Inherent directionality explains the lack of feedback loops in empirical networks

Virginia Domínguez-García[1],Simone Pigolotti[2] and Miguel A. Muñoz[1]
[1]Departamento de Electromagnetismo y Física de la Materia and Instituto Carlos I de Física Teórica y Computacional, Universidad de Granada, 18071 Granada, Spain
[2]Departament de Fisica i Enginyeria Nuclear, Universitat Politecnica de Catalunya, Rambla Sant Nebridi s/n, 08222 Terrassa, Barcelona, Spain.

We explore the hypothesis that the relative abundance of feedback loops in many empirical complex networks is severely reduced owing to the presence of an inherent global directionality. Aimed at quantifying this idea, we propose a simple probabilistic model in which a free parameter γ controls the degree of inherent directionality. Upon strengthening such directionality, the model predicts a drastic reduction in the fraction of loops which are also feedback loops. To test this prediction, we extensively enumerated loops and feedback loops in many empirical biological, ecological and socio-technological directed networks. We show that, in almost all cases, empirical networks have a much smaller fraction of feedback loops than network randomizations. Quite remarkably, this empirical finding is quantitatively reproduced, for all loop lengths, by our model by fitting its only parameter γ. Moreover, the fitted value of γ correlates quite well with another direct measurement of network directionality, performed by means of a novel algorithm. We conclude that the existence of an inherent network directionality provides a parsimonious quantitative explanation for the observed lack of feedback loops in empirical networks [1].

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