

Restaurant location recommendation

Sudhir Bangaru

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Problem Statement: A year ago, a friend of mine had moved to Blacksburg, Virginia, USA. She has observed that there are many Indians and Asians settled around Virginia Tech University. However, there are not many Indian restaurants around. Herself being a good cook, she senses there is a good business opportunity to open a restaurant with Indian cuisine. She had recently requested me to study the feasibility of the idea and suggest a location. I have considered taking this as my problem statement for the capstone project.

Introduction

Blacksburg is a city located in Virginia, as shown in figure 1. Based on the United States city population data, the population in 2020 is estimated to be around 44392. Located in the New River Valley of Southwest Virginia the, US office of Management and Budget defines Blacksburg-Christiansburg as the Metropolitan Statistical Area, as shown in figure 2. The MSA is dominated by the presence of Virginia Tech and Radford University. Blacksburg is the home of Virginia Tech University while Radford University is in Radford. Christiansburg is a town between Blacksburg and Radford and is home to many restaurants and stores.



Figure 1: Blacksburg, Virginia, USA (from Wikipedia)



Figure 2: Blacksburg MSA

Data

Part I: Firstly, the feasibility of opening a restaurant will be investigated.

Population and census data have been collected from 'worldpopulationreview.com' and 'census.data.gov'. Figure 3 shows the MSA population data in the last ten years. It can be observed that the population has been steadily increasing and a sudden spurt in population growth is seen in recent years from 2017.

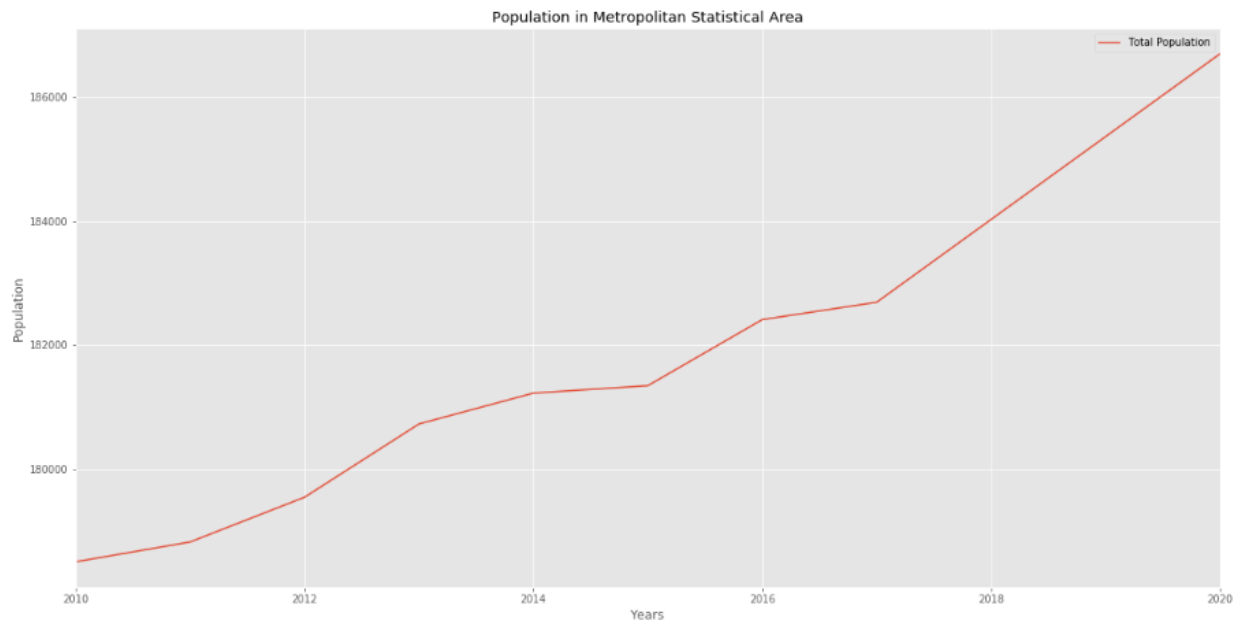


Figure 3: MSA population in the last 10 years

Figure 4 shows the percentage of population by race. From the figure, it can be observed that Asians form the second-highest group followed by African-Americans.

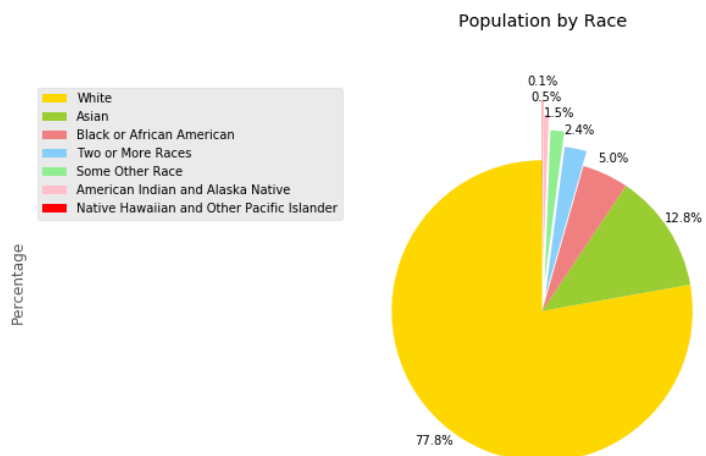


Figure 4: Population by race

From figure 5 the origin of non-native Americans is observed to be largely from Asia followed by Europe. Non-citizens from Asia are seen to dominate the group.

