

Power in Networks

By Valdis Krebs

They say the golden rule in Real Estate is: *Location, Location, Location*. Might this rule also hold in social networks? In real estate, location is determined by geography – your *physical* location. In social networks, location is determined by your connections and the connections of those around you – your *virtual* location.

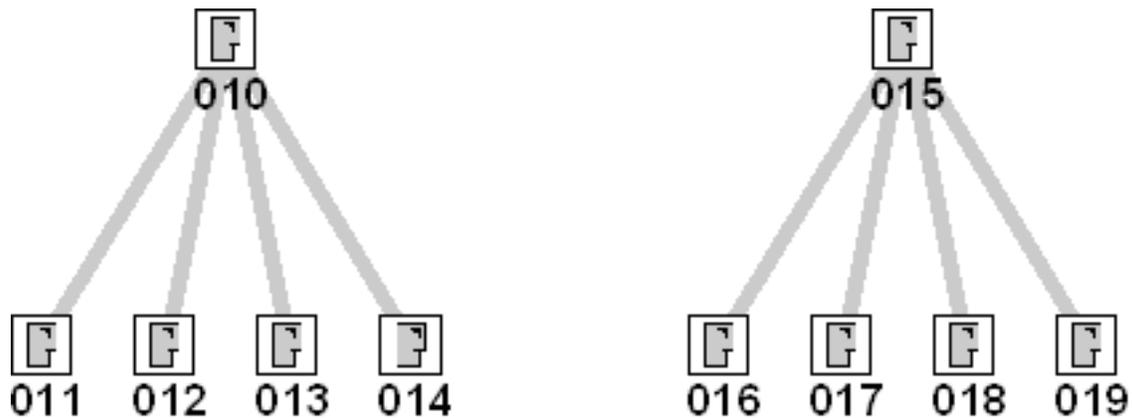
Two social network measures, Betweenness and Closeness, are particularly revealing of a node's advantageous or constrained location in a network. The values of both metrics are dependent upon the pattern of connections that a node is embedded in. Betweenness measures the *control* a node has over what flows in the network – how often is this node on the path between other nodes? Closeness measures how easily a node can *access* what is available via the network – how quickly can this node reach all others in the network? A combination where a node has easy access to others, *while* controlling the access of other nodes in the network, reveals high *informal power*.

We will look at a simple human network and watch how power changes in the network based on connections made and lost in the network over time.

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Below are two groups – A and B, each organized as a hierarchy. A node represents a person in each group. A grey line indicates the prescribed structure of the organization – the formal network or hierarchy. All information and resources flow through each group’s leader – nodes 010 and 015. Measuring each node’s Power, our *InFlow*TM software reveals the obvious. Each leader is in complete control of their group – they each have a perfect Power score of 1.00. We see two equivalent groups – same size, same structure.



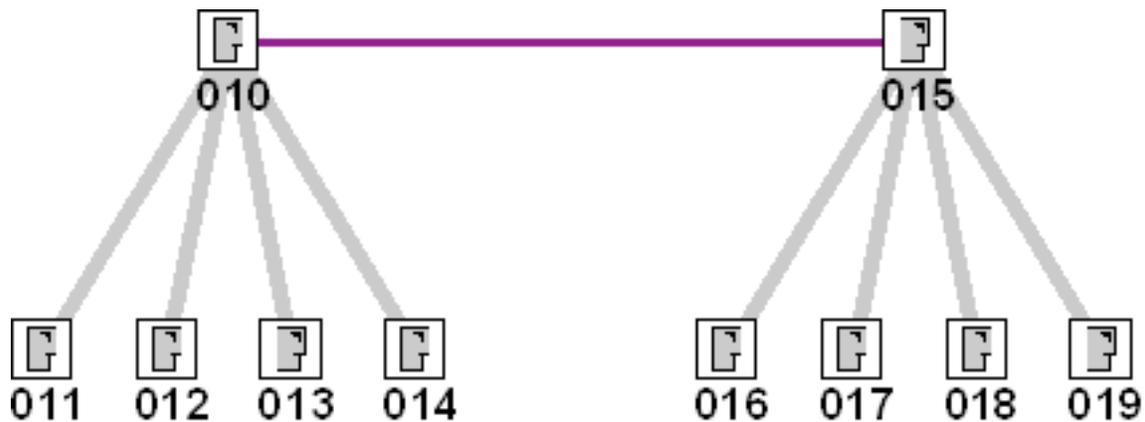
Group A : Power		Group B : Power	
<u>Score</u>	<u>Node</u>	<u>Score</u>	<u>Node</u>
1.000	010	1.000	015
0.286	011	0.286	016
0.286	012	0.286	017
0.286	013	0.286	018
0.286	014	0.286	019

