Experiment 1

Aim

To understand data handling, visualization, and exploratory data analysis using NumPy, Pandas, Matplotlib, and Seaborn for Machine Learning applications.

Theory

NumPy provides fast array operations and mathematical functions for numerical computing. It enables efficient data manipulation and normalization.

Pandas offers DataFrame structures for data loading, cleaning, and transformation. It simplifies real-world data analysis tasks.

Matplotlib creates customizable plots and charts for data visualization. It provides fine control over visual elements.

Seaborn builds on Matplotlib to create statistical visualizations with minimal code. It integrates seamlessly with Pandas DataFrames.

These libraries form the foundation of machine learning data preprocessing and analysis workflows.

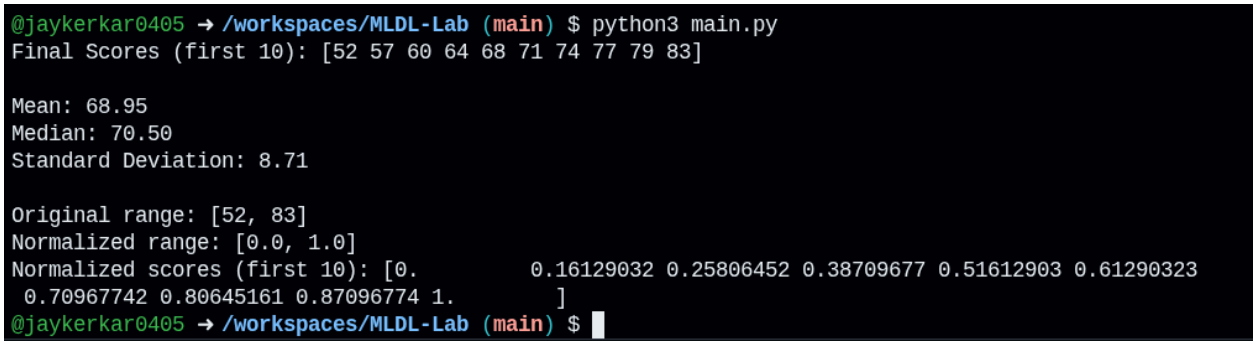
Exercise 1: NumPy Basics

Code

```
import numpy as np
import pandas as pd

df = pd.read_csv('student_performance.csv')

# 1. Load Final_Score as NumPy array
```

```
final_scores = df['Final_Score'].values
print("Final Scores (first 10):", final_scores[:10])

# 2. Compute statistics
mean_score = np.mean(final_scores)
median_score = np.median(final_scores)
std_score = np.std(final_scores)
print(f"\nMean: {mean_score:.2f}")
print(f"Median: {median_score:.2f}")
print(f"Standard Deviation: {std_score:.2f}")

# 3. Min-Max Normalization
min_val = np.min(final_scores)
max_val = np.max(final_scores)
normalized_scores = (final_scores - min_val) / (max_val -
min_val)
print(f"\nOriginal range: [{min_val}, {max_val}]")
print(f"Normalized range: [0.0, 1.0]")
print("Normalized scores (first 10):", normalized_scores[:10])
```

Output



Exercise 2: Pandas Data Handling

Code

```
# 1. Load and explore dataset
df = pd.read_csv('student_performance.csv')
print("Shape:", df.shape)
print("\nColumns:", df.columns.tolist())
print("\nFirst 5 rows:\n", df.head())

# 2. Check data quality
print("\nData Types:\n", df.dtypes)
print("\nMissing Values:\n", df.isnull().sum())
print("\nStatistics:\n", df.describe())

# 3. Create Performance label
def categorize_performance(score):
    if score ⩾ 80:
        return 'Excellent'
    elif score ⩾ 60:
        return 'Good'
    elif score ⩾ 40:
        return 'Average'
    else:
        return 'Needs Improvement'

df['Performance'] =
df['Final_Score'].apply(categorize_performance)
print("\nPerformance Distribution:\n",
df['Performance'].value_counts())
```

