l2

August 1, 2024

0.1 LAB ASSIGNEMNT 02

Name: Imaad Hajwnae
Year: 4th
SRN: 202101132 / 23

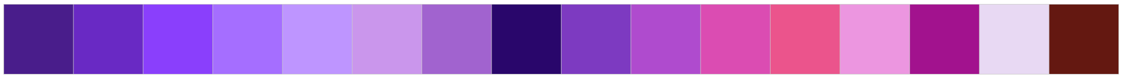
Topic: Implementation of:
1. Multiple Regression Model
2. Naive Bayis - Classification & Regression
3. Random Forest Classification
4. Decision Tree Regression

Import Libraries

[1]:
```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import seaborn as sns

from prettytable import PrettyTable
import missingno as msno
import matplotlib.pyplot as plt

data = pd.read_csv("C:
↪\\Users\\iamim\\OneDrive\\\Desktop\\Seventh_Semester\\ML_LAB\\L2\\df_arabica_clean.
↪csv")
```

COLOR PALLET INITIALIZATION

[22]:
```
purple = ['#491D8B', '#6929C4', '#8A3FFC', '#A56EFF',
          '#BE95FF', '#CA96EC', '#A163CF', '#29066B',
          '#7D3AC1', '#AF4BCE', '#DB4CB2', '#EB548C',
          '#EC96E0', '#A2128E', '#E8D9F3', '#641811']

sns.palplot(purple, size = 2)
```



[30]:
```
data = data.copy()
data.head(n=10).style.background_gradient(cmap="Purples_r")
```

[30]:
```
<pandas.io.formats.style.Styler at 0x1e3d3525b90>
```

[31]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 207 entries, 0 to 206
Data columns (total 41 columns):
 #   Column                 Non-Null Count  Dtype
---  ------                 --------------  -----
 0   Unnamed: 0             207 non-null    int64
 1   ID                     207 non-null    int64
 2   Country of Origin      207 non-null    object
 3   Farm Name              205 non-null    object
 4   Lot Number             206 non-null    object
 5   Mill                   204 non-null    object
 6   ICO Number             75 non-null     object
 7   Company                207 non-null    object
 8   Altitude               206 non-null    object
 9   Region                 205 non-null    object
 10  Producer               206 non-null    object
 11  Number of Bags         207 non-null    int64
 12  Bag Weight             207 non-null    object
 13  In-Country Partner     207 non-null    object
 14  Harvest Year           207 non-null    object
 15  Grading Date           207 non-null    object
 16  Owner                  207 non-null    object
 17  Variety                201 non-null    object
 18  Status                 207 non-null    object
 19  Processing Method      202 non-null    object
 20  Aroma                  207 non-null    float64
 21  Flavor                 207 non-null    float64
 22  Aftertaste             207 non-null    float64
 23  Acidity                207 non-null    float64
 24  Body                   207 non-null    float64
 25  Balance                207 non-null    float64
 26  Uniformity             207 non-null    float64
 27  Clean Cup              207 non-null    float64
 28  Sweetness              207 non-null    float64
 29  Overall                207 non-null    float64
 30  Defects                207 non-null    float64
 31  Total Cup Points       207 non-null    float64
 32  Moisture Percentage    207 non-null    float64
 33  Category One Defects   207 non-null    int64
 34  Quakers                207 non-null    int64
 35  Color                  207 non-null    object
 36  Category Two Defects   207 non-null    int64
 37  Expiration             207 non-null    object
 38  Certification Body     207 non-null    object
 39  Certification Address  207 non-null    object
 40  Certification Contact  207 non-null    object
dtypes: float64(13), int64(6), object(22)
memory usage: 66.4+ KB
```

[32]:
```
data.describe().T.style.background_gradient(cmap = "magma")
```

[32]:
```
<pandas.io.formats.style.Styler at 0x1e3d2512310>
```

[26]:
```
print("Totally there are {} null values in the dataset".format(df.isnull().
  ↪sum().sum()))
```

```
Totally there are 153 null values in the dataset
```

[34]:
```
table = PrettyTable()
table.field_names = ['Feature', 'Data Type']

for column in data.columns:
    column_dtype = str(data[column].dtype)
    table.add_row([column, column_dtype])

print(table)
```

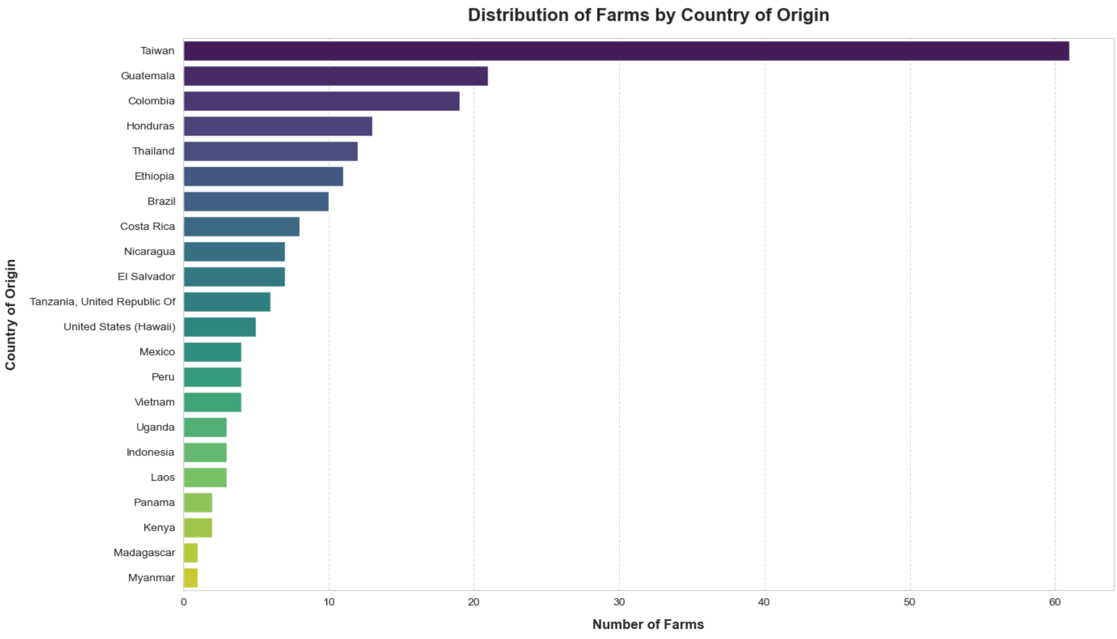
```
+-----------------------+-----------+
|        Feature        | Data Type |
+-----------------------+-----------+
|       Unnamed: 0      |   int64   |
|           ID          |   int64   |
|   Country of Origin   |   object  |
|       Farm Name       |   object  |
|       Lot Number      |   object  |
|          Mill         |   object  |
|       ICO Number      |   object  |
|        Company        |   object  |
|        Altitude       |   object  |
|         Region        |   object  |
|        Producer       |   object  |
|     Number of Bags    |   int64   |
|       Bag Weight      |   object  |
|   In-Country Partner  |   object  |
|      Harvest Year     |   object  |
|      Grading Date     |   object  |
|         Owner         |   object  |
|        Variety        |   object  |
|         Status        |   object  |
|   Processing Method   |   object  |
|         Aroma         |  float64  |
|         Flavor        |  float64  |
|       Aftertaste      |  float64  |
|        Acidity        |  float64  |
|          Body         |  float64  |
|        Balance        |  float64  |
|       Uniformity      |  float64  |
|       Clean Cup       |  float64  |
|       Sweetness       |  float64  |
|        Overall        |  float64  |
|        Defects        |  float64  |
|    Total Cup Points   |  float64  |
|  Moisture Percentage  |  float64  |
|  Category One Defects |   int64   |
|        Quakers        |   int64   |
|         Color         |   object  |
|  Category Two Defects |   int64   |
|       Expiration      |   object  |
|   Certification Body  |   object  |
| Certification Address |   object  |
| Certification Contact |   object  |
+-----------------------+-----------+
```

Data Visualization

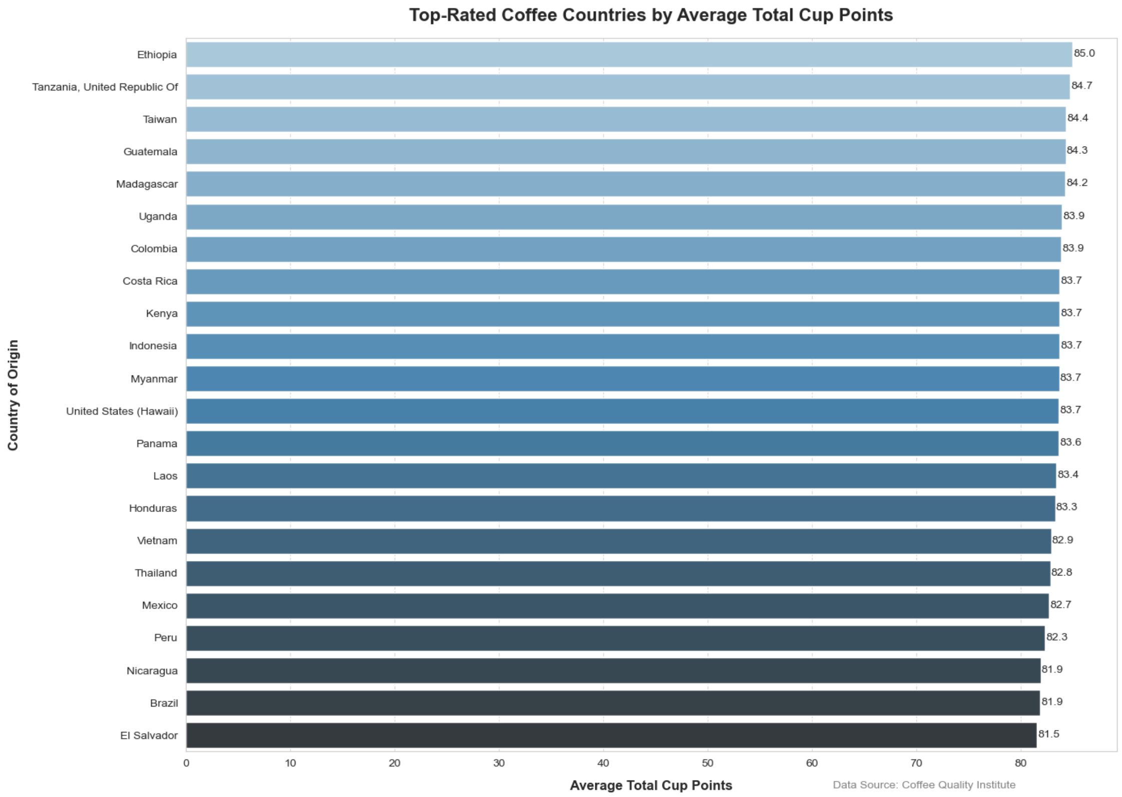
[35]:

```
# Set a style for the plot
sns.set_style('whitegrid')

# Create a figure and axis object with a specific size
plt.figure(figsize=(14, 8))

# Generate the count plot with improved aesthetics
sns.countplot(
    data=df,
    y='Country of Origin',
    order=df['Country of Origin'].value_counts().index,
    palette='viridis'  # Use a color palette for better aesthetics
)

# Add labels and title with improved fonts and styles
plt.xlabel('Number of Farms', fontsize=12, fontweight='bold', labelpad=10)
plt.ylabel('Country of Origin', fontsize=12, fontweight='bold', labelpad=10)
plt.title('Distribution of Farms by Country of Origin', fontsize=16,␣
  ↪fontweight='bold', pad=15)

# Add a grid for better readability
```

```
plt.grid(axis='x', linestyle='--', alpha=0.7)

# Adjust layout for better spacing
plt.tight_layout()

# Display the plot
plt.show()
```



[29]:
```
# Calculate average points for each country
average_points = data.groupby('Country of Origin')['Total Cup Points'].mean().
  ↪reset_index()

# Sort countries by average total cup points in descending order
sorted_countries = average_points.sort_values('Total Cup Points',␣
  ↪ascending=False)

# Set the style and color palette for the plot
sns.set_style('whitegrid')
palette = sns.color_palette('Blues_d', len(sorted_countries))

# Create the figure and axis
plt.figure(figsize=(14, 10))

# Generate the bar plot
sns.barplot(
    data=sorted_countries,
    x='Total Cup Points',
    y='Country of Origin',
    palette=palette
)

# Set the labels and title with enhanced fonts
plt.xlabel('Average Total Cup Points', fontsize=12, fontweight='bold', labelpad=10)
plt.ylabel('Country of Origin', fontsize=12, fontweight='bold', labelpad=10)
plt.title('Top-Rated Coffee Countries by Average Total Cup Points', fontsize=16, fontweight='bold', pad=15)

# Add a grid for better readability
plt.grid(axis='x', linestyle='--', alpha=0.7)

# Customize ticks
plt.xticks(fontsize=10)
plt.yticks(fontsize=10)

# Annotate bars with the average points value
for index, value in enumerate(sorted_countries['Total Cup Points']):
    plt.text(value + 0.1, index, f'{value:.1f}', va='center', fontsize=10)

# Add a legend or additional text if necessary
plt.figtext(0.9, 0.02, 'Data Source: Coffee Quality Institute', horizontalalignment='right', fontsize=10, color='gray')

# Adjust layout to prevent clipping of ylabel/title
plt.tight_layout()

# Display the plot
plt.show()
```



[37]:

```
import plotly.express as px

# Group by 'Country of Origin' and 'Farm Name', calculating the mean of 'Total␣
↪Cup Points'
average_points = data.groupby(['Country of Origin', 'Farm Name'])['Total Cup␣
↪Points'].mean().reset_index()

# Sort farms within each country by total cup points in descending order
sorted_farms = average_points.sort_values(['Country of Origin', 'Total Cup␣
↪Points'], ascending=[True, False])

# Select the top farm for each country
top_farms = sorted_farms.groupby('Country of Origin').first().reset_index()

# Create a scatter plot using Plotly Express
fig = px.scatter(
    top_farms,
    x='Total Cup Points',
    y='Country of Origin',
    text='Farm Name',
    title='Top Coffee Farms in Each Country',
    color='Total Cup Points',
    labels={'Total Cup Points': 'Average Total Cup Points'},
    size='Total Cup Points',
    size_max=15,
    hover_data={
        'Total Cup Points': ':.2f',  # Format Total Cup Points to two decimal␣
 ↪places
        'Country of Origin': True,
        'Farm Name': True
    },
    template='plotly_white'
)

# Update traces for better text position and marker aesthetics
fig.update_traces(
    textposition='top center',
    marker=dict(
        line=dict(width=1, color='DarkSlateGrey'),
        opacity=0.7
    )
)

# Update layout with enhanced title, axis labels, and grid
fig.update_layout(
    xaxis_title='Average Total Cup Points',
    yaxis_title='Country of Origin',
    title={
        'text': 'Top Coffee Farms in Each Country by Average Total Cup Points',
        'font': {'size': 20, 'family': 'Arial', 'color': 'DarkSlateGrey'},
        'x': 0.5,  # Center the title
        'xanchor': 'center'
    },
    xaxis=dict(
        tickfont=dict(size=12),
        titlefont=dict(size=14, family='Arial', color='Black'),
        gridcolor='LightGray',
        zerolinecolor='Gray'
    ),
    yaxis=dict(
        tickfont=dict(size=12),
        titlefont=dict(size=14, family='Arial', color='Black'),
        gridcolor='LightGray',
        zerolinecolor='Gray'
    ),
    coloraxis_colorbar=dict(
        title='Total Cup Points',
        thickness=15,
        len=0.5,
        yanchor='middle',
        xanchor='right',
        xpad=20
    ),
    hoverlabel=dict(
        bgcolor='white',
        font_size=12,
        font_family='Arial'
    ),
    margin=dict(l=60, r=60, t=80, b=60),  # Adjust margins
    width=900,
    height=600
)

# Show the plot
fig.show()
```

[38]:

```
columns = ['Flavor', 'Aroma', 'Aftertaste', 'Acidity', 'Body', 'Balance',
           'Uniformity', 'Sweetness', 'Overall']
data['Mean Score'] = data[columns].mean(axis=1)
best_coffee_row = data.loc[data['Mean Score'].idxmax()]
best_coffee_details = best_coffee_row[['Company', 'Variety', 'Country of␣
 ↪Origin', 'Farm Name', 'Processing Method']]
print("Best Coffee Combination:")
print("Company:", best_coffee_details['Company'])
print("Variety:", best_coffee_details['Variety'])
print("Country of Origin:", best_coffee_details['Country of Origin'])
print("Farm Name:", best_coffee_details['Farm Name'])
print("Processing Method:", best_coffee_details['Processing Method'])
```

```
Best Coffee Combination:
Company: Coffee Quality Union
Variety: Castillo
Country of Origin: Colombia
Farm Name: Finca El Paraiso
Processing Method: Double Anaerobic Washed
```

[39]:

```
import pandas as pd
import plotly.express as px

# Step 1: Calculate Farm Count per Company
company_counts = data['Company'].value_counts().reset_index()
company_counts.columns = ['Company', 'Farm Count']

# Step 2: Sort Companies by Farm Count in Descending Order
sorted_companies = company_counts.sort_values('Farm Count', ascending=False)
```

```python
# Step 3: Select Top 5 Companies with the Most Farms
top_companies = sorted_companies.head(5)

# Step 4: Analyze Moisture Percentage for Each Variety of Coffee in Top Companies
for company in top_companies['Company']:
    company_data = data[data['Company'] == company]

    # Calculate the average moisture percentage per variety for the company
    variety_moisture = company_data.groupby('Variety')['Moisture Percentage'].mean().reset_index()

    # Sort varieties by moisture percentage in ascending order
    sorted_varieties = variety_moisture.sort_values('Moisture Percentage', ascending=True)

    # Identify the variety with the best (lowest) moisture percentage
    best_variety = sorted_varieties.iloc[0]['Variety']

    # Step 5: Plot the Moisture Percentage for Each Variety
    fig = px.bar(
        sorted_varieties,
        x='Variety',
        y='Moisture Percentage',
        title=f'Average Moisture Percentage by Variety for {company}',
        labels={'Moisture Percentage': 'Average Moisture Percentage'},
        text='Moisture Percentage',
        template='plotly_white',
        color='Moisture Percentage',
        color_continuous_scale='Blues'
    )

    # Enhance the figure with additional layout and styling
    fig.update_traces(
        texttemplate='%{text:.2f}%',  # Format the moisture percentage to two decimal places
        textposition='outside',       # Place the text labels outside the bars
        marker=dict(
            line=dict(width=1, color='DarkSlateGrey')
        )
    )

    fig.update_layout(
        xaxis_title='Variety',
        yaxis_title='Average Moisture Percentage',
        title={
            'text': f'Average Moisture Percentage by Variety for {company}',
            'font': {'size': 20, 'family': 'Arial', 'color': 'DarkSlateGrey'},
            'x': 0.5,  # Center the title
            'xanchor': 'center'
        },
        xaxis=dict(
            tickfont=dict(size=12),
            titlefont=dict(size=14, family='Arial', color='Black'),
            gridcolor='LightGray',
            zerolinecolor='Gray'
        ),
        yaxis=dict(
            tickfont=dict(size=12),
            titlefont=dict(size=14, family='Arial', color='Black'),
            gridcolor='LightGray',
            zerolinecolor='Gray'
        ),
        margin=dict(l=60, r=60, t=80, b=60),  # Adjust margins
        width=900,
        height=600
    )

    # Display the plot
    fig.show()
```

[ ]:

```
```

[40]:

```
company_counts = data['Company'].value_counts().reset_index()
company_counts.columns = ['Company', 'Farm Count']
sorted_companies = company_counts.sort_values('Farm Count', ascending=False)
top_companies = sorted_companies.head(5)
for company in top_companies['Company']:
    company_data = data[data['Company'] == company]
    variety_flavor = company_data.groupby('Variety')['Flavor'].mean().
 ↪reset_index()
    sorted_varieties = variety_flavor.sort_values('Flavor', ascending=False)
    best_variety = sorted_varieties.iloc[0]['Variety']
    fig = px.bar(sorted_varieties, x='Variety', y='Flavor',
                 title=f'Best Flavor Variety for {company}', labels={'Flavor':␣
 ↪'Average Flavor'})

    fig.show()
```

[41]:

```
variety_counts = data['Variety'].value_counts().reset_index()
variety_counts.columns = ['Variety', 'Farm Count']
sorted_varieties = variety_counts.sort_values('Farm Count', ascending=False)
top_varieties = sorted_varieties.head(15)
fig = px.bar(top_varieties, x='Variety', y='Farm Count',
             title='Top Varieties', labels={'Farm Count': 'Number of Farms'})
fig.show()
fig = px.sunburst(top_varieties, path=['Variety'], values='Farm Count',
                  title='Top Varieties')
fig.show()
```

[42]:

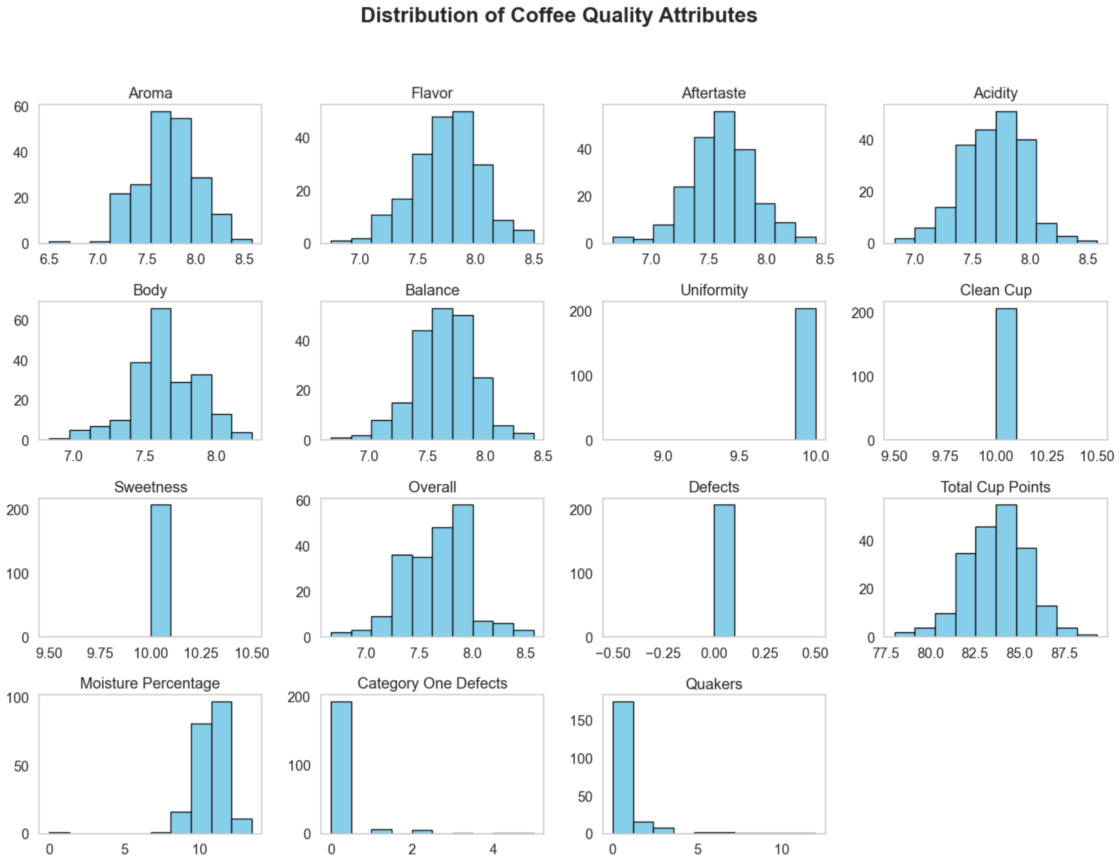
```
import pandas as pd
import plotly.express as px

# Step 1: Calculate the Number of Farms per Company
company_counts = data['Company'].value_counts().reset_index()
company_counts.columns = ['Company', 'Farm Count']

# Step 2: Sort Companies by Farm Count in Descending Order
sorted_companies = company_counts.sort_values('Farm Count', ascending=False)

# Step 3: Identify the Top Company with the Most Farms
top_company = sorted_companies.iloc[0]['Company']

# Step 4: Filter Data for the Top Company
top_company_data = data[data['Company'] == top_company]

# Step 5: Calculate the Number of Farms per Country for the Top Company
country_counts = top_company_data['Country of Origin'].value_counts().
 ↪reset_index()
country_counts.columns = ['Country', 'Farm Count']

# Step 6: Create a Choropleth Map to Show Farm Distribution by Country
fig = px.choropleth(
    country_counts,
    locations='Country',
    locationmode='country names',
    color='Farm Count',
    title=f'Distribution of Farms by Country for Top Company: {top_company}',
    labels={'Farm Count': 'Number of Farms'},
    color_continuous_scale=px.colors.sequential.Plasma,
    template='plotly_white',
    hover_data={'Country': True, 'Farm Count': True}
)

# Step 7: Enhance the Layout and Aesthetics of the Map
fig.update_geos(
    projection_type='natural earth',  # Use a natural earth projection
    showcountries=True,
    countrycolor='LightGrey',
    showcoastlines=True,
    coastlinecolor='LightBlue',
    showland=True,
    landcolor='whitesmoke'
)

fig.update_layout(
    title={
        'text': f'Distribution of Farms by Country for Top Company:␣
  ↪{top_company}',
        'font': {'size': 20, 'family': 'Arial', 'color': 'DarkSlateGrey'},
        'x': 0.5,  # Center the title
        'xanchor': 'center'
    },
    margin=dict(l=50, r=50, t=100, b=50),  # Adjust margins
    coloraxis_colorbar=dict(
        title='Number of Farms',
        thickness=15,
        len=0.5,
        yanchor='middle',
        xanchor='right',
        xpad=20
    ),
    hoverlabel=dict(
        bgcolor='white',
        font_size=12,
        font_family='Arial'
    ),
    width=1000,
    height=600
)

# Step 8: Display the Choropleth Map
fig.show()
```

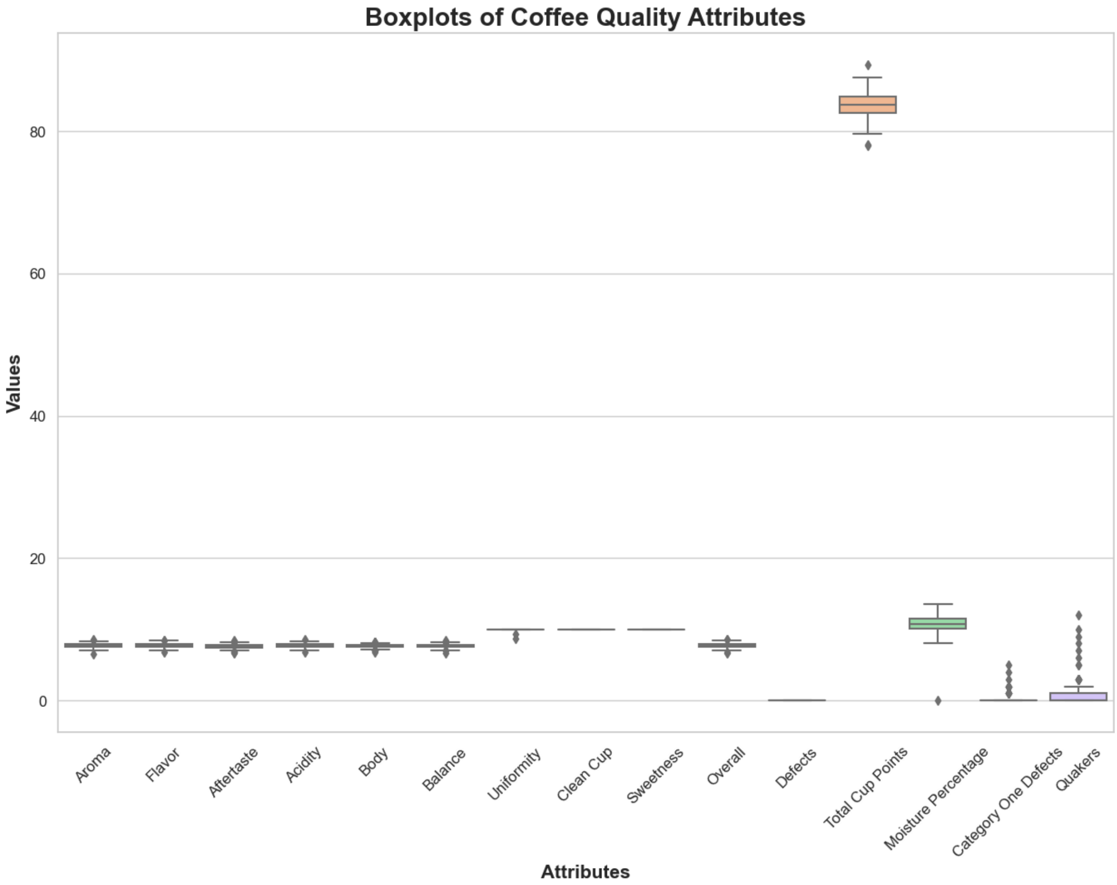
[43]:

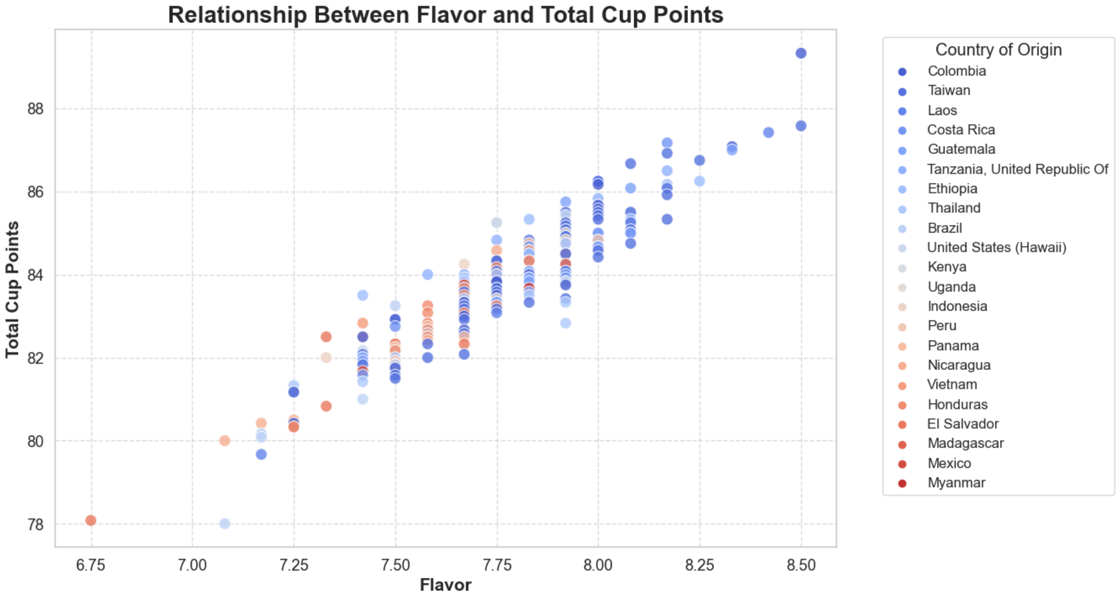
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

# Define the list of variables for analysis
variables = [
    'Aroma', 'Flavor', 'Aftertaste', 'Acidity', 'Body', 'Balance',
    'Uniformity', 'Clean Cup', 'Sweetness', 'Overall', 'Defects',
    'Total Cup Points', 'Moisture Percentage', 'Category One Defects',
    'Quakers'
]

# Set the style for the plots
sns.set(style='whitegrid', palette='muted', font_scale=1.2)
```

```
# Step 1: Histograms for Each Variable
plt.figure(figsize=(15, 12))
data[variables].hist(bins=10, figsize=(15, 12), color='skyblue',␣
 ↪edgecolor='black', grid=False)
plt.suptitle('Distribution of Coffee Quality Attributes', fontsize=20,␣
 ↪fontweight='bold')
plt.tight_layout(rect=[0, 0.03, 1, 0.95])  # Adjust layout to make space for␣
 ↪the title
plt.show()

# Step 2: Boxplot for Each Variable
plt.figure(figsize=(15, 10))
sns.boxplot(data=data[variables], palette='pastel')
plt.title('Boxplots of Coffee Quality Attributes', fontsize=20,␣
 ↪fontweight='bold')
plt.xlabel('Attributes', fontsize=15, fontweight='bold')
plt.ylabel('Values', fontsize=15, fontweight='bold')
plt.xticks(rotation=45, fontsize=12)
plt.yticks(fontsize=12)
plt.show()

# Step 3: Scatter Plot - Flavor vs. Total Cup Points
plt.figure(figsize=(12, 8))
sns.scatterplot(data=data, x='Flavor', y='Total Cup Points', hue='Country of␣
 ↪Origin',
                palette='coolwarm', s=100, alpha=0.8, edgecolor='w',␣
 ↪linewidth=0.8)
plt.title('Relationship Between Flavor and Total Cup Points', fontsize=20,␣
 ↪fontweight='bold')
plt.xlabel('Flavor', fontsize=15, fontweight='bold')
plt.ylabel('Total Cup Points', fontsize=15, fontweight='bold')
plt.legend(title='Country of Origin', bbox_to_anchor=(1.05, 1), loc='upper␣
 ↪left', fontsize=12)
plt.grid(True, linestyle='--', alpha=0.7)
plt.show()

# Step 4: Bar Plot - Country of Origin vs. Total Cup Points
plt.figure(figsize=(15, 8))
sns.barplot(data=data, x='Country of Origin', y='Total Cup Points',␣
 ↪palette='viridis', ci=None)
plt.title('Average Total Cup Points by Country of Origin', fontsize=20,␣
 ↪fontweight='bold')
plt.xlabel('Country of Origin', fontsize=15, fontweight='bold')
plt.ylabel('Average Total Cup Points', fontsize=15, fontweight='bold')
plt.xticks(rotation=45, fontsize=12)
plt.yticks(fontsize=12)
plt.grid(axis='y', linestyle='--', alpha=0.7)
plt.show()

# Step 5: Correlation Heatmap
plt.figure(figsize=(15, 10))
corr = data[variables].corr()
sns.heatmap(corr, annot=True, cmap='coolwarm', fmt='.2f', linewidths=0.5,
            annot_kws={'size': 10, 'weight': 'bold', 'color': 'darkblue'})
plt.title('Correlation Heatmap of Coffee Quality Attributes', fontsize=20,␣
 ↪fontweight='bold')
plt.xticks(rotation=45, fontsize=12)
plt.yticks(fontsize=12)
plt.show()
```

