MATLAB EXPO 2016

Machine Learning and Deep Learning

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Deep Learning is Everywhere

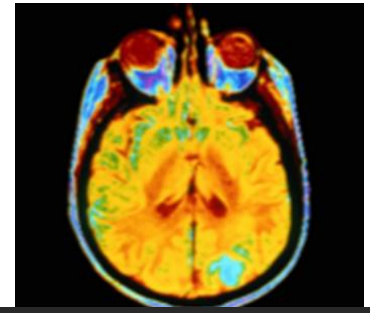
&

MATLAB Accelerates Deep Learning

Deep Learning is Everywhere

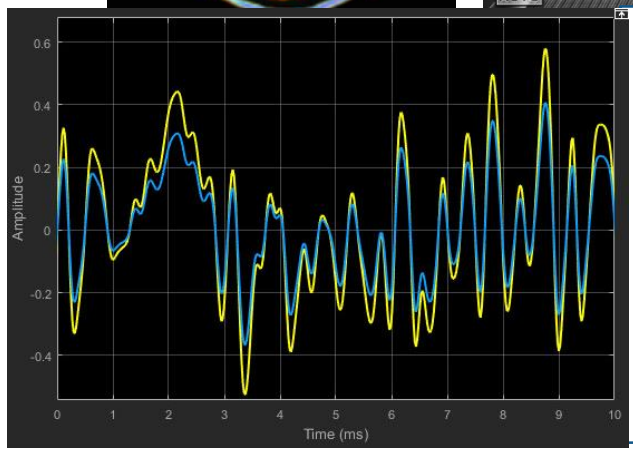
Computer Vision

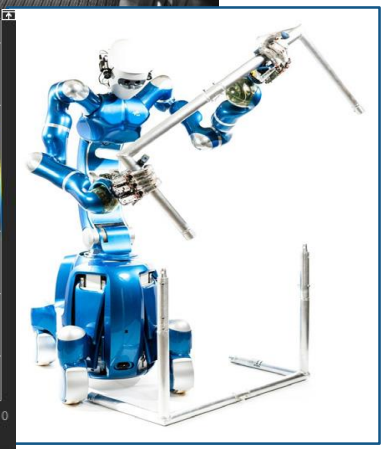
- Pedestrian and traffic sign detection
- Landmark identification
- Scene recognition
- Medical diagnosis and drug discovery



Text and Signal Processing

- Speech Recognition
- Speech & Text Translation





Robotics & Controls

and many more…

What is Deep Learning?

Deep Learning is a Subset of Machine Learning

E.g. Google Captioning Project

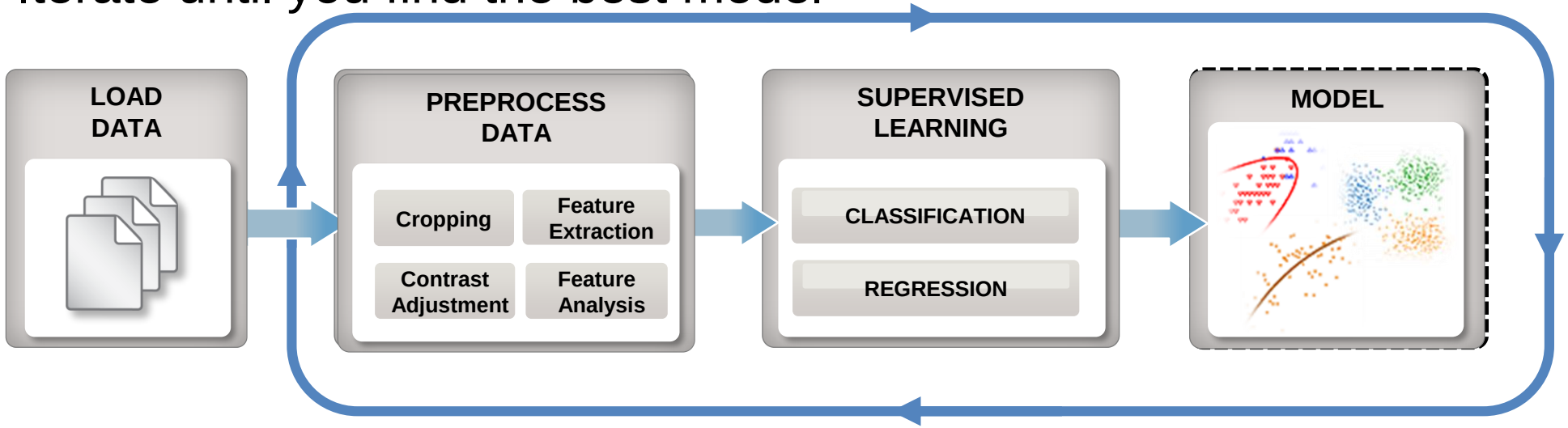
Machine learning is the science of getting computers to act without being explicitly programmed.

Deep learning algorithms can learn tasks directly from data, eliminating the need for manual feature selection.

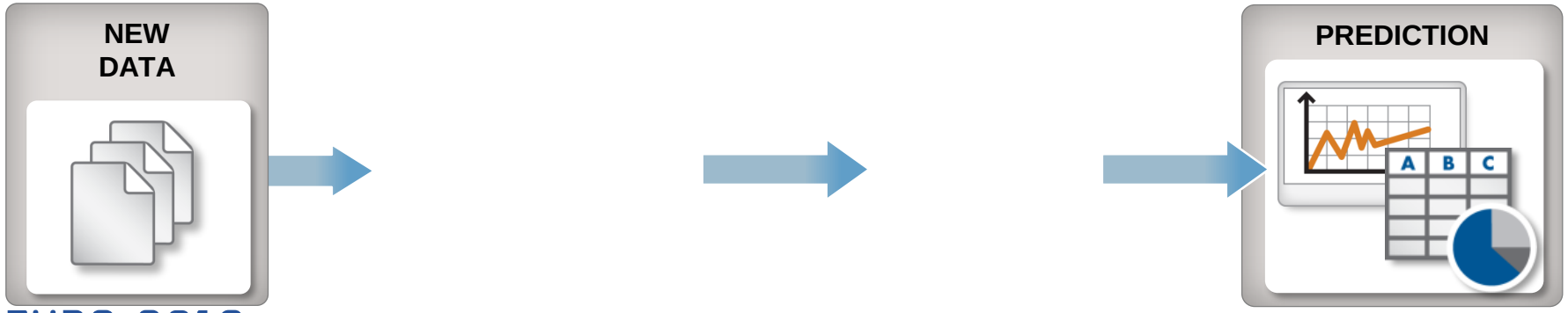
http://googleresearch.blogspot.com/2014/11/a-picture-is-worth-thousand-coherent.html

Shallow Machine Learning Workflow

Train: Iterate until you find the best model



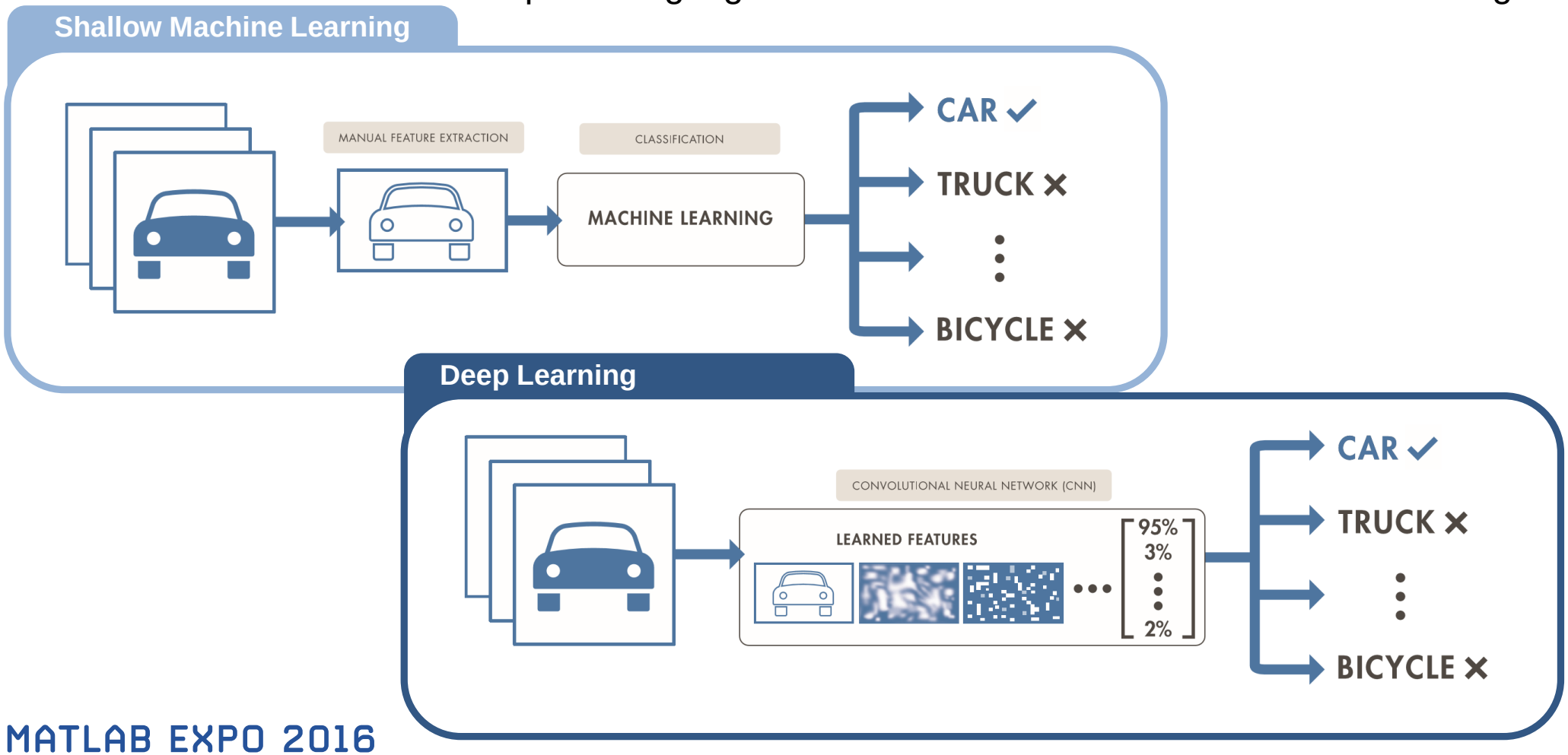
Predict: Integrate trained models into applications



