

Fire – Forests

Description:

Forest fires are a well-known phenomenon. They occur periodically and are affected by many environmental conditions, including wind, rain, lightning strikes, and (re)growth of trees and other plants. Freemantle Forestry work with the Australian Government and local landowners to provide advice and support on how to manage forest fires and mitigate their effects. They are particularly interested in understanding the effects of rain, wind, and plant regrowth on the size and number of forest fires occurring. They have seen some results of simple models and are interested in understanding if and how they can be applied in more realistic situations. In particular, they are hoping to determine how such models work when wind direction, rain, or plant regrowth are taken into account. They are also interested in what the model can tell them about possible strategies to prevent or mitigate forest fires.

Aims:

Freemantle Forestry wish to understand some/all of the following:

- Can the model treat systems with wind, rain, and variable regrowth rates?
- If so, what does it tell us about the effects of these aspects on the size and frequency of forest fires?
- What are the effects of changing the regrowth rate, for example by planting different species?
- If there is a predominant wind direction, are certain shapes of forests less susceptible to fires?
- Is there any real-world data that the model can be benchmarked against? In particular, is it possible to determine reasonable values for any of the parameters?

An initial model:

Environment:

A two-dimensional domain, divided up into a grid of square cells.

Agents:

The cells themselves, which can be (i) flammable; (ii) growing; (iii) burnt; (iv) burning.

Algorithm:

The motivation for the model is that fire spreads to neighbouring areas. After trees have burnt they take some time to regrow and become flammable again.

For an arbitrary state, one update of the system consists of the following steps, performed in parallel for all cells:

1. **Spread fire:** a flammable cell with at least one burning neighbour becomes burning (otherwise it remains flammable).
2. **Burning:** a burning cell becomes burnt.
3. **Germination:** a burnt cell becomes growing.

4. **Grow:** a growing cell becomes flammable.

Reference:

‘Forest fires spread modeling using cellular automata approach’, Bodrožić, Ljiljana, Darko Stipaničev, and Marijo Šerić., Department of Modelling and Intelligent Systems, University of Split 2100, 2006.