The Battle of Neighborhoods

CAPSTONE PROJECT

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Introduction

Background

The success of a new business depends on a number of factors, one of them is to perform market research. Market research allows a prospective business owner to identify gaps in supply as well as determine if an area has demand for their goods. Doing this research will ensure a new business is set up for success and their hard work does not go to waste, however it is currently very time consuming.

This project aims to identify demand for different types of cuisines based on availability and population demand. The findings will allow new restaurant owners to decide where to open their venue as well as what type of food they will serve.

Scope

For the purpose of this project, and scope of this project will only target Canada and be limited to food shops.

Data

Sources

This project will utilize data from several sources:

1. Geospatial data will be gathered from http://www.geonames.org/
2. Census data from Statistics Canada https://www.statcan.gc.ca/
3. Current business/venue data from https://foursquare.com/

The geospatial and census data will be combined to form a larger dataset, the data will be joined by post code. Finally, the FourSquare API will be used to identify restaurants within a 30KM radius. The responses from FourSquare will be cached due to rate limitations on the API.

Preview of the geospatial data, there is a total of 1656 records in the entire dataset:

country code	postal code	place name	state name	state code	latitude	longitude	accuracy
CA	T0A	Eastern Alberta	Alberta	AB	54.766	-111.717	6
CA	T0B	Wainwright Region	Alberta	AB	53.0727	-111.582	6
CA	T0C	Central Alberta	Alberta	AB	52.1431	-111.694	5
CA	T0E	Western Alberta	Alberta	AB	53.6758	-115.095	5
CA	T0G	North Central Alberta	Alberta	AB	55.6993	-114.453	6

Note: 4 columns were removed as they consist of nan values

Preview of census data, there is a total of 1650 records in the full dataset:

postal code	Geographic name	Province or territory	Incompletely enumerated Indian reserves and Indian settlements, 2016	Population, 2016	Total private dwellings, 2016	Private dwellings occupied by usual residents, 2016
1	Canada	NaN	T	35151728	15412443	14072079
A0A	A0A	Newfoundland and Labrador	NaN	46587	26155	19426
A0B	A0B	Newfoundland and Labrador	NaN	19792	13658	8792
A0C	A0C	Newfoundland and Labrador	NaN	12587	8010	5606
A0E	A0E	Newfoundland and Labrador	NaN	22294	12293	9603

The data above was combined and cleaned to form a new table which contained the relevant information for analysis and calling the four square APIs:

postal code	place name	state name	state code	latitude	longitude	Population
T0A	Eastern Alberta	Alberta	AB	54.766	-111.717	59234
T0B	Wainwright Region	Alberta	AB	53.0727	-111.582	64072
T0C	Central Alberta	Alberta	AB	52.1431	-111.694	62701
T0E	Western Alberta	Alberta	AB	53.6758	-115.095	43729
T0G	North Central Alberta	Alberta	AB	55.6993	-114.453	42905

Using the geospatial data, the foursquare API was used to get all food venues within a 30 KM radius. A total of 112, 732 records retrieved. The records are limited as a maximum of 99 venues can be retrieved for each area.

Neighborhood	Population	Venue	Venue Latitude	Venue Longitude	Venue Category
Eastern Alberta	59234	a&w	54.76694	-111.981	Fast Food Restaurant
Eastern Alberta	59234	subway lac la biche	54.76208	-111.964	Sandwich Place
Eastern Alberta	59234	taco bell	54.77161	-111.973	Taco Place
Eastern Alberta	59234	subway® restaurants	54.77097	-111.976	Sandwich Place
Eastern Alberta	59234	tarra's pizza	54.76901	-111.979	Pizza Place

In addition to the data above we will use more granular census data to get details about each state individually, this dataset includes a lot of demographic details such age, language spoken, and family characteristics. It is not possible to display a sample of all the data as there are nearly 800 features, here is an example of the first 5:

State	Age characteristics 15 years	Age characteristics 16 years	Age characteristics 17 years	Age characteristics 18 years
NB	8740	9030	9285	9455
NL	5805	5840	5900	6020
NS	11040	11085	11420	11755
ON	21235	22140	21715	22995
PE	1965	1895	1830	1915
QC	93910	95980	97700	100035

