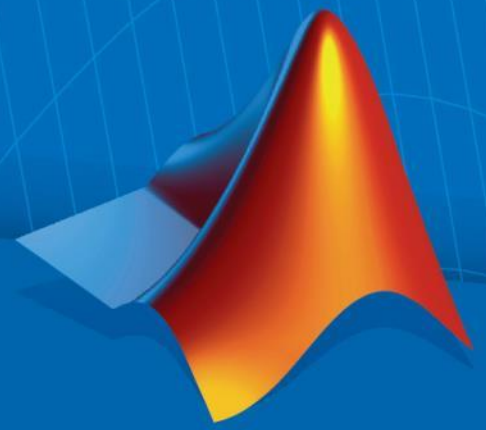
TeraSoft
www.terasoft.com.tw

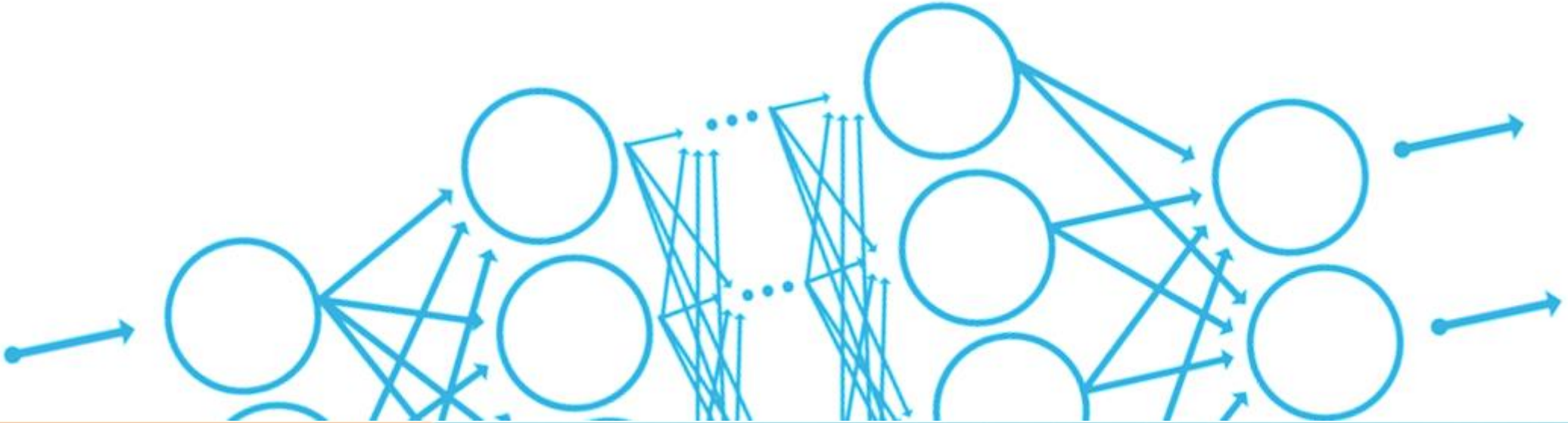


Deep Learning with MATLAB

Claire Chuang
Application Engineer

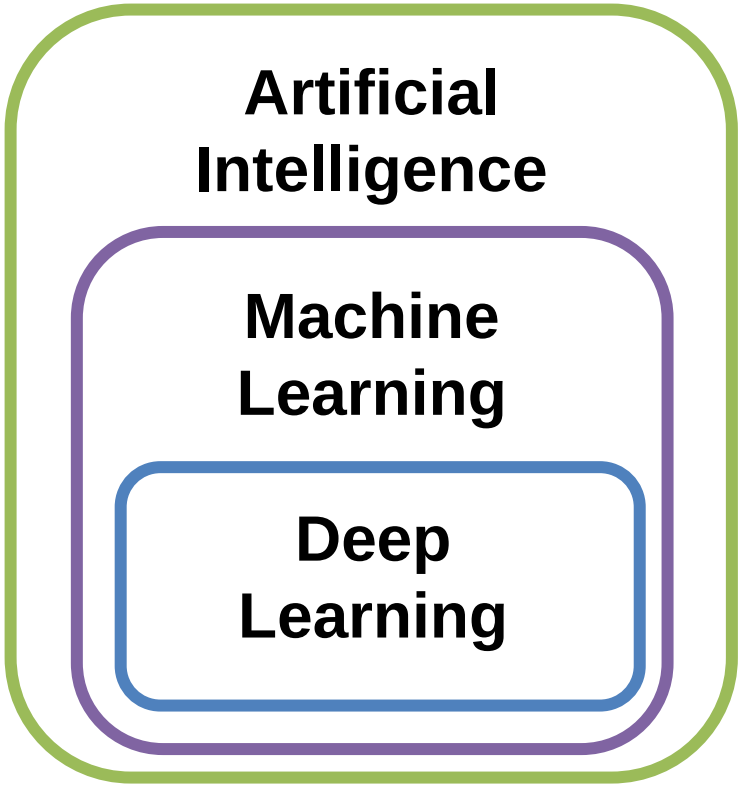
MathWorks®
Accelerating the pace of engineering and science

What is Deep Learning?



Deep Learning

- Subset of machine learning that performs **automatic feature extraction**
  - Learns features and tasks directly from data

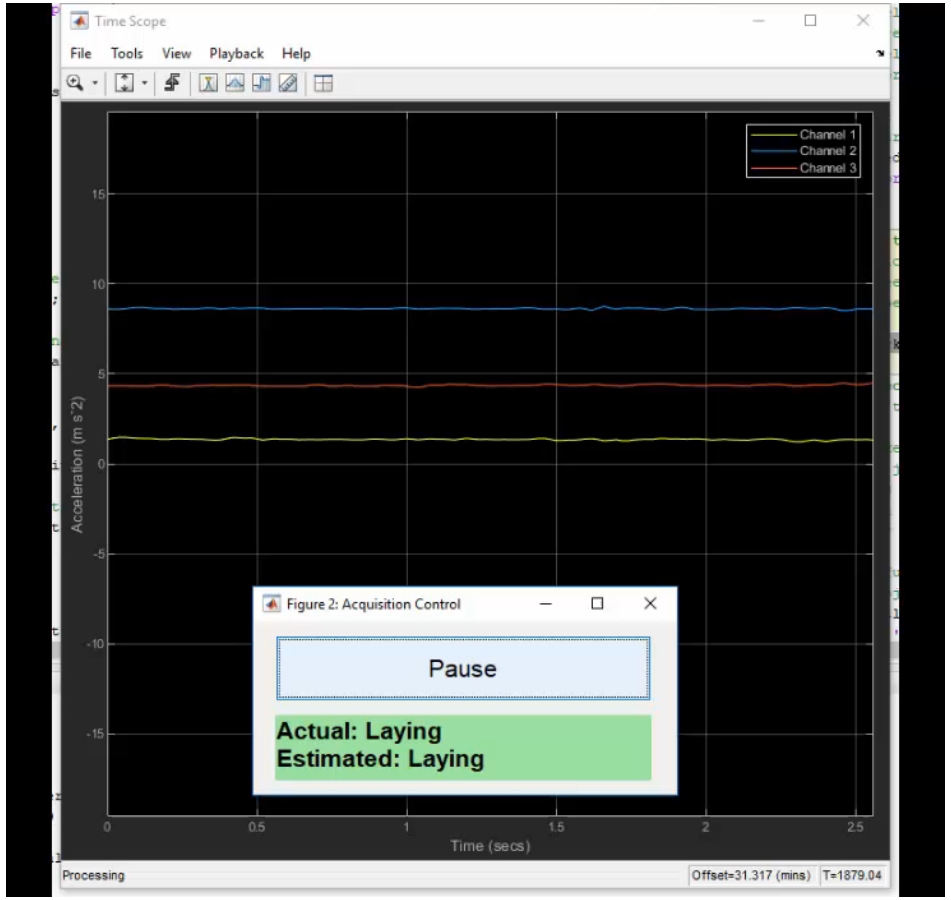


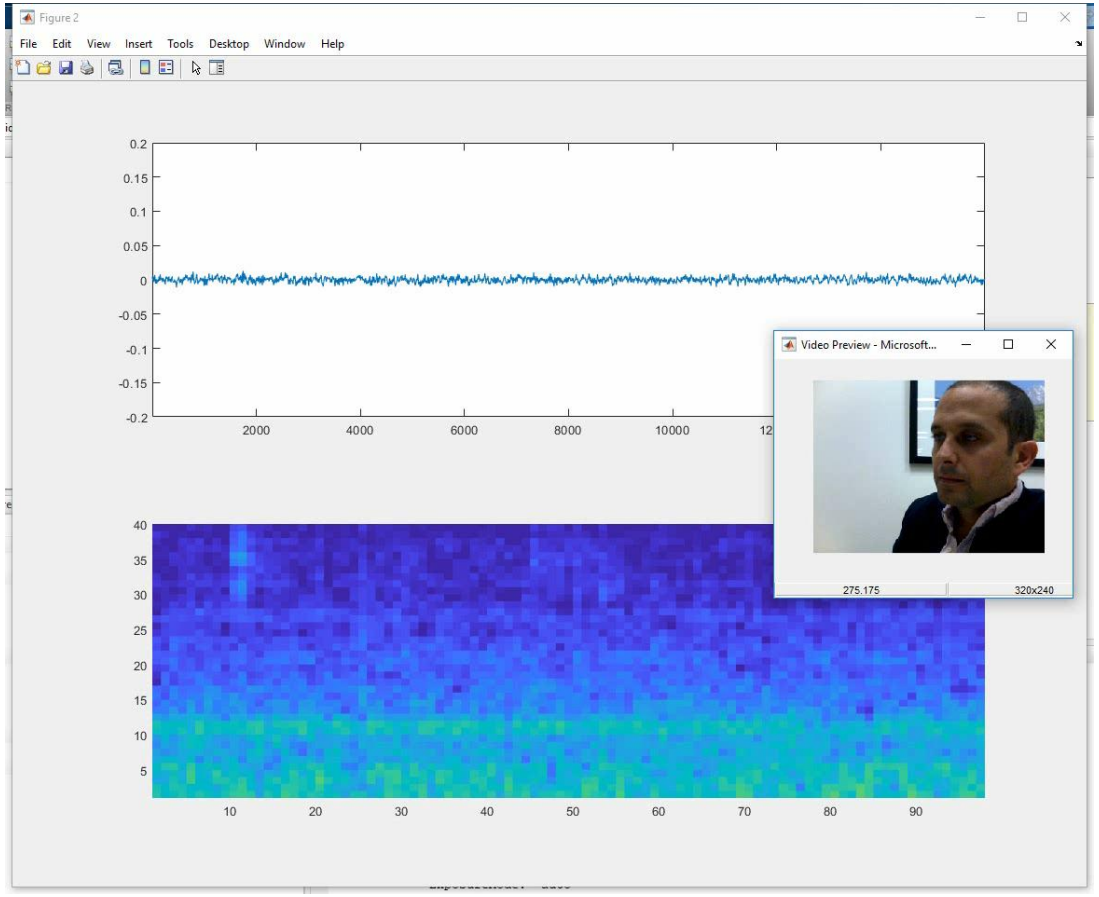
Example 1: Detection and localization using deep learning

YOLO v2 (You Only Look Once)

