Projects
Dynamics of species

m 5740, Spring 2014

Please read all five projects. Choose your preferences.

Each project should be done by one or two groups. The group prepares the powerpoint or pdf presentation and writes a complementary note if needed. After the class presentation and questions-answers session, the presentation can be corrected before final submission.

The presentations start next week. Plan for 17 minute talk and 6 minutes of questions. Bring you computer or send me the file. Practice presenting the material; at home, your talk should last 13-14 minutes (a speaker needs an additional time because of the stress of a public speech).

A Leslie model and a modificaion

- Introduce Leslie model, find data
- Find stable age distribution and the growth rate. Compute the dynamics. Graph the results
- Modify the model by adding a stabilizer: assume that the growth rate depends on the size of the population. Compute the dynamics

B Reaction-diffusion equation: Allee model with a diffusion term

- Describe the model, simulate the dynamics. What happens when diffusivity is zero (is infinity)
- Assume that initial data $P(n,0)$ are below and above the threshold value K is different points, for example $P(1,0) = .5K,\ P(2,0) = 1.5K$, etc. Experiment with various initial data sets.

  Impose periodic boundary conditions: $P(0,m) = P(n,m),\ P(1,m) = P(n+1,m)$ for all m.

C Species interaction and competition.

Consider a model with two species X and Y that compete for a resource and a predator Z that preys on them.

$$\dot{X} = \alpha_1 X - \beta_1 X\,Y - \gamma_1 X\,Z$$
$$\dot{Y} = \alpha_2 Y - \beta_2 X\,Y - \gamma_2 Y\,Z$$
$$\dot{Z} = -\alpha_3 Y + \delta_3 X\,Z - \delta_3 Y\,Z$$

- Find the equilibrium points. Investigate their stability
- Simulate the dynamics, using different initial conditions, $X(0) \ll Y(0)$, and $X(0) \gg Y(0)$.
  (You may consider either differential on difference model.)

D Delay equation in population dynamics

- Read "DELAY DIFFERENTIAL EQUATIONS IN SINGLE SPECIES DYNAMICS" by Shigui Ruan
  (http://www.math.miami.edu/ ruan/MyPapers/Ruan-nato.pdf)
- Present the technique of delay equations, and illustrate them using logistic growth and Allee model with delay.
- Discuss instabilities and bifurcations.

E Epidemics spread

- Read Wikipedia articles
  en.wikipedia.org/wiki/Epidemic_model,
  en.wikipedia.org/wiki/Compartmental$_m$*odels_in_epidemiology*,
  and (as a complement)
  en.wikipedia.org/wiki/Mathematical_modelling_of_infectious_disease
- Describe and simulate SIR, SIRS, SEIS models. Explain the difference
  You may use either differential or difference equations.