UNIVERSITAT POLITÈCNICA DE VALÈNCIA

VRAIN
Valencian Research Institute for Artificial Intelligence

Agent-Based Simulation in Complex Networks

ESSAI 2024. Athens

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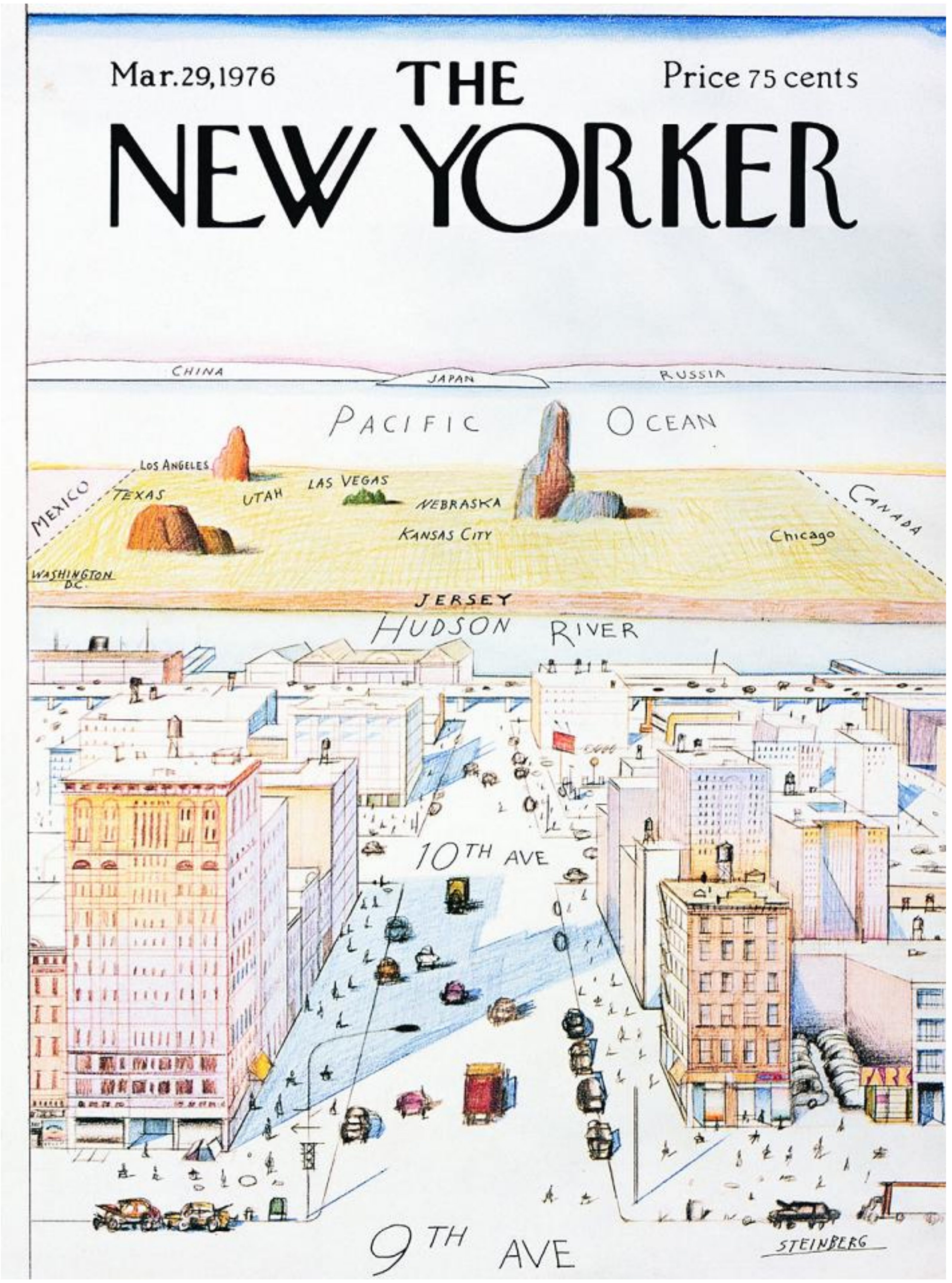
Session 3. Centrality

Searchability



Kleinberg proved that, besides these short paths exists, furthermore, people can locate this paths using only their local information.

