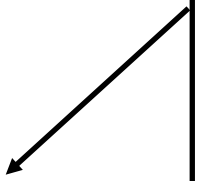
The Modeling Process – How do we develop a model ??

1. Produce model (ideas)
2. Implement (program)
3. Derive results (solve)
4. Evaluate model (compare)



Related to general approach in science – develop hypothesis then test (experiment)

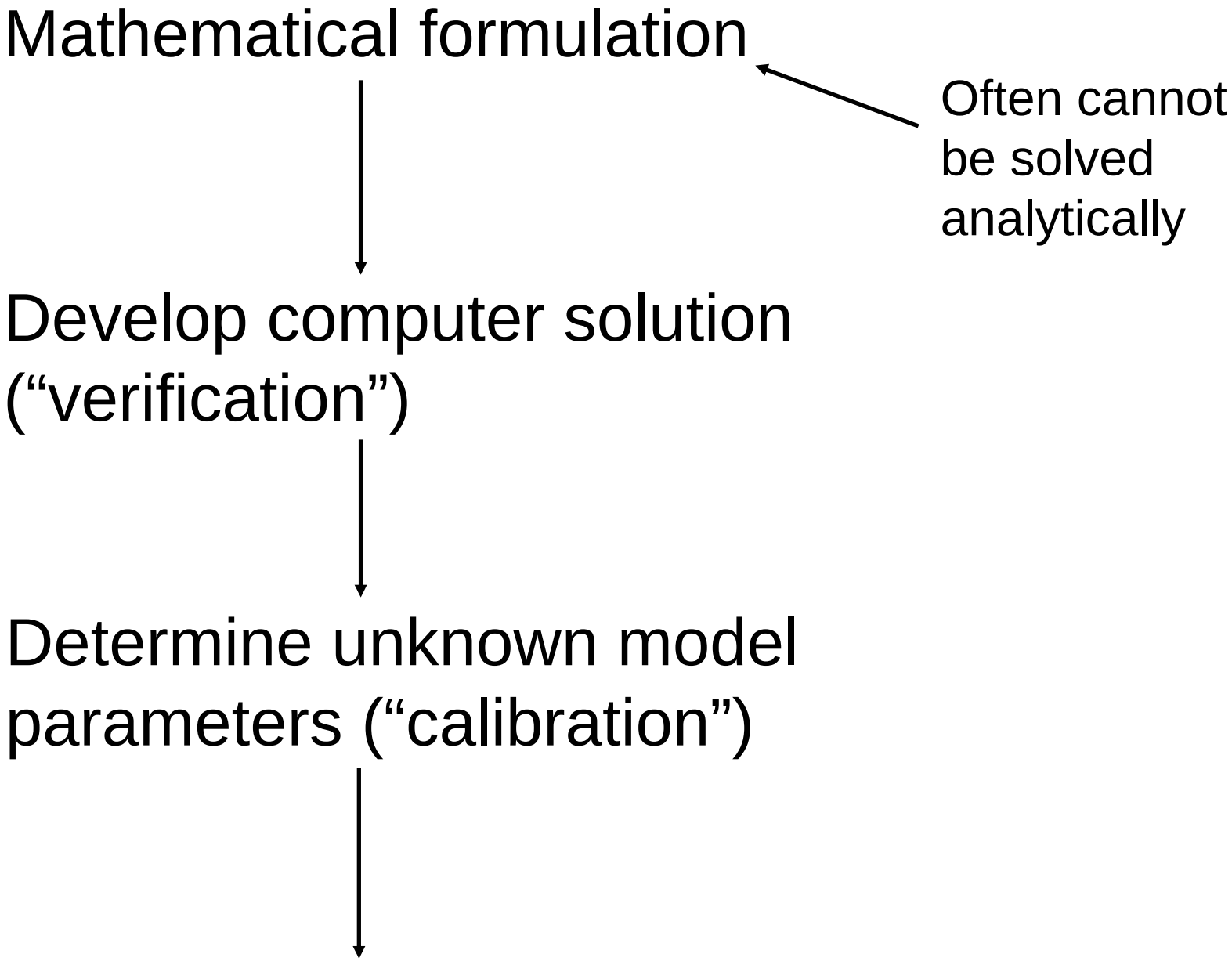
1) Classical modeling approach

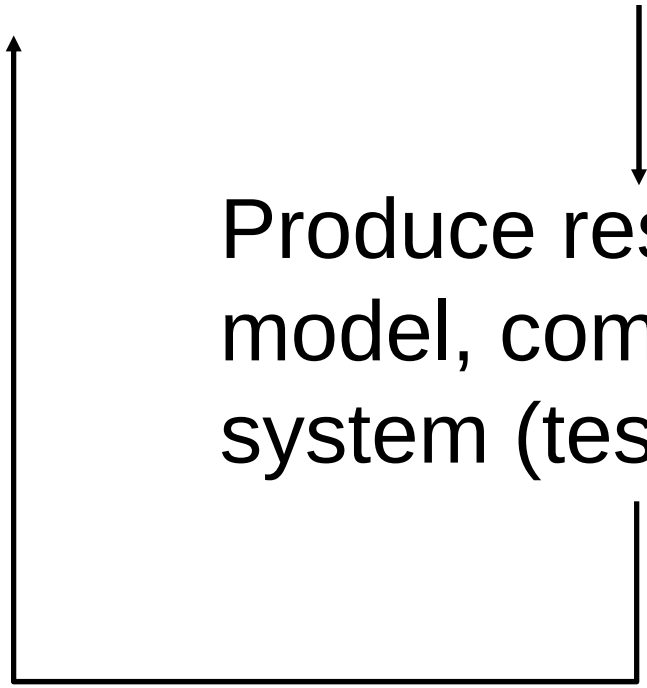
Model objectives

What is system being studied?
What are questions?
Purpose? How good?

Hypotheses

For a growing population, increasing pop size (density) eventually decreases the pop growth rate


Mathematical formulation
Often cannot be solved analytically
Develop computer solution ("verification")
Determine unknown model parameters ("calibration")



Repeat as needed !

2) Alternative approach

Develop multiple hypotheses, multiple models and compare.

For example, population models…

Population models

Simple model assumptions

- Growth rate only determined by population
- Sexual reproduction not considered
- Age not considered
- No spatial or geographic considerations

Basic general model of this form:

$$N_{t+1} = N_t + N_t f\left(N_t\right)$$

Two alternatives:

- Density independence – per capita reproduction not affected by N
- Density dependence – per capita reproduction affected by N

$$N_{t+1} = N_t + N_t f\left(N_t\right)$$

Density independent:

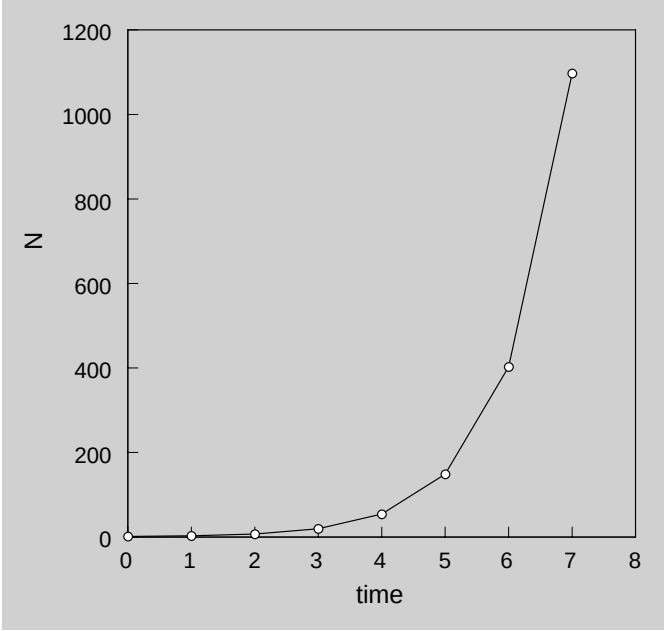
Lab 1 model

$$f\left(N_t\right) = r$$

$$N_{t+1} = N_t + rN_t$$

Growth rate increases without limit as pop increases

Good model ??



Density dependent model

$$f(N_t) = a - bN_t$$

r varies with N

$$a = r$$

$$b = \frac{r}{K}$$

$$N_{t+1} = N_t + N_t\left\{r - \left(\frac{r}{K}\right)N_t\right\}$$

$$N_{t+1} = N_t + rN_t\left(1 - \frac{N_t}{K}\right)$$

What if pop is very small ?

$$N_t \ll K$$

Pop grows exponentially

What if pop near *K* ?

$$N_t = K$$

Pop stops growing

Questions for alternative models :

Which model would better “fit” a population when :

Population size (density) is small ?

Population size is large ?