IMAGERY ANALYSIS

VEGETATION MAPPING - CSP7201

U.S. Fish & Wildlife Service
National Conservation Training Center
Shepherdstown, West Virginia

What will we do this week?

- Discover where to find imagery
- Understand on a basic level, what imagery is
- Learn basic functionality of ENVI 5.0
- Unsupervised Classification
- Supervised Classification
- Feature Extraction (Line Segmentation)

- I can help you with your own projects

Finding Imagery

Objective:

- Learn where to download imagery

Photo Credits: Google

Problem???

- Imagery can be very expensive and in the current fiscal climate, it's all about the $$$
- There is not always a clear mechanism to acquire imagery. But, that doesn't mean it is difficult

Solution

It might be easier than you think to find high quality **free** imagery. But sometimes, finding imagery can be like herding wet cats, in a dark room, with a flash light and one hand tied behind your back

Acronym Game:

WARP GLOVIS CIDR EE GDG RDOG LLV

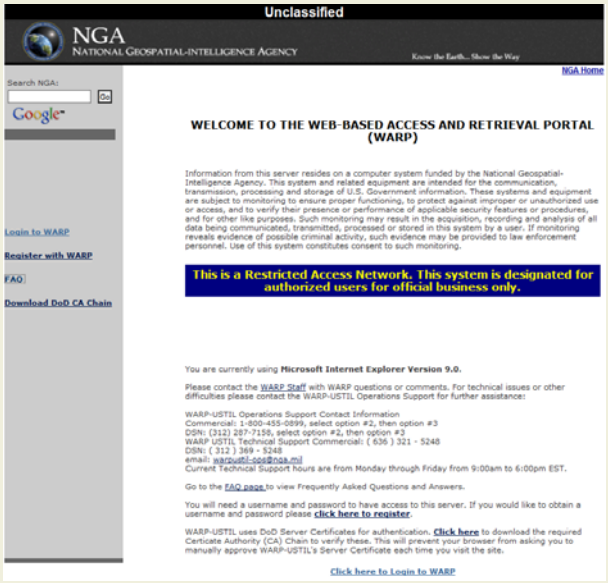
ANSWERS

WARP = Web-Based Access and Retrieval Portal (NGA)
GLOVIS = Global Visualization Viewer (USGS)
CIDR = CRSSP Imagery Derived Requirements Tool (USGS)
EE = Earth Explorer (USGS)
GDG = Geospatial Data Gateway (USDA)
RDOG = Rapid Delivery of Geospatial Intelligence (NGA)
LLV = LandsatLook Viewer (USGS)

Lions and Bears and Acronyms….Oh My!!!

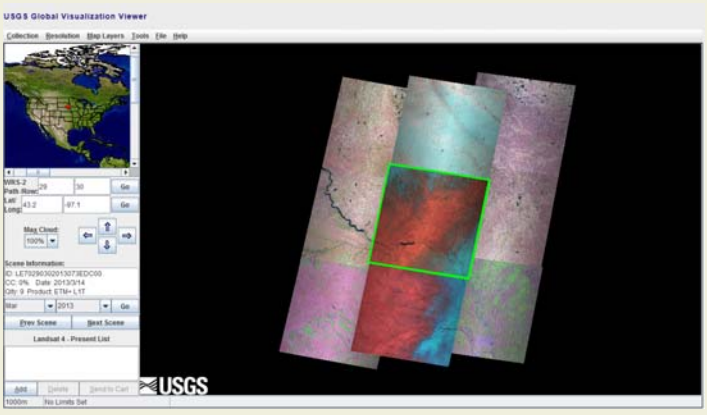
Web-Based Access and Retrieval Portal (WARP)

- Access to a huge assortment of Imagery
  - Panchromatic to Multispectral Imagery
  - Access can be somewhat challenging
    - Wait period
    - Long Password
    - Account lock after 2 months of inactivity
- "Clunky Layout", not a user friendly search device



Global Visualization Viewer (GLOVIS)

- Older/Legacy Imagery
  - I don't find this site very useful, but the site is easy to navigate and use
  - Operated by the Earth Resources Observation and Science Center (EROS)



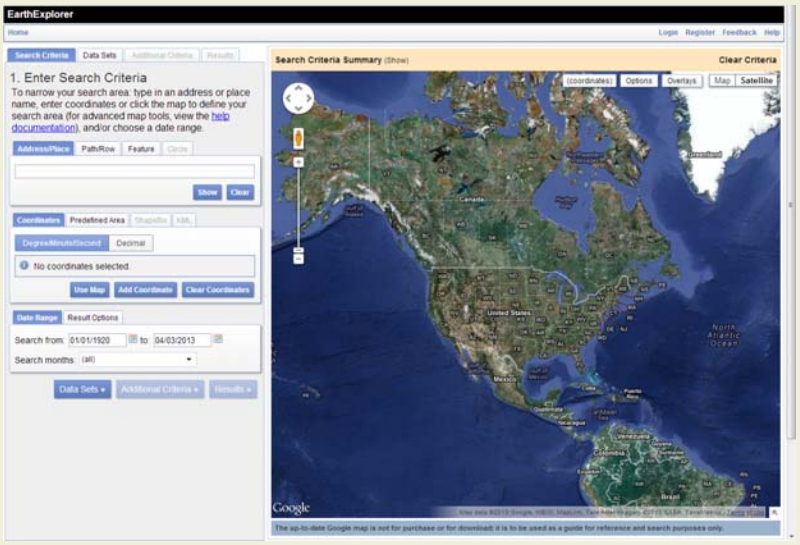
CRSSP Imagery Derived Requirements (CIDR) Tool

- You can put in a request for imagery that has already been shot
  - Imagery will typically be put into Earth Explorer for download
- You can request imagery be shot for a specific area
  - Constraints – no larger then a city
  - No guarantee that imagery will be acquired
  - Limited number of shoots per year (contract constraint)

Earth Explorer (EE)

- Large collection of commercial imagery
  - Geoeye, DigitalGlobe
- Easy to Search and can use bulk download feature
  - Great for downloading large areas

"Kenny's Favorite"



Geospatial Data Gateway (GDG)

- Access to NAIP imagery (3 band only) & other data types
  - Bulk downloads using a ftp solution. (Great for downloading high resolution 3 band NAIP)
  - Access to census, water and roads data and so much more

Rapid Delivery of Geospatial Intelligence (RDOG)

- New DigitalGlobe imagery distribution system
- DG hopes by the fall of 2013, to have daily orthorectified imagery uploaded daily
- Can download imagery to your machine or use as a Image Service

LandsatLook Viewer (LLV)

- Great viewer for downloading Landsat imagery
  - Best source for landsat
  - Imagery from the beginning of the Landsat Program (1972)

Let's get us some imagery!!!

- Login in to EarthExplorer
  http://earthexplorer.usgs.gov/
- You should have your user name and password that you created
- If you don't, shame on you! Watch your neighbor. (I have a copy on a thumb drive for you)

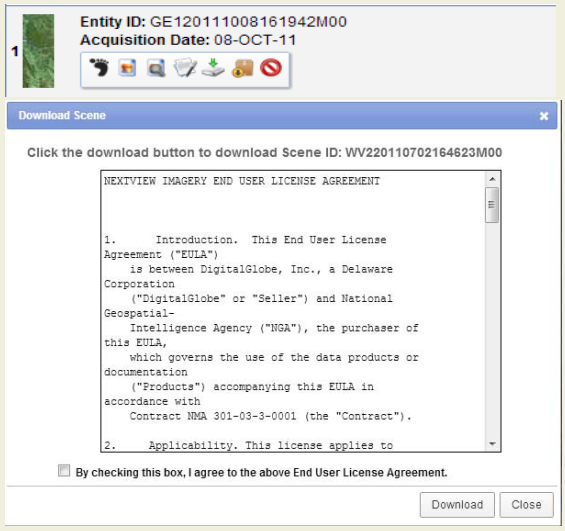
You imagery for the course

- We are going to zoom in and find imagery near Pulaski, VA
- Everyone is going to work on the same imagery for the class section. If you need help with imagery from your duty station, I can help you in the Project Consolations section of the class

Earth Explorer Demo

DEMO

Earth Explorer Download Example



Sign your life away!!!

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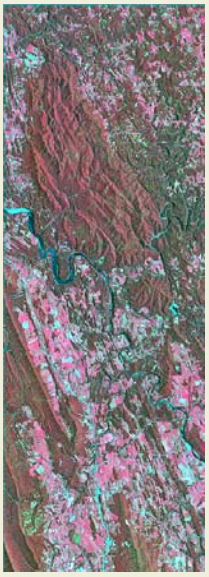


Note about imagery

- Most Imagery downloaded from a source has some kind of metadata associated with it. It is advised that you read through it
- Many government imagery sources provide imagery in NITF Format. This format was designed for the intelligence community and will not work in ENVI without a module extension. FWS will purchase 1 of these extensions and have it available at the start of FY14
- Imagery can be converted to another file format from ArcGIS Desktop or ENVI

Imagery Basics

What is Imagery?

Raster Data Anyone?

Matrix or Array of Values

In remote sensing values can represent:

- Brightness of an object (optical) – also called intensity.
- Surface roughness (radar)
- Elevation (DEM)

Computer recognizes numbers that represent an element in an array.

- Must know format to display correctly

ENVI reads almost any format.

ENVI data format – flat binary – very efficient reading/writing.

EXELIS
Visual Information Solutions

Raster vs. Vector

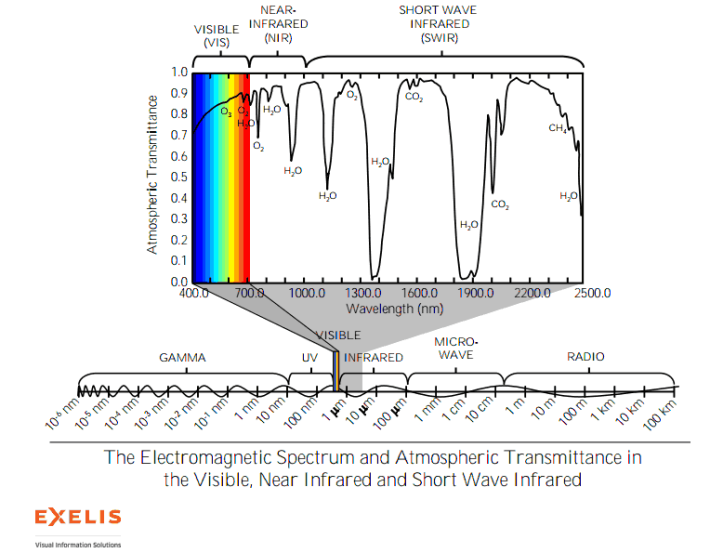
Values	Name	Count
1	Forest	10
2	Grass	9
3	Beach	2
4	Water	4

FID#	Name	value	Public?	Owner
1	Water	4	Yes	State
2	Beach	3	Yes	State
3	Grass	2	Yes	State
4	Forest	1	No	Warner

Imagery concepts to be familiar with

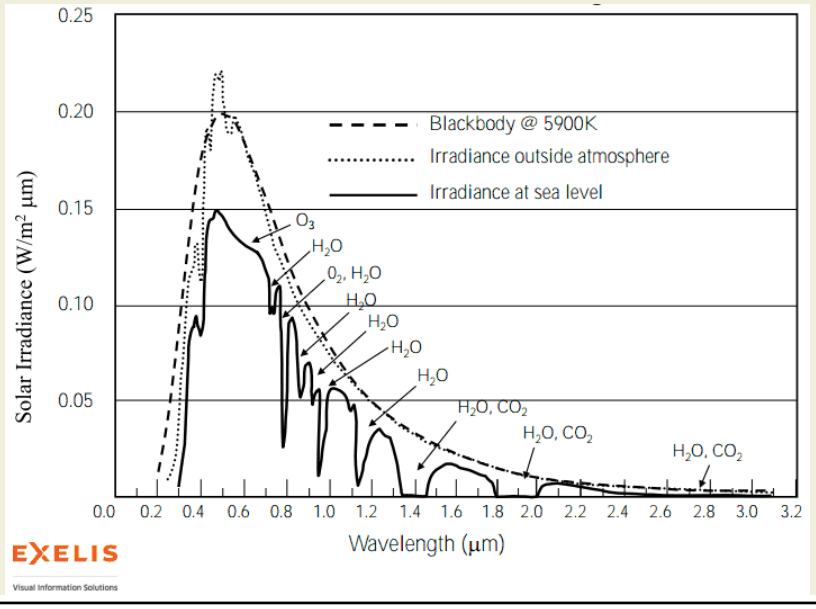
- Electromagnetic Spectrum
- Solar Irradiance
- Interleave
- Image Contrast Stretching

Electromagnetic Spectrum



The Electromagnetic Spectrum and Atmospheric Transmittance in the Visible, Near Infrared and Short Wave Infrared

Solar Irradiance



Interleave

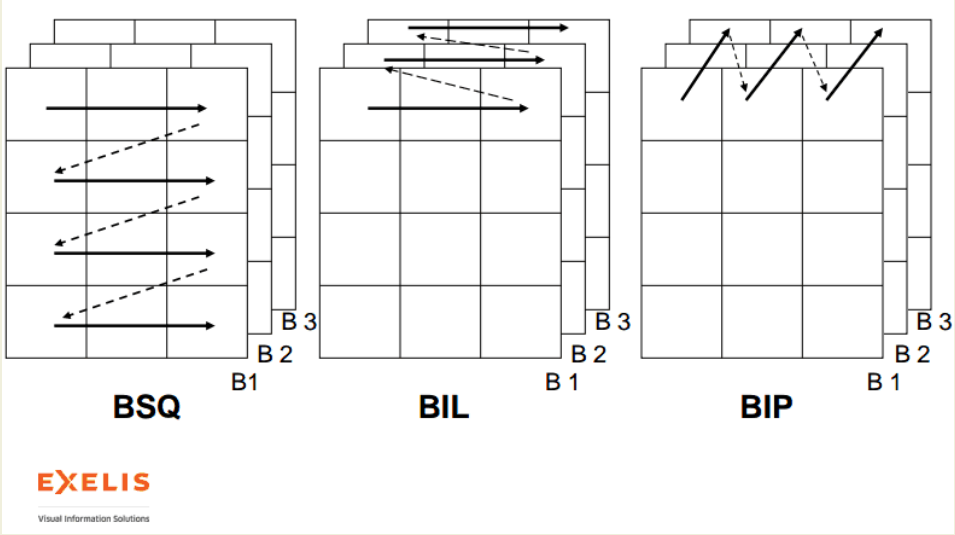


Image Contrast Stretching

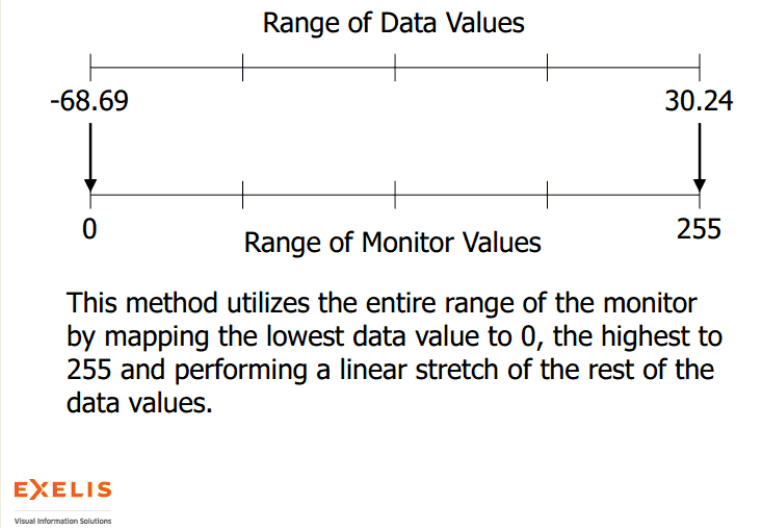
Possible Data Values -> Possible Monitor Values - 8 vs. 24 bit

Stretch Types

- Linear
  - Linear 0-255 – not a stretch; maps 0 to 0, etc.
  - Linear – lowest value = 0, highest = 255
  - Linear 2% - Make 2% of lowest and 2 % of highest values, 0 and 255, respectively.
- Gaussian – mean 127, +/-3 SD = 0 and 255
- Equalization – non-linear – image values assigned to display levels based on frequency of occurrence.
- Square root – takes square root of histogram and applies linear stretch.
- Logarithmic – enhances darker parts of the image
- Optimized Linear - default contrast stretch is for unsigned integer data. This is a dynamic range adjustment and it prohibits use of the contrast enhancement tool

EXELIS
Visual Information Solutions

Example: Linear Stretch



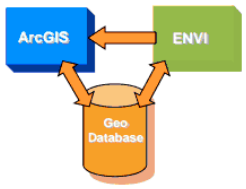
Working With ENVI 5.0

Objective:

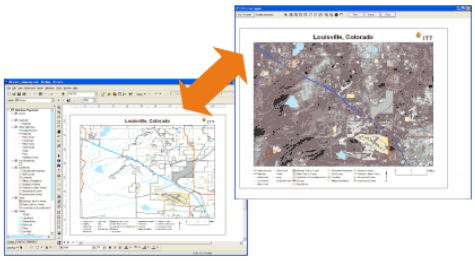
- A basic understanding of how to navigate through the ENVI 5.0 interface

Interoperability

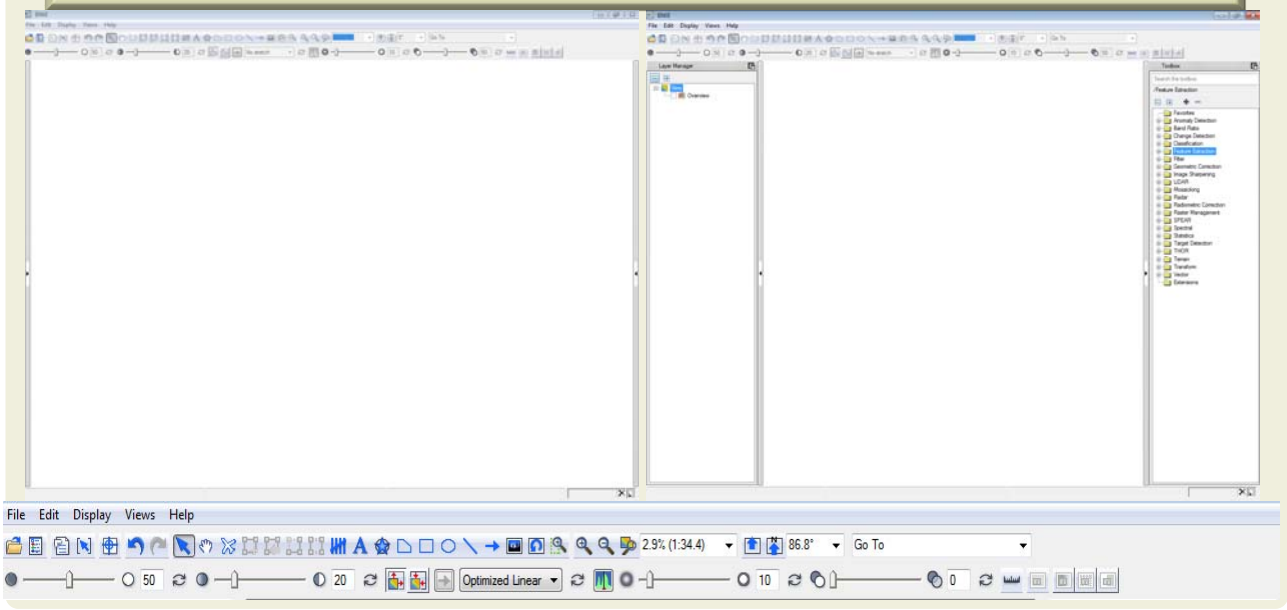
- Geodatabase read/write capabilities in ENVI
- Supports Enterprise, Personal, and File Geodatabase types
- ENVI Standard file format read/write in ArcGIS
- ENVI Geo Link To ArcMap
- ENVI NITF for ArcGIS extension
- Display and Processing of ESRI Layers within ENVI
- Symbology of *.lyr preserved
- Drag-and-drop support from ArcMap & ArcCatalog into ENVI
- Launch ArcMap and create map compositions directly from ENVI