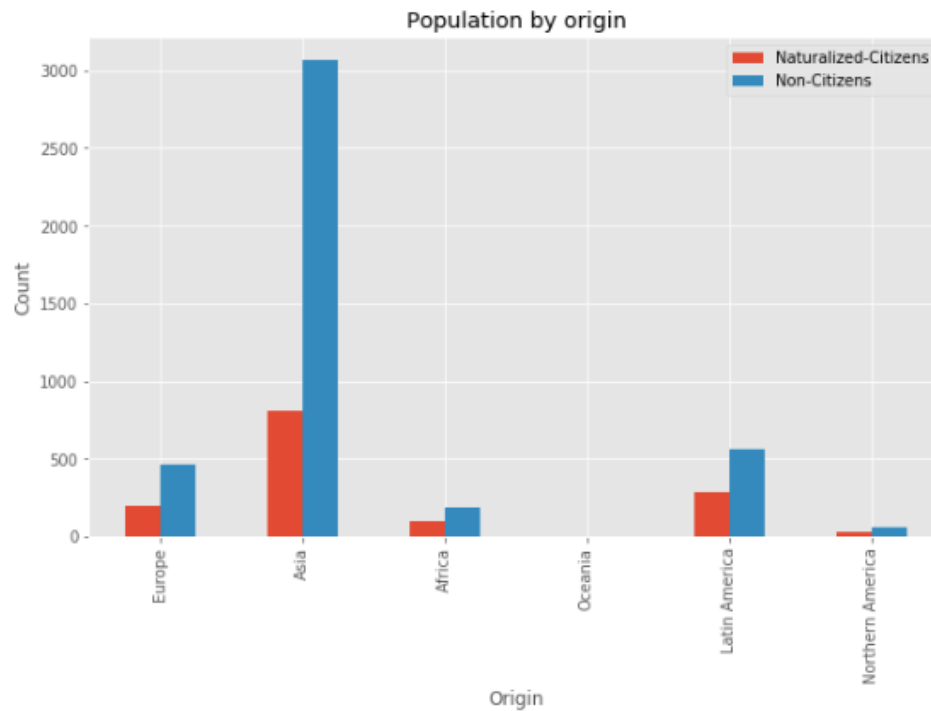


Figure 5: Population by origin

Figure 6 shows that the population is greatly dominated by the age group of 15 to 25. Except in the age group of 20, males and females are nearly equal in number for all other age groups.