Searchability

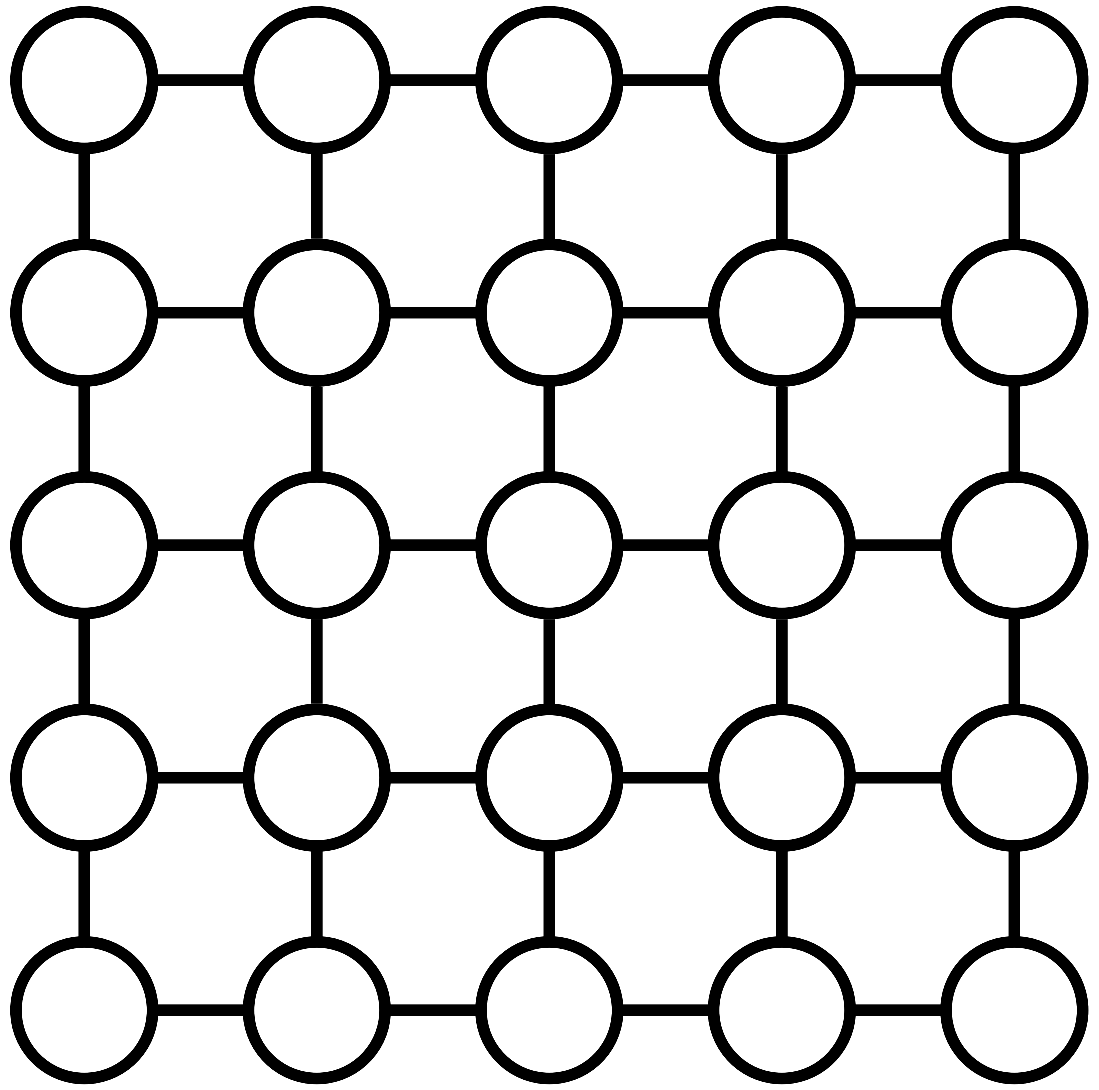
It begins with a regular, 2-d lattice and add q long-range edge at random with a probability proportional to the Manhattan distance

