

MATLAB TOUR 2017

Machine Learning y Deep Learning con MATLAB

Lucas García



Deep Learning is Everywhere

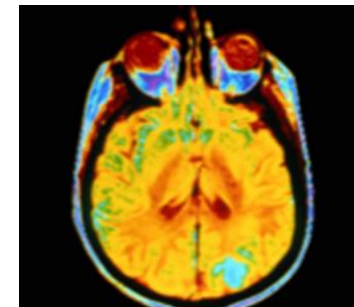
&

MATLAB framework makes Deep Learning Easy and Accessible

Deep Learning is Everywhere

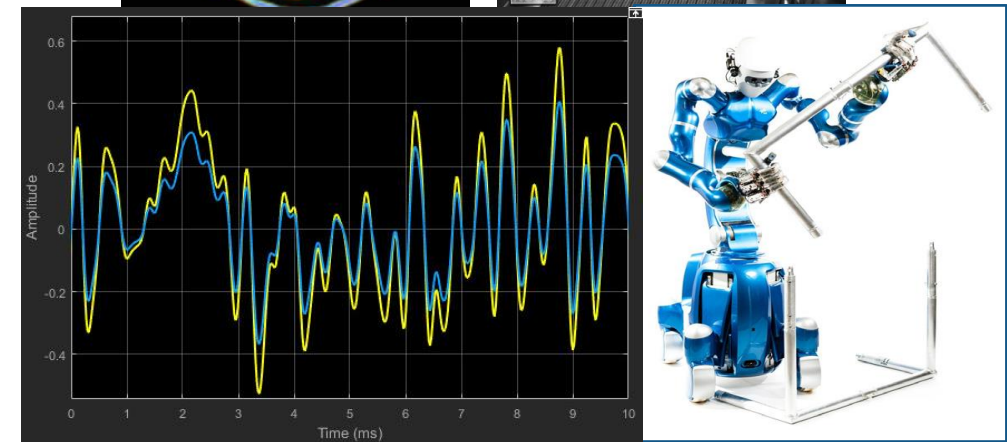
Computer Vision

- Pedestrian and traffic sign detection
- Landmark identification
- Scene recognition
- Medical diagnosis and drug discovery



Text and Signal Processing

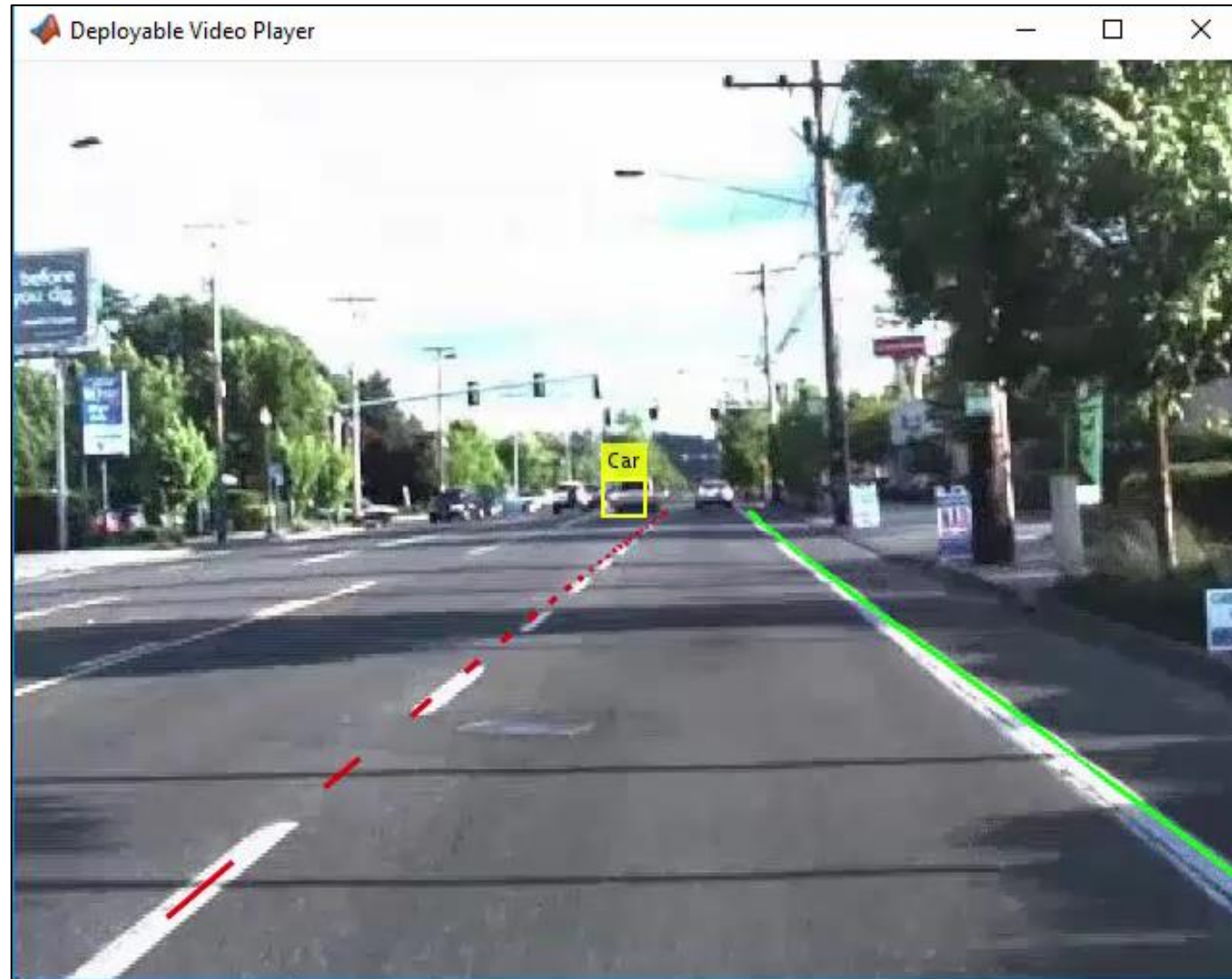
- Speech Recognition
- Speech & Text Translation



Robotics & Controls

Deep Learning Use Case

e.g. Automated Driving



What is Deep Learning?

Deep Learning is a Subset of Machine Learning

e.g. Google Captioning Project



Machine learning is the science of getting computers to act without being explicitly programmed.

Deep learning algorithms can learn tasks directly from data, eliminating the need for manual feature selection.

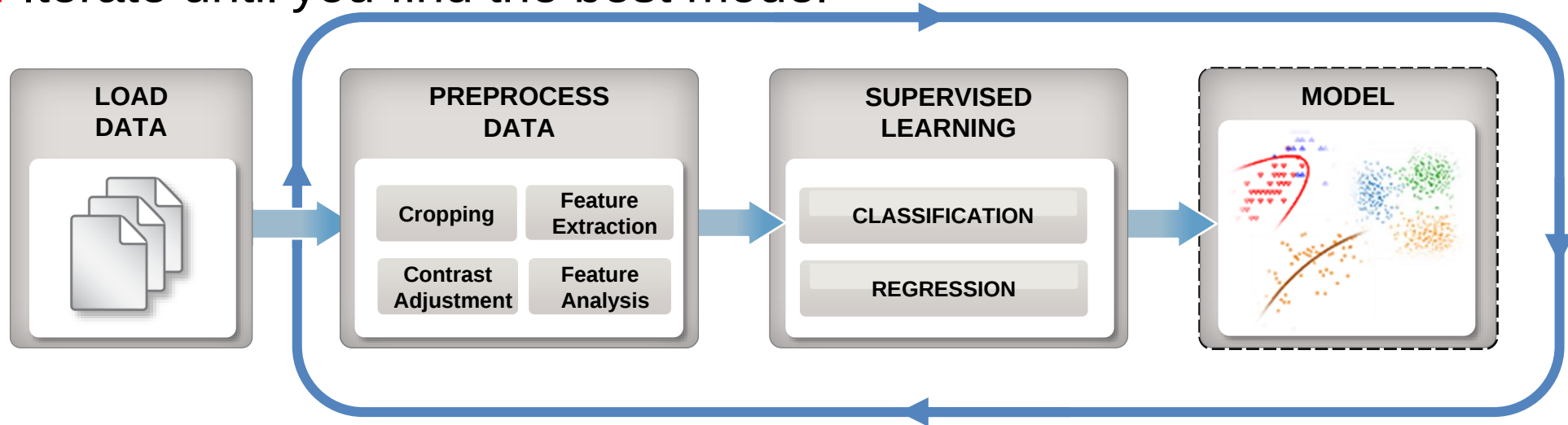


<http://googleresearch.blogspot.com/2014/11/a-picture-is-worth-thousand-coherent.html>

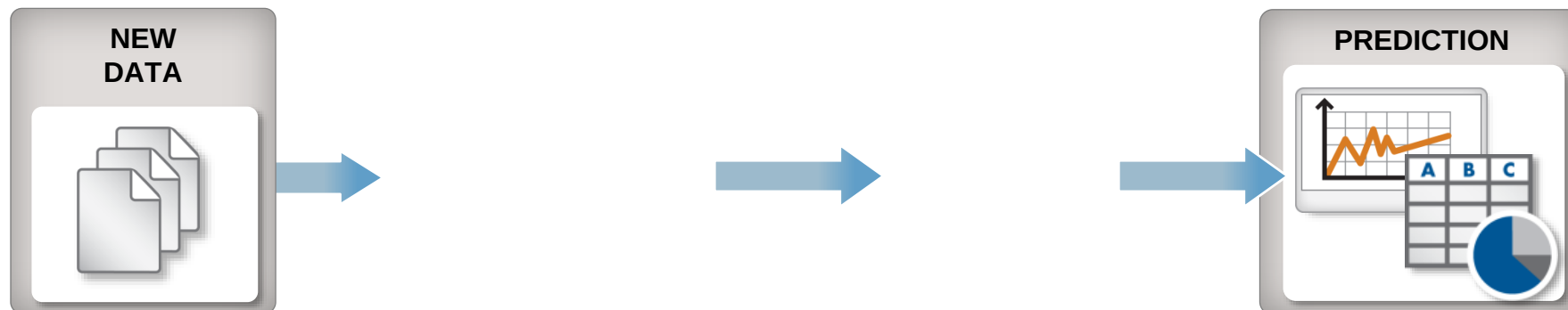
MATLAB TOUR 2017

Shallow Machine Learning Workflow

Train: Iterate until you find the best model



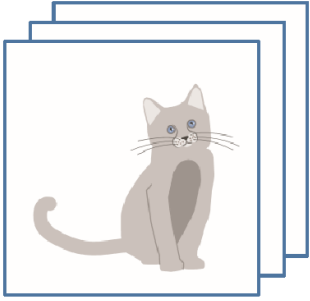
Predict: Integrate trained models into applications



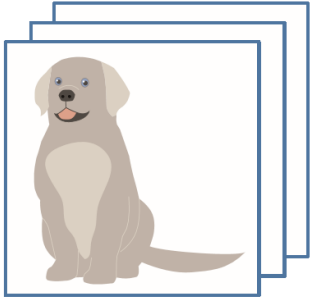
What is Deep Learning?

