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Introduction to Rusho's Transform Lakshmann and Smith Model: A Machine Learning Approach to Earthquake Detection

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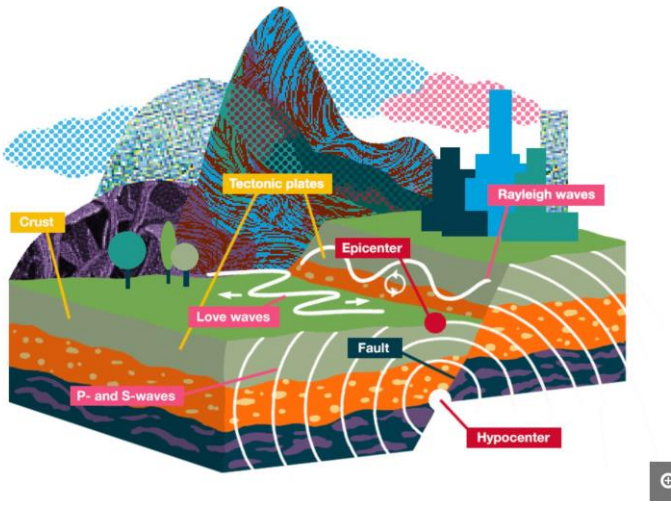
Abstract: Machine learning now become one of the demandable field in engineering and life sciences , IT is now the cutting edge of technological development , The threat of climate change makes it crucial to improve our understanding of the climate system . This paper has been inspired by the book : Machine Learning and Data Mining Approaches to climate science . From this book I am inspired to find a new branch of machine learning for the earthquake detection and intro climate +physics or Climato -physics Modelling . Using Artificial intelligence is one of the remarkable steps to find the optimal solution of Earthquake detection . Approximately 20,000 people are killed every year by earthquakes. There are over 500 active faults in California and most of its residents live within 30 miles of an active fault. So if we can predict the earth-quake before it occurred , we can make active step and save millions of life . It is similar to weather detection and thunderstorms detection , same algorithm will be implemented in thunderstorm and weather detection , but we will use both as well as machine learning model and artificial intelligence model ,Rats, weasels, snakes, and centipedes reportedly left their homes and headed for safety several days before a destructive earthquake. Anecdotal evidence abounds of animals, fish, birds, reptiles, and insects exhibiting strange behavior anywhere from weeks to seconds before an earthquake. So we will first understand why and how earthquake happen and biological mechanism of understanding fish , birds , reptiles and insects hearing . Then we will use the datasets of global earthquake pattern . And finally we will put all in one and relate the algorithm with storm-detection. So, Let's start.

Introduction:

The earth has four major layers: the inner core, outer core, mantle and crust. The crust and the top of the mantle make up a thin skin on the surface of our planet. But this skin is not all in one piece – it is made up of many pieces like a puzzle covering the surface of the earth. Not only that, but these puzzle pieces keep slowly moving around, sliding past one another and bumping into each other. We call these puzzle pieces tectonic plates, and the edges of the plates are called the plate boundaries. The plate boundaries are made up of many faults, and most of the earthquakes around the world occur on these faults. Since the edges of the plates are rough, they get stuck while the rest of the plate keeps moving. Finally, when the plate has moved far enough, the edges unstick on one of the faults and there is an earthquake.



https://scienceexchange.caltech.edu/topics/earthquakes/what-causes- earthquakes

While the edges of faults are stuck together, and the rest of the block is moving, the energy that would normally cause the blocks to slide past one another is being stored up. When the force of the moving blocks finally overcomes the **friction** of the jagged edges of the fault and it unsticks, all that stored up energy is released. The energy radiates outward from the fault in all directions in the form of **seismic waves** like ripples on a pond. The seismic waves shake the earth as they move through it, and when the waves reach the earth's surface, they shake the ground and anything on it,

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Table 3
The test data for ANN

