In [4]:

```python
import numpy as np
import pandas as pd
```

In [5]:

```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
import os
import yellowbrick
import pickle

from matplotlib.collections import PathCollection
from statsmodels.graphics.gofplots import qqplot
from sklearn.preprocessing import MinMaxScaler
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.svm import SVC
from sklearn.naive_bayes import GaussianNB
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier, GradientBoostingClassifier, AdaBoostClassifier, ExtraTreesClassifier
from sklearn.metrics import classification_report, accuracy_score
from xgboost import XGBClassifier
from yellowbrick.classifier import PrecisionRecallCurve, ROCAUC, ConfusionMatrix
from yellowbrick.style import set_palette
from yellowbrick.model_selection import LearningCurve, FeatureImportances
from yellowbrick.contrib.wrapper import wrap

# --- Libraries Settings ---
warnings.filterwarnings('ignore')
sns.set_style('whitegrid')
plt.rcParams['figure.dpi']=100
set_palette('dark')
```

In [22]:

```python
red_grad = ['#FF0000', '#BF0000', '#800000', '#400000', '#000000']
pink_grad = ['#8A0030', '#BA1141', '#FF5C8A', '#FF99B9', '#FFDEEB']
purple_grad = ['#4C0028', '#7F0043', '#8E004C', '#A80059', '#C10067']
color_mix = ['#F38BB2', '#FFB9CF', '#FFD7D7', '#F17881', '#E7525B']
black_grad = ['#100C07', '#3E3B39', '#6D6A6A', '#9B9A9C', '#CAC9CD']
```

In [7]:

```python
df = pd.read_csv("heart.csv")

df.head()
```

Out[7]:

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal	target
0	52	1	0	125	212	0	1	168	0	1.0	2	2	3	0
1	53	1	0	140	203	1	0	155	1	3.1	0	0	3	0
2	70	1	0	145	174	0	1	125	1	2.6	0	0	3	0
3	61	1	0	148	203	0	1	161	0	0.0	2	1	3	0
4	62	0	0	138	294	1	1	106	0	1.9	1	3	2	0

In [8]:

```
# --- Print Dataset Info ---
print('\033[1m'+'.: Dataset Info :.'+'\033[0m')
print('*' * 30)
print('Total Rows:'+'\033[1m', df.shape[0])
print('\033[0m'+'Total Columns:'+'\033[1m', df.shape[1])
print('\033[0m'+'*' * 30)
print('\n')

# --- Print Dataset Detail ---
print('\033[1m'+'.: Dataset Details :.'+'\033[0m')
print('*' * 30)
df.info(memory_usage = False)
```

```
.: Dataset Info :.
******************************
Total Rows: 1025
Total Columns: 14
******************************


.: Dataset Details :.
******************************
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1025 entries, 0 to 1024
Data columns (total 14 columns):
 #   Column    Non-Null Count  Dtype  
---  ------    --------------  -----  
 0   age       1025 non-null   int64  
 1   sex       1025 non-null   int64  
 2   cp        1025 non-null   int64  
 3   trestbps  1025 non-null   int64  
 4   chol      1025 non-null   int64  
 5   fbs       1025 non-null   int64  
 6   restecg   1025 non-null   int64  
 7   thalach   1025 non-null   int64  
 8   exang     1025 non-null   int64  
 9   oldpeak   1025 non-null   float64
 10  slope     1025 non-null   int64  
 11  ca        1025 non-null   int64  
 12  thal      1025 non-null   int64  
 13  target    1025 non-null   int64  
dtypes: float64(1), int64(13)
```

In [9]:

```
# --- Fix Data Types ---
lst=['sex', 'cp', 'fbs', 'restecg', 'exang', 'slope', 'ca', 'thal']
df[lst] = df[lst].astype(object)
```

In [10]:

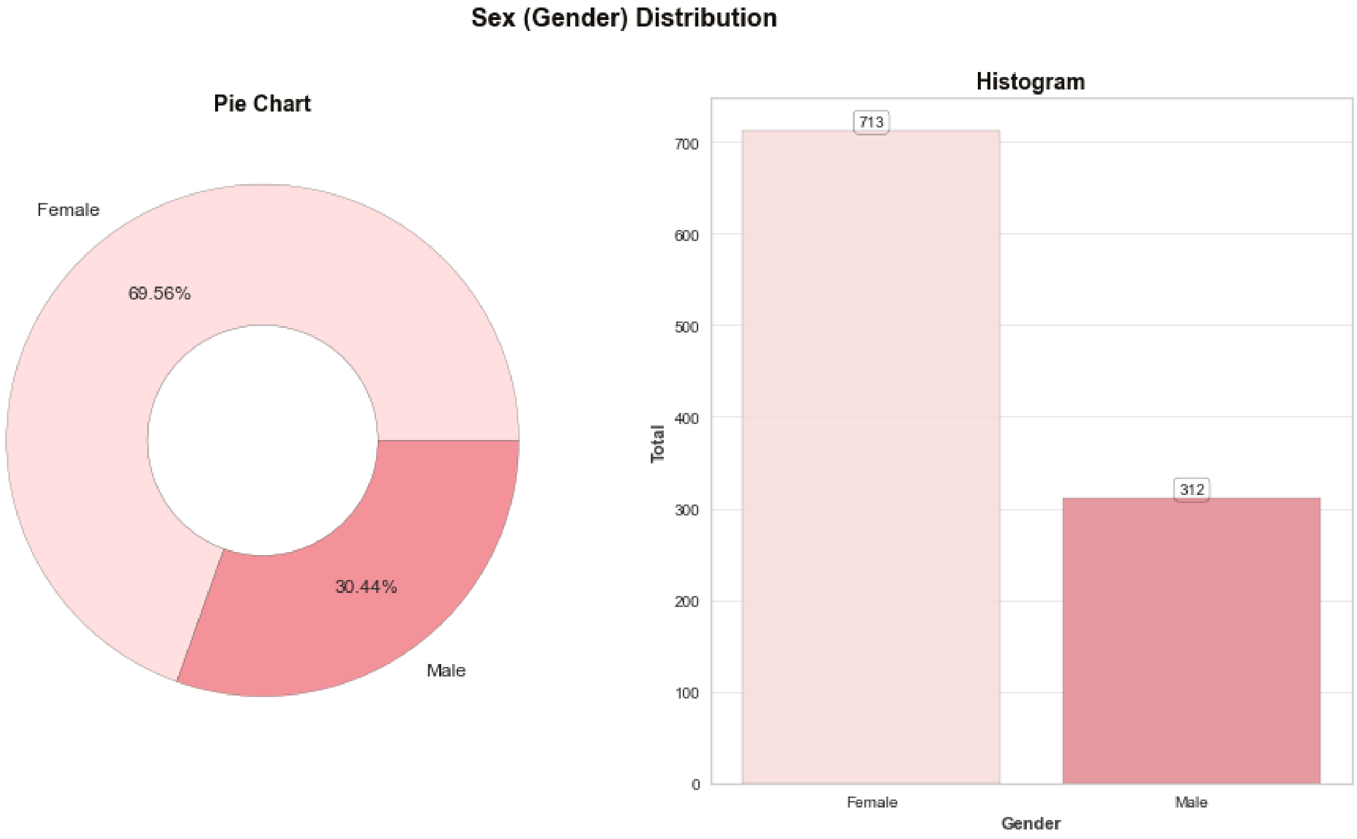
```
# --- Setting Colors, Labels, Order ---
colors=color_mix[2:4]
labels=['Female', 'Male']
order=df['sex'].value_counts().index

# --- Size for Both Figures ---
plt.figure(figsize=(16, 8))
plt.suptitle('Sex (Gender) Distribution', fontweight='heavy', 
             fontsize='16', fontfamily='sans-serif', color=black_grad[0])

# --- Pie Chart ---
plt.subplot(1, 2, 1)
plt.title('Pie Chart', fontweight='bold', fontsize=14,
          fontfamily='sans-serif', color=black_grad[0])
plt.pie(df['sex'].value_counts(), labels=labels, colors=colors, pctdistance=0.7,
        autopct='%.2f%%', wedgeprops=dict(alpha=0.8, edgecolor=black_grad[1]),
        textprops={'fontsize':12})
centre=plt.Circle((0, 0), 0.45, fc='white', edgecolor=black_grad[1])
plt.gcf().gca().add_artist(centre)
```

```
# --- Histogram ---
countplt = plt.subplot(1, 2, 2)
plt.title('Histogram', fontweight='bold', fontsize=14,
          fontfamily='sans-serif', color=black_grad[0])
ax = sns.countplot(x='sex', data=df, palette=colors, order=order,
                   edgecolor=black_grad[2], alpha=0.85)
for rect in ax.patches:
    ax.text (rect.get_x()+rect.get_width()/2,
             rect.get_height()+4.25,rect.get_height(),
             horizontalalignment='center', fontsize=10,
             bbox=dict(facecolor='none', edgecolor=black_grad[0],
                       linewidth=0.25, boxstyle='round'))

plt.xlabel('Gender', fontweight='bold', fontsize=11, fontfamily='sans-serif',
           color=black_grad[1])
plt.ylabel('Total', fontweight='bold', fontsize=11, fontfamily='sans-serif',
           color=black_grad[1])
plt.xticks([0, 1], labels)
plt.grid(axis='y', alpha=0.4)
countplt
# --- Count Categorical Labels w/out Dropping Null Walues ---
print('*' * 25)
print('\033[1m'+'.: Sex (Gender) Total :.'+'\033[0m')
print('*' * 25)
df.sex.value_counts(dropna=False)
```

```
*************************
.: Sex (Gender) Total :.
*************************
```

