Data Science Final Project: Group2

Title: Sleep Disorder Classification

Objective: Develop a predictive model to classify individuals as either having or not having a sleep disorder based on relevant features.

Dataset: Sleep Health and Lifestyle Dataset (Kaggle)

Link: https://www.kaggle.com/code/wilmerarltstrmberg/sleep-disorder-feature-analysis

```
# Import Needed Libraries

import pandas as pd
import numpy as np

import seaborn as sns
import matplotlib.pyplot as plt

from sklearn.preprocessing import LabelEncoder
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler

from sklearn.linear_model import LogisticRegression
from sklearn.svm import SVC
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier

from sklearn.metrics import confusion_matrix
```

1. Exploration of Data Analysis

1.1 CHARACTERISTIC OF DATA

```
#***Load the data and print a few row***

file_path = "Sleep_health_and_lifestyle_dataset.csv"
myData = pd.read_csv(file_path)
myData.head(10)
```

```
   Person ID Gender  Age            Occupation  Sleep Duration  \
0          1   Male   27     Software Engineer             6.1
1          2   Male   28                Doctor             6.2
2          3   Male   28                Doctor             6.2
3          4   Male   28  Sales Representative             5.9
4          5   Male   28  Sales Representative             5.9
```

```
5           6   Male   28     Software Engineer             5.9
6           7   Male   29               Teacher             6.3
7           8   Male   29                Doctor             7.8
8           9   Male   29                Doctor             7.8
9          10   Male   29                Doctor             7.8

   Quality of Sleep  Physical Activity Level  Stress Level BMI
Category  \
0                 6                       42             6
Overweight
1                 6                       60             8
Normal
2                 6                       60             8
Normal
3                 4                       30             8
Obese
4                 4                       30             8
Obese
5                 4                       30             8
Obese
6                 6                       40             7
Obese
7                 7                       75             6
Normal
8                 7                       75             6
Normal
9                 7                       75             6
Normal

  Blood Pressure  Heart Rate  Daily Steps Sleep Disorder
0         126/83          77         4200           None
1         125/80          75        10000           None
2         125/80          75        10000           None
3         140/90          85         3000    Sleep Apnea
4         140/90          85         3000    Sleep Apnea
5         140/90          85         3000       Insomnia
6         140/90          82         3500       Insomnia
7         120/80          70         8000           None
8         120/80          70         8000           None
9         120/80          70         8000           None
```

```
#***Count the number of rows and columns in the dataset***

myData.shape
```

```
(374, 13)
```

We can see that there are 374 rows and 13 columns in the dataset.

```
#***Check the data types***

myData.dtypes
```

```
Person ID                    int64
Gender                      object
Age                          int64
Occupation                  object
Sleep Duration             float64
Quality of Sleep             int64
Physical Activity Level      int64
Stress Level                 int64
BMI Category                object
Blood Pressure              object
Heart Rate                   int64
Daily Steps                  int64
Sleep Disorder              object
dtype: object
```

```
# ***Get the column names in the dataset***

print("Column names:")
for col in myData.columns:
        print(col)
```

```
Column names:
Person ID
Gender
Age
Occupation
Sleep Duration
Quality of Sleep
Physical Activity Level
Stress Level
BMI Category
Blood Pressure
Heart Rate
Daily Steps
Sleep Disorder
```

```
# ***Get some statistics on the dataset***

myData.describe()
```

```
        Person ID         Age  Sleep Duration  Quality of Sleep  \
count  374.000000  374.000000      374.000000        374.000000
mean   187.500000   42.184492        7.132086          7.312834
std    108.108742    8.673133        0.795657          1.196956
min      1.000000   27.000000        5.800000          4.000000
25%     94.250000   35.250000        6.400000          6.000000
50%    187.500000   43.000000        7.200000          7.000000
```

```
75%    280.750000   50.000000         7.800000          8.000000
max    374.000000   59.000000         8.500000          9.000000
```

```
       Physical Activity Level  Stress Level  Heart Rate   Daily Steps
count                374.000000    374.000000  374.000000    374.000000
mean                  59.171123      5.385027   70.165775   6816.844920
std                   20.830804      1.774526    4.135676   1617.915679
min                   30.000000      3.000000   65.000000   3000.000000
25%                   45.000000      4.000000   68.000000   5600.000000
50%                   60.000000      5.000000   70.000000   7000.000000
75%                   75.000000      7.000000   72.000000   8000.000000
max                   90.000000      8.000000   86.000000  10000.000000
```

After getting these statistics, We can see the average age was 42.184 and the oldest in this dataset was 59 years old, while the youngest was 27 years old.

1.2 DATA CLEANSING

```
#***Check if there's missing values in all columns***

nan_count = myData.isna().sum()
print(nan_count)
```

