Class 5 - Classification

1 Pixel based classification

Classification is the process of information extraction from images in order to recognize patterns and homogeneous objects. The ***pixel based Classifiers*** *employ the spectral information of each pixel in order to find homogeneous regions.*

The final result of a classification project is a digital image that constitutes a map of classified "pixels", represented by graphic symbols or colors.

The most common techniques of pixel based multispectral classification are: minimum-distance-to-means, parallelopiped classifier, and maximum likelihood (MAXVER).

MAXVER takes into account the weight of the distances between the means of the digital numbers of the classes, using statistical parameters. In order for the maximum likelihood classification to be sufficiently precise it is necessary that a reasonably high number of "pixels" be available for each training set. The training sets define the dispersion diagram of the classes and its probability distribution, considering the normal probability distribution for each training class.

Before we present the procedures for the execution of a classification we describe the logical sequence of the operations to be performed:

1. ***Create the Context file*** *- This file stores the bands that will be a part of the classification process, the method employed (pixel or region) and the samples in the case of pixel based classification.*

2. ***Execute the training*** *- Sampling should be performed over the image in the drawing area.*

3. ***Analyze the samples*** *– Allows the verification of the validity of the collected samples.*

4. ***Perform the classification*** *– With the samples and chosen bands the image is classified.*

5. ***Perform a post-classification*** *– A pixel extraction process as a function of a threshold and a weight provided by the user (non compulsory).*

6. ***Perform the Class Mapping*** *– Allows the transformation of a classified image (category Image) into a raster thematic map (category Thematic).*

⇒ ***Pixel based classification:***

*Windows: **#Start – Spring<version><Language><system> – Spring<version> <Language>***

Linux: # Command to be typed on the Console (Shell) – # s_spring

*MAC: #Dock – Launchpad – Spring <version> < **language** >*

SPRING

Load database **Course*

Load Project **Brasilia*

Visualize a RGB color composite of bands **TM4, TM5, and TM3 or one band only.*

– [Image][Classification…]

⇒ ***Creating the context file:***

Classification

– (Create…)

Context Creation

– {Name: contx1}

– (Analysis Type ⇔ Pixel)

– (Bands | TM3, TM4, and TM5) – select the bands

– (Apply)

⇒ ***Training classification:***

Classification

- *(Contexts | contx1) – select the context file*
- *(Training…)*

Training

- {Name: vegetation}

** Select color (press OK when done) - (Create)*

- (Type Acquisition)

⇒ ***Acquiring rectangular samples:***

Training

- (Contour Rectangle)

** Select sample on the image as if performing a zoom*

- (Get)

⇒ ***Acquiring polygonal samples:***

Training

- (Contour Polygon)

** Digitize the contour of the sample area, closing the polygon with the right button. The first point will automatically close the polygon with the last one.*

- (Get)

** You should acquire as many samples as possible for each theme*

** Repeat for other themes:* **urban1, urban2, water**

⇒ ***Visualizing themes and samples that were acquired:***

Training

- (Themes vegetation)

- (View)

- (Samples / 1)

- (View)

Note: *After analyzing the samples (the object of a section ahead) it could be necessary to change the type of the sample, without the need of eliminating it. The change of the type of a sample from* ***Acquisition*** *to* ***Test****, will trigger its analysis but it will not be taken into account by the classifier.*

⇒ ***Changing the sample type:***

- (Samples / 2)

- (Type Test)

- *(Change)* *This is the Change button besides the Samples list
- *(Save)*
- *(Close)*

⇒ ***Classifying the Image:***

Classification

- *(Classification...)*

Image Classification

- *{Name: tmc}*
- *(Create)*
- *(Classifier Maxver)*
- *(Acceptance-Threshold: 100%)*
- *(Sample Analysis...)*

Sample Analysis

**Analyze the acquisition and test samples for each theme*

**For the samples with high confusion (analyze the Theme Confusion Matrix) you should return to the training for editing.*

- *(Close)*

Image Classification

- *(Classify)*

**View the classified image (named "tmc")*

** If the option "Automatic Visualization of infolayer created" is actived in the tool "Environment Configuration", by clicking "Apply" your IF will be automatic drawn on the assistant page.*

⇒ ***Eliminating the classification noises - Post-classification:***

Classification

- *(Post-Classification...)*

Post-Classification

- *(Classified Images | tmc)*
- *(Weight 2)*
- *(Threshold 5)*
- *(Apply)*

**View the resulting image*

*Test with other weights and thresholds

* If the option "Automatic Visualization of infolayer created" is actived in the tool "Environment Configuration", by clicking "Apply" your IF will be automatic drawn on the assistant page.

