

# Exercise 10: Accuracy Assessment

72 Points scaled to 20 Points

## Introduction

In this exercise, you will calculate metrics from confusion matrices to assess the overall and class-level accuracies of a classification product. In the first section, you will analyze provided error matrices. In the second section, you will generate a validation set in ArcGIS Pro then calculate assessment metrics from it.

## Objectives

- *Interpret confusion matrices to assess overall and class-level classification performance*
- *Calculate the following metrics from confusion matrices: overall accuracy, the Kappa statistic, class user's accuracy, and class producer's accuracy*
- *Understand the meaning of and appropriate use of different assessment metrics*
- *Synthesize information provided in a confusion matrix to determine what classes are most confused and the dominant sources of error*

## Prerequisite Materials

- ❖ Modules: Classification and Accuracy Assessment
- ❖ Videos
  - Confusion Matrix: <https://youtu.be/6XHyYh45PxA>
  - Lab 9 Intro: <https://youtu.be/tytnxVwpxgc>
  - Accuracy Assessment in R (Optional): <https://youtu.be/ww8KWgT98Hw>

## Data

- ❖ **WV\_Spectral\_classes\_NAIP\_2016.tif**: land cover dataset for West Virginia derived from National Agriculture Imagery Program (NAIP) orthophotography using geographic object-based image analysis (GEOBIA) and machine learning
- ❖ **WV\_Spectral\_classes\_NAIP\_2016.lyr**: layer file for symbolizing the land cover raster grid
- ❖ **validation\_points.shp**: validation locations across the state of West Virginia to assess accuracy of land cover dataset

This paper describes how this dataset was created:

Maxwell, A.E., M.P. Strager, T.A. Warner, C.A. Ramezan, A.N. Morgan, and C.E. Pauley, 2019. Large-area, high spatial resolution land cover mapping using random forests, GEOBIA, and NAIP orthophotography: findings and recommendations, *Remote Sensing*, 11(12) 1409: 1-27. <https://doi.org/10.3390/rs11121409>.

## Background Questions

Question 1: Explain the difference between overall accuracy and the Kappa statistic. (4 Points)

Question 2: Explain the difference between producer's accuracy and user's accuracy. (4 Points)

Question 3: Explain the difference between precision and recall. (4 Points)

Question 4: Explain the relationship between precision and recall and user's and producer's accuracy. (4 Points)

Question 5: Why is it important that validation samples be collected using unbiased, randomized methods? (4 Points)

Question 6: Explain the concept of a population confusion matrix? Why is a population confusion matrix more informative than a non-population confusion matrix? (4 Points)

## Part 1: Calculations from the Confusion Matrix

### Confusion Matrix 1

Answer the provided questions using the example confusion matrix, which represents a general land cover classification.

|                |                | Reference |                |        |       |
|----------------|----------------|-----------|----------------|--------|-------|
|                |                | Developed | Low Vegetation | Forest | Water |
| Classification | Developed      | 152       | 35             | 11     | 13    |
|                | Low Vegetation | 31        | 189            | 17     | 5     |
|                | Forest         | 2         | 27             | 231    | 11    |
|                | Water          | 7         | 6              | 8      | 93    |

Question 7: How many total validation samples were collected? (2 Points)

Question 8: How many samples were correct? (2 Points)

Question 9: What was the overall accuracy of the classification? (2 Points)

Question 10: What was the Kappa statistic for the classification? (2 Points)

Question 11: What was the producer's accuracy for the Low Vegetation class? (2 Points)

Question 12: What was the producer's accuracy for the Developed class? (2 Points)

Question 13: What was the user's accuracy for the Low Vegetation class? (2 Points)

Question 14: What was the user's accuracy for the Developed class? (2 Points)

Question 15: Describe the dominant sources of error in the classification and what classes were most confused. (2 Points)

### Confusion Matrix 2

Answer the questions using the provided binary confusion matrix.

