Time-varying directed networks from EEG signals

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Complex network theory has been largely used in neuroscience, where brain networks are typically constructed from either anatomical and functional neuroimaging data. Brain networks in healthy subjects have been demonstrated to exhibit non-trivial topological properties related to optimal information processing, i.e. small-world, scale-free, etc. whereas diseased brains typically show a critical deviation from such optimal architectures. The large part of these brain networks were constructed by integrating information over a relatively long time period (in the order of seconds), thus neglecting the transient connectivity changes, which in the case of task performances could instead reveal critical dynamics. In the present work, we propose a method to construct time-varying brain networks from EEG signals by means of recursive Kalman-based Granger causality estimates. The method is then validated on a group of healthy subjects during a motor task performance to reveal the brain network dynamical changes at a very high temporal resolution. Results showed that during the preparation of the movement the brain network showed a transient economical small-world property reflecting an optimal balance between topological organization and connection density.

Multiple opinion leaders in a multi-layer social network

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The social network in which individuals are enmeshed influence their opinion formation and therefore their political choices. For this reason it has been a classic theme of research in sociology and political science. Here we identify opinion leaders in an online social network and observe that their impact on users changes in function of the social interaction considered. To that effect we can understand the online social network as a multi-layer network, where at each layer a different interaction takes place. We observe that different opinion leaders emerge at each level highlighting the need to consider all the different interactions when studying such social networks.