TOLOMEO

TOoLs for Open Multi-risk assessment using Earth Observation data

TOLOMEO – WP6 – Protocol

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1. Introduction

This report documents the usage of the *POER HMM Cascade* tool available in the InterIMAGE software [1]. The tool is a realisation of the probabilistic approach to multitemporal remote sensing image classification described in [3]. A video demonstrating the usage of the software tool is also available (see [2]).

The operator is based on a Hidden Markov Model (HMM) which is designed for estimating the LC/LU classes of a post event situation. In the underlying model, the class labels are not directly observable and are hence referred to as hidden random variables $^A\omega$ and $^B\omega$ related to time steps t_A and t_B, respectively. The class labels are related to image features $^A\mathbf{x}$ and $^B\mathbf{x}$, which can be observed in the data (e.g. pre and post event remote sensing images). Inference about the class labels is achieved by maximising the joint probability of the involved variables given the observed data. For further details about the methodology the reader is referred to [3].
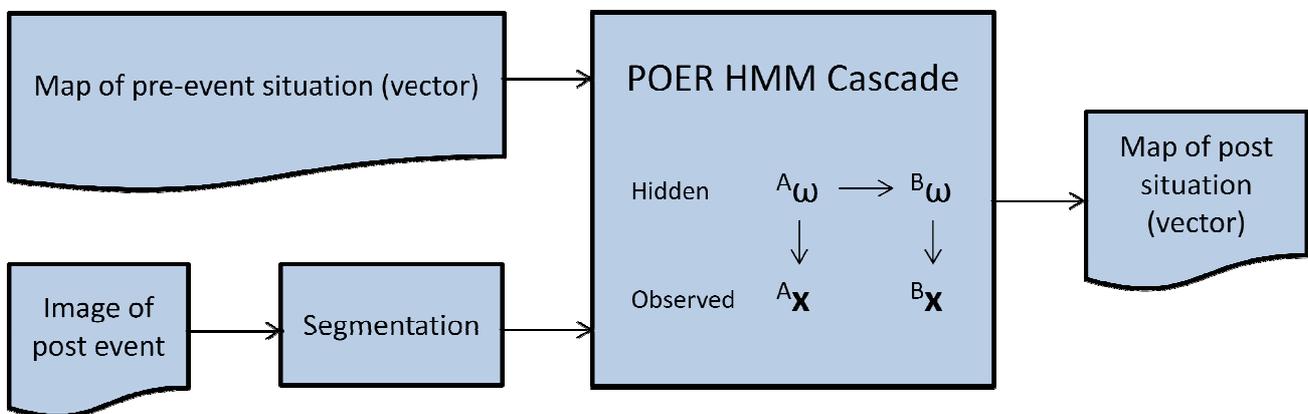
Figure 1: Possible scenario for the usage of the POER HMM Cascade operator.

A processing chain designed for a post-event classification scenario involving the presented operator is depicted in Figure 1. The operator takes as input the class labels $^A\omega$ of the first epoch t_A and an image of the same geographic region taken at the second date t_B. Likelihoods that relate the observed data ($^B\mathbf{x}$) to the class labels are acquired from Gaussian probability distributions, which are learned from training data. Class transition probabilities have to be defined by manual user input.

2. Prerequisites

The POER HMM Cascade operator requires InterIMAGE version 1.40 or higher. The operator is designed to run on segments. As input to the operator the following information needs to be available:

- Segmentation (.SHP file format)
- Class labels $^A\omega$ valid for the first epoch (Attributes file (.SHP/.DBF))
- Image taken at the second epoch (.TIF image)

In the present documentation the segmentation is conducted prior to the actual processing; however, it can be conducted within InterIMAGE, too.

3. Step-by-Step Guide

In the remainder of this document a step-by-step guide for the usage of the POER HMM Cascade operator is given.

Create New Project

- Start InterIMAGE
- Select *File → New Project* in the InterIMAGE toolbar
- In the dialog window set a project name and working directory
- Under 'Resources' browse for the image file containing the data to be classified by the operator, give it a 'Key' name, set it as 'Default Image' and click on the '+'-button
- Browse for the shape-file containing the geometry of the segments and add it to the Resources List
- Browse for the shape-file with the class labels of epoch t_A and add it to the Resources List
- Click 'OK'
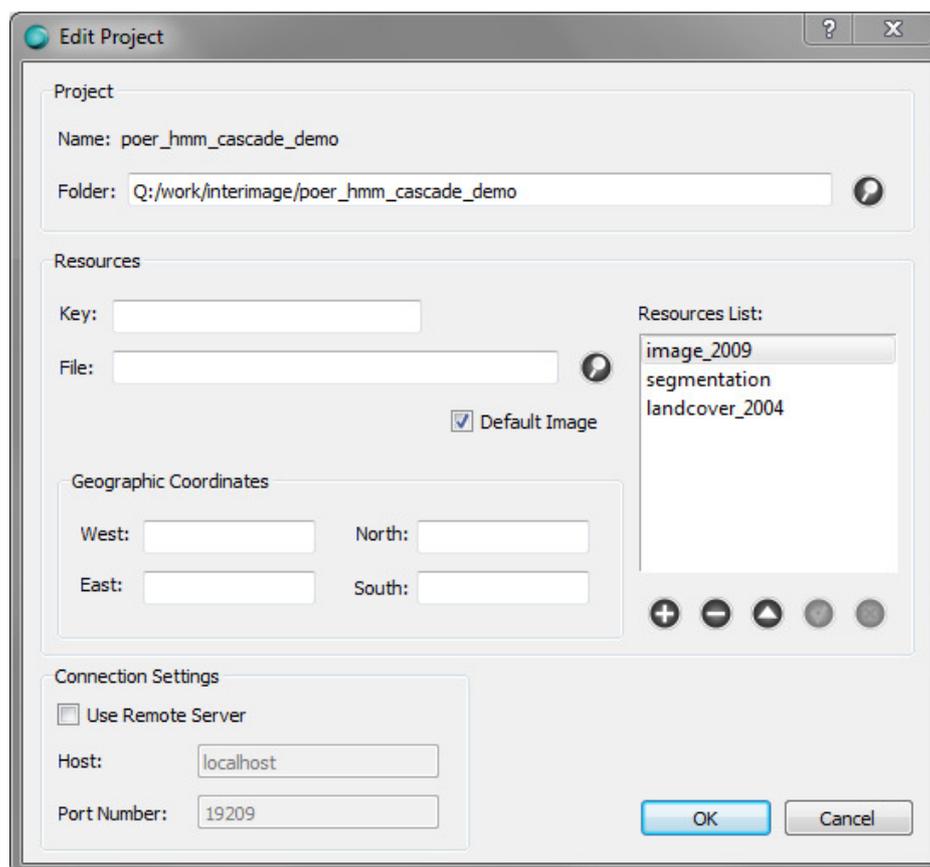
- In the 'Shape'-tab of the InterIMAGE-Layers window click 'Add', select the shape-file containing the segments from the drop-down list and click the 'Save'-button
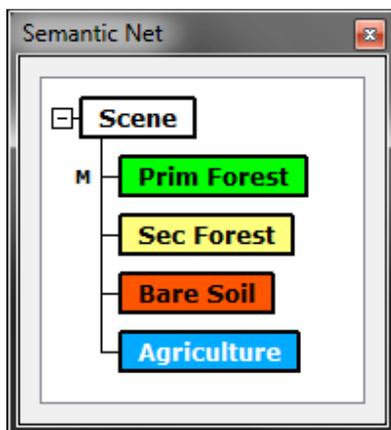
In the visualisation window the image with the overlaid segments should appear.
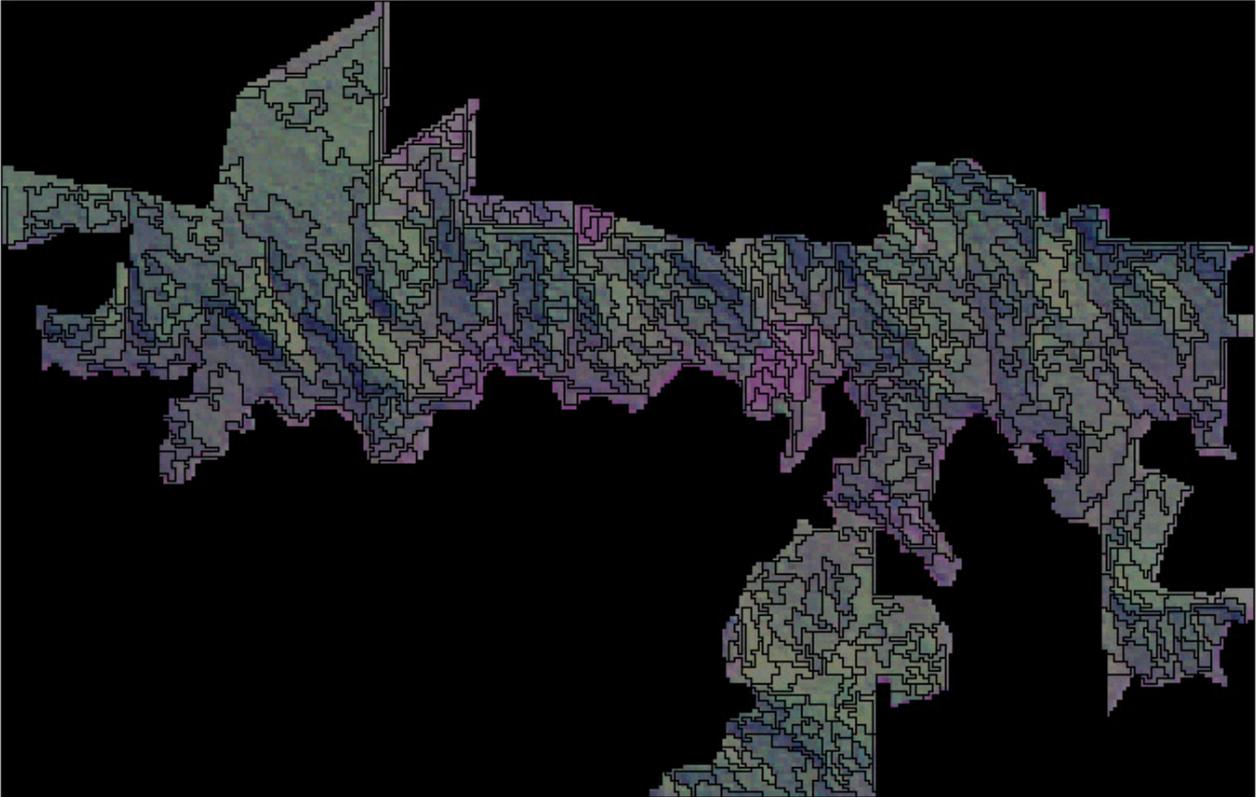
Semantic Net

