A Neural-Network Based System on the World Wide Web for Prognosis and Indication of Surgery in Head and Brain Trauma

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Background . Artificial neural networks (ANN) have been used with success to implement medical decision making systems in many areas (Sabbatini, 1992), particularly in those applications where pattern recognition is required. A typical application involves dozens of input variables, which are associated in a linear or non-linear way to predict one or few output variables, using as the knowledge base several hundreds or thousands of examples ('cases') taken from the real world. This is the case of the application reported here, which had the aim of developing an useful and reliable model for making simple prognosis of patients with head/brain trauma, using ANNs, as well as for providing the indication for need of surgery. In order to experiment with a vehicle for making available the final decision-support tool to users in an Intranet or in the Internet, we have also developed an interactive hypertext system in HTML and Perl.

System. A subset of 159 retrospective cases of head trauma recorded in the Neurosurgical Division of the University Hospital of the Faculty of Medicine in Uberaba, Brazil, was selected from the original DBF database with 45 recorded variables at the time of admission, including diagnosis, CT evaluation, intracranial pressure evaluation, degree of coma in the Glasgow scale, etc., as well as the outcome of each case (death, partial or full recovery, etc.), in a 7-point scale, and whether the patient was submitted to neurosurgery or not. Two sets of three-layer feedforward perceptrons ANNs were constructed, using the backpropagation algorithm. The first set of ANNs had the aim of providing a single output, predicting the prognosis of a case; while the second set had the aim of providing the indication for surgery. After extensive experimentation, the two best configurations network configuration were selected. The prognosis network had 27 input nodes and 10 hidden nodes, and the surgical indication network had 39 input nodes and 10 hidden nodes. The case database was randomly divided into 80 cases for the training dataset and 79 cases for the test dataset. A complete performance analysis using ROC curves was performed. The prognosis network achieved an accuracy rate of 95 %, sensitivity of 84.6 % and specificity of 97 %; and the surgical indication network achieved 88.7, 81.8 and 93.6 % respectively.

The final networks were implemented in Perl script, using the backpropagation algorithm and the set of weights derived from training. A set of HTML pages with an extensive hypertext-based tutorial on head/brain trauma was developed, a set of 10 typical trauma cases with text and images as well as an interactive questionnaire for on-line decision support in prognosis and surgery indication. They were tested and validated in an Intranet environment, using the WWW paradigm and will be implemented in the Internet, too.

Evaluation and Conclusions Both ANNs developed for decision support in head trauma had excellent accuracy, sensitivity and specificity rates, well above the clinically acceptable threshold, in a complex and multivariable situation. Thirty additional cases from the same department were also tested with the best networks and similar results were obtained. The implementation in the form of a hypermedia tutorial using the WWW paradigm will increase their availability and potential for practical usage in a clinical, routine setting using an Intranet, and will permit the exploration of this technology in the context of public Internet. We intend to use the system for the education of neurosurgery residents in the University hospital.

Reference

Sabbatini, R.M.E. - Applications of connectionist systems in Biomedicine. In: Lun, K.C.; Degoulet, P. & Piemme, T. (Eds.) - *Proceed. 7th World Congress on Medical Informatics (MEDINFO 92)*. p. 418-425, 1992.