# MATLAB CONFERENCE 2017

Developing Deep Learning Algorithms using MATLAB

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## New MATLAB framework makes <u>deep learning</u> easy and accessible



## **Object Recognition using Deep Learning**





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









### Why is Deep Learning So Popular Now?



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### **Deep Learning Enablers**

### Acceleration with GPUs

### Massive sets of labeled data



Availability of state of the art models from experts

70 60

50





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Image classification using pre-trained network

Transfer learning to classify new objects

Locate & classify objects in images and video





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### Image Classification Using Pre-trained Network (Video)

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net = alexnet;

classify(net,im)

im = imread('peppers.png'); im = imresize(im,[227 227]);



### **Convolutional Neural Networks**



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### Visualize Deep Learning Features







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### 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



MATLAB CONFERENCE 2017 New Data





### Transfer Learning to Classify New Objects

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4		^
5	%% Load Image Data	
6	% Data is 5 different categories of automobiles. How do we read in all of	
7	% these images?	
8	% Create an imageDataStore to read images. Label all images based on their	
9	% foldernames and include all subfolders in the directory	-
10		
11	% Load in input images I	
12 -	<pre>imds = imageDatastore('/ImageSetFinal/', 'IncludeSubfolders',true,</pre>	
13	'LabelSource', 'FolderNames');	
14		
15 -	imds.countEachLabel	
16		
17	%% Visualize random images from the set	
18	% We can visually inspect individual images	
19-	<pre>visImds = splitEachLabel(imds,1,'randomize');</pre>	
20		
21 -	for ii = 1:5	
22		
23 -	<pre>subplot(2,3,ii);</pre>	
24 -	<pre>imshow(visImds.readimage(ii));</pre>	
25 -	<pre>title(char(visImds.Labels(ii)));</pre>	
26		~
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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)





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#### **Training Accuracy Plot**



#### Deep Dream Laver conv3 Features

Network Activations





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MathWorks Neural Network Toolbox Team	Contributions in All	View by Date 🔹
6 total contributions since 2017	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
	Submitted Neural Network Toolbox(TM) Model for AlexNet Network Pre-trained AlexNet network model for image classification 18 days ago   502 downloads   ★★★★	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 = alexnetNet2 = vqq16Net3 = vqq19



### 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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### 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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