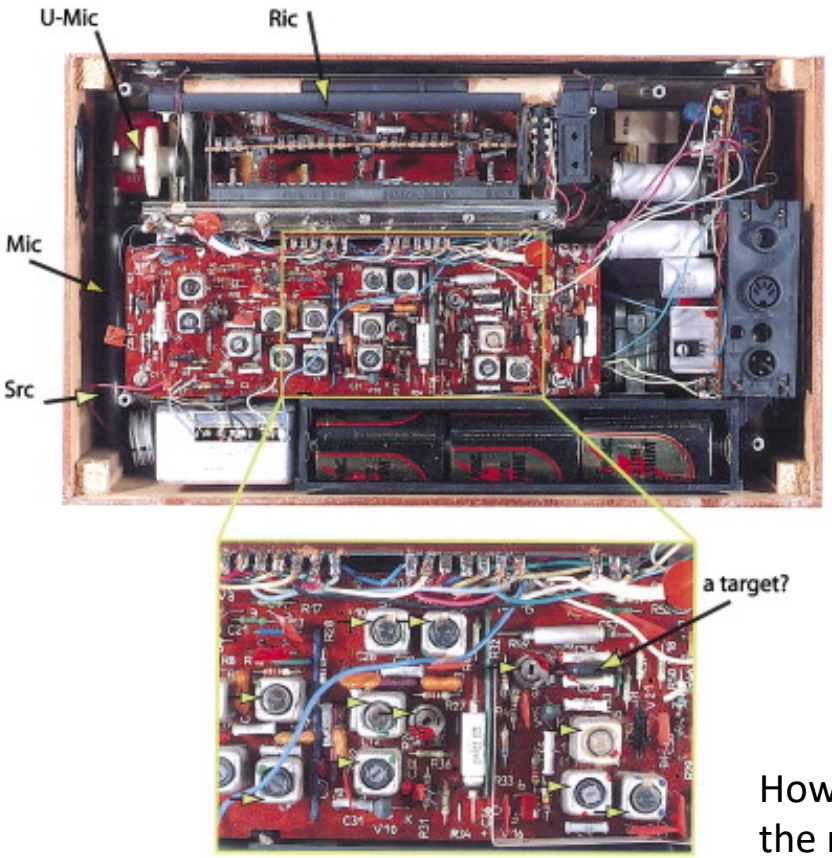
Introduction to mathematical modelling with ODEs

Prof Chris Barnes
Dept of Cell and Developmental Biology
UCL
christopher.barnes@ucl.ac.uk
@cssb_lab

Can a biologist fix a radio?

Lazebnik, Cancer Cell, 2002



Serendipitously Recovered Component (Src)

Most Important Component (Mic)

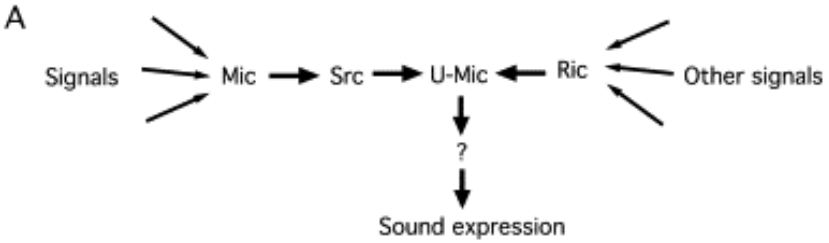
Really Important Component (Ric)

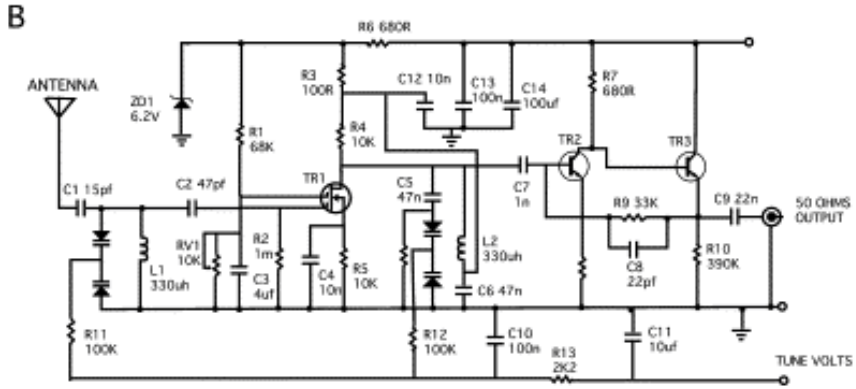
Can the information that we accumulated help us to repair the radio?
Sometimes….

However, if the defect is in the tunable components, the radio may not work because several components are not tuned properly, which is not reflected in their appearance or their connections.

Can a biologist fix a radio?

Lazebnik, Cancer Cell, 2002





Engineers can discuss the radio using terms that are understood unambiguously by the parties involved.

Once the number of components in a system reaches a certain threshold, understanding the system without formal analytical is impossible

Answer: Not without a formal language and the use of computational tools

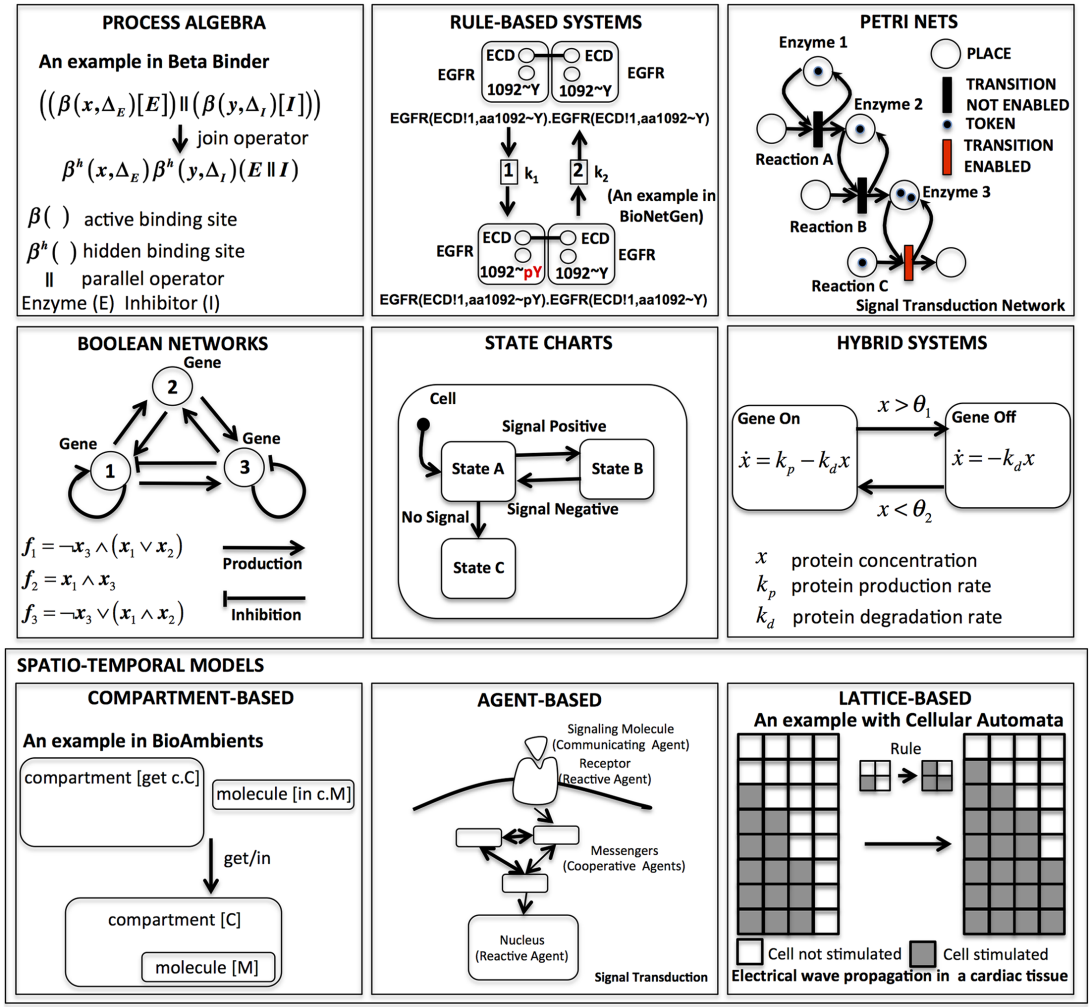
What is a model?

- A model is a simplified representation of reality that is complex enough to provide us with information on certain aspects of a system.

  - "All models are wrong, but some of them are useful" George Box.

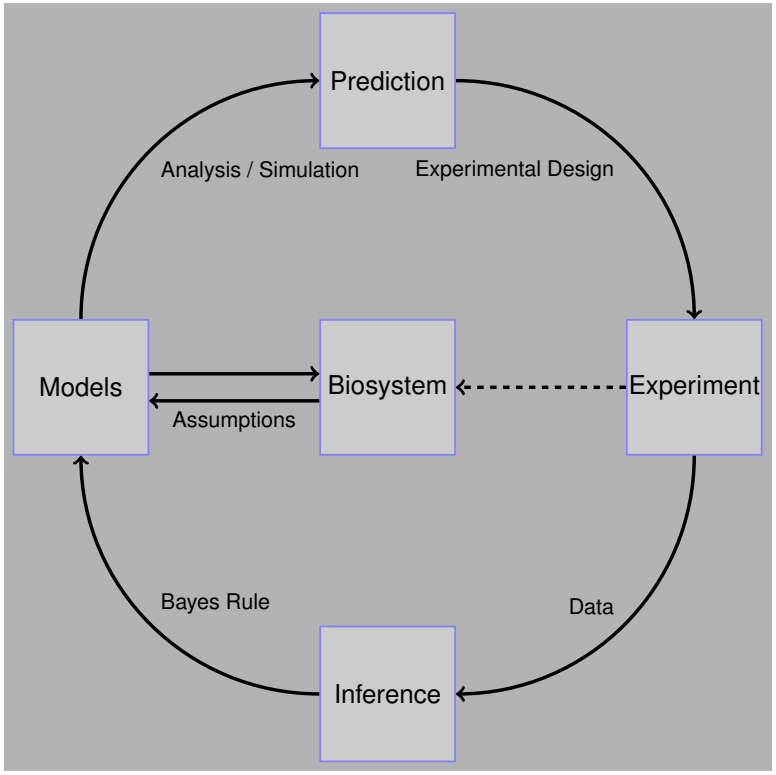
  - "Everything should be made as simple as possible, but no simpler" Albert Einstein.

Models in biology



Computational Modeling, Formal Analysis, and Tools for Systems Biology, Bartocci and Lio, PLoS Comp Biol 2016

Why are models useful?



- Models formalise our knowledge of the system

- They make predictions and can be modified in the light of
  - more data
  - change of assumptions

Overview

We will demonstrate the modelling of dynamical biological systems using differential equations.

1. Reactions
2. Dynamics
3. Connected systems
4. Gene regulation
5. Gene regulatory networks