Statistical Inference in a Stochastic Epidemic SEIR Model with Control Intervention: Ebola as a Case Study

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But...

- Ebola is quite preventable.

Question: How does preventative intervention influence the course of the epidemic?

The model

Use a susceptible-exposed-infectious-recovered (SEIR) model.

Generally speaking, the model takes four parameters:

β: base transmission rate (before intervention)

$1/\varrho$: mean incubation period

$1/\gamma$: mean infectious period

q: decay in rate of transmission after intervention

Work on a discrete time scale at one-day intervals. Assume binomial distributions on number of people transitioning from state to state.
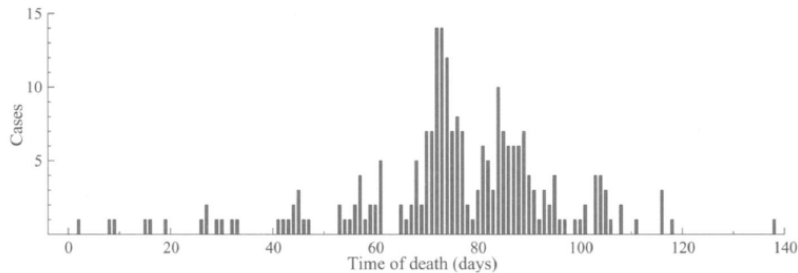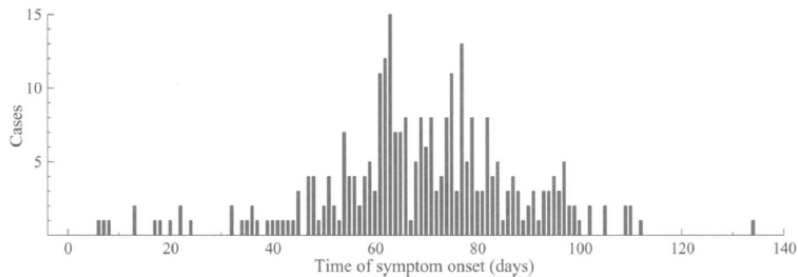
Inference

If we had complete data...

- Compute likelihood of data given parameters
- Find parameters which maximize likelihood

or

- Put prior distributions on parameters
- Use MCMC methods to sample from posterior distribution

Challenge: Missing data

Problem: It's an SEIR model, but we have no data on the S→E transition.

Solution: A clever imputation scheme—sample from conditional distribution, while making sure that the number of exposed stays consistent with the number of recovered.

Problem: We don't have all the E→I or I→R data either.

Solution: ???

Simulation studies using the estimated parameter values show:

	With intervention	Without intervention
Epidemic length	~ 200 days	~ 950 days
Epidemic size	~ 300	~ 3.5 million

Summary

Scientific contribution: How does intervention impact the spread of Ebola?

Statistical contribution: How can we make inference in a four-state model when transitions from state 1 to state 2 are entirely unobserved?

Problem (for me): What happens with that *other* missing data?