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Estimating of Human Life Losses Caused Through Earthquake Employing Neural Network

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Abstract

As a matter of fact, the estimated loss of the human life caused by the earthquake is a crucial issue. This estimate helped to administrators in planning for the preventive measures or the crisis management after the earthquake. In this article, we represented a new model for measuring the loss of human life utilizing the self-organizing competitive neural networks. In the latest model, the neural network is initially trained via the given trainings of the parameters of the earthquake depth, magnitude, the maximum of the ground acceleration, speed vibration, duration of the earthquake, the intensity of the earthquake and etc. Then, this procedure used to predict and estimate the loss of human life. In fact, the recent educational model was experimented on the region 3 of Esfahan. Nevertheless, the total results can thoroughly show that Isfahan province can be classified as the third class of vulnerability against the earthquake.

Keywords: *Earthquakes, Losses of Human Life, Neural Networks, Estimates, Notions*

1. Introduction

One of the common issues that most of cities are dealing with all around the world is the natural disaster of the earthquake annually that is associated with more losses of the financial factors and human life. In Iran, in terms of the geological, climatic and environmental features, the natural catastrophes which are corresponded with the growing population, highly considered as the most widespread concern in people's lives [1]. This country (Iran), nonetheless, is geographically situated on the actual seismic belt of the Alpine-Himalayan. An earthquake is categorized as the first rank in Iran and world among other geological damages and casualties and besides, it is classified in the second category after the flood terms of the financial losses. On the top of that, Iran has experienced the largest number of the earthquake since 1982 to 1991s. In fact, 6000 earthquakes have been registered between 600 up to 1976s [2] in Iran. The official statistics show the approximate amount of 6 percent of the casualties of the country horribly was caused by the earthquake nearly about 30 years ago [3].

In Fact, the earthquakes usually occur in Iran in a surface or depth of 32 kilometers and rarely occurred with a depth of more than 50 km in the country. Unfortunately, the earthquakes of Iran are shallow and therefore, the earthquakes of this country are the most destructive ones having the highest power of the destruction in a district [4]. The damages incurred due to these natural disasters can have the adverse effects and conditions on the various aspects of a community's life. However, these effects may

sometimes have the significant changes to the lives of these communities over years. But since human beings are not necessarily doomed by encountering these such fatal incidents , so, following the proper planning and carrying out the basic measures and using the power of their knowledge can possibly be influential for decreasing a great extent of injuries[5]. Looking at the loss of such a large earthquake in Bam, Rudbar, Manjil and Buin Zahra, we find out that it is crucially necessary to predict an earthquake and estimate the financial and life losses. Since most of the losses of an earthquake occur to the old buildings and apartments, estimating the financial and life losses can be reduced by reinforcing all buildings against the earthquake.

The considerable study case by Safayi and Tajmir Riahi (2011) is the city of Esfahan. As a result, the movement of faults again shakes your head earthquake with a magnitude that measures 7.34 on the richter scale in the region. We want to classify the loss of human life caused by the earthquake. Supposing that in the incident of an earthquake with a magnitude of 7.34 on the richter scale on the region 3 of Esfahan, contracts the class of vulnerability. For accessing this, the affair was considered the human vulnerability factors. The factors affecting the loss of human life of the earthquake including the depth of earthquake, magnitude, maximum ground vibration acceleration, speed vibration, duration of the earthquake, the intensity of the earthquake, the mechanism of the earthquake, the major building materials quake-hit area and the time of the earthquake event (day and night), the number of the injuries and death toll. For the classification of the loss of human life by the earthquake ,the data mining algorithms have been used .The input of all the algorithms is the factors affecting the loss of human life of the earthquake. The best accuracy was obtained by the self-organizing neural network algorithm .Using the classification , the urban districts are classified with the higher vulnerability .After considering the classification, the high vulnerability areas identified and the preventive measures applied to the less vulnerable area.

This paper is organized as follows. In section 2, we review the related work. In section 3,we review the listed methodology used and the implementation of the algorithms in this article .In section 4, the listed results and discussion of the methodology used in the paper and paid to discuss the results with the conclusions of others' and then, in section 5,theindicated results of this paper are revised.

2. Related Work

In the study done by Amini and his colleagues [6] in a region of Tehran, they actually studied estimating the possible damage caused through an earthquake, according to the methods based on the database utilizing the radial program, three scenarios based on three faults in north of Tehran, Mosha and Ray. The processed conclusions based on the scenario of Mosha fault, it destroyed something like 9873 buildings, 2371people were killed and according to the scenario of the fault in north Tehran, it demolished 17867 buildings and 7482 people were killed, 3998 buildings were knocked down and 347people will be killed in the future.

In another research, the vulnerability modeling of Barcelona has been processed by assessing the economic and human damages [7]. In this study, employing these such models in RISK_UE was notified to assess the damage and used the new generation of two analysis methods of the seismic risk in the urban zones. The first method VIM and second method CSBM are based on the results of this study. It was found that the city of Barcelona contract has the sufficient reliability and analysis power in the low range up

to the medium risk in terms of the vulnerability and these two methods for estimating the risks of an earthquake.

