Matlab Programs

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Degree-preserving random rewiring and correlation profile of a complex network

MATLAB programs

To generate a randomized null-model network in which the degrees of all nodes are strictly preserved use:

- For a directed network use dir_generate_srand.m
- For undirected network use sym_generate_srand.m

To calculate the correlation profile quantifying degree-degree correlations use:

- For a directed network use dir_correlation_profile.m
- For undirected network use sym_correlation_profile.m

The science behind these algorithms

In our 2002 paper Kim Sneppen and I proposed a numerical algorithm that constructs a null-model of a given complex network preserving the degrees (numbers of immediate neighbors) of each of its nodes. Such randomized counterpart of a given complex network can be used to identify its important non-random topological patterns, which are significantly over- (or under-) represented in the real network compared to this null-model. The algorithm implemented in dir_generate_srand.m and sym_generate_srand.m consists of repeated application (4 x (number of edges) times) of the elementary rewiring step shown below:

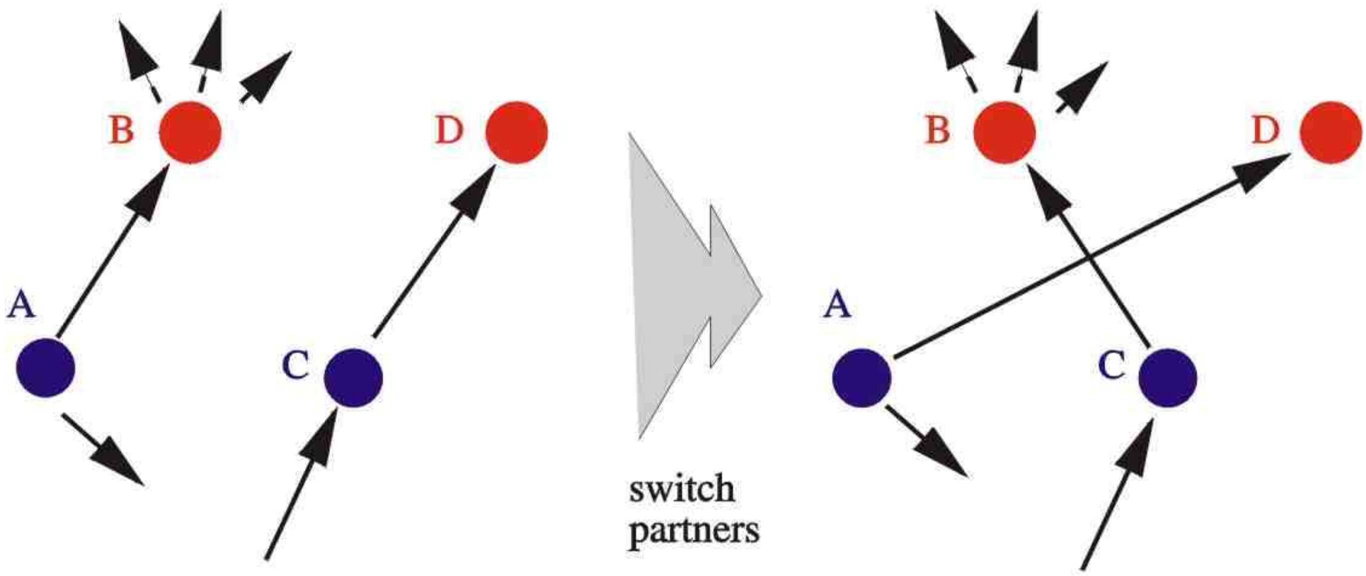

Figure 1. A pair of directed edges A ->B and
C -> D is randomly selected. These edges are then rewired
in such a way that A becomes connected to D, while C to B,
provided that none of these edges already exist in the network,
in
which case the rewiring step is aborted and a new pair of edges
is
selected. Note that the above rewiring algorithm conserves
both the in-
and out- connectivity of each individual node

Degree-degree correlations in the network are quantified by what we call its correlation profile. It measures if nodes of a given degree K_1 prefer (or, alternatively, avoid) to connect to nodes of another degree K_2 . The idea is to compare the number of edges $N(K_1,K_2)$ connecting any pair of nodes with degrees K_1 and K_2 in the real complex network and its randomized version $N_r(K_1,K_2)$. Deviations from the null-model manifest themselves in the ratio: $R(K_1,K_2)=N(K_1,K_2)/\overline{N}_r(K_1,K_2)$. In the pseudocolor plots generated by dir_correlation_profile.m or sym_correlation_profile.m they are visible as orange/red and blue/green areas. The statistical significance of these deviations is quantified by the Z-score: $Z(K_1,K_2)=(N(K_1,K_2)-\bar{N}_r(K_1,K_2))/\mathrm{sigma}(K_1,K_2)$, where $\mathrm{sigma}(K_1,K_2)$ is the standard deviation of $N_r(K_1,K_2)$ in many realizations of the randomized network.