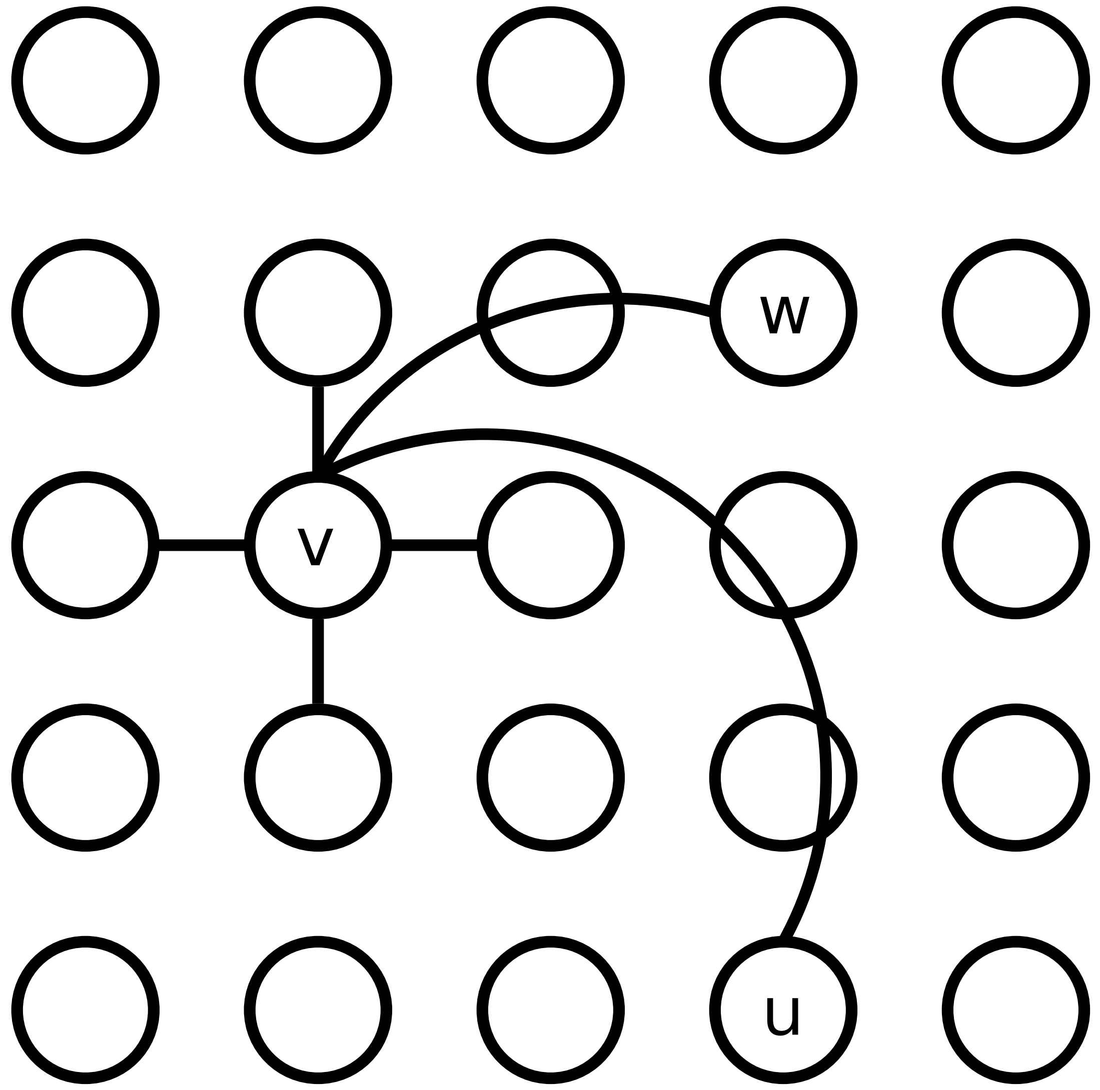
The network shows

- short path lengths

- searchability (distance)