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

Cat



Dog



Bird



Car



Learned Features



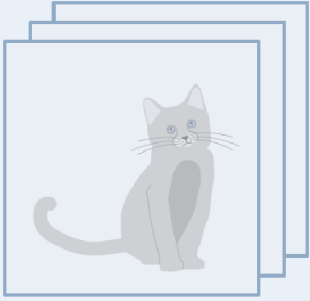
...

94%
3%
2%
1%

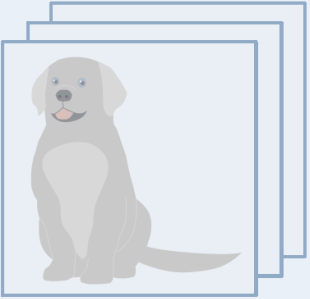
Car ✓
Dog
Cat
Bird

What is Deep Learning?

Cat



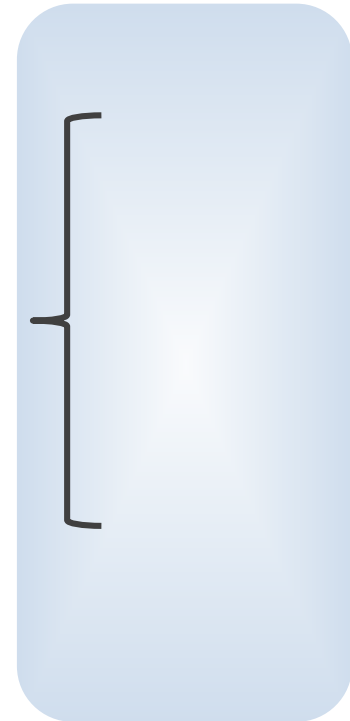
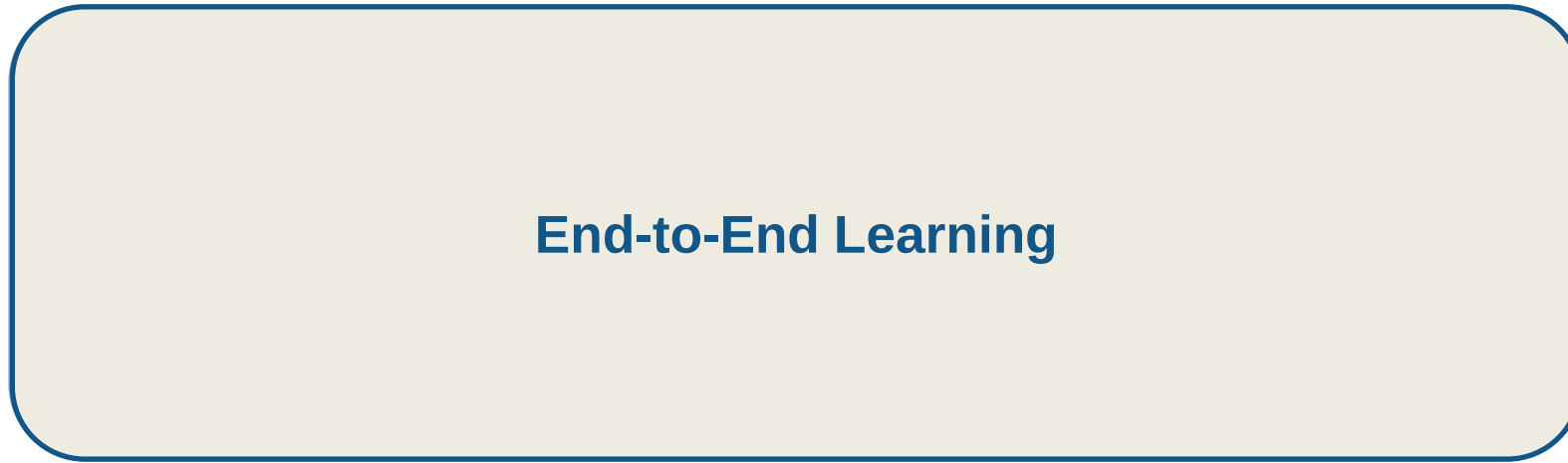
Dog



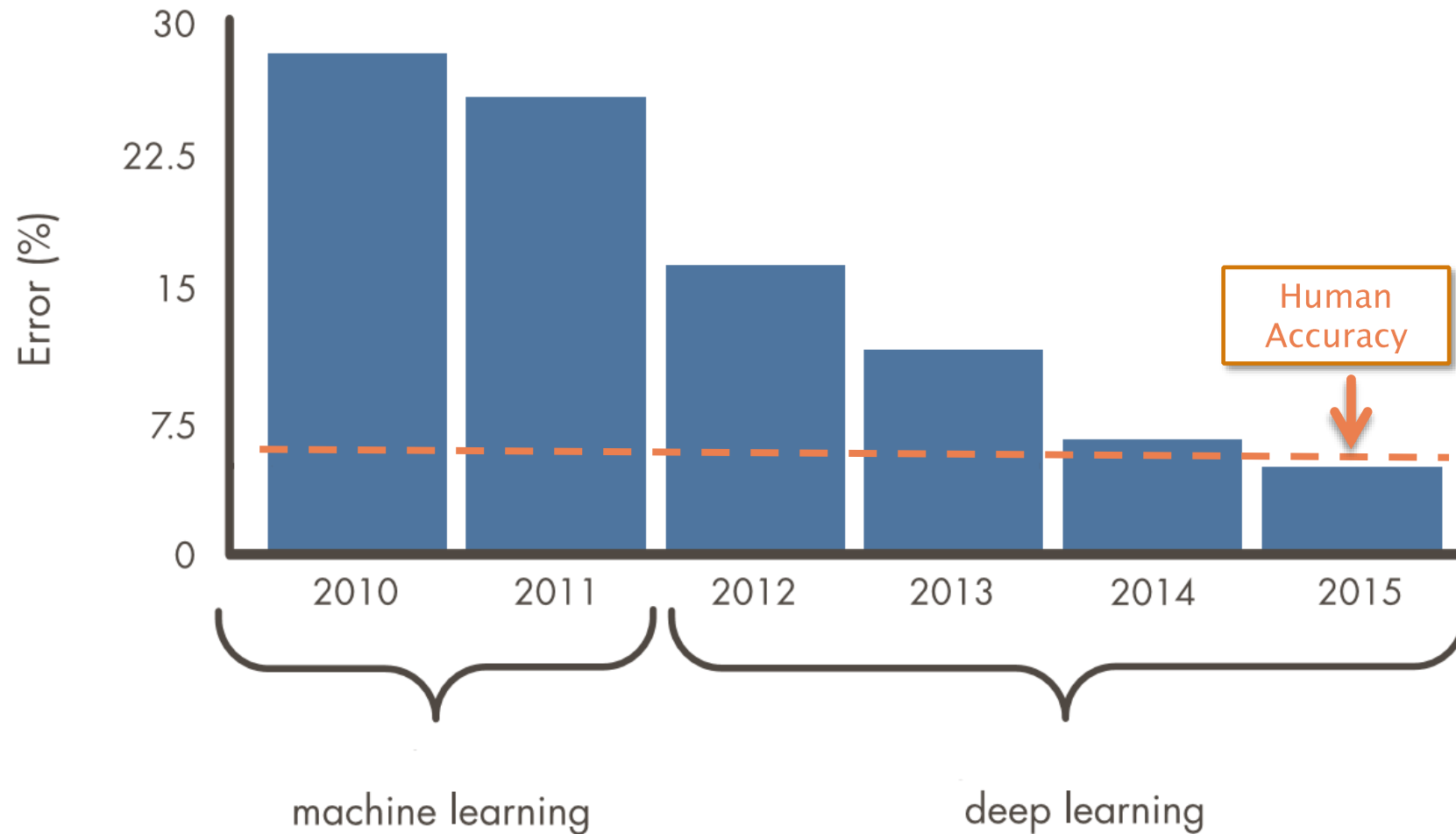
Bird



Car

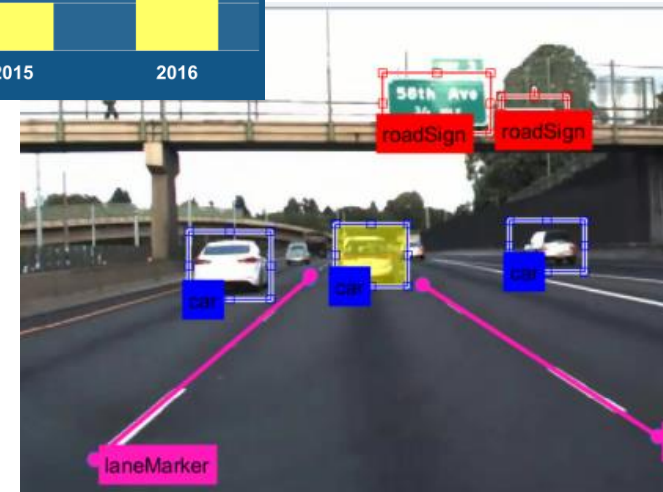
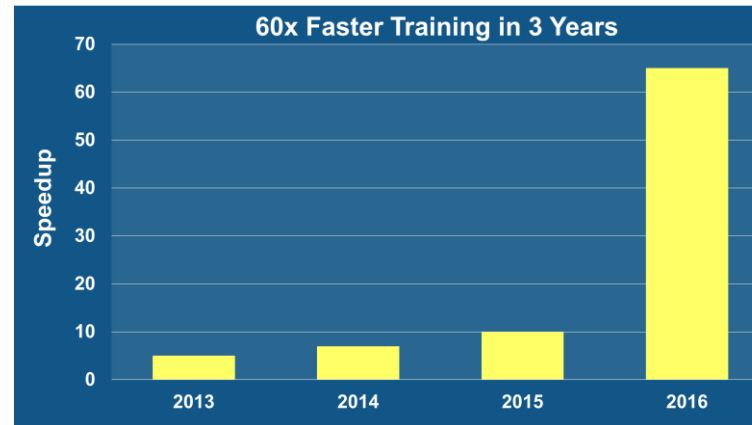


Why is Deep Learning so popular now?