- In the Semantic Net window right-click on the Scene-node and add one child node for each class
- Name and colourise the semantic net according to the land use/land cover

NOTE: The class names must not be longer than 12 characters

Training data

For learning the probability distributions relating the observed image data to the unknown class labels, training data can be selected in the InterIMAGE Samples Editor.

- Select *View* → *Samples Editor* in the InterIMAGE toolbar

- Select the *TA_ShapeFile_import* operator from the drop-down list of the 'TopDown Operator'
- Set the 'Shape File Name' according the file that contains the geometry of the segments (here: 'classes_2004')
- Set the 'Label Image Resolution' in accordance with the geometric resolution of the underlying image file (here: '30' [m])
- Click the 'Segment' button

The image with overlaid segmentation geometry should appear in the visualisation window of the Samples Editor. The classes defined in the semantic net should appear in the drop-down list in the Sampler/Class section of the Samples Editor. Now the training data can be selected:

- Chose a class from the list
- Click the 'Collect Samples' button
- Select training samples by left-clicking on the appropriate segments (clicking again on the samples de-selects it)
- Click the 'Collect Samples' button again to quit the selection mode

Repeat these steps for any further class.

Feature selection
- Click the 'Export' button
- Click the 'Class' button, select 'All' and click 'OK'
- Click the 'Expression' button and select appropriate features for classification. Here the mean values of the single spectral bands (red, green and blue) and the standard deviation of the green band is chosen.
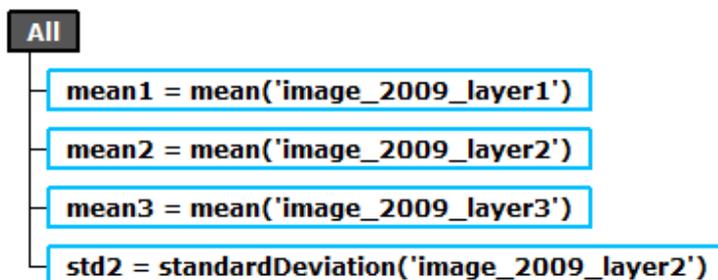
- Click 'OK' and save the samples to the working directory
- Close the Samples Editor.

