

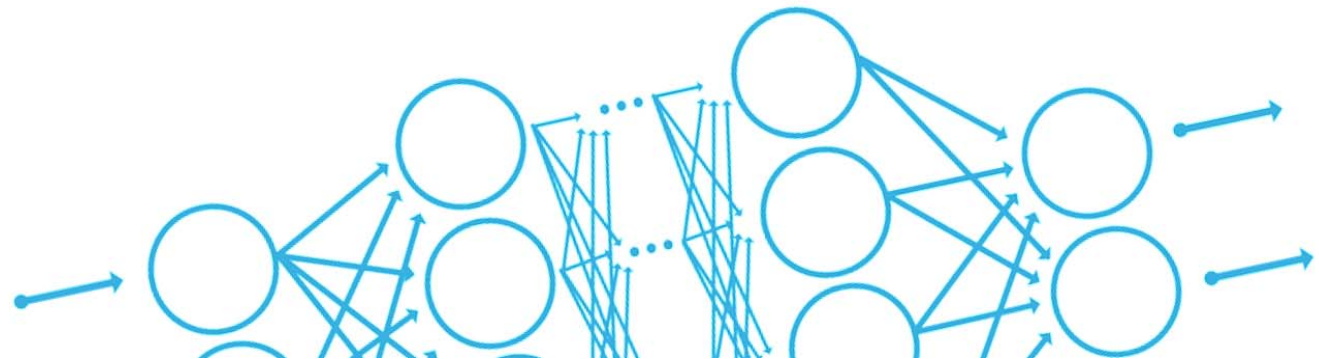
The background of the slide is a complex geometric composition. It features several overlapping shapes in shades of blue, grey, and white. On the right side, there is a prominent 3D wireframe mesh that transitions from yellow at the top to blue at the bottom. In the lower right corner, there are faint, light blue circuit board traces and components. The overall aesthetic is clean, modern, and technical.

# MATLAB EXPO 2017

Computer Vision System Design

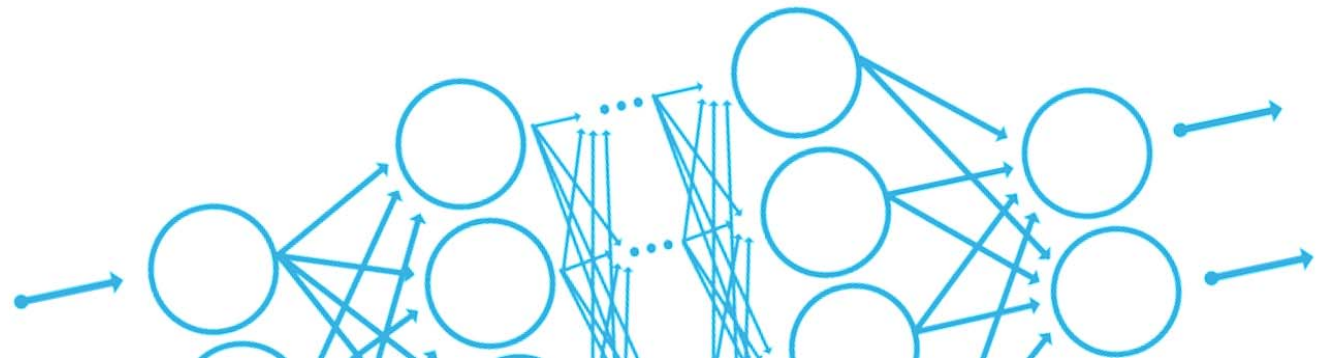
# Computer Vision

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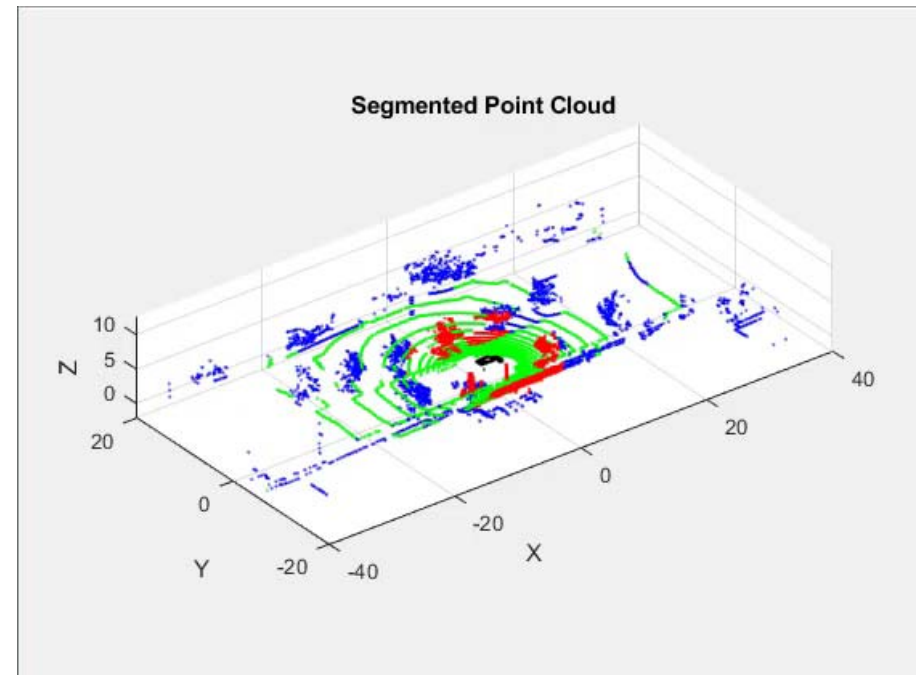
# Computer Vision *for* Autonomous Systems

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## Computer vision for autonomous systems

- An increasingly important part of the pipeline
- One of the key sensors in many applications is the camera
- Other sensors also provide vision
  - Depth sensors
  - Infrared
  - LiDAR
  - RADAR



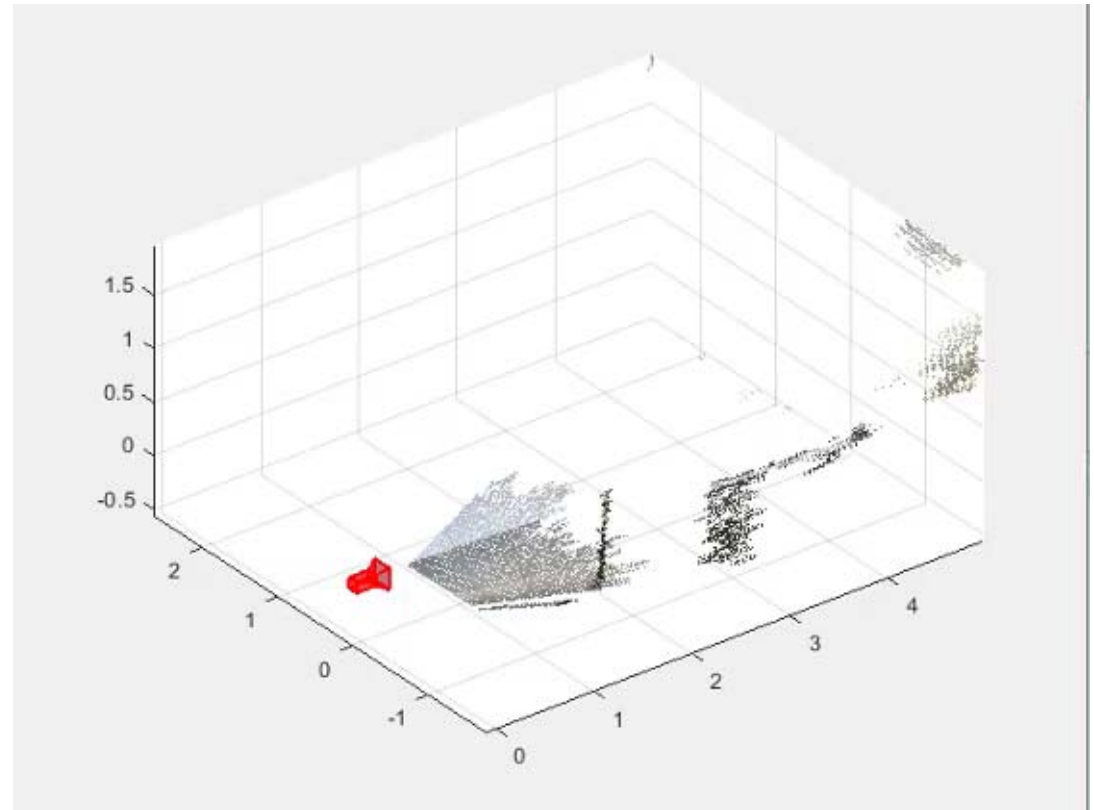
# More Sensors

## Infrared



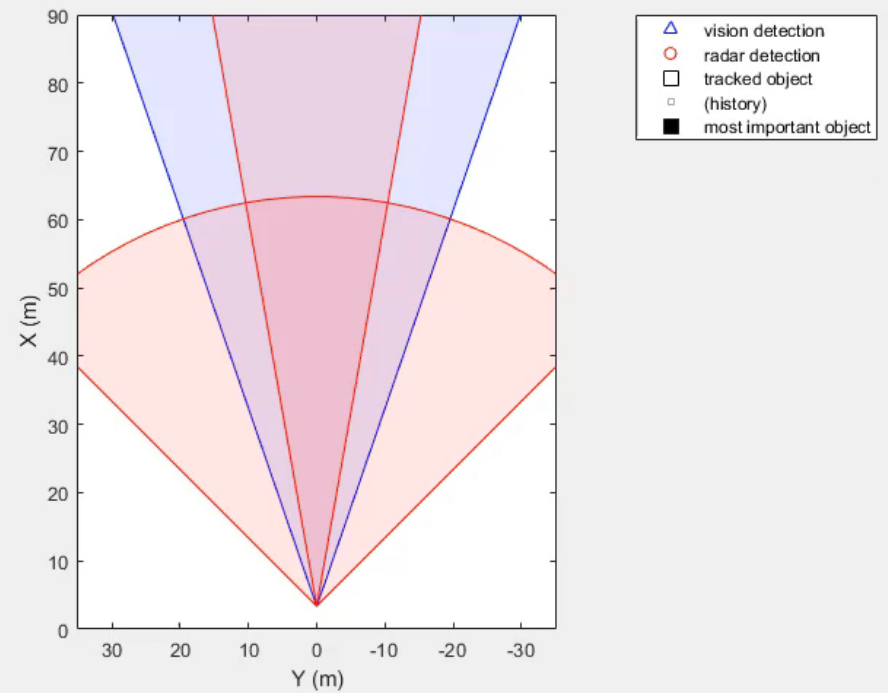
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## Depth

