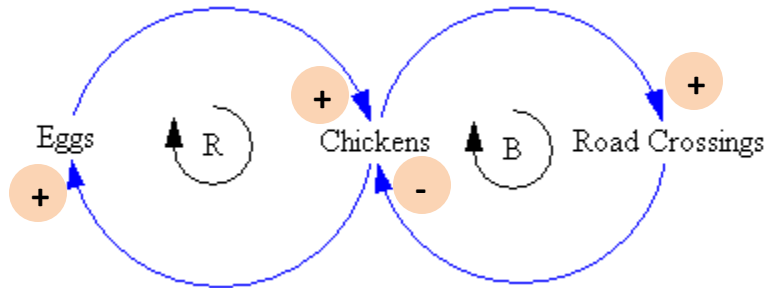


Instructions. Always explain your work – use each question as opportunity to demonstrate what you know. Time 1:15

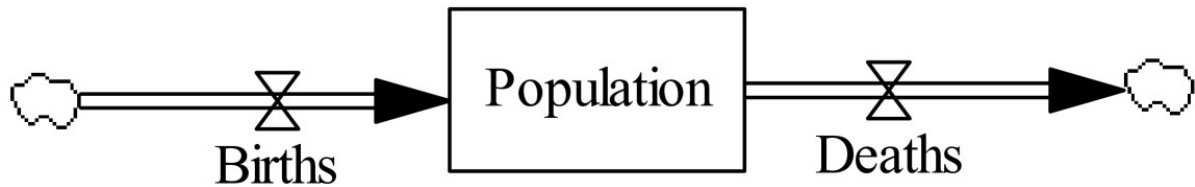
Consider this example of a causal loop diagram.



1. Explain each of the plus or minus signs next to the circular labels.

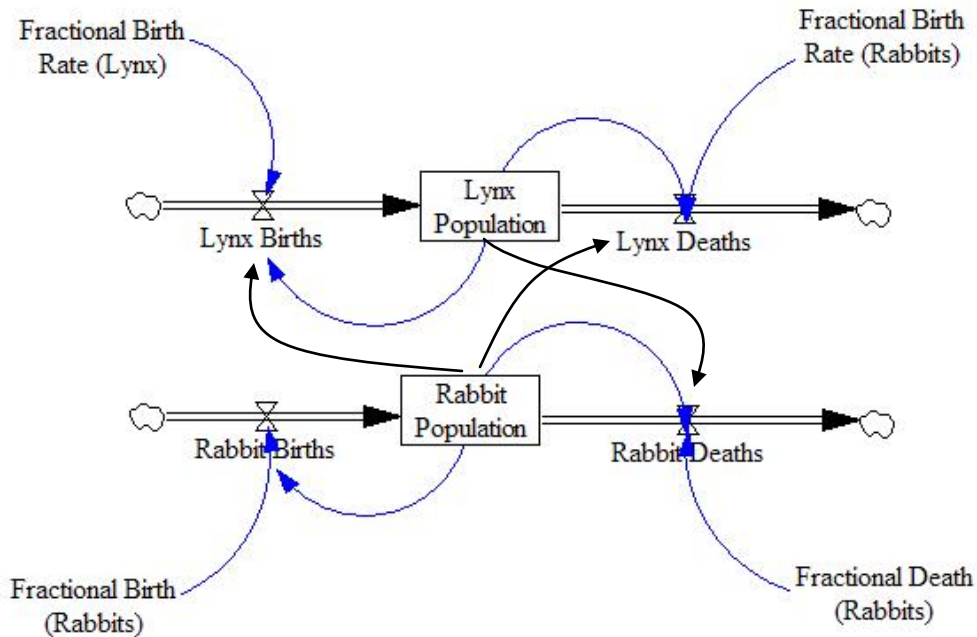
2. What do the R and B loops indicate?

Consider this diagram.

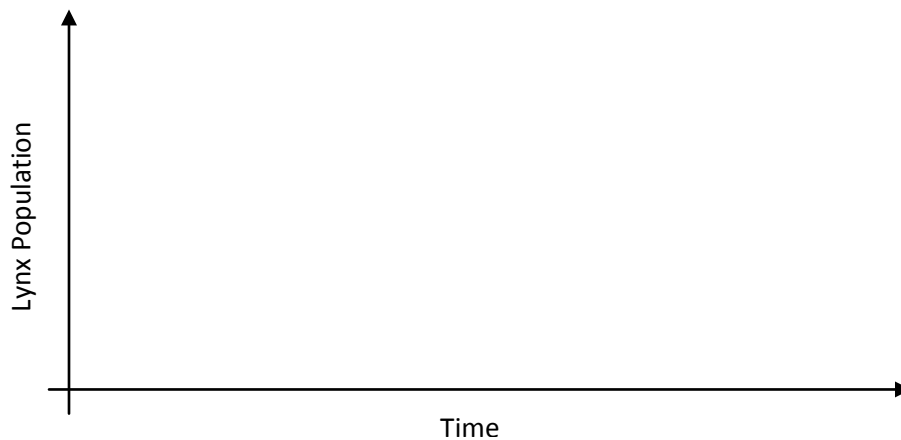


3. **Write an equation** for population at time $t+1$ (i.e., P_{t+1})

A typical "predator-prey" model is shown below. It relates population of lynx's (a type of wild cat) and population of rabbits (a favorite lynx food). In the diagram, the birth and death "valves" get information from rates and population because the number of births in a time period depends on birth rate and number of adults



4. Depending on parameters such as birth and death rates, initial populations, etc. this system can evolve in differently over time. **Sketch three different long term trajectories that the lynx population could follow**, depending on how this model worked. Label these A, B, and C and explain (on next page), briefly, what each one represents

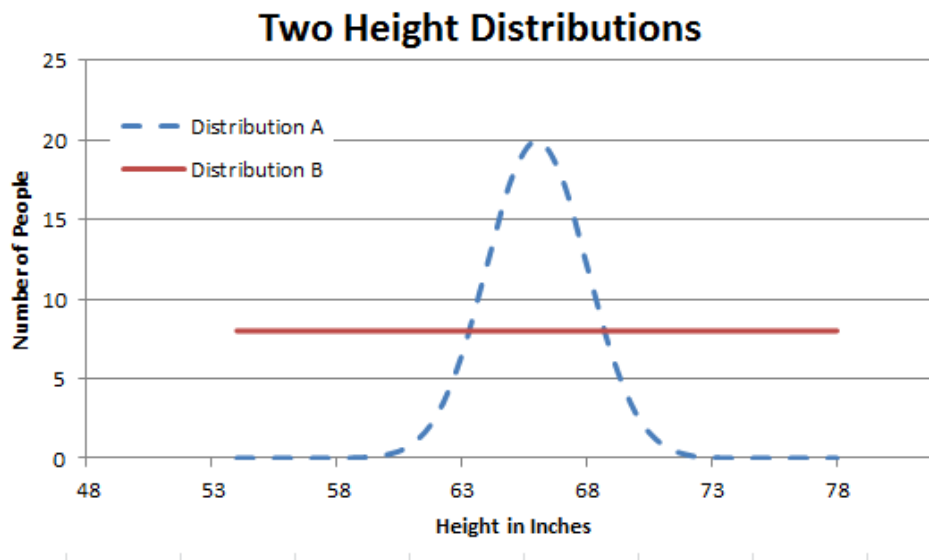


5. A _____

6. B _____

7. C _____

8. Suppose we have two groups of people. In one group, height is uniformly distributed. In the other group it is normally distributed as shown below. If one individual is randomly selected from each group, **compare the likelihood** that they are of average height (say, 66 inches).



9. Consider a dropout prevention program at a high school in Oakland. The director has asked you to put together a stock and flow model showing the basics of how kids "flow" through the system. They give you the following information.

Kids enter the first year of high school, ninth grade, from several feeder schools. The high school tracks students year by year: 9th (freshmen), 10th (sophomores), 11th (juniors), 12th (seniors). They know that they lose students each year. Facing various problems (arrest, substance abuse, pregnancy, academic problems, etc.), some of the kids simply drop out of school each year — there is, one might say, "leakage" out of each class.

10. What are the stocks?

11. What are the flows?

12. What are the informational variables in the model?

13. **Draw the stock and flow diagram** showing stocks, flows, valves, clouds.

14. Your principal tells you that she needs help **modeling how to deploy the counseling staff** among the different grades each year based on the previous year's results. There are 12 counselors altogether and they can be divided up among the different years depending on where the need is the greatest. The counselors' job is to stem the "leakage" of students from the class year to which they are assigned. They used to just have 3 for each year but then they noticed that there were more dropping out from some years than others. Suggest a stock and flow approach to incorporate this into the model.

15. We are asked to put together a very simple Monte Carlo simulation of a social service agency. The agency has staff in the office who provide a service to walk-in clients. There are two staff available to help clients. During each time period they can handle one client each (two total per time period). We are given the following probability distribution of the frequency with which different numbers of clients show up

- 10% of the time, no clients arrive in a given hour
- 30% of the time, 1 client arrives per hour
- 30% of the time, 2 clients arrive per hour
- 20% of the time 3 clients arrive per hour
- 10% of the time 4 clients arrive per hour

Assuming you pick a random number R from the random number table below, explain how you would use it to decide how many clients arrived in a given time period.

96	59	97	39	7	31	18	83	1	38
11	30	8	69	16	77	22	57	92	7
10	67	80	58	36	69	65	20	0	99
20	56	55	11	11	12	17	28	30	74
28	30	50	76	86	42	94	82	19	22
32	1	16	3	5	9	40	93	94	45
59	65	70	70	81	63	26	76	2	21
91	11	63	62	37	22	40	61	69	81
18	83	9	48	89	92	69	99	29	77
56	75	93	17	5	71	17	81	7	65

Starting in the upper left of the table and moving across, simulate the first five time periods of this model.

Time Period	Random Number	Arrivals	Total Requiring Service	Number Served This Period	Number Waiting at end of Period	Cumulative Total Waits
1						
2						
3						
4						
5						

HONOR CODE – write out and sign on back of this sheet.