LOCATIONS RECOMMENDATION FOR A NEW AFRICAN RESTAURANT IN THE CITY OF TORONTO

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February 28th, 2019

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1- Introduction: Business Problem

In this project we will try to find an optimal location for a restaurant. Specifically, this report will be targeted to stakeholders interested in opening an **African restaurant** in **Toronto**, Canada.

Since African foods are not very popular, our strategy will be to bring them near to other restaurants; so that most new customers shall be discovering African meals while going to have a launch. Another thing is that when restaurants are gathered, people tend to visit the neighborhood at launch time, thus giving them the opportunity to discover African restaurants. We will try to detect **locations with high density of restaurants**. We are also particularly interested in **areas with no African restaurants in vicinity**. We would also prefer locations **as close to city center as possible**, assuming that those conditions are met.

We will use our data science powers to generate a few most promising neighborhoods based on these criteria. Advantages of each area will then be clearly expressed so that best possible final location can be chosen by stakeholders.

2- Data

Based on definition of our problem, factors that will influence our decision are:

- number of existing restaurants in the neighborhood (any type of restaurant)
- number of and distance to African restaurants in the neighborhood, if any
- distance of neighborhood from city center

We decided to use regularly spaced grid of locations, centered around city center, to define our neighborhoods.

Following data sources will be needed to extract/generate the required information:

- centers of candidate areas will be generated algorithmically and approximate addresses of centers of those areas will be obtained using **OpenCage reverse Geocoder API**
- number of restaurants and their type and location in every neighborhood will be obtained using **Foursquare API**
- coordinate of Toronto center will be obtained using **OpenCage Geocoder API** of well-known Toronto location (Yonge–Dundas Square)

Neighborhood Candidates

Let's create latitude & longitude coordinates for centroids of our candidate neighborhoods. We will create a grid of cells covering our area of interest which is approx. 12x12 kilometers centered around Toronto city center.

Let's first find the latitude & longitude of Toronto city center, using specific, well known address and OpenCage Geocoder API.

```
Coordinate of Yonge–Dundas Square: [43.6560992, -79.3801563]
```

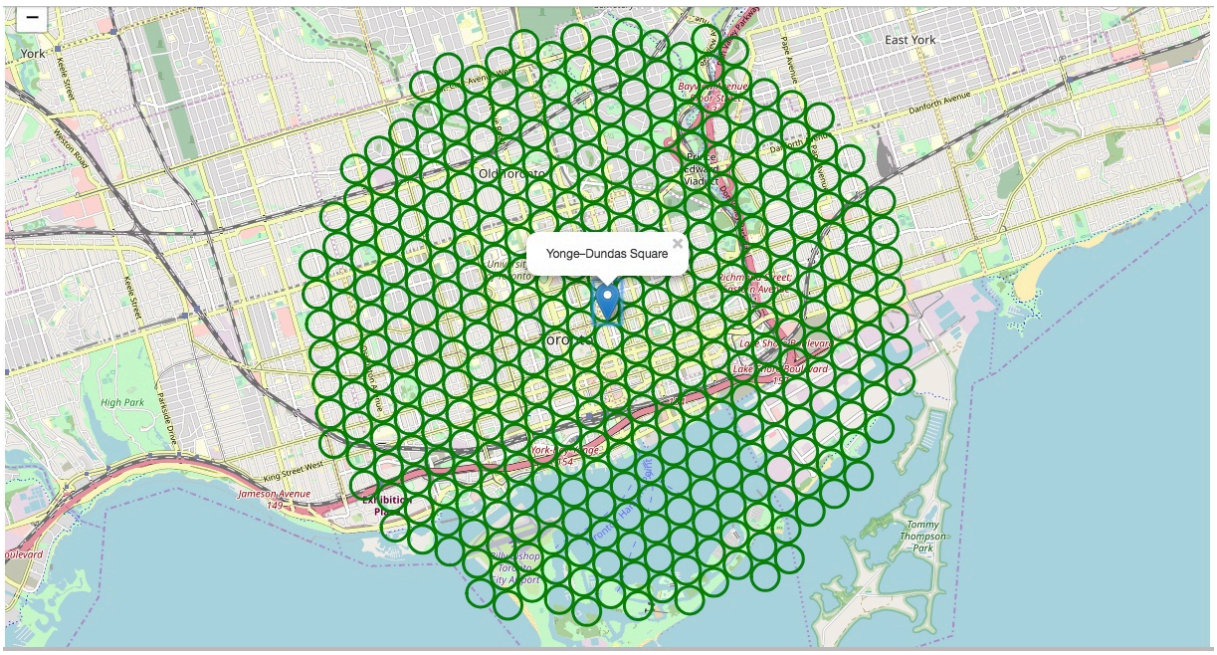
Now let's create a grid of area candidates, equally spaced, centered around city center and within ~6km from Yonge–Dundas Square. Our neighborhoods will be defined as circular areas with a radius of 300 meters, so our neighborhood centers will be 600 meters apart.

To accurately calculate distances, we need to create our grid of locations in Cartesian 2D coordinate system which allows us to calculate distances in meters (not in latitude/longitude degrees). Then we'll project those coordinates back to latitude/longitude degrees to be shown on Folium map. So, let's create functions to convert between WGS84 spherical coordinate system (latitude/longitude degrees) and UTM Cartesian coordinate system (X/Y coordinates in meters).

```
Yonge–Dundas Square longitude=-79.3801563, latitude=43.6560992
Yonge–Dundas Square UTM X=-5310159.053993876, Y=10507055.916044617
Yonge–Dundas Square longitude=-79.38015630000045, latitude=43.6560991
9999976
```

Let's visualize the data we have so far: city center location and candidate neighborhood centers:

364 candidate neighborhood centers generated.



OK, we now have the coordinates of centers of neighborhoods/areas to be evaluated, equally spaced (distance from every point to it's neighbors is exactly the same) and within ~6km from Yonge–Dundas Square.

Let's now use OpenCage Geocoder API to get approximate addresses of those locations.

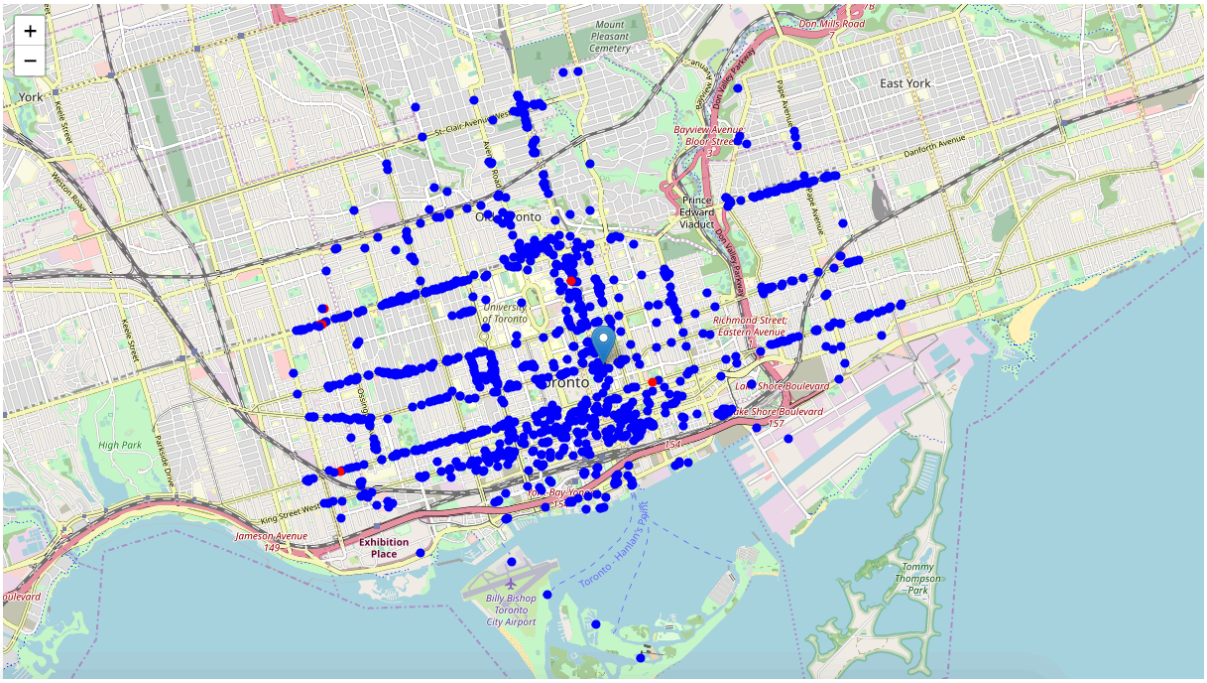
```
df_locations.head(10)
```

	Address	Latitude	Longitude	X	Y	Distance from center
0	Portlands Energy Centre, 470 Unwin Avenue, Tor...	43.648823	-79.329586	-5.311959e+06	1.050134e+07	5992.495307
1	Portlands Energy Centre, 470 Unwin Avenue, Tor...	43.652549	-79.330147	-5.311359e+06	1.050134e+07	5840.376700
2	Toronto Transit Commission - Lakeshore Complex...	43.656275	-79.330708	-5.310759e+06	1.050134e+07	5747.173218
3	2 Rushbrooke Avenue, Toronto, ON M4M 1L4	43.660001	-79.331268	-5.310159e+06	1.050134e+07	5715.767665
4	18 Curzon Street, Toronto, ON M4M 1L7	43.663727	-79.331829	-5.309559e+06	1.050134e+07	5747.173218
5	Leslieville Junior Public School, 254 Leslie S...	43.667453	-79.332391	-5.308959e+06	1.050134e+07	5840.376700
6	413 Leslie Street, Toronto, ON M4M 2A1	43.671180	-79.332952	-5.308359e+06	1.050134e+07	5992.495307
7	Martin Goodman Trail, Old Toronto, Toronto, ON...	43.642883	-79.333188	-5.312859e+06	1.050186e+07	5855.766389
8	Richard L. Hearn Thermal Generating Station (c...	43.646608	-79.333749	-5.312259e+06	1.050186e+07	5604.462508
9	109 Basin Street, Toronto, ON M5A 1A6	43.650333	-79.334310	-5.311659e+06	1.050186e+07	5408.326913

