Advancing real time outbreak analysis

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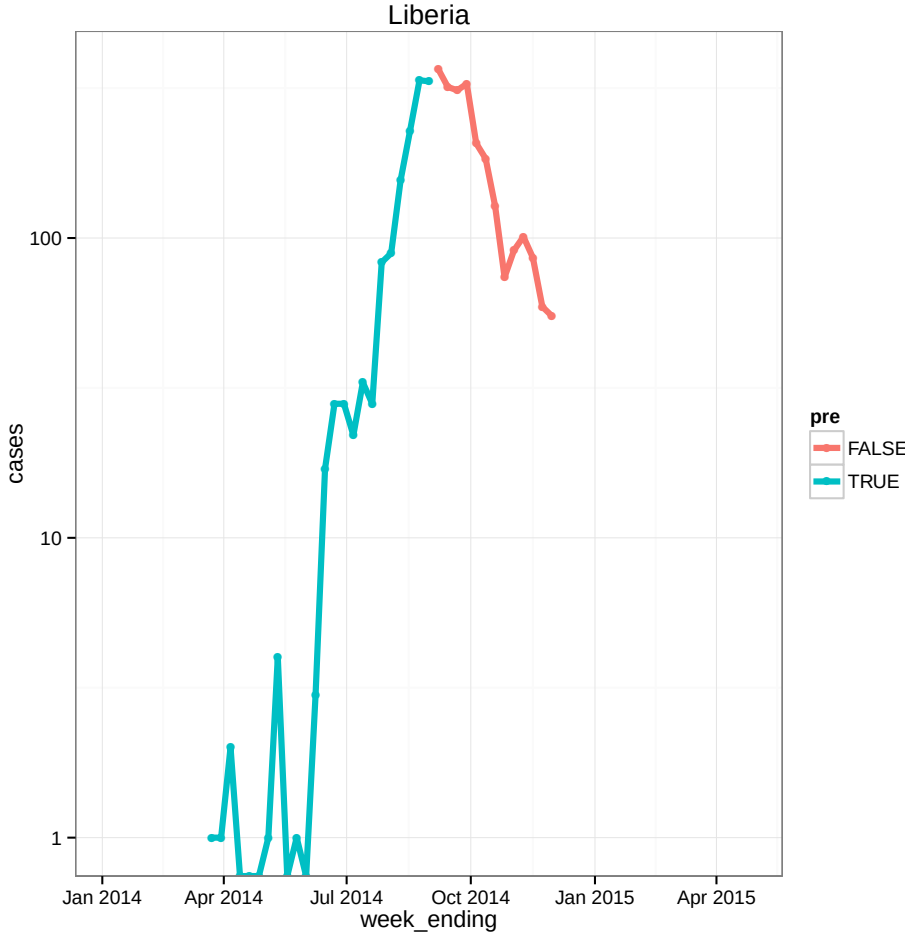
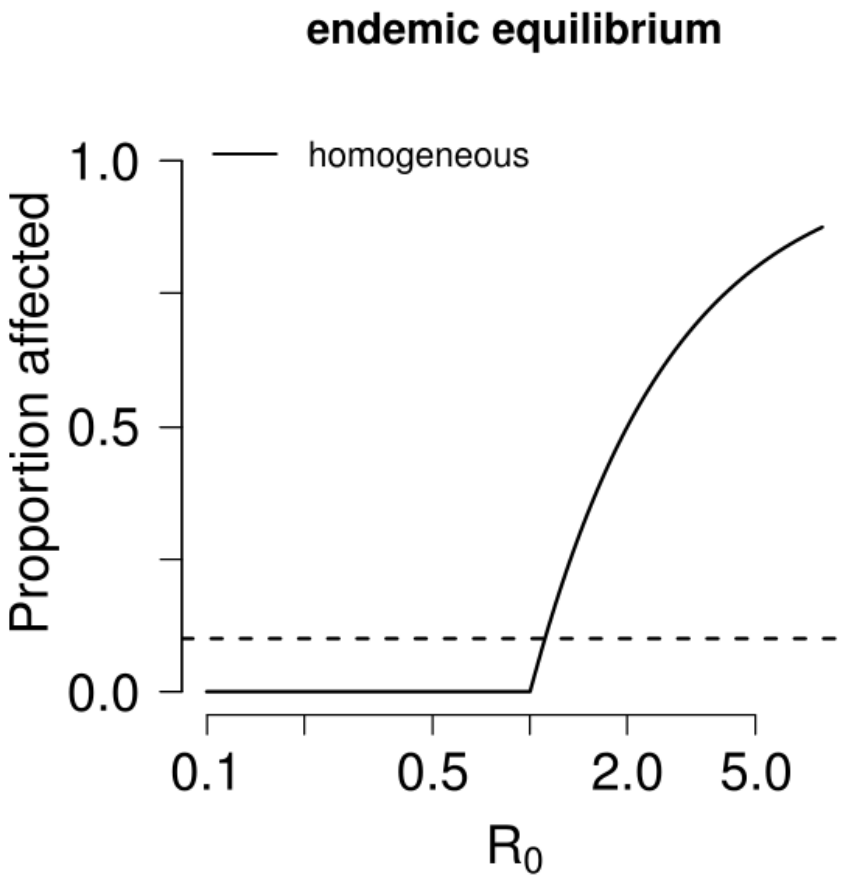
Dynamic modeling

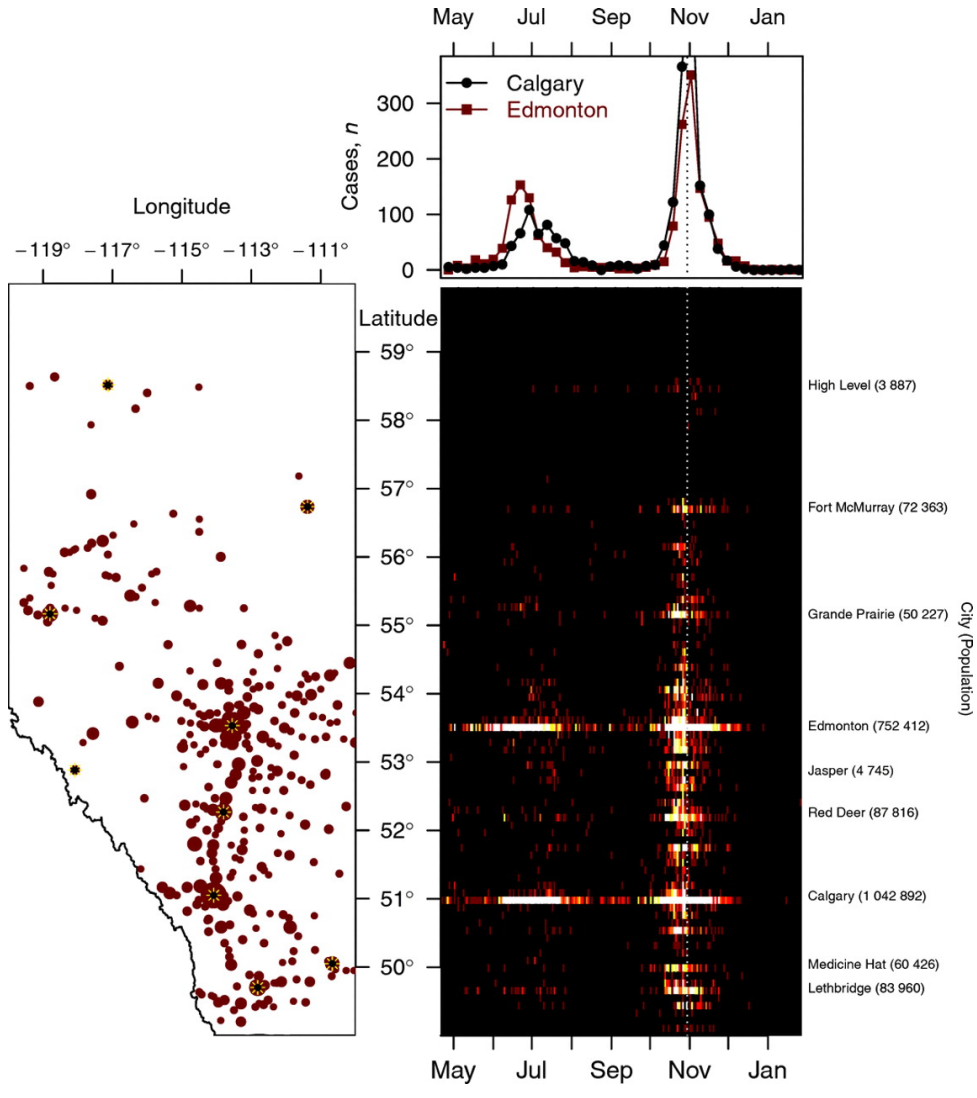
Connects scales



Yellow fever in Panama



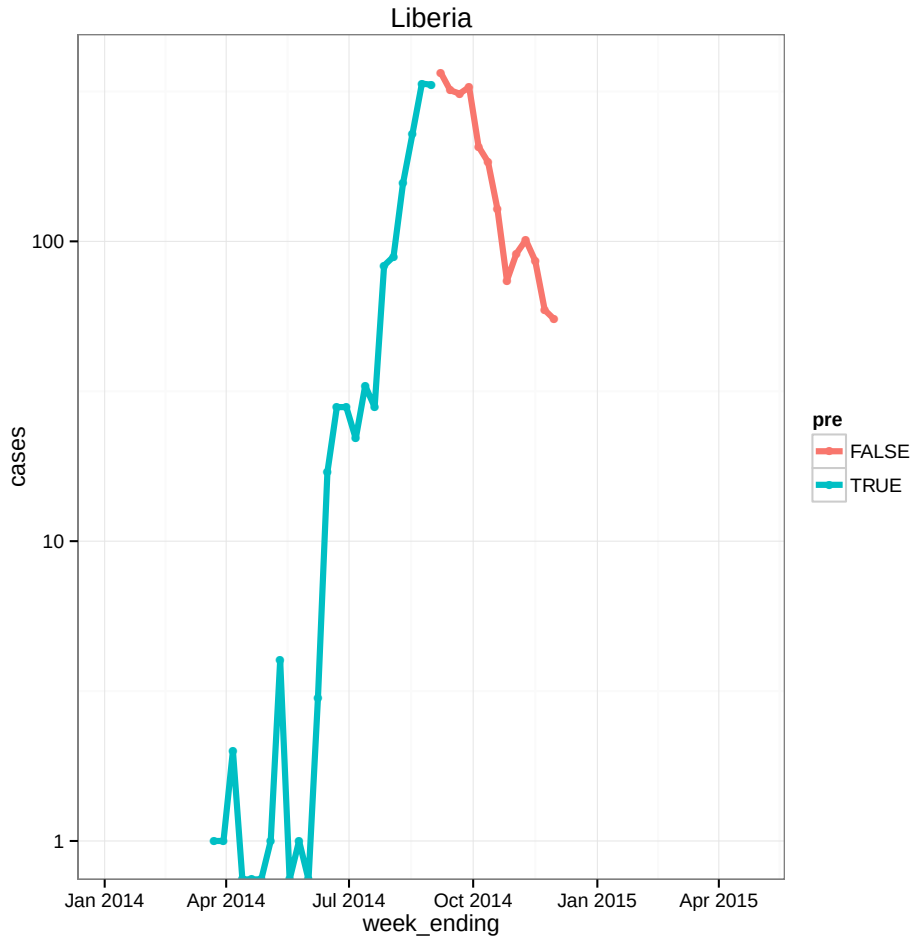
2009 pandemic Alberta



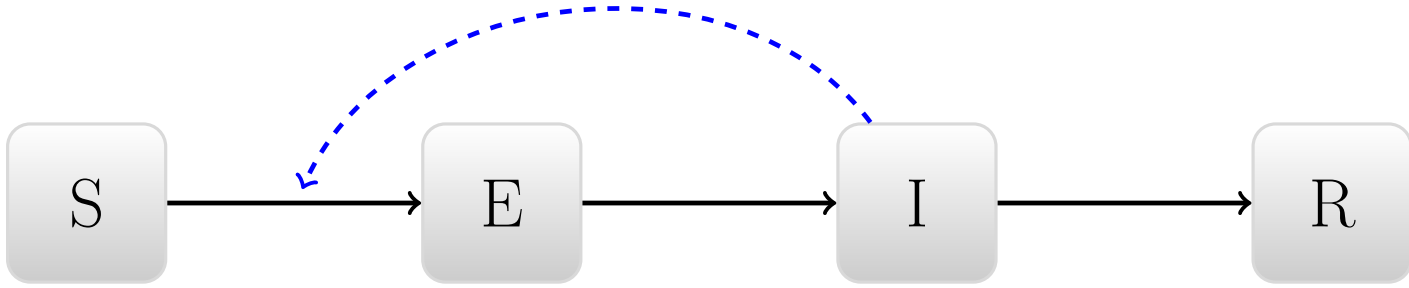
Goals

- Quickly make *transparent* predictions
  - Including responses to intervention scenarios
- Be *realistic* about uncertainty
  - Investigate how uncertainty can be reduces
- Be *open* about calculations
  - And open to people who want to use our machinery but change our assumptions

