Introduction To Business Analytics

Final Project

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Necessary Libraries and Dataset

In [1]:
```
#Import necessary libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import r2_score
```

In [2]:
```
#Read the dataset
data = pd.read_csv('insurance.csv')

#Print sample data
data.head()
```

Out[2]:

	age	sex	bmi	children	smoker	region	charges
0	19	female	27.900	0	yes	southwest	16884.92400
1	18	male	33.770	1	no	southeast	1725.55230
2	28	male	33.000	3	no	southeast	4449.46200
3	33	male	22.705	0	no	northwest	21984.47061
4	32	male	28.880	0	no	northwest	3866.85520

In [3]:
```
#Shape of the data(rows,columns)
data.shape
```

Out[3]: (1338, 7)

Exploratory Data Analysis (EDA)

Duplicates

In [4]:
```
#Check duplicates
duplicates = data.duplicated().sum()
print(f"Number of duplicate records: {duplicates}")

#Drop duplicates if any
data = data.drop_duplicates()
```

```
Number of duplicate records: 1
```

In [5]:
```
#Shape of the data after dropping duplicates
data.shape
```

Out[5]: (1337, 7)

Summary Statistics

In [6]:
```
#Summary statistics for potential outliers
print(data.describe())
```

```
               age          bmi     children       charges
count  1337.000000  1337.000000  1337.000000   1337.000000
mean     39.222139    30.663452     1.095737  13279.121487
std      14.044333     6.100468     1.205571  12110.359656
min      18.000000    15.960000     0.000000   1121.873900
25%      27.000000    26.290000     0.000000   4746.344000
50%      39.000000    30.400000     1.000000   9386.161300
75%      51.000000    34.700000     2.000000  16657.717450
max      64.000000    53.130000     5.000000  63770.428010
```

Missing Values

In [7]:
```
#Check for missing values
missing_values = data.isnull().sum()
print("Missing values in each column:\n", missing_values)
```

```
Missing values in each column:
 age         0
sex         0
bmi         0
children    0
smoker      0
region      0
charges     0
dtype: int64
```

Outliers

In [8]:
```
#Function to find which numerical columns have outliers
def find_outliers_iqr(df):
    outlier_columns = []
    for column in df.select_dtypes(include=['float64', 'int64']).columns:
        Q1 = df[column].quantile(0.25)
        Q3 = df[column].quantile(0.75)
        IQR = Q3 - Q1
        lower_bound = Q1 - 1.5 * IQR
        upper_bound = Q3 + 1.5 * IQR
        #Identify if there are any outliers
        outlier_mask = (df[column] < lower_bound) | (df[column] > upper_bound)
        if df[outlier_mask].shape[0] > 0:
            outlier_columns.append(column)
    return outlier_columns

#Find columns
outlier_columns = find_outliers_iqr(data)
print("Columns with outliers:", outlier_columns)
```

```
Columns with outliers: ['bmi', 'charges']
```

In [9]:
```
#Detecting Outliers using IQR for 'bmi' and 'charges'
def detect_outliers(df, column):
    Q1 = df[column].quantile(0.25)
    Q3 = df[column].quantile(0.75)
    IQR = Q3 - Q1
    lower_bound = Q1 - 1.5 * IQR
    upper_bound = Q3 + 1.5 * IQR
    return df[(df[column] < lower_bound) | (df[column] > upper_bound)]

#Outliers in 'bmi'
bmi_outliers = detect_outliers(data, 'bmi')
print(f"Number of outliers in 'bmi': {len(bmi_outliers)}")

#Outliers in 'charges'
charges_outliers = detect_outliers(data, 'charges')
print(f"Number of outliers in 'charges': {len(charges_outliers)}")
```

```
Number of outliers in 'bmi': 9
Number of outliers in 'charges': 139
```

In [10]:
```
#Function to cap outliers at 1st and 99th percentiles
def cap_outliers(df, column):
    lower_cap = df[column].quantile(0.01)
    upper_cap = df[column].quantile(0.99)
    df[column] = df[column].apply(lambda x: upper_cap if x > upper_cap else lower_cap if x < lower_cap else x)
    return df

#Cap outliers for 'bmi'
data = cap_outliers(data, 'bmi')

#Cap outliers for 'charges'
data = cap_outliers(data, 'charges')

data.shape
```

Out[10]:
```
(1337, 7)
```

Encode the smoker column - categorical column

In [11]:
```
#Encoding 'smoker' column: 'yes' -> 1, 'no' -> 0
data['smoker'] = data['smoker'].apply(lambda x: 1 if x == 'yes' else 0)

#Check the transformation
data.head()
```

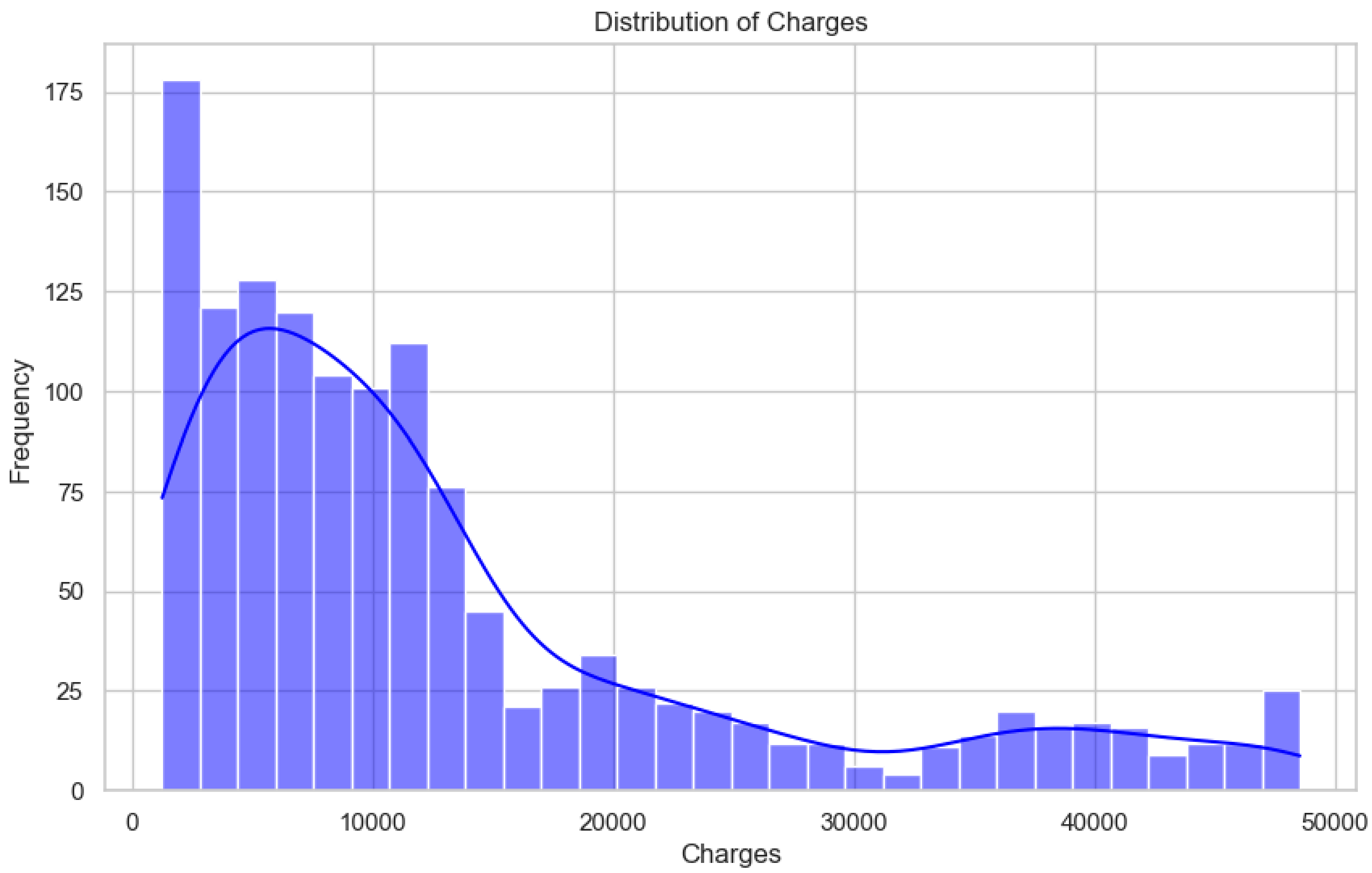
Out[11]:

	age	sex	bmi	children	smoker	region	charges
0	19	female	27.900	0	1	southwest	16884.92400
1	18	male	33.770	1	0	southeast	1725.55230
2	28	male	33.000	3	0	southeast	4449.46200
3	33	male	22.705	0	0	northwest	21984.47061
4	32	male	28.880	0	0	northwest	3866.85520

Data Visualization

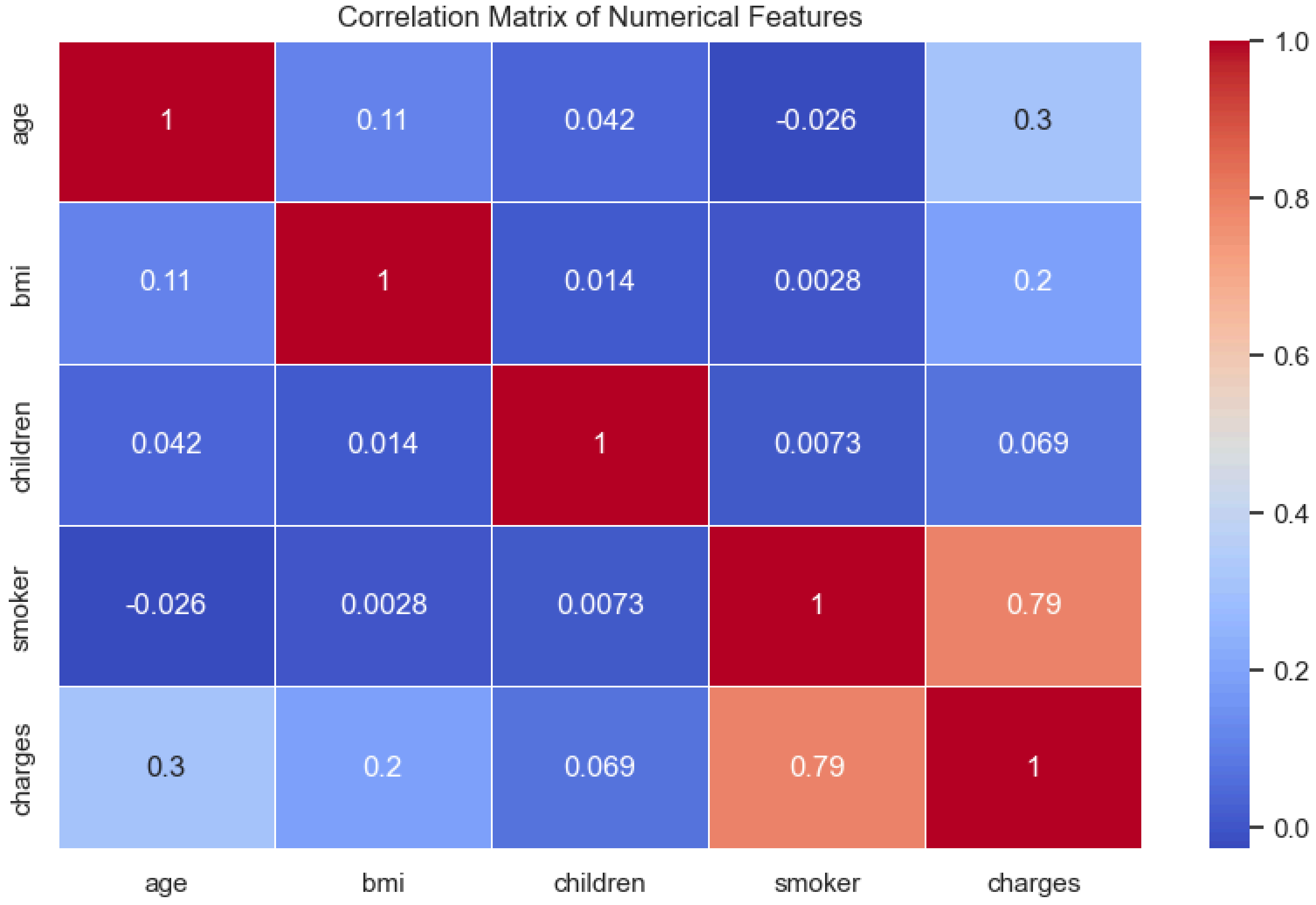
In [12]:
```
#Set style for plot
sns.set(style="whitegrid")

#Distribution of Charges
plt.figure(figsize=(10, 6))
sns.histplot(data['charges'], bins=30, kde=True, color='blue')
plt.title('Distribution of Charges')
plt.xlabel('Charges')
plt.ylabel('Frequency')
plt.show()
```



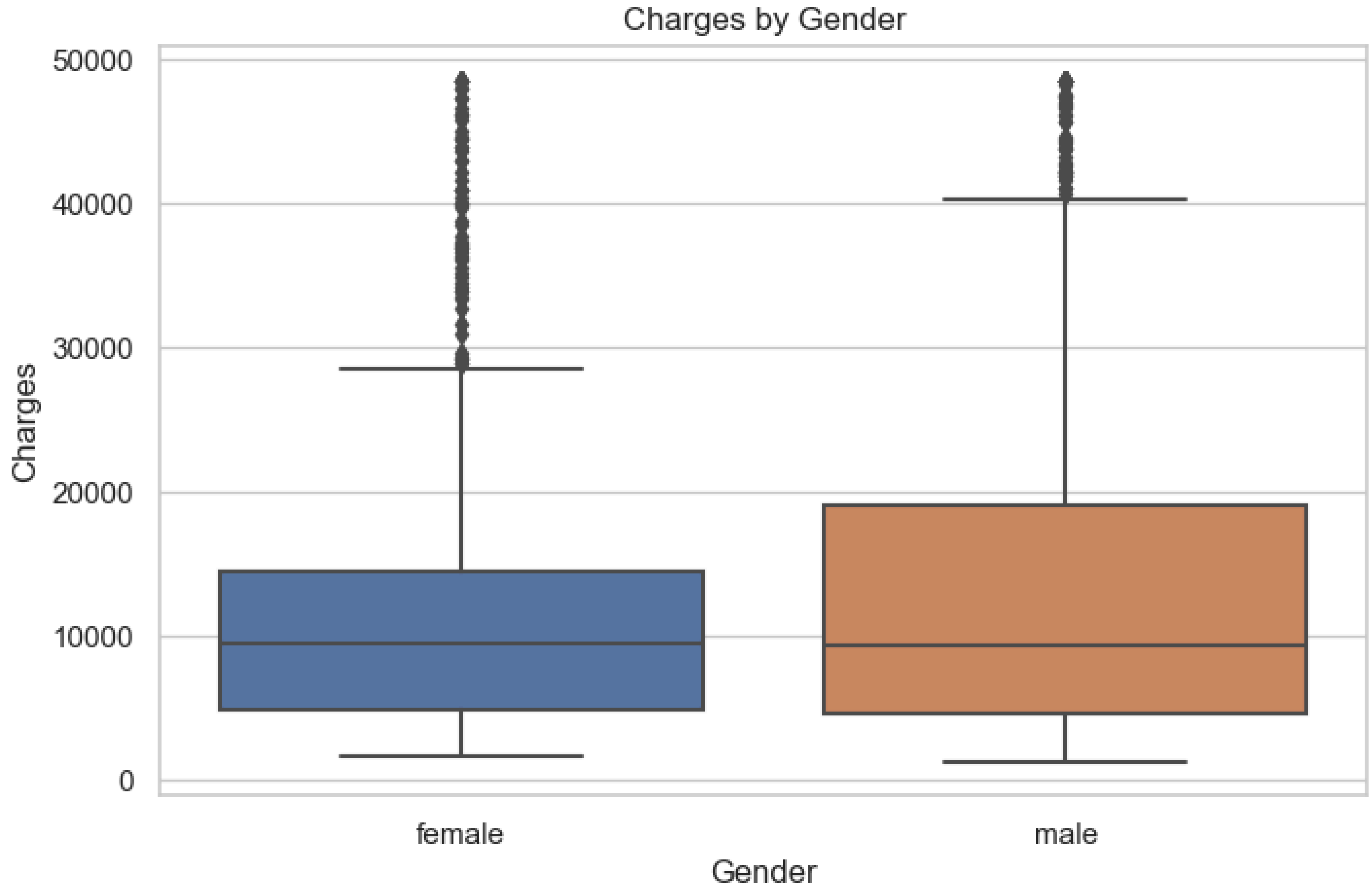
In [13]:
```
#Set style for plot
sns.set(style="whitegrid")

#Correlation Matrix
plt.figure(figsize=(10, 6))
corr_matrix = data[['age', 'bmi', 'children', 'smoker','charges']].corr()
sns.heatmap(corr_matrix, annot=True, cmap='coolwarm', linewidths=0.5)
plt.title('Correlation Matrix of Numerical Features')
plt.show()
```



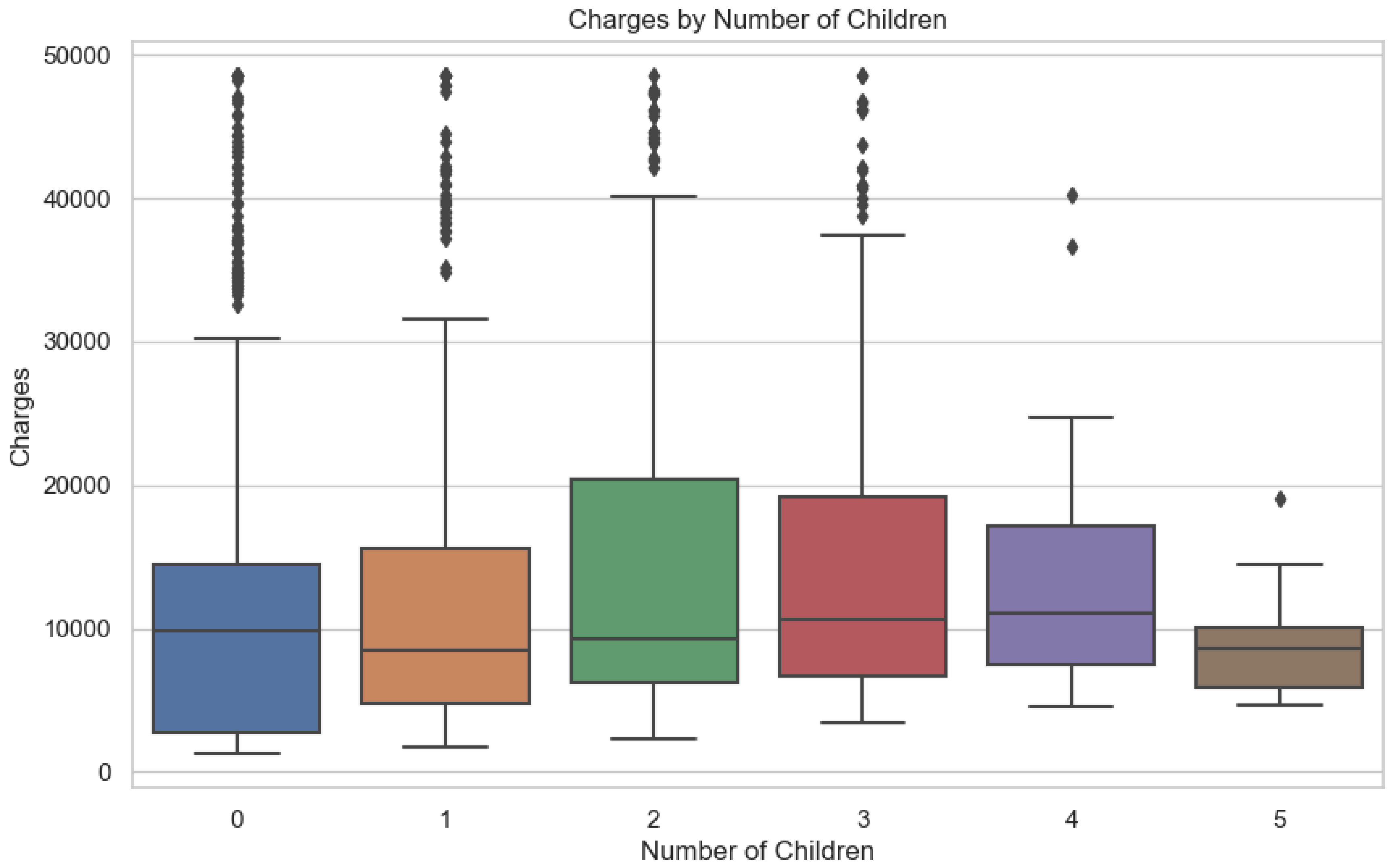
In [14]:
```
#Set style for plot
sns.set(style="whitegrid")

#Charges by Gender
plt.figure(figsize=(8, 5))
sns.boxplot(x='sex', y='charges', data=data)
plt.title('Charges by Gender')
plt.xlabel('Gender')
plt.ylabel('Charges')
plt.show()
```



