FWI Prediction System Using Regression Techniques

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1 Introduction

Forest fires are one of the major environmental hazards that cause serious damage to forests, wildlife, and human life. Early prediction of forest fire risk can help authorities take preventive measures in advance.

In this project, we focus on developing a system to predict the **Fire Weather Index (FWI)** based on various environmental and meteorological features.Machine learning regression techniques are used to model the relationship between these features and the FWI value.

The goal of this project is to build an accurate and efficient FWI prediction model and using a Flask web application so that users can easily input parameters and obtain predictions.

2 Dataset Collection and Preprocessing

2.1 Dataset Collection

The dataset used in this project is collected from publicly available forest fire datasets that contain historical weather and fire-related information. The data includes important attributes such as FFMC, DMC, DC, ISI, temperature, relative humidity, wind speed, and rainfall, which play a significant role in determining forest fire risk.

The dataset represents real-world fire scenarios and provides sufficient samples for training and testing regression models used for predicting the Fire Weather Index.

2.2 Dataset Preprocessing

Dataset preprocessing is an essential step to improve the quality and performance of the prediction model. In this phase, missing values are identified and handled appropriately. Irrelevant or redundant features are removed to reduce noise in the data.

Feature scaling and normalization techniques are applied to ensure that all features contribute equally to the regression model. The processed dataset is then divided into training and testing sets to evaluate model performance effectively.In the dataset which i have taken month,day features are also there so the categorical data is converted into the numerical data and then handling the missing values and standardlising the values.

2.3 Sample Dataset

Table 1 shows a sample of the cleaned and preprocessed dataset used for Fire Weather Index (FWI) prediction. The dataset includes spatial information, temporal features, weather parameters, and fire-related indices.

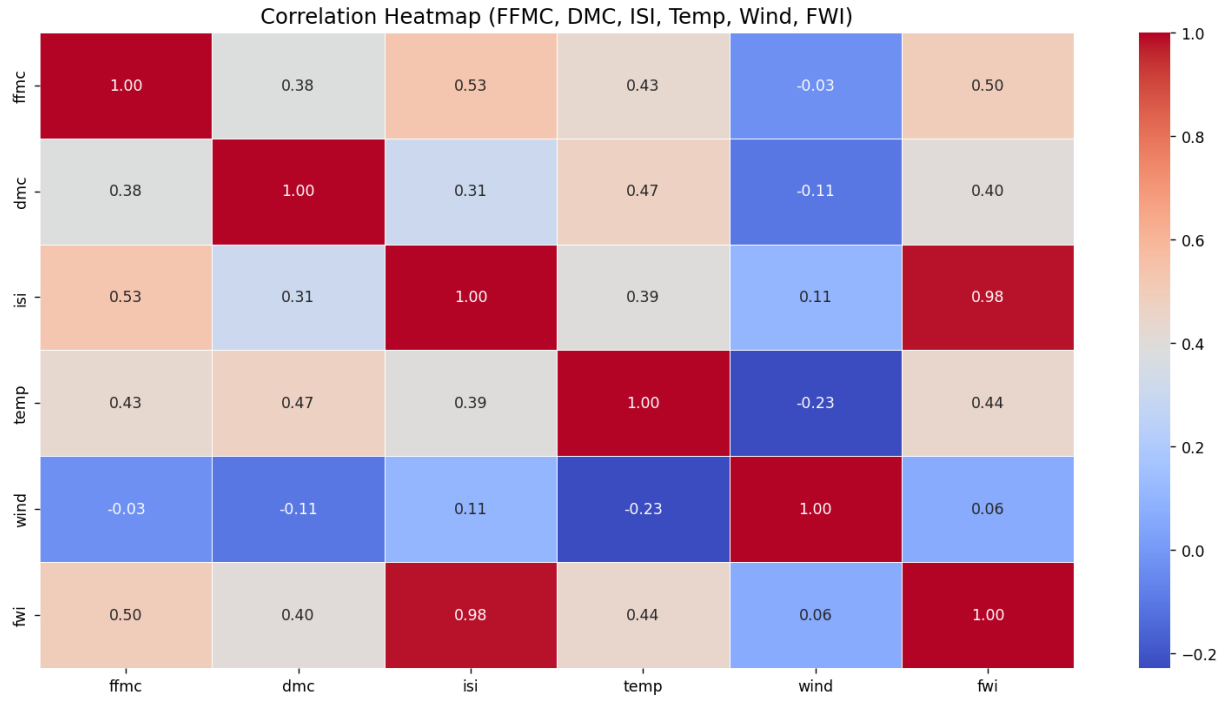
Table 1: Sample Records from the Forest Fire Dataset

