Improving in-patient satisfaction through personalized hospital selection

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1 Introduction

1.1 Background

Some people love being in a hospital, some hate it, others are indifferent. However, what is common to all is that their in-patient experience can be improved with the welcome escape to their favourite retreat, be-it a cafe, theatre or certain type of cuisine.

Given the choice of which hospital to be admitted to, this will likely bear some weight on the patient's selection of hospital and be relevant to stakeholders such as:

- For medical professionals that are making these referrals, getting the best outcome for their patient includes making them feel comfortable in what will be a unfamiliar place.
- For healthcare referral apps and also local search-and-discovery apps there is an unmet demand for pre-emptive hospital selection based on personalised nearby venues of interest.

Pre-empting the choice of hospital can be achieve by knowing the patient's preference for their top 5 nearby venues and matching that to a clustered group of hospitals and nearby venues

2 Data acquisition and cleaning

2.1 Data source

To conduct the analysis we use the Foursquare API to explore hospitals in Toronto, ON. The Foursquare Places API provides location based experiences with diverse information about venues, users, photos, and check-ins. The API supports real time access to places, Snap-to-Place that assigns users to specific locations, and Geo-tag.

There are built-in functions which allow the user to explore nearby venues and get information on those nearby venues.

We use the search function to find all hospitals in Toronto and then use the getNearbyVenues function to get the most common venue categories within walking distance (500m) to each hospital.

The results are retuned as a JSON file which is filtered for necessary columns such as venue ID, name and location data. The JSON is then converted into a pandas dataframe for further cleansing of data including dropping of NaNs.

The hospital data has the following format:

index	id	name	lat	lng	address	postalCode
3	5de14daedb954c00086c07b2	Sunnybrook Hospital	43.721838	-79.375978	2075 Bayview Ave.	M4N 3M5

The venues data is extracted using the getNearbyVenues function, which is then grouped by hospital and venue count. Unique categories are extracted for analysis.

3 Methodology

This section describes how we explore venue data near hospitals in the Toronto area and group hospital with similar features using k-means clustering. K-means is vastly used for clustering in many data science applications, especially useful if you need to quickly discover insights from unlabeled data. In this notebook, you will learn how to use k-Means for hospital segmentation.

1. We use the search function to find all hospitals in Toronto
2. Then use the getNearbyVenues function to get the most common venue categories near to each hospital
3. We use this feature to group the hospitals into clusters and use the k-means clustering algorithm to complete this task.
4. The Folium library is used to visualize the hospitals in Toronto and their emerging clusters.
5. Finally, we analyze the cluster to find the dominant features characterizing it

For the analysis we encode venue categorical features as a one-hot numeric array and group by hospital to determine the frequency of occurrence of each venue category per hospital

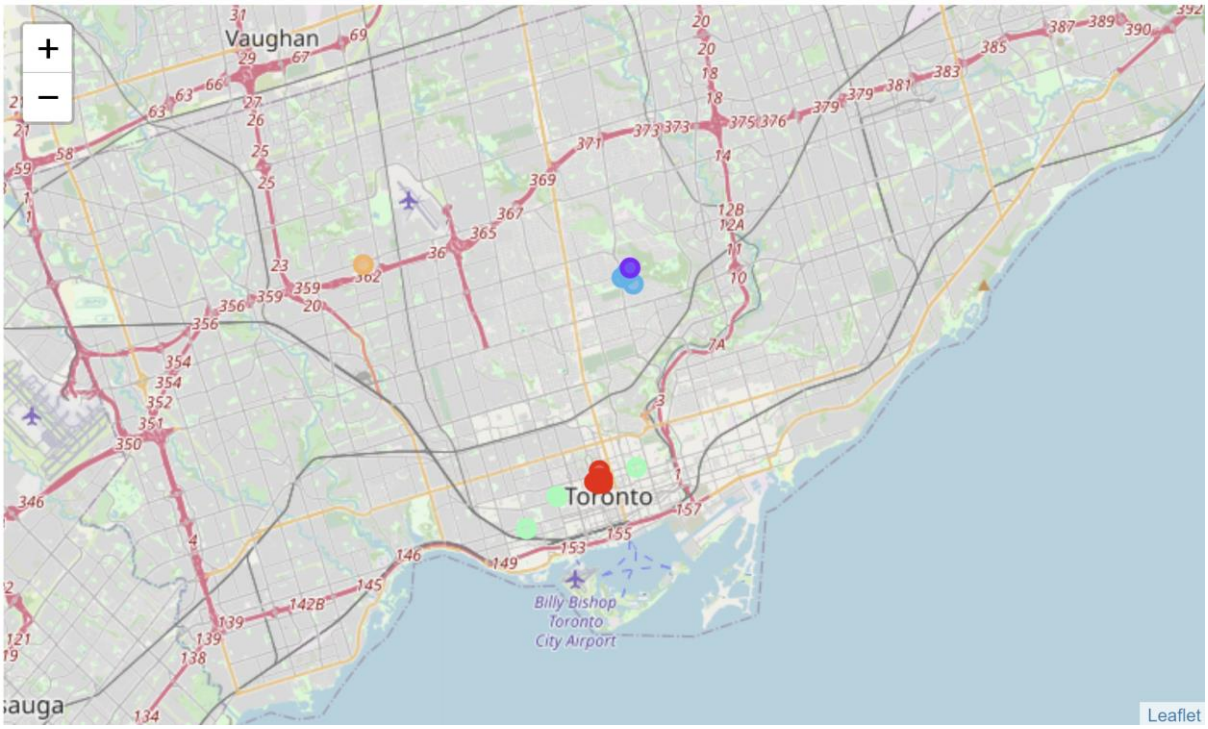
We select the top 10 venues per hospital, as shown below, and generate k-means clusters (shown in the following results section)

4 Results: K-means

k-means clustering is a method that aims to partition n observations into k clusters in which each observation belongs to the cluster with the nearest mean (cluster centers or cluster centroid).

k-means clustering minimizes within-cluster variances to find groups which have not been explicitly labeled in the data. In this example, this is used to idenitfy venue groups within the venues data returned by the foursquare API call to getNearbyVenues.

