zad. 1

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import math

from google.colab import drive
drive.mount('/content/drive',force_remount=True)

import os
os.chdir('/content/drive/My Drive/DM')
```

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

```
data = pd.read_csv('Boston.csv')
data
```

	Unnamed: 0	crim	zn	indus	chas	nox	rm	age	dis	rad	tax	ptratio
0	1	0.00632	18.0	2.31	0	0.538	6.575	65.2	4.0900	1	296	15.3
1	2	0.02731	0.0	7.07	0	0.469	6.421	78.9	4.9671	2	242	17.8
2	3	0.02729	0.0	7.07	0	0.469	7.185	61.1	4.9671	2	242	17.8
3	4	0.03237	0.0	2.18	0	0.458	6.998	45.8	6.0622	3	222	18.7
4	5	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222	18.7
...	...	...	...	...	...	...	...	...	...	...	...	...
501	502	0.06263	0.0	11.93	0	0.573	6.593	69.1	2.4786	1	273	21.0
502	503	0.04527	0.0	11.93	0	0.573	6.120	76.7	2.2875	1	273	21.0
503	504	0.06076	0.0	11.93	0	0.573	6.976	91.0	2.1675	1	273	21.0
504	505	0.10959	0.0	11.93	0	0.573	6.794	89.3	2.3889	1	273	21.0
505	506	0.04741	0.0	11.93	0	0.573	6.030	80.8	2.5050	1	273	21.0

a. Jak liczny jest zbiór danych? – 506 elementów

b. Iloma atrybutami jest opisany? – 15-ma

c. Jakiego typu są wartości poszczególnych atrybutów?

```
df = pd.DataFrame(data)
datatypes = df.dtypes
datatypes
```

```
Unnamed: 0      int64
crim          float64
zn            float64
indus         float64
chas            int64
nox           float64
rm            float64
age           float64
dis           float64
rad             int64
tax             int64
ptratio       float64
black         float64
lstat         float64
medv          float64
dtype: object
```

d. Czy w zbiorze są brakujące dane (pola NULL)?

```
df.info(verbose=True)
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 506 entries, 0 to 505
Data columns (total 15 columns):
 #   Column      Non-Null Count  Dtype  
---  ------      --------------  -----  
 0   Unnamed: 0  506 non-null    int64  
 1   crim        506 non-null    float64
 2   zn          506 non-null    float64
 3   indus       506 non-null    float64
 4   chas        506 non-null    int64  
 5   nox         506 non-null    float64
 6   rm          506 non-null    float64
 7   age         506 non-null    float64
 8   dis         506 non-null    float64
 9   rad         506 non-null    int64  
 10  tax         506 non-null    int64  
 11  ptratio     506 non-null    float64
 12  black       506 non-null    float64
 13  lstat       506 non-null    float64
 14  medv        506 non-null    float64
dtypes: float64(11), int64(4)
memory usage: 59.4 KB
```

```
df.info(verbose=False)
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 506 entries, 0 to 505
Columns: 15 entries, Unnamed: 0 to medv
dtypes: float64(11), int64(4)
memory usage: 59.4 KB
```

zad. 2

```
print('Minimum:')
```

```
print(data.min())
print("------------------------\n")

print('Maximum:')
print(data.max())
print("------------------------\n")

print('Wartość średnia:')
print(data.mean())
```

```
Minimum:
Unnamed: 0      1.00000
crim            0.00632
zn              0.00000
indus           0.46000
chas            0.00000
nox             0.38500
rm              3.56100
age             2.90000
dis             1.12960
rad             1.00000
tax           187.00000
ptratio        12.60000
black           0.32000
lstat           1.73000
medv            5.00000
dtype: float64
------------------------

Maximum:
Unnamed: 0    506.0000
crim           88.9762
zn            100.0000
indus          27.7400
chas            1.0000
nox             0.8710
rm              8.7800
age           100.0000
dis            12.1265
rad            24.0000
tax           711.0000
ptratio        22.0000
black         396.9000
lstat          37.9700
medv           50.0000
dtype: float64
------------------------

Wartość średnia:
Unnamed: 0    253.500000
crim            3.613524
zn             11.363636
indus          11.136779
chas            0.069170
nox             0.554695
rm              6.284634
age            68.574901
dis             3.795043
rad             9.549407
tax           408.237154
```

```
ptratio        18.455534
black         356.674032
lstat          12.653063
medv           22.532806
dtype: float64
```

```
# Odchylenie standardowe:
data_col = data['crim']

# 1) liczymy średnią arytmetyczną:
sa = data['crim'].sum() / data['crim'].count()

# 2) wariancja
sum_roz = 0

for i in data_col:
  sum_roz += (i - sa) ** 2

war = sum_roz / data['crim'].count()

# 3) odchylenie standardowe
odch_st = math.sqrt(war)
odch_st
```

```
8.59304135129577
```

```
print("Odchylenie standardowe:\n")
# z (axis=1) da dla wartości w kolumnie
print(np.std(data, axis=0))
```

```
Odchylenie standardowe:

Unnamed: 0    146.069333
crim            8.593041
zn             23.299396
indus           6.853571
chas            0.253743
nox             0.115763
rm              0.701923
age            28.121033
dis             2.103628
rad             8.698651
tax           168.370495
ptratio         2.162805
black          91.204607
lstat           7.134002
medv            9.188012
dtype: float64
```

zad. 3

```
data_col_1 = data['rm']
data_col_2 = data['medv']
X = data_col_1.sum() / data_col_1.count()
Y = data_col_2.sum() / data_col_2.count()
```

```
count = data_col_1.count()
licznik = 0
mian1 = 0
mian2 = 0

for i in range(0, count):
  licznik += (data_col_1[i] - X) * (data_col_2[i] - Y)
  mian1 += ((data_col_1[i] - X) ** 2)
  mian2 += ((data_col_2[i] - Y) ** 2)

# Kowariancja:
kw = licznik / (count - 1)

# Korelacja
kr = licznik / ((mian1*mian2) ** 0.5)

print("Kowariancja: ", kw)
print("Korelacja:  ", kr)
```

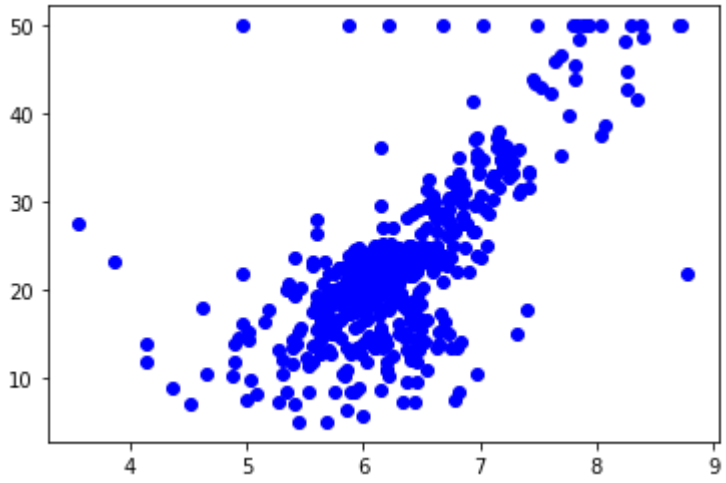
```
Kowariancja:  4.493445879544476
Korelacja:   0.6953599470715388
```

```
# macierz korelacji dla całego zbioru danych
data.cov()
```

	Unnamed: 0	crim	zn	indus	chas	nox	
Unnamed: 0	21378.500000	512.381872	-352.578218	400.668663	-0.139604	6.755757	·
crim	512.381872	73.986578	-40.215956	23.992339	-0.122109	0.419594	·
zn	-352.578218	-40.215956	543.936814	-85.412648	-0.252925	-1.396148	
indus	400.668663	23.992339	-85.412648	47.064442	0.109669	0.607074	·
chas	-0.139604	-0.122109	-0.252925	0.109669	0.064513	0.002684	
nox	6.755757	0.419594	-1.396148	0.607074	0.002684	0.013428	·
rm	-8.215627	-1.325038	5.112513	-1.887957	0.016285	-0.024603	
age	838.722871	85.405322	-373.901548	124.513903	0.618571	2.385927	·
dis	-93.045936	-6.876722	32.629304	-10.228097	-0.053043	-0.187696	
rad	873.364356	46.847761	-63.348695	35.549971	-0.016296	0.616929	·
tax	16427.306931	844.821538	-1236.453735	833.360290	-1.523367	13.046286	-3
ptratio	92.138119	5.399331	-19.776571	5.692104	-0.066819	0.047397	·
black	-3938.380535	-302.381816	373.721402	-223.579756	1.131325	-4.020570	
lstat	269.868842	27.986168	-68.783037	29.580270	-0.097816	0.488946	·
medv	-304.723960	-30.718508	77.315176	-30.520823	0.409409	-0.455412	

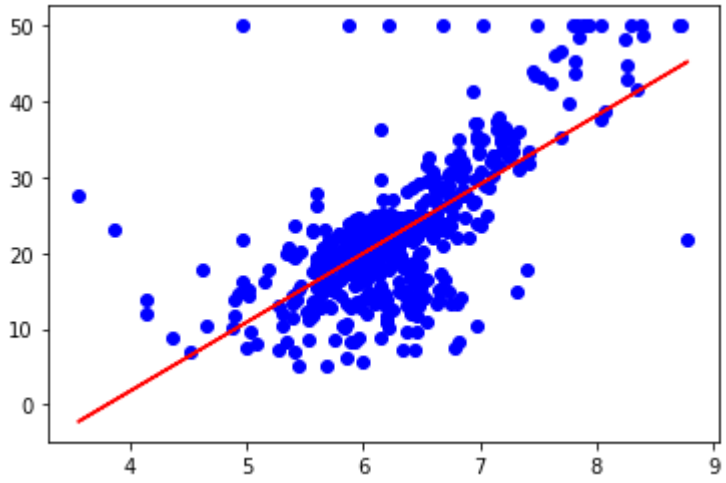
zad. 4

