Statistical analysis using SciPy and statsmodels

In [31]:
```
import warnings
import sys
if not sys.warnoptions:
    warnings.simplefilter("ignore")
```

Step 1: Setup and Dataset Loading

In [33]:
```
import seaborn as sns
import numpy as np
from scipy import stats
import statsmodels.api as sm
import matplotlib.pyplot as plt

# Load the tips dataset
tips = sns.load_dataset('tips')

# Display the first few rows of the dataset
print(tips.head())
```

```
   total_bill   tip     sex smoker  day    time  size
0       16.99  1.01  Female     No  Sun  Dinner     2
1       10.34  1.66    Male     No  Sun  Dinner     3
2       21.01  3.50    Male     No  Sun  Dinner     3
3       23.68  3.31    Male     No  Sun  Dinner     2
4       24.59  3.61  Female     No  Sun  Dinner     4
```

Step 2: Descriptive Statistics

In [35]:
```
# Descriptive statistics for 'total_bill' and 'tip'
columns = ['total_bill', 'tip']

for col in columns:
    print(f"Statistics for {col}:")
    print(f"Mean: {tips[col].mean()}")
    print(f"Median: {tips[col].median()}")
```

```
    print(f"Variance: {tips[col].var()}")
    print(f"Standard Deviation: {tips[col].std()}")
    print(f"Skewness: {stats.skew(tips[col])}")
    print(f"Kurtosis: {stats.kurtosis(tips[col])}\n")
```

```
Statistics for total_bill:
Mean: 19.78594262295082
Median: 17.795
Variance: 79.25293861397826
Standard Deviation: 8.902411954856856
Skewness: 1.1262346334818638
Kurtosis: 1.1691681323851366

Statistics for tip:
Mean: 2.99827868852459
Median: 2.9
Variance: 1.9144546380624725
Standard Deviation: 1.3836381890011826
Skewness: 1.4564266884221506
Kurtosis: 3.5495519893455114
```

Step 3: Hypothesis Testing

3.1 T-Test: Smokers vs. Non-Smokers

In [37]:
```
# Separate tips for smokers and non-smokers
smokers = tips[tips['smoker'] == 'Yes']['tip']
non_smokers = tips[tips['smoker'] == 'No']['tip']

# Perform independent t-test
t_stat, p_val = stats.ttest_ind(smokers, non_smokers)
print(f"T-Statistic: {t_stat}, P-Value: {p_val}")
```

```
T-Statistic: 0.09222805186888201, P-Value: 0.9265931522244976
```

3.2 Correlation Analysis

In [39]:
```
# Pearson correlation between total_bill and tip
corr, p_val = stats.pearsonr(tips['total_bill'], tips['tip'])
```

```
print(f"Correlation Coefficient: {corr}, P-Value: {p_val}")
```

```
Correlation Coefficient: 0.6757341092113645, P-Value: 6.692470646863819e-34
```

3.3 ANOVA Test

In [41]:
```
# Perform ANOVA for total_bill across days
anova_result = stats.f_oneway(
    tips[tips['day'] == 'Thur']['total_bill'],
    tips[tips['day'] == 'Fri']['total_bill'],
    tips[tips['day'] == 'Sat']['total_bill'],
    tips[tips['day'] == 'Sun']['total_bill']
)
print(f"F-Statistic: {anova_result.statistic}, P-Value: {anova_result.pvalue}")
```

```
F-Statistic: 2.7674794432863363, P-Value: 0.04245383328952047
```

Step 4: Regression Analysis

In [43]:
```
# Prepare data for regression
X = tips['total_bill']
y = tips['tip']

# Add a constant for the intercept
X = sm.add_constant(X)

# Fit the OLS model
model = sm.OLS(y, X).fit()

# Print the model summary
print(model.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                    tip   R-squared:                       0.457
Model:                            OLS   Adj. R-squared:                  0.454
Method:                 Least Squares   F-statistic:                     203.4
Date:                Sat, 28 Dec 2024   Prob (F-statistic):           6.69e-34
Time:                        17:24:40   Log-Likelihood:                -350.54
No. Observations:                 244   AIC:                             705.1
Df Residuals:                     242   BIC:                             712.1
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.9203      0.160      5.761      0.000       0.606       1.235
total_bill     0.1050      0.007     14.260      0.000       0.091       0.120
==============================================================================
Omnibus:                       20.185   Durbin-Watson:                   2.151
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               37.750
Skew:                           0.443   Prob(JB):                     6.35e-09
Kurtosis:                       4.711   Cond. No.                         53.0
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

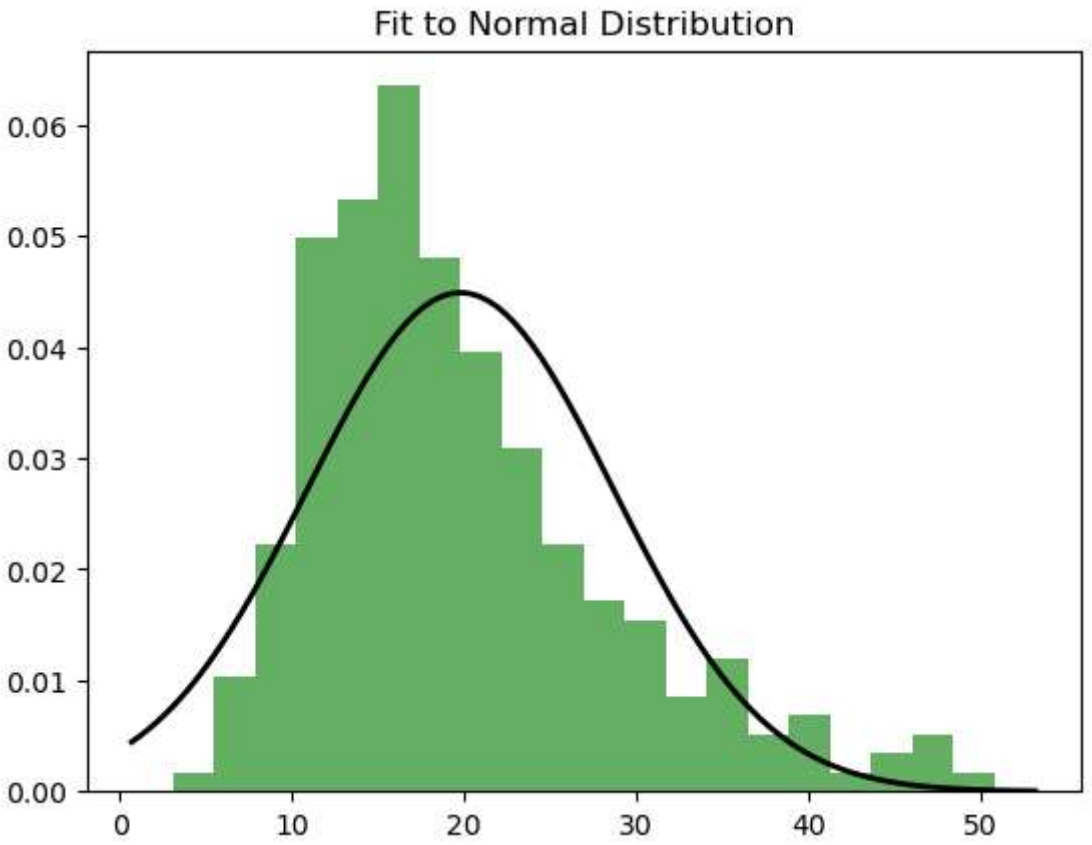
Step 5: Distribution Fitting

In [45]:
```python
# Fit total_bill to a normal distribution
mean, std = stats.norm.fit(tips['total_bill'])

# Plot histogram and PDF
plt.hist(tips['total_bill'], bins=20, density=True, alpha=0.6, color='g')
xmin, xmax = plt.xlim()
x = np.linspace(xmin, xmax, 100)
p = stats.norm.pdf(x, mean, std)
plt.plot(x, p, 'k', linewidth=2)
plt.title("Fit to Normal Distribution")
plt.show()

# Perform goodness-of-fit test
```

```
stat, p_val = stats.kstest(tips['total_bill'], 'norm', args=(mean, std))
print(f"Kolmogorov-Smirnov Test Statistic: {stat}, P-Value: {p_val}")
```




```
Kolmogorov-Smirnov Test Statistic: 0.1188459508899175, P-Value: 0.0018463244831193226
```

Interpreting Results

1. **Descriptive Statistics:** Understand the data's distribution and shape.
2. **Hypothesis Testing:**

   a. **T-Test:** Determine if smoking affects tipping. b. **Correlation:** Evaluate the strength and direction of the relationship between total bill and tip. c. **ANOVA:** Check if the day of the week impacts spending.

3. **Regression Analysis:** Assess the relationship between total bill and tip, including model significance.

4. **Distribution Fitting:** Evaluate if total_bill follows a normal distribution.