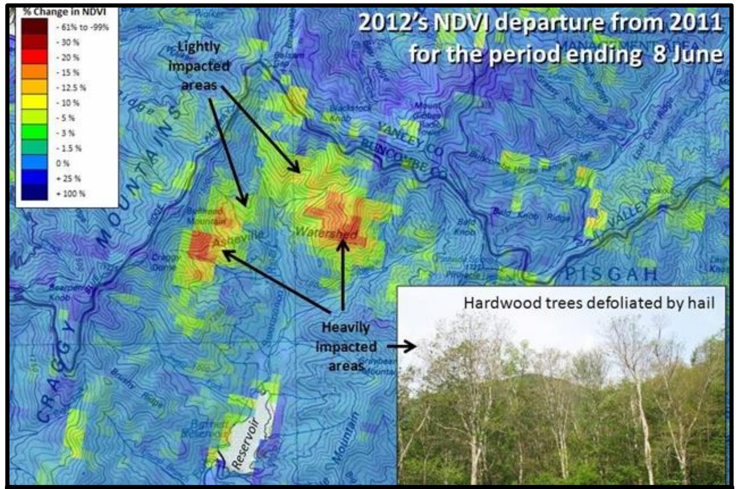
Image Processing and Computer Vision

IPCV Applications



NASA Develops Warning System for Detecting Forest Disturbances

Beth Israel Medical Center Improves MRI Accuracy

CNH Develops Intelligent Filling System for Forage Harvesters

FLIR Accelerates Development of Thermal Imaging FPGA

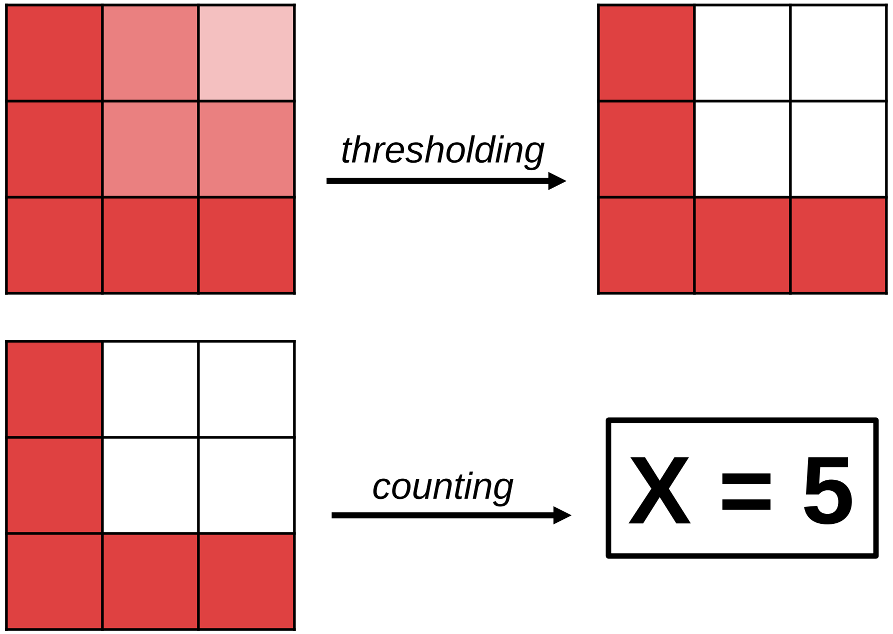
Veoneer (Autoliv) Builds Radar Sensor using LiDAR-Based Verification

Image Processing & Computer Vision

Image Processing	Computer Vision
Import, Display, and Exploration	Camera Calibration and 3D-Vision
Geometric Transform and Image Registration	Tracking and Motion Estimation
Image Filtering and Enhancement	Feature Detection and Extraction
Image Segmentation and Analysis	LiDAR and Point Cloud Processing
3D Volumetric Processing	Deep Learning

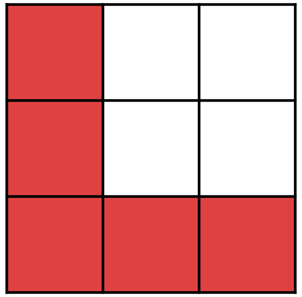
Image Processing

Manipulation of images to extract meaningful information



Computer Vision

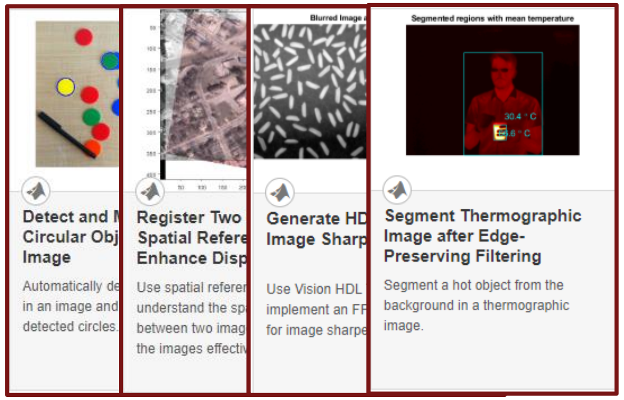
Teaching computers to understand images and video



This is the letter "L"

Why Use MATLAB?

Ease of Use and Thorough Documentation



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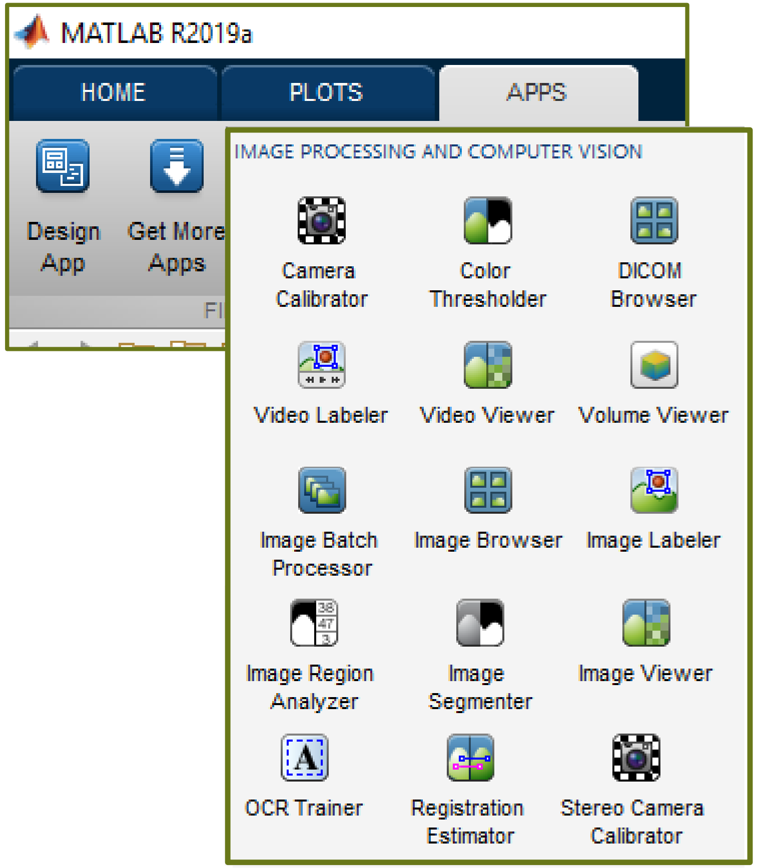
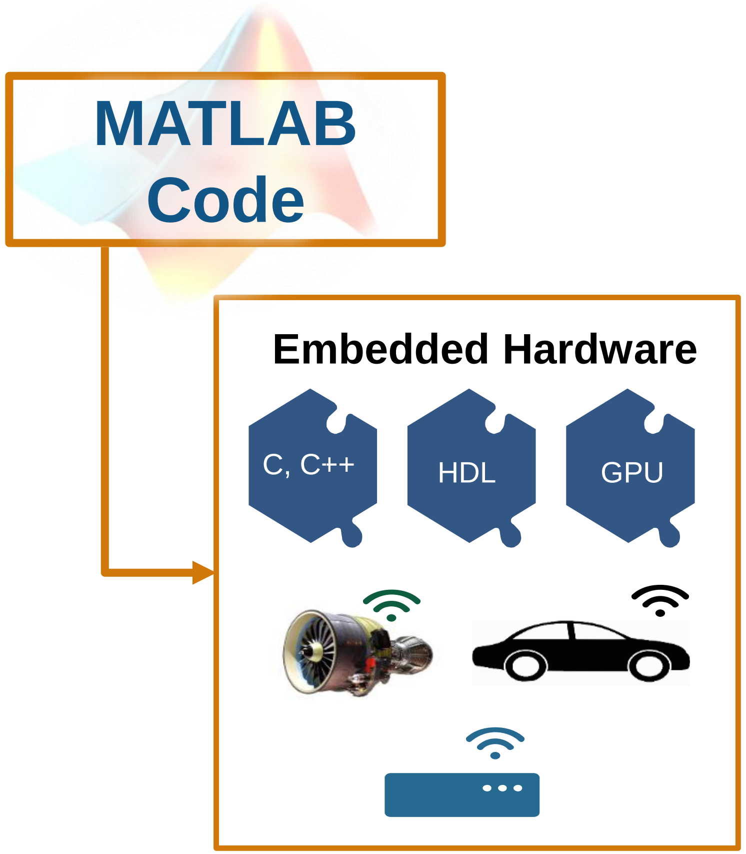
Need Technical Help?

