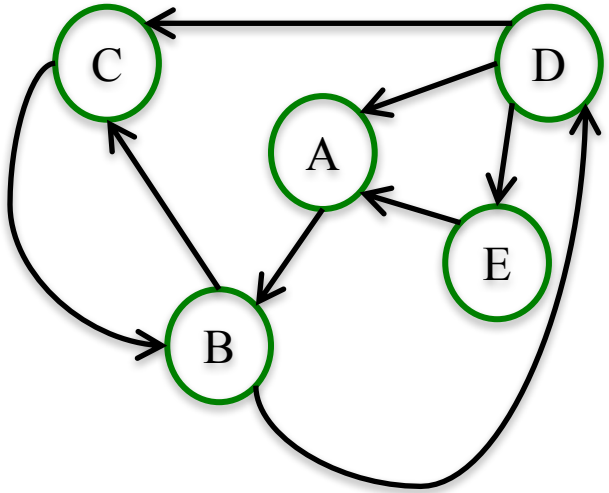
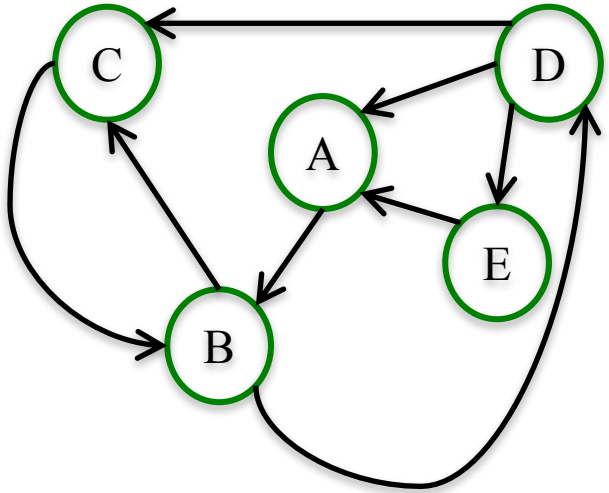
Interpreting PageRank

The PageRank of a node at step k is the probability that a ***random walker*** lands on the node after taking k steps.



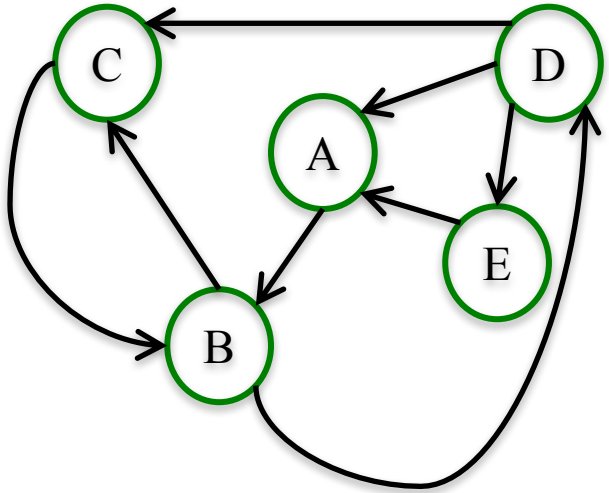
Interpreting PageRank

Random walk of k steps: Start on a random node.



Interpreting PageRank

Random walk of k steps: Start on a random node. Then choose an outgoing edge at random and follow it to the next node.

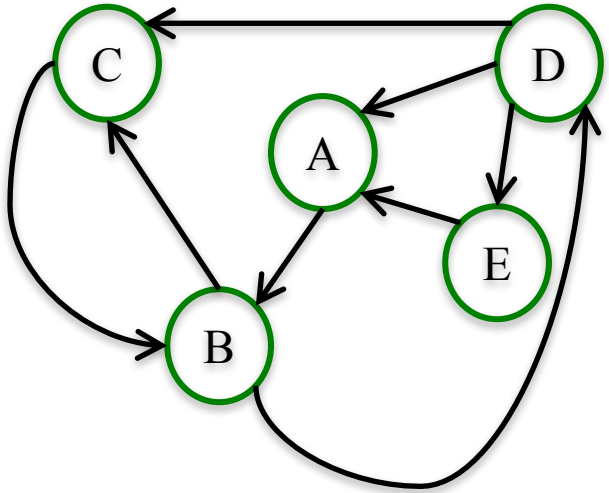


Interpreting PageRank

Random walk of k steps: Start on a random node. Then choose an outgoing edge at random and follow it to the next node. Repeat k times.

