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
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
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)
Convolutional Neural Networks

[Diagram showing the process of Convolutional Neural Networks with input image, convolution, rectified linear units (ReLU), pooling, and fully connected layers for classification of objects like Flower, Cup, Car, and Tree.]
Visualize Deep Learning Features
Agenda

- 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

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New Data

AlexNet
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
% foldernames and include all subfolders in the directory

% Load in input images
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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MATLAB makes Deep Learning **Easy** and **Accessible**

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```matlab
imageDS = imageDatastore(dir)
Easily manage large sets of images
```
MATLAB makes Deep Learning Easy and Accessible

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Training modes supported:

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

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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

TRUCK

SUV

CAR
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