Caterina Fuses
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Copenhagen Student Networks II

Sapiezynski et al, (2019) Interaction data from the Copenhagen Networks Study

Agenda

1. Network Description
2. Communities
3. Dynamics
4. Discussion

1. Network Description

A network of interactions among over 700 university students at Technical University of Denmark collected via smartphones over a period of 4 weeks

Bluetooth (Proximity)

Each device in the experiment discovers nearby Bluetooth devices every 5 minutes and measures RSSI (Received Signal Strength) that can be mapped to physical distance.

Calls

Call logs obtained from smartphones every day and recorded as caller and callee. Duration of call is also measured.

SMS

Message logs obtained from smartphones every day and recorded as sender and recipient.

Facebook

Used Facebook API to access tokens provided by participants to collect FB data everyday and presented as a friendship network

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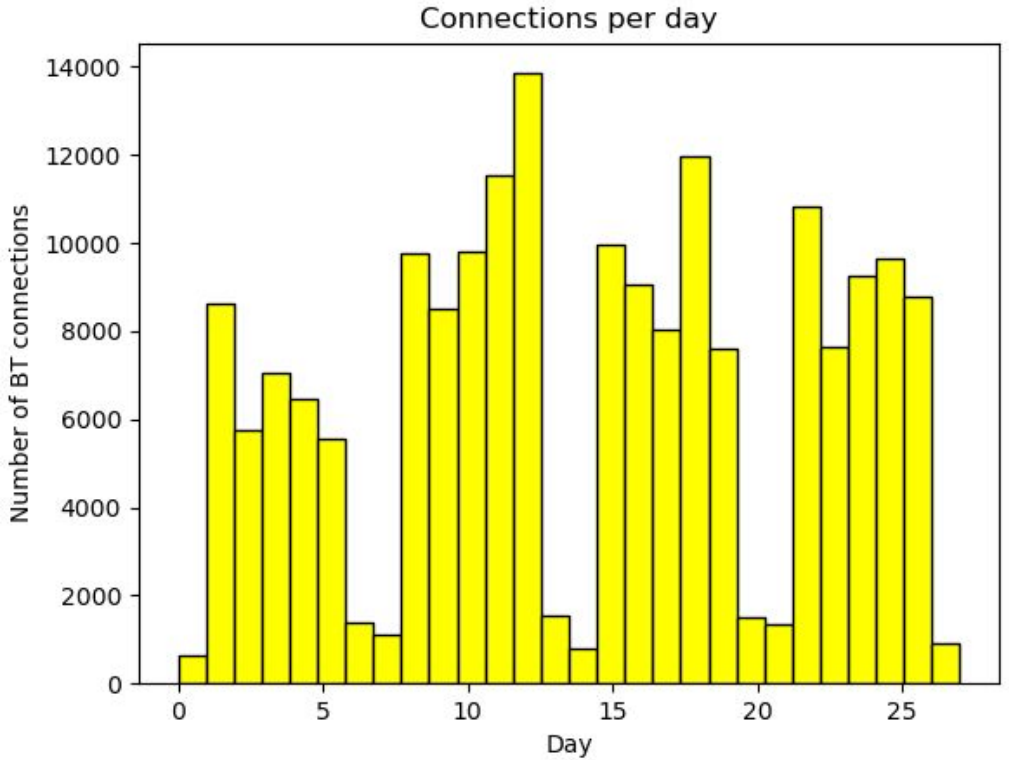
Bluetooth Network