- Technical Support
- Application Engineers

Rapid Prototyping and Algorithm Development



Code Generation for Embedded Deployment



Agenda

Image Processing Workflow

Morphology and Segmentation

Object Detection and Tracking

Deep Learning

Summary + Next Steps

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Image Processing Workflow

Access Data

- Files
- Hardware
- Software

Explore and Discover

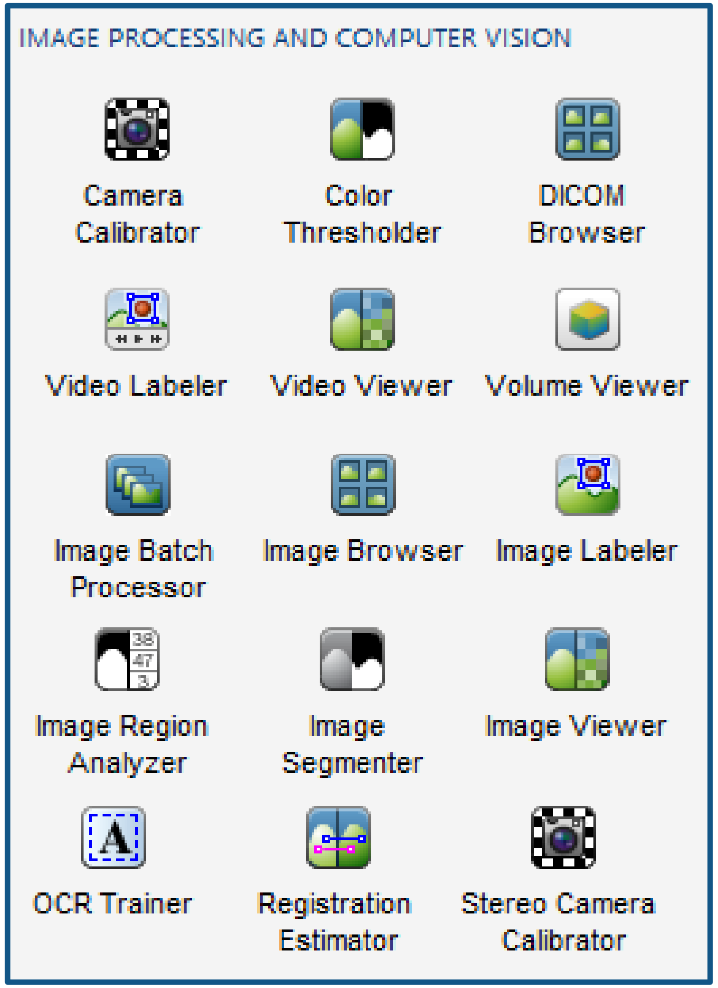
- Data Analysis and Modeling
- Algorithm Development
- Application Creation

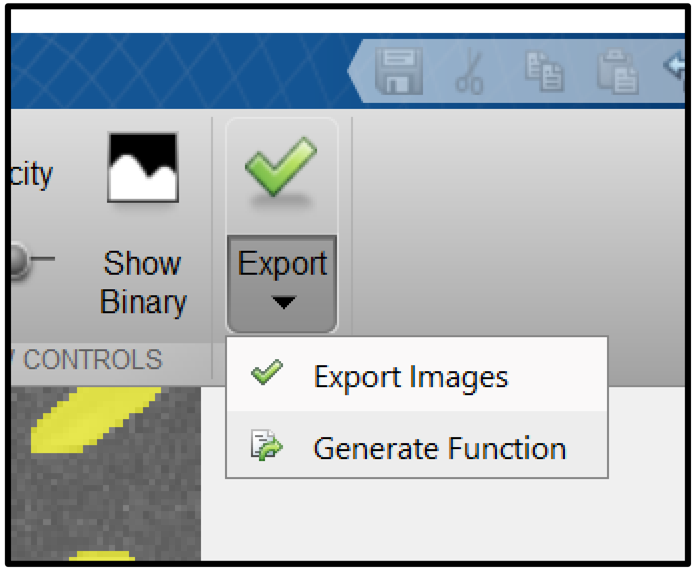
Share Results

- Embedded Code
- Enterprise Application
- Reports

Iterate and Automate

IPCV Apps Accelerate Workflow





Instructor Demo

IPCVParasitologyWorkflow.mlx

Takeaways

- Data management with **`imageDatastore`**
- **IPCV apps** perform a variety of processes and can generate MATLAB Code
  - *(Additional Apps to generate embedded code)*

Agenda

Image Processing Workflow

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Summary + Next Steps

Morphology and Segmentation

Image processing techniques that facilitate the extraction of information

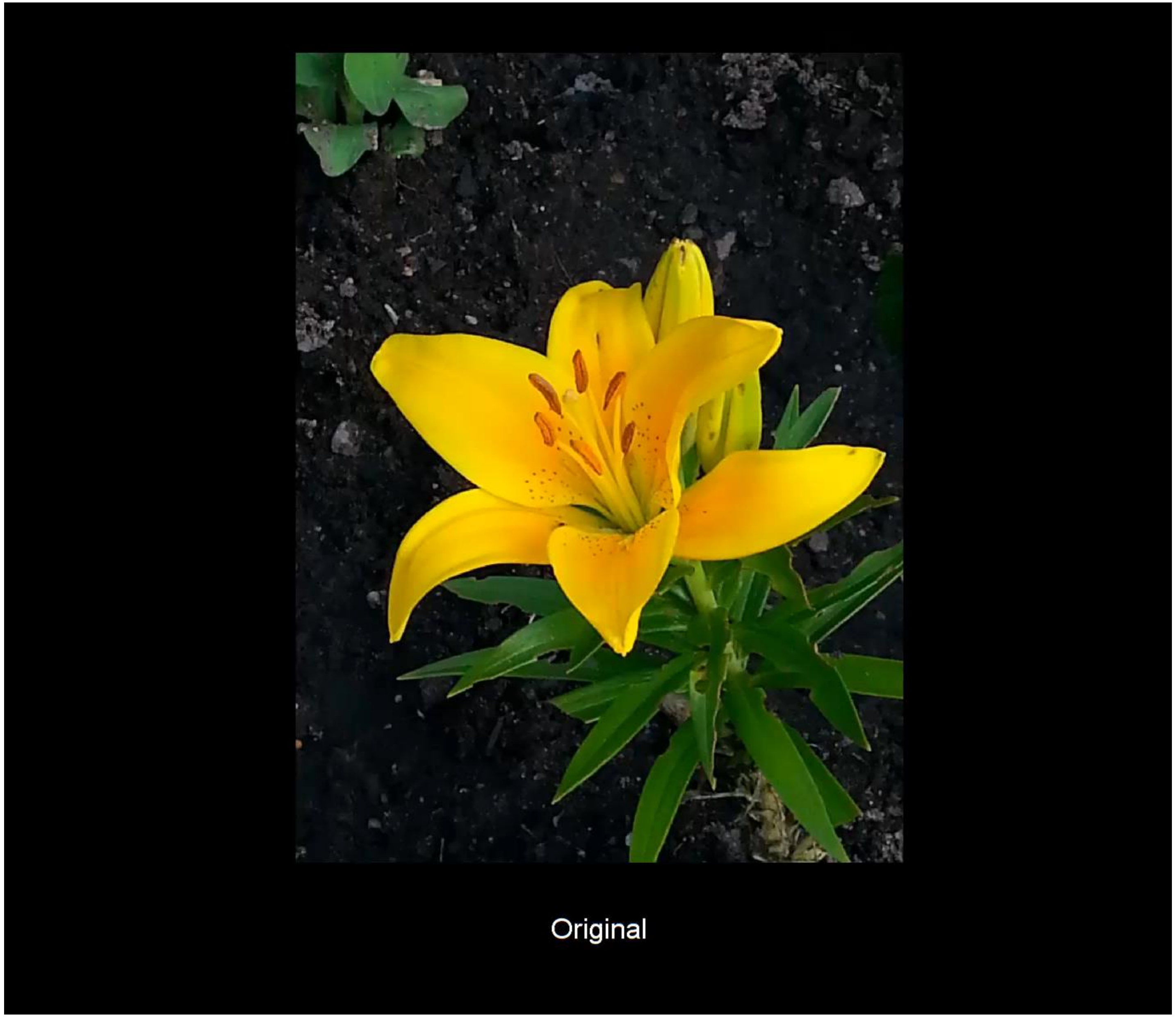


Image Morphology

Structuring Element: 3-pixel line

Rule: ***Dilation*** *(max)*

Image Morphology

Structuring Element: 3-pixel line

Rule: ***Erosion*** *(min)*

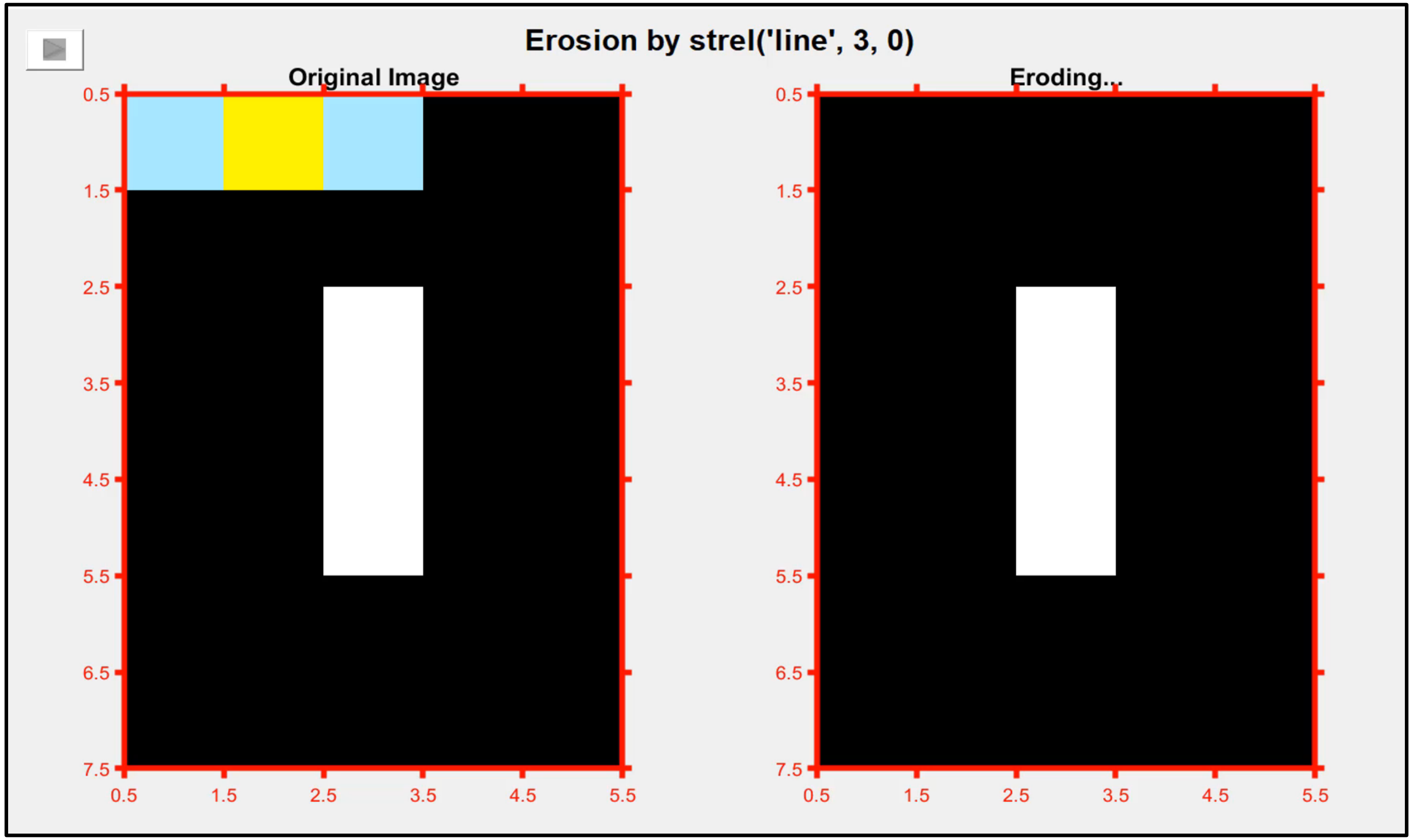
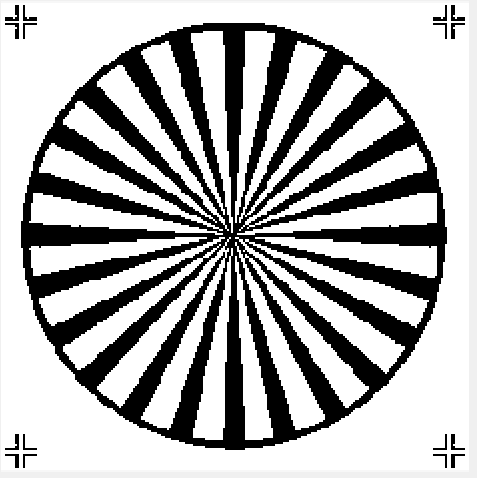


