



# ArcGIS Pro: Image Segmentation, Classification, and Machine Learning

Jeff Liedtke and Han Hu

An abstract 3D architectural graphic on the right side of the slide. It consists of several overlapping, semi-transparent planes in shades of blue, orange, green, and red. The planes are oriented at various angles, creating a sense of depth and perspective. Some planes feature patterns like topographic contour lines or a grid of small orange dots. The overall composition is dynamic and modern.

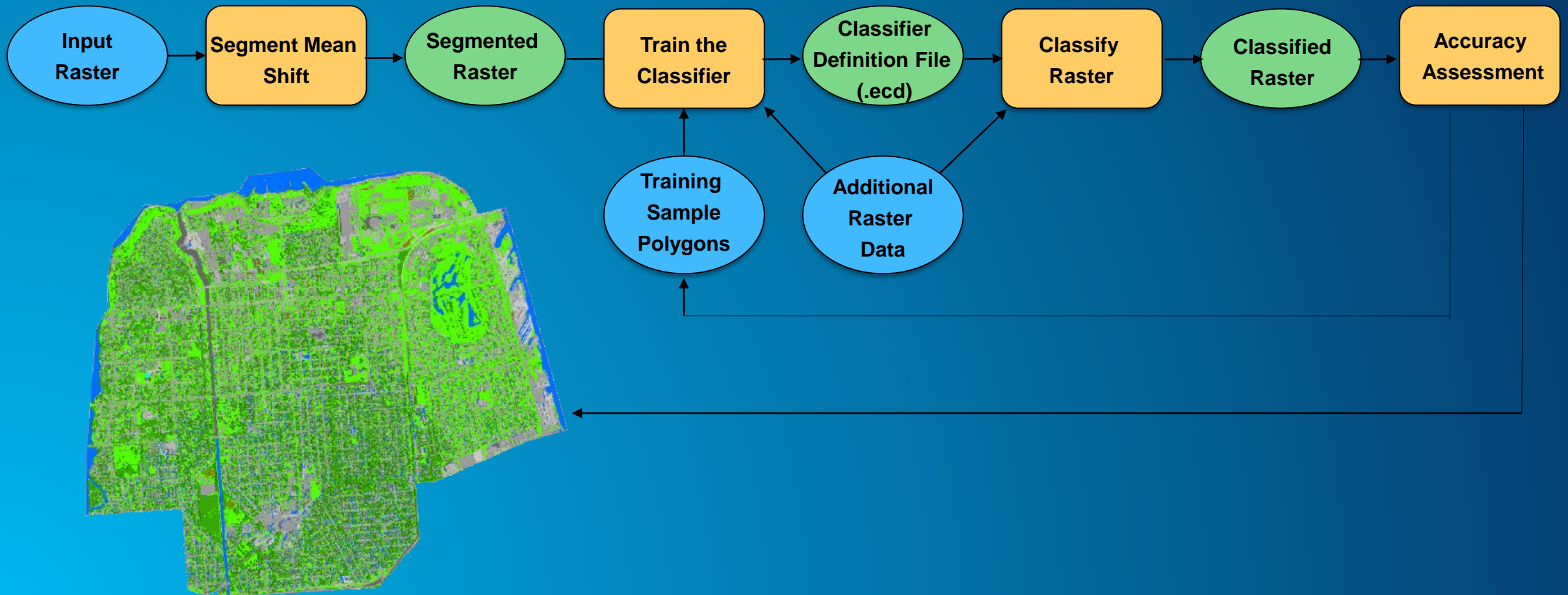
**GIS  
INSPIRING  
WHAT'S  
NEXT**

# Overview of Image Classification in ArcGIS Pro

- Overview of the classification workflow
- Classification tools available in Image Analyst (and Spatial Analyst)
- See the Pro Classification group on the Imagery tab (on the main ribbon)
- The Classification Wizard
- Segmentation
- Description of the steps of the classification workflow
- Introducing Deep Learning

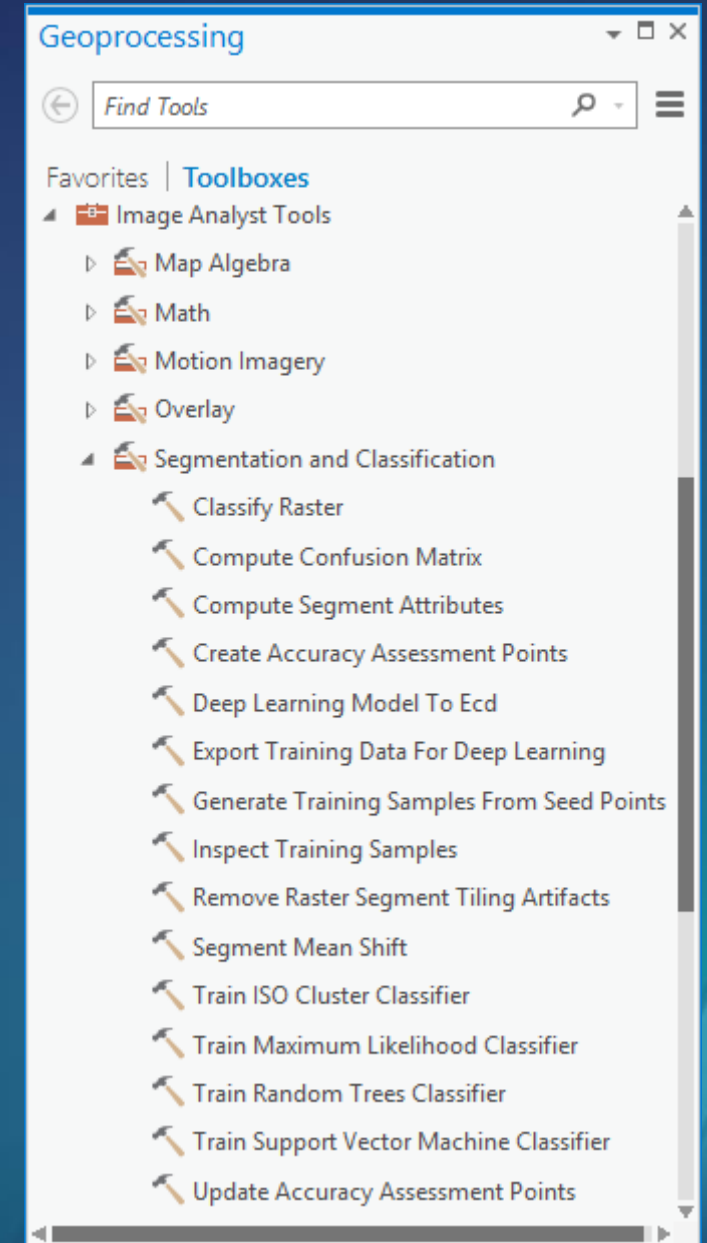
# Conceptual Supervised Classification Workflow