For example, a random walk of 5 steps on this graph looks like this:

Step 1: Choose a random node.



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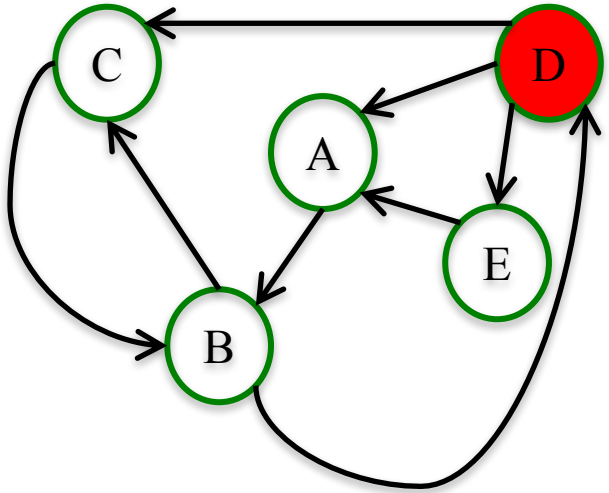
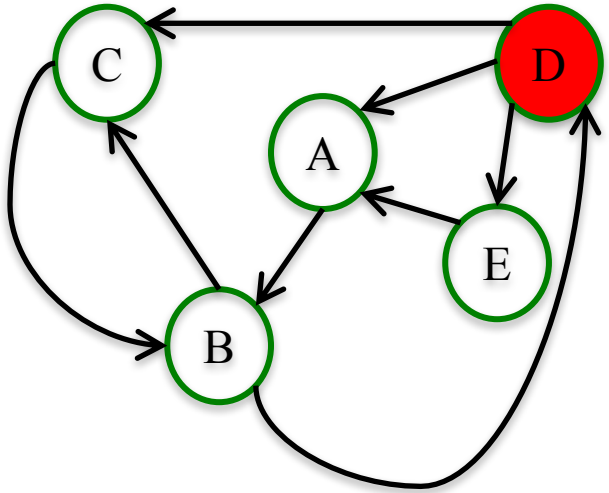


Interpreting PageRank

Random walk of k steps: Start on a random node. Then choose an outgoing edge at random and follow it to the next node. Repeat k times.

For example, a random walk of 5 steps on this graph looks like this:

Step 1: Choose a random outgoing edge.

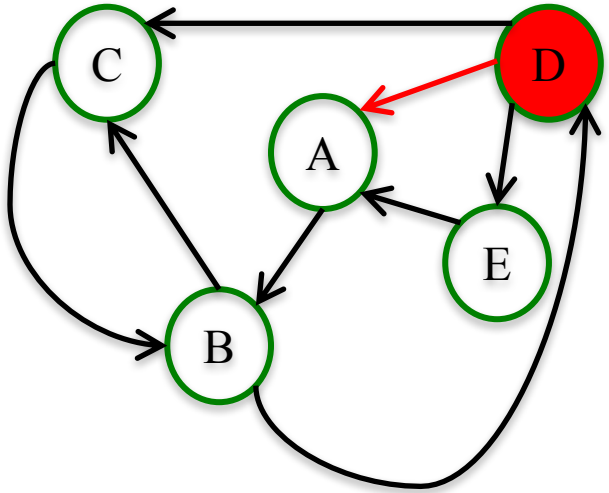


Interpreting PageRank

Random walk of k steps: Start on a random node. Then choose an outgoing edge at random and follow it to the next node. Repeat k times.

For example, a random walk of 5 steps on this graph looks like this:

Step 1: Choose a random outgoing edge.

