# Determining the Optimum Location for a Microbrewery within the Greater Denver-Aurora-Lakewood Metropolitan Area

Joel Corley

5 September 2020

# Table of Contents

# 1. Introduction

## 1.1 Background

Within the last decade the US market has favored the growth of craft beer. In 2019 craft breweries took 13.6% of the overall US beer market by volume. [1] Colorado in particular ranks *3rd* in the US for the most breweries at 348 as of *March 2019*. Per capita this translates into an astonishing 8.4 Breweries per person statewide, the most of any state. 2013-2017 saw a significant increase in the number of local independent breweries in Colorado which jumped from 118 to 330. [2]

A local economy clearly exists within the Denver Metro area which supports the patronage of microbreweries.

## 1.2 Challenge

An investment opportunity exists for the construction of a new microbrewery within the Denver metro area, but with a sizeable number of breweries already in the marketplace guidance is needed regarding the selection of a good locale.

In this report an examination of existing brewery sites is undertaken and coupled with US Census data for cities that compromise the Denver-Aurora-Lakewood metro area. Existing local market brewery information, provided by Foursquare, is leveraged to determine ideal metro area locations for a new microbrewery.

## 1.3 Interest

Those who will find the most interest in the construction of a new microbrewery include: potential investors, financial institutions weighing in on the risk and reward of issuing loans, market economists, and consumers interested in finding new local breweries.

# 2. Data Acquisition & Preparation

## 2.1 Data Sources

Data has been obtained from two chief sources. Numbers for total population, and geographic boundaries for cities are derived from the most recent US Census Data in 2018. Local brewery information has been obtained from Foursquare for December 31, 2018 in order to match 2018 US Census Bureau data.

Foursquare is an American tech company which provides venue information based upon geographical proximity. Foursquare has partnered with Uber, Tencent, Apple, Samsung and Twitter. [3]

## 2.2 Data Cleaning

Data obtained from the US Census Bureau, census.gov, present an estimated total population and city geographical boundary information for the metro area in 2018.

A Margin of Error (MOE) was presented for population estimates. The cities of Denver and Broomfield had no MOE reported and therefore their population estimates have an unknown reliability.

Either jurisdiction is among the largest cities within the metro area. Denver and Broomfield have grown in population considerably within the last decade, and as a result it is likely population estimation was difficult in 2018. Broomfield had a newer hospital built near their airport in 2017 and there has also been a creeping population expansion northwards within city limits; coinciding with the construction of numerous apartment buildings.

Foursquare venue information was obtained through their website API which enables access to their database through search queries. A venue category of 'brewery' was utilized along with geographical coordinates for downtown Denver, and a search radius of 15-miles. Results returned appeared to be limited to 50-venues. A search of 8 major metropolitan cities (Denver, Aurora, Lakewood, Centennial, Littleton, Lakewood, Golden, Thornton, and Arvada) was therefore undertaken in order to obtain as many venues as possible within the geographical boundary of Denver-Aurora-Lakewood. This was done by altering search criteria for latitude and longitude to match the respective city in question. Duplicate venue information was later dropped.

Foursquare appears to have a limited dataset for Denver area breweries where a number of famous local breweries are omitted.

## 2.3 Feature Selection

After cleaning 2018 US Census data there were 61 cities and 17 features. Not all features immediately assisted the task at hand and were dropped.

Table 1 – Simple feature selection of US Census Bureau data cleaning

| **Retained Features** | **Dropped Features** | **Reason for Dropping Features** |
|---|---|---|
| NAME, INTPTLAT, INTPTLON, GEOMETRY | STATEFP, PLACEFP, GEOID, NAMELSAD, CLASSFP, PCICBSA, PCINECTA, MTFCC, FUNSTAT | US Census data include a number of codes for State, place, etc. which have no utility. |
| ALAND | AWATER | Water surface area is not included for population density purposes. |

Table 2 – Simple feature selection of Foursquare data cleaning

| **Retained Features** | **Dropped Features** | **Reason for Dropping Features** |
|---|---|---|
| name, lat, lng | Numerous features dropped including: 'delivery' the short name for venue 'category', etc. | Limited utility for pin-pointing the brewery's geographic location. |

# 3. Methodology

## 3.1 Box and Whisker Plot

A Box and whisker plots, or Box Plot, will be utilized to determine quantiles for population density of each respective city in order to observe underlying statistical patterns.

## 3.2 Visualization of Each City's Total Population

A choropleth plot will be used in order to visualize the relative density of each city.

