Employing machine learning & UAS for effective autumn olive treatment on reclaimed surface mines

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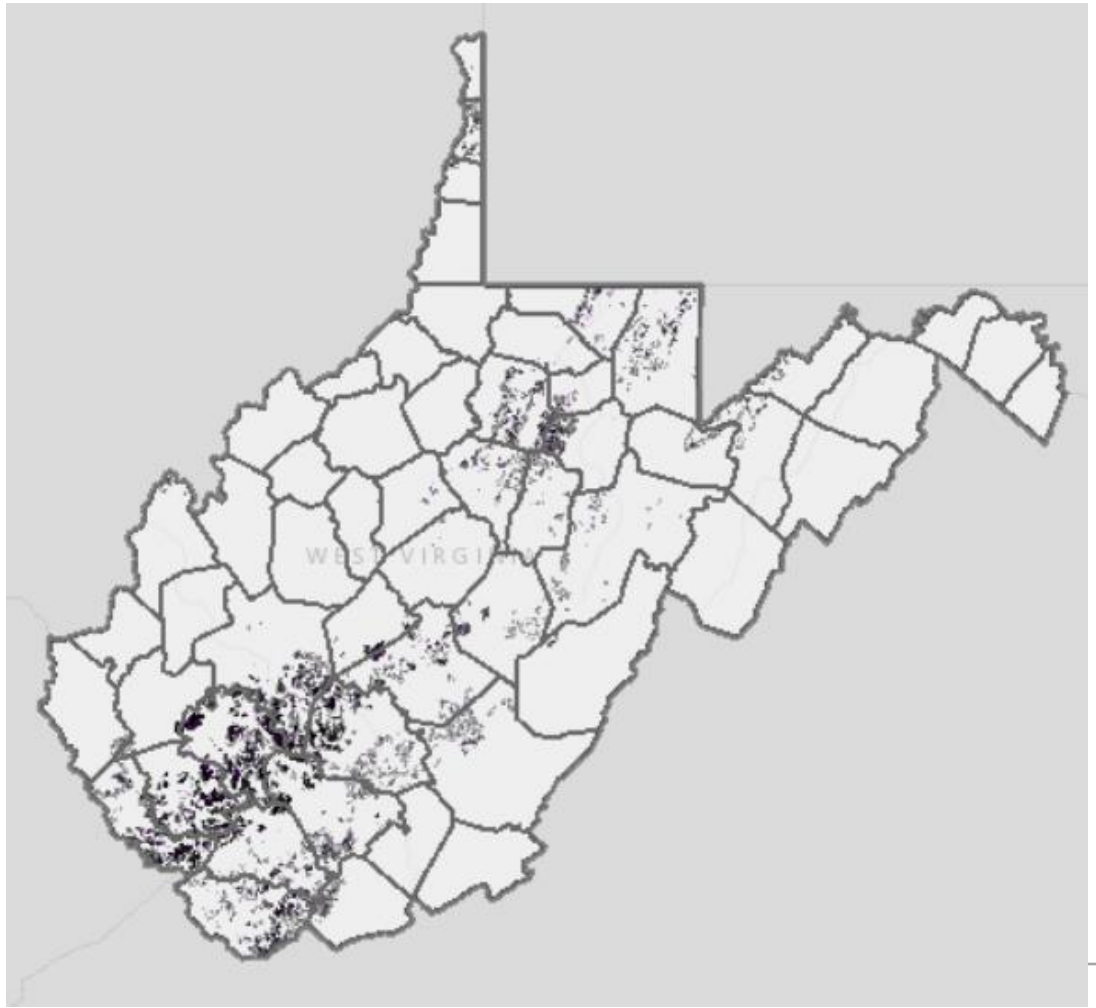
West Virginia University

Surface Mining in Appalachia



- Over 600,000 ha of land has been disturbed by MTR in Appalachia (Zipper et al., 2011b)
- Exotic and invasive species introduced
- Reduction of desirable native species and biodiversity

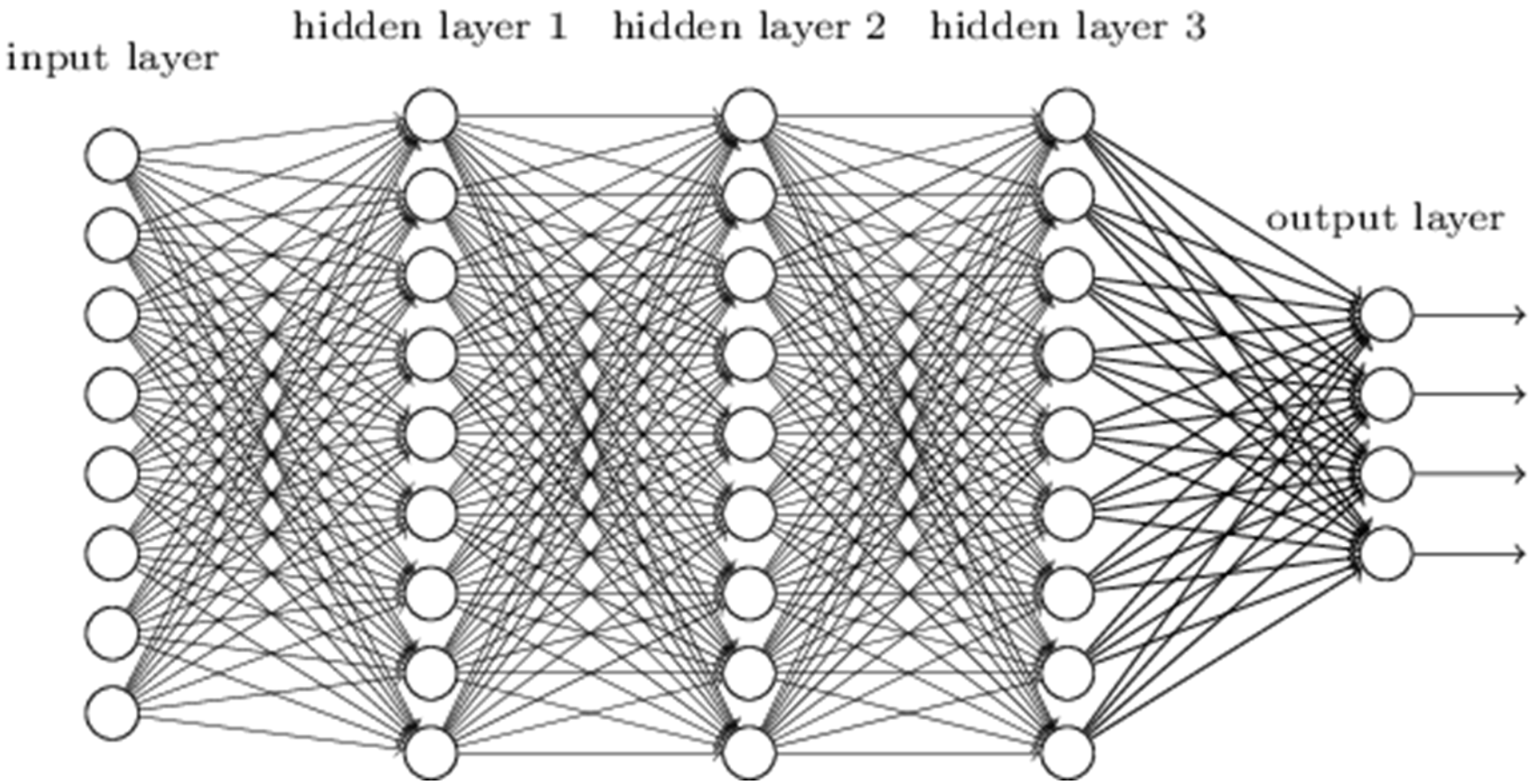
Autumn Olive

- Non-native and invasive plant found throughout Appalachia.
- Used for soil stabilization, establishing rapid vegetation cover, and provide habitat for wildlife.
- Able to outcompete native species, especially on poor soils, due to nitrogen fixing ability
- Dominates reclaimed surface mines.

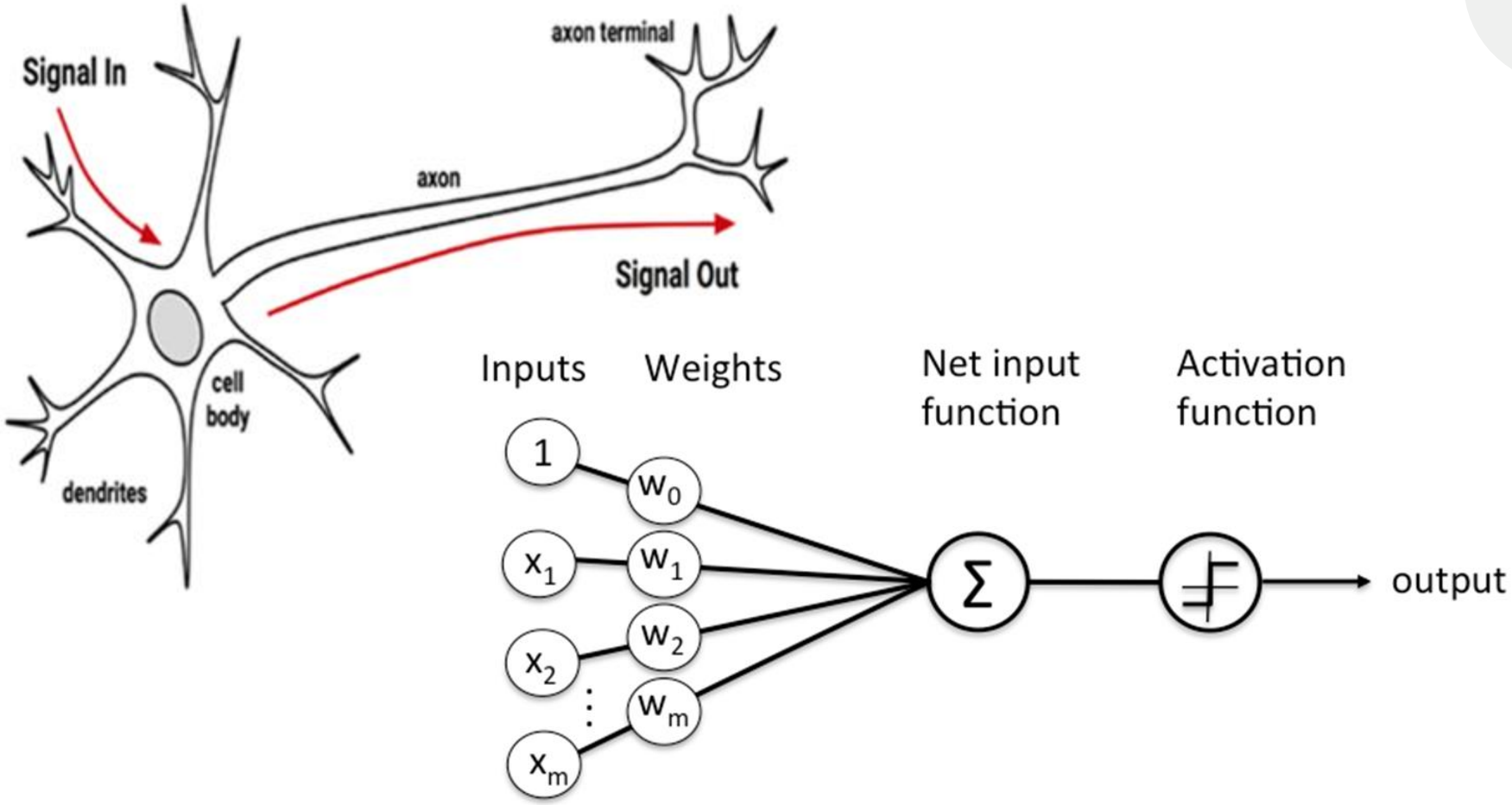
Identifying Invasive Species

- Visual identification can be variable and is dependent on experience and training.
- Traditional ML techniques can be time consuming and offer varying overall accuracies in a dense forest landscape.
- Can be improved with use of sUAS mounted sensors.
- CNNs provide an improved classification method which aims to extract more complex features.

Convolutional Neural Network



Convolutional Neural Networks



Data Collection

DJI Matrice 300

DJI Matrice 200

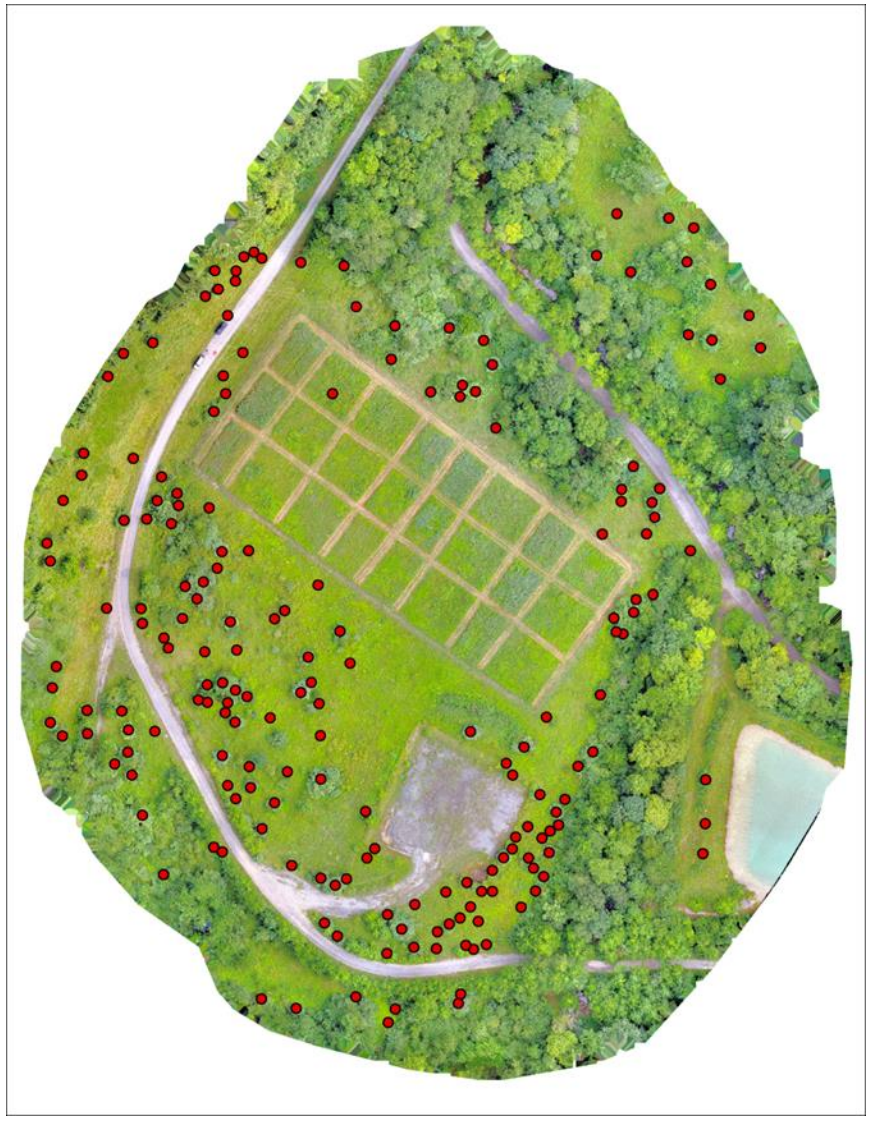
Sentera 6X Multispectral Sensor

Data Collection

Goshen Road

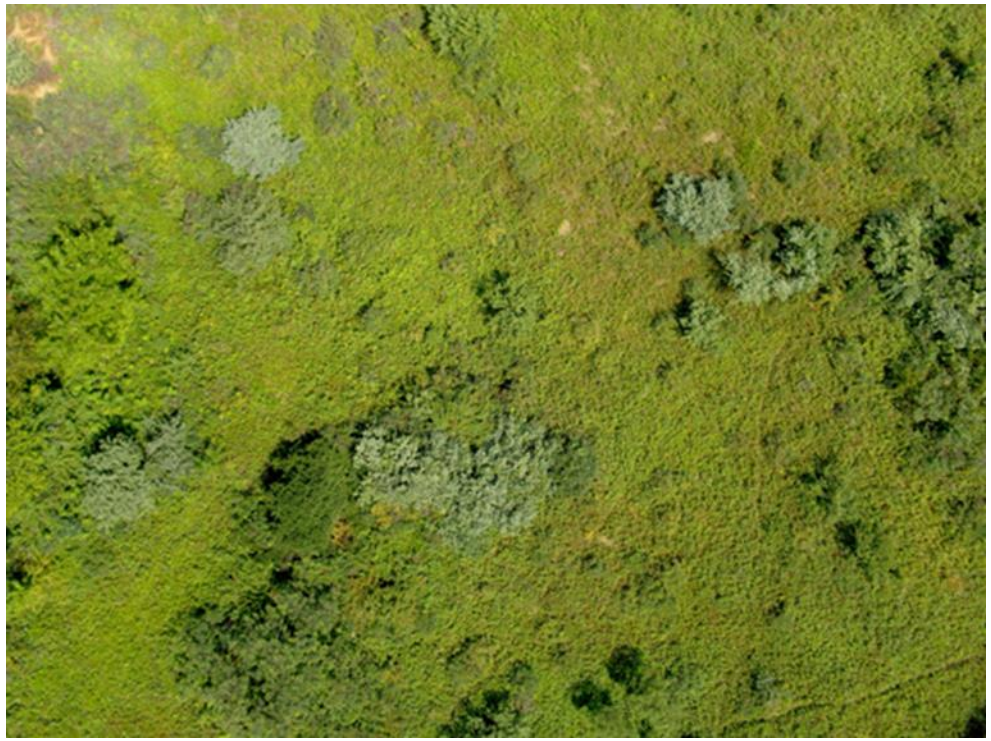
Little Indian Creek

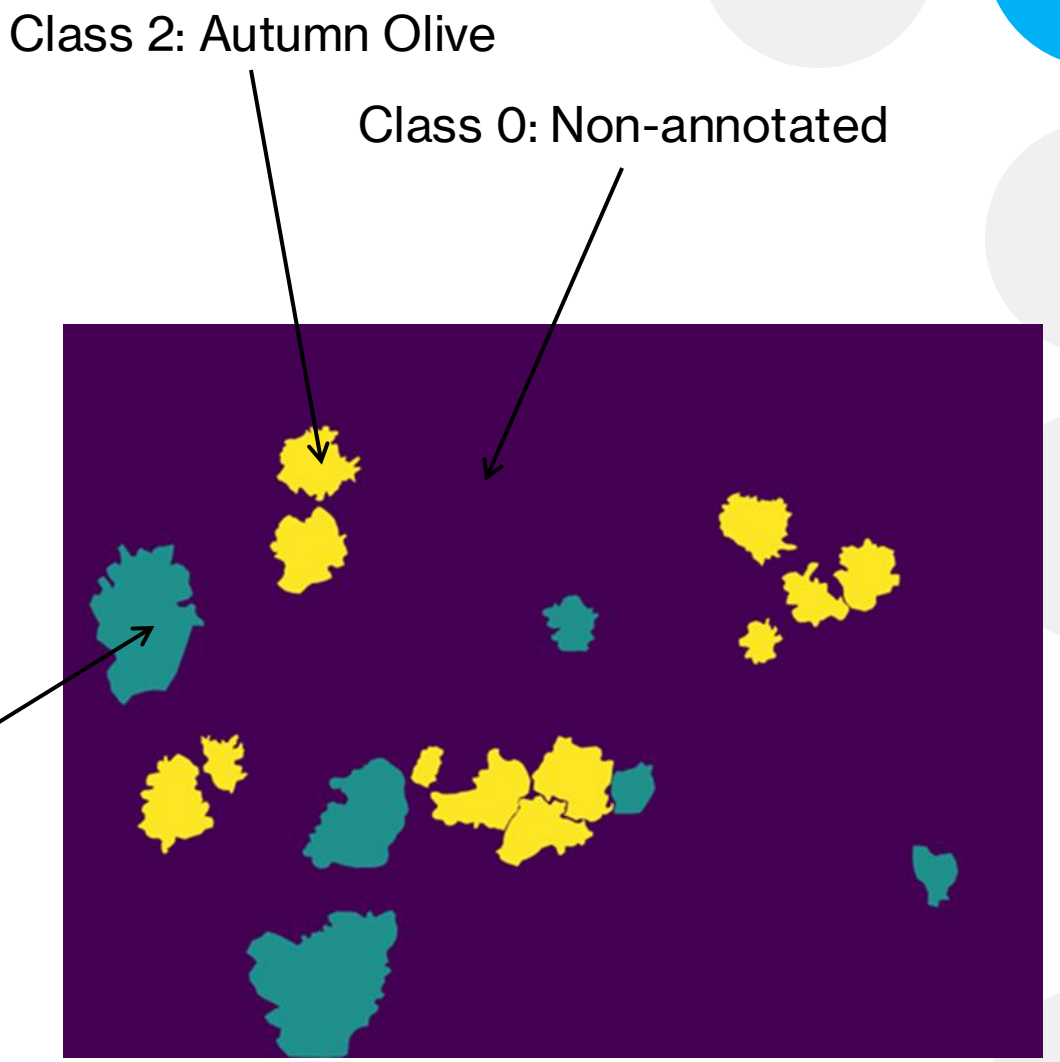
Data Collection



