



DCS/CSCI 2350: Social and Economic Networks

Intro to Graph Theory

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An abstract network diagram on the left side of the slide. It features a complex web of interconnected nodes (small dots) and edges (thin lines) in a dark red color. The background is a light pinkish-red with a subtle geometric pattern of overlapping triangles and polygons.

Networks:
A modern way of looking at,
reasoning about, and making
sense of our connected world

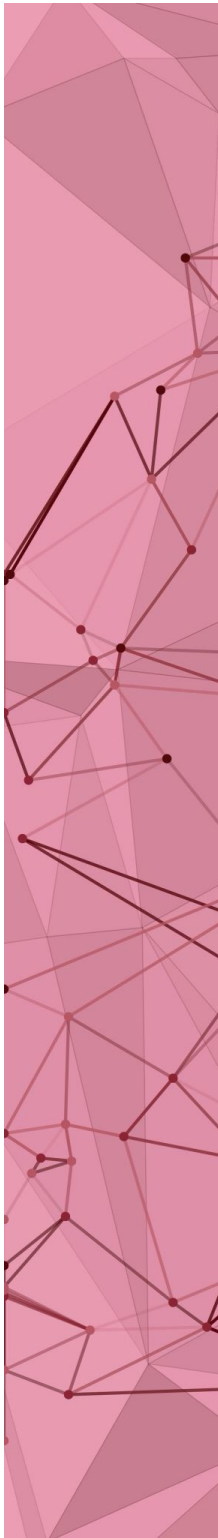
Real-world examples

Autism mutations rewire protein interaction networks to drive neurodevelopmental pathology

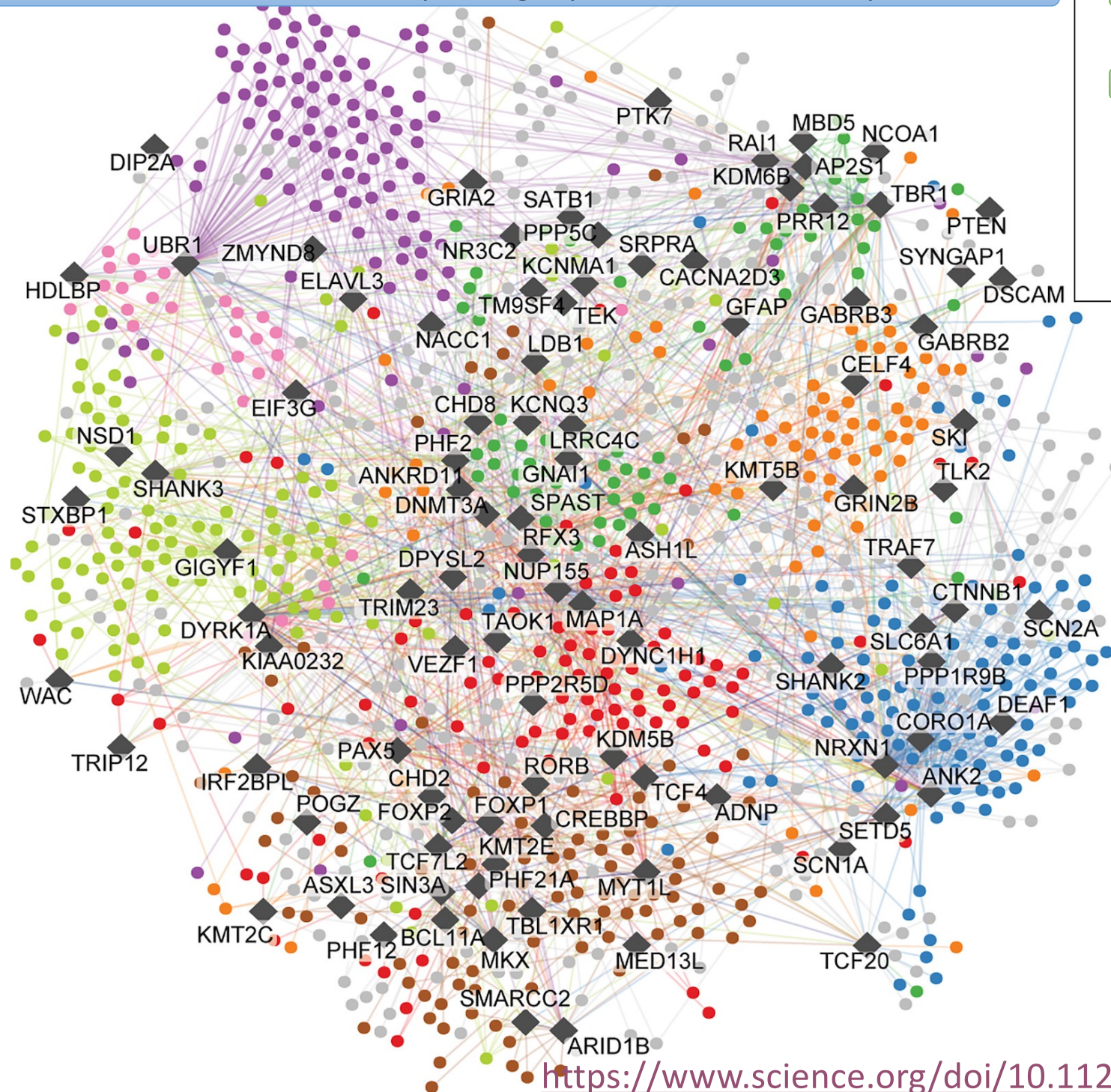
“Valuable insights into the biology of autism spectrum disorder (ASD) through mapping 100 high-confidence ASD genes and producing a large protein-protein-interaction (PPI) network. The authors showed that disease-associated variants selectively weakened or strengthened specific PPIs.” (Mattia Maroso, Editor, paraphrased)

Link to paper:

<https://www.science.org/doi/10.1126/science.ady4523>



Protein-Protein interaction map using alpha-fold structural prediction



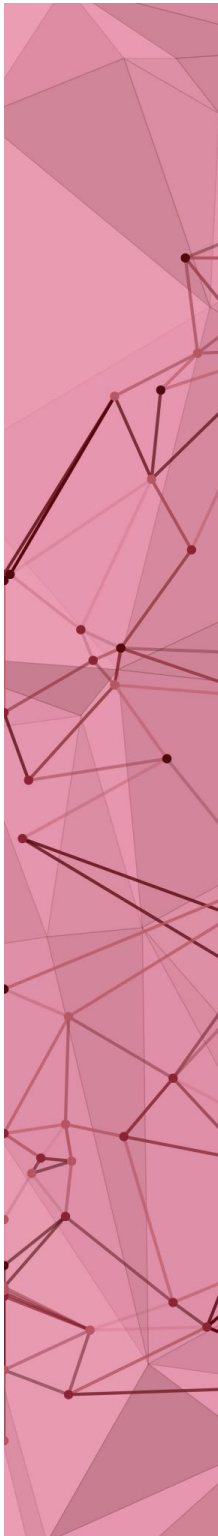
<https://www.science.org/doi/10.1126/science.ady4523>

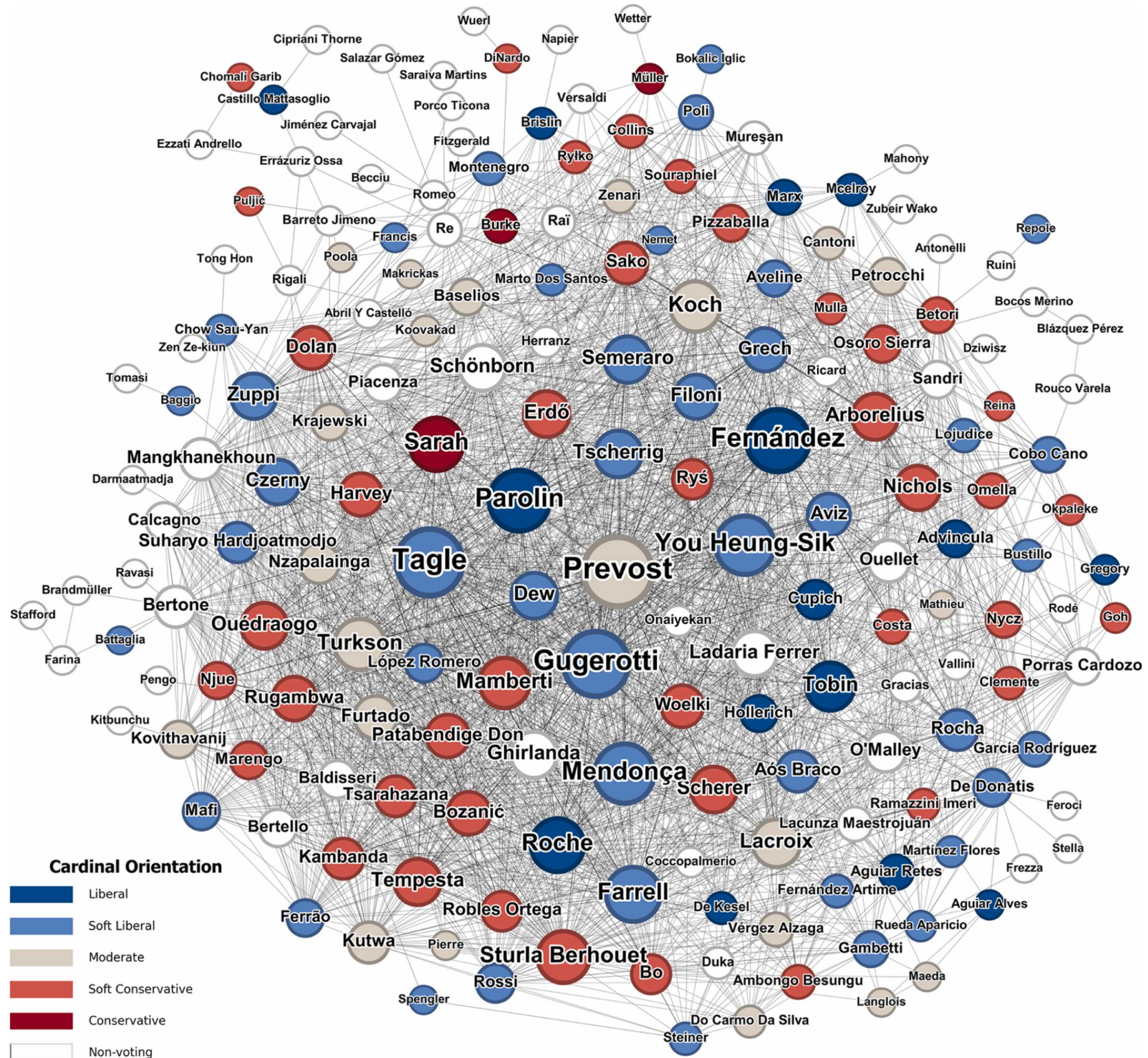
In the network of the conclave: Social connections and the making of a pope

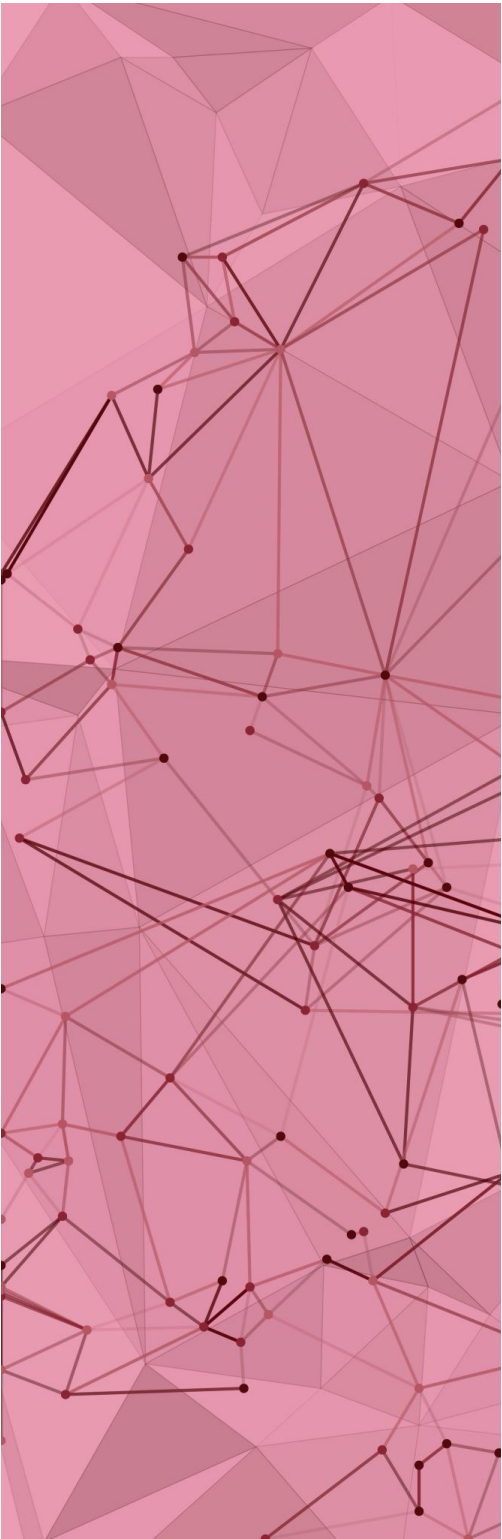
“Our descriptive study—publicly released prior to the May 8, 2025 election of Pope Leo XIV—shows that Cardinal Robert F. Prevost, largely ignored by pundits, bookmakers, and AI models, held a uniquely advantageous position in the Vatican network, by virtue of being central in multiple respects.”

Link to paper:

<https://www.sciencedirect.com/science/article/pii/S0378873325000449>

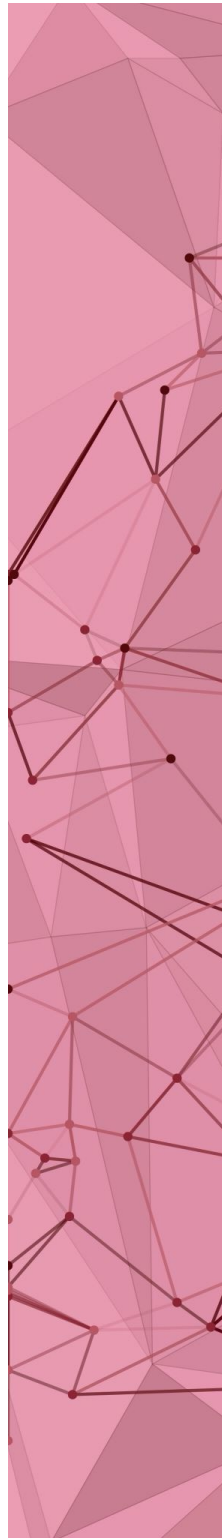






From autism and
Pope election to ...

This will be our running example.





Reading: Ch 2 (Easley-Kleinberg)

Also see handout

Networks/Graphs

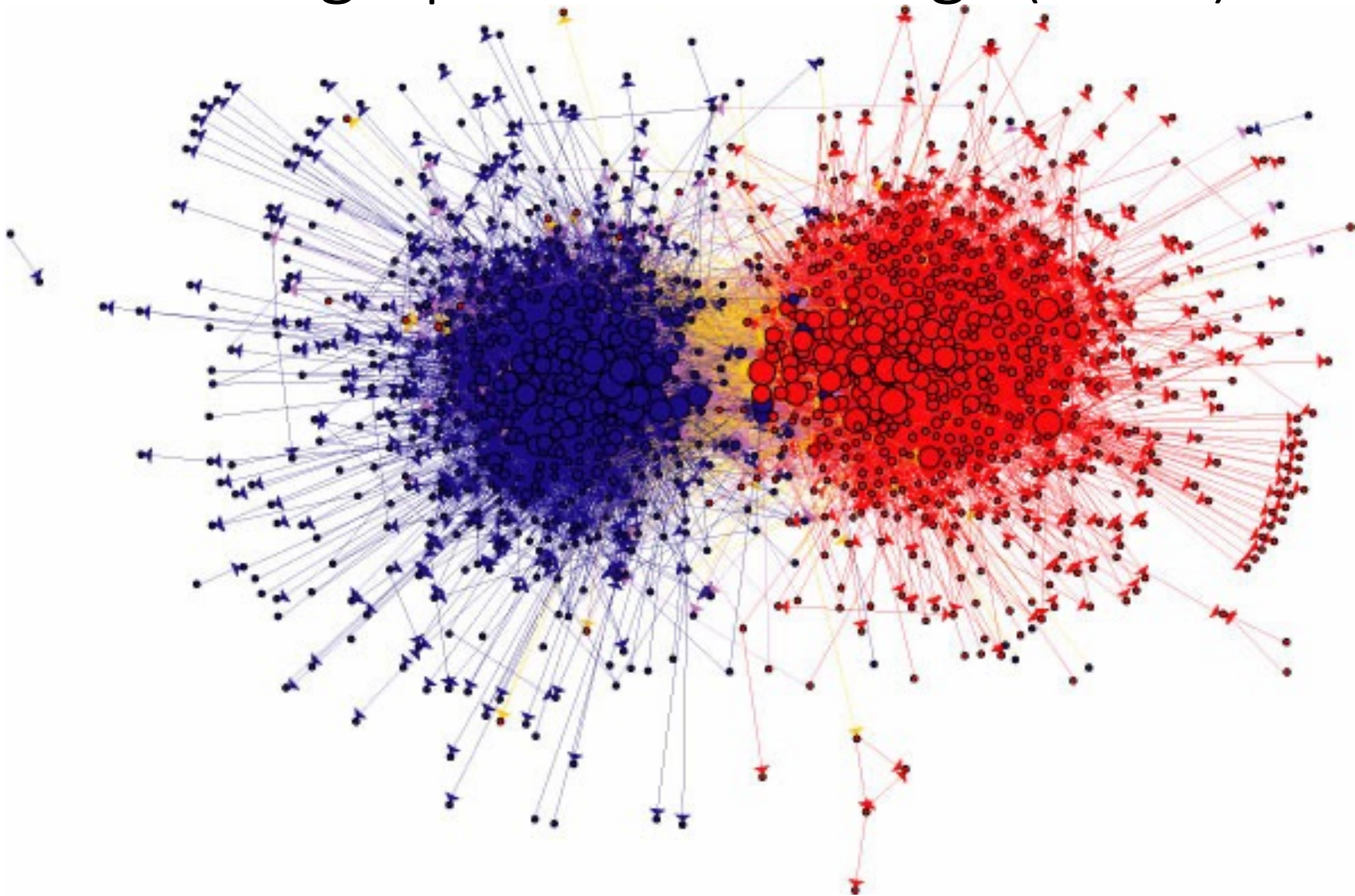
Basic Terminology

"Graph theory is a terminological jungle, in which any newcomer may plant a tree." – John Barnes

Undirected graph: Where do friends live? (2010)



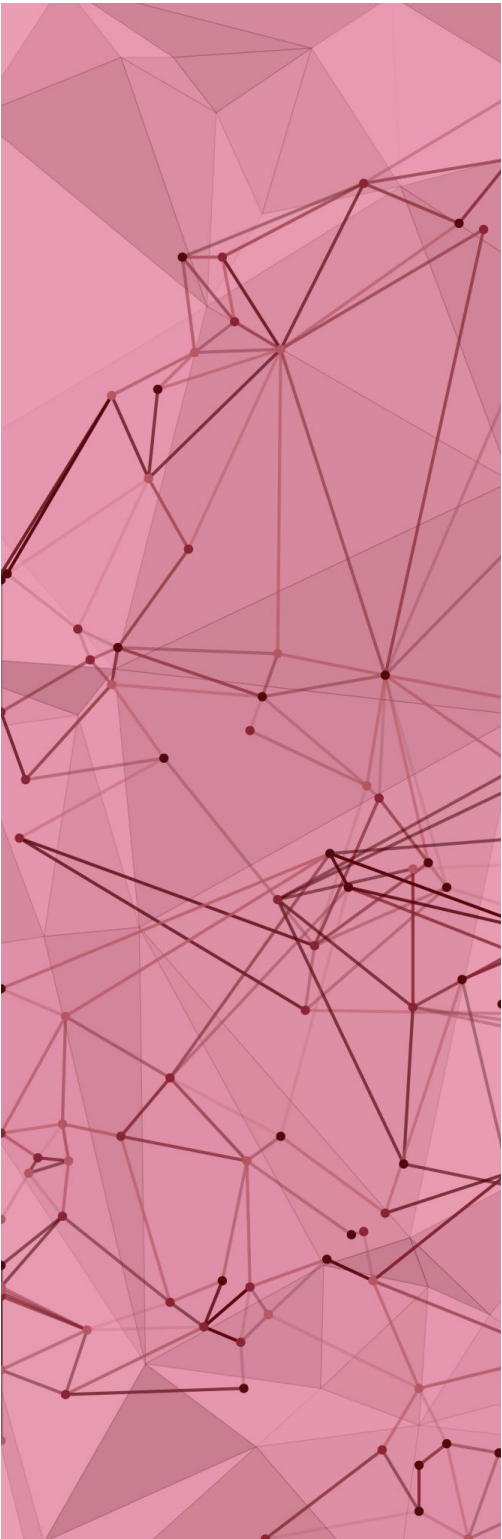
Directed graph: Political blogs (2005)



Homework

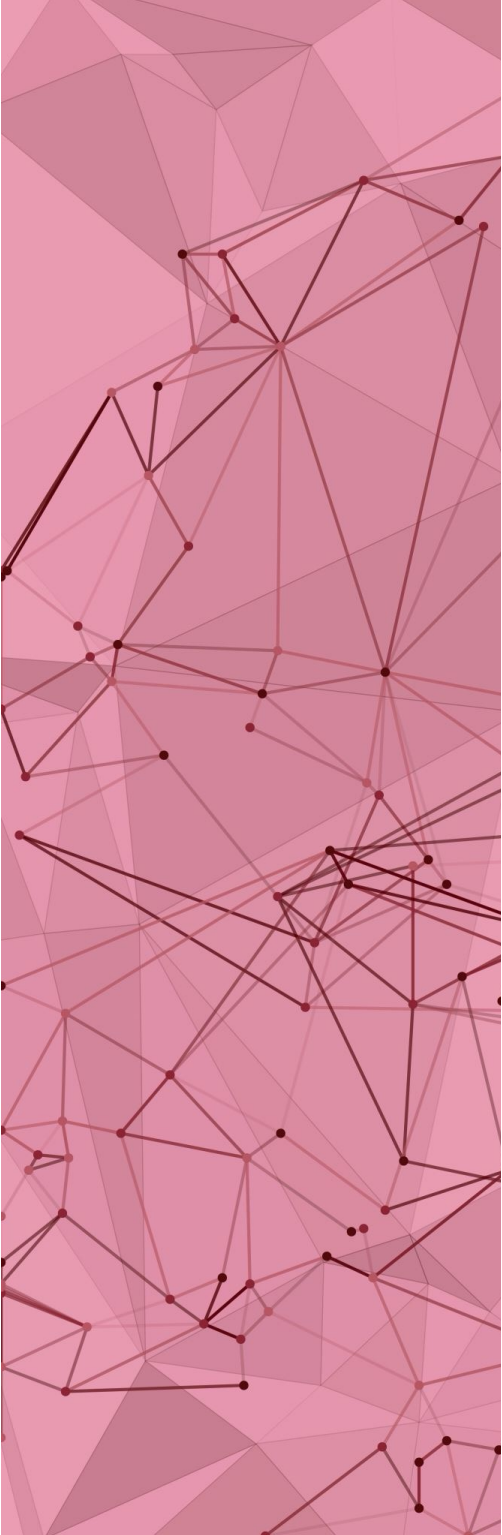
Submit FA 1 on Canvas





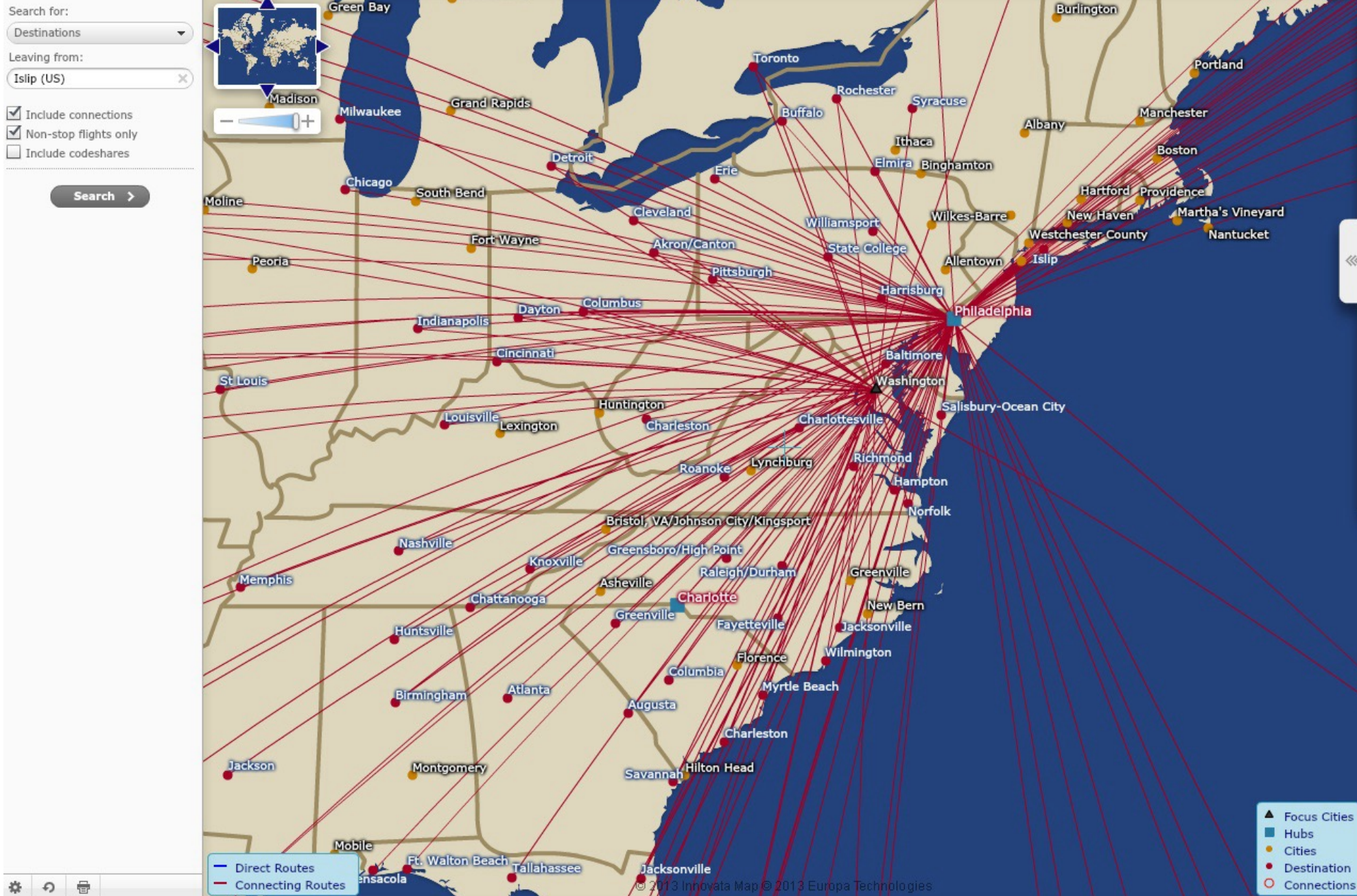
Some ~~Properties~~ Puzzles

Degree-sum formula
Max # of edges

An abstract network diagram on the left side of the slide. It features a complex web of dark red lines connecting numerous small, dark red circular nodes. The background of this section is a light pink color with a subtle, darker pink geometric pattern of overlapping triangles and polygons. The network itself is dense and irregular, with many nodes and edges, suggesting a complex system or a large dataset.

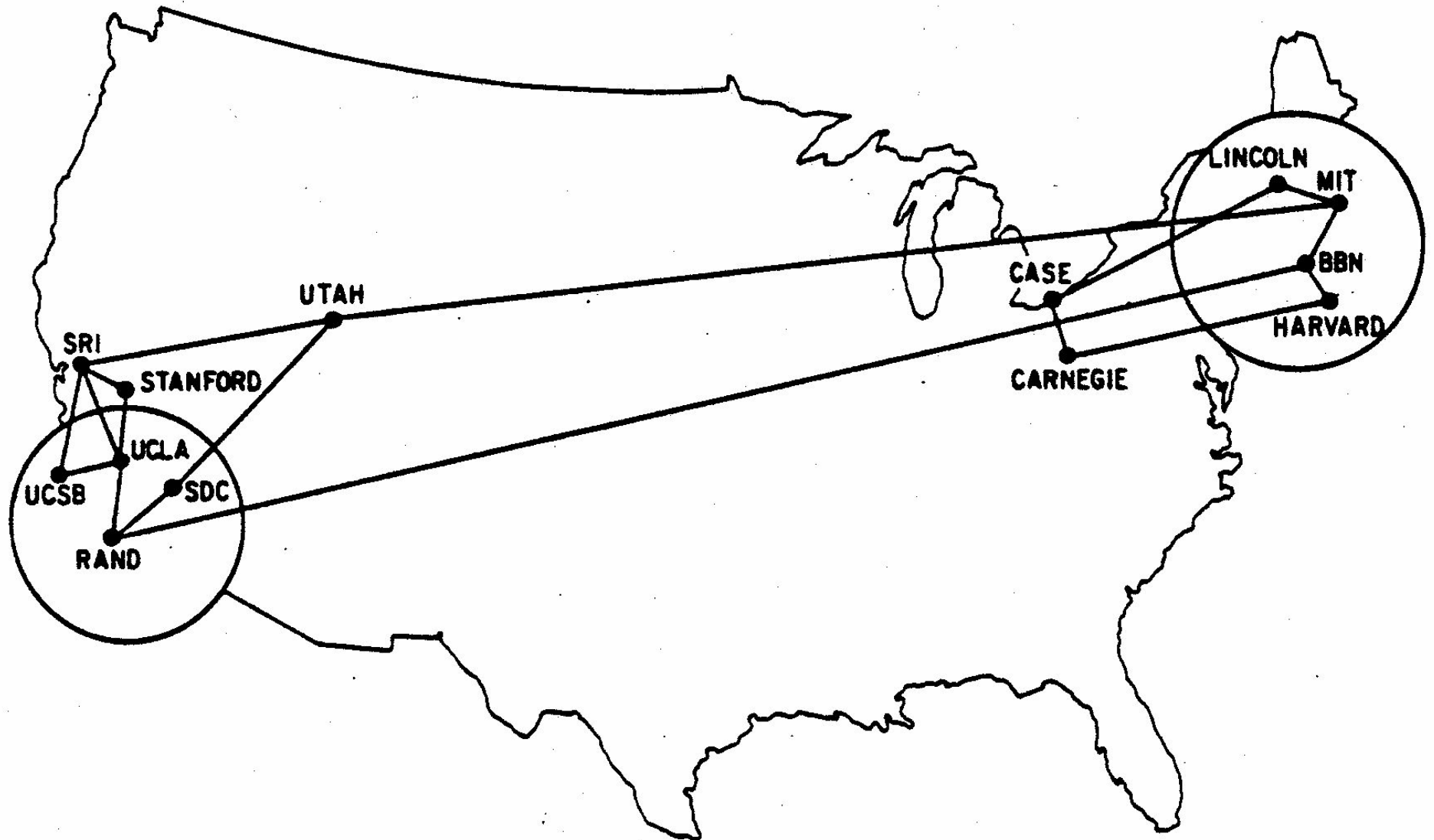
Paths and Cycles

For studying the flow of something in a network

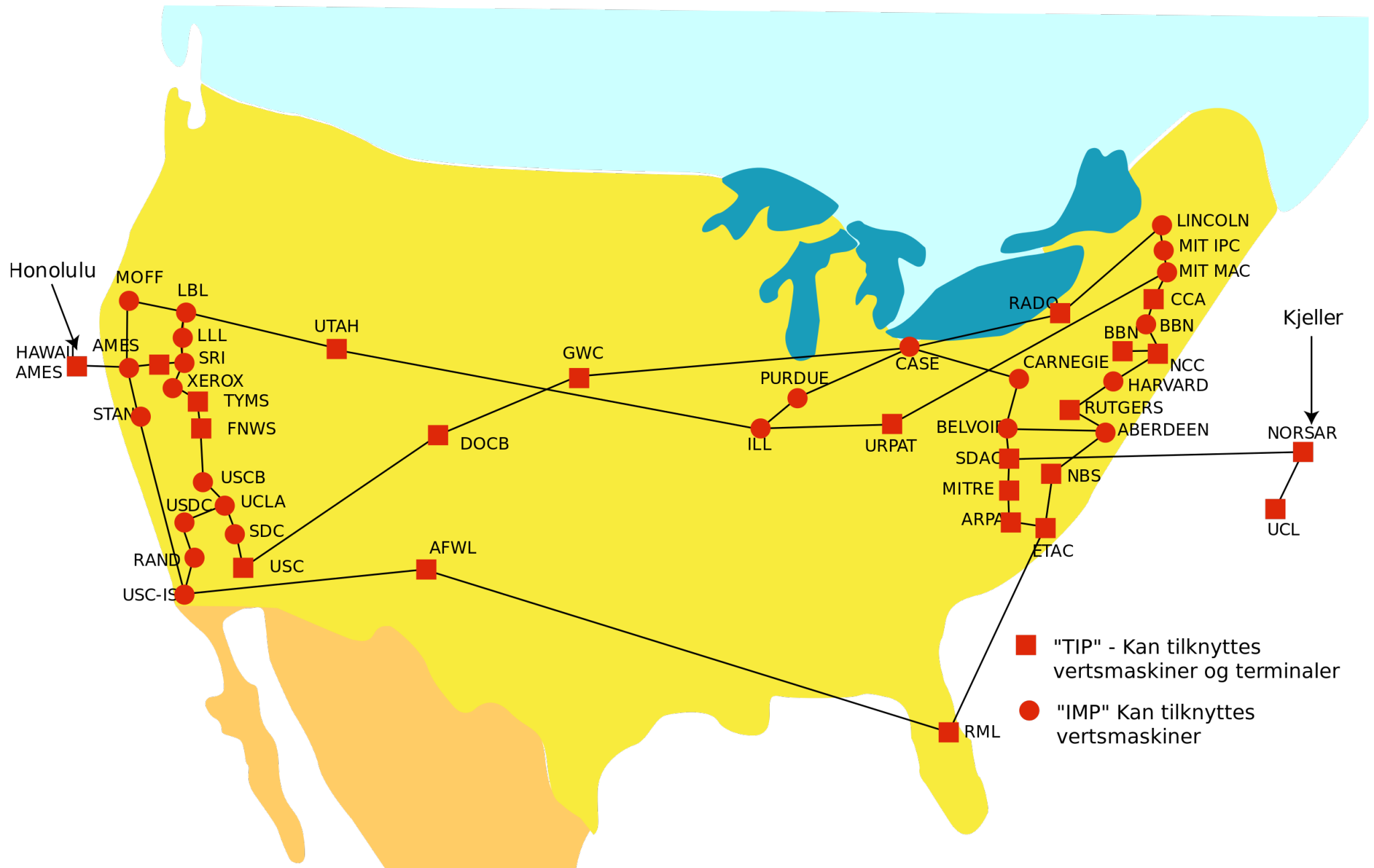


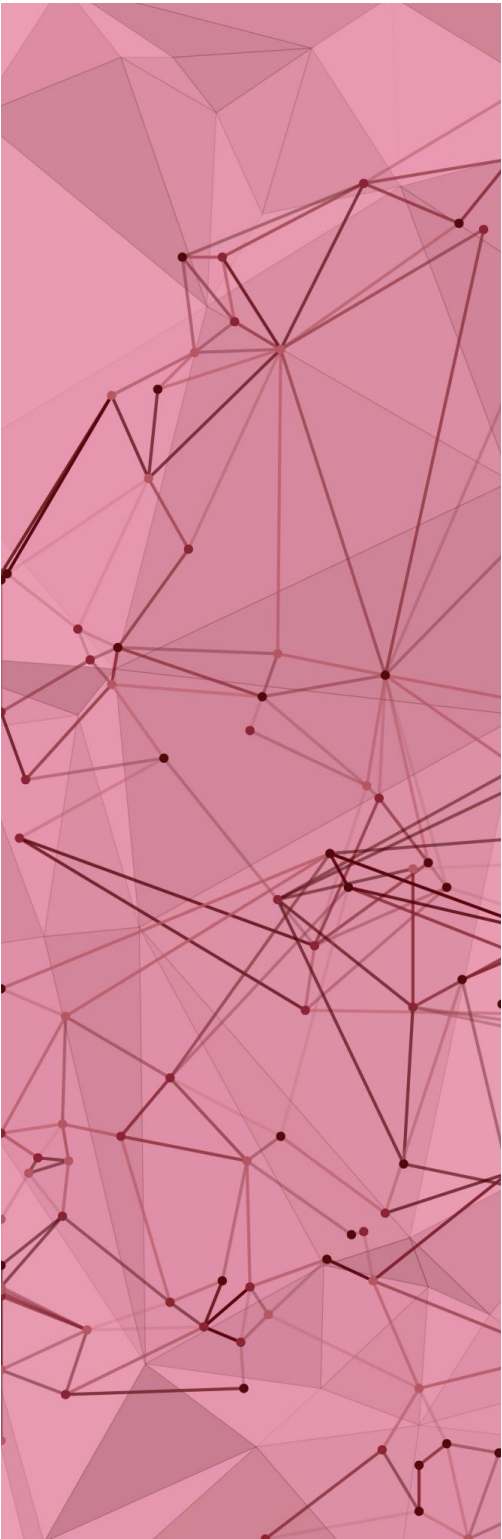


ARPANET (1970)



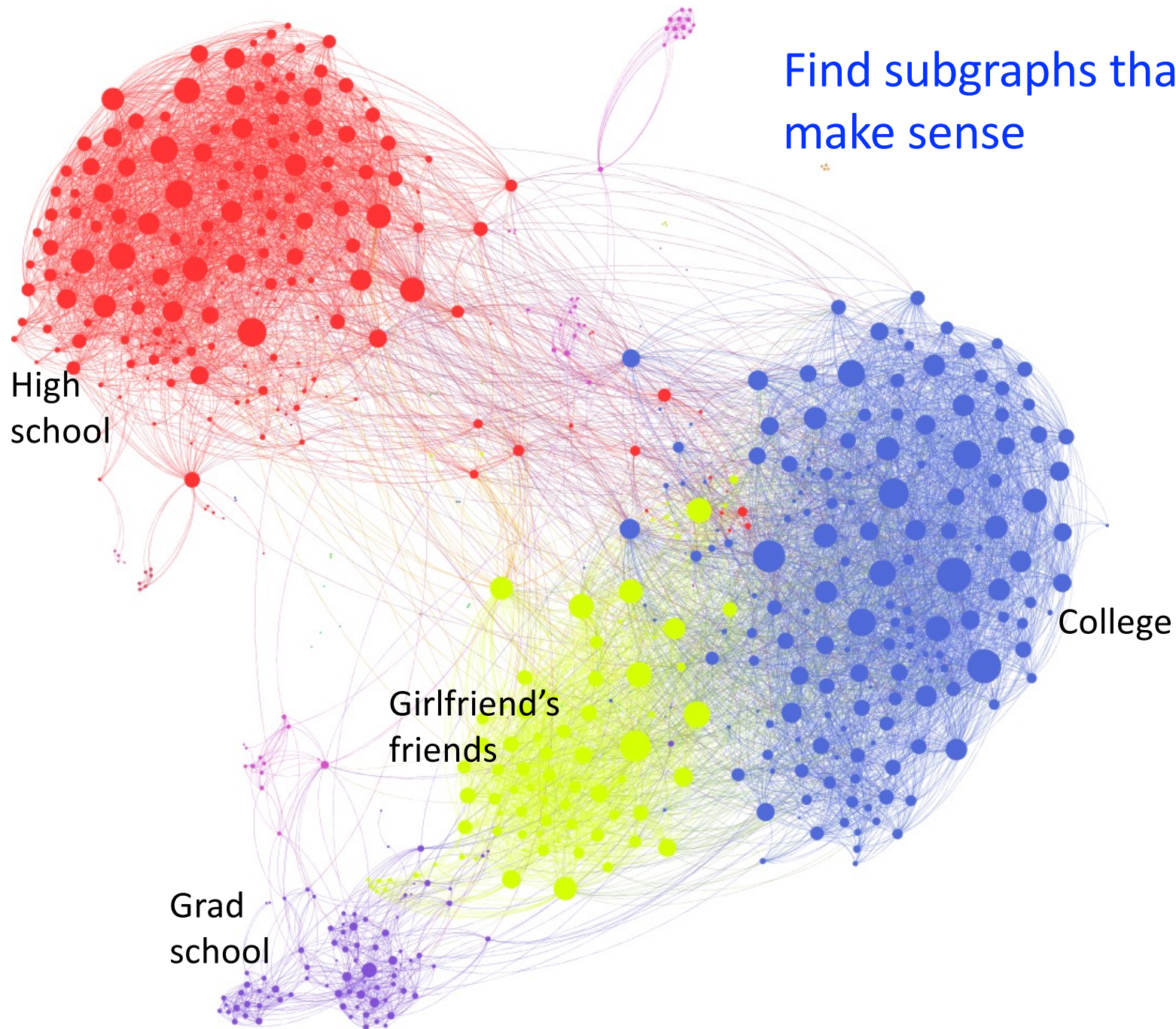
ARPANET (1974)



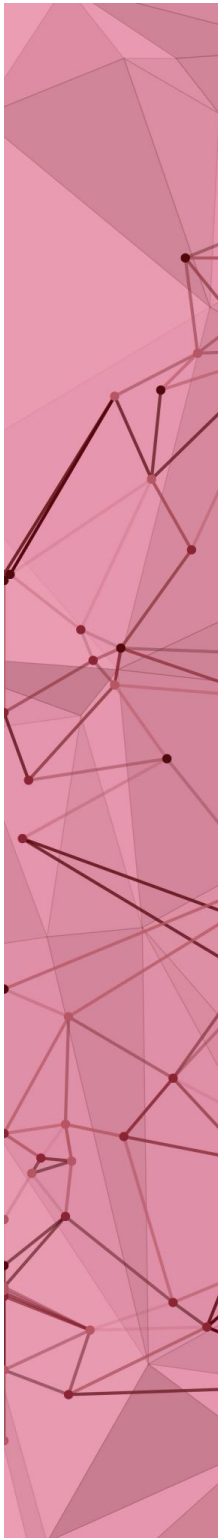


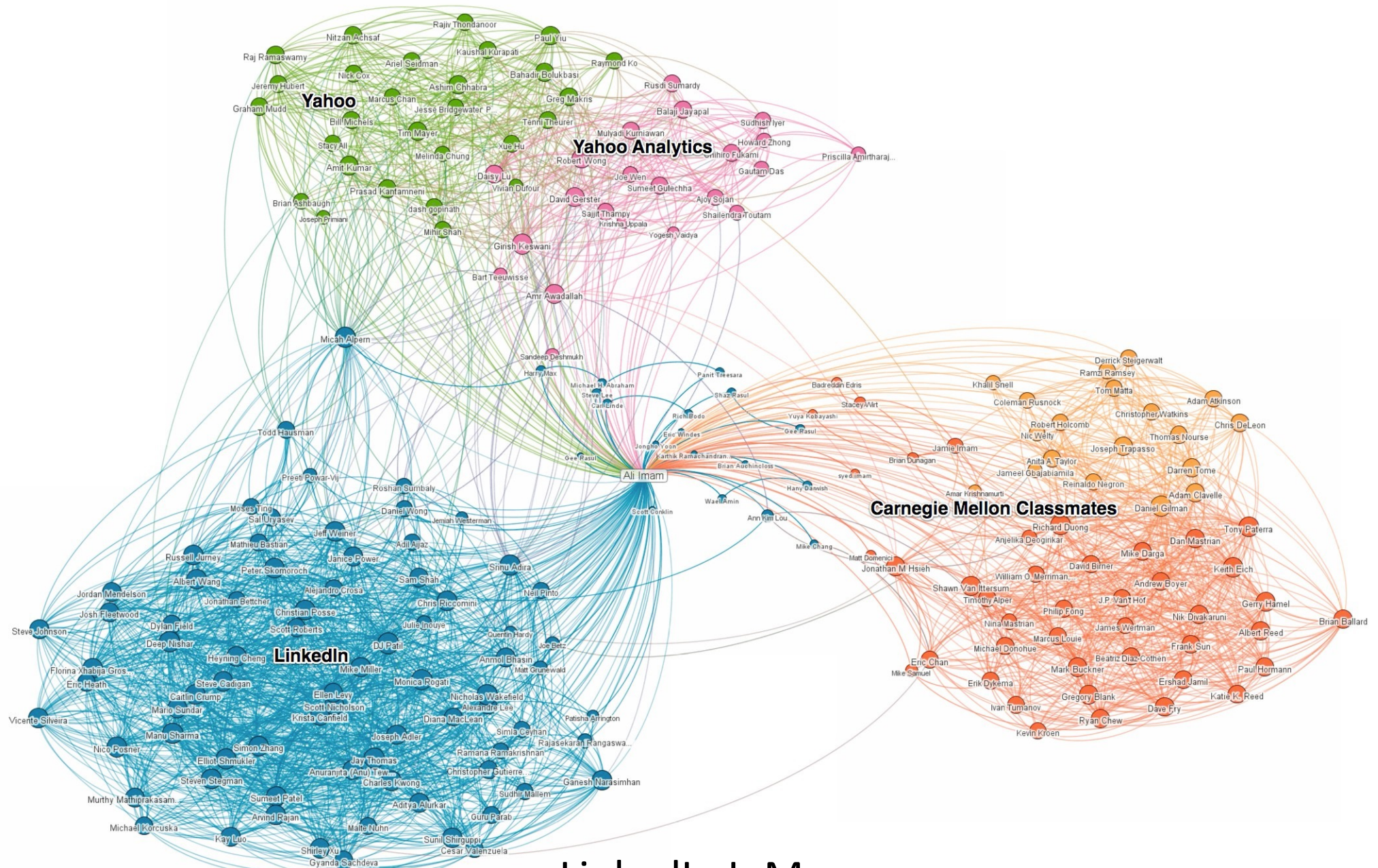
Connectivity:
subgraph
component

Find subgraphs that
make sense



<https://griffgraphs.wordpress.com/2012/07/02/a-facebook-network/>



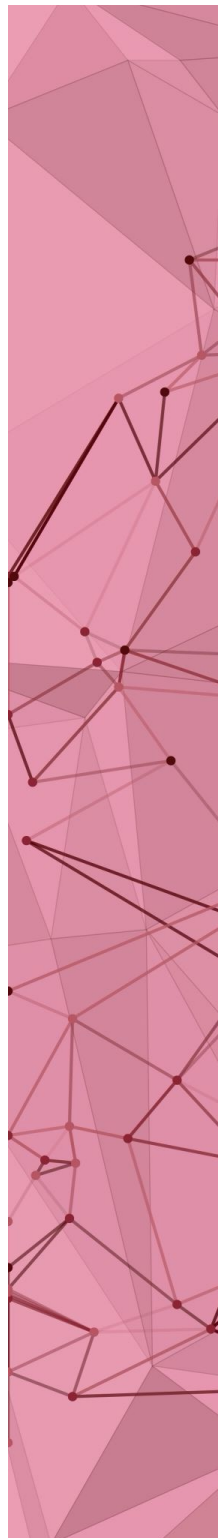
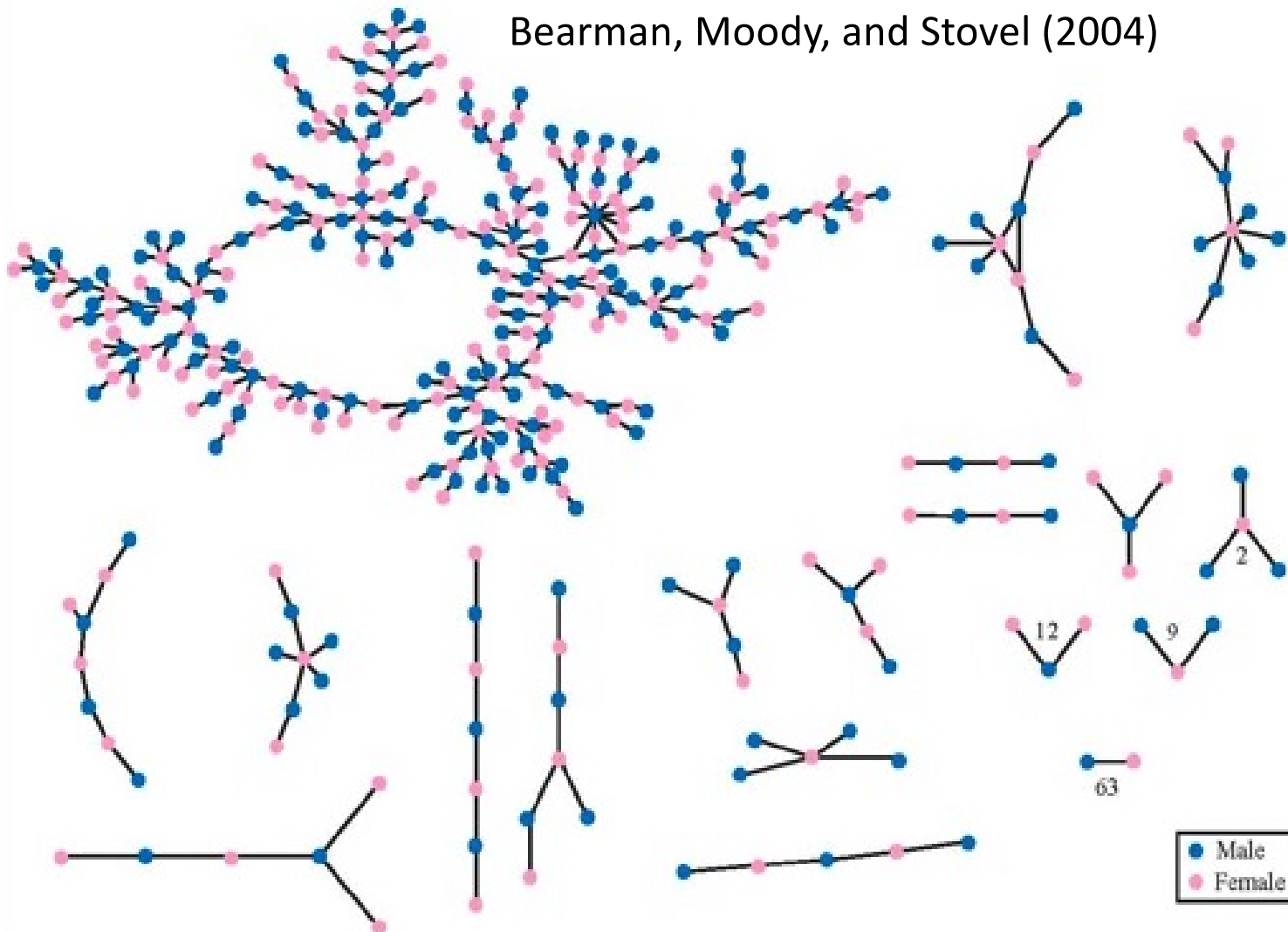


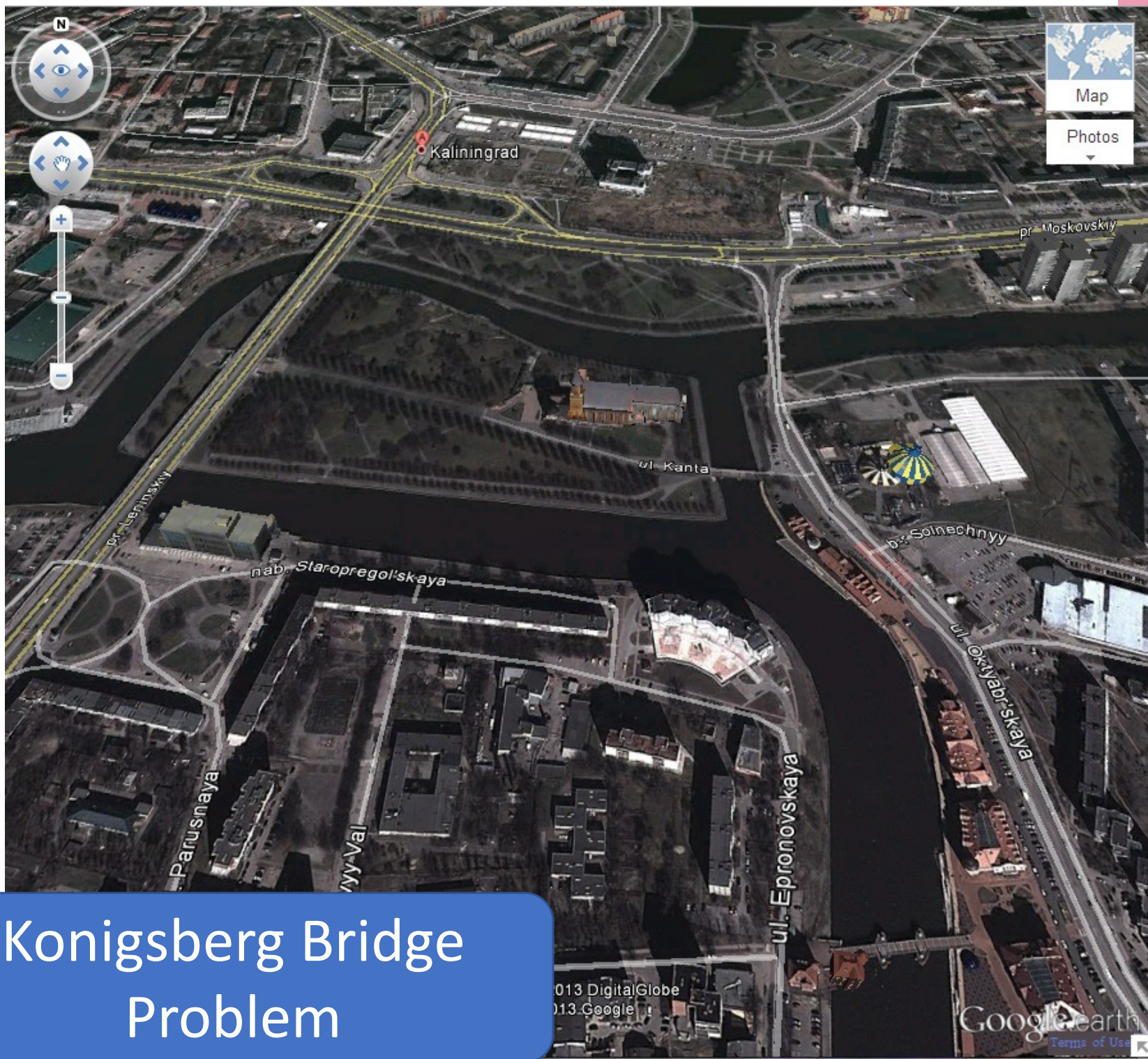
LinkedIn InMaps

<https://blog.linkedin.com/2011/01/24/linkedin-inmaps>

High school relationships (1993-95)

Bearman, Moody, and Stovel (2004)





Königsberg Bridge Problem

Review of vocabulary

Network $\leftrightarrow$ Graph

Node $\leftrightarrow$ Vertex

Edge: undirected vs. directed (arc)

Degree of a node

Endpoints of an edge

Directed, undirected, mixed graphs

Simple vs non-simple graph

Degree-sum formula

Maximum number of edges

Path

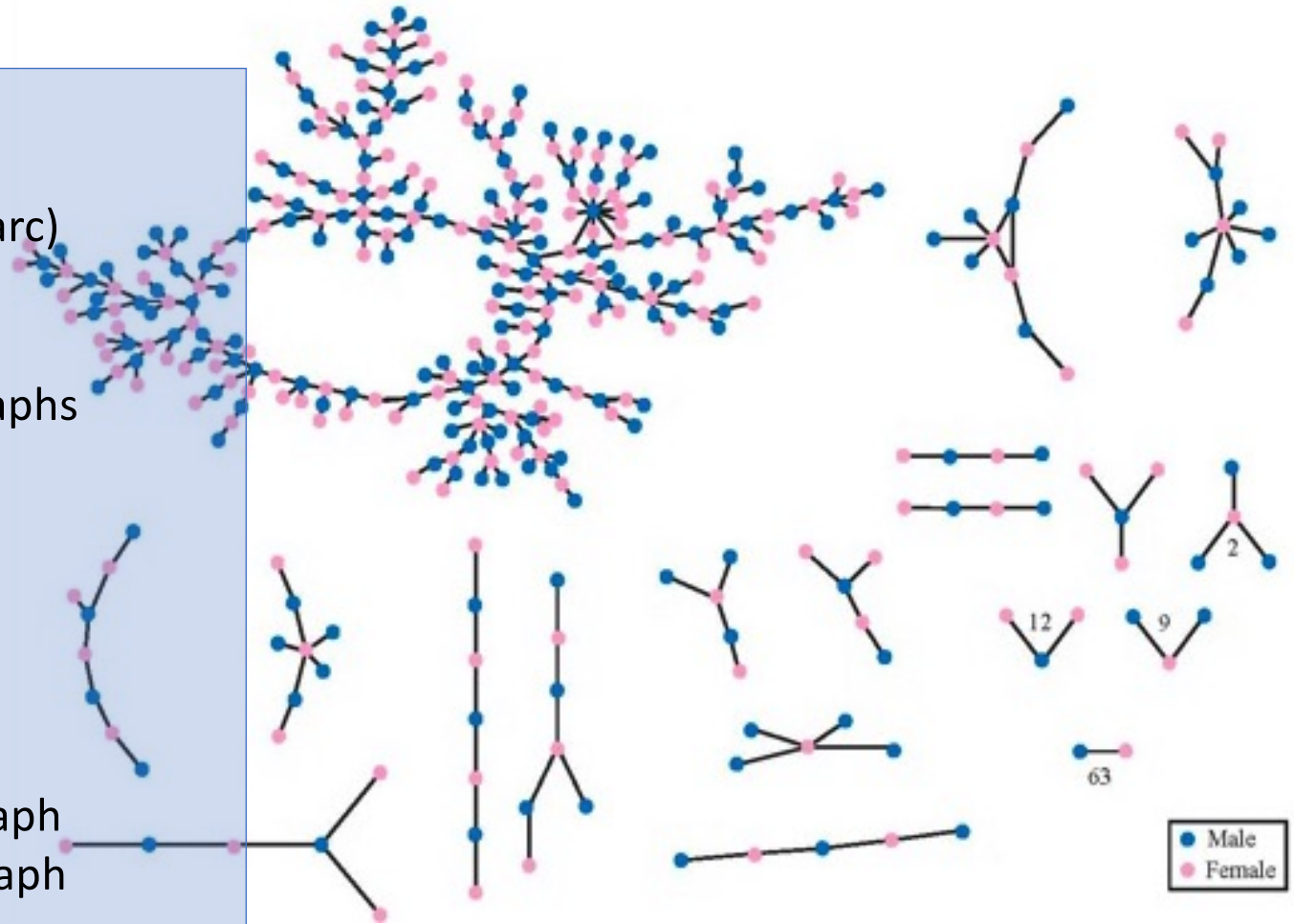
Cycle

Subgraph

Connected vs. disconnected graph

Connected components of a graph

Eulerian circuit problem



Reading

Chapter 2 of Easley-Kleinberg

