DESCRIPTION

were are currently updating our project and you will be regularly updated and for more infomation notes,pdf,code,full png ans svg map you can follow us on following and DM on social media platforms.

`instagram` https://www.instagram.com/ahanger.asif?igsh=MXZiczBreWgwd25iMA==

`facebook` https://www.facebook.com/ahangerasifahanger.asif

📊 Complete Data Science Practice: NumPy, Pandas & Matplotlib

1. NumPy Fundamentals

In [1]:
```
# 📦 Import Libraries
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

print("✅ Libraries imported successfully!")
```

```
✅ Libraries imported successfully!
```

In [2]:
```
# 🎯 1. Array Creation & Basic Operations
print("🎯 1. NUMPY ARRAY BASICS")
print("="*50)

# Create arrays
arr1 = np.array([1, 2, 3, 4, 5])
arr2 = np.arange(1, 11)  # 1 to 10
arr3 = np.linspace(0, 1, 5)  # 5 equally spaced values
zeros = np.zeros((3, 3))
ones = np.ones((2, 4))
identity = np.eye(4)
random_arr = np.random.rand(5)

print(f"Simple array: {arr1}")
print(f"arange: {arr2}")
print(f"linspace: {arr3}")
print(f"\nZeros matrix:\n{zeros}")
print(f"\nOnes matrix:\n{ones}")
print(f"\nIdentity matrix:\n{identity}")
print(f"\nRandom array: {random_arr}")
```

```
🎯 1. NUMPY ARRAY BASICS
==================================================
Simple array: [1 2 3 4 5]
arange: [ 1  2  3  4  5  6  7  8  9 10]
linspace: [0.   0.25 0.5  0.75 1.  ]

Zeros matrix:
[[0. 0. 0.]
 [0. 0. 0.]
 [0. 0. 0.]]

Ones matrix:
[[1. 1. 1. 1.]
 [1. 1. 1. 1.]]

Identity matrix:
[[1. 0. 0. 0.]
 [0. 1. 0. 0.]
 [0. 0. 1. 0.]
 [0. 0. 0. 1.]]

Random array: [0.54327993 0.63467729 0.68924604 0.69511724 0.67940271]
```

In [3]:

```python
# 🔢 2. Array Mathematics
print("\n🔢 2. ARRAY MATHEMATICS")
print("="*50)

a = np.array([1, 2, 3, 4])
b = np.array([5, 6, 7, 8])

print(f"Array a: {a}")
print(f"Array b: {b}")
print(f"\nAddition: {a + b}")
print(f"Subtraction: {b - a}")
print(f"Multiplication: {a * b}")
print(f"Division: {b / a}")
print(f"\nSquare of a: {a ** 2}")
print(f"Square root of b: {np.sqrt(b)}")
print(f"Exponential of a: {np.exp(a)}")
```

```
🔢 2. ARRAY MATHEMATICS
==================================================
Array a: [1 2 3 4]
Array b: [5 6 7 8]

Addition: [ 6  8 10 12]
Subtraction: [4 4 4 4]
Multiplication: [ 5 12 21 32]
Division: [5.         3.         2.33333333 2.        ]

Square of a: [ 1  4  9 16]
Square root of b: [2.23606798 2.44948974 2.64575131 2.82842712]
Exponential of a: [ 2.71828183  7.3890561  20.08553692 54.59815003]
```

In [4]:

```python
# 📐 3. Multi-dimensional Arrays
print("\n📐 3. MULTI-DIMENSIONAL ARRAYS")
print("="*50)

matrix = np.array([[1, 2, 3], [4, 5, 6], [7, 8, 9]])
```

```
print(f"2D Matrix:\n{matrix}")
print(f"\nShape: {matrix.shape}")
print(f"Dimensions: {matrix.ndim}")
print(f"Size: {matrix.size}")
print(f"Data type: {matrix.dtype}")
print(f"\nFirst row: {matrix[0]}")
print(f"Second column: {matrix[:, 1]}")
print(f"Element at [1,2]: {matrix[1, 2]}")
```

```
📐 3. MULTI-DIMENSIONAL ARRAYS
==================================================
2D Matrix:
[[1 2 3]
 [4 5 6]
 [7 8 9]]

Shape: (3, 3)
Dimensions: 2
Size: 9
Data type: int64

First row: [1 2 3]
Second column: [2 5 8]
Element at [1,2]: 6
```

In [5]:

```
# 🎲 4. Array Manipulation
print("\n🎲 4. ARRAY MANIPULATION")
print("="*50)

arr = np.array([1, 2, 3, 4, 5, 6])

print(f"Original array: {arr}")
print(f"\nReshaped to 2x3:\n{arr.reshape(2, 3)}")
print(f"\nTranspose of 2x3 matrix:\n{arr.reshape(2, 3).T}")
print(f"\nFlattened array: {arr.reshape(2, 3).flatten()}")
print(f"\nSorted array: {np.sort(np.array([3, 1, 4, 1, 5]))}")
print(f"Reversed array: {arr[::-1]}")
```

```
🎲 4. ARRAY MANIPULATION
==================================================
Original array: [1 2 3 4 5 6]

Reshaped to 2x3:
[[1 2 3]
 [4 5 6]]

Transpose of 2x3 matrix:
[[1 4]
 [2 5]
 [3 6]]

Flattened array: [1 2 3 4 5 6]

Sorted array: [1 1 3 4 5]
Reversed array: [6 5 4 3 2 1]
```

In [6]:

```
# 📊 5. Statistical Operations
print("\n📊 5. STATISTICAL OPERATIONS")
print("="*50)

data = np.array([23, 45, 67, 89, 34, 56, 78, 90, 12, 45])
```

```
print(f"Dataset: {data}")
print(f"\nMean: {np.mean(data)}")
print(f"Median: {np.median(data)}")
print(f"Standard Deviation: {np.std(data)}")
print(f"Variance: {np.var(data)}")
print(f"Minimum: {np.min(data)}")
print(f"Maximum: {np.max(data)}")
print(f"Sum: {np.sum(data)}")
print(f"Product: {np.prod(data[:5])}")
```

```
📊 5. STATISTICAL OPERATIONS
==================================================
Dataset: [23 45 67 89 34 56 78 90 12 45]

Mean: 53.9
Median: 50.5
Standard Deviation: 25.606444501335986
Variance: 655.6899999999999
Minimum: 12
Maximum: 90
Sum: 539
Product: 209837970
```

2. Pandas Data Handling

In [7]:

```
# 📋 6. DataFrame Creation
print("📋 6. DATAFRAME CREATION")
print("="*50)

# Create DataFrame from dictionary
data = {
    'Name': ['Alice', 'Bob', 'Charlie', 'Diana', 'Eve'],
    'Age': [25, 30, 35, 28, 32],
    'City': ['NYC', 'LA', 'Chicago', 'Miami', 'Seattle'],
    'Salary': [50000, 60000, 75000, 55000, 80000],
    'Department': ['HR', 'IT', 'Finance', 'Marketing', 'IT']
}

df = pd.DataFrame(data)
print("DataFrame created successfully!")
print(f"\nShape: {df.shape}")
print(f"\nFirst 3 rows:")
print(df.head(3))
print(f"\nDataFrame Info:")
print(df.info())
```

```
📋 6. DATAFRAME CREATION
==================================================
DataFrame created successfully!

Shape: (5, 5)

First 3 rows:
      Name  Age     City  Salary Department
0    Alice   25      NYC   50000         HR
1      Bob   30       LA   60000         IT
2  Charlie   35  Chicago   75000    Finance

DataFrame Info:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5 entries, 0 to 4
Data columns (total 5 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   Name        5 non-null      object
 1   Age         5 non-null      int64
 2   City        5 non-null      object
 3   Salary      5 non-null      int64
 4   Department  5 non-null      object
dtypes: int64(2), object(3)
memory usage: 332.0+ bytes
None
```

