



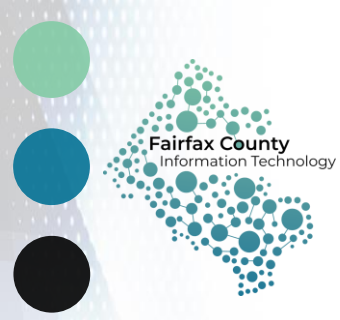
# Use of Deep Learning tools to Extract Land Cover and Ground Features from Imagery for Environmental Analysis

Michael Liddle and Gregory Bacon  
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# Topics

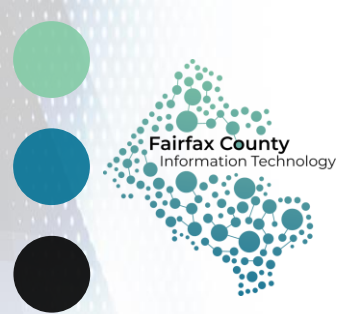
- Geospatial Initiatives – remotely sensed data
  - Aerial photography program
  - 3D Technology – digital twin
  - Planimetric data update – from 2017 to annual cycle
  - LiDAR
- Convergence and leverage of investments



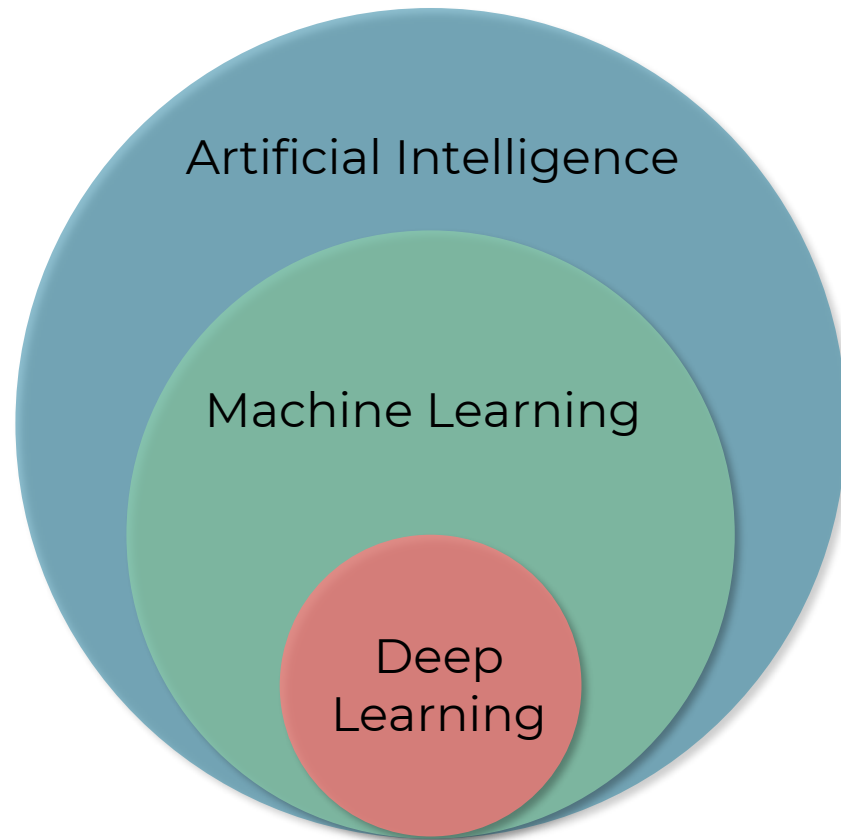


# Topics

- Use of deep learning tools to extract land cover and ground features from imagery for environmental analysis
- Deep learning in Geographic Information Systems (GIS)
- Land cover classification
- Evergreen tree detection
- Parting thoughts



# Deep Learning in GIS Context



*“The spatial component often takes the form of some measure of shape, density, contiguity, spatial distribution, or proximity.”*

