Determining Retail Categories to Open in the Church Hill Neighborhood of Richmond, VA

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Introduction - Background

- **Goal: Determine under-represented retail categories with a high likelihood of success for a growing neighborhood.**
- **For whom: Property managers, entrepreneurs, and existing retail business owners.**
- **Where: Church Hill in Richmond, Virginia, a growing neighborhood.**
- **How: Compare Church Hill retail to similar neighborhoods.**

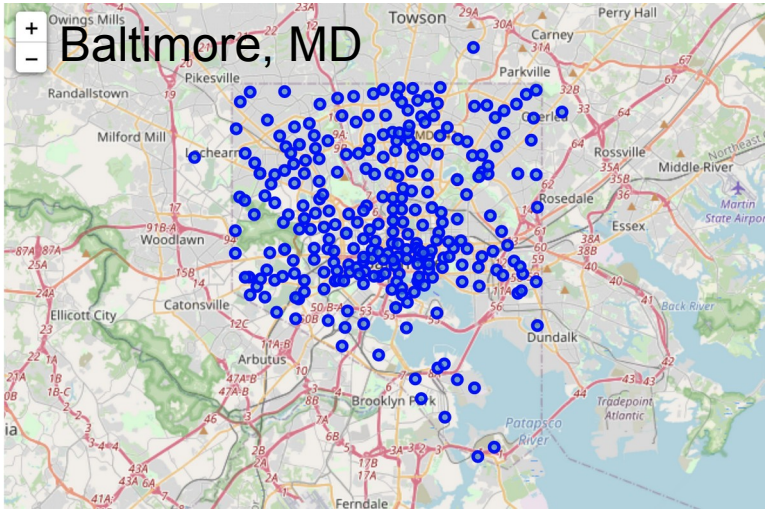
Introduction - Problem

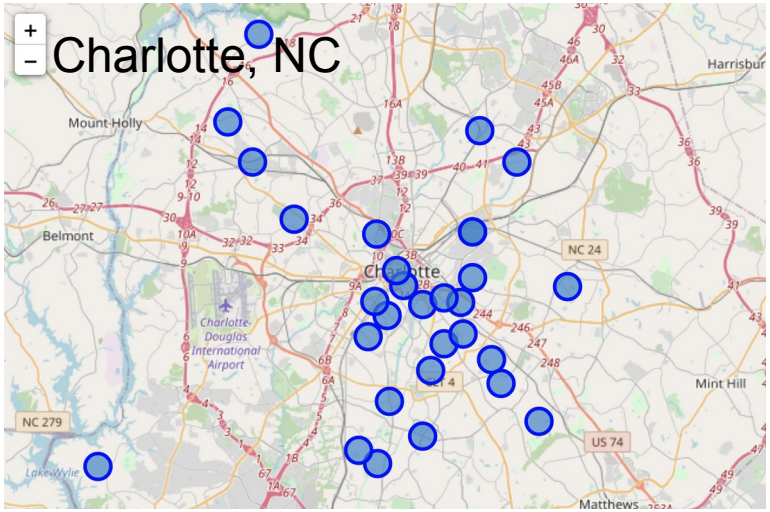
- How can we characterize the retail of Church Hill?
- How can we determine neighborhoods with similar retail to Church Hill?
- How will we compare Church Hill retail to these similar neighborhoods?

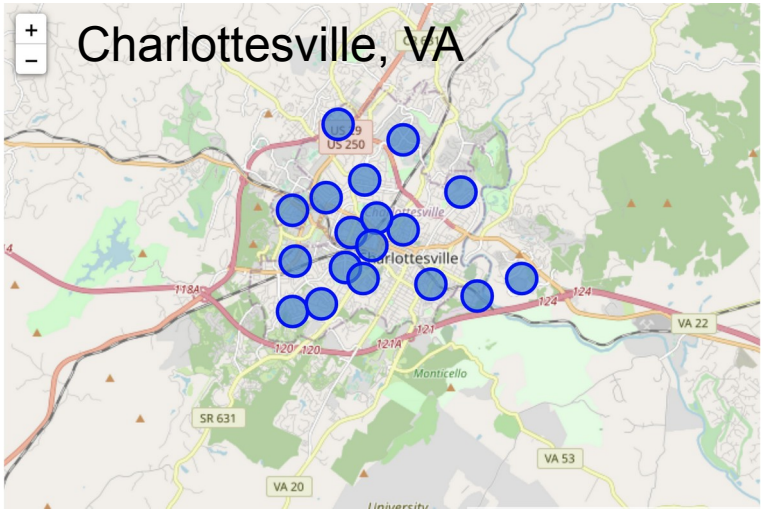
Introduction - Plan

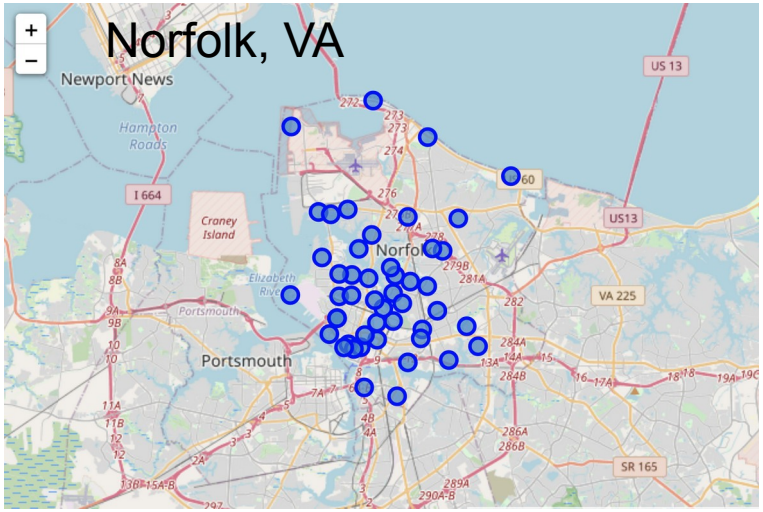
- Compile a list of retail categories present in many neighborhoods.
- Machine Learning clustering to find neighborhoods similar to Church Hill.
- Compare Church Hill retail categories to average frequency of retail categories in the similar cluster.

