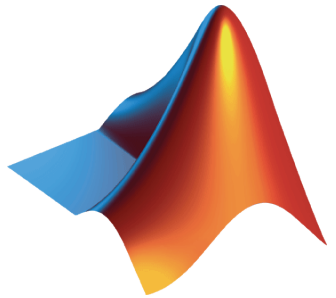
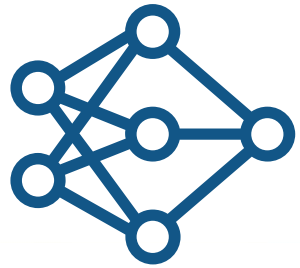
Deep Learning with MATLAB



Simon Thor
MATLAB Student Ambassador



© 2019 The MathWorks, Inc.

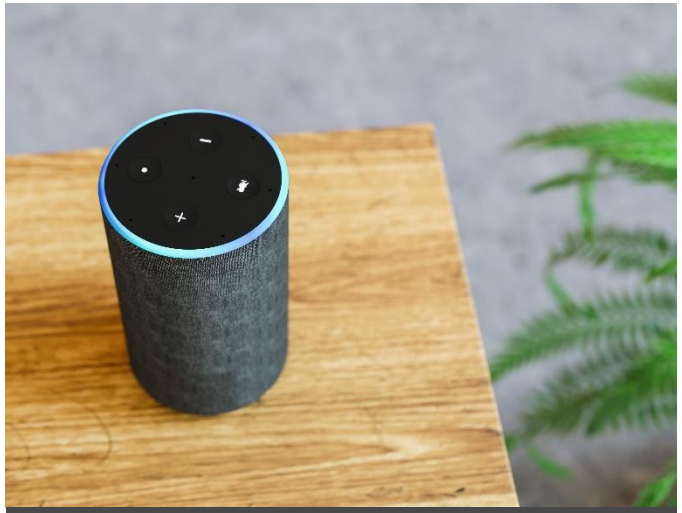
Poll

- How much about deep learning with MATLAB do you already know?

