BRIDGE CENTRALITY:
IDENTIFYING BRIDGE SYMPTOMS IN PSYCHOPATHOLOGY NETWORKS

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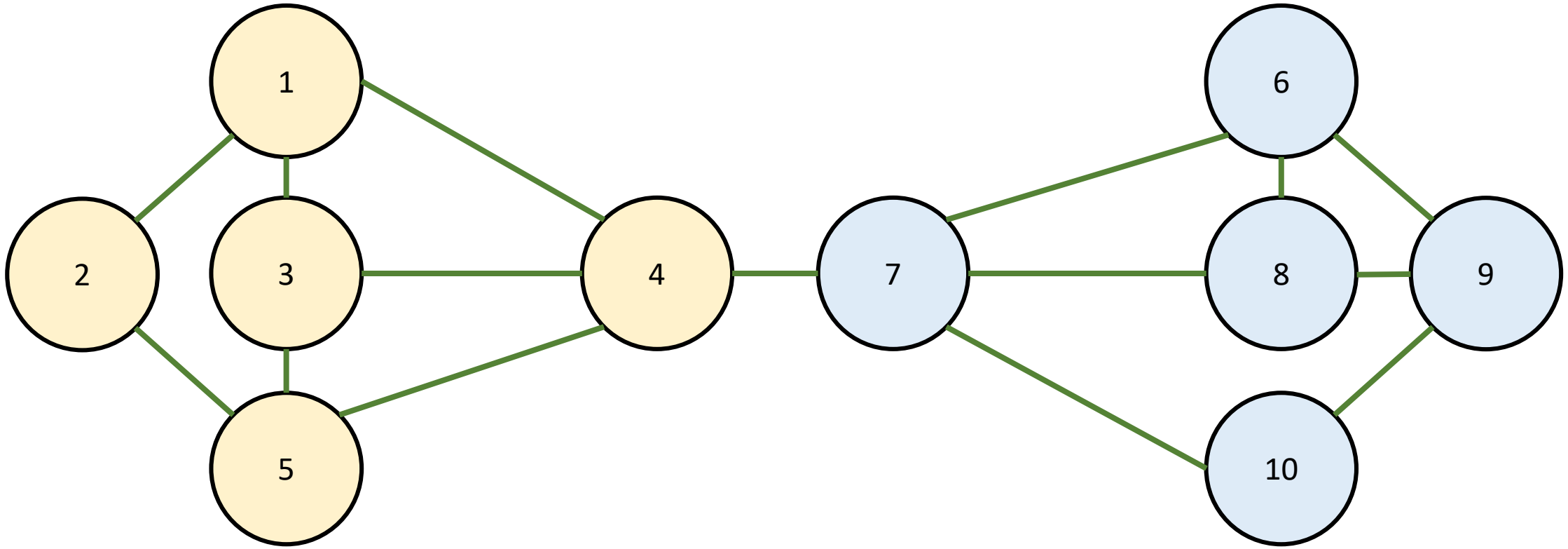
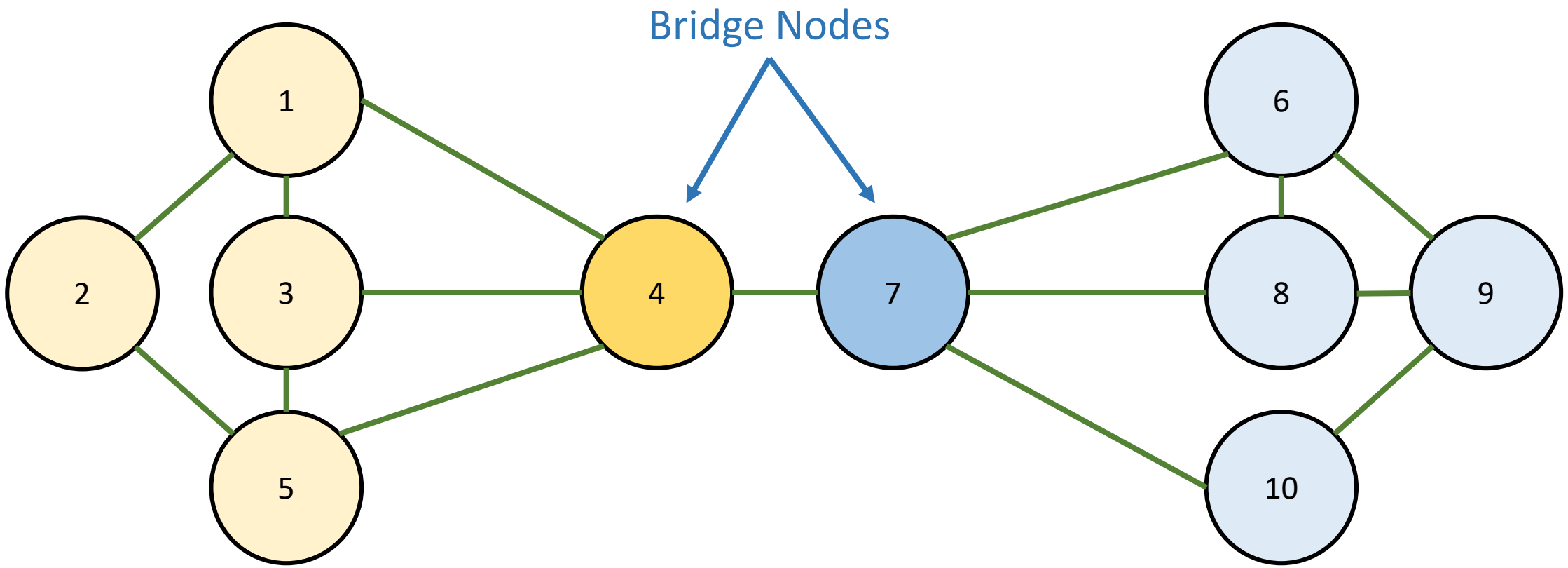
Harvard University

Master's Thesis Presentation

Mental Disorder Comorbidity




Bridge Nodes
1
2
3
4
5
6
7
8
9
10

MOTIVATING QUESTION:

CAN WE DETECT BRIDGE NODES IN COMPLEX NETWORKS?

