**EXERCISE 15  DIGITAL CLASSIFICATION (SUPERVISED)**

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**15.1 INTRODUCTION**

You have learnt to apply unsupervised classification on single band and multispectral image in Exercise 14. In this exercise, you will learn to apply supervised classification on multispectral image. You will learn the process of supervised classification by generating a supervised classified from a multispectral image.

**Objectives**

After performing this exercise, you should be able to:

- create samples;
- display feature spaces;
- generate a supervised classified image by employing a classification algorithm;
- evaluate classified results; and
- apply post classification operations.

**15.2 REQUIREMENTS**

To carry out this exercise, you need to have the following:

- a computer with ILWIS installed in it, and
- sample satellite data.

**15.3 STEPS**

Supervised classification is the more widely used method in digital classification. In this exercise, you will learn to apply supervised classification on a multispectral image.

If you are using a 3 band image then you will have three DN values corresponding to the three bands for a given pixel. For example, a pixel at row $y$ and column $x$ will have DN values (55, 30, 126). It is essential to note that in classification jargon, the three bands are called *features* and the DN values for one pixel in several bands are known as *feature vectors*. Concept of classification lies in the assumption that all pixels (i.e. feature vectors) belonging to a particular ground cover type (class) will be similar but will vary for other ground cover types (classes). In other words, different ground
cover types (classes) have different types of feature vectors. The process of supervised classification can be broadly divided into following two phases:

- establishment of relationship between ground cover types (classes) and DN values by creating samples (i.e. signatures), and
- transferring the knowledge (i.e. relationship) to a classifier.

In this exercise, you will use the same multispectral image that you have used in Exercise 14. The multispectral image has 3 bands. Follow the steps given in the following four sections to generate a supervised classified product and the fifth section to apply post classification operations.

### 15.3.1 Creating Samples

You should note that supervised classification is performed only when we have knowledge about the study area in terms of the ground cover types and its relationship with the image DN values. The knowledge is obtained from ground truthing or some reference maps, if available. You will perform ground truthing in the next exercise but keep in mind that it is generally performed prior to image classification and the number of sample points observed during a ground truthing is generally, divided into two sets. One of the sample sets is used for guiding the supervised classification and the other set is used for accuracy estimation of the classified product.

Guiding of the classification is performed by sampling (i.e. training). In the process of training, some knowledge about the relationship between ground cover types (classes) and feature vectors is established. In other words, you assign a particular class label to a limited number (or group) of pixels having similar feature vectors. The process is considered complete when you have assigned class labels to all the pixels belonging to different types of ground cover types you are interested to extract information about.

Follow the steps given below to create sample sites for different ground cover types (classes):

1. Switch on your computer.
2. Open a catalog window of ILWIS.
3. Create a map list which contains the image bands and display it as a colour composite by using *tmb3* for *Red*, *tmb2* for *Green* and *tmb1* for *Blue*.
4. Save the colour composite as a map view.
5. Go to *Operation-Tree* tab, expand *Create* and double click *New Sample Set*. The Sampling dialogue box opens as in Fig. 15.1. Provide input to the boxes.

![Fig. 15.1: Create sample set dialogue box](image.png)
6. Create a domain for the classes to be sampled by selecting the *Create Domain* button. It opens *Create Domain* dialogue box as in Fig. 15.2.

![Create Domain dialogue box](image)

**Fig. 15.2:** Create domain dialogue box

7. Type `tm_classes` in the *Domain Name*. Clicking *OK* button opens the *Domain Class* editor (Fig. 15.3).

![Domain class editor](image)

**Fig. 15.3:** Domain class editor

8. Clicking the *Add Item* button from the toolbar of the *Domain Class* editor opens the *Add Domain Item* dialogue box.

9. Enter *Water body* in the *Name* and `w` in the *Code* and click *OK*. Similarly, insert the names and codes of other classes you have used in the Exercise 13. You can also refer to topographic maps of the area, if available. Use the first letter of the class name as its *Code* and class names as its *Name*.

10. After completing the step for all the classes, click on the *Open Representation* button in the toolbar of the *Domain Class* editor which opens *Representation Class* editor.

11. Select different colours for different classes by clicking a colour box.

12. Now close the *Representation Class* editor and also the *Domain Class* editor to return to the *Create Sample Set* dialogue box. You will notice that the *MapList* you have created before is already filled out.

13. Clicking *OK* in the *Create Sample Set* dialogue box opens the *Sample Set* editor and displays two windows *i.e.* a map window showing the colour composite and another window showing the sample set statistics.

14. Zoom in on an area within the image having water body. To return to normal mode click the *Normal* button in the toolbar.

15. Select pixels by pressing the left mouse button, drag the cursor and release the left mouse button. Upon release it shows statistics of the current selection of pixels in the *Sample Statistics* window as *Current Selections*. The *Sample Statistics* window shows the code and name of
the selected class and the number of bands along with the following statistics, mean, standard deviation (StdDev), number of pixels having the value (Nr), the predominant pixel value (Pred) and the total number of selected pixels (Total).

