

*Washington, DC and Neighborhood Diversity*

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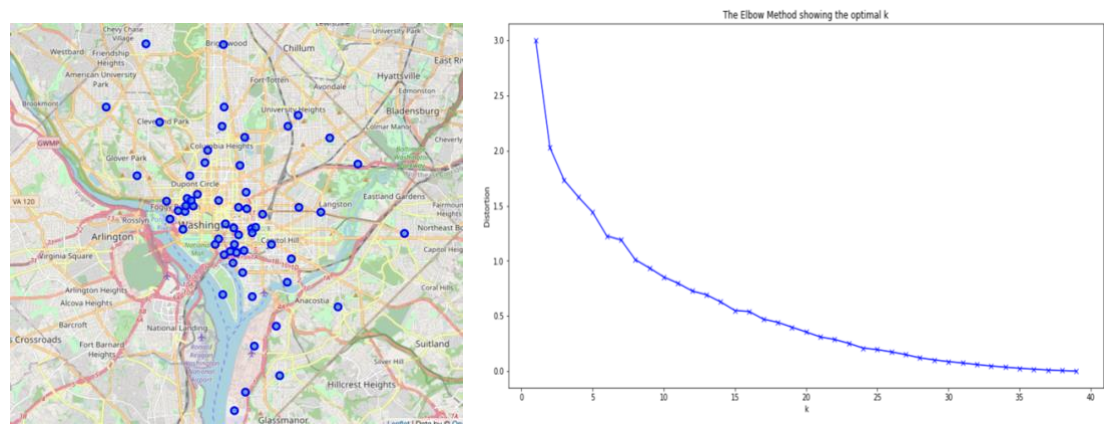
## **Introduction**

Washington, DC is well known for its diverse neighborhoods. Each area of the city provides its own unique contribution to the city's overall cultural and economic diversity. Whether it be a vibrant night life, renown restaurants, or nationally recognized museums, DC neighborhoods offer a wide variety of culture. But how similar are these neighborhoods? An individual or family in the real estate market may want to more accurately assess these similarities and differences as it pertains to cultural diversity. A simple walk through the neighborhood may not be sufficient. Through machine learning methods, a thorough analysis of DC neighborhood's cultural diversity as a factor of most common venues is presented.

## **Data and Methodology**

Foursquare location data will be used to assess the relative characteristics of each neighborhood. For example, the strength of commercial development can be measured through the number of restaurants and bars present in each neighborhood. K-means cluster analysis was used to assess the relative differences between neighborhoods. This type of analysis excels at grouping data into similar clusters. Main zip codes and their coordinates were first collected. While there are technically over 100 zip codes in DC, many are redundant or out of use. A more parsimonious list was collected and utilized covering 61 different zip codes ranging across the entire area of the district. The coordinates of these zip codes were matched to Foursquare location data. More specifically, the coordinates were matched to the first 100 venues within a 500-meter radius. These venues were then grouped into general categories, such as Dive Bar, Pet Store, and Gym. There are 383 unique categories. The top 10 most common venue categories are

then computed for each neighborhood. It is with this grouped data that the machine learning analysis is implemented.



Results

Before the k-means cluster analysis can be implemented, the optimal number of clusters need to be configured. The Elbow Method reveals that after 11, any additional cluster only marginally decreases the distortion in the model. Each neighborhood and their ten most common venues within their respective cluster are listed below.

Cluster 0

	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
17	Southeast Washington	Fried Chicken Joint	Yoga Studio	Food & Drink Shop	Falafel Restaurant	Farmers Market	Fast Food Restaurant	Filipino Restaurant	Fish Market	Flea Market	Food Court

