MATLAB CONFERENCE 2017

Developing Deep Learning Algorithms using MATLAB

David Willingham

New MATLAB framework makes deep learning easy and accessible

Object Recognition using Deep Learning

ACCESS

LEARN

INTEGRATE

Training (using GPU)	Millions of images from 1000 different categories
Prediction	Real-time object recognition using a webcam connected to a laptop

What is Deep Learning ?

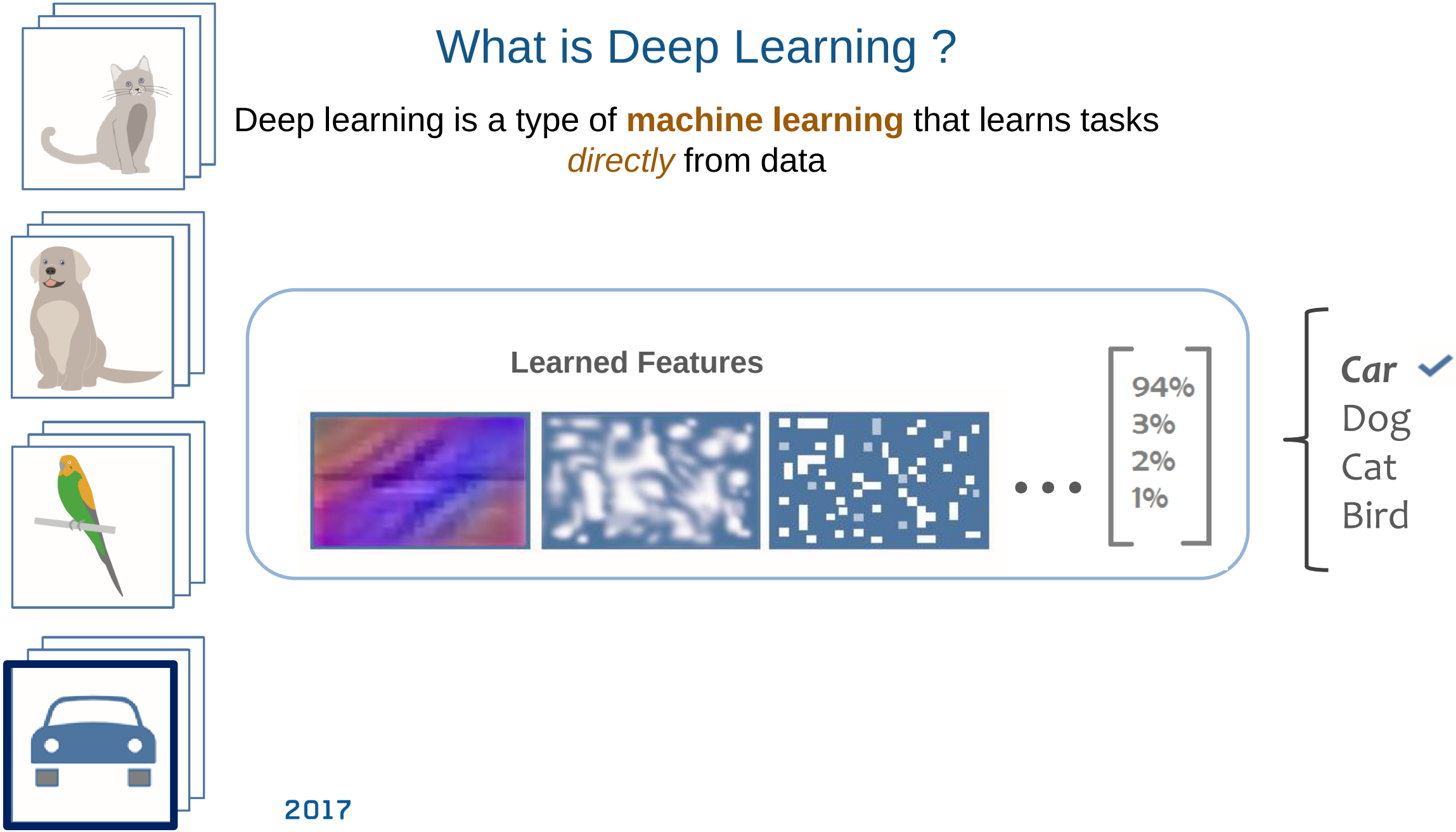
Deep learning is a type of **machine learning** that learns tasks *directly* from data

Cat

Dog

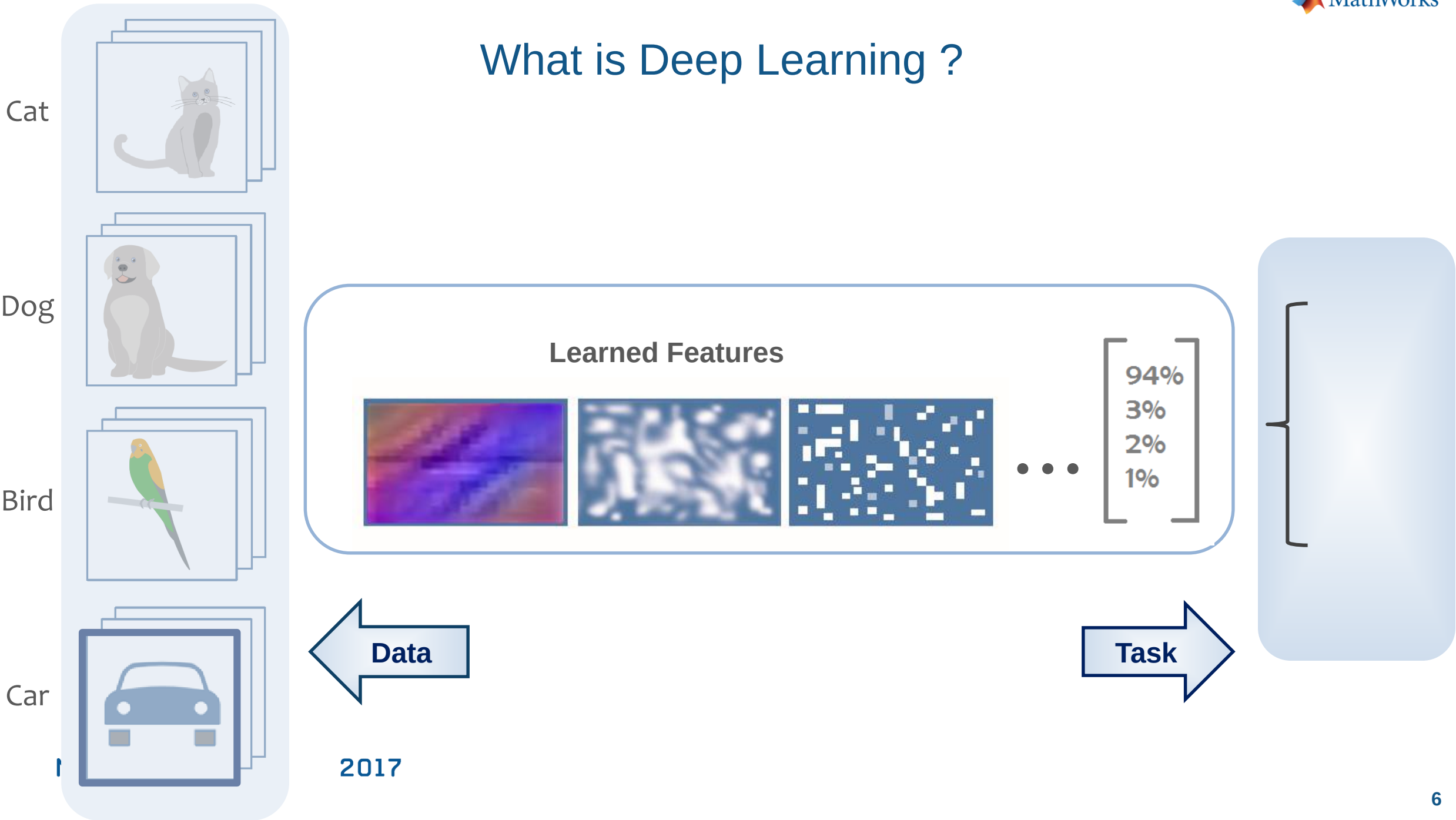
Bird

Car

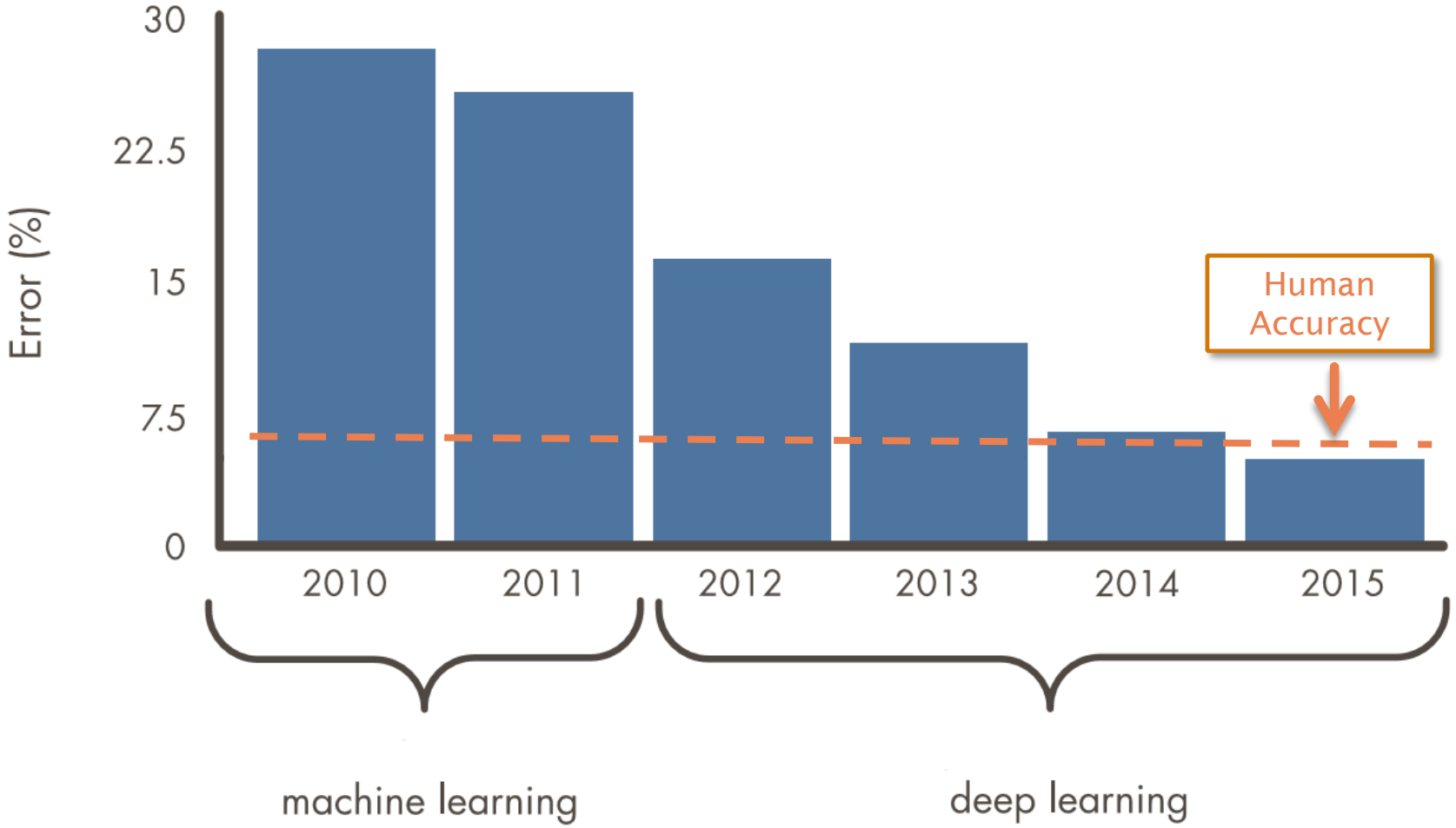


2017

What is Deep Learning ?



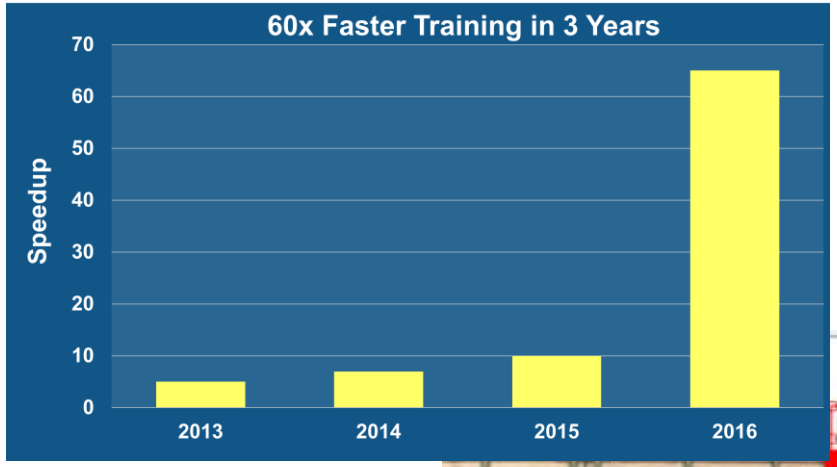
Why is Deep Learning So Popular Now?



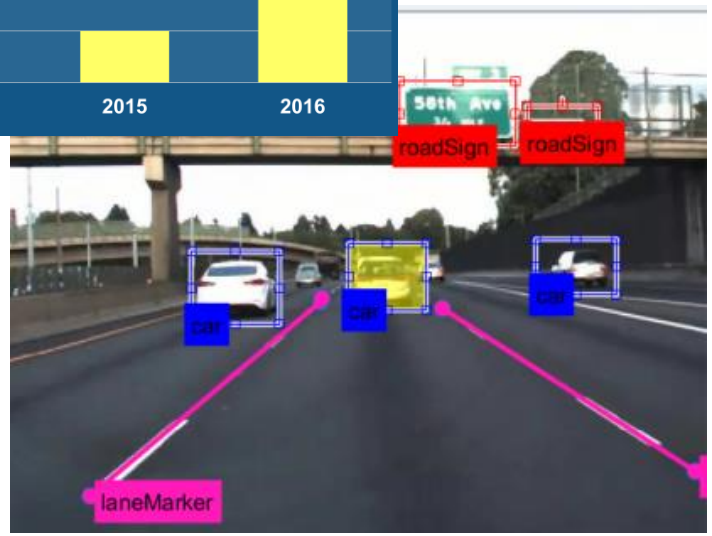
Source: ILSVRC Top-5 Error on ImageNet

Deep Learning Enablers

Acceleration with GPUs



Massive sets of labeled data



Availability of state of the art models from experts

AlexNet
PRETRAINED MODEL

VGG-16
PRETRAINED MODEL

Caffe
MODELS

MATLAB makes Deep Learning Easy and Accessible

Learn about new MATLAB capabilities to

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- Visualize and debug deep neural networks
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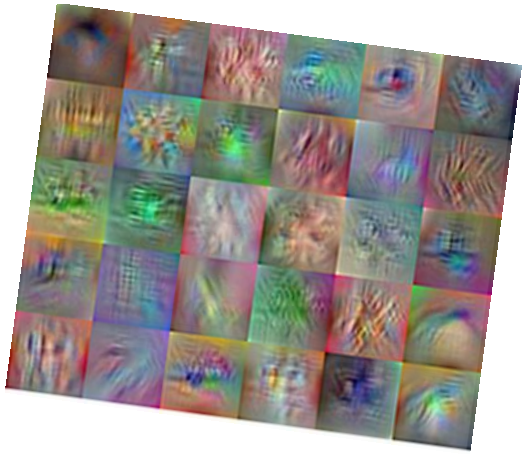

AlexNet
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VGG-16
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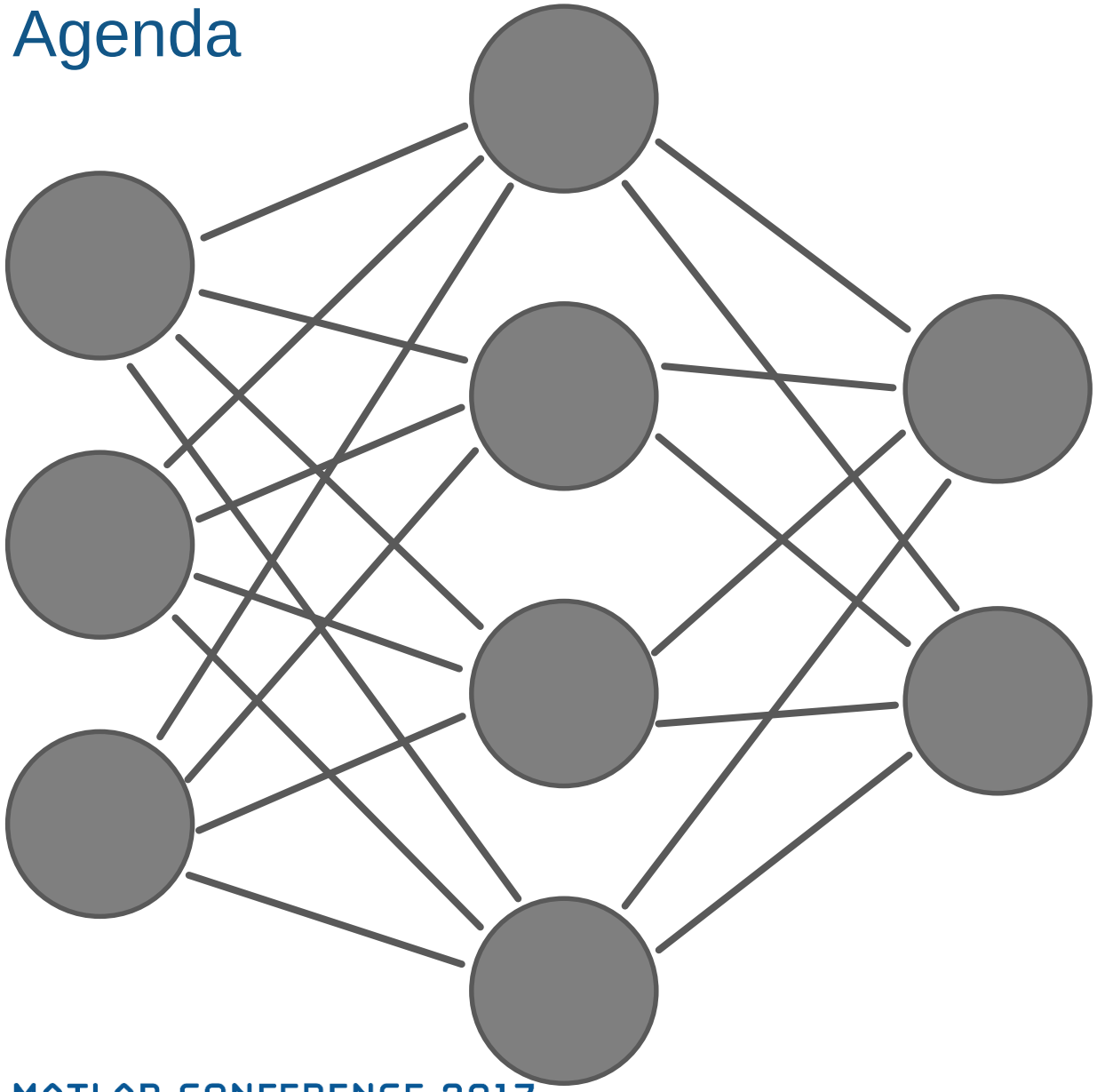
MODELS

Agenda



- Image classification using pre-trained network
- Transfer learning to classify new objects
- Locate & classify objects in images and video

