STATS 3DA3

Homework Assignment 6

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Question

1)

Our target variable measure the severity of heart disease which can be defined as binary classification problem. Our goal would then to be able to predict the probability of heart disease. This means we can carry out a logistic regression and a random forest classifier to predict the presence and absence of heart disease.

2)

```
from ucimlrepo import fetch_ucirepo

heart_disease = fetch_ucirepo(id=45)

X = heart_disease.data.features
y = heart_disease.data.targets

print(f"It is {str(X['ca'].isnull().sum() > 0).lower()} that there are missing values for 'ca'

print(f"Length of X before transformations: {len(X)}")
```

```
It is true that there are missing values for 'ca' and
true that there are missing values for 'thal' in the dataset.
Length of X before transformations: 303
```

3)

We have 13 features and 1 target variable. Starting with our features, we have age (age in years), sex (1 = male; 0 = female), cp (1: typical angina, 2: atypical angina, 3: non-anginal pain, 4: asymptomatic), trestbps (resting blood pressure in mm Hg on admission to the hospital), chol (serum cholestoral in mg/dl), fbs (fasting blood sugar > 120 mg/dl where 1 = true; 0 = false), restecg (resting electrocardiographic results), exang (exercise induced angina), oldpeak (ST depression induced by exercise relative to rest), slope (1 = upsloping, 2 = flat, 3 = downsloping), ca (number of major vessels colored by floursopy), thal (3 = normal; 6 = fixed defect; 7 = reversable defect). Finally our target variable, 'num', is the diagnosis of heart disease.

```python
print(f"Observations in X: {len(X)}")
print(f"Summary of X:\n{X.describe()}")
print(f"Summary of y:\n{y.describe()}")
```

```
Observations in X: 303
Summary of X:
              age         sex          cp    trestbps        chol         fbs  \
count  303.000000  303.000000  303.000000  303.000000  303.000000  303.000000
mean    54.438944    0.679868    3.158416  131.689769  246.693069    0.148515
std      9.038662    0.467299    0.960126   17.599748   51.776918    0.356198
min     29.000000    0.000000    1.000000   94.000000  126.000000    0.000000
25%     48.000000    0.000000    3.000000  120.000000  211.000000    0.000000
50%     56.000000    1.000000    3.000000  130.000000  241.000000    0.000000
75%     61.000000    1.000000    4.000000  140.000000  275.000000    0.000000
max     77.000000    1.000000    4.000000  200.000000  564.000000    1.000000

          restecg     thalach       exang     oldpeak       slope          ca  \
count  303.000000  303.000000  303.000000  303.000000  303.000000  299.000000
mean     0.990099  149.607261    0.326733    1.039604    1.600660    0.672241
std      0.994971   22.875003    0.469794    1.161075    0.616226    0.937438
min      0.000000   71.000000    0.000000    0.000000    1.000000    0.000000
25%      0.000000  133.500000    0.000000    0.000000    1.000000    0.000000
50%      1.000000  153.000000    0.000000    0.800000    2.000000    0.000000
75%      2.000000  166.000000    1.000000    1.600000    2.000000    1.000000
max      2.000000  202.000000    1.000000    6.200000    3.000000    3.000000
```

```
             thal
count  301.000000
mean     4.734219
std      1.939706
min      3.000000
25%      3.000000
50%      3.000000
75%      7.000000
max      7.000000
Summary of y:
              num
count  303.000000
mean     0.937294
std      1.228536
min      0.000000
25%      0.000000
50%      0.000000
75%      2.000000
max      4.000000
```

We find that the average age of patients is 54.4 years old, with a standard deviation of 9.1 years.

```
print(f"Data Types of X: \n{X.dtypes}")
print(f"\nData Types of y: \n{y.dtypes}")
```

```
Data Types of X:
age          int64
sex          int64
cp           int64
trestbps     int64
chol         int64
fbs          int64
```

```
restecg       int64
thalach       int64
exang         int64
oldpeak     float64
slope         int64
ca          float64
thal        float64
dtype: object

Data Types of y:
num    int64
dtype: object
```

All of our data types in X are numerical but some representing categorical variables.

4)

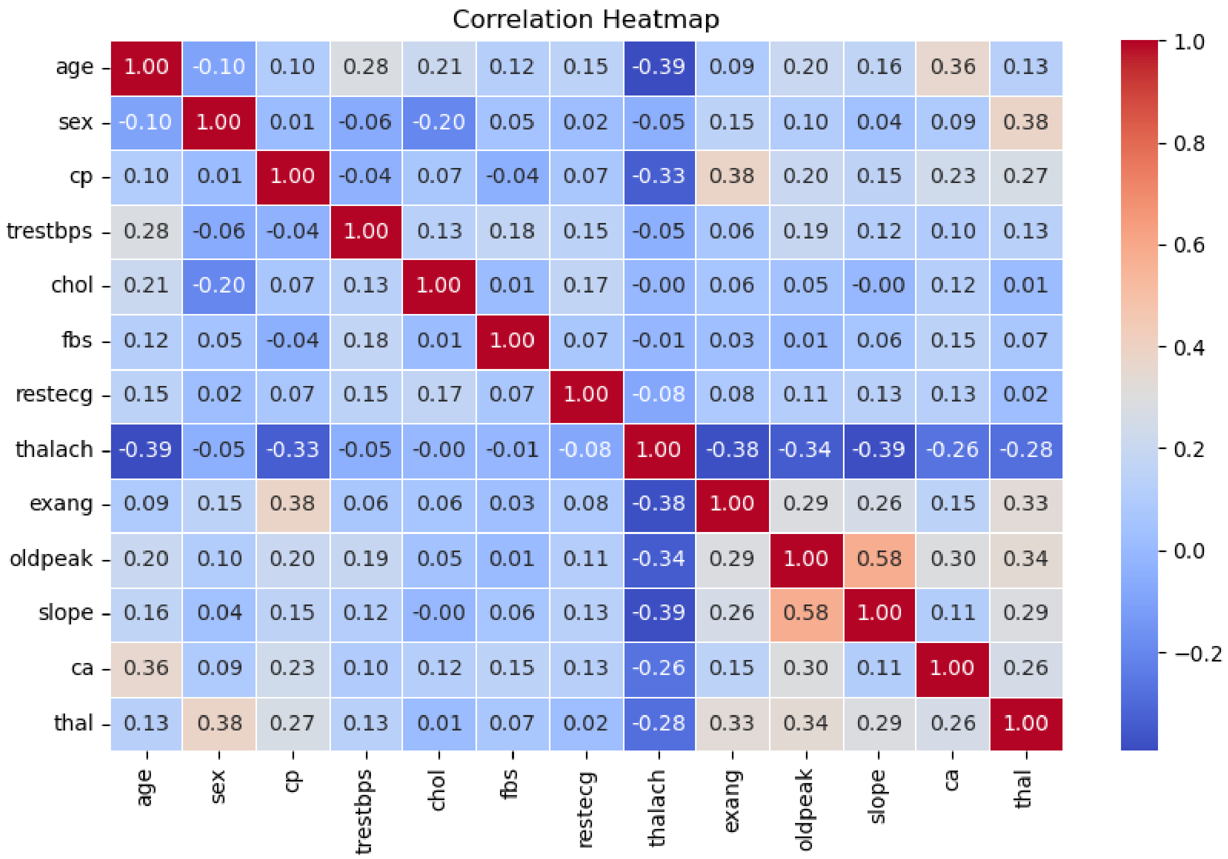
```python
print(f"y before transformation: {y['num'].value_counts()}")
y['num'] = y['num'].apply(lambda x: 1 if x > 0 else 0)
print(f"y before transformation: {y['num'].value_counts()}")
```

```
y before transformation: num
0    164
1     55
2     36
3     35
4     13
Name: count, dtype: int64
y before transformation: num
0    164
1    139
Name: count, dtype: int64
```

```
C:\Users\JC\AppData\Local\Temp\ipykernel_25828\2854447611.py:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/
  y['num'] = y['num'].apply(lambda x: 1 if x > 0 else 0)
```

5)

```python
import seaborn as sns
import matplotlib.pyplot as plt

corr_matrix = X.corr()

plt.figure(figsize=(10, 6))
sns.heatmap(corr_matrix, annot=True, cmap='coolwarm', fmt=".2f", linewidths=0.5)
plt.title("Correlation Heatmap")
plt.show()
```



From this correlation matrix, we can conclude that thalach (max heart rate) has a strong negative correlation (-0.39) with age and oldpeak. We can assume that younger individuals tend to have a higher heart rate, while those with more severe heart disease (higher oldpeak) have lower thalach. We also found that ca (number of major vessels) has a strong positive correlation (0.36) with age. We can say that older individuals are more likely to have more blocked vessels.

6)

```
X.dropna(subset=['ca', 'thal'], inplace=True)

print(f"Length of X after transformations: {len(X)}")
```

```
Length of X after transformations: 297
```

```
C:\Users\JC\AppData\Local\Temp\ipykernel_25828\2589721772.py:1: SettingWithCopyWarning:
```

```
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/
  X.dropna(subset=['ca', 'thal'], inplace=True)
```

7)