Load the samples to the project
Add the file containing the training samples to the project by the following steps:

- Select *File → Edit Project* in the InterIMAGE toolbar
- Add the shape file containing the samples to the Resources List
- Click 'OK'
- Save the project.

Running the operator
The project is now prepared for the execution of the actual operator.

- In the Node Editor, associate the *POER HMM Cascade* operator to the first scene node
- Set the TopDown Multi-Class flag to true
- Associate the 'Class labels of previous epoch' with the shape file containing the class labels of the first epoch. **The shape file must contain one field called 'class' and its entries must match the class names of the semantic net**.
- Set the elements of the state transition matrix, i.e. the transition probabilities between each possible pair of classes. The matrix must contain *#classes* times *#classes* elements. The elements must be separated by blanks. **The elements must be given in alphabetical order**. That means, the first value given in this field indicates the transition probability between the first class in alphabetical order (here: Agriculture) and itself; the second value indicates the transition probability between the first and the second class (here: between Agriculture and Bare Soil), and so on.
- Associate the 'Training Set File' with the shape file containing the training samples of the second epoch.
- In the field 'Shape File Attributes' the features used for the classification must be listed, separated by blanks.
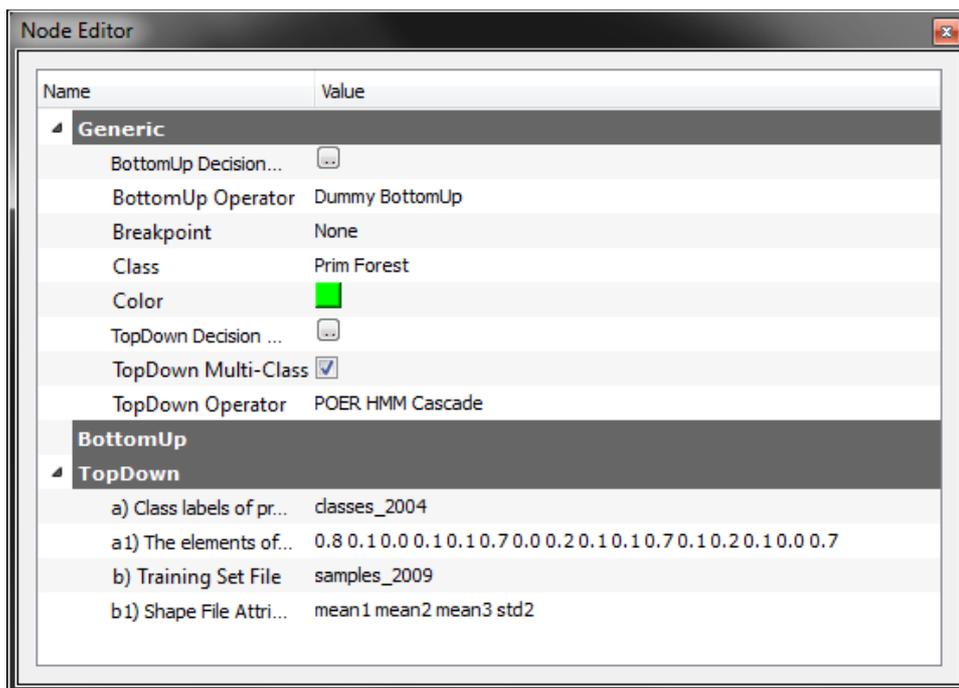

In this case the values given in field a1) correspond to the following transition matrix:

		$^{2009}\omega$			
		Agriculture	Bare Soil	Prim Forest	Sec Forest
$^{2004}\omega$	Agriculture	0.8	0.1	0.0	0.1
	Bare Soil	0.1	0.7	0.0	0.2
	Prim Forest	0.1	0.1	0.7	0.1
	Sec Forest	0.2	0.1	0.0	0.7

Note: If all transition probabilities are equal, the operator will perform a maximum likelihood classification.