One of the things which was applied in order to reduce the damage caused by the earthquake in the city, is the urban planning to organize the damaged and ancient urban fabric.Solymaniand his workmates [8] considered many indicators for determining the position of the old places in his article. The given time of the earthquake is presented the value and vulnerability of the proposals to transform the construction, repair or reinforcing the ancient buildings and apart from that, the time also be helpful and they have slowed down the physical disadvantages during an earthquake.

Kienzle and his colleagues [9] have processed a micro earthquake in the hazardous zone in Bucharest in their studies. In this study, they used a large number of the information of the geotechnical drilling (drilling of about 1200 samples), DGM and GIS models for integrating the information to do the micro earthquake ofthe hazardous zone in Bucharest.On behalf of that, calculating the transitional functions and the linear modeling software (Pro Shake) was utilized for thereaction and dynamic of the earth. In this study, the interpolation method is used for measurring the distribution of the spectral forces and acceleration in the context of Bucharest. In fact, the interpolation is fulfilled in the case of the geological factors and moreover, the historical earthquake damage has been done by the statistical regression analysis between these two parameters (geological factors and historical earthquake) .

Hashemi and Alesheikh [10] have experimented the evaluation of the earthquake losses by using GIS-based studies in Tehran. In this article, they processed the eartquake scenario planned by placing the fault of Mosha and they likewise concerned the evaluation of human losses and blocking streets in their studies due to the building collapse. The results represent the sum of the losses and damages in which are as the following census: 64% damage to the existent buildings, 33% death toll of the total population, 27% injured statistics of the residents and finally,22% for the obstruction of the streets that will be caused because of overturning and falling the materials of the buildings for the entire streets .

Esfandiary and his colleagues[11] determined the major faults on the seismic coefficient of Ardabil within the principled and confronting direction and even the reduction of the seismic vulnerability and by placing the results of studies using the proposed method by Coburn et al ,determined the number of the personal losses caused by the earthquake and the relief in the different time zones. According to the obtained results, it was proven that the earthquake normaly happens overnight, especially without the relief and it possibly causes the most severe losses. 74,945 residents or about 55/17% of the population will be killed in the city of Ardabil during this sort of the earthquake.

Martinelli and his piers [12] represented a way in order to assess the seismic vulnerability of the residential buildings of an Italian city (Salvan). However, this way of measurring was fulfilled on a simple set of the data including the typological features and factors which were related to the seismic behavior of the entire buildings.The vulnerability assessment ofthe buildings was somehowchecked out by using the curves and RISK_UE models in a different manner of the intensity in an earthquake and they even processed the different intensities of the earthquake for estimating and modeling the probable damage caused by the possible earthquake [12].

In the methods which are provided to assess the loss of the human life and the properties in the earthquake, the researchers use the indicators that are related to a specific region and have created their model based on the same area. To implement the model of the other region of the relevant studying zone, there is going to be the need of collecting the data .In this article,the self-organizing neural network was used in order to advance and expedite the estimations of the losses that was modelled and it's based on the previous earthquakes and also considered many of the non-modelling conditions such as the human's errors by training the neural network.Since the considerable network was configured based on the all available information in Iran and for this reason, there is going to be a need of a record for entering the network for processing each single sample.However, a significant saving is going to be done about the considerable time.Therefore,we will be able to dedicate more time on the urban planning regarding the reduction of the probable risks of the seismic vulnerability.

3. Methodology

3.1 Determining effective parameters in caused losses by the earthquake citations

The clustering index of the earthquake losses includes the depth of the earthquake, magnitude, the maximum ground of the vibration acceleration, the vibration of the speed, the duration of the earthquake, the earthquake intensity, the mechanism of the earthquake, the quake-hit district of the major steel constructive materials and the time of the earthquake incident (day and night) and the number of the injured and the death toll. The factors that influence in the estimates are given in table 1.

The magnitude of an earthquake is one of the influential factors affecting the estimated losses and the injured through the earthquake. The earthquake magnitude is utilized in order to measure earthquakes and obtain a criterion for comparing and measuring earthquakes which can be calculated by taking swings of the mapping .The whole amount of the energy which is released during an earthquake of the deep focal is called the earthquake magnitude .Each earthquake has its own magnitude which is identified and distinguished from the other earthquakes. The first magnitude scale was defined for the earthquakes in south of California on the Richter scale in 1935 [13].

Table 1: Factors affecting the estimation of losses caused by earthquakes

Criteria	Descriptions	Descriptions values
Earthquake Magnitude	The amount of energy released by epicenter of an earthquake	Number
Earthquake Depth	The distance between the center of a major earthquake to the ground	Number
Intensity Earthquake	Visible effects of earthquakes in places and people	Number 1 of 12
Earthquake Mechanism	Switching between the two edge fault	1: dip-slip 2: dip-slip
Duration of Earthquake	There is a time when earthquakes happen	Number
Time of Earthquake Incident	When an earthquake occurs	0: night 1: day
Ground Vibration Acceleration	Earthquake acceleration than acceleration of gravity	Number
Speed Vibration	Than speed of earthquake ground motion speed	Number
f Major Gender o Building Materials	Major Gender of materials used in the construction of a building	1: Engineering 2: Non-Engineering
Injured	The number of injured quake	Number
Death Toll	The death toll of the earthquake	Number

The deep focal or the earthquake center is located in the place where the seismic waves are released by the rupture of the shell and the depth of the earthquakes which is between the distance of the depth of the earthquakes' focal up to the earth's surface. According to the depth, all types of earthquakes split into three categories: shallow (a depth of 0 to 70 km), medium (with the depth of 70 to 300 km.) and the deep earthquake (with the depth of more than 300 km). An earthquake having the equal magnitude, but the different depths brings the different damages. Because the deeper an earthquake focal is, the greater the Seismic waves pass through the distance to the surface of the earth over that during this time decreases and disappears the amount of energy that is released [13].