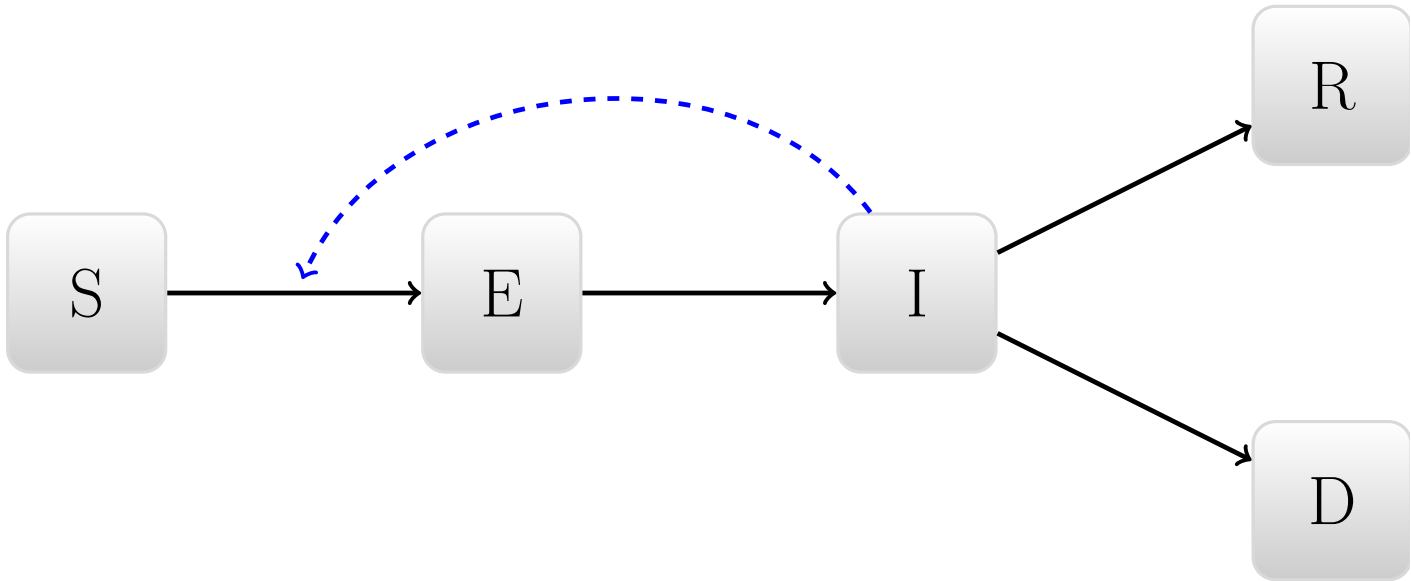
The CDC and the West African outbreak



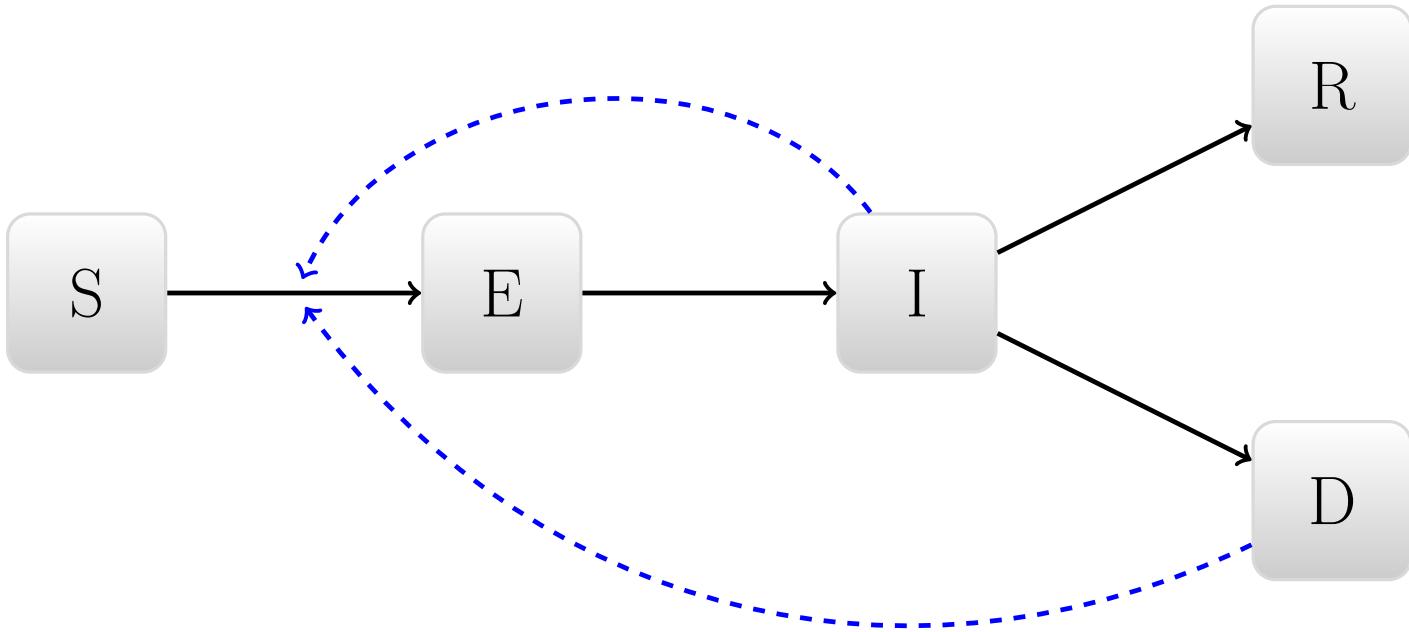
Standard disease model



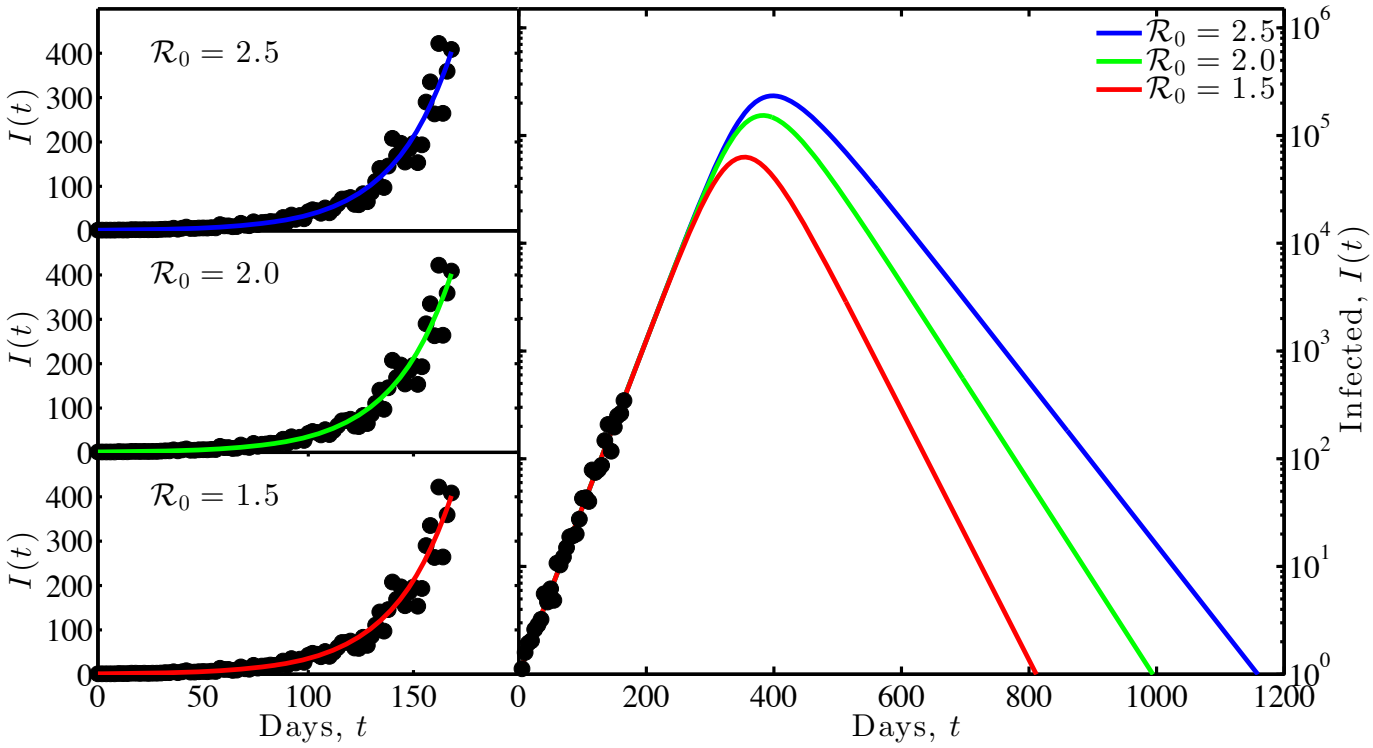
Disease model including post-death transmission

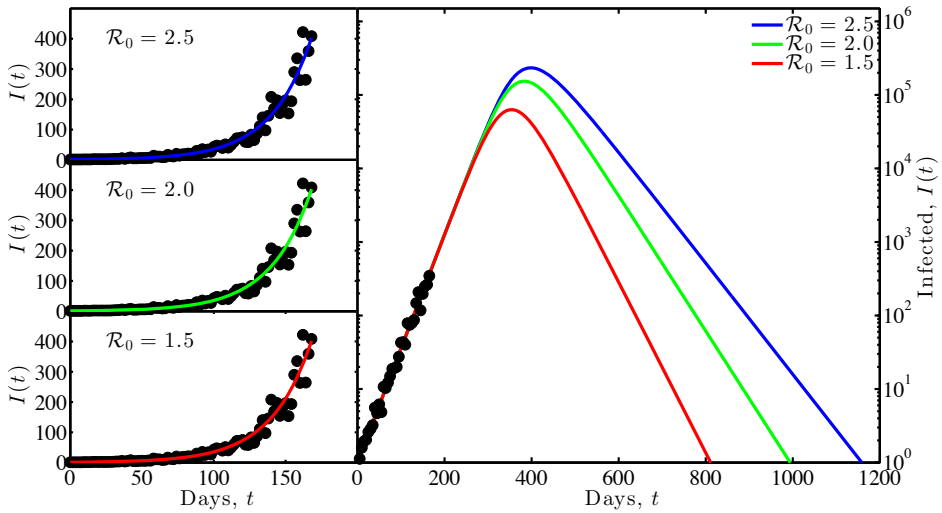


Disease model including post-death transmission



Scenarios


$\mathcal{R}_0 = 2.5$
$\mathcal{R}_0 = 2.0$
$\mathcal{R}_0 = 1.5$
$I(t)$
Days, t
Infected, $I(t)$

