Investigate_a_Dataset

January 27, 2020

1 Project: Investigate the important factors that help predicting the non-show up of patients.

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Introduction

Dataset: in order to understand the main factors that lead the patients to not show up, I have selected the no-show appointements dataset. this dataset collects information from 100k medical appointments in Brazil where a number of characteristics about the patient are included in each row. 'ScheduledDay' tells us on what day the patient set up their appointment, 'Neighborhood' indicates the location of the hospital, 'Scholarship' indicates whether or not the patient is enrolled in Brasilian welfare program Bolsa Família, 'No-show' 'No' if the patient showed up to their appointment, and 'Yes' if they did not show up.

Questions: the main focus is to get a better understanding of the data in order to predict whether or not patients show up for their appointment, I am going to investigate the relation of different factors with fact of not showing up.

1.2 Importing the necessary packages

```
In [2]: import pandas as pd
        import numpy as np
        import matplotlib.pyplot as plt
        import seaborn as sns

        %matplotlib inline
```

Data Wrangling

1.2.1 General Properties

Loading the data and printing out the first and last 5 lines.

In [3]:
```
df = pd.read_csv('noshowappointments.csv')
df.head()
```

Out[3]:

	PatientId	AppointmentID	Gender	ScheduledDay	AppointmentDay	Age	Neighbourhood	Scholarship	Hipertension	Diabetes	Alcoholism	Handcap	SMS_received	No-show
0	2.987250e+13	5642903	F	2016-04-29T18:38:08Z	2016-04-29T00:00:00Z	62	JARDIM DA PENHA	0	1	0	0	0	0	No
1	5.589978e+14	5642503	M	2016-04-29T16:08:27Z	2016-04-29T00:00:00Z	56	JARDIM DA PENHA	0	0	0	0	0	0	No
2	4.262962e+12	5642549	F	2016-04-29T16:19:04Z	2016-04-29T00:00:00Z	62	MATA DA PRAIA	0	0	0	0	0	0	No
3	8.679512e+11	5642828	F	2016-04-29T17:29:31Z	2016-04-29T00:00:00Z	8	PONTAL DE CAMBURI	0	0	0	0	0	0	No
4	8.841186e+12	5642494	F	2016-04-29T16:07:23Z	2016-04-29T00:00:00Z	56	JARDIM DA PENHA	0	1	1	0	0	0	No

In [4]:
```
df.tail()
```

Out[4]:

	PatientId	AppointmentID	Gender	ScheduledDay	AppointmentDay	Age	Neighbourhood	Scholarship	Hipertension	Diabetes	Alcoholism	Handcap	SMS_received	No-show
110522	2.572134e+12	5651768	F	2016-05-03T09:15:35Z	2016-06-07T00:00:00Z	56	MARIA ORTIZ	0	0	0	0	0	1	No
110523	3.596266e+12	5650093	F	2016-05-03T07:27:33Z	2016-06-07T00:00:00Z	51	MARIA ORTIZ	0	0	0	0	0	1	No
110524	1.557663e+13	5630692	F	2016-04-27T16:03:52Z	2016-06-07T00:00:00Z	21	MARIA ORTIZ	0	0	0	0	0	1	No
110525	9.213493e+13	5630323	F	2016-04-27T15:09:23Z	2016-06-07T00:00:00Z	38	MARIA ORTIZ	0	0	0	0	0	1	No
110526	3.775115e+14	5629448	F	2016-04-27T13:30:56Z	2016-06-07T00:00:00Z	54	MARIA ORTIZ	0	0	0	0	0	1	No

inspecting the data

```
In [5]: df.describe()
```

```
Out[5]:           PatientId  AppointmentID            Age    Scholarship  \
        count  1.105270e+05   1.105270e+05  110527.000000  110527.000000
        mean   1.474963e+14   5.675305e+06      37.088874       0.098266
        std    2.560949e+14   7.129575e+04      23.110205       0.297675
        min    3.921784e+04   5.030230e+06      -1.000000       0.000000
        25%    4.172614e+12   5.640286e+06      18.000000       0.000000
        50%    3.173184e+13   5.680573e+06      37.000000       0.000000
        75%    9.439172e+13   5.725524e+06      55.000000       0.000000
        max    9.999816e+14   5.790484e+06     115.000000       1.000000

                Hipertension       Diabetes     Alcoholism        Handcap  \
        count  110527.000000  110527.000000  110527.000000  110527.000000
        mean        0.197246       0.071865       0.030400       0.022248
        std         0.397921       0.258265       0.171686       0.161543
        min         0.000000       0.000000       0.000000       0.000000
        25%         0.000000       0.000000       0.000000       0.000000
        50%         0.000000       0.000000       0.000000       0.000000
        75%         0.000000       0.000000       0.000000       0.000000
        max         1.000000       1.000000       1.000000       4.000000

                SMS_received
        count  110527.000000
        mean        0.321026
        std         0.466873
        min         0.000000
        25%         0.000000
        50%         0.000000
        75%         1.000000
        max         1.000000
```

```
In [6]: df.query('Age < 0')
```

```
Out[6]:           PatientId  AppointmentID Gender          ScheduledDay  \
        99832  4.659432e+14        5775010      F  2016-06-06T08:58:13Z

                     AppointmentDay  Age Neighbourhood  Scholarship  Hipertension  \
        99832  2016-06-06T00:00:00Z   -1          ROMÃO            0             0

               Diabetes  Alcoholism  Handcap  SMS_received No-show
        99832         0           0        0             0      No
```

```
In [7]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 110527 entries, 0 to 110526
```

```
Data columns (total 14 columns):
PatientId         110527 non-null float64
AppointmentID     110527 non-null int64
Gender            110527 non-null object
ScheduledDay      110527 non-null object
AppointmentDay    110527 non-null object
Age               110527 non-null int64
Neighbourhood     110527 non-null object
Scholarship       110527 non-null int64
Hipertension      110527 non-null int64
Diabetes          110527 non-null int64
Alcoholism        110527 non-null int64
Handcap           110527 non-null int64
SMS_received      110527 non-null int64
No-show           110527 non-null object
dtypes: float64(1), int64(8), object(5)
memory usage: 11.8+ MB
```

```
In [8]: # inspecting the unique values in each column.
        df.nunique()
```

```
Out[8]: PatientId          62299
        AppointmentID     110527
        Gender                 2
        ScheduledDay      103549
        AppointmentDay        27
        Age                  104
        Neighbourhood         81
        Scholarship            2
        Hipertension           2
        Diabetes               2
        Alcoholism             2
        Handcap                5
        SMS_received           2
        No-show                2
        dtype: int64
```

```
In [9]: # inspecting if there is any missing or possibly errant data.
        df.isna().sum()
```

```
Out[9]: PatientId         0
        AppointmentID     0
        Gender            0
        ScheduledDay      0
        AppointmentDay    0
        Age               0
        Neighbourhood     0
        Scholarship       0
```

```
Hipertension      0
Diabetes          0
Alcoholism        0
Handcap           0
SMS_received      0
No-show           0
dtype: int64
```

```
In [10]: # inspecting if there is any duplicated rows.
         df.duplicated().sum()
```

```
Out[10]: 0
```

We have 110527 samples with 14 features, there is no null, na's , or duplicated rows. We have data where the patient age is 0, I assume thoese are new born, There is one row where the patient is -1 years old which is not normal, it has be removed

the data types are good except for dates : Scheduled Day and Appointment Day which I will fix next

1.2.2 Data Cleaning

Removing the row that contain a patient that has -1 years old

```
In [11]: df = df.drop((df.query('Age < 0 ')).index)
```

Fixing the data type of the Scheduled day and Appointment day columns

```
In [12]: df.ScheduledDay = pd.to_datetime(df.ScheduledDay)
         df.AppointmentDay = pd.to_datetime(df.AppointmentDay)
```

