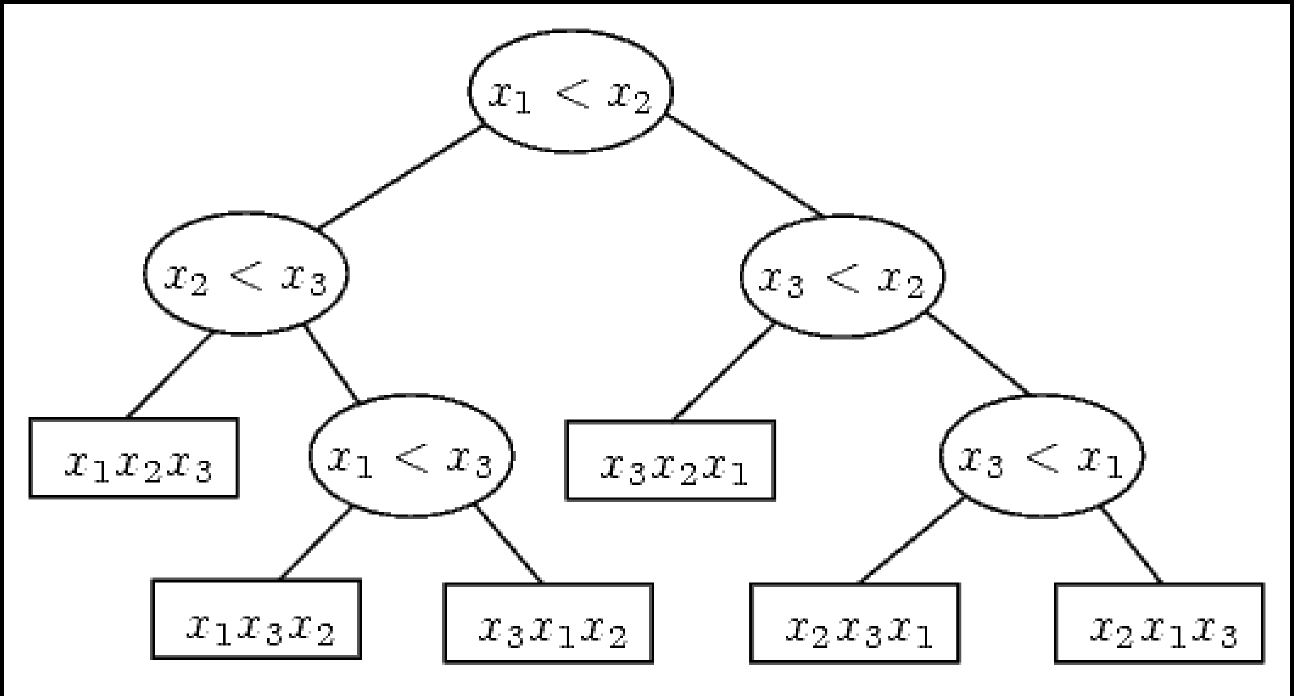
Remote Sensing

Image classification

Machine learning

Decision trees

- Decision tree learning is a common method used in data mining. The goal is to create a model that predicts the value of a target variable based on several input variables.
- The tree is composed of the root (origin), internodes (connection between the root, other internodes and leaves) and leaves (classes).
- Tree generation:
  - Attribute choice for data splitting
  - Creation of sub-tree
  - Creation of leave (if there are no more attributes for data splitting)
- Prunning – “cutting” of some leaves/internodes:
  - Post prunning (mostly used, after the whole tree has been generated)
  - Pre prunning (the generation of a tree is stopped before the end of the process)

