

```

1 import numpy as np
2 import pandas as pd
3 import random
4 from datetime import datetime, timedelta
5
6 # Function to generate timestamp
7 def generate_timestamp(start, end, num_samples):
8     time_diff = (end - start).total_seconds()
9     timestamps = [start + timedelta(seconds=random.uniform(0, time_diff)) for _ in range(num_samples)]
10    timestamps.sort()
11    return timestamps
12
13 # Settings
14 num_samples = 10000
15 start_time = datetime(2024, 1, 1)
16 end_time = datetime(2024, 12, 31)
17 sensor_types = ['temperature', 'vibration', 'pressure']
18 normal_ranges = {
19     'temperature': (20, 80), # degrees Celsius
20     'vibration': (0.1, 5.0), # mm/s
21     'pressure': (100, 500) # kPa
22 }
23
24 # Generate Data
25 data = []
26 timestamps = generate_timestamp(start_time, end_time, num_samples)
27 for timestamp in timestamps:
28     sample = {'timestamp': timestamp}
29     for sensor in sensor_types:
30         normal_range = normal_ranges[sensor]
31         value = random.uniform(*normal_range)
32         sample[sensor] = value
33     data.append(sample)
34
35 # Convert to DataFrame
36 df = pd.DataFrame(data)
37
38 # Save to CSV
39 df.to_csv('created_iot_data.csv', index=False)
40

```

```

1 print(df)

```

```

timestamp  temperature  vibration  pressure
0  2024-01-01 02:42:21.183460  49.392945  1.169905  450.649255
1  2024-01-01 03:16:55.114979  77.083568  2.271737  155.279227
2  2024-01-01 04:04:25.978733  30.959897  4.579936  158.667657
3  2024-01-01 04:25:31.229079  74.834754  3.131460  424.348659
4  2024-01-01 05:09:22.707758  48.665105  3.033871  294.505406
...      ...      ...      ...
9995 2024-12-30 20:18:22.246433  69.329737  4.262927  332.396657
9996 2024-12-30 20:40:15.261398  57.582948  0.560980  250.020322
9997 2024-12-30 21:29:25.914441  68.883325  3.753144  145.952556
9998 2024-12-30 22:19:45.044972  29.907982  1.498958  333.970891
9999 2024-12-30 23:59:34.998156  64.380688  4.035525  108.546850

```

```

[10000 rows x 4 columns]

```

```

1 def introduce_anomalies(df, anomaly_fraction=0.08):
2     num_anomalies = int(len(df) * anomaly_fraction)
3     anomaly_indices = random.sample(range(len(df)), num_anomalies)
4     for idx in anomaly_indices:
5         sensor = random.choice(sensor_types)
6         # Create a spike or drop in the sensor reading
7         df.at[idx, sensor] = df.at[idx, sensor] * random.uniform(1.5, 2.5)
8     return df
9
10 df_with_anomalies = introduce_anomalies(df)
11 df_with_anomalies.to_csv('created_iot_data_with_anomalies.csv', index=False)
12

```

```

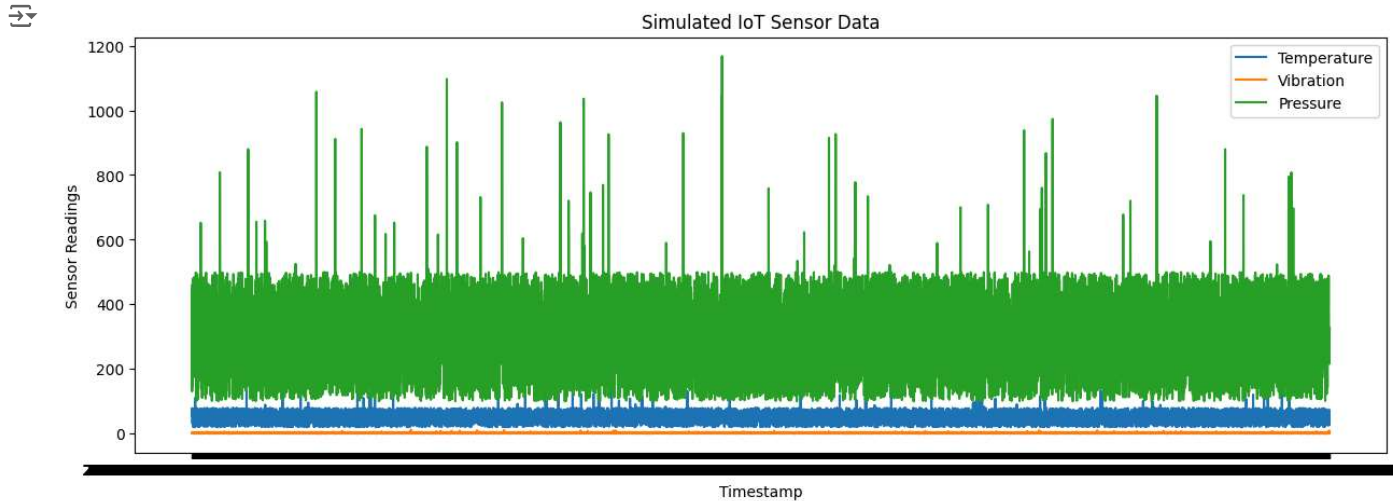
1 import matplotlib.pyplot as plt
2 import seaborn as sns
3
4 # Load data

