PREDICTION OF STRUCTURAL COLLAPSE

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ABSTRACT- Prediction of Structural Collapse is a project on predicting the collapse of a building, that is obtaining the result in a binary value(yes or no). Collapse of a building depends upon several constraints say number of years it has constructed, number of stairs the building has, type of material used in the construction, magnitude of earthquake in that region etc. Buildings are known for their failure with the intervention of nature i.e, due to earthquakes, floods etc. The magnitude of the earthquake and the strength of the building together determine the building collapse. Taking magnitude of the earthquake, height of the building and number of years it has constructed into consideration, prediction of structural collapse is determined. Machine learning is used to predict future analysis based on the past experience. In this project, we predict the building may collapse or not by giving the constraints as parameters in the dataset using machine learning algorithms.

Keywords- machine learning algorithm, structural collapse

1. INTRODUCTION

Artificial Intelligence is an approach to make a computer, a robot, or a product to think how smart human think. Artificial Intelligence is a study of how human brain think, learn, decide and work, when it tries to solve problems. And finally this study outputs intelligent software systems. The aim of Artificial Intelligence is to improve computer functions which are related to human knowledge, for example, reasoning, learning, and problem-solving. Artificial Intelligence is now being used in various fields like marketing, medical field, banking sector, finance, agriculture, gaming, chat bots, automobile industry.

Machine learning (**ML**) is the scientific study of algorithms and statistical models that computer systems use to perform a specific task without using explicit instructions, relying on patterns and inference instead. It is seen as a subset of artificial intelligence. Machine learning algorithms build a mathematical model based

on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to perform the task. Machine learning algorithms are used in a wide variety of applications, such as email filtering and computer vision, where it is difficult or infeasible to develop a conventional algorithm for effectively performing the task.

Machine learning is closely related to computational statistics, which focuses on making predictions using computers. The study of mathematical optimization delivers methods, theory and application domains to the field of machine learning. Data mining is a field of study within machine learning, and focuses on exploratory data analysis through unsupervised learning. In its application across business problems, machine learning is also referred to as predictive analytics.

Anaconda Navigator is a desktop graphical user interface (GUI) included in Anaconda® distribution that allows you to launch applications and easily manage conda packages, environments, and channels without using command-line commands. Navigator can search for packages on Anaconda Cloud or in a local Anaconda Repository. It is available for Windows, MacOS, and Linux. Anaconda is an open-source software that contains Jupyter, spyder, PyCharm, VSCode, Gluevix etc that are used for large data processing, data analytics, heavy scientific computing. Anaconda works for R and python programming language. Spyder(sub-application of Anaconda) is used for python. Opencv for python will work in spyder. Package versions are managed by the package management system, conda.

1.2 PROBLEM STATEMENT

Building failure conditions depends on the natural disasters. It has been witnessed that in many cases building collapse occur due to drastic change in weather conditions. Thus we have to take the climatic conditions into account. So we predict the failure of the building, based on the following factors.

Temperature
Rainfall per annum
Depth of the building
Age of the building
Height of the building
Magnitude of the earthquake

To solve these predictions we must use some algorithms. Here we use Logistic Regression algorithm for our prediction. Like all regression analyses, the logistic regression is a predictive analysis. Logistic regression is used to describe data and to explain the relationship between one dependent binary

variable and one or more nominal, ordinal, interval or ratio-level independent variables.

