New Mexico SuperComputing Challenge

Final Report

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Project Title: STEM Reforestation Nation

Team Number: 43

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Executive Summary -

Deforestation is a problem because each year, trees get killed by pollution. In order to model this, we used NetLogo. We changed the Urban Suite Pollution model by removing loggers and adding power plants . The variables that we can change when we run experiments with the model are the pollution rate and the planting rate. We ran experiments with low, middle range, and high settings for these variables. From these experiments, we think our model suggests that pollution will go really low but never actually get to zero. Saying. Maybe, the pollution rate can drop to zero if we started planting more trees and if we stopped using power plants and relied on solar, hydraulic, and other sources of energy.

Problem Statement

The problem is that too many trees are being cut down (deforestation). Our project is to look at possible solutions which include: stopping too many trees from being cut down, planting new trees to replace what is cut down, and investigating how to protect the trees from loggers by limiting the amount they cut down. We think we want to find out which trees are most important to cut down and to regrow.

Problem Solving Method

The base name model from netlogoweb.org that we chose to use as a foundation for our model was "Urban Suite - Pollution."

We needed to create two variables to track over time; how many trees we are planting and how likely is each tree to die. We wanted to know, how does the code figure out when to make a tree go away? We also wanted to know, why are the trees dying in the code?

Then we added a slider for tree strength. We changed the life span of the trees by changing the beginning health when a tree is hatched from "set health 5" to "set health strength" so that's the slider.

Turtles own health in breeds. We could put trees' health and trees' lifespan so that they reflect different species (like elms). So that the strength of trees could correspond to species, we added a chooser where the user can pick between three different species represented by three different strength levels. We added notes to the chooser to show which strength level represented which tree species.

Next, we added a global variable, strength. We got an error code called "already widget named strength". It came up whenever we clicked the go button, so we needed to go delete the strength slider.

How We Verified and Validated Our Model

So first we started looking at loggers. We looked at how many loggers there are, and how we can help reduce the rate of logging. To do that we had different ideas on how to preserve trees. We said we could plant the trees in places the loggers can't get to, then we said we will reduce the amount of loggers.

But then while looking at loggers we changed to planting trees. In the model we first made trees, then we changed the strength of them to see how it will affect trees. While changing the strength of the trees, we put the strength conditions of them to very low, and that made all the trees die off. Then we put it to very high, and pollution was low, but too many people started to die off. We expected the tree population to decline, but they haven't died off yet. The trees were strong enough to last for thousands of years.

We kept testing and changing the strength of the trees by adding a slider for tree strength. Sometimes the trees died a lot faster than the people, but sometimes it was the opposite. We continued with our experiments putting tree strength at one (to see how fast it will die if the planting rate went up). So we first, changed strength and ran the model, then we changed the planting rate. We kept making one change, and then analyzing to see if it had an effect.

Another thing we did was we put the tree strength all the way down, and it equaled no trees, because when the tree strength was up, and all the planting rate was down, there were still many trees. Now if the planting rate was high, trees would die off quickly because there are a lot of them, and there is a net increase because the trees are being planted quicker than they die.

There are a lot more people than trees if less trees are planted, the green line and red line on the graph are very close together so as more people exist, more trees exist and same with The death of the trees. But on the last one the trees kept just going up and up even though people went up and down. So we changed the strength of trees to see how it affects the model. From very low (all died off) to very high (pollution low, too many people so starting to die off). We expected the tree population to decline but they haven't died off yet; they are very hardy trees and last for thousands of years, many generations.

For all of this testing by changing the strength of trees by adding a slider for tree strength, sometimes the trees died a lot faster than the people if they are not strong trees, but sometimes the people died first. We wanted to try putting tree strength at 1 and see how fast it died if the planting rate went up. So first, we change strength and

run THEN change planting rate. We always make one change and then analyze so we can tell if it had an effect. With strength all the way down, there were no trees because when strength up and planting rate all down there were still not being planted.

Next, we looked at planting rate high and saw trees die off quickly, but there's a lot of them and it's a net increase because people are planting quicker than the trees die - even though tree strength all the way at one it still takes like a year to die. When there are a lot more people than trees, it looks like the green line and red line on the graph are very close together so as more people exist, more trees exist and same with death. But on the last one the trees kept just going up and up even though people went up and down.

This is basically quality vs quantity. So we picked three types of trees to look at and compare to see how their resilience to the environment (how long they can stay alive) is more important than how many are planted.

Computational Model

```
breed [ people person ]
breed [ trees tree ]
breed [ polluters polluter ]

turtles-own [ health ]

patches-own [
  pollution
  is-power-plant?
  moisture
]

to setup
  clear-all

  set-default-shape people "person"
  set-default-shape trees "tree"
  set-default-shape polluters "square"

  ask patches [
    ;;set pollution 0
    set moisture one-of[12 30 50 80]
    set is-power-plant? false
```

```
  ]

  create-power-plants

  ask patches [ pollute ]

  create-people initial-population [
    set color black
    setxy random-pxcor random-pycor
    set health 5
  ]

  reset-ticks
end

to go

  if not any? people [ stop ]

  ask people [
    wander
    reproduce
    maybe-plant
    eat-pollution
    maybe-die
  ]

  diffuse pollution 0.8

  ask patches [ pollute ]

  ask patches [ pollute ]

  ask trees [
    cleanup
    maybe-die
  ]

  tick
end

to create-power-plants
  crt pollution-number[ set breed polluters set color red set shape "square"
    setxy random-xcor random-ycor]

end

;;ask patches
;;is any turtle here with breed = polluter [set pollution + pollution value]
;;diffuse pollution diffusion
;;end

;;to create-power-plants

  ;;ask n-of power-plants patches [
    ;;set is-power-plant? true
  ;;]
```

```
;;end