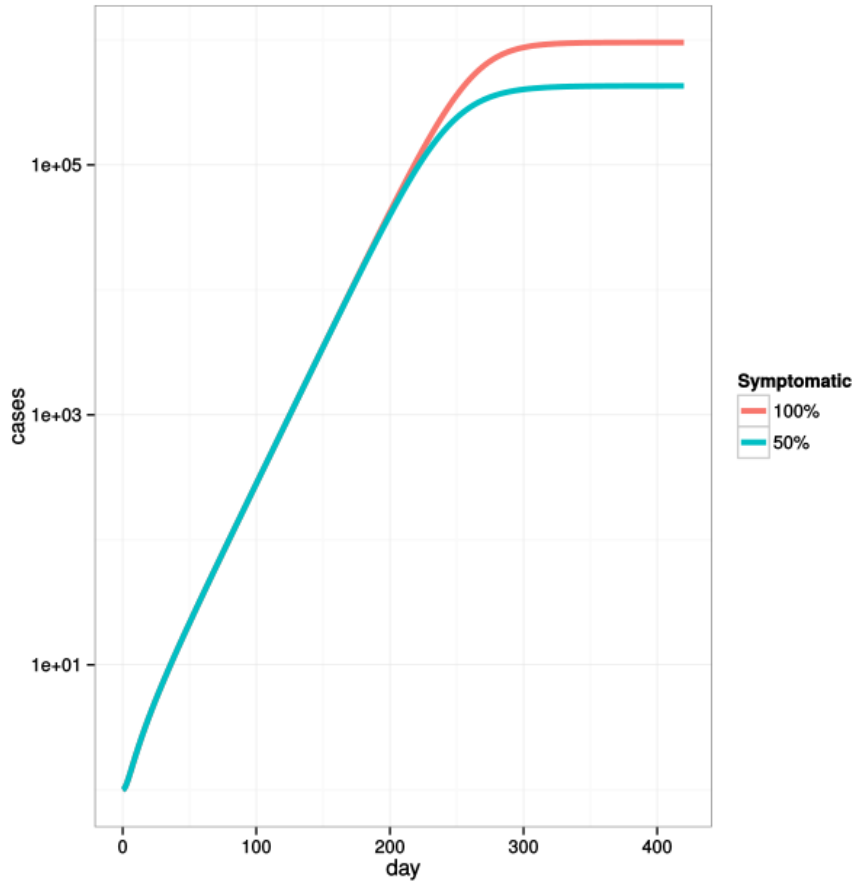


- Different assumptions produce identical fits
- More after-death transmission $\Rightarrow$
  - Higher $\mathcal{R}_0$
  - Larger epidemics
  - Larger importance of safe burials

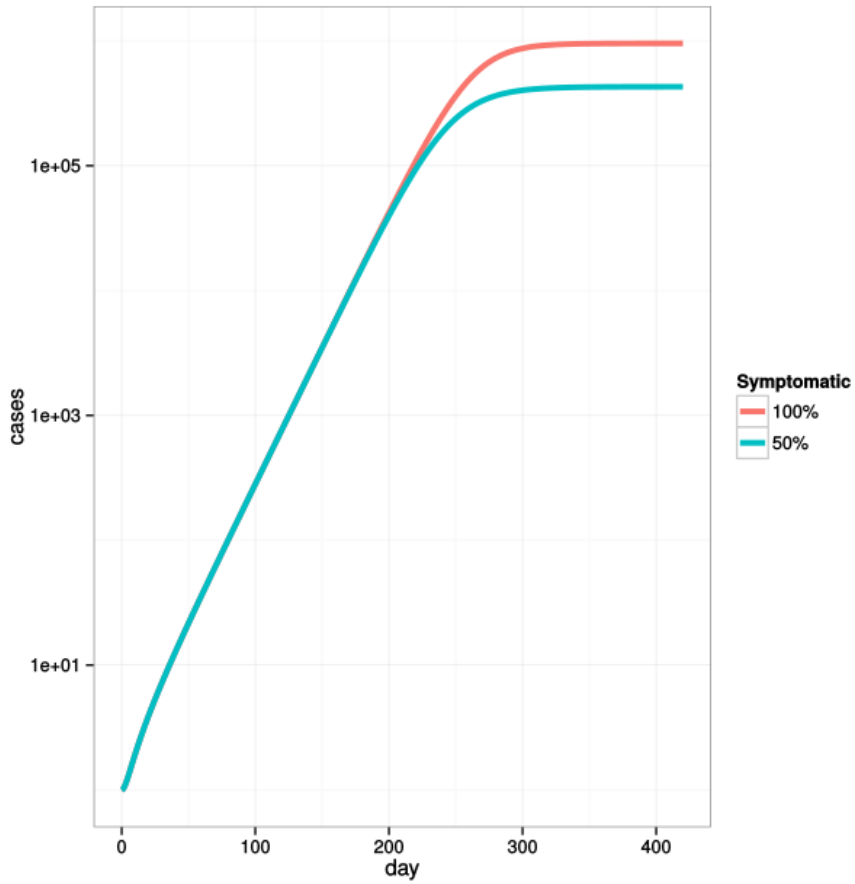
Subclinical infection

- Does Ebola virus produce subclinical infection?
  - Infection that does not present as Ebola virus disease
- Can subclinically infected individuals pass infection to others?
- Is subclinical infection immunizing?
- What are the dynamic effects?

Subclinical infection dynamics



Subclinical infection dynamics



- Effects visible late in epidemic
- Or in future epidemics

How do we measure invading epidemics?

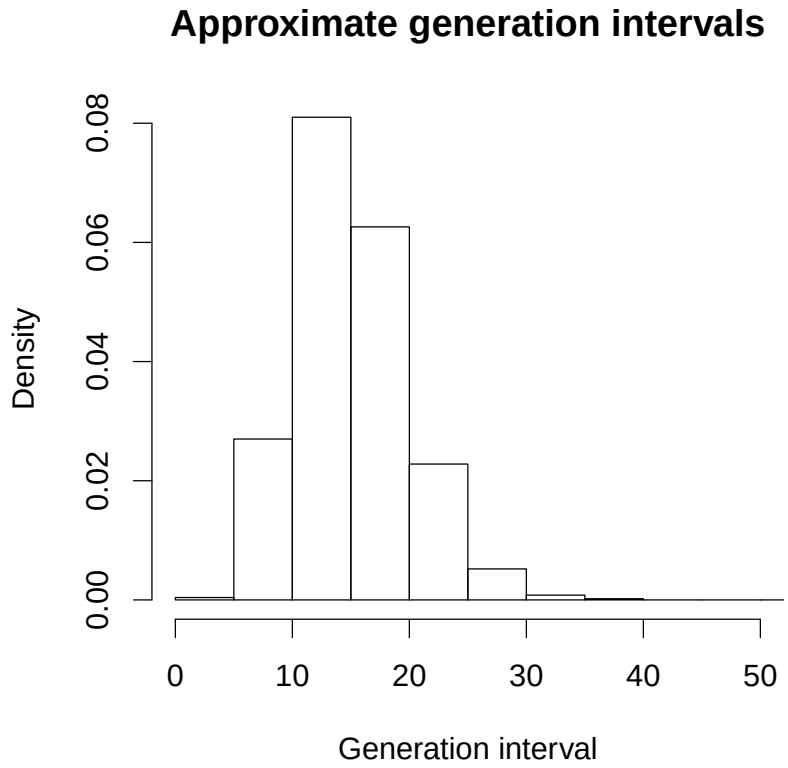
- Strength
- Speed
- Danger

How do we measure invading epidemics?

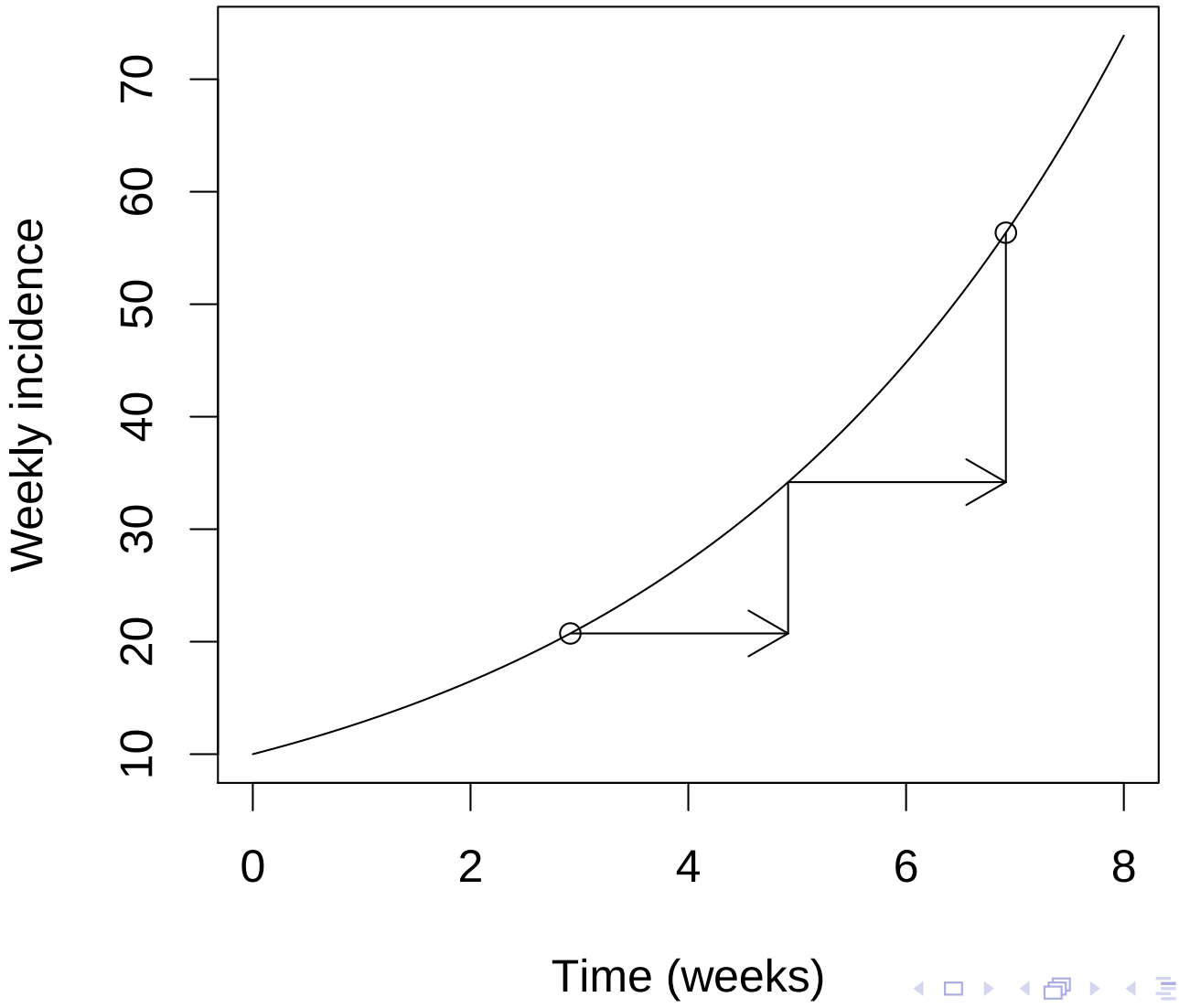
- Strength – $\mathcal{R}$
- Speed – r
- Danger – α