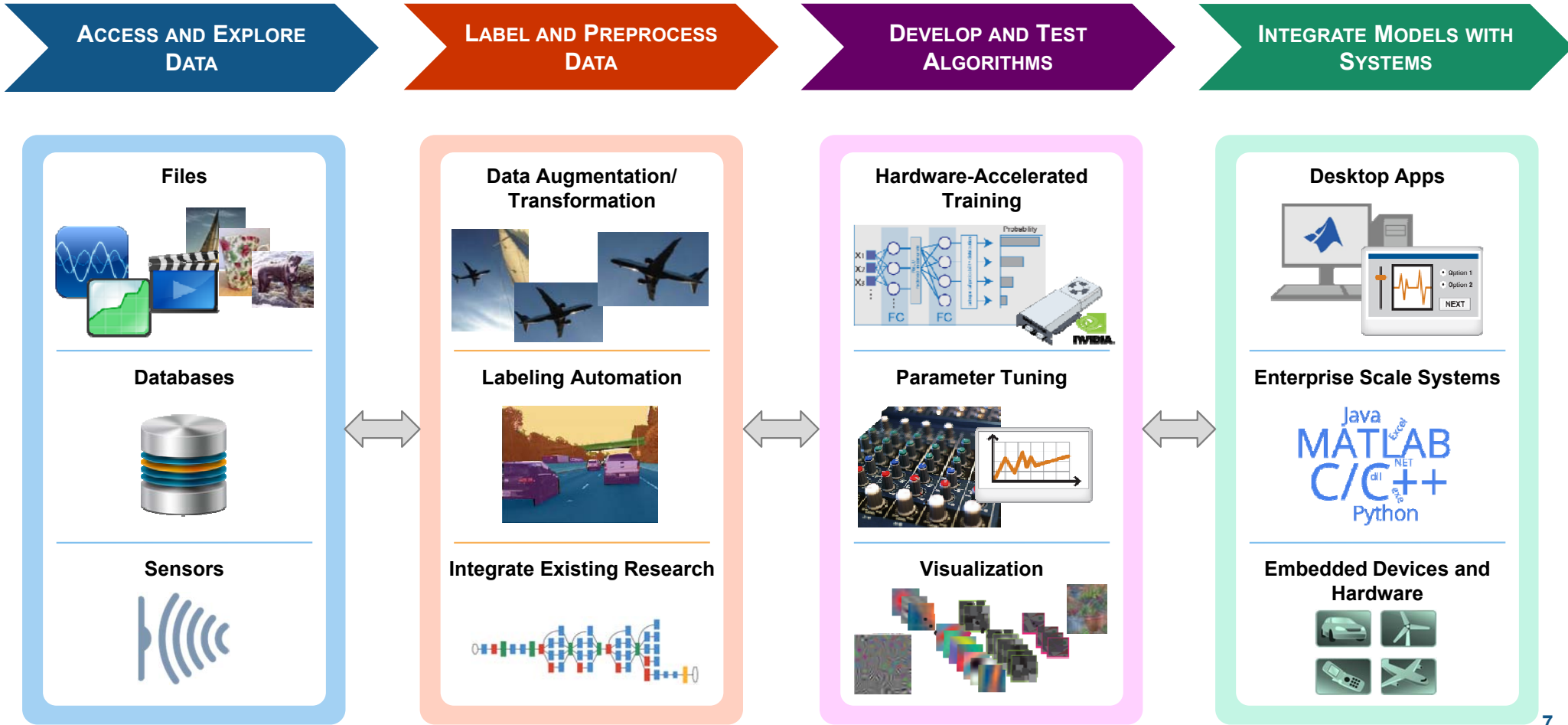


# Multi sensor fusion

Recorded Video

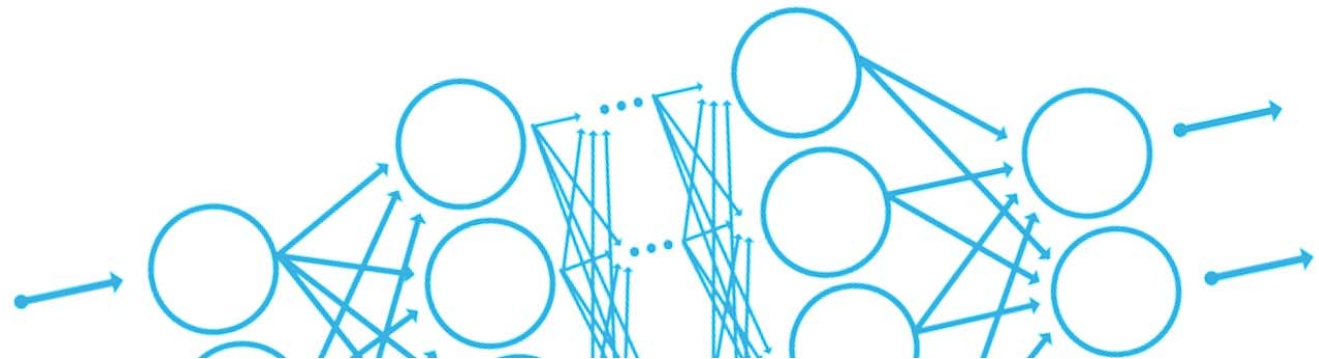


# Computer vision system design



# Full System Design Example

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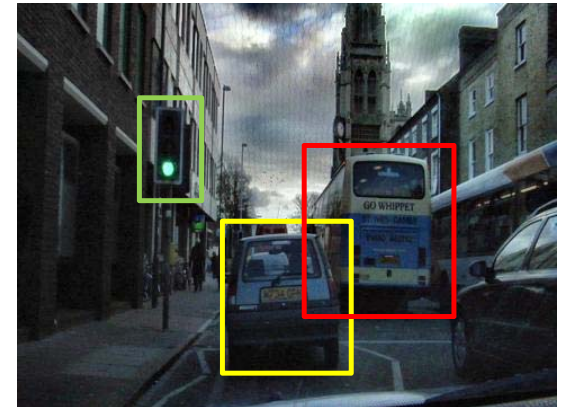




## Original Image



## ROI detection



## Pixel classification



# Semantic Segmentation

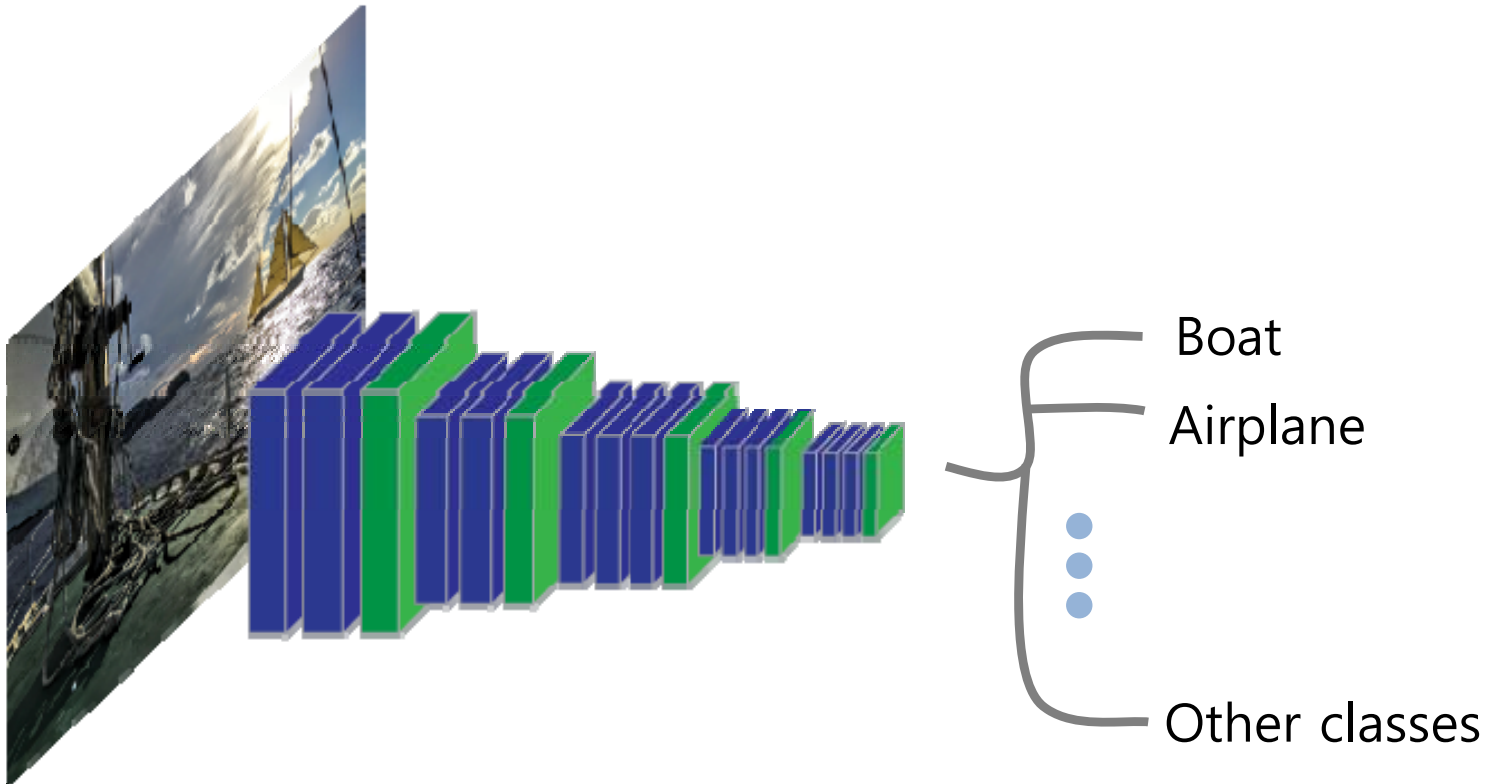


CamVid Dataset

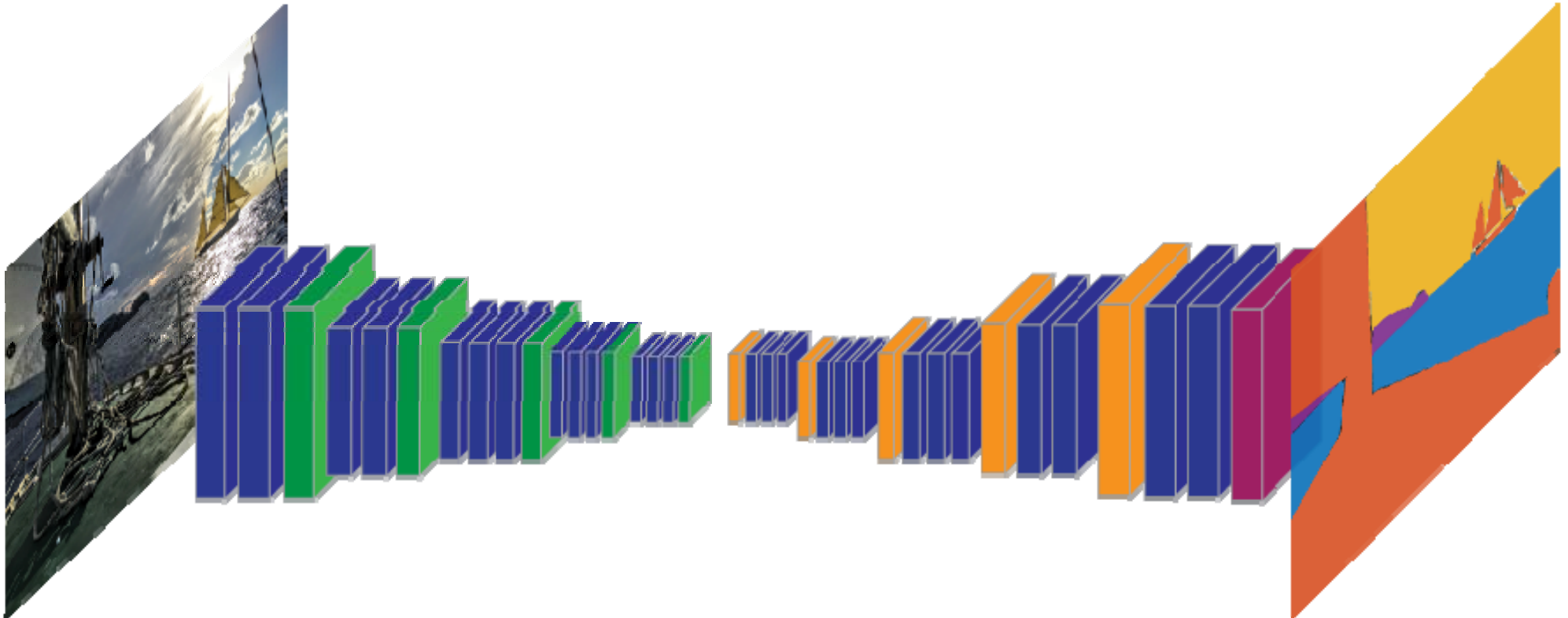
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1. *Segmentation and Recognition Using Structure from Motion Point Clouds, ECCV 2008*
2. *Semantic Object Classes in Video: A High-Definition Ground Truth Database ,Pattern Recognition Letters*

# Image Classification Network

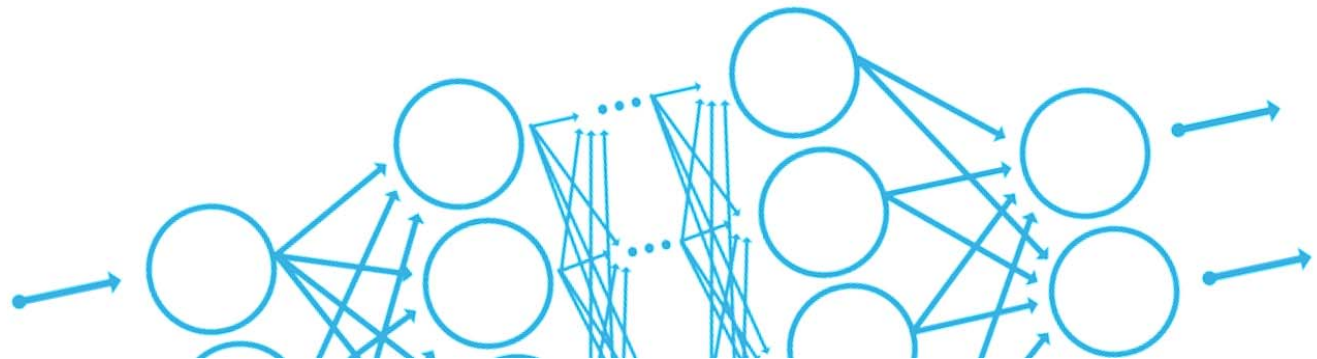


# Semantic Segmentation Network

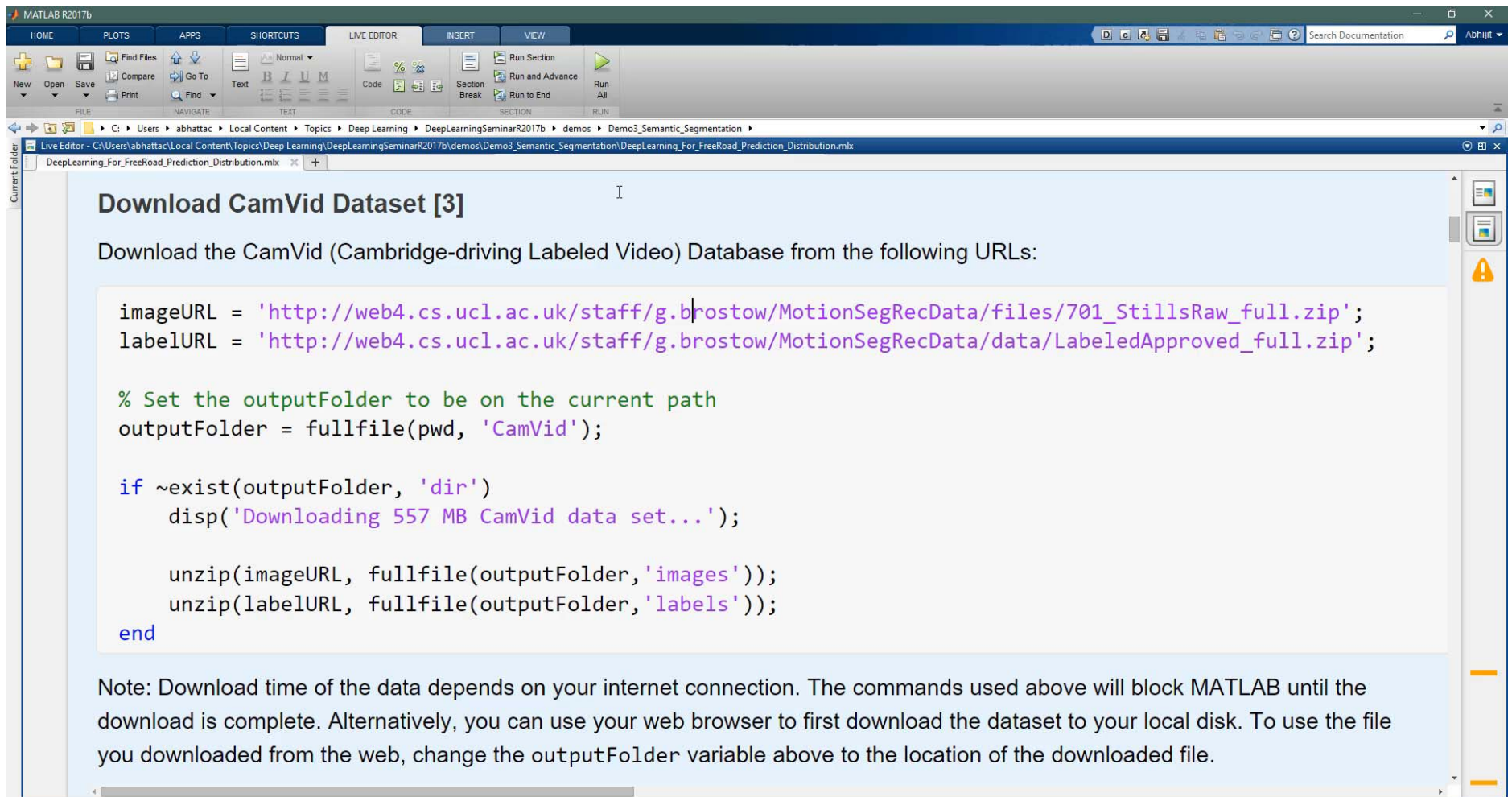


# Access and Explore Data

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# Access image/video data



**Download CamVid Dataset [3]**

Download the CamVid (Cambridge-driving Labeled Video) Database from the following URLs:

```

imageURL = 'http://web4.cs.ucl.ac.uk/staff/g.brostow/MotionSegRecData/files/701_StillsRaw_full.zip';
labelURL = 'http://web4.cs.ucl.ac.uk/staff/g.brostow/MotionSegRecData/data/LabeledApproved_full.zip';

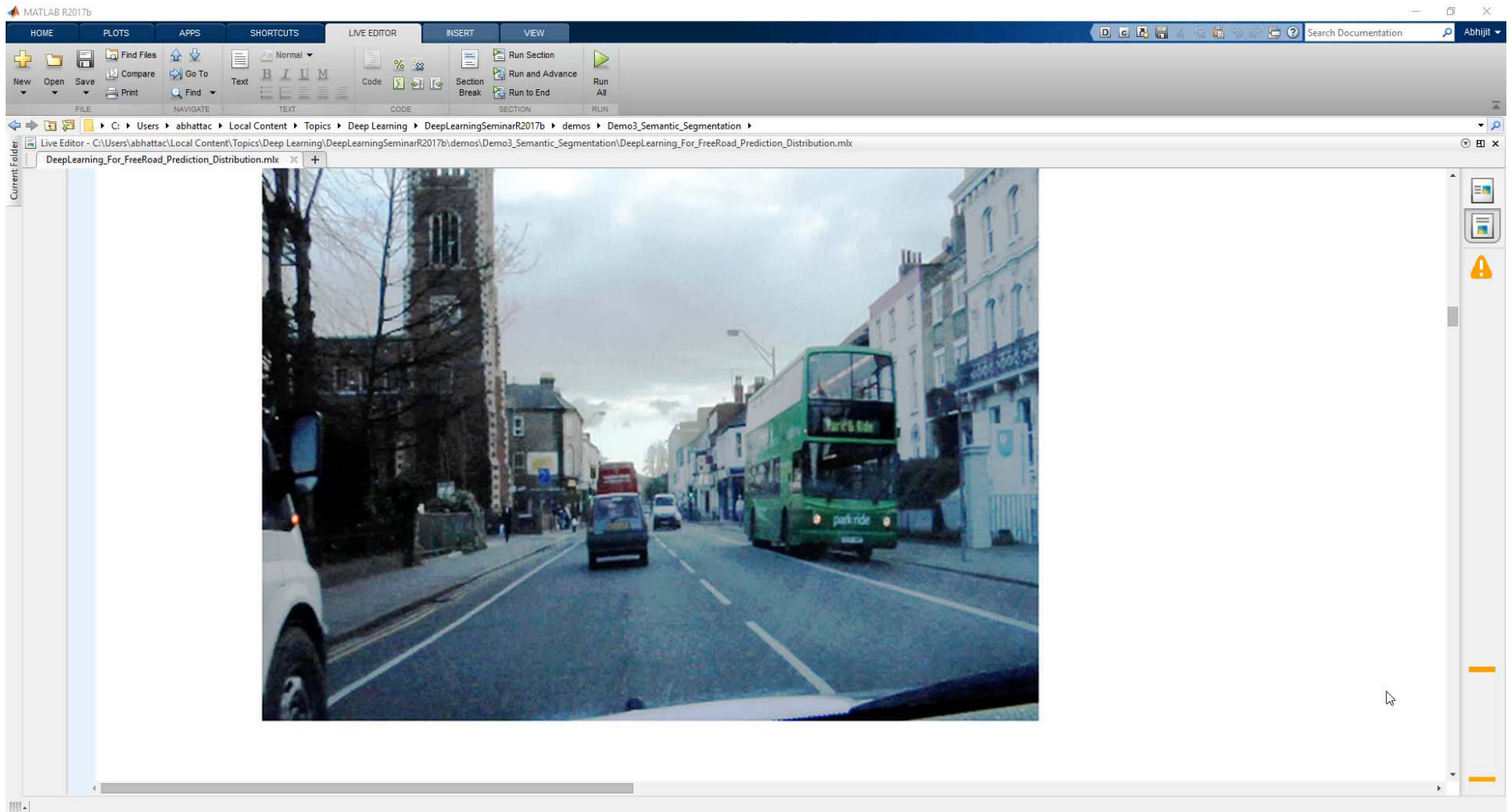
% Set the outputFolder to be on the current path
outputFolder = fullfile(pwd, 'CamVid');

if ~exist(outputFolder, 'dir')
    disp('Downloading 557 MB CamVid data set...');

    unzip(imageURL, fullfile(outputFolder, 'images'));
    unzip(labelURL, fullfile(outputFolder, 'labels'));
end
    
```

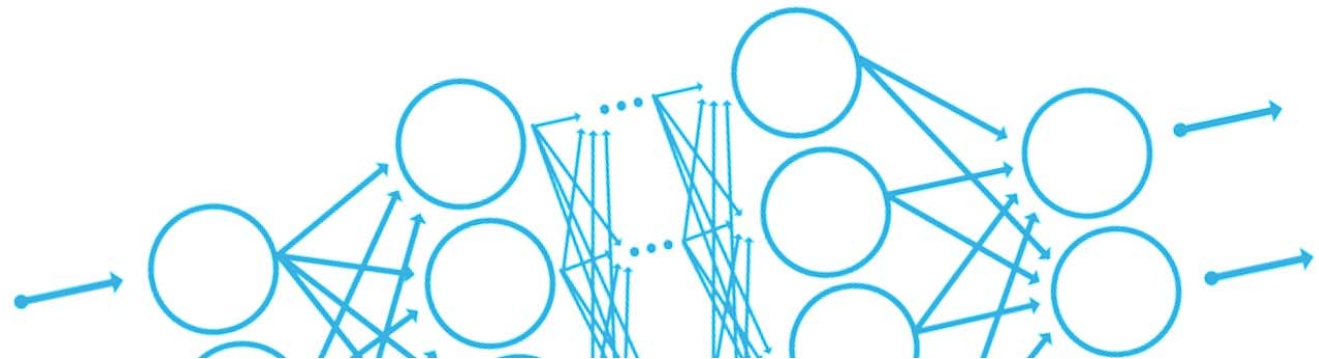
Note: Download time of the data depends on your internet connection. The commands used above will block MATLAB until the download is complete. Alternatively, you can use your web browser to first download the dataset to your local disk. To use the file you downloaded from the web, change the outputFolder variable above to the location of the downloaded file.

