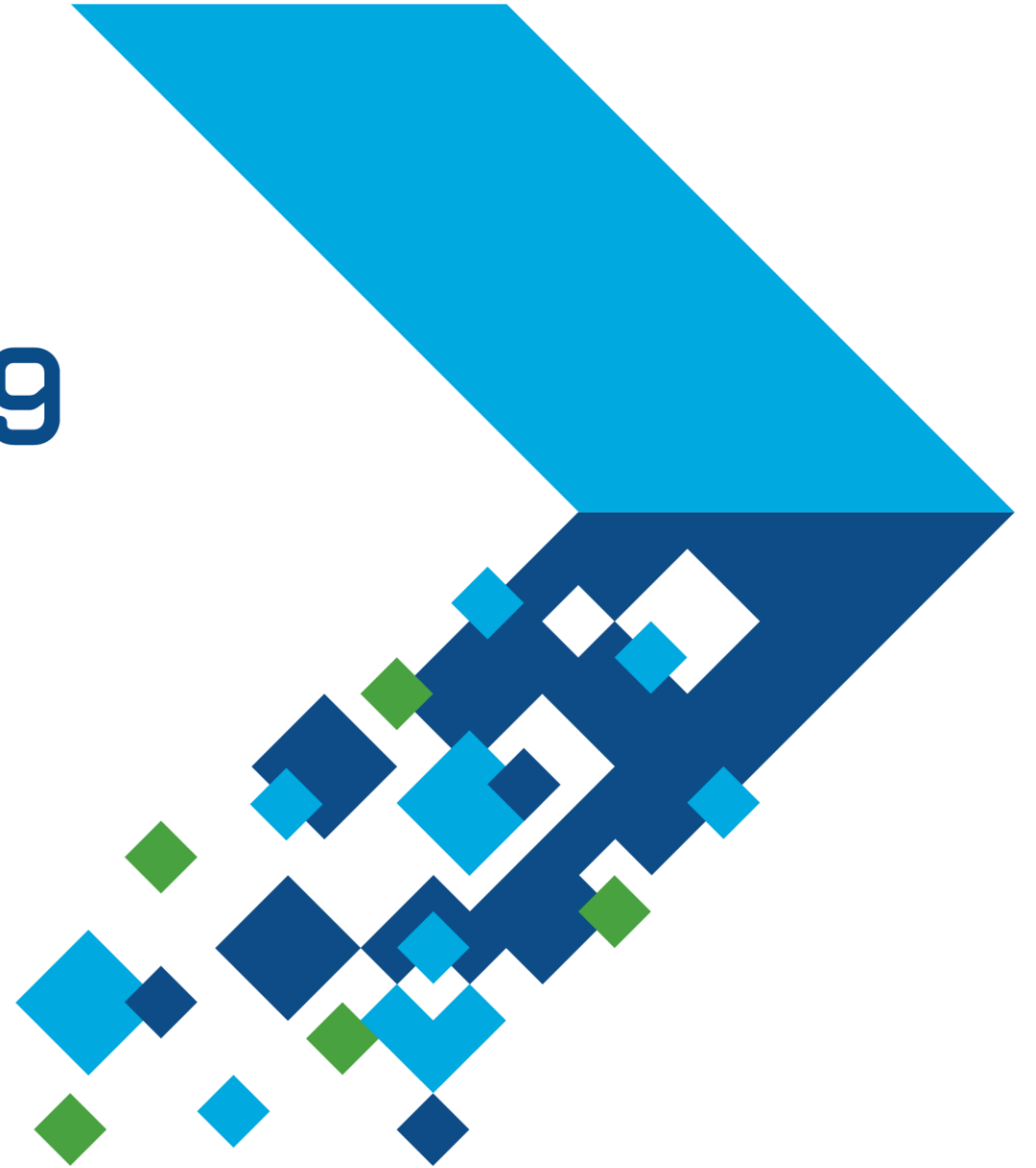


MATLAB EXPO 2019

Deep Learning y
Reinforcement Learning para
Inteligencia Artificial

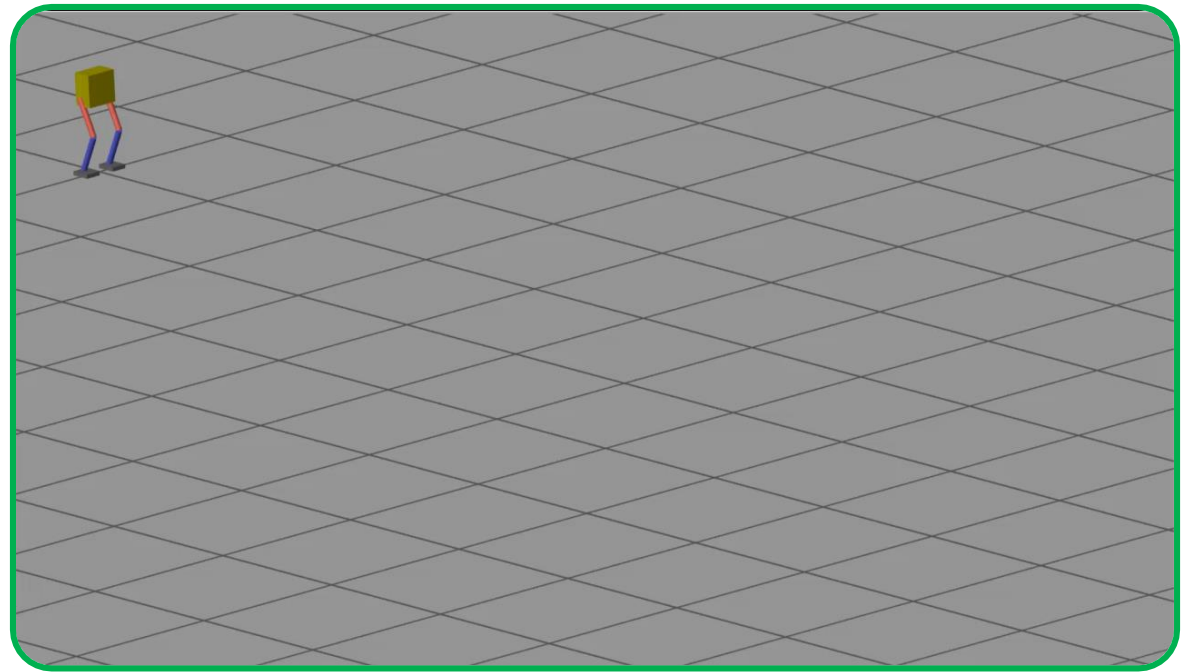
Lucas García



Why MATLAB for Artificial Intelligence?

Artificial Intelligence

Development of computer systems to perform tasks that normally require human intelligence



A.I. Applications



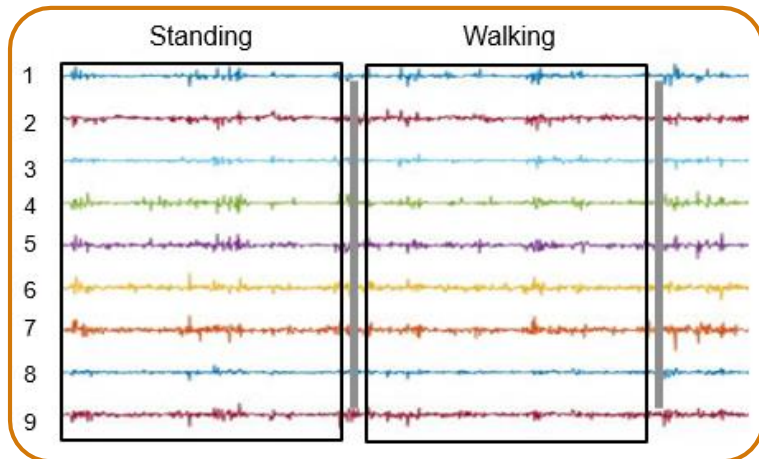
Object Classification



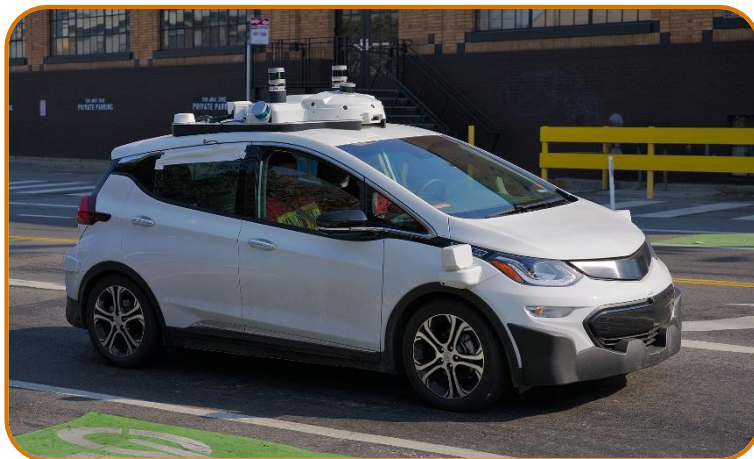
Speech Recognition



Predictive Maintenance



Signal Classification

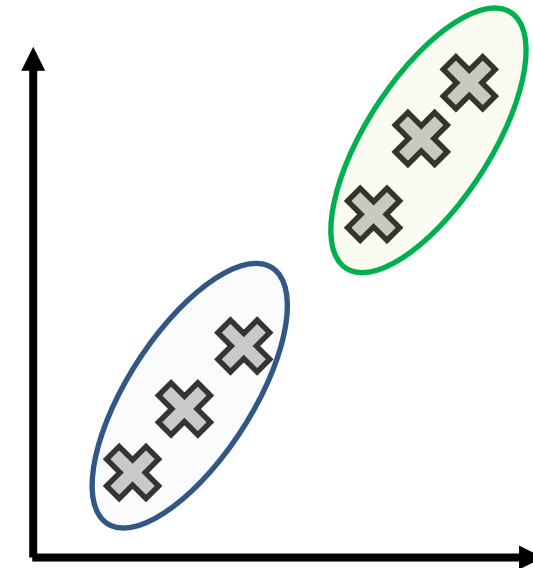
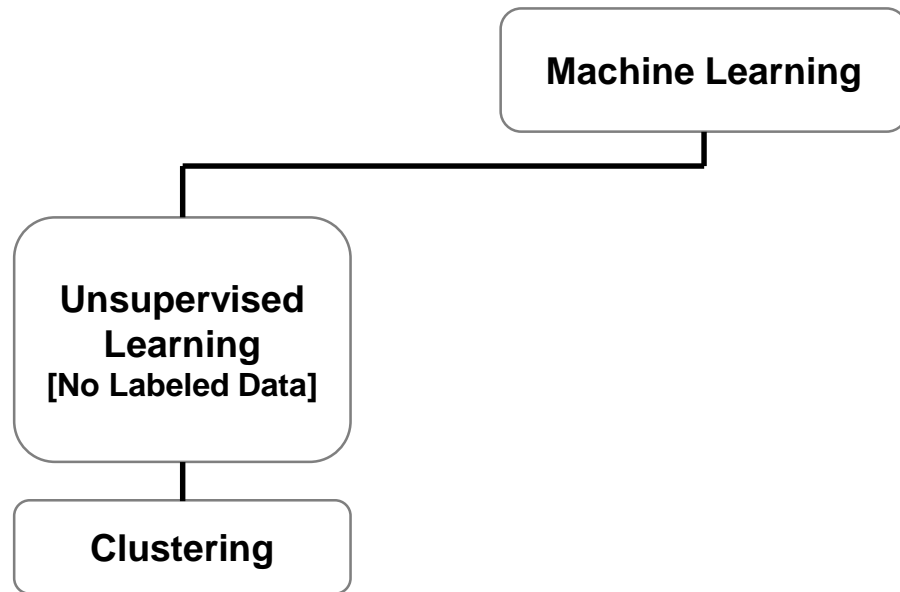


