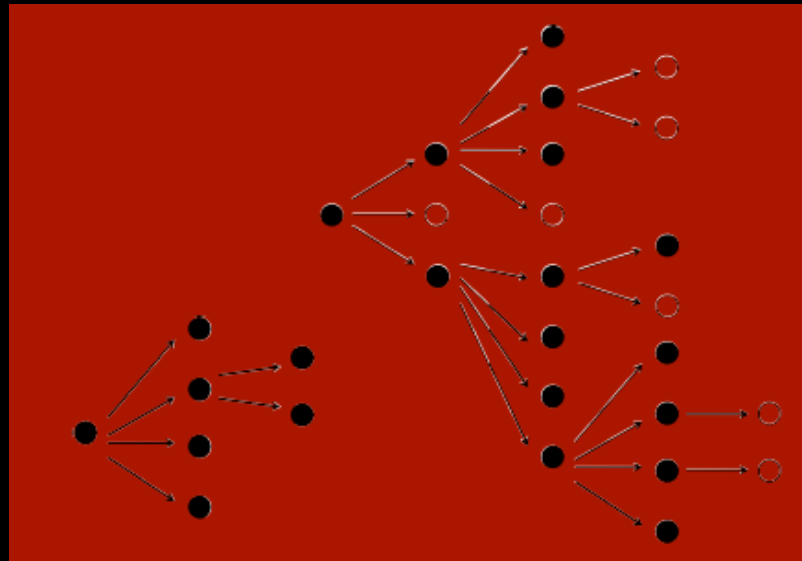


E²M²: Ecological and Epidemiological Modeling in Madagascar

Welcome!

What are we doing here?



January 13 – January 22, 2016

Centre ValBio

Ranomafana National Park, Madagascar

Thanks to our sponsors!



ICI3D: International Clinics on Infectious Disease, Dynamics, and Data

<http://www.ici3d.org/>

MMED: *Clinic on the Meaningful Modeling of Epidemiological Data*

May-June 2018, Cape Town,
South Africa



DAIDD: *Clinic on Dynamical Approaches to Infectious Disease Data*

December 2018, Florida, USA



ICI3D: International Clinics on Infectious Disease, Dynamics, and Data

**South African Center for
Epidemiological Modeling
and Analysis (SACEMA),
Director**

Dr. Juliet Pulliam

University of Stellenbosch



ICI3D, Program Director

Dr. Steve Bellan

University of Georgia

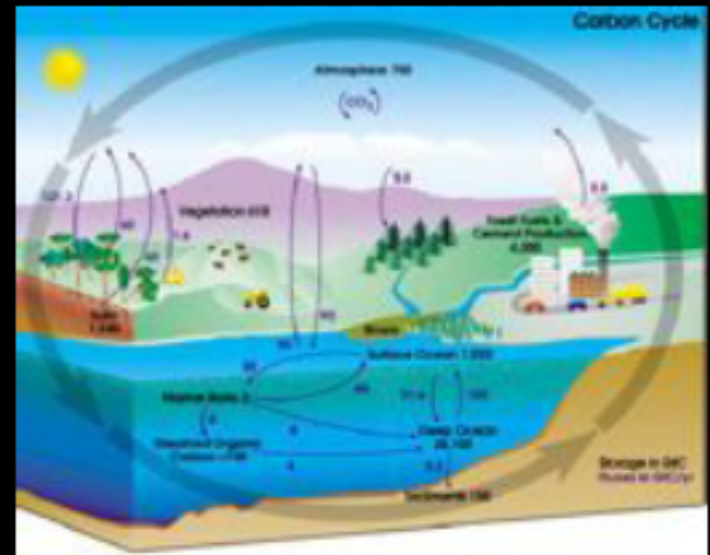


Types of Models

- Physical



- Conceptual



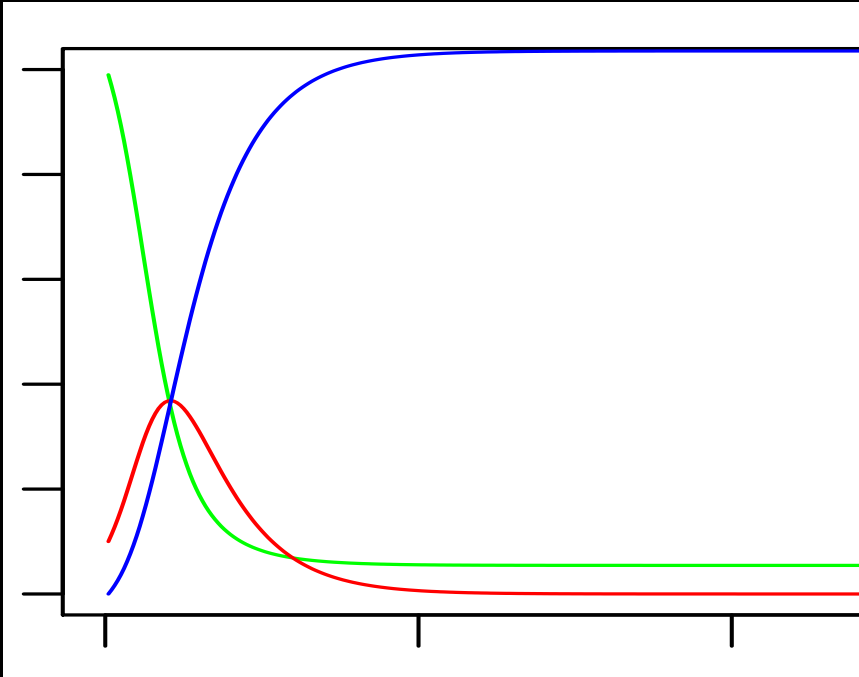
- Mathematical



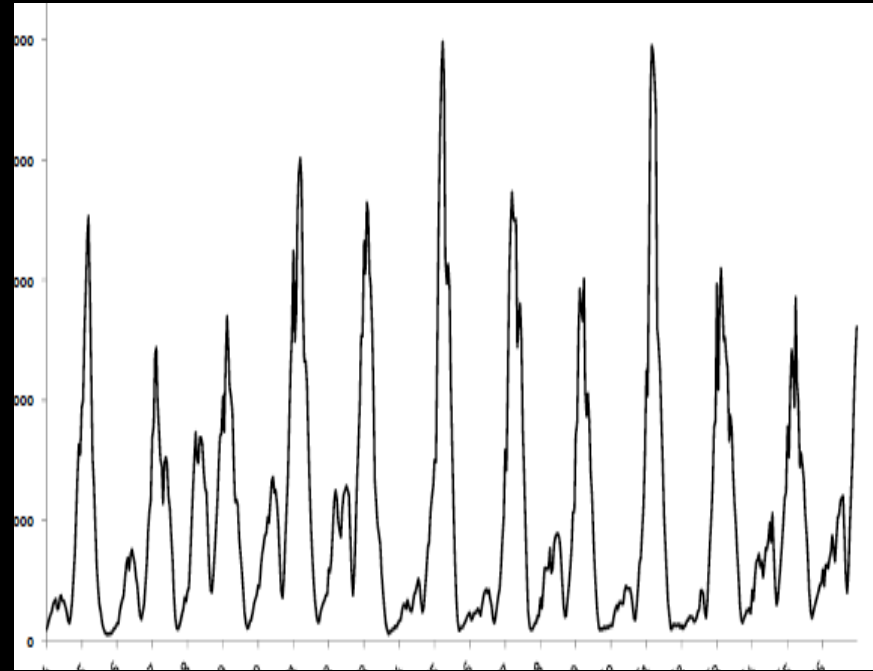
$$\frac{\partial}{\partial a} \ln f_{a, \sigma^2}(\xi_1) = \frac{(\xi_1 - a)}{\sigma^2} f_{a, \sigma^2}(\xi_1) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left(-\frac{(\xi_1 - a)^2}{2\sigma^2}\right)$$

$$\int T(x) \cdot \frac{\partial}{\partial \theta} f(x, \theta) dx = M\left(T(\xi) \cdot \frac{\partial}{\partial \theta} \ln L(\xi, \theta)\right) \int \frac{\partial}{\partial \theta} f(x, \theta) dx$$

