Question3_b

March 24, 2023

Importing necessary libraries

[ ]:
```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
import csv
from scipy.optimize import curve_fit
from scipy.stats.distributions import  t
import seaborn as sns
```

Read csv file as pandas dataframe

[ ]:
```
p2 = pd.read_csv('Q3_second_part_data.csv')
```

Renaming column names for ease of use

[ ]:
```
df = p2[1:]
df = df.rename(columns={'Force(N)': 'f', "Voltage(mv)": "v_20d", "Unnamed: 2":␣
 ↪"v_22d", "Unnamed: 3": "v_24d",
                        "Unnamed: 4": "v_28d", "Unnamed: 5": "v_30d", "Unnamed:␣
 ↪6": "v_32d", "Unnamed: 7": "v_34d",
                        "Unnamed: 8": "v_36d", "Unnamed: 9": "v_38d", "Unnamed:␣
 ↪10": "v_40d"})
df
```

[ ]:

	f	v_20d	v_22d	v_24d	v_28d	\
1	0.0	6.006905827	-2.423679253	-1.722799529	-6.933400103	
2	1.0	-3.106761297	3.539384952	3.135793254	-2.957198958	
3	2.0	-2.461201398	7.46668575	8.063233487	3.908818507	
4	3.0	2.610435387	3.308725995	13.58262318	4.24332935	
5	4.0	0.222915629	3.810135577	-9.309103593	13.37303825	
..	…	…	…	…	…	
96	95.0	6.562904759	49.72346432	79.81869583	157.7428474	
97	96.0	9.007491572	43.21648247	87.47228247	165.6245551	
98	97.0	12.03388393	47.35557317	87.22951431	166.5920236	
99	98.0	7.384459586	62.02480688	86.17742592	168.0524904	
100	99.0	6.73246141	56.0909217	86.26760537	171.3225548	

	v_30d	v_32d	v_34d	v_36d	v_38d	\

```
1     4.402350146  5.127226165  -2.438079736  1.176198994  0.594977734
2     9.181497501  8.988834808   5.956020222  10.72079503  1.398080898
3     9.376398329  10.85365658   6.878377871    6.5946179  9.000673466
4     3.220049265  3.353392541   11.62082585  16.10695551  20.59429028
5     13.63587884  12.51947226   19.91945165  16.10564786  21.90660563
..            …            …             …            …            …
96    207.8793925  243.1154874   276.7808167  324.1662774  359.4739022
97    208.6206138   236.790158   287.9101194  323.5151864  350.0001343
98    206.4196747  241.9564881   272.9193761  341.7868454  363.5262394
99     202.459576  243.3556196   292.8882799  330.8531526  369.5762804
100   208.9561533  249.6213226   286.9346059  323.9530022   366.754561

            v_40d
1     16.19796427
2     10.99186748
3     9.885164868
4     22.64298299
5     18.14079966
..            …
96     396.813557
97    390.5850987
98    407.4387574
99    403.1583333
100   407.6005699

[100 rows x 11 columns]
```

Linear fit for each column

[ ]:
```
cols = df.columns[1:]

def func(x, a, b):
        return a*x + b

_params = []
_params_cov = []
_a2 = []

for i in cols:
    _val = df[i].astype(float)

    param, param_cov = curve_fit(func, df["f"], _val)
    _params.append(param)
    _params_cov.append(param_cov)

for i in _params:
    _a2.append(i[0]) # a2 coefficient for each column in linear fit
```

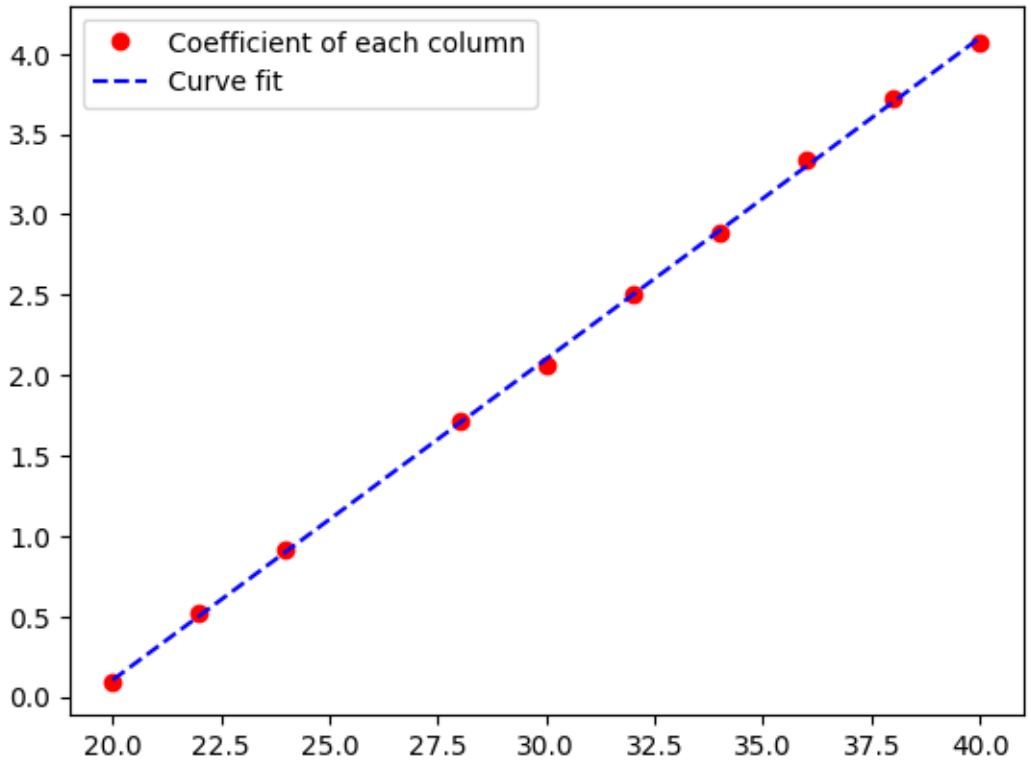
```
_col_num = [20, 22, 24, 28, 30, 32, 34, 36, 38, 40]
```

plotting the coefficient of each linear fit, and performing a secondary linear fit for all coefficients

[ ]:
```
param_t, param_cov_t = curve_fit(func, _col_num, _a2)

_a2 = np.array(_a2)
_col_num = np.array(_col_num)
ans = param_t[0]*_col_num + param_t[1]

plt.plot(_col_num, _a2, 'o', color ='red', label ="Coefficient of each column")
plt.plot(_col_num, ans, '--', color ='blue', label ="Curve fit")
plt.legend()
plt.show()
param_t
```



[ ]:
```
array([ 0.19982715, -3.89377181])
```

[ ]:
```
_coeff33 = param_t[0]*33 + param_t[1]
_volt = 67.0
c1 = 3
```

```
_f = (_volt + c1)/_coeff33
print("The force is: ", _f)
```

```
The force is:  25.920893318868856
```

[ ]:
```
_voltage_values = [2.1, 10.5, 67.0, 34.3, 11.3, 88.9]

_force_33 = []
_force_39 = []

_c = _params[7][1]

for i in _voltage_values:
    """calculate for 33 degrees"""
    _tmp = param_t[0]*33 + param_t[1]
    _volt = i
    _f = (_volt - _c)/_tmp
    _force_33.append(_f)

    """calculate for 39 degrees"""
    _tmp = param_t[0]*39 + param_t[1]
    _volt = i
    _f = (_volt - _c)/_tmp
    _force_39.append(_f)

"""calculate deviation"""

_tmp = param_t[0]*36 + param_t[1]
_volt = 3
_f = _volt/_tmp
print(_f)
print(-_f)
```

```
0.9090893476364842
-0.9090893476364842
```

Respective forces

[ ]:
```
print("The force for 33 degrees is: ", _force_33)
print("The force for 39 degrees is: ", _force_39)
```

```
The force for 33 degrees is:  [0.3609038318738258, 3.4714110301380887,
24.393274923225093, 12.284514758553499, 3.7676498109251617, 32.50281154727121]
The force for 39 degrees is:  [0.24993787773652817, 2.4040673137746573,
16.89315221093588, 8.507434049216021, 2.6092224981592413, 22.509275383463862]
```

[ ]:
```

```