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Scenario One

The leaders decide to form a tie between themselves for possible collaboration, or exploitation. By creating this informal tie [purple line], each leader can now monitor the other group. Each leader remains dominant over their respective group and neither leader loses power relative to the other – they have equal power scores. Yet, both leaders have lost some power by joining their groups! Before they had total dominance over the group they ruled. Now they share equal dominance over a larger group. Collaboration can reduce individual dominance. Notice that *everyone's* power decreases! Information flow is less constrained and therefore everyone has *less* control over it.

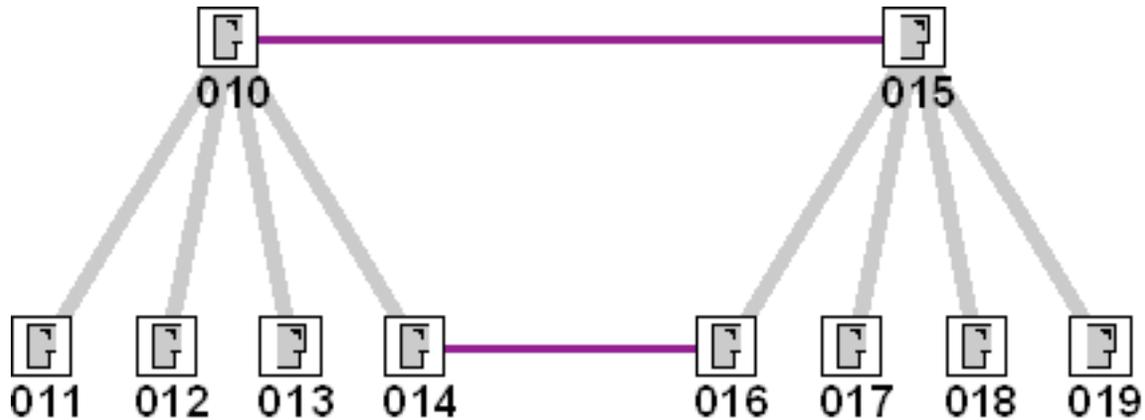


Power	
Score	Node
0.707	010
0.707	015
0.214	011
0.214	012
0.214	013
0.214	014
0.214	016
0.214	017
0.214	018
0.214	019

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Unbeknownst to the leaders another connection emerges between their groups. Person 016 of Group B befriends person 014 of Group A. Soon information is flowing along this link also.