https://menti.com

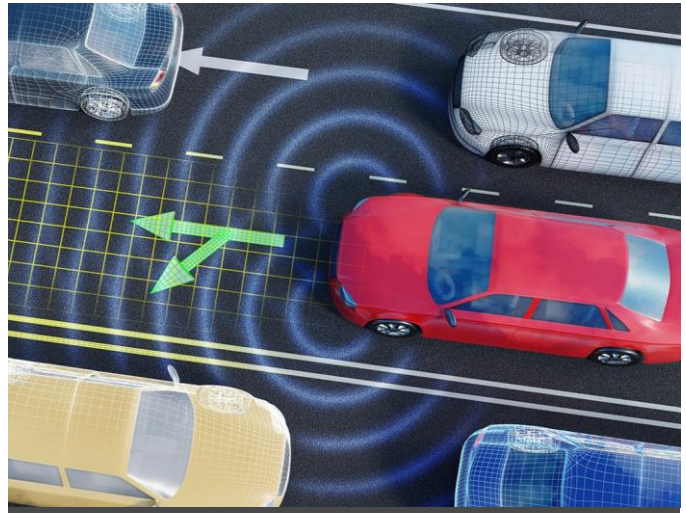
Code: 3539 4588

Deep learning is part of our everyday lives



Speech Recognition

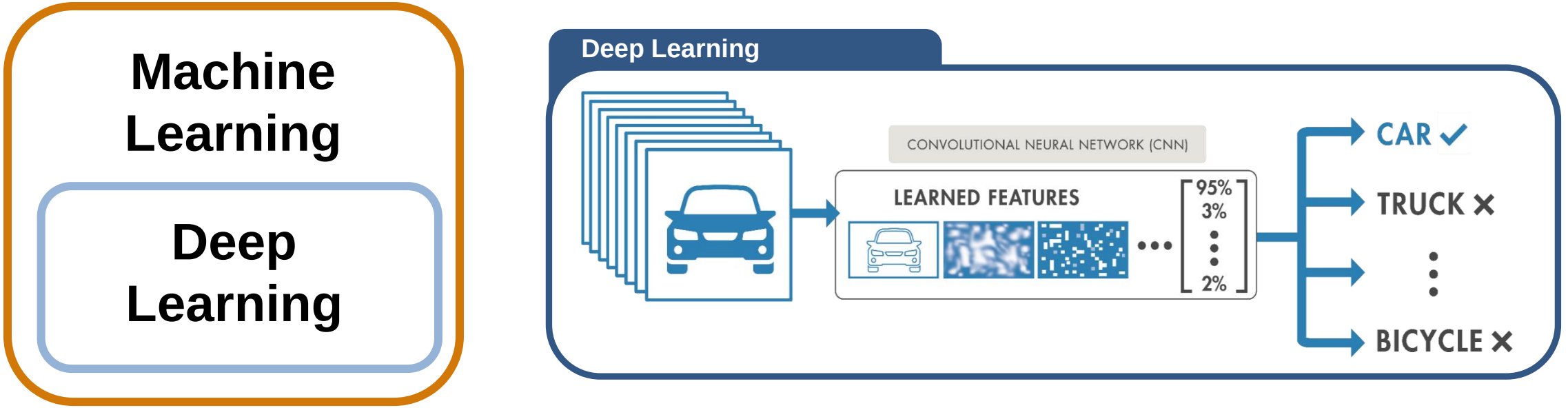
Face Detection



Automated Driving

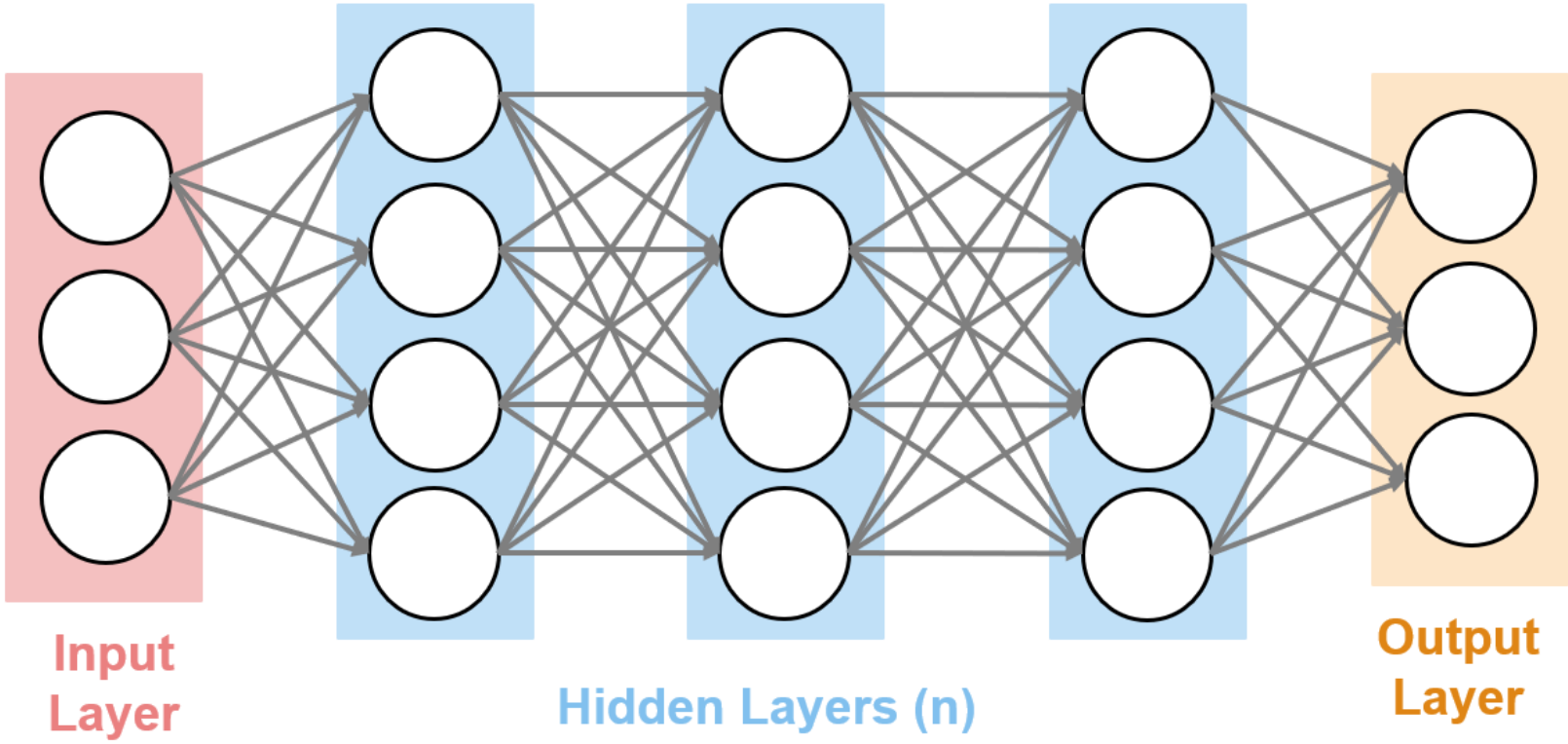
What is Deep Learning?

- Subset of machine learning with automatic feature extraction
  - Learns features and tasks directly from data
- Accuracy can surpass traditional ML Algorithms



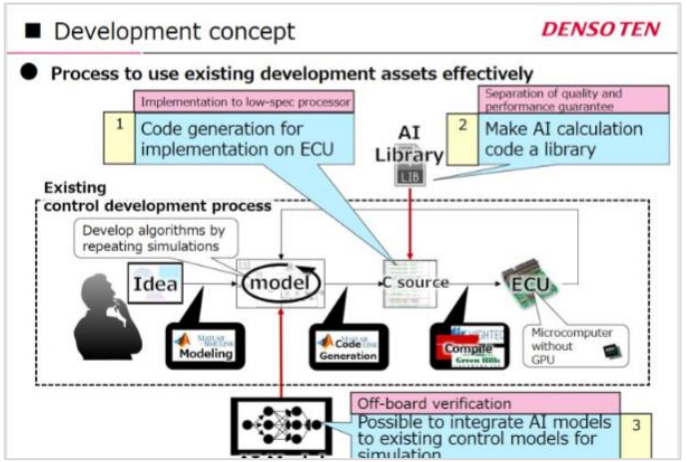
Deep Learning Models are Neural Networks

- Deep neural networks have many layers
- Data is passed through the network, and the layer parameters are updated (training)