Let's inspect the data again to confirm

```
In [13]: df.describe()
```

```
Out[13]:           PatientId  AppointmentID            Age    Scholarship  \
         count   1.105260e+05   1.105260e+05  110526.000000  110526.000000
         mean    1.474934e+14   5.675304e+06      37.089219       0.098266
         std     2.560943e+14   7.129544e+04      23.110026       0.297676
         min     3.921784e+04   5.030230e+06       0.000000       0.000000
         25%     4.172536e+12   5.640285e+06      18.000000       0.000000
         50%     3.173184e+13   5.680572e+06      37.000000       0.000000
         75%     9.438963e+13   5.725523e+06      55.000000       0.000000
         max     9.999816e+14   5.790484e+06     115.000000       1.000000

                 Hipertension       Diabetes     Alcoholism        Handcap  \
         count  110526.000000  110526.000000  110526.000000  110526.000000
         mean        0.197248       0.071865       0.030400       0.022248
         std         0.397923       0.258266       0.171686       0.161543
         min         0.000000       0.000000       0.000000       0.000000
```

```
25%         0.000000       0.000000       0.000000       0.000000
50%         0.000000       0.000000       0.000000       0.000000
75%         0.000000       0.000000       0.000000       0.000000
max         1.000000       1.000000       1.000000       4.000000

        SMS_received
count  110526.000000
mean        0.321029
std         0.466874
min         0.000000
25%         0.000000
50%         0.000000
75%         1.000000
max         1.000000
```

```
In [14]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 110526 entries, 0 to 110526
Data columns (total 14 columns):
PatientId         110526 non-null float64
AppointmentID     110526 non-null int64
Gender            110526 non-null object
ScheduledDay      110526 non-null datetime64[ns]
AppointmentDay    110526 non-null datetime64[ns]
Age               110526 non-null int64
Neighbourhood     110526 non-null object
Scholarship       110526 non-null int64
Hipertension      110526 non-null int64
Diabetes          110526 non-null int64
Alcoholism        110526 non-null int64
Handcap           110526 non-null int64
SMS_received      110526 non-null int64
No-show           110526 non-null object
dtypes: datetime64[ns](2), float64(1), int64(8), object(3)
memory usage: 12.6+ MB
```

Exploratory Data Analysis

What is the number and percentage of patients that did not show up?

```
In [16]: df_not_showing = df[df['No-show']== 'Yes']
         df_showing = df[df['No-show']== 'No']
         No_notShowing = len(df_not_showing)
         No_notShowing
```

```
Out[16]: 22319
```

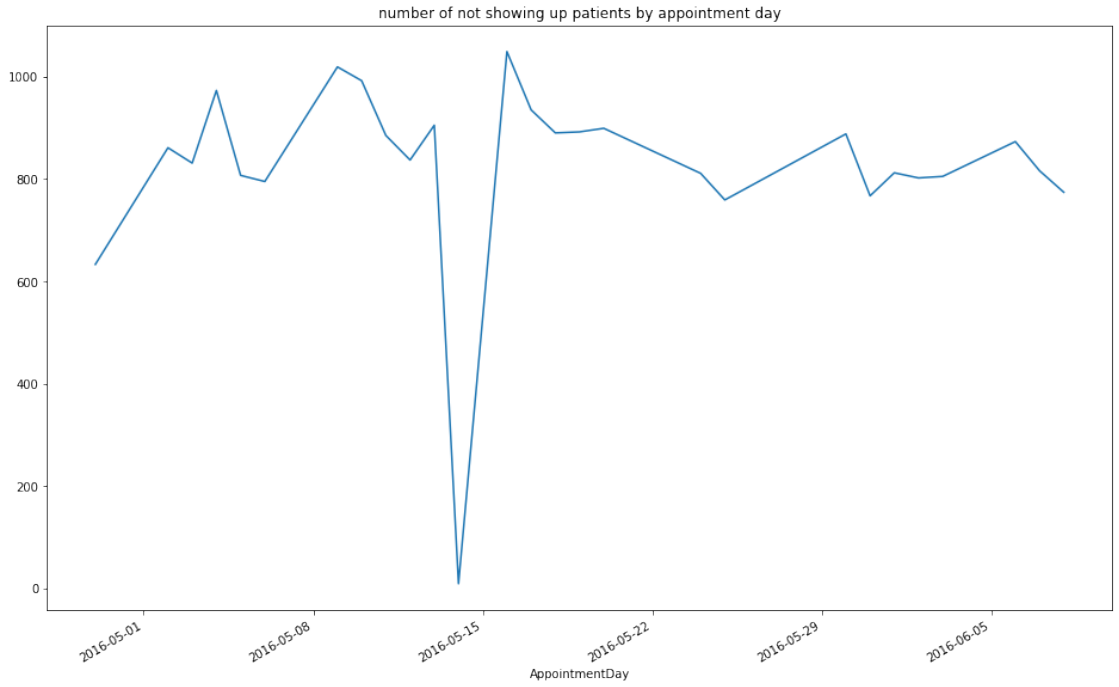
```
In [17]: pct_notShowing = 100 * (No_notShowing / len(df))
         pct_notShowing

Out[17]: 20.193438647919944
```

