Assignment 3 - Handling arrays with NumPy

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Exercise 1

Import the data set “Boston_Housing.csv”
Extract ['PRICE'] into an array
Plot a histogram of housing price
Find the mean, max, 75th percentile of the housing price.
Create an array of two rows, with the first row from [‘’RM”], and the second row from [“PRICE”]
Find the number of houses with “RM” < 5
Find the mean of the housing price, with “RM” > 5
Plot a scatter plot to show the relationship between number of rooms and housing price (use plt.scatter())

In [4]:
```
# import the data set

import os
import pandas as pd
import numpy as np
data = pd.read_csv("Boston_Housing.csv")
data
```

Out[4]:

	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO	LSTAT	PRICE
0	0.00632	18.0	2.31	0	0.538	6.575	65.2	4.0900	1	296	15.3	4.98	24.0
1	0.02731	0.0	7.07	0	0.469	6.421	78.9	4.9671	2	242	17.8	9.14	21.6
2	0.02729	0.0	7.07	0	0.469	7.185	61.1	4.9671	2	242	17.8	4.03	34.7
3	0.03237	0.0	2.18	0	0.458	6.998	45.8	6.0622	3	222	18.7	2.94	33.4
4	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222	18.7	5.33	36.2
...	...	...	...	...	...	...	...	...	...	...	...	...	...
501	0.06263	0.0	11.93	0	0.573	6.593	69.1	2.4786	1	273	21.0	9.67	22.4
502	0.04527	0.0	11.93	0	0.573	6.120	76.7	2.2875	1	273	21.0	9.08	20.6
503	0.06076	0.0	11.93	0	0.573	6.976	91.0	2.1675	1	273	21.0	5.64	23.9
504	0.10959	0.0	11.93	0	0.573	6.794	89.3	2.3889	1	273	21.0	6.48	22.0
505	0.04741	0.0	11.93	0	0.573	6.030	80.8	2.5050	1	273	21.0	7.88	11.9

506 rows × 13 columns

In [5]:
```
# extract price

price = np.array(data["PRICE"])
price
```

Out[5]:
```
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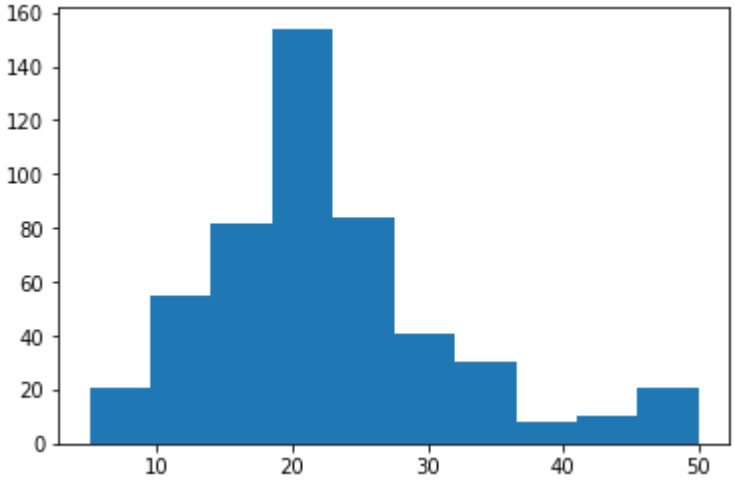
       23.1, 19.7, 18.3, 21.2, 17.5, 16.8, 22.4, 20.6, 23.9, 22. , 11.9])
```

In [6]:
```
# plot histogram

import matplotlib.pyplot as plt
plt.hist(price)
```

Out[6]:
```
(array([ 21.,  55.,  82., 154.,  84.,  41.,  30.,   8.,  10.,  21.]),
 array([ 5. ,  9.5, 14. , 18.5, 23. , 27.5, 32. , 36.5, 41. , 45.5, 50. ]),
 <BarContainer object of 10 artists>)
```



In [7]:
```
# find the mean, max, 75th percentile of the housing price

print(price.mean())
print(price.max())
print(np.percentile(price,75))
```

```
22.532806324110677
50.0
25.0
```

In [8]:
```
# create an array of two rows from "RM" and "PRICE"

rm = np.array(data["RM"])
rm

first_row = rm[0:2]
print(first_row)

second_row = price[0:2]
print(second_row)
```

```
[6.575 6.421]
[24.  21.6]
```

In [9]:
```
# Find the number of houses with “RM” < 5

np.count_nonzero(rm < 5)
```

Out[9]: 15

In [10]:
```
# find the mean housing price where "RM" is greater than 5

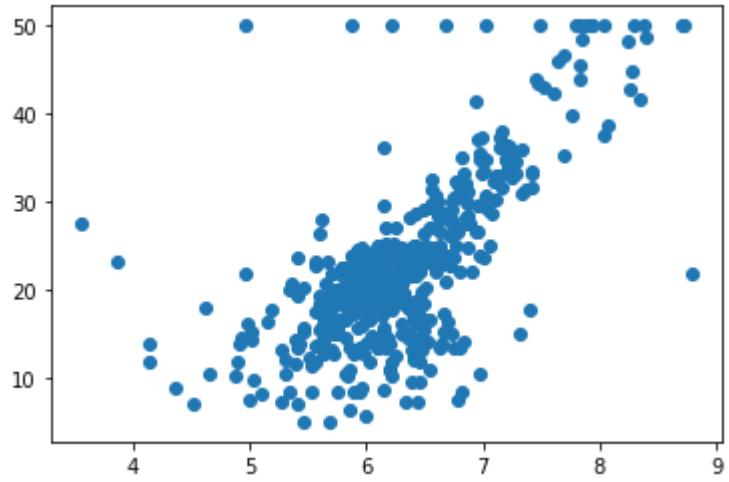
np.sum(rm > 5)/price.mean()
```

Out[10]: 21.746070726915516

In [231…
```
# plot scatterplot to show the relationship between number of rooms and housing price

plt.scatter(rm, price)
```

Out[231… <matplotlib.collections.PathCollection at 0x2cad45dd8e0>



Exercise 2

Create a 1000x1 array of numbers, x which divides the interval from -10 to 10 into equal widths.

Reshape the array x into 20x50 array, then:

(a) Find the shape, dimension, and data type of the array.

(b) Access the last element of each row

(c) Access first element and then every other elements of each row

(d) Access the subarray 7th to 10th rows and 5th to 11th columns

(e) find the sum of the 7th column

(f) Print the elements in each column which is greater 0.

(g) Replace all the negative numbers of the array with 0.

(h) Sort each column of the array in descending order.

In [73]:
```
# Create a 1000x1 array of numbers, x which divides the interval from -10 to 10 into eq
x = np.linspace(-10,10, num =1000)
x.reshape((1000,1))
```

Out[73]:
```
array([[-10.        ],
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```

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In [77]:
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```

In [78]:
```
# (a) Find the shape, dimension, and data type of the array.

print(x_reshaped.shape)
print(x_reshaped.ndim)
print(x_reshaped.dtype)
```

```
(20, 50)
2
float64
```

In [79]:
```
# (b) Access the last element of each row

x_reshaped[:,-1]
```

Out[79]:
```
array([-9.01901902, -8.01801802, -7.01701702, -6.01601602, -5.01501502,
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        5.995996  ,  6.996997  ,  7.997998  ,  8.998999  , 10.        ])
```

In [80]:
```
#(c) Access first element and then every other elements of each row
x_reshaped[::,::2]
```

Out[80]:
```
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          9.97997998]])
```

In [81]:
```
# (d) Access the subarray 7th to 10th rows and 5th to 11th columns
acc = x_reshaped[6:10, 4:11]
acc
```

Out[81]:
```
array([[-3.91391391, -3.89389389, -3.87387387, -3.85385385, -3.83383383,
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        -0.81081081, -0.79079079]])
```

In [208…
```
# (e) find the sum of the 7th column

sum_col = x_reshaped[:, 6].sum()
sum_col
```

Out[208…
```
7.407407407407412
```

In [91]:
```
# (f) print the elements in each column which is greater 0.
```

```
for row in x_reshaped:
    for element in row:
        if element > 0:
            print(element)
```

```
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0.09009009009009006
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8.95895895895896
8.97897897897898
8.998998998999
```

