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Wildland Fire Modeling Using Convolutional Neural Networks

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Abstract Insert your abstract here. Include keywords, PACS and mathematical subject classification numbers as needed.

Keywords Wildland Fire · Machine Learning · Neural Network · Fire Spread

1 Introduction

Wildland fire propagation is a complex process which involves the interactions of many underlying physical phenomena. Since fully resolving these processes remains a research effort; quasi-empirical fire spread models are often used to predict spread across large domains [1]. Quasi-empirical models are based on fitting experimental measurements to an expected functional form [2], such as the model of Rothermel [3,4] which uses empirical correlations for heat source and sink terms in conservation of energy [5]. Difficulties arise when modeling complex scenarios which do not fit the functional form for which the quasi-empirical model was developed. One of the key advantages of applying machine learning is the capacity of the model to learn an underlying functional form.

Several researchers have applied machine learning algorithms to predict the total burned area of a fire based on meteorological data. Safi *et al.* used a deep feed-forward neural network with the Montesinho Natural Park data set (MNP) [6]. Castelli *et al.* compared total burned area estimates using multiple machine learning algorithms (genetic programming, random forests, feed-forward neural network, etc.) with MNP [7]. Storer *et al.* improved the estimates using a feed-forward neural network by training the weights using Particle Swarm Optimization with MNP [8]. Naganathan *et al.* compared support vector machines, k-nearest neighbors, and decision trees burned area predictions of US fires trained with MNP [9]. Cao *et al.* compared burned area predictions using logistic regression, feed-forward neural network, and random forest algorithms with Yunnan Province fire data [10]. These models have been limited to total burned area predictions, which will not capture the spatial-temporal distribution of the fire front.

McCormick developed a quasi-empirical fire spread model which used predictions from a feed-forward neural network to propagate the fire front [11,12]. The model considers a 3x3 neighborhood of pixels to classify the center pixel as burned or unburned. The order pixels are considered is based on the fire growth modeling by Finney which considers an ellipsoidal growth profile in the direction of wind [13]. The results shown good spatial agreement between predicted and known fires. One limitation of this model is the inability to predict the time-resolved fire front. The author used pixels from all 11 fires to predict each of the fires which begs the question how well the model would predict a fire which none of the pixels were used to train the network.

The objective of this study is to develop a fire spread model using a convolutional neural network which accurately predicts the spatial-temporal distribution of the fire front in a wildland fire. Sensitivity of the network to each input parameter is examined. The trained parameters of the network are used to infer relationships about input parameters.

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Table 1 Please write your table caption here

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2 Methods

Wildland fires

2.1 Wildland Fire Prediction

Description goes here.

2.2 Convolutional Neural Networks

Description goes here.

2.3 Network Architecture

Description goes here.

2.4 Data Pre-Processing

Description goes here.

3 Results

Cool pictures go here.

4 Discussion

Talk about what the resutls show us and why the readers should care.

5 Conclusion

Summarize impact of the work.

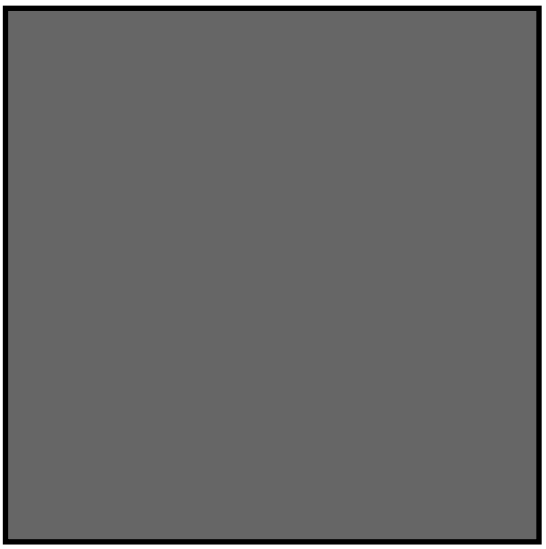

Fig. 1 Please write your figure caption here

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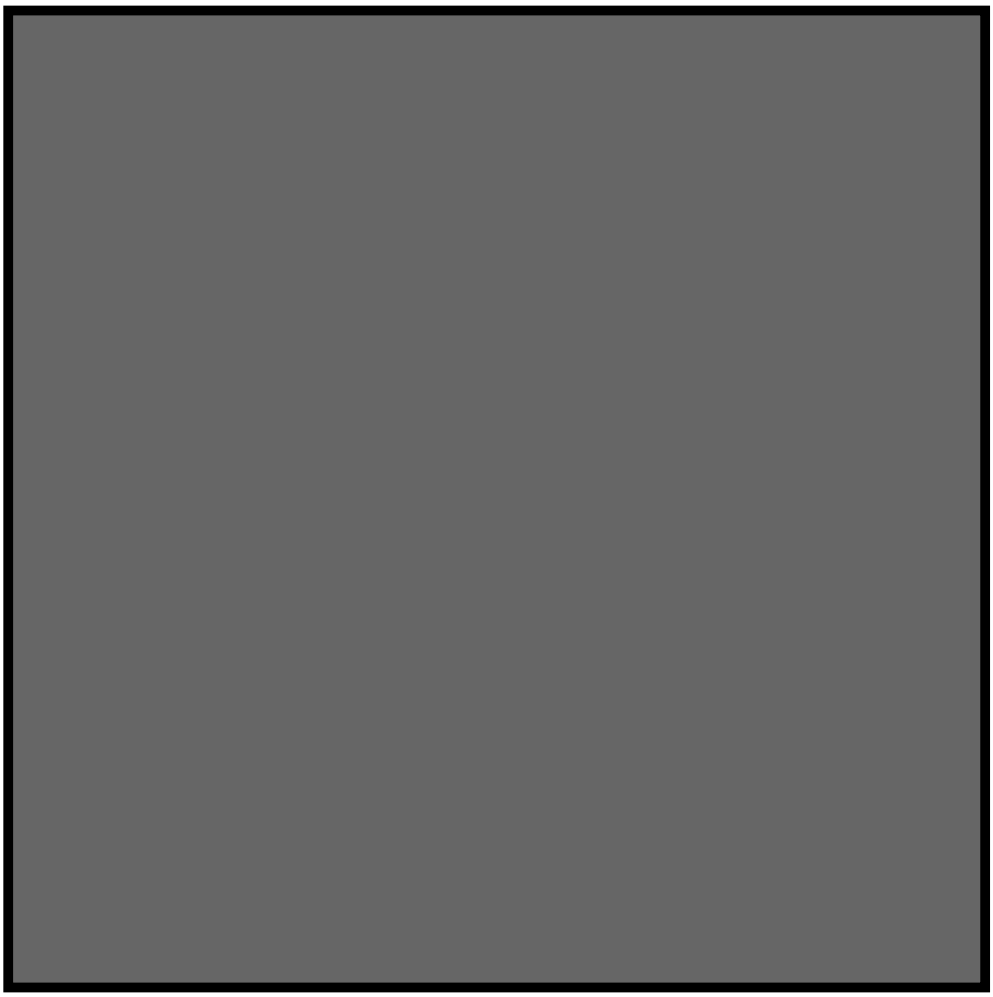

Fig. 2 Please write your figure caption here