- Support Vector Machine
- Random Trees
- Deep Learning
- Maximum Likelihood

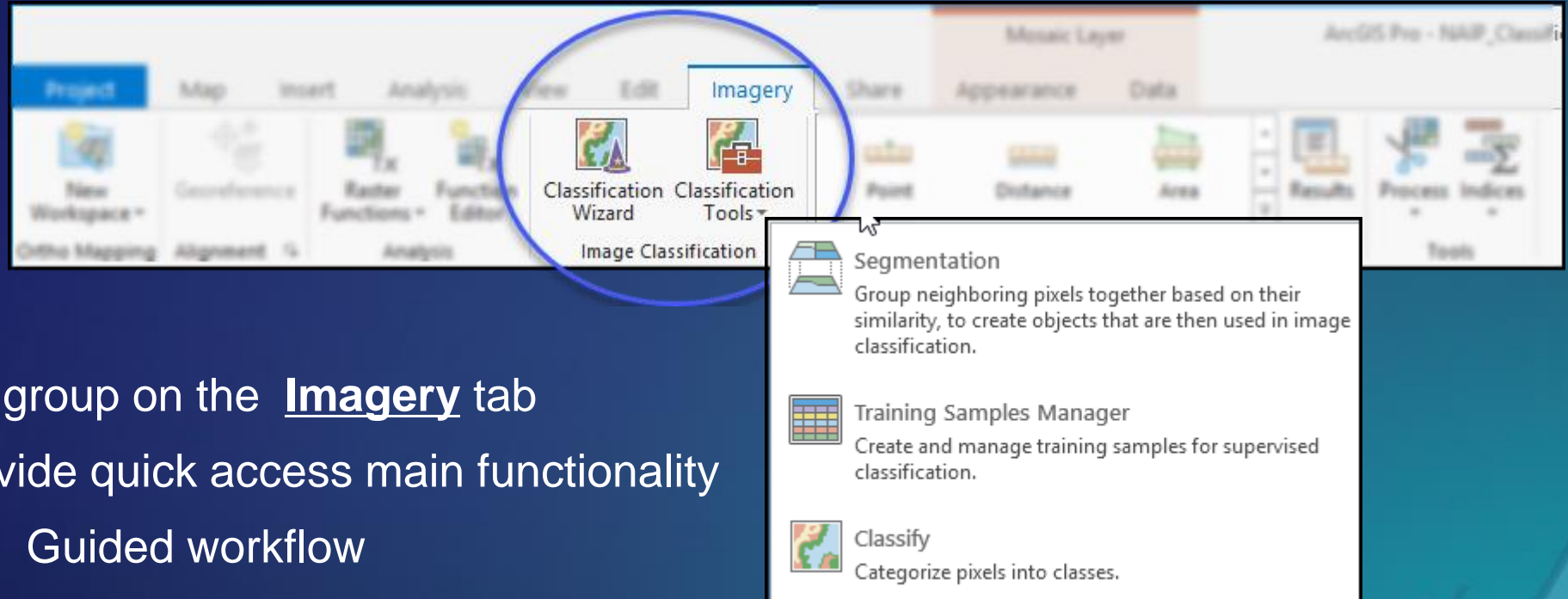


# Segmentation and Classification GP Tools

- In the Image Analyst Toolbox
- Includes tools to support the entire classification workflow
  - Segmentation
  - Training Sample collection and editing
  - Classifiers
    - Supervised - Random Forest, SVM, Deep Learning, MLC
    - Unsupervised - ISO Cluster
  - Class merging and editing
  - Accuracy assessment



# Image Classification on the main Pro toolbar

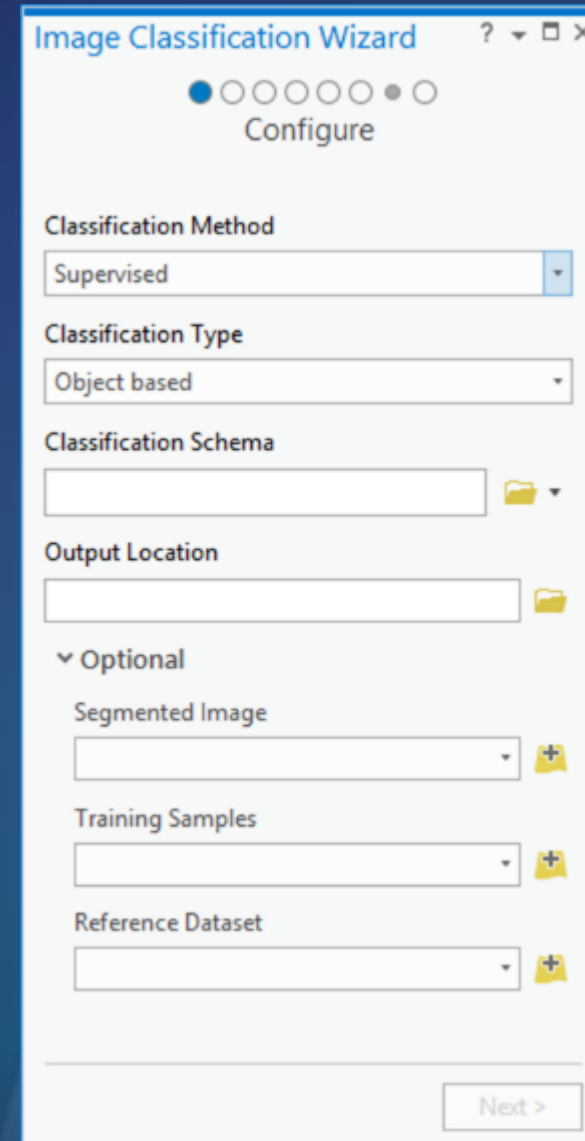


- Image Classification group on the Imagery tab
- Classification tools provide quick access main functionality
- Classification Wizard - Guided workflow



# Image Classification Wizard

- Guided workflow for all the major classification steps
  - Configure your classification project
  - Set up image segmentation
  - Training Sample Manager
  - Train the classifier
  - Image classification
  - Merge Classes
  - Accuracy Assessment
  - Reclassifier



The screenshot shows the 'Image Classification Wizard' window, specifically the 'Configure' step. The window title is 'Image Classification Wizard' and it has standard window controls. Below the title bar, there is a progress indicator with seven circles, the first of which is filled, and the word 'Configure' below it. The main area contains several configuration options:

- Classification Method:** A dropdown menu set to 'Supervised'.
- Classification Type:** A dropdown menu set to 'Object based'.
- Classification Schema:** An empty text box with a folder icon and a dropdown arrow to its right.
- Output Location:** An empty text box with a folder icon to its right.
- Optional:** A section header with a dropdown arrow.
- Segmented Image:** An empty text box with a plus icon to its right.
- Training Samples:** An empty text box with a plus icon to its right.
- Reference Dataset:** An empty text box with a plus icon to its right.

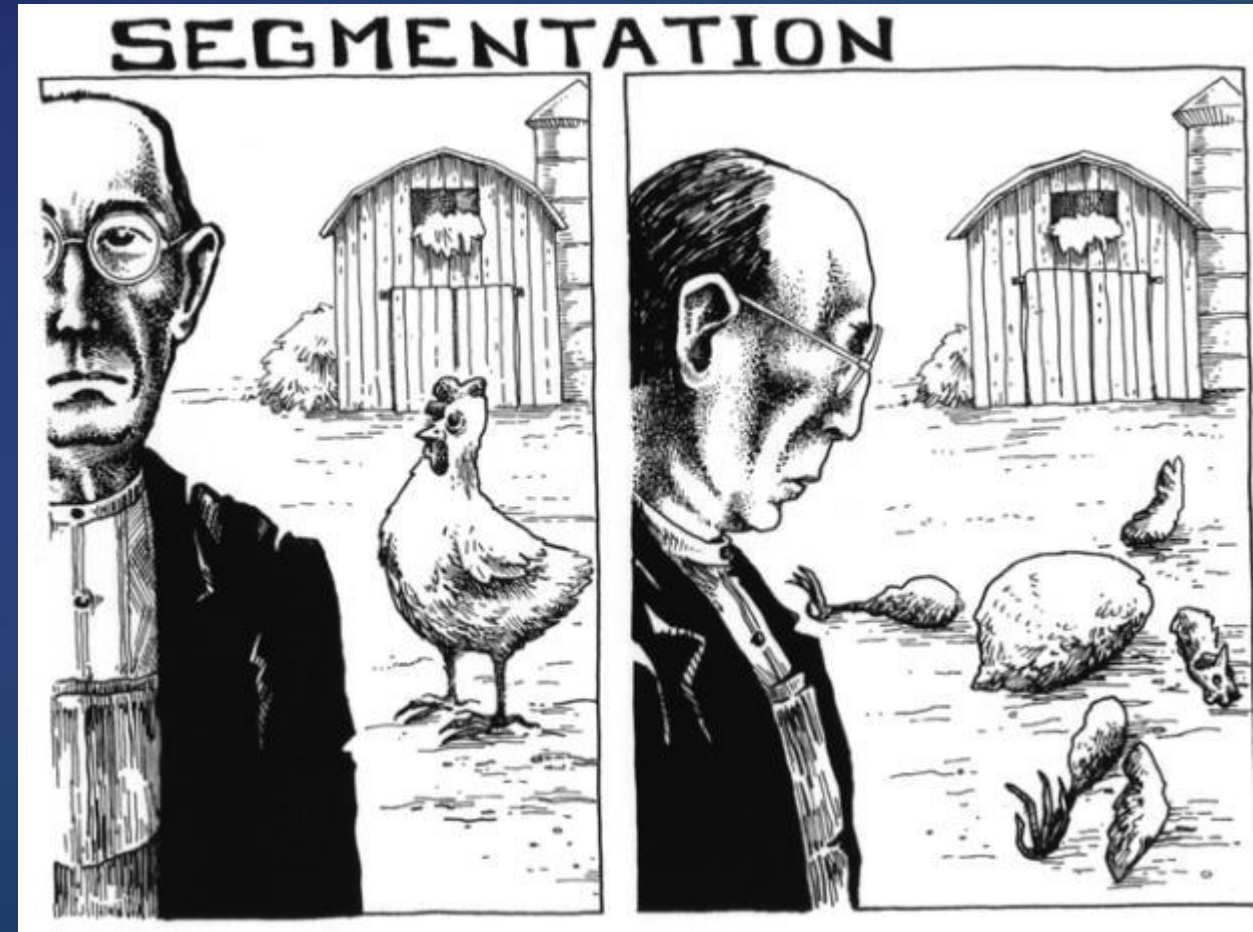
At the bottom right of the window, there is a 'Next >' button.

# Support in different ArcGIS processing frameworks

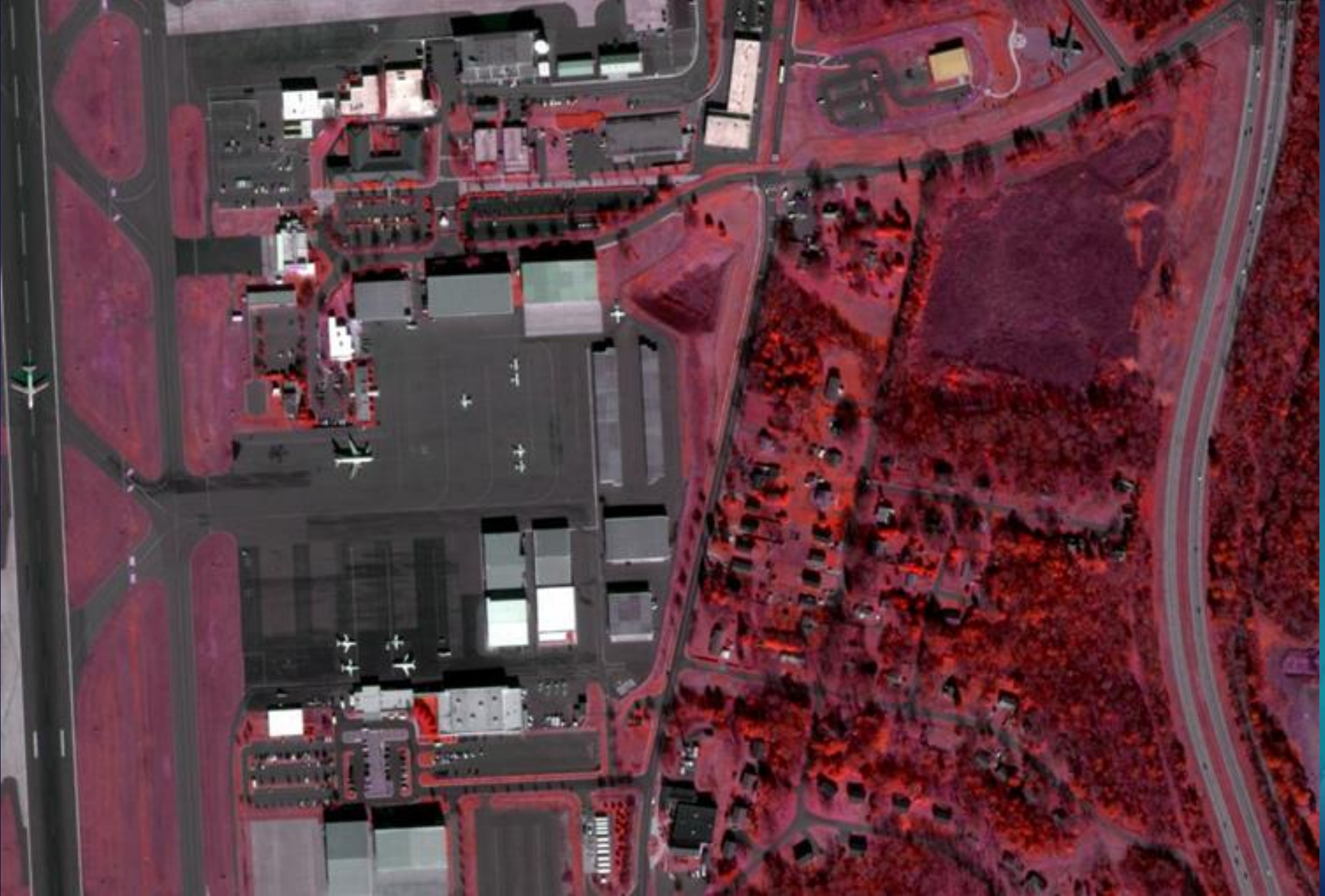
	On-the-fly Processing	Geoprocessing	Raster Analytics
Segmentation	√	√	√
Train		√	√
Classify	√	√	√

# Object-Based Image Analysis (OBIA)

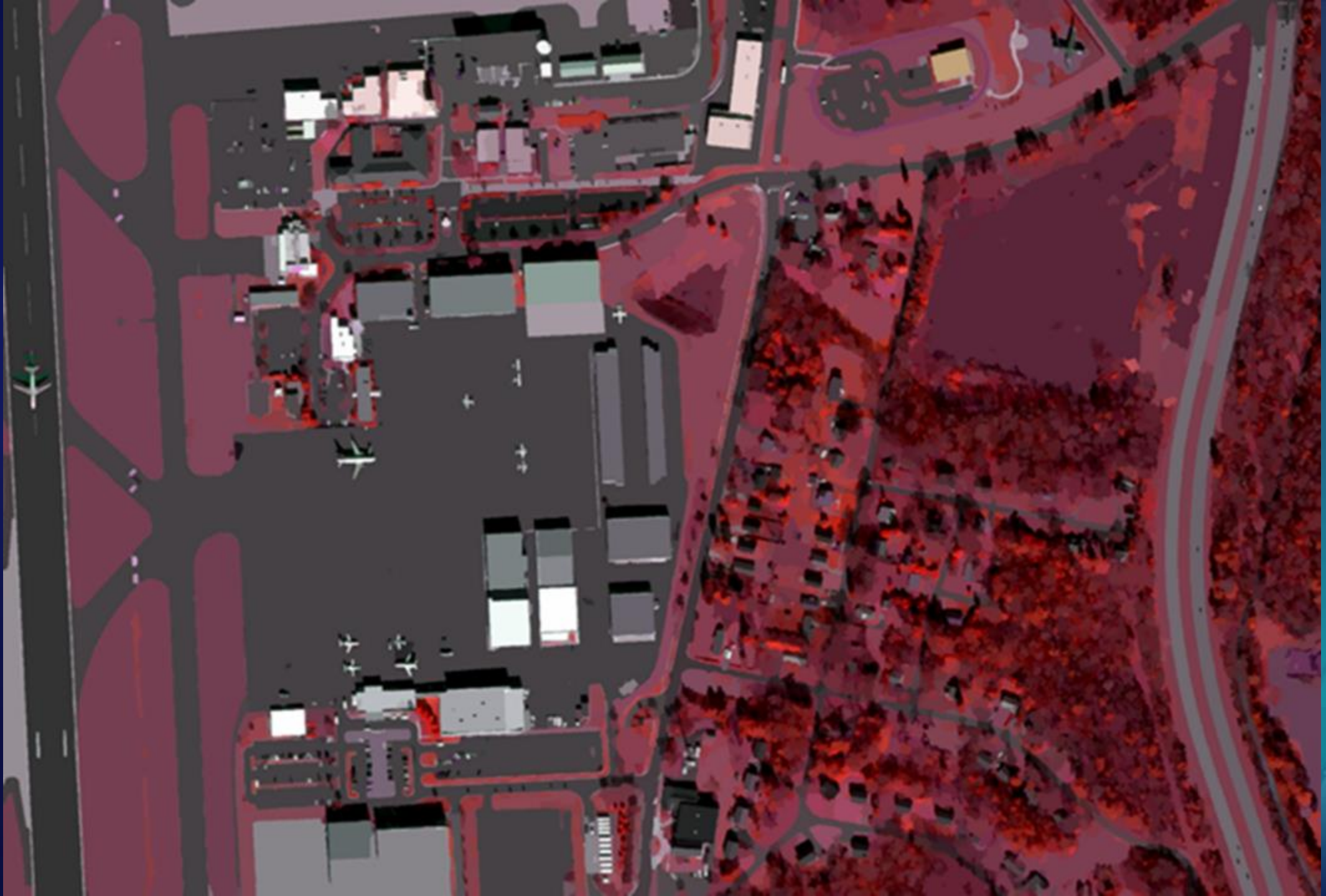
- Image Segmentation
  - Groups adjacent pixels having similar spectral characteristics into segments called “Objects”
- Objects are treated as “super pixels” by the classifiers
- Objects can be classified according to spectral and spatial characteristics
- Objects are representative of ground features



