

# PageRank (Extra Material)

Introduction to Network Science

Carlos Castillo

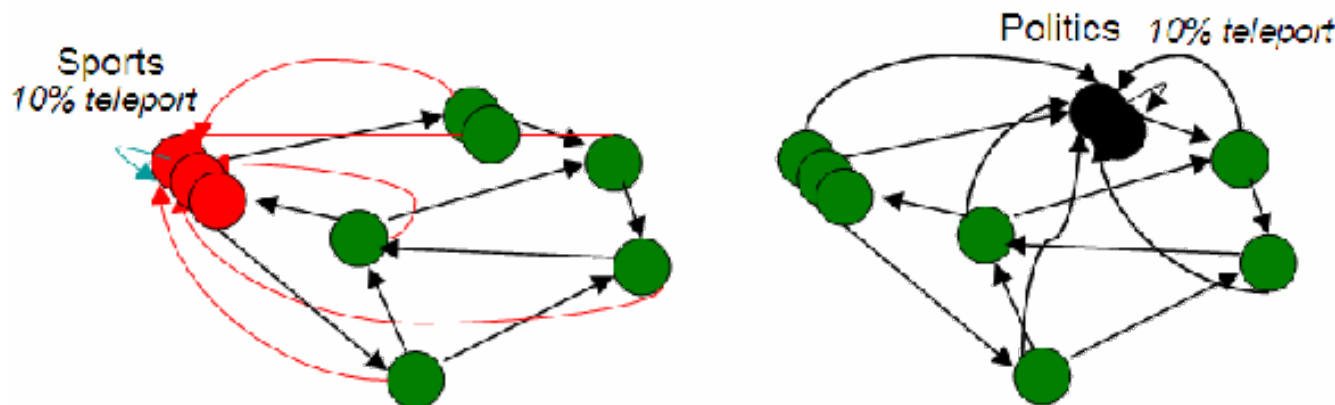
Topic 16

# Sources

- Networks, Crowds, and Markets Ch 14
- Fei Li's lecture on PageRank
- Evimaria Terzi's lecture on link analysis.
- C. Castillo: Link-based ranking slides 2016

# Variant: **personalized** PageRank

- Modify  $R(i)$  according to users' tastes (e.g. user interested in sports vs politics)



# PageRank and internal linking

- A website has a maximum amount of Page Rank that is distributed between its pages by internal links [depends on internal links]
- The maximum amount of Page Rank in a site increases as the number of pages in the site increases.
- By linking poorly, it is possible to fail to reach the site's maximum Page Rank, but it is not possible to exceed it.

# PageRank Implementation

- Suppose there are  $n$  pages and  $m$  links
- Trivial implementation of PageRank requires  $O(M+N)$  memory

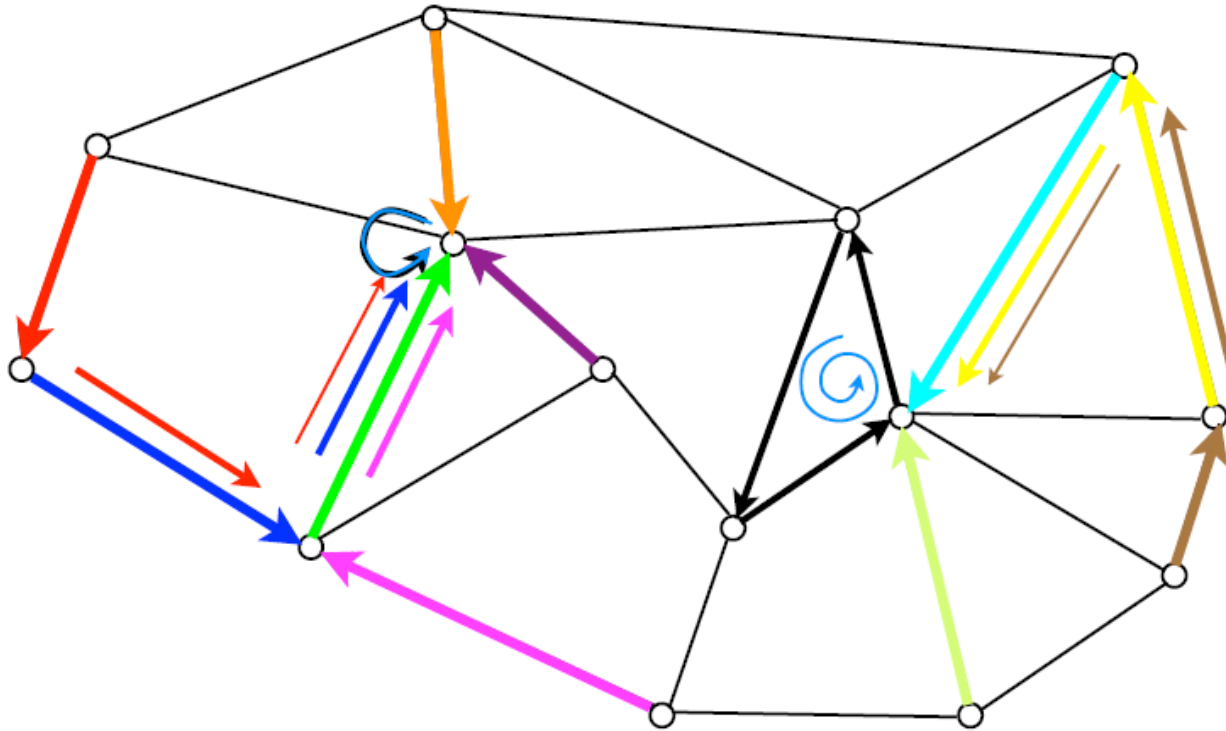
**Streaming** implementation requires  $O(N)$  memory ... *how?*  
"Streaming" means the graph is never held on memory