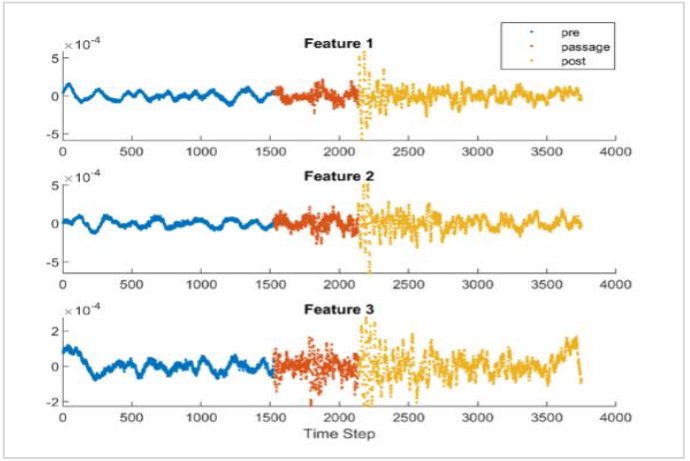


MATLAB Deep Learning used in Industry

Automatic Defect Detection
Airbus



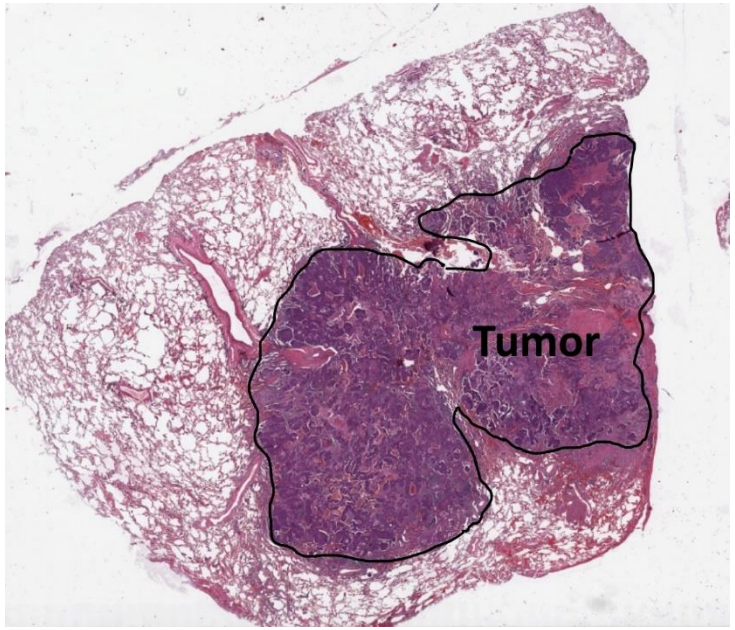
ECU Vehicle Control
Denso



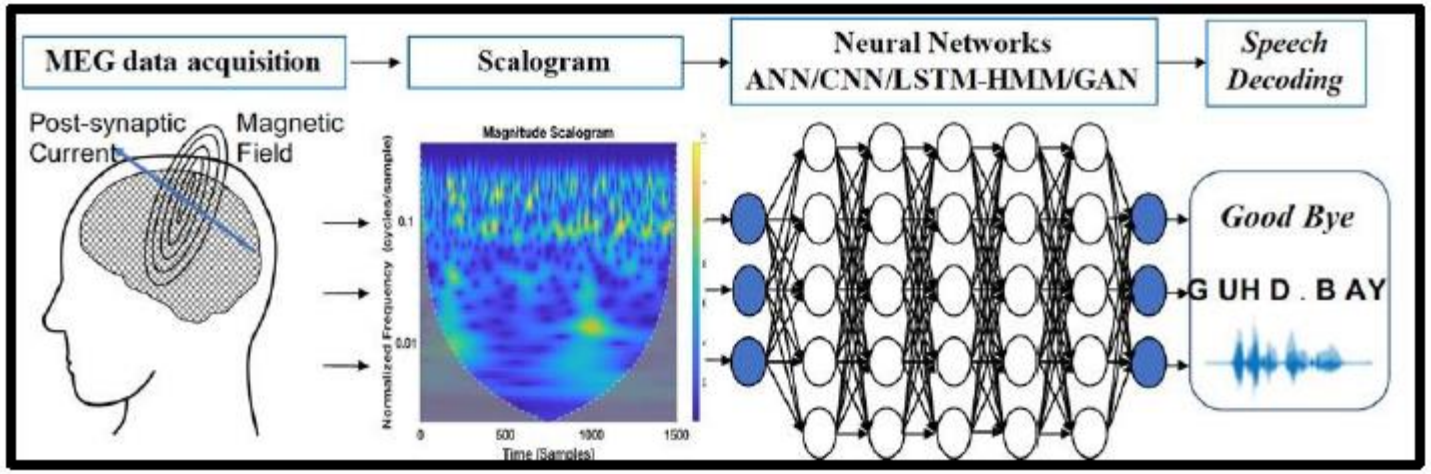
Seismic Event Detection
Shell

6

MATLAB Deep Learning used in Research



[Predicting gastrointestinal cancer](#) (July 2019)



[Converting brain waves to speech to help ALS patients communicate](#) (Nov 2019)