Another factor affecting in the estimates of the earthquake losses, is the intensity of earthquakes. The intensity of an earthquake is determined in a particular location according to the effects that observe the earthquake in that location .The intensity of an earthquake is shown in one place by the buildings and the surface of the land and moreover, it shows the degree of the destruction and the earthquake damage. Therefore ,the accuracy in determining the intensity of an earthquake depends on the careful observer. The various scales exist for determining the earthquake intensity such as the modified Mercalli scale [13].

The earthquake focal mechanism is known as one of the most important parameters that is associated with the seismic sources having the great importance in the study of seismology and seismicity. One of the methods used to specify the focal mechanisms of the earthquake with the seismic mapping is the modeling method based on the waveform .The different types of faults are divided into two groups base on the formation, movement and displacement mechanism among its edges: dip-slip faults, the edges of the fault that have the vertical displacement respect to another fault and are

themselves divided into two types: normal and reversed, and strike the slip faults. The switch among two edges of the fault is in the horizontal direction and is divided into two types: left-slip and right –slip [14].

Another factor that estimates the losses of the earthquake is the duration of the earthquake. The duration of the severe movement has the considerable impact on the intensity of the movement and shaking structures so that an earthquake that has the maximum of the average acceleration and longtime durability creates more damage than the earthquake with a larger acceleration but shorter duration [15].

The time of the earthquake is divided into two categories: day and night. Since the earthquake occurs at night when people are asleep or the majority of people are in their homes ,however, the losses at night are more than day.

The ground acceleration during earthquakes is another effective factor in estimating the losses from the earthquake. According to the geological and the seismic defined values, there is an accelerated basis in each region. The maximum speed and the ground movements are usually estimated based on the maximum ground acceleration. The dependent maximum ground acceleration on the distance from the earthquake center is defined as the attenuation by the researchers. By increasing the distance, the earthquake center decreases the maximum ground acceleration [15].

Another factor affecting in estimating the losses is in the major materials of the building. According to the types of the construction, buildings are divided into four categories: steel, reinforced concrete, unspecified materials and other sorts. The buildings have been assigned the grouping components of other types that placed the components including brick -steel, stone -steel, brick, wood or stone and wood, cement blocks (with any type of roof), all brick or stone, brick, wood, clay, wood, mud and eventually, other materials [16]. In this article, the first and second types of buildings are categorized as the engineering groups and the third and fourth houses are known as the non-engineering ones.

3.2 Collecting the sample data

The required data for the neural network have been collected from the statistics center, red crescent, geophysical center of Tehran, the international institute of earthquake engineering and center of seismology research, housing and urban development (Iranian earthquake strong motion network) and the national center for the environmental information.

3.3 Necessary data mining algorithms

Simply, the data mining can be used to extract knowledge from a massive amount of the data. For this reason, many people find this term synonymous for the term "knowledge discovery". The data mining includes a set of the techniques that can be found in other areas of science such as databases, statistics, machine learning, neural networks, data retrieval and pattern recognition.

Both data mining and clustering are assumed as two of the major solutions in which process its own patterns. In fact, the data mining is a supervised procedure so that a set of data is made. If either a defined structure or the mining exists in the data set, it will be recognizable. If a new input enters in data, it can transfer the new entered case to one of the sets. Mining is fulfilled by the aid of Bayes law, regressions, SVM2 algorithms, neural networks and genetic algorithms. The decision trees are normally known as one of the most popular methods of mining [17].

The type of the Decision tree used in this research is the Decision tree of the gain ratio. The gain ratio Decision tree is based on the entropy (information gain) approach, which selects the splitting attribute that minimizes the value of the entropy and Thus, it maximizes the information gain. To identify the splitting attribute of the decision tree, one must calculate the information gain for each attribute and then select the attribute that maximizes the information gain [18].

Decision tree is classified received data based on their feature values. In the beginning, decision tree is made from pre-classified data. The most important issue for selecting features which have the best samples is divided them into different classes. This process is applied recursively on each divided subset lf data. The process ends when all the data in existing subset are assigned to the same class. Decision trees' mechanism goal is not to only make a tree, but also to produce a series nested modified trees which all of them are optimized candidates. Decision tree is done the following recursively:

1) Calculating obtained information for each feature

2) Feature with the highest information is selected as a feature which the division operation will be performed on it.

3) If the selected feature is discrete, the corresponding node is derived to all possible values. If the selected feature is continuous, one cut point is selected with the highest obtained information.

4) After segmentation, it is considered that a new node is leaf or not (data are belonging to the same type), otherwise the new node will be sub trees' root.

5) All the above steps are repeated until all new nodes are leaves.

The main problem here is the decision about features which the best division is done in their corresponding class. Decision tree has various algorithms, some of them include: ID3 (is introduced in 1986 by Quilan), C4.5 (is introduced in 1993 by Quilan) and C5.0. C4.5 algorithm is developed ID3 [19].

The clustering of the objects' division is in a way that looks like a group and being distinguished with the objects of all other groups. The algorithms K-Mean and K-Medoid and SOM are the advanced algorithms in the case of clustering.

The K-Mean is the most popular partitioning method of the clustering. It was firstly proposed by MacQueen in 1967s.The K-Mean is an unsupervised, non-deterministic, numerical, iterative method of the clustering. In the K-Mean, each cluster is represented by the mean value of the objects in the cluster. Here, we partition a set of an object into the k cluster so that inter the cluster similarity which pretty is low and the intra cluster similarity is high. Thes imilarity is measured in term of the mean value of the objects in a cluster[20].

The K-Medoid is a classical partitioning technique of the clustering that clusters the data set of the objects into the k number of the clusters. This k: the number of the clusters required is to be given by user. This algorithm operates on the principle of minimizing the sum of the dissimilarities between each object and its corresponding reference point. The algorithm randomly chooses the k objects in dataset D as the initial

representative objects called medoids. A medoid can be defined as the object of a cluster whose average dissimilarity is minimal i.e for all objects in the cluster. It is a most centrally located point in the given data set. Then, for all objects in the dataset, it assigns each object to the nearest cluster depending upon the object's distance to the cluster medoid. After every assignment of a data object to the particular cluster, the new medoid is decided [21].

Bayesian classifiers are simple probabilistic classifiers which are based on statistical classifiers. In this method, the probability of a given sample that is a member of a specific class can be predicted. Bayesian classifier which is based on bayes theorem assumes that all the features are independent. According to this assumption, there is no dependency between the attribute value on a given class and the values of the other features. This hypothesis is named class conditional independence and because it makes the computation easier, it is called "naive" [22].

Support vector machine is proposed by Vapnik in 1995. In recent years Investigations shown that this method is one of the strongest and more accurate methods in machine learning algorithms that is used for classification, regression and prediction. High efficiency and appropriate generalization of SVM led to this method found great popularity among researchers. Performance of this method is that SVM first maps the input vector into a higher dimensional feature space and then obtain the optimal separating hyper-plane in the higher dimensional feature space. Moreover, a decision boundary, i.e. the separating hyper-plane, is determined by support vectors rather than the whole training samples and thus is extremely robust to outliers. It should be noted that support vectors are the training samples close to decided boundary. SVM is able to generate user-defined parameters, which is called penalty factor. It allows users to make a tradeoff between the number of misclassified samples and the width of a decision boundary. SVM is able to minimize the structural risks of statistical learning theory. Therefore it shows the ability of good learning and skills of generalization of two features in intrusion detection that indicate a high dimensional datasets or altered to the top understanding [23].

3.4 Design and training network

The self-organizing networks apply the competitive learning for the training map and basically, it has been developed according to some of the specific characteristics of a human brain. The cells were organized in the different areas of a human brain that are presented in the various sensory areas with the possible regular and significant computational maps. For example , the input of tactile - hearing sensory and other cases are related by a meaningful geometric sequence to the different areas [24].

A self-organizing network is usually shown by the symbol (SOM) or sometimes (SOFM) the processing units placed in a network node having forms of the one-dimensional, two-dimensional or others. The whole units in a competitive learning process are either regular or relative for the input patterns. The place of the adjusted units is ordered in a way that a meaningful coordinating system should be installed on the input features of the network. Therefore, a self-organizing map actually forms a topographical map containing the input patterns in which the location of the units is corresponded with the intrinsic properties of the input patterns [24].

The type of the competitive learning employed in these networks is that the units compete with each other in every step of learning in order to enable each other and in the end, a stage competition will win only one unit where the weights are relative and

the weights of other units will be changed into a different form. This type of learning is called the unsupervised learning [24].

The algorithm of the self-organizing map is a relation of the returnable non-variable regression which correlates a set of vectors such as m∈ R^ninto the space vectors $x \in R^n$ to the map through the following steps. At each one of the training steps, an x sample vector is randomly chosen from the set of the input data. The distances between x and all the prototype vectors are computed. The best matching unit (BMU), which is denoted here by equation "(1)", is the unit of the map with the closest prototype to x [25].

$$\|x - m_b\| = \min_i\{\|x - m_i\|\} \quad (1)$$

Next, the prototype vectors are updated. The BMU and its topological neighbors are moved closer to the input vector into the input space. The update rule for the prototype vector of unit (i) is denoted here by equation "(2)" [25].

$$m_i(t+1) = m_i(t) + \alpha(t)h_{bi}(t)[x(t) - m_i(t)] \quad (2)$$

Unit t represents the time that the network self-organizing map is trained as a process of going back, $\alpha(t)$ is the song of the learning and training that is an indicator of the adaptation and it is uniformly decreased with the regression process (time) and $h_{bi}(t)$ is a neighboring kernel which is a decreasing function of the distance between the models i-th and b-th on the grid map and it focuses on the winning unit. The neighboring function is considered as the following equation "(3)" [26].

$$h_{bi}(t) = exp\left(-\frac{\|r_i - r_b\|^2}{2\sigma^2(t)}\right) \quad (3)$$

In fact,r_b and r_i are the equal positions of the neurons b and i on the SOM grid. Both $\alpha(t)$ and $\sigma^2(t)$ are monotonically reduced by passing time. There is also a batch version of the algorithm where the adaptation coefficient is not used. In the case of a discrete data set and fixed neighboring kernel, the error function of SOM can be shown like equation "(4)" [26]:

$$E = \sum_{i=1}^{N}\sum_{j=1}^{C} h_{bi}\left\|x_i - m_j\right\|^2 \quad (4)$$

N is the number of the training samples and m is the number of the map units. Neighboring kernel h_{bi} is centered at the unit b, which is the BMU of vector x_i, and evaluated for the unit j.

