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Finite Size Effects and Symmetry Breaking in the Evolution of Networks of Competing Boolean Nodes[1] KEVIN BASSLER, MIN LIU, University of Houston — The effects of finite network size on the evolutionary dynamics of a Boolean network are analyzed. In the model considered, Boolean networks evolve via a competition between nodes that punishes those in the majority. Finite size networks evolve in a fundamentally different way than infinitely large networks do. The symmetry of the evolutionary dynamics of infinitely large networks that selects for canalizing Boolean functions is broken in finite size networks. In finite size networks there is an additional selection for input inverting Boolean functions. Classes of functions are found empirically to evolve with the same frequency. The classes depend on the symmetry of the evolutionary dynamics and correspond to orbits of the relevant symmetry group. The empirical results match analytic results, determined by utilizing Polya's theorem, for the number of orbits expected in both finite size and infinitely large networks. The reason for the symmetry breaking is due to the need for nodes in finite size networks to behave differently in order to cooperate to collectively perform efficiently. The results suggest that both finite size effects and symmetry are important for understanding the evolution of real-world complex networks, including genetic regulatory networks.

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