7

Deep Learning Workflow

Data Preparation

Data cleansing and preparation

Human insight

Simulation-generated data

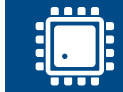
AI Modeling

Model design and tuning

Hardware accelerated training

Interoperability

Deployment



Embedded devices

Enterprise systems

Edge, cloud, desktop

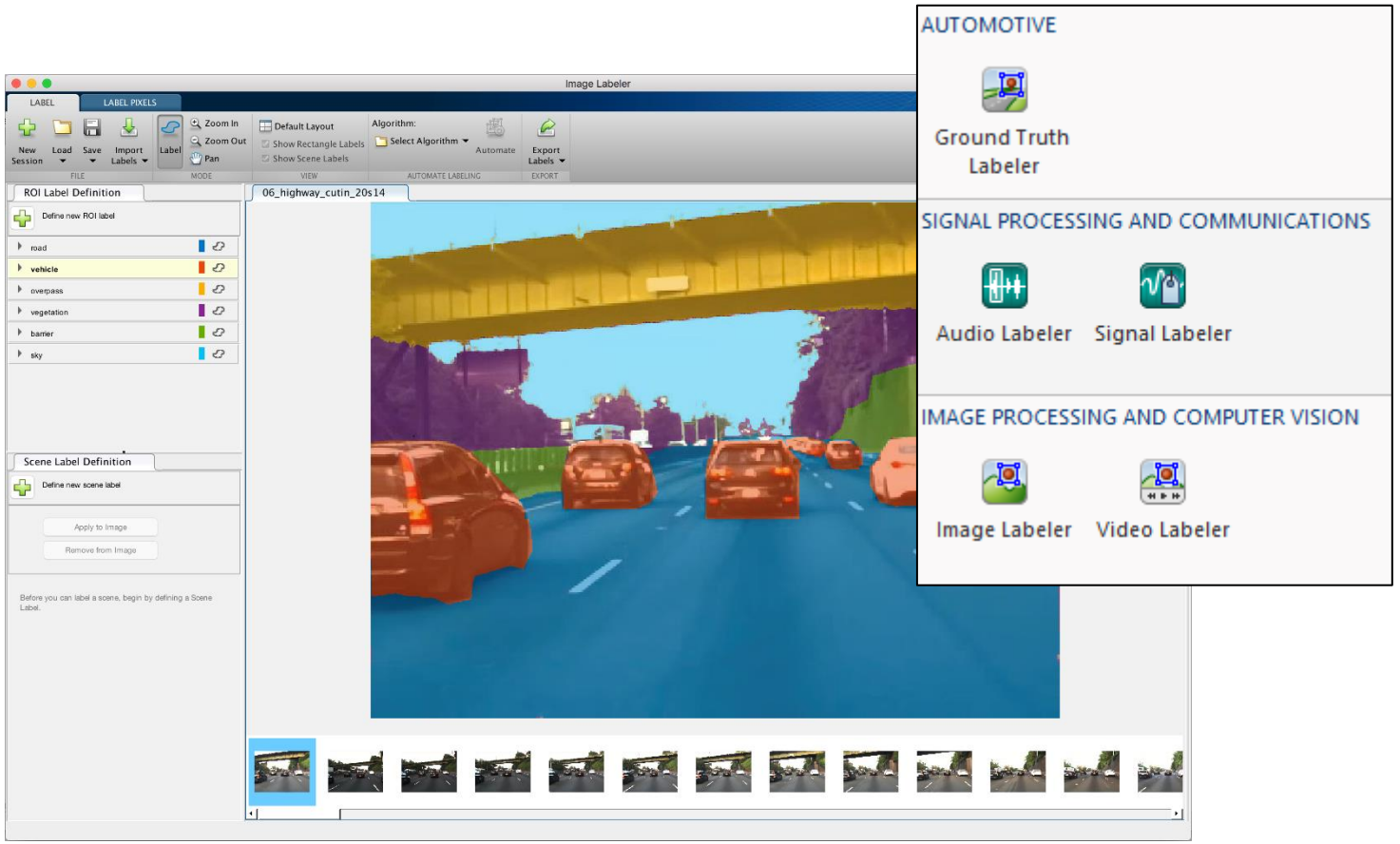
8

Spend less time preprocessing and labeling data

Synchronize disparate time series, filter noisy signals, automate labeling of video, and more.

Data Preparation

- Data cleansing and preparation
- Human insight
- Simulation-generated data

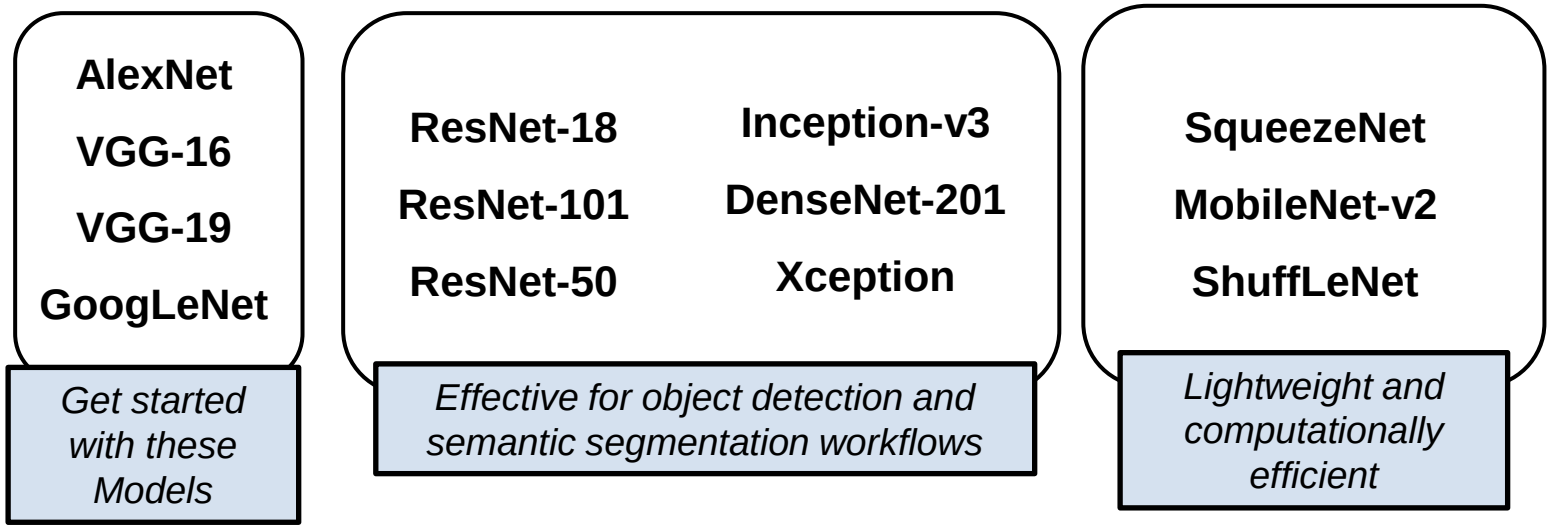


Use labeling apps for deep learning workflows like semantic segmentation

9

We Can Build Networks from Scratch or Use Pretrained Models

- Pretrained models have predefined layer orders and parameter values
- Can be used directly for inference (AlexNet Example)



