ASSIGNMENT

Create a synthetic multivariate time series data of at least 1 GB using the following code. And apply any simple anomaly detection algorithms and display the results like shown below. (plotting done at the end)

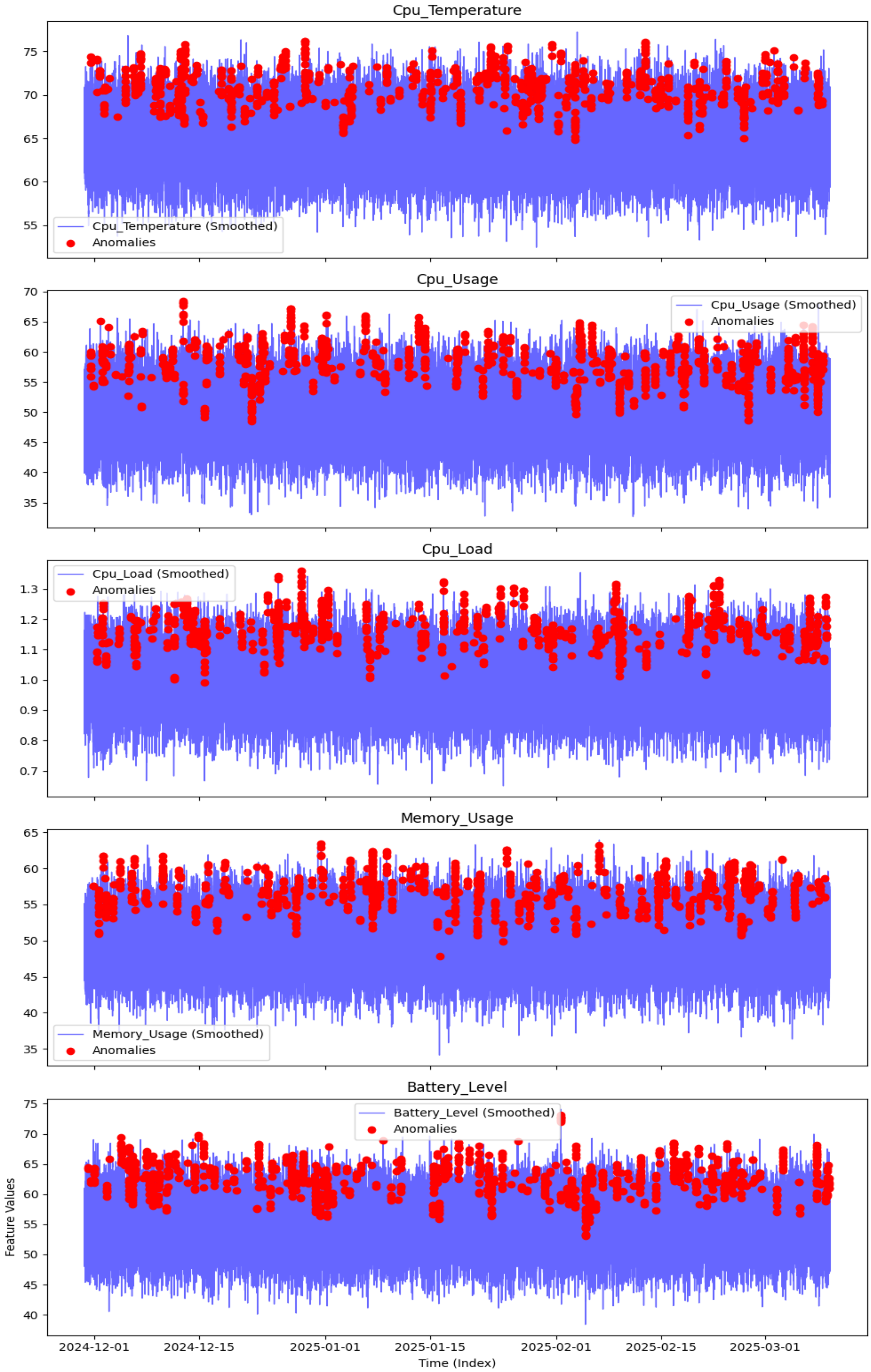
```
import pandas as pd
import random
import numpy as np
import datetime
import matplotlib.pyplot as plt
from sklearn.ensemble import IsolationForest

from scipy.signal import find_peaks
```