Life cycle

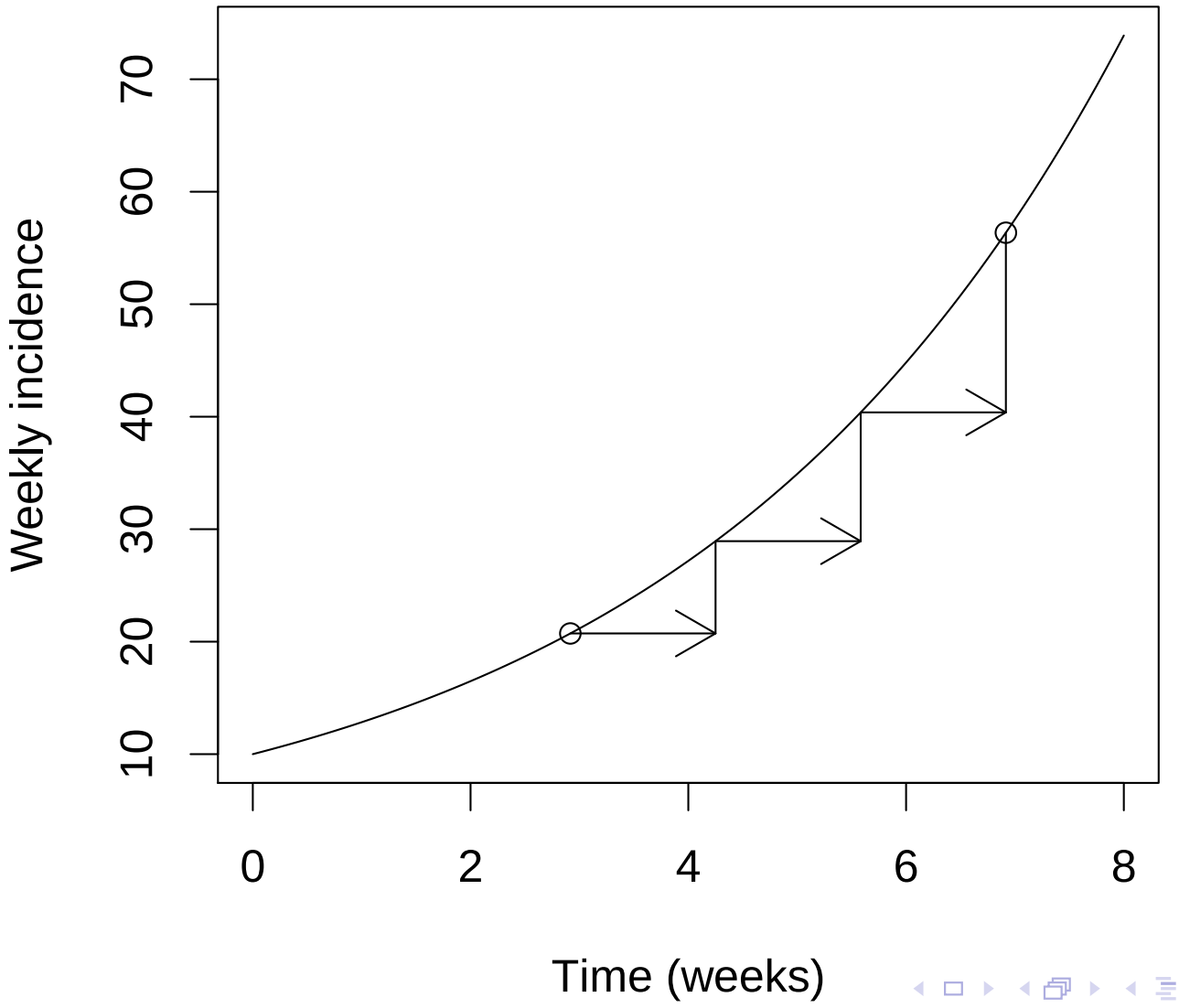
- The link between r and $\mathcal{R}$ is the generation distribution G
  - Interval between "index" infection and resulting infection
- What is the effect of a fast G?
  - It depends!



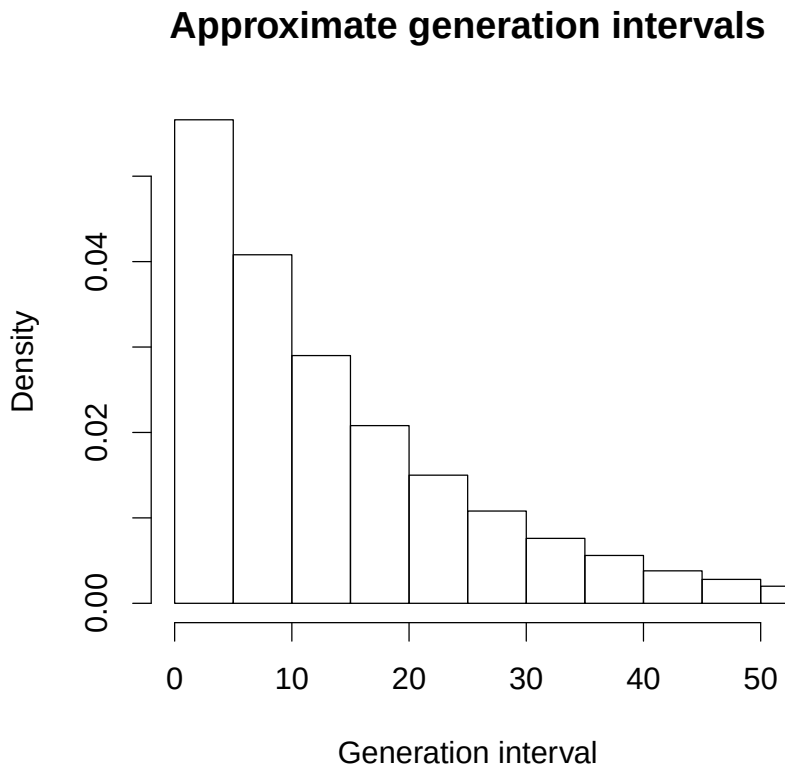
Generations and $\mathcal{R}$

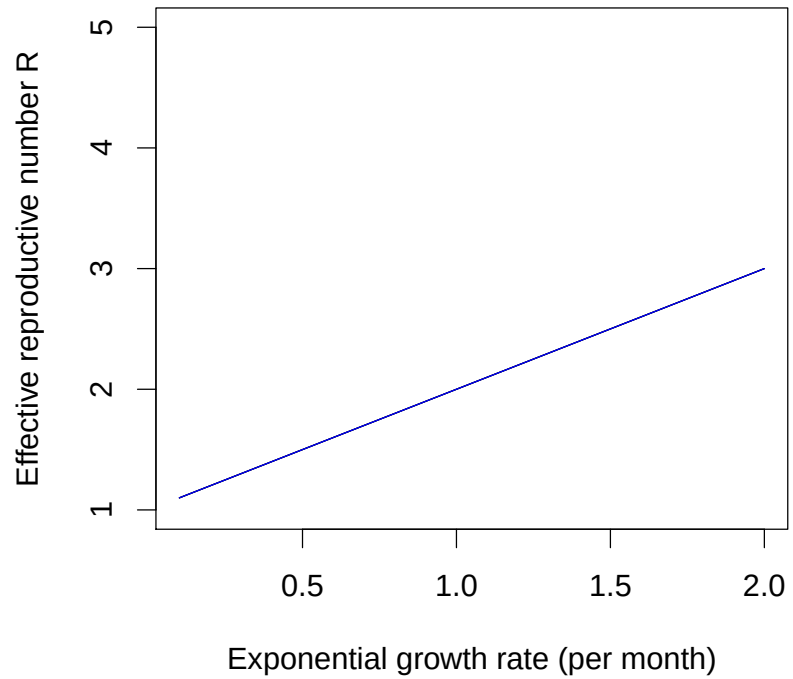


Generations and $\mathcal{R}$



Strength vs. speed





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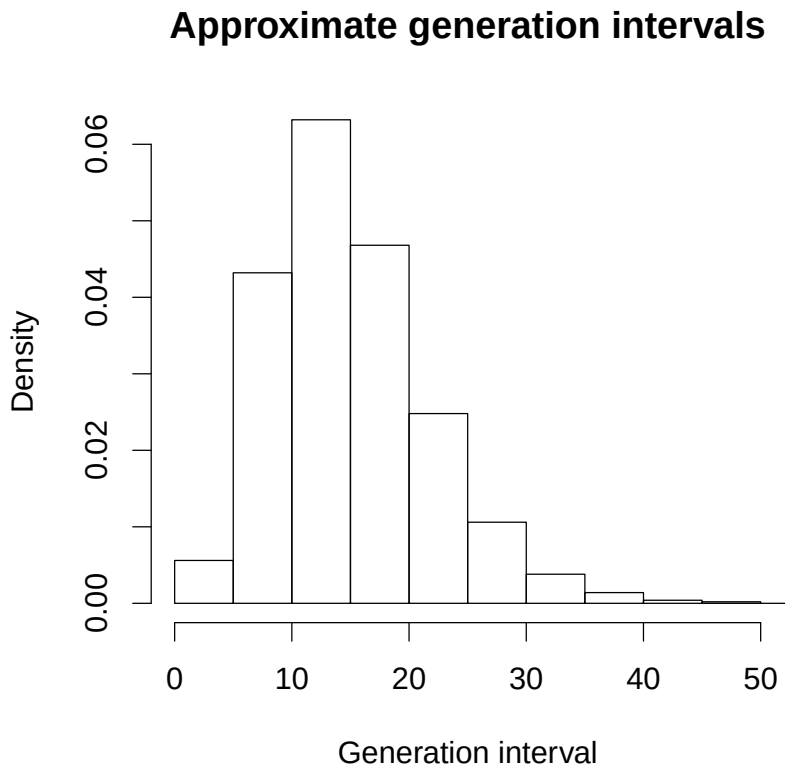

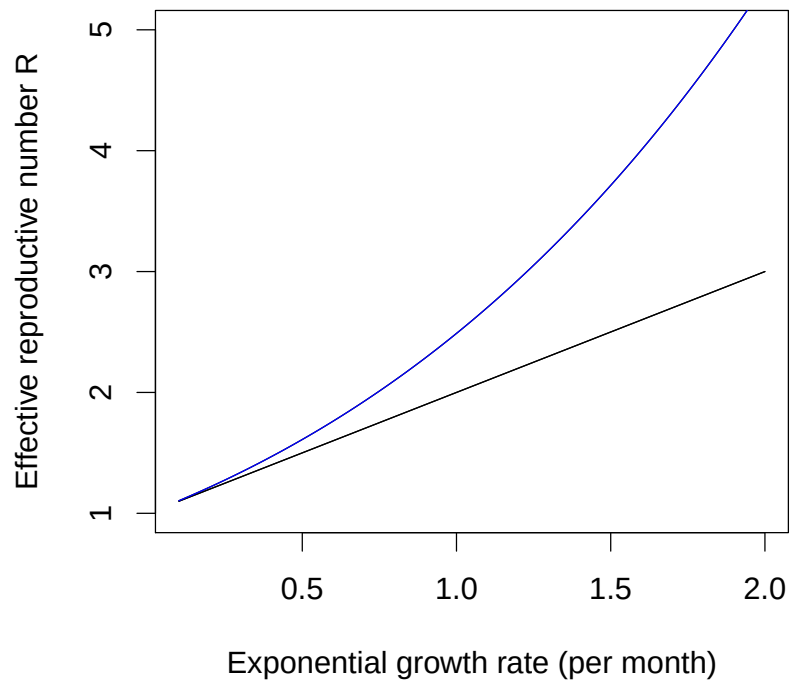

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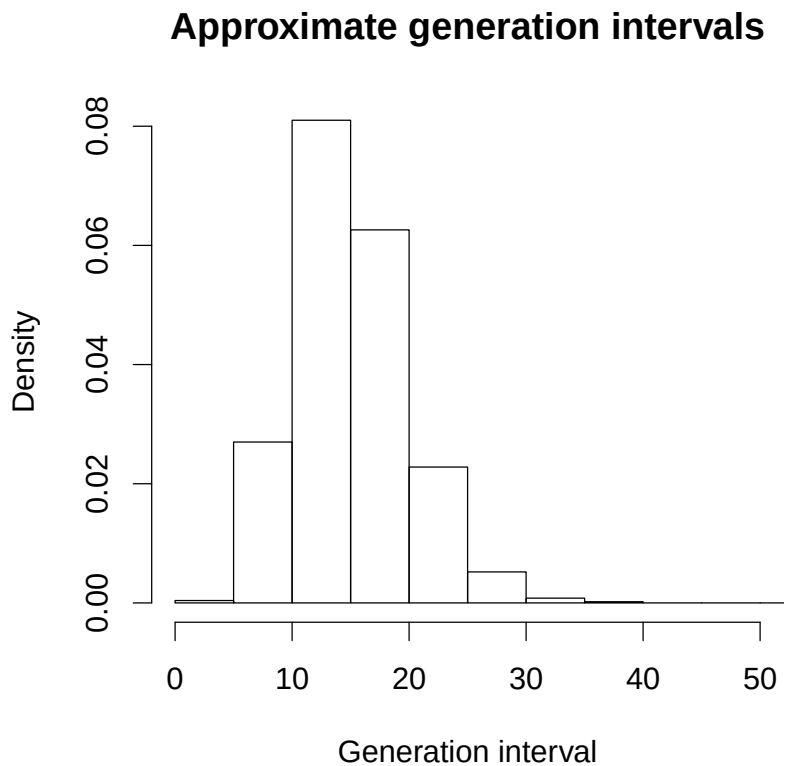

