Background and Motivation

Addictive Behavior

Physical addiction

Psychological dependence

Smoking Mortality due to smoking
- Estimated economic costs of smoking per year:
  - $97 billion in lost productivity
  - $96 billion in health care expenditures
  - $10 billion due to secondhand smoke

Prevalence of smoking
- National Health Interview Survey
- Framingham Heart Study

Modeling Smoking Epidemics

Smoking Epidemics
- Starts with small population
- A large percentage gets infected after some time
- There exist a peer influence network
- Big impact on health

Structured Resistance Model
- Susceptibility is structured into \( n \) states
- Susceptibility \( \gamma \) (or stays same) with infection (or \( \alpha \))
- Recovery rate \( \sigma \) (or stays same) with infection \( \gamma \)
- Susceptibility \( \gamma \) (or \( \sigma \)) with time based on waning rate \( \beta \)

Simulation Setup and Results

Framingham Heart Study
- Offspring cohort social network spanning years 1971-2008
- Network with children, adolescents, and adults
- Edges corresponds to various social and familial ties
- Time varying social network with edges present at different times and for different duration
- We assume each edge to be undirected

Approach

Structured Resistance Model

State update equations for fully mixed population

Backward Bifurcation

- When \( Q \) is positive and increasing in \( \beta \) then the epidemic bifurcation is a backward bifurcation

Results and Conclusions

Simulation Setup and Results

Framingham Heart Study

Parameters for Simulation
- We choose the prob. of \( S_i \rightarrow I_i \) to be increasing with \( \alpha_i \)
- We choose recovery rate \( \gamma \) to be decreasing with \( \gamma_i \)
- Infection does not decrease susceptibility
- We experiment with three level structured resistance model

Bifurcation Experiment
- Two initial conditions: 5% (IC1) and 65% (IC2) nodes in I states
- IC2 converges to upper steady state
- Upper threshold corresponds to lower steady state

Smoking Prevalence Experiment
- 1. Initialize network with random
- 2. Run the model until it reaches a stationary state
- 3. Decrease \( \beta \) slowly to simulate increase in awareness
- 4. Fract. of nodes in I states decreases along the blue curve

Conclusions
- Presented an extended SIS model that captures the dynamics of addictive behavior
- Levels in the model corresponds to increasing susceptibility and addiction to a behavior
- Presented model exhibits a backward bifurcation that suggests a possible reason for slow decline of smoking prevalence
- Model can be extended to build ecology of smoker, i.e., to incorporate: access to cigarettes, exposure to advertisement, socioeconomic status, prices, policies etc.