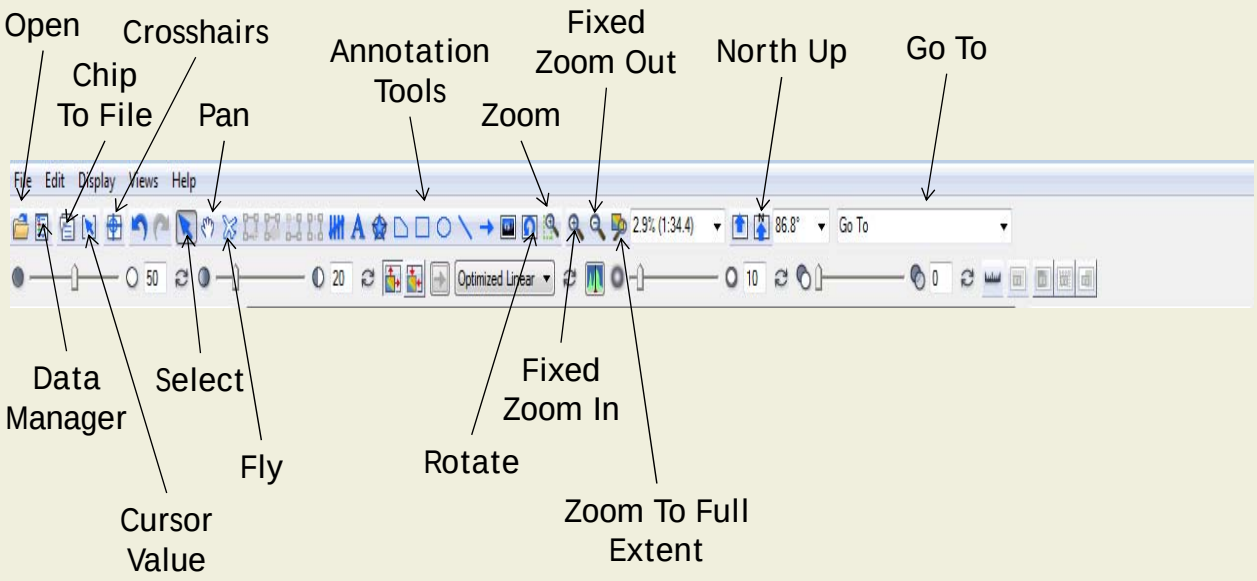
EXELIS
Visual Information Solutions



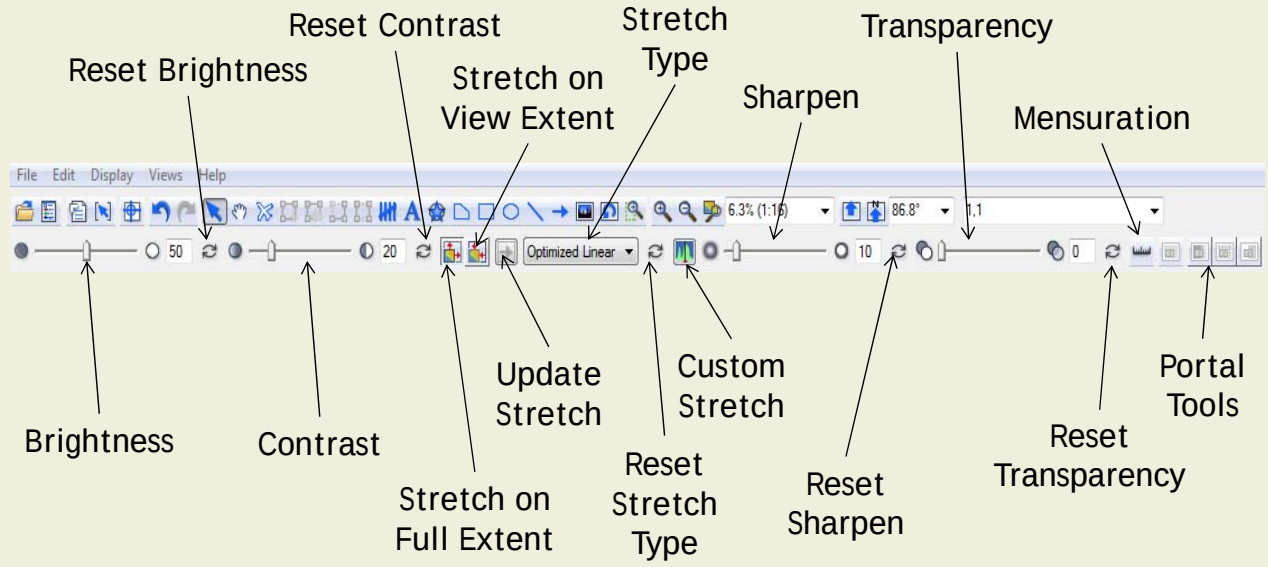
Main Screen



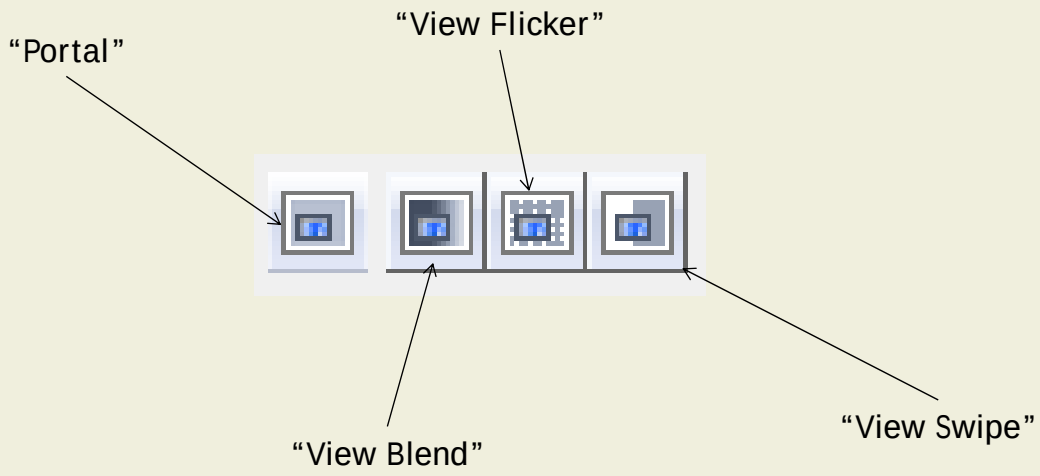
The tools – Top Row



The Tools – Bottom Row

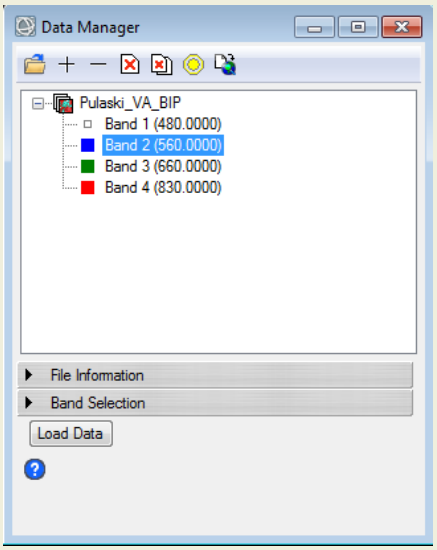


Portal Tools



Data Manager

- Lists the files that are opened and allows you to select bands to display



Questions???