Automated Driving

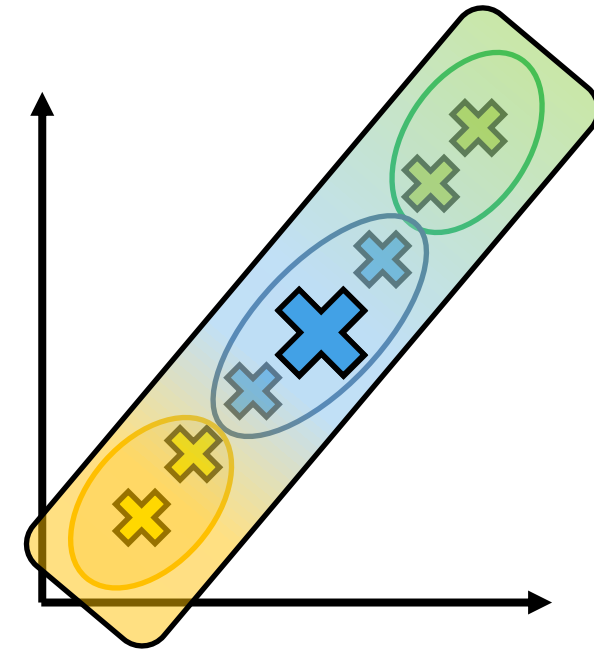
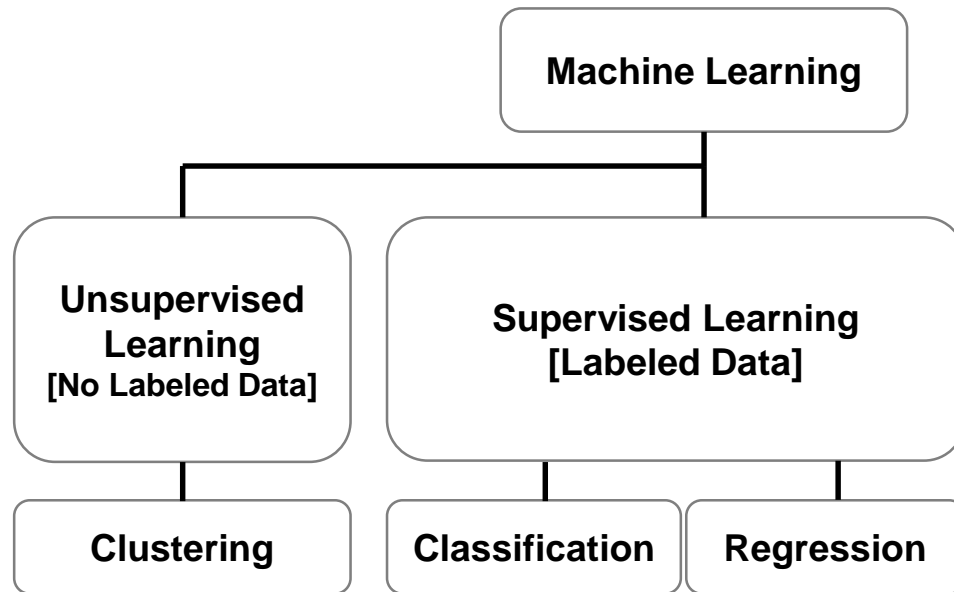


Stock Market Prediction

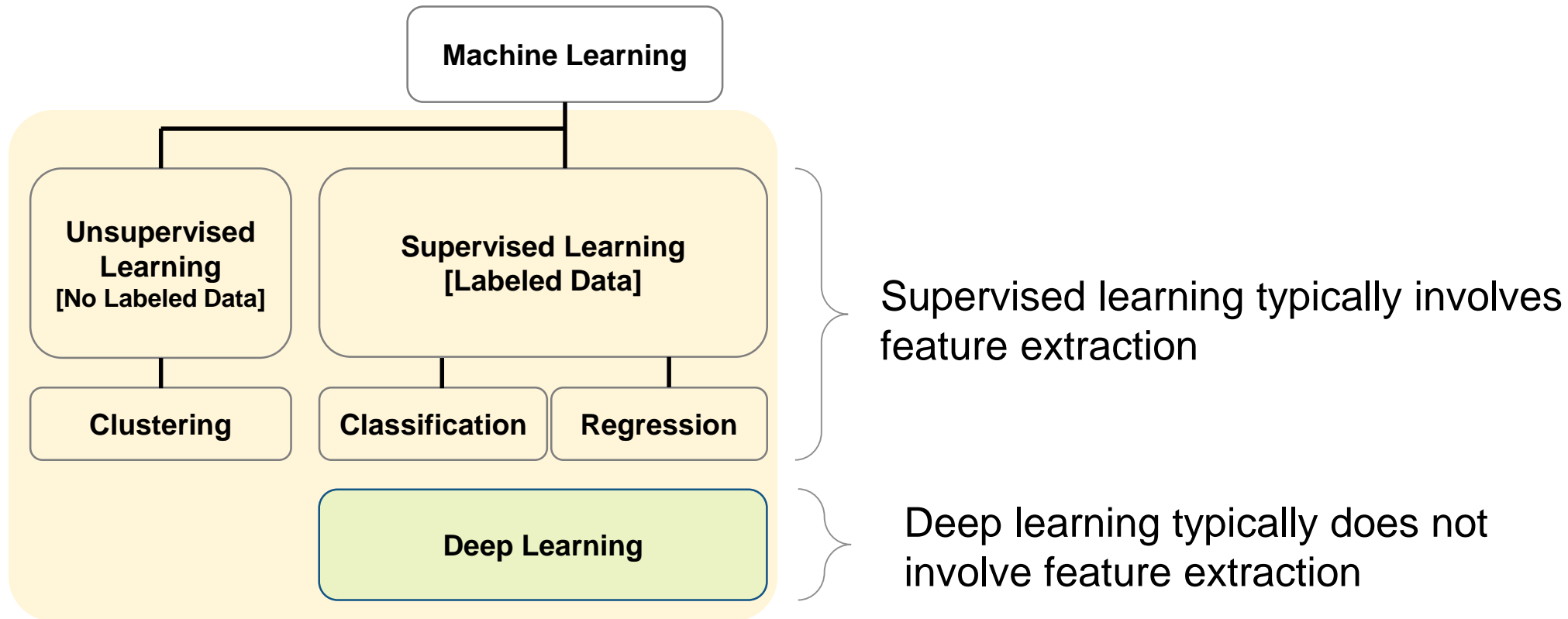
Machine Learning and Deep Learning



Machine Learning and Deep Learning



Machine Learning and Deep Learning

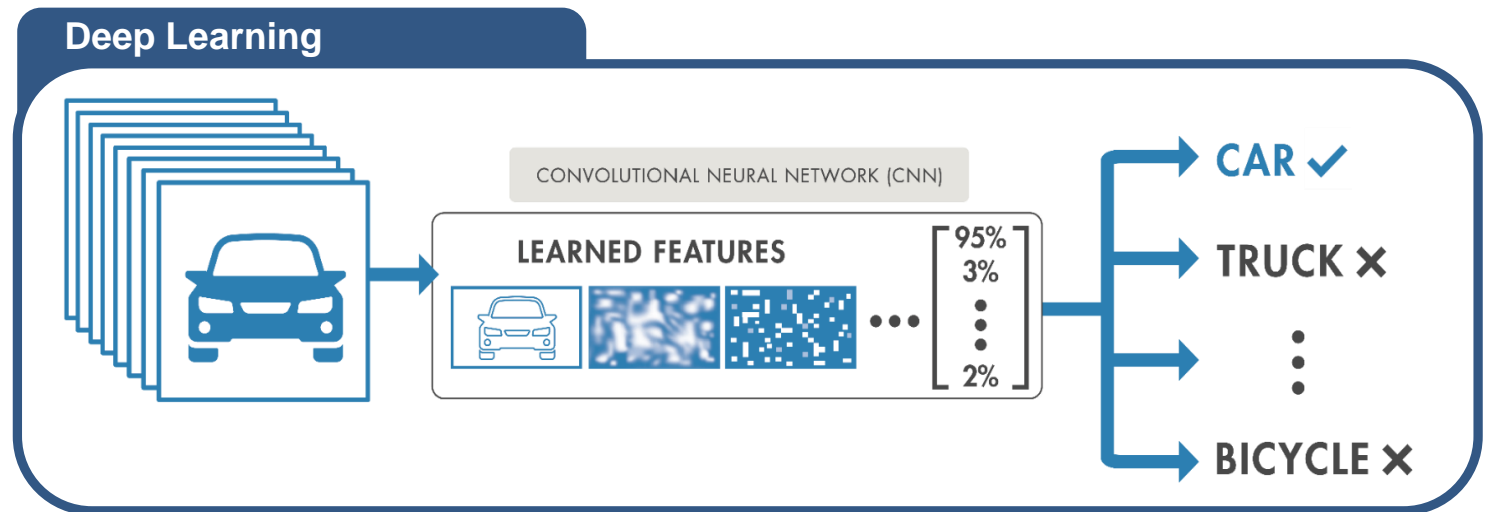


Deep Learning

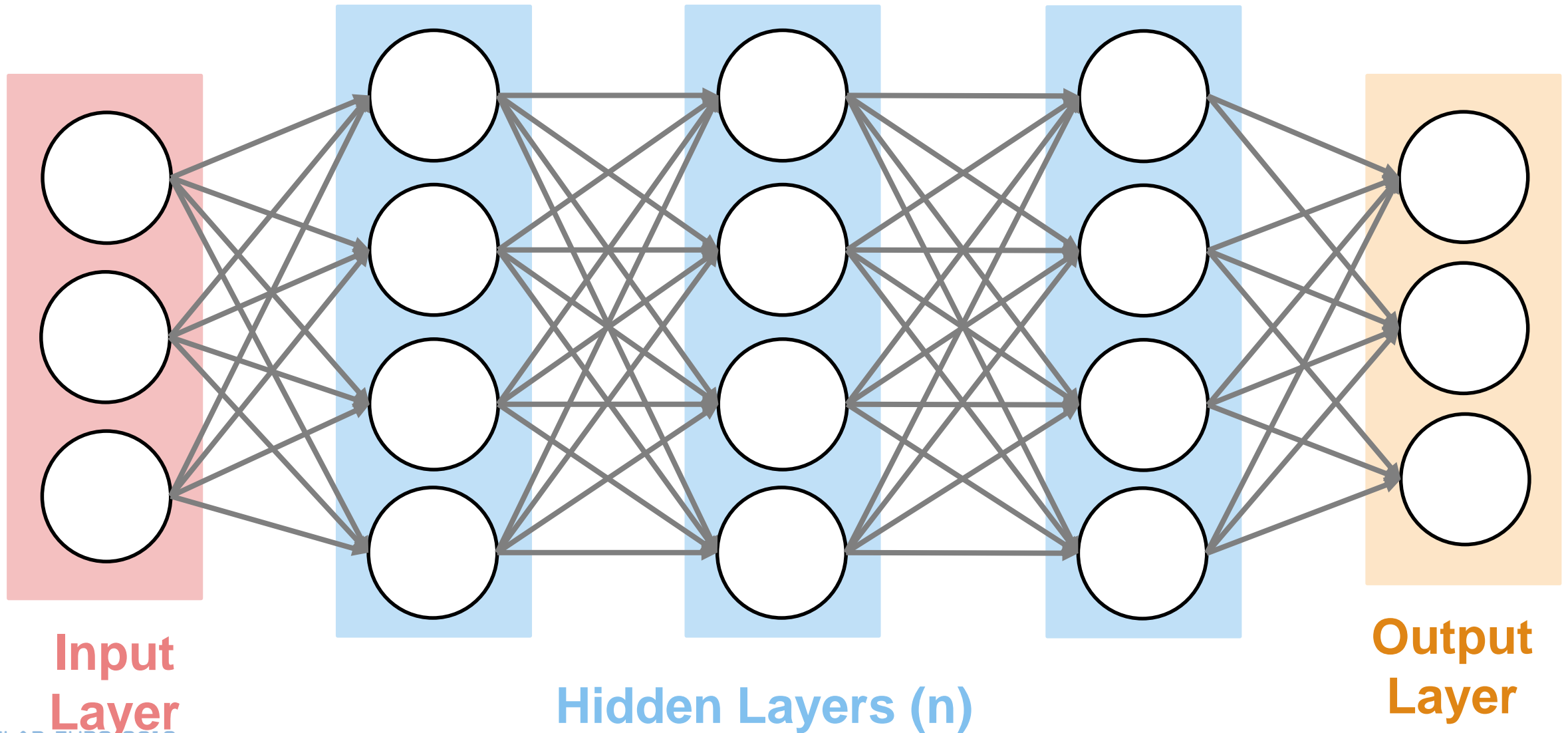
- Subset of machine learning with **automatic feature extraction**
 - Learns features and tasks directly from data
 - More Data = better model

**Machine
Learning**

**Deep
Learning**




Deep Learning Uses a Neural Network Architecture



11

A scenic view of Mount Fuji, Japan, with vibrant red autumn foliage in the foreground framing the snow-capped mountain. The mountain's reflection is visible in the calm water of a lake, and a small boat is visible on the water.

[illegible]

Deep Learning Workflow

Prepare Data



Data access and preprocessing



Ground truth labeling

Train Model



Model design,
Hyperparameter
tuning



Model exchange
across frameworks



Hardware-
accelerated training

Deploy

Multiplatform code
generation (CPU, GPU)



Edge deployment



Enterprise
Deployment

Why MATLAB for A.I. Tasks?

Increased productivity with interactive tools

Generate simulation data for complex models and systems

Ease of deployment and scaling to various platforms

Full A.I. workflows that cannot be easily replicated by other toolchains

Why MATLAB for A.I. Tasks?

Increased productivity with interactive tools

Labeling

Training

**Model
Exchange**

**Full A.I. workflows that cannot be easily
replicated by other toolchains**

Labeling for deep learning is **repetitive,**
tedious, and **time-consuming...**

but necessary

Image Labeler

LABEL

New Session

Load

Save

Import Labels

Label

Zoom In

Zoom Out

Pan

Default Layout

Show Rectangle Labels

Show Scene Labels

Algorithm:

Select Algorithm

Automate

Export Labels

FILEMODEVIEWAUTOMATE LABELINGEXPORT

ROI Label Definition

Define new ROI label

Vehicle

Scene Label Definition


Define new scene label


Apply to Image


Remove from Image

To label a scene, you must first define a scene label.

