

```

import numpy as np # Importing NumPy library
import pandas as pd # Importing Pandas library
import matplotlib.pyplot as plt # Importing Matplotlib library's
"pyplot" module
import seaborn as sns # Importing Seaborn library
import os

```

```
data = pd.read_csv("Volumetric_features.csv")
```

```
data.info()
```

```

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4226 entries, 0 to 4225
Columns: 141 entries, S.No to dataset
dtypes: float64(122), int64(19)
memory usage: 4.5 MB

```

```
data.head()
```

	S.No	Left-Lateral-Ventricle	Left-Inf-Lat-Vent	\
0	1	22916.9	982.7	
1	2	22953.2	984.5	
2	3	23320.4	1062.1	
3	4	24360.0	1000.5	
4	5	25769.4	1124.4	

	Left-Cerebellum-White-Matter	Left-Cerebellum-Cortex	Left-Thalamus
0	15196.7	55796.4	6855.5
1	15289.7	55778.6	6835.1
2	15382.1	55551.2	7566.0
3	14805.4	54041.8	8004.6
4	16331.1	54108.6	6677.4

	Left-Caudate	Left-Putamen	Left-Pallidum	3rd-Ventricle	...	\
0	2956.4	4240.7	2223.9	2034.4	...	
1	3064.2	4498.6	2354.1	1927.1	...	
2	3231.7	4456.2	1995.4	2064.7	...	
3	3137.3	4262.2	1983.4	2017.7	...	
4	2964.4	4204.6	2409.7	2251.8	...	

	rh_supramarginal_thickness	rh_frontalpole_thickness	\
0	2.408	2.629	
1	2.417	2.640	
2	2.374	2.601	

3	2.366	2.639
4	2.381	2.555

	rh_temporalpole_thickness	rh_transversetemporal_thickness \
0	3.519	2.009
1	3.488	2.111
2	3.342	2.146
3	3.361	2.056
4	3.450	2.052

	rh_insula_thickness	rh_MeanThickness_thickness
BrainSegVolNotVent.2 \		
0	2.825	2.33635
1093846		
1	2.720	2.34202
1099876		
2	2.684	2.31982
1097999		
3	2.700	2.29215
1070117		
4	2.574	2.30397
1075926		

	eTIV.1	Age	dataset
0	1619602.965	85	1
1	1624755.130	85	1
2	1622609.518	86	1
3	1583854.236	87	1
4	1617375.362	89	1

[5 rows x 141 columns]

data.tail()

	S.No	Left-Lateral-Ventricle	Left-Inf-Lat-Vent \
4221	4222	27065.6	532.4
4222	4223	28408.8	912.7
4223	4224	34467.9	1659.6
4224	4225	31627.5	1334.4
4225	4226	14879.4	704.2

	Left-Cerebellum-White-Matter	Left-Cerebellum-Cortex	Left-Thalamus \
4221	12425.1	51042.9	
6354.8			
4222	14024.8	43103.5	
6060.7			
4223	12744.5	54924.8	
6256.7			
4224	15883.2	57148.2	

6982.4
4225
6935.4

11346.6

50468.5

	Left-Caudate	Left-Putamen	Left-Pallidum	3rd-Ventricle	...	\
4221	3822.6	4490.5	2019.4	1256.2	...	
4222	3114.2	3731.0	1937.4	1669.9	...	
4223	3573.4	3526.6	2189.9	3063.1	...	
4224	4475.8	4464.4	2317.8	3809.0	...	
4225	3258.5	3751.5	2226.5	1898.4	...	

	rh_supramarginal_thickness	rh_frontalpole_thickness	\
4221	2.505	2.666	
4222	2.385	3.008	
4223	2.028	2.995	
4224	2.491	2.865	
4225	2.474	3.150	

	rh_temporalpole_thickness	rh_transversetemporal_thickness	\
4221	2.915	2.243	
4222	3.572	2.040	
4223	3.706	1.928	
4224	3.456	2.317	
4225	3.691	2.337	

	rh_insula_thickness	rh_MeanThickness_thickness
BrainSegVolNotVent.2	\	
4221	2.683	2.29264
1108782		
4222	2.866	2.30156
960586		
4223	2.610	2.19622
1033357		
4224	2.900	2.43580
1073339		
4225	2.787	2.43420
992086		

	eTIV.1	Age	dataset
4221	1561822.106	79	9
4222	1530179.480	79	9
4223	1604323.353	84	9
4224	1620891.799	80	9
4225	1513076.040	86	9

[5 rows x 141 columns]

data.describe()

	S.No	Left-Lateral-Ventricle	Left-Inf-Lat-Vent \
count	4226.000000	4226.000000	4226.000000
mean	2113.500000	13370.040795	574.849716
std	1220.085448	9194.928348	594.590387
min	1.000000	2204.100000	0.000000
25%	1057.250000	7031.625000	243.200000
50%	2113.500000	10669.950000	385.800000
75%	3169.750000	17332.650000	720.825000
max	4226.000000	79812.500000	7533.800000

	Left-Cerebellum-White-Matter	Left-Cerebellum-Cortex	Left-Thalamus \
count	4226.000000	4226.000000	
mean	14646.696711	52002.811571	
std	2622.868798	6378.435917	
min	6920.100000	29911.800000	
25%	12909.875000	47359.675000	
50%	14277.000000	51333.650000	
75%	15959.725000	56287.775000	
max	35042.500000	79948.200000	

	Left-Caudate Ventricle ... \	Left-Putamen	Left-Pallidum	3rd-
count	4226.000000	4226.000000	4226.000000	4226.000000 ...
mean	3337.653526	4505.158755	1958.214458	1418.947373 ...
std	502.352001	713.658580	287.139826	635.143286 ...
min	1035.600000	2294.000000	851.900000	39.700000 ...
25%	2984.500000	4008.125000	1764.700000	941.825000 ...
50%	3294.050000	4438.100000	1940.100000	1225.450000 ...
75%	3655.125000	4963.025000	2128.000000	1780.225000 ...
max	6018.000000	8446.100000	4357.700000	4461.600000 ...

rh_supramarginal_thickness rh_frontalpole_thickness \

count	4226.000000	4226.000000
mean	2.429779	2.684327
std	0.185543	0.275245
min	1.345000	1.655000
25%	2.309000	2.510000
50%	2.440500	2.685000
75%	2.562750	2.851000
max	2.996000	3.928000

	rh_temporalpole_thickness	rh_transversetemporal_thickness \
count	4226.000000	4226.000000
mean	3.555803	2.288283
std	0.332094	0.269851
min	1.940000	1.176000
25%	3.360000	2.105000
50%	3.586500	2.297000
75%	3.790000	2.476000
max	4.487000	3.123000

	rh_insula_thickness	rh_MeanThickness_thickness
BrainSegVolNotVent.2 \		
count	4226.000000	4226.000000
4.226000e+03		
mean	2.846123	2.372266
1.085468e+06		
std	0.195038	0.146944
1.248881e+05		
min	1.533000	1.483290
6.279600e+05		
25%	2.720000	2.274935
9.957585e+05		
50%	2.851000	2.383375
1.075919e+06		
75%	2.975000	2.483142
1.168888e+06		
max	3.482000	2.803730
1.545129e+06		

	eTIV.1	Age	dataset
count	4.226000e+03	4226.000000	4226.000000
mean	1.514925e+06	58.374586	4.533838
std	1.651798e+05	20.064099	3.057928
min	8.329815e+05	18.000000	1.000000
25%	1.404471e+06	43.000000	1.000000
50%	1.511767e+06	61.000000	4.000000
75%	1.625445e+06	76.000000	8.000000
max	2.075213e+06	96.000000	9.000000

[8 rows x 141 columns]

data.corr()

	S.No	Left-Lateral-Ventricle \
S.No	1.000000	-0.273051
Left-Lateral-Ventricle	-0.273051	1.000000
Left-Inf-Lat-Vent	-0.297935	0.758895
Left-Cerebellum-White-Matter	0.108163	-0.185344
Left-Cerebellum-Cortex	0.228461	-0.115200
...
rh_MeanThickness_thickness	0.551083	-0.473704
BrainSegVolNotVent.2	0.241622	-0.143671
eTIV.1	-0.012108	0.311918
Age	-0.448086	0.569539
dataset	0.966876	-0.269706

