Project 4: Organisms

Group 5

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Introduction:

In this project, groups were assigned to create organisms that could survive in single organism and multiple organism environments. They were to survive in the harshest environments possible. Also, they were to have a higher total energy, higher total organism count, or higher average organism energy than any other organism that had survived. Those were the possible metrics. This emulates a very simple kind of nature. The simulator had the following variable values that could be changed to create a harsher environment:

Parameter	Meaning
m	Horizontal size
n	Vertical size
p	Probability of spontaneous appearance of food
q	Probability of food doubling
s	Energy consumed in staying put
v	Energy consumed in moving or reproducing
u	Energy per unit of food
M	Maximum energy per organism
k	Maximum food units per cell

Ideas and evolution:

The first step we took for our player was a conservative but dumb player. If they had less than (M - u) energy and they were not on food, they would move around in a semi-random fashion (they would choose a random direction; if an enemy was on it, they would choose another direction; they would stay put if surrounded) to find food. If they had more than that amount of energy, they reproduced into another dumb player. They would rest on energy until they were fully replenished. If the player had less than (2u) energy, they would not move at all, until food was next to them. If there were no enemies on that pile of food, they would move to it and start feeding to regain energy. Suffice to say, this dumb player did extremely well in area with plentiful food, and experienced massive extinction at the end of a cycle, which is found out by (k * u). However, the organism did poorly in conditions with little food. It also suffered from the plague all the groups experienced: it was a matter of luck when p or q was very low that they would find a sustainable food source right at the beginning. If they didn't, they would simply die off.

We had to surely evolve from this incredibly simple player. We had three routes we considered: the colony player, the in-game evolving player, and the life cycle player.

Colony Player:

The colony player would consist of one queen, protectors of that queen that would barricade other players, and scouts that would look for suitable areas for more colonies. In each colony on the board, there would be one queen that would reproduce protectors and, if possible due to plentiful food, more scouts. We considered small colonies that could easily sustain a single queen in a 2 by 2 farm. Every time there was enough food to create a scout, one would be created and sent out to find another suitable colony area. This scout could then in turn become the queen of the new area. The availability of food would be a simple count of the amount of food on each cell in the farm and the amount of energy of the queen. This idea fell apart after we saw how badly farms larger than a single space did in class. So we did not take that approach for a final player.

In-Game Evolving Player:

This was a very attractive idea. We wanted to introduce a learning player into the game, and this player would automatically create the best organisms through natural selection. Organisms that could live longer and have more food in general would reproduce more. How does one organism live longer than another? It can live longer if it's aggressive enough to find food but passive enough to sit back and not waste energy. However, very strong players end up being players that reproduce sparsely, so they must be forced to reproduce eventually. Although this is a good idea, and produces emergent behavior through natural selection, we were interested in tinkering with the values ourselves and having a learning player whose feat of learning we controlled. We did this with the third possibility: the life cycle player.

Life Cycle Player:

The life cycle player was the idea we considered to be the best, and it is found in our final player. Here each player goes through a life cycle, and as it gets older, it tends to reproduce more and more. So the older players would reproduce more and the younger players would try to become older. This does some of what the in-game evolving player does. Based on the main commodity (food), an organism's life cycle would change in length. If there were a lot of food around the reproducing organism, the child would get older much faster and be able to reproduce sooner. The organisms just die off when there is no more food left. Hence, the player adapts to times of plenty and times of scarcity. And in times of plenty, those that get to a good reproductive age quicker have the advantage. Food affects the length of time spent in each period in the life cycle. Each life cycle denotes how ready an organism is to reproduce. The amount of food eaten by an organism divided by its age also describes how ready an organism is to reproduce. Another important feature is the lineage. If the lineage of the organism is very high, and it's parent, grandparents, great grandparents, etc., date very far back, they are allowed to reproduce even more. Also, when the organisms are cramped together, they are discouraged in reproducing more. This helps to stop overpopulation of an area. In the earlier stages of life, an organism would have to be very healthy and full of energy to reproduce, but in later stages, they are more susceptible to the act of reproduction.

