

Neuroengineering 2021-2022

Exam 15 September 2022 – Part II

How to submit your answers.

Most answers can be typed in the Exam.net editor.

Write the answers in the same sequence as the questions (A1, A2, ...) and write the same headers as the test on a separate line just above your answer, e.g.:

Problem
A1
<your answer to question A1 goes here>
A2
<your answer to question A2 goes here>
...

Textual answers must be typed in the editor. When graphical elements are required in the answer, the latter can be written on paper and scanned using your mobile phone at the end of the exam.

Keep your answers tidy. Messy, hard-to-read answers may penalize your mark.

The maximum total score for part II is 11.

Problem

Carefully read the following scenario and answer the questions listed below.

A study has the aim to investigate the evolution of a **neurodegenerative brain condition** that affects **memory functions**. To this purpose, a neuroelectrical screening is performed in **two sessions**, at three months' distance. The recordings are performed during the execution of a **short term memory task**.

From previous studies, it is already known that the **direction** of the expected connectivity links plays a major role in the task, while no specific role is attributed to different **frequencies**. The memory task is also known to involve a communication between the **frontal** and the **occipito-parietal** (posterior) lobes.

To prevent **learning and habituation effects** during the memory task, the recording sessions are kept **short**.

The **brain functional networks** obtained for the **first session** (at time T_0) and for the **second session** (at time T_1 , after three months) are reported in **Fig.1**.

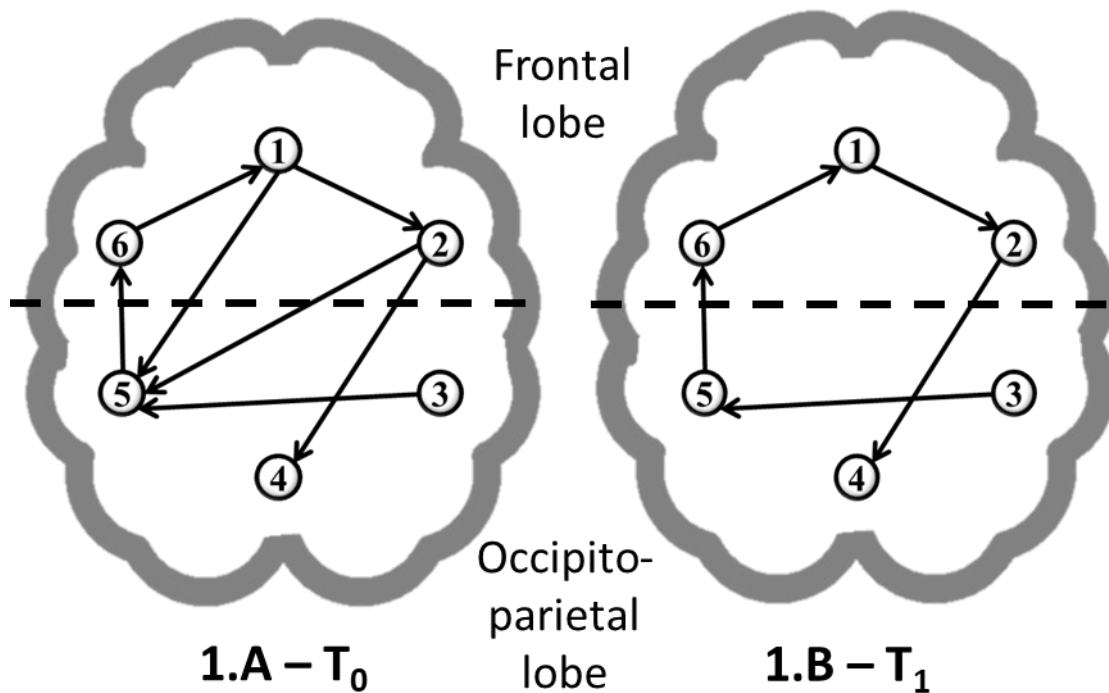


Fig. 1 – Brain Functional Networks obtained at T_0 (first screening session) and at T_1 (after three months). The brain is seen from above, the frontal lobe points to the upper part of the figure.

Questions

(unless otherwise specified, write the answer in the exam.net editor)

- A1.** Indicate **which connectivity estimator** you would use to perform the **functional connectivity analysis**. Justify your choice, based on the above-mentioned conditions. *(4 points)*
- A2.** Given the functional connectivity networks obtained for the two sessions, as reported in **Fig.1:** *(write the answer on paper and scan the solution)*
- A2.1.** Write down the two **adjacency matrices** (at T_0 and at T_1) and compute the **indegree** and **outdegree** of each node. *(1 point)*
- A2.2.** Compute the **Global Efficiency** for each of the two graphs *(3 points)*
- A2.3.** Considering that regions 1, 2 and 6 belong to the frontal lobe and regions 3, 4 and 5 belong to the occipito-parietal lobe, compute the **density of the communications between the two lobes**, defined as the number of links connecting the two lobes divided by the maximum number of links that could exist between them *(2 points)*
- A3.** Comment on the results obtained at point A2.2 and A2.3. Indicate if the **efficiency of the communications** in the network and the **communication between the two lobes** are **changed** between the two sessions and **how**. *(1 point)*

Total maximum mark: 11 points