Introduction to Network Analysis

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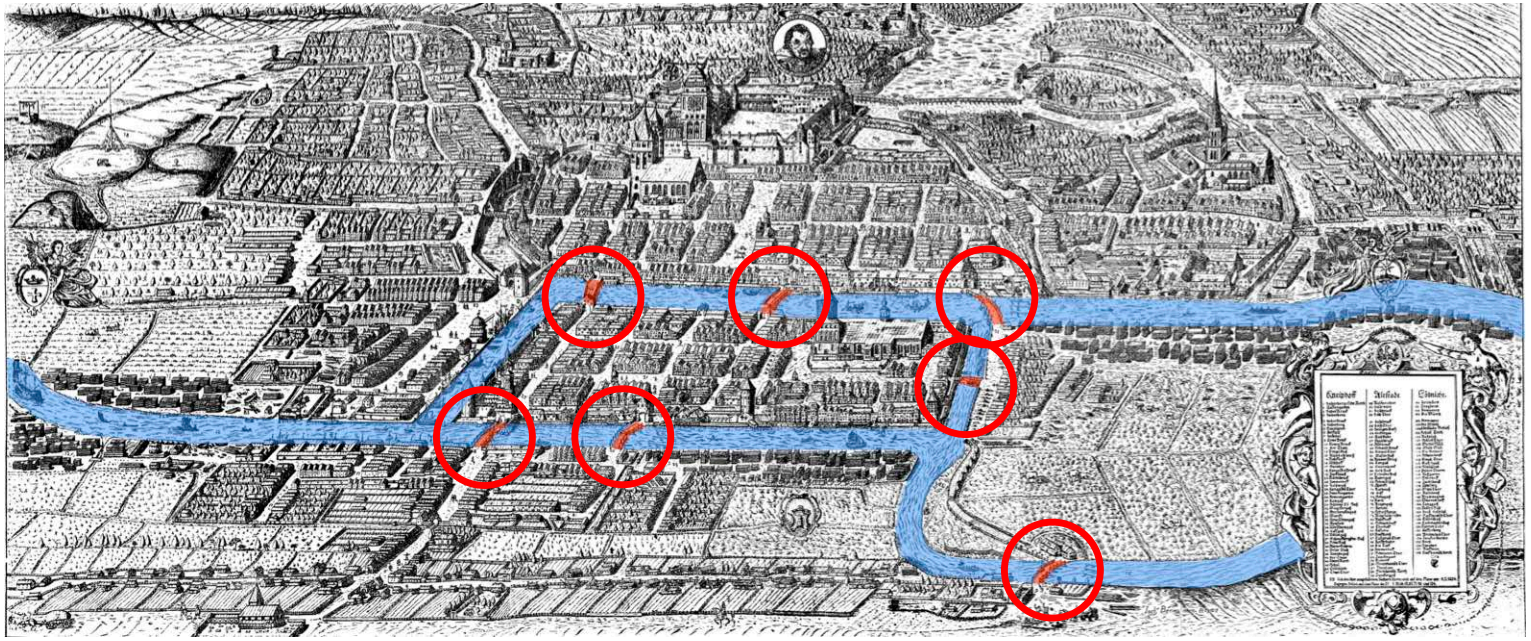
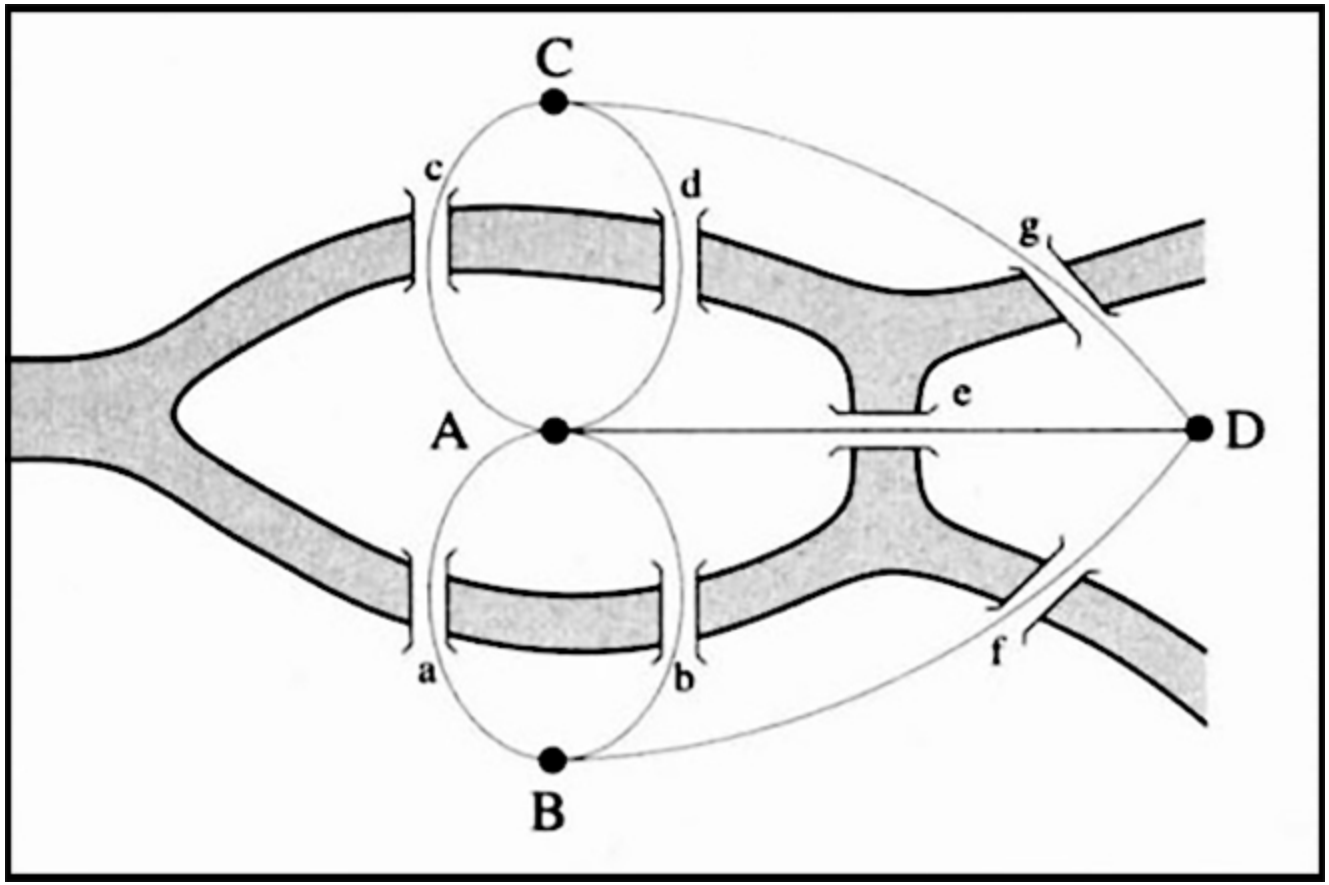
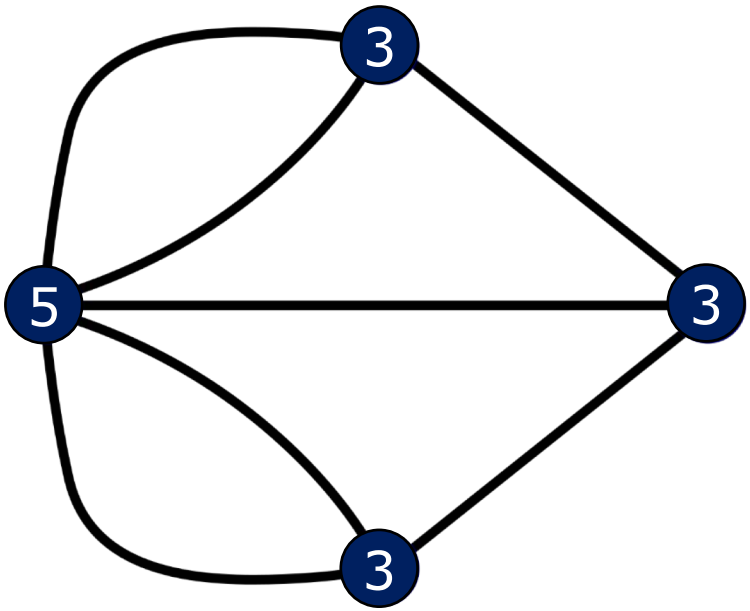
Euler and the Seven Bridges of Königsberg (1736)



Euler and the Seven Bridges of Königsberg



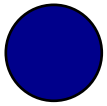
Euler and the Seven Bridges of Königsberg



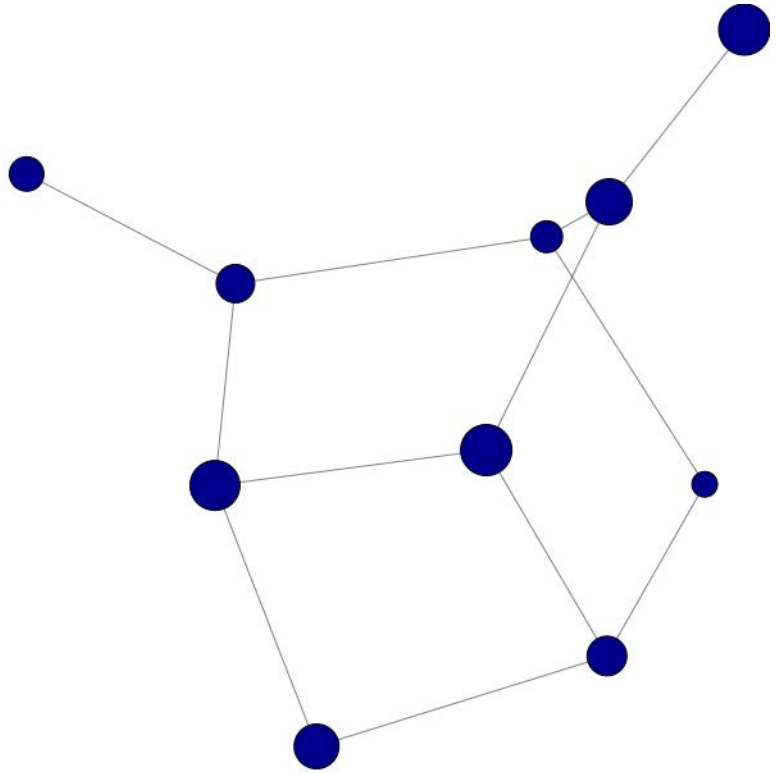
Condition for "Eulerian Cycle":
All of vertices with an even number (>0) of connections to other vertices in the graph.

