CS230

Wildfire Prediction Using Deep Learning Models for Remote Sensing Data

Project Category: Computer Vision

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1 Introduction

Climate change is making extreme weather events more probable and intense and it is becoming increasingly important to estimate extreme event risk to build informed resilience. Wildfires are one such event of extreme importance, especially in California where wildfire risk is high. For authorities to implement consequential wildfire management, accurate estimation of wildfire likelihood is essential.

We propose a deep learning model for predicting wildfire occurrence based on remote sensing data of factors influencing wildfires such as topography, max/min temperature, precipitation, drought index, wind speed, Normalized Difference Vegetation Index (NDVI), and humidity. Given the features influencing wildfire, we predict the spread of wildfire the *next* day.

2 Data

We use the remote sensing data aggregated by Huot et al. [2021] from various data sources available in Google Earth Engine (GEE).[1] Here, we provide a brief description of the data.[2]

The data consists of remote sensing images (across United States) of size 64km x 64km at 1 km resolution and includes input features that influence wildfire: elevation, wind direction and wind speed, minimum and maximum temperatures, humidity, precipitation, drought index, normalized difference vegetation index (NDVI), and energy release component (ERC). The historical wildfire data consists of fire masks at time t and at $t+1$ showing the locations of 'fire' versus 'no fire', with an extra classification for uncertain labels. Fires separated by more than 10 km are considered to be belonging to a different fire. For the purpose of machine learning algorithm, the fire mask at time t is considered as an input feature.

The objective is to predict where the fire will spread on date $t+1$ given input features at date t. Figure 1 displays examples from the dataset where each row represent one example.

In Figure 1, each row corresponds to the input features and fire mask at time t at a particular location. As mentioned, the fire mask at date t is considered as an input feature and labeled as the 'previous fire mask' whereas 'fire mask' corresponds to the $t+1$. In the fire masks, red denotes fire, while grey implies no fire. Black indicates uncertain labels.

[1] The dataset is posted on Kaggle by the authors.
[2] Details can be found in Huot et al. [2020, 2021].

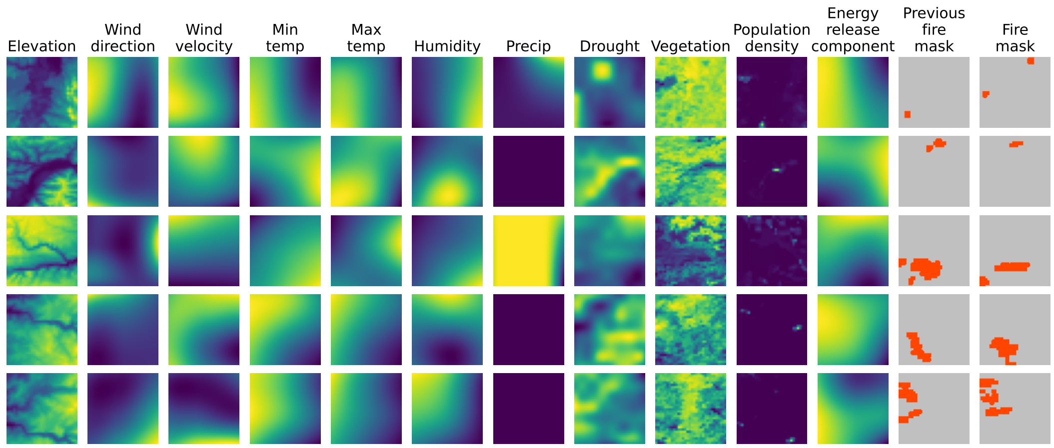

Figure 1: Examples from the dataset

3 Model Architecture

Since the dataset consists of spatial features, we will employ a convoluted neural net architecture for predicting next day wildfire mask. For the outcome variable ('fire mask'), each area as labelled either as containing fire or no fire.

4 Evaluation

We will evaluate the results using three main quantitative metrics - Precision, Recall, and the Area under the Receiver Operator Curve. Qualitatively, the models will produce predictive images of the fire masks which can then be compared to the actual images from Google Earth Engine.

5 GitHub Link

We have posted the code to pre-process and visualize the data on Github.

References

Fantine Huot, R Lily Hu, Matthias Ihme, Qing Wang, John Burge, Tianjian Lu, Jason Hickey, Yi-Fan Chen, and John Anderson. Deep learning models for predicting wildfires from historical remote-sensing data. *arXiv preprint arXiv:2010.07445*, 2020.

Fantine Huot, R Lily Hu, Nita Goyal, Tharun Sankar, Matthias Ihme, and Yi-Fan Chen. Next day wildfire spread: A machine learning data set to predict wildfire spreading from remote-sensing data. *arXiv preprint arXiv:2112.02447*, 2021.