Tugas Besar 2 IF3170 - Intelegensi Buatan

Kelompok Butuh Passingan

Nama Anggota :

1. Andreas Halim - 13516003
2. Dafi Faraz - 13516057
3. Aldo Azali - 13516125
4. Untung Tanujaya - 13516135
5. Jeffry - 13516156

In [1]:

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
```

In [2]:

```
df = pd.read_csv('tubes2_HeartDisease_train.csv', na_values='?')
dg = pd.read_csv('tubes2_HeartDisease_test.csv', na_values='?')
df.shape
```

Out[2]:

```
(779, 14)
```

In [3]:

```
df.head()
```

Out[3]:

	Column1	Column2	Column3	Column4	Column5	Column6	Column7	Column8	Colu
0	54	1	4	125.0	216.0	0.0	0.0	140.0	0.0
1	55	1	4	158.0	217.0	0.0	0.0	110.0	1.0
2	54	0	3	135.0	304.0	1.0	0.0	170.0	0.0
3	48	0	3	120.0	195.0	0.0	0.0	125.0	0.0
4	50	1	4	120.0	0.0	0.0	1.0	156.0	1.0

In [4]:

```
df.columns = ['Age', 'Sex', 'Chest-Pain_Type', 'Resting_Blood_Pressure', 'Seru
m_Cholestrol', 'Fasting_Blood_Sugar_120',
       'resting_ECG', 'Max-Heart_Rate_Achieved', 'Exercise_Induced_Angina', 'S
T_Depression', 'Peak_Exercise', 'Number_Major_Vessels',
       'Thal', 'Diagnosis_HD']
dg.columns = ['Age', 'Sex', 'Chest-Pain_Type', 'Resting_Blood_Pressure', 'Seru
m_Cholestrol', 'Fasting_Blood_Sugar_120',
       'resting_ECG', 'Max-Heart_Rate_Achieved', 'Exercise_Induced_Angina', 'S
T_Depression', 'Peak_Exercise', 'Number_Major_Vessels',
       'Thal']
```

In [5]:

```
df.head()
```

Out[5]:

	Age	Sex	Chest-Pain_Type	Resting_Blood_Pressure	Serum_Cholestrol	Fasting_Blood_Sug
0	54	1	4	125.0	216.0	0.0
1	55	1	4	158.0	217.0	0.0
2	54	0	3	135.0	304.0	1.0
3	48	0	3	120.0	195.0	0.0
4	50	1	4	120.0	0.0	0.0

Data Preprocessing

Add some description to data

In [6]:

```
df['Sex'] = df['Sex'].replace(1, 'Male')
df['Sex'] = df['Sex'].replace(0, 'Female')
df['Chest-Pain_Type'] = df['Chest-Pain_Type'].replace(1, 'Typical_Angina')
df['Chest-Pain_Type'] = df['Chest-Pain_Type'].replace(2, 'Atypical_Angina')
df['Chest-Pain_Type'] = df['Chest-Pain_Type'].replace(3, 'Non-Anginal_Pain')
df['Chest-Pain_Type'] = df['Chest-Pain_Type'].replace(4, 'Asymptotic')
df['Fasting_Blood_Sugar_120'] = df['Fasting_Blood_Sugar_120'].replace(1, True)
df['Fasting_Blood_Sugar_120'] = df['Fasting_Blood_Sugar_120'].replace(0, False
)
df['resting_ECG'] = df['resting_ECG'].replace(0, 'normal')
df['resting_ECG'] = df['resting_ECG'].replace(1, 'having_ST-T_wave_abnormalit
y')
df['resting_ECG'] = df['resting_ECG'].replace(2, 'left_ventricular_hyperthroph
y')
df['Exercise_Induced_Angina'] = df['Exercise_Induced_Angina'].replace(1, 'YES'
)
df['Exercise_Induced_Angina'] = df['Exercise_Induced_Angina'].replace(0, 'NO')
df['Peak_Exercise'] = df['Peak_Exercise'].replace(1, 'upsloping')
df['Peak_Exercise'] = df['Peak_Exercise'].replace(2, 'flat')
df['Peak_Exercise'] = df['Peak_Exercise'].replace(3, 'downsloping')
df['Thal'] = df['Thal'].replace(3, 'normal')
df['Thal'] = df['Thal'].replace(6, 'fixed_defect')
df['Thal'] = df['Thal'].replace(7, 'reversable_defect')
df.head()
```

Out[6]:

	Age	Sex	Chest-Pain_Type	Resting_Blood_Pressure	Serum_Cholestrol	Fasting_Blooc
0	54	Male	Asymptotic	125.0	216.0	False
1	55	Male	Asymptotic	158.0	217.0	False
2	54	Female	Non-Anginal_Pain	135.0	304.0	True
3	48	Female	Non-Anginal_Pain	120.0	195.0	False
4	50	Male	Asymptotic	120.0	0.0	False

In [7]:

```
dg['Sex'] = df['Sex'].replace(1, 'Male')
dg['Sex'] = df['Sex'].replace(0, 'Female')
dg['Chest-Pain_Type'] = df['Chest-Pain_Type'].replace(1, 'Typical_Angina')
dg['Chest-Pain_Type'] = df['Chest-Pain_Type'].replace(2, 'Atypical_Angina')
dg['Chest-Pain_Type'] = df['Chest-Pain_Type'].replace(3, 'Non-Anginal_Pain')
dg['Chest-Pain_Type'] = df['Chest-Pain_Type'].replace(4, 'Asymptotic')
dg['Fasting_Blood_Sugar_120'] = df['Fasting_Blood_Sugar_120'].replace(1, True)
dg['Fasting_Blood_Sugar_120'] = df['Fasting_Blood_Sugar_120'].replace(0, False
)
dg['resting_ECG'] = df['resting_ECG'].replace(0, 'normal')
dg['resting_ECG'] = df['resting_ECG'].replace(1, 'having_ST-T_wave_abnormalit
y')
dg['resting_ECG'] = df['resting_ECG'].replace(2, 'left_ventricular_hyperthroph
y')
dg['Exercise_Induced_Angina'] = df['Exercise_Induced_Angina'].replace(1, 'YES'
)
dg['Exercise_Induced_Angina'] = df['Exercise_Induced_Angina'].replace(0, 'NO')
dg['Peak_Exercise'] = df['Peak_Exercise'].replace(1, 'upsloping')
dg['Peak_Exercise'] = df['Peak_Exercise'].replace(2, 'flat')
dg['Peak_Exercise'] = df['Peak_Exercise'].replace(3, 'downsloping')
dg['Thal'] = df['Thal'].replace(3, 'normal')
dg['Thal'] = df['Thal'].replace(6, 'fixed_defect')
dg['Thal'] = df['Thal'].replace(7, 'reversable_defect')
dg.head()
```

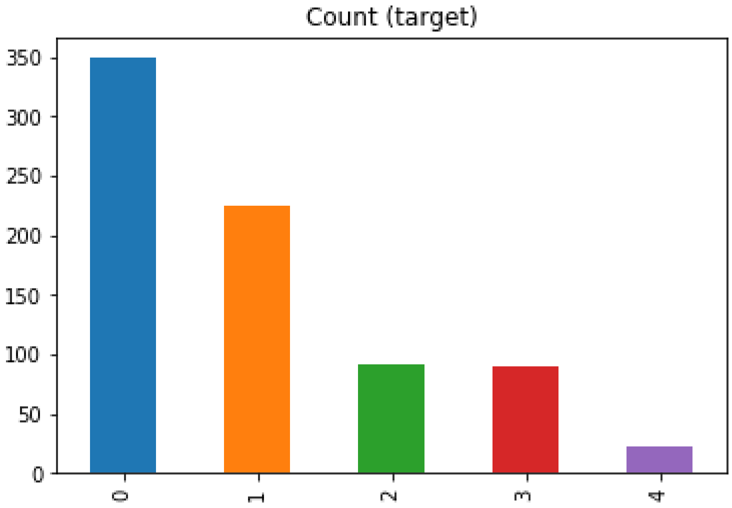
Out[7]:

	Age	Sex	Chest-Pain_Type	Resting_Blood_Pressure	Serum_Cholestrol	Fasting_Bloo
0	60	Male	Asymptotic	160.0	267.0	False
1	61	Male	Asymptotic	148.0	203.0	False
2	54	Female	Non-Anginal_Pain	130.0	242.0	True
3	48	Female	Non-Anginal_Pain	120.0	260.0	False
4	57	Male	Asymptotic	130.0	308.0	False

Data Analysis with graphic

In [8]:
```
target_count = df.Diagnosis_HD.value_counts()
print('Class 0:', target_count[0])
print('Class 1:', target_count[1])
print('Class 2:', target_count[2])
print('Class 3:', target_count[3])
print('Class 4:', target_count[4])
print('Proportion:', round(target_count[0] / target_count[1], 2), ': 1')
target_count.plot(kind='bar', title='Count (target)');
```

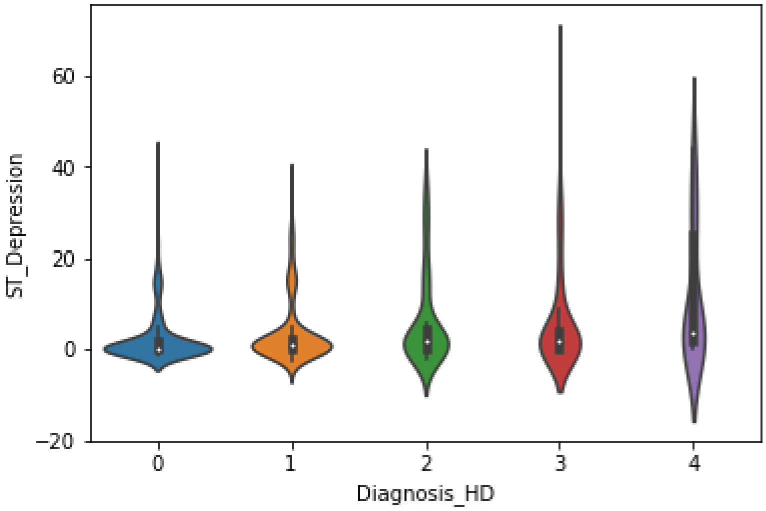
```
Class 0: 349
Class 1: 225
Class 2: 92
Class 3: 90
Class 4: 23
Proportion: 1.55 : 1
```



```
In [9]: # "Age", Resting_Blood_Pressure , Serum_Cholestrol , "Max-Heart_Rate_Achieved"
         , ST_Depression
        sns.violinplot(x=df['Diagnosis_HD'], y=df['ST_Depression'])
```

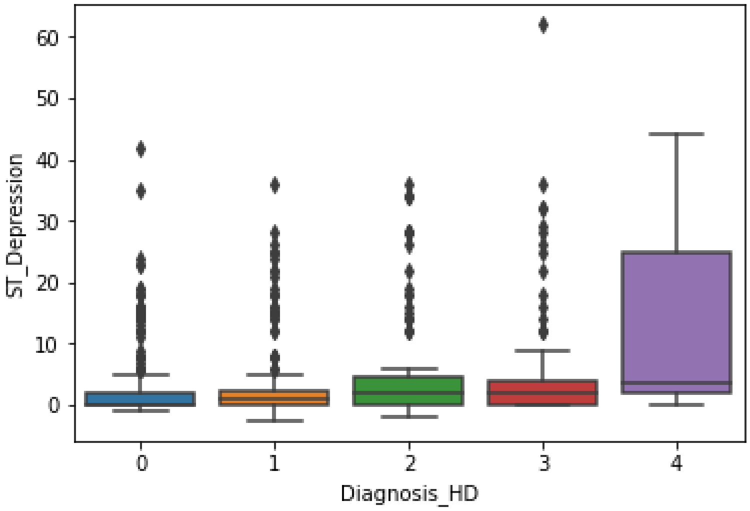
```
c:\users\aldo azali\appdata\local\programs\python\python36-32\lib\site-packag
es\scipy\stats\stats.py:1713: FutureWarning: Using a non-tuple sequence for m
ultidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr
[seq]`. In the future this will be interpreted as an array index, `arr[np.arr
ay(seq)]`, which will result either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

```
Out[9]: <matplotlib.axes._subplots.AxesSubplot at 0x10ff5770>
```

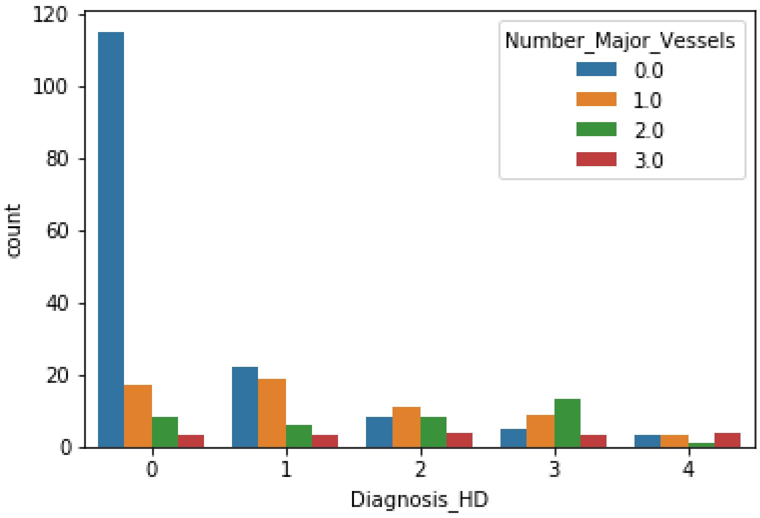


```
In [10]: # "Age", Resting_Blood_Pressure , Serum_Cholestrol , "Max-Heart_Rate_Achieved"
          , ST_Depression
         sns.boxplot(x=df['Diagnosis_HD'], y=df['ST_Depression'])
```

```
Out[10]: <matplotlib.axes._subplots.AxesSubplot at 0x1315f7d0>
```



```
In [11]: # "Chest-Pain_Type" , -resting_ECG- ,"Peak_Exercise" , "Thal"  , "Number_Major
         _Vessels", Fasting_Blood_Sugar_120, "Exercise_Induced_Angina"
         sns.countplot(x=df['Diagnosis_HD'], hue=df['Number_Major_Vessels'])

Out[11]: <matplotlib.axes._subplots.AxesSubplot at 0x131da490>
```



Check Null Values

If there is null values, then change it to :

1. Median
2. dummy value (ex : 'Empty' OR '?')
3. mode

```
In [12]: df.isnull().sum()

Out[12]: Age                          0
         Sex                          0
         Chest-Pain_Type              0
         Resting_Blood_Pressure      47
         Serum_Cholestrol            24
         Fasting_Blood_Sugar_120     78
         resting_ECG                  2
         Max-Heart_Rate_Achieved     44
         Exercise_Induced_Angina     44
         ST_Depression               49
         Peak_Exercise              262
         Number_Major_Vessels       514
         Thal                       408
         Diagnosis_HD                 0
         dtype: int64
```

In [13]:

```
# RBP, SC, MHRA, STD,  = median
# FBS, ecg, EIA, pe, NMV, thal = mode
# fbs, ECG , eia, PE,nmv, THAL = 'Empty'
rbp_med = df['Resting_Blood_Pressure'].median()
sc_med = df['Serum_Cholestrol'].median()
mhra_med = df['Max-Heart_Rate_Achieved'].median()
std_med = df['ST_Depression'].median()
```

In [14]:

```
# Fill with median
df['Resting_Blood_Pressure'] = df['Resting_Blood_Pressure'].fillna(rbp_med)
df['Serum_Cholestrol'] = df['Serum_Cholestrol'].fillna(sc_med)
df['Max-Heart_Rate_Achieved'] = df['Max-Heart_Rate_Achieved'].fillna(mhra_med)
df['ST_Depression'] = df['ST_Depression'].fillna(std_med)
# Others Fill with '?'
df = df.fillna('?')
```

In [15]:

```
rbp_medg = dg['Resting_Blood_Pressure'].median()
sc_medg = dg['Serum_Cholestrol'].median()
mhra_medg = dg['Max-Heart_Rate_Achieved'].median()
std_medg = dg['ST_Depression'].median()
```

In [16]:

```
# Fill with median
dg['Resting_Blood_Pressure'] = dg['Resting_Blood_Pressure'].fillna(rbp_medg)
dg['Serum_Cholestrol'] = dg['Serum_Cholestrol'].fillna(sc_medg)
dg['Max-Heart_Rate_Achieved'] = dg['Max-Heart_Rate_Achieved'].fillna(mhra_medg
)
dg['ST_Depression'] = dg['ST_Depression'].fillna(std_medg)
# Others Fill with '?'
dg = dg.fillna('?')
```

In [17]:

```
dg.isnull().sum()
```

Out[17]:

```
Age                        0
Sex                        0
Chest-Pain_Type            0
Resting_Blood_Pressure     0
Serum_Cholestrol           0
Fasting_Blood_Sugar_120    0
resting_ECG                0
Max-Heart_Rate_Achieved    0
Exercise_Induced_Angina    0
ST_Depression              0
Peak_Exercise              0
Number_Major_Vessels       0
Thal                       0
dtype: int64
```

In [18]:

```
dg.head()
```

Out[18]:

	Age	Sex	Chest-Pain_Type	Resting_Blood_Pressure	Serum_Cholestrol	Fasting_Blooc
0	60	Male	Asymptotic	160.0	267.0	False
1	61	Male	Asymptotic	148.0	203.0	False
2	54	Female	Non-Anginal_Pain	130.0	242.0	True
3	48	Female	Non-Anginal_Pain	120.0	260.0	False
4	57	Male	Asymptotic	130.0	308.0	False

Data Train

In [19]:

```
from scipy.stats import ttest_ind
```

In [20]:

```
y_train = df['Diagnosis_HD']  # yang ingin diprediksi
X_train = df.drop(['Diagnosis_HD'], axis = 1)
```

Create Data Split Train and Data Split Test(80:20)

In [21]:

```
from sklearn.model_selection import train_test_split
X_train_split, X_test_split, y_train_split, y_test_split = train_test_split(X_
train, y_train, test_size = 0.2)
X_train_split.head()
```

Out[21]:

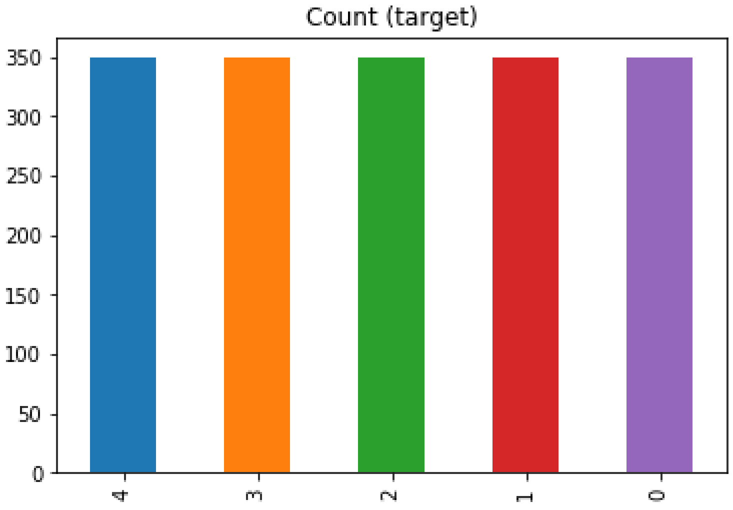
	Age	Sex	Chest-Pain_Type	Resting_Blood_Pressure	Serum_Cholestrol	Fasting_Bl
500	63	Male	Typical_Angina	145.0	233.0	True
525	52	Male	Asymptotic	170.0	225.0	False
566	46	Male	Asymptotic	110.0	240.0	False
367	51	Male	Asymptotic	130.0	0.0	True
608	36	Male	Atypical_Angina	120.0	267.0	False

Make Oversampling for data train

In [22]:
```
# Class count
count_class_0, count_class_1,count_class_2, count_class_3, count_class_4 = df.
Diagnosis_HD.value_counts()

# Divide by class
df_class_0 = df[df['Diagnosis_HD'] == 0]
df_class_1 = df[df['Diagnosis_HD'] == 1]
df_class_2 = df[df['Diagnosis_HD'] == 2]
df_class_3 = df[df['Diagnosis_HD'] == 3]
df_class_4 = df[df['Diagnosis_HD'] == 4]
```

In [23]:
```
df_class_1_over = df_class_1.sample(count_class_0, replace=True)
df_class_2_over = df_class_2.sample(count_class_0, replace=True)
df_class_3_over = df_class_3.sample(count_class_0, replace=True)
df_class_4_over = df_class_4.sample(count_class_0, replace=True)
df_over = pd.concat([df_class_0, df_class_1_over, df_class_2_over, df_class_3_
over, df_class_4_over], axis=0)

print('Random over-sampling:')
print(df_over.Diagnosis_HD.value_counts())

df_over.Diagnosis_HD.value_counts().plot(kind='bar', title='Count (target)');
```

```
Random over-sampling:
4    349
3    349
2    349
1    349
0    349
Name: Diagnosis_HD, dtype: int64
```



In [24]:
```
X_train_split = df_over.drop(['Diagnosis_HD'], axis = 1)
y_train_split = df_over['Diagnosis_HD']
```

```
In [25]: X_train = df_over.drop(['Diagnosis_HD'], axis = 1)
         y_train = df_over['Diagnosis_HD']
```

Data Processing

Feature Engineering

```
In [26]: conditions = [
             (X_train_split['Age'] < 30),
             (X_train_split['Age'] >= 30) & (X_train_split['Age'] < 40),
             (X_train_split['Age'] >= 40) & (X_train_split['Age'] < 50),
             (X_train_split['Age'] >= 50) & (X_train_split['Age'] < 60),
             (X_train_split['Age'] >= 60) & (X_train_split['Age'] < 70),
             (X_train_split['Age'] >= 70) ]
         choices = ['< 30', '30 - 39', '40 - 49', '50 - 59', '60 - 69', '> 70']
         X_train_split['Age_range'] = np.select(conditions, choices, default='50 - 59')
         X_train_split.head()
```

Out[26]:

	Age	Sex	Chest-Pain_Type	Resting_Blood_Pressure	Serum_Cholestrol	Fasting_Bl
2	54	Female	Non-Anginal_Pain	135.0	304.0	True
3	48	Female	Non-Anginal_Pain	120.0	195.0	False
5	64	Female	Asymptotic	130.0	303.0	False
7	58	Male	Atypical_Angina	130.0	251.0	False
8	42	Male	Atypical_Angina	150.0	268.0	False

In [27]:

```
condition = [
    (X_test_split['Age'] < 30),
    (X_test_split['Age'] >= 30) & (X_test_split['Age'] < 40),
    (X_test_split['Age'] >= 40) & (X_test_split['Age'] < 50),
    (X_test_split['Age'] >= 50) & (X_test_split['Age'] < 60),
    (X_test_split['Age'] >= 60) & (X_test_split['Age'] < 70),
    (X_test_split['Age'] >= 70)]
choice = ['< 30', '30 - 39', '40 - 49', '50 - 59', '60 - 69', '> 70']
X_test_split['Age_range'] = np.select(condition, choice, default='50 - 59')
X_test_split.head()
```

Out[27]:

	Age	Sex	Chest-Pain_Type	Resting_Blood_Pressure	Serum_Cholestrol	Fasting_
344	59	Male	Non-Anginal_Pain	180.0	213.0	False
288	48	Male	Atypical_Angina	110.0	229.0	False
384	63	Female	Asymptotic	124.0	197.0	False
708	41	Female	Non-Anginal_Pain	112.0	268.0	False
606	52	Male	Asymptotic	140.0	404.0	False

In [28]:

```
conditions = [
    (X_train['Age'] < 30),
    (X_train['Age'] >= 30) & (X_train['Age'] < 40),
    (X_train['Age'] >= 40) & (X_train['Age'] < 50),
    (X_train['Age'] >= 50) & (X_train['Age'] < 60),
    (X_train['Age'] >= 60) & (X_train['Age'] < 70),
    (X_train['Age'] >= 70)]
choices = ['< 30', '30 - 39', '40 - 49', '50 - 59', '60 - 69', '> 70']
X_train['Age_range'] = np.select(conditions, choices, default='50 - 59')
X_train.head()
```

