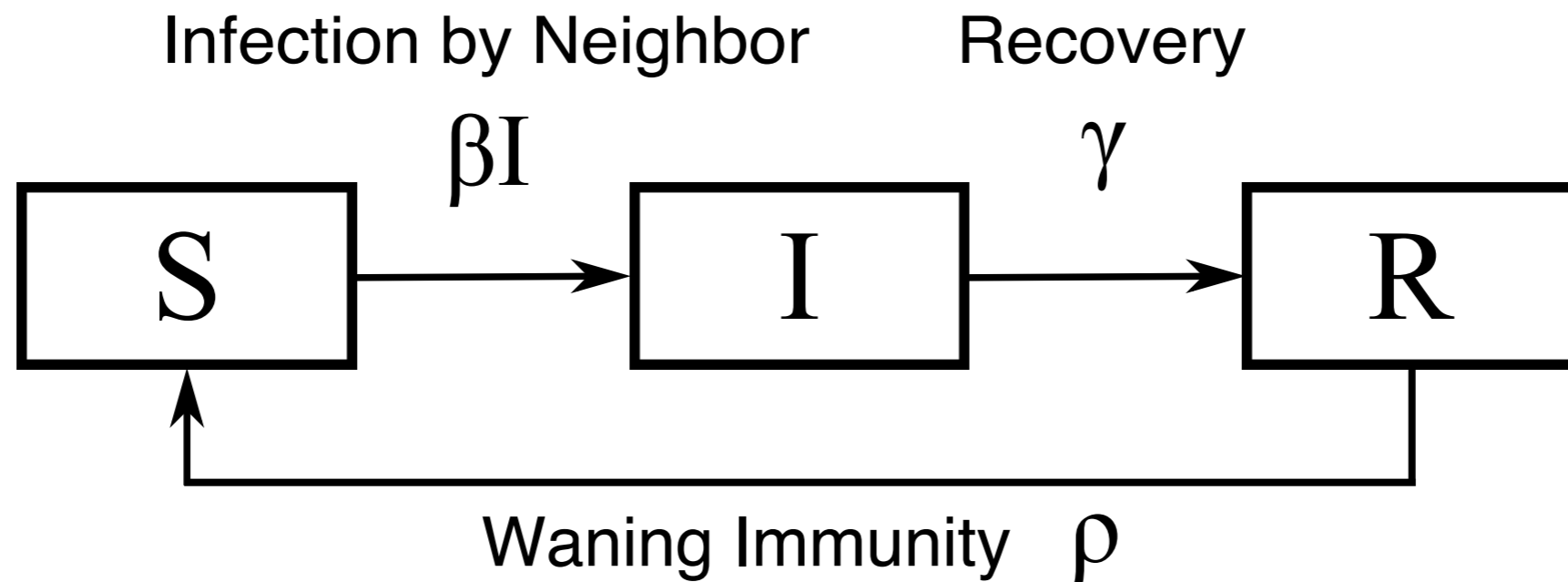


Contact Network Heterogeneity and Persistence of Endemic Disease

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Endemic Infection

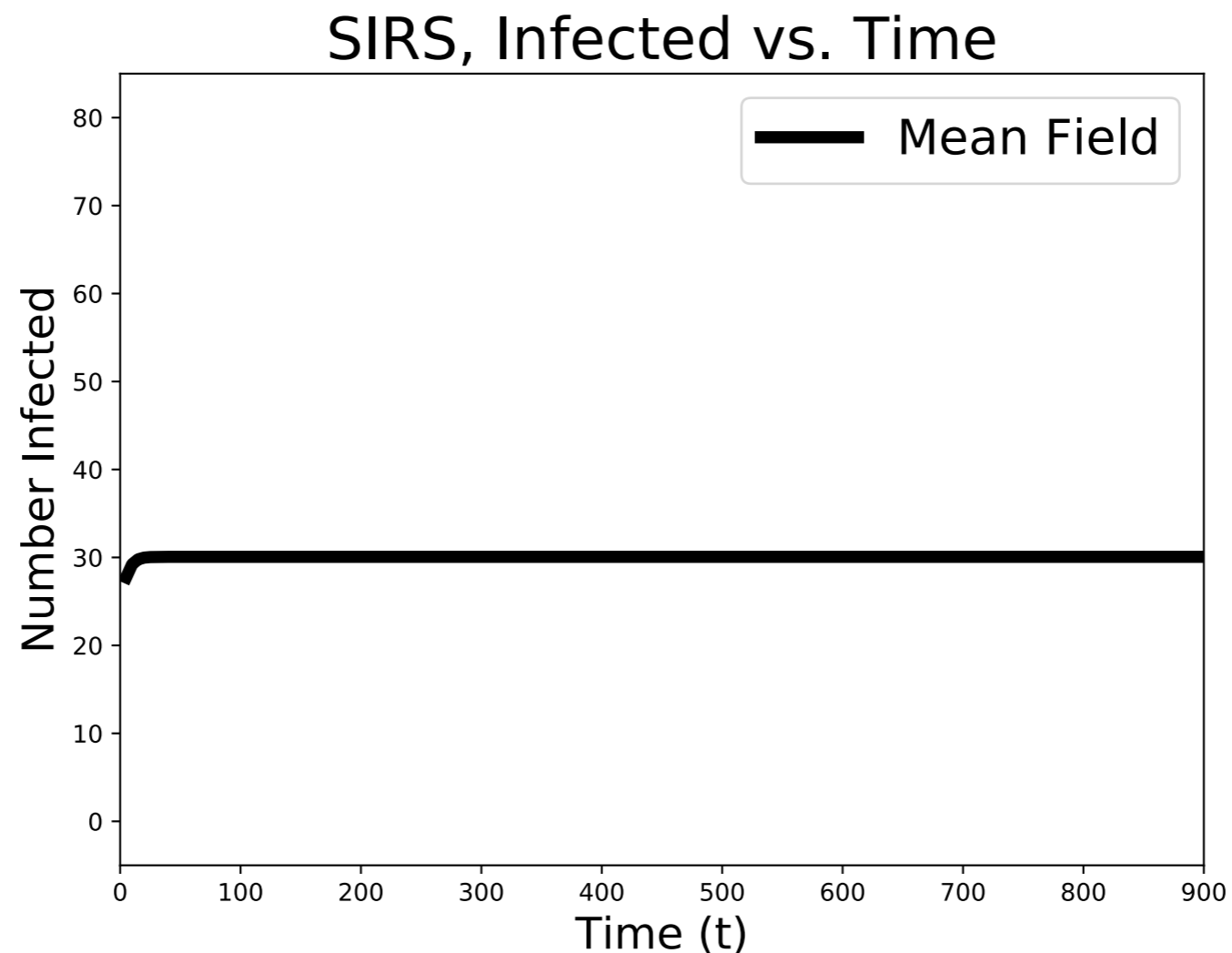
- Susceptibles are replenished
- Example: SIR with waning immunity