#Set parameters for a larger dataset

```
duration_hours = 24 # 1 day (24 hours)
sampling_rate_hz = 100 # 100Hz
num_samples = duration_hours * 60 * 60 * sampling_rate_hz

def generate_data(num_samples):
        time_stamps = []
        cpu_temps = []
        cpu_usage = []
        cpu_load = []
        memory_usage = []
        battery_level = []
        cpu_power = []

# Generating synthetic data
for i in range(num_samples):
        time_stamps.append(datetime.datetime.now() + datetime.timedelta(seconds=i))
        cpu_temps.append(random.uniform(30, 100)) # CPU temp in C
        cpu_usage.append(random.uniform(0, 100)) # CPU usage in percentage
        cpu_load.append(random.uniform(0, 2)) # CPU load between 0 and 2
        memory_usage.append(random.uniform(10, 90)) # Memory usage percentage
        battery_level.append(random.uniform(10, 100)) # Battery level in percentage
        cpu_power.append(random.uniform(10, 50)) # CPU power usage in watts

# Create a DataFrame
data = {
        'Time': time_stamps,
        'Cpu_Temperature': cpu_temps,
        'Cpu_Usage': cpu_usage,
        'Cpu_Load': cpu_load,
        'Memory_Usage': memory_usage,
        'Battery_Level': battery_level,
        'Cpu_Power': cpu_power
        }
df = pd.DataFrame(data)
return df
```

```python
try:
    df = generate_data(num_samples)
    df.to_csv('hardware_monitor_data_with_anomalies_large.csv', index=False)
    print("Data generated and saved successfully.")
except Exception as e:
    print(f"Error generating or saving data: {e}")

#  Anomaly Detection using Isolation Forest
try:
    df = pd.read_csv('hardware_monitor_data_with_anomalies_large.csv')
except FileNotFoundError:
    print("CSV file not found. Make sure the file path is correct.")
except Exception as e:
    print(f"Error reading the CSV file: {e}")

# Columns to check for anomalies
columns_to_check = ['Cpu_Temperature', 'Cpu_Usage', 'Cpu_Load', 'Memory_Usage', 'Battery_Level', 'Cpu_Power']

# Handle anomaly detection and potential issues with IsolationForest
try:
    anomaly_detector = IsolationForest(contamination=0.01)
    df['Anomaly'] = anomaly_detector.fit_predict(df[columns_to_check])

# Anomalies will be marked as -1, normal points as 1
    df['Anomaly'] = df['Anomaly'].apply(lambda x: 'Anomaly' if x == -1 else 'Normal')
except Exception as e:
    print(f"Error during anomaly detection: {e}")

#LOAD THE DATA

chunk_size = 100000
chunks = []

for chunk in pd.read_csv('hardware_monitor_data_with_anomalies_large.csv', chunksize=chunk_size):
    chunks.append(chunk)

df = pd.concat(chunks, axis=0)


# thresholds for each feature to simulate anomaly conditions
thresholds = {
'Cpu_Temperature': 90, # Anything above 90°C can be considered an anomaly
'Cpu_Usage': 85, # CPU usage greater than 85% could be an anomaly
'Cpu_Load': 1.8, # Load greater than 1.8 could indicate a high load anomaly
'Memory_Usage': 80, # Memory usage greater than 80% could indicate an anomaly
'Battery_Level': 10, # Battery level below 10% is considered an anomaly
'Cpu_Power': 40 # CPU power usage greater than 40W could be an anomaly
}

for feature, threshold in thresholds.items():
```

```
        df[f'Anomaly_{feature}'] = df[feature] > threshold

time_stamps = [datetime.datetime.now() + datetime.timedelta(seconds=i) for i in range(len(df))]
# Adding 'Time' column to the DataFrame
df['Time'] = time_stamps
print(df.columns)
#PLOT

# Downsample by taking every 10th row
df_subsampled = df_clean.iloc[::10]

# Apply a rolling mean to smooth the data for numerical columns

df_subsampled_smooth = df_subsampled.drop(columns=['Time']).rolling(window=50).mean()

fig, axs = plt.subplots(5, 1, figsize=(10, 18), sharex=True)

# Helper function to plot anomalies and peaks
def plot_anomalies(ax, df, feature, color='r'):

# Calculate the rolling mean (smoothed data)
        rolling_mean = df[feature].rolling(window=50).mean()
        threshold = rolling_mean + 3 * rolling_mean.std()
        anomalies = df[feature] > threshold
        ax.plot(df.index, df[feature], label=f'{feature} (Smoothed)', color='b', alpha=0.6, linewidth=1)
        ax.scatter(df.index[anomalies], df[feature][anomalies], color=color, label='Anomalies', zorder=5)
        ax.set_title(f'{feature}')
        ax.legend()


plot_anomalies(axs[0], df_subsampled_smooth, 'Cpu_Temperature')
plot_anomalies(axs[1], df_subsampled_smooth, 'Cpu_Usage')
plot_anomalies(axs[2], df_subsampled_smooth, 'Cpu_Load')
plot_anomalies(axs[3], df_subsampled_smooth, 'Memory_Usage')
plot_anomalies(axs[4], df_subsampled_smooth, 'Battery_Level')

plt.xlabel('Time (Index)')
plt.ylabel('Feature Values')
plt.tight_layout()
plt.show()
```


Cpu_Temperature
Cpu_Temperature (Smoothed)
Anomalies
Cpu_Usage
Cpu_Usage (Smoothed)
Anomalies
Cpu_Load
Cpu_Load (Smoothed)
Anomalies
Memory_Usage
Memory_Usage (Smoothed)
Anomalies
Battery_Level
Battery_Level (Smoothed)
Anomalies
Feature Values
2024-12-01
2024-12-15
2025-01-01
2025-01-15
2025-02-01
2025-02-15
2025-03-01
Time (Index)