Out[10]:

```
1    713
0    312
Name: sex, dtype: int64
```



In [11]:

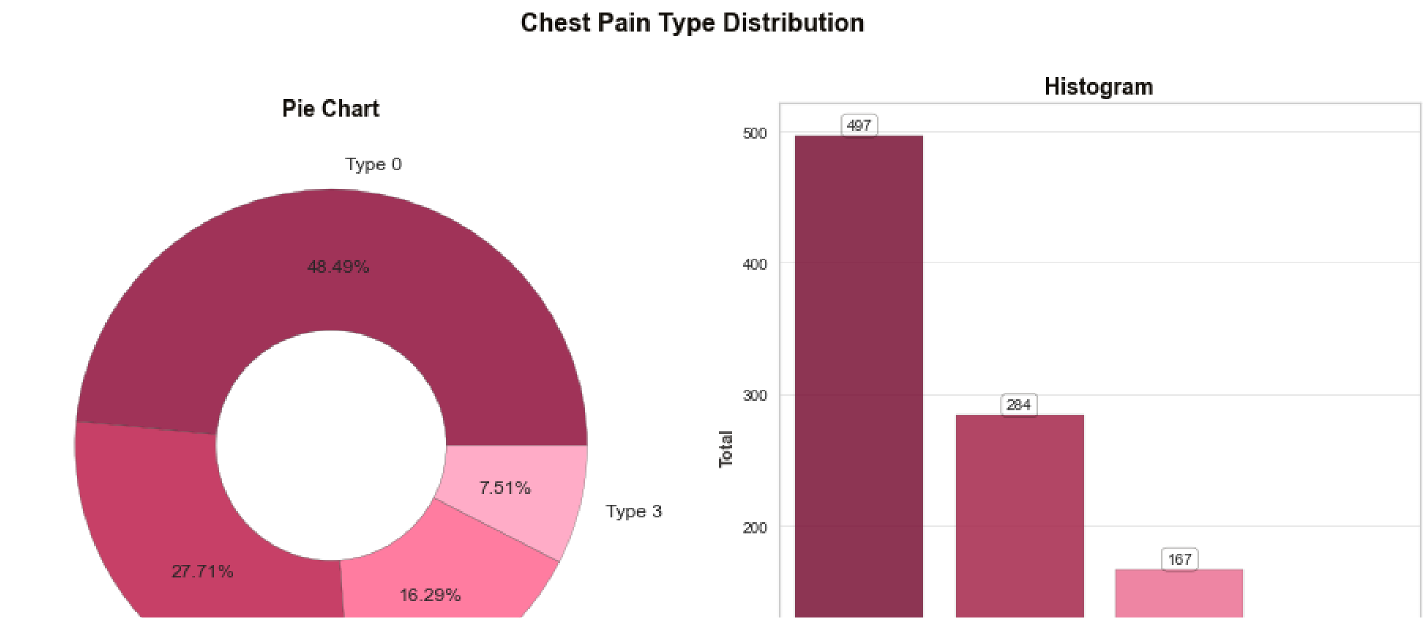
```
# --- Setting Colors, Labels, Order ---
colors=pink_grad[0:4]
labels=['Type 0', 'Type 2', 'Type 1', 'Type 3']
order=df['cp'].value_counts().index

# --- Size for Both Figures ---
```

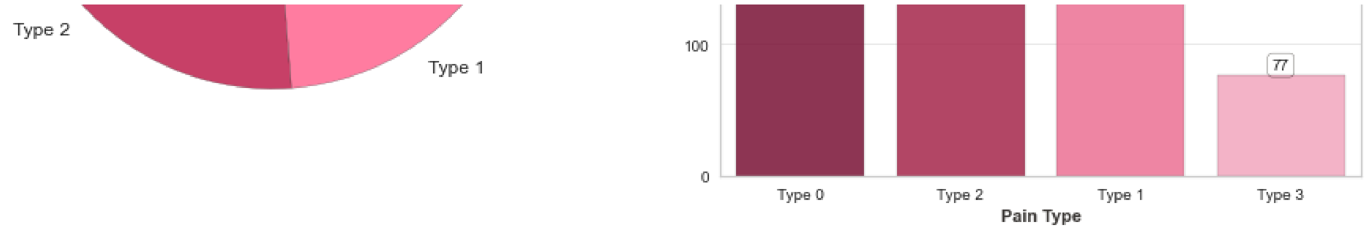
```
plt.figure(figsize=(16, 8))
plt.suptitle('Chest Pain Type Distribution', fontweight='heavy', fontsize=16,
             fontfamily='sans-serif', color=black_grad[0])

# --- Pie Chart ---
plt.subplot(1, 2, 1)
plt.title('Pie Chart', fontweight='bold', fontsize=14,fontfamily='sans-serif',
          color=black_grad[0])
plt.pie(df['cp'].value_counts(), labels=labels, colors=colors, pctdistance=0.7,
        autopct='%.2f%%', textprops={'fontsize':12},
        wedgeprops=dict(alpha=0.8, edgecolor=black_grad[1]))
centre=plt.Circle((0, 0), 0.45, fc='white', edgecolor=black_grad[1])
plt.gcf().gca().add_artist(centre)

# --- Histogram ---
countplt = plt.subplot(1, 2, 2)
plt.title('Histogram', fontweight='bold', fontsize=14, fontfamily='sans-serif',
          color=black_grad[0])
ax = sns.countplot(x='cp', data=df, palette=colors, order=order,
                   edgecolor=black_grad[2], alpha=0.85)
for rect in ax.patches:
    ax.text (rect.get_x()+rect.get_width()/2,
             rect.get_height()+4.25,rect.get_height(),
             horizontalalignment='center', fontsize=10,
             bbox=dict(facecolor='none', edgecolor=black_grad[0], linewidth=0.25,
                       boxstyle='round'))

plt.xlabel('Pain Type', fontweight='bold', fontsize=11, fontfamily='sans-serif',
           color=black_grad[1])
plt.ylabel('Total', fontweight='bold', fontsize=11, fontfamily='sans-serif',
           color=black_grad[1])
plt.xticks([0, 1, 2, 3], labels)
plt.grid(axis='y', alpha=0.4)
countplt

# --- Count Categorical Labels w/out Dropping Null Walues ---
print('*' * 30)
print('\033[1m'+'.: Chest Pain Type Total :.'+'\033[0m')
print('*' * 30)
df.cp.value_counts(dropna=False)
```

```
******************************
.: Chest Pain Type Total :.
******************************
```