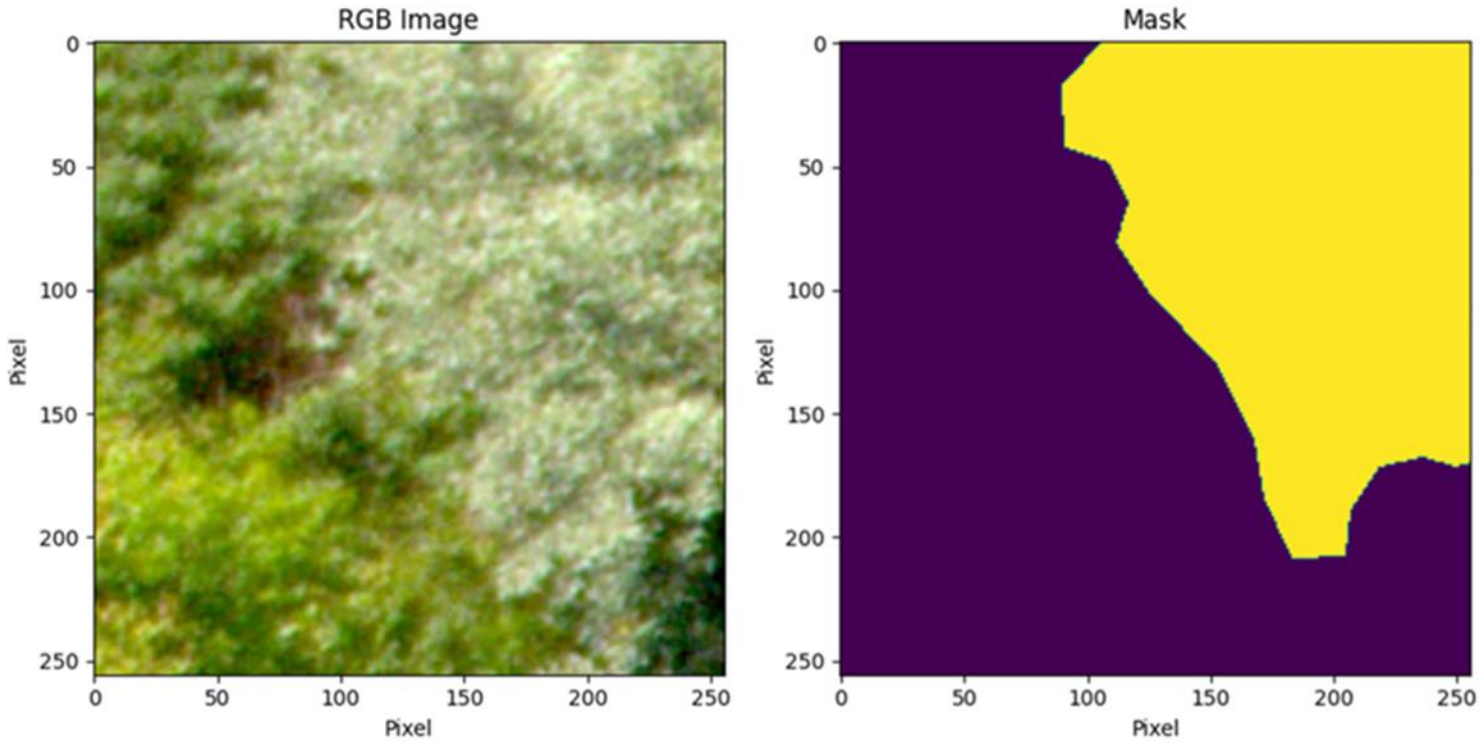
Data Annotation

Data Annotation

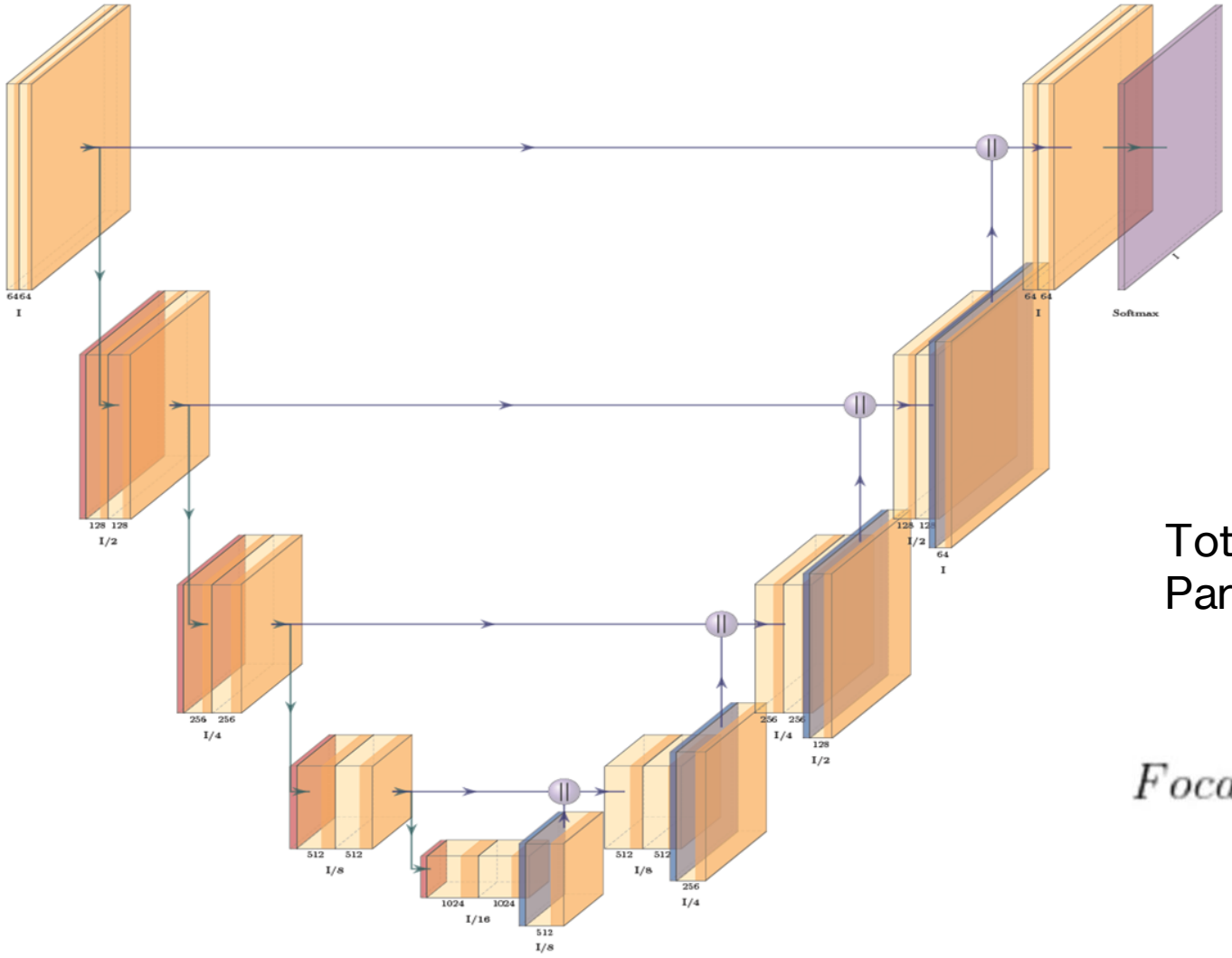




Data Annotation



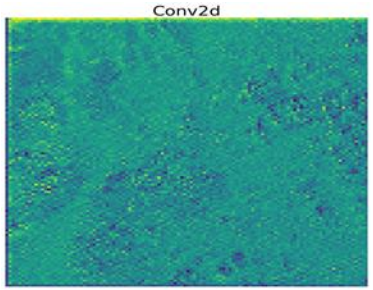
Training

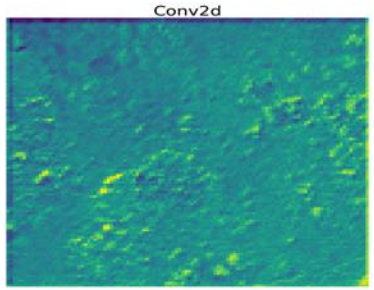


Total Training
Parameters: 34,170,192

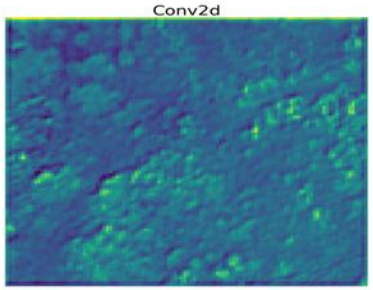
