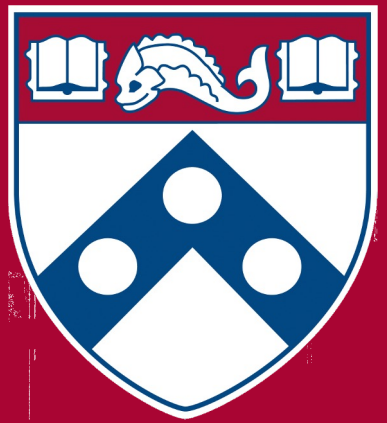
Graphs Applications:

Epidemiology (HW7)

CIT594



Background

- Graphs can be used to model contact between individuals
- Vertices represent individuals
- Edges represent a contact between two individuals
- The probability of infection can be represented as the weight of the edges

Basic Reproduction Number

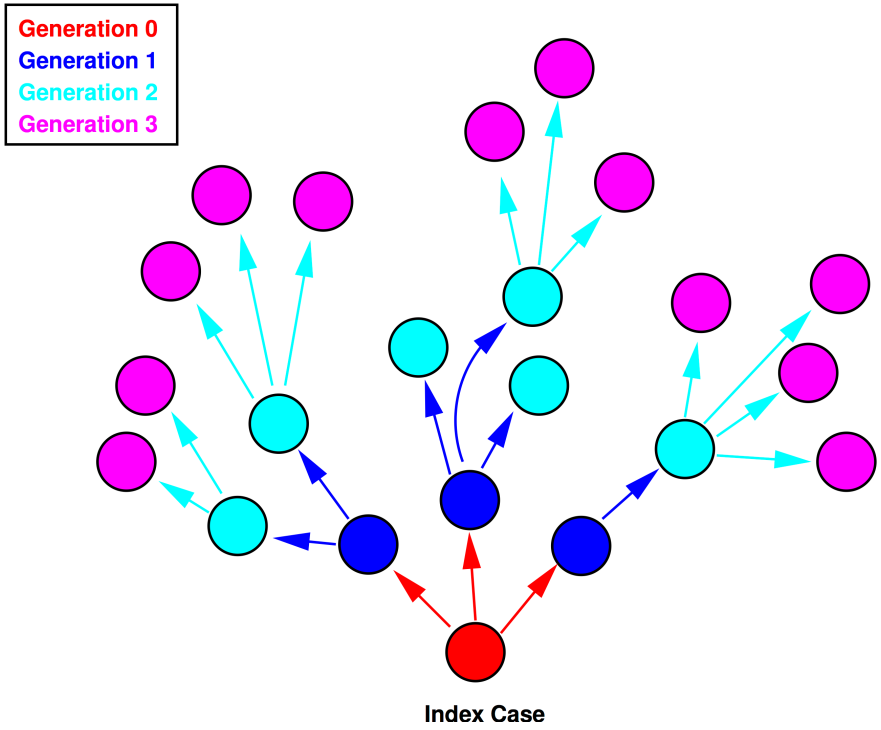
- *The basic reproduction number, R_0, is defined as the expected number of secondary cases produced by a single infection in a completely susceptible population*

$$R_0 = \tau \cdot c \cdot d$$

- τ is the transmissibility (i.e., probability of infection given contact between a susceptible and infected individual)
- c is the average rate of contact between susceptible and infected individuals, it is the **average degree of the graph**
- d is the duration of infectiousness.

Generations

- *Waves of secondary infection that flow from each previous infection*
- Can help assess the pressure on the healthcare system



Immunization

- Goal: lower the reproduction number
- We want to lower the average degree of the graph

1. Remove all nodes with a high degree
2. Reduce the number of cliques in the graph (clustering coefficient)
3. Remove nodes with high degrees that are less likely to be a member of a clique

Clique & Clustering Coefficient

- A Clique is a subset of vertices of an undirected graph such that every two distinct vertices in the clique are adjacent
- The clustering coefficient is a measure of the degree to which nodes in a graph tend to cluster together
- The clustering coefficient quantifies how close the neighbors of a node are to being a clique
- The clustering coefficient is a value between 0 and 1

Immunization Strategies

1. Remove all nodes with high degree
    - Should lower the average degree of the graph
2. Remove all nodes with high clustering coefficient
    - Will it lower the average degree of the graph?
3. Remove all nodes with high degree and low clustering coefficients
    - Will it lower the average degree of the graph?

HW7 Goal

- Which strategy will be the most effective?

- References
  - https://web.stanford.edu/class/earthsys214/notes/R0.html
  - https://en.wikipedia.org/wiki/Clustering_coefficient