“Machine Learning in ArcGIS” blog article – ESRI 2017

*Prediction  
Classification  
Pattern Recognition  
Clustering*



*Solving Spatial Problems*



# Deep Learning in GIS - Imagery

- Python libraries integrated with specialized GIS tools
  - U-net
  - DeepForest
  - MaskRCNN
- Typically require large amounts of training data

However



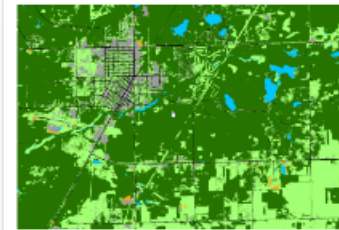
- Pretrained models are becoming widely available



Building Footprint Extraction - USA

Deep Learning Package By [esri\\_analytics](#)

Deep learning model to extract building footprints from high-resolution aerial and satellite imagery.



High Resolution Land Cover Classification - USA

Deep Learning Package By [esri\\_analytics](#)

Deep learning model to perform land cover classification on high resolution imagery.



Solar Panel Detection - USA

Deep Learning Package By [esri\\_analytics](#)

Deep learning model to detect solar panels from high resolution imagery.

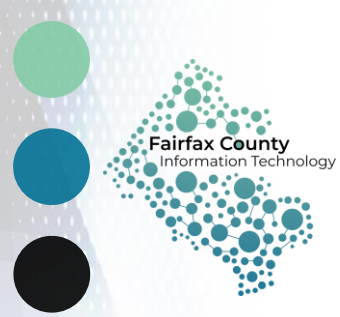


Tree Detection

Deep Learning Package By [esri\\_analytics](#)

Deep learning model to detect trees in high resolution imagery.





# Land Cover Classification

## Who wants this data and why?

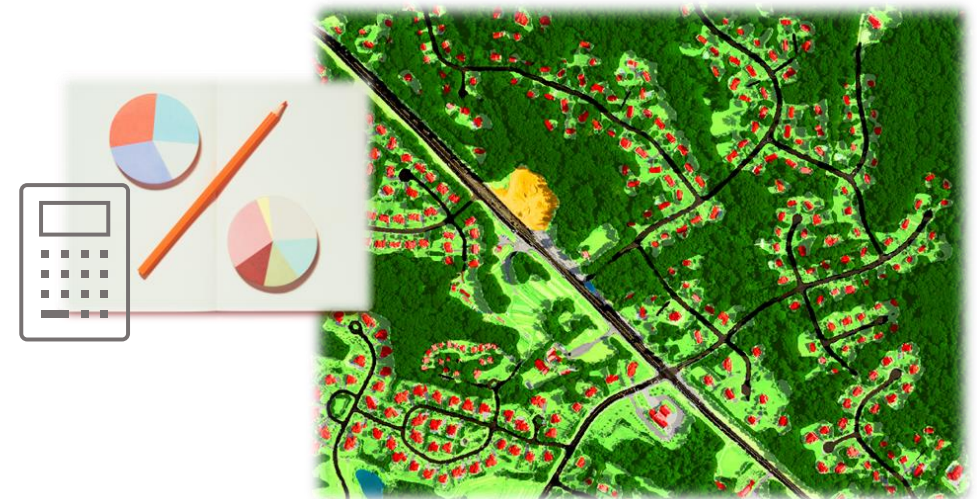
### County Users

Department of Public Works & Environmental Services  
Land Development Services  
Park Authority  
Office of Environmental & Energy Coordination

### Public/External Users

Tree Commissioners  
Students/Other Researchers  
Residents via Public Web Applications  
Environmental Quality Advisory Council

