

# Disaster Management with Sentiment Analysis and Earthquake/Tsunami/Flood Prediction System

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**Abstract:** Earthquakes, floods, and tsunamis are ever-present dangers to people and property, calling for efficient and prompt disaster management plans. This work presents a hybrid system that combines “Random Forest (RF) and Long Short-Term Memory (LSTM)” algorithms to forecast natural disasters and categorize social media data regarding humanitarian aid sentiments. Using datasets of tweets about disasters as training, the LSTM model classifies people's demands during these times into sentiment classes including pity, urgent pleas for help, and other similar terms. Predicting the probability of earthquakes, tsunamis, and floods using environmental variables like rainfall, latitude, longitude, depth, and dam height is done using the Random Forest method. The use of an extension that makes use of the XGBoost ensemble algorithm significantly improves prediction accuracy, reaching 99.5%. Metrics for accuracy, precision, recall, and F-score show that the system outperforms more conventional models like SVM (92.0%) and RF (95.63%). This paper presents a framework for early warning systems that efficiently use machine learning techniques for real-time disaster prediction and humanitarian relief. A web application built in Python was used to create the system. It provides a user-friendly interface for sentiment analysis and disaster prediction.

*“Index Terms - Disaster Management, Sentiment Analysis, Earthquake Prediction, Tsunami Prediction, Long Short-Term Memory (LSTM), Random Forest (RF) Algorithm.”*

## 1. INTRODUCTION

Destructive and life-threatening natural disasters, including earthquakes, floods and tsunamis, are still like a great concern for people around the world. Traditional disaster action procedures often overwhelm from the unpredictability and quick the beginning of these disasters, more efficient and timely production management systems [1]. New methods have become possible for prognosis and management of destruction because for recent

technological development, especially in data analysis and machine learning areas.

There is no better chance of improving disaster management than social media platforms, thanks to the abundance of real-time user-borne materials. People often use social media pages such as Twitter and Facebook to express their needs, concerns and experiences after natural destruction. When evaluated, this data can reveal a lot about emotional stages and immediate demands from affected people. This can help officials and the first

respondents prefer rescue operations, use available resources and meet the most important human needs [2].

Particularly used here is a method of emotional analysis, Natural Language Processing (NLP). One way to classify public reactions and requirements is by looking at the tone of the Social Media Post. This can help with things such as immediate arguments, rescue actions and identification of compassion. This classification increases the effectiveness of the crisis management strategy, which allows for more targeted and effective reaction [3].

Prophet Natural Catastrophe is another area where machine learning approaches have shown considerable ability including emotional analysis. Machine learning algorithms can predict earthquakes, tsunami and the possibility of flooding by examining the environmental variables, including the height of rain, latitude, longitude, depth and pond. Officers and fellowship are capable of continuously planning and thanking these predictions, which can save life and reduce financial loss [4].

The combination of different machine learning methods is one of the best ways to cope with this field. An example of an approach that has shown promising results is a combination of emotional analysis using Long Short -term Memory (LSTM) Network and Disaster Prediction using Random Forest (RF) algorithm. It is possible to improve the performance of these models by using enchanted approaches such as XGBOOST, which has been shown to increase the accuracy of prophecy [5].

## 2. RELATED WORK

Research in effective methods of disaster reproduct and management has been followed extensively due

to the increasing frequency and severity of natural destruction. Cahyanti (2024) [6] Tsunami Memorial Museum in Japan and Indonesia examines the places of depressed tourism after disasters after disasters, and see how they teach people about the incident and how they miss it. The importance of remembering previous disasters to create flexibility and awareness in local communities has been emphasized in this study. The psychological flexibility of teenagers and their caregivers after disasters are also examined by Lomley-Rodriguez et al. (2024) [7]. The importance of mental health care in disaster recovery has been postponed by their study, providing valuable insight into ways that can help affected communities become more psychologically flexible.

Using AI to reduce disaster risk, especially in agriculture, is the primary emphasis on Neong et al. (2024) [8]. By increasing the processes of early warning systems and decision -making processes in agriculture, the most receptive areas for natural disasters, highlighting their work highlights the possibility of artificial intelligence technology to reduce the effect of disasters. A study organized by Nuraisyah et al. In his research on the execution of politics, the author postpones the difficulties and disabilities of Disaster Recovery Financial Assistance Distribution.