They do no need a lot of energy to go and reproduce. This is another way of getting the old to die quicker. Those that reproduce run the risk (though a minimal risk) of reproducing to death. Another important feature that many of the groups used was getting the child to move away from the parent. If the child could move away, it would, and this is another trick that aids in stopping, reducing, and evading organisms that have been crammed together.

Group5Player3:

Group5Player3, better known as “The Black Plague”, uses the life cycle approach. We called it the Black Plague, for when it covers the playing field, it seems like a dark mass on the board. We made slight modifications with values for the length of time denoting each part of a life cycle and the variables that modify the want to reproduce until we had a competent and competitive player. Our aim for our player was to be able to survive very well in medium and low p and q values. We are also looking for a positive result when the value for moving or reproducing, v, is much lower than the value for energy per unit of food, u. In the multiplayer games, we hope to do well in areas of high food concentration, but we fear that some of the more adaptive players will extinguish our players in the later rounds.

Tournament Analysis:

There were two types of tournaments run for the organisms. Each organism had single organism tournaments (where the board had no other opponents) and seven organism tournaments (where all groups were represented). The importance for each possible scenario is at what round the organism could not survive and the prior total energy and number of organisms. The first round is highest variable value, and round number the organism dies at will represent the lowest variable value it could survive in. Below are the table for the single and seven organism tournaments, and they show our rank for that particular setting, the round at which our organism died, the value of the decreasing variable, the average number of organisms in the previous round, and the average total energy in the previous round:

Single Organism Results				
(u,v)	P Decreasing		Q Decreasing	
	K = 57	K = 83	K = 57	K = 83
(20, 4)	**10th** Round 21 P = 0.00089 185.64 24816.4	**7th** Round 24 P = 0.00075 224.41 33873.4	**9th (Tie)** Round 1 Q = 0.009990 P = .001 N/A N/A	**9th (Tie)** Round 0 Q = 0.009990 P = 0.001 N/A N/A
(20, 10)	**9th** Round 35 P = 0.00134 224.31 34019.2	**8th** Round 31 P = 0.00109 244.88 39017.5	**6th** Round 29 Q = 0.008450 P = 0.002 142.66 19099.7	**6th** Round 35 Q = 0.006320 P = .002 98.94 12591.0
(20, 18)	**7th** Round 42 P = 0.00150 238.28 36482.8	**6th** Round 47 P = 0.00126 261.53 43374.8	**3rd** Round 47 Q = 0.000260 P = 0.005 6.57 900.7	**2nd** Round 54 Q = 0.000210 P = .005 6.12 845.4
(100, 10)	**8th** Round 22 P = 0.00049 284.49 43532.8	**4th (Tie)** Round 32 P = 0.00033 285.4 44112.1	**1st (tie)** Round 55 Q = 0.00001 P = 0.001 52.25 6497.3	**1st (tie)** Round 55 Q = 0.000010 P = .001 51.88 6456.3

<table>
<tr><td colspan="5">Seven Organism Results Set 1</td></tr>
<tr><td>(u,v)</td><td colspan="2">P Decreasing</td><td colspan="2">Q Decreasing</td></tr>
<tr><td></td><td>K = 57</td><td>K = 83</td><td>K = 57</td><td>K = 83</td></tr>
<tr><td>(20, 4)</td><td>4th (Tie)
Round 2
P = .01
Q = .02
2.47
372.3</td><td>7th (Tie)
Round 1
P = 0.010
Q = 0.020
N/A
N/A</td><td>8th
Round 2
P = .01
Q = .02
6.52
720.2</td><td>8th
Round 11
P = .010
Q near 0.0
1.0
153.5</td></tr>
<tr><td>(20, 10)</td><td>8th (Tie)
Round 1
P = 0.010
Q = 0.020
N/A
N/A</td><td>5th (Tie)
Round 1
P = 0.010
Q = 0.020
N/A
N/A</td><td>8th (Tie)
Round 1
P = 0.010
Q = 0.020
N/A
N/A</td><td>8th
Round 7
P = 0.010
Q = 0.0000002
3.55
469.2</td></tr>
<tr><td>(20, 18)</td><td>6th (Tie)
Round 1
P = 0.010
Q = 0.020
N/A
N/A</td><td>7th
Round 4
P = 0.00077491
Q = 0.020
1896.66
391514.7</td><td>5th (Tie)
Round 15
P = .010
Q near 0.0
4.74
687.3</td><td>6th
Round 14
P = .010
Q near 0.0
18.17
2446.7</td></tr>
<tr><td>(100, 10)</td><td>6th (Tie)
Round 2
P = .01
Q = .02
305.34
41382.8</td><td>6th
Round 4
P = 0.00010
Q = 0.020
1349.23
220754.9</td><td>1st (Tie)
Round 15
P = .010
Q near 0.0
69.16
9525.5</td><td>1st (Tie)
Round 15
P = .010
Q near 0.0
229.41
31356.6</td></tr>
</table>

Seven Organism Results Set 2				
(u,v)	P Decreasing		Q Decreasing	
	K = 57	K = 83	K = 57	K = 83
(20, 4)	**3rd (Tie)** Round 1 P = 0.0010 Q = 0.0020 N/A N/A	**5th (Tie)** Round 1 P = 0.0010 Q = 0.0020 N/A N/A	**3rd (Tie)** Round 1 P = 0.00050 Q = 0.00050 N/A N/A	**3rd (Tie)** Round 1 P = 0.000500 Q = 0.0005000 N/A N/A
(20, 10)	**4th (Tie)** Round 1 P = 0.0010 Q = 0.0020 N/A N/A	**2nd (Tie)** Round 1 P = 0.0010 Q = 0.0020 N/A N/A	**2nd (Tie)** Round 1 P = 0.0010 Q = 0.00075 N/A N/A	**2nd (Tie)** Round 1 P = 0.0010 Q = 0.000984 N/A N/A
(20, 18)	**2nd (Tie)** Round 1 P = .0019688 Q = 0.0020 N/A N/A	**3rd (Tie)** Round 1 P = .0019844 Q = 0.0020 N/A N/A	**2nd (Tie)** Round 1 P = 0.002000 Q = 0.000875 N/A N/A	**2nd (Tie)** Round 1 P = 0.002000 Q = 0. 0009922 N/A N/A
(100, 10)	**3rd (Tie)** Round 1 P = 0.0010 Q = 0.0020 N/A N/A	**3rd (Tie)** Round 1 P = 0.0010 Q = 0.0020 N/A N/A	**5th** Round 4 P = 0.0010 Q = 0.000125 325.67 40641.2	**3rd (Tie)** Round 1 P = 0.0010 Q = 0.0020 N/A N/A

Most of the ties in the second and third tables that accompany a round number of one are the default rankings for all the losing organisms in that setting. One must notice, however, that when our group wins, we usually win with a very high population and a very high total energy. When we are successful in a setting, our values are very high. When we are not, we obviously lose. Sometimes, however, we do get low values that still survive. In the multiplayer games, we do well, but we could have done better. In very harsh conditions, most of the players simply could not survive, but a select few would do well in certain situations.

In the first table, there is an obvious pattern. As the values of p and q decrease, our rank is actually better. When u and v are very close (20 and 18), we do very well. However, we do even better when u and v are far apart (100 and 10). As one goes down the table, our rankings get better. As one goes from the left to the right of the table, our ranking also gets better. We are pretty happy with our single player rankings.

We would also like to note that we were small brain organisms, for our organism was composed of less than 10,000 lines of code. This makes our single organism ranking even better, and it also makes our multiplayer rankings look better.

Our aim for our organism was to be able to survive very well in medium and low p and q values. Since we were conservative in reproduction and movement, we did well in those situations. We were also looking for a positive result when the value for moving or reproducing, v, is much lower than the value for energy per unit of food, u. That also occurred. However, we also did well when v and u were very close to each other, which was slightly surprising but still a welcome outcome.

Conclusion:

We were happy with our tournament results. We could hold our own in single organism situations, but we had difficulty, like many other organisms, in multiplayer situations. Nevertheless, we enjoyed this project. It's one step closer to a complex natural simulation. Seeing that this project has been slightly modified from a previous Organisms projects, we think that the continuation of this project (with or without modifications), would definitely be enjoyable. This project was probably the most imaginative and open-ended we had. The amount of ideas that came out in class were staggering. We had some fantastic ideas like farming (which was not very successful except for when the farm is a single cell) and some colony-like behaviors. Also, the adapting and evolving players were really great to watch. Just when one thinks they were beaten, they would have a steady and quick growth to overtake the other organisms.

A different perspective at the picture:

There was a short discussion in class about how these simple organisms can emulate nature. First of all, it deals with very simple factors and variables, and the massive and near infinite complexities and relations found in nature simply cannot be found in a simulator of this magnitude. Ignoring that, how complex should we consider our organisms?

The first possible answer is that each entity of the organism a group creates can work on its own, blind to the organisms around it. Since there is nothing even as complex as carnivorous behavior in this simulator, it does not have to worry about killing its own kind to survive. Attempting to eat live and healthy organisms of the same species is pretty unproductive in an evolutionary sense. I am convinced that a dumb player with no understanding of teamwork and hierarchy can perform very well in a simple simulator. Many real-world bacteria do not work together, and they survive very well. One obvious example is E. Coli: given the right conditions (like a human intestine), E. Coli can quickly reproduce to staggering numbers. And they just don't care what or who they are next to; they just keep reproducing.

The second possible answer is that the organisms live in one giant community. Each organism can take on a job, and these jobs are aimed at protecting the entire colony or key components of a colony. In this situation, we are leaving the realm of simple organisms. In fact, this reaches to the bounds of humans, where each cell works for a specific goal (such as getting oxygen from lungs to muscles or lining the stomach walls). A simpler example would be an ant colony. There are ants that harvest the food, there are ants that lay eggs (the queen), and there are ants that protect the queen. For this simulation, they can be interpreted as scouts, who look for food in case of a shortage, barrier organisms, that box in a certain amount of food for the queen, and the queen, who reproduces within the box created by the barrier organisms. Even with this simple example, the simplicity of the brains increases greatly. However, their success was evident in class. Although there were attempts at creating colony players, their success was deterred by the aggressive nature of the simple and highly reproductive players.

The third possible answer is just an extrapolation of the second answer: colonies can branch off to create more colonies. These types of organisms tend to do very well given enough room, for with more than one colony, the chances of at least one of them surviving (and possibly branching off again), increase greatly. One example of the success of this kind of activity of behavior in a group of people called the Hutterites. The Hutterites can be found in southwestern Canada and the northwestern United States. Each colony is called a Bruderhof. They are often compared to the Amish, although they do use electronic devices to increase their agrarian productivity. They even have a website! However, what's important is what happens when they have too many people in the colony. After they have enough specialists (teachers, shoemakers, cattle herders, etc.), they simple divide up the colony as evenly as possible, and one half gets up and moves away from the first colony. They keep their colonies spaced out so as to maximize their farmlands and consequently their productivity. This adds a bit more complexity to the second possible answer to the complexity question, but it is well worth it. Branching colonies tend to do very well. In fact, the Hutterites have an egg monopoly in some of the northern states of the Union. Closer to the realm of computer science, in class, we saw a player that held onto single cells as farms. When a scout was created, it goes to create another farm. This was a pretty successful and elegant player. Even if some of the farms were forced to die off due to aggressive players outside the farm, most of the time, at least some of the farms would still survive.

All of these are good answers, and they all exist and thrive in nature. I don't see a clear answer to the posed question, since we see so many good examples of each in nature.