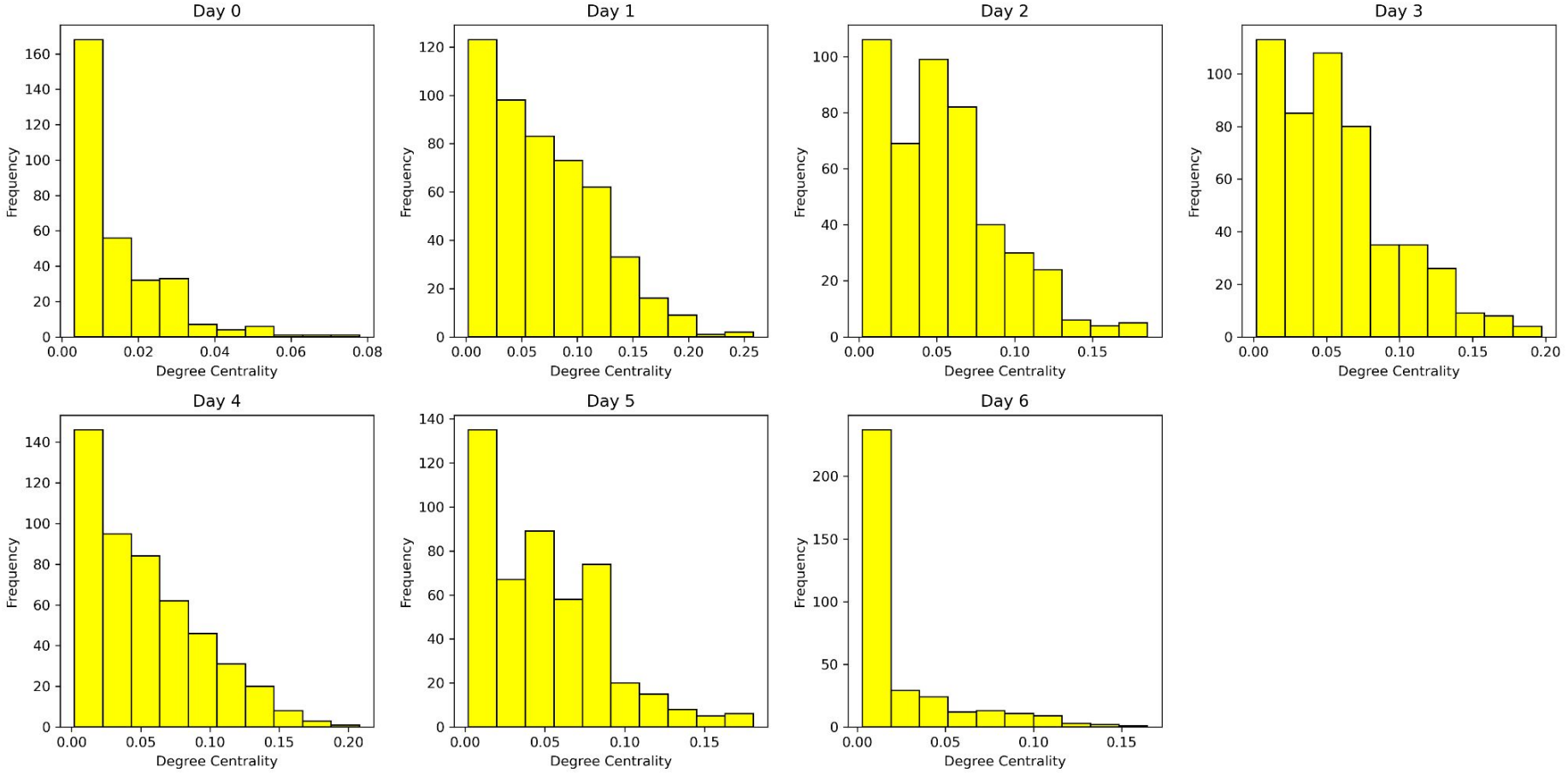
692 nodes

79530 links

Weighted by **RSSI**, undirected



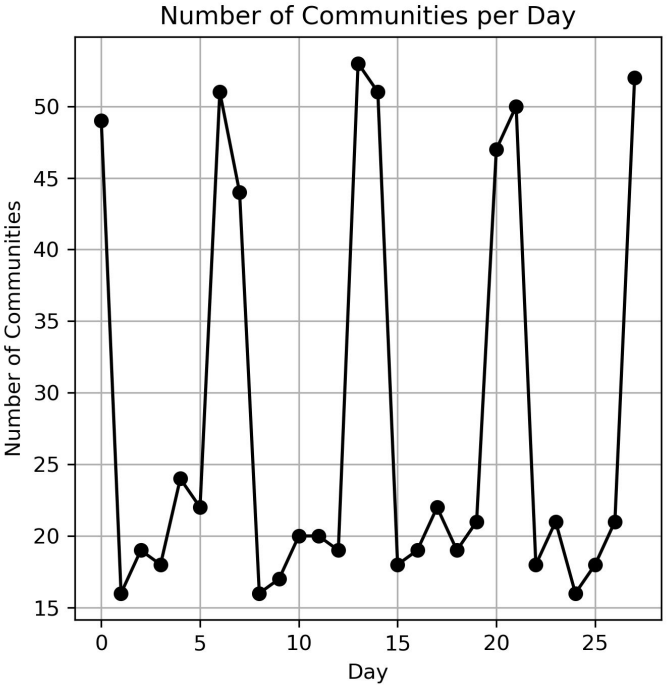
Centrality distribution during the first week

