Drone Delivery Opportunities

in Los Angeles, California

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Introduction / Business Problem

Are you involved in a Business wishing to expand market share but realize in-store visits may not be a growth area? Do you have an existing website where you take orders but constantly receive feedback that delivery times are too long? There may be a solution on the horizon… Bring the store to your customers in as little as 30 minutes using Drone Delivery!

Fig. 1: Possible delivery items: Prescriptions, Pizza and Office Supplies

The success of quick delivery has caught the attention of retailers as large as Amazon with their Amazon Prime Now 2 hour delivery (https://primenow.amazon.com). Amazon are also moving into the idea of even shorter delivery times using Drones (https://www.amazon.com/Amazon-Prime-Air/b?ie=UTF8&node=8037720011).

The idea presented in this report is to begin to implement the drone delivery option in Los Angeles, CA using a series of existing aviation friendly locations (Heliports). The effort will begin by targeting the 10 most popular venues nearest each heliport and determining if they are interested in providing drone delivery.

The reason for using heliports as a base location is because neighbors are more likely to be 'aviation friendly' and not complain of noise or have concern over low flying aircraft. Longer term, it might make sense for each store/restaurant location to have their own drone launch pad. But that is a potentially costly investment that may be too risky in the immediate future. Concentrating the drone delivery fleet at centralized locations is a good starting point.

Data

1. Airport/Heliport information:

Airport/Heliport information for Los Angeles, California is obtained from the United States Department of Transportation : http://osav-usdot.opendata.arcgis.com/datasets/a36a509eab4e43b4864fb594a35b90d6_0 The columns of interest are:

FullName : a description of the location
City : will only deal with 'Los Angeles' to start
Y : Latitude
X : Longitude

2. Target businesses (Phase 1):

The effort to target businesses that might be interested in drone delivery will initially be concentrated on venues surrounding the above heliports. This will be obtained using the Foursquare venues/explore API call. The specifics:

https://api.foursquare.com/v2/venues/explore?
&client_id/&client_secret (not disclosed)
&ll : latitude and longitude from the DOT database above
&radius : the distance around each Heliport we will target businesses.

3. Target businesses (Phase 2):

Any chain of retailers or restaurants would be a good target. Their location information can typically be scraped from their website using variety of techniques. The general idea is:

- read the html
- use BeautifulSoup to get the address information
- store this in a Pandas DataFrame
- plot locations on a map to determine the flight range each store's drone(s) would be responsible for.

Methodology

Two general ideas were incorporated into the report. First, look at publicly available aviation related data that would narrow the search for suitable delivery locations in Los Angeles. This is described in 'Exploratory data analysis' below. Second, use a Machine Learning clustering algorithm to determine if suitable delivery locations have something in common. This is described in 'Machine Learning used' below. With that overview in mind…

Exploratory data analysis

Reviewed the 'Description' of United States Airport Information from U.S. Department of Transportation website http://osav-usdot.opendata.arcgis.com/datasets/a36a509eab4e43b4864fb594a35b90d6_0. It looked like it could be used to identify heliports in the City of Los Angeles, California.

Manually downloaded the dataset as a CSV file and confirmed 'Dataset Attributes':
State Name : searched on California
City Name : search on Los Angeles
Elevation : heliport could be at ground level or could be on a building rooftop.

Machine Learning used

A clustering algorithm was used to group heliports according to local venues determined by accessing the Foursquare API venues/explore method. The top 10 venues within 500 meters from each heliport was encoded using one_hot_encoding and then KMeans was used as the clustering algorithm. The 'elbow method' was used to determine a reasonable value of 'k' to use in the KMeans algorithm.

Results

The purpose of ML KMeans clustering was to see if certain heliport areas are only served by certain venues. This would limit the types of delivery options available and reduce the viability of that heliport as a delivery location.

In [32]:
```
# Will first determine the optimal value of 'k' by using the 'elbow method'
LA_grouped_clustering = LA_grouped.drop ('FullName', 1)
import matplotlib.pyplot as plt
%matplotlib inline

Sum_of_squared_distances = []
K = range (1,15)
for k in K:
    km = KMeans (n_clusters=k)
    km = km.fit (LA_grouped_clustering)
    Sum_of_squared_distances.append (km.inertia_)

plt.plot (K, Sum_of_squared_distances, 'bx-')
plt.xlabel ('k')
plt.ylabel ('Sum_of_squared_distances')
plt.title ('Elbow Method for Optimal K')
plt.show()
```

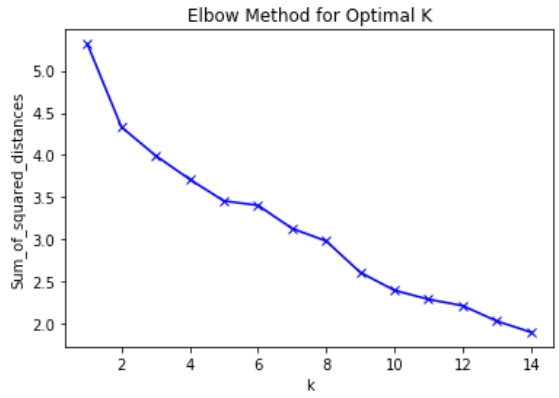

Fig 2 : Determine reasonable number of clusters for KMeans

From the KMeans clustering results, an 'elbow' is seen at 'k' = 5. This will be used as the 'k' argument in KMeans.

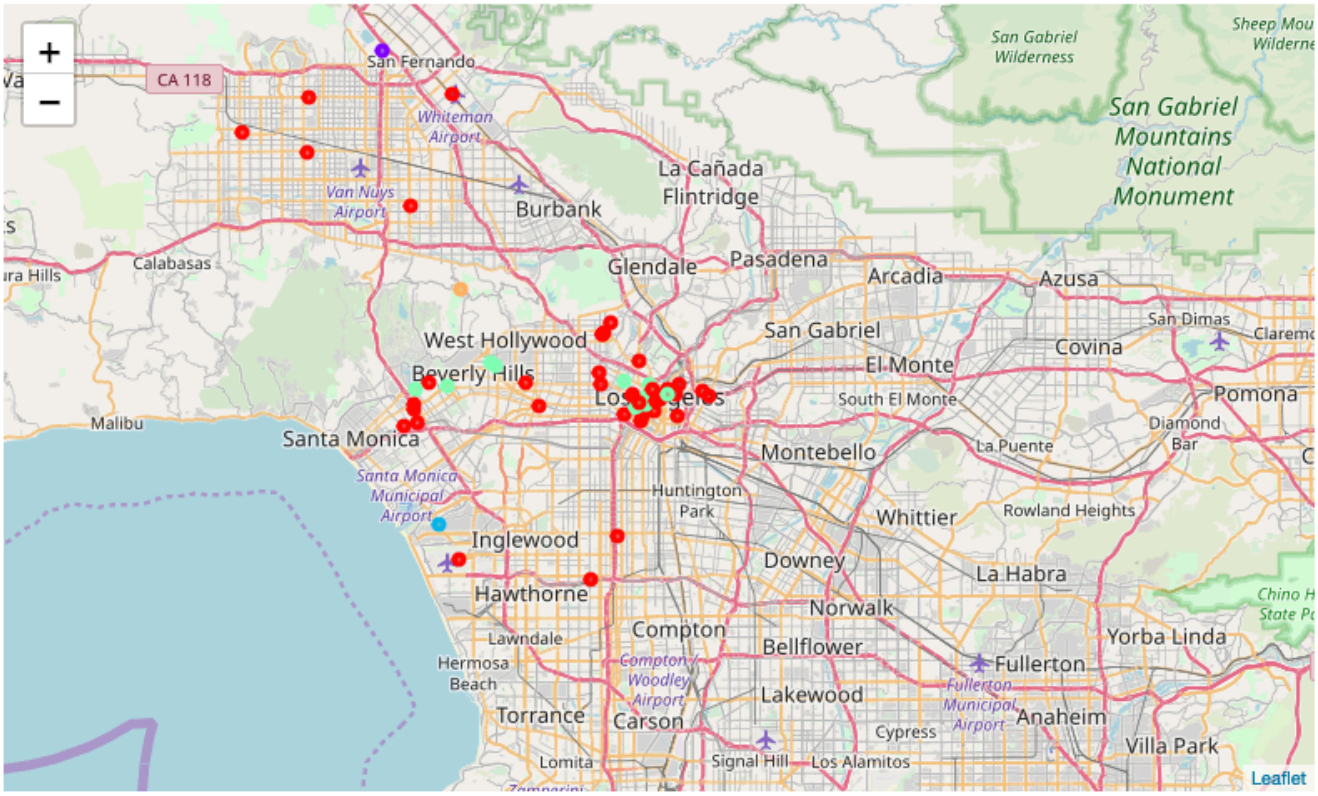

Fig 3 : Location of drone delivery heliports (after KMeans clustering)

The map above shows a concentration of heliports in the downtown and West LA areas. There are fewer heliports in the San Fernando Valley area as well as the South LA area. If needed, additional drone delivery sites could be incorporated into specific businesses that experience success with drone delivery in the San Fernando Valley or South LA areas.

Discussion

Success with drone delivery is certainly not a guarantee. There are technical, regulatory and social hurdles that will have to be addressed. To start the discussion, there are four topics that need to be addressed:

1. Regulatory approval:

Los Angeles would need to work with the U.S. Federal Aviation Administration to implement a pilot program (https://www.faa.gov/uas/programs_partnerships/integration_pilot_program/). This would be similar to that used in Reno, Nevada for drone

delivery https://www.smartcitiesdive.com/news/reno-nv-conducts-faa-approved-drone-delivery-flight/532451/

2. Heliports as delivery base:

Some heliports are on building rooftops. This may limit access by delivery personnel. Therefore it would be good to highlight heliports whose elevation is different from ground level. Ground level could be determined using USGS The National Map - Elevation Point Query Service (HTTP GET requests) https://nationalmap.gov/epqs/

3. How to confirm delivery to correct address?

One method to confirm correct location would be to require delivery recipient have a mobile phone with GPS location service enabled. Then the location of the phone would be used as the delivery location. Using the same elevation service mentioned above (USGS Elevation Point Query Service) it could be determined if the phone was on ground level (delivery will proceed) or on the upper floor of a building (would need to confirm where drone will land).

4. How to confirm delivery to correct person?

One idea is to require a Bluetooth connection between the drone and the delivery recipients mobile phone at the delivery location latitude/longitude. This would confirm the person who ordered the item is present at the delivery location. The drone would orbit 10 feet off the ground for 5 minutes while waiting for this connection. If Bluetooth connection cannot be established, either ask the mobile phone user for permission to land or keep the item on the drone and return to base (no delivery).

Conclusion

Drone delivery for items below a certain weight and size seems like a good business opportunity. Some cities are already on the path towards implementing this - https://www.faa.gov/uas/programs_partnerships/integration_pilot_program/lead_participants/

There will be hiccups along the way (high winds, rain, recipient not at the right location to receive items, etc). However, those can be worked through as experience is gained over time. It's likely that certain items or customer profiles will end up using the service more than others. Perhaps Whole Foods customers (upscale grocery store owned by Amazon) will be

more likely to pay an additional fee for drone delivery over Costco customers (membership warehouse store concentrating on selling larger quantities of items). Also, health related items or last minute party snacks could prove popular. For instance, someone may have a headache or be sick and need aspirin or cough medicine but can't leave the house. Or perhaps they are hosting a party and running low on chips and dip or need more bread (lightweight items).

The next few years should prove an exciting time for businesses willing to take a risk and add drone delivery to their list of options for getting their products to customers.