Neighborhood Data Collection









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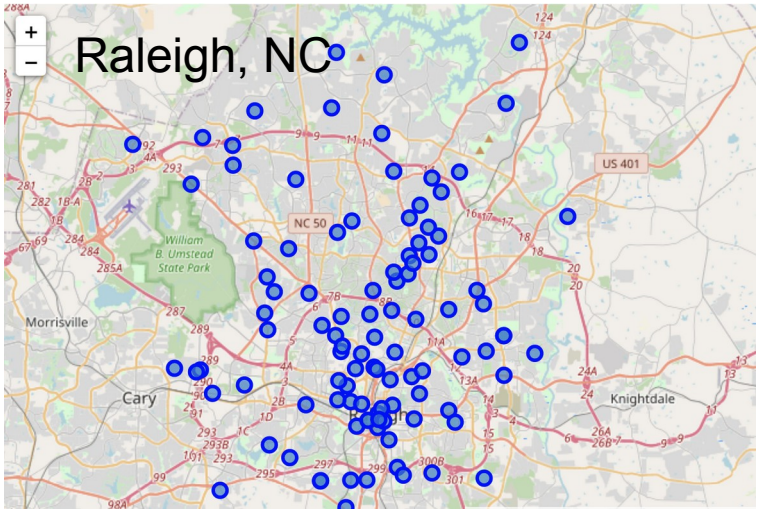
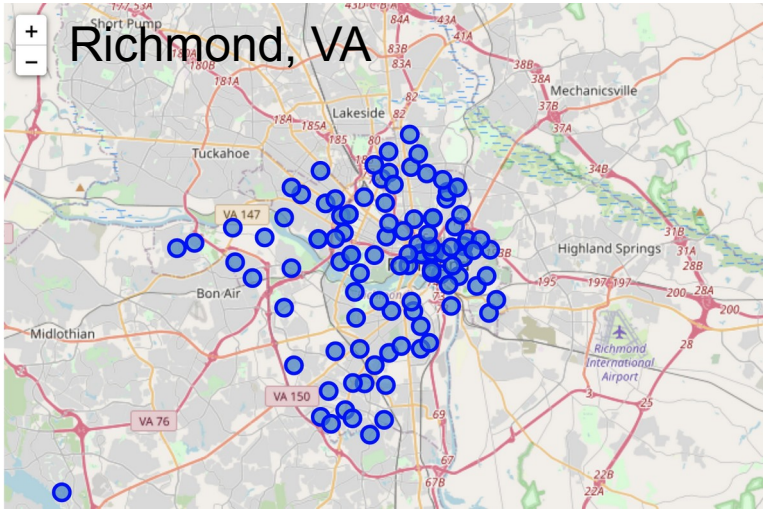
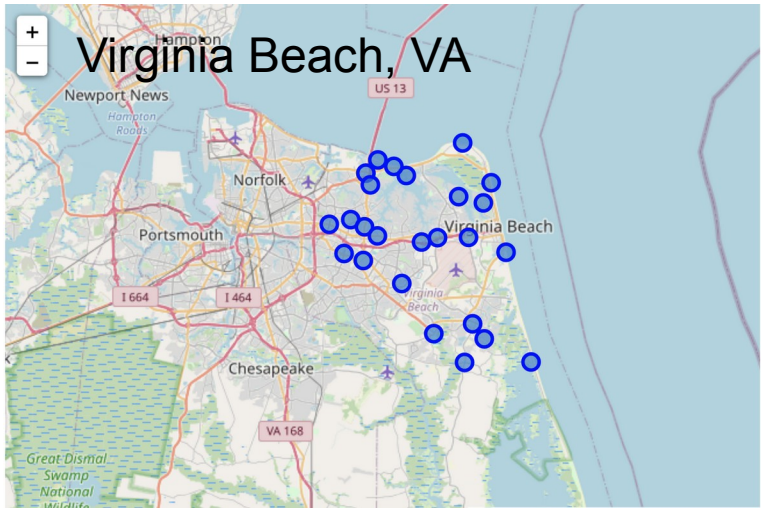
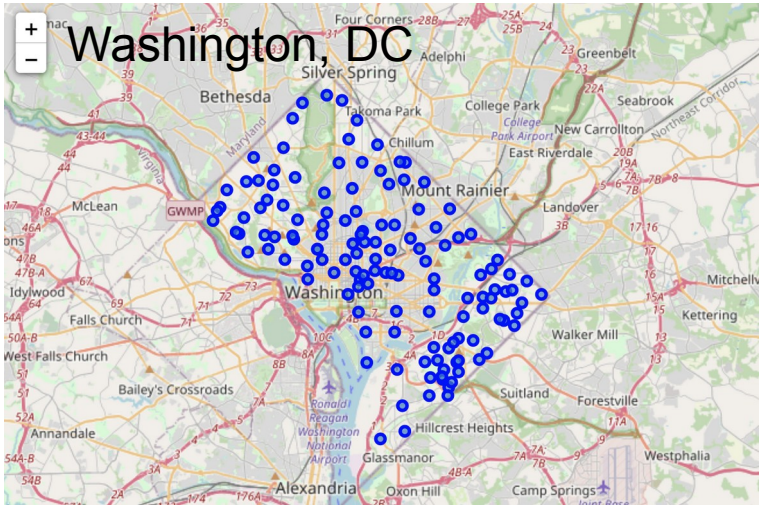








