Medical image segmentation using hopfield neural networks case study example

Technology, Internet

Application of Neural Networks in Medicine

Artificial Neural Networks are extremely parallel, distributed processing systems that using new computational technology founded on the analogy of human information processing system. Artificial neural networks exhibit the propensity to save previous knowledge and after learning it make it available for use for future computations. Artificial Neural Networks have been defined as extraordinarily connected network of simple processing elements known as neurons. ANN has been applied in a number of fields including pattern recognition, classification, function approximation and testing (G. Schaefer).

Predicting drug-target interactions using restricted Boltzmann machines

In silico prediction of drug target interaction is an important study in the identification and use of existing and new drugs. Network-based approaches have not been successful in drug-target interaction because they only predict binary interactions between drugs and targets.

Boltmann machine is used to predict unknown drug target relationships or drug mode of actions. According to research by a two-layer undirected graphical model known as restricted Boltmann machine (RBM) is used to represent a multidimensional DTI network, which decides different types of networks. Using a practical learning algorithm called Contrastive Divergence to train the RBM model, predictions of the different unknown DTIs were determined. The algorithm was tested on two public databases which contain drug data about drug-target interaction and drug modes of action. The test implied that the RBM model can be used as a highly powerful for interacting different types of DTIs into a multidimensional network that can predict different type of interactions to a high level of accuracy. The results of

integrating different types of DTIs into distinctive predictions imply that a high level of accuracy of up to 89. 6 areas under precision recall curve (AUPR) is attained. This outperform other prediction mechanism utilized so far either on a mixed multiple types of interactions or using only a single interaction type.

Artificial neural networks have found its use in medical image segmentation where segmentation of tissues and structures from medical images is conducted as the first stage in image analysis for medical diagnosis. Multi-Layer perceptron, Radial Basis Function, Hopfield, Cellular, and Pulse-Coupled neural networks are al used for image segmentation and are categorically represented as feed-forward (associative) and feedback (auto-associative).

Hopfield neural networks comprises of pool of neutrons connected to each other with a weight in the network. All neurons act as input and output where output is represented by a binary value (0, 1 or -1, 1). The primary application of HNN is associative memory where the pattern is able to determine and save a given pattern by determining proper sets of weights. In image segmentation, HNN has N x M neurons with pixels as rows and classes as columns. HNN is used as a map between image pixel and the corresponding labels. The winner takes all neuron is used to calculate the input-output function of the k-th pixel and is given as

Where neuron dynamics is given by

and Rkl is the symmetric distance measured.

Pulse-coupled Neural networks are developed in reference to a cat’s visual

cortex. Recently, they are used in a variety of image processing applications such as segmentation, feature and face extraction, noise reduction and motion detection. PCNN comprise of a pool of resources where each neuron correspond to a pixel in the image receiving its local information and the stimuli from its adjacent neuron.

A PCNN neuron comprise of three sections dentritic tree, modulation, and pulse generator. Feeding inputs receives a stimulus from other neurons and external sources while linking gets them from other neuron outputs.

PCNN is proven to work well in magnetic resonance images of the brain and abdomen as well as contrast enhancement.

Image segmentation using feed-forward Neural Networks

Kohenen introduced self organized map as a feed-forward neural network for medical image segmentation. The method produced high dimensional space in to a low dimensional space. SOM is made up of 2D array of nodes where each node is associated with a weight vector wi of equal dimension and a position in the map space. A training process factors the neighbouring nodes of the best matching unit and updates their subsequent weight factor using the formulae:

Where alpha of t is monotonically reducing learning coefficient and hci (t) is the neighbourhood function. SOM is used to segment mammogram images using multi-scale analysis and SOM.

Sleep classification in infants using decision tree based neural networks

Backpropagation neural networks are used to classify sleep in infants. Sleep stages is an important component of diagnosing some serious diseases associated with typical sleep disorders. Physiological signals such as electroencephalogram, electrooculogram, electromyogram and other indicators such as blood pressure, body movement, heart rate and body movement are analyzed using automatic scoring system which uses MLP, and Learning Vector Quantization LVQ. However, in using TBNN, faster and more accurate resulst are obtained. The performance of decision trees makes it possible to start backpropagation training from a point that is already close to good solution or acceptable local minimum. TBNN is found to be superior and better than MLP and LVQ.

Mean parameter aspects of NID3 module TBNN

Results are useful in the study of diseases such as Sudden Death Infant SyndromeNon-morphological distinction between glomerular and tubular renal diseasesMedical Decision Aids that use rule-based reasoning to solve clinical problems is difficult to develop because they do not use complex interactive information sufficiently. Neural Networks have stepped in to provide reliable relationships between input and output variables. An application of neural network is nephrological decision making where Kohonen topological map is used differentiate between glomerular and tubular diseases based on laboratory results. The system has been tested and used in the Department of Internal Medicine, Renal Division, University Hospital Gent, Belgium (Wim Van Biesen). Using a Kohonen topological map

with square two dimensional architecture, a rule-based system with eight dimensional networks was developed. Nephrologists supply conditional rules based on known knowledge to distinguish between two types of diseases. The system classifies the patient according to its morphological and medical data presented. The results indicate higher accuracy for classification of the two renal diseases than rule-based and nephrologist’s analysis. Kohonen topological map classifies data of nephrological patients into those with tubular and glomerular. Kohonen maps have also been used to classify brain tumour, diagnostic of cardiac arrhythmias and data reduction for transmission of radiological images (Wim Van Biesen).

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