- Persistence of infected individuals in a population

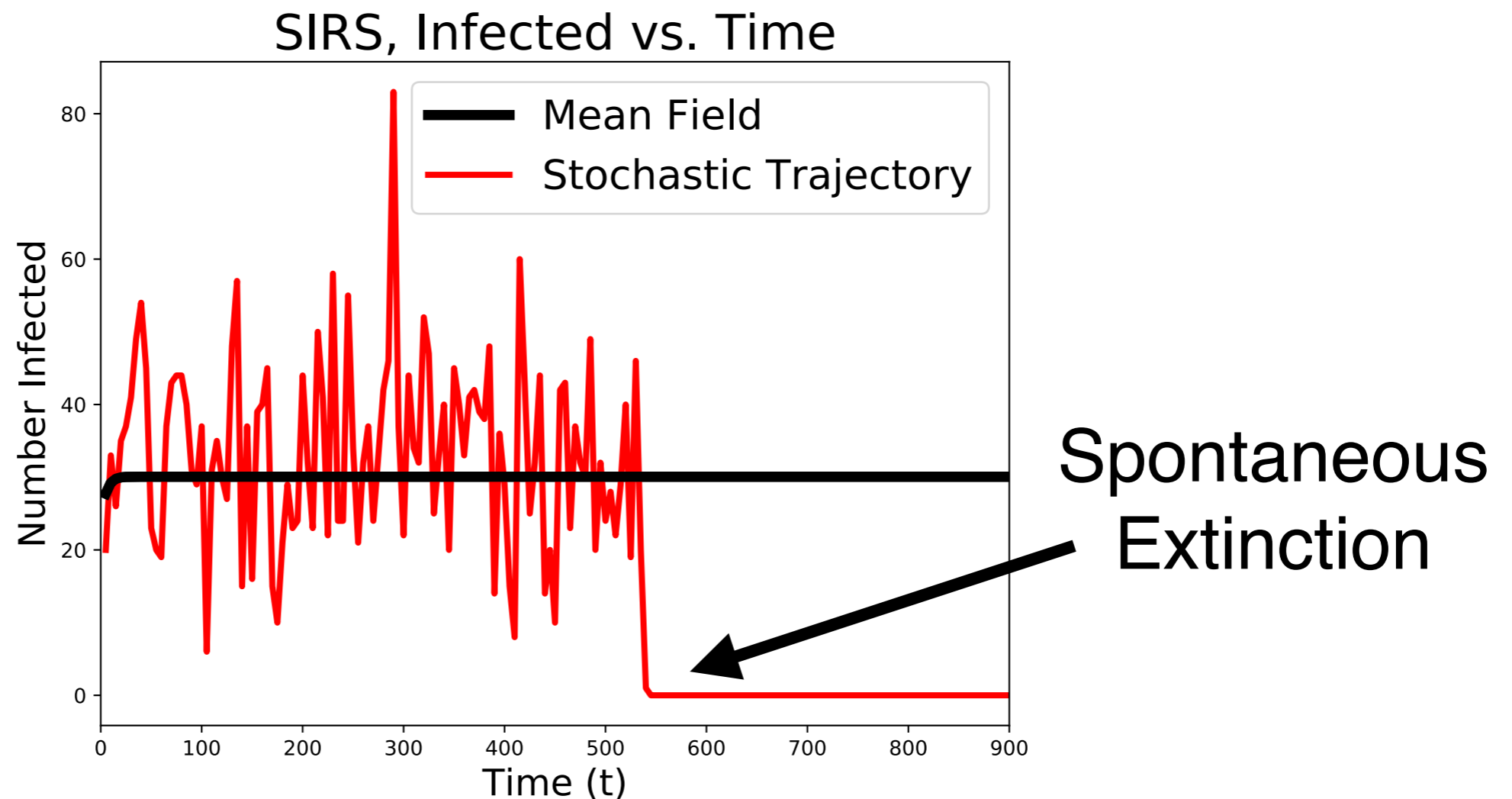
Spontaneous Extinctions

- Endemic states not stable in finite populations



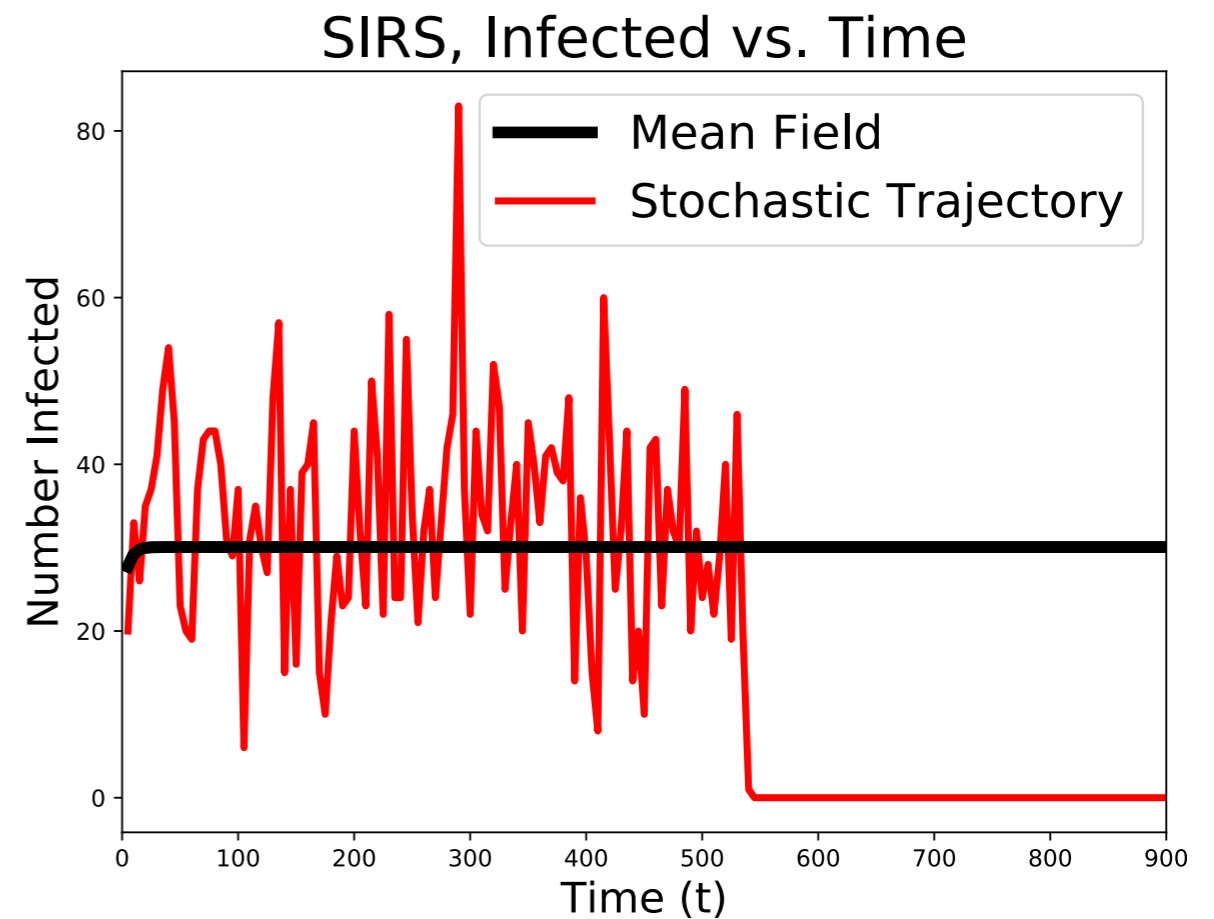
Spontaneous Extinctions

- Endemic states not stable in finite populations
- Stochastic fluctuations bring infection level to 0