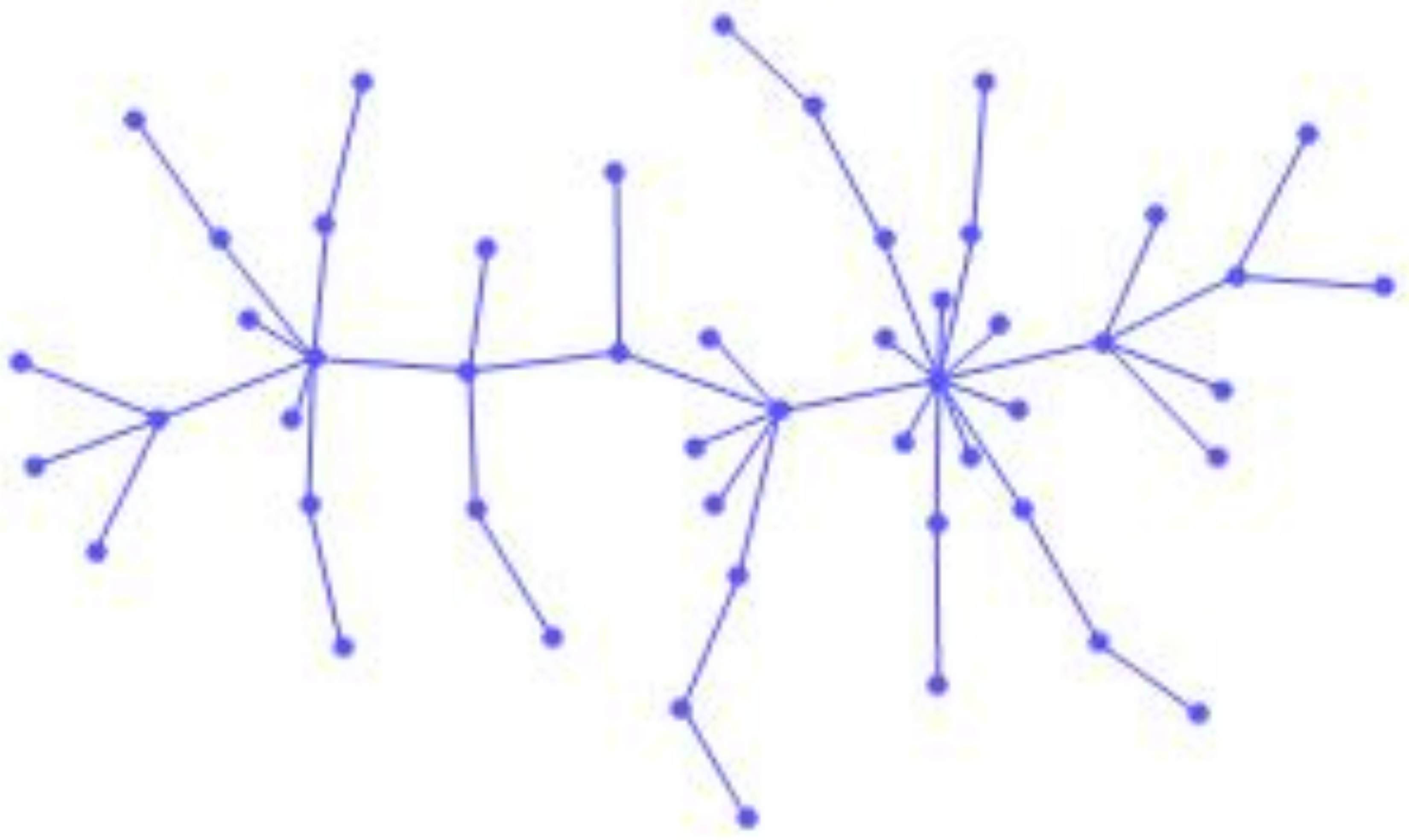
. . . but a low clustering

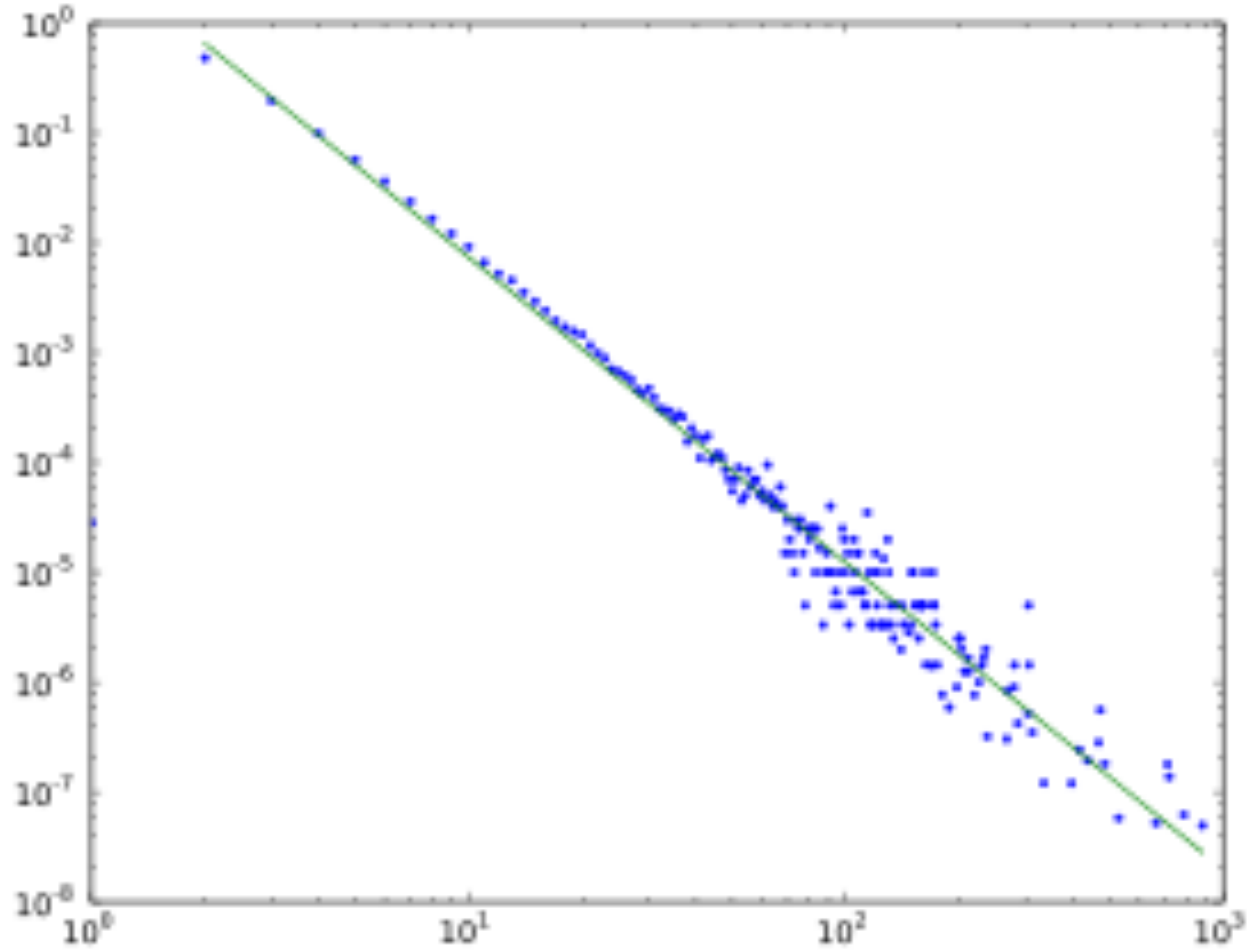




Preferential attachment (Barabasi & Albert)