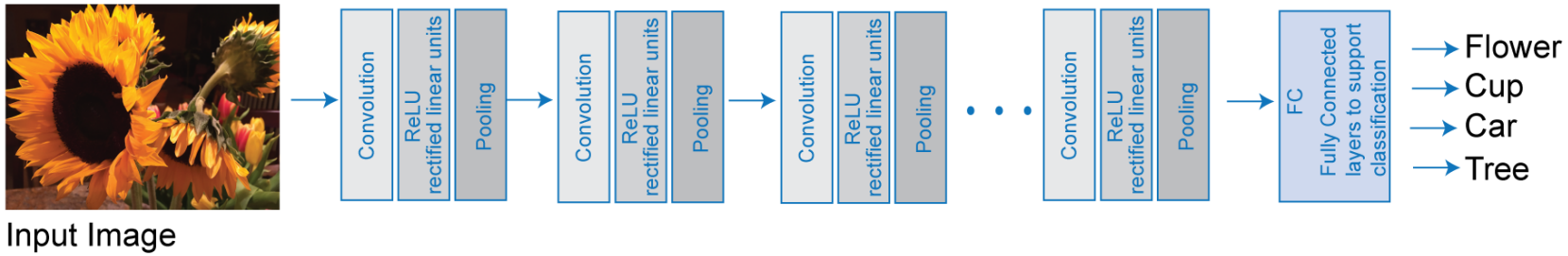
Shallow vs Deep Learning

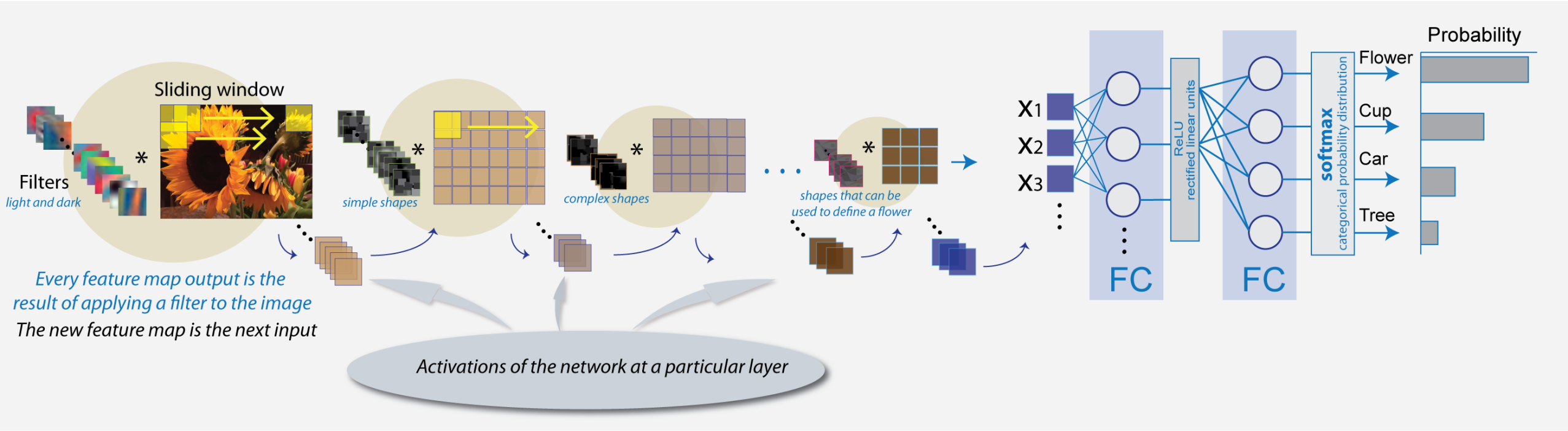
Deep learning performs **end-to-end learning** by learning **features, representations and tasks** directly from **images, text and sound**

Deep learning algorithms also **scale with data –** shallow learning **converges**



