Assignment 2

Neurorobotics 2024/2025

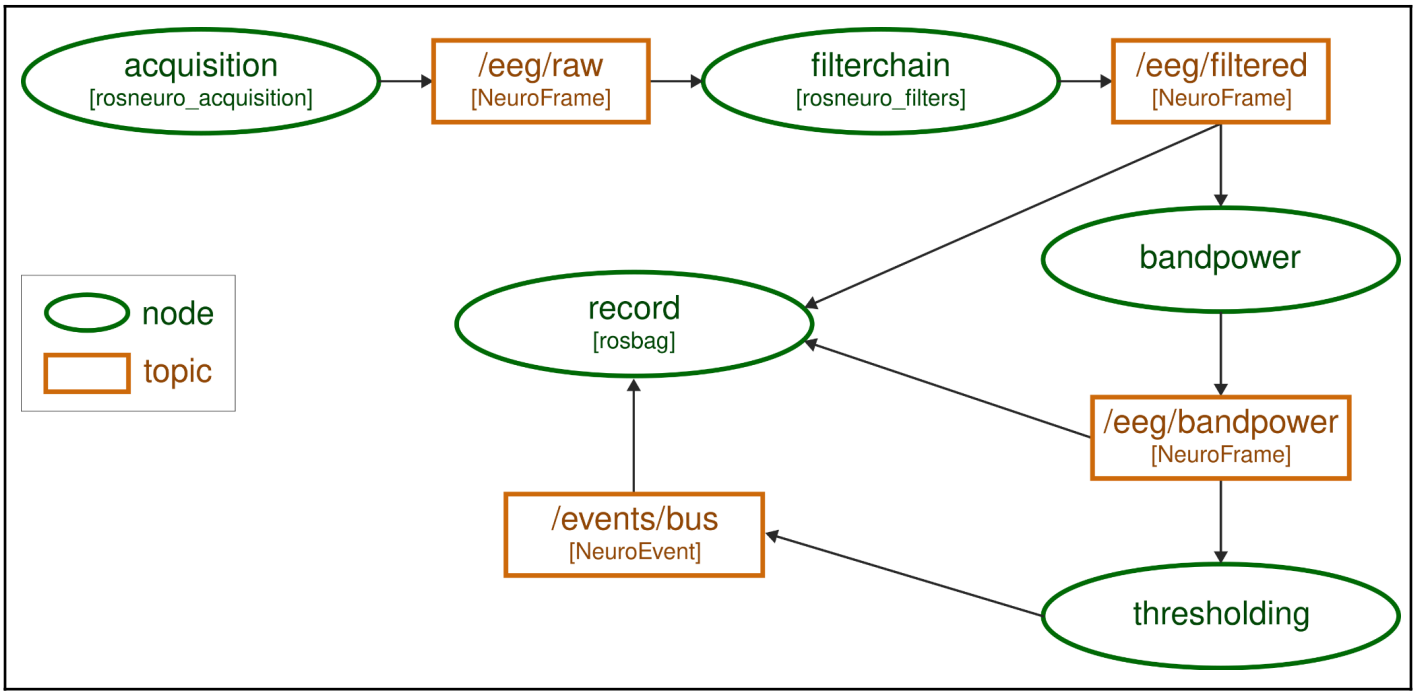
Objective:
Students are asked to implement a processing chain in ROS-Neuro to determine when the logarithmic bandpower of the EEG signal crosses a given threshold.

Data description:
The GDF file provided was recorded using a 16-channel EEG amplifier (g.USBamp, g.Tec) at a sampling rate of 512 Hz. Electrodes were positioned according to the 10-20 international system. Please refer to the first assignment and to the material provided during the class for the placement and order of electrodes.

Data Link: `ah7.20170613.161402.offline.mi.mi_bhbf.gdf`

Resources:
Students can refer to the ROS-Neuro tutorial to implement the required nodes.

Assignments:
Students are required to set up the processing chain based on the ROS and ROS-Neuro modules covered in class. The final processing chain must look as depicted in the figure below.



`acquisition`, `filterchain` and `record` nodes are already provided in the ROS / ROS-Neuro ecosystem. A custom configuration of these nodes might be required (e.g., setting the correct parameters or remapping the names of the topics). **Students are asked to develop the `bandpower` and `thresholding` nodes**. These nodes can be developed in Python or C++.

acquisition node
• The acquisition node will be used to acquire data from the GDF file and provide a stream of `NeuroFrame` messages • The node must publish the raw data in the `/eeg/raw` topic • Resource: rosneuro_acquisition

filterchain node

- The filterchain node will filter the raw EEG data (`NeuroFrame` messages) by applying the following filters:

  1. Butterworth low-pass filter

  Cut-off frequency: 14 Hz
  Order: 2

  2. Butterworth high-pass filter

  Cut-off frequency: 6 Hz
  Order: 2

  3. CAR filter

- The node must publish the filtered data in the `/eeg/filtered` topic
- Resource: ROS-Neuro Filtering Tutorial

bandpower node

- The bandpower node will be used to compute the logarithmic bandpower of the filtered data
- The node must publish the bandpower data in the `/eeg/bandpower` topic
- Resources: ROS-Neuro Bandpower Tutorial

thresholding node

- The thresholding node will apply a given threshold to a channel of the bandpower data
- Students must autonomously select an appropriate channel and determine the threshold
- When the signal crosses the threshold, a `NeuroEvent` must be published in the `/events/bus` topic (the event value is irrelevant)
- The selected channel and threshold value must be provided as parameters of the node

rosbag node

- The rosbag node must record the following topics:
  - `/eeg/filtered`
  - `/eeg/bandpower`
  - `/events/bus`
- Resources: ROS Tutorial Bags, ROS Tutorial rosbag

ROS package

Students are required to provide the developed software as a ROS package named `logbandpower`, following this structure below. Please refer to ROS Tutorial Creating a ROS package for details on the creation of the ROS package.

```
threshold_on_bandpower
├── package.xml
├── CMakeLists.txt
├── include
│   └── threshold_on_bandpower
│       └── bandpower.h
│       └── thresholding.h
├── src
│   └── bandpower.cpp
│   └── thresholding.cpp
└── launch
    └── threshold_on_bandpower.launch
```

Note 1: This structure is an example. Additional files may be required.
Note 2: This structure is meant for a C++ implementation of the package. A Python package might be slightly different

Guidelines for the submission

1. Format:

- The assignment must be submitted as a zip file
- The zip file must contain:
    - ROS package `logbandpower`
    - A bag file with the requested topics recorded
    - A README file with Each group member's contribution

2. Data:

- **Do not include** raw EEG data in the submission.

3. Plagiarism Check:

- A plagiarism check will be conducted on the submission