Agenda

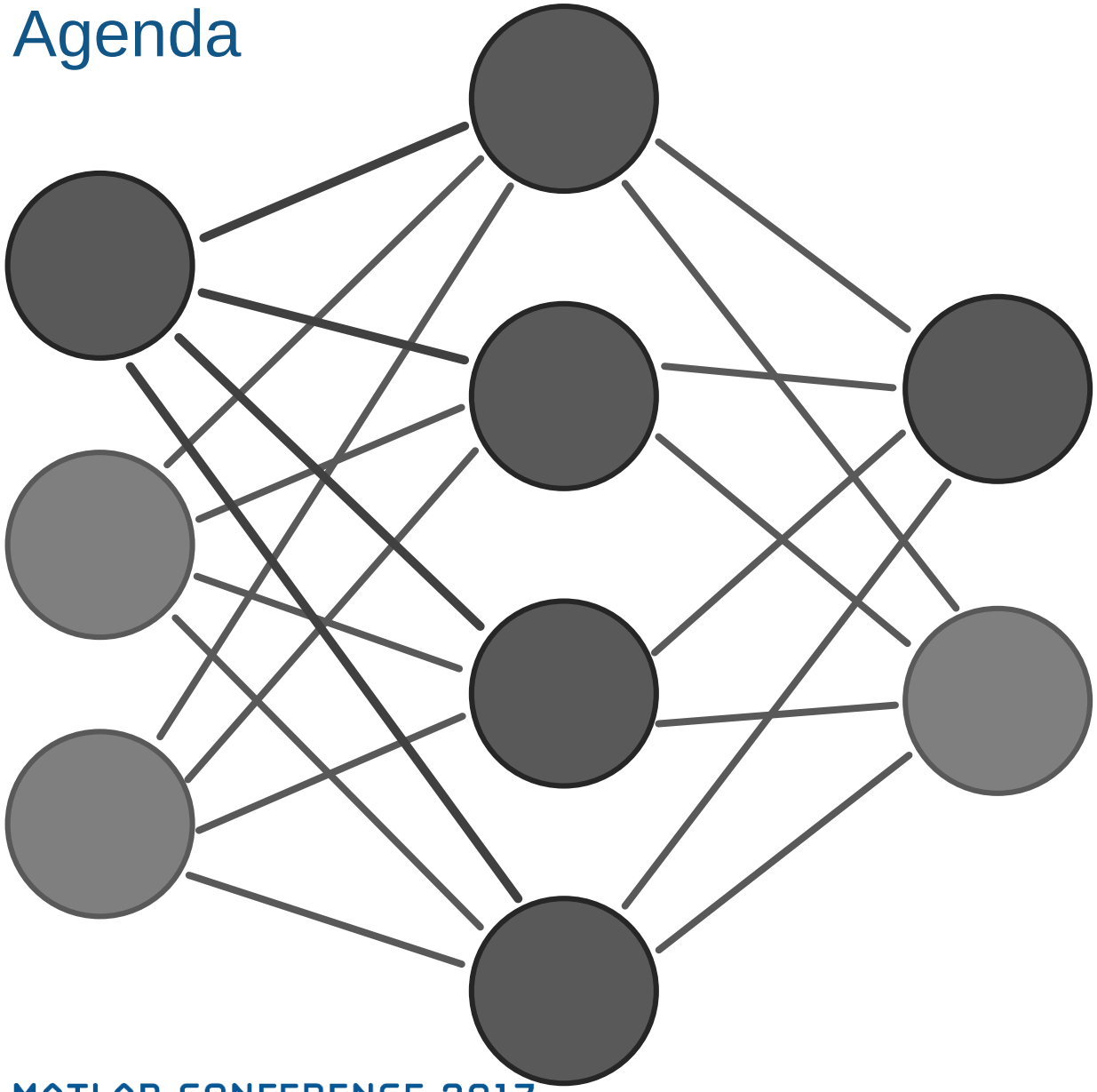


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Image Classification Using Pre-trained Network (Video)

MATLAB R2017a

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Live Editor - Webinar_4LinesOfCode.mlx *

Webinar_4LinesOfCode.mlx *

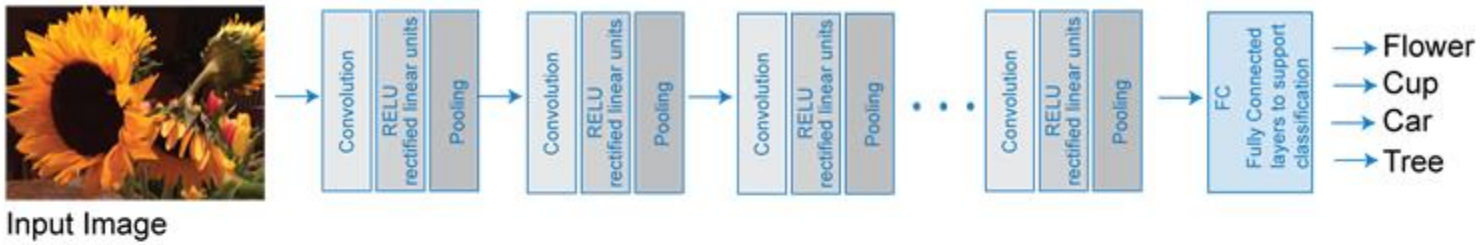
Classifying Images with AlexNet

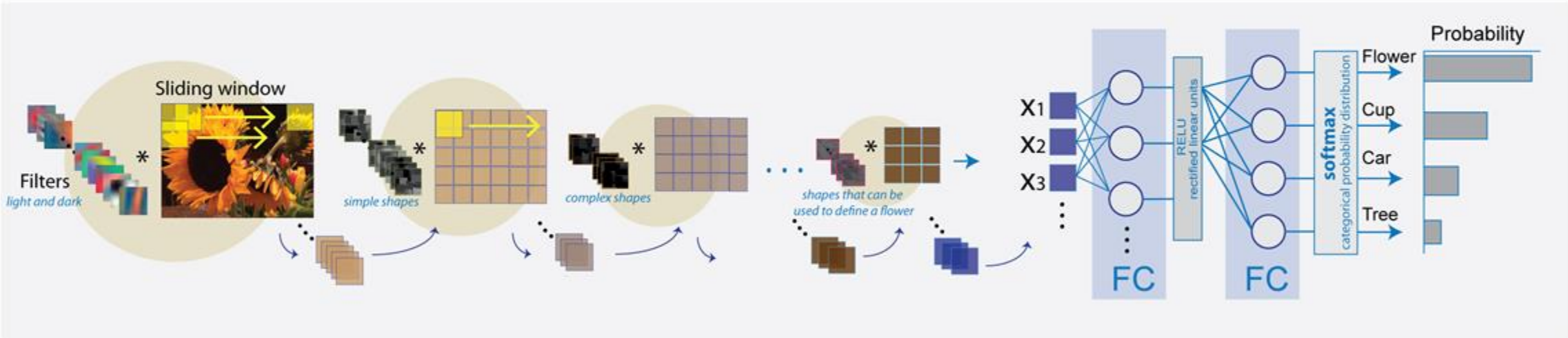
```
% The image we're classifying
imshow(imread('peppers.png'));
```

Classify 'peppers' in 4 lines of code

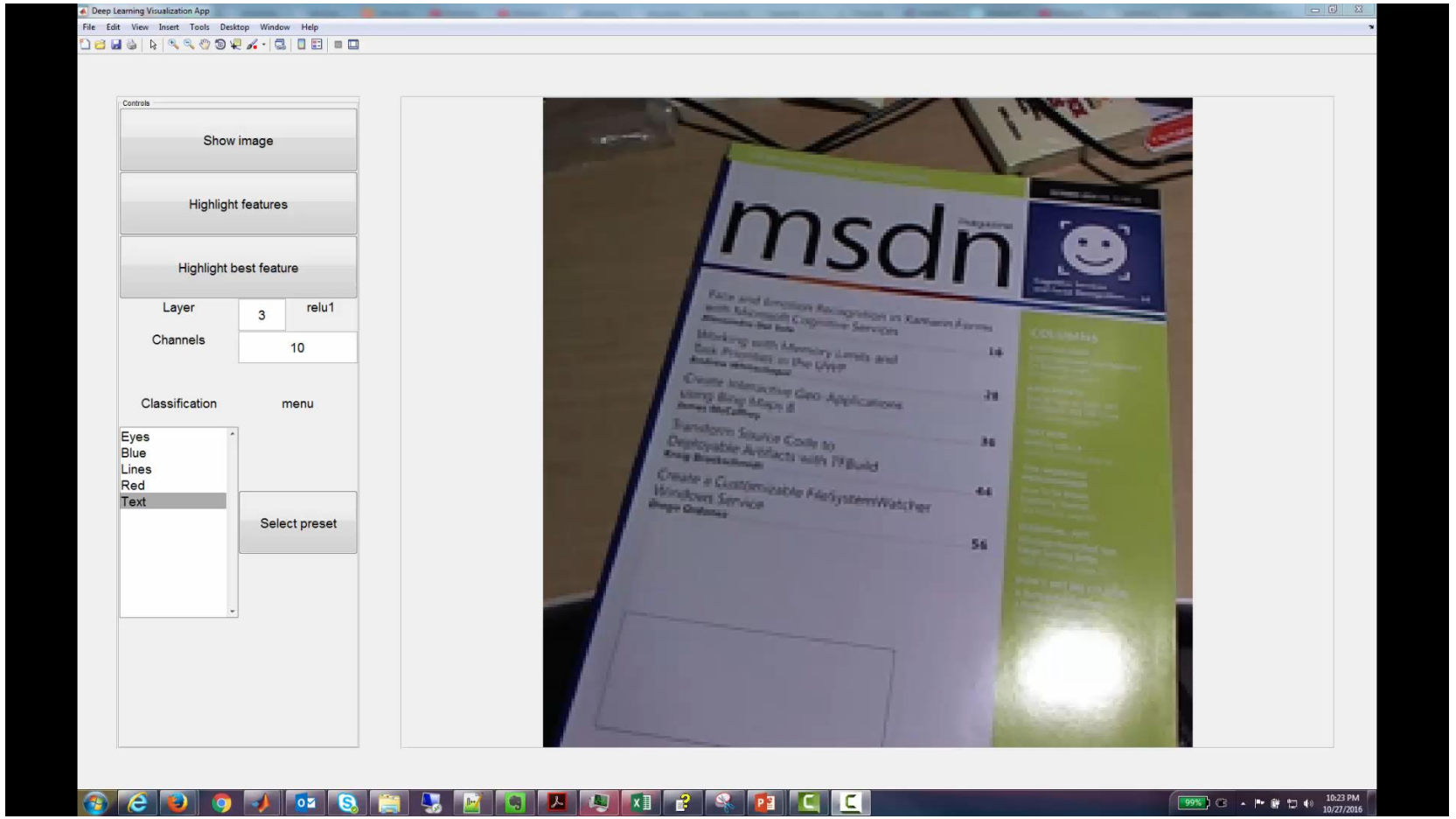
```
net = alexnet;
im = imread('peppers.png');
im = imresize(im,[227 227]);
classify(net,im)
```

Convolutional Neural Networks





Visualize Deep Learning Features



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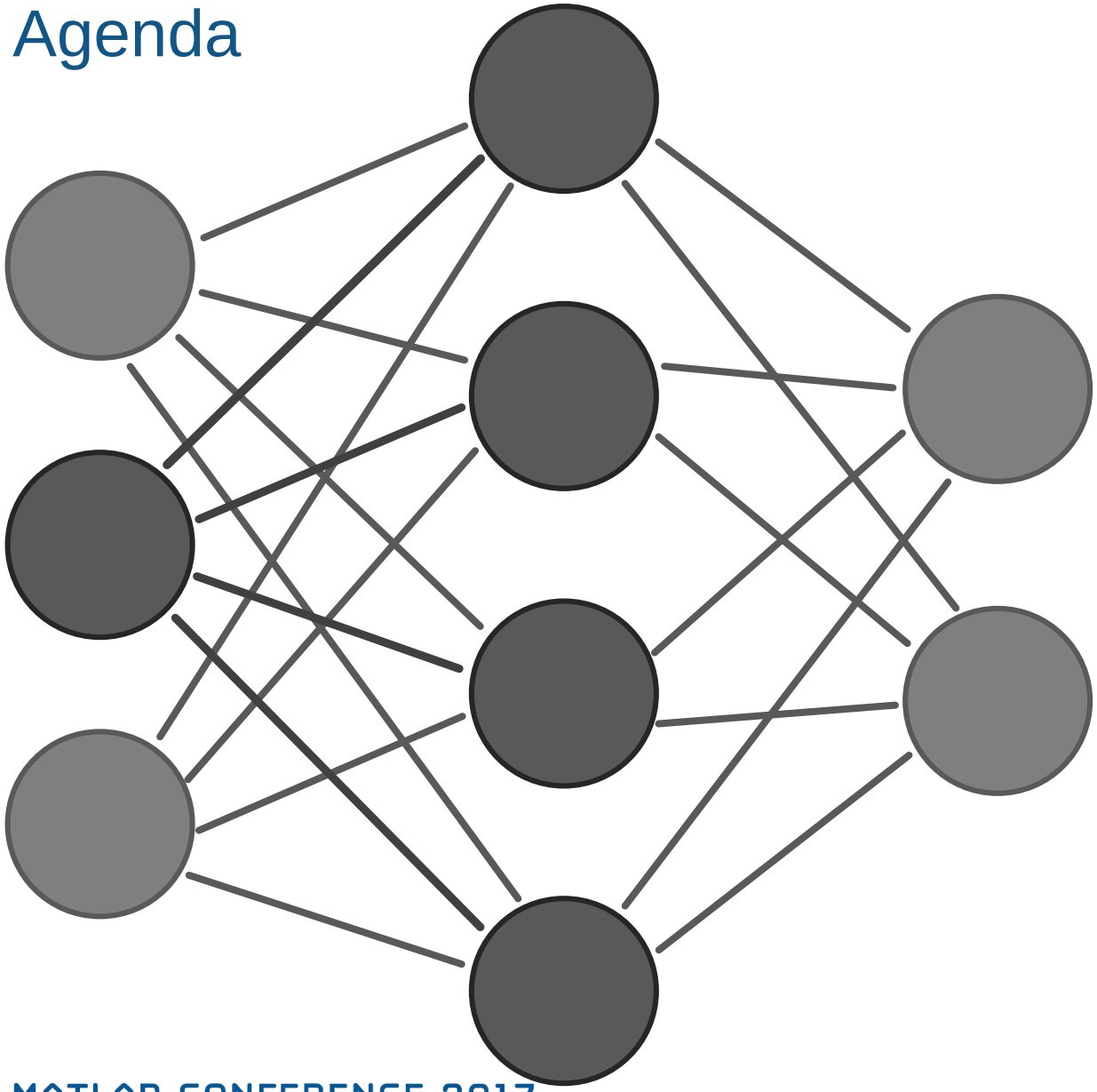
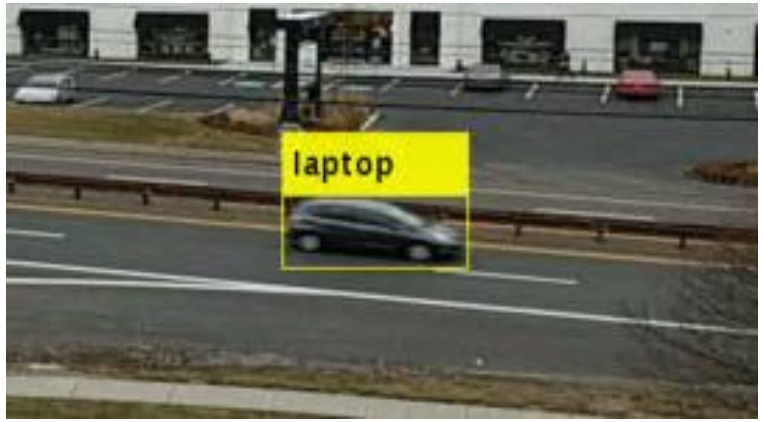


- Image classification using pre-trained network
- Transfer learning to classify new objects
- Locate & classify objects in images and video

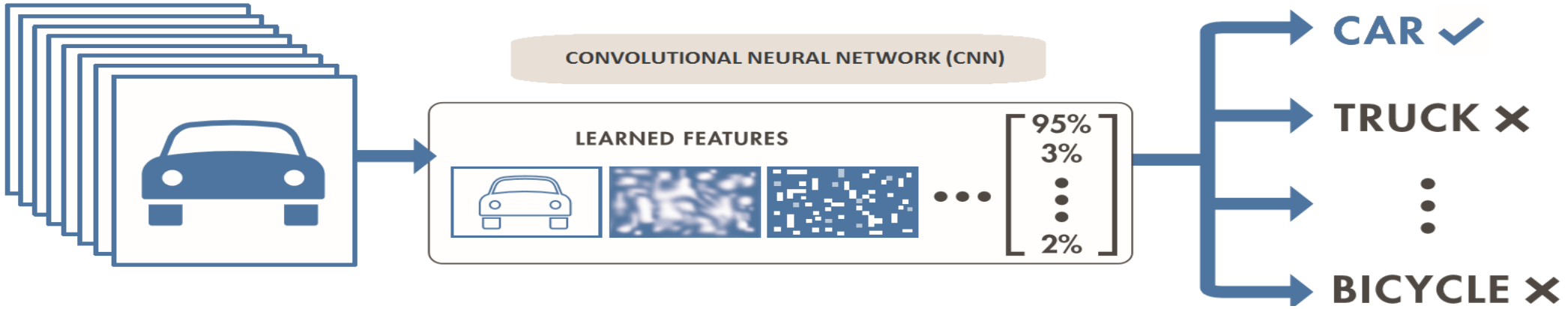
Why Train a New Model ?

- Models from research do not work on your data
- Pre-trained model not available for your data type
- Improve results by creating a model specific to your problem

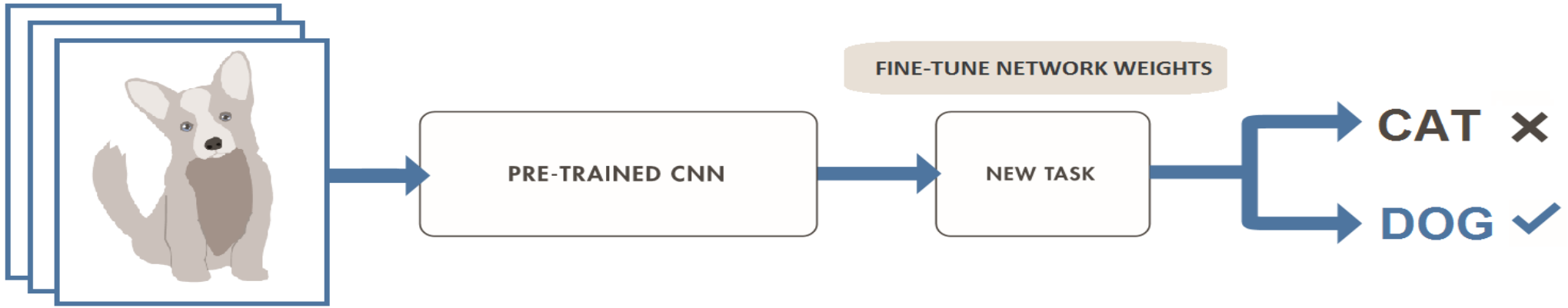


Two Approaches for Deep Learning

1. Train a Deep Neural Network from Scratch



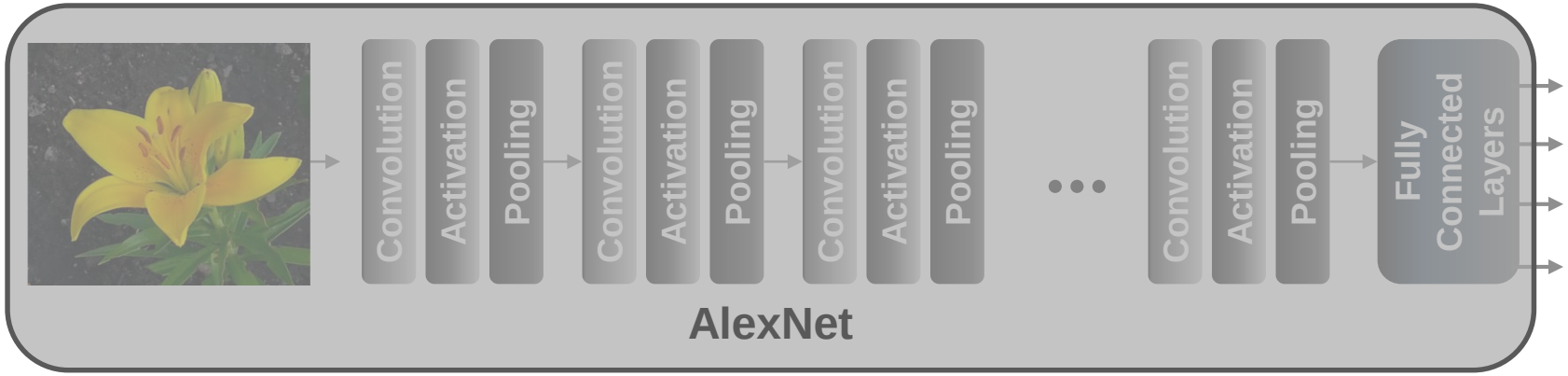
2. Fine-tune a pre-trained model (transfer learning)



Why Perform Transfer Learning

- Requires less data and training time
- Reference models (like AlexNet, VGG-16, VGG-19) are great feature extractors
- Leverage best network types from top researchers

