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Asymmetric random matrices: What do we need them for?

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Complex systems are typically represented by large ensembles of observations. Correlation matrices provide an efficient formal framework to extract information from such multivariate ensembles and identify in a quantifiable way patterns of activity that are reproducible with statistically significant frequency compared to a reference chance probability, usually provided by random matrices as fundamental reference. The character of the problem and especially the symmetries involved must guide the choice of random matrices to be used for the definition of a baseline reference. For standard correlation matrices this is the Wishart ensemble of symmetric random matrices. The real world complexity however often shows asymmetric information flows and therefore more general correlation matrices are required to adequately capture the asymmetry. Here we first summarize the relevant theoretical concepts. We then present some examples of human brain activity where asymmetric time-lagged correlations are evident and hence highlight the need for further theoretical developments.

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