Notes for Week 13 Lab Section

So in the lab section today, we are going to simulate the apparent competition model with logistic prey growth and create the figure you’ve seen earlier in the lecture that shows the areas of coexistence and exclusion.

***Part 1. Create the function***

In that figure, we have *r1/a1*and *r2/a2* as the axes. So basically, the idea is to cut the space into many many small grids, each associated with a pair of *r1/a1*and *r2/a2*, and create a function that takes the parameter pairs and determine the outcome.

Since we have two parameters *r* and *a* at the same time, we can make it simpler by fixing *a* as a constant and only changing the values of *r*. So in this function, we only have two arguments *r1*and *r2* rather than four.

Now let’s break the function down a bit. Again, we start with the model specification, the parameters, and run the ode. After the simulation is done, we extract the final population size of the two prey species *N1* and *N2*, and use them to determine the competition outcome.

Theoretically, under competitive exclusion, either *N1* or *N2* should become zero. But in reality, the number will be infinitesimally small. So here, I just set a threshold 10-5 for extinction: If *N1* is below this value, *N1* is deemed extinct, and *N2* wins. Vice versa. If none of them falls below this threshold, then they coexist.

***Part 2. Apply the function***

Now we have our function at hand, we can run it with different combinations of *r1*and *r2* values. Here we run the *r* values from 0 to 2.5 and cut the range into 300 intervals. Of course, the larger the *n*, the finer the resolution, but the running time will also grow exponentially.

We then map, or pass a grid of *r1*and *r2* values to the function we created earlier. This might take a while because we have 300\*300 simulations to run!

***Part 3. Visualization***

After we finish the simulations, we can visualize the results in the grids. Remember each grid is associated with a specific pair of *r1*and *r2* values right? So we can color that grid based on the simulation outcome. Finally, we added the analytical boundaries, which are pretty close to our simulation boundaries.

The areas of coexistence and exclusion depend on the boundary slopes, which are a function of *m, e, a,* and *K*. You can make the red area wider or narrower by altering these parameters.