Can a computer be taught to recognise osteo-arthritis?

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Artificial Neural Networks (ANNs) are computer programs which model the structure of neural pathways within the brain (Ahmed, 2005). ANNs consist of a series of units (nodes) which represent neurons. By allowing the firing potential and strength of connection between these neurons to change, then the system can be "taught" to recognise patterns in data. A typical example is shown in Figure 1.

The ANN analysis was carried out using MemBrain, a freeware neural network editor and simulator. Two, three layer neural networks were designed to present the data in differing input formats. The ideal number of hidden nodes was calculated using the geometric pyramid rule (Kaastra and Boyd 1995).

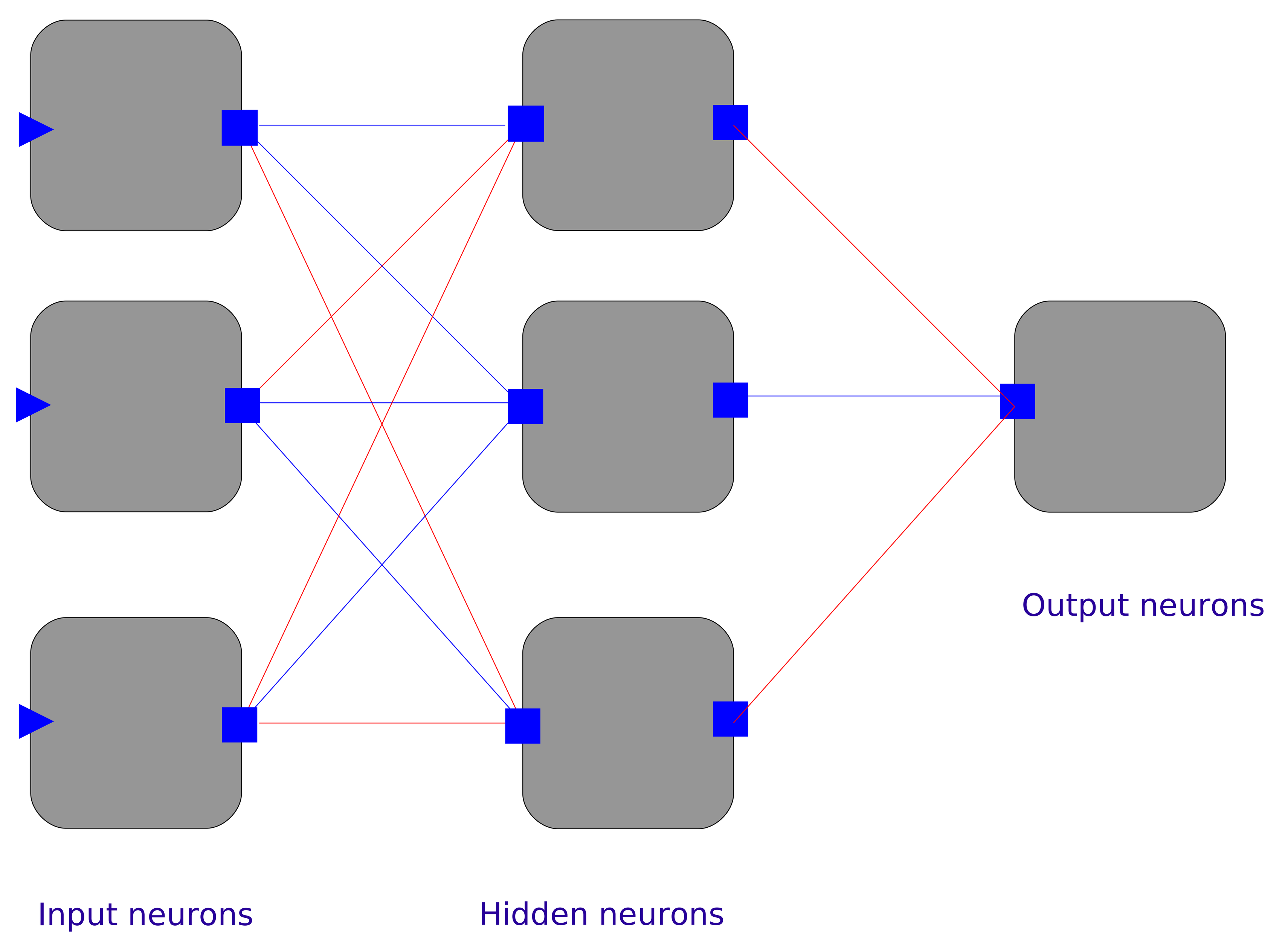

Figure 1 Typical structure of a neural network. Red connections represent those which are "firing," blue, those that are not

The data used to test this network were taken from cases of osteo-arthritis (OA) selected from The University of Glasgow's Weipers Centr for Equine Welfare radiographic database. Nine veterinary experts in the field of equine orthopaedics were presented with four radiographic projections, of tarsal joints from three horses (12 radiographs in total). On two occasions, at a minimum of six weeks apart, the experts were asked to rate the severity of seven features which were considered significantly associated with OA on a scale from 0-100. The joints were then scored to define the severity of OA in that joint (mild, moderate or severe).

Data set	No. data sets	Number correct	Percent correct
Training 1	567	550	99
		552	99
		549	97
		556	98
Test 1	81	77	95
		78	96
		77	95
		78	96
Training 2	135	135	100
		135	100
		135	100
		135	100
Test 2	27	27	100
		26	96
		27	100
		27	100

Table 1 Efficacy of an ANN in determining the degree of OA in a distal limb joint in the horse. Data set 1 consists of each of four views analysed separately, a total of 648 radiographic examinations. Data set 2 represents the analysis with all four views analysed together, a total of 162 radiographic examinations. The number correct represents the number of examinations that the ANN predicted the correct severity of OA.

Two analyses were carried out. In the first each radiographic view was treated independently. In the second all four views were considered together. In both cases, the data were split randomly into a training set and a test set. These analyses were repeated four times, using different training and test sets each time. The results are given in Table 1

In all cases the ANN could correctly identify the majority of radiographs, both within the training sets, and in the test sets. The percentage correct improved when all four views were considered together. A suitably trained ANN could be a useful clinical tool to aid diagnosis of OA.

References
Ahmed, F. E., 2005. Artificial neural networks for diagnosis and survival prediction in colon cancer. Molecular Cancer. 4:29-41.
Kaastra, I., and Boyd M., 1995. Designing a neural network for forecasting financial and economic time series. Neurocomputing. 10:215-236.

Acknowledgements
Membrain is available for free download from: http://www.membrain-nn.de
This research was funded as part of the DEFRA-funded VTRI project 0101