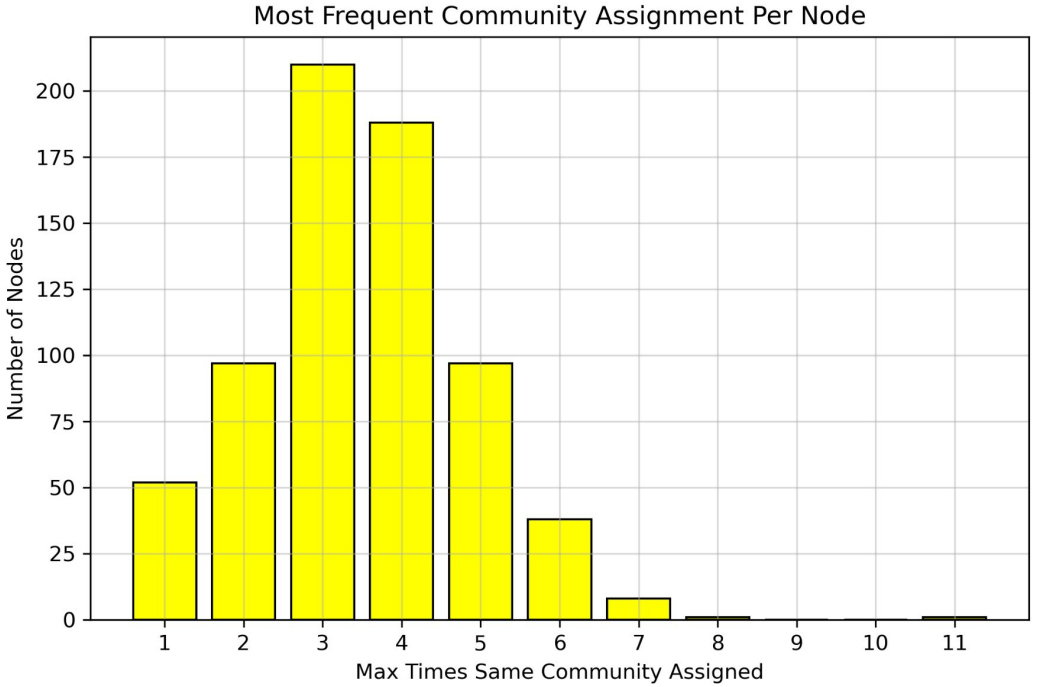


2. Communities

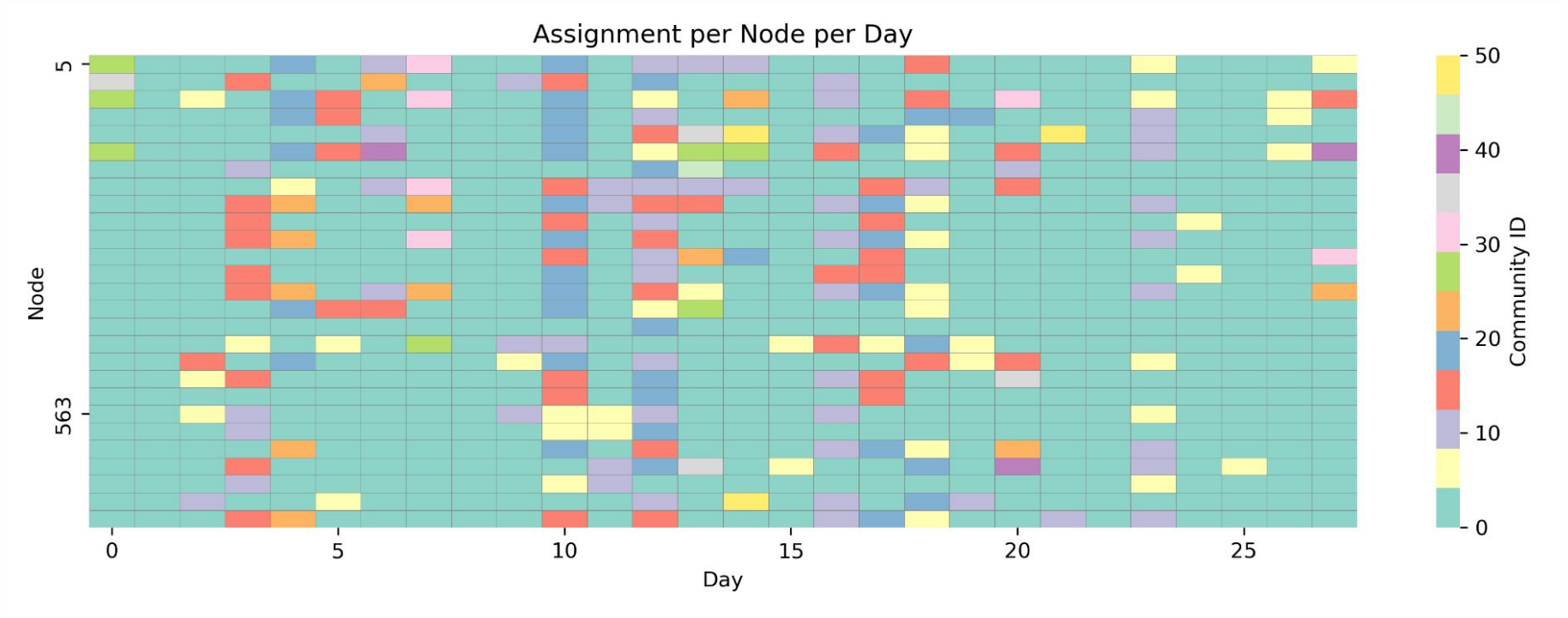
Louvain algorithm

54 communities found





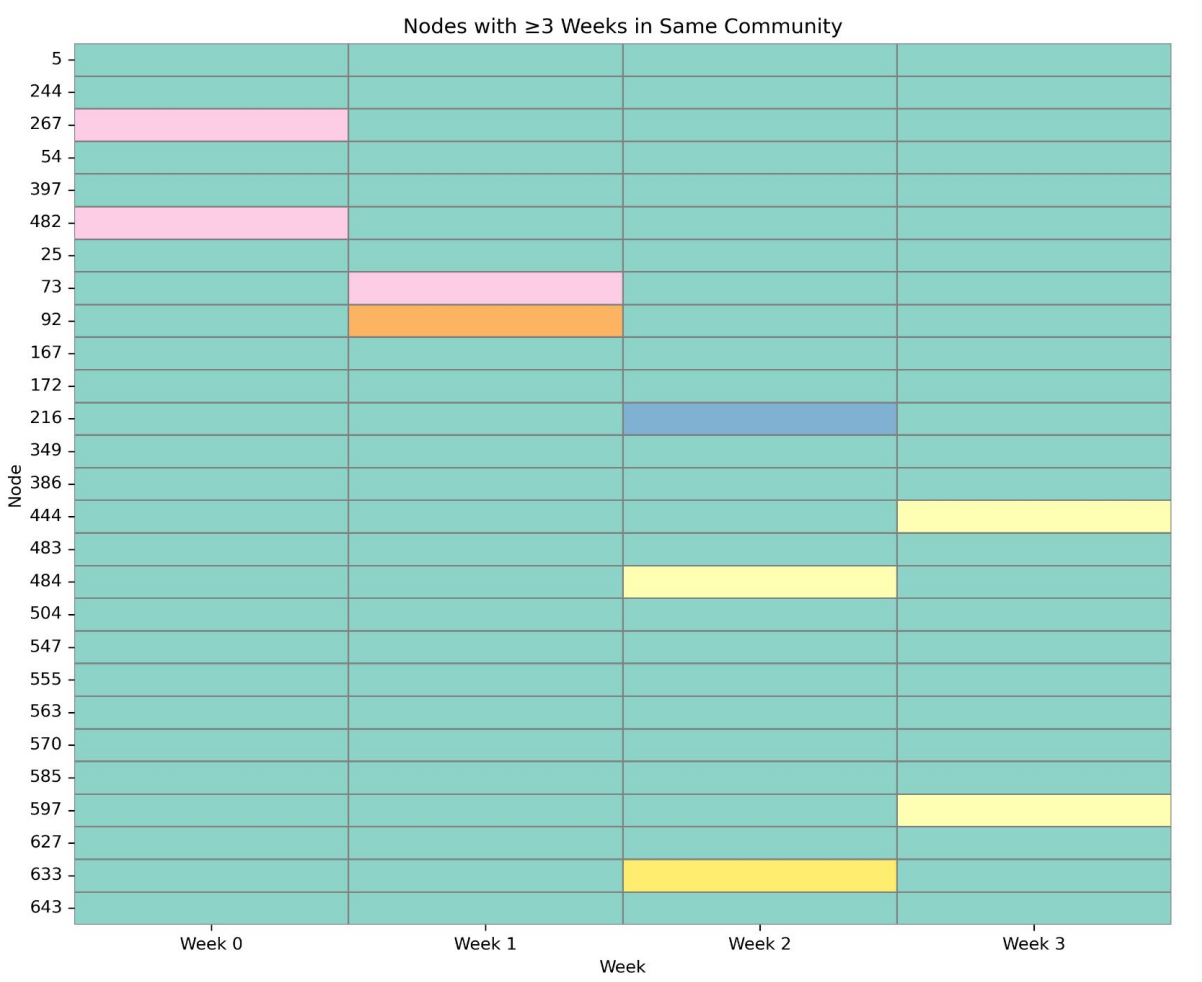
Louvain algorithm



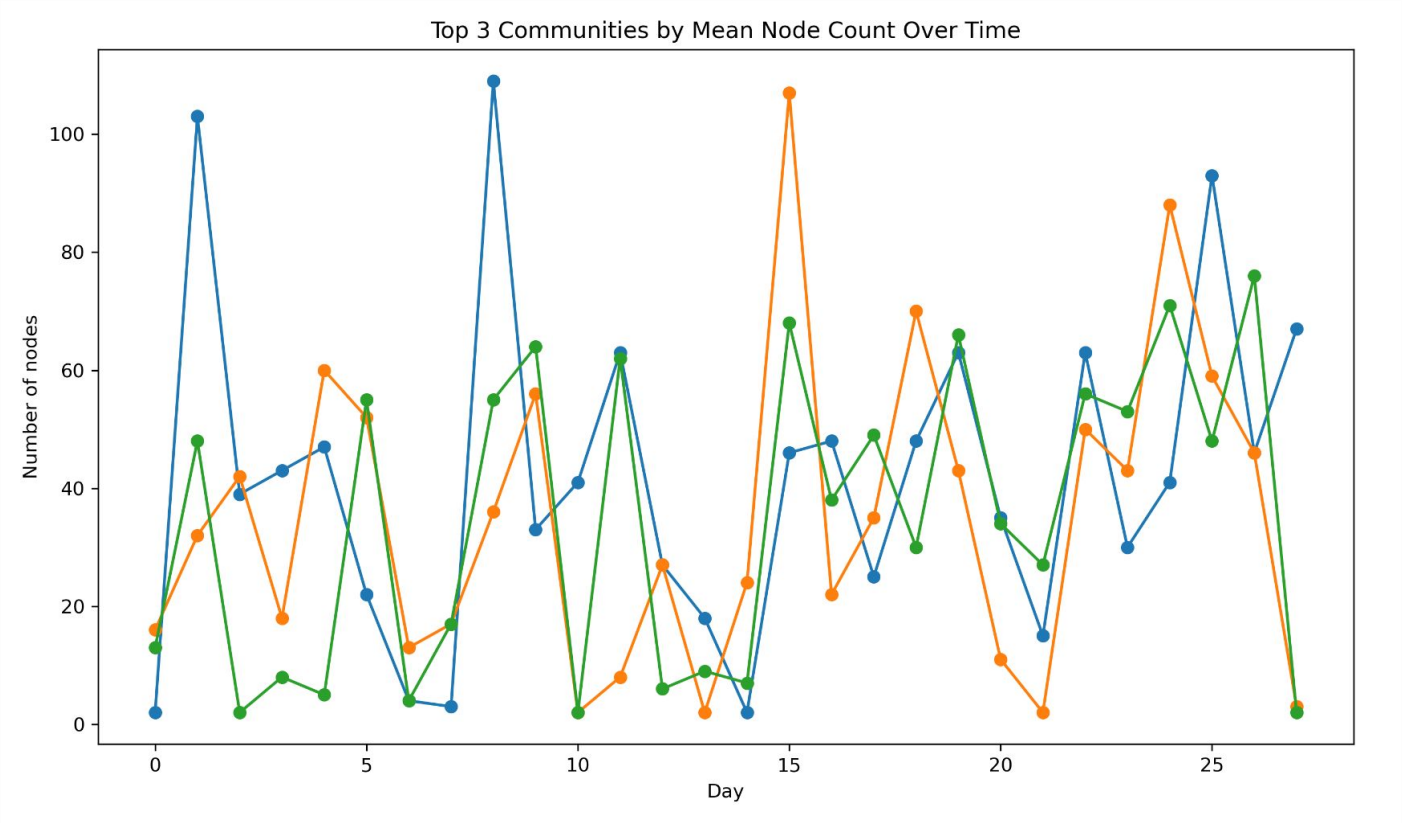
Louvain algorithm

(Taking most assigned node each week)

The most conserved node assignations are in nodes of the same community

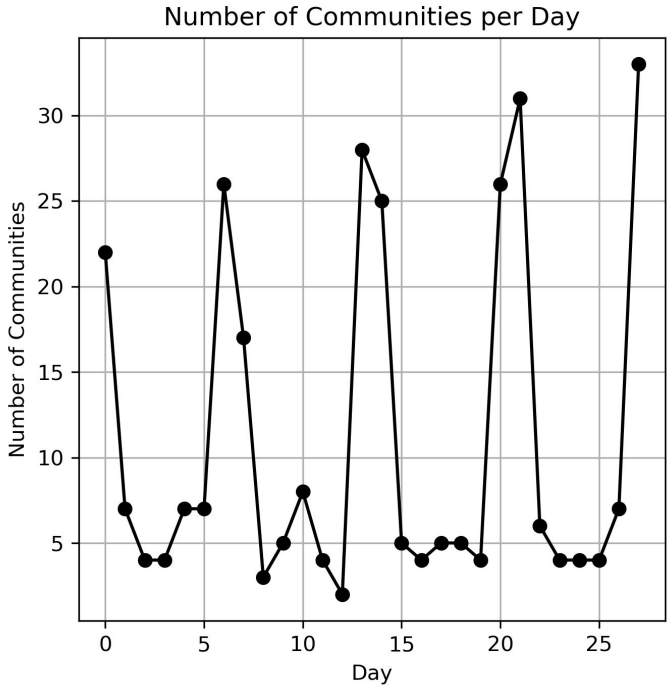


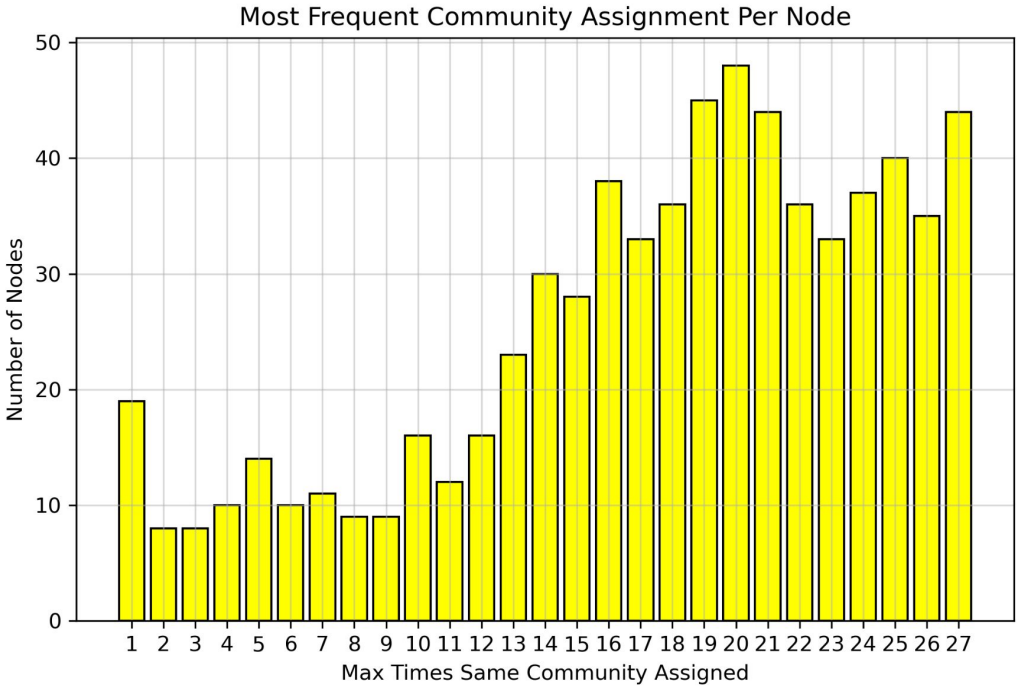
Louvain algorithm



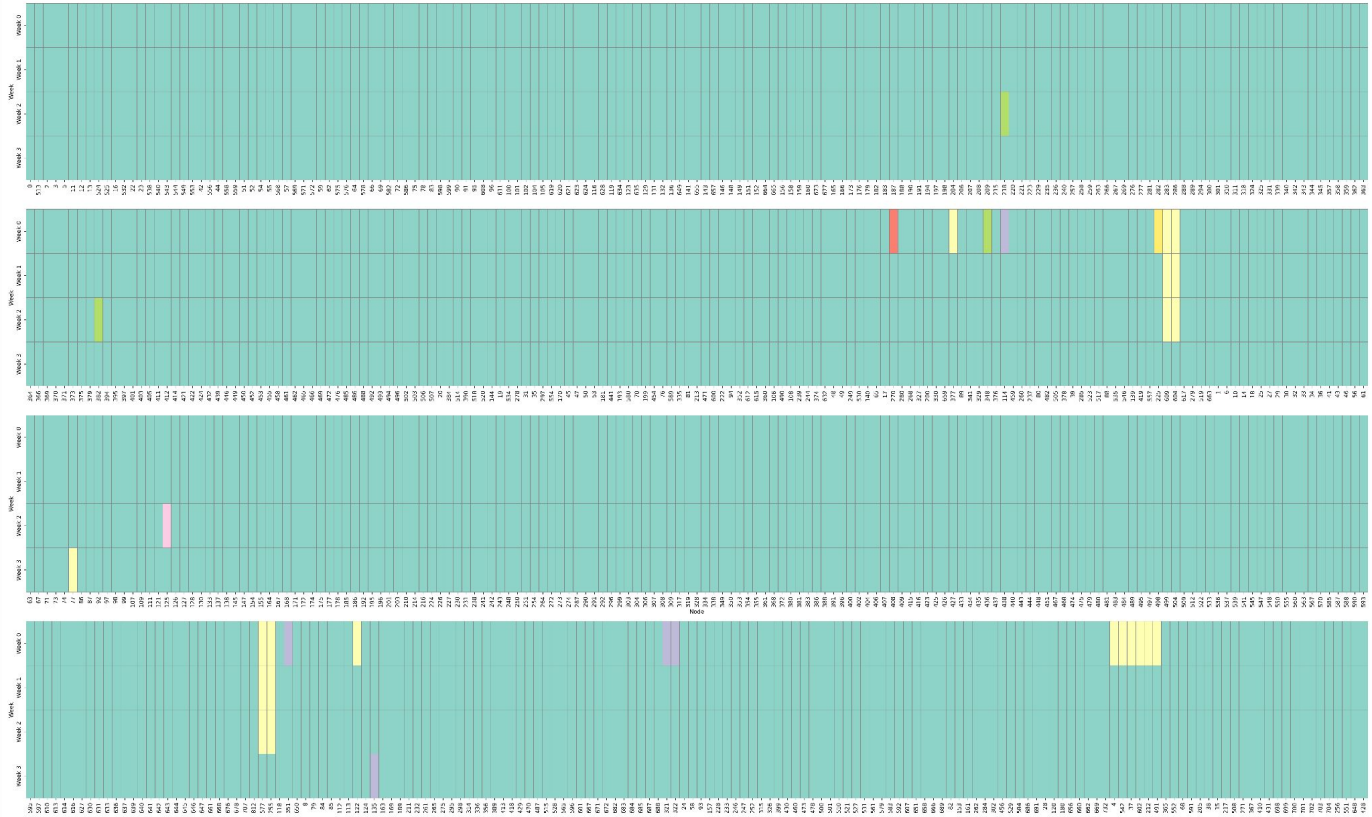
Girvan-Newman algorithm

33 communities found

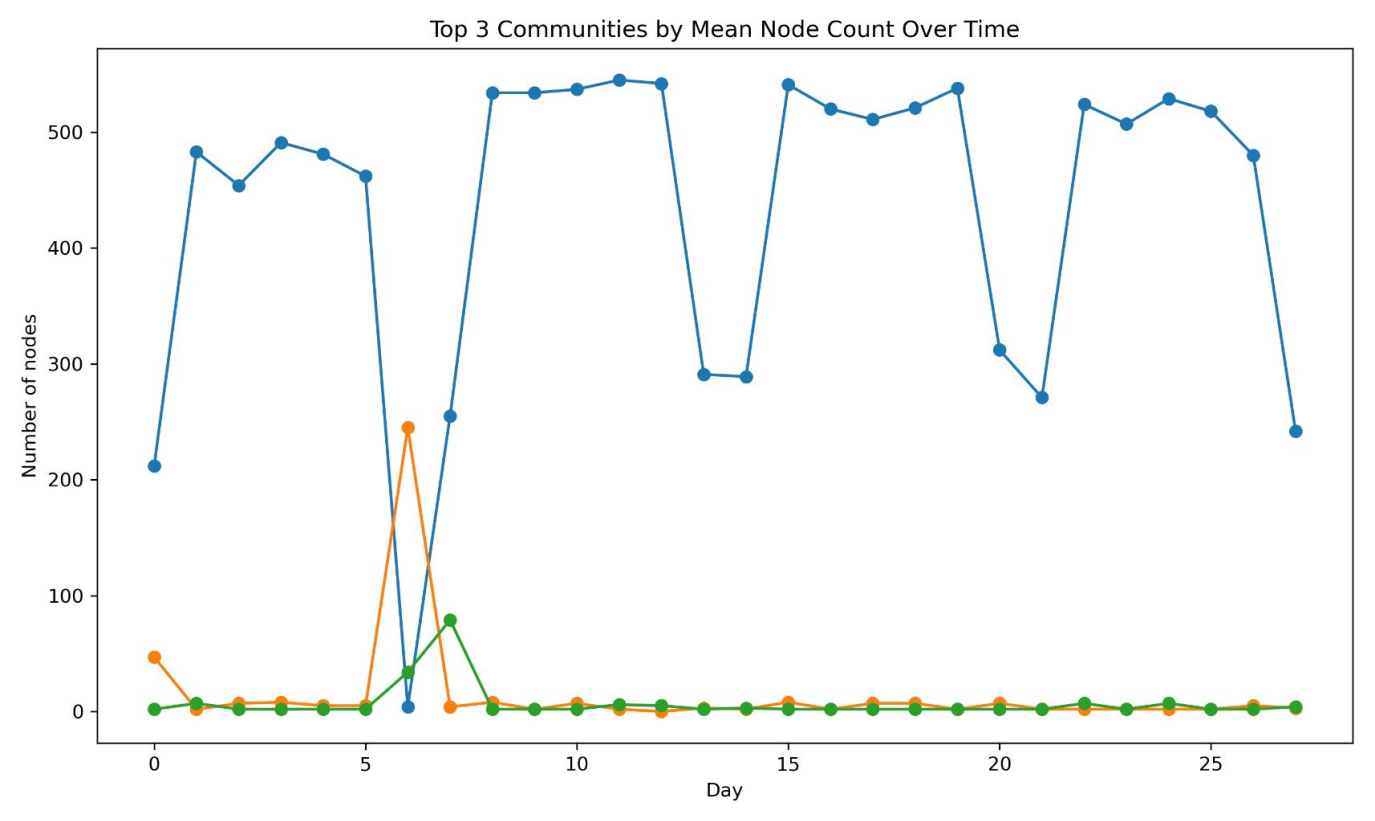




Girvan-Newman algorithm

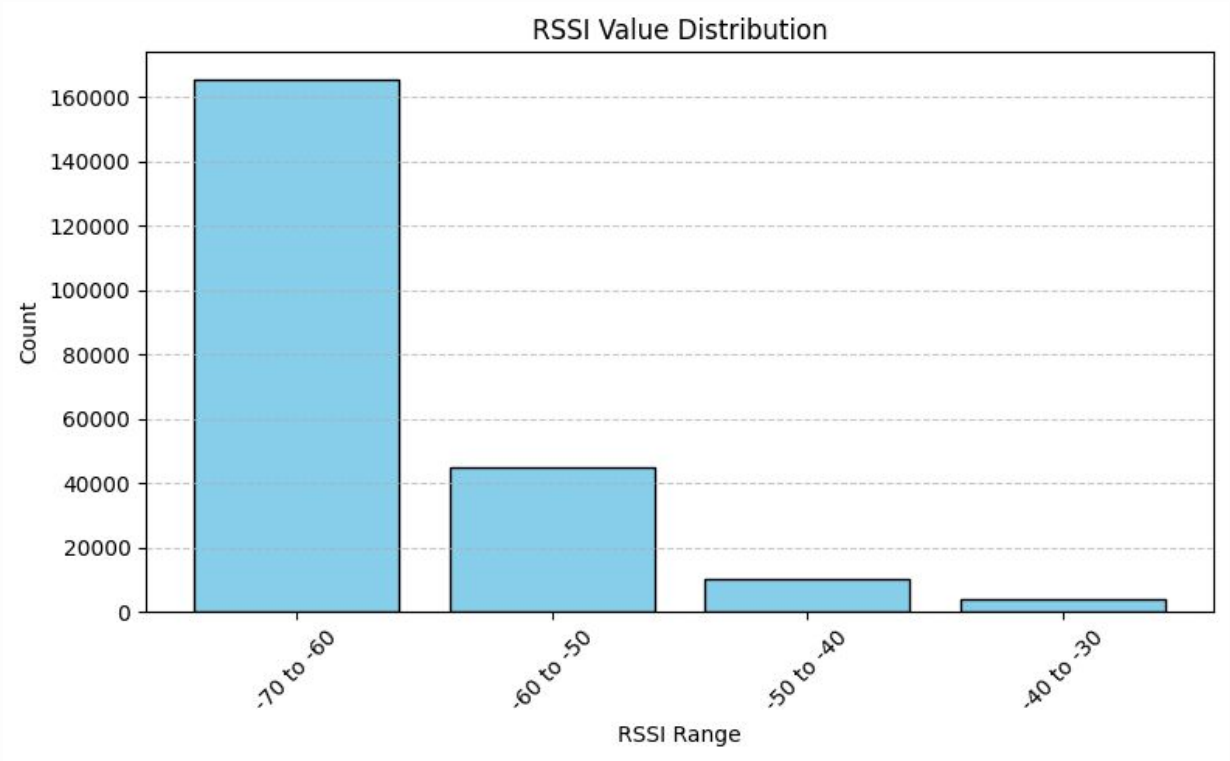


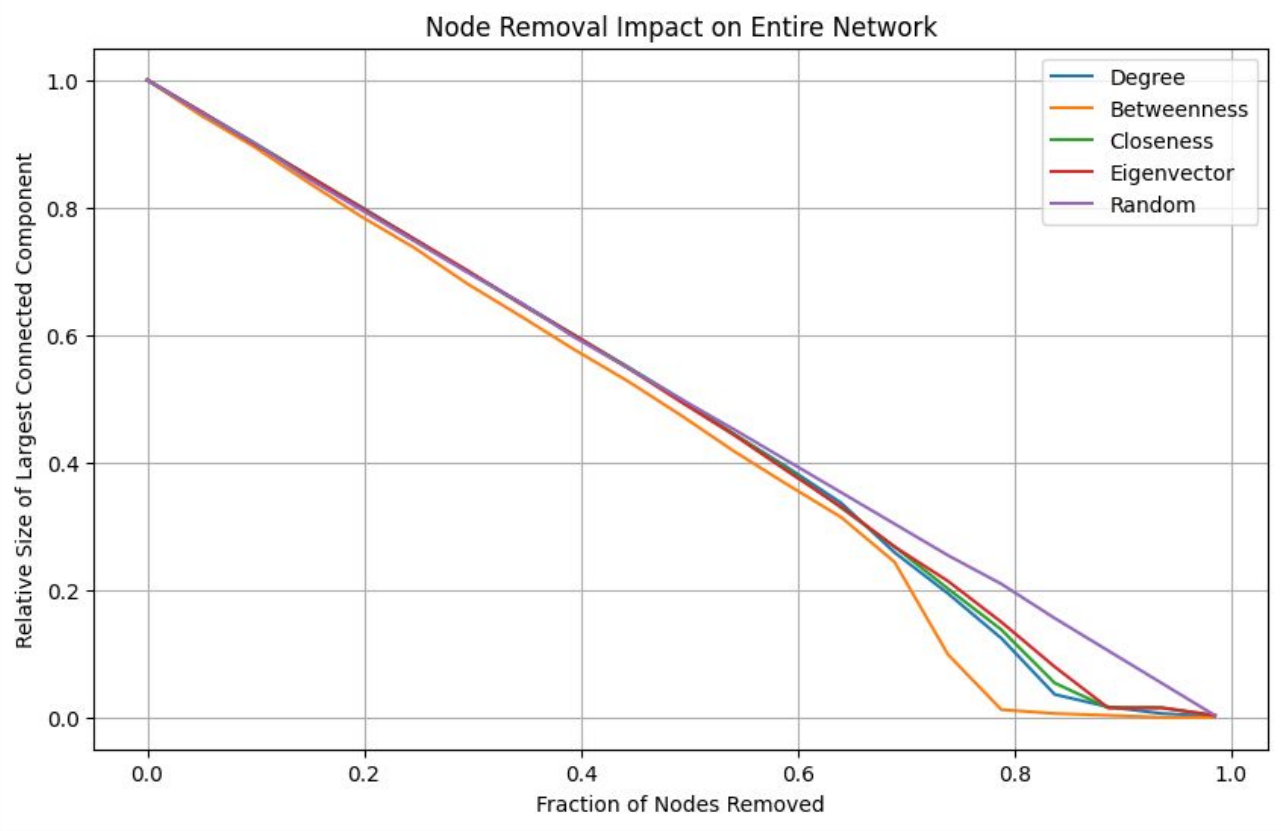
Girvan-Newman algorithm

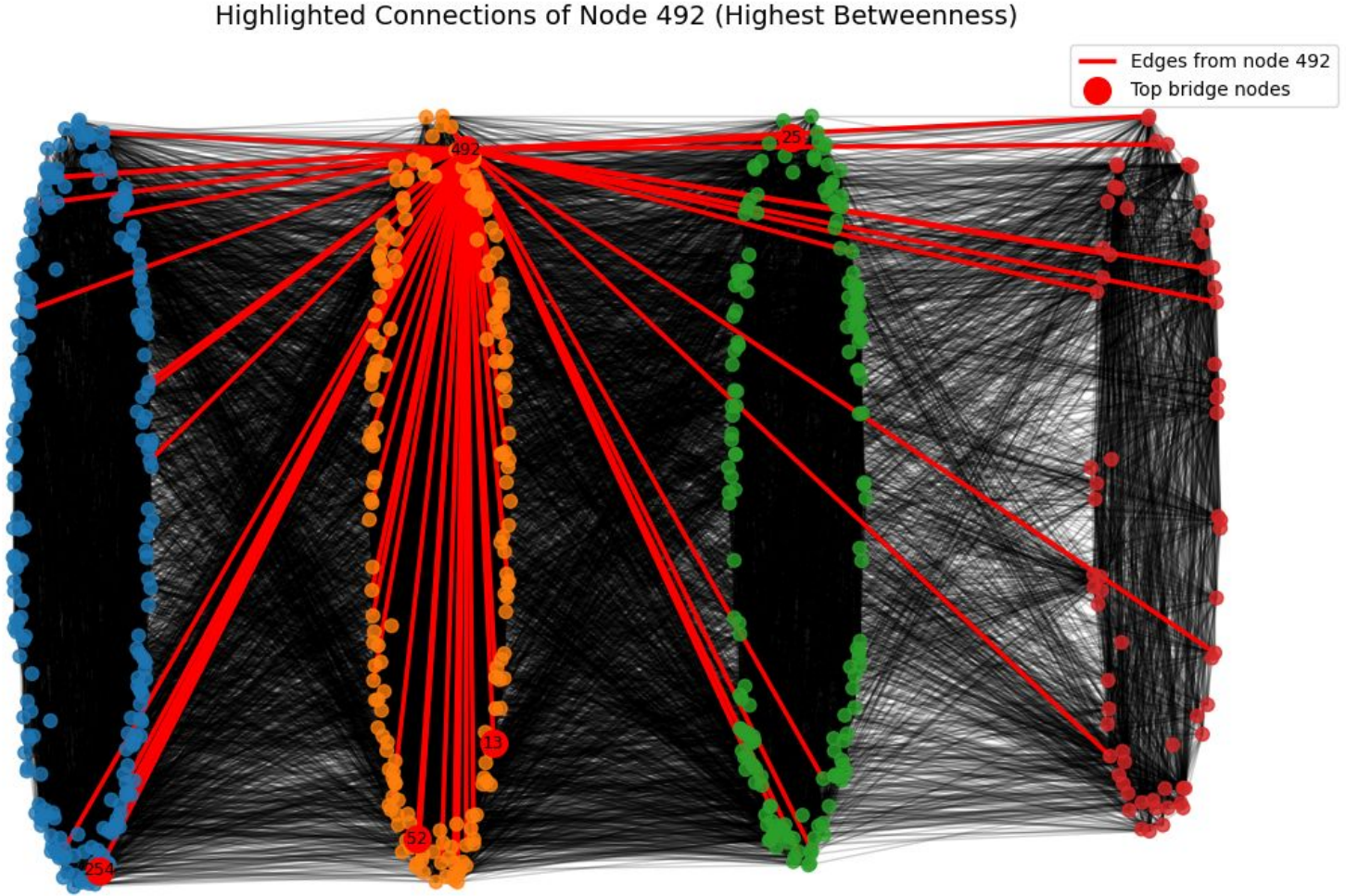


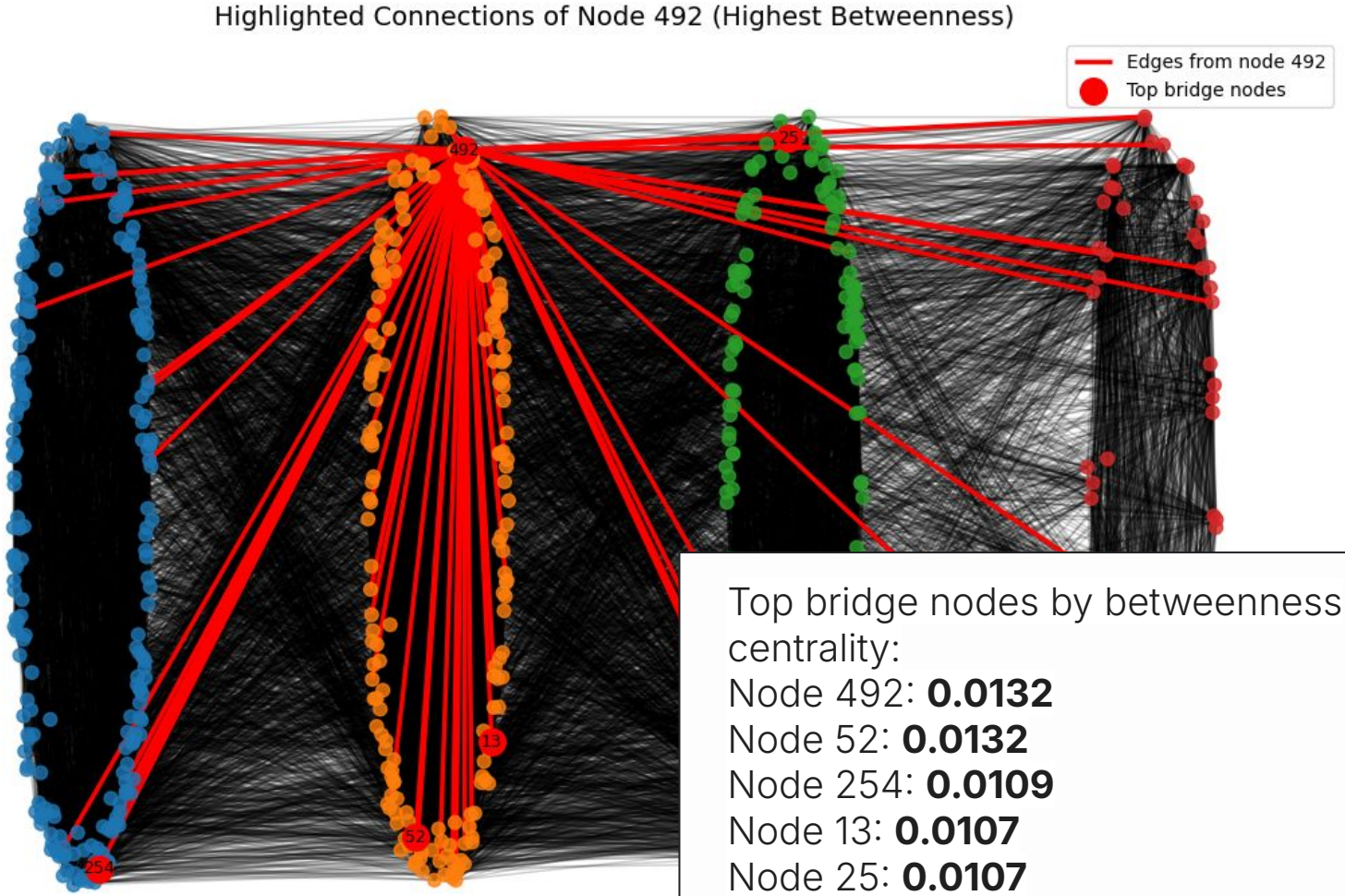
4. Dynamics

Signal strength	RSSI (dBm)	Meaning
Excellent	-30 to -70 dBm	Your connection is strong and you shouldn't have any issues
Good	-71 to -80 dBm	Your connection is good enough for most activities.
Fair	-81 to -90 dBm	Your connection is fine for most tasks, but you may experience some issues.
Weak	Below -90 dBm	Your connection isn't strong enough for most activities.


RSSI Value Distribution
160000
140000
120000
100000
80000
60000
40000
20000
0
Count
-70 to -60
-60 to -50
-50 to -40
-40 to -30
RSSI Range


Node Removal Impact on Entire Network
Relative Size of Largest Connected Component
Fraction of Nodes Removed
0.0
0.2
0.4
0.6
0.8
1.0
Degree
Betweenness
Closeness
Eigenvector
Random


Highlighted Connections of Node 492 (Highest Betweenness)
Edges from node 492
Top bridge nodes
492
13
52
254



Top bridge nodes by betweenness centrality:
Node 492: **0.0132**
Node 52: **0.0132**
Node 254: **0.0109**
Node 13: **0.0107**
Node 25: **0.0107**

Disease spread using SIR simulation in the bluetooth network when first people infected are the **top 5 bridge nodes** versus **random 5 nodes**

Top 5 Bridge nodes

Day	S	I	R
0	664	6	0
7	587	58	25
14	339	200	131
21	181	192	297
28	135	116	419

Random 5 nodes

Day	S	I	R
0	665	4	0
7	640	22	8
14	494	111	65
21	296	192	182
28	205	151	327

The top bridge nodes don’t have very high betweenness, so it makes sense that there isn’t much of a difference between infecting 5 random people and the top 5 bridge people.

Top 5 Bridge nodes

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Disease spread SIR simulation in two random models: **Watts-Strogatz** and **Barabasi-Albert** networks when first people infected are the **top 5 bridge nodes**

Watts-Strogatz

Day	S	I	R
0	492	7	1
7	483	10	7
14	476	7	17
21	471	8	21
28	462	9	29

Barabasi-Albert

Day	S	I	R
0	486	13	1
7	418	66	16
14	324	107	69
21	261	99	140
28	220	79	201

Watt-Strogatz has more tightly-knit communities, so maybe the disease gets trapped in them.

Barabasi-Albert has power law degree distribution, so the few nodes that do have a lot of connections might spread the disease farther

Watts-Strogatz

Day	S	I	R
0	492	7	1
7	483	10	7
14	476	7	17
21	471	8	21
28	462	9	29

Barabasi-Albert

Day	S	I	R
0	486	13	1
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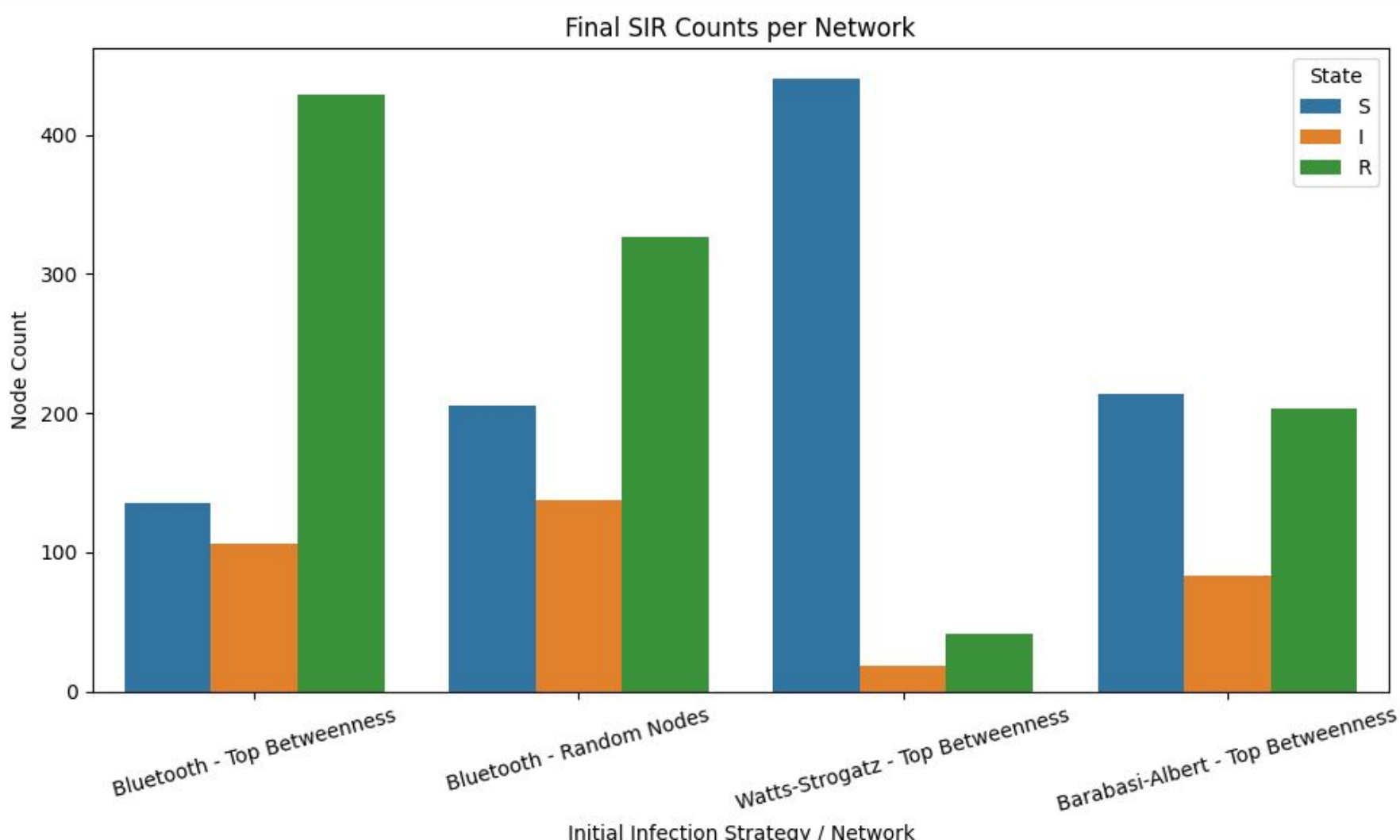
Final SIR Counts per Network
State
S
I
R
Node Count
0
100
200
300
400
Bluetooth - Top Betweenness
Bluetooth - Random Nodes
Watts-Strogatz - Top Betweenness
Barabasi-Albert - Top Betweenness
Initial Infection Strategy / Network

5. Discussion

5. Discussion

- Community algorithms: different community assignation, but showing the same tendencies.
- Community more closely resembles Barabasi-Albert model in terms of disease spread

- Use other networks to compare if communities are similar across different communication media.
- Calls vs. bluetooth: not very tight-knit community again