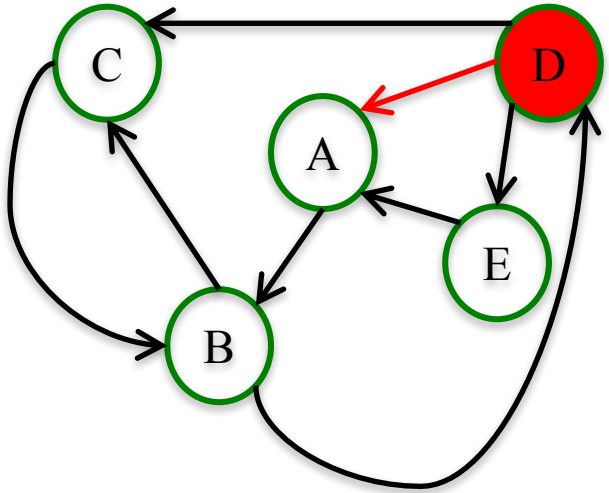


Interpreting PageRank

Random walk of k steps: Start on a random node. Then choose an outgoing edge at random and follow it to the next node. Repeat k times.

For example, a random walk of 5 steps on this graph looks like this:

Step 1: Follow the edge to the next node.

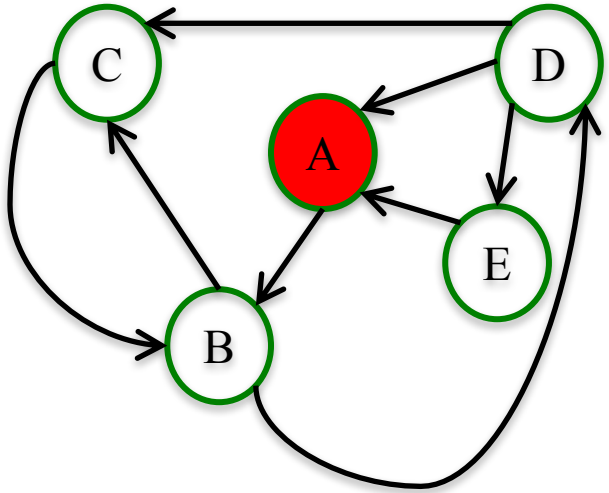


Interpreting PageRank

Random walk of k steps: Start on a random node. Then choose an outgoing edge at random and follow it to the next node. Repeat k times.

For example, a random walk of 5 steps on this graph looks like this:

Step 1: Follow the edge to the next node.

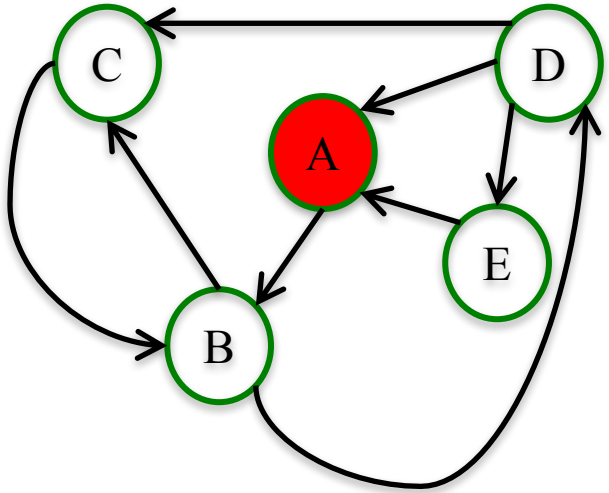


Interpreting PageRank

Random walk of k steps: Start on a random node. Then choose an outgoing edge at random and follow it to the next node. Repeat k times.

For example, a random walk of 5 steps on this graph looks like this:

Step 2: Choose a random outgoing edge and follow it.

