Neuroengineering 2023-2024

September 10th 2024

Part II

Solutions

Q1: The text states that this task is known to induce activity and connectivity between cortical areas in the alpha and beta bands. This implies the choice of a spectral estimator. The choice is therefore limited to Ordinary Coherence or Partial Directed Coherence (PDC).

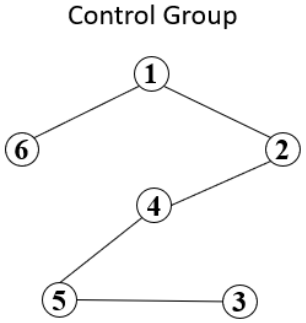
PDC guarantees more accurate results, because it is directional (whereas Ordinary Coherence is not) and multivariate (which allows to mitigate the common source problem, that leads to spurious connections). However, due to the large number of parameters used in the multivariate model, PDC requires long recordings, whereas the text states that only a limited number of trials could be acquired due to the complexity of the task and the clinical conditions of the patients.

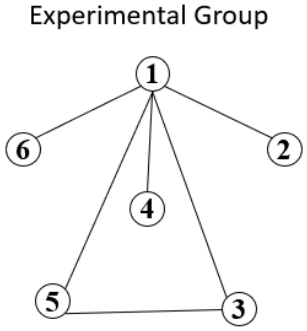
For this reason, the choice is limited to the Ordinary Coherence.

Pros in relation to the specific scenario: it is spectral, as required, it is robust to data paucity, which is the case.

Cons in relation to the specific scenario: it does not indicate the direction of interaction and thus causality (it only measures the synchrony between signals); it can more easily lead to spurious links and thus inaccurate results.

Q2.1:





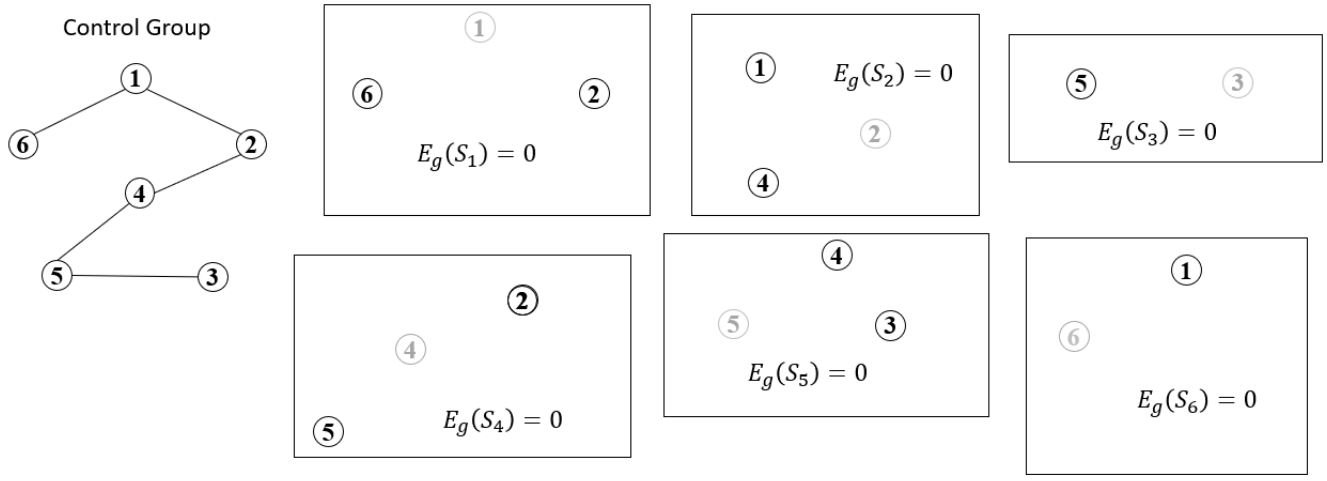
A_{CTR}=

						Degree
-	1	0	0	0	1	2
1	-	0	1	0	0	2
0	0	-	0	1	0	1
0	1	0	-	1	0	2
0	0	1	0	-	0	1
1	0	0	0	0	-	1

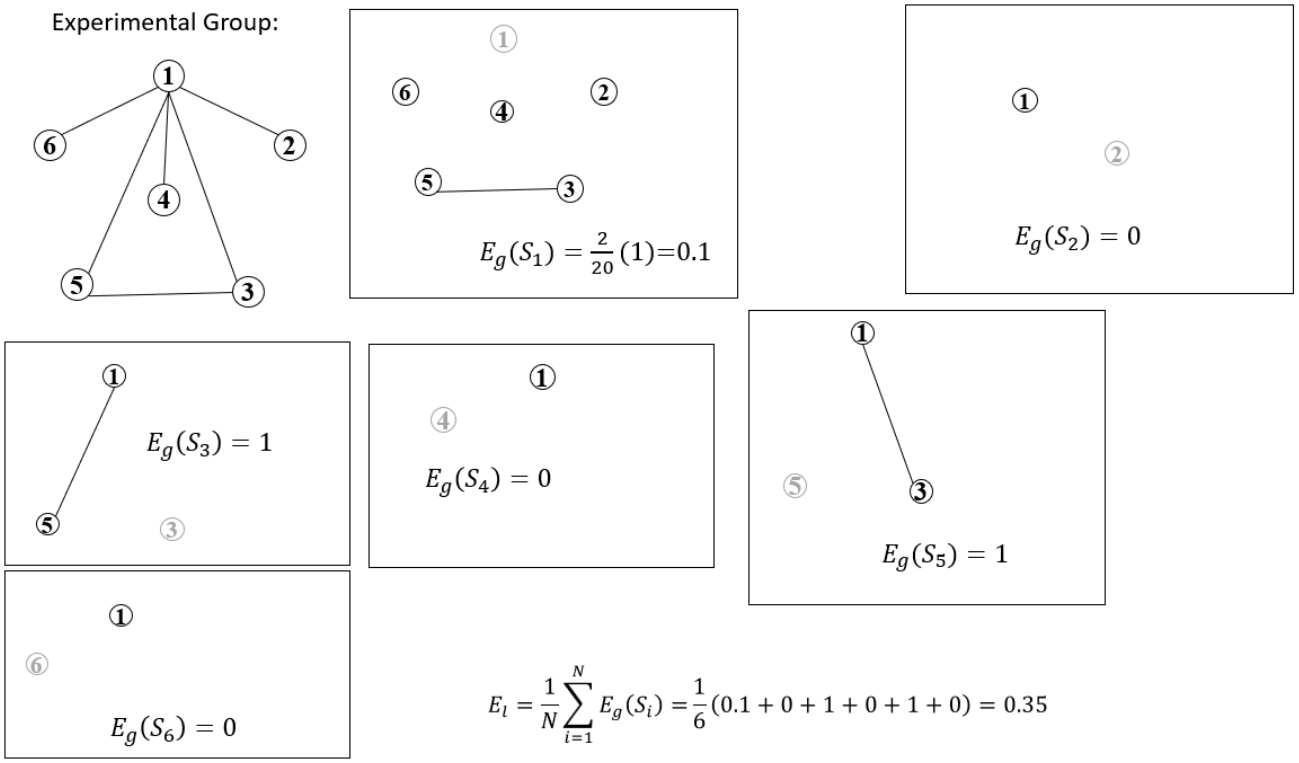
A_{EXP}=

						Degree
-	1	1	1	1	1	5
1	-	0	0	0	0	1
1	0	-	0	1	0	2
1	0	0	-	0	0	1
1	0	1	0	-	0	2
1	0	0	0	0	-	1

Q2.3:



$$E_l = \frac{1}{N}\sum_{i=1}^{N} E_g(S_i) = 0$$



$$E_l = \frac{1}{N}\sum_{i=1}^{N} E_g(S_i) = \frac{1}{6}(0.1 + 0 + 1 + 0 + 1 + 0) = 0.35$$

Q3: The group characterized by the network with the greatest tendency to form closely connected subgroups is the experimental one. In fact, the local efficiency, which is zero in the control group, is equal to 0.35 in the experimental group. This indicates that the network of the control group has no tendency to form closely connected subgroups, whereas in the experimental group this has changed as a result of the new therapy applied, making it easier for the network to get closer to a physiological condition. In fact, healthy brain networks have a small word structure, with non-zero local efficiency.