exp3

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Computational Neuroscience Experiment 3

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MBA Tech. EXTC SEM 8

Part 1: Calculating Characteristics

[ ]:

```
import pandas as pd
import numpy as np
import glob
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings("ignore")
```

[ ]:

```
def shannon_entropy(x):
    prob_energy = pow(x,2)/np.sum(pow(x,2))
    shannon = - np.sum(prob_energy*np.log2(prob_energy))
    return shannon

def lee(x):
    prob_energy = pow(x,2)/np.sum(pow(x,2))
    log_energy = np.sum(prob_energy*np.log(prob_energy))
    return log_energy
```

[ ]:

```
def individual_chars(path):
    data = pd.read_csv(path)
    for col in ['FZ -A2 ', 'CZ -A1 ','PZ -A2 ', 'BP2-REF']:
        data.pop(col)
    print(f"Individual Data for {path}\n")
    data_chars = pd.DataFrame({"Mean":data.mean(),"Median":data.
 ↪median(),"Summation":data.sum(),"Variance":data.var(),"Standard Deviation":
 ↪data.std(),"Shannon Entropy":shannon_entropy(data),"Log Energy Entropy":
 ↪lee(data)})
    return data_chars
```

[ ]:

```
def hemisphere_chars(path):
    print(f"Hemisphere Data for {path}")
    data = pd.read_csv(path)
    for col in ['FZ -A2 ', 'CZ -A1 ','PZ -A2 ', 'BP2-REF']:
        data.pop(col)
    right_hemisphere = data[[i for i in data.columns if "A2" in i]].sum()
    left_hemisphere = data[[i for i in data.columns if "A1" in i]].sum()
    combined = pd.DataFrame({"Mean":[left_hemisphere.mean(),right_hemisphere.
↪mean()],"Median":[left_hemisphere.median(),right_hemisphere.
↪median()],"Summation":[left_hemisphere.sum(),right_hemisphere.
↪sum()],"Variance":[left_hemisphere.var(),right_hemisphere.var()],"Standard␣
↪Deviation":[left_hemisphere.std(),right_hemisphere.std()],"Shannon Entropy":
↪[shannon_entropy(left_hemisphere),shannon_entropy(right_hemisphere)],"Log␣
↪Energy Entropy":[lee(left_hemisphere),lee(right_hemisphere)]})
    combined.index = ["Left","Right"]
    combined = combined.transpose()
    return combined
```

```
[ ]: def ecg_chars(path):
         print(f"ECG Data for {path}")
         data = pd.read_csv(path)
         data = data[["BP1-REF","BP2-REF"]]
         bp1 = data["BP1-REF"]
         bp2 = data["BP2-REF"]
         combined = pd.DataFrame({"Mean":[bp2.mean(),bp1.mean()],"Median":[bp2.
     ↪median(),bp1.median()],"Summation":[bp2.sum(),bp1.sum()],"Variance":[bp2.
     ↪var(),bp1.var()],"Standard Deviation":[bp2.std(),bp1.std()],"Shannon␣
     ↪Entropy":[shannon_entropy(bp2),shannon_entropy(bp1)],"Log Energy Entropy":
     ↪[lee(bp2),lee(bp1)]})
         combined.index = ["BP1","BP2"]
         combined = combined.transpose()
         return combined
```

```
[ ]: for file in list(glob.glob("*"))[:2]:
         print(individual_chars(file),"\n\n")

     for file in list(glob.glob("*"))[:2]:
         print(hemisphere_chars(file),"\n\n")

     for file in list(glob.glob("*"))[:2]:
         print(ecg_chars(file),"\n\n")
```

```
Individual Data for 5_filtered.csv

             Mean  Median  Summation     Variance  Standard Deviation  \
FP2-A2   0.037109    -1.0       95.0   826.277247           28.745039
F8 -A2   0.013281     0.0       34.0   374.283528           19.346409
T4 -A2   0.019922    -1.0       51.0   629.104331           25.081952
T6 -A2  -0.014453     0.0      -37.0   361.839963           19.022091
F4 -A2   0.015234    -0.5       39.0   367.993906           19.183167
```

```
C4 -A2   0.032813    -1.0       84.0     399.743354            19.993583
P4 -A2   0.003125     0.0        8.0     576.565836            24.011785
O2 -A2   0.007422     0.0       19.0     325.106236            18.030703
FP1-A1  -0.016016     1.0      -41.0    1015.930576            31.873666
F7 -A1  -0.012109     0.0      -31.0     682.249560            26.119907
T3 -A1  -0.008594     0.0      -22.0     475.606804            21.808411
T5 -A1  -0.006250     0.0      -16.0     524.801837            22.908554
F3 -A1   0.001953     0.0        5.0     542.681903            23.295534
C3 -A1  -0.013672     0.0      -35.0     510.626230            22.597040
P3 -A1  -0.024219     1.0      -62.0     521.439820            22.835057
O1 -A1  -0.017188     2.0      -44.0    1264.352186            35.557730
BP1-REF  0.066016   -37.0      169.0  125332.497790           354.023301

         Shannon Entropy  Log Energy Entropy
FP2-A2          9.991692           -6.925713
F8 -A2          9.989861           -6.924444
T4 -A2          9.702919           -6.725551
T6 -A2          9.910432           -6.869388
F4 -A2         10.286965           -7.130381
C4 -A2          9.960380           -6.904010
P4 -A2         10.069736           -6.979809
O2 -A2         10.051941           -6.967474
FP1-A1          9.845378           -6.824296
F7 -A1         10.197430           -7.068320
T3 -A1         10.057748           -6.971500
T5 -A1         10.117729           -7.013075
F3 -A1          9.989024           -6.923864
C3 -A1         10.054928           -6.969545
P3 -A1         10.057916           -6.971616
O1 -A1          9.956933           -6.901620
BP1-REF         9.165193           -6.352828


Individual Data for 5_unfiltered.csv

               Mean  Median  Summation      Variance  Standard Deviation  \
FP2-A2   -532.105078  -538.0 -1362189.0  34918.605992          186.865208
F8 -A2   -912.291406  -919.5 -2335466.0  50633.135057          225.018077
T4 -A2   -683.771094  -685.0 -1750454.0  36277.901470          190.467586
T6 -A2   -291.118359  -296.5  -745263.0  40198.961757          200.496787
F4 -A2  -1018.371875 -1019.0 -2607032.0  10643.294246          103.166343
C4 -A2   -370.224609  -378.0  -947775.0  37360.661137          193.289061
P4 -A2    -56.543750   -62.5  -144752.0  49656.828097          222.838121
O2 -A2   -748.427344  -750.5 -1915974.0  30537.644582          174.750235
FP1-A1     89.635156    89.0   229466.0   8488.654645           92.133895
F7 -A1    182.542188   181.5   467308.0   9088.840736           95.335412
T3 -A1   -268.410937  -268.0  -687132.0   9389.642710           96.900169
T5 -A1   -174.315234  -176.0  -446247.0   8472.975618           92.048768
```

```
F3 -A1     -5.176953    -6.0    -13253.0  11575.022603          107.587279
C3 -A1   -280.126562  -280.0  -717124.0    5242.481826           72.404985
P3 -A1     49.713672    49.0    127267.0   9956.438109           99.781953
O1 -A1    349.441797   348.0    894571.0  12698.221699          112.686386
BP1-REF  -908.325000  -936.0 -2325312.0  162914.573505          403.626775

         Shannon Entropy  Log Energy Entropy
FP2-A2         11.020299           -7.638689
F8 -A2         11.160303           -7.735733
T4 -A2         11.120128           -7.707885
T6 -A2         10.563676           -7.322182
F4 -A2         11.292742           -7.827532
C4 -A2         10.767502           -7.463464
P4 -A2         10.774761           -7.468495
O2 -A2         11.176100           -7.746682
FP1-A1         10.433953           -7.232265
F7 -A1         10.770833           -7.465772
T3 -A1         11.006232           -7.628939
T5 -A1         10.765435           -7.462031
F3 -A1         10.779446           -7.471743
C3 -A1         11.146279           -7.726012
P3 -A1         10.560701           -7.320120
O1 -A1         11.066104           -7.670439
BP1-REF        11.107876           -7.699393


Hemisphere Data for 5_filtered.csv
                          Left        Right
Mean                -30.750000    36.625000
Median              -33.000000    36.500000
Summation          -246.000000   293.000000
Variance            406.785714  1774.553571
Standard Deviation   20.168929    42.125450
Shannon Entropy       2.445421     2.238853
Log Energy Entropy   -1.695037    -1.551855


Hemisphere Data for 5_unfiltered.csv
                            Left         Right
Mean               -1.814300e+04 -1.476113e+06
Median              5.700700e+04 -1.556322e+06
Summation          -1.451440e+05 -1.180890e+07
Variance            3.243688e+11  6.978557e+11
Standard Deviation  5.695338e+05  8.353776e+05
Shannon Entropy     2.296372e+00  2.467787e+00
Log Energy Entropy -1.591724e+00 -1.710539e+00
```

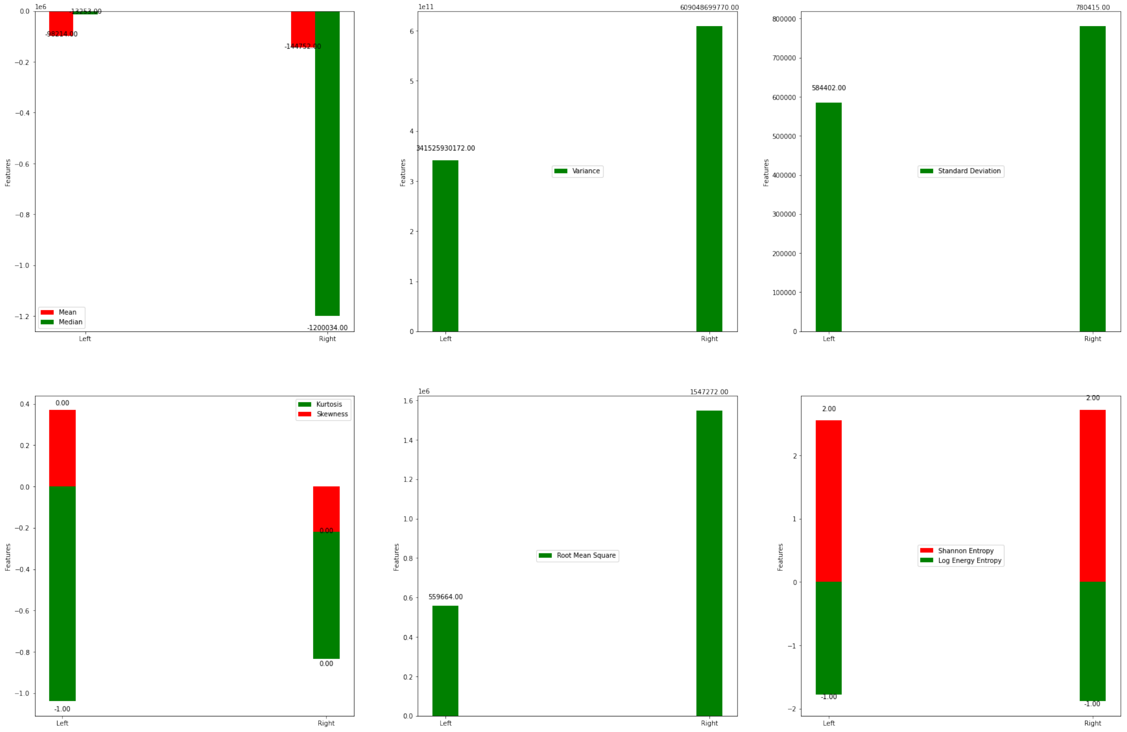
```
ECG Data for 5_filtered.csv
                           BP1            BP2
Mean                 -0.024219       0.066016
Median                0.000000     -37.000000
Summation           -62.000000     169.000000
Variance            246.054122  125332.497790
Standard Deviation   15.686112     354.023301
Shannon Entropy       9.299781       9.165193
Log Energy Entropy   -6.446117      -6.352828


ECG Data for 5_unfiltered.csv
                             BP1           BP2
Mean               -6.062273e+02 -9.083250e+02
Median             -6.050000e+02 -9.360000e+02
Summation          -1.551942e+06 -2.325312e+06
Variance            5.767807e+02  1.629146e+05
Standard Deviation  2.401626e+01  4.036268e+02
Shannon Entropy     1.131739e+01  1.110788e+01
Log Energy Entropy -7.844618e+00 -7.699393e+00
```

Part 2: Unfiltered Data Graphs

[ ]:
```
N = 2
ind = np.arange(N)
width = 0.1

fig = plt.figure(figsize=(30,20))
ax = fig.add_subplot(2,3,1)

mean = [-98214.66,-144752.0]
rects1 = ax.bar(ind, mean, width, color='r')

median = [-13253.0,-1200034.5]
rects2 = ax.bar(ind+width, median, width, color='g')

ax.set_ylabel('Features')
ax.set_xticks(ind+width)
ax.set_xticklabels( ('Left', 'Right') )
ax.legend(['Mean','Median'],loc="best")
def autolabel(rects):
  for rect in rects:
    h = rect.get_height()
    ax.text(rect.get_x()+rect.get_width()/2., 1.05*h, '%0.
 ↪2f'%int(h),ha='center', va='bottom')
```

```
autolabel(rects1)
autolabel(rects2)

ax = fig.add_subplot(2,3,2)
var = [341525930172.0,609048699770.4888]
rects1 = ax.bar(ind+width, var, width, color='g')

ax.set_ylabel('Features')
ax.set_xticks(ind+width)
ax.set_xticklabels( ('Left', 'Right') )
ax.legend(['Variance'],loc="center")
autolabel(rects1)

ax = fig.add_subplot(2,3,3)
std = [584402.19,780415.72]
rects1 = ax.bar(ind+width, std, width, color='g')

ax.set_ylabel('Features')
ax.set_xticks(ind+width)
ax.set_xticklabels( ('Left', 'Right') )
ax.legend(['Standard Deviation'],loc="center")
autolabel(rects1)

ax = fig.add_subplot(2,3,4)
kurt =         [-1.0395,-0.833]
rects2 = ax.bar(ind+width, kurt, width, color='g')

skew = [0.370,-0.219]
rects1 = ax.bar(ind+width, skew, width, color='r')

ax.set_ylabel('Features')
ax.set_xticks(ind+width)
ax.set_xticklabels( ('Left', 'Right') )
ax.legend(['Kurtosis','Skewness'],loc="best")
autolabel(rects1)
autolabel(rects2)

ax = fig.add_subplot(2,3,5)
rms = [559664.833,1547272.762]
rects1 = ax.bar(ind+width, rms, width, color='g')

ax.set_ylabel('Features')
ax.set_xticks(ind+width)
ax.set_xticklabels( ('Left', 'Right') )
ax.legend(['Root Mean Square'],loc="center")
autolabel(rects1)
```

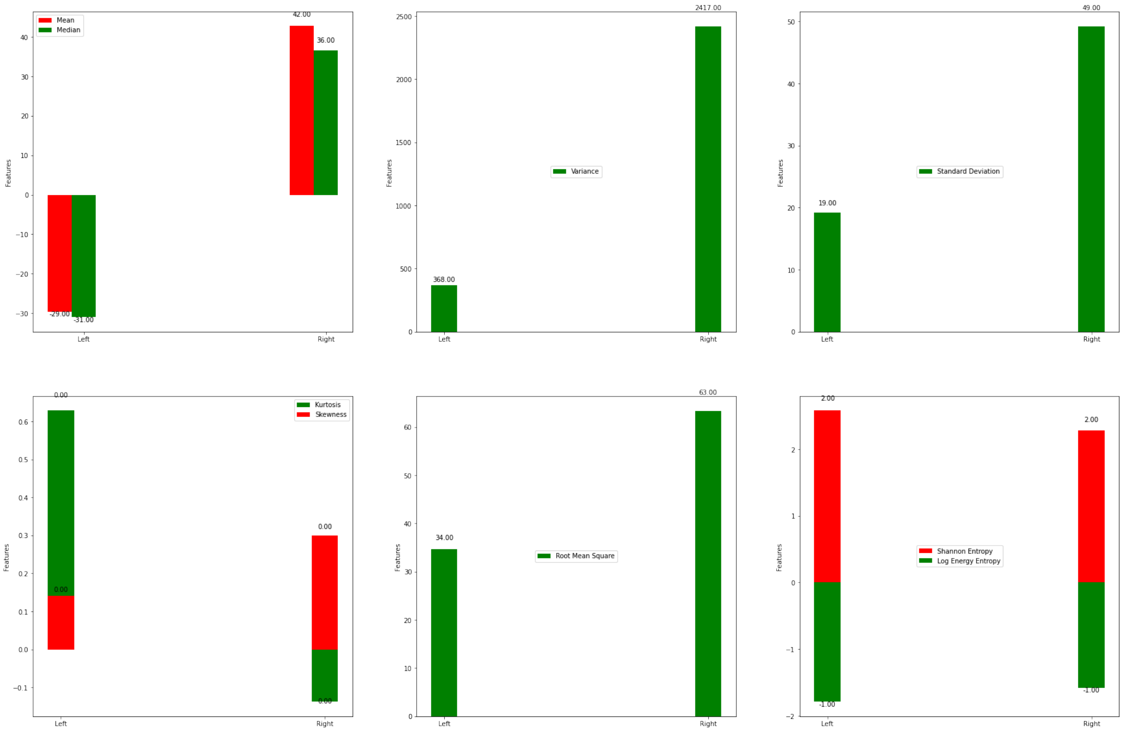
```
ax = fig.add_subplot(2,3,6)
se = [2.560,2.720]
rects1 = ax.bar(ind+width, se, width, color='r')

lee = [-1.774        ,-1.885]
rects2 = ax.bar(ind+width, lee, width, color='g')

ax.set_ylabel('Features')
ax.set_xticks(ind+width)
ax.set_xticklabels( ('Left', 'Right') )
ax.legend(['Shannon Entropy','Log Energy Entropy'],loc="center")
autolabel(rects1)
autolabel(rects2)
```



Part 3: Filtered Data Graphs

```
[ ]: N = 2
     ind = np.arange(N)
     width = 0.1

     fig = plt.figure(figsize=(30,20))
     ax = fig.add_subplot(2,3,1)

     mean = [-29.555         , 42.8]
```

```
rects1 = ax.bar(ind, mean, width, color='r')

median = [-31.0        , 36.5]
rects2 = ax.bar(ind+width, median, width, color='g')

ax.set_ylabel('Features')
ax.set_xticks(ind+width)
ax.set_xticklabels( ('Left', 'Right') )
ax.legend(['Mean','Median'],loc="best")
def autolabel(rects):
  for rect in rects:
    h = rect.get_height()
    ax.text(rect.get_x()+rect.get_width()/2., 1.05*h, '%0.
  ↪2f'%int(h),ha='center', va='bottom')

autolabel(rects1)
autolabel(rects2)

ax = fig.add_subplot(2,3,2)
var = [368.777        ,2417.733]
rects1 = ax.bar(ind+width, var, width, color='g')

ax.set_ylabel('Features')
ax.set_xticks(ind+width)
ax.set_xticklabels( ('Left', 'Right') )
ax.legend(['Variance'],loc="center")
autolabel(rects1)

ax = fig.add_subplot(2,3,3)
std = [19.203        , 49.170]
rects1 = ax.bar(ind+width, std, width, color='g')

ax.set_ylabel('Features')
ax.set_xticks(ind+width)
ax.set_xticklabels( ('Left', 'Right') )
ax.legend(['Standard Deviation'],loc="center")
autolabel(rects1)

ax = fig.add_subplot(2,3,4)
kurt =         [0.629, -0.138]
rects2 = ax.bar(ind+width, kurt, width, color='g')

skew = [0.141,0.300]
rects1 = ax.bar(ind+width, skew, width, color='r')

ax.set_ylabel('Features')
ax.set_xticks(ind+width)
ax.set_xticklabels( ('Left', 'Right') )
ax.legend(['Kurtosis','Skewness'],loc="best")
autolabel(rects1)
autolabel(rects2)

ax = fig.add_subplot(2,3,5)
rms = [34.660        , 63.307]
rects1 = ax.bar(ind+width, rms, width, color='g')

ax.set_ylabel('Features')
ax.set_xticks(ind+width)
ax.set_xticklabels( ('Left', 'Right') )
ax.legend(['Root Mean Square'],loc="center")
autolabel(rects1)

ax = fig.add_subplot(2,3,6)
se = [2.583        , 2.282]
rects1 = ax.bar(ind+width, se, width, color='r')

lee_met = [-1.790, -1.582]
rects2 = ax.bar(ind+width, lee_met, width, color='g')

ax.set_ylabel('Features')
ax.set_xticks(ind+width)
ax.set_xticklabels( ('Left', 'Right') )
ax.legend(['Shannon Entropy','Log Energy Entropy'],loc="center")
autolabel(rects1)
autolabel(rects2)
```



🟥 Mean
🟩 Median
42.00
36.00
-29.00
-31.00
40
30
20
10
0
−10
−20
−30
Features
Left
Right
🟩 Variance
2417.00
368.00
2500
2000
1500
1000
500
0
Features
Left
Right
🟩 Standard Deviation
49.00
19.00
50
40
30
20
10
0
Features
Left
Right
🟩 Kurtosis
🟥 Skewness
0.00
0.00
0.00
0.00
0.6
0.5
0.4
0.3
0.2
0.1
0.0
−0.1
Features
Left
Right
🟩 Root Mean Square
63.00
34.00
60
50
40
30
20
10
0
Features
Left
Right
🟥 Shannon Entropy
🟩 Log Energy Entropy
2.00
2.00
-1.00
-1.00
2
1
0
−1
−2
Features
Left
Right

[ ]: