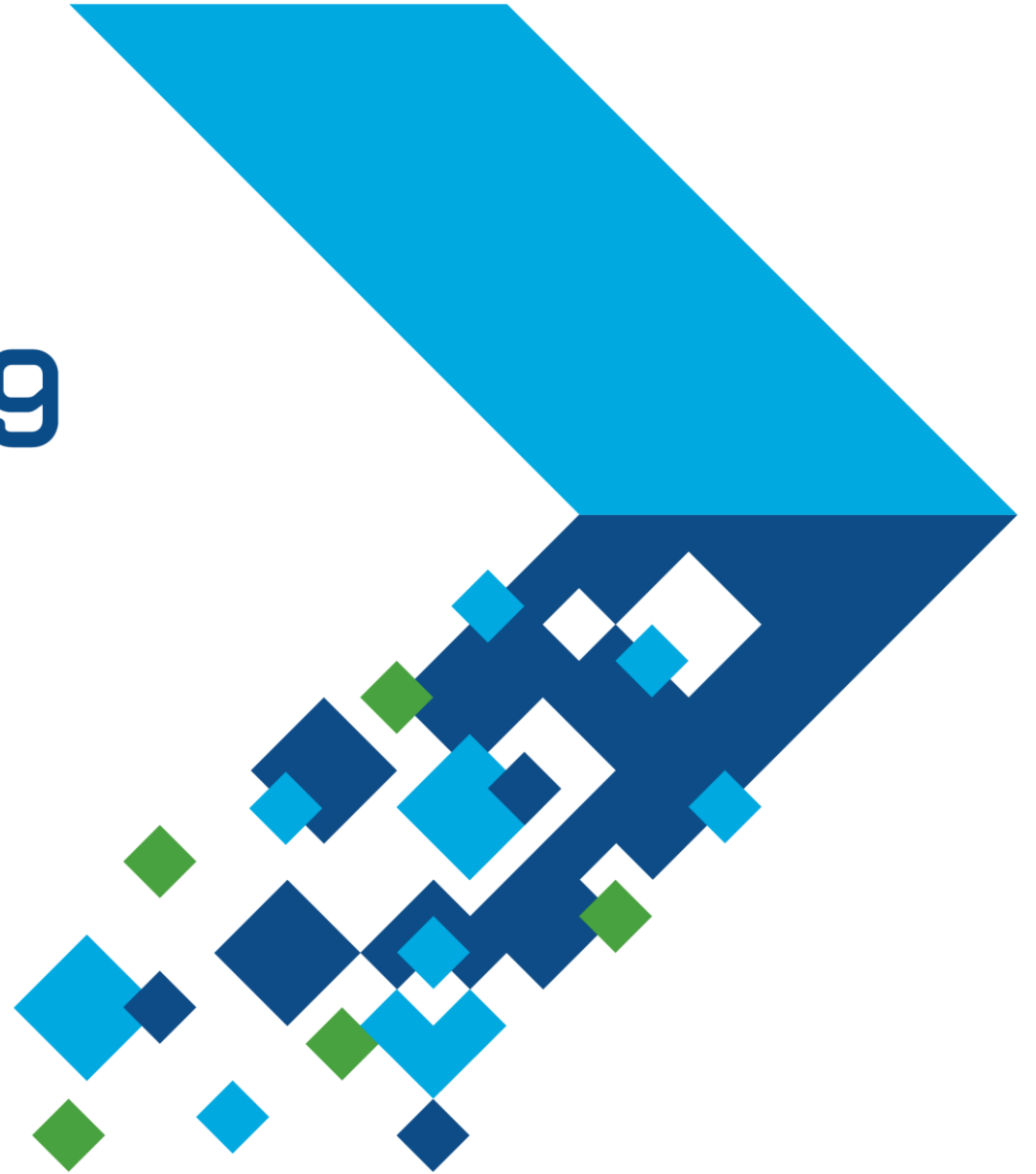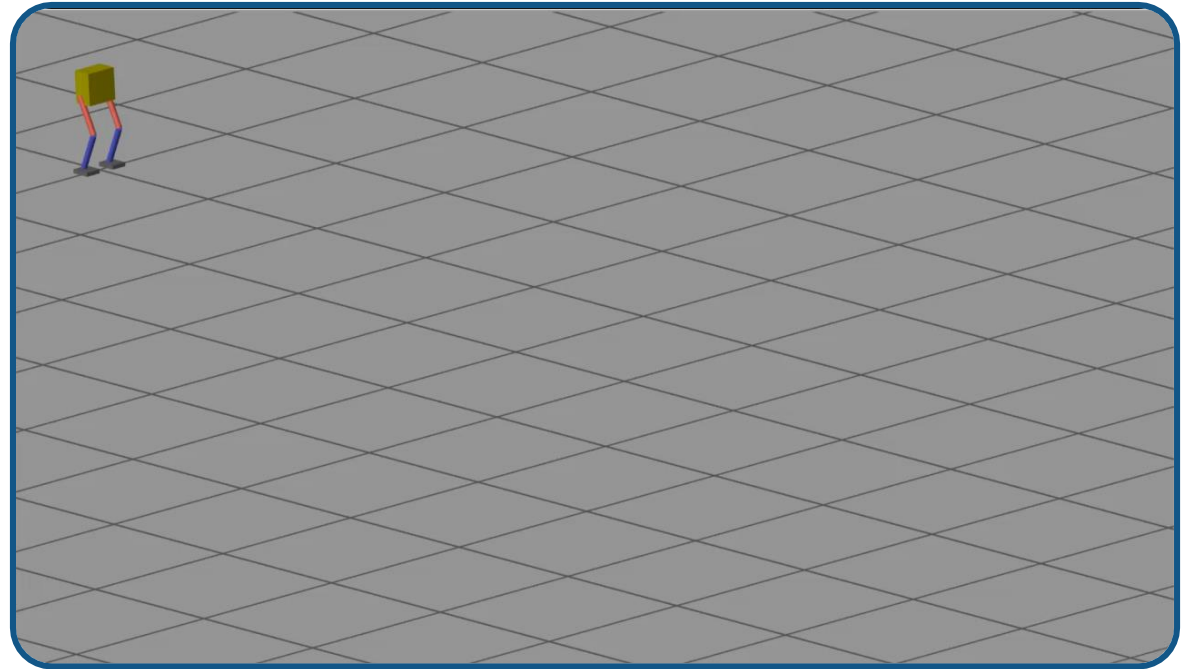# MATLAB EXPO 2019