```
plt.scatter(data_col_1, data_col_2, c = "blue")
plt.show()
```




```
mx = np.array(((np.sum(data_col_1*data_col_1),  np.sum(data_col_1)), (np.sum(data_col_1),
mod = np.linalg.inv(mx)
mx2 = np.array((np.sum(data_col_1*data_col_2), np.sum(data_col_2)))
mx2.shape = (2, 1)
m = mod.dot(mx2)
a = m[0][0]
b = m[1][0]

plt.plot(data_col_1, a*data_col_1 + b, color = "red")
plt.scatter(data_col_1, data_col_2, c = "blue")
plt.show()
```



zad. 5

```
data.corr()
```

	Unnamed: 0	crim	zn	indus	chas	nox	rm	
Unnamed: 0	1.000000	0.407407	-0.103393	0.399439	-0.003759	0.398736	-0.079971	0
crim	0.407407	1.000000	-0.200469	0.406583	-0.055892	0.420972	-0.219247	0
zn	-0.103393	-0.200469	1.000000	-0.533828	-0.042697	-0.516604	0.311991	-0
indus	0.399439	0.406583	-0.533828	1.000000	0.062938	0.763651	-0.391676	0
chas	-0.003759	-0.055892	-0.042697	0.062938	1.000000	0.091203	0.091251	0
nox	0.398736	0.420972	-0.516604	0.763651	0.091203	1.000000	-0.302188	0
rm	-0.079971	-0.219247	0.311991	-0.391676	0.091251	-0.302188	1.000000	-0
age	0.203784	0.352734	-0.569537	0.644779	0.086518	0.731470	-0.240265	1
dis	-0.302211	-0.379670	0.664408	-0.708027	-0.099176	-0.769230	0.205246	-0
rad	0.686002	0.625505	-0.311948	0.595129	-0.007368	0.611441	-0.209847	0
tax	0.666626	0.582764	-0.314563	0.720760	-0.035587	0.668023	-0.292048	0

```
data_col_1 = data['nox']
data_col_2 = data['dis']
X = data_col_1.sum() / data_col_1.count()
Y = data_col_2.sum() / data_col_2.count()
count = data_col_1.count()
licznik = 0
mian1 = 0
mian2 = 0

for i in range(0, count):
  licznik += (data_col_1[i] - X) * (data_col_2[i] - Y)
  mian1 += ((data_col_1[i] - X) ** 2)
  mian2 += ((data_col_2[i] - Y) ** 2)

# Korelacja
kr = licznik / ((mian1*mian2) ** 0.5)
print("Korelacja: ", kr)

mx = np.array(((np.sum(data_col_1*data_col_1),  np.sum(data_col_1)), (np.sum(data_col_1),
mod = np.linalg.inv(mx)
mx2 = np.array((np.sum(data_col_1*data_col_2), np.sum(data_col_2)))
mx2.shape = (2, 1)
m = mod.dot(mx2)
a = m[0][0]
b = m[1][0]

plt.plot(data_col_1, a*data_col_1 + b, color = "yellow")
plt.scatter(data_col_1, data_col_2, c = "blue")
plt.show()
```

```
Korelacja:  -0.7692301132258254
```