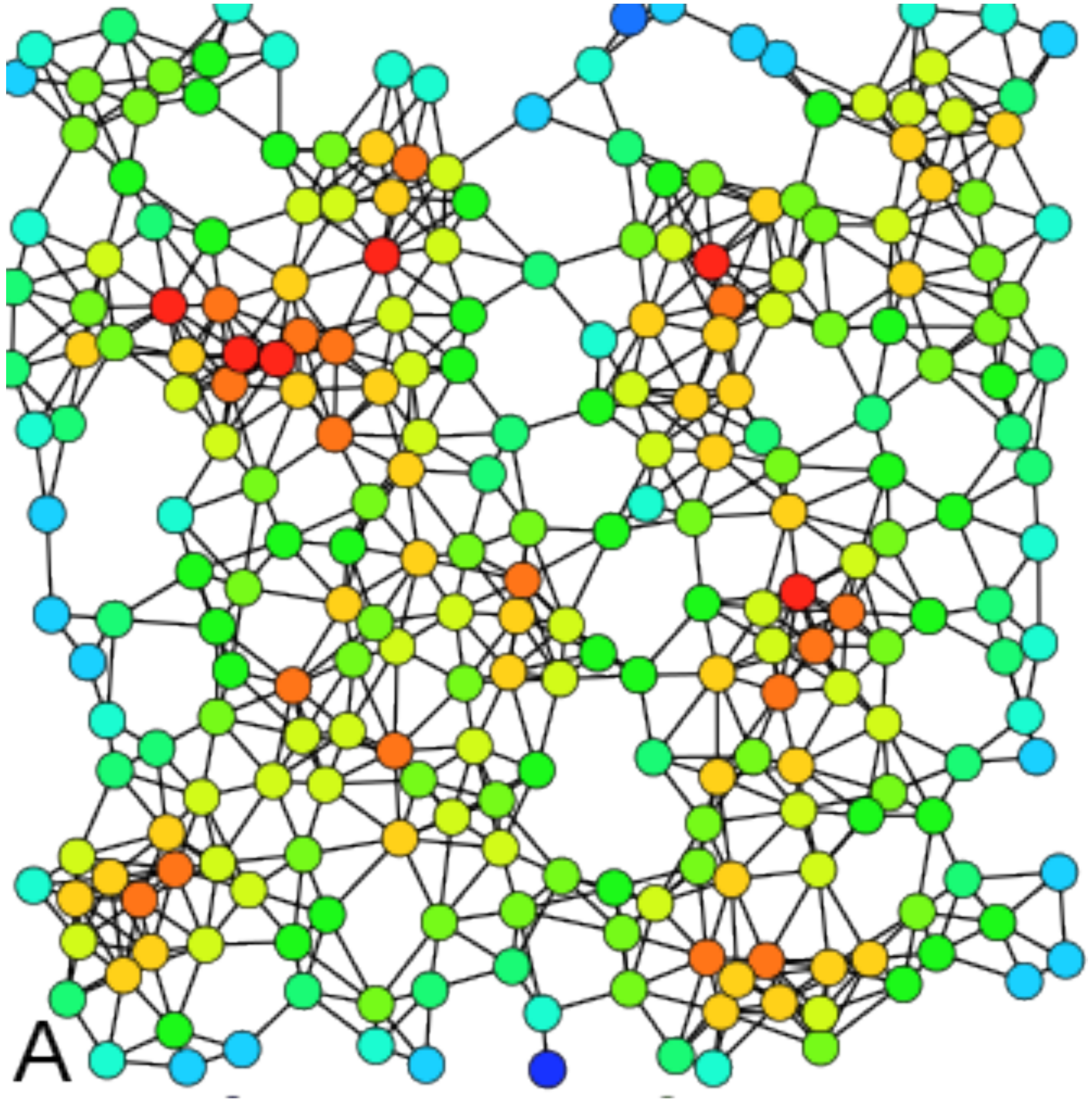
It begins with a regular, 2-d lattice and add q long-range edge at random with a probability proportional to the Manhattan distance





high clustering, but dependent on the network size
short path lengths
power law degree distribution $p(k) \sim k-\alpha$, $2 < \alpha < 3$
Matthew effect (the richest get richer)