Foursquare Retail Venue Data

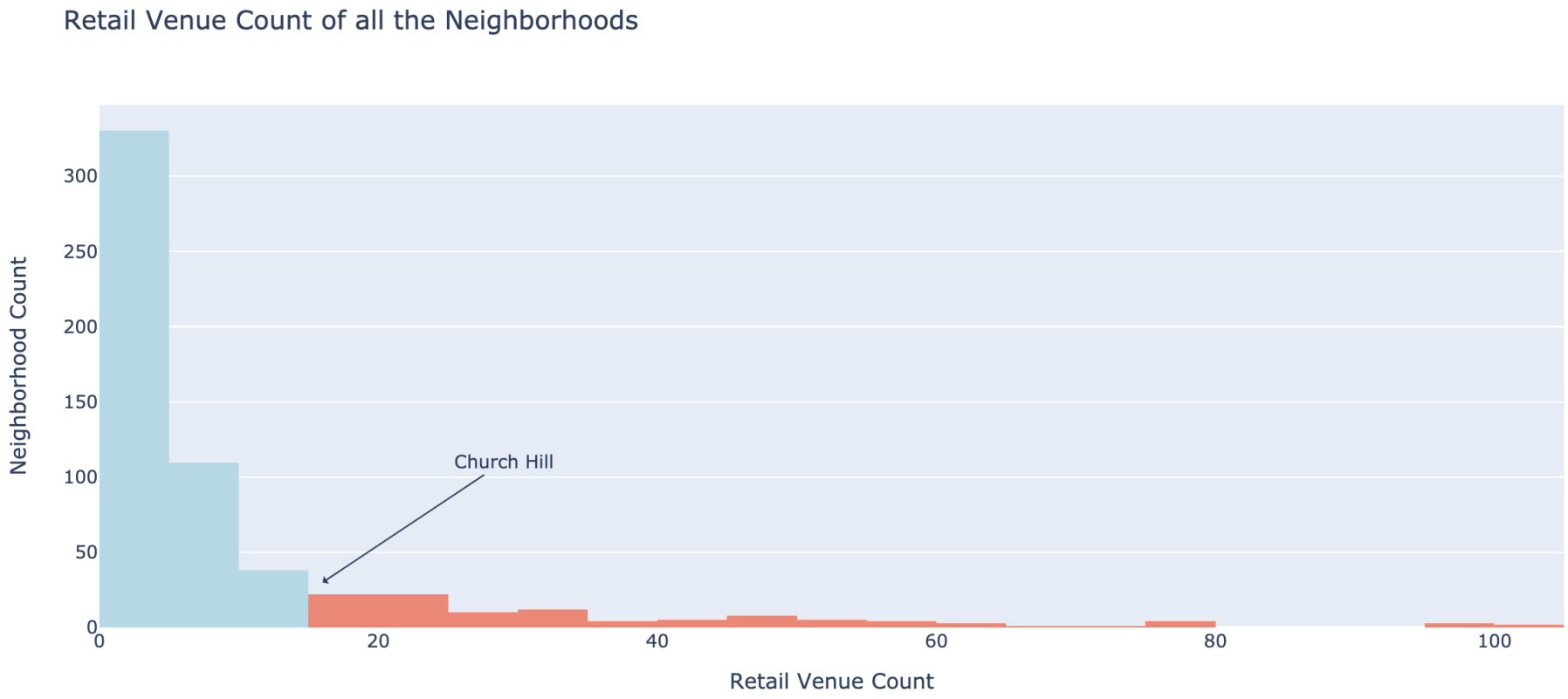
	Neighborhood	City	State	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Arts District	Richmond	VA	37.543453	-77.438963	Pop's Market on Grace	37.542080	-77.438512	Café
1	Arts District	Richmond	VA	37.543453	-77.438963	Secret Sandwich Society	37.541787	-77.438228	Sandwich Place
2	Arts District	Richmond	VA	37.543453	-77.438963	Perly's	37.543848	-77.441436	Deli / Bodega
3	Arts District	Richmond	VA	37.543453	-77.438963	Rappahannock Restaurant	37.542810	-77.439207	Seafood Restaurant
4	Arts District	Richmond	VA	37.543453	-77.438963	Salt & Forge	37.545206	-77.440183	Sandwich Place
...	...	...	...	...	...	...	...	...	...
5735	Starmount	Charlotte	NC	35.141693	-80.868220	Park South Station Pool and Fitness Club	35.145354	-80.864310	Club House
5736	Starmount	Charlotte	NC	35.141693	-80.868220	On The Go Mart	35.143072	-80.875201	Gas Station
5737	Stonehaven	Charlotte	NC	35.155497	-80.763010	Quality Grill Parts, LLC	35.156302	-80.761389	Business Service
5738	Stonehaven	Charlotte	NC	35.155497	-80.763010	Betty Boos Treats	35.155218	-80.756179	Bakery
5739	University City	Charlotte	NC	36.037769	-79.034256	DW EVANS ELECTRIC INC	36.033431	-79.029239	Home Service

5740 rows × 9 columns

We've collected data on a total of 5740 retail venues from the eight cities and 747 neighborhoods.

Data Cleaning – Removing Small Neighborhoods

- **First we get rid of unwanted Foursquare venue entries.**
- **Then we remove entire neighborhoods with less than 15 retail venues.**
- **Now we have 106 neighborhoods to cluster.**



Data Preparation – Category Frequencies

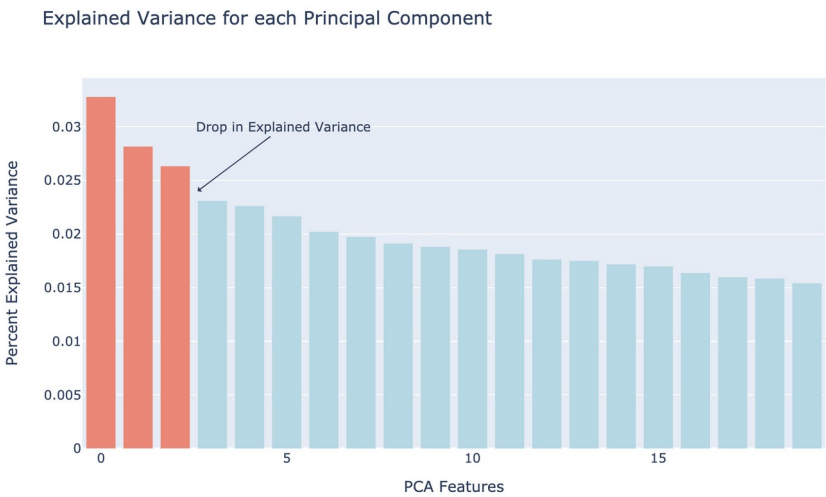
	Neighborhood	City	State	Neighborhood Latitude	Neighborhood Longitude	Neighborhood Venue Count	ATM	Accessories Store	Afghan Restaurant	African Restaurant	...
0	Adams Morgan	Washington	DC	38.921242	-77.043493	52	0.0	0.0	0.019231	0.0	...
1	Aragona Village	Virginia Beach	VA	36.858903	-76.152288	15	0.0	0.0	0.000000	0.0	...
2	Arts District	Richmond	VA	37.543453	-77.438963	23	0.0	0.0	0.000000	0.0	...
3	Bayside	Virginia Beach	VA	36.902925	-76.134380	34	0.0	0.0	0.000000	0.0	...
4	Bellevue	Richmond	VA	37.590832	-77.457554	15	0.0	0.0	0.000000	0.0	...
...	...	...	...	...	...	...	...	...	...	...	...
101	West Raleigh Historic District	Raleigh	NC	35.777619	-78.638765	78	0.0	0.0	0.000000	0.0	...
102	Westhampton	Richmond	VA	37.574101	-77.514645	19	0.0	0.0	0.000000	0.0	...
103	Wilder's Grove	Raleigh	NC	35.798804	-78.564528	19	0.0	0.0	0.000000	0.0	...
104	Willow Lawn	Richmond	VA	37.581870	-77.497587	39	0.0	0.0	0.000000	0.0	...
105	Wyman Park	Baltimore	MD	39.330870	-76.627553	22	0.0	0.0	0.000000	0.0	...

