CSE 6730: Computer Simulation
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Checkpoint 1 Submission

Project Introduction & Description

For our project, our team will be modeling forest fires. Annually, forest fires consume 4 to 5 million acres of land in the United States rending this land and anything else in the fire's path barren and charred. By attempting to model forest fires, we hope to be able to greater understand the factors that contribute to the spreading of forest fires in order to help people make more educated decisions about stopping them and inform preventative policy measures that can be enacted to curtail these fires.

Expected Approaches and Literature Review

At its core, we will be modeling where the fire has spread to at a certain time step (having started at time = 0), where it is likely to spread and where it has already been. This set up is well modelled by cellular automata models where each cell represents a discrete unit of a forest and is either aflame, not on fire, or already charred and thus not able to catch fire again. Cells that border those on fire naturally have a higher likelihood of igniting in the next time steps.

To begin, we will model this spread through a very basic cellular automata model that only takes into account whether or not surrounding cells are on fire. In this case, the forest is assumed to be uniform and therefore the probability of transition does not differ across the forest. Time is treated as a discrete unit. This model is very similar to basic ones used in models studying things like the spread of infectious disease.

Although this model will serve as a useful baseline, real forest fires are heavily affected by other factors in the forest. As explained in the paper entitled "A cellular automata model for forest fire spreading simulation" by Xuehua et al., other factors that influence the spread of fires include meteorological elements like wind speed, air temperature, and air humidity, as well as static factors like terrain and the natural combustibility of the trees in the forest. In our project, we hope to replicate some of the models presented in this work in order to incorporate these factors into a cellular automata model. Even within each of these categories, the factors are highly variate and thus can have an excitatory or retardant effect on fire. For instance, coniferous trees have relatively low water content and therefore burn relatively fast whereas broadleaf trees have higher water content and burn more slowly. It is our hope that by including some of these factors we can achieve a more accurate model of fire spread throughout a forest.

Other literature in the forest fire domain such as “Modelling forest fire spread using hexagonal cellular automata” by Encinas et al. suggests the use of hexagonal fields to model fire spread in order to get more accurate results. Their research also includes factors such as the influence of wind. We hope to incorporate this more complex cellular automata model into our tutorial as well.

Development Platform

We will be using Jupyter notebooks with Python3 to produce our tutorials and models.

Division of Labor

As we move forward on our project, we plan to work concurrently on different cellular automata models. Once we have a basic cellular automata working, we can each work separately on building models that incorporate things like wind, terrain, etc. and then combine this work into one model with all these factors. Additionally, we can run separate experiments with each of the other factors mentioned above.

Links

Git repo

- https://github.gatech.edu/hxu317/ComputerSimProject1.git

Sources

1. https://www.nationalgeographic.com/environment/natural-disasters/wildfires/
2. https://ieeexplore.ieee.org/document/7849971
3. https://www.sciencedirect.com/science/article/pii/S0307904X06000916