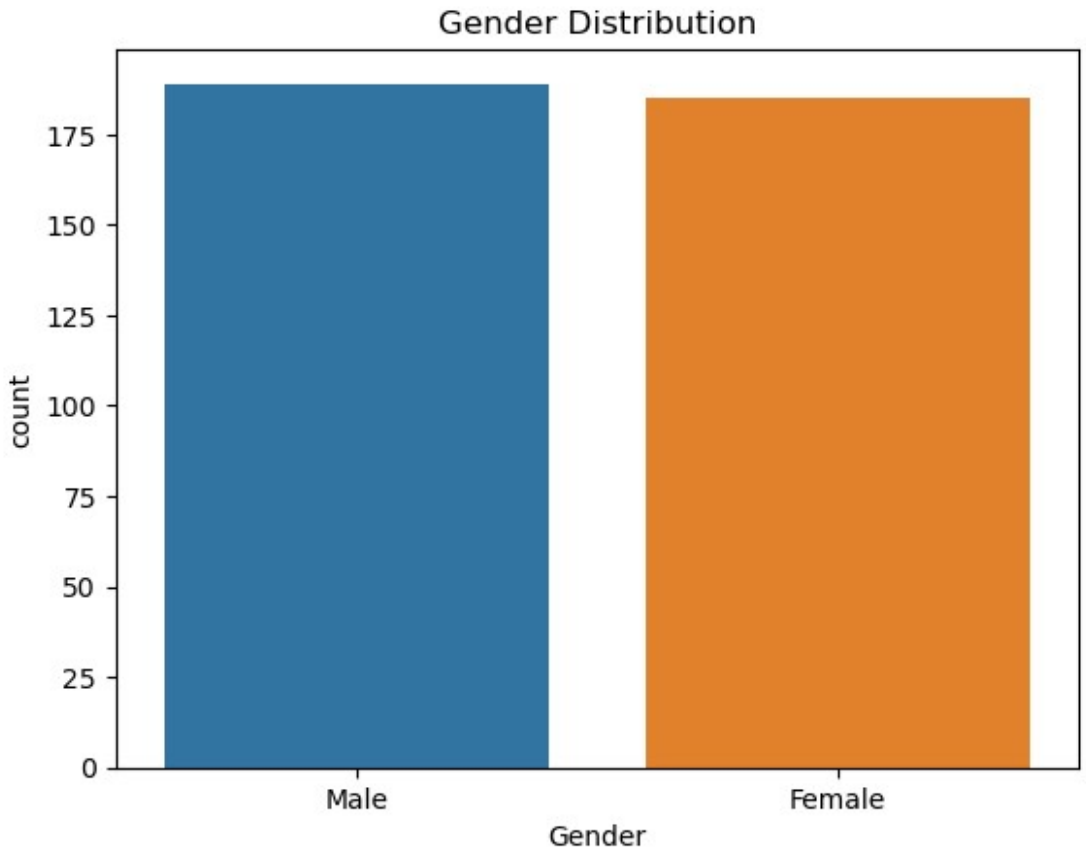
```
Person ID                  0
Gender                     0
Age                        0
Occupation                 0
Sleep Duration             0
Quality of Sleep           0
Physical Activity Level    0
Stress Level               0
BMI Category               0
Blood Pressure             0
Heart Rate                 0
Daily Steps                0
Sleep Disorder             0
dtype: int64
```

We can see that there are no missing values in the dataset. Now, we will turn categorical variables into numbers to make it easier to create visualizations.

```
# ***Encoding categorical variables***


#Encode 'Sleep Disorder' column: 1 for 'Sleep Apnea' or 'Insomnia',
and 0 for 'None'
myData['Sleep Disorder Numeric'] = myData['Sleep Disorder'].map(lambda
x: 1 if x in ['Sleep Apnea', 'Insomnia'] else 0)

#Encode 'Gender' column: 1 for 'Female', and 0 for 'Male'
myData['Gender Numeric'] = myData['Gender'].map(lambda x: 1 if x in
['Female'] else 0)

#Encode 'BMI Category' column:
bmi_mapping = {
    'Normal': 0,
    'Normal Weight': 0,
    'Overweight': 1,
    'Obese': 1,
}
myData['BMI Category Numeric'] = myData['BMI
Category'].map(bmi_mapping)

#Encode 'Occupation Numeric' column:
le = LabelEncoder()
myData['Occupation Numeric'] = le.fit_transform(myData['Occupation'])
```

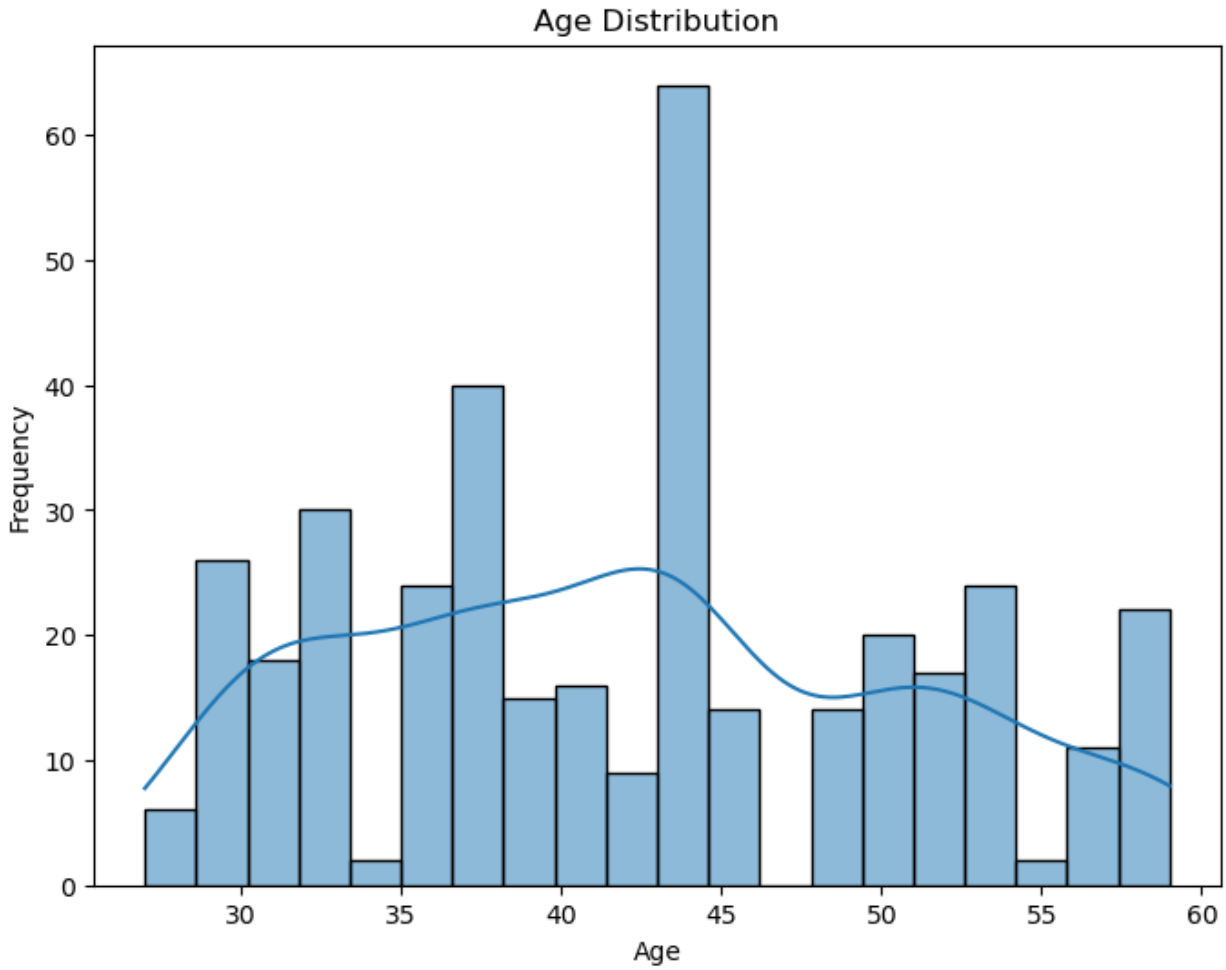
2. Data Visualization

```
# ***Countplot for Gender distribution***
sns.countplot(x='Gender', data=myData)
plt.title('Gender Distribution')
plt.show()
```