```

```

5 df = pd.read_csv('created_iot_data_with_anomalies.csv')
6
7 # Plotting
8 plt.figure(figsize=(15, 5))
9 sns.lineplot(data=df, x='timestamp', y='temperature', label='Temperature')
10 sns.lineplot(data=df, x='timestamp', y='vibration', label='Vibration')
11 sns.lineplot(data=df, x='timestamp', y='pressure', label='Pressure')
12 plt.xlabel('Timestamp')
13 plt.ylabel('Sensor Readings')
14 plt.legend()
15 plt.title('Simulated IoT Sensor Data')
16 plt.show()
17

```



```

1 import pandas as pd
2 import numpy as np
3 from sklearn.model_selection import train_test_split
4 from sklearn.ensemble import RandomForestClassifier
5 from sklearn.metrics import classification_report, confusion_matrix, roc_auc_score

```

```

1 # Load data
2 df = pd.read_csv('created_iot_data_with_anomalies.csv')
3
4 # Convert timestamp to datetime
5 df['timestamp'] = pd.to_datetime(df['timestamp'])
6
7

```

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1 print(df)

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```

```
6 df = df.drop(columns=['timestamp'])
7
8 # Features and labels
9 X = df.drop(columns=['maintenance_required'])
10 y = df['maintenance_required']
```

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```
↩ temperature vibration pressure maintenance_required
0 56.152099 1.917923 297.422215 0
1 78.738909 4.027058 130.785814 0
2 66.432220 1.984206 440.468128 0
3 38.158172 0.818703 146.033380 0
4 30.324411 3.432388 461.625207 0
... ..
9995 39.699535 9.841437 307.510785 1
9996 59.230216 0.556972 216.407399 0
9997 26.337234 1.430932 305.655371 0
9998 38.354017 2.432895 284.487005 0
9999 42.080552 4.704790 325.507490 0

[10000 rows x 4 columns]
```

```
1 X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

```
1 # Initialize the model
2 model = RandomForestClassifier(n_estimators=100, random_state=42)
3
4 # Train the model
5 model.fit(X_train, y_train)
```

```
↩ RandomForestClassifier ⓘ ?
RandomForestClassifier(random_state=42)
```

```
1 from sklearn.metrics import accuracy_score, classification_report
```

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```
1 # Make predictions
2 y_pred = model.predict(X_test)
3 y_prob = model.predict_proba(X_test)[:, 1]
4
```

```
↩ Classification Report:
      precision    recall  f1-score   support

     0       1.00      1.00      1.00      1972
     1       1.00      1.00      1.00        28

 accuracy          1.00          1.00      2000
macro avg          1.00          1.00      2000
weighted avg          1.00          1.00      2000

Confusion Matrix:
[[1972   0]
 [   0   28]]
ROC AUC Score: 1.0
```

```
1 accuracy = accuracy_score(y_test, y_pred)
2 print(f"Classification Model Accuracy: {accuracy}")
3 print(classification_report(y_test, y_pred))
```

```
↩ Classification Model Accuracy: 0.921
      precision    recall  f1-score   support

