Async Learning Task: Prey-Predator Ecosystems

Fox-Rabbit Ecosystems

Ecosystem Configuration:

max-turn 50

max-forward 50

rabbit-population 50

Fox-population 50

regrow 100

reproduction-chance 30 (1/30)

rabbit-eating 10

fox-eating 50

Scenario #1: Set the initial population of preys to 100 and predators to 100. Run your model 10 times. In each run, stop the simulation at tick 500 and log the total population of your preys, predators, and food.

1. How would you describe the general behavior of your model up to tick 500?

When the model ran strictly until the 500th tick, we observe that the predators usually die out. It occurred 9/10 times during the test run. This may be due to more competitors in finding rabbits and the increased crowdedness in the plane. The rabbits live on but as we can observe in the table below, there were instances where the population of rabbits was also at 0. This may be because of the sudden growth of the prey population without any predators to control them. Because of this, food became sparse for the rabbits which can be seen in one of the test runs. It is likely that when the program is continued beyond the 500th tick, the 213 rabbits will also die out because there were only 828 green patches left.

2. What is the average total population of your preys, predators, and food at tick 500 for all 10 runs of your model?

	Foxes	Rabbits	Green Patches (Grass)
	0	20	3090
	0	75	1623
	0	0	3721
	0	0	3721
	0	0	3721
	53	24	2712
	0	213	828
	0	0	3721
	0	0	3721
	0	0	3721
Average	5.3	33.2	3057.9

Table 1

Now, run your model 10 times again. Let them run until either one of the prey, predator, or food populations go down to 0 (e.g. all predators died). Log the tick when that happened and the total population of the preys, predators, and food.

	Ticks	Foxes	Rabbits	Green Patches
	80	331	0	1246
	1499	0	104	1660
	177	0	25	3326
	80	440	0	955
	142	0	8	3410
	85	241	0	1359
	77	343	0	1427
	192	0	3	3046
	3382	0	28	2978
	158	0	6	3565
Average	587.2	135.5	17.4	2297.2

Table 2

1. How would you describe the general behavior of your model when it runs indefinitely?

When the program ran indefinitely, we can observe a pattern in which the prey and predators die. When the prey dies out, the population of predators is usually overwhelming. However, when this happens, the tick number is usually quite low, generally less than 100 ticks. A plausible explanation for this is since there are 100 predators and prey respectively, the plane is overwhelmed with limited space. Because of this, the prey does not have many places to go and therefore gets easily consumed at an early time in the program. Because of this, the foxes rapidly reproduce but since there are no more rabbits. They also die extremely quickly. The second case is when the predators die out. A plausible explanation for this is since there are an equal number of predators and rabbits, there are a huge number of predators that have to be satisfied and the rabbits all have to be properly distributed for their survival. But when they somehow miss the prey, their hunger at that point will also be close to 0. Because of this, they all die out leaving a few prey behind. In this case, as the program runs, the prey will continue to increase without the threat of predators, but they will inevitably die as well when they run out of food which can be seen in table 1.

2. How does it compare to the average behavior up to tick 500?

Although some of the results may be conflicting due to randomness wherein the predators died out more often when running until the 500th tick compared to running it indefinitely, realizations can still be made from the pattern present in the tables. In the results of the model being run indefinitely, we can observe three behaviors which are namely: 1) the extinction of prey and the domination of predators at a low tick rate 2) The disappearance of predators and the low number of prey at a higher tick rate. 3) the inclination of both prey and predators to approach 0 as the tick rate increases.

When this is compared to the behavior of running until the 500th tick, the first case which is the dominance of predators can be easily matched with the cases on the first table in which both the value of prey and predators are 0 in the table. This is because the predators have also dominated which happened 6/10 times when running it until the 500th tick. However as the 500th tick is reached, the predators have already died out. In the first table, 3/10 had the predators die out and the prey had a small value. They will eventually grow to a larger value which can be seen in the first table which had one of the populations of rabbits reach 213 and similarly to the second table approach the value of 0 as the tick rate increases due to overpopulation.

3. Out of the 10 runs, how many times did the following populations become extinct (population == 0):
    - Preys = 4
    - Predators = 6
    - Food = 0 times

Scenario #2: Set the initial population of preys to 50 and predators to 100. Run your model 10 times. In each run, stop the simulation at tick 500 and log the total population of your preys, predators, and food.

1. How would you describe the general behavior of your model up to tick 500?
2. What is the average total population of your preys, predators, and food at tick 500 for all 10 runs of your model?

There is a continuous increase and decrease in the population between foxes and rabbits. Moreover, there are more instances wherein there are more foxes than rabbits. However, the green patches are consistently many. By averaging all the populations with those 3 variables, there are more foxes than rabbits, and there are more green patches since there are initially more foxes than rabbits.

	Foxes	Rabbits	Green Patches (Grass)
	2	126	1446
	44	63	2083
	149	85	1327
	149	27	1844
	71	55	2216
	10	17	3041
	21	62	2121
	179	45	1439
	13	34	2713
	127	32	1913
Average	76.5	54.6	2014.3

Now, run your model 10 times again. Let them run until either one of the prey, predator, or food populations go down to 0 (e.g. all predators died). Log the tick when that happened and the total population of the preys, predators, and food.

1. How would you describe the general behavior of your model when it runs indefinitely?
2. How does it compare to the average behavior up to tick 500?
3. Out of the 10 runs, how many times did the following populations become extinct (population == 0):
    - Preys
    - Predators

- Food

	Ticks	Foxes	Rabbits	Green Patches
	1460	0	133	1437
	3321	0	7	3321
	219	0	128	1326
	1711	0	69	722
	130	0	2	3296
	170	0	11	3289
	1744	0	28	3059
	171	0	6	3433
	2512	0	63	2307
	205	0	17	3026
Average	1164.3	0	46.4	2521.6

Running the model indefinitely would cause all the foxes to die ranging from low to high number of ticks. This is a stark contrast to the previous test wherein there are more foxes than rabbits on average. The average number of green patches also increased as well compared to the previous one.

Scenario #3: Set the initial population of preys to 100 and predators to 50. Run your model 10 times. In each run, stop the simulation at tick 500 and log the total population of your preys, predators, and food.

1. How would you describe the general behavior of your model up to tick 500?

Most of the time, the model ends up being just patches of grass with no foxes or rabbits alive. In some rare occurrences, the rabbits would survive. In all runs, the foxes would always die because there are no rabbits to eat or they are unable to find the rabbits. The model will never have the food = 0 because of how fast it regrows.

2. What is the average total population of your preys, predators, and food at tick 500 for all 10 runs of your model?

Run	Foxes	Rabbits	Green Patches (Grass)
#1	0	0	3721
#2	0	0	3721

#3	0	0	3721
#4	0	0	3721
#5	0	113	1914
#6	0	0	3721
#7	0	0	3721
#8	0	28	2648
#9	0	0	3721
#10	0	0	3721
Average	0	14.1	3433

Now, run your model 10 times again. Let them run until either one of the prey, predator, or food populations go down to 0 (e.g. all predators died). Log the tick when that happened and the total population of the preys, predators, and food.

1. How would you describe the general behavior of your model when it runs indefinitely?

The more common event to happen is for the foxes to eat all the rabbits. There are some rare occurrences where not all rabbits are eaten by the foxes. The model would most often run until around 100 ticks only. If all the foxes die and the rabbits live, the model will tick until 150-191.

2. How does it compare to the average behavior up to tick 500?

For the behavior up to tick 500, foxes would always die because there are no longer any rabbits to be preyed upon. As we can see from the indefinite runs of the model, the common behavior is for the rabbits to all die. This would explain why when the model runs until 500 ticks, foxes would always all die.

3. Out of the 10 runs, how many times did the following populations become extinct (population == 0):
   - Preys 8 times
   - Predators 2 times
   - Food 0 times

Run	**Ticks**	**Fox**	**Rabbit**	**Green Patches(Grass)**
#1	103	146	0	832

#2	95	259	0	481
#3	102	175	0	678
#4	105	274	0	886
#5	191	0	14	3362
#6	154	0	4	3398
#7	101	244	0	664
#8	96	213	0	493
#9	91	352	0	421
#10	102	398	0	685
Average	114	206.1	1.8	1190

Scenario #4: Come up with your scenario(s) with different initial configurations. You can also play around with your other variables if you hypothesize that they can change the behavior of your prey-predator ecosystem. Run your model 10 times. In each run, stop the simulation at tick 500 and log the total population of your preys, predators, and food.

CONFIGURATION:

Grass regrowth from 100 to 50

Reproduction Chance from 1/30 to 1/50

Rabbit Population 50

Fox Population 25

Rabbit hunger at 10

Fox hunger at 40

1. How would you describe the general behavior of your model up to tick 500?

The general behavior of this model configuration is that the population of the Foxes and Rabbits alternates between a rising fox population and a rising rabbit population. At 500 ticks, the simulation, on average, ends with a fox-rabbit population at a 1 to 3 ratio. With the consistent alternating population changes of the fox and rabbit population, one can infer that this model will likely be able to continue over a long period of time. Without either agent dying out. In addition, one can also observe the alternating population of rabbits and grass patches as well since the rabbits eat grass.