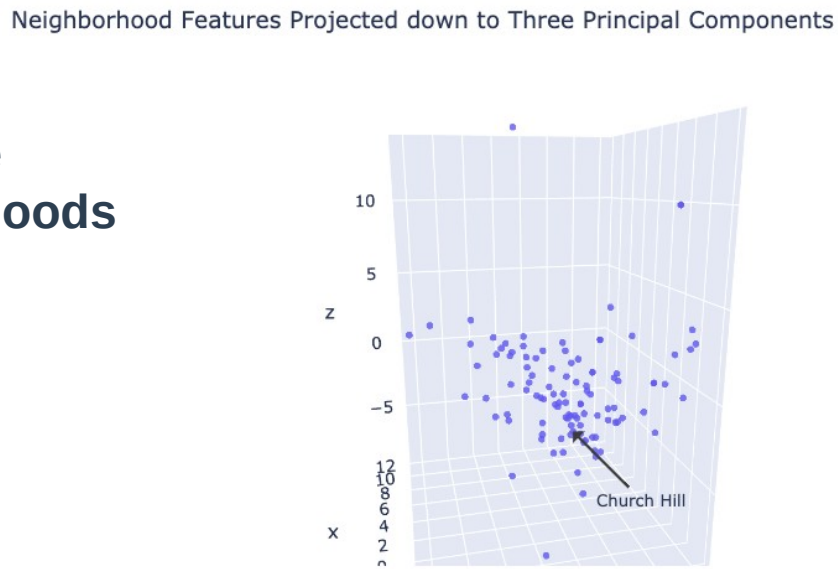
106 rows × 315 columns

- We create a dummy column for each retail category and place a 1 in the corresponding venue row.
- We group each neighborhood together and take the mean of the columns for a category frequency value.
- There are 309 retail categories total.
- We will also include the venue count column so we'll have 310 features for clustering.

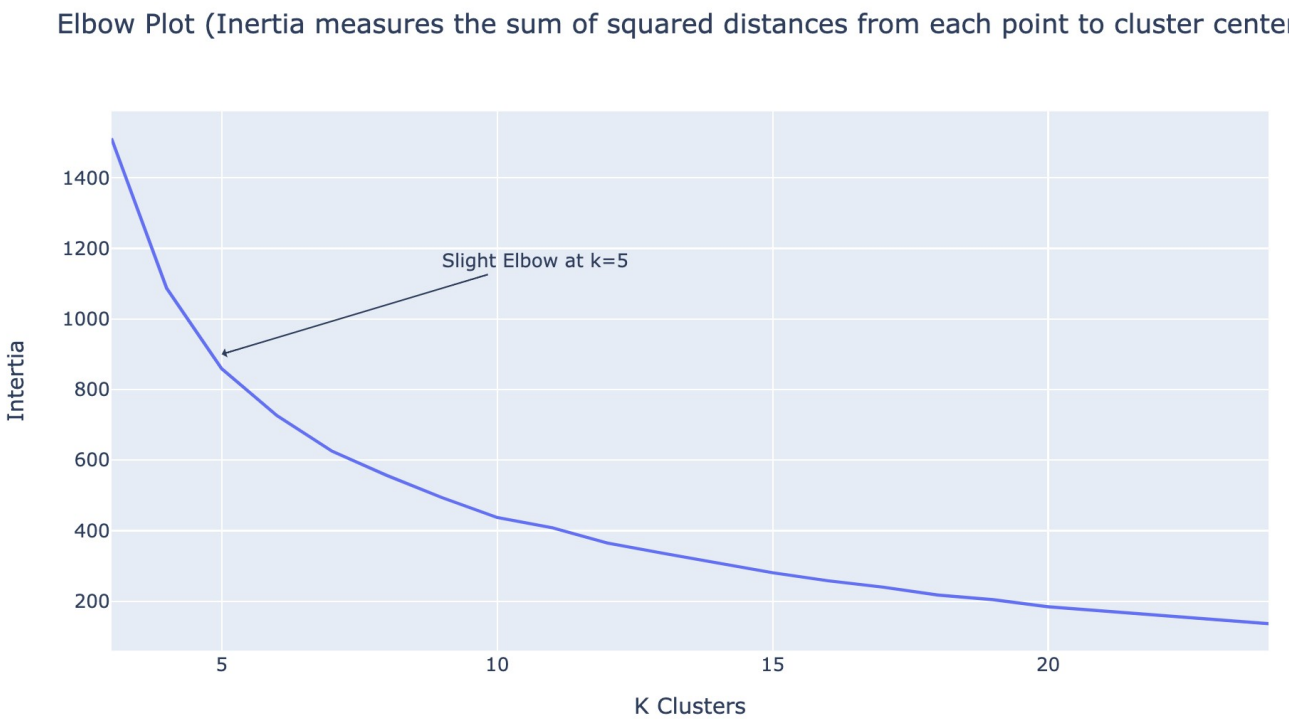
Data Preparation – PCA Dimensionality Reduction

- Address data sparsity with principle component analysis.
- Project the 310-dim data down to lower dimensions.
- Choose 3 dimensions based on explained variance plot.
- Plot the first three principle components to visualize the spread of the 106 neighborhoods before clustering.