X	Y	Month	Day	FFMC	DMC	DC	ISI	Temp	RH	Wind	BUI	FWI
7	5	7	0	86.2	26.2	94.3	5.1	8.2	51	6.7	30.9	13.1
7	4	10	5	90.6	35.4	669.1	6.7	18.0	33	0.9	62.5	21.8
7	4	10	2	90.6	43.7	686.9	6.7	14.6	33	1.3	75.4	23.1
8	6	7	0	91.7	33.3	77.5	9.0	8.3	97	4.0	34.9	26.4
8	6	7	3	89.3	51.3	102.2	9.6	11.4	99	1.8	57.1	32.4
8	6	1	3	92.3	85.3	488.0	14.7	22.2	29	5.4	118.7	68.1

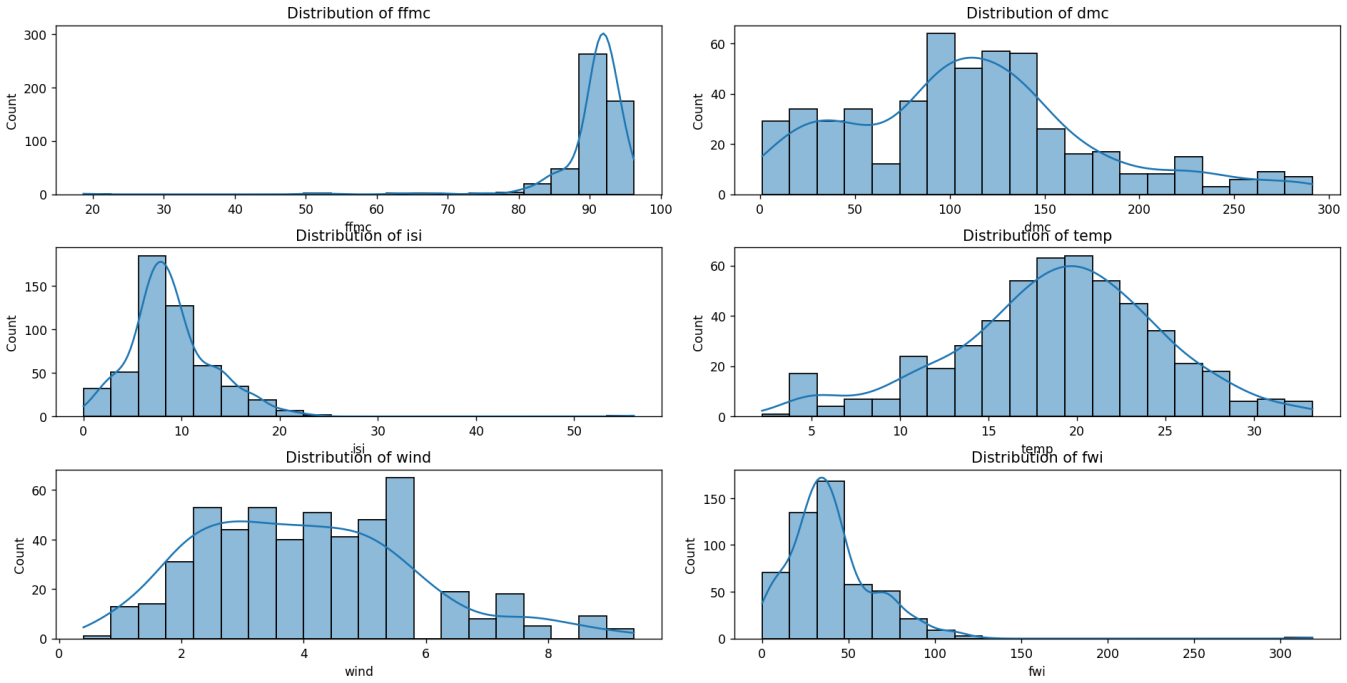
2.4 Dataset Statistics

Dataset statistics provide an overall understanding of the data distribution and feature characteristics.

These statistics help in identifying trends, outliers, and correlations among the variables. Visualization techniques such as histograms and correlation matrices can also be used to analyze the relationship between different features and the target variable (FWI). Understanding dataset statistics plays a crucial role in selecting appropriate regression models and improving prediction accuracy.



Correlation map



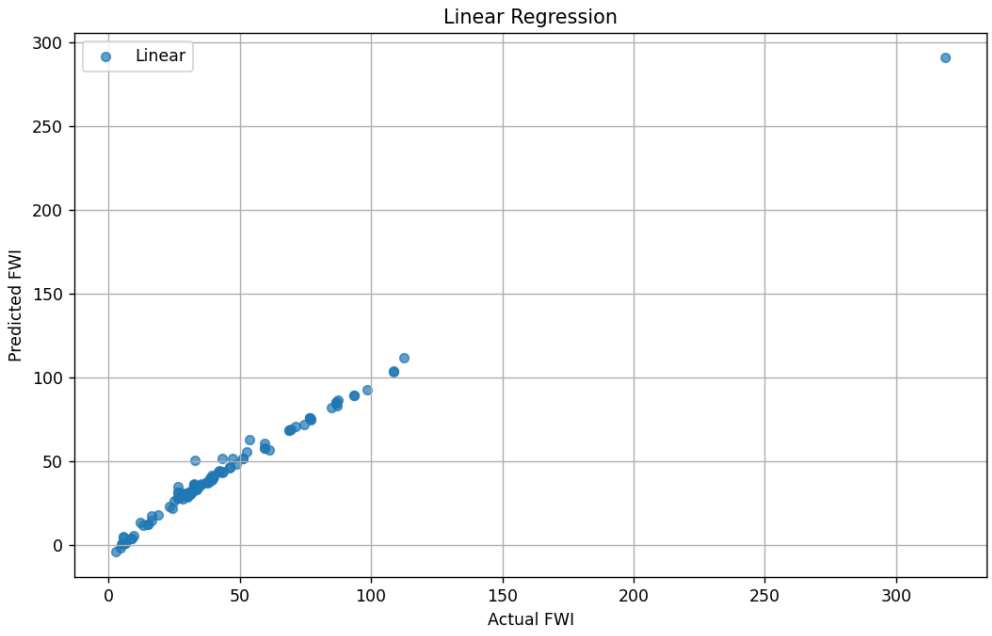
Histograms

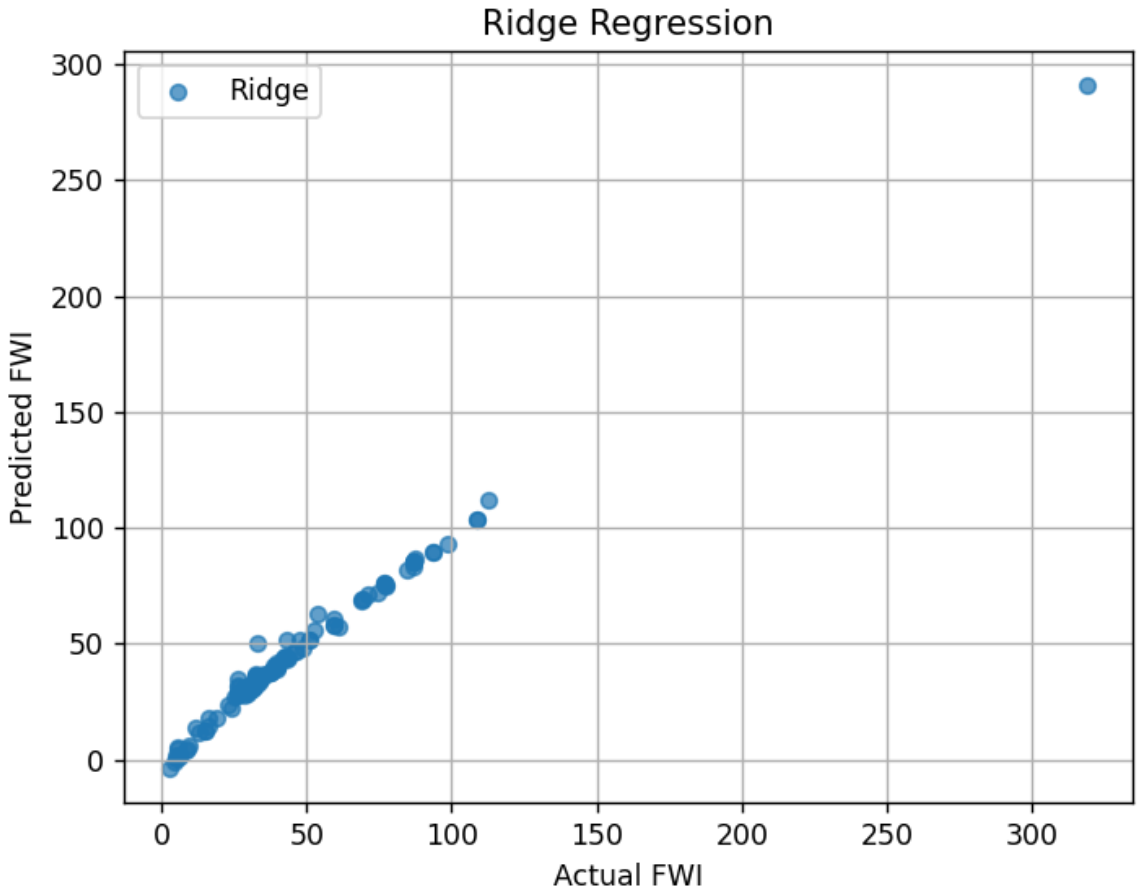
3 Regression

Regression techniques are used to predict the continuous FWI value based on the selected features. In this project, regression models such as Linear Regression

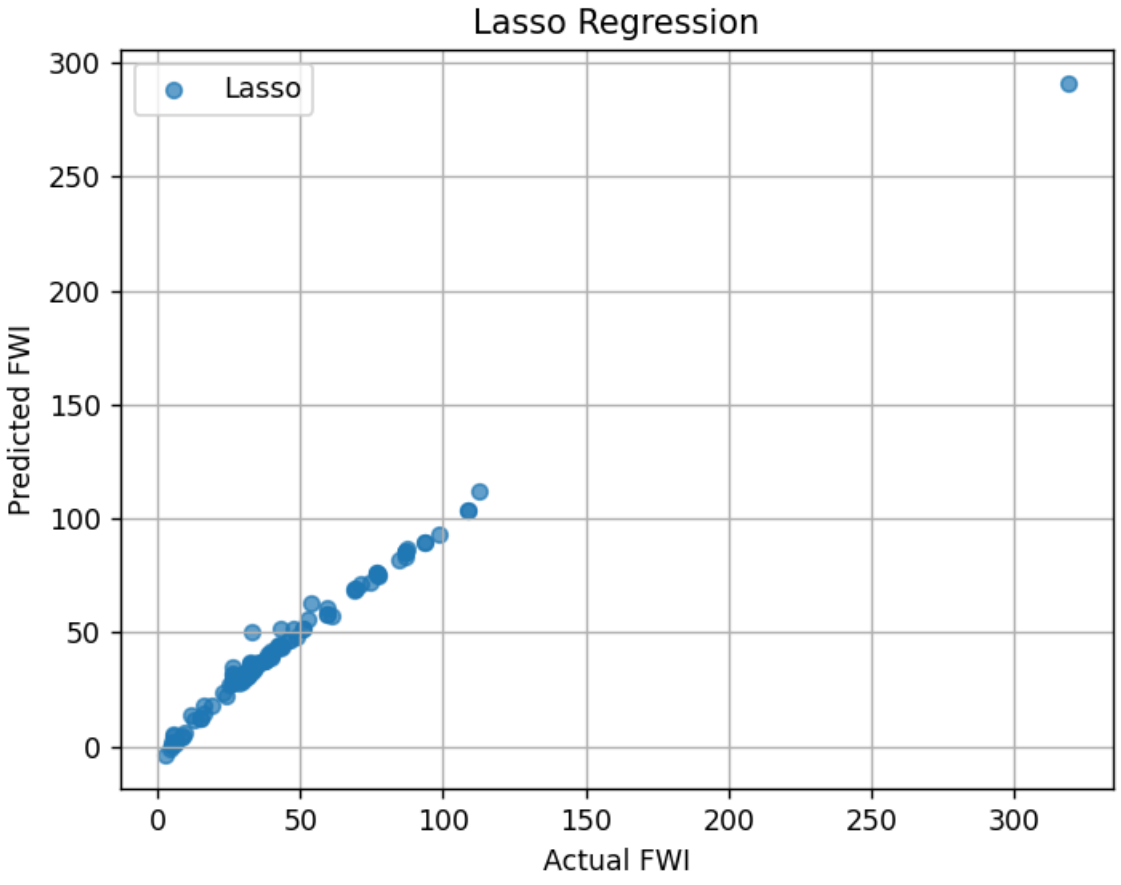
The regression model learns the relationship between input features and the target variable using training data. Model performance is evaluated using metrics such as Mean Squared Error (MSE), Mean Absolute Error (MAE), and R-squared value. The best-performing regression model is selected based on accuracy and reliability.

Regression plays a key role in estimating fire risk levels and helps in making data-driven decisions for forest fire management.





Ridge Regression



Lasso Regression

Output of the model

Linear Regression:

Train MSE: 8.357235604952326

Test MSE: 18.531852712437423

Train MAE: 1.884242817409061

Test MAE: 2.4761289668109807

Train R2: 0.9835806313462451

Test R2: 0.98694823113165

Train root mean square: 2.8908883764255453

Test root mean square: 4.3048638436584055

Ridge Regression:

Train MSE: 8.357235604974715

Test MSE: 18.5318979664072

Train MAE: 1.8842432481355387

Test MAE: 2.4761315213305655

Train R2: 0.9835806313462011

Test R2: 0.986948199259804

Train root mean square: 2.8908883764294178

Test root mean square: 4.304869099799342

Lasso Regression:

Train MSE: 8.357245559734926

Test MSE: 18.5293558295332

Train MAE: 1.8845321154066454

Test MAE: 2.475565919876343

Train R2: 0.9835806117881934

Test R2: 0.9869499896573118

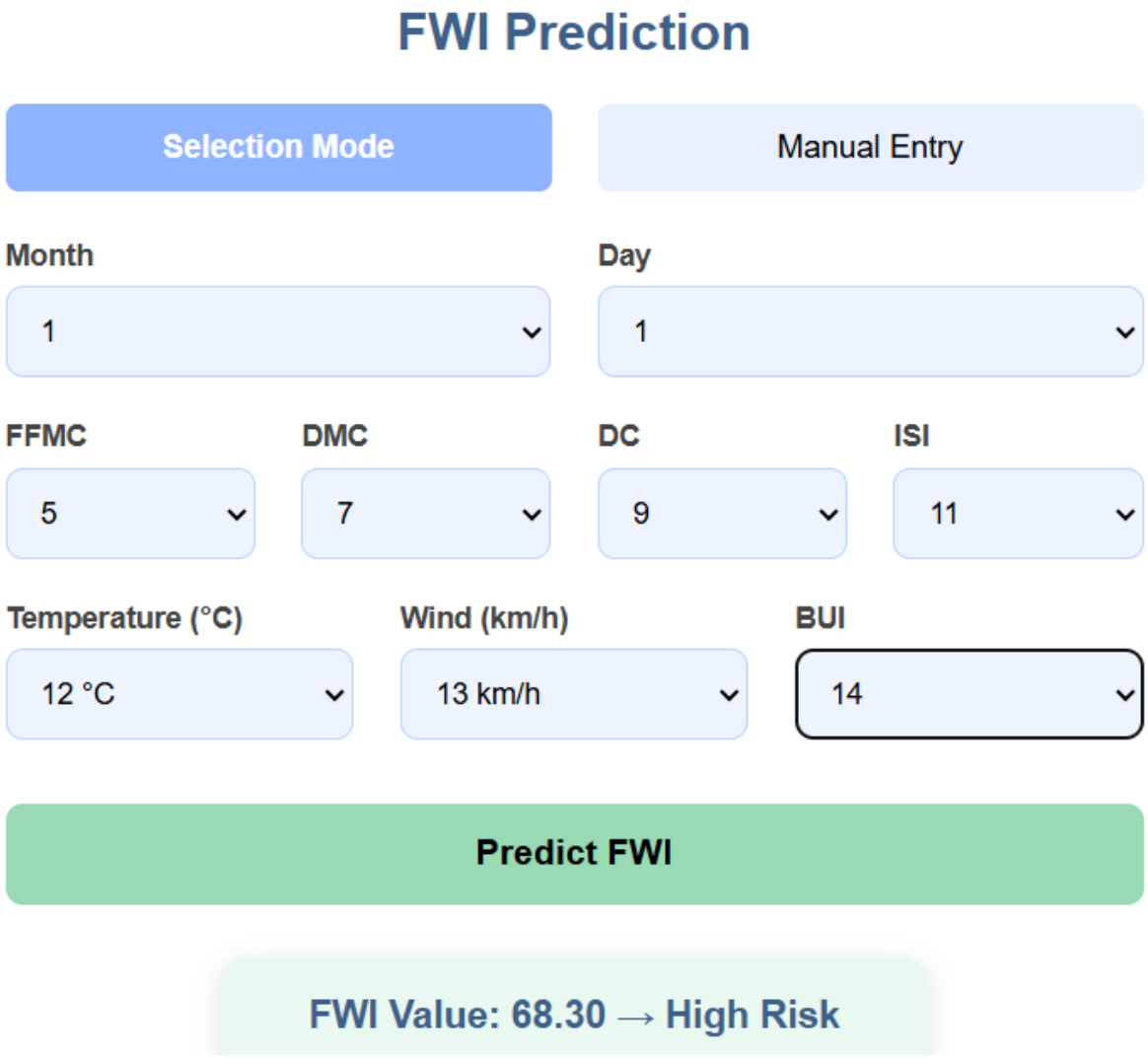
Train root mean square: 2.8908900981764987

Test root mean square: 4.304573826702615

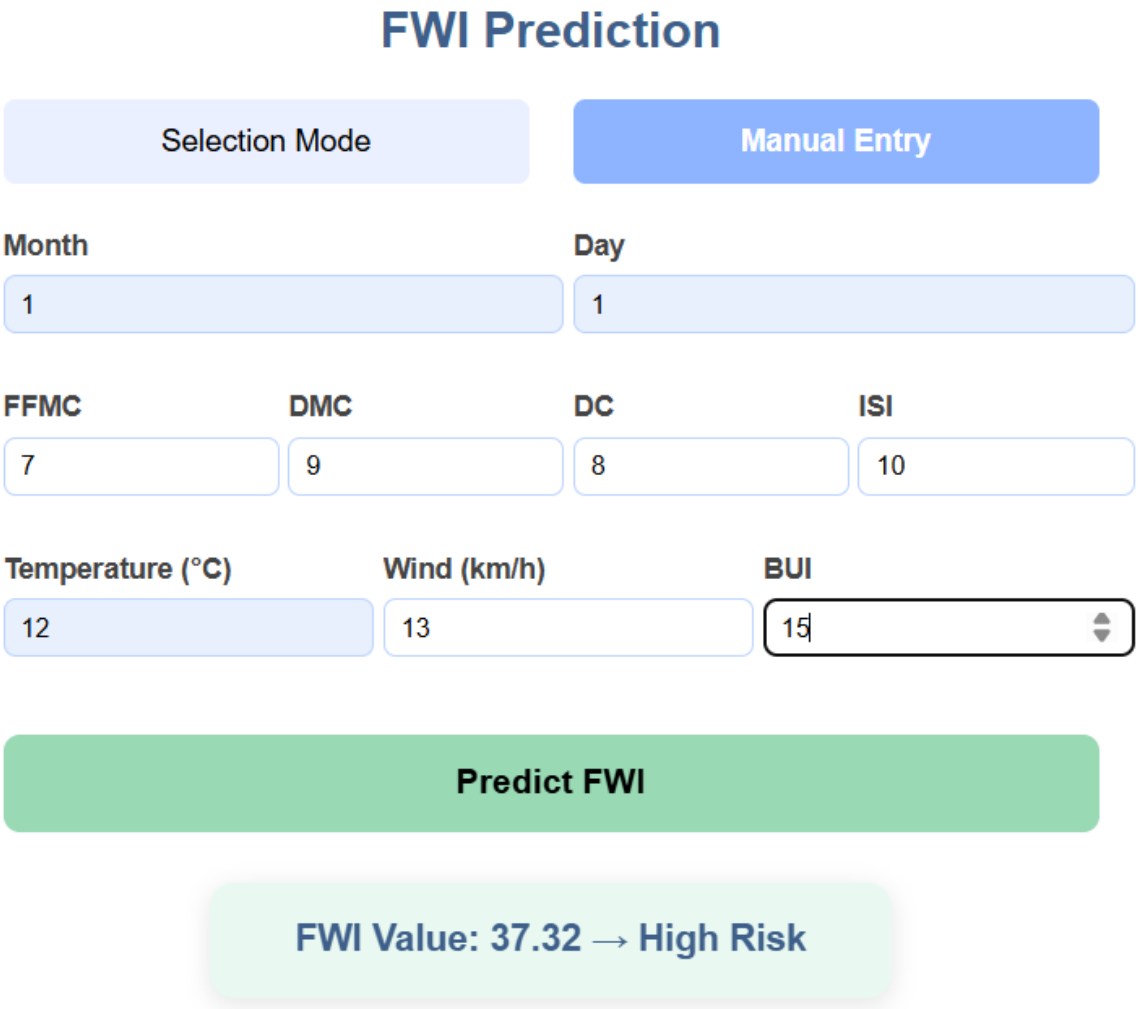
4 Flask App

A Flask web application is developed using the trained FWI prediction model. Flask is a lightweight Python web framework that allows easy integration of machine learning models into web applications.

The Flask app provides a user-friendly interface where users can input environmental parameters such as temperature, humidity, wind speed, and other required features. Once the input is submitted, the trained regression model processes the data and predicts the Fire Weather Index. The predicted result is then displayed on the web page. This application makes the FWI prediction system accessible, interactive, and prac- tical for real-world usage.



Prediction of FWI using Selection Mode



Prediction of FWI using Manual Entry