Data cleaning

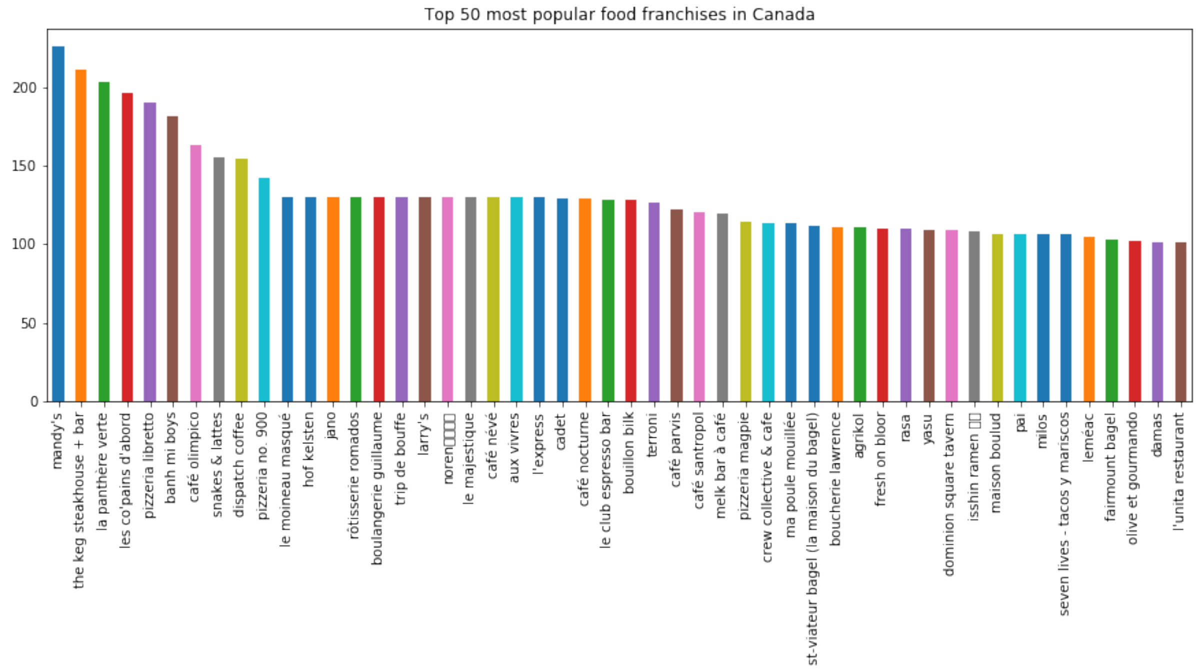
Several steps were taken to clean the data throughout the process to improve the accuracy of the analysis.

Where	What
Census data: place name	Removal of suburb names usually presented in brackets. This is unnecessary as the foursquare API does not use it.
Census/Geospatial data	Removal of any rows with missing latitude & longitude
Geospatial data	Remove any whitespace from place names
Foursquare data	Removal of any areas where foursquare did not have any records.
Foursquare data	Remove any areas that are not in Canada (Foursquare does area searches that retrieve venues from the USA in the border states)

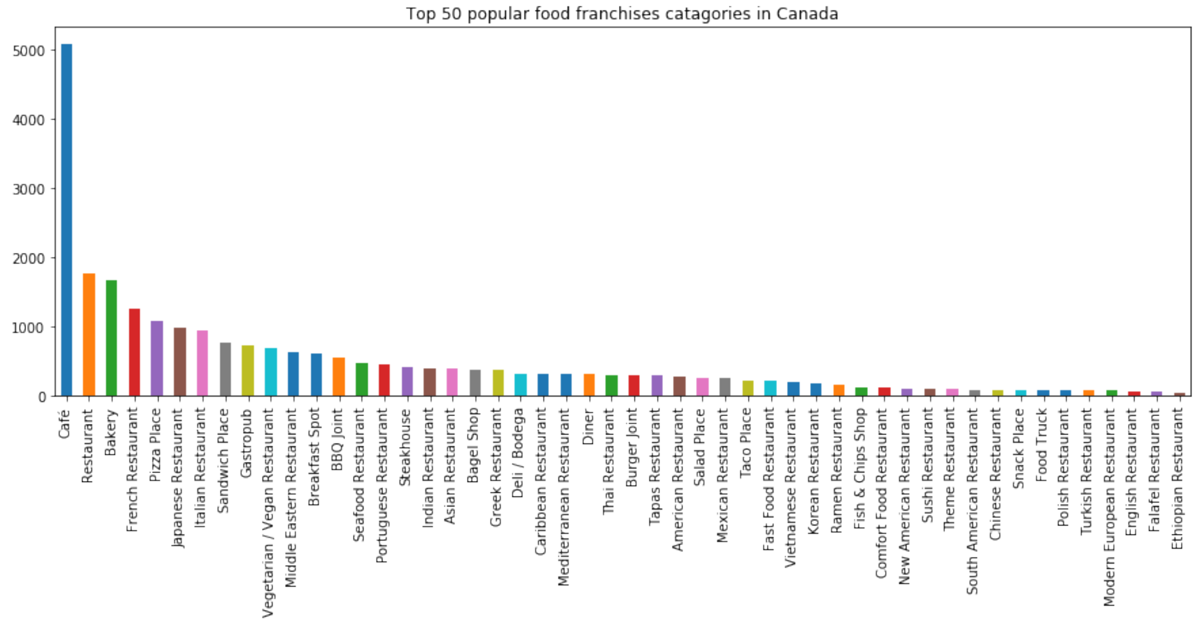
After data clean-up there is a total of 25400 records and 807 attributes.