At every step of the training in this algorithm, all the training vectors are randomly applied into the network and weight coefficients and bias are updated after the presentation of each vector. The self-organizing map network has been taught using the random learning algorithms for clustering the input data set. The education is stopped as soon as one of the criteria in the maximum number of the training courses will achieve the least error or maximum amount of time. Then, the network is determined of the winner neurons and the weights of the winning and neighboring neurons get closer in each other in the learning step up to the input vector. The weight of the winner neurons r and the neighboring neurons are changed due to the learning songs. The learning songs which are away from the neighboring ones are updated in the form of two stages' order and arrangement [27].

3.5 The use of data mining algorithm

The first step in the data mining is the data preparation for the data mining operation. This paper used the Rapid Miner software for the preparation data. Finally, the weighted case between 0 and 1 was assigned to each feature .Following attribute weighting application, each attribute gained a value between 0 and 1 indicating the importance of it. All variables with the weights equal to or higher than 0.5, selected and saved as the new dataset; consequently, 10 new datasets were created. These newly formed datasets were named according to their applied attribute weighting models (Information gain, Information gain ratio, Rule, Deviation, Chi squared, Gini index, Uncertainty, Relief, SVM(Support Vector Machine) and PCA(Primary Component Analysis)). The effective weighting criteria to estimate the losses caused by the earthquake are shown in the table 2.

Table 2:Effective weighting criteria to estimate the losses caused by the earthquake

Criteria	weight
Earthquake Magnitude	7
Earthquake Intensity	7
Ground Vibration Acceleration	6
Duration of the Earthquake	3
Earthquake Depth	2

The best performance in the K-Means algorithm is for the data set Uncertainty with amount of 57% and the worst performance is for the data sets Information gain ratio and PCA with amount of 30.7%. The best performance in the K-Medoids algorithm is for the data set Uncertainty with amount of 58.8% and the worst performance is for the data sets Rule, Deviation and PCA with amount of 31.6% by using the clustering features , the K-Means algorithm and K-Medoids algorithm are shown in the table 3.

Table 3: By using clustering features K-Means algorithm and K-Medoids algorithm

Row	Data set	K-Means	K-Medoids
1	Chi squared	0.561	0.544
2	Deviation	0.325	0.316
3	Gini Index	0.351	0.447
4	Information Gain	0.368	0.482
5	Information Gain Ratio	0.307	0.325
6	PCA	0.307	0.316
7	Relief	0.351	0.351
8	Rule	0.325	0.316
9	SVM	0.561	0.632
10	Uncertainty	0.570	0.588

The best performance is for the data sets of the Chi squared cases and SVM with amount of 37.3% and the worst performance is for the data set Information gain ratio with amount of 14.9% in the Perception algorithm. The best performance is for the data set Chi squared with amount of 65.6% and the worst performance is for the data set rule with amount of 23.7% in the Neural Network algorithm. The best performance in Auto MLP algorithm is for the data sets SVM with amount of 64.8% and the worst performance is for the data set Rule and PCA with amount of 31.6%.The implementation of the Neural Networks with 3 cases including the algorithm Perceptron, Neural Network and Auto MLP are shown in table 4.

Table 4: Implementation Neural Networks with 3 algorithm perceptrons,neural network and AutoMLP

Row	Data Set	Auto MLP	Neural Network	Perceptron
1	Uncertainty	0.552	0.579	0.333
2	SVM	0.648	0.639	0.373
3	Rule	0.420	0.430	0.176
4	Relief	0.316	0.237	0.298
5	PCA	0.316	0.352	0.324
6	Information Gain Ratio	0.490	0.517	0.149
7	Information Gain	0.553	0.570	0.297
8	Gini Index	0.542	0.560	0.297
9	Deviation	0.334	0.327	0.324
10	Chi squared	0.639	0.656	0.373

The best performance in the Naive Bayes algorithm is for the data sets Chi squared and SVM with amount of 58.8% and the worst performance is for the data sets Deviation and PCA with amount of 29%. The best performance in the Bayes Kernel algorithm is for the data sets Chi squared and SVM with amount of 60.5% and the worst performance is for the data sets Deviation and PCA with amount of 31.9%. The implementation of the Naive Bayes algorithm and Bayes Kernel algorithm are shown in table 5.

Table 5: Implementation naive bayes algorithm and bayes kernel algorithm

Row	Data set	Naive Bayes	Bayes Kernel
1	Rule	0.6528	0.3742
2	Uncertainty	0.5863	0.5969
3	Relief	0.5340	0.5340
4	Information Gain Ratio	0.5348	0.5368
5	Information Gain	0.5613	0.5598
6	Gini Index	0.5613	0.5598
7	Chi squared	0.5878	0.6053
8	Deviation	0.2901	0.3189
9	PCA	0.2901	0.3189
10	SVM	0.5878	0.6053

The best performance in the 160 Decision tree (16 models in 10 data set) is for the data sets Gini index and the information gain with amount of 64.9% and the worst performance is for the data sets Deviation and PCA with amount of 27.2%.The best performance in the Decision tree is shown in figure 1.

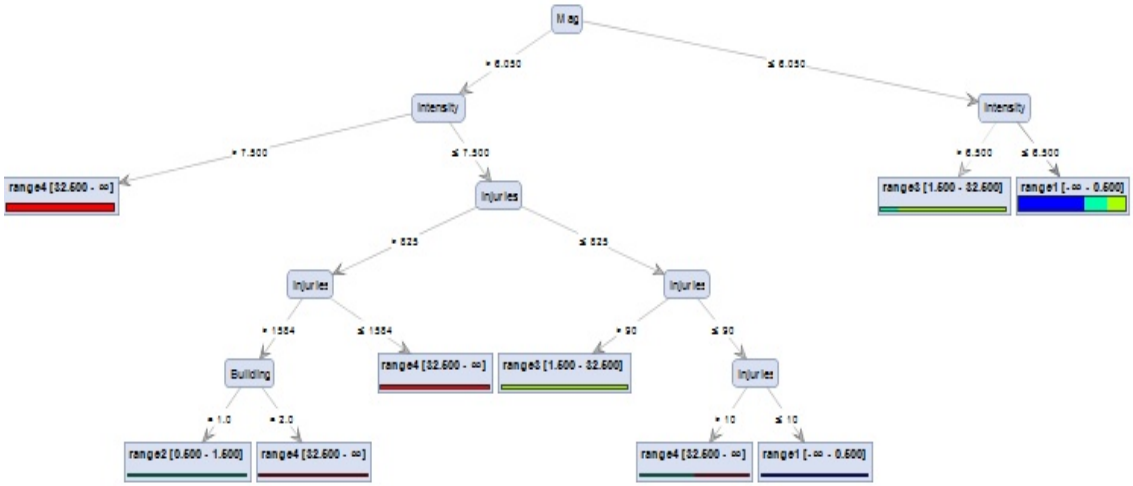

Figure 1. The best performance in Decision Tree

Mag > 6.050

| Intensity > 7.500: range4 [32.500 - ∞] {range1 [-∞ - 0.500]=0, range2 [0.500 - 1.500]=0, range3 [1.500 - 32.500]=0, range4 [32.500 - ∞]=27}

| Intensity ≤ 7.500

| | Injuries > 825

| | | Injuries > 1584

| | | | Building = 1.0: range2 [0.500 - 1.500] {range1 [-∞ - 0.500]=0, range2 [0.500 - 1.500]=3, range3 [1.500 - 32.500]=0, range4 [32.500 - ∞]=0}

| | | | Building = 2.0: range4 [32.500 - ∞] {range1 [-∞ - 0.500]=0, range2 [0.500 - 1.500]=0, range3 [1.500 - 32.500]=0, range4 [32.500 - ∞]=3}

| | | Injuries ≤ 1584: range4 [32.500 - ∞] {range1 [-∞ - 0.500]=0, range2 [0.500 - 1.500]=0, range3 [1.500 - 32.500]=0, range4 [32.500 - ∞]=5}

| | Injuries ≤ 825

| | | Injuries > 90: range3 [1.500 - 32.500] {range1 [-∞ - 0.500]=0, range2 [0.500 - 1.500]=0, range3 [1.500 - 32.500]=5, range4 [32.500 - ∞]=0}

| | Injuries ≤ 90

| | | Injuries > 10: range4 [32.500 - ∞] {range1 [-∞ - 0.500]=0, range2 [0.500 - 1.500]=1, range3 [1.500 - 32.500]=0, range4 [32.500 - ∞]=1}

| | | Injuries ≤ 10: range1 [-∞ - 0.500] {range1 [-∞ - 0.500]=2, range2 [0.500 - 1.500]=0, range3 [1.500 - 32.500]=0, range4 [32.500 - ∞]=0}

Mag ≤ 6.050

| Intensity > 6.500: range3 [1.500 - 32.500] {range1 [-∞ - 0.500]=0, range2 [0.500 - 1.500]=1, range3 [1.500 - 32.500]=6, range4 [32.500 - ∞]=0}

| Intensity ≤ 6.500: range1 [-∞ - 0.500] {range1 [-∞ - 0.500]=37, range2 [0.500 - 1.500]=13, range3 [1.500 - 32.500]=10, range4 [32.500 - ∞]=0}

3.6 The use of neural network

Regarding to the parameters that were listed in the 3-1 section, the neural network includes 11 input neurons. The neurons of the input layer are the earthquake depth, magnitude, maximum ground vibration acceleration, speed vibration, duration of the earthquake, intensity earthquake, mechanism earthquake, major building materials quake-hit area and the time of the earthquake event (day and night), the number of injured and death toll. The self-organizing competitive neural network output comprises 4 neurons which are selected based on the size of the layer. Each of the output neurons represents a class. The output classes include the small sizes of the vulnerability, medium vulnerability, high vulnerability and very high vulnerability. As a good result, a desired size is considered 2 cases in this article. According to this size of the layer, the layer output has 4 neurons (2*2). In figure 2, a schematic of the self-organizing competitive neural network was created for you to observe in this article. Accuracy of the self-organizing neural network is 73%.