Foursquare

Now that we have our location candidates, let's use Foursquare API to get info on restaurants in each neighborhood.

We're interested in venues in 'food' category, but only those that are proper restaurants - coffee shops, pizza places, bakeries etc. are not direct competitors so we don't care about those. So, we will include in our list only venues that have 'restaurant' in category name, and we'll make sure to detect and include all the subcategories of specific 'African restaurant' category, as we need info on African restaurants in the neighborhood.



Looking good. So now we have all the restaurants in area within few kilometers from Yonge-Dundas Square, and we know which ones are African restaurants! We also know which restaurants exactly are in vicinity of every neighborhood candidate center.

This concludes the data gathering phase - we're now ready to use this data for analysis to produce the report on optimal locations for a new African restaurant!

3- Methodology

In this project we will direct our efforts on detecting areas of Toronto that have high restaurant density, particularly those with low number of African restaurants. We will limit our analysis to area ~6km around city center.

In first step we have collected the required **data: location and type (category) of every restaurant within 6km from Toronto center** (Yonge-Dundas Square). We have also **identified African restaurants** (according to Foursquare categorization).

Second step in our analysis will be calculation and exploration of '**restaurant density**' across different areas of Toronto.

In third and final step we will create **clusters of locations that meet some basic requirements** established in discussion with stakeholders: we will take into consideration locations with **at least ten restaurants in radius of 250 meters**, and we want locations **without African restaurants in radius of 500 meters**. We will present map of all such locations but also create clusters (using **k-means**

clustering) of those locations to identify general zones / neighborhoods / addresses which should be a starting point for final 'street level' exploration and search for optimal venue location by stakeholders.

4- Analysis

Let's perform some basic explanatory data analysis and derive some additional info from our raw data. First let's count the **number of restaurants in every area candidate**:

	Address	Latitude	Longitude	X	Y	Distance from center	Restaurants in area
0	Portlands Energy Centre, 470 Unwin Avenue, Tor...	43.648823	-79.329586	-5.311959e+06	1.050134e+07	5992.495307	0
1	Portlands Energy Centre, 470 Unwin Avenue, Tor...	43.652549	-79.330147	-5.311359e+06	1.050134e+07	5840.376700	0
2	Toronto Transit Commission - Lakeshore Complex...	43.656275	-79.330708	-5.310759e+06	1.050134e+07	5747.173218	0
3	2 Rushbrooke Avenue, Toronto, ON M4M 1L4	43.660001	-79.331268	-5.310159e+06	1.050134e+07	5715.767665	1
4	18 Curzon Street, Toronto, ON M4M 1L7	43.663727	-79.331829	-5.309559e+06	1.050134e+07	5747.173218	9
5	Leslieville Junior Public School, 254 Leslie S...	43.667453	-79.332391	-5.308959e+06	1.050134e+07	5840.376700	0
6	413 Leslie Street, Toronto, ON M4M 2A1	43.671180	-79.332952	-5.308359e+06	1.050134e+07	5992.495307	0
7	Martin Goodman Trail, Old Toronto, Toronto, ON...	43.642883	-79.333188	-5.312859e+06	1.050186e+07	5855.766389	0
8	Richard L. Hearn Thermal Generating Station (c...	43.646608	-79.333749	-5.312259e+06	1.050186e+07	5604.462508	0
9	109 Basin Street, Toronto, ON M5A 1A6	43.650333	-79.334310	-5.311659e+06	1.050186e+07	5408.326913	0

OK. Now let's calculate one more important thing for each location candidate: **number of restaurants in vicinity** (we'll use radius of **250 meters**)

	Address	Latitude	Longitude	X	Y	Distance from center	Restaurants in area	Distance to African restaurant	Number of Restaurant whitin 250
0	Portlands Energy Centre, 470 Unwin Avenue, Tor...	43.648823	-79.329586	-5.311959e+06	1.050134e+07	5992.495307	0	4948.095439	0
1	Portlands Energy Centre, 470 Unwin Avenue, Tor...	43.652549	-79.330147	-5.311359e+06	1.050134e+07	5840.376700	0	4819.872439	0
2	Toronto Transit Commission - Lakeshore Complex...	43.656275	-79.330708	-5.310759e+06	1.050134e+07	5747.173218	0	4764.314451	0
3	2 Rushbrooke Avenue, Toronto, ON M4M 1L4	43.660001	-79.331268	-5.310159e+06	1.050134e+07	5715.767665	1	4783.953809	1
4	18 Curzon Street, Toronto, ON M4M 1L7	43.663727	-79.331829	-5.309559e+06	1.050134e+07	5747.173218	9	4877.882317	5
5	Leslieville Junior Public School, 254 Leslie S...	43.667453	-79.332391	-5.308959e+06	1.050134e+07	5840.376700	0	5041.949797	0
6	413 Leslie Street, Toronto, ON M4M 2A1	43.671180	-79.332952	-5.308359e+06	1.050134e+07	5992.495307	0	5269.609057	0
7	Martin Goodman Trail, Old Toronto, Toronto, ON...	43.642883	-79.333188	-5.312859e+06	1.050186e+07	5855.766389	0	4799.312297	0
8	Richard L. Hearn Thermal Generating Station (c...	43.646608	-79.333749	-5.312259e+06	1.050186e+07	5604.462508	0	4549.826412	0
9	109 Basin Street, Toronto, ON M5A 1A6	43.650333	-79.334310	-5.311659e+06	1.050186e+07	5408.326913	0	4369.032185	0

