Research Proposal

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Title: Modelling and Simulating Bushfires

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Background

The destruction caused by bushfires have led to great efforts into the prevention and minimization of their effects. One method to achieve this is to develop models, and simulate the effects that bushfires can have on the landscape, in order to handle current disasters and prepare for future threats.

The motivation behind this work is to provide fire managers with a robust statistical tool for determining short-term allocation of fire fighting resources [5] or facilitate the development of alternative strategies for ecosystem management [3]. In order to predict the spread of the fires accurately, an appropriate model is required.

A bushfire can be characterized as having complex behaviour that results from the inclusion of external influences and the inherent concurrency of the interactions between them [4]. Due to the advances in computer technology, the types of modelling techniques available to simulate complex systems has increased. One model has been the cellular automata approach. This consists of grids of cells where each cell is governed by a set of rules that are influenced by neighbouring cells.

Mraz et al. [6] had success in predicting wind driven bushfire shapes using fuzzy logic in cellular automatas. Their work was comparable to statistical methods and real data collection [2]. Ronald et al. [3] used the approach of artificial neural networks for modelling bushfires over a long term. They see their approach as having a significant impact on the management of areas where bushfires regularly occur. Shu et al. [8] took a different approach by using fractal modelling techniques to simulate the spread of bushfire fronts. The difference between the actual results and simulated results were about 7.4%.

Aim

The process of bushfire spread has self-replicating features because every cell on fire can ignite other cells around it which contain combustible material [8]. This creates a need to develop approaches to modelling such concurrent systems. My project will investigate the use of cellular automata as an appropriate simulation environment for modelling bushfires.

Rothermel [7] bases a fire propagation model on three general parameters:

- vegetation type, such as mineral content and density;
- fuel properties like flammability; and
- environment parameters including wind speed and direction, fuel humidity, and land slope.

Using these rules Wainer et al [1] developed a cellular model using Discrete Event Systems specifications (DEVS) with relative success.

My project will focus on producing a model that will enable users to create landscapes that include all of Rothermels parameters. Following this they would then be able to run a simulation of the effect of a bushfire .

Method

Initially I will research into how bushfires spread over landscapes under different environmental conditions. This will lead to ideas about how to design the overall system.

While researching how bushfires spread, and before any serious designs, time will be spent learning Swarm [9]. Swarm is a package used for multi-agent simulation of complex systems. It was designed to be used as the basic architecture to simulate collections of concurrently interacting agents [10].

Once there has been sufficient research into the dynamics of bushfires, the overall model of the system will be designed. Rules will be created to represent flammability and slope of the land, wind speeds, humidity, and other factors outlined in the research. A broad knowledge of the Swarm package will be a crucial part of this stage because of the need to develop a model that fits into the Swarm paradigm.

The implementation of the design will be the next challenge of the project. By then hopefully my knowledge of the Swarm package will be proficient allowing me to begin programming the application. Using Swarm I aim to describe the models' components and any plausible interactions between them.

Testing the system will go on throughout the implementation, including comments on the overall feasibility of using the cellular automata approach to simulating bushfires. The model will be compared to empirical data from actual bushfires collected during the research phase. More data will be collected as a comparison if necessary. This will give me a basis to decide if the rules chosen were correct or need modification.

When the model is complete, an overall assessment of using the Cellular Automata approach to modelling bushfires can be determined. At present it is difficult to have a timeline for the completion of each part of this project because of the uncertainty of each section.

Software and Hardware Requirements

The project will be created in the Linux X windows environment, using Swarm Libraries. Keeping it cross compatible with the Windows platform will be preferable and kept in mind.

References

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