Semantic Segmentation using SegNet

Example 2: Analyzing signal data using deep learning

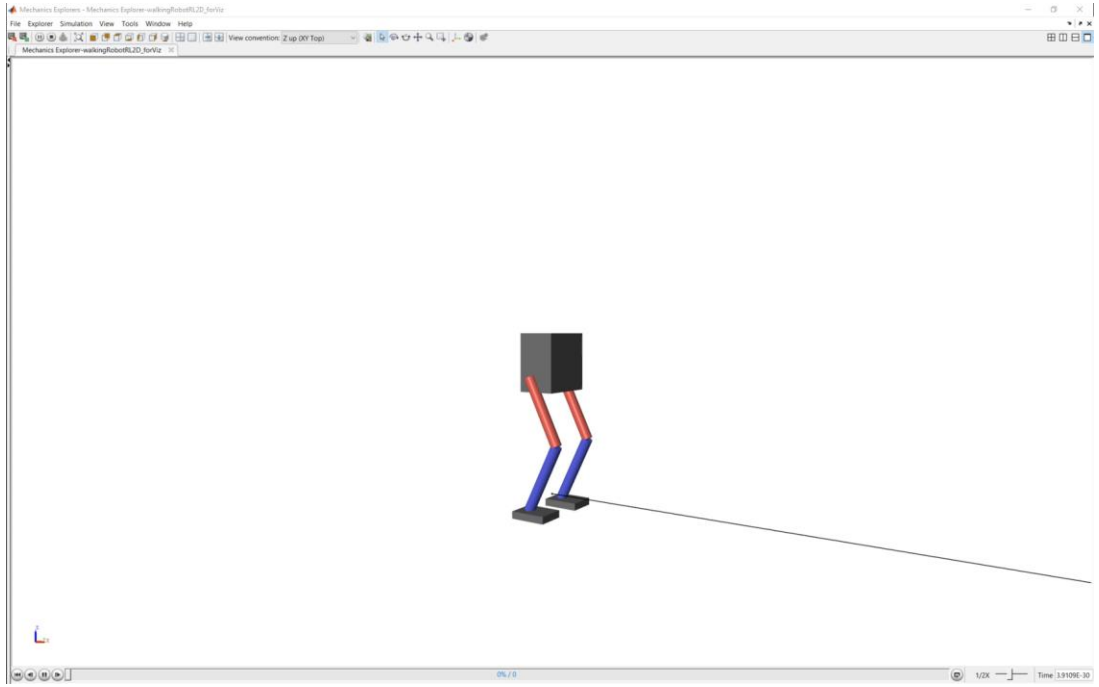


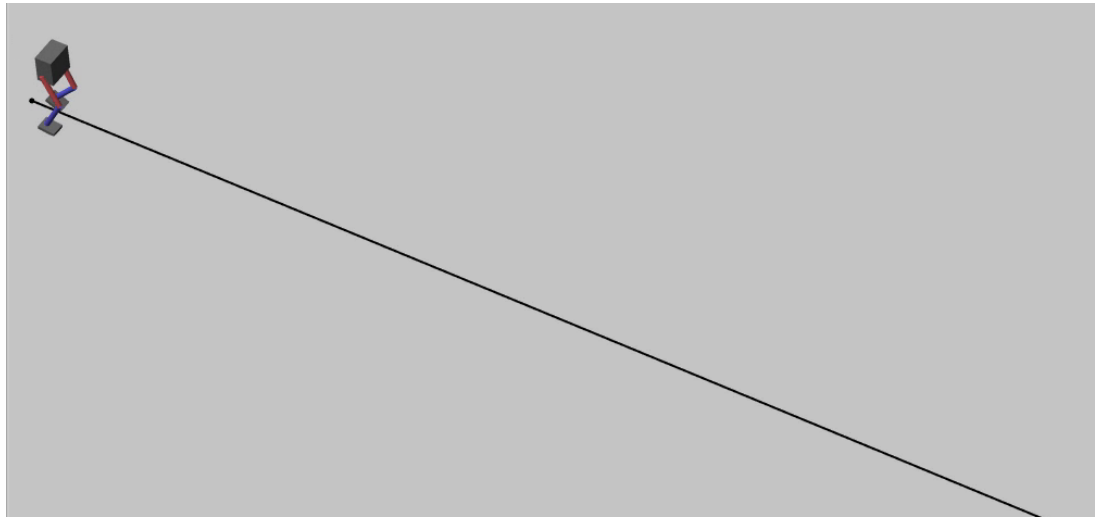


Signal Classification using LSTMs

Speech Recognition using CNNs

Example 3: Robot walking with deep reinforcement learning



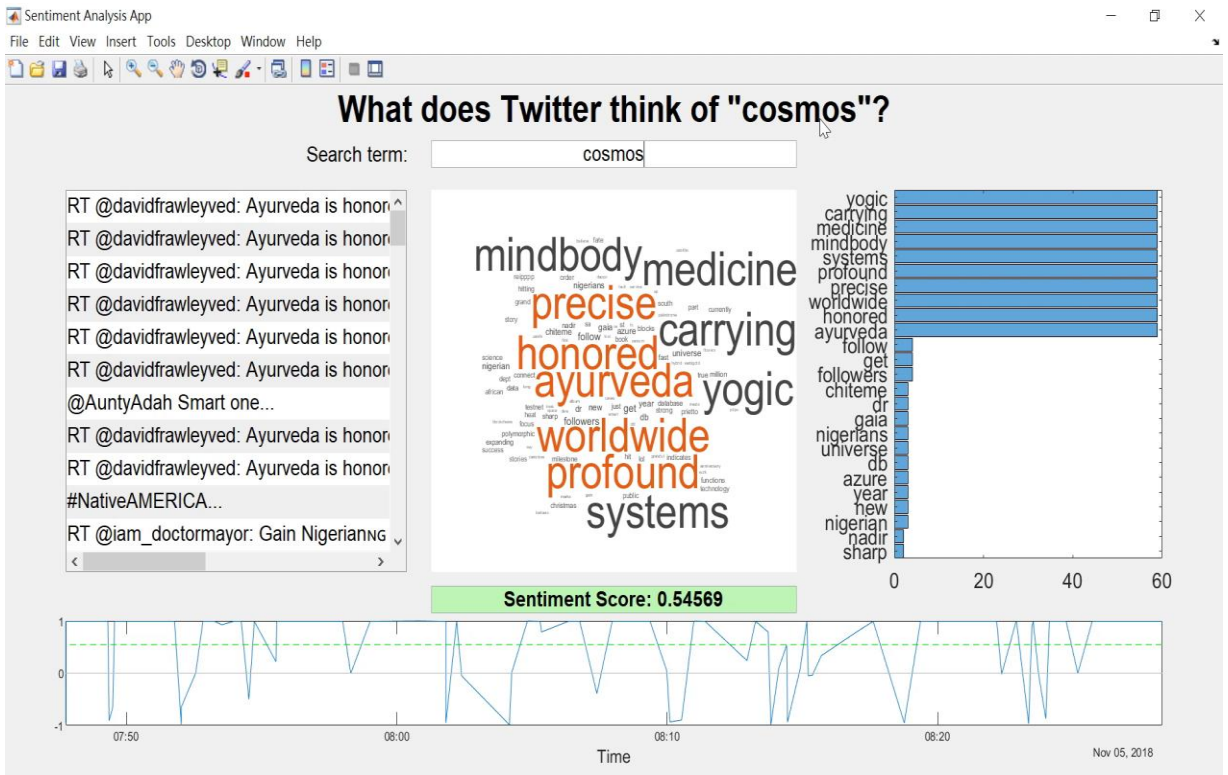


Simulation During Training

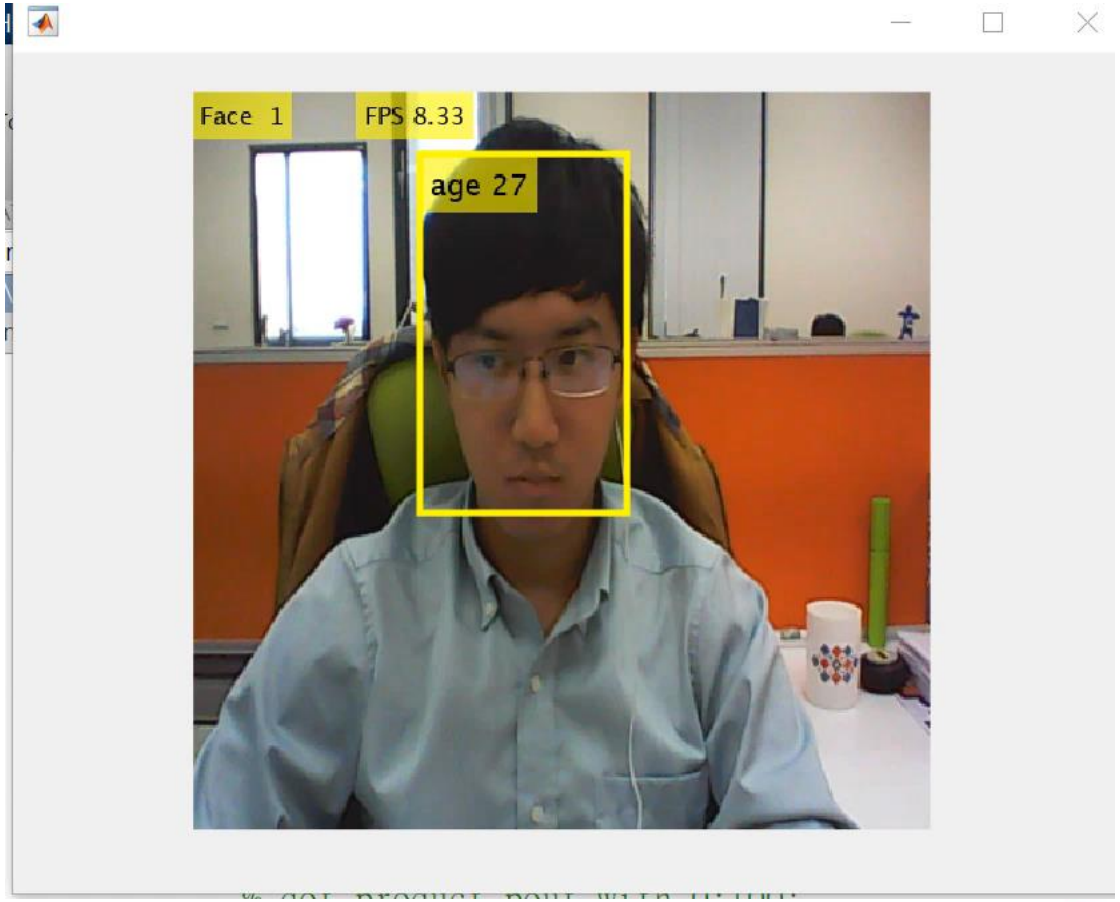
Trained Agent (DQN, DDPG, etc.)

Example 4: Interesting application

Twitter Sentiment Analysis

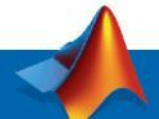


Age Detection



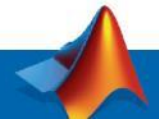
Agenda

- Machine Learning Overview
- How to use Pretrained model
- Create Deep Learning Model(MNIST)
- Try to do Transfer Learning

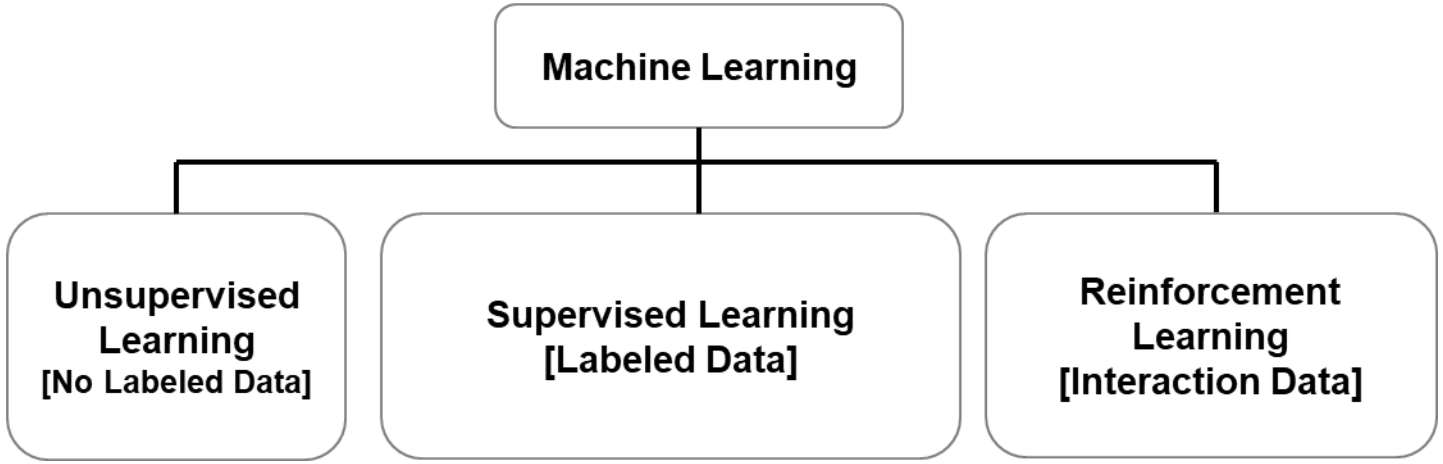


Agenda

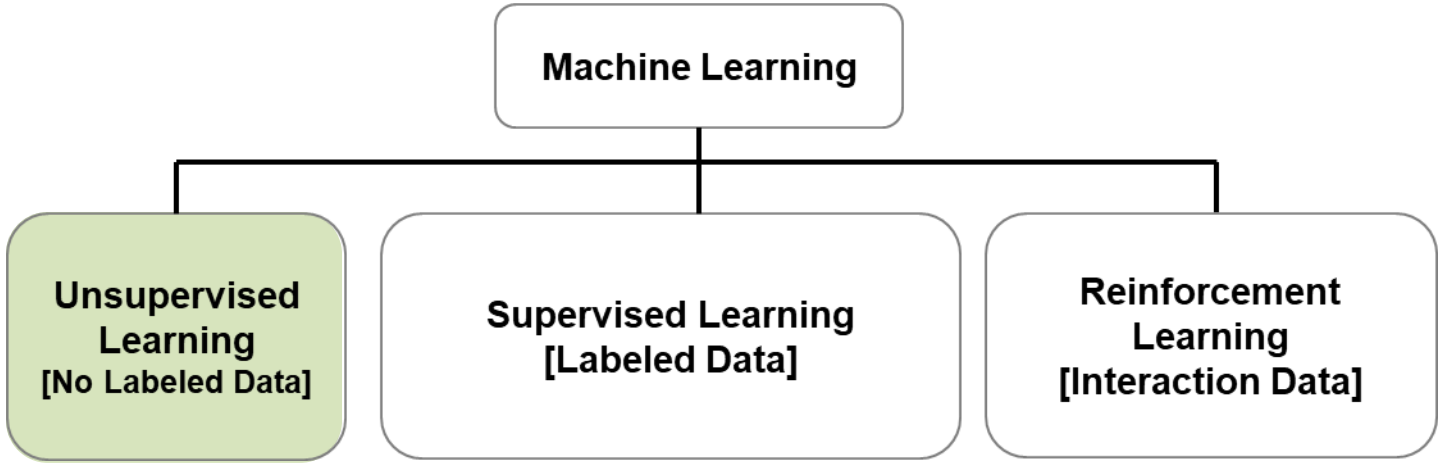
- Machine Learning Overview
- How to use Pretrained model
- Create Deep Learning Model(MNIST)
- Try to do Transfer Learning