Out[28]:

	Age	Sex	Chest-Pain_Type	Resting_Blood_Pressure	Serum_Cholestrol	Fasting_Bl
2	54	Female	Non-Anginal_Pain	135.0	304.0	True
3	48	Female	Non-Anginal_Pain	120.0	195.0	False
5	64	Female	Asymptotic	130.0	303.0	False
7	58	Male	Atypical_Angina	130.0	251.0	False
8	42	Male	Atypical_Angina	150.0	268.0	False

In [29]:

```
conditions = [
    (dg['Age'] < 30),
    (dg['Age'] >= 30) & (dg['Age'] < 40),
    (dg['Age'] >= 40) & (dg['Age'] < 50),
    (dg['Age'] >= 50) & (dg['Age'] < 60),
    (dg['Age'] >= 60) & (dg['Age'] < 70),
    (dg['Age'] >= 70)]
choices = ['< 30', '30 - 39', '40 - 49', '50 - 59', '60 - 69', '> 70']
dg['Age_range'] = np.select(conditions, choices, default='50 - 59')
dg.head()
```

Out[29]:

	Age	Sex	Chest-Pain_Type	Resting_Blood_Pressure	Serum_Cholestrol	Fasting_Blooc
0	60	Male	Asymptotic	160.0	267.0	False
1	61	Male	Asymptotic	148.0	203.0	False
2	54	Female	Non-Anginal_Pain	130.0	242.0	True
3	48	Female	Non-Anginal_Pain	120.0	260.0	False
4	57	Male	Asymptotic	130.0	308.0	False

Make Dummies

In [30]:

```
X_train_split = pd.get_dummies(X_train_split)
X_test_split = pd.get_dummies(X_test_split)
```

In [31]:

```
X_train = pd.get_dummies(X_train_split)
dg = pd.get_dummies(dg)
```

In [32]:

```
X_train_split.head()
```

Out[32]:

	Age	Resting_Blood_Pressure	Serum_Cholestrol	Max-Heart_Rate_Achieved	ST_Depressi
2	54	135.0	304.0	170.0	0.0
3	48	120.0	195.0	125.0	0.0
5	64	130.0	303.0	122.0	2.0
7	58	130.0	251.0	110.0	0.0
8	42	150.0	268.0	136.0	0.0

5 rows × 40 columns

In [33]:

```
null_in_test = list(set(X_train_split.columns) - set(X_test_split.columns))
null_in_train = list(set(X_test_split.columns) - set(X_train_split.columns))
print(null_in_test)
print(null_in_train)
```

```
['resting_ECG_?']
[]
```

In [34]:

```
for col in null_in_test:
    X_test_split[col] = 0

for col in null_in_train :
    X_train_split[col] = 0
```

In [35]:

```
null_in_dg = list(set(X_train.columns) - set(dg.columns))
null_in_df = list(set(dg.columns) - set(X_train.columns))
print(null_in_dg)
print(null_in_df)
```

```
['resting_ECG_?']
[]
```

In [36]:

```
for col in null_in_dg:
    dg[col] = 0

for col in null_in_df :
    X_train[col] = 0
```

