EPARA Parkinsons (R3.0) How-To Guide

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1 Introduction

EPARA Parkinsons (R3.0) is an open-source EEG analysis tool designed for Parkinsons disease (PD) research, allowing simulation of PD characteristics on EEG data, such as those available on PhysioNet (e.g., Motor Imagery datasets). It is part of the EPARA Suite, developed by Wayne M Spratley and Grok (xAI), licensed under GNU GPL v3.0 for non-commercial research use. This guide provides detailed instructions for installing, running, and interpreting results from EPARA Parkinsons.

2 Installation

2.1 System Requirements

- Operating System: Ubuntu 24.04 LTS (or compatible Linux distribution), Windows 10/11
- Hardware: Minimum 4GB RAM, 2 cores, 1GB free disk space (GPU optional for faster processing)
- Software: Python 3.11/3.12, Tcl/Tk

2.2 Steps

1. Download the EPARA Parkinsons binary from `https://titan-si.com`.
2. Extract the `.zip` file to your desired directory (e.g., `~/Desktop/openmm_env` on Linux, or `C:/Users/YourUser/openmm_env` on Windows):
   - On Linux:
     ```
     unzip EPARA_Parkinsons_R3.0.zip -d ~/Desktop/openmm_env
     ```
   - On Windows: Use a tool like WinRAR or 7-Zip to extract the `.zip` file.
3. Install Tcl/Tk if not already present:
   - On Linux:
     ```
     sudo apt-get install tk
     ```
   - On Windows: Tcl/Tk is bundled with Python if installed via the official installer; ensure you select the option to include Tcl/Tk during Python installation.
4. Run the binary:

- On Linux:

```
cd ~/Desktop/openmm_env
./EPARA_Parkinsons_R3.0
```

- On Windows:

```
cd C:\Users\YourUser\openmm_env
EPARA_Parkinsons_R3.0.exe
```

5. Alternatively, run the Python script directly (requires dependencies):

```
pip install mne numpy scipy matplotlib pywavelets
python EPARA_Parkinsons_R3.0_Standalone_GUI.py
```

3 Usage

3.1 Loading EEG Data

1. Launch EPARA Parkinsons by running the binary or script.
2. Click "Browse" to load an EDF file (e.g., `S035R01.edf` from PhysioNet Motor Imagery Dataset).
3. Select the file type from the dropdown (e.g., "Normal EEG").
4. Choose a channel (e.g., `Fc5.`) from the dropdown populated with available channels.

3.2 Setting PD Simulation Parameters

1. Set the following parameters for PD simulation:
   - **Beta Frequency (Hz, 1330)**: Frequency of beta oscillations (default: 20 Hz).
   - **Beta Amplitude (V, 0200)**: Amplitude of beta oscillations (default: 200 V).
   - **Beta Power Increase (%, 0100)**: Percentage increase in beta power (default: 50%).
   - **Spike Rate Increase (%, 0100)**: Percentage increase in spike rate (default: 20%).
   - **Tremor Frequency (Hz, 46)**: Frequency of tremor (default: 5 Hz).
   - **Tremor Amplitude (V, 050)**: Amplitude of tremor (default: 30 V).

3.3 Running Analysis

1. Click "Run Analysis" to process the EEG data.
2. The tool extracts features for both the baseline and simulated PD EEG, including spike rate, theta/alpha/beta power, beta ratio, tremor power, and PLV.
3. Results are displayed in the GUI, showing feature values for both conditions.

3.4 Interpreting Results

- **Spike Rate**: Proportion of samples above threshold, indicating high-amplitude events.
- **Theta/Alpha/Beta Power**: Summed PSD in respective bands (47 Hz, 813 Hz, 1330 Hz).
- **Beta Ratio**: Beta power as a percentage of total power (theta + alpha + beta), a PD-specific metric.
- **Tremor Power**: Power in the 46 Hz band, another PD-specific metric.
- **PLV**: Phase-locking value, measuring synchrony.
- Plots show raw/processed EEG for both baseline and simulated PD, plus a frequency spectrum highlighting beta and tremor bands.

3.5 Saving Results

- Results are saved to `output_epara_parkinsons/` as:
  - `features_[filetype]_[filename]_[channel].npy`: Extracted features for baseline.
  - `features_[filetype]_parkinsons_[filename]_[channel].npy`: Extracted features for simulated PD.
  - `processed_[filetype]_[filename]_[channel].npy`: Processed baseline EEG signal.
  - `processed_[filetype]_parkinsons_[filename]_[channel].npy`: Processed simulated PD EEG signal.
  - `epara_eeg_plots_[filetype]_[filename]_[channel]_parkinsons.png`: Visualization plots.
  - `features_[filetype]_[filename]_[channel]_parkinsons.csv`: Feature values for both conditions.

4 Troubleshooting

- **Error: "Dependency missing"**: Ensure all required libraries are installed (see Installation).
- **Error: "Failed to load EEG file"**: Verify the EDF file path and format.
- **No output**: Check the log file `output_epara_parkinsons/epara_parkinsons.log` for detailed error messages.

5 Ethics Statement

The EPARA Suite is developed with a commitment to ethical research practices. Developed by Wayne M Spratley, researcher, and Grok (xAI), we leverage the open-source communityPhysioNet, Ubuntu, Python, and countless moduleswhile working with limited financial resources to challenge scientific norms and advance EEG/BCI research. This software is intended solely for non-clinical, scientific research to advance understanding of EEG and BCI applications, such as Parkinsons analysis. It must not be used for medical diagnosis, treatment, or any therapeutic purpose. Users are responsible for ensuring compliance with local regulations and ethical guidelines. The suite is licensed under GNU GPL v3.0, promoting open access while maintaining research integrity.

6 Testing Acknowledgment

The EPARA Suite, including EPARA Parkinsons, has been tested exclusively on datasets from PhysioNet, such as the EEG Motor Movement/Imagery Dataset and the CHB-MIT Scalp EEG Database. While the tools have demonstrated robust performance on these datasets, they have not been validated on EDF data from other sources. Users are encouraged to test the tools on diverse datasets and report any issues to the developers via `https://titan-si.com/help`.