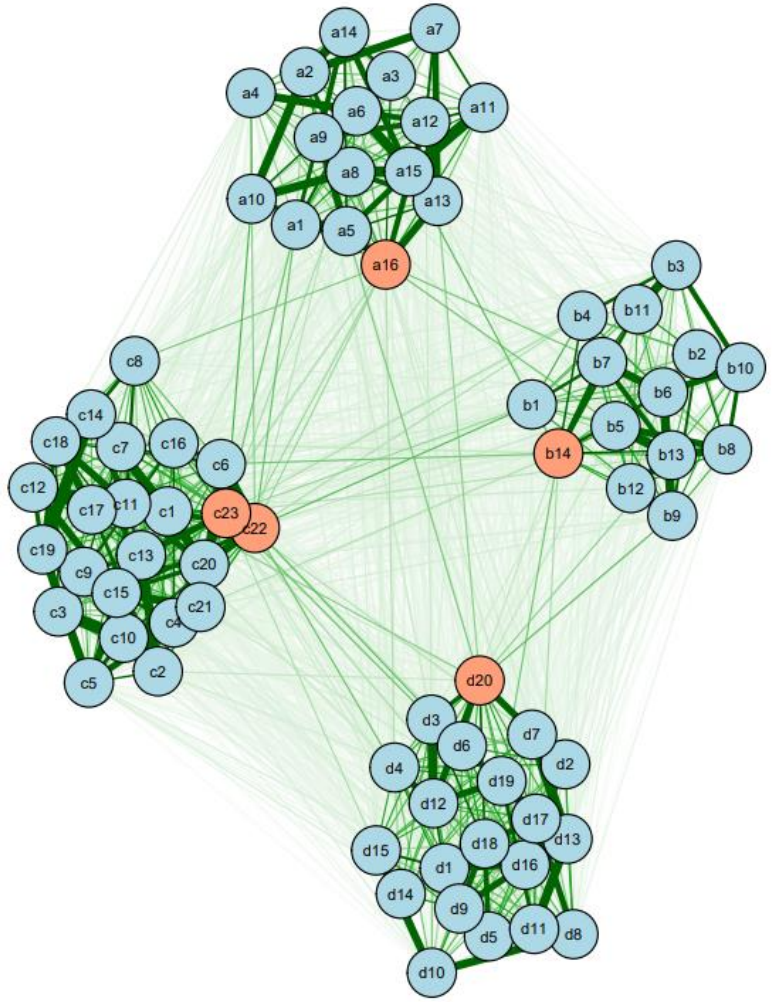
BRIDGE CENTRALITY

$$\textit{bridge strength} = \sum_{b \in (N(a) - V(A))} |w_{ab}|$$

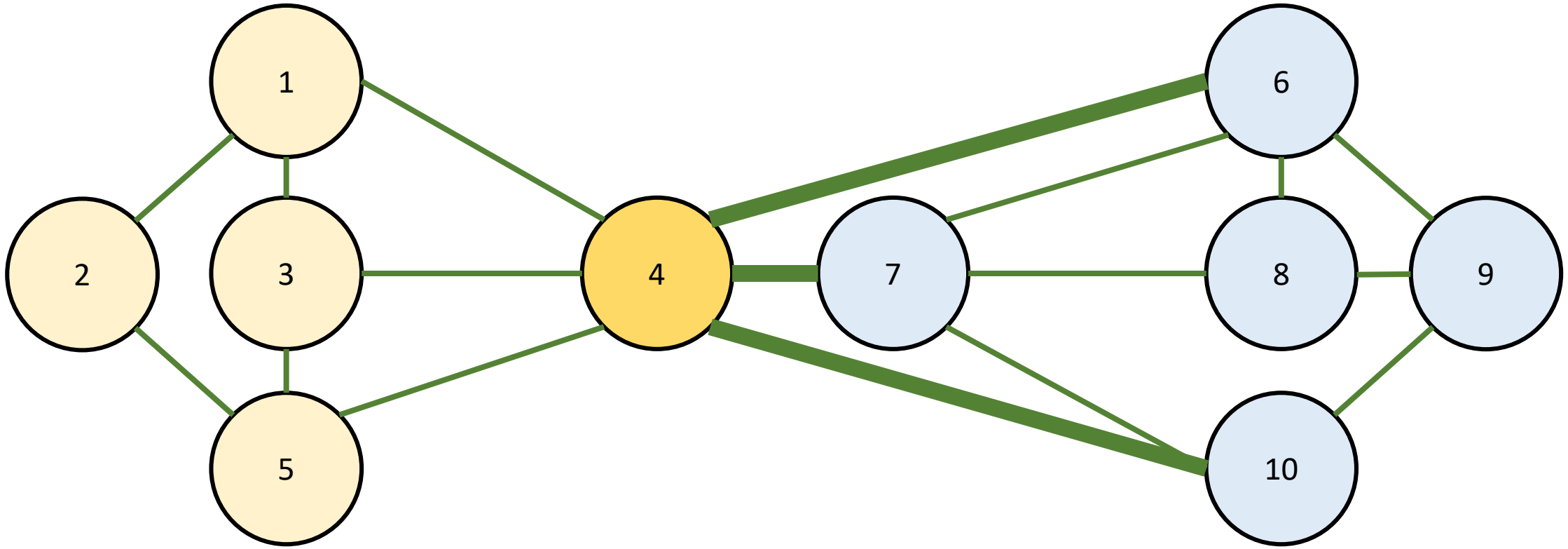
$$\textit{bridge betweenness} = \sum_{i \in V(G)} x$$

$$\textit{bridge closeness} = \frac{\left|V(G) - V(A)\right|}{\sum_{b \in (V(G) - V(A))} \sum_{e_k \in E(P_{ab})} \frac{1}{w_k}}$$

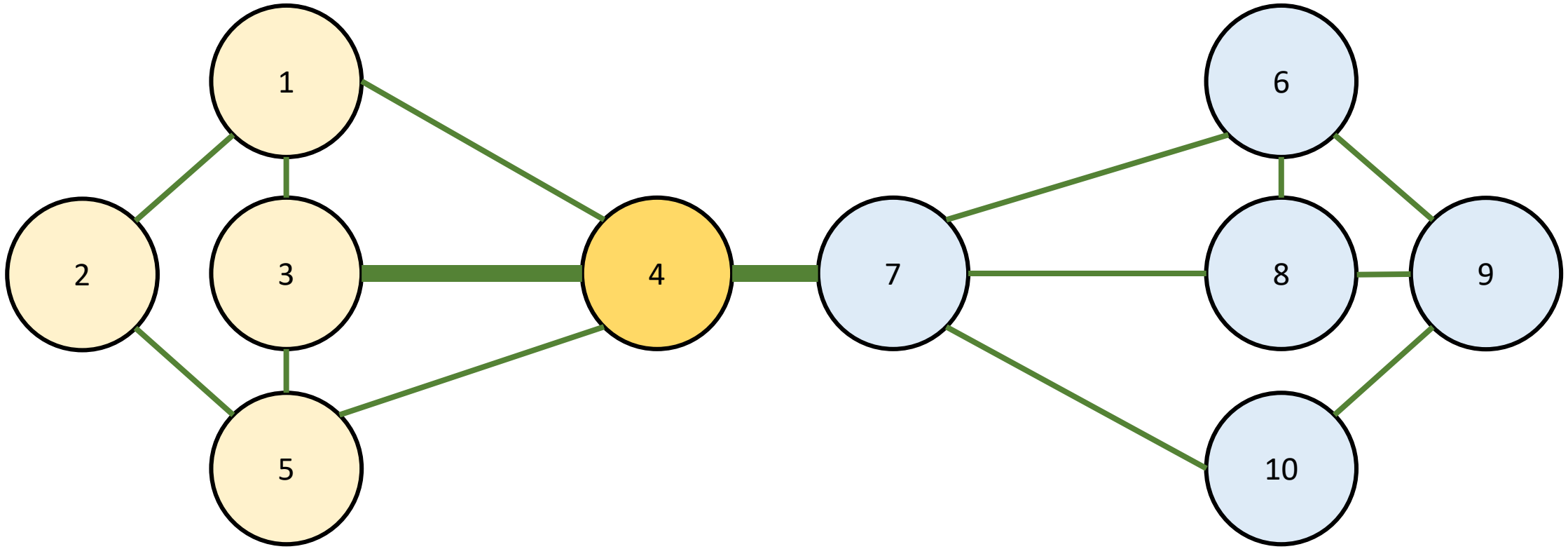
$$\textit{bridge expected influence} = \sum_{b \in (N(a) - V(A))} w_{ab}$$



