Deforestation Simulation

New Mexico Military Institute (Team # 58)

Supercomputing Challenge Final Report

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1. Executive Summary

Deforestation is a major issue in our world. It reduces the number of trees in our ecosystem, resulting in a decrease in biodiversity and the depletion of natural resources Researchers estimate the abolishment of rainforests within one-hundred years at our current rate of deforestation; this proves the severity of deforestation. Trees are significant to our ecosystem. It absorbs the carbon dioxide and greenhouse gases in our atmosphere, which means that as deforestation accelerates, global warming will exponentially accelerate as well. The global warming rate will increase directly with the deforestation rate; the habitats and food of the countless plants, animals, and people on earth will decrease.

Our NetLogo-based simulation will find the optimal solution to delay our deforestation rate by finding the most efficient method of planting trees. A few variables our deforestation simulation will include is the population in an area, forestry growth, and the environment renewal rate. Our variables will be able to be adjusted using sliders, which is a convenient feature in NetLogo that allows us to change a variable without having to recode the procedure every time so that we can apply our simulation in any area. For example, by adjusting the number of populations, and our other variables, we would theoretically be able to apply this simulation to the U.S and by adjusting the values of the variables accordingly based on accurate research, we would then be able to apply it to Australia and other areas of the globe. Based on our research we have verified that our variables are realistic factors that greatly affect deforestation and will give us the most effective way of planting trees in an area.

2. Introduction

Deforestation is a global problem that has been occurring over the last few decades. Every year, an average of 15 billion trees were destroyed due to human activity and other natural disasters. It is very important to solve this environmental problem because this does not only affect and ruin the environment, but also affects people, animals, and plants; deforestation greatly affects the entire ecosystem.

Many schools in the United States teach students how to protect trees and participate in tree-planting activities. In other parts of the globe such as Africa, approximately 130 schools participated in planting trees to create an eco-friendlier environment. In schools such as Kyangombe Secondary School, located in Tanzania, 183 students, after being taught the severity of deforestation, have planted 1007 trees. If we take the product of the total number of schools that participated in this movement and set the number of trees planted by the students in Kyangombe Secondary School as the average number of trees planted per school, a total of 130,910 trees would have been planted just with one movement to help the ecosystem. Such educational approaches, as shown in Figure 1, into planting more trees do contribute to improving the health of the ecosystem. However, it would be great if there was a simulation that could make the process of learning how many trees would have to be planted for effective environmental renewal. That is what our simulation does.

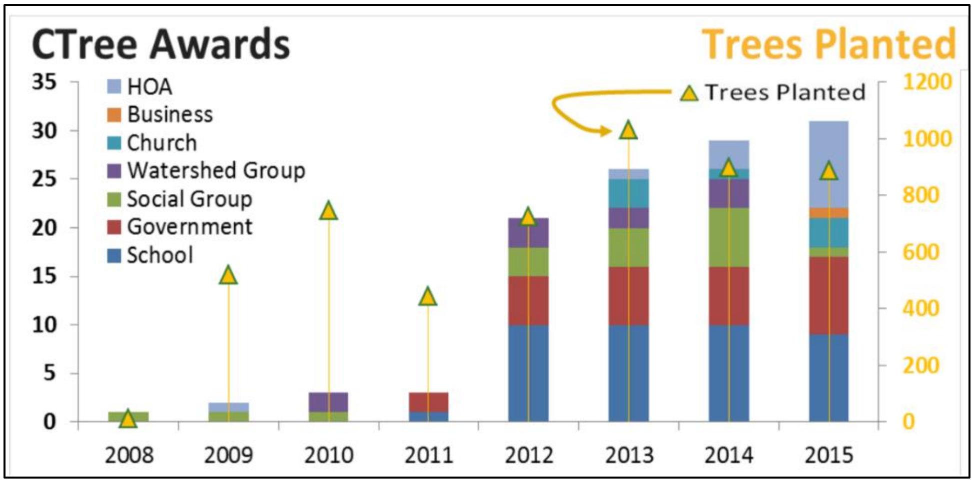

Figure 1 (The Effect of Education in Tree-Planting Activity): This is a graph that shows several organizations that are involved in planting trees. This does not account for every organization and individuals who planted the 15 billion trees but still proves that the number of trees increases significantly because of education.