Example: Classify Vehicles With Transfer Learning



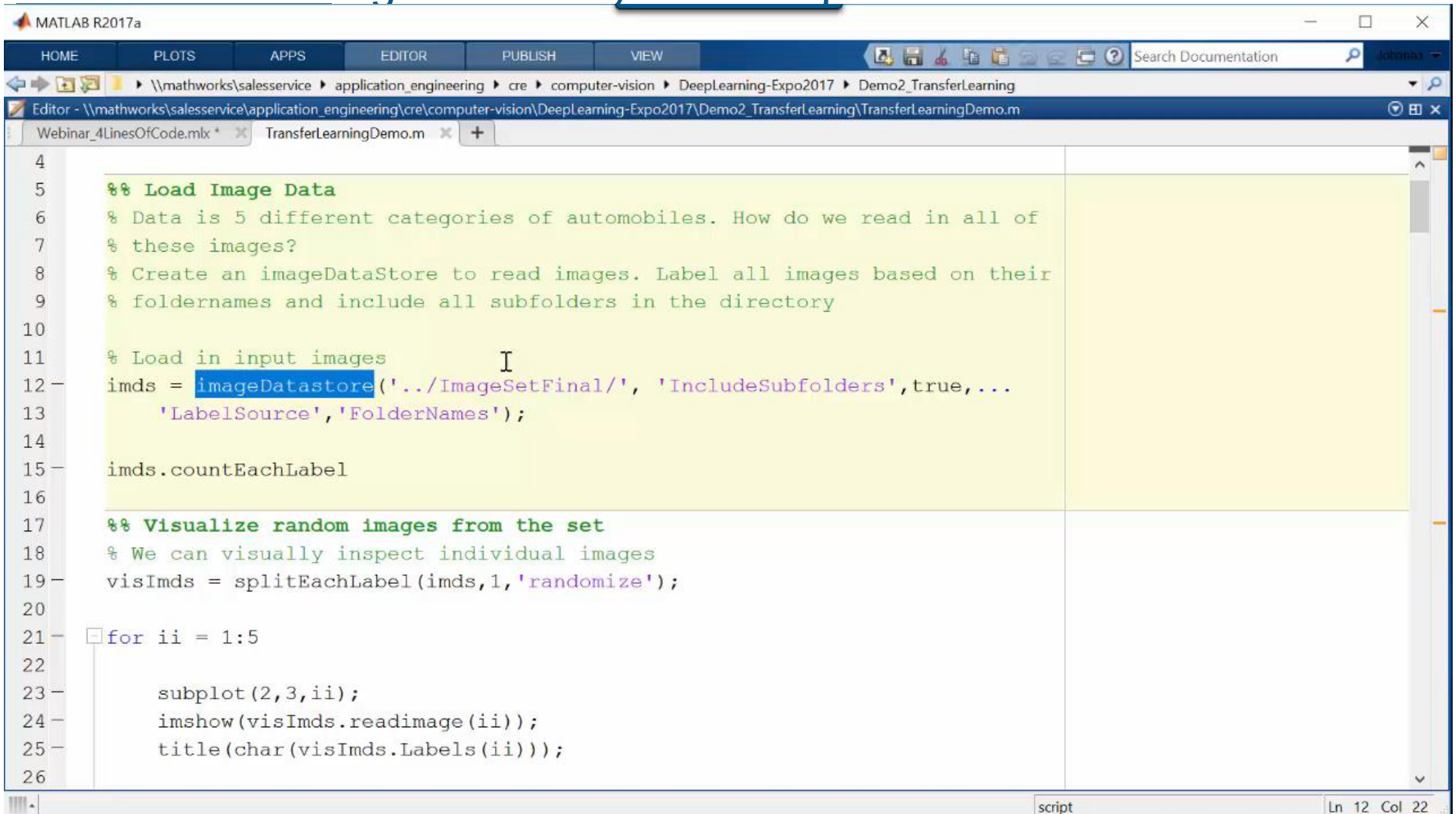
New Data

AlexNet

car
suv
pickup
van
truck

5 Category Classifier

Transfer Learning to Classify New Objects



New MATLAB framework makes deep learning easy and accessible

MATLAB makes Deep Learning Easy and Accessible

Learn about new MATLAB capabilities to

- Handle and label large sets of images
- Accelerate deep learning with GPUs
- Visualize and debug deep neural networks
- Access and use models from experts

```
imageDS = imageDatastore(dir)
```

Easily manage large sets of images

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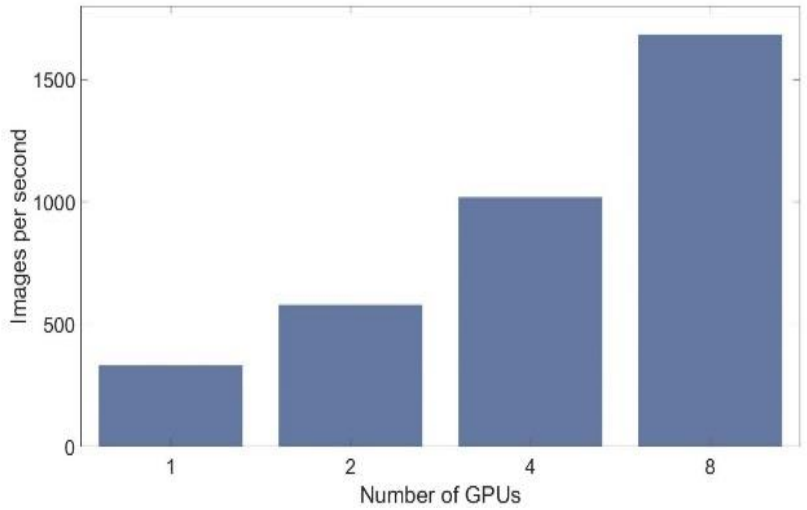
Training modes supported:

Auto Select
GPU
Multi GPU (local)
Multi GPU (cluster)



Acceleration with Multiple GPUs

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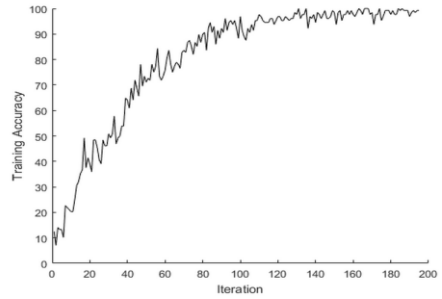
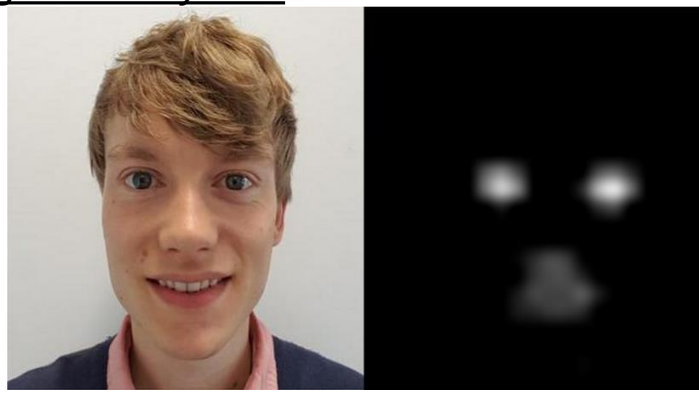
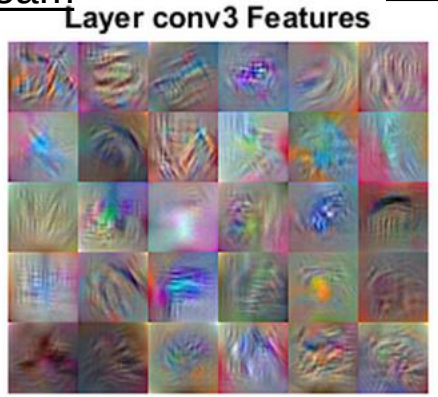


Training Accuracy Plot

Deep Dream



Network Activations



Feature Visualization

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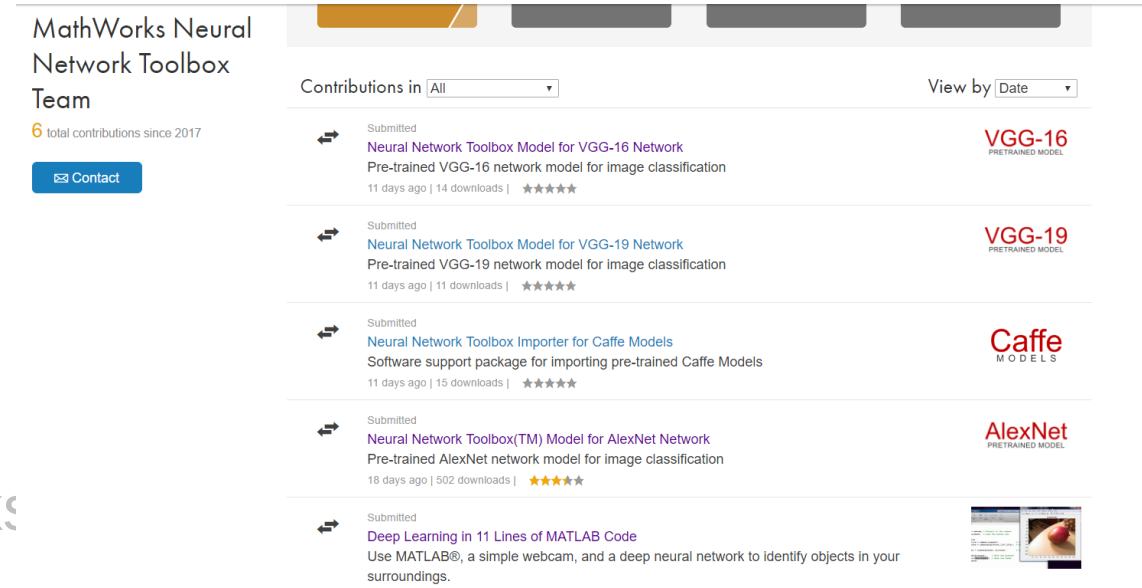


Curated Set of Pretrained Models

Access Models with 1-line of MATLAB Code

```
Net1 = alexnet
Net2 = vgg16
Net3 = vgg19
```

Regression Support for Deep Learning

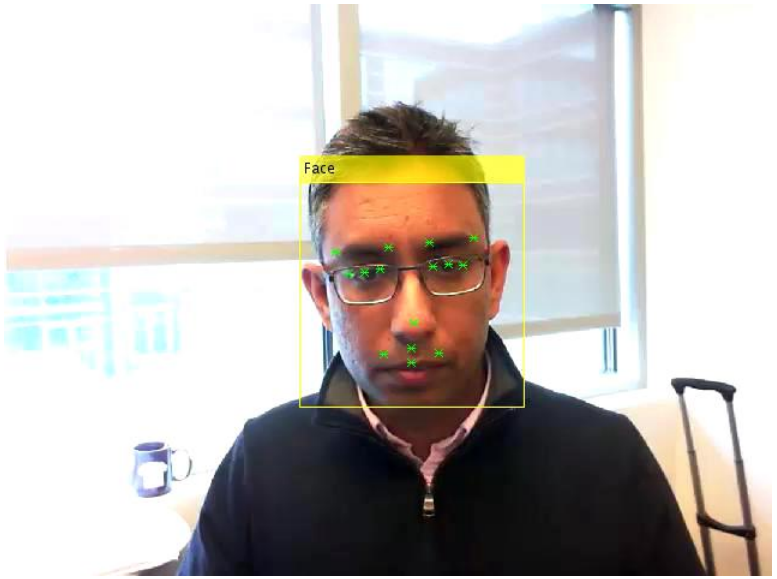
Classification vs. Regression

- Classification – outputs categories/labels
- Regression – outputs numbers

Supported by new regression layer:

```
routputlayer = regressionLayer('Name','routput')
```