2. What is the average total population of your preys, predators, and food at tick 500 for all 10 runs of your model?

	Foxes	Rabbits	Green Patches (Grass)
	69	120	1303
	66	115	1421
	20	187	1144
	40	180	1156
	13	235	940
	66	143	1387
	60	118	1488
	66	104	1453
	61	141	1335
	45	109	1505
Average	50.6	145.2	1313.2

Now, run your model 10 times again. Let them run until either one of the prey, predator, or food populations go down to 0 (e.g. all predators died). Log the tick when that happened and the total population of the preys, predators, and food.

	Fox	Rabbits	Green Patches (Grass)	Ticks
	0	51	2638	59194
	0	160	1388	20549
	0	230	995	373821
	0	243	945	399493

	0	219	923	80463
	0	101	1858	247176
	0	75	2178	161546
	0	199	1123	425916
	0	138	1530	855609
	0	260	945	650889
Average	0	167.6	1452.3	357273.5556

1. How would you describe the general behavior of your model when it runs indefinitely?

The model continues for an extensively long period of time where the population of rabbits and foxes alternate. Based on observations, the model will run continuously until the foxes get unlucky and can't find any rabbits to eat when rabbits are scarce. This can be seen from the foxes going extinct in all 10 runs. Following this, the run-time of the model is inconsistent due to the random movement and repopulation chance of each animal.

2. How does it compare to the average behavior up to tick 500?

The behavior of this model is similar to the 500-tick model. This model proves that the ecosystem can survive for a long period of time without any external factors. When comparing the results, the foxes eventually die out in every run, likely due to the limited number of prey. In the other model, the ecosystem wasn't allowed to run for long so the challenges of surviving haven't repeated too much which allows the fox population to still exist.

3. Out of the 10 runs, how many times did the following populations become extinct (population == 0):
   - Preys 0 times
   - Predators 10 times
   - Food 0 times

Scenario #5: Reduce energy by 5 after reproducing

CONFIGURATION:

Grass regrowth to 50

Rabbit Reproduction Chance 1/35

Fox Reproduction Chance 1/60

Rabbit Population 50

Fox Population 20

Rabbit hunger at 10

Fox hunger at 35

1. How would you describe the general behavior of your model up to tick 500?

Running the model until the 500th tick shows a consistent trend of a high rabbit-to-fox ratio. The random movement of foxes makes them seem less intelligent than they really are. Because of this, their species struggle to survive in the model.

2. What is the average total population of your preys, predators, and food at tick 500 for all 10 runs of your model?

Run	Fox	Rabbit	Green Patches(Grass)
#1	0	328	967
#2	4	209	1012
#3	21	175	1152
#4	8	219	1021
#5	8	223	900
#6	25	200	1052
#7	18	196	1083
#8	8	246	893
#9	19	217	1004
#10	11	212	972
Average	12.2	222.5	1005.6

Now, run your model 10 times again. Let them run until either one of the prey, predator, or food populations go down to 0 (e.g. all predators died). Log the tick when that happened and the total population of the preys, predators, and food.

Run	Ticks	Fox	Rabbit	Green Patches(Grass)
#1	7845	0	224	1000
#2	1245	0	219	1083
#3	12612	0	224	969
#4	1086	0	237	939
#5	12338	0	220	1031
#6	5172	0	238	935
#7	2108	0	240	989
#8	933	0	213	1084
#9	1342	0	243	980
#10	541	0	211	939
Average	4522.2	0	226.9	994.9

1. How would you describe the general behavior of your model when it runs indefinitely?

   As the tick rate reaches a high number, the foxes consistently become extinct with the given configuration while the rabbits maintain a high population count. Despite the foxes' higher energy bar, their lower reproduction rate makes it harder for them to have greater control of the model's plane and consume the other rabbits. Because of this, the foxes maintained a low population count throughout the runs and consistently approached 0. Despite an additional consideration for the different reproduction rates of rabbits and foxes and the corresponding energy costs of it, the random movement is still a significant limitation, especially for the predators.

2. How does it compare to the average behavior up to tick 500?

   The behavior is similar in that the predators maintain a low population

   count throughout the run and slowly approach 0. Running the model with a much higher tick rate also shows some insights regarding the model. Comparing it to running it on 500 ticks, the green patches and rabbits count both remain consistent. This shows that with the given configuration, the population of rabbits and the growth of grass have found a comfortable balance between them.

3. Out of the 10 runs, how many times did the following populations become extinct (population == 0):
    - Preys 0 times
    - Predators 10 times
    - Food 0 times