## Cluster 1

	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	Shaw	Intersection	Grocery Store	Gym / Fitness Center	Dive Bar	Dog Run	Coffee Shop	Pet Store	Southern / Soul Food Restaurant	Fried Chicken Joint	Thai Restaurant
1	H Street Corridor	Art Gallery	Pizza Place	Bar	Convenience Store	Liquor Store	Bike Rental / Bike Share	Cocktail Bar	Wine Bar	Taco Place	Asian Restaurant
2	Capitol Hill	Historic Site	Food Truck	American Restaurant	Pizza Place	Café	Monument / Landmark	Sushi Restaurant	Bar	Hotel	Taco Place
5	Georgetown	Italian Restaurant	Hotel	Coffee Shop	Grocery Store	American Restaurant	French Restaurant	Asian Restaurant	Pizza Place	Hotel Bar	Cosmetics Shop
6	Woodley Park, Forest Hills	Italian Restaurant	Thai Restaurant	Mediterranean Restaurant	Mexican Restaurant	Steakhouse	Grocery Store	Liquor Store	Gift Shop	Supplement Shop	Deli / Bodega
7	Adams Morgan	Latin American Restaurant	Vietnamese Restaurant	Park	Pizza Place	Ethiopian Restaurant	Bar	Bakery	Diner	Taco Place	Cocktail Bar
8	Park View, Mount Pleasant	Bar	Bakery	Café	Pizza Place	Asian Restaurant	Filipino Restaurant	Mexican Restaurant	Shipping Store	Seafood Restaurant	Beer Garden
14	Brookland	Gas Station	Bar	Rental Car Location	Convenience Store	Pharmacy	Ethiopian Restaurant	Spa	Business Service	Gastropub	Grocery Store
15	Langdon	Park	Ice Cream Shop	Martial Arts School	Men's Store	Gas Station	Fried Chicken Joint	Bus Stop	Paper / Office Supplies Store	Chinese Restaurant	Clothing Store
24	Pleasant Plains	Bar	Pizza Place	Sandwich Place	Gym	Gay Bar	New American Restaurant	Hookah Bar	Thai Restaurant	Nightclub	Cocktail Bar
28	Capitol Hill	Historic Site	Food Truck	American Restaurant	Pizza Place	Café	Monument / Landmark	Sushi Restaurant	Bar	Hotel	Taco Place
29	Southwest Washington	Boat or Ferry	Park	Theater	Food Truck	Grocery Store	Yoga Studio	Gastropub	Coffee Shop	Seafood Restaurant	Bike Rental / Bike Share
41	Georgetown	Italian Restaurant	Hotel	Coffee Shop	Grocery Store	American Restaurant	French Restaurant	Asian Restaurant	Pizza Place	Hotel Bar	Cosmetics Shop
42	Kalorama Heights	Italian Restaurant	Massage Studio	Spa	Asian Restaurant	Bar	Bookstore	Cocktail Bar	Grocery Store	Thai Restaurant	Hotel
43	Columbia Heights	Park	Asian Restaurant	Gym / Fitness Center	Yoga Studio	Concert Hall	Spa	New American Restaurant	Bus Stop	Soccer Field	Supermarket
45	Southwest Washington	Boat or Ferry	Park	Theater	Food Truck	Grocery Store	Yoga Studio	Gastropub	Coffee Shop	Seafood Restaurant	Bike Rental / Bike Share
50	Capitol Hill	Historic Site	Food Truck	American Restaurant	Pizza Place	Café	Monument / Landmark	Sushi Restaurant	Bar	Hotel	Taco Place
51	Petworth	Coffee Shop	Grocery Store	Pizza Place	Italian Restaurant	Donut Shop	New American Restaurant	Southern / Soul Food Restaurant	Gas Station	Farmers Market	Mexican Restaurant
60	Carver	Fast Food Restaurant	Liquor Store	Pizza Place	Sandwich Place	Light Rail Station	Park	Pool	Pharmacy	Women's Store	Grocery Store

## Cluster 2

	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
19	Congress Heights	Health & Beauty Service	Gym	Baseball Field	Park	Yoga Studio	Fish Market	Falafel Restaurant	Farmers Market	Fast Food Restaurant	Filipino Restaurant
36	Congress Heights	Health & Beauty Service	Gym	Baseball Field	Park	Yoga Studio	Fish Market	Falafel Restaurant	Farmers Market	Fast Food Restaurant	Filipino Restaurant

## Cluster 3

	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
37	Blue Plains	Intersection	Food Truck	Food Court	Sandwich Place	Hotel	Gym	Post Office	Yoga Studio	Fast Food Restaurant	Exhibit

## Cluster 4

	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
34	Joint Base Anacostia-Bolling	Playground	Park	Donut Shop	Baseball Field	Post Office	Falafel Restaurant	Farmers Market	Fast Food Restaurant	Filipino Restaurant	Fish Market
35	Joint Base Anacostia-Bolling	Playground	Park	Donut Shop	Baseball Field	Post Office	Falafel Restaurant	Farmers Market	Fast Food Restaurant	Filipino Restaurant	Fish Market

## Cluster 5

	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
12	Chevy Chase	Athletics & Sports	Grocery Store	Recreation Center	Farmers Market	Fast Food Restaurant	Flea Market	Eye Doctor	Falafel Restaurant	Filipino Restaurant	Fish Market

## Cluster 6

	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
59	Gateway	Thrift / Vintage Store	Gas Station	Wine Shop	Shipping Store	Liquor Store	Home Service	Yoga Studio	Fast Food Restaurant	Eye Doctor	Falafel Restaurant

## Cluster 7

	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
3	Downtown, Chinatown	Hotel	History Museum	American Restaurant	Coffee Shop	Science Museum	Exhibit	Sandwich Place	Art Museum	Theater	Salad Place
4	Mt Vernon Triangle	Hotel	Coffee Shop	Sandwich Place	Salon / Barbershop	Hotel Bar	Italian Restaurant	Gym / Fitness Center	Latin American Restaurant	Sushi Restaurant	Deli / Bodega
11	East End	Food Truck	Hotel	Sandwich Place	Monument / Landmark	Café	Park	Deli / Bodega	Scenic Lookout	Coffee Shop	Gym / Fitness Center
13	Cathedral Heights	Coffee Shop	Student Center	Bagel Shop	Burger Joint	Park	Tennis Court	Shipping Store	College Cafeteria	Sandwich Place	Bank
18	Southwest Waterfront	Theater	Hotel	Harbor / Marina	Park	Music Venue	Mexican Restaurant	Fish Market	Seafood Restaurant	Coffee Shop	Ice Cream Shop
20	Dupont Circle	Coffee Shop	Sandwich Place	Hotel	Salad Place	American Restaurant	Pizza Place	Yoga Studio	Hotel Bar	Mediterranean Restaurant	Thai Restaurant
21	Foggy Bottom	Hotel	Sandwich Place	Coffee Shop	Pizza Place	American Restaurant	Vegetarian / Vegan Restaurant	Bakery	Café	Performing Arts Venue	Indian Restaurant
22	Foggy Bottom	Hotel	Sandwich Place	Coffee Shop	Pizza Place	American Restaurant	Vegetarian / Vegan Restaurant	Bakery	Café	Performing Arts Venue	Indian Restaurant
23	Mt Vernon Square	American Restaurant	Hotel	Italian Restaurant	Ramen Restaurant	Plaza	New American Restaurant	Mediterranean Restaurant	Coffee Shop	Sandwich Place	Salad Place
25	Dupont Circle	Coffee Shop	Sandwich Place	Hotel	Salad Place	American Restaurant	Pizza Place	Yoga Studio	Hotel Bar	Mediterranean Restaurant	Thai Restaurant
26	University Heights	Pizza Place	Coffee Shop	Spa	Sandwich Place	Art Gallery	Bookstore	Breakfast Spot	Ethiopian Restaurant	Martial Arts School	College Cafeteria
27	L'Enfant Plaza	Food Truck	Sandwich Place	Coffee Shop	Hotel	Burger Joint	Mexican Restaurant	Exhibit	Mediterranean Restaurant	Donut Shop	Fish Market
30	National Mall	Science Museum	History Museum	Exhibit	Art Museum	Food Truck	Sandwich Place	Coffee Shop	Museum	Art Gallery	Café
31	National Mall	Science Museum	History Museum	Exhibit	Art Museum	Food Truck	Sandwich Place	Coffee Shop	Museum	Art Gallery	Café
32	McMillan	Cafeteria	Coffee Shop	Ethiopian Restaurant	Salon / Barbershop	College Basketball Court	Chinese Restaurant	Liquor Store	Pizza Place	Bar	Vegetarian / Vegan Restaurant
33	Southwest Waterfront	Theater	Hotel	Harbor / Marina	Park	Music Venue	Mexican Restaurant	Fish Market	Seafood Restaurant	Coffee Shop	Ice Cream Shop

