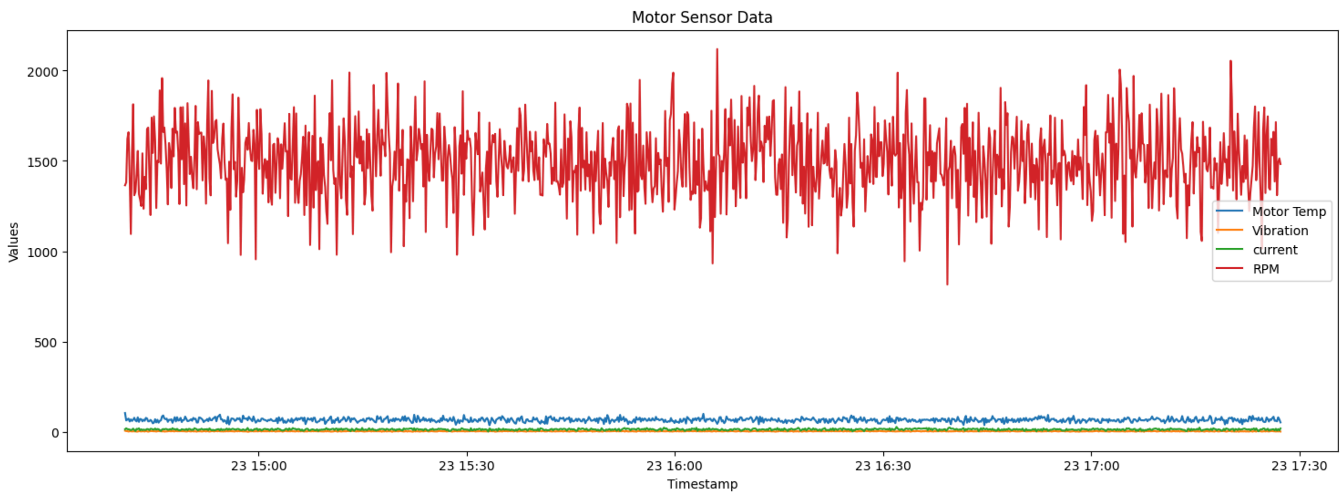
Below code to undestand Python and its libraries by example::: simulates motor sensor data and saves it to a CSV file named motor_sensor_data.csv.

```
import numpy as np
import pandas as pd
from datetime import datetime, timedelta
import random

# Configuration for data generation
num_records = 1000
start_time = datetime.now()
time_interval = timedelta(seconds=10)

# Data holders - lists to store the generated data
timestamps = []
motor_temp = []
motor_vibration = []
motor_current = []
motor_rpm = []
status = []

# Function to classify motor status based on sensor values
def classify_status(temp, vib, curr):
    if temp > 80 or vib > 5.0 or curr > 18:
        return 2  # Faulty status
    elif temp > 70 or vib > 3.5 or curr > 16:
        return 1  # Warning status
    else:
        return 0  # Healthy status

# Simulate Data generation
for i in range(num_records):
    timestamps.append(start_time + i * time_interval)

    # Simulate sensor data with small randomness
    temp = np.random.normal(loc=65, scale=10)  # Simulate temperature with mean 65°C and std dev 10
    vib = np.random.normal(loc=2.0, scale=1.0)  # Simulate vibration with mean 2 mm/s and std dev 1
    curr = np.random.normal(loc=12, scale=4)  # Simulate current with mean 12 A and std dev 4
    rpm = np.random.normal(loc=1500, scale=200)  # Simulate RPM with mean 1500 and std dev 200

    # Occasionally inject faults into the data
    if i % 250 == 0:
        temp += random.randint(20, 30) # Increase temp to simulate fault
        vib += random.uniform(2.0, 3.0) # Increase vibration to simulate fault
        curr += random.uniform(5.0, 7.0) # Increase current to simulate fault

    # Append rounded sensor values and calculated status to lists
    motor_temp.append(round(temp, 2))
    motor_vibration.append(round(vib, 2))
    motor_current.append(round(curr, 2))
    motor_rpm.append(int(rpm))
    status.append(classify_status(temp, vib, curr))

# Create DataFrame from the simulated data
df = pd.DataFrame({
    'timestamp': timestamps,
    'motor_temp': motor_temp,
    'motor_vibration': motor_vibration,
    'motor_current': motor_current,
    'motor_rpm': motor_rpm,
    'status': status
})

# Save the DataFrame to a CSV file
df.to_csv(r'motor_sensor_data.csv', index=True)
print("✅ Sensor data saved to 'motor_sensor_data.csv'")

# Redefining the classify_status function (already defined above, can be removed)
def classify_status(temp, vib, curr):
    if temp > 80 or vib > 5.0 or curr > 18:
        return 2  # Faulty
    elif temp > 70 or vib > 3.5 or curr > 16:
        return 1  # Warning
    else:
        return 0  # Healthy
```

```
✅ Sensor data saved to 'motor_sensor_data.csv'
```

Below code loads the simulated motor sensor data from the CSV file and creates a time series plot of the sensor values.

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

# Load the dataset from the CSV file
df = pd.read_csv("motor_sensor_data.csv")

# Convert the 'timestamp' column to datetime objects
df['timestamp'] = pd.to_datetime(df['timestamp'])

# Create a figure for the plot with a specified size
plt.figure(figsize=(18,6))

# Plot each sensor value against the timestamp
plt.plot(df['timestamp'], df['motor_temp'], label='Motor Temp')
plt.plot(df['timestamp'], df['motor_vibration'], label='Vibration')
plt.plot(df['timestamp'], df['motor_current'], label='current')
plt.plot(df['timestamp'], df['motor_rpm'], label='RPM')

# Add labels and title to the plot
plt.xlabel('Timestamp')
plt.ylabel('Values')
plt.title('Motor Sensor Data')

# Add a legend to identify each line
plt.legend()

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

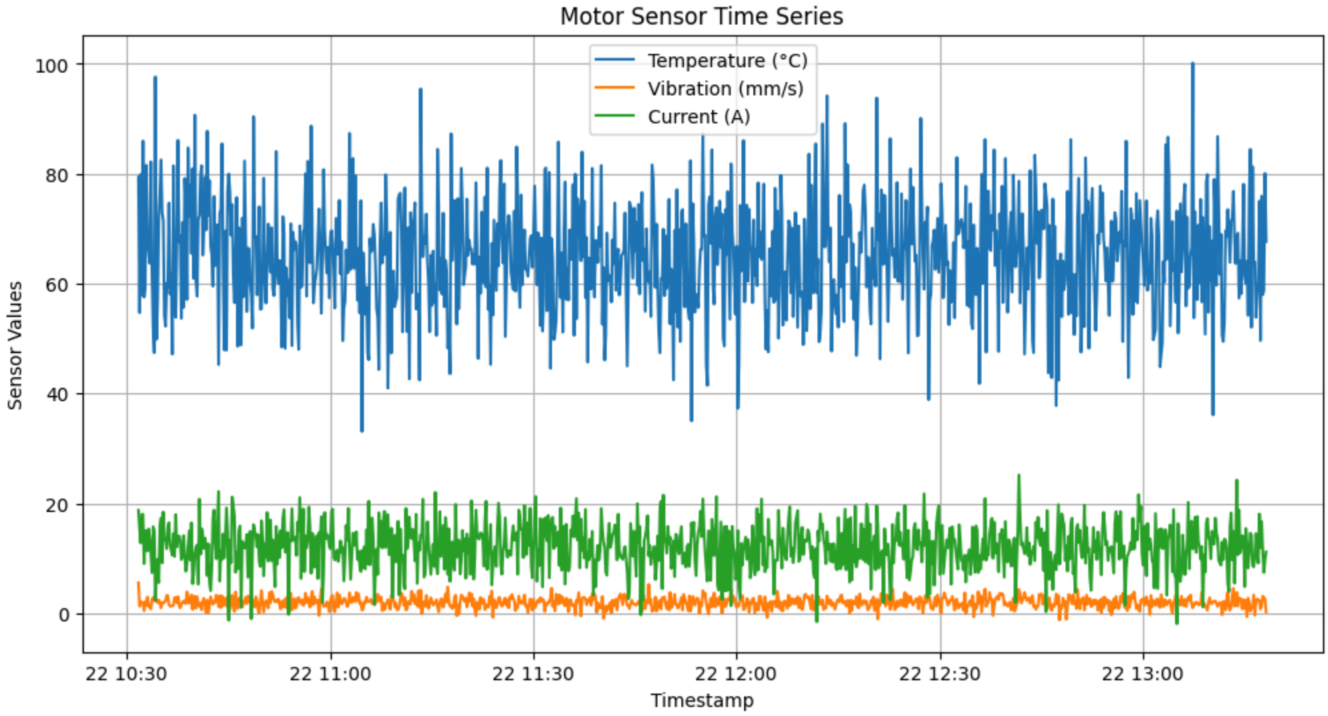


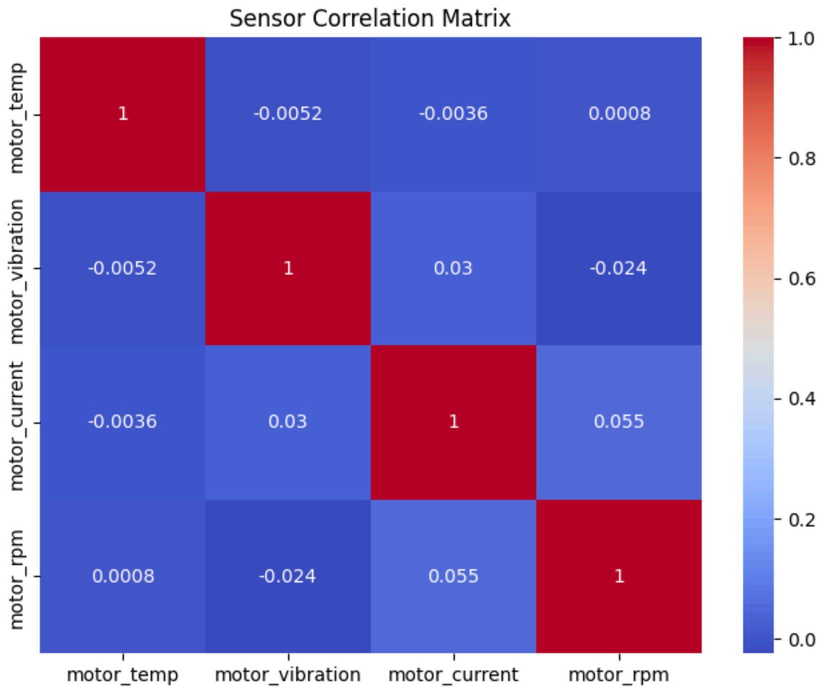
Below code performs several data analysis and visualization tasks on the motor sensor data, including summary statistics, time-series plots, a correlation heatmap, and a pie chart of the motor health status distribution.

```
# Step 1: Import libraries
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

# Step 2: Load CSV
df = pd.read_csv("/content/drive/MyDrive/motoror_sensor_data.csv") # Load data from CSV
df['timestamp'] = pd.to_datetime(df['timestamp']) # Convert timestamp column to datetime objects

# Step 3: Summary statistics
print(df.describe()) # Print descriptive statistics of the DataFrame
print("\nStatus counts:\n", df['status'].value_counts()) # Print the counts of each status category
```

```python
# Step 4: Time-series plots
plt.figure(figsize=(12, 6)) # Create a figure for the time series plot
plt.plot(df['timestamp'], df['motor_temp'], label='Temperature (°C)') # Plot temperature over time
plt.plot(df['timestamp'], df['motor_vibration'], label='Vibration (mm/s)') # Plot vibration over time
plt.plot(df['timestamp'], df['motor_current'], label='Current (A)') # Plot current over time
plt.xlabel("Timestamp") # Set x-axis label
