**MSCS-634: Lab assignment: Lab Report: Data Visualization, Data Preprocessing, and Statistical Analysis Using Python in Jupyter Notebook**

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MSCS-634 Advanced Big Data and Data Mining

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## 1. Introduction

This report documents the complete process of Lab 1 for the course MSCS-634 - Advanced Big Data and Data Mining.
The lab involved the use of Python (via Jupyter Notebook) for data preprocessing, visualization, and statistical analysis.
In addition to the analysis itself, this report also includes environment setup, challenges faced, and decisions made.

## 2. Environment Setup

The lab was performed on a Mac system using a Python virtual environment created using `python3 -m venv venv`.
Jupyter Notebook was run from within the virtual environment to ensure package isolation and dependency management.
The following packages were installed manually due to missing module errors encountered during the lab execution:
- pandas
- matplotlib
- scikit-learn

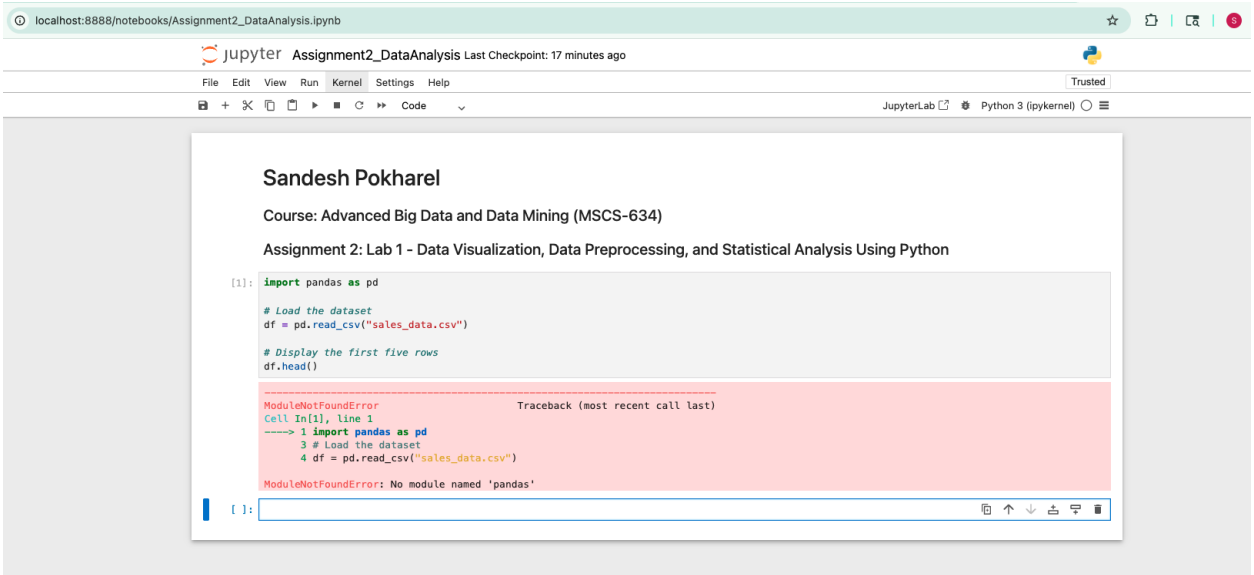
Each package was installed using pip from within the activated virtual environment:

```
$ source venv/bin/activate
$ pip install pandas matplotlib scikit-learn
```