Generally, the idea of the **model** is to recapitulate the **data**



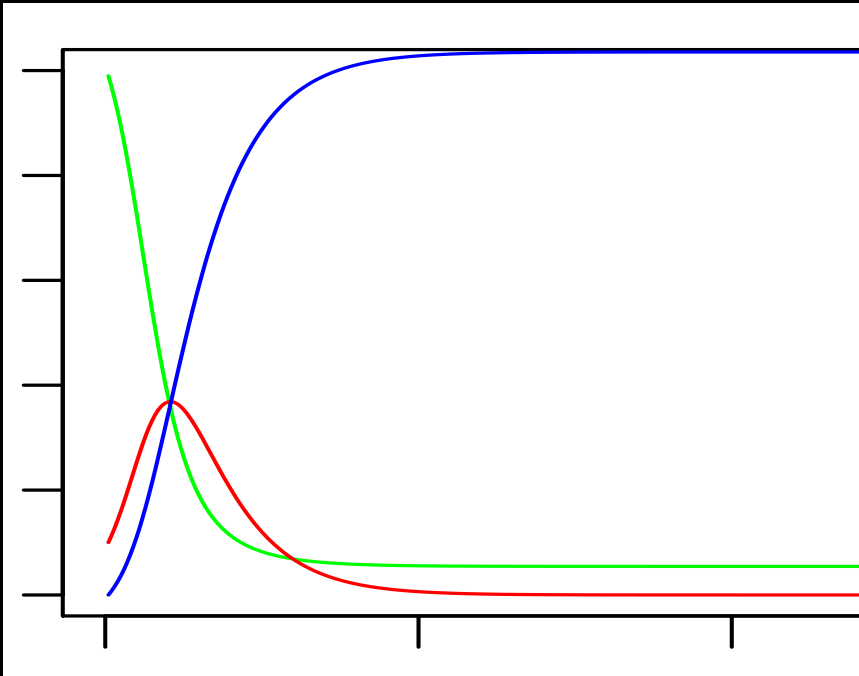
Models



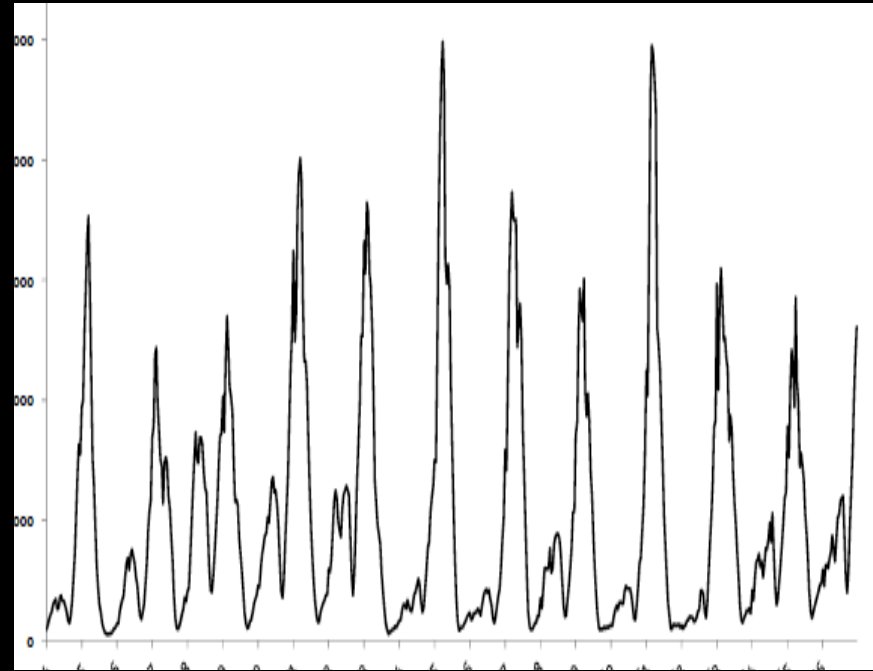
Data

Generally, the idea of the **model** is to recapitulate the **data**

But, sometimes, **data** are complex!



