```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split


df = pd.read_csv("/content/heart.csv")
df
```

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal
0	63	1	3	145	233	1	0	150	0	2.3	0	0	1
1	37	1	2	130	250	0	1	187	0	3.5	0	0	2
2	41	0	1	130	204	0	0	172	0	1.4	2	0	2
3	56	1	1	120	236	0	1	178	0	0.8	2	0	2
4	57	0	0	120	354	0	1	163	1	0.6	2	0	2
...	...	...	...	...	...	...	...	...	...	...	...	...	...
298	57	0	0	140	241	0	1	123	1	0.2	1	0	3
299	45	1	3	110	264	0	1	132	0	1.2	1	0	3
300	68	1	0	144	193	1	1	141	0	3.4	1	2	3
301	57	1	0	130	131	0	1	115	1	1.2	1	1	3
302	57	0	1	130	236	0	0	174	0	0.0	1	1	2

303 rows × 14 columns

Next steps: View recommended plots

```
df.head(5)
```

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal
0	63	1	3	145	233	1	0	150	0	2.3	0	0	1
1	37	1	2	130	250	0	1	187	0	3.5	0	0	2
2	41	0	1	130	204	0	0	172	0	1.4	2	0	2
3	56	1	1	120	236	0	1	178	0	0.8	2	0	2
4	57	0	0	120	354	0	1	163	1	0.6	2	0	2

Next steps: View recommended plots

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 303 entries, 0 to 302
Data columns (total 14 columns):
 #   Column    Non-Null Count  Dtype  
---  ------    --------------  -----  
 0   age       303 non-null    int64  
 1   sex       303 non-null    int64  
 2   cp        303 non-null    int64  
 3   trestbps  303 non-null    int64  
 4   chol      303 non-null    int64  
 5   fbs       303 non-null    int64  
 6   restecg   303 non-null    int64  
 7   thalach   303 non-null    int64  
 8   exang     303 non-null    int64  
 9   oldpeak   303 non-null    float64
 10  slope     303 non-null    int64  
 11  ca        303 non-null    int64  
 12  thal      303 non-null    int64  
 13  target    303 non-null    int64  
dtypes: float64(1), int64(13)
memory usage: 33.3 KB
```

```
df.describe()
```

	age	sex	cp	trestbps	chol	fbs	restecg
count	303.000000	303.000000	303.000000	303.000000	303.000000	303.000000	303.000000
mean	54.366337	0.683168	0.966997	131.623762	246.264026	0.148515	0.528053
std	9.082101	0.466011	1.032052	17.538143	51.830751	0.356198	0.525860
min	29.000000	0.000000	0.000000	94.000000	126.000000	0.000000	0.000000
25%	47.500000	0.000000	0.000000	120.000000	211.000000	0.000000	0.000000
50%	55.000000	1.000000	1.000000	130.000000	240.000000	0.000000	1.000000
75%	61.000000	1.000000	2.000000	140.000000	274.500000	0.000000	1.000000
max	77.000000	1.000000	3.000000	200.000000	564.000000	1.000000	2.000000

```
df.shape
```

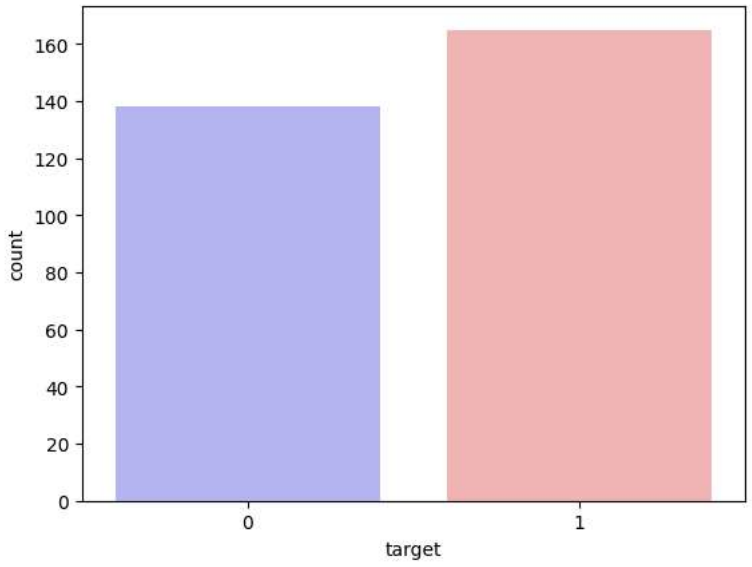
```
(303, 14)
```

```
df.target.value_counts()
```

```
target
1    165
0    138
Name: count, dtype: int64
```

```
sns.countplot(x='target',data=df,palette='bwr')
plt.show()
```

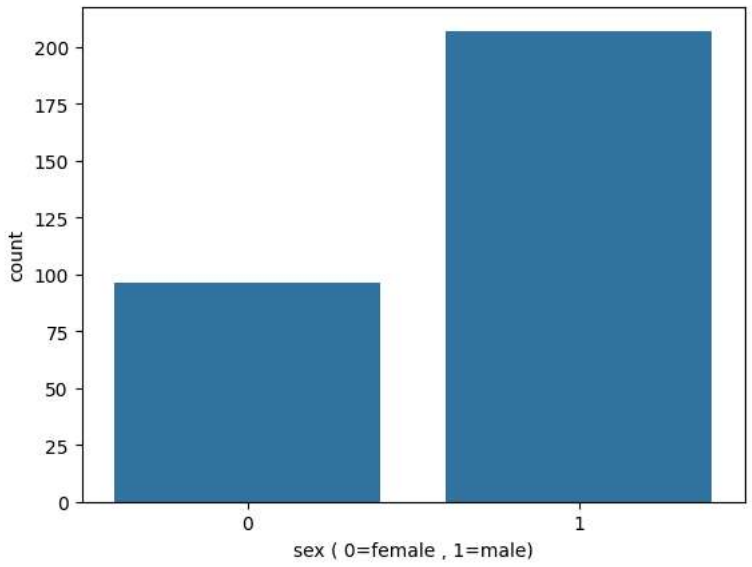
```
<ipython-input-9-bb3406af18fd>:1: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v0.14.0.

  sns.countplot(x='target',data=df,palette='bwr')
```




```
count_nodisease = len(df[df.target == 0])
count_disease = len(df[df.target == 1])
total_count = len(df)

percentage_nodisease = (count_nodisease / total_count) * 100
percentage_disease = (count_disease / total_count) * 100

print("Percentage of people not having heart disease: {:.2f}%".format(percentage_nodisease))
print("Percentage of people having heart disease: {:.2f}%".format(percentage_disease))
```

```
Percentage of people not having heart disease: 45.54%
Percentage of people having heart disease: 54.46%
```