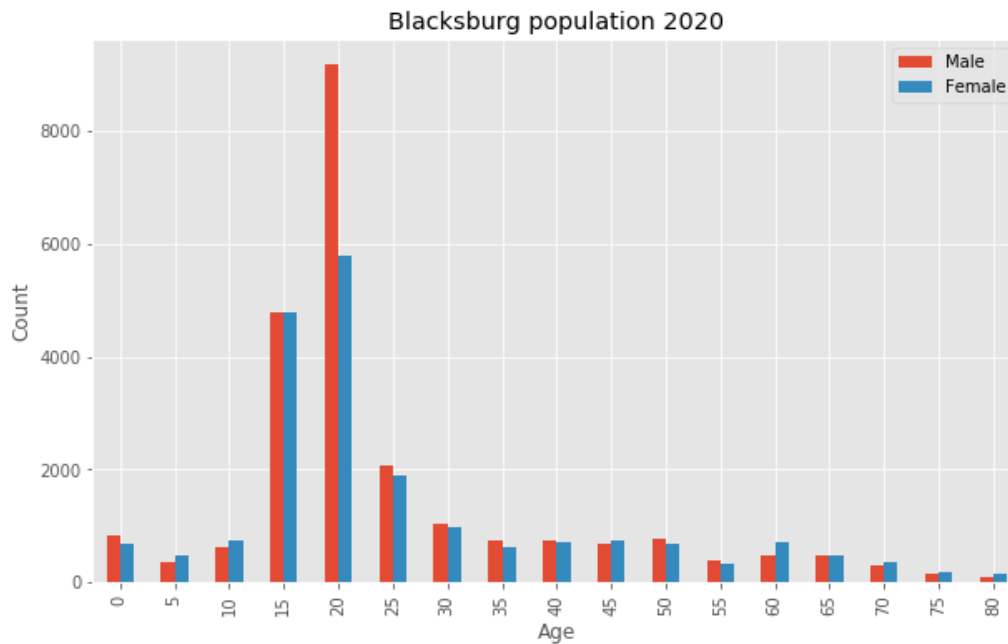


Figure 6: Population by age

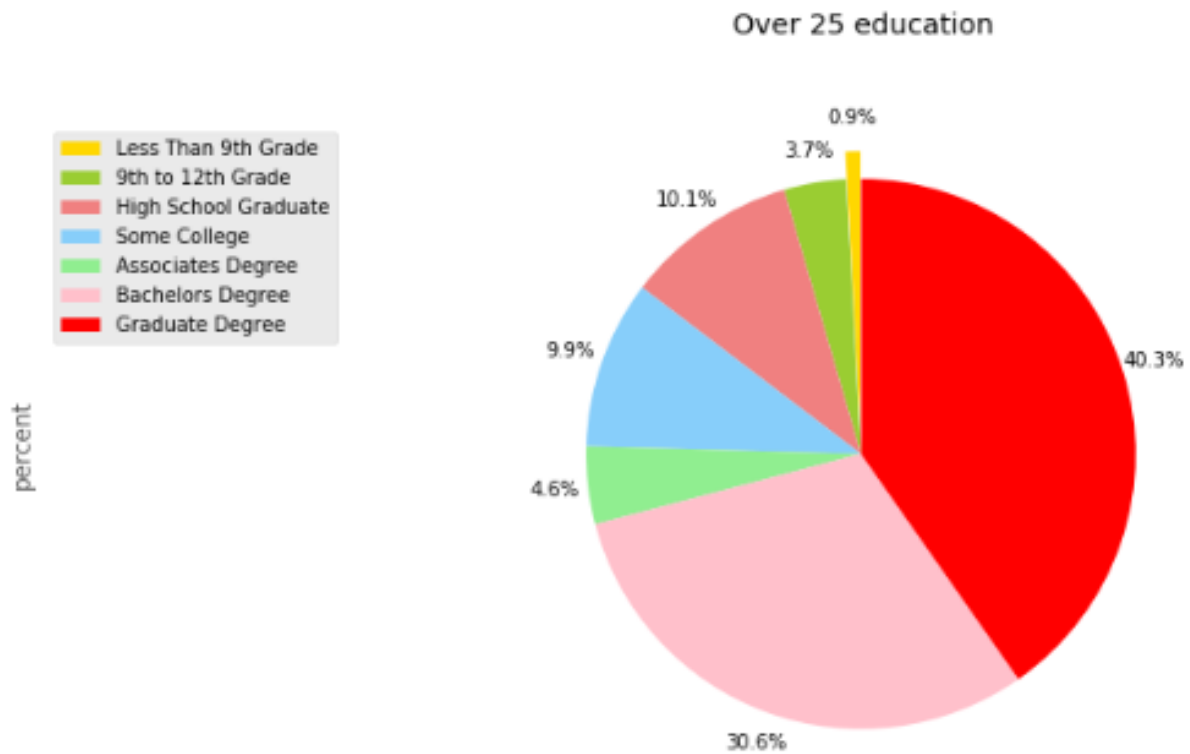


Figure 7: Education over 25 years of age

From figures 7 and 8, it can be seen observed that most of the population is college going pursuing either Bachelors or a Graduate degree.

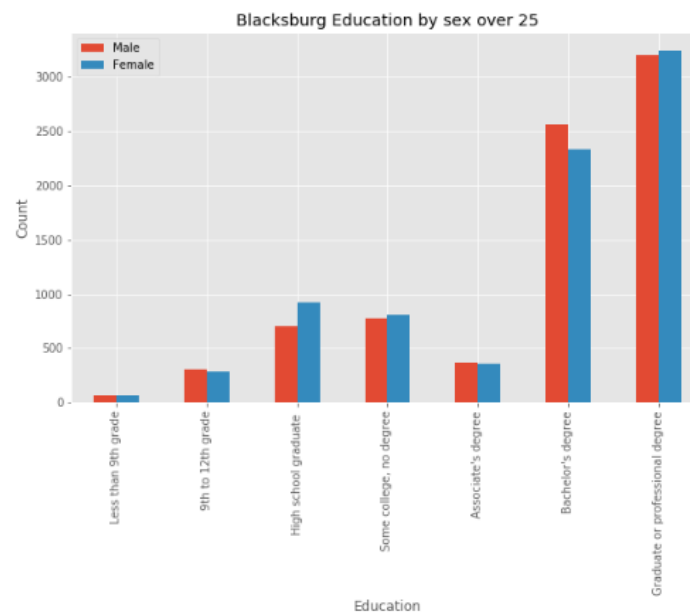


Figure 8: Education by Gender

Figure 9 shows the highest level of education by race. Ignoring Whites, Asians are the largest among the group.

