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Developing Deep Learning Algorithms using MATLAB

David Willingham
New MATLAB framework makes deep learning easy and accessible
Object Recognition using Deep Learning

<table>
<thead>
<tr>
<th>Training (using GPU)</th>
<th>Millions of images from 1000 different categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prediction</td>
<td>Real-time object recognition using a webcam connected to a laptop</td>
</tr>
</tbody>
</table>
What is Deep Learning?

Deep learning is a type of **machine learning** that learns tasks *directly* from data.
What is Deep Learning?

Learned Features

Data

Task

2017

94%
3%
2%
1%
Why is Deep Learning So Popular Now?

Source: ILSVRC Top-5 Error on ImageNet

Human Accuracy

Error (%)

2010 2011 2012 2013 2014 2015

Machine learning Deep learning
Deep Learning Enablers

- Acceleration with GPUs
- Massive sets of labeled data
- Availability of state of the art models from experts

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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

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Agenda

- 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)

Classifying Images with AlexNet

```matlab
% 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
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

AlexNet

Convolution → Activation → Pooling → Convolution → Activation → Pooling → Convolution → Activation → Pooling → ... → Convolution → Activation → Pooling → Fully Connected Layers

1000 Category Classifier

car →
suv →
pickup →
van →
truck →

5 Category Classifier

New Data
Transfer Learning to Classify New Objects

%% Load Image Data
% Data is 5 different categories of automobiles. How do we read in all of
% these images?
% Create an imageDatastore to read images. Label all images based on their
% folder names and include all subfolders in the directory

%% Load in input images
I

imds = imageDatastore('..\ImageSetFinal\', 'IncludeSubfolders',true,...
    'LabelSource','FolderNames');

imds.countEachLabel

%% Visualize random images from the set
% We can visually inspect individual images
visImds = splitEachLabel(imds,1,'randomize');

for ii = 1:5
    subplot(2,3,ii);
    imshow(visImds.readimage(ii));
    title(char(visImds.Labels(ii)));
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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)

Acceleration with Multiple GPUs
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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:

\[ \text{routputlayer} = \text{regressionLayer('Name','routput')} \]

Example predict facial key-points:
Agenda

- Image classification using pre-trained network
- 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
Video: Object Detection using Faster R-CNN
Label Images with MATLAB
Labeling Videos with MATLAB
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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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Thank You