Out[11]:

```
0    497
2    284
1    167
3     77
Name: cp, dtype: int64
```





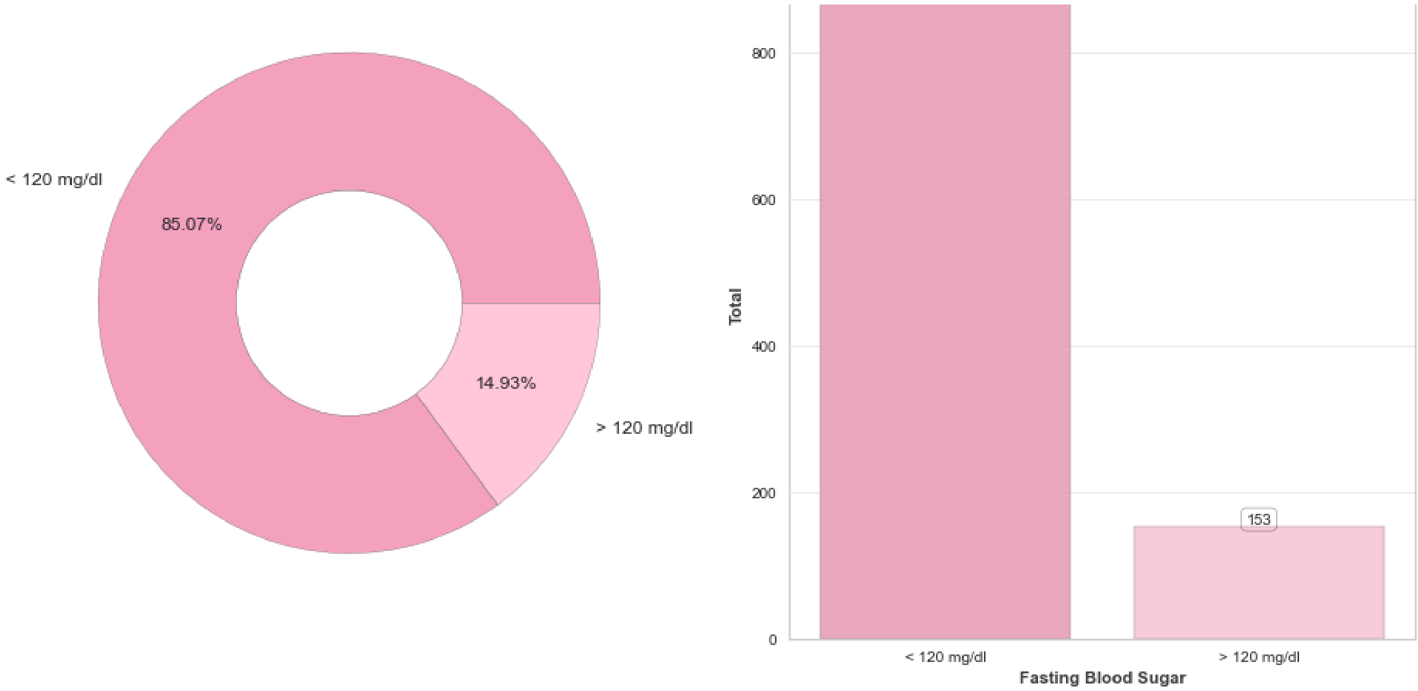
In [12]:

```
# --- Setting Colors, Labels, Order ---
colors=color_mix[0:2]
labels=['< 120 mg/dl', '> 120 mg/dl']
order=df['fbs'].value_counts().index

# --- Size for Both Figures ---
plt.figure(figsize=(16, 8))
plt.suptitle('Fasting Blood Sugar Distribution', fontweight='heavy',
             fontsize=16, fontfamily='sans-serif', color=black_grad[0])

# --- Pie Chart ---
plt.subplot(1, 2, 1)
plt.title('Pie Chart', fontweight='bold', fontsize=14, fontfamily='sans-serif',
          color=black_grad[0])
plt.pie(df['fbs'].value_counts(), labels=labels, colors=colors,
        wedgeprops=dict(alpha=0.8, edgecolor=black_grad[1]), autopct='%.2f%%',
        pctdistance=0.7, textprops={'fontsize':12})
centre=plt.Circle((0, 0), 0.45, fc='white', edgecolor=black_grad[1])
plt.gcf().gca().add_artist(centre)

# --- Histogram ---
countplt = plt.subplot(1, 2, 2)
plt.title('Histogram', fontweight='bold', fontsize=14, fontfamily='sans-serif',
          color=black_grad[0])
ax = sns.countplot(x='fbs', data=df, palette=colors, order=order,
                   edgecolor=black_grad[2], alpha=0.85)
for rect in ax.patches:
    ax.text (rect.get_x()+rect.get_width()/2,
             rect.get_height()+4.25,rect.get_height(),
             horizontalalignment='center', fontsize=10,
             bbox=dict(facecolor='none', edgecolor=black_grad[0], linewidth=0.25,
                       boxstyle='round'))

plt.xlabel('Fasting Blood Sugar', fontweight='bold', fontsize=11,
           fontfamily='sans-serif', color=black_grad[1])
plt.ylabel('Total', fontweight='bold', fontsize=11, fontfamily='sans-serif',
           color=black_grad[1])
plt.xticks([0, 1], labels)
plt.grid(axis='y', alpha=0.4)
countplt


# --- Count Categorical Labels w/out Dropping Null Walues ---
print('*' * 32)
print('\033[1m'+'.: Fasting Blood Sugar Total :.'+'\033[0m')
print('*' * 32)
df.fbs.value_counts(dropna=False)
```

```
********************************
.: Fasting Blood Sugar Total :.
********************************
```

Out[12]:

```
0    872
1    153
Name: fbs, dtype: int64
```



In [13]:

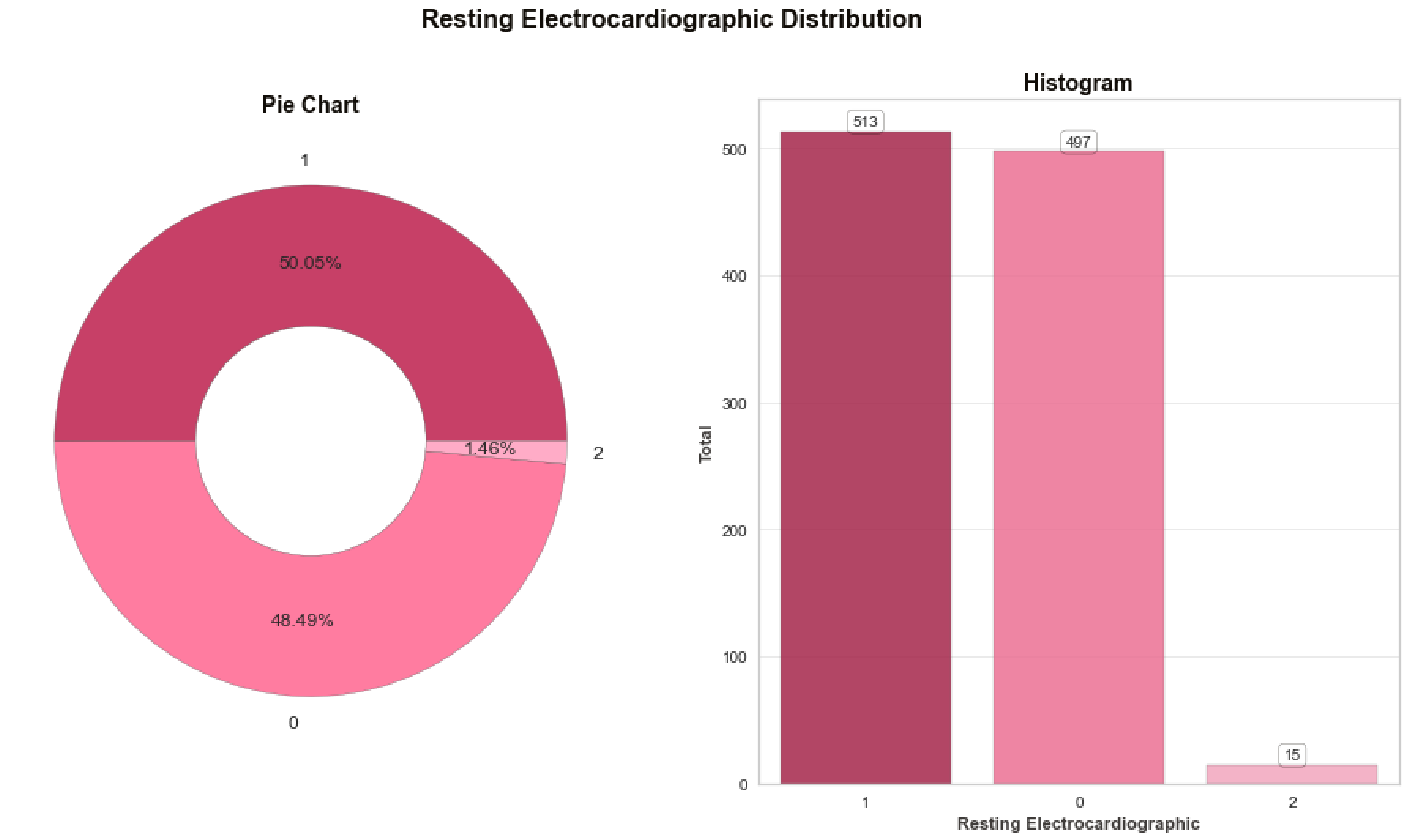
```
# --- Setting Colors, Labels, Order ---
colors=pink_grad[1:4]
labels=['1', '0', '2']
order=df['restecg'].value_counts().index

# --- Size for Both Figures ---
plt.figure(figsize=(16, 8))
plt.suptitle('Resting Electrocardiographic Distribution', fontweight='heavy',
             fontsize=16, fontfamily='sans-serif', color=black_grad[0])

# --- Pie Chart ---
plt.subplot(1,2,1)
plt.title('Pie Chart', fontweight='bold', fontsize=14, fontfamily='sans-serif',
          color=black_grad[0])
plt.pie(df['restecg'].value_counts(), labels=labels, colors=colors,
        wedgeprops=dict(alpha=0.8, edgecolor=black_grad[1]), autopct='%.2f%%',
        pctdistance=0.7, textprops={'fontsize':12})
centre=plt.Circle((0, 0), 0.45, fc='white', edgecolor=black_grad[1])
plt.gcf().gca().add_artist(centre)

# --- Histogram ---
countplt = plt.subplot(1, 2, 2)
plt.title('Histogram', fontweight='bold', fontsize=14, fontfamily='sans-serif',
          color=black_grad[0])
ax = sns.countplot(x='restecg', data=df, palette=colors, order=order,
                   edgecolor=black_grad[2], alpha=0.85)
for rect in ax.patches:
    ax.text (rect.get_x()+rect.get_width()/2,
             rect.get_height()+4.25,rect.get_height(),
             horizontalalignment='center', fontsize=10,
             bbox=dict(facecolor='none', edgecolor=black_grad[0], linewidth=0.25,
                       boxstyle='round'))

plt.xlabel('Resting Electrocardiographic', fontweight='bold', fontsize=11,
           fontfamily='sans-serif', color=black_grad[1])
plt.ylabel('Total', fontweight='bold', fontsize=11, fontfamily='sans-serif',
           color=black_grad[1])
plt.grid(axis='y', alpha=0.4)
countplt

# --- Count Categorical Labels w/out Dropping Null Walues ---
print('*' * 50)
print('\033[1m'+'.: Resting Electrocardiographic Results Total :.'+'\033[0m')
print('*' * 50)
df.restecg.value_counts(dropna=False)
```

```
**************************************************
```

```
.: Resting Electrocardiographic Results Total :.
**************************************************
```

Out[13]:

```
1    513
0    497
2     15
Name: restecg, dtype: int64
```


Resting Electrocardiographic Distribution

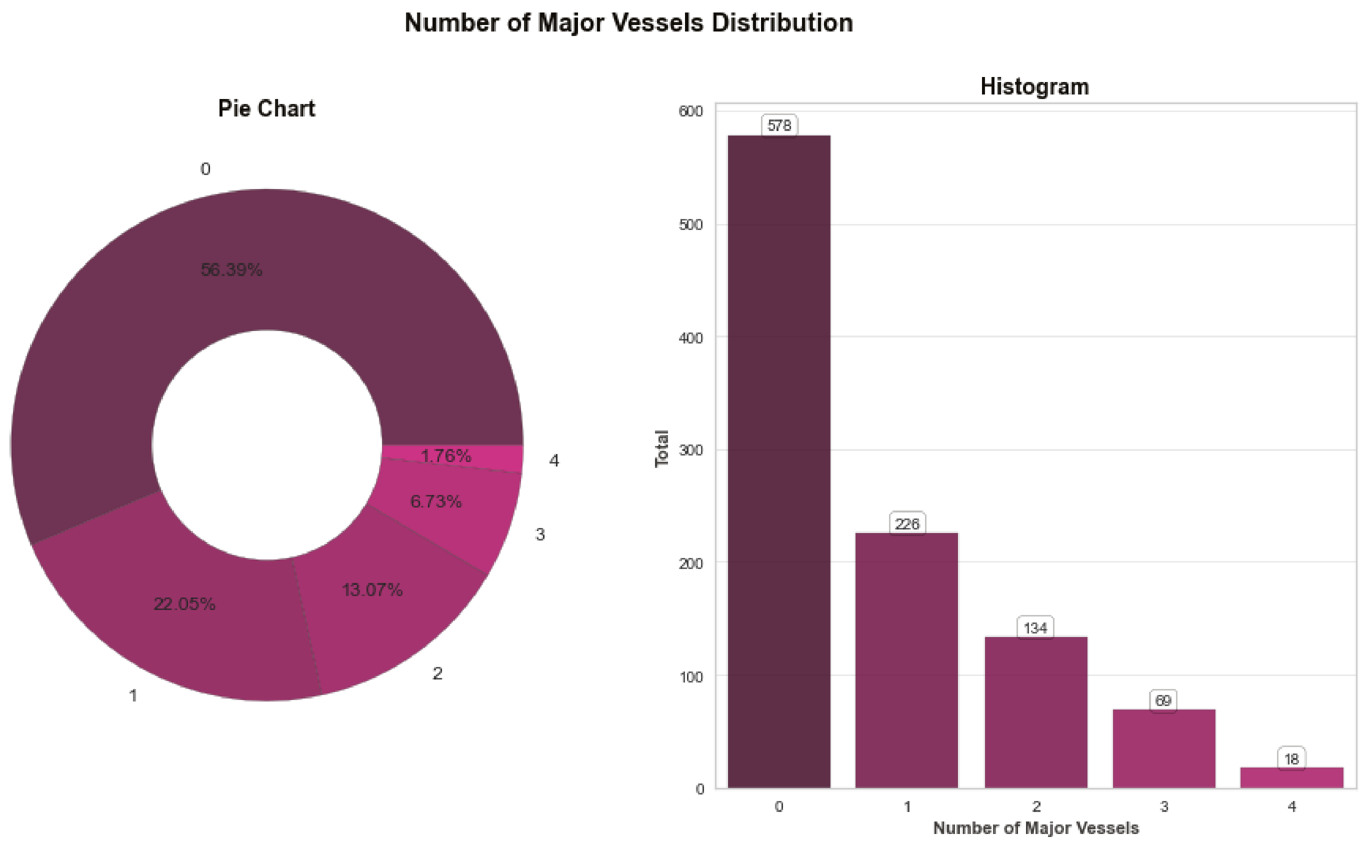
In [16]:

```
# --- Setting Colors, Labels, Order ---
colors=purple_grad
labels=['0', '1', '2', '3', '4']
order=df['ca'].value_counts().index

# --- Size for Both Figures ---
plt.figure(figsize=(16, 8))
plt.suptitle('Number of Major Vessels Distribution', fontweight='heavy',
             fontsize=16, fontfamily='sans-serif', color=black_grad[0])

# --- Pie Chart ---
plt.subplot(1,2,1)
plt.title('Pie Chart', fontweight='bold', fontsize=14, fontfamily='sans-serif',
          color=black_grad[0])
plt.pie(df['ca'].value_counts(), labels=labels, colors=colors,
        wedgeprops=dict(alpha=0.8, edgecolor=black_grad[1]),
        autopct='%.2f%%', pctdistance=0.7, textprops={'fontsize':12})

centre=plt.Circle((0, 0), 0.45, fc='white', edgecolor=black_grad[1])
plt.gcf().gca().add_artist(centre)

# --- Histogram ---
countplt = plt.subplot(1, 2, 2)
plt.title('Histogram', fontweight='bold', fontsize=14, fontfamily='sans-serif',
          color=black_grad[0])
ax = sns.countplot(x='ca', data=df, palette=colors, order=order,
                   edgecolor=black_grad[2], alpha=0.85)
for rect in ax.patches:
    ax.text (rect.get_x()+rect.get_width()/2,
             rect.get_height()+4.25,rect.get_height(),
             horizontalalignment='center', fontsize=10,
               bbox=dict(facecolor='none', edgecolor=black_grad[0], linewidth=0.25,
                         boxstyle='round'))

plt.xlabel('Number of Major Vessels', fontweight='bold', fontsize=11,
           fontfamily='sans-serif', color=black_grad[1])
plt.ylabel('Total', fontweight='bold', fontsize=11, fontfamily='sans-serif',
           color=black_grad[1])
plt.grid(axis='y', alpha=0.4)
countplt

# --- Count Categorical Labels w/out Dropping Null Walues ---
print('*' * 40)
print('\033[1m'+'.: Number of Major Vessels Total :.'+'\033[0m')
print('*' * 40)
df.ca.value_counts(dropna=False)
```

```
****************************************
.: Number of Major Vessels Total :.
****************************************
```

