Simulating Fire Spread with Python

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SHORT BIO(S)

Filipe Alvelos holds a PhD in Operations Research from the University of Minho (2005) and a bachelor's and master's degree in Electrical and Computer Engineering from the Faculty of Engineering of the University of Porto. He is an Associate Professor in the Department of Production and Systems, School of Engineering, University of Minho. He is also a researcher at the Algoritmi Research Centre/Associated Laboratory for Intelligent Systems. His area of expertise is the use of optimization to solve relevant social problems (e.g. kidney-exchange programs, forest management, fire suppression) from modelling to software implementation (python, C++, GIS). He has participated and has been the principal investigator of several national and international projects. He is currently vice-president of the board of the Portuguese Operational Research Association (2022-). He was chair of the conference 'Optimization and Wildfire', 1-4 October 2024, Luso, Portugal, and co-editor of the associated proceedings to be published in the series Lecture Notes in Operations Research, Springer.

WORKSHOP DESCRIPTION

Wildfire management includes many planning and operational activities. In many of them, wildfire spread simulation plays an important role.

For example, by running wildfire spread simulations under different conditions (e.g. locations of the ignitions or winds) it is possible to obtain burn probabilities of different areas. Other examples include the evaluation of the need to evacuate populations, the management of firefighting resources, or fire-smart forest management. We briefly refer to each of these applications.

A crucial measure for deciding if a population must be evacuated is the fire arrival time at different points of the landscape, which are provided by the fire simulation.

Within the scope of the management of firefighting resources, a problem that has been addressed recently through fire spread simulation and optimization is, given an ignition or set of ignitions, decide how to conduct the initial attack, i.e. which resources to use, where to attack fire and which routes should the resources use.

Fire spread simulations can also play a relevant role in fuel management, or, more generally, in forest management, where selected prescriptions and or / operations and / or fuel breaks locations may be supported by it.

This workshop has the main objective of introducing the concepts and methods used in fire spread simulators.

Objectives

1. To understand fire spread models that are used in landscape level simulation software (e.g. FlamMap)

2. To implement and run a basic fire spread simulator coded in Python

3. To visualize fire spread from the outputs of the basic fire spread simulator

Contents

1. Fundamentals of fire spread modelling at a landscape level

2. Computational implementation of a model

3. Fire spread simulation

4. Data gathering and fire behavior models

5. GIS and visualization

Activities

1. Exposition of existing fire spread models.

2. Programming the basic fire spread simulator: defining a fire network, using shortest path tree algorithms, validating.

3. Defining input data

4. Formatting output data and visualization.

Pre-requisite: basic python programming

Participants need to install:

- a python IDE (e.g. spyder)

- networkx and geopandas packages

- QGIS (optional)

Keywords: Fire Spread Landscape-level, Programming, Minimum Travel Time Principle

More information

Length of the workshop:	3 hours
Number of participants:	Minimum 3 / Maximum 10
Special facility needs:	Participants laptops with: - a python IDE (e.g. spyder) with the networkx and geopandas packages - QGIS **(optional)** - Internet