Modeling with ML

In [37]:

```
from sklearn.metrics import accuracy_score
```

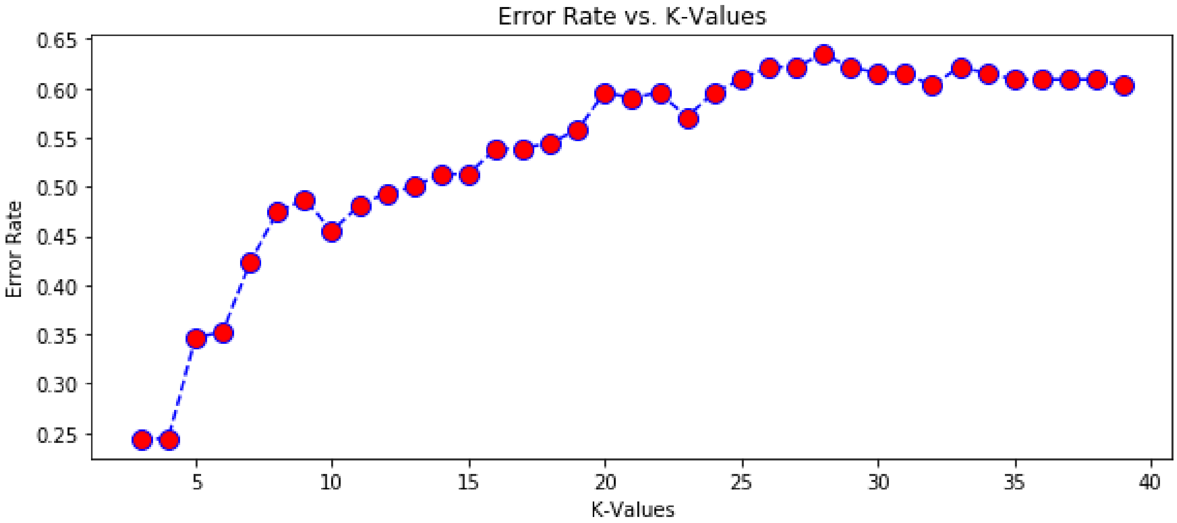
KNN (K Nearest Neighbors)

```
In [38]: from sklearn.neighbors import KNeighborsClassifier
```

```
In [39]: error_rate = []
         error_min = 1
         min = 0
         for i in range(3,40):
             knn_split = KNeighborsClassifier(n_neighbors=i)
             knn_split.fit(X_train_split, y_train_split)
             predict_knn_i_split = knn_split.predict(X_test_split)
             error_rate.append(np.mean(predict_knn_i_split != y_test_split))
             if(np.mean(predict_knn_i_split != y_test_split) < error_min):
                 error_min = np.mean(predict_knn_i_split != y_test_split)
                 min = i
```

```
In [40]: # Configure and plot error rate over k values
         plt.figure(figsize=(10,4))
         plt.plot(range(3,40), error_rate, color='blue', linestyle='dashed', marker='o'
         , markerfacecolor='red', markersize=10)
         plt.title('Error Rate vs. K-Values')
         plt.xlabel('K-Values')
         plt.ylabel('Error Rate')
```

```
Out[40]: Text(0, 0.5, 'Error Rate')
```



```
In [41]: knn = KNeighborsClassifier(n_neighbors=min)
         knn.fit(X_train_split, y_train_split)
```

```
Out[41]: KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
                    metric_params=None, n_jobs=None, n_neighbors=3, p=2,
                    weights='uniform')
```

```
In [42]: predict_knn = knn.predict(X_test_split)
         print('Nilai akurasi knn  : ', accuracy_score(y_test_split, predict_knn))
```

```
         Nilai akurasi knn  :  0.7564102564102564
```

```
In [43]: predict_knn[0:20]
```

```
Out[43]: array([1, 1, 1, 0, 0, 1, 1, 0, 1, 0, 3, 0, 1, 1, 3, 2, 1, 0, 0, 0],
               dtype=int64)
```

```
In [44]: y_test_split.head(20)
```

```
Out[44]: 344    0
         288    1
         384    1
         708    0
         606    1
         274    1
         298    1
         717    0
         66     1
         343    0
         359    3
         5      0
         669    1
         2      0
         645    3
         349    2
         372    1
         689    0
         458    0
         549    0
         Name: Diagnosis_HD, dtype: int64
```

```
In [45]: knn.score(X_train_split ,y_train_split)
```

```
Out[45]: 0.9140401146131805
```

```
In [46]: knn.score(X_test_split, y_test_split)
```

```
Out[46]: 0.7564102564102564
```

```
In [47]: # Import classification report and confusion matrix to evaluate predictions
         from sklearn.metrics import classification_report, confusion_matrix
```

```
In [48]: print(classification_report(y_test_split, predict_knn))
```

```
                       precision    recall  f1-score   support

                   0       0.88      0.69      0.77        67
                   1       0.64      0.66      0.65        44
                   2       0.68      0.90      0.78        21
                   3       0.77      1.00      0.87        20
                   4       0.80      1.00      0.89         4

           micro avg       0.76      0.76      0.76       156
           macro avg       0.76      0.85      0.79       156
        weighted avg       0.77      0.76      0.75       156
```

In [49]:

```
# Print out confusion matrix
cmat = confusion_matrix(y_test_split, predict_knn)
print(cmat)
print('TP - True Positive {}'.format(cmat[0,0]))
print('FP - False Positive {}'.format(cmat[0,1]))
print('FN - False Negative {}'.format(cmat[1,0]))
print('TN - True Negative {}'.format(cmat[1,1]))
print('Accuracy Rate: {}'.format(np.divide(np.sum([cmat[0,0],cmat[1,1]]),np.su
m(cmat))))
print('Misclassification Rate: {}'.format(np.divide(np.sum([cmat[0,1],cmat[1,0
]]),np.sum(cmat))))
```

```
[[46 16  2  3  0]
 [ 5 29  7  2  1]
 [ 1  0 19  1  0]
 [ 0  0  0 20  0]
 [ 0  0  0  0  4]]
TP - True Positive 46
FP - False Positive 16
FN - False Negative 5
TN - True Negative 29
Accuracy Rate: 0.4807692307692308
Misclassification Rate: 0.1346153846153846
```

Predict Data Full Test

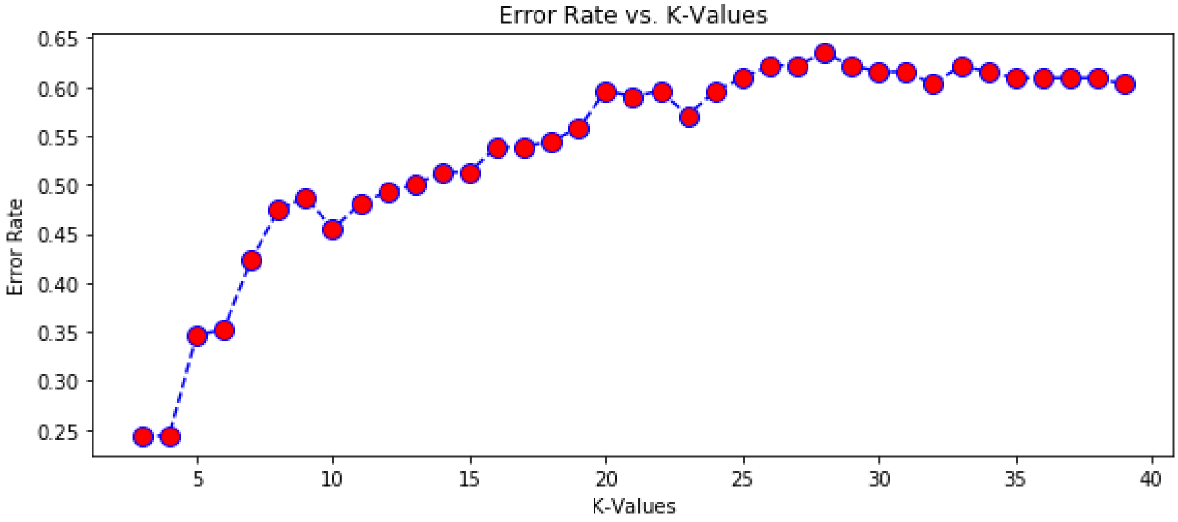
In [50]:

```
X_train = pd.get_dummies(X_train)
```

In [51]:

```
error_rate = []
error_min = 1
min = 0
for i in range(3,40):
    knn = KNeighborsClassifier(n_neighbors=i)
    knn.fit(X_train, y_train)
    predict_knn_i = knn.predict(X_test_split)
    error_rate.append(np.mean(predict_knn_i != y_test_split))
    if(np.mean(predict_knn_i_split != y_test_split) < error_min):
        error_min = np.mean(predict_knn_i_split != y_test_split)
        min = i
```

```
In [52]: # Configure and plot error rate over k values
         plt.figure(figsize=(10,4))
         plt.plot(range(3,40), error_rate, color='blue', linestyle='dashed', marker='o'
         , markerfacecolor='red', markersize=10)
         plt.title('Error Rate vs. K-Values')
         plt.xlabel('K-Values')
         plt.ylabel('Error Rate')

Out[52]: Text(0, 0.5, 'Error Rate')
```



```
In [53]: knn = KNeighborsClassifier(n_neighbors=min)
         knn.fit(X_train, y_train)

Out[53]: KNeighborsClassifier(algorithm='auto', leaf_size=30, metric='minkowski',
                    metric_params=None, n_jobs=None, n_neighbors=3, p=2,
                    weights='uniform')
```

Create Model Joblib

```
In [54]: from sklearn.externals import joblib
         joblib.dump(knn,'KNN_Model.joblib')

Out[54]: ['KNN_Model.joblib']
```

Output to CSV

In [55]:
```
output = knn.predict(dg)
output
```

Out[55]:
```
array([3, 0, 1, 0, 1, 0, 3, 3, 0, 1, 2, 3, 0, 1, 1, 1, 3, 0, 2, 0, 3, 2,
       0, 0, 3, 2, 1, 3, 0, 2, 0, 3, 3, 1, 3, 2, 1, 0, 1, 3, 1, 0, 1, 2,
       1, 2, 1, 1, 1, 3, 3, 1, 1, 2, 1, 0, 0, 0, 0, 0, 3, 0, 3, 1, 0, 1,
       2, 0, 0, 0, 2, 0, 1, 2, 1, 0, 1, 0, 0, 2, 0, 1, 0, 2, 1, 4, 2, 0,
       1, 2, 3, 2, 0, 1, 0, 0, 0, 0, 1, 0, 3, 0, 2, 0, 3, 0, 0, 2, 1, 0,
       0, 2, 0, 1, 0, 1, 0, 3, 0, 2, 1, 3, 0, 0, 2, 0, 0, 1, 3, 2, 0, 0,
       3, 2, 3, 4, 0, 1, 2, 1, 0], dtype=int64)
```

In [56]:
```
output = pd.DataFrame(output)
output.columns = ['Diagnosis_HD']
```

In [57]:
```
output.to_csv("tubes2_HeartDisease_predict.csv", index=False)
```

Referensi

https://medium.com/@kbrook10/day-11-machine-learning-using-knn-k-nearest-neighbors-with-scikit-learn-350c3a1402e6 (https://medium.com/@kbrook10/day-11-machine-learning-using-knn-k-nearest-neighbors-with-scikit-learn-350c3a1402e6)