Accuracy Assessment

Accuracy & Precision

- Accuracy relates to the quality of a result
  - Accuracy is the degree (%) of correspondence between observation and reality
- Precision relates to the quality of the operation by which the result is obtained.
- Image classification precision
  - Levels of classification scheme (data precision)
  - Quality of repeated procedures (operation precision)

Classification Accuracy

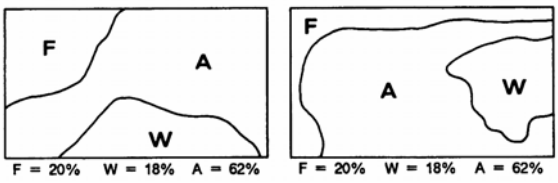
- Supporting evidence of the quality and validity of a digital map product
- How do we know if something is accurate?
  - Compare it to a known truth

Sources of Classification Error

- Data acquisition errors:
  - Ambiguity of spectral classes
  - Mixel
  - Atmospheric condition
  - Phenology
  - Terrain
  - Land-use/cover change
- Data processing errors:
  - Misregistration
  - Classification methods
  - Accuracy assessment methods (e.g., sampling scheme)
- Scene-dependent errors:
  - Ambiguity of classification scheme
  - Image characteristics (diversity, shape complexity, area…)

Measurement of Map Accuracy

- Classified maps and reference maps/data
- Non-site specific accuracy (inventory error)
- Site-specific accuracy (classification error)
- Error matrix (contingency table)



Ground Truthing

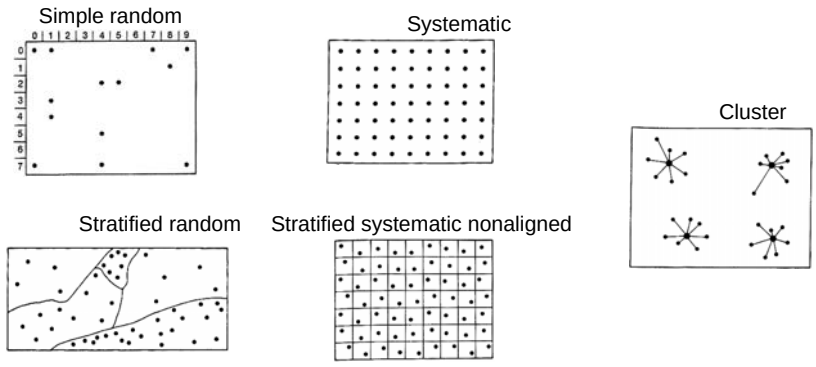
- For training and for accuracy assessment
- Data collected
  - Ground cover condition and attributes
  - Site condition
  - Time & date
  - Location information (coordinates)
  - Miscellaneous info

Data Collection Plan

- Field radiometry – for calibration
  - Field spectroradiometers
  - Reference target (perfect reflector – pure white surface)
  - Relative reflectance ratio
    Reflectance of sample/reflectance of reference
  - Matching satellite/airborne sensors
- Field survey
  - Nominal data (classification)
  - Biophysical data (e.g., tree plot survey, LAI)
  - Unmanned Airborne Vehicles
  - GPS
  - Geographic sampling

Geographic Sampling

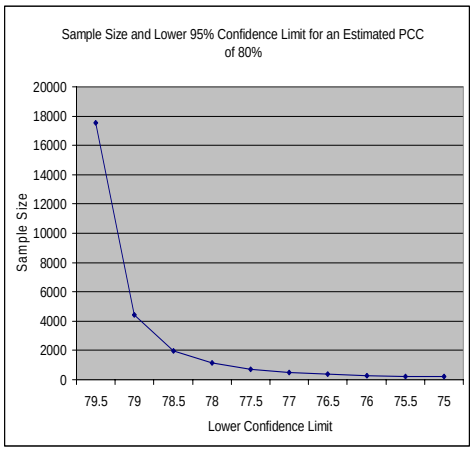
- Sample size
- Sample size per nominal class
- Sampling methods



Sample Size

$$s = P - \left[z\sqrt{PQ/N} + \frac{50}{N} \right]$$

s: Lower confidence limit
P: Classification accuracy (80%)
Q: Classification error (100 – 80)%
z: z value (1.645 @ 95% confidence)
N: Sample size



Error Matrix

- aka confusion matrix or contingency table
- Overall accuracy (Percentage correctly classified - PCC)

	Reference Data					
	Residential	**Commercial**	**Wetland**	**Forest**	**Water**	**Row total**
Residential	**70**	5	0	13	0	**88**
Commercial	3	**55**	0	0	0	58
Wetland	0	0	**99**	0	0	99
Forest	0	0	4	**37**	0	41
Water	0	0	0	0	**121**	121
Column total	73	60	103	50	121	**407**

Overall Accuracy = 382/407 = 93.86%

Errors of Omission and Commission

- Users are more interested in the % of map data that are reliable.
- Producers are more interested in the % of actual land-cover that are correctly mapped.

Producer's Accuracy (omission error)

Residential = 70/73 = 96% 4% omission error
Commercial = 55/60 = 92% 8% omission error
Wetland = 99/103 = 96% 4% omission error
Forest = 37/50 = 74% 26% omission error
Water = 20/22 = 100% 0% omission error

User's Accuracy (commission error)

Residential = 70/88 = 80% 20% commission error
Commercial = 55/58 = 95% 5% commission error
Wetland = 99/99 = 100% 0% commission error
Forest = 37/41 = 90% 10% commission error
Water = 121/121 = 100% 0% commission error

	Residential	Commercial	Wetland	Forest	Water	Row total
Residential	**70**	5	0	13	0	**88**
Commercial	3	**55**	0	0	0	58
Wetland	0	0	**99**	0	0	99
Forest	0	0	4	**37**	0	41
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Kappa Coefficient ($\hat{\kappa}$)

A measure of agreement that is adjusted for chance agreement.

	Residential	Commercial	Wetland	Forest	Water	Row total
Residential	**70**	5	0	13	0	**88**
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Computation of K_{hat} Coefficient of Agreement

$$\hat{K} = \frac{N\sum_{i=1}^{k} x_{ii} - \sum_{i=1}^{k} (x_{i+} \times x_{+i})}{N^2 - \sum_{i=1}^{k} (x_{i+} \times x_{+i})}$$

where $N = 407$

$$\sum_{i=1}^{k} x_{ii} = (70 + 55 + 99 + 37 + 121) = 382$$

$$\sum_{i=1}^{k} (x_{i+} \times x_{+i}) = (88 \times 73) + (58 \times 60) + (99 \times 103) + (41 \times 50) + (121 \times 121) = 36{,}792$$

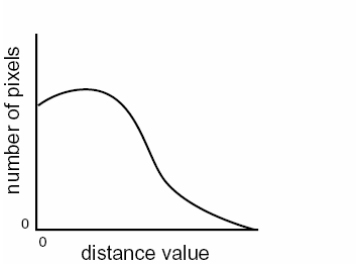
$$\text{therefore } \hat{K} = \frac{407(382) - 36792}{407^2 - 36792} = \frac{155474 - 36792}{165649 - 36792} = \frac{118682}{128857} = 92.1\%$$

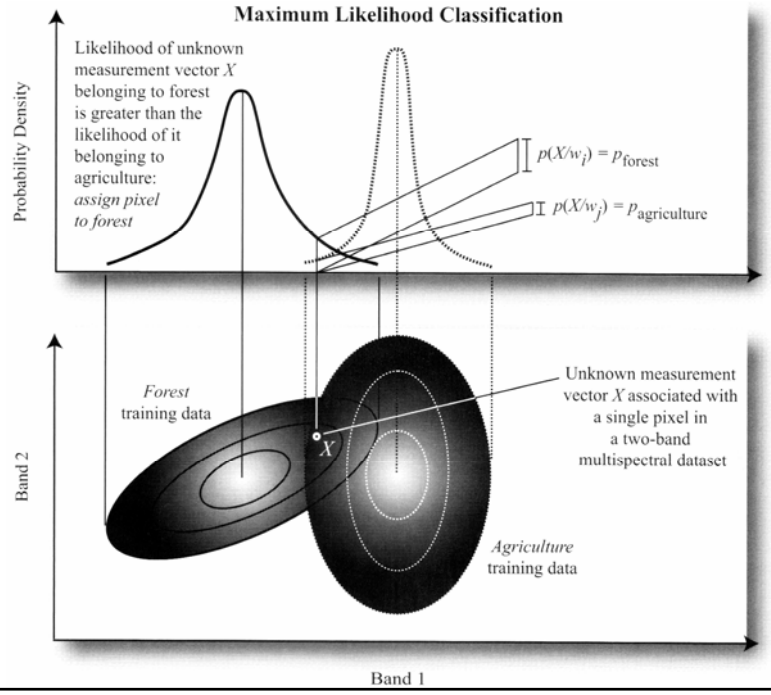
Classification Distance File

Distance Value:

- Min distance classifier: Euclidean spectral distance (i.e., distance between means)
- Mahalanobis or max likelihood classifiers: Mahalanobis distance (i.e., distance between means adjusted by covariances)

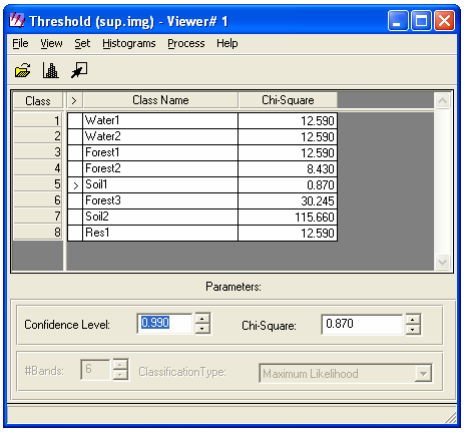
Histogram of a Distance Image



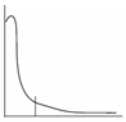


Chi-square Statistics

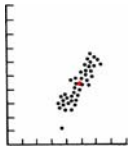
- An estimate of the combined distribution of the prob. distance to the mean of i independent variables (i.e., bands).
- The number i is referred to as the degree of freedom.

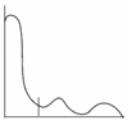


Thresholding

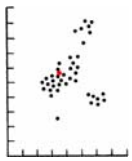


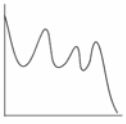
Smooth chi-square shape—try to find the breakpoint where the curve becomes more horizontal, and cut off the tail.



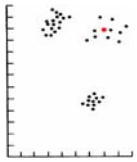


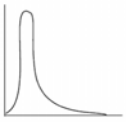
Minor mode(s) (peaks) in the curve probably indicate that the class picked up other features that were not represented in the signature. You probably want to threshold these features out.



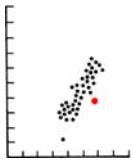


Not a good class. The signature for this class probably represented a polymodal (multipeaked) distribution.

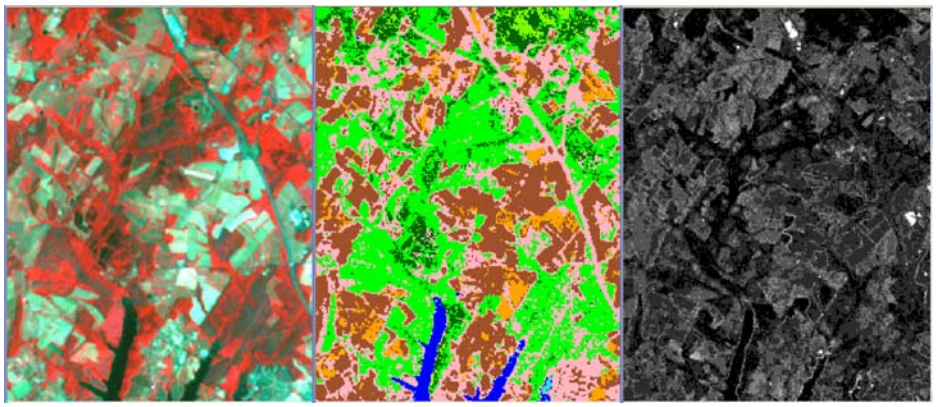




Peak of the curve is shifted from 0. Indicates that the signature mean is off-center from the pixels it represents. You may need to take a new signature and reclassify.



TM Bands 4,3,2 | Classified Map | Distance Image



Unclassified
Water1
Water2
Forest1
Forest2
Soil1
Forest3
Soil2
Res1