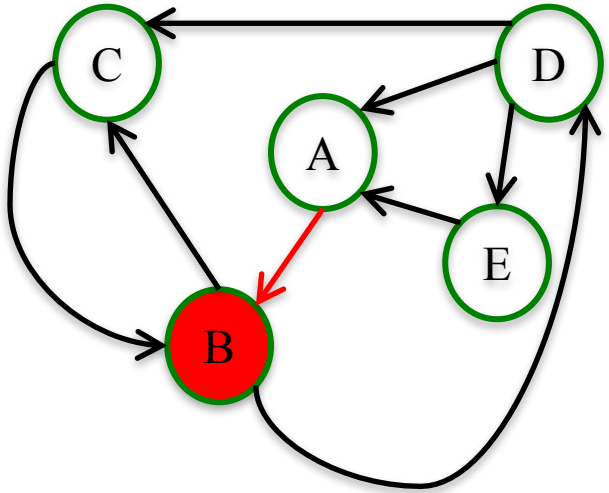


Interpreting PageRank

Random walk of k steps: Start on a random node. Then choose an outgoing edge at random and follow it to the next node. Repeat k times.

For example, a random walk of 5 steps on this graph looks like this:

Step 2: Choose a random outgoing edge and follow it.

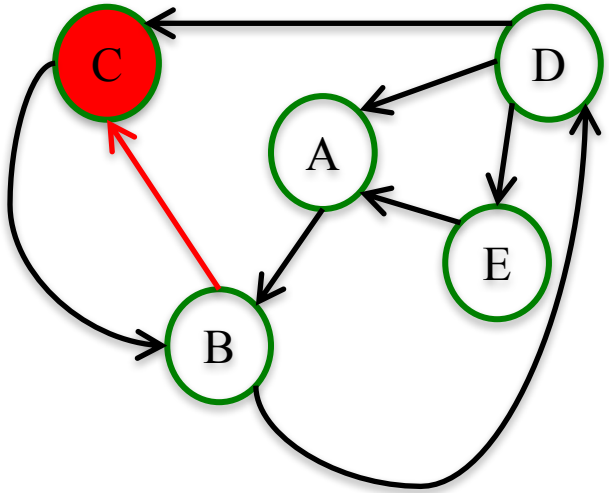


Interpreting PageRank

Random walk of k steps: Start on a random node. Then choose an outgoing edge at random and follow it to the next node. Repeat k times.

For example, a random walk of 5 steps on this graph looks like this:

Step 3: Choose a random outgoing edge and follow it.

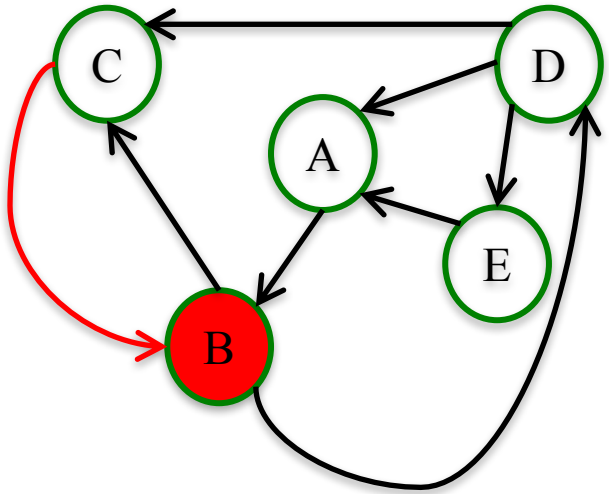


Interpreting PageRank

Random walk of k steps: Start on a random node. Then choose an outgoing edge at random and follow it to the next node. Repeat k times.

For example, a random walk of 5 steps on this graph looks like this:

Step 4: Choose a random outgoing edge and follow it.

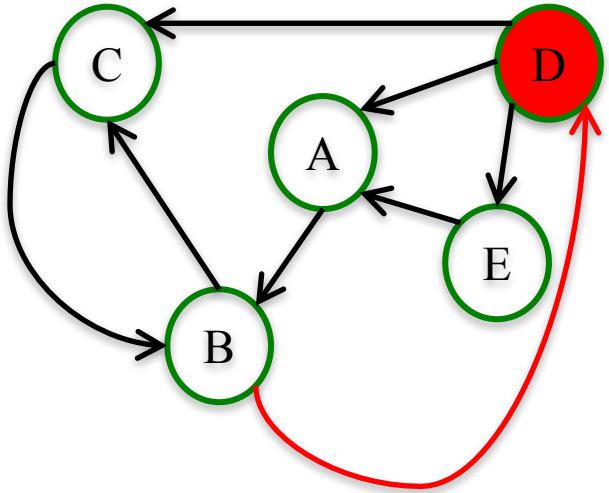


Interpreting PageRank

Random walk of k steps: Start on a random node. Then choose an outgoing edge at random and follow it to the next node. Repeat k times.

