Project 1: ORGANISMS

Group 1
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1. Overview

In this project, the goal was to create a species of organisms that survived under different conditions, with constraints laid on the environment in terms of the availability and amount of food available, the initial energy with which an organism was born, the energy spent in making a move, reproducing and staying put, and the energy per unit of food.

Thus the Organisms project provided us with a computationally difficult problem, with hidden parameters, knowledge of the domain restricted locally, constraint on the communication mechanism and the fact that the organisms had to survive in a very competitive environment with other equally intelligent players. While the single player setting was conducive to more flamboyant strategies, the multiplayer situation put a check on the extravagance of the approaches that could be used to attain continued success.

2. Ideas and Evolution

We were able to get an insight into the ideas that the previous year players implemented. Some noticeable observations were that many players specialized in certain environments, and performed poorly in others. A lot of interesting concepts were explored starting from staying dormant to various techniques of farming. The results of these strategies lead us to start thinking about an organism that can survive irrespective of the environment. This was not achieved by last year's participants due to the lack of knowledge and understanding of the food and board conditions early enough. While a lot of groups did put in a lot of effort in estimating the values of 'p' and 'q', the estimates were often misleading due to the intricacy involved in making such measurements.

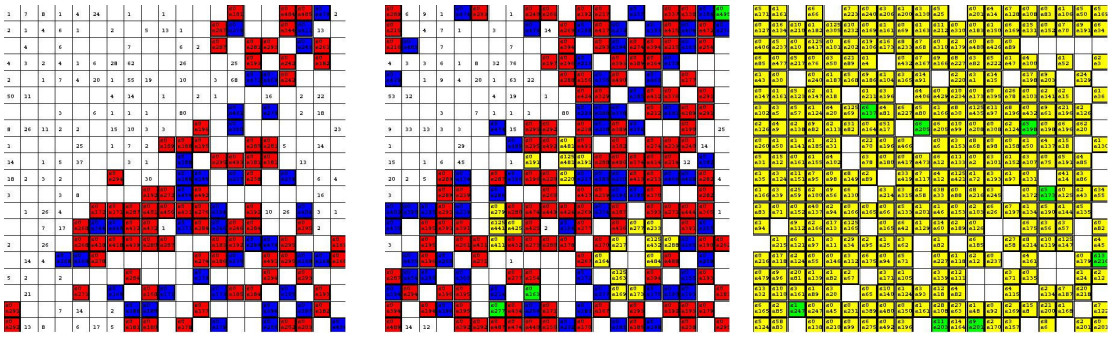
We started off by estimating 'p' in the single player environment, but in spite of a lot of different approaches, the final results were almost an order of magnitude away from the actual numbers. An important observation that came out of this was that distinguishing between environments was imperative, and not the actual numbers. It was possible to categorize the food situations based on a range of likely measures of the food available rather than the tangible values of 'p' and 'q'. A further simplification that we came up with is the lack of a need to estimate 'q'. This is because while an organism can sense the presence of food around it, the amount of food was known to it only after moving into that cell, thus making the knowledge of 'p' more crucial to an organism than 'q'.

3. Players and Methods

3.1 Single Player Strategy

Method:
We start off with 2 types of players, one that is uneducated and has a random motion, and another that is intelligent and goes about estimating ‘p’. Initially both types of organisms are produced on alternate reproduction moves. The intelligent organisms begin estimating ‘p’ by polling an adjacent cell for food, moving into it, eating the food completely, returning to its previous cell, and continues the above process until it gets 5 such measures of the food. An average over the 5 moves is taken to obtain the value of ‘p’.

The next step in this strategy is communicating the newly found measure of ‘p’ to the uneducated players as well as other intelligent players to get a better distribution of the estimate of ‘p’ over the span of the game. Thus, towards the later stages, the game is dominated by the intelligent players whose reproduction threshold is decided based on ‘p’. Higher the probability of food appearing, lesser was the threshold for reproduction.



In the above illustrations, red implies uneducated, blue implied intelligent, green implies knowledge of ‘p’ and hence enlightenment and yellow implies communication between organisms to propagate their knowledge of ‘p’.

Advantages:

- Better comprehension of the environment and hence better comprehension of the limit on reproduction
- Good communication mechanism amongst the players
- Exchanging of estimates of ‘p’ between intelligent players leading to smoothening out the outlier estimates
- Good coverage of the board by randomizing the motion
- Backup plan of the uneducated players surviving harsh conditions where the intelligent players might not survive the education phase

Disadvantages:

- Values of ‘p’ differ by an order of magnitude from the genuine values
- State and hence communication can easily be spoofed
- Strategy no good in multiplayer situations

3.2 Multiplayer Strategy: Red Hot Chilli Peppers

Method:
This method had only one type of player whose energy threshold at different stages in the game determined its rate of reproduction. Here, we followed on the idea first introduced by the previous year's team, Black Plague, where the ability of an organism to have babies increased with age! We used a more conservative approach in that the organisms had to grow in number as the game proceeds. This would lead to a larger population towards the later stages where we had to compete with other large enemy populations as well.

Each parent passed on information to its child, which consisted of the age of the game, and a decision whether the child had to move or not based on the number of enemy players surrounding the parent. The state of each organism was fixed to 4, and this was used to distinguish an enemy from a friend.

Advantages:
- Survived well under harsh conditions, due to the large population that went in search of food randomly
- The new organisms are born with the knowledge of their neighbors

Disadvantages:
- Performed poorly in all other situations
- Initial swamping was not sustained later due to the random movement and children moving away from the cells with food regardless of the amount of food left in them
- Mechanism for passing the state information was trivial and can easily be spoofed

3.3 Multiplayer Strategy: Red Dragon

Method:
This scheme aims at creating organisms that can survive irrespective of the environment by gauging the food availability very early into the game. Based on the estimated food availability in the first 50 moves, the organism adopts a conservative or an aggressive approach.

The game begins with all the organisms using an aggressive approach: reproducing, moving in a random direction, and trying to swamp the board, all the while monitoring the food condition. Thus, every organism till it reaches the age of 500, is a non conservative player.

The presence of food is measured by maintaining a ratio of the number of moves made by each organism to the number of cells with food it moved into. We used the offline training technique that was one of the ideas raised in class. The training was done by running mini tournaments offline and making note of the changing food ratio values that were seen by each organism in the early stages of the game. We observed that it only took 50 moves to get consistent values as the organisms were spread widely enough to

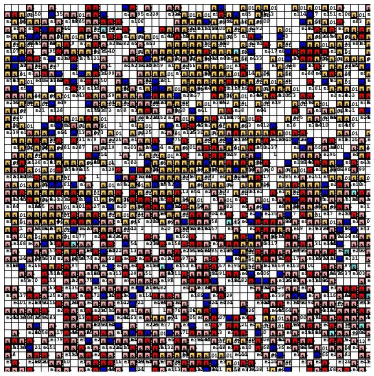
get a uniform estimate, and the number of enemies on the board were still limited. The following are the ranges of the food ratio detected for the various environments:

Food Ratio	Value of 'p'	Environment
0 – 5	0.01 – 0.008	Good
6 – 11	0.007 – 0.003	Moderate
> 11	0.003 – 0.001	Harsh

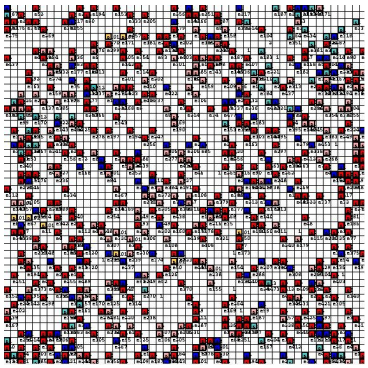
Once the environment is predicted, the organisms decide on the main strategy to be used for the rest of the game. The good conditions require that once the initial swamping is done, the organisms take a more conservative route, by reproducing only onto cells with food, and limiting movement to only when no more food is left in the current cells. The harsh conditions, on the other hand, require that that the organisms are non-conservative and go hunting! The organisms reproduced even onto cells without food in them, but made sure that the children went hunting for food. Another change was that the organisms moved if they had enough energy for 6 moves which is based on the values of 'u' and 'v' which is known to each of them.

