LAB 2 - Wildfire Spread Dynamics

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1 Introduction

Forest fires not only represent a significant threat towards human life and property, but also affect the ecosystem. The northeast region of Portugal in particular has a history of wildfires because more than a third is covered by forests. Adding in the factor of hot and dry summers can potentially increase the risk of wildfires[1]. Even though wildfires are a normal part of the renewal process of forests, the forests are getting drier and people are living closer to them which causes an increase in safety issues[2]. This is why it is important for us to understand the behavior of wildfires, in particular the speed in which fire spreads.

With this investigation, we can continue to discuss how wildfires affect the environment along with social-economics and explore opportunities to do our part to put in place appropriate measures of safety. Along with produce strategies to minimize the risk of wildfires. This research will interest be in the interest of Environmental Scientists and Ecologists along with Fire Management Agencies who goal of protecting an decreases any through towards human life along with the ecosystem. To create a starting point for this discussion, this research will investigate the following research question:

> *How does Fine Fuel Moisture Code (FFMC) help us understand how quick a fire spreads in the northeast region of Portugal?*

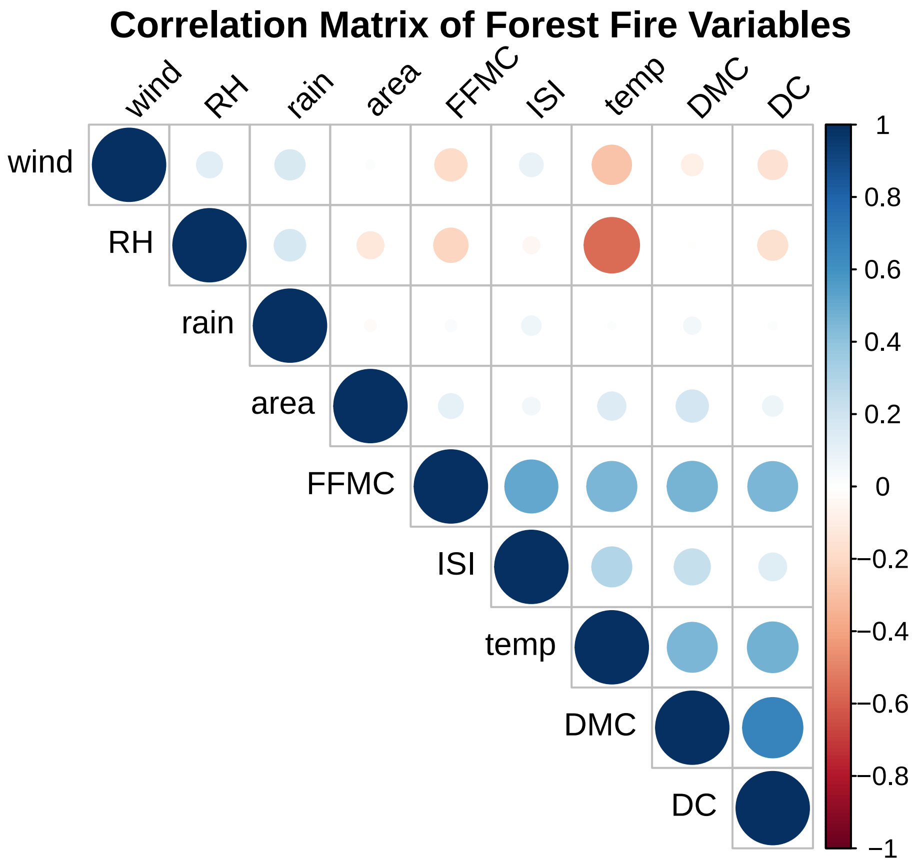
To measure fire spread, we will use Initial Spread Index (ISI). Both FFMC and ISI are key components of the Canadian Forest Fire Weather Index system which are used to assess fire behavior. To provide context, FFMC represents fuel moisture of forest litter fuel under the shade of a forest canopy and ISI is a numeric rating that estimates how quickly a fire will spread after it starts. Exploring the relationship between these two variables can provide valuable insights in what conditions cause rapid wildfire spread. To answer this research question we will perform a bivariate analysis be developing a regression models by iteratively applying variable transformation. Then evaluating both the statistical and practical significance of results.

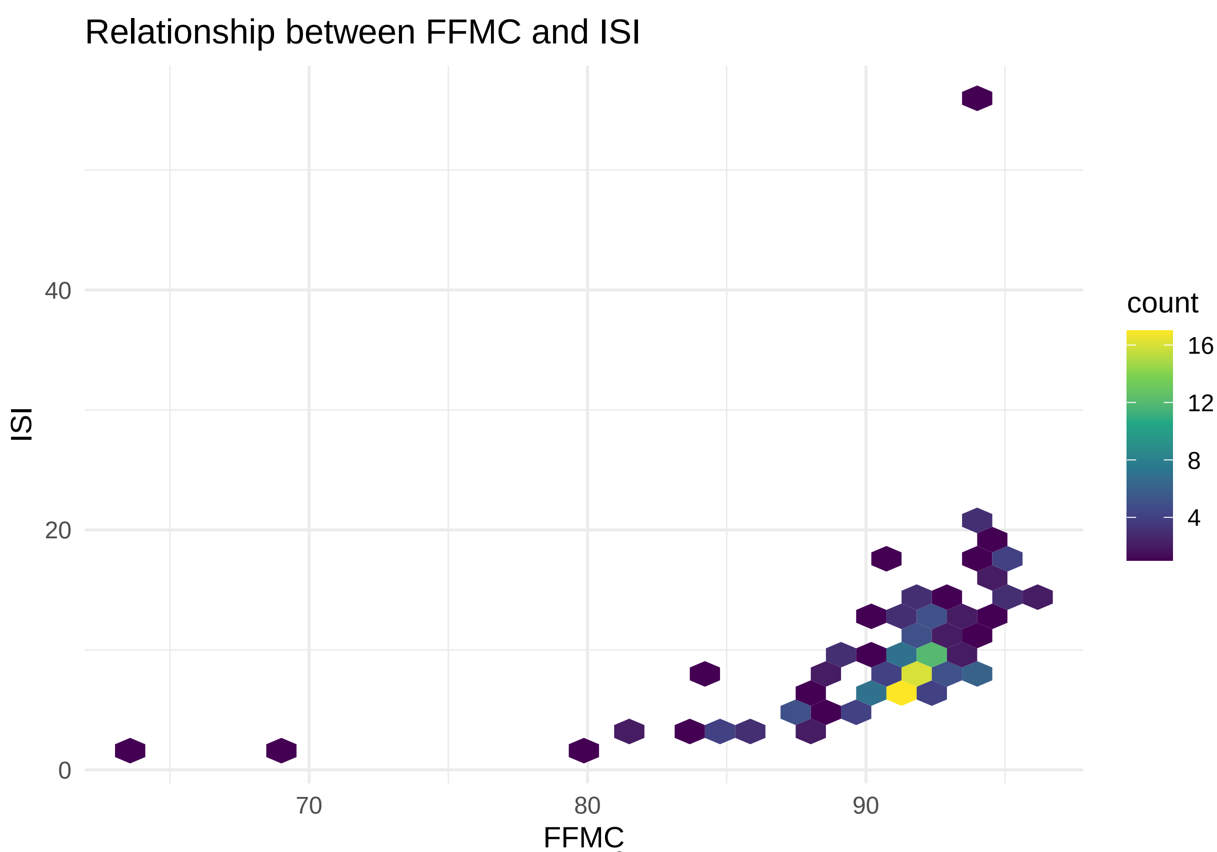
2 Description of the Data Source

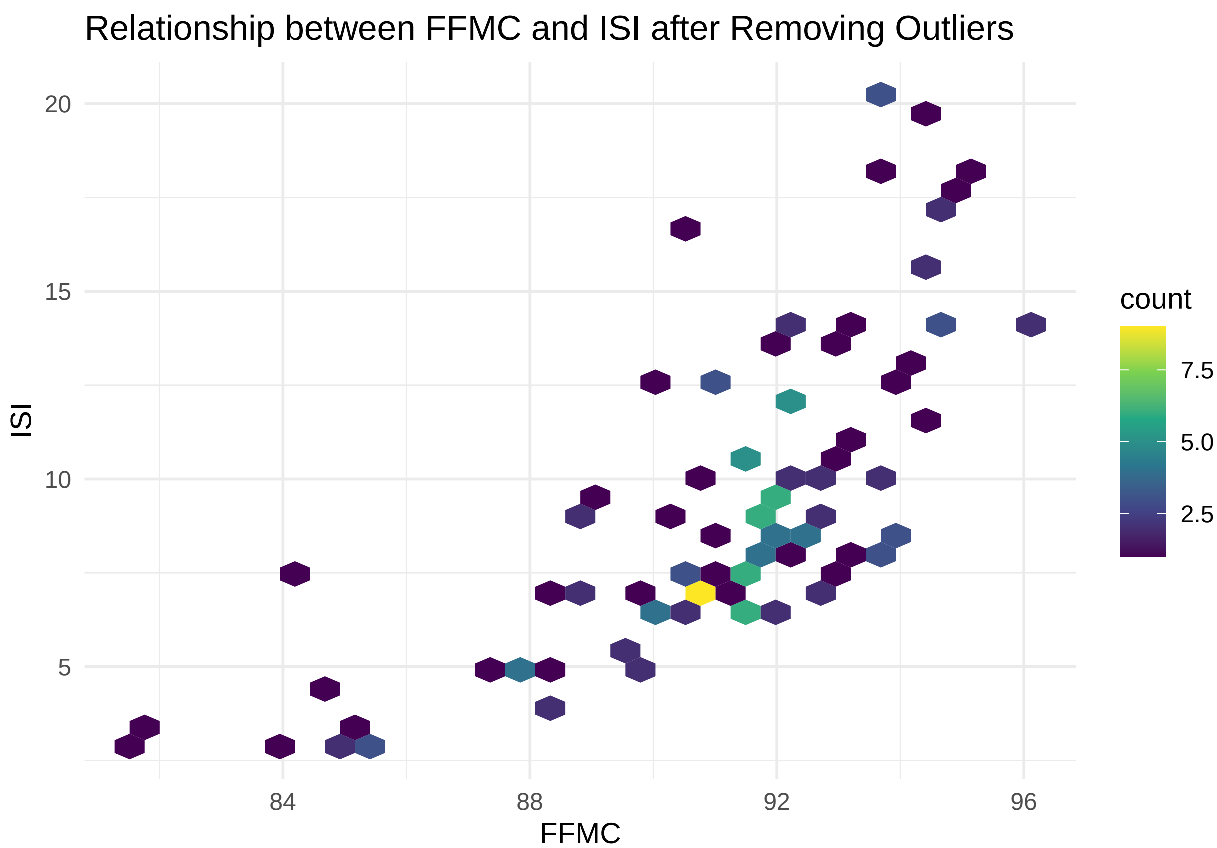
The dataset we will be using for this research is from the UCI Machine Learning Repository which is called "Forest Fires" and can be found here: https://archive.ics.uci.edu/dataset/162/forest+fires. This data set has 517 instances with 13 feature that consists of climate and physical factors of the Montesinho natural park. The data was collected between January 2000 and December 2003. This can be used to understand forest fire behavior in northeast region of Portugal.

[1]The Subday Times. "Portugal wildfires: what to expect if you're travelling in summer 2024" (2024).
[2]National Geographic. "How to live with mega-fires? Portugal's feral forests may hold the secret" (2019).

3 Data Wrangling & Operationalization

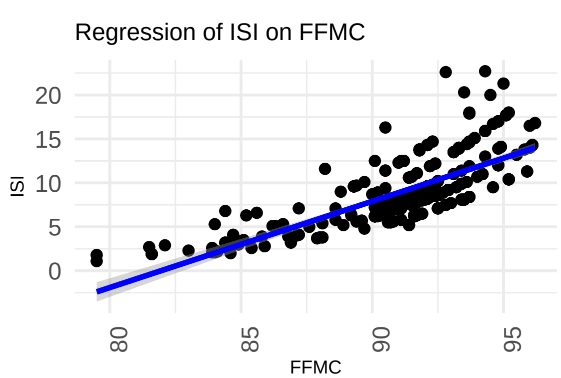


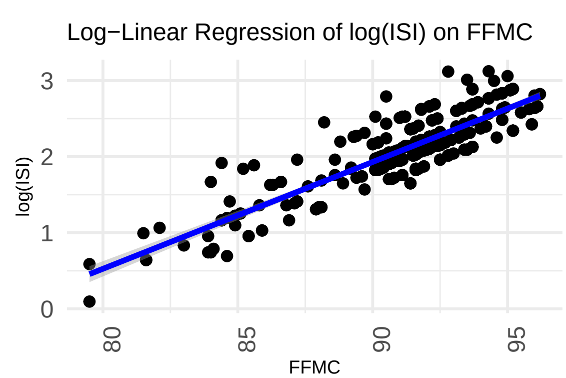




4 Model Specification

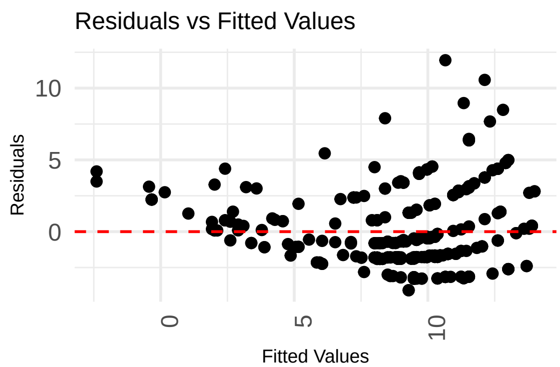
We started with a simple linear regression model to establish a baseline relationship between FFMC and ISI. After plotting the model, we saw a strong linear relationship between the variables. After this we applied log transformation to address skewness and improve model fit, and again saw a good line of best fit. The log transformation helped in normalizing the distribution of the dependent variable, which can lead to a better fit and more reliable statistical inference. We used log-transform for the ISI variable was based on an initial observation of skewness in the data.





5 Model Assuptions

6 Model Results and Interpretation



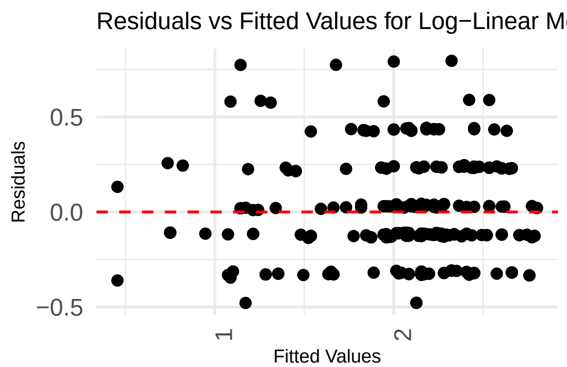


Table 1: Log-Linear Regression Model Results

	Dependent variable:
	log(ISI)
FFMC	0.14^{***} (0.004)
Constant	-10.71^{***} (0.40)
Observations	355
R^2	0.74
Adjusted R^2	0.74
Residual Std. Error	0.25 (df = 353)
F Statistic	$1{,}022.88^{***}$ (df = 1; 353)
Note:	*p<0.1; **p<0.05; ***p<0.01