main

December 20, 2019

1 Important note

Folium maps won't show on display. You can either open them by running insides saved in folder `maps` using Internet Browser or run the notebook manually.

You can also see a sample image corresponding to map's name in folder `previews`.

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[87]:
```
%matplotlib inline
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import geopandas as gpd
```

Download data from `kaggle` under the link: https://www.kaggle.com/dgomonov/new-york-city-airbnb-open-data

It's data from AirBnB including mostly recent (as for december 2019) informations and metrics about hotels located in New York City.

[88]:
```
df = pd.read_csv('input/AB_NYC_2019.csv')
```

3 1. Data check

[89]:
```
df.head()
```

[89]:
```
     id                                              name  host_id  \
0  2539                Clean & quiet apt home by the park     2787
1  2595                             Skylit Midtown Castle     2845
2  3647               THE VILLAGE OF HARLEM…NEW YORK !     4632
3  3831                   Cozy Entire Floor of Brownstone     4869
4  5022  Entire Apt: Spacious Studio/Loft by central park     7192

     host_name neighbourhood_group neighbourhood  latitude  longitude  \
0         John            Brooklyn    Kensington  40.64749  -73.97237
1     Jennifer           Manhattan       Midtown  40.75362  -73.98377
2    Elisabeth           Manhattan        Harlem  40.80902  -73.94190
3  LisaRoxanne            Brooklyn  Clinton Hill  40.68514  -73.95976
4        Laura           Manhattan   East Harlem  40.79851  -73.94399

         room_type  price  minimum_nights  number_of_reviews last_review  \
0     Private room    149               1                  9  2018-10-19
1  Entire home/apt    225               1                 45  2019-05-21
2     Private room    150               3                  0         NaN
3  Entire home/apt     89               1                270  2019-07-05
4  Entire home/apt     80              10                  9  2018-11-19

   reviews_per_month  calculated_host_listings_count  availability_365
0               0.21                               6               365
1               0.38                               2               355
2                NaN                               1               365
3               4.64                               1               194
4               0.10                               1                 0
```

[90]:
```
df.columns
```

[90]:
```
Index(['id', 'name', 'host_id', 'host_name', 'neighbourhood_group',
       'neighbourhood', 'latitude', 'longitude', 'room_type', 'price',
       'minimum_nights', 'number_of_reviews', 'last_review',
       'reviews_per_month', 'calculated_host_listings_count',
       'availability_365'],
      dtype='object')
```

[91]:
```
df.shape
```

[91]:
```
(48895, 16)
```

[92]:
```
df.dropna().shape
```

[92]: (38821, 16)

Comment:

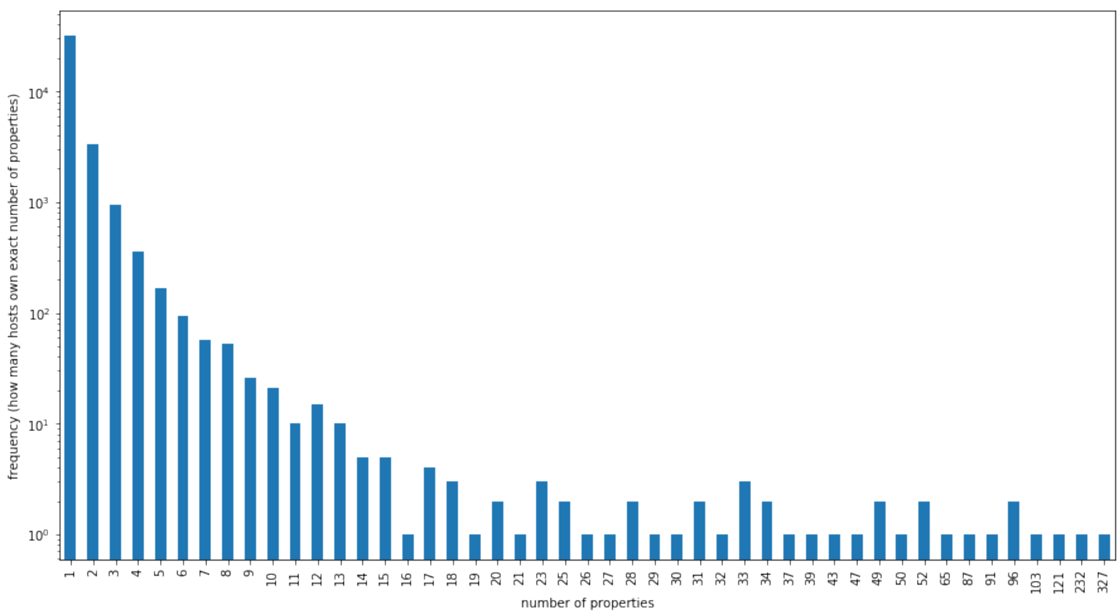
Around 20% of all rows have at least one missing value (NaNs).