Deep Learning Enablers

1. Acceleration with GPU's



2. Massive sets of labeled data

3. Availability of state of the art models from experts

AlexNet
PRETRAINED MODEL

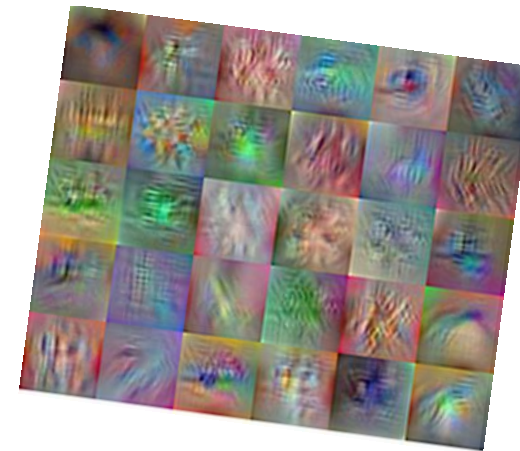
VGG-16
PRETRAINED MODEL

Caffe
MODELS

MATLAB makes Deep Learning Easy and Accessible

Learn about new MATLAB capabilities to

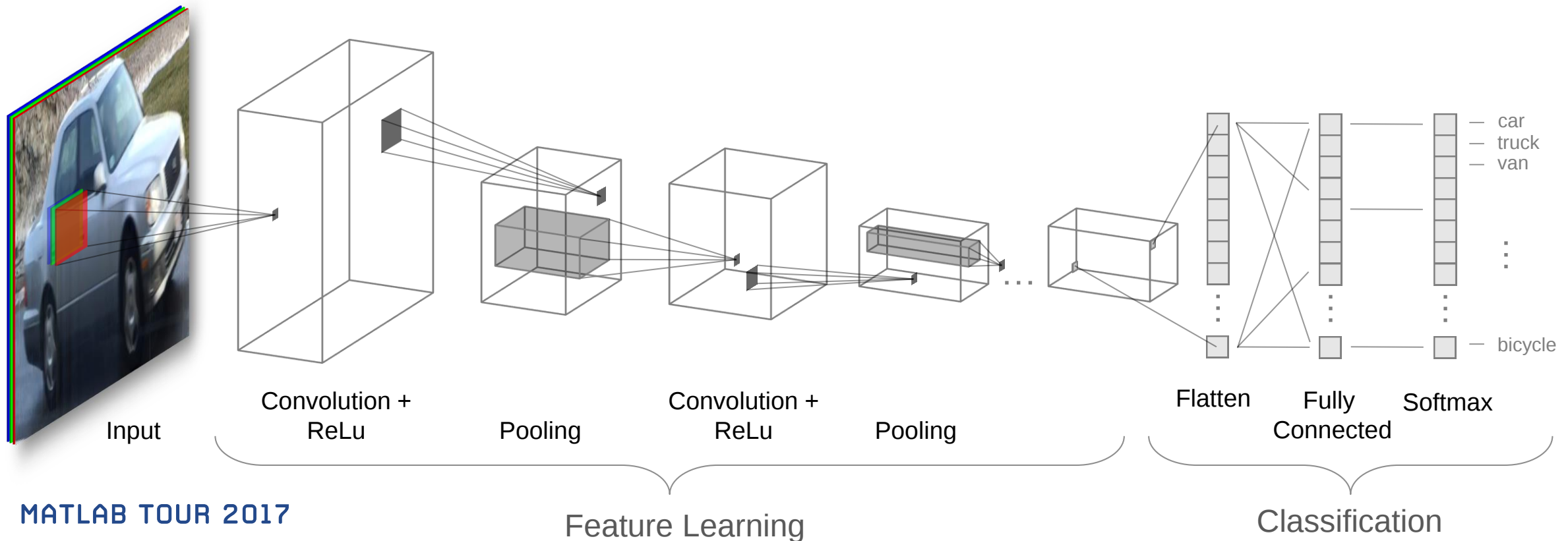
- Handle and label large sets of images
- Accelerate deep learning with GPUs
- Visualize and debug deep neural networks
- Access and use models from experts



AlexNet
PRETRAINED MODEL
Caffe MODELS
VGG-16
PRETRAINED MODEL

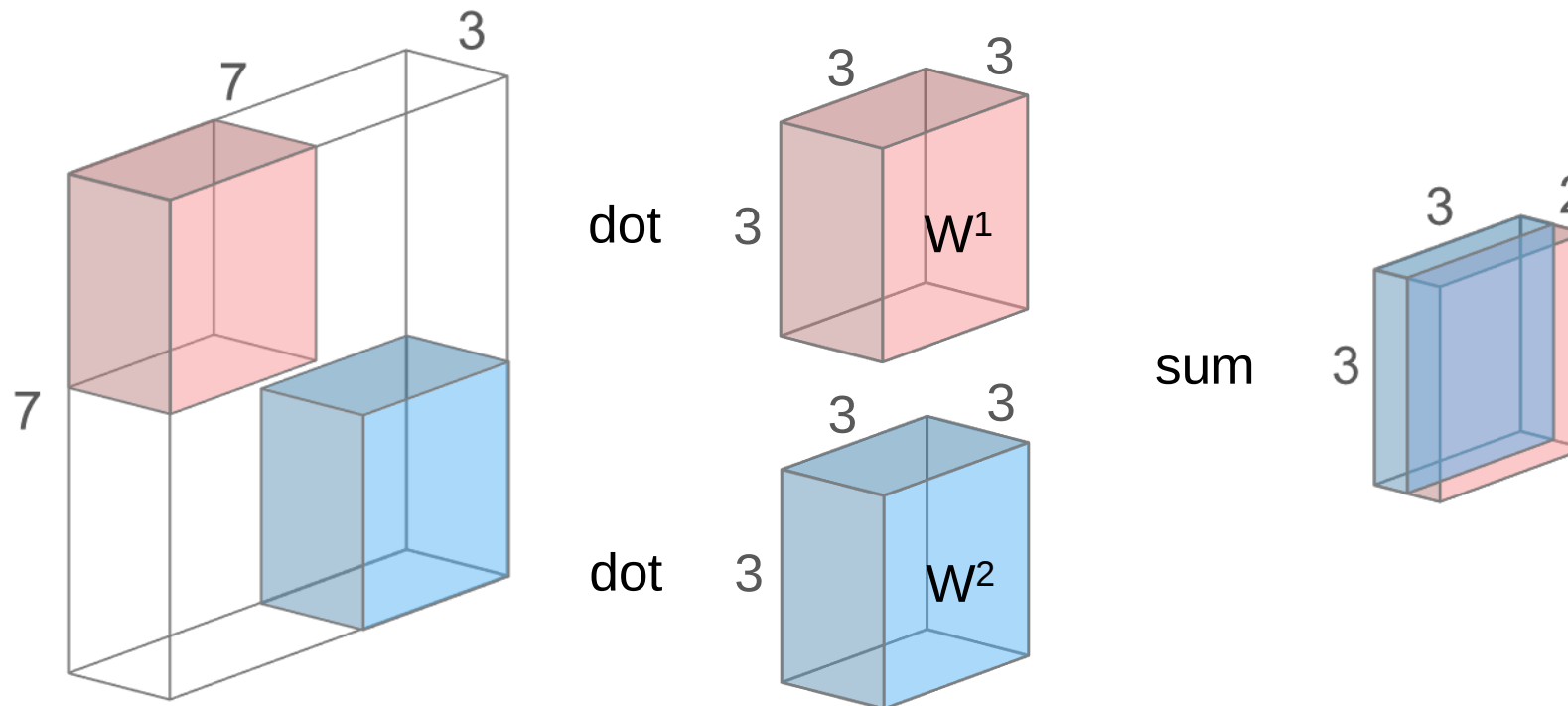
Convolutional Neural Networks

- Train “deep” neural networks on structured data (e.g. images, signals, text)
- Implements Feature Learning: Eliminates need for “hand crafted” features
- Trained using GPUs for performance



Convolution Layer

- Core building block of a CNN
- Convolve the filters sliding them across the input, computing the dot product