A qualitative study was conducted by Purnaomo et al. (2024) [10] to evaluate the emergency preparedness of nurses in case of flood disaster. Better health services Reactions during destruction can be achieved through programs with increased disaster preparations, as their findings highlight training and lack of emergency preparedness among health professionals. At the same time conditional plan according to prehistoric methods, Walter (2024) [11] provides a new perspective on disaster management by mapping the development of crisis

strategy. At the moment for better understanding the destruction response systems, this historical perspective is quite favorable.

The gender perspective is used by Özdeemir (2024) [12] to analyze social policy, and serve as a case study with an earthquake on February 6. In order to guarantee fair and effective reactions, this research emphasizes the importance of gender -specific weaknesses and needs in disaster management strategies. The use of subject modeling in Saladana Villa (2024) [13] [13] The analysis of disaster framing in Chile -the wires highlights the methods where media stories affect public opinion and response to disasters. This method emphasizes the importance of providing correct and up -to -date information on time and providing the function of communication in destruction management. The analysis of crisis communication in Japan during 2011 and 2024 Earthquake has been analyzed in a double case study [14].

The findings from the study highlight the need for effective message strategy to reduce the importance and public fear of well -coordinated destruction reactions. Polat and Tejakan (2024) [15] investigate factors affecting earthquake decisions and travel behavior. Their research helps to emphasize how people work in crises, which in turn affects withdrawal plans and the authorities' decisions.

### 3. MATERIALS AND METHODS

Through the use of a machine learning algorithm for the natural disaster -the prediction and spiritual analysis of humanitarian aids derived from social media data, the proposed system intended to build a state -Art -art disaster control structure. To analyze emotions and estimate natural disasters, the system uses a hybrid approach that combines LSTM and random forest. A dataset with tweets, including

immediate, rescue and support, will be used to classify tweets for human assistance requests under disasters to LSTM. To predict earthquakes, tsunamis and floods, random forest analyzes analyzes environmental variables including latitudes, longitude, depth, rainfall and height of the dam. We want to optimize the functional choice and increase model performance by incorporating an extension using XGBOOST Enchanted Approach. This prediction will further increase accuracy. A web application on Python will provide power to the system, which will provide the opportunity for emotional analysis of real -time and disaster exceptions through an interactive platform. This will improve disaster response and management efficiency.

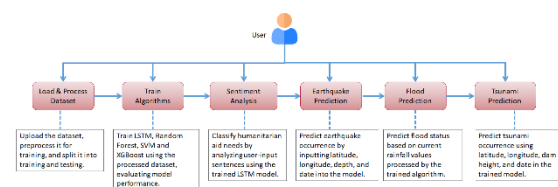


Fig.1 Proposed Architecture

The graphic representation of system architecture (Fig.1) uses the disaster management system's machine learning to assess human needs and provide predictions on future natural disasters. This includes several algorithms, such as “LSTM, Random Forest and XGBOOST”, in the earthquake, flood and tsunami prediction modules. Humanitarian assistance requirements can be better evaluated and auxiliary operations can be better controlled by a sense of user -generated material.

#### i) Dataset Collection:

Requirements for human relief during destruction are the main focus of the data collection process, including collecting tweets from social media

platforms relevant to disasters. Tweets marked with many emotion categories are included in the dataset. These categories include immediate demand, rescue efforts and expressions of sympathy. Machine learning models that classify emotions and use environmental variables for natural disasters such as floods, earthquakes and tsunami forecasts are trained on this data set.

### ii) Load & Process Dataset

Users can upload a dataset with tweets related to disasters using the "Load and Process Dataset" module. When the data is uploaded, the data is processed by the system in preparation for model training. This involves preparing data for machine learning algorithms, cleaning them and dealing with lack of information. To guarantee effective and reliable analysis, collected data is later used to train many models for emotional classification and disaster prediction.

### iii) Train Algorithms:

The machine learning model can be trained using a treated dataset with the "Train Algorithm" module. This section supplies the data that is cleaned and designed for processing for many algorithms, such as "XGBOOST, Random Forest (RF) and long short-term memory (LSTM)". A total of 80% datasets are used to train algorithms and keep separate for 20% test purposes. The module considers the effect of these models by calculating their accuracy, F-point, recall and accuracy. In addition, it is contrary to the results, which show the high accuracy of XGBOOST, guarantees the most reliable forecast for disaster exception and emotional classification.

