

CybPhys Training School

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MatrixProfile enables you to quickly and easily analyze a time series. At its core, the module is made of 4 primary concepts.

```
[1] from google.colab import drive
drive.mount('/content/drive', force_remount=True)

Mounted at /content/drive

!pip install -U matrixprofile
```

Result:

```
Project.ipynb
File Edit View Insert Runtime Tools Help All changes saved
+ Code + Text
Requirement already satisfied: numpy>=1.16.2 in /usr/local/lib/python3.8/dist-packages (from matrixprofile) (1.21.6)
Requirement already satisfied: scipy<2.0.0,>=1.3.2 in /usr/local/lib/python3.8/dist-packages (from matrixprofile) (1.7.3)
Requirement already satisfied: six>=1.9 in /usr/local/lib/python3.8/dist-packages (from protobuf==3.11.2->matrixprofile) (1.15.0)
Requirement already satisfied: setuptools in /usr/local/lib/python3.8/dist-packages (from protobuf==3.11.2->matrixprofile) (57.4.0)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.8/dist-packages (from matplotlib>=3.0.3->matrixprofile) (2.8.2)
Requirement already satisfied: pyparsing!=2.0.4,!2.1.2,!2.1.6,>=2.0.1 in /usr/local/lib/python3.8/dist-packages (from matplotlib>=3.0.3->matrixprofile) (3.0.9)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.8/dist-packages (from matplotlib>=3.0.3->matrixprofile) (0.11.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.8/dist-packages (from matplotlib>=3.0.3->matrixprofile) (1.4.4)
Installing collected packages: protobuf, matrixprofile
  Attempting uninstall: protobuf
    Found existing installation: protobuf 3.19.6
    Uninstalling protobuf-3.19.6:
      Successfully uninstalled protobuf-3.19.6
ERROR: pip's dependency resolver does not currently take into account all the packages that are installed. This behaviour is the source of the following dependenc
tensorflow-metadata 1.12.0 requires protobuf<4,>=3.13, but you have protobuf 3.11.2 which is incompatible.
tensorflow-datasets 4.8.2 requires protobuf>=3.12.2, but you have protobuf 3.11.2 which is incompatible.
proto-plus 1.22.2 requires protobuf<5.0.0dev,>=3.19.0, but you have protobuf 3.11.2 which is incompatible.
grpcio-status 1.48.2 requires protobuf>=3.12.0, but you have protobuf 3.11.2 which is incompatible.
googleapis-common-protos 1.58.0 requires protobuf!=3.20.0,!3.20.1,!4.21.1,!4.21.2,!4.21.3,!4.21.4,!4.21.5,<5.0.0dev,>=3.19.5, but you have protobuf 3.11.2 v
google-cloud-translate 3.8.4 requires protobuf!=3.20.0,!3.20.1,!4.21.0,!4.21.1,!4.21.2,!4.21.3,!4.21.4,!4.21.5,<5.0.0dev,>=3.19.5, but you have protobuf 3.
google-cloud-language 2.6.1 requires protobuf!=3.20.0,!3.20.1,!4.21.0,!4.21.1,!4.21.2,!4.21.3,!4.21.4,!4.21.5,<5.0.0dev,>=3.19.5, but you have protobuf 3.1
google-cloud-firestore 2.7.3 requires protobuf!=3.20.0,!3.20.1,!4.21.0,!4.21.1,!4.21.2,!4.21.3,!4.21.4,!4.21.5,<5.0.0dev,>=3.19.5, but you have protobuf 3.
google-cloud-datastore 2.11.1 requires protobuf!=3.20.0,!3.20.1,!4.21.0,!4.21.1,!4.21.2,!4.21.3,!4.21.4,!4.21.5,<5.0.0dev,>=3.19.5, but you have protobuf 3.
google-cloud-bigquery 3.4.2 requires protobuf!=3.20.0,!3.20.1,!4.21.0,!4.21.1,!4.21.2,!4.21.3,!4.21.4,!4.21.5,<5.0.0dev,>=3.19.5, but you have protobuf 3.1
google-cloud-bigquery-storage 2.18.1 requires protobuf!=3.20.0,!3.20.1,!4.21.0,!4.21.1,!4.21.2,!4.21.3,!4.21.4,!4.21.5,<5.0.0dev,>=3.19.5, but you have pro
google-api-core 2.11.0 requires protobuf!=3.20.0,!3.20.1,!4.21.0,!4.21.1,!4.21.2,!4.21.3,!4.21.4,!4.21.5,<5.0.0dev,>=3.19.5, but you have protobuf 3.11.2 v
Successfully installed matrixprofile-1.1.10 protobuf-3.11.2
```

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Scikit-learn Machine Learning in Python Simple and efficient tools for predictive data analysis.

```
!pip uninstall scikit-learn -y
```