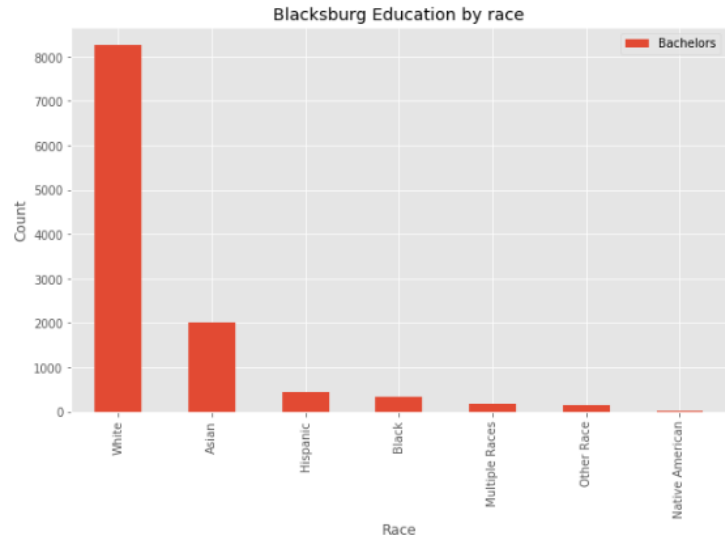


Figure 9: Education by race

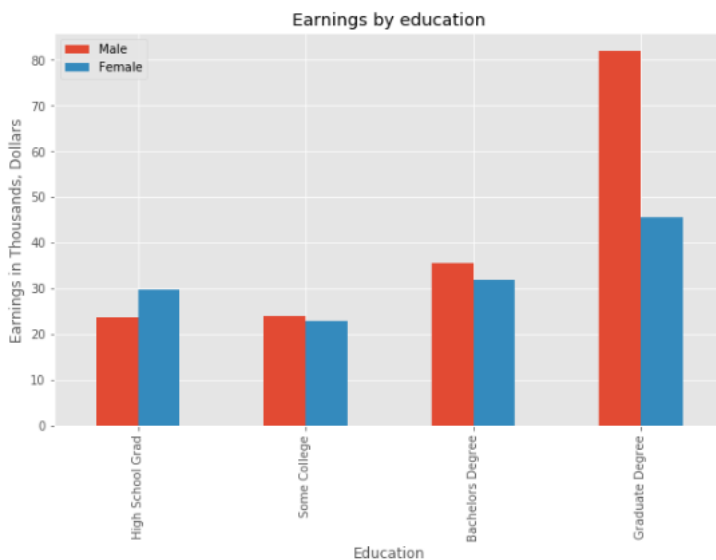


Figure 10: Earnings by education

From figure 10 it can be observed that people holding Bachelors and higher degrees earn higher than others.

Blacksburg being the home for Virginia Tech University attracts students from all around the world. From the above data, it can be inferred that Asians form the largest group of migrants to the USA to pursue Bachelors' or Graduate degrees. It is further observed that many of the naturalized citizens are from Asia. Owing to their higher education they are also seen to be earning more than others with only school or small college degrees. Also, the population consists of mostly students between 15 to 30 years of age. Students usually wouldn't have time to cook or would not know to cook all the dishes. Therefore, it is safe to assume that an Indian restaurant with good pricing would be an attractive choice among them. Indian cuisine is very close to Pakistani and Bangladeshi. Keeping the above observations in view, the choice of restaurant location is presented further.

Part II: In the second part, data collected from various neighborhoods in and near Blacksburg is presented. This data is used to suggest a suitable location for the restaurant.

A search for Asian restaurants using the Foursquare API function returned 24 places as shown in the map.

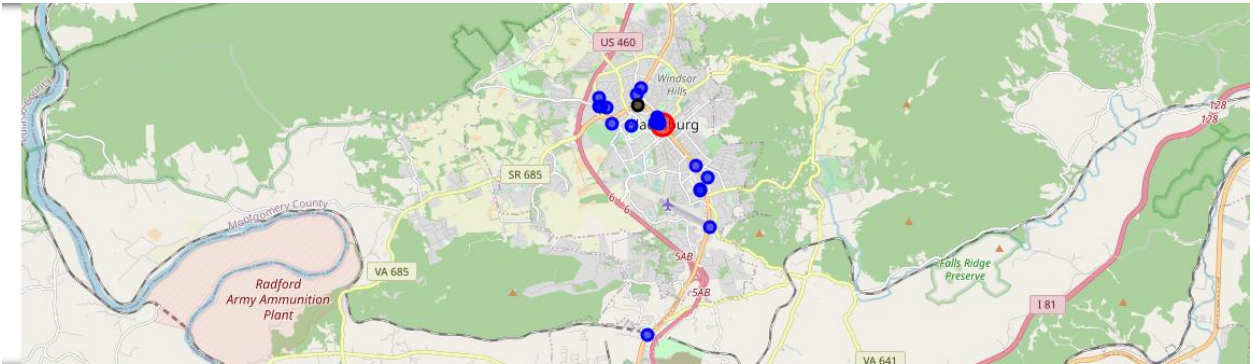


Figure 11:Restaurant locations in Blacksburg

After data cleaning, figure 12 shows the list of restaurants returned by Foursquare. From the table, the list of restaurants included cuisines from all around the world including Asia.

	name	categories
0	Blacksburg No. 1 Restaurant	Noodle House
1	Gillie's	Vegetarian / Vegan Restaurant
2	Asian Grill Buffet	Chinese Restaurant
3	Hokie Hair	Salon / Barbershop
4	Bojangles' Famous Chicken 'n Biscuits	Fast Food Restaurant
5	Poor Billy's	Seafood Restaurant
6	Abby's Restaurant & Bar	American Restaurant
7	The Palisades Restaurant	None
8	Boudreaux's	Cajun / Creole Restaurant
9	The Gobbler Italian Restaurant	Food
10	Preston's Restaurant	Restaurant
11	El Mariachi Mexican Restaurant	Mexican Restaurant
12	Napoli's Italian Restaurant	Italian Restaurant
13	Avellinos Restaurant	Italian Restaurant
14	Hunan King	Chinese Restaurant
15	Zeppoli's Restaurant & Wine Shop	Italian Restaurant
16	India Garden	Indian Restaurant
17	Japanese Restaurant Kayo	Japanese Restaurant
18	Sake House	Sushi Restaurant
19	Hokie House	Bar
20	The Cellar	Bar
21	Macado's Restaurant & Bar	Sandwich Place

Figure 12: List of Restaurants in Blacksburg.

Figure 14 shows the number of restaurants with different cuisines. There are 3 Italian restaurants, 2 Chinese restaurants, and one each of different cuisine or type. There is also one Indian restaurant named 'India Garden' on Prices Fork Road in Blacksburg. The restaurant is indicated with a black circle on the map in figure 15.