22319 patients (20.19%) didn't show up

Is the appointment day not suitable for patients to show up?

```
In [78]: df_not_showing.groupby(['AppointmentDay'])['PatientId'].count().plot(figsize= (16,10),
```



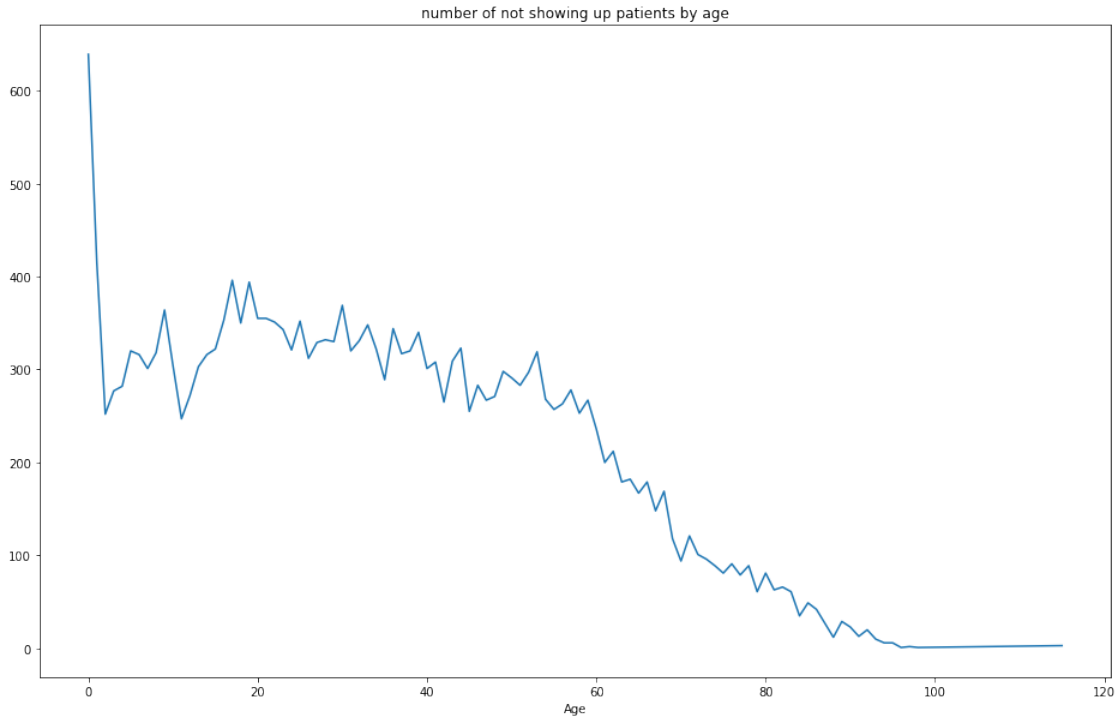

```
In [80]: df[df['AppointmentDay'] == '2016-05-15']

Out[80]: Empty DataFrame
         Columns: [PatientId, AppointmentID, Gender, ScheduledDay, AppointmentDay, Age, Neighbou
         Index: []
```

Appointment days has no direct impact on the patients who didn't show up

What is the number and age of patients that did not show up?

```
In [62]: df_not_showing.groupby(['Age'])['PatientId'].count().plot(figsize= (16,10), title= 'num
```




```
In [63]: df_not_showing.query('Age <= 1')['PatientId'].count()
```

```
Out[63]: 1054
```