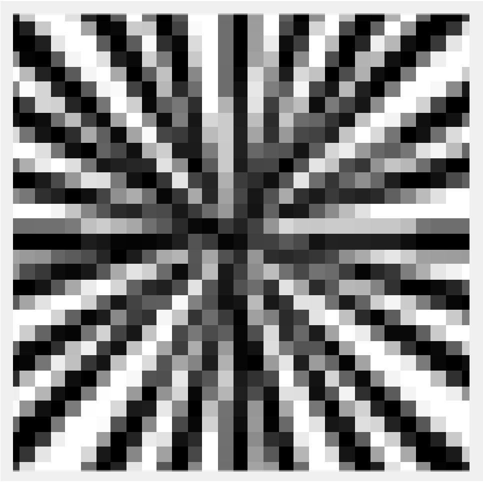
Image Morphology Example

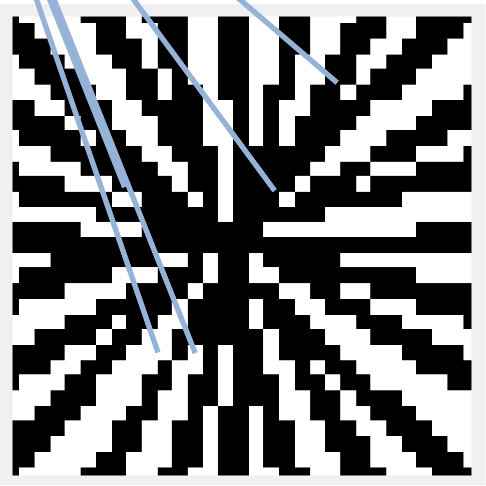
These are
“8-Connected ROIs”

Image Morphology

Count white spokes?





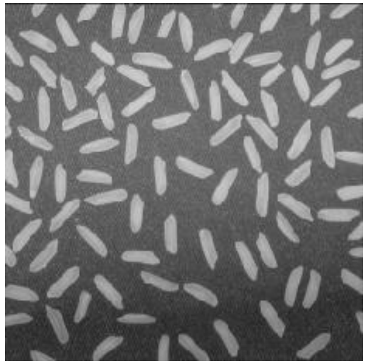


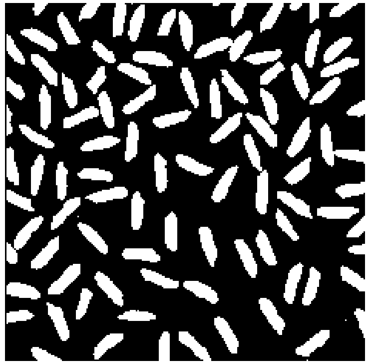
Binarization without morphology leads to connectivity issues, but **`imclearborder`** *(morphology) provides clarity.*

Image Segmentation

Creating masks where ROIs with similar traits are assigned the same value

Image Segmentation

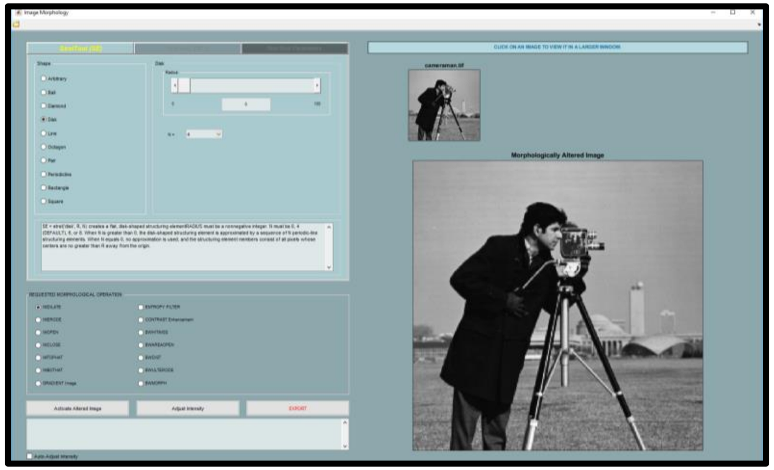


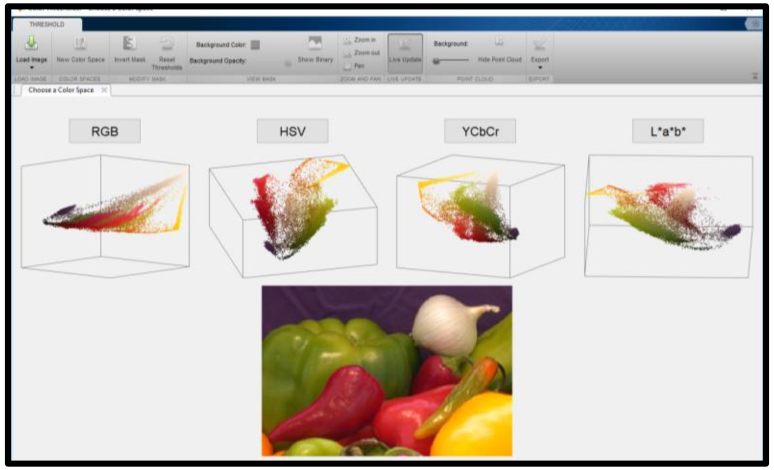


Apps for Morphology and Segmentation

Image Morphology

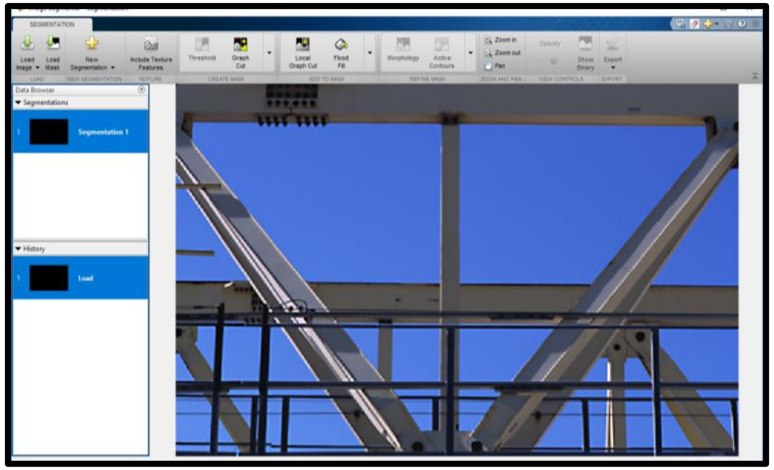
(file exchange)





Color Thresholder

Image Segmenter



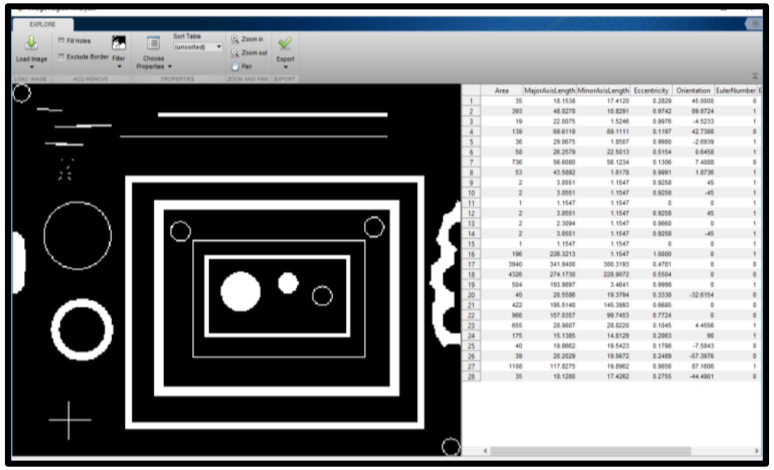


Image Region Analyzer

Instructor Demo

MorphologyAndSegmentation.mlx

Takeaways

- Dilation and erosion are building blocks of common morphological operations
- Morphology and segmentation often used together to extract meaningful information from images.