```
9.01901901901902
9.03903903903904
9.05905905905906
9.07907907907908
9.0990990990991
9.11911911911912
9.13913913913914
9.15915915915916
9.17917917917918
9.1991991991992
9.21921921921922
9.23923923923924
9.25925925925926
9.27927927927928
9.2992992992993
9.31931931931932
9.33933933933934
9.35935935935936
9.37937937937938
9.3993993993994
9.41941941941942
9.43943943943944
9.45945945945946
9.47947947947948
9.4994994994995
9.51951951951952
9.53953953953954
9.55955955955956
9.57957957957958
9.5995995995996
9.61961961961962
9.63963963963964
9.65965965965966
9.67967967967968
9.6996996996997
9.71971971971972
9.73973973973974
9.75975975975976
9.77977977977978
9.7997997997998
9.81981981981982
9.83983983983984
9.85985985985986
9.87987987987988
9.8998998998999
9.91991991991992
9.93993993993994
9.95995995995996
9.97997997997998
10.0
```

In [92]:

```
# (g) Replace all the negative numbers of the array with 0.
num = x_reshaped
print(np.where(num < 0, 0, num))
```

```
[[ 0.          0.          0.          0.          0.          0.
   0.          0.          0.          0.          0.          0.
   0.          0.          0.          0.          0.          0.
   0.          0.          0.          0.          0.          0.
   0.          0.          0.          0.          0.          0.
   0.          0.          0.          0.          0.          0.
   0.          0.          0.          0.          0.          0.
   0.          0.          0.          0.          0.          0.
   0.          0.        ]
 [ 0.          0.          0.          0.          0.          0.
```

```
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.        ]
  [ 0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.        ]
  [ 0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.        ]
  [ 0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.        ]
  [ 0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.        ]
  [ 0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.        ]
  [ 0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.        ]
  [ 0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
    0.          0.          0.          0.          0.          0.
```

```
  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
  0.          0.        ]
[ 0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
  0.          0.        ]
[ 0.01001001  0.03003003  0.05005005  0.07007007  0.09009009  0.11011011
  0.13013013  0.15015015  0.17017017  0.19019019  0.21021021  0.23023023
  0.25025025  0.27027027  0.29029029  0.31031031  0.33033033  0.35035035
  0.37037037  0.39039039  0.41041041  0.43043043  0.45045045  0.47047047
  0.49049049  0.51051051  0.53053053  0.55055055  0.57057057  0.59059059
  0.61061061  0.63063063  0.65065065  0.67067067  0.69069069  0.71071071
  0.73073073  0.75075075  0.77077077  0.79079079  0.81081081  0.83083083
  0.85085085  0.87087087  0.89089089  0.91091091  0.93093093  0.95095095
  0.97097097  0.99099099]
[ 1.01101101  1.03103103  1.05105105  1.07107107  1.09109109  1.11111111
  1.13113113  1.15115115  1.17117117  1.19119119  1.21121121  1.23123123
  1.25125125  1.27127127  1.29129129  1.31131131  1.33133133  1.35135135
  1.37137137  1.39139139  1.41141141  1.43143143  1.45145145  1.47147147
  1.49149149  1.51151151  1.53153153  1.55155155  1.57157157  1.59159159
  1.61161161  1.63163163  1.65165165  1.67167167  1.69169169  1.71171171
  1.73173173  1.75175175  1.77177177  1.79179179  1.81181181  1.83183183
  1.85185185  1.87187187  1.89189189  1.91191191  1.93193193  1.95195195
  1.97197197  1.99199199]
[ 2.01201201  2.03203203  2.05205205  2.07207207  2.09209209  2.11211211
  2.13213213  2.15215215  2.17217217  2.19219219  2.21221221  2.23223223
  2.25225225  2.27227227  2.29229229  2.31231231  2.33233233  2.35235235
  2.37237237  2.39239239  2.41241241  2.43243243  2.45245245  2.47247247
  2.49249249  2.51251251  2.53253253  2.55255255  2.57257257  2.59259259
  2.61261261  2.63263263  2.65265265  2.67267267  2.69269269  2.71271271
  2.73273273  2.75275275  2.77277277  2.79279279  2.81281281  2.83283283
  2.85285285  2.87287287  2.89289289  2.91291291  2.93293293  2.95295295
  2.97297297  2.99299299]
[ 3.01301301  3.03303303  3.05305305  3.07307307  3.09309309  3.11311311
  3.13313313  3.15315315  3.17317317  3.19319319  3.21321321  3.23323323
  3.25325325  3.27327327  3.29329329  3.31331331  3.33333333  3.35335335
  3.37337337  3.39339339  3.41341341  3.43343343  3.45345345  3.47347347
  3.49349349  3.51351351  3.53353353  3.55355355  3.57357357  3.59359359
  3.61361361  3.63363363  3.65365365  3.67367367  3.69369369  3.71371371
  3.73373373  3.75375375  3.77377377  3.79379379  3.81381381  3.83383383
  3.85385385  3.87387387  3.89389389  3.91391391  3.93393393  3.95395395
  3.97397397  3.99399399]
[ 4.01401401  4.03403403  4.05405405  4.07407407  4.09409409  4.11411411
  4.13413413  4.15415415  4.17417417  4.19419419  4.21421421  4.23423423
  4.25425425  4.27427427  4.29429429  4.31431431  4.33433433  4.35435435
  4.37437437  4.39439439  4.41441441  4.43443443  4.45445445  4.47447447
  4.49449449  4.51451451  4.53453453  4.55455455  4.57457457  4.59459459
  4.61461461  4.63463463  4.65465465  4.67467467  4.69469469  4.71471471
  4.73473473  4.75475475  4.77477477  4.79479479  4.81481481  4.83483483
  4.85485485  4.87487487  4.89489489  4.91491491  4.93493493  4.95495495
  4.97497497  4.99499499]
[ 5.01501502  5.03503504  5.05505506  5.07507508  5.0950951   5.11511512
  5.13513514  5.15515516  5.17517518  5.1951952   5.21521522  5.23523524
  5.25525526  5.27527528  5.2952953   5.31531532  5.33533534  5.35535536
  5.37537538  5.3953954   5.41541542  5.43543544  5.45545546  5.47547548
  5.4954955   5.51551552  5.53553554  5.55555556  5.57557558  5.5955956
```

```
  5.61561562  5.63563564  5.65565566  5.67567568  5.6956957   5.71571572
  5.73573574  5.75575576  5.77577578  5.7957958   5.81581582  5.83583584
  5.85585586  5.87587588  5.8958959   5.91591592  5.93593594  5.95595596
  5.97597598  5.995996  ]
[ 6.01601602  6.03603604  6.05605606  6.07607608  6.0960961   6.11611612
  6.13613614  6.15615616  6.17617618  6.1961962   6.21621622  6.23623624
  6.25625626  6.27627628  6.2962963   6.31631632  6.33633634  6.35635636
  6.37637638  6.3963964   6.41641642  6.43643644  6.45645646  6.47647648
  6.4964965   6.51651652  6.53653654  6.55655656  6.57657658  6.5965966
  6.61661662  6.63663664  6.65665666  6.67667668  6.6966967   6.71671672
  6.73673674  6.75675676  6.77677678  6.7967968   6.81681682  6.83683684
  6.85685686  6.87687688  6.8968969   6.91691692  6.93693694  6.95695696
  6.97697698  6.996997  ]
[ 7.01701702  7.03703704  7.05705706  7.07707708  7.0970971   7.11711712
  7.13713714  7.15715716  7.17717718  7.1971972   7.21721722  7.23723724
  7.25725726  7.27727728  7.2972973   7.31731732  7.33733734  7.35735736
  7.37737738  7.3973974   7.41741742  7.43743744  7.45745746  7.47747748
  7.4974975   7.51751752  7.53753754  7.55755756  7.57757758  7.5975976
  7.61761762  7.63763764  7.65765766  7.67767768  7.6976977   7.71771772
  7.73773774  7.75775776  7.77777778  7.7977978   7.81781782  7.83783784
  7.85785786  7.87787788  7.8978979   7.91791792  7.93793794  7.95795796
  7.97797798  7.997998  ]
[ 8.01801802  8.03803804  8.05805806  8.07807808  8.0980981   8.11811812
  8.13813814  8.15815816  8.17817818  8.1981982   8.21821822  8.23823824
  8.25825826  8.27827828  8.2982983   8.31831832  8.33833834  8.35835836
  8.37837838  8.3983984   8.41841842  8.43843844  8.45845846  8.47847848
  8.4984985   8.51851852  8.53853854  8.55855856  8.57857858  8.5985986
  8.61861862  8.63863864  8.65865866  8.67867868  8.6986987   8.71871872
  8.73873874  8.75875876  8.77877878  8.7987988   8.81881882  8.83883884
  8.85885886  8.87887888  8.8988989   8.91891892  8.93893894  8.95895896
  8.97897898  8.998999  ]
[ 9.01901902  9.03903904  9.05905906  9.07907908  9.0990991   9.11911912
  9.13913914  9.15915916  9.17917918  9.1991992   9.21921922  9.23923924
  9.25925926  9.27927928  9.2992993   9.31931932  9.33933934  9.35935936
  9.37937938  9.3993994   9.41941942  9.43943944  9.45945946  9.47947948
  9.4994995   9.51951952  9.53953954  9.55955956  9.57957958  9.5995996
  9.61961962  9.63963964  9.65965966  9.67967968  9.6996997   9.71971972
  9.73973974  9.75975976  9.77977978  9.7997998   9.81981982  9.83983984
  9.85985986  9.87987988  9.8998999   9.91991992  9.93993994  9.95995996
  9.97997998 10.        ]]
```

In [161…

```
# (h) sort each column of the array in descending order.

arrg = (-np.sort(-x_reshaped))
arrg
```

Out[161…

```
array([[ -9.01901902,  -9.03903904,  -9.05905906,  -9.07907908,
         -9.0990991 ,  -9.11911912,  -9.13913914,  -9.15915916,
         -9.17917918,  -9.1991992 ,  -9.21921922,  -9.23923924,
         -9.25925926,  -9.27927928,  -9.2992993 ,  -9.31931932,
         -9.33933934,  -9.35935936,  -9.37937938,  -9.3993994 ,
         -9.41941942,  -9.43943944,  -9.45945946,  -9.47947948,
         -9.4994995 ,  -9.51951952,  -9.53953954,  -9.55955956,
         -9.57957958,  -9.5995996 ,  -9.61961962,  -9.63963964,
         -9.65965966,  -9.67967968,  -9.6996997 ,  -9.71971972,
         -9.73973974,  -9.75975976,  -9.77977978,  -9.7997998 ,
         -9.81981982,  -9.83983984,  -9.85985986,  -9.87987988,
         -9.8998999 ,  -9.91991992,  -9.93993994,  -9.95995996,
         -9.97997998, -10.        ],
       [ -8.01801802,  -8.03803804,  -8.05805806,  -8.07807808,
         -8.0980981 ,  -8.11811812,  -8.13813814,  -8.15815816,
         -8.17817818,  -8.1981982 ,  -8.21821822,  -8.23823824,
         -8.25825826,  -8.27827828,  -8.2982983 ,  -8.31831832,
         -8.33833834,  -8.35835836,  -8.37837838,  -8.3983984 ,
```

```
  -8.41841842,  -8.43843844,  -8.45845846,  -8.47847848,
  -8.4984985 ,  -8.51851852,  -8.53853854,  -8.55855856,
  -8.57857858,  -8.5985986 ,  -8.61861862,  -8.63863864,
  -8.65865866,  -8.67867868,  -8.6986987 ,  -8.71871872,
  -8.73873874,  -8.75875876,  -8.77877878,  -8.7987988 ,
  -8.81881882,  -8.83883884,  -8.85885886,  -8.87887888,
  -8.8988989 ,  -8.91891892,  -8.93893894,  -8.95895896,
  -8.97897898,  -8.998999  ],
[ -7.01701702,  -7.03703704,  -7.05705706,  -7.07707708,
  -7.0970971 ,  -7.11711712,  -7.13713714,  -7.15715716,
  -7.17717718,  -7.1971972 ,  -7.21721722,  -7.23723724,
  -7.25725726,  -7.27727728,  -7.2972973 ,  -7.31731732,
  -7.33733734,  -7.35735736,  -7.37737738,  -7.3973974 ,
  -7.41741742,  -7.43743744,  -7.45745746,  -7.47747748,
  -7.4974975 ,  -7.51751752,  -7.53753754,  -7.55755756,
  -7.57757758,  -7.5975976 ,  -7.61761762,  -7.63763764,
  -7.65765766,  -7.67767768,  -7.6976977 ,  -7.71771772,
  -7.73773774,  -7.75775776,  -7.77777778,  -7.7977978 ,
  -7.81781782,  -7.83783784,  -7.85785786,  -7.87787788,
  -7.8978979 ,  -7.91791792,  -7.93793794,  -7.95795796,
  -7.97797798,  -7.997998  ],
[ -6.01601602,  -6.03603604,  -6.05605606,  -6.07607608,
  -6.0960961 ,  -6.11611612,  -6.13613614,  -6.15615616,
  -6.17617618,  -6.1961962 ,  -6.21621622,  -6.23623624,
  -6.25625626,  -6.27627628,  -6.2962963 ,  -6.31631632,
  -6.33633634,  -6.35635636,  -6.37637638,  -6.3963964 ,
  -6.41641642,  -6.43643644,  -6.45645646,  -6.47647648,
  -6.4964965 ,  -6.51651652,  -6.53653654,  -6.55655656,
  -6.57657658,  -6.5965966 ,  -6.61661662,  -6.63663664,
  -6.65665666,  -6.67667668,  -6.6966967 ,  -6.71671672,
  -6.73673674,  -6.75675676,  -6.77677678,  -6.7967968 ,
  -6.81681682,  -6.83683684,  -6.85685686,  -6.87687688,
  -6.8968969 ,  -6.91691692,  -6.93693694,  -6.95695696,
  -6.97697698,  -6.996997  ],
[ -5.01501502,  -5.03503504,  -5.05505506,  -5.07507508,
  -5.0950951 ,  -5.11511512,  -5.13513514,  -5.15515516,
  -5.17517518,  -5.1951952 ,  -5.21521522,  -5.23523524,
  -5.25525526,  -5.27527528,  -5.2952953 ,  -5.31531532,
  -5.33533534,  -5.35535536,  -5.37537538,  -5.3953954 ,
  -5.41541542,  -5.43543544,  -5.45545546,  -5.47547548,
  -5.4954955 ,  -5.51551552,  -5.53553554,  -5.55555556,
  -5.57557558,  -5.5955956 ,  -5.61561562,  -5.63563564,
  -5.65565566,  -5.67567568,  -5.6956957 ,  -5.71571572,
  -5.73573574,  -5.75575576,  -5.77577578,  -5.7957958 ,
  -5.81581582,  -5.83583584,  -5.85585586,  -5.87587588,
  -5.8958959 ,  -5.91591592,  -5.93593594,  -5.95595596,
  -5.97597598,  -5.995996  ],
[ -4.01401401,  -4.03403403,  -4.05405405,  -4.07407407,
  -4.09409409,  -4.11411411,  -4.13413413,  -4.15415415,
  -4.17417417,  -4.19419419,  -4.21421421,  -4.23423423,
  -4.25425425,  -4.27427427,  -4.29429429,  -4.31431431,
  -4.33433433,  -4.35435435,  -4.37437437,  -4.39439439,
  -4.41441441,  -4.43443443,  -4.45445445,  -4.47447447,
  -4.49449449,  -4.51451451,  -4.53453453,  -4.55455455,
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```

Exercise 3

This exercise illustrates a simple machine learning algorithm. Suppose you have two arrays of numbers. You are going to teach the machine to learn the relationship between the two arrays.

In [36]:
```
# - Create an array of 100 random numbers, x. Each number is between 0 and 1.
x = np.random.uniform(0, 1, 100)
x
```

Out[36]:
```
array([0.06324394, 0.98965165, 0.43998117, 0.49208359, 0.43905128,
       0.54603446, 0.34221063, 0.91510079, 0.11594021, 0.41468049,
       0.58097581, 0.48093286, 0.30978054, 0.21097073, 0.43908979,
       0.16724737, 0.7955972 , 0.94561291, 0.46109415, 0.23898572,
       0.69932897, 0.05477927, 0.34268371, 0.94484567, 0.44157053,
```

```
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       0.27248312, 0.80465294, 0.62040199, 0.66248424, 0.45328609,
       0.62315031, 0.95375556, 0.06427289, 0.33634327, 0.01619285,
       0.20055772, 0.4299752 , 0.95535778, 0.5574418 , 0.58426941,
       0.00846764, 0.52875259, 0.30056163, 0.69072777, 0.62713526,
       0.14025122, 0.87740954, 0.37038932, 0.84596128, 0.86885123,
       0.18868089, 0.22127068, 0.34202245, 0.58494262, 0.61112737,
       0.09923783, 0.94898915, 0.81425579, 0.43131841, 0.68373322,
       0.62901807, 0.94490243, 0.91512584, 0.91134749, 0.78515756,
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       0.88925484, 0.75956508, 0.2846162 , 0.46677826, 0.51487684,
       0.15044828, 0.19553272, 0.68956683, 0.0046584 , 0.53594218,
       0.41318959, 0.99809582, 0.10326843, 0.23257547, 0.17837982,
       0.24461366, 0.05544967, 0.54499043, 0.56043011, 0.71297089,
       0.32234368, 0.88815168, 0.35456631, 0.14246678, 0.5240304 ])
```

In [37]:
```
#  Create an array, y, and y = 3x + 2

y = 3*x + 2
y
```

Out[37]:
```
array([2.18973183, 4.96895496, 3.3199435 , 3.47625078, 3.31715385,
       3.63810339, 3.02663188, 4.74530236, 2.34782063, 3.24404148,
       3.74292743, 3.44279859, 2.92934162, 2.63291219, 3.31726937,
       2.50174212, 4.38679161, 4.83683873, 3.38328244, 2.71695715,
       4.0979869 , 2.16433781, 3.02805113, 4.83453701, 3.3247116 ,
       2.0980913 , 3.07083301, 2.73910781, 3.42796678, 3.41369314,
       2.81744936, 4.41395883, 3.86120596, 3.98745273, 3.35985827,
       3.86945093, 4.86126667, 2.19281867, 3.00902982, 2.04857856,
       2.60167316, 3.2899256 , 4.86607334, 3.67232539, 3.75280823,
       2.02540293, 3.58625777, 2.9016849 , 4.07218332, 3.88140577,
       2.42075365, 4.63222863, 3.11116797, 4.53788383, 4.60655368,
       2.56604267, 2.66381203, 3.02606735, 3.75482785, 3.83338212,
       2.29771349, 4.84696746, 4.44276738, 3.29395524, 4.05119965,
       3.88705421, 4.83470728, 4.74537751, 4.73404248, 4.35547268,
       4.65500207, 3.26635005, 2.71470837, 4.84825838, 4.15513967,
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       2.73384097, 2.166349  , 3.6349713 , 3.68129032, 4.13891268,
       2.96703105, 4.66445503, 3.06369893, 2.42740035, 3.57209121])
```

In [38]:
```
# - Create two numbers, a and b. Initialize them to be 0.

a = 0
b = 0
```

In [39]:
```
# - Create 3 empty lists.

list1 = []
list2 = []
list3 = []
```

In [40]:
```
# - the machine predicts the value of y, y_pred: y_pred = a*x+b
# calculate the cost value = sum of the square of difference between y_pred and actual
# Iterate the above optimization steps 1000 times.

y_pred = a*x + b

for i in range(1000):
    cost = np.dot((y_pred - y), (y_pred - y))
```

```
# update the values of a and b

    da = 2*np.dot((y_pred - y),(x))
    db = 2*np.sum(y_pred - y)

    a = a - 0.001*da
    b = b - 0.001*db
    y_pred = a*x + b

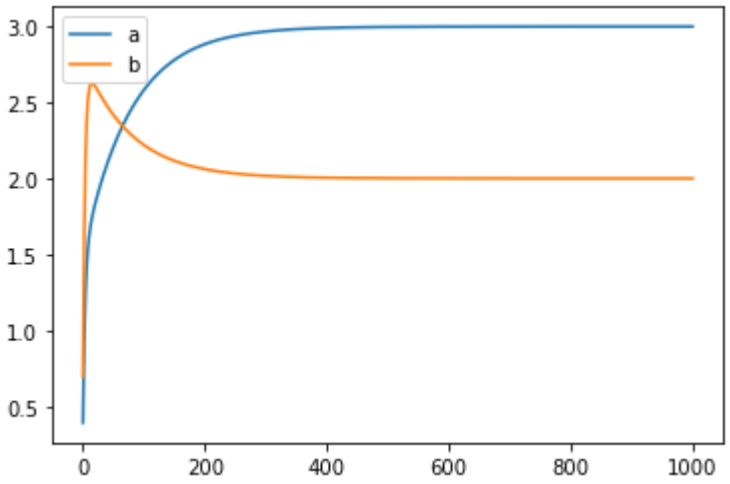
# - Store the values of a, b and cost in the 3 lists you created.

    list1.append(a)
    list2.append(b)
    list3.append(cost)
```

In [41]:
```
# Plot a graph to show how the values of a and b change over iteration.

plt.plot(list1, label='a')
plt.plot(list2, label='b')
plt.legend()
```

Out[41]: <matplotlib.legend.Legend at 0x21059213610>



In [42]:
```
plt.plot(list3)
```

Out[42]: [<matplotlib.lines.Line2D at 0x210592e2df0>]