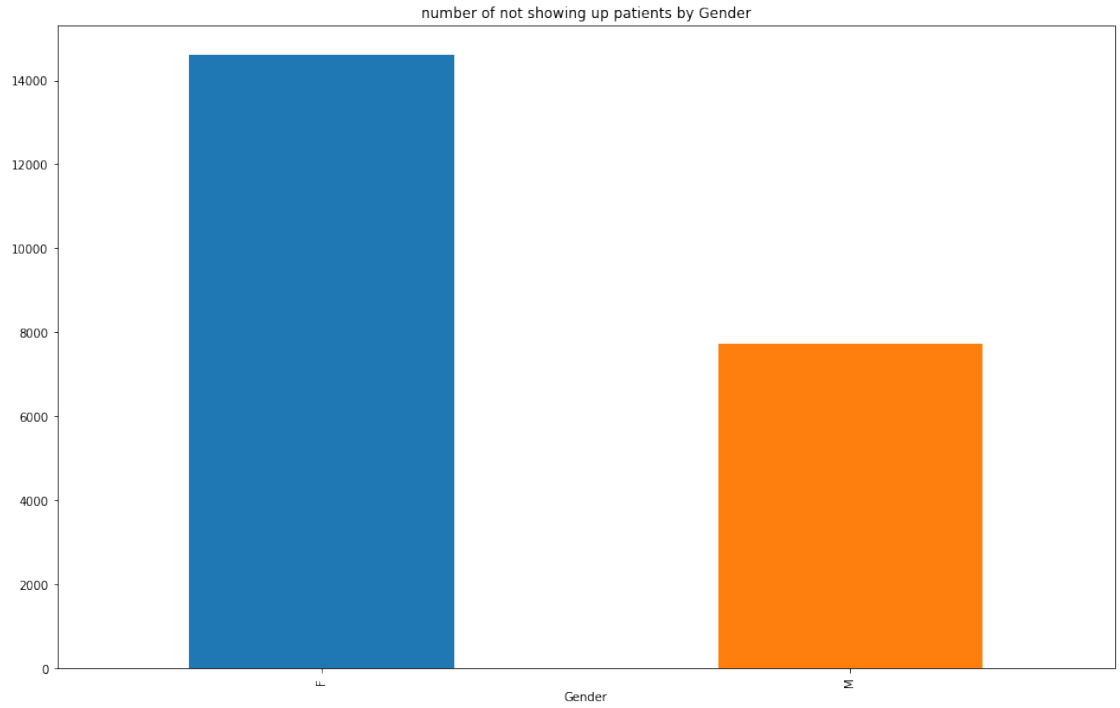
it seems like the older the patient the most likelihood he show up,and the new born ones has the highest rate (1054) of not showing up,

What about Gender?

```
In [21]: df_not_showing.groupby(['Gender'])['PatientId'].count()
```

```
Out[21]: Gender
         F    14594
         M     7725
         Name: PatientId, dtype: int64
```

```
In [64]: df_not_showing.groupby(['Gender'])['PatientId'].count().plot(kind= 'bar',figsize= (16,1
```




```
In [65]: 100 * (len(df_not_showing.query('Gender == "F"')) / len(df_not_showing))

Out[65]: 65.3882342398853
```

Females have higher rate of not showing up than males

do patients from specefic neighbourhood have a higher rates of not showing up?

```
In [51]: pct_by_Neighbourhood = 100 * df_not_showing.groupby(['Neighbourhood'])['PatientId'].cou
         pct_by_Neighbourhood.sort_values(ascending= False)

Out[51]: Neighbourhood
         JARDIM CAMBURI                 6.563914
         MARIA ORTIZ                    5.461714
         ITARARÉ                        4.135490
         RESISTÊNCIA                    4.059322
         CENTRO                         3.149783
         JESUS DE NAZARETH              3.118419
         JARDIM DA PENHA                2.827188
         CARATOÍRA                      2.647968
         TABUAZEIRO                     2.567319
         BONFIM                         2.464268
         ILHA DO PRÍNCIPE               2.383619
         ANDORINHAS                     2.334334
         SÃO PEDRO                      2.307451
```

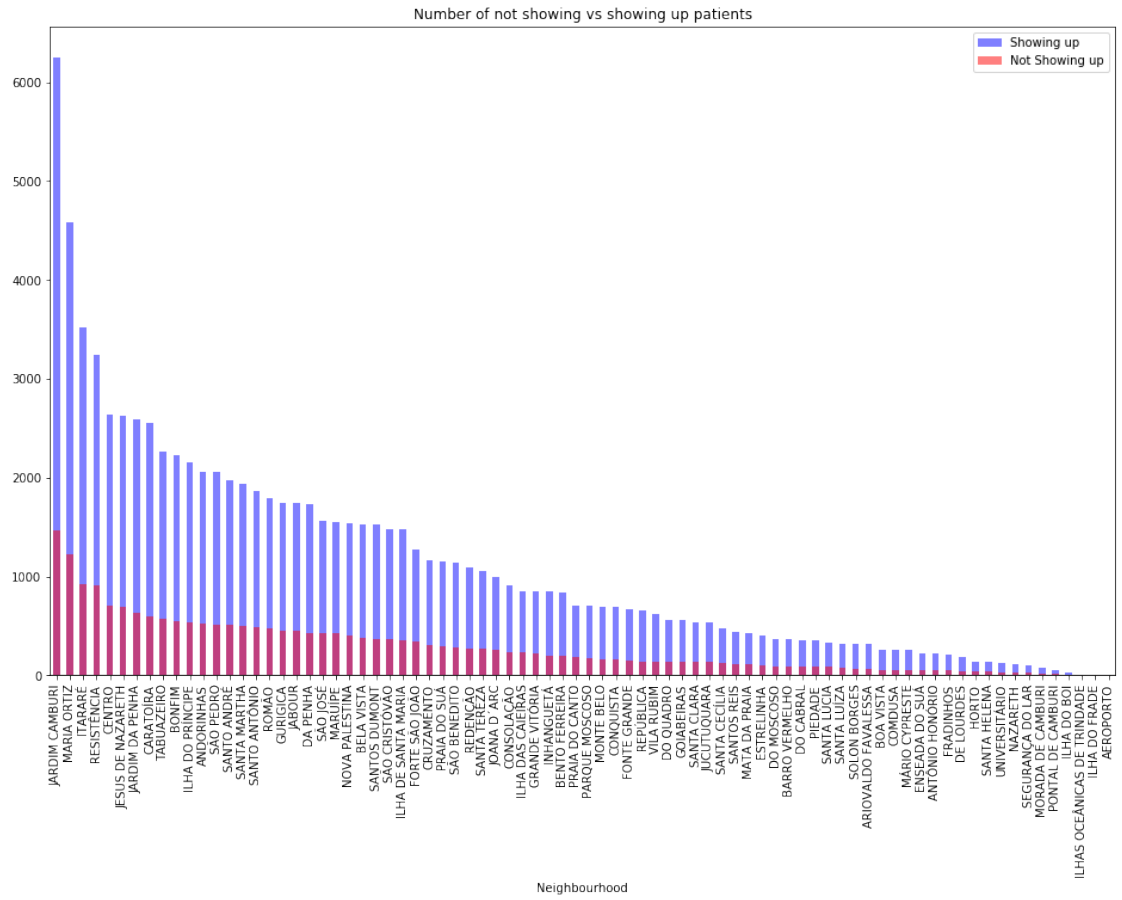
SANTO ANDRÉ	2.276088
SANTA MARTHA	2.222322
SANTO ANTÔNIO	2.168556
ROMÃO	2.123751
GURIGICA	2.043102
JABOUR	2.020700
DA PENHA	1.922129
SÃO JOSÉ	1.917649
MARUÍPE	1.899727
NOVA PALESTINA	1.801156
BELA VISTA	1.720507
SANTOS DUMONT	1.653300
SÃO CRISTÓVÃO	1.626417
ILHA DE SANTA MARIA	1.617456
FORTE SÃO JOÃO	1.550249
CRUZAMENTO	1.362068
PRAIA DO SUÁ	1.317263
	...
SANTA CECÍLIA	0.551100
SANTOS REIS	0.501815
MATA DA PRAIA	0.492854
ESTRELINHA	0.474932
DO MOSCOSO	0.412205
BARRO VERMELHO	0.407724
DO CABRAL	0.394283
PIEDADE	0.394283
SANTA LÚCIA	0.385322
SANTA LUÍZA	0.344998
SOLON BORGES	0.309154
ARIOVALDO FAVALESSA	0.277790
BOA VISTA	0.259868
COMDUSA	0.250907
MÁRIO CYPRESTE	0.241946
ENSEADA DO SUÁ	0.232985
ANTÔNIO HONÓRIO	0.224024
FRADINHOS	0.215063
DE LOURDES	0.210583
HORTO	0.188180
SANTA HELENA	0.165778
UNIVERSITÁRIO	0.143376
NAZARETH	0.129934
SEGURANÇA DO LAR	0.125454
MORADA DE CAMBURI	0.071688
PONTAL DE CAMBURI	0.053766
ILHA DO BOI	0.013441
ILHAS OCEÂNICAS DE TRINDADE	0.008961
ILHA DO FRADE	0.008961
AEROPORTO	0.004480

```
Name: PatientId, Length: 80, dtype: float64
```