For example, a random walk of 5 steps on this graph looks like this:

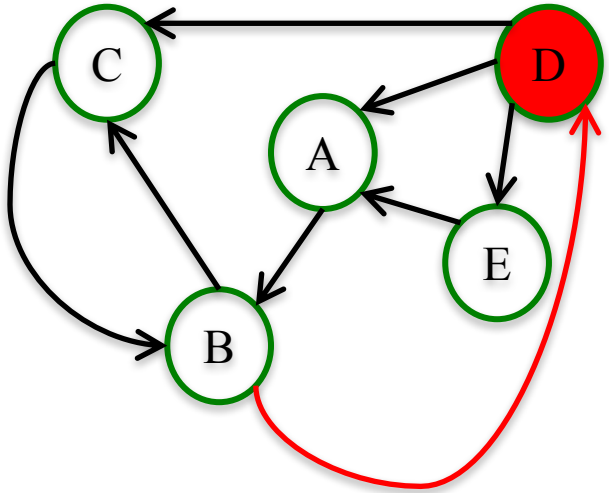
Step 5: Choose a random outgoing edge and follow it.



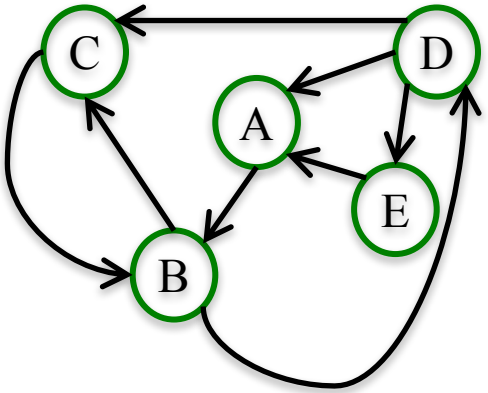
Interpreting PageRank

Random walk of k steps: Start on a random node. Then choose an outgoing edge at random and follow it to the next node. Repeat k times.

	Page Rank				
	A	B	C	D	E
k=∞	.12	.38	.25	.19	.06



PageRank Problem



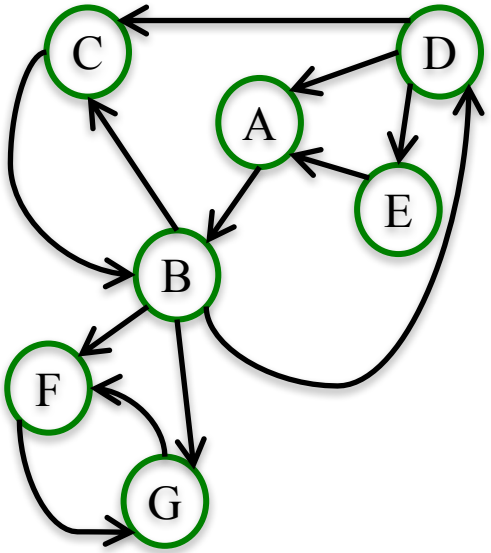
PageRank Problem

What's the PageRank of the nodes in this network? [Hint: think about the random walk interpretation]

For a large enough k: F and G each have PageRank of ½ and all the other nodes have PageRank 0.

Why? Imagine a random walk on this network. Whenever the walk lands on F or G, it is "stuck" on F and G.

This seems problematic!