# Access pixel label data



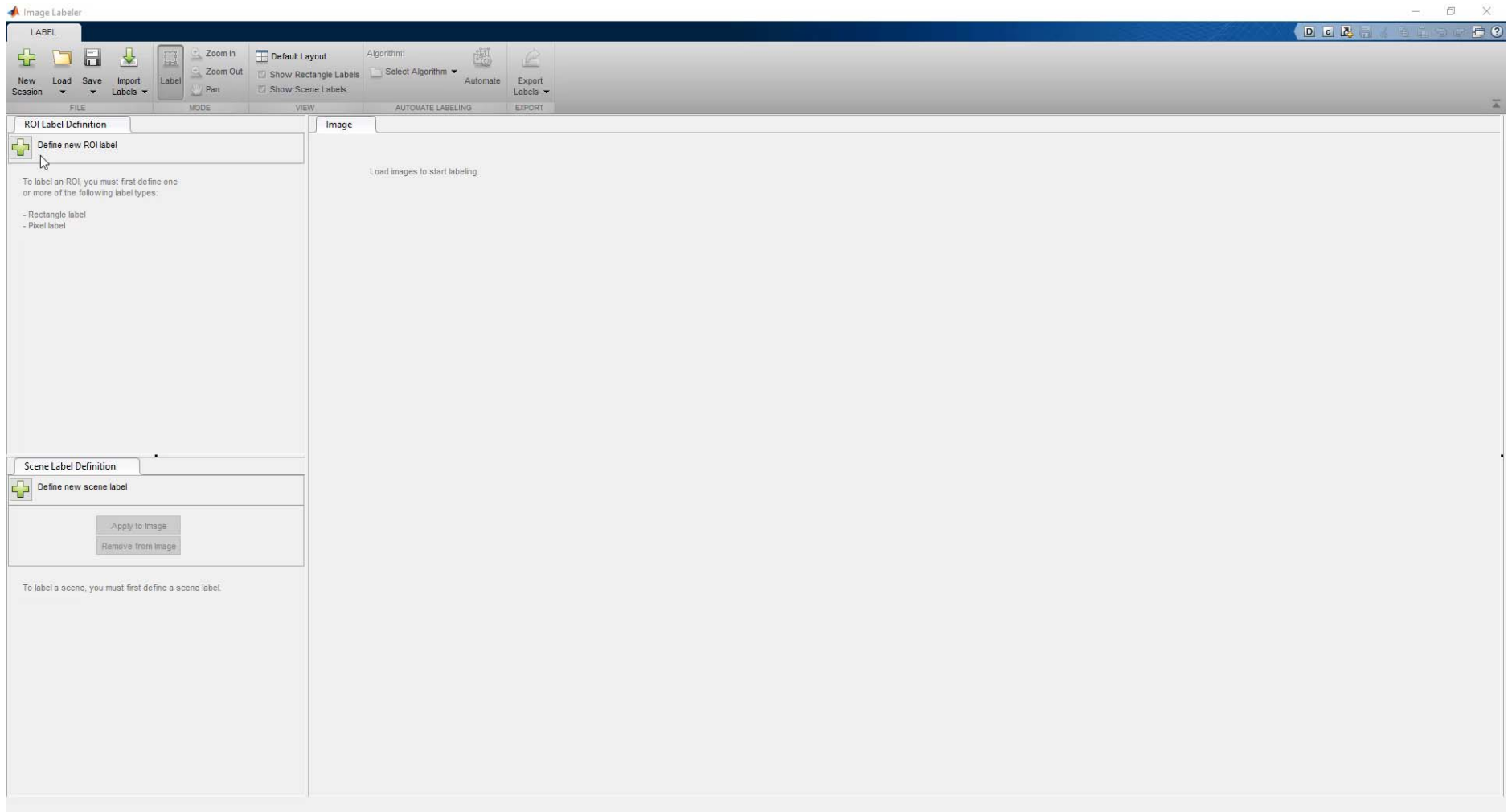
# Label and Preprocess Data

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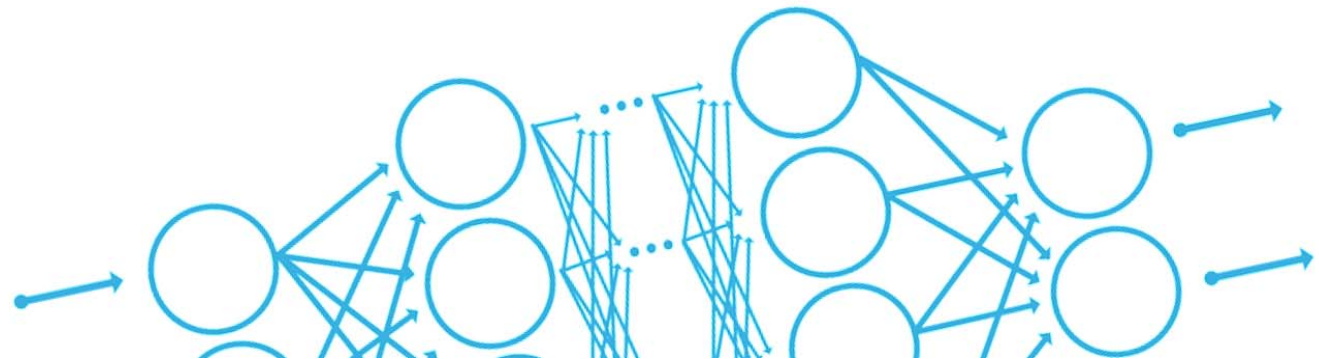


# Using image labeling tools



# Develop and Test Algorithms

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# Prepare the network for training

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Get More Apps Install App Package App Image Viewer Video Viewer Camera Calibrator Filter Designer MATLAB Coder Application Compiler Color Threshold Image Acquisition Image Region Analyzer Signal Analyzer Classification Learner Ground Truth Labeler

FILE APPS

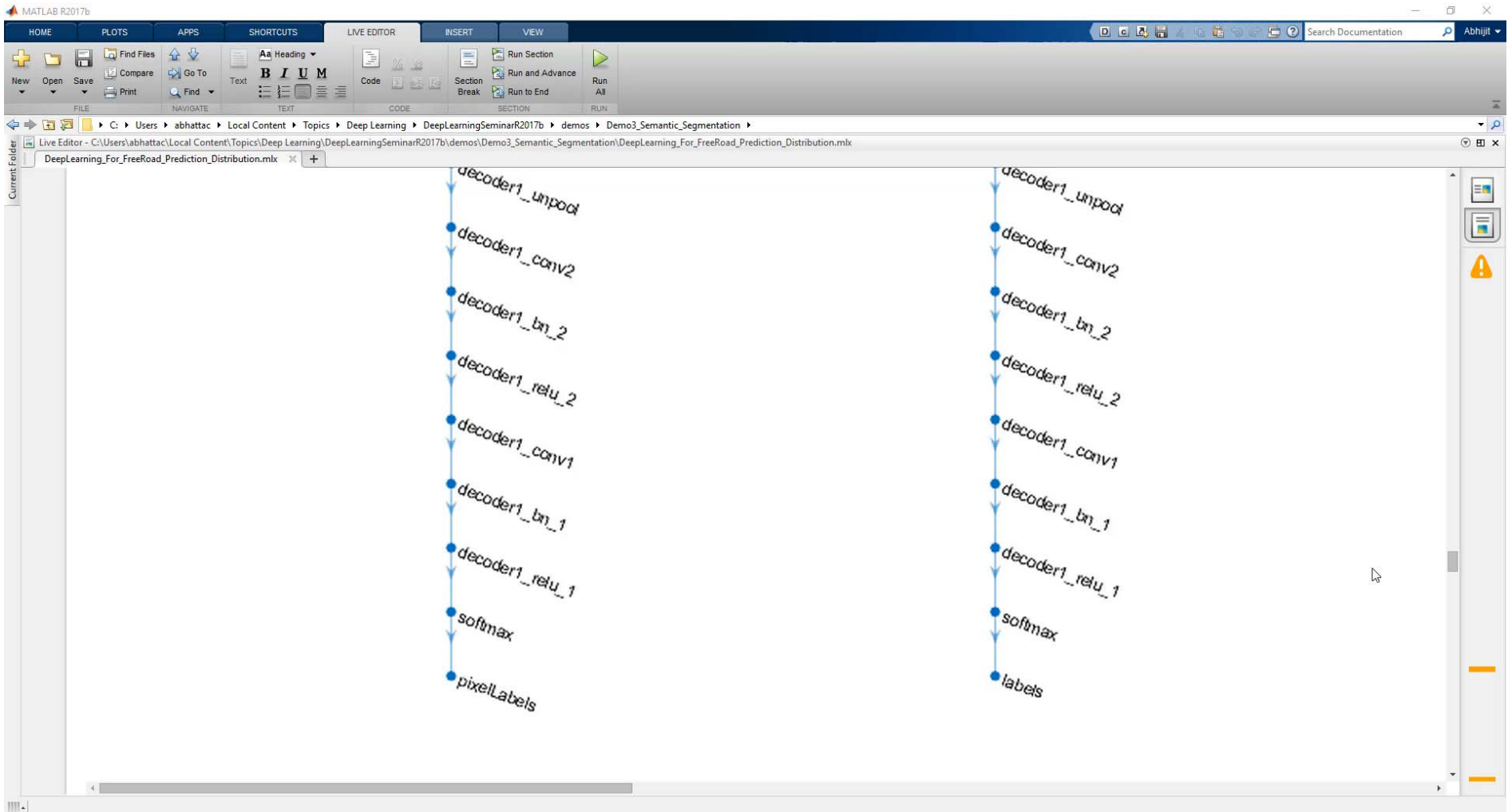
C:\Users\abhatac\Local Content\Topics\Deep Learning\DeepLearningSeminarR2017b\demos\Demo3\_Semantic\_Segmentation