38	Navy Yard	Sandwich Place	Italian Restaurant	Residential Building (Apartment / Condo)	Brewery	Southern / Soul Food Restaurant	Clothing Store	Coffee Shop	Seafood Restaurant	Salad Place	River
39	East End	Food Truck	Hotel	Sandwich Place	Monument / Landmark	Café	Park	Deli / Bodega	Scenic Lookout	Coffee Shop	Gym / Fitness Center
40	L'Enfant Plaza	Food Truck	Sandwich Place	Coffee Shop	Hotel	Burger Joint	Mexican Restaurant	Exhibit	Mediterranean Restaurant	Donut Shop	Fish Market
44	L'Enfant Plaza	Food Truck	Sandwich Place	Coffee Shop	Hotel	Burger Joint	Mexican Restaurant	Exhibit	Mediterranean Restaurant	Donut Shop	Fish Market
46	Foggy Bottom	Hotel	Sandwich Place	Coffee Shop	Pizza Place	American Restaurant	Vegetarian / Vegan Restaurant	Bakery	Café	Performing Arts Venue	Indian Restaurant
47	Foggy Bottom	Hotel	Sandwich Place	Coffee Shop	Pizza Place	American Restaurant	Vegetarian / Vegan Restaurant	Bakery	Café	Performing Arts Venue	Indian Restaurant
48	East End	Food Truck	Hotel	Sandwich Place	Monument / Landmark	Café	Park	Deli / Bodega	Scenic Lookout	Coffee Shop	Gym / Fitness Center
49	Sursum Corda	American Restaurant	Italian Restaurant	Ramen Restaurant	Bar	Japanese Restaurant	Salad Place	Hotel	Taco Place	Indian Restaurant	Cycle Studio
52	National Mall	Science Museum	History Museum	Exhibit	Art Museum	Food Truck	Sandwich Place	Coffee Shop	Museum	Art Gallery	Café
53	National Mall	Science Museum	History Museum	Exhibit	Art Museum	Food Truck	Sandwich Place	Coffee Shop	Museum	Art Gallery	Café
54	Foggy Bottom	Hotel	Sandwich Place	Coffee Shop	Pizza Place	American Restaurant	Vegetarian / Vegan Restaurant	Bakery	Café	Performing Arts Venue	Indian Restaurant
55	Chinatown	Science Museum	History Museum	Art Museum	Theater	Plaza	American Restaurant	Indian Restaurant	Sculpture Garden	Salad Place	Cocktail Bar
56	Dupont Circle	Coffee Shop	Sandwich Place	Hotel	Salad Place	American Restaurant	Pizza Place	Yoga Studio	Hotel Bar	Mediterranean Restaurant	Thai Restaurant
57	Foggy Bottom	Hotel	Sandwich Place	Coffee Shop	Pizza Place	American Restaurant	Vegetarian / Vegan Restaurant	Bakery	Café	Performing Arts Venue	Indian Restaurant
58	L'Enfant Plaza	Food Truck	Sandwich Place	Coffee Shop	Hotel	Burger Joint	Mexican Restaurant	Exhibit	Mediterranean Restaurant	Donut Shop	Fish Market

