Rail Data Science

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1 Data Exploration and Visualisation

Data exploration means a lot of rough analyses, mostly qualitatively. For this, plotting comes handy. We start by importing some packages.

```
In [2]: # Plot library
        import matplotlib
        import matplotlib.pyplot as plt
        import pandas as pd
        # More plot styles
        import seaborn as sns
        # Clickable d3.js-Plots
        import plotly.offline as po

        # Plots to appear in notebook
        %matplotlib inline

        ---------------------------------------------------------------------------
        ModuleNotFoundError                       Traceback (most recent
        <ipython-input-2-fe4fe701af3c> in <module>
              6 import seaborn as sns
              7 # Clickable d3.js-Plots
        ----> 8 import plotly.offline as po
              9
             10 # Plots to appear in notebook

        ModuleNotFoundError: No module named 'plotly'
```

Most likely, importing plotly results in an error:

In this case, change to your terminal, call

`conda install plotly`

and confirm with `y`

```
(base) raphael@DeepThought ifv-rail-data-science % conda install plotly
Collecting package metadata (current_repodata.json): done
Solving environment: done

## Package Plan ##

  environment location: /Users/raphael/opt/anaconda3

  added / updated specs:
    - plotly


The following packages will be downloaded:

    package                    |            build
    ---------------------------|-----------------
    conda-4.9.2                |   py38hecd8cb5_0         2.9 MB
    plotly-4.14.3              |     pyhd3eb1b0_0         3.6 MB
    retrying-1.3.3             |             py_2          14 KB
    ------------------------------------------------------------
                                           Total:         6.5 MB

The following NEW packages will be INSTALLED:

  plotly             pkgs/main/noarch::plotly-4.14.3-pyhd3eb1b0_0
  retrying           pkgs/main/noarch::retrying-1.3.3-py_2

The following packages will be UPDATED:

  conda              conda-forge::conda-4.9.1-py38h50d1736~ --> pkgs/main::conda-4.9.
2-py38hecd8cb5_0


Proceed ([y]/n)? y


Downloading and Extracting Packages
retrying-1.3.3       | 14 KB     | ##################################### | 100%
conda-4.9.2          | 2.9 MB    | ##################################### | 100%
plotly-4.14.3        | 3.6 MB    | ##################################### | 100%
Preparing transaction: done
Verifying transaction: done
Executing transaction: done
(base) raphael@DeepThought ifv-rail-data-science %
```

In this way, you used the conda package manager for the first time!

[1]:
```python
# Plot library
import matplotlib
import matplotlib.pyplot as plt
import pandas as pd
# More plot styles
import seaborn as sns
# Clickable d3.js-Plots
import plotly.offline as po

# Plots to appear in notebook
%matplotlib inline
```

1.1 Analyse Emmas trace

We will once again take a look at Emmas trace, BTW this is Emma:

We start onve again by importing the dataset from Amazons Cloud storage.

[2]:
```
df = pd.read_json('https://s3-eu-west-1.amazonaws.com/ifvworkshopdata/
↪emma1000.json')
df.head()
```

[2]:

	y	x	z	v
0	47.992597	9.678717	557.519958	-1.0
1	47.992597	9.678717	557.519958	-1.0
2	47.992538	9.678639	561.268433	0.0
3	47.992538	9.678639	561.268433	0.0
4	47.992538	9.678639	562.678432	0.0

For a brief analysis, we use the `describe()`-Methodd:

[3]:
```
df.describe()
```

[3]:

	y	x	z	v
count	1000.000000	1000.000000	1000.000000	1000.000000
mean	47.992761	9.679069	554.755151	1.349290
std	0.000315	0.000555	2.376241	0.955252
min	47.992196	9.677698	552.592451	-1.000000
25%	47.992465	9.678720	553.121804	0.290000
50%	47.992756	9.679228	554.343775	1.510000
75%	47.993149	9.679509	555.323952	1.992500
max	47.993192	9.679838	579.272549	3.670000

From the results of describe(), we observe that of course the longitude and latitude do not vary much, it is a park railway in the end. The velocity shows the behaviour as before, with -1-entries during startup of the GPS.