⇒ ***Mapping themes of the classified image into classes of the database:***

Classification

- *(Mapping…)*

Class Mapping

- *(Classified Images | tmc)*
- *(Categories | Land_Use)*
- *(Themes | vegetation)*
- *(Classes | Forest)*

*Repeat for every theme. For each theme there should be one associated thematic class.

- *(Apply)*

*View the thematic layer **tmc-T** under the Land_Use category.

* If the option "Automatic Visualization of infolayer created" is actived in the tool "Environment Configuration", by clicking "Apply" your IF will be automatic drawn on the assistant page.

2 Segmentation

In this process, the image is divided into regions that should correspond to the areas of interest of the application. By region we mean a set of neighboring pixels that spread bidirectionally and which present uniformity.

The division in portions basically consists in region growing processes, border detection or basin detection.

Region growing

It is a technique for grouping data where only spatially adjacent regions can be grouped. Initially this process of segmentation labels

each pixel as a distinct region. A similarity criterion is calculated for each spatially adjacent region. This similarity criterion is based on the statistical hypothesis test that tests the average between regions. Then the image is divided into a set of sub-images, and then the union between them is performed, according to a defined aggregation threshold.

Basin detection

The classification by basin detection is performed on the image resultant from a border extraction process. The border extraction is performed by a border detection algorithm, that is by a Sobel filter. Such algorithm takes into account the gradient in the gray levels of the original image to generate a gradient image or an image of border intensity.

The algorithm calculates a threshold for border detection. Whenever it finds a pixel with a value that is higher than the established threshold the process of border detection is started. The neighborhood is verified to identify the next pixel with a higher digital number and that direction is followed until another border or the image limit is found. From this process a binary image is generated where border pixels are set to 1 whereas non-border pixels are set to 0.

The binary image will be labeled such that the portions of the image with zero value will constitute regions delimited by values 1 thus constituting the labeled image.

The segmentation process by basin detection presupposes a topographic representation of the image, that is, for a certain gradient image the digital value of each pixel is equivalent to an elevation value at that point. The image would be the equivalent to a topographic surface with relief features or a region with basins of different depths.

The result in both cases is a labeled image, each region having its own label (digital number), and each region should be classified by region classifiers.

The user should thus execute the following steps to generate a classification fro a segmented image.

1. ***Create a segmented image*** *– generate an image, separated in regions based upon the analysis of the gray levels.*
2. ***Create a Context file*** *– such file stores which bands will make part of the classification process by region.*
3. ***Execute the training*** *– sampling on an image on the drawing area should be performed.*
4. ***Analyze the samples*** *– allows the verification of the validity of the collected samples.*
5. ***Extract the regions*** *– in this procedure the algorithm extracts the statistical information of means and variable of each region, taking in consideration the bands indicated in the context.*
6. ***Classification*** *– to perform the classification of a segmented image one must use the classifier by region.*
7. ***Perform the classification*** *– with the samples and the chosen bands the image is classified.*
8. ***Perform the mapping into classes*** *– allows the transformation of the classified image (category Image) into a raster thematic map (category Thematic).*

⇒ ***Performing a segmentation:***

*Windows: **#Start – Spring<version><Language><system> – Spring<version> <Language>***

Linux: # Command to be typed on the Console (Shell) – # s_spring

*MAC: #Dock – Launchpad – Spring <version> < **language** >*

SPRING

Load database **Course*
Load project **Brasilia*
– [Image][Segmentation…]

Segmentation

– (Bands | TM3_Sample, TM4_sample, TM5_sample)
– (Method Region growing)

- *{Similarity: 12}*
- *{Area (pixels): 15}*
- *{Segmented Image: seg-12-15}*
- *(Arc smoothing Yes)*
- *(Apply)*

** View the image labeled **seg-12-15**, superimposed to the other image*

**Test with other similarity and area values if the result is not satisfactory*

** If the option "Automatic Visualization of infolayer created" is actived in the tool "Environment Configuration", by clicking "Apply" your IF will be automatic drawn on the assistant page.*

3 Classification by region

*The **region based classifiers** use the spatial information that includes the relationship of each pixel and its neighbors, besides the spectral content of each pixel. These classifiers try to simulate the behavior of a photo-interpreter in recognizing homogeneous areas in the image, based on the spectral and spatial properties of the images. The border information is initially used to separate regions and the spatial and spectral properties will unite areas with a same texture.*

*The **Isoseg** classifier is the algorithm available in Spring to classify the regions of a segmented image. It is a non-supervised grouping algorithm applied to a set of regions, which are characterized by their statistical attributes of mean, covariance matrix, and also by the area.*

*⇒ **Region based classification:***

*Windows: **#Start - Spring<version><Language><system> - Spring<version> <Language>***

Linux: # Command to be typed on the Console (Shell) - # s_spring

*MAC: #Dock - Launchpad - Spring <version> < **language** >*

SPRING

Load database **Course *Load project **Brasilia** *View the image **TM3_sample***

- *[Image][Classification...]*

⇒ ***Creating the context file:***

Classification

- *(Create...)*

Context creation

-{ Name: clasreg}

- *(Type of Analysis Region)*
- *(Bands | TM3_sample, TM4_sample, TM5_sample)*
- *select the bands*
- *(Segmented Images | **seg-12-15**)*
- *(Apply)*

⇒ ***Extracting regions:***

Classification

- *(Region Extraction)*

⇒ ***Non-supervised classification:***

Classification

- *(Classification...)*

Image Classification

-{Name: tm345sub-isoseg}

- *(Create)*
- *(Classifier | Isoseg)*
- *(Acceptance Threshold | 99%)*
- *(Apply)*

** View the classified image*

** If the option "Automatic Visualization of infolayer created" is actived in the tool "Environment Configuration", by clicking "Apply" your IF will be automatic drawn on the assistant page.*

⇒ ***Supervised classification:***

Classification

- *(Training...)*

Tranining

-{Name: vegetation}

- *Select color*
- *(Create)*
- *(Type | Acquisition)*

** Click over the region (delimited by segmentation seg-12-15) that represents the theme "vegetation". Observe the region contours.*

- (Get)

**You should acquire as many samples as possible for each theme*

**Repeat for other themes (water, urban1, urban2, etc...)*

- (Save)

- (Close)

⇒ ***Classifying:***

Classification

- (Classification...)

Image Classification

- {Name: tmsub-bata}

- (Create)

- (Classifier ⇔ Bhattacharya)

- (Acceptance-Threshold ⇔ 99%)

- (Classify)

** Visualize the classified image and a color composite*

** If the option "Automatic Visualization of infolayer created" is actived in the tool "Environment Configuration", by clicking "Apply" your IF will be automatic drawn on the assistant page.*

⇒ ***Mapping themes from the classified image into classes of a thematic map:***

Classification

- (Mapping...)

Mapping into classes

- (Category | Land_Use)

- (Classified Images | tmsub-bata)

- (Themes | Vegetation)

- (Classes | Forest)

** Repeat for every theme. For each theme there should be a thematic class associated*

- (Apply)

* *View the thematic layer* ***tmsub-bata-T under*** *the Land_Use category.*

** If the option "Automatic Visualization of infolayer created" is actived in the tool "Environment Configuration", by clicking "Apply" your IF will be automatic drawn on the assistant page.*

4 Image mosaic

Following you will see how to perform an image mosaic.

⇒ ***Creating a mosaic:***

Windows: ***#Start - Spring<version><Language><system> - Spring<version> <Language>***

Linux: # Command to be typed on the Console (Shell) - # s_spring

MAC: #Dock - Launchpad - Spring <version> < ***language*** *>*

SPRING

Load database* ***Course*
Load project* ***Brasilia*

⇒ ***Creating an information layer for the mosaic:***

SPRING

- [Edit][Infolayer...] or the button 

Infolayers

- (Categories / TM_Image)
- {Name: tm5-mosaic}
**Define a bounding box equal to the one of the project*
- {Resolution - X(m): 30}, {Y(m): 30}
- (Create)
- (Close)

⇒ ***Image mosaicking:***

SPRING

Load infolayer* ***tm5-mosaic*

- [Image][Mosaic...]

Mosaic

- (Projects / Brasilia)
- (Categories / TM_Image)

- *(Origin Infolayers | TM5_sample)*
- *(Apply)*

**Mosaicking with the second image*

- *(Projects | Brasilia)*
- *(Categories | TM_Image)*
- *(Infolayers | TM5_part2)*
- *(Mosaic)*
- *(Apply)*
- *(Close)*

View the image **tm5-mosaic*

**Repeat the above process using another project, defined by the user.*