

**Homework 8**  
**Due Thursday, March 7th**

Instructions: write up solutions to all problems below. Neatness counts: be sure to follow guidelines for homework in the syllabus.

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Reading Assignment: 5.5, 5.6, 5.7

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This homework is similar in spirit to Homework 6. We will consider a different model, but the underlying goal of the problem is the same: explore a single model in detail, using the tools from the course so far.

Suppose that we have a population of predators and a population of prey.

1. Write down the predator prey model, using your own notation. Explain what each term in your model represents, and explain the choice of signs for each term. Be sure to explain what each variable you use represents in context of the model.
2. Find all equilibria for the system you wrote down in the previous part. Do this problem without choosing values for your parameters, so that your final answers depend on the parameters in the model.
3. Suppose that the predator's natural per-capita reproduction rate is  $-0.4$  and their coupling constant equals  $0.005$ ; also suppose that the prey natural per-capita reproduction rate is  $2$  and their coupling constant equals  $0.04$ . Draw a phase diagram for the system. (Remember what is entailed in the phase diagram.)
4. For each region of phase diagram in the previous part, choose a test point, and draw an arrow to represent the change in the predator and prey populations at that point.
5. Explain in your own words the difference between stable, unstable, and semistable equilibria of systems of autonomous equations.
6. For this part, you will need to go out on a limb. Describe what you think the long-term dynamics of the system look like. In particular, make a guess as to whether the equilibria you found in part (c) are stable, unstable, or semi-stable. (Note that there is no right-or-wrong answer to this part; what matters is the explanation you give to justify your answer.)