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Grand canonical ensemble of heterogeneous weighted networks

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In the last years the formulation of statistical ensembles of binary and weighted random graphs satisfying some arbitrary constraints has attracted much attention in phys/math communities for its two-fold potential application [1, 2]: (i) The construction of appropriate null models for the statistical validation of high order properties of real networks; (ii) the reconstruction of the statistical properties of real network starting for partial accessible information. The cornerstone of the statistical physics of complex networks is the idea that the links, and not the nodes, are the effective particles of the system. Here we formulate a mapping between weighted networks and lattice gasses, making the conceptual step forward of interpreting weighted links as particles with a generalised coordinate [3]. This leads to the definition of the grand canonical ensemble of weighted complex networks. We derive exact expressions for the partition function and thermodynamic quantities, both in the cases of global and local (i.e., node-specific) constraints on density and mean energy of particles. We further show that, when modeling real cases of networks, the binary and weighted statistics of the ensemble can be disentangled, leading to a simplified framework for a range of practical applications.

References

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