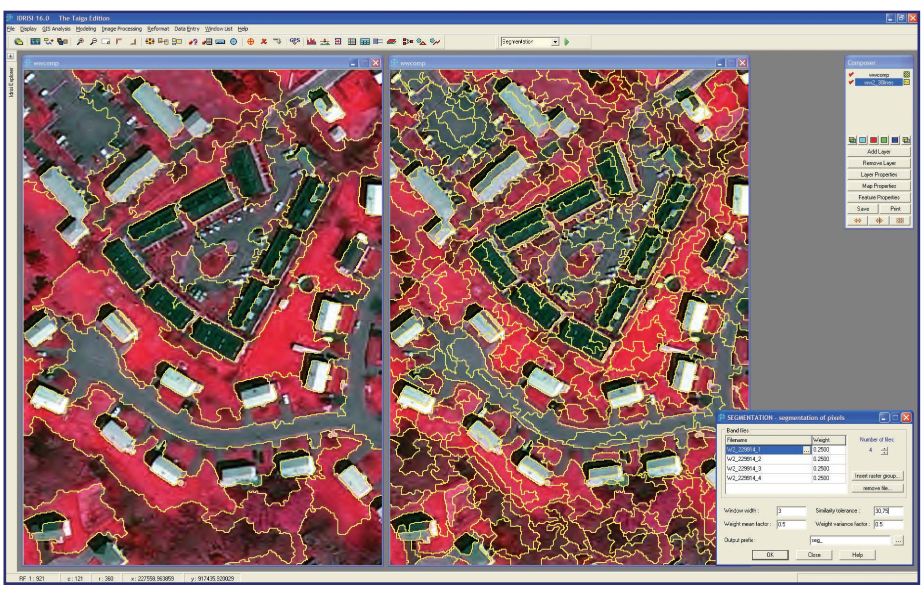
IDRISI Focus Paper

Segmentation and Segment-Based Classification

Unlike traditional pixel-based classification methods, segment-based classification is an approach that classifies a remotely-sensed image based on image segments. Segmentation is the process of defining homogeneous pixels into these spectrally similar image segments.

The goal of the segmentation process is to change the characteristics of the image into more meaningful ones, thus facilitating interpretation and classification. Because these image segments better represent objects in the landscape than do the original pixels, each step of the classification process, from defining training sites to classifying from these segments, is simplified. It is also possible to achieve better accuracy. The common salt-and-pepper effect that results from a pixel-based classification is reduced and a more cartographic-grade map is the result.

Segment-based classification is highly suited for applications that utilize medium to high resolution satellite imagery and is a useful addition for those mapping land cover and monitoring land change. Other applications such as biodiversity and habitat mapping, where a lone pixel in the classification result may not fit in its context, can also take advantage of this classification approach. This paper explores how this functionality is incorporated within IDRISI and also outlines the workflow.



The SEGMENTATION module creates an image of segments that have spectral similarity across many input bands. This example shows two levels of segmentation from half-meter 4-band aerial photography in the blue, green, red and near infrared wavelengths for Woburn, Massachusetts in 2005. The image on the left uses a larger similarity threshold than the one on the right, resulting in more generalized, less homogeneous segments. Using this threshold, the image allows for segments that wholly contain building features.

Utilizing a powerful set of existing classification tools, from the traditional maximum likelihood to the cutting edge machine learning tools such as the multi-layer perceptron and classification tree analysis, IDRISI's methodology combines pixel-based and segment-based approaches. Three modules have been developed to facilitate the creation of a segment-based classified map. SEGMENTATION creates an image of segments. SEGTRAIN interactively develops training sites and signatures. SEGCLASS classifies the image utilizing a majority rule algorithm.

IMAGE SEGMENTATION

The SEGMENTATION module generates an image of segments where pixels identified within a segment share a homogeneous spectral similarity. Across space and over all input bands, a moving window assesses this similarity and segments are defined according to a user-specified similarity threshold. The smaller the threshold, the more homogeneous the segments. A larger threshold will cause a more heterogeneous and generalized segmentation result.

IDRISI utilizes a watershed delineation approach for the initial partition of the input images. Then, similar segments are merged to form larger segments, based on a user-specified similarity threshold. The segmentation process consists of three procedures:

1. Derive surface image

First, for each input image, a corresponding variance image is created using a user-defined filter. As an example, pixels that are more homogeneous will be assigned lower variance values, while pixels at the boundaries of homogeneous regions will be assigned higher values.