Date	Latitude (N)	Longitude (E)	Radon (kBq m^{-3})	Depth of earthquake (km)	Pressure (mbar)	TS 5 cm, °C	TS 50 cm, °C	TS 100 cm, °C	Magnitude of earthquake (Mw)	ANN Model	*Relative Error %
08.11.2004 21:15	38.391	39.068	12.078	5.0	863	32.8	28.2	25.5	3.1	3.2	3.2
08.11.2004 21:30	38.446	39.193	9.138	5.0	862	32.8	28.2	25.5	3.5	3.2	8.6
08.11.2004 21:45	38.456	39.184	10.118	5.0	862	32.8	28.2	25.5	3.3	3.3	.00
08.13.2004 23:45	38.332	39.143	7.766	6.1	867	30.0	25.0	25.5	3.1	3.1	.00
08.14.2004 03:00	38.512	39.275	9.138	4.9	868	28.0	26.0	25.5	3.3	2.9	12.12
08.16.2004 13:30	38.440	39.174	11.294	5.0	864	42.5	27.9	25.6	3.4	3.5	2.9
08.16.2004 16:15	38.422	39.132	12.666	5.0	864	41.0	27.9	25.6	3.8	3.7	2.6
08.17.2004 09:00	38.359	39.216	13.450	5.0	866	42.2	27.9	25.6	3.3	3.3	.00

* Relative Error % = (|Magnitude of Earthquake−ANN Model|/Magnitude of Earthquake).

Külahcı, Fatih et al. "Artificial Neural Network Model for Earthquake Prediction with Radon Monitoring." Applied Radiation and Isotopes 67.1 (2009): 212–219. Web.like our houses and us! Src : https://www.geologypage.com/2017/10/what-is-earthquake.html

Radon Signals for Earthquake Prediction:

Citation:
KHAN, H. A., ., M. T., & ., A. A. Q. (1990). RADON SIGNALS FOR EARTHQUAKE PREDICTION AND GEOLOGICAL PROSPECTION. *Journal of Islamic Academy of Sciences 3:3*. https://doi.org/https://jag.journalagent.com/ias/pdfs/IAS_3_3_229_231.pdf

Certain phenomena have been found to be associated with earthquakes. These include (1) the cyclic occurrences of earthquakes, (2) strike of earthquake during full/new moon periods, (3) movement of liquids and gases within the earth before the arrival of an earthquake, (4) change in water/oil levels in wells, (5) change in electromagnetic properties of the earth, (6) change in gravitational/magnetic attaraction, (7) unusual weather and, (8) strange behavior of certain animals and human beings. All of these are precursorey phenomena but only a few have a scientific basis.

To predict Earthquakes we can make a machine learning algorithm in three layer :-

1) Input layer : it consists all of the parameters
2) Hidden layer : It consist the behavioural change of animals
3) Output layer : It consists the probabilities output of earthquakes forecasting

Now One of the problems that occur during ANN training is overfitting. The error on the training set becomes driven to a very small value, but when new data is presented to the network the error is large. The network has memorised the training examples, but it has not learned to generalise to new situations (The Mathwork Inc., 2007). The simplest way to avoid overfitting is to devise an automated training–testing routine, in which the network training is halted periodically at predetermined intervals, and the network is then run in recall mode on the test set to evaluate the network's performance, with various error criteria. This process continues iteratively without human intervention with interim results that meet the error criteria savings for later use (Kulahci et al. 2006).

Now to develop a strong Mathematical model we will take rat brain as a sample , One can think many animal can predict earthquake strongly , then why will use rats , you will find the answer after reading this New-York Times article "Researchers Say They've Recreated Part of a Rat Brain Digitally :https://www.nytimes.com/2015/10/09/science/rat-brain- digital-reconstruction-human-brain-project.html" .

The Blue Brain Project built a reconstruction of a section of rat brain in a computer, and hopes to do the same with a human brain eventually.

Credit…..

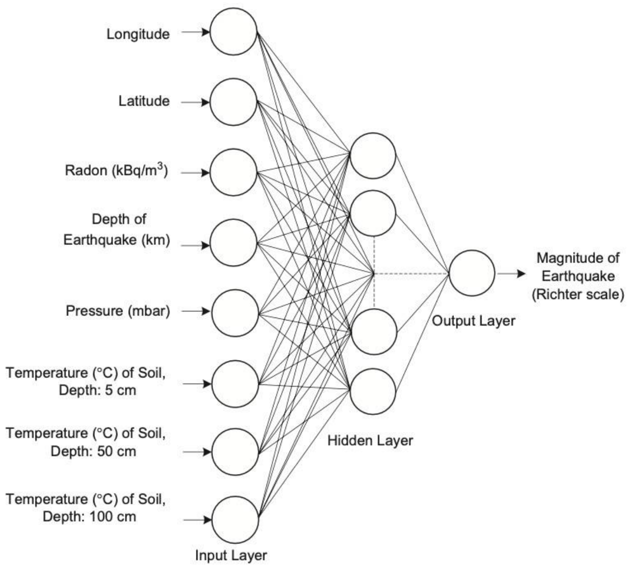


Fig. 3. Neural network architecture that was used in modeling magnitude of earthquake.