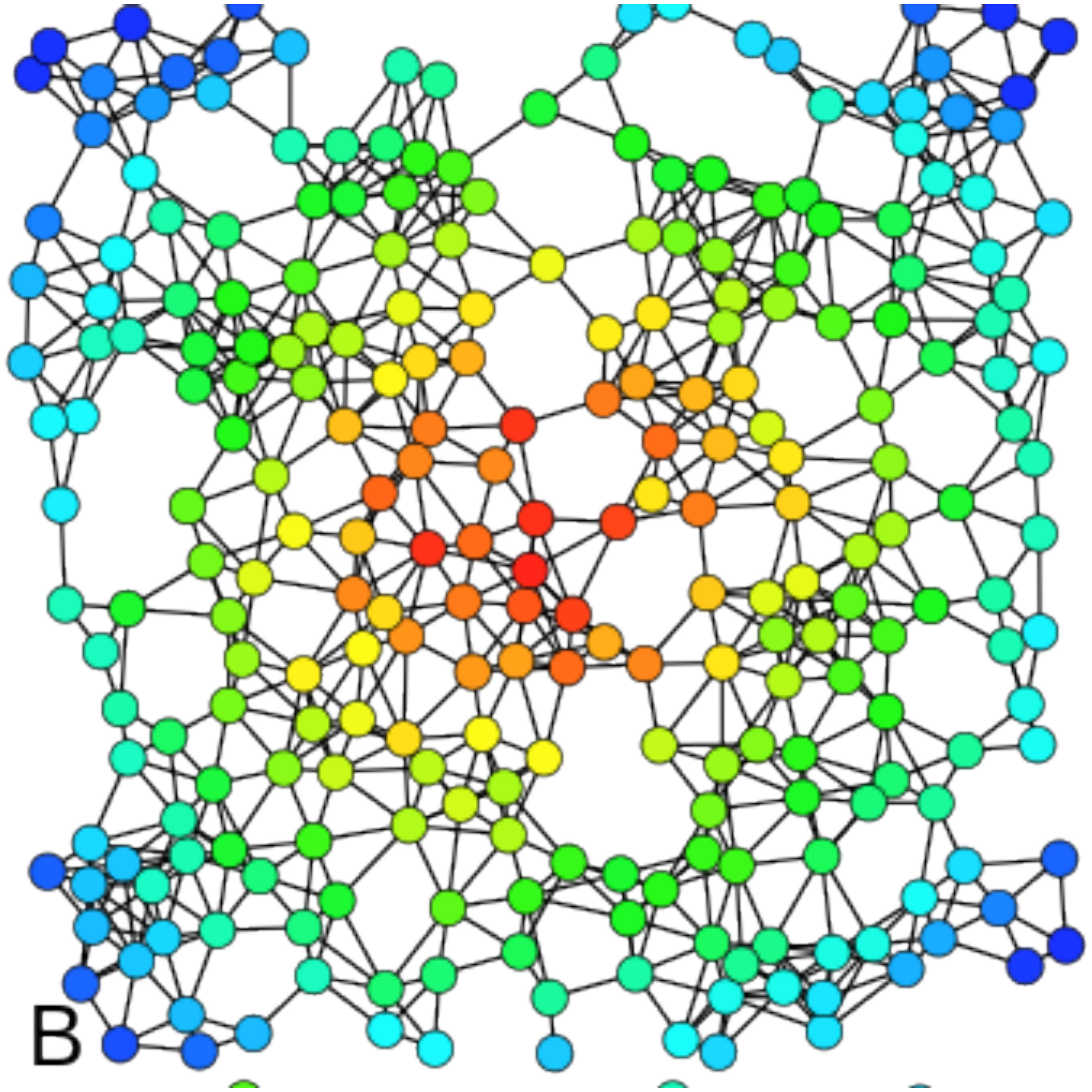
Centrality. Degree



The importance of a node in the network depends on its degree

$$C_D(i) = d_i$$

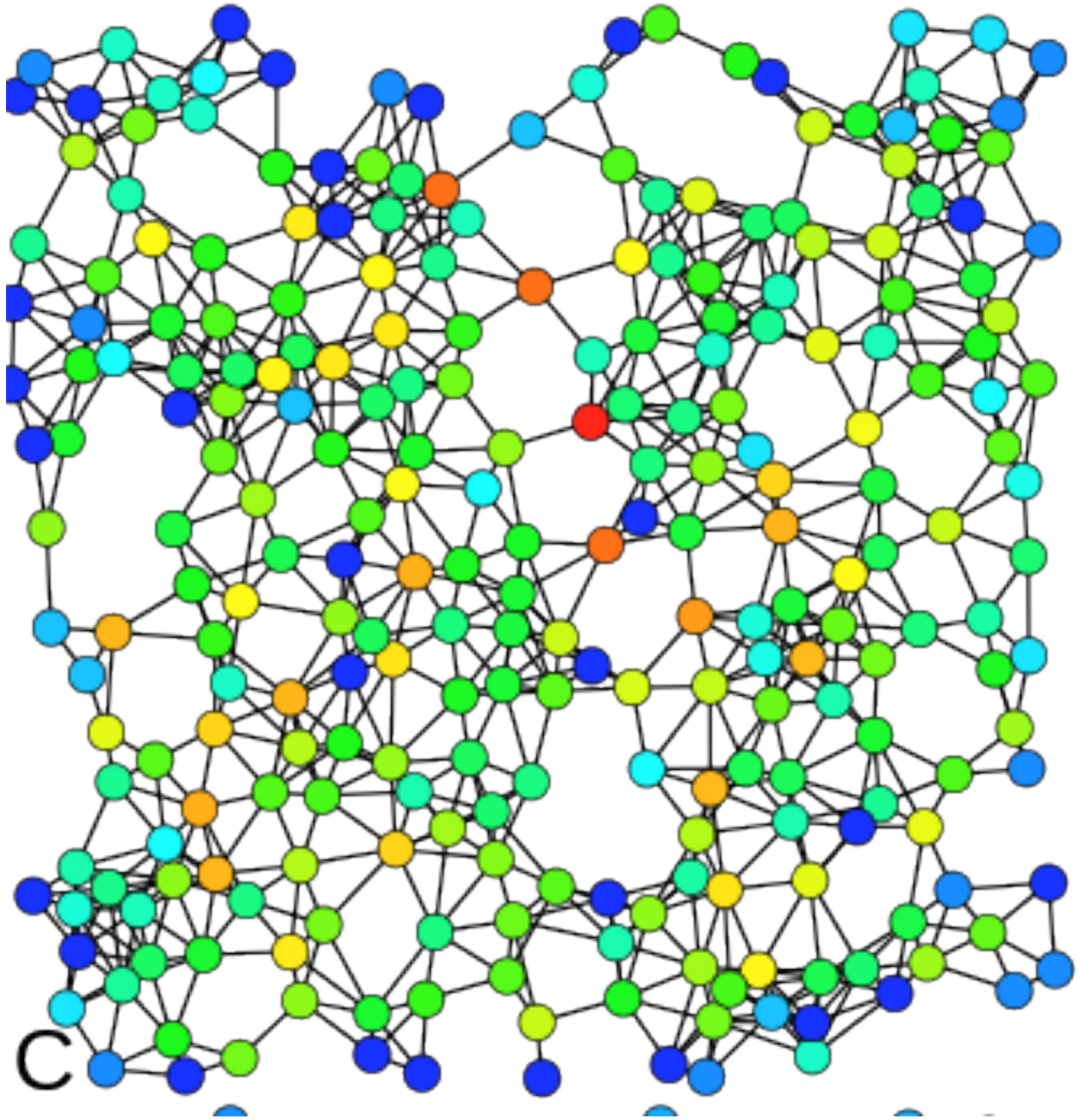
Centrality. Closeness



The most central node is the nearest one to any other node