Found existing installation: scikit-learn 1.0.2
Uninstalling scikit-learn-1.0.2:
Successfully uninstalled scikit-learn-1.0.2



Project.ipynb

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RAM Disk Editing

```
[3] Found existing installation: scikit-learn 1.0.2  
Uninstalling scikit-learn-1.0.2:  
Successfully uninstalled scikit-learn-1.0.2
```

```
[4] !pip install -U scikit-learn
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/  
Collecting scikit-learn  
  Downloading scikit_learn-1.2.1-cp38-cp38-manylinux_2_17_x86_64_manylinux2014_x86_64.whl (9.8 MB)  
    9.8/9.8 MB 51.8 MB/s eta 0:00:00  
Requirement already satisfied: scipy>=1.3.2 in /usr/local/lib/python3.8/dist-packages (from scikit-learn) (1.7.3)  
Requirement already satisfied: threadpoolctl>=2.0.0 in /usr/local/lib/python3.8/dist-packages (from scikit-learn) (3.1.0)  
Requirement already satisfied: numpy>=1.17.3 in /usr/local/lib/python3.8/dist-packages (from scikit-learn) (1.21.6)  
Requirement already satisfied: joblib>=1.1.1 in /usr/local/lib/python3.8/dist-packages (from scikit-learn) (1.2.0)  
Installing collected packages: scikit-learn  
Successfully installed scikit-learn-1.2.1
```

```
import sklearn  
sklearn.__version__
```

'1.2.1'

Import Modules.

Then we imported the packages that we'll need to load, analyze, and plot the data and, later, to build simple decision tree models.

```
import pandas as pd
import pickle

import matplotlib.pyplot as plt
import seaborn as sns

from sklearn.model_selection import train_test_split

from sklearn.metrics import mean_squared_error
from sklearn.metrics import mean_absolute_error
from sklearn.metrics import mean_absolute_percentage_error

import time

from numpy import array
from keras.models import Sequential
from keras.layers import LSTM
from keras.layers import Dense
from keras.layers import Flatten

from keras.layers import Bidirectional

from keras.layers import ConvLSTM2D
```

```
with open('/content/drive/MyDrive/CybPhys/Data/data_one_day.pickle', 'rb') as f:
    df1 = pickle.load(f)
```

+ Code + Text

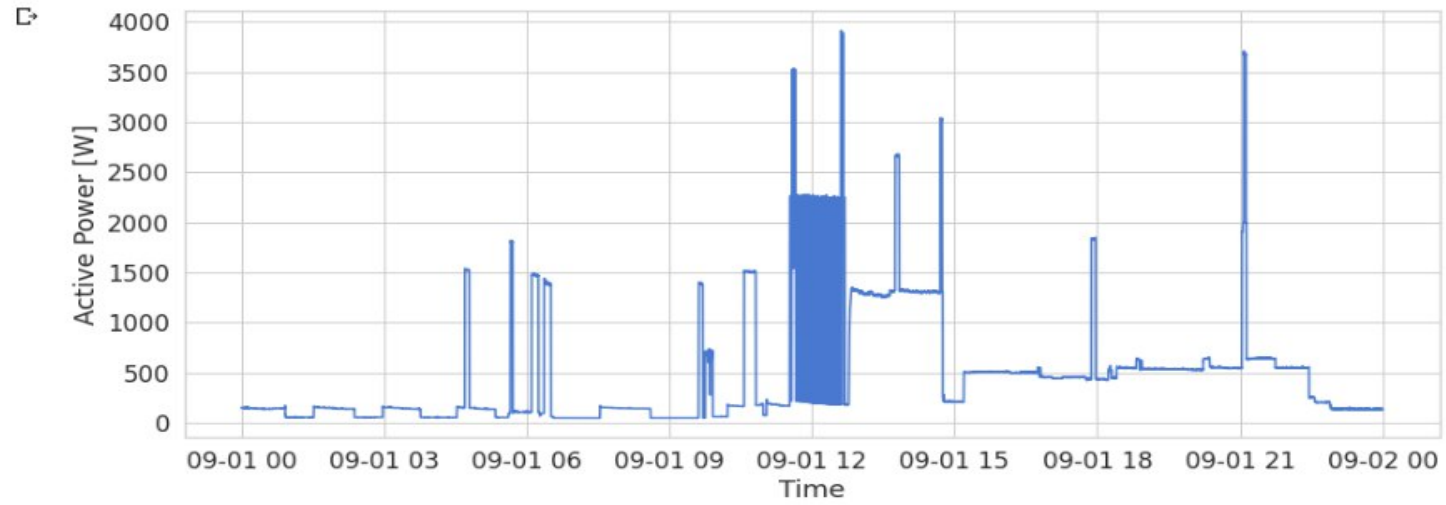
RAM Disk Editing

Navigation icons: up, down, link, comment, settings, print, trash, menu

```
sns.set(style='whitegrid', palette='muted', font_scale=1.5)

plt.figure(figsize=(15, 6))
plt.plot(df1["power"][:,10])

plt.ylabel("Active Power [W]"); plt.xlabel("Time")
plt.savefig('/content/drive/MyDrive/CybPhys/Figures/one_day.pdf', format='pdf', dpi=1000)
plt.show()
```



```
df1["power"][:,5]

timestamp
2020-09-01 00:00:00    150.0
2020-09-01 00:00:05    148.0
2020-09-01 00:00:10    149.0
2020-09-01 00:00:15    151.0
2020-09-01 00:00:20    146.0
...
2020-09-01 23:59:35    135.0
2020-09-01 23:59:40    137.0
2020-09-01 23:59:45    131.0
2020-09-01 23:59:50    137.0
2020-09-01 23:59:55    131.0
Name: power, Length: 17280, dtype: float64
```

+ Code + Text

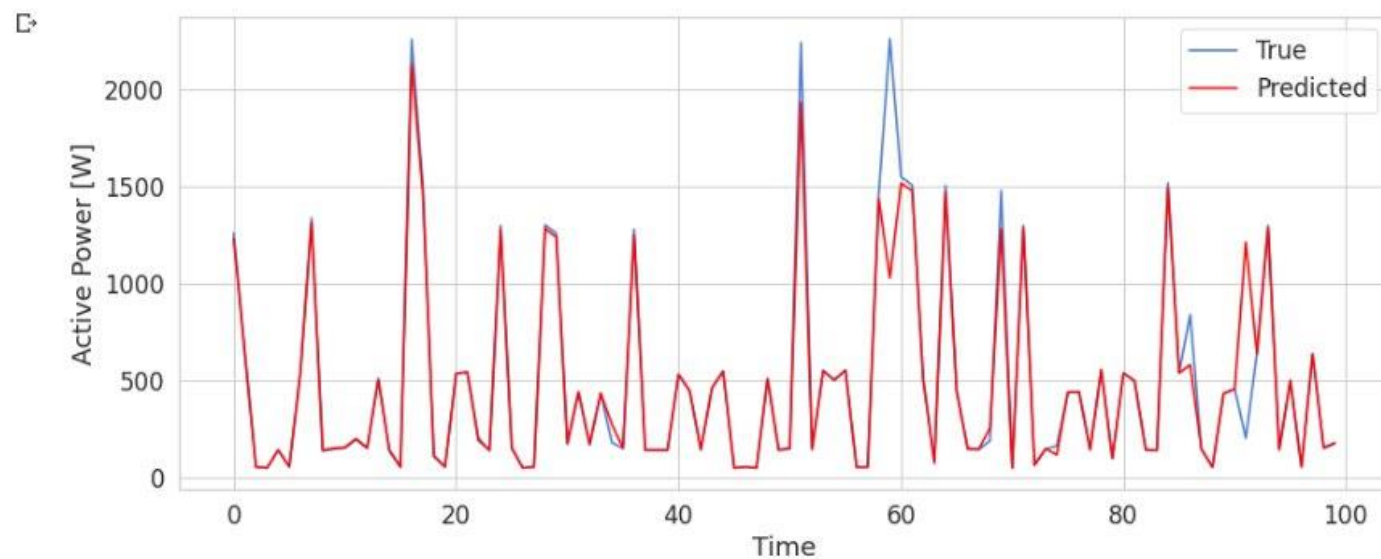
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Disk Editing

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```
sns.set(style='whitegrid', palette='muted', font_scale=1.5)
```

```
plt.figure(figsize=(15, 6))  
plt.plot(y_test[0:100])  
plt.plot(y_pred[0:100], color='red')
```

```
plt.legend(['True', 'Predicted'])  
plt.ylabel("Active Power [W]"); plt.xlabel("Time")  
plt.savefig('/content/drive/MyDrive/CybPhys/Figures/true_vs_predicted.pdf', format='pdf', dpi=1000)  
plt.show()
```



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Conclusion

The Matrix Profile and how it can be used to analyze time series data. It is a less known approach as it is still new, but is a fast and domain agnostic method. Once you have the Matrix Profile it is trivial to extract common patterns (motifs) and anomalies (discords). In our project, we illustrated anomaly through visualization.

Keep in mind that we only introduced the Matrix Profile and a few concepts. It provides many more capabilities. Incremental mode for streaming data analysis, semantic segmentation and snippet discovery are a few more capabilities. We highly encourage anyone interested in the Matrix Profile or time series analysis to check out the supplemental section.