Example predict facial key-points:



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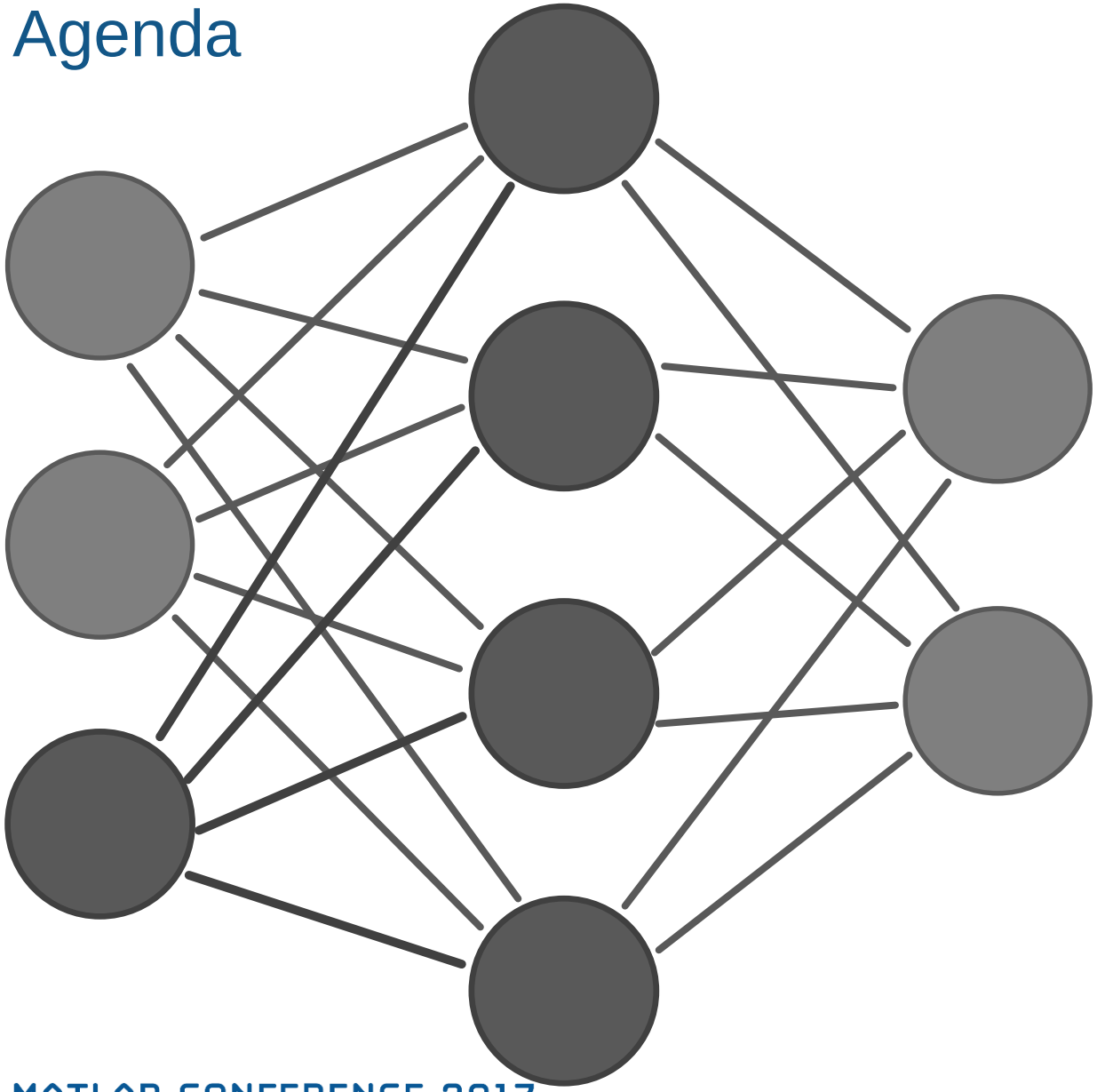

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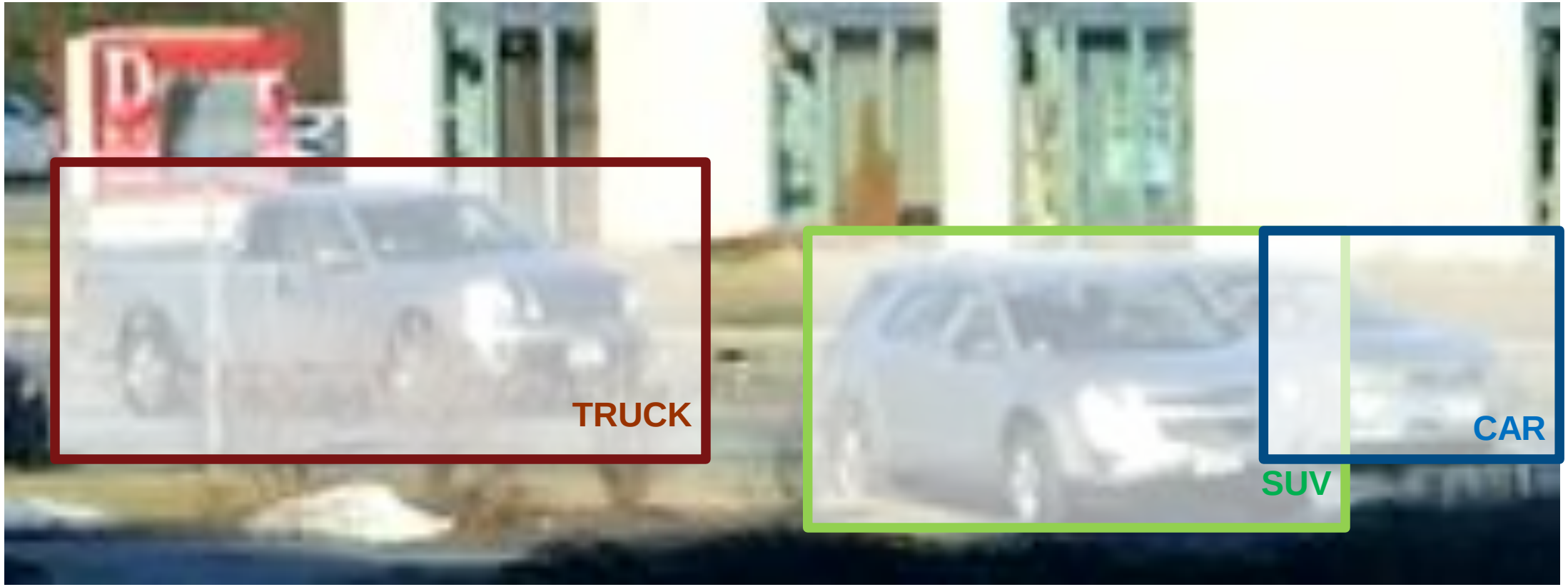
Is Object Recognition/Classification Enough ?

Car

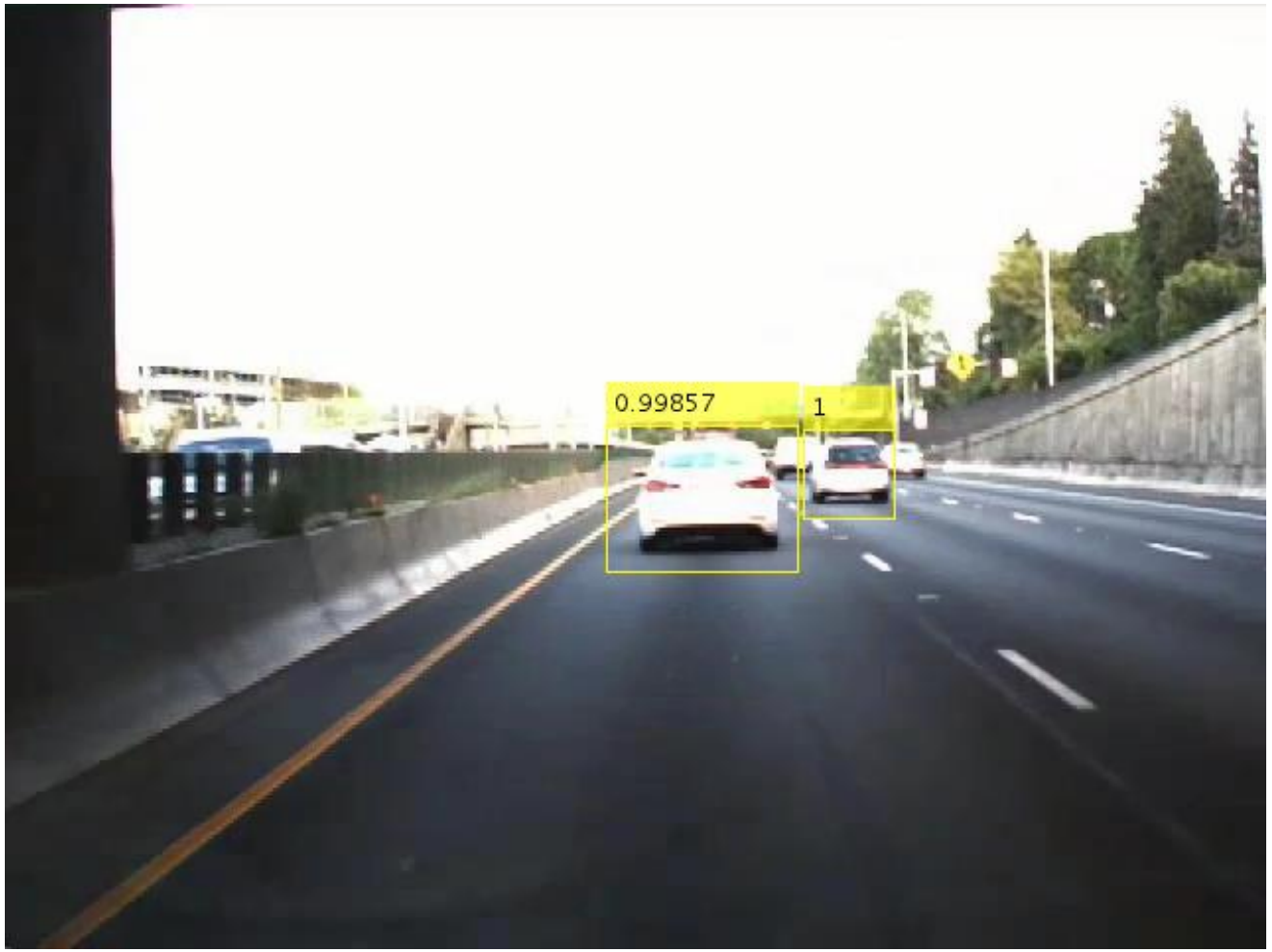
Label for entire image

Car ? SUV? Truck?