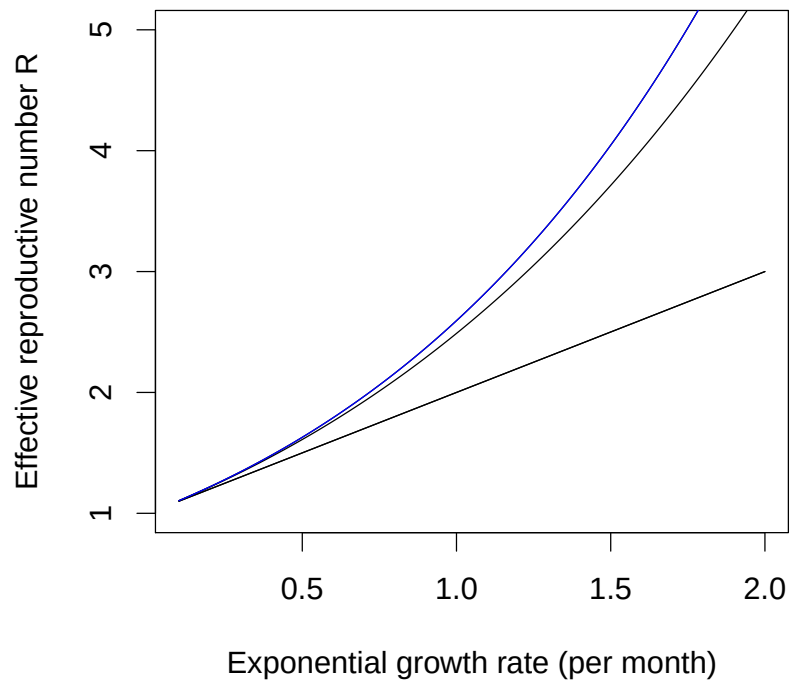

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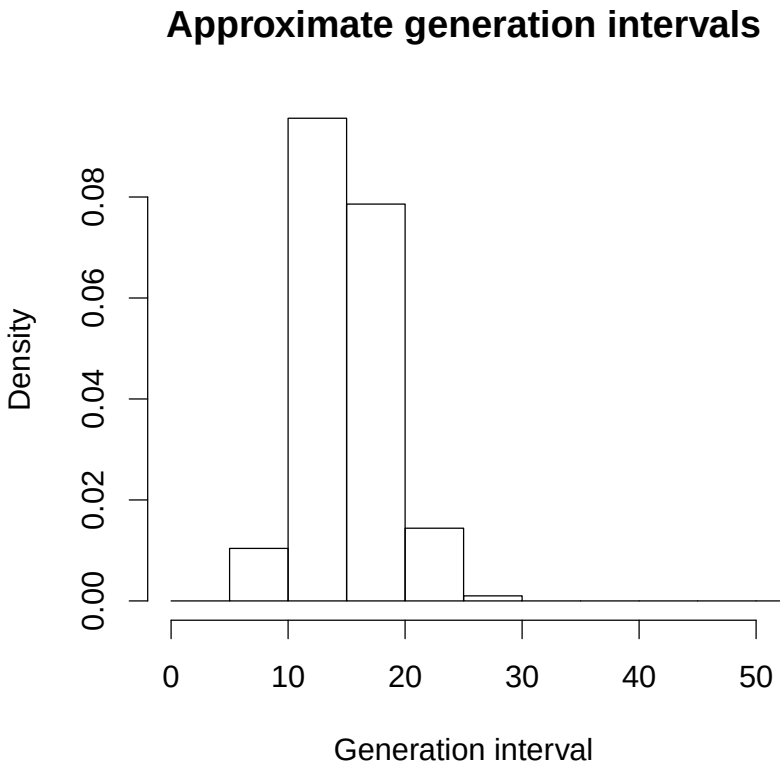
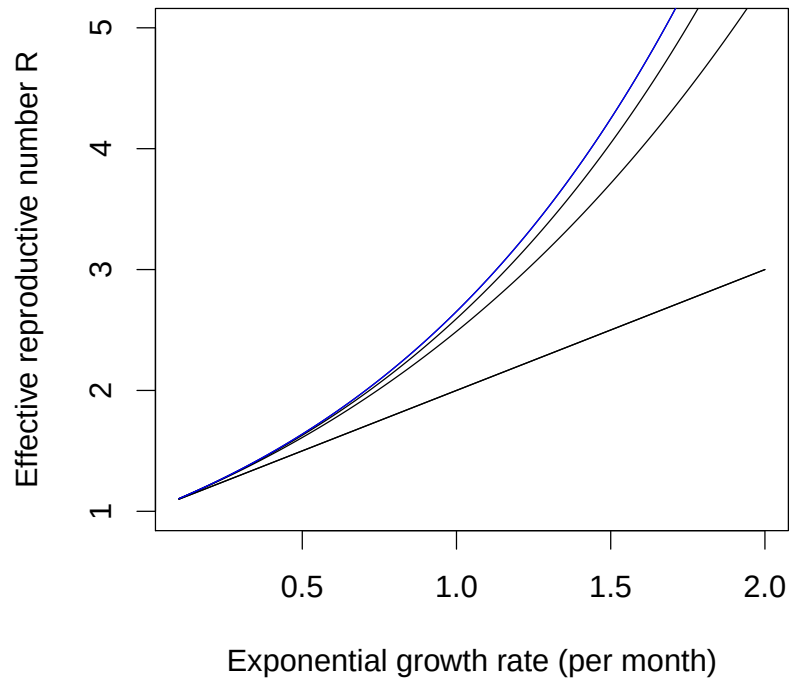
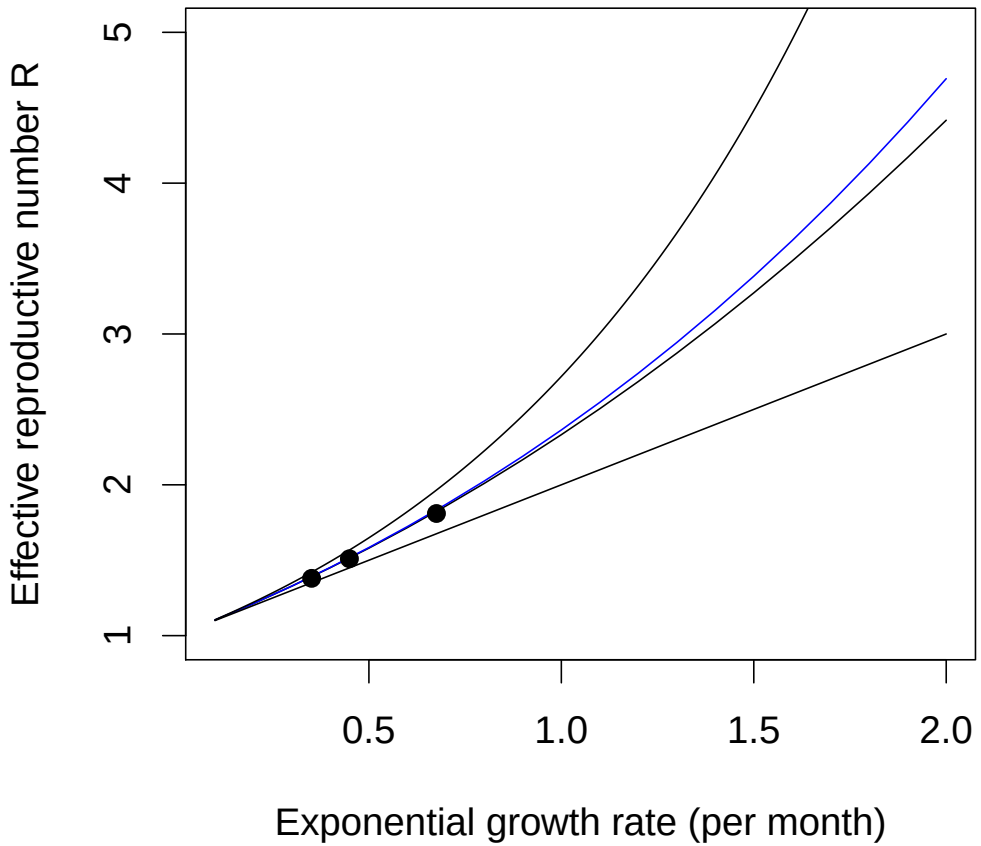
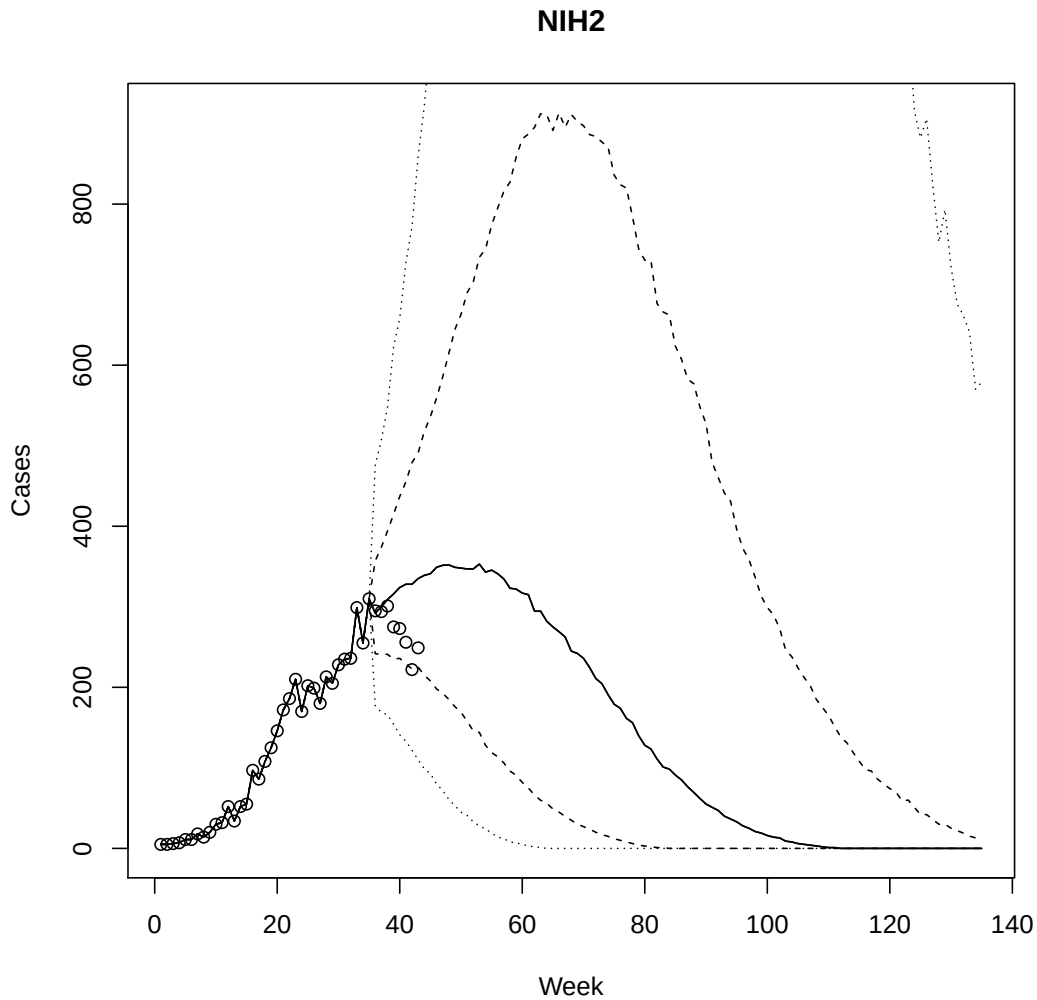