$$C_C(i) = \frac{1}{\sum_{j \neq i} d(i,j)}$$

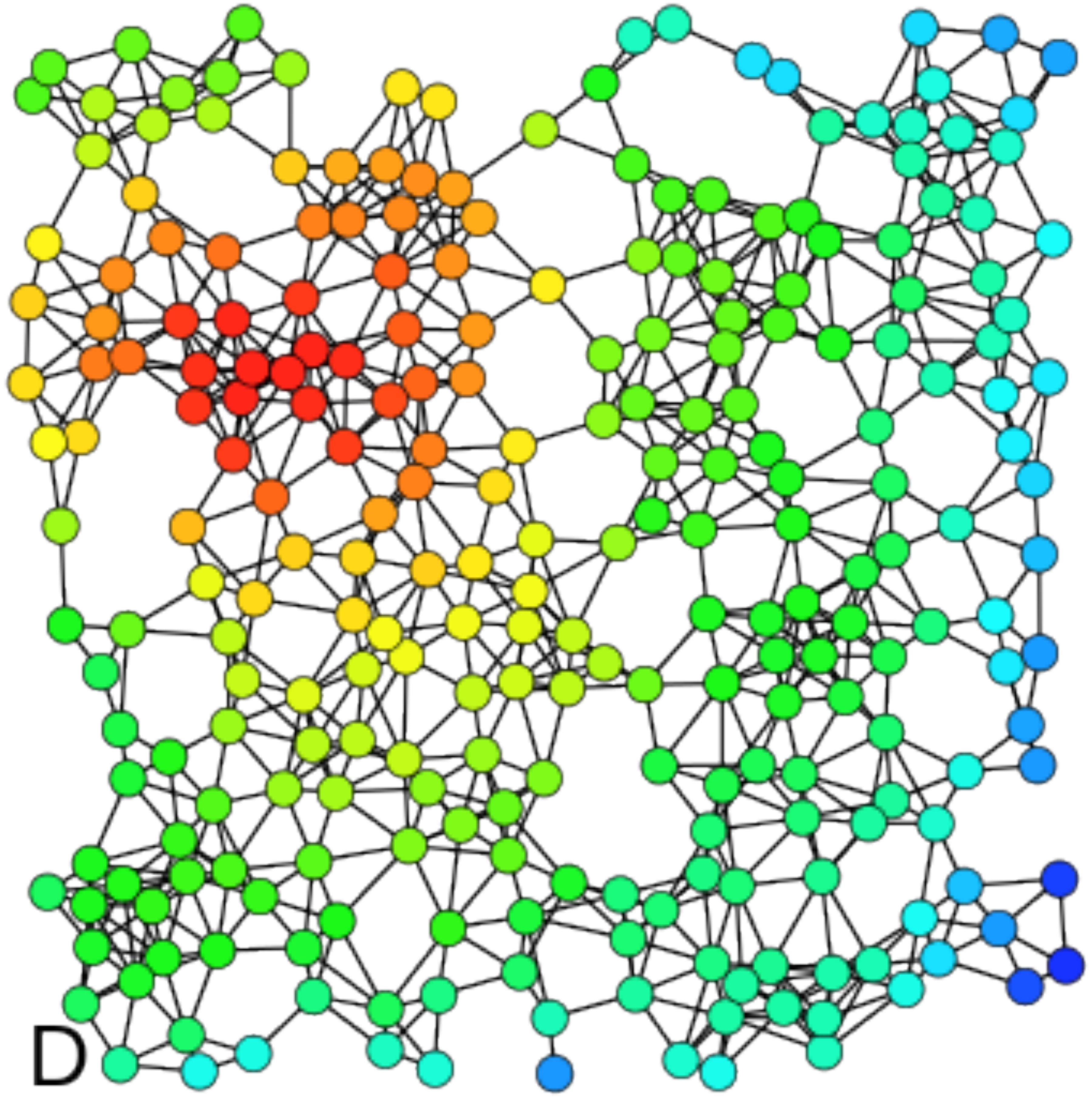
Centrality. Betweenness



The importance of a node in the network depends on how many shortest paths pass through it (bridge)

