Optimizing Prescribed Burns on a Spatiotemporal Level with Machine Learning

A Preprint

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December 2, 2020

Abstract

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***K*eywords** Machine learning · Wildfire management · Prescribed Burns · Geospatial Data

1 Introduction

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2 Headings: first level

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*Use footnote for providing further information about author (webpage, alternative address)—*not* for acknowledging funding agencies.

2.1 Headings: second level

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$$\xi_{ij}(t) = P(x_t = i, x_{t+1} = j | y, v, w; \theta) = \frac{\alpha_i(t) a_{ij}^{w_t} \beta_j(t+1) b_j^{v_{t+1}}(y_{t+1})}{\sum_{i=1}^{N} \sum_{j=1}^{N} \alpha_i(t) a_{ij}^{w_t} \beta_j(t+1) b_j^{v_{t+1}}(y_{t+1})} \tag{1}$$

2.1.1 Headings: third level

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3 Examples of citations, figures, tables, references

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The documentation for `natbib` may be found at

`http://mirrors.ctan.org/macros/latex/contrib/natbib/natnotes.pdf`

Of note is the command `\citet`, which produces citations appropriate for use in inline text. For example,

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produces

> Hasselmo, et al. (1995) investigated...

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3.1 Figures

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[2] Sample of the first footnote.

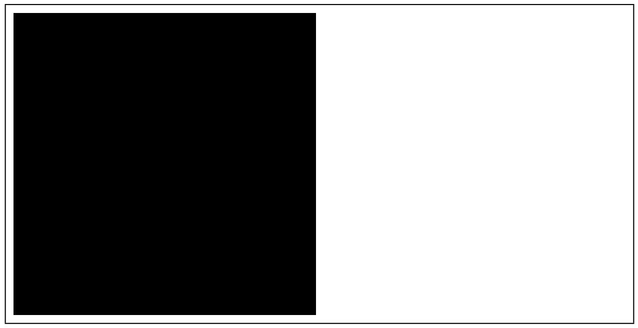

Figure 1: Sample figure caption.

Table 1: Sample table title

Part		
Name	Description	Size (μm)
Dendrite	Input terminal	$\sim$100
Axon	Output terminal	$\sim$10
Soma	Cell body	up to 10^6

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3.2 Tables

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3.3 Lists

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4 Reference Annotations

[1, Contains extensive information on the intersection of geographic information systems and using AI to process those formats of data; implements a 2D convolutional neural network with simple parameters; evaluates historical fire perimeters from GeoMAC, a United States Geological Survey (USGS) database, for each of the training and testing fires; fairly preliminary work, limited by data amount and quality]

[2, Very novel and interesting approach towards a problem typically viewed in a geospatial or at least spatiotemporal sense; uses tweets with geolocation and natural language processing for the early detection of fires; extensive Twitter mining and sentiment analysis work done to correlate with wildfires; offers a creative approach to locate and estimate fires with high precision compared to standard reporting]

[3, Highly relevant to my original ideas–dicusses finding optimal conditions for prescribed burns; quantifies a machine learning approach in XGBoost for temperature, RH, 10 m wind speed, boundary layer depth, Lavdas Atmospheric Dispersion Index, daily total precipitation, and the climatological probability of fire; works towards probability-based prediction for wildfires to be aided by prescribed burns]

[4, Discusses spatially spreading processes (SSPs) in depth, and machine learning applications to model and account for these intricacies; this source adopts a more complex reinforcement learning approach to "game" the model, with an agent policy rewarded by the correct identification of cells with/without fire as validated by satellite images; very extensive implementations and validation through five RL algorithms: value iteration, policy iteration, Q-learning, Monte Carlo Tree Search, and Asynchronous Advantage Actor-Critic (A3C).]

[5, Similar but not entirely the same for my research; uses computer vision techniques implemented on UAVs to judge and measure effiacy of controlled burns–could be useful to open source in the situation of actually testing and evaluating methods in real-time; adopts probabilistic neural networks (slightly non-industry standard); to measure factors like vegetation, soil burn severity etc.; appears to be moderately effective at identifying relevant conclusions on burn severity]

[6, Focuses on the quality and availability for machine learning applications in forest fire optimizations; examines sample sizes, imbalances, transferability, and need for classifiers; employs random forest models to test inferences for each parameter of datasets; discovers a discrepancy in wildfire prediction vs. optimizing prescribed burns with similar data, likely due to the poorer classification performance for low fire severity classes, the dominant severity classes in prescribed burns; classification is mostly accurate]

[7, Focuses on Alaska, but not a huge deal because of cross-trainaiblity; this paper uses decision trees (solid, simpler method) to investigate final fire sizes at time of ignition; accuracy is not signficant at around 50%, but these investigations can provide valuable insight once analyzed about resource allocation and the intricacies of quantification on fire sizes and their relevance to fire intensity]

[8, Leverages slightly varying conditions like topography and fuels to quantify the effects of topography, fuel characteristics, road networks and fire suppression effort on the perimeter locations of large fires; they develop a prediction model for geolocational fire control taking into account fuel types, topographic features and natural and anthropogenic barriers; uses boosted logistic regression to a decently accurate margin in spatiotemporal terms; highly relevant, may look to open source from authors to build off of or test another model for]

[9, Broad, encompassing overview on the research done on machine learning methods for wildfire-based problems; very recent research; categorizes six approximate domains for fire-related machine learning problems: 1) fuels characterization, fire detection, and mapping; 2) fire weather and climate change; 3) fire occurrence, susceptibility, and risk; 4) fire behavior prediction; 5) fire effects; and 6) fire management; analyzes data size, computational requirements, generalizability, and interpretability, potential advances in of wildfires management within machine learning applications; reviews over 300 papers in this issue; this will likely be my most useful source]

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