Out[16]:

```
0    578
1    226
2    134
3     69
4     18
Name: ca, dtype: int64
```



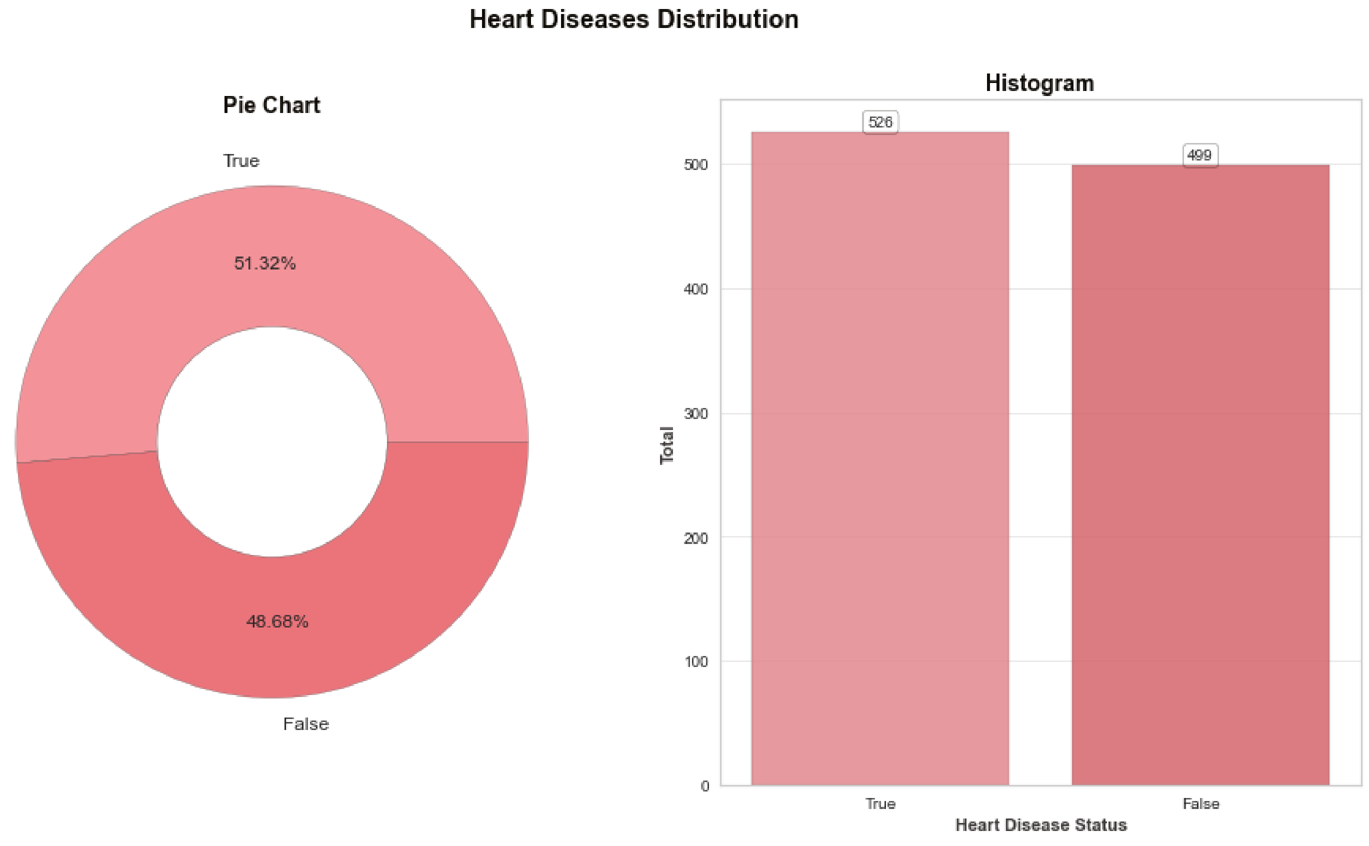
In [18]:

```
# --- Setting Colors, Labels, Order ---
colors=color_mix[3:5]
labels=['True', 'False']
order=df['target'].value_counts().index

# --- Size for Both Figures ---
plt.figure(figsize=(16,8))
plt.suptitle('Heart Diseases Distribution', fontweight='heavy',
             fontsize=16, fontfamily='sans-serif', color=black_grad[0])

# --- Pie Chart ---
plt.subplot(1, 2, 1)
plt.title('Pie Chart', fontweight='bold', fontsize=14, fontfamily='sans-serif',
          color=black_grad[0])
plt.pie(df['target'].value_counts(), labels=labels, colors=colors,
        wedgeprops=dict(alpha=0.8, edgecolor=black_grad[1]), autopct='%.2f%%',
        pctdistance=0.7, textprops={'fontsize':12})
centre=plt.Circle((0, 0), 0.45, fc='white', edgecolor=black_grad[1])
plt.gcf().gca().add_artist(centre)

# --- Histogram ---
countplt = plt.subplot(1, 2, 2)
plt.title('Histogram', fontweight='bold', fontsize=14, fontfamily='sans-serif',
          color=black_grad[0])
ax = sns.countplot(x='target', data=df, palette=colors, order=order,
                   edgecolor=black_grad[2], alpha=0.85)
for rect in ax.patches:
    ax.text (rect.get_x()+rect.get_width()/2,
             rect.get_height()+4.25,rect.get_height(),
             horizontalalignment='center', fontsize=10,
             bbox=dict(facecolor='none', edgecolor=black_grad[0], linewidth=0.25,
                       boxstyle='round'))

plt.xlabel('Heart Disease Status', fontweight='bold', fontsize=11,
           fontfamily='sans-serif', color=black_grad[1])
plt.ylabel('Total', fontweight='bold', fontsize=11, fontfamily='sans-serif',
           color=black_grad[1])
plt.xticks([0, 1], labels)
plt.grid(axis='y', alpha=0.4)
countplt

# --- Count Categorical Labels w/out Dropping Null Walues ---
print('*' * 45)
print('\033[1m'+'.: Heart Diseases Status (target) Total :.'+'\033[0m')
print('*' * 45)
df.target.value_counts(dropna=False)
```

```
*********************************************
.: Heart Diseases Status (target) Total :.
*********************************************
```

