NATURAL DISASTER INTENSITY ANALYSIS AND CLASSIFICATION

USING ARTIFICIAL INTELLIGENCE

A Project report submitted in partial fulfilment of 7th semester in degree Of

BACHELOR OF ENGINEERING
IN

ELECTRONICS AND COMMUNICATION ENGINEERING
Submitted By

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NOV-2022

V.S.B ENGINEERING COLLEGE, KARUR

(Approved by AICTE & Affiliated by Anna University, Chennai)

BONAFIDE CERTIFICATE

Certified that this project report "**NATURAL DISASTER INTENSITY ANALYSIS AND CLASSIFICATION"** is the Bonafide record work done by **Ms PREETHI S** (**922519106114**), **Ms LEEBIKA S** (**922519106082**), **Ms MANGAIYARKARASI B** (**922519106087**), and **Ms KAVIYARASI G** (**922519106074**) for **IBM- NALAIYATHIRAN** in **VII** semester of**B.E.,** degree course **in Electronics and Communication Engineering** branch during the academic year of 2022 – 2023.

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Mrs. Dr P.S Gomathi

ACKNOWLEDGEMENT

First and foremost, we express my thanks to our parents for providing us a very nice environment for doing this mini project. We wish to express our sincere thanks to our founder and Chairman **Shri.V.S.BALSAMY** for his endeavour in educating us in this premier institution.

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ABSTRACT

Natural disasters have posed threats and challenges to the survival and welfare of mankind. In the meantime, their frequent occurrences have also served as incentives for humans to create wisdoms, cultures and civilisations. The ongoing global warming not only increases the probability of climate-induced disasters (such as drought, heatwaves and wildfires), but it also increases the probability of flooding-related hazards and exacerbates the compounding effects of the interactions between a primary oceanic flooding hazard, coastal water–level rise and inland fluvial flooding hazards. Although the probability of occurrence of natural disasters has nothing to do with political borders, crisis preparedness and postdisaster relief and reconstruction tend to be less effective in cross-border areas than elsewhere. Finally, we suggest an innovative, cross-border approach for policymakers and practitioners to improve their work performances in the prevention, preparedness and relief of border-related natural disasters.

TABLE OF FIGURES

Source Code GitHub & Project Demo Link

EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES

1.INTRODUCTION

A natural disaster is characterized by the abnormal intensity of a natural agent (flood, mudslide, earthquake, avalanche, drought) when the usual measures to be taken to prevent this damage were not able to prevent their emergence or were not able to be taken. A natural disaster is "**the negative impact following an actual occurrence of natural hazard in the event that it significantly harms a community**". A natural disaster can cause loss of life or damage property, and typically leaves some economic damage in its wake.
Disaster management is **a process of effectively preparing for and responding to disasters**. It involves strategically organizing resources to lessen the harm that disasters cause. It also involves a systematic approach to managing the responsibilities of disaster prevention, preparedness, response, and recovery.

PROJECT OBJECTIVE

PROJECT OBJECTIVE:

By the end of this project you will:

- **You will be able to learn how to get and prepare the dataset.**
- **You will be able to know how to do image processing.**
- **You will understand how to reduce the risk of disaster caused by the human error.**
- **Classify images using a Natural Disaster intensity analysis and classification.**
- **You will be able to know what are the multi disaster oriented technologies can be used.**
- **You will be able to know how to do safety precautions before the disasters .**
- **You will know Natural disaster intensity analysis and classification using AI Problems. Upon learning and completing all the above objectives, we can obtain a model which predicts the forest fire.**

2. LITERATURE SURVEY

2.1 REFERENCES

1) Aamir, M., Ali, T., Irfan, M., Shaf, A., Azam, M. Z., Glowacz, A., ... & Rahman, S. (2021). Natural disasters intensity analysis and classification based on multispectral images using multi-layered deep convolutional neural network. *Sensors*, *21*(8), 2648.

2) Wirasinghe, S. C., Caldera, H. J., Durage, S. W., & Ruwanpura, J. Y. (2013, July). Preliminary analysis and classification of natural disasters. In *Proceedings of the ninth annual conference of the International Institute for Infrastructure, Renewal and Reconstruction*.

3) Kappes, M. S., Keiler, M., von Elverfeldt, K., & Glade, T. (2012). Challenges of analyzing multi-hazard risk: a review. *Natural hazards*, *64*(2), 1925-1958.

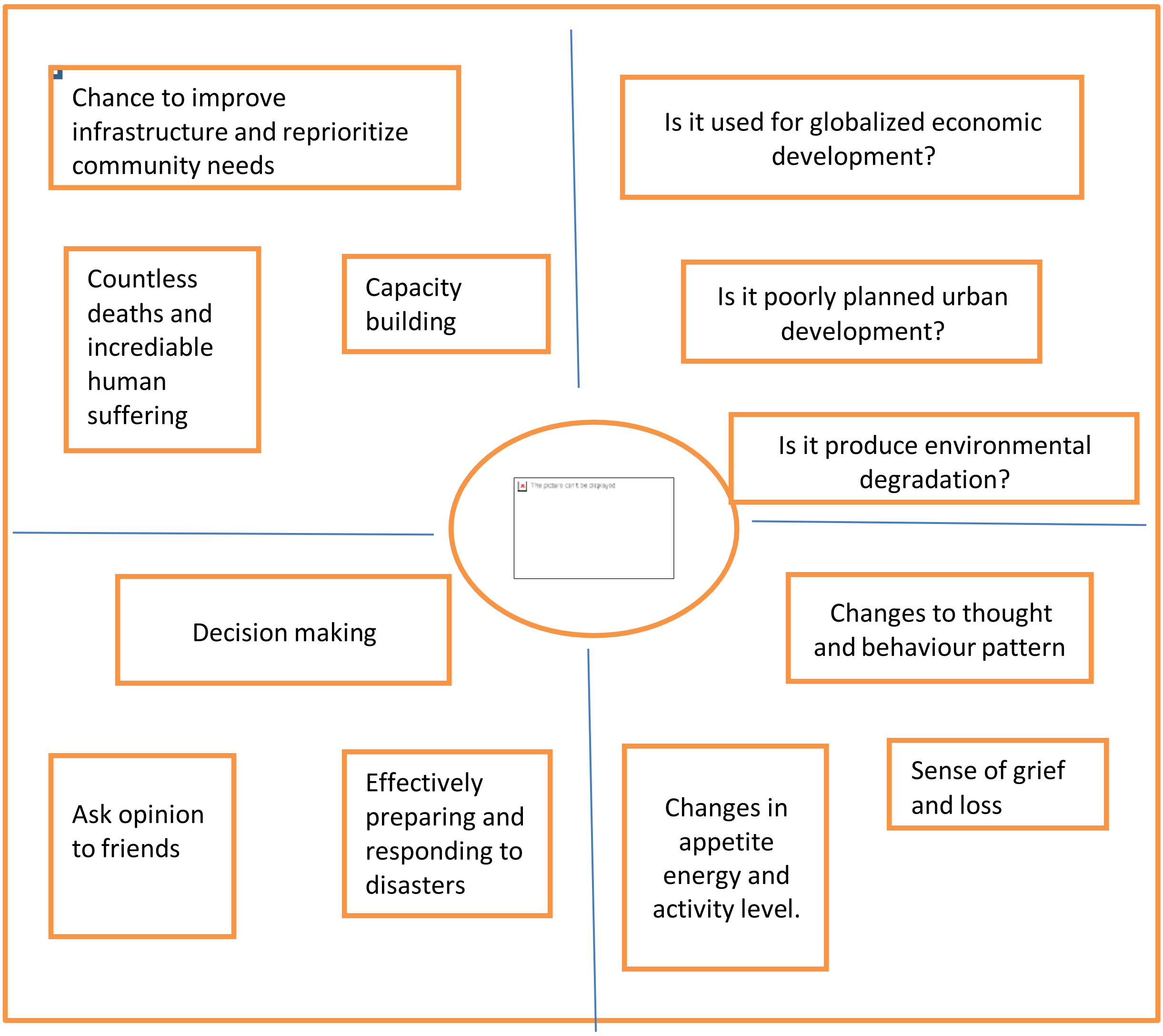
4) Day, S., & Fearnley, C. (2015). A classification of mitigation strategies for natural hazards: implications for the understanding of interactions between mitigation strategies. *Natural Hazards*, *79*(2), 1219-1238.

2.2 PROBLEM STATEMENT DEFINITION

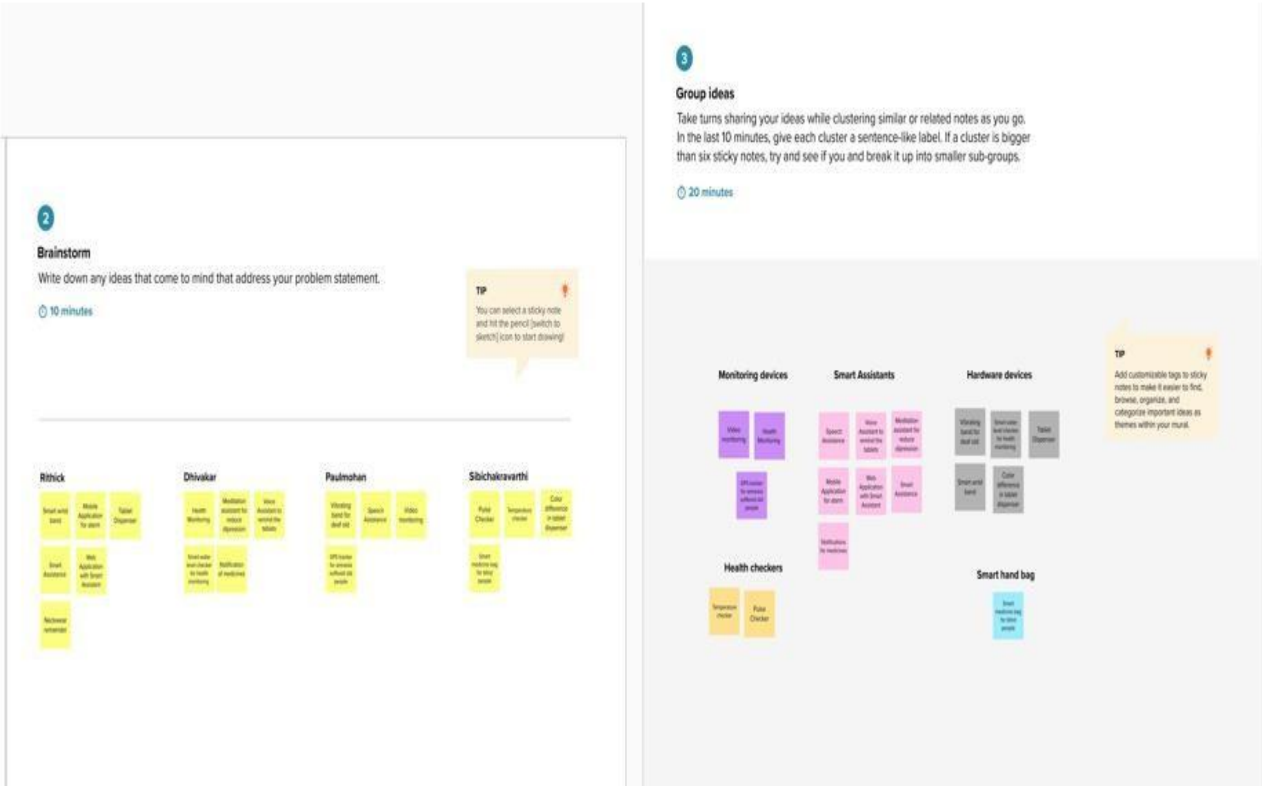
Poor co-ordination at the local level, lack of early-warning systems, often very slow responses, paucity of trained dedicated clinicians, lack of search and rescue facilities and poor community empowerment are some of the factors, which have been contributing to poor response following disasters in the past. In a disaster, **you face the danger of death or physical injury. You may also lose your home, possessions, and community**. Such stressors place you at risk for emotional and physical health problems. Stress reactions after a disaster look very much like the reactions seen after any type of trauma