	Left-Inf-Lat-Vent	Left-Cerebellum-White-Matter \
S.No	-0.297935	
0.108163		
Left-Lateral-Ventricle	0.758895	-
0.185344		
Left-Inf-Lat-Vent	1.000000	-
0.185624		
Left-Cerebellum-White-Matter	-0.185624	
1.000000		
Left-Cerebellum-Cortex	-0.114728	
0.453275		
...	...	
...		
rh_MeanThickness_thickness	-0.460625	
0.228483		
BrainSegVolNotVent.2	-0.178073	
0.573532		
eTIV.1	0.171763	
0.389334		
Age	0.496304	-
0.334077		
dataset	-0.289179	
0.114491		

	Left-Cerebellum-Cortex	Left-Thalamus \
S.No	0.228461	0.355100
Left-Lateral-Ventricle	-0.115200	-0.339383
Left-Inf-Lat-Vent	-0.114728	-0.324770
Left-Cerebellum-White-Matter	0.453275	0.552485
Left-Cerebellum-Cortex	1.000000	0.614980
...
rh_MeanThickness_thickness	0.383172	0.520636
BrainSegVolNotVent.2	0.738842	0.779632
eTIV.1	0.584460	0.478718

Age	-0.471327	-0.696598
dataset	0.209924	0.355051

	Left-Caudate	Left-Putamen	Left-
Pallidum \			
S.No	0.218686	0.343462	
0.213620			
Left-Lateral-Ventricle	0.033166	-0.297033	-
0.042405			
Left-Inf-Lat-Vent	-0.000890	-0.270332	-
0.100457			
Left-Cerebellum-White-Matter	0.232840	0.363488	
0.470753			
Left-Cerebellum-Cortex	0.406568	0.481604	
0.453184			
...
.			
rh_MeanThickness_thickness	0.329966	0.496941	
0.241270			
BrainSegVolNotVent.2	0.511158	0.671049	
0.646115			
eTIV.1	0.445154	0.408873	
0.541690			
Age	-0.316839	-0.596201	-
0.283967			
dataset	0.205266	0.341155	
0.227400			

	3rd-Ventricle	...
rh_supramarginal_thickness \		
S.No	-0.323219	...
0.482818		
Left-Lateral-Ventricle	0.758326	...
0.450547		-
Left-Inf-Lat-Vent	0.639533	...
0.432036		-
Left-Cerebellum-White-Matter	-0.195800	...
0.228181		
Left-Cerebellum-Cortex	-0.131148	...
0.367147		
...
...		
rh_MeanThickness_thickness	-0.507112	...
0.907426		
BrainSegVolNotVent.2	-0.159878	...
0.389036		
eTIV.1	0.267492	...
0.083583		
Age	0.616427	...
0.665053		-

dataset	-0.315232	...
0.472830		

	rh_frontalpole_thickness \
S.No	0.367264
Left-Lateral-Ventricle	-0.258031
Left-Inf-Lat-Vent	-0.280111
Left-Cerebellum-White-Matter	0.059456
Left-Cerebellum-Cortex	0.095156
...	...
rh_MeanThickness_thickness	0.534222
BrainSegVolNotVent.2	0.095958
eTIV.1	-0.092126
Age	-0.343172
dataset	0.354453

	rh_temporalpole_thickness \
S.No	0.213806
Left-Lateral-Ventricle	-0.236771
Left-Inf-Lat-Vent	-0.298658
Left-Cerebellum-White-Matter	0.129812
Left-Cerebellum-Cortex	0.156303
...	...
rh_MeanThickness_thickness	0.446643
BrainSegVolNotVent.2	0.175485
eTIV.1	0.011810
Age	-0.257899
dataset	0.232550

	rh_transversetemporal_thickness \
S.No	0.343197
Left-Lateral-Ventricle	-0.346898
Left-Inf-Lat-Vent	-0.313795
Left-Cerebellum-White-Matter	0.083770
Left-Cerebellum-Cortex	0.262683
...	...
rh_MeanThickness_thickness	0.671823
BrainSegVolNotVent.2	0.231965
eTIV.1	0.039924
Age	-0.481280
dataset	0.321139

	rh_insula_thickness	
rh_MeanThickness_thickness \		
S.No	0.410412	
0.551083		
Left-Lateral-Ventricle	-0.399022	-
0.473704		
Left-Inf-Lat-Vent	-0.388870	-
0.460625		

