Location of skyports for Air taxi services in Paris

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1. Description of the problem

VTOLs (Vertical Take-Off and Landing) vehicules, also know as flying cars, have a great chance to become a reality in the next decade. Several concepts are proposed every years and some are already being tested as for exemple the Volocopter[1] or Lilium[2]. There is a great number companies developping the aircraft but Uber seems to be clearly ahead of the competition concerning the setup of an air taxi service with the elevate project[3].

To provide this service, aircraft are needed as well as bases for the aircraft to land on. Theses bases are called skyports and some will be located directly inside big cities for easy commute between different places in the city. Given the fact that these facilities are expensive to build and will be placed in costly real-estate environment, it is crucial to place them correctly in order to maximise profit and ensure economic viability.

Air taxi services, will be, as road taxis, a network proper to one city. Living close to this city, I have chosen Paris since I may also discover new insights of my city. But this work can be done for all major cities in the world.

So the problem I would like to answer is : where should the first dozen(10) of skyports in Paris be located?

2. Data

Paris is divided in administrative neighbouthoods called « arrondissements ». Data regarding them can be gathered with the help of the API [4].

The Initial data used concerns luxury venues as explained in the following paragraph. A list of the 5-stars and palace hotels can be scrapped at [5]. The best restaurants of France are awerded with stars from the « Guide Michelin » a list in paris can be scrapped at (6]. Finaly, Paris is well know for its luxury fashion industry also called « haute couture ». A list the businessse with this label « haute couture is available at [7] and is directly copied and pasted.

3. Methodology

a. Initial thaughts

To answer our question, we first need to identify the potential clients. As the technology will be beginning and investment costs will be huge, ticket prices will certainly be expensive at first. So the location of the first skyports should be convenient to clients able to pay the price of the tickets. I have identified two kind of clients :

- Poeple with deep pockets, who spend a lot in leisures.

- Professional whose time is expensive and companies are ready to pay for the time gained

After identifying the clients, we need to identify the venues that these categories of clients are the most susceptible to visit.

It may be a little cliché, the first category of venues which comes to my mind is luxury businesses. The idea is to get a list luxury restaurants, hotels and clothes shops. The list of CAC40 (40 biggest companies in France) headquarters will be added. The service would also provide a great added value for these venues which could therefore provide great finacial support and lobbying power to make the first skyports appear. Luxury venues include 5 stars and palace hotels, Michelin-star-awarded restaurants, « haute couture » fashion shops. We can also include jewelries and watch shops

The location of all these venues can be found using the Fourquare API. The locations can then be clustered so that a base serves a maximum of venues.

Finally, if we make the assumption that current buildings do not offer sufficient safety to land on the roof (weight of the aircraft on building, roof area and slope, private properties), we can find the closest square to the centroid of the cluster to install the skyport.

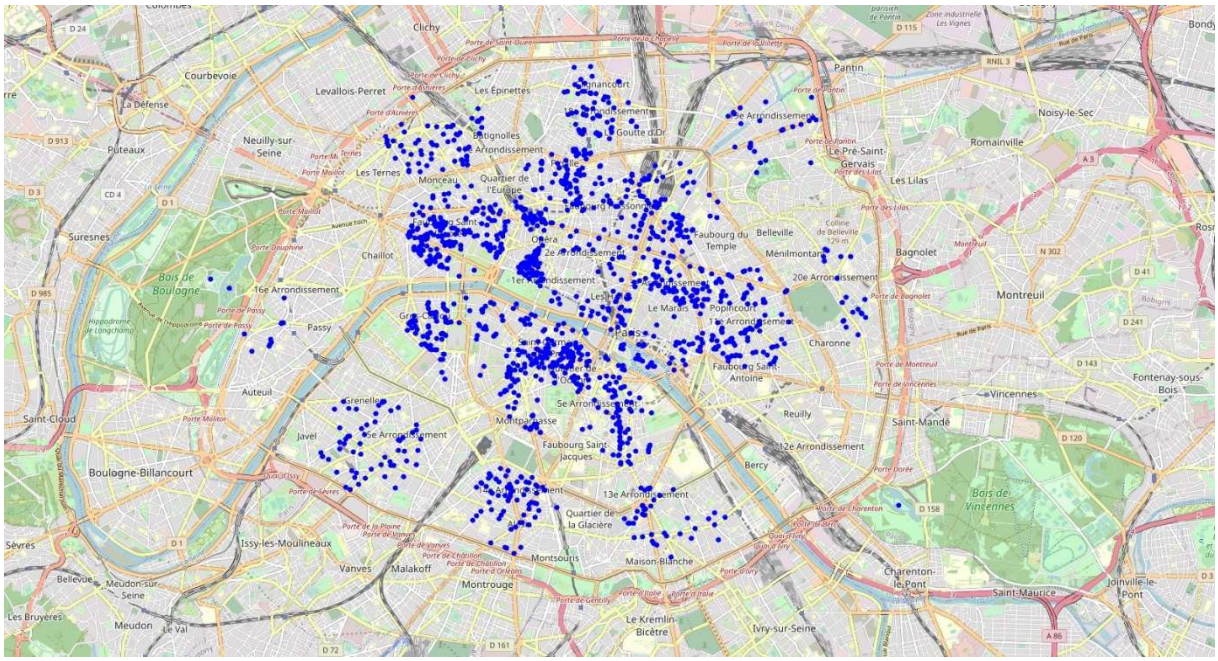
b. Actual methodology

The actual methodology applied is different from the predicted because some methods actually not work as expected. In particular,it was very difficult to make the name of a venue from Foursquare with the name from a list coming from another website. This because they are not written in the same way, sometimes precising 'Hotel' or 'Paris', sometimes not, and it is really difficult automatize the the process so that it always works. Thus the strategy of making queries and then filtering the interesting ones with matching strings has been abandonned. Instead the luxury venues have extracted only via the research 'Luxury hotels'on Foursquare. For the same reason, restaurants with stars awarded by the guide Michemin have been replace by french restaurants, which are ofter high end in Paris. The new methodology is therefore the following :

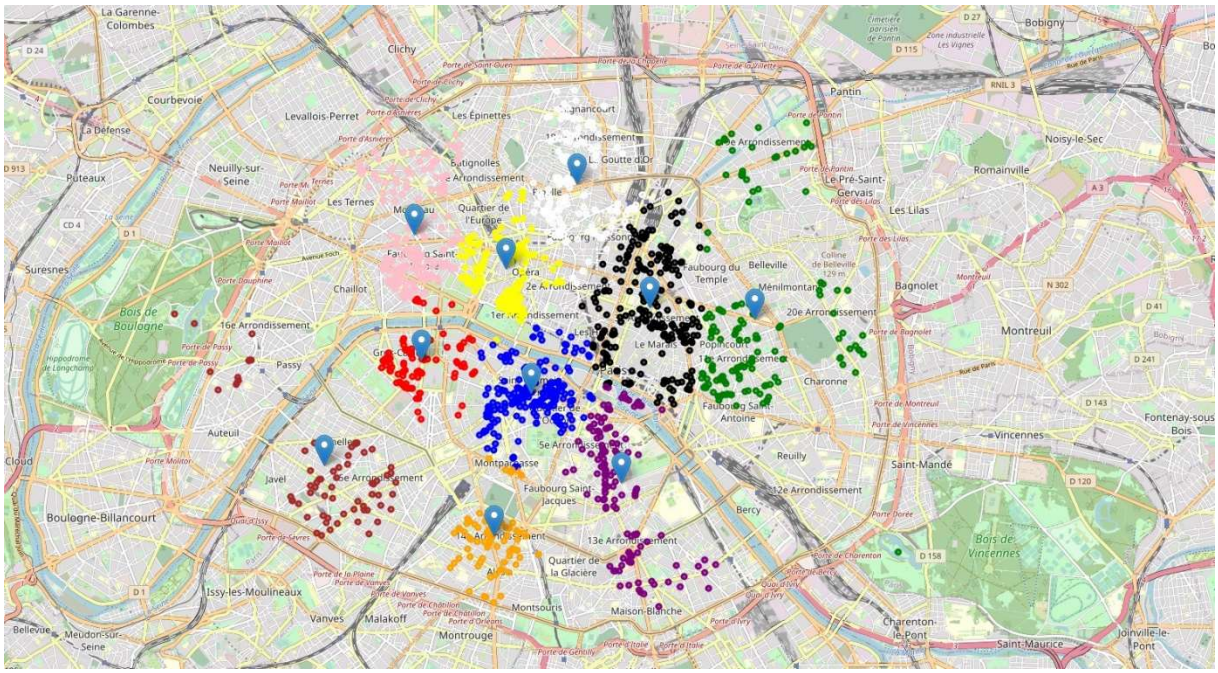
- Gather location data of the arrondissements (latitude, longitude, area) with [4]
- For a radius sufficiently large (850m) around the center of each arrondissement, gather luxury venues (luxury hotels, french retaurant, jewleries, boutiques, perfume shopes, watchmakers) in order to cover the whole city area.
- Produce A map of the venues clustered in 10
- Compute the location of the centroids of the clusters to indicate a good place to locate a skyport
- Attribute venues to each arrondissement with the help of the postal code.
- Compute the density of each type venue for each arrondissement
- Cluster the arrondissments in 3, using k-means. Since we have only luxury shops, the clusters should be low, medium and high density arrondissements. Similar arrondissements with a high density should be to target in priority