Deep Learning

Dr. Yvonne Blum

Why MATLAB for Artificial Intelligence?

Artificial Intelligence

Development of computer systems to perform tasks that normally require human intelligence.
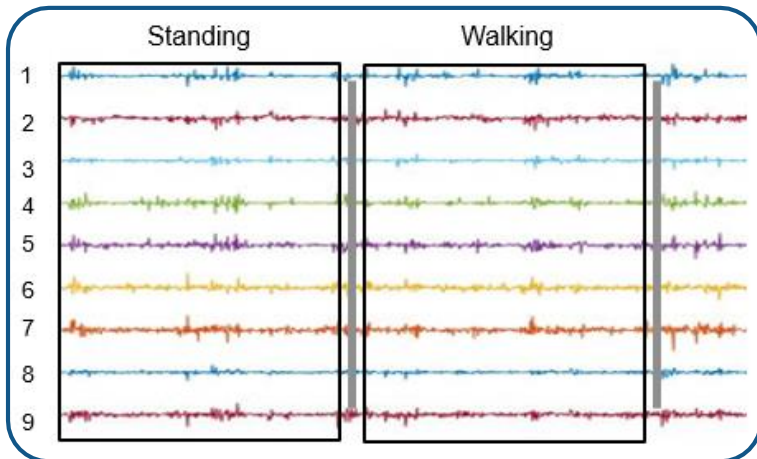
A.I. Applications

