ed20b045-tut1

August 24, 2023

[1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from scipy.optimize import minimize
```

[2]:
```
df = pd.read_csv('student-por_2.csv', sep=';')
```

[3]:
```
df.head
```

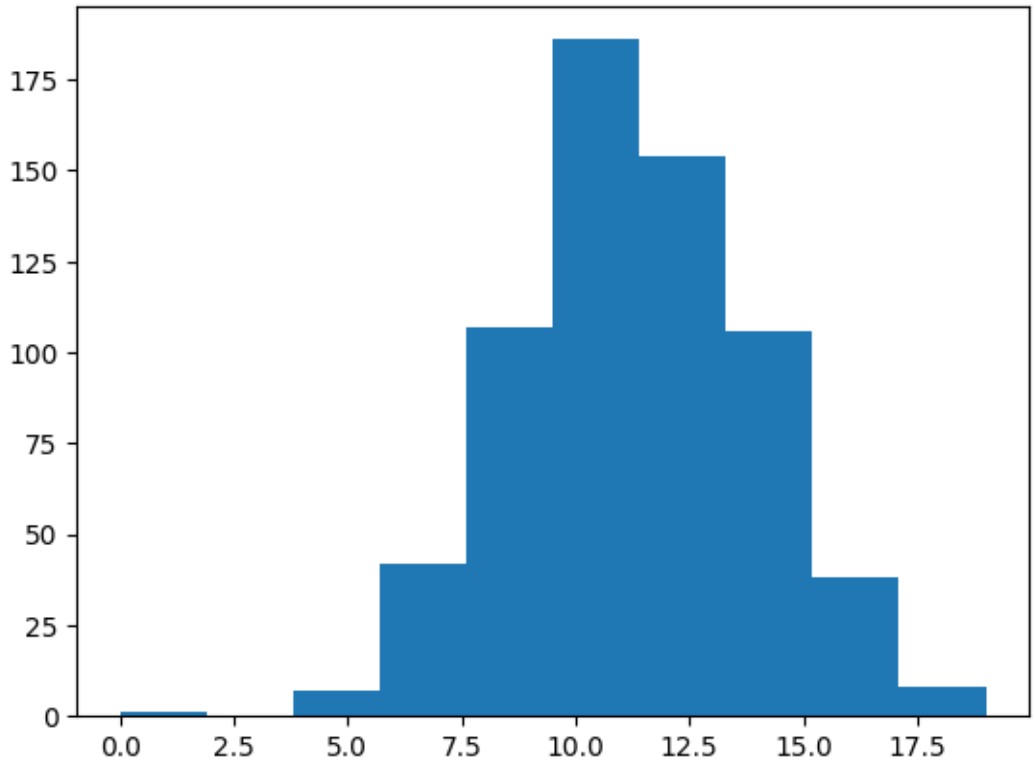
[3]:
```
<bound method NDFrame.head of     school sex  age address famsize Pstatus  Medu
Fedu      Mjob      Fjob  \
0       GP   F   18       U     GT3       A     4     4   at_home   teacher
1       GP   F   17       U     GT3       T     1     1   at_home     other
2       GP   F   15       U     LE3       T     1     1   at_home     other
3       GP   F   15       U     GT3       T     4     2    health  services
4       GP   F   16       U     GT3       T     3     3     other     other
..     …  ..  …      …     …   …   …       …       …
644     MS   F   19       R     GT3       T     2     3  services     other
645     MS   F   18       U     LE3       T     3     1   teacher  services
646     MS   F   18       U     GT3       T     1     1     other     other
647     MS   M   17       U     LE3       T     3     1  services  services
648     MS   M   18       R     LE3       T     3     2  services     other

     … famrel freetime  goout  Dalc  Walc health absences  G1  G2  G3
0    …      4        3      4     1     1      3        4   0  11  11
1    …      5        3      3     1     1      3        2   9  11  11
2    …      4        3      2     2     3      3        6  12  13  12
3    …      3        2      2     1     1      5        0  14  14  14
4    …      4        3      2     1     2      5        0  11  13  13
..   …    …       …    …   …   …    …       …  ..  ..  ..
644  …      5        4      2     1     2      5        4  10  11  10
645  …      4        3      4     1     1      1        4  15  15  16
646  …      1        1      1     1     1      5        6  11  12   9
647  …      2        4      5     3     4      2        6  10  10  10
648  …      4        4      1     3     4      5        4  10  11  11

