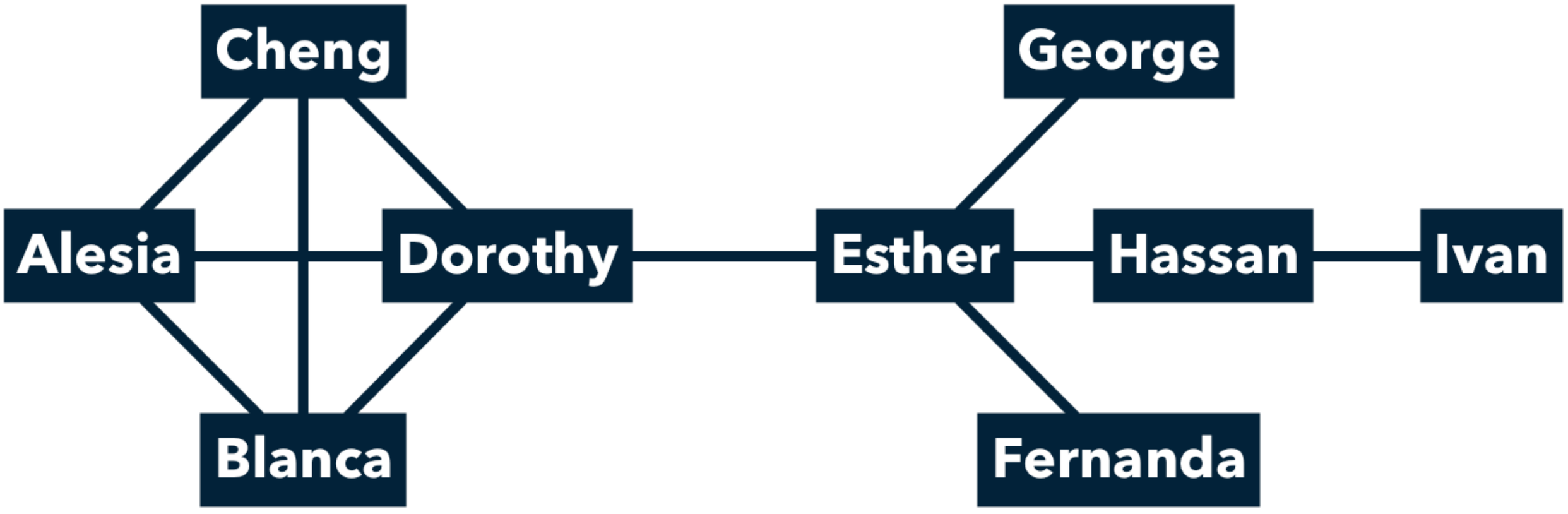
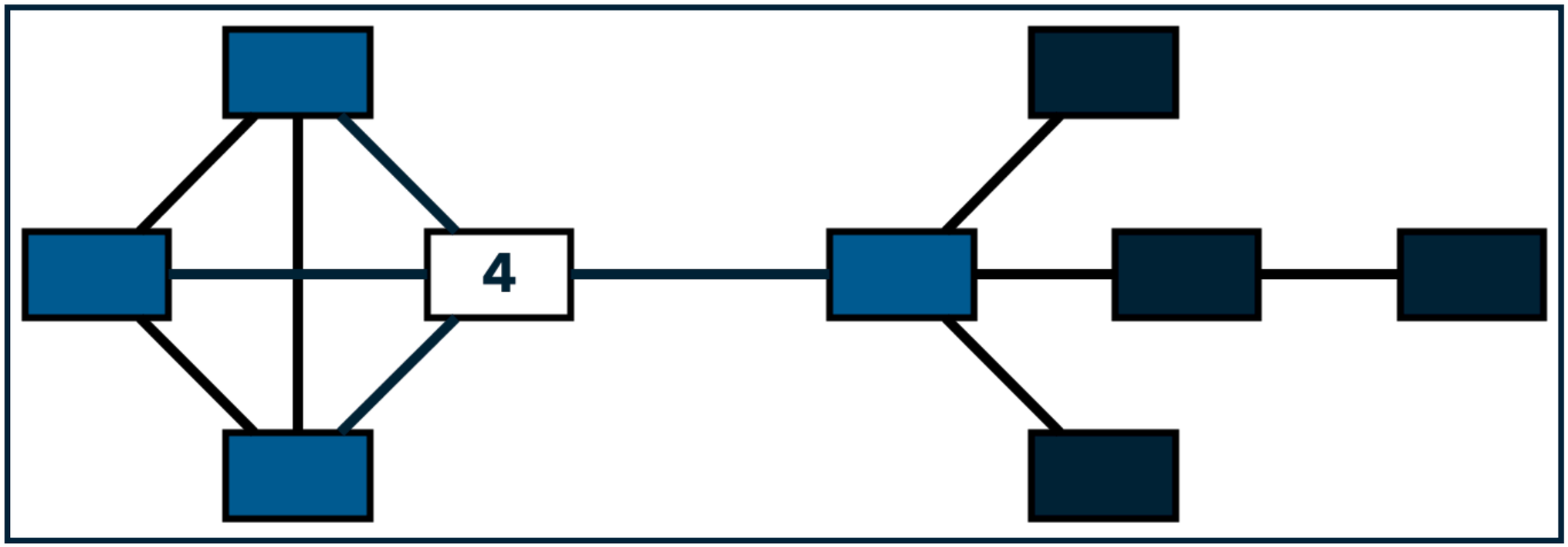
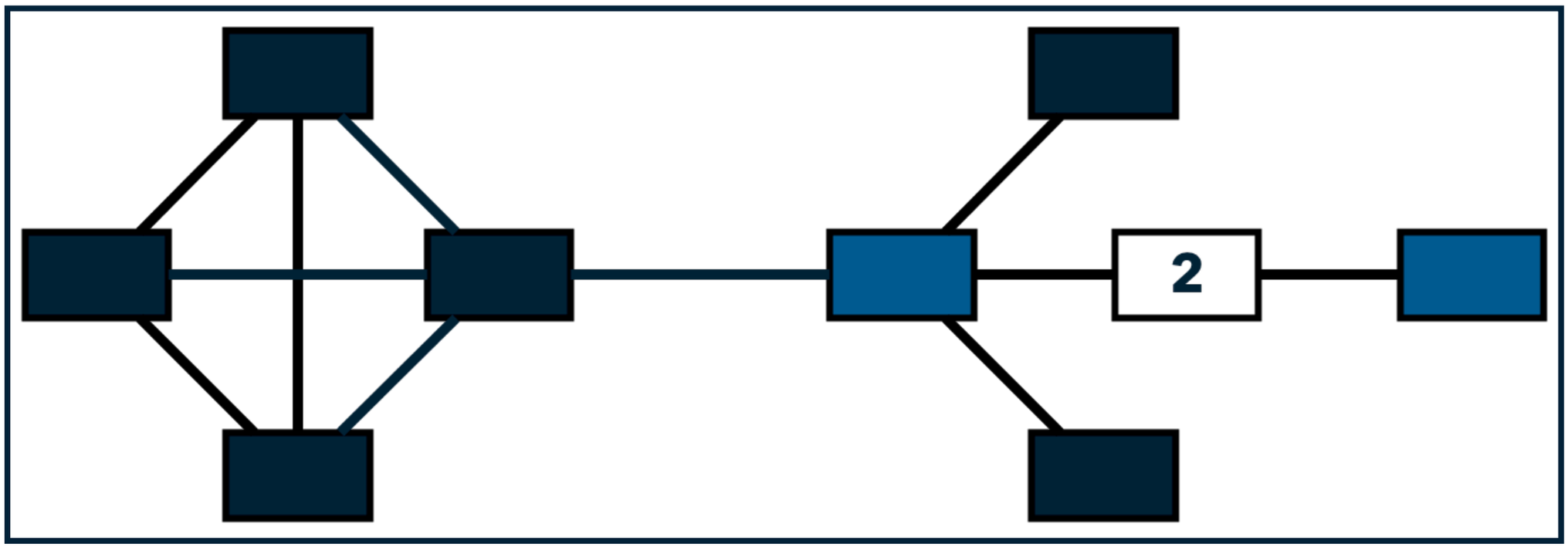
Some measures of centrality

An Artificial Example

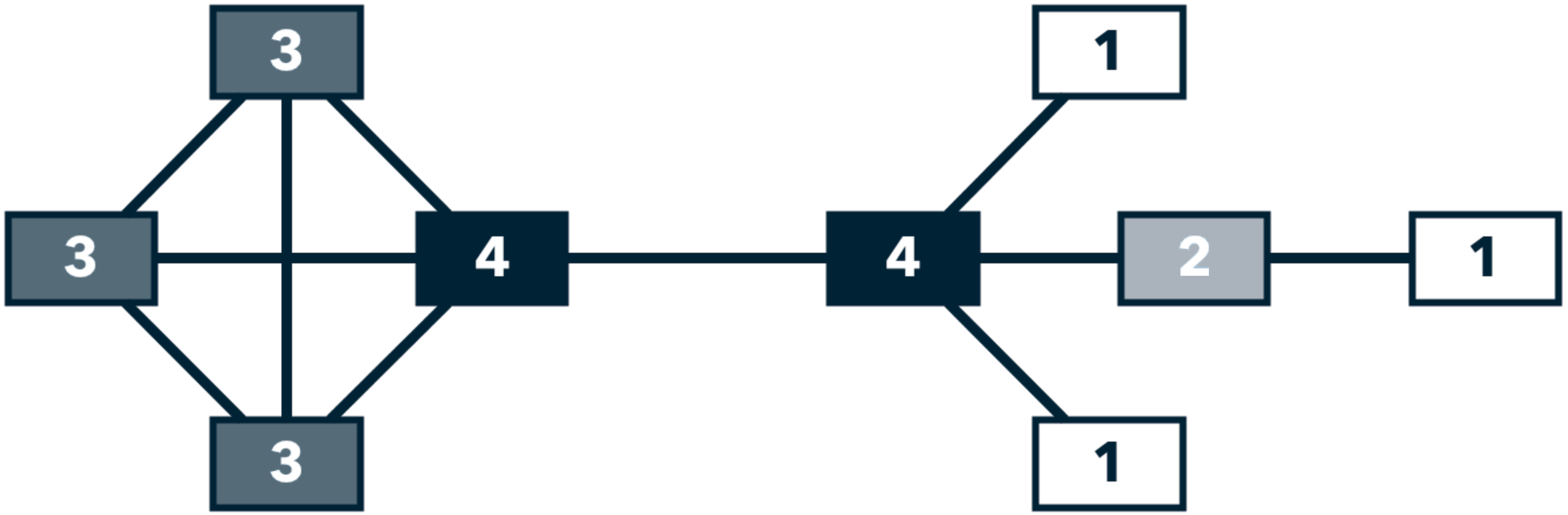


Degree Centrality



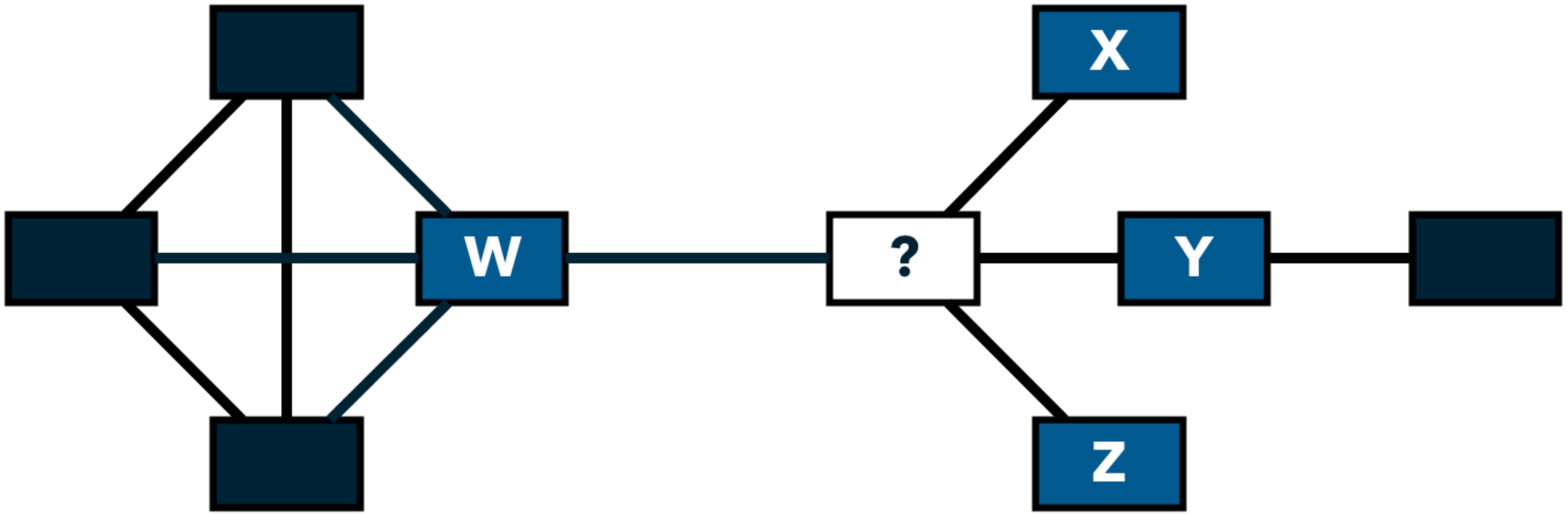


Degree Centrality



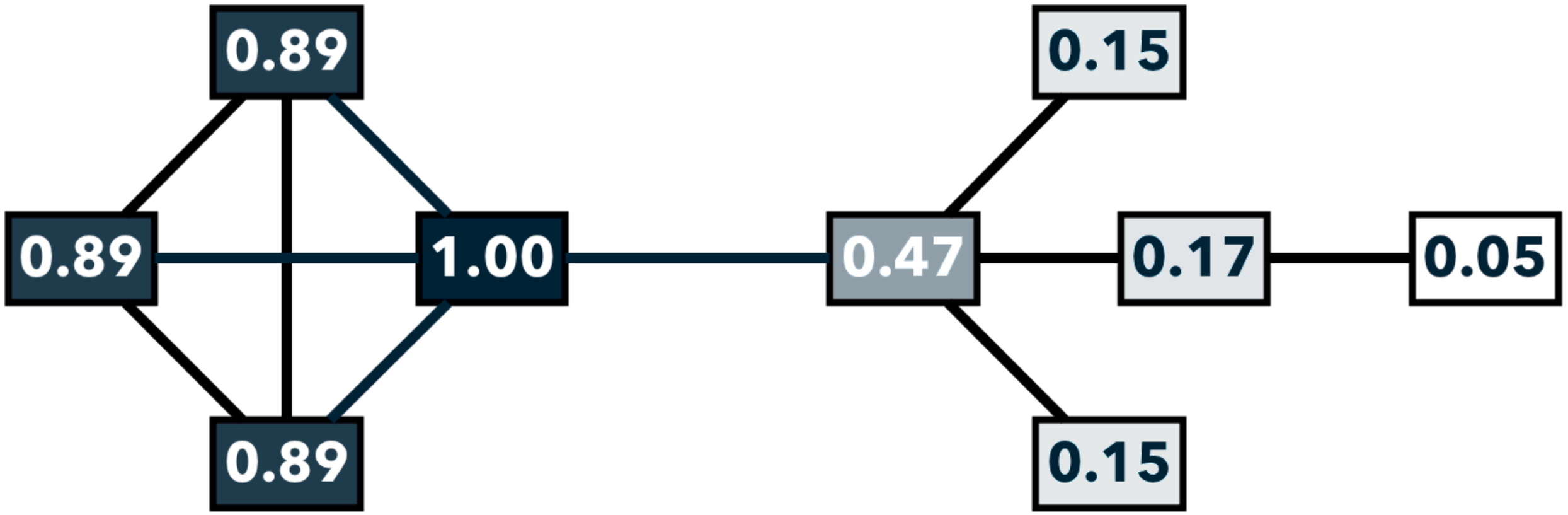
Eigenvector Centrality

$$? = (W + X + Y + Z) / \lambda$$



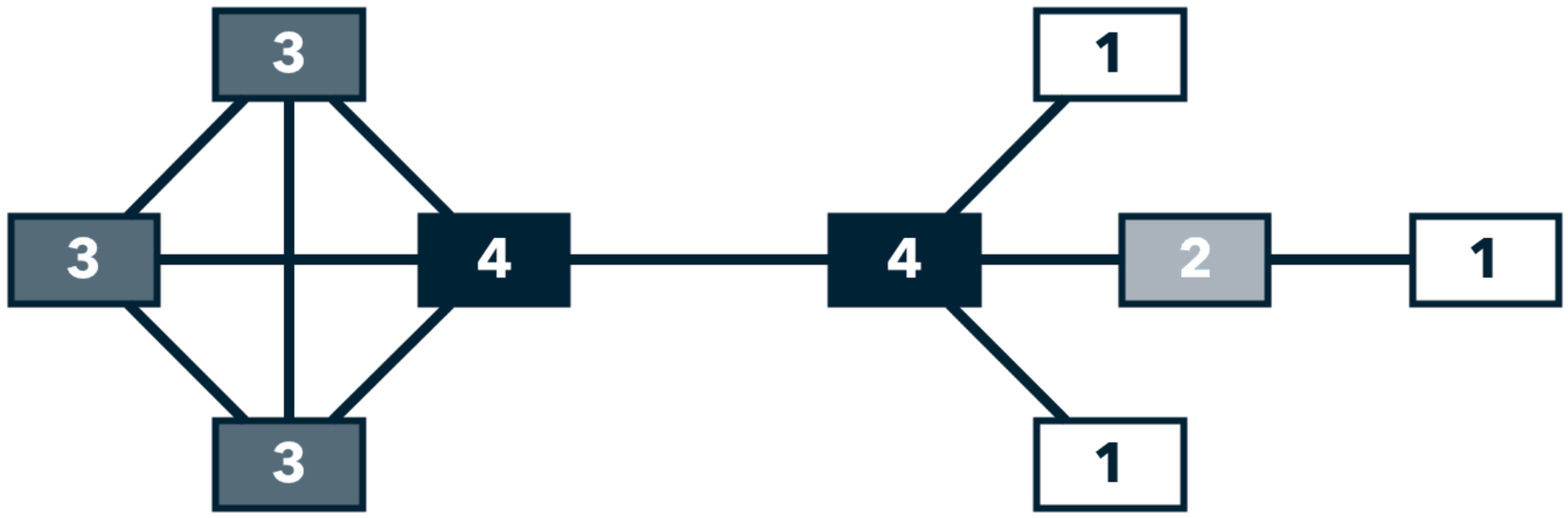
$$C_E(i) = \frac{1}{\lambda} \sum_{j \in N(i)} C_E(j)$$

Eigenvector Centrality

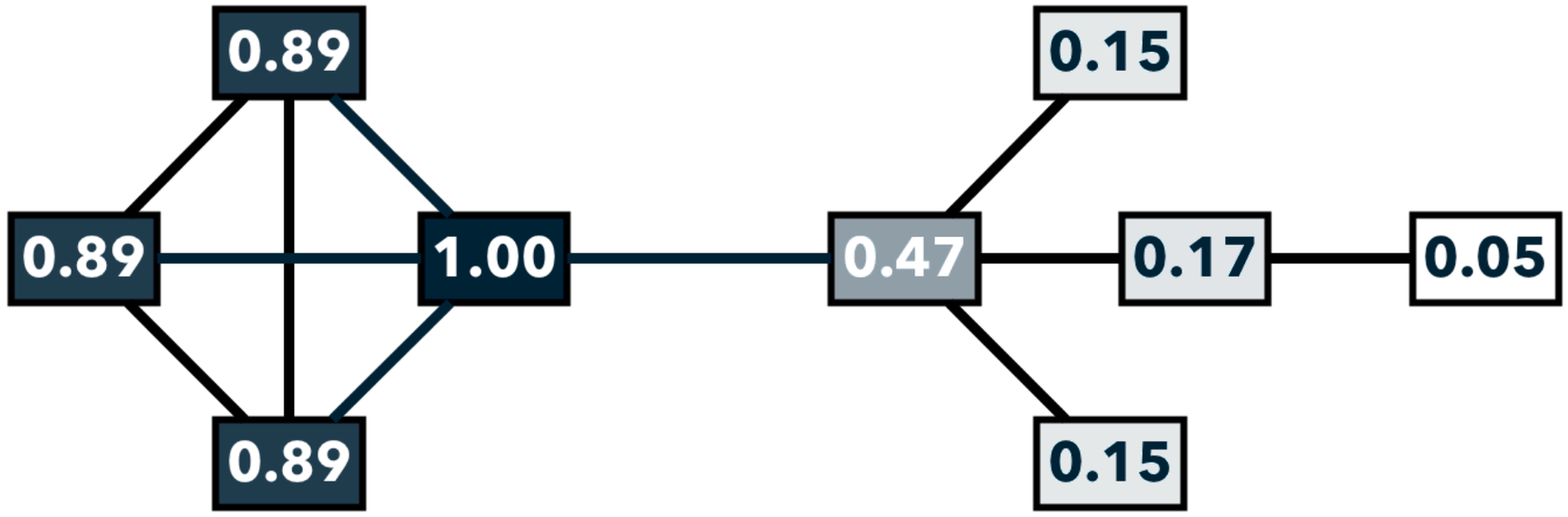


Degree vs eigenvector

Degree



Eigenvector



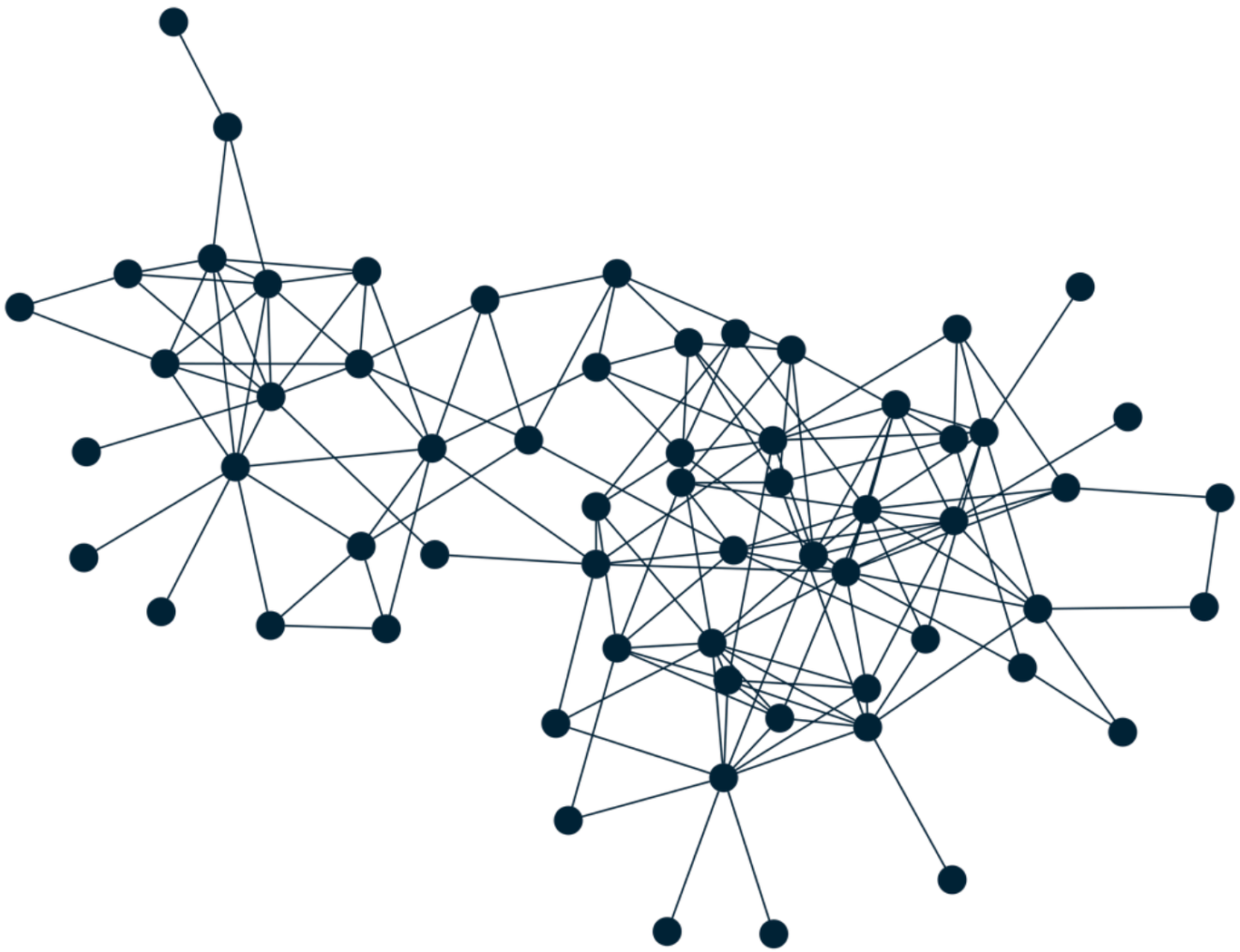
Dolphins

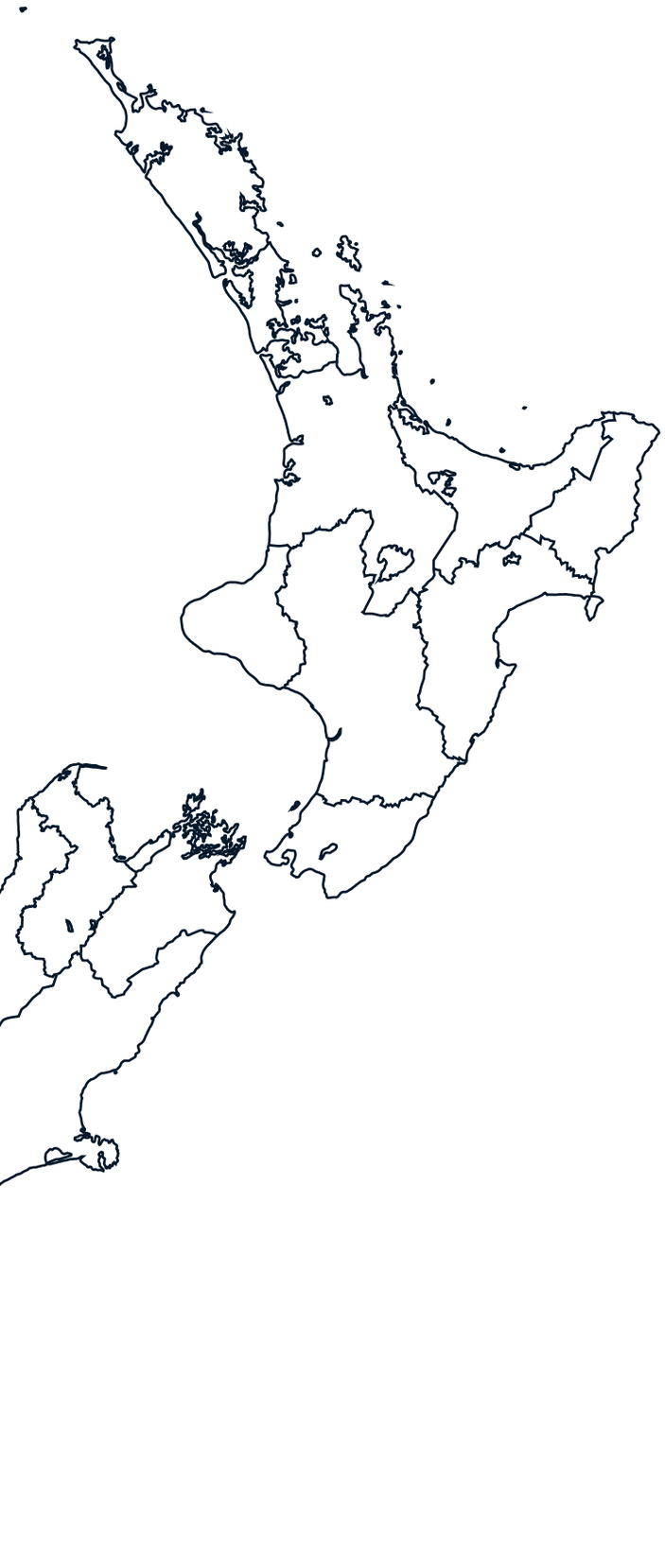
Lusseau, David, Karsten Schneider, Oliver J. Boisseau, Patti Haase, Elisabeth Slooten, and Steve M. Dawson. 2003. “The Bottlenose Dolphin Community of Doubtful Sound Features a Large Proportion of Long-Lasting Associations.” *Behavioral Ecology and Sociobiology* 54 (4) (September 1): 396–405.

