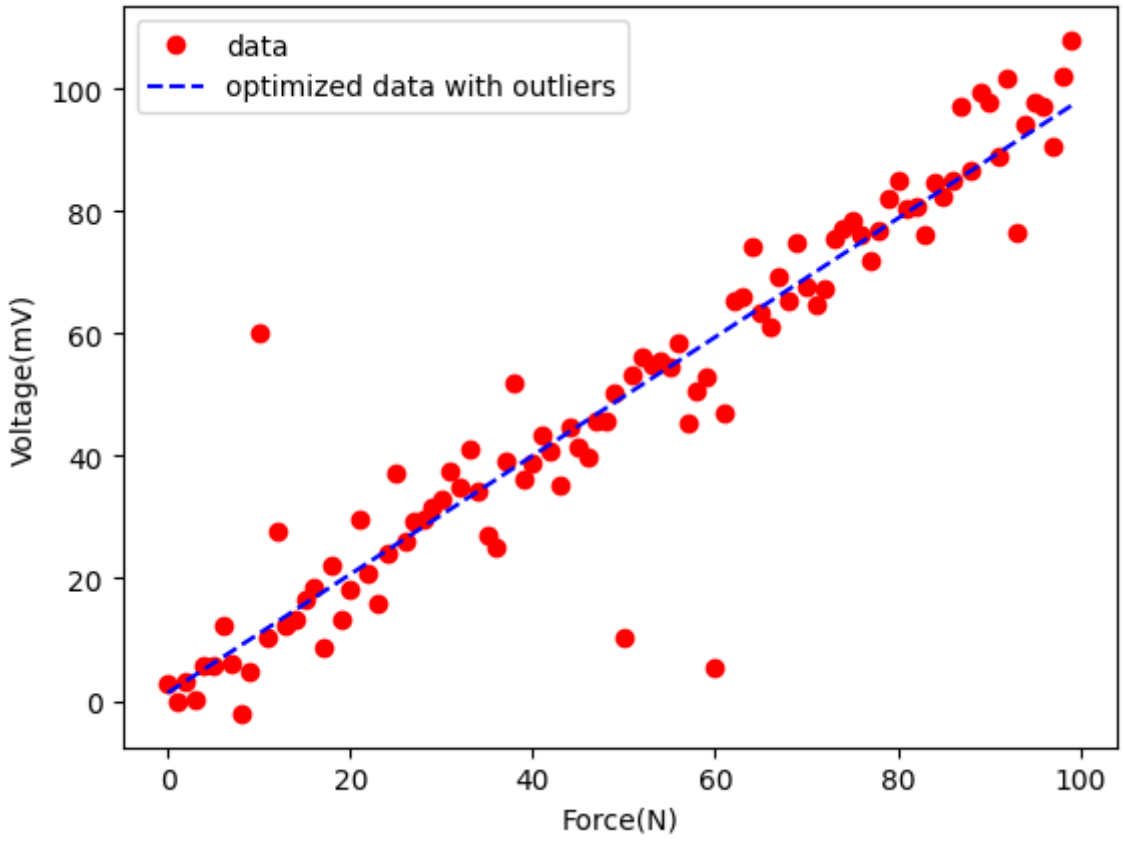
In [ ]:
```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
import csv
from scipy.optimize import curve_fit
from scipy.stats.distributions import  t
import seaborn as sns
```

In [ ]:
```
p1 = pd.read_csv('Q3_first_part_data.csv')
p2 = pd.read_csv('Q3_second_part_data.csv')
# rename the columns
p1 = p1.rename(columns={'Force(N)': 'f', 'voltage(mv)': 'v'})
```

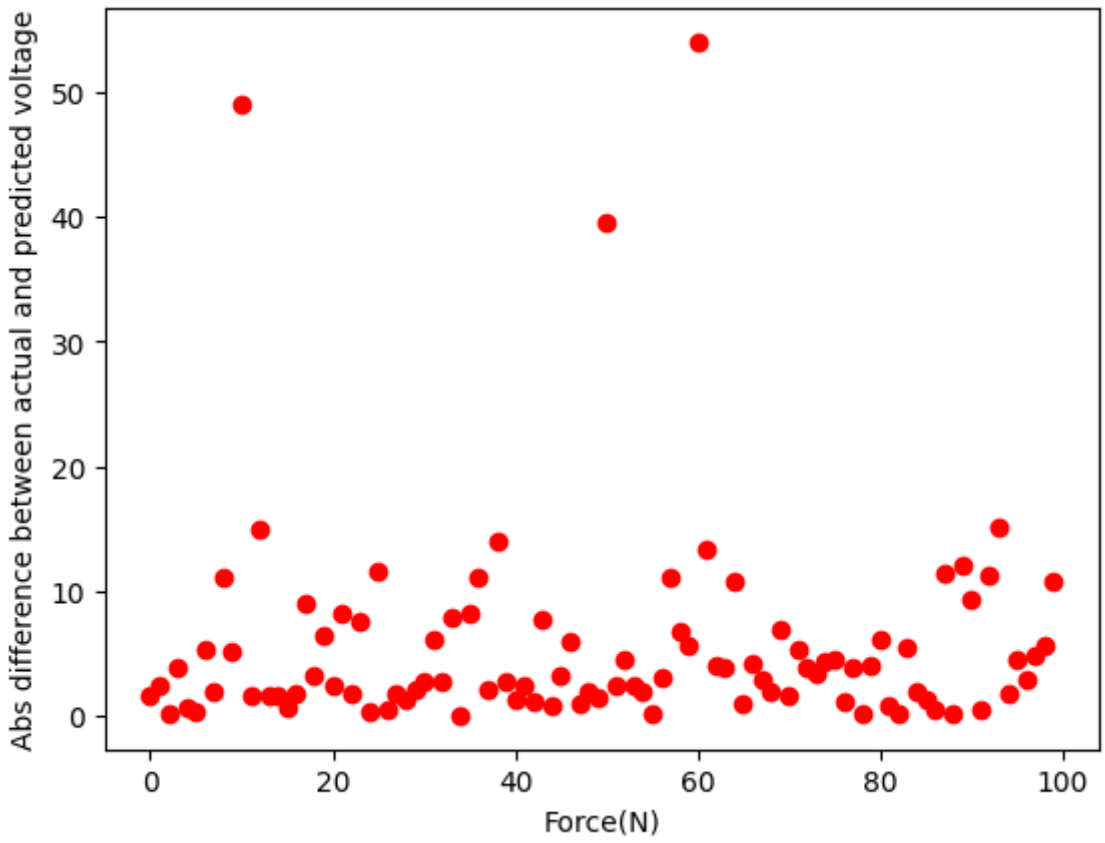
mx + c linear plot

In [ ]:
```
def func(x, a, b):
    return a*x + b

param, param_cov = curve_fit(func, p1["f"], p1["v"])
print("function coefficients:")
print(param)
print("Covariance of coefficients:")
print(param_cov)

v_tcap = param[0]*p1["f"] + param[1]

plt.plot(p1["f"], p1["v"], 'o', color ='red', label ="data")
plt.plot(p1["f"], v_tcap, '--', color ='blue', label ="optimized data with outliers
plt.xlabel("Force(N)")
plt.ylabel("Voltage(mV)")
plt.legend()
plt.show()
```

```
function coefficients:
[0.96908216 1.27142099]
Covariance of coefficients:
[[ 1.24053509e-03 -6.14064857e-02]
 [-6.14064857e-02  4.07329614e+00]]
```



In [ ]:
```
# p1.f.describe(percentiles=[0.05,0.95])
_diff = abs(p1.v - v_tcap)
_err_f = _diff/100
plt.plot(p1['f'], _diff, 'o', color ='red', label ="data")
plt.xlabel("Force(N)")
plt.ylabel("Abs difference between actual and predicted voltage")
plt.show()
lower_bound, upper_bound =  np.percentile(_diff, [0, 95])
```

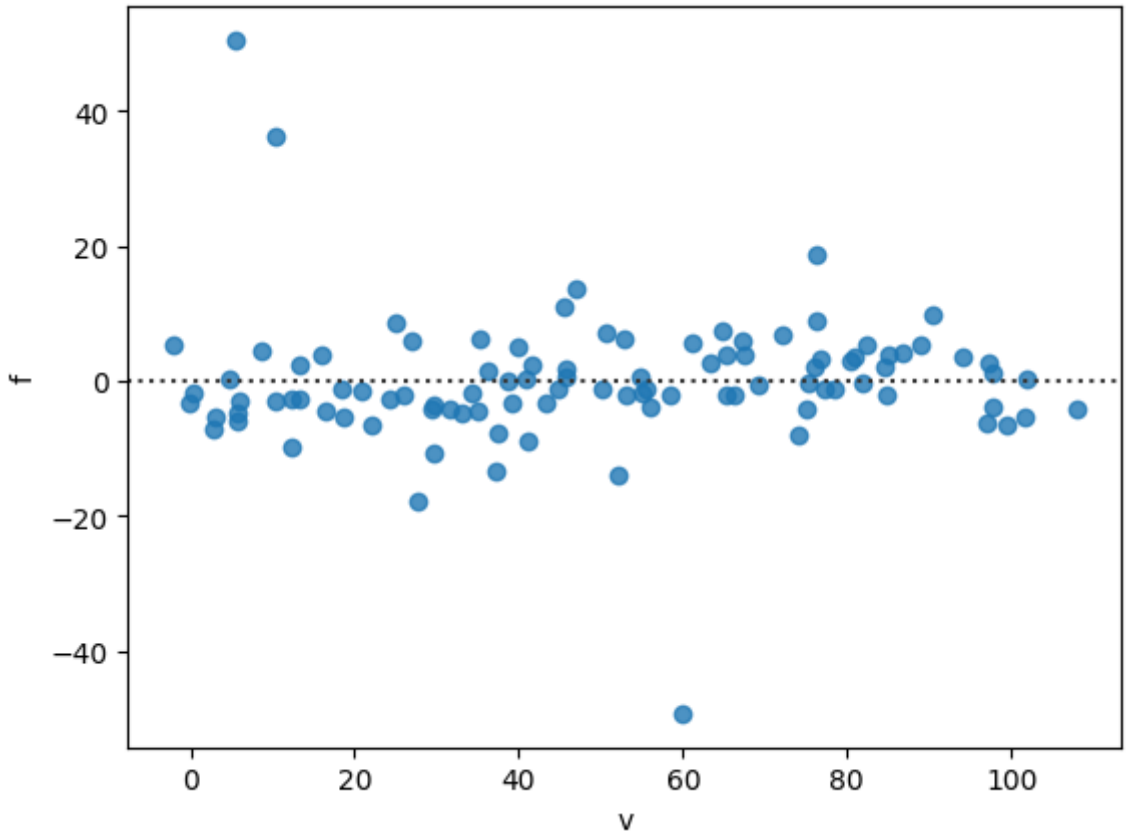


In [ ]:
```
# remove outliers
# _df = p1["f"][_diff < upper_bound]
_max_er = np.percentile(_diff, 95)
print("Accuracy of the model is:", _err_f.max())
# 52.3 mV
print("The maximum error is:", _max_er)
# _value = param[0]*p1["f"] + param[1]
_force = (52.3 - param[1])/param[0]
print("The force is+: ", _force + _max_er)

_force = (52.3 - param[1])/param[0]
print("The force is-:", _force - _max_er)

print("The force is:", _force)
# average force
_avg = (_force + _max_er + _force - _max_er)/2
print("The average force is:", _avg)

_forces = [_force + _max_er, _force - _max_er]

# calculate the standard deviation
_sd = np.std(_forces)
print("The standard deviation is:", _sd)
```

```
Accuracy of the model is: 0.539927507548057
The maximum error is: 14.02706850457919
The force is+:  66.68367593351635
The force is-: 38.62953892435798
The force is: 52.65660742893717
The average force is: 52.65660742893717
The standard deviation is: 14.027068504579187
```

In [ ]:
```
sns.residplot(x='v', y='f', data=p1, ) # not absolute value
```

Out[ ]:
```
<AxesSubplot:xlabel='v', ylabel='f'>
```


40
20
0
−20
−40
f
0
20
40
60
80
100
v