```
sns.countplot(x='sex',data=df)
plt.xlabel("sex ( 0=female , 1=male)")
plt.show()
```



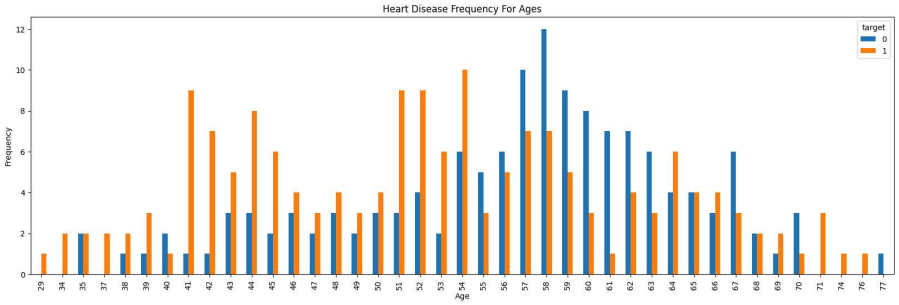

```
countFemale = len(df[df.sex == 0])
countMale = len(df[df.sex == 1])
total_count = len(df)

percentage_female = (countFemale / total_count) * 100
percentage_male = (countMale / total_count) * 100

print("Percentage of Female patient: {:.2f}%".format(percentage_female))
print("Percentage of Male patient: {:.2f}%".format(percentage_male))
```

```
Percentage of Female patient: 31.68%
Percentage of Male patient: 68.32%
```

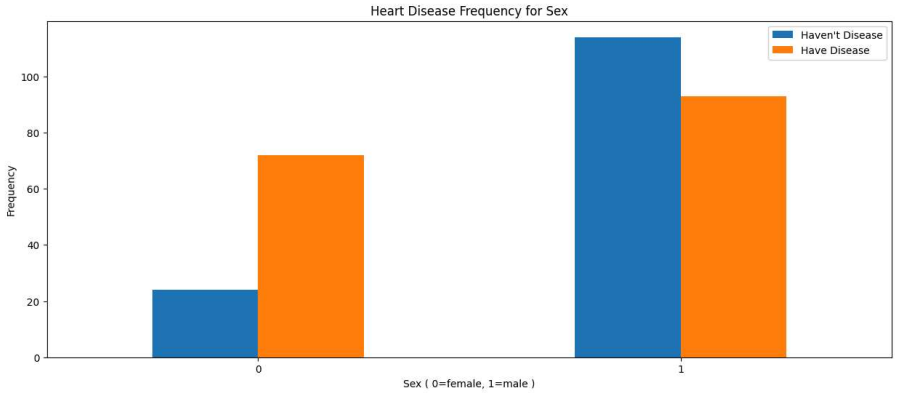
```
df.groupby('target').mean()
```

target	age	sex	cp	trestbps	chol	fbs	restecg	thala
0	56.601449	0.826087	0.478261	134.398551	251.086957	0.159420	0.449275	139.1014
1	52.496970	0.563636	1.375758	129.303030	242.230303	0.139394	0.593939	158.4666

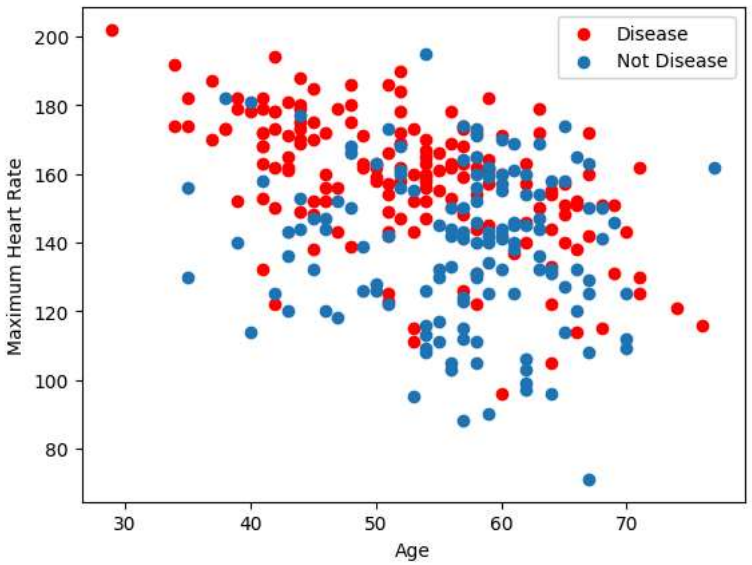
```
pd.crosstab(df.age,df.target).plot(kind='bar',figsize=(20,6))
plt.title("Heart Disease Frequency For Ages")
plt.xlabel('Age')
plt.ylabel('Frequency')
plt.savefig('heartdiseaseandages.png')
plt.show()
```



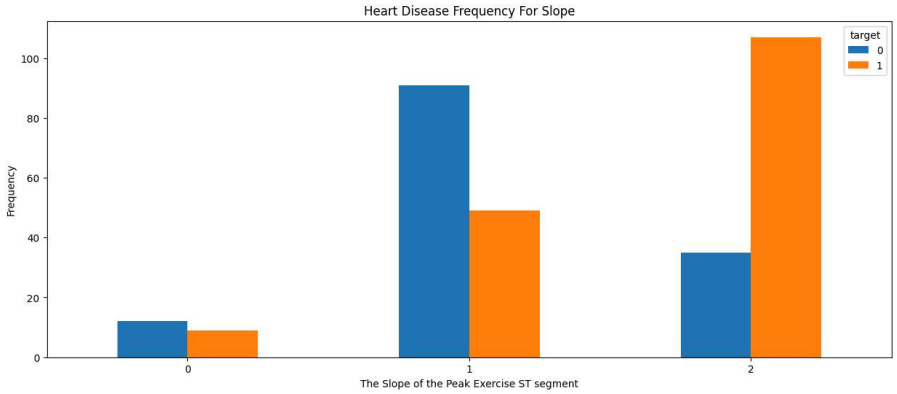

```
pd.crosstab(df.sex,df.target).plot(kind='bar',figsize=(15,6))
plt.title("Heart Disease Frequency for Sex")
plt.xlabel("Sex ( 0=female, 1=male )")
plt.xticks(rotation=0)
plt.legend(["Haven't Disease", "Have Disease"])
plt.ylabel('Frequency')
plt.show()
```




```
plt.scatter(x=df.age[df.target==1],y=df.thalach[(df.target==1)],c="red")
plt.scatter(x=df.age[df.target==0],y=df.thalach[(df.target==0)])
plt.legend(["Disease","Not Disease"])
plt.xlabel("Age")
plt.ylabel("Maximum Heart Rate")
plt.show()
```

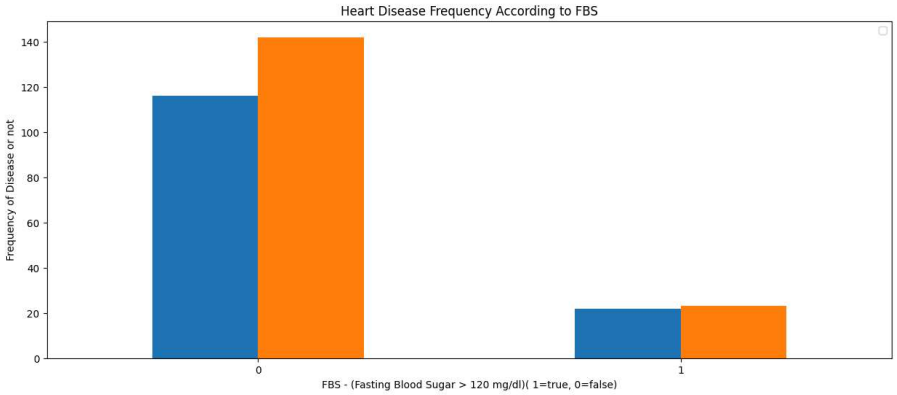



```
pd.crosstab(df.slope,df.target).plot(kind="bar", figsize=(15,6))
plt.title("Heart Disease Frequency For Slope")
plt.xlabel("The Slope of the Peak Exercise ST segment")
plt.ylabel("Frequency")
plt.xticks(rotation=0)
plt.show()
```

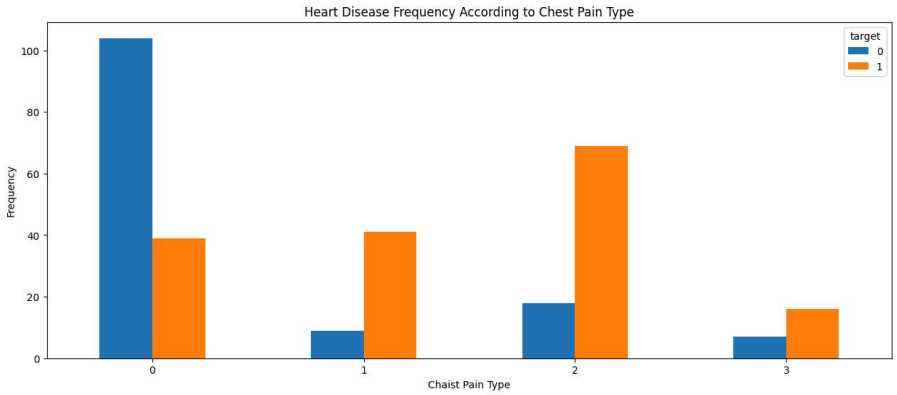



```
pd.crosstab(df.fbs,df.target).plot(kind="bar",figsize=(15,6))
plt.title("Heart Disease Frequency According to FBS")
plt.xlabel("FBS - (Fasting Blood Sugar > 120 mg/dl)( 1=true, 0=false)")
plt.xticks(rotation=0)
plt.legend("Haven't Disease","Have Diesease")
plt.ylabel("Frequency of Disease or not")
plt.show()
```

```
<ipython-input-18-fc81d7471bc1>:5: UserWarning: Legend does not support handles for str
A proxy artist may be used instead.
See: https://matplotlib.org/stable/tutorials/intermediate/legend_guide.html#controlling-
  plt.legend("Haven't Disease","Have Diesease")
```




```
pd.crosstab(df.cp,df.target).plot(kind="bar",figsize=(15,6))
plt.title("Heart Disease Frequency According to Chest Pain Type")
plt.xlabel("Chaist Pain Type")
plt.xticks(rotation=0)
plt.ylabel("Frequency")
plt.show()
```




```
a = pd.get_dummies(df['cp'],prefix='cp')
b = pd.get_dummies(df['thal'],prefix='thal')
c = pd.get_dummies(df['slope'],prefix='slope')
```

```
frames = [ df,a,b,c ]
df = pd.concat(frames,axis=1)
df.head()
```

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	...	cp_1	cp_2
0	63	1	3	145	233	1	0	150	0	2.3	...	False	False
1	37	1	2	130	250	0	1	187	0	3.5	...	False	True
2	41	0	1	130	204	0	0	172	0	1.4	...	True	False
3	56	1	1	120	236	0	1	178	0	0.8	...	True	False
4	57	0	0	120	354	0	1	163	1	0.6	...	False	False

5 rows × 25 columns

Double-click (or enter) to edit

```
df = df.drop(columns=['cp','thal','slope'])
df.head()
```

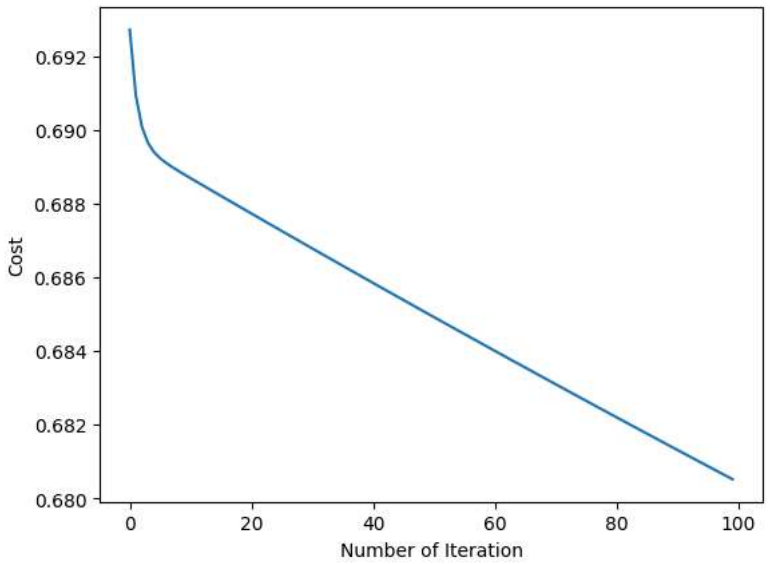
	age	sex	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	ca	...	cp_1	cp_2
0	63	1	145	233	1	0	150	0	2.3	0	...	False	False
1	37	1	130	250	0	1	187	0	3.5	0	...	False	True
2	41	0	130	204	0	0	172	0	1.4	0	...	True	False
3	56	1	120	236	0	1	178	0	0.8	0	...	True	False
4	57	0	120	354	0	1	163	1	0.6	0	...	False	False

5 rows × 22 columns