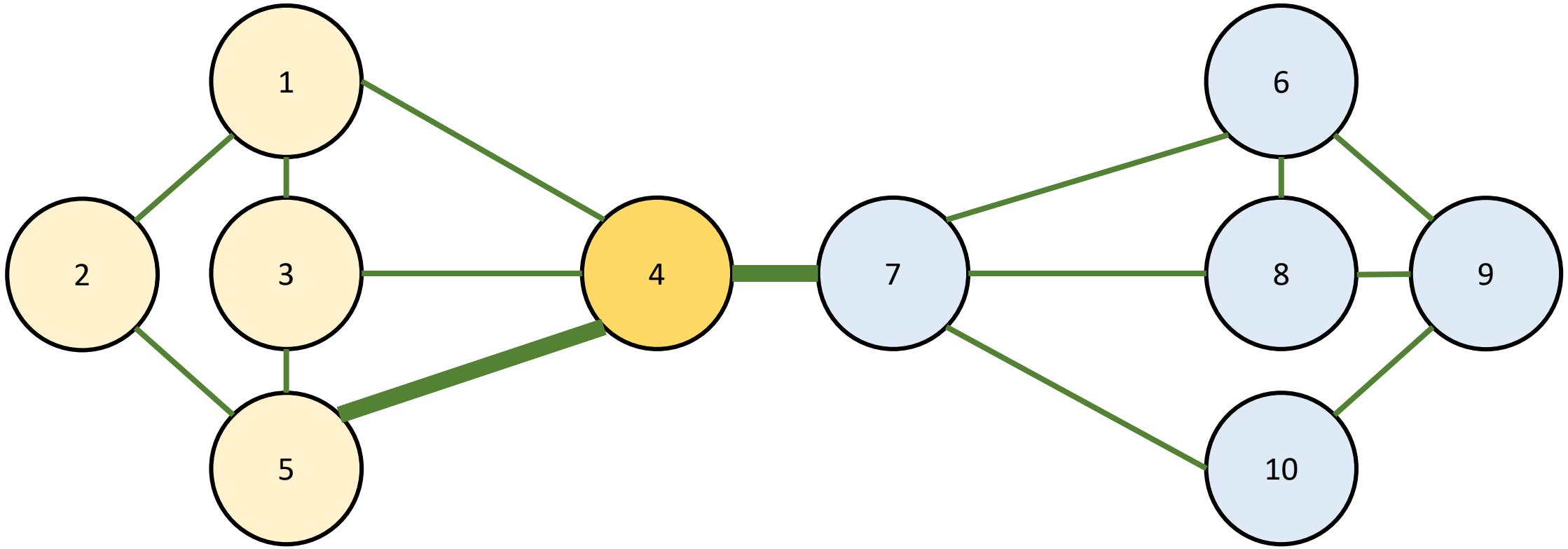
Bridge Strength



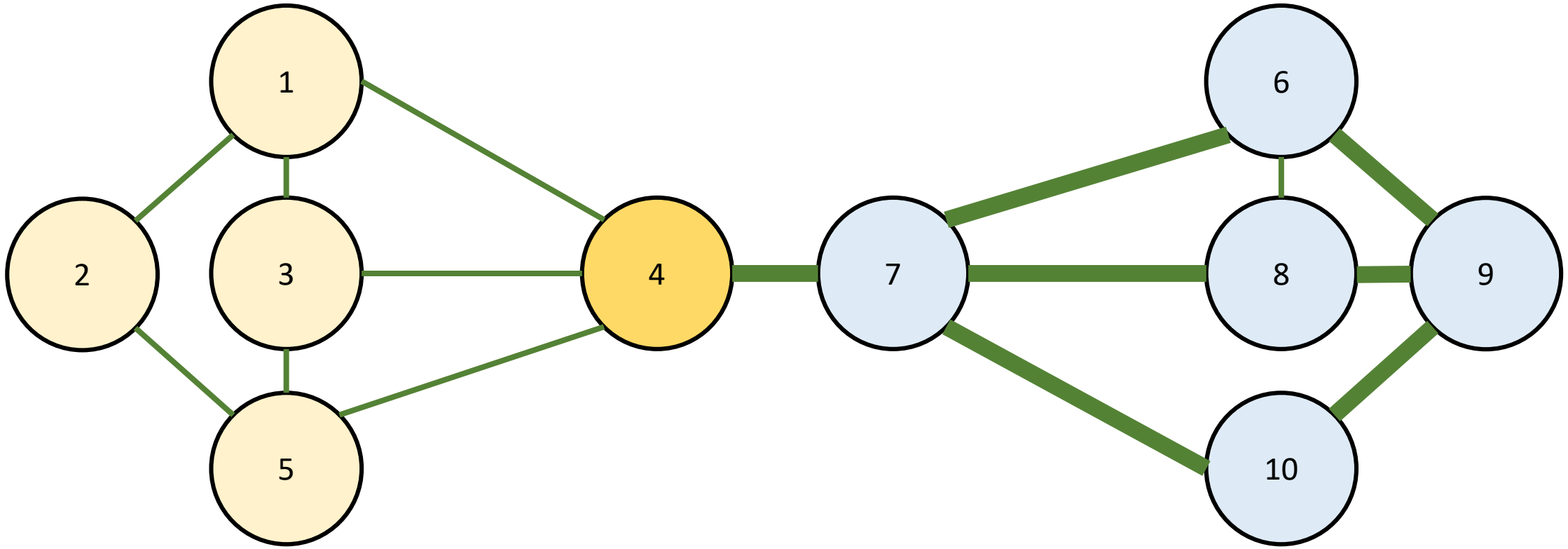
Bridge Betweenness



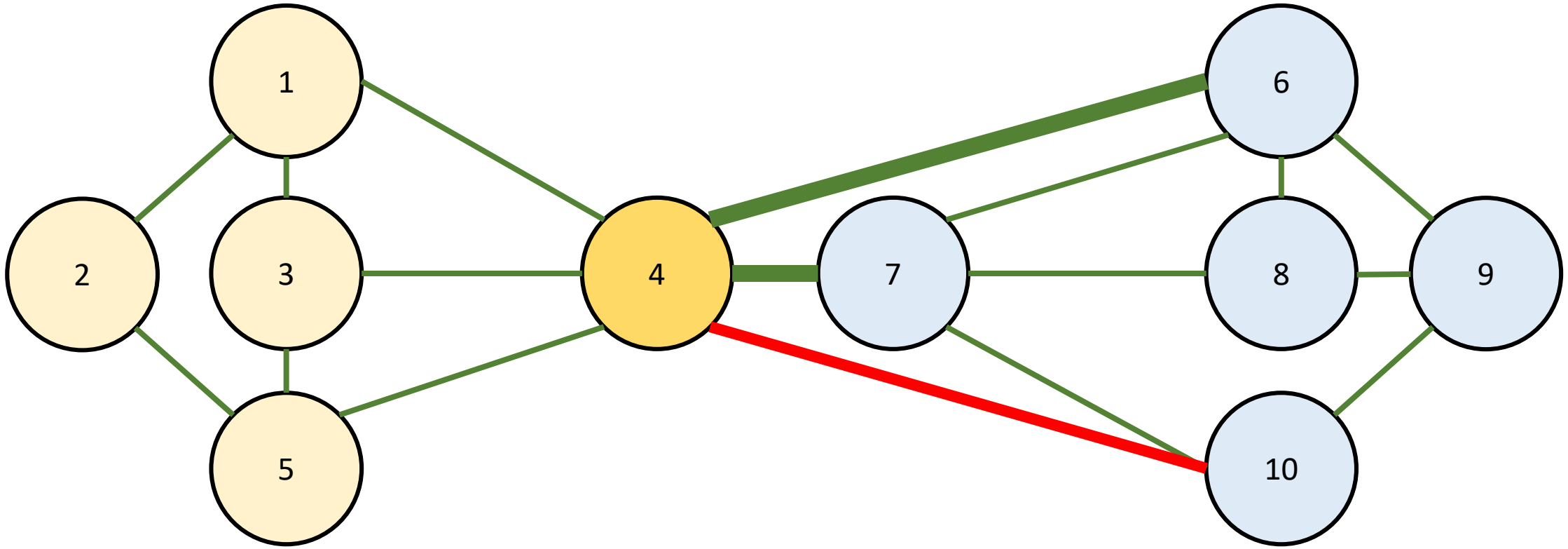
Bridge Betweenness



Bridge Closeness



Bridge Expected Influence



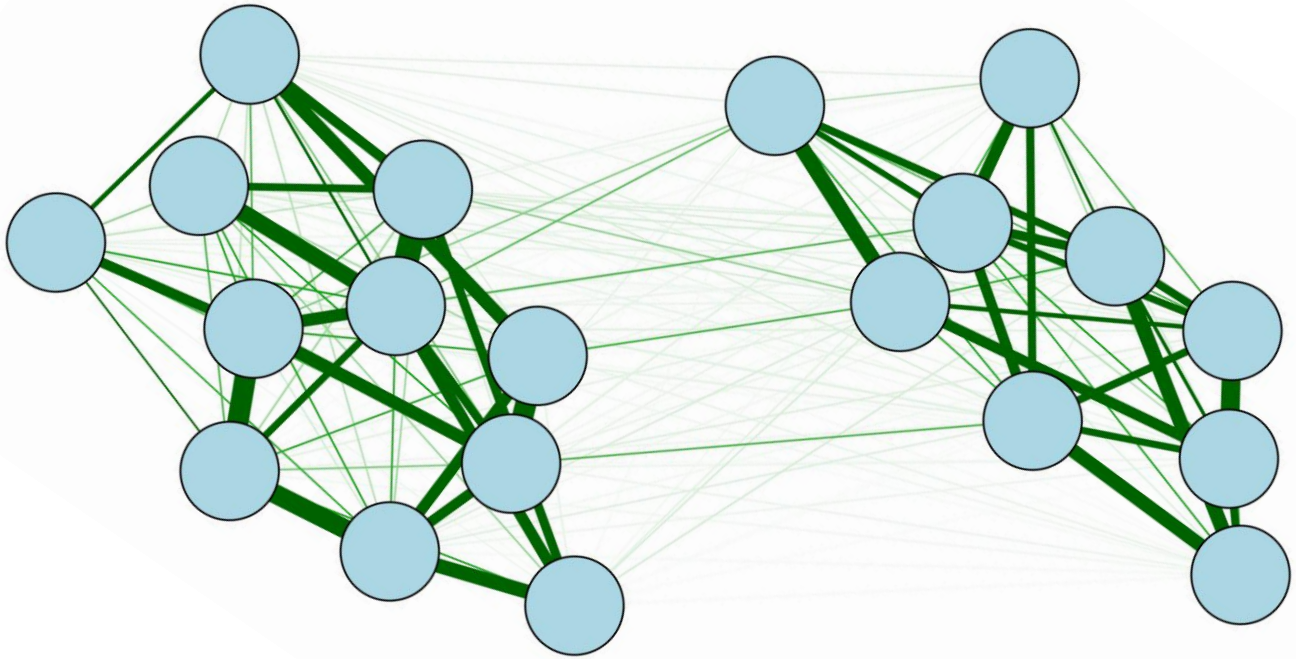
IS BRIDGE CENTRALITY ACCURATE?

