Spark – A bushfire simulation toolkit

The development of Spark was motivated by the need for a flexible and configurable bushfire prediction framework. The system can incorporate as many or as few elements of fire behaviour as required, allowing the simulation of hours of fire spread at a landscape scale in a matter of seconds. 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.

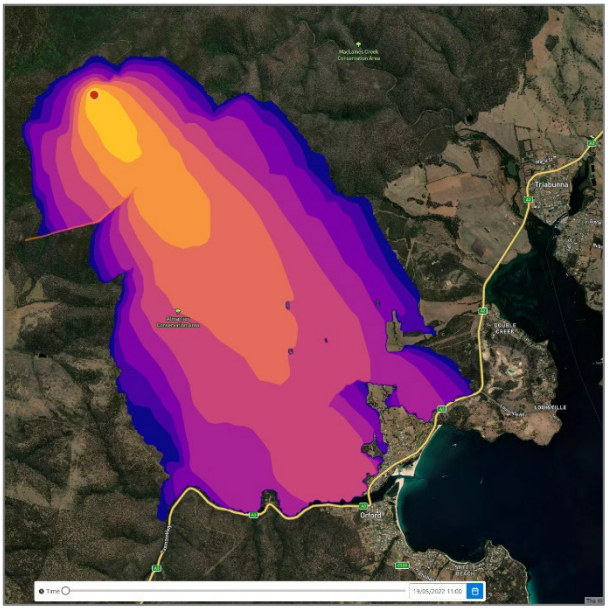

Figure 1 Spark web user interface

The challenge and our response

Bushfires are potentially devastating natural events. 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 and test the fire behaviour models of the future.
- A configurable system to provide end-users with operational tools based on state-of the 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.

The model

The system allows simulation of any number of distinct fire fronts, taking into account merging and coalescence as the fire evolves. Any number of input data layers to be used in common geospatial formats. 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. Similarly, the system allows models for the generation, transport and subsequent ignition of firebrands in a fully configurable manner.

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.

Maximum flexibility

Spark is built using Geostack, an open-source platform for accelerated geospatial modelling and simulation. Spark is written in Python for compatibility with common GIS processing and data workflows.

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 fire behaviour components, such as firebrand transport, local wind and pressure effects, disruptions and fuel breaks.
- Ensemble analysis capabilities which allow hundreds of simulations concurrently, enabling variation in weather conditions, fuel or ignition sources.
- A client/server architecture based on a REST API. This allows Spark simulations to be run through web-based calls and scaled as needed for demanding ensemble simulations or operations.
- A web-based user-interface providing a range of role-dependent capability from basic fire simulations to research model implementation.

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 firebrand transport models.

Operational warning and response

Spark will be used for national operations for predictive warning and response. The model provides location-based bushfire arrival times, giving information on when communities and assets could be impacted. Spark also allows mitigation and containment strategies to be simulated during ongoing bushfires.

Collaboration is key

To solve the greatest challenges through innovative science and technology, diversity of thought and collaboration is essential.

The Spark team are currently collaborating with a variety of organisations to expand the Spark toolkit.

Spark Operational – in partnership with AFAC and Minderoo Foundation, Spark is being developed to be utilised by Australasian fire and emergency service agencies.

Contact the Spark team to learn more.

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