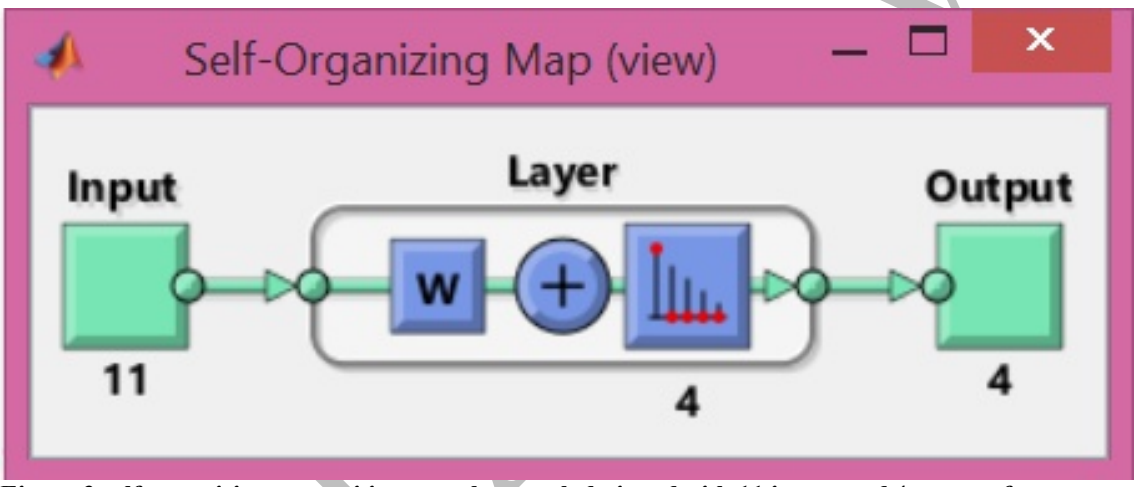

Figure 2.self-organizing competitive neural network designed with 11 inputs and 4 outputs for neurons

The data set includes 110 records. The data used in the self-organizing competitive neural network was built using MATLAB software which should be used for inverted ones. In table number 6, you can see the records used in this article. To use record, the changings of the data should be applied on them and variable that the character values are converted into the numbers such as the variables of table 1 that are converted into numbers.

Table 6. Record of the earthquake in Iran

Injuries	Deaths	Populatio n	Building	Time	time Energy	AC C	Intensit y	Mechanism	Ma g	Dept h	Long	Lat	Date
	15000	36000	Non engineering	Day	8.55	303	10	right turn	7.4	34	57.44	33.37	1978/9/16
60000	35000	150000	Non engineering	Day	7.66	487	9	Compressiv e	7.4	19	49.41	36.96	1990/6/20
50000	25000	100000	Non engineering	Night	9.68	623	9		6.9	7	58.33	29.04	2003/12/26
3000	600	30000	Non engineering	Night	19.88	232	8	Right-lateral slip	6.5	10	56.77	30.8	2005/2/22
4500	327	300000	Non engineering	Day	5.88	520	8	Levorotatory strike-slip	6.5	9	46.8	38.39	2012/8/11
14	6	300000		Night	4.59	69	7	Right-lateral slip	5.1	11.3	59.95	28.46	2012/9/2
269	0	114071	Engineering	Night	7.88	93	6	Drive With subsidiary components Strike slip	5.3	6	55.70	26.76	2009/7/22
1000	1500	5000	Non engineering	Night	9.46	268	8	right turn	7	11	57.77	29.99	1981/7/28
400	35	268000		Day	13.64	160	5	Reverse	6.4	16	51.61	36.28	2004/5/28

Figure 3, shows the design of an SOM layer. The neurons are seen in the blue (gray) colors the anddirect communication of the neighbors are also marked with the red lines.The more neighboring neurons' distance goes far away, the darker color is made among them. The black color shows a farthest distance between the neighboring neurons.The black olorchas been formed between the class with a low vulnerability and the class with a very high amount of the vulnerability.

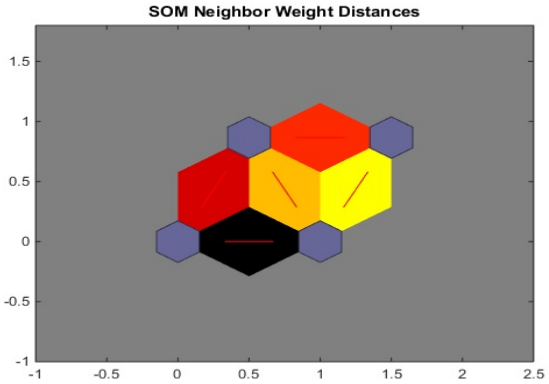

Figure 3 . The distance between adjacent neurons .

Figure 4, shows the design of an SOM layer. The relative number for each neuron input vector is displayed through the colored pieces or the numbers written on it. In fact, it indicates that the output neurons have been successful in attracting some examples and that's why a number is assigned to each neuron.