Since African foods are not very popular, our strategy will be to bring them near to other restaurants; so that most new customers shall be discovering African meals while going to have a launch. Another thing is that when restaurants are gathered, people tend to visit the neighborhood at launch time, thus giving them the opportunity to discover African restaurants. OK. Let us now **filter** those locations: we're interested only in **locations with at least 10 restaurants in radius of 250 meters**, and **no African restaurants in radius of 500 meters**. Other criteria will be **locations in a radius of 2Km from Yonge-Dundas Square**

```
Locations with at least 10 restaurants nearby: 27
```

```
Locations with no African restaurants within 500m: 343
Locations within 2Km from the city center: 42
Locations with the 3 conditions met: 7
```

Looking good. What we have now is a clear indication of zones with low number of restaurants in vicinity, and *no* African restaurants at all nearby.

Let us now **cluster** those locations to create **centers of zones containing good locations**. Those zones, their centers and addresses will be the final result of our analysis.


```
============================================================
Addresses of centers of areas recommended for further analysis
============================================================

    1.  Commerce Court, Traders Bank, 67 Yonge Street, Toronto, ON M5E 1J8 => 1.2km from Yonge-Dunda
        s Square
    2.  12 Maitland Street, Toronto, ON M4Y 1X9            => 1.4km from Yonge-Dundas Square
    3.  38 D'Arcy Street, Toronto, ON M5T 1Y5              => 1.6km from Yonge-Dundas Square
    4.  Qwest Condo, Richmond Street West, Toronto, ON M5V 1V6 => 1.4km from Yonge-Dundas Square
```

This concludes our analysis. We have created 4 addresses representing centers of zones containing locations with high number of restaurants and no African restaurants nearby, all zones being fairly close to city center (all less than 2km from Yonge-Dundas Square). Although zones are shown on map with a radius of ~500 meters (green circles), their shape is actually very irregular, and their centers/addresses should be considered only as a starting point for exploring area neighborhoods in search for potential restaurant locations.

5- Results and Discussion

Our analysis shows that although there is a great number of restaurants in Toronto (~1200 in our initial area of interest which was 12x12km around Yonge-Dundas Square), there are pockets of low restaurant density fairly close to city center.

After directing our attention to this narrower area of interest we first created a dense grid of location candidates (spaced 100m apart); those locations were then filtered so that those with less than 10 restaurants in radius of 250m and those with an African restaurant closer than 500m were removed.

Those location candidates were then clustered to create zones of interest which contain greatest number of location candidates. Addresses of centers of those zones were also generated using **OpenCage** reverse Geocoder API to be used as markers/starting points for more detailed local analysis based on other factors.

Result of all this is 4 zones containing largest number of potential new restaurant locations based on number of and distance to existing venues - both restaurants in general and African restaurants particularly. This, of course, does not imply that those zones are actually optimal locations for a new restaurant! Purpose of this analysis was to only provide info on areas close to Toronto center but not crowded with existing restaurants (particularly African) - it is entirely possible that there is a very good reason for small number of restaurants in any of those areas, reasons which would make them unsuitable for a new restaurant regardless of lack of competition in the area. Recommended zones should therefore be considered only as a starting point for more detailed analysis which could eventually result in location which has not only no nearby competition, but also other factors taken into account and all other relevant conditions met.

6- Conclusion

Purpose of this project was to identify Toronto areas close to center with high number of restaurants (particularly with no African restaurants) in order to aid stakeholders in narrowing down the search for optimal location for a new African restaurant. By calculating restaurant density distribution from Foursquare sdata, we have generated extensive collection of locations which satisfy some basic requirements regarding existing nearby restaurants. Clustering of those locations was then performed in order to create major zones of interest (containing greatest number of potential locations) and addresses of those zone centers were created to be used as starting points for final exploration by stakeholders.

Final decision on optimal restaurant location will be made by stakeholders based on specific characteristics of neighborhoods and locations in every recommended zone, taking into consideration additional factors like attractiveness of each location (proximity to park or water), levels of noise /

proximity to major roads, real estate availability, prices, social and economic dynamics of every neighborhood etc.