Dolphins

Doubtful Sound, NZ

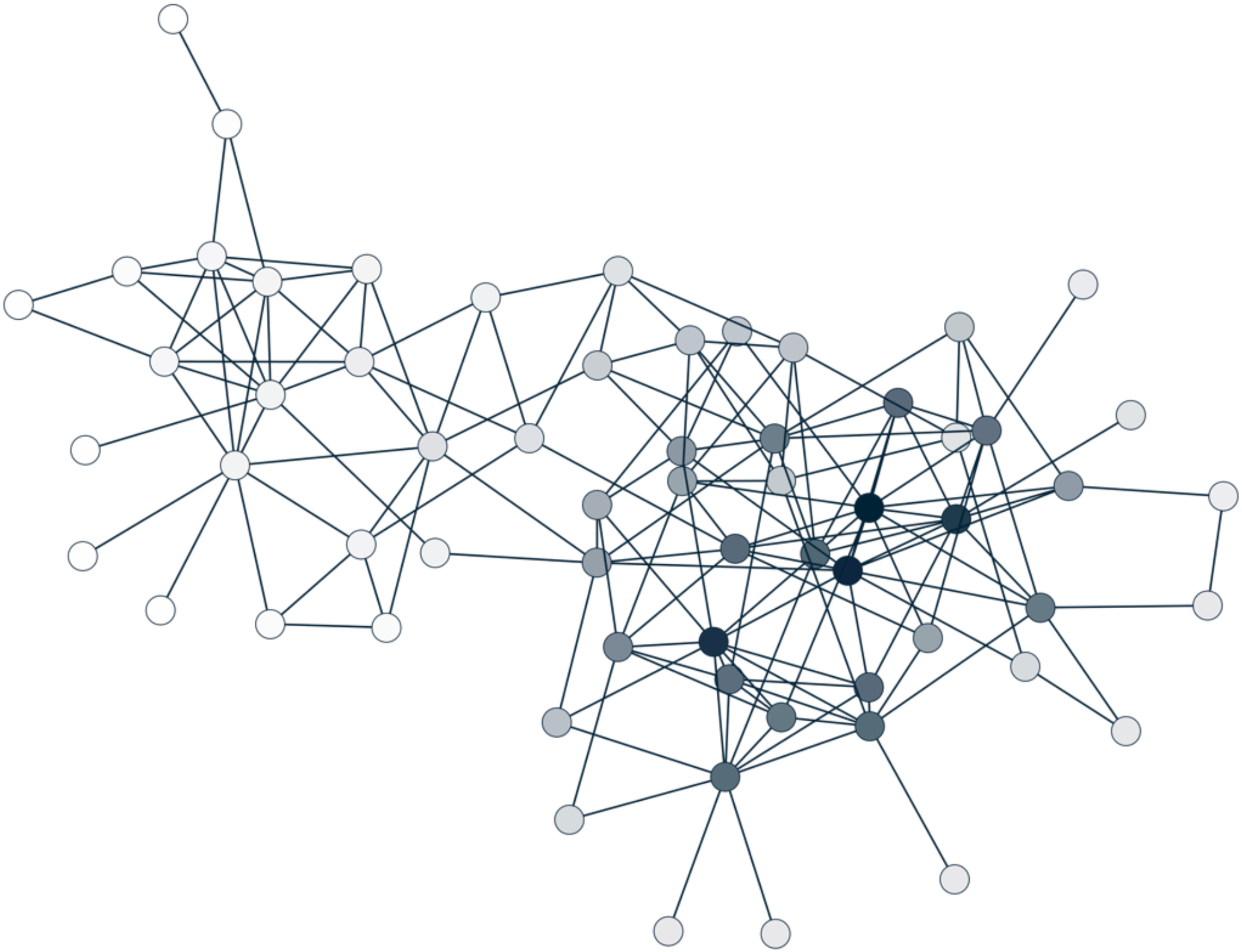
Dolphins



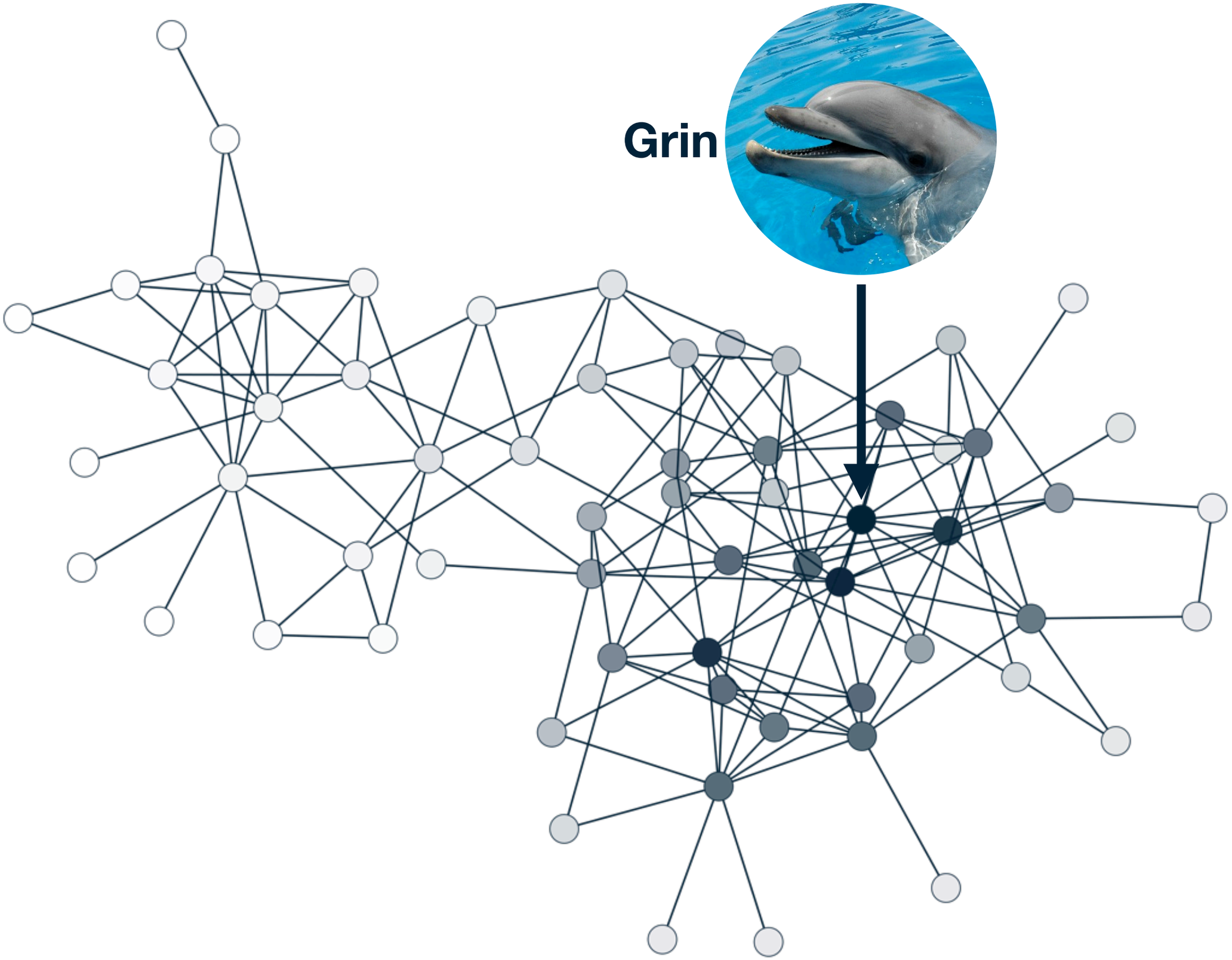


Doubtful Sound, NZ

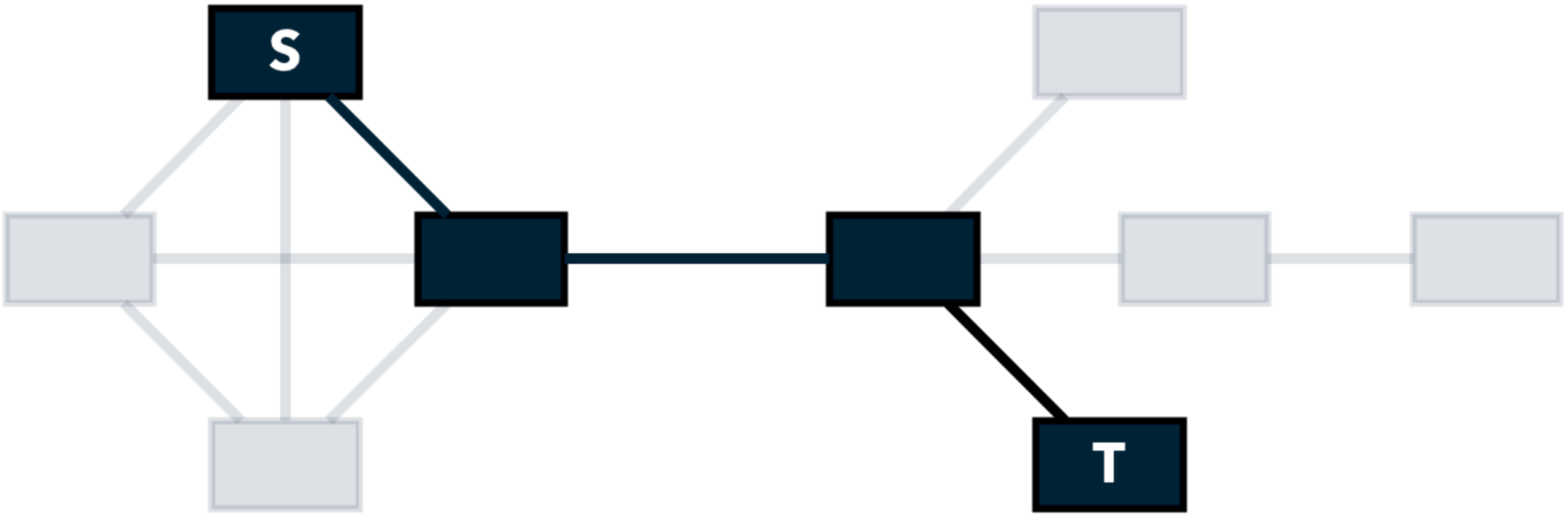
Eigenvector Centrality



Eigenvector Centrality

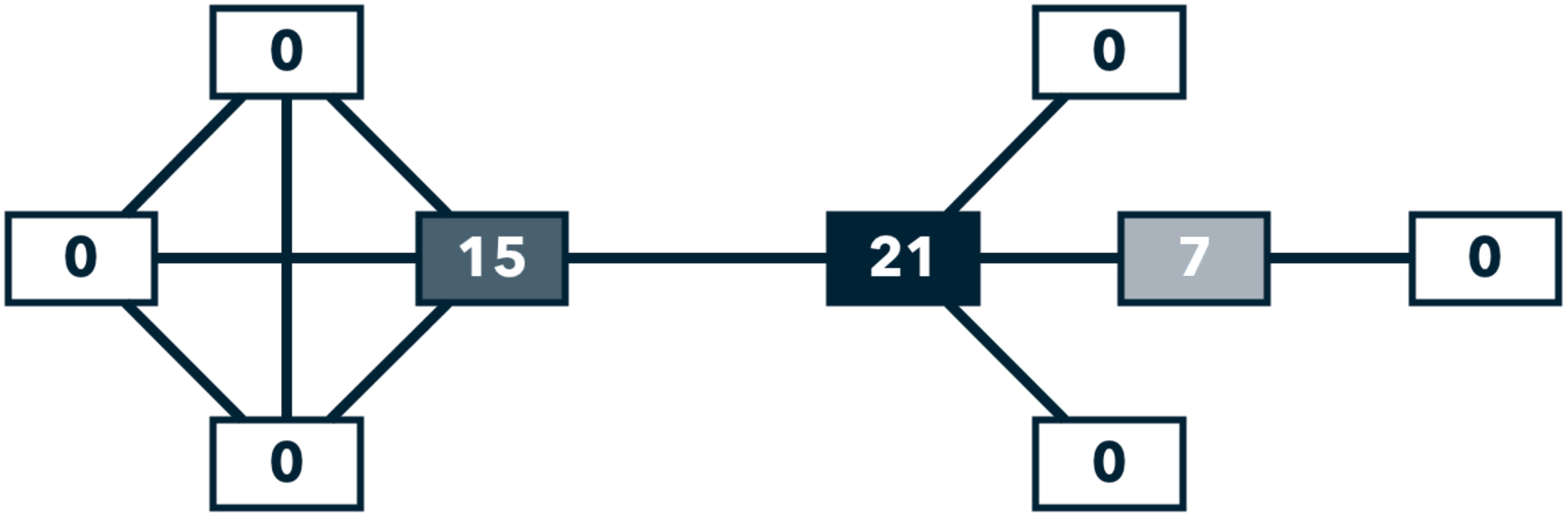


Betweenness Centrality