Prepping the Image

- Convert to TIFF (draws faster as a TIFF)
- Change the Interleave (for practice)
- Define Wavelengths (for practice)
- Run the FLAASH Atmospheric Correction Tool (*Not going to complete this step in class)

Convert to TIFF

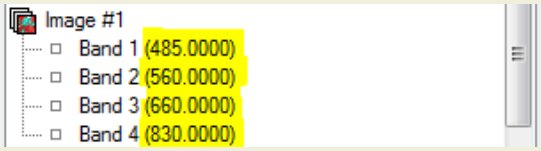
- First we are going to convert from a NITF to TIFF format. (This allows us to change the interleave so we can adjust for atmospheric effects if desired)
- Load the image in ENVI 5.0 and click → File → Save As

Change the Interleave

- Type “Interleave” in the toolbox look up and double click on “convert interleave”. Select Pulaski_VA.tif and click Ok
- Select BIP and enter the output filename Pulaski_VA_BIP

Define Wavelength

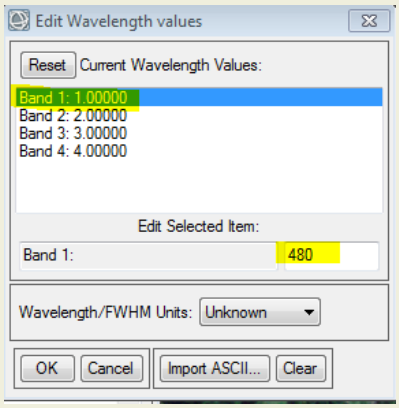
- Click on the Data Manger and note the band wavelength from the original image



- In the Toolbox look up type “Header” and double click on “Edit ENVI Header”
- Select Pulaski_VA_BIP and click the “Edit Attributes” pull-down and select wavelengths

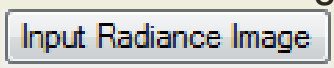
Define Wavelengths

- Set the Wavelengths to
  - Band 1: 480
  - Band 2: 560
  - Band 3: 660
  - Band 4: 830

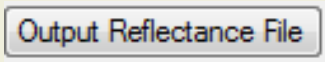


FLAASH Atmospheric Correction Tool

- Type “FLAASH” into the Toolbox look up and double click “Flash Atmospheric Correction”
- Select Pulaski_VA_BIP as the “Input Radiance Image” and click Ok. Use single scale factor of 1.0000



- “Output Reflectance File” in your class working folder and save it as Pulaski_VA_BIP_FLAASH



FLAASH Atmospheric Correction Tool

Fill in all required values in the tool. The tool will prompt you for all required values. (Not doing this step in class)

Unsupervised Classification

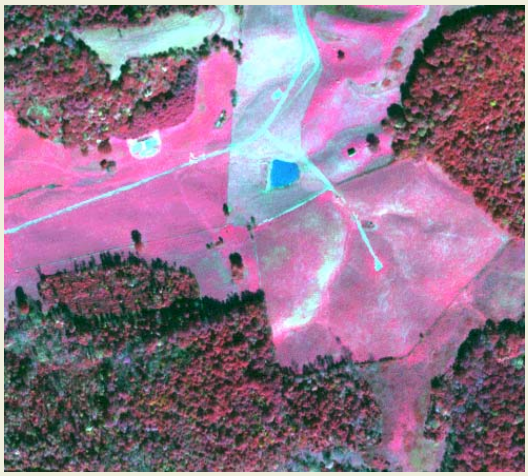
Objectives:

- Run an unsupervised classification on your radiance imagery
- Please load “Pulaski_VA_BiP into ENVI 5.0

Unsupervised Classification

Method of classifying pixels into categories (classes) without any previous knowledge of the scene

Unsupervised Classification



- Make sure your image in the layer manager has been loaded as a 4,3,2 image
- Trees are dark red in this image, while grasses are pinkish

Unsupervised Classification

In a ideal world, all vegetation would have the same spectral signature, but in this world, this is not the case

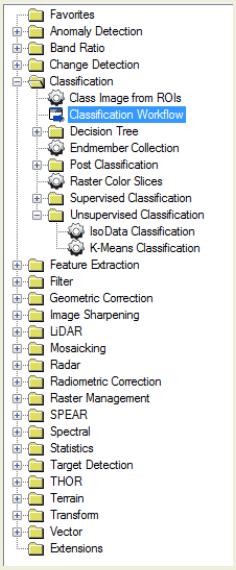
Click on Display → Spectral Profile and click around water, trees and roads. See how the profiles differ

Unsupervised Classification

- You will notice that even though you are hitting trees, the spectral profiles will be slightly different. This is because we are not in an ideal world

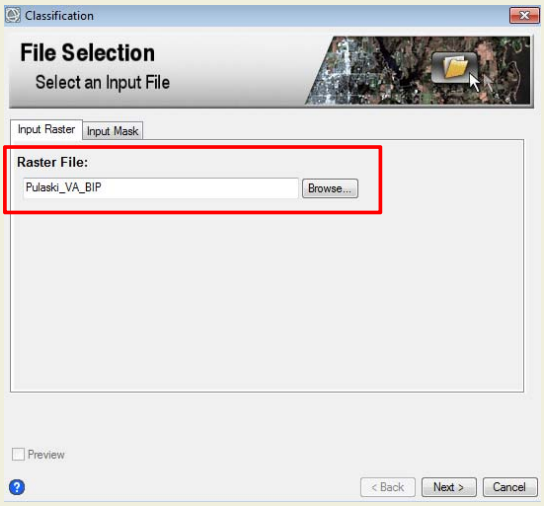
Unsupervised Classification

- There are two ways to do an unsupervised classification
  - Using the Workflow
  - Raw Tool
- I can teach you both, but our primary tool will be the "Classification Workflow"



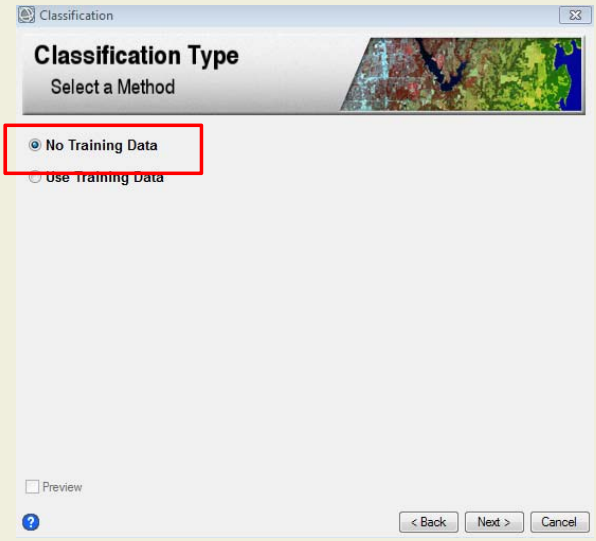
Unsupervised Classification

- Input Pulaski_VA_BIP
- We are not using a mask for this exercise, but you can play with masks later

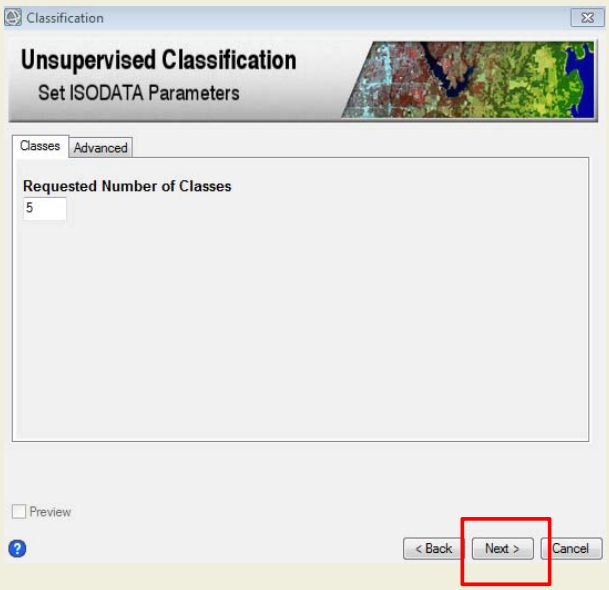


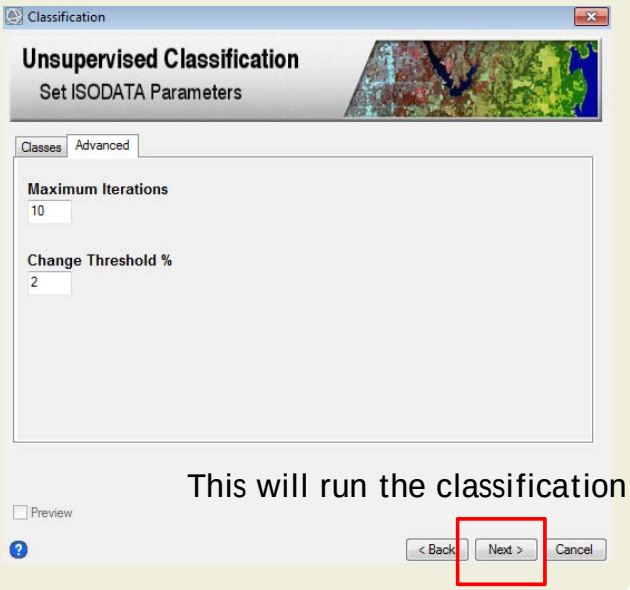
Unsupervised Classification

- "No Training Data" equals Unsupervised
- "Use Training Data" equals Supervised



Unsupervised Classification





This will run the classification

Unsupervised Classification

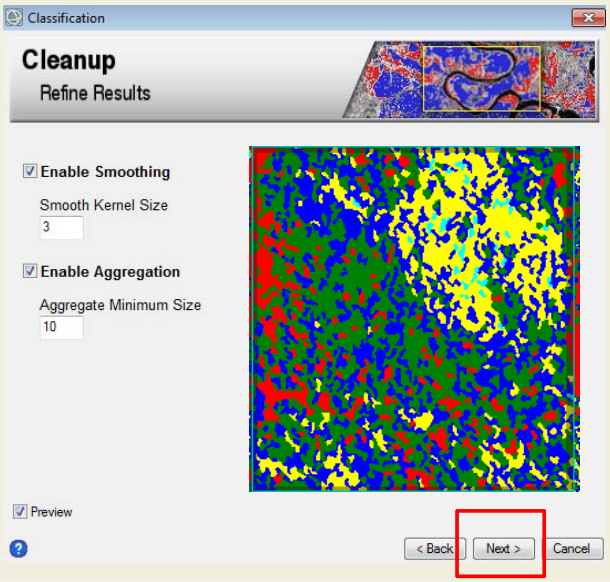
This will take approximately 15 minutes to run

Question time or General comments can be fielded now

Unsupervised Classification

You can tinker with the cleanup and turn the preview on to see what adjustments will look like in the final product.

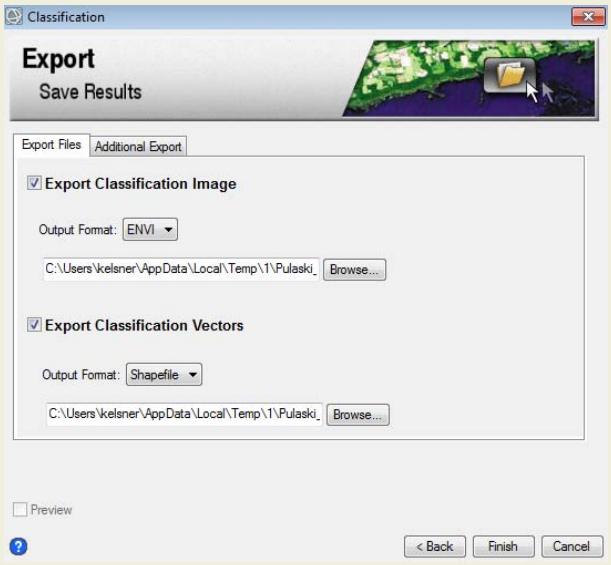
Click next to run the cleanup



Unsupervised Classification

Export the classification image to appropriate folder. Turn off "Export Classification Vectors"

In the additional exports you can export the classification statistics if desired



Unsupervised Classification

After the classification is run, we have to “proof” (test for accuracy) the imagery

The best way to proof the imagery is on the ground in the field, but who has the time?