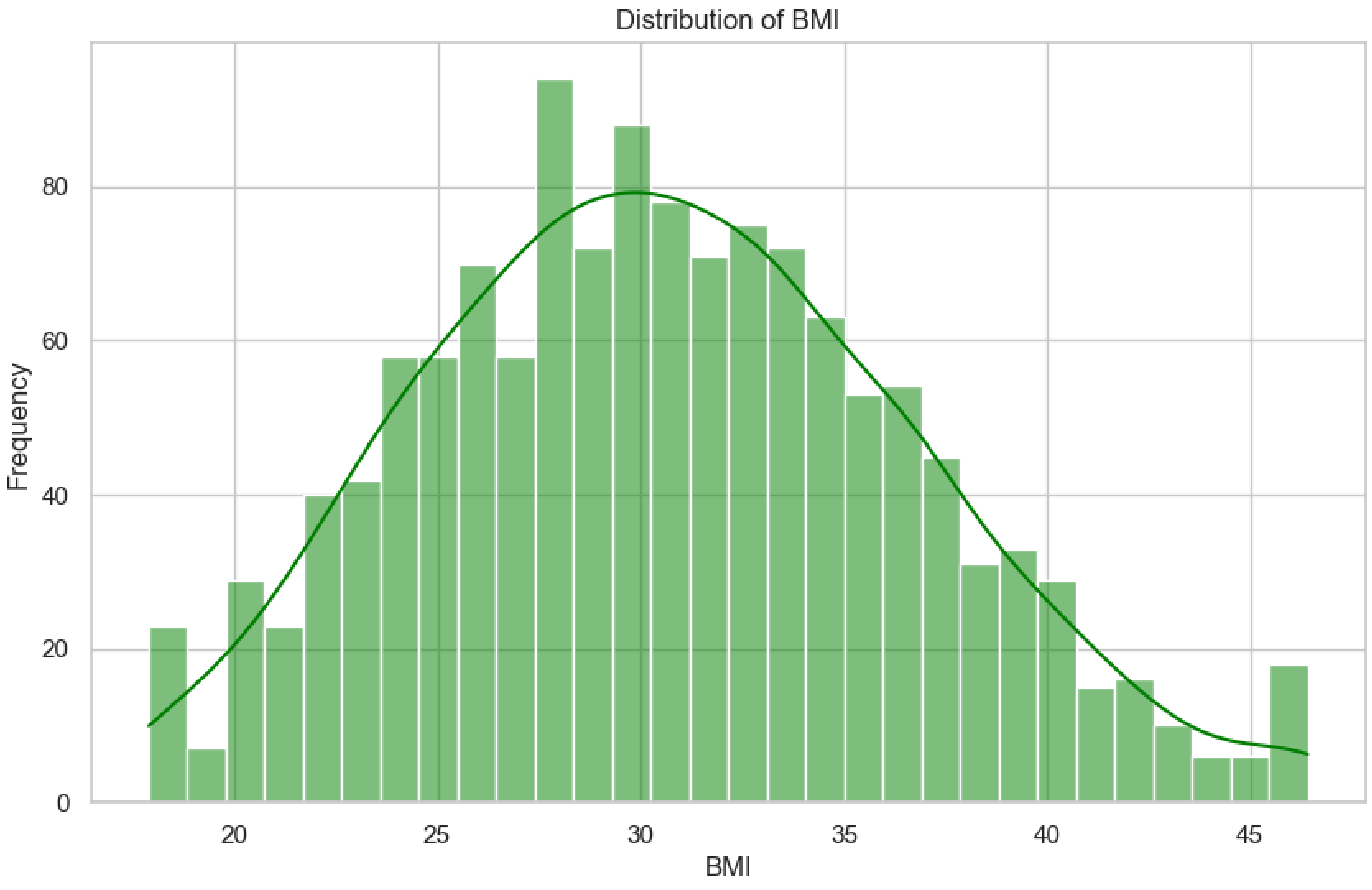
In [15]:
```
#Set style for plot
sns.set(style="whitegrid")

#Charges vs Number of Children
plt.figure(figsize=(10, 6))
sns.boxplot(x='children', y='charges', data=data)
plt.title('Charges by Number of Children')
plt.xlabel('Number of Children')
plt.ylabel('Charges')
plt.show()
```



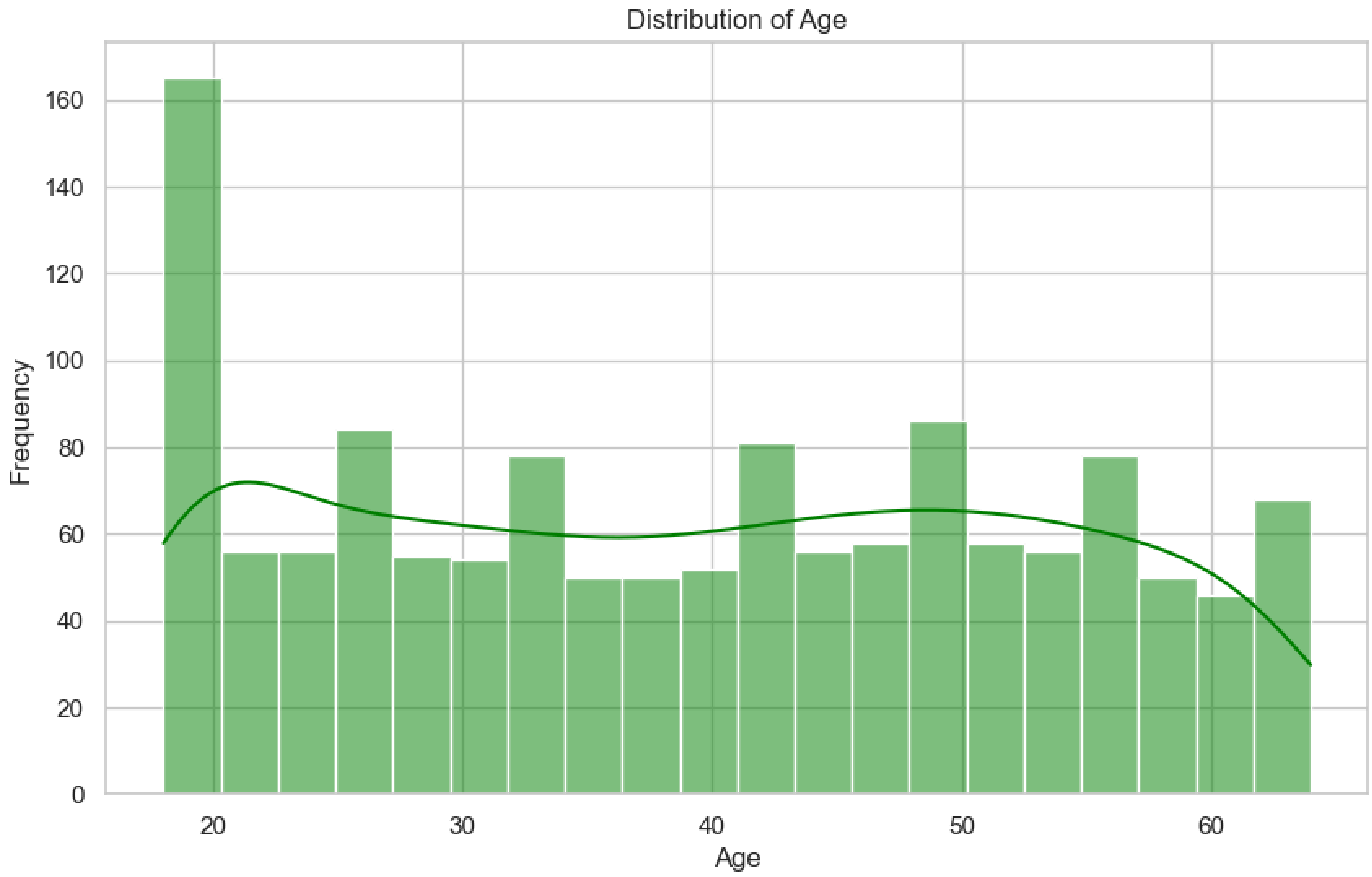
In [16]:
```
#Set style for plot
sns.set(style="whitegrid")

#Distribution of BMI
plt.figure(figsize=(10, 6))
sns.histplot(data['bmi'], bins=30, kde=True, color='green')
plt.title('Distribution of BMI')
plt.xlabel('BMI')
plt.ylabel('Frequency')
plt.show()
```



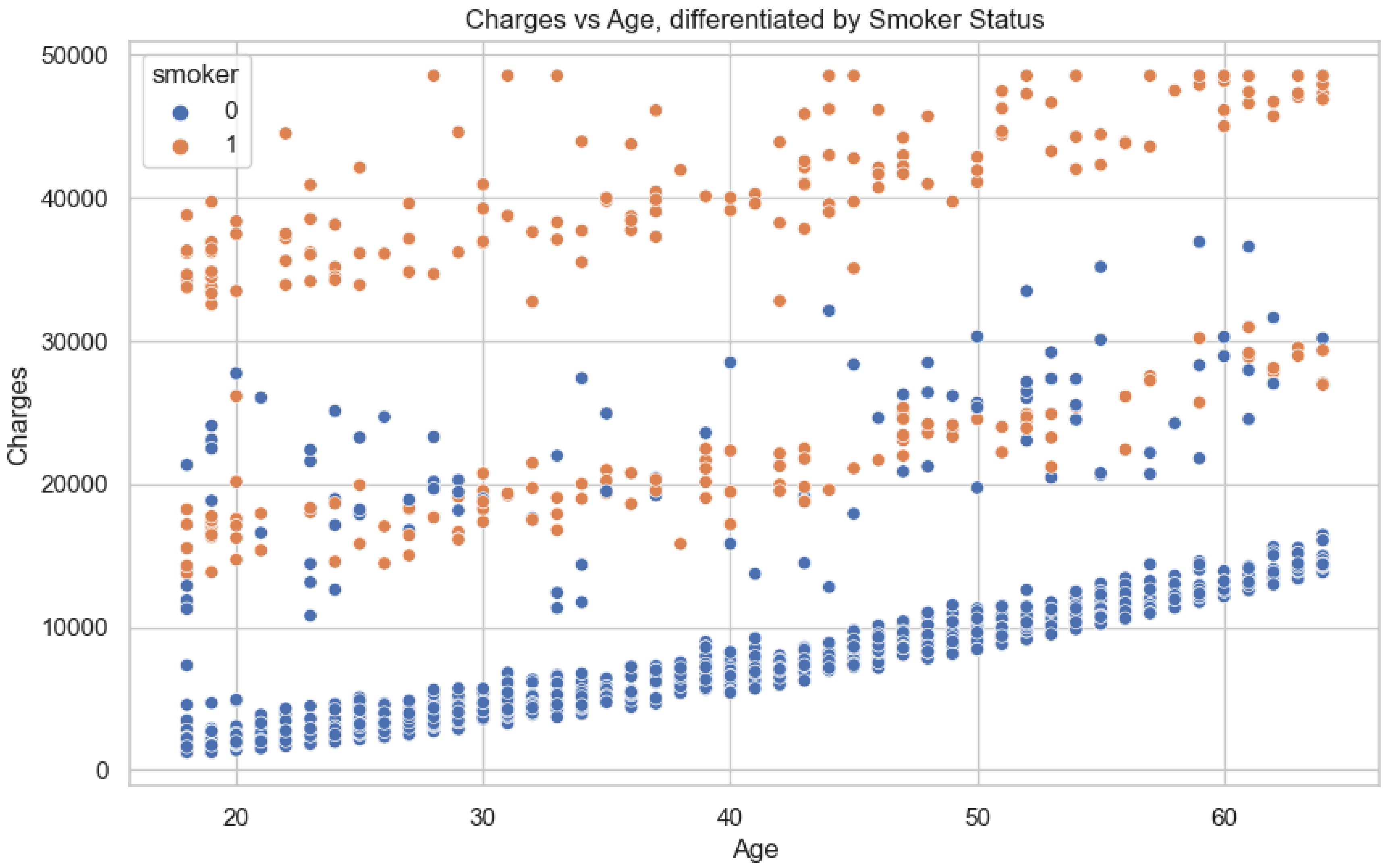
In [17]:
```
#Set style for plot
sns.set(style="whitegrid")

#Distribution of Age
plt.figure(figsize=(10, 6))
sns.histplot(data['age'], bins=20, kde=True, color='green')
plt.title('Distribution of Age')
plt.xlabel('Age')
plt.ylabel('Frequency')
plt.show()
```



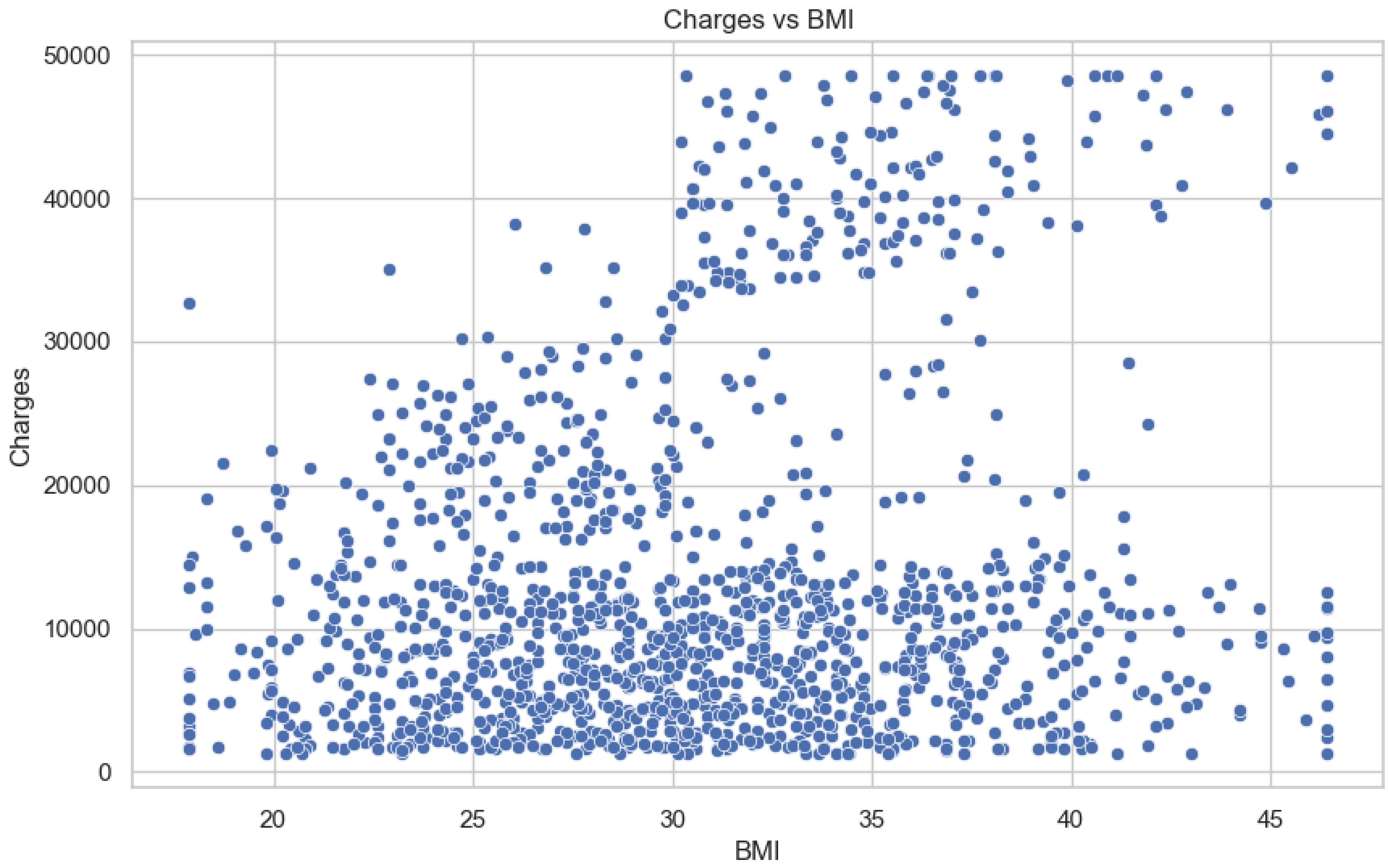
In [18]:
```
#Set style for plot
sns.set(style="whitegrid")

#Charges vs Age, differentiated by Smoker status
plt.figure(figsize=(10, 6))
sns.scatterplot(x='age', y='charges', hue='smoker', data=data)
plt.title('Charges vs Age, differentiated by Smoker Status')
plt.xlabel('Age')
plt.ylabel('Charges')
plt.show()
```



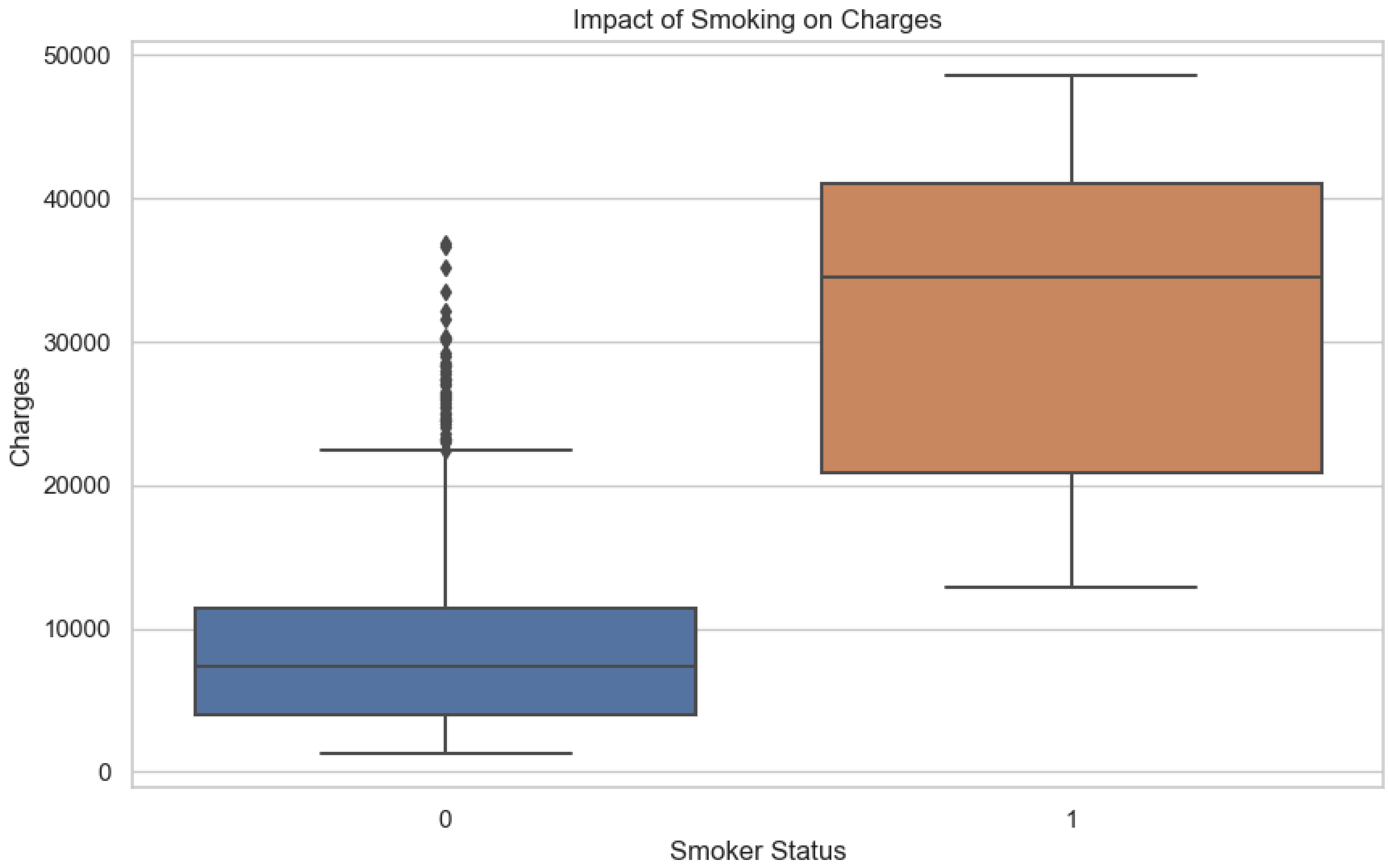
In [19]:
```
#Set style for plot
sns.set(style="whitegrid")

#Charges vs BMI
plt.figure(figsize=(10, 6))
sns.scatterplot(x='bmi', y='charges', data=data)
plt.title('Charges vs BMI')
plt.xlabel('BMI')
plt.ylabel('Charges')
plt.show()
```



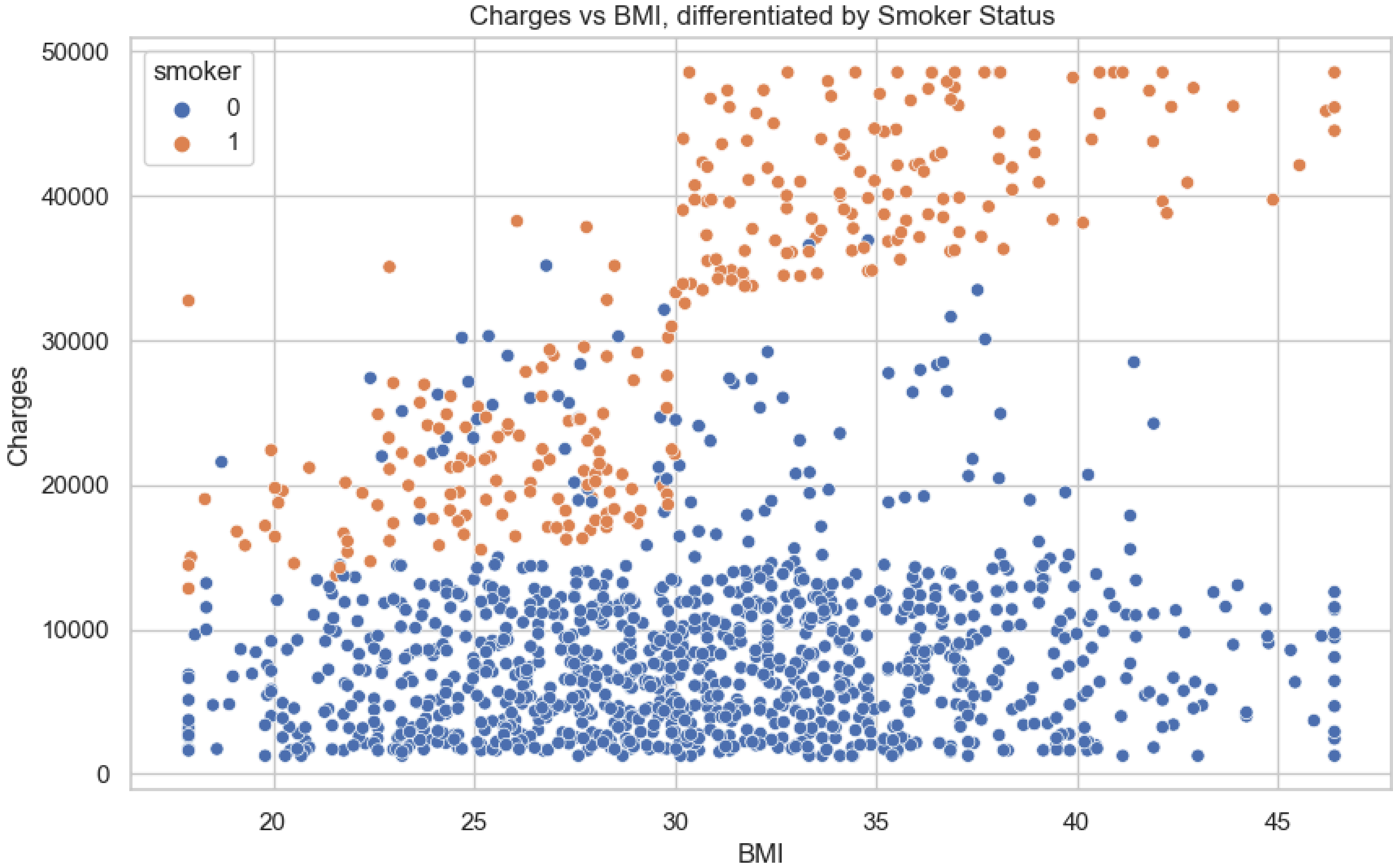
In [20]:
```
#Set style for plot
sns.set(style="whitegrid")

#Impact of Smoking on Charges
plt.figure(figsize=(10, 6))
sns.boxplot(x='smoker', y='charges', data=data)
plt.title('Impact of Smoking on Charges')
plt.xlabel('Smoker Status')
plt.ylabel('Charges')
plt.show()
```