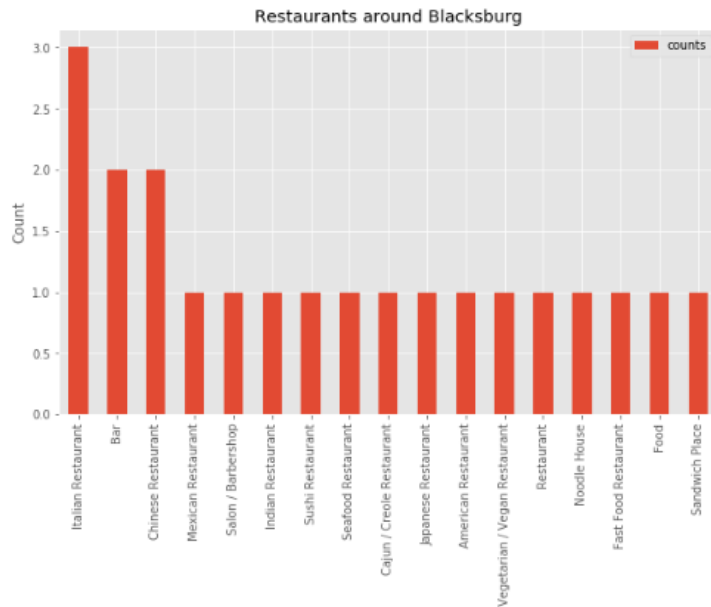


Figure 14: Restaurants in Blacksburg

	name	categories	address	cc	city
0	India Garden	Indian Restaurant	210 Prices Fork Rd	US	Blacksburg
1	One Stop Convenience Store	Convenience Store	Prices Fork Road	US	Blacksburg
2	Benny Marzano's	Pizza Place	210 Prices Fork Rd	US	Blacksburg
3	Spicity	Chinese Restaurant	210 Prices Fork Rd	US	Blacksburg
4	Best Wishes Flowers & Gifts	Flower Shop	880 University City Blvd Ste C	US	Blacksburg

Figure 13: Indian restaurant in Blacksburg

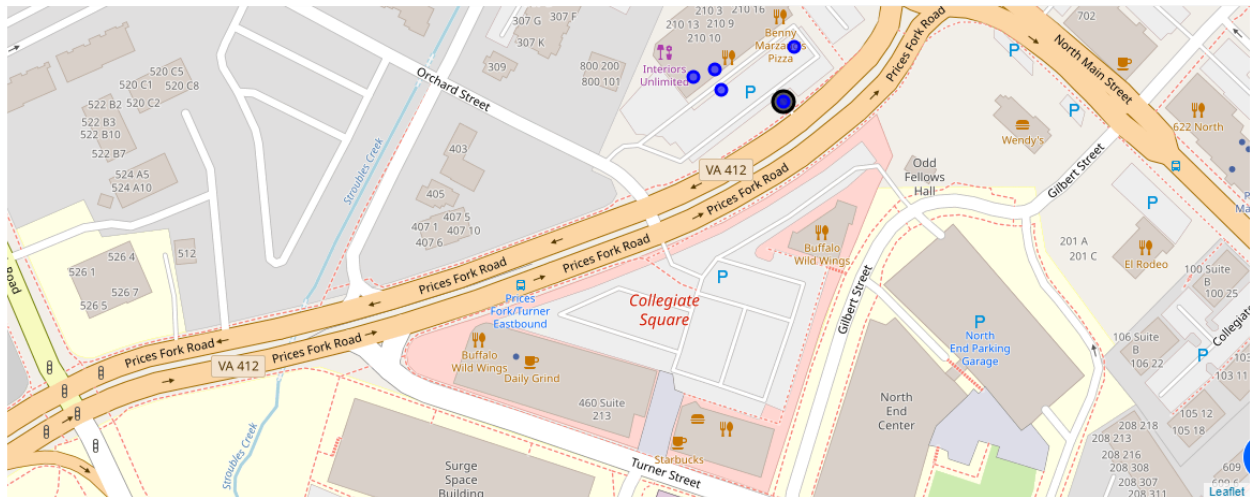


Figure 15: India Garden, marked in black

Since the Blacksburg area has only one Indian restaurant the nearby neighborhoods in the town were also investigated. Using a search radius of 100 miles, a list of famous neighborhoods around Blacksburg was prepared. The neighborhoods are indicated by circles in the map in figure 17. The list of neighborhoods is shown in figure 16.

	Neighborhood	Latitude	Longitude
0	Blacksburg	37.2296	-80.4139
1	Christensburg	37.1299	-80.4089
2	Prices Fork	37.2097	-80.4903
3	Radford	37.1318	-80.5764
4	Roanoke	37.2710	-79.9414
5	Wytheville	36.9485	-81.0848
6	Lynchburg	37.4138	-79.1422
7	Pulaski	37.0479	-80.7798
8	Salem	37.2935	-80.0548

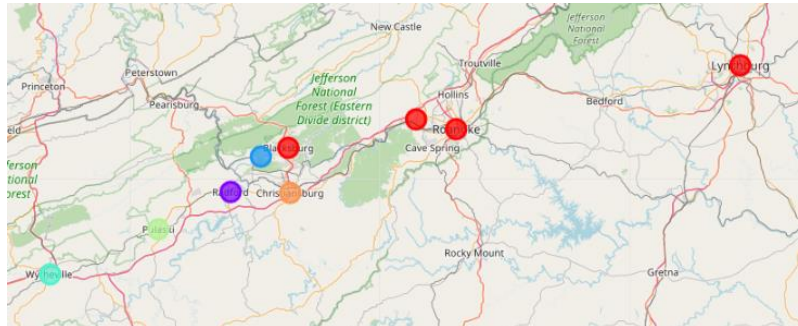


Figure 17: Various Neighborhoods near Blacksburg

Figure 16:Neighborhoods near Blacksburg

All the neighborhoods were explored using the Foursquare API and a list of 205 venues was collected. Area wise count of venues is shown in the table below. Roanoke has most venues followed by Blacksburg.

Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
Blacksburg	53	53	53	53	53	53
Christensburg	14	14	14	14	14	14
Lynchburg	29	29	29	29	29	29
Prices Fork	2	2	2	2	2	2
Pulaski	6	6	6	6	6	6
Radford	6	6	6	6	6	6
Roanoke	67	67	67	67	67	67
Salem	19	19	19	19	19	19
Wytheville	9	9	9	9	9	9

Figure 18: Count of venues in each Neighborhood

The top ten most common venues in each neighborhood are shown in figure 19.

Neighborhood	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
0 Blacksburg	Pizza Place	Bar	Mexican Restaurant	Café	Chinese Restaurant	Pub	Coffee Shop	Gourmet Shop	Men's Store	Market
1 Christensburg	American Restaurant	Fast Food Restaurant	Pizza Place	Dance Studio	Bakery	Bank	Optical Shop	Chinese Restaurant	Liquor Store	Sandwich Place
2 Lynchburg	American Restaurant	Pizza Place	Diner	Hotel	Trail	Bar	New American Restaurant	Liquor Store	Photography Studio	Dessert Shop
3 Prices Fork	Flea Market	Brewery	Wings Joint	Cosmetics Shop	Dance Studio	Deli / Bodega	Dessert Shop	Diner	Discount Store	Farmers Market
4 Pulaski	American Restaurant	Italian Restaurant	Discount Store	Food	Bike Rental / Bike Share	Boutique	Greek Restaurant	Gym	Deli / Bodega	Dessert Shop
5 Radford	History Museum	Spa	Italian Restaurant	Music Venue	Fast Food Restaurant	Pizza Place	Cosmetics Shop	Cupcake Shop	Dance Studio	Deli / Bodega
6 Roanoke	American Restaurant	Sandwich Place	Restaurant	Bar	Bus Station	Café	Coffee Shop	Diner	Farmers Market	Lounge
7 Salem	American Restaurant	Ice Cream Shop	Pizza Place	Sandwich Place	Antique Shop	Brewery	Coffee Shop	Cosmetics Shop	Deli / Bodega	Farmers Market
8 Wytheville	Hotel	Post Office	Grocery Store	History Museum	Hot Dog Joint	Italian Restaurant	Liquor Store	Park	American Restaurant	Taco Place

Figure 19: Top 10 Venues in each neighborhood

Methodology

The neighborhoods are converted to clusters using the k-means algorithm. The Elbow method is used to estimate the optimum number of clusters into which the data is clustered. There are two methods to estimate the optimum number of clusters using the Elbow method.

- Distortion:** It is calculated as the average of the squared distances from the cluster centers of the respective clusters. Figure 20 shows the result of the distortion method. No conclusion can be arrived at using this method.
- Inertia:** It is the sum of squared distances of samples to their closest cluster center. Figure 21 shows the result of the inertia method. The smallest variation in inertia occurs for k values greater than 6. Therefore, the clustering is done using six clusters.

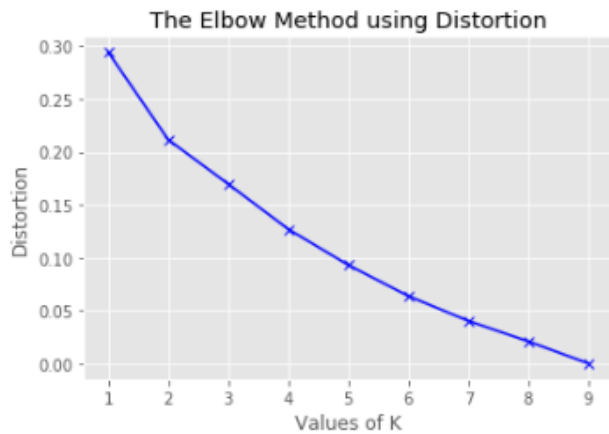


Figure 20: Distortion method

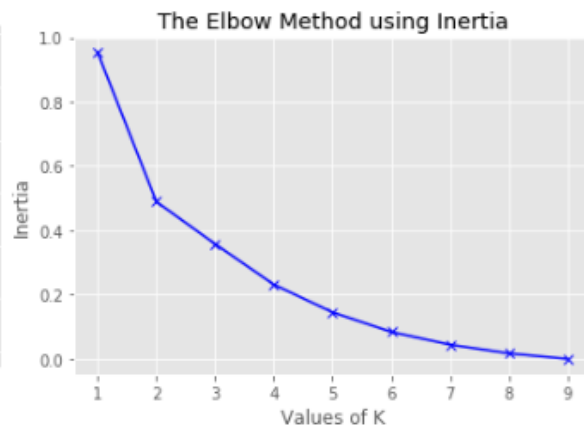


Figure 21: Inertia method

Results and Discussion

Figure 22 shows the clustered data based using the k-means method.

