**Forest Fire Prediction Using Machine Learning**

**1. Project Overview**

Forest fires are devastating natural disasters that result in significant environmental and economic losses. This project aims to develop a **machine learning model** to predict the likelihood of forest fires based on historical weather and environmental data. By leveraging **classification and regression techniques**, we aim to provide an early warning system to help mitigate fire risks.

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**2. Problem Statement**

Traditional fire prediction methods rely on meteorological analysis and expert judgment, which can be time-consuming and prone to human error. The goal of this project is to create a **data-driven approach** using machine learning to accurately predict fire occurrences based on key environmental factors such as temperature, humidity, wind speed, and rainfall.

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**3. Dataset Used**

**Source:**

The dataset was obtained from publicly available wildfire databases and meteorological sources.

**Features:**

The dataset consists of multiple environmental parameters, including:

- **Temperature (°C)** - Affects fire ignition and spread.
- **Humidity (%)** - Higher humidity reduces fire risks.
- **Wind Speed (km/h)** - Stronger winds increase fire spread.
- **Rainfall (mm)** - More rainfall lowers fire probability.
- **Area Burned (hectares)** - Historical fire impact data.
- **Other relevant meteorological parameters.**

**Target Variable:**

- Binary classification: **Fire (1) / No Fire (0)**.

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**4. Technology Stack**

- **Programming Language:** Python
- **Libraries:** Pandas, NumPy, Scikit-learn, Matplotlib, Seaborn
- **Machine Learning Models:**

    - Logistic Regression
    - Decision Tree
    - Random Forest
    - Support Vector Machine (SVM)
    - Gradient Boosting
- **Development Tools:** Jupyter Notebook, VS Code

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**5. Methodology**

**Step 1: Data Preprocessing**

- Handling missing values and cleaning the dataset.
- Feature selection to retain the most relevant attributes.
- Data normalization and scaling.

**Step 2: Exploratory Data Analysis (EDA)**

- Visualizing relationships between environmental factors and fire occurrences.
- Identifying correlations using heatmaps.

**Step 3: Model Selection & Training**

- Splitting data into training and testing sets (80:20 ratio).
- Training various ML models and tuning hyperparameters.
- Evaluating model performance using accuracy, precision, recall, and F1-score.

**Step 4: Model Evaluation**

- Comparing model performance using **confusion matrix and ROC-AUC curve**.
- Selecting the best model based on prediction accuracy and computational efficiency.

**Step 5: Deployment (Future Scope)**

- Deploying the trained model as a **Flask-based web application** for real-time predictions.

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**6. Results & Analysis**

- **Random Forest Model** achieved the highest accuracy of **92%**.
- **Feature Importance Analysis** showed that temperature and wind speed were the most critical factors in predicting forest fires.

- **Confusion Matrix Analysis:** Precision and recall scores indicate a balanced model with minimal false positives.

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**7. Challenges Faced**

- **Data Imbalance:** The dataset had significantly more "No Fire" cases, requiring oversampling techniques.
- **Feature Correlation:** Some meteorological variables were highly correlated, affecting model performance.
- **Model Overfitting:** Addressed using cross-validation and hyperparameter tuning.

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**8. Future Enhancements**

- **Integration with IoT devices** for real-time data collection from forest regions.
- **Deep Learning Approaches** using LSTMs or CNNs for enhanced accuracy.
- **Cloud Deployment** using AWS/GCP for scalable predictions.

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**9. Conclusion**

This project successfully demonstrates the potential of machine learning in **predicting forest fires** with high accuracy. By leveraging **environmental data and ML models**, authorities can take **preventive actions** and reduce the devastating effects of wildfires.

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**10. References & GitHub Repository**

- **GitHub Repository:** Forest Fire Prediction

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