Out[18]:

```
1    526
0    499
Name: target, dtype: int64
```



In [21]:

```
# --- Descriptive Statistics ---
df.select_dtypes(exclude='object').describe()
```

Out[21]:

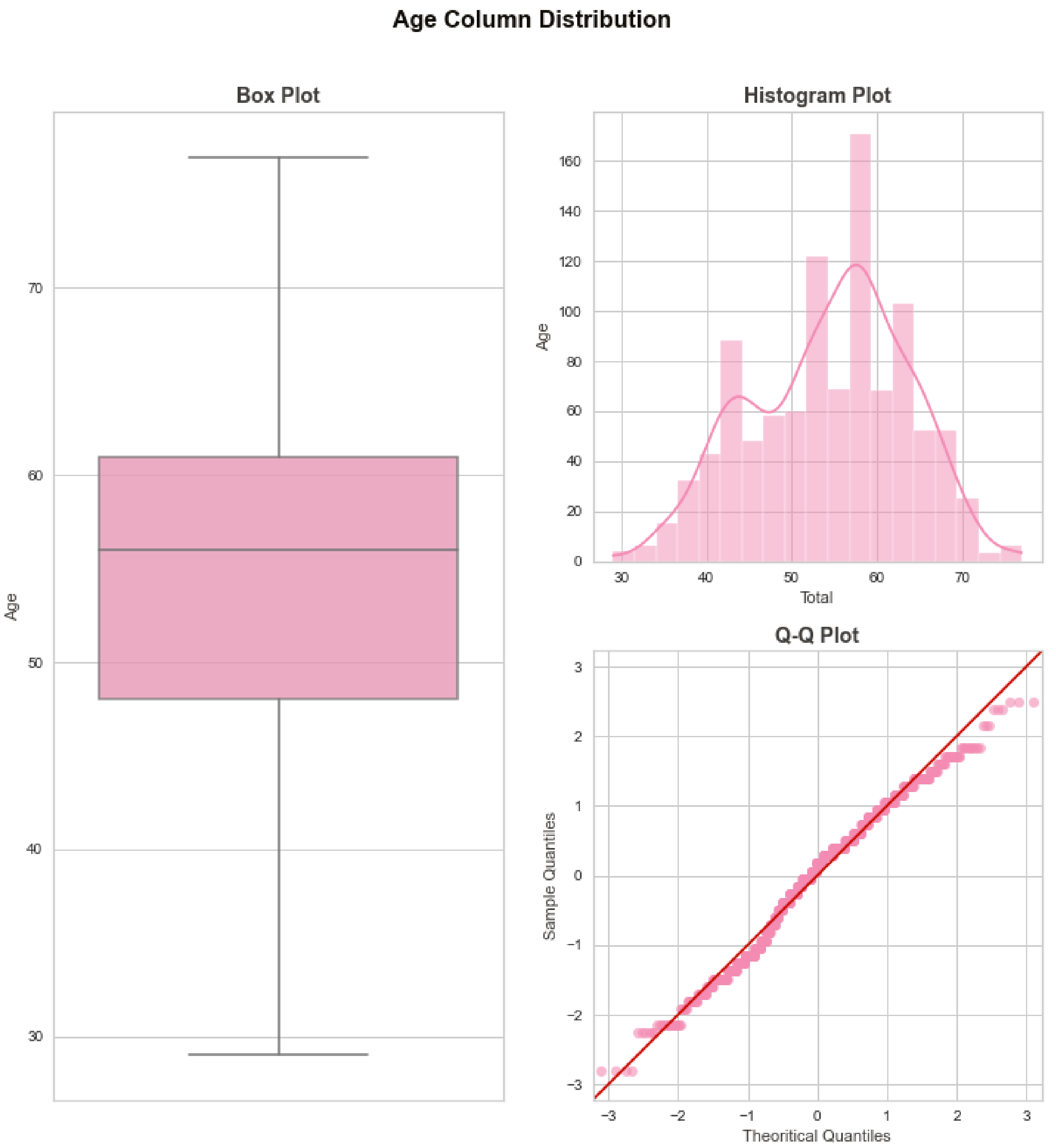
	age	trestbps	chol	thalach	oldpeak	target
count	1025.000000	1025.000000	1025.00000	1025.000000	1025.000000	1025.000000
mean	54.434146	131.611707	246.00000	149.114146	1.071512	0.513171
std	9.072290	17.516718	51.59251	23.005724	1.175053	0.500070
min	29.000000	94.000000	126.00000	71.000000	0.000000	0.000000
25%	48.000000	120.000000	211.00000	132.000000	0.000000	0.000000
50%	56.000000	130.000000	240.00000	152.000000	0.800000	1.000000
75%	61.000000	140.000000	275.00000	166.000000	1.800000	1.000000
max	77.000000	200.000000	564.00000	202.000000	6.200000	1.000000

In [23]:

```
# --- Variable, Color & Plot Size ---
var = 'age'
color = color_mix[0]
fig=plt.figure(figsize=(12, 12))

# --- Skewness & Kurtosis ---
print('\033[1m'+'.: Age Column Skewness & Kurtosis :.'+'\033[0m')
print('*' * 40)
print('Skewness:'+'\033[1m {:.3f}'.format(df[var].skew(axis = 0, skipna = True)))
print('\033[0m'+'Kurtosis:'+'\033[1m {:.3f}'.format(df[var].kurt(axis = 0, skipna = True
)))
print('\n')

# --- General Title ---
fig.suptitle('Age Column Distribution', fontweight='bold', fontsize=16,
             fontfamily='sans-serif', color=black_grad[0])
fig.subplots_adjust(top=0.9)

# --- Histogram ---
ax_1=fig.add_subplot(2, 2, 2)
plt.title('Histogram Plot', fontweight='bold', fontsize=14,
          fontfamily='sans-serif', color=black_grad[1])
sns.histplot(data=df, x=var, kde=True, color=color)
plt.xlabel('Total', fontweight='regular', fontsize=11,
           fontfamily='sans-serif', color=black_grad[1])
plt.ylabel('Age', fontweight='regular', fontsize=11, fontfamily='sans-serif',
           color=black_grad[1])

# --- Q-Q Plot ---
ax_2=fig.add_subplot(2, 2, 4)
plt.title('Q-Q Plot', fontweight='bold', fontsize=14,
          fontfamily='sans-serif', color=black_grad[1])
qqplot(df[var], fit=True, line='45', ax=ax_2, markerfacecolor=color,
       markeredgecolor=color, alpha=0.6)
plt.xlabel('Theoritical Quantiles', fontweight='regular', fontsize=11,
           fontfamily='sans-serif', color=black_grad[1])
plt.ylabel('Sample Quantiles', fontweight='regular', fontsize=11,
           fontfamily='sans-serif', color=black_grad[1])

# --- Box Plot ---
ax_3=fig.add_subplot(1, 2, 1)
plt.title('Box Plot', fontweight='bold', fontsize=14, fontfamily='sans-serif',
          color=black_grad[1])
sns.boxplot(data=df, y=var, color=color, boxprops=dict(alpha=0.8), linewidth=1.5)
plt.ylabel('Age', fontweight='regular', fontsize=11, fontfamily='sans-serif',
           color=black_grad[1])
```

```
plt.show()
```

```
.: Age Column Skewness & Kurtosis :.
****************************************
Skewness: -0.249
Kurtosis: -0.526
```