4. Results

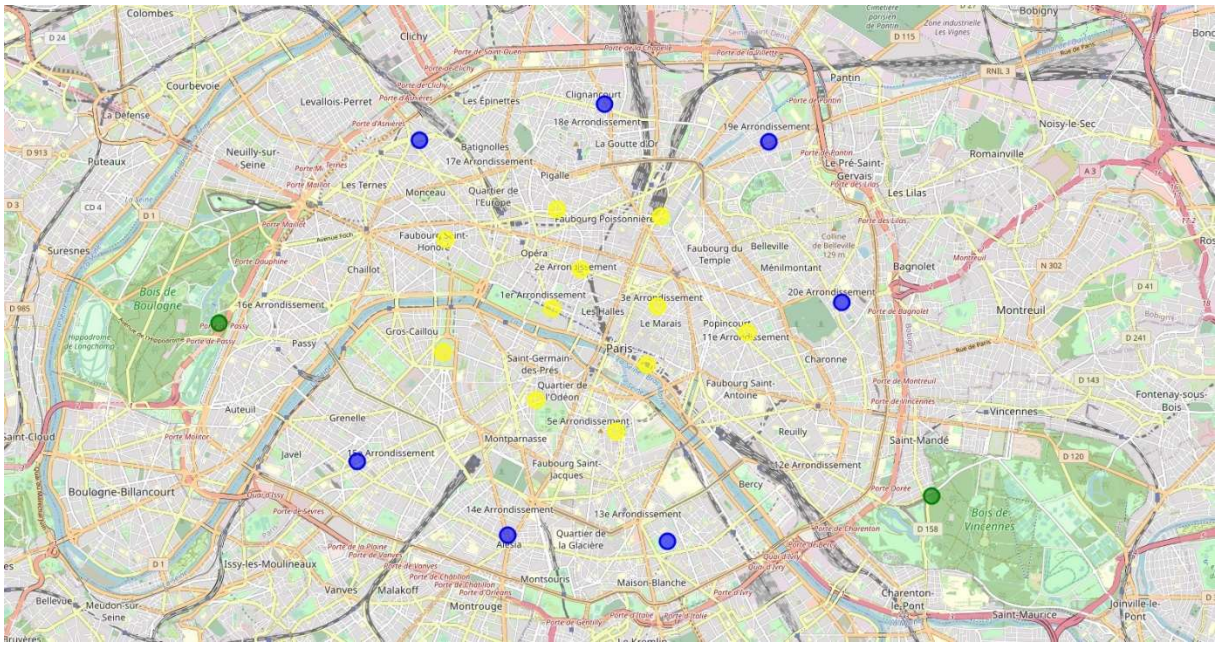
The map indicating cluster of luxury venues gives already godd insights. The density of this kind of shops is higher in the center than in the outer of the city.



Then these venues have been geographically clustered in 10 clusters so that the 10 first skyports can be located close to the centroid of each cluster. The centroids are indicated with a Marker on the Map. They are logically more towards the center but some are further to still cover a great portion of the city.
This answers our main question.



To investigate further, all the 20 arrondissements were clustered into 3 clusters. As some arrondissement are vast and other much smaller the number of venues has been normalized by the area of the arrondissement and thus be classified by density of each type of venue. The map of clustered arrondissements confirms the results of the first map with the arrondissements in the city center belonging to the same cluster. The two ‘low density’ arrondissements are in this category because their area include woods.



5. Discussion

The results given are interesting and correspond quite accurately to my knowledge of Paris. However, if the methodology looks great in theory, it is much more difficult in reality. While it is easy to gather lists, the correspondance check within this list is very difficult because a name can be written differently. Annexes in the notebook present the web scraping and the attempt to check the presence of venues within the lists.To overcome this issue, the research « luxury hotel » on foursquare does not seem perfect and should be improved. Also, two arrondissment are much larger than the others because they include woods which of course contain no venue and the area should be just the « built » part.

6. Conclusion

In this study we have seen that central arrondissemnts (neighbourhoods) of paris are much dense in terms of luxury venues. So much that it can be seen at naked eye. The clustering confirms that the central arrondissements belong to the same group, which must be arrondissements with a high density of venues. A geographical clustering has been realised and ideal location for skyports (i.e. centroids of clusters) indicated with the help of Markers. This method of geographical clustering can be interesting to locate facilities or businesses if venues from which proximity would be benficial are known.

7. Future directions

As explained previously, in my mind, the best improvement would be to select more accurately the venues which have to be in the dataset. The list of hotels looks not like it is purely luxury hotels, and jewelries can be non-luxury jowelries. Also, more generally, the selection of only luxury venues can be discussed with the clients as the target audience for air taxi service can be broader.

8. Bibliography

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[7] https://www.challenges.fr/luxe/la-nouvelle-liste-des-maisons-de-haute-couture_7623