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FLOOD FORECASTING SYSTEM USING MACHINE LEARNING

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Abstract: Floods pose a growing threat to communities worldwide, necessitating advancements in forecasting systems to mitigate their impact. This study presents a comprehensive approach to flood prediction by integrating machine learning algorithms. Our proposed flood forecasting system harnesses the capabilities of machine learning algorithms to analyze historic data of rivers including daily runoff, weekly runoff, discharge and flood runoff. Also state wise data is also included. The creation of this prediction system offers better performance and affordable options. This article creates a prediction model to predict the frequency of floods caused by rainfall. Based on the range of rainfall in certain locations, the model predicts whether a flood will occur or not.

Index Terms **– Mitigate, machine learning, algorithms, harnesses, runoff, discharge, prediction.**

I. INTRODUCTION

Floods represent one of the most devastating natural disasters, causing significant loss of life, property damage, and economic disruption worldwide. Traditional flood forecasting methods, reliant on historical data and simplistic modeling, often fall short in accurately predicting the complexities of flood events, especially in the face of changing climate patterns and urbanization. In recent years, the integration of machine learning (ML) techniques into flood forecasting has shown promising results, offering the potential to revolutionize how we predict and mitigate the impacts of floods. Unlike conventional methods, which rely heavily on deterministic models and simplified assumptions, ML algorithms can effectively analyze vast datasets, identify intricate patterns, and adapt to changing environmental conditions, thus enhancing the accuracy and reliability of flood forecasts.

This research paper aims to explore the application of various ML techniques in flood forecasting and assess their effectiveness in improving prediction accuracy, lead time, and spatial resolution. By leveraging advanced algorithms such as logistic regression, linear discriminant analysis (LDA), K- neighbors classifier, decision tree classifier, Gaussian naive Bayes and support vector machines (SVMs), this study seeks to address key challenges in flood forecasting, including nonlinearity, spatial heterogeneity, and data uncertainty.

II. OBJECTIVES

The objective for a proposed Flood Forecasting System are as follows :

i. To implement algorithms to significantly improve the accuracy of flood forecasts.
ii. To design a user-friendly interface that allows a wide range of stakeholder.
iii. To ensure accessibility across different devices and browsers to reach a wide range of users.
iv. To implement a feedback mechanism for users to report discrepancies or provide input, facilitating ccontinuous improvement of the forecasting system.

III. LITERATURE SURVEY

i. **Title : Flood Prediction Using Machie Learning Models**
Author : Amir Mosavi, Pinar Ozturk, Kwok-wing Chau

This article gives an overview of machine learning models used in flood prediction along woth developing classification scheme to analyze the existing literature. Here binary logistic regression provides high accuracy while K-nearest neighbors provides low accuracy. These can provide accurate and timely predictions, enabling disaster management authorities to take appropriate measures to minimize damage.

ii. **Title : Flood Prediction using Machine Learning**
Author : Prof. Priyanka Pujari, Nidhi Kulkarni, Vinay C Hiremath, Vinay Bhushi

This paper proposed flood prediction model where machine learning algorithms are used to analyze historical weather data, river levels and other relevant data to develop a robust predictive model. Also a brief comparison is given about existing models. The model will be trained on different geographical regions. Deep learning techniques are also used to capture temporal dependencies.

iii. **Title : Flood Prediction using Deep Learning Models**
Author : Muhanmmad Hafizi Mohd Ali, Siti Azirah Asmai, Z. Zainal Abidin, Zuraida Abal Abas, Nurul A. Emran

This developed system is totally depended on deep learning. In this long short-term memory (LSTM) networks used as it is ideal for processing, classifying and forecasting time series. But deep recurrent neural network produces lowest mean squared error with Leaky ReLU which is well performed compared to LSTM.

iv. **Title : Flood Prediction using Machine Learning**
Author : Kishan Kashyap M, Ajay Karthik K, ShivaKumar G. S

In this research, authors used rainfall data of India. Here different algorithms such as logistic regression, support vector machine, k-nearest neighbors and decision tree classifier used. From above algorithms logistic regression had highest accuracy and also considered best algorithm for flood prediction.

v. **Title : An Innovative Flood Prediction System using Improved Machine Learning Approach**
Authors : Cynthia Cui, Leonardo Cui

This paper is from the Canadian science fair journal where authors get award. In this paper linear regression model algorithm is used. The authors proved that local climate data has significant effect on water level during flood season. Based on their research, they implemented a new approach of data visualization with a web based simulation map which helps communities.

IV. EXISTING SYSTEM

Existing systems of flood forecasting using machine learning algorithms typically rely on various features such as historical river discharge levels, rainfall data, soil moisture content, topographical information, and sometimes satellite imagery. These features are utilized to train different machine learning models, including artificial neural networks, support vector machines, decision trees, and random forests. Once trained, these models analyze actual-time data streams, such as rainfall and river levels, to generate forecasts of potential flooding events. These forecasts include predictions of flood severity which is integrated into decision support systems used by emergency management agencies and local governments to facilitate timely response efforts and mitigate the impact of flooding. Periodic updates to the models ensure their accuracy and relevance to changing environmental conditions.

The primary disadvantages is the modes of existing frameworks are :

i. Flood forecasting accuracy can be sensitive to the selection and quality of input variables, requiring careful consideration and validation.
ii. Continuous model updating and calibration are necessary.

V. PROPOSED SYSTEM

i. Problem Statement

The purpose of the system is to develop an accurate flood forecasting system that leverages machine learning techniques to provide rainfall prediction with flood prediction.

ii. Scope of Project

A flood forecasting system that provides prediction can be valuable tool for mitigating the impact of the floods and saving lives and property. The scope for a project on flood forecasting using machine learning on a dataset can be quite broad and very depending on factors such as available data, project objectives, and resources.

iii. Proposed System

The proposed system is build using machine learning algorithms. For this we have use daily, weekly and flood runoff data of five rivers namely Cauvery, Godavari, Krishna, Mahanadi and Son. Also the rainfall data of Indian states from 1901 to 2017 of each month is used. Firstly all the datasets are trained individually. Further using that individual trained datasets the final dataset is trained which is used for making final model using Flask framework.

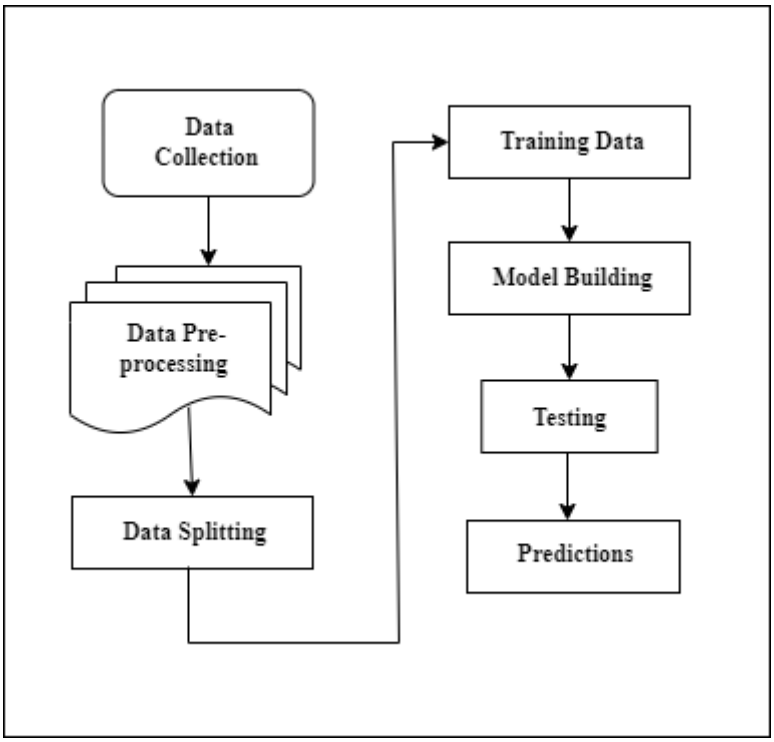

fig. 1 proposed system

i. **Data Collection:** Raw data from different resources along with datasets.
ii. **Data Preprocessing:** Checking, cleaning, and organizing collected data for analysis. This step involves handling missing values, removing noises, and converting data to usable format.
iii. **Data Splitting:** Generally, we split the data into two parts – one to train the model and the other to test the trained model. In that model, it remembers data and learns the patterns.
iv. **Building Model:** After the above steps model is built. In it, different algorithms are used to check for accuracies, and depending upon those accuracies the higher accuracy algorithm is selected for the final model.
v. **Prediction:** It is nothing but applying a trained model to new or unseen data to generate predictions. Here in the case of flood forecasting, it means, predicting rainfall and analyzing whether there is a flood or not.

VI. RESEARCH METHODOLOGY

i. Flask

Flask is a web structure that is written in Python. It is nothing but an application programming interface (API). It enables inventors to make web applications rspeedily and efficiently. Here in flood forecasting, Flask is used to deploy the model. Firstly we have to import the libraries, then using app=Flask(__name__) we create an instance of the flask.

ii. Jupyter Notebook

The Jupyter Notebook formerly known as IPython Notebook. It is an interactive web application for creating and participating computational documents. In today's world, Jupyter Notebook is mostly used for training and testing machine learning and deep learning models. Here in this flood forecasting system,it is used for model training and testing along with deployment with Flask.

iii. Web Technologies

As Flood Forecasting System is a web app, for frontend purpose web technologies are used such as HTML, CSS, and Javascript. Web development is essential and can help to build more advanced web applications. Examples of such systems are recommender systems, forecasting systems, etc.

iv. Machine Learning

For prediction -system nowadays machine learning is used. It is a subset of artificial intelligence. In it, different machine learning algorithms are used based on their features. Its algorithm has different set of features which is further used for creating a model. The highest accuracy algorithms are used to get accurate predictions.

VII. RESULTS

As different algorithms are used here for checking accuracy and depending on that accuracies, the higher accuracy algorithm is used further for making model. Not only accuracies but also standard deviation is checked. Standard deviation is aa number which describes how values are spread out. Here logistic regression, support vector machine, decision tree classifier, k-nearest neighbors, LDA and gaussian naïve bayes algorithms are used. The below table describes the comparison of accuracies and standard deviation with boxplot.

Table 1 comparison of algorithms

Sr. No.	Algorithm	Accuracy	Standard Deviation
1	Logistic Regression (LR)	0.996955	0.001315
2	Linear Discriminant analysis (LDA)	0.988258	0.003007
3	K-Nearest Neighbors (KNN)	0.985253	0.002300
4	Decision Tree Classifier (CART)	1.000000	0.000000
5	Gaussian Naive Bayes (NB)	0.993613	0.001442
6	Support Vector Machine (SVM)	0.997088	0.001482

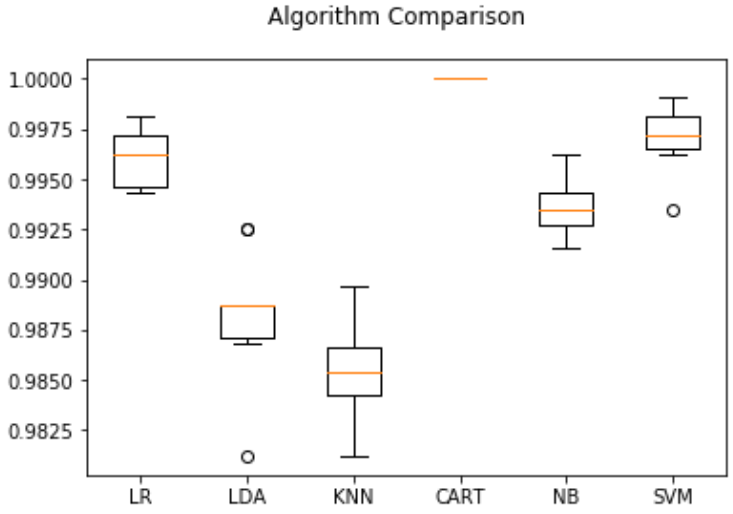

Fig. 2 algorithm comparison

Further K-Nearest neighbors and Linear discriminant analysis are selected. For these both some parameters are calculated including confusion matrix, precision, recall, F1 score. Comparing both linear discriminant analysis has better results and confusion matrix is displayed. The confusion matrix for linear discriminant analysis is following :

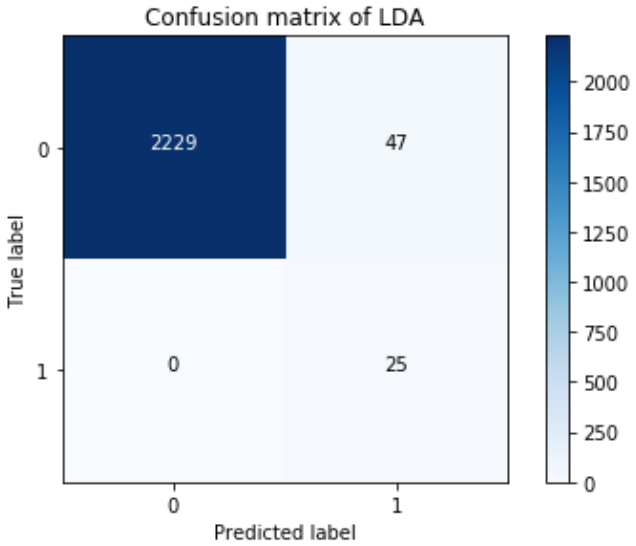

fig. 3 Confusion matrix for LDA

VIII. FUTURE SCOPE

In the future, flood forecasting using machine learning on datasets holds significant promise for advancing our capabilities in predicting and mitigating the impacts of flooding events. Continued research and development efforts are expected to lead to enhanced model performance through the integration of advanced machine learning techniques such as deep learning algorithms, which can capture complex spatio-temporal patterns in data more effectively. Additionally, there is a growing emphasis on integrating additional data sources, such as social media data and sensor networks, to enrich existing datasets and provide valuable insights for improving flood forecasting models, particularly in urban areas. Ultimately, these advancements aim to empower communities, reduce vulnerabilities, and enhance resilience to flooding events globally.

IX. CONCLUSION

Flood forecasting system aims for accurate prediction of rainfall and flood. It has user friendly interface. In conclusion, flood forecasting leveraging machine learning on datasets represents a transformative approach with immense potential for revolutionizing our ability to predict and mitigate the impacts of floods. As machine learning gets better and we use more kinds of data together, like from different sources and experts working together, our flood predictions can become more accurate, detailed, and easier to use practically. In this proposed system Linear Discriminant Analysis provides better results and is used for model. By using machine learning and working together, we can make communities stronger, reduce how easily they can get hurt by floods, and lessen the damage floods cause to people's lives and jobs all around the world.

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