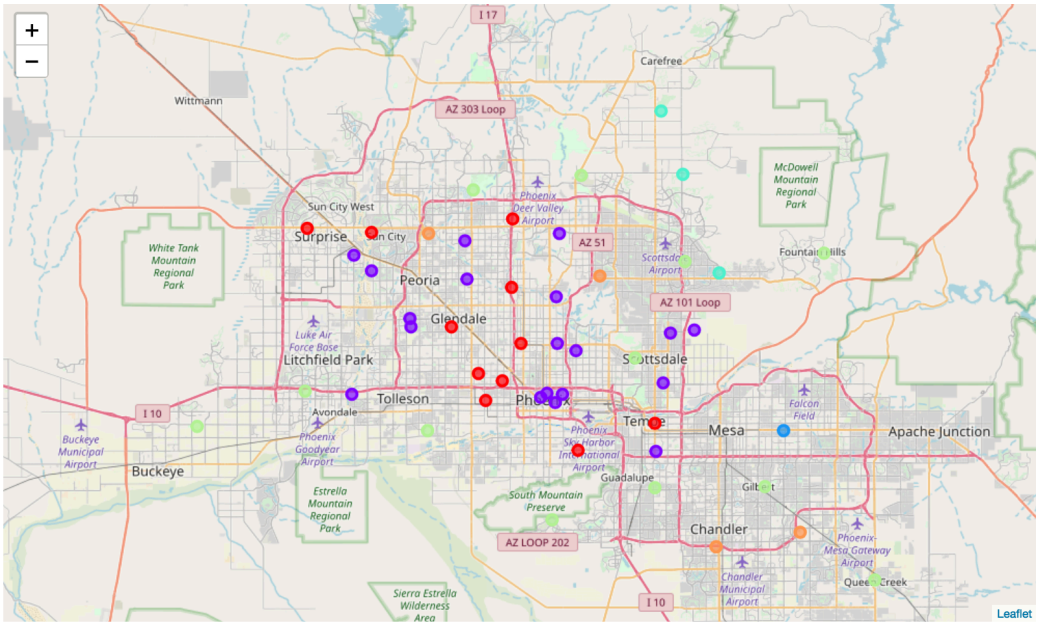
With guidance from this source, two segments were teased out for Manhattan and eventually up to six were forced within Maricopa county in order to find a group that fits loosely to characteristics for a potential up and coming "Laptops and Lattes"-like segment to target. Manhattan's Foursquare Cluster 2 did show support of the Laptops and Lattes Tapestry Segment. This cluster, accounted for 22 neighborhoods around Manhattan with indication of higher occurrences of gyms, fitness centers, spas, and yoga studios visited among the top venue categories along with Coffee Shops and Cafes. Hotels are more frequented as well, mostly likely due to business travelers, consultants, and tourists that can afford the luxury of the area. Fancier cuisines like Italian, Sushi, Japanese, French appear on the top 20 list more so than the areas within Cluster 1.

Venue Category	Cluster2 Avg
Italian Restaurant	0.054091
Coffee Shop	0.036364
American Restaurant	0.030000
Hotel	0.024545
Gym / Fitness Center	0.024091
Bakery	0.024091
Gym	0.021818
Pizza Place	0.019545
Café	0.018636
French Restaurant	0.018636
Cocktail Bar	0.015909
Japanese Restaurant	0.015909
Sushi Restaurant	0.015000
Spa	0.015000
Yoga Studio	0.014545
Park	0.014545
Wine Bar	0.014091
Wine Shop	0.013182
Theater	0.012727
Seafood Restaurant	0.012273

