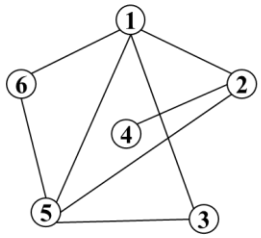
Neuroengineering 2023-2024

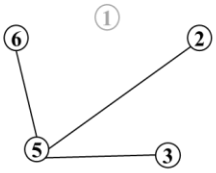
February 3rd 2025

Part II - Solutions

A1. *Local Efficiency for the functional connectivity network reported in the figure:*



①



D_1=

	2	3	5	6
2	-	2	1	2
3		-	1	2
5			-	1
6				-

$$E_g(S_1) = \frac{2}{12}(3 + \frac{3}{2}) = 0.75$$

②

D_1=

	1	4	5
1	-	∞	1
4		-	∞
5			-

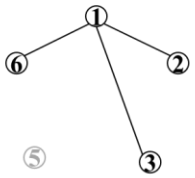
$$E_g(S_2) = \frac{2}{6}(1) = 0.33$$

$$E_g(S_3) = 1$$

③

④

$$E_g(S_4) = 0$$



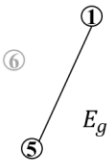
⑤

D_1=

	1	2	3	6
1	-	1	1	1
2		-	2	2
3			-	2
6				-

$$E_g(S_5) = \frac{2}{12}(3 + \frac{3}{2}) = 0.75$$

⑥



$$E_g(S_6) = 1$$

$$E_l = \frac{1}{N}\sum_{i=1}^{N} E_g(S_i) = \frac{1}{6}(0.75 + 0.33 + 1 + 0 + 0.75 + 1) = 0.64$$

A2. *The aims consist of studying synchronicity between brain activities, with a focus in the spectral domain. Moreover, the network in the figure does not show any directionality. Among the connectivity estimators studied in the course, only the Ordinary Coherence is a spectral measure of synchronicity and not of causality, and it is therefore undirected (GC and PDC are measures of causality and imply directionality). The network was therefore obtained by applying the Ordinary Coherence.*

Pros of this estimator:

- *it can be computed under hypothesis that are easily met by any brain measures;*
- *it is spectral;*
- *it is normalized between 0 and 1 and it can be interpreted in terms of percentage values;*
- *it does not require long recordings.*

Cons:

- *being pairwise, it is prone to the hidden source problem, which can lead to reduced accuracy;*
- *it is undirected.*