Introduction to Simulation Modeling

Highlights and Discussion

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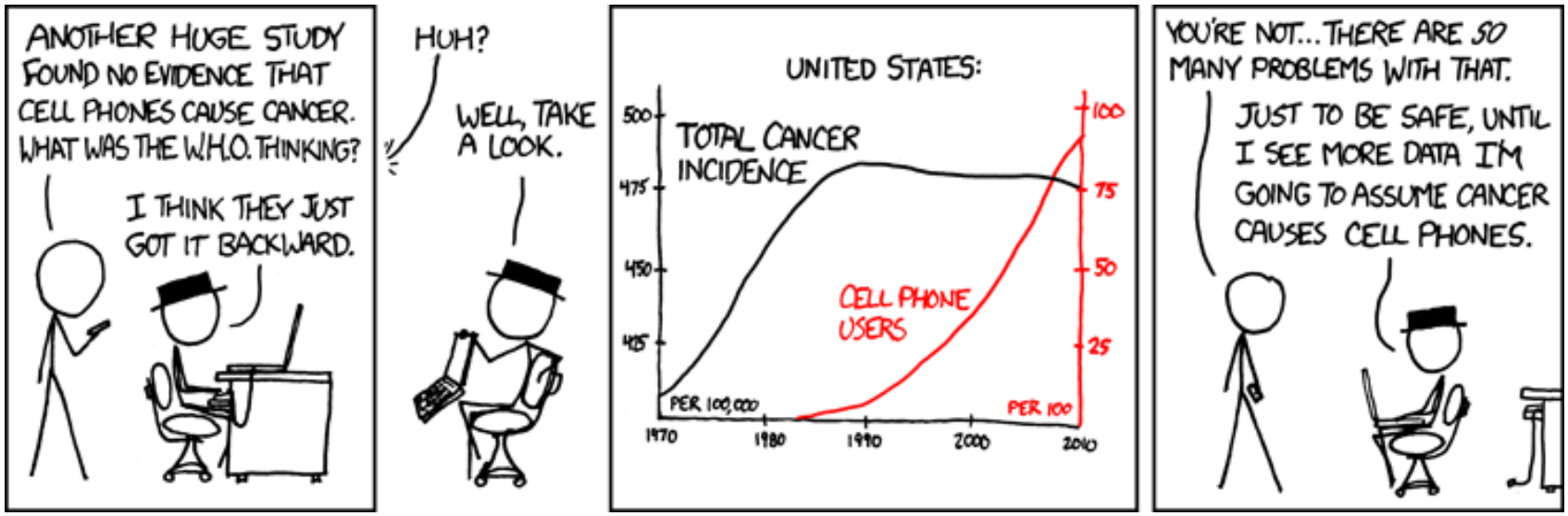
Introduction

- This lecture is a very short introduction to within-host simulation modeling.
- More information and details are in the previously recorded lectures and the readings on the SMI website.
- We'll have a Q&A/Discussion at the end. Also use Slack for any questions/thoughts/feedback.

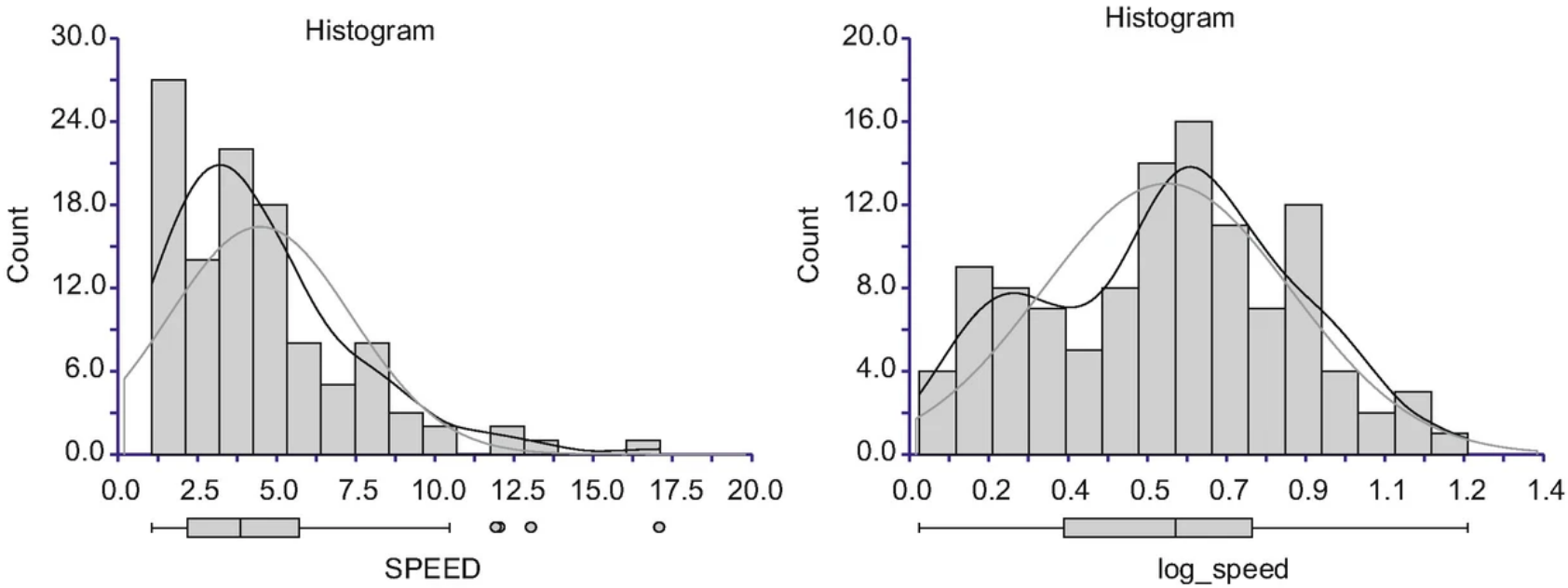
Phenomenological/non-mechanistic/(statistical) models

- Examples: t-test, linear/logistic regression model, deep neural network
- Always applied to data
- Are sometimes causal
- Do not describe mechanisms underlying the system of study