$$C_B(i) = \sum \frac{\#shortestpaths_{st}(i)}{\#shortestpaths_{st}}$$

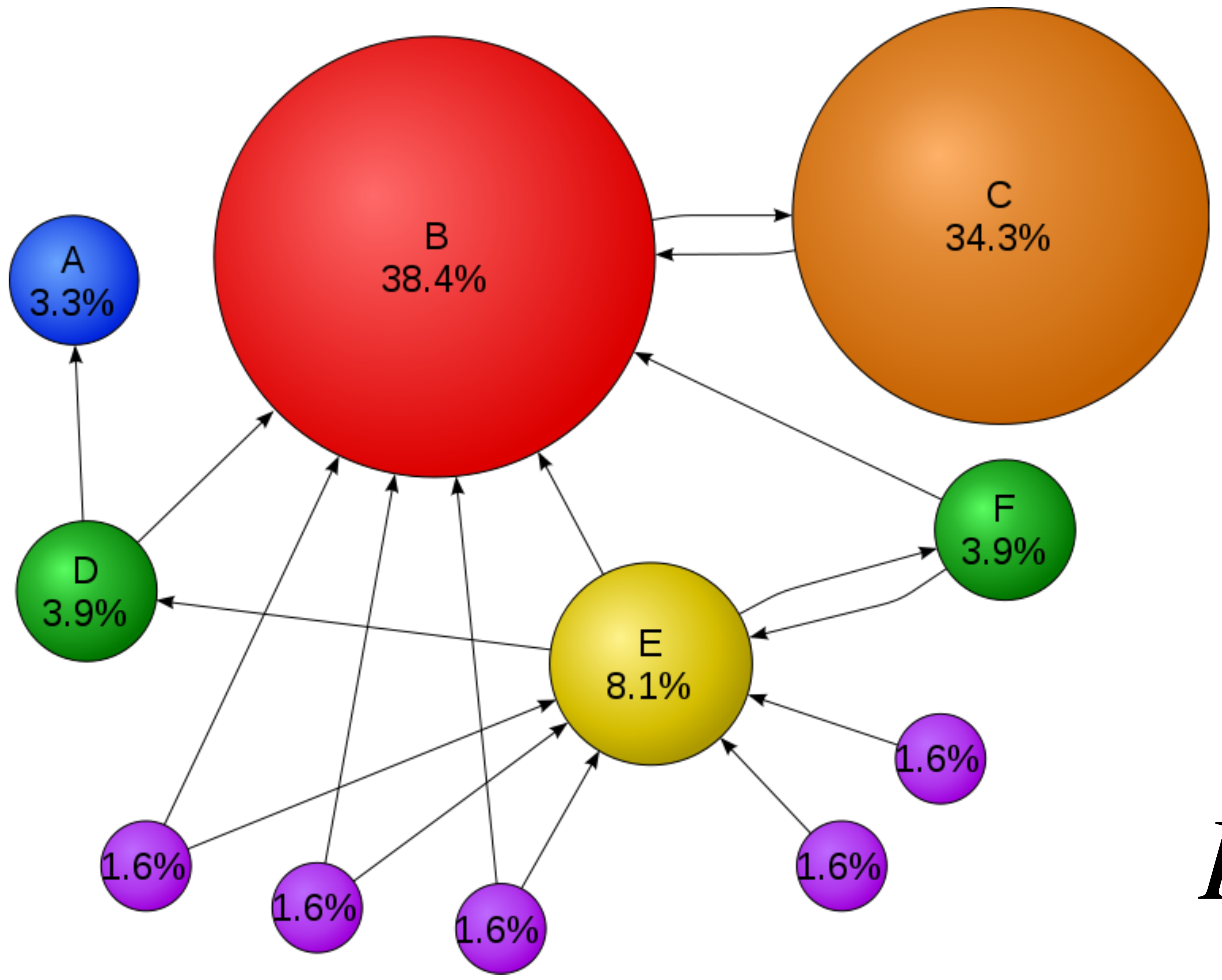
Centrality. Eigenvalue



The importance of a node depends on the importance of its neighbors

$$C_E(i) = \frac{1}{\lambda} \sum_{j \in N(i)} C_E(j)$$

Centrality. Pagerank



An special case of eigenvalue centrality.

Used by Google to rank the importance of web pages.

$$PR(i) = \frac{1-d}{N} + d \sum_{j \in N(i)} \frac{PR(j)}{d_j)}$$