- Intuition: learn filters that activate when they “see” some specific feature

Agenda

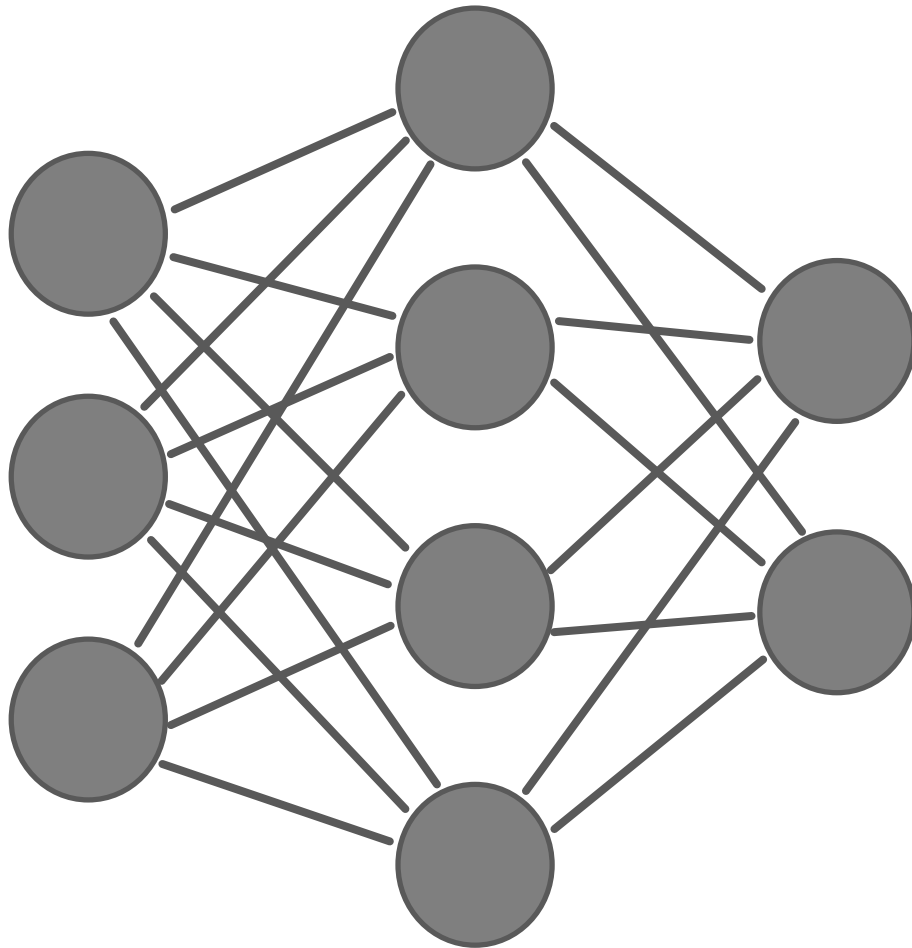


Image classification using pre-trained network

Training a Deep Neural Network from scratch

Transfer learning to classify new objects

Locate & classify objects in images and video

Agenda

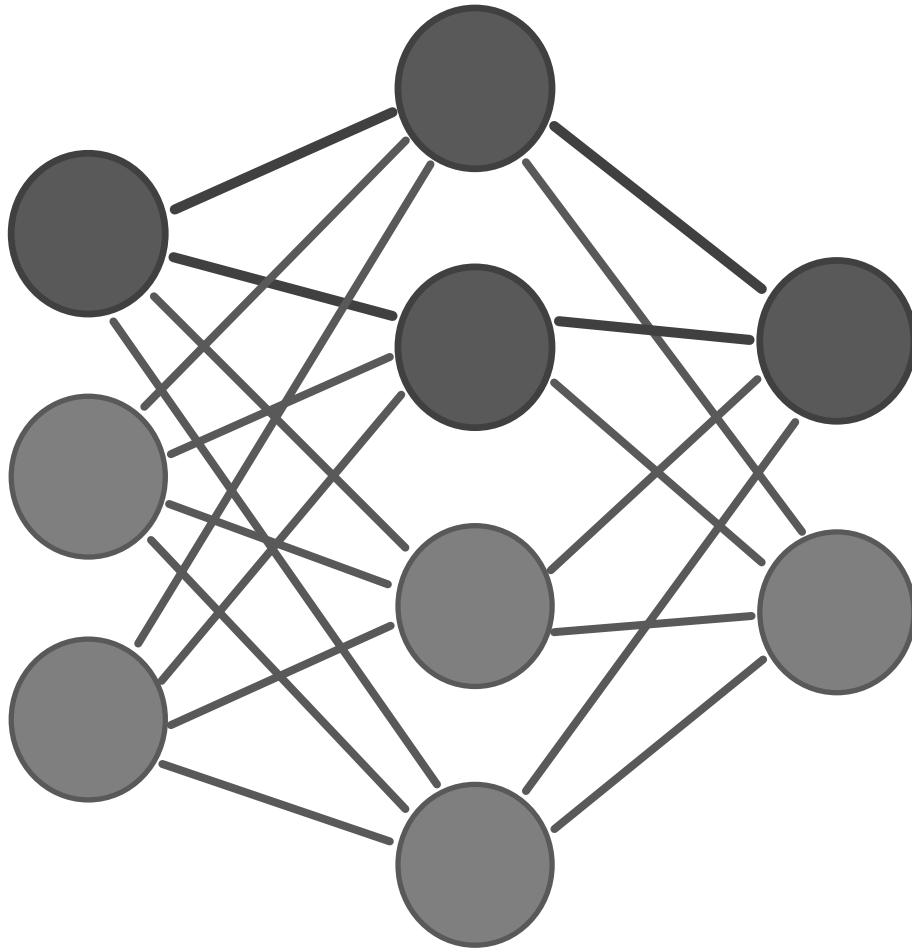


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Image classification using pre-trained network

```
1 clear
2 camera = webcam(); % Connect to the camera
3
4
5 picture = camera.snapshot; % Take a picture
6
7
8 image(picture); % Show the picture
9
10
11
```

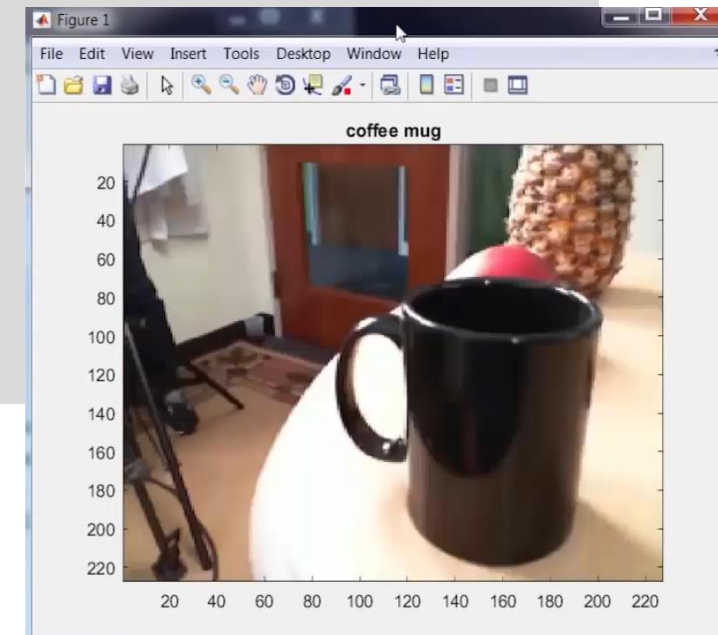


Image classification using pre-trained network



Agenda

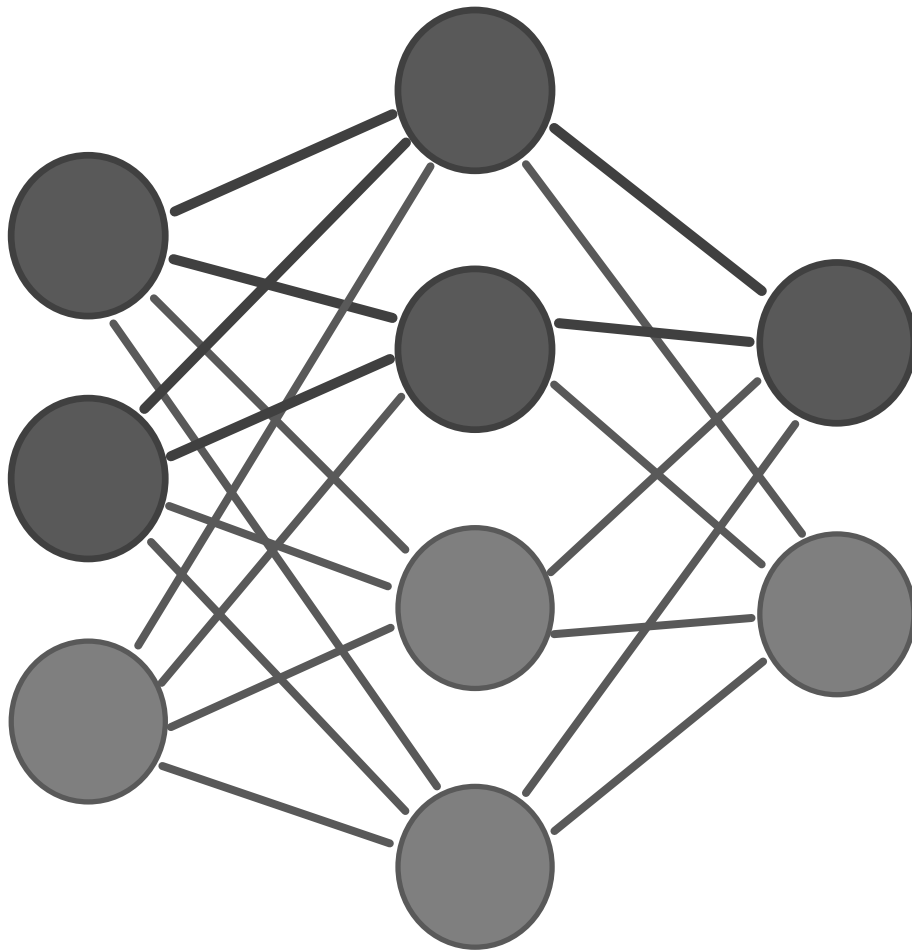


Image classification using pre-trained network

Training a Deep Neural Network from scratch

Transfer learning to classify new objects

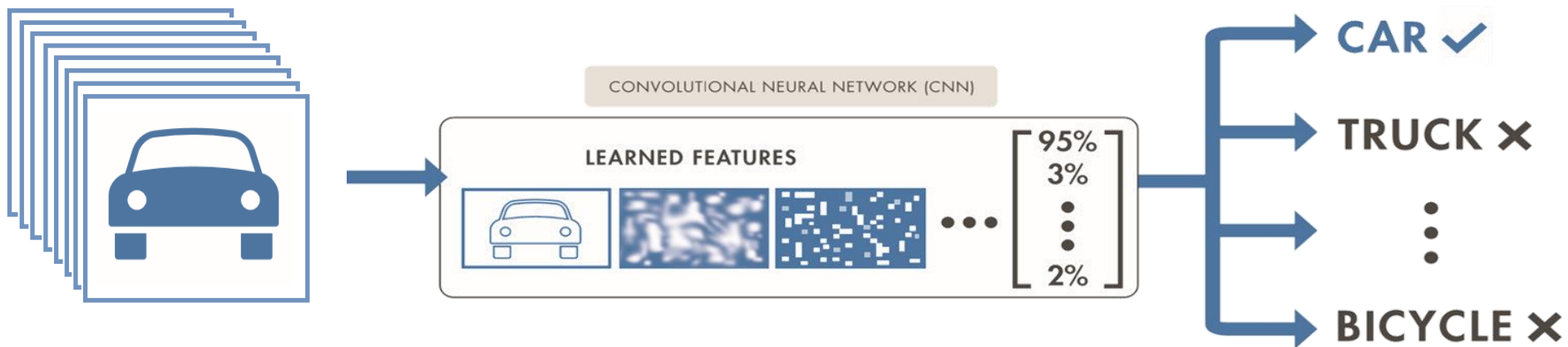
Locate & classify objects in images and video

Two Deep Learning Approaches

Approach 1: Train a Deep Neural Network from Scratch

Configure and train a CNN (convolutional neural network)

- Configure a network architecture to learn a specific task
- Gather a training set with massive amount of training data



Use when necessary:

Training data	Thousands to millions of labeled images
Computation	Compute-intensive (requires GPU)
Training Time	Days to weeks for real problems
Model accuracy	High (but can overfit to small datasets)

Demo: Classifying the CIFAR-10 dataset

Approach 1: Train a Deep Neural Network from Scratch

Objective: Train a Convolutional Neural Network to classify the CIFAR-10 dataset

Data:

Input Data	Thousands of images of 10 different Classes
Response	AIRPLANE, AUTOMOBILE, BIRD, CAT, DEER, DOG, FROG, HORSE, SHIP, TRUCK

Approach:

- Import the data
- Define an architecture
- Train and test the CNN

airplane



automobile



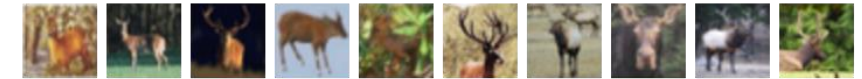
bird



cat



deer



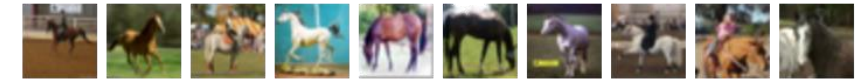
dog



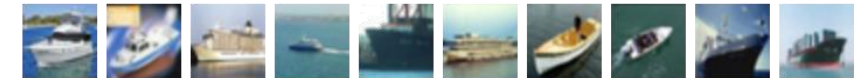
frog



horse



ship



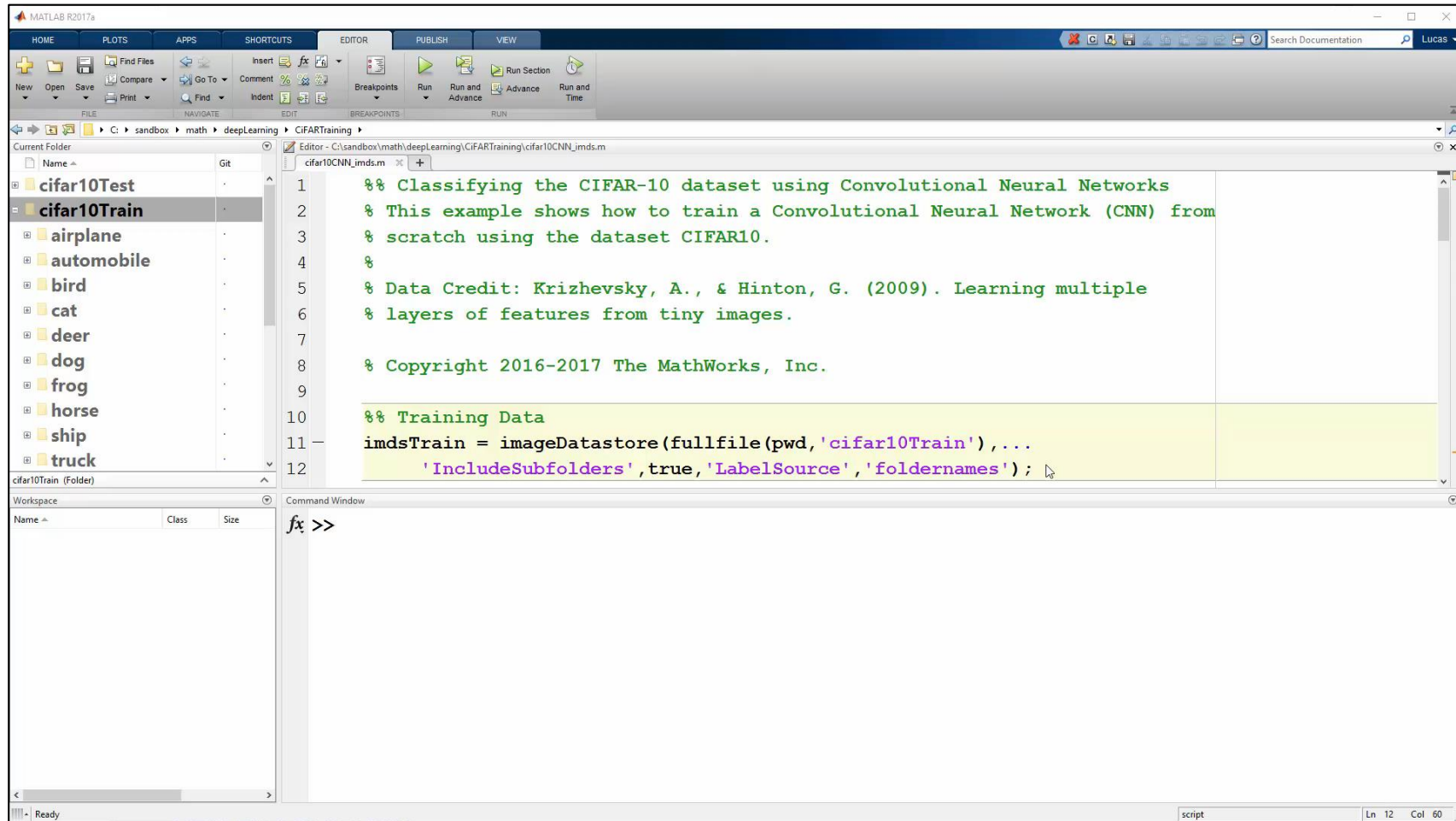
truck



Data Credit: [Learning Multiple Layers of Features from Tiny Images](https://www.cs.toronto.edu/~kriz/cifar.html), Alex Krizhevsky, 2009.
<https://www.cs.toronto.edu/~kriz/cifar.html>

Demo: Classifying the CIFAR-10 dataset

Approach 1: Train a Deep Neural Network from Scratch



Agenda

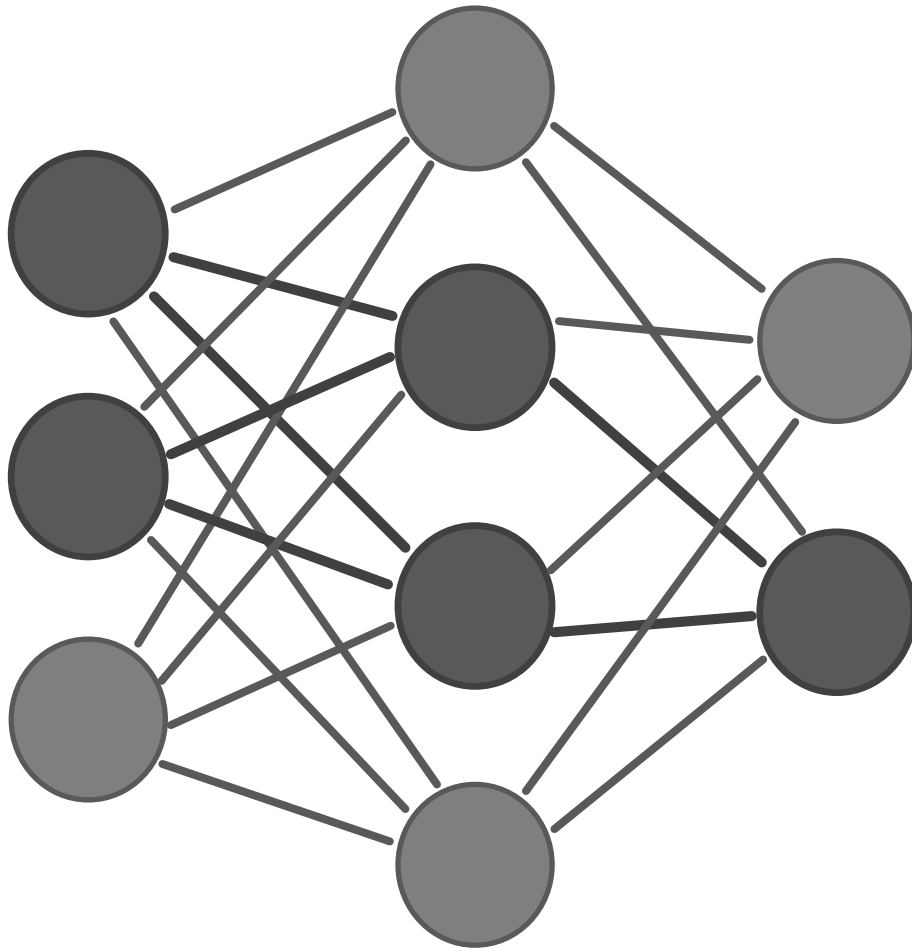


Image classification using pre-trained network

Training a Deep Neural Network from scratch

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
- Improve results by creating a model specific to your problem

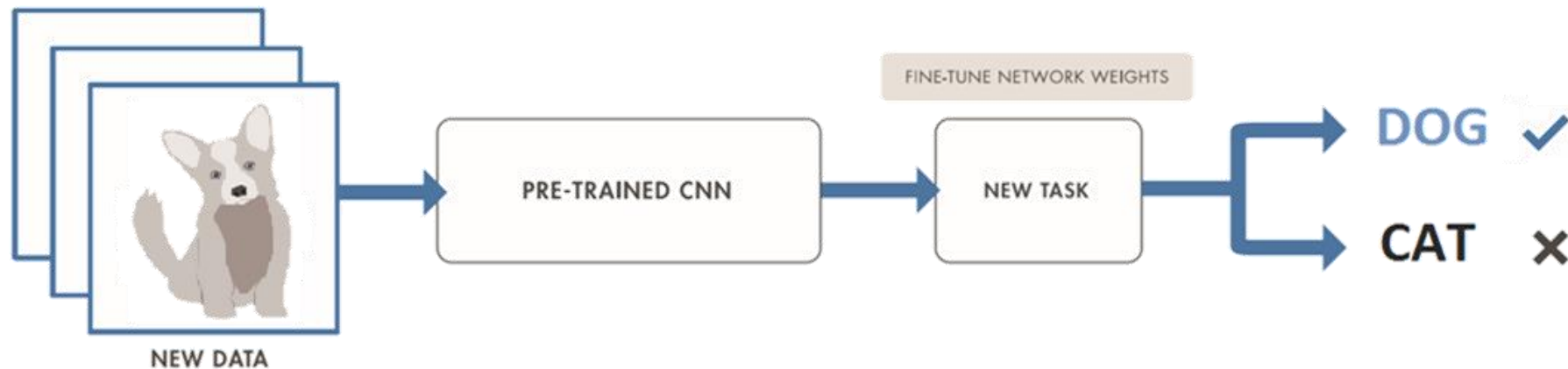


Two Deep Learning Approaches

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

CNN already trained on massive sets of data

- Trained model has robust learned representations
- Can then be fine-tuned for *new data or task* using small/medium-size datasets



Use when possible:

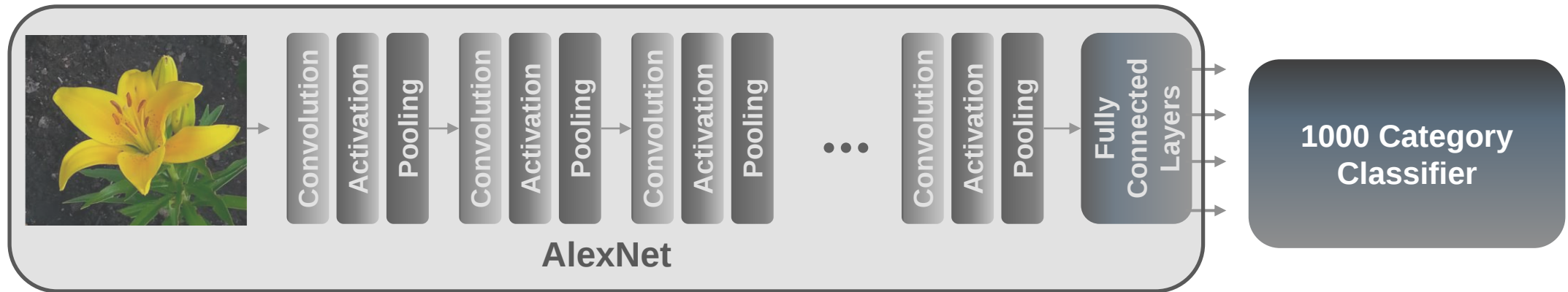
Training data	Hundreds to thousands of labeled images (small)
Computation	Moderate computation (GPU optional)
Training Time	Seconds to minutes
Model accuracy	Good, depends on the pre-trained CNN model

Why Perform Transfer Learning

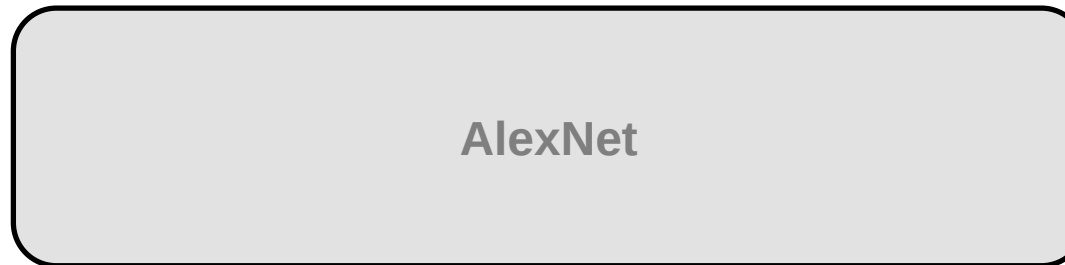
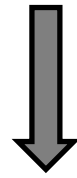
- Requires less data and training time
- Reference models (like AlexNet, VGG-16, VGG-19) are great feature extractors
- Leverage best network types from top researchers

