

Paper to Read

Social Networks 33 (2011) 88–97



Contents lists available at ScienceDirect

Social Networks

journal homepage: www.elsevier.com/locate/socnet



Spine segments in small world networks

Noah E. Friedkin*

Department of Sociology, University of California, Santa Barbara, CA 93107, United States

ARTICLE INFO

Keywords:
Small worlds
Networks

ABSTRACT

Investigations of small world contact networks, defined as networks with a short characteristic path length and a substantial local clustering of contacts in the neighborhood of each node, have emphasized the process performance of such networks. The argument that large-scale, small world, contact networks are structures with startlingly efficient process performance is premised on the existence of shortcuts, without which the characteristic path lengths of the networks would be substantially larger. No doubt, given a high probability of transmission in each contact of a network, such shortcuts are a potential structural basis of reliable flows of information, influence, material and disease. However, interpersonal

Introducing

- Noah Friedkin, Department of Sociology, University of California, Santa Barbara
- Title: Spine segments in small world networks
- Social Networks, Volume 33, Issue 1 (January 2011), pp.88–97

Thesis of paper

- Investigation of large-scale groups... with works on small-world contact networks
- Particular structural features of large-scale networks enable **reliable** transmission...

While acknowledging the Watts-Strogatz model...

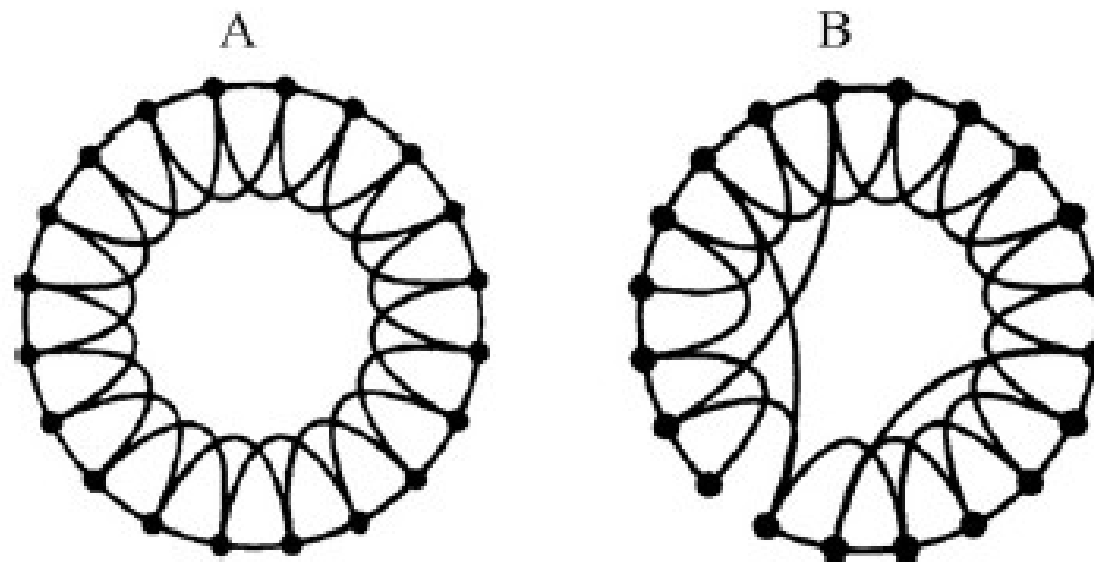


Fig. 1. Watts-Strogatz small-world ring. (A) Each node is situated in a maximal complete clique of size 3 that intersects with two other cliques, based on two shared nodes, in single cycle of intersections. (B) The result of a constrained random rewiring of the edges of (A). The number of nodes of the ring, here 20, and number of shortcuts, here 3, may both be increased to generate a large-scale small-world network.

The author argues that...

- While the shortcuts provides **efficient** communication channels between different parts of a system...
- the reliability of such links is called into question.
- When a fixed contact networks is assumed, whether performance of transmission is "ambiguous" (p.89)

Counter argument...

- citing Granovetter 1973: that average edge of the cliques of contact network is more reliable than the shortcut edge
- empirically edges of small-world networks are clustered
- therefore, pointing to implication of edge-failure probabilities and path redundancies.