Exploratory Data Analysis

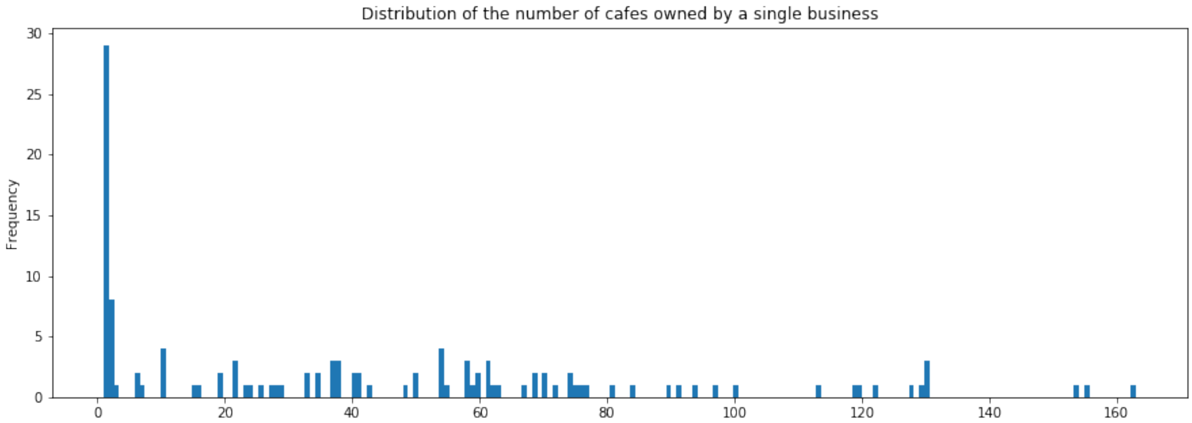
Once the data has been cleaned a range of insights can be gathered. Firstly we need to identify what type of venues are likely to succeed in Canada. Firstly we can observe that Canada has a range of franchises that are popular. According to the data, the Maddy's Pub & Restaurant franchises is the most popular food venue in Canada.



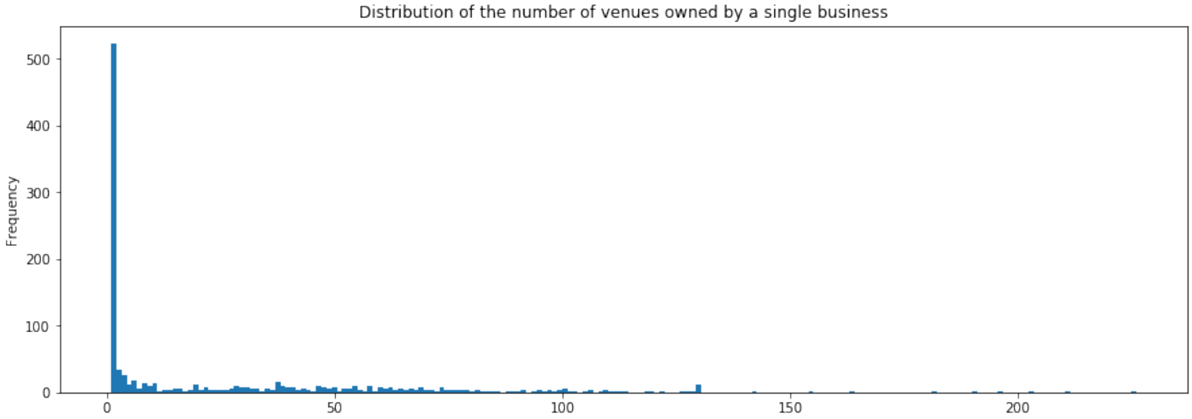
Observing the types of venues in Canada, it can be said that the most popular is the café with a density more than double of the next popular type of venue. This is rather counter intuitive as the top franchises in Canada don't have many cafés.