	Neighborhood	Latitude	Longitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
0	Blacksburg	37.2296	-80.4139	0	Pizza Place	Bar	Mexican Restaurant	Café	Chinese Restaurant	Pub	Coffee Shop	Gourmet Shop	Men's Store	Market
1	Christensburg	37.1299	-80.4089	5	American Restaurant	Fast Food Restaurant	Pizza Place	Dance Studio	Bakery	Bank	Optical Shop	Chinese Restaurant	Liquor Store	Sandwich Place
2	Prices Fork	37.2097	-80.4903	2	Flea Market	Brewery	Wings Joint	Cosmetics Shop	Dance Studio	Deli / Bodega	Dessert Shop	Diner	Discount Store	Farmers Market
3	Radford	37.1318	-80.5764	1	History Museum	Spa	Italian Restaurant	Music Venue	Fast Food Restaurant	Pizza Place	Cosmetics Shop	Cupcake Shop	Dance Studio	Deli / Bodega
4	Roanoke	37.2710	-79.9414	0	American Restaurant	Sandwich Place	Restaurant	Bar	Bus Station	Café	Coffee Shop	Diner	Farmers Market	Lounge
5	Wytheville	36.9485	-81.0848	3	Hotel	Post Office	Grocery Store	History Museum	Hot Dog Joint	Italian Restaurant	Liquor Store	Park	American Restaurant	Taco Place
6	Lynchburg	37.4138	-79.1422	0	American Restaurant	Pizza Place	Diner	Hotel	Trail	Bar	New American Restaurant	Liquor Store	Photography Studio	Dessert Shop
7	Pulaski	37.0479	-80.7798	4	American Restaurant	Italian Restaurant	Discount Store	Food	Bike Rental / Bike Share	Boutique	Greek Restaurant	Gym	Deli / Bodega	Dessert Shop
8	Salem	37.2935	-80.0548	0	American Restaurant	Ice Cream Shop	Pizza Place	Sandwich Place	Antique Shop	Brewery	Coffee Shop	Cosmetics Shop	Deli / Bodega	Farmers Market

Figure 22: Clustered data

The places in clusters are as follows. Blacksburg, Roanoke, Lynchburg, and Salem are in cluster 0. Radford is in cluster 1. Prices Fork is in cluster 2. Wytheville is in cluster 3. Pulaski is in cluster 4. Lastly, Christiansburg is in cluster 5. The clusters are shown on the map in figure 23.

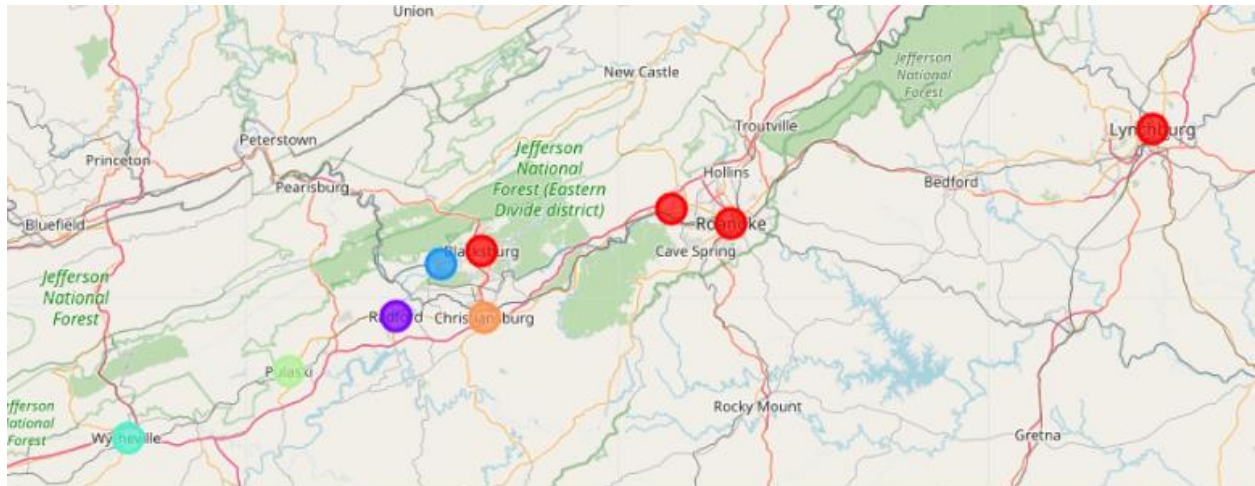


Figure 23: Clustered data

Figure 24 shows cluster 0 and mostly consists of diners and coffee shops.

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
Bar	Mexican Restaurant	Café	Chinese Restaurant	Pub	Coffee Shop	Gourmet Shop	Men's Store	Market
Sandwich Place	Restaurant	Bar	Bus Station	Café	Coffee Shop	Diner	Farmers Market	Lounge
Pizza Place	Diner	Hotel	Trail	Bar	New American Restaurant	Liquor Store	Photography Studio	Dessert Shop
Ice Cream Shop	Pizza Place	Sandwich Place	Antique Shop	Brewery	Coffee Shop	Cosmetics Shop	Deli / Bodega	Farmers Market

Figure 24: Cluster 0, Blacksburg, Salem, Roanoke, and Lynchburg

Figure 25 shows cluster 1 and has a few eateries.