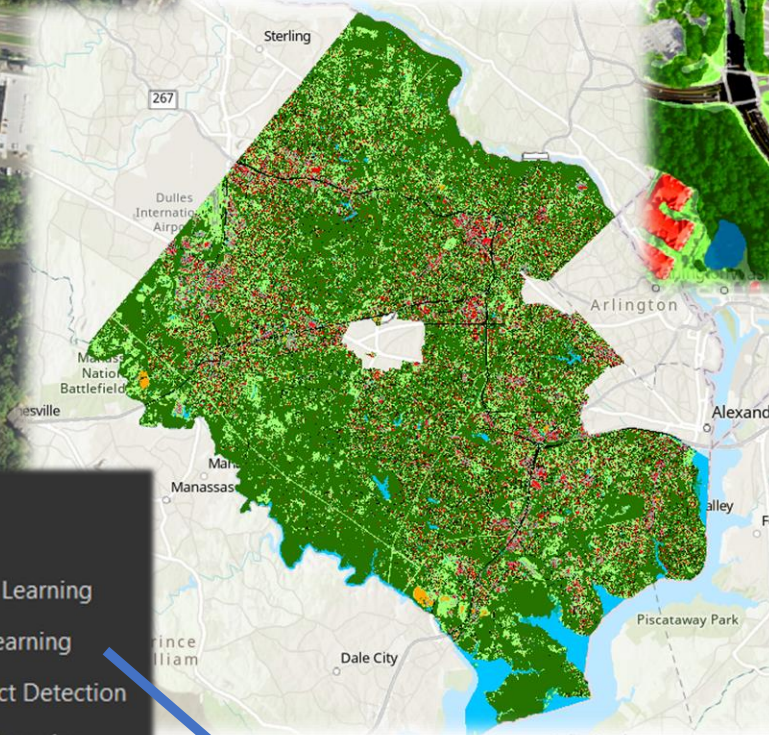
Vegetation Management  
Tree Canopy Monitoring  
Runoff Calculations  
Planning  
Climate Resilience  
Equity Analysis  
Change Detection





# Land Cover Classification

2021 Imagery from USDA National Agriculture Imagery Program



- Image Analyst Tools
- Deep Learning
    - Classify Objects Using Deep Learning
    - Classify Pixels Using Deep Learning
    - Compute Accuracy For Object Detection
    - Detect Change Using Deep Learning
    - Detect Objects Using Deep Learning
    - Export Training Data For Deep Learning

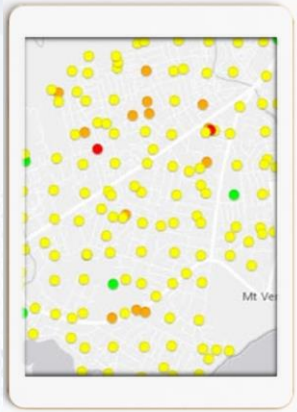
- Land Cover 2021
- Class
- Water
  - Wetlands
  - Tree Canopy
  - Shrubland
  - Low Vegetation
  - Barren
  - Structures
  - Impervious Surfaces
  - Impervious Roads