Study 1: Detection in simulations

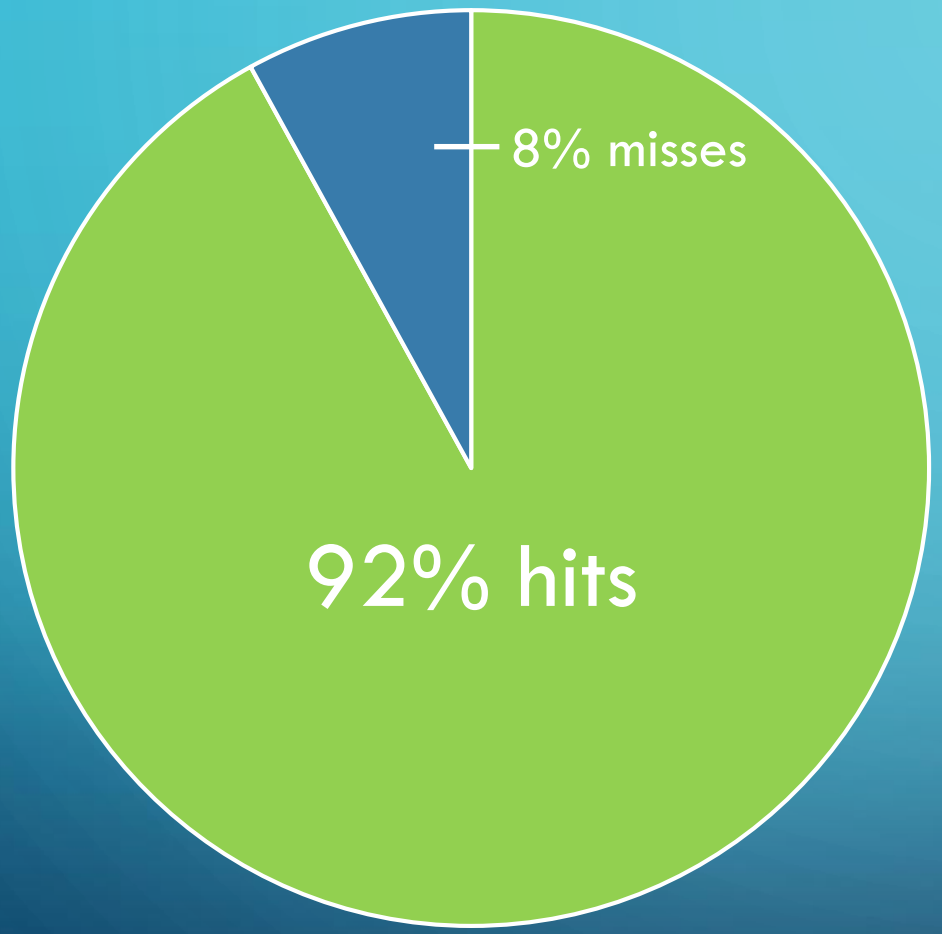
Trials:

1. Adding noise
2. Adding causal direction
3. Adding uncertainty about clusters

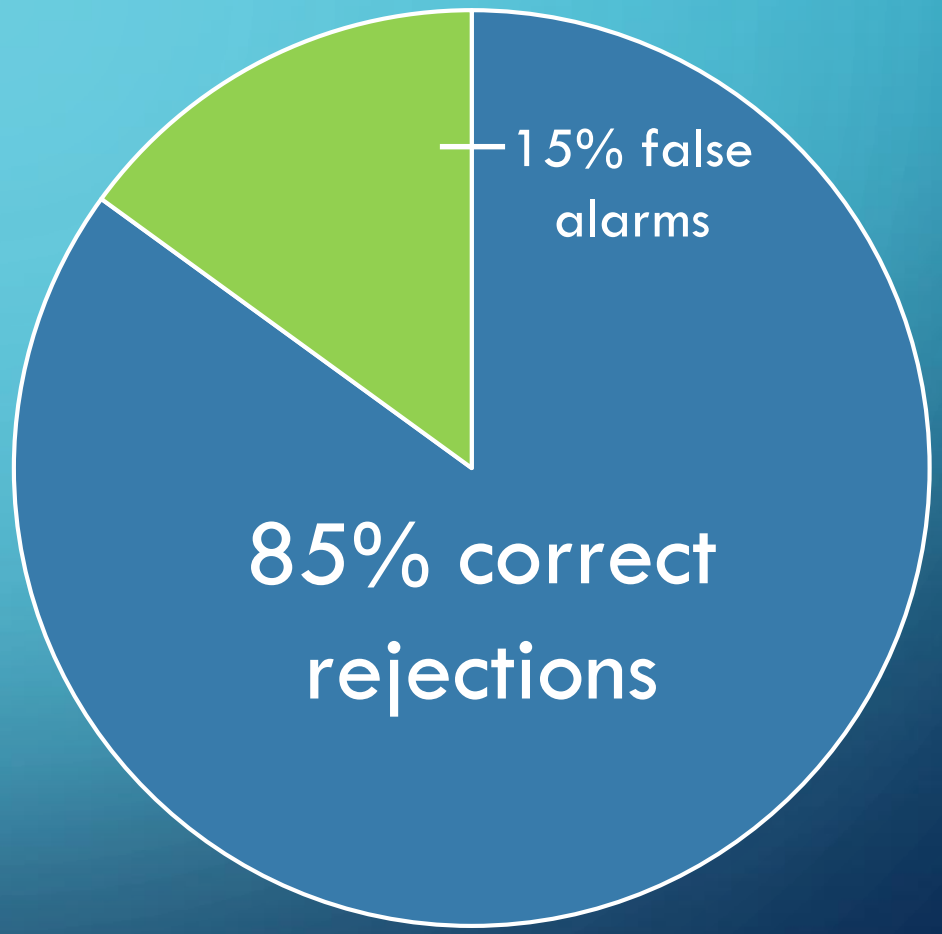
2 x 2 x 2 x 500 = 4,000 simulations



Sensitivity



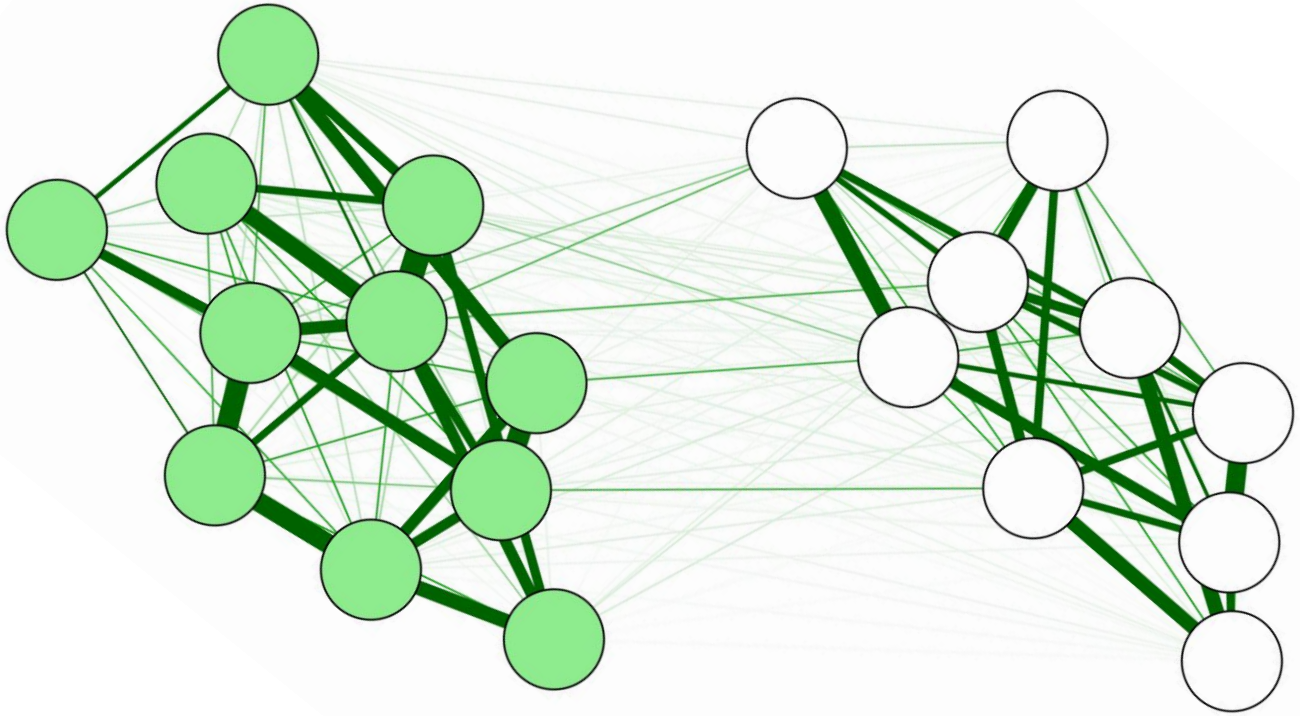
Specificity



IS BRIDGE CENTRALITY USEFUL?

