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Design and Development of a Triage System in Predicting Patient Disposition using Artificial Neural Networks

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Abstract: ***Medical Decision is based on acknowledging complex patterns of the patient's signs and symptoms. Neural Networks have proven effective in this type of pattern recognition. In this study, a neural network is used to foretell which of the patients seen in an emergency room need to be admitted, transferred to a specialty care or discharged. A multilayer feedforward network model maps input datasets to a corresponding output. The complexity of multilayer feedforward can be altered by changing the number of layers and the number of nodes in each layer. It has been shown that the multilayered neural network can estimate virtually any function to any desired accuracy with the given hidden nodes and enough data. "Feedforward" describes how the neural network processes the pattern and remembers the patterns. Backpropagation describes how this type of neural network is trained. The algorithms "backpropagation" and "feedforward" have been used together here to compare the accuracy of patient disposition in triage. The current study in vestigates the performance of the back propagation algorithm to train Feed Forward Neural Network to produce better results in the area of patient triage disposition.***

Keywords: Multi Layered Feedforward, Back Propagation, triage, Neural Networks, machine learning, CDSS

1. Introduction

The triage service is a crucial part of the emergency room (ED) in all hospitals, only as a way to better distribute the resources of the hospitals [1]. Triage is a decision making process of categorizing patients to appropriate care level that best meets the patient' s medical needs. The decision process must take into consideration the seriousness of the patient's medical complaint. Once the emergency department realized the benefits of applying information technology to the triage process, the aim was to use the effective algorithms or methods to better sort the patients based on their acuity of illness [2].

In recent years, machine learning methods have been widely used in prediction, especially in medical decision making. A neural network is an interconnected set of simple processing elements whose functionality is loosely based on the neuron. The processing capacity of the network is stored in the connection points between units or weights obtained by a process of adaptation, or learning a set of training patterns [3]. A Feedforward neural network is a massively parallel distributed processor that has a natural propensity for storing experimental knowledge and making it available for use. The network acquires knowledge through learning techniques and interconnection strengths such as synaptic weights used to store knowledge. Backpropagation training algorithm for the feedforward neural network is a common neural network training algorithm [4]. It works by analyzing the error of the output of the neural network. Each neuron in the contribution of output layer, according to the weight, the error is determined. These weights are adjusted to minimize the error.

2. Medical Decision Making

Medical decision making is based on acknowledging complex patterns of the patient's signs and symptoms. Neural Networks have proven effective in this type of pattern recognition. Medical decision support systems or Clinical Decision Support Systems (CDSS) are interactive systems designed to help physicians and other healthcare professionals with decision making tasks, such as determining diagnosis. The most important quality criterion for any CDSS is the accuracy of inferences. Besides accuracy other important features include robustness when some knowledge is missing, redundant or inconsistent and support adaptability - new knowledge is added to the knowledge base. Other noticeable features include the speed to return the decision (triage level – disposition of the patient), The specificity to assign a low triage level to true non-urgent cases, which translates into cost reduction, the ability to integrate knowledge from different systems [5]. The academic research projects have found neural networks as a methodology with good predictive performance for the purpose of making reliable triage decision.

3. Background to the Problem

Triage or sorting, means prioritization of patients based on the urgency and severity of their situation. Proper performance of the application of triage ensures a reasonable likelihood of a minor illness. The main purpose of triage is not only helping the patient to dispose in a right care location, but also help in minimizing the delay in order to provide suitable service to patients. Though diagnosis helps to disposition the patient into appropriate care location, but it is not main aim of Triage. Most current systems to help triage in EDs built by experts have shown little accuracy, if they ever validated. There is still a large gap between the systems

that are in use currently and the proposed system in this research. The purpose of the current research is to close the gap and develop a reliable system for triage disposition [6].

4. Design Approach

The computer assisted program will be designed to provide each emergency service patient with brief medical evaluation, decision regarding priority of need for care and assignment to the appropriate service within or outside of the hospital. All incoming patients with chest pain will be briefly evaluated at triage station, although seriously ill or incapacitated patients will be taken directly to the appropriate treatment area. The triage officer will be available to initiate emergency measures and to maintain reasonably orderly flow of patients [7]. Alternative decisions available to triage officers include assignment for immediate emergency treatment in the indicated specialty service, transfer to other hospital services, referral for private medical care, appointment to a specific outpatient clinic, direct discharge etc. Emergency service records of all patients registered during certain period are analyzed with respect to the nature of disposition of patients following emergency care.

Artificial neural networks methods are applied to evaluate the triage decision support system using decision making principles that closely emulate the decision making process of a triage nurse. In this research, patients in the ED are disposed into one of the three possible disposition levels. 1. Admit 2. Refer and 3. Discharge.

Data gathering and Preprocessing: Triage data has been collected from the public dataset. Some of the important knowledge variables that play a vital role in the scoring of classification and contribute to the accuracy of triage disposition are Chief Complaint, ED Acuity Assessment, ED responsiveness assessment, Systolic, Diastolic Blood Pressure, Respiratory Rate, Temperature Reading, ED Disposition, ED Disposition Diagnosis. For data preprocessing, identified most significant pieces of information for training set, look for information redundancy etc.,

Scoring the Data: Statistical tool SPSS has been used to score the information to input to the neural networks.

Considering the goals of the triage that include not missing a patient that is in need of urgent medical care, even if the physician was successful in predicting the ED Admit disposition, the sensitivity and specificity of the triage method will be measured to see if the results are favorable to the triage system. Neural Network is constructed and trained using backpropagation algorithm. Feedforward-back propagation is perfect match for these kinds of studies.

5. System Implementation

Statistical tool SPSS has been used to score the data to input to the neural networks. The process of applying a predictive model to a set of data like ED Acuity assessment, ED responsiveness assessment, systolic blood pressure, diastolic blood pressure, ED respiratory rate, ED temperature reading and ED diagnosis information referred to as scoring the data. Scoring is treated as transformation of the data. The score is taken 1-10 scale and assign the value to pain score and 1-7 scale and assign the value to Chest Pain Category. The model is expressed internally as a set of numeric transformations to be applied to a given set of fields (variables) – the predictors specified in the model in order to obtain a predicted result.

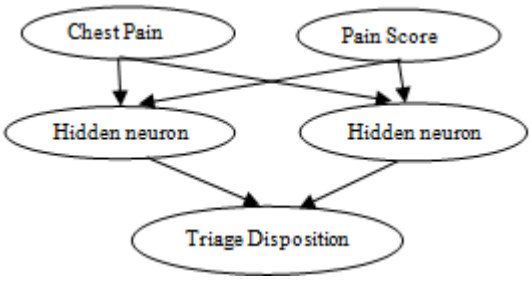

Figure 1: Neural Network for triage disposition

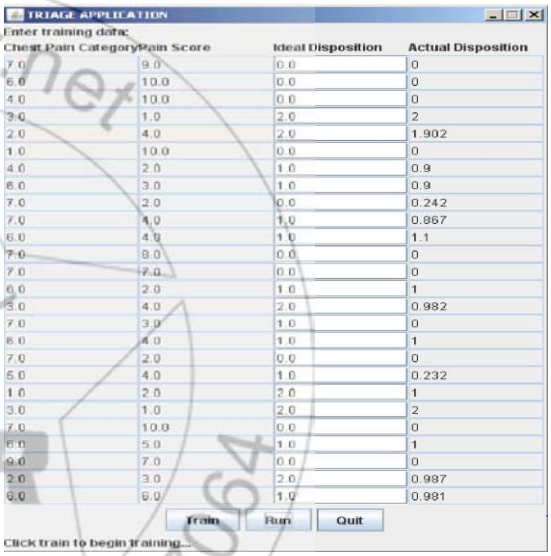

Figure 2: Triage Client UI

The above figure is UI for triage client. The user interface is used to check the results of the program against the ideal outputs to see how correct the triage disposition is. When the user clicks on Train button, the network will be trained with inputs Chest Pain Category on the scale of 1 – 7 and pain score on the scale of 1 – 10. Clicking more than once on the train button will create the treads those many number of times and start training the network simultaneously. This multithreading concept will be helpful to improve the performance of the neural network. Once the neural network is trained, the actual outputs will be displayed under the actual disposition section of the above screen. These results can be compared against the ideal disposition values to see the accuracy of the triage disposition. After improving the performance of the network by training several times, the results are displayed in the triage UI.

The success rate was about 80% in the current study of the triage disposition. When CP_Category is 7 and the pain score is 8, then the disposition is Admit, which is same as ideal output. When CP_Category is 6 and the pain score is 5, then the disposition is Transfer. When CP_Category is 3 and pain

score is 4, then the disposition is Transfer instead of Discharge, which is little far from ideal output.

6. Conclusion and Summary

Study results have shown that we were able to achieve higher accuracy in disposition of the patient into right care location. These results were compared against the testing dataset to see the accuracy of the triage system. The results drawn are quite matching with the ideal outputs and were able to achieve the accuracy up to 80%. By constantly training the network with the most recent data will give even better results and the study will be continued further to achieve the higher level of accuracy in the area of triage disposition.

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