Training the K-Means Model



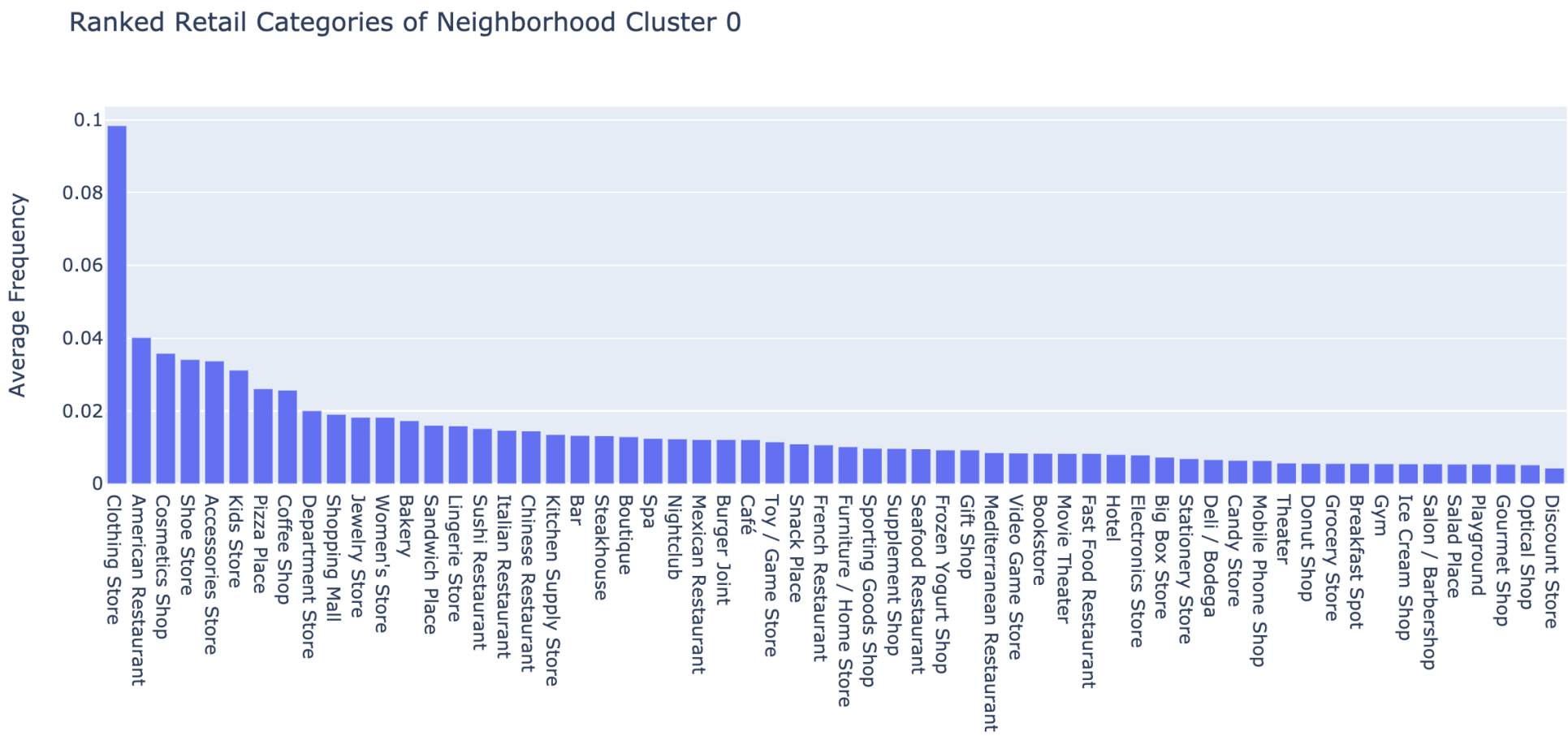
- **Choose K-Means clustering for efficiency and control over number of clusters.**
- **Choose k=5 clusters based on inertia measurements in elbow plot.**