So we will use the portal tools to compare the classified image to the Color Infrared Imagery and True Color Imagery

Supervised Classification

Method of classifying pixels into categories (classes) which requires an analyst to select training areas

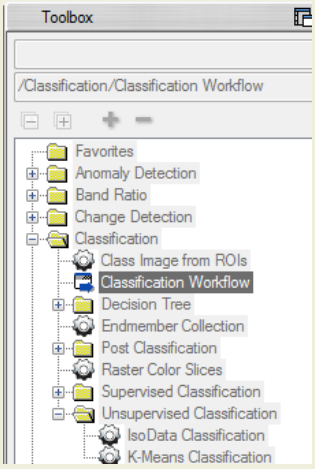
Most training areas are of known homogenous areas (example…forests, water bodies, bare earth, snow capped peaks, parking lots

Supervised Classification

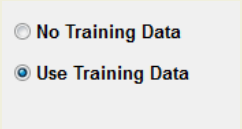
- Consider this when drawing ROIs
  - Homogenous polygons
  - Be precise as possible
  - Keep the polygons relatively small. (Big polygons for oceans and water bodies are okay)

Supervised Classification

Locate the Classification Workflow in the Toolbox and select Pulaski_VA_BIP and click next



Select "Use Training Data and click next



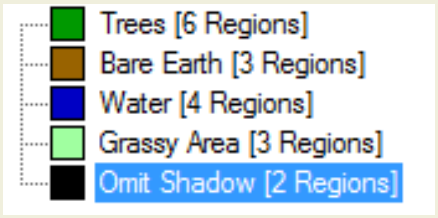
Supervised Classification

We are going to create Regions of Interest (ROI) in the Workflow tool

Add another ROI by clicking the "add class" button 

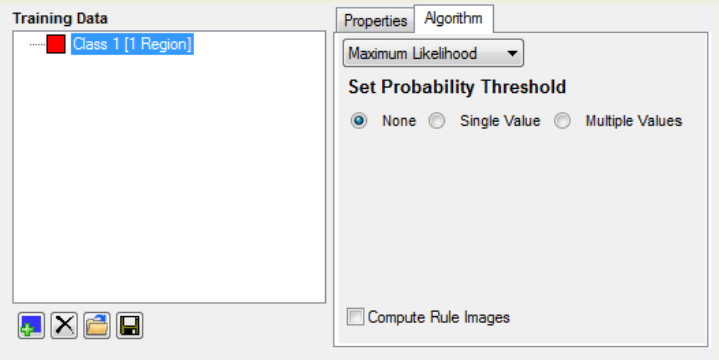
Supervised Classification

- ROIs to create (many more that you can create)
  - Forest
  - Bare Earth
  - Water
  - Grassy Fields
  - Omit Shadow



- Other fields to consider
  - Shadow field (or you can mask the shadows)
  - Bright sports (sun glare)

Supervised Classification



You can change the Algorithm and see how it effects the classification. Maximum Likelihood, Minimum Distance, and Mahalanobis Distance are available

Supervised Classification

Maximum Likelihood – Each pixel is assigned to the class for which the highest probability is calculated

Works best when the data are normally distributed. Many pixels can remained unclassified with this algorithm

Supervised Classification

Minimum Distance – A pixel is assigned to the class corresponding to the ROI with the closest mean

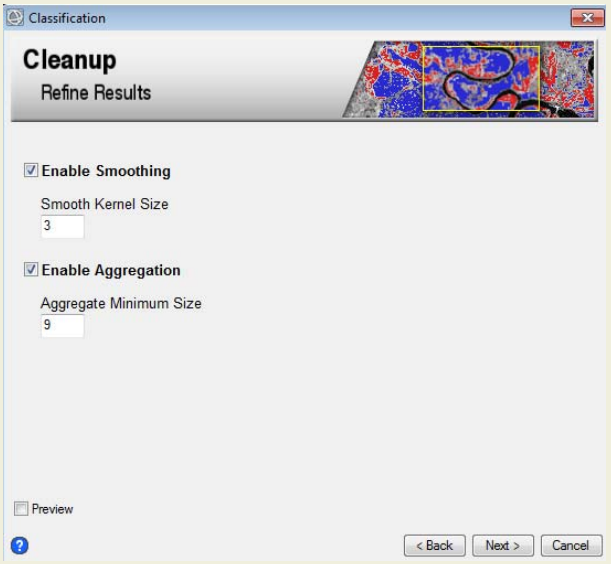
If the pixel is beyond the threshold distance from the closest mean, it will remain unclassified

Supervised Classification

Mahalanobis Distance – Direction sensitive distance classifier which is similar to the Maximum Likelihood but assumes all class covariance are equal

Supervised Classification

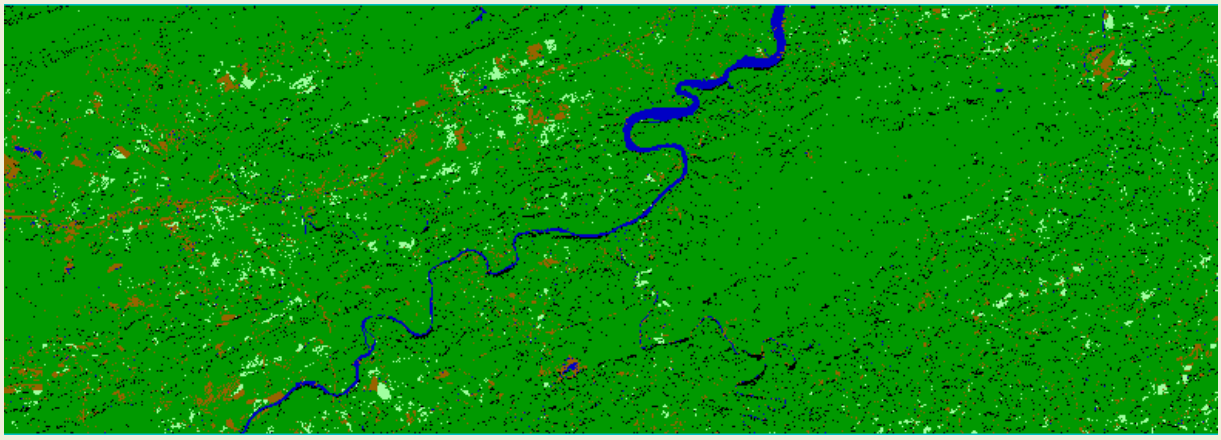
Click Next and it will start the supervised classification. After it has run, the clean-up and export routine is the same as the unsupervised classification



Supervised Classification

- Turn off "Export Classification Vectors"
- After the export is completed, proofing needs to be conducted
- You most likely will not get a great classification the first time. You need to tweak your ROIs and make sure they are apporpriate

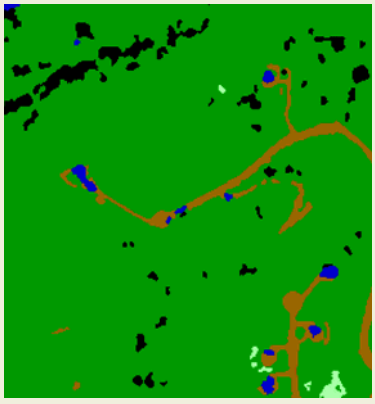
Supervised Classification

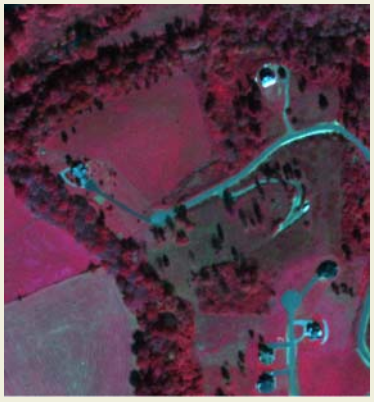


Supervised Classification

My Results

- I threw 5 ROIs together in about 2 minutes.
- Results are about what one would expect from 2 minutes of work





Supervised Classification

Conclusions

- Using the supervised classification without the appropriate amount of time for constructing good ROIs was a waste of my time.

Supervised vs. Unsupervised

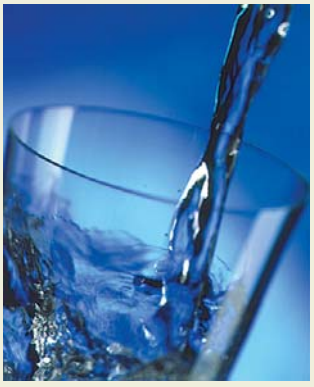
Unsupervised Classification quickly takes advantage of the spectral variability in the image, but does not care what we think are important features in the image

Supervised achieves good separation of classes but requires strong training datasets (ROIs) which take time to develop

Questions???

Feature Extraction

- Rule based feature extraction is based on human knowledge and reasoning about specific feature types.



Feature Extraction

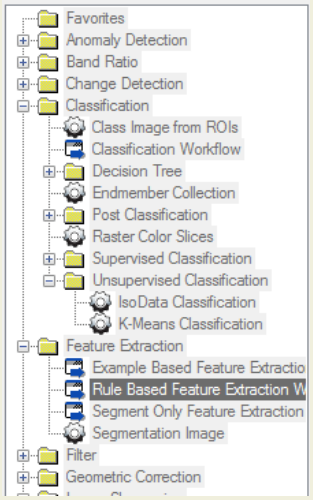
- Most tree canopies are highly variable
- Tree canopies are heterogeneous with lots of variation in leaf orientation, branches and shadows
- With image segments containing one or more trees, textural and shape attributes can be used to make classification of trees more accurate

Feature Extraction

- Once you create a rule set, you can save it and use it on other imagery datasets. (as long as the other datasets have similar vegetation types)

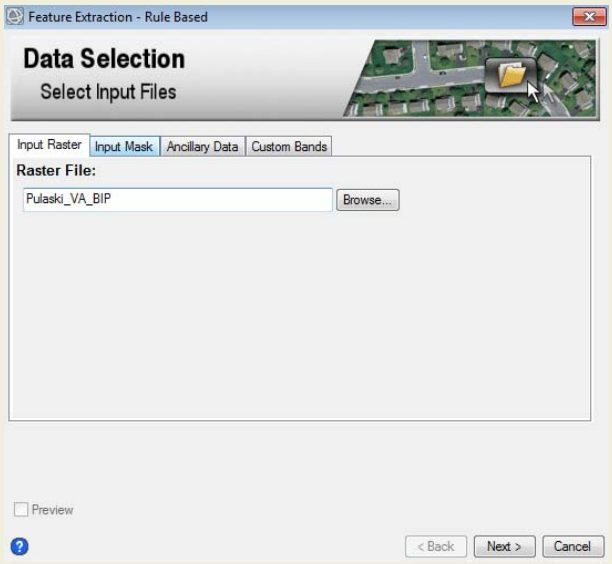
Feature Extraction

Click on “Rule Based Feature Extraction”



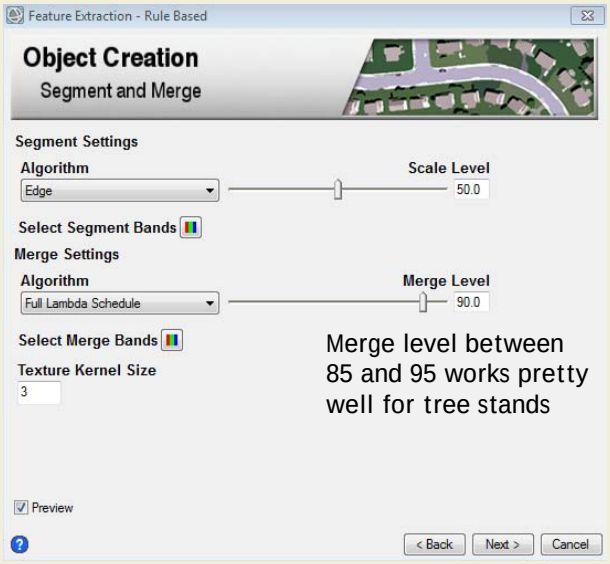
Feature Extraction

- Select Pulaski_VA_BIP as the input raster. There are options for masks and ancillary data (Elevation or a Digital Surface Model)
- Click Next



Feature Extraction

- Click the preview box in the bottom left corner and adjust the algorithm for "Segment Settings" and "Merge Settings" (PLAY WITH IT)
- Click Next



Merge level between 85 and 95 works pretty well for tree stands

Feature Extraction

This will take approximately 15 minutes to run

Question time or General comments can be fielded now

Feature Extraction

A image is added to the layer manager after the process runs

Now we can create rules in the “Create Rules” step of the process

Click on the “Add Class Icon” 

Feature Extraction

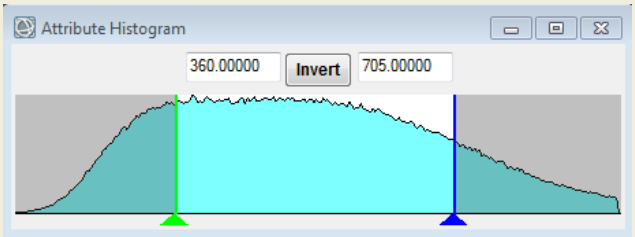
Change the “Class Name” to Trees and change the color to green

Select the Spectral Mean (Band 1) and change to Band 4. Click the Dock/Undock button near the histogram 

Green is classified as a tree. Move the green and blue sliders on the historgrams while using the preview portal. Tinker Away!

Feature Extraction

This is the histogram I came up with. It isn't perfect but it does a decent job of picking up on trees and open space



Feature Extraction

Let's create some more rules based on our knowledge and experience

Click "Rule" and "Add Attribute To Rule"

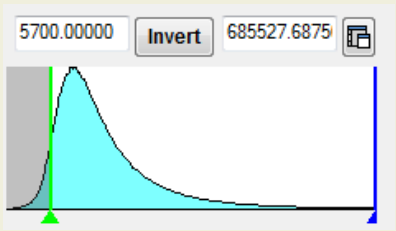
In the attributes tab under "Type" select texture and under "Name" select Texture Variance.

Change the band to band 4

Feature Extraction

Notice the craziness of the histogram. Decouple the histogram and tinker with the values by either typing in values or pulling the green and blue bars

My Results



Feature Extraction

You can continue to add rules under you are blue in the face. My suggestion is to focus on 2 – 5 rules that you can spend time manipulating to get the best result.

Another effective technique is to use masks

Feature Extraction

Since time is short, we are going to be satisfied with Texture Variance and Spectral Mean

Click Next. This will run the rule classification

After it is done running, export to appropriate location and click finish

Questions???