Models



Data

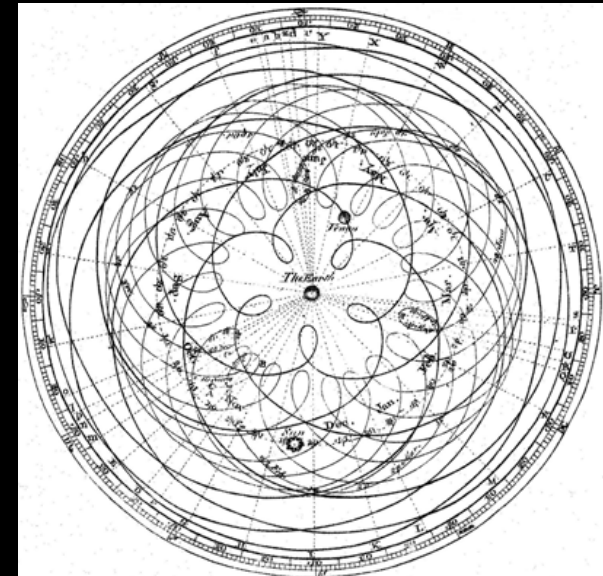
Claudius Ptolemy, AD 90-168



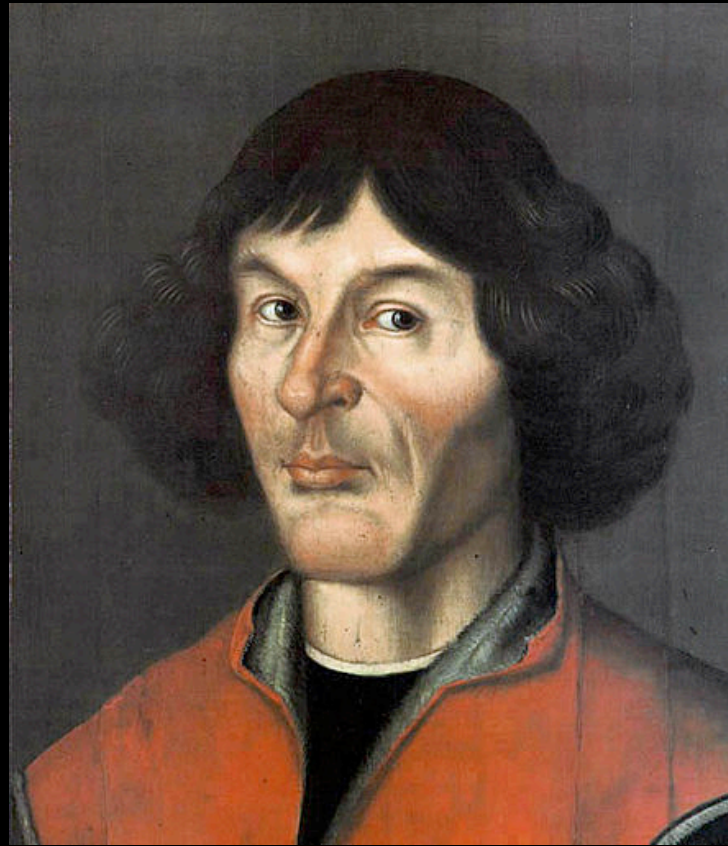
Model:

All planets and moons in the solar system cycle around the Earth (“epicycles”)

Forged **data** to support his model!



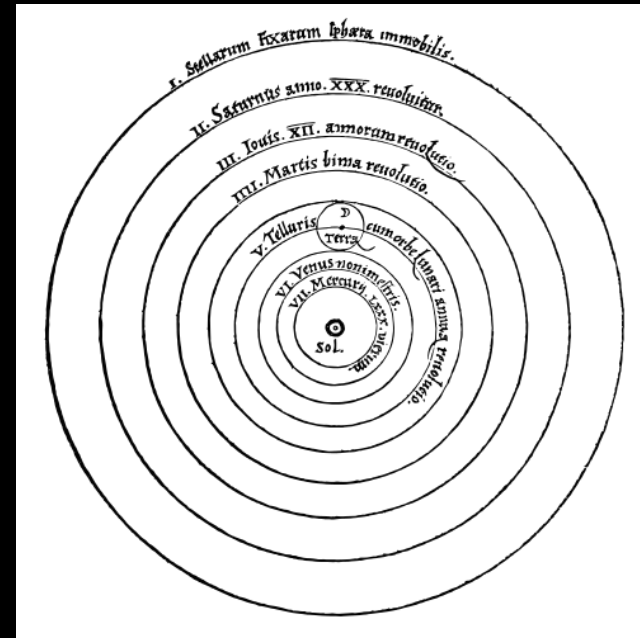
Nicolaus Copernicus, 1473-1543



Model:

All celestial bodies orbit the sun.

*But he didn't have any **data**!*

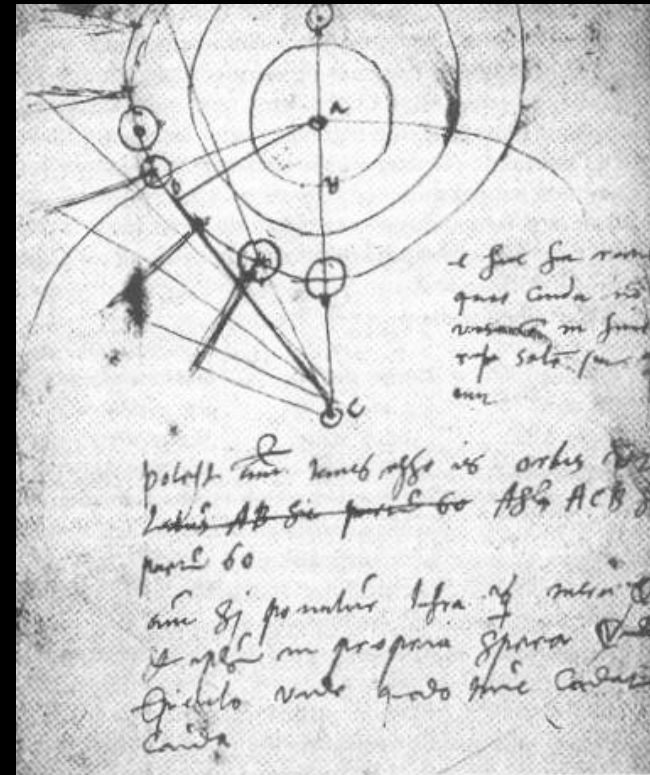


Tycho Brahe, 1546-1601



Collected very a large amount of precise data but still remained loyal to the Ptolemaic model.

Compromised -
Adapted Model:
The sun and the moon orbit the Earth but everything else orbits the sun



Johannes Kepler, 1571-1630



Used Brahe's data to fit Copernicus' model

New Paradigm:
All celestial bodies orbit the sun.



Johannes Kepler, 1571-1630



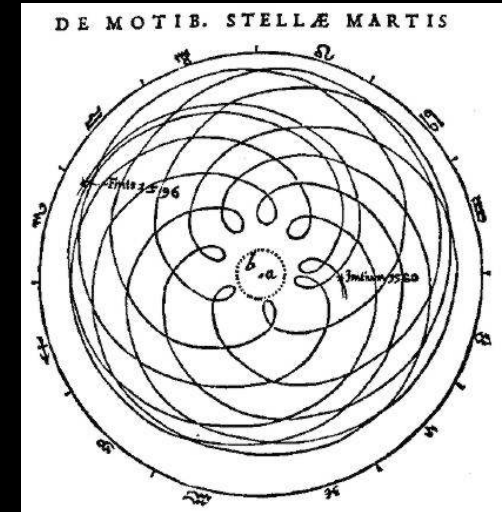
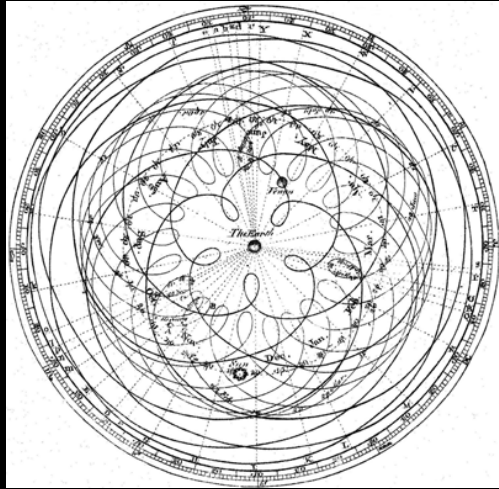
Used Brahe's data to fit Copernicus' model

New Paradigm:
All celestial bodies orbit the sun.

A model becomes paradigm when it is overwhelmingly accepted as fact.

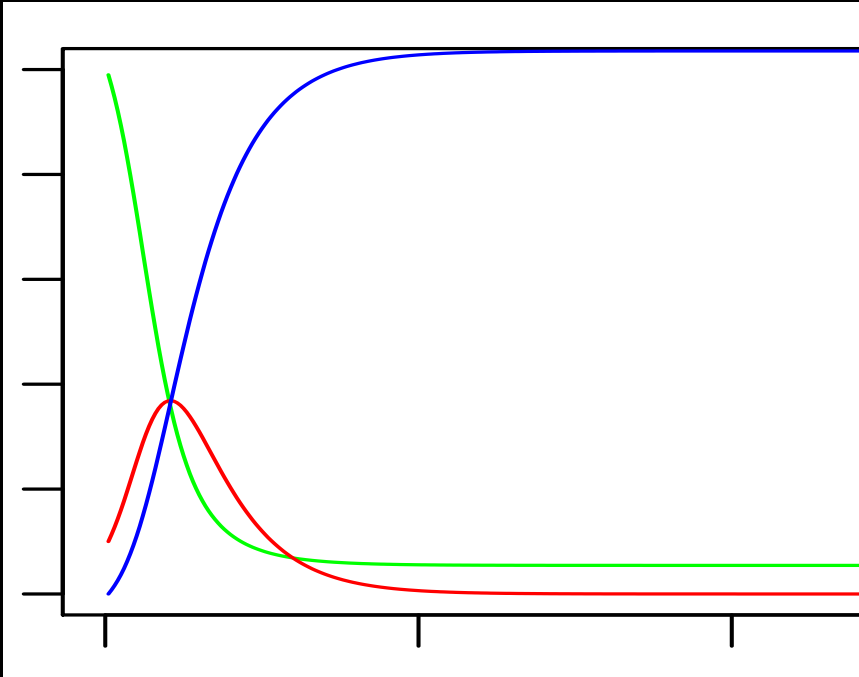


The Utility of Models

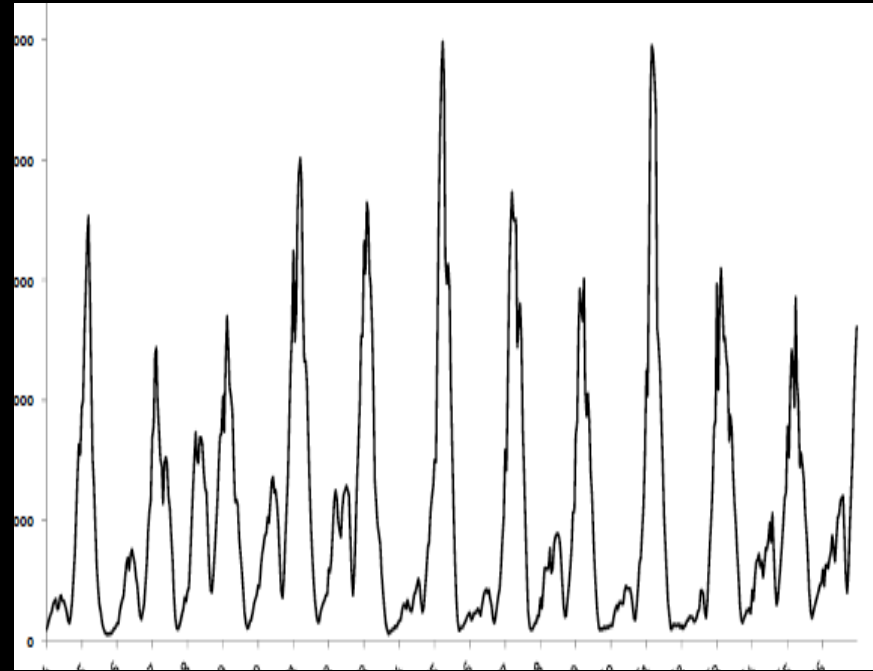


- “All models are wrong, but some are useful.”
– George Box
- We use models to **predict**, but also to **explain**.