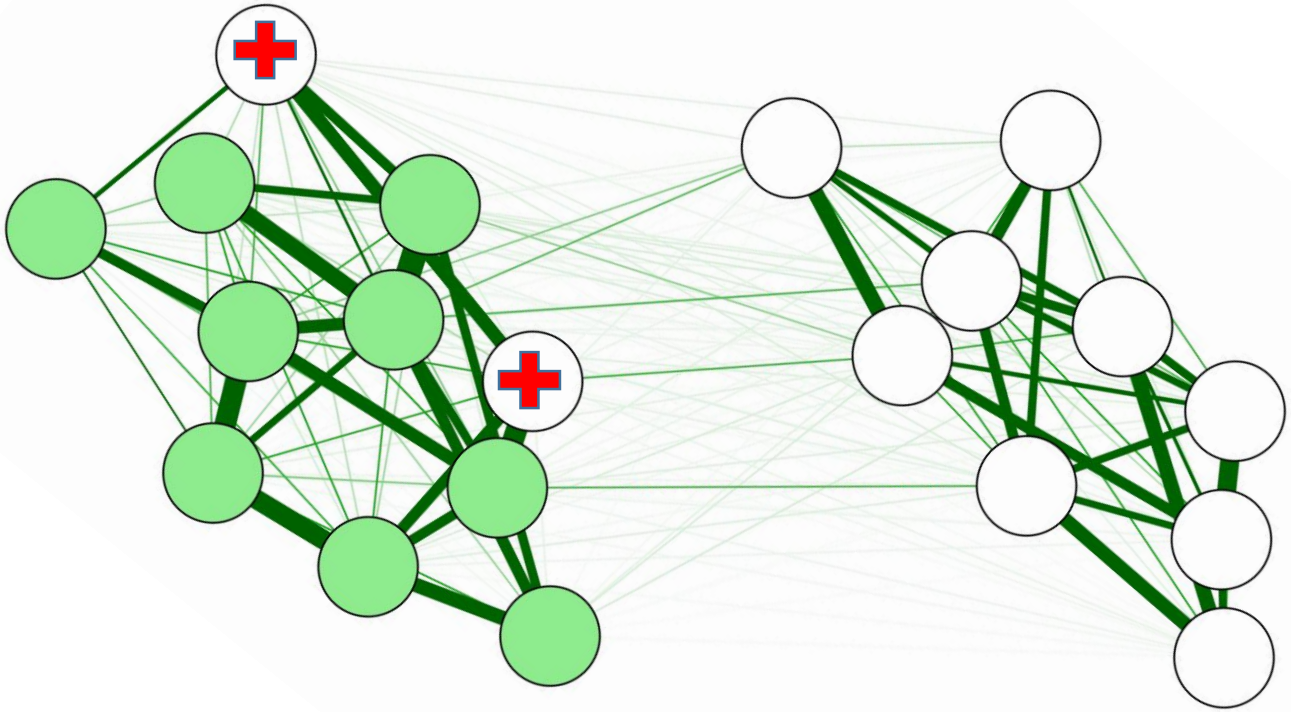
Study 2: Simulation of contagion

1. Start with one community activated
2. Allow the activation to spread over many iterations

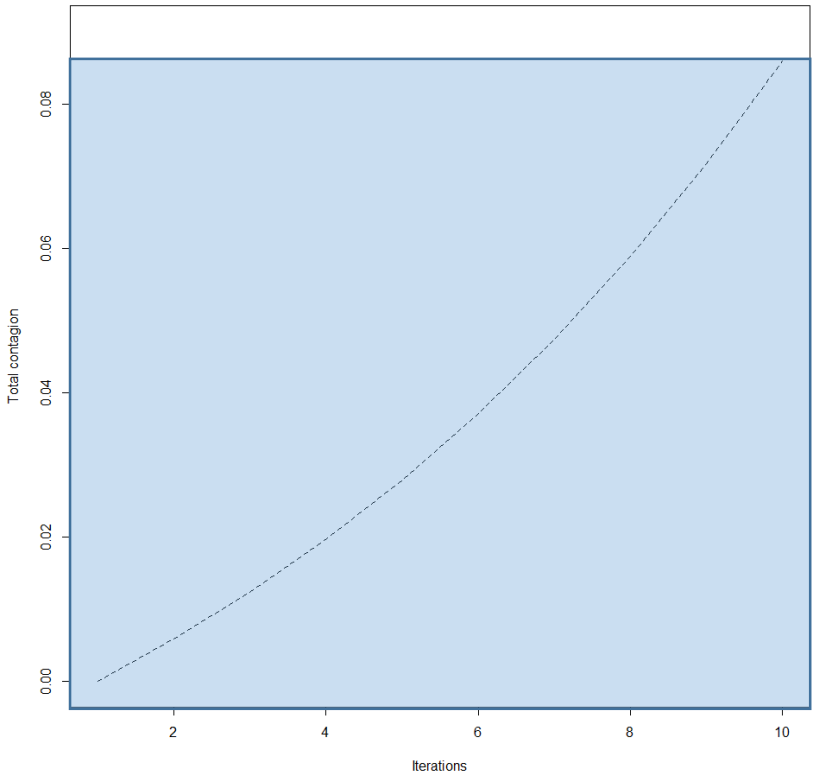


Study 2: Simulation of contagion

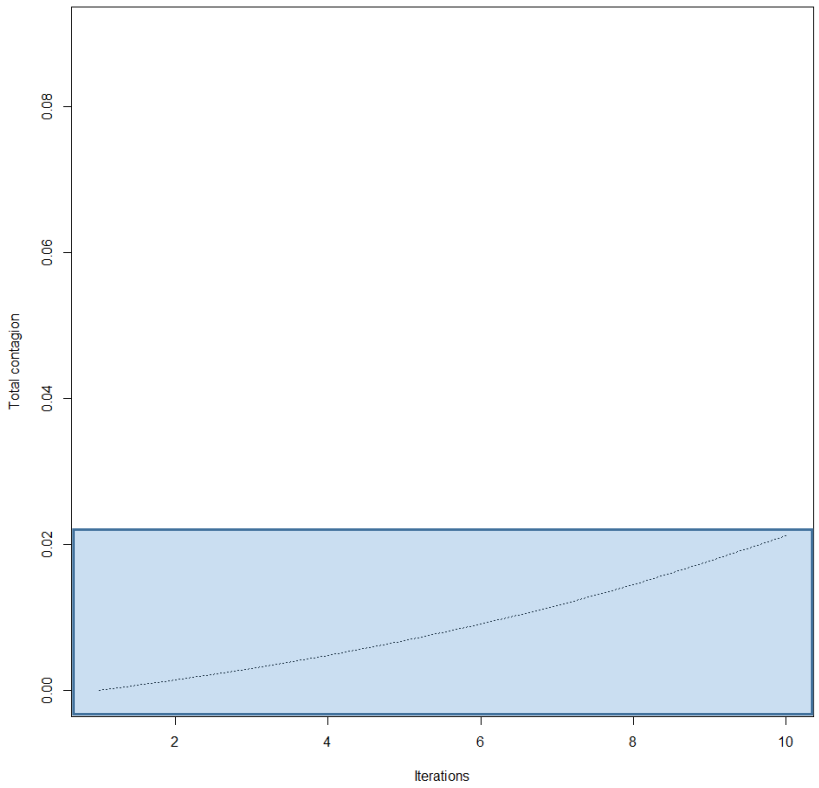
1. Start with one community activated
2. Allow the activation to spread over many iterations
3. Treat a limited number of nodes
4. Bridge centrality vs. previous metrics