|                |       | Reference |       |
|----------------|-------|-----------|-------|
|                |       | True      | False |
| Classification | True  | 193       | 27    |
|                | False | 13        | 167   |

Question 16: How many samples were False Negatives? (2 Points)

Question 17: How many samples were False Positives? (2 Points)

Question 18: What is the recall value relative to the True class? (2 Points)

Question 19: What is the precision value relative to the True class? (2 Points)

Question 20: What is the F1 Score for the True class? (2 Points)

### Confusion Matrix 3

Answer the provided questions using the example confusion matrix, which represents a classification of forest types.

|                |                   | Reference        |                   |        |          |             |
|----------------|-------------------|------------------|-------------------|--------|----------|-------------|
|                |                   | Mixed Mesophytic | Northern Hardwood | Spruce | Oak/Pine | Oak/Hickory |
| Classification | Mixed Mesophytic  | 152              | 38                | 4      | 26       | 34          |
|                | Northern Hardwood | 41               | 142               | 11     | 31       | 19          |
|                | Spruce            | 2                | 7                 | 120    | 8        | 6           |
|                | Oak/Pine          | 17               | 21                | 31     | 135      | 61          |
|                | Oak/Hickory       | 31               | 51                | 27     | 57       | 159         |

Question 21: What is the overall accuracy of the classification? (2 Points)

Question 22: Which class has the lowest producer's accuracy? (2 Points)

Question 23: Which class has the lowest user's accuracy? (2 Points)

One means to potentially reduce classification error is to merge classes that are similar or commonly confused. Re-populate the confusion matrix using the following groupings:

- ❖ Deciduous = Mixed Mesophytic + Northern Hardwood
- ❖ Spruce = Spruce
- ❖ Oak Dominant = Oak/Pine + Oak/Hickory

|                |              | Reference |        |              |
|----------------|--------------|-----------|--------|--------------|
|                |              | Deciduous | Spruce | Oak Dominant |
| Classification | Deciduous    |           |        |              |
|                | Spruce       |           |        |              |
|                | Oak Dominant |           |        |              |

Question 24: What is the overall accuracy once categories are combined? (2 Points)

## Part 2: Generate Confusion Matrix in ArcGIS Pro using Reference Samples

You have been provided with a vector point layer of validation locations. Each location has the correct classification associated with it in the “GrndTruth” column. You have also been provided with a classification result as a raster grid. Using the validation points, correct classification, and predicted class, generate a confusion matrix. The class codes are defined below.

- ❖ 1 = Forest
- ❖ 2 = Low Vegetation
- ❖ 3 = Barren
- ❖ 4 = Water
- ❖ 5 = Impervious
- ❖ 6 = Mixed Developed

In order to complete this task, you will need to:

- ❖ Open the provided project file.
- ❖ Extract the land cover codes from the raster grid at each point location. This can be accomplished with the Update Accuracy Assessment Points Tool. Use the provided “Classified” column.
- ❖ Compute a confusion matrix with the Compute Confusion Matrix Tool.

Fill out the provided confusion matrix using your results.

|                |                 | Reference |                |        |       |            |                 |
|----------------|-----------------|-----------|----------------|--------|-------|------------|-----------------|
|                |                 | Forest    | Low Vegetation | Barren | Water | Impervious | Mixed Developed |
| Classification | Forest          |           |                |        |       |            |                 |
|                | Low Vegetation  |           |                |        |       |            |                 |
|                | Barren          |           |                |        |       |            |                 |
|                | Water           |           |                |        |       |            |                 |
|                | Impervious      |           |                |        |       |            |                 |
|                | Mixed Developed |           |                |        |       |            |                 |

Question 25: What is the overall accuracy of the classification? (2 Points)

Question 26: What is the Kappa statistic for the classification? (2 Points)

Question 27: Which class had the highest producer's accuracy? (2 Points)

Question 28: Which class had the lowest producer's accuracy? (2 Points)

Question 29: Which class had the highest user's accuracy? (2 Points)

Question 30: Which class had the lowest user's accuracy? (2 Points)