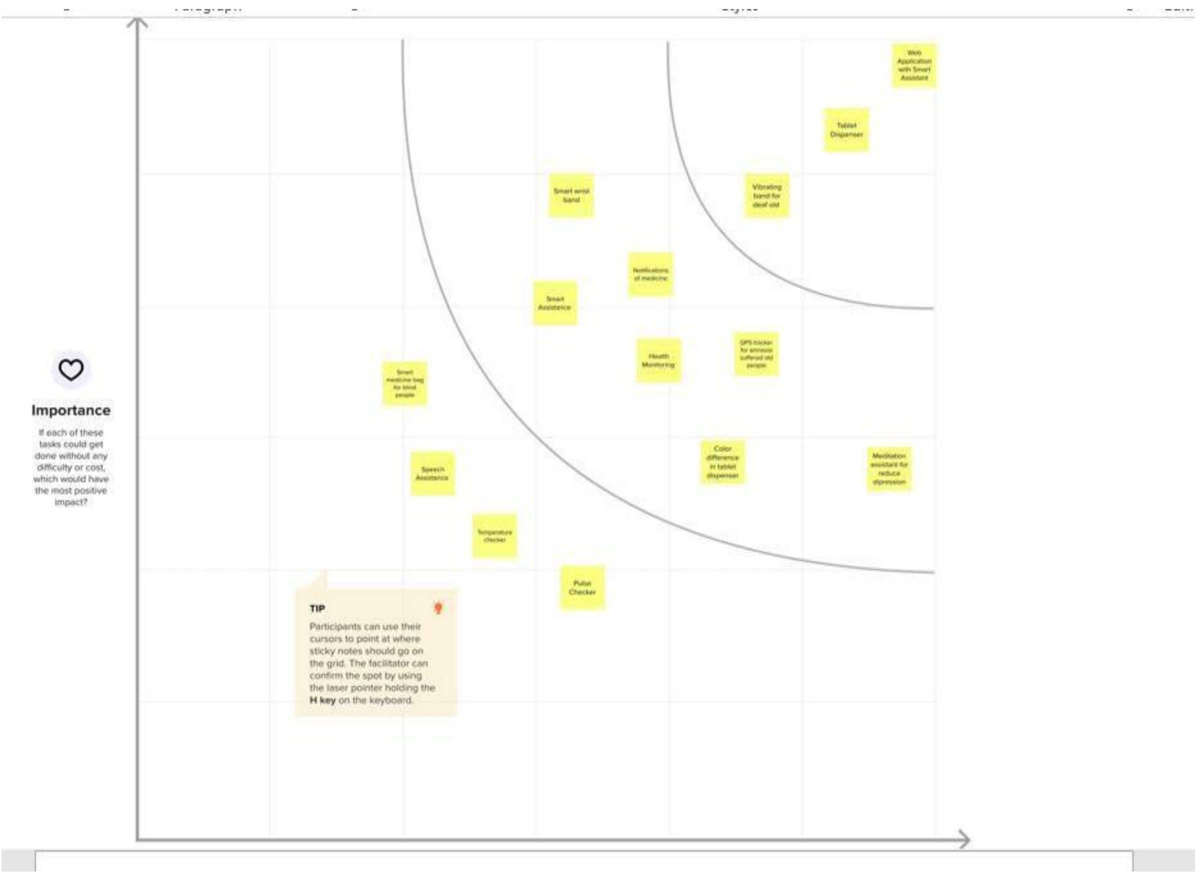
3. IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS



3.2 IDEATION & BRAINSTROMING

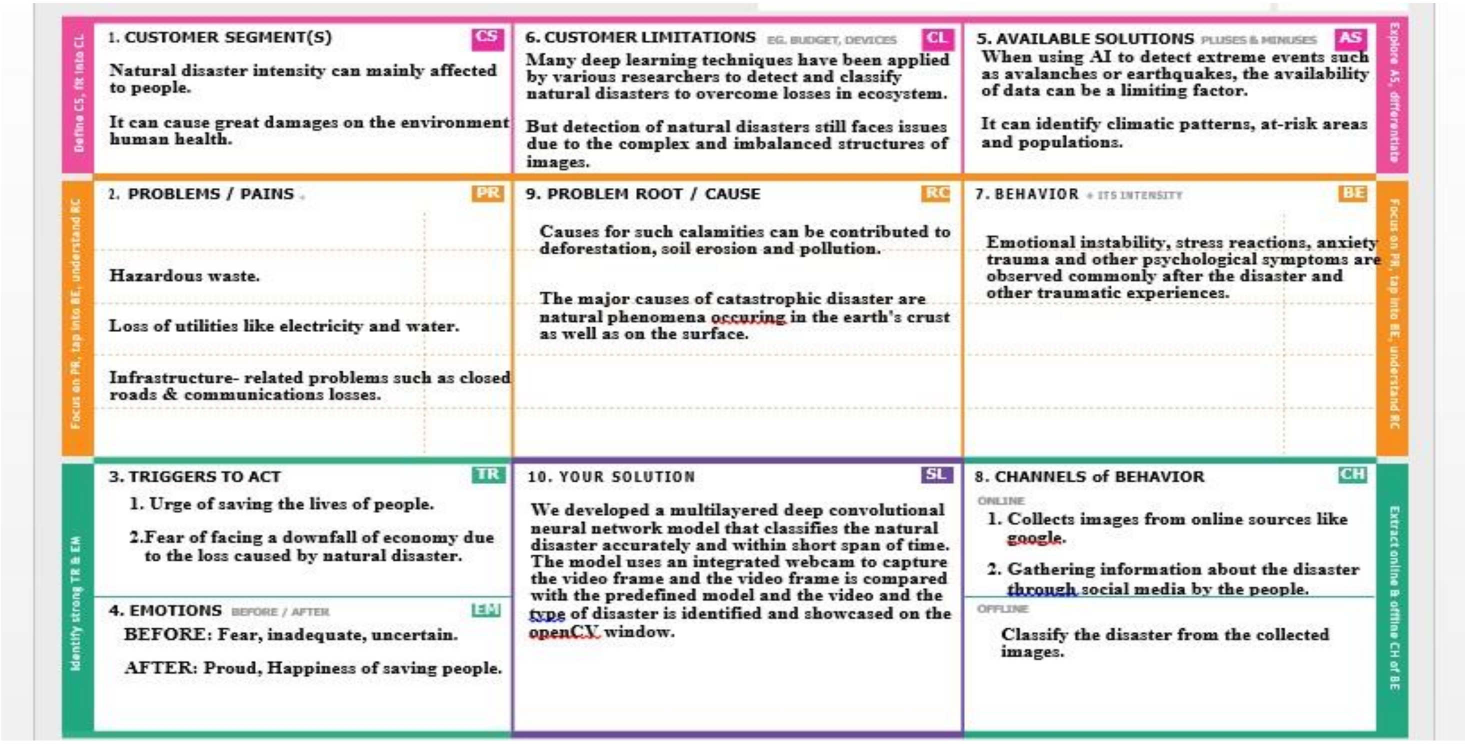



Importance
If each of these tasks could get done without any difficulty or cost, which would have the most positive impact?
Web Application with Smart Assistant
Tablet Dispenser
Smart wrist band
Vibrating band for deaf old
Notifications of medicine
Smart Assistance
Health Monitoring
Smart medicine bag for blind people
Color difference in tablet dispenser
Meditation assistant for reduce depression
Speech Assistance
Temperature checker
Pulse Checker
TIP
Participants can use their cursors to point at where sticky notes should go on the grid. The facilitator can confirm the spot by using the laser pointer holding the H key on the keyboard.

3.3 PROPOSED SOLUTION

S. No.	Parameter	Description
1.	**Problem Statement (Problem to be solved)**	To monitoring and predicting the disasters and its intensity of impacts on the region
2.	**Idea / Solution description**	To use classification algorithm to identify the impacts ofdisaster.
3.	**Novelty / Uniqueness**	A Natural disaster is" the negative impact following an actual occurrence of natural hazard in the event that issignificantly harms a community".
4.	**Social Impact / Customer Satisfaction**	Copying capacity,culturals impacts,loss of livelihood,lossabsorption,loss acceptance,social vulnerability
5.	**Business Model (Revenue Model)**	Revenue generated through Royalty payments, productlicense costs in department , research and educational platforms. Revenue generated through Royalty payments, productlicense costs in department , research and educational platforms. Revenue generated through Royalty payments, productlicense costs in department , research and educational platforms.
6.	**Scalability of the Solution**	A first scalable implicit solver for nonlinear time-evolutionearthquakes city problem on low ordered unstructured finite elements with artificial intelligence

3.4 PROBLEM SOLUTION FIT



Define CS, fit into CL

1. CUSTOMER SEGMENT(S) CS

Natural disaster intensity can mainly affected to people.

It can cause great damages on the environment human health.

6. CUSTOMER LIMITATIONS EG. BUDGET, DEVICES CL

Many deep learning techniques have been applied by various researchers to detect and classify natural disasters to overcome losses in ecosystem.

But detection of natural disasters still faces issues due to the complex and imbalanced structures of images.

5. AVAILABLE SOLUTIONS PLUSES & MINUSES AS

When using AI to detect extreme events such as avalanches or earthquakes, the availability of data can be a limiting factor.

It can identify climatic patterns, at-risk areas and populations.

Explore AS, differentiate

Focus on PR, tap into BE, understand RC

2. PROBLEMS / PAINS PR

Hazardous waste.

Loss of utilities like electricity and water.

Infrastructure- related problems such as closed roads & communications losses.

9. PROBLEM ROOT / CAUSE RC

Causes for such calamities can be contributed to deforestation, soil erosion and pollution.

The major causes of catastrophic disaster are natural phenomena occuring in the earth's crust as well as on the surface.

7. BEHAVIOR + ITS INTENSITY BE

Emotional instability, stress reactions, anxiety trauma and other psychological symptoms are observed commonly after the disaster and other traumatic experiences.

Focus on PR, tap into BE, understand RC

Identify strong TR & EM

3. TRIGGERS TO ACT TR

1. Urge of saving the lives of people.
2. Fear of facing a downfall of economy due to the loss caused by natural disaster.

4. EMOTIONS BEFORE / AFTER EM

BEFORE: Fear, inadequate, uncertain.

AFTER: Proud, Happiness of saving people.

10. YOUR SOLUTION SL

We developed a multilayered deep convolutional neural network model that classifies the natural disaster accurately and within short span of time. The model uses an integrated webcam to capture the video frame and the video frame is compared with the predefined model and the video and the type of disaster is identified and showcased on the openCV window.

8. CHANNELS of BEHAVIOR CH

ONLINE

1. Collects images from online sources like google.
2. Gathering information about the disaster through social media by the people.

OFFLINE

Classify the disaster from the collected images.

Extract online & offline CH of BE

4. REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENTS

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	**TSUNAMI**	A series of large waves of extremely long wavelength and periodusually generated by a violent, impulsive undersea disturbance or activity near the coast or in the ocean. Whena sudden displacement of a large volume of water occurs, or if the seafloor is suddenly raised or dropped byan earthquake, big tsunami waves can be formed.

		When a sudden displacement of a large volume of water occurs, or if the seafloor is suddenly raised or dropped byan earthquake, big tsunami waves can be formed.
FR-2	**EARTHQUAKE**	Any sudden shaking of the ground caused by the passage of seismic waves through Earth's rocks. Seismic waves are produced when some form of energy stored in Earth's crust is suddenly released, usually when masses of rock straining against one another suddenly fracture and "slip."
FR-3	**DROUGHTS**	The primary cause of any drought is efficiency of rainfall and inparticular , the timing, distribution and intensity of this deficiency in relation to existing reserves.
FR-4	**TROPICAL CYCLONES**	The major natural disaster that affects the coastal regionsof India is cyclone and has a coastline of about 7516 kilometres , it is exposed to nearly 10% of worlds tropical cyclones.
FR-5	**Landslides**	**Landslides:** It mainly affects the Himalayan region and the western ghats of India. Landslides are also common in the nilgiri range. It is estimated that 30 percent of the world's landslides occur in the Himalayas. The Himalayan mountains which constitute the youngest and most dominating mountain system in the world.**:** It mainly affects the Himalayan region and the western ghats of India. Landslides are also common in the nilgiri range. It is estimated that 30 percent of the world's landslides occur in the Himalayas. The Himalayan mountains which constitute the youngest and most dominating mountain system in the world.

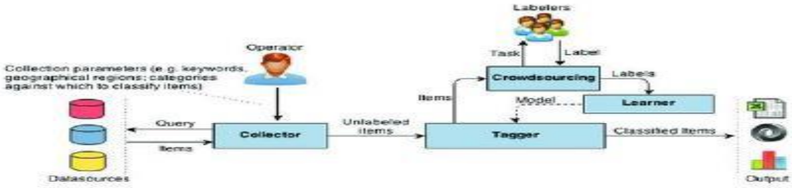
4.2 NON – FUNCTIONAL REQUIREMENTS

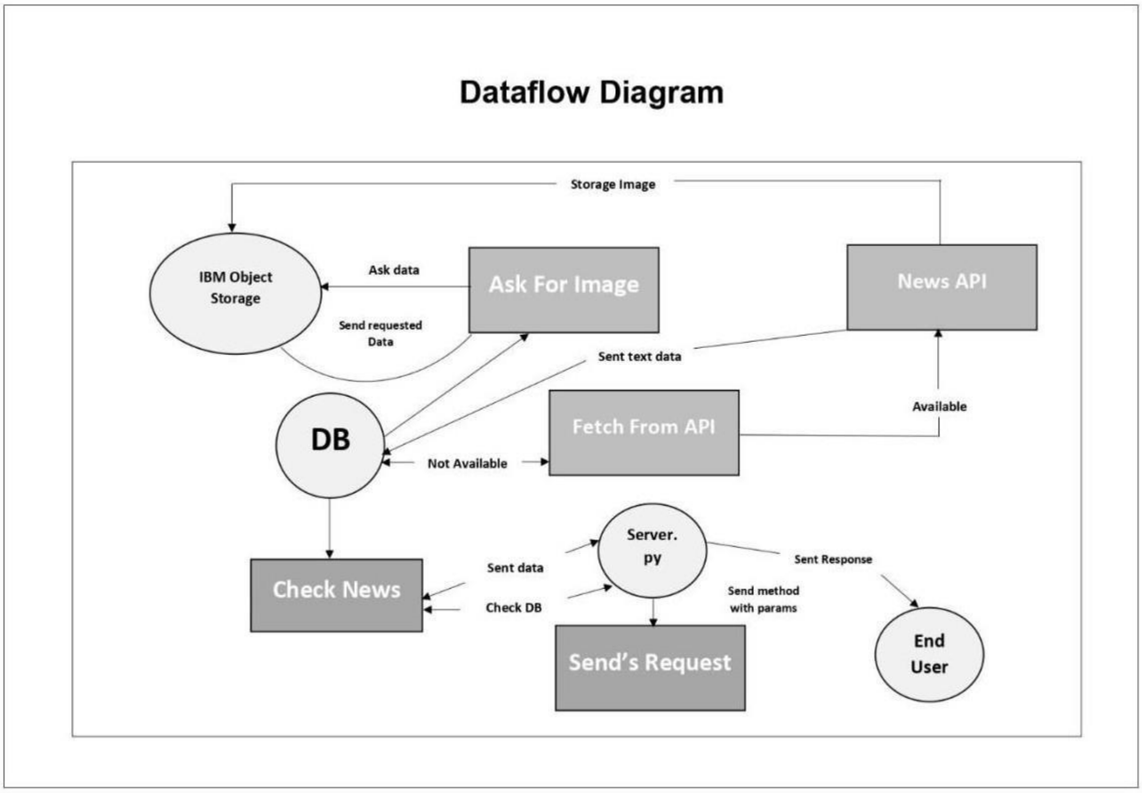
Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The wide spectrum of technologies used in Geographical Information System, Global Positioning System (GPS), Satellite navigationsystem,Satellitecommunication.
NFR-2	**Security**	Identification and measuring disaster risk. Incorporating DRM into national planning and investment
NFR-3	**Reliability**	Disaster-related damages are typically measured by separately examining the numbers of fatalities, injuries.
NFR-4	**Performance**	The identification of hazards; a review of the technical characteristics of hazards such as their location, intensity, frequency and probability.
NFR-5	**Availability**	The number and cost of weather and climate disasters is rising due to a combination of population growth and development along with the influence of human-caused climate change
NFR-6	**Scalability**	The Richter scale was calculated for only one type of earthquake wave. It was replaced with the Moment Magnitude Scale, which records all the different seismic waves from an earthquake to seismographs across the world.

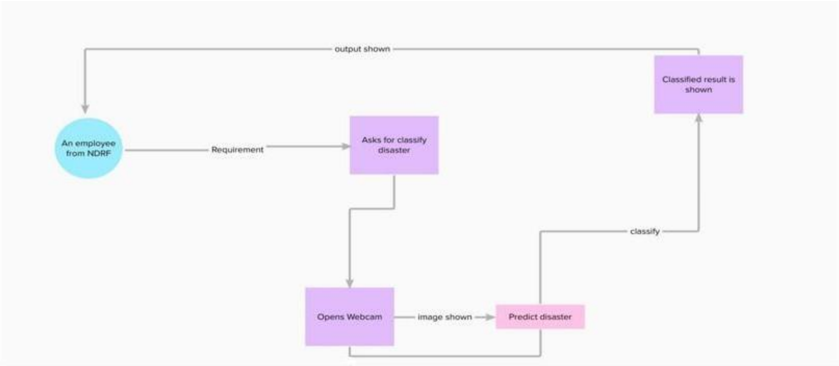
5. PROJECT DESIGN

5.1 DATA FLOW DIAGRAM





5.2 SOLUTION & TECHNICAL ARCHITECTURE



User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer	Registration	USN-1	As a user, registration should be done	Proper email id and password is accepted	High	Sprint-1
Customer	Area to be monitored	USN-2	As user ,I can particularly select the area to be continuously checked and analyzed	The areas should be checked and selected without lapse.	Medium	Sprint-1
Customer	Safety	USN-3	As a user,I should monitor the device is in the secured place which should cover wide area	Safety measures should be done to prevent disaster	High	Sprint-2
Customer	Examination of Natural anamoly	USN-4	As a user,I should analyse the depth of the occurrence of the phenomena	I should monitor the factors which causes disaster	High	Sprint-1
Customer	Battery Backup	USN-5	As a user,I want to check the battery to prevent from power loss	Aware to always keep battery backup .Sometimes it may help in any crucial situations.	Low	Sprint-3
Customer	Algorithm to be used	USN-6	As a user,I should be very conscious in selecting required algorithm	Algorithm provides a correct understanding about the model designed.	Medium	Sprint-4
Customer(Web user)	Internet Connectivity	USN-7	As a user,I should monitor the internet connection periodically	Strong internet connection is required in emergency situations.	High	Sprint-2

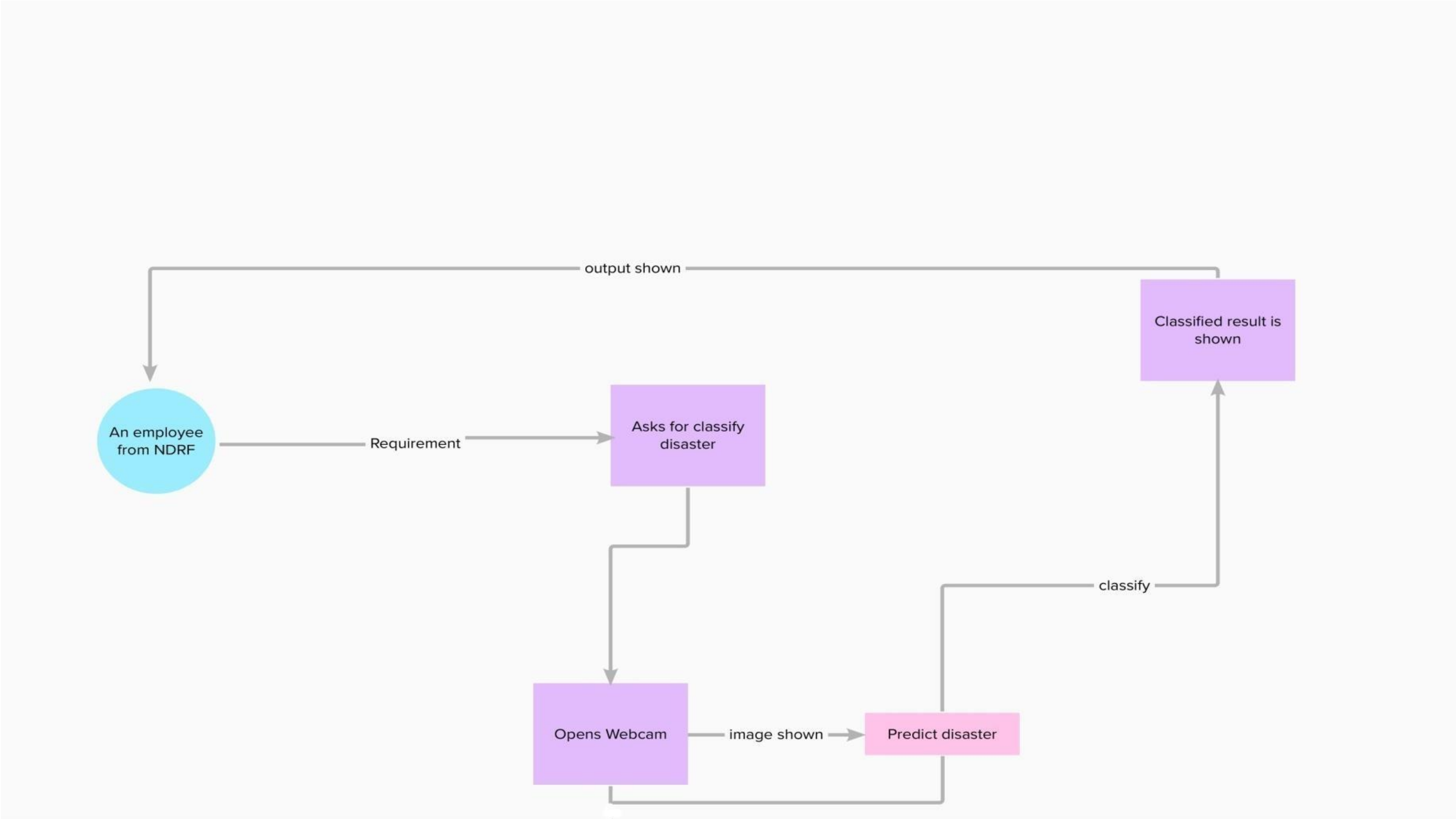
Customer(web User)	Social media	USN-8	As a user ,I will be active in social media sites to know more updates about specific diasaster	Active in social media sites to know updates	Medium	Sprint-4
Customer	Prediction and analysis of data	USN-9	As a user,I can ale to predict and visualize data	Using algorithms and some visualization	High	Sprint-3
User Type	**Functional Requirement (Epic)**	**User Story Number**	**User Story / Task**	**Acceptance criteria**	**Priority**	**Release**
				techniques to predict disaster		
Customer	Generating the possible outcome	USN-10	As a user generating possible output for the disaster occurrence	Several disasters can be captured and output is shown	High	Sprint-4

Project Design Phase-II
Data Flow Diagram &User Stories

Data Flow Diagrams:

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.

Data Flow Diagram for “Natural Disasters Intensity Analysis and Classification using Artificial Intelligence”:



User Stories

Here the list all the user stories for the project "Natural Disaster Intensity Analysis and Classification Using Artificial Intelligence".

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer	Registration	USN-1	As a user, registration should be done	Proper email id and password is accepted	High	Sprint-1
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				techniques to predict disaster		
Customer	Generating the possible outcome	USN-10	As a user,generating possible output for the disaster occurrence	Several disasters can be captured and output is shown	High	Sprint-4

PROJECT DESIGN PHASE- 1

SOLUTION ARCHITECTURE

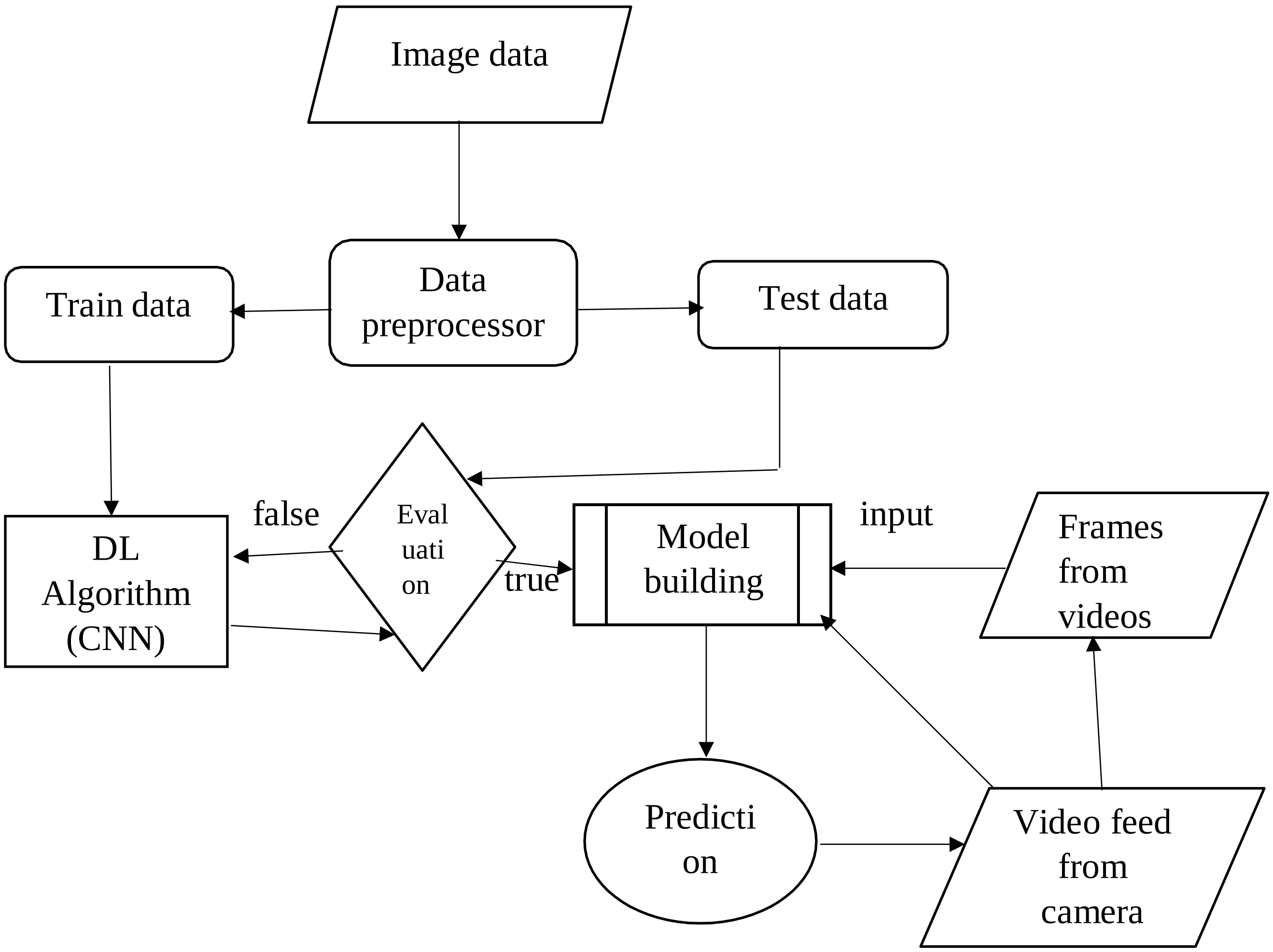
Date	6th October 2022
Team ID	PNT2022TMID38277
Project name	Natural disaster intensity analysis and classification using artificial intelligence
Maximum marks	4 marks

Solution Architecture:

Solution architecture is a complex process with many sub-processes that bridges the gap between business problems and technology solutions. Its goals are to

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed, and delivered.

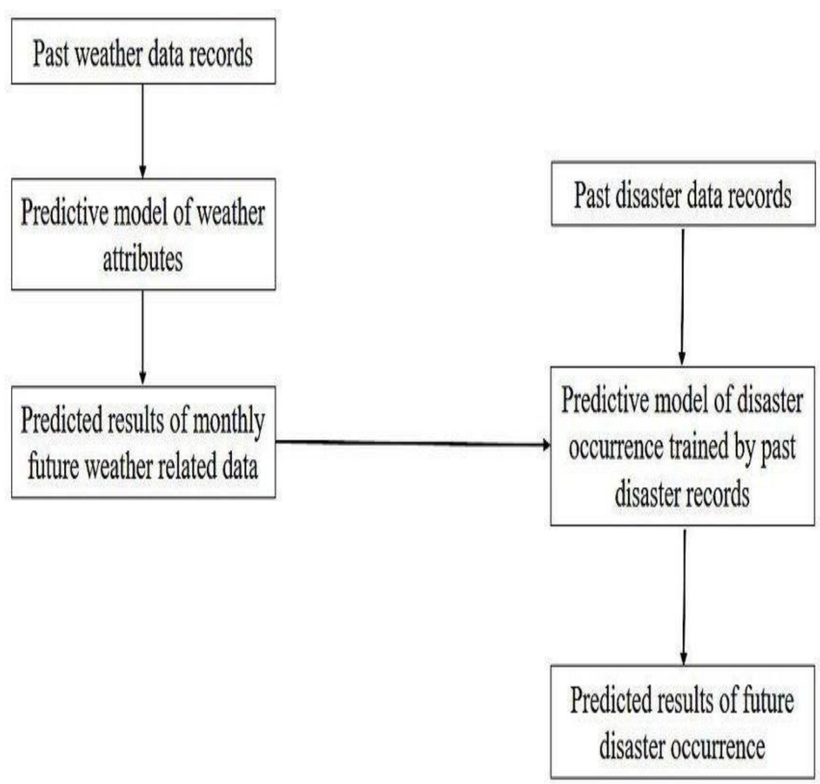
Solution Architecture diagram:



Project Design Phase-II
Data Flow Diagram & User Stories

Data Flow Diagrams:

Disasters caused by natural hazards are receiving increasing attention globally. They cause enormous casualties and huge economic losses, and adversely affect social stability.Simultaneously, social media popularity for sudden major disasters has also surged. Many individuals employ social media as an effective channel for timely accessible information in emergencies.



User Stories

Use the below template to list all the user stories for the product.

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Enduser (Customer) …………	preparedness	USN-1	Proposed method can predict the Short term spread the wildfire.	I can access the proposed method of wildfire.	High	Sprint-1
Enduser (Customer)	Mitigation	USN-2	Develop a public platform to inform early tsunami prediction and information.	Public feedback is compulsoryfor the prediction process.	Low	Sprint-1
Enduser\ (Customer)	Random forest	USN-3	Evaluate the flood severity in terms of sensitivity, specificity and accuracy as 71.4% respectively.	Particle swarm optimization and deep learning techniques can be used as a framework.	High	Sprint-2
Enduser (Customer)	Recovery	USN-4	Prediction occurs in the past dataset to recover the natural disaster issue.	Dynamic time series data required for clustering process.	High	Sprint-1
Enduser (Customer)	Machine learning techniques	USN-5	The gradient boosting tree and CLIPPER model used for cyclone prediction.	Model is still weak to produce velocity sensitivities.	Low	Sprint-2
Enduser (Customer)	Artificial neural network	USN-6	A fully connected neural network for segmentation which is used for multivariable pattern recognition at different levels.	It works on multivariable parameters rather than the pixel by parameters.	High	sprint-1
Enduser (Customer)	Update Disaster information	USN-7	As an administrator, I can update information about disasters.	I can update disaster information.	High	sprint-1
Enduser (Customer)	Disaster queries	USN–8	Both are can able to ask disaster queries	We can ask queries about disasters.	High	sprint-1

Project Planning Phase

Project Planning Template (Product Backlog, Sprint Planning, Stories, Story points)

Date	18 October 2022
Team ID	PNT2022TMID38512
Project Name	Project - Natural Disasters Intensity Analysis and Classification using Artificial Intelligence
Maximum Marks	8 Marks

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Use the below template to create product backlog and sprint schedule

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	2	High	k.RAJESHWARI
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application	1	High	K.KRITHIKA
Sprint-2		USN-3	As a user, I can register for the application through Facebook	2	Low	T.KAVIYA
Sprint-1		USN-4	As a user, I can register for the application through Gmail	2	Medium	V.NANDINI
Sprint-1	Login	USN-5	As a user, I can log into the application by entering email & password	1	High	K,KRITHIKA
	Dashboard					

Project Tracker, Velocity & Burndown Chart: (4 Marks)

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

Velocity:
Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

Burndown Chart:

A burn down chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as Scrum. However, burn down charts can be applied to any project containing measurable progress over time.

https://www.visual-paradigm.com/scrum/scrum-burndown-chart/
https://www.atlassian.com/agile/tutorials/burndown-charts

Reference:
https://www.atlassian.com/agile/project-management
https://www.atlassian.com/agile/tutorials/how-to-do-scrum-with-jira-software
https://www.atlassian.com/agile/tutorials/epics
https://www.atlassian.com/agile/tutorials/sprints
https://www.atlassian.com/agile/project-management/estimation
https://www.atlassian.com/agile/tutorials/burndown-charts

PROJECT DEVELOPMENT PHASESPRINT-I

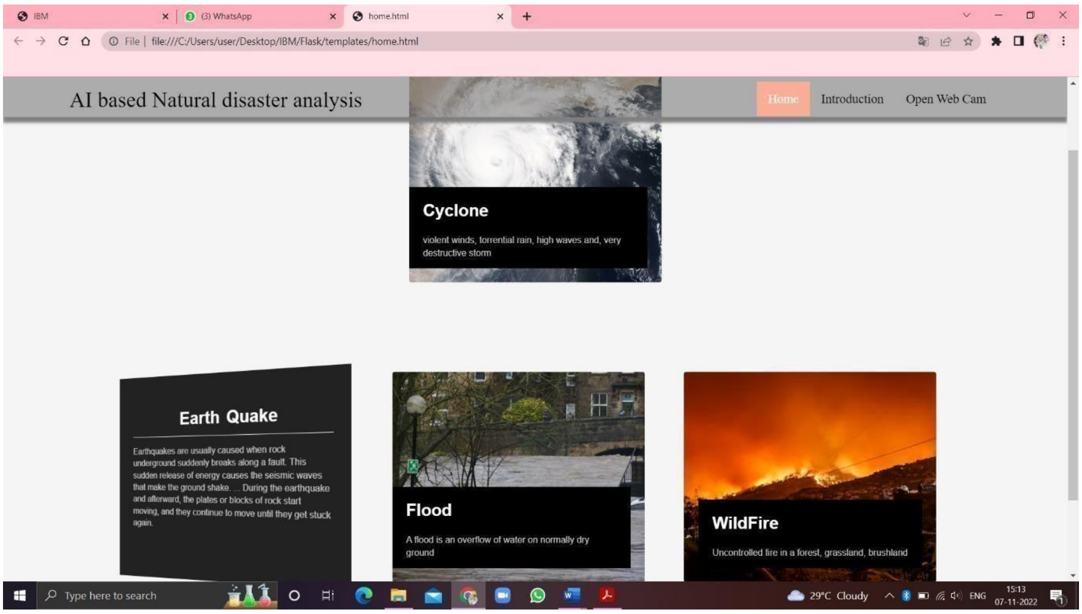
Date	16 November 2022
Team ID	PNT2022TMID38277
Project Name	Natural Disaster Intensity Analysis and Classification using Artificial Intelligence

COLLECTION OF DATASET:

The images of Disaster-prone areas are collected and organized into the subdirectories. The images of four types of Natural Disasters, Cyclone, Earthquake, Flood, Wildfire are collected and saved with the respective names. For more accuracy, Dataset with more images is selected and trained.

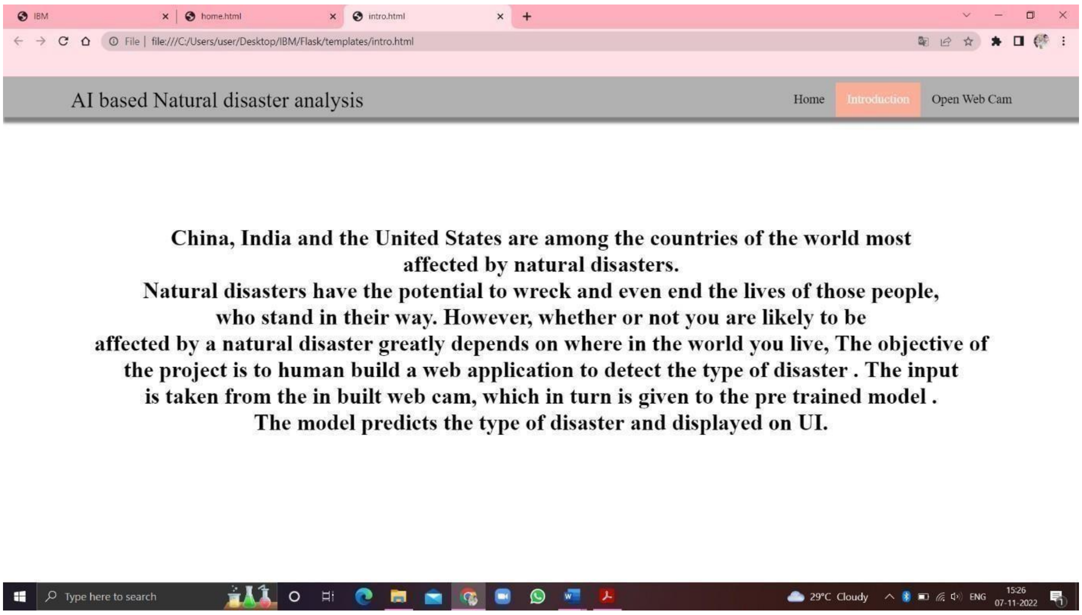
CREATION OF HOME PAGE:

Using HTML and CSS, the Home page is created. From the Home page the User can be able to know the basics of the frequently occurring Disasters. The home.html page is given below:



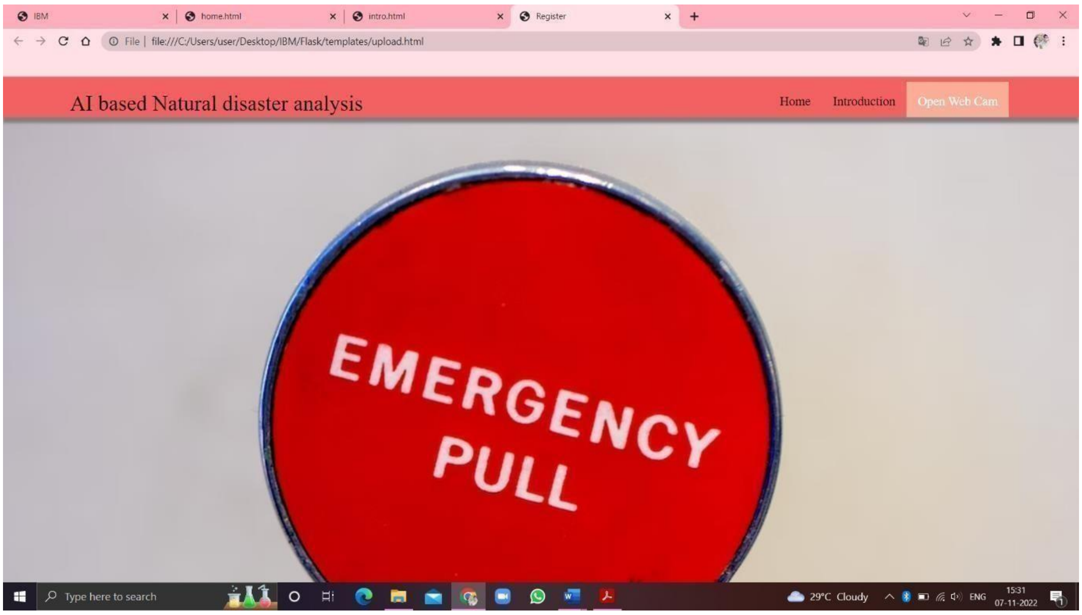
CREATION OF INTRO PAGE:

Using HTML and CSS, the intro page is created. From the intro page the user can be able to know about the project's introduction or abstract. The intro.html page is given below:



OPENING WEB CAM:

Using HTML and CSS, the upload.html page is created. Through this page User can be able to open the web cam to know about current disaster. The upload.html page is given below:



PROJECT DEVELOPMENT PHASE

SPRINT-III

DETECTION AND ANALYSIS OF DATA:

After Testing and Training the model, data which given in dataset are analysed and visualised effectively to detect the Disaster Type. Using webcam, it can capture image or video stream of Disaster, to detect and analyse the type of Disaster.

Inserting necessary libraries

In [1]:
```
import numpy as np#used for numerical analysis
import tensorflow #open source used for both ML and DL for computation
from tensorflow.keras.models import Sequential #it is a plain stack of layers
from tensorflow.keras import layers #A layer consists of a tensor-in tensor-out computation function
#Dense layer is the regular deeply connected neural network layer
from tensorflow.keras.layers import Dense,Flatten
#Faltten-used fot flattening the input or change the dimension
from tensorflow.keras.layers import Conv2D,MaxPooling2D #Convolutional layer
#MaxPooling2D-for downsampling the image
from keras.preprocessing.image import ImageDataGenerator
```
```
Using TensorFlow backend.
```

In [2]:
```
tensorflow.__version__
```
Out[2]:
```
'2.5.0'
```

In [3]:
```
tensorflow.keras.__version__
```
Out[3]:
```
'2.5.0'
```

Image Data Augumentation

In [4]:
```
#setting parameter for Image Data agumentation to the training data
train_datagen = ImageDataGenerator(rescale=1./255,shear_range=0.2,zoom_range=0.2,horizontal_flip=True)
#Image Data agumentation to the testing data
```

MODEL BUILDING:

Building a Model with web application named “FLASK”, model building process consist several steps like,

- Import the model building Libraries
- Initializing the model

- Adding CNN Layers
- Adding Hidden Layer
- Adding Output Layer
- Configure the Learning Process
- Training and testing the model

all the above processes are done and saved in a model.

Inserting necessary libraries

```
In [1]: import numpy as np#used for numerical analysis
        import tensorflow #open source used for both ML and DL for computation
        from tensorflow.keras.models import Sequential #it is a plain stack of layers
        from tensorflow.keras import layers #A layer consists of a tensor-in tensor-out computation function
        #Dense layer is the regular deeply connected neural network layer
        from tensorflow.keras.layers import Dense,Flatten
        #Faltten-used fot flattening the input or change the dimension
        from tensorflow.keras.layers import Conv2D,MaxPooling2D #Convolutional layer
        #MaxPooling2D-for downsampling the image
        from keras.preprocessing.image import ImageDataGenerator

        Using TensorFlow backend.

In [2]: tensorflow.__version__
Out[2]: '2.5.0'

In [3]: tensorflow.keras.__version__
Out[3]: '2.5.0'
```

Image Data Augumentation

```
In [4]: #setting parameter for Image Data agumentation to the training data
        train_datagen = ImageDataGenerator(rescale=1./255,shear_range=0.2,zoom_range=0.2,horizontal_flip=True)
        #Image Data agumentation to the testing data
        test_datagen=ImageDataGenerator(rescale=1./255)
```

```
# import the necessary packages
from flask import Flask,render_template,request
# Flask-It is our framework which we are going to use to run/serve our application.
#request-for accessing file which was uploaded by the user on our application.
#import operator
import cv2 # opencv library
from tensorflow.keras.models import load_model#to load our trained model
import numpy as np
#import os
from werkzeug.utils import secure_filename
#from playsound import playsound
#from gtts import gTTS
'''
def playaudio(text):
    speech=gTTS(text)
    print(type(speech))
    speech.save("output1.mp3")
    playsound("output1.mp3")
    return
'''
app = Flask(__name__,template_folder="templates") # initializing a flask app
# Loading the model
model=load_model(r'C:\Users\user\Desktop\IBM\Flask\templates\disaster.h5')
print("Loaded model from disk")


app=Flask(__name__,template_folder="templates")
@app.route('/', methods=['GET'])
def index():
    return render_template('home.html')
@app.route('/home', methods=['GET'])
def home():
    return render_template('home.html')
@app.route('/intro', methods=['GET'])
def about():
    return render_template('intro.html')
@app.route('/upload', methods=['GET', 'POST'])
```

Project Flow

- Aerial imagery captured via unmanned aerial vehicles (UAVs) is playing an increasingly important role in disaster response.

- Unlike satellite imagery, aerial imagery can be captured and processed within hours rather than days.

- In addition, the spatial resolution of aerial imagery is an order of magnitude higher than the imagery produced by the most sophisticated commercial satellites today.

- Both the United States Federal Emergency Management Agency (FEMA) and the European Commission's Joint Research Center (JRC) have noted that aerial imagery will inevitably present a big data challenge.

- The purpose of this article is to get ahead of this future challenge by proposing a hybrid crowdsourcing and real-time machine learning solution to rapidly process large volumes of aerial data for disaster response in a time-sensitive manner.

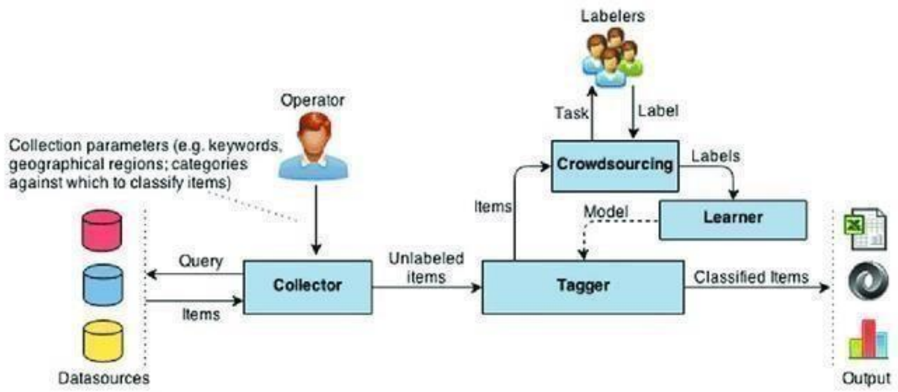
- Crowdsourcing can be used to annotate features of interest in aerial images (such as damaged shelters and roads blocked by debris).

- These human-annotated features can then be used to train a supervised machine learning system to learn to recognize such features in new unseen images.

- In this article, we describe how this hybrid solution for image analysis can be implemented as a module (i.e., Aerial Clicker) to extend an existing platform called Artificial Intelligence for Disaster Response (AIDR), which has already been deployed to classify microblog messages during disasters using its Text Clicker module and in response to Cyclone Pam, a category 5 cyclone that devastated Vanuatu in March 2015.

- The hybrid solution we present can be applied to both aerial and satellite imagery and has applications beyond disaster response such as wildlife protection, human rights, and archeological exploration.

- As a proof of concept, we recently piloted this solution using very high-resolution aerial photographs of a wildlife reserve in Namibia to support rangers with their wildlife conservation efforts
- The results suggest that the platform we have developed to combine crowdsourcing and machine learning to make sense of large volumes of aerial images can be used for disaster response.



```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta http-equiv="X-UA-Compatible" content="IE=edge">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <link href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.2/dist/css/bootstrap.min.css"rel="stylesheet"
integrity="sha384- Zenh87qX5ĩnK2ĩl0vWa8Ck2rdkQ2Bzep5IDxbcnCeuOxjzrPF/et3URy9Bv1WTRi"
crossorigin="anonymous">
  <title>Document</title>
</head>
<body>
  <div class="card text-center">
    <div class="card-header">
     <ul class="nav nav-tabs card-header-tabs">
      <li class="nav-item">
       <a class="nav-link" aria-current="true" href="home.html" style="font-size:
24px;">Home</a>
      </li>
      <li class="nav-item">
       <a class="nav-link active" href="intro.html" style="font-size: 24px;">Introduction</a>
      </li>
      <li class="nav-item">
       <a class="nav-link" href="upload.html" style="font-size: 24px;">Upload</a>
      </li>
     </ul>
```

```
    <h3 style="float: right;">AI based ffiatural Disaster Analysis</h3>
   </div>
  </div>
  <h2 style="padding: 50px; margin: 50px; word-spacing: 15px; text-align: center ;line-height:1.6;">
   China, India and the United States are among the countries in the world most
affected by natural disasters.
ffiatural disasters have the potential to wreck and even end the lives of those people,who
stand in their way. <br><br> However, whether or not you are likely to be
affected by a natural disaster dramatically depends on where in the world you live, The objective ofthe
project is to human build a web application to detect the type of disaster. The input
is taken from the in-built webcam, which in turn is given to the pre-trained model.The
model predicts the type of disaster and displayed on UI.
  </h2>
</body>
</html>
```

```
<!DOCTYPE html>

<html lang=”en”>

<title>Home – Natural Disasters Database</title>

<meta charset=”UTF-8”>

<meta name=”viewport” content=”width=device-width, initial-scale=1”>

<link rel=”stylesheet” href=https://www.w3schools.com/w3css/4/w3.css>

<link rel=”stylesheet” href=https://fonts.googleapis.com/css?family=Lato>

<link rel=”stylesheet” href=https://fonts.googleapis.com/css?family=Montserrat>

<link rel=”stylesheet” href=https://cdnjs.cloudflare.com/ajax/libs/font-awesome/4.7.0/css/font-awesome.min.css>

<style>

Body,h1,h2,h3,h4,h5,h6 {font-family: “Lato”, sans-serif}

.w3-bar,h1,button {font-family: “Montserrat”, sans-serif}

.fa-anchor,.fa-coffee {font-size:200px}

</style>

<body>


<!—Navbar →

<div class=”w3-top”>

  <div class=”w3-bar w3-black w3-card w3-left-align w3-large”>

    <a class=”w3-bar-item w3-button w3-hide-medium w3-hide-large w3-right w3-padding-large w3-hover-white w3-large w3-red” href=”javascript:void(0);” onclick=”myFunction()” title=”Toggle Navigation Menu”><i class=”fa fa-bars”></i></a>

    <a href=”{% url ‘home’ %}” class=”w3-bar-item w3-button w3-hide-small w3-padding-large w3-hover-white”>Home</a>

    <a class=”w3-bar-item w3-button w3-padding-large w3-white”>Earthquake</a>

    <a href=”{%url ‘tsunami’%}” class=”w3-bar-item w3-button w3-hide-small w3-padding-large w3-hover-white”>Tsunami</a>

    <a href=”{%url ‘tornado’%}” class=”w3-bar-item w3-button w3-hide-small w3-padding-large w3-hover-white”>Tornado</a>
```

```
    <a href="{%url 'volcano'%}" class="w3-bar-item w3-button w3-hide-small w3-padding-large w3-hover-white">Volcanic Activity</a>
  </div>

  <!—Navbar on small screens →
  <div id="navDemo" class="w3-bar-block w3-white w3-hide w3-hide-large w3-hide-medium w3-large">
    <a href="#" class="w3-bar-item w3-button w3-padding-large">Earthquake</a>
    <a href="#" class="w3-bar-item w3-button w3-padding-large">Tsunami</a>
    <a href="#" class="w3-bar-item w3-button w3-padding-large">Tornado</a>
    <a href="#" class="w3-bar-item w3-button w3-padding-large">Volcanic Activity</a>
  </div>
</div>

<!—Header →
<header class="w3-container w3-grey w3-center" style="padding:128px 16px">
  <h1 class="w3-margin w3-jumbo">Earthquakes</h1>
  <p class="w3-xlarge">Natural Disasters Database</p>
</header>
<div class="w3-container">
  <h2>Earthquakes</h2>
  <table class="w3-table-all">
    <tr>
      <th>Earthquake_id</th>
      <th>Intensity</th>
      <th>Date</th>
      <th>Country</th>
      <th>Place</th>
      <th>Latitude</th>
      <th>Longitude</th>
```

```
    {% for quake in all_quakes %}
      <tr>
        <td>{{quake.earthquake_id}}</td>
        <td>{{quake.intensity}}</td>
        <td>{{quake.date}}</td>
        <td>{{quake.country}}</td>
        <td>{{quake.place}}</td>
        <td>{{quake.latitude}}</td>
        <td>{{quake.longitude}}</td>
      </tr>
    {% endfor %}

  </table>
</div>

<div class="w3-container">
  <h2>Damage caused by the quakes</h2>
  <table class="w3-table-all">
    <tr>
      <th>Earthquake_id</th>
      <th>Amount (in million)</th>
      <th>Deaths (in thousands)</th>
      <th>House_destroyed (in thousands)</th>
    </tr>
    {% for d in damage %}
      <tr>
        <td>{{d.earthquake_id}}</td>
        <td>{{d.amount}}</td>
        <td>{{d.deaths}}</td>
```

```
    <td>{{d.house_destroyed}}</td>
   </tr>
  {% endfor %}

 </table>
</div>

<div class="w3-container w3-black w3-center w3-opacity w3-padding-50">
  <h1 class="w3-margin w3-xlarge">Thanks for visiting the website</h1>
</div>

<!—Footer →
<footer class="w3-container w3-padding-40 w3-center w3-opacity">
 <div class="w3-xlarge w3-padding-20">
  <h1>A Database project </h1>
</footer>

<script>
// Used to toggle the menu on small screens when clicking on the menu button
Function myFunction() {
 Var x = document.getElementById("navDemo");
 If (x.className.indexOf("w3-show") == -1) {
  x.className += " w3-show";
 } else {
  x.className = x.className.replace(" w3-show", "");
 }
}
</script>
```

</body>

1. </html>

```
<!DOCTYPE html>

<html lang="en">

<head>

<meta charset="UTF-8">

<meta http-equiv="X-UA-Compatible" content="IE=edge">

<meta name="viewport" content="width=device-width, initial-scale=1.0">

<link
href="https://cdn.jsdelivr.net/npm/bootstrap@5.2.2/dist/css/bootstrap.min.
css"

rel="stylesheet" integrity="sha384-
Zenh87qX5JnK2Jl0vWa8Ck2rdkQ2Bzep5IDxbcnCeuOxjzrPF/et3URy9Bv1WTRi">

<title>Document</title>

</head>

<body>

<div class="card text-center">

<div class="card-header">

<ul class="nav nav-tabs card-header-tabs">

<li class="nav-item">

<a class="nav-link active" aria-current="true" href="home.html"
style="font-size:

24px;">Home</a>

</li>

<li class="nav-item">

<a class="nav-link" href="intro.html" style="font-size:
24px;">Introduction</a>
```

```
</li>

<li class="nav-item">

<a class="nav-link" href="upload.html" style="font-size: 24px;">Upload</a>

</li>

</ul>

<h3 style="float: right;">AI based Natural Disaster Analysis</h3>

</div>

</div>

<div class = "container" style="text-align: center;">

<div class="card" style="width: 18rem; padding: 10px; margin: 40px;
margin-left:

40px;display:inline-block">

<img class="card-img-top" src="{{ url_for('static',
filename='cyclone.jpg') }}" alt="Cardimage cap">

<div class="card-body" >

<h5 class="card-title">Cyclone</h5>

<p class="card-text">cyclone, large system of winds that circulates
counterclockwise directionnorth of the Equator and clockwise direction to
the south.</p>

<a href="https://en.wikipedia.org/wiki/Cyclone" class="btn
btn-primary">Know more</a></div>

</div>

<div class="card" style="width: 18rem; padding: 10px; margin: 40px;
margin-left:

40px;display:inline-block">
```

```
<img class="card-img-top" src="{{ url_for('static',
filename='earthquake.jpg') }}" alt="Cardimage cap">

<div class="card-body" >

<h5 class="card-title">Earthquake</h5>

<p class="card-text">A sudden violent shaking of the ground, causing great
destruction, as aresult of movements within the earth's crust.</p>

<a href="https://en.wikipedia.org/wiki/Earthquake" class="btn
btn-primary">Knowmore</a>

</div>

</div>

</div>

<div class = "container" style="text-align: center;">

<div class="card" style="width: 18rem; padding: 10px; margin: 40px;
margin-left:

40px;display:inline-block">

<img class="card-img-top" src="{{ url_for('static', filename='flood.jpg')
}}" alt="Cardimagecap">

<div class="card-body" >

<h5 class="card-title">Flood</h5>

<p class="card-text">An overflow of a large amount of water beyond its
normal limits, especially over what is normally dry land.</p>

<a href="https://en.wikipedia.org/wiki/Flood" class="btn btn-primary">know
more</a></div>

</div>

<div class="card" style="width: 18rem; padding: 10px; margin: 40px;
margin-left:

40px;display:inline-block">
```

```html
<img class="card-img-top" src="{{
url_for('static',filename='wildfire.jpg') }}" alt="Cardimage cap">

<div class="card-body" >

<h5 class="card-title">Wild Fire</h5>

<p class="card-text">A wildfire is an unplanned, uncontrolled and
unpredictable fire inanarea of combustible vegetation starting in rural
and urban areas.</p>

<a href="https://en.wikipedia.org/wiki/Wildfire" class="btn
btn-primary">Know more</a></div>

</div>

</div>

</body>

</html>
```

Train Test and Save Model:-

Table of Contents:-

Step 1 – Import the library

```
From sklearn import model_selection, datasets
From sklearn.tree import DecisionTreeClassifier
From sklearn.externals import joblib
Import pickle
```

We have imported model_selection, datasets, joblib, DecisionTreeClassifier and pickel which will be needed for the dataset.

Step 2 – Setting up the Data

We have loaded inbuilt wine dataset and stored data in x and target in y. We have used test_train_split to split the dataset such that 30% of data is for testing the model.

```
Dataset = datasets.load_wine()
```

```
X = dataset.data; y = dataset.target
X_train, X_test, y_train, y_test = model_selection.train_test_split(X, y, test_size=0.3)
```

Master the Art of Classification in Machine Learning to Become a Pro

Step 3 – Training and Saving the Model

We are using DecisionTreeClassifier as a model. We have trained the model by training data. We can save the model by using joblib.dump in which we have passed the parameter as model and the filename.

```
Model = DecisionTreeClassifier()
Model.fit(X_train, y_train)

Filename = “Completed_model.joblib”
Joblib.dump(model, filename)
```

Step 4 – Loading the Saved Model

So here we are loading the saved model by using joblib.load and after loading the model we have used score to get the score of the pretrained saved model.

```
Loaded_model = joblib.load(filename)
```

```
Result = loaded_model.score(X_test, y_test)

Print(result)
```

So the output comes as:

0.9444444444444444

Document an existing experience

Narrow your focus to a specific scenario or process within an existing product or service. In the **Steps** row, document the step-by-step process someone typically experiences, then add detail to each of the other rows.

TIP
As you add steps to the experience, move each these “Five Es” the left or right depending on the scenario you are documenting.

SCENARIO **Browsing, booking, attending, and rating a local city tour**	**Entice** How does someone initially become aware of this process?	**Enter** What do people experience as they begin the process?	**Engage** In the core moments in the process, what happens?	**Exit** What do people typically experience as the process finishes?	**Extend** What happens after the experience is over?
Steps What does the person (or group) typically experience?	Continues radio and television broadcaste. Involve the local media in the planning process. Develop coordinated preparedness among the local industry Setup awareness booths at school and public places	If you have insurance and damages, you must fle a claim with your insurance compan Tracking and analyzing real-time data	Increasing public awareness about reducing the socio economic impact. The provision of situational awareness and decision support,	We can measure disaster risk by analysing trends. Identify Critical Operations	poverty may exist How we can prepare on the disaster problems
Interactions What interactions do they have at each step along the way? ▪ **People:** Who do they see or talk to? ▪ **Places:** Where are they? ▪ **Things:** What digital touchpoints or physical objects would they use?	Live in environment affecting places Develop mutual aid and assistance agreement.	Rehabilitation Through social media via internet.	Design of system which support protection and prevention policy Through social media we can prepare.	Detect wildfire. detection based	GPS satellite could warn the incoming disaster. Classify the disaster on various parameter
Goals & motivations At each step, what is a person’s primary goal or motivation? (“Help me...” or “Help me avoid...”)	Help me to assure appropriate assistance to victims of disaste Help me to achieve rapid and effective recovery	lay beliefs regarding prosocial behavior.	Help me to feel safety during disaster.	helps to minimize economy disaster	Help me to deal with climate related risk
Positive moments What steps does a typical person find enjoyable, productive, fun, motivating, delightful, or exciting?	Accelerated replacement capital Create an emergency management plan	Rebuilding effort	Limit exposure to images of the disaster	Increases recovery	creating condition for growing plants.
Negative moments What steps does a typical person find frustrating, confusing, angering, costly, or time-consuming?	People lose home possession and community.	Loss of utilities	Loss of their lives and people may go for depression	Loss of utilities like electricity.	Exposure economic growth
Areas of opportunity How might we make each step better? What ideas do we have? What have others suggested?	Planning to warn people which will minimize the effectr.of disaste	Don't keep fuel sources on your property	Use fre resistant building materials when possible	Reduce the level of inequality	Ensure timely and effective response to disaster

ADVANTAGES AND DISADVANTAGES:

ADVANTAGES:

When data of precipitation as the main cause of flooding accidents during flood damage were compared, the average precipitation was 331 mm d^{-1} before the maintenance project and 215 mm d^{-1} after the maintenance project. It could be seen that the amount of precipitation was decreased by 35 % when flood damage occurred after the maintenance project. The sharp decrease in the loss rate after the maintenance project could be due to not only the effect of maintenance project, but also decreased rainfalls.

The initial cost of each maintenance project was collected through The Public Data Portal and the average cost of the maintenance project was calculated. For the loss rate, the average loss rate of the loss area was used. For the annual loss amount, the average annual loss for the study period (2009–2019) was used as seen in Table 7. However, it was assumed that no additional costs incurred due to the maintenance project. Figure 8 shows calculation results before and after the maintenance projects, which reveals that the loss amount becomes smaller after 8 years due to investment through the maintenance projects.

Disaster management plays an integral role in keeping communities safe. It involves coordinating the resources, such as pollution control systems, and responsibilities, such as following best practice policies, needed to prevent, prepare for, respond to, and recover from emergencies.

Minimizing the effects of natural hazards on the agricultural sector, and on an entire economy, can reduce the vulnerabilities and increase the ability to survive natural disasters. This can be achieved by incorporating natural hazard information into the preparation of agricultural investment projects. How it is done, and its relationship to an integrated development study, are discussed in this section.

Integrated development planning is a multisectoral and multidisciplinary approach to generating plans and proposals for economic and social development. It brings together issues concerning various sectors and analyzes them in an integrated fashion vis-a-vis the needs of the population and the characteristics of the natural resource base. Appropriate natural resource use along sound environmental management guidelines seeks to maximize development opportunities while minimizing environmental conflicts (see Chapter 3). The creation of an integrated development planning study is a complex process, within which the preparation of investment projects is only one step. The preparation of planning studies and investment projects is very similar. That similarity is often a source of confusion.

An integrated development planning study is composed of four basic stages: the Preliminary Mission, Phase I or the Development Diagnosis, Phase II or Project Formulation and Action Plan, and Implementation. (See Chapter I for a detailed discussion of the four stages of integrated development planning.) The preparation of investment projects within the development planning study also entails four steps: Project Profile, Prefeasibility Analysis, Feasibility Analysis, and Implementation. The information needs of the four development planning study stages are described in the box below.

Although most institutions do not require risk information in project preparation guidelines except at the engineering design stage, both integrated development planning studies and investment project preparation are improved when analysts incorporate natural hazard information into all stages of development planning. Guidelines for the use of natural hazard information in project preparation are listed in Figure 2-3 and discussed below.

DISADVANTAGES:

Notwithstanding the term "natural," a natural hazard has an element of human involvement. A **physical event,** such as a volcanic eruption, that does not affect human being is a **natural phenomenon** but not a natural hazard. A natural phenomenon that occurs in a populated are is a **hazardous event.** A hazardous event that causes unacceptably large numbers of fatalities and/or overwhelming property damage is a **natural disaster.** In areas where there are no human interests, natural phenomena do not constitute hazards nor do they result in disasters. This definition is thus at odds with the perception of natural hazards as unavoidable havoc wreaked by the unrestrained forces of nature. It shifts the burden of cause from purely natural processes to the concurrent presence of human activities and natural events.

Figure 2-2 illustrates this approach incorporating another argument into the discussion: the relationship of human and economic losses to the severity of an event and the degree of vulnerability (or survival capability) of human and economic interests.

The survival capability of projects depends on many factors. Losses from a severe event may be no worse or even less than those from a milder event if the former occurs in an area where both the population is adequately prepared to respond and the physical structures are designed and built to withstand its impact. One of the main differences between losses suffered by industrialized and less developed countries is the extent to which natural hazards and mitigation measures have been considered in the development planning process.

In a disaster, **you face the danger of death or physical injury. You may also lose your home, possessions, and community**. Such stressors place you at risk for emotional and physical health problems. Stress reactions after a disaster look very much like the common reactions seen after any type of trauma.

Disaster management involves examining and managing causal factors. It requires assessing the extent to which a community can withstand a disaster. Some communities are more vulnerable than others. For example, poorer communities have fewer resources to prepare themselves for a storm or bounce back from flood damage.

The empirical research presented in this paper draws on two sets of data to explore in depth the relationship between international tourist arrivals and global disasters, measured through three different impact metrics (costs, deaths and affected people). The effects that these different disasters might have on inbound flows at a national level were investigated though a gravity model, estimated by panel data with destination-fixed effects and using yearly data. By doing so, spurious potential determinants related to the destination but not the disaster can be avoided. As a result, however, recurrent disasters affecting the same destination and those with a very short-run effect have not been captured.

Findings of this analysis provide evidence that the economic consequences of a disaster in a particular country generally affect international tourism arrivals negatively. This is likely due to damages to infrastructure, key attractions and a wider weakening of the economy in the host country. All of these reduce the destination ability to cater for tourism, undermine investment into tourism supply, and reduce destination attractiveness, at least in the short-term.

At the same time, the analysis reveals that evaluating the tourism impacts of a disaster in terms of deaths and affected people is more ambiguous.

Natural disasters and unexpected events have wide reaching effects on all spheres of life, including tourism. From a theoretical point of view, it has been assumed that a negative relationship between disasters and inbound tourism dominates (e.g. a Cró & Martins, 2017a). However, because of some motivating factors identified in the literature, and due to the methodology and definition used by the UNWTO in collecting international tourist arrivals, an increase in visitation after a disaster seems also plausible.

The number of inbound tourism arrivals directly impacts the performance of the national tourism industry, and ultimately the government, especially in countries where tourism is a major contributor to the national economy and fiscal revenue (Massidda & Mattana, 2013). It is therefore of great importance for policymakers to improve their understanding of how disaster events affect visitor demand. This research highlights the need to consider different types of disasters and their varied consequences when assessing the consequences for tourism.

The analysis of the different disaster impacts reveals how, on the one hand, costs always present a negative relationship with international tourist arrivals. This confirms that the economic costs of a disaster are an important measure for tourism managers, probably because of the inherent damage to local infrastructure that is captured. On the other hand, the impact of some types of disaster evaluated in terms of deaths shows a positive relationship with tourist arrivals. This does not mean that the occurrence of these disasters will have a *net* positive effect on the arrival of tourists, since the negative effect of the associated costs must be taken into account when deriving an overall estimate of impact. As outlined earlier, the number of deaths could be related with the arrival of people for humanitarian reasons, or with a flow of people who travel to see (and support) friends and relatives affected by the event. This could present a significant effect in relative terms for those countries with a low base level of arrivals. The total effect also should consider the impacts of the number of affected people that for some disasters have a reducing effect (*Droughts, Tsunamis* and *Volcanoes*), while for others there seems to be an increase in the number of tourists (*Industrial Accidents, Wildfires* and *Storms*).

CONCLUSION:

Due to increasing threats to the lives of the general public and built assets from natural disasters, a variety of risk mitigation activities are being carried out extensively. Given the continuous trend toward natural disaster risk mitigation, the significance of relevant economic analyses has been underlined, against the limited public budget and its economic feasibility. To overcome this difficulty, this study proposed a strategic framework for natural disaster risk mitigation, highlighting two different SIPs. SIP-1 introduced more powerful method that can improve the predictability of natural disaster-triggered financial loss values using deep learning, while SIP-2 highlighted the risk mitigation strategy at the project level, adopting a cost-benefit analysis method. In SIP-1, a DNN model for natural disaster loss prediction was developed, and the improved predictability was validated by comparing with MRA. The developed model learned and generalized the loss amount of natural disaster risk indicator facilities (building type, wind speed, total rainfall, and peak ground acceleration) and wind and flood insurance. By evaluating learning performances of 18 different DNN alternatives using RMSE and MAE values as representative evaluation indicators of deep learning algorithms, 25-25-25 hidden layers with dropouts of 0.0 structure was selected as the optimal learning model. The robustness of the developed model was technically validated by comparing RMSE and MAE values of a conventional parametric model using a multiple regression analysis. Validation results confirmed that the non-parametric DNN model was powerful for predicting non-linear characteristics of losses caused by natural disasters. In SIP-2, The cost-benefit analysis was conducted on the disaster risk reservoir maintenance project that occurred before and after the completion of the flood damage. As the result, it was difficult to expect profits from the maintenance business in the short term. However, in the long term (more than 8 years), it was found that the maintenance business was economically profitable. The proposed framework is unique as it provides a combinational approach to mitigating cost risk impacts of natural disasters at both financial loss and project levels. The main findings of this study could be used as a guideline for decision-making on natural disaster management policies and investment in natural disaster risk reduction projects. This study is its first kind and supports the current knowledge framework. This study will help practitioners quantify the loss from various natural disasters, while allowing them to evaluate the cost-effectiveness of risk reduction projects through a holistic approach.