Lecture 18 - State-space modeling: Gatenby and Vincent 2003

Can't give you much background on cancer...

CONCEPTUALLY, what does the first half of this paper infer?

CONCEPTUALLY, what is the basis for that inference?

CONCEPTUALLY, what was their model?

Modeling density-independent growth

Unlimited growth of a population over discrete time steps:

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

Change in population over a single time step:

$$N_{t+1} - N_t = RN_t$$

Change in population over any time step:

$$\frac{\Delta N}{\Delta t} = R_N N$$

Considering a very small change in time gives us the continuous differential equation:

$$\frac{dN}{dt} = RN$$

Density-independent growth isn't very realistic. Why?

Density-dependent growth adds realism to density-independent growth

$$\frac{dN}{dt} = R(1 - \alpha N)N$$

α is a coefficient describing competition with individuals from the same population.

The inverse of this is carrying capacity $\frac{1}{K}$.

So the equation above can also be written as:

$$\frac{dN}{dt} = R(1 - \frac{N}{K})N$$

SPECIFICALLY, what was their model?

State variables vs. parameters

State variables are quantities of individuals, matter, or energy that are simulated through time.

Parameters are constants or values that describe change in state variables or relationships amongst state variables.

What are the the state variables and parameters in Gatenby and Vincent?

What are the the state variables and parameters in Gatenby and Vincent?

- State variables
  - N_N: normal cells
  - N_T: tumor cells
- Parameters
  - R_N: growth rate for normal cells; [time^{-1}]
  - K_N: carrying capacity for normal cells; [cells]
  - α_{NT}: effect of tumor cells on normal cells; [cells cell^{-1}]
  - R_T: growth rate for tumor cells; [time^{-1}]
  - K_T: carrying capacity for normal cells; [cells]
  - α_{TN}: effect of normal cells on tumor cells; [cells cell^{-1}]

SPECIFICALLY, what model behavior was the basis for the authors' conceptual inferences?

Wednesday

talk about how to simulate models with `Python` and `R`

recreate Gatenby & Vincent 2003 and extend to other examples