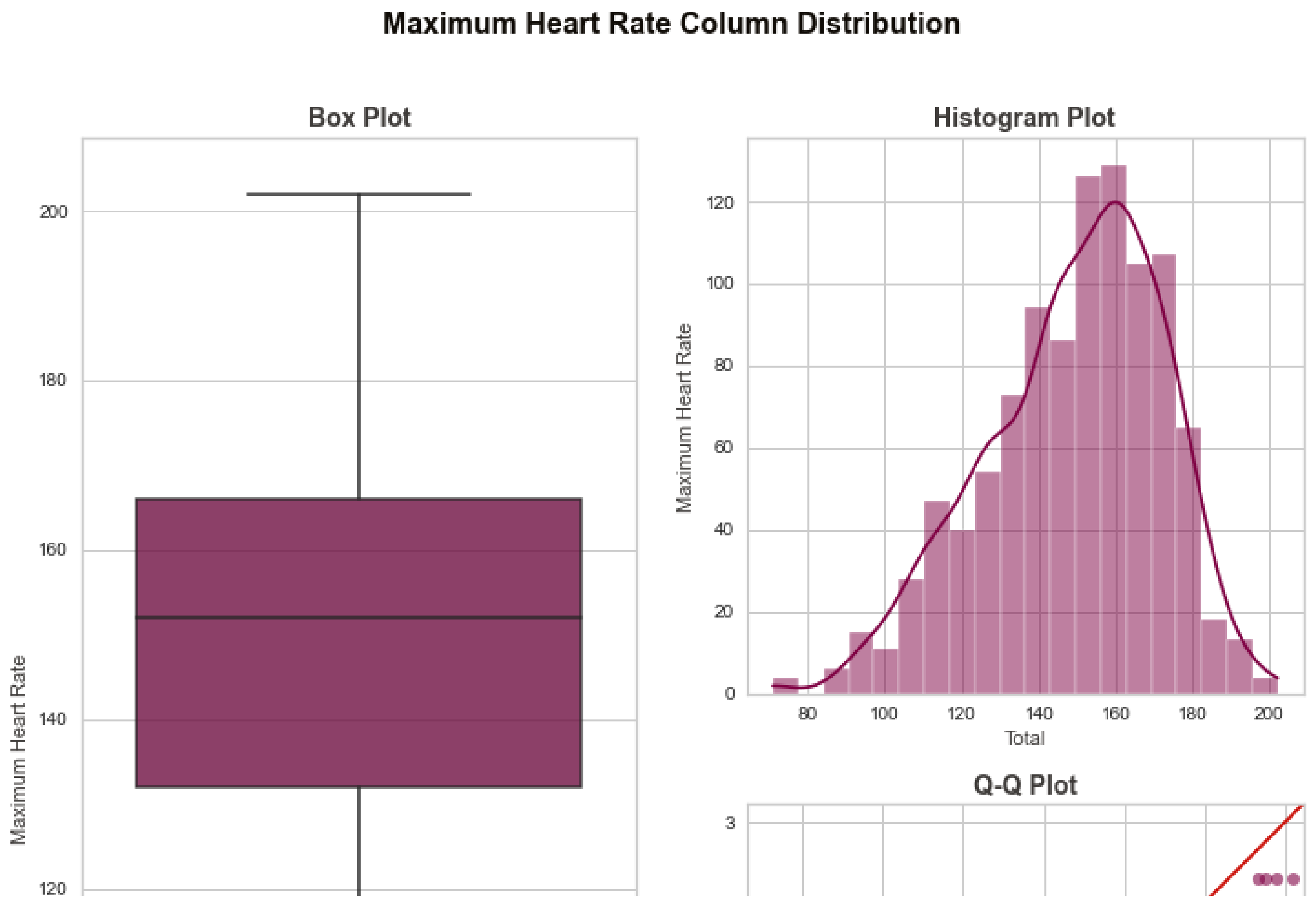


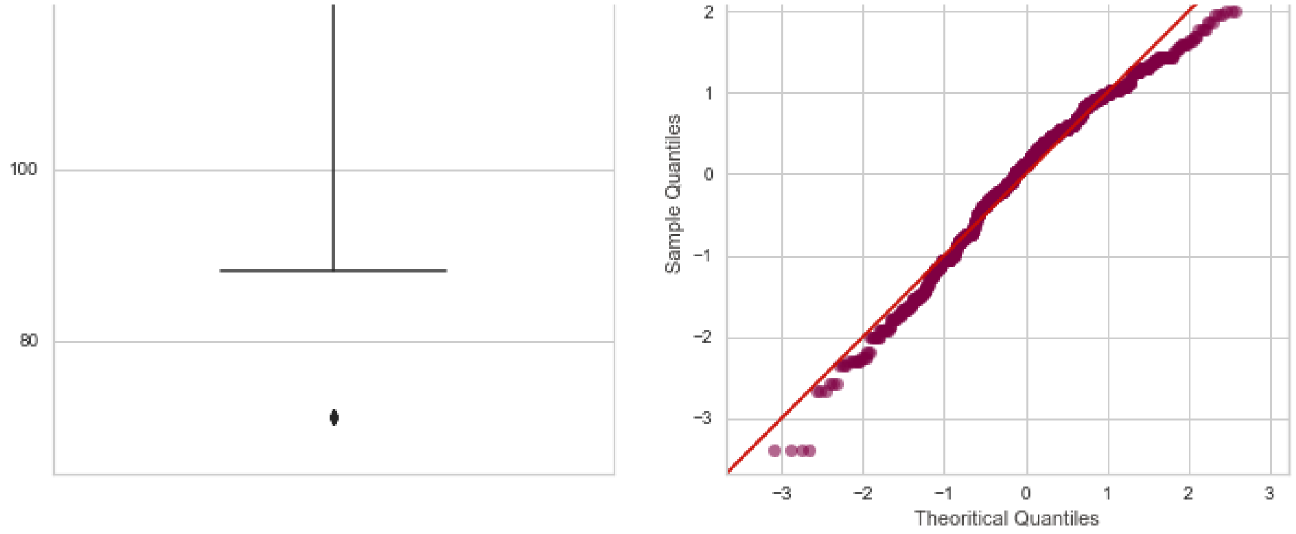
In [26]:

```
# --- Variable, Color & Plot Size ---
var = 'thalach'
color = purple_grad[1]
fig=plt.figure(figsize=(12, 12))

# --- Skewness & Kurtosis ---
print('\033[1m'+'.: Maximum Heart Rate Column Skewness & Kurtosis :.'+'\033[0m')
print('*' * 50)
print('Skewness:'+'\033[1m {:.3f}'.format(df[var].skew(axis = 0, skipna = True)))
print('\033[0m'+'Kurtosis:'+'\033[1m {:.3f}'.format(df[var].kurt(axis = 0, skipna = True
)))
print('\n')
```

```
# --- General Title ---
fig.suptitle('Maximum Heart Rate Column Distribution', fontweight='bold',
             fontsize=16, fontfamily='sans-serif', color=black_grad[0])
fig.subplots_adjust(top=0.9)

# --- Histogram ---
ax_1=fig.add_subplot(2, 2, 2)
plt.title('Histogram Plot', fontweight='bold', fontsize=14,
          fontfamily='sans-serif', color=black_grad[1])
sns.histplot(data=df, x=var, kde=True, color=color)
plt.xlabel('Total', fontweight='regular', fontsize=11,
           fontfamily='sans-serif', color=black_grad[1])
plt.ylabel('Maximum Heart Rate', fontweight='regular', fontsize=11,
           fontfamily='sans-serif', color=black_grad[1])

# --- Q-Q Plot ---
ax_2=fig.add_subplot(2, 2, 4)
plt.title('Q-Q Plot', fontweight='bold', fontsize=14, fontfamily='sans-serif',
          color=black_grad[1])
qqplot(df[var], fit=True, line='45', ax=ax_2, markerfacecolor=color,
       markeredgecolor=color, alpha=0.6)
plt.xlabel('Theoritical Quantiles', fontweight='regular', fontsize=11,
           fontfamily='sans-serif', color=black_grad[1])
plt.ylabel('Sample Quantiles', fontweight='regular', fontsize=11,
           fontfamily='sans-serif', color=black_grad[1])

# --- Box Plot ---
ax_3=fig.add_subplot(1, 2, 1)
plt.title('Box Plot', fontweight='bold', fontsize=14,
          fontfamily='sans-serif', color=black_grad[1])
sns.boxplot(data=df, y=var, color=color, boxprops=dict(alpha=0.8), linewidth=1.5)
plt.ylabel('Maximum Heart Rate', fontweight='regular', fontsize=11,
           fontfamily='sans-serif', color=black_grad[1])

plt.show()
```

```
.: Maximum Heart Rate Column Skewness & Kurtosis :.
************************************************
Skewness: -0.514
Kurtosis: -0.089
```