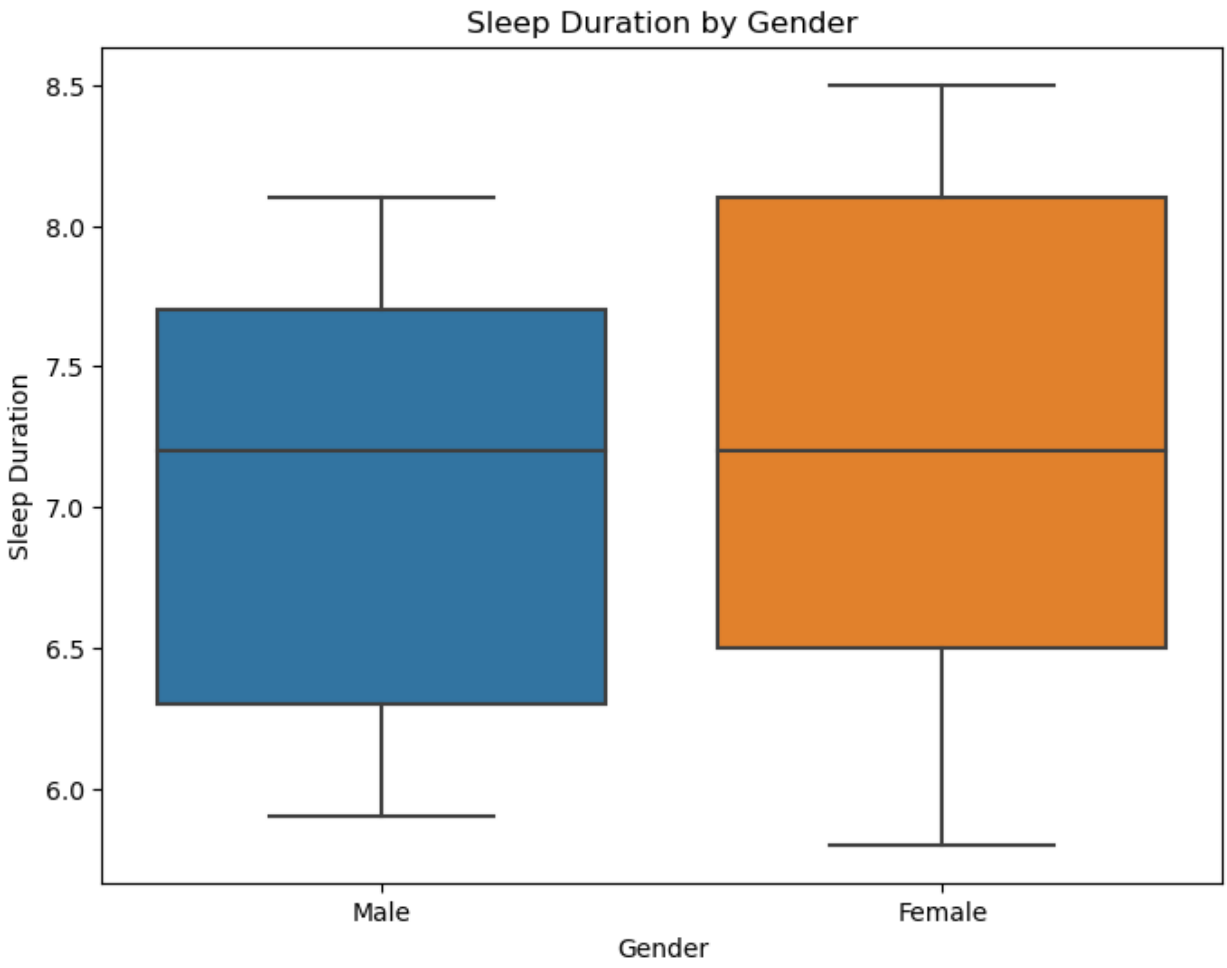


Visualize the Gender Distribution by using a bar plot.It's clear that there are slightly more males than females.

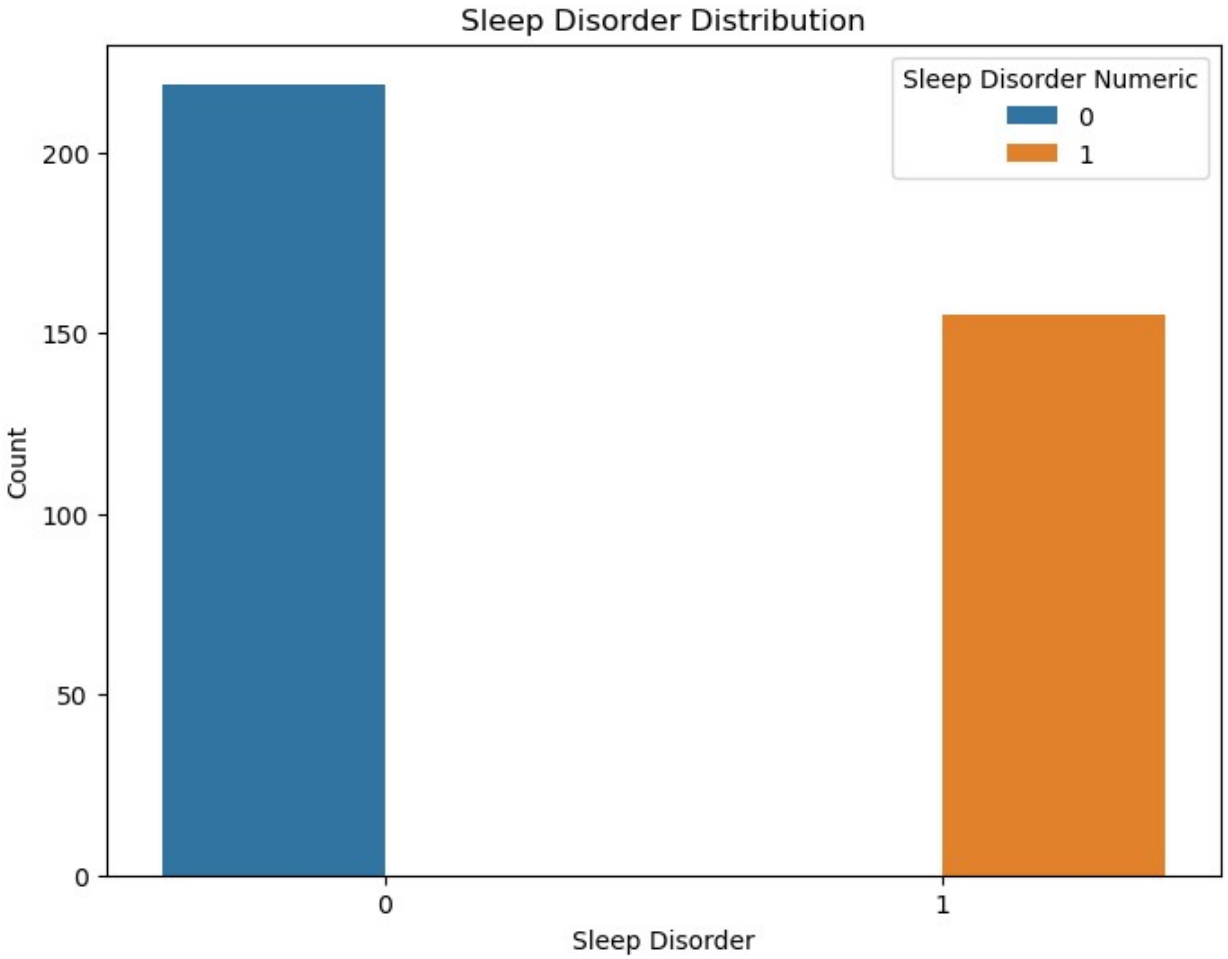
```
# ***Histogram for Age distribution***
plt.figure(figsize=(8, 6))
sns.histplot(myData['Age'], bins=20, kde=True)
plt.title('Age Distribution')
plt.xlabel('Age')
plt.ylabel('Frequency')
plt.show()
```



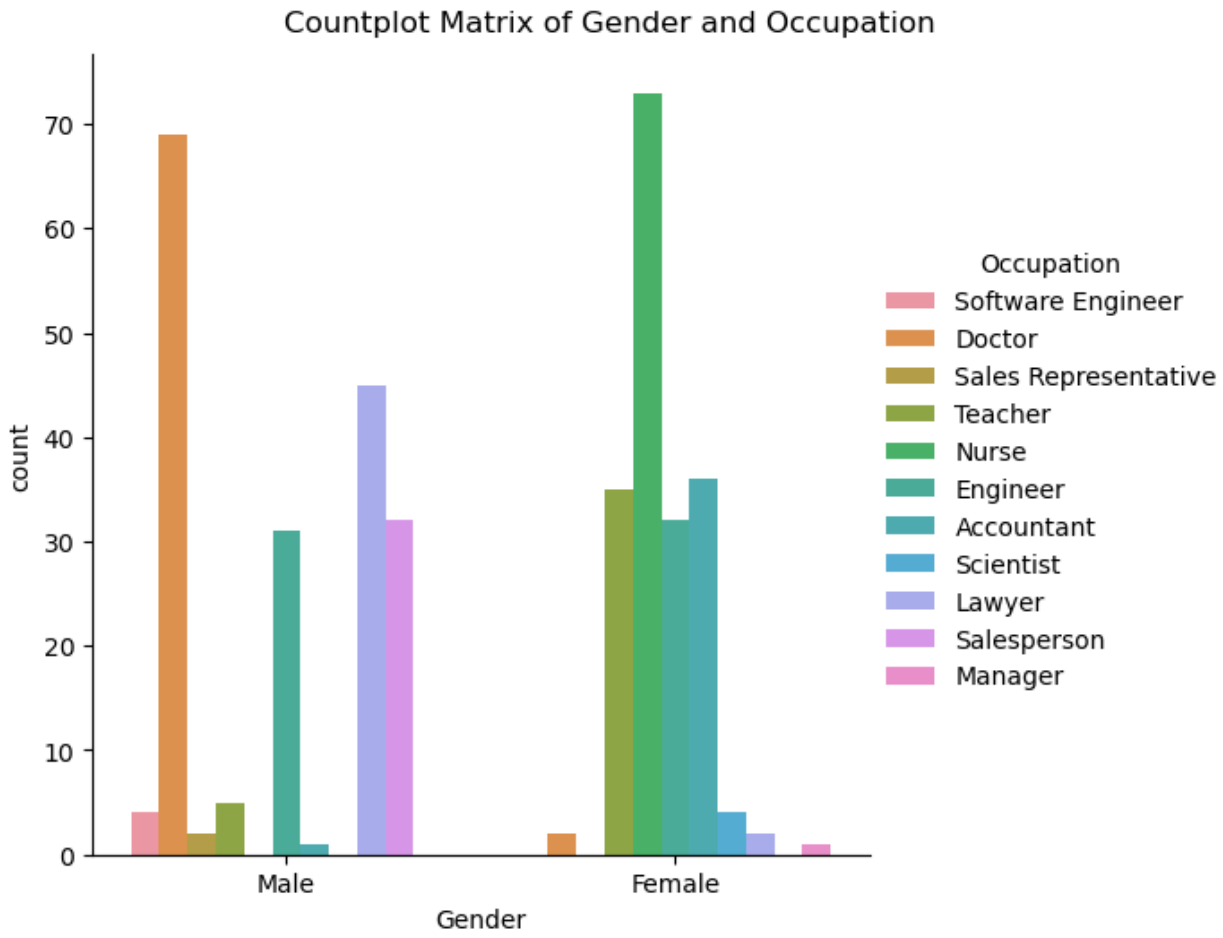

```
# Boxplot for Sleep Duration by Gender
plt.figure(figsize=(8, 6))
sns.boxplot(x='Gender', y='Sleep Duration', data=myData)
plt.title('Sleep Duration by Gender')
plt.xlabel('Gender')
plt.ylabel('Sleep Duration')
plt.show()
```




```
# Countplot for Sleep Disorder
plt.figure(figsize=(8, 6))
sns.countplot(x='Sleep Disorder Numeric',hue='Sleep Disorder Numeric',
data=myData)
plt.title('Sleep Disorder Distribution')
plt.xlabel('Sleep Disorder')
plt.ylabel('Count')
plt.show()

#Note:
# 0 = None
# 1 = Sleep Disorder
```

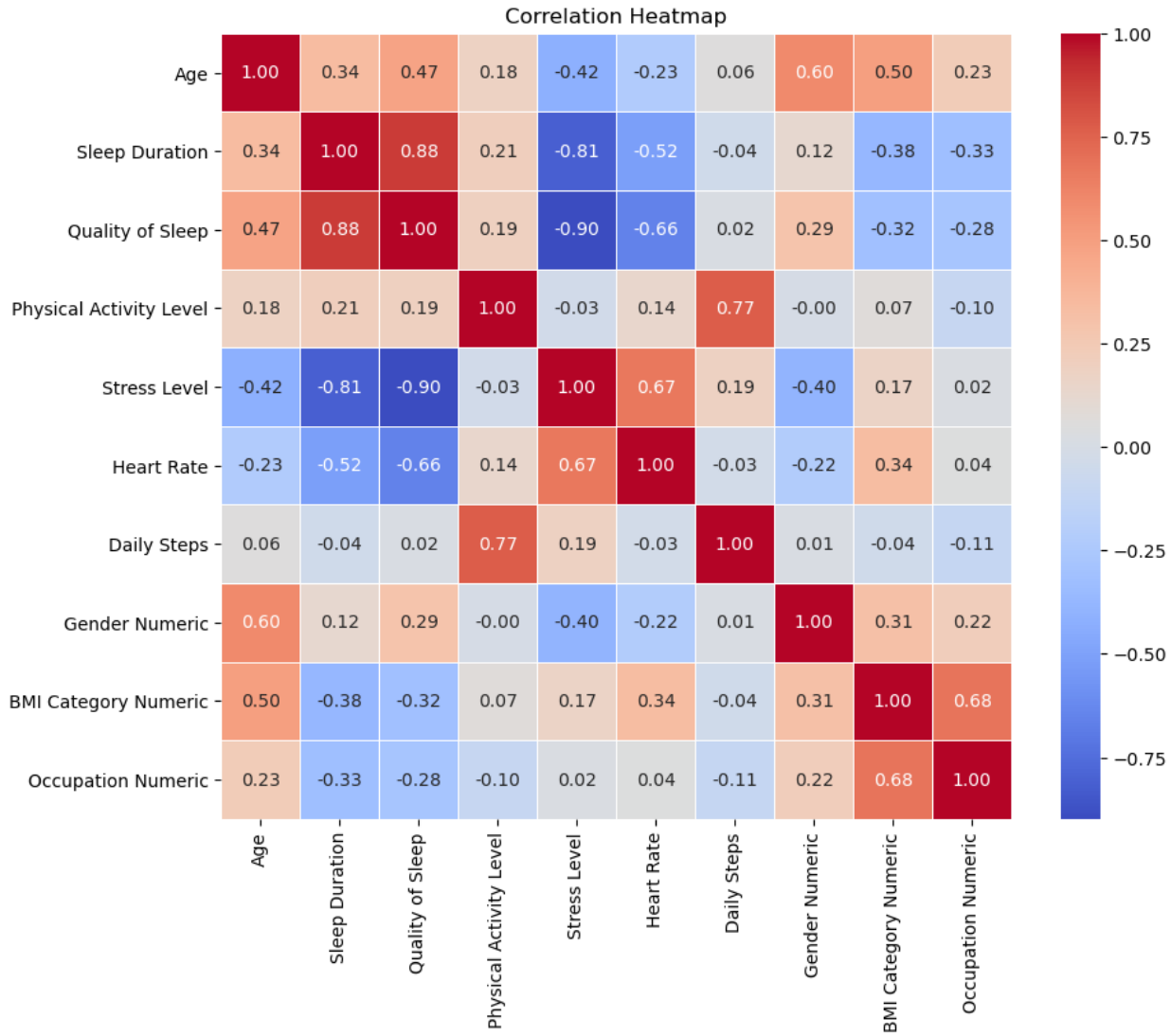



```
# Countplot Matrix of Gender and Occupation
sns.catplot(x='Gender', hue='Occupation', kind='count', data=myData)
plt.suptitle('Countplot Matrix of Gender and Occupation', y=1.02)
plt.show()
```



The result from countplot above, We can see the majority of females are in the nursing profession, while the majority of males are doctors.

```
# Drop Categories Columns
df = myData.drop(columns=['Person ID','Occupation','BMI
Category','Blood Pressure','Sleep Disorder','Gender','Sleep Disorder
Numeric'])

# Correlation Heatmap
plt.figure(figsize=(10, 8))
numeric_columns = df.select_dtypes(include=['number']).columns
correlation_matrix = df[numeric_columns].corr()
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm',
fmt='.2f', linewidths=0.5)
plt.title('Correlation Heatmap')
plt.show()
```



With The correlation matrix above, We can see that Sleep Disorder and BMI category show a strong correlation, as do sleep duration and sleep quality.

3. Modeling

3.1 MODEL IMPLEMENTATION

```
#***Prepare Data for Model Training***

columns_except_target = [col for col in myData.columns if col != 
'Sleep Disorder Numeric']
new_order = columns_except_target + ['Sleep Disorder Numeric']
newData = myData[new_order]
newData
```

```
     Person ID  Gender  Age            Occupation  Sleep Duration  \
0            1    Male   27     Software Engineer             6.1
1            2    Male   28                Doctor             6.2
2            3    Male   28                Doctor             6.2
3            4    Male   28  Sales Representative             5.9
4            5    Male   28  Sales Representative             5.9
..         ...     ...  ...                   ...             ...
369        370  Female   59                 Nurse             8.1
370        371  Female   59                 Nurse             8.0
371        372  Female   59                 Nurse             8.1
372        373  Female   59                 Nurse             8.1
373        374  Female   59                 Nurse             8.1

     Quality of Sleep  Physical Activity Level  Stress Level BMI
Category  \
0                   6                       42             6
Overweight
1                   6                       60             8
Normal
2                   6                       60             8
Normal
3                   4                       30             8
Obese
4                   4                       30             8
Obese
..                ...                      ...           ...
...
369                 9                       75             3
Overweight
370                 9                       75             3
Overweight
371                 9                       75             3
Overweight
372                 9                       75             3
Overweight
373                 9                       75             3
Overweight

    Blood Pressure  Heart Rate  Daily Steps Sleep Disorder  Gender
Numeric  \
0           126/83          77         4200           None
0
1           125/80          75        10000           None
0
2           125/80          75        10000           None
0
3           140/90          85         3000    Sleep Apnea
0
4           140/90          85         3000    Sleep Apnea
0
```

```
..              ...          ...           ...             ...
...
369          140/95           68          7000    Sleep Apnea
1
370          140/95           68          7000    Sleep Apnea
1
371          140/95           68          7000    Sleep Apnea
1
372          140/95           68          7000    Sleep Apnea
1
373          140/95           68          7000    Sleep Apnea
1

     BMI Category Numeric  Occupation Numeric  Sleep Disorder Numeric

0                       1                   9                       0

1                       0                   1                       0

2                       0                   1                       0

3                       1                   6                       1

4                       1                   6                       1

..                    ...                 ...                     ...

369                     1                   5                       1

370                     1                   5                       1

371                     1                   5                       1

372                     1                   5                       1

373                     1                   5                       1


[374 rows x 17 columns]
```

```
#***Drop Categories Column***

columnsToDrop = ['Person ID','Gender','Occupation','BMI
Category','Blood Pressure','Sleep Disorder']
dataAfterDropped = newData.drop(columns=columnsToDrop)
dataAfterDropped
```

```
     Age  Sleep Duration  Quality of Sleep  Physical Activity Level  \
0     27             6.1                 6                       42
1     28             6.2                 6                       60
2     28             6.2                 6                       60
```

```
3     28              5.9                   4                        30
4     28              5.9                   4                        30
..   ...              ...                 ...                       ...
369   59              8.1                   9                        75
370   59              8.0                   9                        75
371   59              8.1                   9                        75
372   59              8.1                   9                        75
373   59              8.1                   9                        75

     Stress Level  Heart Rate  Daily Steps  Gender Numeric  \
0               6          77         4200               0
1               8          75        10000               0
2               8          75        10000               0
3               8          85         3000               0
4               8          85         3000               0
..            ...         ...          ...             ...
369             3          68         7000               1
370             3          68         7000               1
371             3          68         7000               1
372             3          68         7000               1
373             3          68         7000               1

     BMI Category Numeric  Occupation Numeric  Sleep Disorder Numeric

0                       1                   9                       0

1                       0                   1                       0

2                       0                   1                       0

3                       1                   6                       1

4                       1                   6                       1

..                    ...                 ...                     ...

369                     1                   5                       1

370                     1                   5                       1

371                     1                   5                       1

372                     1                   5                       1

373                     1                   5                       1


[374 rows x 11 columns]
```

```
#***Split data into independent(input features) and dependent
variables (output)***
```

```
X = dataAfterDropped.iloc[:, 0:10].values
Y = dataAfterDropped.iloc[:, -1].values

#***Split the data again, this time into 80% training(X_train and
Y_train) and 20% testing (X_test and Y_test) data sets***

X_train, X_test, Y_train, Y_test = train_test_split(X, Y,
test_size=0.2, random_state=42)

#Feature Scaling

sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)
```