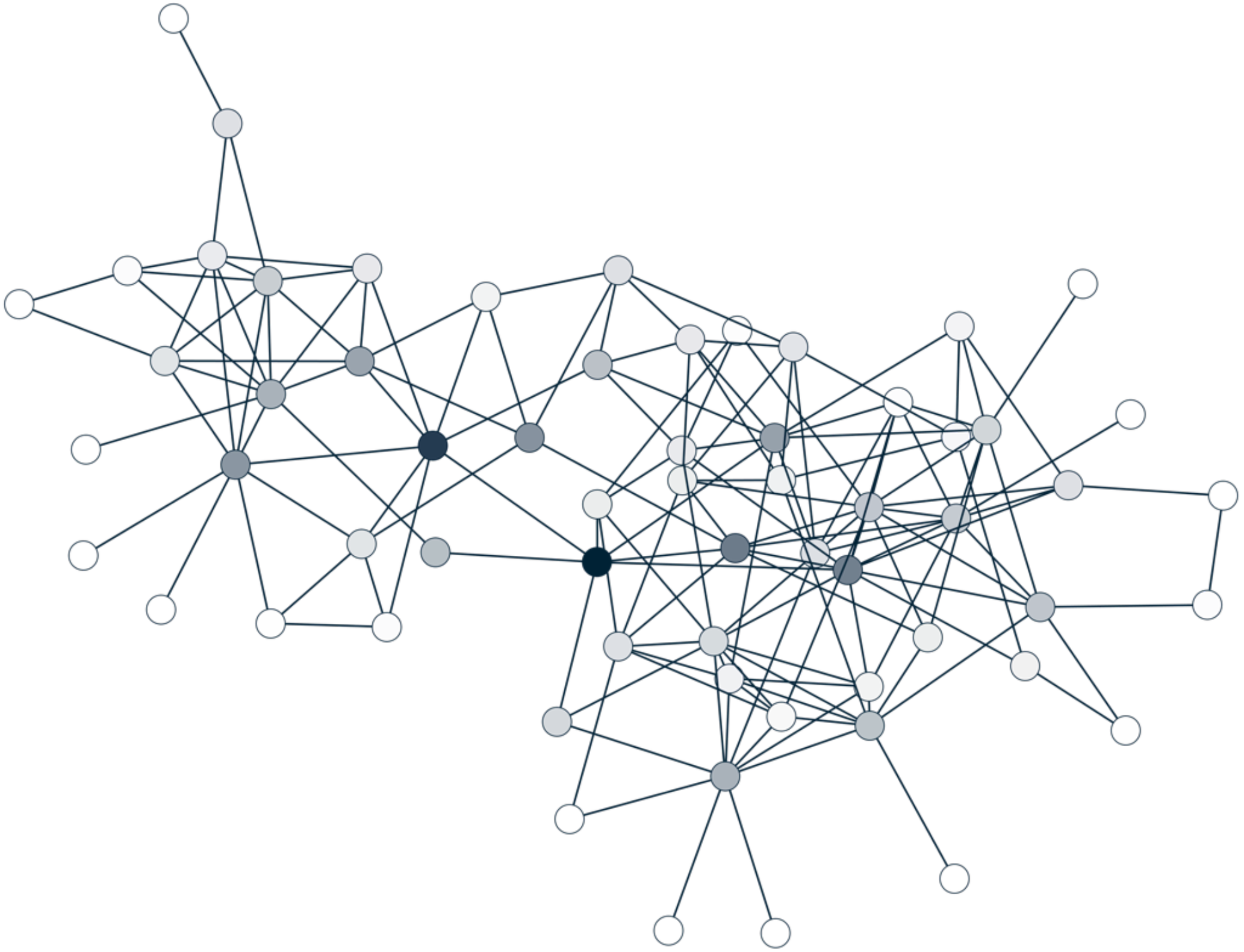


Shortest path (*geodesic*) from **S** to **T**

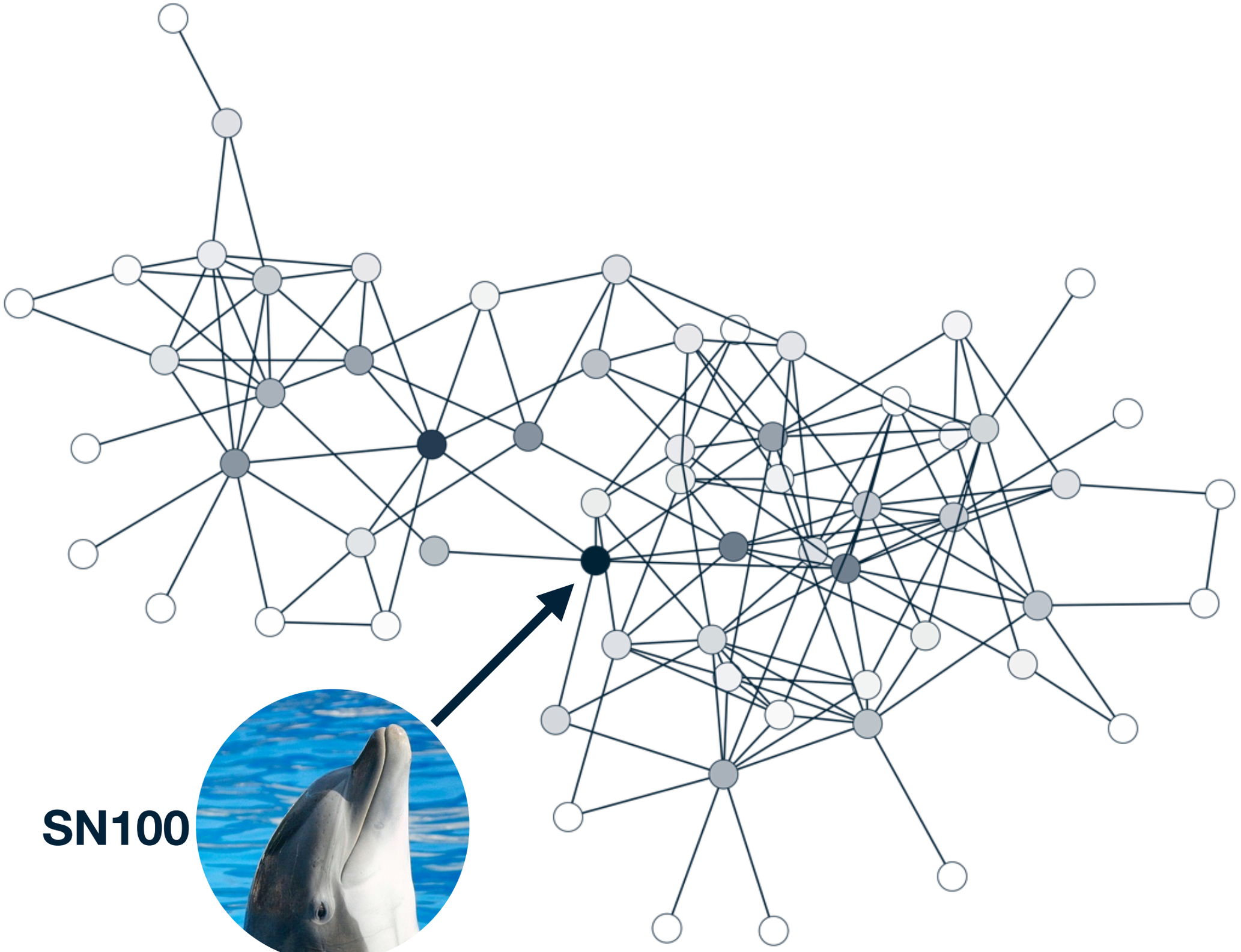
Betweenness Centrality



Betweenness Centrality

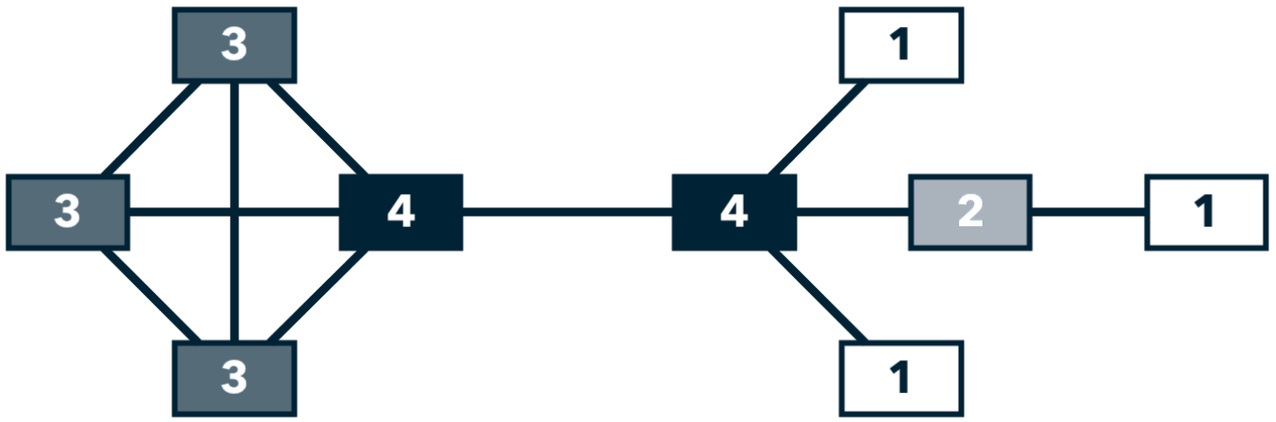


Betweenness Centrality



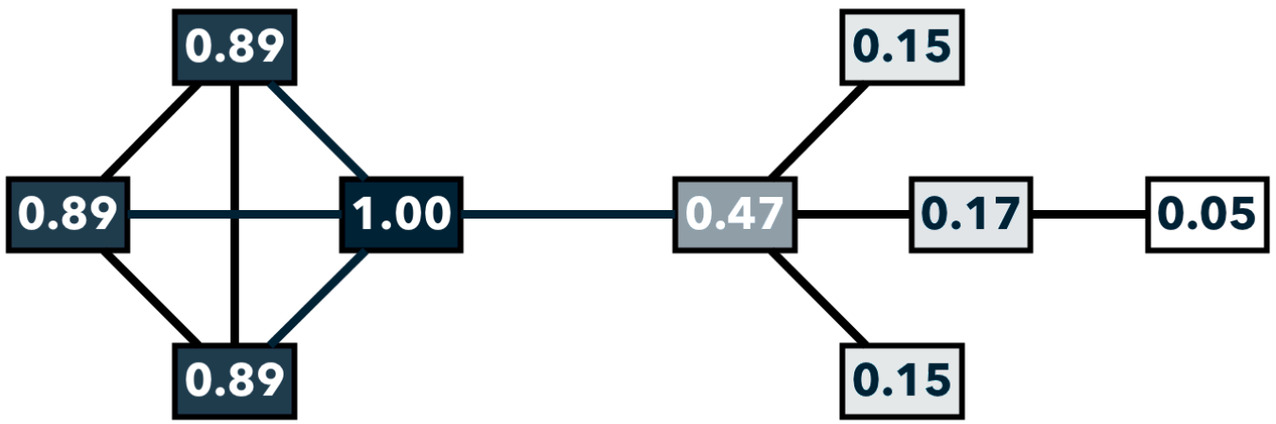
Comparison