We will now proceed to remove the lines with -1-entries from the dataframe using drop(). I use df[df['v'] == -1].indexto obtain the indices of these lines, to feed to the index-keyword of drop(). It is done inplace in order to speed things up and save memory.

[4]:
```
df.drop(index = df[df['v'] == -1].index, inplace=True)
```

1.2 Exercise

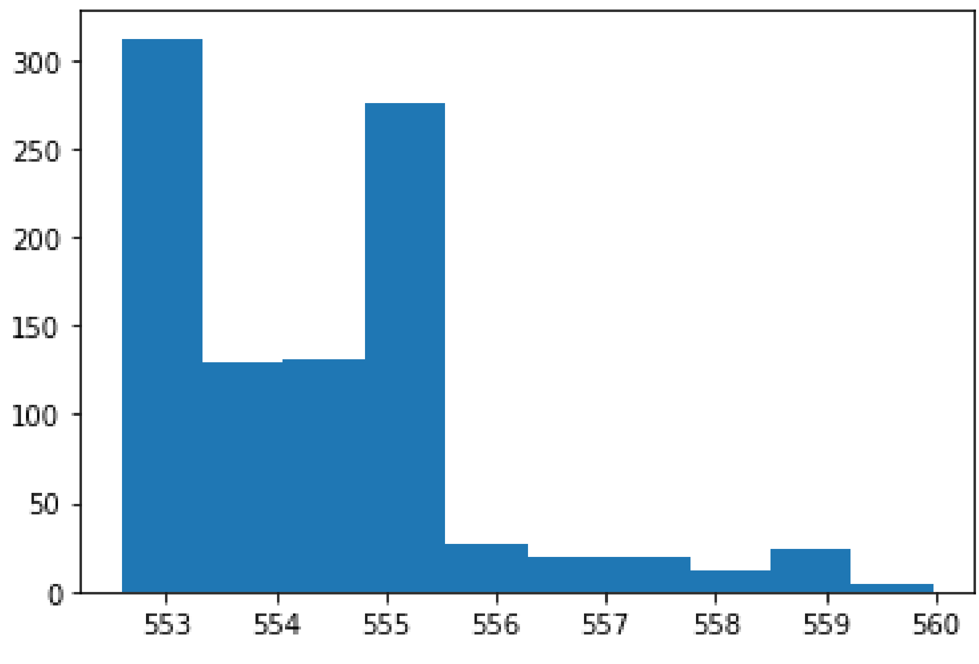
Knowing where the data originates from, also the maximum altitude appears questionable, we will consequently drop all values with $z > 560$, which is your exercise.

[5]:
```
df.drop(index = df[df['z'] > 560].index, inplace=True)
```

We can then proceed to plot a velocity histogram with Matplotlib, the most basic plotting library in Python. Try the keywords cumulative = True and density = True to obtain a normed cumulative distribution as well as bins = 20.

You may also wish to save the returned arrays, as they tend to be disturbing.

[6]:
```
trash = plt.hist(df['z'])
```

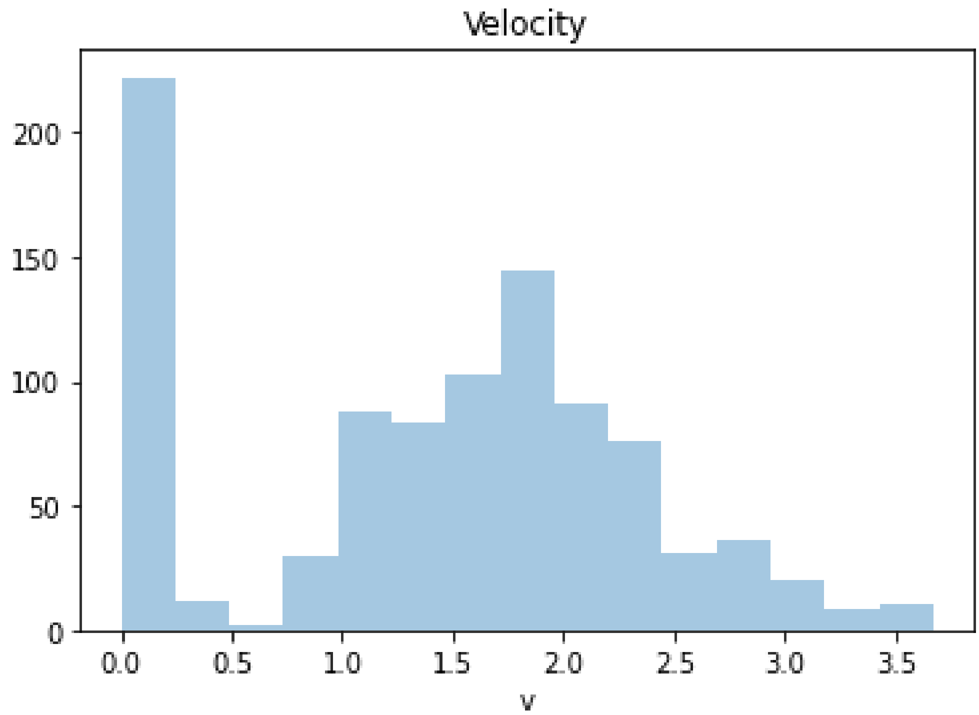


I prefer to use Seaborn for plotting, which accepts all Matplotlib options but looks better. Here we use

- distplot
- plt.title('Velocity')
- plt.savefig('emmavelocity.png', dpi = 600

to generate a histogram, add a title and to save the figure as a file. the `kde = False` inhibits the generate of a kernel density estimation.

[7]:
```
f = plt.figure(111)
ax = sns.distplot(df['v'], kde = False)
plt.title('Velocity')
plt.savefig('emmavelocity.png', dpi = 600)
```



The velocity distribution looks like a typical rail vehicle velocity on a curvy track: with dwell time and a centered distribution around an average.

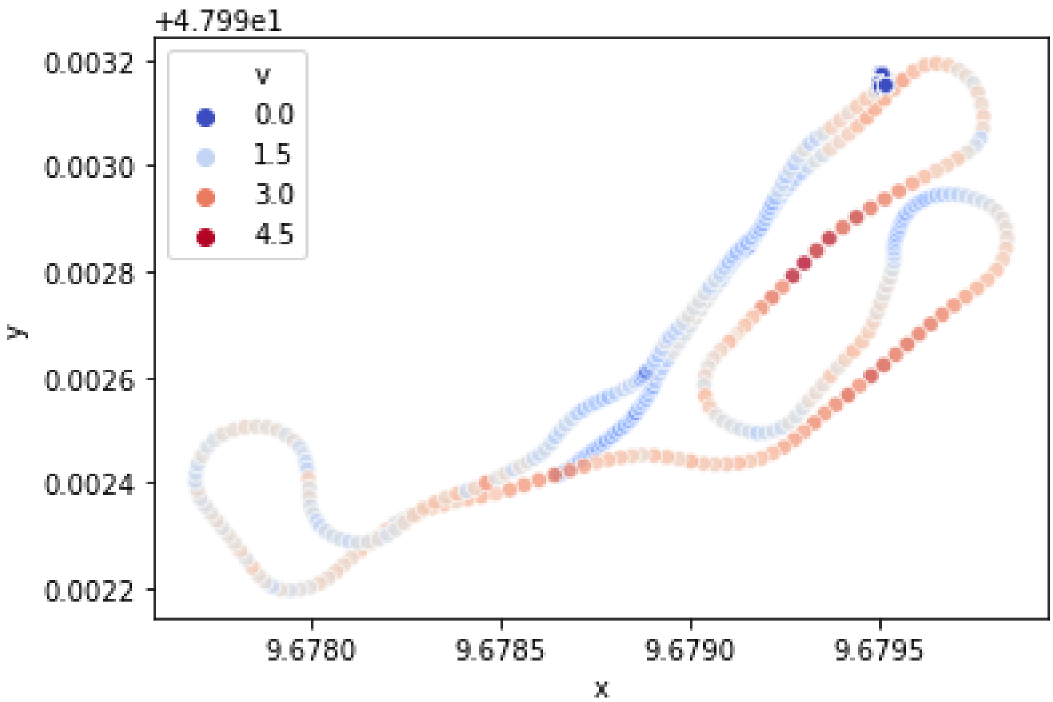
Next I will introduce you to the plotly library, which enables you to generate clickable html plots of data. The plot opens in a new window. Just try the interface, which comes without any additional effort.

The HTML-figure is also saved in the current folder and be reused without Python.

[8]:
```
data = [# Each curve is a dictionary structure
        {'type': 'scatter',
        'y': df['v'],
        'name': 'velocity'},
        {'type': 'scatter',
        'y': df['z']-df['z'].mean(), # Here I remove the mean of the data
        'name': 'Rel. altitude'}
       ]
layout = {"title": 'Emmas velocity'}
fig = dict( data=data, layout=layout )
trash = po.plot(fig, validate=True, filename='emmavelocity.html')
```

To introduce you to some more plotting option, lets plot the geographic distribution of the data featuring the velocity.

[9]:
```
ax = sns.scatterplot(y=df['y'], x=df['x'], alpha = 0.5, hue = df['v'],␣
    ↪palette = "coolwarm")
```



1.3 Exercise:

- Load the open data set on platform height and length from: http://download-data.deutschebahn.com/static/datasets/bahnsteig/DBSuS-Bahnsteigdaten-Stand2020-03.csv
- Produce a scatter plot of platform length ('Netto-baulÃd'nge (m)') and ('HÃűhe Bahnsteigkante (cm)"' [sic!])
- Do you find any interesting patterns?
- Can you repeat your findings using `distplot`to investigate the individual data?

Hint: use `plt.figure()` to plot on a new figure.

[ ]:
```

```

1.4 Plot beach usage ð§ŔŰð§Ŕİ

Well, actually it's Scharbeutz, but however. . .

Let's read in the data:

[10]:
```
df = pd.read_csv(
    'https://opendatarepo.lsh.uni-kiel.de/data/scharbeutz/
 ↪Scharbeutz_Strandabschnitt_21-24_2020-11-14.csv',
    sep = ';', # Separator default is ","
    decimal=",") # German decimal separator
df.head()
```

[10]:
```
             timestamp                             area sensor  value
0  14.11.2020 00:00:00  Scharbeutz - Strandabschnitt  21-24  count    0.0
1  14.11.2020 00:01:00  Scharbeutz - Strandabschnitt  21-24  count    0.0
2  14.11.2020 00:02:00  Scharbeutz - Strandabschnitt  21-24  count    0.0
3  14.11.2020 00:03:00  Scharbeutz - Strandabschnitt  21-24  count    0.0
4  14.11.2020 00:04:00  Scharbeutz - Strandabschnitt  21-24  count    0.0
```

It is quite unhandy that the timestamp is not the index, we can change this using the `index_col`, `parse_dates` and `infer_datetime_format` options.

[11]:
```
df = pd.read_csv(
    'https://opendatarepo.lsh.uni-kiel.de/data/scharbeutz/
 ↪Scharbeutz_Strandabschnitt_21-24_2020-11-14.csv',
    sep = ';', # Separator default is ","
    decimal=",",
    index_col = 'timestamp',
    parse_dates = True,
    infer_datetime_format = True) # German decimal separator
df.head()
```

[11]:
```
                                             area sensor  value
timestamp
2020-11-14 00:00:00  Scharbeutz - Strandabschnitt  21-24  count    0.0
2020-11-14 00:01:00  Scharbeutz - Strandabschnitt  21-24  count    0.0
2020-11-14 00:02:00  Scharbeutz - Strandabschnitt  21-24  count    0.0
2020-11-14 00:03:00  Scharbeutz - Strandabschnitt  21-24  count    0.0
2020-11-14 00:04:00  Scharbeutz - Strandabschnitt  21-24  count    0.0
```

1.5 Exercise:

How is the data distributed over a *November* day?

Plot the data using `df.plt()` with kwarg `rot = 90` and try some of the `kind` options:

```
- âĂŸlineâĂŹ : line plot (default)
- âĂŸhistâĂŹ : histogram
- âĂŸboxâĂŹ : boxplot
- âĂŸkdeâĂŹ : Kernel Density Estimation plot
- âĂŸdensityâĂŹ : same as âĂŸkdeâĂŹ
- âĂŸareaâĂŹ : area plot
- âĂŸpieâĂŹ : pie plot
- âĂŸscatterâĂŹ : scatter plot
- âĂŸhexbinâĂŹ : hexbin plot
```

```
[ ]:
```