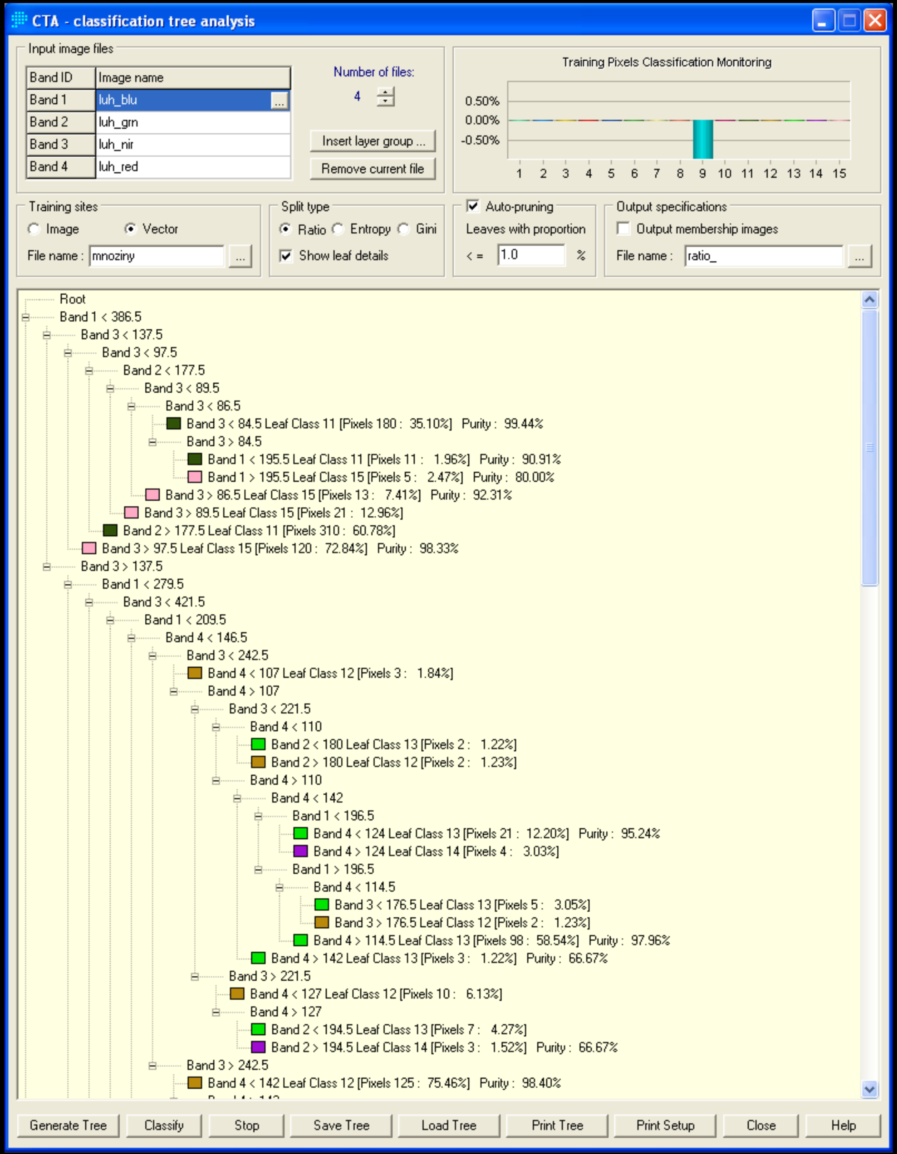


Source: http://ksp.mff.cuni.cz/tasks/18/k181.png

Example of a simple decision tree

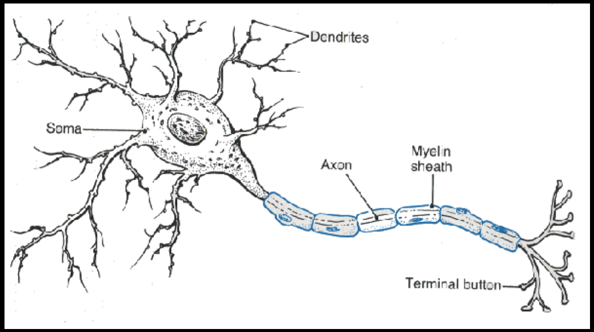
Idrisi Taiga: Classification Tree Analysis (CTA)

- CTA is a non-parametric univariate technique for classifying remotely sensed data. Using training site data, CTA successively splits the data to form homogenous subsets resulting in a hierarchical tree of decision rules.
- Three algorithms: Entropy, Gain Ratio, Gini
- Supervised classification (need of training fields)



Artificial Neural Networks (ANN)

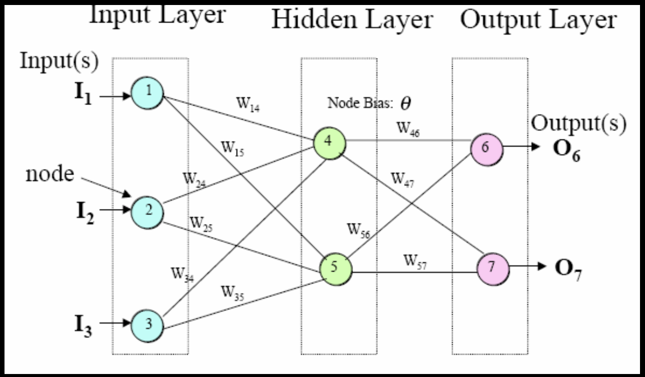
- ANN are inspired by brain of living being
- The basic component of an ANN is a neuron – specialized cell for transfer, processing and storing of information



- 1943 – the first mathematical model of neuron (McCulloch a Pitts)
- ANN are not copies of brain, they only imitate his functions
- A neuron (or node) gets impulse from various neighboring neurons, the energy is summarized until it passes a threshold, then the energy moves on

Network dynamics

- Organizational – changes in topology,
  - feed-forward / recurrent



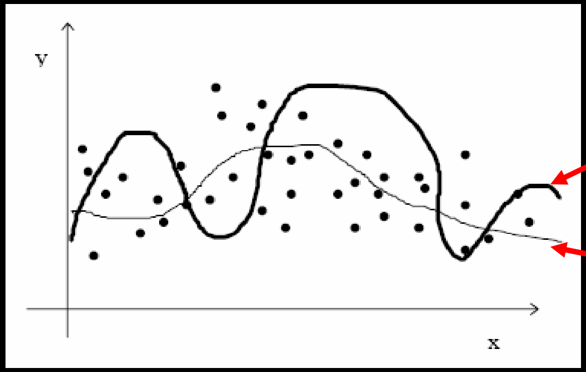
- Active – changes in estate (activation functions)
- Adaptive – change of configuration (weights)
  - Supervised learning
  - Unsupervised learning

ANN classification

1. Training of the network (learning)
2. Classification

- Every training gives different results due to randomly placed weights in the beginning of the training
- Overfitting (overtraining)

The goal of ANN is to create a system that generalizes well in unseen examples. If the network represents too well the training data, there is no (or poor) generalization and the network is overfitted.