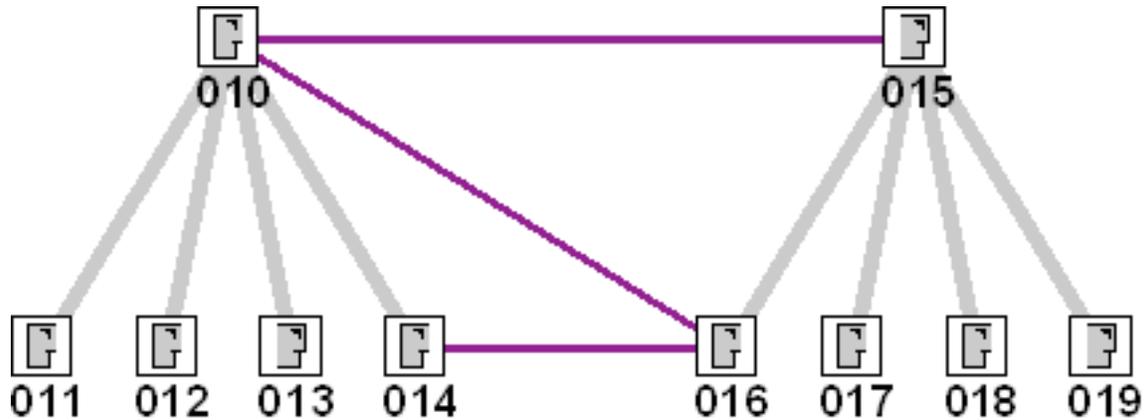
This new link, between formerly separate groups, increases the power for both nodes that create this bridge – though ever so slightly. Also, the leaders’ grasp on power is reduced – at a similarly imperceptible rate. The change is not noticed other than by 014 and 016.

Power	
Score	Node
0.666	010
0.666	015
0.265	014
0.265	016
0.214	011
0.214	012
0.214	013
0.214	017
0.214	018
0.214	019

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Person 014 having learned to trust 016 decides to introduce the new friend to the leader of Group A. Node 015 is currently unaware of this new connection. Person 016 now has more links to the other group than to their home group.



Naturally person 016's power increases, while their leader's [015] power inches lower. Leader 010's power increase because there are now two paths to Group B. Being *connected to the powerful* also increases a node's power. Nodes 011, 012, and 013 benefit from leader 010's increase in power.

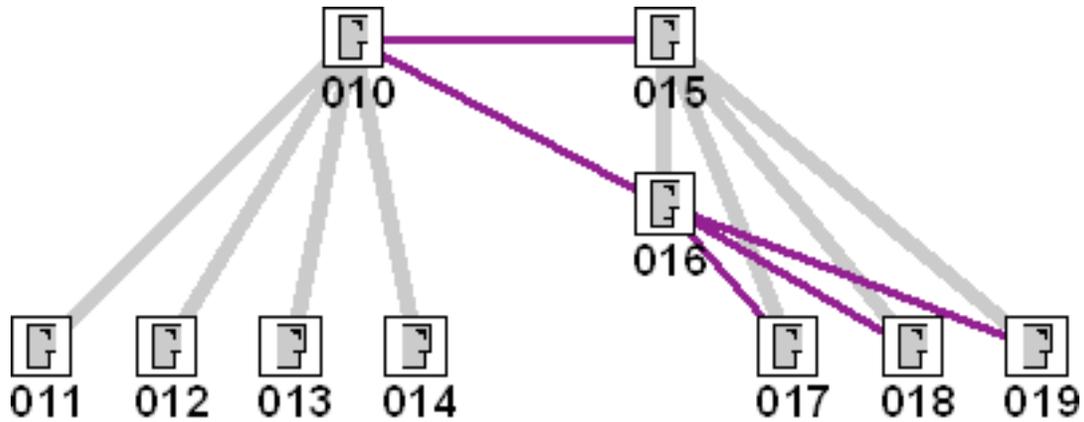
Power	
Score	Node
0.694	010
0.638	015
0.328	016
0.237	014
0.225	011
0.225	012
0.225	013
0.214	017
0.214	018
0.214	019

Soon word gets out in Group B, that 016 is well connected! Networks often, but not always, follow the law of increasing returns – the rich get richer. People who are well connected attract

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new ties from others hoping to take advantage of the many connections. 016's colleagues [017, 018, 019] soon form a tie with the emergent boundary spanner[016].



These three new connections, low in the hierarchy, really change the playing field. The power gap between the two formal leaders is now wide and obvious to everyone involved. 015's well-connected subordinate[016] *now has as much informal power as the boss!* 015 and 016 are *structurally equivalent* in the network – they both have the same ties. A power struggle may be inevitable.