## 3.3 Venue Locations

A graphical plot of brewery locations within the geographic boundary of the Denver Metro area will be performed. This will aid in visually locating brewery locations and identification of any observable spatial patterns.

## 3.4 DBSCAN

DBSCAN stands for Density-Based Spatial Clustering of Applications with Noise, and is an Unsupervised Machine Learning algorithm. [4] This technique is among the most common clustering algorithms which works by detecting spatial density of objects relative to one-another. If a particular point belongs to a cluster, it should be near to other points in that said cluster.

# 4. Results

## 4.1 Population

The following horizontal bar graph reveals Denver is by far the most populous city within the metro area with approximately 700,000 people. Aurora and then Lakewood, sequentially, appear to have half the population of each other. A group of 6 cities beginning with Lakewood emerge as intermediate-sized cities in the range of 100,000 to 150,000 persons. The remainder of the cities (53), with the exception of Broomfield, have a total population of roughly 50,000 or less.

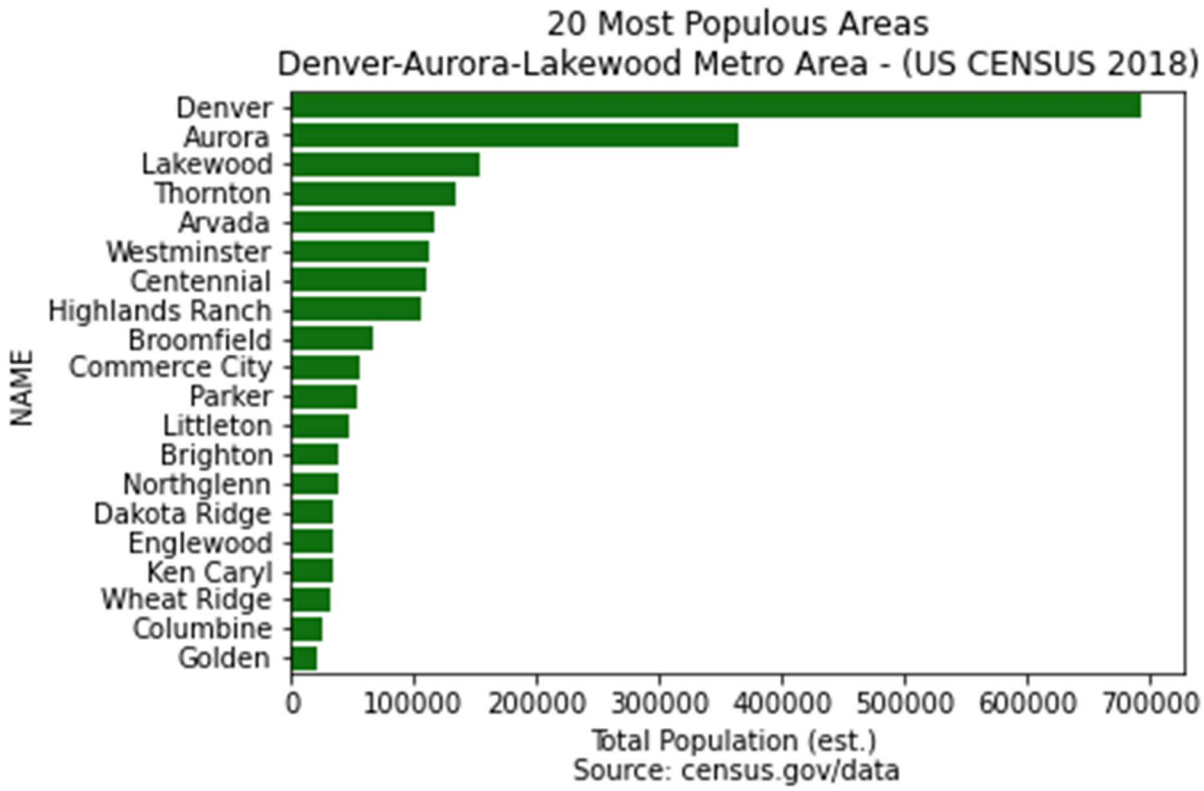
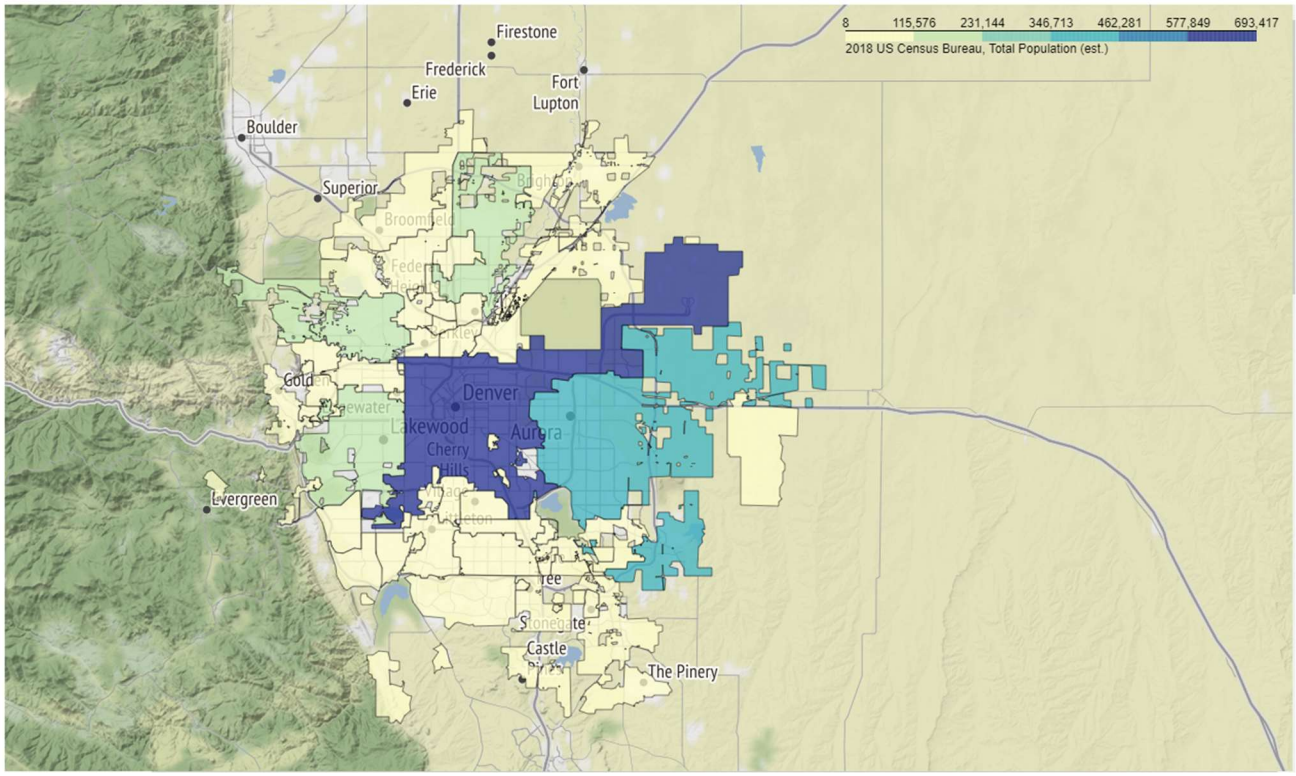
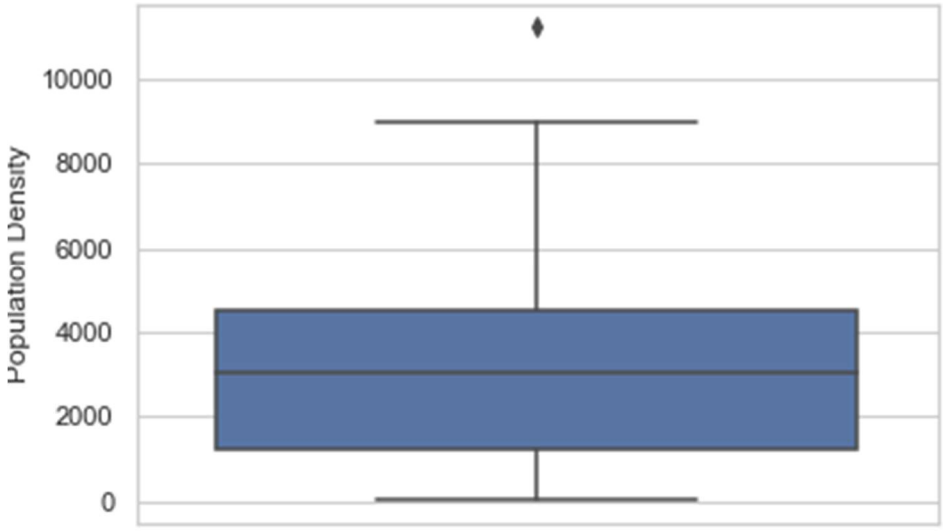



**Figure 2 – Total Population by City, Choropleth**



From the choropleth we observe that the City and County of Denver holds Denver International Airport within its jurisdiction.

