

Spatial Statistical Modeling of Wildfire Incidence in Arizona

STAT574E | Group 3

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Executive Summary

The *Wildland Fire Incident Locations* dataset we selected for study (provided by the National Interagency Fire Center) contains spatial coordinates of a wildfire's origin and its resulting size in acreage (among several other useful attributes) for all wildfire incidence in the US as archived in the IRWIN system since 2014. Our research goals included the study of factors that may influence the resulting size of a wildfire, and to build spatial models that may aid as a tool for wildfire risk assessment and resource allocation, forecasting, and other possible real-world applications. We were also interested whether wildfire incidence, when treated as a point pattern, occurs as a completely spatially random process, or if there really is inhomogeneity in spatial intensity for incidence and thus truly higher risk in some spatial regions than others.

Attributes contained in the dataset allowed us to take three different approaches to spatial statistical modeling. Using the incident size as a continuous response, we built a spatial linear model that predicts wildfire size based on spatial and selected covariate inputs. Filtering the data using incident size as well as other incident attributes also allowed us to treat wildfire incidence data as a point process. We fit a Log-Gaussian Cox Process (LGCP) spatial model to study spatial intensity, as well as a binary response spatial logistic regression model to map spatially the regions of highest probability of large wildfire (≥ 1000 acres) incidence in the region of study.

Our modeling efforts studied Coconino County (CC) in Northern Arizona, which has the highest overall wildfire incidence as compared to the rest of the state. We gathered data for incidence proximity to roads, environmental, and census data corresponding to spatial coordinates to use as covariates for our models to support our research questions. These covariates improved performance of our models by AIC metrics. **Our LGCP model indicated that wildfires are not CSR, and there is thus greater risk of wildfire incidence in certain regions of CC.** Our models require some further refinements, but serve as a solid foundation and proof of concept for our real-world application goals.

Introduction

Wildfire incidence data describes the spatial origin of a wildfire, and is one of many ways that wildfires can be studied; it is also a type of data that lends itself well to be studied by methods in spatial statistical analyses. Spatial statistical models can be valuable in real applications for wildfire prevention, giving inferential insights into wildfire risk as well as tools to aid in resource allocation for mitigation efforts and planning. Our project seeks to build models that could be useful for these kinds of efforts, and our research questions aim to provide insight to what kinds of environmental and human factors can influence the size of a resulting wildfire based upon where it originates spatially.

Research Questions

The research questions we chose to explore were the following.

Does the proximity of a wildfire's origin to a road influence its resulting size?

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Can environmental or human factors be useful predictors in modeling resulting wildfire size?

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Are the patterns of human or non human caused fires spatially CSR, or do they exhibit an inhomogeneous spatial intensity?

If we filter our data to a desired "type" to study (for example large, naturally occurring wildfires) as a realization of some Poisson process with intensity $\lambda(s)$, can we identify higher risk areas of the fire type in question? Or are they not more than completely spatially random (CSR). As an extension, can we model the probability of these types of fires we choose to assess risks in terms of probabilities given conditions (covariates) that we choose for our model fits?

Exploratory Data Analysis

Statistical Analyses

Fixed, Continuous Response

Spatial Linear Model

Point Process

Log-Gaussian Cox Process

Binary Response GLM Logistic Regression

Conclusions