Degree



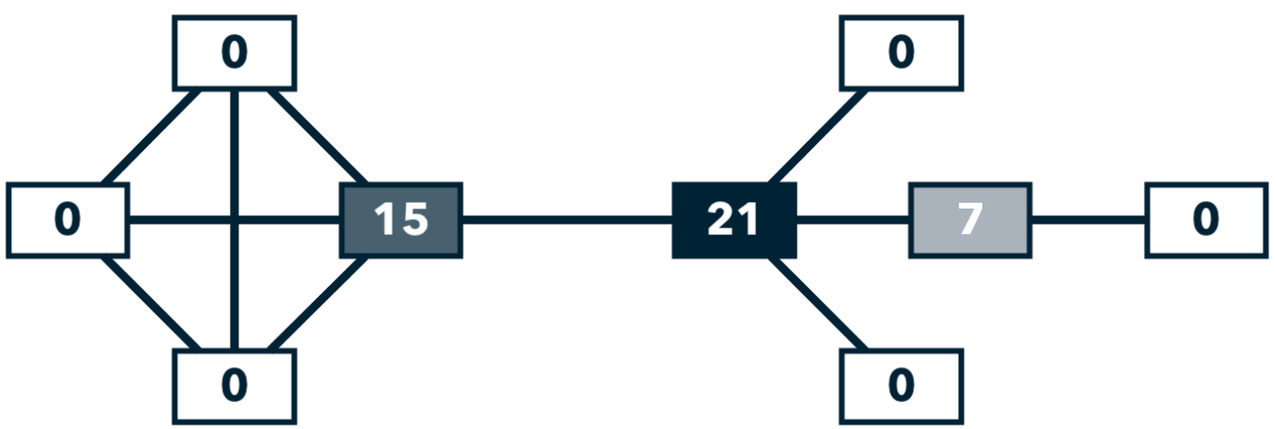
connected to many other vertices

Eigenvector



connected to many other *well connected* vertices

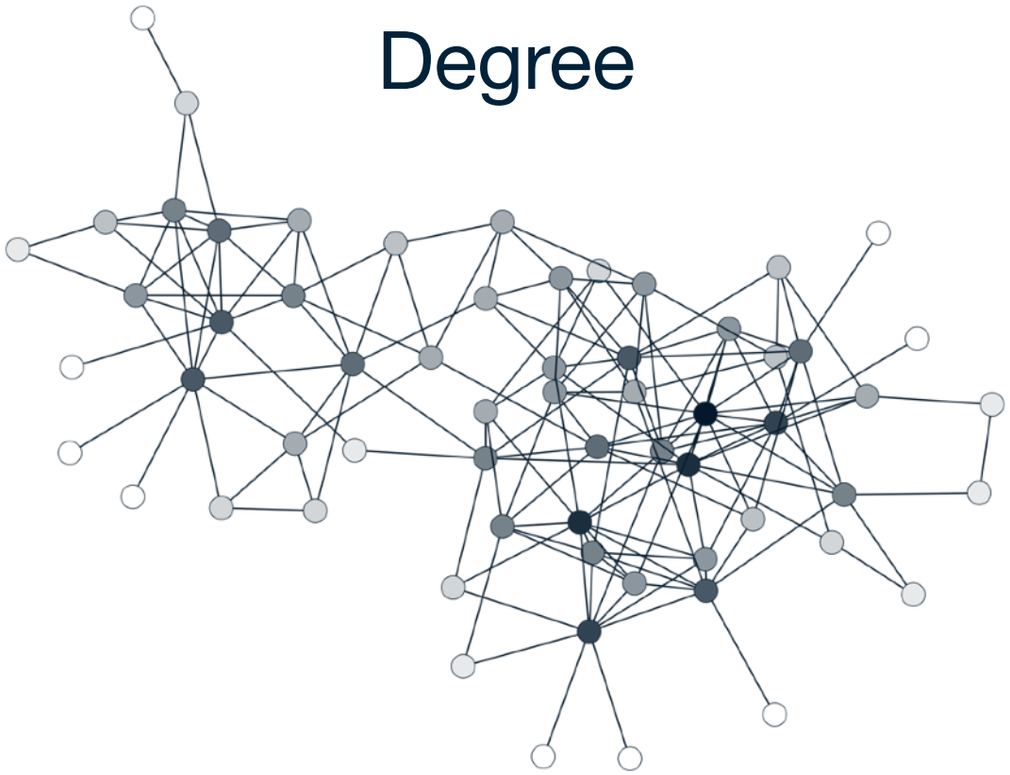
Betweenness



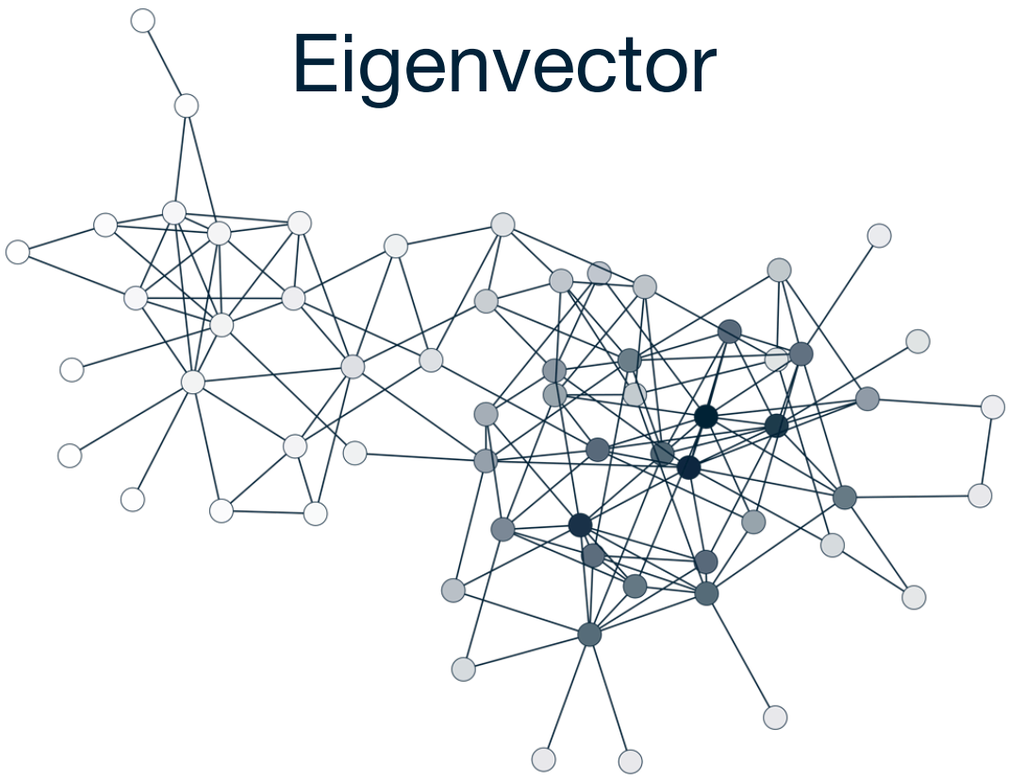
on the shortest path connecting many pairs of vertices