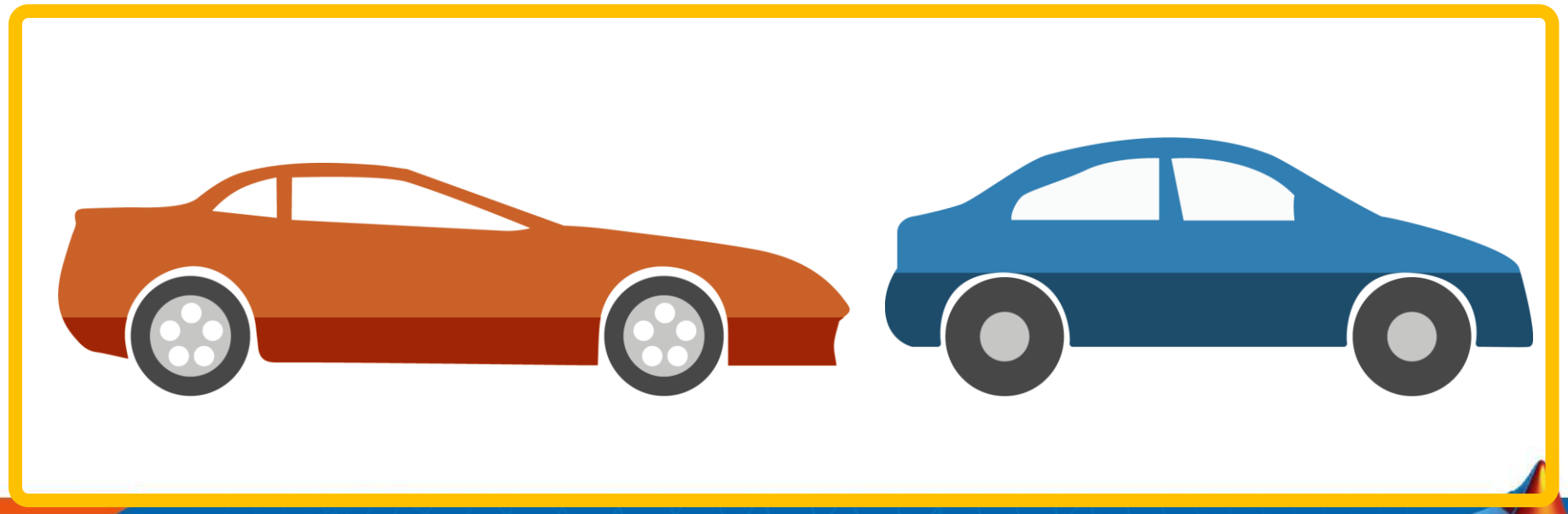


Reinforcement Learning vs Machine Learning vs Deep Learning

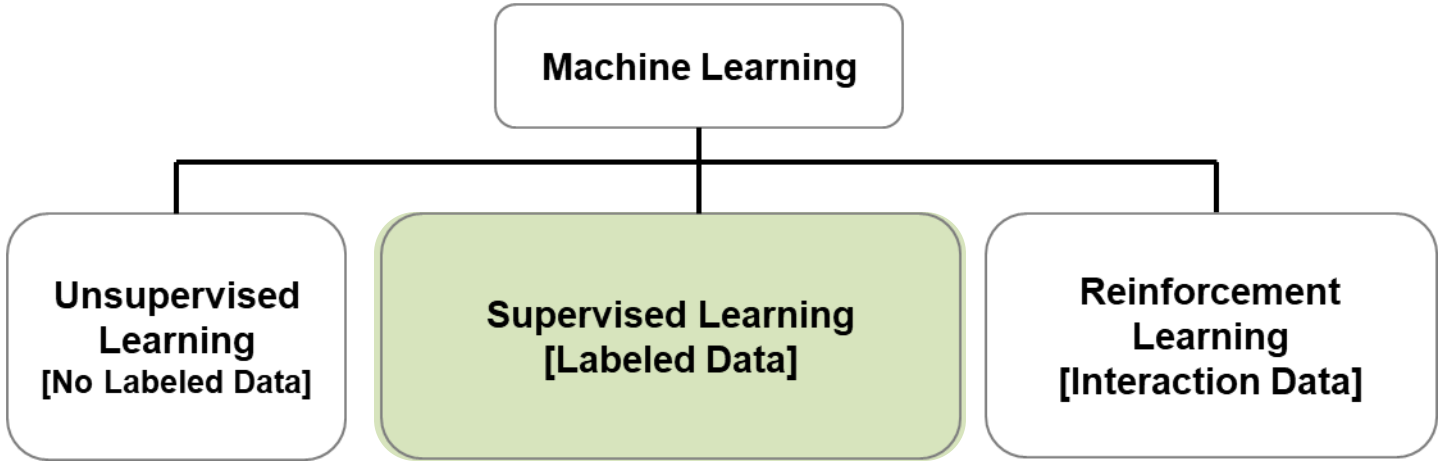


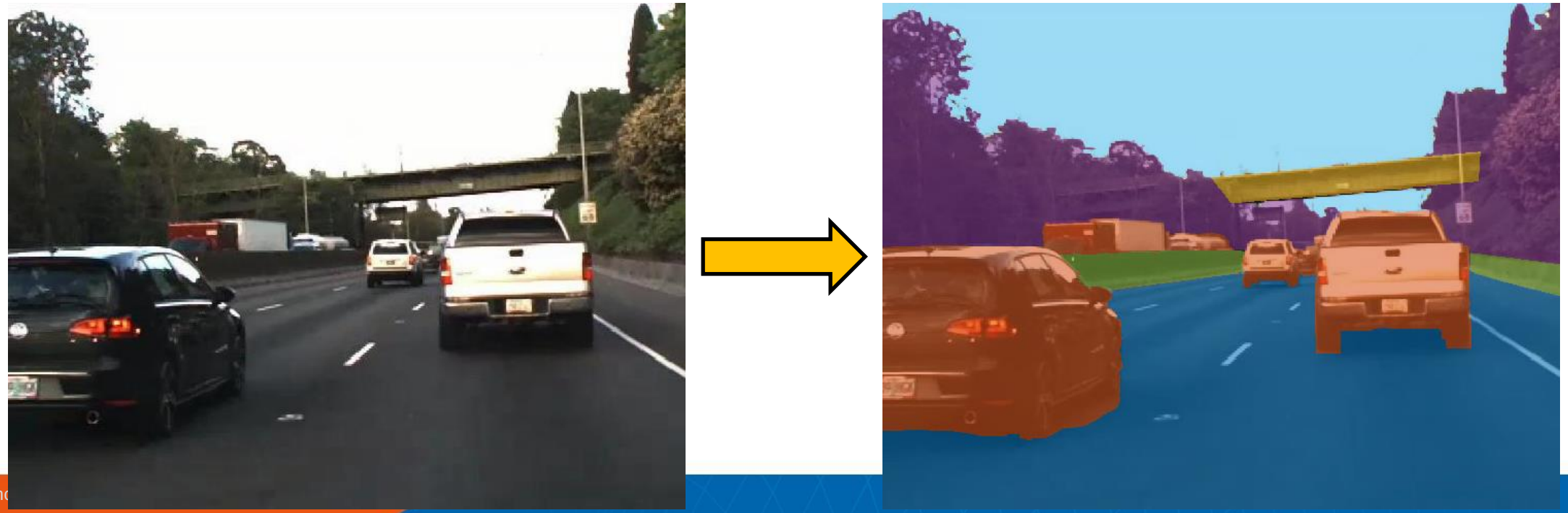
Reinforcement Learning vs Machine Learning vs Deep Learning