## Cluster 8

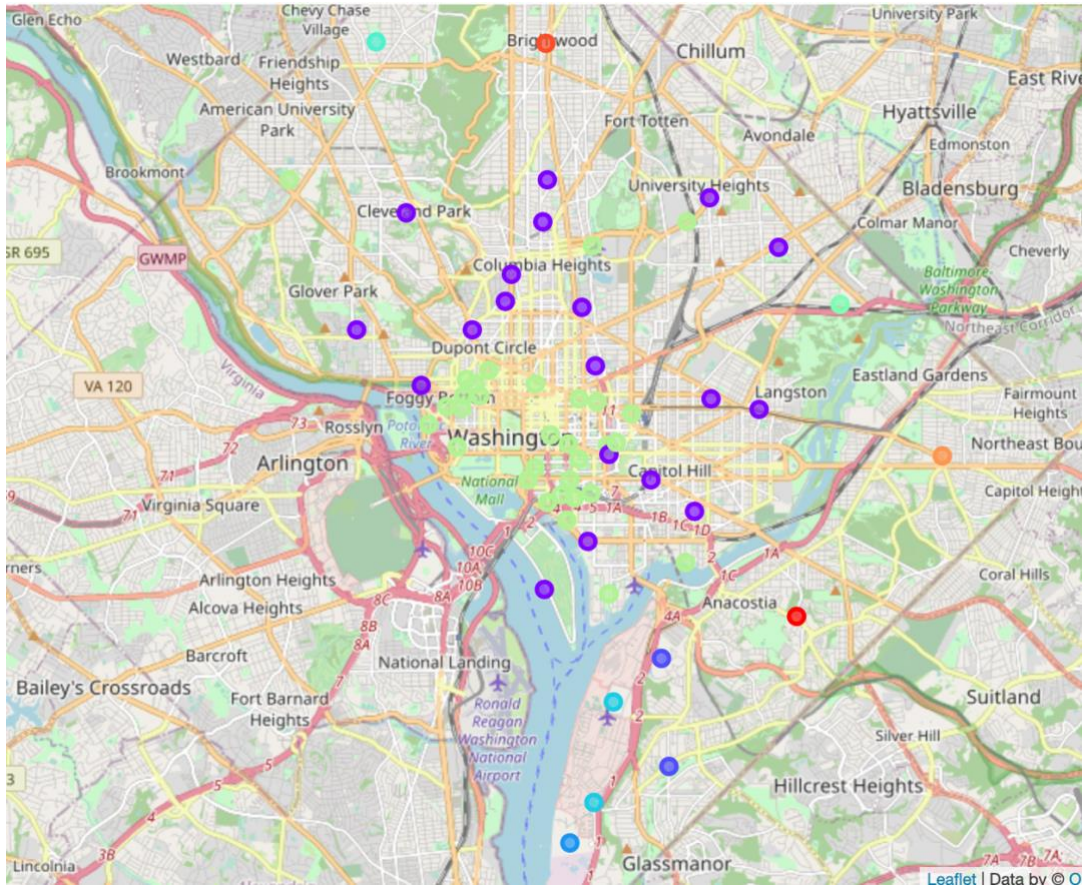
	Neighborhood	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
10	Shepherd Park	Fast Food Restaurant	Donut Shop	Convenience Store	Pizza Place	Liquor Store	Caribbean Restaurant	Bank	Gym	Wings Joint	Bus Station

## Cluster 9

	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
16	Benning Heights	Shop & Service	Gas Station	Parking	Park	Seafood Restaurant	Dry Cleaner	Donut Shop	Sandwich Place	Breakfast Spot	Convenience Store

## Cluster 10

	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
9	Brightwood	Pizza Place	Sandwich Place	Fast Food Restaurant	Big Box Store	Coffee Shop	Bus Stop	Mexican Restaurant	Chinese Restaurant	Mobile Phone Shop	Historic Site



## Discussion

The 11 clusters reveal an interesting pattern throughout the city. Two clusters are of particular note, 7 and 1. Cluster 7 reveals strong similarities between neighborhoods in downtown DC, including in and around the national mall. This seems consistent with naïve intuition. However, Cluster 1 exposes a somewhat counterintuitive result. All neighborhoods surrounding Cluster 7 form just one cluster, Cluster 1. This includes neighborhoods as far west as Georgetown and as far east as Capitol Hill. Further, neighborhoods east of the Anacostia River are expectedly different from the rest of the city west of the river. However, it also suggests that there is a lot of diversity between the neighborhoods east of the Anacostia. More specifically, there are five distinct clusters.



## **Conclusion**

Washington, DC is a large diverse city with many vibrant neighborhoods. Through k-means clustering, we are able to more rigorously quantify the similarities and differences amongst and between these neighborhoods. The results indicate similarities between a wide range of neighborhoods surrounding the downtown DC area. Further, it reveals a diverse collection of neighborhoods east of the Anacostia, an area of the city that is traditionally viewed monolithically. Both findings can aid buyers in the real estate market in making more informed investments. A better understanding of a neighborhood's cultural and economic diversity and its relation to other neighborhoods in the city will make for a more complete assessment of a property's value.