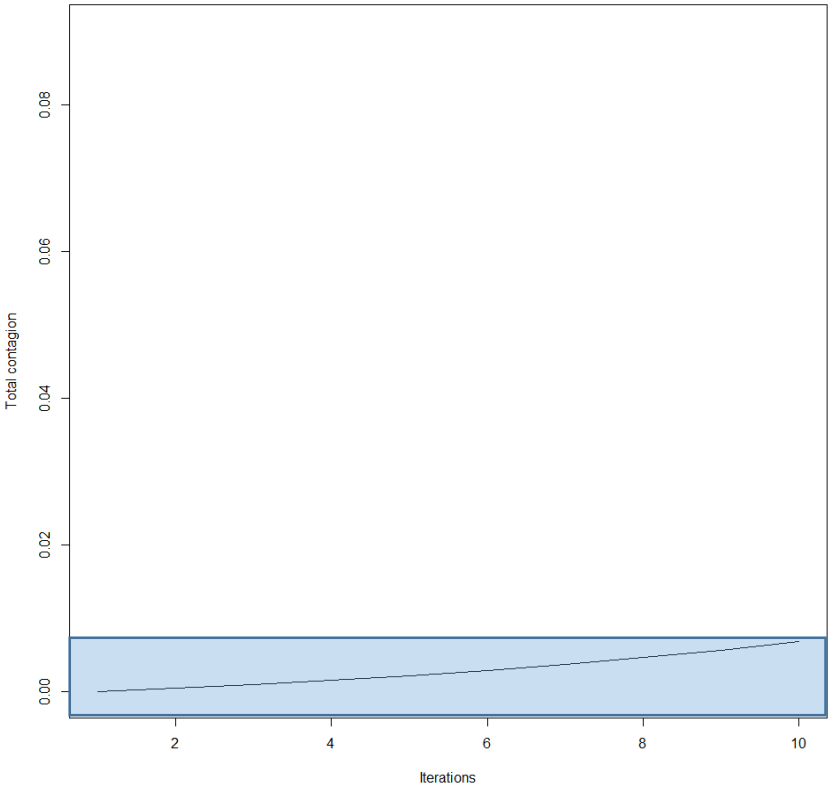
Control 1



Control 2



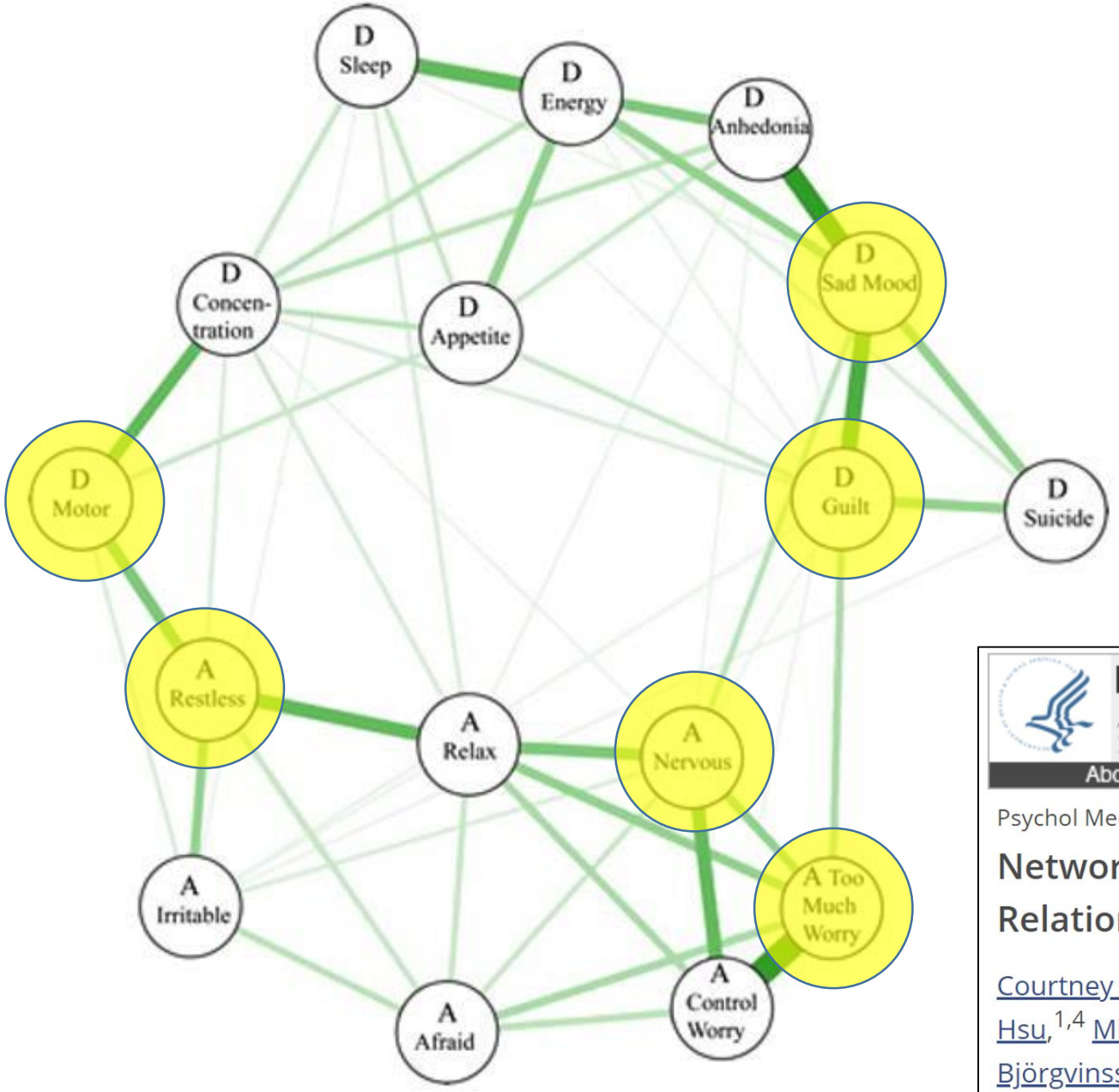
Bridge Centrality



DOES BRIDGE CENTRALITY WORK IN REAL LIFE SITUATIONS?

RE-ANALYSIS:

- 18 published networks
- Bridge symptoms reported by researchers
- Bridge symptoms indicated by bridge centrality



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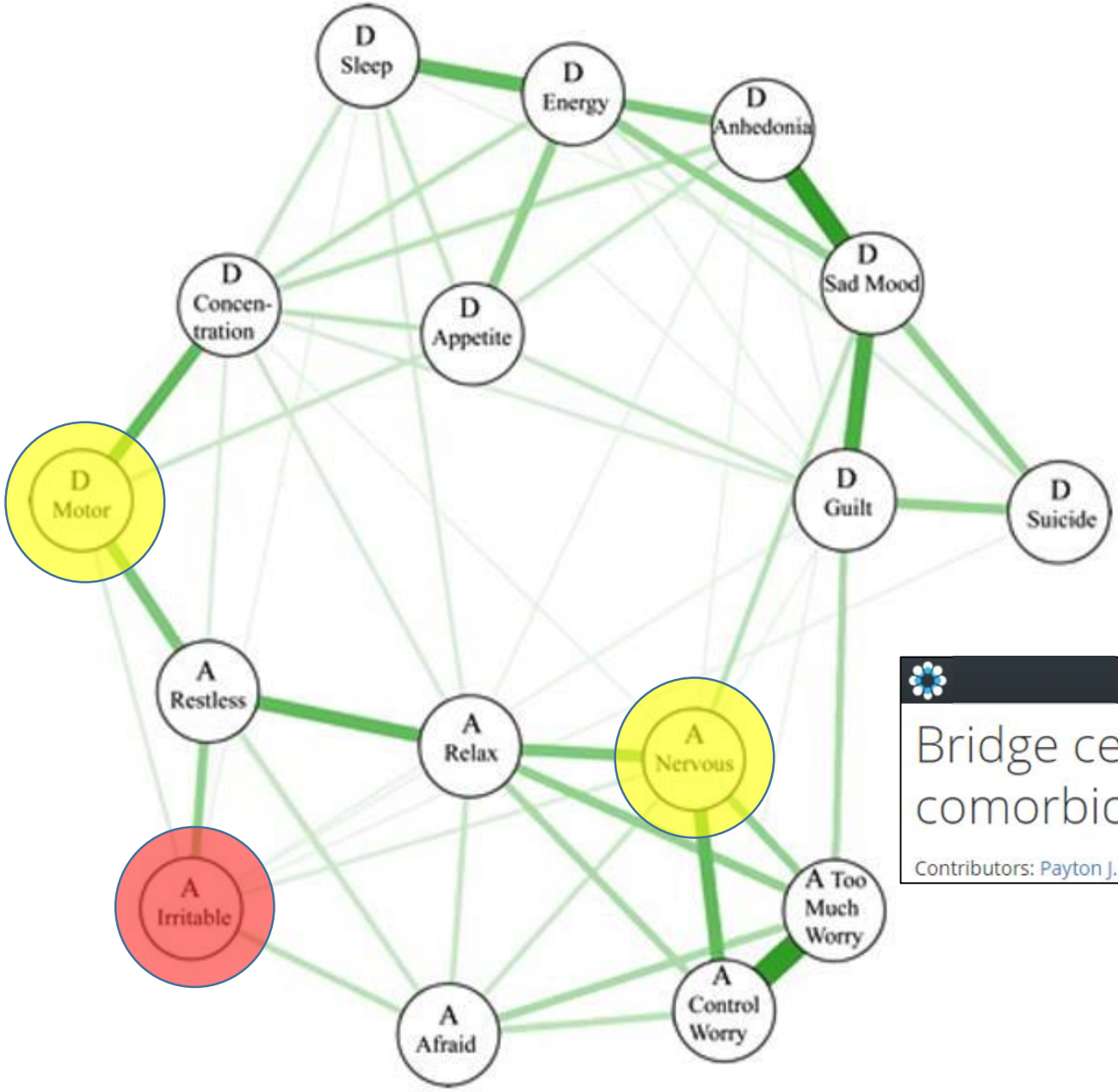
Network Analysis of Depression and Anxiety Symptom Relations in a Psychiatric Sample

Courtney Beard,[1,*] Alex J. Millner,[1,2,*] Marie J. C. Forgeard,[1] Eiko I. Fried,[3] Kean J. Hsu,[1,4] Michael Treadway,[1,5] Chelsea V. Leonard,[5] Sarah Kertz,[6] and Thröstur Björgvinsson[1]



Bridge centrality: A network approach to understanding comorbidity

Contributors: Payton J. Jones, Ruofan Ma, Richard J. McNally

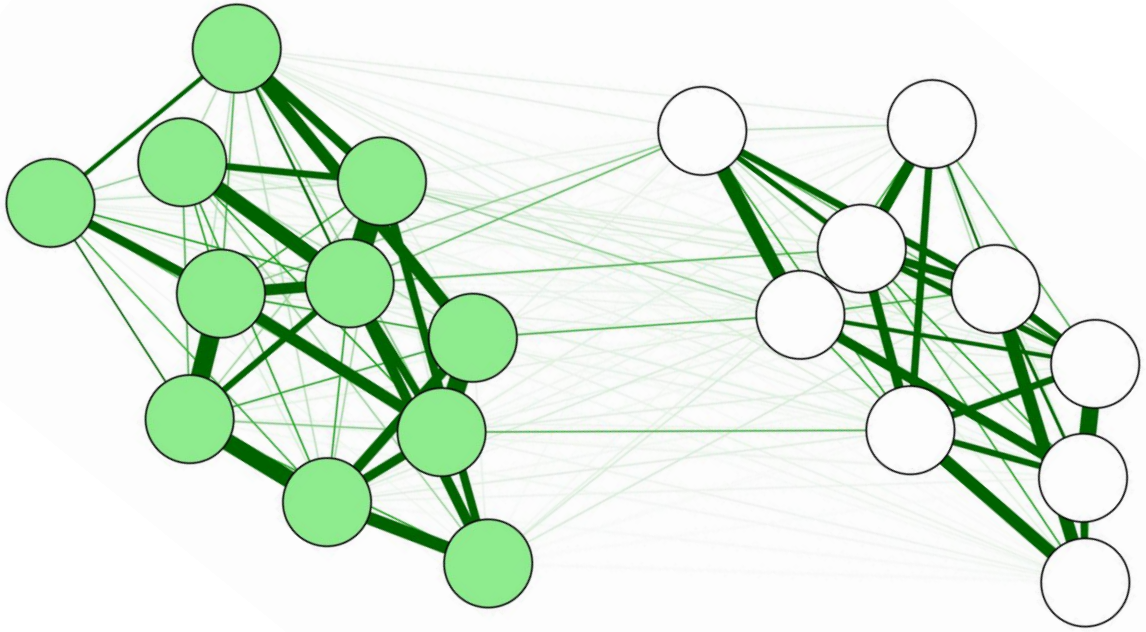
HOW CAN I USE BRIDGE CENTRALITY?

BRIDGE CENTRALITY: BEYOND MENTAL DISORDERS?

- Social Anxiety – Depression
- Grief – Growth
- Borderline Personality – Narcissistic Personality
- State-Trait Anxiety – Neuroticism
- Cognitive – Affective (Attitudes)

	A	B	C	D	E	F	G	H	I	J
1	scaleX_1	scaleX_2	scaleX_3	scaleX_4	scaleX_5	scaleY_1	scaleY_2	scaleY_3	scaleY_4	scaleY_5
2	3	4	3	4	3	4	2	5	3	3
3	1	3	5	2	5	1	1	1	3	1
4	3	4	3	3	4	1	5	2	2	1
5	1	4	2	4	2	1	5	3	2	3
6	1	3	5	2	2	4	1	4	1	4
7	2	5	2	3	3	5	3	2	4	4
8	4	5	2	1	3	1	2	3	2	5

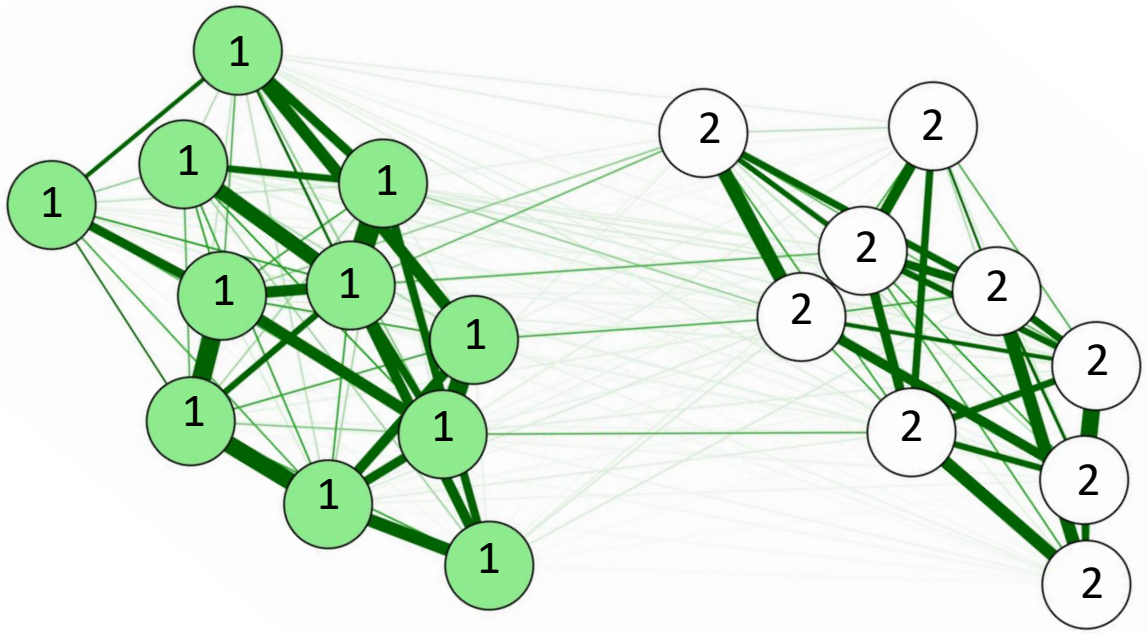
GENERATE A NETWORK



```
network <- qgraph(cor(data),
                  graph="glasso",
                  sampleSize=1000)
```