```
y = df.target.values
x_data = df.drop(['target'],axis = 1)


x = (x_data - np.min(x_data)) / (np.max(x_data) - np.min(x_data))



x_train,x_test,y_train,y_test = train_test_split(x,y,test_size=0.2)


x_train = x_train.T
y_train = y_train.T
x_test = x_test.T
y_test = y_test.T


def initialize(dimension):
  weight = np.full((dimension,1),0.01)
  bias = 0.0
  return weight,bias


def sigmoid(z):
  y_head = 1/(1+np.exp(-z))
  return y_head


def forwardBackward(weight,bias,x_train,y_train):
  y_head = sigmoid(np.dot(weight.T,x_train) + bias)
  loss = -(y_train*np.log(y_head) + ( 1-y_train)*np.log(1-y_head))
  cost = np.sum(loss) / x_train.shape[1]

  derived_weight = np.dot(x_train,((y_head-y_train).T))/x_train.shape[1]
  derived_bias = np.sum(y_head-y_train)/x_train.shape[1]
  gradients = {"Derived Weight" : derived_weight, "Derived Bias" : derived_bias}
  return cost,gradients
```

```
def update(weight,bias,x_train,y_train,learningRate,iteration):
  costList = []
  index = []
  for i in range (iteration):
    cost,gradients = forwardBackward(weight,bias,x_train,y_train)
    weight = weight - learningRate * gradients["Derived Weight"]
    bias = bias - learningRate * gradients["Derived Bias"]

    costList.append(cost)
    index.append(i)

  parameters = {"weight": weight,"bias":bias}

  print("iteraion :",iteration)
  print("cost :",cost)

  plt.plot(index,costList)
  plt.xlabel("Number of Iteration")
  plt.ylabel("Cost")
  plt.show()

  return parameters, gradients



def predict(weight,bias,x_test):
  z = np.dot(weight.T,x_test) + bias
  y_head = sigmoid(z)

  y_prediction = np.zeros((1,x_test.shape[1]))

  for i in range (y_head.shape[1]):
    if y_head[0,i] <= 0.5:
      y_prediction[0,i] = 0
    else:
      y_prediction[0,i] = 1
  return y_prediction


def logistic_regression(x_train,y_train,x_test,y_test,learningRate,iteration):
  dimension = x_train.shape[0]
  weight,bias = initialize(dimension)

  parameters, gradients = update(weight,bias,x_train,y_train,learningRate,iteration)

  y_prediction = predict(parameters["weight"],parameters["bias"],x_test)

  print("Mannual Test Accuracy: {:.2f}%".format((100-np.mean(np.abs(y_prediction)))))


logistic_regression(x_train,y_train,x_test,y_test,1,100)
```

```
iteraion : 100
cost : 0.6805180043953309
```




```
Mannual Test Accuracy: 99.00%
```

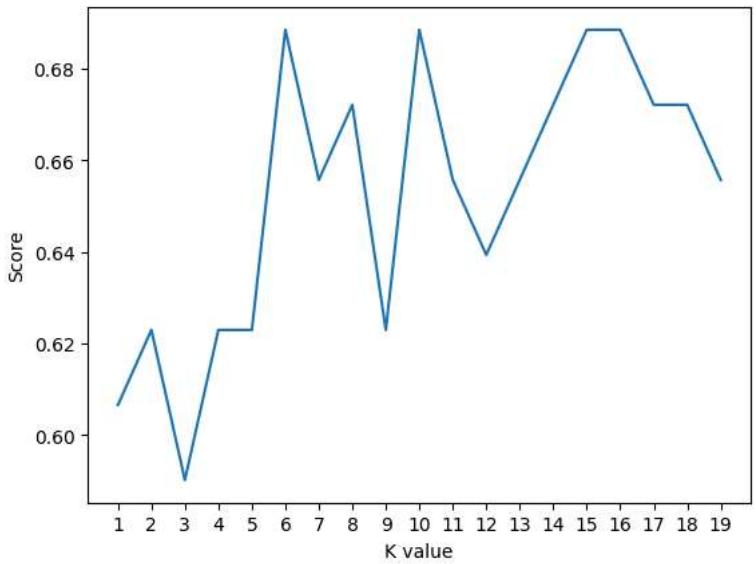
```
accuracies = {}

lr = LogisticRegression()
lr.fit(x_train.T, y_train.T)
acc = lr.score(x_test.T,y_test.T)*100

accuracies['logistic Regression'] = acc
print("Test Acuuracy {:.2f}%".format(acc))
```

```
Test Acuuracy 57.38%
```

```
from sklearn.neighbors import KNeighborsClassifier
knn = KNeighborsClassifier(n_neighbors = 2)
knn.fit(x_train.T,y_train.T)
prediction = knn.predict(x_test.T)
print("{} NN Score: {:.2f}%".format(2,knn.score(x_test.T,y_test.T)*100))
```

```
2 NN Score: 62.30%
```

```
scoreList = []
for i in range(1,20):
  knn2 = KNeighborsClassifier(n_neighbors = i)
  knn2.fit(x_train.T,y_train.T)
  scoreList.append(knn2.score(x_test.T,y_test.T))

plt.plot(range(1,20),scoreList)
plt.xticks(np.arange(1,20,1))
plt.xlabel("K value")
plt.ylabel("Score")
plt.show()

acc = max(scoreList)*100
accuracies['KNN'] = acc
print("Maximum KNN Score is {:.2f}%".format(acc))
```




```
Maximum KNN Score is 68.85%
```

```
from sklearn.svm import SVC


svm = SVC(random_state = 1)
svm.fit(x_train.T,y_train.T)

acc = svm.score(x_test.T,y_test.T)*100
accuracies['SVM'] = acc
print("Test Accuracy of SVM Algorithm : {:.2f}%".format(acc))
```

```
Test Accuracy of SVM Algorithm : 60.66%
```

```
from sklearn.naive_bayes import GaussianNB
nb = GaussianNB()
nb.fit(x_train.T,y_train.T)

acc = nb.score(x_test.T,y_test.T)*100
accuracies['Naive Bayes'] = acc
print("Accuracy of Naive Bayes : {:.2f}%".format(acc))
```

```
Accuracy of Naive Bayes : 80.33%
```

```
from sklearn.tree import DecisionTreeClassifier
dtc = DecisionTreeClassifier()
dtc.fit(x_train.T,y_train.T)

acc = dtc.score(x_test.T,y_test.T)*100
accuracies['Decision Tree'] = acc
print("Decision Tree Test Accuracy : {:.2f}%".format(acc))
```

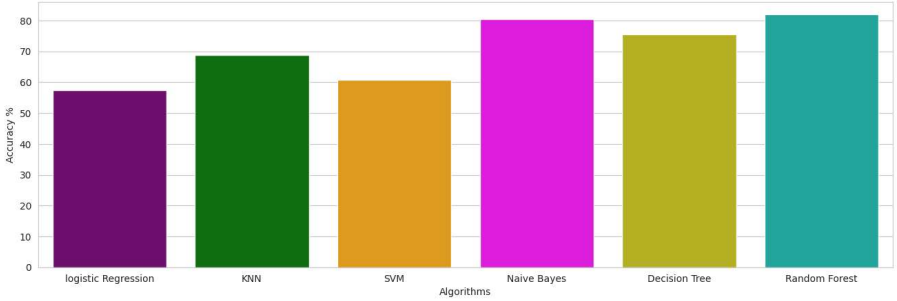
```
Decision Tree Test Accuracy : 75.41%
```

