module-3

October 20, 2023

1 Module 3: Data Exploration (Homework 2)

The following tutorial contains examples of Python code for data exploration. You should refer to the "Data Exploration" chapter of the "Introduction to Data Mining" book (available at https://www-users.cs.umn.edu/~kumar001/dmbook/index.php) to understand some of the concepts introduced in this tutorial notebook. The notebook can be downloaded from http://www.cse.msu.edu/~ptan/dmbook/tutorials/tutorial3/tutorial3.ipynb.

Data exploration refers to the preliminary investigation of data in order to better understand its specific characteristics. There are two key motivations for data exploration: 1. To help users select the appropriate preprocessing and data analysis technique used. 2. To make use of humans' abilities to recognize patterns in the data.

Read the step-by-step instructions below carefully. To execute the code, click on the cell and press the SHIFT-ENTER keys simultaneously.

1.1 3.1. Summary Statistics

Summary statistics are quantities, such as the mean and standard deviation, that capture various characteristics of a potentially large set of values with a single number or a small set of numbers. In this tutorial, we will use the Iris sample data, which contains information on 150 Iris flowers, 50 each from one of three Iris species: Setosa, Versicolour, and Virginica. Each flower is characterized by five attributes:

- sepal length in centimeters
- sepal width in centimeters
- petal length in centimeters
- petal width in centimeters
- class (Setosa, Versicolour, Virginica)

In this tutorial, you will learn how to:

- Load a CSV data file into a Pandas DataFrame object.
- Compute various summary statistics from the DataFrame.

To execute the sample program shown here, make sure you have installed the Pandas library (see Module 2).

1. First, you need to download the Iris dataset from the UCI machine learning repository.

Code: The following code uses Pandas to read the CSV file and store them in a DataFrame object named data. Next, it will display the first five rows of the data frame.

[ ]:
```
import pandas as pd

data = pd.read_csv('http://archive.ics.uci.edu/ml/machine-learning-databases/
 ↪iris/iris.data',header=None)
data.columns = ['sepal length', 'sepal width', 'petal length', 'petal width',␣
 ↪'class']

data.head()
```

[ ]:

	sepal length	sepal width	petal length	petal width	class
0	5.1	3.5	1.4	0.2	Iris-setosa
1	4.9	3.0	1.4	0.2	Iris-setosa
2	4.7	3.2	1.3	0.2	Iris-setosa
3	4.6	3.1	1.5	0.2	Iris-setosa
4	5.0	3.6	1.4	0.2	Iris-setosa

2. For each quantitative attribute, calculate its average, standard deviation, minimum, and maximum values.

Code:

[ ]:
```
from pandas.api.types import is_numeric_dtype

for col in data.columns:
    if is_numeric_dtype(data[col]):
        print('%s:' % (col))
        print('\t Mean = %.2f' % data[col].mean())
        print('\t Standard deviation = %.2f' % data[col].std())
        print('\t Minimum = %.2f' % data[col].min())
        print('\t Maximum = %.2f' % data[col].max())
```

```
sepal length:
         Mean = 5.84
         Standard deviation = 0.83
         Minimum = 4.30
         Maximum = 7.90
sepal width:
         Mean = 3.05
         Standard deviation = 0.43
         Minimum = 2.00
         Maximum = 4.40
petal length:
         Mean = 3.76
         Standard deviation = 1.76
         Minimum = 1.00
         Maximum = 6.90
```

```
petal width:
         Mean = 1.20
         Standard deviation = 0.76
         Minimum = 0.10
         Maximum = 2.50
```

3. For the qualitative attribute (class), count the frequency for each of its distinct values.

Code:

```
[ ]: data['class'].value_counts()
```

```
[ ]: Iris-setosa        50
     Iris-versicolor    50
     Iris-virginica     50
     Name: class, dtype: int64
```

4. It is also possible to display the summary for all the attributes simultaneously in a table using the describe() function. If an attribute is quantitative, it will display its mean, standard deviation and various quantiles (including minimum, median, and maximum) values. If an attribute is qualitative, it will display its number of unique values and the top (most frequent) values.

Code:

```
[ ]: data.describe(include='all')
```

```
[ ]:         sepal length  sepal width  petal length  petal width        class
     count      150.000000   150.000000    150.000000   150.000000          150
     unique            NaN          NaN           NaN          NaN            3
     top               NaN          NaN           NaN          NaN  Iris-setosa
     freq              NaN          NaN           NaN          NaN           50
     mean         5.843333     3.054000      3.758667     1.198667          NaN
     std          0.828066     0.433594      1.764420     0.763161          NaN
     min          4.300000     2.000000      1.000000     0.100000          NaN
     25%          5.100000     2.800000      1.600000     0.300000          NaN
     50%          5.800000     3.000000      4.350000     1.300000          NaN
     75%          6.400000     3.300000      5.100000     1.800000          NaN
     max          7.900000     4.400000      6.900000     2.500000          NaN
```

Note that count refers to the number of non-missing values for each attribute.

5. For multivariate statistics, you can compute the covariance and correlation between pairs of attributes.

Code:

```
[ ]: print('Covariance:')
     data.cov()
```

```
Covariance:
```

```
<ipython-input-27-4f52c089a412>:2: FutureWarning: The default value of
numeric_only in DataFrame.cov is deprecated. In a future version, it will
default to False. Select only valid columns or specify the value of numeric_only
to silence this warning.
  data.cov()
```

[ ]:

	sepal length	sepal width	petal length	petal width
sepal length	0.685694	-0.039268	1.273682	0.516904
sepal width	-0.039268	0.188004	-0.321713	-0.117981
petal length	1.273682	-0.321713	3.113179	1.296387
petal width	0.516904	-0.117981	1.296387	0.582414

[ ]:
```
print('Correlation:')
data.corr()
```

```
Correlation:

<ipython-input-28-1826941e9562>:2: FutureWarning: The default value of
numeric_only in DataFrame.corr is deprecated. In a future version, it will
default to False. Select only valid columns or specify the value of numeric_only
to silence this warning.
  data.corr()
```

[ ]:

	sepal length	sepal width	petal length	petal width
sepal length	1.000000	-0.109369	0.871754	0.817954
sepal width	-0.109369	1.000000	-0.420516	-0.356544
petal length	0.871754	-0.420516	1.000000	0.962757
petal width	0.817954	-0.356544	0.962757	1.000000

1.2 3.2. Data Visualization

Data visualization is the display of information in a graphic or tabular format. Successful visualization requires that the data (information) be converted into a visual format so that the characteristics of the data and the relationships among data items or attributes can be analyzed or reported.

In this tutorial, you will learn how to display the Iris data created in Section 3.1. To execute the sample program shown here, make sure you have installed the matplotlib library package (see Module 0 on how to install Python packages).