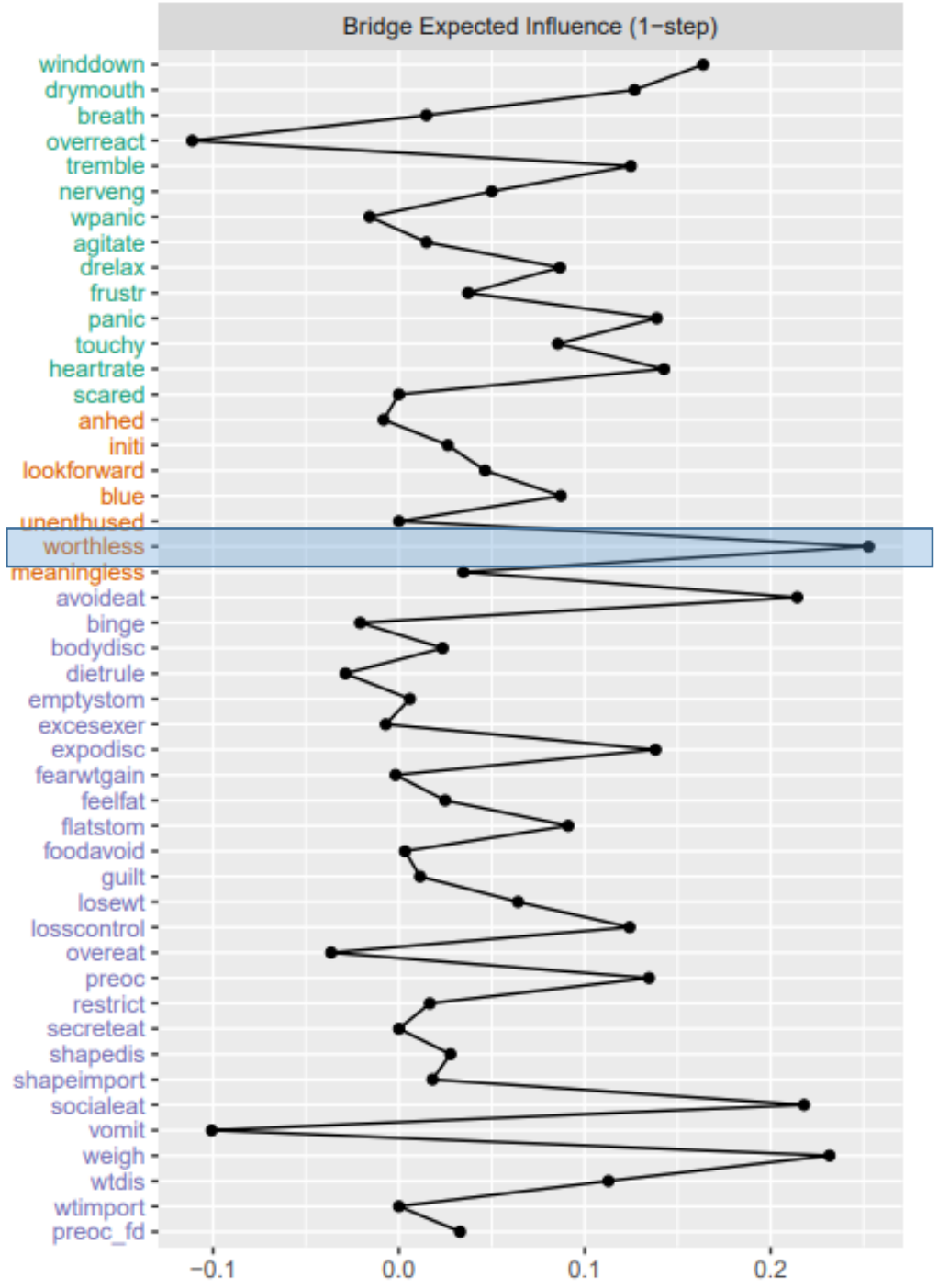
DEFINE COMMUNITIES

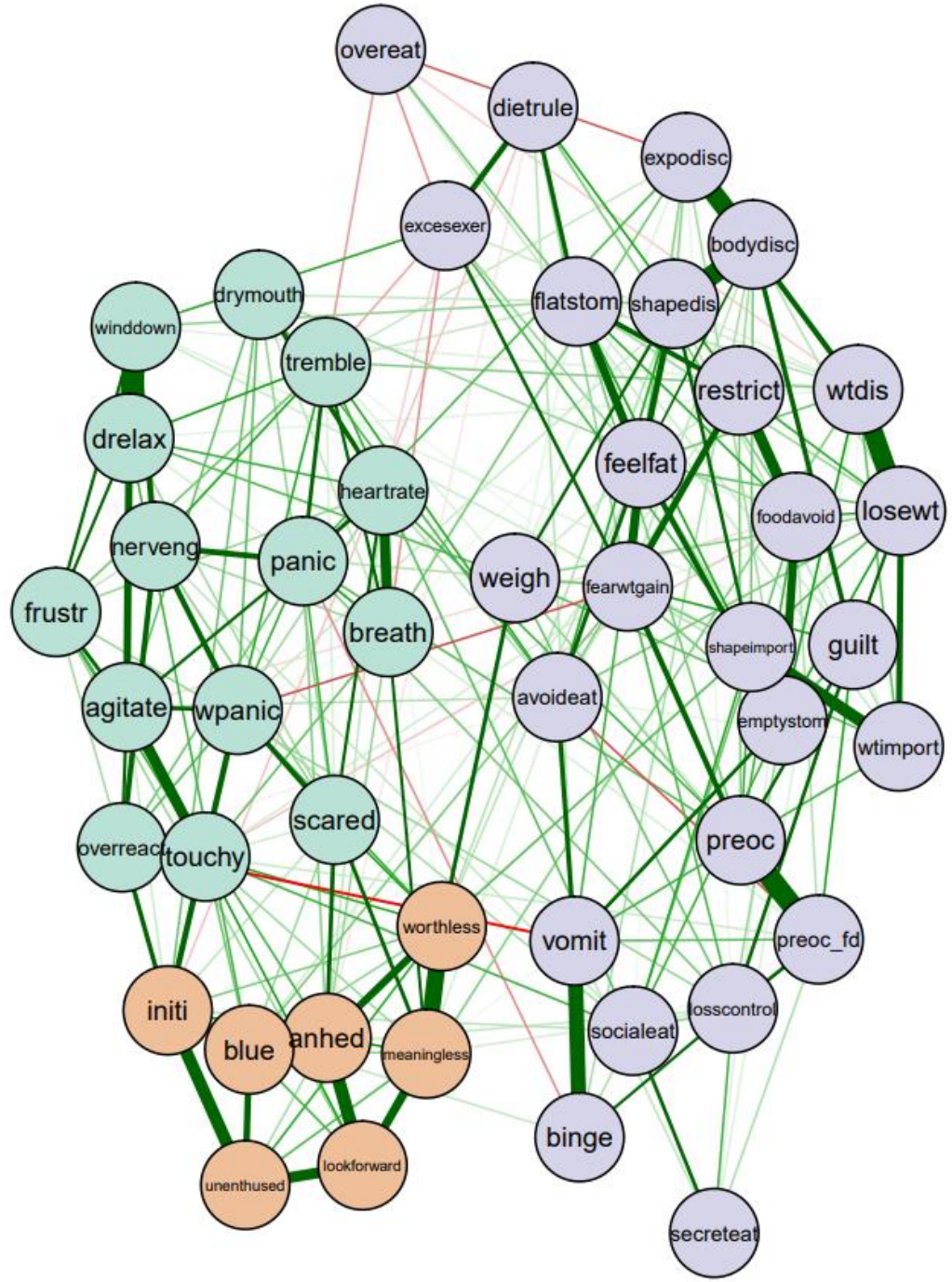
```
communities <- c(rep("1", 11), rep("2", 9))
```

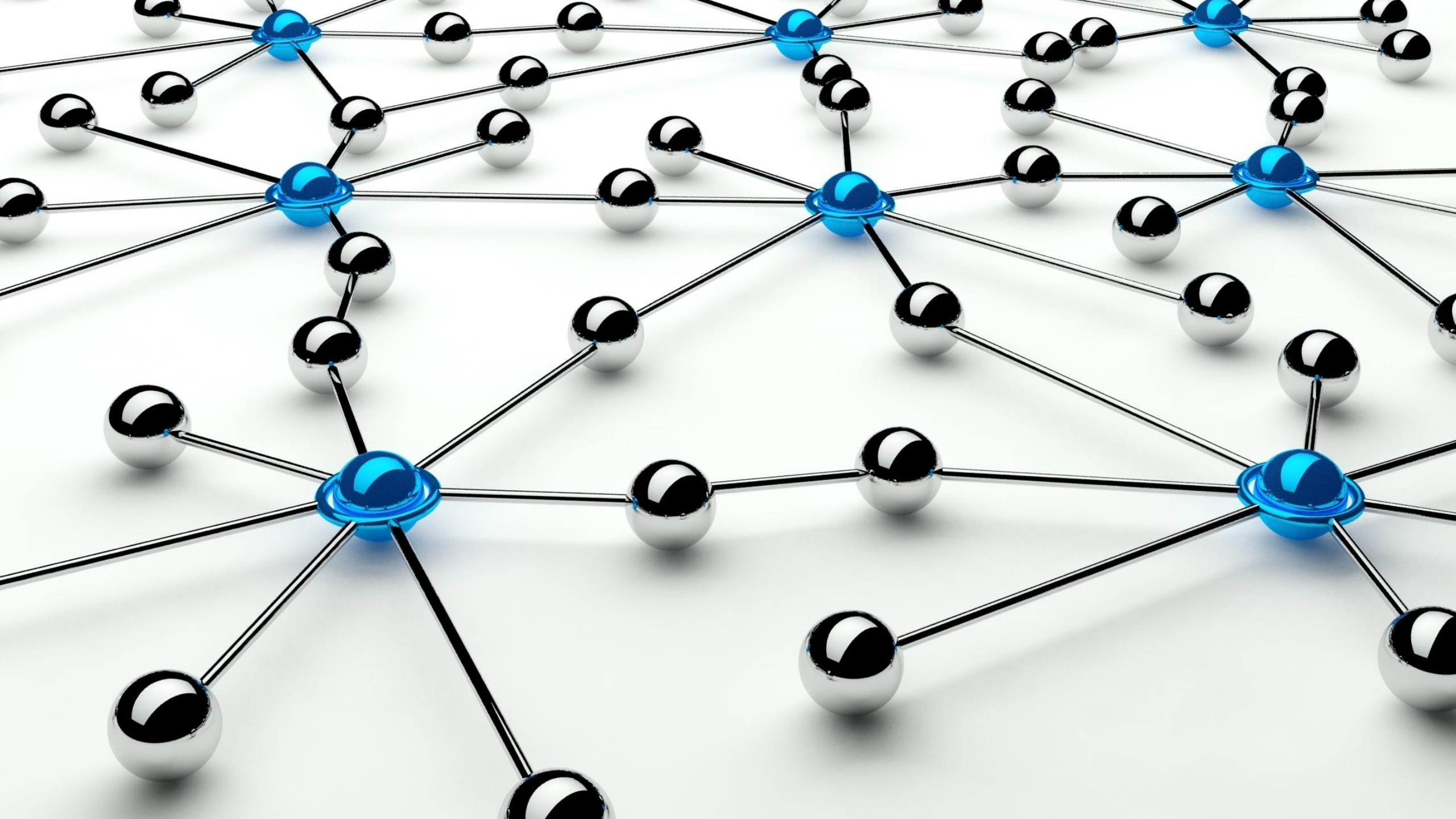


BRIDGE CENTRALITY

```
b <- bridge(network, communities)
plot(b, include="Bridge Strength")
```


Bridge Expected Influence (1−step)
winddown
drymouth
breath
overreact
tremble
nerveng
wpanic
agitate
drelax
frustr
panic
touchy
heartrate
scared
anhed
initi
lookforward
blue
unenthused
worthless
meaningless
avoideat
binge
bodydisc
dietrule
emptystom
excesexer
expodisc
fearwtgain
feelfat
flatstom
foodavoid
guilt
losewt
losscontrol
overeat
preoc
restrict
secreteat
shapedis
shapeimport
socialeat
vomit
weigh
wtdis
wtimport
preoc_fd
−0.1
0.0
0.1
0.2


overeat
dietrule
expodisc
excesexer
bodydisc
drymouth
flatstom
shapedis
winddown
tremble
restrict
wtdis
drelax
feelfat
heartrate
foodavoid
losewt
nerveng
panic
weigh
fearwtgain
frustr
breath
shapeimport
guilt
avoideat
agitate
wpanic
emptystom
wtimport
scared
overreact
touchy
preoc
worthless
vomit
preoc_fd
initi
losscontrol
blue
anhed
socialeat
meaningless
binge
unenthused
lookforward
secreteat



THANK YOU!

Read the preprint:
https://osf.io/c5dkj/

Use the R package:
networktools