Test Data And Accuracy Test For Ann Model Inprediction Of Earthquake

Makram et al./Cell 2015

We are getting very positive result on researching Rat's brain , here is our training setup for earthquake detection model :

First of all we will make 2 null hypothesis Null hypothesis :

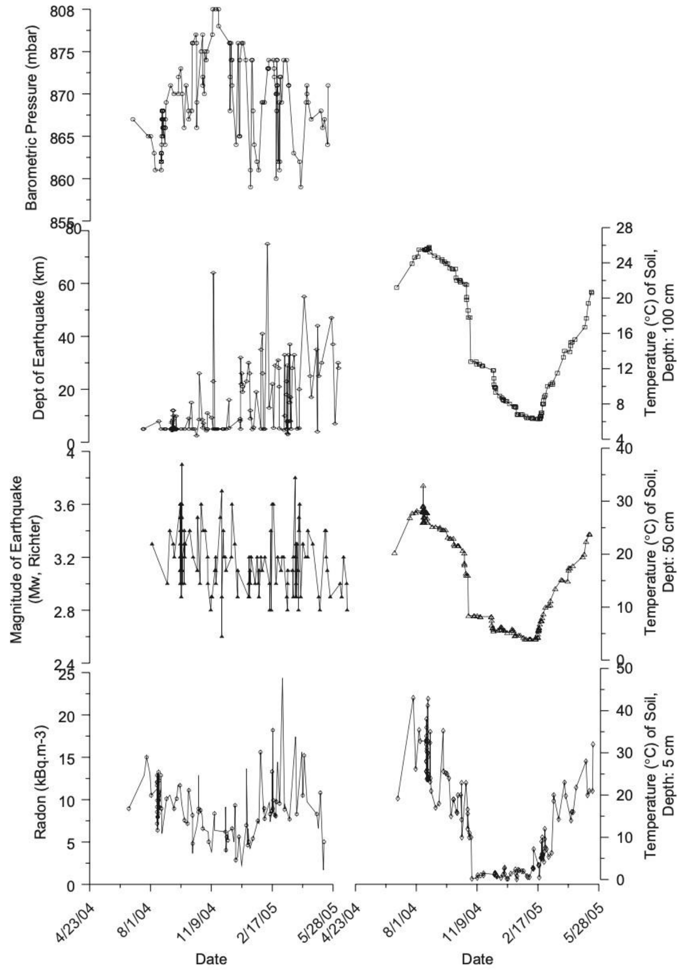


Fig. 4. Training data for ANNs.

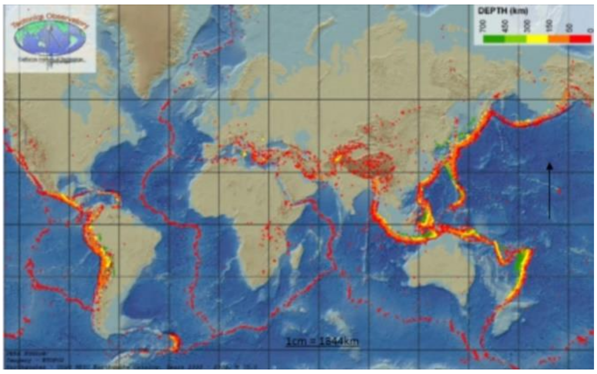
Külahcı, Fatih et al. "Artificial Neural Network Model for Earthquake Prediction with Radon Monitoring." Applied Radiation and Isotopes 67.1 (2009): 212–219. Web.

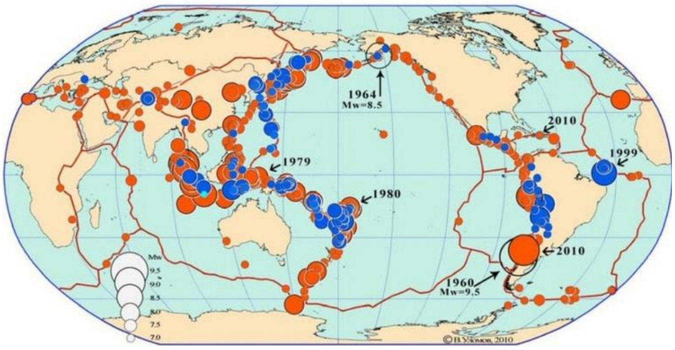
1) We Are Successful To Make A Complete Neural Mapping Of Rats And It's Brain And Sensing Factors All Are Digitally Stored In Computer