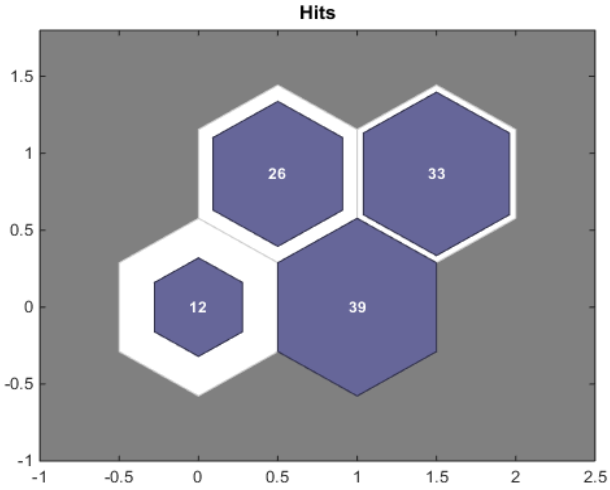

Figure 4 . The proportion absorbed by the neurons of the output samples

4. Results and Discussion

Selecting a neural network using the training algorithm and the proper structure can provide the useful tools in the various fields of the prediction. The result is predicted strong enough to cover an entire collection. The advantage of the artificial neural network system with the high speed and unlimited capability is in the modeling parameters that are compared to other methods (manual analysis, regression analysis, etc.). It should be noted that providing a neural network model requires a lot of data

which may take a long time to collect data, but whatever the number of data is more applied for training. The network's ability is increased for generalizing the results and the simulation [28]. In table 7, you can see the accuracy of the data mining algorithms.

Table 7.Results from data mining algorithms

Data mining algorithms	Data set	Worst performance	Data set	Best performance
Decision tree	Deviation and PCA	27.2%	Gini index and Information gain	0.64.9%
Bayes Kernel	Deviation and PCA	31.9%	Chi squared and SVM	60.5%
Naive Bayes	Deviation and PCA	29%	Chi squared and SVM	58.8%
Perceptron	Information gain ratio	14.9%	Chi squared and SVM	37.3%
Neural network	Rule	23.7%	Chi squared	65.6%
Auto MLP	Rule and PCA	31.6%	SVM	64.8%
K-Means	Information gain ratio and PCA	30.7%	Uncertainty	57%
K-Medoids	Rule, Deviation and PCA	31.6%	Uncertainty	58.8%
SOM	PCA			73%

The criteria oftheearthquake magnitude, intensity earthquake, ground vibration acceleration, duration of the earthquake and the earthquake depth had most impact on among other factors .The SOM had the best performance with a value of 73% among other algorithms .After considering the classification, the areas with the high vulnerability were identified and the preventive measures applied to the less vulnerable area.

The parameters are considered as the effective factors to estimate the human casualties that incorporate the earthquake depth, magnitude, maximum ground vibration acceleration, speed vibration, duration of the earthquake, the intensity of the earthquake, earthquake mechanism, major materials in a building, the quake-hit district, the time of the earthquake event (day and night), the number of the injured and death toll. The output of the self-organizing neural network competition contains 4 neurons which the output is divided into 4 classes. The output classes include the small, medium, high and very high amount of the vulnerabilities. In this study, the data collected from the previous earthquakes in Iran are 110 samples. After entering these such records into the network and training it, the considerable sample for each class is described according to following: the first class of 12 samples, the second class of39 samples, the third class sample of 26 and the fourth class of 33 samples. When the earthquake occurs on the zone3 of Esfahan with the seismic specifications of the earthquake magnitude of the 7.34 on the Richter scale, acceleration of the 352.5 gal and the density of 109968

population , the designed network classifies Esfahan province in the third class (high vulnerability).

In the event of an earthquake in the zone 3 of Esfahan, the seismic specification, earthquake magnitude 7.34 measuring on the richter scale, acceleration of 352.5 gal and the population density of 109 968 is located as the third class (high vulnerability).

For example, these occurred earthquakes are located in the various classes like the earthquake of Varamin city on august 25th, 2007 with a small vulnerability class, the Masjed Soleyman's earthquake on december 14th,1978 having the medium vulnerability class, the earthquake occurred at Qaen on january 16th, 1979 with a high vulnerable class and the one happened in Dasht Bayaz on august 31th,1968 at very high vulnerability class.

Jamal Amini and his workmates investigated a research on the Region 1 of Tehran. In the event of an earthquake with the seismic specifications, earthquake magnitude of 7.1 on the Richter scale, the population density of 339 334 and the intensity of the earthquake of9, the estimated death toll of 2371 people and the number of the injured equal to 28542 people that it tests the self-organizing neural network competition designed in this article for placing a member of the fourth class (very high vulnerability).

5. Conclusion

Because of the geographical position of Iran on the Alpine-Himalayan belt, Iran has experienced 130 earthquakes with the magnitude estimated5.7 on the Richter scale or more in the past centuries. In this article ,Predicting the losses of an earthquake and the self-organizing neural network is used. The output of the self-organizing neural network competition contains 4 neurons, which the output is divided into 4 classes. The output classes include the small percent of the vulnerability, medium, high and very high vulnerabilities. Since the configured network is based on the information of Iran, there is only going to need a record for processing each sample in order to enter to the network so that a significant time saving will be fulfilled over time and therefore, we can certainly spend more time on the urban planning for decreasing the risks of the seismic vulnerabilities. In an earthquake incident in the zone 3 of Esfahan with the earthquake magnitude measuring 7.34 on the Richter scale, acceleration of 352.5 gal and the population density of 109 968 people is located as the third class (high vulnerability).

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