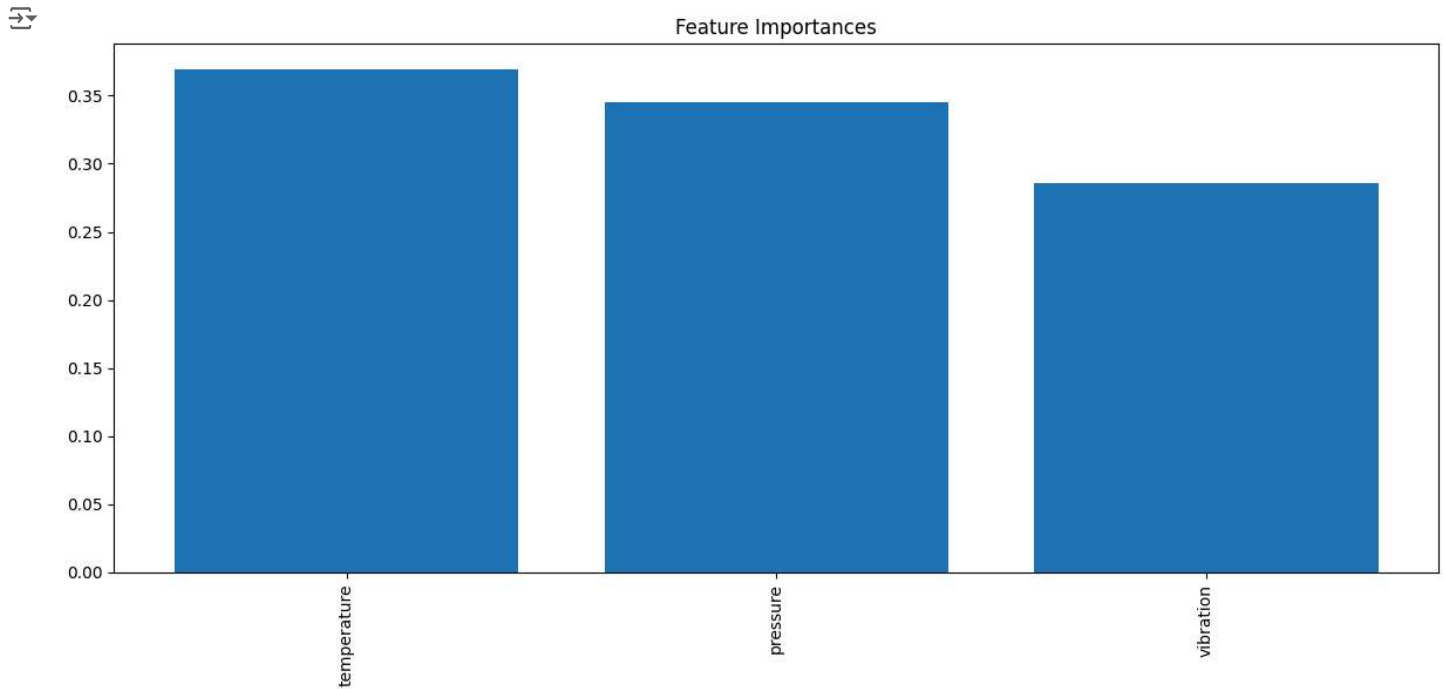
     0       0.93      0.99      0.96      1860
     1       0.18      0.04      0.06       140

 accuracy          0.92          0.92      2000
macro avg          0.56          0.51      2000
weighted avg          0.88          0.92      2000
```

```

1 import matplotlib.pyplot as plt
2 import seaborn as sns
3
4 # Feature importance
5 importances = model.feature_importances_
6 indices = np.argsort(importances)[::-1]
7
8 # Plot feature importances
9 plt.figure(figsize=(12, 6))
10 plt.title("Feature Importances")
11 plt.bar(range(X.shape[1]), importances[indices], align='center')
12 plt.xticks(range(X.shape[1]), X.columns[indices], rotation=90)
13 plt.tight_layout()
14 plt.show()

```



```

1 def predict_maintenance(features):
2
3     pred = model.predict([features])
4
5     return {
6         'Needs Maintenance' if pred[0] == 1 else 'Normal'
7     }
8
9 # Example prediction
10 input_features = [90,4,500]
11 prediction = predict_maintenance(input_features)
12 print(prediction)

```

```

{ 'Prediction': 'Needs Maintenance' }
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:493: UserWarning: X does not have valid feature names, but RandomForestClassifier
warnings.warn(

```

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```

1 import joblib
2
3 # Save the model to a file
4 joblib.dump(model, 'predict_maintenance_model.pkl')
5
6 print("Model saved to 'predict_maintenance_model.pkl'")
7

```

↔ Model saved to 'predict\_maintenance\_model.pkl'