Agent Based Model for Wildfire Spread with Evolved Spreading Function*

Subtitle

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ABSTRACT

This paper provides a sample of a LaTeX document which conforms, somewhat loosely, to the formatting guidelines for ACM SIG Proceedings.[1]

CCS CONCEPTS

• **Computer systems organization** → **Embedded systems**; *Redundancy*; Robotics; • **Networks** → Network reliability;

KEYWORDS

ACM proceedings, LaTeX, text tagging

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1 INTRODUCTION

Each year, between 4 - 8 million acres of land are damaged by wildfires. Just in the past 10 years, this has represented a $5.1 billion cost in infrastructural damage repair [1]. Forest fires are a complex natural disaster that involve combustion of natural fuels in a wild land subject to complex meteorological conditions. Building predictive models to aid in wildfire preparation and containment efforts is increasingly important. The coupling of the atmospheric systems and the spreading of fire makes modeling these systems non trivial. Current cutting edge wild fire models are complex derivations of fundamental physical laws [3],[5],[4]. To reduce computation time, increase accuracy and leverage the advances in satellite imagery, recent work has been done to model wildfire dynamics with machine learning or evolutionary strategies. This area has seen some great success with increased accuracy of perimeter prediction from historic fires.

While satellite data does exist, the time and space resolution is highly variant in image sets documenting a given fire event. This makes validating fire spreading models very difficult. We propose an agent based model with an evolving spreading function that predicts the behavior of simulated fire perimeter over time. Then, we test the method by simulating the 2016 Fort McMurray Wildfire that occurred during the months of May - September in Fort McMurray, Alberta.

Agent Based models have been used to describe macro behaviors by prescribing micro behaviors to independent landscapes making decisions in discrete time. By evolving the function that governs agent behavior, agent based models can be used to predict macro behavior based on ground truth data. [6] et all modeled crowd dynamics by evolving the agent rule set through a symbolic regression. Additionally, geometric semantic genetic programming has been used to estimate the total area burned for a given fire event [2].

2 METHODS

2.1 The Genetic Program

2.2 Synthetic Fire Prediction

2.3 2016 Fort McMurray Wildfire

3 RESULTS

4 DISCUSSION

5 CONCLUSIONS

This paragraph will end the body of this sample document. Remember that you might still have Acknowledgments or Appendices; brief samples of these follow. There is still the Bibliography to deal with; and we will make a disclaimer about that here: with the exception of the reference to the LaTeX book, the citations in this paper are to articles which have nothing to do with the present subject and are used as examples only.

A HEADINGS IN APPENDICES

The rules about hierarchical headings discussed above for the body of the article are different in the appendices. In the **appendix** environment, the command **section** is used to indicate the start of each Appendix, with alphabetic order designation (i.e., the first is A, the second B, etc.) and a title (if you include one). So, if you need hierarchical structure *within* an Appendix, start with **subsection**

*

†The secretary disavows any knowledge of this author's actions.
‡This author is the one who did all the really hard work.
[1]This is an abstract footnote

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as the highest level. Here is an outline of the body of this document in Appendix-appropriate form:

A.1 Introduction

A.2 The Body of the Paper

A.2.1 Type Changes and Special Characters.

A.2.2 Math Equations.

Inline (In-text) Equations.

Display Equations.

A.2.3 Citations.

A.2.4 Tables.

A.2.5 Figures.

A.2.6 Theorem-like Constructs.

A Caveat for the TEX Expert.

A.3 Conclusions

A.4 References

Generated by bibtex from your `.bib` file. Run latex, then bibtex, then latex twice (to resolve references) to create the `.bbl` file. Insert that `.bbl` file into the `.tex` source file and comment out the command `\thebibliography`.

B MORE HELP FOR THE HARDY

Of course, reading the source code is always useful. The file `acmart.pdf` contains both the user guide and the commented code.

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REFERENCES

[1] [n. d.]. 2019 Verisk Wildfire Risk Analysis: Property Underwriting. ([n. d.]). https://www.verisk.com/insurance/campaigns/location-fireline-state-risk-report/

[2] Mauro Castelli, Leonardo Vanneschi, and Aleš Popovič. 2015. Predicting Burned Areas of Forest Fires: An Artificial Intelligence Approach. *Fire Ecology* 11 (04 2015), 106–118. https://doi.org/10.4996/fireecology.1101106

[3] Rodman Linn, Jon Reisner, J. Coleman, and S. SMITH. 2002. Studying wildfire behavior using FIRETEC. *International Journal of Wildland Fire* 11 (11 2002). https://doi.org/10.1071/WF02007

[4] Jan Mandel, Jonathan D Beezley, and Adam K Kochanski. 2011. Coupled atmosphere-wildland fire modeling with WRF-fire. *arXiv preprint arXiv:1102.1343* (2011).

[5] O. Séro-Guillaume and J. Margerit. 2002. Modelling forest fires. Part I: a complete set of equations derived by extended irreversible thermodynamics. *International Journal of Heat and Mass Transfer* 45, 8 (2002), 1705–1722.

[6] Jinghui Zhong, Linbo Luo, Wentong Cai, and Michael Lees. 2014. Automatic rule identification for agent-based crowd models through gene expression programming. In *Proceedings of the 2014 international conference on Autonomous agents and multi-agent systems*. International Foundation for Autonomous Agents and Multiagent Systems, 1125–1132.