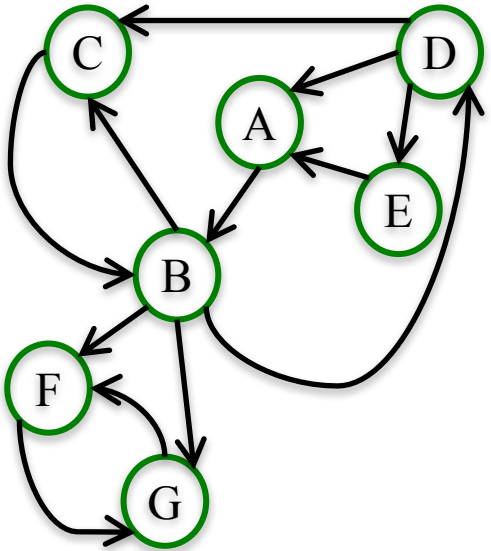
PageRank Problem

To fix this, we introduce a "damping parameter" α.

Random walk of k steps with damping parameter α: Start on a random node. Then:

- With probability α: choose an outgoing edge at random and follow it to the next node.
- With probability $1 - \alpha$: choose a node at random and go to it.

Repeat k times.



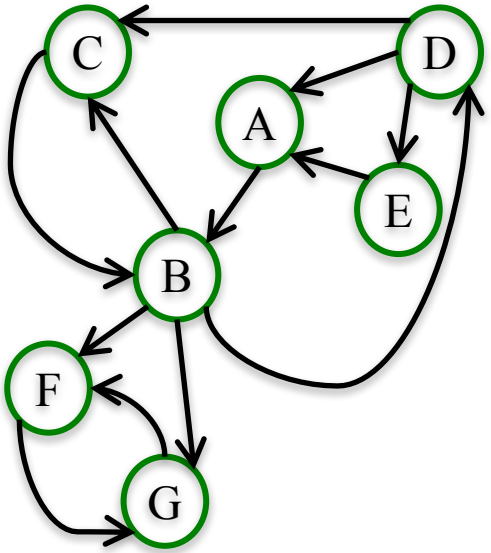
The random walk is no longer "stuck" on nodes F and G.

Scaled PageRank

The **Scaled PageRank** of k steps and damping factor α of a node n is the probability that a random walk with damping factor α lands on a n after k steps.

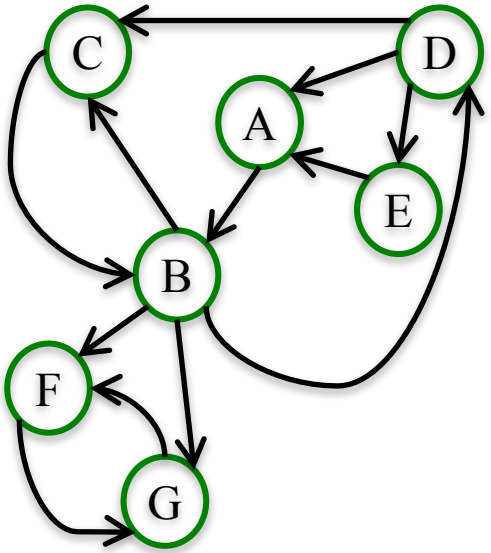
For most networks, as k gets larger, Scaled PageRank converges to a unique value, which depends on α.

In practice, we use a parameter of α between 0.8 and 0.9.



Scaled PageRank

Scaled PageRank ($\alpha = .8, k$ large)						
A	B	C	D	E	F	G
.08	.17	.1	.08	.05	.27	.25



F and G still have high PageRank, but not all the PageRank.

Damping factor works better in very large networks like the Web or large social networks.

You can use NetworkX function pagerank(G, alpha=0.8) to compute Scaled PageRank of network G with damping parameter alpha.

Summary

- The Basic PageRank of a node can be interpreted as the probability that a random walk lands on the node after k random steps.
- Basic PageRank has the problem that, in some networks, a few nodes can "suck up" all the PageRank from the network.
- To fix this problem, Scaled PageRank introduces a parameter α, such that the random walker chooses a random node to jump to with probability $1 - \alpha$.
- Typically we use α between 0.8 and 0.9
- NetworkX function pagerank(G, alpha=0.8) computes Scaled PageRank of network G with damping parameter α=0.8.