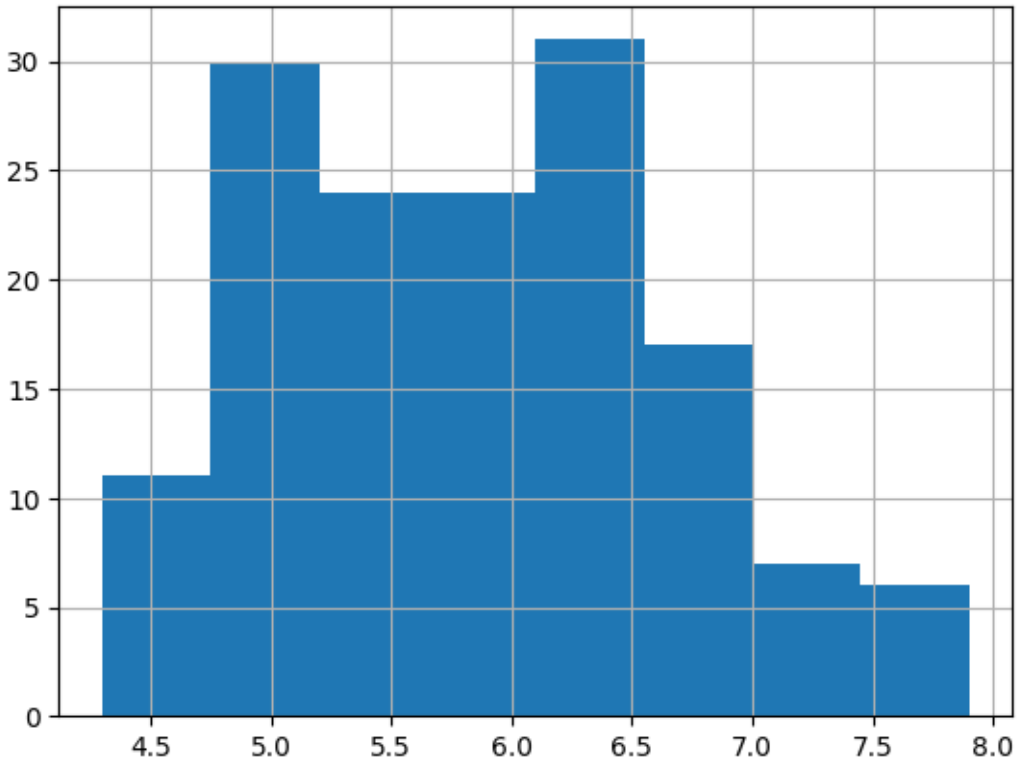
1. First, we will display the histogram for the sepal length attribute by discretizing it into 8 separate bins and counting the frequency for each bin.

Code:

