Hydrothermal Extremophiles

New Mexico

Super Computing Challenge

Final Report

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Team # 25

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Hydrothermal Extremophiles

Project Statement:

This year we have chosen to model a hydrothermal extremophile using star logo. We have been receiving information from a scientist studying our specific extremophile. We hope that our model, when fully finished, is an accurate representation of the actual bacteria and how it grows. We are trying to show others how there could possible, and probably, is life on other planets. Our example is a life form, bacteria, which can live in extreme places and without certain needs. A few extremophiles we have come across can live in lack of oxygen, light, and under pressure ten to a thousand times greater than the gravity no earth's surface. However the bacteria we have decided to focus on is a hydrothermal extremophile that thrives in extreme heat, and feeds off of the sulfur levels around the hydrothermal vents. Information on this subject can be very hard to find, because in this area of science, scientist have started to become more competitive in finding completely new life forms we have never before seen. Lucky for us we found Ruth Henneberger, who is lending us some of his observations from Mount Hood, in order for us to get an idea of numbers and variables.

So to quickly sum up our project, we want our model to be an accurate model of how bacteria grows, only we will have sped up time in order to se the bacteria on a population level.

Hydrothermal Extremophiles

Summary:

Our model, being our main project, is based on the information given to us by Ruth Henneberger. All based on his findings from Mount Hood on hydrothermal extremophiles. We have used Star Logo for our model. We have drawn out a landscape to represent a hydrothermal vent where our extremophile lives. The black around the vent is far to cold for the bacteria to live therefore the turtle dies. The next layer of brownish gray is a low to moderate living condition for the bacteria. After that the next two inner layers are prime living conditions for the bacteria supplying the best heat, and sulfur levels in order for the bacteria to survive. Final, the most inner layer is far to hot for the bacteria, and it dies off instantly.

Method for Modeling:

We stared our modeling looking at regular bacteria, and trying to copy how it grows, onto our model. We were successful in this process and therefore started applying new variables effecting its growth; do to its habitat and how it lives. Instead of living on oxygen it grows using sulfur, and must leave in heated conditions. So we set up limits for living conditions on both the turtles and the environment.

Research:

Our Research has all come from Ruth Henneberger and his findings on Mount Hood. Some of the information he has given us. He has supplied us with new variables, and numbers for the input of our model.

Results:

So far our model is still in a process where we are constantly change, or altering it slightly to get new results and to try and get our variables to work correctly with each other. Though when we do get to that point every now and then when we see our code in action, you can see the bacteria grow from one another, and how they react to various temperature, sulfur, and life limit changes. As we increase the temperature we can easily see a population spike; however, as the temperature drops rapidly we can see the bacteria quickly die off.

Conclusion:

We have indeed created a good working model that represents how a colony of hydrothermal extremophiles grow, and how they are affected by their environment.

Code:

Procedure:

```
turtles-own [Life]

patches-own [ph sulfur-level]


to grow

if ((random 100) < hatch-threshold) [hatch [fd 1]]

if pc = yellow [die]

if pc = black [die]

setsulfur-level (5 + (random 41) / 10)
```

```
setph (5 + (random 41) / 10)

settemperature (160 + (random 100) / 1)

ifelse (life < Life_Span) [setlife life + 1 repeat 8 [if ((random 100) < growth-rate) and
((count-turtles-at dx dy) = 0) [wait .5 hatch [setlife 0 fd 1]] rt 45]] [setc brown wait 2 die]

ifelse (temperature_limit < temperature) [die] [stop hatch]

if temperature_limit < 23 [setc brown wait 2 die]

if color = brown [stop hatch wait 2 die]

end
```

Observer:

```
globals

[vent-color

outer-vent-color

normal-vent-color

inner-vent-color

vent-hatch-threshold

outer-vent-hatch-threshold

normal-hatch-threshold

inner-vent-threshold

vent-temperature

outer-vent-temperature

inner-vent-temperature

normal-temperature]
```

```
patches-own

[hatch-threshold temperature]


to setup

ct

crt 50

set vent-temperature 250

set outer-vent-temperature 200

set inner-vent-temperature 500

set normal-temperature 150

set inner-vent-color yellow

set vent-color red

set outer-vent-color blue

set normal-vent-color brown - 3

set vent-hatch-threshold 20

set outer-vent-hatch-threshold 10

set normal-hatch-threshold 5

set inner-vent-threshold 0


ask-patches

[case patchcolor [vent-color [set hatch-threshold vent-hatch-threshold]

outer-vent-color [set hatch-threshold outer-vent-hatch-threshold]

normal-vent-color [set hatch-threshold normal-hatch-threshold]]]
```

```
ask-turtles
[setc green - 2
setlife 0
setlife_span 10
setgrowth-rate 10
settemperature 160
settemperature_limit random 160 + 145
setxy random random 360 random 360
seth 0
setph 7]
clearplots
set-project-name "The Growth of Hydrothermal Extemophiles"
end

to go
ask-turtles [grow]
end
```

Acknowledgement:

We would like to give a big thank you to Ruth Henneberger, who gave us nearly all of our information and research, as well as our code helpers Irene Lee and Nick Bennet.

Resources:

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