### LSTM (Long Short-Term Memory)

Long short-term memory (LSTM) RNNs is a type of RNN as models gradually data by capturing long

-term addition and reducing the effect of faded gradient problems. This includes memory cells that can store data in many times. Speech recognition, emotional analysis and natural language treatment are some examples of long-term short-term memory (LSTM) network. Extended short-term memory (LSTM) is a powerful tool in NLP to understand references on extended sequences, which helps the model to do things like text classification, trend detection and meaningful output generation based on previous pattern.

### Random Forest

During training, random forest decisions form a dress of trees, and when it is met with a classification or regression problem, it produces the average or average of the predictions of these trees. This increases accuracy by reducing overfitting. Its specific applications include the selection of features, regression and classification. Economic forecasts, prediction of illness and image classification are among areas that use random forests. The primary goal of random forest is the primary target of random forest that improves accuracy from the average of production from many models. It works well in many contexts and can handle data with both linear and non-reactive conditions.

### SVM (Support Vector Machine)

A monitored teaching approach detects the best hyperplane in a place with several dimensions for support Vector Machine (SVMS) class separation. In classification problems, it optimizes margins between data points related to different classes. BIO-information applications of support Vektorm machines include identification and deviations in patterns as well as images and text classifications. Data with high-dimensional functions can be

efficiently classified by using SVM. It guarantees strong classification performance and works especially well in high -dimensional areas, where there are different separation margins.

**XGBoost (Extreme Gradient Boosting)**

The XGBOOST gradient is a framework for increasing that optimizes the model by using the gradient dynasty and the decision appoints trees such as Aadhaar students. It uses regularization to make predictions more accurate and less prone to overfit. Many structured/stained data problems, including ranking, classification and regression, use xgboost. It uses in financial markets, medical research and artificial intelligence competitions. To avoid overfitting, the XGBOOS decision uses regularization to limit trees with trees. The goal is to build a high-demstration model. For the mass dataset provides excellent accuracy and efficiency.

**iv) Sentiment Analysis:**

The input words related to the disaster can be treated by the LSTM model via the "Sentment Analysis" module. Such entrance algorithms are sorted out into the predetermined emotion categories with immediate demand, rescue operations and feelings of mercy. The effectiveness of disaster response sponsorship operations can be increased by identifying individuals of individuals during disasters and emotional reactions. This module provides considerable insights for human relief and resource allocation.

**v) Earthquake Prediction:**

Local and environmental data, such as date, depth, latitude and longitude, can be recorded in the "prediction of earthquakes" by users. With these details, the system runs a machine learning technique like Random Forest to determine how it

will probably hit an earthquake given area. By analysing trends in environmental data, this module can identify potential earthquake risk, provide initial warning and useful insights that can help in disaster preparation and reaction strategies.

**vi) Flood Prediction**

Users can enter environmental data, including today's rainfall level in the "prediction" module to determine the possibility of flooding. A purpose of analyzing these figures and predicting floods, appoints the system machine learning algorithms. Services and communities can take the necessary measures to reduce the effect of potential flood disasters using timely estimates of this module, which can help with initial warnings and planning.

**vii) Tsunami Prediction:**

Users can enter accurate parameters such as date, pond height, latitude and longitude in the "Tsunami Prediction" section. By using these parameters as input, the system calculates the possibility of a tsunami in the specified area using machine learning methods. To reduce the risk and improve disaster control techniques, this module provides important initial warnings about possible tsunamis, which fellowship and officers can use to prepare to prepare the authorities.

**4. RESULTS & DISCUSSION**

**Accuracy:** accuracy epithetical test is its ability towards properly distinguish patient & healthy cases. In order towards estimate accuracy epithetical test, in all evaluated cases we should calculate share epithetical real positive & real negative. Mathematically it can withstand it as:

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN} \quad (1)$$

**Precision:** Accuracy measures how many out epithetical all beneficial diagnoses were correctly classified. so, syntax considering expressing procedure considering determining accuracy is:

$$Precision = \frac{\text{True Positive}}{\text{True Positive} + \text{False Positive}} \quad (2)$$

**Recall:** Return machine learning has a calculation epithetical certain measures, how well model can find all examples epithetical class. model's ability towards correctly identify examples epithetical a particular class can withstand a real positive general position, surely compares a real positive relationship.

$$Recall = \frac{TP}{TP + FN} \quad (3)$$

**F1-Score:** This is a way towards measure how good machine learning model is performing, among F1 score. Accuracy is part epithetical it, but model structure is ignored. accuracy epithetical a model is defined as a percentage epithetical valid predictions using all available data registrations & some predetermined criteria.

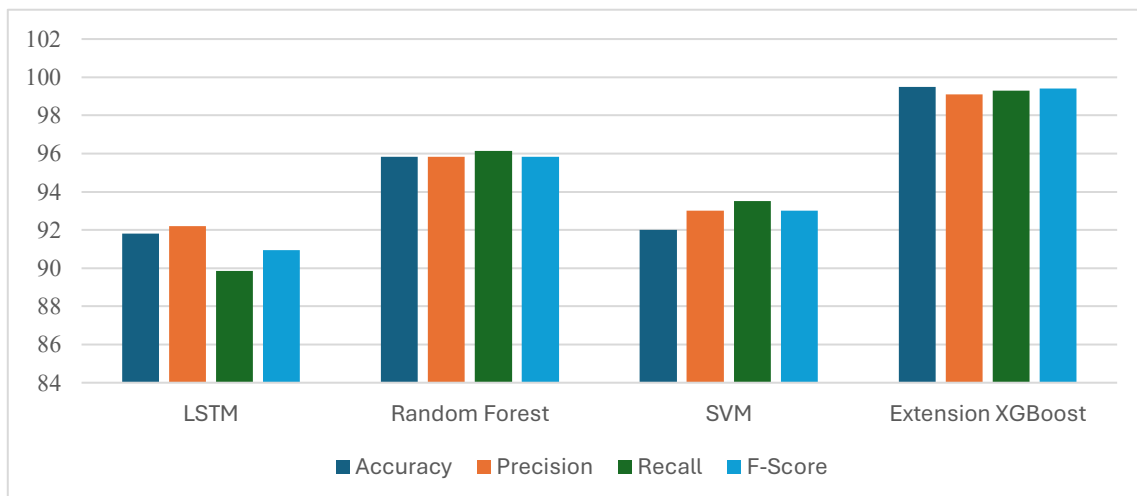
$$F1 \text{ Score} = 2 * \frac{Recall * Precision}{Recall + Precision} * 100 \quad (1)$$

The accuracy, precision, recall, and F1-Score performance indicators for each algorithm are evaluated in Table (1). When compared to other algorithms, the XGBoost always comes out on top. In addition, the tables provide a comparison of the metrics for the alternative methods.

Table.1 Performance Evaluation Table

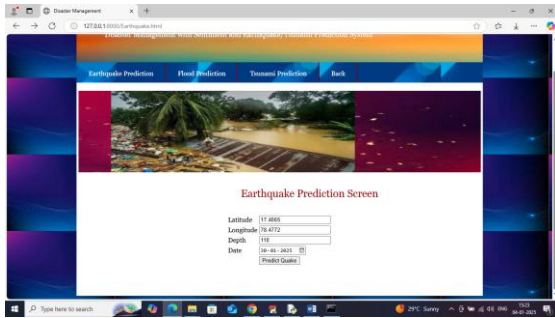
Algorithm Name	Accuracy	Precision	Recall	F-Score
LSTM	91.8	92.21	89.86	90.94
Random Forest	95.83	95.83	96.15	95.83
SVM	92.0	93.0	93.5	93.0
<b>Extension XGBoost</b>	<b>99.5</b>	<b>99.1</b>	<b>99.3</b>	<b>99.4</b>

Graph.1 Comparison Graphs

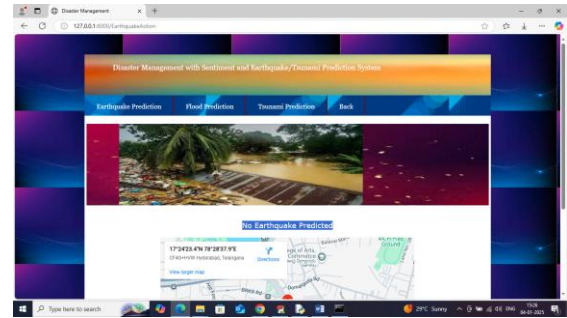


In Graph (1), blue denotes accuracy, orange precision, green recall, and sky-blue denotes F1 - score. The XGBoost outperforms the competition

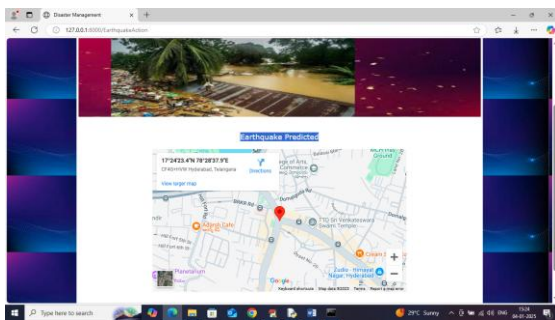
and achieves the best results across the board. These results are graphically shown in the graphs up above.



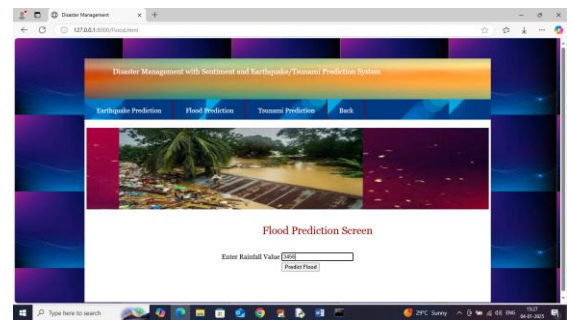
In above screen entering location details along with earthquake depth and date and then press button to get below page



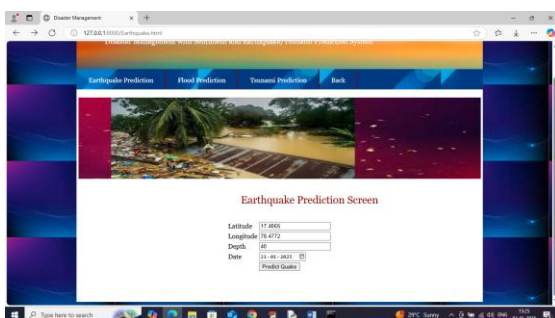
In above screen in blue text can see 'No Earthquake Predicted'. Now click on 'Flood Prediction' link to get below page



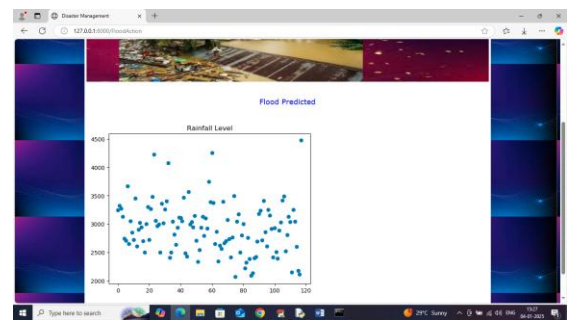
In above screen in blue colour text can see predicted label as 'Earthquake Detected' and can see location in map. Below is another example



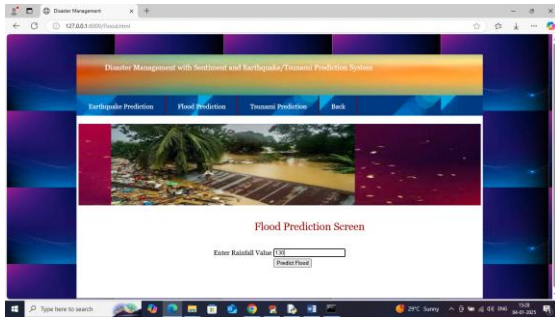
In above screen entering current Rainfall value and then press button to get below page



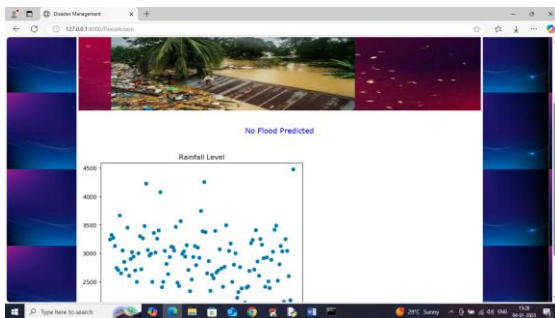
In above screen another input is giving and below is the output



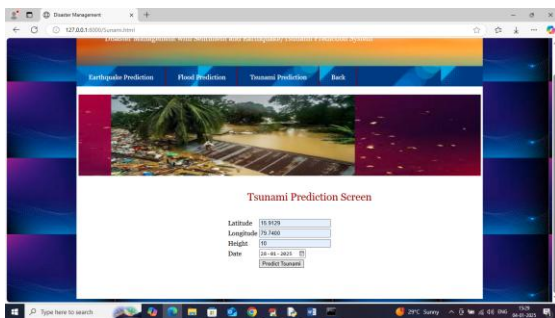
In above screen in blue text can see 'Flood Predicted' and in graph can see Rainfall occurred in different days of year and below is another sample



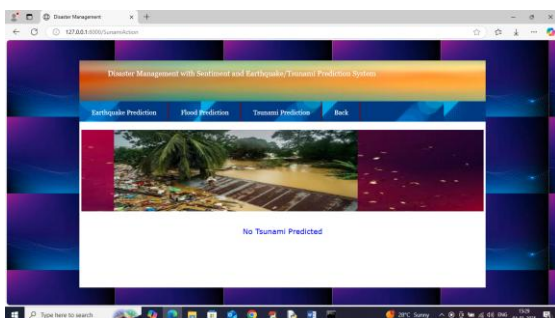
In above screen entering another rainfall level and below is the output



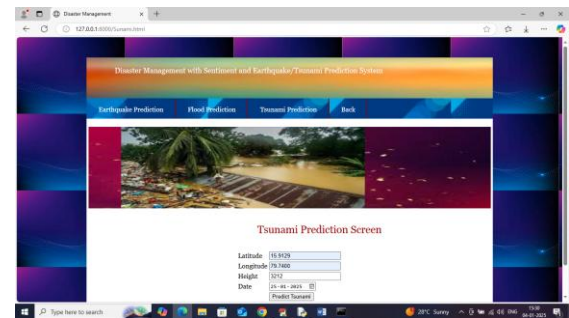
In above screen 'No Flood Predicted' and now click on 'Tsunami Prediction' link to get below page



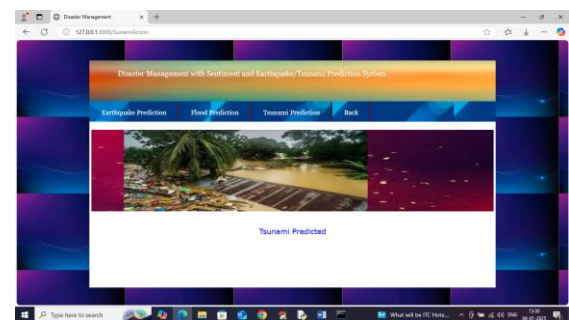
In above screen entering location details along with date and DAM level and then click on 'button' to get below page



In above screen 'No Tsunami Predicted' and below is another example



In above screen entering another input values and below is the output



In above screen 'Tsunami predicted'.

### 5. CONCLUSION

Finally, by integrating sentiment analysis of social media data with predictions of natural catastrophes, the suggested method efficiently combines advanced machine learning techniques for disaster management. Using a combination of LSTM and RF, the system can forecast when earthquakes, floods, and tsunamis would occur and categorize human aid feelings regarding emergency needs. While the random forest algorithm estimates the possibility of natural disasters given to parameters such as location, depth and rainfall, the LSTM model is trained to classify Tweets related to disasters. We improved the performance of the system by adding the XGBOOST –ensemble algorithm. This reached the maximum prediction

accuracy of 99.5% and generally made the system more efficient. This system is a great feature for controlling real-time destruction because the combination of these algorithms guarantees high precision in emotional classification and disaster conditions of activities. Users are able to achieve disaster prognoses and emotional analysis for effective human relief through python-based web applications, which promote even interaction and help make better decisions during disaster operation

Through the integration of additional data sources such as sensor data and satellite imaging, the disaster prediction model will focus on future work with a view to significantly improving the system's accuracy. This can also be useful for examining CNN and other deep teaching models for emotional analysis and the use of reinforcement for adaptation of dynamic disaster reactions. In addition, the system can be expanded to process data in many languages, making it more favorable for different fields and is potentially useful for disaster administration initiatives worldwide.

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