**Earthquake Prediction Model Report**

**1. Introduction**

**1.1 Problem Statement:**

The aim of this project is to develop a predictive model for earthquakes using a dataset

sourced from Kaggle. Earthquakes are complex natural phenomena, and predicting their

magnitudes can have significant implications for disaster preparedness and risk mitigation.

**1.2 Objectives:**

The overarching objectives of this project include exploring and understanding the key

features of earthquake data, visually representing seismic activity on a world map,

partitioning the dataset for training and testing, and constructing a neural network model to

predict earthquake magnitudes based on the provided features.

**2. Data Loading and Exploration**

**2.1 Dataset Information:**

The dataset, acquired from Kaggle, consists of various columns including date, time, location

coordinates (latitude and longitude), earthquake type, depth, and magnitude. The dataset was

loaded into a Pandas DataFrame, and preliminary information such as data types and non-null

counts were examined.

**2.2 Data Visualization:**

To gain a geographical perspective on earthquake occurrences, a function was implemented

using Folium to plot these events on a world map. This visualization aids in understanding

the global distribution of seismic activity.

# Global Visualization using Folium

def plot\_earthquakes\_on\_map(data):

m = folium.Map(location=[data[&#39;Latitude&#39;].mean(), data[&#39;Longitude&#39;].mean()],

zoom\_start=2)

for index, row in data.iterrows():

folium.CircleMarker([row[&#39;Latitude&#39;], row[&#39;Longitude&#39;]], radius=row[&#39;Magnitude&#39;]\*2,

color=&#39;red&#39;).add\_to(m)

return m

**3. Data Preprocessing**

**3.1 Feature Selection:**

Relevant features for the earthquake prediction model were selected, considering factors such

as location, depth, and magnitude.

**3.2 Normalization:**

To ensure consistent and meaningful input to the neural network, the selected features were

normalized using the StandardScaler from scikit-learn.

# Data Preprocessing

# Feature Selection

selected\_features = [&#39;Latitude&#39;, &#39;Longitude&#39;, &#39;Depth&#39;, &#39;Magnitude&#39;]

data\_subset = earthquake\_data[selected\_features]

# Normalize numerical data

scaler = StandardScaler()

normalized\_data = scaler.fit\_transform(data\_subset)

**3.3 Train-Test Split:**

The dataset was split into training and testing sets, with 80% of the data allocated for training

and 20% for testing the model&#39;s performance.

# Split data into features and target variable

X = normalized\_data[:, :-1]

y = normalized\_data[:, -1]

# Split data into train and test sets

X\_train, X\_test, y\_train, y\_test = train\_test\_split(X, y, test\_size=0.2, random\_state=42)

**4. Neural Network Model**

**4.1 Architecture:**

A neural network model was constructed using the Sequential API in TensorFlow&#39;s Keras

module. The model consists of an input layer with 32 neurons, a hidden layer with 16 neurons

and ReLU activation, and an output layer with a single neuron for predicting earthquake

Magnitudes.

**4.2 Compilation:**

The model was compiled with the mean squared error (MSE) loss function and the Adam

optimizer, setting the stage for the training process.

# Neural Network Model

model = Sequential()

model.add(Dense(32, input\_dim=X\_train.shape[1], activation=&#39;relu&#39;))

model.add(Dense(16, activation=&#39;relu&#39;))

model.add(Dense(1, activation=&#39;linear&#39;))

**5. Model Training**

**5.1 Epochs:**

The neural network model underwent training for 50 epochs, with each epoch representing a

complete pass through the entire dataset.

**5.2 Training Visualization:**

To monitor the model&#39;s learning progress, the training and validation loss were plotted over

epochs. This visualization provides insights into the convergence and generalization

capabilities of the model.

# Compile the model

model.compile(loss=&#39;mean\_squared\_error&#39;, optimizer=&#39;adam&#39;)

# Model Training

history = model.fit(X\_train, y\_train, epochs=50, batch\_size=32, validation\_split=0.2,

verbose=1)

**6. Model Evaluation**

**6.1 Mean Squared Error (MSE):**

The model&#39;s performance was evaluated using the Mean Squared Error (MSE) metric on the

test set. MSE quantifies the average squared difference between the predicted and actual

earthquake magnitudes.

# Evaluate the model

y\_pred = model.predict(X\_test)

mse = mean\_squared\_error(y\_test, y\_pred)

print(f&#39;Mean Squared Error: {mse}&#39;)

**7. Conclusion and Next Steps**

In conclusion, a foundational earthquake prediction model has been successfully

implemented. The MSE evaluation provides an initial assessment of the model&#39;s accuracy.

Moving forward, potential next steps include fine-tuning the model parameters, exploring

advanced neural network architectures, and considering the incorporation of additional

features for further enhancing prediction accuracy.

Output:

&lt;class &#39;pandas.core.frame.DataFrame&#39;&gt;

RangeIndex: 23412 entries, 0 to 23411

Data columns (total 21 columns):

# Column Non-Null Count Dtype

--- ------ -------------- -----

0 Date 23412 non-null object

1 Time 23412 non-null object

2 Latitude 23412 non-null float64

3 Longitude 23412 non-null float64

4 Type 23412 non-null object

5 Depth 23412 non-null float64

6 Depth Error 4461 non-null float64

7 Depth Seismic Stations 7097 non-null float64

8 Magnitude 23412 non-null float64

9 Magnitude Type 23409 non-null object

10 Magnitude Error 327 non-null float64

11 Magnitude Seismic Stations 2564 non-null float64

12 Azimuthal Gap 7299 non-null float64

13 Horizontal Distance 1604 non-null float64

14 Horizontal Error 1156 non-null float64

15 Root Mean Square 17352 non-null float64

16 ID 23412 non-null object

17 Source 23412 non-null object

18 Location Source 23412 non-null object

19 Magnitude Source 23412 non-null object

20 Status 23412 non-null object

dtypes: float64(12), object(9)

memory usage: 3.8+ MB

None

Date Time Latitude ... Location Source Magnitude

Source Status

0 01/02/1965 13:44:18 19.246 ... ISCGEM

ISCGEM Automatic

1 01/04/1965 11:29:49 1.863 ... ISCGEM

ISCGEM Automatic

2 01/05/1965 18:05:58 -20.579 ... ISCGEM

ISCGEM Automatic

3 01/08/1965 18:49:43 -59.076 ... ISCGEM

ISCGEM Automatic

4 01/09/1965 13:32:50 11.938 ... ISCGEM

ISCGEM Automatic

[5 rows x 21 columns]

Latitude Longitude ... Horizontal Error Root Mean

Square

count 23412.000000 23412.000000 ... 1156.000000

17352.000000

mean 1.679033 39.639961 ... 7.662759

1.022784

std 30.113183 125.511959 ... 10.430396

0.188545

min -77.080000 -179.997000 ... 0.085000

0.000000

25% -18.653000 -76.349750 ... 5.300000

0.900000

50% -3.568500 103.982000 ... 6.700000

1.000000

75% 26.190750 145.026250 ... 8.100000

1.130000

max 86.005000 179.998000 ... 99.000000

3.440000

Epoch 41/50

1/469 [..............................] - ETA: 8s - loss: 0.8342

69/469 [===&gt;..........................] - ETA: 0s - loss: 0.9589

70/469 [===&gt;..........................] - ETA: 0s - loss: 0.9581

126/469 [=======&gt;......................] - ETA: 0s - loss: 0.9451

182/469 [==========&gt;...................] - ETA: 0s - loss: 0.9525

183/469 [==========&gt;...................] - ETA: 0s - loss: 0.9527

236/469 [==============&gt;...............] - ETA: 0s - loss: 0.9406

277/469 [================&gt;.............] - ETA: 0s - loss: 0.9407

327/469 [===================&gt;..........] - ETA: 0s - loss: 0.9432

328/469 [===================&gt;..........] - ETA: 0s - loss: 0.9420

383/469 [=======================&gt;......] - ETA: 0s - loss: 0.9447

384/469 [=======================&gt;......] - ETA: 0s - loss: 0.9470

419/469 [=========================&gt;....] - ETA: 0s - loss: 0.9534

469/469 [==============================] - 1s 2ms/step - loss: 0.9539 -

val\_loss: 0.9966

Epoch 42/50

1/469 [..............................] - ETA: 0s - loss: 0.8512

62/469 [==&gt;...........................] - ETA: 0s - loss: 0.9668

63/469 [===&gt;..........................] - ETA: 0s - loss: 0.9948

126/469 [=======&gt;......................] - ETA: 0s - loss: 0.9786

127/469 [=======&gt;......................] - ETA: 0s - loss: 0.9771

166/469 [=========&gt;....................] - ETA: 0s - loss: 0.9660

216/469 [============&gt;.................] - ETA: 0s - loss: 0.9710

217/469 [============&gt;.................] - ETA: 0s - loss: 0.9697

255/469 [===============&gt;..............] - ETA: 0s - loss: 0.9681

308/469 [==================&gt;...........] - ETA: 0s - loss: 0.9631

309/469 [==================&gt;...........] - ETA: 0s - loss: 0.9626

355/469 [=====================&gt;........] - ETA: 0s - loss: 0.9687

403/469 [========================&gt;.....] - ETA: 0s - loss: 0.9603

466/469 [============================&gt;.] - ETA: 0s - loss: 0.9523

467/469 [============================&gt;.] - ETA: 0s - loss: 0.9528

469/469 [==============================] - 1s 2ms/step - loss: 0.9525 -

val\_loss: 0.9921

Epoch 43/50

1/469 [..............................] - ETA: 9s - loss: 1.1916

60/469 [==&gt;...........................] - ETA: 0s - loss: 1.0242

61/469 [==&gt;...........................] - ETA: 0s - loss: 1.0276

119/469 [======&gt;.......................] - ETA: 0s - loss: 0.9728

120/469 [======&gt;.......................] - ETA: 0s - loss: 0.9727

177/469 [==========&gt;...................] - ETA: 0s - loss: 0.9403

178/469 [==========&gt;...................] - ETA: 0s - loss: 0.9468

221/469 [=============&gt;................] - ETA: 0s - loss: 0.9744

271/469 [================&gt;.............] - ETA: 0s - loss: 0.9564

319/469 [===================&gt;..........] - ETA: 0s - loss: 0.9594

384/469 [=======================&gt;......] - ETA: 0s - loss: 0.9562

385/469 [=======================&gt;......] - ETA: 0s - loss: 0.9563

424/469 [==========================&gt;...] - ETA: 0s - loss: 0.9599

469/469 [==============================] - 1s 2ms/step - loss: 0.9537 -

val\_loss: 0.9982

Epoch 44/50

1/469 [..............................] - ETA: 0s - loss: 1.2701

71/469 [===&gt;..........................] - ETA: 0s - loss: 0.8902

72/469 [===&gt;..........................] - ETA: 0s - loss: 0.8881

124/469 [======&gt;.......................] - ETA: 0s - loss: 0.9162

170/469 [=========&gt;....................] - ETA: 0s - loss: 0.9537

233/469 [=============&gt;................] - ETA: 0s - loss: 0.9638

234/469 [=============&gt;................] - ETA: 0s - loss: 0.9624

271/469 [================&gt;.............] - ETA: 0s - loss: 0.9596

323/469 [===================&gt;..........] - ETA: 0s - loss: 0.9521

380/469 [=======================&gt;......] - ETA: 0s - loss: 0.9488

381/469 [=======================&gt;......] - ETA: 0s - loss: 0.9498

425/469 [==========================&gt;...] - ETA: 0s - loss: 0.9451

460/469 [============================&gt;.] - ETA: 0s - loss: 0.9494

469/469 [==============================] - 1s 2ms/step - loss: 0.9520 -

val\_loss: 0.9900

Epoch 45/50

1/469 [..............................] - ETA: 7s - loss: 1.0986

54/469 [==&gt;...........................] - ETA: 0s - loss: 0.9695

104/469 [=====&gt;........................] - ETA: 0s - loss: 0.9416

158/469 [=========&gt;....................] - ETA: 0s - loss: 0.9311

159/469 [=========&gt;....................] - ETA: 0s - loss: 0.9306

205/469 [============&gt;.................] - ETA: 0s - loss: 0.9432

266/469 [================&gt;.............] - ETA: 0s - loss: 0.9564

267/469 [================&gt;.............] - ETA: 0s - loss: 0.9558

315/469 [===================&gt;..........] - ETA: 0s - loss: 0.9539

316/469 [===================&gt;..........] - ETA: 0s - loss: 0.9544

363/469 [======================&gt;.......] - ETA: 0s - loss: 0.9519

420/469 [=========================&gt;....] - ETA: 0s - loss: 0.9601

421/469 [=========================&gt;....] - ETA: 0s - loss: 0.9606

464/469 [============================&gt;.] - ETA: 0s - loss: 0.9529

469/469 [==============================] - 1s 2ms/step - loss: 0.9527 -

val\_loss: 0.9925

Epoch 46/50

1/469 [..............................] - ETA: 7s - loss: 1.1711

66/469 [===&gt;..........................] - ETA: 0s - loss: 0.9390

67/469 [===&gt;..........................] - ETA: 0s - loss: 0.9607

124/469 [======&gt;.......................] - ETA: 0s - loss: 0.9155

125/469 [======&gt;.......................] - ETA: 0s - loss: 0.9175

176/469 [==========&gt;...................] - ETA: 0s - loss: 0.9279

177/469 [==========&gt;...................] - ETA: 0s - loss: 0.9264

211/469 [============&gt;.................] - ETA: 0s - loss: 0.9293

256/469 [===============&gt;..............] - ETA: 0s - loss: 0.9190

303/469 [==================&gt;...........] - ETA: 0s - loss: 0.9239

364/469 [======================&gt;.......] - ETA: 0s - loss: 0.9404

417/469 [=========================&gt;....] - ETA: 0s - loss: 0.9449

469/469 [==============================] - 1s 2ms/step - loss: 0.9517 -

val\_loss: 0.9957

Epoch 47/50

1/469 [..............................] - ETA: 7s - loss: 0.7449

77/469 [===&gt;..........................] - ETA: 0s - loss: 0.9799

78/469 [===&gt;..........................] - ETA: 0s - loss: 1.0046

131/469 [=======&gt;......................] - ETA: 0s - loss: 0.9736

132/469 [=======&gt;......................] - ETA: 0s - loss: 0.9713

186/469 [==========&gt;...................] - ETA: 0s - loss: 0.9824

187/469 [==========&gt;...................] - ETA: 0s - loss: 0.9803

230/469 [=============&gt;................] - ETA: 0s - loss: 0.9747

278/469 [================&gt;.............] - ETA: 0s - loss: 0.9756

279/469 [================&gt;.............] - ETA: 0s - loss: 0.9749

325/469 [===================&gt;..........] - ETA: 0s - loss: 0.9633

376/469 [=======================&gt;......] - ETA: 0s - loss: 0.9609

377/469 [=======================&gt;......] - ETA: 0s - loss: 0.9597

420/469 [=========================&gt;....] - ETA: 0s - loss: 0.9548

464/469 [============================&gt;.] - ETA: 0s - loss: 0.9516

469/469 [==============================] - 1s 2ms/step - loss: 0.9514 -

val\_loss: 0.9927

Epoch 48/50

1/469 [..............................] - ETA: 7s - loss: 1.4713

62/469 [==&gt;...........................] - ETA: 0s - loss: 0.8911

63/469 [===&gt;..........................] - ETA: 0s - loss: 0.8884

123/469 [======&gt;.......................] - ETA: 0s - loss: 0.9635

124/469 [======&gt;.......................] - ETA: 0s - loss: 0.9619

162/469 [=========&gt;....................] - ETA: 0s - loss: 0.9558

224/469 [=============&gt;................] - ETA: 0s - loss: 0.9606

225/469 [=============&gt;................] - ETA: 0s - loss: 0.9596

270/469 [================&gt;.............] - ETA: 0s - loss: 0.9619

323/469 [===================&gt;..........] - ETA: 0s - loss: 0.9602

324/469 [===================&gt;..........] - ETA: 0s - loss: 0.9626

373/469 [======================&gt;.......] - ETA: 0s - loss: 0.9598

420/469 [=========================&gt;....] - ETA: 0s - loss: 0.9559

421/469 [=========================&gt;....] - ETA: 0s - loss: 0.9560

466/469 [============================&gt;.] - ETA: 0s - loss: 0.9517

469/469 [==============================] - 1s 2ms/step - loss: 0.9512 -

val\_loss: 0.9917

Epoch 49/50

1/469 [..............................] - ETA: 0s - loss: 0.9528

35/469 [=&gt;............................] - ETA: 0s - loss: 0.9338

89/469 [====&gt;.........................] - ETA: 0s - loss: 0.9280

90/469 [====&gt;.........................] - ETA: 0s - loss: 0.9298

129/469 [=======&gt;......................] - ETA: 0s - loss: 0.9161

181/469 [==========&gt;...................] - ETA: 0s - loss: 0.9599

182/469 [==========&gt;...................] - ETA: 0s - loss: 0.9578

221/469 [=============&gt;................] - ETA: 0s - loss: 0.9716

269/469 [================&gt;.............] - ETA: 0s - loss: 0.9646

270/469 [================&gt;.............] - ETA: 0s - loss: 0.9648

312/469 [==================&gt;...........] - ETA: 0s - loss: 0.9619

358/469 [=====================&gt;........] - ETA: 0s - loss: 0.9667

408/469 [=========================&gt;....] - ETA: 0s - loss: 0.9642

469/469 [==============================] - 1s 2ms/step - loss: 0.9516 -

val\_loss: 0.9938

Epoch 50/50

1/469 [..............................] - ETA: 7s - loss: 0.9212

67/469 [===&gt;..........................] - ETA: 0s - loss: 0.9276

68/469 [===&gt;..........................] - ETA: 0s - loss: 0.9226

124/469 [======&gt;.......................] - ETA: 0s - loss: 0.9402

125/469 [======&gt;.......................] - ETA: 0s - loss: 0.9400

170/469 [=========&gt;....................] - ETA: 0s - loss: 0.9453

231/469 [=============&gt;................] - ETA: 0s - loss: 0.9320

232/469 [=============&gt;................] - ETA: 0s - loss: 0.9321

272/469 [================&gt;.............] - ETA: 0s - loss: 0.9372

321/469 [===================&gt;..........] - ETA: 0s - loss: 0.9362

322/469 [===================&gt;..........] - ETA: 0s - loss: 0.9363

366/469 [======================&gt;.......] - ETA: 0s - loss: 0.9348

417/469 [=========================&gt;....] - ETA: 0s - loss: 0.9370

418/469 [=========================&gt;....] - ETA: 0s - loss: 0.9373

462/469 [============================&gt;.] - ETA: 0s - loss: 0.9544

469/469 [==============================] - 1s 2ms/step - loss: 0.9503 -

val\_loss: 0.9913

1/147 [..............................] - ETA: 6s

7/147 [&gt;.............................] - ETA: 1s

87/147 [================&gt;.............] - ETA: 0s

88/147 [================&gt;.............] - ETA: 0s

147/147 [==============================] - 0s 2ms/step

Mean Squared Error: 1.0205811089773589