

# IMMUNISING NETWORKS

Yiyoung Kim

Supervisor : Dr. Naoki Masuda

## Motivation – The Small World

In 1960s experiments of Milgram

Pass a letter to a target person

296 volunteers in Nebraska and Boston

Target (A) = a stockbroker in Boston

**Rule** = If they did not know 'A' directly, they were to pass the letter to someone else who might know A, and forward the letter to that person.

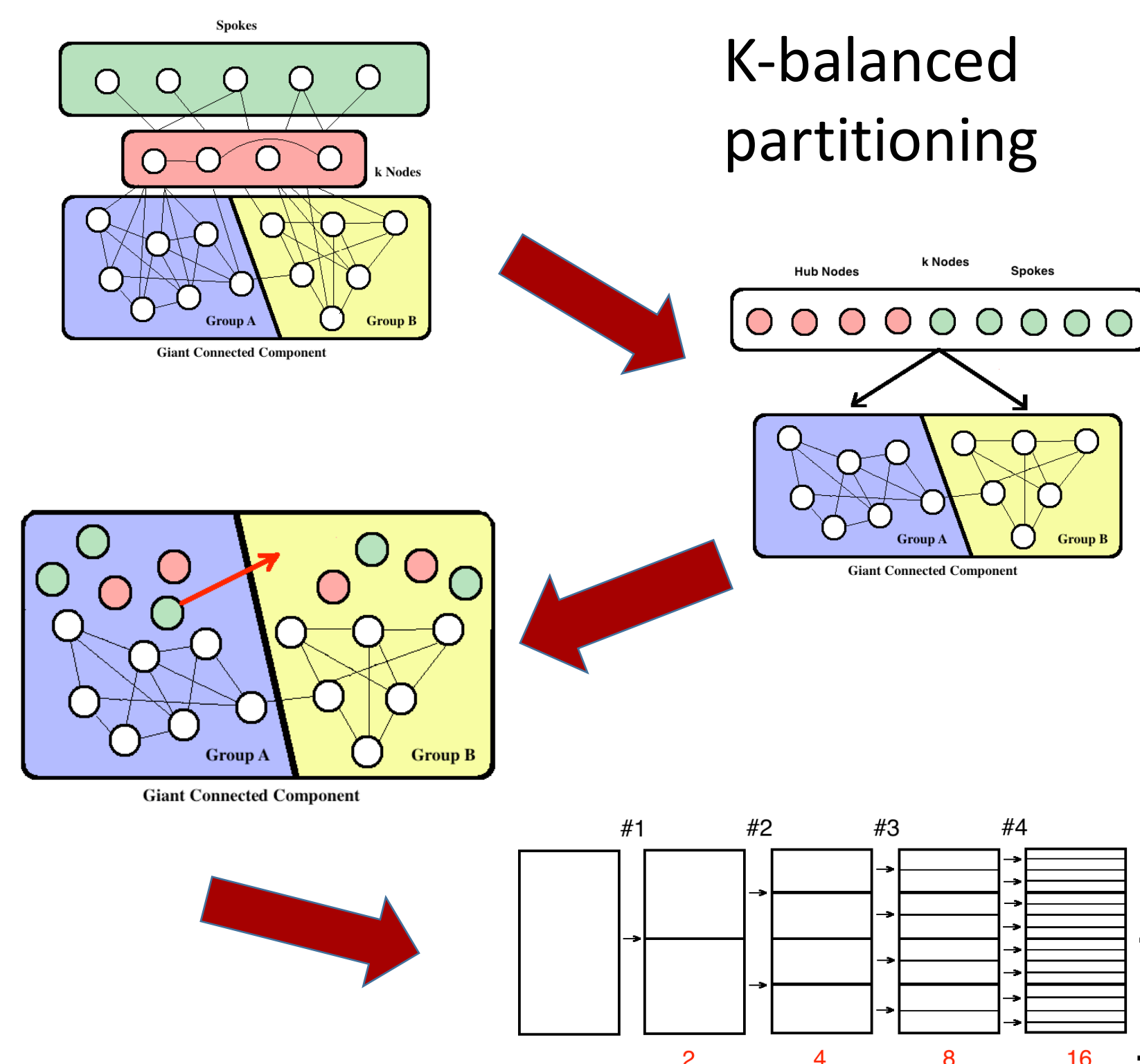
	Random Nebraska	Stockbroker Nebraska	Random Boston	All
Arrived	18 (24%)	24(31%)	22(35%)	64(29%)
Lost	58(76%)	54(69%)	41(65%)	153(71%)
All	76	78	63	217

## Aims

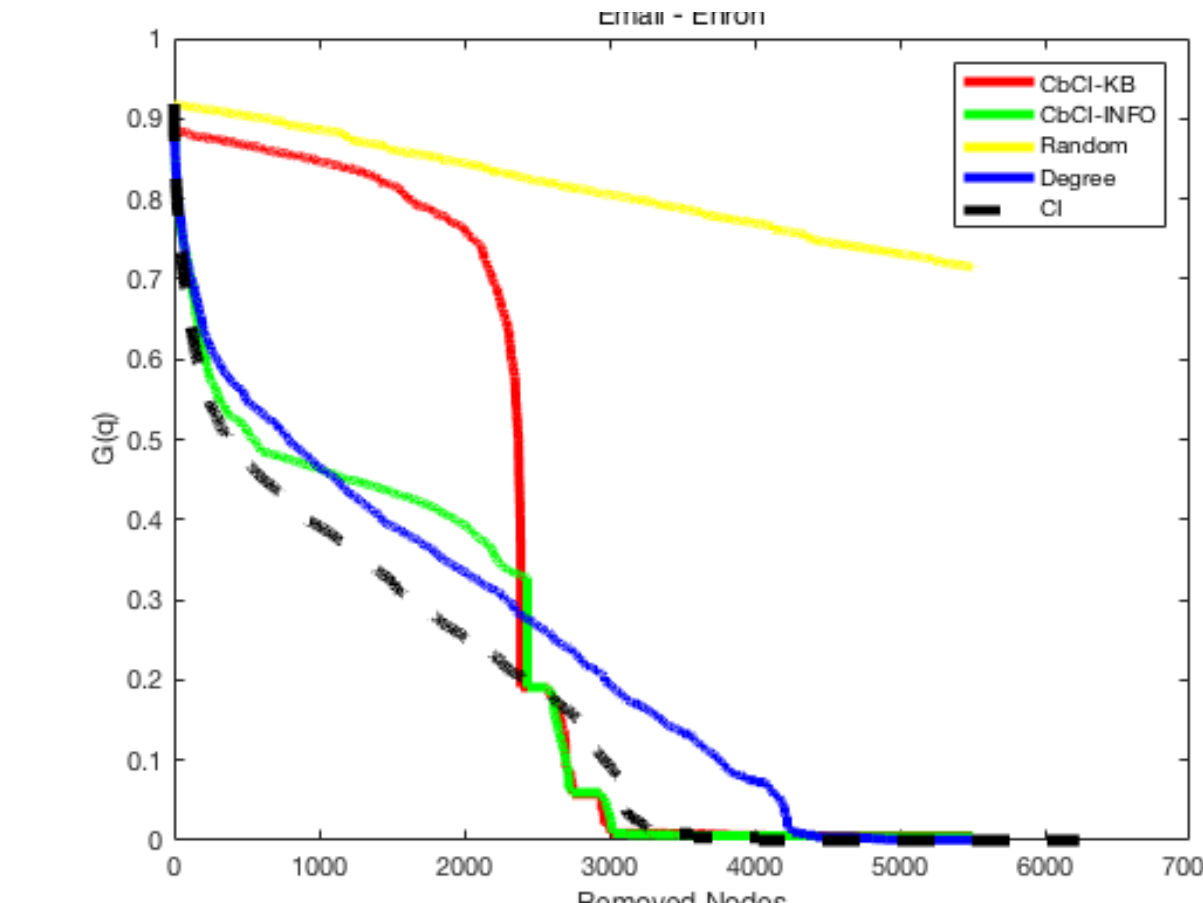
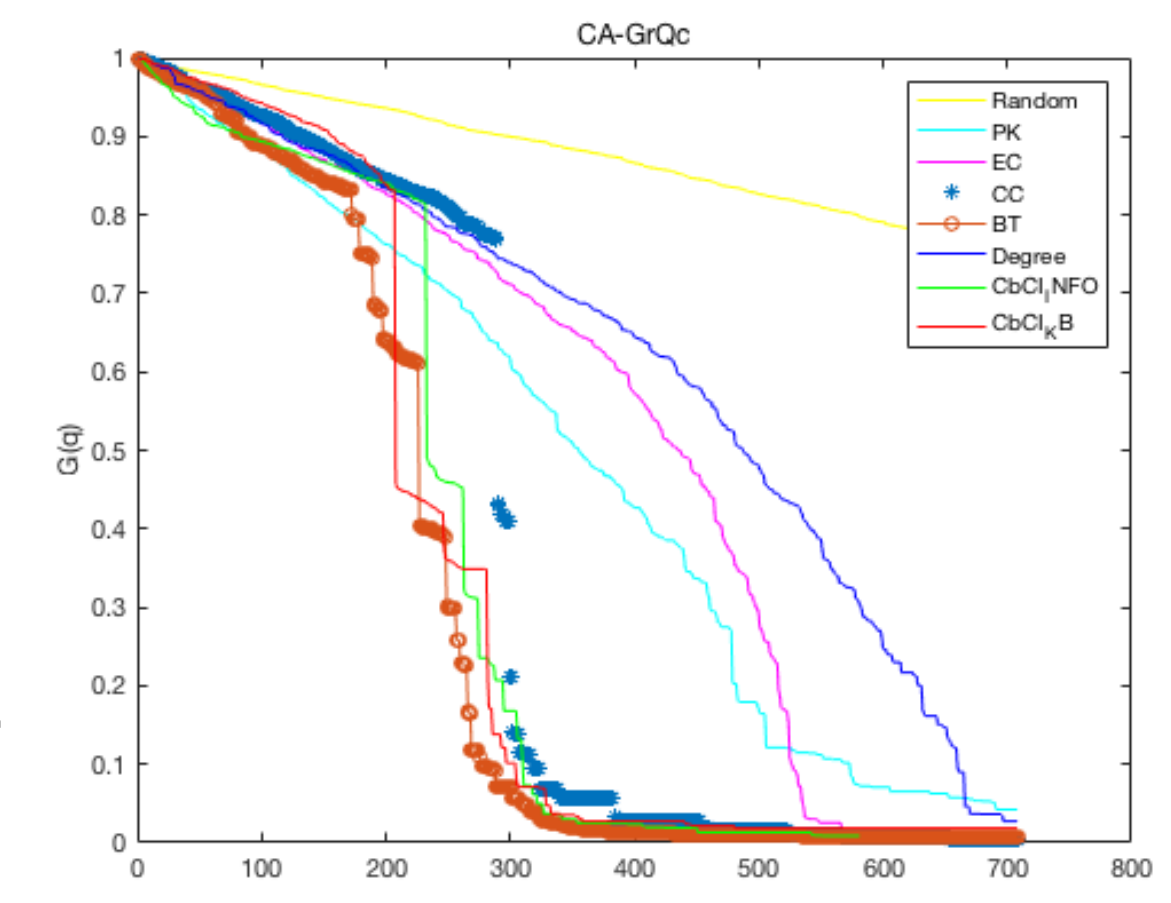
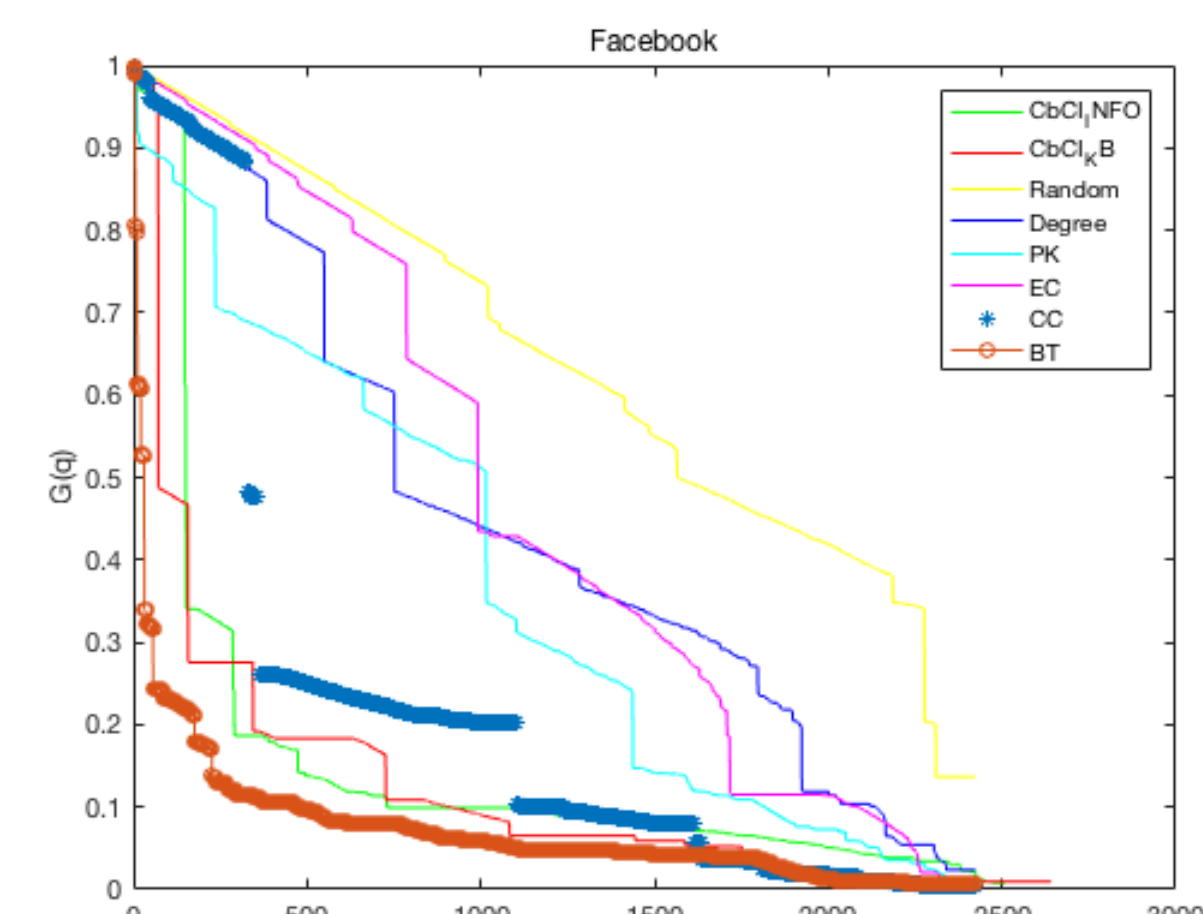
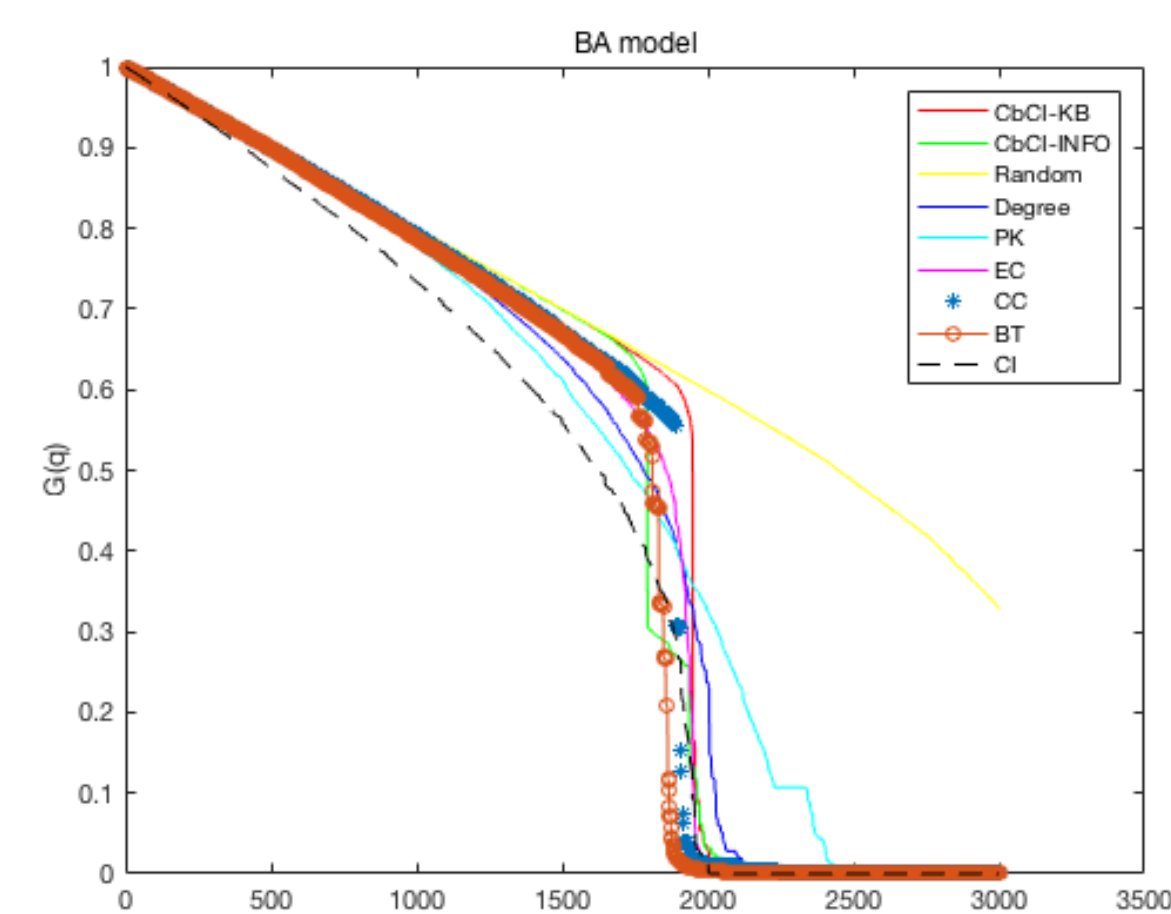
This project tries to simulate and combine some algorithms to find effective low-cost methods for immunising a network with a community structure. The Immunising algorithms aim to prioritise the nodes to be removed, which results in the fragmentation of a network into small pieces. Some community-based algorithms get different results, depending on how nodes are assigned to communities. Hence, the following section is about community detection methods. The next section is about immunising algorithms that segment a network into many small pieces. Finally, all algorithms will be tested on a network model and collected empirical data.

## Community Detection Algorithms

- K-balanced partitioning
- Infomap



## Results



## Algorithms

- Random
- Degree
- Page-Rank
- Eigenvector Centrality
- Closeness Centrality
- Betweenness Centrality
- Collective Influence
- Community-based Collective Influence

## Conclusion

Overall, the project aims were achieved. Many proposed algorithms are tested in different networks. In the results,  $G(q)$  denotes the largest connected component in a network, so all networks are fragmented into small pieces. Even though the K-balanced partitioning is a NP-hard problem, a good bipartition algorithm is developed to the K-balanced partitioning, and it simulated with the CbCI algorithm. The combined algorithm had performed well in networks with community structures.