U-net algorithm puts pixels into categories



# Evergreen Tree Detection

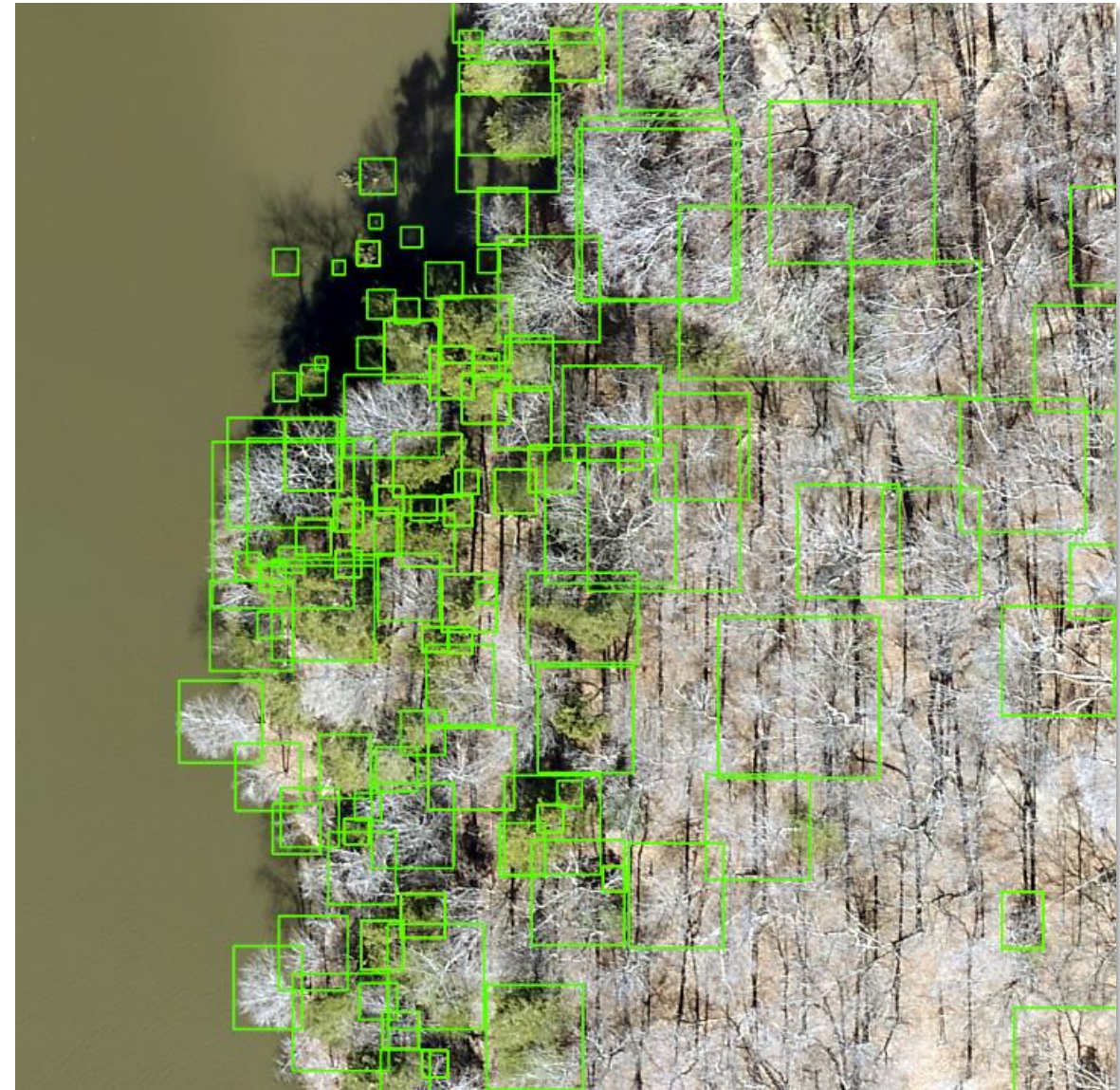
## HEMLOCK WOOLLY ADELGID



Predatory beetles



Tree Injections



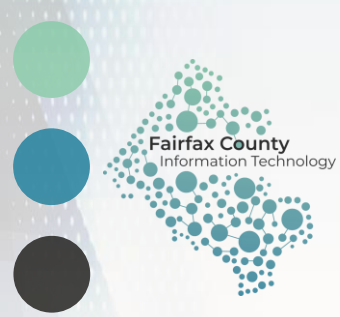
DeepForest algorithm output



# Evergreen Detection in Fountainhead Regional Park to Increase Efficiency of Field Work







# Parting Thoughts/Discussion

- New tools = more self-sufficiency and cost savings
- Data science and GIS technology convergence
- High performance computing capability is needed
- Data creation/analysis of built and natural environment
- Models can be trained to look for other things
  
- Questions/Discussion

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