```
from sklearn.ensemble import RandomForestClassifier
rf = RandomForestClassifier(n_estimators = 1000,random_state = 1 )
rf.fit(x_train.T,y_train.T)

acc = rf.score(x_test.T,y_test.T)*100
accuracies['Random Forest'] = acc
print("Random Forest Algorithm Accuracy Score : {:.2f}%".format(acc))
```

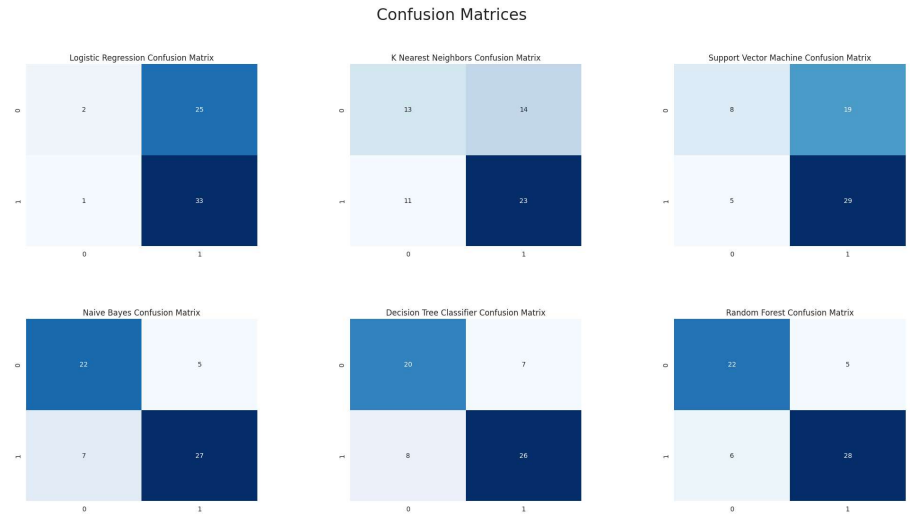
```
Random Forest Algorithm Accuracy Score : 81.97%
```

```
colors = ["purple", "green", "orange", "magenta", "#CFC60E","#0FBBAE"]

sns.set_style("whitegrid")
plt.figure(figsize=(16,5))
plt.yticks(np.arange(0,100,10))
plt.ylabel("Accuracy %")
plt.xlabel("Algorithms")
sns.barplot(x=list(accuracies.keys()), y=list(accuracies.values()), palette = colors)
plt.show()
```

```
<ipython-input-42-ecea6d9cf32b>:8: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v0.14.0.

  sns.barplot(x=list(accuracies.keys()), y=list(accuracies.values()), palette = colors)
```

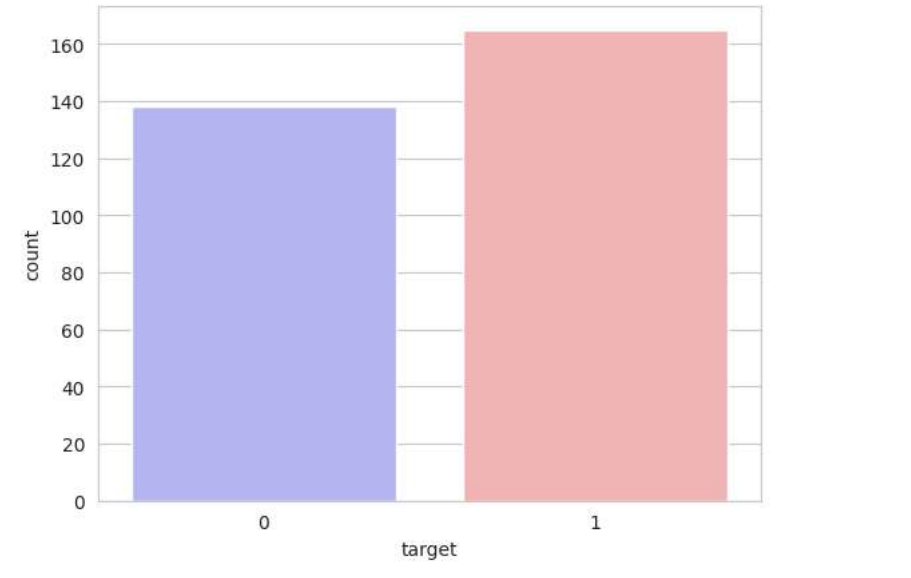


```
y_head_lr = lr.predict(x_test.T)
knn3 = KNeighborsClassifier(n_neighbors = 3)
knn3.fit(x_train.T, y_train.T)
y_head_knn = knn3.predict(x_test.T)
y_head_svm = svm.predict(x_test.T)
y_head_nb = nb.predict(x_test.T)
y_head_dtc = dtc.predict(x_test.T)
y_head_rf = rf.predict(x_test.T)


from sklearn.metrics import confusion_matrix
cm_lr = confusion_matrix(y_test,y_head_lr)
cm_knn = confusion_matrix(y_test,y_head_knn)
cm_svm = confusion_matrix(y_test,y_head_svm)
cm_nb = confusion_matrix(y_test,y_head_nb)
cm_dtc = confusion_matrix(y_test,y_head_dtc)
cm_rf = confusion_matrix(y_test,y_head_rf)


plt.figure(figsize=(24,12))
plt.suptitle("Confusion Matrices",fontsize=24)
plt.subplots_adjust(wspace=0.4,hspace=0.4)

plt.subplot(2,3,1)
plt.title("Logistic Regression Confusion Matrix")
sns.heatmap(cm_lr, annot=True, cmap="Blues", fmt="d",cbar=False)

plt.subplot(2,3,2)
plt.title("K Nearest Neighbors Confusion Matrix")
sns.heatmap(cm_knn, annot=True, cmap="Blues", fmt="d",cbar=False)

plt.subplot(2,3,3)
plt.title("Support Vector Machine Confusion Matrix")
sns.heatmap(cm_svm, annot=True, cmap="Blues", fmt="d",cbar=False)

plt.subplot(2,3,4)
plt.title("Naive Bayes Confusion Matrix")
sns.heatmap(cm_nb, annot=True, cmap="Blues", fmt="d",cbar=False)

plt.subplot(2,3,5)
plt.title("Decision Tree Classifier Confusion Matrix")
sns.heatmap(cm_dtc, annot=True, cmap="Blues", fmt="d",cbar=False)