Comparison

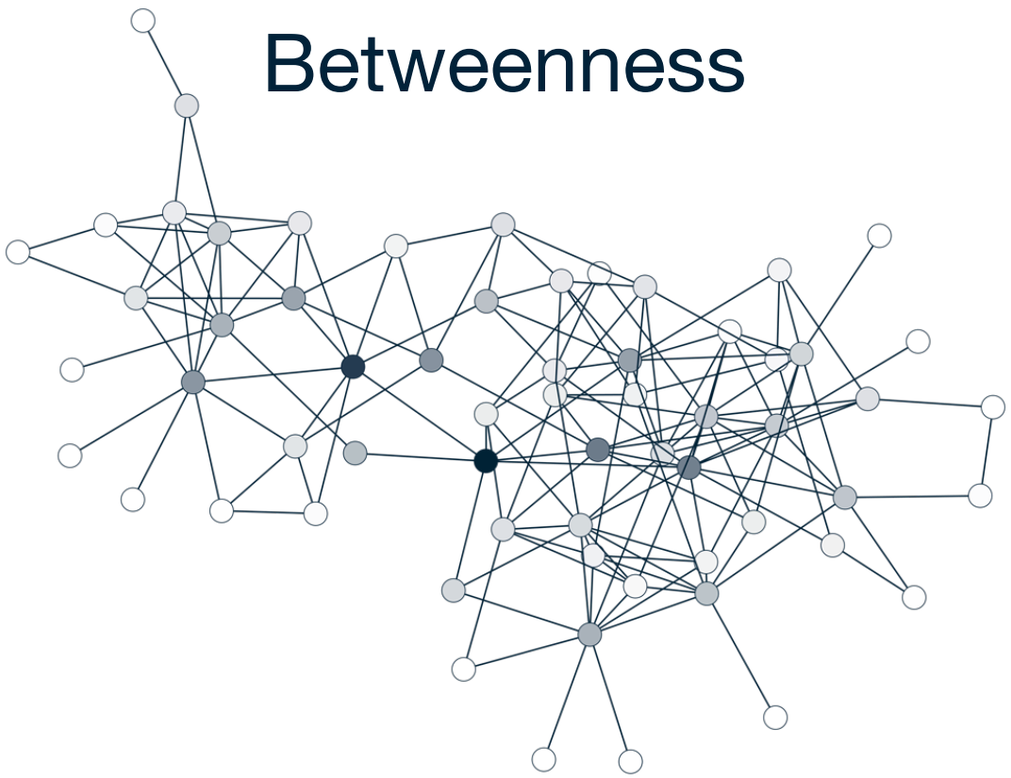
Degree



Eigenvector

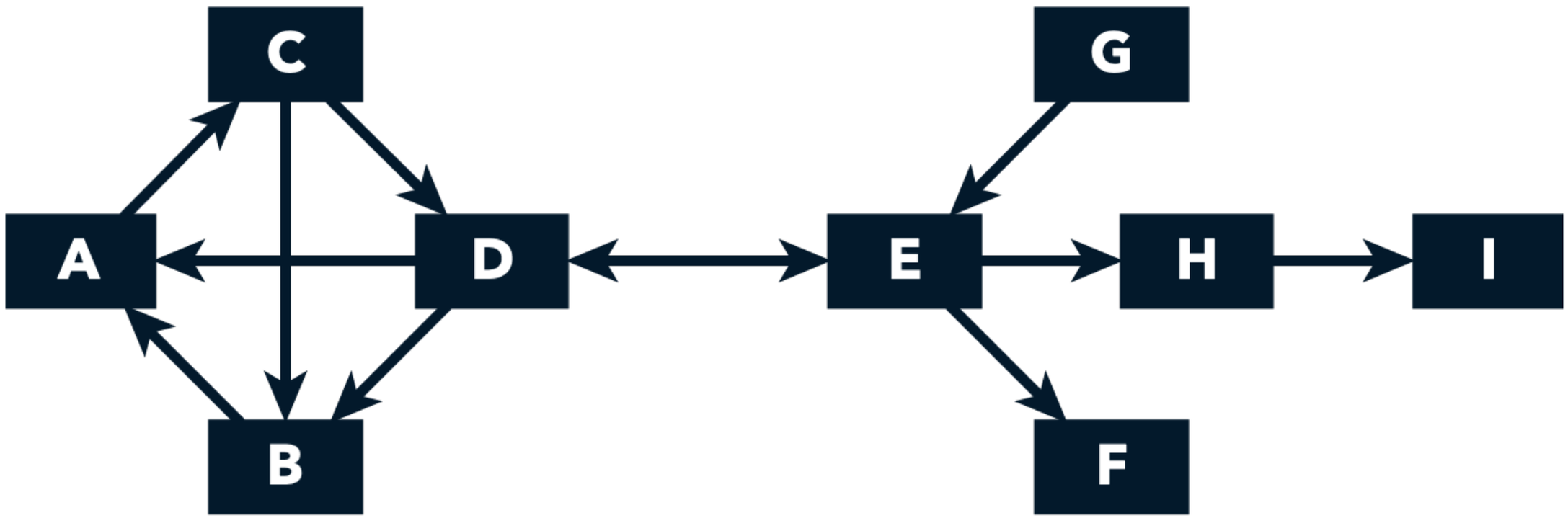


Betweenness



Complications: directed edges and weights

Directed edges



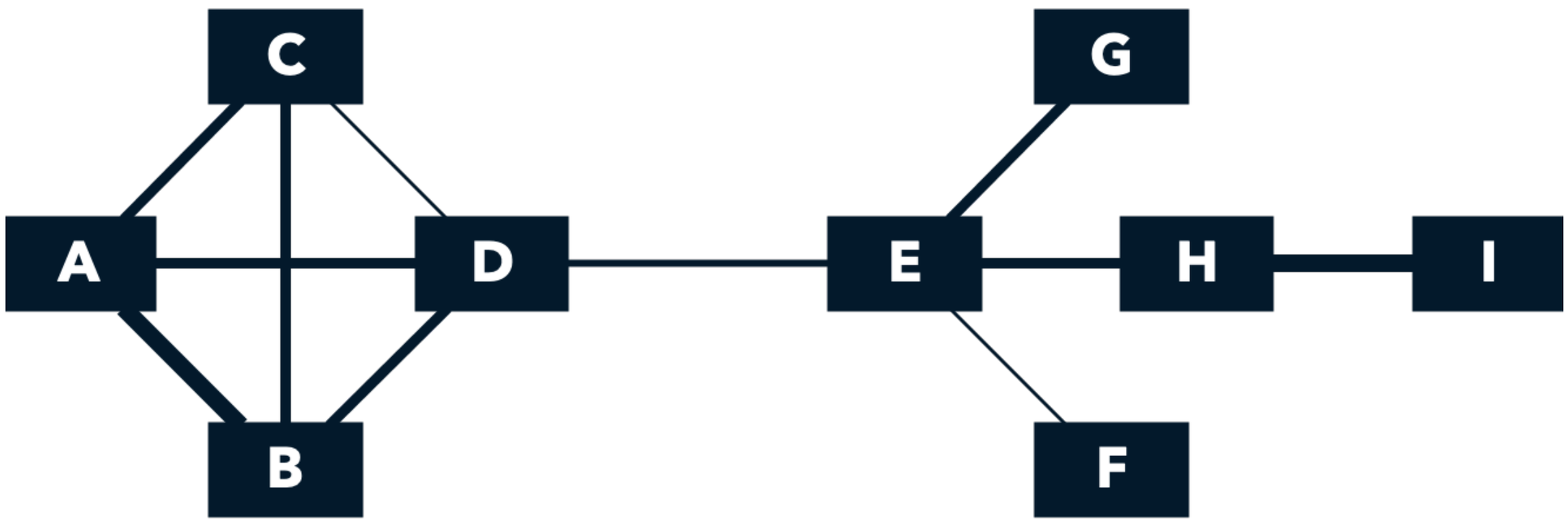
Directed edges affect *degree*

- *In-degree*: number of edges coming into a node
- *Out-degree*: number of edges coming out of a node
- ***Note**: eigenvector centrality on directed networks focusses on in-degree.*

Directed edges affect *paths*

- Paths follow edge directions
- Path from B to E is longer than the path from E to B

Edge weights



Edge weights affect *degree*

- Often want stronger edges contribute more to degree
- Node with a few strong relations can have the same “degree” as a node with many weak relations

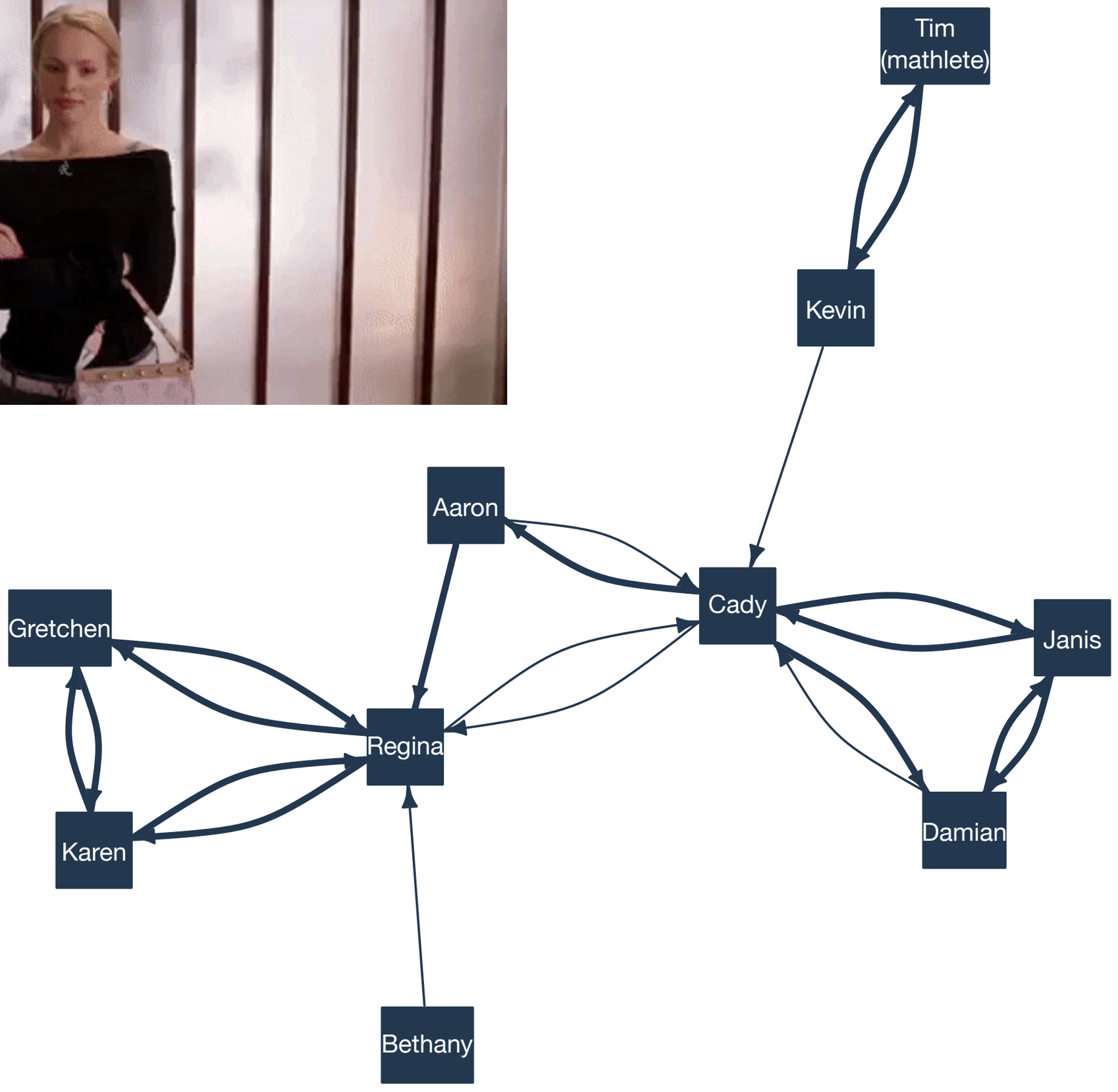
Edge weights affect *paths*

- Edge width affects the ‘distance’ or ‘flow’ between nodes
- Large weights ⇨ long paths?
- Large weights ⇨ wide pipes?

Example

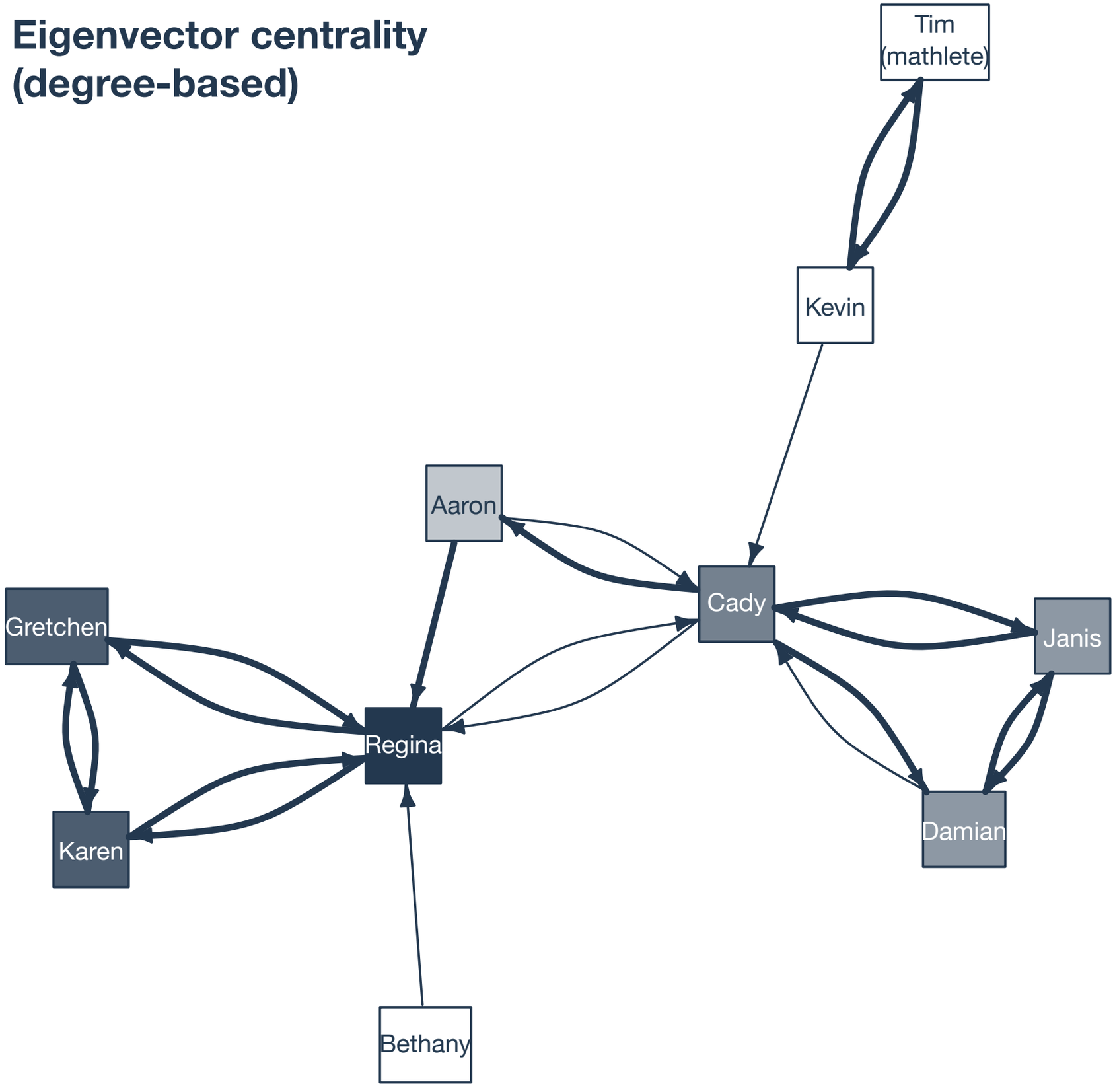
Mean Girls (2004)

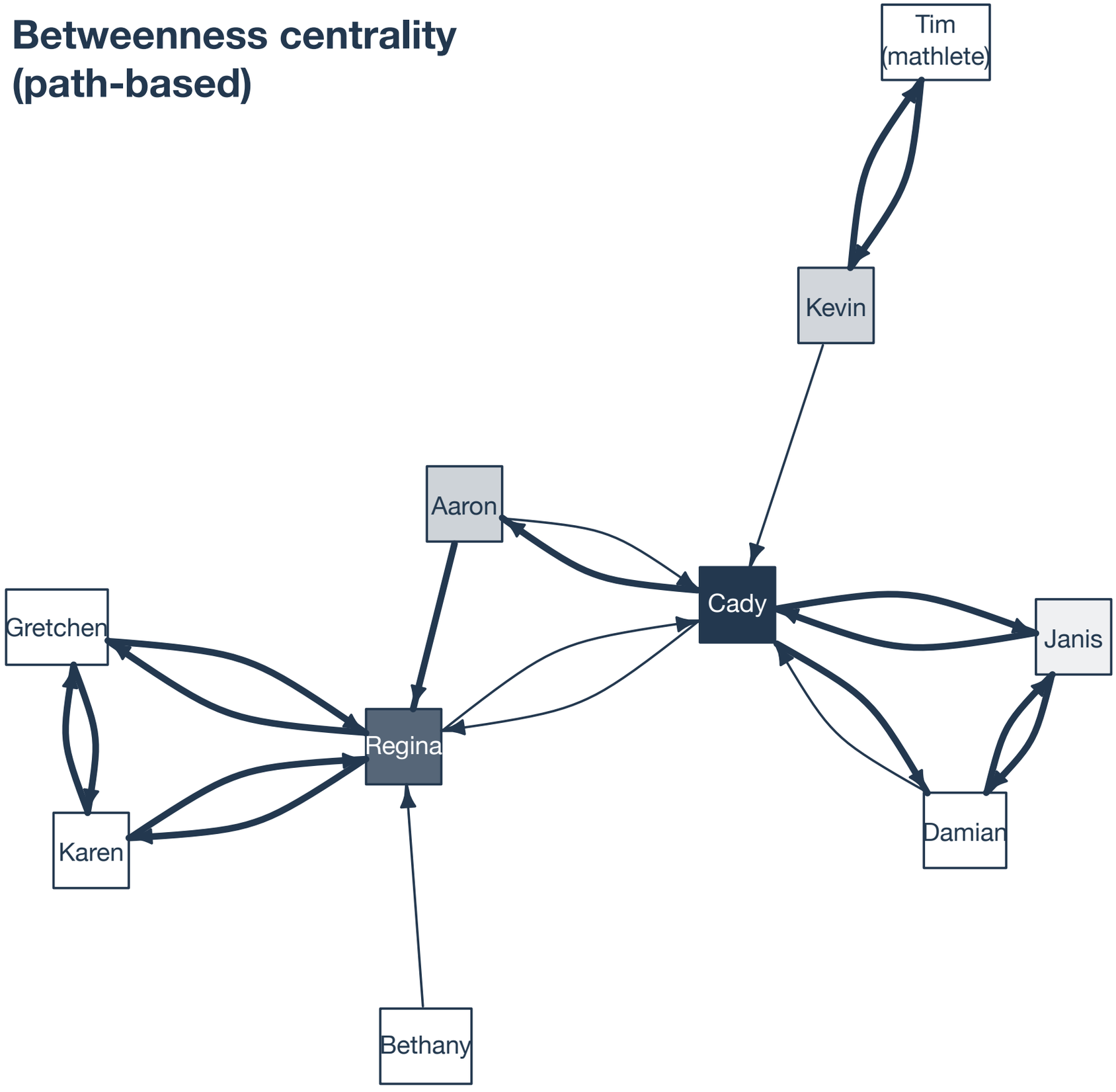
Example


Tim
(mathlete)
Kevin
Aaron
Cady
Janis
Gretchen
Regina
Karen
Damian
Bethany

Example

Eigenvector centrality (degree-based)



Example

Betweenness centrality (path-based)