to pollute  ;; patch procedure
  if is-power-plant? [
    set pcolor red
    set pollution polluting-rate
  ]
  set pcolor scale-color red (pollution - .1) 5 0
end

to cleanup  ;; tree procedure
  set pcolor green + 3
  set pollution max (list 0 (pollution - 1))
  ask neighbors [
    set pollution max (list 0 (pollution - .5))
  ]
  set health health - 0.1
end

to wander  ;; person procedure
  rt random-float 50
  lt random-float 50
  fd 1
  set health health - 0.1
end

to reproduce  ;; person procedure
  if health > 4 and random-float 1 < birth-rate [
    hatch-people 1 [
      set health 5
    ]
  ]
end

to maybe-plant  ;; person procedure
  if random-float 1 < planting-rate [
    hatch-trees 1 [
      set health strength
      set color green
    ]
  ]
end

to eat-pollution  ;; person procedure
  if pollution > 0.5 [
    set health (health - (pollution / 10))
    set pollution (pollution - (moisture * .1) - (strength * .1))  ;;change .1s
to real data-
  ]
end

to maybe-die  ;; die if you run out of health
  if health <= 0 [ die ]
end

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```

Results

For our first test, we used the settings in the image below and then hit set up and

go to see what happened.

What we saw happen in our model is shown in the image below.
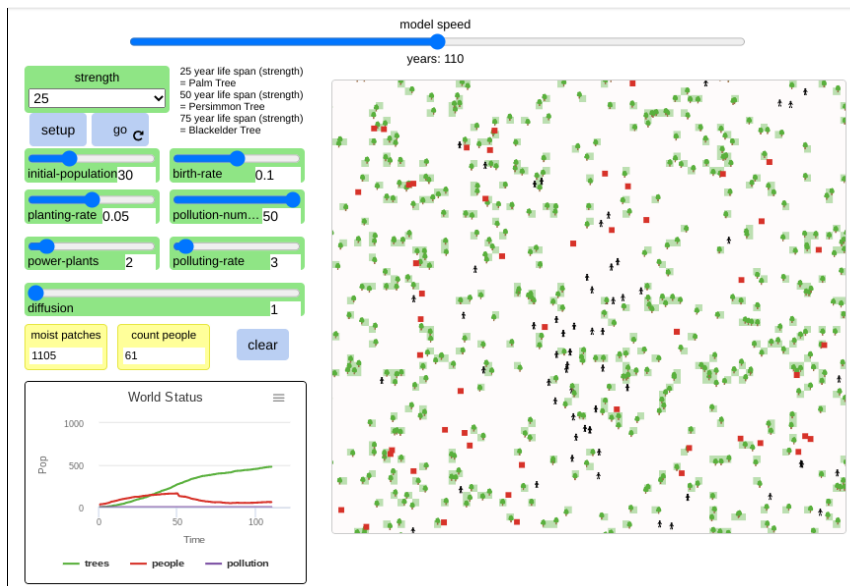
We let the model run for 110 years. The world status graph shows the amount of

trees, people, and pollution in the world (how much each one is growing). The red

square shapes in the model are pollution, the green tree shapes in the model are trees, and the black people shapes in the model are the people. So, what our model shows with these settings is that when the amount of trees went up and when the amount of people, over time, went down, then the pollution line kind of stayed about the same.

We thought the pollution line should have gone down because of more trees and less people. So we decided to see if that would happen if we started out with a higher pollution rate. So we changed the rate from 3 to 45 and ran the experiment again. This time the pollution line still did not change so we knew something wasn't working right. We ran the model again but this time tried putting diffusion at 90. This time the model still did not show a change in pollution. So then we tried to make the worst situation for the most pollution possible with the settings in the image below.
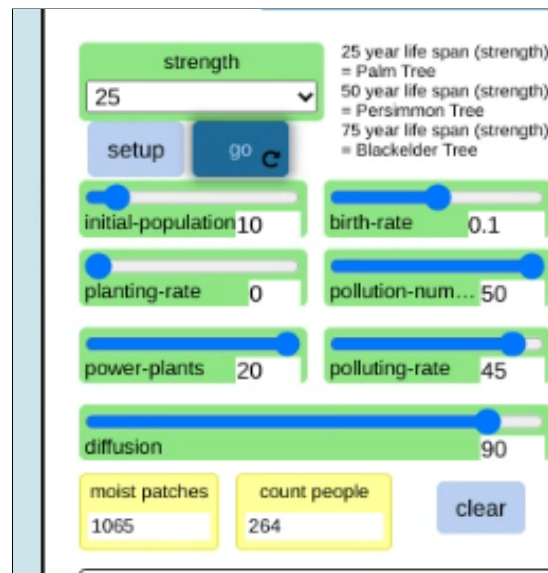
We put the initial population very low. We put the planting rate at zero. We put power plants as high as it could go and left the polluting rate up high at 45. We still had no change in the pollution line so we knew something was wrong with the code because we were not polluting.

This means that we have to find out what is wrong with our pollution and fix it. It turns out we had started to delete pollution lines in the code because we wanted polluting to be a breed instead of a turtle. But, we ran out of time to make all those changes, so to fix the issue, we decided to just go back to polluting the way the model was originally set up with power plants by reverting line 77 to the end of that section back from being commented out. We ran the model a few times to make sure it was working as we expected it to.

Then we were ready to run our experiments. First, we set our parameters to be initial population at 10, birth rate at 0.02, planting rate at 0.02, pollution number at 2, power plants at 1, polluting rate at 1, and tree strength at 25 and ran the model for 1,000 years. These are keeping the settings all at low levels. What we saw happen was everyone died by 60 years the first time, by 65 years the second time, and by 60 years the third time. The trees were dying off as well because they only live 25 years.

Next, we kept the same parameters but changed the tree strength to 50 and then to 75. With the 50 runs, everyone died and the trees were dying as well by year 60, and then year 57, and then year 51. With the 75 runs, the same thing happened but at years 57, 59, and 53. So they seem to be dying off a little quicker each time the strength of the tree goes up when all of the other settings are low.
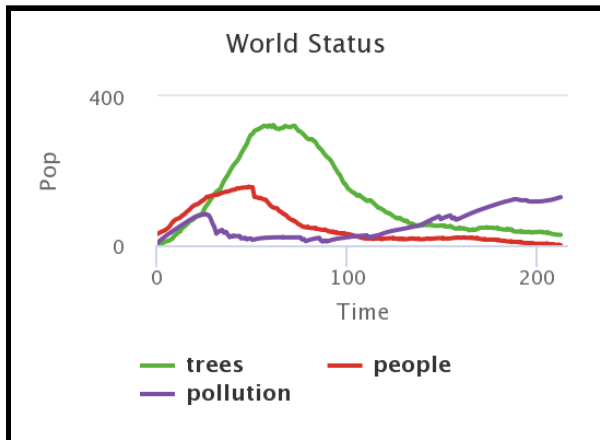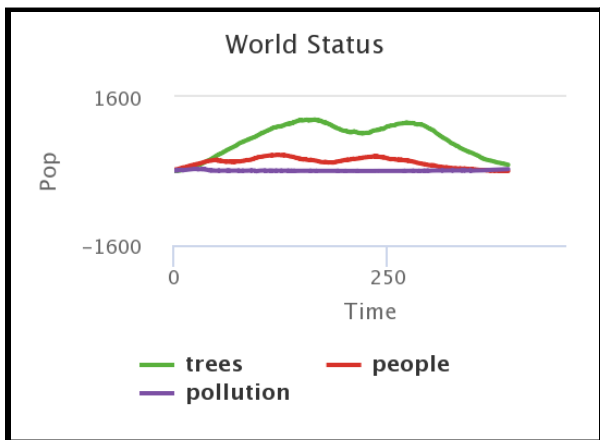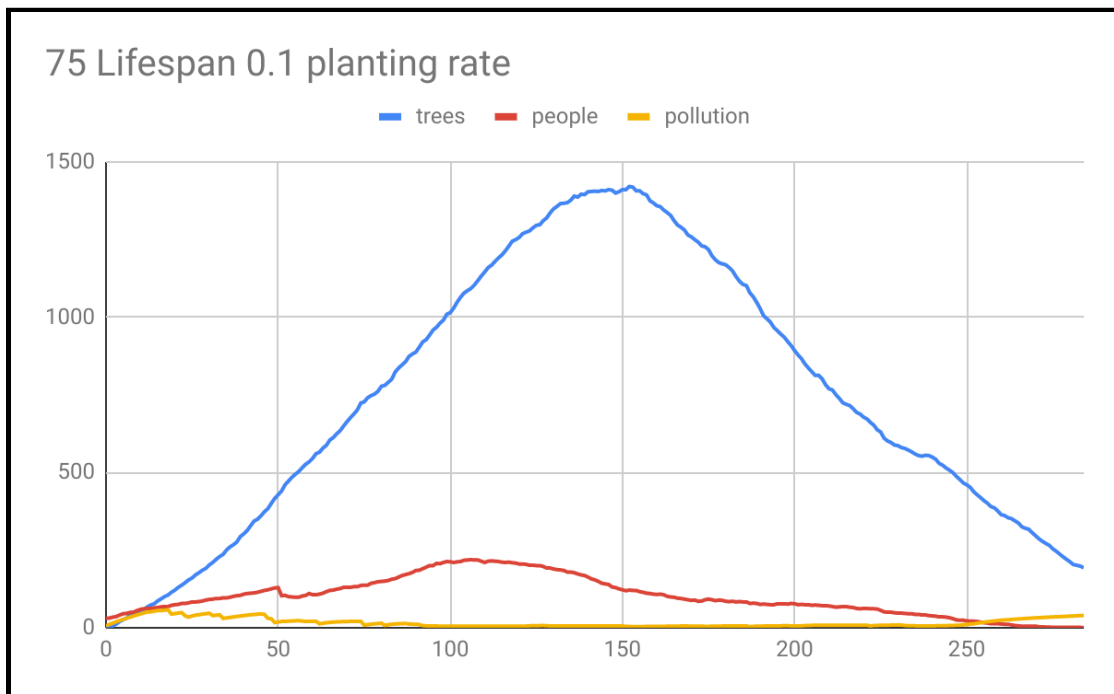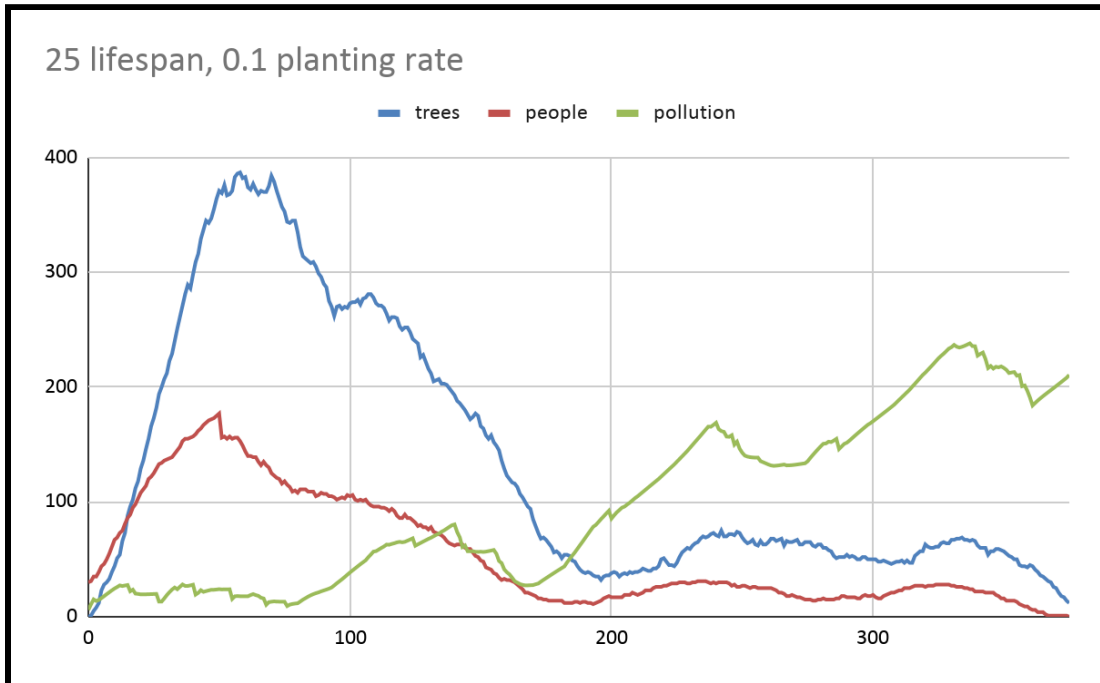
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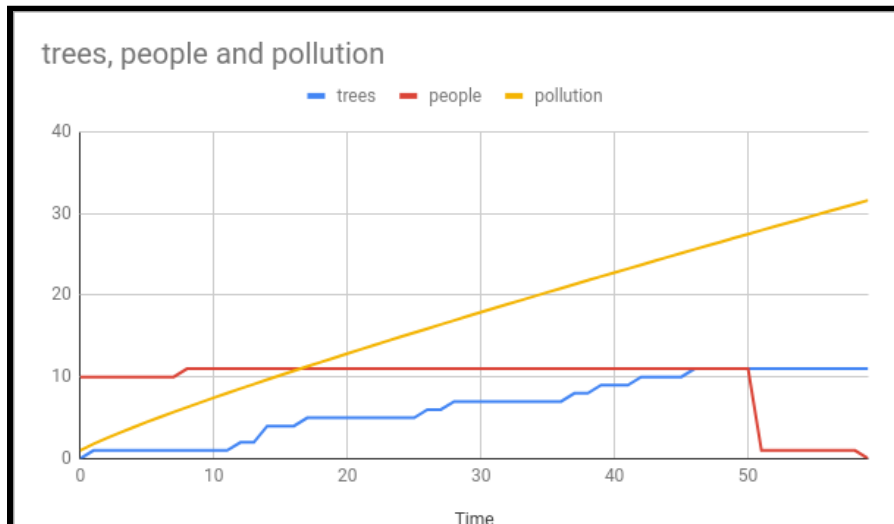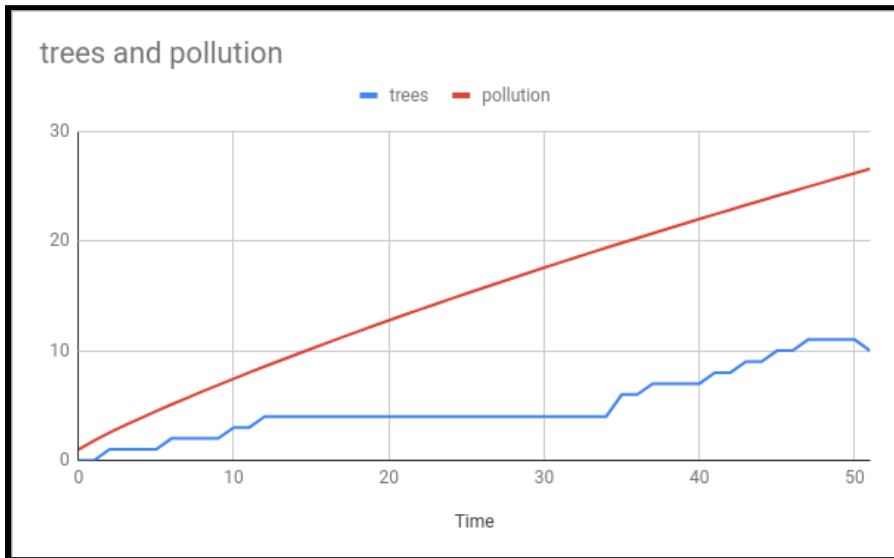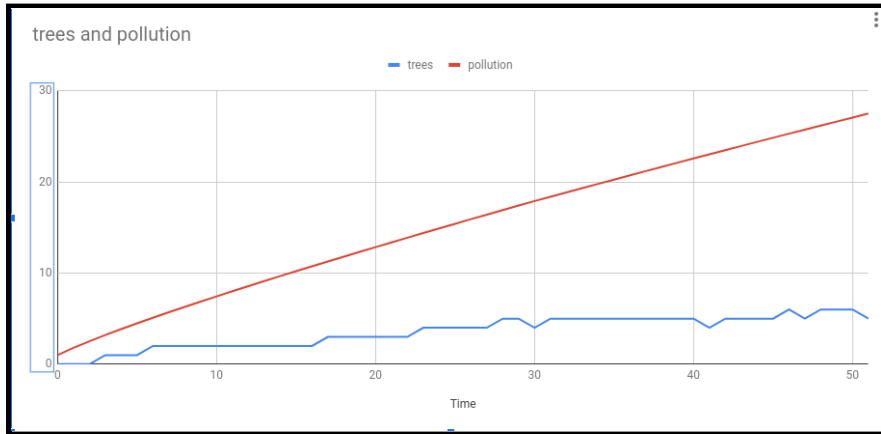