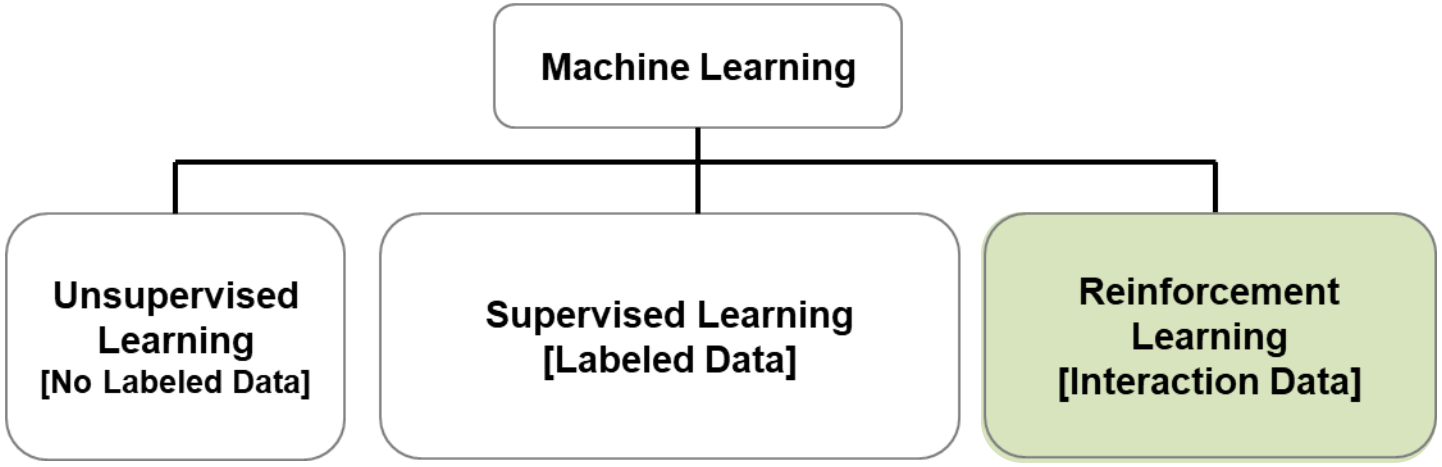


Reinforcement Learning vs Machine Learning vs Deep Learning

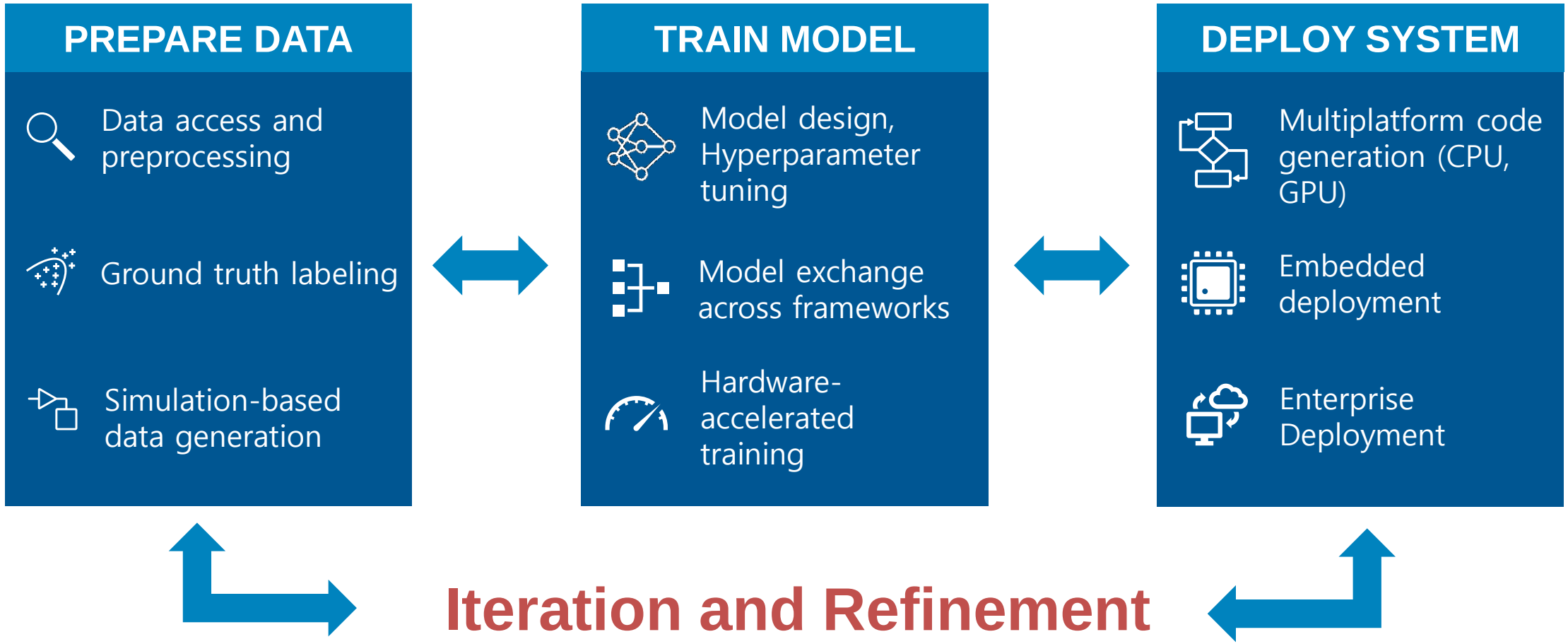




Reinforcement Learning vs Machine Learning vs Deep Learning

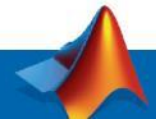


Deep Learning and Reinforcement Learning Workflow



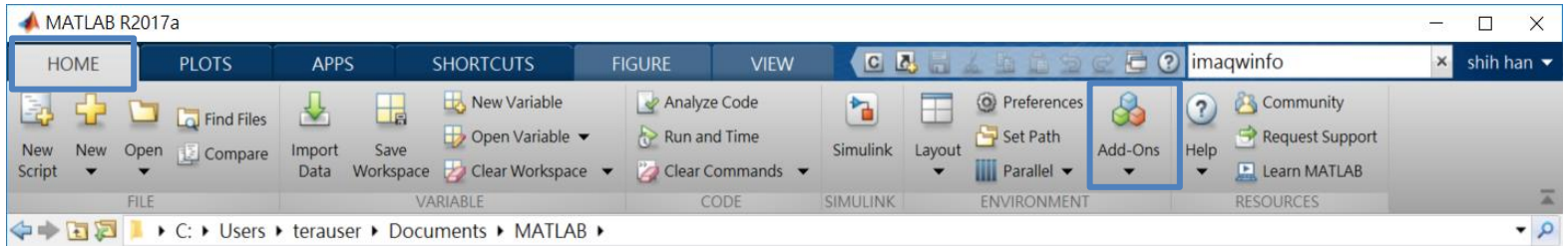
Agenda

- Machine Learning Overview
- How to use Pretrained model
- Create Deep Learning Model(MNIST)
- Try to do Transfer Learning

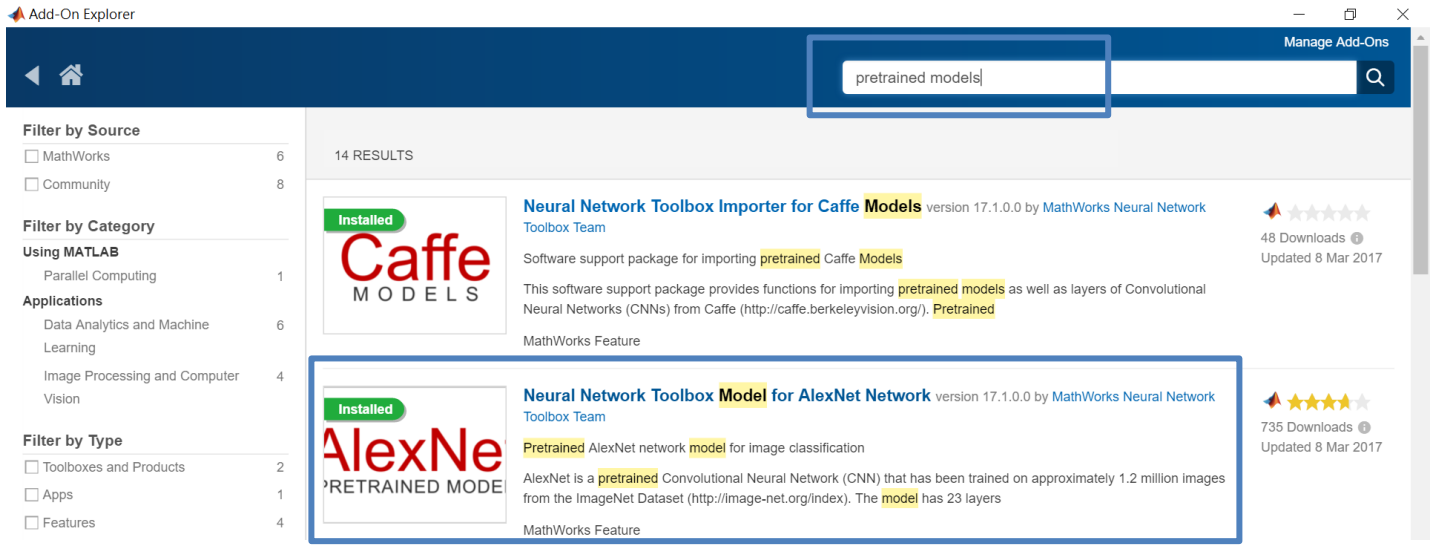


Download and Install Pre-trained Networks

1. Go to the **Home** tab and click the **Add-Ons** icon.

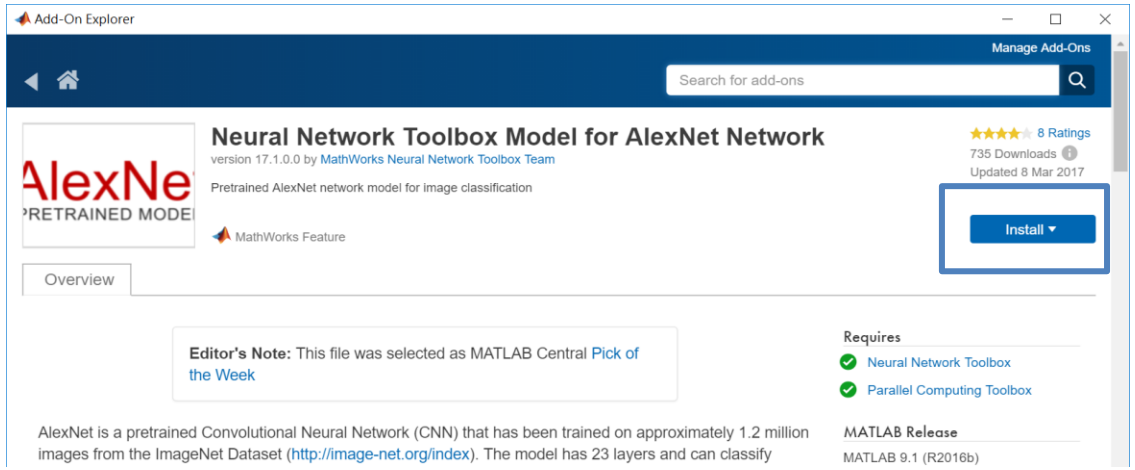


2. Search **'pretrained models'.** Click AlexNet add-on to open its detailed information page.



Download and Install Pre-trained Networks

3. Install the add-on.



4. Import the model by typing **net = alexnet** in command window!

```
Command Window
>> net = alexnet

net =

  SeriesNetwork with properties:

    Layers: [25×1 nnet.cnn.layer.Layer]
```

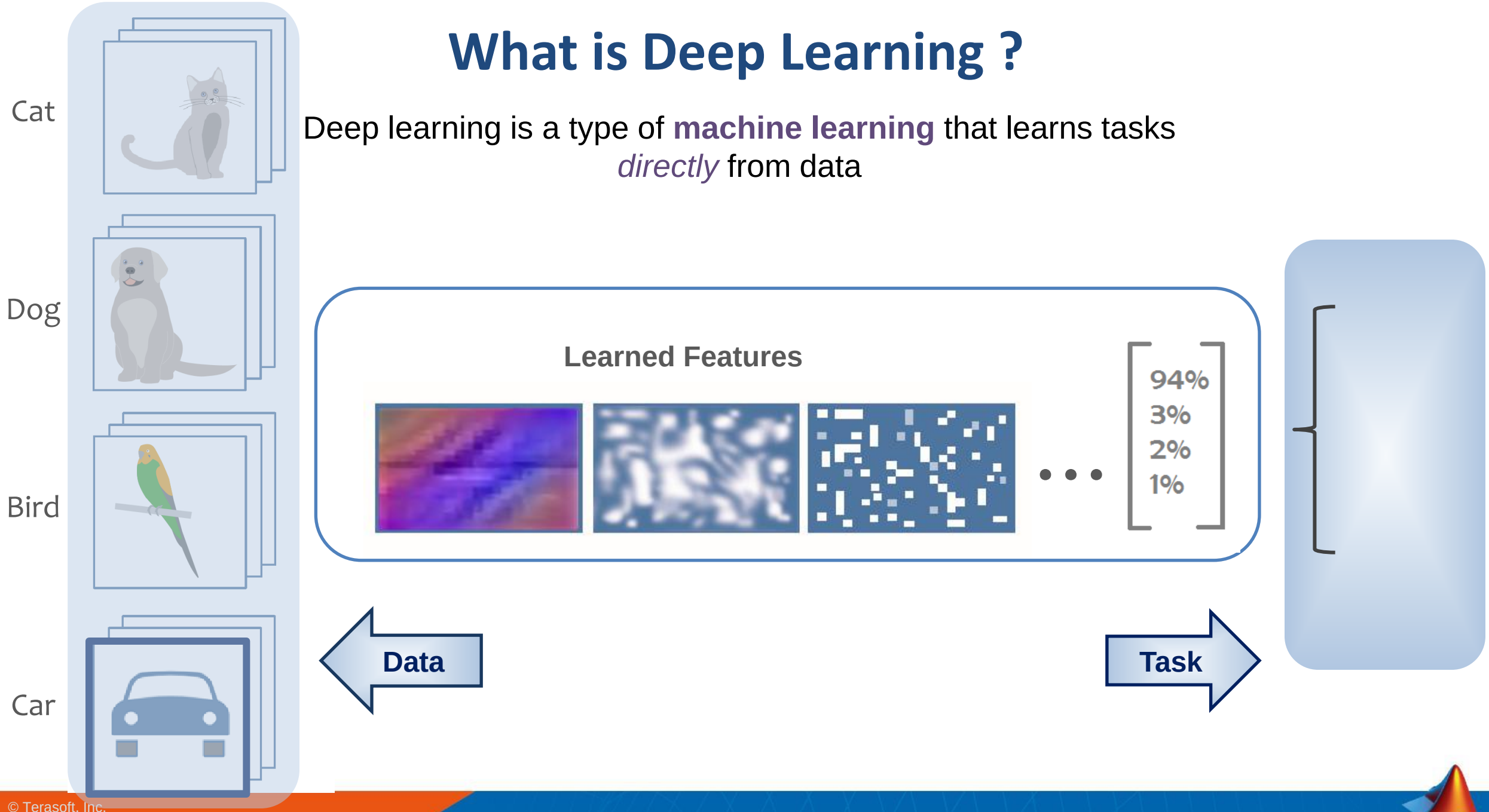
AlexNet PRETRAINED MODEL

VGG-16 PRETRAINED MODEL

Caffe MODELS

What is Deep Learning ?

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

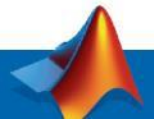


Deep Learning In 5 Lines of Code

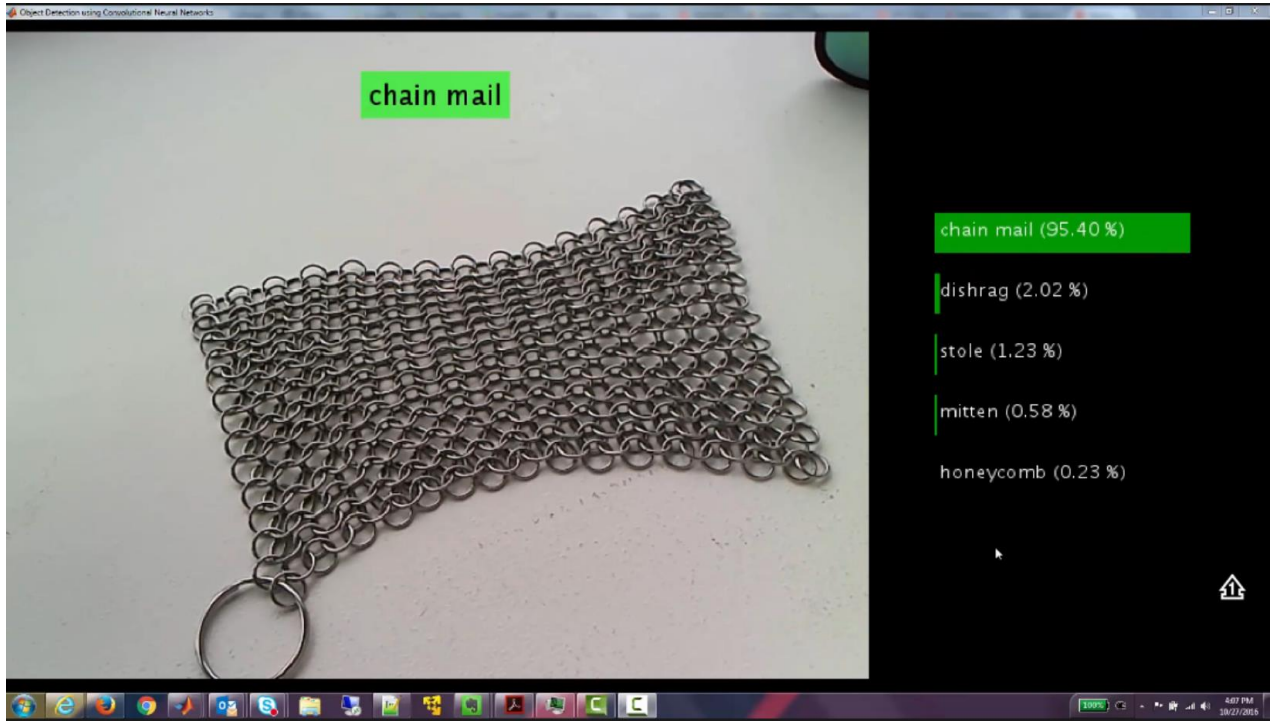
Deep Learning In 5 Lines of Code

```
net = resnet50;

im = imread('r01.jpg');
imshow(im);

imResized = imresize(im,[224 224]);
label = classify(net,imResized)
```

```
label = categorical
     wood rabbit
```