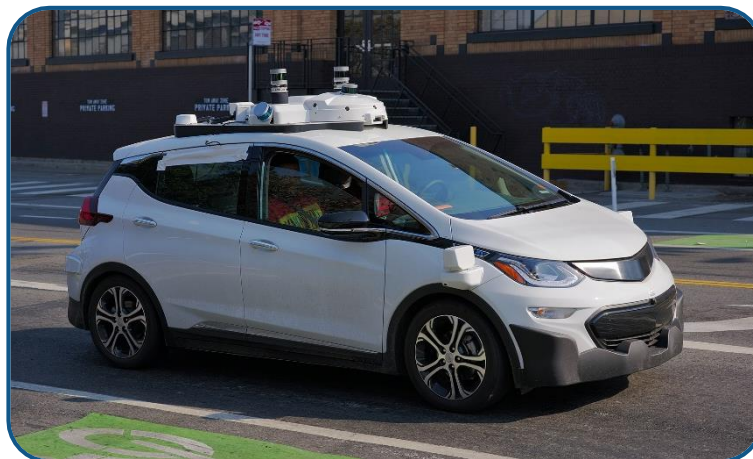*Object Classification*

Speech Recognition

Predictive Maintenance
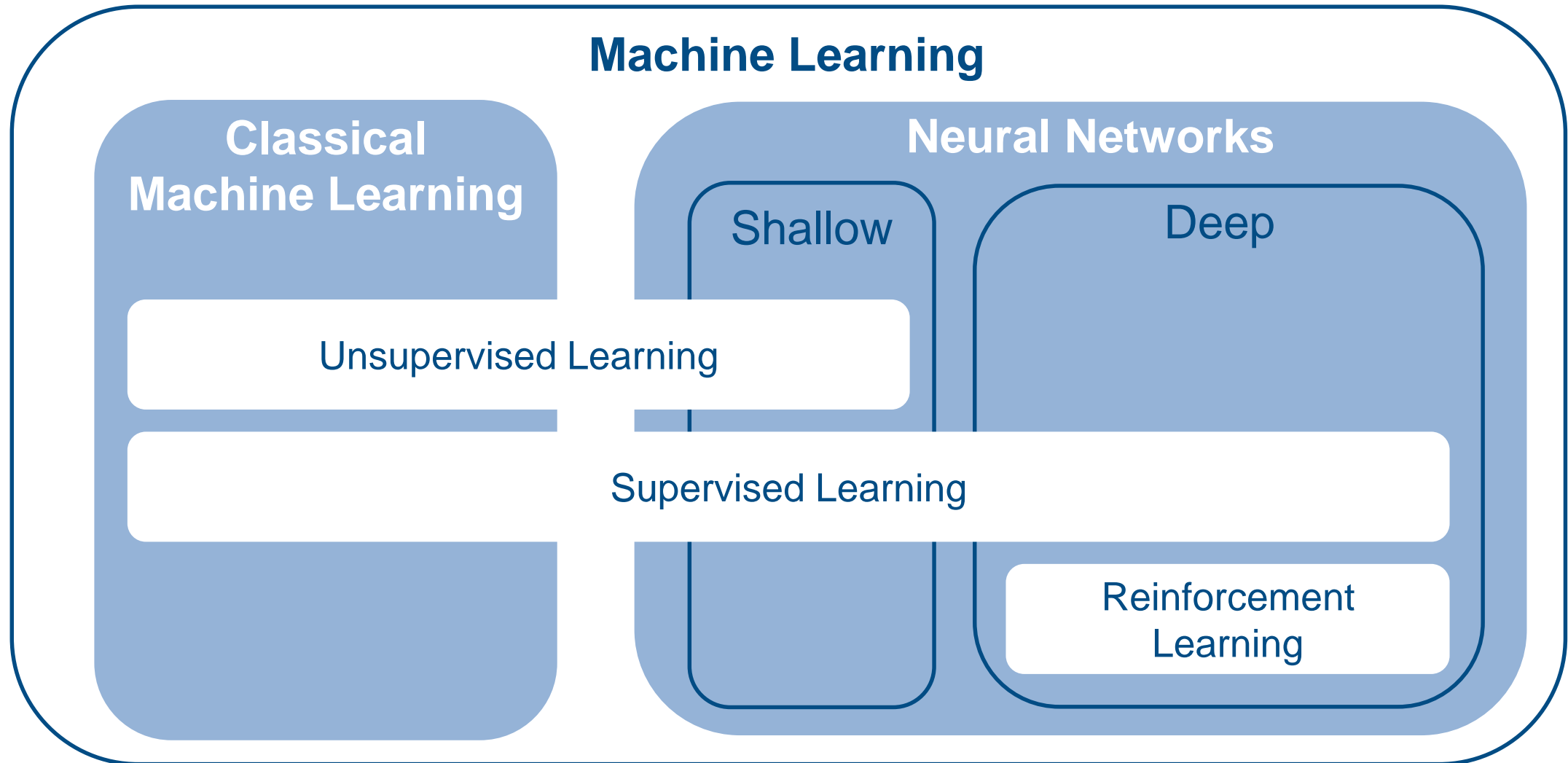

Signal Classification

Automated Driving

Stock Market Prediction

What Is Machine Learning?