Car Image 1







LABEL

Load

Save

Import Labels

Label

Zoom In

Zoom Out

Pan

Layout

Show ROI Labels

Show Scene Labels

Algorithm

Select Algorithm

Configure Automation

Automate

View Label Summary

Export Labels

FILEMODEVIEWAUTOMATE LABELINGSUMMARYEXPORT

ROI Label Definition

Label

Sublabel

Attribute

Lane

Scene Label Definition

Define new scene label

Current Frame


Add Label

Time Interval

Remove Label

To label a scene, you must first define a scene label.

05_highway_lanechange_25s.mp4



00.00000

05.80000

25.00000

25.00000

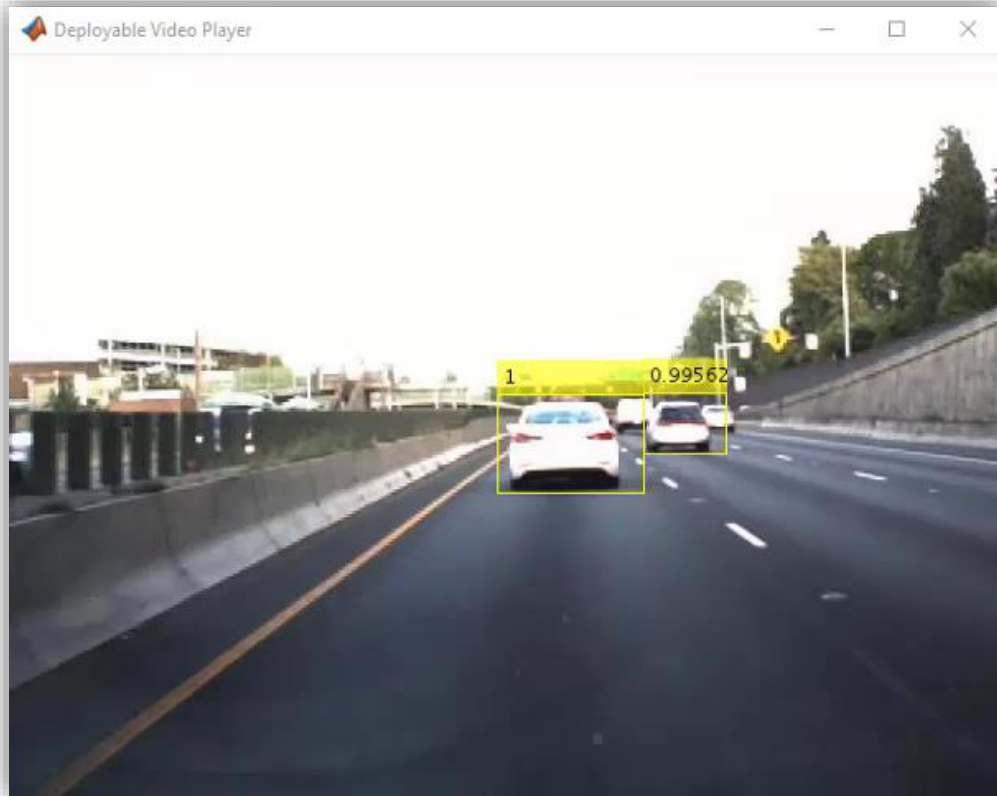
Start Time

Current

End Time

Max Time

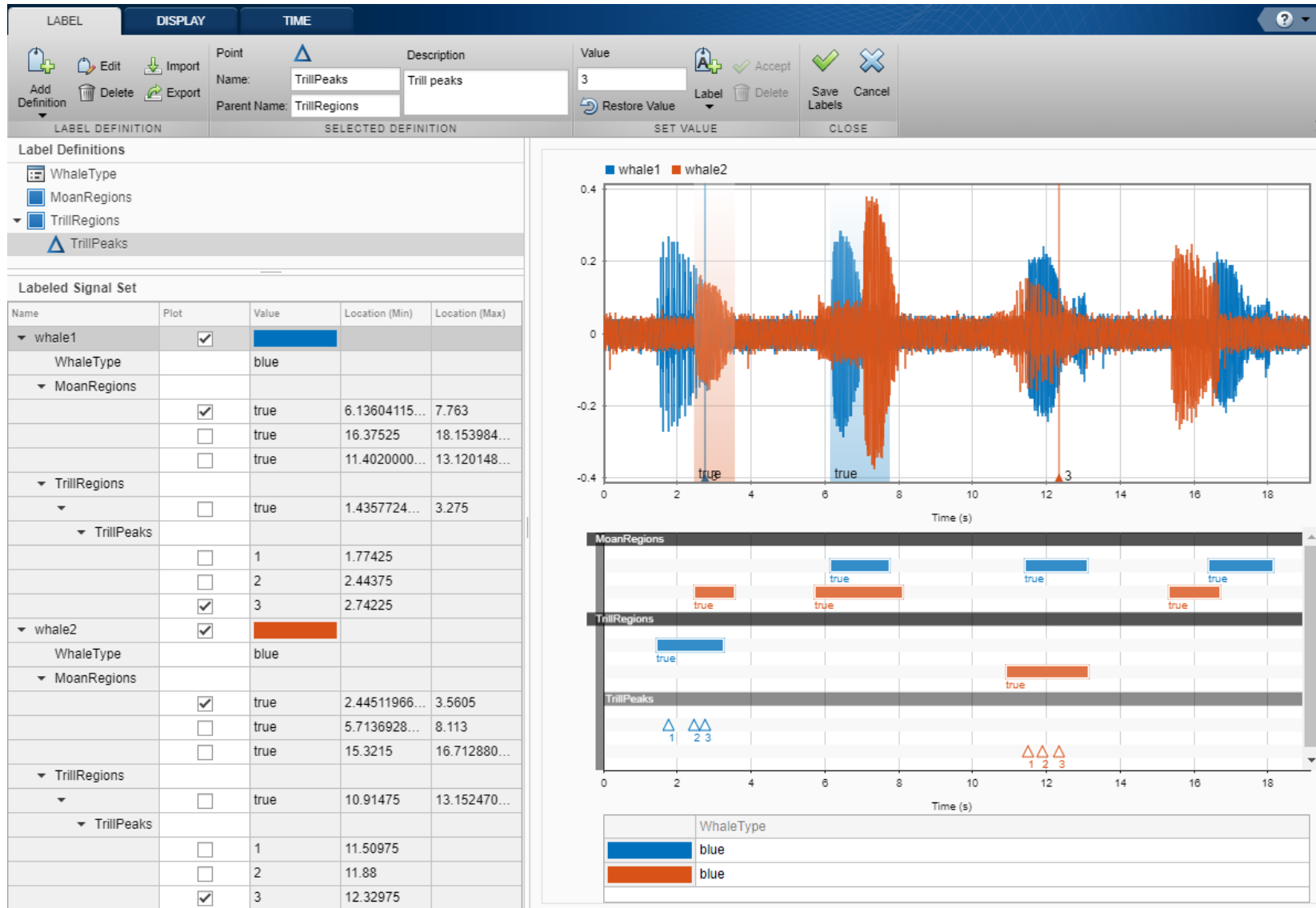
Zoom In Time Interval



Signal Labeler – annotate signals with labels/sublabels, export to workspace for training

Define Labels

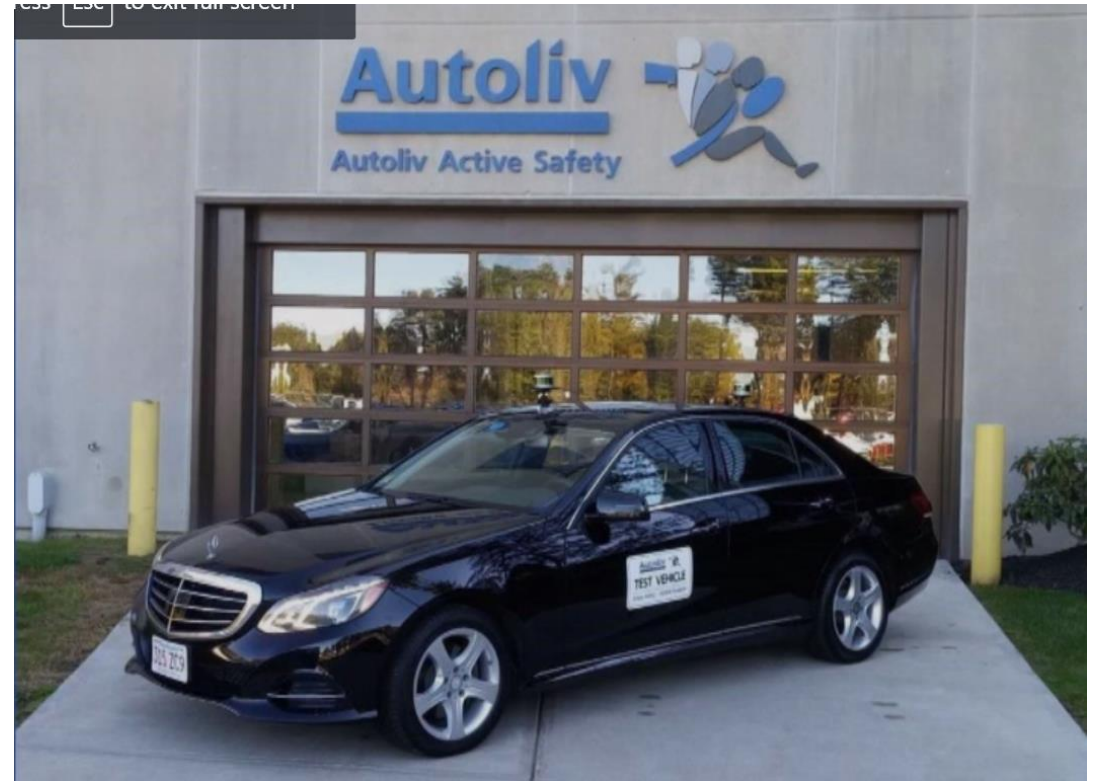
View properties of labels



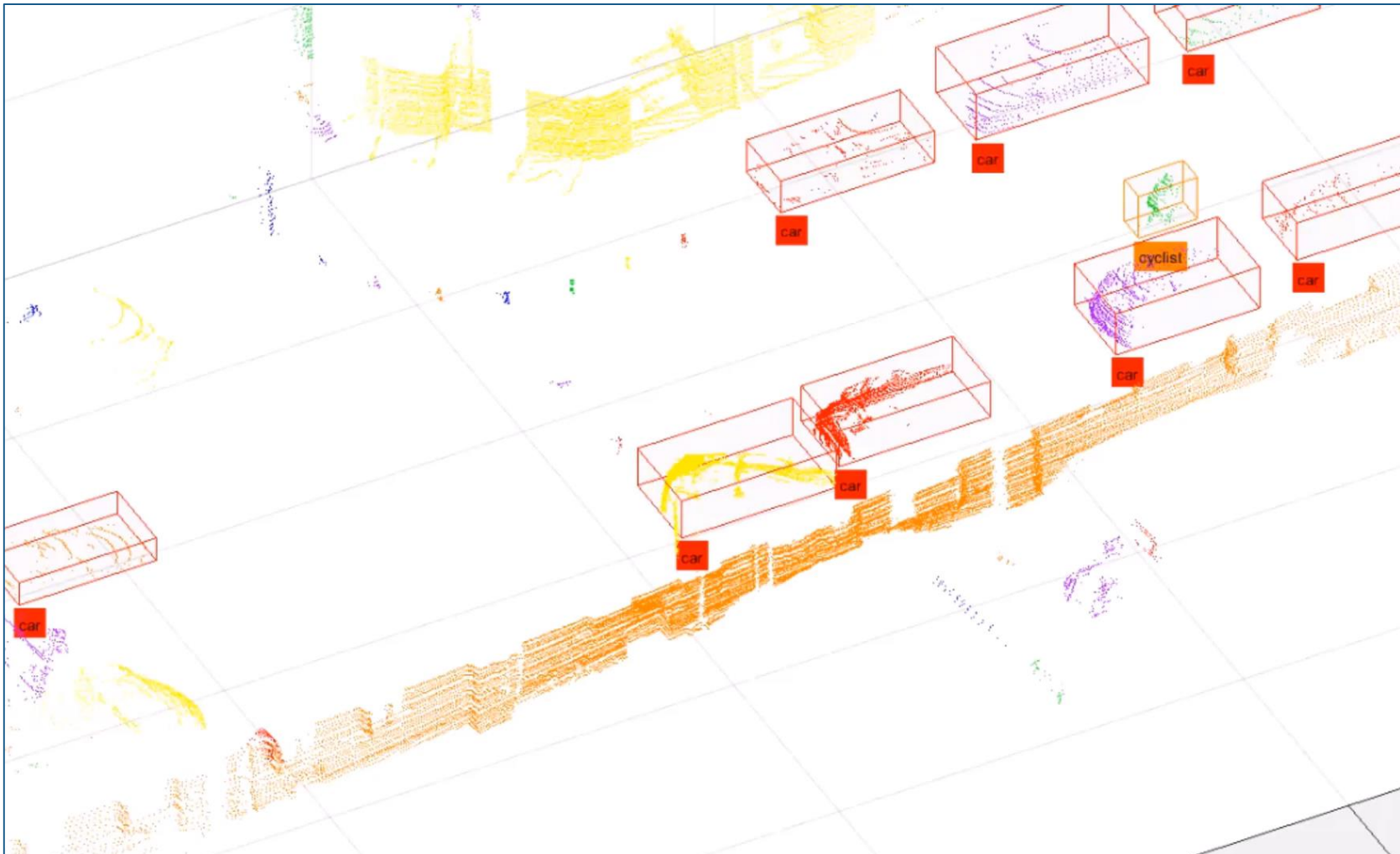
Interactively Label Signals

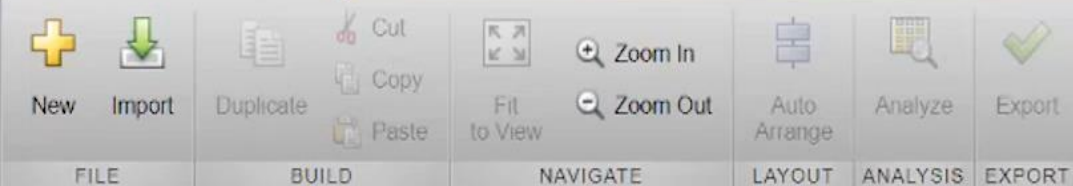
User Story – Veoneer (Autoliv)