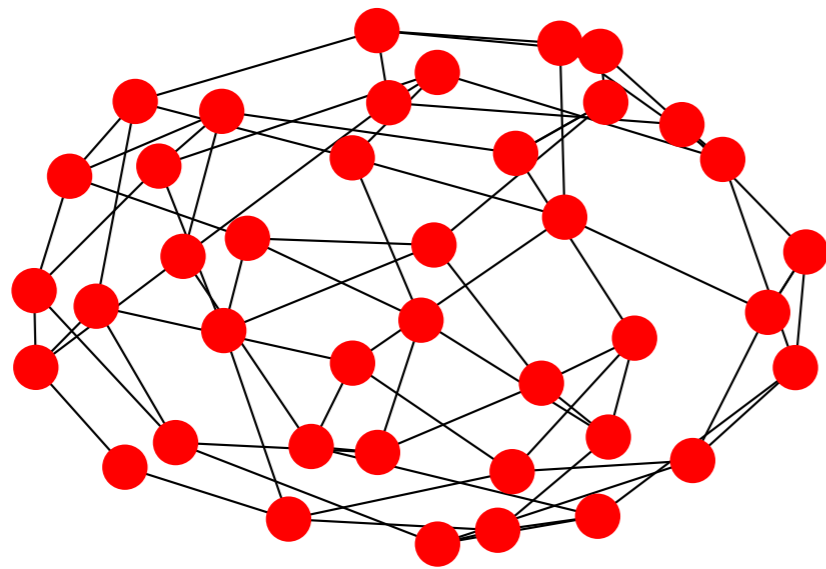
Endemic State Lifetimes

- Characteristic Lifetime
- Depends on
 - Mean Infection μ
 - Fluctuation Size σ

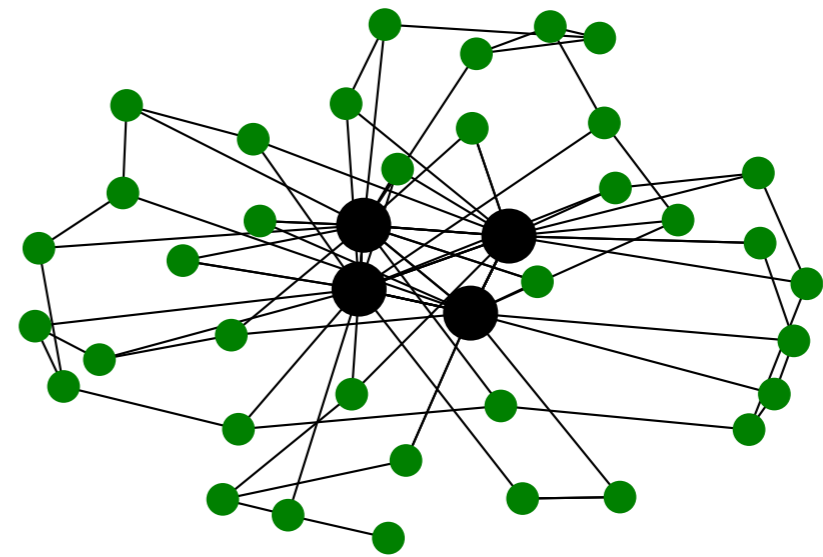


Network Effects

- Change contact network topology
- What happens to the endemic state lifetime?



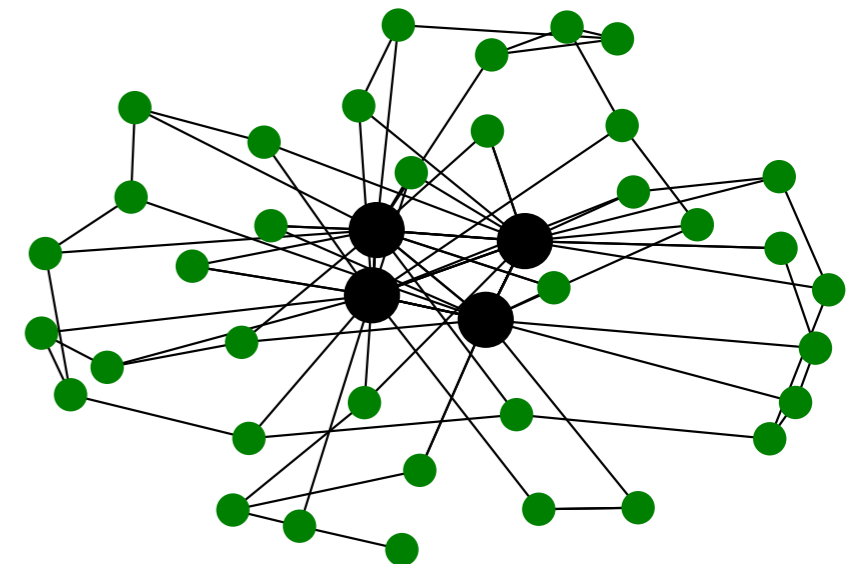
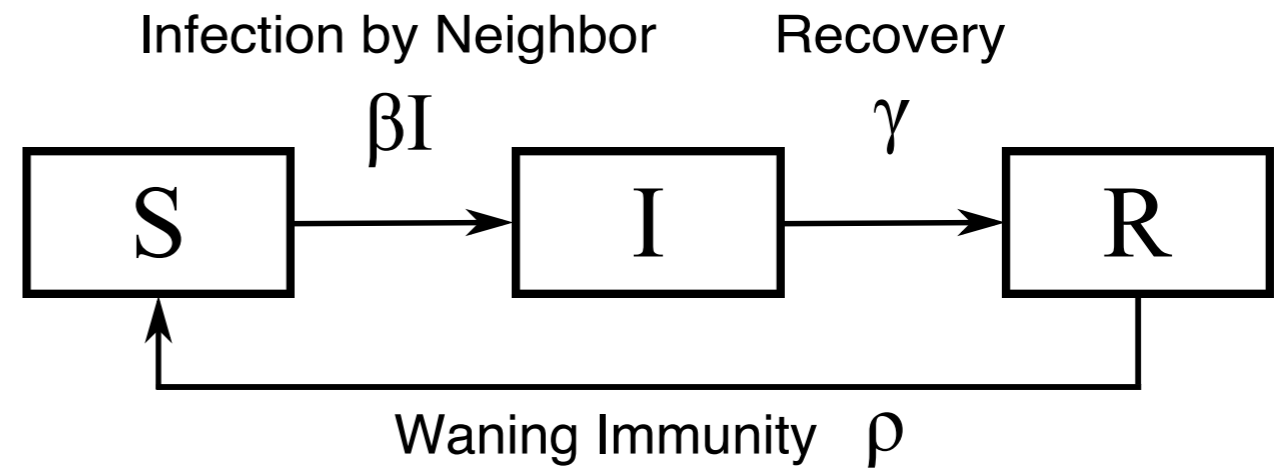
Homogeneous Graph