Live Editor - C:\Users\abhatac\Local Content\Topics\Deep Learning\DeepLearningSeminarR2017b\demos\Demo3\_Semantic\_Segmentation\DeepLearning\_For\_FreeRoad\_Prediction\_Distribution.mlx

DeepLearning\_For\_FreeRoad\_Prediction\_Distribution.mlx

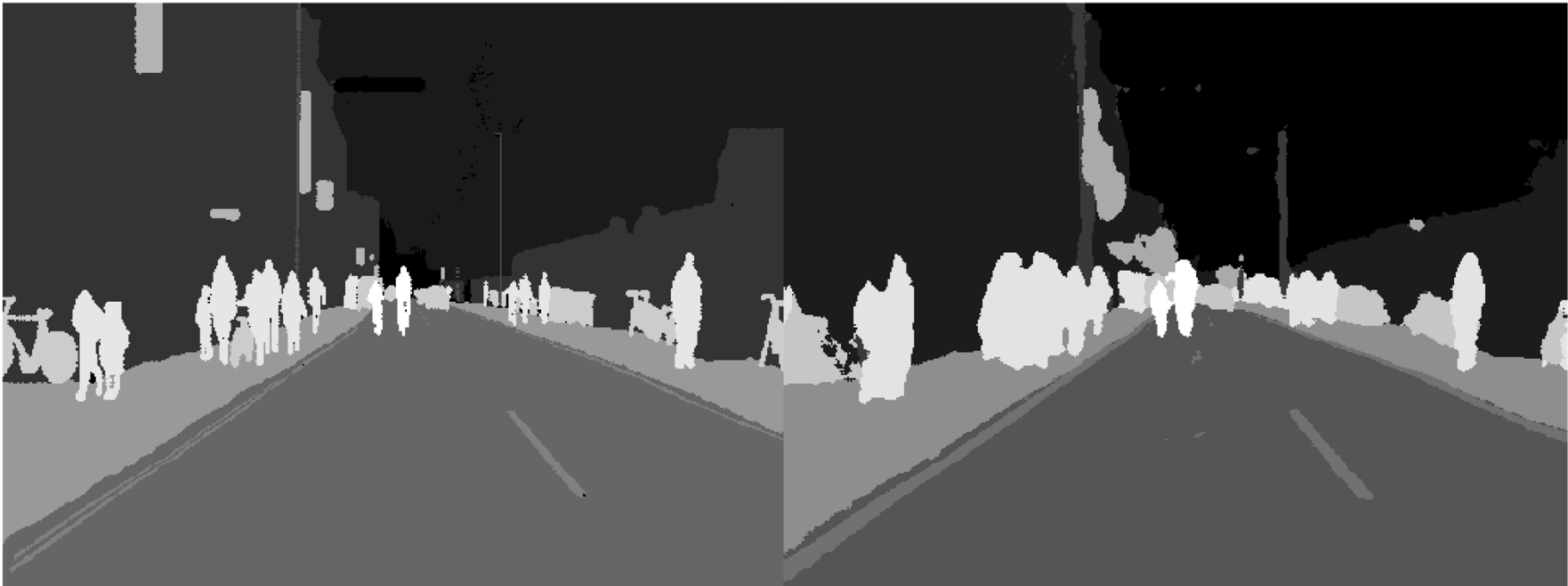
Blue	Bicyclist
Dark Blue	Pedestrian
Purple	Car
Light Blue	SignSymbol
Red	Pavement
Orange	Lane
Green	Road
Grey	Pole
Cyan	Building
Yellow	Environment

# Train and test the network



## Evaluate algorithm performance

Ground Truth labels vs Predicted labels



# More evaluation

MATLAB R2017b

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Find Files Find Go To Text Normal Code Section Break Run Section Run and Advance Run to End Run All

FILE NAVIGATE TEXT CODE SECTION RUN

C:\Users\abhatac\Local Content\Topics\Deep Learning\DeepLearningSeminarR2017b\demos\Demo3\_Semantic\_Segmentation

Live Editor - C:\Users\abhatac\Local Content\Topics\Deep Learning\DeepLearningSeminarR2017b\demos\Demo3\_Semantic\_Segmentation\DeepLearning\_For\_FreeRoad\_Prediction\_Distribution.mlx

```

% Compare differences between images - Image Processing toolbox
imshowpair(expected, predicted, 'montage')
title('Ground Truth labels vs Predicted labels')
    
```

**Ground Truth labels vs Predicted labels**

## Challenges we addressed

- Accessing data
- Labeling and preprocessing
- Using previous research
- Developing an algorithm
- Evaluating the algorithm
- **What's next?**

# Computer vision system design