- Automotive
 - Software and hardware for active safety, autonomous driving, occupant protection, and brake control
- Building radar sensor – check accuracy using LiDAR-based verification
- Human analyzes hours of recorded data
- Used MATLAB to semi-automate labeling and tracking of 3D LiDAR point clouds.



Manual Labeling for 25 events took over 20 minutes.
After full automation with MATLAB's tools, it took 5 minutes





LAYERS

Filter layers...

INPUT

- ImageInputLayer
- SequenceInputLayer

LEARNABLE

- Convolution2DLayer
- TransposedConvolution2DLayer
- FullyConnectedLayer
- LSTMLayer
- BiLSTMLayer

ACTIVATION

- ReLULayer
- LeakyReLULayer
- ClippedReLULayer

NORMALIZATION AND DROPOUT



PROPERTIES

Number of layers	0
Number of connections	0
Input type	None
Output type	None

Transfer Learning with Pre-trained Models

Inception-v3

ResNet-101

VGG-16

**Inception-
ResNet-v2**

ResNet-18

GoogLeNet

DenseNet-201

VGG-19

SqueezeNet

AlexNet

ResNet-50

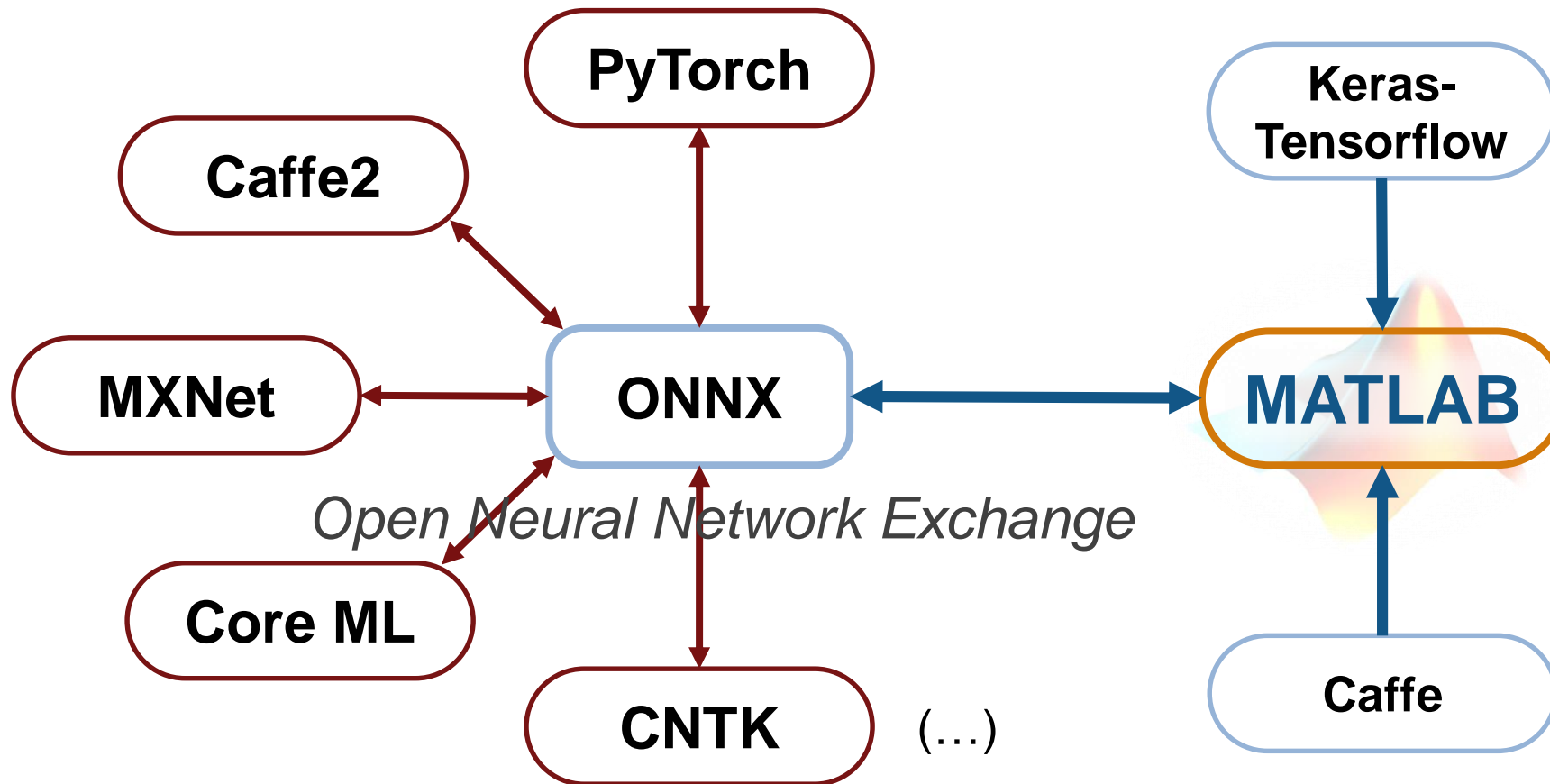
Import & Export Models Between Frameworks

**Keras-Tensorflow
Importer**

**Caffe Model
Importer**

**ONNX Model
Converter**

Model Exchange with MATLAB



Why MATLAB for A.I. Tasks?

Increased productivity with interactive tools

Generate simulation data for complex models and systems

Ease of deployment and scaling to various platforms

Full A.I. workflows that cannot be easily replicated by other toolchains

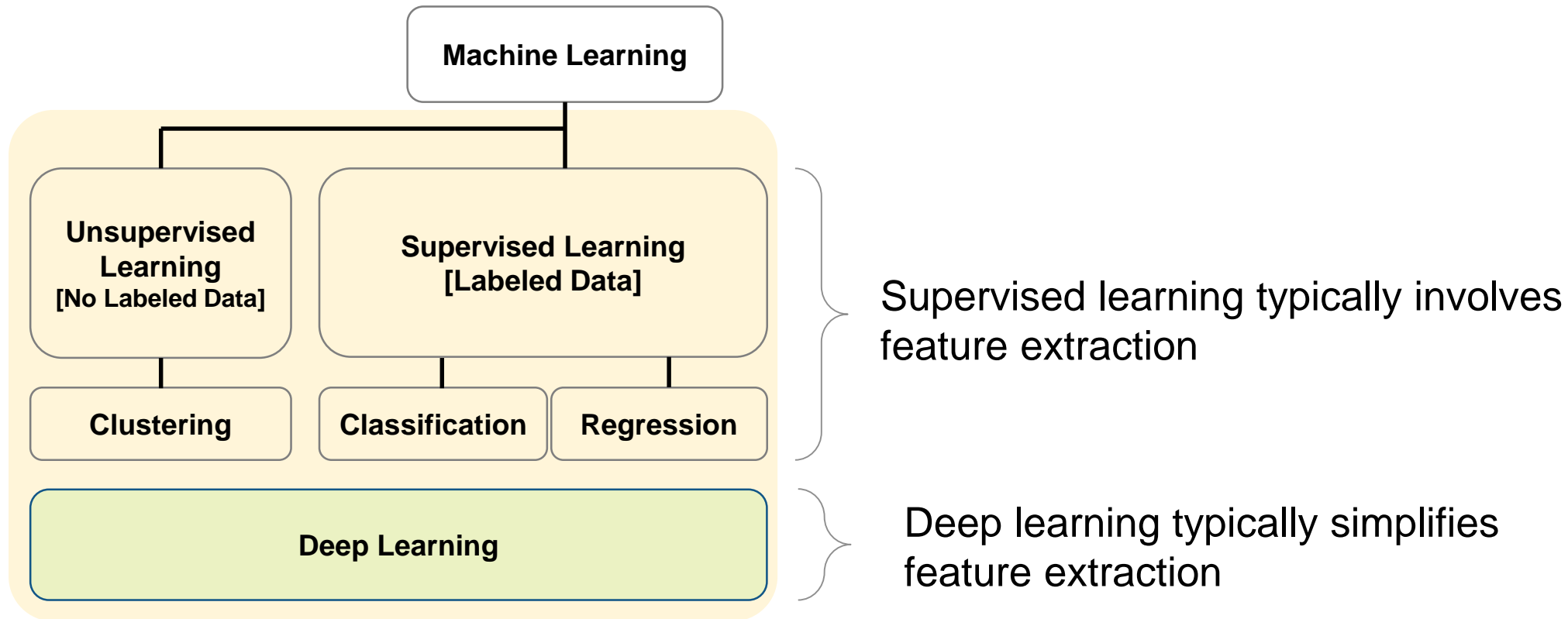
Why MATLAB for A.I. Tasks?

Generate simulation data for complex models and systems

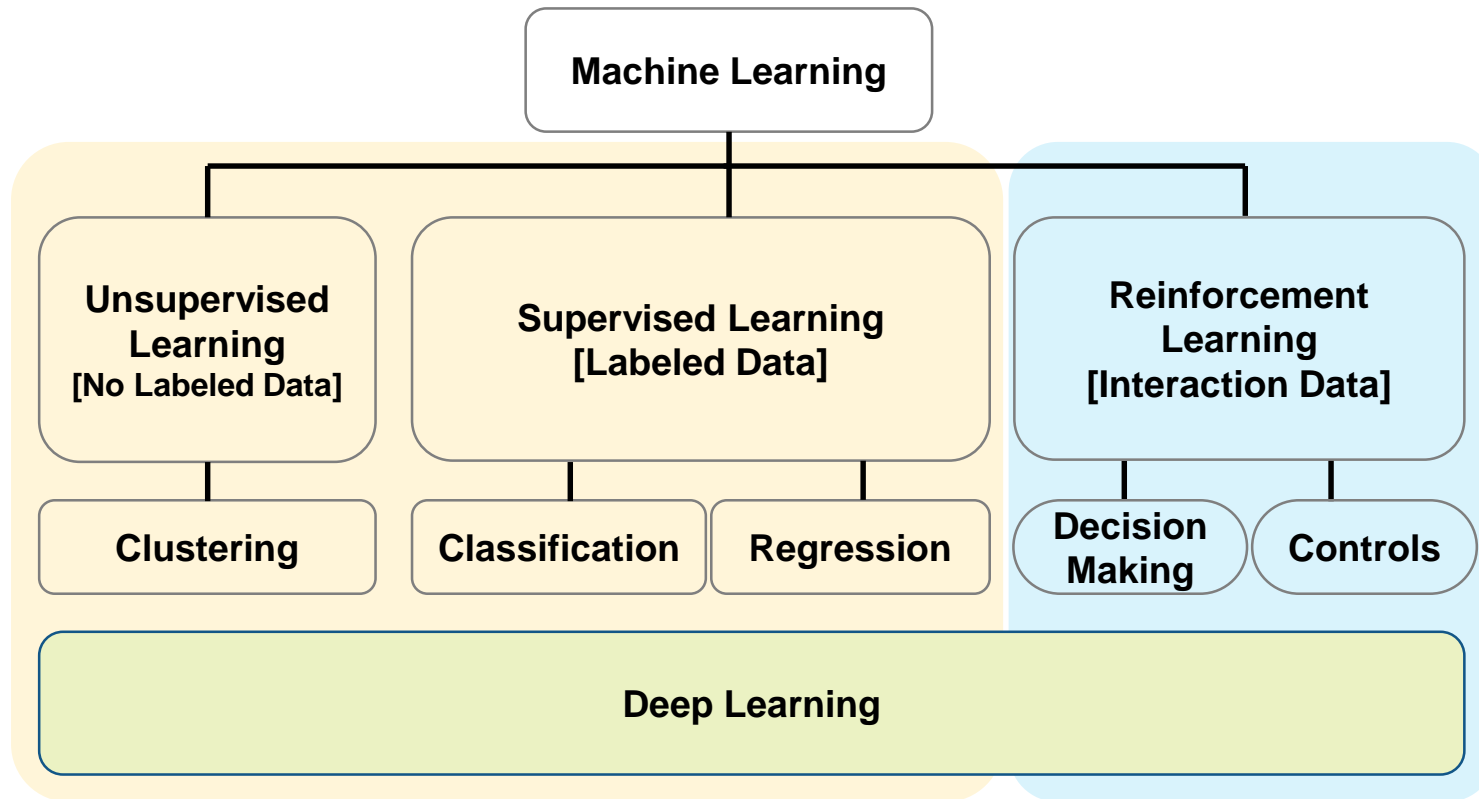
**Reinforcement
Learning**

**Full A.I. workflows that cannot be easily
replicated by other toolchains**

Reinforcement Learning vs Machine Learning vs Deep Learning



Reinforcement Learning vs Machine Learning vs Deep Learning

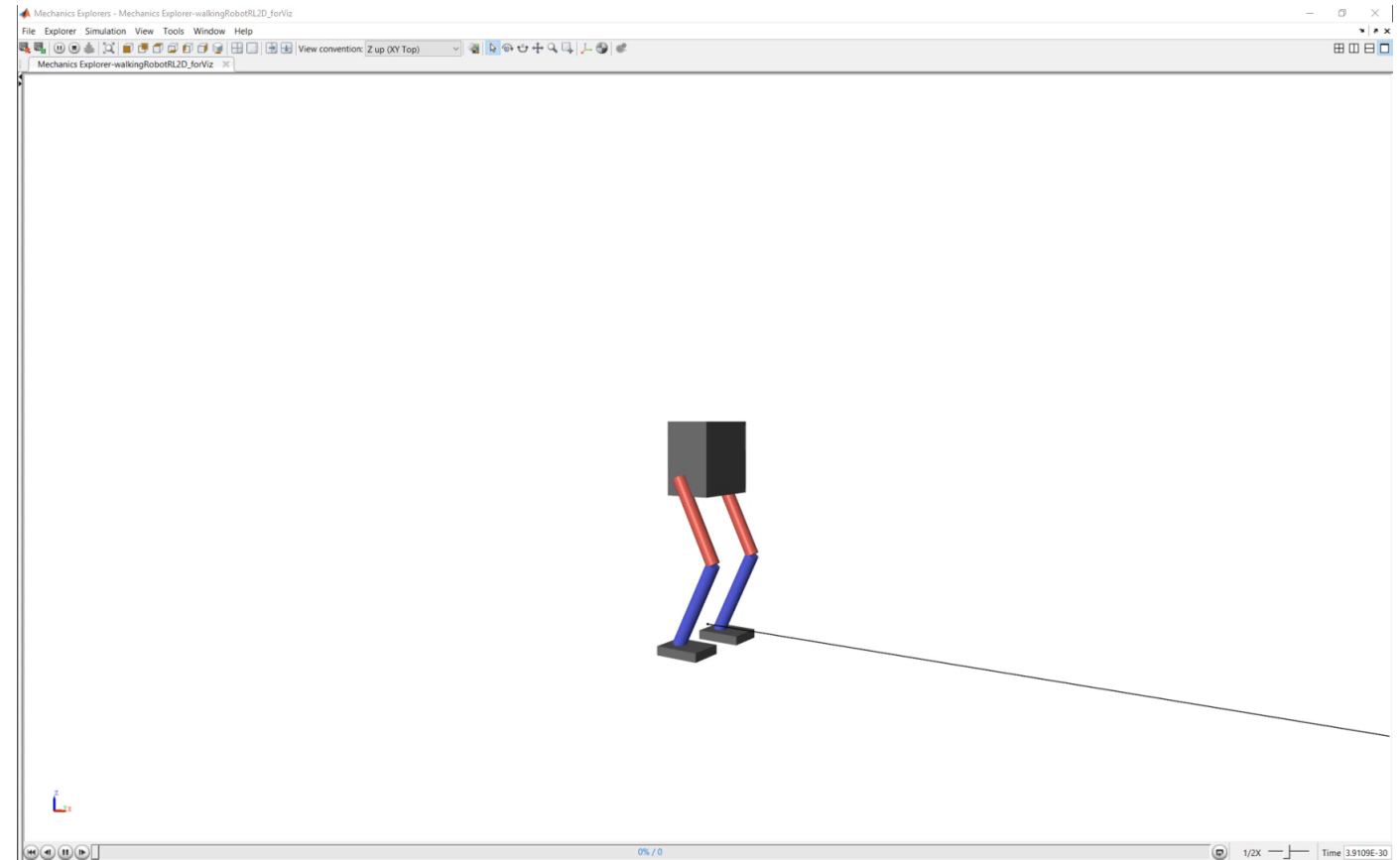


Reinforcement learning:

- Learning through trial & error [*interaction*]
- It's about learning a **behavior** or accomplishing a **task**

What is Reinforcement Learning?

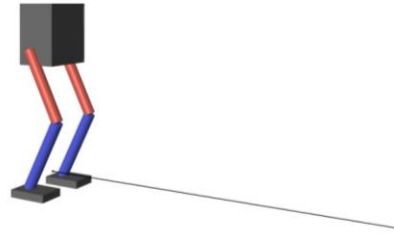
- What is Reinforcement Learning?
 - Type of machine learning that trains an **'agent'** through repeated interactions with an environment
- How does it work?
 - Through a trial & error process that uses a reward system to maximize success



Reinforcement Learning enables the use of Deep Learning for Controls and Decision Making Applications



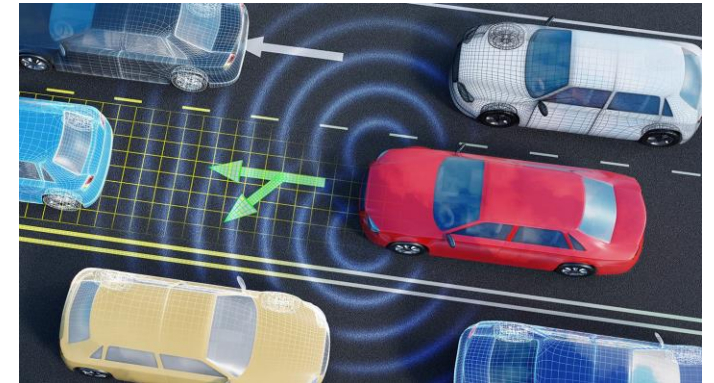
Controls



Robotics

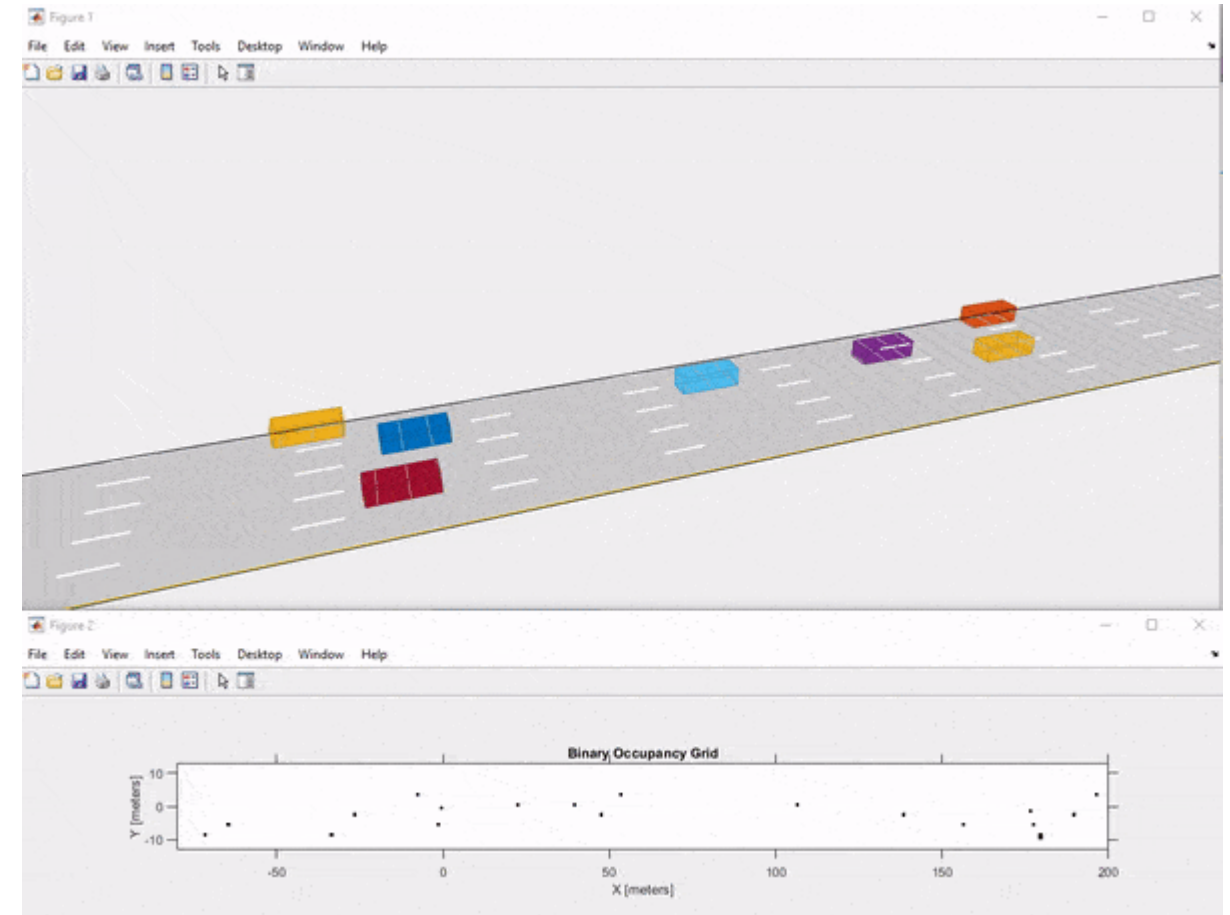
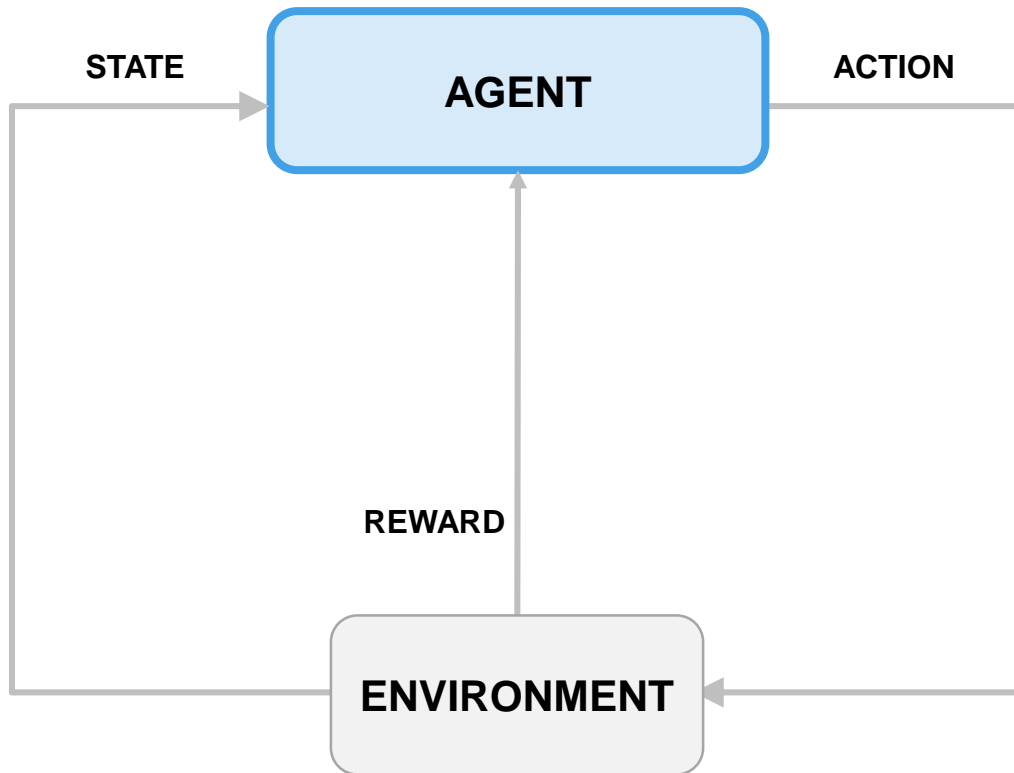