Shallow vs Deep Learning





What problem does Deep Learning solve?

Data

1.2 million images

1000 categories

Tasks

Object recognition

Localization, and more

Metrics

Top-5 error rate

ImageNet Large Scale Visual Recognition Challenge (ILSVRC)

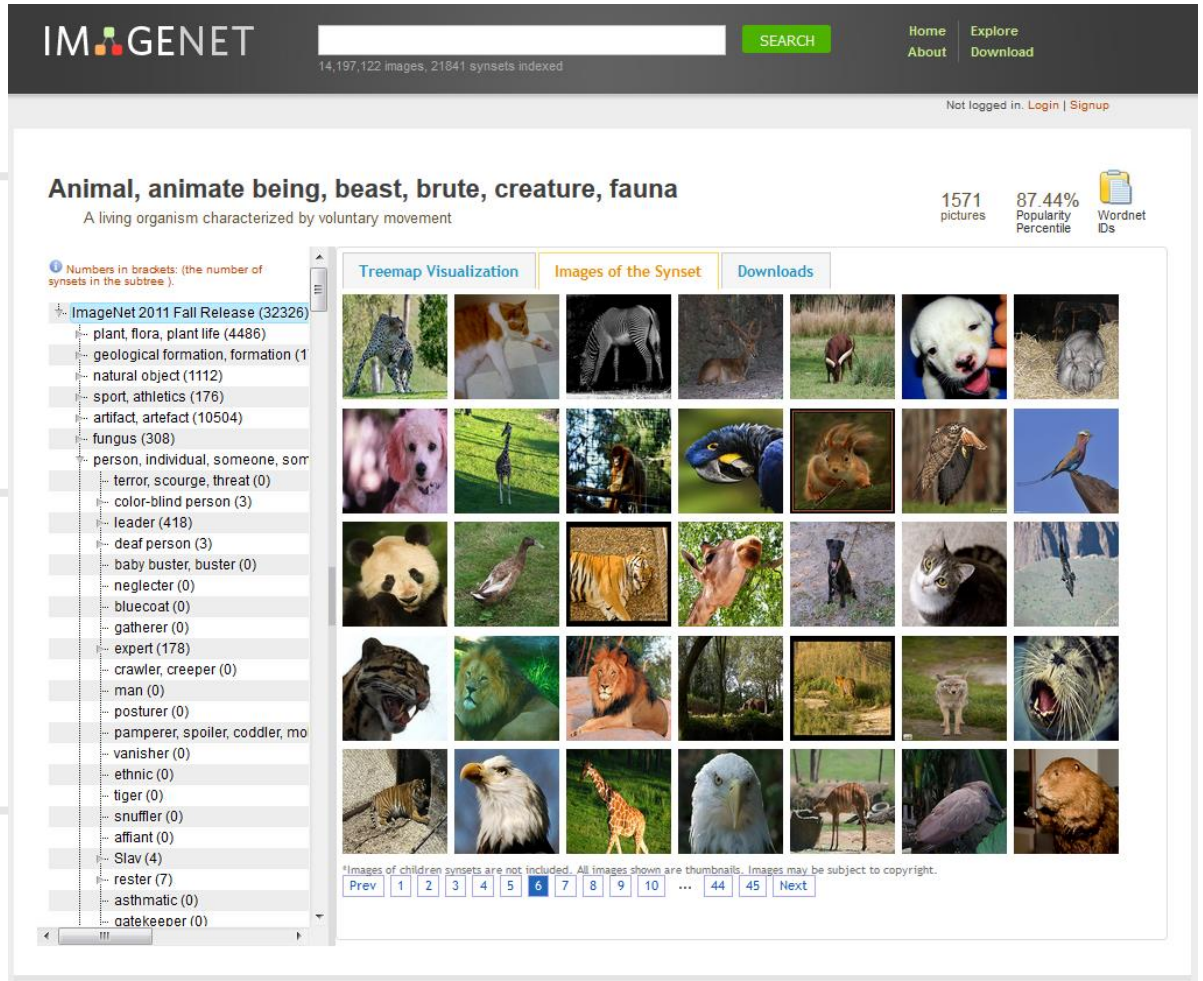
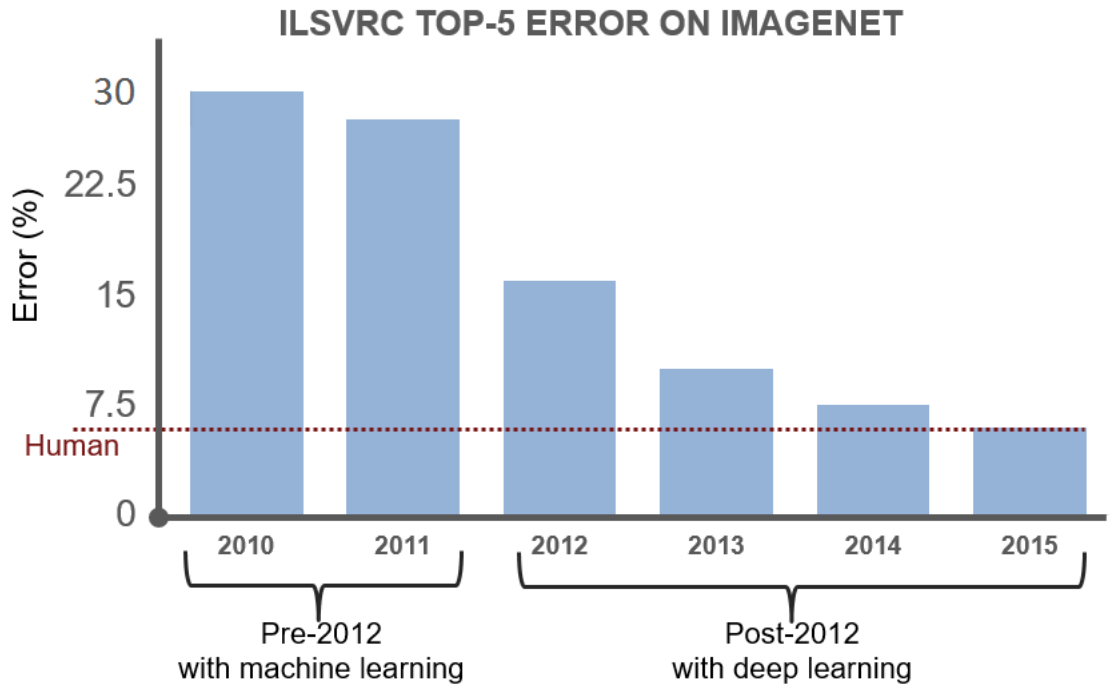