In [53]:
```
df_showing.groupby(['Neighbourhood'])['PatientId'].count().sort_values(ascending= False
df_not_showing.groupby(['Neighbourhood'])['PatientId'].count().sort_values(ascending= F
plt.title('Number of not showing vs showing up patients')

plt.legend()
```

Out[53]: <matplotlib.legend.Legend at 0x7f18e1395278>



In [72]:
```
pct_notShowing_Neighbourhood = 100 * df_not_showing.groupby(['Neighbourhood'])['Patient
pct_notShowing_Neighbourhood[pct_notShowing_Neighbourhood > pct_notShowing].count(), pc
```

Out[72]: (34, 80)

34 over 80 neighbourhoods have a higher rates of not showing up

1.2.3 Patients characteristics:

do patients enrolled in Brasilian welfare program have a better rates?

```
In [55]: df_not_showing.groupby(['Scholarship'])['PatientId'].count()

Out[55]: Scholarship
         0    19741
         1     2578
         Name: PatientId, dtype: int64
```

Indeed the patients who enrolled in Brasilian welfare program do show up more than the ones who didn't enrolled.

what about patients with special maladies?

```
In [56]: df_not_showing.groupby(['Hipertension'])['PatientId'].count()

Out[56]: Hipertension
         0    18547
         1     3772
         Name: PatientId, dtype: int64

In [57]: df_not_showing.groupby(['Diabetes'])['PatientId'].count()

Out[57]: Diabetes
         0    20889
         1     1430
         Name: PatientId, dtype: int64

In [58]: df_not_showing.groupby(['Alcoholism'])['PatientId'].count()

Out[58]: Alcoholism
         0    21642
         1      677
         Name: PatientId, dtype: int64

In [59]: df_not_showing.groupby(['Handcap'])['PatientId'].count()

Out[59]: Handcap
         0    21912
         1      366
         2       37
         3        3
         4        1
         Name: PatientId, dtype: int64
```

it seems that Hipertension, Diabetes, Alcoholism, Handcap has no direct impact of the patients decision to not show up.

What if the patients didn't receive an sms?

```
In [60]: df_not_showing.groupby(['SMS_received'])['PatientId'].count()
```

```
Out[60]: SMS_received
         0    12535
         1     9784
         Name: PatientId, dtype: int64
```

not receiving an sms may be a reason of not showing up but not a decisif one.

Conclusions > No matter the decease, Most patients enrolled in Brasilian welfare program showed up for their appointement, and inversly the ones who didn't enroll mostly didn't show up especialy the younger ones and females.

patients from 34 neighbourhoods didn't show up with a rate esceeding the national mean.

The measures taken by hospitals (sending sms) works but not very well, other measures must be taken to help patients to show up more frequently.

1.3 Submitting your Project

Before you submit your project, you need to create a .html or .pdf version of this notebook in the workspace here. To do that, run the code cell below. If it worked correctly, you should get a return code of 0, and you should see the generated .html file in the workspace directory (click on the orange Jupyter icon in the upper left).

Alternatively, you can download this report as .html via the **File** > **Download as** submenu, and then manually upload it into the workspace directory by clicking on the orange Jupyter icon in the upper left, then using the Upload button.

Once you've done this, you can submit your project by clicking on the "Submit Project" button in the lower right here. This will create and submit a zip file with this .ipynb doc and the .html or .pdf version you created. Congratulations!

```
In [87]: from subprocess import call
         call(['python', '-m', 'nbconvert', 'Investigate_a_Dataset.ipynb'])
```

```
Out[87]: 0
```

```
In [ ]:
```