We took a computational approach in figuring out what would happen to an area that has a certain number of trees continuously planted, a deforestation rate due to several reasons such as human activity and natural disasters, along with several variables that allow this simulation to be more realistic and applicable to real situations. The objective of creating this program is to influence people to plant more trees and allow students to realize the environmental problems the world faces today.

a. The Interface

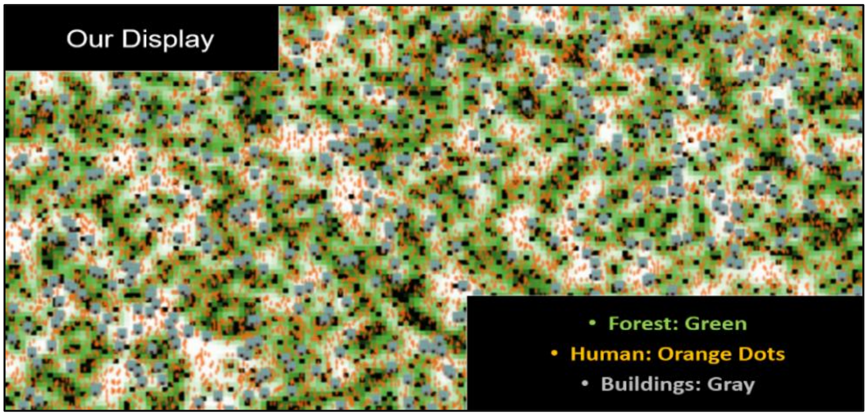

Figure 2 (The Display): The display consists of green, orange, and gray dots. The Green dots represent the trees/forest, the orange dots represent humans, and the gray dots represent the buildings in an area.

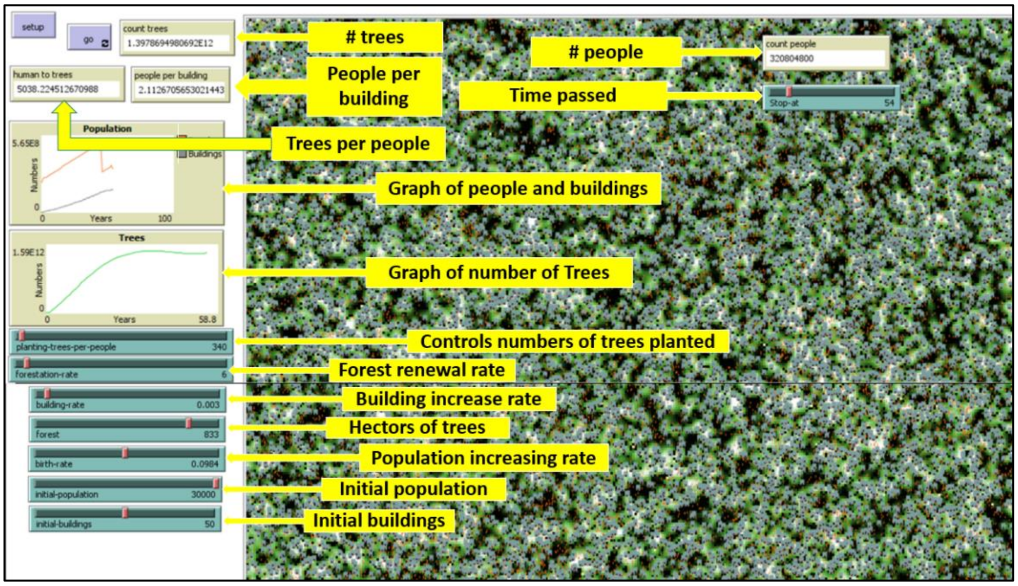

Figure 3 (Button, Graphs, and Variables): On the interface of our simulation, there are several buttons, graphs, and variables that allow us to control variables such as the initial population and the forest renewal rate so that we would be able to obtain more realistic results from this simulation.

3. Methods

This simulation was created with the NetLogo software. There are several variables used. The number of people and buildings are shown the interface. Each building and person have its own “age”. Every tick is one year and every year 0.1 of the turtles’ age decrease. When the age reaches 0 the turtle dies. Because the age of the population is the same at the beginning of the program, the program needs 54 years to even out the age of the population.

The actual program starts when the tick is 54. The variable values are set to the actual average values in the United States. When there are too many people compared to the number of trees, the reproduction rate decreases due to the shortage of oxygen. On the other hand, if the number of trees flourishes, the reproduction rate increases. The building rate is kept constant to match human to building ratio of 2.0~2.6:1.

The forestation rate specifies the density of the forest. As the forest expands, the density of the forest decreases as it reaches the edge of the area of the forest. If the density of the forest is low, the patch color is light green. If the density is high, the patch color is dark green. The buildings represent deforestation due to human activity. The program can be conducted by changing the values of the sliders. By using the sliders, we were able to get the values of what would happen if there are a few numbers of people planting trees, the building rate is high, or low.