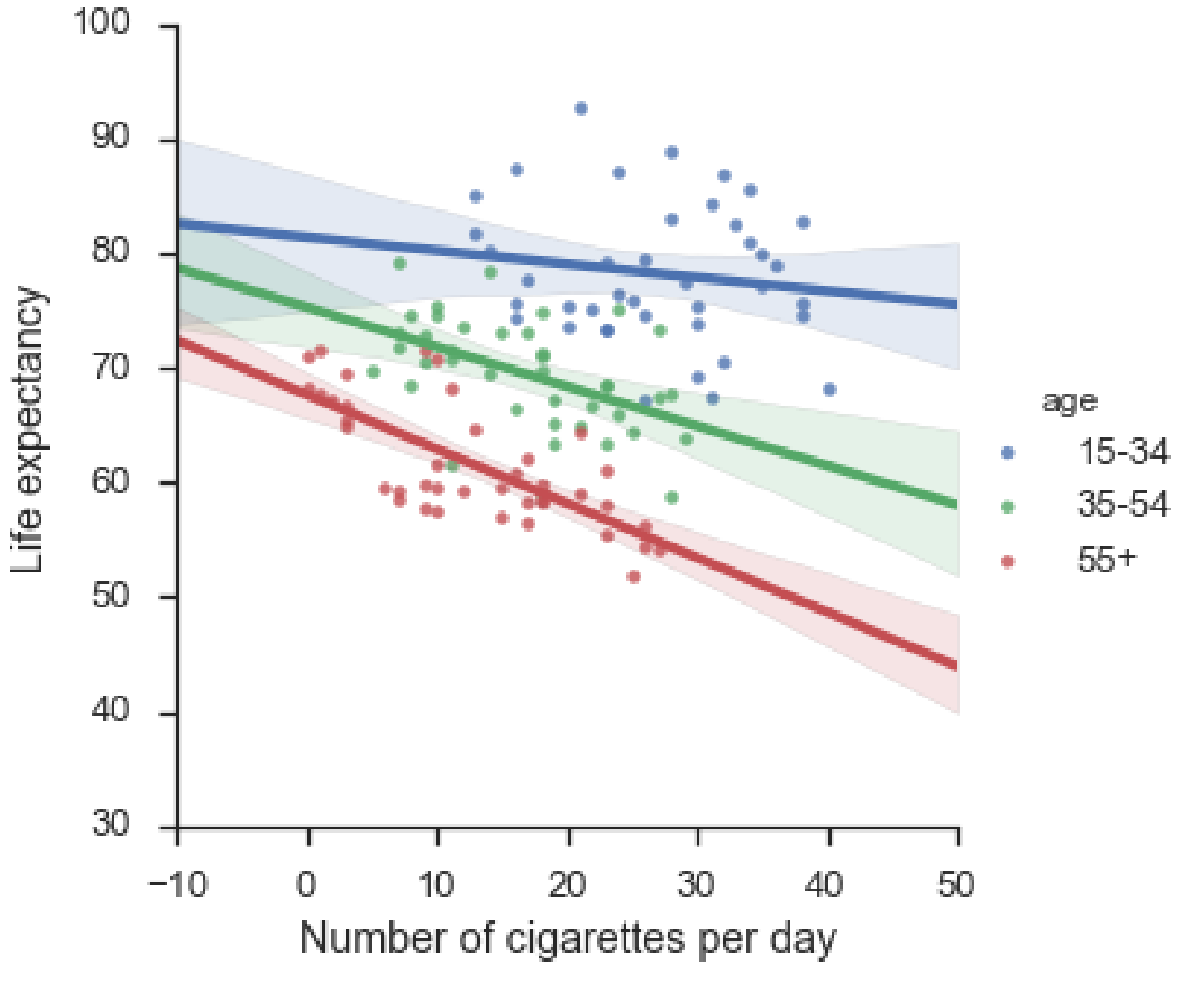
Source: xkcd.com

Descriptive Analysis



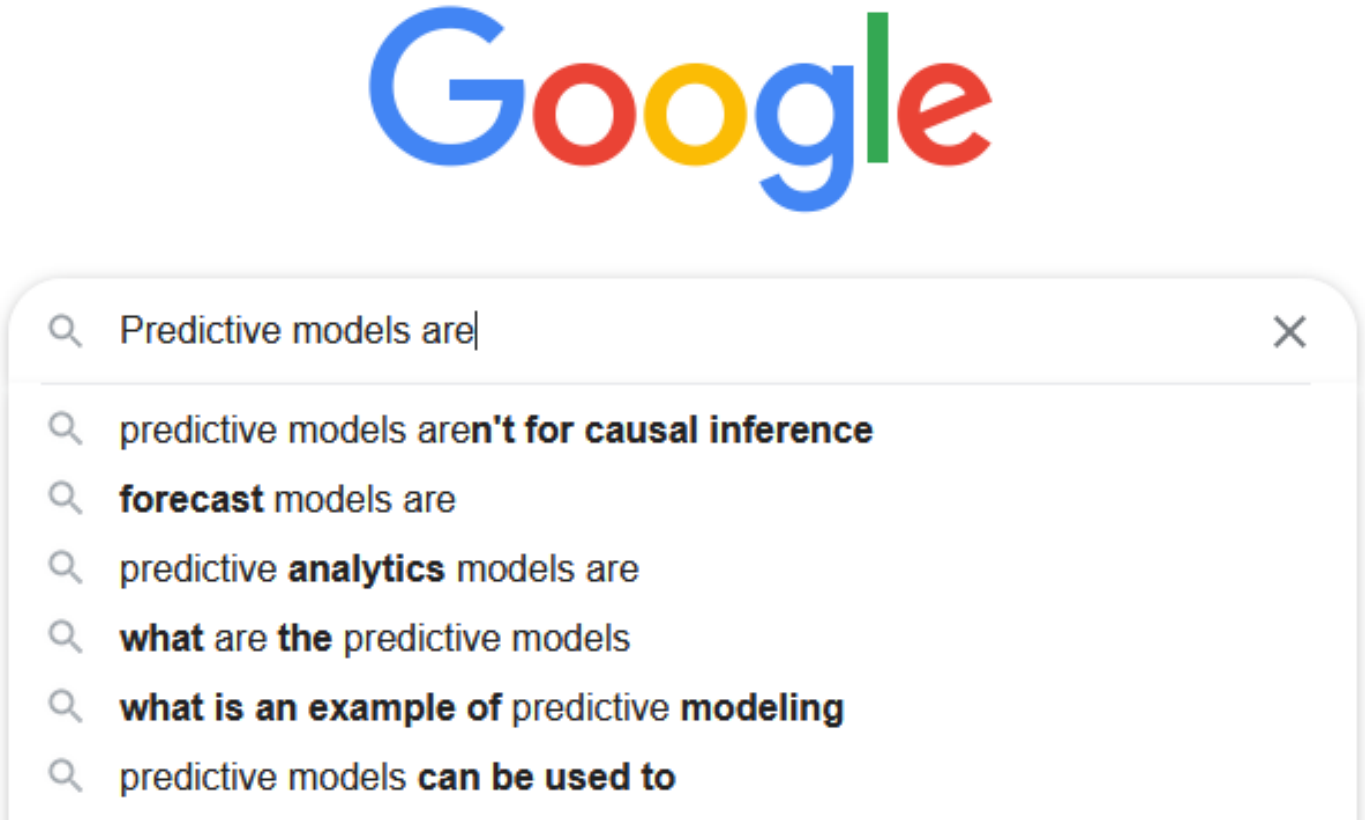
Source: Cooksey 2020 “Illustrating Statistical Procedures: Finding Meaning in Quantitative Data”

Inference



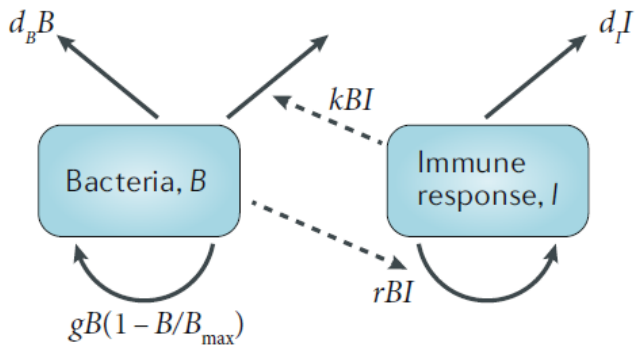
Not real data. See here for details.

Prediction


Google
Predictive models are
predictive models aren't for causal inference
forecast models are
predictive analytics models are
what are the predictive models
what is an example of predictive modeling
predictive models can be used to

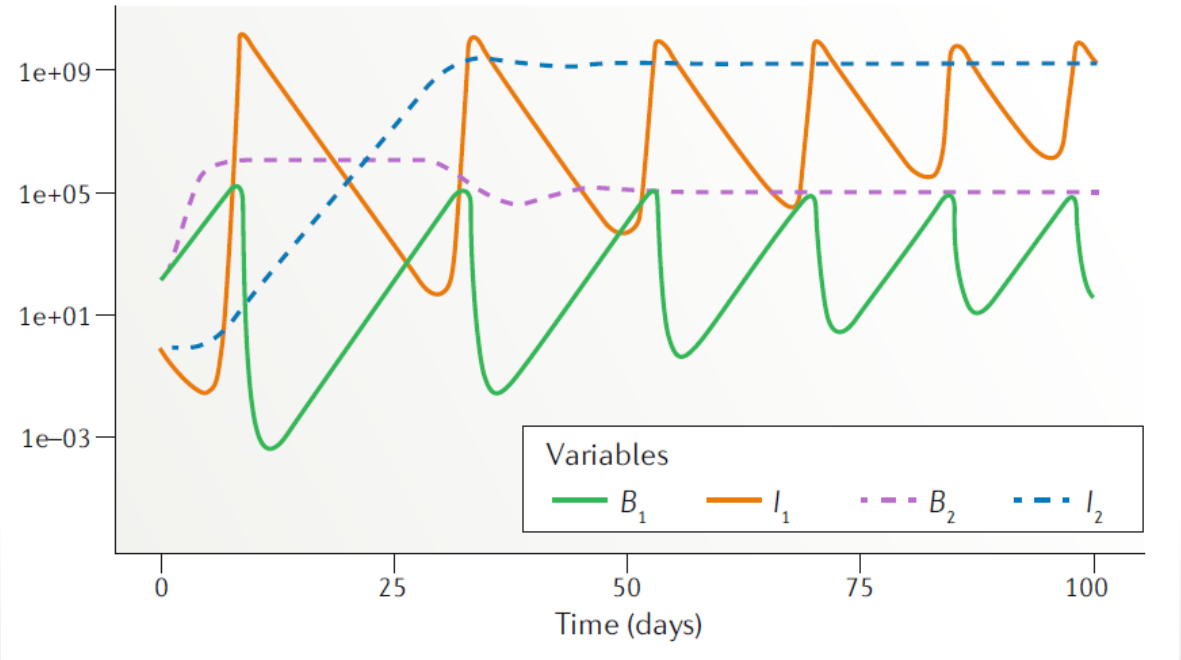
Mechanistic/simulation models

- Include mechanisms
- Are always causal
- Usually have a time/dynamic component
- Can be used with or without data



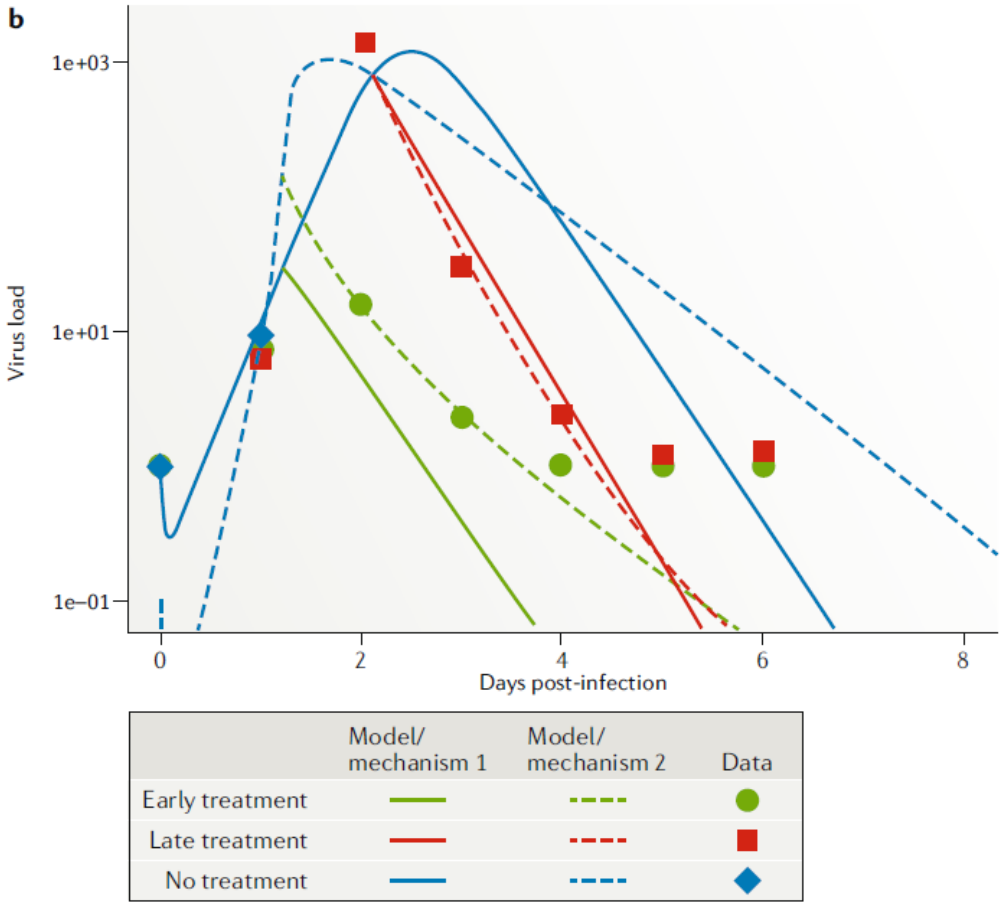
Bacteria $\dot{B} = gB(1 - \frac{B}{B_{max}}) - d_B B - kBI$