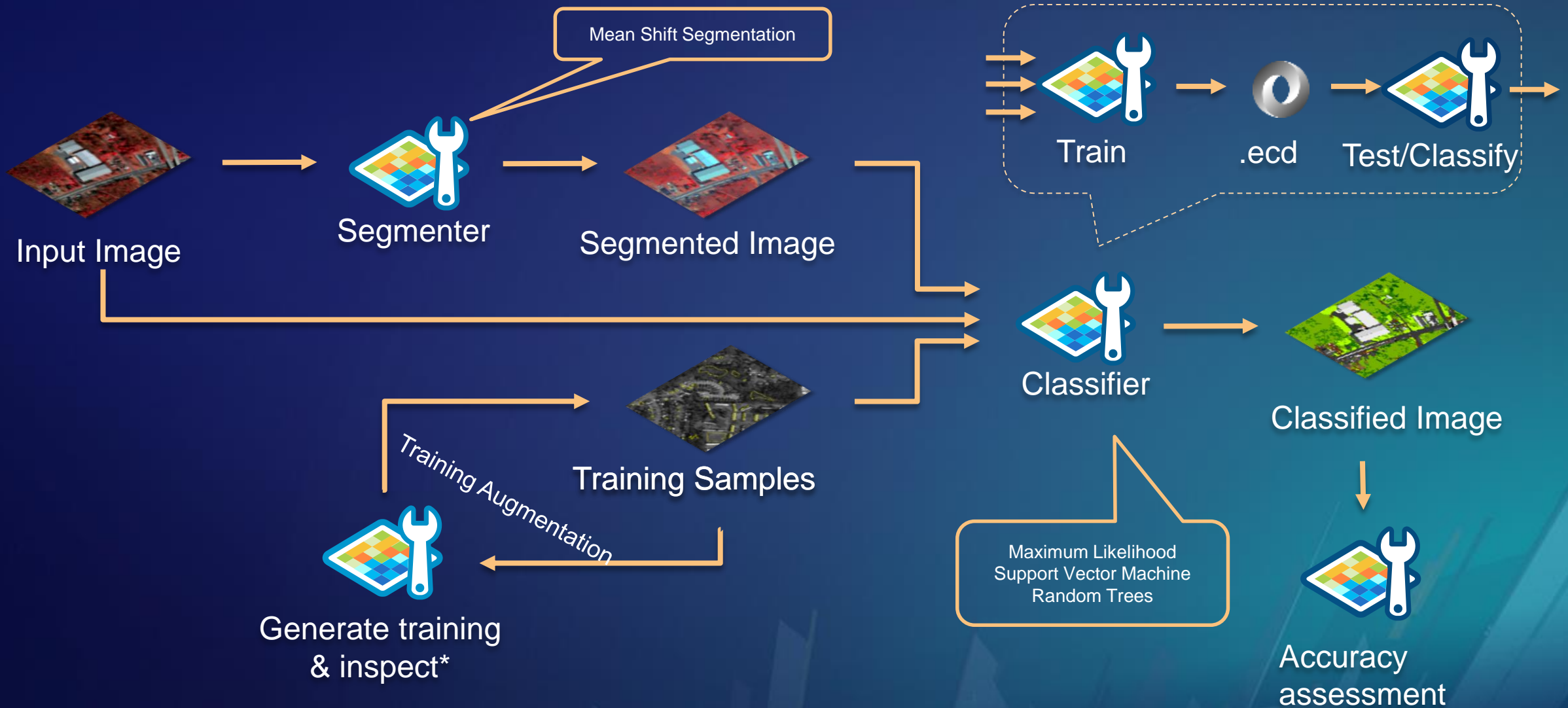




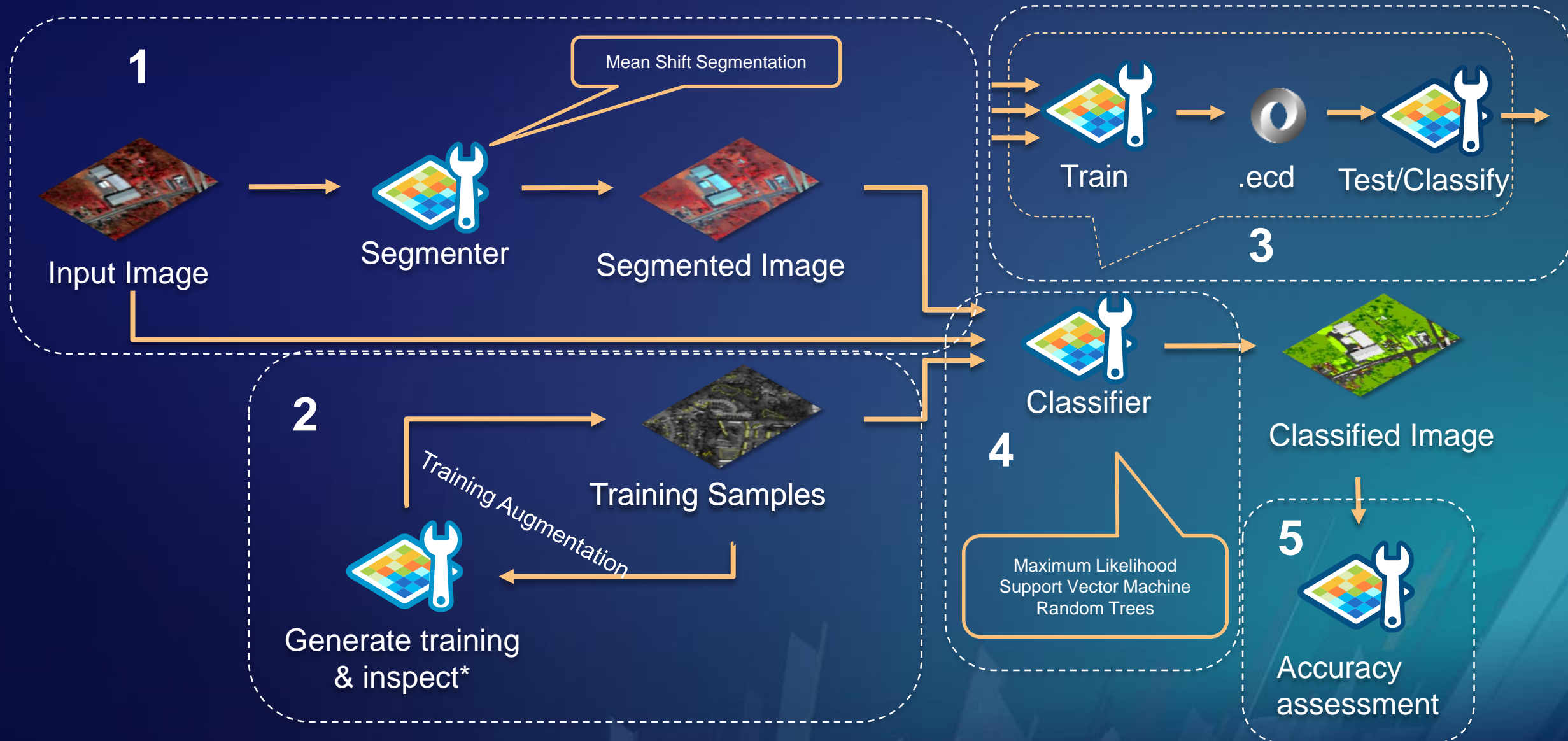




# Supervised Image Classification

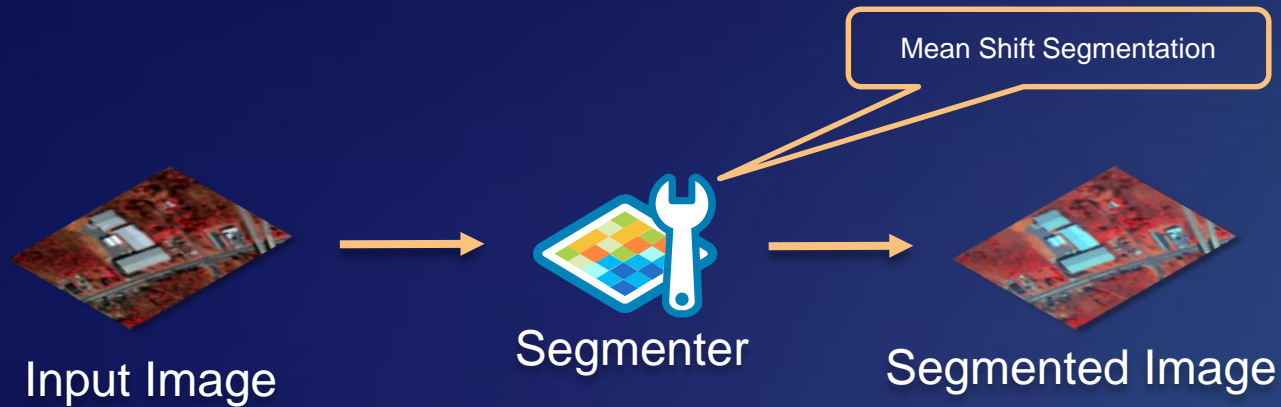


# 5 main steps comprising Supervised Image Classification





# Supervised Image Classification – Image Segmentation

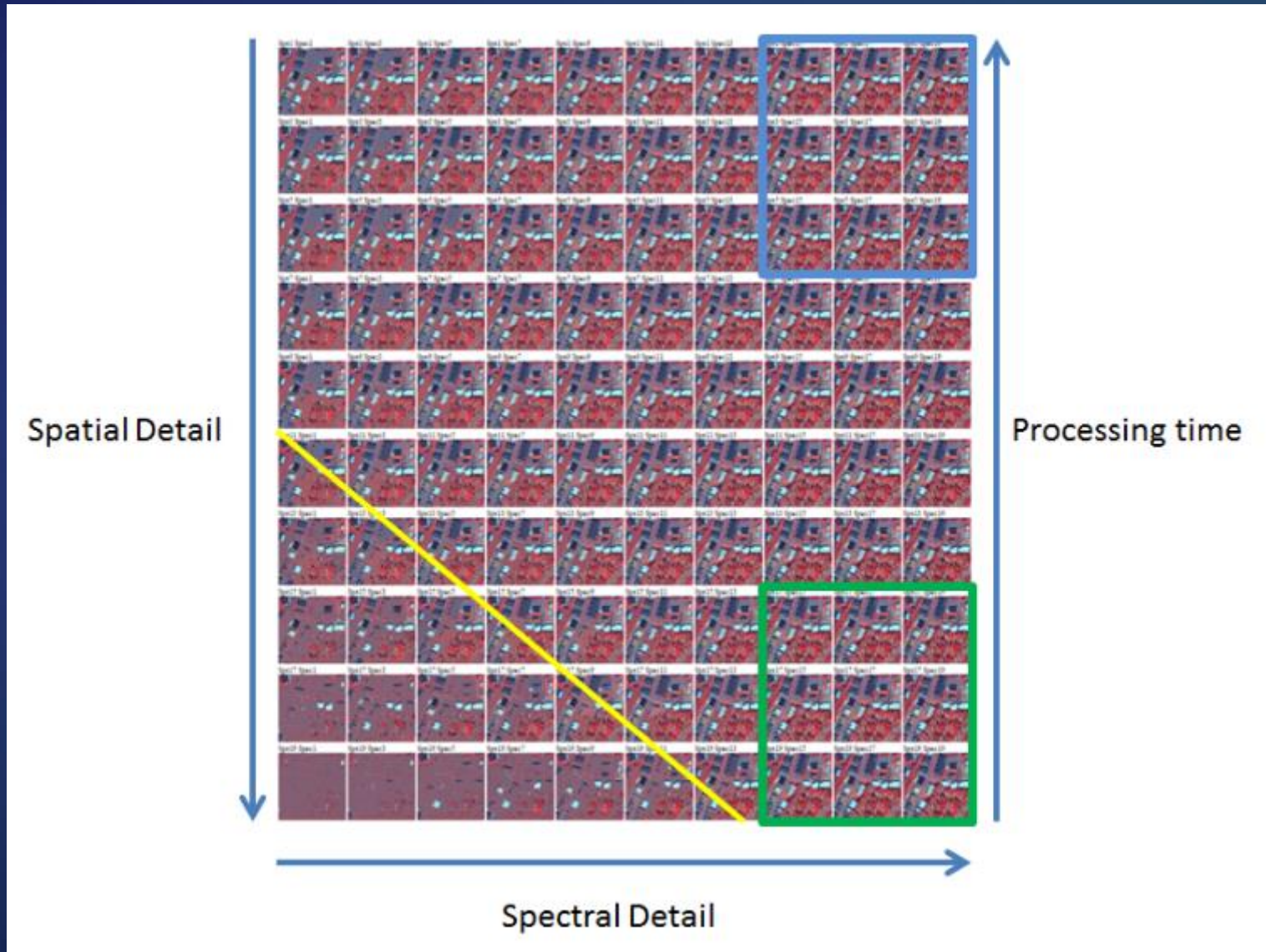


- **Input is a 3-band, 8-bit image**
  - **WYSIWYG** – does not need to look “pretty”
  - **Use the bands that discriminate your features of interest best**
- **Use the raster function to test segmentation parameters**
- **Apply segmentation parameters in desktop Pro or distributed processing using ArcGIS Enterprise configured for Raster Analytics**



# Segmentation Parameters

- Balance between spectral and spatial detail
- Spectral detail dominates
- Max segment size is related to minimum mapping unit (MMU)
- Processing time is related to amount of detail ~ less details takes longer (more smoothing)



# Supervised Image Classification – Training Samples Management

- **Define your classification schema**
- **Collect Training Sample polygons**
  - Polygons, circle, rectangle
  - Segments
- **Generate training samples automatically from a classmap or GIS feature layer**
- **Inspect training samples using cross validation**



# Supervised Image Classification – Train the Classifier

- **Select your classification method**

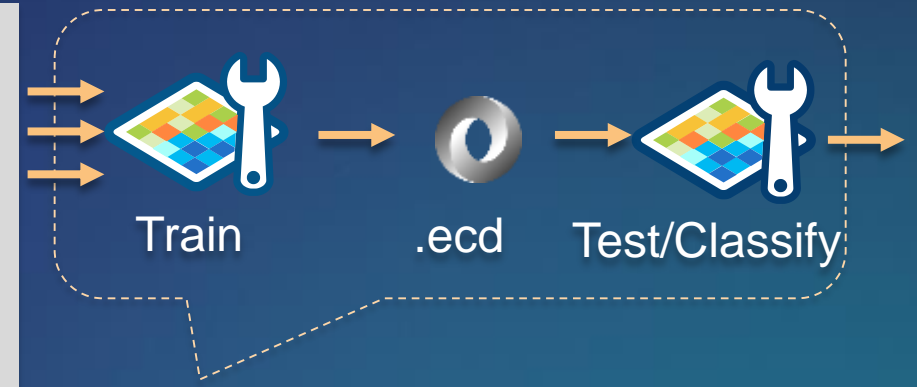
- Support Vector Machine (SVM)
- Random Trees
- Maximum Likelihood
- Iso Cluster (Unsupervised)
- Deep Learning (coming soon)

- **Inputs include:**

- Segmented raster dataset
- Additional raster dataset such DEM or other ancillary data
- Training samples
- Segment attributes – color, mean, std. dev. compactness, rectangularity, count (size)

- **Output is an Esri Classifier Definition file (.ecd)**

- Contains all the definitions for the classifier of choice



# Supervised Image Classification – Classify the image

- **Perform Image Classification**
  - Support Vector Machine (SVM)
  - Random Trees
  - Maximum Likelihood
  - Iso Cluster (Unsupervised)
- **Inputs include:**
  - Segmented raster dataset
  - Additional raster dataset such DEM or other ancillary data
  - Training samples
  - Segment attributes – color, mean, std. dev. compactness, rectangularity, count (size)



# Supervised Image Classification – Accuracy Assessment

- Perform Classification Accuracy Assessment
- Compares classmap with ground reference
  - Sampling Strategies – Random, Stratified Random, Equalized Stratified Random
  - Confusion Matrix for User (Type I) and Producer error (Type II)

OID	ClassValue	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_10	C_11	C_12	C_13	C_14	C_15	Total	U_Accuracy	Kappa
1	C_2	1	500	0	9	46	0	180	0	0	0	0	0	1	0	0	737	0.678426	0
2	C_3	0	0	433	48	0	0	0	0	3	0	0	104	0	0	0	588	0.736395	0
3	C_4	0	0	0	370	0	0	0	0	0	0	0	0	0	0	0	370	1	0
4	C_5	5	0	0	0	363	0	0	0	0	0	0	0	0	0	0	368	0.986413	0
5	C_6	0	0	0	0	0	493	0	0	3	0	0	40	0	0	0	536	0.919776	0
6	C_7	0	0	0	44	21	0	294	0	0	0	3	0	0	0	0	362	0.812155	0
7	C_8	0	0	67	0	0	7	26	500	0	0	0	2	0	0	0	602	0.830565	0
8	C_9	0	0	0	0	0	0	0	0	493	0	0	32	0	0	0	525	0.939048	0
9	C_10	0	0	0	0	0	0	0	0	0	442	58	0	0	26	0	526	0.840304	0
10	C_11	0	0	0	8	0	0	0	0	0	5	436	0	1	0	1	451	0.966741	0
11	C_12	0	0	0	0	0	0	0	0	1	0	0	277	1	0	0	279	0.992832	0
12	C_13	0	0	0	15	0	0	0	0	0	0	1	20	486	51	1	574	0.846669	0
13	C_14	0	0	0	0	0	0	0	0	0	53	0	25	1	423	0	502	0.842629	0
14	C_15	0	0	0	6	0	0	0	0	0	0	2	0	10	0	498	516	0.965116	0
15	Total	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	7500	0	0
16	P_Accuracy	0.988	1	0.866	0.74	0.726	0.986	0.588	1	0.986	0.884	0.872	0.554	0.972	0.846	0.996	0	0.866933	0
17	Kappa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.857429



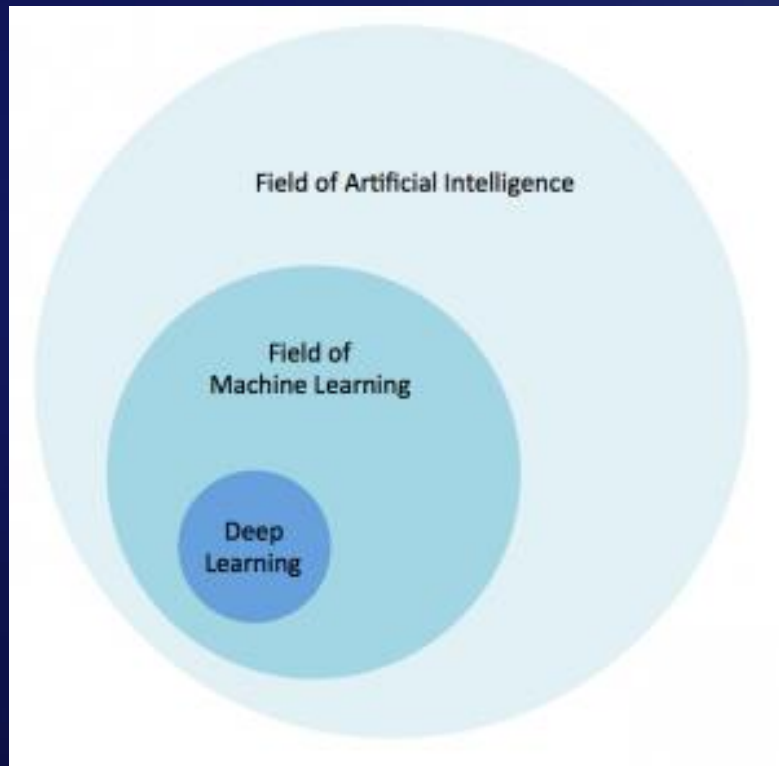
Accuracy  
assessment



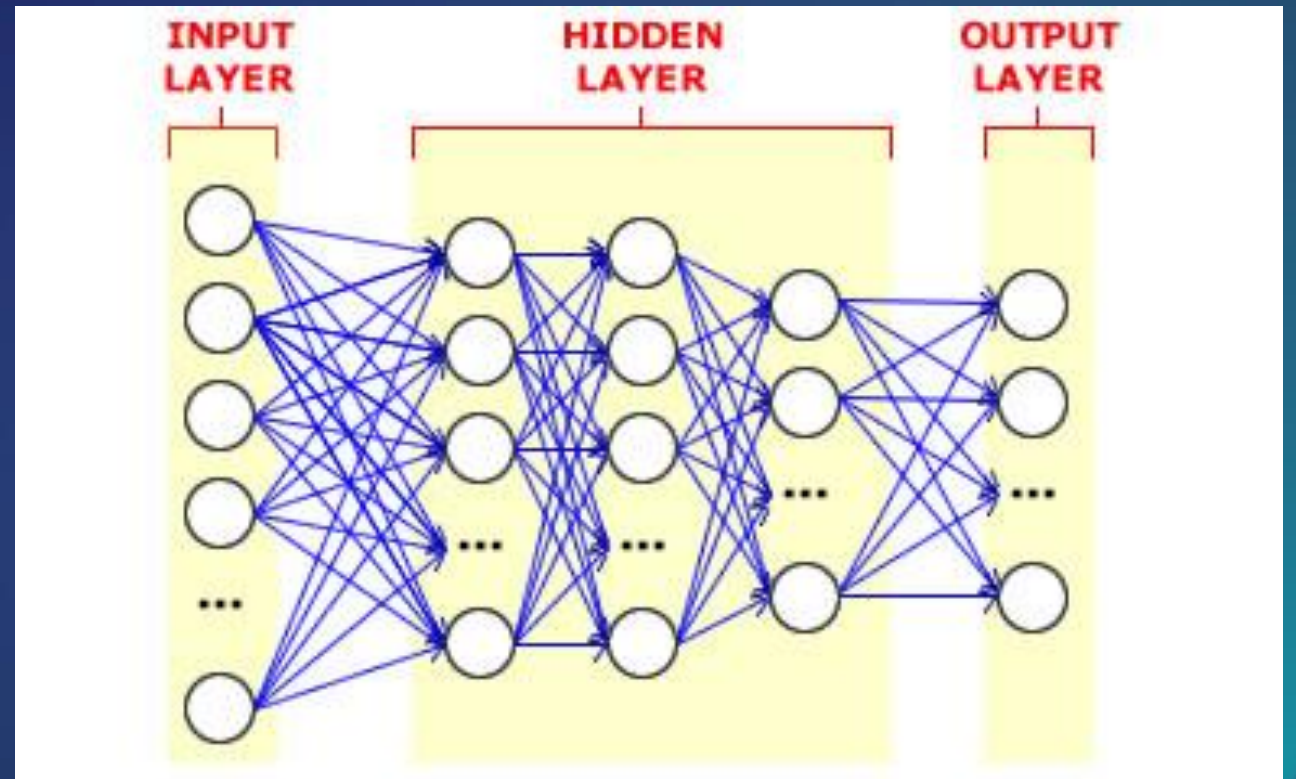
Demo:

Supervised Classification using the  
ArcGIS Pro Classification Wizard

# Deep Learning Introduction



A subset of machine learning

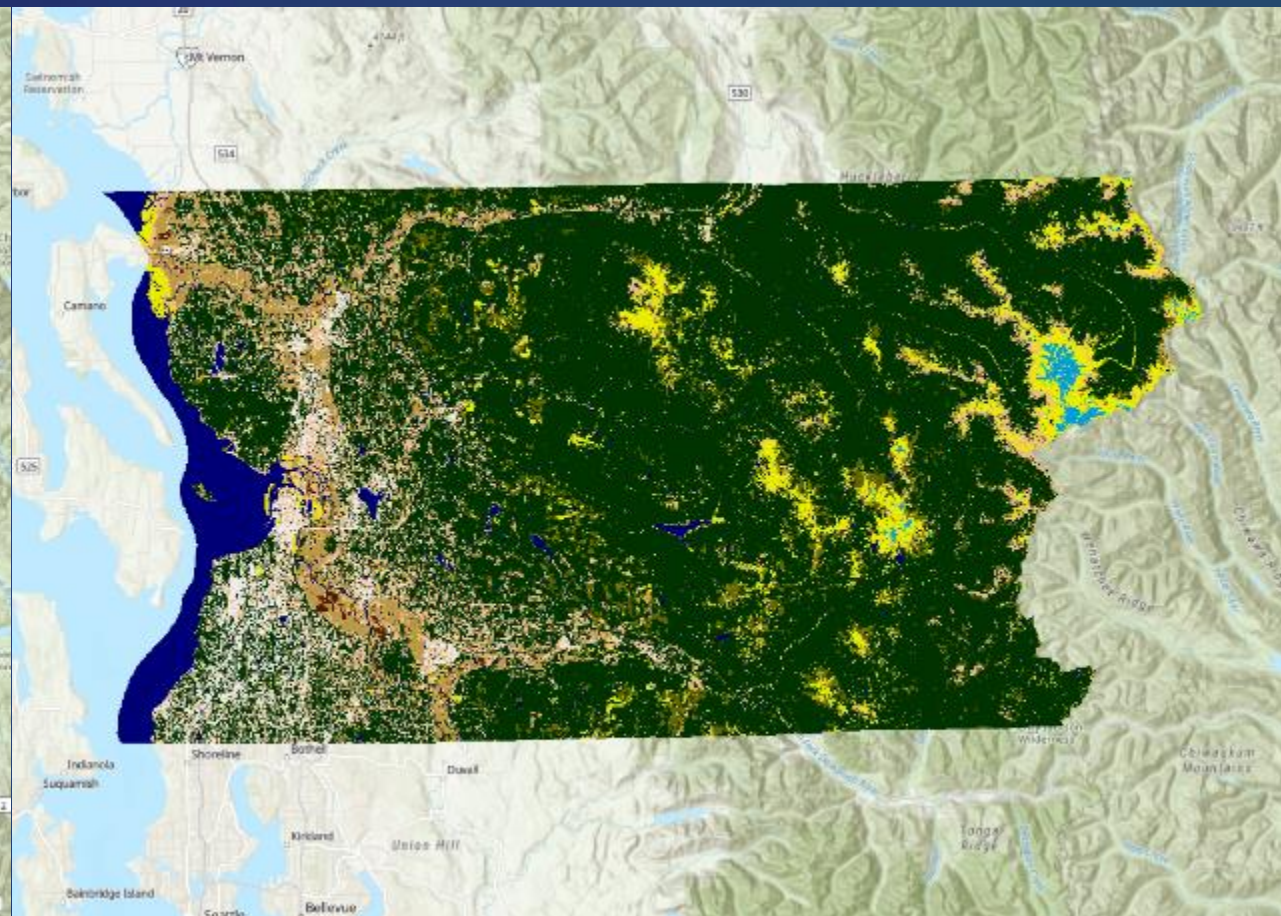
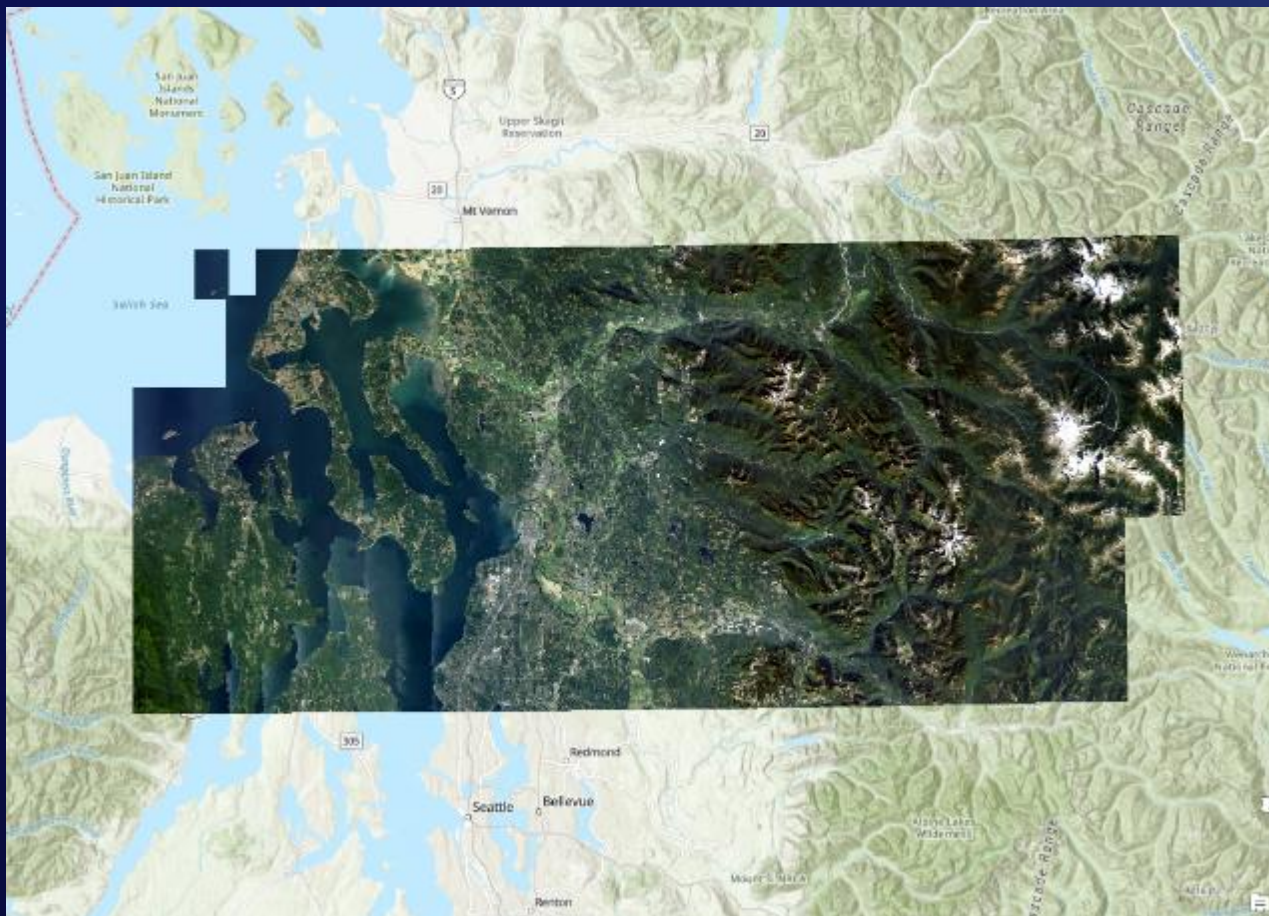


Employs deep neural networks with several layers of nodes between input and output



# The Data

Large region (~2,250 square miles)  
Billions of labeled pixels (11.6 billion)



NAIP images, 1m resolution

Ground truth land classification map with 6 classes:  
Forest, Shrub/Scrub, Bare Land, Impervious Surface, Open Water  
Grassland/Herbaceous