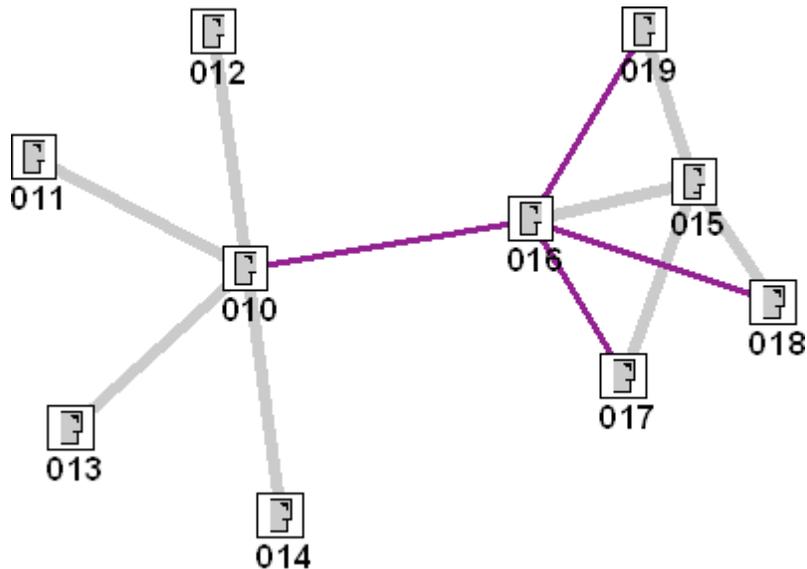
Person 016 lets the tie to node 014 atrophy or weaken – it is no longer critical. One can only maintain a small number of active strong ties.

Power	
Score	Node
0.736	010
0.471	015
0.471	016
0.225	011
0.225	012
0.225	013
0.225	014
0.225	017
0.225	018
0.225	019

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The new connections change the shape of the organization. This is the emergent structure of these two connected groups based on both formal[grey] and informal[purple] connections.



This visualization of the emergent structure of the network reveals something interesting, and counter-intuitive, about networks. Both nodes 010 and 016 have the same pattern of, and the same number of, connections. Yet, node 010 has more power! Why? Node 010 is wisely taking advantage of *structural holes* in the network. A structural hole is anywhere in the network where two nodes could be connected, but are not. There are structural holes between any combination of nodes 011, 012, 013, and 014. This leaves node 010 in a position of total control over the local cluster. A *hub*[010] controls all *spokes*[011,012,013,014] attached to it – like the formal hierarchy we saw in the first diagram.

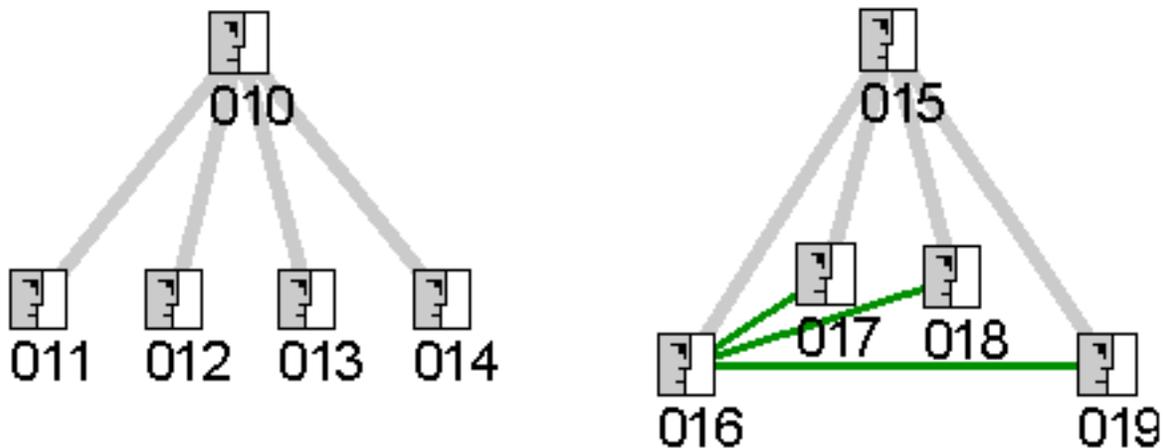
In the other cluster, node 016 is connected to nodes who are somewhat interconnected. There are a few holes in 016's cluster[can you spot them?], but not as many as in 010's cluster. The network in 016's cluster does not provide such control because there are several alternate paths of flow and exchange. Node 15's connections in the cluster provide an *alternative* to dependence on node 016. The nodes in 010's cluster currently have no such choice of where to send and receive information. They are totally dependent on Node 010. Where would you add 3 new links to have the maximum effect of lowering 010's dominance?