Heterogeneous Graph

Our Simulations

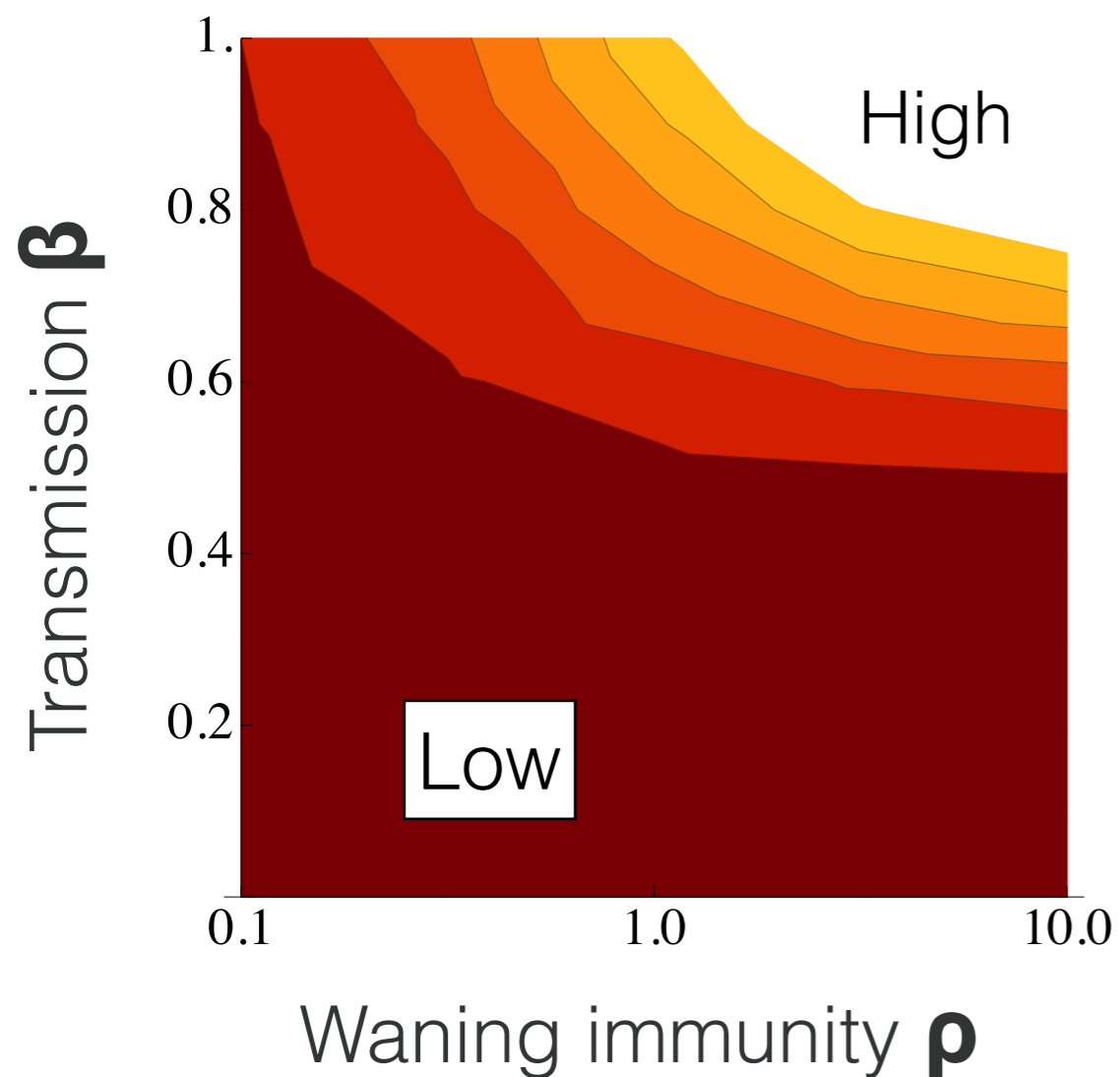
- SIRS model
- Annealed networks
- Vary degree heterogeneity $\langle \sigma_k \rangle$
- Generate ensembles of trajectories
- Measure lifetime of endemic state



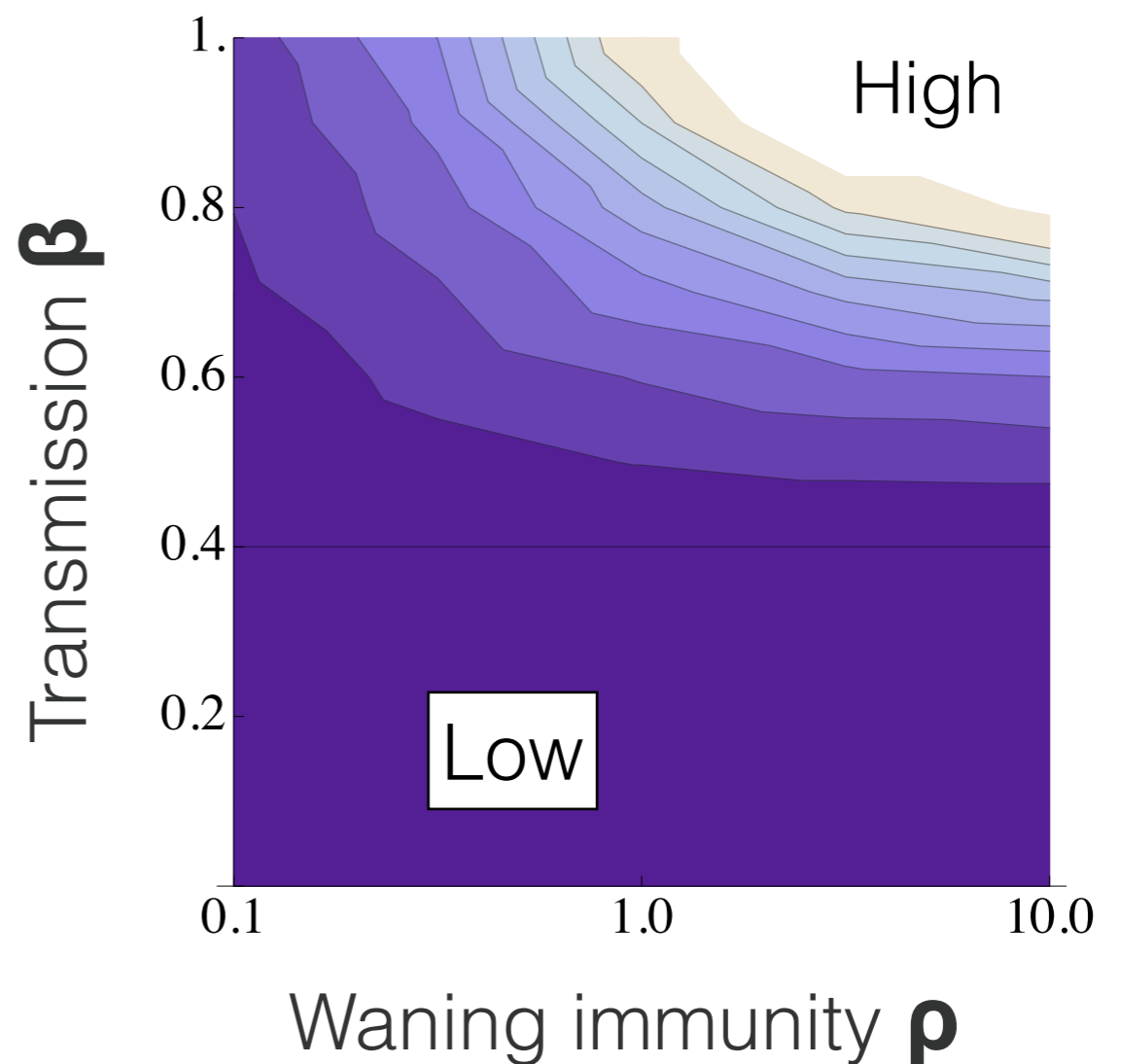
Results

500 nodes, mean degree 10, $\langle \sigma_k \rangle = 10$

Mean Infection Level



Mean Time to Extinction



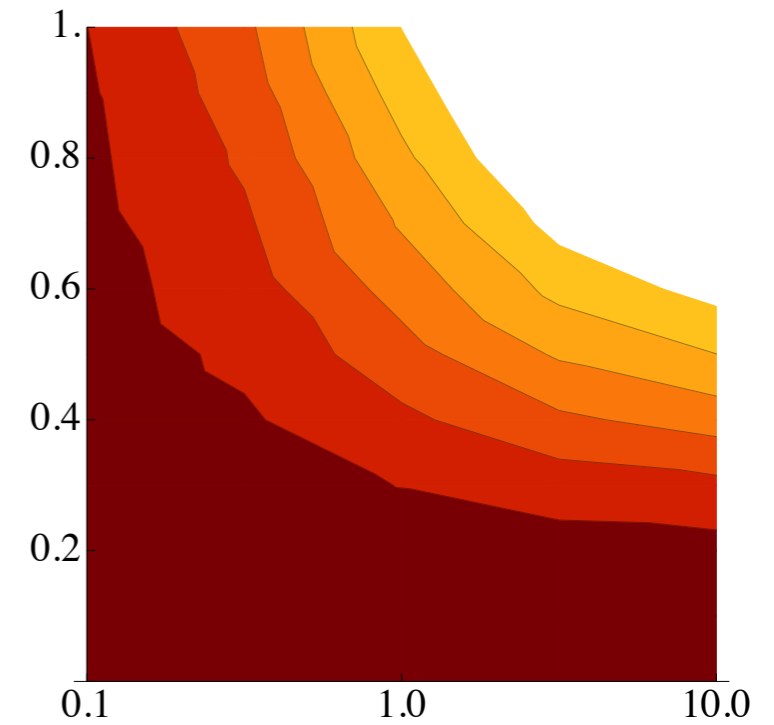
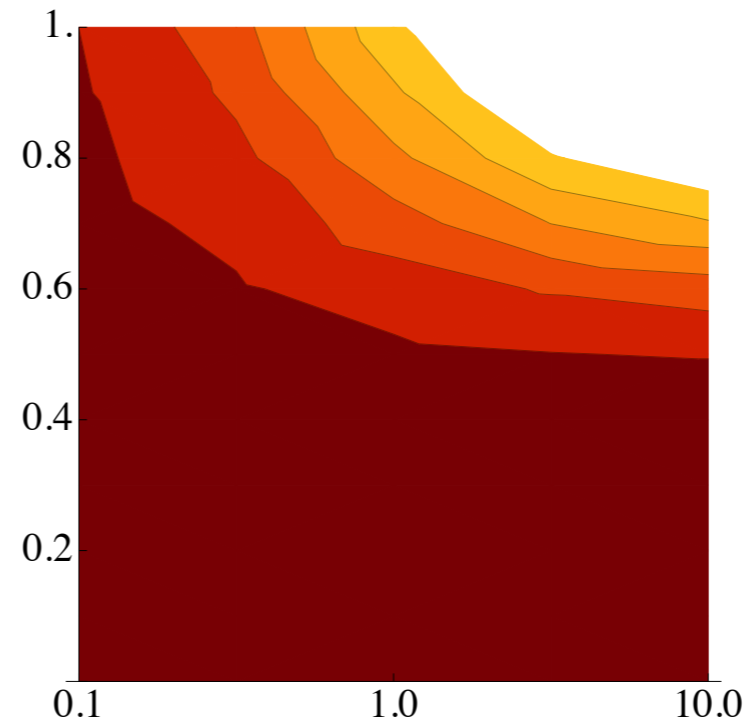
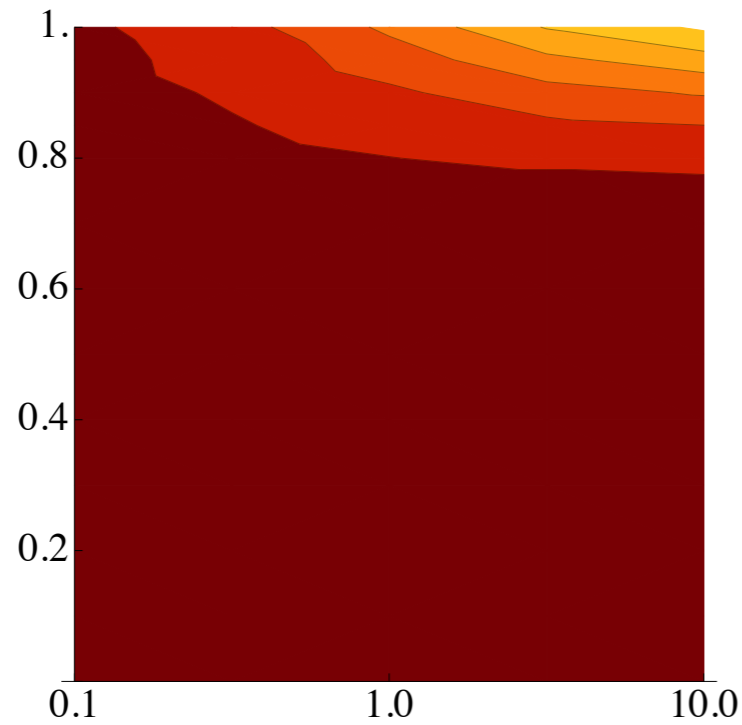
Results: Across Graphs

$\langle \sigma_k \rangle = 5$
(Homogeneous)

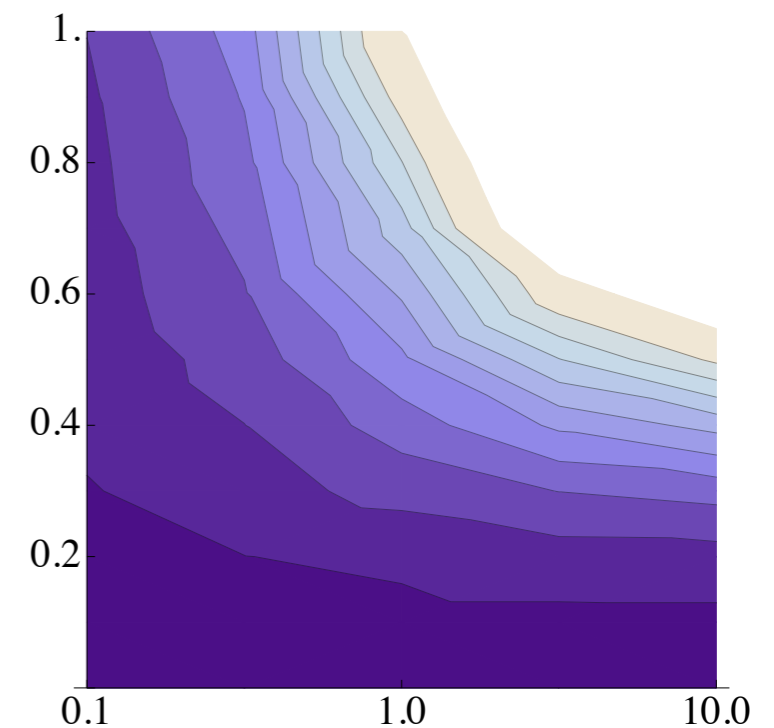
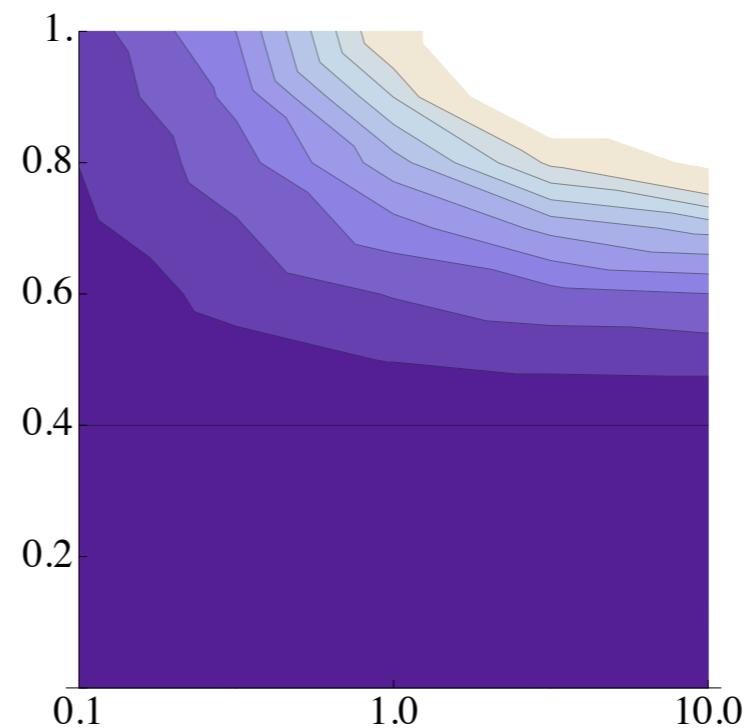
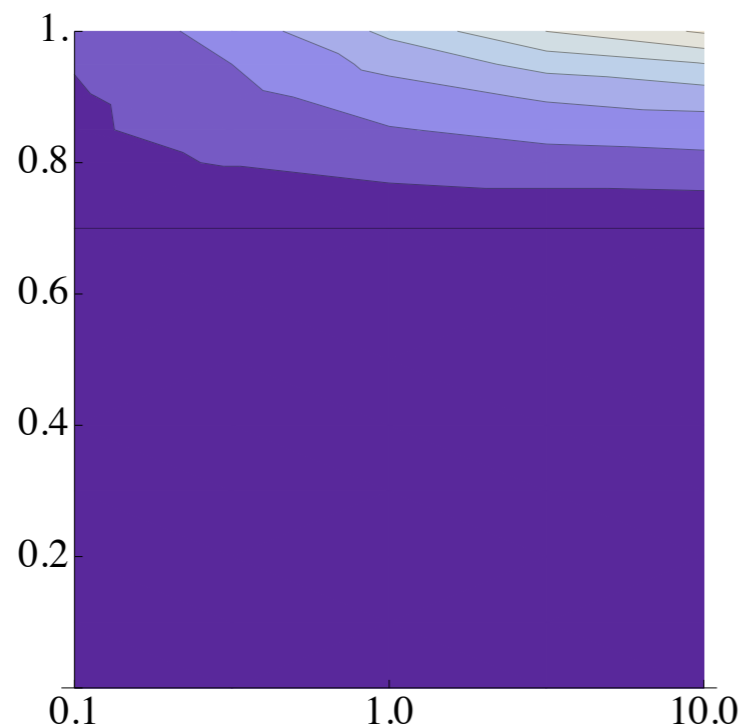
$\langle \sigma_k \rangle = 10$