4 2. Distribution of number of hotels belonging to individal hosts

How many hosts own 1 property, how many own 2 properties, ..., how many own 10 properties, ...?

[93]:
```
s = df['host_id'].value_counts().value_counts().sort_index()
s.plot(kind = 'bar', logy=True, figsize=(15,8))
plt.xlabel('number of properties')
plt.ylabel('frequency (how many hosts own exact number of properties)')
```

[93]: Text(0, 0.5, 'frequency (how many hosts own exact number of properties)')



Comment:

Over 32000 people own a single hotel, which is 66% of all hotels (registered in AirBnB) in New York City. Amount of people owning 2 hotels is 10 times less and equal to 6% of all hotels. There is one person or apparently a company called Sonder which owns 327 hotels registered under single ID.

5 3. Hosts gender statistics

Gender statistics over host names

[94]:
```python
import nltk
from nltk.corpus import names
```

[95]:
```python
male_names = set(names.words('male.txt'))
female_names = set(names.words('female.txt'))
```

[96]:
```python
print(len(male_names), len(female_names))
```

```
2943 5001
```

[97]:
```python
df.shape
```

[97]:
```
(48895, 16)
```

Notice: a "both name" is a name like i.e. "Alex", which can belong to both genders

[98]:
```python
male_count = 0
female_count = 0
both_count = 0
non_identified_count = 0
n = len(df['host_name'])

for name in df['host_name']:
    if name in male_names  and name not in female_names:
        male_count += 1
    elif name in female_names and name not in male_names:
        female_count += 1
    elif name in male_names and name in female_names:
        both_count += 1
    else:
        non_identified_count += 1

print("Male names: {}%\nFemale names: {}%\nBoth names: {}%\nNon_identified: 
 ↪{}%\n".format(
        round(male_count*100/n,1),
        round(female_count*100/n,1),
        round(both_count*100/n,1),
        round(non_identified_count*100/n,1)))
```

```
Male names: 25.8%
Female names: 31.0%
Both names: 10.4%
Non_identified: 32.8%
```

Comment:

It's hard to tell whether most hotels belong to men or women as 32.8% of all names couldn't be identified by algorithm.

6 4. Hotels distribution over districts

Count number of hotels per km^2 in every district

[99]:
```python
import folium
from folium import Choropleth, Circle, Marker
from folium.plugins import HeatMap, MarkerCluster
from shapely.geometry import Point
from collections import Counter
```

[100]:
```python
# Function for displaying the map
def embed_map(m, file_name):
    from IPython.display import IFrame
    m.save(file_name)
    return IFrame(file_name, width='100%', height='500px')
```

6.1 4.1. Read districts' bondaries data

Download map of `Municipal Court Districts (Clipped to Shoreline)` from page https://www1.nyc.gov/site/planning/data-maps/open-data/districts-download-metadata.page as it divides area of New York in many more districts than standard `Neighborhoods` partition.

[101]:
```python
geo = gpd.read_file("input/nymc_19d/nymc.shp").to_crs({'init': 'epsg:4326'})
```

```
/usr/local/lib/python3.6/dist-packages/pyproj/crs.py:77: FutureWarning:
'+init=<authority>:<code>' syntax is deprecated. '<authority>:<code>' is the
preferred initialization method.
  return _prepare_from_string(" ".join(pjargs))
```

Insert a column containing shape areas in km^2 units

[102]:
```python
if 'Area in km^2' in geo:
    geo = geo.drop(['Area in km^2'], axis=1)
geo.insert(5, 'Area in km^2', geo['Shape_Area'] * 9.290304e-8)  # convert ft^2␣
↪to km^2
```

6.2 4.2. Assign hotels to districts and count

How many hotels are in each district?

Create a list containing Point() structures from geographic locations of hotels

[103]:
```python
points = [Point(df['longitude'].iloc[i], df['latitude'].iloc[i]) for i in␣
↪range(df.shape[0])]
```

Check to which district each hotel belongs **(below code takes about a minute to compute)**

```
[104]: district_ID = np.full(len(points), -1) # assign `-1` as an integer nan

for i, point in enumerate(points):
    for j, polygon in enumerate(geo['geometry']):
        if polygon.contains(point):
            district_ID[i] = j
```

Insert a column to `hotel` dataframe (called `df`) that indicates in which district a certain hotel lies

```
[105]: if 'District_ID' in df:
    df = df.drop(['District_ID'], axis=1)
df.insert(5, 'District_ID', district_ID)
```

Insert a column to `district` dataframe (called `geo`) which says how many hotels are in certain district

```
[106]: if 'Number of hotels' in geo:
    geo = geo.drop(['Number of hotels'], axis=1)
geo.insert(6, 'Number of hotels', df['District_ID'].value_counts().
 ↪sort_index()[1:])
```

Calculate values indicating number of hotels per km^2 in all `districts`

```
[107]: if 'Hotel Density' in geo:
    geo = geo.drop(['Hotel Density'], axis=1)
geo.insert(7, 'Hotel Density', (geo['Number of hotels'] / geo['Area in km^2']))
```

6.3 4.3. Create maps `m1` and `m2`

Create a choropleth map of hotel density

```
[108]: # Colors. Note: in frame 'geo' indexes are strings
plot_dict = (geo['Hotel Density'])
plot_dict.index = [str(i) for i in range(0,28)]

# Create a base map
m_1 = folium.Map(location=[40.7,-73.8], tiles='cartodbpositron', zoom_start=10)

# Add a choropleth map to the base map
Choropleth(geo_data=geo.__geo_interface__,
           data=plot_dict,
           key_on="feature.id",
           fill_color='YlGnBu',
           legend_name='number of hotels / km^2',
           bins = [2,30,100,200,400,600,828]
          ).add_to(m_1)
```

```
# Display the map
embed_map(m_1, 'maps/m_1.html')
```

[108]: <IPython.lib.display.IFrame at 0x7f7f12608c50>

Create a heatmap of hotels

[109]:
```
# Create a base map
m_2 = folium.Map(location=[40.7,-73.8], tiles='cartodbpositron', zoom_start=10)

# Convert to Numpy array!
part_data = df[['latitude','longitude']]
part_data = np.array(part_data)

# Add a heatmap to the base map
HeatMap(data=part_data, radius=10).add_to(m_2)

# Display the map
embed_map(m_2, 'maps/m_2.html')
```

[109]: <IPython.lib.display.IFrame at 0x7f7f126086a0>

Comment:

Most cluttered parts of New York in terms of hotels are Manhattan and Brooklyn. Other areas have even 30 times lower density of hotels.

7 5. Distribution of locations of hotels belonging to individual hosts

Investigate locations of hotels belonging to an individual `host`.

The host with hightest amount of hotels is ”`Sonder`”

[110]:
```
from IPython.display import display
from ipywidgets import interact, IntSlider, IntRangeSlider, Button, VBox, Tab
from matplotlib import style
```

7.1 5.1. Create map m3

Create an interactive plot with an interactive slider. Choose an appriopate `ID` to visualise hotels belonging to `ID`-th biggest owner. Please be carefull that moving sliders very fast can make map not reload.

[111]:
```
@interact(ID = IntSlider(1,1,12,1))
def host_hotels(ID):
```

```
    host_id = df['host_id'].value_counts().index[ID-1]
    host = df[df['host_id'] == host_id]
    amount = df['host_id'].value_counts().iloc[ID-1]
    name = df['host_name'].loc[df['host_id'] == host_id].iloc[0]
    print("Currently displaying {} hotels owned by {}".format(amount, name))


    # Create a base map
    m_3 = folium.Map(location=[40.735,-74.0], tiles='cartodbpositron',␣
↪zoom_start=13)

    # Convert to Numpy array! Or else it will crash
    part_data = host[['latitude','longitude']]
    part_data = np.array(part_data)

    # Add a heatmap to the base map
    HeatMap(data=part_data, radius=10).add_to(m_3)

    # Display the map
    display(embed_map(m_3, 'maps/m_3.html'))
```

```
interactive(children=(IntSlider(value=1, description='ID', max=12, min=1), Output()), _dom_clas
```

Comment:

We see that almost all of `Sonder's` apartaments (both `Sonder (NYC)` and `Sonder`) are located pretty dense, within 2 streets, at the south part of `Manhattan`.

`Blueground` owns hotels on equaly spaced space in `Manhattan`.

Basically, all (except `Ken`) biggest hotel owners have their hotels located in `Manhattan`, as it's clearly the most profitable choice.