Condition for an "Eulerian Path":
Exactly two vertices with an odd number of connections to other vertices in the graph.

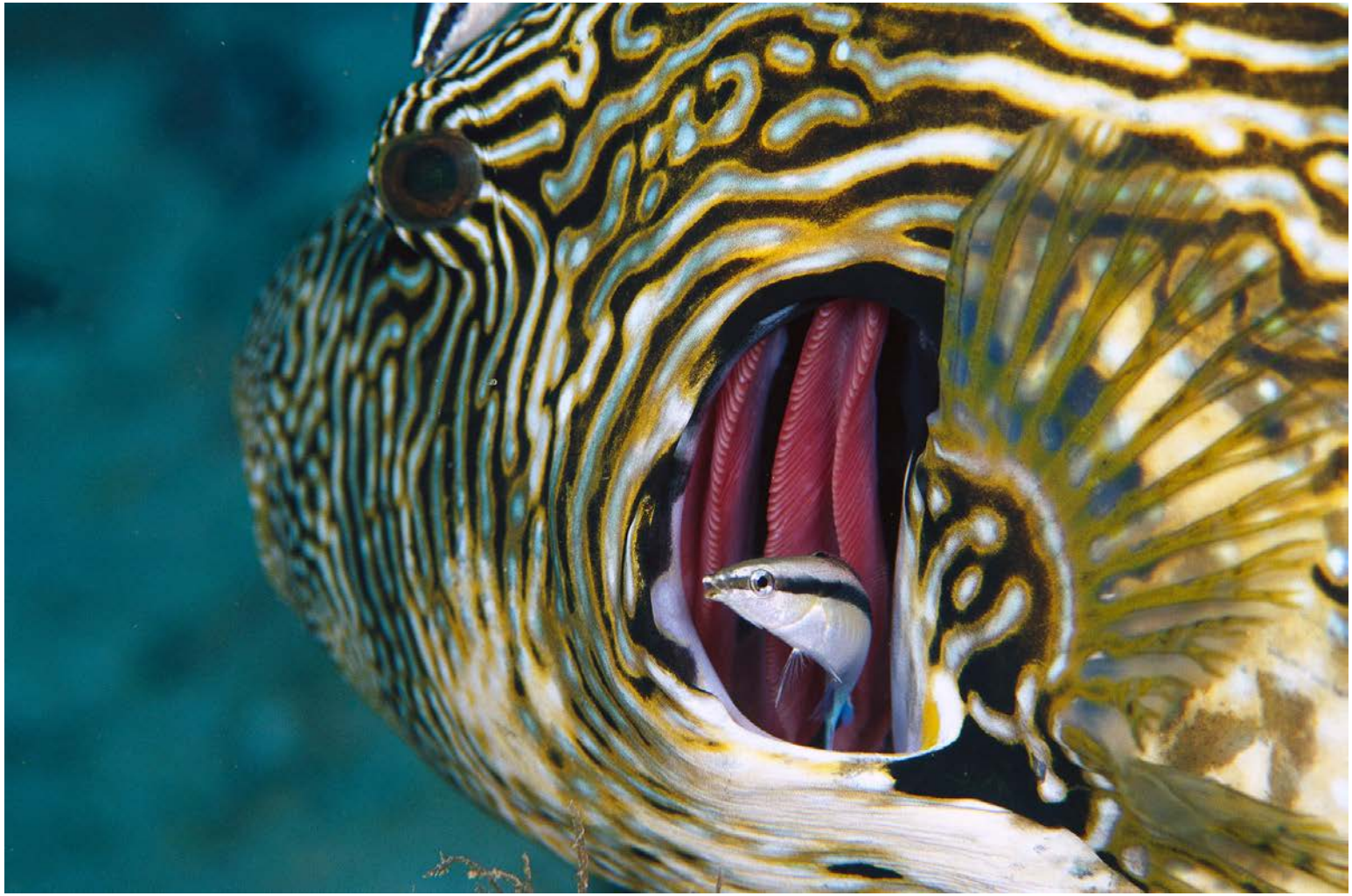
Basic Definitions

nodes/vertices 

edges/links



Ecological Networks

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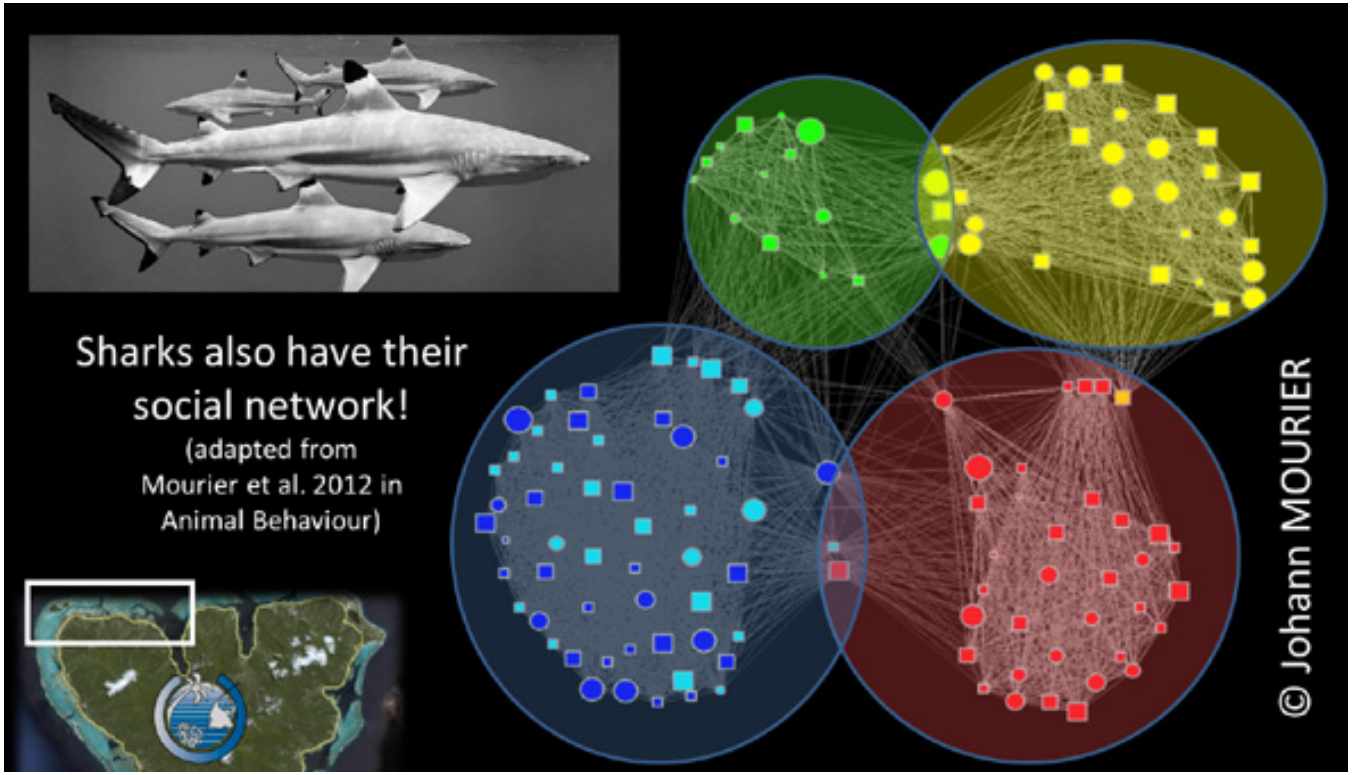
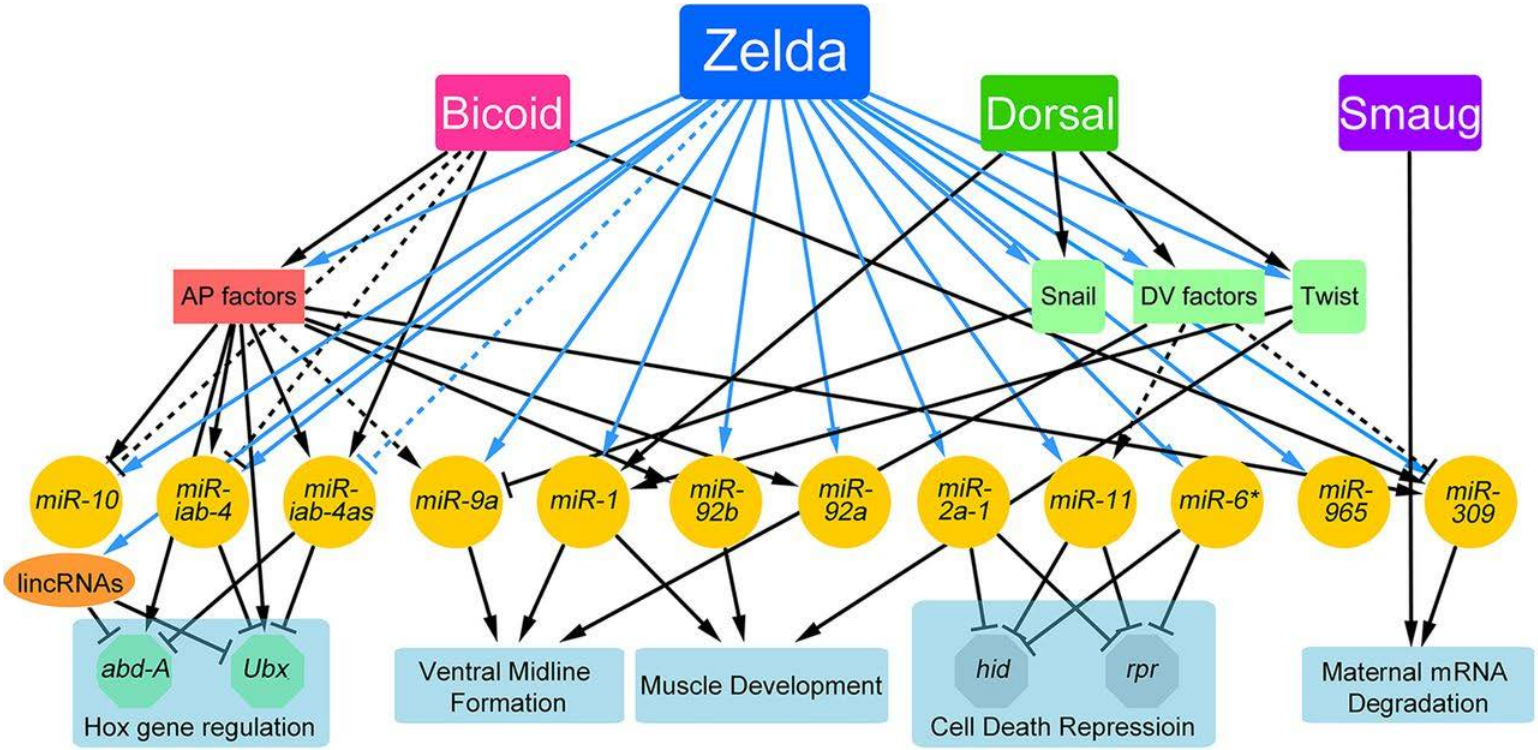
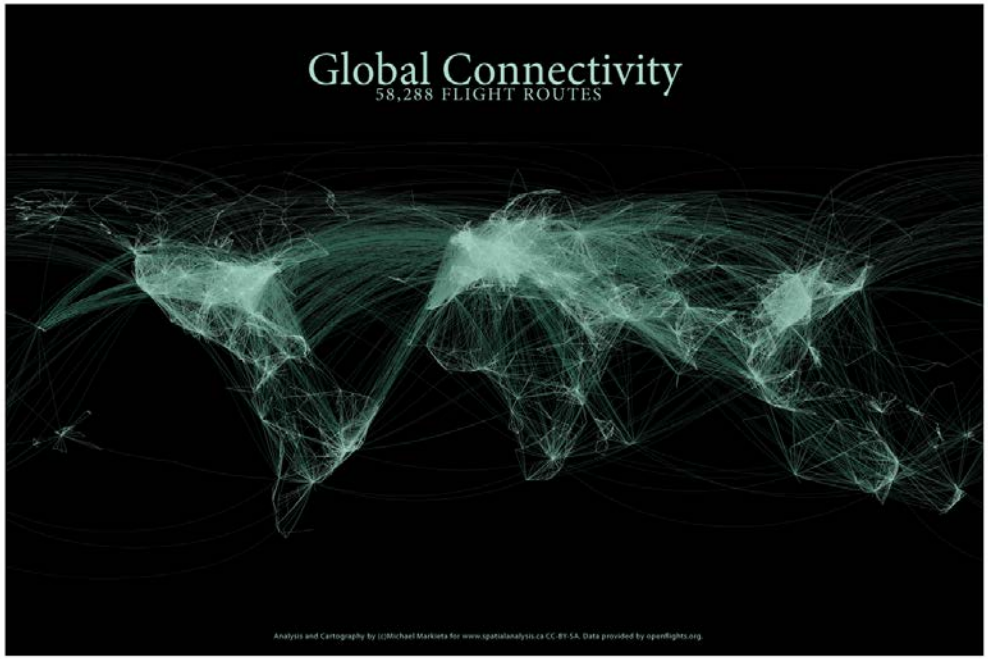
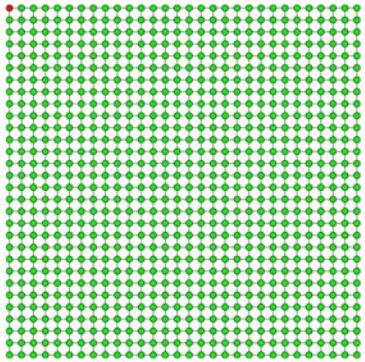
Social Networks

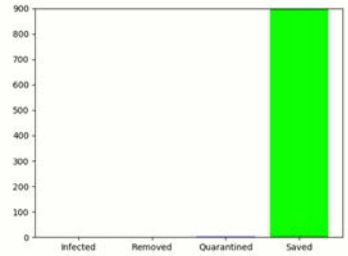


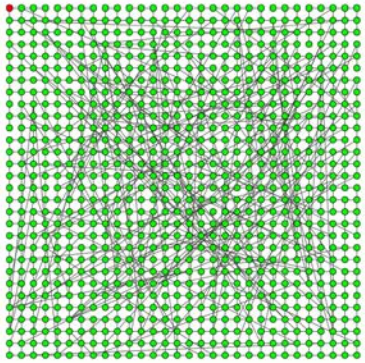
Gene Regulatory Networks

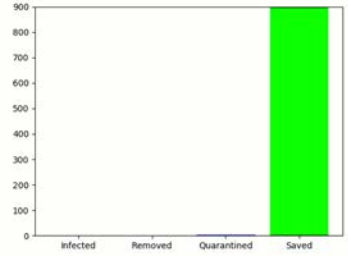








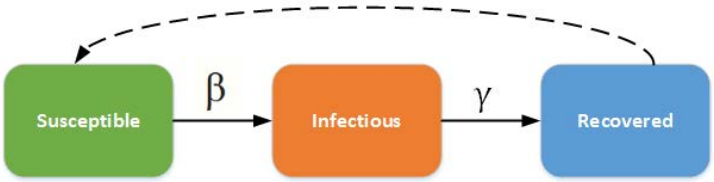




$$\dot{S}(t) = -\frac{\beta}{N} I(t) S(t)$$

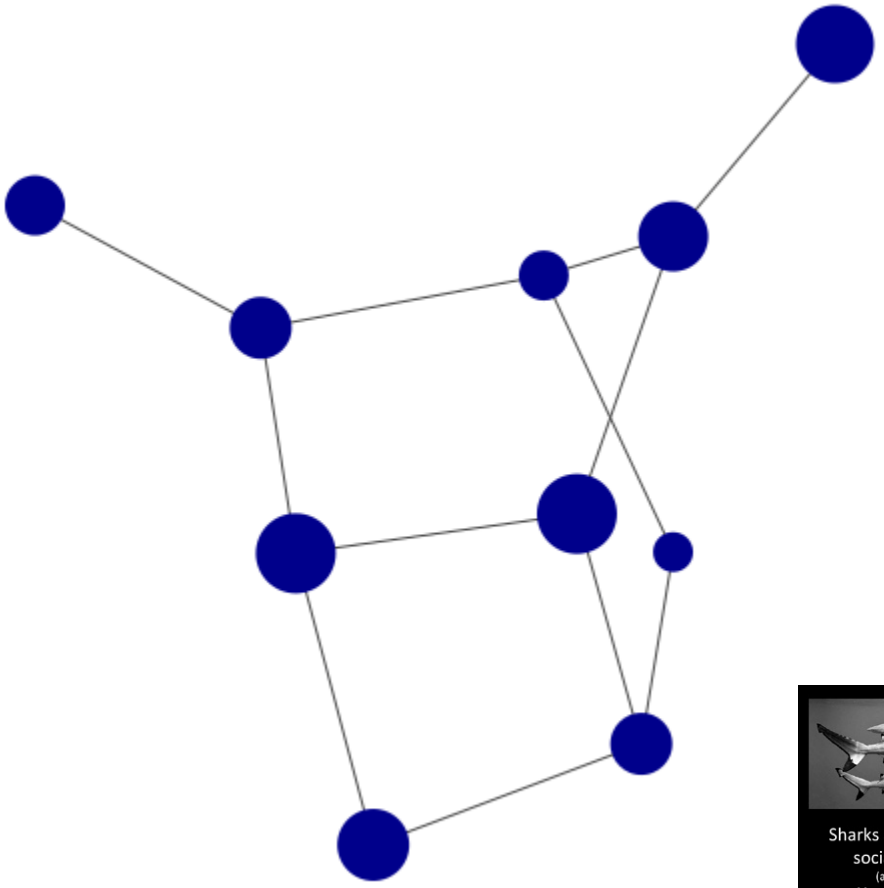
$$\dot{I}(t) = \frac{\beta}{N} I(t) S(t) - \gamma I(t)$$

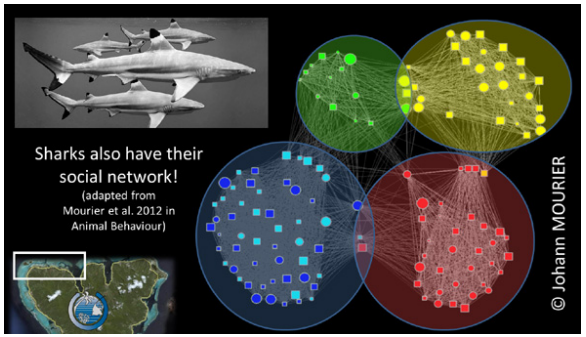
$$\dot{R}(t) = \gamma I(t)$$



Network Classes

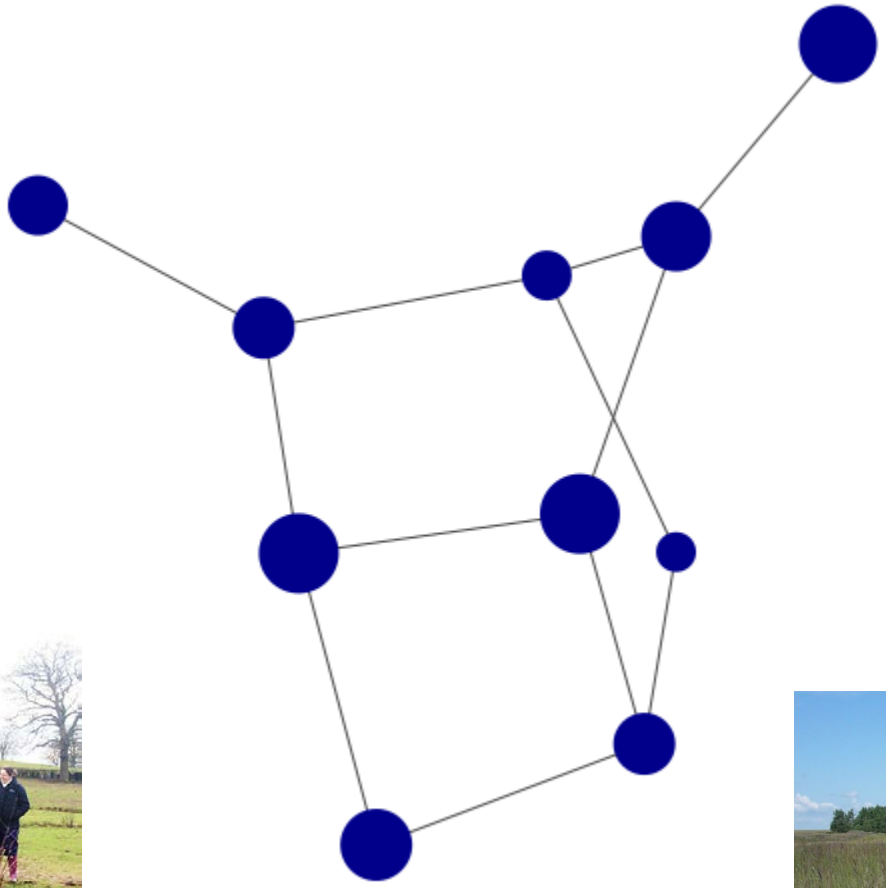
Undirected vs. Directed





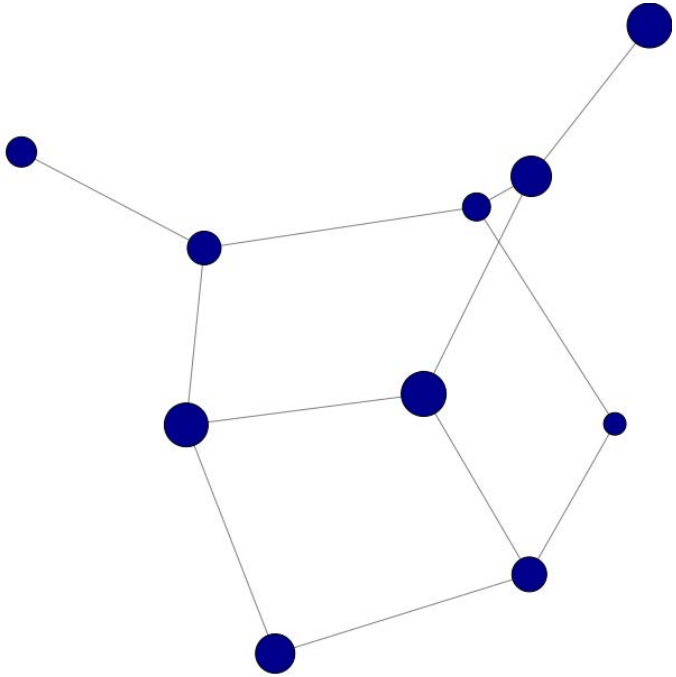
Network Classes

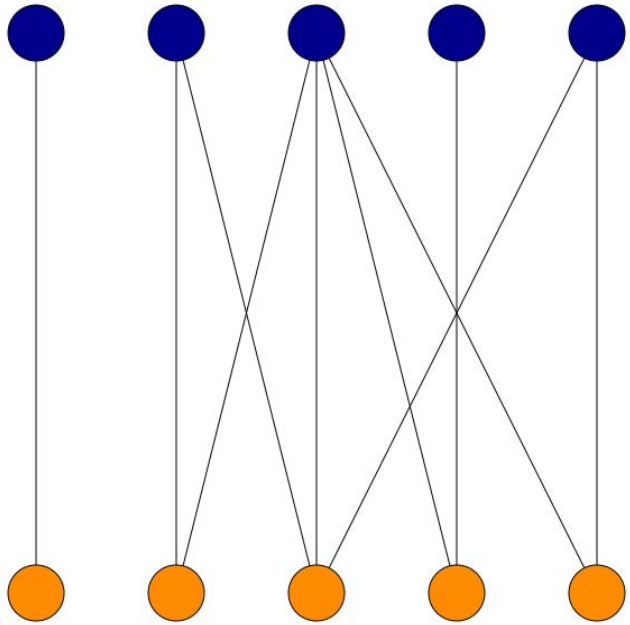
Unweighted vs. Weighted

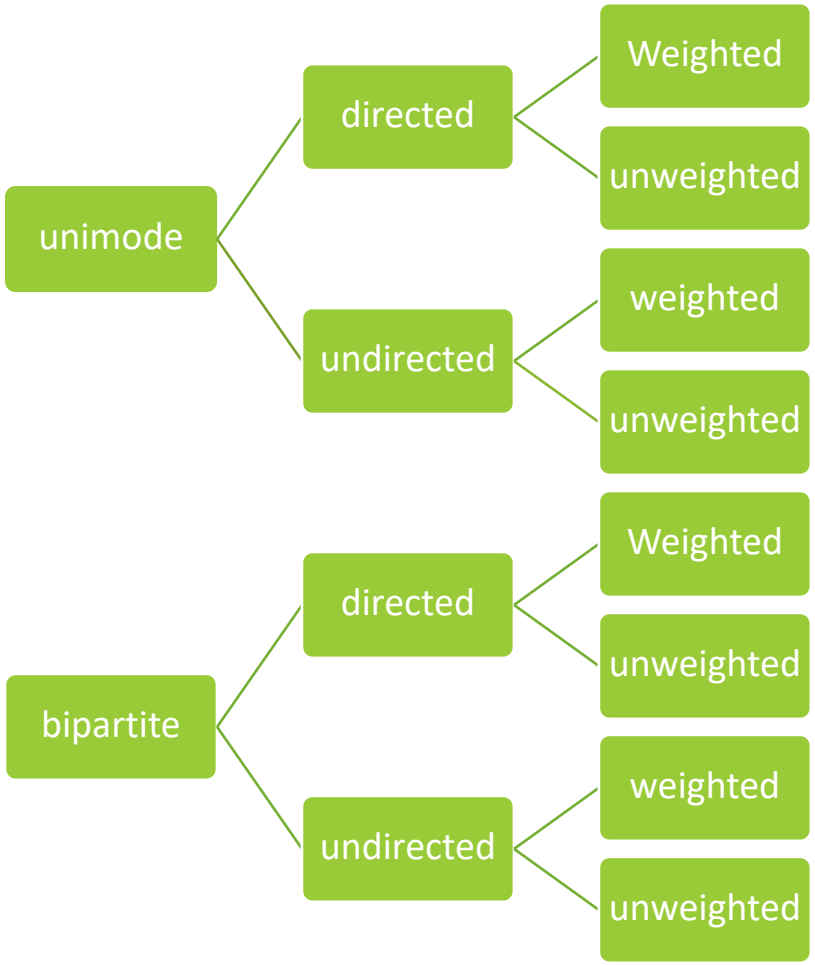


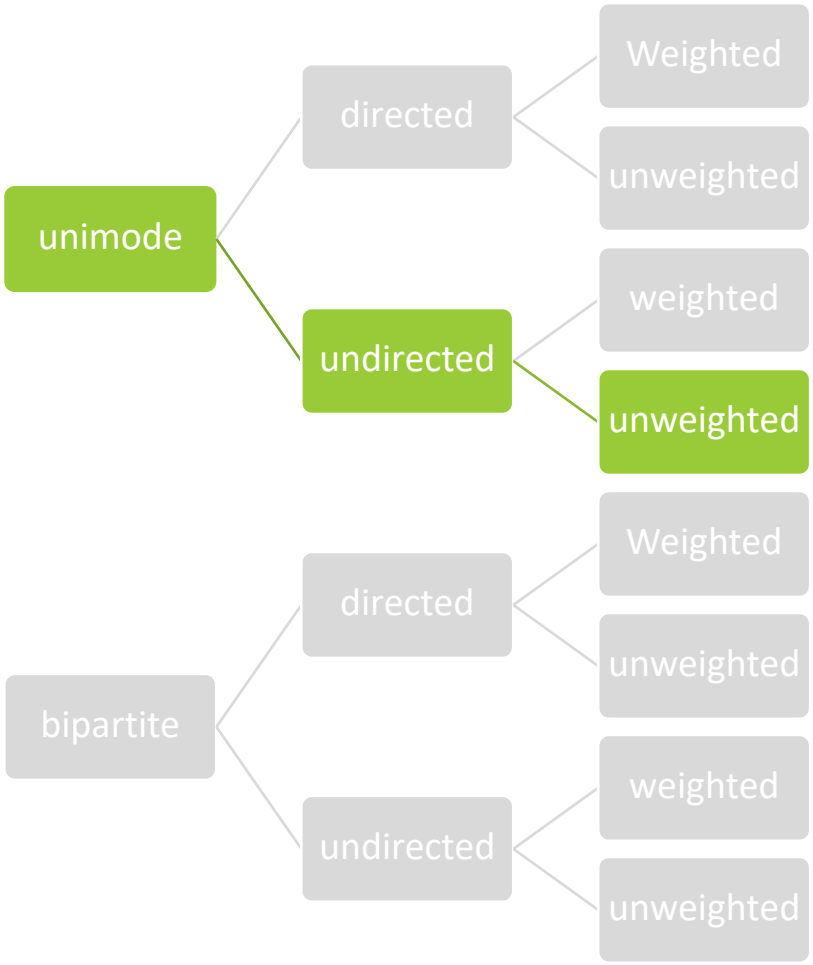
Network Classes

Unimode vs. Bipartite






unimode
directed
Weighted
unweighted
undirected
weighted
unweighted
bipartite
directed
Weighted
unweighted
undirected
weighted
unweighted


unimode
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bipartite
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Weighted
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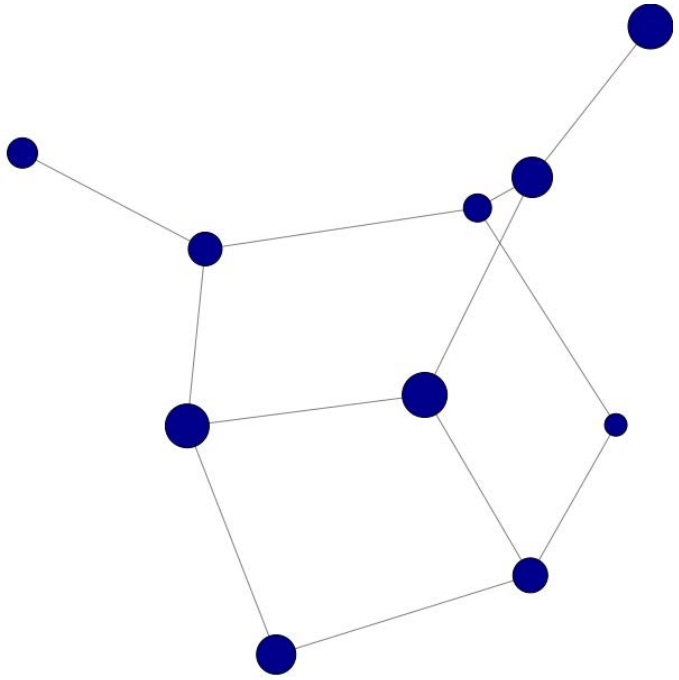

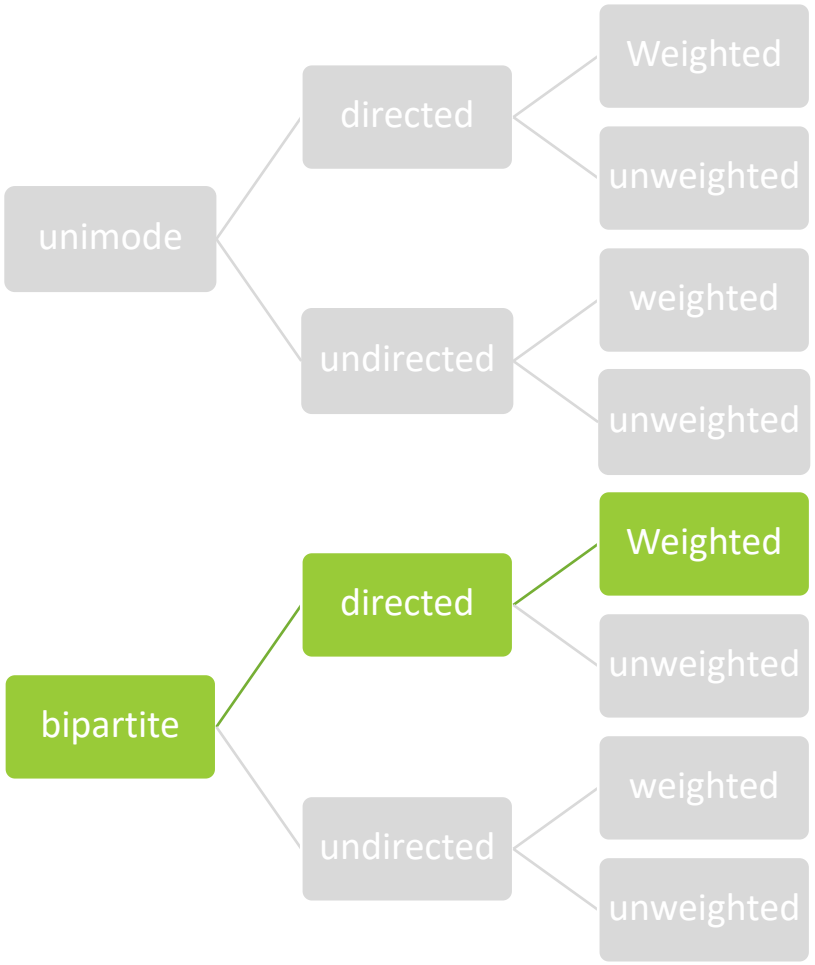
unimode
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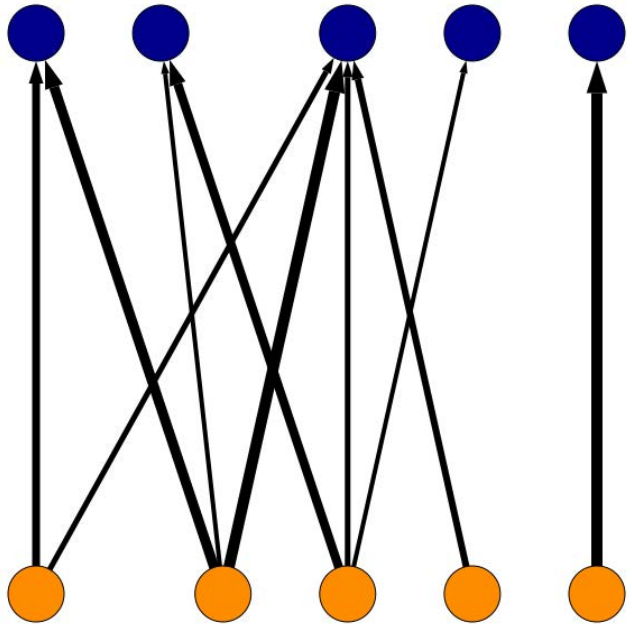
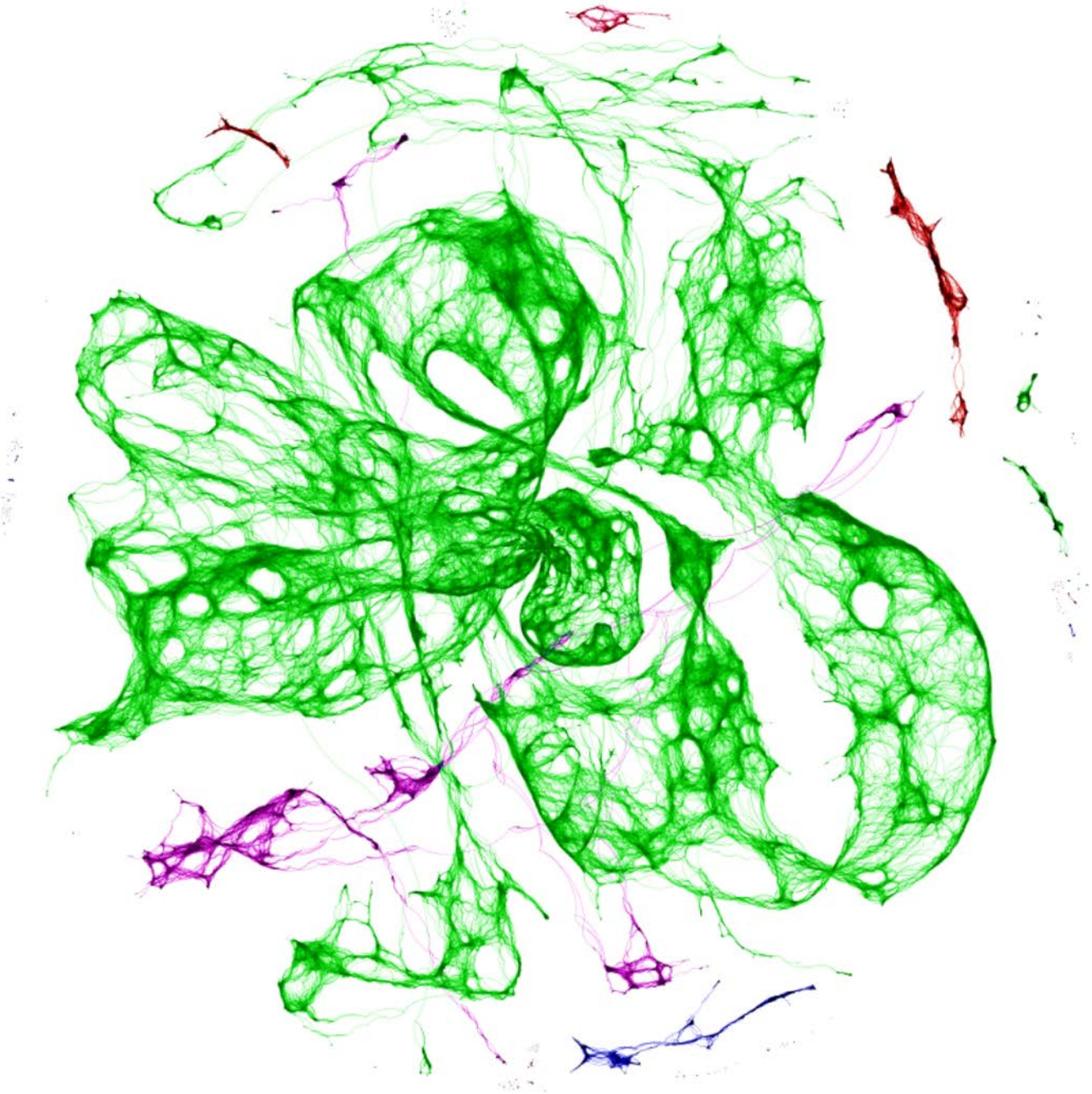
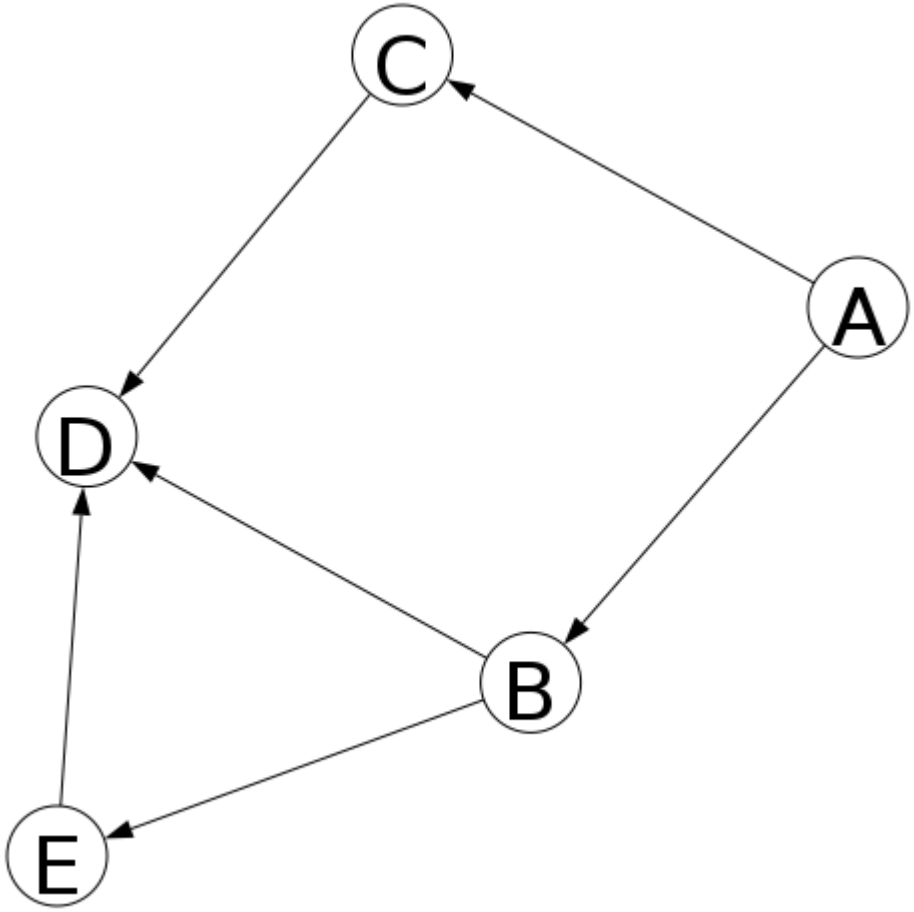




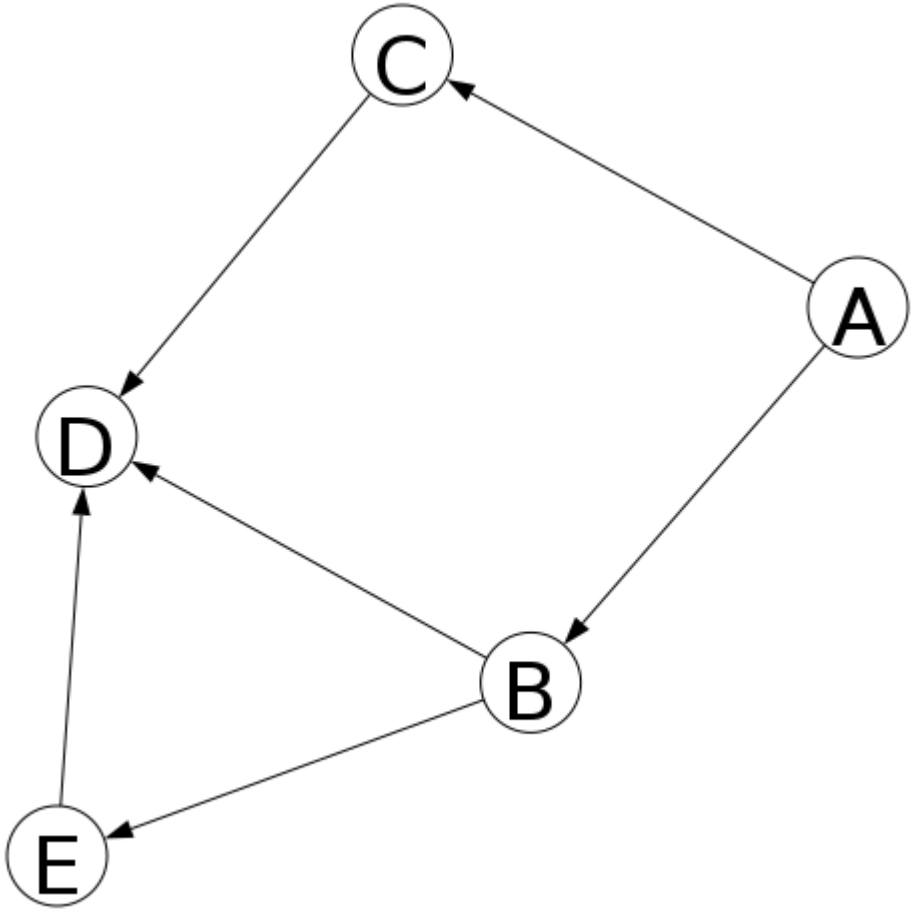
Network Representation - Edgelist



(A, B)
(A, C)
(B, D)
(B, E)
(C, D)
(E, D)

