Optimal Network Modularity For Fast Global Information Diffusion

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Objective

Here we study how network structure affects the time needed for a large cascade to affect all the agents in a network.

Especially, we study whether modular structure can expedite the difussion of information in a scenario of complex contagion.

Linear Threshold Model

Information can diffuse more quickly in Large Network due to easier multiple exposure.

$s_i : 0, 1$

k_i : Degree of node i

θ : Adoption threshold

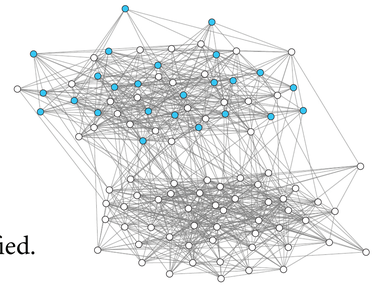
$N(i)$: The set of node i neighbors

$$s_i(t+1) = \begin{cases} 1 & \text{if} \quad \theta k_i < \sum_{j \in \mathcal{N}(i)} s_j(t), \\ 0 & \text{otherwise,} \end{cases}$$

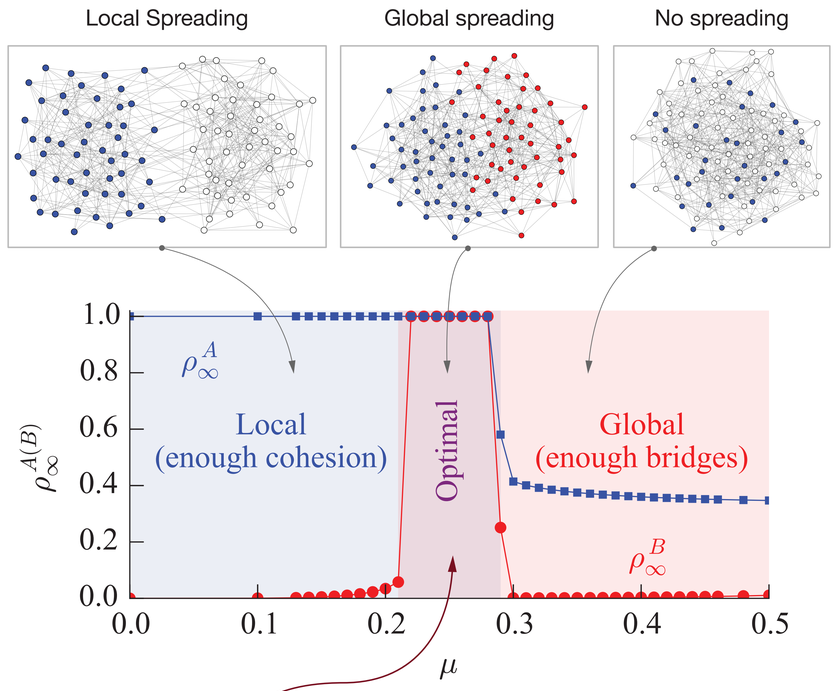
Dynamics

A fraction ρ_0 of randomly selected agents, is initialized in the active state.

A synchronous update of each node if the adoption threshold condition is satisfied.

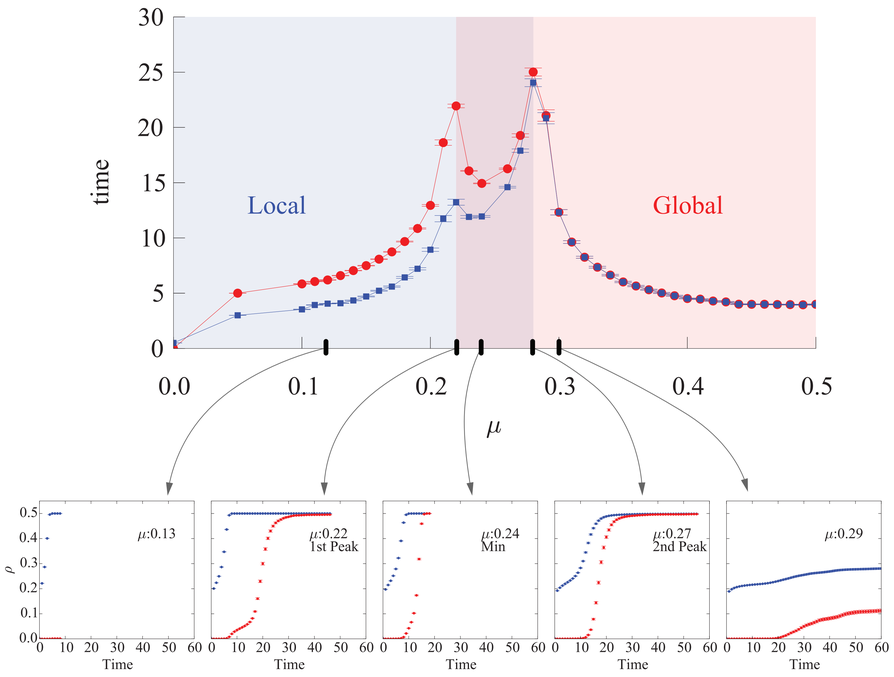


Intra-community vs. Inter-community



In the optimal regime:
Modularity is strong enough to initiate the local spreading and weak enough to induce inter-community spreading.

How long does it take a newly introduced complex contagion to diffuse into a entire network?



Within optimal regime, we show that it is possible to fine-tune the modularity to achieve minimun spreading time.

The time-minimizing modularity is such to provide sufficient internal links in the originating community to generate a fast wide cascade within such community, and sufficient external links to initiate and support a wide cascade in the rest of the network.