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Scenario Two

Instead of connecting to the other group, suppose Node 016 made new connections *within* the group? The emergent group structure may look like this.

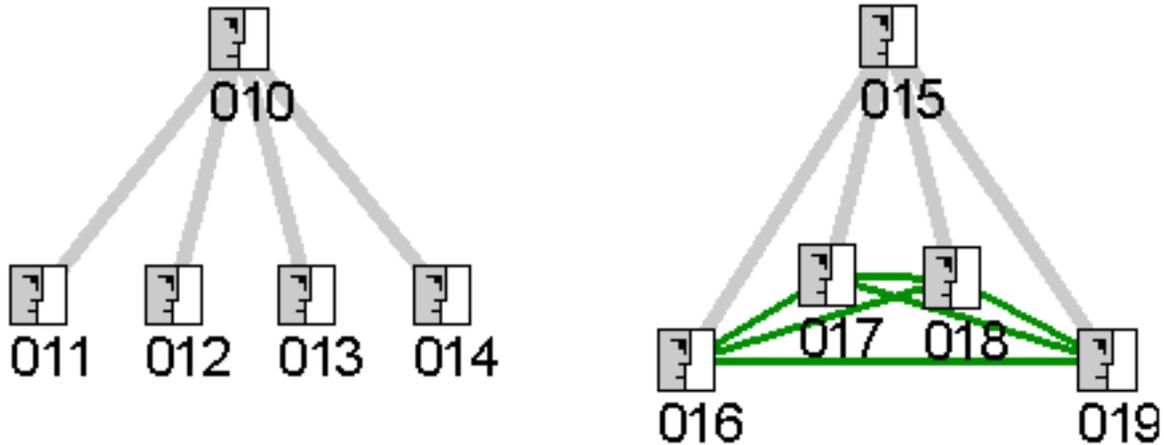


Group A : Power		Group B : Power	
<u>Score</u>	<u>Node</u>	<u>Score</u>	<u>Node</u>
1.000	010	0.625	015
0.286	011	0.625	016
0.286	012	0.333	017
0.286	013	0.333	018
0.286	014	0.333	019

Notice that 015 and 016 become structurally equivalent immediately – they have the same ties. The nodes connected to them increase their power scores because their information flow is no longer constrained by flowing just through one node. If the rest of the nodes in 015's group connect to each other, we have a further dilution of 015's power over the group. In fact, we have an equal distribution of power across the whole group! When everyone is connected to everyone else, no one stands out. This is reflected in everyone having an identical power score of 0.500.

