

# A Broad Overview of Social Network Analysis (SNA)

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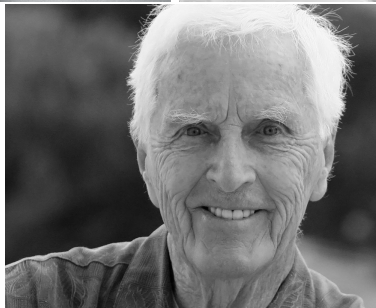
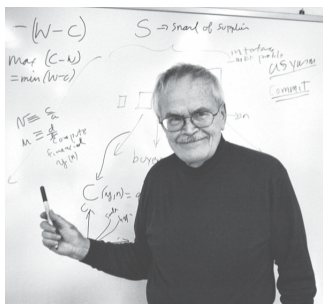
<sup>2</sup> [mboudourid@haverford.edu](mailto:mboudourid@haverford.edu)

*The Social Media Research Summer School 2021*  
Virtual

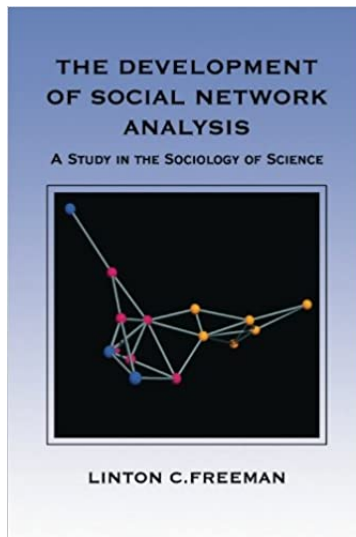
9:45 am EDT, Tuesday, July 10, 2023

# History

# Georg Simmel, Jacob Moreno, Frank Harary, Harrison White, Lin Freeman



Freeman LC (2004) *The development of social network analysis: A study in the sociology of science*. Empirical Press, Vancouver.

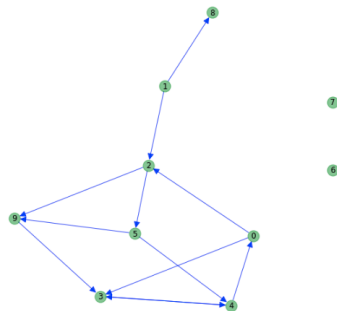
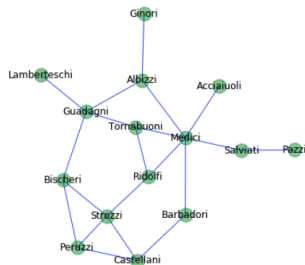


# Lin Freeman's Periodization

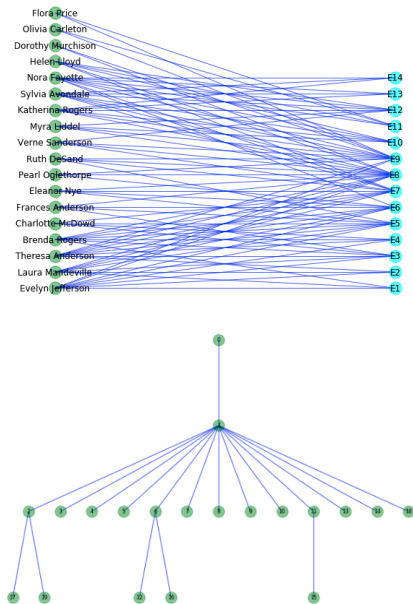
1. Philosophical/Sociological Prehistory
2. Birth at Harvard in the 1920s
3. Birth of Sociometry in the 1930s
4. "Dark Ages I" in the 1940s
5. "Dark Ages II" in the 1950s
6. "Dark Ages III" in the 1960s
7. Renaissance at Harvard in the 1960s
8. The Normal Science of SNA after the 1990s
9. Concurrency with Network Science after the 2010s
10. The Future of Computational SocSci/SNA

