



15.879 Advanced System Dynamics Modeling

Spring 2025

Exercise 4- Predator Prey with Carrying Capacity

Submit your model to the shared dropbox before the class on Friday 2/28/2025

One of the classical models in mathematical biology, predator-prey, tracks the interactions between a predator and a prey population in a closed system. Built independently by Alfred Lotka (1920) and Vito Volterra (1926), the original model is also known as Lotka-Volterra. In this exercise you would work on building an expanded version of this model, accounting for food sources for the prey population (e.g. vegetation) and enhancing the robustness of the original model formulations. Please do not consult existing literature for working through this assignment, instead focus on building the model(s) independently. You can build the model in two steps. Make sure you fully understand the model's dynamics for each step before adding any new components.

- A- Build a model of two interacting populations without concern about food for the prey. Specifically, assuming ample food for the prey, formulate the population dynamics for the two species in a bounded environment (e.g. an island). To make the exercise more concrete, you can keep in mind specific species, such as deer and wolf; but the core model formulations should be generic and more broadly applicable. You will need to think carefully about formulations for births and deaths for each species so that they are robust in various extreme conditions. If possible, try to put the model into an analytical equilibrium as well.
- B- Now expand the model to account for the availability of food for the prey, i.e. edible vegetation. You may find it easier to first consider a fixed food resource, and then relax this assumption to account for dynamics of vegetation. If you get a chance, identify the different modes of behavior that may be generated by this model, i.e. what modes of behavior are feasible if we changed the key parameters of the model?

The description above is intentionally left broad so you consider different architectural choices explicitly (problem definition, time horizon, level of aggregation, and stocks). Nevertheless, focus on building a fairly generic (rather than detailed) model and make sure your resulting model can simulate reasonable behaviors for each species in isolation, and is robust to various extreme conditions when they interact.

Submission Instructions

Put your Vensim models for parts A-B in the shared dropbox folder under session 4. Please name your model submissions as: S04-<Last Name>-PredatorPrey.mdl
for example, "S04-Rahmandad- PredatorPrey.mdl".

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