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Artificial Intelligence in Satellite Imagery Analysis

- Viktor Putrenko, Prof. Dr., American University Kyiv

The Physics of RS

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- Remote sensing data are collected in the electro-magnetic radiation spectrum, principally the visible, infra-red and radio regions
- *Passive* RS systems collect data on energy that is reflected or emitted from the earth
- Most systems are passive, except for microwave and radar, which are active sensing mechanisms.
- Most RS platforms record **reflectance** in multiple wavelengths spectrums

Physics of RS

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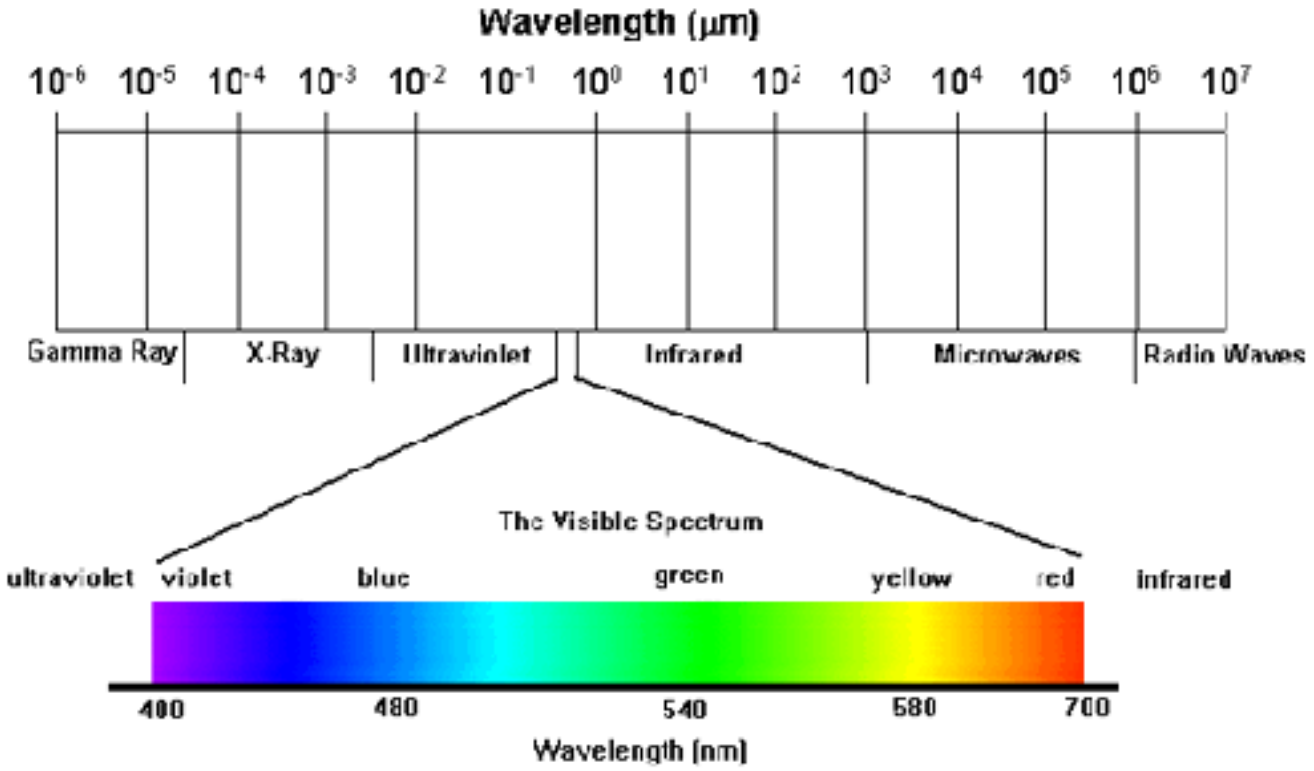
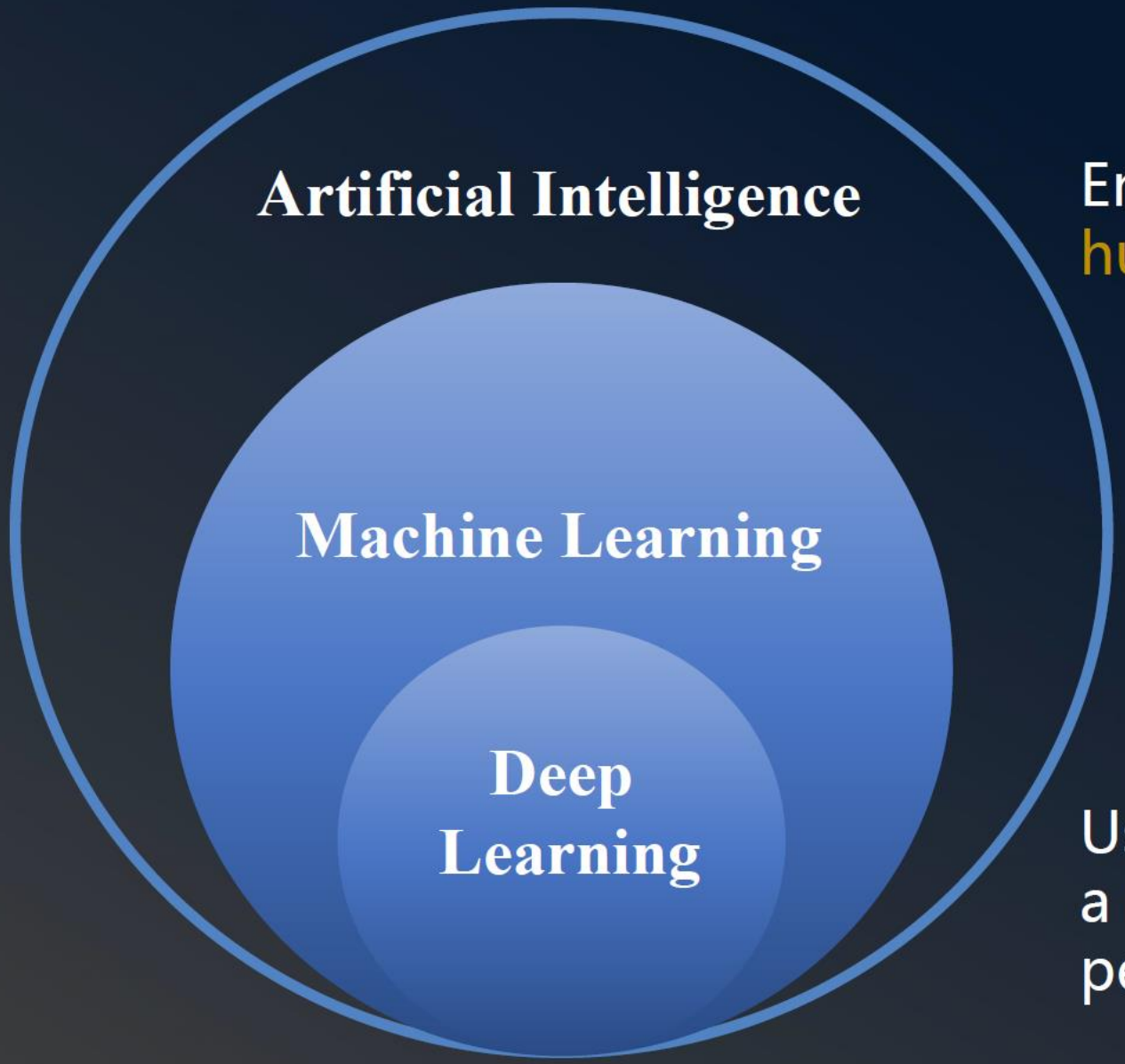
- The visible spectrum constitutes a small portion, bounded by ultraviolet spectrum below and the infrared spectrum above



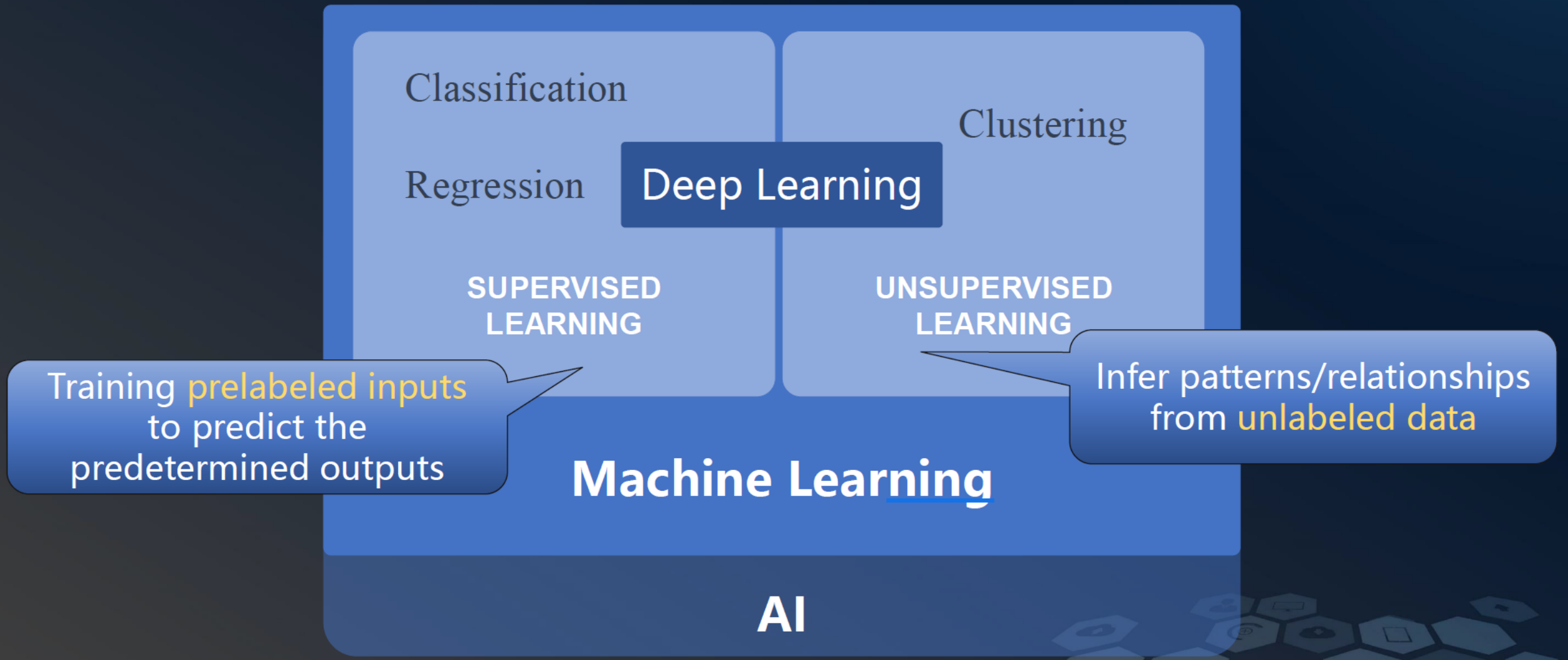


Enable computers to mimic human intelligence

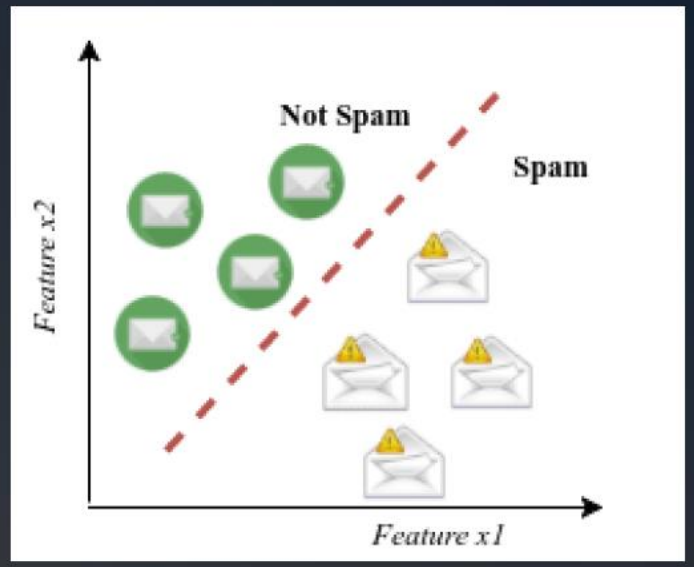
Enable machines to improve at tasks with experience.

Use neural networks that permit a machine to train itself to perform a task

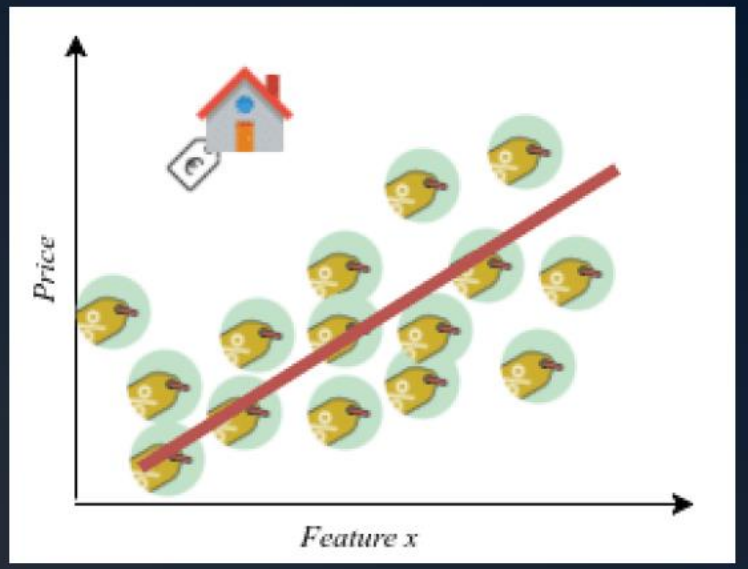
Unsupervised VS Supervised Learning



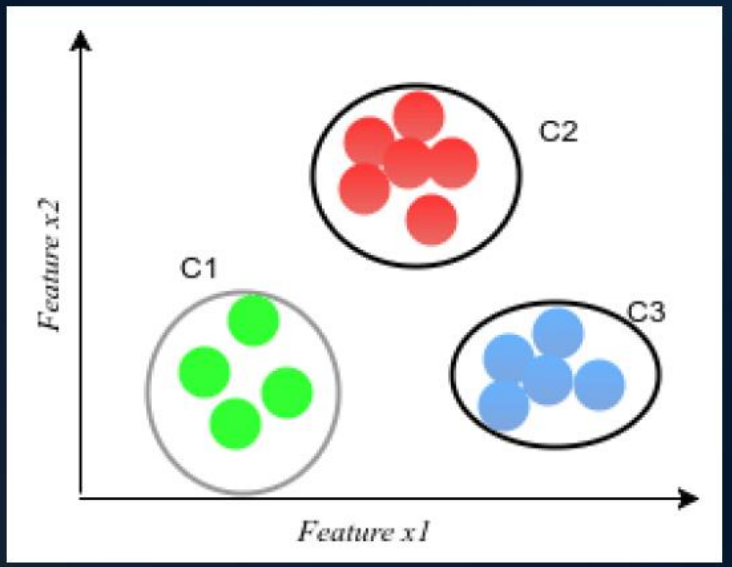
Three Main Machine Learning Tasks



Classification

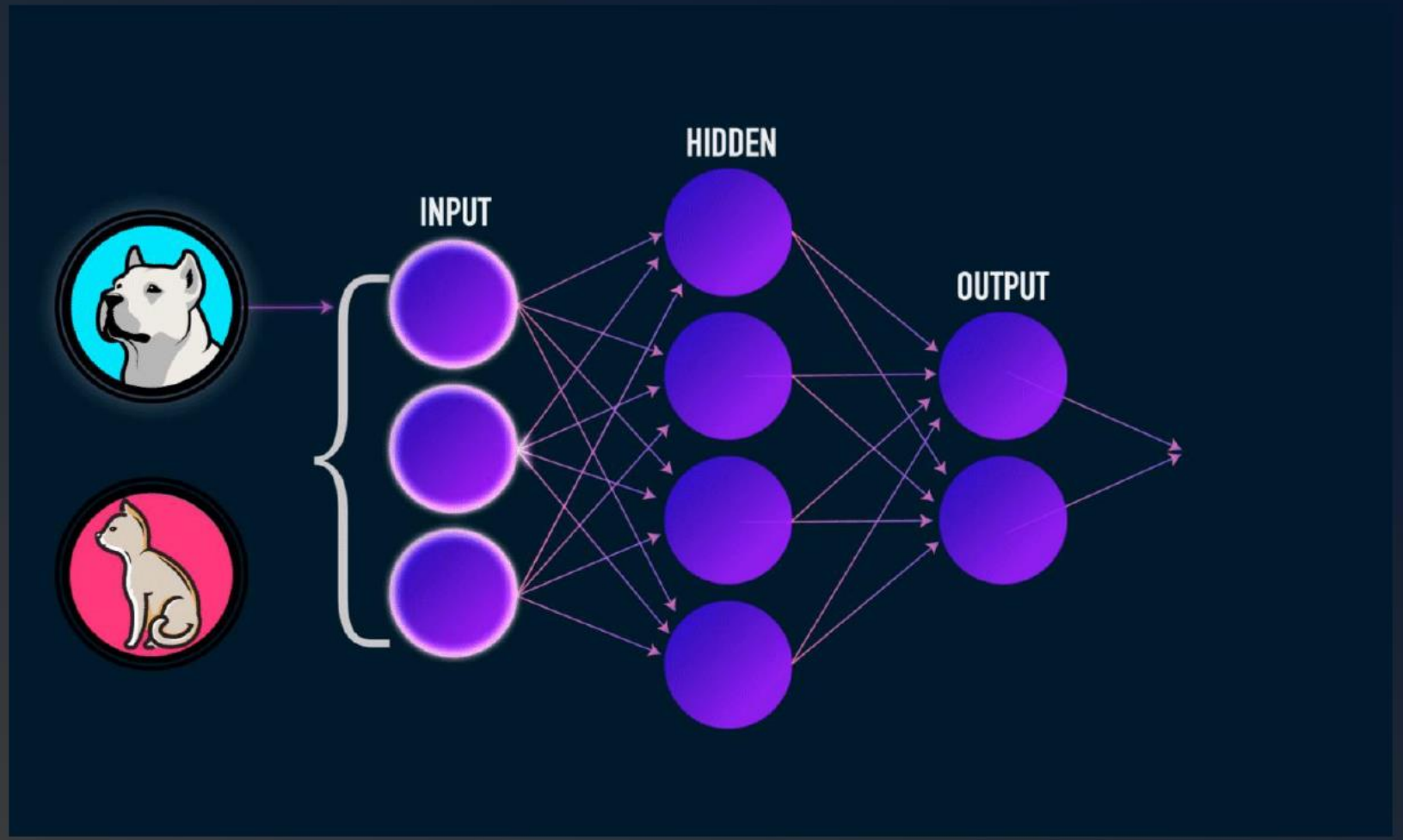


Regression



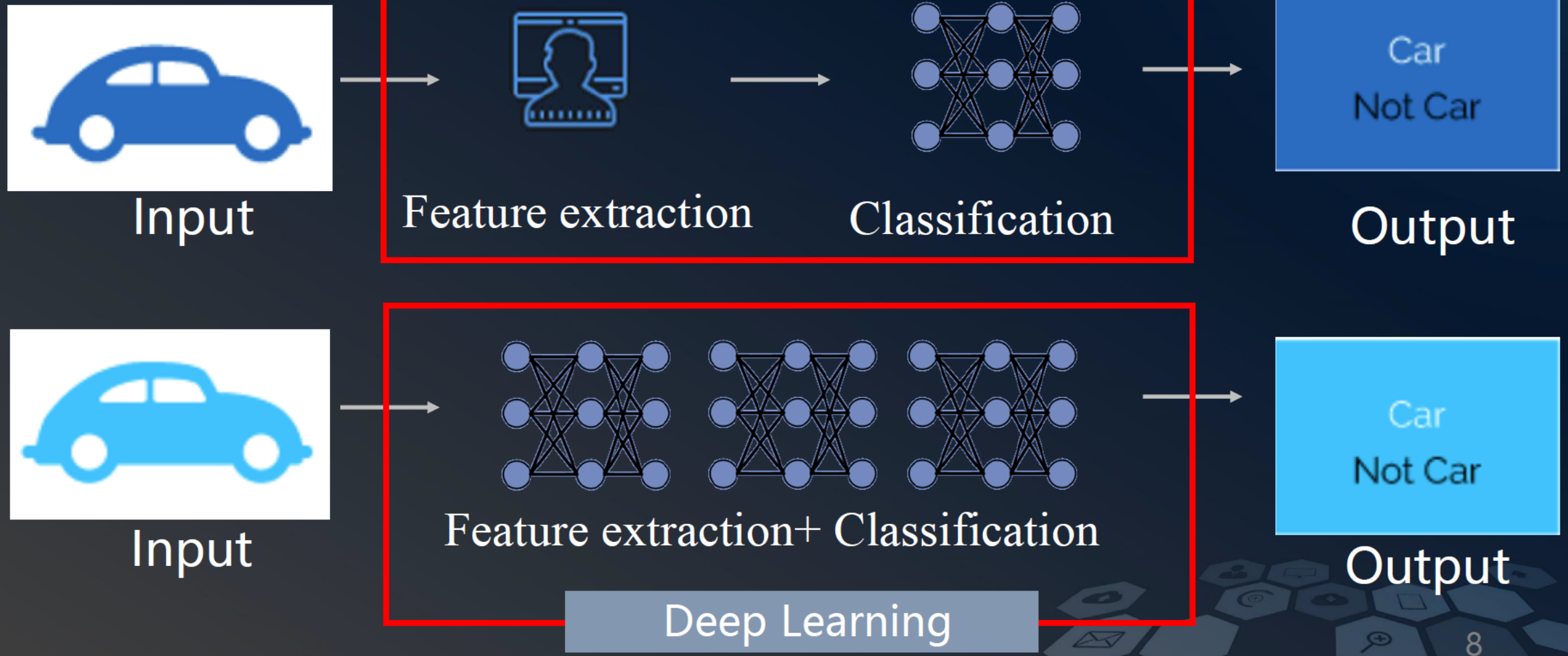
Clustering

Deep Learning & Neural Network



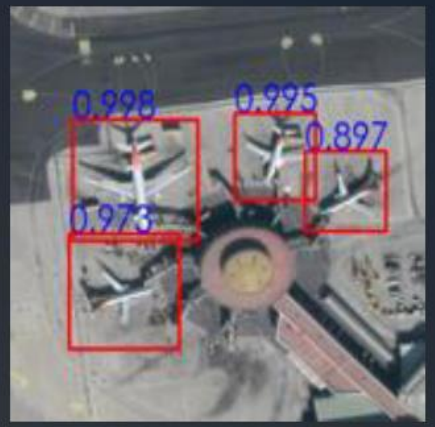
- Abstract of biological processes that take place in the brain
- Mimic the 'firing' of interconnected neutrons in the response to stimuli (new incoming info)

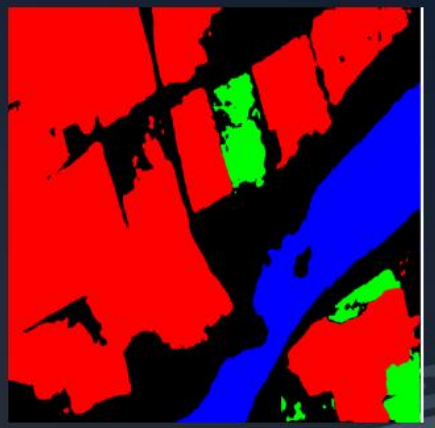
Comparison of ML & DL



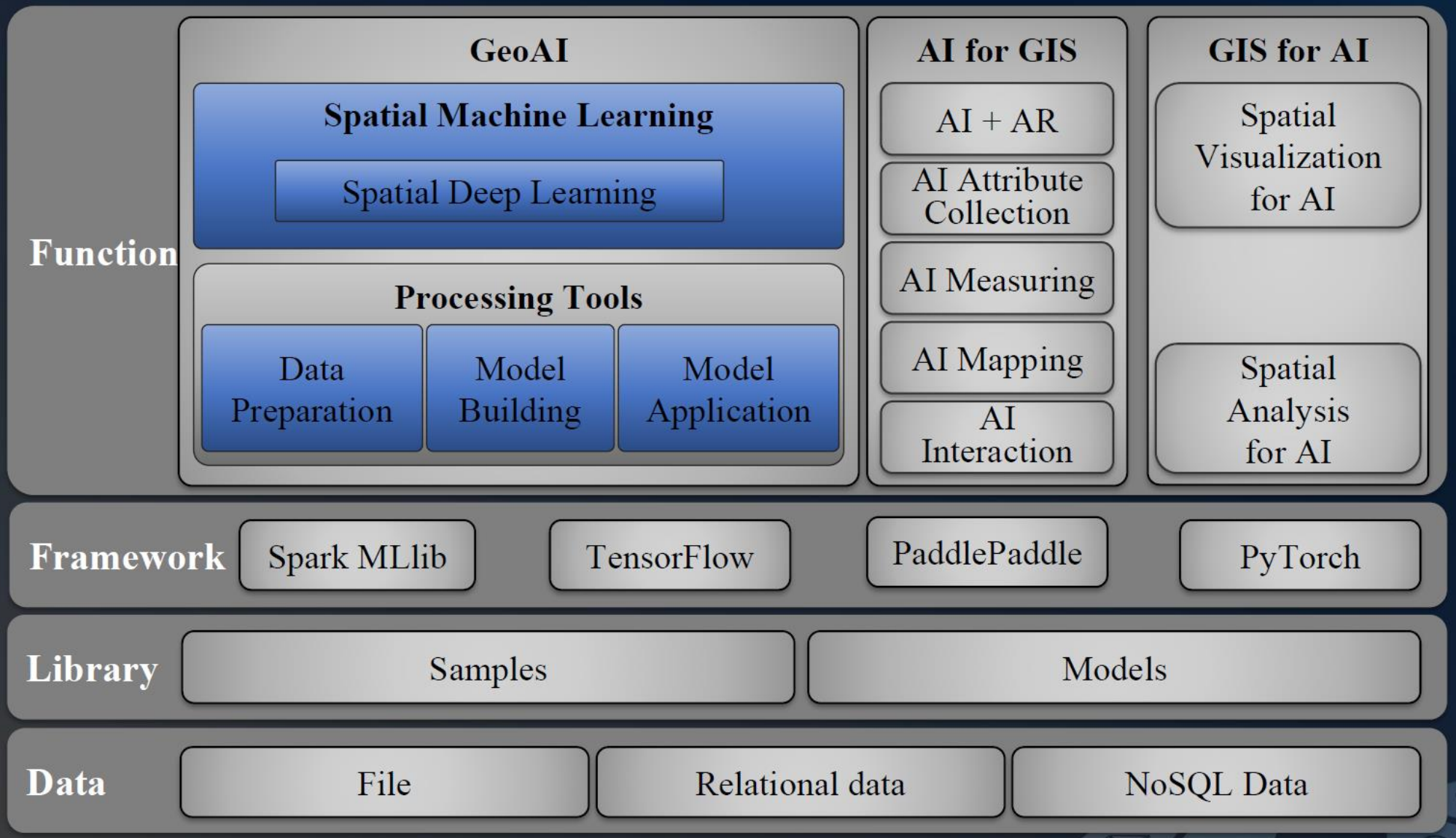
Application of Deep Learning to GIS

Image Classification *Object Detection* *Semantic Segmentation* *Instance Segmentation*





AI GIS Technology System



Spatial Machine Learning Operators

Cluster Analysis

- Spatial Hotspot
- Spatial Density Cluster

Classification Analysis

- Map Matching
- Logistic Regression
- Gradient Boosting Tree Classification
- Decision Tree Classification
- Naive Bayes Classification
- Support Vector Machine Classification
- Address Element Identification
- Random Forest Classification

Regression Analysis

- Gradient Boosting Tree Regression
- Geographical Simulation
- Linear Regression
- Decision Tree Regression
- Geographical Weighted Regression
- Generalized Linear Regression
- Forest-based Regression

Spatial Deep Learning Operators

3D Analysis

- Oblique Photogrammetry, Model DSM, Building Bottom Extraction

Image Analysis

- Object Extraction
- Object Detection
- Scene Classification
- Binary Classification
- Land Use Classification

Spatiotemporal Analysis

- Map Spatiotemporal Analysis

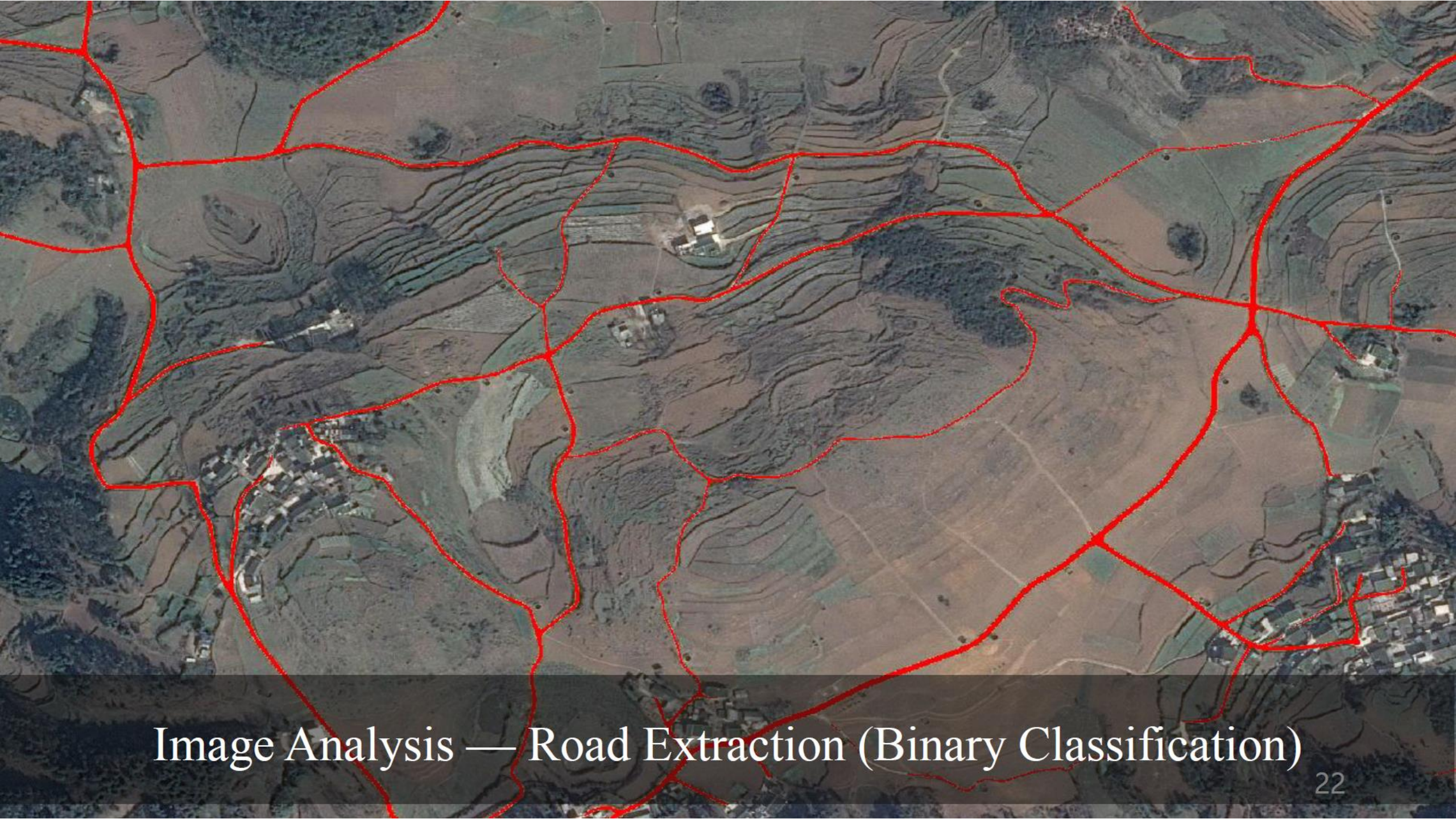


Image Analysis — Road Extraction (Binary Classification)

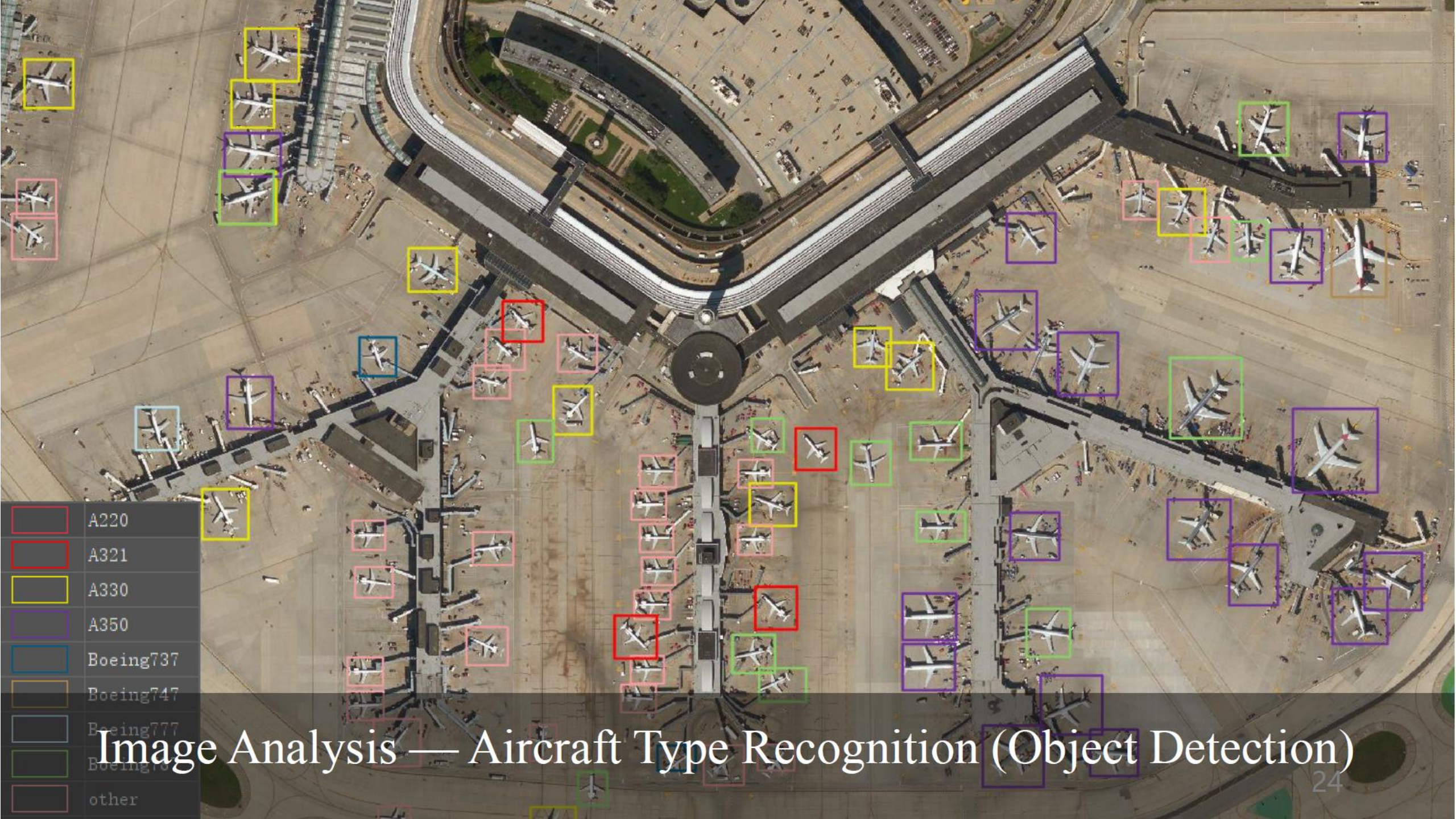


Image Analysis — Aircraft Type Recognition (Object Detection)

Deep Learning Models

	TensorFlow	Paddle	PyTorch			
Object Detection (Image)			Faster R-CNN	Cascade R-CNN	RetinaNet	
Binary/Land Use Classification			D-LinkNet	DeepLab V3+	U-Net	FPN
Object Extraction			Mask R-CNN			
Scene Classification	EfficientNet					
Object Detection (Picture)			Faster R-CNN	Cascade R-CNN	RetinaNet	
Object Detection (Video)	YOLO V4	YOLO V3				
Picture Classification	EfficientNet					
Spatiotemporal Analysis			DCRNN			

Deep Learning Workflow

AI GIS Workflow

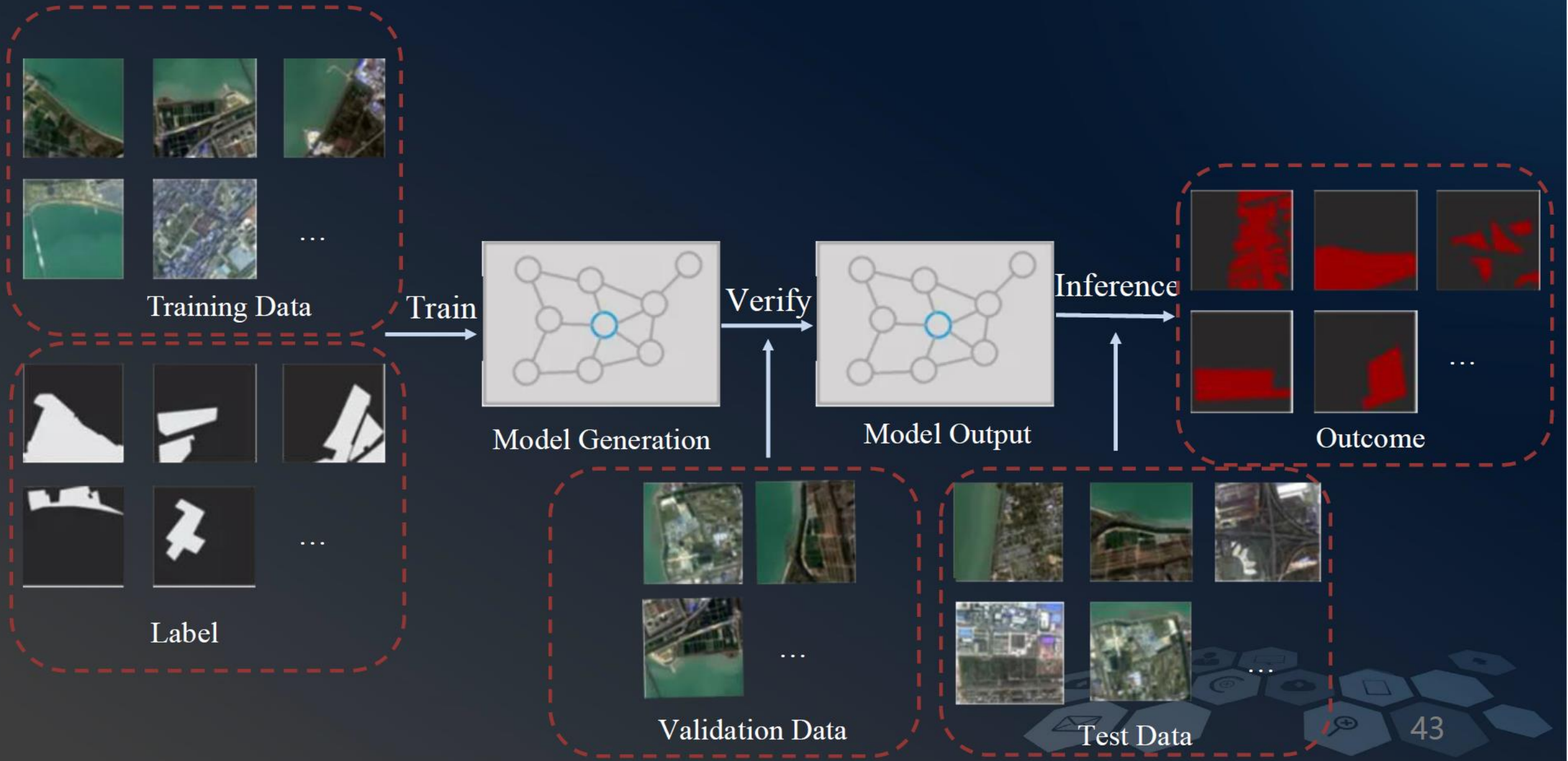


Image Sample Management

Label

Attribute Table

ID	SmID	SmUserID	SmArea	SmPerimeter	SmGeometry	Label_Type
1	4	0	90.7154	38.1376	BinaryData	villa
2	5	0	53.5357	31.1253	BinaryData	villa
3	6	0	165.5737	52.9898	BinaryData	villa
4	7	0	96.5954	46.8498	BinaryData	villa
5	8	0	75.8655	38.1571	BinaryData	apartment
6	10	0	90.4354	38.4046	BinaryData	apartment
7	11	0	111.6438	42.4805	BinaryData	apartment
8	20	0	34.0158	24.3171	BinaryData	school
9	21	0	46.1827	29.8536	BinaryData	school
10	22	0	42.5054	27.5655	BinaryData	school

AI Extraction Results

Ground Truth

Binary classification results

Algorithm：FPN
Training Time：3.5h（GPU）
Accuracy：IOU=0.72

Convolutional neural network

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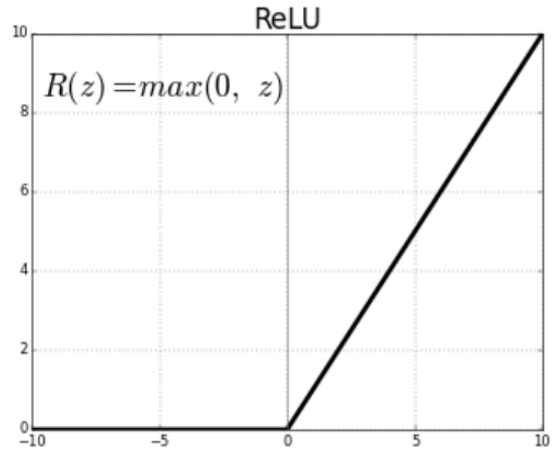
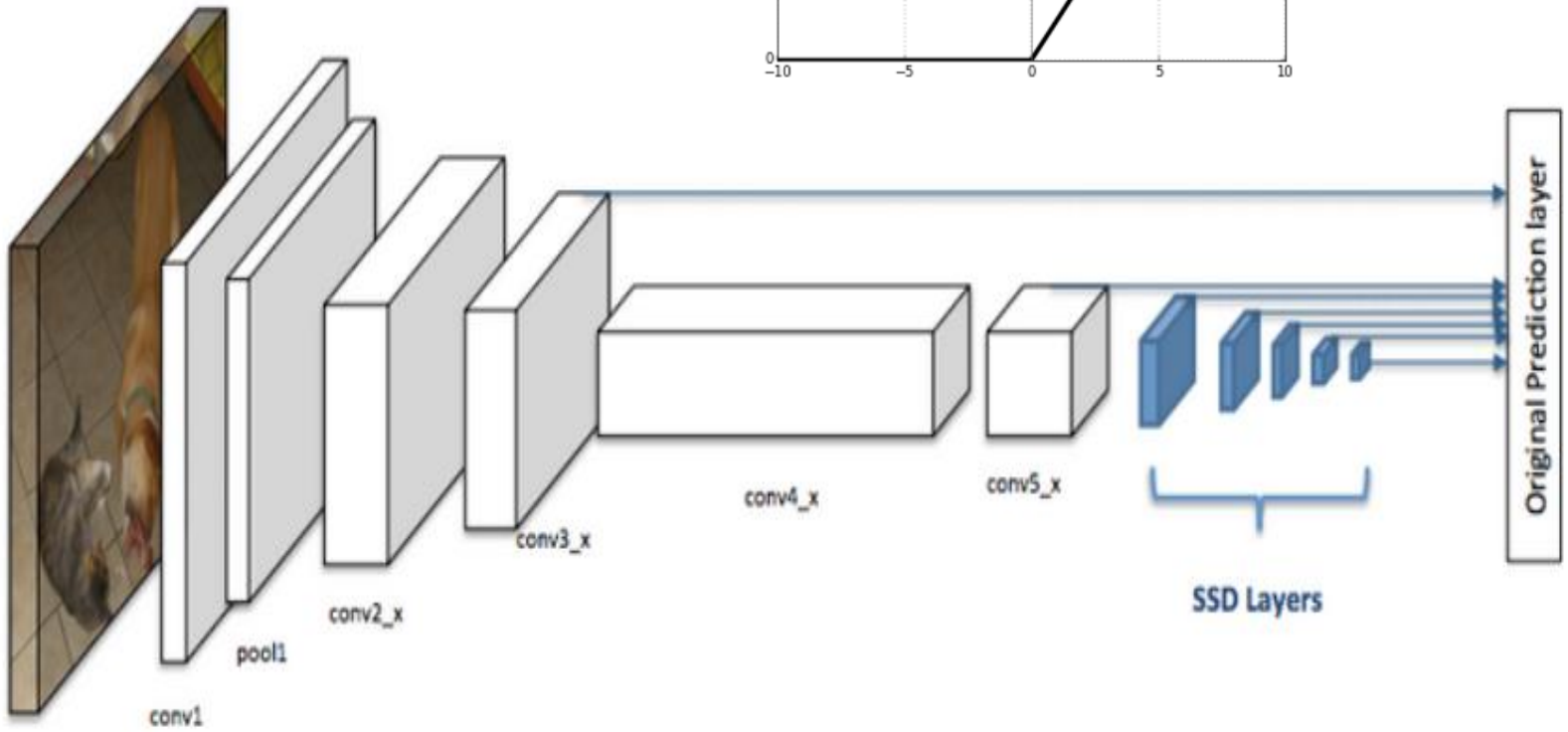
Function softmax

$$f_{ReLU} = max(0, x)$$

$$f_{softmax} = y_i^l = f(x_i^l) = \frac{e^{x_i^l}}{\sum_{k=0}^{n} e^{x_k^l}}$$





Recognition of solar batteries

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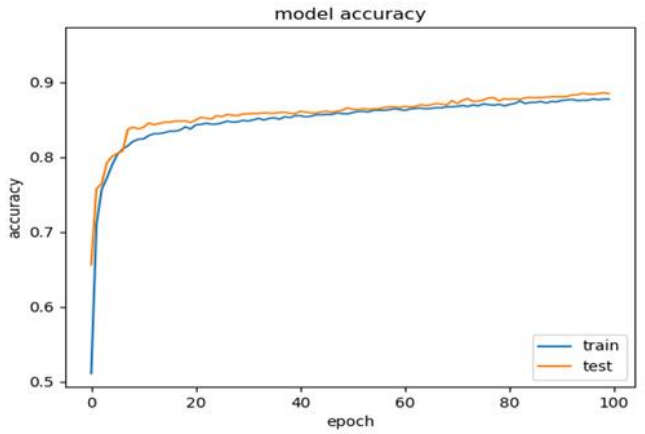
PyTorch
scikit-image
scikit learn
cuDNN
Keras
plotly
DASK
ONNX
fast.ai
TensorFlow
spaCy



Recognition of trees

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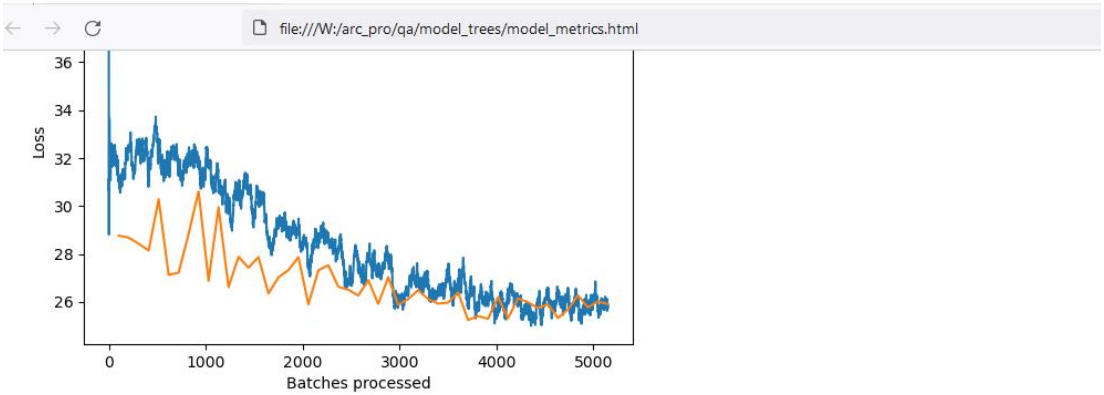
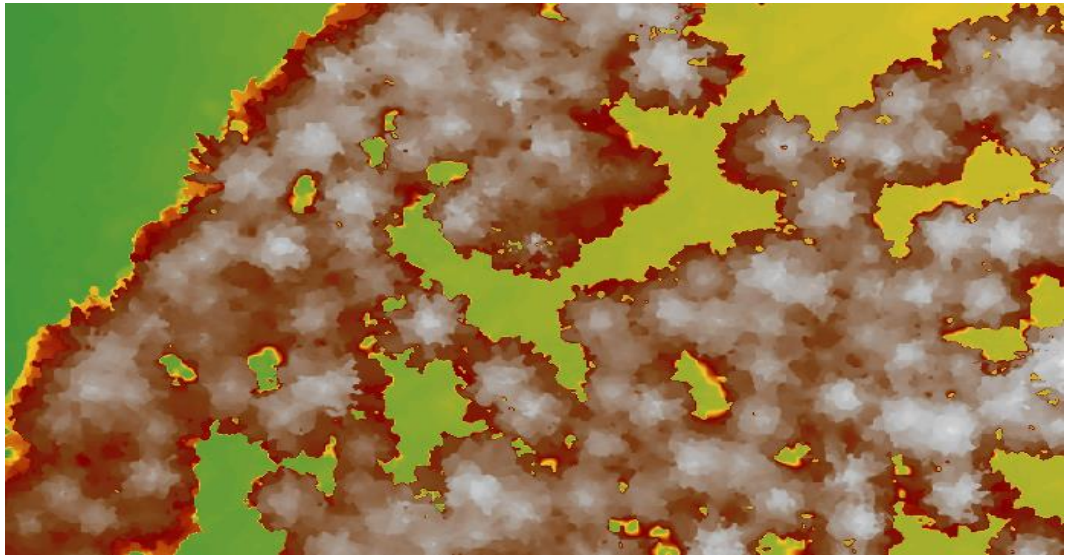


Analysis of the model

Average Precision Score: {'Trees': 0.4310948298285644}

Sample Results



Ground Truth / Predictions

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THANK YOU!