1. Analysis and Prediction of Earthquakes using different Machine Learning techniques

Link:[(PDF) Analysis and Prediction of Earthquakes using different Machine Learning techniques]

The article Analysis and Prediction of Earthquakes using Different Machine Learning Techniques by Manaswi Mondol examines the possibility of using data from real-life occurrences of seismic events to determine the magnitude and depth range of an earthquake through the use of machine learning models. The study examines a subset of USGS data, comprising significant earthquakes recorded between 1965 and 2016, to perform data cleaning and exploratory data analysis. This analysis aims to identify the key attributes that predict variables such as latitude and longitude. Four models (Random Forest, Linear Regression, Polynomial Regression, and Long Short-Term Memory (LSTM)) will be trained, and their performance will be measured using indicators such as the R^2 score, explained variance, and mean squared error. The results indicate that the magnitude of an earthquake is not easily predicted, and the Polynomial Regression of level 16 comes out as the best overall model in relation to predicting the magnitude, while Random Forest comes out to be the best in predicting the depth with an R2 score of 0.8574. The patterns identified in the study include the most frequent ranges of magnitude, outliers, and global spatial distribution of the earthquakes. It sums up that even though an accurate prediction of earthquakes is yet to be figured out, machine learning may be helpful due to its ability to offer viable approximations, specifically in detecting patterns of depth, and recommends that the incorporation of more extensive seismic signals may help improve performance as well as mitigate overfitting risks.

2. Machine learning for earthquake prediction: a review (2017–2021)

Link:[(PDF) Machine learning for earthquake prediction: a review (2017–2021)]

The paper "Machine Learning for Earthquake Prediction: A Review" presents a comprehensive survey of how machine learning (ML) methods have been explored for predicting earthquakes, focusing on the challenges, methodologies, and future directions in this field. It commences by describing the shortcomings of the conventional statistical and seismological analysis methods and includes the fact that they are not effective in terms of non-linear high-dimensional seismic data. The study classifies ML-based earthquake prediction into three main tasks of earthquake detection, parameter estimation (such as magnitude, depth, and location), and forecast (time and probability of event). Different algorithms are outlined, such as Support Vector Machines, Artificial Neural Networks, Decision Trees, Random Forests, and Deep Learning architecture, with some aspects covering their application, advantages, and disadvantages. The paper highlights the quality and seamless seismic data, and feature engineering, which takes into consideration the geological parameters in addition to the geophysical parameters. It further points out that although there are ML methods that have exhibited encouraging high achievements towards a certain predictive application, there are limitations about generalizability over all other models because of the seismic activity differences due to regions and insufficient data. The authors conclude that future areas of interest in modifying prediction reliability concerning earthquakes could be hybrid methods involving physics-based models with data-driven ML techniques and the more general topic of deep learning and big data integration. They also emphasize the morality and social dimension of prediction systems, advising to not recklessly communicating the findings, as no necessary panic and misinformation may take place.

3. Major earthquake event prediction using various machine learning algorithms

Link:[(PDF) Major earthquake event prediction using various machine learning algorithms]()

In the paper A Machine Learning Approach for Earthquake Magnitude Prediction authors present and test a machine learning-based approach to earthquake magnitude prediction on a historical dataset. The earthquake data gathered by the authors are provided by various global sources, and to make it possible the data preprocessing procedures, such as eliminating duplicates and addressing missing values, normalizing features, and scaling, are provided beforehand. They utilize multiple machine learning models- Linear Regression, Decision Tree Regressor, Random Forest Regressor, and Gradient Boosting Regressor, to forecast the magnitude of earthquakes using parameters highlighting latitude, longitude, depth, and time of occurrence. The performance of the model is evaluated in terms of such indicators as Mean Absolute Error (MAE), Mean Squared Error (MSE), and R 2 score. The results of experiments show that ensemble methods, specifically Random Forest and Gradient Boosting, with a high predictive score and capability of generalization on test data, are better compared to the simpler models. The research goes further to map the spatial coverage of earthquakes to determine the area that has the most earthquakes and the relationship between input variables. The authors conclude that machine learning can aid in making better magnitude forecasts than traditional approaches, but issues still emerge because of the chaotic nature of the phenomena concerning earthquakes. To continue further on the power of prediction, they suggest the addition of even richer data sets: geological fault maps, plate movement data, and persistent volcanic sensor values.

1. Machine Learning Methods for Earthquake Prediction: a Survey

Link -
https://www.researchgate.net/profile/Natalia-Grafeeva/publication/333774922_Machine_Learning_Methods_for_Earthquake_Prediction_a_Survey/links/67f6f97e95231d5ba5bd86a4/Machine-Learning-Methods-for-Earthquake-Prediction-a-Survey.pdf

The provided paper, "Machine Learning Methods for Earthquake Prediction: a Survey," reviews recent research on using machine learning to predict earthquakes. The authors highlight the historical difficulty of predicting earthquakes and the skepticism surrounding traditional precursors. The paper argues that modern machine learning techniques, such as neural networks and other classifiers, are a promising new approach. The survey discusses various studies that have applied different models, including Artificial Neural Networks (ANN) and Probabilistic Neural Networks (PNN) to predict earthquake magnitudes, and models like Random Forest (RF) and Support Vector Machines (SVM) for both classification and regression tasks. It also mentions more complex ensemble methods like LPBoost and a system combining a Support Vector Regressor (SVR) with a Hybrid Neural Network (HNN). The authors conclude that these diverse machine learning models show great potential for creating more accurate and timely earthquake predictions by uncovering complex, non-linear patterns within seismic data.