- Save the project
- Run the operator by selecting *Actions* → *Start* from the InterIMAGE toolbar.
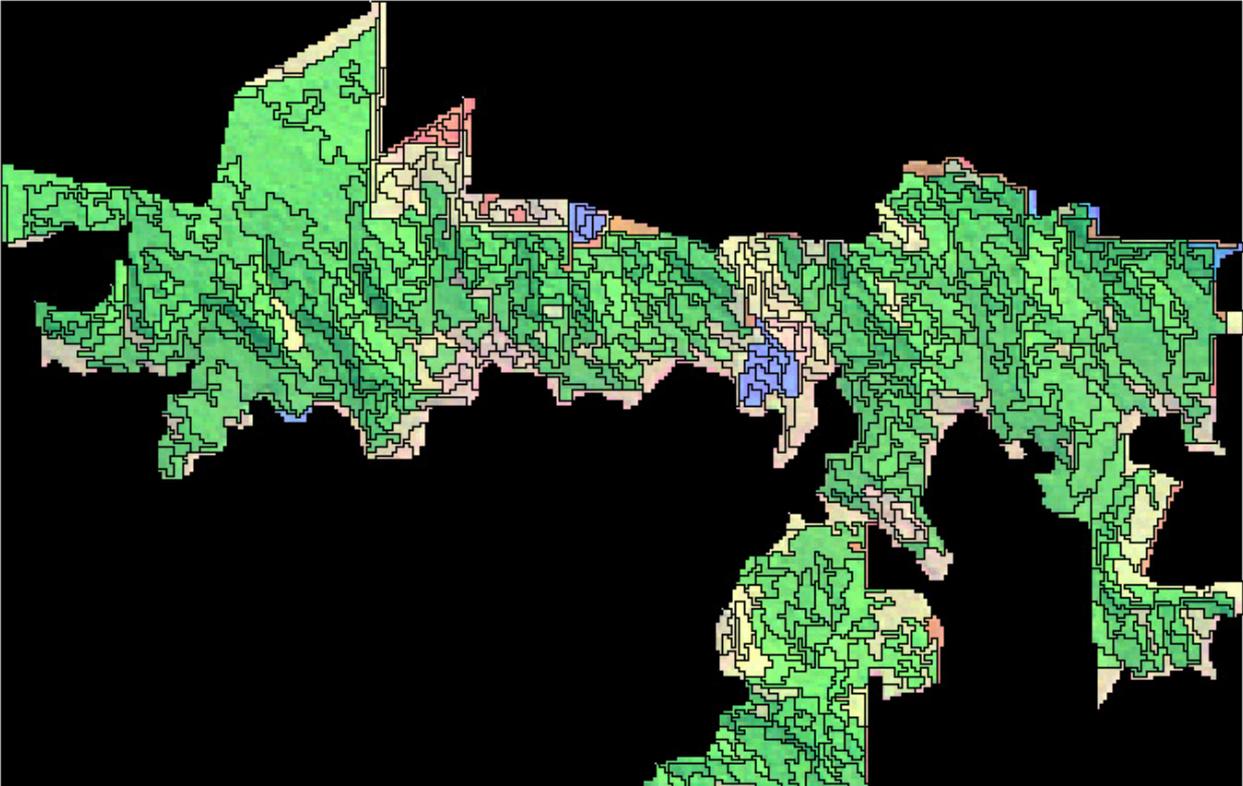
The classification results are automatically added as new layer to the project and can be exported as shape file using the Shapefile Editor.

4. References

[1] InterIMAGE wiki: http://www.lvc.ele.puc-rio.br/projects/interimage/

[2] TOLOMEO videodemo webpage: http://tolomeofp7.unipv.it/VideoDemos

[3] FEITOSA, R.Q., ALVARADO, L. M. T., KLINGER, T., COSTA, G. A. O. P., HEIPKE, C., A Comparison of Statistical and Fuzzy Approaches for Cascade Classification of Multitemporal Remote Sensing images In: 5th GEOBIA, 2014, Thessalonik South-Eastern European Journal of Earth Observation and Geomatics. Thessaloniki: Aristotle University of Thessaloniki, 2014. v.3. p.5 - 10.