$$FocalLoss = -\sum_{i=1}^{i=n}(i - p_i)^{\gamma} log_b(p_i)$$

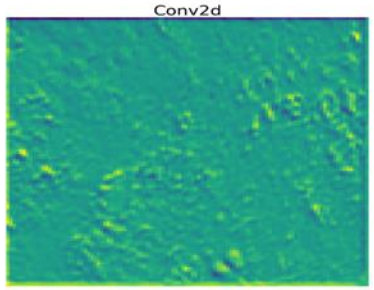
Training



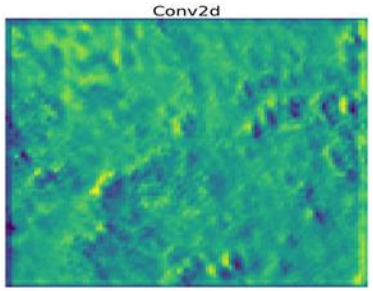


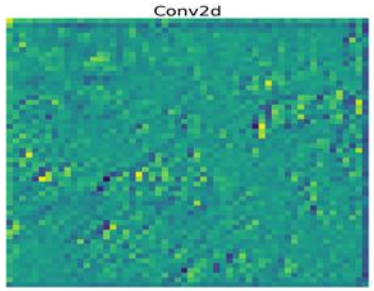
Encoder Block 1 (64, 128, 128)



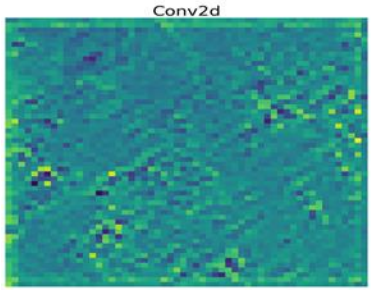


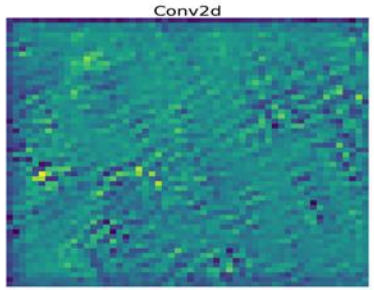
Encoder Block 2 (128, 64, 64)



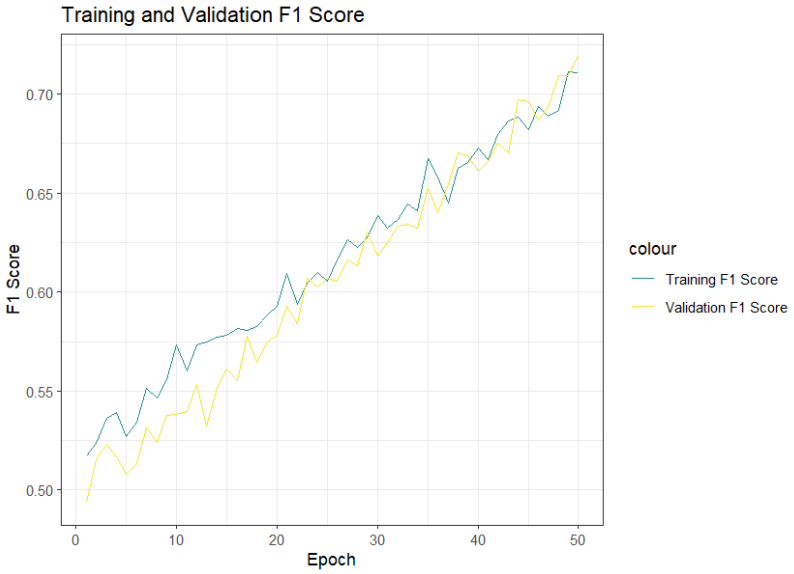


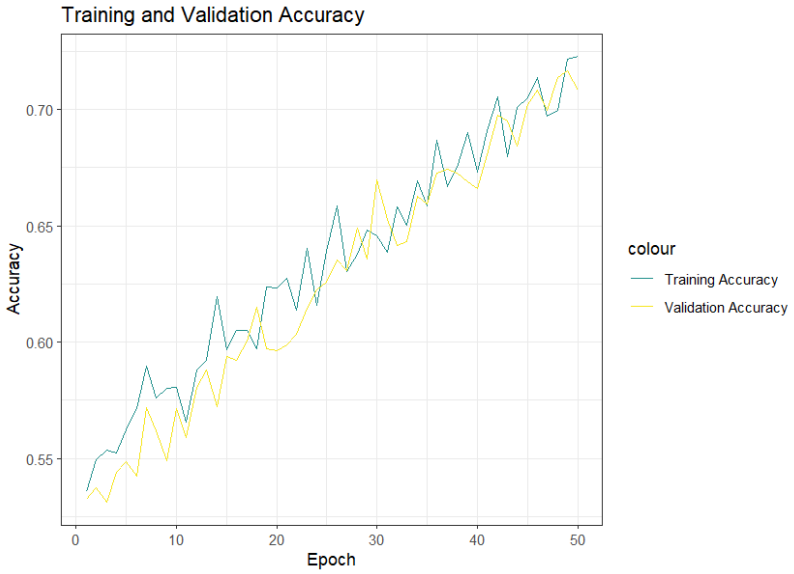
Encoder Block 3 (256, 32, 32)

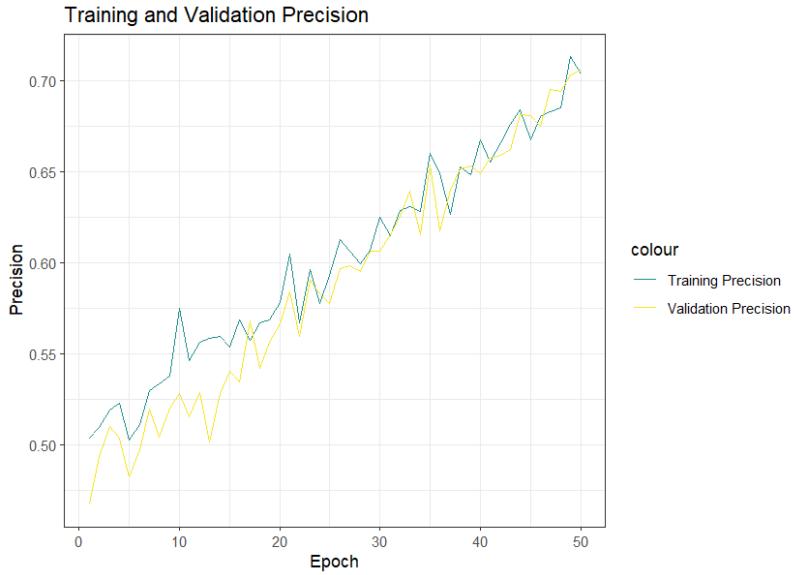


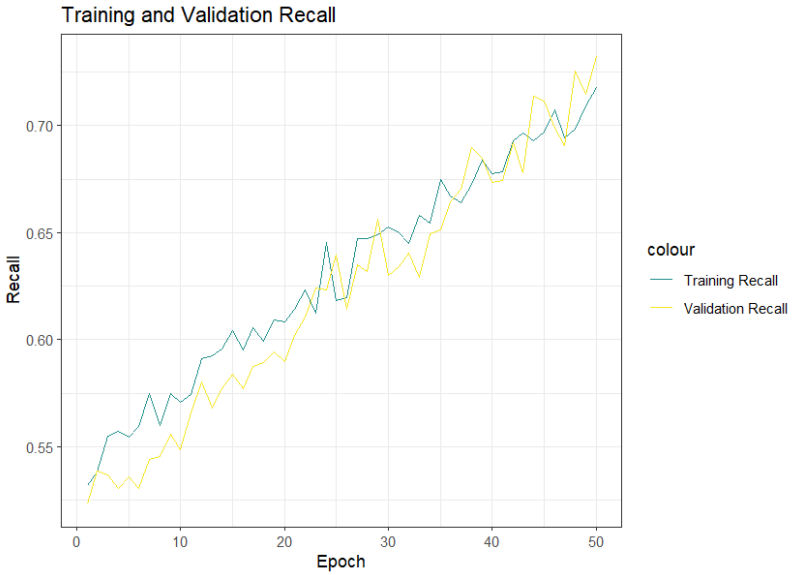


Encoder Block 4 (512, 16, 16)

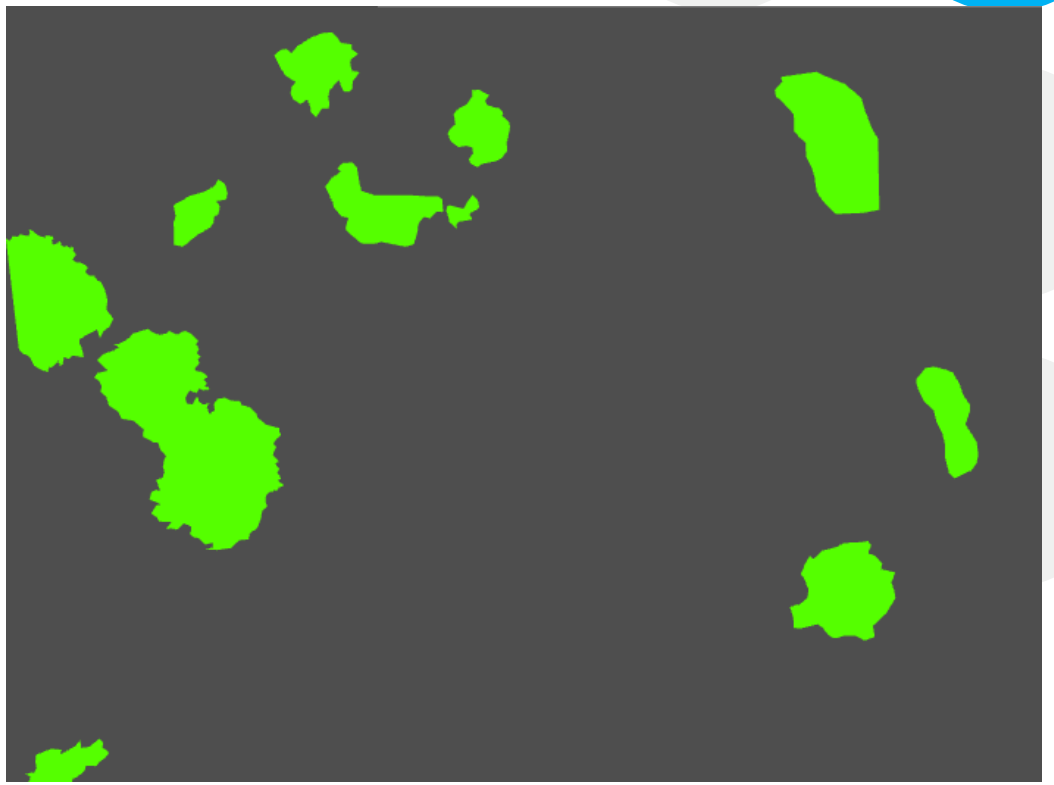

Training and Validation F1 Score
F1 Score
Epoch
colour
Training F1 Score
Validation F1 Score


