Crimes_Section

July 9, 2020

1 Basic Statistics of the Data Set

This is part of the book Chapter 6

The statistics shown here intend to enlighten the characteristics of the data set used to contruct the ABM.

The data was provided by the PMMG, to whom we are very thankful.

The **programmer** is Eric Araujo.

The **last update** was in 29/9/2019

[1]:
```
import pandas as pd
import matplotlib.pyplot as plt
plt.style.use('ggplot')
import geopandas
import descartes
import numpy as np

import folium
import seaborn as sns

%matplotlib inline
```

[2]:
```
xls = pd.ExcelFile('data/Lavras.xls')
registers = pd.read_excel(xls, 'OCORRENCIAS')
```

2 Registers

[3]:
```
registers.head(2)
```

[3]:
```
   Ano Fato                  Bairro  \
0      2014  ANISIO ALVES DE ABREU
1      2014  ANISIO ALVES DE ABREU

                     Desc Longa Meio Utilizado  \
0  AGRESSAO FISICA SEM EMPREGO DE INSTRUMENTOS
1                                ARMAS DE FOGO
```

```
                 Desc Longa Subgrupo Complemento Nat  \
0  BENS / VALORES DE ESTABELECIMENTO /PESSOA JURI…
1  BENS / VALORES DE ESTABELECIMENTO /PESSOA JURI…

  Descrição Longa Local Imediato Descrição Subclasse Nat Principal  \
0           POSTO DE COMBUSTIVEL                             ROUBO
1           POSTO DE COMBUSTIVEL                             ROUBO

  Dia da Semana Fato  Dia Numérico Fato          Faixa 1 Hora Fato   Latitude  \
0       QUARTA-FEIRA                  8  De 03:00 as 03:59         -21.254166
1       QUARTA-FEIRA                 29  De 00:00 as 00:59         -21.254166

   Longitude  Mês Numérico Fato Município         Número REDS  \
0 -44.999031                  1    LAVRAS  2014-000525047-001
1 -44.999031                  1    LAVRAS  2014-002172720-001

  Tentado/Consumado Nat Principal UNIDADE_AREA   Unidade Área Militar  \
0                         TENTADO       08 BPM  54 CIA PM/8 BPM/6 RPM
1                       CONSUMADO       08 BPM  54 CIA PM/8 BPM/6 RPM

   Município - Código
0              313820
1              313820
```

[4]:

```
registers.columns
```

[4]:

```
Index(['Ano Fato', 'Bairro', 'Desc Longa Meio Utilizado',
       'Desc Longa Subgrupo Complemento Nat', 'Descrição Longa Local Imediato',
       'Descrição Subclasse Nat Principal', 'Dia da Semana Fato',
       'Dia Numérico Fato', 'Faixa 1 Hora Fato', 'Latitude', 'Longitude',
       'Mês Numérico Fato', 'Município', 'Número REDS',
       'Tentado/Consumado Nat Principal', 'UNIDADE_AREA',
       'Unidade Área Militar', 'Município - Código'],
      dtype='object')
```

[5]:

```
# Renaming columns
translate_cols = {'Ano Fato': 'year',
                  'Mês Numérico Fato': 'month',
                  'Dia Numérico Fato': 'day',
                  'Dia da Semana Fato': 'week_day',
                  'Bairro': 'neighborhood',
                  'Desc Longa Meio Utilizado': 'violence_type',
                  'Desc Longa Subgrupo Complemento Nat': 'type_object_robbed',
                  'Descrição Longa Local Imediato': 'location_description',
                  'Descrição Subclasse Nat Principal': 'crime_type',
                  'Faixa 1 Hora Fato': 'one_h_window',
                  'Latitude': 'lat',
                  'Longitude': 'lon',
                  'Município': 'city',
                  'Número REDS': 'reds',
                  'Tentado/Consumado Nat Principal': 'committed',
                  'UNIDADE_AREA': 'pm_area',
                  'Unidade Área Militar': 'pm_unity',
                  'Município - Código': 'city_code'
                 }
registers.rename(columns=translate_cols, inplace=True)
```

```
[6]: registers.columns
```

```
[6]: Index(['year', 'neighborhood', 'violence_type', 'type_object_robbed',
            'location_description', 'crime_type', 'week_day', 'day', 'one_h_window',
            'lat', 'lon', 'month', 'city', 'reds', 'committed', 'pm_area',
            'pm_unity', 'city_code'],
           dtype='object')
```

```
[7]: # Removing irrelevant columns
     registers = registers[['year', 'neighborhood', 'violence_type',␣
      ↪'type_object_robbed',
            'location_description', 'crime_type', 'week_day', 'day',
            'one_h_window', 'lat', 'lon', 'month', 'city', 'reds', 'committed',
            ]]

     # Get years 2014-2018
     registers = registers[registers.year.isin([2014,2015,2016,2017,2018])]
```

```
[8]: # Removing white spaces in one_h_window column
     registers.one_h_window = registers.one_h_window.str.rstrip()
```

Checking for duplicates in the registers' tab

```
[9]: print('Number of registers in the file: ', len(registers))
     print('Number of unique REDS - IDs: ', len(set(registers.reds)))
```

```
Number of registers in the file:  862
Number of unique REDS - IDs:  862
```

