Use of artificial neural network for medical risk assessment analysis

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Abstract: For new medical products and new drugs, unanticipated side effects that rise after consuming the new product is a dominant factor in decision making. In this project, an artificial neural network (NN) engine is designed and developed by the authors to the aim of a medical risk assessment. Firstly, an appropriate NN system is designed and trained. We mostly concerned with the procedure of how the developed NN construction and training. The designed NN for this case has three layers of neuron. These three layers include an input layer, a hidden layer and finally an output layer, with 25 neurons in the hidden layer. The results from NN models can match the data used for training.

[Hafshejani M K, Sattari Naeini M, Mohammadsharifi A, Langari A. **Use of Artificial Neural Network for Medical Risk Assessment Analysis.** *Life Sci J* 2012;9(4):923-925] (ISSN:1097-8135). http://www.lifesciencesite.com. 143

Keywords: Medical risk assessment, Neural network (NN)

1. Introduction

Medical and health risk assessment is one of the powerful used screening tools in the field of health promotion and is often the first step in multi-component health promotion programs. Moreover, Risk/benefit assessment plays an important role in market of new drugs, medical devices etc. (Al-Awa *et al.*, 2012; Maghrabi, 2012). Risk assessment I a crucial stage in medical risk management. For new products, unanticipated side effects that rise after consuming the new product is a dominant factor. In addition, FDAs focused on ensuring the appropriate use of products in medical practice. Some reports have focused on the human/economic costs of medication errors, as well as serious adverse events that have occurred even when a medical product has been used appropriately (Report to the FDA commissioner, 1999). Risks have different source, hence effective management of each is different (See figure (1)).

In this work we are going to use Neural Network (NN) for medical risk assessment. NN is a system based on the human brain (www.makhfi.com). It is inherently multiprocessor-friendly architecture and without much modification, it goes beyond one or even two processors of the von Neumann architecture. It has ability to account for any functional dependency. No need to postulate a model, to amend it, etc. Neural networks are a powerful technique to solve many real world problems. They typically consist of many simple processing units, which are wired together in a complex communication network (www.nr.no; Zernikow *et al.* 1998). There is no central CPU following a logical sequence of rules - indeed there is no set of rules or program (www.makhfi.com; Shahbaz *et al.,* 2012; Yang *et al.*, 2012). This structure then is close to the physical workings of the brain and leads to a new type of computer that is rather good at a range of complex tasks.

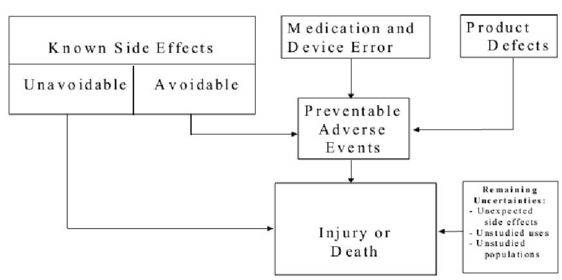

Figure 1. sources of risk from medical products (Report to the FDA commissioner, 1999).

Regardless of the prevention techniques employed, possible threats that could arise the health need to be assessed. Although the exact nature of potential disease or disasters is difficult to determine, it is beneficial to perform a comprehensive medical risk assessment of all threats that can realistically occur to the public health. Quantitative risk assessment employs two fundamental elements; the probability of an event occurring and the likely loss should it occur. Quantitative risk analysis makes use of a single figure produced from these elements (www.nr.no; Zernikow *et al.* 1998).. This is called the 'Annual Loss Expectancy (ALE)' or the

'Estimated Annual Cost (EAC)'. This is calculated for an event by simply multiplying the potential loss by the probability (Balabin & Lomakina, 2009). In this paper, based on an available database, medical risk assessment performed on a typical fault tree. A NN system is designed and trained. This paper is mostly concerned with the procedure of NN construction and training.

2. Fault tree

For this work, in this section a simple fault tree could be considered as has been shown in figure 2. This is a typical fault tree to be applied for designing an artificial Neural Network.

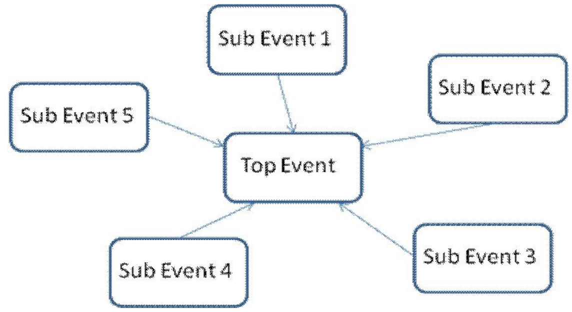

Figure 2. Typical fault tree

3. Available Data Base

Table 1 includes a part of the available data base, performed from our project on risk assessment.

Table 1. Some sets of the fuzzy data base (32768 points)

Frequency of set1	Frequency of set2	Frequency of set 3	Frequency of set 4	Frequency of set 5	Overall frequency
1.25	1.25	1.25	1.25	1.25	1.375
1.25	1.25	1.25	1.25	1.75	1.425
1.25	1.25	1.25	1.25	2.25	1.575
1.25	1.25	1.25	1.75	2.25	1.625
1.25	1.25	1.25	2.75	4.75	2.275
1.25	1.75	1.25	3.25	3.75	2.275
1.25	1.75	3.25	2.75	4.75	2.725
2.25	2.75	3.25	1.75	4.75	2.925
3.25	4.75	1.25	2.75	4.75	3.325
4.75	4.75	4.75	4.75	4.75	4.62

Table 2. Sample of the normalized training data base (32768 points)

Set 1	Set 2	Set 3	Set 4	Set 5	Overall frequency
0.0625	0.0625	0.0625	0.0625	0.0625	0.09375
0.0625	0.0625	0.0625	0.0625	0.1875	0.10625
0.0625	0.0625	0.0625	0.0625	0.3125	0.14375
0.0625	0.0625	0.0625	0.1875	0.3125	0.15625
0.0625	0.0625	0.0625	0.4375	0.9375	0.31875
0.0625	0.1875	0.0625	0.5625	0.6875	0.31875
0.0625	0.1875	0.5625	0.4375	0.9375	0.43125
0.3125	0.4375	0.5625	0.1875	0.9375	0.48125
0.5625	0.9375	0.0625	0.4375	0.9375	0.58125
0.9375	0.9375	0.9375	0.9375	0.9375	0.905

4. Data Normalization

We normalize the data points to be within a specific range. Therefore, the data points are normalized to the range of [0,1] interval. Please note that, the raw data points could be used as they are all in the range of 1 to 5.

5. The Neural Network Constructed

This topology of the constructed neural network is shown in figure 3. The hidden layer includes 25 neurons.

6. The ANN Training Performance

The Levenberg-Marquardt algorithm, as a powerful off-line batch training method for neural networks, is used for training. The learning rate is 0.005. It's run to epoch 300. The final fitness is 0.000187721 (MSE). The performance of training the assumed neural network is shown in figure 4. The Levenberg-Marquardt algorithm is used for this aim and the learning rate is 0.005.

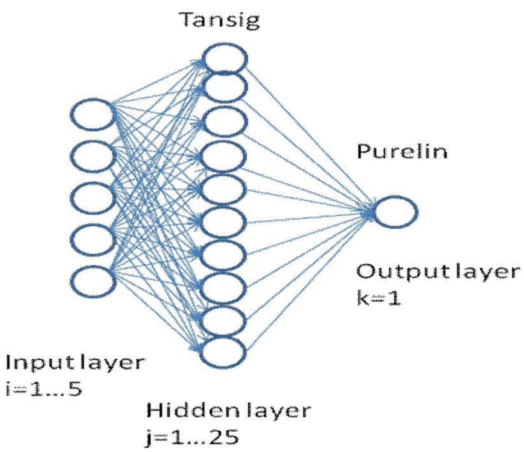

Figure 3. Applied neural network

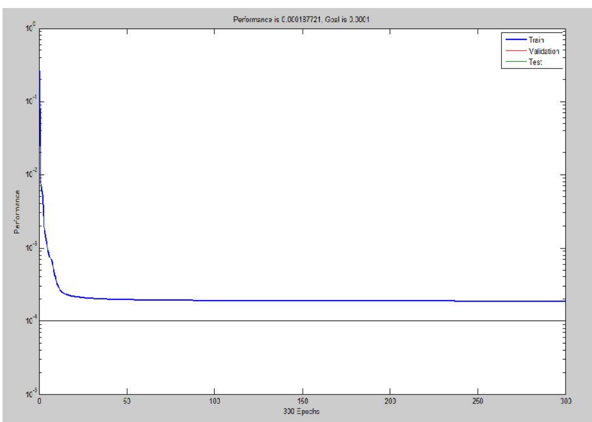

Figure 4. Training performance

7. Conclusions

Medical and health risk assessment is one of the most widely used screening tools in the field of health promotion and is often the first step in multi-component health promotion programs. Moreover, Risk/benefit assessment plays an important role in market of new drugs, medical devices etc.. In this paper, an artificial neural network engine is designed and trained to be applied for a systematic medical risk assessment. The designed neural network for this case has three layers of neuron, input layer, hidden layer and output layer, with 25 neurons in the hidden layer. The results from artificial neural network models can match the data used for training. The Levenberg-Marquardt algorithm is used for this aim and the learning rate is 0.005.

Acknowledgement

The authors of the paper would appreciate to thank all the people contribute in this project.

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9/15/2012