Preview of Tuesday:

Introduction to stochastic modeling

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Today in review (I)

- The epidemic model developed by Reed and Frost represents a class of mathematical models called chain binomial models
  - We have not yet discussed what a “chain binomial model” is
- The Reed-Frost model operates in discrete time units, where each time period is equal to the length of the average serial interval (≈ average incubation period) for the disease being modeled
- The number of cases in a particular time period can be calculated based on the number of cases from an earlier time period
- This calculation also uses the average number of adequate contacts (designated *k*) that each individual has with others in the population during a single time period

The Reed-Frost equation (more review)

- $C_{t+1} = S_t\,(1 - q^{C_t})$
  where:
  t indicates the time period
  C = # of cases (infectious individuals)
  S = # of susceptible individuals
  q = prob. of avoiding adequate contact
- q = 1 – (prob. of adequate contact) = 1 – p
- $p = k\,/(N - 1)$
  where:
  k = average number of adequate contacts by an individual in a single time period
  N = size of the population

Today in review (II)

- Statistical tests, like the chi-square test or G test, can be used to assess the fit of results predicted by a model to actual outbreak data
- The goodness of fit of a model can be optimized by selecting an appropriate value for k
- In the context of the basic Reed-Frost model, k is equivalent to R_0

Deterministic modeling

- The Reed-Frost model, as constructed today, is a *deterministic* model
  - The model produces an estimate of the average number of new cases per time period
  - There is a closed form solution for the Reed-Frost function
  - There is no measure of variability or uncertainty connected with the result
- Real life is rarely so simple. For example…

How many ways can you toss four coins?

etc.

- In four coin tosses, we expect that the most common result will be two heads
  - This would be the result of a deterministic model
- Two heads is not the only possible outcome: chance plays a role
  - A *stochastic* model will account for the role of chance

Stochastic models

- Stochasticity refers to the random or variable nature of events
- Characteristics of biological systems are often variable (usually within limits)
  - *e.g.*, daily milk production
- When modeling disease, it is often useful to account for this natural variability
- Models may also include variability simply because little is known about a system

Coming up tomorrow

- We will continue to work with the Reed-Frost framework, incorporating variability or stochasticity into the basic model
- We will look at the benefits of stochastic modeling
- We will be introduced to some computational tools for creating stochastic models
- We will briefly examine a different approach to disease modeling, which will allow us to create much more complex models