K-Means Clustering Results

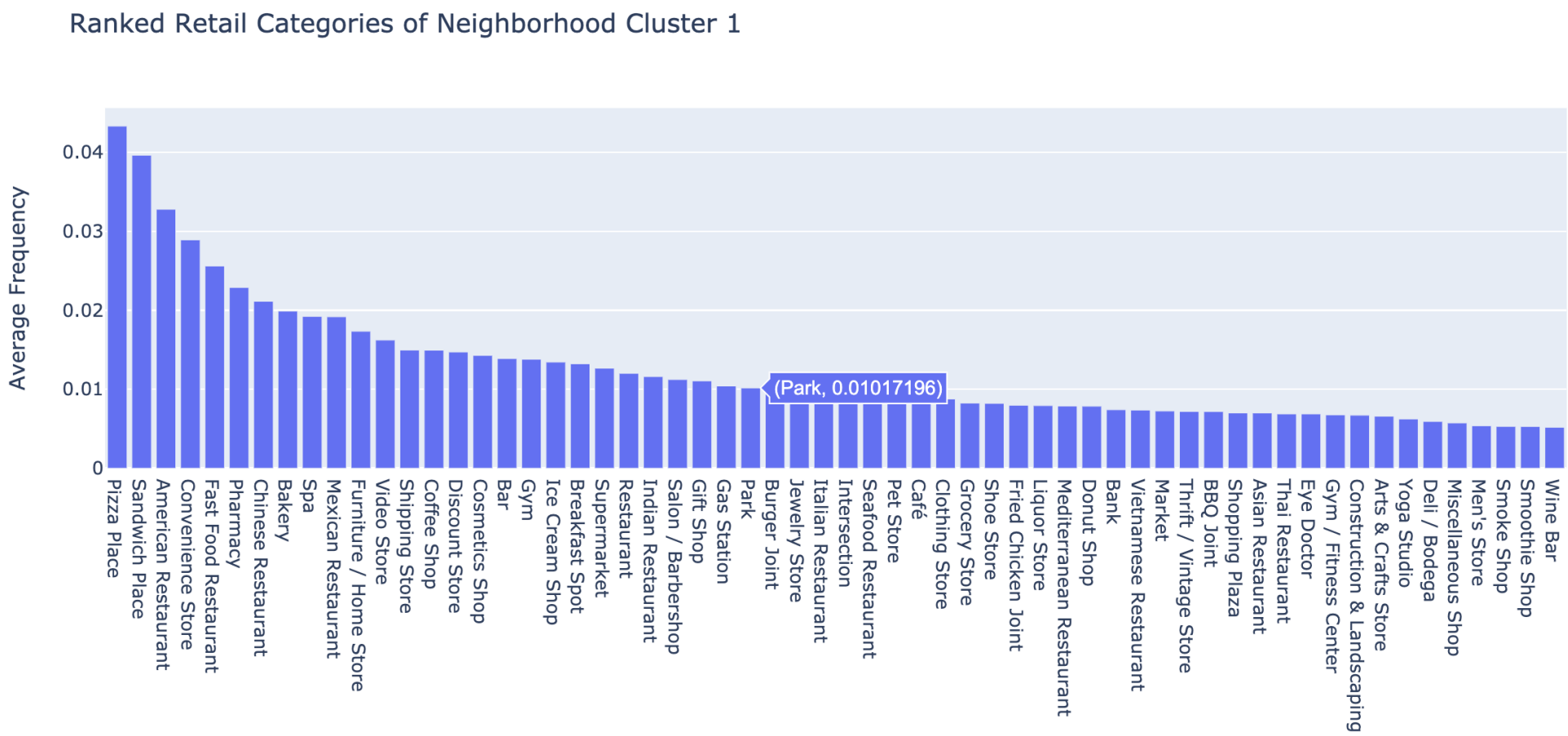
- **Church Hill gets assigned to cluster 3 along with 50 other neighborhoods.**
- **It is the largest and most central cluster in the 3D PCA plot.**
-

Cluster Label	Neighborhood
0	8
1	28
2	17
3	50
4	3

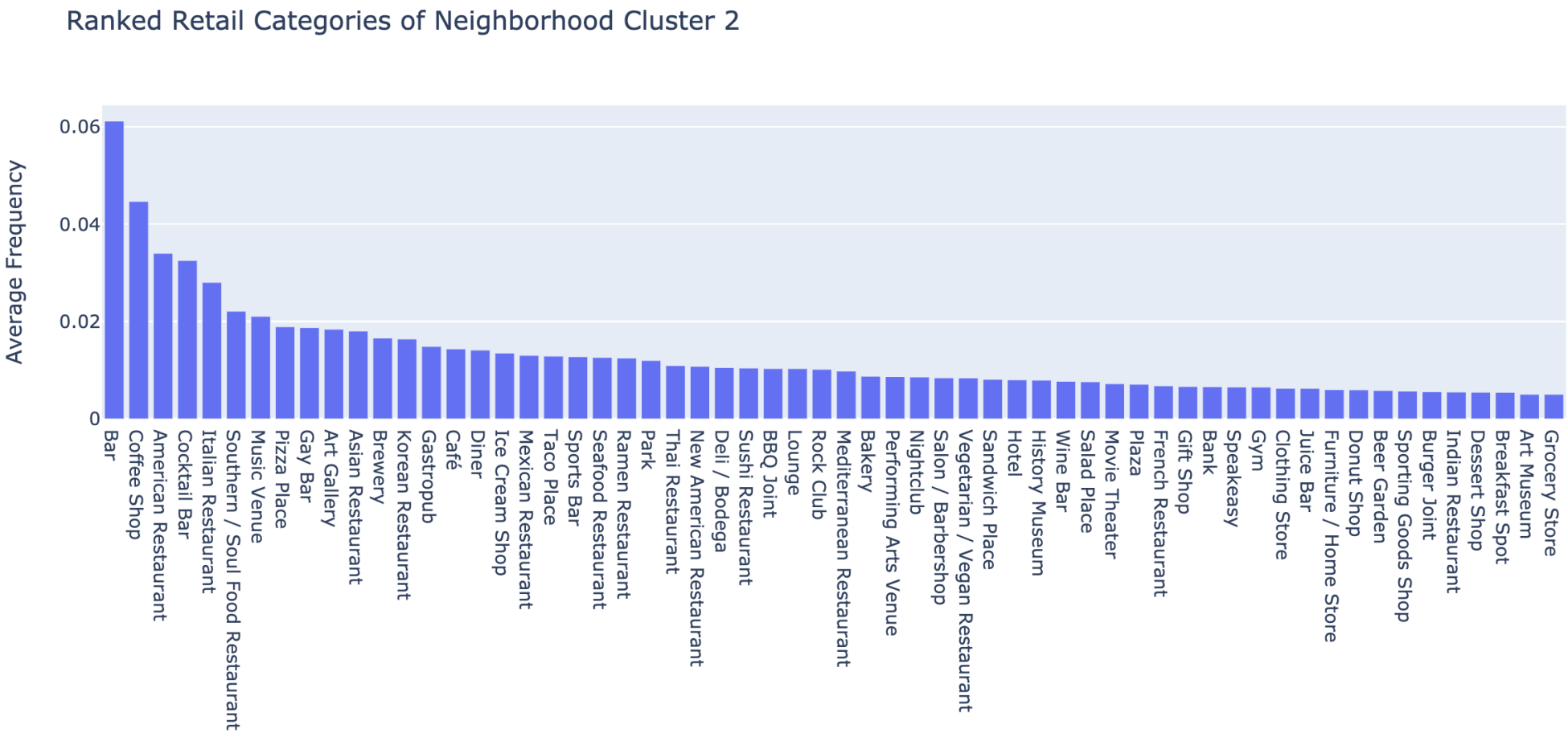
Analysis - Ranked Retail Categories of Cluster 0



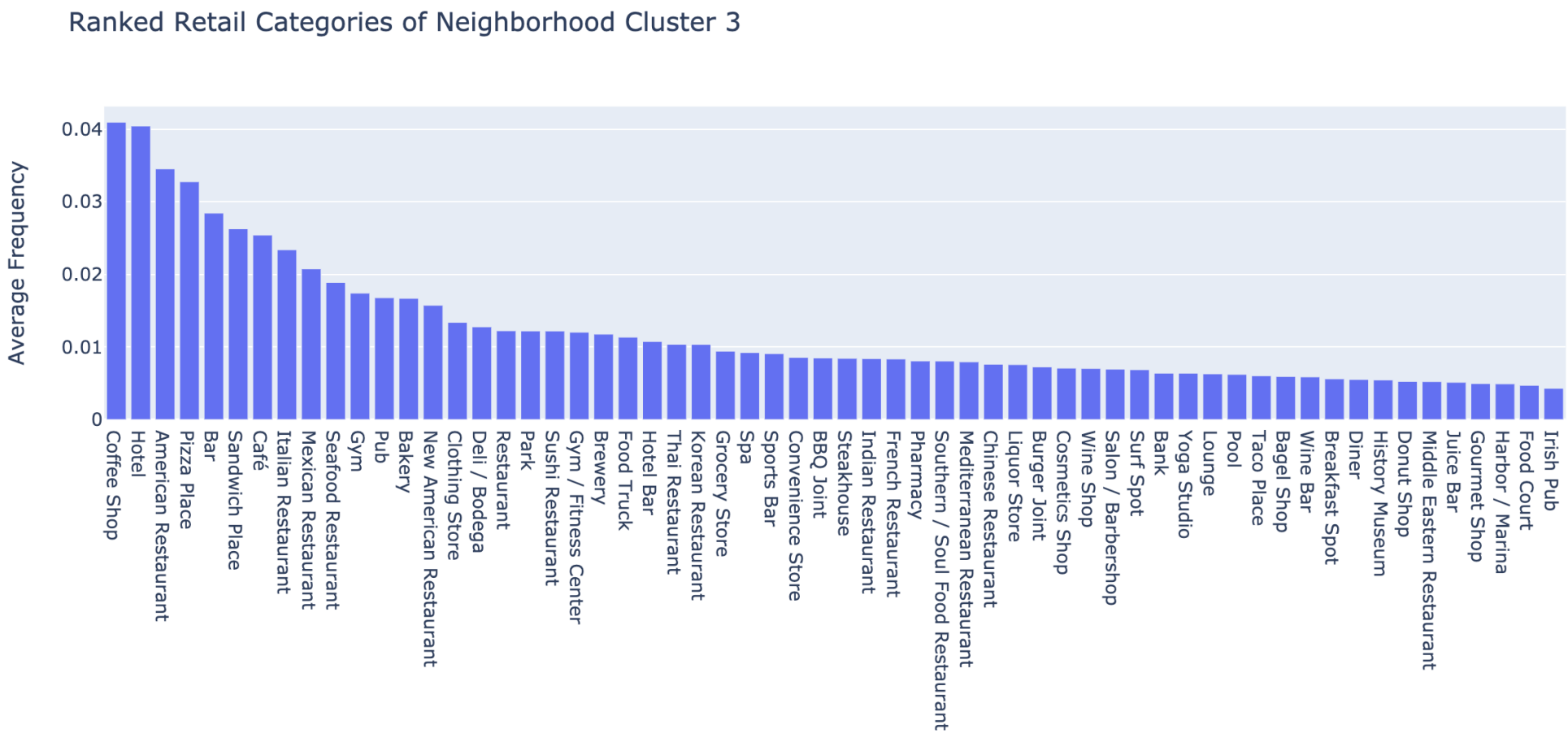
Analysis - Ranked Retail Categories of Cluster 1