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
Spa	Italian Restaurant	Music Venue	Fast Food Restaurant	Pizza Place	Cosmetics Shop	Cupcake Shop	Dance Studio	Deli / Bodega

Figure 25: Cluster 1, Radford

Figure 26 shows cluster 2 and mostly consists of shops and restaurants.

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
Brewery	Wings Joint	Cosmetics Shop	Dance Studio	Deli / Bodega	Dessert Shop	Diner	Discount Store	Farmers Market

Figure 26: Cluster 2, Prices Fork

Figure 27 shows cluster 3 and has a history museum as an attraction.

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
Post Office	Grocery Store	History Museum	Hot Dog Joint	Italian Restaurant	Liquor Store	Park	American Restaurant	Taco Place

Figure 27: Cluster 3, Wytheville

Figure 28 shows cluster 4 and mostly consists of stores in addition to a gym.

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
Italian Restaurant	Discount Store	Food	Bike Rental / Bike Share	Boutique	Greek Restaurant	Gym	Deli / Bodega	Dessert Shop

Figure 28: Cluster 4, Pulaski

Figure 29 shows cluster 5, it has a bank, Dance Studio, and a few eateries.

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
Fast Food Restaurant	Pizza Place	Dance Studio	Bakery	Bank	Optical Shop	Chinese Restaurant	Liquor Store	Sandwich Place

Figure 29: Cluster 5, Christiansburg

In further analysis, the venue categories were filtered for ‘Indian restaurant’. Three Indian restaurants were found. In and around Blacksburg, there are four restaurants in total. One is ‘India Garden’ in Prices Fork. Two others are listed in the table below.

	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
82	Roanoke	37.2710	-79.9414	Nawab Indian Cuisine	37.271769	-79.938329	Indian Restaurant
160	Lynchburg	37.4138	-79.1422	Hot & Cold Cafe	37.415088	-79.142880	Indian Restaurant

Figure 30: Indian Restaurants around Blacksburg

Figure 31 shows the list of Indian restaurants in Roanoke

	name	categories	address	cc	city	country	d
0	Nawab Indian Cuisine	Indian Restaurant	118 Campbell Ave SE Ste A	US	Roanoke	United States	
1	Swagat Indian Cuisine	Food	303 1st St SW	US	Roanoke	United States	

Figure 31: Indian restaurants in Roanoke

Figure 32 shows the list of restaurants in Lynchburg.

	name	categories	address	cc	city	country	di
0	Hot & Cold Cafe	Indian Restaurant	205 9th St	US	Lynchburg	United States	
1	CML Hot Tubs	None	1301 Main St	US	Lynchburg	United States	
2	The Craddock Terry Hotel	Hotel	1312 Commerce St	US	Lynchburg	United States	

Figure 32: Restaurants in Lynchburg

The rating for each Indian restaurant is collected from Foursquare and is listed in the table below.

Restaurant name	Location	Rating
India Garden	Prices Fork Road	7
Nawab Indian cuisine	Roanoke	8.5
Swagat Indian cuisine	Roanoke	Not available
Hot & Cold Cafe	Lynchburg	6.7

Table 1: Indian Restaurant ratings

The locations of the four Indian restaurants are shown on the map.



Figure 33: Indian restaurant locations

To further understand the ease of accessibility the distance from Blacksburg was estimated using Google Maps and is tabulated in table 2.

Neighborhood	Distance from Blacksburg, in miles
Blacksburg	0
Christiansburg	7.7
Prices Fork	2.5
Radford	14.3
Roanoke	42
Wytheville	48
Lynchburg	94.7
Pulaski	27
Salem	31

Table 2: Distance from Blacksburg

Tables 1 and 2 are combined to understand the data better. From the data, we can observe that the closest Indian restaurant is 2.5 miles and has a rating of 7. And the best rated Indian restaurant is 42 miles away.

Restaurant name	Location	Rating	Distance from Blacksburg in miles
India Garden	Prices Fork Road	7	2.5
Nawab Indian cuisine	Roanoke	8.5	42
Swagat Indian cuisine	Roanoke	Not available	42
Hot & Cold Cafe	Lynchburg	6.7	94.7

Table 3: Indian Restaurants and distance

Conclusion & Recommendation.

Blacksburg is home to many international graduate students especially Asians. Based on year on year data it is safe to conclude that the number of Asians in Blacksburg MSA is increasing steadily. Also, Indian cuisine is very close to the middle east and Asian countries. Based on the age group chart we can conclude that the area mostly consists of students. Due to the busy study calendar, it is not uncommon for students to have at least one meal outside. Thus, it is a good idea to open an Indian restaurant in Blacksburg.

Based on the clustering and data analysis of Indian restaurants, two locations can be recommended. From table 3 we can see that there is no restaurant in Blacksburg, while the closest is 2.5 miles away. On a regular day, students or staff would generally prefer to dine in at the nearest restaurant to save time. Thus, Blacksburg can be one of the locations.

The second location based on k-means clustering is Christiansburg. Christiansburg is a business area with a bank, a few restaurants, and supermarkets. Also, it is interesting to note that there are no supermarkets in Blacksburg other than the Farmers market. Also, Christiansburg is located in between Radford, home to Radford University and Blacksburg, home to Virginia Tech University. Thus, it forms an ideal location accessible by both the university students.