Full list of models available HERE

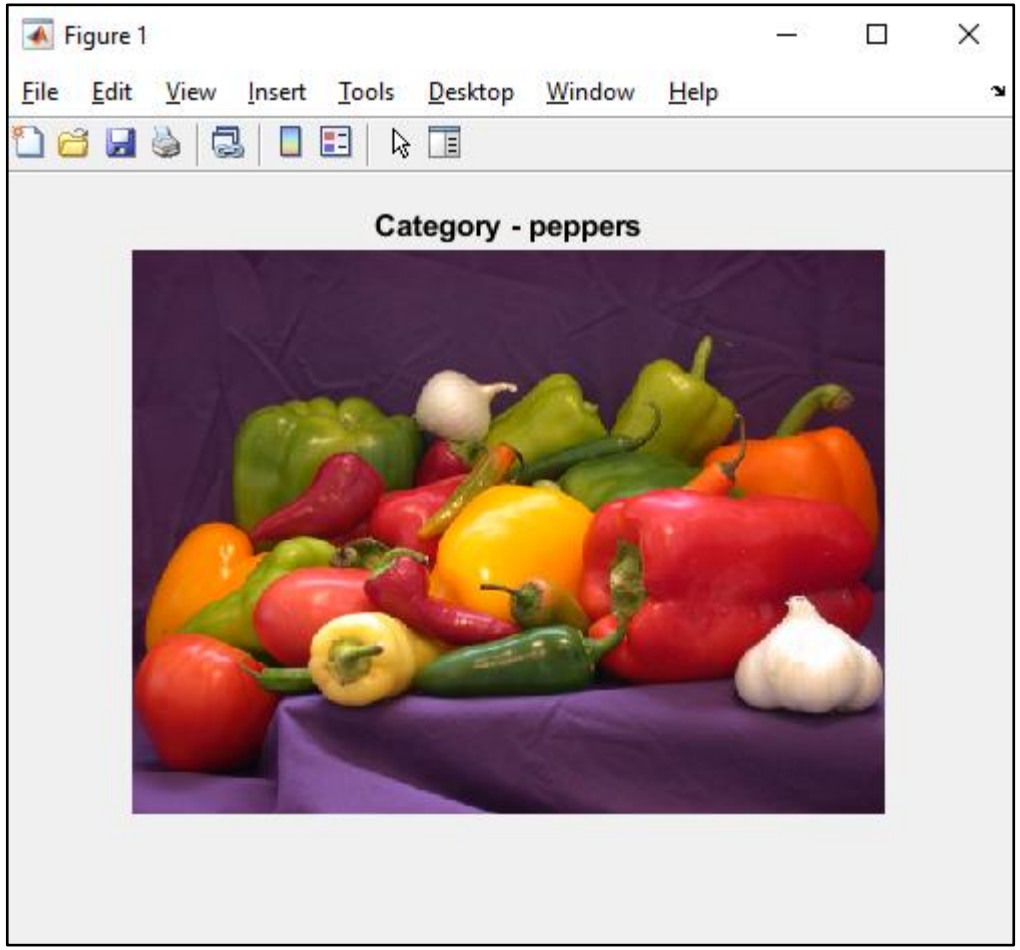
Deep Learning in 4 Lines of Code

- Use a pretrained neural network to classify an image

Demo!

- To follow along, download this folder or launch on MATLAB Online
- Open `pretrained_network_demo.mlx`

- Links available on the Facebook event page



What if pretrained models aren't enough?

Transfer learning

Take a pretrained model and modify it slightly

Pros

- Faster training
- Less data needed
- Most of the work already done

Cons

- Less customizable
- Must have a good pretrained model

Train from scratch

Make and train a neural network from scratch

Pros

- Fully customizable

Cons

- More data needed
- Slower training time

Transfer Learning Workflow

Load pretrained network

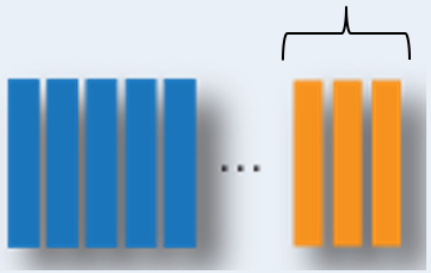
Early layers that learned low-level features (edges, blobs, colors)