Checking for missing data in the registers' tab

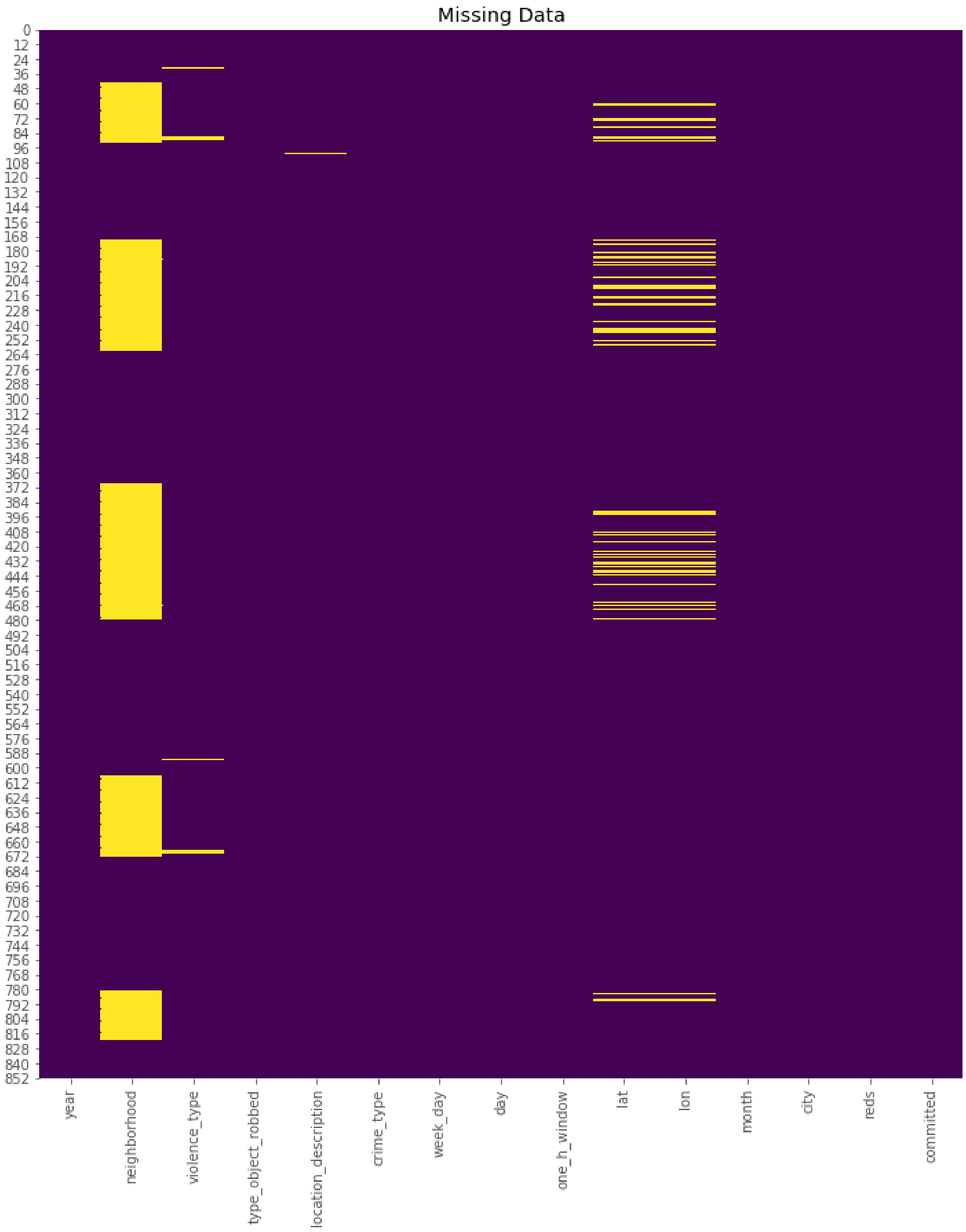
```
[10]: missing_values = ['INVÁLIDO', 'ESCOLARIDADE - IGNORADA', 'IGNORADA',␣
       ↪'PREENCHIMENTO OPCIONAL', 'INVALIDO',
                        'ESTADO CIVIL - IGNORADO', 'ESTADO CIVIL - NAO DECLARADO',␣
       ↪'PREENCHIMENTO OPCIONAL',
                        'GRAU DA LESAO - IGNORADO' ]
      registers.replace(to_replace=missing_values, value=np.nan, inplace=True)
```

[11]:

```
plt.figure(figsize=(12,14))
sns.heatmap(registers.isnull(), cbar = False, cmap = 'viridis')
plt.title('Missing Data')
```

[11]:

```
Text(0.5, 1, 'Missing Data')
```



[12]:

```
# Location description
pd.value_counts(registers.location_description)[:10]
```

[12]:

```
VIA DE ACESSO PUBLICA                               429
POSTO DE COMBUSTIVEL                                118
BAR / LANCHONETE / RESTAURANTE / SIMILAR             68
OUTROS - ESTABELECIMENTOS COMERCIAIS / SERVICOS      34
CASA                                                 33
MERCEARIA / SACOLAO / SUPERMERCADO                   28
CONFEITARIA / PADARIA / PANIFICADORA                 26
LOJA DIVERSA                                         17
SITIO                                                15
BOATE / CASA DE SHOW / SIMILAR                       11
Name: location_description, dtype: int64
```

[13]:

```
100*pd.value_counts(registers.location_description)[:10]/pd.
 ↪value_counts(registers.location_description).sum()
```

[13]:

```
VIA DE ACESSO PUBLICA                               49.883721
POSTO DE COMBUSTIVEL                                13.720930
BAR / LANCHONETE / RESTAURANTE / SIMILAR             7.906977
OUTROS - ESTABELECIMENTOS COMERCIAIS / SERVICOS      3.953488
CASA                                                 3.837209
MERCEARIA / SACOLAO / SUPERMERCADO                   3.255814
CONFEITARIA / PADARIA / PANIFICADORA                 3.023256
LOJA DIVERSA                                         1.976744
SITIO                                                1.744186
BOATE / CASA DE SHOW / SIMILAR                       1.279070
Name: location_description, dtype: float64
```