plt.ylabel("Sensor Values") # Set y-axis label
plt.title("Motor Sensor Time Series") # Set plot title
plt.legend() # Add a legend
plt.grid() # Add a grid
plt.show() # Display the plot

# Step 5: Correlation heatmap
plt.figure(figsize=(8, 6)) # Create a figure for the heatmap
sns.heatmap(df[['motor_temp', 'motor_vibration', 'motor_current', 'motor_rpm']].corr(), annot=True, cmap='coolwarm') # Create a heatmap
plt.title("Sensor Correlation Matrix") # Set heatmap title
plt.show() # Display the heatmap

# Step 6: Status distribution pie chart
df['status'].value_counts().plot.pie(autopct='%1.1f%%', labels=['Healthy', 'Warning', 'Faulty'], colors=['green', 'orange', 'red']) # Cr
plt.title("Motor Health Status Distribution") # Set pie chart title
plt.show() # Display the pie chart
```

```
       Unnamed: 0                      timestamp   motor_temp  \
count  1000.000000                          1000  1000.000000
mean    499.500000  2025-07-22 11:54:57.178997760    65.128840
min       0.000000     2025-07-22 10:31:42.178998    33.090000
25%     249.750000  2025-07-22 11:13:19.678998016    58.347500
50%     499.500000  2025-07-22 11:54:57.178998016    65.265000
75%     749.250000  2025-07-22 12:36:34.678998016    71.705000
max     999.000000     2025-07-22 13:18:12.178998   100.170000
std     288.819436                           NaN    10.055196

       motor_vibration  motor_current    motor_rpm       status
count      1000.000000    1000.000000  1000.000000  1000.000000
mean          2.002260      12.180330  1502.324000     0.591000
min          -1.220000      -1.900000   832.000000     0.000000
25%           1.340000       9.577500  1370.750000     0.000000
50%           2.025000      12.195000  1498.500000     0.000000
75%           2.672500      15.082500  1629.250000     1.000000
max           5.560000      25.190000  2104.000000     2.000000
std           1.005406       4.186435   195.787128     0.732295

Status counts:
 status
0    556
1    297
2    147
Name: count, dtype: int64
```





Motor Health Status Distribution