Deep Learning

New tools for algorithm design and validation

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New MATLAB framework makes deep learning easy and accessible
What is Deep Learning?

Deep learning is a type of machine learning that performs end-to-end learning by learning tasks directly from images, text, and sound.
Why is Deep Learning So Popular Now?

![Bar chart showing error rates for machine learning and deep learning from 2010 to 2015. The error rates decrease significantly from 2010 to 2015 for deep learning, while machine learning remains relatively stable.

Source: ILSVRC Top-5 Error on ImageNet
Deep Learning Enablers

Acceleration with GPU’s

Massive sets of labeled data

Availability of state of the art models from experts
Walkthrough 3 demos

Classification with pre-trained model

Transfer Learning

Object Detection
Two Approaches for Deep Learning

1. Train a Deep Neural Network from Scratch

2. Fine-tune a pre-trained model (transfer learning)
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
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
Convolutional Neural Networks
Demo 1

Classification with pre-trained model

Transfer Learning

Object Detection
Example: Classify Vehicles With Transfer Learning

Vgg16

1000 Category Classifier

car ➔
suv ➔
pickup ➔
van ➔
truck ➔

5 Category Classifier

Vgg16

New Data
Demo 2

Classification with a trained model

Transfer Learning

New Data

Object Detection
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
Labeling Videos and Images with MATLAB

>> groundTruthLabeler
Demo 3

Classification with pre-trained model

Transfer Learning

Object Detection
Regression Networks

Classification
predicts category

Object Detection
predicts box locations and box categories

Regression
predicts numbers
Regression Network for Lane Detection

Image Input

Deep Conv Net

Ego Vehicle Lane Boundaries

\[ ax^2 + bx + c \]

Network outputs \([a, b, c]\)
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
- Gain insight with visualizations
- Access and use models from experts
MATLAB makes Deep Learning **Easy** and **Accessible**

*Learn about new MATLAB capabilities to*

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

```
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)

![Image showing performance with different numbers of GPUs](image-url)
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Curated Set of Pretrained Models

Access Models with 1-line of MATLAB Code

Net1 = alexnet
Net2 = vgg16
Net3 = vgg19
New MATLAB framework makes deep learning easy and accessible

*and*

You can start using deep learning in your projects
A good place to start learning

Create Simple Deep Learning Network for Classification

Transfer Learning and Fine-Tuning of Convolutional Neural Networks