Demo: Classify Vehicles With Transfer Learning

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



New Data



car →

suv →

pickup →

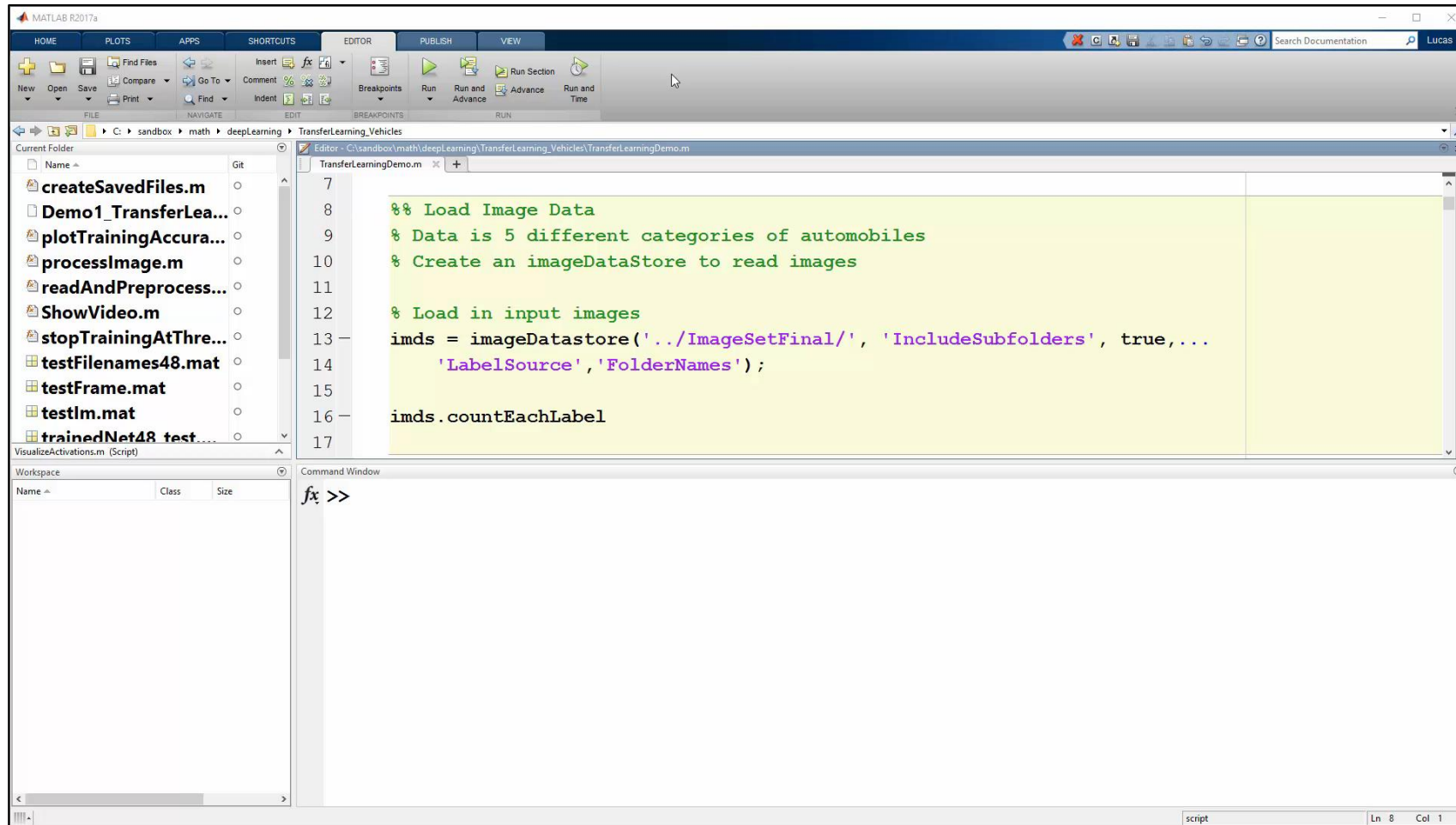
van →

truck →

5 Category
Classifier

Demo: Classify Vehicles With Transfer Learning

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



Agenda

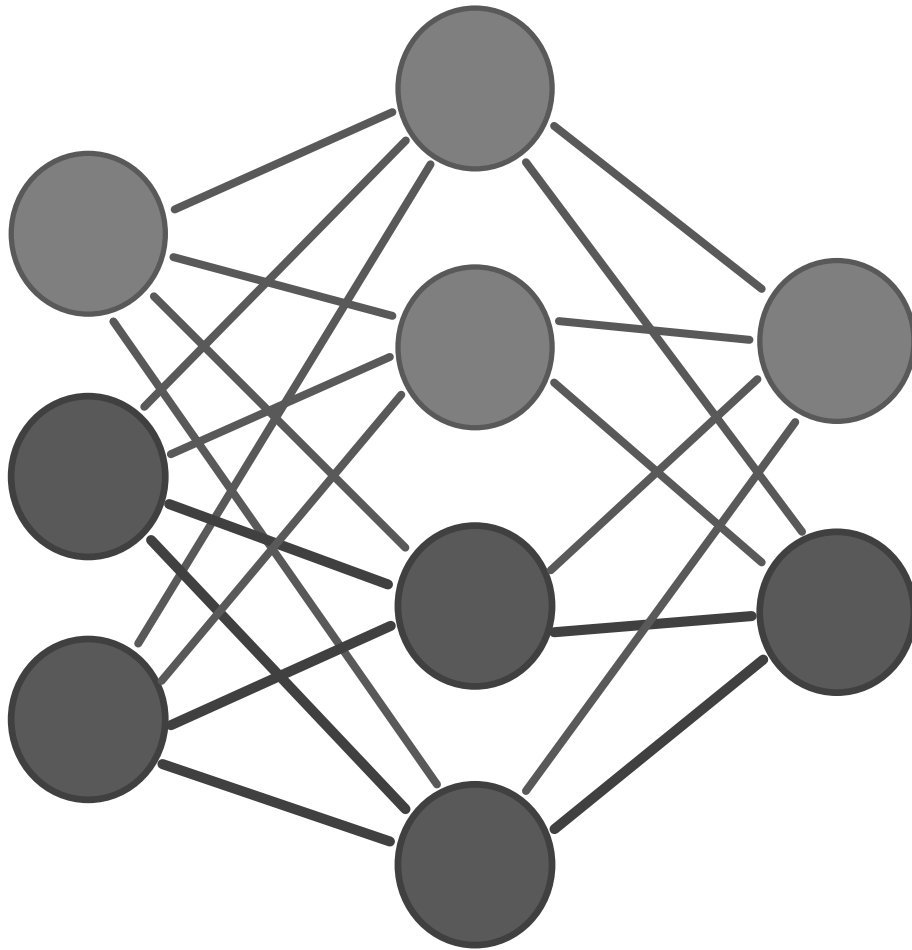


Image classification using pre-trained network

Training a Deep Neural Network from scratch

Transfer learning to classify new objects

Locate & classify objects in images and video

Is Object Recognition/Classification Enough?

Car

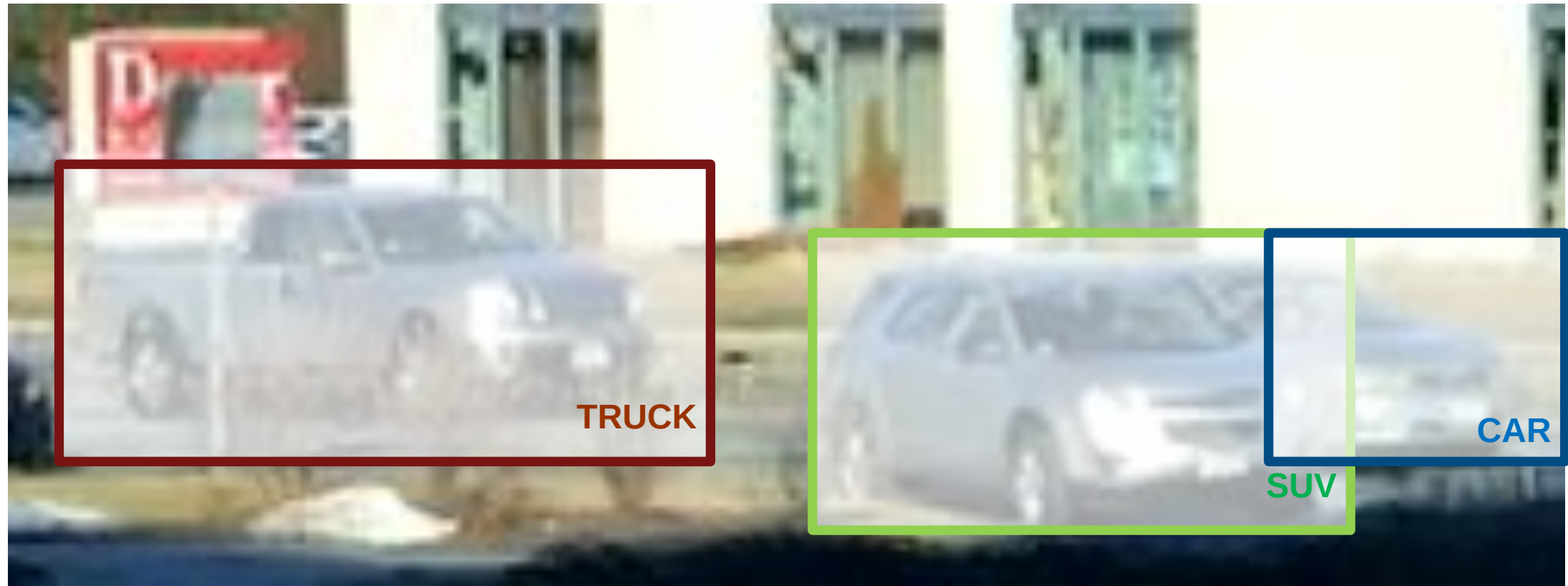


Label for entire image



Car? SUV? Truck?