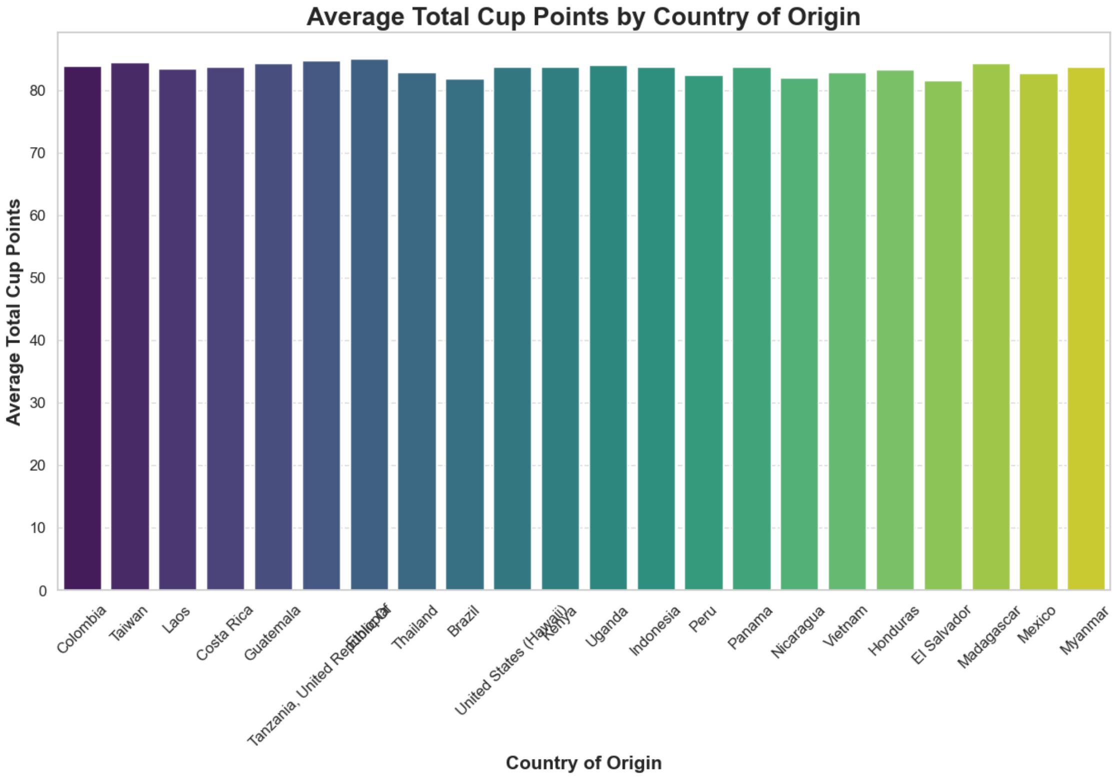
```
<Figure size 1500x1200 with 0 Axes>
```

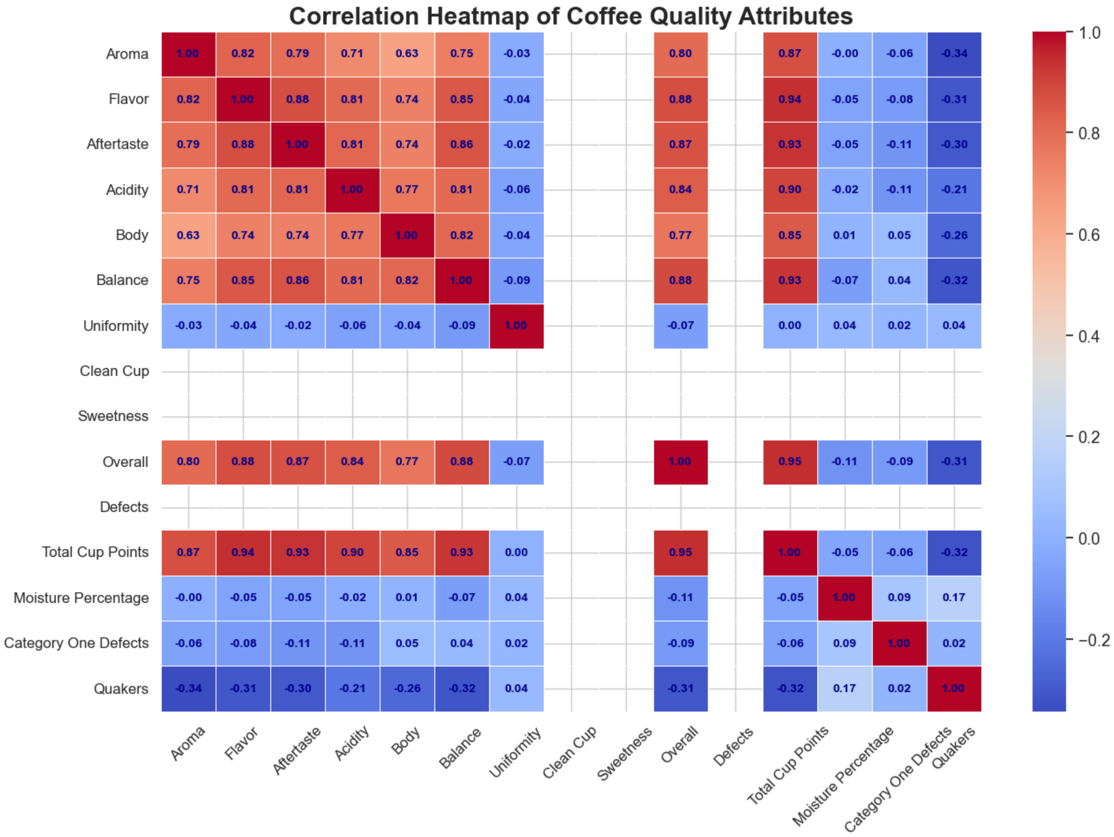



Boxplots of Coffee Quality Attributes
Values
80
60
40
20
0
Attributes
Aroma
Flavor
Aftertaste
Acidity
Body
Balance
Uniformity
Clean Cup
Sweetness
Overall
Defects
Total Cup Points
Moisture Percentage
Category One Defects
Quakers


Relationship Between Flavor and Total Cup Points
Total Cup Points
88
86
84
82
80
78
6.75
7.00
7.25
7.50
7.75
8.00
8.25
8.50
Flavor
Country of Origin
Colombia
Taiwan
Laos
Costa Rica
Guatemala
Tanzania, United Republic Of
Ethiopia
Thailand
Brazil
United States (Hawaii)
Kenya
Uganda
Indonesia
Peru
Panama
Nicaragua
Vietnam
Honduras
El Salvador
Madagascar
Mexico
Myanmar

```
C:\Users\iamim\AppData\Local\Temp\ipykernel_17008\3081503852.py:46:
FutureWarning:



The `ci` parameter is deprecated. Use `errorbar=None` for the same effect.
```





Correlation Analysis

[44]:
```
import plotly.express as px

# Define the variables to analyze correlations
variables = [
    'Aroma', 'Flavor', 'Aftertaste', 'Acidity', 'Body', 'Balance',
    'Uniformity', 'Sweetness', 'Overall', 'Defects', 'Total Cup Points'
]

# Calculate the correlation matrix
corr_matrix = data[variables].corr()

# Create the heatmap using Plotly
fig = px.imshow(
    corr_matrix,
    labels=dict(x="Variables", y="Variables", color="Correlation"),
    x=variables,
    y=variables,
    color_continuous_scale='RdBu_r',  # Reversed 'RdBu' for a more intuitive␣
 ↪color mapping
```

```
    zmin=-1,  # Set minimum correlation value for consistent scaling
    zmax=1,   # Set maximum correlation value for consistent scaling
    title='Correlation Heatmap of Coffee Quality Attributes',
    aspect="auto",  # Ensures aspect ratio is automatically determined
)

# Update layout to enhance appearance
fig.update_layout(
    title={
        'text': 'Correlation Heatmap of Coffee Quality Attributes',
        'font': {'size': 24, 'family': 'Arial', 'color': 'DarkSlateGray'},
        'x': 0.5,
        'xanchor': 'center'
    },
    xaxis_title='Coffee Quality Attributes',
    yaxis_title='Coffee Quality Attributes',
    xaxis=dict(
        tickangle=-45,
        tickfont=dict(size=12, family='Arial', color='Black')
    ),
    yaxis=dict(
        tickfont=dict(size=12, family='Arial', color='Black')
    ),
    width=800,
    height=800,
    margin=dict(l=100, r=100, t=100, b=100),
    coloraxis_colorbar=dict(
        title='Correlation',
        thickness=15,
        len=0.75,
        ticks='outside',
        tickfont=dict(size=12),
        titlefont=dict(size=14)
    ),
    plot_bgcolor='white',  # Background color of the plot
    hoverlabel=dict(
        bgcolor="white",
        font_size=12,
        font_family="Arial"
    ),
)

# Add annotations for better clarity
for i in range(len(corr_matrix)):
    for j in range(len(corr_matrix)):
        fig.add_annotation(
            x=variables[j],
            y=variables[i],
            text=f"{corr_matrix.iloc[i, j]:.2f}",
            showarrow=False,
            font=dict(size=11, color='black' if abs(corr_matrix.iloc[i, j]) < 0.
 ↪6 else 'white')  # Adjust text color based on background
        )

# Show the figure
fig.show()
```