Immune response $\dot{I} = rBI - d_I I$



Inference

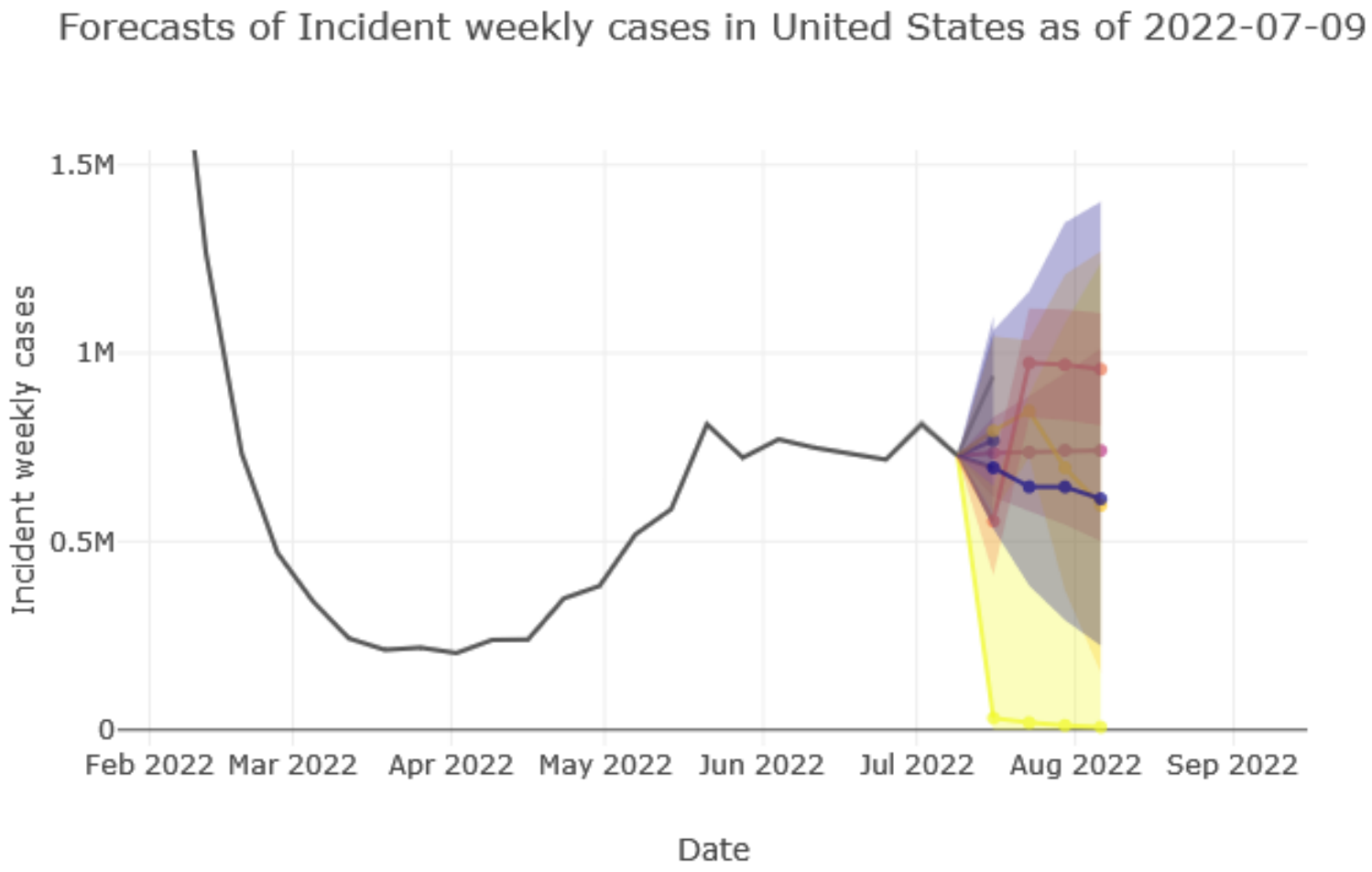
$$\dot{U} = -b(1-e_1)UV$$
$$\dot{I} = bUV - d_I I$$
$$\dot{V} = p(1-e_2)I - d_V V - gb(1-e_1)UV$$



