Spark – A Bushfire Prediction Toolkit

The development of Spark was motivated by the need for a flexible and configurable bushfire prediction toolkit. The system can incorporate as many or as few elements of fire propagation as required. Spark enables the simulation of hours of fire spread at a landscape scale in a matter of minutes. The system has been developed with the capability to be customised for use in risk management, planning, fire spread research, fire response and many more applications.

Spark

Bushfires are natural events that have the potential to be devastating. **The ability to understand and predict the behaviour and spread of a bushfire is an ongoing challenge**. A strong need exists to develop accurate fire behaviour models from field observations or experiments and to translate these models into an operational environment.

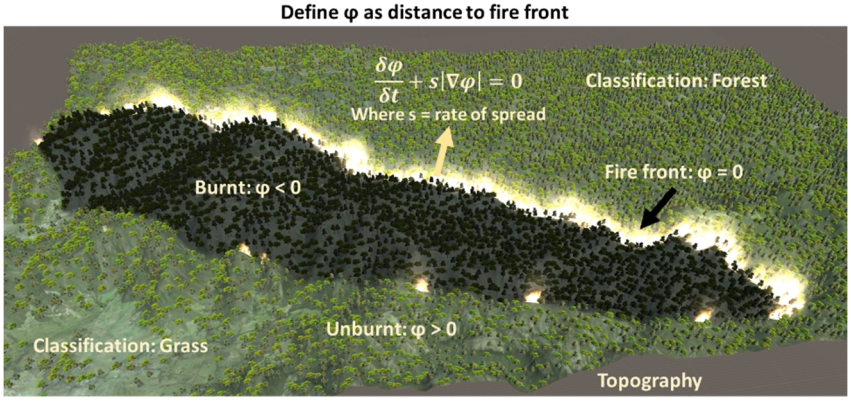
These requirements have led to the development of Spark:

- A tool to predict fire behaviour based on existing models.
- A research platform to build the fire behaviour models of the future.
- A configurable system to provide end-users with operational tools based on state-of the art predictive models and risk processing capability.

Spark uses scalable GPU-based processing, allowing it to be run on computers ranging from desktops to supercomputer clusters. The processing speed of Spark allows rapid evaluation of changing input conditions such as wind changes, the testing of suppression scenarios and construction of risk metrics.

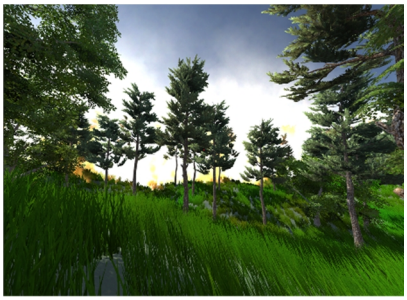
Fire propagation model

The system is based on a **level set** propagation model (see image below), allowing simulation of any number of distinct fire fronts, and multi-front interaction and coalescence as the fire evolves. The method is easily parallelised and enables simulations to run **much faster than real time**. Spark allows **any number of input data layers** to be used. Different fire spread rate models can be used for each fuel type, depending on any fuel or meteorological properties they require. These spread rate models are **fully programmable** within the workflow.



A multi-disciplinary approach

Spark is a built upon the collaboration of a range of disciplines, including **computational scientists** for effective implementation of a propagation models, **fire scientists** for fire behaviour knowledge, **statisticians** for effective analysis and **software engineers** to optimise efficiency of the system. Users can develop custom software modules for Spark, in order to meet their own requirements.



First person virtual reality view of bushfire

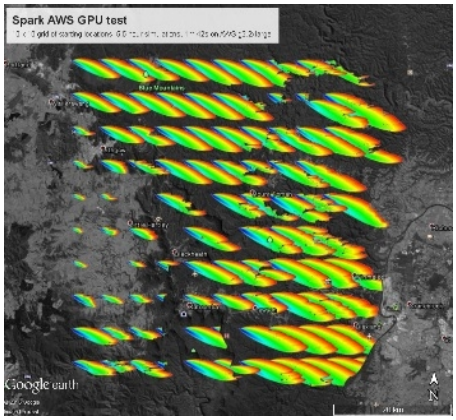
Maximum flexibility

Spark is built for the Data61 developed **Workspace**. Workspace builds up computational solutions using workflows. Each element of the workflow is connected together as required to create a system. Workspace has integrated **geospatial handling**, image analysis, virtual reality visualisation (see image), scripting, database, and **provenance reporting**. This makes Spark compatible with any standard data types.

Extra complexity according to requirements

A range of capabilities are included in Spark. Their use is dependent on the requirements of the application. These capabilities include:

- The use of sub-models which add **extra behaviour models**, such as spotting or road network impact, to the fire propagation model.
- **Ensemble analysis** capabilities which allows hundreds or thousands of simulations concurrently, enabling the use of a set of different weather conditions, or conditions picked from distributions (see image).
- Image analysis capabilities to provide the model with **input data and fire locations from aerial photography** and satellite data.
- An integrated **diagnostic (mass correcting) wind processor** for higher accuracy interpolation of low resolution wind data.
- The ability to visualise a bushfire using **virtual reality** for training and communication purposes (see image above).



Scientific research

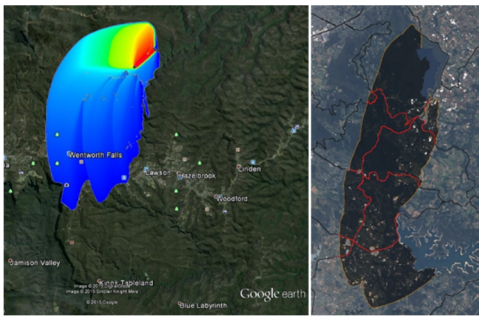
Spark is being used for scientific research into fire spread mechanisms. The flexibility of the toolkit allows new fire behaviour models to be tested. Spark is being used for research into **automatic fuel estimation** from remote sensing data, investigation of **variation in wind and fuel**, fundamental **forms of fire shape**, interaction with wind and terrain and to develop **new spot fire models**.

Planning

The ability to batch run Spark on multiprocessor machines means **thousands of simulations** can be run in parallel. These simulations could be run across different spatial locations and/or using different weather conditions as shown in the image above. Using custom processing tools, these can then be combined to produce customised **risk maps** over large regions or conditions.

Warning and response

Due to the fast computational time of Spark it is capable of being used in **emergency situations** for warning and response. The model provides arrival times for an area, shown in the left image, and can provide information on when communities and assets while be reached. Spark is also able to provide information on when roads are crossed, shown in the right image, for **evacuation management** and access information.



CONTACT US

t 1300 363 400
+61 3 9545 2176
e csiroenquiries@csiro.au
w www.data61.csiro.au

AT CSIRO WE SHAPE THE FUTURE

We do this by using science and technology to solve real issues. Our research makes a difference to industry, people and the planet.

FOR FURTHER INFORMATION

Mahesh Prakash
e Mahesh.Prakash@data61.csiro.au

James Hilton
e James.Hilton@data61.csiro.au

w https://research.csiro.au/spark/