A Neural Adaptive Algorithm for Feature Selection and Classification of Hyperspectral Data

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Recent applications of Pattern Recognition and in particular of Image Analysis and Classification deal with high dimensionality data. In this context, the use of automated classification procedures is still limited by the lack of robust methods able to cope with the intrinsic complexity of high dimensionality and the consequent Hughes phenomenon, implying that the required number of labelled training samples for supervised classification increases as a function of dimensionality. The problem can be addressed in two complementary ways: identify a classification model less sensitive to the Hughes phenomenon and/or reduce the dimensionality of data and redundancies by applying feature selection strategies. Neural networks seems to be very good candidates for simultaneous feature selection and classification. In view of these considerations, I designed an experimental study to investigate the robustness of a non conventional classification model when dealing with high dimensionality data.

In particular this work presents a supervised adaptive classification model built on the top of Multi-Layer Perceptron, able to integrate in a unified framework feature selection and classification stages.

The feature selection task is inserted within the training process and the evaluation of feature saliency is accomplished directly by the back-propagation learning algorithm that adaptively modifies special bell functions in shape and position in order to minimize training error. This mechanism of feature selection avoids trial and error procedures which imply several training stages.

The model includes a method to determine whether a hidden unit should be removed or maintained. This pruning mechanism is fundamental for training speed up and in many cases leads to a hidden layer with only the minimum number of neurons i.e., two. An important aspect of this method is that it avoids to retrain the network after removal of a neuron and relative synapses, because the neuron was excluded by the learning procedure.

The adaptive model is conceived as a composition of full connected neural networks, each of them devoted to selecting the best set of feature for discriminating one class from the others.

Performances were evaluated within a Remote Sensing study aimed to classify MIVIS hyperspectral data. Inside the classification problem, a comparison analysis was conducted with Support Vector Machine and conventional statistical and neural techniques. The adaptive neural classifier performed a selection of the most relevant features and showed a robust behaviour operating under minimal training and noisy situations.

Moreover, experimental results on standard datasets confirm that this feature selection strategy achieves a competitive behaviour with respect to the other methods considered.