8 6. Price distribution over districts

Check distribution of prices amoung districts

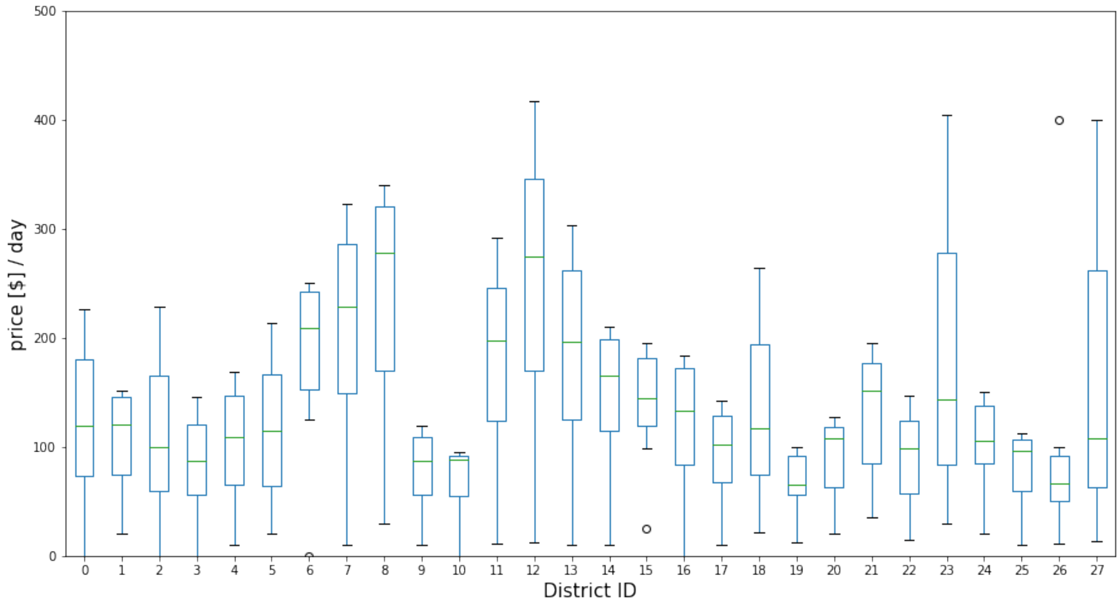
8.1 6.1. Price boxplot for each district

boxplots indicate 25%, 50% and 75% quartiles

[112]:
```
df.groupby('District_ID')['price'].describe().drop(['count'], axis=1).drop(-1).
↪T.plot.box(figsize=(15,8))
plt.ylim(0,500)
plt.xlabel('District ID', size=15)
```

```
plt.ylabel('price [$] / day', size=15)
```

[112]: Text(0, 0.5, 'price [$] / day')



8.2 6.2. Create map m4

Visualise median prices for all districts on an interactive map.

Popup labels indicate `District ID`.

[113]:
```
# Colors. Note: in frame 'geo' indexes are strings
plot_dict = df.groupby('District_ID')['price'].describe().drop(-1)['50%']
plot_dict.index = [str(i) for i in range(0,28)]

# Create a base map
m_4 = folium.Map(location=[40.7,-73.9], tiles='cartodbpositron', zoom_start=11)

# Add markers with labels of `District ID` to the map
for i, point in enumerate(geo['geometry'].centroid):
    Marker([point.y, point.x], popup=(i)).add_to(m_4)

# Add a choropleth map to the base map
Choropleth(geo_data=geo.__geo_interface__,
           data=plot_dict,
           key_on="feature.id",
           fill_color='YlGnBu',
           legend_name='median price [$] / day',
```

```
        ).add_to(m_4)

# Display the map
embed_map(m_4, 'maps/m_4.html')
```

[113]: <IPython.lib.display.IFrame at 0x7f7f138e2cf8>

Comment:

Areas around `Washington Square Park` have much highter median price than most of New York regions, what is quite understable. Noticably, area near Atlantic Beach (`District ID` = 21) is a bit more expensive than surrounding regions. Comparing the map with upper boxplot we can tell, that one of the cheapest hotels are in Bronx side (`District ID` $\in$ {9,10}), which is the most upper part of New York.

8.3 6.3. Create map m5 (interactive sliders)

Create an interactive plot with interactive sliders to manually choose price range. To filter prices up to 10000$, change `multiplier` slider to value `20`. Please be carefull that moving sliders very fast can make map not reload.

[114]:
```
@interact(price_range = IntRangeSlider(value=[50,500],min=0,max=500),␣
↪multiplier=IntSlider(20,1,20,1))
def visualise_price(price_range, multiplier):

    price_range = np.array(price_range) * multiplier
    print("Currently displaying hotels with price range from {}$ to {}$".
↪format(price_range[0], price_range[1]))

    # Filter values
    test = df[(price_range[0] < df['price']) & (df['price'] < price_range[1])]

    # Create a base map
    m_5 = folium.Map(location=[40.7,-73.9], tiles='cartodbpositron',␣
↪zoom_start=10)

    # Convert to Numpy array
    part_data = test[['latitude','longitude']]
    part_data = np.array(part_data)

    # Add a heatmap to the base map
    HeatMap(data=part_data, radius=10).add_to(m_5)

    # Display the map
    display(embed_map(m_5, 'maps/m_5.html'))
```

```
interactive(children=(IntRangeSlider(value=(50, 500), description='price_range', max=500), Int
```

Comment:

We see that south part of Manhatan, around Washington Square Park has the hightest density of hotels with prizes over 1000$ per day.

```
[ ]:
```