Reachability Matrix

- Valued network with edge values being probability whether active or inactive transmission.
- Matrix showing node i either reaches node j or not. The expectation that i reaches j being:

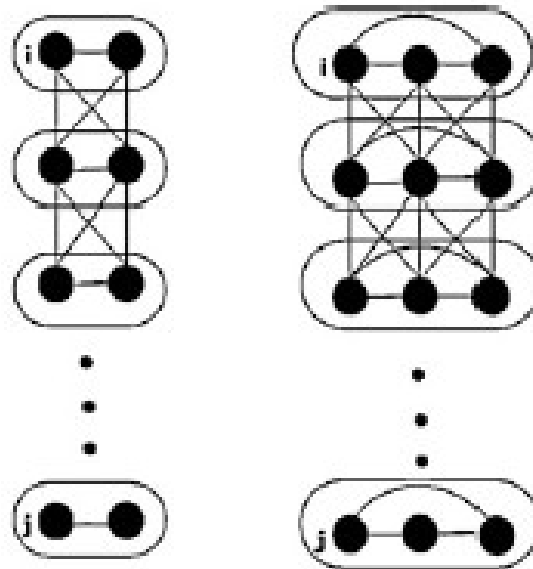
$$\rho_{ij} = \sum_{\mathbf{x}: \phi(\mathbf{x})=1} \prod_{i=1}^{|E|} \pi^{x_i} (1 - \pi)^{1-x_i}$$

Idealized structure...

- **Spine segments** that occur in a graph in which all pairs of nodes at distance > 2 are joined by sequentially intersecting cliques.
- citing Johnsen 1985, and White et al 1976
- citing earlier work (Friedkin 1998) sequential intersections are denoted as spines of ridge structure... shortcuts as structural anomalies.

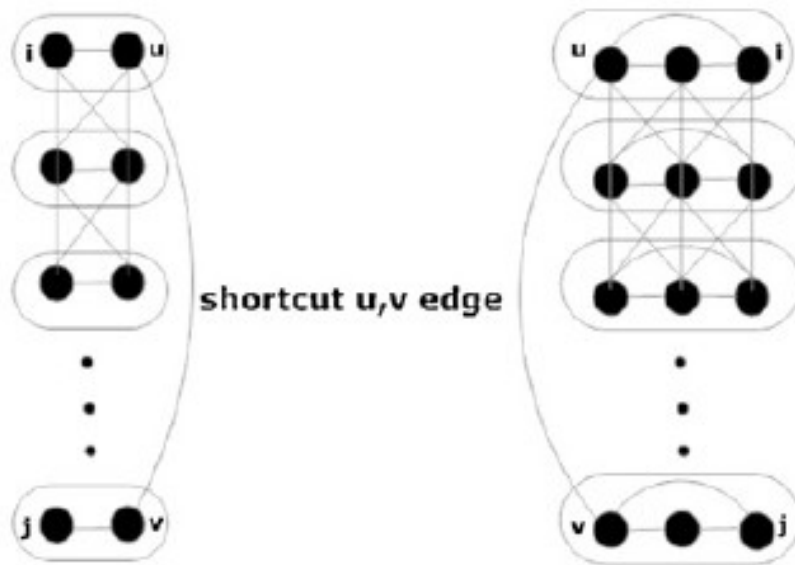
Spine segments

A



Note. Each oval is a position that is occupied by two or more nodes, and the edges are the contacts among these nodes. The inter-position bonds are the complete edge sets (one-blocks in the network's blockmodel) that directly link nodes located in two positions.

Nature of shortcuts (p.92)



- Shortcuts are structural anomalies in the graph of R (sequentially intersecting cliques)...
- end points of shortcut are not structurally equivalent with the nodes

On simulation results...

- all things being equal, as probability of edge failure decreases, the PTS (parallel transmission subsystem, inside the spine segment) reliability value increases
- and, as path redundancy increases, so does the PTS reliability value (in relative terms)

Concluding...

- theoretical importance of clustering as great as shortcuts in small world networks (p.93)
- when local clustering generates a sequence of intersecting cliques, then path redundancy is an implicated structural feature of such sequences (p.93)
- citing Granovetter 1973: research in "local bridges" does not support the emphasis placed on shortcut

Remarks...

- The graphic adjacency of nodes in the helix representation does not imply spatial proximity
- The helices with a backbone that competes with their edge sets could take either 2-dimensional, 3-dimensional (and higher dimension?) form.
[p.94]
- The compact helix form is suggestive when reliability of transmission among elementary nodes is important.

Algorithm ...

- The model being proposed is NP-complete.
(Stating this as obvious, not exactly proving this, on p.95 Appendix A)
- Suggest a random algorithm and showing that the values in the reliability matrix actually converge.

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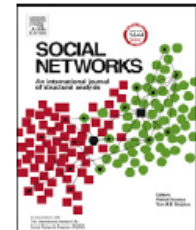
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