$\langle \sigma_k \rangle = 20$
(Heterogeneous)

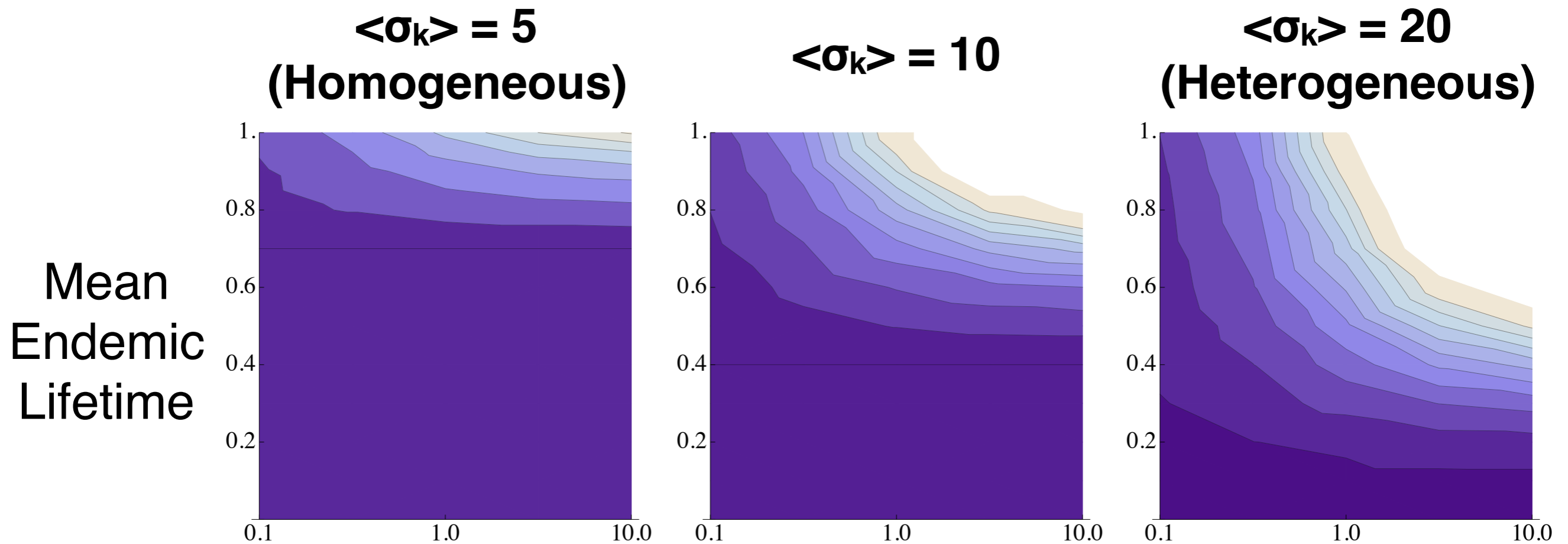
Mean
Number
Infected



Mean
Endemic
Lifetime



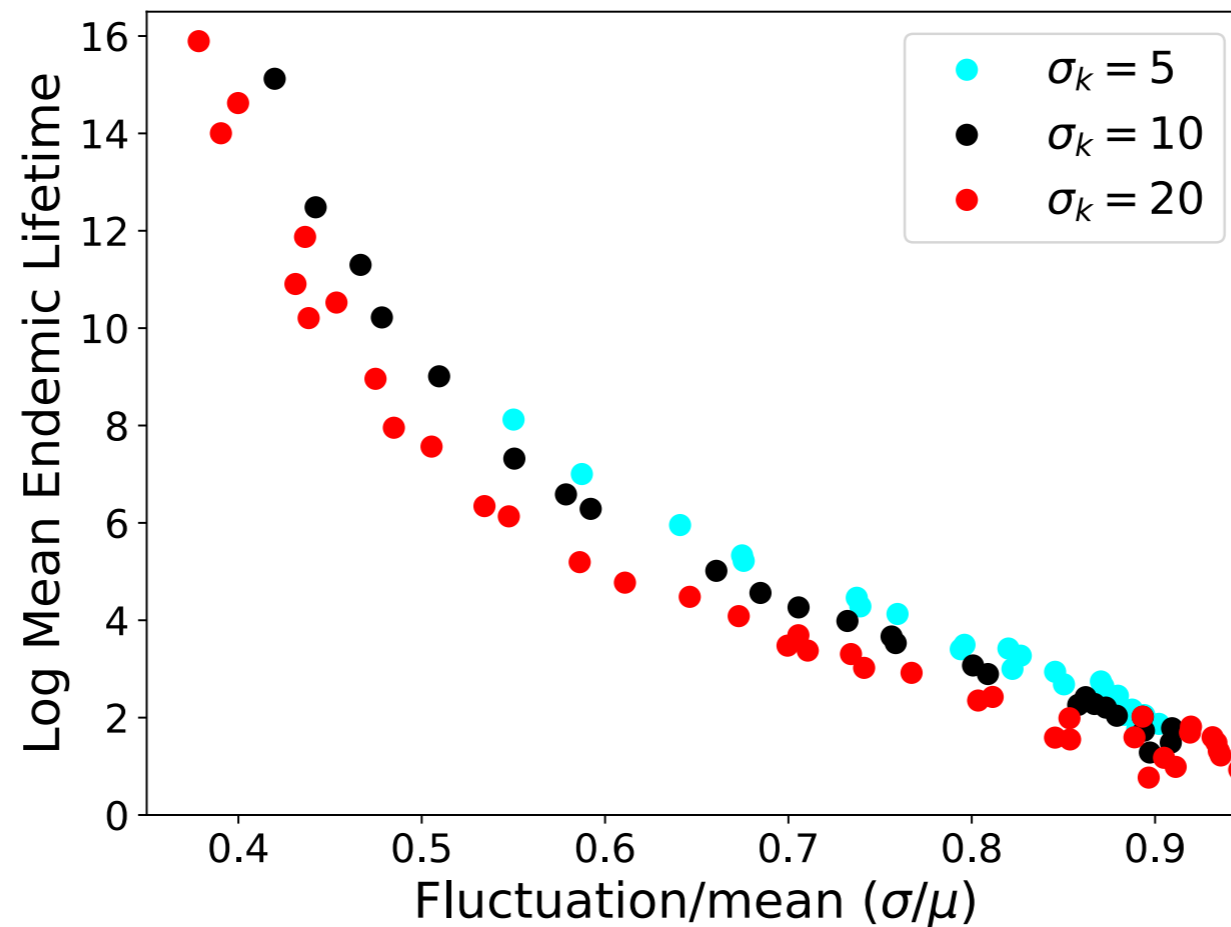
Results: Across Graphs



- Heterogeneous graphs have longer persistence
- Endemic lifetimes depend on topology