In [8]:

```python
# 🔍 7. Data Selection & Filtering
print("\n🔍 7. DATA SELECTION & FILTERING")
print("="*50)

print("Select specific columns:")
print(df[['Name', 'Salary']])

print("\nSelect rows by index:")
print(df.iloc[1:4])  # Rows 1, 2, 3

print("\nFilter: Age > 30:")
print(df[df['Age'] > 30])

print("\nMultiple conditions (Age > 28 AND Department == 'IT'):")
print(df[(df['Age'] > 28) & (df['Department'] == 'IT')])

print("\nFilter by string contains:")
print(df[df['Name'].str.contains('li')])
```

```
🔍 7. DATA SELECTION & FILTERING
==================================================
Select specific columns:
      Name  Salary
0    Alice   50000
1      Bob   60000
2  Charlie   75000
3    Diana   55000
4      Eve   80000

Select rows by index:
      Name  Age     City  Salary Department
1      Bob   30       LA   60000         IT
2  Charlie   35  Chicago   75000    Finance
3    Diana   28    Miami   55000  Marketing

Filter: Age > 30:
      Name  Age     City  Salary Department
2  Charlie   35  Chicago   75000    Finance
4      Eve   32  Seattle   80000         IT

Multiple conditions (Age > 28 AND Department == 'IT'):
  Name  Age     City  Salary Department
1  Bob   30       LA   60000         IT
4  Eve   32  Seattle   80000         IT

Filter by string contains:
      Name  Age     City  Salary Department
0    Alice   25      NYC   50000         HR
2  Charlie   35  Chicago   75000    Finance
```

In [9]:

```python
# 📈 8. Data Manipulation
print("\n📈 8. DATA MANIPULATION")
print("="*50)

# Add new column
df['Bonus'] = df['Salary'] * 0.1
df['Total_Compensation'] = df['Salary'] + df['Bonus']

# Modify existing column
df['Age_Group'] = pd.cut(df['Age'],
                         bins=[20, 30, 40, 50],
                         labels=['20s', '30s', '40s'])

# Drop column
df_dropped = df.drop('City', axis=1)

print("DataFrame with new columns:")
print(df)

print("\nSorted by Salary (descending):")
print(df.sort_values('Salary', ascending=False))
```

```
📈 8. DATA MANIPULATION
==================================================
DataFrame with new columns:
      Name  Age     City  Salary Department   Bonus  Total_Compensation  \
0    Alice   25      NYC   50000         HR  5000.0             55000.0
1      Bob   30       LA   60000         IT  6000.0             66000.0
2  Charlie   35  Chicago   75000    Finance  7500.0             82500.0
3    Diana   28    Miami   55000  Marketing  5500.0             60500.0
4      Eve   32  Seattle   80000         IT  8000.0             88000.0

  Age_Group
0       20s
1       20s
2       30s
3       20s
4       30s

Sorted by Salary (descending):
      Name  Age     City  Salary Department   Bonus  Total_Compensation  \
4      Eve   32  Seattle   80000         IT  8000.0             88000.0
2  Charlie   35  Chicago   75000    Finance  7500.0             82500.0
1      Bob   30       LA   60000         IT  6000.0             66000.0
3    Diana   28    Miami   55000  Marketing  5500.0             60500.0
0    Alice   25      NYC   50000         HR  5000.0             55000.0

  Age_Group
4       30s
2       30s
1       20s
3       20s
0       20s
```

In [ ]:

```
# 📊 9. Aggregation & Grouping
print("\n📊 9. AGGREGATION & GROUPING")
print("="*50)

# Basic statistics
print("Basic Statistics:")
print(df.describe())

print("\nStatistics for numeric columns:")
print(df[['Age', 'Salary', 'Bonus']].agg(['mean', 'median', 'std', 'sum']))

print("\nGroup by Department:")
grouped = df.groupby('Department').agg({
    'Age': 'mean',
    'Salary': ['mean', 'max', 'min', 'count'],
    'Bonus': 'sum'
})
print(grouped)
```

In [ ]:

```
# 🎭 10. Handling Missing Data
print("\n🎭 10. HANDLING MISSING DATA")
print("="*50)

# Create DataFrame with missing values
df_missing = df.copy()
df_missing.loc[1, 'Salary'] = np.nan
df_missing.loc[3, 'Age'] = np.nan
df_missing.loc[4, 'Department'] = np.nan
```

```
print("DataFrame with missing values:")
print(df_missing)

print(f"\nMissing values count:\n{df_missing.isnull().sum()}")

# Fill missing values
df_filled = df_missing.copy()
df_filled['Salary'].fillna(df_filled['Salary'].mean(), inplace=True)
df_filled['Age'].fillna(df_filled['Age'].median(), inplace=True)
df_filled['Department'].fillna('Unknown', inplace=True)

print("\nAfter filling missing values:")
print(df_filled)
```

In [10]:

```
# 🔗 11. Merging & Joining DataFrames
print("\n🔗 11. MERGING & JOINING DATAFRAMES")
print("="*50)

# Create additional DataFrames
df1 = pd.DataFrame({
    'ID': [1, 2, 3, 4],
    'Name': ['Alice', 'Bob', 'Charlie', 'David'],
    'Dept_ID': [101, 102, 101, 103]
})

df2 = pd.DataFrame({
    'Dept_ID': [101, 102, 103, 104],
    'Department': ['HR', 'IT', 'Finance', 'Marketing'],
    'Location': ['NYC', 'LA', 'Chicago', 'Miami']
})

print("DataFrame 1:")
print(df1)
print("\nDataFrame 2:")
print(df2)

# Merge DataFrames
merged_df = pd.merge(df1, df2, on='Dept_ID', how='inner')
print("\nMerged DataFrame (inner join):")
print(merged_df)

# Concatenate DataFrames
df3 = pd.DataFrame({'ID': [5], 'Name': ['Eve'], 'Dept_ID': [104]})
concatenated = pd.concat([df1, df3], ignore_index=True)
print("\nConcatenated DataFrame:")
print(concatenated)
```

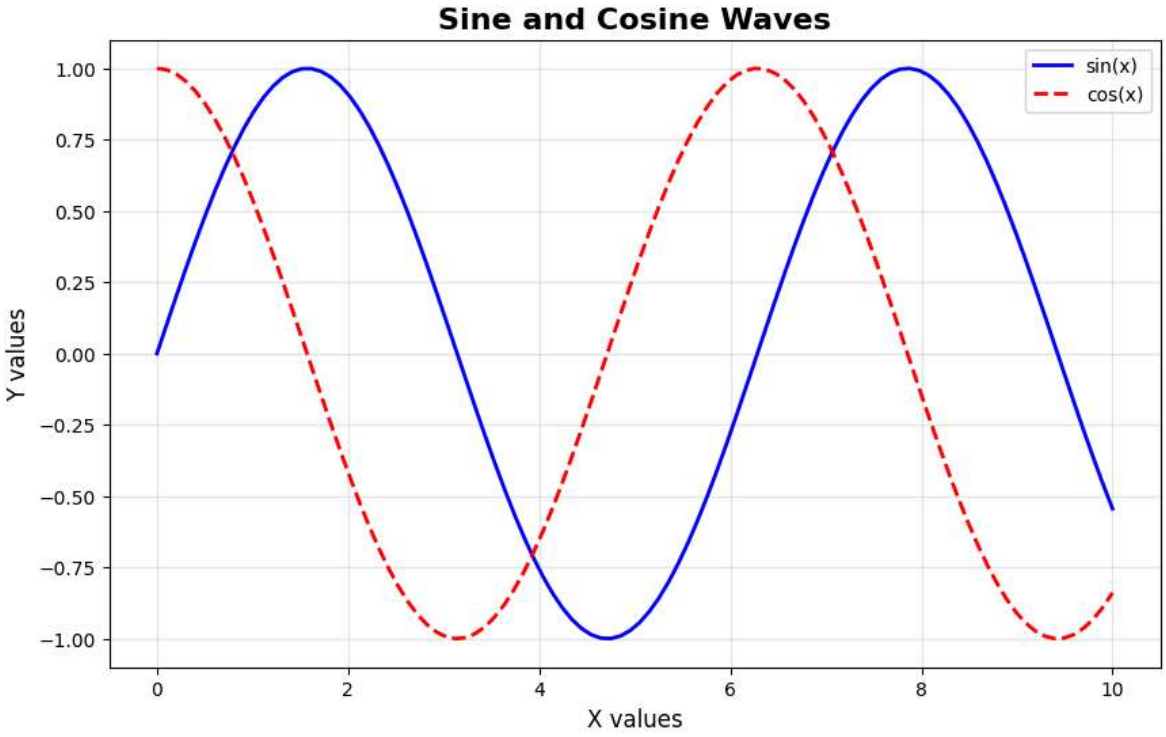
```
🔗 11. MERGING & JOINING DATAFRAMES
==================================================
DataFrame 1:
   ID     Name  Dept_ID
0   1    Alice      101
1   2      Bob      102
2   3  Charlie      101
3   4    David      103

DataFrame 2:
   Dept_ID Department Location
0      101         HR      NYC
1      102         IT       LA
2      103    Finance  Chicago
3      104  Marketing    Miami

Merged DataFrame (inner join):
   ID     Name  Dept_ID Department Location
0   1    Alice      101         HR      NYC
1   2      Bob      102         IT       LA
2   3  Charlie      101         HR      NYC
3   4    David      103    Finance  Chicago

Concatenated DataFrame:
   ID     Name  Dept_ID
0   1    Alice      101
1   2      Bob      102
2   3  Charlie      101
3   4    David      103
4   5      Eve      104
```

3. Matplotlib Visualization

In [11]:

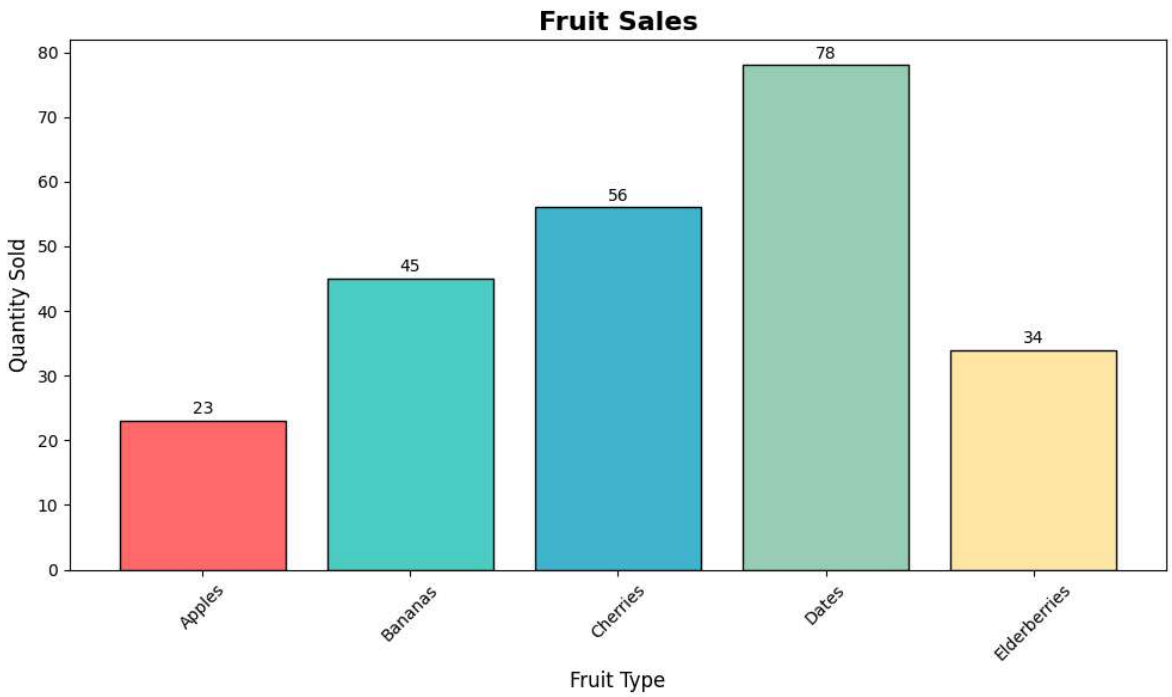
```
# 📊 12. Basic Line Plot
print("📊 12. BASIC LINE PLOT")
print("="*50)

# Create data
x = np.linspace(0, 10, 100)
y1 = np.sin(x)
y2 = np.cos(x)

plt.figure(figsize=(10, 6))
plt.plot(x, y1, label='sin(x)', color='blue', linewidth=2, linestyle='-')
plt.plot(x, y2, label='cos(x)', color='red', linewidth=2, linestyle='--')

plt.title('Sine and Cosine Waves', fontsize=16, fontweight='bold')
plt.xlabel('X values', fontsize=12)
plt.ylabel('Y values', fontsize=12)
plt.legend()
plt.grid(True, alpha=0.3)
plt.show()
```

```
📊 12. BASIC LINE PLOT
==================================================
```



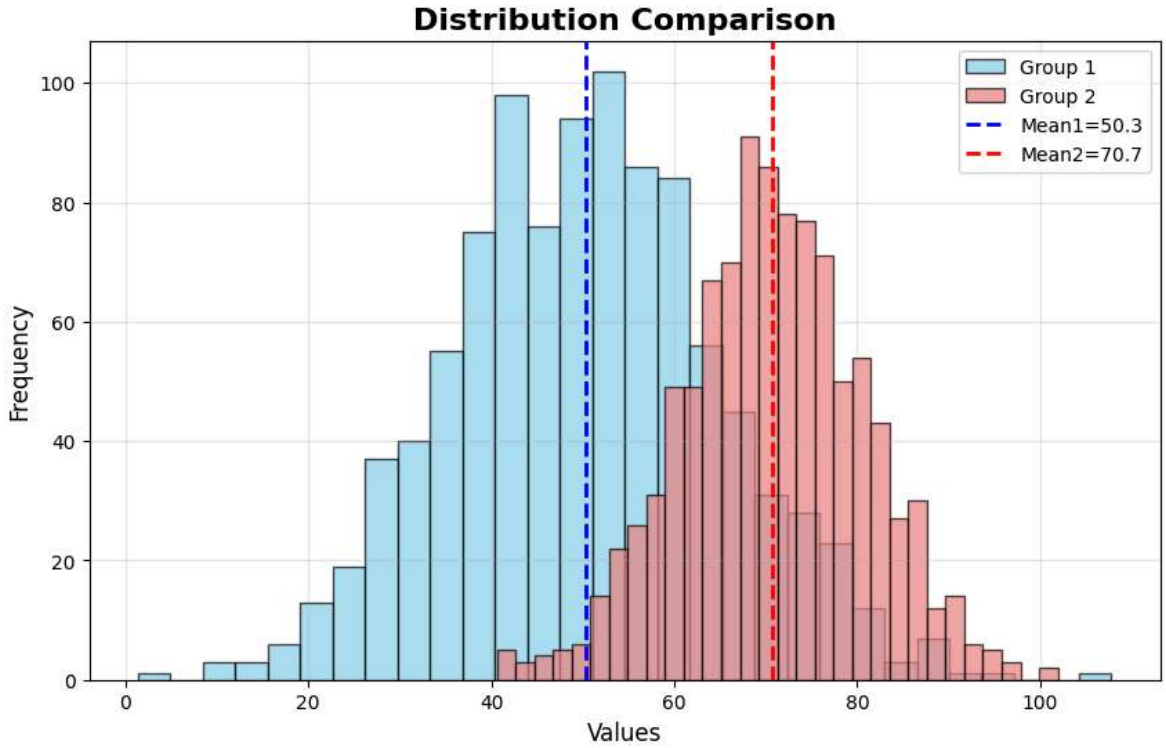
In [12]:
```
# 📊 13. Bar Chart
print("\n📊 13. BAR CHART")
print("="*50)

categories = ['Apples', 'Bananas', 'Cherries', 'Dates', 'Elderberries']
values = [23, 45, 56, 78, 34]
colors = ['#FF6B6B', '#4ECDC4', '#45B7D1', '#96CEB4', '#FFEAA7']

plt.figure(figsize=(10, 6))
bars = plt.bar(categories, values, color=colors, edgecolor='black')

plt.title('Fruit Sales', fontsize=16, fontweight='bold')
plt.xlabel('Fruit Type', fontsize=12)
plt.ylabel('Quantity Sold', fontsize=12)
plt.xticks(rotation=45)

# Add value labels on bars
for bar in bars:
    height = bar.get_height()
    plt.text(bar.get_x() + bar.get_width()/2., height + 0.5,
             f'{int(height)}', ha='center', va='bottom')

plt.tight_layout()
plt.show()
```

```
📊 13. BAR CHART
==================================================
```



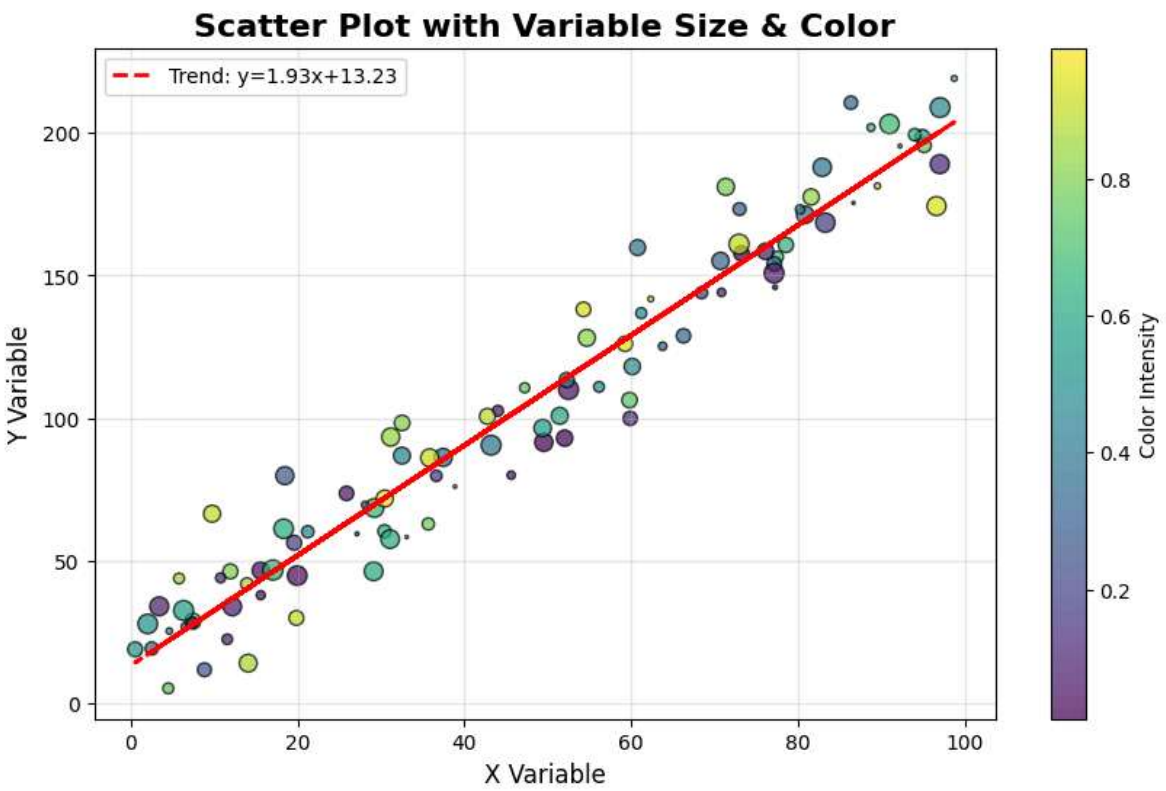
In [13]:
```
# 📊 14. Histogram
print("\n📊 14. HISTOGRAM")
print("="*50)

# Generate random data
np.random.seed(42)
data1 = np.random.normal(50, 15, 1000)  # Mean=50, Std=15
data2 = np.random.normal(70, 10, 1000)  # Mean=70, Std=10

plt.figure(figsize=(10, 6))
plt.hist(data1, bins=30, alpha=0.7, label='Group 1', color='skyblue', edgecolor=
plt.hist(data2, bins=30, alpha=0.7, label='Group 2', color='lightcoral', edgecol

plt.title('Distribution Comparison', fontsize=16, fontweight='bold')
plt.xlabel('Values', fontsize=12)
plt.ylabel('Frequency', fontsize=12)
plt.legend()
plt.grid(True, alpha=0.3)

# Add mean lines
plt.axvline(data1.mean(), color='blue', linestyle='--', linewidth=2, label=f'Mea
plt.axvline(data2.mean(), color='red', linestyle='--', linewidth=2, label=f'Mean

plt.legend()
plt.show()
```

```
📊 14. HISTOGRAM
==================================================
```



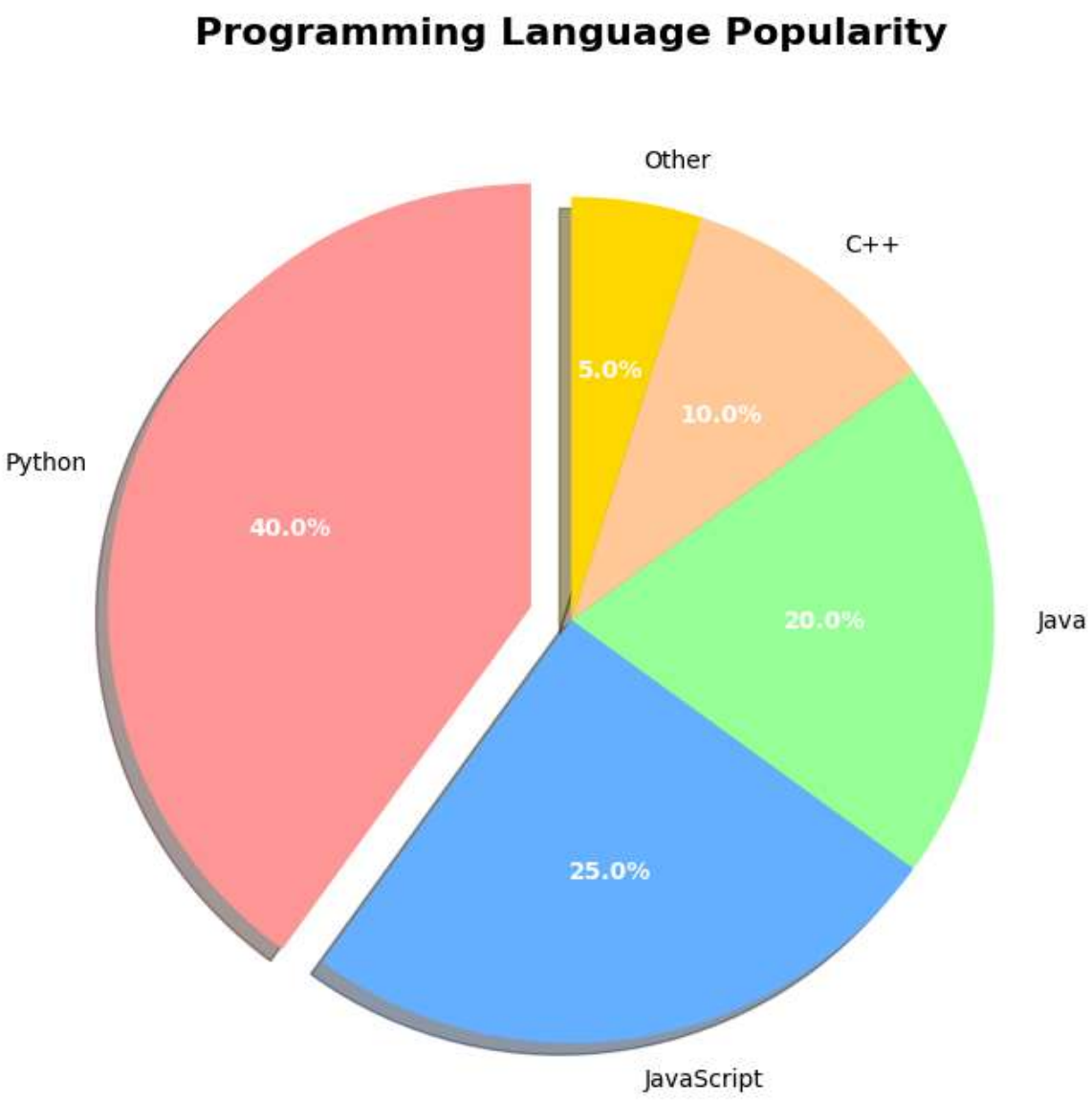
In [14]:
```
# 📊 15. Scatter Plot
print("\n📊 15. SCATTER PLOT")
print("="*50)

# Create sample data
np.random.seed(42)
n_points = 100
x = np.random.rand(n_points) * 100
y = 2 * x + 10 + np.random.randn(n_points) * 15  # Linear relationship with nois
sizes = np.random.rand(n_points) * 100  # Variable point sizes
colors = np.random.rand(n_points)  # Variable colors

plt.figure(figsize=(10, 6))
scatter = plt.scatter(x, y, s=sizes, c=colors, alpha=0.7, cmap='viridis', edgecc

plt.title('Scatter Plot with Variable Size & Color', fontsize=16, fontweight='bo
plt.xlabel('X Variable', fontsize=12)
plt.ylabel('Y Variable', fontsize=12)
plt.colorbar(scatter, label='Color Intensity')

# Add trend line
z = np.polyfit(x, y, 1)
p = np.poly1d(z)
plt.plot(x, p(x), "r--", linewidth=2, label=f'Trend: y={z[0]:.2f}x+{z[1]:.2f}')

plt.legend()
plt.grid(True, alpha=0.3)
plt.show()
```

```
📊 15. SCATTER PLOT
==================================================
```



In [15]:
```
# 📊 16. Pie Chart
print("\n📊 16. PIE CHART")
print("="*50)

labels = ['Python', 'JavaScript', 'Java', 'C++', 'Other']
sizes = [40, 25, 20, 10, 5]
colors = ['#FF9999', '#66B2FF', '#99FF99', '#FFCC99', '#FFD700']
explode = (0.1, 0, 0, 0, 0)  # Explode Python slice

plt.figure(figsize=(8, 8))
wedges, texts, autotexts = plt.pie(sizes, explode=explode, labels=labels, colors
                                   autopct='%1.1f%%', shadow=True, startangle=90

# Style the text
for autotext in autotexts:
    autotext.set_color('white')
    autotext.set_fontweight('bold')

plt.title('Programming Language Popularity', fontsize=16, fontweight='bold', pad
plt.show()
```

```
📊 16. PIE CHART
==================================================
```

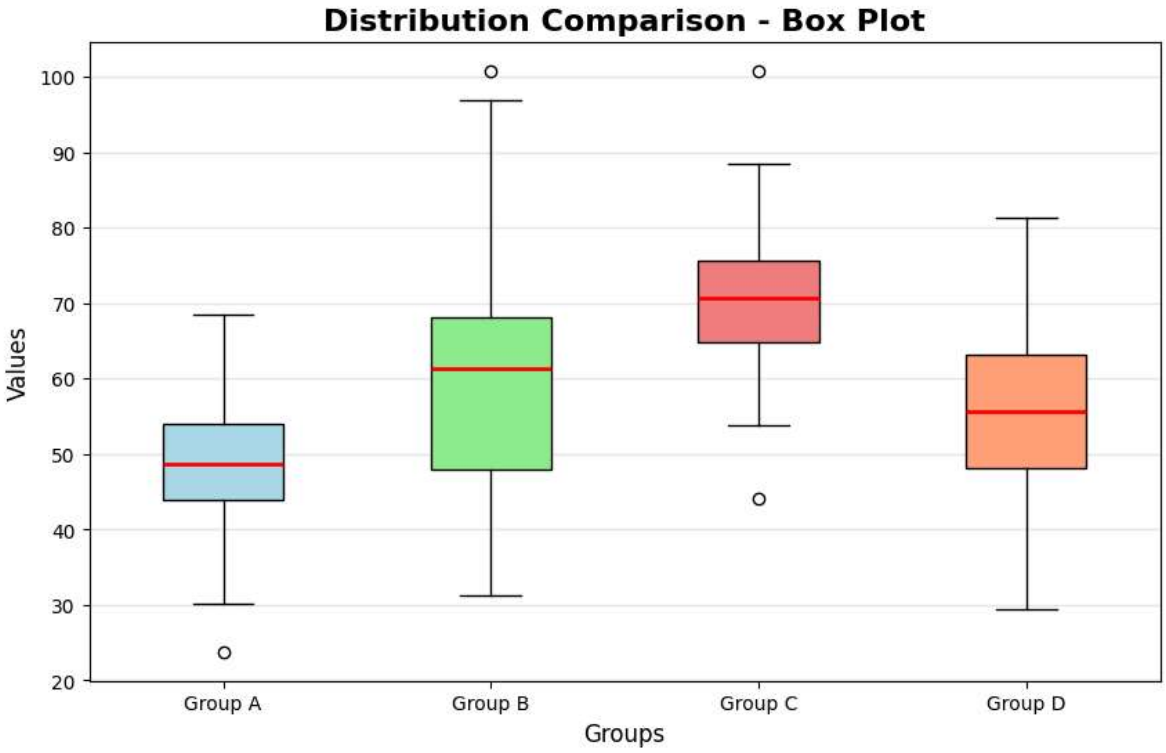


In [16]:
```
# 📊 17. Box Plot
print("\n📊 17. BOX PLOT")
print("="*50)

# Create sample data
np.random.seed(42)
data_groups = [
    np.random.normal(50, 10, 100),
    np.random.normal(60, 15, 100),
    np.random.normal(70, 8, 100),
    np.random.normal(55, 12, 100)
]

labels = ['Group A', 'Group B', 'Group C', 'Group D']

plt.figure(figsize=(10, 6))
box = plt.boxplot(data_groups, labels=labels, patch_artist=True,
                  medianprops={'color': 'red', 'linewidth': 2})

# Customize colors
colors = ['lightblue', 'lightgreen', 'lightcoral', 'lightsalmon']
for patch, color in zip(box['boxes'], colors):
    patch.set_facecolor(color)
```

```
plt.title('Distribution Comparison - Box Plot', fontsize=16, fontweight='bold')
plt.xlabel('Groups', fontsize=12)
plt.ylabel('Values', fontsize=12)
plt.grid(True, alpha=0.3, axis='y')
plt.show()
```

```
📊 17. BOX PLOT
==================================================
```

```
C:\Users\mohda\AppData\Local\Temp\ipykernel_2776\3915155315.py:17: MatplotlibDepr
ecationWarning: The 'labels' parameter of boxplot() has been renamed 'tick_label
s' since Matplotlib 3.9; support for the old name will be dropped in 3.11.
  box = plt.boxplot(data_groups, labels=labels, patch_artist=True,
```

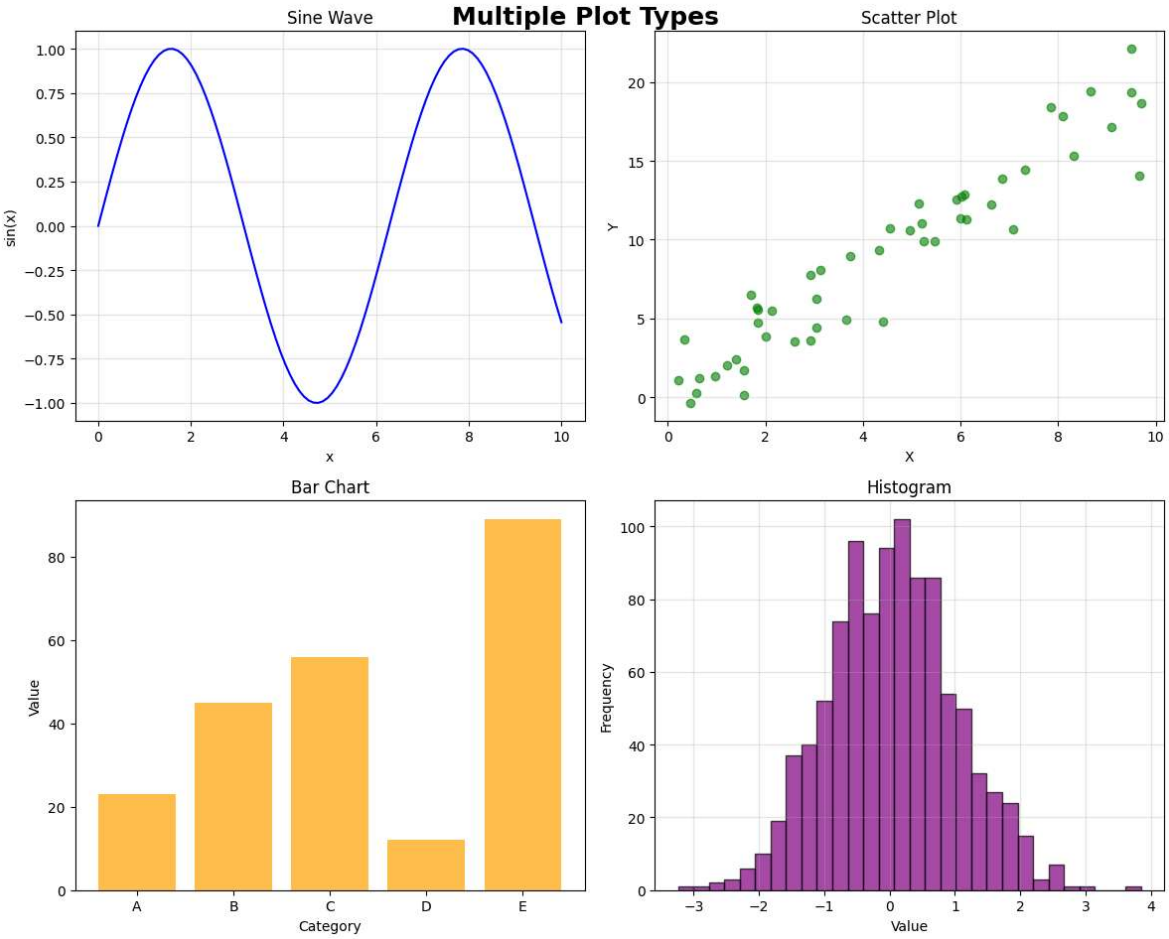


In [17]:

```
# 📊 18. Subplots (Multiple Plots)
print("\n📊 18. SUBPLOTS (MULTIPLE PLOTS)")
print("="*50)

fig, axes = plt.subplots(2, 2, figsize=(12, 10))
fig.suptitle('Multiple Plot Types', fontsize=18, fontweight='bold', y=0.95)

# Plot 1: Line plot
x = np.linspace(0, 10, 100)
axes[0, 0].plot(x, np.sin(x), 'b-')
axes[0, 0].set_title('Sine Wave')
axes[0, 0].set_xlabel('x')
axes[0, 0].set_ylabel('sin(x)')
axes[0, 0].grid(True, alpha=0.3)

# Plot 2: Scatter plot
np.random.seed(42)
x_scatter = np.random.rand(50) * 10
y_scatter = x_scatter * 2 + np.random.randn(50) * 2
axes[0, 1].scatter(x_scatter, y_scatter, alpha=0.6, c='green')
axes[0, 1].set_title('Scatter Plot')
axes[0, 1].set_xlabel('X')
axes[0, 1].set_ylabel('Y')
```

```
axes[0, 1].grid(True, alpha=0.3)

# Plot 3: Bar plot
categories = ['A', 'B', 'C', 'D', 'E']
values = [23, 45, 56, 12, 89]
axes[1, 0].bar(categories, values, color='orange', alpha=0.7)
axes[1, 0].set_title('Bar Chart')
axes[1, 0].set_xlabel('Category')
axes[1, 0].set_ylabel('Value')

# Plot 4: Histogram
data_hist = np.random.normal(0, 1, 1000)
axes[1, 1].hist(data_hist, bins=30, alpha=0.7, color='purple', edgecolor='black'
axes[1, 1].set_title('Histogram')
axes[1, 1].set_xlabel('Value')
axes[1, 1].set_ylabel('Frequency')
axes[1, 1].grid(True, alpha=0.3)

plt.tight_layout()
plt.show()
```

```
📊 18. SUBPLOTS (MULTIPLE PLOTS)
==================================================
```