2) To get a 100% accurate output , computer must be able to store data for an infinite period of time

Experimental Set Up

1) *First we have to find the pattern of earthquake and the places where it occurs most frequently . Because we will get accurate data from there , and our model accuracy depends on the amount of data , Here is the recent study of global pattern of earthquakes . One can download and use the detailed data of global earthquake pattern here : https://www.ukessays.com/essays/geography/global-patterns-earthquakes-1100.php*





https://www.researchgate.net/figure/The-epicenters-of-major-\
earthquakes-of-the-Earth-for-the-period-from-January-1996-to-May_fig5_260021461

2) From seismometer data we know that earthquakes generally radiate seismic waves mainly in the frequency range of 0.01 to 10 Hz, even if they can generate higher frequencies

. We will use frequency sensor based AI machine which will sense the environmental frequency factor and after coming to some threshold frequency I.e o.o1 it will record all environmental changes and make it in a dynamic program , and the Program will be recurrent , the iteration will occur day by day and environmental change record will be reserved to us . Mainly the AI BASES SENSORY MODEL WILL FOLLOW RUSHO''s TRANSFORM LAKSHMANNS Model . It compared the different methods of tracking earthquakes on 3 Statistical criteria :

1) The Duration Of The Track . The Duration Is Longer If There Are Fewer Dropped Associations
2) The Standard Deviation Of The Vertical Integration Liquid Of The Cell In Time . The Standard

Deviation Is Lowered If There Are Fewer Mismatch Here Is The Pseudocode Of This Algorithm :

1) Let define the next earthquake time from now will be tn , Project recent earthquake cell at tn-1 time to the nearest one

2) Sort the earthquake cells at tn-1 by there track length , so that longer-lived tracks are considered first in step 3

3) For each unassociated projected centroid , identify all centurions at tn ,that are within dn-1 km of the projected centroid . Dn-1 is given by $(A/\pi)^{1}/2$, where A is the projected earthquake cell at tn-1.

4) If there is only one centroid within the search radius in steps 3 and if there between it and projected centroid is within 5 km or a minimum threshold distance , then associate or correlate two earthquakes .

5) Repeat steps 3 and 4 until no changes happen . At this point , all unique centroid matches have been performed

6) Define a cost function for the association of candidate cell I at tn and cell j projected forward from tn-1 as :(a cost function will warn next state when the previous state is informed about the earthquake , the threshold must be grater than or equal to 0.o1

$c_{ij} = (x_i - x_j)^2 + (y_i - y_j)^2 + A_j/pie(|A_i - A_j|/A_i\^A_j + | d_i - d_j | /d_i\^d_j)$

Where xi,xj is the consequent x axis location and yi,yj is the y axis location and di is the pick pixel value of cell I(in the spatial field which cells are being detected) . |a| refers the magnitude of a and a^b refers to the maximum of a and b .

.For each unassociated centroid at tn , identifying all projected centroid within dn km where dn is expressed in terms of the area of the cell tn as (A/pie)^1/2

7) Associate each unassociated centroid at tn with the unassociated ,projected centroid within dn for the cost function c is minimum .If there are no centroids within the search radius mark it as a new cell and repeat the above process again and again

8) Now if we substitute it in hidden layers , the overfilling will be reduced approximately to 0.

Previously the ANN over-fitting was

R-mode factor loadings matrix

Variable	Factor 1	Factor 2	Factor 3	Factor 4
TS 100 cm (°C)	.960			
TS 50 cm (°C)	.954			
TS 5 cm (°C)	.893			
Predicted values earthquake (Mw)		.943		
Measured values earthquake (Mw)		.939		
Depth (km)		−.546		
Latitude (N)			.870	
Longitude (E)			.866	
Radon ($kBq.m^{-3}$)				.766
Pressure (mbar)				−.641
% of Variance	37.55	18.36	14.23	10.04
Cumulative %	37.55	55.91	70.14	80.18

Extraction method: principal component analysis.
Rotation method: Varimax with Kaiser Normalization.

The factoring analysis and it's distribution of uncertainty of parameters By using R programming Language

Conclusion:

In this paper I tried to establish a unique algorithm to determine earthquakes prediction. In science we approach every model as a idealistic model, though at the end of the day it requires infinite parameter to smoothly predict earthquakes. But science is progressive, our goal is to improve our model day by day. I hope I create a new knowledge of this branch.