25 h .05 pr
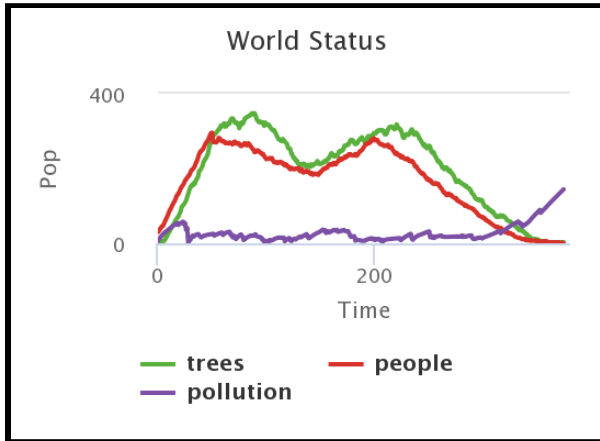
50 h .05 pr

75 h .05 pr

All High

Analysis

When settings are all low:

25: the trees kept on going up and up while the pollution is going straight up.

50: same as 25 but the trees went up more.

75: pollution went straight up and trees went up then stayed the same but the people stayed about the same but then they all died.

When settings are all mid range:

25: The trees went up then down then back up then all the way down while the pollution stayed about the same then went up.

50: The trees went up a lot but then went all the way down but the pollution stayed down but then went up.

75: The trees went up then down then up then all the way down and the pollution stayed down.

When settings are all high:

25: The trees went way up then down and the pollution spiked up and down but eventually up.

75: The trees went up then down and the pollution stayed down.

Most Significant Achievement on the Project

The most significant result from our model is that the pollution goes really low but never 0. So the fact that the pollution never hits 0 is scary cause we constantly breath it in and the trees are also dying from it. And the trees are going way up but dying at an alarming rate which is terrifying. And the people always go up a little but then die down and that's alarming cause we are only getting like 400 people then we die down.

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