Agenda

Image Processing Workflow

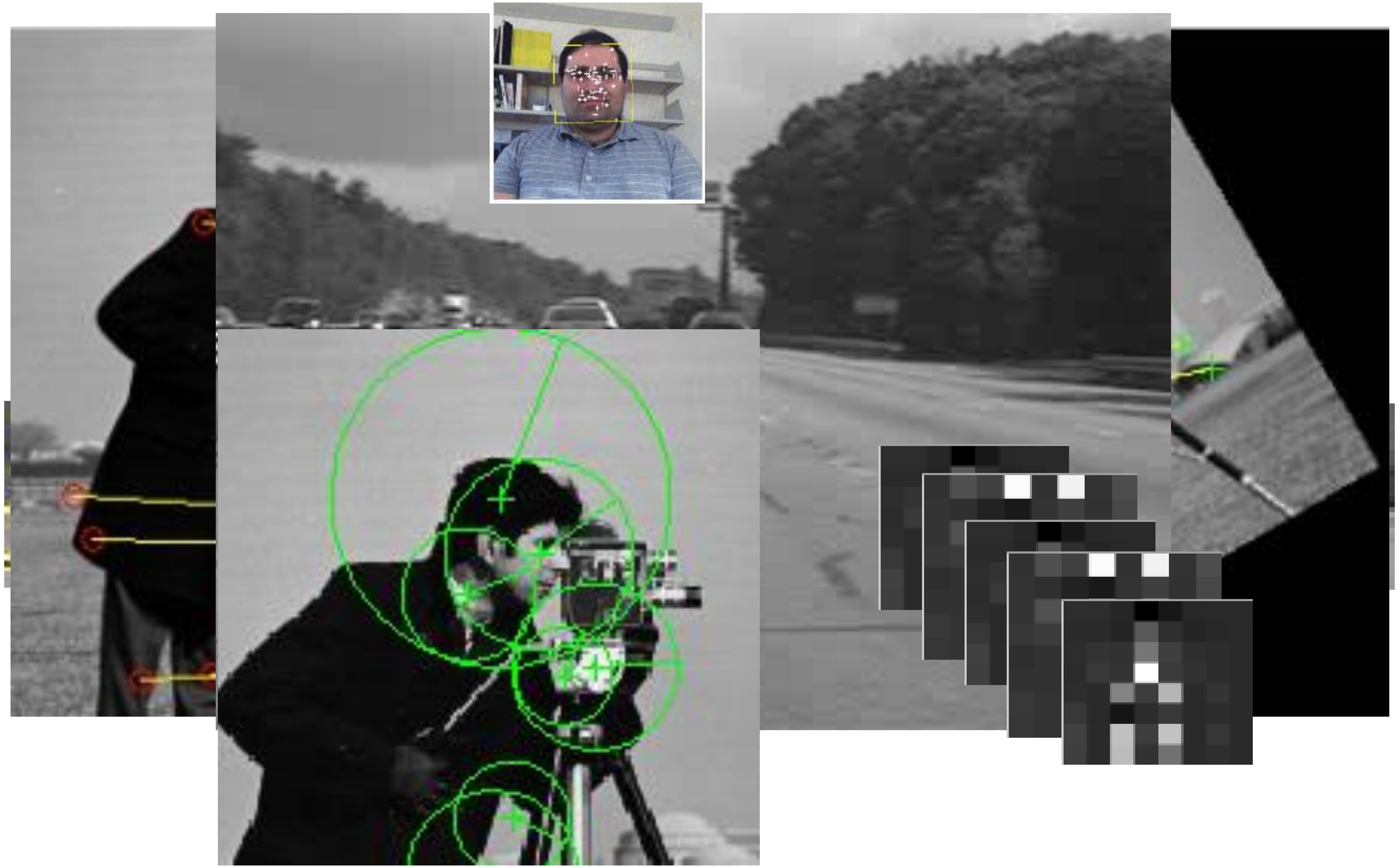
Morphology and Segmentation

Object Detection and Tracking

Deep Learning

Summary + Next Steps

Computer Vision – Analyzing and Understanding Images at Higher Level



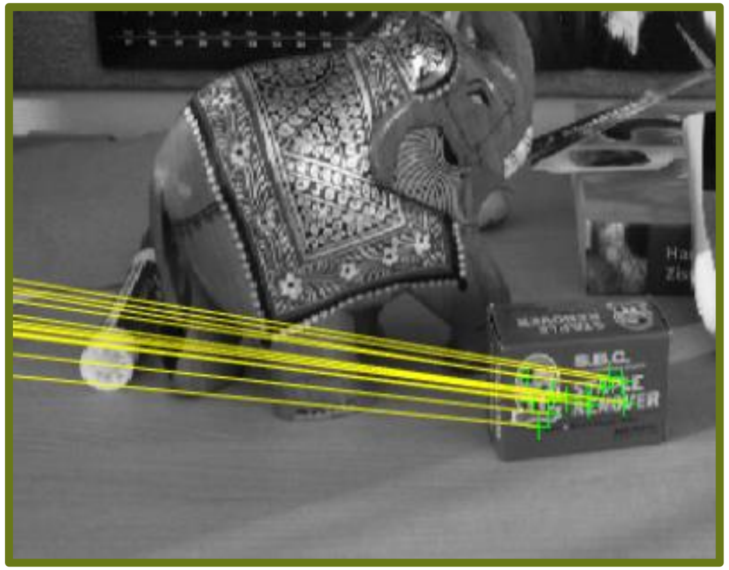
Object Detection Workflow

1. Detect

2. Extract

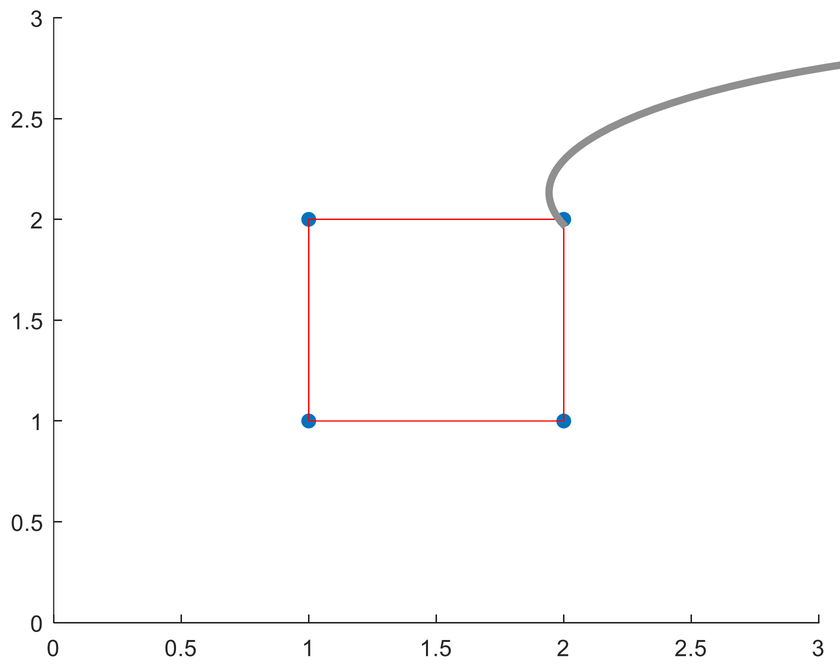
3. Match

Compute a descriptor for each feature

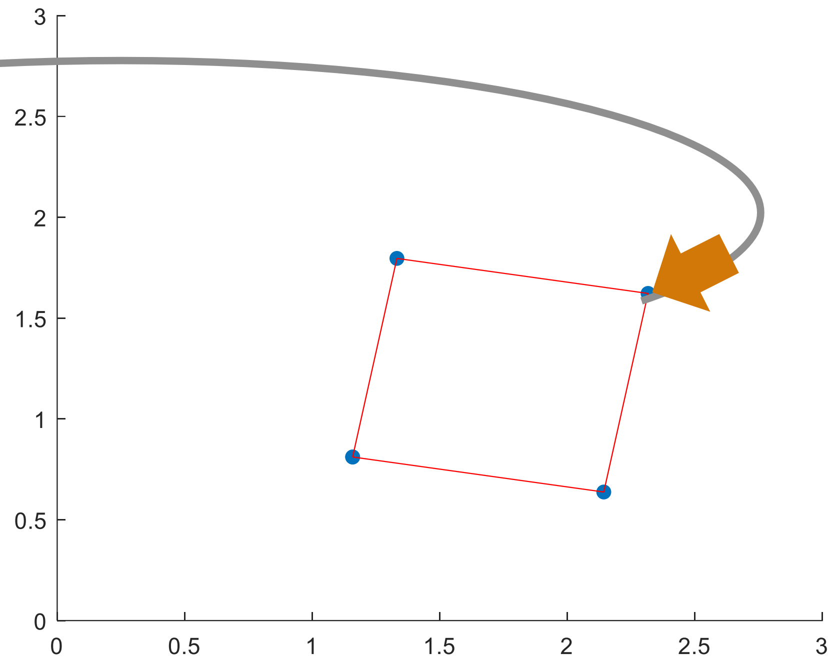


Goal – to find a geometric transform between original image and target image

What is a Geometric Transform?



Original Coordinates



New Coordinates

Instructor Demo

ObjectDetection.mlx

Object Tracking Workflow

1. Detect

2. Extract

3. Match

4. Track

Maintain corresponding feature points from frame to frame

Why can't we detect objects in every frame?

1. *Tracking allows you to maintain history*
2. *Detection requires more computation than tracking*

What If You Don't Have a Reference Image?