Predicting Lifetimes

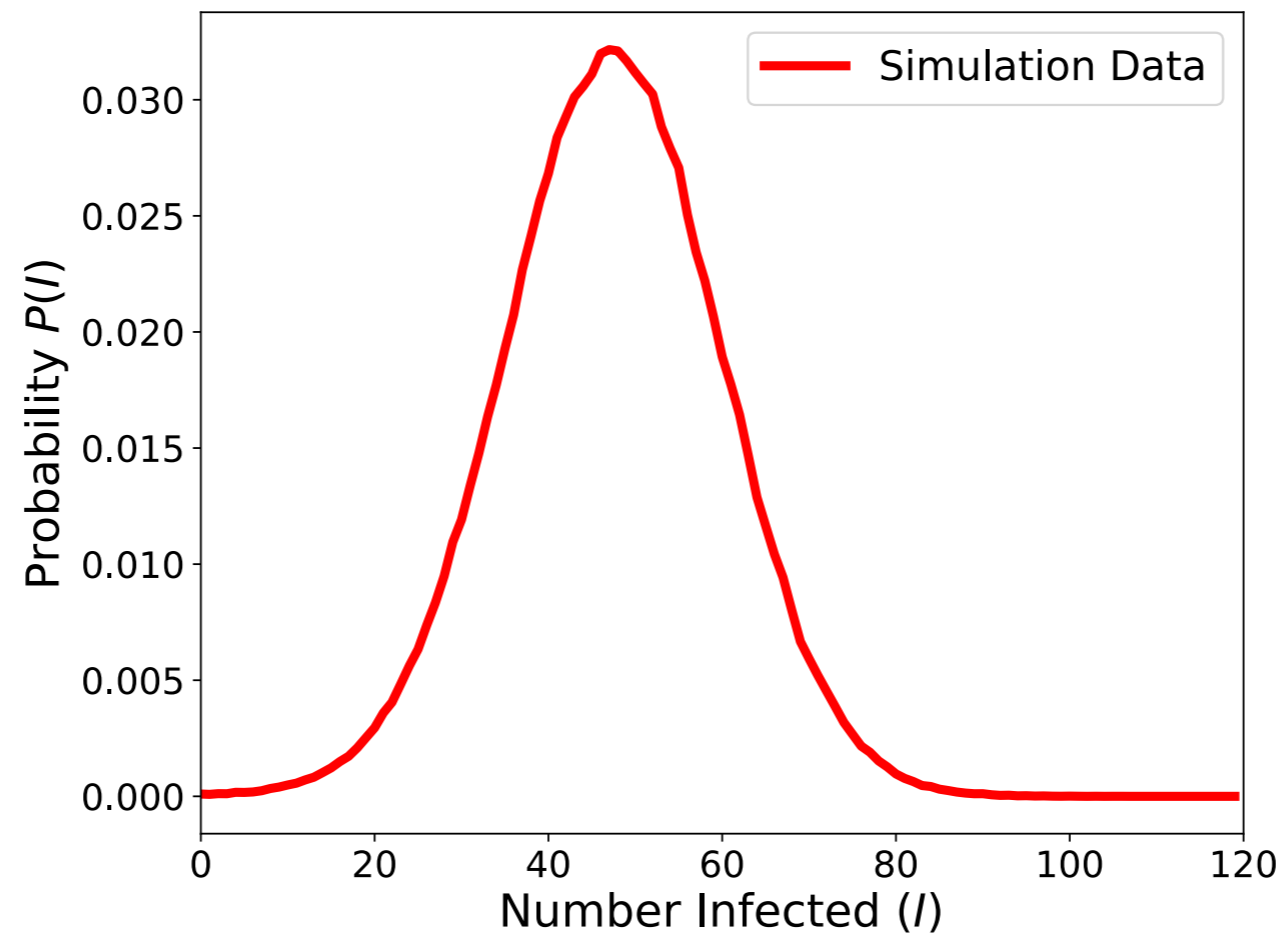
- Can we predict endemic state lifetimes?



