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Statistically validated hypergraphs

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In many real-world systems, successfully represented as networks, interactions are not limited to dyads, but often involve three or more nodes at a time. Under this condition, a better description of the system is given by hypergraphs, where hyperlinks encode higher-order interactions among a group of nodes. We discuss an analytic and computational approach to filter hypergraphs by identifying those hyperlinks that are over-expressed with respect to a random null hypothesis and represent the most relevant higher-order connections [1]. We apply our method to a class of synthetic benchmarks and to several datasets, showing that the method highlights hyperlinks that are more informative than those extracted with pairwise approaches. We also discuss a method for the detection of Statistically Validated Simplices. Statistically validated simplices represent the maximal sets of nodes of any size that consistently interact collectively and do not include co-interacting nodes that appears only occasionally [2].

[1] Musciotto, F., Battiston, F. and Mantegna, R.N., 2021. Detecting informative higher-order interactions in statistically validated hypergraphs. Communications Physics, 4(1), pp.1-9.
[2] Musciotto, F., Battiston, F. and Mantegna, R.N., 2022. Identifying maximal sets of significantly interacting nodes in higher-order networks. arXiv preprint arXiv:2209.12712.

Joint work with Federico Musciotto and Federico Battiston

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