MODEL

Tracking in Action

Instructor Demo

Lecture_ObjectTracking.mlx

Takeaways

- Features are meaningful structures within images
- Computers use features to understand images
- Object Detection = Detect, Extract, Match
- Object Tracking = Detct, Extract Match, Track

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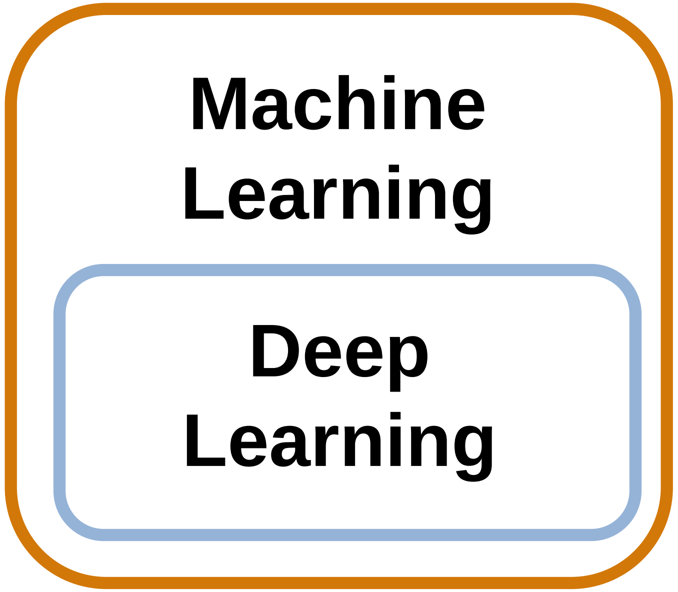
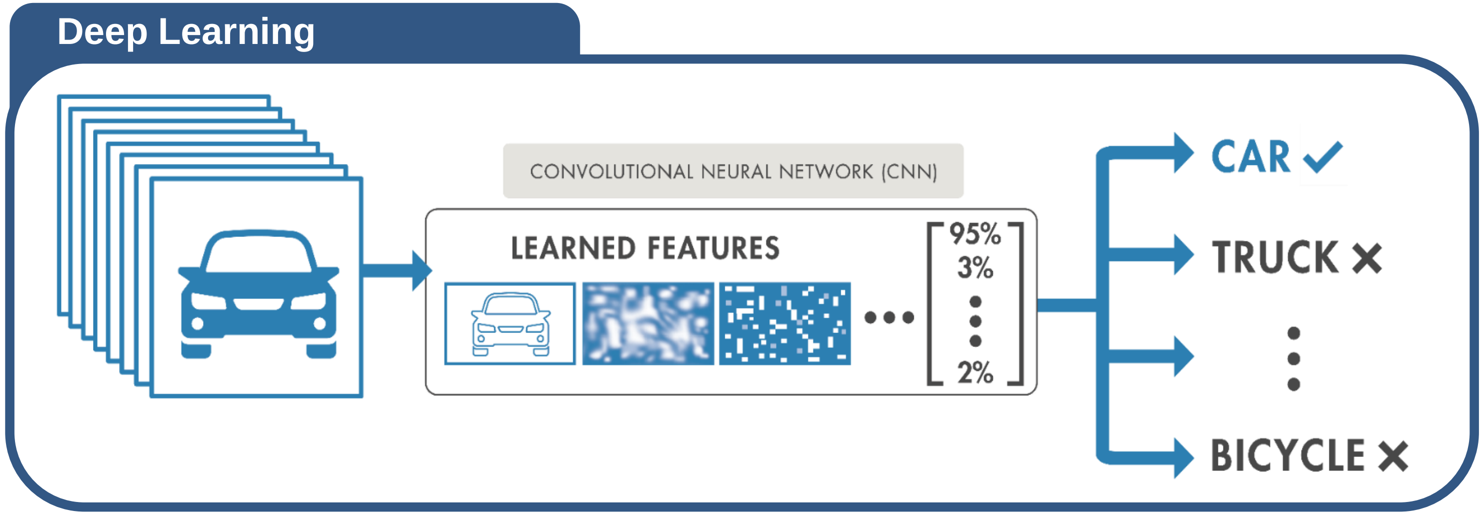
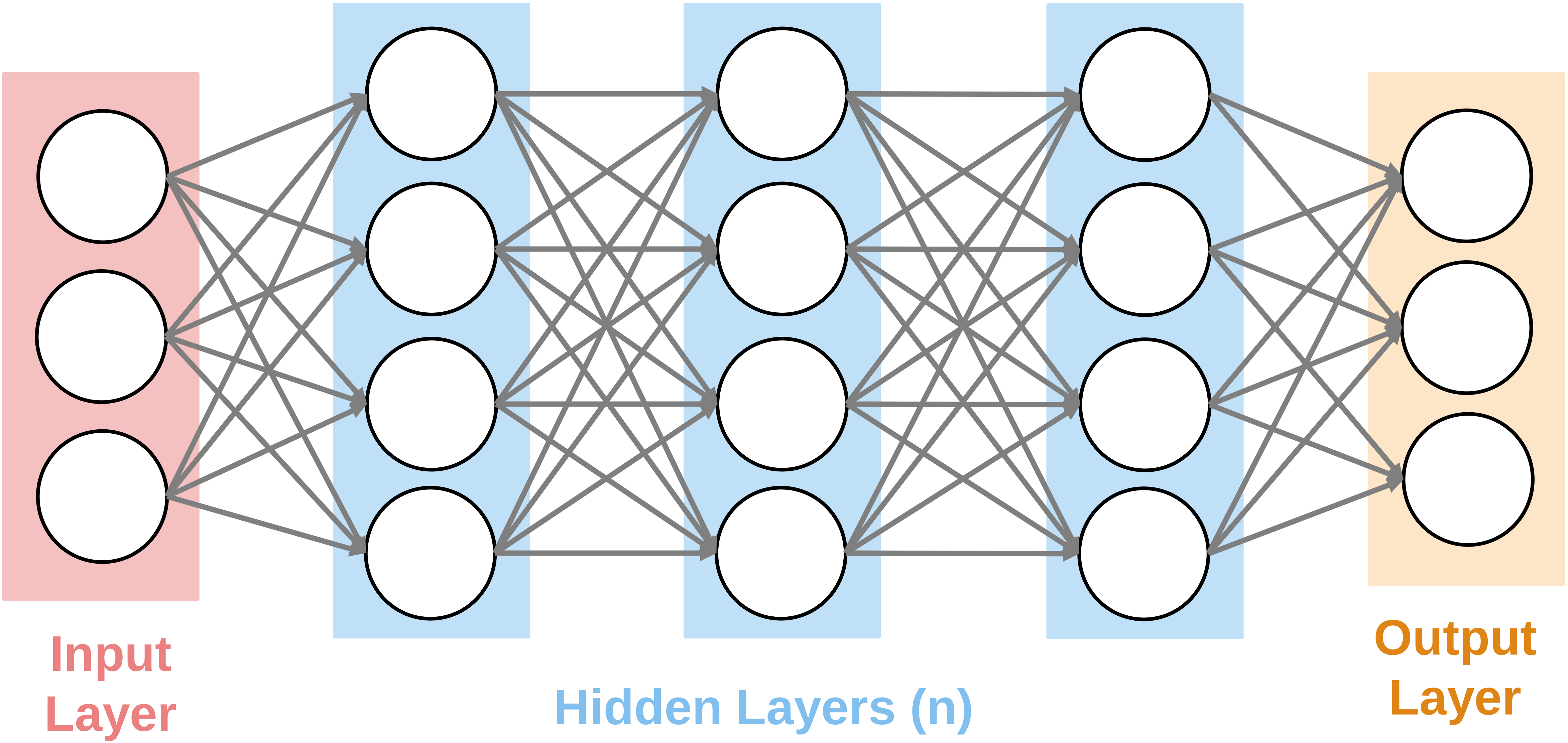
What is Deep Learning?

- Neural networks to learn tasks directly from data
- (Automatic feature extraction)



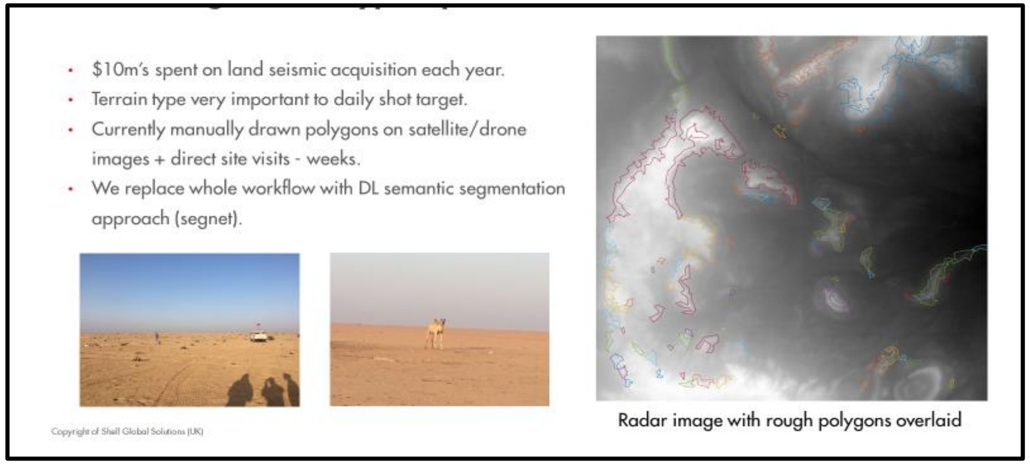


Deep Learning Uses a Neural Network Architecture



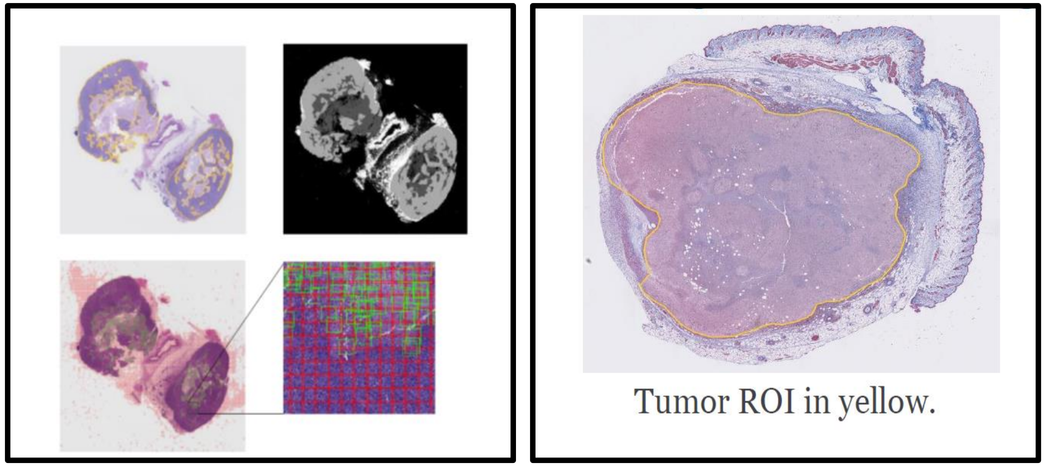
Applications of Deep Learning

Shell



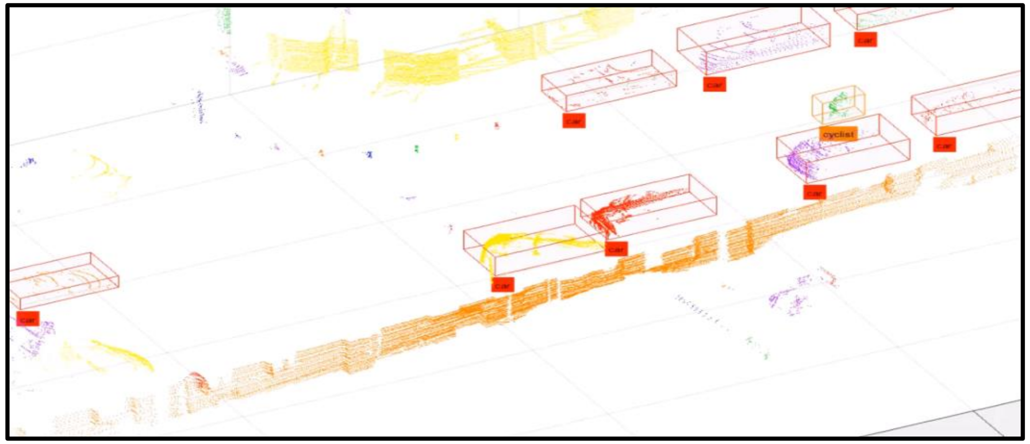
Terrain Recognition with Hyperspectral Data

Genentech



CNNs for Digital Pathology Analysis

Veoneer



LiDAR-Based Sensor Verification

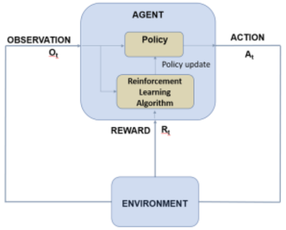
Caterpillar

Equipment Classification

Wide Domain Support for Deep Learning in MATLAB

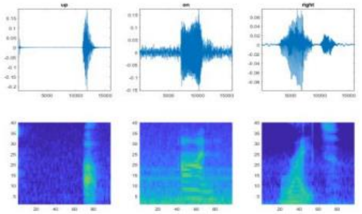
Computer Vision

Image Processing

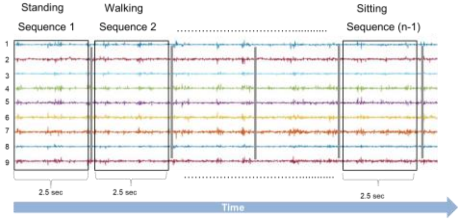


Control Design

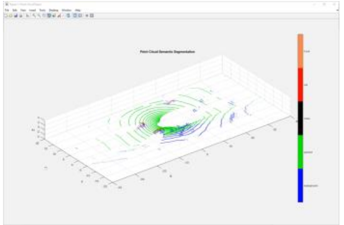
Text Analytics



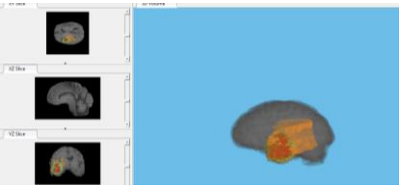
Audio Processing



Sensor Data Analysis

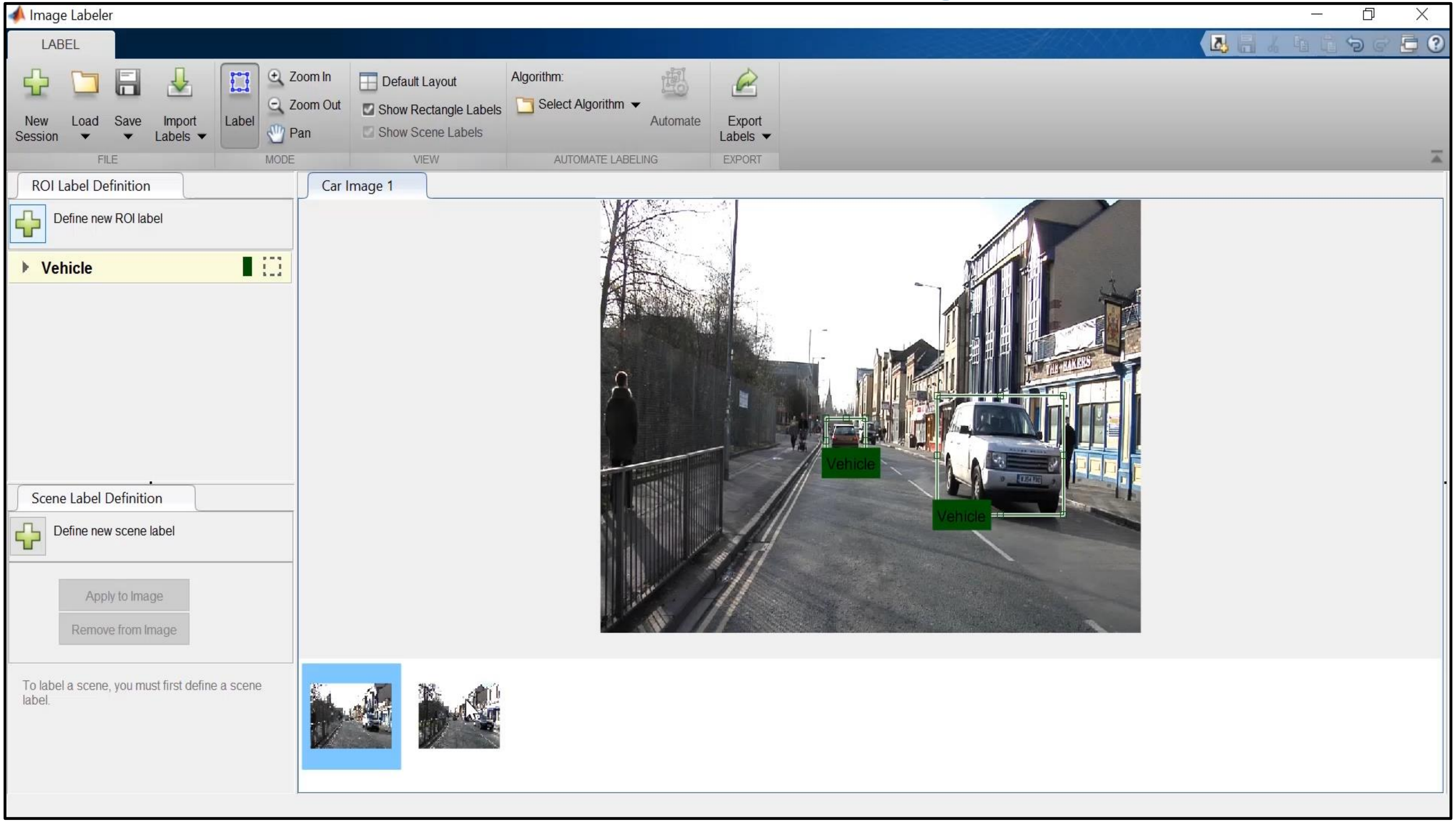


Lidar Processing

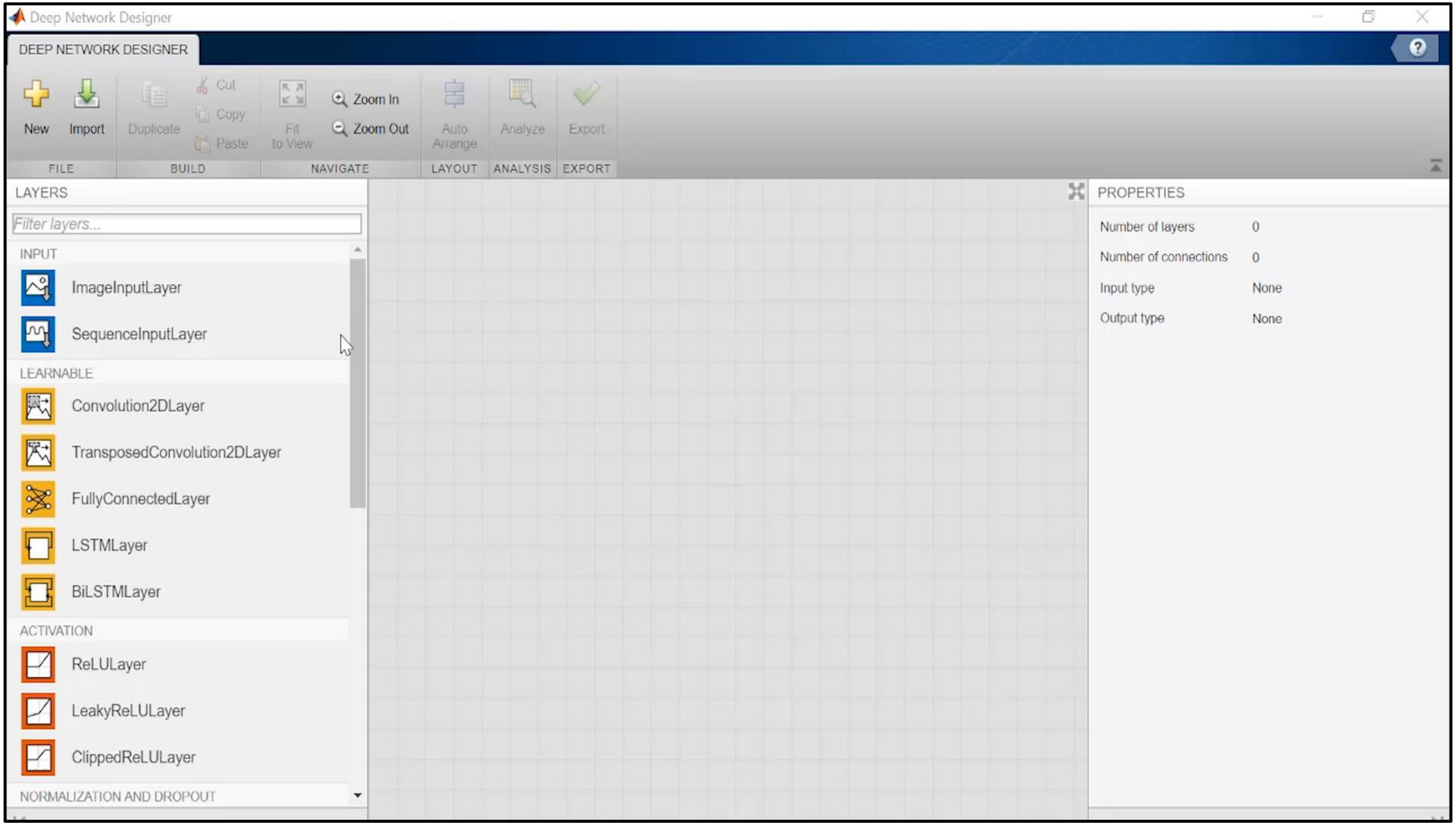


N-D Volumes

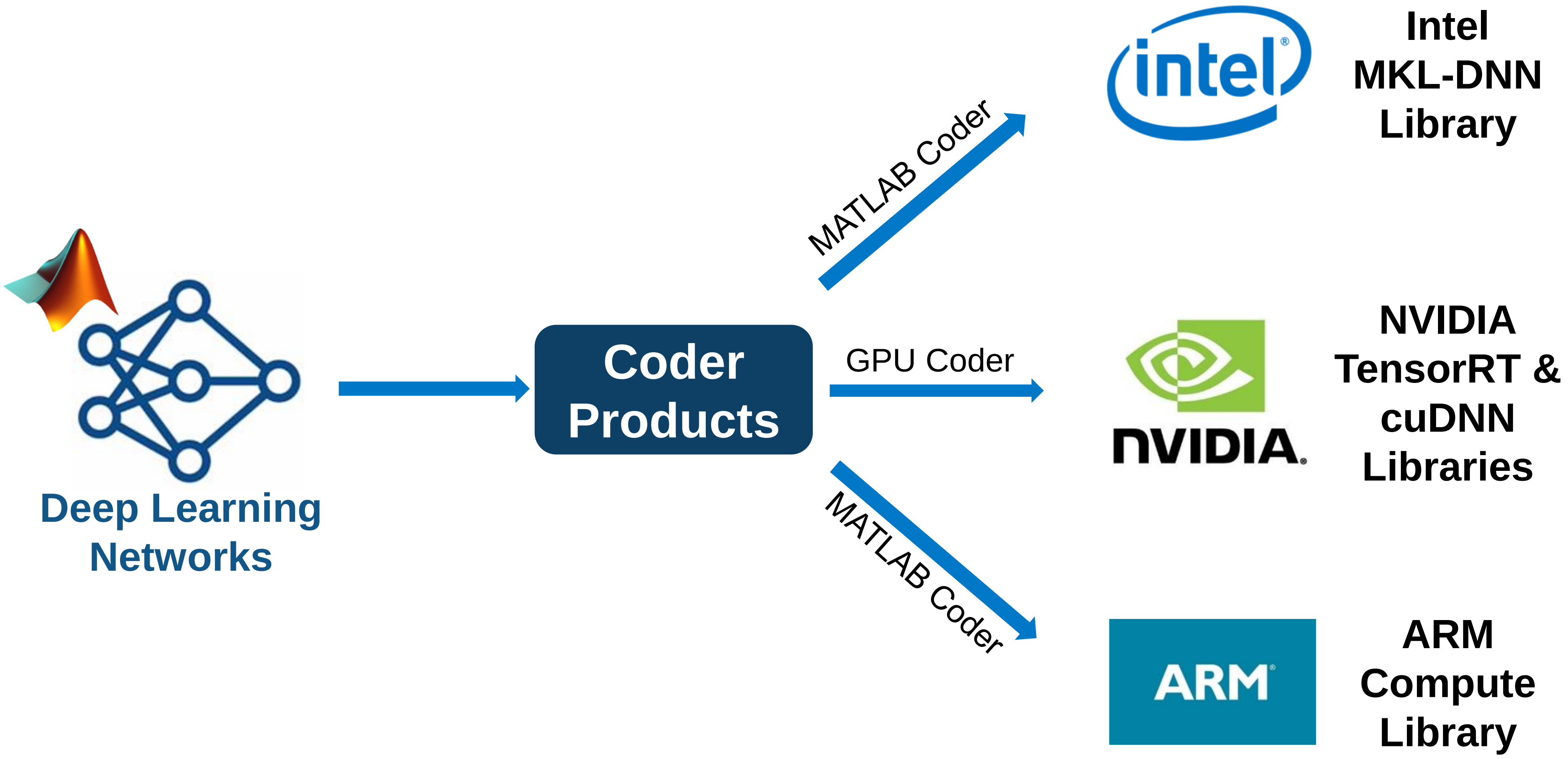
Semi-Automated Labeling with Apps



Interactive Deep Network Creation



Deploying Deep Learning Models for Inference



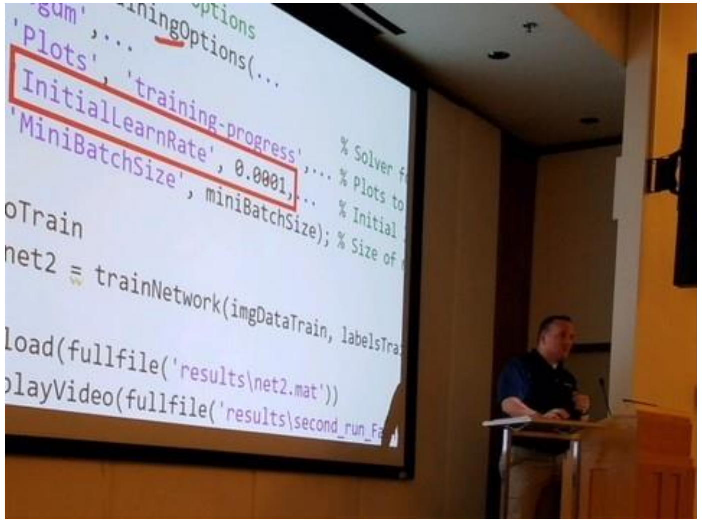
Instructor Demo

DeepLearning.mlx

Hands-on Deep Learning Workshop

Learn deep learning techniques and best practices in MATLAB

- Train deep networks using GPUs.
- Create networks from scratch and with transfer learning.
- Import and export models from Python frameworks (Keras, PyTorch)
- Learn techniques for improving network accuracy
- Label, train, and deploy YOLOv2 Object detector.



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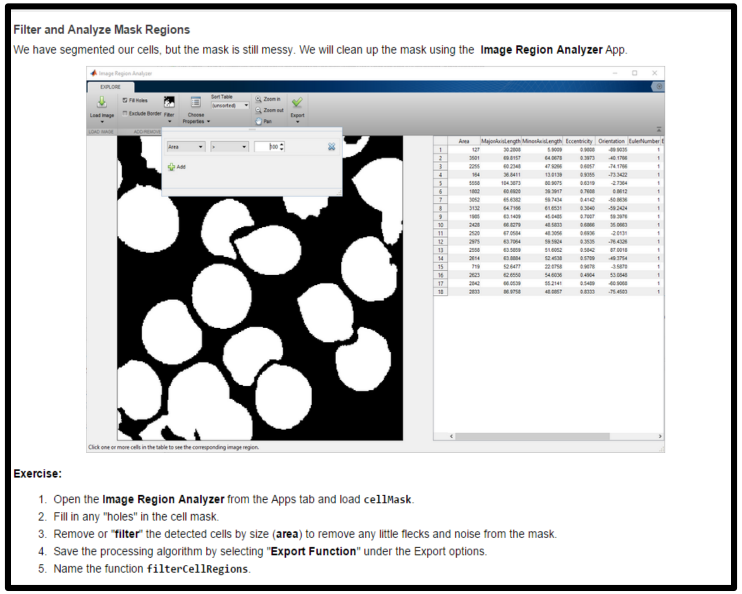
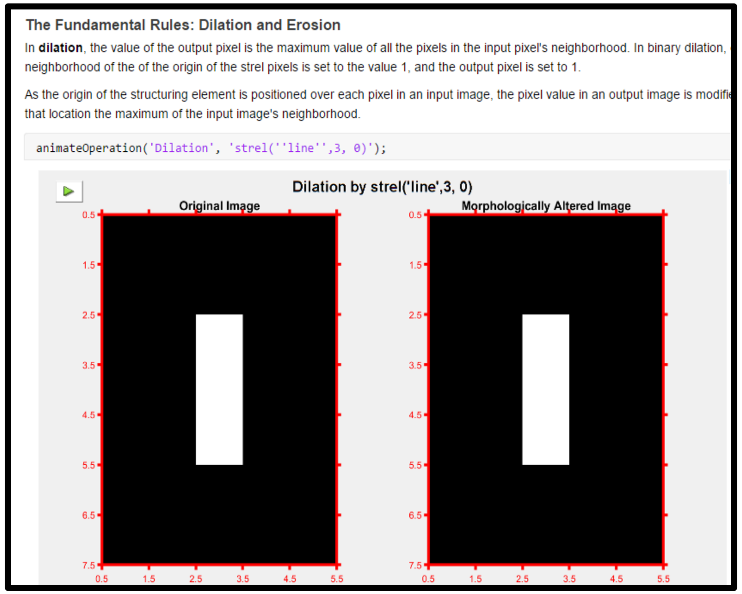
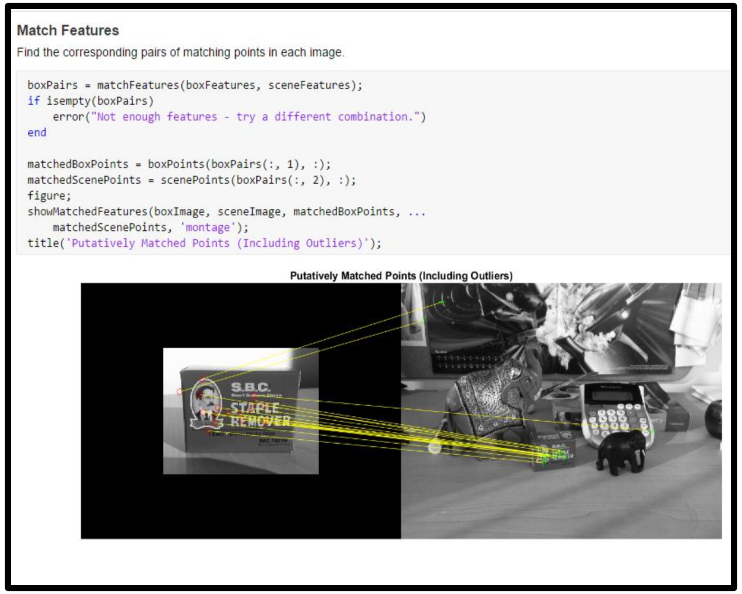
Summary + Next Steps