MODEL EVALUATION

```
#***Create a function within many Machine Learning Models***

def model_training01(X_train,Y_train):

    #Using Logistic Regression Algorithm to the Training Set
    log = LogisticRegression(random_state = 42)
    log.fit(X_train, Y_train)

    #Using SVC method of svm class to use Support Vector Machine
Algorithm
    svc_lin = SVC(kernel = 'linear', random_state = 42)
    svc_lin.fit(X_train, Y_train)

    #Using DecisionTreeClassifier of tree class to use Decision Tree
Algorithm
    tree = DecisionTreeClassifier(criterion = 'entropy', random_state
= 42)
    tree.fit(X_train, Y_train)

    #Using RandomForestClassifier method of ensemble class to use
Random Forest Classification algorithm
    forest = RandomForestClassifier(n_estimators = 10, criterion =
'entropy', random_state = 42)
    forest.fit(X_train, Y_train)

    #print model accuracy on the training data.
    print('[0]Logistic Regression Training Accuracy:',
log.score(X_train, Y_train))

    print('[1]Support Vector Machine (Linear Classifier) Training
Accuracy:', svc_lin.score(X_train, Y_train))
```

```
    print('[2]Decision Tree Classifier Training Accuracy:',
tree.score(X_train, Y_train))

    print('[3]Random Forest Classifier Training Accuracy:',
forest.score(X_train, Y_train))

    return log, svc_lin, tree, forest

#***Print Models***
model = model_training01(X_train,Y_train)
```

```
[0]Logistic Regression Training Accuracy: 0.903010033444816
[1]Support Vector Machine (Linear Classifier) Training Accuracy:
0.903010033444816
[2]Decision Tree Classifier Training Accuracy: 0.939799331103679
[3]Random Forest Classifier Training Accuracy: 0.939799331103679
```

There are two models with the same highest accuracy of 0.9397%.

```
#Show the confusion matrix and accuracy for all the models on the test
data.

for i in range(len(model)):
    cm = confusion_matrix(Y_test, model[i].predict(X_test))
   #extracting TN, FP, FN, TP
    TN, FP, FN, TP = confusion_matrix(Y_test,
model[i].predict(X_test)).ravel()
    print(cm)
    print('Model[{}] Testing Accuracy = "{} !"'.format(i,  (TP + TN) /
(TP + TN + FN + FP)))
    print()# Print a new line
```

```
[[40  3]
 [ 3 29]]
Model[0] Testing Accuracy = "0.92 !"

[[40  3]
 [ 3 29]]
Model[1] Testing Accuracy = "0.92 !"

[[42  1]
 [ 4 28]]
Model[2] Testing Accuracy = "0.9333333333333333 !"

[[42  1]
 [ 4 28]]
Model[3] Testing Accuracy = "0.9333333333333333 !"
```

The models at positions 2 and 3 demonstrated the highest accuracy on the test data among all models evaluated.

NOTE:

False Positive (FP)= A test result which incorrectly indicates that a particular condition or attribute is present.

True Positive (TP)= Sensitivity (also called the true positive rate, or probability of detection in some fields), measures the proportion of actual positives that are correctly identified as such.

True Negative (TN)= Specificity (also called the true negative rate), measures the proportion of actual negatives that are correctly identified as such.

False Negative (FN)= A test result that indicates that a condition does not hold, while in fact, it does.

MODEL SELECTED

The model that we will use to predict if an individual would've sleep disorder, will be the model at position 3 which is the Random Forest Classifier. We choose that model becuase it performed the best, achieving 93.97% accuracy on the training data and 93.33% on the testing data.

Print the Random Forest Classifier Model Predictions for each person and, below it, print the actual values. In our prediction model, '1' indicates the presence of a sleep disorder. '0' signifies that the person is normal.

New Data Testing on Selected Model

Now that we have analyzed the data, created our models and a chosen model for predicting sleep disorders, Let's test and see how well our predictions hold up!!!

We will create a varible of a person named "Emma".