[649 rows x 33 columns]>
```

[4]:
```
plt.hist(df['G1'])
```

[4]:
```
(array([  1.,   0.,   7.,  42., 107., 186., 154., 106.,  38.,   8.]),
 array([ 0. ,  1.9,  3.8,  5.7,  7.6,  9.5, 11.4, 13.3, 15.2, 17.1, 19. ]),
 <BarContainer object of 10 artists>)
```



0.1 It looks like a Normal Distribution.

[5]:
```
def return_params(data):
    mean = np.mean(data)
    std_dev = np.std(data)
    return [mean, std_dev]
```

[6]:
```
params = return_params(df['G1'])
```

[7]:
```
print(params)
```

```
[11.399075500770415, 2.7431493168577212]
```

[16]:
```
# Calculate the negative log-likelihood of a dataset under a normal␣
↪distribution. Minimizing this function provides us with the maximum␣
↪likelihood estimation.
```

```
def likelihood_fn(params,data):
    '''
    param = parameters of distribution - [mean,standard deviation]
    data = data from distribution
    '''
    mean = params[0]
    std_dev = params[1]
    exponent = -((data - mean) ** 2) / (2 * std_dev ** 2)
    pdf = (1 / (std_dev * np.sqrt(2 * np.pi))) * np.exp(exponent)
    pdf[pdf==0]=np.finfo(float).eps
    log_like = np.log(pdf)
    return -np.sum(log_like)
```

[17]:
```
print("The parameters [Mean, Standard Deviation] obtained by maximising log␣
 ↪likelihood for initial guess (i, 2 + (i/10)) are")
for i in range(0, 20):
    j = 1 + (i/10)
    sol = minimize(likelihood_fn, [i, j], args = df['G1'], method = 'Powell')
    print("Parameters obtained:", sol.x, "\t Initial Guess:", (i,j))
```

```
The parameters [Mean, Standard Deviation] obtained by maximising log likelihood
for initial guess (i, 2 + (i/10)) are
Parameters obtained: [11.39898048  2.74345888]   Initial Guess: (0, 1.0)
Parameters obtained: [11.39918821  2.7427911 ]   Initial Guess: (1, 1.1)
Parameters obtained: [11.39908643  2.74311601]   Initial Guess: (2, 1.2)
Parameters obtained: [11.39907437  2.7431526 ]   Initial Guess: (3, 1.3)
Parameters obtained: [11.3989558   2.74347782]   Initial Guess: (4, 1.4)
Parameters obtained: [11.39895203  2.74346604]   Initial Guess: (5, 1.5)
Parameters obtained: [11.39896881  2.74340064]   Initial Guess: (6, 1.6)
Parameters obtained: [11.39887196  2.74357691]   Initial Guess: (7, 1.7)
Parameters obtained: [11.399179    2.74296256]   Initial Guess: (8, 1.8)
Parameters obtained: [11.39933335  2.74278153]   Initial Guess: (9, 1.9)
Parameters obtained: [11.3990755   2.74314878]   Initial Guess: (10, 2.0)
Parameters obtained: [11.39909813  2.74314229]   Initial Guess: (11, 2.1)
Parameters obtained: [11.39907551  2.74314763]   Initial Guess: (12, 2.2)
Parameters obtained: [11.39903409  2.74307442]   Initial Guess: (13, 2.3)
Parameters obtained: [11.39908344  2.74317934]   Initial Guess: (14, 2.4)
Parameters obtained: [11.39907627  2.74315503]   Initial Guess: (15, 2.5)
Parameters obtained: [11.3990755   2.74314934]   Initial Guess: (16, 2.6)
Parameters obtained: [11.3990754   2.74314892]   Initial Guess: (17, 2.7)
Parameters obtained: [11.3990755   2.74315067]   Initial Guess: (18, 2.8)
Parameters obtained: [11.39907551  2.74314913]   Initial Guess: (19, 2.9)
```

[ ]: