Lecture #7: Parameter values and initialization of models

I. Parameter estimation [from Richardson and Pugh (1981)]

A. Necessary accuracy
   1. *If the policy implications of a model do not change when its parameters are varied plus or minus some percent, then from the modeler's point of view the parameters do not need to be estimated any more accurately than that.*

B. Kinds of parameters
   1. Measures
   2. Conversion factors
   3. Reference parameters
   4. Adjustment times
   5. Definitional parameters (possible category in all of the above)

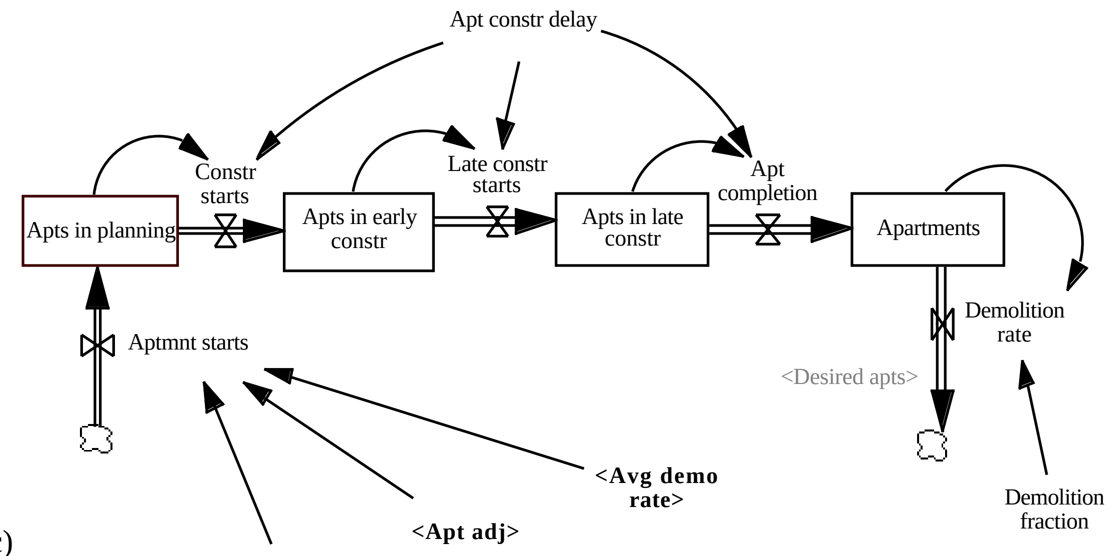
C. Kinds of parameters estimates
   1. In general, three ways:
      a) From firsthand knowledge of a process
      b) From data on individual relationships in a model
      c) From data on overall system behavior
   2. Measurements
   3. Conversion factors
   4. "Normal" or "Reference" parameters
   5. Adjustment times

D. Estimation techniques
   1. Establishing bounds
   2. Estimating from process (e.g., a birth rate fraction): the preferred option
   3. Estimating from behavior (e.g., from doubling time of exponential growth)
   4. Statistical estimation of parameters: difficult (need good statistical tools and good data); technically troubling (errors in feedback loops correlated, biasing parameter estimates, so need instrumental variables or some such sophisticated technique, and the sampling interval problem makes it difficult to get parameters for a continuous model from discrete data); misspecification in estimation equations likely (data from a whole nonlinear, multiloop system ("reality") used to estimate a single link in the model.

E. References:
   1. Graham; Peterson; Richardson; Senge; Crawford, Andersen, and Richardson

II. Initialization

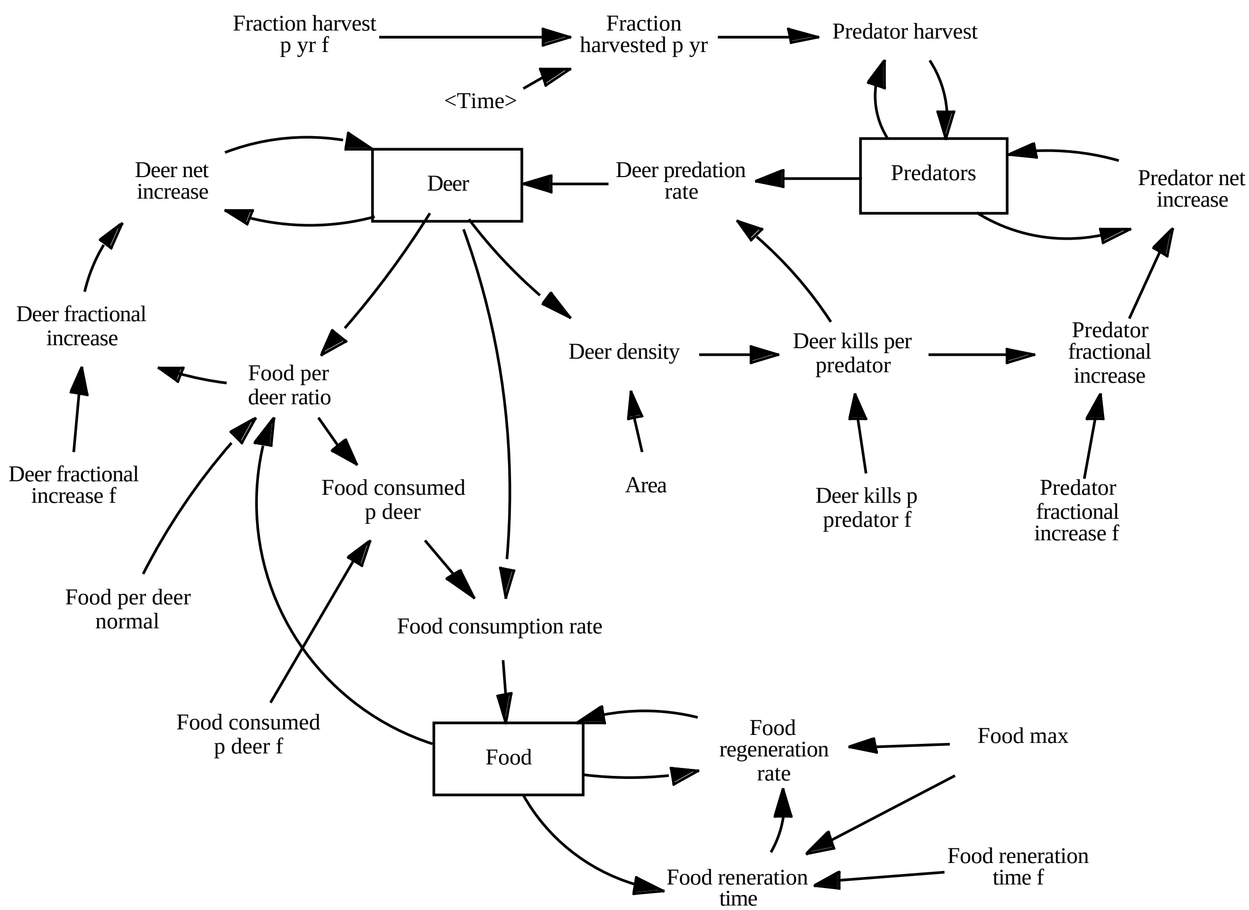
A. In equilibrium
   1. In theory: set up n simultaneous equations for the n levels in a model (net rate = 0) and solve.
      a) Lotka-Volterra equations
         (1) $dx/dt = ax - bxy$
         (2) $dy/dt = cxy - dy$
      b) Aging chain



c)

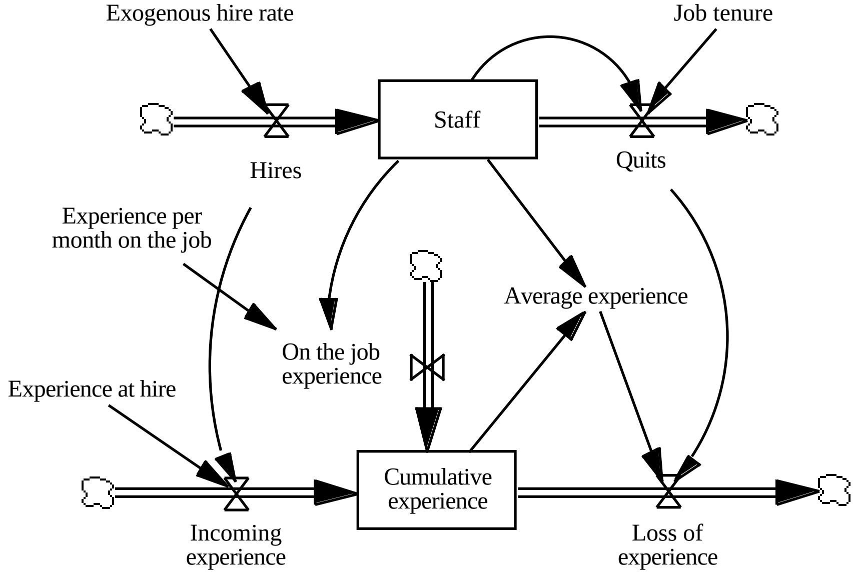
2. In practice:

a) Kaibab model



b)

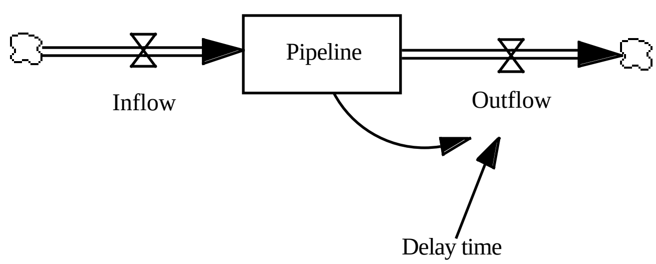
3. Co-flow with experience



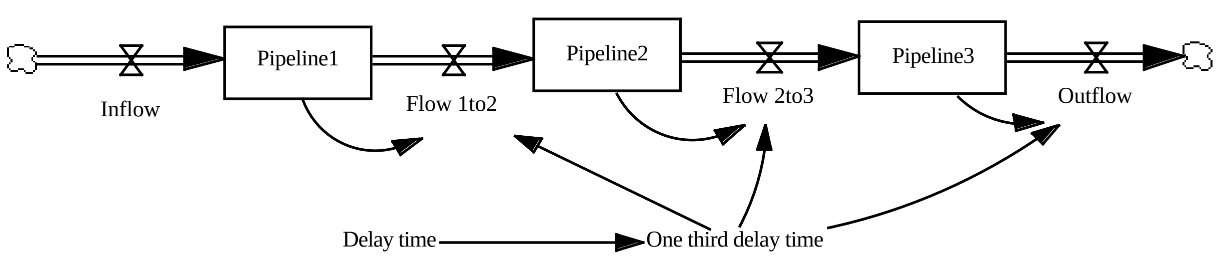
4.

B. In steady-state growth
1. linear:
a) Initialize dx/dt = (In - Out) so x grows linearly at initial growth rate m.
2. exponential:
a) Initialize dx/dt = (In - Out) so x grows exponentially at initial fractional growth rate g.
3. Examples:
a) smooths: $dx/dt = (x^* - x)/\tau$

b) first-order delay



c)
d) third-order delay



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