Identification of Numerical Variables in the dataset

[45]:
```
import pandas as pd

# Assuming 'data' is your DataFrame
numerical_columns = data.select_dtypes(include=['number']).columns

# Print the names of numerical columns
print("Numerical Columns in the DataFrame:")
for col in numerical_columns:
    print(col)
```

```
Numerical Columns in the DataFrame:
Unnamed: 0
ID
Number of Bags
Aroma
Flavor
Aftertaste
Acidity
Body
Balance
Uniformity
Clean Cup
Sweetness
Overall
Defects
Total Cup Points
Moisture Percentage
Category One Defects
Quakers
Category Two Defects
Mean Score
```

0.1.1 Multiple Regression Variable Modeling

[47]:
```python
# Import required libraries
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, r2_score

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

[47]:
```
   Unnamed: 0  ID Country of Origin                 Farm Name  \
0           0   0          Colombia          Finca El Paraiso
1           1   1            Taiwan  Royal Bean Geisha Estate
2           2   2              Laos        OKLAO coffee farms
3           3   3        Costa Rica                 La Cumbre
4           4   4          Colombia           Finca Santuario

                               Lot Number                           Mill  \
0                              CQU2022015               Finca El Paraiso
1  The 2022 Pacific Rim Coffee Summit,T037       Royal Bean Geisha Estate
2  The 2022 Pacific Rim Coffee Summit,LA01  oklao coffee processing plant
3                              CQU2022017        La Montana Tarrazu MIll
4                              CQU2023002                Finca Santuario

  ICO Number                   Company   Altitude                Region  …  \
0        NaN      Coffee Quality Union  1700-1930        Piendamo,Cauca  …
1        NaN  Taiwan Coffee Laboratory       1200                Chiayi  …
2        NaN  Taiwan Coffee Laboratory       1300  Laos Borofen Plateau  …
3        NaN      Coffee Quality Union       1900    Los Santos,Tarrazu  …
4        NaN      Coffee Quality Union  1850-2100         Popayan,Cauca  …

  Moisture Percentage  Category One Defects Quakers         Color  \
0                11.8                     0       0         green
1                10.5                     0       0    blue-green
2                10.4                     0       0     yellowish
3                11.8                     0       0         green
4                11.6                     0       2  yellow-green

  Category Two Defects            Expiration  \
0                    3  September 21st, 2023
1                    0   November 15th, 2023
2                    2   November 15th, 2023
3                    0  September 21st, 2023
4                    2       March 5th, 2024

                 Certification Body  \
0             Japan Coffee Exchange
```

```
1  Taiwan Coffee Laboratory
2  Taiwan Coffee Laboratory
3             Japan Coffee Exchange
4             Japan Coffee Exchange

                               Certification Address  \
0   413-0002        -   1173-58 Izusan, Ata…
1  QAHWAH CO., LTD 4F, No. 225, Sec. 3, Beixin Rd…
2  QAHWAH CO., LTD 4F, No. 225, Sec. 3, Beixin Rd…
3   413-0002        -   1173-58 Izusan, Ata…
4   413-0002        -   1173-58 Izusan, Ata…

                     Certification Contact Mean Score
0        Koju Matsuzawa - +81(0)9085642901   8.814444
1     Lin, Jen-An Neil    - 886-289116612   8.621111
2     Lin, Jen-An Neil    - 886-289116612   8.602222
3        Koju Matsuzawa - +81(0)9085642901   8.574444
4        Koju Matsuzawa - +81(0)9085642901   8.564444

[5 rows x 42 columns]
```

[52]:

```python
# Display data types
print("Data Types:")
print(data.dtypes)

# Separate numeric and non-numeric columns
numeric_cols = data.select_dtypes(include=['number']).columns
non_numeric_cols = data.select_dtypes(exclude=['number']).columns

print("\nNumeric Columns:")
print(numeric_cols)

print("\nNon-Numeric Columns:")
print(non_numeric_cols)

# Fill missing values for numeric columns with column mean
data[numeric_cols] = data[numeric_cols].fillna(data[numeric_cols].mean())

# Handle missing values in non-numeric columns
for col in non_numeric_cols:
    data[col].fillna(data[col].mode()[0], inplace=True)  # Example: filling␣
 ↪with mode

# Verify missing values are handled
print("\nMissing Values after Imputation:")
print(data.isnull().sum())
```

```
# Verify data types after handling missing values
print("\nData Types after Imputation:")
print(data.dtypes)
```

```
Data Types:
Unnamed: 0                 int64
ID                         int64
Country of Origin         object
Farm Name                 object
Lot Number                object
Mill                      object
ICO Number                object
Company                   object
Altitude                  object
Region                    object
Producer                  object
Number of Bags             int64
Bag Weight                object
In-Country Partner        object
Harvest Year              object
Grading Date              object
Owner                     object
Variety                   object
Status                    object
Processing Method         object
Aroma                    float64
Flavor                   float64
Aftertaste               float64
Acidity                  float64
Body                     float64
Balance                  float64
Uniformity               float64
Clean Cup                float64
Sweetness                float64
Overall                  float64
Defects                  float64
Total Cup Points         float64
Moisture Percentage      float64
Category One Defects       int64
Quakers                    int64
Color                     object
Category Two Defects       int64
Expiration                object
Certification Body        object
Certification Address     object
Certification Contact     object
Mean Score               float64
```

```
dtype: object

Numeric Columns:
Index(['Unnamed: 0', 'ID', 'Number of Bags', 'Aroma', 'Flavor', 'Aftertaste',
       'Acidity', 'Body', 'Balance', 'Uniformity', 'Clean Cup', 'Sweetness',
       'Overall', 'Defects', 'Total Cup Points', 'Moisture Percentage',
       'Category One Defects', 'Quakers', 'Category Two Defects',
       'Mean Score'],
      dtype='object')

Non-Numeric Columns:
Index(['Country of Origin', 'Farm Name', 'Lot Number', 'Mill', 'ICO Number',
       'Company', 'Altitude', 'Region', 'Producer', 'Bag Weight',
       'In-Country Partner', 'Harvest Year', 'Grading Date', 'Owner',
       'Variety', 'Status', 'Processing Method', 'Color', 'Expiration',
       'Certification Body', 'Certification Address', 'Certification Contact'],
      dtype='object')

Missing Values after Imputation:
Unnamed: 0               0
ID                       0
Country of Origin        0
Farm Name                0
Lot Number               0
Mill                     0
ICO Number               0
Company                  0
Altitude                 0
Region                   0
Producer                 0
Number of Bags           0
Bag Weight               0
In-Country Partner       0
Harvest Year             0
Grading Date             0
Owner                    0
Variety                  0
Status                   0
Processing Method        0
Aroma                    0
Flavor                   0
Aftertaste               0
Acidity                  0
Body                     0
Balance                  0
Uniformity               0
Clean Cup                0
Sweetness                0
```

```
Overall                  0
Defects                  0
Total Cup Points         0
Moisture Percentage      0
Category One Defects     0
Quakers                  0
Color                    0
Category Two Defects     0
Expiration               0
Certification Body       0
Certification Address    0
Certification Contact    0
Mean Score               0
dtype: int64

Data Types after Imputation:
Unnamed: 0                 int64
ID                         int64
Country of Origin         object
Farm Name                 object
Lot Number                object
Mill                      object
ICO Number                object
Company                   object
Altitude                  object
Region                    object
Producer                  object
Number of Bags             int64
Bag Weight                object
In-Country Partner        object
Harvest Year              object
Grading Date              object
Owner                     object
Variety                   object
Status                    object
Processing Method         object
Aroma                    float64
Flavor                   float64
Aftertaste               float64
Acidity                  float64
Body                     float64
Balance                  float64
Uniformity               float64
Clean Cup                float64
Sweetness                float64
Overall                  float64
Defects                  float64
Total Cup Points         float64
```

```
Moisture Percentage      float64
Category One Defects       int64
Quakers                    int64
Color                     object
Category Two Defects       int64
Expiration                object
Certification Body        object
Certification Address     object
Certification Contact     object
Mean Score               float64
dtype: object
```

[53]:

```python
# Now continue with feature selection, splitting, training, and evaluating the␣
 ↪model
independent_vars = ['Aroma', 'Flavor']  # Example independent variables
dependent_var = 'Total Cup Points'   # Example dependent variable

# Extract features and target
X = data[independent_vars]
y = data[dependent_var]
```

[54]:

```python
# Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)
```

[55]:

```python
# Initialize and train the Linear Regression model
regression_model = LinearRegression()
regression_model.fit(X_train, y_train)
```

[55]:

```
LinearRegression()
```

[56]:

```python
# Display model coefficients
print("\nModel Coefficients:")
print(f"Intercept: {regression_model.intercept_}")
for idx, coef in enumerate(regression_model.coef_):
    print(f"Coefficient for {independent_vars[idx]}: {coef}")
```