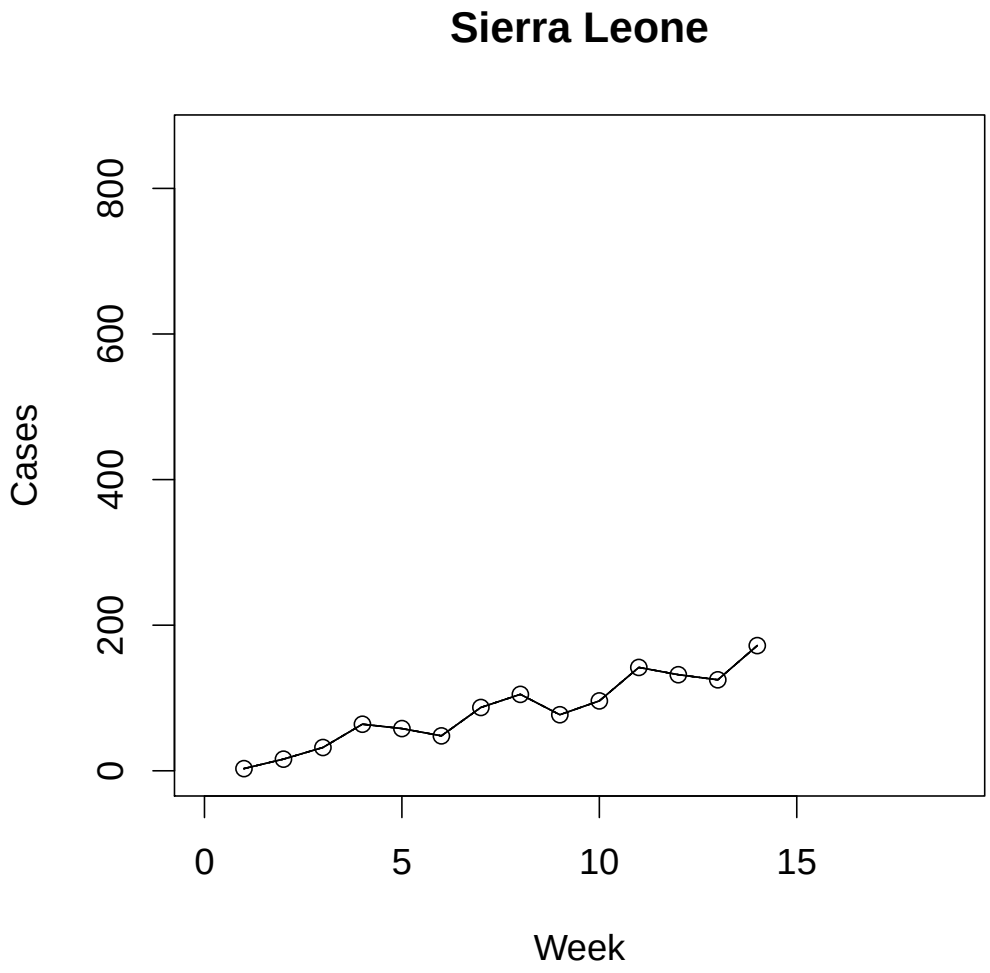
Fitting to Ebola



NIH Ebola Contest



Assessing and reporting uncertainty



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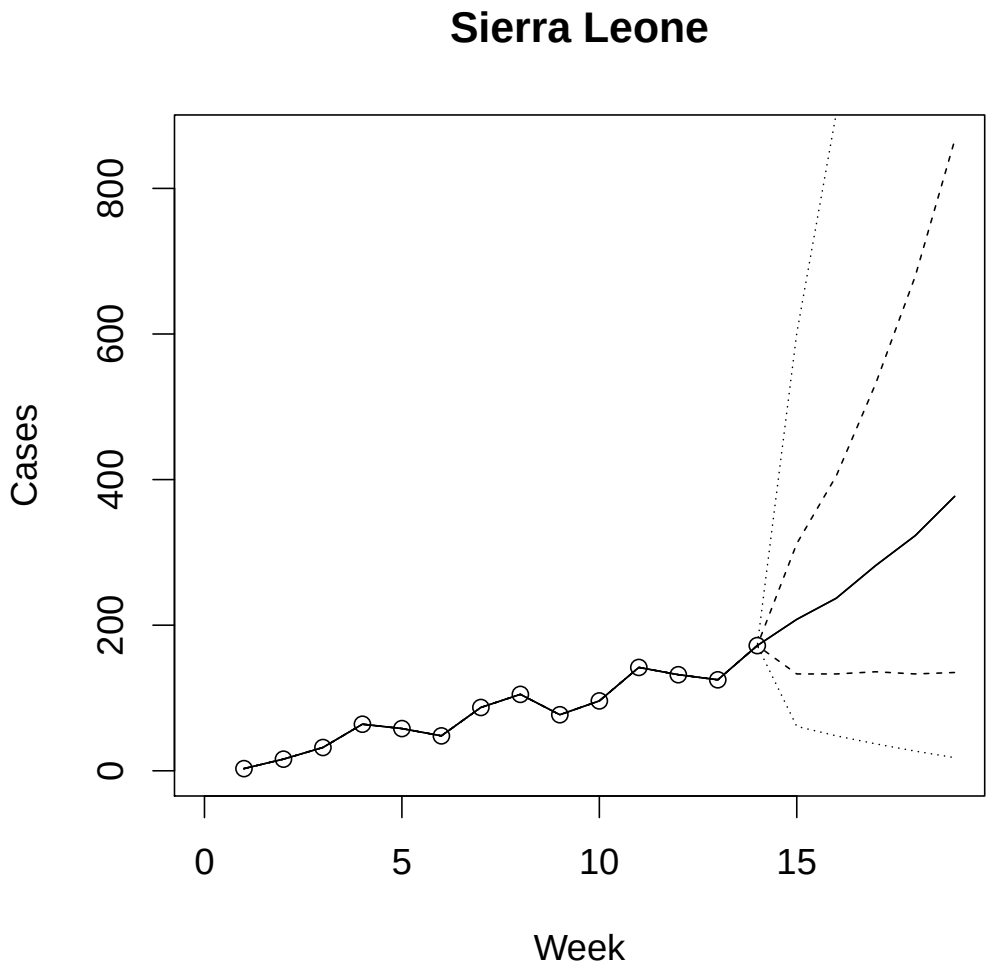

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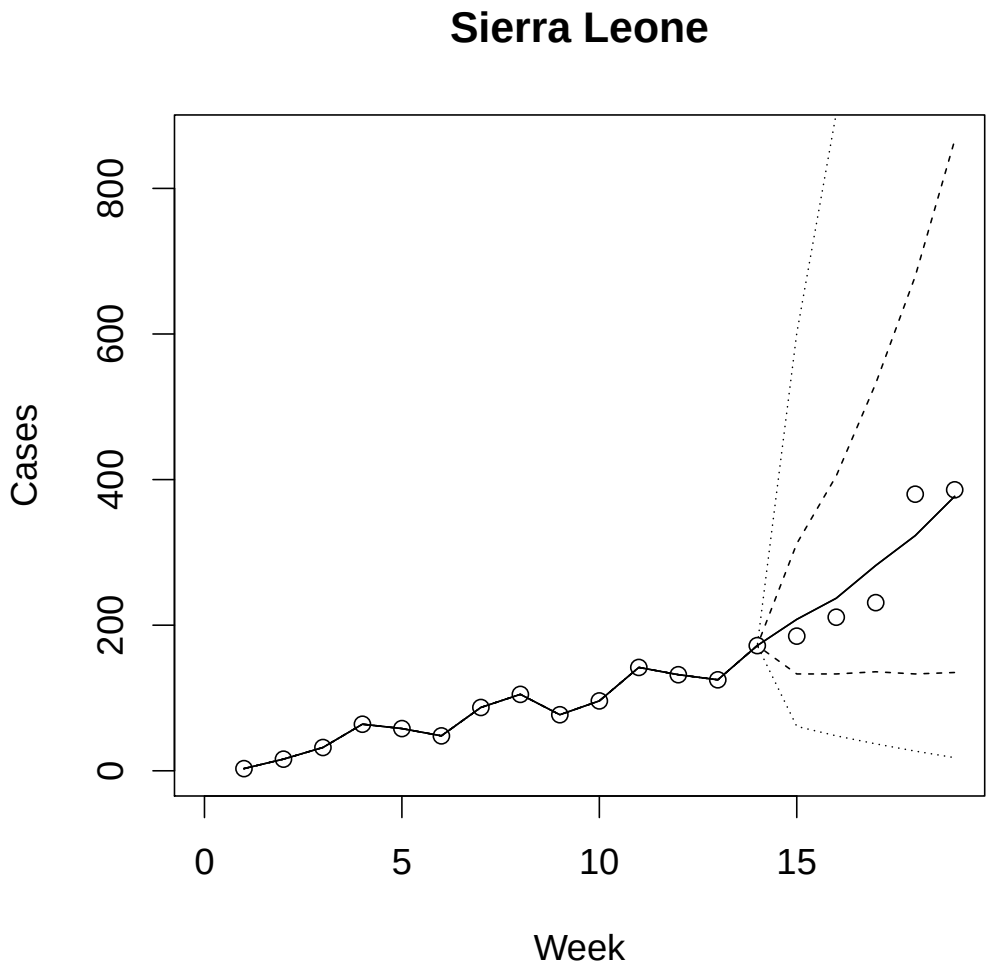

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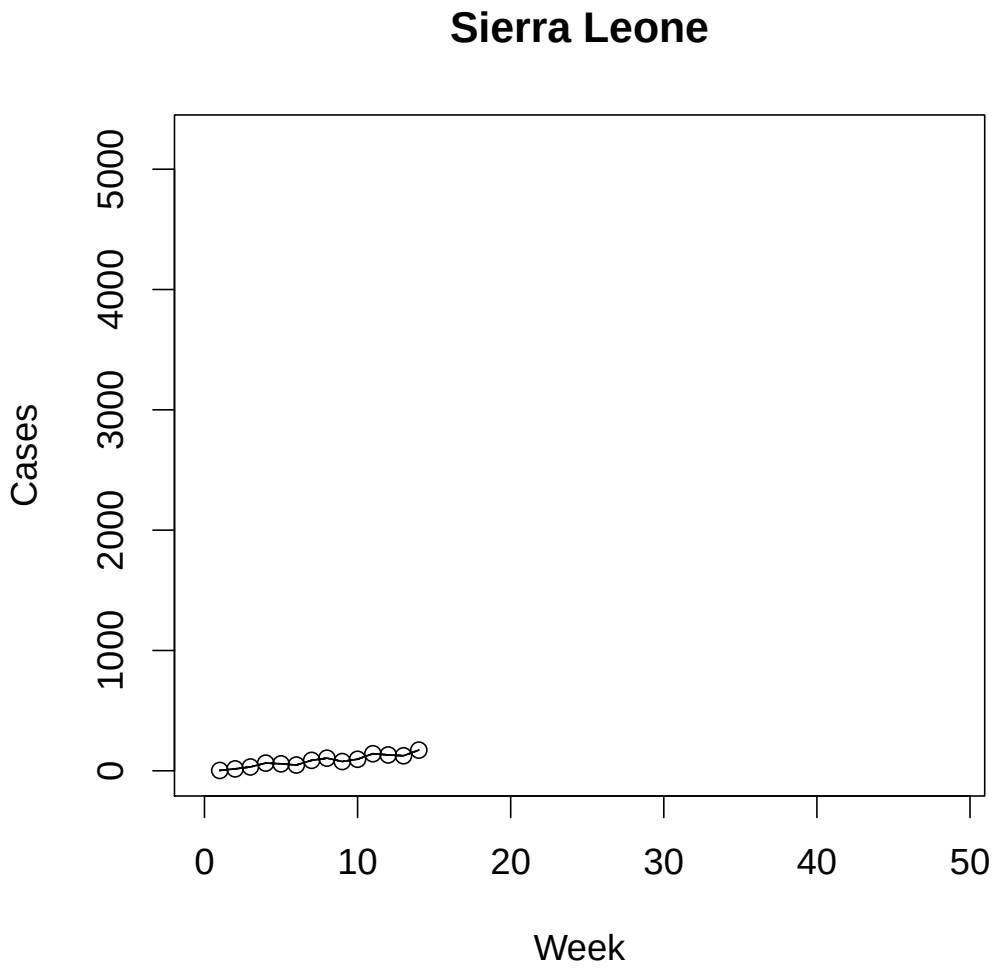

