Modeling Australian forest fire spreading using cellular automata

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Introduction

In past months it was hard to miss, big parts of Australia are on fire threatening nature, humans and wildlife. Altogether, this makes it important and interesting to investigate how wildfires spread. In this project forest fires are simulated using cellular automata and influenced by a set of environmental factors. Therefore, our research question is:

Can a model using vegetation density, height, temperature, rain and wind data simulate fire spreading in Australia accurately?

The hypothesis is that simulating bushfires using cellular automata with this set of influential factors will produce results that will look natural. However, it is hard for such a simplified model to fully reflect real life.

Method

The numerical method used was 2D cellular automata (CA). The model differentiated between the cell states; empty, tree and fire. The rules for fire to spread to neighbouring cells were based on the following environmental factors:[1]

- Vegetation
- Height
- Temperature
- Rain
- Wind

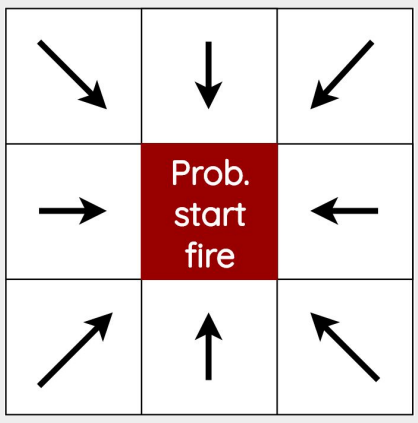

Figure 1: The probability for a tile to start burning was influenced by its environmental factors and the state of surrounding tiles.

The model was validated by satellite fire data for October, November and December 2019 provided by NASA.[2] For every day in this period, when a fire started in South-East Australia, the model initiated a fire at that specific location.

Results

In figure 2, the final result of the model can be seen. The figure shows which tiles are burned down or aren't altered. Figure 3 shows the sum of the amount of burned tiles in the data generated by the simulation, compared to historical data.[2]

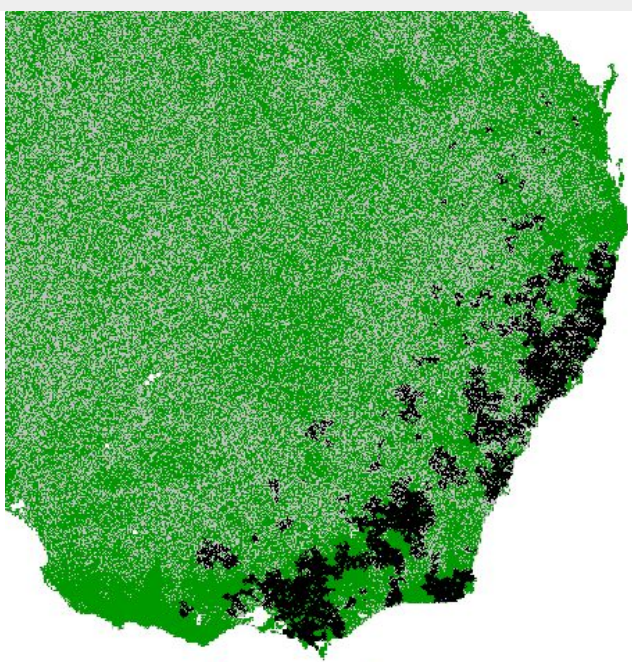

Figure 2: Final result after 90 days. Green tiles are vegetation, red tiles are burned down

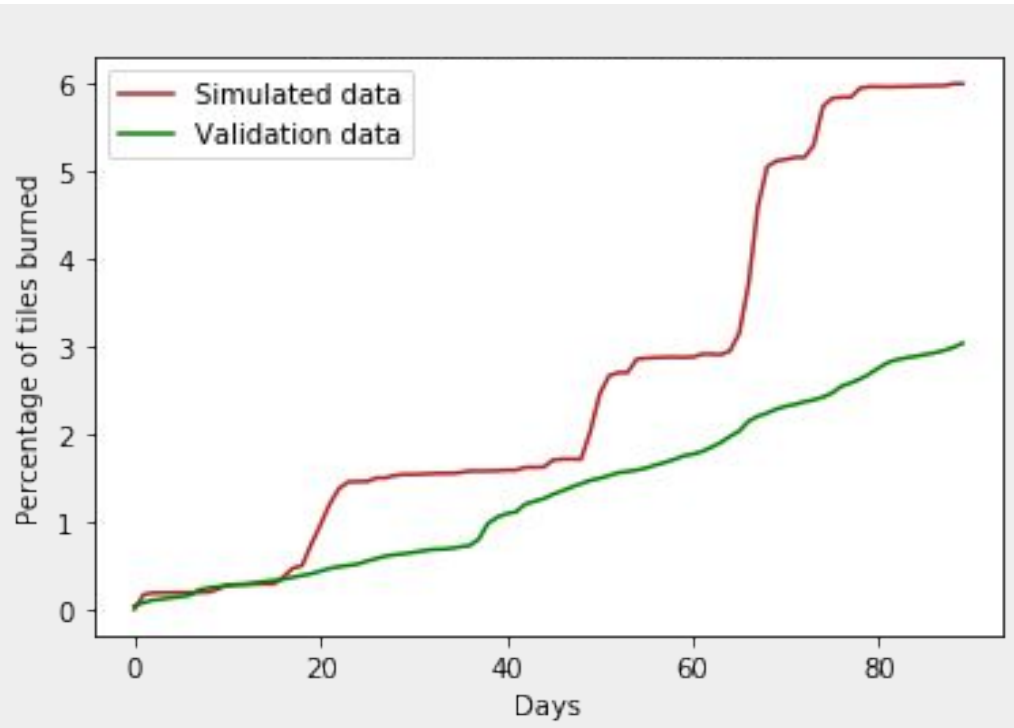

Figure 3: Time series comparing the percentage of tiles burned per time step.

Discussion

Figure 3 shows that the simulated data corresponds to the validation data strongly at the start, yet the data starts to differ increasingly in later timesteps. In this model, not every environmental influence is incorporated. Because of these missing variables, it cannot replicate real life exactly. Additionally, the resolution of the map of Australia is relatively low, which could have resulted in a less accurate simulation.

Future work

To generate more accurate results, many things can be further elaborated upon. The influence of each environmental factor can be fitted to more closely resemble their real life workings. Also, more of these factors could be incorporated into the model, such as humidity, lightning strikes, human activity, etc.

References

[1]Australian Government: bureau of Meteorology. Australian climate data. http://www.bom.gov.au/climate/. Accessed: 20-01-2020.

[2]LANCE FIRMS. Modis/aqua+terra thermal anomalies/fire. https://earthdata.nasa.gov/earth-observation-data/. Accessed: 07-01-2020.