National College of Ireland

Configuration Manual

MSc Research Project
Data Analytics

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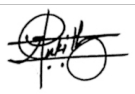
Signature:	
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Configuration Manual

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1 Prelude

This document outlines the steps to configure and run the Variational Mode Decomposition (VMD) and Fourier Analysis Network (FAN) hybrid model for forecasting Air Quality Index (AQI) time-series data. The manual includes details on the software environment, parameters, execution, and troubleshooting.

2 System Requirements

2.1 Hardware Requirements

- GPU: NVIDIA Tesla T4 or equivalent
- CPU: Intel Xeon @ 2.00GHz or higher
- RAM: Minimum 16 GB (51 GB recommended)
- Disk Space: Minimum 50 GB (256 GB recommended)

2.2 Software Requirements

- Python 3.10 or higher
- PyTorch 2.5.1+cu121
- Key Libraries: sktime, statsmodels, numpy, pandas, matplotlib, joblib

3 Installation

3.1 Using Google Colab

1. Open the google colab[1] and start a new notebook
2. Google colab kernel already is pre installed with many required libraries, to install the remaining run the pip install command

[1]Google Colab: `https://colab.google/`

```
%%capture
!pip install sktime
!pip install dask[dataframe]
```

3. Use git to clone the code files

```
!git clone https://github.com/ankithbjoseph/vmd-fan.git
```

4. go to the vmd-fan folder

```
cd vmd-fan
```

5. The required environment is setup and can continue with executing the code.

3.2 Or Install Locally

1. Install Python and create a virtual environment:

```
python3 -m venv venv
source venv/bin/activate  # For Linux/Mac
venv\Scripts\activate     # For Windows
```

2. Run the following command to install required dependencies:

```
pip install -r requirements.txt
```

3. Use git to clone the code files

```
!git clone https://github.com/ankithbjoseph/vmd-fan.git
```

4 Configuration

Parameters

All parameters are specified in a JSON file (`parameters.json`) with the following structure:

Listing 1: parameters.json

```
{
  "VMD": {
      "K": [3,5,7],
      "alpha": [1000,3000],
```

```
        "tau": [1e-6],
        "DC": [false],
        "tol": [1e-5,1e-7]
    },
    "FAN": {
        "window_size": [12],
        "learning_rate": [0.0001,0.00001],
        "p_ratio": [0.15,0.25],
        "fan_units": [64]
    },
    "BaseNN": {
        "window_size": [12],
        "learning_rate": [0.0001,0.00001]
    }
}
```

Command-Line Arguments

The script `main.py` accepts the following arguments:

Argument	Description	Default Value
`--eda`	Perform Exploratory Data Analysis (EDA).	`False`
`--vmd`	Enable VMD decomposition.	`False`
`--input_file`	Path to the dataset file.	`./dataset/air_quality_Taiwan.csv`
`--variable`	Target variable for forecasting.	`aqi`
`--output_dir`	Directory to save results.	`results`
`--model`	Model to use (`FAN` or `BaseNN`).	`None`
`--visualize`	Save visualizations of results.	`False`
`--num_jobs`	Number of parallel jobs.	`1`
`--forecast_horizon`	Number of steps to forecast.	`1`
`--parameter_grid`	Path to parameter grid JSON.	`parameters.json`
`--cities`	List of cities to process (comma-separated).	`all cities in dataset`

Table 1: Command-Line Arguments for `main.py`

5 Code Execution

Step 1: Data Preprocessing

Run the script to clean and segment the data:

```
python main.py --cities "Annan" --eda --visualize --num_jobs 40
```

Step 2: VMD Decomposition

Decompose the dataset into Intrinsic Mode Functions (IMFs):

```
python main.py --cities "Annan" --vmd --visualize --num_jobs 40
```

Step 3: Model Training and Forecasting

Run the FAN or BaseNN model on the decomposed data:

```
python main.py --cities "Annan"  --model 'BaseNN' --visualize --num_jobs 40
```

```
python main.py --cities "Annan" --model 'FAN' --visualize --num_jobs 40
```

```
python main.py --cities "Annan" --vmd --model 'BaseNN' --visualize --num_jobs 40
```

```
python main.py --cities "Annan" --vmd --model 'FAN' --visualize --num_jobs 40
```

6 Directory Structure

The output directory will have the following structure:

```
results/
  |-- city_name/
       |-- city_name_aqi.csv
       |-- vmd_decompositions/
       |-- plots/
  |-- results.csv
```

7 Troubleshooting

Parameter Errors

- Verify the syntax of `parameters.json`. Ensure it is valid JSON.
- Check that the parameter values align with the model requirements.

CUDA Errors

- Ensure that PyTorch is installed with CUDA support. Install the correct version by visiting the PyTorch Installation Guide[2].
- Check GPU availability using the following Python command:

```
import torch
print(torch.cuda.is_available())
```

- If `torch.cuda.is_available()` returns `False`, verify that:
  - The system has a compatible NVIDIA GPU.
  - NVIDIA drivers and CUDA toolkit are installed and up-to-date.

[2]PyTorch Installation Guide: `https://pytorch.org/get-started/locally/`