Screenshot: Terminal showing venv activation and pip install commands

```
/Users/mac/Sandesh_Cumberlands_Assignments/Advanced_Big_Data_And_Data_Mining/MSCS-634-Assignment2 % source venv/bin/activate
(venv) /Users/mac/Sandesh_Cumberlands_Assignments/Advanced_Big_Data_And_Data_Mining/MSCS-634-Assignment2 % pip install pandas
Collecting pandas
  Using cached pandas-2.3.0-cp313-cp313-macosx_11_0_arm64.whl.metadata (91 kB)
Collecting numpy>=1.26.0 (from pandas)
  Using cached numpy-2.3.1-cp313-cp313-macosx_14_0_arm64.whl.metadata (62 kB)
Requirement already satisfied: python-dateutil>=2.8.2 in ./venv/lib/python3.13/site-packages (from pandas) (2.9.0.post0)
Collecting pytz>=2020.1 (from pandas)
  Using cached pytz-2025.2-py2.py3-none-any.whl.metadata (22 kB)
Collecting tzdata>=2022.7 (from pandas)
  Using cached tzdata-2025.2-py2.py3-none-any.whl.metadata (1.4 kB)
Requirement already satisfied: six>=1.5 in ./venv/lib/python3.13/site-packages (from python-dateutil>=2.8.2->pandas) (1.17.0)
Using cached pandas-2.3.0-cp313-cp313-macosx_11_0_arm64.whl (10.7 MB)
Using cached numpy-2.3.1-cp313-cp313-macosx_14_0_arm64.whl (5.1 MB)
Using cached pytz-2025.2-py2.py3-none-any.whl (509 kB)
Using cached tzdata-2025.2-py2.py3-none-any.whl (347 kB)
Installing collected packages: pytz, tzdata, numpy, pandas
Successfully installed numpy-2.3.1 pandas-2.3.0 pytz-2025.2 tzdata-2025.2
(venv) /Users/mac/Sandesh_Cumberlands_Assignments/Advanced_Big_Data_And_Data_Mining/MSCS-634-Assignment2 % open ./
(venv) /Users/mac/Sandesh_Cumberlands_Assignments/Advanced_Big_Data_And_Data_Mining/MSCS-634-Assignment2 % pip install matplotlib
Collecting matplotlib
  Using cached matplotlib-3.10.3-cp313-cp313-macosx_11_0_arm64.whl.metadata (11 kB)
Collecting contourpy>=1.0.1 (from matplotlib)
  Using cached contourpy-1.3.2-cp313-cp313-macosx_11_0_arm64.whl.metadata (5.5 kB)
Collecting cycler>=0.10 (from matplotlib)
  Using cached cycler-0.12.1-py3-none-any.whl.metadata (3.8 kB)
Collecting fonttools>=4.22.0 (from matplotlib)
  Downloading fonttools-4.58.5-cp313-cp313-macosx_10_13_universal2.whl.metadata (106 kB)
Collecting kiwisolver>=1.3.1 (from matplotlib)
  Using cached kiwisolver-1.4.8-cp313-cp313-macosx_11_0_arm64.whl.metadata (6.2 kB)
Requirement already satisfied: numpy>=1.23 in ./venv/lib/python3.13/site-packages (from matplotlib) (2.3.1)
Requirement already satisfied: packaging>=20.0 in ./venv/lib/python3.13/site-packages (from matplotlib) (25.0)
Collecting pillow>=8 (from matplotlib)
  Downloading pillow-11.3.0-cp313-cp313-macosx_11_0_arm64.whl.metadata (9.0 kB)
Collecting pyparsing>=2.3.1 (from matplotlib)
  Using cached pyparsing-3.2.3-py3-none-any.whl.metadata (5.0 kB)
Requirement already satisfied: python-dateutil>=2.7 in ./venv/lib/python3.13/site-packages (from matplotlib) (2.9.0.post0)
Requirement already satisfied: six>=1.5 in ./venv/lib/python3.13/site-packages (from python-dateutil>=2.7->matplotlib) (1.17.0)
Using cached matplotlib-3.10.3-cp313-cp313-macosx_11_0_arm64.whl (8.1 MB)
Using cached contourpy-1.3.2-cp313-cp313-macosx_11_0_arm64.whl (255 kB)
Using cached cycler-0.12.1-py3-none-any.whl (8.3 kB)
Downloading fonttools-4.58.5-cp313-cp313-macosx_10_13_universal2.whl (2.7 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 2.7/2.7 MB 35.7 MB/s eta 0:00:00
Using cached kiwisolver-1.4.8-cp313-cp313-macosx_11_0_arm64.whl (65 kB)
Downloading pillow-11.3.0-cp313-cp313-macosx_11_0_arm64.whl (4.7 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 4.7/4.7 MB 83.7 MB/s eta 0:00:00
Using cached pyparsing-3.2.3-py3-none-any.whl (111 kB)
Installing collected packages: pyparsing, pillow, kiwisolver, fonttools, cycler, contourpy, matplotlib
Successfully installed contourpy-1.3.2 cycler-0.12.1 fonttools-4.58.5 kiwisolver-1.4.8 matplotlib-3.10.3 pillow-11.3.0 pyparsing-3.2.3
(venv) /Users/mac/Sandesh_Cumberlands_Assignments/Advanced_Big_Data_And_Data_Mining/MSCS-634-Assignment2 % pip install scikit-learn
Collecting scikit-learn
  Using cached scikit_learn-1.7.0-cp313-cp313-macosx_12_0_arm64.whl.metadata (31 kB)
Requirement already satisfied: numpy>=1.22.0 in ./venv/lib/python3.13/site-packages (from scikit-learn) (2.3.1)
Collecting scipy>=1.8.0 (from scikit-learn)
  Using cached scipy-1.16.0-cp313-cp313-macosx_14_0_arm64.whl.metadata (61 kB)
Collecting joblib>=1.2.0 (from scikit-learn)
  Using cached joblib-1.5.1-py3-none-any.whl.metadata (5.6 kB)
Collecting threadpoolctl>=3.1.0 (from scikit-learn)
```

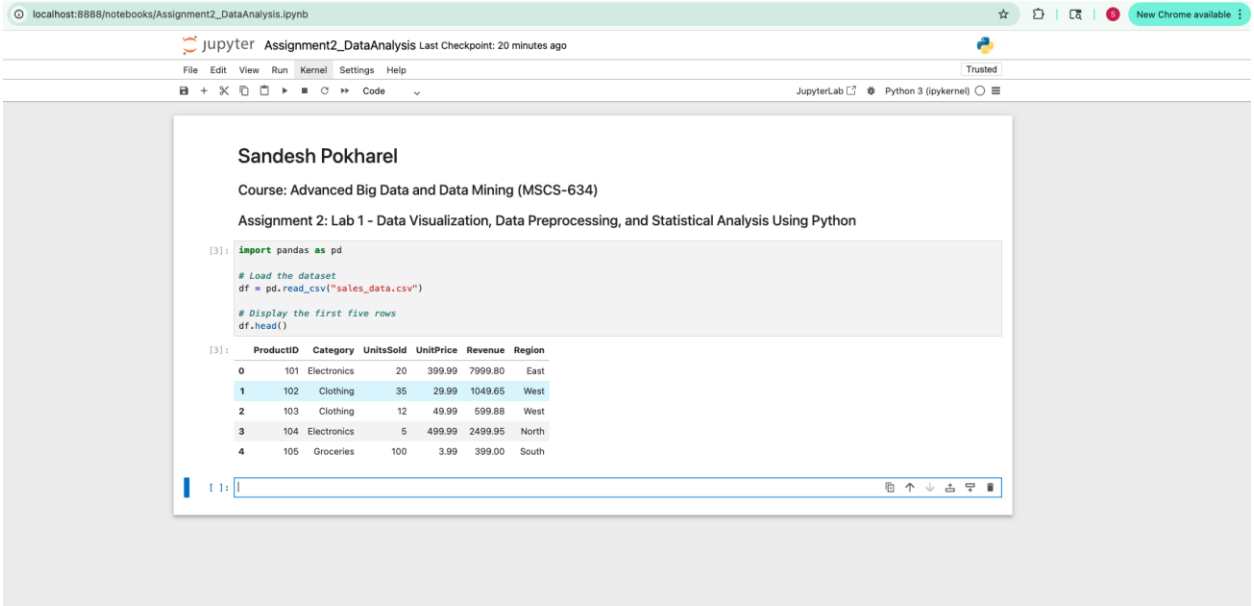
Screenshot: Jupyter Notebook errors (e.g., ModuleNotFoundError) and resolutions



## 3. Dataset Loading and Preview

The dataset used for this lab is a small CSV file named `sales_data.csv`, containing retail sales data.
It includes both numerical and categorical columns suitable for preprocessing and analysis.
The dataset was loaded using pandas and previewed using the `.head()` method.

Screenshot: Output of df.head()




## 4. Data Preprocessing

The following preprocessing steps were performed:
- Missing Values: Simulated missing data in UnitsSold and Region columns, filled using mean and mode.
- Outlier Detection: Used IQR method to detect and demonstrate outlier removal.
- Data Reduction: Sampled 50% of data and dropped irrelevant columns like ProductID.
- Data Scaling: Applied Min-Max Scaling to normalize UnitPrice.
- Discretization: Converted UnitsSold into categorical bins (Low, Medium, High).

Screenshot: Missing values simulation and handling

[8]:
```
# Check for missing values in each column
df.isnull().sum()
```

[8]:
```
ProductID    0
Category     0
UnitsSold    0
UnitPrice    0
Revenue      0
Region       0
dtype: int64
```

[ ]:

[9]:
```
# Simulate missing values in 'UnitsSold' and 'Region'
df.loc[1, 'UnitsSold'] = None
df.loc[3, 'Region'] = None

# Show dataset with missing values (screenshot this)
df
```

[9]:

| | ProductID | Category | UnitsSold | UnitPrice | Revenue | Region |
|---|---|---|---|---|---|---|
| **0** | 101 | Electronics | 20.0 | 399.99 | 7999.80 | East |
| **1** | 102 | Clothing | NaN | 29.99 | 1049.65 | West |
| **2** | 103 | Clothing | 12.0 | 49.99 | 599.88 | West |
| **3** | 104 | Electronics | 5.0 | 499.99 | 2499.95 | None |
| **4** | 105 | Groceries | 100.0 | 3.99 | 399.00 | South |
| **5** | 106 | Groceries | 85.0 | 2.49 | 211.65 | South |
| **6** | 107 | Clothing | 22.0 | 59.99 | 1319.78 | East |
| **7** | 108 | Electronics | 10.0 | 299.99 | 2999.90 | North |
| **8** | 109 | Groceries | 95.0 | 4.49 | 426.55 | South |
| **9** | 110 | Clothing | 18.0 | 39.99 | 719.82 | East |

[ ]:

[10]:
```
# Fill missing numeric value with mean
df['UnitsSold'].fillna(df['UnitsSold'].mean(), inplace=True)

# Fill missing categorical value with mode
df['Region'].fillna(df['Region'].mode()[0], inplace=True)

# Show updated dataset (screenshot this too)
df
```

```
/var/folders/bx/n0b8n8wd0ss985_pj3z33n780000gn/T/ipykernel_91721/781268429.py:2: FutureWarning: A value is trying to be set on a copy of a
DataFrame or Series through chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work because the intermediate object on which we are setting values
always behaves as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using 'df.method({col: value}, inplace=True)' or df[col] = df[col].meth
od(value) instead, to perform the operation inplace on the original object.


  df['UnitsSold'].fillna(df['UnitsSold'].mean(), inplace=True)
/var/folders/bx/n0b8n8wd0ss985_pj3z33n780000gn/T/ipykernel_91721/781268429.py:5: FutureWarning: A value is trying to be set on a copy of a
DataFrame or Series through chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work because the intermediate object on which we are setting values
always behaves as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using 'df.method({col: value}, inplace=True)' or df[col] = df[col].meth
od(value) instead, to perform the operation inplace on the original object.


  df['Region'].fillna(df['Region'].mode()[0], inplace=True)
```

[10]:

| | ProductID | Category | UnitsSold | UnitPrice | Revenue | Region |
|---|---|---|---|---|---|---|
| 0 | 101 | Electronics | 20.000000 | 399.99 | 7999.80 | East |
| 1 | 102 | Clothing | 40.777778 | 29.99 | 1049.65 | West |
| 2 | 103 | Clothing | 12.000000 | 49.99 | 599.88 | West |
| 3 | 104 | Electronics | 5.000000 | 499.99 | 2499.95 | East |
| 4 | 105 | Groceries | 100.000000 | 3.99 | 399.00 | South |
| 5 | 106 | Groceries | 85.000000 | 2.49 | 211.65 | South |
| 6 | 107 | Clothing | 22.000000 | 59.99 | 1319.78 | East |
| 7 | 108 | Electronics | 10.000000 | 299.99 | 2999.90 | North |
| 8 | 109 | Groceries | 95.000000 | 4.49 | 426.55 | South |
| 9 | 110 | Clothing | 18.000000 | 39.99 | 719.82 | East |

[ ]:

Screenshot: Outlier detection and removal

[11]:
```
# Step 1: Calculate Q1, Q3 and IQR
Q1 = df['UnitsSold'].quantile(0.25)
Q3 = df['UnitsSold'].quantile(0.75)
IQR = Q3 - Q1

# Step 2: Calculate bounds
lower_bound = Q1 - 1.5 * IQR
upper_bound = Q3 + 1.5 * IQR

print(f"Q1: {Q1}, Q3: {Q3}, IQR: {IQR}")
print(f"Lower Bound: {lower_bound}, Upper Bound: {upper_bound}")

# Step 3: Identify outliers
outliers = df[(df['UnitsSold'] < lower_bound) | (df['UnitsSold'] > upper_bound)]
print("\nDetected Outliers in 'UnitsSold':")
print(outliers)
```

```
Q1: 13.5, Q3: 73.94444444444444, IQR: 60.44444444444444
Lower Bound: -77.16666666666666, Upper Bound: 164.6111111111111

Detected Outliers in 'UnitsSold':
Empty DataFrame
Columns: [ProductID, Category, UnitsSold, UnitPrice, Revenue, Region]
Index: []
```

[ ]:

Screenshot: Sampled data and reduced columns

```
[12]: # Remove rows that are outliers (just for demonstration)
df_no_outliers = df[(df['UnitsSold'] >= lower_bound) & (df['UnitsSold'] <= upper_bound)]

# Display cleaned dataset
df_no_outliers
```

[12]:

| | ProductID | Category | UnitsSold | UnitPrice | Revenue | Region |
|---|---|---|---|---|---|---|
| 0 | 101 | Electronics | 20.000000 | 399.99 | 7999.80 | East |
| 1 | 102 | Clothing | 40.777778 | 29.99 | 1049.65 | West |
| 2 | 103 | Clothing | 12.000000 | 49.99 | 599.88 | West |
| 3 | 104 | Electronics | 5.000000 | 499.99 | 2499.95 | East |
| 4 | 105 | Groceries | 100.000000 | 3.99 | 399.00 | South |
| 5 | 106 | Groceries | 85.000000 | 2.49 | 211.65 | South |
| 6 | 107 | Clothing | 22.000000 | 59.99 | 1319.78 | East |
| 7 | 108 | Electronics | 10.000000 | 299.99 | 2999.90 | North |
| 8 | 109 | Groceries | 95.000000 | 4.49 | 426.55 | South |
| 9 | 110 | Clothing | 18.000000 | 39.99 | 719.82 | East |

```
[ ]:
```

Screenshot: Scaled and discretized columns

```
[15]: from sklearn.preprocessing import MinMaxScaler
import pandas as pd

# Copy the reduced DataFrame to preserve original
scaled_df = reduced_df.copy()

# 1. Min-Max Scaling for 'UnitPrice'
scaler = MinMaxScaler()
scaled_df['UnitPrice_Scaled'] = scaler.fit_transform(scaled_df[['UnitPrice']])

# 2. Discretization of 'UnitsSold' into 3 bins
scaled_df['UnitsSold_Category'] = pd.cut(scaled_df['UnitsSold'],
                                         bins=3,
                                         labels=['Low', 'Medium', 'High'])

# Display updated DataFrame
scaled_df
```

[15]:

| | Category | UnitsSold | UnitPrice | Revenue | Region | UnitPrice_Scaled | UnitsSold_Category |
|---|---|---|---|---|---|---|---|
| 2 | Clothing | 12.0 | 49.99 | 599.88 | West | 0.116162 | Low |
| 9 | Clothing | 18.0 | 39.99 | 719.82 | East | 0.090909 | Low |
| 6 | Clothing | 22.0 | 59.99 | 1319.78 | East | 0.141414 | Low |
| 4 | Groceries | 100.0 | 3.99 | 399.00 | South | 0.000000 | High |
| 0 | Electronics | 20.0 | 399.99 | 7999.80 | East | 1.000000 | Low |

```
[ ]:
```

## 5. Data Visualization

Multiple visualizations were created to explore and interpret the dataset:
- Bar Chart: Total Revenue by Category
- Pie Chart: Sales distribution by Region
- Histogram: Distribution of numeric features
- Boxplot: Detection of outliers in key numeric columns

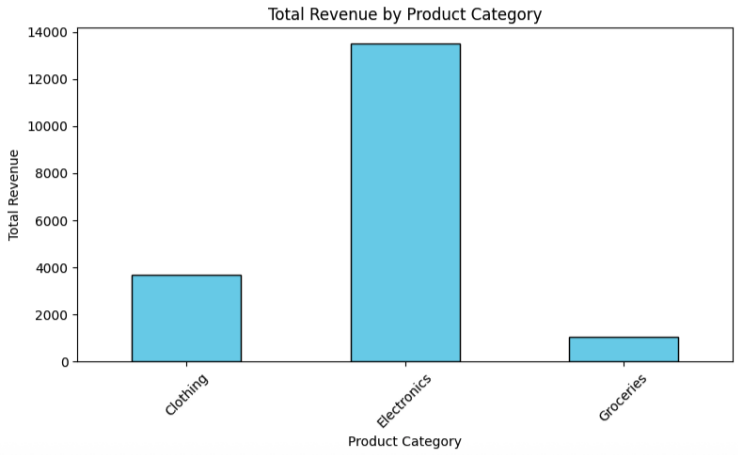
Screenshot s: All visualizations with observations

jupyter Assignment2_DataAnalysis Last Checkpoint: 23 minutes ago

File Edit View Run Kernel Settings Help Trusted

Code JupyterLab Python 3 (ipykernel)

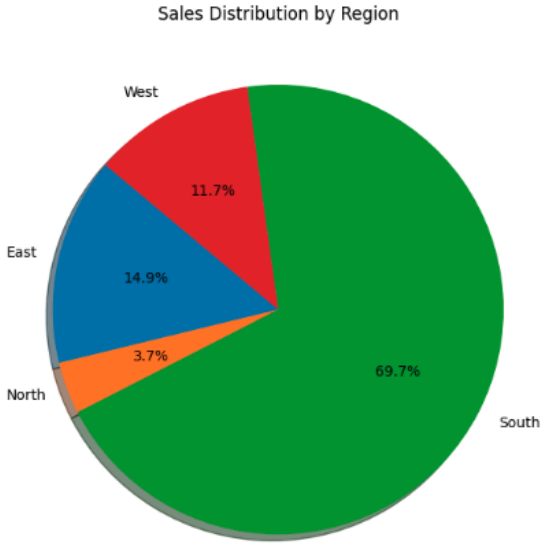
```
# Group by Category and sum the revenue
category_revenue = df.groupby('Category')['Revenue'].sum()

# Plot the bar chart
plt.figure(figsize=(8, 5))
category_revenue.plot(kind='bar', color='skyblue', edgecolor='black')

plt.title('Total Revenue by Product Category')
plt.xlabel('Product Category')
plt.ylabel('Total Revenue')
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```




[ ]:

Trash

[7]:
```
# Group by Region and sum the UnitsSold
region_sales = df.groupby('Region')['UnitsSold'].sum()

# Plot the pie chart
plt.figure(figsize=(6, 6))
region_sales.plot(kind='pie', autopct='%1.1f%%', startangle=140, shadow=True)

plt.title('Sales Distribution by Region')
plt.ylabel('')  # Hides the y-axis label
plt.tight_layout()
plt.show()
```

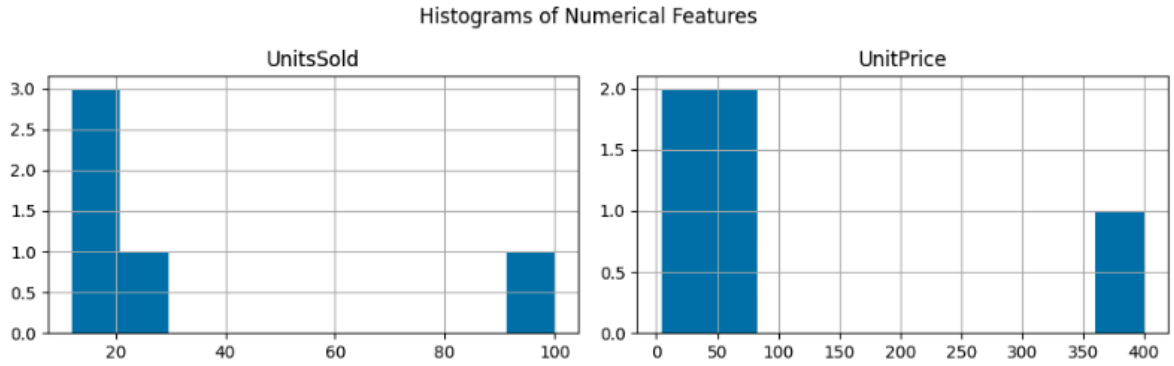


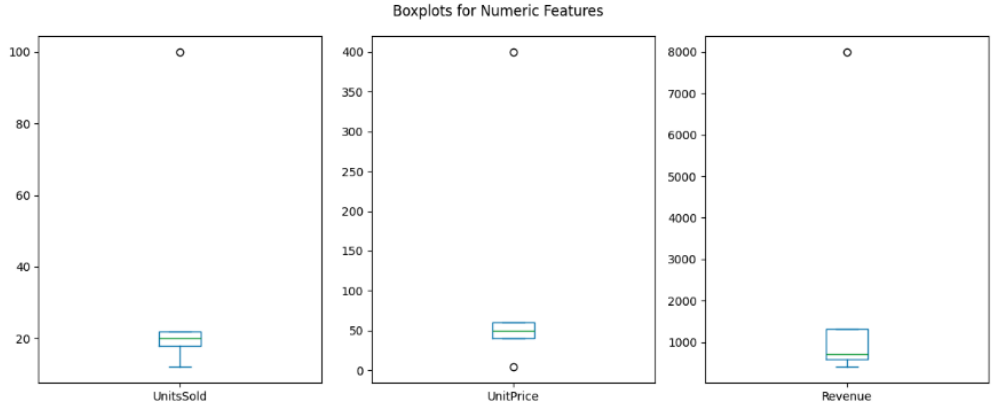

### Insight: Pie Chart – Sales Distribution by Region

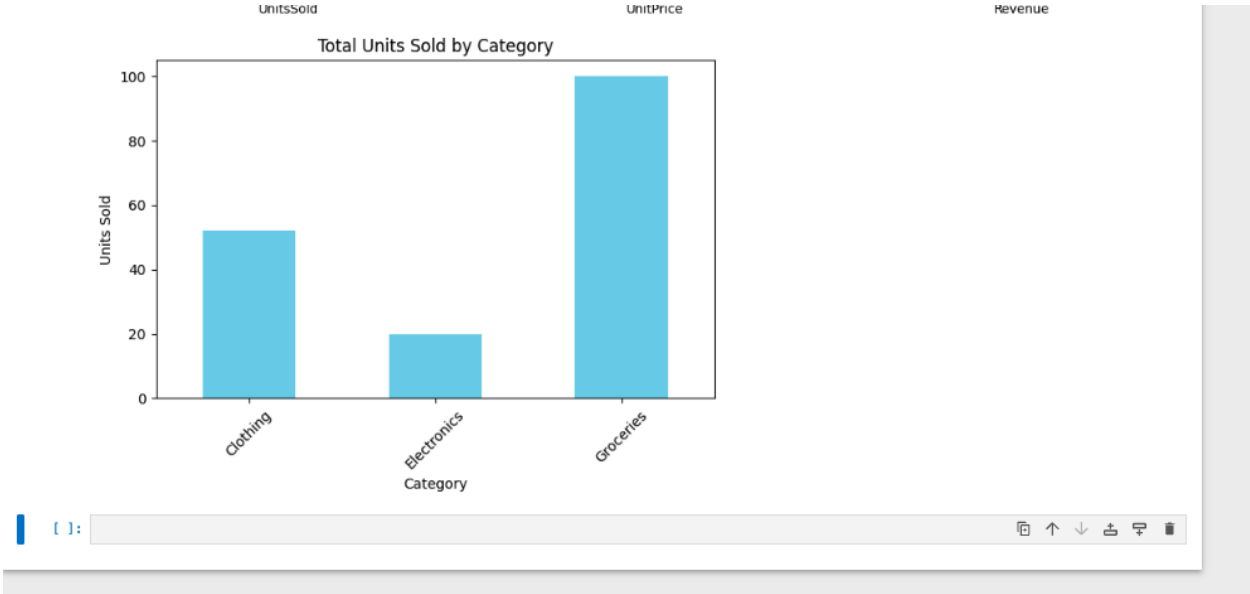
This pie chart shows the proportion of total units sold in each region.
It helps visualize where most of the product sales activity is occurring.
Regions with larger segments indicate stronger sales presence, which may suggest higher demand or market penetration.

[ ]:

```
:
import matplotlib.pyplot as plt

# 1. Histograms
scaled_df.hist(figsize=(10, 6))
plt.suptitle("Histograms of Numerical Features")
plt.tight_layout()
plt.show()

# 2. Boxplots
scaled_df[['UnitsSold', 'UnitPrice', 'Revenue']].plot(kind='box', subplots=True, layout=(1, 3), figsize=(12, 5))
plt.suptitle("Boxplots for Numeric Features")
plt.tight_layout()
plt.show()

# 3. Bar chart of UnitsSold by Category
scaled_df.groupby('Category')['UnitsSold'].sum().plot(kind='bar', color='skyblue')
plt.title("Total Units Sold by Category")
plt.ylabel("Units Sold")
plt.xlabel("Category")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```






## 6. Statistical Analysis

Performed a series of statistical calculations including:
- General Overview using `.info()` and `.describe()`
- Central Tendency: Mean, Median, Mode, Min, Max
- Dispersion: Standard Deviation, Variance, Range
- Correlation and Covariance matrices for numeric attributes

Screenshot s: Info, Describe, Central Tendency, Dispersion, Correlation, Covariance

[16]:
```
# General info about dataset
print("=== Dataset Info ===")
scaled_df.info()

# Statistical summary of numerical columns
print("\n=== Statistical Summary ===")
scaled_df.describe()
```

```
=== Dataset Info ===
<class 'pandas.core.frame.DataFrame'>
Index: 5 entries, 2 to 0
Data columns (total 7 columns):
 #   Column              Non-Null Count  Dtype
---  ------              --------------  -----
 0   Category            5 non-null      object
 1   UnitsSold           5 non-null      float64
 2   UnitPrice           5 non-null      float64
 3   Revenue             5 non-null      float64
 4   Region              5 non-null      object
 5   UnitPrice_Scaled    5 non-null      float64
 6   UnitsSold_Category  5 non-null      category
dtypes: category(1), float64(4), object(2)
memory usage: 417.0+ bytes

=== Statistical Summary ===
```

[16]:

| | UnitsSold | UnitPrice | Revenue | UnitPrice_Scaled |
|---|---|---|---|---|
| **count** | 5.000000 | 5.000000 | 5.000000 | 5.000000 |
| **mean** | 34.400000 | 110.790000 | 2207.656000 | 0.269697 |
| **std** | 36.861904 | 163.043552 | 3256.036397 | 0.411726 |
| **min** | 12.000000 | 3.990000 | 399.000000 | 0.000000 |
| **25%** | 18.000000 | 39.990000 | 599.880000 | 0.090909 |
| **50%** | 20.000000 | 49.990000 | 719.820000 | 0.116162 |
| **75%** | 22.000000 | 59.990000 | 1319.780000 | 0.141414 |
| **max** | 100.000000 | 399.990000 | 7999.800000 | 1.000000 |

[ ]:

[17]:
```
# Central Tendency Measures
print("=== Central Tendency Measures ===")

# Mean
print("\nMean:\n", scaled_df.mean(numeric_only=True))

# Median
print("\nMedian:\n", scaled_df.median(numeric_only=True))

# Mode
print("\nMode:\n", scaled_df.mode(numeric_only=True).iloc[0])  # First mode row

# Minimum
print("\nMinimum:\n", scaled_df.min(numeric_only=True))

# Maximum
print("\nMaximum:\n", scaled_df.max(numeric_only=True))
```

```
=== Central Tendency Measures ===

Mean:
 UnitsSold            34.400000
UnitPrice            110.790000
Revenue             2207.656000
UnitPrice_Scaled       0.269697
dtype: float64

Median:
 UnitsSold            20.000000
UnitPrice            49.990000
Revenue             719.820000
UnitPrice_Scaled      0.116162
dtype: float64

Mode:
 UnitsSold            12.00
UnitPrice             3.99
Revenue             399.00
UnitPrice_Scaled      0.00
Name: 0, dtype: float64

Minimum:
 UnitsSold            12.00
UnitPrice             3.99
Revenue             399.00
UnitPrice_Scaled      0.00
dtype: float64

Maximum:
 UnitsSold           100.00
UnitPrice            399.99
Revenue             7999.80
UnitPrice_Scaled       1.00
dtype: float64
```