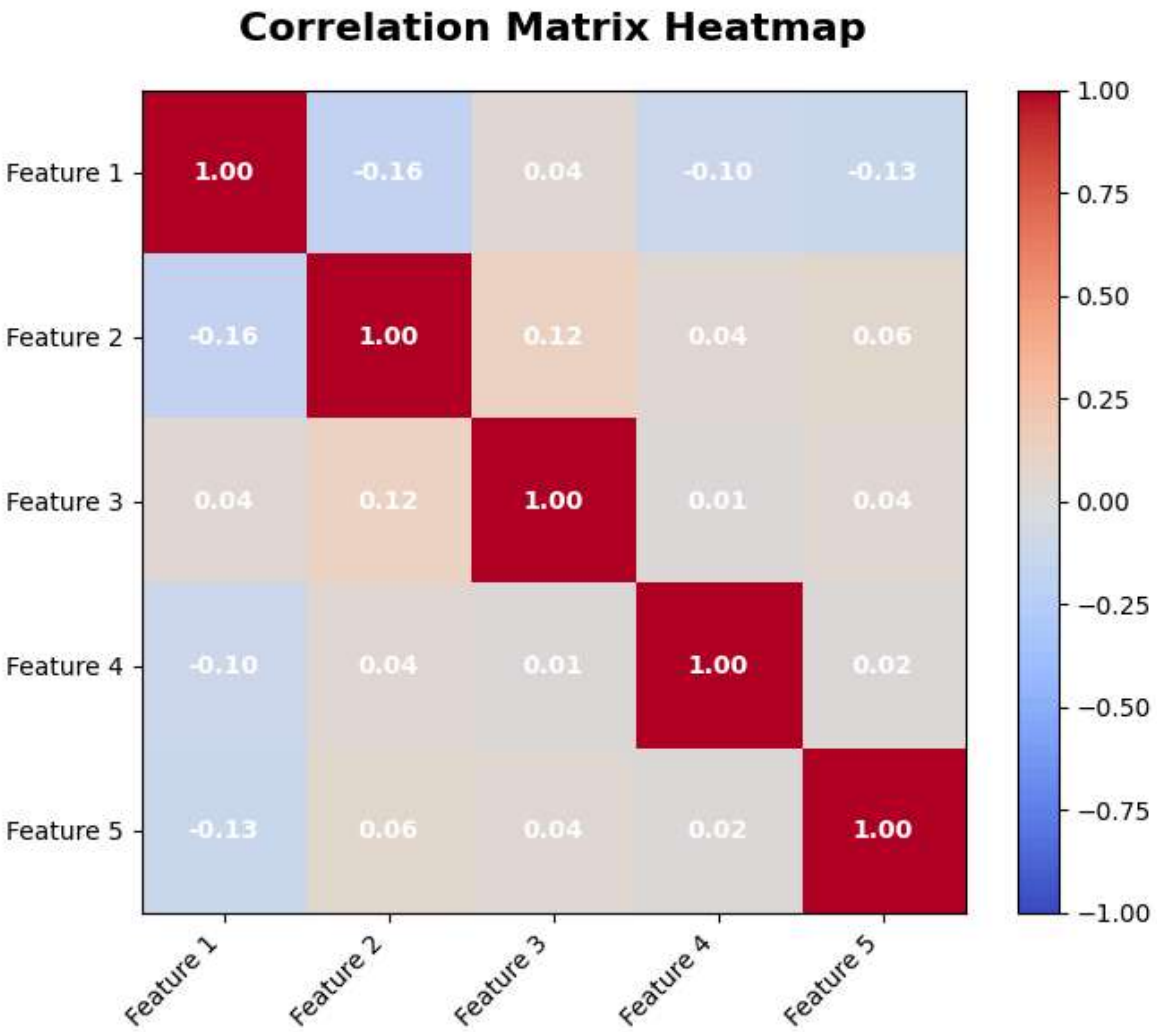


In [18]:

```
# 📊 19. Heatmap
print("\n📊 19. HEATMAP")
print("="*50)

# Create correlation matrix
np.random.seed(42)
data = np.random.randn(100, 5)
corr_matrix = np.corrcoef(data.T)
```

```
labels = ['Feature 1', 'Feature 2', 'Feature 3', 'Feature 4', 'Feature 5']

plt.figure(figsize=(8, 6))
heatmap = plt.imshow(corr_matrix, cmap='coolwarm', vmin=-1, vmax=1)

# Add colorbar
plt.colorbar(heatmap, fraction=0.046, pad=0.04)

# Add text annotations
for i in range(len(labels)):
    for j in range(len(labels)):
        text = plt.text(j, i, f'{corr_matrix[i, j]:.2f}',
                        ha='center', va='center', color='white', fontweight='bold

plt.title('Correlation Matrix Heatmap', fontsize=16, fontweight='bold', pad=20)
plt.xticks(range(len(labels)), labels, rotation=45, ha='right')
plt.yticks(range(len(labels)), labels)
plt.tight_layout()
plt.show()
```

📊 19. HEATMAP
==========

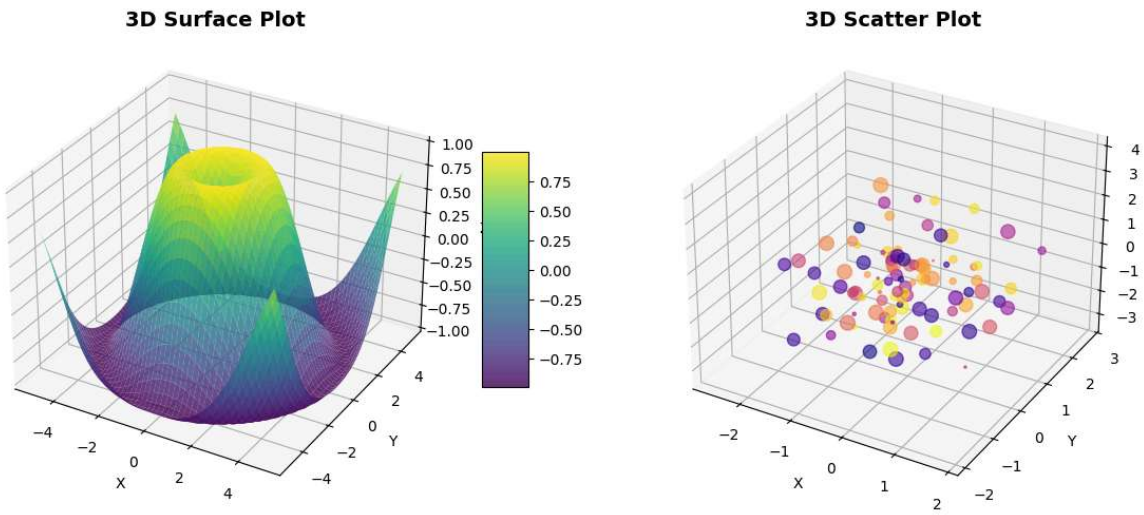


In [19]:

```
# 📊 20. 3D Plot
print("\n📊 20. 3D PLOT")
print("="*50)

from mpl_toolkits.mplot3d import Axes3D
```

```
# Create data for 3D plot
x = np.linspace(-5, 5, 50)
y = np.linspace(-5, 5, 50)
X, Y = np.meshgrid(x, y)
Z = np.sin(np.sqrt(X**2 + Y**2))

fig = plt.figure(figsize=(12, 5))

# 3D Surface plot
ax1 = fig.add_subplot(121, projection='3d')
surf = ax1.plot_surface(X, Y, Z, cmap='viridis', edgecolor='none', alpha=0.8)
ax1.set_title('3D Surface Plot', fontsize=14, fontweight='bold')
ax1.set_xlabel('X')
ax1.set_ylabel('Y')
ax1.set_zlabel('Z')
fig.colorbar(surf, ax=ax1, shrink=0.5, aspect=5)

# 3D Scatter plot
ax2 = fig.add_subplot(122, projection='3d')
np.random.seed(42)
n_points = 100
x_scatter = np.random.randn(n_points)
y_scatter = np.random.randn(n_points)
z_scatter = np.random.randn(n_points)
colors = np.random.rand(n_points)
sizes = 100 * np.random.rand(n_points)

scatter = ax2.scatter(x_scatter, y_scatter, z_scatter, c=colors, s=sizes, alpha=
ax2.set_title('3D Scatter Plot', fontsize=14, fontweight='bold')
ax2.set_xlabel('X')
ax2.set_ylabel('Y')
ax2.set_zlabel('Z')

plt.tight_layout()
plt.show()
```

📊 20. 3D PLOT
==========



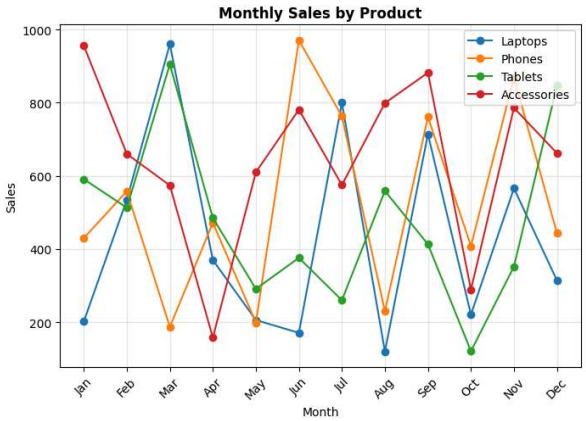
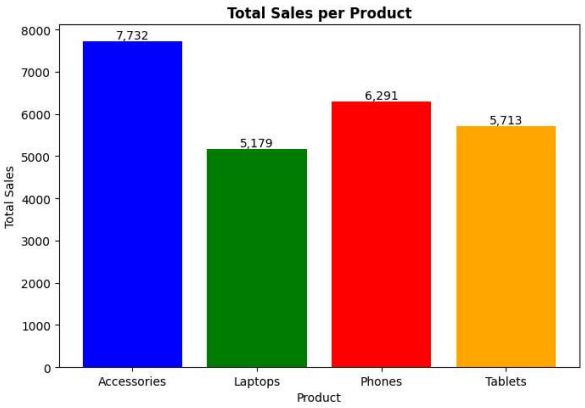
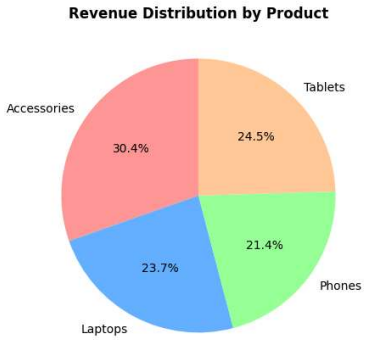
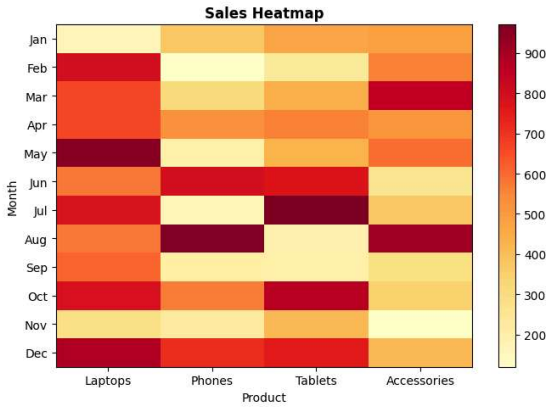
🎯 Practice Exercises

In [20]:
```
# 🎯 EXERCISE 1: Student Grade Analysis
print("🎯 EXERCISE 1: STUDENT GRADE ANALYSIS")
print("="*50)

# Create student data
np.random.seed(42)
students = pd.DataFrame({
    'Student_ID': range(1, 21),
    'Name': [f'Student_{i}' for i in range(1, 21)],
    'Math': np.random.randint(50, 100, 20),
    'Science': np.random.randint(60, 95, 20),
    'English': np.random.randint(55, 90, 20),
    'History': np.random.randint(65, 100, 20)
})

# Add calculated columns
students['Total'] = students[['Math', 'Science', 'English', 'History']].sum(axis
students['Average'] = students['Total'] / 4
students['Grade'] = pd.cut(students['Average'],
                           bins=[0, 60, 70, 80, 90, 100],
                           labels=['F', 'D', 'C', 'B', 'A'])

print("Student Dataframe:")
print(students.head())

# Analyze performance
print("\n\nGrade Distribution:")
print(students['Grade'].value_counts().sort_index())

print("\n\nSubject Averages:")
for subject in ['Math', 'Science', 'English', 'History']:
    print(f"{subject}: {students[subject].mean():.2f}")

# Find top 3 students
print("\n\nTop 3 Students:")
print(students.nlargest(3, 'Average')[['Name', 'Average', 'Grade']])
```

```
🎯 EXERCISE 1: STUDENT GRADE ANALYSIS
==================================================
Student Dataframe:
   Student_ID       Name  Math  Science  English  History  Total  Average  \
0           1  Student_1    88       89       80       79    336    84.00
1           2  Student_2    78       61       56       72    267    66.75
2           3  Student_3    64       80       74       78    296    74.00
3           4  Student_4    92       92       82       87    353    88.25
4           5  Student_5    57       71       61       85    274    68.50

  Grade
0     B
1     D
2     C
3     B
4     D


Grade Distribution:
Grade
F     0
D     5
C    10
B     5
A     0
Name: count, dtype: int64


Subject Averages:
Math: 72.85
Science: 76.05
English: 70.75
History: 80.65


Top 3 Students:
          Name  Average Grade
3    Student_4    88.25     B
6    Student_7    85.75     B
13  Student_14    85.25     B
```

In [21]:

```python
# 🎯 EXERCISE 2: Sales Data Visualization
print("\n🎯 EXERCISE 2: SALES DATA VISUALIZATION")
print("="*50)

# Create sales data
months = ['Jan', 'Feb', 'Mar', 'Apr', 'May', 'Jun', 'Jul', 'Aug', 'Sep', 'Oct',
products = ['Laptops', 'Phones', 'Tablets', 'Accessories']

np.random.seed(42)
sales_data = {
    'Month': months * len(products),
    'Product': [product for product in products for _ in range(len(months))],
    'Sales': np.random.randint(100, 1000, len(months) * len(products)),
    'Revenue': np.random.randint(10000, 500000, len(months) * len(products))
}

sales_df = pd.DataFrame(sales_data)
print("Sales Data (first 10 rows):")
print(sales_df.head(10))
```

```
# Pivot for visualization
pivot_sales = sales_df.pivot_table(index='Month', columns='Product', values='Sal

# Create visualization
fig, axes = plt.subplots(2, 2, figsize=(14, 10))

# Plot 1: Line plot of monthly sales
for product in products:
    product_data = sales_df[sales_df['Product'] == product]
    axes[0, 0].plot(product_data['Month'], product_data['Sales'], marker='o', la
axes[0, 0].set_title('Monthly Sales by Product', fontweight='bold')
axes[0, 0].set_xlabel('Month')
axes[0, 0].set_ylabel('Sales')
axes[0, 0].legend()
axes[0, 0].grid(True, alpha=0.3)
plt.setp(axes[0, 0].xaxis.get_majorticklabels(), rotation=45)

# Plot 2: Bar chart of total sales per product
total_sales = sales_df.groupby('Product')['Sales'].sum()
bars = axes[0, 1].bar(total_sales.index, total_sales.values, color=['blue', 'gre
axes[0, 1].set_title('Total Sales per Product', fontweight='bold')
axes[0, 1].set_xlabel('Product')
axes[0, 1].set_ylabel('Total Sales')
for bar in bars:
    height = bar.get_height()
    axes[0, 1].text(bar.get_x() + bar.get_width()/2., height,
                    f'{int(height):,}', ha='center', va='bottom')

# Plot 3: Pie chart of revenue distribution
revenue_by_product = sales_df.groupby('Product')['Revenue'].sum()
axes[1, 0].pie(revenue_by_product.values, labels=revenue_by_product.index,
               autopct='%1.1f%%', startangle=90, colors=['#ff9999','#66b3ff','#9
axes[1, 0].set_title('Revenue Distribution by Product', fontweight='bold')

# Plot 4: Heatmap of sales data
im = axes[1, 1].imshow(pivot_sales.values, cmap='YlOrRd', aspect='auto')
axes[1, 1].set_title('Sales Heatmap', fontweight='bold')
axes[1, 1].set_xlabel('Product')
axes[1, 1].set_ylabel('Month')
axes[1, 1].set_xticks(range(len(products)))
axes[1, 1].set_xticklabels(products)
axes[1, 1].set_yticks(range(len(months)))
axes[1, 1].set_yticklabels(months)
plt.colorbar(im, ax=axes[1, 1])

plt.tight_layout()
plt.show()
```

```
🎯 EXERCISE 2: SALES DATA VISUALIZATION
==================================================
Sales Data (first 10 rows):
  Month  Product  Sales  Revenue
0   Jan  Laptops    202    77435
1   Feb  Laptops    535   329030
2   Mar  Laptops    960   338947
3   Apr  Laptops    370    41551
4   May  Laptops    206   388360
5   Jun  Laptops    171   283538
6   Jul  Laptops    800   341236
7   Aug  Laptops    120    13890
8   Sep  Laptops    714    51606
9   Oct  Laptops    221   499492
```