- Fluctuation/mean ratio σ/μ is sufficient
- Corrections from changing topology

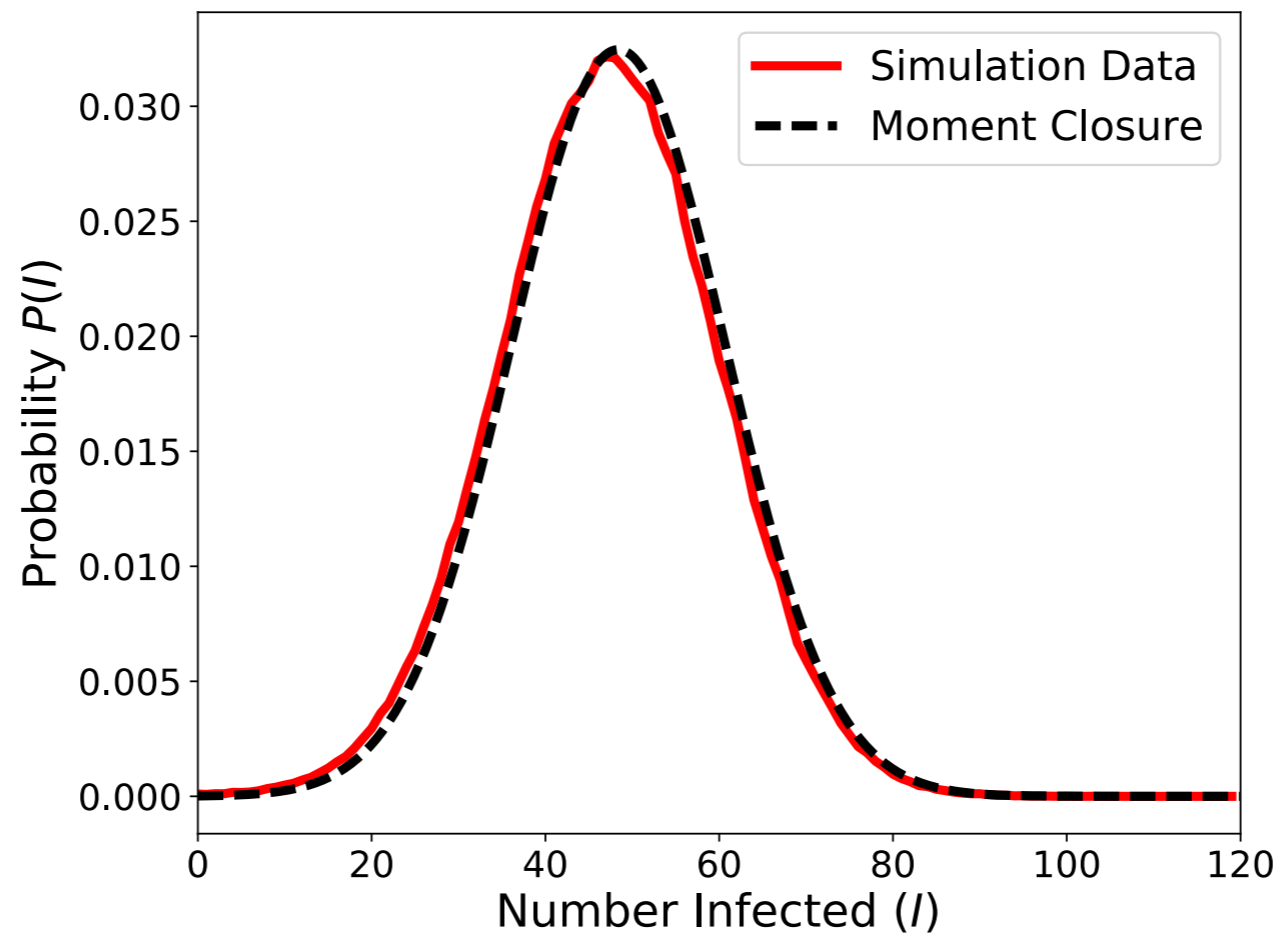
Moment Closure

- Analytical technique
- Predicts means and fluctuation sizes from parameters



Moment Closure

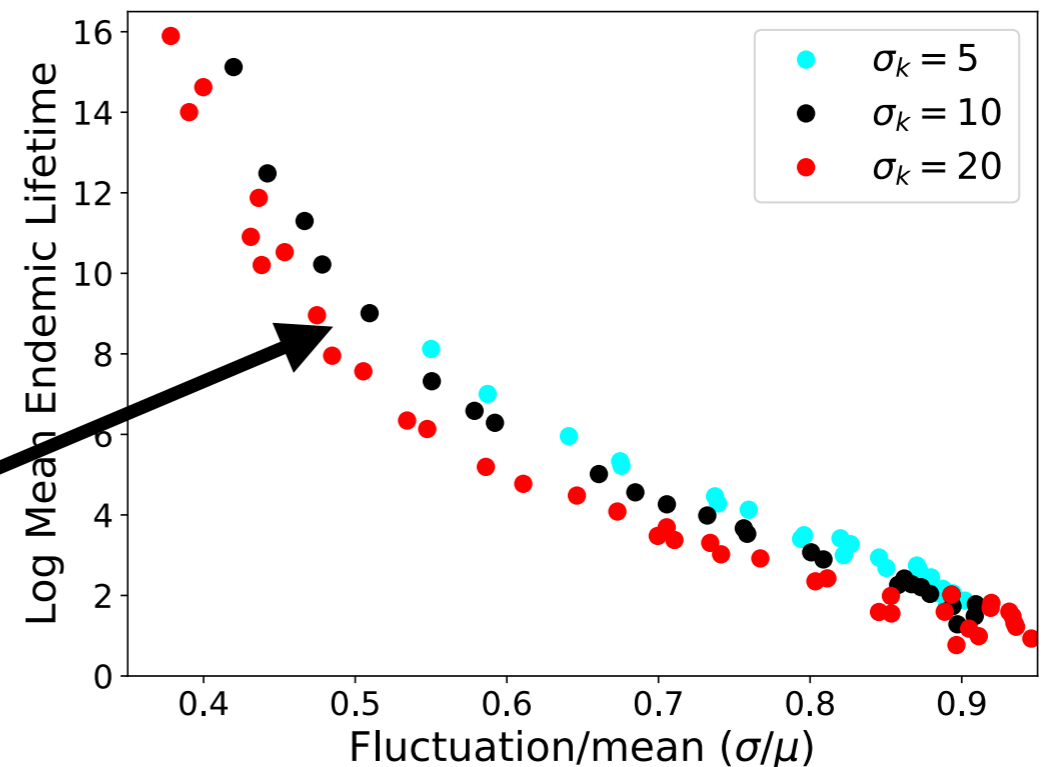
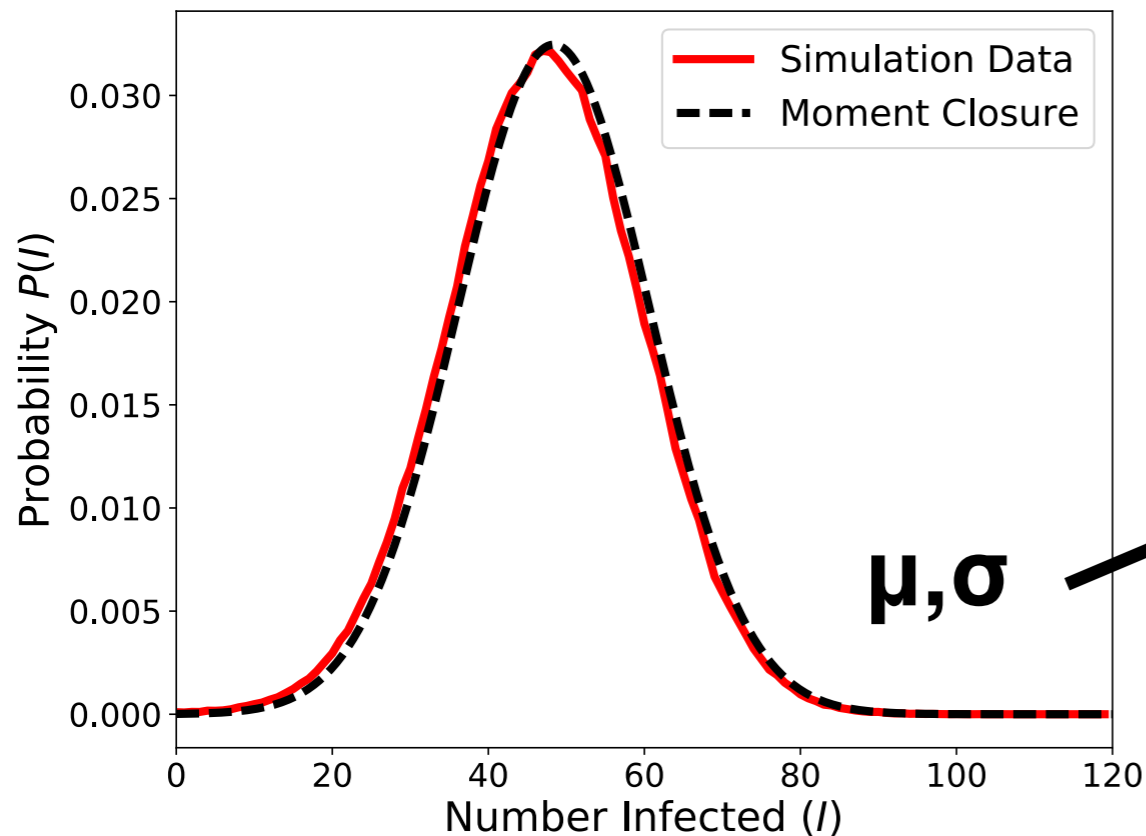
- Analytical technique
- Predicts means and fluctuation sizes from parameters



- Good agreement for annealed networks

Moment Closure

- Analytical technique that predicts *both* means and fluctuation sizes
- Good agreement for annealed networks
- Hypothesis: moment closure for predicting lifetimes



Summary

- Network topology can affect the persistence of endemic disease
- Higher degree heterogeneity leads to longer lifetimes
- Moment closure may be useful for predicting lifetimes

Acknowledgments

- Christopher R. Myers
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