EARTHQUAKE PREDICTION USING MACHINE LEARNING:

BATCH NUMBER

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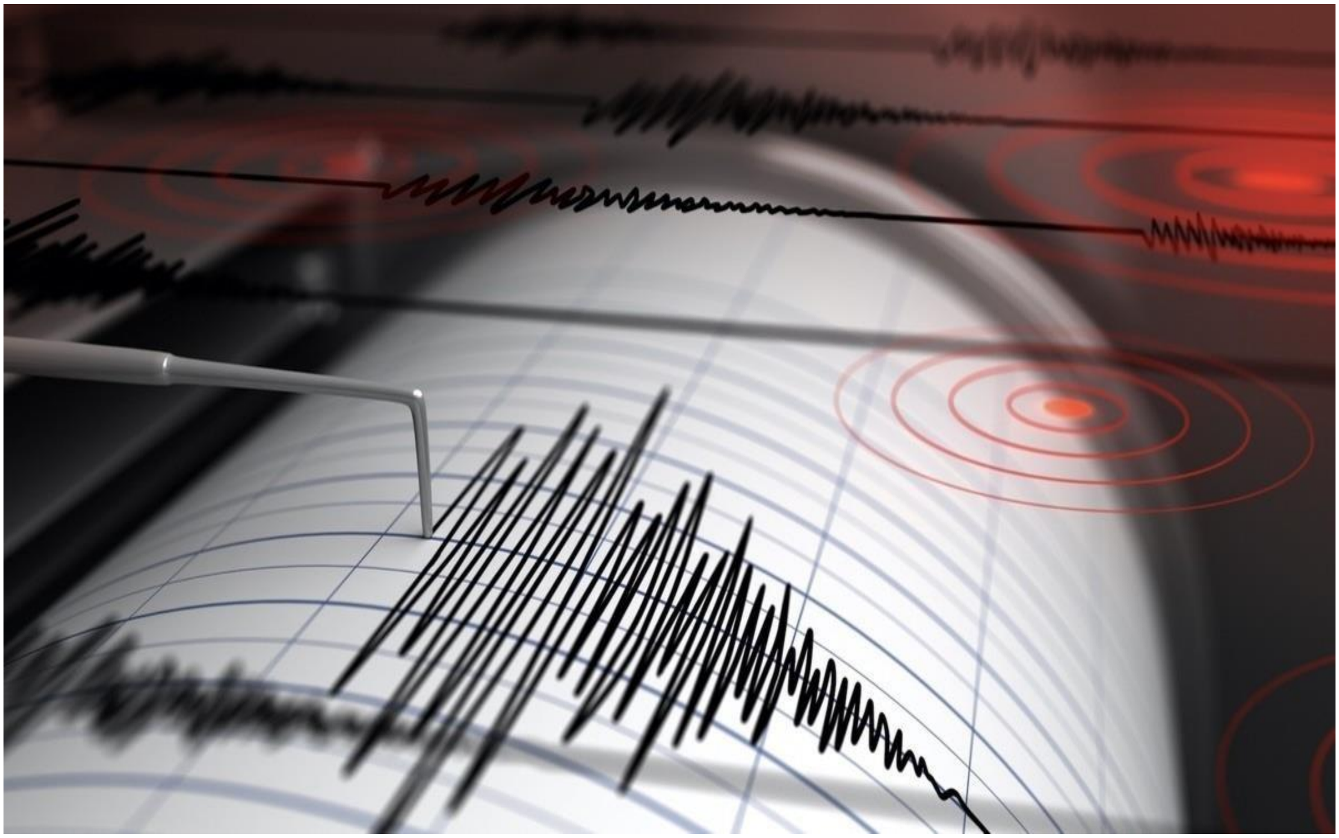
PHASE 3 SUBMISSION DOCUMENT

PROJECT TITLE :EARTHQUAKE PREDICTION MODEL USING PYTHON

PHASE 3: DEVELOPMENT PART 1



Earthquake Prediction Using Machine Learning:

Machine learning has the ability to advance our knowledge of earthquakes and enable more accurate forecasting and catastrophe response. It's crucial to remember that developing accurate and dependable prediction models for earthquakes still needs more study as it is a complicated and difficult topic.

In order to anticipate earthquakes, machine learning may be used to examine seismic data trends. Seismometers capture seismic data, which may be used to spot changes to the earth's surface, like seismic waves brought on by earthquakes. Machine learning algorithms may utilize these patterns to forecast the risk of an earthquake happening in a certain region by studying these patterns and learning to recognize key traits that are linked to seismic activity.

So we will be predicting the earthquake fromDate and Time, Latitude, and Longitude from previous data is not a trend that follows like other things. It is naturally occurring.

CODE:

Importing Libraries

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

import os Code
print(os.listdir("../input"))
```

Output:

```
['database.csv']
```

Read the Dataset

Now we will read the dataset and look for the various features in the dataset.

```
data = pd.read_csv("../input/database.csv")
```

```
2. data.head()
```

	Date	Time	Latitude	Longitude	Type	Depth	Depth Error	Depth Seismic Stations	Magnitude	Magnitude Type	Magnitude Error	Magnitude Seismic Stations	Azimuthal Gap	Horizont Distanc
0	01/02/1965	13:44:18	19.246	145.616	Earthquake	131.6	NaN	NaN	6.0	MW	NaN	NaN	NaN	Na
1	01/04/1965	11:29:49	1.863	127.352	Earthquake	80.0	NaN	NaN	5.8	MW	NaN	NaN	NaN	Na
2	01/05/1965	18:05:58	-20.579	-173.972	Earthquake	20.0	NaN	NaN	6.2	MW	NaN	NaN	NaN	Na
3	01/08/1965	18:49:43	-59.076	-23.557	Earthquake	15.0	NaN	NaN	5.8	MW	NaN	NaN	NaN	Na
4	01/09/1965	13:32:50	11.938	126.427	Earthquake	15.0	NaN	NaN	5.8	MW	NaN	NaN	NaN	Na

```
1. data.columns
```

Output:

```
Index(['Date', 'Time', 'Latitude', '
       'Depth Seismic Stations', 'Ma
       'Magnitude Error', 'Magnitude
       'Horizontal Distance', 'Horiz
       'Source', 'Location Source',
      dtype='object')
```

We need to select the features that will be useful for our prediction.

```
1. data = data[['Date', 'Time', 'Latitude', 'Longitude', 'Depth', 'Magnitude']]
2. data.head()
```

Output:

	Date	Time	Latitude	Longitude	Depth	Magnitude
0	01/02/1965	13:44:18	19.246	145.616	131.6	6.0
1	01/04/1965	11:29:49	1.863	127.352	80.0	5.8
2	01/05/1965	18:05:58	-20.579	-173.972	20.0	6.2
3	01/08/1965	18:49:43	-59.076	-23.557	15.0	5.8
4	01/09/1965	13:32:50	11.938	126.427	15.0	5.8

We will try to frame the time and place of the earthquake that has happened in the past on the world map.

```
Import datetime

Import time


Timestamp = []

For d, t in zip(data['Date'], data['Time']):

   Try:

      Ts = datetime.datetime.strptime(d+' '+t, '%m/%d/%Y %H:%M:%S')

      Timestamp.append(time.mktime(ts.timetuple()))

   Except ValueError:

      # print('ValueError')

      Timestamp.append('ValueError')


timeStamp = pd.Series(timestamp)

data['Timestamp'] = timeStamp.values
```

final_data = data.drop(['Date', 'Time'], axis=1)

final_data = final_data[final_data.Timestamp != 'ValueError']

final_data.head()

Output:

	Latitude	Longitude	Depth	Magnitude	Timestamp
0	19.246	145.616	131.6	6.0	-1.57631e+08
1	1.863	127.352	80.0	5.8	-1.57466e+08
2	-20.579	-173.972	20.0	6.2	-1.57356e+08
3	-59.076	-23.557	15.0	5.8	-1.57094e+08
4	11.938	126.427	15.0	5.8	-1.57026e+08

Visualization

Here, we will visualize the earthquakes that have occurred all around the world.

From mpl_toolkits.basemap import Basemap

M = Basemap(projection='mill',llcrnrlat=-80,urcrnrlat=80, llcrnrlon=-180,urcrnrlon=180,lat_ts=20,resolution='c')

Longitudes = data["Longitude"].tolist()

Latitudes = data["Latitude"].tolist()

#m = Basemap(width=12000000,height=9000000,projection='lcc',

#resolution=None,lat_1=80.,lat_2=55,lat_0=80,lon_0=-107.)

X,y = m(longitudes,latitudes)

Fig = plt.figure(figsize=(12,10))

Plt.title(“All affected areas”)

m.plot(x, y, “o”, markersize = 2, color = ‘blue’)

m.drawcoastlines()

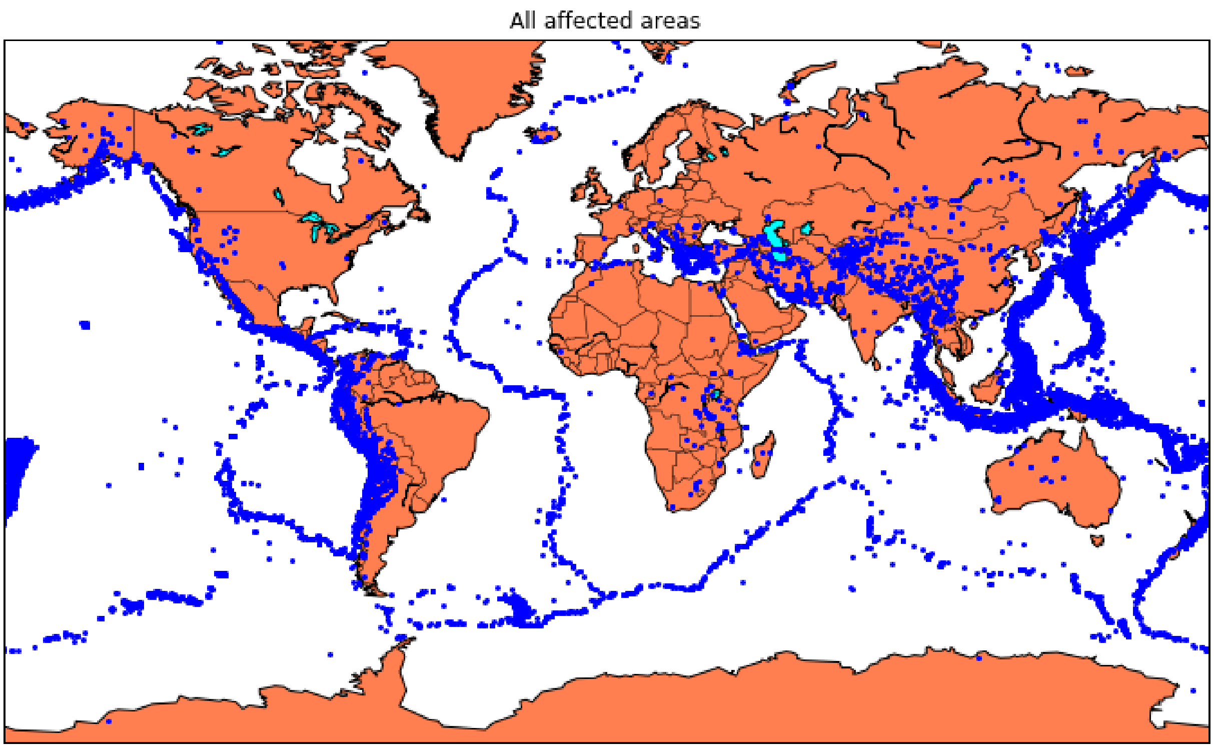
m.fillcontinents(color=’coral’,lake_color=’aqua’)

m.drawmapboundary()

m.drawcountries()

plt.show()

Output:



Splitting The Dataset:

Now we will split the dataset into a training and testing set.

X = final_data[[‘Timestamp’, ‘Latitude’, ‘Longitude’]]

Y = final_data[[‘Magnitude’, ‘Depth’]]

From sklearn.cross_validation import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

Print(X_train.shape, X_test.shape, y_train.shape, X_test.shape)

Output:

Earthquake Prediction Using Machine Learning

We will be using the RandomForestRegressor model to predict the earthquake, here will look for its accuracy.

Reg = RandomForestRegressor(random_state=42)

Reg.fit(X_train, y_train)

Reg.predict(X_test)

Output:

Earthquake Prediction Using Machine Learning

Reg.score(X_test, y_test)

Reg.score(X_test, y_test)

Output:

Earthquake Prediction Using Machine Learning

86% of accuracy is quite high.

Now we will shift to GridSearch

From sklearn.model_selection import GridSearchCV

Parameters = {‘n_estimators’:[10, 20, 50, 100, 200, 500]}

Grid_obj = GridSearchCV(reg, parameters)

Grid_fit = grid_obj.fit(X_train, y_train)

Best_fit = grid_fit.best_estimator_

Best_fit.predict(X_test)

Output:

Earthquake Prediction Using Machine Learning

Best_fit.score(X_test, y_test)

Output:

Earthquake Prediction Using Machine Learning

Considering it’s a natural phenomenon, we have got a high accuracy number.

We will employ a neural network for predicting the earthquake.

Neural Network Model

A neural network model can be employed to forecast earthquakes by examining diverse elements and trends in seismic data. This model harnesses the capabilities of neural networks, which draw inspiration from the neural connections of the human brain, to analyze intricate data and reveal hidden relationships and patterns. By training the neural network on historical earthquake data, it can acquire the ability to identify precursor signals and patterns that indicate the probability of an upcoming earthquake.

From keras.models import Sequential

From keras.layers import Dense

Def create_model(neurons, activation, optimizer, loss):

   Model = Sequential()

   Model.add(Dense(neurons, activation=activation, input_shape=(3,)))

```
    Model.add(Dense(neurons, activation=activation))
    Model.add(Dense(2, activation='softmax'))

    Model.compile(optimizer=optimizer, loss=loss, metrics=['accuracy'])

    Return model

From keras.wrappers.scikit_learn import KerasClassifier

Model = KerasClassifier(build_fn=create_model, verbose=0)

# neurons = [16, 64, 128, 256]
Neurons = [16]
# batch_size = [10, 20, 50, 100]
Batch_size = [10]
Epochs = [10]
# activation = ['relu', 'tanh', 'sigmoid', 'hard_sigmoid', 'linear', 'exponential']
Activation = ['sigmoid', 'relu']
# optimizer = ['SGD', 'RMSprop', 'Adagrad', 'Adadelta', 'Adam', 'Adamax', 'Nadam']
Optimizer = ['SGD', 'Adadelta']
Loss = ['squared_hinge']

Param_grid = dict(neurons=neurons, batch_size=batch_size, epochs=epochs, activation=activation,
optimizer=optimizer, loss=loss)

Grid = GridSearchCV(estimator=model, param_grid=param_grid, n_jobs=-1)
Grid_result = grid.fit(X_train, y_train)

Print("Best: %f using %s" % (grid_result.best_score_, grid_result.best_params_))
```

Means =

grid_result.cv_results_[‘mean_test_score

’]Stds =

grid_result.cv_results_[‘std_test_score’]

Params =

grid_result.cv_results_[‘params’]

For mean, stdev, param in zip(means, stds, params):

Print(“%f (%f) with: %r” % (mean,

stdev, param))Output:

Earthquake Prediction Using

Machine LearningModel =

Sequential()

Model.add(Dense(16, activation=’relu’,

input_shape=(3,)))Model.add(Dense(16,

activation=’relu’)) Model.add(Dense(2,

activation=’softmax’))

Model.compile(optimizer=’SGD’, loss=’squared_hinge’, metrics=[‘accuracy’])

Model.fit(X_train, y_train, batch_size=10, epochs=20, verbose=1, validation_data=(X_test,

y_test))Output:

Earthquake Prediction Using Machine Learning

[test_loss, test_acc] = model.evaluate(X_test, y_test)

Print(“Evaluation result on Test Data : Loss = {}, accuracy =

{}”

FEATURES FOR EARTHQUAKE PREDICTION SYSTEM:

Developing an earthquake prediction system is a complex and challenging task, as earthquakes are inherently difficult to predict with high accuracy. However, several features and data sources can be considered when designing such a system. Keep in mind that while these features can contribute to earthquake prediction, no system can guarantee precise predictions due to the unpredictable nature of seismic events. Here are some features and data sources to consider:

- ❖ Seismic Data: a. Seismic Sensors: Use a network of seismometers and accelerometers to monitor ground motion and vibrations in real-time. b. Seismic Waveforms: Analyze the characteristics of seismic waves, including their amplitude, frequency, and arrival times. c. Seismic Magnitude: Track changes in seismic magnitude over time, as larger earthquakes can be preceded by foreshocks.

- ❖ Fault and Tectonic Activity Data: a. Fault Mapping: Monitor the activity and stress accumulation along known fault lines. b. Plate Movement: Track the movement of tectonic plates to identify areas of potential stress and subduction zones.

- ❖ Geospatial and Geological Data: a. Topography and Elevation: Consider the topographical features and elevation changes in an area, which can influence stress buildup and release. b. Geological Structure: Analyze the geological composition of the region, as certain rock types can influence seismic activity.

- ❖ Historical Earthquake Data: a. Historical Earthquake Catalogs: Use historical records of earthquakes to identify patterns and trends in seismic activity.

- ❖ Environmental and Meteorological Data: a. Changes in Groundwater Levels: Groundwater changes can influence stress in the Earth's crust. b. Changes in Atmospheric Pressure: Rapid changes in atmospheric pressure can potentially trigger seismic events.

- ❖ Machine Learning and AI Algorithms: a. Develop machine learning models to analyze and predict seismic activity based on the above data sources. b. Deep learning techniques for time-series data analysis and pattern recognition.

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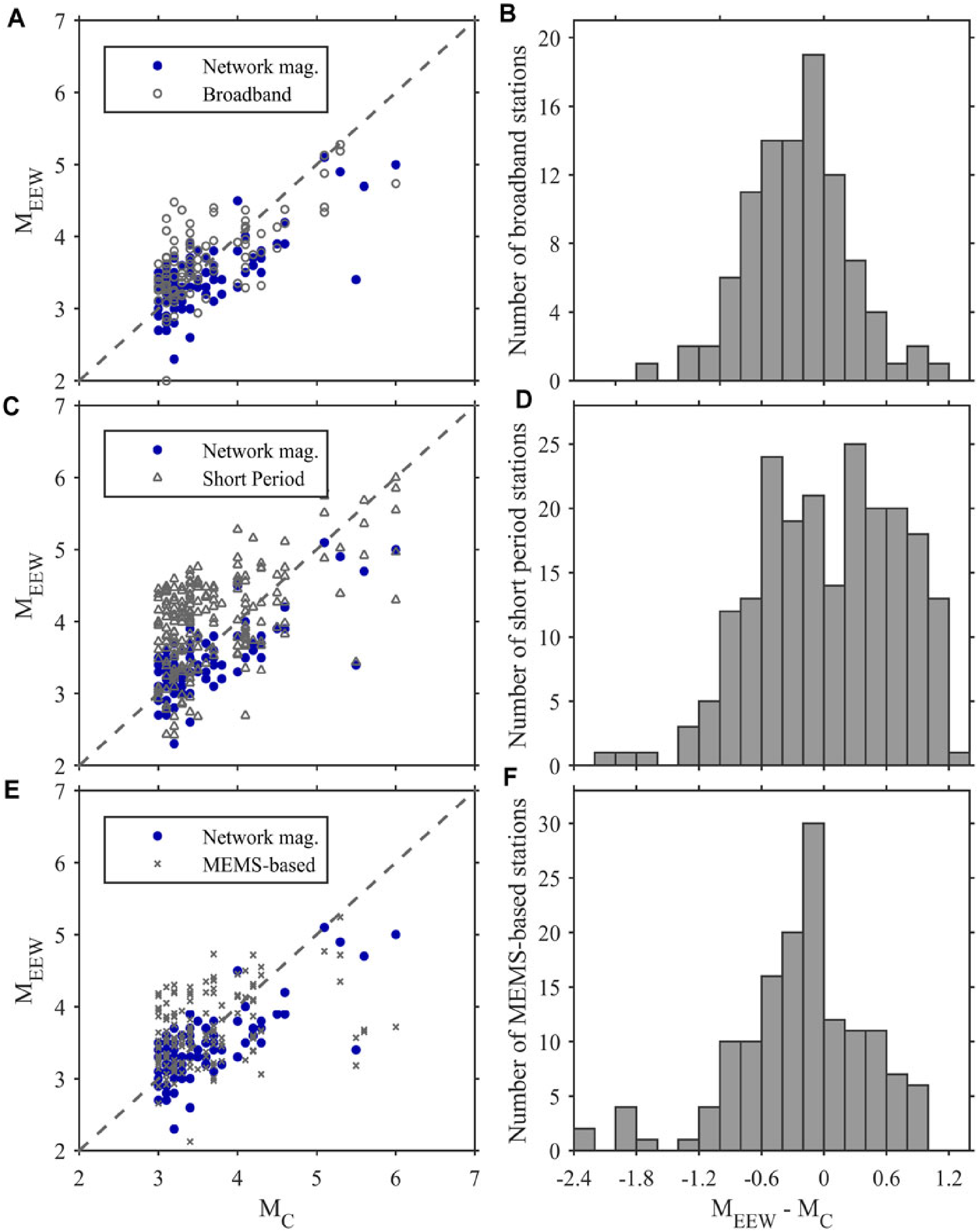
❖ GRAPH STRUCTURE FOR EARTHQUAKE PREDICTION:



BENEFITS FOR EARTHQUAKE PREDICTION SYSTEM:

An earthquake prediction system has the potential to offer several benefits, but it's important to note that predicting earthquakes with a high degree of accuracy is still a significant scientific challenge. Nevertheless, here are some potential benefits of an effective earthquake prediction system:

1. Early Warning and Preparedness: The most immediate benefit of an earthquake prediction system is the potential to provide early warnings to communities in the earthquake's path. This can give people and authorities valuable time to take protective measures, such as evacuating buildings and infrastructure, securing valuable assets, and ensuring public safety.
2. Reduced Loss of Life: By providing advance notice of impending earthquakes, prediction systems can significantly reduce the loss of life, as people can take shelter or evacuate hazardous areas before the quake strikes.
3. Reduced Property Damage: Early warnings can also help minimize damage to buildings, infrastructure, and critical facilities. This, in turn, reduces the financial burden on individuals, businesses, and governments for post-earthquake recovery and reconstruction.
4. Improved Disaster Response: Prediction systems can assist emergency responders in mobilizing resources and personnel in advance of an earthquake, ensuring a more efficient and effective response.
5. Scientific Understanding: Developing an earthquake prediction system involves a deeper understanding of the Earth's processes, which can lead to advances in seismology, geophysics, and geology. This research can improve our understanding of plate tectonics, fault systems, and other geological phenomena.
6. Risk Mitigation and Planning: Communities with access to earthquake prediction systems can incorporate earthquake risks into urban planning, construction codes, and infrastructure design, leading to more resilient and earthquake-resistant structures and systems.
7. Public Awareness and Education: The existence of prediction systems can help raise awareness about earthquake risks and the importance of preparedness, which can lead to more informed and proactive communities.

8. International Cooperation: Developing and sharing earthquake prediction technology can foster international collaboration in monitoring and responding to seismic activity, benefiting regions prone to earthquakes.

It's important to emphasize that while the potential benefits are significant, the development of an accurate and reliable earthquake prediction system remains a complex scientific challenge. Earthquake prediction is still an active area of research, and while progress has been made in earthquake forecasting and early warning systems, predicting the exact time, location, and magnitude of an earthquake with high precision remains elusive.

ADVANTAGES :

- Early Warning: One of the primary advantages of an earthquake prediction system is the potential to provide early warning to communities in the path of an impending earthquake. This early warning can range from seconds to minutes, depending on the system's capabilities, giving people and authorities valuable time to take protective actions.
- Lives Saved: Early warning can significantly reduce the loss of life in earthquake-prone areas. People can evacuate buildings and seek safety, and emergency responders can be better prepared to assist those in need.
- Reduced Injuries: By providing advance notice, earthquake prediction systems can help reduce the number of injuries sustained during an earthquake, as people can take precautions to avoid falling objects, structural collapses, and other hazards.
- Property and Infrastructure Protection: Early warnings can help minimize damage to buildings, infrastructure, and critical facilities. This, in turn, reduces the economic impact and the need for costly post-earthquake recovery and reconstruction.
- Improved Emergency Response: An earthquake prediction system can enhance the efficiency of emergency response efforts, as first responders and relief organizations can mobilize resources and personnel in advance of the event.

1.

DISADVANTAGES:

- Unpredictability: Earthquakes are inherently unpredictable in terms of precise timing, location, and magnitude. The complex and dynamic nature of the Earth's crust makes it challenging to pinpoint when and where a significant seismic event will occur.
- False Alarms: Earthquake prediction systems may produce false alarms, leading to public complacency or unnecessary panic and disruption. Frequent false alarms can erode trust in the system.
- Limited Forecasting Window: Even when early warning systems are in place, the forecasting window is often quite short, typically ranging from seconds to minutes before the earthquake strikes. This limited lead time may not be sufficient for some mitigation measures.
- Technological Challenges: Developing an accurate earthquake prediction system is technologically challenging. Scientists and engineers are still working on finding reliable precursors and methods for prediction.
- Ethical and Legal Concerns: If an earthquake prediction system were to produce a false alarm that led to unwarranted panic, evacuation, or economic disruption, it could raise ethical and legal questions and potential liabilities.

CONCLUSION:

Understanding earthquakes and effectively responding to them remains a complex and challenging task,even with the latest technological advancements. However, leveraging the capabilities of machine
learning can greatly enhance our comprehension of seismic events. By employing machine learning techniques to analyze seismic data, we can uncover valuable insights and patterns that contribute to a deeper understanding of earthquakes. These insights can subsequently inform more effective strategiesfor mitigating risks and responding to seismic events.

As we head towards the future, we might see new technologies that will precisely predict the place andtime of the earthquake that will happen.