**Unilayer network construction and analysis**

1. First, we constructed minimum spanning trees (MST) for the 5 frequency-band-specific EEG networks by applying Kruskal’s algorithm to the functional connectivity matrices. The MST is a binarized sub-graph of the original graph that connects all the nodes in the network without forming loops. This represents the backbone of the network and, importantly, is not hindered by common methodological issues such as the effects of connection strength or link density on the estimated topological characteristics of networks. Edge weights were defined as the inverted PLI values (1/PLI) when constructing the *minimum* spanning tree, since we were interested in the strongest connections.

### The concept of a minimum spanning tree

In graph theory a tree is defined as an acyclic connected graph ([Estrada, 2011](https://www.sciencedirect.com/science/article/pii/S0167876014000907?via%3Dihub" \l "bb0080)). Acyclic means that there are no loops (of any length) in the graph. A graph is connected if there exists a path between each pair of nodes in the graph. A tree with N nodes has exactly m = N − 1 links or edges. A spanning tree is a subgraph that includes all nodes of the original graph (it has the same N) but only N − 1 edges (it has no cycles). A minimum spanning tree (MST) of a connected weighted graph is the spanning tree of this graph that minimizes the sum of the weights of the edges included in the tree. If all the weights in the weighted graph are unique, its minimum spanning tree is also unique ([Mares, 2008](https://www.sciencedirect.com/science/article/pii/S0167876014000907?via%3Dihub" \l "bb0170)). In other words there is only one MST that corresponds to a weighted graph with unique weights.

The major algorithms have been described to construct the MST of a weighted graph ([Kruskal, 1956](https://www.sciencedirect.com/science/article/pii/S0167876014000907?via%3Dihub" \l "bb0135), [Prim, 1957](https://www.sciencedirect.com/science/article/pii/S0167876014000907?via%3Dihub" \l "bb0195)). [Kruskal's algorithm](https://www.sciencedirect.com/topics/psychology/kruskal-algorithm).

Diagram

Description automatically generated

Fig. 2. Comparison of binary graph and minimum spanning tree.

(A) Binary graph constructed from a weighted synchronization matrix after application of a threshold T. Edges correspond to node pairs with a synchronization strength above the threshold T. (B) Minimum spanning tree constructed from the same weighted synchronization matrix as used for the binary graph shown in (A). The colour of the nodes depict the betweenness centrality (blue = 0; red = 1). The minimum spanning tree is an acyclic connected subgraph that maximizes the synchronization strength between all node pairs.

1. Then calculated nodal eigenvector centrality (EC) individually for each of the 5 EEG MSTs and for each fNIRS MST using the brain connectivity toolbox (<https://sites.google.com/site/bctnet/>). EC is a measure of nodal centrality that assumes that a node is more influential if it is connected to nodes that are highly central themselves, and thus considers both the connecections of a node itself as well as the connections of its neighbors.

<https://github.com/multinetlab-amsterdam/projects/tree/master/mumo_paper_2021/script>

**Multilayer network construction and analysis**

A multiplex network is a multilayer network used to describe different interactions between the same set of nodes. We integrate the 7 MSTs to obtain an interconnected multiplex network for every participant. Each participant’s multiplex thus consisted of L = 7 layers (TWO for fNIRS, and 5 for each of the EEG frequency bands), with each layer containing the same set of N = 44 nodes (atlas regions), and each spanning tree and thus layer having M = N – 1 = 43 intralayer links. The weights of the interlayer connections are set to 1, identical to the intralayer connections. The resulting multilayer network is represented as an LxN by LxN supra-adjacency matrix with diagonal blocks encoding intralayer connectivity for each modality and off-diagonal blocks encoding interlayer connectivity. Supra-adjacency matrices are then exported to Python and multilayer nodal EC is calculated.

<https://github.com/multinetlab-amsterdam/data_analysis/tree/Multilayer/Multilayer>

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defining a subnetwork: FPN

L\_IPL/R\_IPL, left/right inferior parietal lobule; L\_MidFG/R\_MidFG, left/right middle frontal gyrus: preC, postC, paraC.