Emulation of Wildfire Rate of Spread Models in the Context of Surface Fire Spread Simulation

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Résumé

Wildfires pose significant threats due to their destructive capacity and complex propagation behavior, necessitating accurate prediction models for effective forest and fire management. The rising hazard of extreme wildfire events, coupled with the increasing availability of high-resolution data-such as surface wind forecasts, satellite images, and lidar measurements for fuel characterization-makes this a hot topic of research particularly suitable for data-driven innovations. In this work, we present an innovative hybrid approach that integrates a front-tracking method, designed specifically for handling wildfire spread (asynchronous updates, no mass conservation), with a neural network which can be trained to predict the fire rate of spread in correspondence of the evolving surface markers. For every marker, the model leverages features from the physiographic and meteorological data which are given as input to the model in the form of high resolution maps. We present a proof of concept where this wildfire emulator is trained to learn state-of-the-art rate of spread (ROS) model. In a first approach by using Sobol sequences to cover the model parameter space, then by training the model on datasets built directly from running simulations. Further development will involve in-built wildfire emulators where the ROS is learned directly from data, given sufficiently detailed fire propagation contours along with available meteorological and geophysical data.

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