Object Detection – Locate and Classify Object



Goal: Create Object Detector to Locate Vehicles

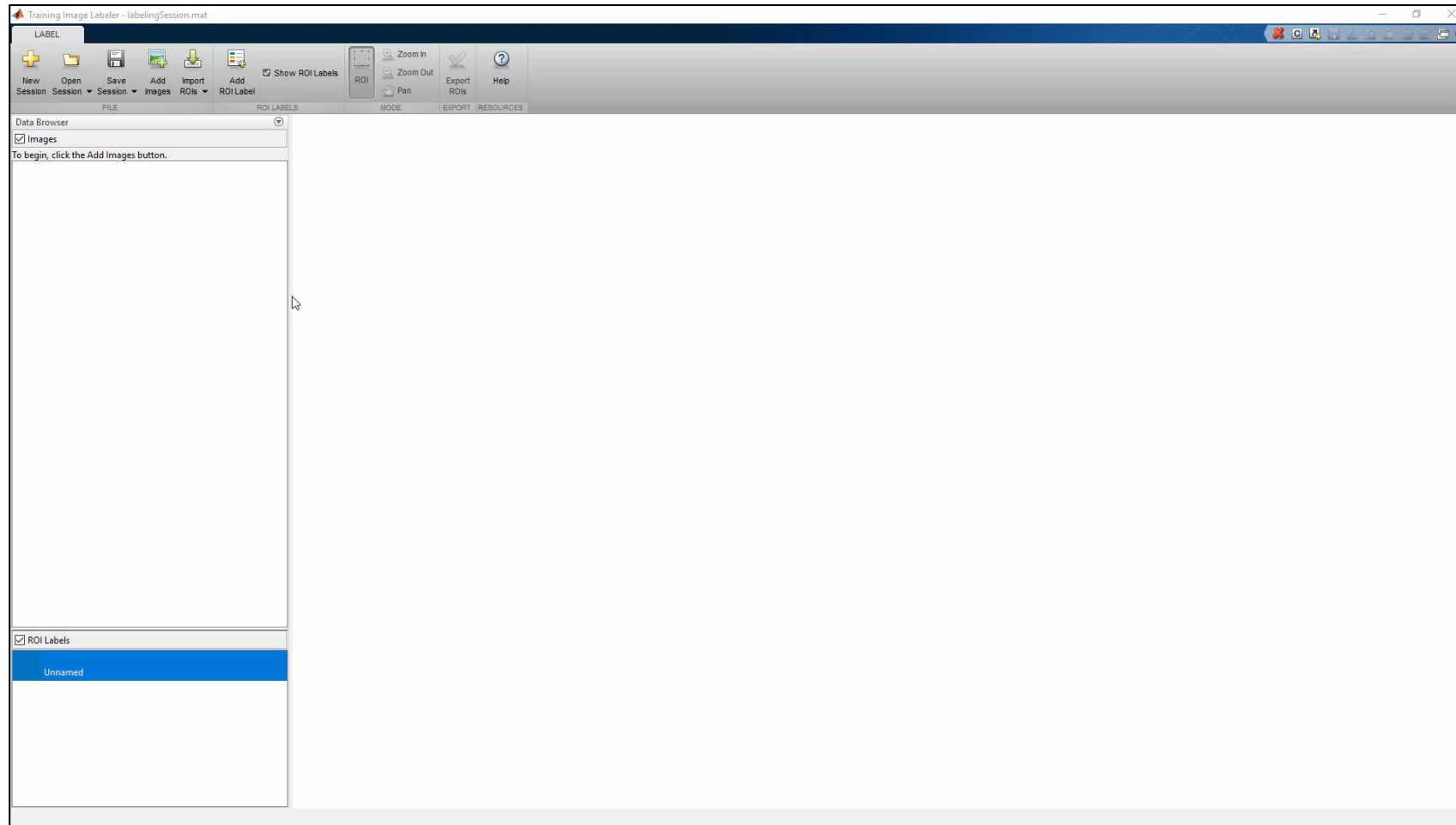


Step 1: Label / Crop data

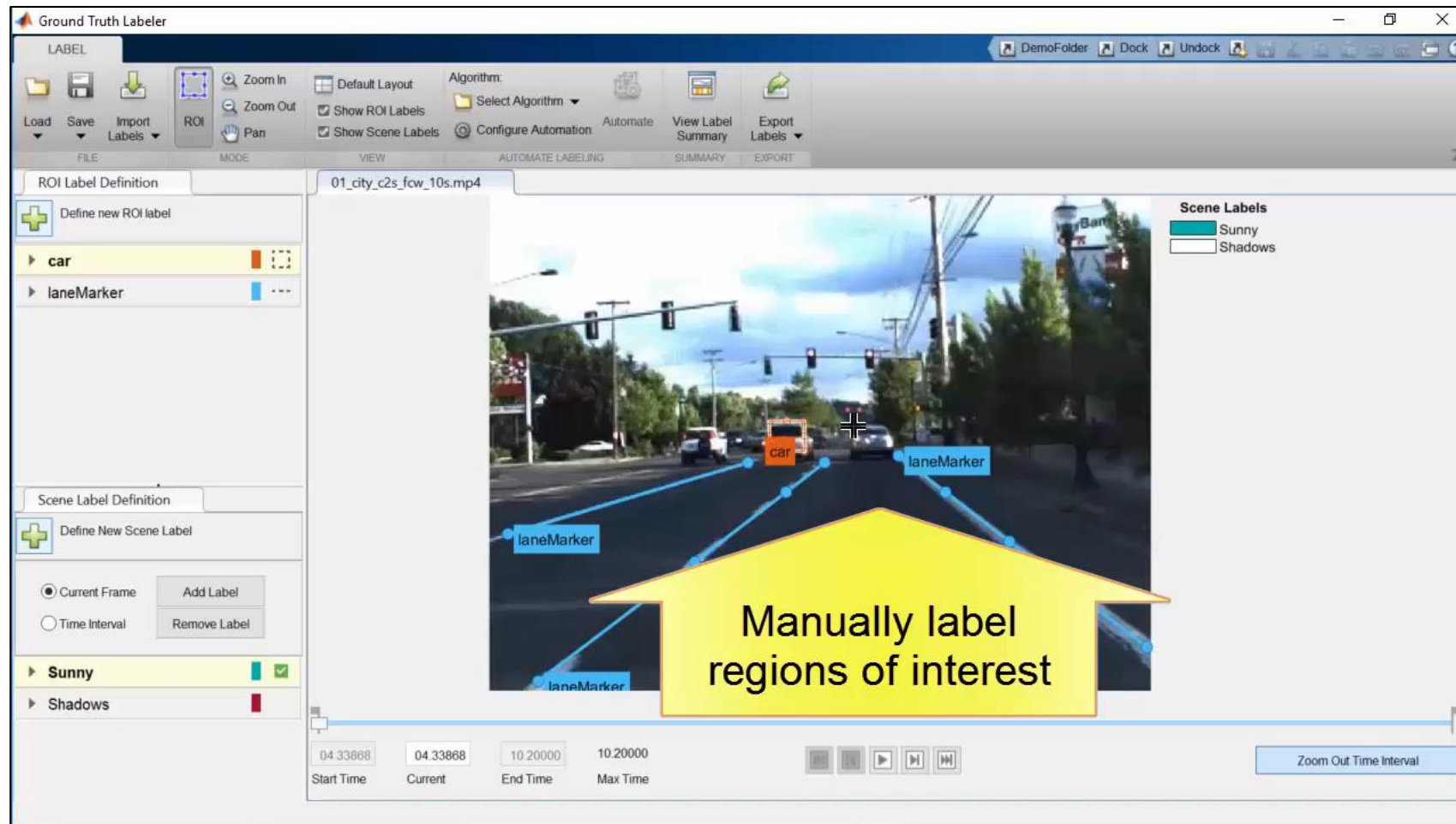
Step 2: Train detector

Step 3: Use detector

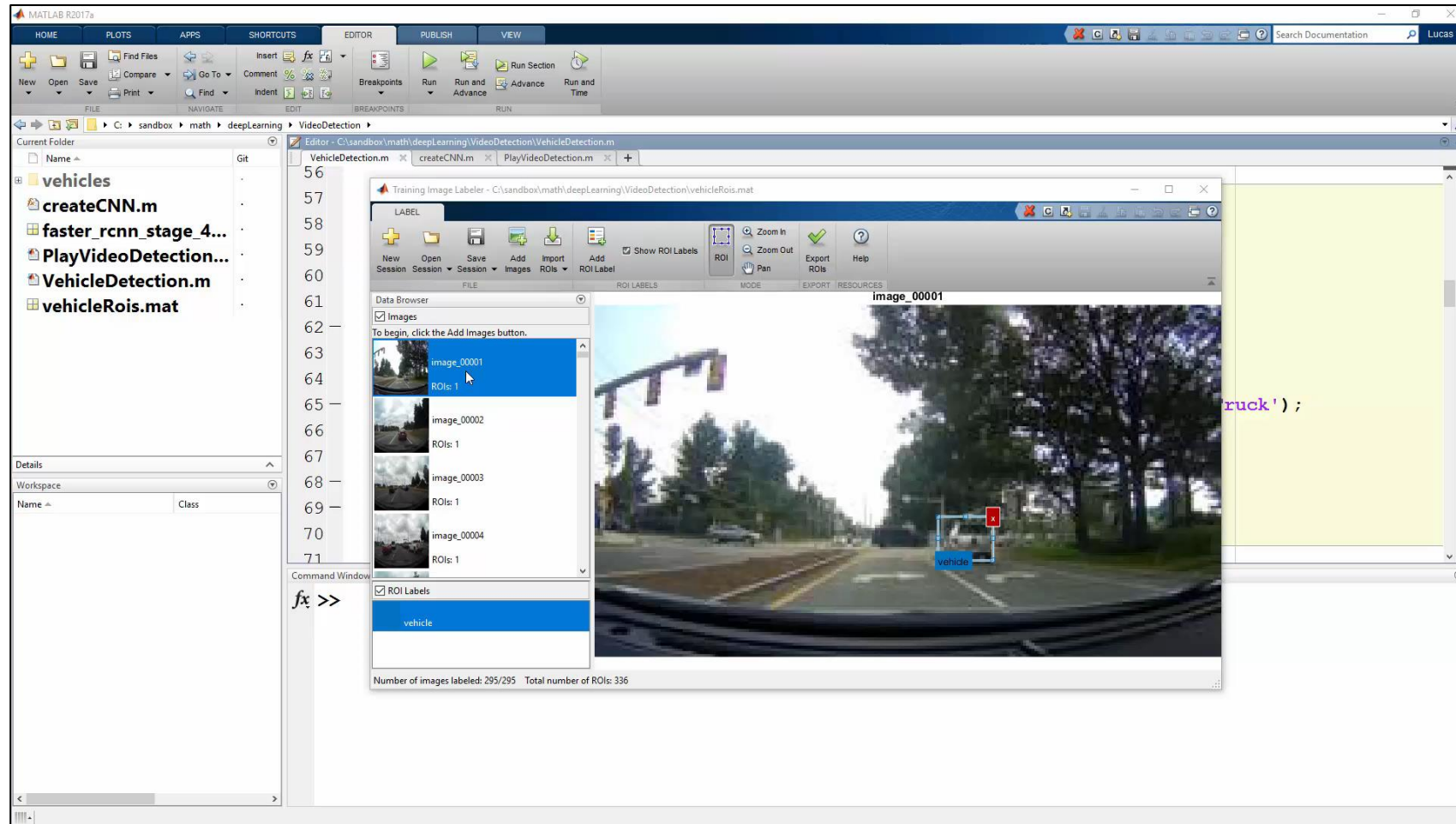
Label Images with MATLAB



Labeling Videos with MATLAB



Demo: Vehicle detection using Faster R-CNNs



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

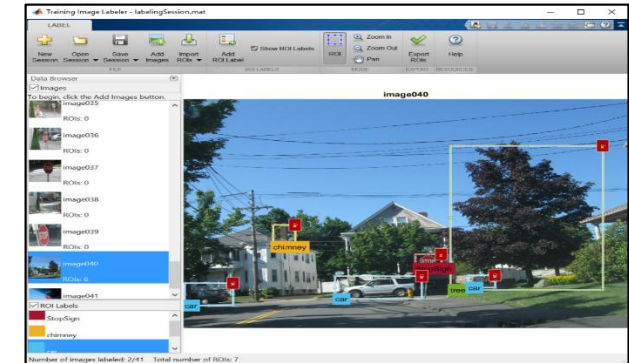
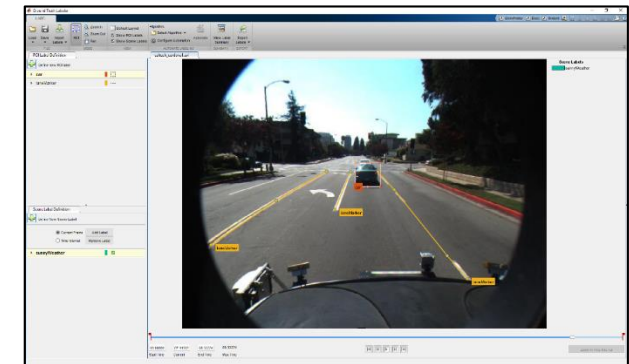


Image Labeler



Video Labeler

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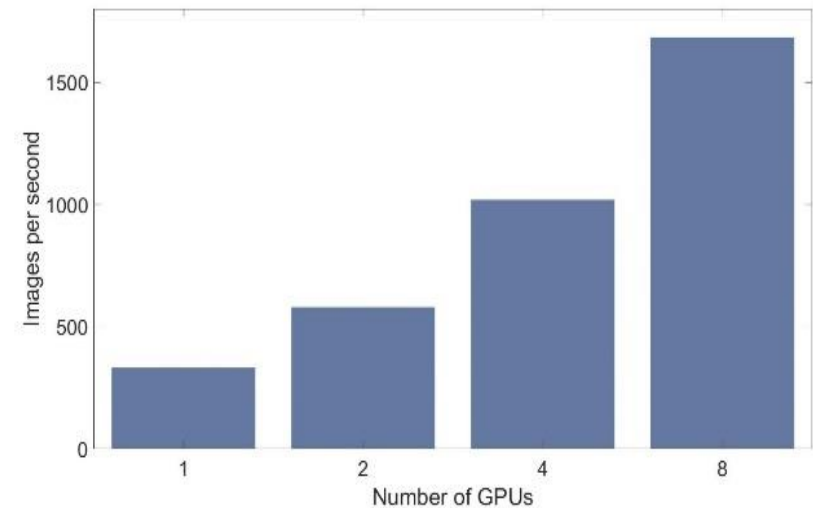
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Training modes supported:

**Auto Select
GPU**

Multi GPU (local)

Multi GPU (cluster)

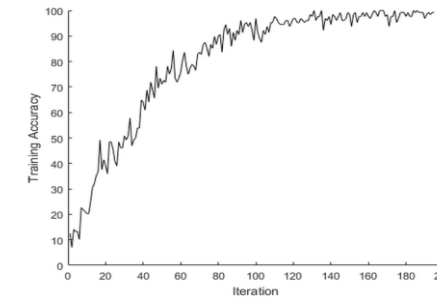


Acceleration with Multiple GPUs

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Training Accuracy Plot

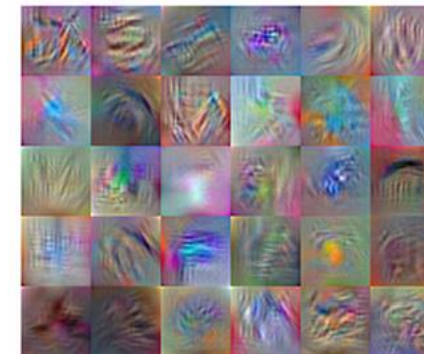


Deep Dream



Network Activations

Layer conv3 Features



Feature Visualization

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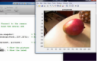
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MATLAB TOUR 2017

MathWorks Neural
Network Toolbox
Team