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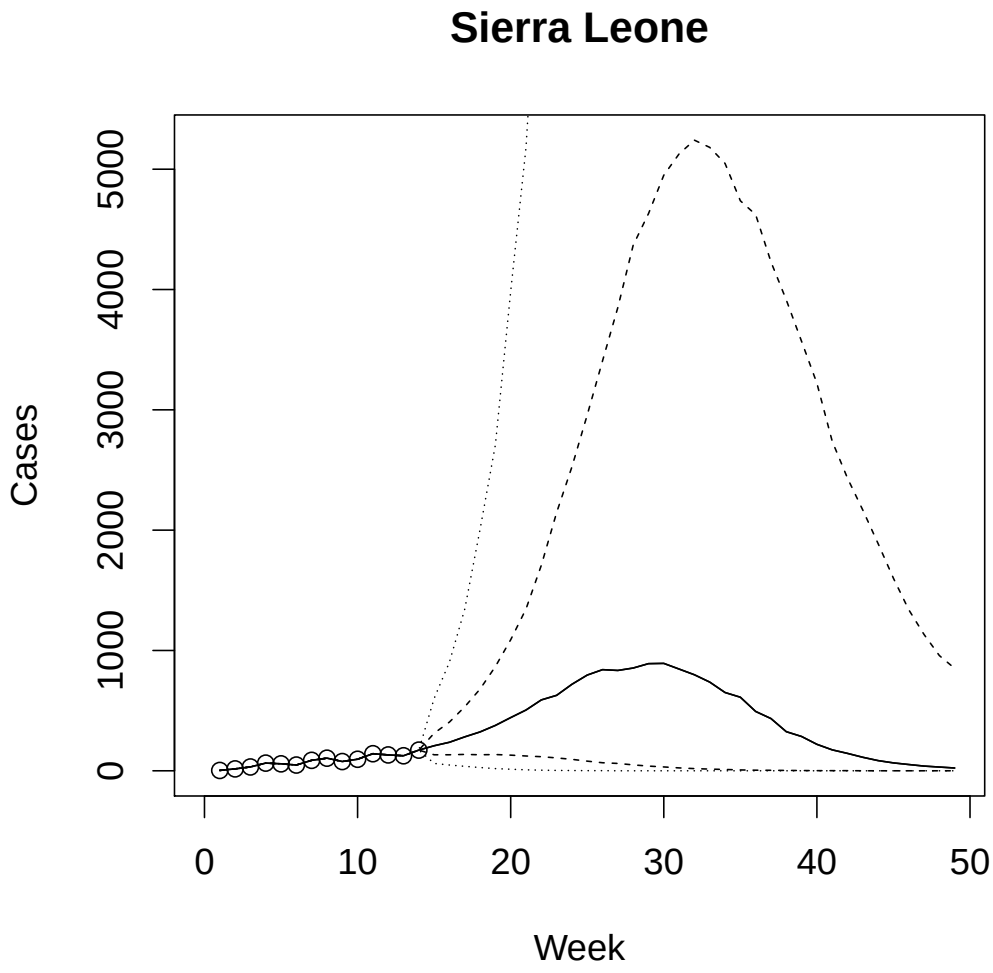

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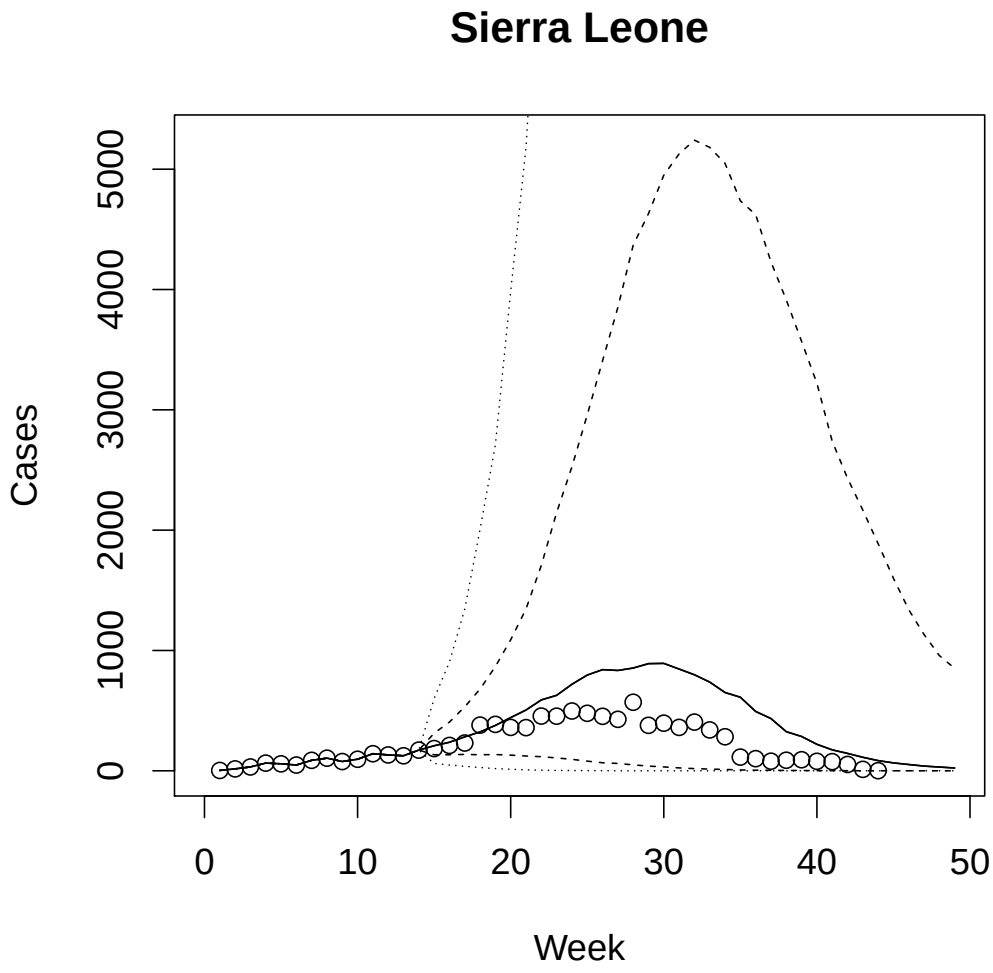

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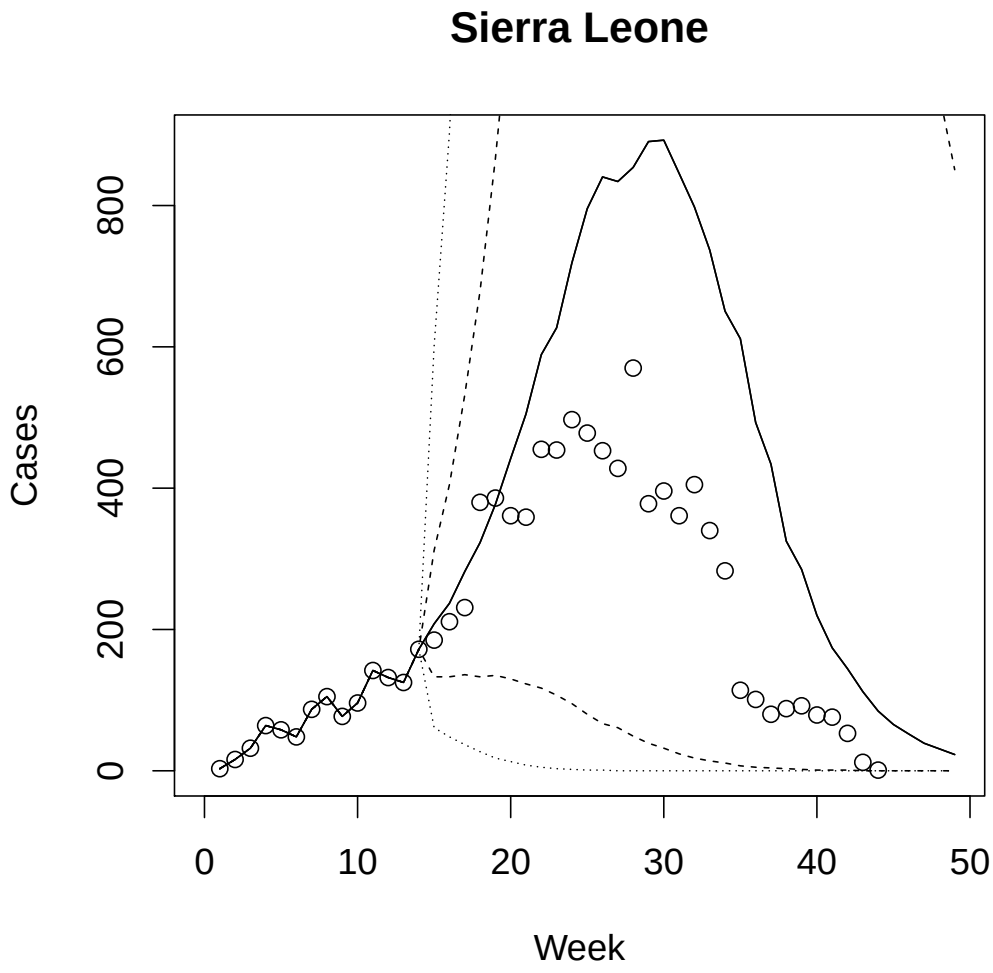


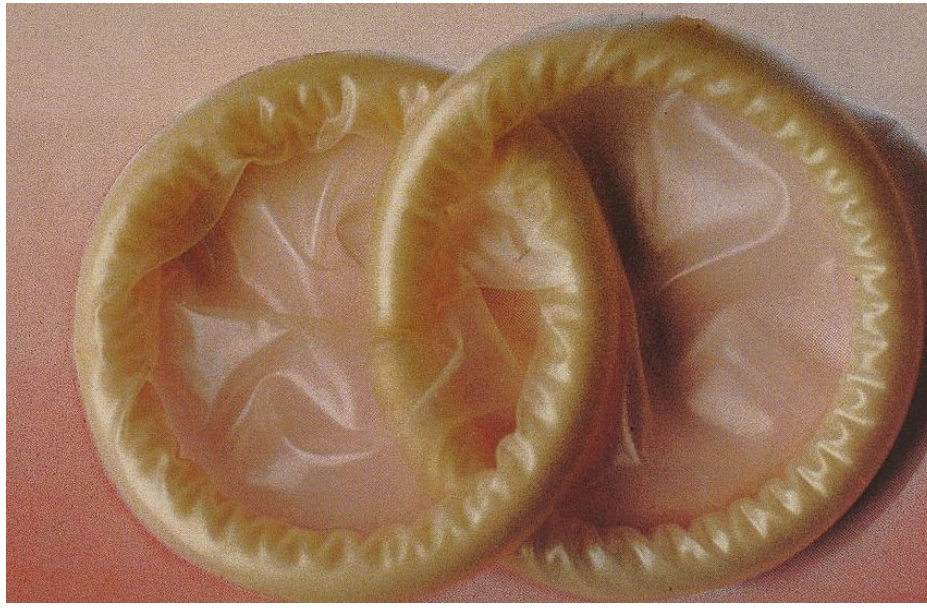
Reporting, response and behaviour

- What are the factors that contribute to uncertainty?
- What do we need to
  - *measure*
  - *model*
- to reduce uncertainty?

Reporting process

- How does case ascertainment and communication change as a disease spreads?
- How do these changes affect the public?

Behaviour change



Behaviour change

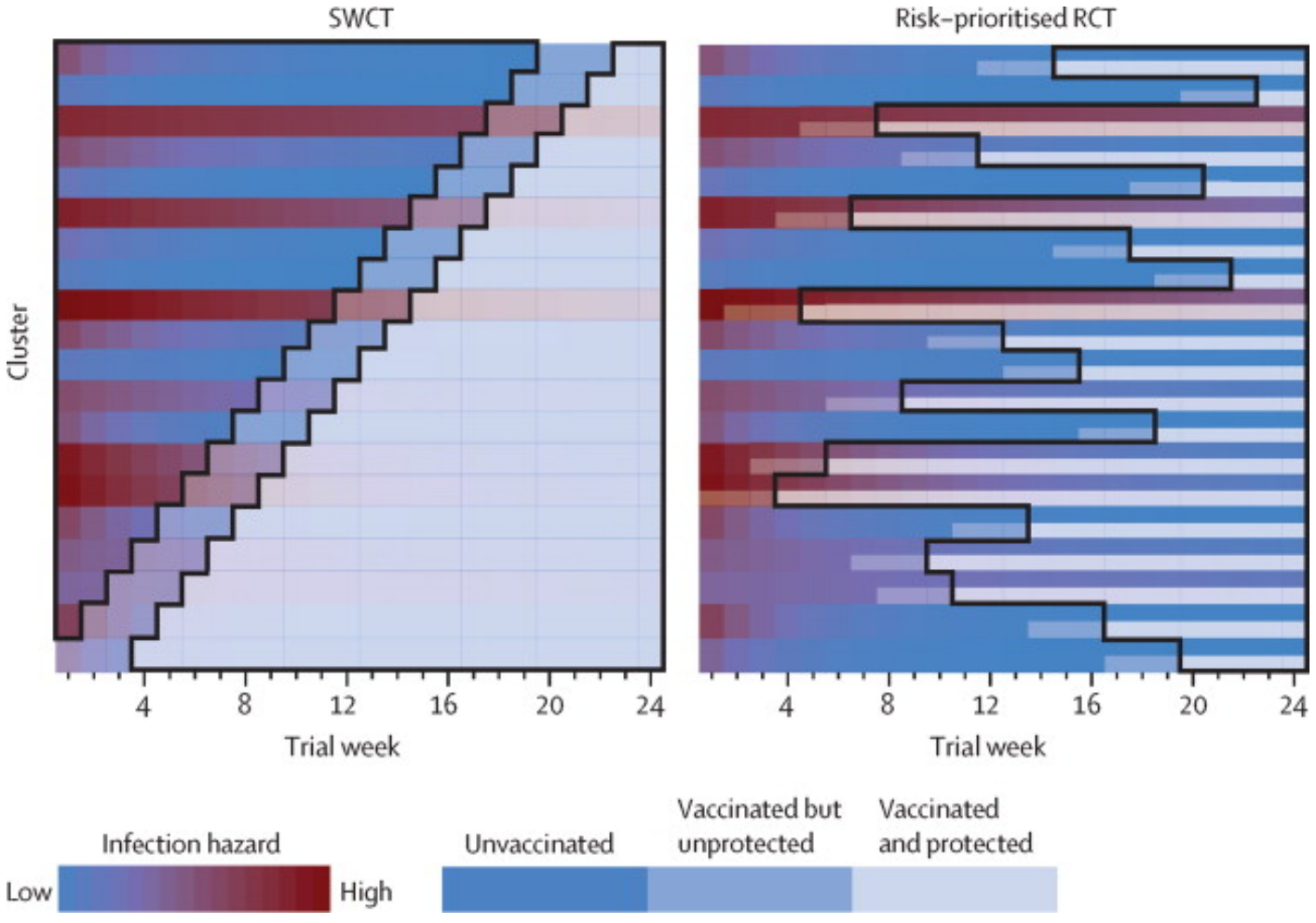
- How do we measure behaviour change?
- How do we predict behaviour change?

Tools and pipelines

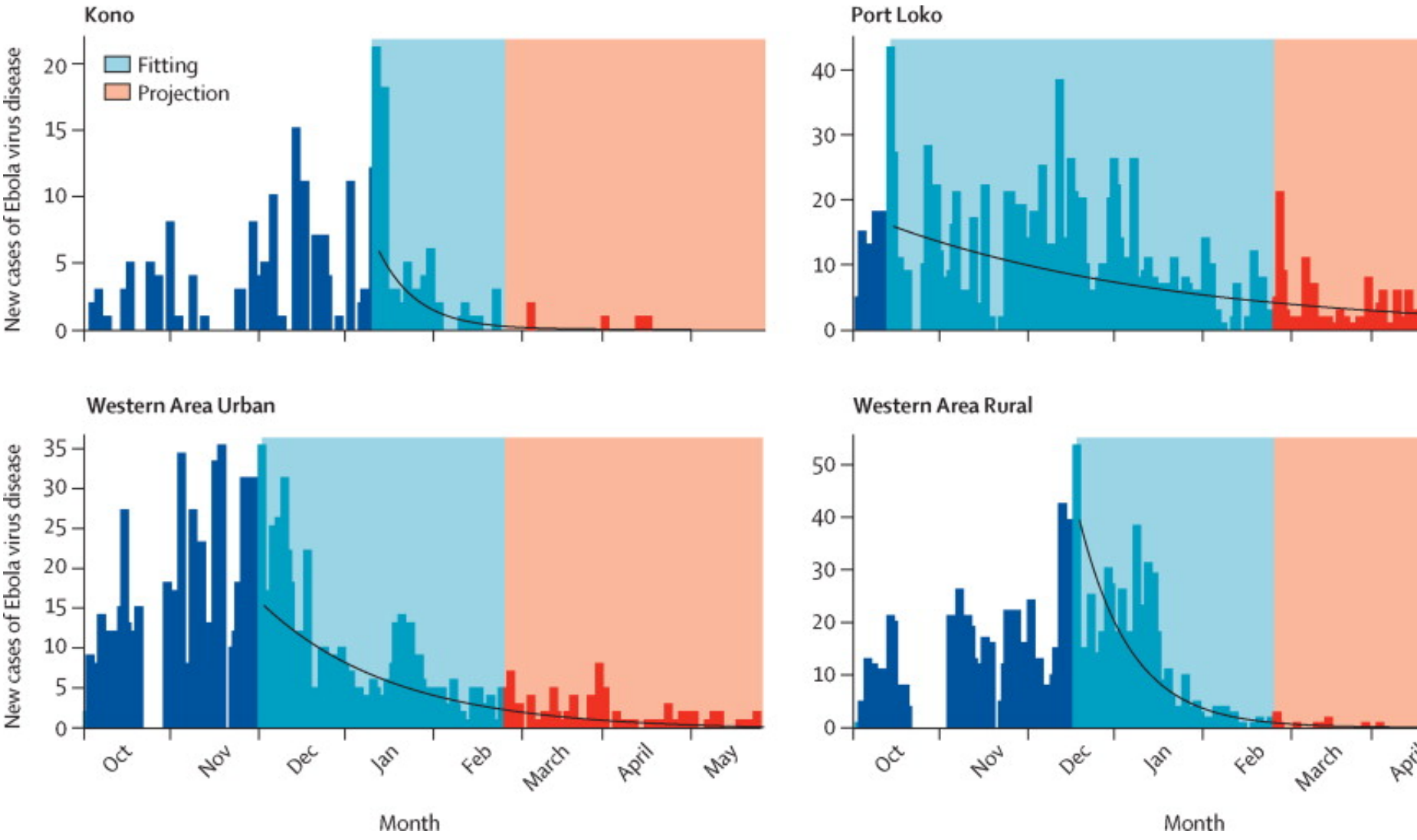
Tools and pipelines

- Reproducible
- Pipelined
- Documented
- Open source

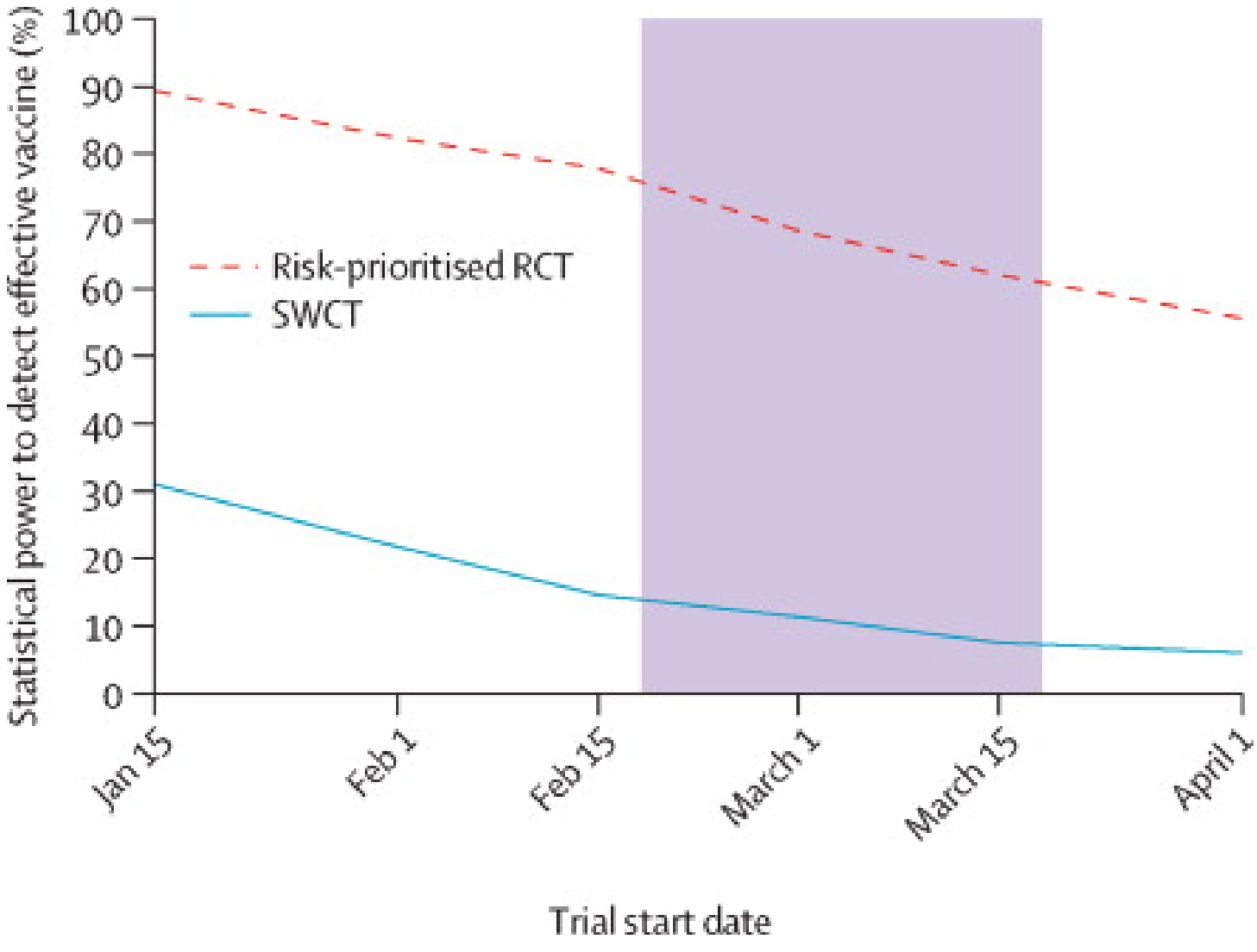
Vaccination trials: ethics and practice



Vaccine trials



Vaccine trials



Thanks

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- Audience
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- Funders: CIHR, NSERC