# Liquid democracy

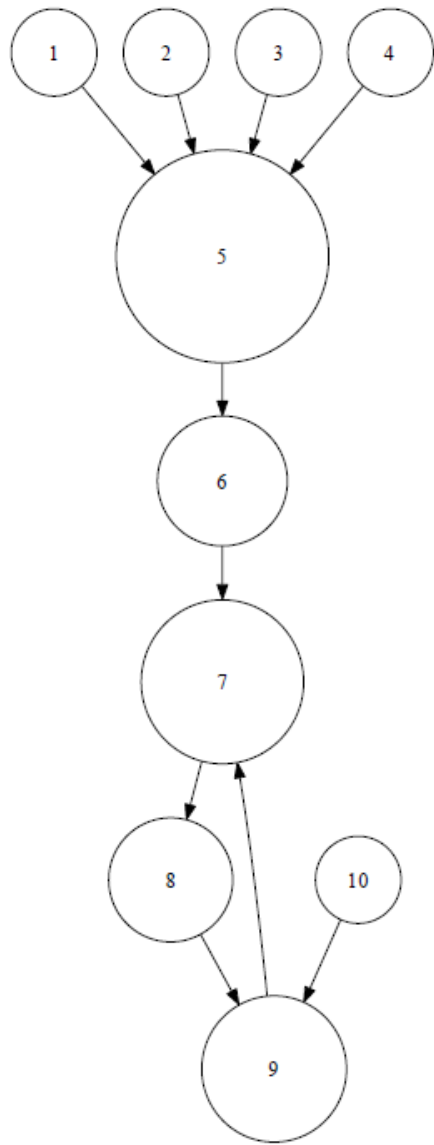
# PageRank as a form of actual voting (liquid democracy)

- If  $\alpha = 1$ , we can implement liquid democracy
  - In liquid democracy, people chose to either vote or to delegate their vote to somebody else
- If  $\alpha < 1$ , we have a sort of “viscous” democracy where delegation is not total

# PageRank as a form of liquid democracy

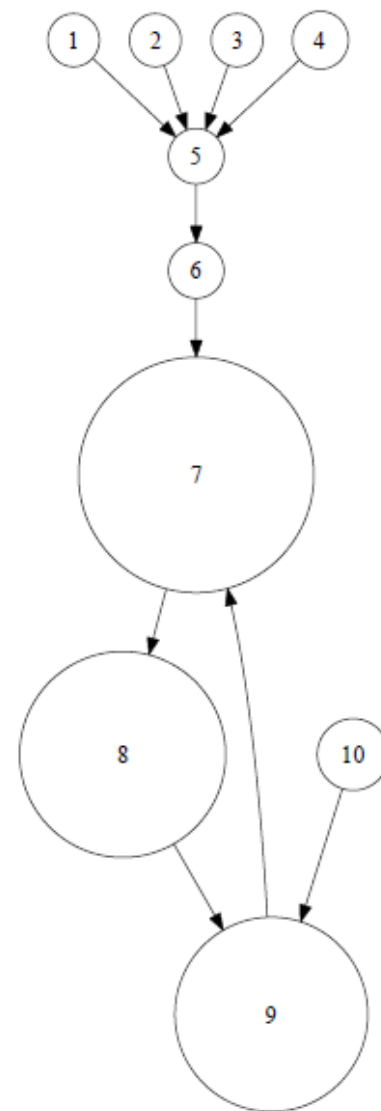






These two graphs  
have different alpha  
(0.2 and 0.9)

Which one is  
which?



# Summary

# Things to remember

- Personalized PageRank
- Liquid democracy example, will help you understand the role of the parameter  $\alpha$