16. If you want to select multiple training pixels, drag a rectangle or hold the Ctrl key of the keyboard.

You have now learnt the process of sampling (training). However, you should note that a good number of training samples should be taken per class depending upon the spectral variability within a class.

### 15.3.2 Displaying Feature Spaces

For the sample multispectral image being used here, a feature vector is a 3 dimensional vector because it has 3 components (DN values). Such a feature vector can be plotted in 2 or 3 dimensional space, known as feature space. In other words, feature space is a graph which shows the plot of DN values of one band against DN values of other band.

Now, recall from Unit 13 of MGY-002 when you plot a feature space, pixels belonging to the same ground cover class having similar characteristics will be near to each other in a feature space. Hence, all the pixels belonging to a particular ground cover type (class) will form a cluster in the feature space, and pixels belonging to other ground cover types (class) will make different separate clusters outside this cluster. The classes can be plotted in different colours in the feature space which enables our visual discrimination of the classes. If you find that there are different clusters for a particular class than you can create sub-classes so as to separately classify as two different classes. The subclass can be joined in the end product after classification process is over.

Follow the steps given below to visualise feature spaces:

1. Go to the toolbar of the Sample Set editor.
2. Click on the Feature Space button which opens the Feature Space dialogue box.
3. Select two bands for which you want to create a feature space. Select tmb1 (band 1) for the horizontal axis and tmb2 (band 2) for the vertical axis.
4. Clicking the OK button displays the feature space of tmb1 against tmb2.
5. You can try any other band combinations.
6. After finishing the sampling process, close all the windows and return to the main window of ILWIS.

### 15.3.3 Employing a Classification Algorithm

There are number of algorithms which are used for performing supervised classification. In ILWIS, following classifiers are available:

- Box classifier
- Minimum distance classifier
- Mahalanobis distance classifier, and
- Maximum likelihood classifier.

All the classifiers use a sample set however the procedure to apply a classifier is different. Follow the steps given below to learn to apply box classifier.

1. In the Catalog window click the sample set tm_classes with the right button of the mouse and select Classify, which opens the Classify dialogue box as in Fig. 15.4.
2. Select Box Classifier as Classification Method and accept the default Multiplication Factor. Type tm_box for the Output Raster Map name and click Show. It runs the classification process and displays the result.

4. Repeat the procedure using a larger Multiplication Factor and then visually compare the results with the classified map you have obtained using the default multiplication factor.

6. Close all map windows when you have finished the exercise.

15.3.4 Evaluating Classified Result
You will learn about it in detail in Exercise 16 but to get acquainted with the process of evaluating the results of classification follow the steps given below:

1. If you have topographic map of the same area open it otherwise open the unsupervised classified map. Check this also for the TM data.

2. Go to the pixel information window and add the maps tm_b1, tm_b2, tm_b3 and tm_box by clicking right button of the mouse and selecting Add Map. Open the raster maps.

3. Evaluate the pixels for which you have defined different cover classes and the result of your supervised classification.

4. Close the map window.

15.3.5 Applying Post Classification Operations
The final classified output may not be good if there are overlaps in the sample set or improper and insufficient training. Classification process should be repeated until you achieve the desired result by incorporating sufficient number of proper representative samples and/or taking more spectral sub-classes. The sub-classes can be joined (merged) again. If the result is still not satisfactory then some more bands or ancillary information such as elevation data can be considered.
In many cases, one or small groups of pixels occur in a classified image which has been labeled as another class as compared to the large homogeneous class in the surrounding. Such small groups of pixels create problem when you integrate the map with other datasets. You can remove these pixels by applying spatial filters.

Follow the steps given below to apply post classification operation such as filtering:

1. Go to Operations menu, select Image Processing and further select Filter. It opens the Filter dialogue box. You can also open the dialogue box by first opening one of the classified output maps you have created and clicking with the right mouse button from the pixel information window and selecting Image Processing and Filter from the map window.

2. Select Majority as Filter Type and Majundef as Filter Name.

3. Type maj as Output Raster Map name and accept all other defaults. Clicking the Show button creates the map maj and displays the maj map.

4. Also display the original classified output image and compare both images.

5. Close the map windows after finishing the exercise and exit ILWIS.

After completing the exercise submit the following to your instructor for evaluation:

1. A snapshot of the original image used for classification.
2. A snapshot of output of the supervised classification.
3. A snapshot of the classified image after applying majority filter.

15.4 HOME WORK: DO IT YOURSELF

1. Perform supervised classifications using other classifiers.
2. Classify with or without using a threshold distance.
3. Compare the results with the box classified maps.
4. Find out what happens when you apply majority filter several times in a classified output?
5. Find out the difference between the spatial filters you have applied in Exercise 11 and the spatial filters you have applied in this exercise.

15.5 FURTHER/SUGGESTED READING