# Graph/Networks Typology

# Undirected or Directed (Simple)

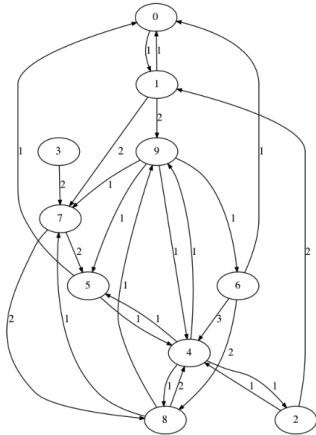
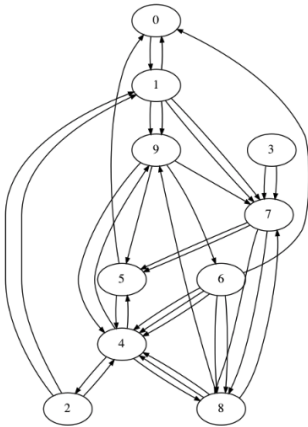


# Bipartite [Two-Mode] – Tree

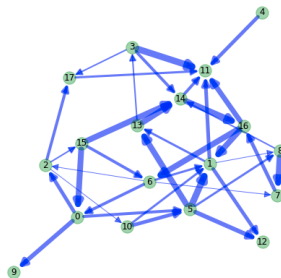
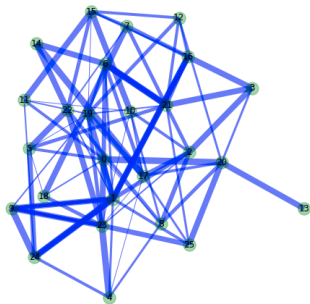




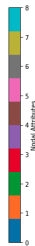
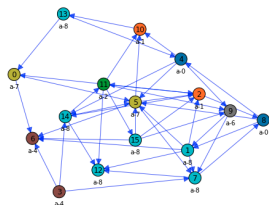
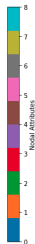
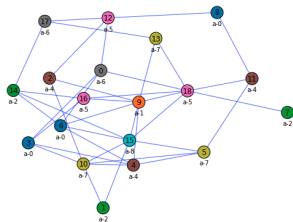
Multigraph [Edge Weighted] Undirected or Directed (with Edge Weight)



# Multigraph [Edge Weighted] Undirected or Directed (with Edge Width)

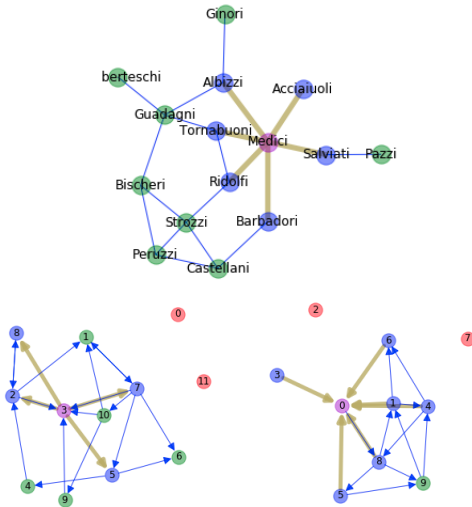


# Node Labeled Undirected or Directed (with Node Attributes)

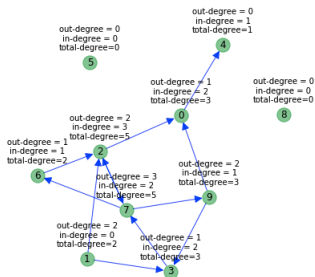
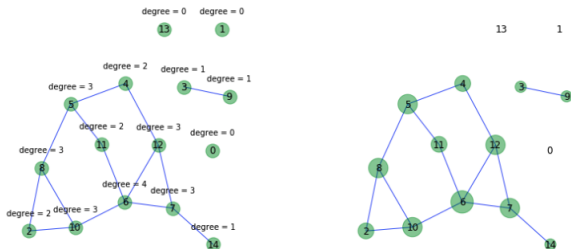


# Adjacency

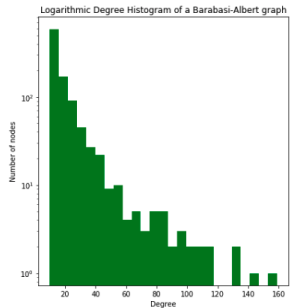
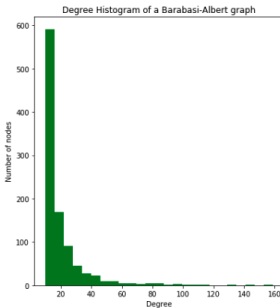
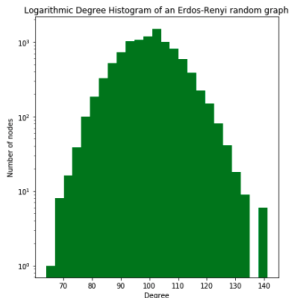
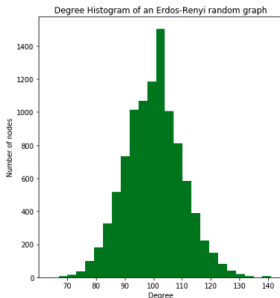
# Neighbors, In-Coming, Out-Going