Object Detection – Locate and Classify Object



Goal: Create Object Detector to Locate Vehicles

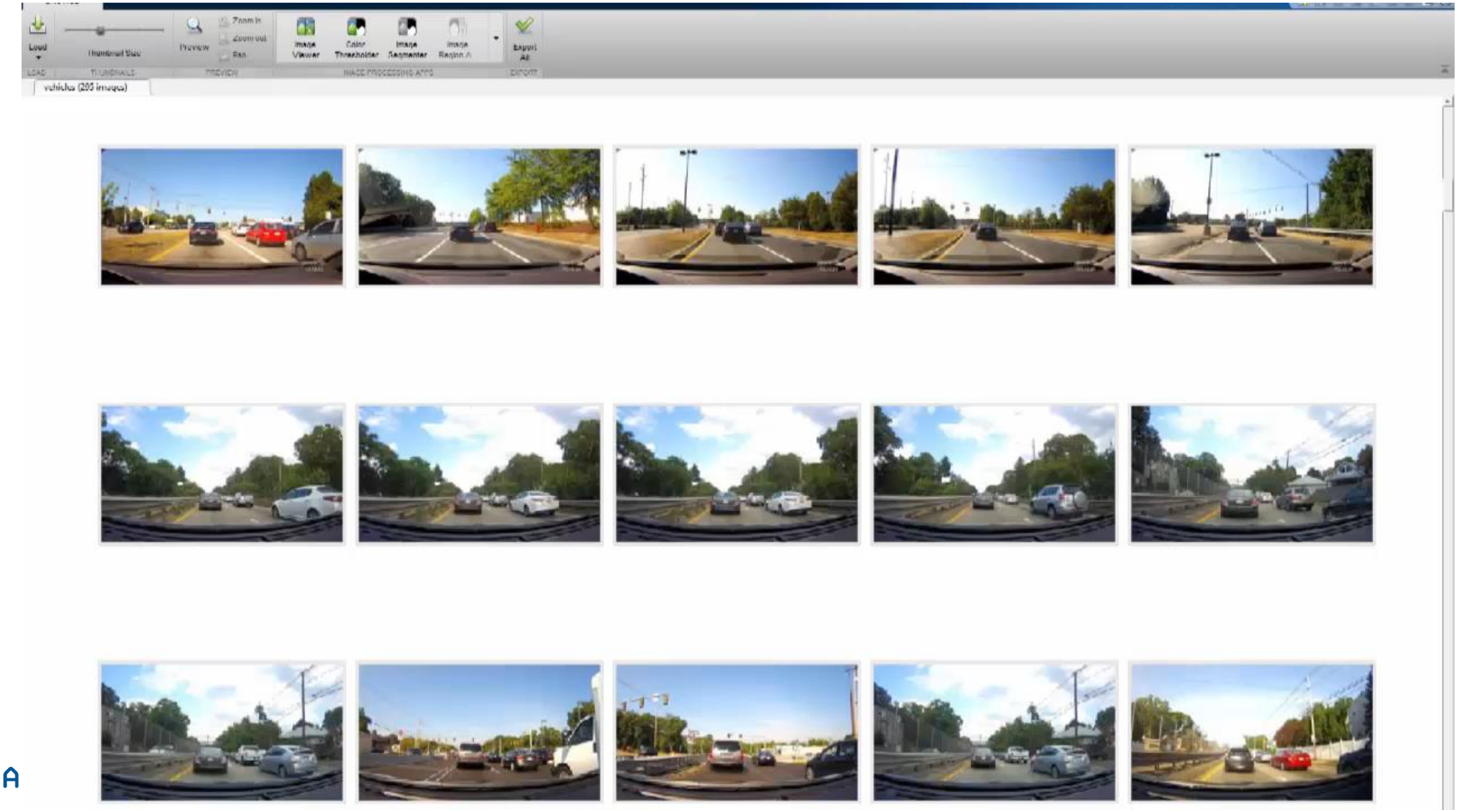


Step 1: Label / Crop data

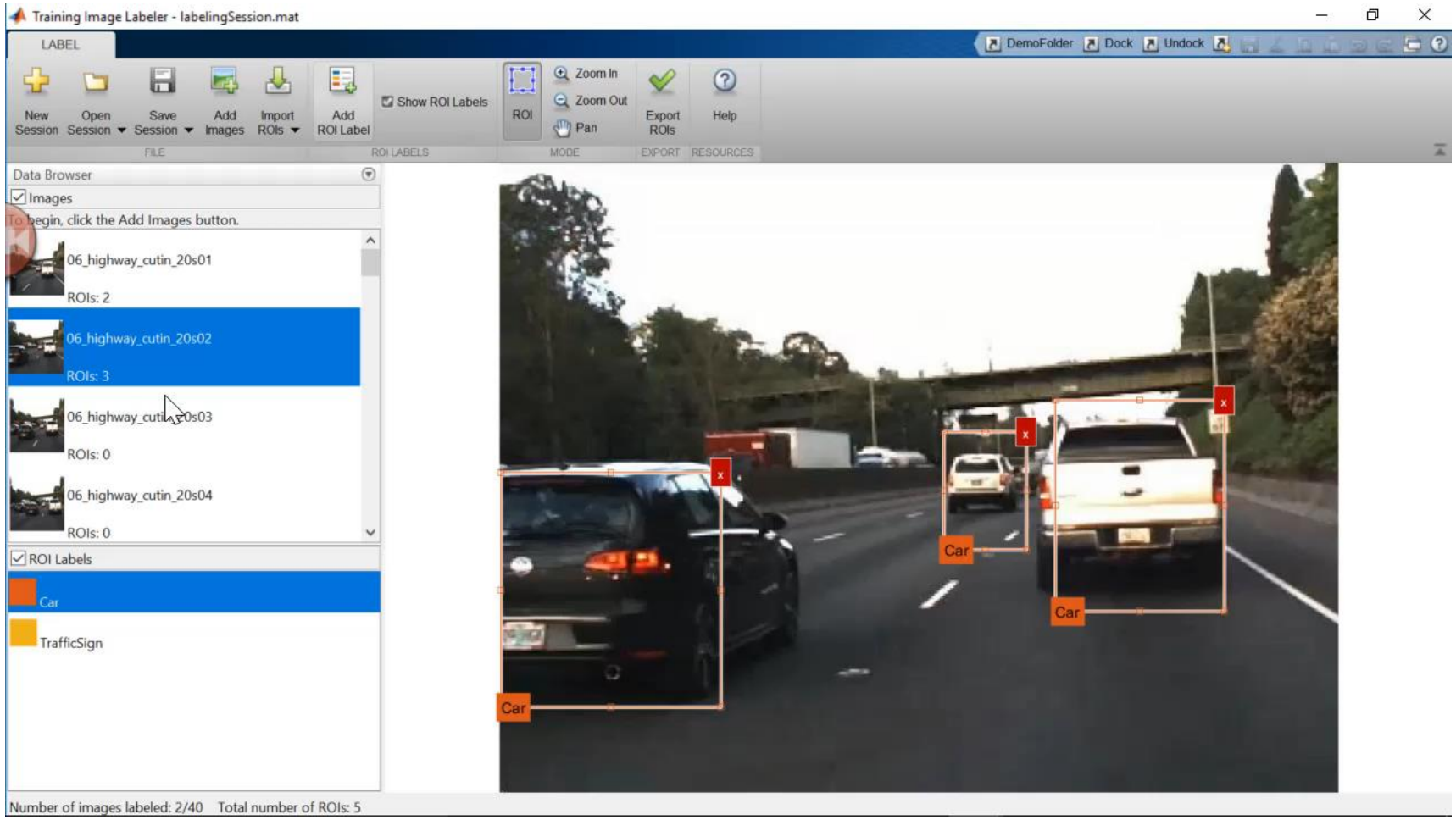
Step 2: Train detector

Step 3: Use detector

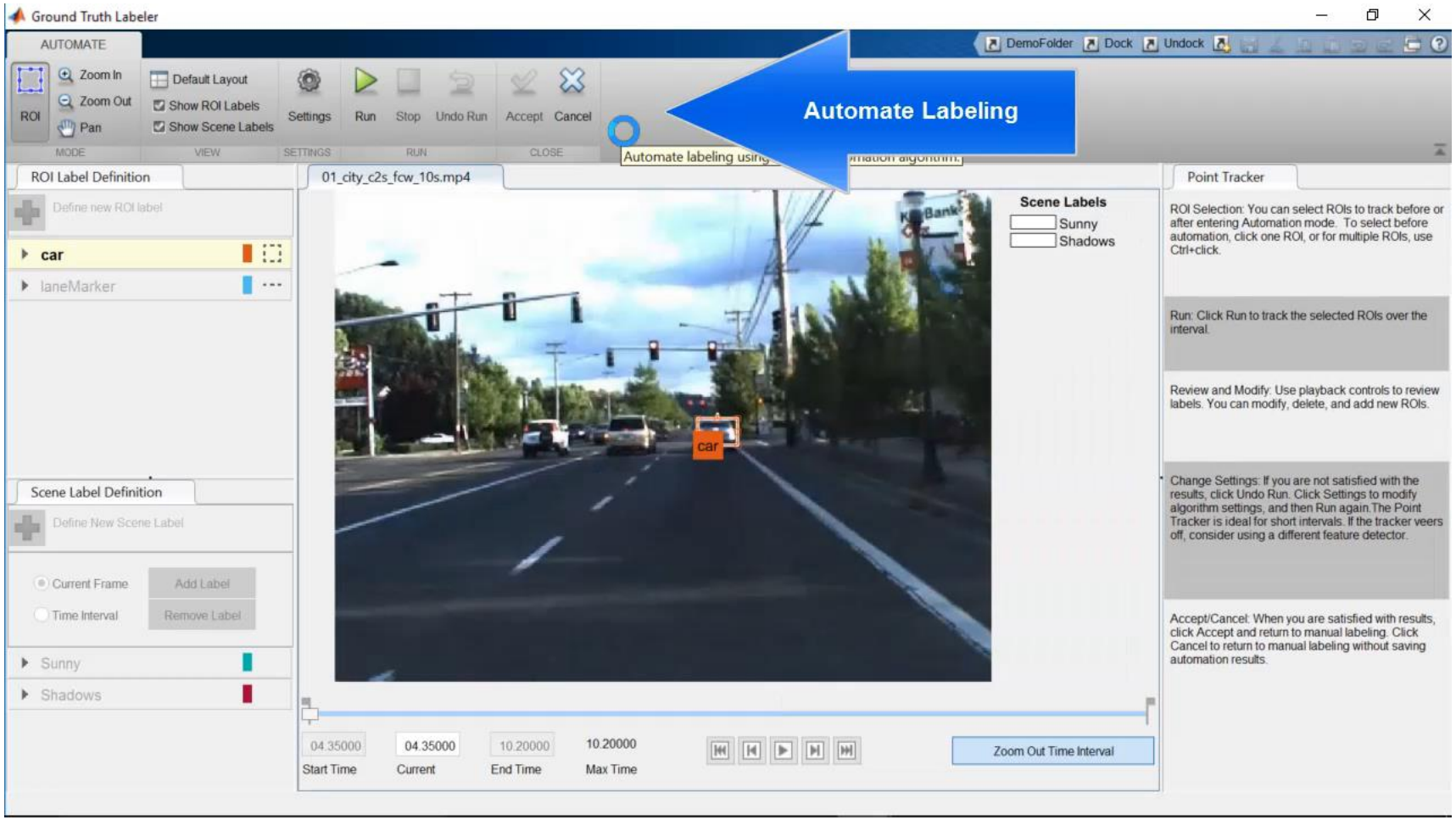
Video: Object Detection using Faster R-CNN