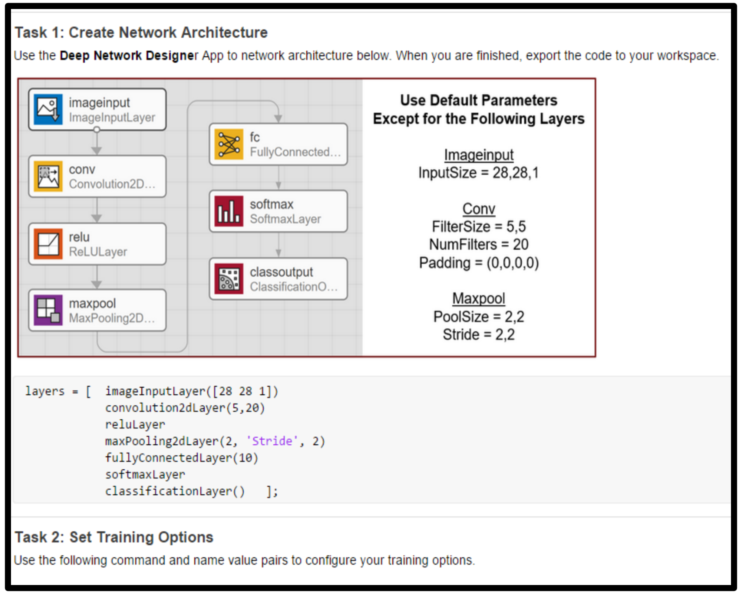
Core Modules

1. IPCV Workflow
2. Morphology and Segmentation
3. Object Detection and Tracking
4. Intro to Deep Learning









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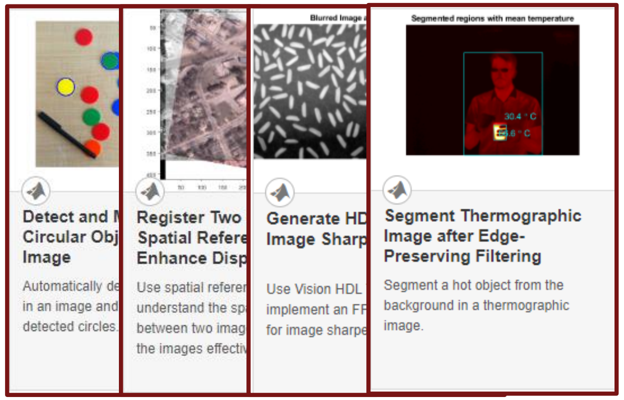

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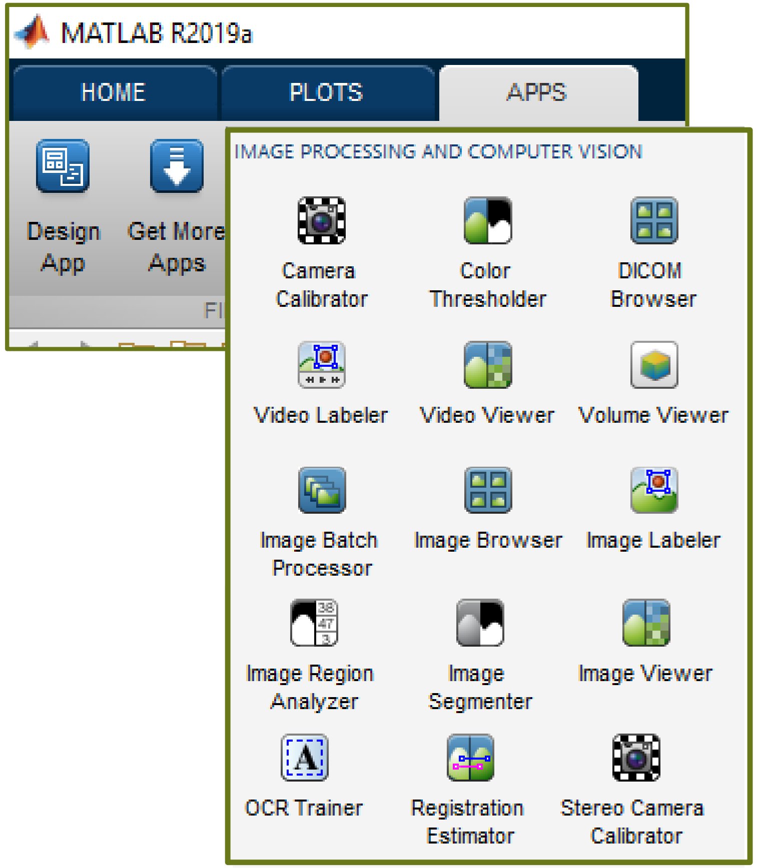

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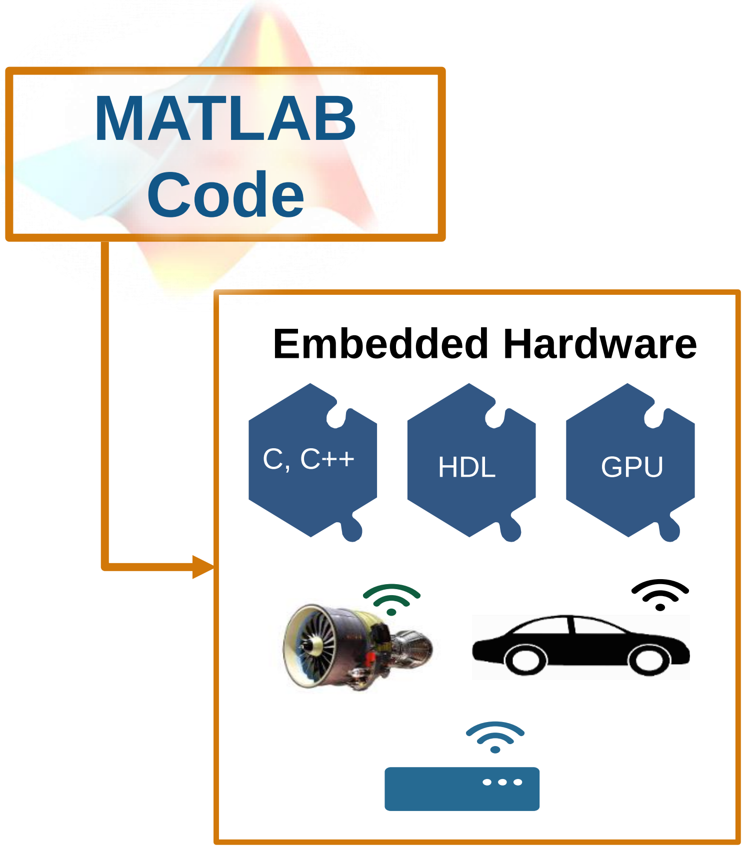

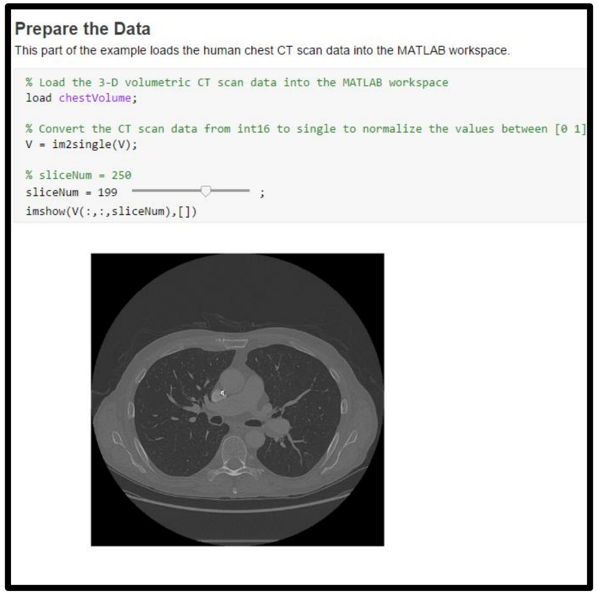

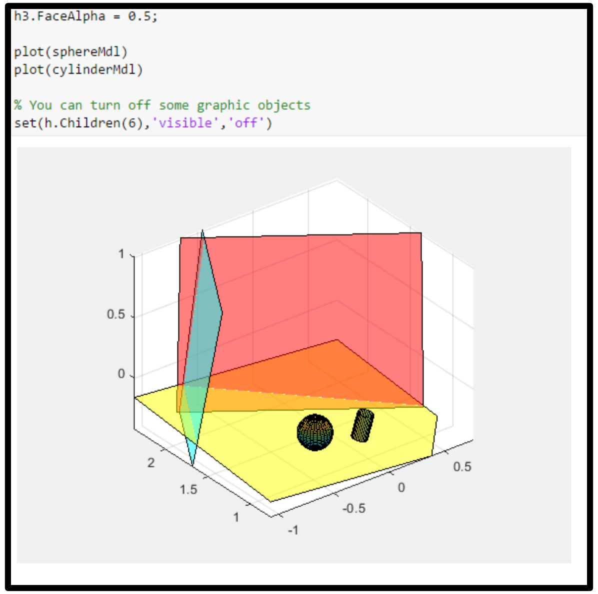

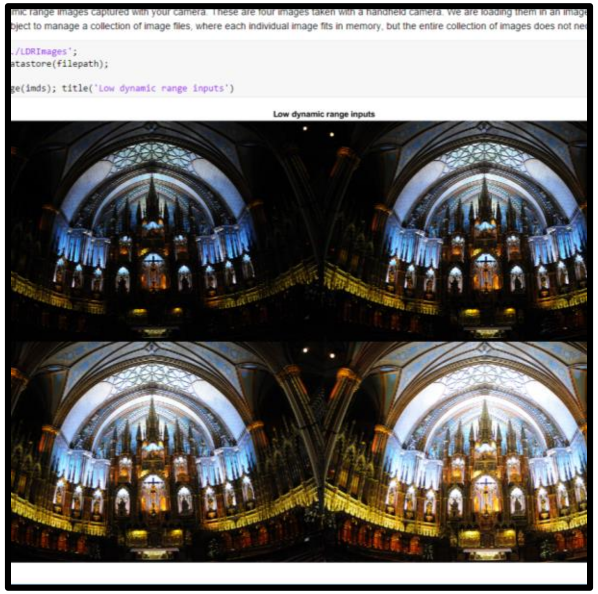

Additional Modules

- 3D Vision and Point Cloud Processing
- Image Registration
- 3D Image Processing and Visualization
- Camera Pipeline Workflow
  - Image formation
  - LDR to HDR
  - Haze reduction and low-light enhancement
- Deep Learning Workshop