Last layers that learned task specific features

1 million images
1000s classes

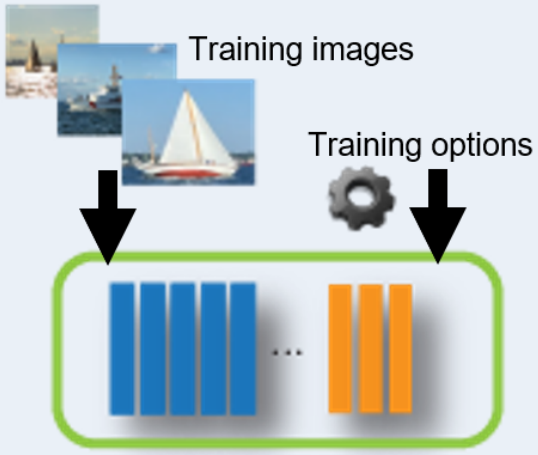
Replace final layers

New layers to learn features specific to your data



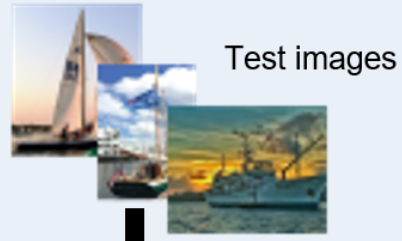
Fewer classes
Learn faster

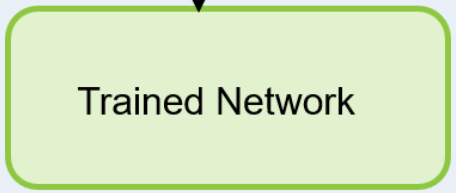
Train network



100s images
10s classes

Predict and assess network accuracy





Classifying MathWorks Merch

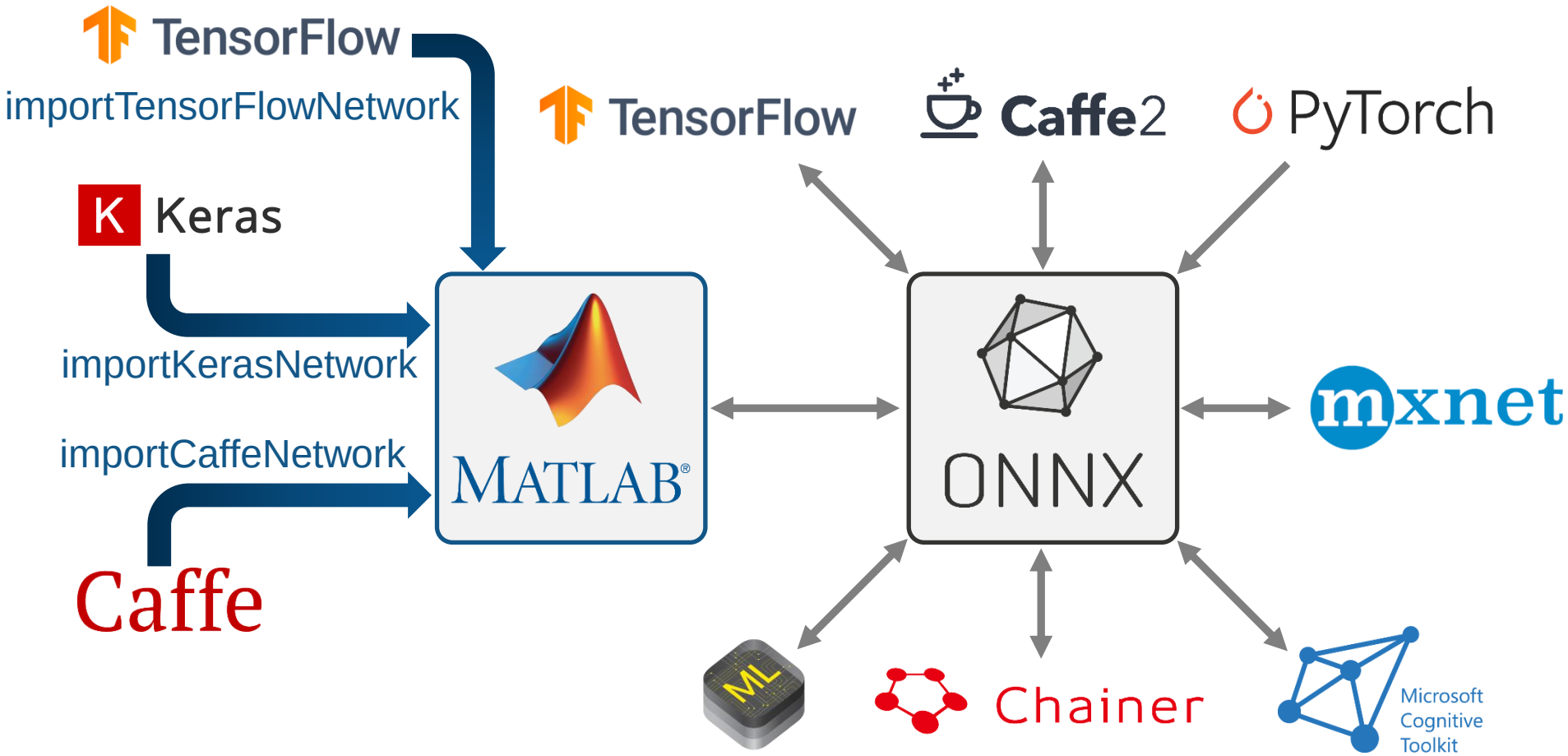
Purpose:

- Use transfer learning to leverage a pretrained model to classify different MathWorks merch items

Demo!

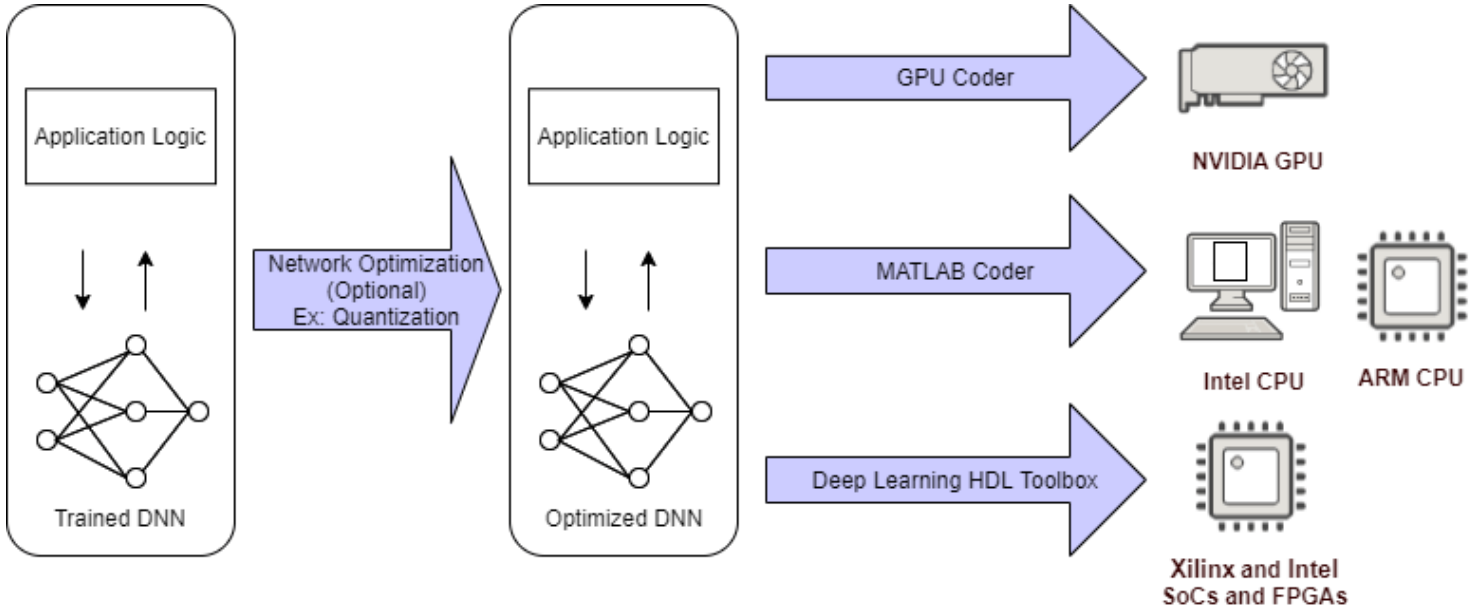
- Same link as before
- Open `transfer_learning_demo.mlx`

Import and Export Models to/from other Frameworks



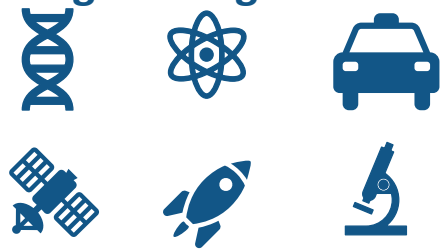
Code Generation for Deep Learning

- Generate CUDA, C/C++ code
- Compress model
  - Reduce precision of floats, ints
  - Approximate convolutions
- Deploy models on GPUs, CPUs, FPGAs



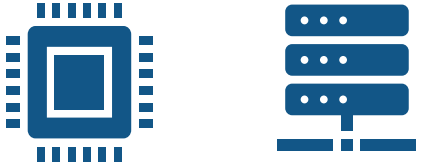
Why MATLAB & MathWorks for Deep Learning?