Machine Learning

Classical Machine Learning

Neural Networks

Shallow

Deep

Unsupervised Learning

Supervised Learning

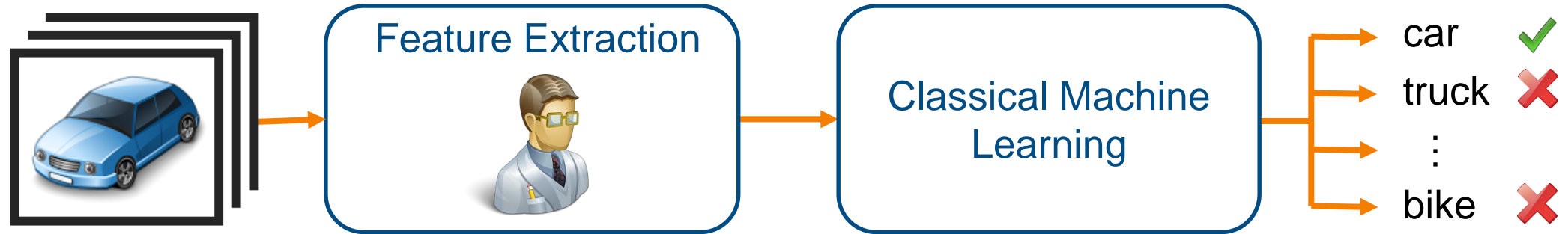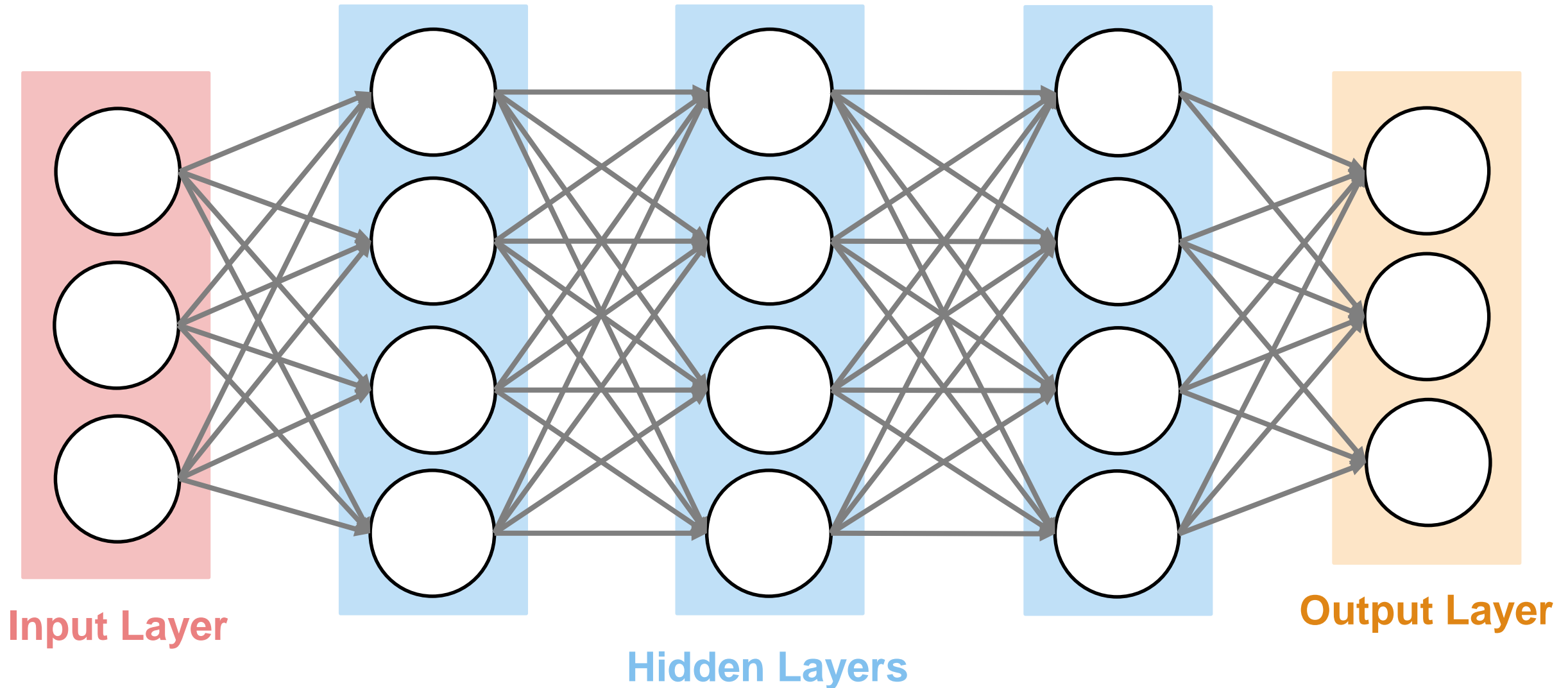Reinforcement Learning