Label Images with MATLAB



Labeling Videos with MATLAB



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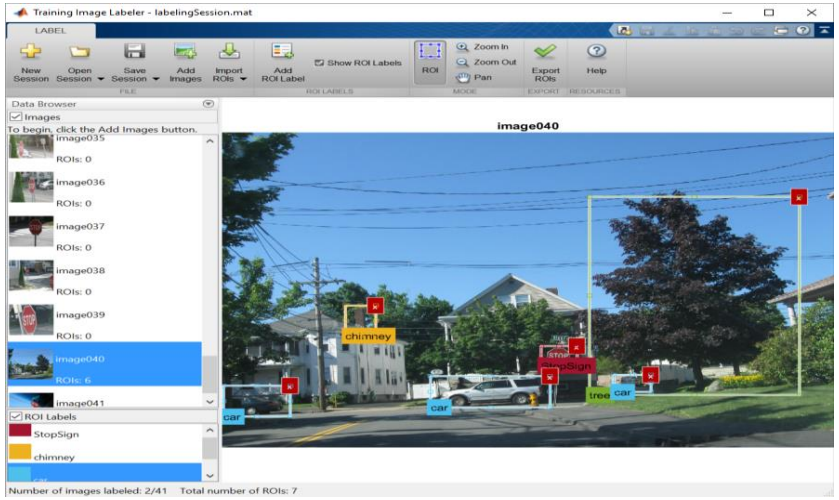
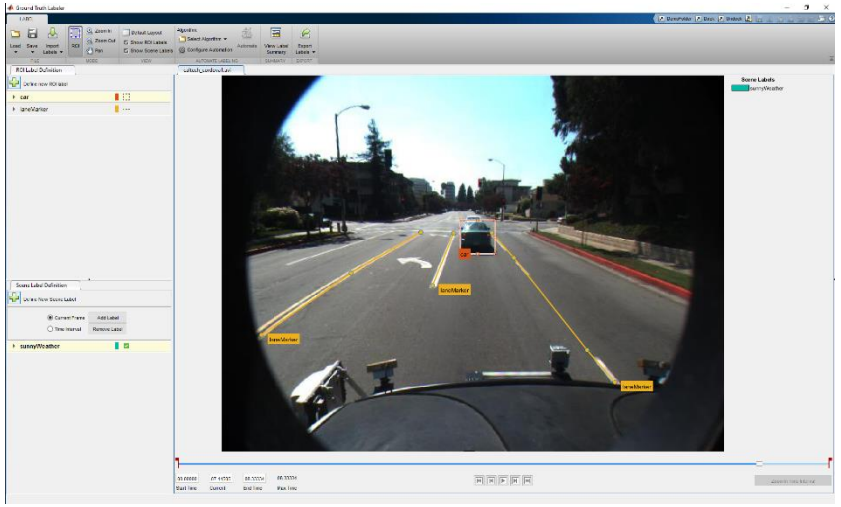


Image Labeler

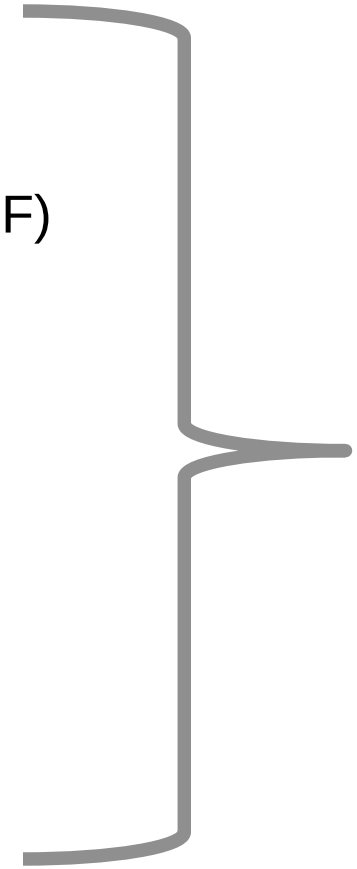


Video Labeler

Object Detection Frameworks in MATLAB

Machine Learning
1. Cascade Object Detector
2. Aggregate Channel Features (ACF)

Deep Learning
1. R-CNN
2. Fast R-CNN
3. Faster R-CNN



Same labels , train any detector.

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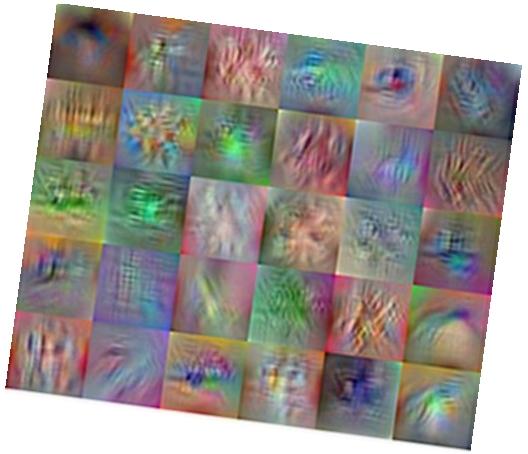

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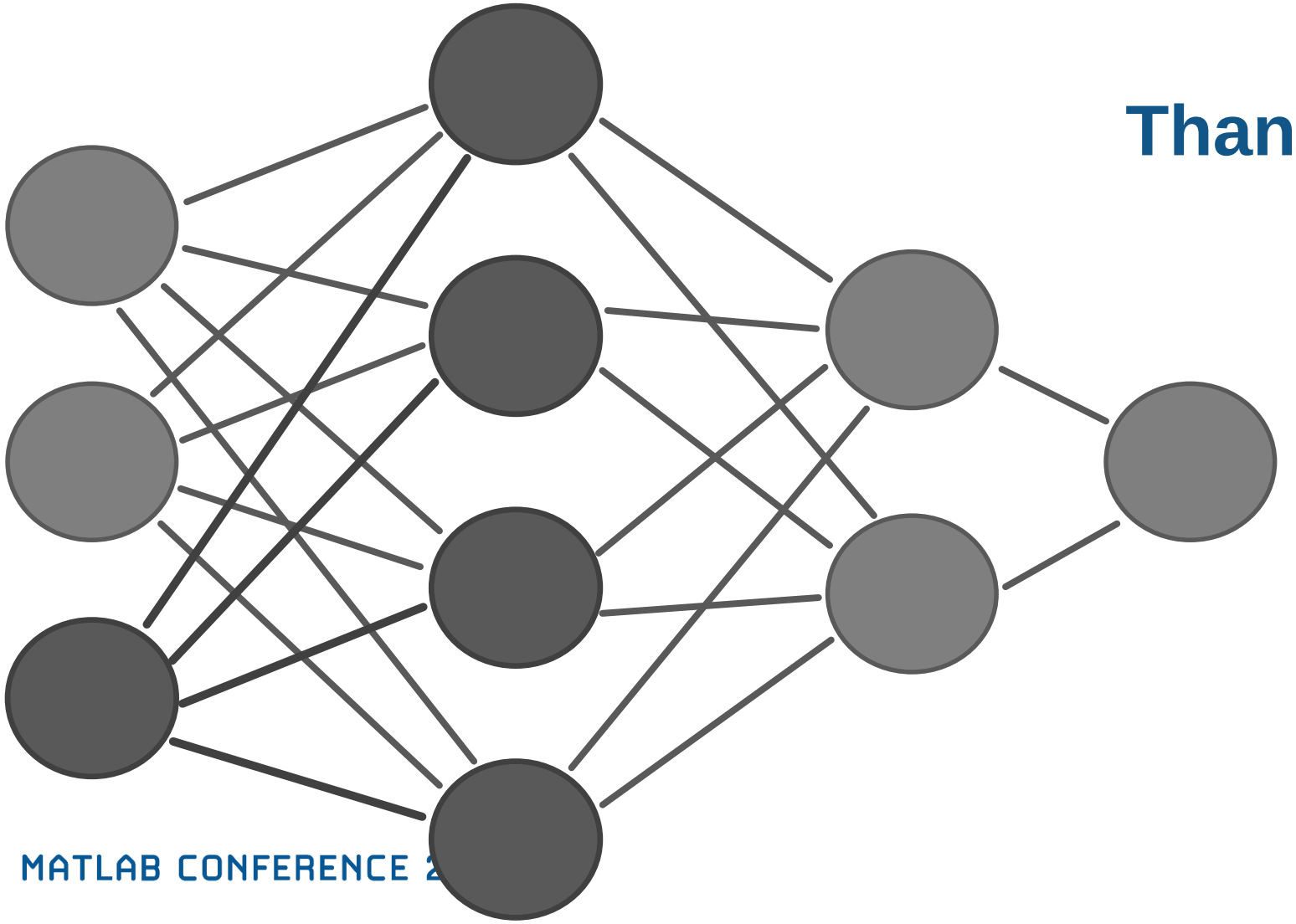

Thank You