Object Recognition Using Deep Learning



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

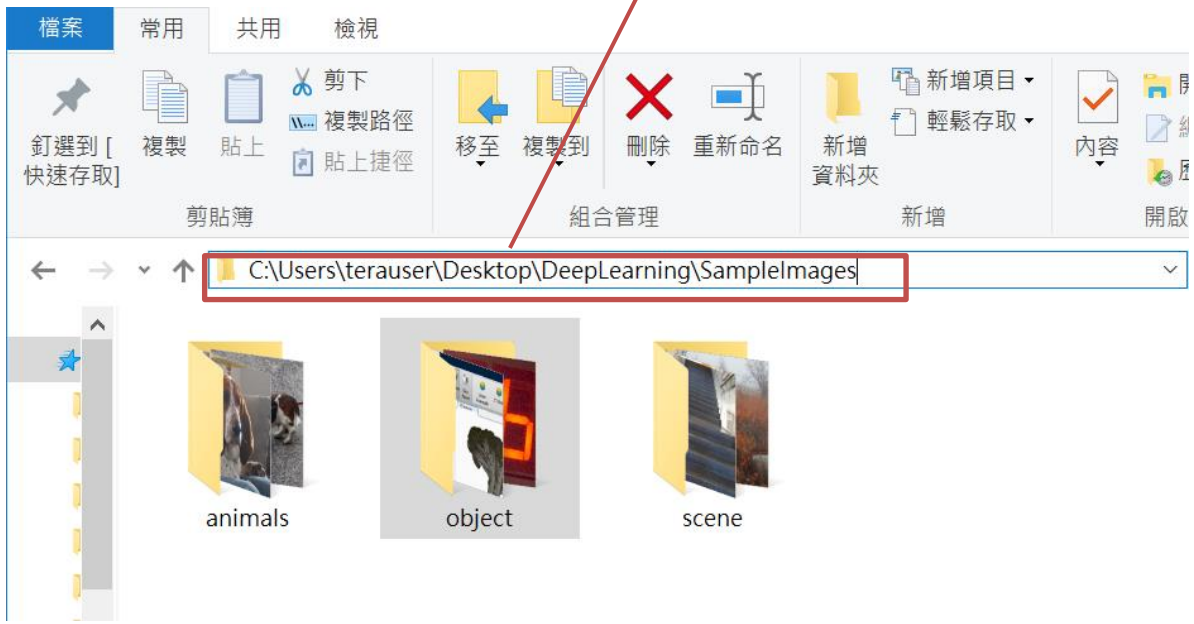
Manage Large Sets of Images – (1)

- imds = imageDatastore(ImagesPath, …

  'IncludeSubfolders', true,…

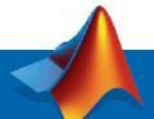
  'LabelSource','foldernames',…

  'ReadFcn', @customreader);



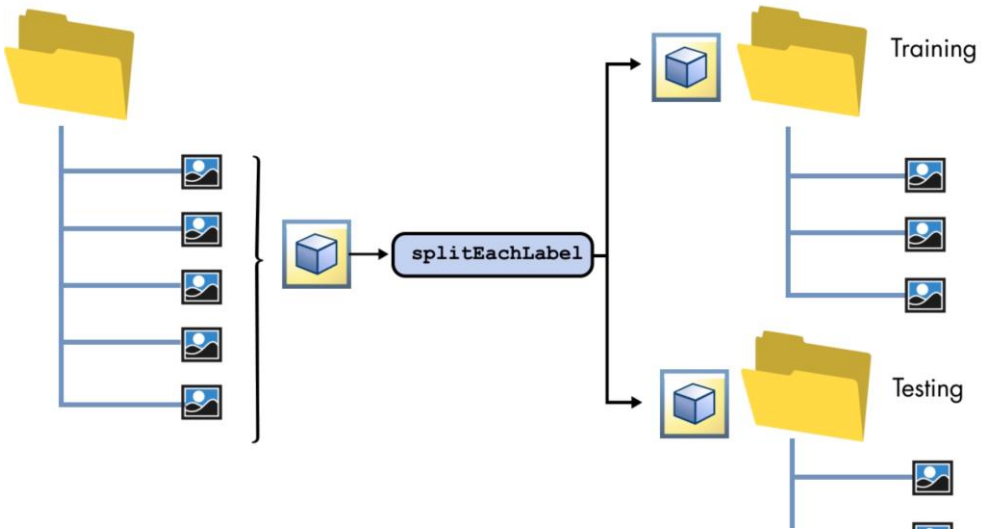
Customized MATLAB function

```
function Iout = customreader(filename)

    I = imread(filename);

    % Some images may be grayscale. Replicate the image 3 times to
    % create an RGB image.
    if ismatrix(I)
       I = cat(3,I,I,I);
    end

    % Resize the image as required for the CNN.
    Iout = imresize(I, [227 227]);
```

Manage Large Sets of Images – (2)

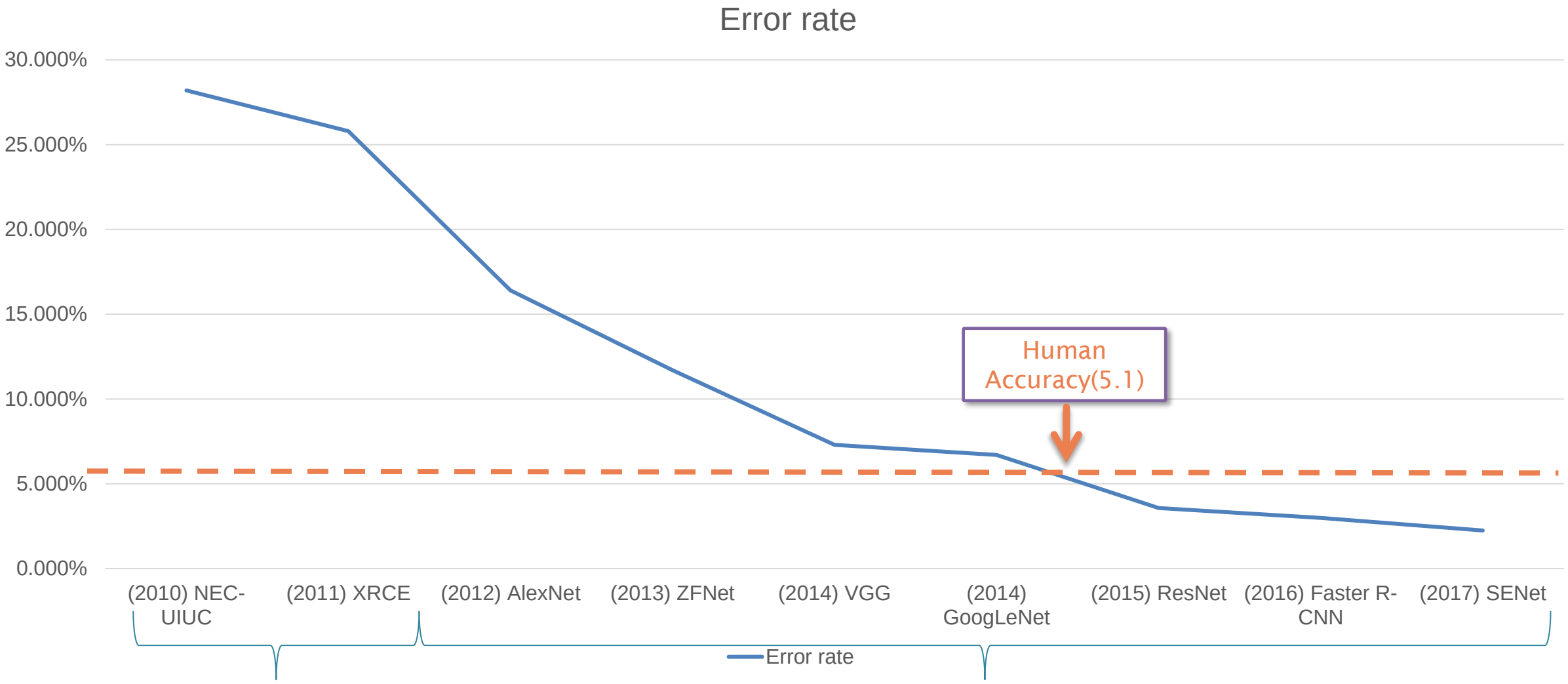
- Methods for ImageDatastore:
  - **splitEachLabel:** Split ImageDatastore labels by proportions
  - **countEachLabel:** Count files in ImageDatastore labels
  - **readimage:** Read specified image from ImageDatastore




```
>> countEachLabel(imds)
ans =
  5×2 table
```

Label	Count
MathWorks Cap	15
MathWorks Cube	15
MathWorks Playing Cards	15
MathWorks Screwdriver	15
MathWorks Torch	15

Why is Deep Learning So Popular Now?



Computer Vision Tasks in Deep Learning

Classification

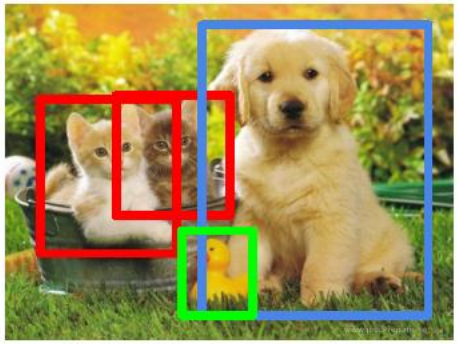
CAT

Classification + Localization

CAT

Single object

Object Detection



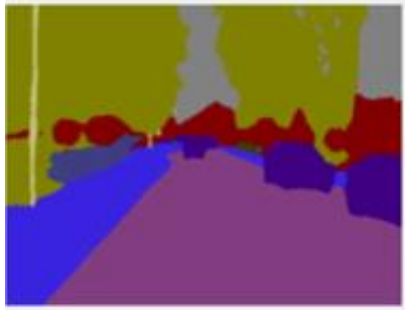
CAT, DOG, DUCK

Instance Segmentation

CAT, DOG, DUCK

Multiple object

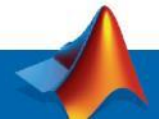
Semantic Segmentation



No object , just pixel

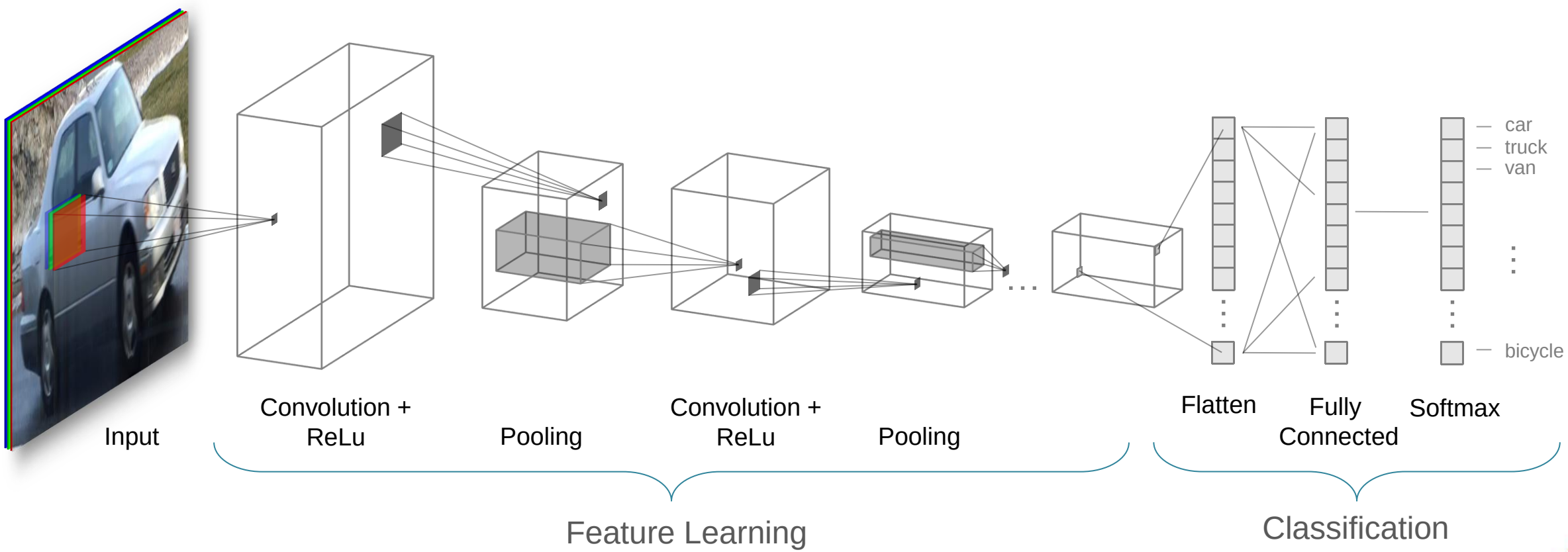
Agenda

- Machine Learning Overview
- How to use Pretrained model
- Create Deep Learning Model(MNIST)
- Try to do Transfer Learning

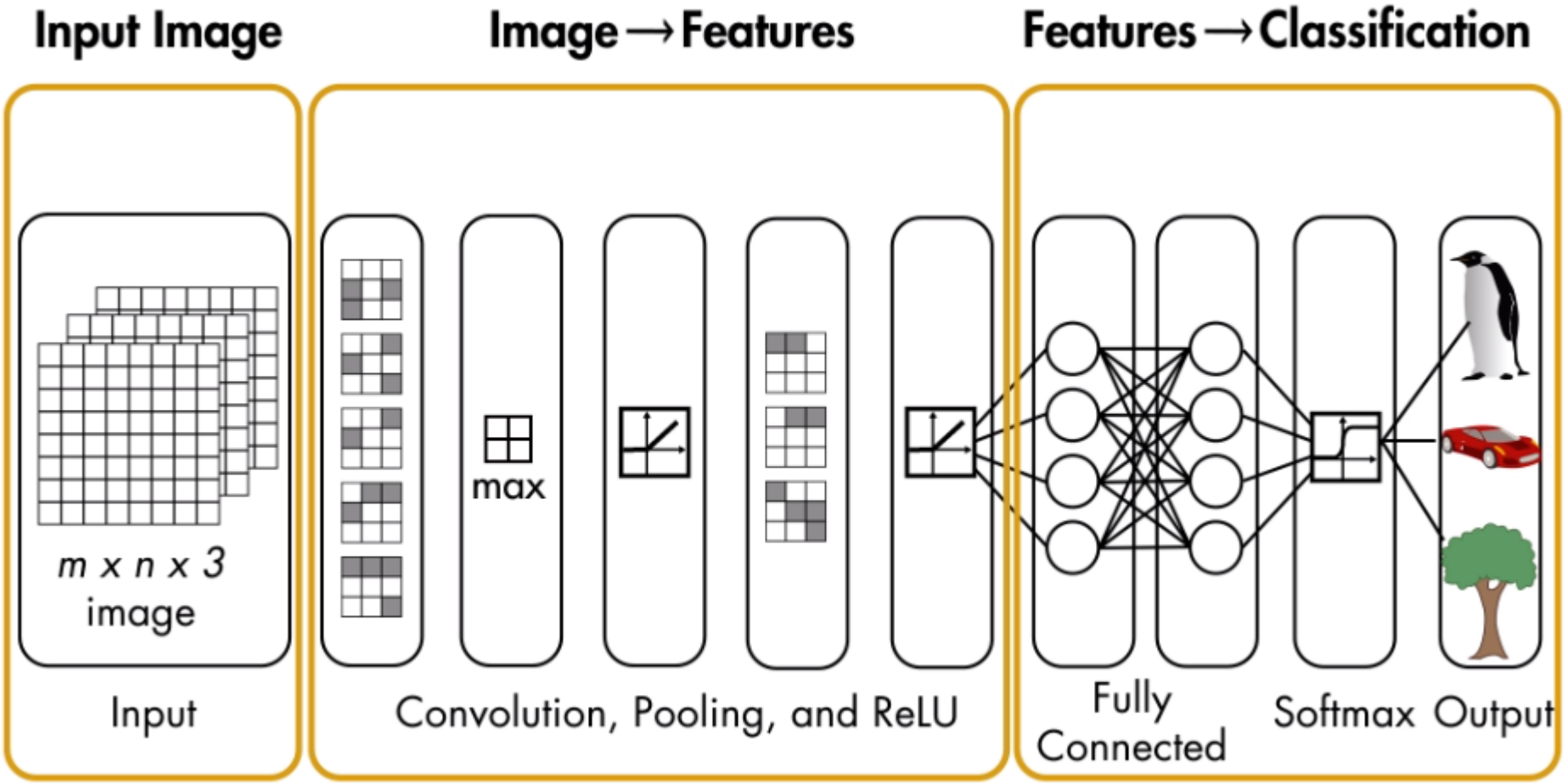


Deep Learning:
Convolutional Neural Networks (CNN/ConvNet)

- Multi-layered neural network

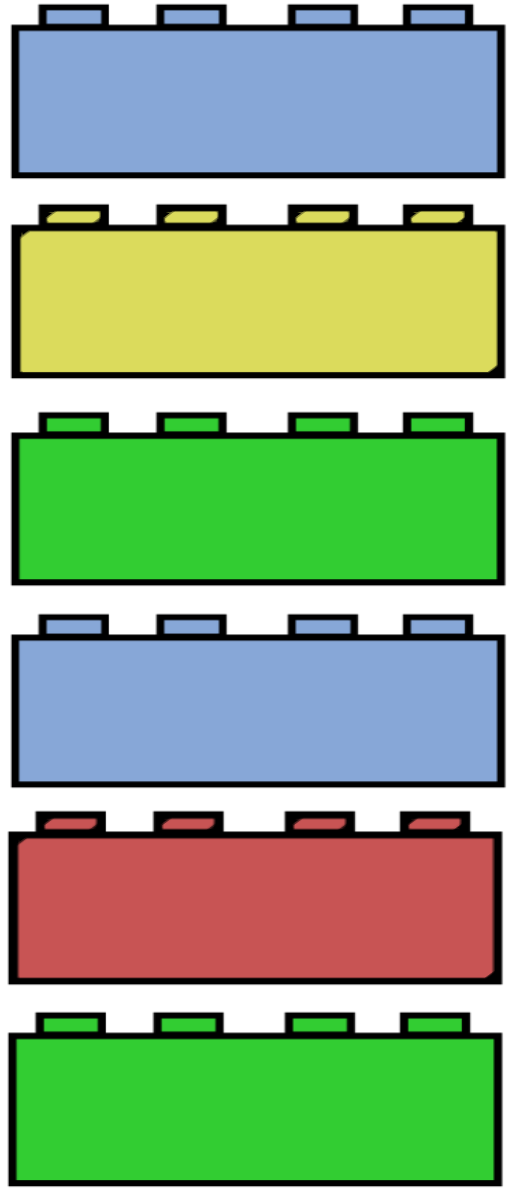


Convolutional Neural Networks (CNN/ConvNet)



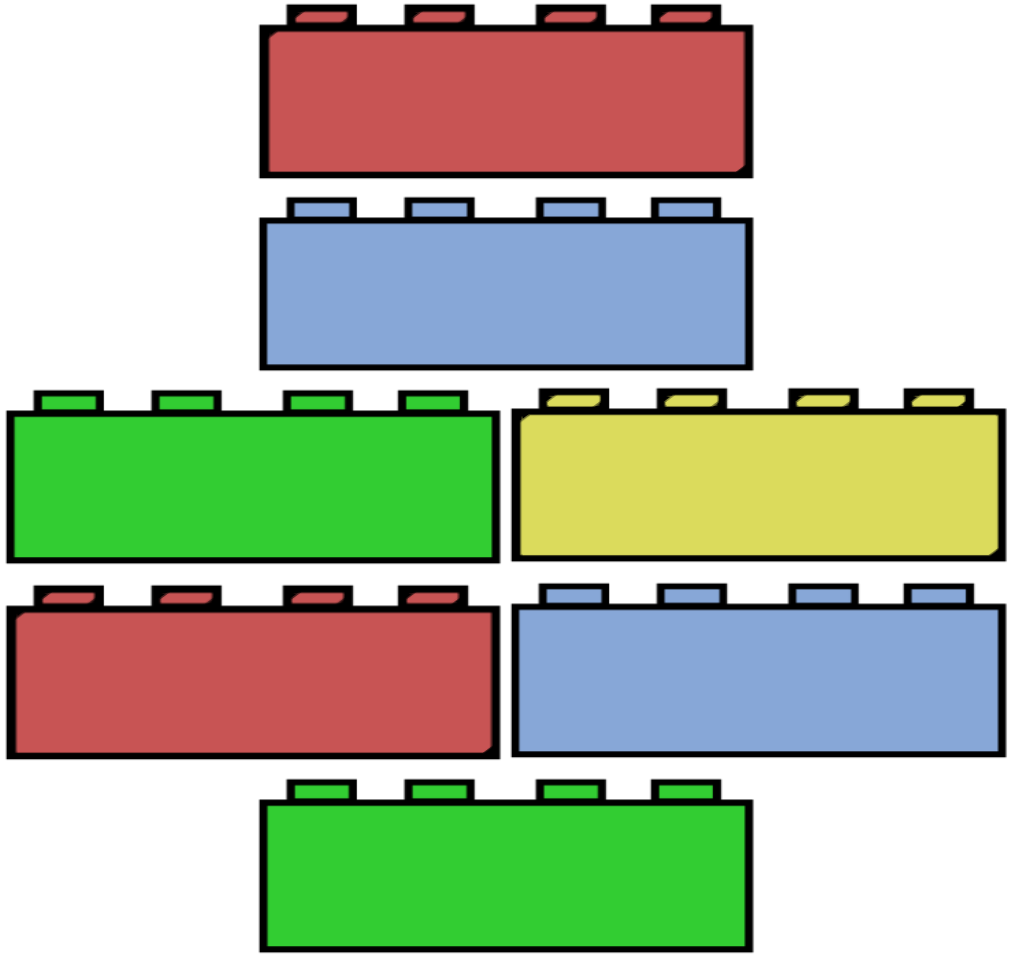
Thinking about Layers

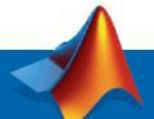
- Layers are like blocks
  - Stack on top of each other
  - Replace one block with a different one
- Each hidden layer processes the information from the previous layer



Thinking about Layers

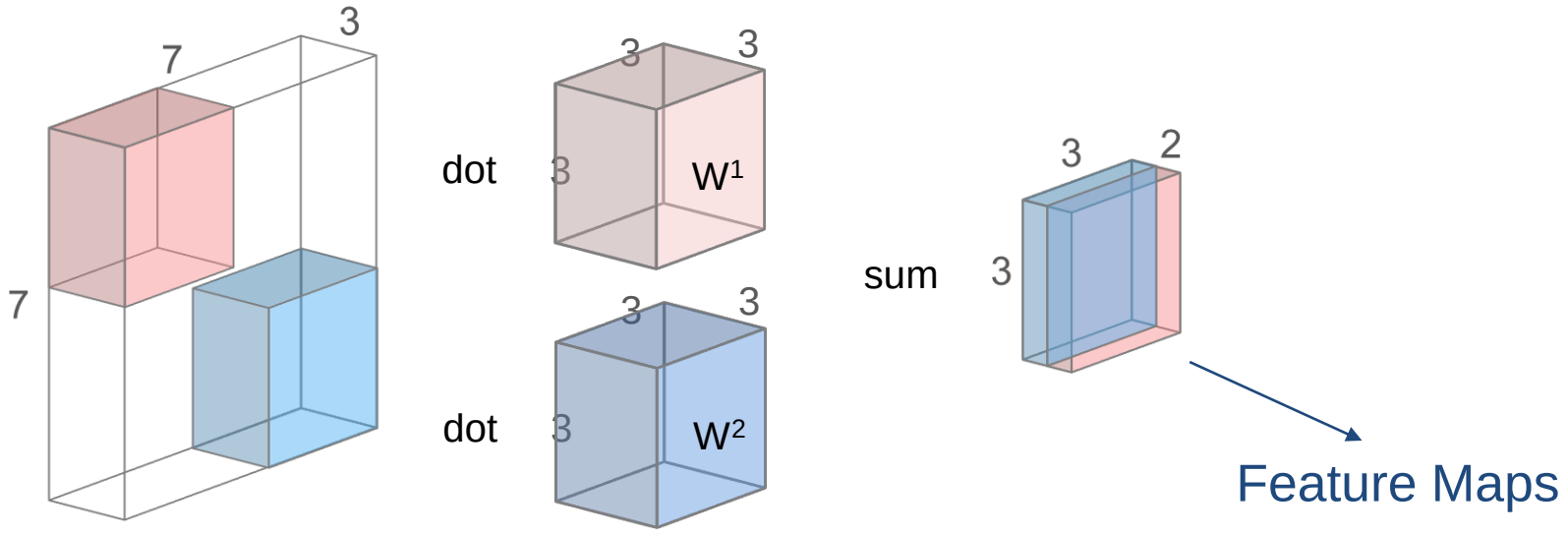
- Layers are like blocks
  - Stack on top of each other
  - Replace one block with a different one
- Each hidden layer processes the information from the previous layer
- Layers can be ordered in different ways