[ ]:
```
%matplotlib inline

data['sepal length'].hist(bins=8)
```

[ ]:
```
<Axes: >
```

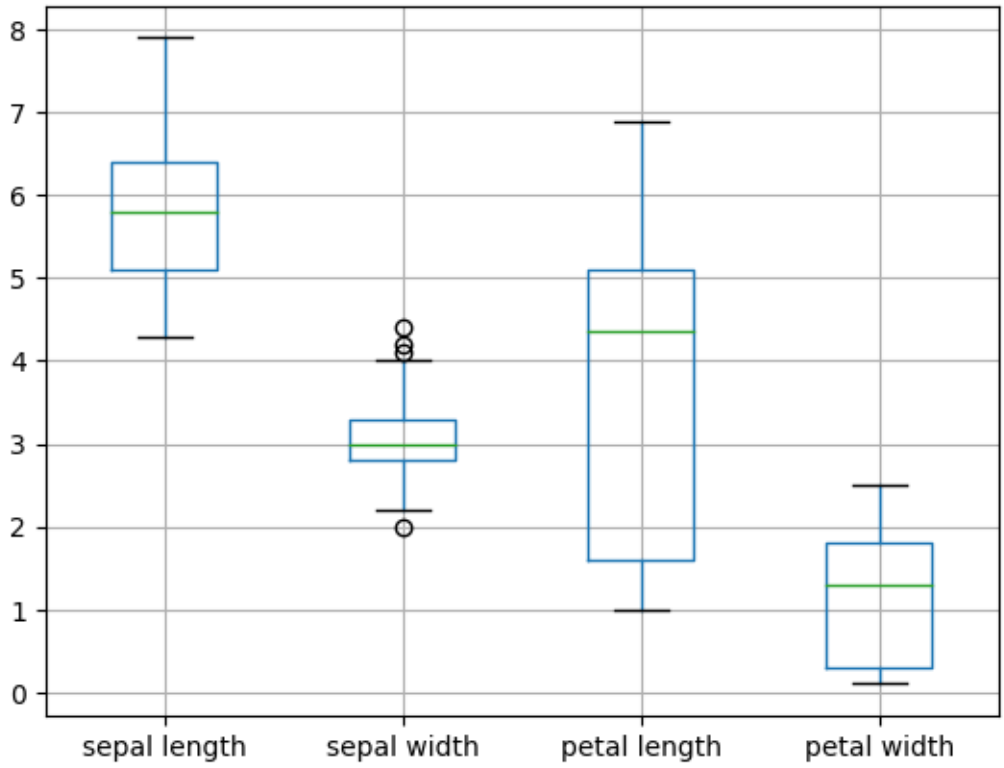


2. A boxplot can also be used to show the distribution of values for each attribute.

Code:

```
[ ]: data.boxplot()
```

```
[ ]: <Axes: >
```

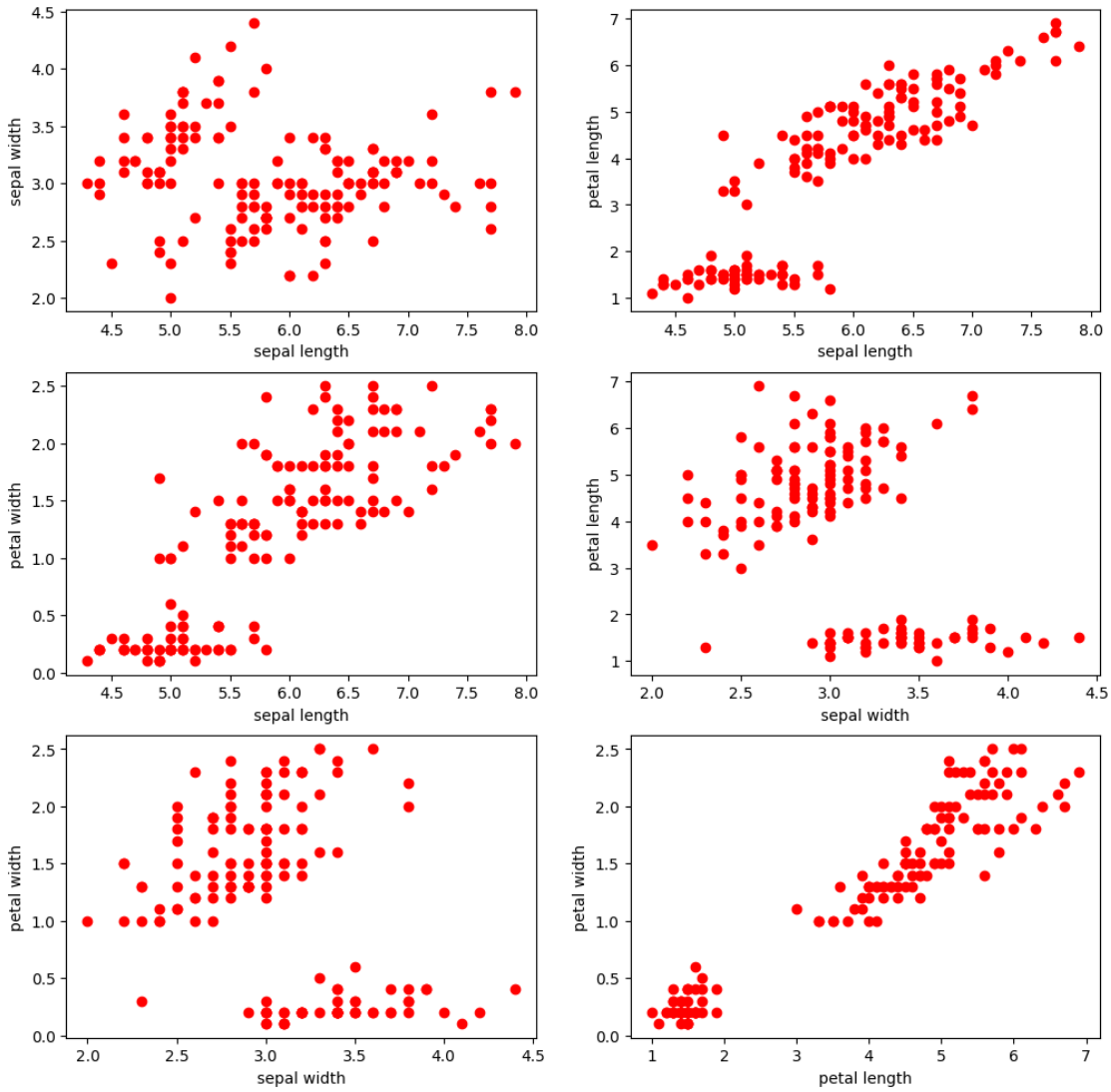


3. For each pair of attributes, we can use a scatter plot to visualize their joint distribution.

Code:

[ ]:
```
import matplotlib.pyplot as plt

fig, axes = plt.subplots(3, 2, figsize=(12,12))
index = 0
for i in range(3):
    for j in range(i+1,4):
        ax1 = int(index/2)
        ax2 = index % 2
        axes[ax1][ax2].scatter(data[data.columns[i]], data[data.columns[j]],␣
 ↪color='red')
        axes[ax1][ax2].set_xlabel(data.columns[i])
        axes[ax1][ax2].set_ylabel(data.columns[j])
        index = index + 1
```



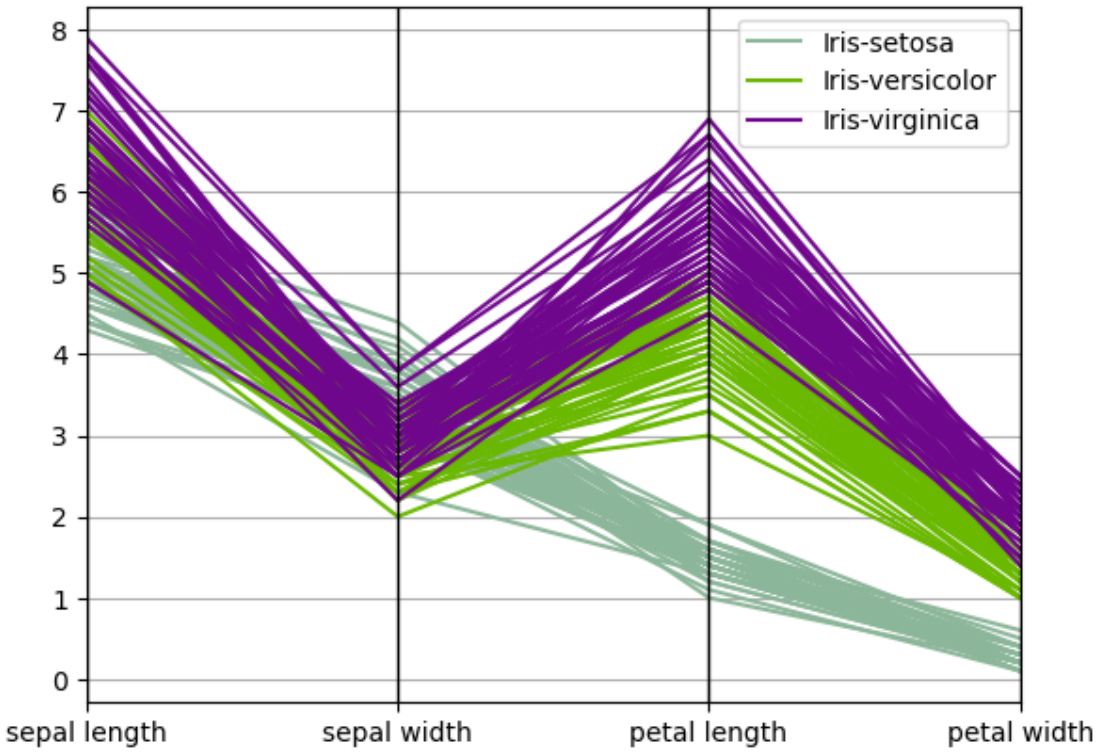
4. Parallel coordinates can be used to display all the data points simultaneously. Parallel coordinates have one coordinate axis for each attribute, but the different axes are parallel to one other instead of perpendicular, as is traditional. Furthermore, an object is represented as a line instead of as a point. In the example below, the distribution of values for each class can be identified in a separate color.

Code:

```
[ ]: from pandas.plotting import parallel_coordinates
     %matplotlib inline

     parallel_coordinates(data, 'class')
```

```
[ ]: <Axes: >
```



1.3 3.3. Summary

This tutorial presents several examples for data exploration and visualization using the Pandas and matplotlib library packages available in Python.

References:

1. Documentation on Pandas. https://pandas.pydata.org/
2. Documentation on matplotlib. https://matplotlib.org/
3. Lichman, M. (2013). UCI Machine Learning Repository [http://archive.ics.uci.edu/ml]. Irvine, CA: University of California, School of Information and Computer Science.

1.4 In-clas (Homework 2)

Please do not manually look for answers even if you can.

[1]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

[ ]:
```
import pandas as pd
import numpy as np
```

```
[ ]: happiness_df = pd.read_csv('/content/drive/MyDrive/shared/happiness_2017.csv')
     happiness_df.head()
```

```
[ ]:        Country          Region  Rank  HappinessScore  Life Ladder  \
    0       Norway  Western Europe     1           7.537     7.578745
    1      Denmark  Western Europe     2           7.522     7.593702
    2      Iceland  Western Europe     3           7.504     7.476214
    3  Switzerland  Western Europe     4           7.494     7.473593
    4      Finland  Western Europe     5           7.469     7.788252

       Log GDP per capita  Social support  Healthy life expectancy at birth  \
    0           11.081789        0.950128                          71.086586
    1           10.748989        0.952100                          71.662498
    2           10.760409        0.966753                          72.755981
    3           10.955548        0.949661                          73.173759
    4           10.612338        0.963826                          71.696960

       Freedom to make life choices  Generosity  Perceptions of corruption  \
    0                      0.953017    0.210104                   0.249711
    1                      0.955416    0.145387                   0.181148
    2                      0.938783    0.235479                   0.726845
    3                      0.924997    0.167875                   0.316183
    4                      0.962199   -0.012174                   0.192413

       Positive affect  Negative affect  Confidence in national government
    0         0.849100         0.202914                          0.717160
    1         0.823667         0.205775                          0.572353
    2         0.895255         0.148160                          0.365042
    3         0.773997         0.195871                          0.819707
    4         0.787137         0.176066                          0.597539
```

```
[ ]: print(happiness_df.shape)
     happiness_df.columns
```

```
    (140, 14)
```

```
[ ]: Index(['Country', 'Region', 'Rank', 'HappinessScore', 'Life Ladder',
           'Log GDP per capita', 'Social support',
           'Healthy life expectancy at birth', 'Freedom to make life choices',
           'Generosity', 'Perceptions of corruption', 'Positive affect',
           'Negative affect', 'Confidence in national government'],
          dtype='object')
```

```
[ ]: life_ladder_df = happiness_df[['Life Ladder','Generosity']]
     print(life_ladder_df['Life Ladder'].min())
     print(life_ladder_df.shape)
     life_ladder_df.head(2)
```

```
2.66171813
(140, 2)
```

