Neural Network Toolkit

A POWERFUL CLASSIFICATION SOFTWARE PRODUCT
BASED ON NEURAL NETWORK TECHNOLOGY
TO EFFICIENTLY CLASSIFY OBJECTS OF INTEREST

The Aphelion™ Neural Network Toolkit (NNTK) enhances Aphelion™ Dev with an optional tool to automatically classify objects of interest, based on a supervised classification assigning objects to categories or classes. NNTK frees the user from the necessity of specifying complex rules for object recognition and classification that are required by probability and information based classifiers.

The NNTK includes tools to:

- Load ObjectSets in a classification project
- Define object classes
- Select measurements to compute on all loaded ObjectSets
- Select attributes to use during the training process
- Compute classifier parameters automatically
- Apply the neural network classifier to any Aphelion ObjectSet, whatever its origin
- Perform a manual classification
- Run the classifier in Aphelion Dev

NNTK works with Classifier Builder, a front-end for classification application that is included with the Dev product. With Classifier Builder, the user can easily and seamlessly perform a manual classification to assign objects of interest to known classes. This is especially useful for creating a training database. By default, Classifier Builder includes a Fuzzy Logic classifier to quickly perform a classification of objects based on a Fuzzy Logic classification method.

The NNTK software was developed in partnership with the University of Caen (Normandy, France). It is based on MONNA, a software product, originally conceived by Dr. Olivier Lezoray, PhD, University of Caen[1].

Training Database Generation

The first step to be performed before specifying the classifier is to build a training database. This is done by selecting an ObjectSet and manually assigning its objects to object classes. Classifier Builder provides tools to define object classes, to load ObjectSets, to display associated objects, and to manually assign objects to a class.

The list of defined classes is saved as an XML file in an Aphelion Project. The Classifier Builder takes as input one or more Aphelion ObjectSets, and adds a new attribute that will contain an object's class.

Classifier Settings

The second step of the classification process is to specify the NNTK classifier settings (i.e., define user parameters including settings used during the classification process).

This step includes the computation of the object attributes selected by the user from the list of measurements available in Aphelion Dev. These include shape attributes (area, perimeter, Feret diameters, etc.), texture attributes (Haralick parameters, etc.), and statistical attributes (pixel mean, minimum, maximum, etc.). The list of selected attributes is saved in the user's Aphelion Project.
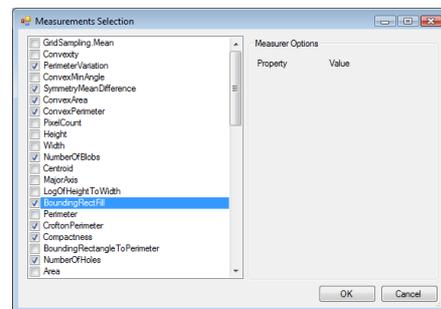
The class attribute and all computed attributes are added to the loaded ObjectSets. The ObjectSets can be saved and later imported into Aphelion Dev for further analysis.

By default, the Aphelion NNTK proposes a classifier comprised of a set of single-layer neural network classifiers according to the MONNA[1] architecture. Combining multiple single-layer networks gives
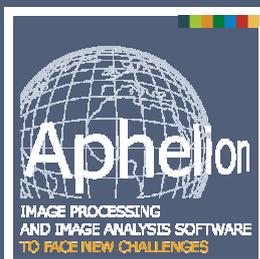
Main benefits of Neural Network ToolKit:

- Easy to use graphical interface designed specifically for classification applications
- Powerful tools for advanced image understanding using Aphelion Dev ObjectSets
- Optimized classification based on the MONNA architecture
- Capable of high-level classification for a broad range of applications

better results than just using one single-layer network.

A wizard is available to enable the user to quickly select the attributes used in the classification process and to define the number of neurons used to discriminate between two classes.

The number of parameters used to define the classifier was intentionally reduced to simplify the definition process. However, the NNTK software also enables developers to use as many layers and networks as needed, and to define advanced parameters when working outside Classifier Builder.

The third step trains the classifier by computing a weight for each neuron. These weights will minimize the errors resulting from the NNTK classifier's assignment of classes to the training database objects. The output data generated by the NNTK classifier during the training step can be displayed in a text window or as a chart. The user can check the convergence of the classifying process by reviewing the output data.

Picture 001 - Key = 9
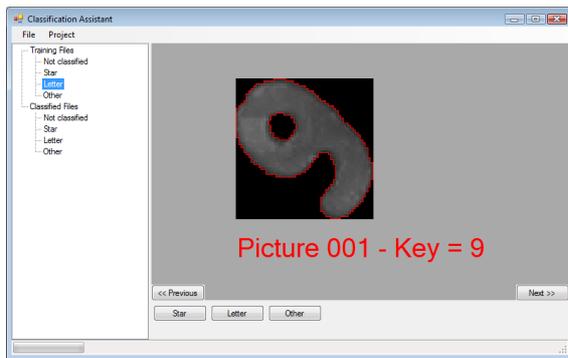
Classification Process

Once the classifier is fully defined, it can be saved in an Aphelion Project and then applied to an ObjectSet using Classifier Builder. The classification results can be reviewed by browsing all of the object pictures and their assigned classes. In the screen captures above, the text "Picture XXX - Key = YY" connects the picture with index "XXX" to its corresponding object "YY" in the ObjectSet.

Any NNTK classifier can be called from the Aphelion Dev environment in order to apply the classifier to new ObjectSets.

Comparison with other classification techniques

One of the most important benefits of the Aphelion NNTK is that it is more efficient than a standard

multi-layer neural network in that it has less complexity, a shorter training cycle (partial training is possible), and better accuracy when more than two classes are defined.

Classification accuracy comparison between multi-layer neural networks and Aphelion Neural Network Toolkit

Database	# of Classes	Multi-Layer Network	Aphelion NNTK
Liver Bupa	2	71%	71%
Pima	2	76,6%	76,6%
Ionosphere	2	90,1%	90,1%
Cancer	2	97,1%	97,1%
Wine	3	97,3%	100%
Vehicle	4	71,9%	78,4%
PageBlock	5	85,4%	90,1%
Glass	7	66,7%	82,2%
Segmentat	7	82,4%	87,8%
OptDigits	9	78,1%	81,6%

Application fields

The NNTK has been successfully used in the fields of biology, cytology (e.g., cell analysis), agriculture, quality control, optical character recognition (e.g., license plate analysis), remote sensing, and more. Its versatility makes it well-suited for any image domain requiring advanced classification tools.
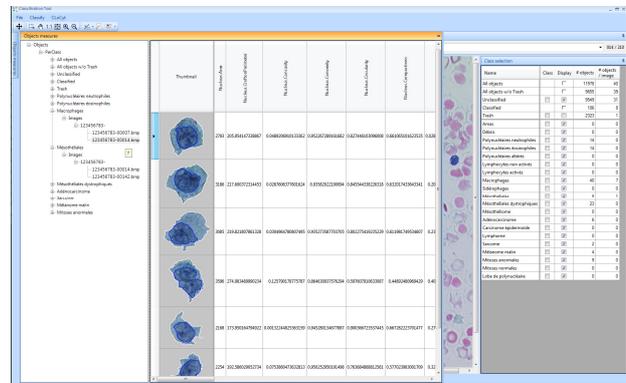
Supported Operating Systems

Windows XP, Windows Vista, and Windows 7 (32-bit and 64-bit versions).

(1) For further information, refer to
http://users.info.unicaen.fr/~lezoray/BibtexPublications.php