Five k-means clusters are generated together with longitude and latitude location for each hospital is shown below:



4.1 Cluster 1

The discriminating venue categories that distinguish cluster 1 are fast food, deli and coffee shops.

Hospital	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Veterans Centre: Sunnybrook	Food Court	Deli / Bodega	Coffee Shop	Thai Restaurant	Café	Yoga Studio	Escape Room	Electronics Store	Donut Shop	Doner Restaurant

4.2 Cluster 2

The discriminating venue categories that distinguish cluster 2 are bars, Italian restaurants, coffee shops and art venues.

Hospital	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
CAMH	Bar	Men's Store	Art Gallery	Vietnamese Restaurant	Vegetarian / Vegan Restaurant	Theater	Seafood Restaurant	Café	Restaurant	Furniture / Home Store
Dundas Euclid Animal Hospital	Bar	Italian Restaurant	Cocktail Bar	Restaurant	Pizza Place	Sandwich Place	Art Gallery	Taco Place	Hobby Shop	New American Restaurant
Sherbourne Health Centre	Coffee Shop	Restaurant	Pub	Diner	Grocery Store	Gastropub	Japanese Restaurant	Italian Restaurant	Hotel	Breakfast Spot
Toronto Western Hospital	Bar	Café	Vegetarian / Vegan Restaurant	Taco Place	Mexican Restaurant	Burger Joint	Comfort Food Restaurant	Ramen Restaurant	Japanese Restaurant	Poutine Place

4.3 Cluster 3

The discriminating venue categories that distinguish cluster 3 are delicatessen, coffee and thai food.

Hospital	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Sunnybrook Hospital	Deli / Bodega	Coffee Shop	Thai Restaurant	Food Court	Yoga Studio	Dog Run	Escape Room	Electronics Store	Donut Shop	Doner Restaurant

4.4 Cluster 4

The discriminating venue categories that distinguish cluster 4 are parks, grocery stores and Vietnamese restaurants and pharmacy.

Hospital	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Humber River Hospital	Park	Grocery Store	Vietnamese Restaurant	Pharmacy	Coffee Shop	Distribution Center	Electronic Store	Donut Shop	Doner Restaurant	Dog Run

4.5 Cluster 5

The discriminating venue categories that distinguish cluster 5 are coffee shops and Asian food.

Hospital	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th

Toronto General Hospital	Coffee Shop	Sushi Restaurant	Chinese Restaurant	Spa	Bubble Tea Shop	Gym / Fitness Center	Ice Cream Shop	Italian Restaurant	Japanese Restaurant	Café
The Hospital for Sick Children (SickKids)	Coffee Shop	Sandwich Place	Italian Restaurant	Café	Bubble Tea Shop	Burger Joint	Donut Shop	Portuguese Restaurant	Poke Place	Pizza Place
R. Fraser Elliot Building - Toronto General Ho...	Coffee Shop	Sandwich Place	Burger Joint	Café	Italian Restaurant	Bubble Tea Shop	Yoga Studio	Middle Eastern Restaurant	Poke Place	Pizza Place
Women's College Hospital	Coffee Shop	Sushi Restaurant	Café	Sandwich Place	Bookstore	Park	Beer Bar	Distribution Center	Smoothie Shop	Pizza Place
Princess Margaret Cancer Centre	Coffee Shop	Café	Ice Cream Shop	Sushi Restaurant	French Restaurant	Art Gallery	Sandwich Place	Japanese Restaurant	Salad Place	Bookstore
Mount Sinai Hospital	Coffee Shop	Café	Japanese Restaurant	Gastropub	Art Gallery	Bubble Tea Shop	Sandwich Place	French Restaurant	Ramen Restaurant	Salad Place
Ellicsr, Health, Wellness & Cancer Survivorshi ...	Coffee Shop	Café	Italian Restaurant	French Restaurant	Bubble Tea Shop	Sandwich Place	Thai Restaurant	Middle Eastern Restaurant	Pizza Place	Park
Casey House Hospice	Coffee Shop	Restaurant	Grocery Store	Breakfast Spot	Japanese Restaurant	Men's Store	Pub	Burger Joint	Pie Shop	Pharmacy
Sleep Medicine and Research Rounds at Toronto ...	Coffee Shop	Chinese Restaurant	Sushi Restaurant	Bubble Tea Shop	Burger Joint	Italian Restaurant	Japanese Restaurant	Spa	Yoga Studio	Modern European Restaurant
Women’s College Covid Assessment Centre	Coffee Shop	Italian Restaurant	Sushi Restaurant	Park	Yoga Studio	Distribution Center	Mexican Restaurant	Martial Arts School	Japanese Restaurant	Fried Chicken Joint

5 Discussion

The application of k-means clustering was straightforward and showed a good amount of explanatory data can be collected using this method from the foursquare dataset. Further analysis can be done to optimize the number of clusters used in the analysis. There are possible improvements to the foursquare dataset that can be made, such as a additional query items to specify the type of hospital or medical centers. Some venue categories, such as coffee shops, are generic and can be removed before performing the clustering in-order to focus on discriminating venue categories. Additionally, foursquare user tips can be incorporated to find anecdotal data for hospital experience and nearby venues.

6 Conclusion

The results from the data analysis show that there is explanatory information within foursquare to help an app developer to match in-patient user preferences to the clustered groups and prioritize the choice of hospital based on the patient's nearby venue preferences.