Genetic Information:
Each parent passes onto its children a 32 bit key that is used to pass on the following information:

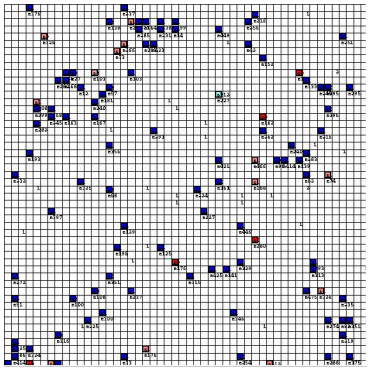
Bits	Information
0 – 9	Lineage
10	Move/not
11	Conservative/not
12	Go hunting/not
13 - 21	# moves
22 – 30	# cells with food



Good conditions



Moderate conditions



Harsh conditions

Advantages:

- Knows the conduciveness of the environment very early into the game
- Adopts a strategy based on the predicted environment
- Demonstrates complete dominance in moderate conditions
- Is able to survive most conditions

Disadvantages:

- Die out in the later stages in harsh conditions as the non conservative organisms are constantly moving, and do not stay dormant at any point of time

4. Tournament Analysis

Single Player

```
[X=50, Y=50, u=100, v=10, p=0.0050, q=0.01]
```
Group1PlayerFinal 132.84:28977.2:-1
```
[X=40, Y=40, u=100, v=2, p=0.0080, q=0.0020]
```
Group1PlayerFinal 612.79:160528.5:-1
```
[X=40, Y=40, u=100, v=10, p=0.0050, q=0.0020]
```
Group1PlayerFinal 85.38:20613.6:-1
```
[X=75, Y=75, u=100, v=10, p=0.0020, q=0.0]
```
Group1PlayerFinal 103.35:22975.0:-1
```
[X=25, Y=25, u=100, v=10, p=0.01, q=0.02]
```
Group1PlayerFinal 66.93:15961.9:-1

In case of the single player games in the tournament, we survived all the conditions, for the whole 5000 rounds, though the tournament results did not resemble the results we have seen with the same players in the same conditions in the mini tournaments that we ran. The results in this tournament show that the organism has lesser population in case of higher p value; whereas the tournaments we ran show that the population was proportional to the probability p for the availability of food.

Multi Player

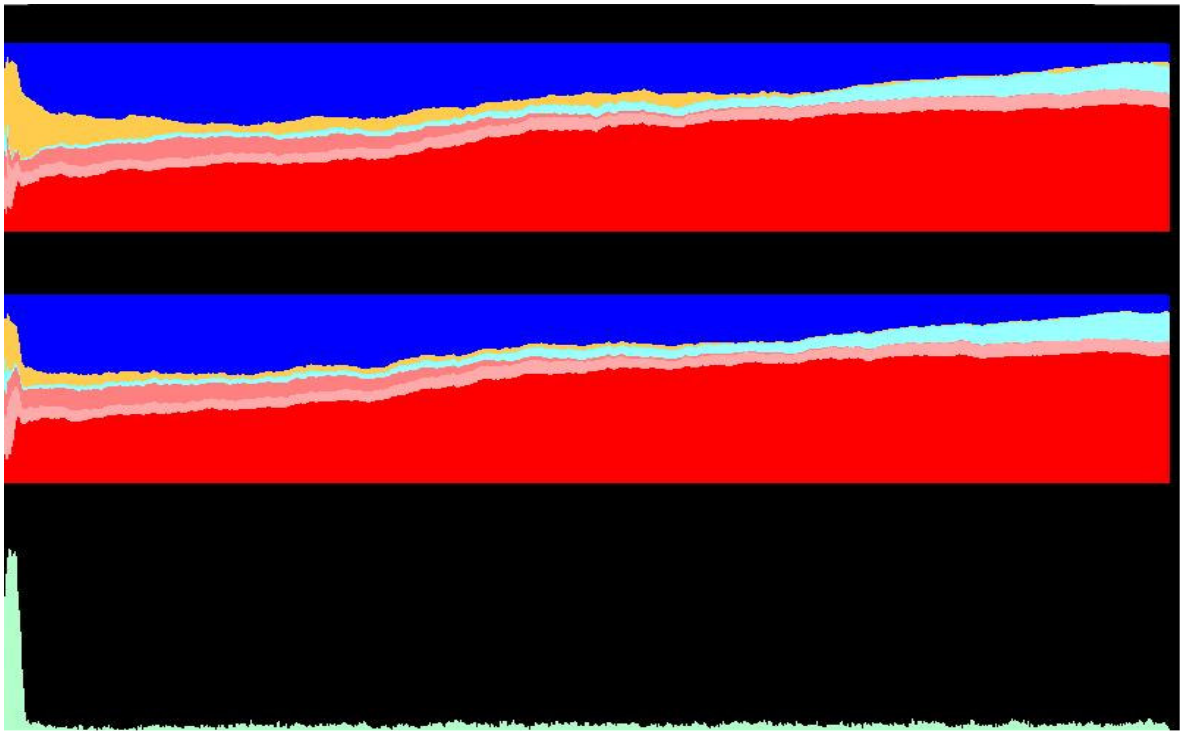
```
[X=50, Y=50, u=100, v=10, p=0.0050, q=0.01]
```
Group1PlayerFinal 0.0:0.0:567
```
[X=100, Y=100, u=100, v=7, p=0.02, q=0.2]
```
Group1PlayerFinal 652.85:166622.9:-1
```
[X=100, Y=100, u=100, v=7, p=0.02, q=0.2]
```
Group1PlayerFinal 652.85:166622.9:-1
```
[X=40, Y=40, u=100, v=2, p=0.0080, q=0.0020]
```
Group1PlayerFinal 27.93:6712.7:-1
```
[X=40, Y=40, u=100, v=10, p=0.0050, q=0.0020]
```
Group1PlayerFinal 0.0:0.0:508
```
[X=75, Y=75, u=100, v=10, p=0.0020, q=0.0]
```
Group1PlayerFinal 0.0:0.0:300
```
[X=25, Y=25, u=100, v=10, p=0.01, q=0.02]
```
Group1PlayerFinal 0.0:0.0:79

[X=50, Y=50, u=100, v=10, p=0.01, q=0.02]
Group1PlayerFinal 0.0:0.0:383
[X=50, Y=50, u=100, v=10, p=0.0050, q=0.0]
Group1PlayerFinal 0.0:0.0:457

In case of the multi player games in the tournament, again the results were weird in a sense that there was no pattern for the cases in which we lost as compared to the tournaments we ran. We survived in the case of p = 0.02, p= 0.02 and p= 0.008. We were surprised to see that we died in the case of p = 0.005, where we dominated all other players in the mini tournaments we ran. We also provide the results of the tournaments we ran.

[X=50, Y=50, u=100, v=10, p=0.0010, q=0.002]
Group1PlayerFinal 0.0:0.0:2457
[X=50, Y=50, u=100, v=10, p=0.0050, q=0.01]
Group1PlayerFinal 404.0:101329.0:-1
[X=50, Y=50, u=100, v=10, p=0.010, q=0.02]
Group1PlayerFinal 96.0:26370.0:-1

The results of the tournaments we ran were in accordance to what we expected. We dominated in the moderate environments with p = 0.005 with a high population of 404 by the end of 5000 rounds. In case of harsh conditions, we run out around 2500 moves, as the Group3 swamps the board. In case of good conditions, we survive the 5000 rounds with a small population compared to the Group7 player, but we have a large amount of energy for such small population, which lets us survive for a longer time. The graph shown below shows the dominance of our player in the moderate environments.



Moderate conditions

5. Conclusion

A lot of effort was put into making the organisms survive under any condition by predicting the environment very early into the game. Though we were able to predict the food availability accurately, the strategy employed thereafter was probably not that accurate. The organisms performed well in good conditions, dominated in moderate ones, but did not endure the later stages in harsh ones.

On the whole, Organisms was a very interesting project in spite of a huge number of ideas being explored previously. It was interesting to note that, while most of the teams last year specialized in certain environments, the focus was more on creating organisms that adapted to different conditions. We observed that most of the more elaborate and complex techniques used by other teams did not have the expected success rates, mainly because of the dynamics of a multi player game. More often than not, the organisms died out before they could execute the intricate patterns. Thus we can safely conclude that, the simpler the strategy, the better!

6. Acknowledgements

We would like to acknowledge the previous year player, Black Plague, from where we got the concept of being conservative.

We also want to thank Group 8 who came up with the idea of offline training initially, which we adopted for getting an idea of the food availability.