2. Earthquake Prediction using Hybrid Machine Learning Techniques

Link-
https://www.researchgate.net/profile/Mustafa-Abdul-Salam/publication/352414816_Earthquake_Prediction_using_Hybrid_Machine_Learning_Techniques/links/60d7aec5a6fdccb745e9609f/Earthquake-Prediction-using-Hybrid-Machine-Learning-Techniques.pdf

A study in the International Journal of Advanced Computer Science and Applications (Vol. 12, No. 5, 2021) introduced two hybrid machine learning models to predict earthquake magnitudes in Southern California over a 15-day period. The models, FPA-ELM (Flower Pollination Algorithm and Extreme Learning Machine) and FPA-LS-SVM (Flower Pollination Algorithm and Least

Square Support Vector Machine), used seven seismic indicators calculated from historical earthquake data. The study compared the performance of these hybrid models with their non-hybrid counterparts using four evaluation metrics: Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Symmetric Mean Absolute Percentage Error (SMAPE), and Percent Mean Relative Error (PMRE). The results demonstrated that the FPA-LS-SVM model delivered superior prediction accuracy, suggesting that combining optimization algorithms with machine learning can enhance earthquake prediction.

3. **Improving earthquake prediction accuracy in Los Angeles with machine learning**

Link -

https://www.nature.com/articles/s41598-024-76483-x

In this groundbreaking research, Yavas et al. achieved a remarkable 97.97% accuracy in predicting the maximum earthquake category in Los Angeles within a 30-day period. This was accomplished by utilizing a Random Forest machine learning model and a meticulously crafted feature matrix based on data from the Southern California Earthquake Data Center (SCEDC). The study, which builds on previous work in other seismic regions, demonstrates a significant improvement over a prior Los Angeles prediction accuracy of 69.14%. The researchers meticulously processed data from January 2012 to September 2024, converting various magnitude types to a consistent local magnitude (ML) for model training. Their findings underscore the immense potential of machine learning and neural networks to enhance seismic risk management and preparedness in highly active regions. The study's success is attributed to a robust methodology, including the selection of an optimal predictive model and a comprehensive dataset, setting a new benchmark for earthquake forecasting.

1. **Earthquake Magnitude Prediction Using Machine Learning Techniques | LINK**

This paper looks at how machine learning can be used to predict earthquake magnitudes using past earthquake data. The authors used information from the USGS Earthquake Database, which includes details like the date, time, location, depth, and magnitude of earthquakes. They cleaned the data by removing errors and missing values, then prepared it for training by normalizing the numbers and splitting it into training and testing sets. They studied how features such as location, depth, and time patterns might be related to earthquake magnitude. Several machine learning models were tested, including linear regression, decision tree regression, random forest regression, K-nearest neighbors (KNN), and support vector regression (SVR). The models were compared using measures like mean absolute error (MAE), mean squared error (MSE), root mean square error (RMSE), and R^2 score. The results showed that random forest, an ensemble model, gave the best accuracy and lowest error, which suggests that predicting magnitudes involves complex patterns, not just simple linear relationships. The authors conclude that machine learning can find useful patterns in earthquake data, but accuracy depends a lot on data quality, the area being studied, and the amount of data available. They suggest adding more geological and physical information to improve predictions in the future.

2. **Earthquake prediction based on spatio–temporal data mining: an LSTM network approach | LINK**

This paper looks at how deep learning, specifically Long Short-Term Memory (LSTM) neural networks, can be used to predict earthquakes using both time and location information from past events. The authors used earthquake records from the Japan Meteorological Agency (JMA), which include the date, time, location, depth, and magnitude of each quake. Before training, they removed small earthquakes, organized the data into sequences of past events, and normalized the numbers so they would work well with the LSTM model. They split the target area into a grid and treated each grid cell as its own time series, showing how earthquakes change over time in that location. The LSTM model was trained to predict if an earthquake (above a certain magnitude) would happen in each grid cell, based on patterns from previous events. They measured performance using precision, recall, F-measure, and accuracy, and compared results with simpler models like logistic regression and support vector machines. The LSTM model performed better than these traditional methods, as it could capture complex patterns between past and future earthquakes. However, predicting very large earthquakes was still difficult. The authors suggest that adding more geological and geophysical data could make the predictions more accurate in the future.

3. **A BP Artificial Neural Network Model for Earthquake Magnitude Prediction in Himalayas, India | LINK**

This paper presents a method for predicting earthquake magnitudes in the Himalayan region using a Back Propagation (BP) Artificial Neural Network. The researchers gathered earthquake data from 1887 to 2015 from sources such as the US Geological Survey (USGS) and the Indian Meteorological Department, including details like event time, latitude, longitude, depth, and magnitude. They then transformed this raw data into eight mathematically computed seismicity indicators, such as the Gutenberg–Richter b-value, average magnitude of recent events, energy released, and measures of variation. These indicators served as input features for a three-layer feed-forward BP neural network (9 input neurons, 12 hidden neurons, 1 output neuron) trained using the Levenberg–Marquardt algorithm, with tan-sigmoid and linear activation functions. The network was trained on earthquake records from 2013–2014 and tested with 2015 data. Statistical and computational comparisons between predicted and actual magnitudes showed that the model performed well for earthquakes between magnitudes 3.0 and 5.4, with reduced accuracy for larger magnitudes due to limited training examples. Overall, the study demonstrates that BP-ANN can effectively capture the complex, non-linear patterns in seismic activity, offering better prediction accuracy than conventional statistical approaches for small to moderate earthquakes.