1. Age = 21.
2. Sleep duration = 7.
3. Quality of sleep = 6
4. Physical activity level(minutes/day) = 30
5. Stress level = 7
6. Heart rate = 85
7. Daily steps = 3800
8. Gender = 1
9. BMI = 0
10. Occupation = 9 (software engineer)

```
my_sleep_condition = [[20,8,7,30,4,80,2400,0,0,9]]

#Print Prediction of Random Forest Classifier model
pred = model[2].predict(my_sleep_condition)
print(pred)

if pred == 0:
```

```
    print("Great news! There's no indication of a sleep disorder for
you.")
else:
  print("Yikes! It seems you may be dealing with a sleep disorder!!!")
```

```
[0]
Great news! There's no indication of a sleep disorder for you.
```

Modeling With Selected Input Features Based On Correlation Heatmap

```
#***Drop Columns***

columnsToDrop02 = ['Quality of Sleep','Heart Rate','Daily
Steps','Gender Numeric','Occupation Numeric']
dataAfterDropped02 = dataAfterDropped.drop(columns=columnsToDrop02)
dataAfterDropped02
```

```
     Age  Sleep Duration  Physical Activity Level  Stress Level  \
0     27             6.1                       42             6
1     28             6.2                       60             8
2     28             6.2                       60             8
3     28             5.9                       30             8
4     28             5.9                       30             8
..   ...             ...                      ...           ...
369   59             8.1                       75             3
370   59             8.0                       75             3
371   59             8.1                       75             3
372   59             8.1                       75             3
373   59             8.1                       75             3

     BMI Category Numeric  Sleep Disorder Numeric
0                       1                       0
1                       0                       0
2                       0                       0
3                       1                       1
4                       1                       1
..                    ...                     ...
369                     1                       1
370                     1                       1
371                     1                       1
372                     1                       1
373                     1                       1

[374 rows x 6 columns]
```

```
#***Split data into independent(input features) and dependent
variables (output)***

X01 = dataAfterDropped02.iloc[:, 0:5].values
Y02 = dataAfterDropped02.iloc[:, -1].values

#***Split the data again, this time into 80% training(X_train and
Y_train) and 20% testing (X_test and Y_test) data sets***

X_train02, X_test02, Y_train02, Y_test02 = train_test_split(X01, Y02,
test_size=0.2, random_state=42)

#***Create a function within many Machine Learning Models***

def model_training02(X_train02,Y_train02):

    #Using Logistic Regression Algorithm to the Training Set
    log = LogisticRegression(random_state = 42)
    log.fit(X_train02, Y_train02)

    #Using SVC method of svm class to use Support Vector Machine
Algorithm
    svc_lin = SVC(kernel = 'linear', random_state = 42)
    svc_lin.fit(X_train02, Y_train02)

    #Using DecisionTreeClassifier of tree class to use Decision Tree
Algorithm
    tree = DecisionTreeClassifier(criterion = 'entropy', random_state
= 42)
    tree.fit(X_train02, Y_train02)

    #Using RandomForestClassifier method of ensemble class to use
Random Forest Classification algorithm
    forest = RandomForestClassifier(n_estimators = 10, criterion =
'entropy', random_state = 42)
    forest.fit(X_train02, Y_train02)

    #print model accuracy on the training data.
    print('[0]Logistic Regression Training Accuracy:',
log.score(X_train02, Y_train02))

    print('[1]Support Vector Machine (Linear Classifier) Training
Accuracy:', svc_lin.score(X_train02, Y_train02))

    print('[2]Decision Tree Classifier Training Accuracy:',
tree.score(X_train02, Y_train02))

    print('[3]Random Forest Classifier Training Accuracy:',
forest.score(X_train02, Y_train02))
```

```
    return log, svc_lin, tree, forest

#***Print Models***
model02 = model_training02(X_train02,Y_train02)
```

```
[0]Logistic Regression Training Accuracy: 0.903010033444816
[1]Support Vector Machine (Linear Classifier) Training Accuracy:
0.903010033444816
[2]Decision Tree Classifier Training Accuracy: 0.939799331103679
[3]Random Forest Classifier Training Accuracy: 0.939799331103679
```

```
#Show the confusion matrix and accuracy for all the models on the test
data.

for i in range(len(model02)):
    cm = confusion_matrix(Y_test02, model02[i].predict(X_test02))
   #extracting TN, FP, FN, TP
    TN, FP, FN, TP = confusion_matrix(Y_test02,
model02[i].predict(X_test02)).ravel()
    print(cm)
    print('Model[{}] Testing Accuracy = "{} !"'.format(i,  (TP + TN) /
(TP + TN + FN + FP)))
    print()# Print a new line
```

```
[[40  3]
 [ 4 28]]
Model[0] Testing Accuracy = "0.9066666666666666 !"

[[40  3]
 [ 3 29]]
Model[1] Testing Accuracy = "0.92 !"

[[42  1]
 [ 4 28]]
Model[2] Testing Accuracy = "0.9333333333333333 !"

[[42  1]
 [ 4 28]]
Model[3] Testing Accuracy = "0.9333333333333333 !"
```

We will create a new variable with the below selected input features:

1. Age = 21.
2. Sleep duration = 7.
3. Physical Activity Level = 30
4. Stress Level = 7
5. BMI = 0

```
my_sleep_condition02 = [[21,7,30,7,0]]

#Print Prediction of Random Forest Classifier model
pred02 = model02[2].predict(my_sleep_condition02)
print(pred02)

if pred02 == 0:
    print("Great news! There's no indication of a sleep disorder for
you.")
else:
  print("Yikes! It seems you may be dealing with a sleep disorder!!!")
```

```
[0]
Great news! There's no indication of a sleep disorder for you.
```

Conclusion

That is it, We are done creating the program to predict if an individual would have sleep disorder or not!