The code

```
breed [people person]
breed [buildings building]
turtles-own [age]
patches-own
  [forestation
  is-there-forest?]
globals [new_person count_up]


to setup
  clear-all
  ask patches[set pcolor white]
  set-default-shape people "person"
  set-default-shape buildings "building"
   set new_person 0
  ask patches [
    set forestation 0
    set is-there-forest? false]
  construct
  ask patches [forestify]
  create-people initial-population [
    setxy random-pxcor random-pycor
    set age 4.55
    set color orange]

  create-buildings initial-buildings [
    setxy random-pxcor random-pycor
    set size 2.5
    set age 5]
  reset-ticks
  set count_up 0
end


to go
  if not any? people [stop]
  ask people [
    wander-around
    reproduce
    dwell
    build
    death]
diffuse forestation 0.8
  ask patches [ forestify ]
  ask buildings [
    clean
    death]
 tick
 set count_up (count_up + 1)
 If count_up = Stop-at [ stop ]
end
```

```
to forestify
  if is-there-forest? [
    set pcolor green
    set forestation forestation-rate]
  set pcolor scale-color green (forestation - .1) 5 0
end
to construct
  ask n-of forest patches [
    set is-there-forest? true]
end
to clean
  set pcolor yellow + 3
  set forestation max (list 0 (forestation - 1))
  ask neighbors [
   set forestation max (list 0 (forestation - .5))
  ]
  set age age - 0.1
end
to wander-around
  rt random-float 60
  lt random-float 60
  fd 1
  set age age - 0.1
end
to build
  if random-float 1 < building-rate [
    hatch-buildings 1 [
      set age 5
      set size 2.5]]
end


to reproduce
  if age > 4.36 and random-float 1 < birth-rate [
    hatch-people 1 [set age 5.2
      set new_person (new_person + 1)
      set color orange]
  ]
end

to death
  if age <= 0 [die]
end

to dwell
  if new_person = planting-trees-per-people [
    plant
    set new_person 0]
end

to plant
   ask n-of forest patches [
    set is-there-forest? true
  ]
end
```

```
to no-oxygen
  if (sum [forestation] of patches * 500 / count people) < 800 [set birth-rate birth-rate - 0.0000001]
  if (sum [forestation] of patches * 500 / count people) < 600 [set birth-rate birth-rate - 0.0000002]
  if (sum [forestation] of patches * 500 / count people) < 200 [set birth-rate birth-rate - 0.0000003]
  if (sum [forestation] of patches * 500 / count people) < 200 [set birth-rate birth-rate - 0.0000005]
  if (sum [forestation] of patches * 500 / count people) > 800 [set birth-rate birth-rate + 0.0000001]
  if (sum [forestation] of patches * 500 / count people) > 900 [set birth-rate birth-rate + 0.0000001]
  if (sum [forestation] of patches * 500 / count people) > 1000 [set birth-rate birth-rate + 0.0000001]
  if (sum [forestation] of patches * 500 / count people) > 1500 [set birth-rate birth-rate + 0.0000005]
  if (sum [forestation] of patches * 500 / count people) > 2000 [set birth-rate birth-rate + 0.0000005]
end
;gender
;affect of trees on population
```

4. Results

Our program can predict the number of trees and people in the future using real-life-based data from several reliable sources. After the program was finished, we ran many tests using several different independent variables and dependent variables to receive results of the number of trees 500 years before we apply our solution as well as the number of trees 500 years after we apply our solution.

We have many independent variables, but the main ones are the rate of tree growth, the rate of population growth, and the rate of building growth. By changing those variables, we would be able to obtain different results, which are the dependent variables such as the number of trees, the number of people, and the number of buildings after 500 years. Our control is data that we inputted according to the current average tree growth rate and population growth rate in the United States.

According to the data that we got from the test, the rate of deforestation is 288,000,000 trees per year if we continue our current deforestation rate, which would result in only 156,000,000,000 trees left in the United States in the next 500 years; the current number of trees in the U.S. is 300,000,000,000, which means we might lose almost half (48%) the number of trees that we have today. Another factor is the population, the current population is 328,000,000 with 770,000 people born in America every year, resulting in 713,000,000 people after 500 years.

The last variable is the building rate that increases by 342,000 every year. After 500 years, the number of buildings was 309,000, also, our current number of buildings is 138,000,000. However, after doing some calculations using our solution, we can reduce the rate of deforestation to 130,000,000 per year, which is about half of the rate before, and this will result in 235,000,000,000 trees after 500 years instead of 156,000,000,000 trees.

Also, more people will be born if we apply our solution. It increases the birthrate to 876, 000 people per year, but the results regarding population were not too different from before. The number of buildings decreases rapidly by using our solution, the number of buildings reduce from 309,000,000 buildings to 259,000,000 buildings which prevent the trees from being destroyed. Also, the rate of building growth reduces from 342,000 buildings per year to 242,000 per year.

5. Conclusion

Deforestation is a significant problem that needs an effectivesolution. Throughout the research our team conducted, we were able to create a program that predicts the number of people and trees so that this issue can be resolved more effectively in the future. In our program, we have created different independent variables that would correspond to an actual dependent variable. For example, the number of trees will come out as we input the correct independent variable which is the rate of tree growth in the United States. Also, we tested our program multiple times using different variables both before and after 500 years from the current time to determine and verify how significant the differences would be.

After completing numerous calculations, we found out that our solution will decrease the rate of deforestation. It is important to resolve the global deforestation problem in our world to prevent devastating climate changes and global warming. As our program has been working thoroughly, we believe it will provide an efficient way to plant trees and contribute to helping the deforestation problem.

6. Acknowledgments

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