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Tentative Title: Predicting Largescale Wildland Fire Events in Canada and Alaska Using Convolutional Neural Networks that Pay Attention to Spatial Interactions

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Abstract:

Climate change is associated with increasing climate variability and extreme weather events. In some areas, that is leading to an upsurge in extreme wildfires, primarily driven by extreme fire weather conditions. The boreal forest regions of Canada and Alaska are among those areas projected to experience substantial increases in both the area burned by wildland fire and wildland fire intensity. At the same time, the wildland urban interface is expanding, increasing the areas where active wildfire suppression is required. The result is mounting pressure that threatens to overwhelm fire management agencies, many of which are already grappling soaring costs and workloads.

This study employs emerging technologies to develop a predictive framework for largescale wildland fire events. At large spatial scales and relatively short temporal scales, such events often cluster in response to extreme weather events, rather than occurring randomly. Reliably predicting these event locations would provide valuable information to support resource allocation, risk management, and proactive prevention measures.

Many attempts to predict wildland fires use model frameworks that are inherently spatially agnostic. Such models cannot consider spatial context when making predictions. This study proposes a deep convolutional neural network (CNN) model that can capture both localized and overarching spatial and temporal patterns. The CNN is enhanced by attention mechanisms that help detect variable importance and interactions at varying spatial scales, bolstering model contextualization.

This research addresses three questions: (1) Can a deep convolutional neural network architecture be designed to develop a contextualized largescale wildland fire occurrence prediction model? (2) Can the predictive power of such a model be enhanced by using a broad study area to capture both mesoscale and synoptic weather patterns? (3) What input variables are most valuable for predicting wildland fire events across Canadian and Alaskan forest regions, and are there regional variations in variable importance?

Ultimately, the study aims to contribute to a safer, more sustainable, and cost-effective approach to mitigating the impact of largescale wildfires in these critical regions.