plt.subplot(2,3,6)
plt.title("Random Forest Confusion Matrix")
sns.heatmap(cm_rf, annot=True, cmap="Blues", fmt="d",cbar=False)

plt.show()
```



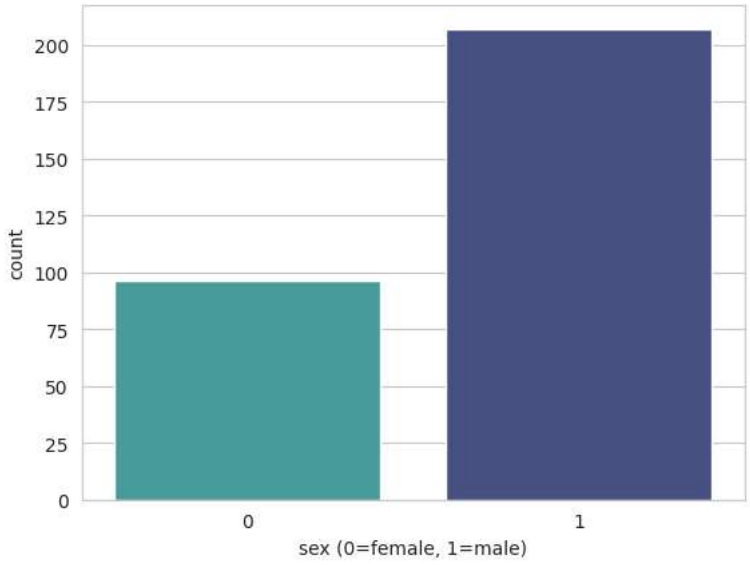

```
sns.countplot(x="target",data=df,palette="bwr")
plt.show()
```

```
<ipython-input-52-e73fc92b4fef>:1: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v0.14.0.

  sns.countplot(x="target",data=df,palette="bwr")
```

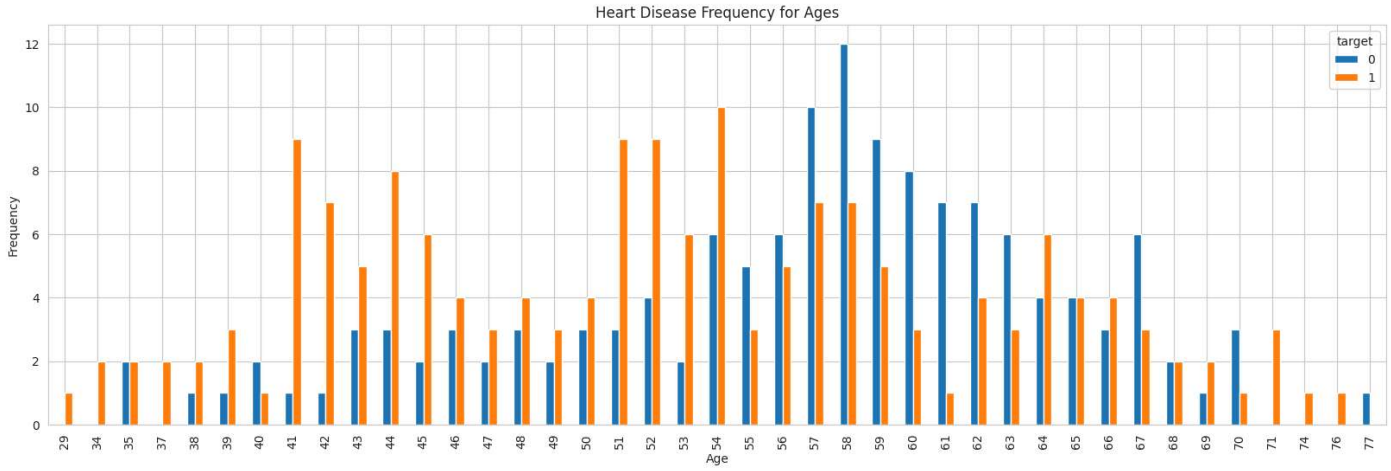



```
sns.countplot(x='sex',data=df, palette="mako_r")
plt.xlabel("sex (0=female, 1=male)")
plt.show()
```

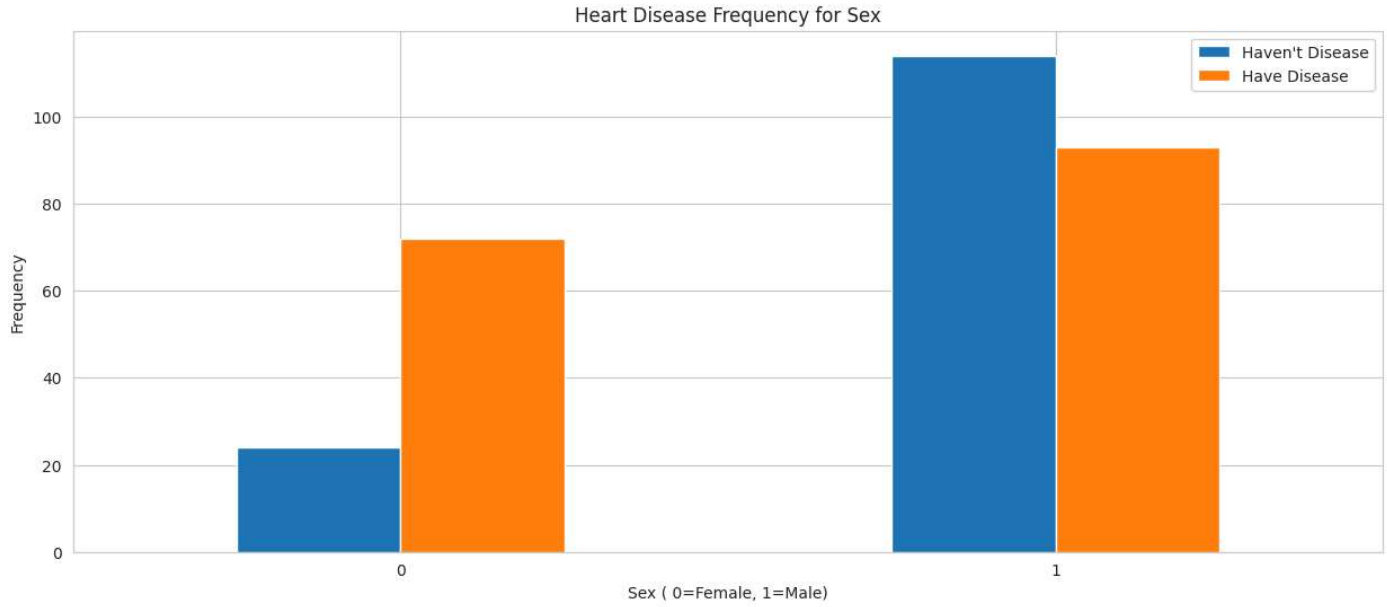
```
<ipython-input-53-e1baa4a42e25>:1: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v0.14.0.

  sns.countplot(x='sex',data=df, palette="mako_r")
```



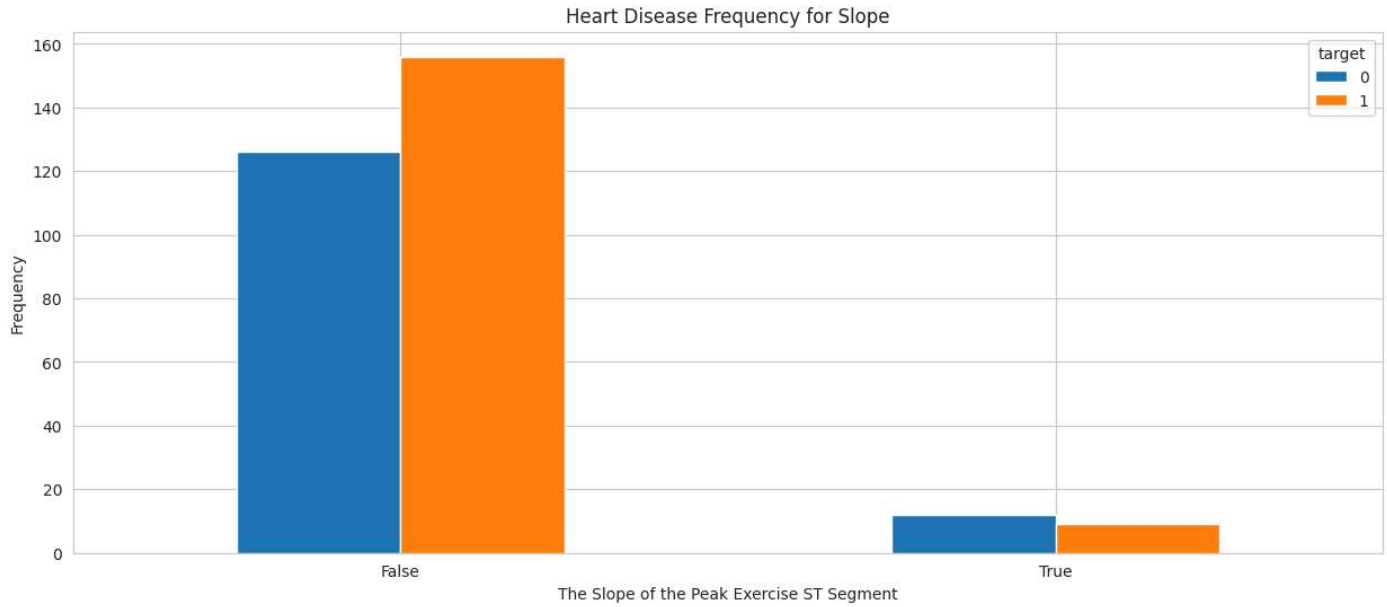

```
pd.crosstab(df.age,df.target).plot(kind='bar',figsize=(20,6))
plt.title("Heart Disease Frequency for Ages")
plt.xlabel("Age")
plt.ylabel('Frequency')
plt.savefig("heartDiseaseAndAges.png")
plt.show()
```



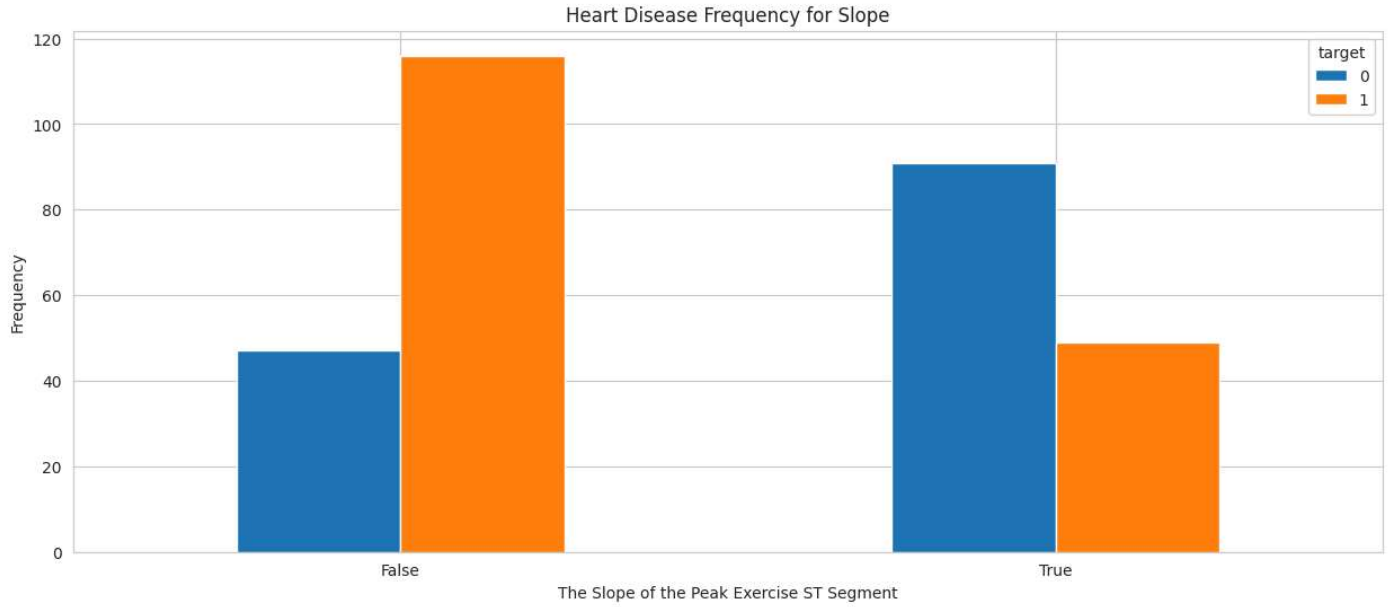