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
Upper East Side	Exhibit	Italian Restaurant	Bakery	Coffee Shop	Yoga Studio	Gym / Fitness Center	Hotel	Seafood Restaurant	American Restaurant	Grocery Store
Lenox Hill	Italian Restaurant	Gym / Fitness Center	Pizza Place	Sushi Restaurant	Coffee Shop	Burger Joint	Bakery	Gym	Sporting Goods Shop	Deli / Bodega
Upper West Side	Italian Restaurant	Coffee Shop	American Restaurant	Indian Restaurant	Wine Bar	Ice Cream Shop	Bakery	Bar	Burger Joint	Gym
Lincoln Square	Italian Restaurant	French Restaurant	Gym / Fitness Center	Jazz Club	Plaza	Theater	Gym	Concert Hall	Café	Hotel
Clinton	Italian Restaurant	Theater	Gym / Fitness Center	Wine Shop	Hotel	American Restaurant	Burger Joint	Bakery	Coffee Shop	Gym
Midtown	Coffee Shop	Theater	Hotel	Japanese Restaurant	Bakery	Cuban Restaurant	Steakhouse	Plaza	Sandwich Place	Bookstore
Murray Hill	Hotel	Coffee Shop	Japanese Restaurant	Gym / Fitness Center	American Restaurant	Italian Restaurant	Sandwich Place	Gym	Burger Joint	Cocktail Bar
Chelsea	Coffee Shop	Art Gallery	American Restaurant	Italian Restaurant	Ice Cream Shop	Bakery	Hotel	Seafood Restaurant	Cupcake Shop	Market
Greenwich Village	Italian Restaurant	Clothing Store	Coffee Shop	Sushi Restaurant	Gym	American Restaurant	Seafood Restaurant	Café	Pizza Place	Mediterranean Restaurant
Tribeca	Coffee Shop	Italian Restaurant	American Restaurant	Park	Spa	Hotel	Cocktail Bar	French Restaurant	Sushi Restaurant	Bakery

For Maricopa county, out of six clusters, I also landed on Cluster 2 (purple pins) as best fit to compare with Manhattan's Cluster 2. Cluster 1 (red pins) was more of the 'Multi Cultural Urban Quarters' where diversity is high, with larger families and lower income. Cluster 3 (blue pin) was more of a 'Blended New Family Area' with larger average household size and mid to upper income earnings. Clusters 4-6 (turquoise, green, orange pins) are the

upper echelon of neighborhoods encompassing the likes of Paradise Valley and DC Ranch Scottsdale where individuals are likely to be more settled and focus on home improvement and raising families. Here's how they mapped out for the region:



I would describe the segment of focus, Cluster 2, as more of the 'Restless "On-the-Go" Young Professionals' group. This segment encompasses 19 neighborhoods netting a relatively high diversity index, averaging 68.5 across the area with 78.3 within the top quartile (0 = not very diverse and 100 = extremely diverse). This is roughly 7% higher than the US average and 36% higher than Manhattan's Cluster 2 (proxied by Laptop and Latte segment's diversity index). Income is higher than the poorest neighborhoods within Maricopa. Not the richest group, but folks in this area of Phoenix appear to be earlier in their careers. Average household size is smaller than the rest of the neighborhood clusters in the study making this group more likely to be single households or not yet with children. Percent of home ownership is the lowest in comparison to other neighborhood segments.

	bus_estab	avg_hh_income	avg_hh_sz	diversity_index	median_age	rent_pct	own_pct
count	19.000000	19.000000	19.000000	19.000000	19.000000	19.000000	19.000000
mean	866.368421	69938.210526	2.354211	68.478947	36.169298	0.443601	0.429926
std	635.379870	13396.448392	0.493275	13.747417	5.460188	0.127965	0.143049
min	85.000000	30589.000000	1.485000	31.500000	25.850000	0.233323	0.137202
25%	496.000000	65796.000000	2.095000	64.400000	31.950000	0.368535	0.337485
50%	726.000000	71692.000000	2.260000	72.400000	36.100000	0.433853	0.478373
75%	1120.500000	76474.000000	2.622500	78.250000	38.650000	0.539140	0.534642
max	2453.000000	89785.000000	3.360000	83.550000	48.100000	0.677895	0.641486

Mexican food made it to the top, but that may be due to the abundance of them in Phoenix due to the vicinity to the borders as was pointed out earlier. Easy access makes for easy check-ins. We also see check-ins more often at gas stations, quick eateries and restaurants. Although not the same exact characteristics of the Laptops and Lattes group of Manhattan's

Cluster 2, the neighborhoods within this cluster would be closest to compare and contrast for opportunities to provide additional services targeting these mobile young professionals.

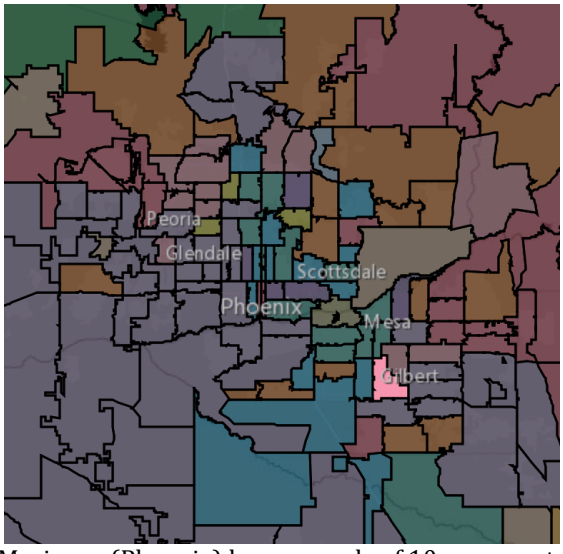
Venue Category	Cluster2 Avg
Mexican Restaurant	0.073636
Pizza Place	0.056364
Sandwich Place	0.051818
Convenience Store	0.046364
Coffee Shop	0.037273
Fast Food Restaurant	0.035455
Burger Joint	0.026364
Pharmacy	0.026364
Chinese Restaurant	0.022727
Grocery Store	0.021818
American Restaurant	0.021818
Gas Station	0.021818
Discount Store	0.017273
Breakfast Spot	0.015455
Bar	0.014545
Italian Restaurant	0.014545
Seafood Restaurant	0.012727
Ice Cream Shop	0.011818
Hotel	0.011818
Thai Restaurant	0.010909

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
Avondale	Mexican Restaurant	Gym	Fast Food Restaurant	Coffee Shop	Pizza Place	Burger Joint	Asian Restaurant	American Restaurant	Japanese Restaurant	Convenience Store
Barrel District	Pizza Place	Mexican Restaurant	Sandwich Place	Coffee Shop	Grocery Store	Burger Joint	Gym	Vietnamese Restaurant	Italian Restaurant	Fast Food Restaurant
Biltmore	American Restaurant	Burger Joint	Pizza Place	Mexican Restaurant	Italian Restaurant	New American Restaurant	Coffee Shop	Grocery Store	Spa	Sushi Restaurant
Brentwood-Cavalier	Coffee Shop	Mexican Restaurant	Sandwich Place	Grocery Store	Ice Cream Shop	Liquor Store	Pizza Place	Donut Shop	American Restaurant	Bar
Camelback East	Mexican Restaurant	Coffee Shop	Pizza Place	Bar	Art Gallery	Pub	American Restaurant	Café	Hotel	Taco Place
Central City	Coffee Shop	Pizza Place	Mexican Restaurant	Bar	American Restaurant	Art Gallery	Pub	Theater	Music Venue	Hotel
Cheery Lynn Historic District	American Restaurant	Pizza Place	Mexican Restaurant	Ice Cream Shop	Sandwich Place	Coffee Shop	Sushi Restaurant	Burger Joint	Spa	Bookstore
Cooper Square	Coffee Shop	Bar	Pizza Place	American Restaurant	Art Gallery	Theater	Pub	Hotel	Cocktail Bar	Music Venue
El Mirage	Fast Food Restaurant	Mexican Restaurant	Pharmacy	American Restaurant	Coffee Shop	Grocery Store	Convenience Store	Diner	Ice Cream Shop	Pizza Place
Glendale	Clothing Store	Pizza Place	Hotel	Convenience Store	American Restaurant	Fast Food Restaurant	Pharmacy	Sandwich Place	Coffee Shop	Lingerie Store

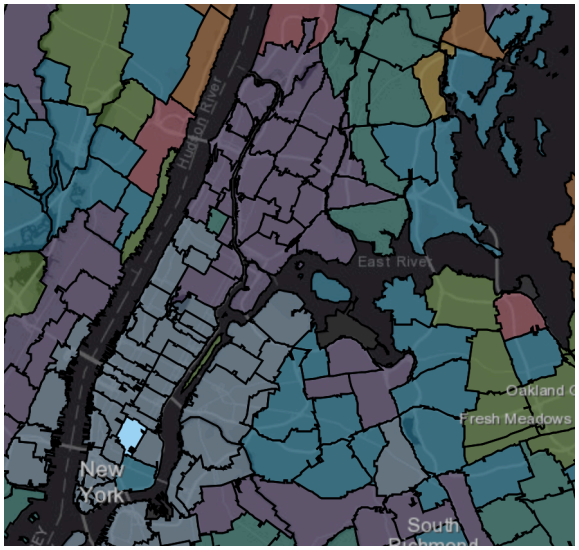
5. RESULTS AND DISCUSSION

As mentioned earlier, there were many unexpected challenges to completing this study in a more thorough manner. Phoenix is a large city with a growing population across a huge land mass. Many neighborhoods are very widespread with their own distinct flavors, which is why the clustering exercise during this study has shown difficulties in merging groups for segmentation. The urban core or downtown Phoenix is not as densely populated as they are within NYC. In fact, some surrounding neighborhoods have higher population density per capita than downtown.

Unlike Manhattan, where the culture has been pretty well established as an urban center, patterns were not as easy to pick up for the Phoenix area either, even within the select county of Maricopa. Referring back to the Tapestry Segmetation schematics, you can see the visual differences here by the amount of different segment shadings across the two regions:



Maricopa (Phoenix) has upwards of 10+ segments



Manhattan (NYC) has basically two main segments

One other thing to consider is that the individuals here in Phoenix may not be as avid Foursquare users to check-in everywhere they go either. Given the amount of traveling by car versus public transportation like the metro in NYC, individuals are less likely to always be glued to their phones to be mindful of using the Foursquare app if at all. Therefore, inherent biases and flaws already exist with the venue visitation data and could partially contribute to difficulties of breaking up the neighborhood groups.

The variety of neighborhoods in Maricopa and the complexity of the make up did require a lot more data and processing time to drill in and test different approaches for a more informed study. During this quick study, additional ZIP code statistics were manually compiled to supplemental the intelligence for learning.

Cluster 2, the'Restless "On-the-Go" Young Professionals', within Maricopa showed some promising indications for providing services that would cater to younger, career-focused professionals with a busy lifestyle. In comparison to Manhattan's Cluster 2 ("Laptops and Lattes" group), there were 73% less check-ins at Italian restaurants and gyms were no where at the top. Perhaps this could be an opportunity to invest in opening up quality Italian venues within these neighborhoods. Other services around health and fitness or maybe even for special quality dry cleaning services would support an active, on-the-go lifestyle for these up and coming career oriented folks and could be an areas of opportunity as well. Of course, more input data would be needed to understand if there is a need for more quality Italian cuisine, gyms, spas, or dry cleaning within any of the neighborhoods that fell within this cluster.

In future work, additional overlay for daytime demographics as well as residential demographics will help decipher work related commuting activities as well as industry business statistics to understand types of business established and where within proximity to targeted locations for opening new businesses would take this evaluation much further. Information that can programmatically be retrieved from paid platforms would be much more fruitful in conducting this type of work as well. Additional plotting of density features using heatmaps or choropleth maps with segments superimposed could add more visual context as well. If only I had more time and bandwidth for processing left. Not being limited in processing space on a platform could take this analysis to the next level. There is definitely a lot more

intelligence to unearth for Phoenix with so much more opportunity for growth in both business and investments opportunities if key nuggets of information can be gained for analytics.

6. CONCLUSION

The Phoenix metropolitan region is definitely unique and marches to the beat of it's own drums. It is a new type of city with a different vibe and behavior patterns. Thus it should be appreciated for what it is becoming instead of forcing it to replicate another New York, LA, or even Chicago. Although we can borrow ideas from other cities, whether it is successful or not remains to be seen. With dispersed areas of city living, this adds a different kind of urban flavor that takes a typical city adventure beyond a congested concrete jungle. There's obviously plenty of room for growth, development, and a ton of indoor/outdoor adventures to be had.

7. REFERENCES

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