

## Discrete Event Simulation for Pandemics

Consider an undirected graph  $G=(V,E)$  representing a population. Nodes of the graph are individuals. The presence of an edge between two individuals indicates that they are in close contact with each other (e.g, sharing a home or a workplace).

Generate a graph on 100 nodes as follows: for each pair of nodes, toss a fair coin and put an edge between them if and only if you get a heads. This gives you a population graph.

Every individual is in one of the following states: susceptible, infected, or recovered (aka removed). The possible transition for each individual is *susceptible* to *infected* to *recovered*.

- Data Structures:
  - Sets **S**, **I** and **R**.
  - Binary heap with nodes having
    - **Node id**
    - **TimeStamp**
    - **Event type: Infection/Recovery**
- Initially all nodes are in S.
- Choose a starting node arbitrarily and call it **u**.
- **Insert** this infection event in the min-Queue **Q**, with timestamp 0.
- **While(;;)**
  - **e<-DeleteMin(Q)**
  - If **e** is a Recovery event,
    - **R<- R U {e.nodeID}**
    - **I<- I \ {e.nodeID}**
  - If **e** is an infection event,
    - **I<- I U {e.nodeID}**
    - **S<- S \ {e.nodeID}**
    - **Forall susceptible neighbors u of e.nodeid**
      - **Generate an infectionTime as follows**
        - Toss a fair coin five times
        - Let **j** be the first time a head comes (if a head doesn't appear at all, **u** doesn't get infected because of **e.nodeid**), **continue** to next neighbor
      - **Insert into Q:**
        - **Node id:u**
        - **TimeStamp: e.timeStamp+j**
        - **Event type: Infection**
      - (If **u** did get infected) **generate recovery event:**
        - Generate a random number **k** uniformly between **e.timeStamp+j** and **e.timeStamp+j+5**
      - **Insert into Q:**
        - **Node id:u**
        - **TimeStamp: k**
        - **Event type: Recovery**

1. Plot the number of susceptible, infected and recovered individuals, against  $t$ .
2. Compare the instant at which a node gets infected with its shortest distance from the start node  $s$ .