```
pd.crosstab(df.sex,df.target).plot(kind="bar",figsize=(15,6))
plt.title("Heart Disease Frequency for Sex")
plt.xlabel("Sex ( 0=Female, 1=Male)")
plt.xticks(rotation=0)
plt.legend(["Haven't Disease", "Have Disease"])
plt.ylabel("Frequency")
plt.show()
```



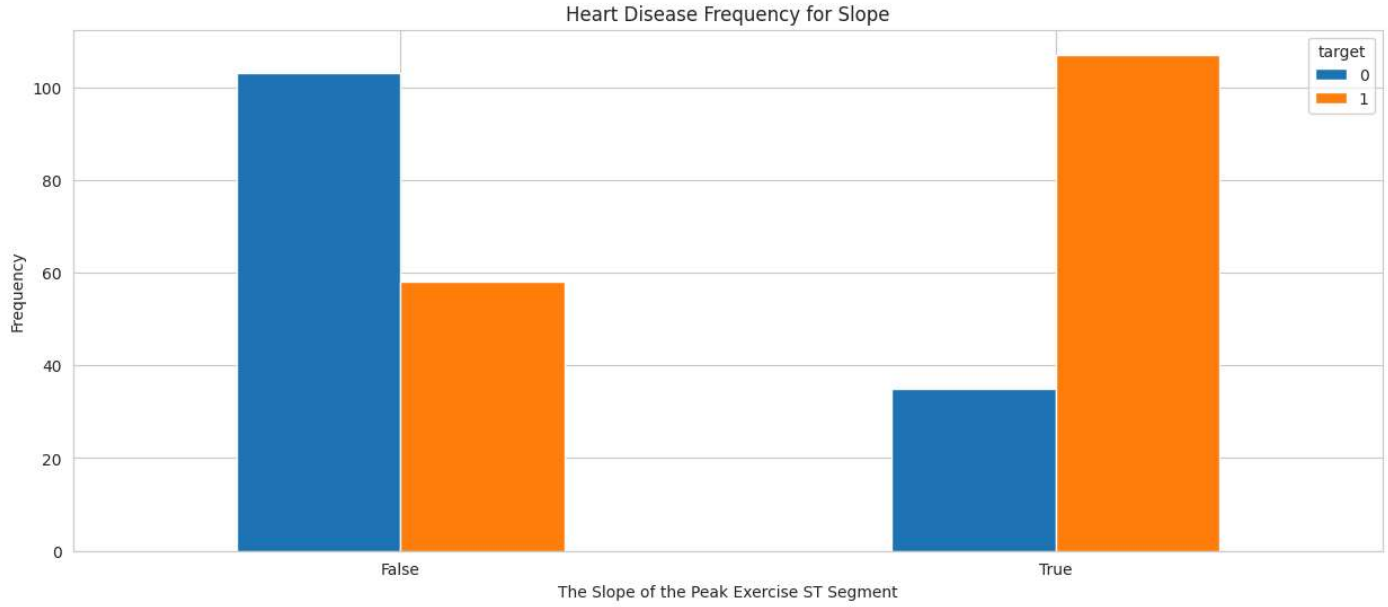

```
pd.crosstab(df.slope_0,df.target).plot(kind="bar",figsize=(15,6))
plt.title("Heart Disease Frequency for Slope")
plt.xlabel("The Slope of the Peak Exercise ST Segment")
plt.xticks(rotation=0)
plt.ylabel("Frequency")
plt.show()
```



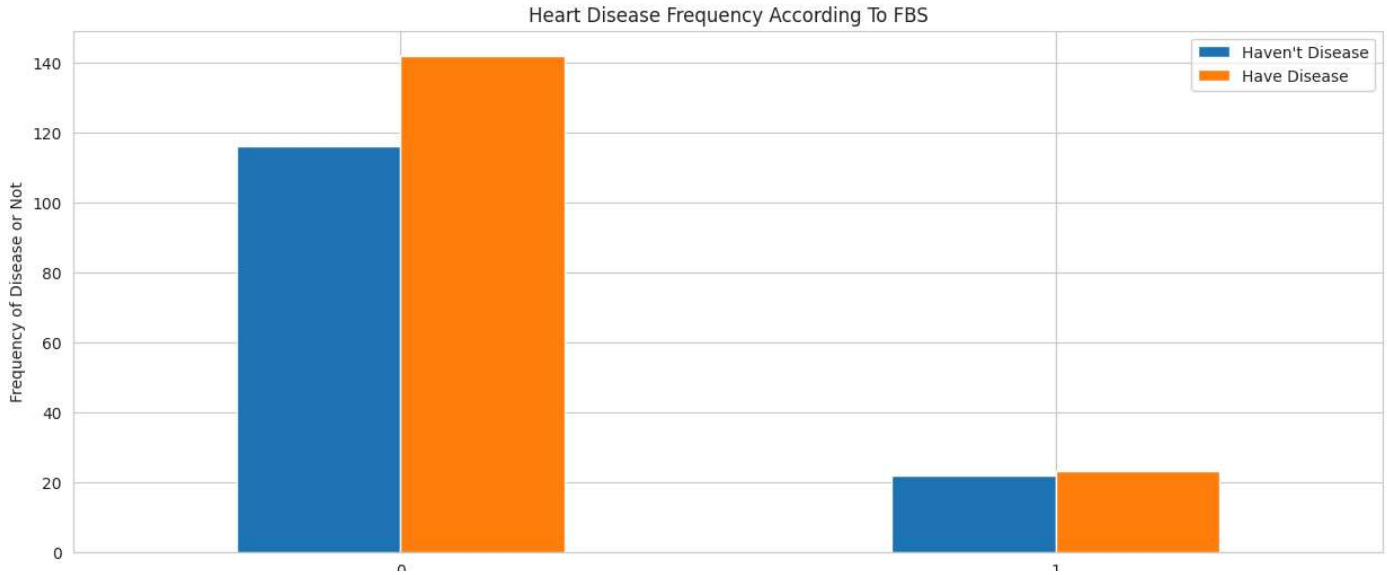

```
pd.crosstab(df.slope_1,df.target).plot(kind="bar",figsize=(15,6))
plt.title("Heart Disease Frequency for Slope")
plt.xlabel("The Slope of the Peak Exercise ST Segment")
plt.xticks(rotation=0)
plt.ylabel("Frequency")
plt.show()
```




```
pd.crosstab(df.slope_2,df.target).plot(kind="bar",figsize=(15,6))
plt.title("Heart Disease Frequency for Slope")
plt.xlabel("The Slope of the Peak Exercise ST Segment")
plt.xticks(rotation=0)
plt.ylabel("Frequency")
plt.show()
```




```
pd.crosstab(df.fbs,df.target).plot(kind="bar",figsize=(15,6))
plt.title("Heart Disease Frequency According To FBS")
plt.xlabel("FBS - (Fasting Blood Sugar > 120 mg/dl) ( 1=true; 0=false)")
plt.xticks(rotation=0)
plt.legend(["Haven't Disease","Have Disease"])
plt.ylabel("Frequency of Disease or Not")
plt.show()
```




```
pd.crosstab(df.cp_0,df.target).plot(kind="bar",figsize=(15,6))
plt.title("Heart Disease Frequency According to Chest Pain Type")
plt.xlabel("Chest Pain Type")
plt.xticks(rotation=0)
plt.ylabel("Frequency of Disease or Not")
plt.show()
```