# Degrees, In-Degrees, Out-Degrees

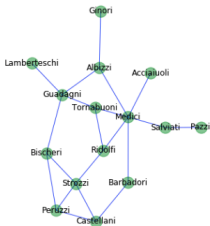


# Degree Histograms

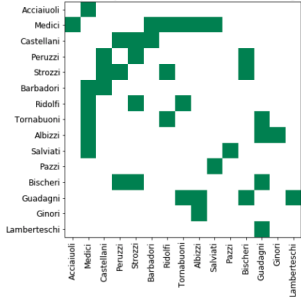


# Adjacency Matrices of Simple Graphs

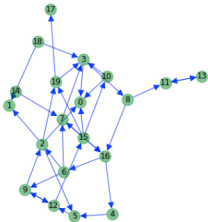
### The Florentine Families graph



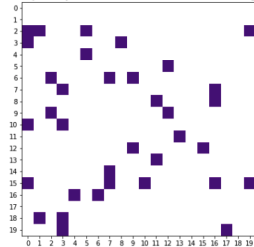
The adjacency matrix of the Florentine Families graph



### An directed Gnm random graph



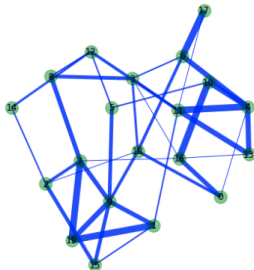
The adjacency matrix of an directed  $G_{nm}$  random graph



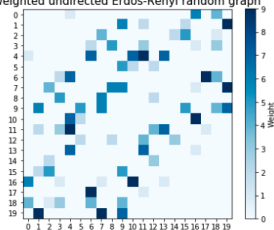


# Adjacency Matrices of MultiGraphs

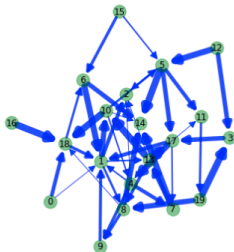
An weighted undirected Erdos-Renyi random graph



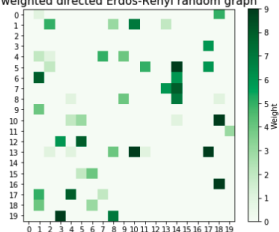
The adjacency matrix of an weighted undirected Erdos-Renyi random graph



An weighted directed Erdos-Renyi random graph



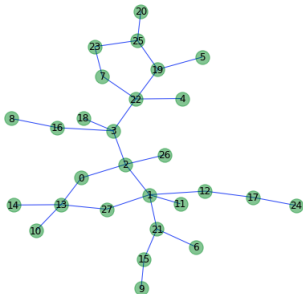
The adjacency matrix of an weighted directed Erdos-Renyi random graph



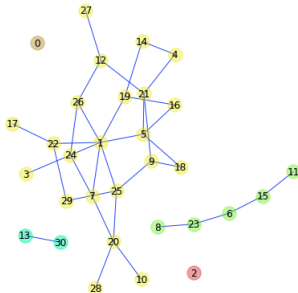
# Connectedness

# Connected and Disconnected Simple Undirected Graphs

A connected undirected Erdos-Renyi random graph

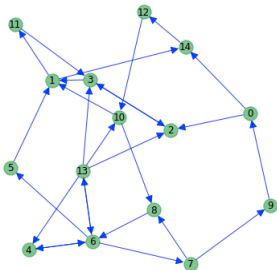


A disconnected undirected Erdos-Renyi random graph

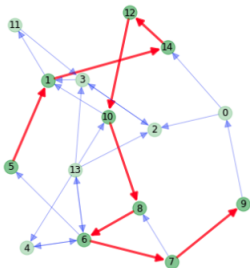


# Strongly Connected Simple Directed Graphs

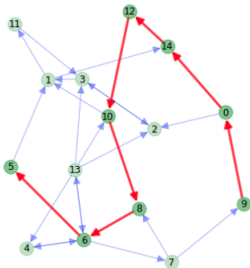
A strongly connected directed Erdos-Renyi random graph



