ISA

Seminar
Wildfire and Optimization
Prevention and Suppression
April 8, 2024
Salão Nobre, ISA

14:30 Welcome and Introduction

14:35 Fire Suppression: Optimization Models and a Software Prototype
Filipe Alvelos (Professor at Universidade do Minho, Member of Algoritmi, Principal Investigator of O3F)

15:05 Forest Road Network for Firefighter Access
Miguel Constantino (Professor at Ciências ULisboa, Member of CMAFcIO)

15:35 Coffee Break

16:00 Forest Management: Integrating Mixed Integer Pro4gramming and Fire Spread
Isabel Martins (Professor at ISA, Member of CMAFcIO, Co-Principal Investigator of O3F)

16:30 An Integrative Approach to Reduce Fire Impacts: from Forest Management to Landscape Fire Mitigation Planning
Ana Sá (Senior Researcher at CoLAB ForestWISE)

17:00 Closing Discussion

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Wildfire and Optimization
Prevention and Suppression

Fire Suppression: Optimization Models and a Software Prototype
This presentation discusses optimization models for dispatch, routing, and positioning of resources for forest fire suppression.
These models are based on the principle that fire follows the fastest path between any two locations in a landscape, allowing the modeling of fire spread as a set of shortest paths in a network. The developed optimization models rely on this network and the estimation of fire spread speeds in homogeneous conditions (obtained based on fire behavior models that consider slope, fuel, and wind).
These optimization models not only simulate fire spread but also define the best attack positions for each available resource (ground or aerial) and the route they should take from their bases to these positions, for example, to minimize the burned area.
Furthermore, a software prototype is discussed, which implements these models and utilizes the Python framework pyO3F (developed within the project "O3F · An optimization framework for reducing forest fire"). The software's operation is illustrated in a landscape in Portugal.

Forest Road Network for Firefighter Access
Forest fires pose a growing threat to the environment, economy, and human life, demanding immediate prevention and firefighting strategies. Despite the vital role of forest roads in granting access to firefighters, their planning frequently overlooks firefighting requirements. In this presentation, we introduce models designed to identify the most cost-effective road network for ensuring firefighter access to the forest within a 200-meter range. We discuss models for both single-path and dual-path access. Additionally, we present results from a case study conducted in the Vale do Sousa forest**.**

Forest Management: Integrating Mixed Integer Programming and Fire Spread
A major activity in forest management is planning silviculture activities. Mixed integer programming (MIP) has been used to obtain optimal plans considering management objectives and constraints (e.g. carbon stock, biodiversity, and soil erosion). Our contribution is addressing fire not as an attribute/parameter of the MIP model, but by simulating its spread. Initially, the MIP model is solved. Subsequently, a worst-case fire spread simulation is conducted to identify fire paths with an excessively high rate of spread. Each identified unacceptable path results in an additional constraint in the MIP. This process is repeated until no unacceptable paths are identified, ensuring that no fire paths will have a rate of spread higher than a specified threshold.

An Integrative Approach to Reduce Fire Impacts: from Forest Management to Landscape Fire Mitigation Planning
Forest management planning to reduce fire risk requires an integrative bottom-up wildfire management approach. Besides forest management objectives towards improving forest yield and protecting values against fire impacts, it is crucial to integrate any fuel management plan in a fire hazard landscape context. Landscape strategic placement of fuel treatments is necessary to reduce fire exposure, mitigate future wildfire impacts and create opportunities for safe fire suppression. A case study is presented to show how fire spread and behavior simulations can aid decision-making in wildfire management.