In [21]:
```
#Set style for plot
sns.set(style="whitegrid")

#BMI vs Charges, differentiated by Smoker status
plt.figure(figsize=(10, 6))
sns.scatterplot(x='bmi', y='charges', hue='smoker', data=data)
plt.title('Charges vs BMI, differentiated by Smoker Status')
plt.xlabel('BMI')
plt.ylabel('Charges')
plt.show()
```



Linear Regression

Modeling

In [22]:
```
#Selecting the features (age, bmi, smoker) and target variable (charges)
X = data[['age', 'bmi', 'smoker']]
y = data['charges']
```

In [23]:
```
#Split the data into training and testing sets (70% train, 30% test)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

In [24]:
```
#Build the linear regression model
mlr_model = LinearRegression()
mlr_model.fit(X_train, y_train)
```

Out[24]:
```
▾ LinearRegression
LinearRegression()
```

In [25]:
```
#Predict on the test set
y_pred = mlr_model.predict(X_test)
```

In [26]:
```
#Output model coefficients
print("Coefficients:", mlr_model.coef_)
print("Intercept:", mlr_model.intercept_)
```

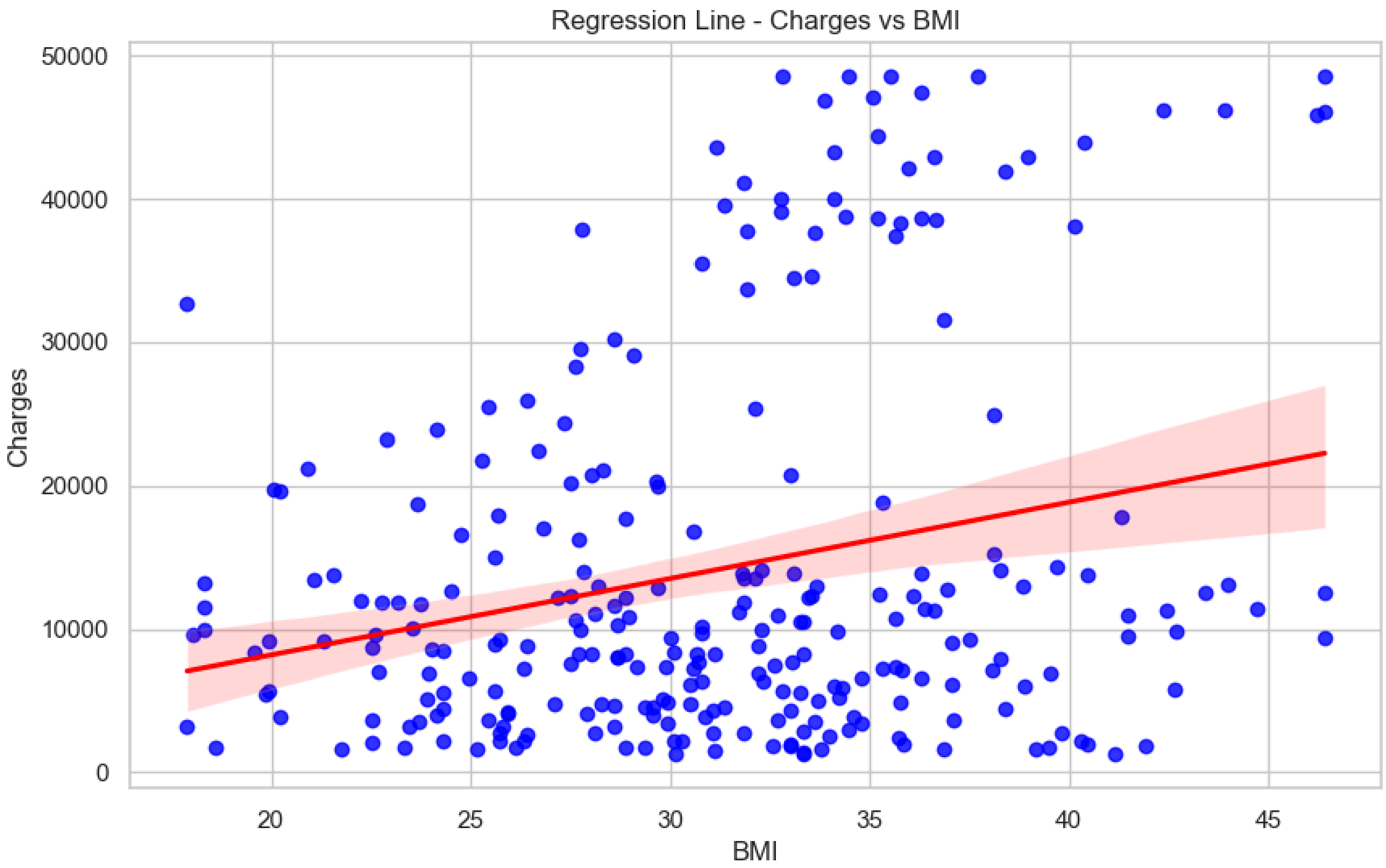
```
Coefficients: [  251.25291594   307.550037   22941.7278966 ]
Intercept: -10825.658774827712
```

Model Evaluation

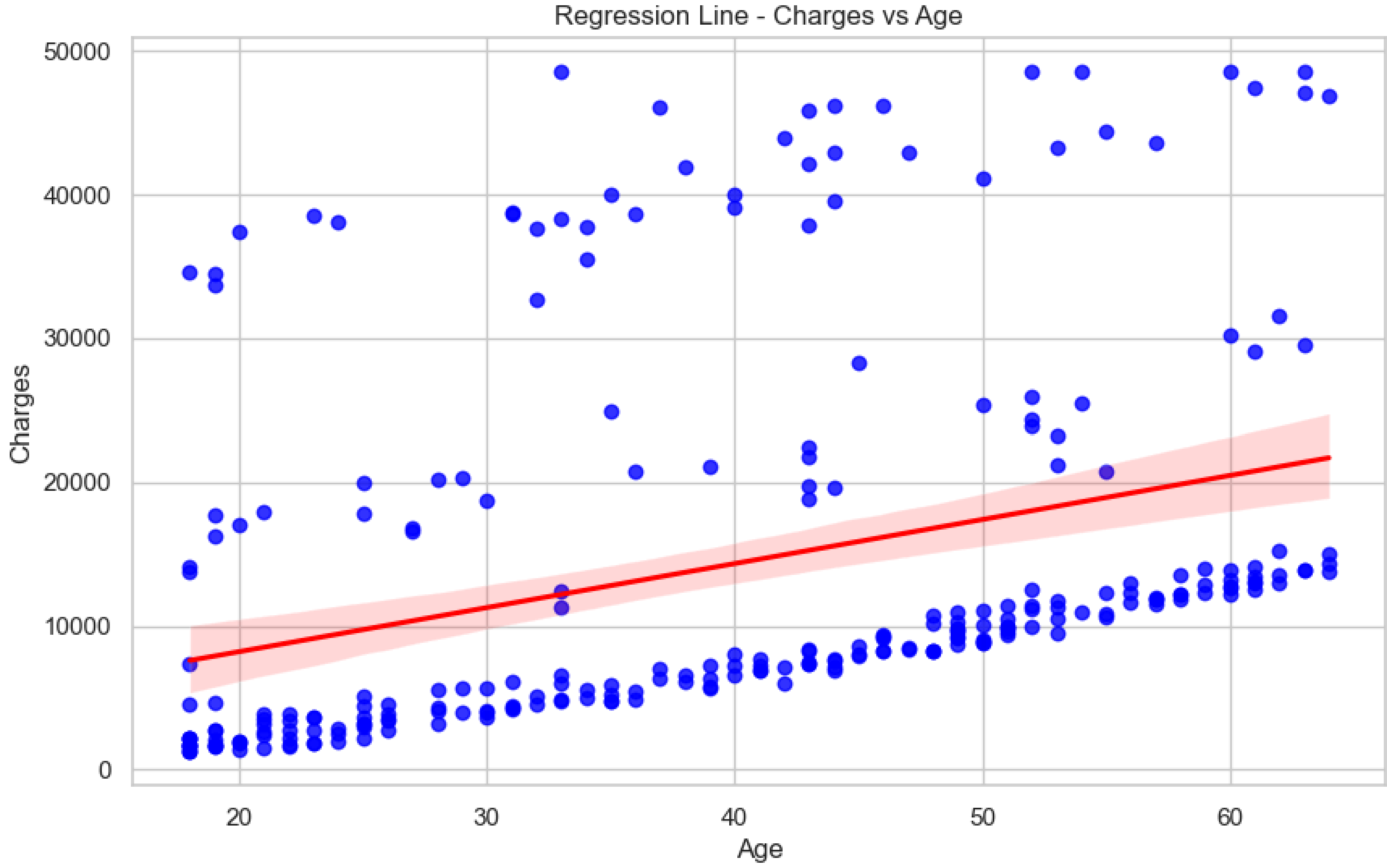
In [27]:
```
#Evaluate the model using r-squared
r_squared = r2_score(y_test, y_pred)
print(f"R-squared value: {r_squared}")
```

```
R-squared value: 0.8191380921263752
```

In [28]:
```
#Visualizing the relationship between 'bmi' and 'charges' with regression line
plt.figure(figsize=(10, 6))
sns.regplot(x=X_test['bmi'], y=y_test, scatter_kws={"color": "blue"}, line_kws={"color": "red"})
plt.title('Regression Line - Charges vs BMI')
plt.xlabel('BMI')
plt.ylabel('Charges')
plt.show()
```

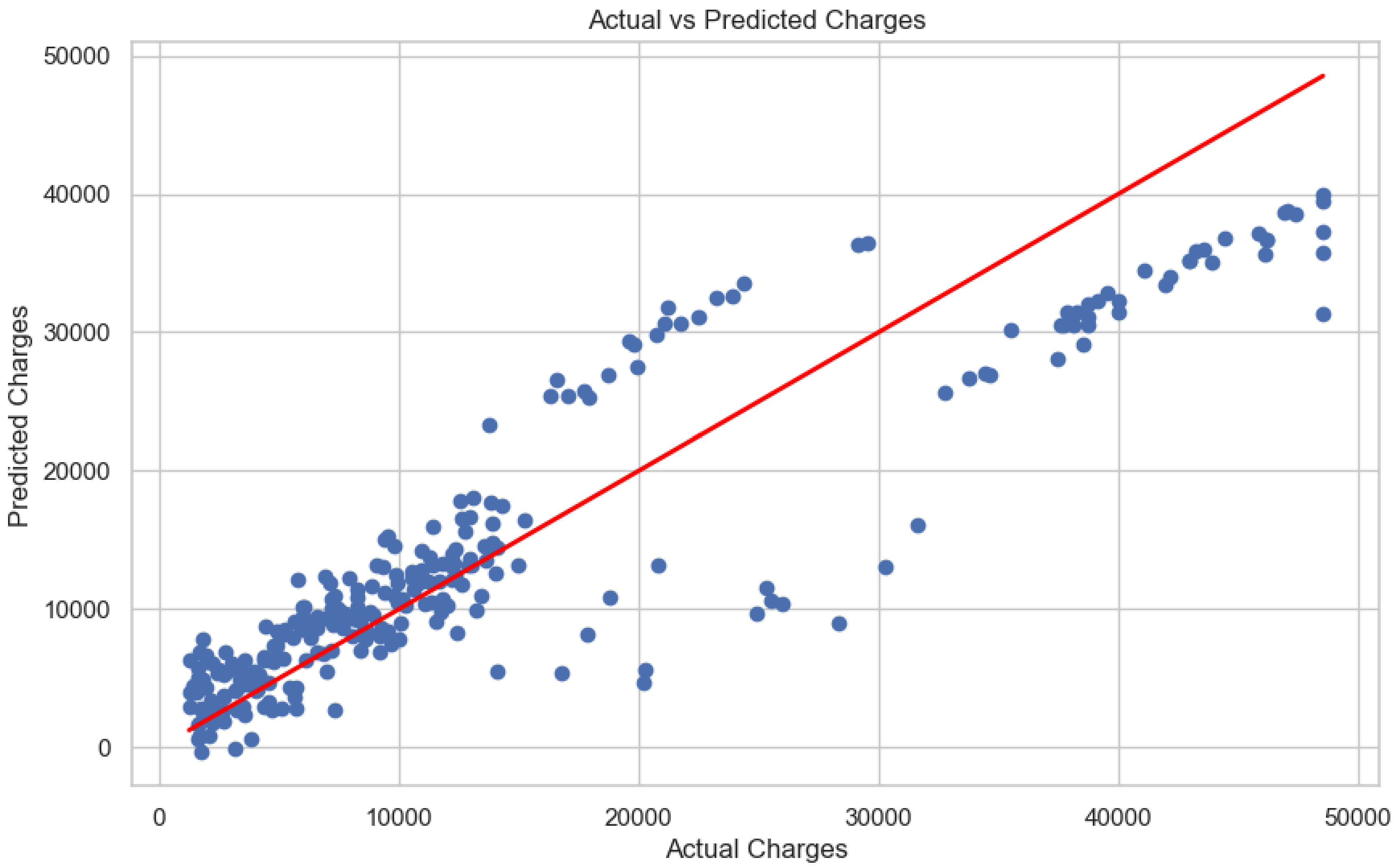


In [29]:
```
#Visualizing the relationship between 'bmi' and 'charges' with regression line
plt.figure(figsize=(10, 6))
sns.regplot(x=X_test['age'], y=y_test, scatter_kws={"color": "blue"}, line_kws={"color": "red"})
plt.title('Regression Line - Charges vs Age')
plt.xlabel('Age')
plt.ylabel('Charges')
plt.show()
```



Visualize Predictions

In [30]:
```
#Scatter plot: Actual vs Predicted charges
plt.figure(figsize=(10, 6))
plt.scatter(y_test, y_pred)
plt.plot([y_test.min(), y_test.max()], [y_test.min(), y_test.max()], color='red', lw=2)
plt.title('Actual vs Predicted Charges')
plt.xlabel('Actual Charges')
plt.ylabel('Predicted Charges')
plt.show()
```



In [31]:
```
#Residual Plot
plt.figure(figsize=(10, 6))
residuals = y_test - y_pred
plt.scatter(y_pred, residuals)
plt.axhline(0, color='red', linestyle='--')
plt.title('Residual Plot')
plt.xlabel('Predicted Charges')
plt.ylabel('Residuals')
plt.show()
```