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Predicting the forest fire duration enriched with meteorological data using Feature Construction Techniques

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Abstract: The spread of contemporary artificial intelligence technologies, particularly Machine Learning, has significantly enhanced the capacity to predict natural disasters. Wildfires constitute a prominent example, as machine learning can be employed to forecast not only their spatial extent but also their environmental and socio-economic impacts, propagation dynamics, and even their duration. Such predictive capabilities are of critical importance for effective wildfire management, as they inform the strategic allocation of material resources, and the optimal deployment of human personnel in the field. The necessity of leveraging machine learning tools has become imperative in our era, as climate change has disrupted traditional wildfire management models due to prolonged droughts, rising temperatures, and the increasing frequency of extreme weather events. For this reason, our research seeks to fully exploit the potential of Principal Component Analysis (PCA), Minimum Redundancy Maximum Relevance (MRMR), and Grammatical Evolution, both for constructing Artificial Features and for generating Neural Network Architectures. For this purpose, we utilized the highly detailed and publicly available datasets provided by the Hellenic Fire Service for the years 2014–2021, which we further enriched with meteorological data, corresponding to the prevailing conditions at both the onset, and the suppression of each wildfire event. The research concluded that the Feature Construction technique, using Grammatical Evolution, outperforms other methods in terms of stability and accuracy. Specifically, the model accuracy of wildfire duration using Feature Construction, the mean error was 8.79%, indicating an overall accuracy of 91.21%.

Keywords: Forest fires; Machine learning; Neural networks; Feature Construction; Genetic Programming; Grammatical Evolution

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