[14]:

```
# Means used to commit the crime
pd.value_counts(registers.violence_type)[:10]
```

[14]:

```
ARMAS DE FOGO                                                  376
INSTRUMENTO CONTUNDENTE / CORTANTE / PERFURANTE (ARMA BRANCA)    184
AGRESSAO FISICA SEM EMPREGO DE INSTRUMENTOS                     94
AMEACA                                                          87
OUTROS MEIOS (DESCREVER EM CAMPO ESPECIFICO)                    83
SIMULACRO DE ARMA DE FOGO                                       27
EMBOSCADA (INCLUI SAIDINHA DE BANCO)                             2
Name: violence_type, dtype: int64
```

[15]:

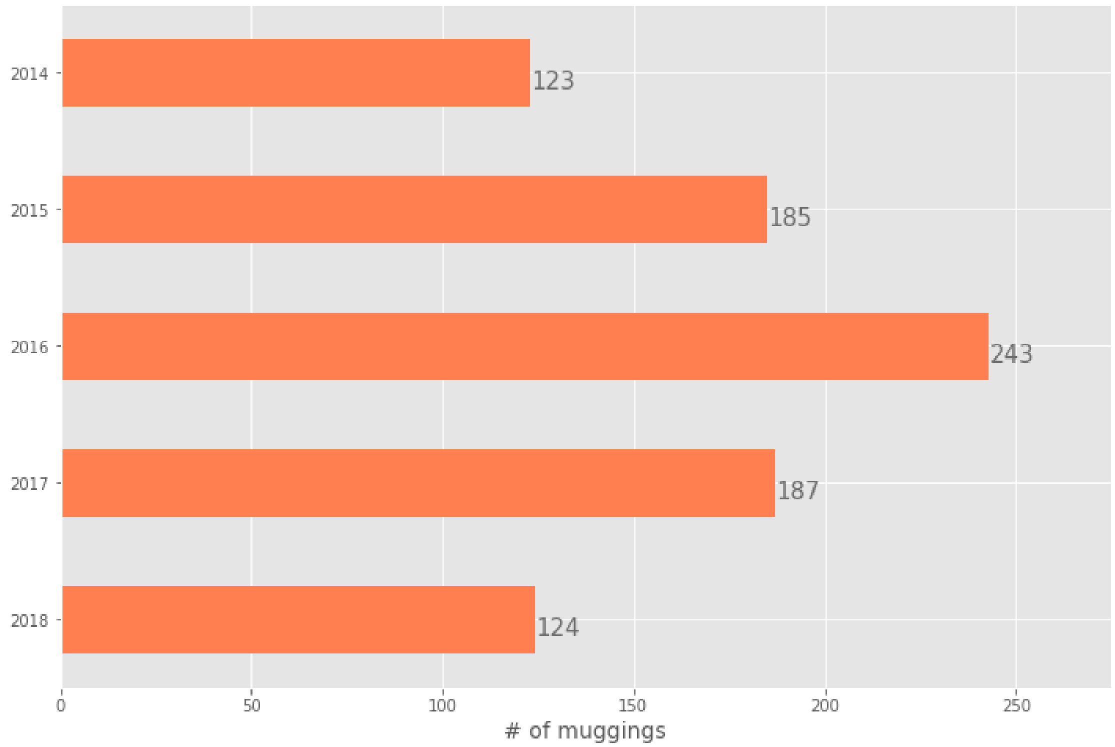
```
pd.value_counts(registers.violence_type)[:10]*100/pd.value_counts(registers.
 ↪violence_type)[:10].sum()
```

```
[15]: ARMAS DE FOGO                                                     44.079719
      INSTRUMENTO CONTUNDENTE / CORTANTE / PERFURANTE (ARMA BRANCA)    21.570926
      AGRESSAO FISICA SEM EMPREGO DE INSTRUMENTOS                      11.019930
      AMEACA                                                           10.199297
      OUTROS MEIOS (DESCREVER EM CAMPO ESPECIFICO)                      9.730363
      SIMULACRO DE ARMA DE FOGO                                         3.165299
      EMBOSCADA (INCLUI SAIDINHA DE BANCO)                              0.234467
      Name: violence_type, dtype: float64
```

```
[16]: # Crimes per year
      ax = registers.year.value_counts().sort_index(ascending=True).plot(kind='barh',
                                                                      figsize=((12,8)),
                                                                      color='coral')
      ax.set_alpha(0.8)
      #plt.title('Robberies per year in Lavras (2014-2018)', fontsize=18)
      plt.xlabel('# of muggings', fontsize=14)
      plt.xlim(0,275)
      # create a list to collect the plt.patches data
      totals = []

      # find the values and append to list
      for i in ax.patches:
          totals.append(i.get_width())
          #print(totals)

      for i in ax.patches:
          # get_width pulls left or right; get_y pushes up or down
          ax.text(i.get_width()+.3, i.get_y()+.37, \
                  str(round((i.get_width()), 2)), fontsize=15,
      color='dimgrey')
      # invert for largest on top
      ax.invert_yaxis()
```



[17]:

```
one_h_replacement_dict = {   'De 00:00 as 00:59': '00:00 - 00:59',
                             'De 01:00 as 01:59': '01:00 - 01:59',
                             'De 02:00 as 02:59': '02:00 - 02:59',
                             'De 03:00 as 03:59': '03:00 - 03:59',
                             'De 04:00 as 04:59': '04:00 - 04:59',
                             'De 05:00 as 05:59': '05:00 - 05:59',
                             'De 06:00 as 06:59': '06:00 - 06:59',
                             'De 07:00 as 07:59': '07:00 - 07:59',
                             'De 08:00 as 08:59': '08:00 - 08:59',
                             'De 09:00 as 09:59': '09:00 - 09:59',
                             'De 10:00 as 10:59': '10:00 - 10:59',
                             'De 11:00 as 11:59': '11:00 - 11:59',
                             'De 12:00 as 12:59': '12:00 - 12:59',
                             'De 13:00 as 13:59': '13:00 - 13:59',
                             'De 14:00 as 14:59': '14:00 - 14:59',
                             'De 15:00 as 15:59': '15:00 - 15:59',
                             'De 16:00 as 16:59': '16:00 - 16:59',
                             'De 17:00 as 17:59': '17:00 - 17:59',
                             'De 18:00 as 18:59': '18:00 - 18:59',
                             'De 19:00 as 19:59': '19:00 - 19:59',
                             'De 20:00 as 20:59': '20:00 - 20:59',
                             'De 21:00 as 21:59': '21:00 - 21:59',
                             'De 22:00 as 22:59': '22:00 - 22:59',
                            'De 23:00 as 23:59': '23:00 - 23:59'}
```

[18]:

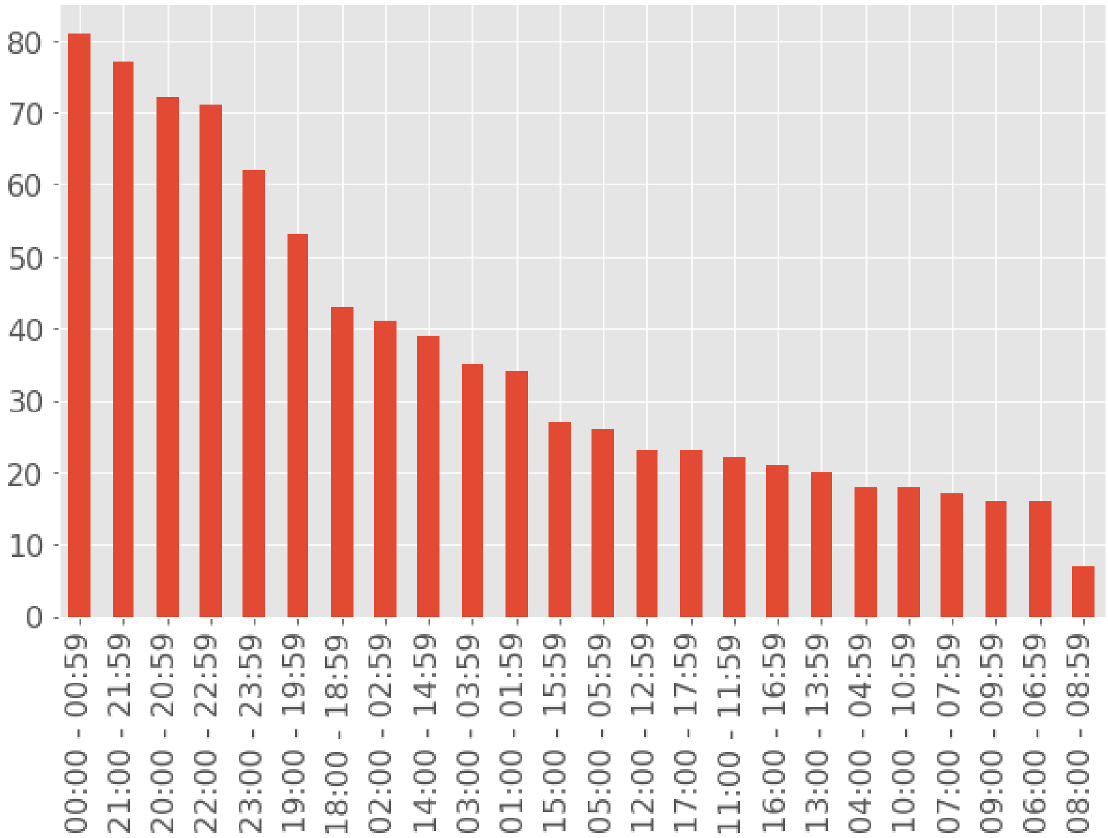
```
registers.one_h_window.replace(one_h_replacement_dict, inplace=True)
#registers.one_h_window
```

[41]:

```
#plt.rcParams.update({'font.size': 16})
plt.tick_params(labelsize=16)
registers.one_h_window.value_counts().plot(kind='bar', figsize=((10,6)))
```

[41]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x12e454250>
```

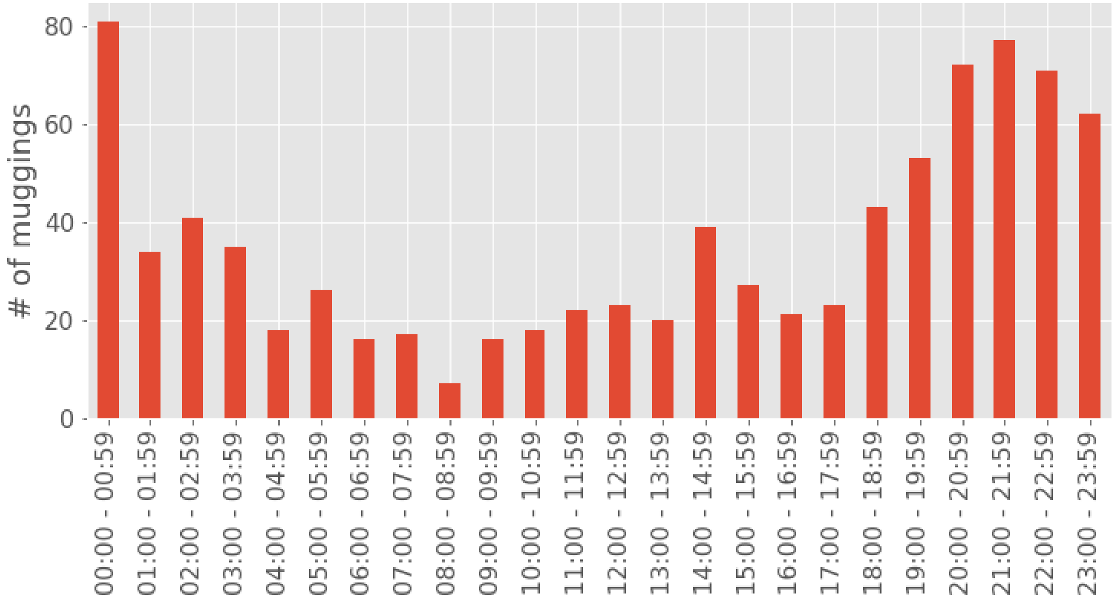


[28]:

```
night_times = ['18:00 - 18:59',
               '19:00 - 19:59',
               '20:00 - 20:59',
               '21:00 - 21:59',
               '22:00 - 22:59',
               '23:00 - 23:59',
               '00:00 - 00:59',
               '01:00 - 01:59',
               '02:00 - 02:59',
               '03:00 - 03:59',
               '04:00 - 04:59',
               '05:00 - 05:59'
              ]
day_times = ['06:00 - 06:59',
             '07:00 - 07:59',
             '08:00 - 08:59',
             '09:00 - 09:59',
             '10:00 - 10:59',
             '11:00 - 11:59',
             '12:00 - 12:59',
             '13:00 - 13:59',
             '14:00 - 14:59',
             '15:00 - 15:59',
             '16:00 - 16:59',
             '17:00 - 17:59'
            ]

ax = registers.one_h_window.value_counts().sort_index().plot(kind='bar',␣
 ↪figsize=((12,5)))
#ax.set_xlabel('Time of the day')
ax.set_ylabel('# of muggings')
```

```
[28]: Text(0, 0.5, '# of muggings')
```



```
[29]: print('Total of crimes committed in day time: \t\t', len(registers[registers.
       ↪one_h_window.isin(day_times)]))
```

```
print('Total of crimes committed in night time: \t', len(registers[registers.
 ↪one_h_window.isin(night_times)]))
```

```
Total of crimes committed in day time:           249
Total of crimes committed in night time:         613
```

[30]:

```
times_crimes = registers.one_h_window.value_counts().sort_index().
 ↪reset_index(drop=True)
```

[31]:

```
times_crimes.mean()
```

[31]:

```
35.916666666666664
```

[32]:

```
times_crimes.std()
```

[32]:

```
21.993905611736427
```

[33]:

```
times_crimes.median()
```

[33]:

```
26.5
```

[34]:

```
times_crimes_window = times_crimes.append(times_crimes)
times_crimes_window = times_crimes_window.rolling(window=6).sum()[5:-19]
times_crimes_window
```

[34]:

```
5     235.0
6     170.0
7     153.0
8     119.0
9     100.0
10    100.0
11     96.0
12    103.0
13    106.0
14    138.0
15    149.0
16    152.0
17    153.0
18    173.0
19    206.0
20    239.0
21    289.0
22    339.0
23    378.0
0     416.0
1     397.0
2     366.0
```

```
3     324.0
4     271.0
Name: one_h_window, dtype: float64
```

[35]:

```
tc_window_df = pd.DataFrame(times_crimes_window).sort_index()
```

[36]:

```
# When the cummulative sum of crimes exceeds 40% of the total
tc_window_df['hot_times'] = tc_window_df.one_h_window > len(set(registers.
 ↪reds))*0.4
```

[37]:

```
tc_window_df[tc_window_df.hot_times]
```

[37]:

```
    one_h_window  hot_times
0          416.0       True
1          397.0       True
2          366.0       True
23         378.0       True
```

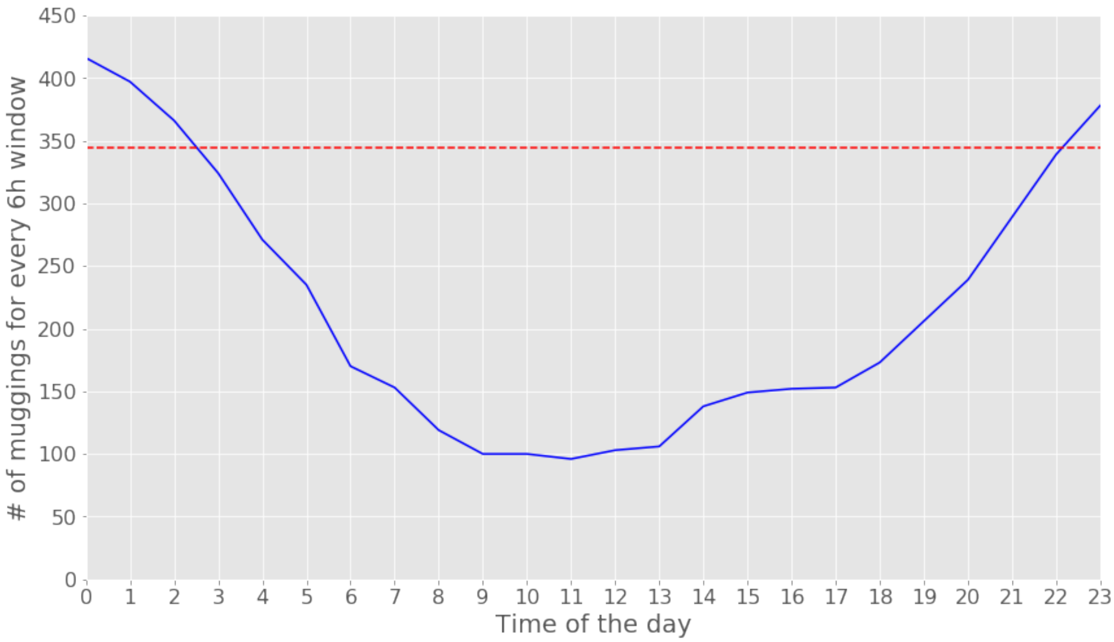
[38]:

```
ax = tc_window_df.plot(figsize=((14,8)), color='b', legend=False)
ax.set_ylim(0,450)
ax.set_xlabel('Time of the day')
ax.set_ylabel('# of muggings for every 6h window')
ax.set_xticks(np.arange(0, 24, 1))

# Line dividing 40% of the cases
hline = len(set(registers.reds))*0.4
ax.axhline(y=hline, color='r', linestyle='--')
```

[38]:

```
<matplotlib.lines.Line2D at 0x12de553d0>
```



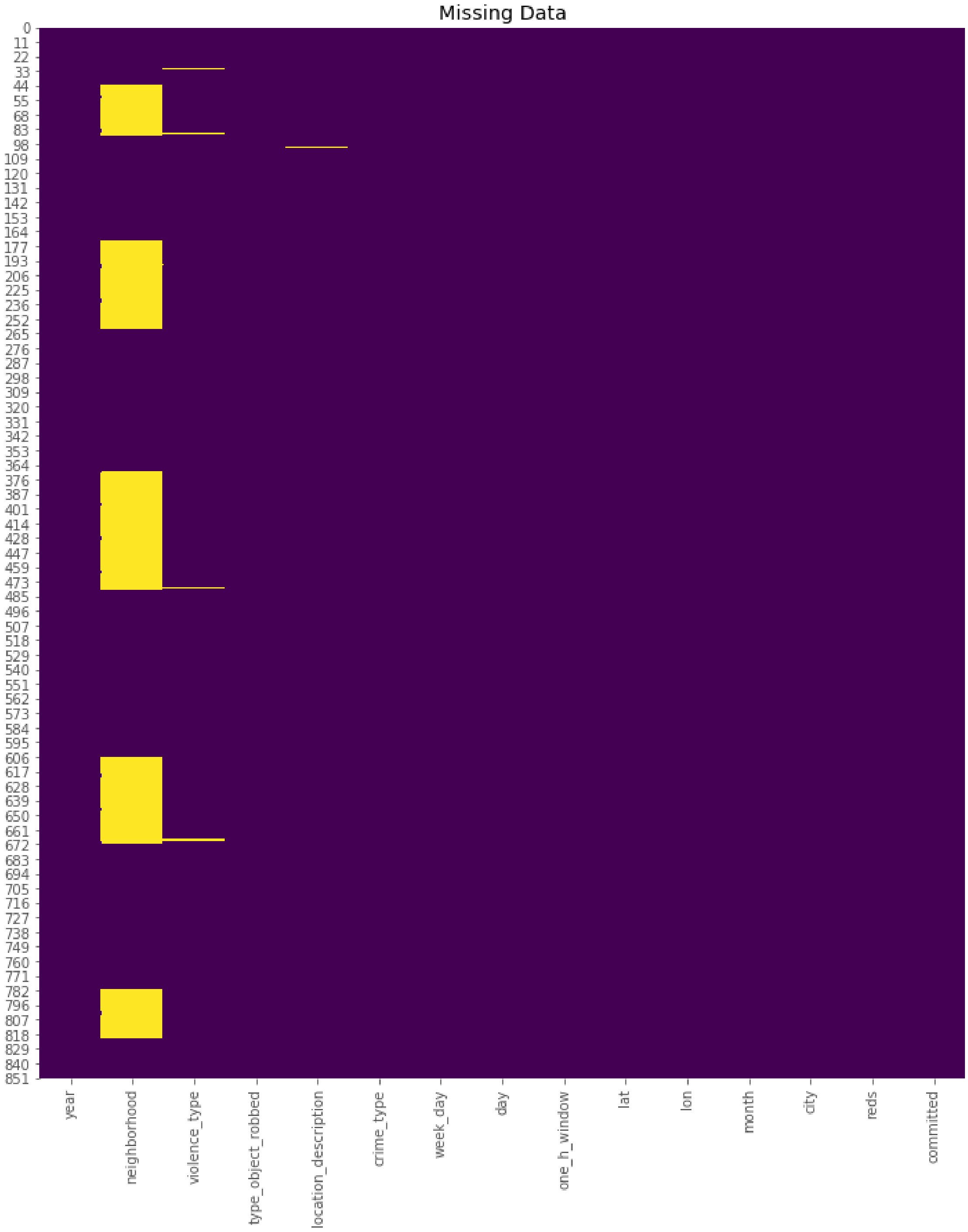
2.0.1 Cleaning the registers data

```
[29]: registers.dropna(axis=0, subset=['lat', 'lon'], inplace=True)
      len(registers)
```

