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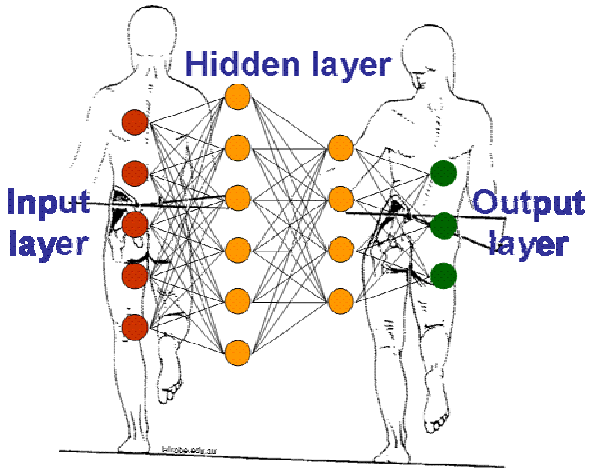
Application of an artificial neural network (ANN) for the prediction of a rehabilitation progress after a hip arthroplasty basing on the Trendelenburg sign

Over the past years, the application of cognitive algorithms in the field of biomechanics has increased. An example is the use of artificial neural networks (ANN) in the study of human locomotion, motor control and motor behaviour. This relatively new way of studying biomechanics using adaptive methods prompted several studies analysing the benefits and the application of machine learning to be published. Schöllhorn [1] and Uthmann & Dauscher [2] give a current overview of the application of neural networks in clinical biomechanics and the latter analysing motor control and behaviour in multiagent systems by means of neural networks.

The Trendelenburg gait is an abornormality in the gait patterns (see figure below) resulting from the weakness of abductor muscles of the lower limb, gluteus medius and glutes minimus. The Trendelenburg sign is positive if the patient stands on one leg and the pelvis drops on the side opposite to the stance leg. Therefore the patient cannot maintain balance leading to instability.



The purpose of this study is to develop a model for diagnosing the rehabilitation performance for patients having the Trendelenburg gait. Artificial neurl networks are used to develop a means of accessing the rehabilitation success of the patients. ANN have been proven to be more effective than conventional statistics in the decision making of certain gait analysis Holzreitner and Kohle [3].

There are 16 patients having Trendelenburg gait present for this study and for each person, four sets measurements are taken from a series of test that the patients had to undergo. Thus 64 sets of data are obtained from the patients and each set with a corresponding evaluation from the doctor pertains to the rehabilitations rate. The physician's diagnosis ranged from 0 to 3, with 3 being the worst grade and 0 being the best one.

Matlab Neural Network Toolbox is used to design a model that enables the study of the relationship between the measured data and the physician's diagnosis. The purpose of this study is to determine if a neural network is able to accurately predict the rehabilitation performance of patients suffering from the Trendelenburg gait.

A feedforward backpropagation network shows the most promising results for modelling a relationship between the measured data and the physician's diagnosis. Out of the 64 data sets, 2 sets of data were discarded because of some irregularities in measurement. 52 data sets are used as training sets and the balance 10 sets of data are set aside for the testing phase. The input vector for the neural network is a matrix having 52 columns and 3 rows containing parameters from biomechanical gait analysis. The output is a scalar.

A neural network model with 2 hidden layers is able to predict in very short time (ms) the rehabilitation performance of the Trendelenburg gait patients with a high accuracy of approx. **90%**. It was also possible to achieve **100%** accuracy in some cases. The neural network model consists of 20 neurons in its first hidden layer and 10 neurons in its second hidden layer.

Different networks trained with adapt function have an optimum number of training cycles. Too few cycles result in low accuracy because the network do not have sufficient training to fully learn the

exactly relationship between the input data and the target outputs. On the other hand, too many cycles cause overtraining. Therefore a balance has to be found where sufficient training, without overtraining, is carried out where the network is flexible enough to accurately model and predict outputs. In this particular network, the optimum number of cycles is 4000. Additionally the influence of the number of hidden neurons/layers on the training process and the number of cycles is studied.

References

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