1º WORKSHOP NACIONAL EM REDES NEURONAIS E 1ª ESCOLA DE REDES NEURONAIS

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Infraestrutura Básica Disponível (Hardware/Software)

- 2 IBM 4381
- 4 IBM RISC 6000
- 2 PS2 mod 95
- NEURALWORKS
- NEXTOOL

Cooperações Técnico-Científicas Existentes (Nacionais e Internacionais):

Instituto Nacional de Pesquisas Espaciais

USING NEURAL NETWORKS FOR THE INTERPRETATION OF IMAGES FROM THE AMAZONIA

IBM Rio Scientific Center

The Amazon region is one of the major components of the planet's environment. Covering several million square kilometers, the region has the world's largest rain forest and river system, and therefore plays a very important role in many global processes. Recent decades have witnessed a dramatic increase in human activity in the region, as deforestation, dam and road building, mining and agriculture, with potential effects on environmental stability.

Although of great relevance in the context of several global issues, the understanding of the extent to which human activity in the Amazon region can be harmful is rather superficial, particularly because of the lack of reliable information. The use of satellite imagery for nearly a decade has improved the situation somewhat, but the process of extracting significant information from the remotely-sensed images is still rudimentary, representing a serious bottleneck, as it has to be repeated yearly for incremental monitoring.

The research project we briefly describe here is part of a larger project undertaken by INPE (Brazil's National Institute for Space Research) and IBM Rio Scientific Center on the Brazilian Amazonia. The project will be conducted along three major lines of research, namely Information Extraction from Remotely-Sensed Data, Design of Large Geo-Coded Data Bases, and Modeling of Physical Processes. The information-extraction subproject will itself be carried along two fronts, one for image classification on a pixel-by-pixel basis employing traditional statistics-based techniques, and another for image classification and interpretation using relatively unorthodox techniques. We provide in the remainder an outline of this second front.

Our approach to image classification deals with segmented images, as opposed to pixel-based approaches. In a first phase of the project, the goal is to build classifiers that can sort each segment into one of five categories, namely nonforest, forest, deforested area, water, and cloud. We plan, as a short-term milestone, to have a classifier using a feed-forward neural network trained by the back-propagation algorithm, and another using a feed-forward network consisting of fuzzy neurons. The use of these simple classifiers will then yield measures that can be employed in determining the total fraction of deforested area, as well as its progress from year to year.

The sequel to this first phase of the project will deal with the topic of image interpretation, which seeks not only to classify the various segments into categories, but also to utilize the knowledge of photo-interpreters as a basis for further extracting a segment's characteristics. For example, a deforested segment can be the result of various types of human activity, as farming, urban settlements, etc. Similarly, deforested areas to sometimes give rise to vegatation that will eventually evolve into a forest area, and this can be detected at an early stage. It is expected that, in this second phase of the project, hybrid approaches incorporating advanced Artificial Intelligence techniques will play a major role.

NEXTOOL - NEURAL EXpert Tool
IBM Rio Scientific Center

NEXTOOL is an environment for developing expert systems capable of self adjusting and improving their knowledge with the experience absorbed when solving classification problems. To achieve this ability and to make expert systems less brittle and less dependent on knowledge acquisition we adopted the approaches of neural networks and genetic algorithms. The main modules of the NEXTOOL architecture are:

- Connectionist Knowledge Base,
- Learning Machine,
- Knowledge Acquisition module,
- Inference Machine,
- Interfaces for End-user and for the Knowledge Engineer,
- Cases Data Base.

The main differences of NEXTOOL architecture in relation to the architecture of classical expert systems are:

- The Knowledge Base is replaced by a semantic and a neural network called the Connectionist Knowledge Base.

- The Working Memory no longer exists, since the input evidences and conclusions are represented by the activations of the neurons in the network.

- The Inference Machine becomes a program that simulates the functioning of a parallel neural network in a serial computer. It is able to compute the possibility degree of each hypothesis, accepting those ones surpassing an acceptance threshold. It is also able to determine the optimal question to be asked next to the user, and to provide explanations.

- The Learning Machine is actually the major innovation. It is able to refine incrementally the current knowledge stored in the neural network, or alternatively to learn from scratch when no knowledge is available. Two learning schemes work in consonance: a Punishment and Reward Mechanism for adjusting synaptic weights, and a Genetic Algorithm to search for the best network topology.

The combination of the Combinatorial Neural Model and genetic algorithms allows the system to inherit the following desirable properties from both the fields of neural networks and expert systems:

- expert knowledge representation,
- calculus of consensus among different experts,
- knowledge base intelligibility,
- maintenance of separate problem domain views corresponding to different experts,
- learning by examples,
- incremental learning,
- feature selection,
- fuzzy logic inference,
- treatment of vague, uncertain and incomplete input information,
- cost conscious inquiry,
- reasoning explanation.