Analysis - Ranked Retail Categories of Cluster 2

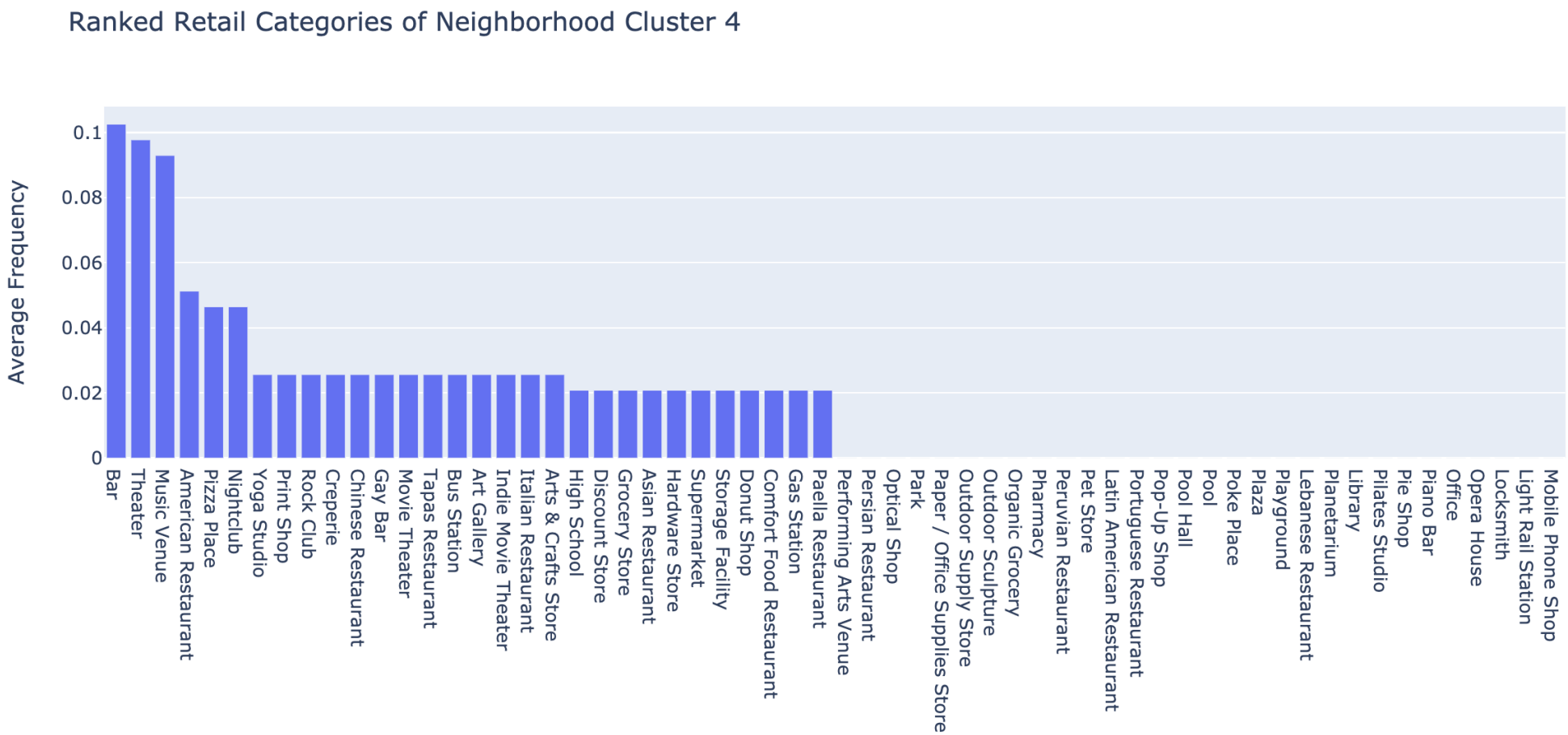


Analysis - Ranked Retail Categories of Cluster 3

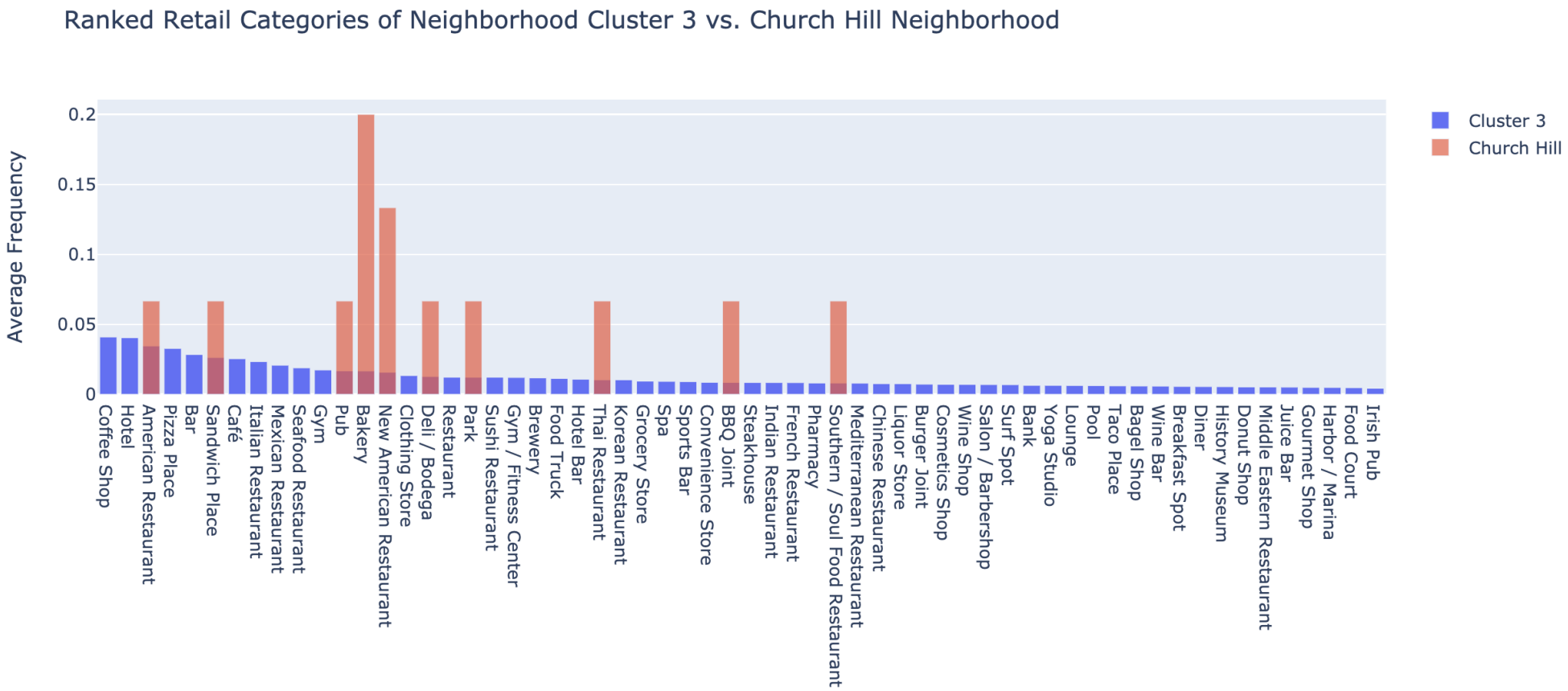


Church Hill belongs to this cluster so we will come back to this plot.

Analysis - Ranked Retail Categories of Cluster 4



Analysis- Church Hill Compared to its Cluster



Categories in blue without red bars are not represented in Church Hill.

Conclusion - Results for Church Hill

Top Retail Choices:

1) **Coffee shop**
2) **Hotel**
3) **Pizza place**
4) **Bar**
5) **Cafe**
6) **Italian Restaurant**
7) **Seafood Restaurant**
8) **Gym**
9) **Clothing store**
10) **Sushi restaurant**

Conclusion – Validity of Results

- **Some retail venues seem to be missing from Foursquare.**
- **Data sparsity made quality clustering difficult.**
- **From personal experience with Church Hill I can say these results makes sense.**

Conclusion – Further Work

- Try other clustering algorithms such as DBSCAN or entropy-weighted K-Means.

- Reduce data sparsity by:
- … adding more neighborhoods,
- … adding more data about the neighborhoods,
- … adding more finely tuned retail subcategory information