[ ]:

[18]:
```
# Dispersion Measures
print("=== Dispersion Measures ===")

# Standard Deviation
print("\nStandard Deviation:\n", scaled_df.std(numeric_only=True))

# Variance
print("\nVariance:\n", scaled_df.var(numeric_only=True))

# Range = Max - Min
range_vals = scaled_df.max(numeric_only=True) - scaled_df.min(numeric_only=True)
print("\nRange:\n", range_vals)
```

```
=== Dispersion Measures ===

Standard Deviation:
 UnitsSold             36.861904
UnitPrice             163.043552
Revenue              3256.036397
UnitPrice_Scaled        0.411726
dtype: float64

Variance:
 UnitsSold           1.358800e+03
UnitPrice            2.658320e+04
Revenue              1.060177e+07
UnitPrice_Scaled     1.695184e-01
dtype: float64

Range:
 UnitsSold             88.0
UnitPrice             396.0
Revenue              7600.8
UnitPrice_Scaled        1.0
dtype: float64
```

[ ]:

[19]:
```
# Correlation and Covariance
print("=== Correlation Matrix ===")
print(scaled_df.corr(numeric_only=True))

print("\n=== Covariance Matrix ===")
print(scaled_df.cov(numeric_only=True))
```

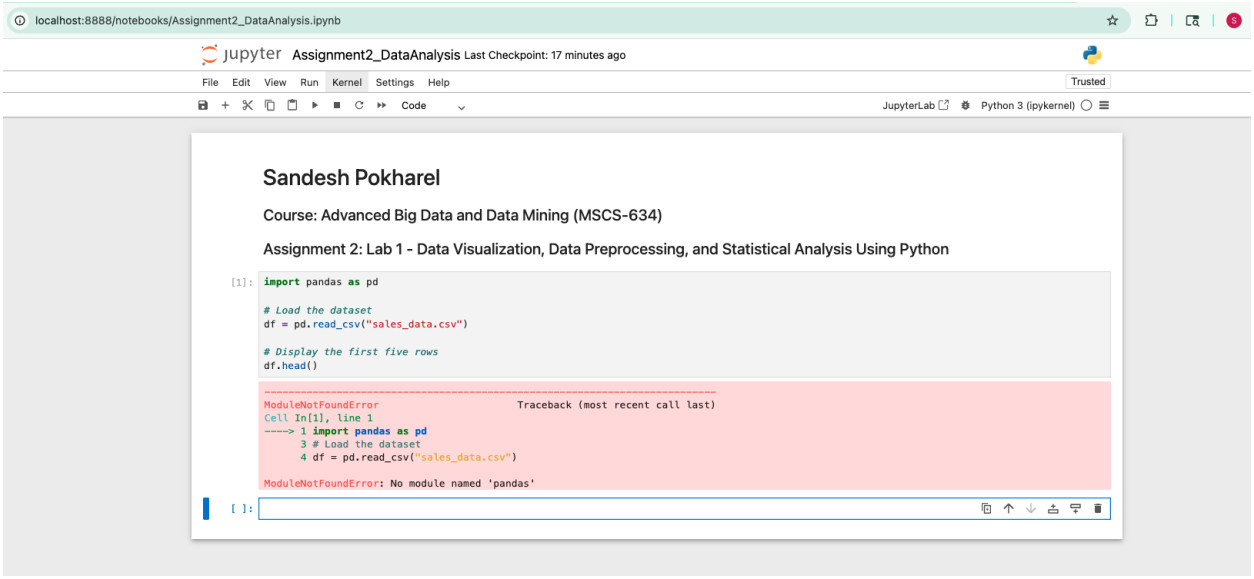
```
=== Correlation Matrix ===
                UnitsSold  UnitPrice   Revenue  UnitPrice_Scaled
UnitsSold        1.000000  -0.333505 -0.272093         -0.333505
UnitPrice       -0.333505   1.000000  0.996678          1.000000
Revenue         -0.272093   0.996678  1.000000          0.996678
UnitPrice_Scaled -0.333505   1.000000  0.996678          1.000000

=== Covariance Matrix ===
                   UnitsSold      UnitPrice       Revenue  UnitPrice_Scaled
UnitsSold         1358.800000   -2004.400000 -3.265759e+04         -5.061616
UnitPrice        -2004.400000   26583.200000  5.291120e+05         67.129293
Revenue         -32657.588000  529112.044000  1.060177e+07       1336.141525
UnitPrice_Scaled     -5.061616      67.129293  1.336142e+03          0.169518
```

[ ]:

## 7. Challenges and Decisions Made

- Encountered `pip` not found error initially due to not activating the virtual environment.
- Jupyter was unable to detect packages unless installed from within the virtual environment.
- Identified and resolved module import errors via console traceback.
- Learned to capture and interpret terminal + Jupyter feedback to guide debugging.
- Ensured screenshots were taken throughout all required and additional stages.