Output

```
First 5 rows:
   Hours_Studied  Attendance  Assignment_Score  Midterm_Score  Final_Score
0              1          60                55             50           52
1              2          65                58             55           57
2              3          70                60             58           60
3              4          75                65             62           64
4              5          80                68             65           68
```

```
Statistics:
       Hours_Studied  Attendance  Assignment_Score  Midterm_Score  Final_Score
count      20.000000   20.000000         20.000000      20.000000    20.000000
mean        5.650000   80.150000         69.750000      65.750000    68.950000
std         2.621269   10.524533          9.025549       8.005755     8.941182
min         1.000000   60.000000         55.000000      50.000000    52.000000
25%         3.750000   71.500000         61.500000      59.500000    62.250000
50%         6.000000   81.000000         70.500000      67.500000    70.500000
75%         8.000000   88.500000         76.500000      71.250000    75.500000
max        10.000000   95.000000         85.000000      78.000000    83.000000

Performance Distribution:
 Performance
Good         14
Average       4
Excellent     2
Name: count, dtype: int64
```

```
Updated DataFrame (first 10 rows):
   Hours_Studied  Attendance  Assignment_Score  Midterm_Score  Final_Score Performance
0              1          60                55             50           52     Average
1              2          65                58             55           57     Average
2              3          70                60             58           60        Good
3              4          75                65             62           64        Good
4              5          80                68             65           68        Good
5              6          85                72             68           71        Good
6              7          90                75             70           74        Good
7              8          95                78             72           77        Good
8              9          88                80             75           79        Good
9             10          92                85             78           83   Excellent
```

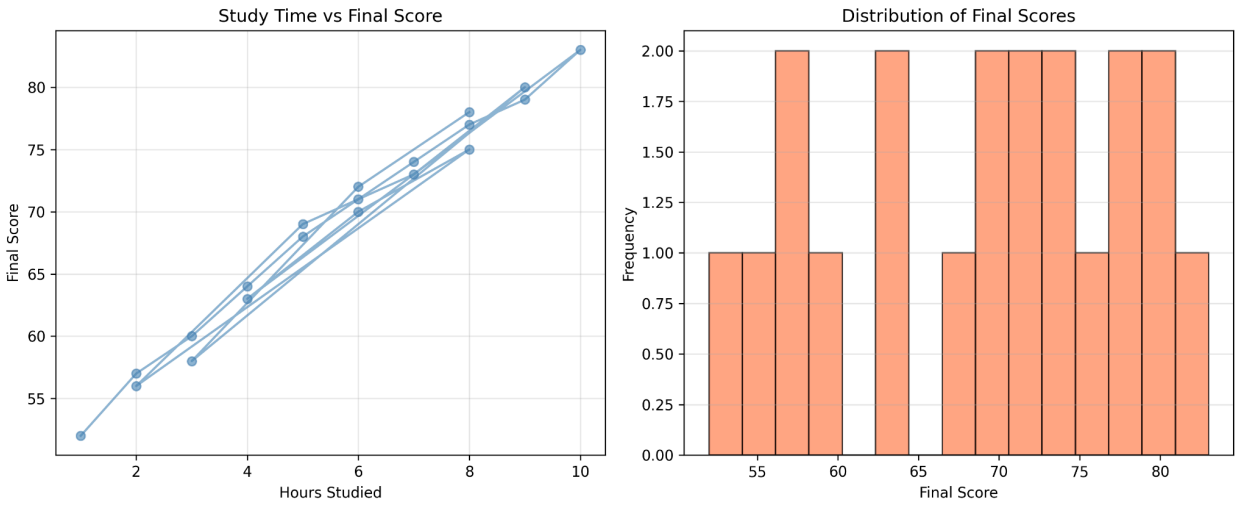
Exercise 3: Matplotlib Visualization

Code

```
import matplotlib.pyplot as plt

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

# 1. Line plot: Hours Studied vs Final Score
plt.subplot(1, 2, 1)
plt.plot(df['Hours_Studied'], df['Final_Score'], 'o-', alpha=0.6)
plt.xlabel('Hours Studied')
```

```
plt.ylabel('Final Score')
plt.title('Study Time vs Final Score')
plt.grid(True, alpha=0.3)

# 2. Histogram of Final Scores
plt.subplot(1, 2, 2)
plt.hist(df['Final_Score'], bins=15, edgecolor='black',
alpha=0.7)
plt.xlabel('Final Score')
plt.ylabel('Frequency')
plt.title('Distribution of Final Scores')
plt.grid(True, alpha=0.3, axis='y')

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

Output



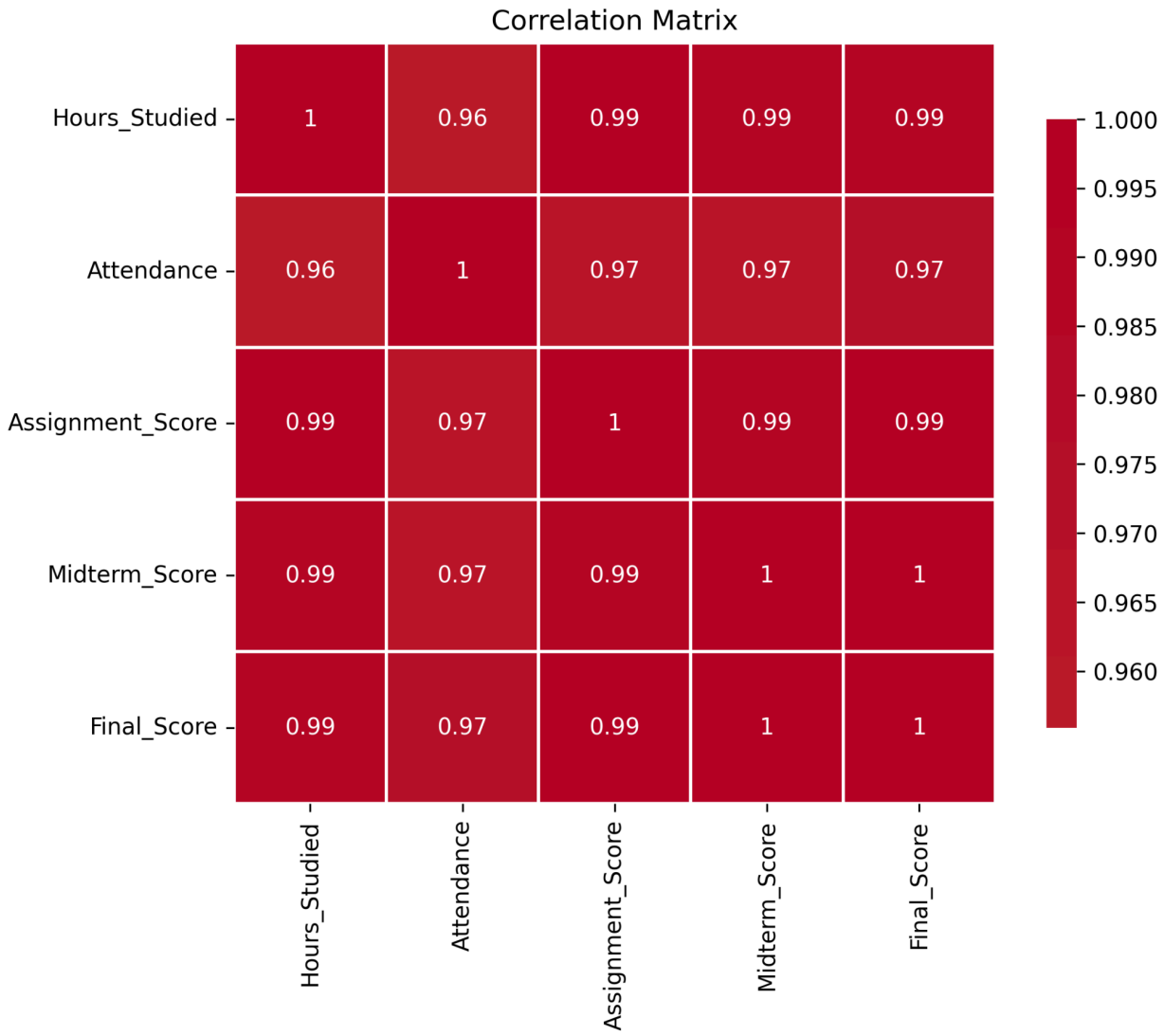
Exercise 4: Seaborn Visualization

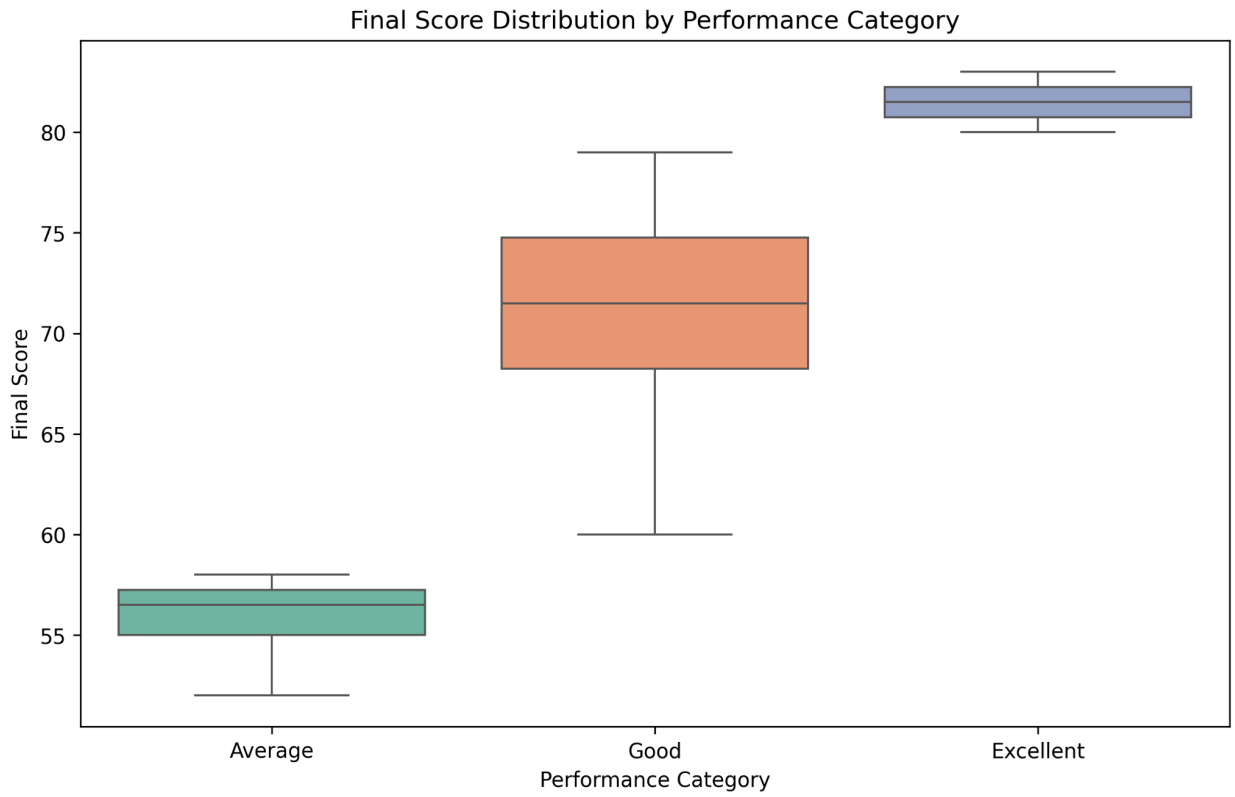
Code

```
import seaborn as sns

# 1. Scatter plot
plt.figure(figsize=(8, 5))
sns.scatterplot(data=df, x='Hours_Studied', y='Final_Score',
                hue='Performance', palette='viridis', s=100)
plt.title('Study Hours vs Final Score by Performance')
plt.show()

# 2. Correlation heatmap
plt.figure(figsize=(8, 6))
corr = df[['Hours_Studied', 'Attendance', 'Assignment_Score',
           'Midterm_Score', 'Final_Score']].corr()
sns.heatmap(corr, annot=True, cmap='coolwarm', center=0,
square=True)
plt.title('Correlation Matrix')
plt.show()

# 3. Boxplot
plt.figure(figsize=(10, 6))
sns.boxplot(data=df, x='Performance', y='Final_Score',
palette='Set2')
plt.title('Final Score Distribution by Performance Category')
plt.show()
```

Output


Study Hours vs Final Score by Performance
Performance
Average
Good
Excellent
Final_Score
80
75
70
65
60
55
2
4
6
8
10
Hours_Studied


Correlation Matrix
Hours_Studied
Attendance
Assignment_Score
Midterm_Score
Final_Score
1
0.96
0.99
0.99
0.99
0.96
1
0.97
0.97
0.97
0.99
0.97
1
0.99
0.99
0.99
0.97
0.99
1
1
0.99
0.97
0.99
1
1
1.000
0.995
0.990
0.985
0.980
0.975
0.970
0.965
0.960



Conclusion

This lab demonstrated essential Python libraries for machine learning data analysis. NumPy enabled efficient numerical operations and normalization. Pandas facilitated data exploration and transformation. Matplotlib and Seaborn provided powerful visualization capabilities to identify patterns and relationships in the data. These skills are fundamental for effective machine learning preprocessing and exploratory data analysis.