```

Model Coefficients:
Intercept: 35.79207032807622
Coefficient for Aroma: 1.9013565731881188
Coefficient for Flavor: 4.292202508997079
```

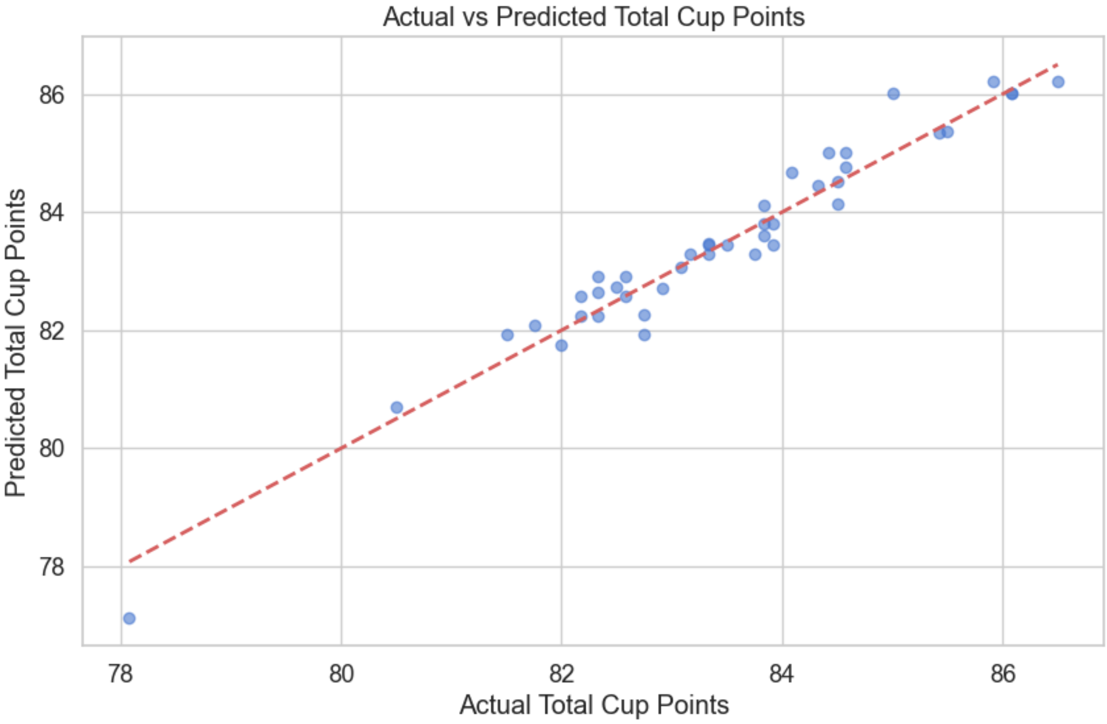
[57]:

```python
# Predict on the test set and evaluate the model
y_pred = regression_model.predict(X_test)
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)
```

```
print(f"\nModel Evaluation Metrics:")
print(f"Mean Squared Error (MSE): {mse:.2f}")
print(f"R² Score: {r2:.2f}")
```

```
Model Evaluation Metrics:
Mean Squared Error (MSE): 0.14
R² Score: 0.94
```

[58]:
```
# Plot actual vs predicted values
plt.figure(figsize=(10, 6))
plt.scatter(y_test, y_pred, alpha=0.6, color='b')
plt.plot([y_test.min(), y_test.max()], [y_test.min(), y_test.max()], 'r--',␣
  ↪lw=2)
plt.xlabel('Actual Total Cup Points')
plt.ylabel('Predicted Total Cup Points')
plt.title('Actual vs Predicted Total Cup Points')
plt.show()
```



0.1.2 Navie bayis

Classification

0.1.3

[63]:

```
from sklearn.model_selection import train_test_split
from sklearn.naive_bayes import GaussianNB
from sklearn.metrics import accuracy_score, classification_report,␣
 ↪confusion_matrix

# Define features and target
features = ['Aroma', 'Flavor', 'Aftertaste', 'Acidity', 'Body', 'Balance',␣
 ↪'Uniformity',
             'Clean Cup', 'Sweetness', 'Overall', 'Defects', 'Total Cup Points',
             'Moisture Percentage', 'Category One Defects', 'Quakers',␣
 ↪'Category Two Defects', 'Mean Score']
target = 'Category One Defects'  # Assuming this is categorical

# Extract features and target
X = data[features]
y = data[target]

# Check the unique values in the target variable
print("\nUnique values in target variable:")
print(y.unique())
```

```
Unique values in target variable:
[0 2 1 3 4 5]
```

[64]:

```
# Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)

# Check the shapes of the train and test sets
print(f"Training set shape (X_train): {X_train.shape}")
print(f"Test set shape (X_test): {X_test.shape}")
```

```
Training set shape (X_train): (165, 17)
Test set shape (X_test): (42, 17)
```

[65]:

```
# Initialize the Naive Bayes classifier
nb_model = GaussianNB()

# Train the model using the training data
nb_model.fit(X_train, y_train)

# Display model parameters (optional)
print("\nModel Parameters:")
print(nb_model.get_params())
```

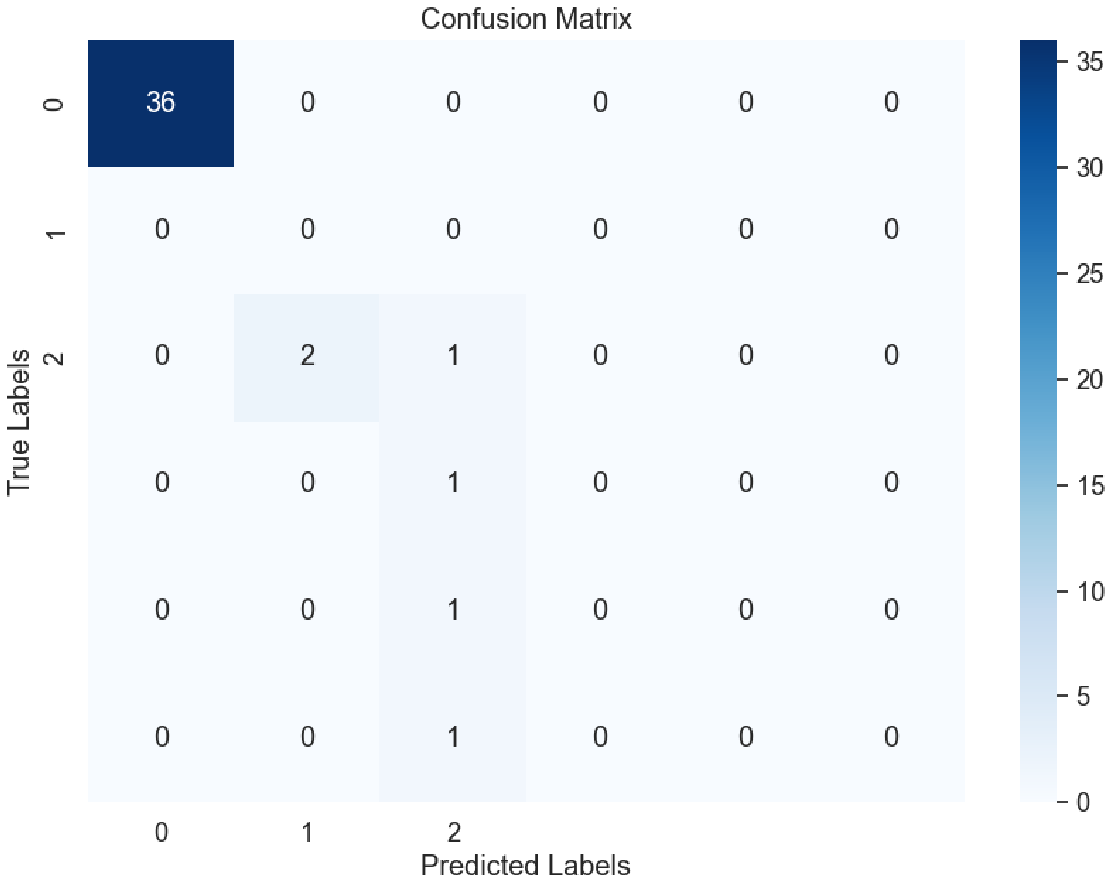
```
Model Parameters:
{'priors': None, 'var_smoothing': 1e-09}
```

[66]:

```
# Predict on the test set
y_pred = nb_model.predict(X_test)

# Calculate accuracy
accuracy = accuracy_score(y_test, y_pred)
print(f"\nAccuracy: {accuracy:.2f}")

# Classification report
print("\nClassification Report:")
print(classification_report(y_test, y_pred))

# Confusion matrix
conf_matrix = confusion_matrix(y_test, y_pred)
print("\nConfusion Matrix:")
print(conf_matrix)

# Plot confusion matrix using seaborn
plt.figure(figsize=(10, 7))
sns.heatmap(conf_matrix, annot=True, fmt='d', cmap='Blues',
            xticklabels=nb_model.classes_, yticklabels=nb_model.classes_)
plt.xlabel('Predicted Labels')
plt.ylabel('True Labels')
plt.title('Confusion Matrix')
plt.show()
```

```
Accuracy: 0.88

Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        36
           1       0.00      0.00      0.00         0
           2       0.25      0.33      0.29         3
           3       0.00      0.00      0.00         1
           4       0.00      0.00      0.00         1
           5       0.00      0.00      0.00         1

    accuracy                           0.88        42
   macro avg       0.21      0.22      0.21        42
weighted avg       0.88      0.88      0.88        42


Confusion Matrix:
```

```
[[36  0  0  0  0  0]
 [ 0  0  0  0  0  0]
 [ 0  2  1  0  0  0]
 [ 0  0  1  0  0  0]
 [ 0  0  1  0  0  0]
 [ 0  0  1  0  0  0]]

c:\Users\iamim\anaconda3\Lib\site-
packages\sklearn\metrics\_classification.py:1469: UndefinedMetricWarning:

Precision and F-score are ill-defined and being set to 0.0 in labels with no
predicted samples. Use `zero_division` parameter to control this behavior.

c:\Users\iamim\anaconda3\Lib\site-
packages\sklearn\metrics\_classification.py:1469: UndefinedMetricWarning:

Recall and F-score are ill-defined and being set to 0.0 in labels with no true
samples. Use `zero_division` parameter to control this behavior.

c:\Users\iamim\anaconda3\Lib\site-
packages\sklearn\metrics\_classification.py:1469: UndefinedMetricWarning:

Precision and F-score are ill-defined and being set to 0.0 in labels with no
predicted samples. Use `zero_division` parameter to control this behavior.

c:\Users\iamim\anaconda3\Lib\site-
packages\sklearn\metrics\_classification.py:1469: UndefinedMetricWarning:

Recall and F-score are ill-defined and being set to 0.0 in labels with no true
samples. Use `zero_division` parameter to control this behavior.

c:\Users\iamim\anaconda3\Lib\site-
packages\sklearn\metrics\_classification.py:1469: UndefinedMetricWarning:

Precision and F-score are ill-defined and being set to 0.0 in labels with no
predicted samples. Use `zero_division` parameter to control this behavior.

c:\Users\iamim\anaconda3\Lib\site-
packages\sklearn\metrics\_classification.py:1469: UndefinedMetricWarning:

Recall and F-score are ill-defined and being set to 0.0 in labels with no true
samples. Use `zero_division` parameter to control this behavior.
```



Regression

[73]:
```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.linear_model import BayesianRidge
from sklearn.metrics import mean_squared_error, r2_score
import matplotlib.pyplot as plt
import seaborn as sns
```

[74]:
```
# Define features and target
features = ['Aroma', 'Flavor', 'Aftertaste', 'Acidity', 'Body', 'Balance',␣
 ↪'Uniformity',
             'Clean Cup', 'Sweetness', 'Overall', 'Defects', 'Total Cup Points',
             'Moisture Percentage', 'Category One Defects', 'Quakers',␣
 ↪'Category Two Defects', 'Mean Score']
target = 'Total Cup Points'  # Change to your target variable for regression

X = data[features]
```

```
y = data[target]
```

[75]:

```
# Split the data
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)
```

[76]:

```
# Scale features
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)
```

[77]:

```
# Initialize and train Bayesian Ridge Regression model
model = BayesianRidge()
model.fit(X_train_scaled, y_train)
```

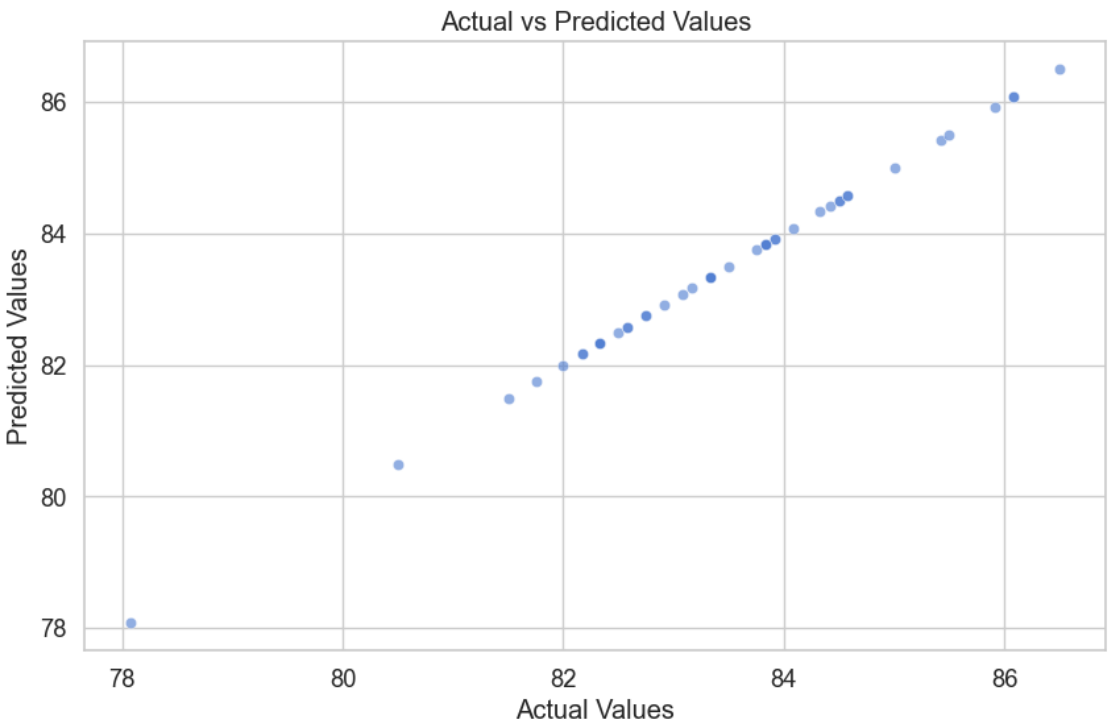
[77]:

```
BayesianRidge()
```

[78]:

```
# Predict on the test set
y_pred = model.predict(X_test_scaled)

# Evaluate the model
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)

print(f"Mean Squared Error: {mse:.2f}")
print(f"R^2 Score: {r2:.2f}")

# Plot predictions vs actual values
plt.figure(figsize=(10, 6))
sns.scatterplot(x=y_test, y=y_pred, alpha=0.6)
plt.xlabel('Actual Values')
plt.ylabel('Predicted Values')
plt.title('Actual vs Predicted Values')
plt.show()
```

```
Mean Squared Error: 0.00
R^2 Score: 1.00
```



0.1.4 Random Forest Classifier

[79]:

```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score, classification_report,␣
 ↪confusion_matrix
import seaborn as sns
import matplotlib.pyplot as plt
```

[80]:

```
# Define features and target
features = ['Aroma', 'Flavor', 'Aftertaste', 'Acidity', 'Body', 'Balance',␣
 ↪'Uniformity',
             'Clean Cup', 'Sweetness', 'Overall', 'Defects', 'Total Cup Points',
             'Moisture Percentage', 'Category One Defects', 'Quakers',␣
 ↪'Category Two Defects', 'Mean Score']
target = 'Category One Defects'  # Replace with your target variable

X = data[features]
y = data[target]
```

[81]:
```
# Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)
```

[82]:
```
# Scale features
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)
```

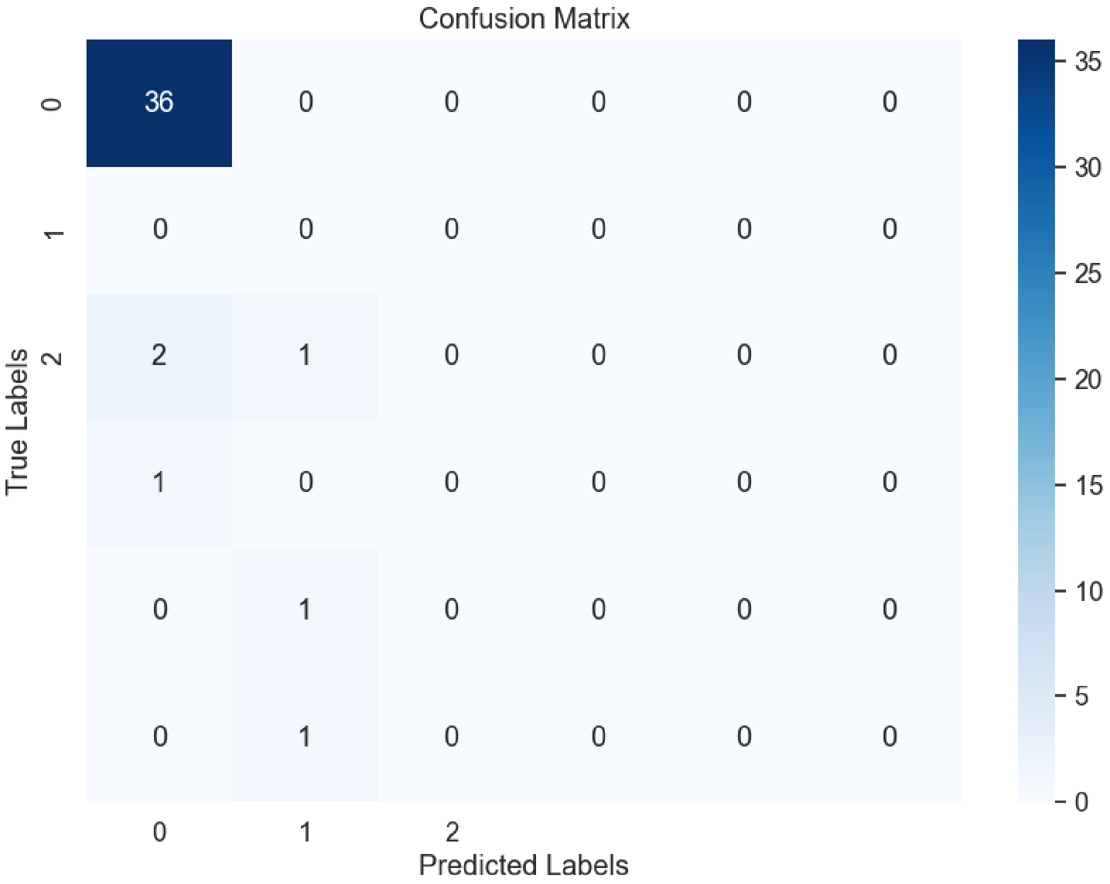
[83]:
```
# Initialize and train Random Forest Classifier
rf_model = RandomForestClassifier(n_estimators=100, random_state=42)
rf_model.fit(X_train_scaled, y_train)
```

[83]:
```
RandomForestClassifier(random_state=42)
```

[84]:
```
# Predict on the test set
y_pred = rf_model.predict(X_test_scaled)

# Evaluate the model
accuracy = accuracy_score(y_test, y_pred)
print(f"Accuracy: {accuracy:.2f}")

print("\nClassification Report:")
print(classification_report(y_test, y_pred))

# Confusion Matrix
conf_matrix = confusion_matrix(y_test, y_pred)
print("\nConfusion Matrix:")
print(conf_matrix)

# Plot confusion matrix using seaborn
plt.figure(figsize=(10, 7))
sns.heatmap(conf_matrix, annot=True, fmt='d', cmap='Blues',
            xticklabels=rf_model.classes_, yticklabels=rf_model.classes_)
plt.xlabel('Predicted Labels')
plt.ylabel('True Labels')
plt.title('Confusion Matrix')
plt.show()
```

```
Accuracy: 0.86

Classification Report:
              precision    recall  f1-score   support

           0       0.92      1.00      0.96        36
           1       0.00      0.00      0.00         0
           2       0.00      0.00      0.00         3
           3       0.00      0.00      0.00         1
           4       0.00      0.00      0.00         1
           5       0.00      0.00      0.00         1

    accuracy                           0.86        42
   macro avg       0.15      0.17      0.16        42
weighted avg       0.79      0.86      0.82        42


Confusion Matrix:
[[36  0  0  0  0  0]
 [ 0  0  0  0  0  0]
 [ 2  1  0  0  0  0]
 [ 1  0  0  0  0  0]
 [ 0  1  0  0  0  0]
 [ 0  1  0  0  0  0]]
c:\Users\iamim\anaconda3\Lib\site-
packages\sklearn\metrics\_classification.py:1469: UndefinedMetricWarning:

Precision and F-score are ill-defined and being set to 0.0 in labels with no
predicted samples. Use `zero_division` parameter to control this behavior.

c:\Users\iamim\anaconda3\Lib\site-
packages\sklearn\metrics\_classification.py:1469: UndefinedMetricWarning:

Recall and F-score are ill-defined and being set to 0.0 in labels with no true
samples. Use `zero_division` parameter to control this behavior.

c:\Users\iamim\anaconda3\Lib\site-
packages\sklearn\metrics\_classification.py:1469: UndefinedMetricWarning:

Precision and F-score are ill-defined and being set to 0.0 in labels with no
predicted samples. Use `zero_division` parameter to control this behavior.

c:\Users\iamim\anaconda3\Lib\site-
packages\sklearn\metrics\_classification.py:1469: UndefinedMetricWarning:

Recall and F-score are ill-defined and being set to 0.0 in labels with no true
samples. Use `zero_division` parameter to control this behavior.

c:\Users\iamim\anaconda3\Lib\site-
packages\sklearn\metrics\_classification.py:1469: UndefinedMetricWarning:

Precision and F-score are ill-defined and being set to 0.0 in labels with no
predicted samples. Use `zero_division` parameter to control this behavior.

c:\Users\iamim\anaconda3\Lib\site-
```

```
packages\sklearn\metrics\_classification.py:1469: UndefinedMetricWarning:

Recall and F-score are ill-defined and being set to 0.0 in labels with no true
samples. Use `zero_division` parameter to control this behavior.
```



0.1.5 Decision Tree Regression

[2]:
```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeRegressor
from sklearn.metrics import mean_squared_error, r2_score
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.tree import plot_tree
```

[4]:
```
# Load the dataset
```

```
data = pd.read_csv('C:
 ↪\\Users\\iamim\\OneDrive\\Desktop\\Seventh_Semester\\ML_LAB\\L2\\df_arabica_clean.
 ↪csv')  # Replace 'your_dataset.csv' with your actual file path

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

# Check for missing values
print(data.isnull().sum())

# Fill missing values with the column mean (if needed)
data.fillna(data.mean(numeric_only=True), inplace=True)
```

```
   Unnamed: 0  ID Country of Origin                 Farm Name  \
0           0   0          Colombia          Finca El Paraiso
1           1   1            Taiwan  Royal Bean Geisha Estate
2           2   2              Laos        OKLAO coffee farms
3           3   3        Costa Rica                 La Cumbre
4           4   4          Colombia           Finca Santuario

                                Lot Number                           Mill  \
0                               CQU2022015               Finca El Paraiso
1  The 2022 Pacific Rim Coffee Summit,T037       Royal Bean Geisha Estate
2  The 2022 Pacific Rim Coffee Summit,LA01  oklao coffee processing plant
3                               CQU2022017        La Montana Tarrazu MIll
4                               CQU2023002                Finca Santuario

  ICO Number                  Company   Altitude                Region  …  \
0        NaN      Coffee Quality Union  1700-1930        Piendamo,Cauca  …
1        NaN  Taiwan Coffee Laboratory       1200                Chiayi  …
2        NaN  Taiwan Coffee Laboratory       1300  Laos Borofen Plateau  …
3        NaN      Coffee Quality Union       1900    Los Santos,Tarrazu  …
4        NaN      Coffee Quality Union  1850-2100         Popayan,Cauca  …

  Total Cup Points  Moisture Percentage Category One Defects Quakers  \
0            89.33                 11.8                    0       0
1            87.58                 10.5                    0       0
2            87.42                 10.4                    0       0
3            87.17                 11.8                    0       0
4            87.08                 11.6                    0       2

          Color Category Two Defects            Expiration  \
0         green                    3  September 21st, 2023
1    blue-green                    0   November 15th, 2023
2     yellowish                    2   November 15th, 2023
3         green                    0  September 21st, 2023
4  yellow-green                    2       March 5th, 2024
```

```
                 Certification Body  \
0             Japan Coffee Exchange
1  Taiwan Coffee Laboratory
2  Taiwan Coffee Laboratory
3             Japan Coffee Exchange
4             Japan Coffee Exchange

                               Certification Address  \
0   413-0002        -  1173-58 Izusan, Ata…
1  QAHWAH CO., LTD 4F, No. 225, Sec. 3, Beixin Rd…
2  QAHWAH CO., LTD 4F, No. 225, Sec. 3, Beixin Rd…
3   413-0002        -  1173-58 Izusan, Ata…
4   413-0002        -  1173-58 Izusan, Ata…

                     Certification Contact
0        Koju Matsuzawa - +81(0)9085642901
1     Lin, Jen-An Neil    - 886-289116612
2     Lin, Jen-An Neil    - 886-289116612
3        Koju Matsuzawa - +81(0)9085642901
4        Koju Matsuzawa - +81(0)9085642901

[5 rows x 41 columns]
Unnamed: 0                 0
ID                         0
Country of Origin          0
Farm Name                  2
Lot Number                 1
Mill                       3
ICO Number               132
Company                    0
Altitude                   1
Region                     2
Producer                   1
Number of Bags             0
Bag Weight                 0
In-Country Partner         0
Harvest Year               0
Grading Date               0
Owner                      0
Variety                    6
Status                     0
Processing Method          5
Aroma                      0
Flavor                     0
Aftertaste                 0
Acidity                    0
Body                       0
```

```
Balance                    0
Uniformity                 0
Clean Cup                  0
Sweetness                  0
Overall                    0
Defects                    0
Total Cup Points           0
Moisture Percentage        0
Category One Defects       0
Quakers                    0
Color                      0
Category Two Defects       0
Expiration                 0
Certification Body         0
Certification Address      0
Certification Contact      0
dtype: int64
```

[5]:

```
# Define features and target variable
features = ['Aroma', 'Flavor', 'Aftertaste']  # Independent variables
target = 'Total Cup Points'  # Dependent variable

X = data[features]
y = data[target]

# Split the dataset into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)
```

[6]:

```
# Create the Decision Tree Regressor
dt_regressor = DecisionTreeRegressor(random_state=42)

# Fit the model on the training data
dt_regressor.fit(X_train, y_train)
```

[6]:

```
DecisionTreeRegressor(random_state=42)
```

[7]:

```
# Predict on the test data
y_pred = dt_regressor.predict(X_test)
```

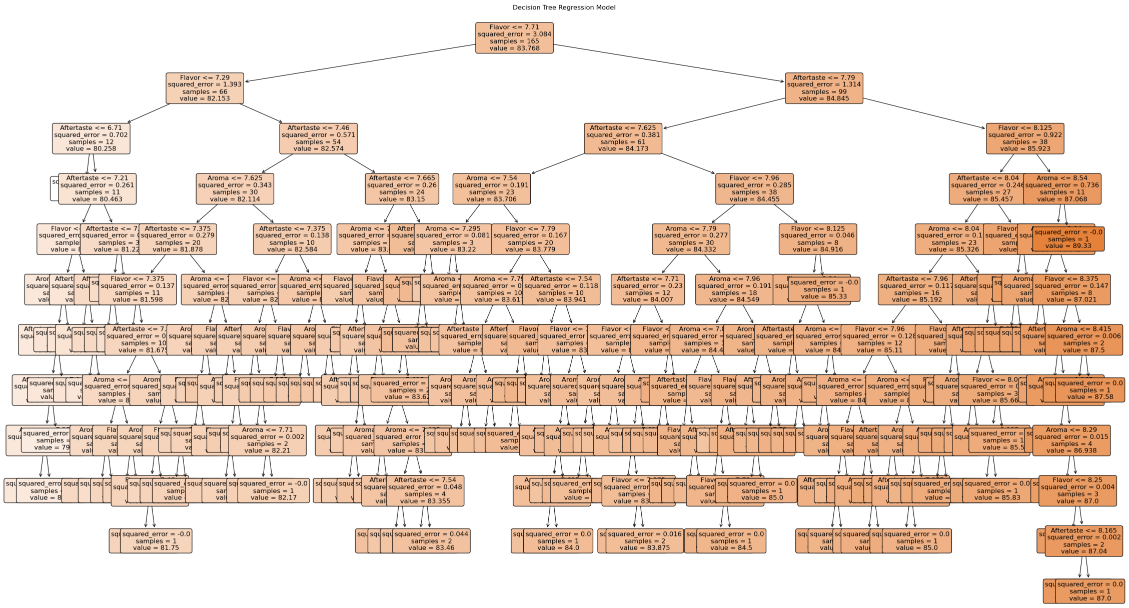
[8]:

```
# Calculate Mean Squared Error (MSE) and R^2 Score
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)

# Print the evaluation metrics
print(f"Mean Squared Error: {mse:.2f}")
print(f"R^2 Score: {r2:.2f}")
```

```
Mean Squared Error: 0.38
R^2 Score: 0.85
```

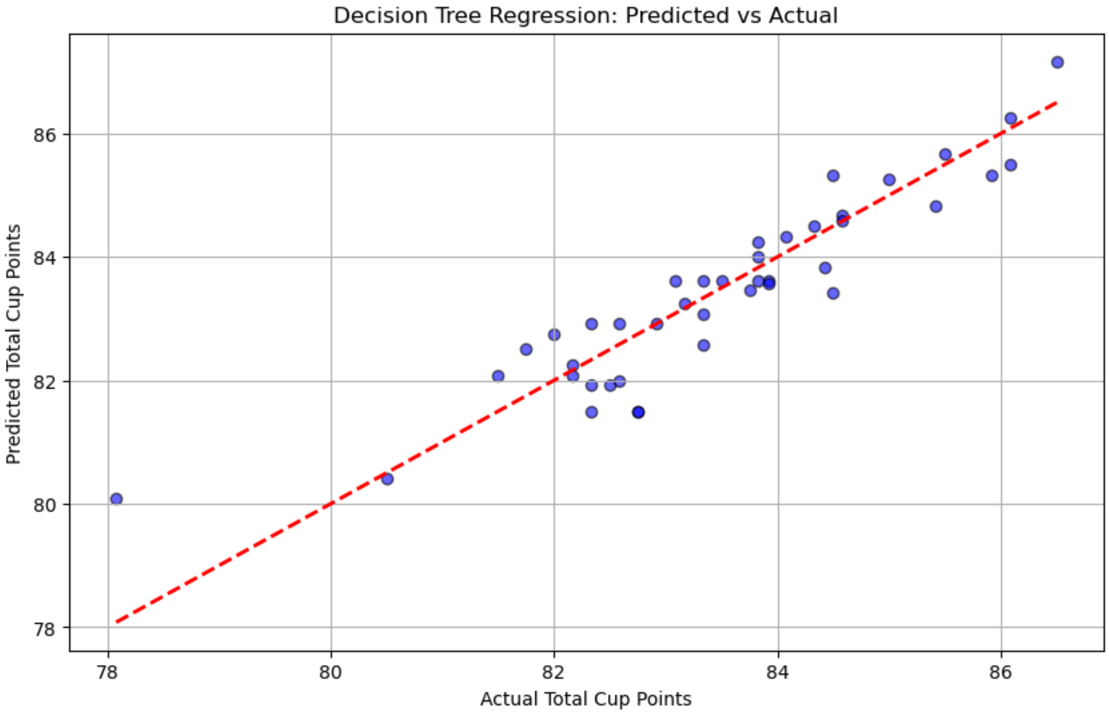
[11]:

```python
# Plotting the decision tree
plt.figure(figsize=(35, 20))
plot_tree(dt_regressor, feature_names=features, filled=True, rounded=True,
fontsize=12)
plt.title('Decision Tree Regression Model')
plt.show()
```



[12]:

```python
# Plot predicted vs actual values
plt.figure(figsize=(10, 6))
plt.scatter(y_test, y_pred, color='blue', edgecolor='k', alpha=0.6)
plt.plot([min(y_test), max(y_test)], [min(y_test), max(y_test)], color='red',␣
  ↪linestyle='--', linewidth=2)
plt.xlabel('Actual Total Cup Points')
plt.ylabel('Predicted Total Cup Points')
plt.title('Decision Tree Regression: Predicted vs Actual')
plt.grid(True)
plt.show()
```


Decision Tree Regression: Predicted vs Actual
Predicted Total Cup Points
Actual Total Cup Points
78
80
82
84
86
78
80
82
84
86