Screenshot: Error messages and fixed outputs




```
/Users/mac/Sandesh_Cumberlands_Assignments/Advanced_Big_Data_And_Data_Mining/MSCS-634-Assignment2 % source venv/bin/activate
(venv) /Users/mac/Sandesh_Cumberlands_Assignments/Advanced_Big_Data_And_Data_Mining/MSCS-634-Assignment2 % pip install pandas
Collecting pandas
  Using cached pandas-2.3.0-cp313-cp313-macosx_11_0_arm64.whl.metadata (91 kB)
Collecting numpy>=1.26.0 (from pandas)
  Using cached numpy-2.3.1-cp313-cp313-macosx_14_0_arm64.whl.metadata (62 kB)
Requirement already satisfied: python-dateutil>=2.8.2 in ./venv/lib/python3.13/site-packages (from pandas) (2.9.0.post0)
Collecting pytz>=2020.1 (from pandas)
  Using cached pytz-2025.2-py2.py3-none-any.whl.metadata (22 kB)
Collecting tzdata>=2022.7 (from pandas)
  Using cached tzdata-2025.2-py2.py3-none-any.whl.metadata (1.4 kB)
Requirement already satisfied: six>=1.5 in ./venv/lib/python3.13/site-packages (from python-dateutil>=2.8.2->pandas) (1.17.0)
Using cached pandas-2.3.0-cp313-cp313-macosx_11_0_arm64.whl (10.7 MB)
Using cached numpy-2.3.1-cp313-cp313-macosx_14_0_arm64.whl (5.1 MB)
Using cached pytz-2025.2-py2.py3-none-any.whl (509 kB)
Using cached tzdata-2025.2-py2.py3-none-any.whl (347 kB)
Installing collected packages: pytz, tzdata, numpy, pandas
Successfully installed numpy-2.3.1 pandas-2.3.0 pytz-2025.2 tzdata-2025.2
(venv) /Users/mac/Sandesh_Cumberlands_Assignments/Advanced_Big_Data_And_Data_Mining/MSCS-634-Assignment2 % open ./
(venv) /Users/mac/Sandesh_Cumberlands_Assignments/Advanced_Big_Data_And_Data_Mining/MSCS-634-Assignment2 % pip install matplotlib
Collecting matplotlib
  Using cached matplotlib-3.10.3-cp313-cp313-macosx_11_0_arm64.whl.metadata (11 kB)
Collecting contourpy>=1.0.1 (from matplotlib)
  Using cached contourpy-1.3.2-cp313-cp313-macosx_11_0_arm64.whl.metadata (5.5 kB)
Collecting cycler>=0.10 (from matplotlib)
  Using cached cycler-0.12.1-py3-none-any.whl.metadata (3.8 kB)
Collecting fonttools>=4.22.0 (from matplotlib)
  Downloading fonttools-4.58.5-cp313-cp313-macosx_10_13_universal2.whl.metadata (106 kB)
Collecting kiwisolver>=1.3.1 (from matplotlib)
  Using cached kiwisolver-1.4.8-cp313-cp313-macosx_11_0_arm64.whl.metadata (6.2 kB)
Requirement already satisfied: numpy>=1.23 in ./venv/lib/python3.13/site-packages (from matplotlib) (2.3.1)
Requirement already satisfied: packaging>=20.0 in ./venv/lib/python3.13/site-packages (from matplotlib) (25.0)
Collecting pillow>=8 (from matplotlib)
  Downloading pillow-11.3.0-cp313-cp313-macosx_11_0_arm64.whl.metadata (9.0 kB)
Collecting pyparsing>=2.3.1 (from matplotlib)
  Using cached pyparsing-3.2.3-py3-none-any.whl.metadata (5.0 kB)
Requirement already satisfied: python-dateutil>=2.7 in ./venv/lib/python3.13/site-packages (from matplotlib) (2.9.0.post0)
Requirement already satisfied: six>=1.5 in ./venv/lib/python3.13/site-packages (from python-dateutil>=2.7->matplotlib) (1.17.0)
Using cached matplotlib-3.10.3-cp313-cp313-macosx_11_0_arm64.whl (8.1 MB)
Using cached contourpy-1.3.2-cp313-cp313-macosx_11_0_arm64.whl (255 kB)
Using cached cycler-0.12.1-py3-none-any.whl (8.3 kB)
Downloading fonttools-4.58.5-cp313-cp313-macosx_10_13_universal2.whl (2.7 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 2.7/2.7 MB 35.7 MB/s eta 0:00:00
Using cached kiwisolver-1.4.8-cp313-cp313-macosx_11_0_arm64.whl (65 kB)
Downloading pillow-11.3.0-cp313-cp313-macosx_11_0_arm64.whl (4.7 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 4.7/4.7 MB 83.7 MB/s eta 0:00:00
Using cached pyparsing-3.2.3-py3-none-any.whl (111 kB)
Installing collected packages: pyparsing, pillow, kiwisolver, fonttools, cycler, contourpy, matplotlib
Successfully installed contourpy-1.3.2 cycler-0.12.1 fonttools-4.58.5 kiwisolver-1.4.8 matplotlib-3.10.3 pillow-11.3.0 pyparsing-3.2.3
(venv) /Users/mac/Sandesh_Cumberlands_Assignments/Advanced_Big_Data_And_Data_Mining/MSCS-634-Assignment2 % pip install scikit-learn
Collecting scikit-learn
  Using cached scikit_learn-1.7.0-cp313-cp313-macosx_12_0_arm64.whl.metadata (31 kB)
Requirement already satisfied: numpy>=1.22.0 in ./venv/lib/python3.13/site-packages (from scikit-learn) (2.3.1)
Collecting scipy>=1.8.0 (from scikit-learn)
  Using cached scipy-1.16.0-cp313-cp313-macosx_14_0_arm64.whl.metadata (61 kB)
Collecting joblib>=1.2.0 (from scikit-learn)
  Using cached joblib-1.5.1-py3-none-any.whl.metadata (5.6 kB)
Collecting threadpoolctl>=3.1.0 (from scikit-learn)
```

# 8. Conclusion

This lab provided practical experience with preprocessing, visualization, and statistical analysis in Python.

It also reinforced environment management using virtual environments and troubleshooting real-time errors.

The techniques used in this lab lay a foundation for deeper data mining and machine learning tasks.