Image credit: http://image-net.org/synset

Why is Deep Learning so popular?

- **RESULTS:** Unparalleled accuracy in image recognition
- **DATA:** Enormous labeled data sets available
  - e.g. ImageNet , PASCAL VoC , Kaggle
- **COMPUTING POWER:** GPUs enable training on massive amounts of data
- **BOOTSTRAPPING:** Start prototyping with the best available solutions



Three Reasons to Use MATLAB for Deep Learning

ACCESS Easily manipulate big data and networks

LEARN Use MATLAB to learn about the field

INTEGRATE Unify multiple domains in a single workflow

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Object Recognition using Deep Learning

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

Handle Large Image Sets Easily

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

Also `datastore` *for other collections of data*

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Two Approaches for Deep Learning

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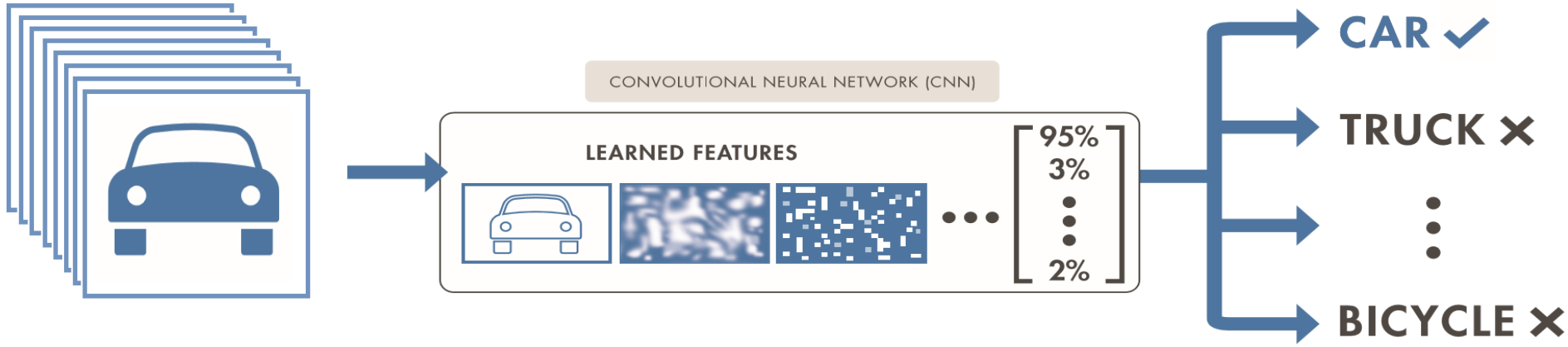
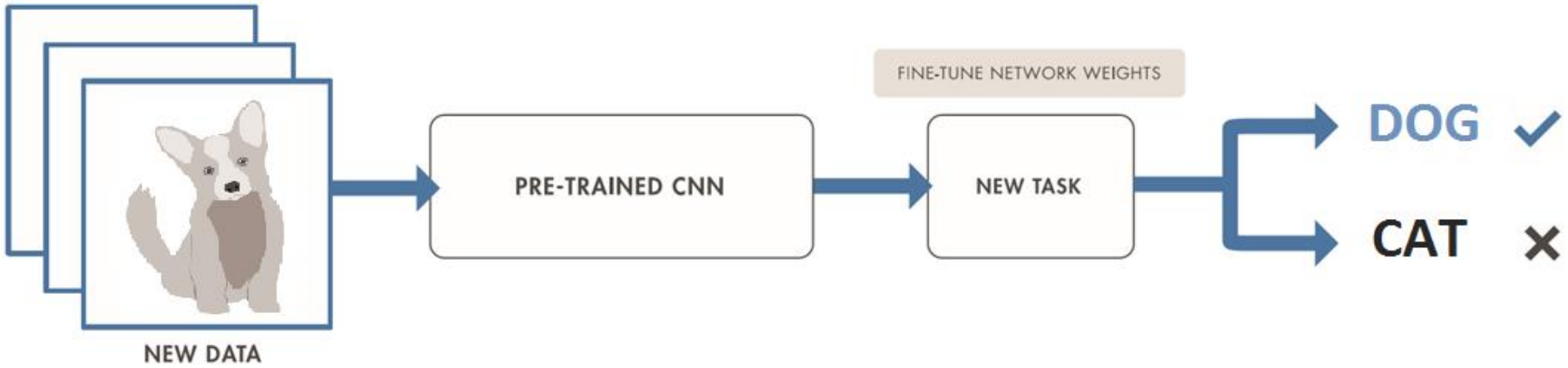
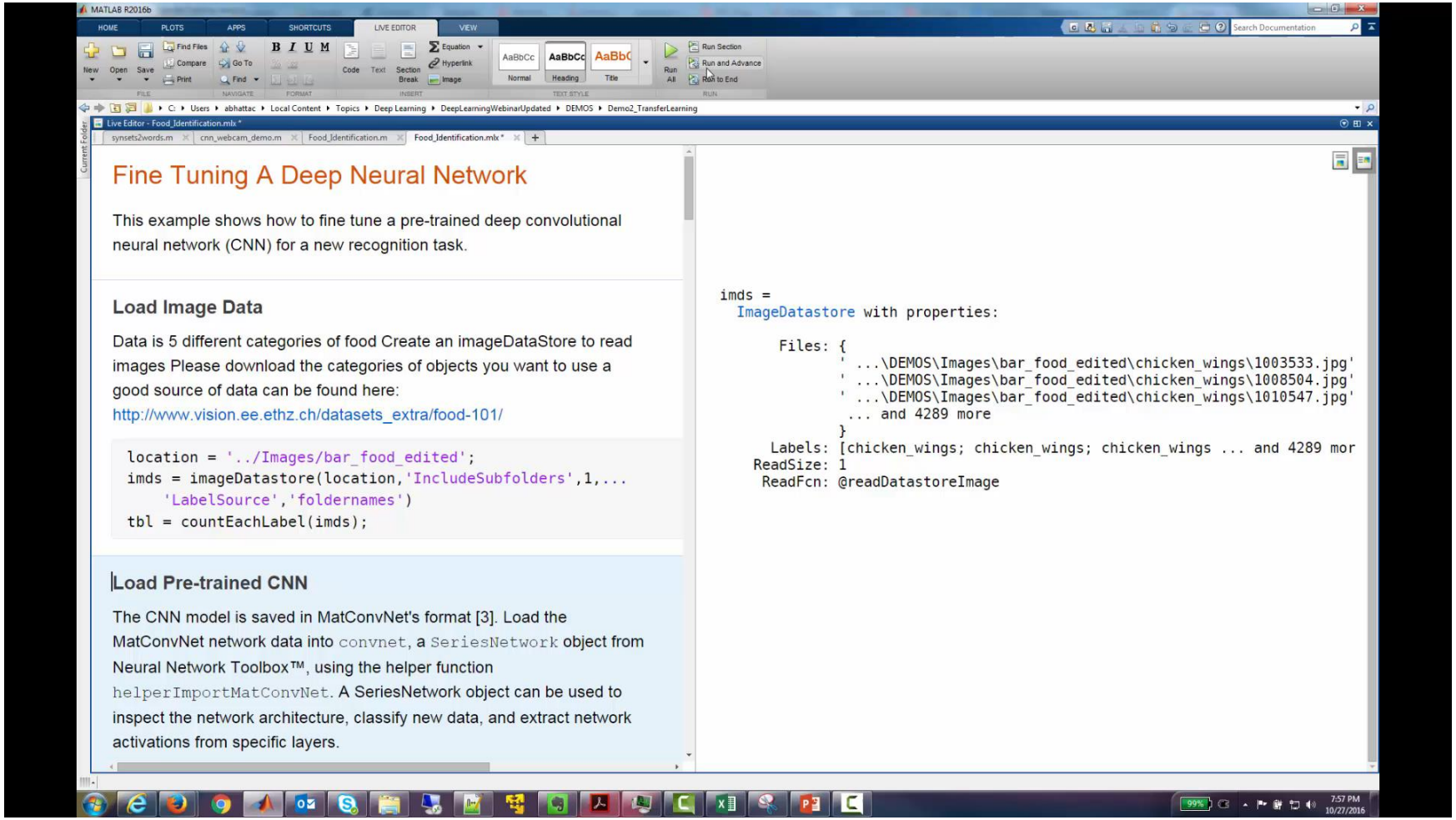
1. Train a Deep Neural Network from Scratch



2. Fine-tune a pre-trained model (transfer learning)



Transfer Learning in MATLAB



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Manipulate Deep Learning Networks Easily

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Perform net surgery

Modify the existing network by deleting later layers and adding new ones.

```
% Here we only need to keep everything except the last 3 layers.
layers = net.Layers(1:end-3);

% Add new fully connected layer for 2 categories.
layers(end+1) = fullyConnectedLayer(64, 'Name', 'special 2');
layers(end+1) = reluLayer;

% the new layer adding non-linearity and improves the network's ability to handle data
layers(end+1) = fullyConnectedLayer(height(tbl), 'Name', 'fc8_2');

% Add the softmax layer and the classification layer
layers(end+1) = softmaxLayer;
layers(end+1) = classificationLayer()
```

DELETE LAYERS

ADD LAYERS

Manipulate Deep Learning Networks Easily

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Set options for training

```
opts = trainingOptions('sgdm');
```

Train the network

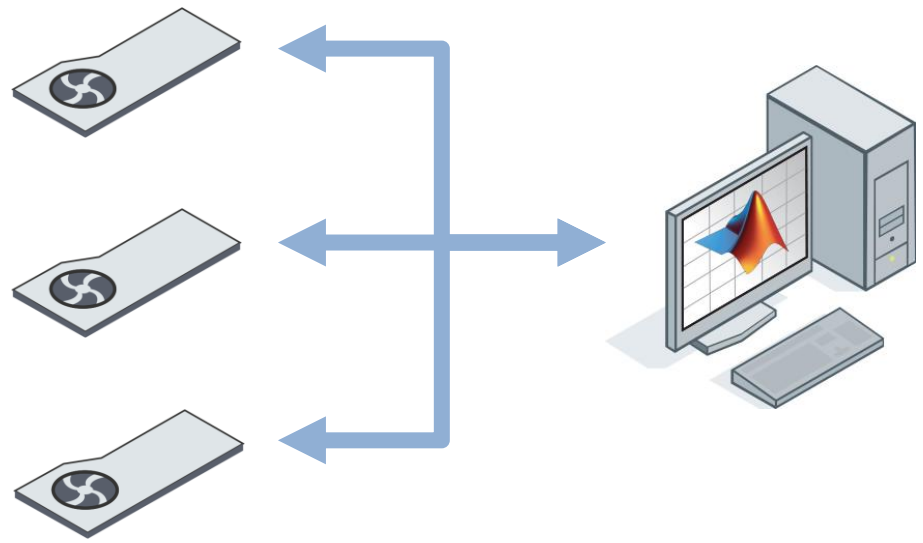
```
net = trainNetwork(imds, layers, opts);
```

Make predictions

```
label = classify(net, im);
```

Extract features

```
features = activations(net, Xtrain, 'fc7');
```



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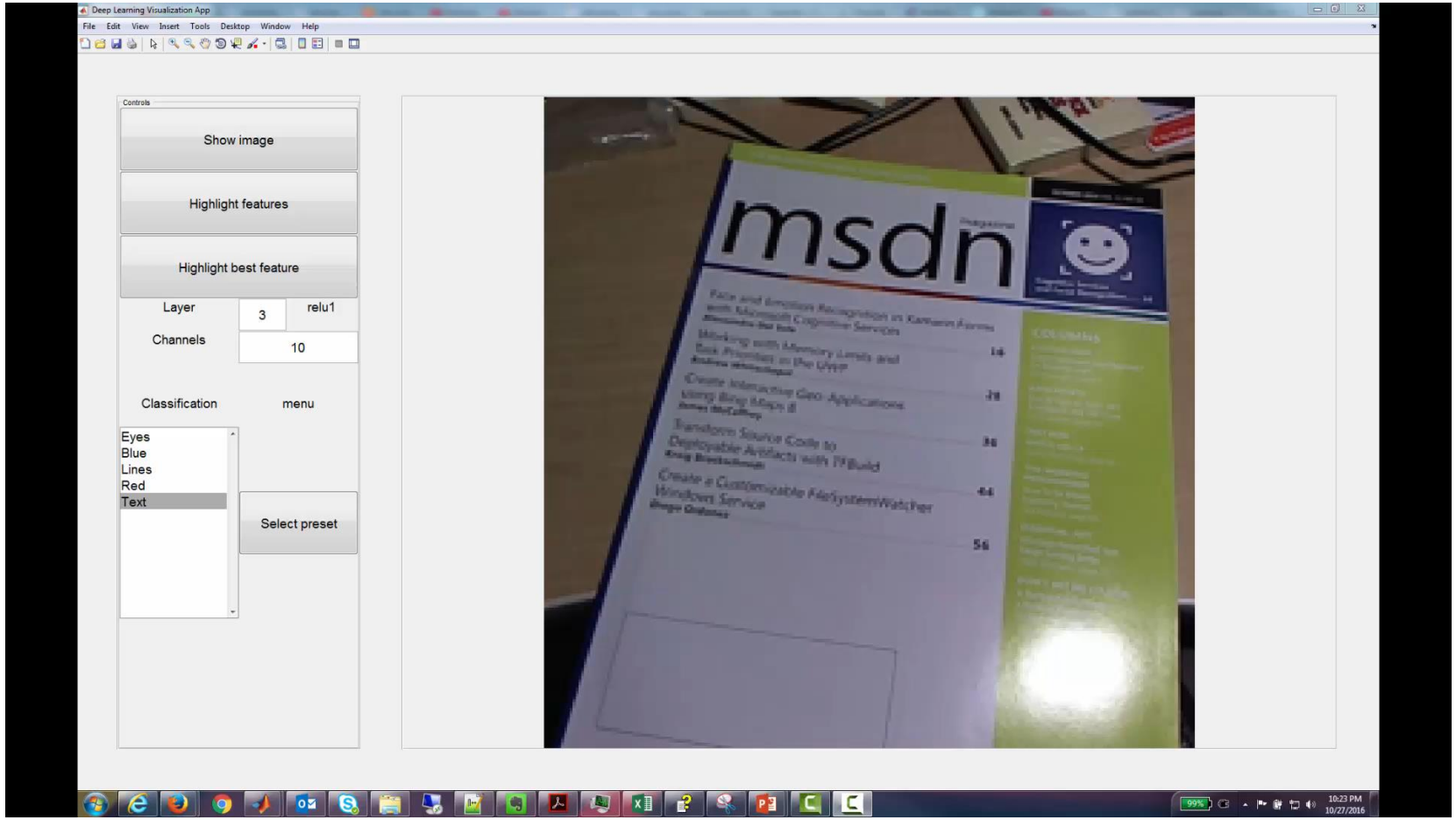
Visualize Deep Learning Features



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Other Resources

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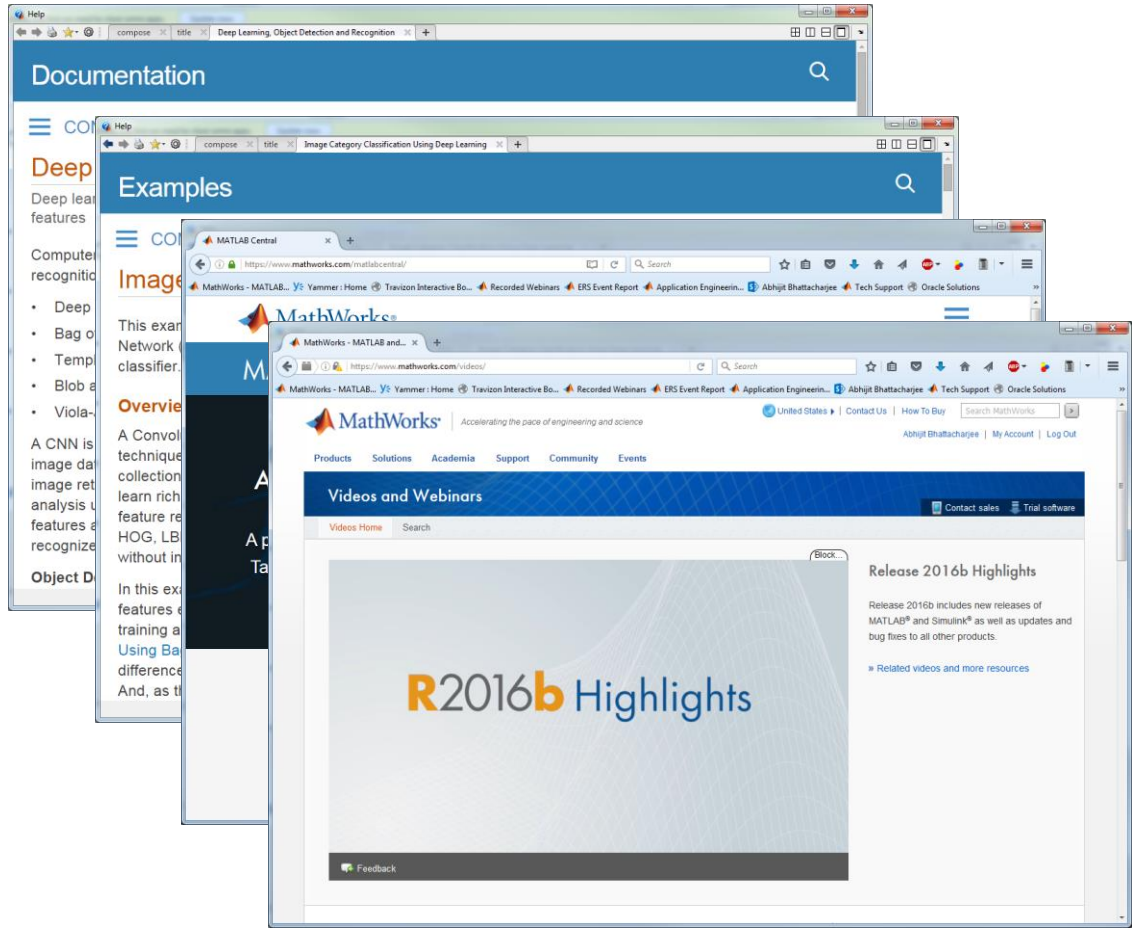
- Documentation
- Examples and Tutorials
- MATLAB Community
- Videos and Seminars



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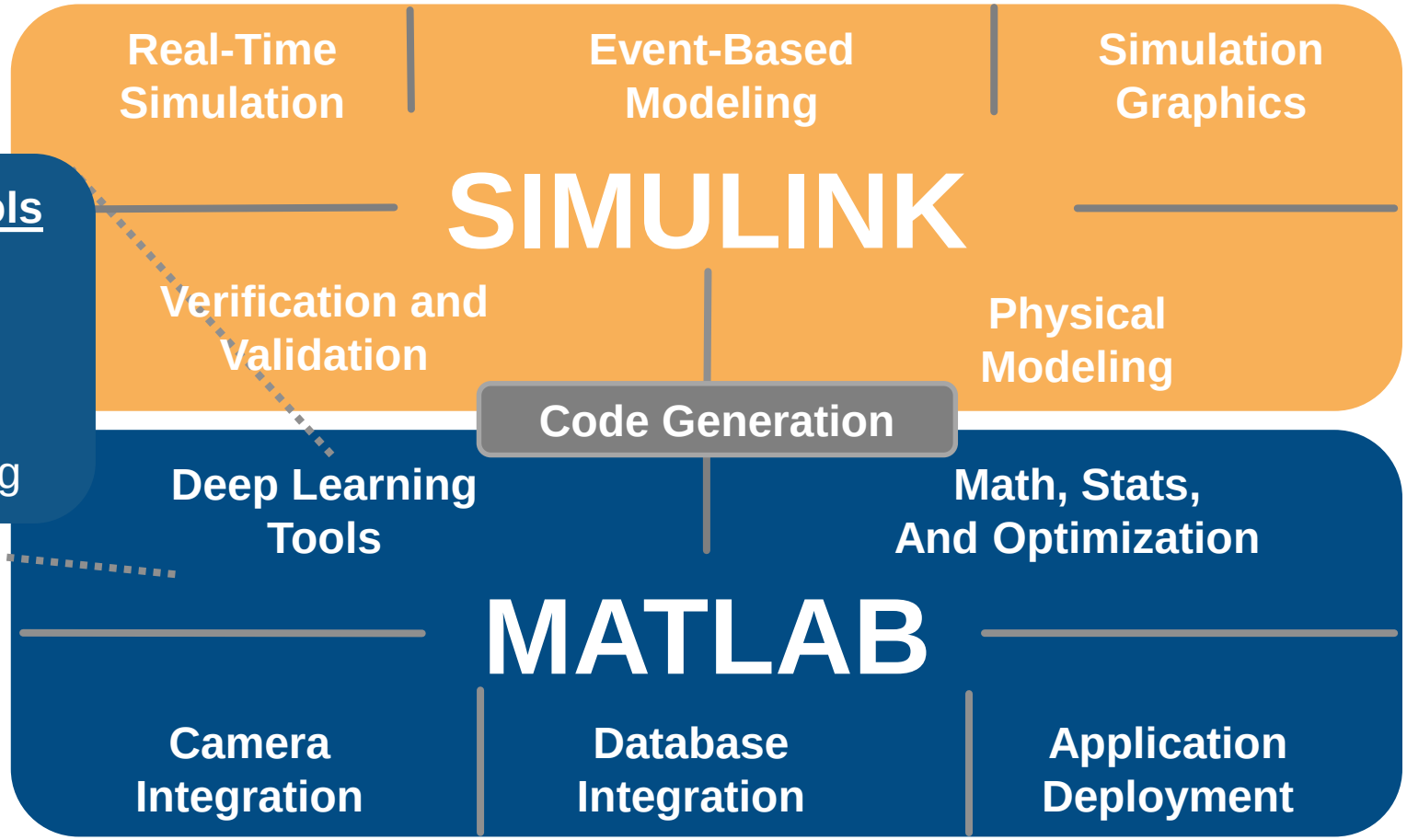
Deep Learning Tools

- Image Processing
- Computer Vision
- Machine Learning
- Neural Networks
- Parallel Computing



Customer Examples

Continental

Machine Learning

for traffic sign recognition

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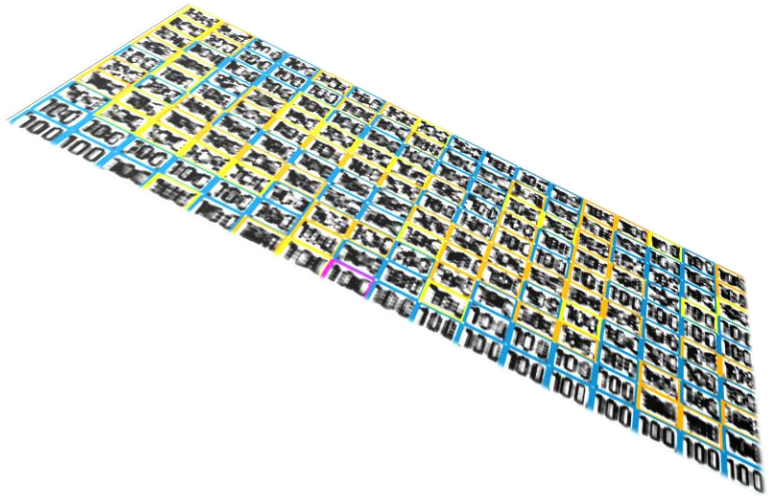
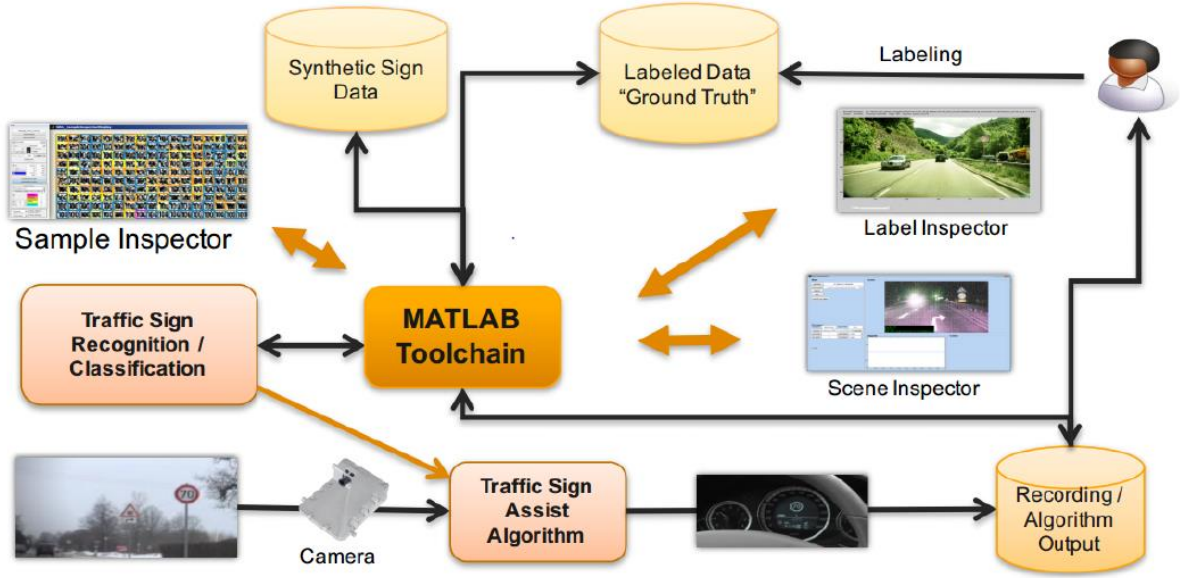
- Extract hundreds of thousands of signs
- Confirm sign type and build a database
- Train system to deal with normal and imperfect signs





75,000

speed limit signs in the training set

Alpine

Machine Learning and MATLAB Coder

for automatic ground detection

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- Detect cars, pedestrians, and other obstacles
- Median recognition rate of 99%
- Converted to C code running without MATLAB

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Questions and Answers