If we can get the **model** to recapture the **data**,
then maybe the **model** can help explain what's
going on in the **data**

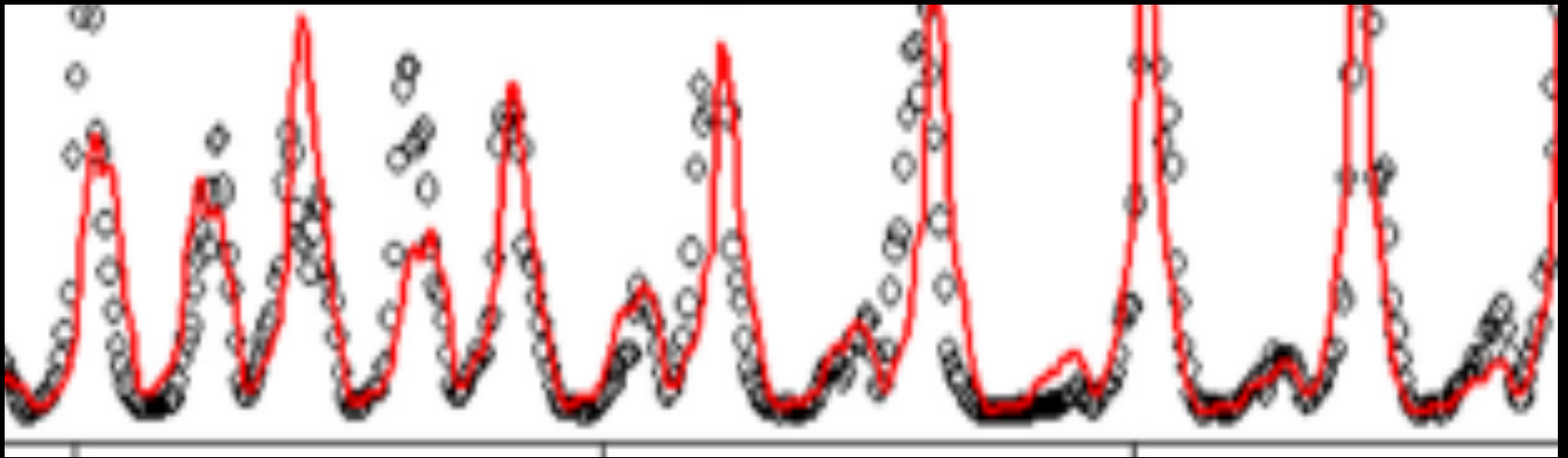


Models



Data

If we can get the **model** to recapture the **data**,
then maybe the **model** can help explain what's
going on in the **data**



Model Fitted to Data

Road Map

schedule and materials live at:

<https://carabrook.github.io/E2M2.html>

Road Map

- Lectures
- Tutorials/Activities
- Independent Work

Sunday: “Thinking About Data”

- Models and Data
- Linear regression & simple stats
- Exploring and Visualizing Data in R
- Basic statistical modeling in R
- Student introductions & presentations

Monday: “Deeper Thinking About Data”

- Intro to Mixed Modeling
- Intro to Occupancy Modeling
- Mixed modeling in R
- Occupancy modeling in R
- Formulating research questions

Wednesday: “Fitting Models to Data”

- Model Fitting in Practice – the Basic Concept
- Alternative Approaches to Model Fitting
- Epidemic Cards
- Model Fitting with Epidemic Cards
- Model Telephone

Tuesday: “Thinking About Mechanism”

- Intro to Compartmental Models & Differential Equations
- Building mechanistic models in R
- Dynamical Fever
- Refining research questions for modeling
- Defining a model world

Thursday: “Refining Your Work”

- Modeling Extensions: Metapopulation Theory, Including Heterogeneity, etc.
- Intro to Network Modeling
- Intro to Spatial Modeling
- Intro to Network Modeling
- Spatial Modeling & Statistics in R
- Final research plans

Friday: “Putting it All in Perspective”

- Model Evaluation and Comparison
- Modeling in Practice: The Lifecycle of a Modeling Project
- Model Selection with Age-Prevalence Data
- Research plan work time

Monday: “Sharing Your Work”

- Final student presentations