6 total contributions since 2017

Contact

Contributions in All			View by Date
Submitted	Neural Network Toolbox Model for VGG-16 Network Pre-trained VGG-16 network model for image classification 11 days ago 14 downloads ★★★★★	VGG-16 PRETRAINED MODEL	
Submitted	Neural Network Toolbox Model for VGG-19 Network Pre-trained VGG-19 network model for image classification 11 days ago 11 downloads ★★★★★	VGG-19 PRETRAINED MODEL	
Submitted	Neural Network Toolbox Importer for Caffe Models Software support package for importing pre-trained Caffe Models 11 days ago 15 downloads ★★★★★	Caffe MODELS	
Submitted	Neural Network Toolbox(TM) Model for AlexNet Network Pre-trained AlexNet network model for image classification 18 days ago 502 downloads ★★★★★	AlexNet PRETRAINED MODEL	
Submitted	Deep Learning in 11 Lines of MATLAB Code Use MATLAB®, a simple webcam, and a deep neural network to identify objects in your surroundings.		

Curated Set of Pretrained Models

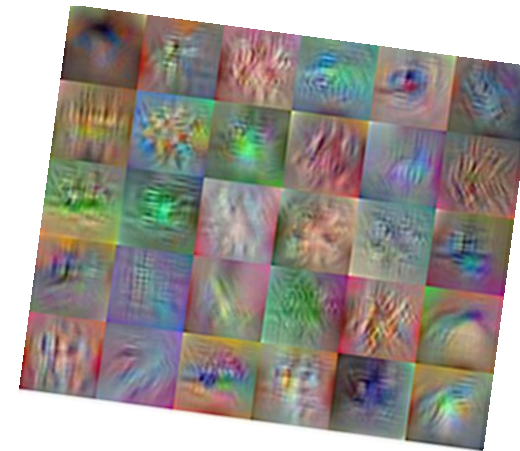
Access Models with 1-line of MATLAB Code

```
net1 = alexnet  
net2 = vgg16  
net3 = vgg19
```

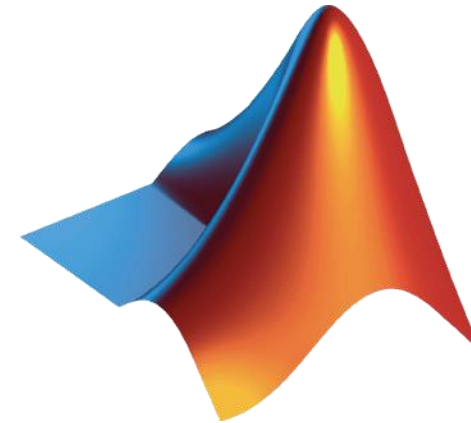
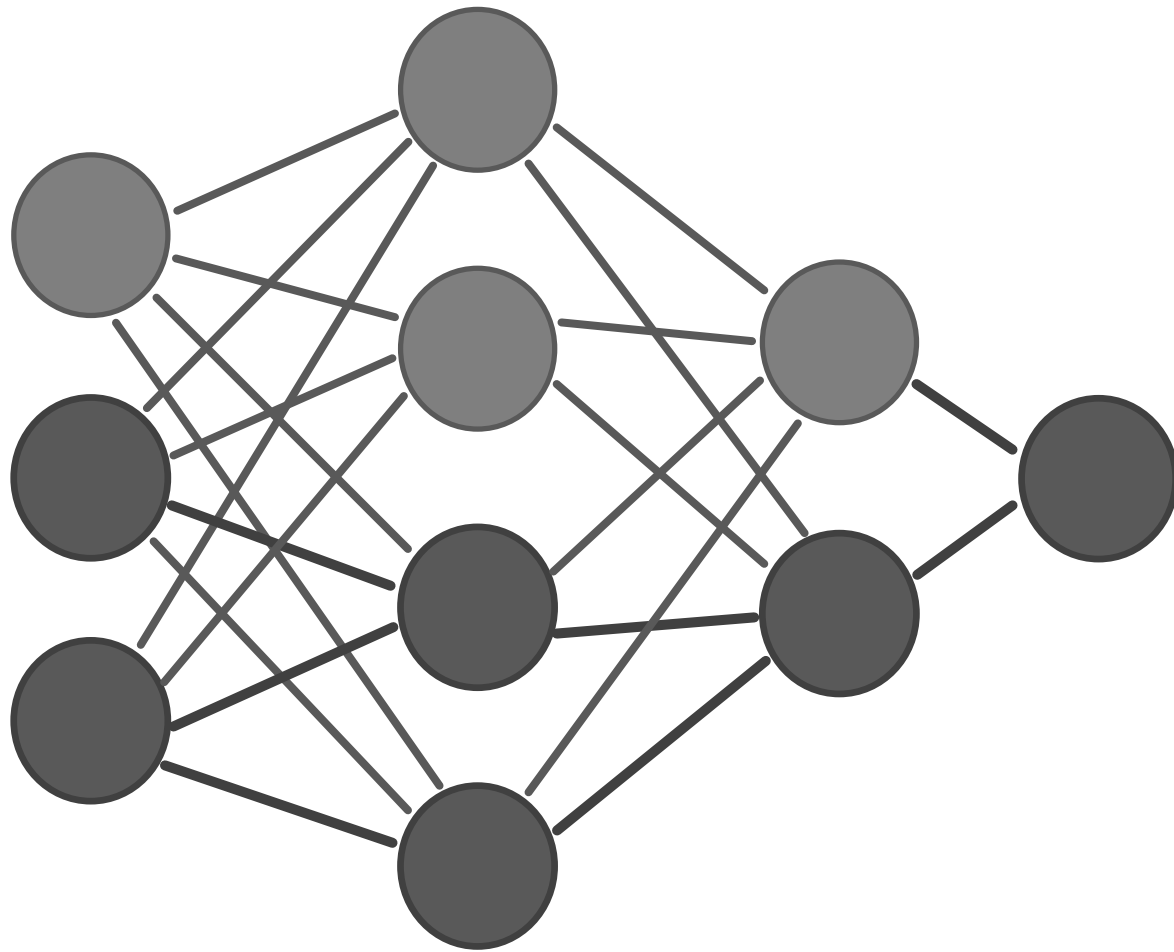
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AlexNet
PRETRAINED MODEL
Caffe MODELS
VGG-16
PRETRAINED MODEL



% Questions?