Overfitted network

Good generalization

Some types of ANN (Idrisi)

- Multi-Layer Perceptron (Idrisi: MLP)
  - Input layer, may have hidden layer(s), output layer
  - Back-propagation, sigmoid function, supervised classification
  - Soft and hard results of classification

- Kohonen's Self-Organizing Map (Idrisi: SOM)
  - Input layer, output layer
  - The most important ANN for unsupervised classification, may be used as supervised classification as well

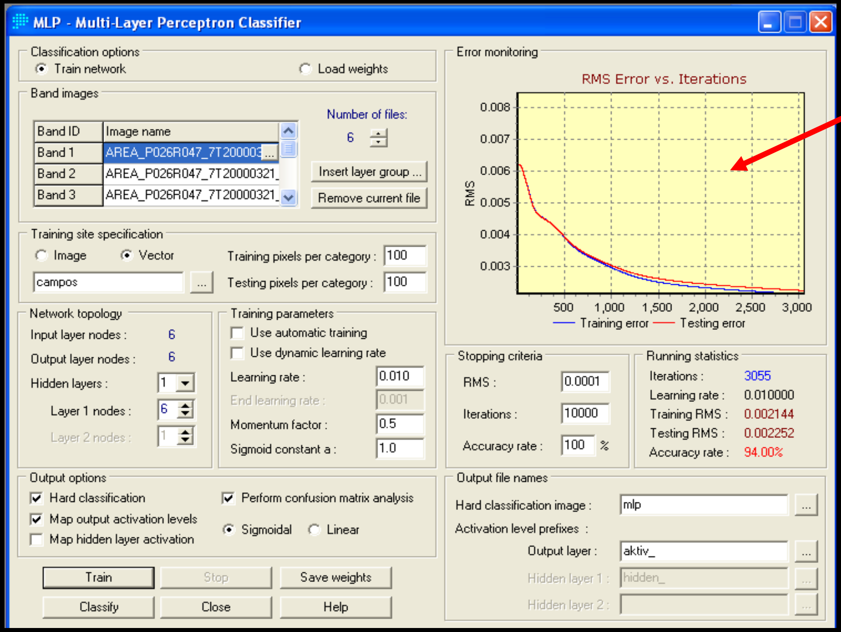
- Associative ANN (Idrisi: Fuzzy ARTMAP)
  - Input layer, output layer
  - Nodes are connected with each other
  - Supervised or unsupervised classification

Setting of module MLP

- Training and Testing pixels per category – on basis of training fields
- Training parametres:
  - *Learning rate* (LR)
    - Controls size of adjustment of synaptic weights
    - $0<\alpha<1$
    - Near to 0: conservative adjustment
    - Near to 1: radical adjustment
    - Too small – overloading of the NN and time consume,
    - Too high – fluctuation
    - Setting by method trial and error, recommended value: 0,01 – 0,2
  - *Momentum factor* (MF)
    - Size of weight resistance to changes
    - increase stability of learning and decrease needful amount of time
    - recommended value: 0,5 – 0,6
    - It is not a factor so crucial as LR
  - *Sigmoid constant*
    - value: > 1 and usually smaller than 10
    - Defines shape of sigmoid curve and gradient of activation function

- Stopping criteria:
  - *RMS*
    - Acceptable error ratio
    - Root Mean Square (RMS) Error
  - *Iterations*
    - Number of iterations, when the training (learning) stops
    - Too many iterations may cause overfitting of the network
  - *Accuracy rate*
    - On the basis of training pixels for learning and testing
  - tlačítko “*Stop*”
- Output options:
  - *Hard classification*
    - A map of categories
  - *Map output activation levels*
    - Equivalent to soft classification, maps of probabilities for each class
  - *Perform matrix confusion analysis*
    - Error matrix

Interpretation of MLP



Red and blue lines should be in close alignment.
Both lines should slope down in time.

If not: the networ is overfitted

References

- Baatz, M. et all. 2004: eCognition User Guide 4, Definiens Imaging, München, Germany
- Dobrovolný, P. 1998: Dálkový průzkum Země, digitální zpracování obrazu, Masarykova Univerzita, Brno
- Eastman, J.R. 2006: Idrisi ANDES Guide to GIS and Image Processing, Clark Labs, Worcester, MA
- Lillesand, T.M. a Kiefer, R.W. 2000: Remote Sensing and Image Interpretation, John Wiley and Sons, Inc., New York
- Volná, E. 2002: Neuronové sítě 1, Ostravská Univerzita, Přírodovědecká fakulta