Assignment # 1

Introduction to Supervised Classification

GISC9216 - Digital Image Processing

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Mrs Janet Finlay,

Re: GISC9216 Assignment 1 – D1 - Introduction to Supervised Classification

Please accept this letter as my formal submission of Assignment 1: D1 Introduction to Supervised Classification for GISC9216 – Digital Image Processing.

This assignment is a great opportunity to practice all skills developed in this program for the GISC9216 – Digital Image Processing. It has as a purpose to involve the creation of training areas and the production of a supervised classification. This assignment includes: A professional cover letter and a report contains the answers to the questions created using Microsoft Office Word. Moreover, it contains a Subset Image, an Unsupervised Classification Image, and Supervised Classification Image; all created using ERDAS. Thus, this assignment has a great value for all students from GIS program.

Should you require further information, any questions regarding the enclosed documents, or if there are technical issues regarding the files please do not hesitate to contact me by e-mail (rafael.linoec@gmail.com) at your convenience. I look forward to your comments and suggestions. Thank you for your time and consideration.

Regards,

Rafael Lino dos Santos

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Enclosures: 1) LINORGISC9216D1;
2) subsetlino.img (Subset Image);
3) lino2015unsupervised (Unsupervised Classification Image), and
4) supervisedlinospectralangle (Supervised Classification Image)
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1. Introduction

As presented in the Terms of Reference for Deliverable GISC9216 D1 (Assignment #1) the classification process allows to categorize all of the pixels in a digital image into one of several land cover classes, or “themes”. This categorized data can be used to produce thematic maps of the land cover present in an image.

For this assignment, two main image classification techniques were used: Unsupervised Classification, and Supervised Classification. Unsupervised image classification refers that the outcomes are based on the software analysis where the user does not provide simple classes. The computer uses techniques on the image classification. On the other hand, supervised image classification is based on the idea that the user can control the image classification through the image processing software.
2. Purpose

As presented in the Terms of Reference for Deliverable GISC9216 D1 (Assignment #1) this assignment is a great opportunity to practice all skills developed in the entire program for the GISC9216 - Digital Image Processing. Moreover, this assignment presents as a purpose to involve the creation of training areas and the production of a supervised classification.
3. Methodology

3.1. Subset

A subset was created through of the six features that were identified within the area. These features included water, urban area, cropland, forest, farmland, and field. Thus, through of the six features was possible to complete an Unsupervised Classification, and a Supervised Classification. Moreover, a Histogram Plot Control Panel was created in order to analyze the histograms for the layers to make our own evaluations and comparisons. As required for this assignment, the subset presents a size of 512 x 512 pixels. The Figure 2 shows the selected subset used for the classification process.

![Subset Image](image-url)
3.2. Unsupervised Classification

Once the subset image was established, the process of Unsupervised Classification became possible. Firstly, some parameter (number of classes, maximum iterations, convergence threshold, and skip factor) were set within the unsupervised classification dialogue window as it shown in the figure 3 below.

![Unsupervised Classification dialogue window.](image)

Secondly, each different class was identified according to its feature. The features noticed were water, urban area, cropland, forest, farmland, and field. Thus, these features were established within of the 10 classes. Class 1 (water), Class 2 (Forest), Class 3 (Cropland), Class 4 (Urban area), Class 5 (Farmland), Class 6 (Field), Class 7 (Farmland), Class 8 (Farmland), Class 9 (Field), and Class 10 (Cropland). Some classes present the same common features because of the similarities presented. Thus, appropriate colors were set within the Attribute Table in order to make distinction among the features. Through of the Figure 4 below is possible the changes made within the Attribute Table.
Finally, the Recode tool was used in order to group the pixels, according to their technical features. Thus, the six classes used were water, urban area, cropland, forest, farmland, and field. The Figure 4 shows the Unsupervised Classification completed successfully.

Figure 5: Attribute Table of the Unsupervised Classification.
Figure 6: Unsupervised Classification Image.
3.3. **Supervised Classification**

Once the Unsupervised Classification was concluded, the Supervised Classification has started. The same subset image was used to complete this step. Through of the ERDAS’ Drawing/Geometry tools was possible to create the specific classes. It allows selecting training sites into the image of interest and represents the distinct classes. Thus, the Signature Editor was opened, and the specific classes were set according to their similarities. The Figure 6 below shows the Signature Editor window, and how the classes were grouped. As a result, 6 signatures were created (Water, Farmland, Cropland, Field, Forest, and Urban Area).

![Signature Editor Window](image)

**Figure 7: Signature Editor Window.**

Once the six signatures were created, the most effective supervised classification method was used to set Supervised Classification. The Spectral Angle Mapper was the method chosen to the Supervised Classification because it allowed the most accurate view of the covered area according to the classes previously established. The method was chosen through the Supervised Classification window shown in the Figure 7. The Spectral Angle Mapper Classification (SAM) treats both (the questioned and known) spectra as vectors and calculates the spectral angle between them. The result of the SAM classification is an image showing the best match at each pixel. *(Analysis of Hyperspectral Imagery).*
Figure 8: Supervised Classification window.

The Supervised Classification image can be seen in the figure 8 below.
Figure 9: Supervised Classification image, Spectral Angle Mapper method.
3.3.1. Discuss the differences between the three types of classification (Maximum likelihood, Mahalanobis distance, Minimum distance)

3.3.1.1. Maximum Likelihood Classifier

Maximum Likelihood Classifier is a supervised statistical approach to pattern recognition (Classification Methods for Remotely Sensed Data, pag. 58). Maximum Likelihood classification can be considered the most accurate because it assumes that the statistics for each class in the bands are well distributed. Moreover, the Maximum Likelihood classification uses variance and covariance analysis. However, Maximum Likelihood method seems to be computationally slower comparing to other methods. The Figure 9 shows the Supervised Classification image through of the Maximum Likelihood method.
Figure 10: Supervised Classification image, Maximum Likelihood method.

3.3.1.2. Mahalanobis Distance Classifier

The Mahalanobis Distance Classifier is a direction distance where statistics are used for each class. It assumes that all classes covariance are equal, and it makes a faster method comparing with Maximum Likelihood classification. Similar to Minimum Distance method assumes histograms have normal distribution (Niagara, C., 2015). The Figure 10 shows the Supervised Classification image through of the Mahalanobis Distance method.
Figure 11: Supervised Classification image, Mahalanobis Distance method.
3.3.1.3. Minimum Distance Classifier

The Minimum Distance Classifier determines a pixel’s level through the minimum distance between the pixel and the class centers, measured either by the Euclidian distance (Classification Methods for Remotely Sensed Data, pag. 57). To the Minimum Distance method the distance between pixels are determined through of the mean spectral value in each band for each category. However, it presents a problem comparing to other methods because it does not use the standard deviation. The Figure 11 shows the Supervised Classification image through of the Minimum Distance method.

Figure 12: Supervised Classification image, Minimum Distance method.
3.4. **Histogram Plot Control Panel**

Histograms are useful to help determine if training areas that have been selected are homogeneous and classes have good separability in different bands (Niagara, C., 2015). Thus, a histogram from the water class was provided to show the accuracy of the process previously completed. The Figure 12 shows the histogram of Supervised Classification classified as Water.

3.4.1. **What does the x-axis show and what does the y-axis show?**

![Histogram of Supervised Classification (Classified as Water).](image)

*Figure 13: Histogram of Supervised Classification (Classified as Water).*

The Supervised Classification presents both x and y-axis. The x-axis presents the pixel values and the y-axis presents the frequency that these pixels appear in the bands.

Moreover, through of the Signature Editor Window was possible to get the Statics window and the Mean Plot of Supervised Classification Class (Water) as is shown in the Figure 13 and Figure 14, respectively.
Figure 14: Statistics (Water) Window.

Figure 15: Mean Plot of 8 Supervised Classification Class (Water).
3.5. Classifications Comparison

After all procedures to Supervised Classification and the Unsupervised Classification were completed, it is possible to prepare a summary of some advantages and disadvantages of both procedures. The two types of image classification present the same goal and both showed to be effective; however, each one presents its own benefits and failures.

Through of the Supervised Classification the user can select pixels in an image, and use training sites for the classification in the image. The training sites are selected according to the knowledge of the user. The training sites were chosen according to the areas in the image that are known to representative of a specific class. The spectral signature of the pixels were determined within each area. Thus, mean and variance of the classes could be defined. Therefore, it is important to choose training sites that cover the full area of interest because it allows a great accuracy of the process.

After concluded the Supervised Classification method, it was possible realized that this method can be very effective and accurate; however, the user need to have a great knowledge and to be able to identify where the classes of interest are located.

On the other hand, the Unsupervised Classification uses software to analyse an image. The software identifies a number of classes and each pixel is assigned to a class. The computer uses techniques to determine which pixels are related and groups them into classes (ESRI 2011. ArcGIS Desktop). However, the user should be able to determine labels to each class. Consequently, the user have to have a knowledge of the area. The Unsupervised Classification method tends to be more accurate than the Supervised Classification method, because it requires less human intervention.

The figure 14 below shows a flowchart of the Supervised Classification and Unsupervised Classification.
Figure 16: Flowchart of the Supervised Classification and Unsupervised Classification.

Figure available on: http://web.pdx.edu/~jduh/courses/Archive/geog481w07/Students/Vea_FeatureSpace.pdf.
Consulted on January 29th, 2015.

Some advantages and disadvantages of both procedures can be noticed after Supervised Classification and Unsupervised Classification were completed:

- SUPERVISED CLASSIFICATION METHOD:

  Advantages:

  - User has the control over the selected classes that allows getting the most effective results;
  - Presents statistical monitoring that includes the Signature Editor Statistics window, the Signature Separability panel, and Histograms;
  - Faster method comparing to Unsupervised Method;
Training sites when developed properly can make the Supervised Classification Method more effective than Unsupervised classifications.

Disadvantages

- Can present human failures;
- Requires experienced user including a great background;
- Training data selected may not be accurate;
- Selection of training data can take a long time if the user does not present experience;
- Dependent of the user’s ability.

**UNSUPERVISED CLASSIFICATION METHOD:**

**Advantages:**

- The user does not need necessarily present a prior knowledge of the area;
- Human error is minimized.

**Disadvantages**

- Slower comparing to Supervised Classification method;
- The user has limited control of classes;

For this assignment, the Supervised Classification method seemed to be the most efficient because it presents more detail and delineation of area. It can be easily noticed through the features presents on the Supervised Classification. The urban area is more detailed, and some features like farmland and cropland are more apparent containing a great number of details. The figure 15 shows both images obtained through of the Supervised Classification method and Unsupervised Classification method.
Figure 17: Supervised Classification and Unsupervised Classification image.
4. Conclusion

In conclusion, it is possible notice the importance of the ERDAS IMAGINE Software and its tools. Through of this assignment was possible to work on the two main methods of classification, and notice how both methods are important for Digital Image Processing. Supervised and unsupervised classification allow the user to be able to work within the pixels of the images. Both methods present their own advantages and disadvantages. Thus, the quality of each classification depends on of which situation it is going to be applied. Moreover, through this assignment was possible to realize that the user should present a background about Digital Image Processing as well as a familiarity with the area of interest. All of these factors are fundamental to get an accurate process.

In addition, this assignment allowed a better understanding about everything that students have been learning at GIS - Program, mainly in Digital Image Processing.
5. References/Bibliography