The geodesic path from node 5 to node 9 in the previous graph

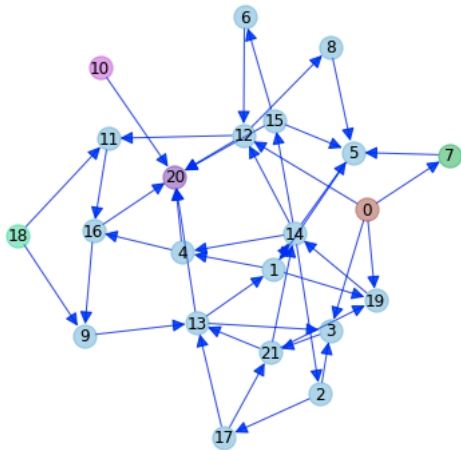


The geodesic path from node 9 to node 5 in the previous graph



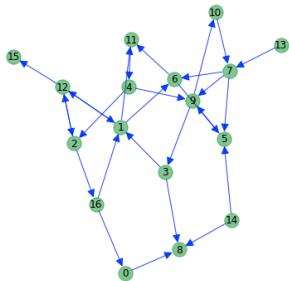
# Strongly Disconnected Simple Directed Graphs

A strongly disconnected directed Erdos-Renyi random graph

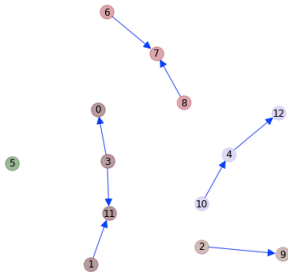


# Weakly Connected and Disconnected Simple Directed Graphs

A weakly connected directed Erdos-Renyi random graph



A weakly disconnected directed Erdos-Renyi random graph

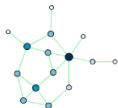


# Centrality Measures

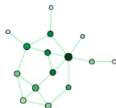
# Centrality Indices of Undirected Graphs

Centrality Indices of a Florentine Families graph

Degree Centrality Index



Closeness Centrality Index



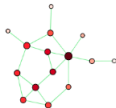
Betweenness Centrality Index



Eigenvector Centrality Index



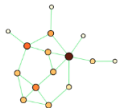
Hits Centrality Index



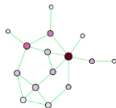
Katz Centrality Index



PageRank Centrality Index



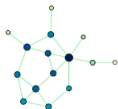
Load Centrality Index



Communicability Centrality Index



Current Flow Centrality Index



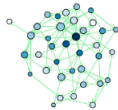


# Centrality Indices of Directed Graphs

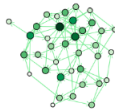
Centrality Indices of a Weakly Connected Erdos-Renyi Random Directed Graph



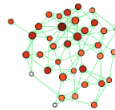
Out\_Degree Centrality Index



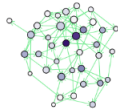
In\_Degree Centrality Index



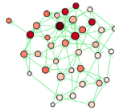
Closeness Centrality Index



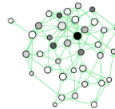
Betweenness Centrality Index



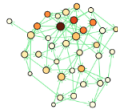
Eigenvector Centrality Index



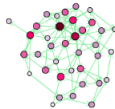
Hits\_Hubs Centrality Index



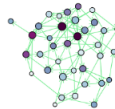
Hits\_Auths Centrality Index



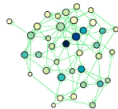
Katz Centrality Index



Pagerank Centrality Index



Load Centrality Index



# Community Partitions

# Community Partitioning of Undirected Graphs

Various Community Partitions of a Florentine Families graph

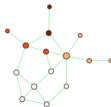
Girvan-Newman communities (3)



Louvain communities (4)



Label propagation communities (4)



Asynchronous label propagation communities (5)



Fluid communities (5)



Various Community Partitions of a Karate Club graph

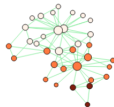
Girvan-Newman communities (3)



Louvain communities (4)



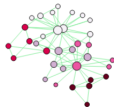
Label propagation communities (3)



Asynchronous label propagation communities (5)



Fluid communities (5)



# Community Partitioning of Directed Graphs

## Various Community Partitions of a Weakly Connected Erdos-Renyi Random Directed Graph



Girvan-Newman communities (3)



Asynchronous label propagation communities (2)