Figure 3 – Population Density (Total Population/Square Mile), BoxPlot

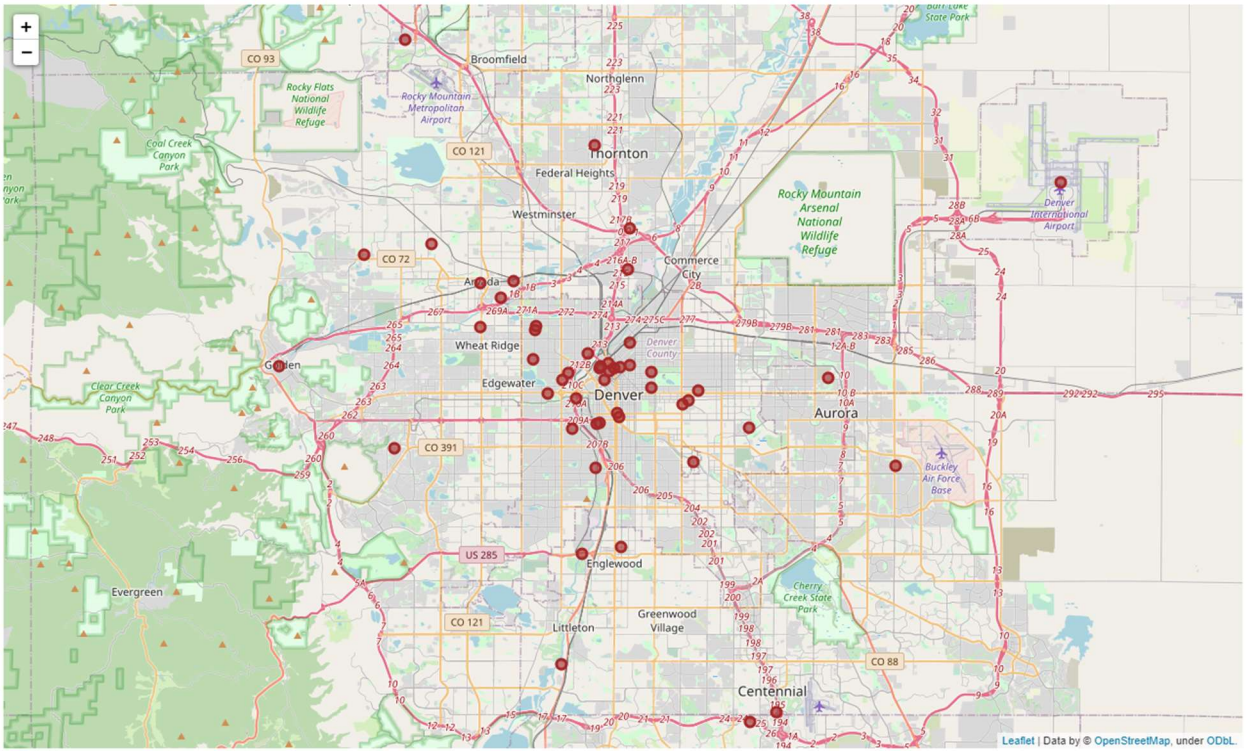



The most densely populated cities appear to have a well-defined geographic boundary, and include Aetna Estates, and Glendale which is actually completely surrounded by Denver County.

## 4.2 Brewery Locations

A cluster of breweries with its centroid located just North of the urban core close to a district called River North (RiNo) is identified in the brewery locale plot. The majority of breweries in the metro area lie within a Northwest-Southeast trending line from Arvada to Denver. Downtown Aurora which only has one brewery in the Foursquare dataset appears pretty far removed. The remaining breweries are dispersed throughout the metro area, leaving plenty of room for a startup microbrewery.

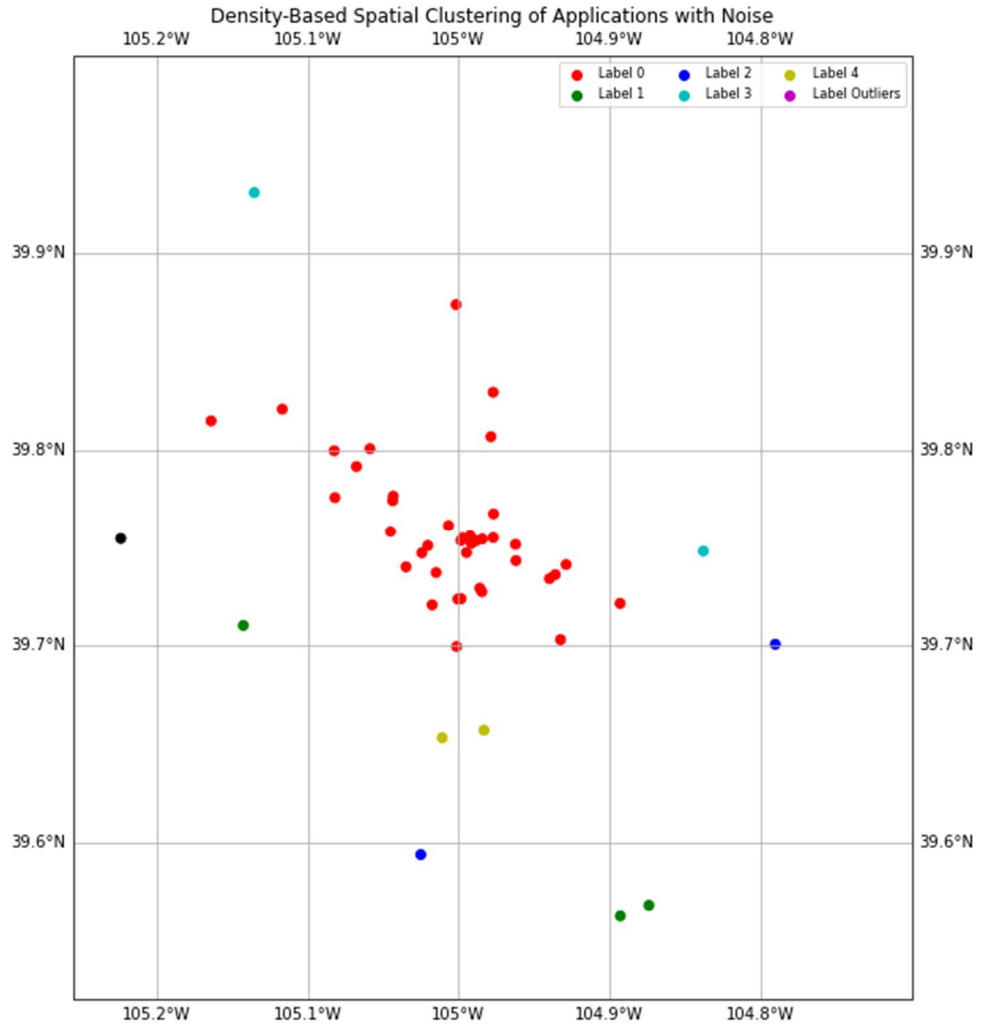
**Figure 4 - Brewery Locations**




## 4.3 DBSCAN

DBSCAN identified 5 brewery groupings and an outlier in Golden. The central cluster, 'Label 0', encompasses the urban core of Denver and includes all breweries North-to-Northwest of downtown Denver, with 1 exception.

Figure 5 – DBSCAN Plot




## Discussion

The majority of breweries within the Denver Metro area reside within a Northwest-Southeast trending band approximately 10-miles in length and 2.5-miles in width. DBSCAN confirms the presence of this grouping with a central clustering of breweries that are spatially related by proximal radial distance. The band is centered around a region of comparatively higher total population and encompasses the cities of Arvada, Thornton, and Denver. The population densities for both Denver and Aurora are comparatively low in the group of 61 jurisdictions, which indicates their geographic boundaries cover a range well outside of their core populations.

## Conclusion

While the majority of breweries are found within a Northwest-Southeast trending band encompassing Denver, immediately west of Denver in Lakewood there are comparatively few breweries. Lakewood is the third most populated area within the metro region, and only has 1 brewery according to the Foursquare dataset.

More data will need to be obtained for brewery locations within the Denver Metro area in order to provide a more exhaustive analysis.

A subdivision of the major core areas within, Denver, Aurora, and Lakewood will need to be undertaken in the future to determine the most densely populated parts of each city. Surprisingly, these cities rank comparatively lower with regard to population density; meaning each city likely has at least one core and then a surrounding peripheral population.

## References

[1] https://www.brewersassociation.org/statistics-and-data/national-beer-stats/

[2] worldatlas.com.

[3] https://foursquare.com/about/

[4] https://www.aaai.org/Papers/KDD/1996/KDD96-037.pdf

## Acknowledgements

- IBM Data Scientist Professional Certification course
- Stackoverflow.com