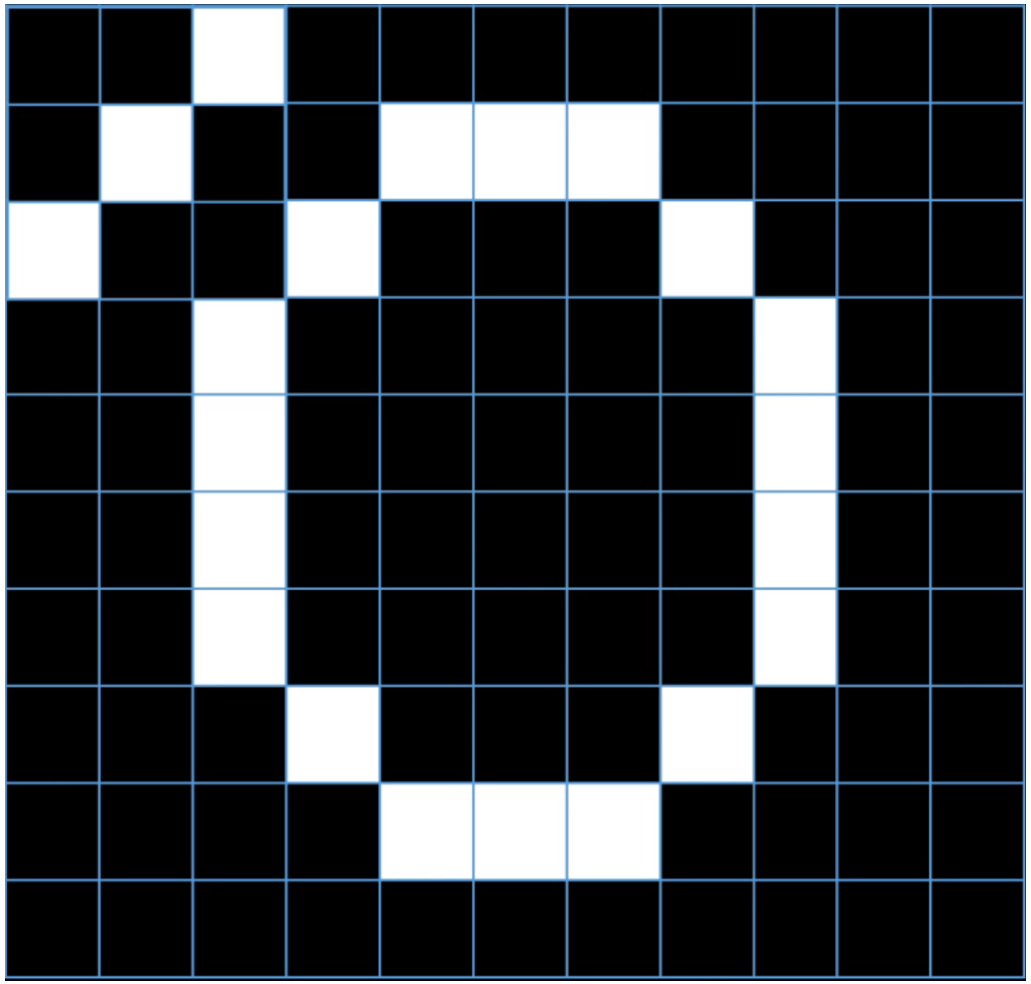
Convolution Layer

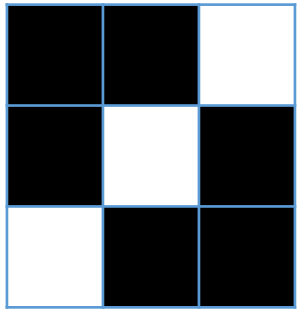
- Core building block of a CNN
- Convolve the filters sliding them across the input, computing the dot product

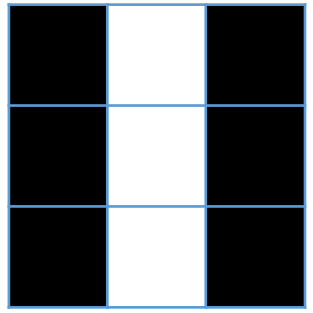


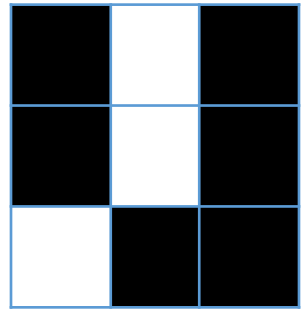
- Intuition: learn filters that activate when they “see” some specific feature

Convolution Layers Search for Patterns

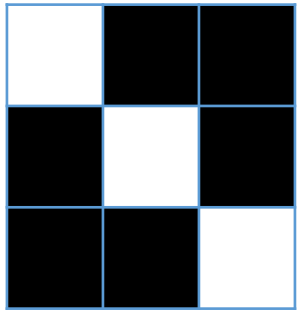


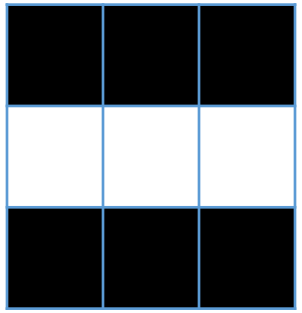


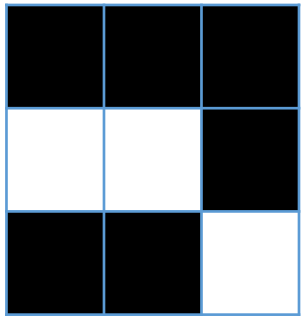




These patterns would be common in the number 0



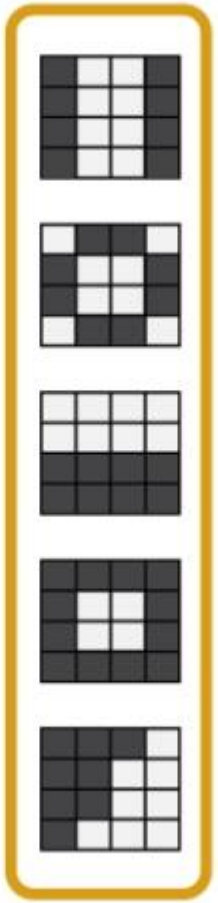




Convolution Layer – (2)

Input image

Filters



Vertical stripes

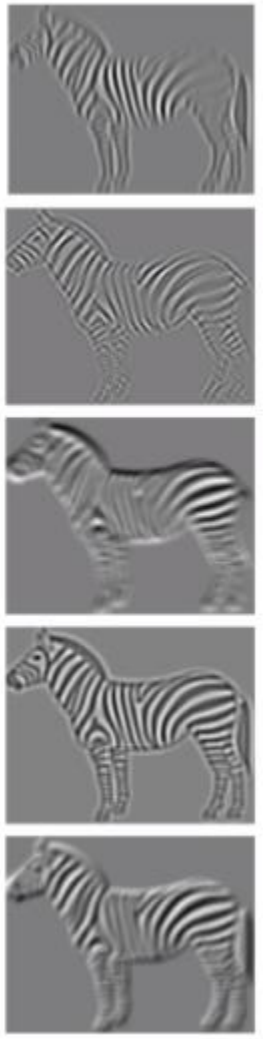
Diagonal cross

Horizontal edge

White blob

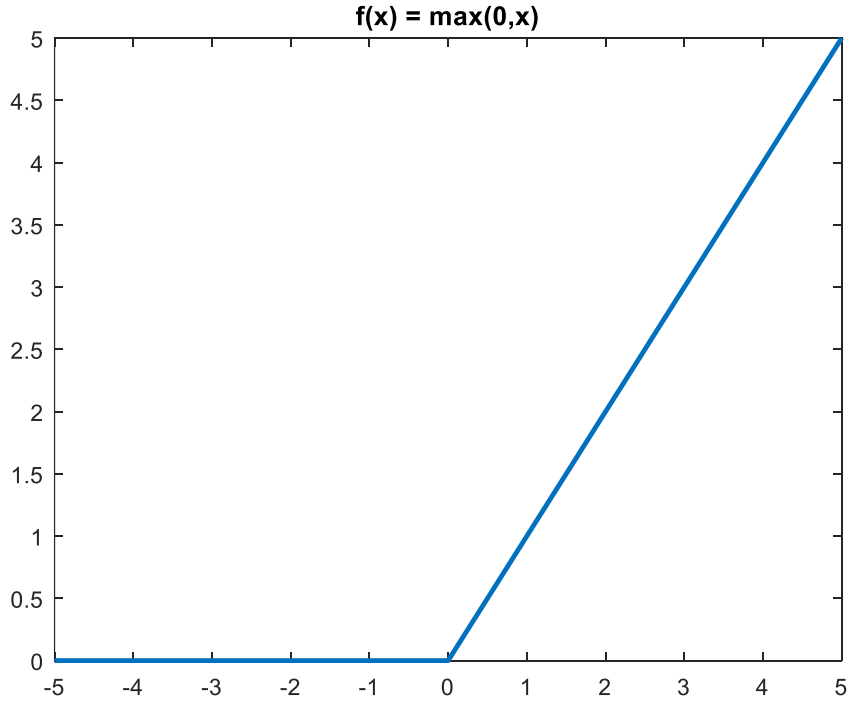
Diagonal edge

Feature Maps



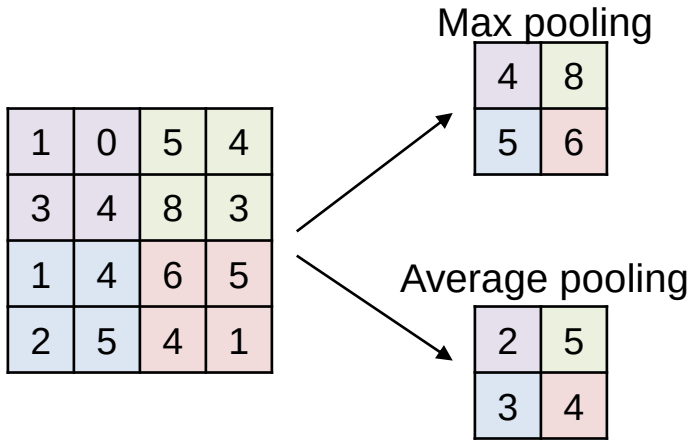
Rectified Linear Unit (ReLU) Layer

- Frequently used in combination with Convolution layers
- Allows for faster and more effective training
- $\boldsymbol{f(x) = max(0, x)}$, activation is thresholded at 0



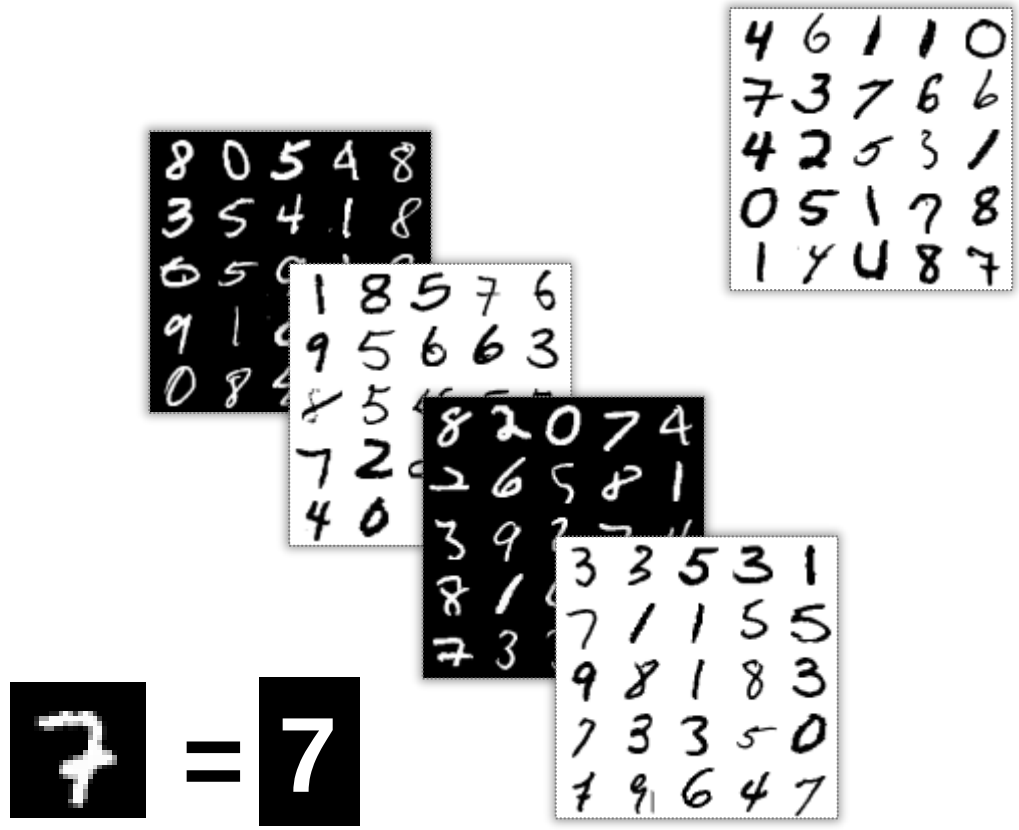
Pooling Layer

- Perform a downsampling operation across the spatial dimensions
- Goal: reducing the number of parameters
- Max pooling and average pooling methods



MNIST: The “Hello, World!” of Computer Vision – (1)

What?	A set of handwritten digits from 0-9
Why?	An easy task for machine learning beginners
How many?	60,000 training images 10,000 test images
Best results?	99.79% accuracy



Sources: http://yann.lecun.com/exdb/mnist/
https://rodrigob.github.io/are_we_there_yet/build/classification_datasets_results

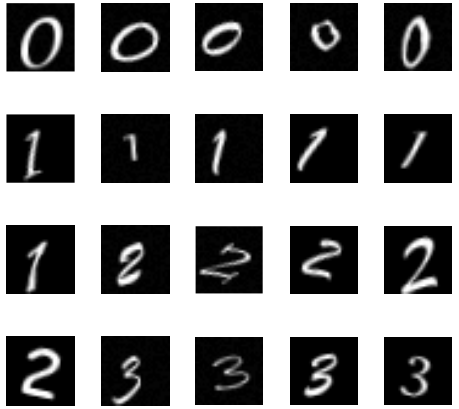
MNIST: The “Hello, World!” of Computer Vision – (2)

```
imds= imageDatastore(location);
```

```
layers = [ ...
    imageInputLayer([28 28 1], 'Normalization', 'none');
    convolution2dLayer(5, 20);
    reluLayer();
    maxPooling2dLayer(2, 'Stride', 2);
    fullyConnectedLayer(10);
    softmaxLayer();
    classificationLayer()];
```

```
opts = trainingOptions('sgdm',…
                       'MaxEpochs', 5,…
                       'InitialLearnRate',0.01,...
                       'MiniBatchSize',128,...
                       'ExecutionEnvironment', ‘multi-gpu’,…
                       'Plots','training-progress');

net = trainNetwork(imds, layers, opts);
```

```
label = classify(net, img)
```



Handle training images.

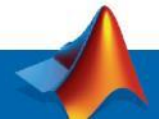
Create the layers for CNN.

Set training options and train.

Classify image.

Agenda

- Machine Learning Overview
- How to use Pretrained model
- Create Deep Learning Model(MNIST)
- Try to do Transfer Learning



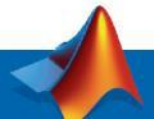
Transfer Learning with Pretrained Models

- Inception-v3
- MobileNet-v2
- VGG-16
- Inception-ResNet-v2
- ResNet-18/50/101
- GoogLeNet
- DenseNet-201
- NASNet
- SqueezeNet
- AlexNet
- Places365-GoogLeNet
- Xception

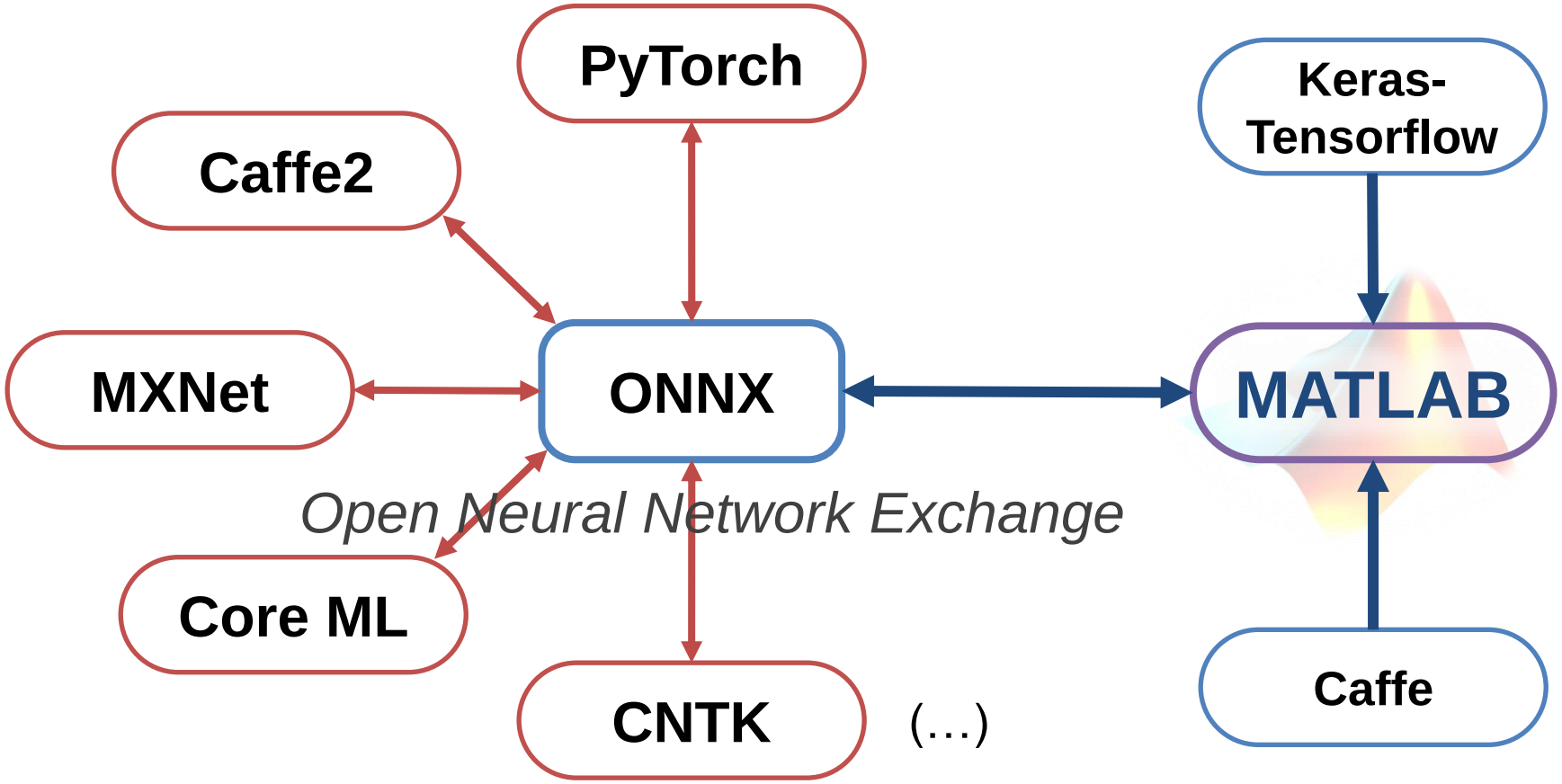
Import & Export Models Between Frameworks

- Keras-Tensorflow Importer
- Caffe Model Importer
- ONNX Model Converter

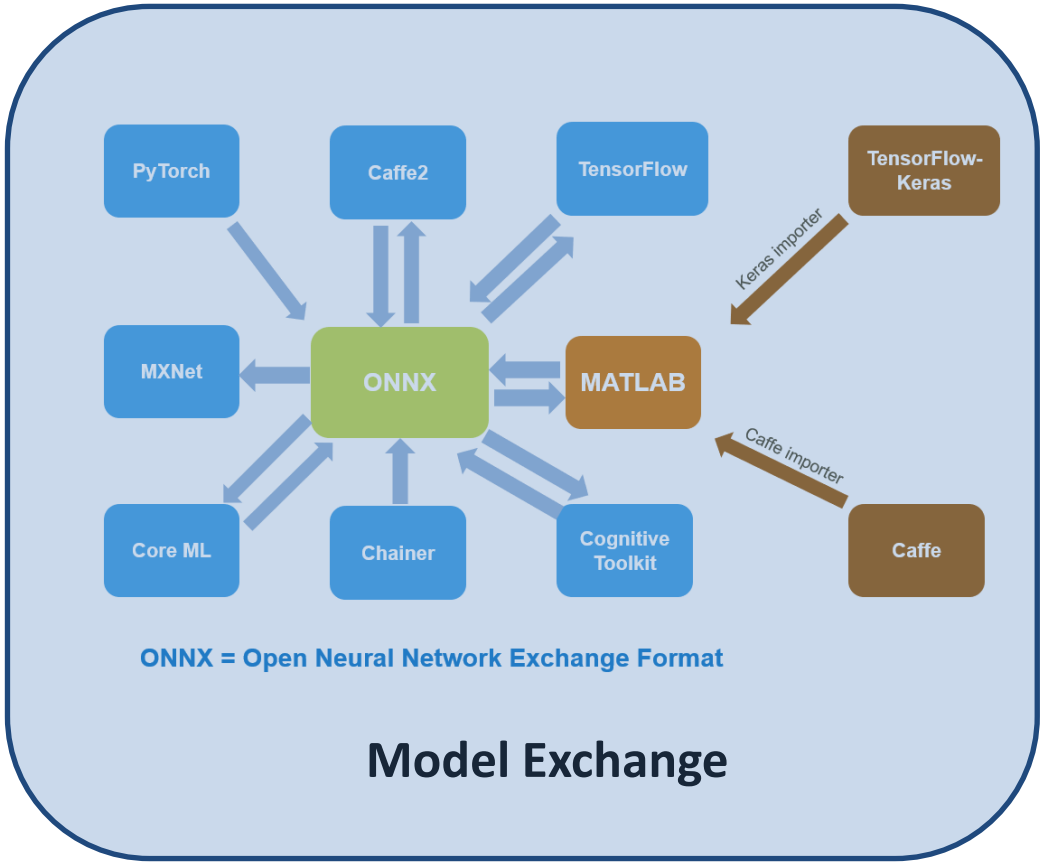
More comprehensive list here: https://www.mathworks.com/help/deeplearning/ug/pretrained-convolutional-neural-networks.html



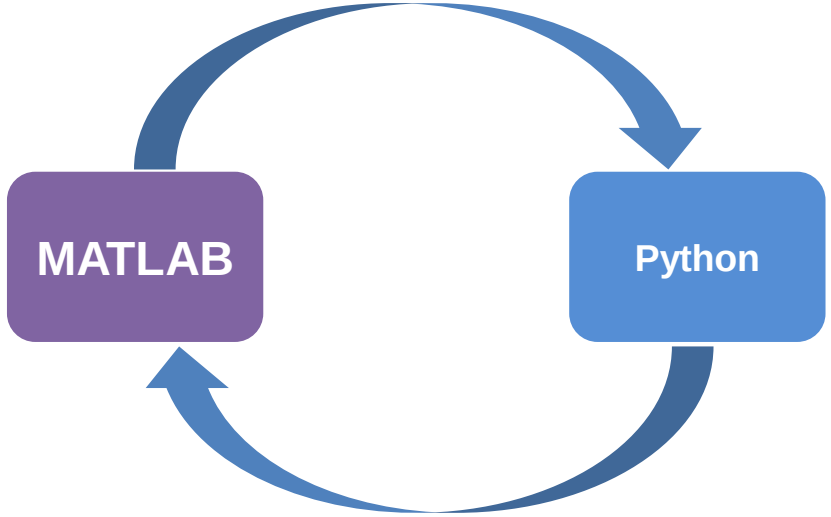
Model Exchange with MATLAB



Two Ways to Work with TensorFlow and PyTorch



Model Exchange



Co-execution (Python and C++)

Transfer Learning Workflow

Load pretrained network

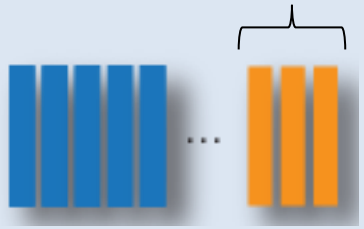
Early layers that learned low-level features (edges, blobs, colors)

Last layers that learned task specific features

1 million images
1000s classes

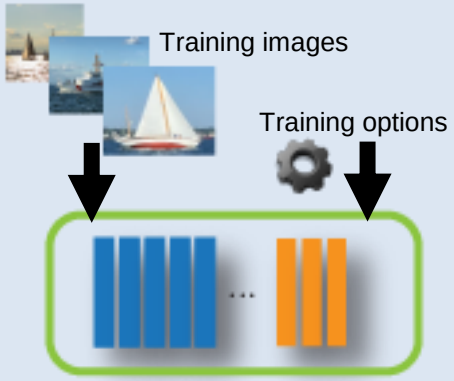
Replace final layers

New layers to learn features specific to your data



Fewer classes
Learn faster

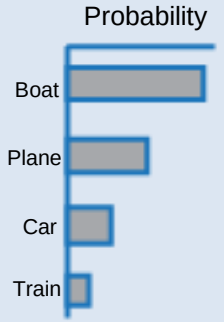
Train network



100s images
10s classes

Predict and assess network accuracy

Deploy results



Thank you!