Network Representation –Matrix

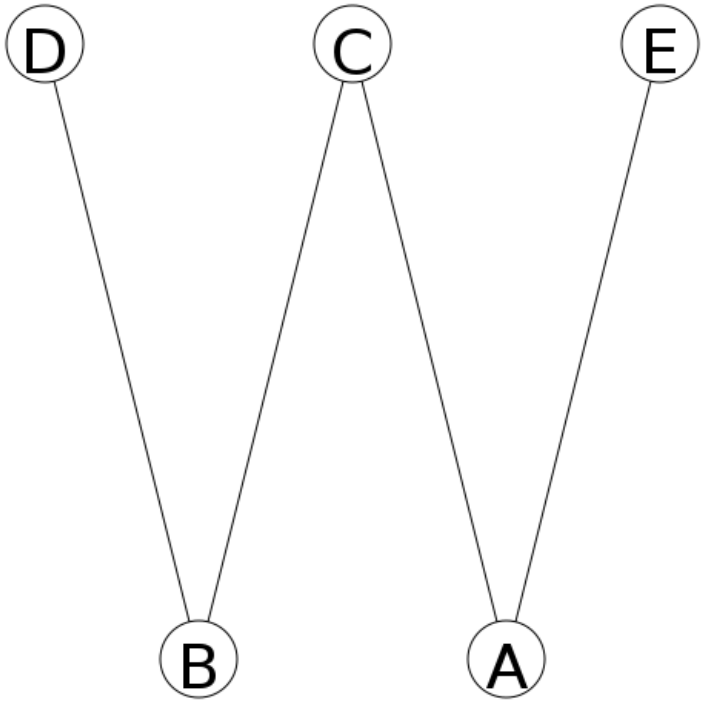
Unimode Networks



	A	B	C	D	E
A	0	1	1	0	0
B	0	0	0	1	1
C	0	0	0	1	0
D	0	0	0	0	0
E	0	0	0	1	0

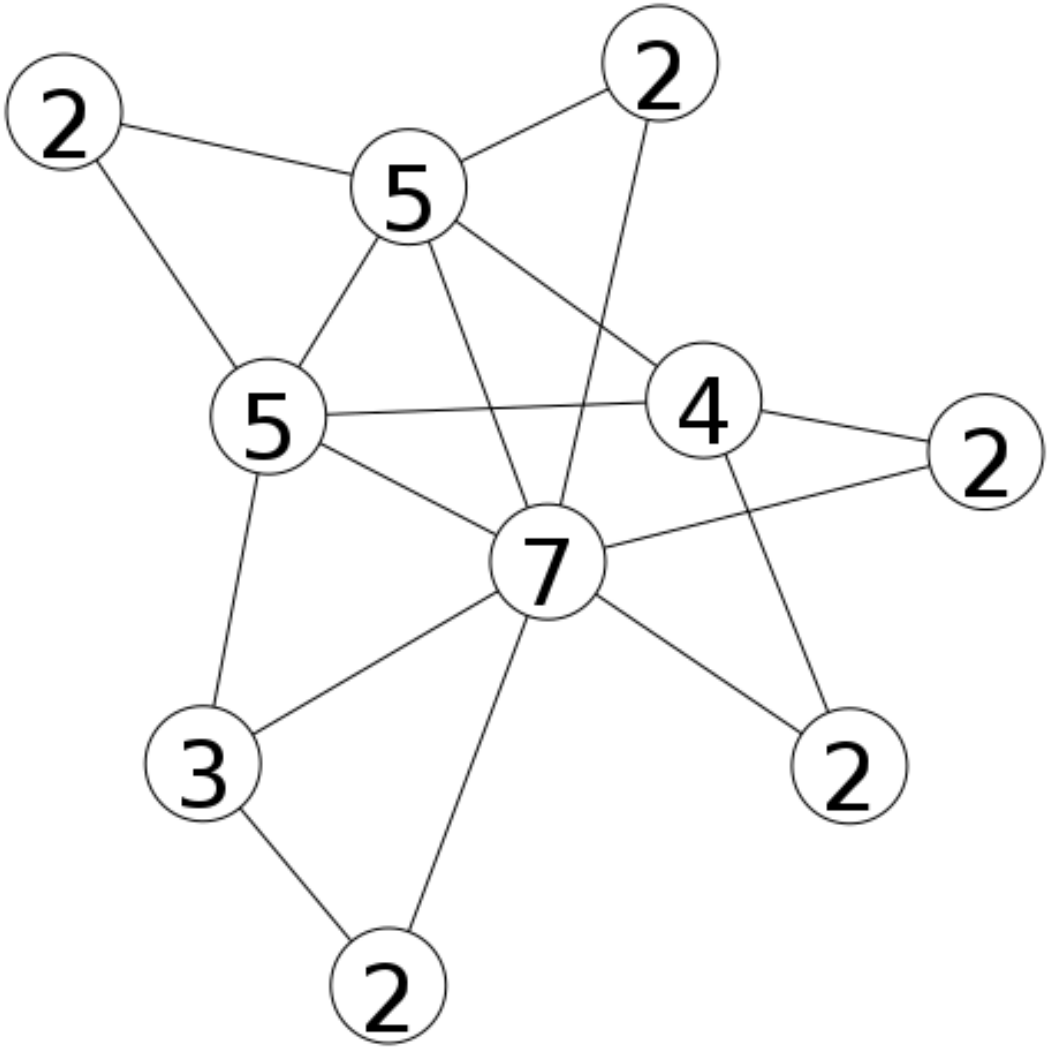
Network Representation –Matrix

Bipartite Networks

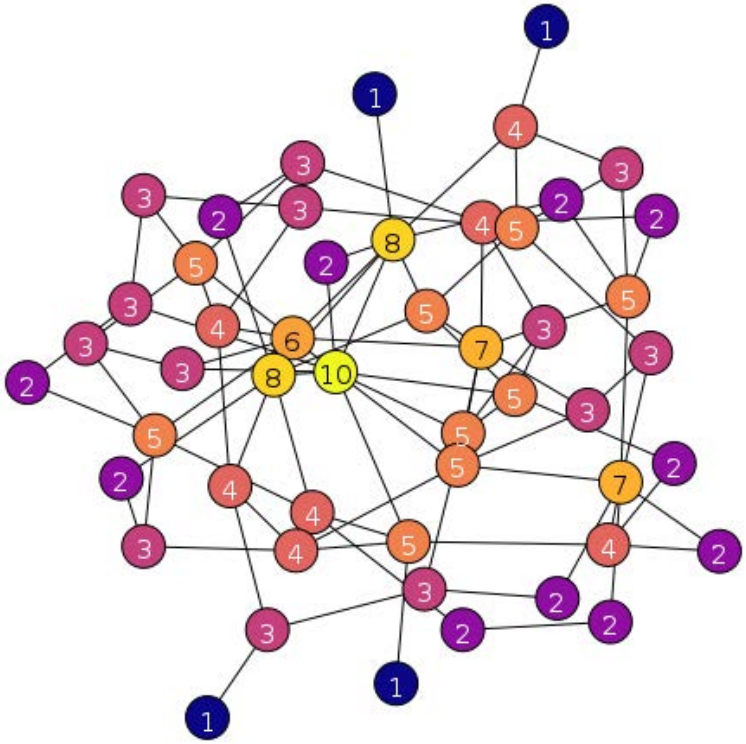


	C	D	E
A	1	0	1
B	1	1	0

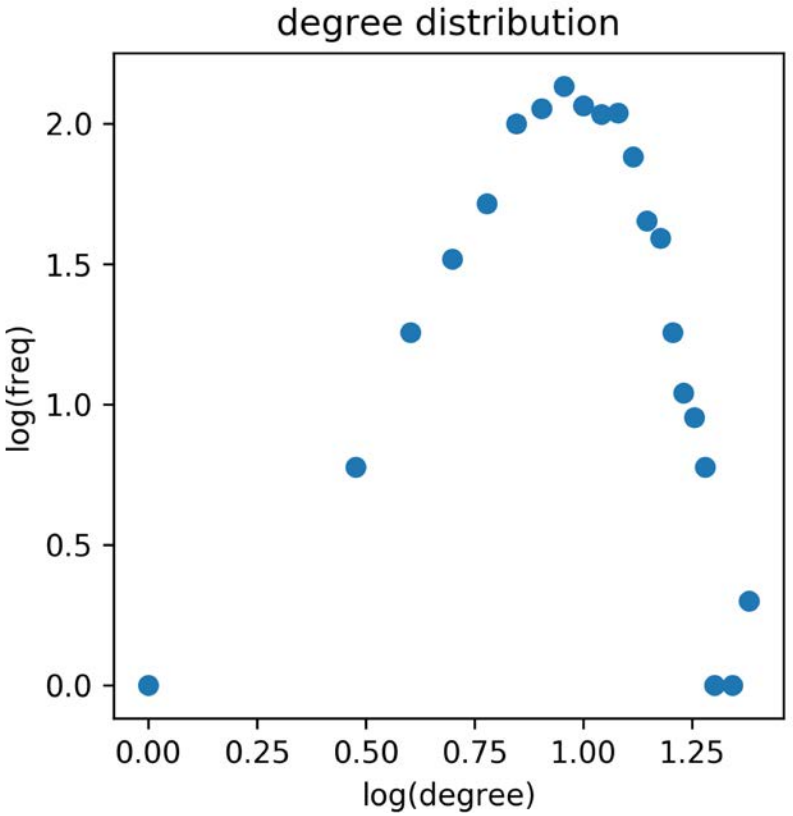
Network Properties – Node Degree



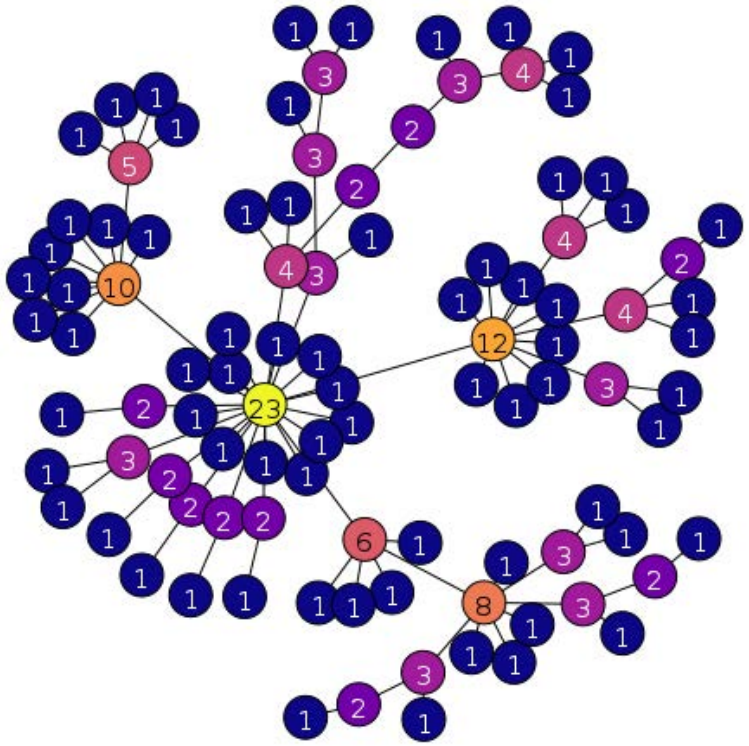
Network Properties – Degree Distribution



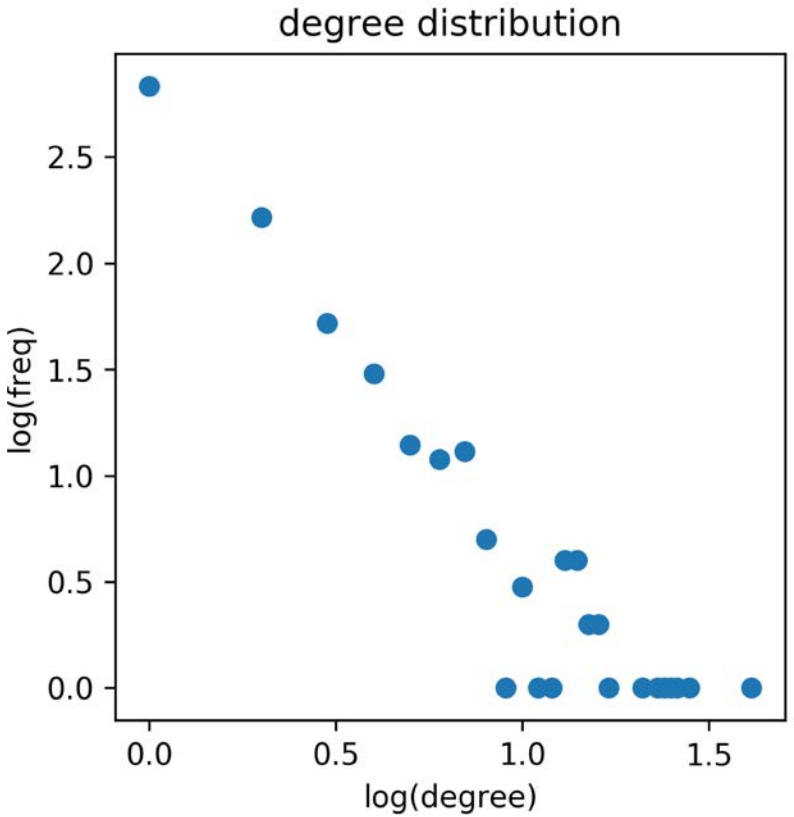
Random Network



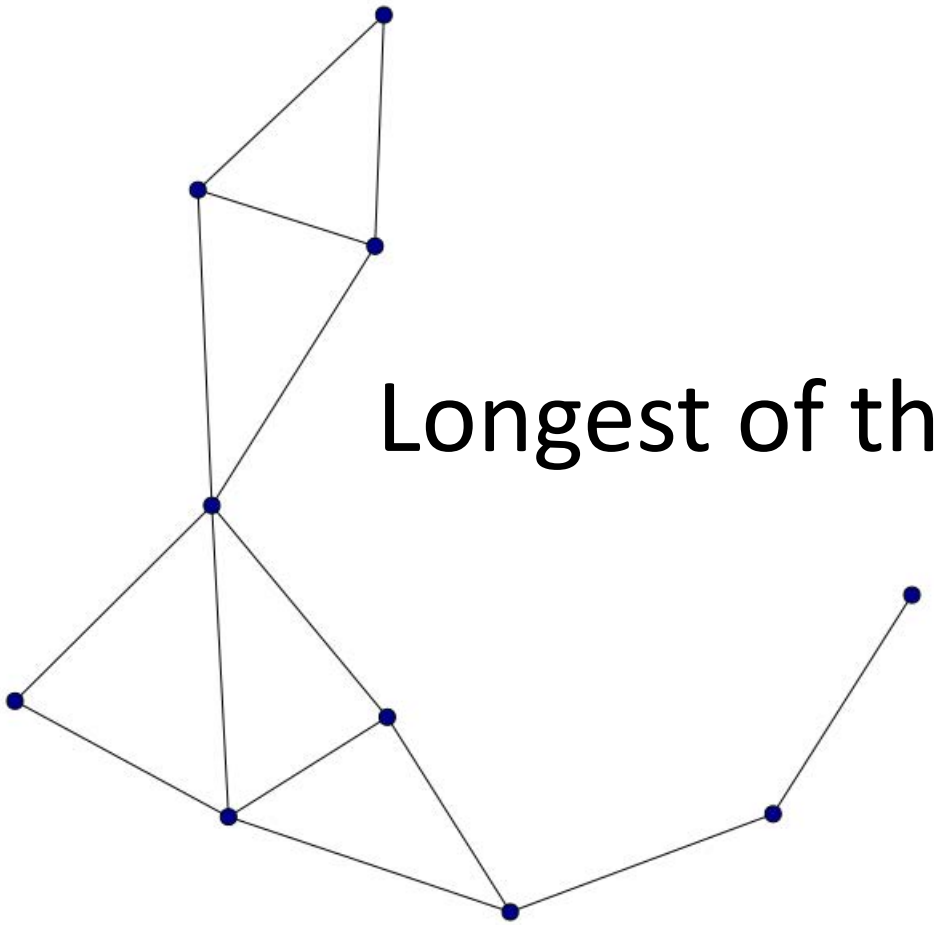
Network Properties – Degree Distribution



Power Law Network

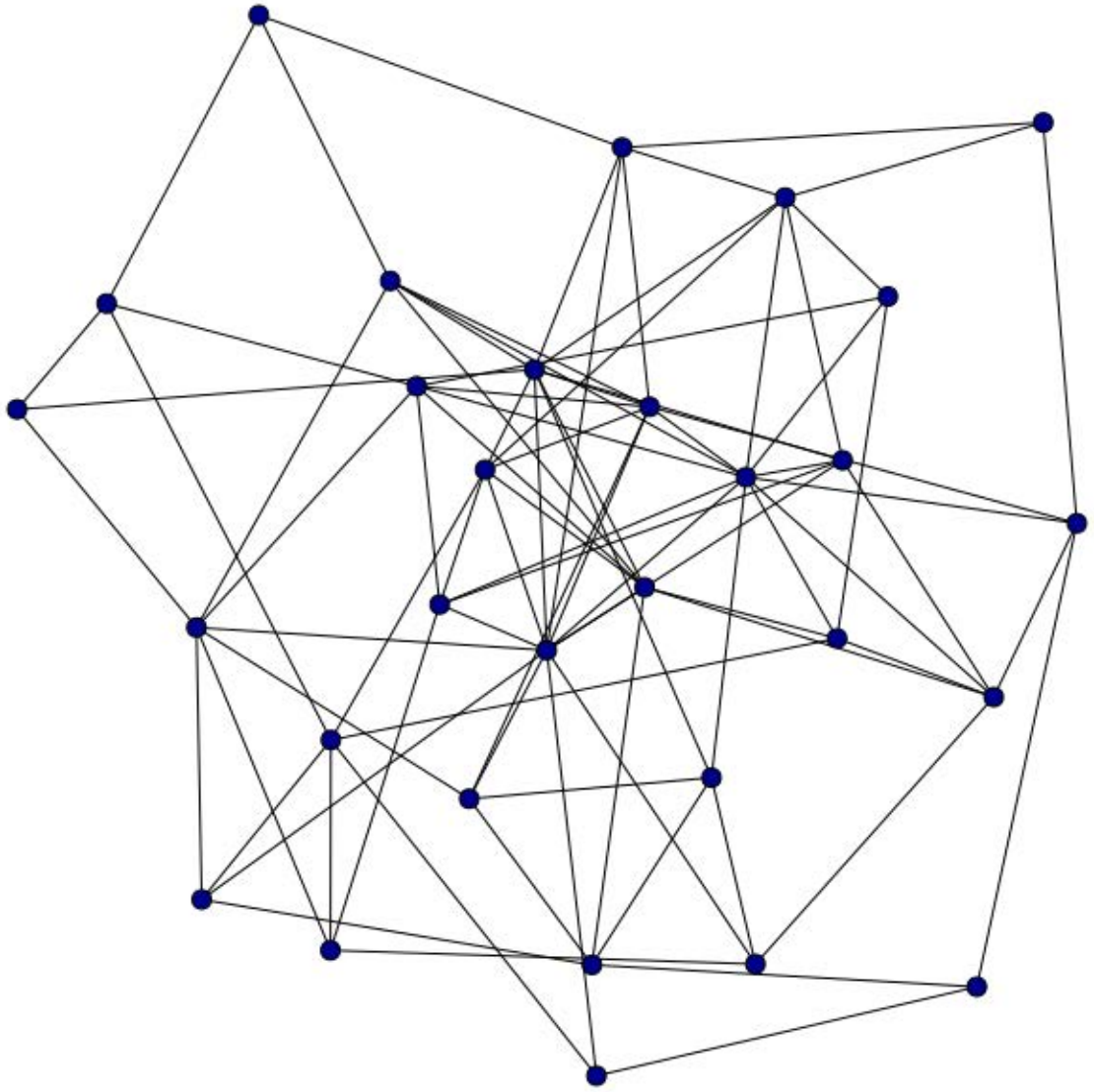


Network Properties – Diameter

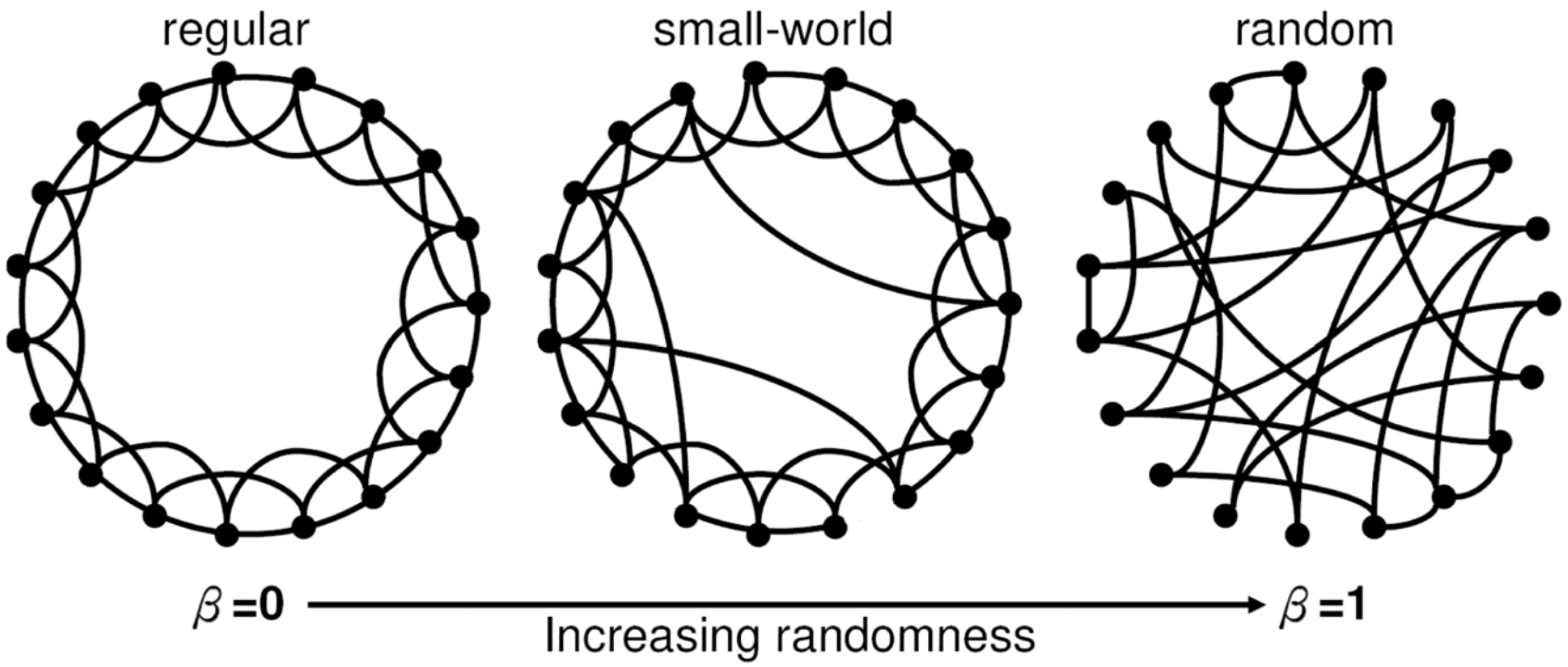


Longest of the shortest paths

Network Properties – Diameter



Small World



Watts, D. J., & Strogatz, S. H. (1998). Collective dynamics of ‘small-world’networks. Nature, 393(6684), 440-442. (**Cited more than 38000 times!**).

Thank you!

Slides, code, selected references/online material:

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