```
[29]: 803
```

```
[30]: plt.figure(figsize=(12,14))
      sns.heatmap(registers.isnull(), cbar = False, cmap = 'viridis')
      plt.title('Missing Data')
```

```
[30]: Text(0.5, 1, 'Missing Data')
```



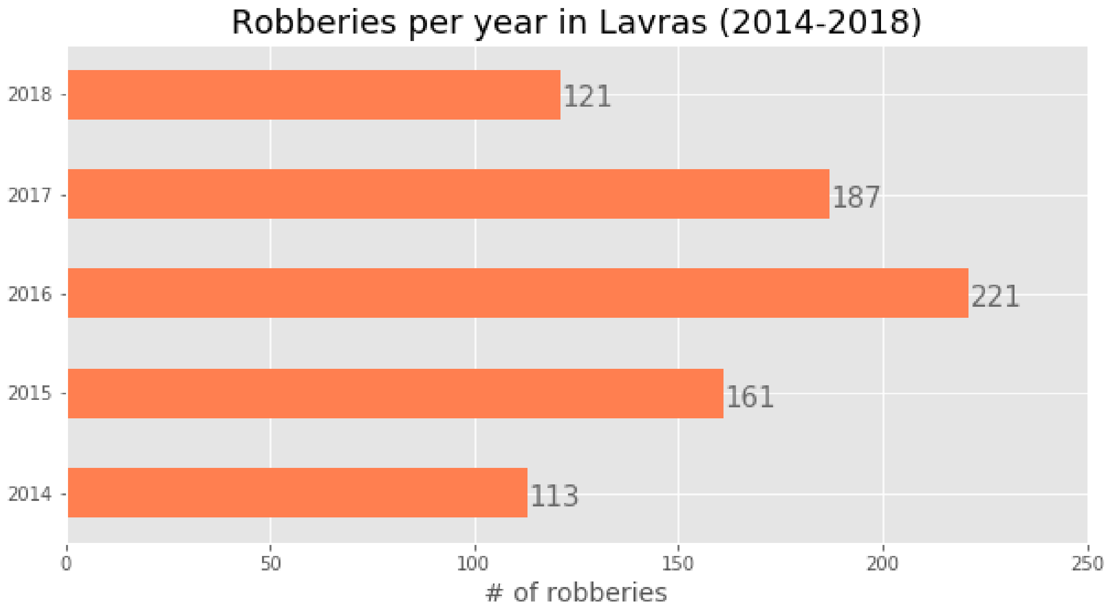
[31]:
```
# Crimes per year
ax = registers.year.value_counts().sort_index(ascending=False).plot(kind='barh',
                                                                    figsize=((10,5)),
                                                                    color='coral')
ax.set_alpha(0.8)
```

```
plt.title('Robberies per year in Lavras (2014-2018)', fontsize=18)
plt.xlabel('# of robberies', fontsize=14)
plt.xlim(0,250)
# create a list to collect the plt.patches data
totals = []

# find the values and append to list
for i in ax.patches:
    totals.append(i.get_width())
    print(totals)

for i in ax.patches:
    # get_width pulls left or right; get_y pushes up or down
    ax.text(i.get_width()+.3, i.get_y()+.38, \
            str(round((i.get_width()), 2)), fontsize=15,
color='dimgrey')
# invert for largest on top
ax.invert_yaxis()
```

```
[121]
[121, 187]
[121, 187, 221]
[121, 187, 221, 161]
[121, 187, 221, 161, 113]
```



[32]:
```
# Location description
pd.value_counts(registers.location_description)[:10]
```

[32]:

```
VIA DE ACESSO PUBLICA                                  407
POSTO DE COMBUSTIVEL                                   113
BAR / LANCHONETE / RESTAURANTE / SIMILAR                62
CASA                                                    29
OUTROS - ESTABELECIMENTOS COMERCIAIS / SERVICOS         29
MERCEARIA / SACOLAO / SUPERMERCADO                      27
CONFEITARIA / PADARIA / PANIFICADORA                    24
LOJA DIVERSA                                            16
SITIO                                                   12
BOATE / CASA DE SHOW / SIMILAR                          11
Name: location_description, dtype: int64
```

[33]:

```
# Means used to commit the crime
pd.value_counts(registers.violence_type)[:10]
```

[33]:

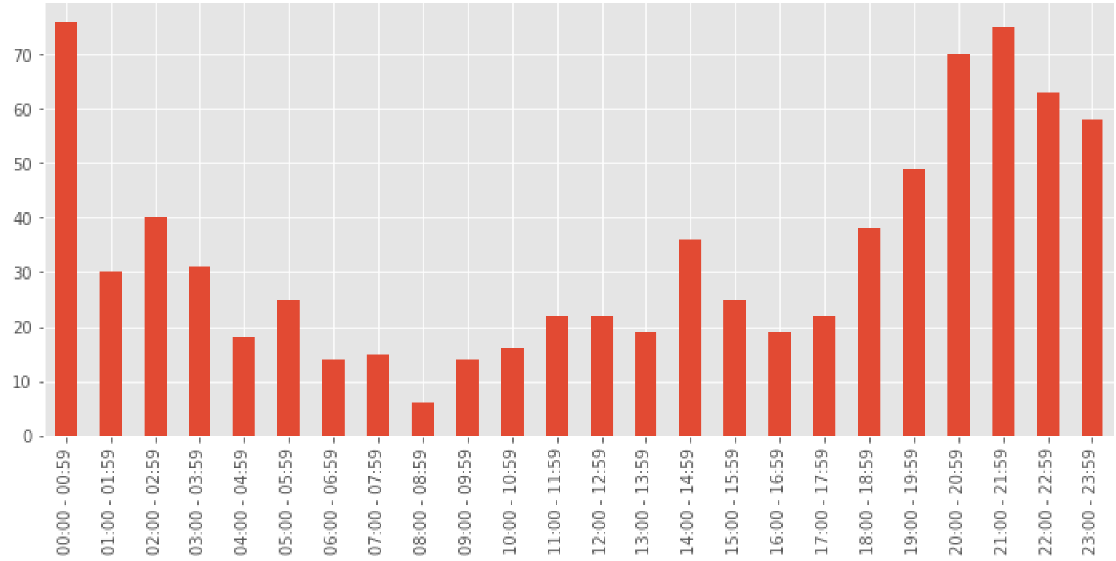
```
ARMAS DE FOGO                                                        342
INSTRUMENTO CONTUNDENTE / CORTANTE / PERFURANTE (ARMA BRANCA)        177
AGRESSAO FISICA SEM EMPREGO DE INSTRUMENTOS                           91
AMEACA                                                                81
OUTROS MEIOS (DESCREVER EM CAMPO ESPECIFICO)                          79
SIMULACRO DE ARMA DE FOGO                                             25
EMBOSCADA (INCLUI SAIDINHA DE BANCO)                                   1
Name: violence_type, dtype: int64
```

[34]:

```
registers.one_h_window.value_counts().sort_index().plot(kind='bar',␣
 ↪figsize=((12,5)))
```

[34]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x12d75f310>
```



[35]:

```
times_crimes = registers.one_h_window.value_counts().sort_index().
 ↪reset_index(drop=True)
times_crimes_window = times_crimes.append(times_crimes)
times_crimes_window = times_crimes_window.rolling(window=6).sum()[5:-19]
times_crimes_window
```

[35]:

```
5     220.0
6     158.0
7     143.0
8     109.0
9      92.0
10     90.0
11     87.0
12     95.0
13     99.0
14    129.0
15    140.0
16    143.0
17    143.0
18    159.0
19    189.0
20    223.0
21    273.0
22    317.0
23    353.0
0     391.0
1     372.0
2     342.0
3     298.0
4     253.0
Name: one_h_window, dtype: float64
```

[36]:

```
tc_window_df = pd.DataFrame(times_crimes_window).sort_index()
# When the cummulative sum of crimes exceeds 40% of the total
tc_window_df['hot_times'] = tc_window_df.one_h_window > len(set(registers.
 ↪reds))*0.4
```

[37]:

```
tc_window_df[tc_window_df.hot_times]
```

[37]:

```
    one_h_window  hot_times
0          391.0       True
1          372.0       True
2          342.0       True
23         353.0       True
```

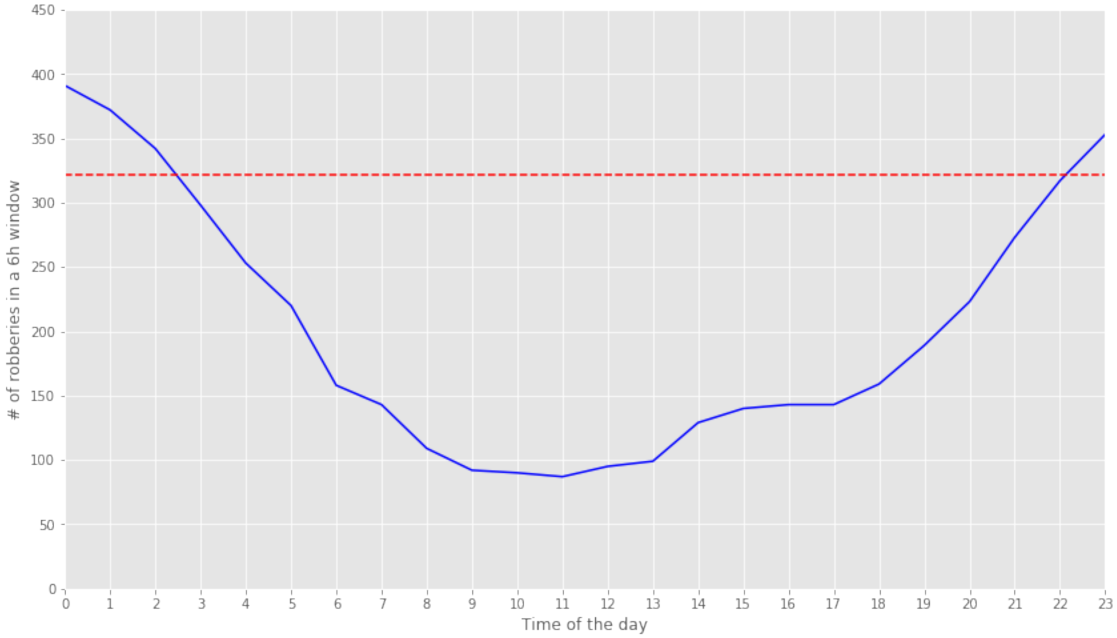
[38]:

```
ax = tc_window_df.plot(figsize=((14,8)), color='b', legend=False)
ax.set_ylim(0,450)
ax.set_xlabel('Time of the day')
ax.set_ylabel('# of robberies in a 6h window')
ax.set_xticks(np.arange(0, 24, 1))

# Line dividing 40% of the cases
hline = len(set(registers.reds))*0.4
ax.axhline(y=hline, color='r', linestyle='--')
```

[38]:

```
<matplotlib.lines.Line2D at 0x12de4b850>
```



[ ]: