

## Math 172      Fall 2012      WS 8

1. You are studying competition between red and black desert scorpions. The populations are measured in millions of individuals.

If only a single species is present, it would grow following the logistic model, with a carrying capacity  $K_1 = 100$  for the red scorpion, and  $K_2 = 150$  for the black scorpion.

a. Write the Lotka-Volterra competition model equations for the two species, assuming competition coefficients of  $\alpha = 2$  for the red scorpion, and  $\beta = 3$  for the black scorpion. Use  $r_1 = r_2 = 1$ .

b. Assume the initial populations are 44 million red ants and 31 million black scorpions. Use Euler's method with  $\Delta t = 1$  in order to estimate the values of both populations at  $t = 1, 2, 3$ . Also find the values of  $P_1$  and  $P_2$  at some large values of  $t$ . It is up to you how large to choose  $t$  but it should be large enough to show the long run behavior of the system.

c. Sketch the state-space and show the values that you found in b. as points in the state-space. Which equilibrium value seems to be approached in the long run?

3. Repeat problem 1 with  $r_1 = r_2 = 1$ ,  $K_1 = 100$ ,  $K_2 = 150$ ,  $\alpha = 0.5$ ,  $\beta = 2$ . Assume the initial values to be:

a.  $N_1 = 80$ ,  $N_2 = 45$

b.  $N_1 = 50$ ,  $N_2 = 40$ .

4. Repeat the questions in problem 1 with  $r_1 = r_2 = 1$ ,  $K_1 = 100$ ,  $K_2 = 150$ ,  $\alpha = 0.5$ ,  $\beta = 0.75$ . Assume the initial values of the population to be  $N_1 = 50$ ,  $N_2 = 70$ .