Domain-specialized workflows for **engineering and science**



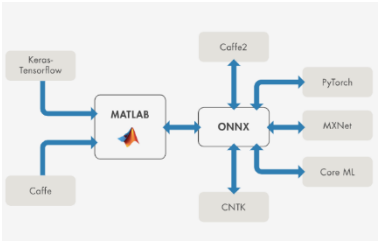
People

Multi-platform **deployment of full applications and systems**

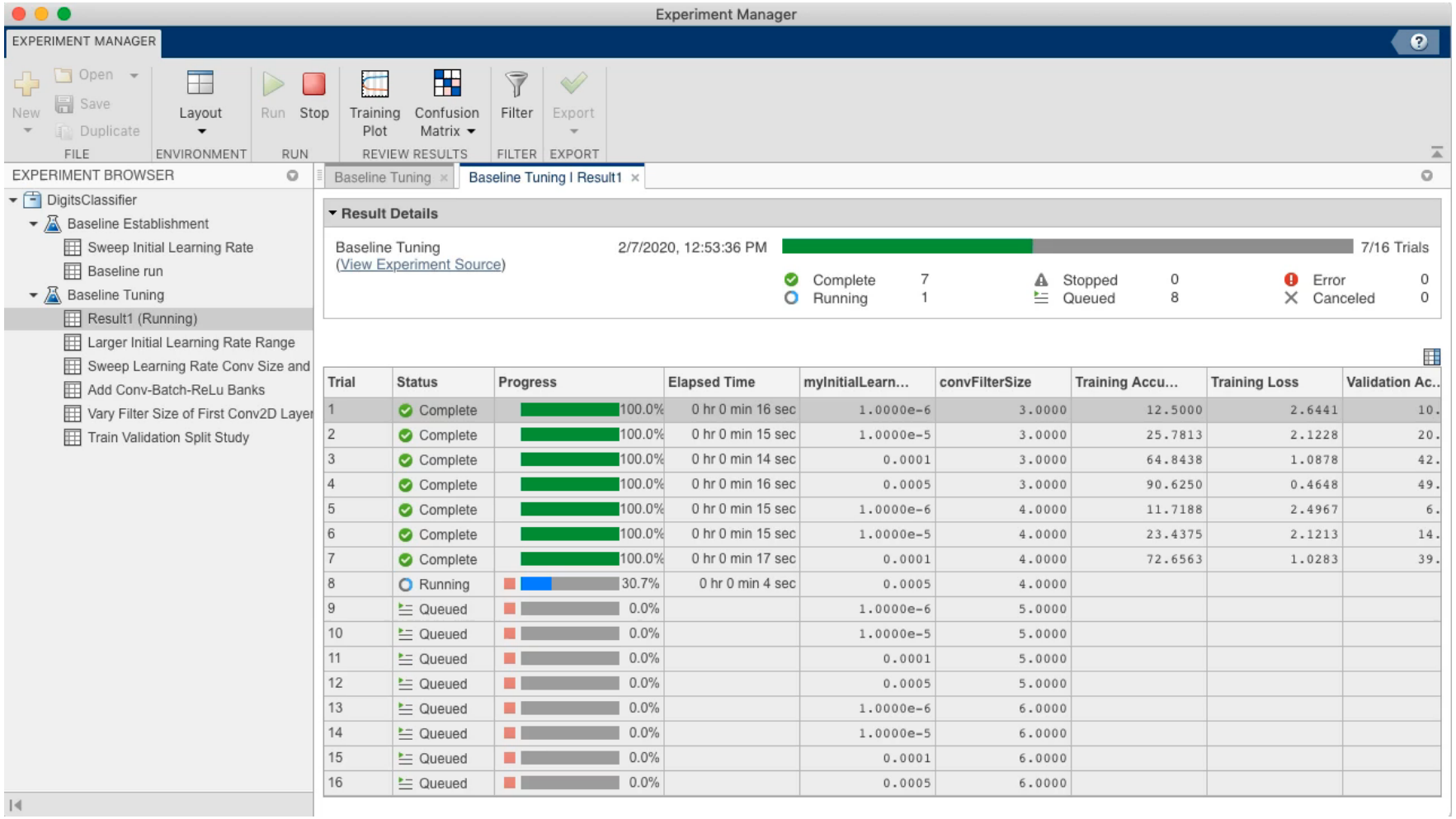


Platform productivity

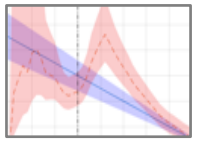
Interoperability with TensorFlow and PyTorch



Experiment Manager – Run, Track, and Analyze Multiple Deep Learning Experiments



MathWorks Focus on Deep Learning and AI for Engineering and Science

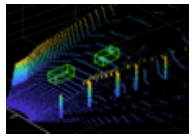


Predictive Maintenance
- Bearing Prognosis
- Pump Fault Diagnosis

Predictive Maintenance Toolbox™

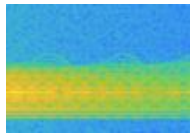
Land-Use Classification
- Semantic Segmentation for Multispectral Images

Image Processing Toolbox™



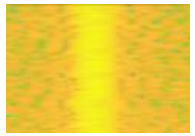
Lidar
- Lidar Point Cloud Semantic Segmentation
- 3-D Object Detection Using PointPillars

Lidar Toolbox™



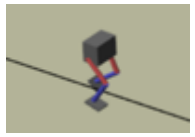
Radar
- Radar Waveform Classification
- Pedestrian and Bicyclist Classification

Phased Array System Toolbox™



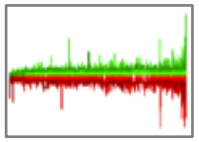
Wireless Communications
- Modulation Classification
- Detect WLAN Router Impersonation

Communications Toolbox™



Reinforcement Learning
- Train Biped Robot to Walk
- PMSM Motor Control

Reinforcement Learning Toolbox™



Computational Finance
- Machine Learning for Statistical Arbitrage

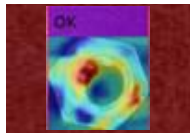
Financial Toolbox™

Robotics
- Avoid Obstacles using Reinforcement Learning

Robotics System Toolbox™

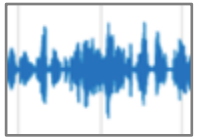
Automated Driving
- Deep Learning Vehicle Detector
- Occupancy Grid with Semantic Segmentation

Automated Driving Toolbox™



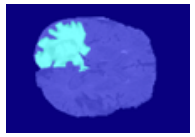
Visual Inspection
- Manufacturing Defect Detection
- Anomaly Detection for Cloth Manufacturing

Image Processing Toolbox™



Audio
- Speech Command Recognition
- Cocktail Party Source Separation

Audio Toolbox™



Medical Imaging
- 3-D Brain Tumor Segmentation
- Breast Cancer Tumor Classification

Image Processing Toolbox™

Self-paced Online Courses

- Getting Started (12)
- MATLAB (4)
- Simulink (5)
- **AI, Machine Learning, and Deep Learning (5)**
- Math and Optimization (6)
- Image and Signal Processing (3)

Explore over 50 virtual and in-person **classroom courses**

AI, Machine Learning, and Deep Learning

Machine Learning Onramp

40%

6 modules | 2 hours | Languages

Learn the basics of practical machine learning methods for classification problems.

Machine Learning with MATLAB

7 modules | 12 hours | Languages

Explore data and build predictive models.

Deep Learning Onramp

5%

5 modules | 2 hours | Languages

Get started quickly using deep learning methods to perform image recognition.

Deep Learning with MATLAB

55%

13 modules | 8 hours | Languages

Learn the theory and practice of building deep neural networks with real-life image and sequence data.

Reinforcement Learning Onramp

36%

5 modules | 3 hours | Languages

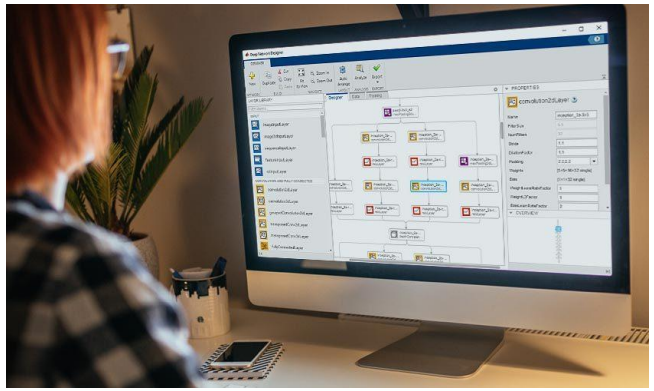
Master the basics of creating intelligent controllers that learn from experience.

https://matlabacademy.mathworks.com/

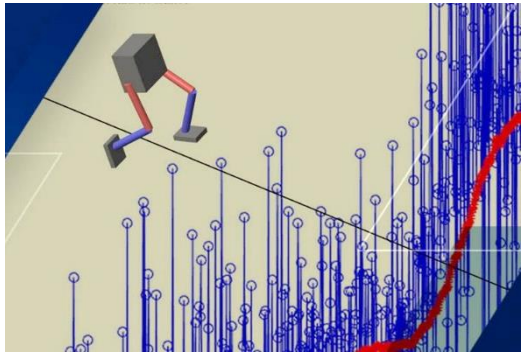
"The interactive MATLAB tutorials were perfect for engaging students and getting them up to speed quickly."

–Dr. Yu-li Wang, Carnegie Mellon University

More Deep Learning Resources from MathWorks

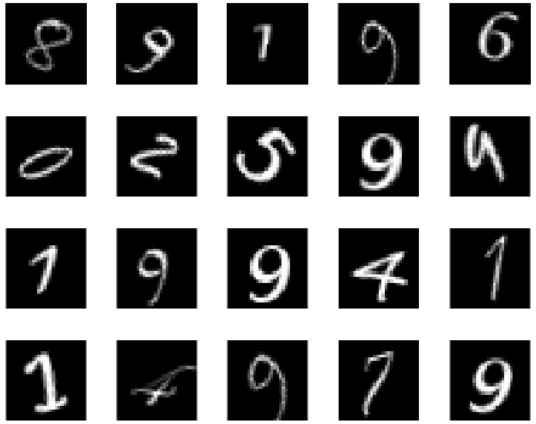


[Deep learning tutorials and examples with MATLAB]



[Reinforcement learning toolbox]

[Deep learning toolbox]



[Learn to create a neural network from scratch]

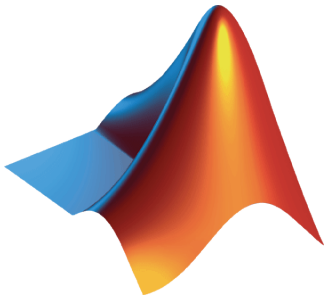
[Transformer models in MATLAB]

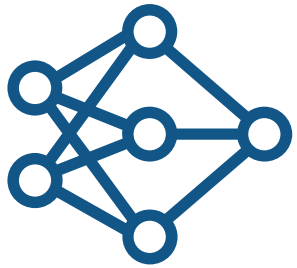
Learn Deep Learning at KTH

- DD2421 Machine learning
- DD2424 Deep learning in data science
- Masters program in machine learning
- KTH AI Society
- MATLAB@KTH

Thank you!

Questions?





Simon Thor
MATLAB Student Ambassador

Special thanks to Rohit Agrawal's for providing the basis of this presentation

© 2019 The MathWorks, Inc.