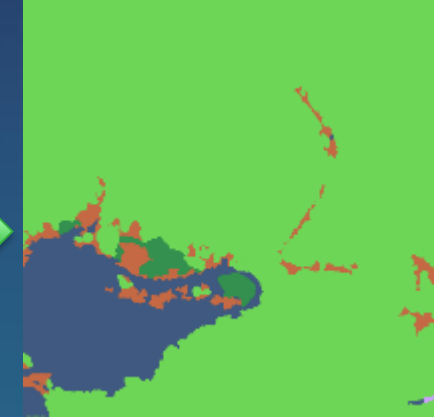
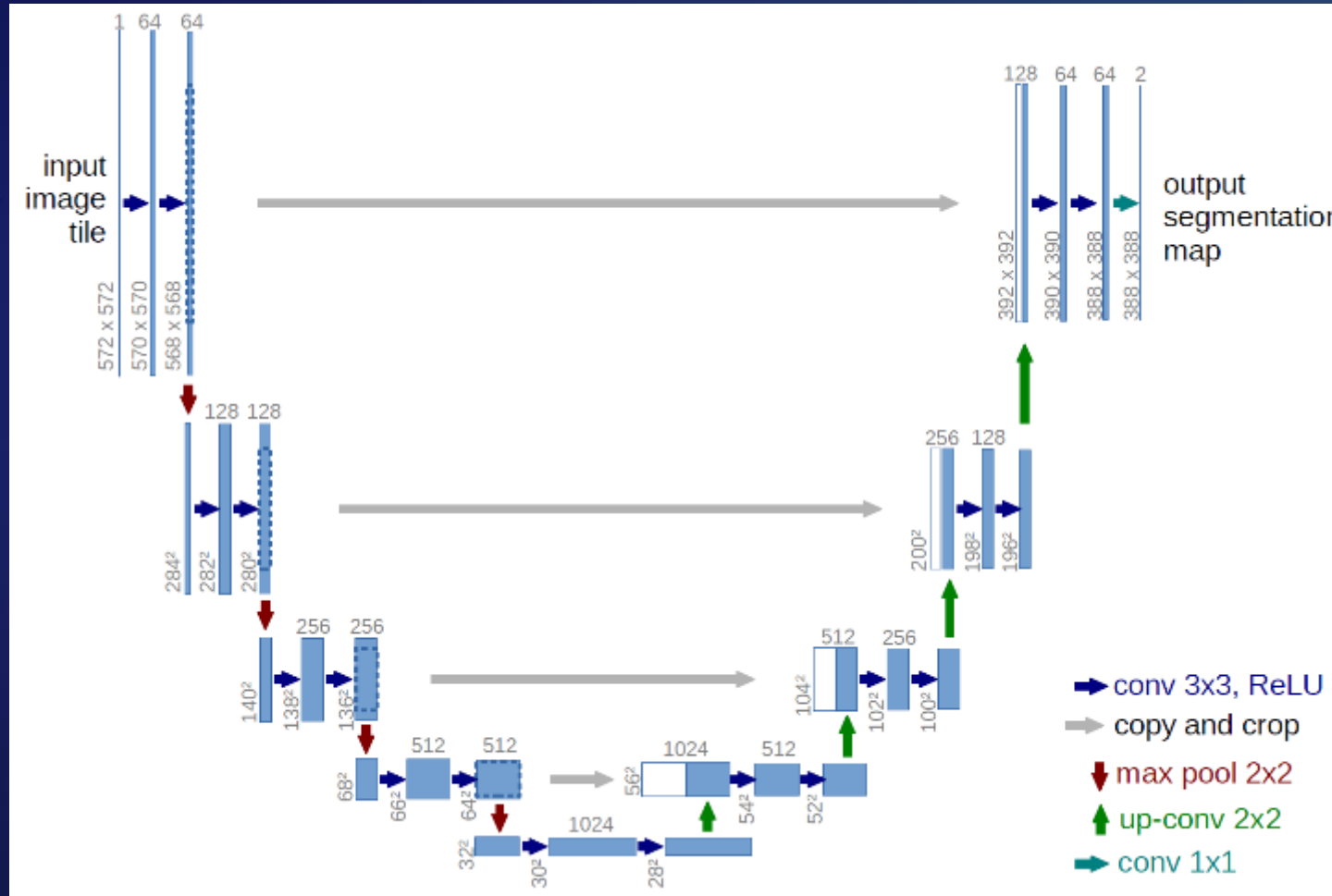
# Export Training Data for Deep learning

The screenshot displays the ArcGIS Pro software interface. The main map area shows a satellite view of a forested region with a semi-transparent classification overlay. The interface includes a ribbon menu at the top with tabs for Project, Map, Insert, Analysis, View, Edit, Imagery, Share, Appearance, and Data. The Contents pane on the left lists layers such as Source Data, mosaic, mosaic1, SetNull\_sno\_co\_1.tif, and World Topographic Map. The Geoprocessing pane on the right is open to the 'Export Training Data for Deep Learning' tool. The tool's parameters are as follows:

- Input Raster: mosaic
- Output Folder: train\_data
- Input Feature Class Or Classified Raster: sno\_co\_draft\_ccap\_fc\_20180105.img
- Image Format: TIFF format
- Tile Size X: 256
- Tile Size Y: 256
- Stride X: 128
- Stride Y: 128
- Output No Feature Tiles:
- Meta Data Format: Classified tifs
- Start Index: 0

The status bar at the bottom indicates the map's coordinates as 122.1012001°W 48.4382554°N and shows 0 selected features.

# Training



U-Net: Convolutional Networks for Biomedical Image Segmentation



# Results



Overall Accuracy: 92%

## Summary

- ArcGIS Pro supports the entire image classification workflow
- Pro provides both statistical and advanced machine learning classifiers
- Coming Soon - Deep Learning classifier

**For more information about image classification and Deep Learning, visit the Imagery Island at the Exhibit Showcase**

# Thank You

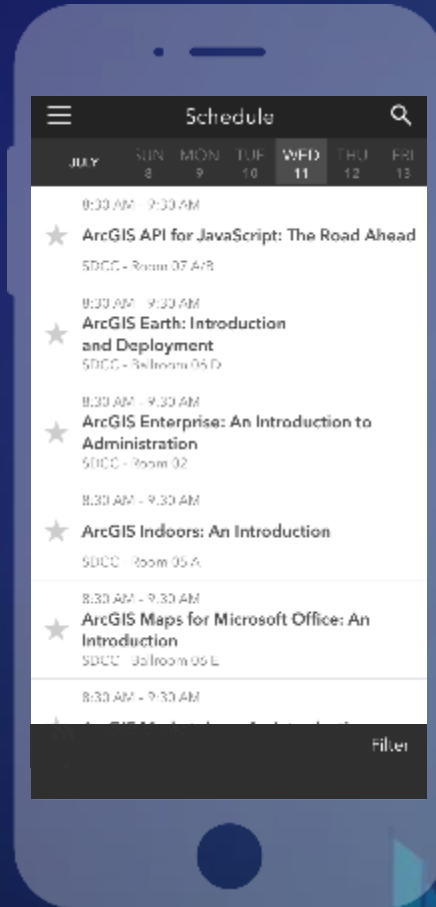
Hhu@esri.com, jliedtke@esri.com

# Please Take Our Survey on the App

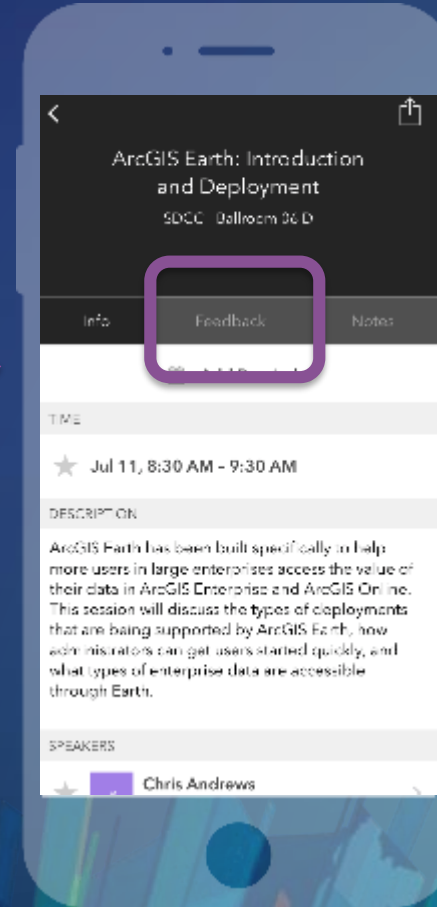
Download the Esri Events app and find your event



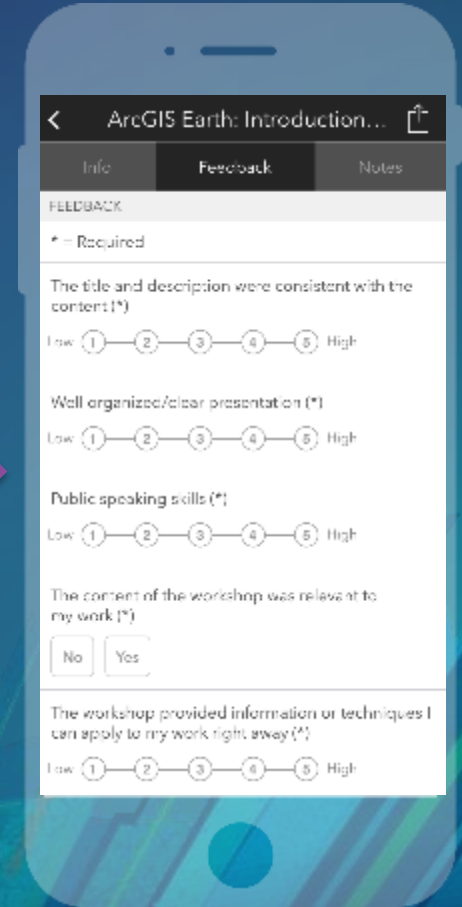
Select the session you attended



Scroll down to find the feedback section



Complete answers and select "Submit"







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