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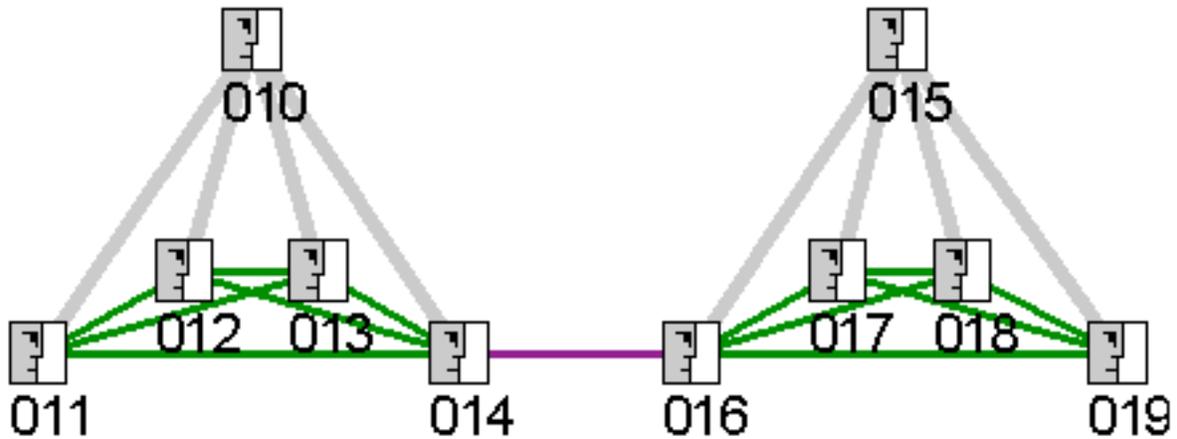


Group A : Power		Group B : Power	
<u>Score</u>	<u>Node</u>	<u>Score</u>	<u>Node</u>
1.000	010	0.500	015
0.286	011	0.500	016
0.286	012	0.500	017
0.286	013	0.500	018
0.286	014	0.500	019

Soon Node 016 from Group B spans a boundary and connects to Node 014 from Group A. Before long the behavior in Group B[all subordinates interconnected] spreads to Group A. This removes non-hierarchical power from the formal leaders[010 and 015] of both groups and transfers it to the boundary spanners [014, 016].

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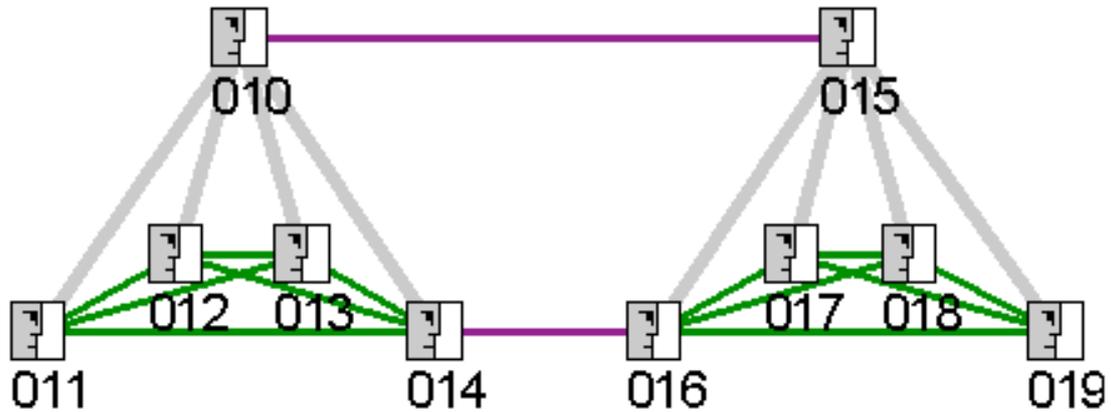


Power	
Score	Node
0.624	014
0.624	016
0.250	010
0.250	011
0.250	012
0.250	013
0.250	015
0.250	017
0.250	018
0.250	019

One strategy for the group leaders to gain informal power would be to become a boundary spanners themselves. This not only increases their power rankings but also increases the rankings for the whole group. The advantage to the whole group increases as more bridges are created. Yet, as more bridges are built, the individual advantage of being part of a bridge begins to diminish.

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Power	
Score	Node
0.457	010
0.457	015
0.457	014
0.457	016
0.265	012
0.265	013
0.265	011
0.265	017
0.265	018
0.265	019

A centralized network, such as a hierarchy or a hub-and-spoke, has centralized power. These networks have a few nodes with many connections, while also containing many nodes with only a few connections. As the disconnected start to connect, power becomes more distributed.

*All social network analysis and visualization performed using **InFlow**TM software.
For more information, see: <http://www.orgnet.com/software.html>*