Source: *Simulation modelling for immunologists*

Prediction

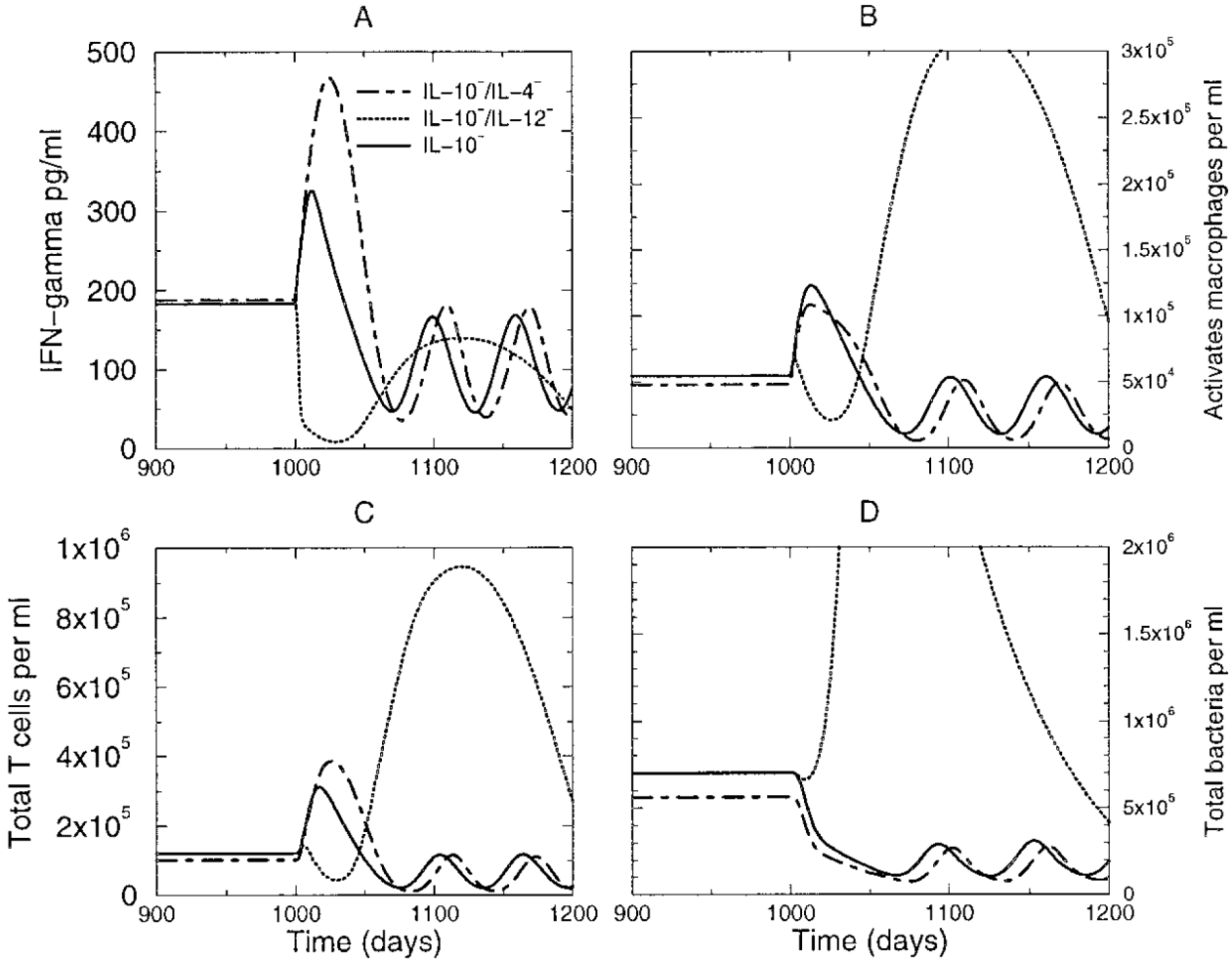
Also sometimes called forecasting



https://covid19forecasthub.org/

Causal exploration

Also called what-if explorations



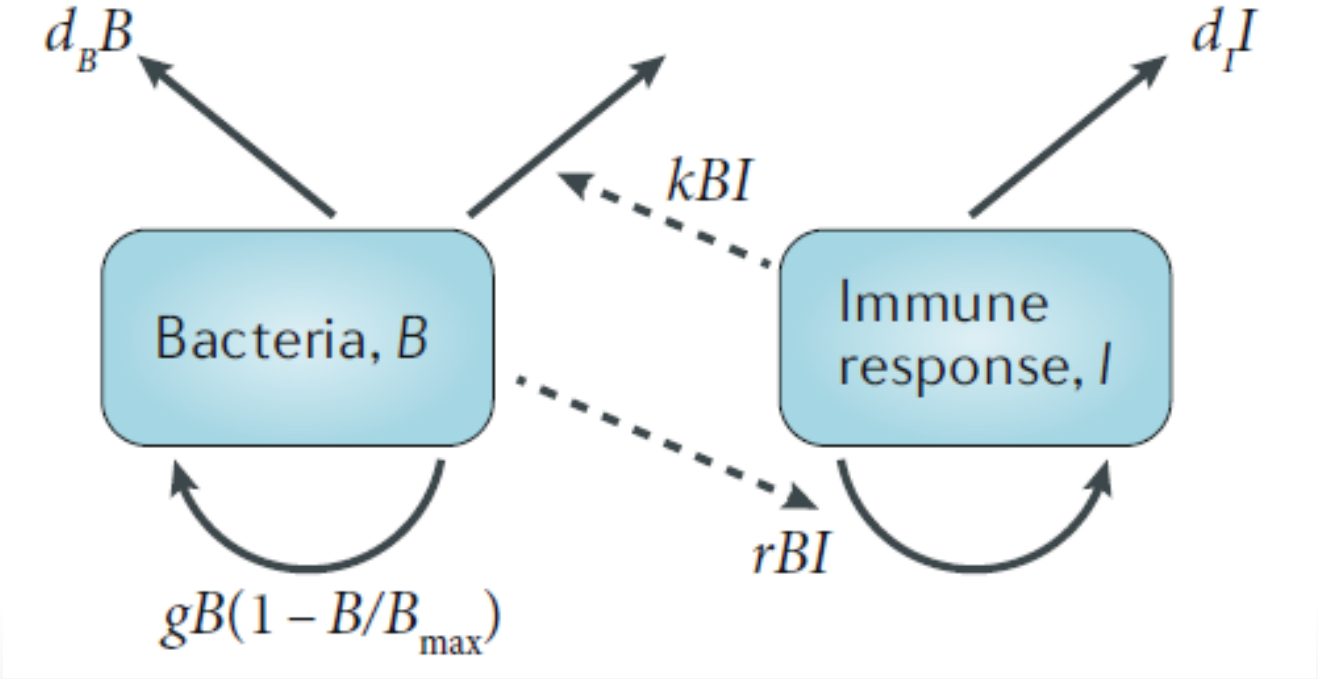
Exploring/predicting cytokine-based interventions for TB (Wigginton and Kirschner, 2001 J Imm)

Our models

- Compartmental models (tracking total numbers of different types/compartments)
- Ordinary differential (or difference) equations

$$\text{Bacteria} \qquad \dot{B} = gB(1 - \frac{B}{B_{max}}) - d_B B - kBI$$

$$\text{Immune Response} \qquad \dot{I} = rBI - d_I I$$



Our topics

- We will explore/play with a few simple models.
- We will do some activities that do not involve writing code, we'll also at the end of the course look at and modify some code.
- We unfortunately can't cover fitting models to data, but see DSAIRM and ask questions.

Discussion, Q&A

- Type in Slack or Zoom Chat or just unmute yourself and ask.