What Is Deep Learning?

Deep Learning learns both features and tasks directly from the data.

What Is a Neural Network?

Input Layer

Hidden Layers

Output Layer

Deep Learning Datatypes

Image

Signal

Numeric

Text

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

Network Design

Model Exchange

Labeling

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

but necessary!

Labeling

Labeling

Labeling

Network Design

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

Why MATLAB for A.I. Tasks?

Increased productivity with interactive tools

Generate simulation data for complex models and systems

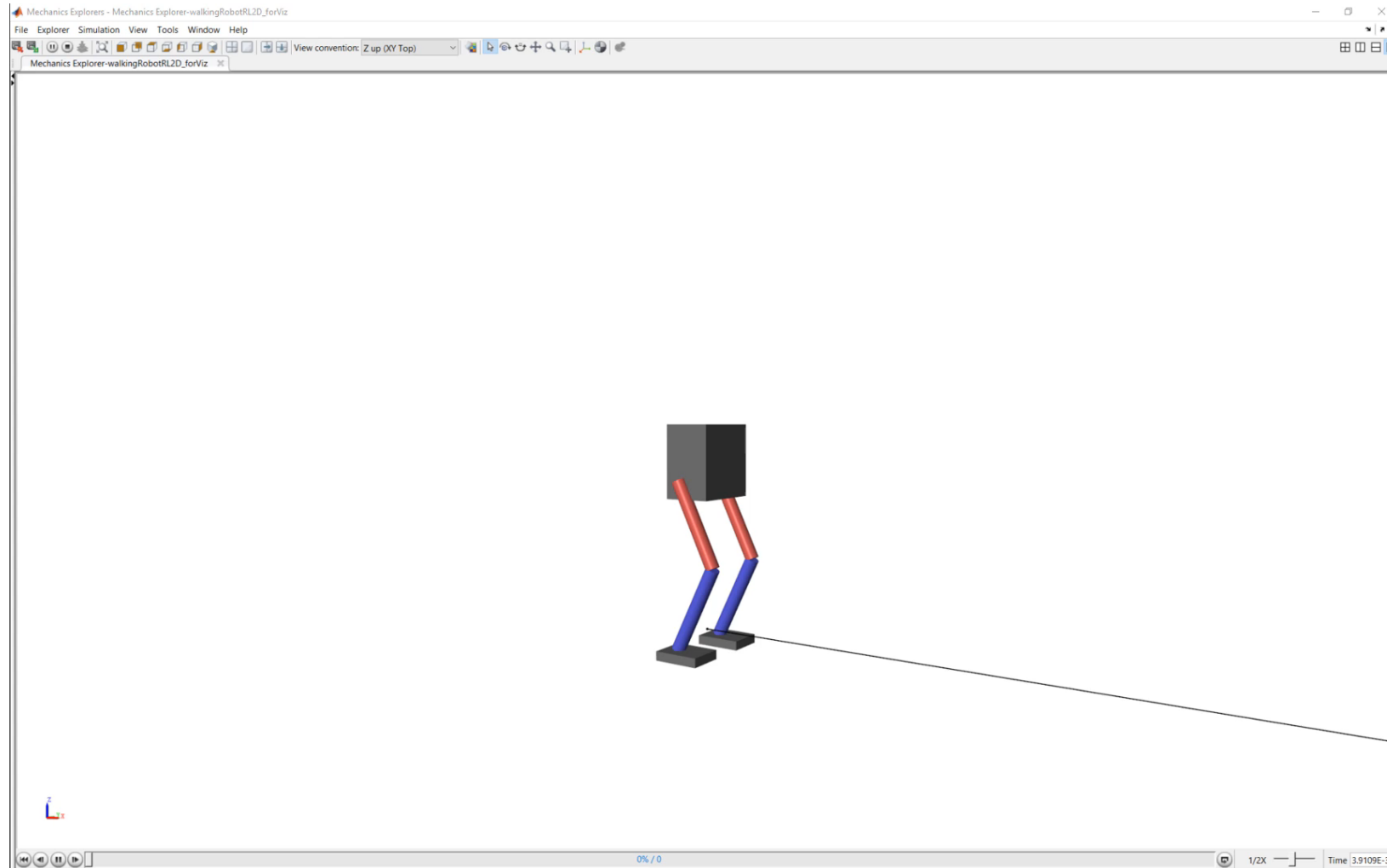Ease of deployment and scaling to various platforms

Why MATLAB for A.I. Tasks?

Generate simulation data for complex models and systems

Reinforcement Learning

What Is Reinforcement Learning?

Reinforcement Learning for Control and Decision Making
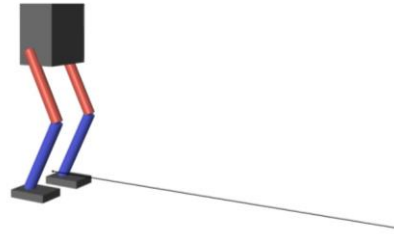
Robotics

Controls
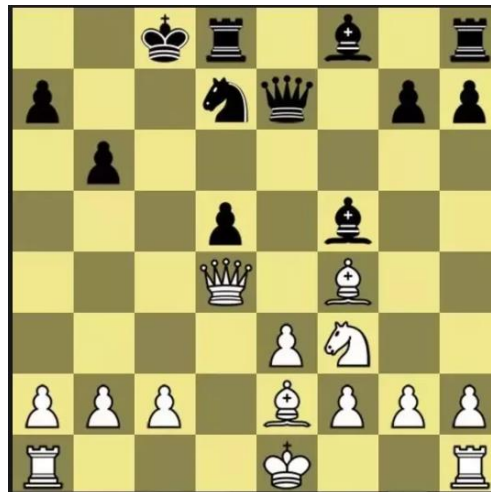
A.I. Gameplay
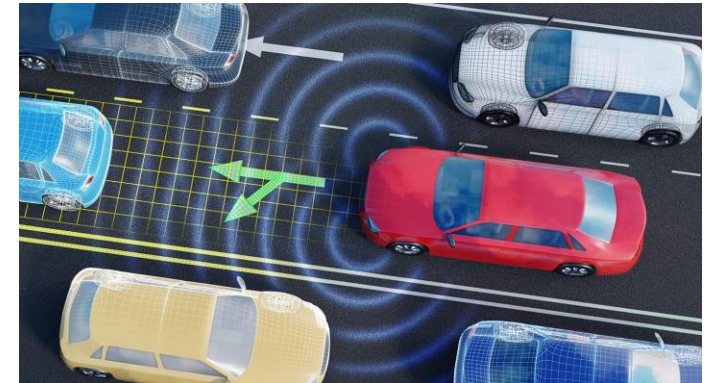
Autonomous driving