Left-Cerebellum-White-Matter	0.196011	
0.228483		
Left-Cerebellum-Cortex	0.318206	
0.383172		
...	...	
...		
rh_MeanThickness_thickness	0.728960	
1.000000		
BrainSegVolNotVent.2	0.323182	
0.397472		
eTIV.1	0.078768	
0.056084		
Age	-0.547973	-
0.706354		
dataset	0.426840	
0.536616		

	BrainSegVolNotVent.2	eTIV.1	Age
\			
S.No	0.241622	-0.012108	-0.448086
Left-Lateral-Ventricle	-0.143671	0.311918	0.569539
Left-Inf-Lat-Vent	-0.178073	0.171763	0.496304
Left-Cerebellum-White-Matter	0.573532	0.389334	-0.334077
Left-Cerebellum-Cortex	0.738842	0.584460	-0.471327
...
rh_MeanThickness_thickness	0.397472	0.056084	-0.706354
BrainSegVolNotVent.2	1.000000	0.786937	-0.530925
eTIV.1	0.786937	1.000000	-0.109157
Age	-0.530925	-0.109157	1.000000
dataset	0.237614	-0.019869	-0.430217

	dataset
S.No	0.966876
Left-Lateral-Ventricle	-0.269706
Left-Inf-Lat-Vent	-0.289179
Left-Cerebellum-White-Matter	0.114491
Left-Cerebellum-Cortex	0.209924
...	...

```
rh_MeanThickness_thickness    0.536616
BrainSegVolNotVent.2         0.237614
eTIV.1                        -0.019869
Age                           -0.430217
dataset                       1.000000
```

```
[141 rows x 141 columns]
```

```
X = data.drop(["Age"], axis=1)
y = data.Age.values
```

```
from sklearn.model_selection import train_test_split
```

```
x_train, x_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)
```

```
from sklearn.linear_model import LinearRegression
```

```
multiple_linear_reg = LinearRegression(fit_intercept=False)
multiple_linear_reg.fit(x_train, y_train)
```

```
LinearRegression(fit_intercept=False)
```

```
from sklearn.model_selection import cross_val_predict # For K-Fold
Cross Validation
```

```
from sklearn.metrics import r2_score # For find accuracy with R2
Score
```

```
from sklearn.metrics import mean_squared_error # For MSE
```

```
from math import sqrt # For squareroot operation
```

```
y_pred_MLR_train = multiple_linear_reg.predict(x_train)
y_pred_MLR_test = multiple_linear_reg.predict(x_test)
```

```
accuracy_MLR_train = r2_score(y_train, y_pred_MLR_train)
print("Training Accuracy for Multiple Linear Regression Model: ",
accuracy_MLR_train)
```

```
accuracy_MLR_test = r2_score(y_test, y_pred_MLR_test)
print("Testing Accuracy for Multiple Linear Regression Model: ",
accuracy_MLR_test)
```

```
RMSE_MLR_train = sqrt(mean_squared_error(y_train, y_pred_MLR_train))
print("RMSE for Training Data: ", RMSE_MLR_train)
```

```
RMSE_MLR_test = sqrt(mean_squared_error(y_test, y_pred_MLR_test))
print("RMSE for Testing Data: ", RMSE_MLR_test)
```

```
Training Accuracy for Multiple Linear Regression Model:
```

```
0.8606321489465106
```

```
Testing Accuracy for Multiple Linear Regression Model:
```

```
0.856165378016878
```

RMSE for Training Data: 7.469098605888389

RMSE for Testing Data: 7.680844761268997

```
sns.scatterplot(y_train, y_pred_MLR_train)
```

/Users/caramatthews/opt/anaconda3/lib/python3.9/site-packages/seaborn/_decorators.py:36: FutureWarning: Pass the following variables as keyword args: x, y. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.

```
warnings.warn(
```

<AxesSubplot:>

