Epidemiology Modeling for Compliance Graph Analysis

CS-7863: Scientific and Statistical Computing

Final Proposal

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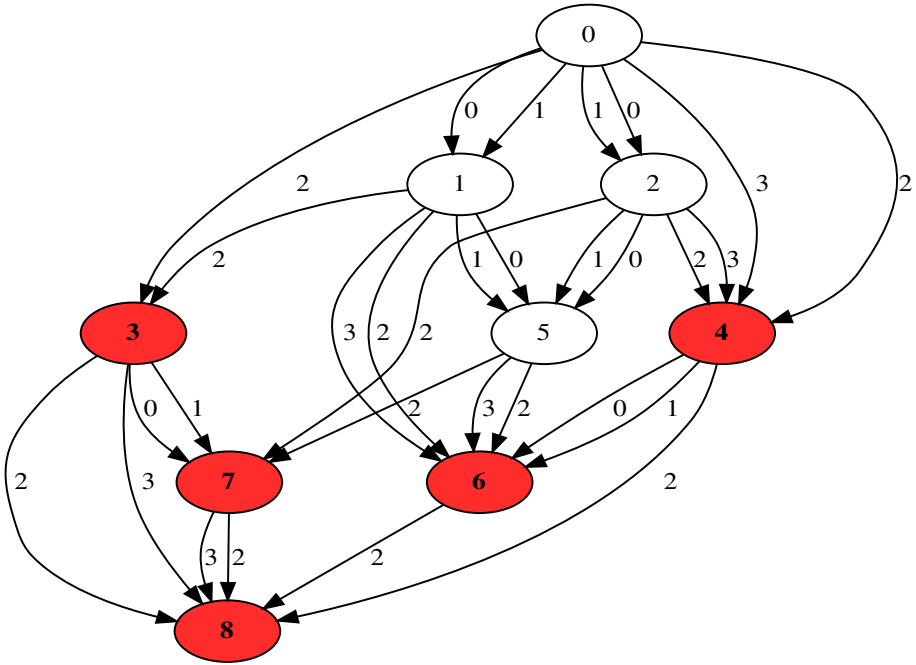
Introduction to Compliance Graphs

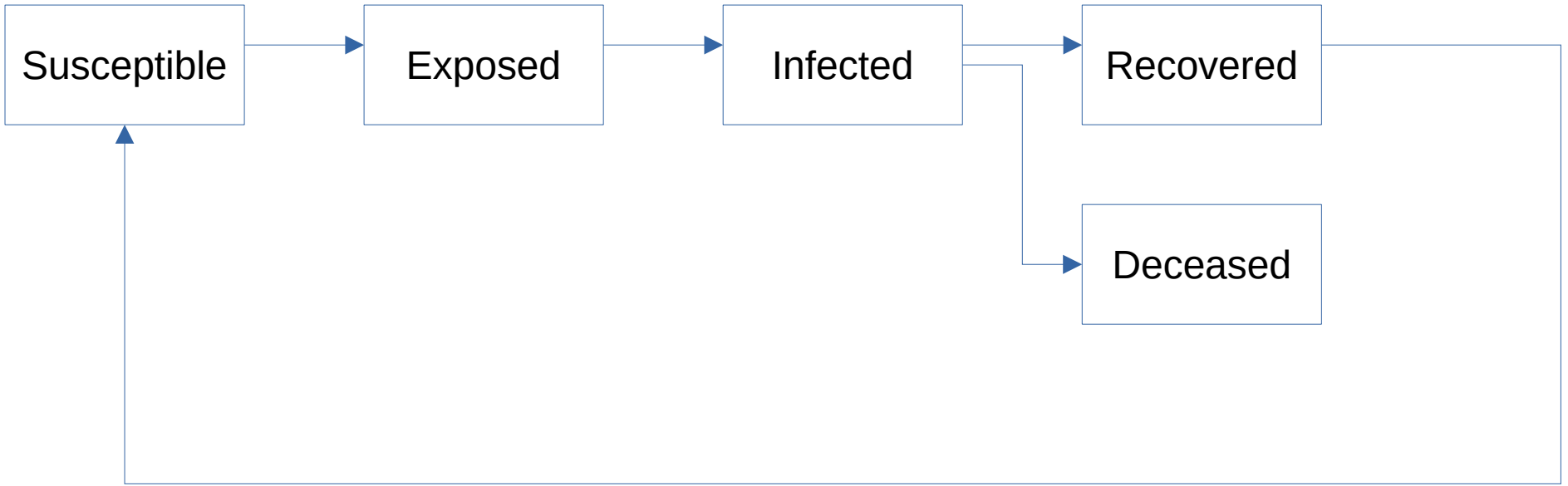
- Determine all possible ways systems may fall out of compliance
- Directed Acyclic Graph
  - (DAG)



Epidemiology Model

- SEIRDS
  - S: Susceptible
  - E: Exposed
  - I_R: Subset of Infectious that Recovers
  - I_D: Subset of Infectious that Die
  - R: Recovered
  - D: Deceased
  - S: Susceptible

Model, Cont.



Model, Cont.

$$S_{t+1} = S_t - \beta \frac{S_t(I_{R,t} + I_{D,t})}{N_t} + \omega R_t$$

$$E_{t+1} = E_t + \beta \frac{S_t(I_{R,t} + I_{D,t})}{N_t} - \delta E_t + \epsilon$$

$$I_{R,t+1} = I_{R,t} + \delta(1-\mu)E_t - \gamma_R I_{R,t} + \epsilon$$

$$I_{D,t+1} = I_{D,t} + \delta\mu E_t - \gamma_D I_{D,t} + \epsilon$$

$$R_{t+1} = R_t + \gamma_R I_{R,t} - \omega R_t$$

$$D_{t+1} = D_t + \gamma_D I_{D,t}$$

Parameters

$\beta =$ rate of infection

$\delta =$ symptom appearance rate

$\gamma_R =$ recovery rate

$\gamma_D =$ death rate

$\mu =$ fatality ratio

$\epsilon =$ infected import rate

$\omega =$ waning immunity rate

Contextualization to Compliance Graphs

- S: All other nodes
- E: Nodes flagged with “warning”
  - Intrusion Detection Systems, license expiration, or other user-specified metric
- I_R: Infected nodes that have an out-edge to an uninfected node
- I_D: Infected nodes that have no out-edge
- R: Nodes with an immediate in-edge from an infected node
  - Nodes that are able to auto-correct
  - Automatic certificate renewal, license renewal, scheduled maintenance
- D: Leaf nodes that are infected
  - Removed nodes
  - Node quarantine, removal of legacy systems, DMZ
- S: All other nodes

Pitch

- Derive parameters and compartments from generated compliance graphs
- Create SIERDS models based on the compliance graphs
- Analyze the model to:
  - Predict rate of compliance violations
  - Determine risk of the environment
- Additional:
  - Use graphs as-is (unweighted), and
  - Assign basic weighting to edges