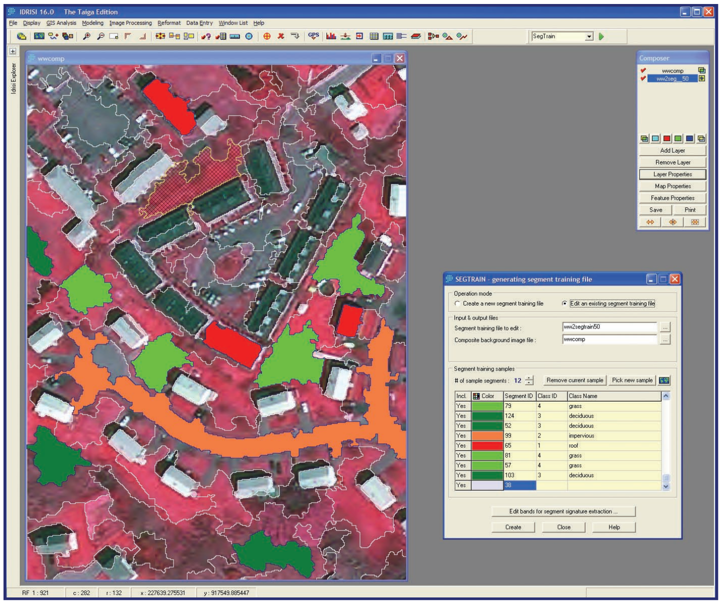
If there is more than one input image, the final surface image will be a weighted average of all variance images from all image layers. The weight of each image is specified by the user.

2. Delineate watersheds

The pixels' values within the variance image are then treated like elevation values within a digital elevation model. Pixels are grouped into one watershed if they are within one catchment. Each watershed is given a unique integral value as its ID.

3. Merge watersheds

The watersheds or image segments are then merged to form new segments. The process is guided by the following logic:



The module SEGTRAIN assigns these segments to specific land cover types for the development of training site data. The user interactively selects segments and assigns class IDs and class names.

CLASSIFICATION

The last step in segment-based classification is to classify the image segments. This is done with the assistance of a reference image. A reference image is an already classified image. This image can be created using the segment-based signatures or some other approach. The important point here is that this reference image is used to assign the majority class within each segment.

A majority rule algorithm is applied within each segment to determine its class assignment. Since the base unit in a segment-based classification is an image segment, the accuracy may improve upon the pixel-based classification and produce a cartographic-grade classification result as well.

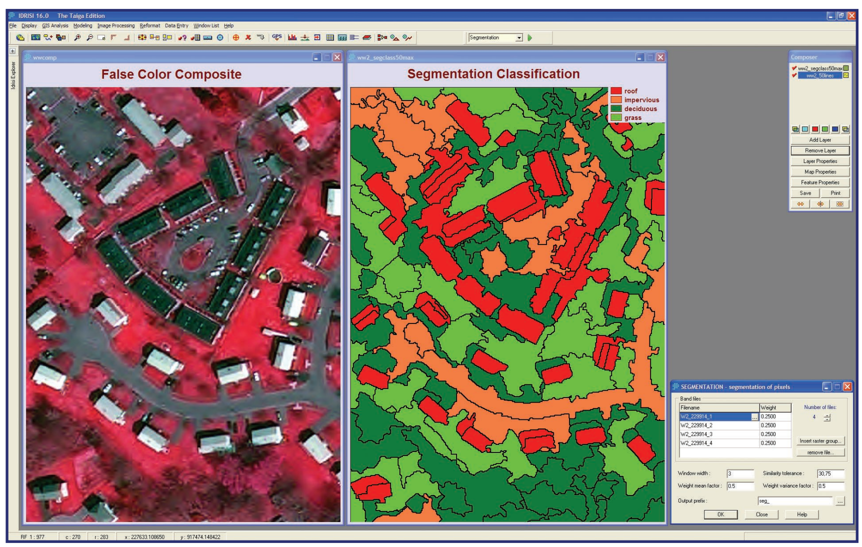
The segment-based classification approach within IDRISI is straightforward and bypasses the complex rule-base construction process found in other tools. It also provides the user with a variety of classification choices for the creation of the reference image. The option also exists for combining the many pixel-based classifiers with this approach to create a hybrid classification procedure not found elsewhere.

-- The segments must be adjacent and mutually most similar.

-- The difference between the mean and standard deviation values of the two segments within a pair must be less than the user-specified threshold. A flexible tuning mechanism is included to allow one measurement to have more weight over the other if appropriate. The threshold, or similarity tolerance, controls the generalization level. The larger the value, the fewer number of segments in the output.

TRAINING SITES AND SIGNATURE DEVELOPMENT

The next step in the classification process is to derive training sites and signature classes from the image segments. In addition to the current signature development tools, the SEGTRAIN module creates training sites and signature classes based on the image segments. With an intuitive graphical interface, you can interactively select segments of interest as sample sites for particular classes. Once a segment is selected, all pixels in that segment are used for signature development. These images can then be used as input into one of IDRISI's many classifiers.



The module SEGCLASS classifies the imagery using a majority rule algorithm to assign each segment to the majority class from the reference image. SEGCLASS can improve the accuracy of a pixel-based classification and produce a smoother map-like classification result while preserving the boundaries between the segments.

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