A.I. Gameplay



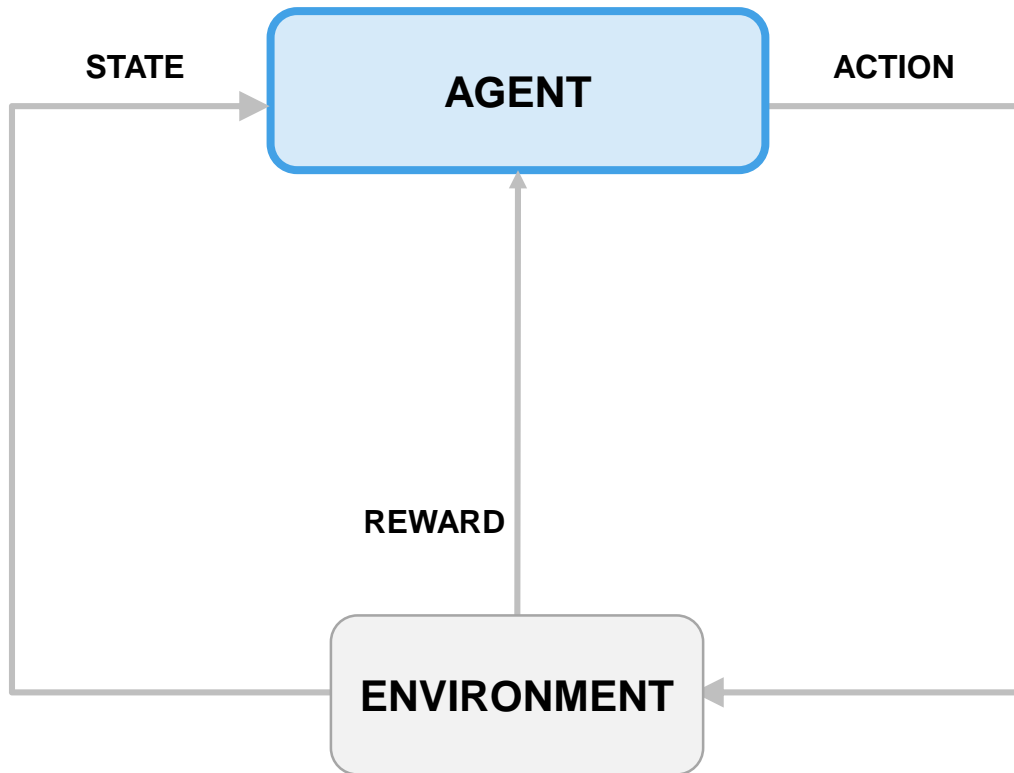
Autonomous driving

How Does Reinforcement Learning Work?



A Practical Example of Reinforcement Learning

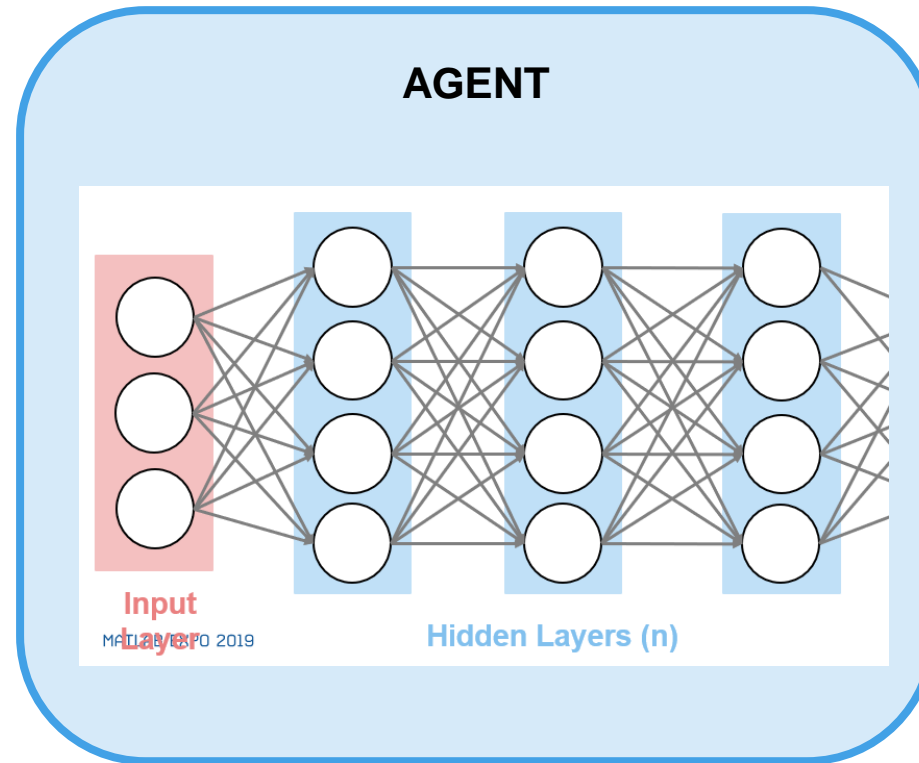
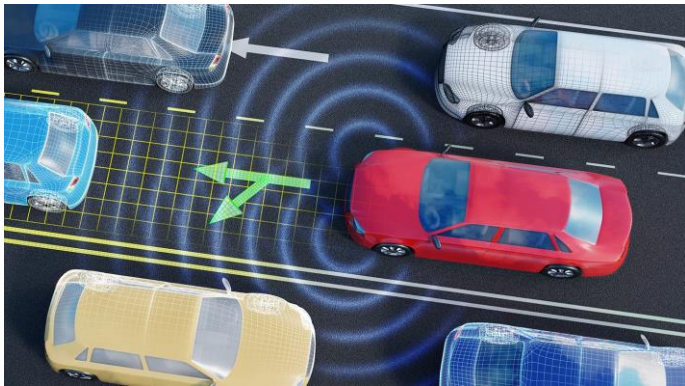
Training a Self-Driving Car



- Vehicle's computer learns how to drive...
(**agent**)
- using sensor readings from LIDAR, cameras,...
(**state**)
- that represent road conditions, vehicle position,...
(**environment**)
- by generating steering, braking, throttle commands,...
(**action**)
- to avoid collisions and lane deviation...
(**reward**).

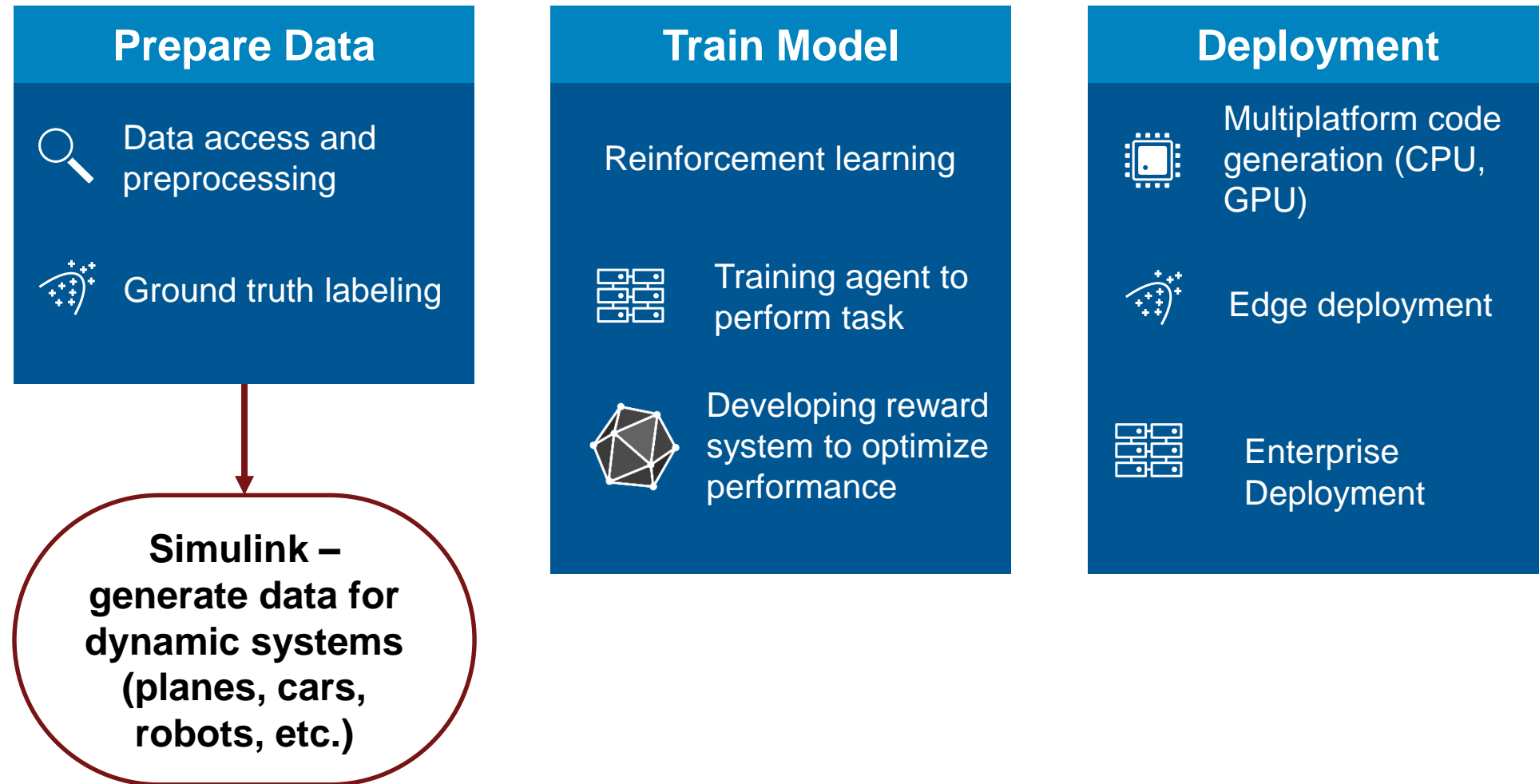
The goal of Reinforcement learning is for the agent to find an optimal algorithm for performing a task

Deep Networks are commonly found in the agent, because they can model complex problems.



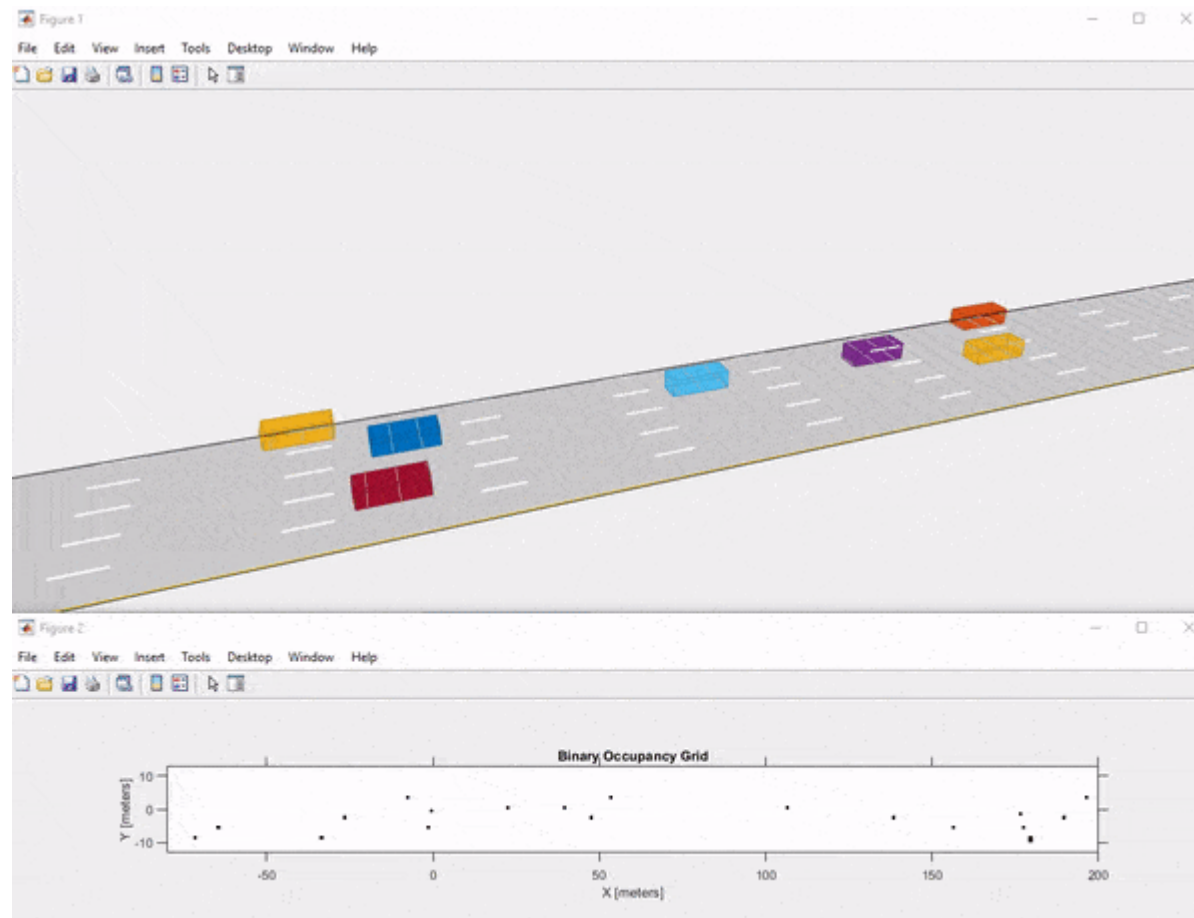
- **Turn left**
- **Turn right**
- **Brake**
- **Accelerate**

