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Consistently weighted measures for complex network topologies

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Most measures of the structural and topological properties of a complex network are of a combinatorial nature, basically counting certain nodes, edges, triangles, paths, etc. But the typically finite set of nodes of the studied network is often either explicitly or implicitly considered representative of a much larger finite or infinite set of objects of interest, either by being a subset of this larger set or by being some kind of discretisation or aggregation of it. Examples are networks consisting of a statistically sampled number of members of a large social or scientific community, networks of discrete regular grid points on a surface or of irregular mesh cells in some manifold, or networks constructed from recurrence plots of time series with regular or irregular time intervals. This selection procedure typically results in individual nodes of the studied network representing quite differently sized regions of the domain of interest, inducing substantial biases in derived network statistics.

To avoid these problems, we propose an axiomatic scheme based on the idea of *node splitting invariance* to derive consistently weighted variants of various commonly used statistical network measures which approximate the corresponding properties of the underlying domain of interest. The practical relevance and applicability of our approach is demonstrated for the example of climate networks — networks constructed from climate data on grids with heterogenous mesh cell areas.