Data Simulation Algorithm For Hierarchical Networks

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Simulating The Network

1. Generate the top layer Graph:

1.1 initiate the graph of the top layer (i.e ℓ^{th} layer) consisting of n_ℓ nodes.

If the top layer is fully connected:

1.1.1 Generate a Wattz Strogratz graph with n_ℓ nodes. Each node is connected to its n_ℓ nearest neighbors and with probability p_ℓ of rewiring. This yields a graph $\mathcal{G}_\ell = \{E, V\}$ with edges $E = \{e_{ij}\ \forall\ i \neq j\}$ and nodes $V = \{n_i\}_{i=1}^{n_\ell}$

If the top layer is disconnected:

1.1.2 Generate a graph of n_ℓ nodes with no edges. This yields a graph $\mathcal{G}_\ell = \{E, V\}$ where $E = \emptyset$ and $V = \{n_i\}_{i=1}^{n_\ell}$

2. For the remaining $\ell - 1$ layers in the hierarchy:

For each node in $\mathcal{G}_\ell$:

2.1 Generate a small world, scale free, or random subgraph $\mathcal{G}_{\ell-1}$ with $m \sim$ Uniform(a, b) nodes:

If the subgraph is a small world graph:

$\mathcal{G}_{\ell-1}$ is generated as a Watts Strogatz graph with m nodes where each node is connected to its k nearest neighbors and with probability of rewiring $p_{\ell-1} = p_\ell/(\frac{1}{2}a + b)$

If the subgraph is a random graph:

$\mathcal{G}_{\ell-1}$ is generated as a Erdős-Rényi graph with m nodes and $E \sim$ uniform(a, b) edges

If the subgraph is a scale free graph:

$\mathcal{G}_{\ell-1}$ is generated as a Barabási-Albert graph with m nodes and $g \sim$ uniform$(2, m-1)$ possible edges for each node