[ ]:
```
   Life Ladder  Generosity
0     7.578745    0.210104
1     7.593702    0.145387
```

[ ]:
```
# selecting multiple columns by names.
df_1 = happiness_df.loc[:, 'Life Ladder':'Generosity']
df_1.head()
```

[ ]:
```
   Life Ladder  Log GDP per capita  Social support  \
0     7.578745           11.081789        0.950128
1     7.593702           10.748989        0.952100
2     7.476214           10.760409        0.966753
3     7.473593           10.955548        0.949661
4     7.788252           10.612338        0.963826

   Healthy life expectancy at birth  Freedom to make life choices  Generosity
0                         71.086586                      0.953017    0.210104
1                         71.662498                      0.955416    0.145387
2                         72.755981                      0.938783    0.235479
3                         73.173759                      0.924997    0.167875
4                         71.696960                      0.962199   -0.012174
```

[ ]:
```
# slicing
df_2 = happiness_df.iloc[10:100, 5:10]
df_2.head()
```

[ ]:
```
    Log GDP per capita  Social support  Healthy life expectancy at birth  \
10            9.670634        0.921697                         69.867302
11           10.716226        0.906218                         72.359711
12           10.899869        0.921003                         69.770920
13           11.066487        0.943482                         71.709785
14           10.711184        0.892166                         71.079102

    Freedom to make life choices  Generosity
10                      0.935618   -0.078269
11                      0.890031    0.124997
12                      0.868497    0.181657
13                      0.905341    0.206802
14                      0.840728    0.135308
```

[ ]:
```
happiness_df['Region'].unique()
```

[ ]:
```
array(['Western Europe', 'North America and ANZ',
       'Middle East and North Africa', 'Latin America and Caribbean',
```

```
       'Central and Eastern Europe', 'Southeast Asia', 'East Asia',
       'Commonwealth of Independent States', 'Sub-Saharan Africa',
       'South Asia'], dtype=object)
```

[ ]:
```
western_enrope_df = happiness_df[happiness_df['Region'] == "Western Europe"]
print(western_enrope_df.shape)
western_enrope_df.head(2)
```

```
(20, 14)
```

[ ]:
```
   Country          Region  Rank  HappinessScore  Life Ladder  \
0   Norway  Western Europe     1           7.537     7.578745
1  Denmark  Western Europe     2           7.522     7.593702

   Log GDP per capita  Social support  Healthy life expectancy at birth  \
0           11.081789        0.950128                          71.086586
1           10.748989        0.952100                          71.662498

   Freedom to make life choices  Generosity  Perceptions of corruption  \
0                      0.953017    0.210104                   0.249711
1                      0.955416    0.145387                   0.181148

   Positive affect  Negative affect  Confidence in national government
0         0.849100         0.202914                          0.717160
1         0.823667         0.205775                          0.572353
```

1.4.1 Q-1: Calculating the average, standard deviation, maximum, mininum, median of happiness scores.

Your solution should only show these statistics for happiness scores.

[ ]:

1.4.2 Q-2: What is the name and happiness score of the country with the lowest confidence in their national government?

[ ]:

1.4.3 Q-3 How many countries are in Western Europe?

This will be very easy wiht grouping function, but you can still do it without it

[ ]:

1.4.4 Q-4: Which two factors have the largest positive correlation and Which two factors have the largest negative correlation?

[ ]:
```
# this is how I would normally do this!
correlation_matrix = happiness_df.corr()
largest_positive_corr = (correlation_matrix[correlation_matrix < 1].stack().
 ↪idxmax())
factor1_pos, factor2_pos = largest_positive_corr
largest_negative_corr = (
    correlation_matrix[correlation_matrix > -1]
    .stack()
    .idxmin())
factor1_neg, factor2_neg = largest_negative_corr
largest_positive_corr_value = correlation_matrix.loc[factor1_pos, factor2_pos]
largest_negative_corr_value = correlation_matrix.loc[factor1_neg, factor2_neg]
print(f"The two factors with the largest positive correlation are␣
 ↪'{factor1_pos}' and '{factor2_pos}' with a correlation of␣
 ↪{largest_positive_corr_value:.2f}.")
print(f"The two factors with the largest negative correlation are␣
 ↪'{factor1_neg}' and '{factor2_neg}' with a correlation of␣
 ↪{largest_negative_corr_value:.2f}.")
```

```
The two factors with the largest positive correlation are 'HappinessScore' and
'Life Ladder' with a correlation of 0.93.
The two factors with the largest negative correlation are 'Rank' and
'HappinessScore' with a correlation of -0.99.
```

```
<ipython-input-58-35fdebe80184>:2: FutureWarning: The default value of
numeric_only in DataFrame.corr is deprecated. In a future version, it will
default to False. Select only valid columns or specify the value of numeric_only
to silence this warning.
  correlation_matrix = happiness_df.corr()
```

[ ]:
```
correlation_matrix = happiness_df.corr()
correlation_matrix.style.background_gradient(cmap='coolwarm')
```

```
<ipython-input-61-9287acdac567>:1: FutureWarning: The default value of
numeric_only in DataFrame.corr is deprecated. In a future version, it will
default to False. Select only valid columns or specify the value of numeric_only
to silence this warning.
  correlation_matrix = happiness_df.corr()
```

[ ]:
```
<pandas.io.formats.style.Styler at 0x7fe04ec822c0>
```

[ ]:
```
correlation_matrix = happiness_df.corr()
#print(type(correlation_matrix))
correlation_matrix=correlation_matrix[correlation_matrix < 1].stack()
#print(type(correlation_matrix))
```

```
correlation_matrix_pos = correlation_matrix.idxmax()
#print(type(correlation_matrix_pos))
print(correlation_matrix_pos)
max_corr_value = correlation_matrix[correlation_matrix_pos]
print(max_corr_value)
```

```
('HappinessScore', 'Life Ladder')
0.9305290155706081
```

```
<ipython-input-65-56bb16c2e0e6>:1: FutureWarning: The default value of
numeric_only in DataFrame.corr is deprecated. In a future version, it will
default to False. Select only valid columns or specify the value of numeric_only
to silence this warning.
  correlation_matrix = happiness_df.corr()
```

1.5 Merging data

Let's load the world polulation data.

[ ]:
```
world_pop_df = pd.read_csv('/content/drive/MyDrive/shared/world_countries.csv').
↪dropna(axis=1, how='all')
world_pop_df.head()
```

[ ]:

	Country	Code	Region	Population	Area	\
0	Afghanistan	AFG	ASIA (EX. NEAR EAST)	31056997	647500	
1	Albania	ALB	EASTERN EUROPE	3581655	28748	
2	Algeria	DZA	NORTHERN AFRICA	32930091	2381740	
3	American Samoa	ASM	OCEANIA	57794	199	
4	Andorra	AND	WESTERN EUROPE	71201	468	

	Pop. Density	Coastline	Net migration	Infant mortality	GDP	…	\
0	48.0	0.00	23.06	163.07	700.0	…	
1	124.6	1.26	-4.93	21.52	4500.0	…	
2	13.8	0.04	-0.39	31.00	6000.0	…	
3	290.4	58.29	-20.71	9.27	8000.0	…	
4	152.1	0.00	6.60	4.05	19000.0	…	

	Phones	Arable	Crops	Other	Climate	Birthrate	Deathrate	Agriculture	\
0	3.2	12.13	0.22	87.65	1.0	46.60	20.34	0.380	
1	71.2	21.09	4.42	74.49	3.0	15.11	5.22	0.232	
2	78.1	3.22	0.25	96.53	1.0	17.14	4.61	0.101	
3	259.5	10.00	15.00	75.00	2.0	22.46	3.27	NaN	
4	497.2	2.22	0.00	97.78	3.0	8.71	6.25	NaN	

	Industry	Service
0	0.240	0.380
1	0.188	0.579
2	0.600	0.298

```
3       NaN      NaN
4       NaN      NaN

[5 rows x 21 columns]
```

To extract populations from world_pop_df, we have to merge happiness_df with world_pop_df. As you probably can remember that some of the country names in world_counties.csv and happiness_2007.csvdo not match (Optional).

There are 4 kinds of merge: 'inner', 'outer', 'left', and 'right'. We practiced inner merge previously.

You may find examples from https://jakevdp.github.io/PythonDataScienceHandbook/03.07-merge-and-join.html: Example: US States Data

1.5.1 Q-5. Which country has the largest population in Latin America and Caribbean.

[ ]:

1.5.2 Q-6. Find the average population of East Asia.

[ ]:

[ ]:
```
!apt-get install texlive texlive-xetex texlive-latex-extra pandoc
!pip install pypandoc
```

```
Reading package lists… Done
Building dependency tree… Done
Reading state information… Done
pandoc is already the newest version (2.9.2.1-3ubuntu2).
pandoc set to manually installed.
The following additional packages will be installed:
  dvisvgm fonts-droid-fallback fonts-lato fonts-lmodern fonts-noto-mono fonts-
texgyre
  fonts-urw-base35 libapache-pom-java libcommons-logging-java libcommons-parent-
java
  libfontbox-java libfontenc1 libgs9 libgs9-common libidn12 libijs-0.35
libjbig2dec0 libkpathsea6
  libpdfbox-java libptexenc1 libruby3.0 libsynctex2 libteckit0 libtexlua53
libtexluajit2 libwoff1
  libzzip-0-13 lmodern poppler-data preview-latex-style rake ruby ruby-net-
telnet ruby-rubygems
  ruby-webrick ruby-xmlrpc ruby3.0 rubygems-integration t1utils teckit tex-
common tex-gyre
  texlive-base texlive-binaries texlive-fonts-recommended texlive-latex-base
  texlive-latex-recommended texlive-pictures texlive-plain-generic tipa xfonts-
encodings
  xfonts-utils
Suggested packages:
```

```
  fonts-noto fonts-freefont-otf | fonts-freefont-ttf libavalon-framework-java
  libcommons-logging-java-doc libexcalibur-logkit-java liblog4j1.2-java poppler-
utils ghostscript
  fonts-japanese-mincho | fonts-ipafont-mincho fonts-japanese-gothic | fonts-
ipafont-gothic
  fonts-arphic-ukai fonts-arphic-uming fonts-nanum ri ruby-dev bundler debhelper
gv
  | postscript-viewer perl-tk xpdf | pdf-viewer xzdec texlive-fonts-recommended-
doc
  texlive-latex-base-doc python3-pygments icc-profiles libfile-which-perl
  libspreadsheet-parseexcel-perl texlive-latex-extra-doc texlive-latex-
recommended-doc
  texlive-luatex texlive-pstricks dot2tex prerex texlive-pictures-doc vprerex
default-jre-headless
  tipa-doc
The following NEW packages will be installed:
  dvisvgm fonts-droid-fallback fonts-lato fonts-lmodern fonts-noto-mono fonts-
texgyre
  fonts-urw-base35 libapache-pom-java libcommons-logging-java libcommons-parent-
java
  libfontbox-java libfontenc1 libgs9 libgs9-common libidn12 libijs-0.35
libjbig2dec0 libkpathsea6
  libpdfbox-java libptexenc1 libruby3.0 libsynctex2 libteckit0 libtexlua53
libtexluajit2 libwoff1
  libzzip-0-13 lmodern poppler-data preview-latex-style rake ruby ruby-net-
telnet ruby-rubygems
  ruby-webrick ruby-xmlrpc ruby3.0 rubygems-integration t1utils teckit tex-
common tex-gyre texlive
  texlive-base texlive-binaries texlive-fonts-recommended texlive-latex-base
texlive-latex-extra
  texlive-latex-recommended texlive-pictures texlive-plain-generic texlive-xetex
tipa
  xfonts-encodings xfonts-utils
0 upgraded, 55 newly installed, 0 to remove and 18 not upgraded.
Need to get 182 MB of archives.
After this operation, 572 MB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu jammy/main amd64 fonts-droid-fallback all
1:6.0.1r16-1.1build1 [1,805 kB]
Get:2 http://archive.ubuntu.com/ubuntu jammy/main amd64 fonts-lato all 2.0-2.1
[2,696 kB]
Get:3 http://archive.ubuntu.com/ubuntu jammy/main amd64 poppler-data all
0.4.11-1 [2,171 kB]
Get:4 http://archive.ubuntu.com/ubuntu jammy/universe amd64 tex-common all 6.17
[33.7 kB]
Get:5 http://archive.ubuntu.com/ubuntu jammy/main amd64 fonts-urw-base35 all
20200910-1 [6,367 kB]
Get:6 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libgs9-common
all 9.55.0~dfsg1-0ubuntu5.5 [752 kB]
```

```
Get:7 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libidn12 amd64
1.38-4ubuntu1 [60.0 kB]
Get:8 http://archive.ubuntu.com/ubuntu jammy/main amd64 libijs-0.35 amd64
0.35-15build2 [16.5 kB]
Get:9 http://archive.ubuntu.com/ubuntu jammy/main amd64 libjbig2dec0 amd64
0.19-3build2 [64.7 kB]
Get:10 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libgs9 amd64
9.55.0~dfsg1-0ubuntu5.5 [5,030 kB]
Get:11 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libkpathsea6
amd64 2021.20210626.59705-1ubuntu0.1 [60.3 kB]
Get:12 http://archive.ubuntu.com/ubuntu jammy/main amd64 libwoff1 amd64
1.0.2-1build4 [45.2 kB]
Get:13 http://archive.ubuntu.com/ubuntu jammy/universe amd64 dvisvgm amd64
2.13.1-1 [1,221 kB]
Get:14 http://archive.ubuntu.com/ubuntu jammy/universe amd64 fonts-lmodern all
2.004.5-6.1 [4,532 kB]
Get:15 http://archive.ubuntu.com/ubuntu jammy/main amd64 fonts-noto-mono all
20201225-1build1 [397 kB]
Get:16 http://archive.ubuntu.com/ubuntu jammy/universe amd64 fonts-texgyre all
20180621-3.1 [10.2 MB]
Get:17 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libapache-pom-java
all 18-1 [4,720 B]
Get:18 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libcommons-parent-
java all 43-1 [10.8 kB]
Get:19 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libcommons-logging-
java all 1.2-2 [60.3 kB]
Get:20 http://archive.ubuntu.com/ubuntu jammy/main amd64 libfontenc1 amd64
1:1.1.4-1build3 [14.7 kB]
Get:21 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libptexenc1
amd64 2021.20210626.59705-1ubuntu0.1 [39.1 kB]
Get:22 http://archive.ubuntu.com/ubuntu jammy/main amd64 rubygems-integration
all 1.18 [5,336 B]
Get:23 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 ruby3.0 amd64
3.0.2-7ubuntu2.4 [50.1 kB]
Get:24 http://archive.ubuntu.com/ubuntu jammy/main amd64 ruby-rubygems all
3.3.5-2 [228 kB]
Get:25 http://archive.ubuntu.com/ubuntu jammy/main amd64 ruby amd64 1:3.0~exp1
[5,100 B]
Get:26 http://archive.ubuntu.com/ubuntu jammy/main amd64 rake all 13.0.6-2 [61.7
kB]
Get:27 http://archive.ubuntu.com/ubuntu jammy/main amd64 ruby-net-telnet all
0.1.1-2 [12.6 kB]
Get:28 http://archive.ubuntu.com/ubuntu jammy/universe amd64 ruby-webrick all
1.7.0-3 [51.8 kB]
Get:29 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 ruby-xmlrpc all
0.3.2-1ubuntu0.1 [24.9 kB]
Get:30 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libruby3.0
amd64 3.0.2-7ubuntu2.4 [5,113 kB]
```

```
Get:31 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libsynctex2
amd64 2021.20210626.59705-1ubuntu0.1 [55.5 kB]
Get:32 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libteckit0 amd64
2.5.11+ds1-1 [421 kB]
Get:33 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libtexlua53
amd64 2021.20210626.59705-1ubuntu0.1 [120 kB]
Get:34 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libtexluajit2
amd64 2021.20210626.59705-1ubuntu0.1 [267 kB]
Get:35 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libzzip-0-13 amd64
0.13.72+dfsg.1-1.1 [27.0 kB]
Get:36 http://archive.ubuntu.com/ubuntu jammy/main amd64 xfonts-encodings all
1:1.0.5-0ubuntu2 [578 kB]
Get:37 http://archive.ubuntu.com/ubuntu jammy/main amd64 xfonts-utils amd64
1:7.7+6build2 [94.6 kB]
Get:38 http://archive.ubuntu.com/ubuntu jammy/universe amd64 lmodern all
2.004.5-6.1 [9,471 kB]
Get:39 http://archive.ubuntu.com/ubuntu jammy/universe amd64 preview-latex-style
all 12.2-1ubuntu1 [185 kB]
Get:40 http://archive.ubuntu.com/ubuntu jammy/main amd64 t1utils amd64
1.41-4build2 [61.3 kB]
Get:41 http://archive.ubuntu.com/ubuntu jammy/universe amd64 teckit amd64
2.5.11+ds1-1 [699 kB]
Get:42 http://archive.ubuntu.com/ubuntu jammy/universe amd64 tex-gyre all
20180621-3.1 [6,209 kB]
Get:43 http://archive.ubuntu.com/ubuntu jammy-updates/universe amd64 texlive-
binaries amd64 2021.20210626.59705-1ubuntu0.1 [9,848 kB]
Get:44 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-base all
2021.20220204-1 [21.0 MB]
Get:45 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-fonts-
recommended all 2021.20220204-1 [4,972 kB]
Get:46 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-latex-base
all 2021.20220204-1 [1,128 kB]
Get:47 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-latex-
recommended all 2021.20220204-1 [14.4 MB]
Get:48 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive all
2021.20220204-1 [14.3 kB]
Get:49 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libfontbox-java all
1:1.8.16-2 [207 kB]
Get:50 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libpdfbox-java all
1:1.8.16-2 [5,199 kB]
Get:51 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-pictures
all 2021.20220204-1 [8,720 kB]
Get:52 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-latex-extra
all 2021.20220204-1 [13.9 MB]
Get:53 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-plain-
generic all 2021.20220204-1 [27.5 MB]
Get:54 http://archive.ubuntu.com/ubuntu jammy/universe amd64 tipa all 2:1.3-21
[2,967 kB]
```

```
Get:55 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-xetex all
2021.20220204-1 [12.4 MB]
Fetched 182 MB in 3s (71.1 MB/s)
Extracting templates from packages: 100%
Preconfiguring packages …
Selecting previously unselected package fonts-droid-fallback.
(Reading database … 120876 files and directories currently installed.)
Preparing to unpack …/00-fonts-droid-fallback_1%3a6.0.1r16-1.1build1_all.deb
…
Unpacking fonts-droid-fallback (1:6.0.1r16-1.1build1) …
Selecting previously unselected package fonts-lato.
Preparing to unpack …/01-fonts-lato_2.0-2.1_all.deb …
Unpacking fonts-lato (2.0-2.1) …
Selecting previously unselected package poppler-data.
Preparing to unpack …/02-poppler-data_0.4.11-1_all.deb …
Unpacking poppler-data (0.4.11-1) …
Selecting previously unselected package tex-common.
Preparing to unpack …/03-tex-common_6.17_all.deb …
Unpacking tex-common (6.17) …
Selecting previously unselected package fonts-urw-base35.
Preparing to unpack …/04-fonts-urw-base35_20200910-1_all.deb …
Unpacking fonts-urw-base35 (20200910-1) …
Selecting previously unselected package libgs9-common.
Preparing to unpack …/05-libgs9-common_9.55.0~dfsg1-0ubuntu5.5_all.deb …
Unpacking libgs9-common (9.55.0~dfsg1-0ubuntu5.5) …
Selecting previously unselected package libidn12:amd64.
Preparing to unpack …/06-libidn12_1.38-4ubuntu1_amd64.deb …
Unpacking libidn12:amd64 (1.38-4ubuntu1) …
Selecting previously unselected package libijs-0.35:amd64.
Preparing to unpack …/07-libijs-0.35_0.35-15build2_amd64.deb …
Unpacking libijs-0.35:amd64 (0.35-15build2) …
Selecting previously unselected package libjbig2dec0:amd64.
Preparing to unpack …/08-libjbig2dec0_0.19-3build2_amd64.deb …
Unpacking libjbig2dec0:amd64 (0.19-3build2) …
Selecting previously unselected package libgs9:amd64.
Preparing to unpack …/09-libgs9_9.55.0~dfsg1-0ubuntu5.5_amd64.deb …
Unpacking libgs9:amd64 (9.55.0~dfsg1-0ubuntu5.5) …
Selecting previously unselected package libkpathsea6:amd64.
Preparing to unpack …/10-libkpathsea6_2021.20210626.59705-1ubuntu0.1_amd64.deb
…
Unpacking libkpathsea6:amd64 (2021.20210626.59705-1ubuntu0.1) …
Selecting previously unselected package libwoff1:amd64.
Preparing to unpack …/11-libwoff1_1.0.2-1build4_amd64.deb …
Unpacking libwoff1:amd64 (1.0.2-1build4) …
Selecting previously unselected package dvisvgm.
Preparing to unpack …/12-dvisvgm_2.13.1-1_amd64.deb …
Unpacking dvisvgm (2.13.1-1) …
Selecting previously unselected package fonts-lmodern.
```

```
Preparing to unpack …/13-fonts-lmodern_2.004.5-6.1_all.deb …
Unpacking fonts-lmodern (2.004.5-6.1) …
Selecting previously unselected package fonts-noto-mono.
Preparing to unpack …/14-fonts-noto-mono_20201225-1build1_all.deb …
Unpacking fonts-noto-mono (20201225-1build1) …
Selecting previously unselected package fonts-texgyre.
Preparing to unpack …/15-fonts-texgyre_20180621-3.1_all.deb …
Unpacking fonts-texgyre (20180621-3.1) …
Selecting previously unselected package libapache-pom-java.
Preparing to unpack …/16-libapache-pom-java_18-1_all.deb …
Unpacking libapache-pom-java (18-1) …
Selecting previously unselected package libcommons-parent-java.
Preparing to unpack …/17-libcommons-parent-java_43-1_all.deb …
Unpacking libcommons-parent-java (43-1) …
Selecting previously unselected package libcommons-logging-java.
Preparing to unpack …/18-libcommons-logging-java_1.2-2_all.deb …
Unpacking libcommons-logging-java (1.2-2) …
Selecting previously unselected package libfontenc1:amd64.
Preparing to unpack …/19-libfontenc1_1%3a1.1.4-1build3_amd64.deb …
Unpacking libfontenc1:amd64 (1:1.1.4-1build3) …
Selecting previously unselected package libptexenc1:amd64.
Preparing to unpack …/20-libptexenc1_2021.20210626.59705-1ubuntu0.1_amd64.deb
…
Unpacking libptexenc1:amd64 (2021.20210626.59705-1ubuntu0.1) …
Selecting previously unselected package rubygems-integration.
Preparing to unpack …/21-rubygems-integration_1.18_all.deb …
Unpacking rubygems-integration (1.18) …
Selecting previously unselected package ruby3.0.
Preparing to unpack …/22-ruby3.0_3.0.2-7ubuntu2.4_amd64.deb …
Unpacking ruby3.0 (3.0.2-7ubuntu2.4) …
Selecting previously unselected package ruby-rubygems.
Preparing to unpack …/23-ruby-rubygems_3.3.5-2_all.deb …
Unpacking ruby-rubygems (3.3.5-2) …
Selecting previously unselected package ruby.
Preparing to unpack …/24-ruby_1%3a3.0~exp1_amd64.deb …
Unpacking ruby (1:3.0~exp1) …
Selecting previously unselected package rake.
Preparing to unpack …/25-rake_13.0.6-2_all.deb …
Unpacking rake (13.0.6-2) …
Selecting previously unselected package ruby-net-telnet.
Preparing to unpack …/26-ruby-net-telnet_0.1.1-2_all.deb …
Unpacking ruby-net-telnet (0.1.1-2) …
Selecting previously unselected package ruby-webrick.
Preparing to unpack …/27-ruby-webrick_1.7.0-3_all.deb …
Unpacking ruby-webrick (1.7.0-3) …
Selecting previously unselected package ruby-xmlrpc.
Preparing to unpack …/28-ruby-xmlrpc_0.3.2-1ubuntu0.1_all.deb …
Unpacking ruby-xmlrpc (0.3.2-1ubuntu0.1) …
```

```
Selecting previously unselected package libruby3.0:amd64.
Preparing to unpack …/29-libruby3.0_3.0.2-7ubuntu2.4_amd64.deb …
Unpacking libruby3.0:amd64 (3.0.2-7ubuntu2.4) …
Selecting previously unselected package libsynctex2:amd64.
Preparing to unpack …/30-libsynctex2_2021.20210626.59705-1ubuntu0.1_amd64.deb
…
Unpacking libsynctex2:amd64 (2021.20210626.59705-1ubuntu0.1) …
Selecting previously unselected package libteckit0:amd64.
Preparing to unpack …/31-libteckit0_2.5.11+ds1-1_amd64.deb …
Unpacking libteckit0:amd64 (2.5.11+ds1-1) …
Selecting previously unselected package libtexlua53:amd64.
Preparing to unpack …/32-libtexlua53_2021.20210626.59705-1ubuntu0.1_amd64.deb
…
Unpacking libtexlua53:amd64 (2021.20210626.59705-1ubuntu0.1) …
Selecting previously unselected package libtexluajit2:amd64.
Preparing to unpack
…/33-libtexluajit2_2021.20210626.59705-1ubuntu0.1_amd64.deb …
Unpacking libtexluajit2:amd64 (2021.20210626.59705-1ubuntu0.1) …
Selecting previously unselected package libzzip-0-13:amd64.
Preparing to unpack …/34-libzzip-0-13_0.13.72+dfsg.1-1.1_amd64.deb …
Unpacking libzzip-0-13:amd64 (0.13.72+dfsg.1-1.1) …
Selecting previously unselected package xfonts-encodings.
Preparing to unpack …/35-xfonts-encodings_1%3a1.0.5-0ubuntu2_all.deb …
Unpacking xfonts-encodings (1:1.0.5-0ubuntu2) …
Selecting previously unselected package xfonts-utils.
Preparing to unpack …/36-xfonts-utils_1%3a7.7+6build2_amd64.deb …
Unpacking xfonts-utils (1:7.7+6build2) …
Selecting previously unselected package lmodern.
Preparing to unpack …/37-lmodern_2.004.5-6.1_all.deb …
Unpacking lmodern (2.004.5-6.1) …
Selecting previously unselected package preview-latex-style.
Preparing to unpack …/38-preview-latex-style_12.2-1ubuntu1_all.deb …
Unpacking preview-latex-style (12.2-1ubuntu1) …
Selecting previously unselected package t1utils.
Preparing to unpack …/39-t1utils_1.41-4build2_amd64.deb …
Unpacking t1utils (1.41-4build2) …
Selecting previously unselected package teckit.
Preparing to unpack …/40-teckit_2.5.11+ds1-1_amd64.deb …
Unpacking teckit (2.5.11+ds1-1) …
Selecting previously unselected package tex-gyre.
Preparing to unpack …/41-tex-gyre_20180621-3.1_all.deb …
Unpacking tex-gyre (20180621-3.1) …
Selecting previously unselected package texlive-binaries.
Preparing to unpack …/42-texlive-
binaries_2021.20210626.59705-1ubuntu0.1_amd64.deb …
Unpacking texlive-binaries (2021.20210626.59705-1ubuntu0.1) …
Selecting previously unselected package texlive-base.
Preparing to unpack …/43-texlive-base_2021.20220204-1_all.deb …
```

```
Unpacking texlive-base (2021.20220204-1) …
Selecting previously unselected package texlive-fonts-recommended.
Preparing to unpack …/44-texlive-fonts-recommended_2021.20220204-1_all.deb …
Unpacking texlive-fonts-recommended (2021.20220204-1) …
Selecting previously unselected package texlive-latex-base.
Preparing to unpack …/45-texlive-latex-base_2021.20220204-1_all.deb …
Unpacking texlive-latex-base (2021.20220204-1) …
Selecting previously unselected package texlive-latex-recommended.
Preparing to unpack …/46-texlive-latex-recommended_2021.20220204-1_all.deb …
Unpacking texlive-latex-recommended (2021.20220204-1) …
Selecting previously unselected package texlive.
Preparing to unpack …/47-texlive_2021.20220204-1_all.deb …
Unpacking texlive (2021.20220204-1) …
Selecting previously unselected package libfontbox-java.
Preparing to unpack …/48-libfontbox-java_1%3a1.8.16-2_all.deb …
Unpacking libfontbox-java (1:1.8.16-2) …
Selecting previously unselected package libpdfbox-java.
Preparing to unpack …/49-libpdfbox-java_1%3a1.8.16-2_all.deb …
Unpacking libpdfbox-java (1:1.8.16-2) …
Selecting previously unselected package texlive-pictures.
Preparing to unpack …/50-texlive-pictures_2021.20220204-1_all.deb …
Unpacking texlive-pictures (2021.20220204-1) …
Selecting previously unselected package texlive-latex-extra.
Preparing to unpack …/51-texlive-latex-extra_2021.20220204-1_all.deb …
Unpacking texlive-latex-extra (2021.20220204-1) …
Selecting previously unselected package texlive-plain-generic.
Preparing to unpack …/52-texlive-plain-generic_2021.20220204-1_all.deb …
Unpacking texlive-plain-generic (2021.20220204-1) …
Selecting previously unselected package tipa.
Preparing to unpack …/53-tipa_2%3a1.3-21_all.deb …
Unpacking tipa (2:1.3-21) …
Selecting previously unselected package texlive-xetex.
Preparing to unpack …/54-texlive-xetex_2021.20220204-1_all.deb …
Unpacking texlive-xetex (2021.20220204-1) …
Setting up fonts-lato (2.0-2.1) …
Setting up fonts-noto-mono (20201225-1build1) …
Setting up libwoff1:amd64 (1.0.2-1build4) …
Setting up libtexlua53:amd64 (2021.20210626.59705-1ubuntu0.1) …
Setting up libijs-0.35:amd64 (0.35-15build2) …
Setting up libtexluajit2:amd64 (2021.20210626.59705-1ubuntu0.1) …
Setting up libfontbox-java (1:1.8.16-2) …
Setting up rubygems-integration (1.18) …
Setting up libzzip-0-13:amd64 (0.13.72+dfsg.1-1.1) …
Setting up fonts-urw-base35 (20200910-1) …
Setting up poppler-data (0.4.11-1) …
Setting up tex-common (6.17) …
update-language: texlive-base not installed and configured, doing nothing!
Setting up libfontenc1:amd64 (1:1.1.4-1build3) …
```

```
Setting up libjbig2dec0:amd64 (0.19-3build2) …
Setting up libteckit0:amd64 (2.5.11+ds1-1) …
Setting up libapache-pom-java (18-1) …
Setting up ruby-net-telnet (0.1.1-2) …
Setting up xfonts-encodings (1:1.0.5-0ubuntu2) …
Setting up t1utils (1.41-4build2) …
Setting up libidn12:amd64 (1.38-4ubuntu1) …
Setting up fonts-texgyre (20180621-3.1) …
Setting up libkpathsea6:amd64 (2021.20210626.59705-1ubuntu0.1) …
Setting up ruby-webrick (1.7.0-3) …
Setting up fonts-lmodern (2.004.5-6.1) …
Setting up fonts-droid-fallback (1:6.0.1r16-1.1build1) …
Setting up ruby-xmlrpc (0.3.2-1ubuntu0.1) …
Setting up libsynctex2:amd64 (2021.20210626.59705-1ubuntu0.1) …
Setting up libgs9-common (9.55.0~dfsg1-0ubuntu5.5) …
Setting up teckit (2.5.11+ds1-1) …
Setting up libpdfbox-java (1:1.8.16-2) …
Setting up libgs9:amd64 (9.55.0~dfsg1-0ubuntu5.5) …
Setting up preview-latex-style (12.2-1ubuntu1) …
Setting up libcommons-parent-java (43-1) …
Setting up dvisvgm (2.13.1-1) …
Setting up libcommons-logging-java (1.2-2) …
Setting up xfonts-utils (1:7.7+6build2) …
Setting up libptexenc1:amd64 (2021.20210626.59705-1ubuntu0.1) …
Setting up texlive-binaries (2021.20210626.59705-1ubuntu0.1) …
update-alternatives: using /usr/bin/xdvi-xaw to provide /usr/bin/xdvi.bin
(xdvi.bin) in auto mode
update-alternatives: using /usr/bin/bibtex.original to provide /usr/bin/bibtex
(bibtex) in auto mode
Setting up lmodern (2.004.5-6.1) …
Setting up texlive-base (2021.20220204-1) …
/usr/bin/ucfr
/usr/bin/ucfr
/usr/bin/ucfr
/usr/bin/ucfr
mktexlsr: Updating /var/lib/texmf/ls-R-TEXLIVEDIST…
mktexlsr: Updating /var/lib/texmf/ls-R-TEXMFMAIN…
mktexlsr: Updating /var/lib/texmf/ls-R…
mktexlsr: Done.
tl-paper: setting paper size for dvips to a4:
/var/lib/texmf/dvips/config/config-paper.ps
tl-paper: setting paper size for dvipdfmx to a4:
/var/lib/texmf/dvipdfmx/dvipdfmx-paper.cfg
tl-paper: setting paper size for xdvi to a4: /var/lib/texmf/xdvi/XDvi-paper
tl-paper: setting paper size for pdftex to a4: /var/lib/texmf/tex/generic/tex-
ini-files/pdftexconfig.tex
Setting up tex-gyre (20180621-3.1) …
Setting up texlive-plain-generic (2021.20220204-1) …
```

```
Setting up texlive-latex-base (2021.20220204-1) …
Setting up texlive-latex-recommended (2021.20220204-1) …
Setting up texlive-pictures (2021.20220204-1) …
Setting up texlive-fonts-recommended (2021.20220204-1) …
Setting up tipa (2:1.3-21) …
Setting up texlive (2021.20220204-1) …
Setting up texlive-latex-extra (2021.20220204-1) …
Setting up texlive-xetex (2021.20220204-1) …
Setting up rake (13.0.6-2) …
Setting up libruby3.0:amd64 (3.0.2-7ubuntu2.4) …
Setting up ruby3.0 (3.0.2-7ubuntu2.4) …
Setting up ruby (1:3.0~exp1) …
Setting up ruby-rubygems (3.3.5-2) …
Processing triggers for man-db (2.10.2-1) …
Processing triggers for fontconfig (2.13.1-4.2ubuntu5) …
Processing triggers for libc-bin (2.35-0ubuntu3.1) …
/sbin/ldconfig.real: /usr/local/lib/libtbbmalloc.so.2 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbbind.so.3 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbbind_2_5.so.3 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbmalloc_proxy.so.2 is not a symbolic
link

/sbin/ldconfig.real: /usr/local/lib/libtbbbind_2_0.so.3 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbb.so.12 is not a symbolic link

Processing triggers for tex-common (6.17) …
Running updmap-sys. This may take some time… done.
Running mktexlsr /var/lib/texmf … done.
Building format(s) --all.
        This may take some time…
```

[ ]:
```
!jupyter nbconvert  '/content/drive/MyDrive/datamining/module-3.ipynb' --to pdf
```

```
[NbConvertApp] Converting notebook
/content/drive/MyDrive/datamining/module-3.ipynb to pdf
[NbConvertApp] Support files will be in module-3_files/
[NbConvertApp] Making directory ./module-3_files
[NbConvertApp] Making directory ./module-3_files
[NbConvertApp] Making directory ./module-3_files
[NbConvertApp] Making directory ./module-3_files
[NbConvertApp] Writing 63599 bytes to notebook.tex
[NbConvertApp] Building PDF
[NbConvertApp] Running xelatex 3 times: ['xelatex', 'notebook.tex', '-quiet']
[NbConvertApp] Running bibtex 1 time: ['bibtex', 'notebook']
```

```
[NbConvertApp] WARNING | bibtex had problems, most likely because there were no
citations
[NbConvertApp] PDF successfully created
[NbConvertApp] Writing 305692 bytes to
/content/drive/MyDrive/datamining/module-3.pdf
```