Training and Validation Accuracy
Accuracy
Epoch
colour
Training Accuracy
Validation Accuracy


Training and Validation Precision
Precision
Epoch
colour
Training Precision
Validation Precision


Training and Validation Recall
Recall
Epoch
colour
Training Recall
Validation Recall

Output

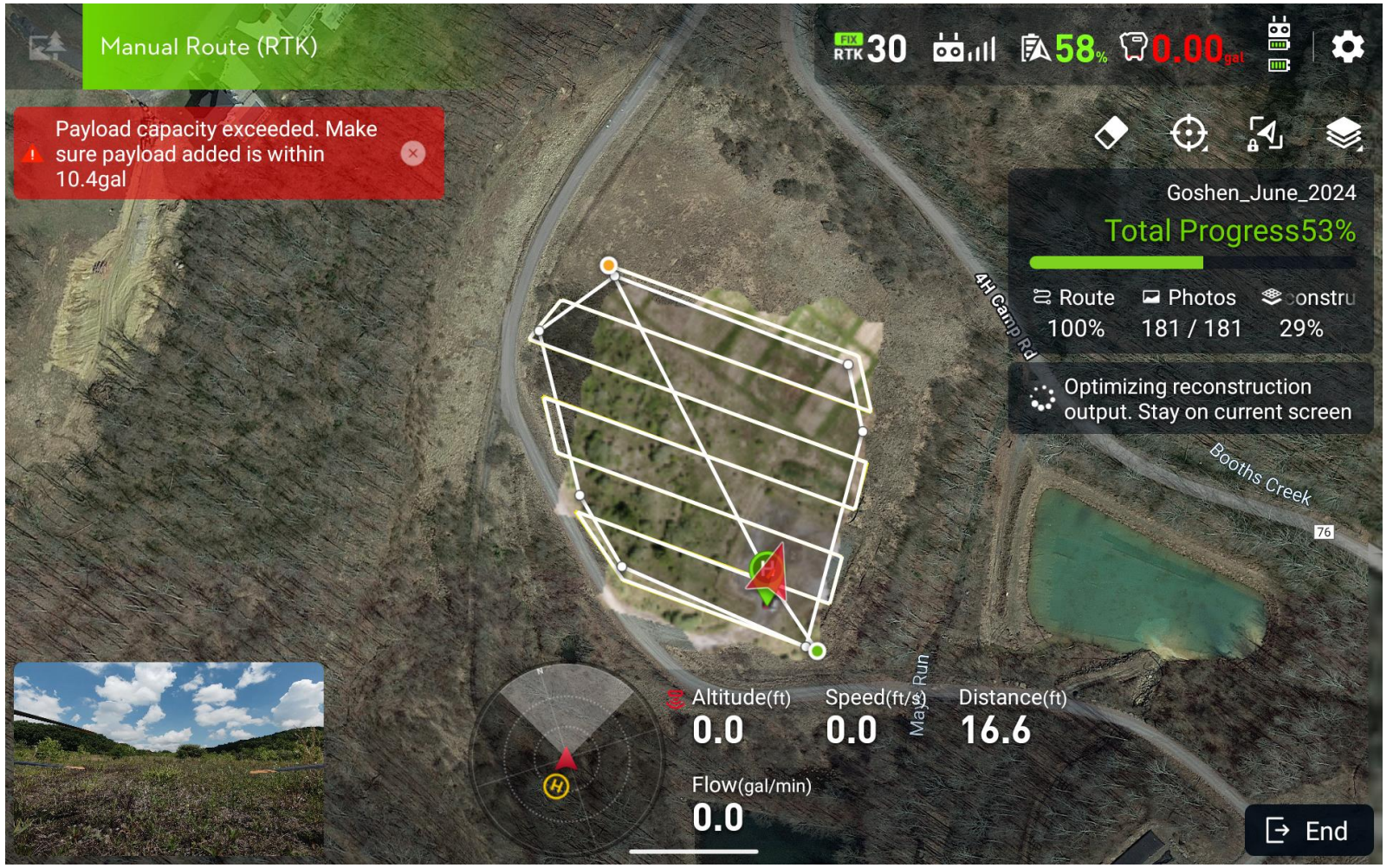


Treatment

Part 137: Dispensing Chemicals and Agricultural Products

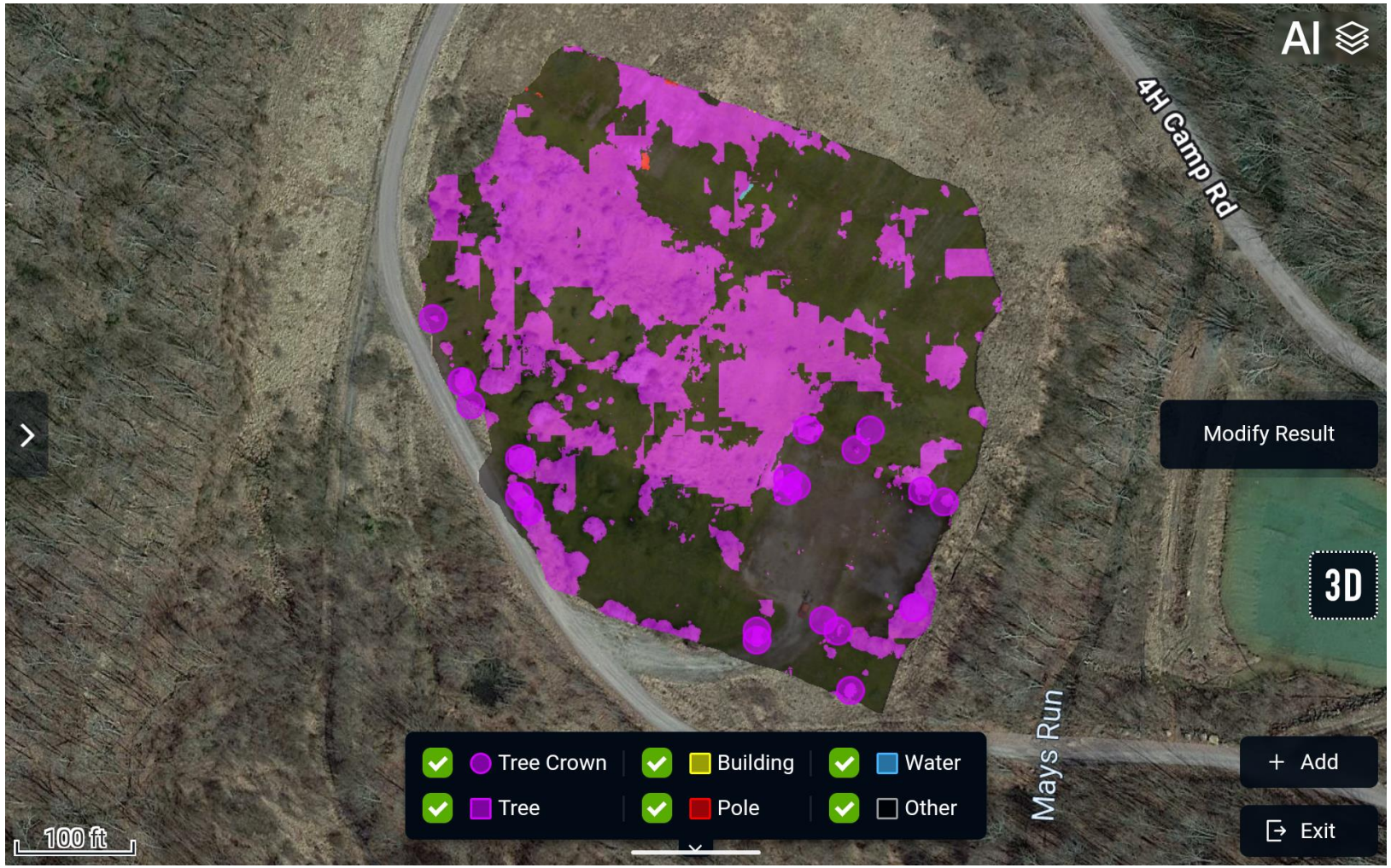
Agras T-40 Spray Drone

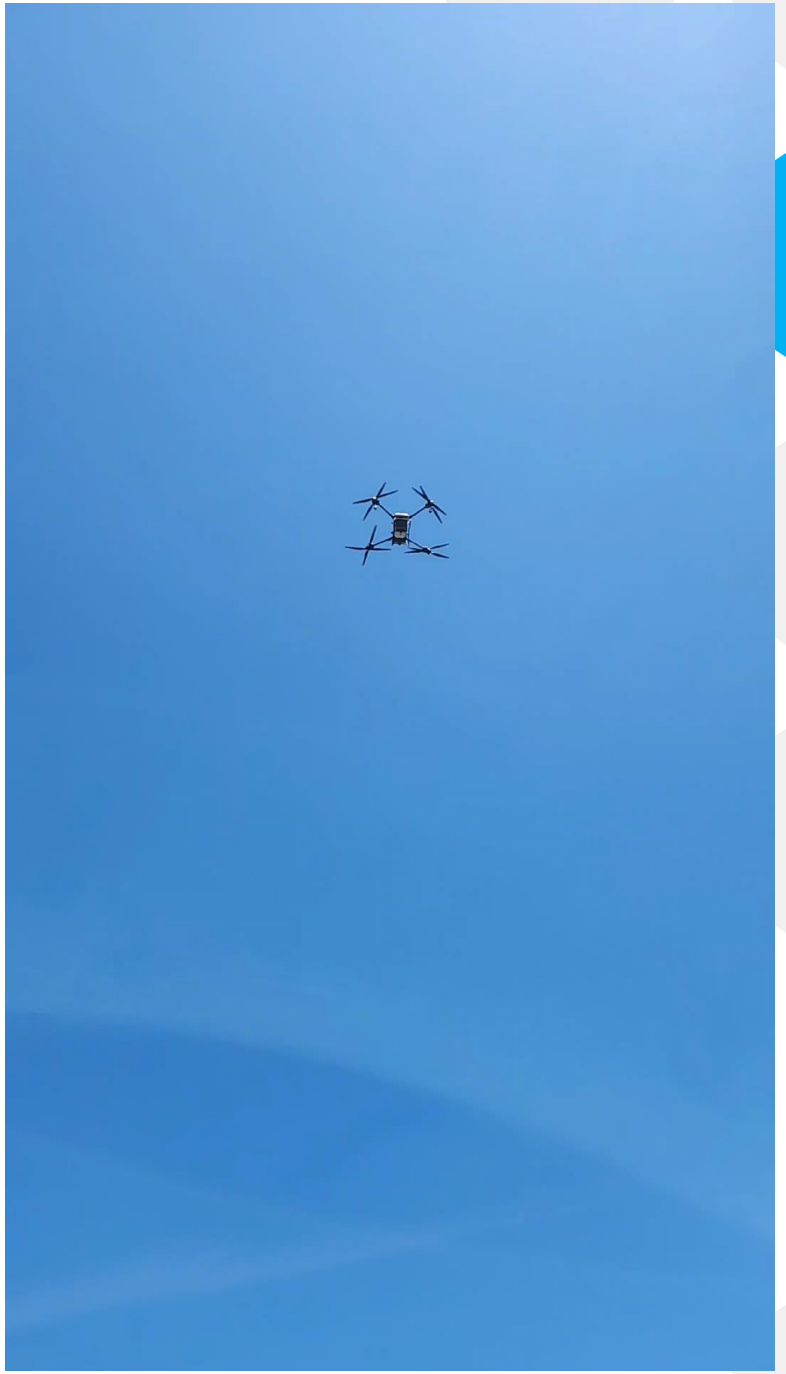
Treatment


Manual Route (RTK)
FIX RTK 30
58%
0.00gal
Payload capacity exceeded. Make sure payload added is within 10.4gal
Goshen_June_2024
Total Progress53%
Route 100%
Photos 181 / 181
Optimizing reconstruction output. Stay on current screen
4H Camp Rd
Booths Creek
76
Mays Run
Altitude(ft) 0.0
Speed(ft/s) 0.0
Distance(ft) 16.6
Flow(gal/min) 0.0
End

Treatment

Treatment


AI
4H Camp Rd
Modify Result
3D
Mays Run
Tree Crown
Building
Water
Tree
Pole
Other
Add
Exit
100 ft



What's Next?

- Utilizing the Thorny Flats High-Performance Computing cluster to explore performance of hyperparameters.
  - Train using a "random search" loop for hyperparameters.
- Incorporate more image bands (RE, NIR) and canopy height model.
- Compare CNN performance to traditional ML approach.
- Perform cost-benefit analysis of UAS spray drone treatment for autumn olive on reclaimed surface mines.

Questions?

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Acknowledgments
Funding for this project has been provided through the Office of Surface Mining under 15.255 – Applied Science Program Cooperative Agreements Related to Coal Mining and Reclamation.

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