Coding Assignment 3

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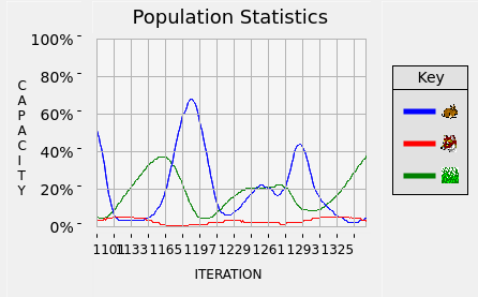
Problem 1 — Lotka-Volterra Model

Part 1: Questions from Biology Corner

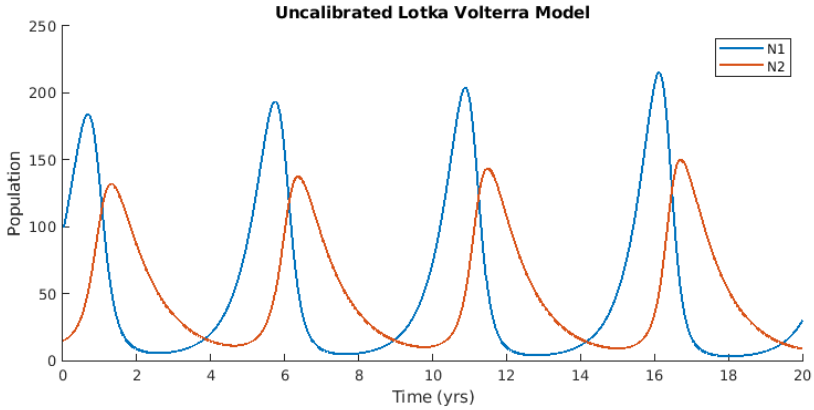
1. Over time, the grass becomes healthier/greener as rabbit population declines, since less rabbits are there to eat it. Rabbits get more populous with more abundant green grass. Wolves don't survive because the wolf population is so highly dependent on the rabbit population density that when the rabbit population decreases, the large number of wolves cannot survive/mate.
2. In order to get a stable run for 1000+ iterations, the parameters need to be modified s.t. the wolves clear out just the right amount of rabbits as the grass gets eaten up. I did this by setting Rabbit repo age to **5**, the wolf repo age to **15** and wolf repo food level to **140**.
3. For the above to work, forest size needed to be set at **huge**.



Problem 1 — Lotka-Volterra Model

Part 2: Simulate LV Model

The initial, uncalibrated simulation of my model is shown below:



Problem 1 — Lotka-Volterra Model

Part 2: Cost Function Used

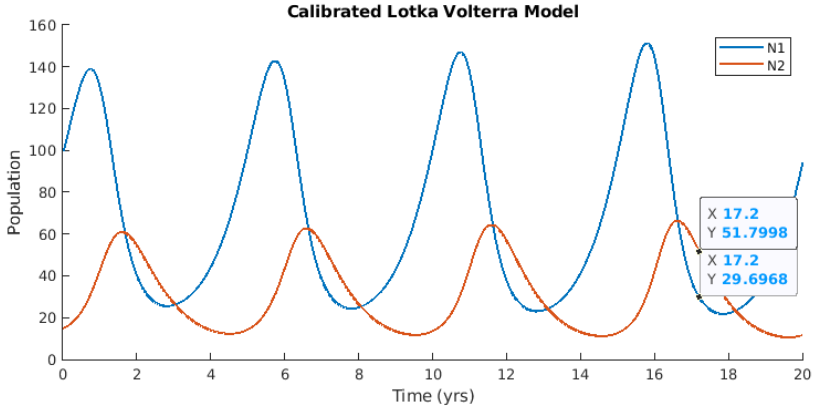
I decided to use the sum of the sum of square errors:

$$Error = \sum_{i=1}^{len(N_1)} (N_{1(i)} - Obs_{(i)})^2 + \sum_{j=1}^{len(N_2)} (N_{2(j)} - Obs_{(j)})^2$$

Problem 1 — Lotka-Volterra Model

Part 2: Calibrate LV Model

The calibrated simulation of my model is shown below:



Note: the datatips match the observed data.

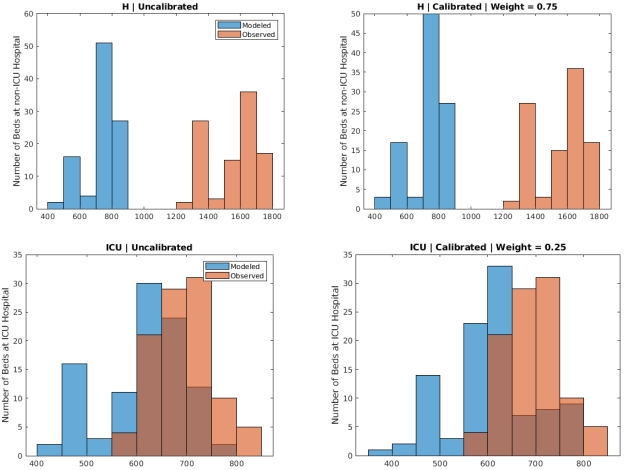
Problem 2 — Task 1 Model Calibration

I used MSE this time as my cost function, trying to minimize error using `fmincon`:

$$Error = \alpha MSE_H + (1 - \alpha) MSE_{ICU}$$

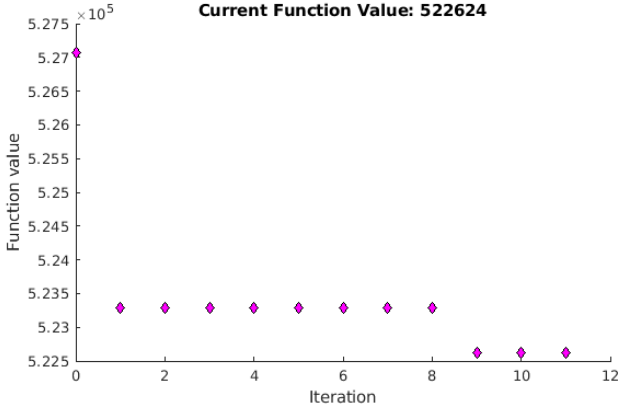
Problem 2 — Task 1 Model Calibration

The calibration can be visualized using histograms. α was chosen to be .75 in order to bias the calibration towards H.



Problem 2 — Task 1 Model Calibration

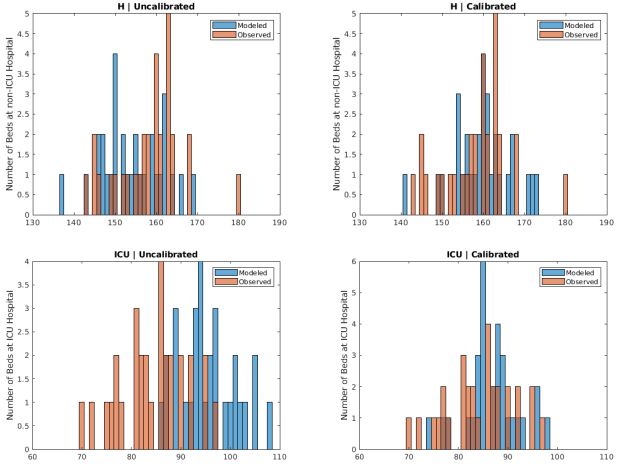
It should be noted that in the above slide, the calibration appears to have worsened the ICU distribution match, while ever so slightly improving the H match. My guess is in this part, the output of the model (a 1×200) matrix only reflected a set of ICU values, hence the overlap in the distributions. The H values outputted were just too low and could not be calibrated. Here is how the optimization went:



Note: The high SSE is not sufficiently reduced over 12 iterations.

Problem 2 — Task 2 Model Calibration

The calibration can be visualized similarly using histograms. The same cost function in Part 1 was used. α was chosen to be .5 in order to evenly weight the calibration.



Problem 2 — Task 2 Model Calibration

It can be clearly seen above that calibration improved the ICU representation. Here is the output of my cost function over 2 iterations. Note how the MSE drops substantially when parameters are varied. The exact l_1, l_2, l_3 parameters the calibration chose is found in the `params` vector after running my `part1.m` and `part2.m` scripts: