Exploring the interaction between models and data

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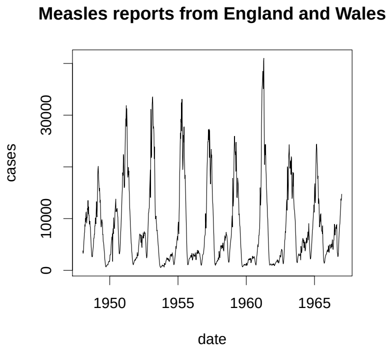
2016 Summer Course on Mathematical Modeling and Analysis of Infectious Diseases

National Taiwan University

Goals

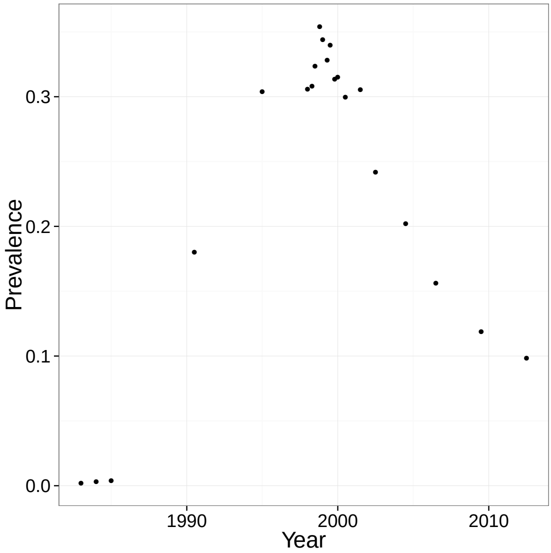
- Explore some ideas of using a model to explore disease data
- Use estimates of HIV prevalence from Zimbabwe as an example

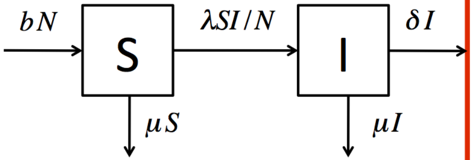
Bridging



- Models are the tool we use to bridge between data and mechanisms
- In both directions

Estimated HIV prevalence in Zimbabwe





$b =$ birth rate

$N = S + I$

$\lambda =$ rate at which new infections occur

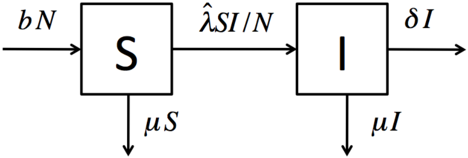
$\delta =$ disease induced mortality rate

$\mu =$ background mortality rate

The basic model

Phenomenological heterogeneity

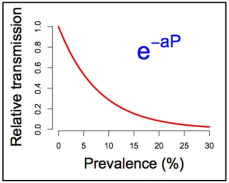
- Just *assume* that you can approximate this complicated phenomenon with a simple functional form, $\beta = f(P)$
  - Original study used $\beta = \beta_0 \exp(-\alpha P)$
  - We will use $\beta = \beta_0 (1 - P)^\kappa$
- Both forms start with $\beta = \beta_0$ and decline smoothly with prevalence



$b =$ birth rate

$N = S + I$

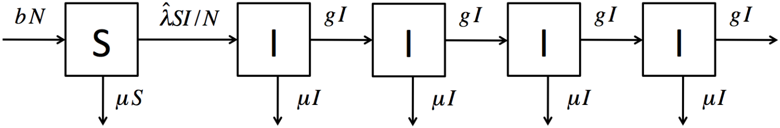
$\hat{\lambda} = \lambda e^{-aP}$



$\delta =$ disease induced mortality rate

$\mu =$ background mortality rate

Heterogeneity in sexual behaviour



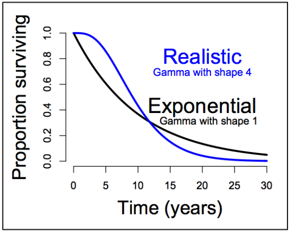
$b =$ birth rate

$N = S + I$

$\lambda =$ rate at which new infections occur

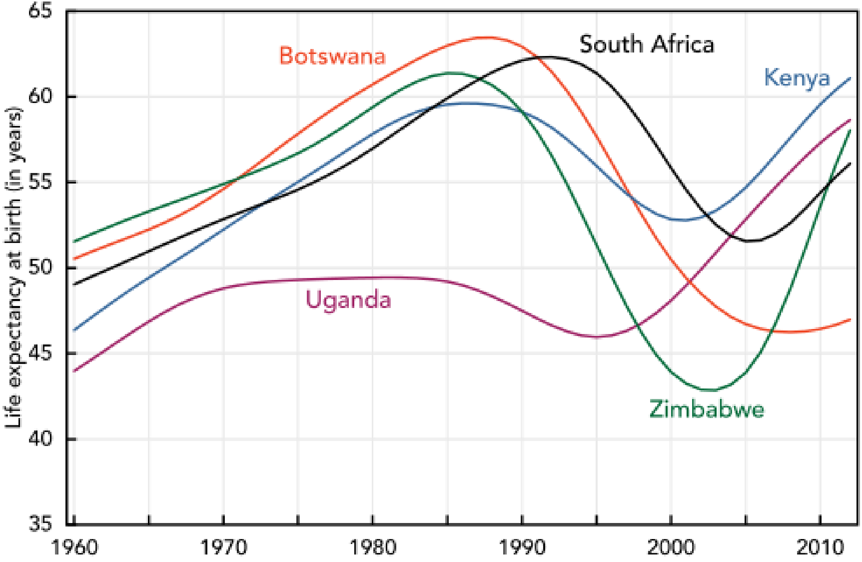
$\delta = g/4$

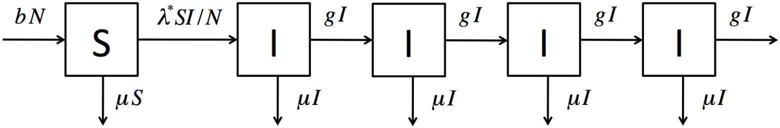
$\mu =$ background mortality rate



Realistic survival times

Are people *responding* to the epidemic?





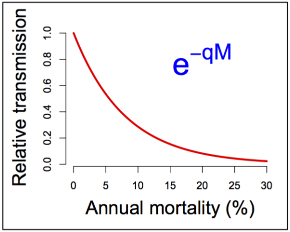
$b =$ birth rate

$N = S + I$

$\lambda^{*} = \hat{\lambda} e^{-qM}$

$\delta = g/4$

$\mu =$ background mortality rate



Mortality leads to behaviour change