2. LITERATURE SURVEY

Earthquake is one of the most devastating natural disasters that threaten human life. It is vital to retrieve the building damage status for planning rescue and reconstruction after an earthquake. In cases when the number of completely collapsed buildings is far less than intact or less-affected buildings (e.g., the 2010 Haiti earthquake), it is difficult for the classifier to learn the minority class samples, due to the imbalance learning problem. In this study, the convolutional neural network (CNN) was utilized to identify collapsed buildings from post-event satellite imagery with the proposed workflow. Producer accuracy (PA), user accuracy (UA), overall accuracy (OA), and Kappa were used as evaluation metrics. To overcome the imbalance problem, random over-sampling, random under-sampling, and cost-sensitive methods were tested on selected test A and test B regions. The results demonstrated that the building collapsed information can be retrieved by using post-event imagery. Therefore, a suitable balancing method should be considered when facing imbalance dataset to retrieve the distribution of collapsed buildings.[1]

To overcome the problem of outlier data in the regression analysis for numerical-based damage spectra, the C4.5 decision tree learning algorithm is used to predict damage in reinforced concrete buildings in future earthquake scenarios. Reinforced concrete buildings are modelled as single-degree-of-freedom systems and various time-history nonlinear analyses are performed to create a dataset of damage indices. Subsequently, two decision trees are trained using the qualitative interpretations of those indices. The first decision tree determines whether damage occurs in an RC building. Consequently, the second decision tree predicts the severity of damage as repairable, beyond repair, or collapse. Predicting damage in structures as a result of future earthquakes can be a very useful tool for seismic risk mitigation plans. A reliable estimation of damage has wide ranges of application in the seismic vulnerability evaluation of buildings that have not been designed to withstand earthquake loads. Such damage prediction can be used in scenario studies where effects of a single earthquake, often historically significant, on present-day portfolios in a region are evaluated.[2]

Most earthquakes involve widespread damage, ongoing aftershocks and losses in

billions of dollars. With help of artificial intelligence and low cost remote sensing data you can detect building collapse in post-earthquake environment. Being able to map the distribution of damage quickly and with confidence can help locate appropriate aid to the most severely impacted regions. Accurate mapping can also aid in determining whether citizens can return safely to their home. In addition it can prevent casualties from delayed building collapses. Using the machine learning techniques developed, future disaster relief professionals might be able to use a more limited field-based damage assessment, in combination with remote-sensing-based data, to identify highly damaged areas more quickly and at lower cost. Developing a structural damage classifier with support vector machines can help with prediction of post-earthquake damage state, given the building features and input ground motion. Classifier can also be used for accelerating post-earthquake damage evaluation of critical buildings. This will allow faster recovery time and decrease financial losses expected from downtime and repair. With k-means clustering, each ground motion is categorized based on frequency content but most influential feature is the correlation between the fundamental period and the earthquake type.[3]

3. PROPOSED METHOD

3.1 METHODOLOGY

In the proposed system, we predict the collapse of the building by taking past building collapses data due to earthquakes. By training the previous data using the machine learning algorithms, we can forecast the building collapse that can occur in future due to earthquakes.

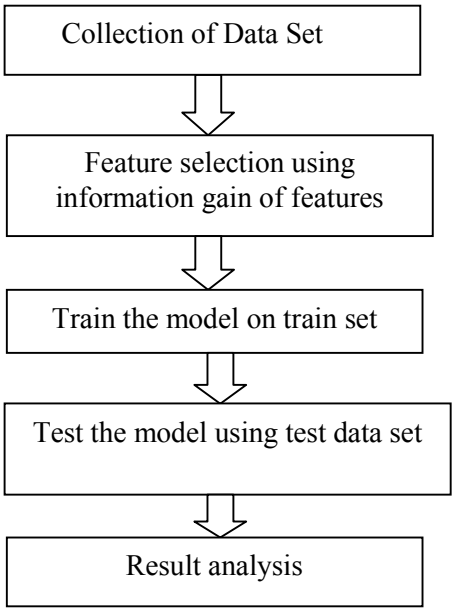

Fig : Steps in Prediction of Structural Collapse

Step1-Collection of Dataset

The dataset is a collection of related sets of information that is composed of separate elements but can be manipulated as a unit by a computer. For this project, the dataset is prepared manually. To create a machine learning model, the first thing required is a dataset as a machine learning model completely works on data. The collected data for a

particular problem in a proper format is known as the dataset

```
[3]: data
```

[3]:

	Depth	Rainfall per annum	Temperature	Age(years)	Height	Magnitude	Failure
0	15	1009	30	3	2	3.8	no
1	18	1236	29	6	3	3.5	no
2	12	2036	45	9	1	2.6	no
3	20	2000	45	15	5	4.0	no
4	25	2365	25	23	10	3.6	no
5	21	2598	36	12	6	4.2	no
6	20	2145	36	25	5	2.8	no
7	28	2365	23	40	19	5.4	yes
8	27	1254	56	56	22	4.8	yes
9	34	1278	35	25	50	7.2	yes
10	45	1469	37	12	56	4.1	no
11	30	1500	33	23	51	4.9	yes
12	15	1698	29	45	20	5.8	yes
13	28	999	28	15	12	4.2	no
14	20	890	50	56	45	5.0	yes
15	20	1925	41	89	66	7.0	yes

Fig: Dataset of Structural Collapse

Step2-Importing Libraries and splitting the dataset.

In order to perform data preprocessing using Python, to import some predefined Python libraries. These libraries are used to perform some specific jobs. There are three specific libraries that will use for data preprocessing. To make requests to the prediction and process the returned data we will make use of few standard libraries Those libraries are pandas, numpy, matplotlib.

Step3-Checking the null values

Sometimes you may find some data are missing in the dataset. We need to be equipped to handle the problem when we come across them. Obviously you could remove the entire line of data but what if you are unknowingly removing crucial information.

Step 4—Train and Split Dataset

Now we need to split our dataset into two sets—a Training set and a Test set. We will train our machine learning models on our training set, i.e our machine learning models will try to understand any correlations in our training set and then we will test the models on our test set to check how accurately it can predict. Assuming that your test set meets the preceding two conditions, your goal is to create a model that generalizes well to new data. Our test set serves as a proxy for new data. For example, consider the following figure. Notice that the model learned for the training data is very simple. This model doesn't do a perfect job—a few predictions are wrong. However, this model does about as well on the test data as it does on the training data. In other words, this simple model does not overfit the training data. Validating the trained model against test data.Never train on test data. If you are seeing surprisingly good results on your evaluation metrics, it might be a sign that you are accidentally training on the test set.

Step 5- Normalize the data

Before we do fitting, let's normalize the data so that the data is centered around the mean and has unit standard deviation. Normalization of the data can be done by the sklearn Standard Scalar. Data is pre-processes before it is used for analysis and prediction.

Step 6- Visualization

Fit the model to selected supervised data by using the matplotlib library for visualizing the independent variables and dependent variables. X label represents the year and the Y label represents the economic damage occurs in each state.

Step 7- Model fitting and prediction

Fit the model into the decision tree algorithm by training the model by the supervised learning. Predicting the result by using Logistic Regression technique and the decision tree regression algorithm,.

4. RESULTS AND DISCUSSION

Prediction: It is used to predict the accurate results. To calculate the accurate result in the code there are some calculations given in the code.

```
y_pred1=mlr.predict([[34,45,42]])
y_pred1
```

```
array([17.850860055])
```

Fig: Predicted value

Accuracy is one metric for evaluating the classificationmodels.

Informally, **accuracy** is the fraction of predictions our model got right. Accuracy comes out to 0.91, or 91% (91 correct predictions out of 100 total examples). Actually, let's do a closer analysis of positives and negatives to gain more insight into our model's performance.

5. CONCLUSION

In this project we constructed a model that is able to accurately predict whether a building gets collapse or not based on various parameters like depth of the building, height of the building, age of the building, rainfall per annum, temperature and magnitude of the earthquake. This prediction is done by using Logistic Regression. The output of the project is whether the building collapses or not. With the help of our work, we will be predicting the collapse of the building and analyzing the factors which strongly affect the failure. This prediction will give suggestions based on the result obtained which level of attribute can lead to a failure. This intimates the people to respond on the building's condition before anything goes wrong.

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