Reinforcement Learning Workflow



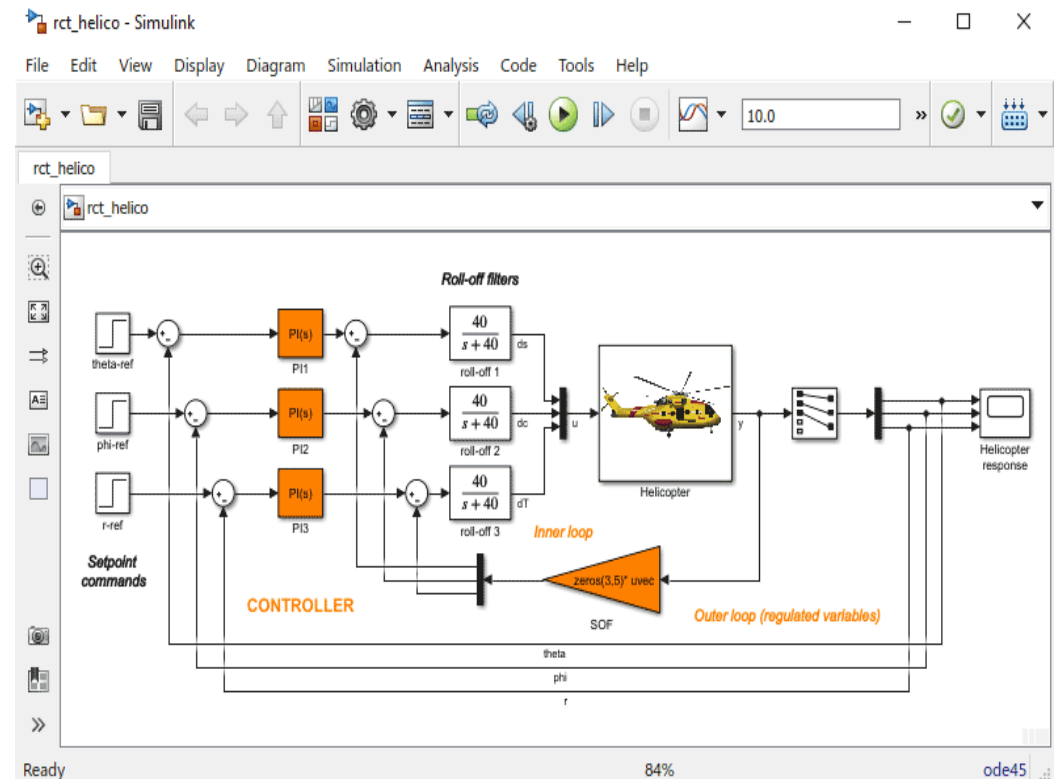
Why MATLAB and Simulink for Reinforcement Learning?

Virtual models allow you to simulate conditions hard to emulate in the real world.



Using MATLAB and Simulink for Reinforcement Learning

- Reinforcement learning is a dynamic process
- Decision making problems
 - Financial trading, calibration, etc.
- Controls-based problems
 - Lane-keep assist, adaptive cruise control, robotics, etc.



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Generate simulation data for complex models and systems

Ease of deployment and scaling to various platforms

Full A.I. workflows that cannot be easily replicated by other toolchains

Why MATLAB for A.I. Tasks?

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Code

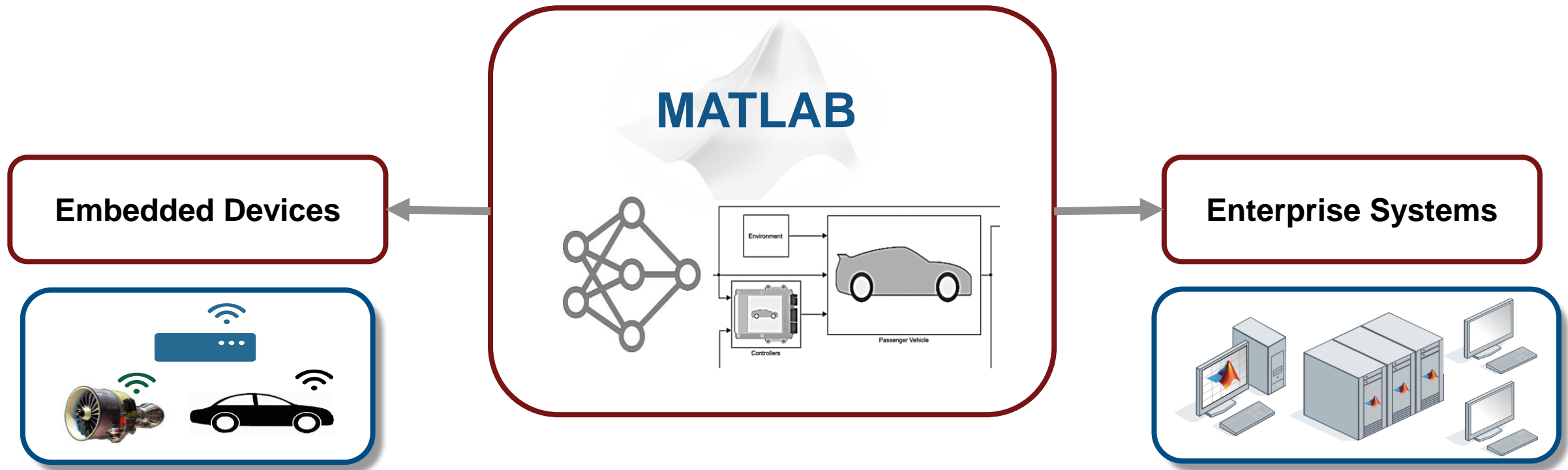
Embedded

Enterprise

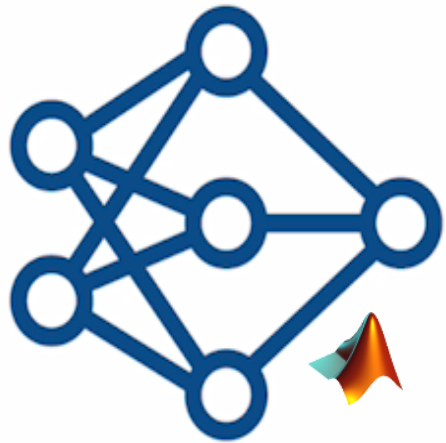
Ease of deployment and scaling to various platforms

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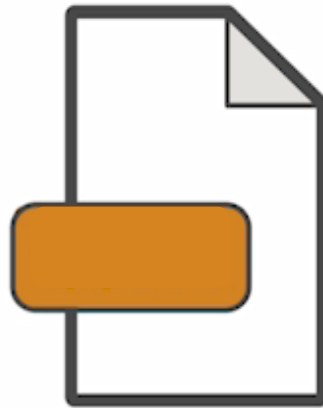
Deployment and Scaling for A.I.



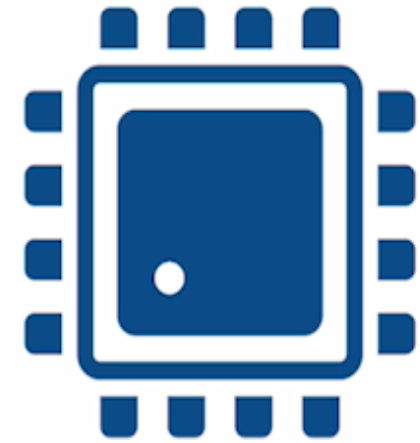
Embedded Devices – Automatic Code Generation



MATLAB Code

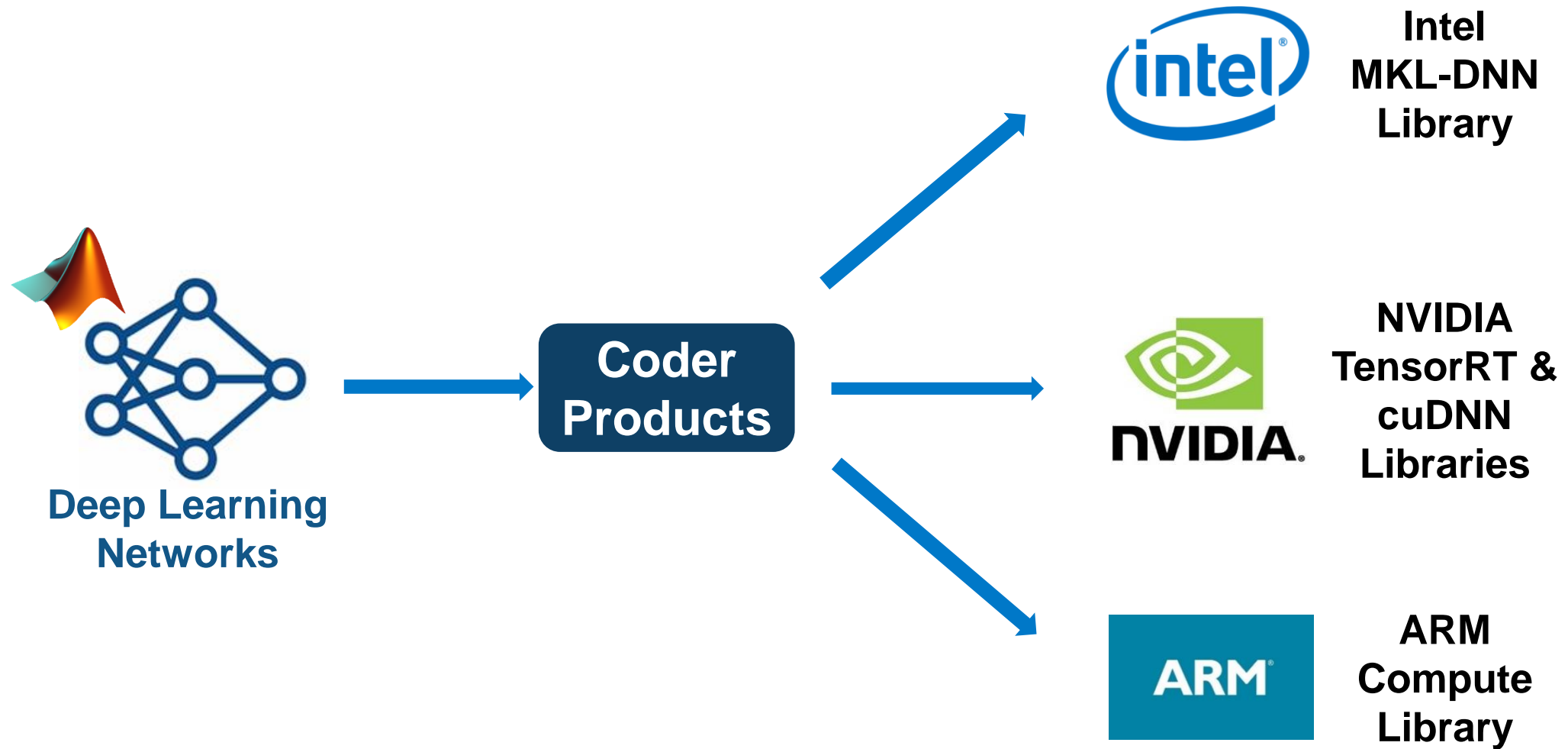


Auto-generated
Code
(C/C++/CUDA)

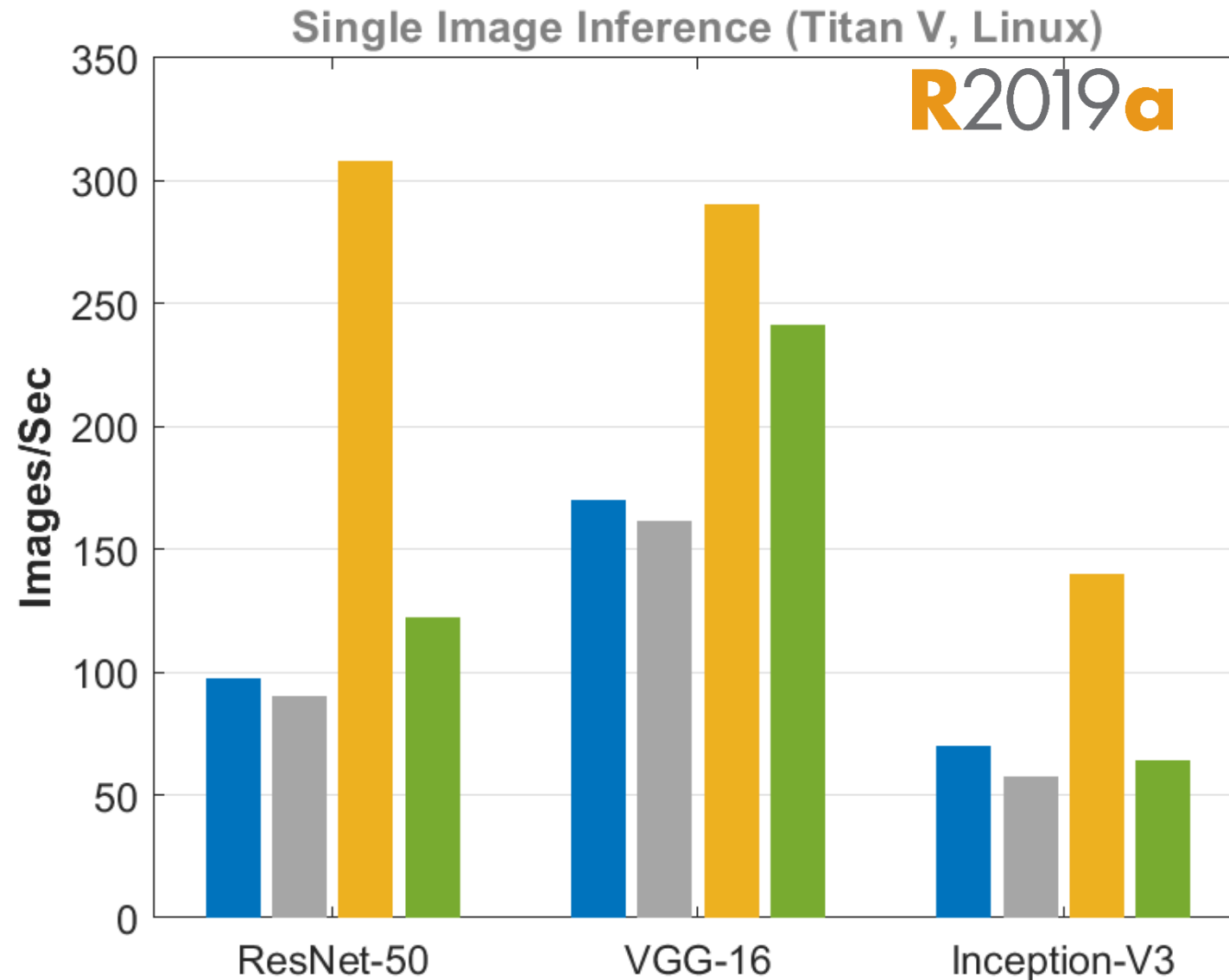


Deployment
Target

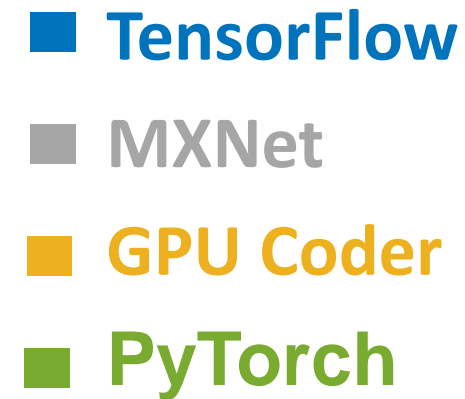
Deploying Deep Learning Models for Inference



With GPU Coder, MATLAB is fast

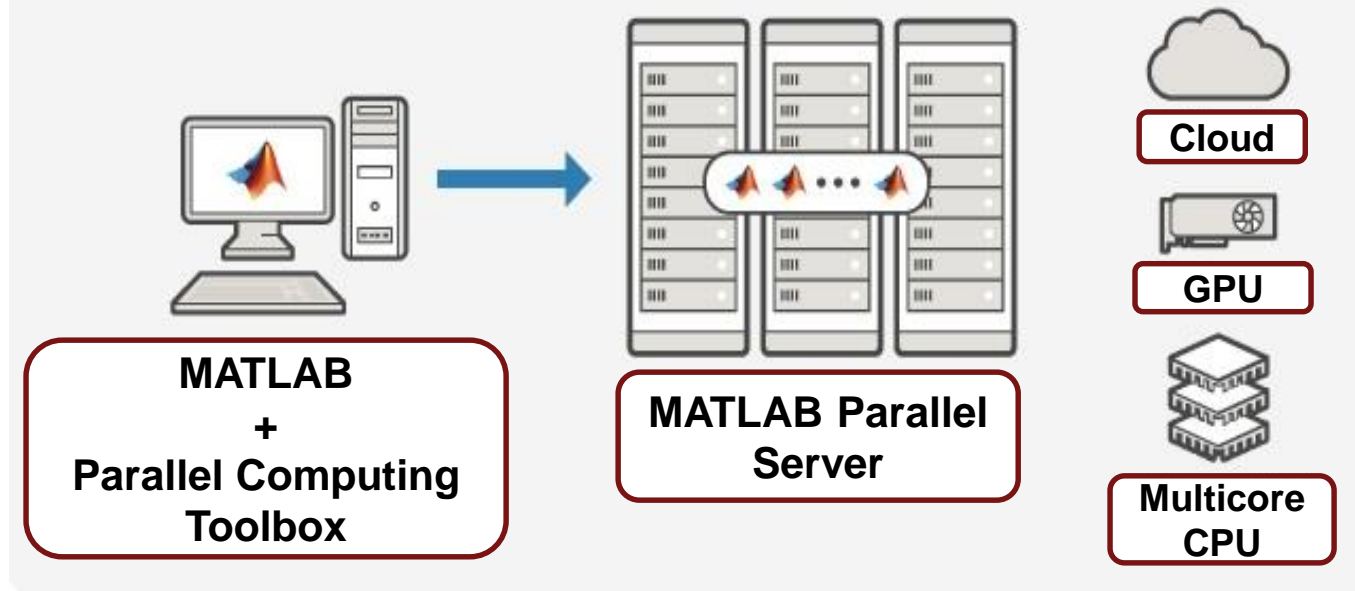


GPU Coder is faster than TensorFlow, MXNet and Pytorch



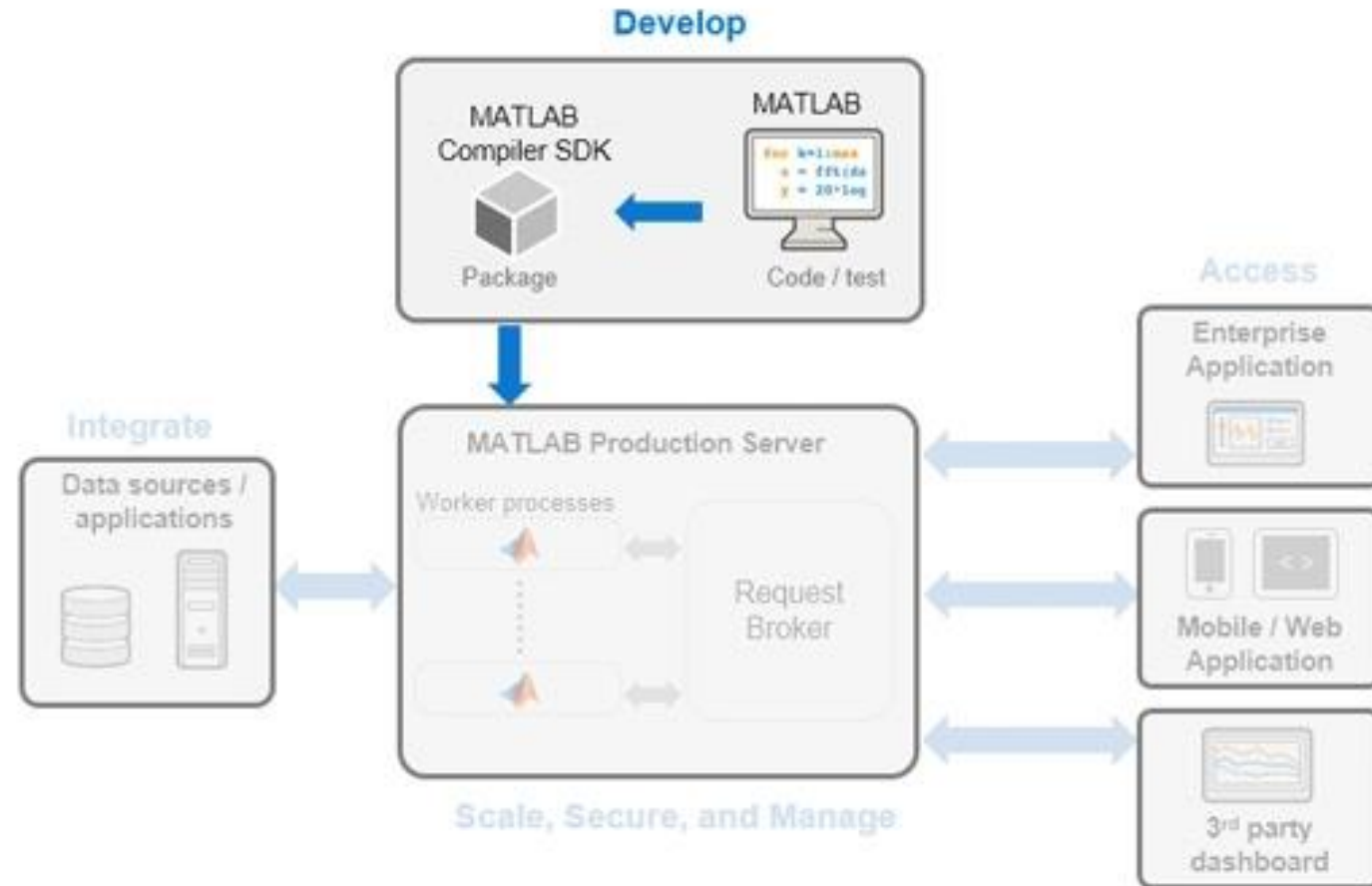
Enterprise Deployment

```
>> parpool(parcluster('HPC1'),100);  
>> parfor i = 1:3000,  
>>     c(:,i) = eig(rand, 1000);  
>> end
```



Run thousands of simulations in parallel with MATLAB Parallel Server to save hours of training time.

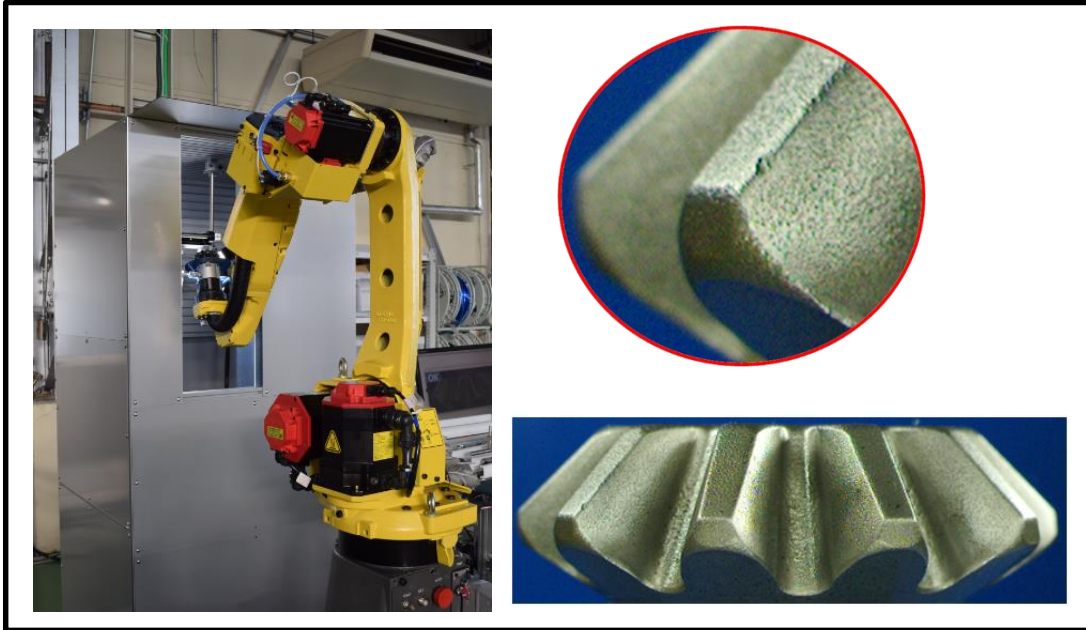
Enterprise Deployment



Deployment to the cloud with MATLAB Compiler and MATLAB Production Server

Musashi Seimitsu Industry Co.,Ltd.

Detect Abnormalities in Automotive Parts



Automated visual inspection of 1.3 million bevel gear per month

MATLAB use in project:

- Preprocessing of captured images
- Image annotation for training
- Deep learning based analysis
 - Various transfer learning methods (Combinations of CNN models, Classifiers)
 - Estimation of defect area using Class Activation Map (CAM)
 - Abnormality/defect classification
- Deployment to NVIDIA Jetson using GPU Coder



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