Looking closer at cafés it quickly becomes clear that the results observed above is due to the fact that most cafés are small businesses with less than 5 stores:



This helps to confirm that small business can thrive in Canada.



Modelling

It is important to understand that it is a sample and it is not completely representative of the population. One of the reasons for this is due to the fact the Foursquare API can only return 100 venues for a given place. This means that when we aggregate the dataset, every record where the venue count is 100 may actually mean that there are more than 100 venues; this issue can be solved with machine learning.

Feature selection

All non-identifiable (i.e. Neighbourhood) data was selected for modelling. Population and Venue counts were scaled using Min max scaling, and the Venue Category was encoded using the label encoder.

Additionally, the data retrieved for areas where 100 records were retrieved were ignored.

Data wrangling

Machine learning models are sensitive to class imbalance, the dataset used for modelling has a lot of class imbalance. To solve this issue the imblearn package was used to oversample minority classes in the data used for modelling.

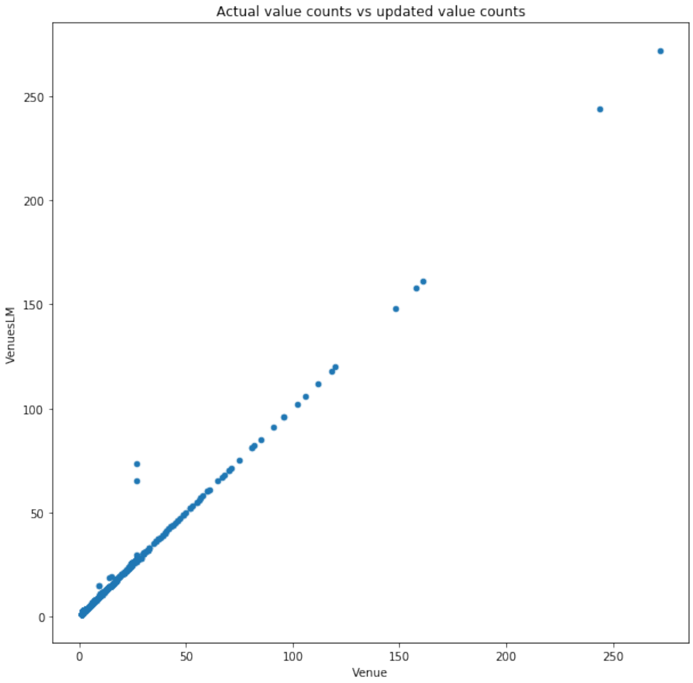
Model evaluation

A variety of models were tested including:

- Descension tree
- Random Forest
- K Nearest Neighbour
- Multilayer Perceptron (Neural Network)

The Random Forest model preformed the best with an average cross validation score of 0.98

It can be observed that the model only affected the values in a small way, there were only a handful of values where the value the model predicted was more than 1 off the original value.



Descriptive analysis

Going back to the original purpose of the project, three matrices will be used to determine if and what type of business will succeed in a given area:

1. Area population/venue density vs national statistics
2. Area population change vs national statistics
3. Area population/venue/category density vs national statistics

In the associated notebook, a user can select the area they wish to analyse using a dropdown and run the next cell. It will produce a report, for example, for the area of Downtown Toronto the report is:

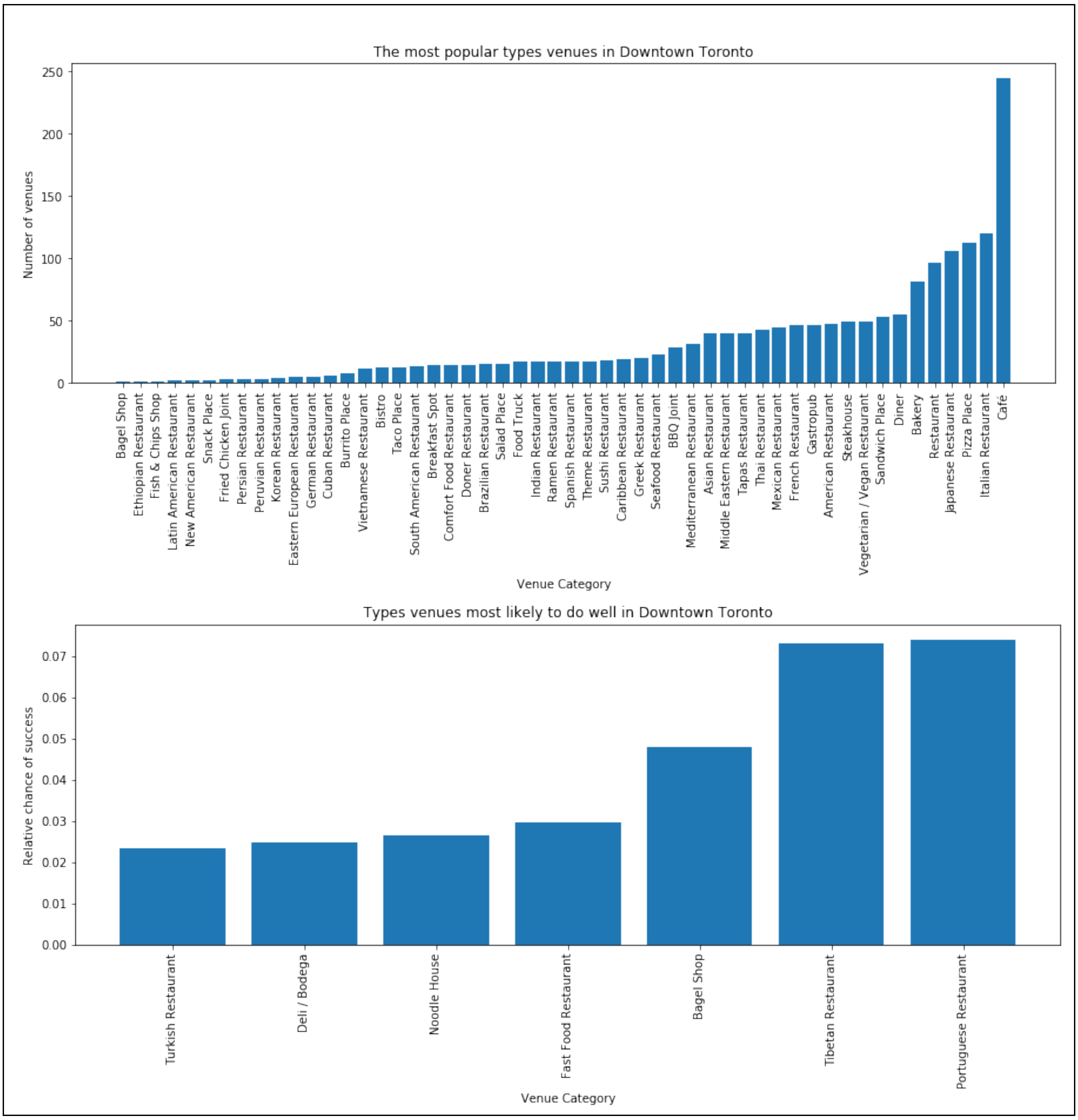
```
Downtown Toronto has a total population of 15951 and 1700 venues. The
standardised population/venue ratio is 0.423 which is more than the
national median of 0.026, nationally the population/venue is an average
is 22087 and 25450 per Neighbourhood.

Downtown Toronto has had a population change of 0.011% p/a which is less
than the national average of 0.01%. Therefore, new businesses in Downtown
Toronto has a greater chance of success.

Based on the data, there are 7 types of venues that are likely to do well
in Downtown Toronto (see graph below). A Portuguese Restaurant is most
likely to do well and a Café is likely to do the worst as it is
oversaturated based on the national data.

Top 10 Venue Categories for new businesses in Downtown Toronto:
0    Portuguese Restaurant
1       Tibetan Restaurant
2               Bagel Shop
3     Fast Food Restaurant
4             Noodle House
5            Deli / Bodega
6       Turkish Restaurant
7        Afghan Restaurant
8            Hot Dog Joint
9       Falafel Restaurant
Name: Venue Category, dtype: object


Bottom 10 Venue Categories for new businesses in Downtown Toronto:
72    Vegetarian / Vegan Restaurant
73                       Steakhouse
74                   Sandwich Place
75                            Diner
76                           Bakery
77                       Restaurant
78              Japanese Restaurant
79                      Pizza Place
80               Italian Restaurant
81                             Café
Name: Venue Category, dtype: object
```



The most popular types venues in Downtown Toronto

Types venues most likely to do well in Downtown Toronto

Conclusions

In this study, census, geospatial, and Foursquare data was combined to determine if a new food business would survive in a given area and what type of food they should serve to increase the chance of success.

A range of data science methods were used to clean, modify, and combine data and then model it using various types of machine learning algorithms.

Discussions

This project was completed as an assignment and as such it should not be used to make any real-world decisions. The data used in fairly old (census data from 2011) and the geospatial data isn't the most accurate (crowdsourced).