In [32]:

```
# --- Creating Dummy Variables for cp, thal and slope ---
cp = pd.get_dummies(df['cp'], prefix='cp')
thal = pd.get_dummies(df['thal'], prefix='thal')
slope = pd.get_dummies(df['slope'], prefix='slope')

# --- Merge Dummy Variables to Main Data Frame ---
frames = [df, cp, thal, slope]
df = pd.concat(frames, axis = 1)
```

In [34]:

```
df.head()
```

Out[34]:

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	...	cp_1	cp_2	cp_3	thal_0	thal_1	thal_2	thal_3	sl
0	52	1	0	125	212	0	1	168	0	1.0	...	0	0	0	0	0	0	1	
1	53	1	0	140	203	1	0	155	1	3.1	...	0	0	0	0	0	0	1	
2	70	1	0	145	174	0	1	125	1	2.6	...	0	0	0	0	0	0	1	
3	61	1	0	148	203	0	1	161	0	0.0	...	0	0	0	0	0	0	1	
4	62	0	0	138	294	1	1	106	0	1.9	...	0	0	0	0	0	1	0	

5 rows × 25 columns

In [35]:

```
# --- Drop Unnecessary Variables ---
df = df.drop(columns = ['cp', 'thal', 'slope'])
```

In [37]:

```
# --- Display New Data Frame ---
df.head()
```

Out[37]:

	age	sex	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	ca	...	cp_1	cp_2	cp_3	thal_0	thal_1	thal_2	thal_3	sl
0	52	1	125	212	0	1	168	0	1.0	2	...	0	0	0	0	0	0	1	
1	53	1	140	203	1	0	155	1	3.1	0	...	0	0	0	0	0	0	1	
2	70	1	145	174	0	1	125	1	2.6	0	...	0	0	0	0	0	0	1	
3	61	1	148	203	0	1	161	0	0.0	1	...	0	0	0	0	0	0	1	
4	62	0	138	294	1	1	106	0	1.9	3	...	0	0	0	0	0	1	0	

5 rows × 22 columns

In [38]:

```
# --- Seperating Dependent Features ---
x = df.drop(['target'], axis=1)
y = df['target']
```

In [39]:

```
# --- Data Normalization using Min-Max Method ---
x = MinMaxScaler().fit_transform(x)
```

In [40]:

```
# --- Splitting Dataset into 80:20 ---
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.2, random_state=4)
```

In [87]:

```
# --- Applying Logistic Regression ---
LRclassifier = LogisticRegression(max_iter=1000, random_state=1, solver='liblinear', penalty='l1')
LRclassifier.fit(x_train, y_train)
y_pred_LR = LRclassifier.predict(x_test)
# --- LR Accuracy ---
LRAcc = accuracy_score(y_pred_LR, y_test)
print('  Logistic Regression Accuracy:'+'\033[1m {:.2f}%'.format(LRAcc*100))
```

```
  Logistic Regression Accuracy: 83.90%
```

In [88]:

```
# --- Applying KNN ---
KNNClassifier = KNeighborsClassifier(n_neighbors=3)
KNNClassifier.fit(x_train, y_train)
y_pred_KNN = KNNClassifier.predict(x_test)
# --- KNN Accuracy ---
KNNAcc = accuracy_score(y_pred_KNN, y_test)
print(' K-Nearest Neighbour Accuracy:'+'\033[1m {:.2f}%'.format(KNNAcc*100))
```

```
 K-Nearest Neighbour Accuracy: 95.61%
```

In [89]:

```
# --- Applying SVM ---
SVMclassifier = SVC(kernel='linear', max_iter=1000, C=10, probability=True)
SVMclassifier.fit(x_train, y_train)
y_pred_SVM = SVMclassifier.predict(x_test)
# --- SVM Accuracy ---
SVMAcc = accuracy_score(y_pred_SVM, y_test)
print(' Support Vector Machine Accuracy:'+'\033[1m {:.2f}%'.format(SVMAcc*100))
```

```
 Support Vector Machine Accuracy: 83.90%
```

In [91]:

```
# --- Applying Random Forest ---
RFclassifier = RandomForestClassifier(n_estimators=1000, random_state=1, max_leaf_nodes=20, min_samples_split=15)
RFclassifier.fit(x_train, y_train)
y_pred_RF = RFclassifier.predict(x_test)# --- Random Forest Accuracy ---
RFAcc = accuracy_score(y_pred_RF, y_test)
print(' Random Forest Accuracy:'+'\033[1m {:.2f}%'.format(RFAcc*100))
```

```
 Random Forest Accuracy: 88.78%
```

In [93]:

```
# --- Applying Gradient Boosting ---
GBclassifier = GradientBoostingClassifier(random_state=1, n_estimators=100, max_leaf_nodes=3, loss='exponential',
                                          min_samples_leaf=20)
GBclassifier.fit(x_train, y_train)
y_pred_GB = GBclassifier.predict(x_test)# --- Gradient Boosting Accuracy ---
GBAcc = accuracy_score(y_pred_GB, y_test)
print('   Gradient Boosting Accuracy:'+'\033[1m {:.2f}%'.format(GBAcc*100))
```

```
   Gradient Boosting Accuracy: 86.83%
```

In [95]:

```
from sklearn.neural_network import MLPClassifier

MLPclf = MLPClassifier(hidden_layer_sizes=(15, 5), random_state=1, warm_start=True)

MLPclf.fit(x_train, y_train)
y_pred_MLP = MLPclf.predict(x_test)
# --- Gradient Boosting Accuracy ---
MLPAcc = accuracy_score(y_pred_MLP, y_test)
print('  MLP Accuracy:'+'\033[1m {:.2f}%'.format(MLPAcc*100))
```

```
  MLP Accuracy: 86.34%
```