Reinforcement Learning Utilizes Deep Neural Networks
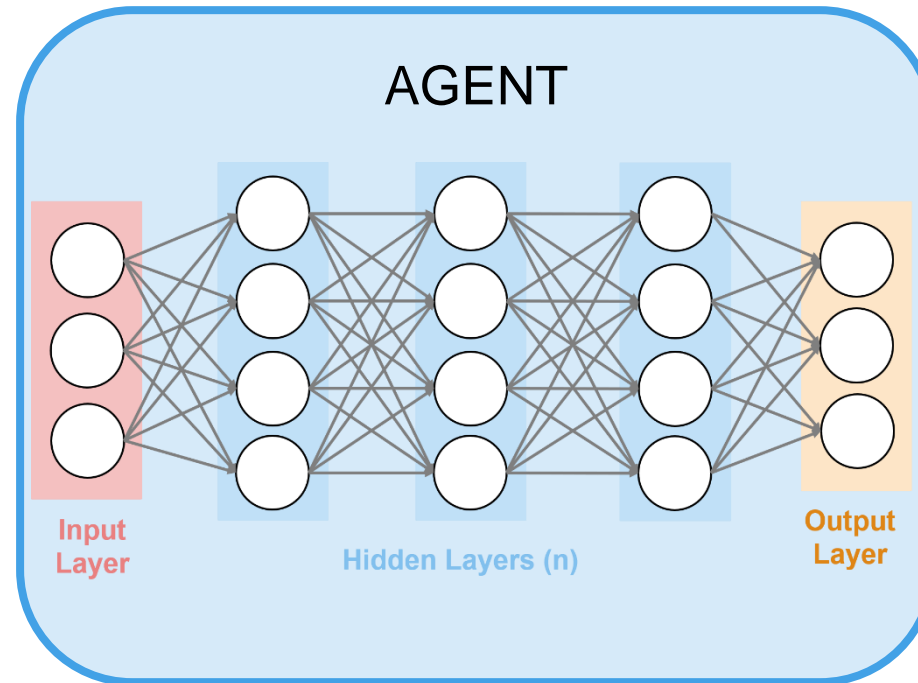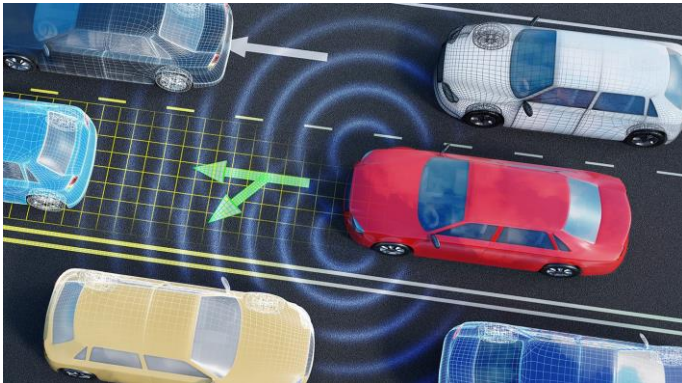
- Turn left/right
- Brake
- Accelerate

Reinforcement Learning Workflow

Prepare Data

Data access and preprocessing

Ground truth labeling

Simulink
Generate data for dynamic systems

Train Model

Reinforcement learning

Training agent to perform task

Developing reward system to optimize performance

Deployment

Multiplatform code generation (CPU, GPU)

Edge deployment

Enterprise Deployment
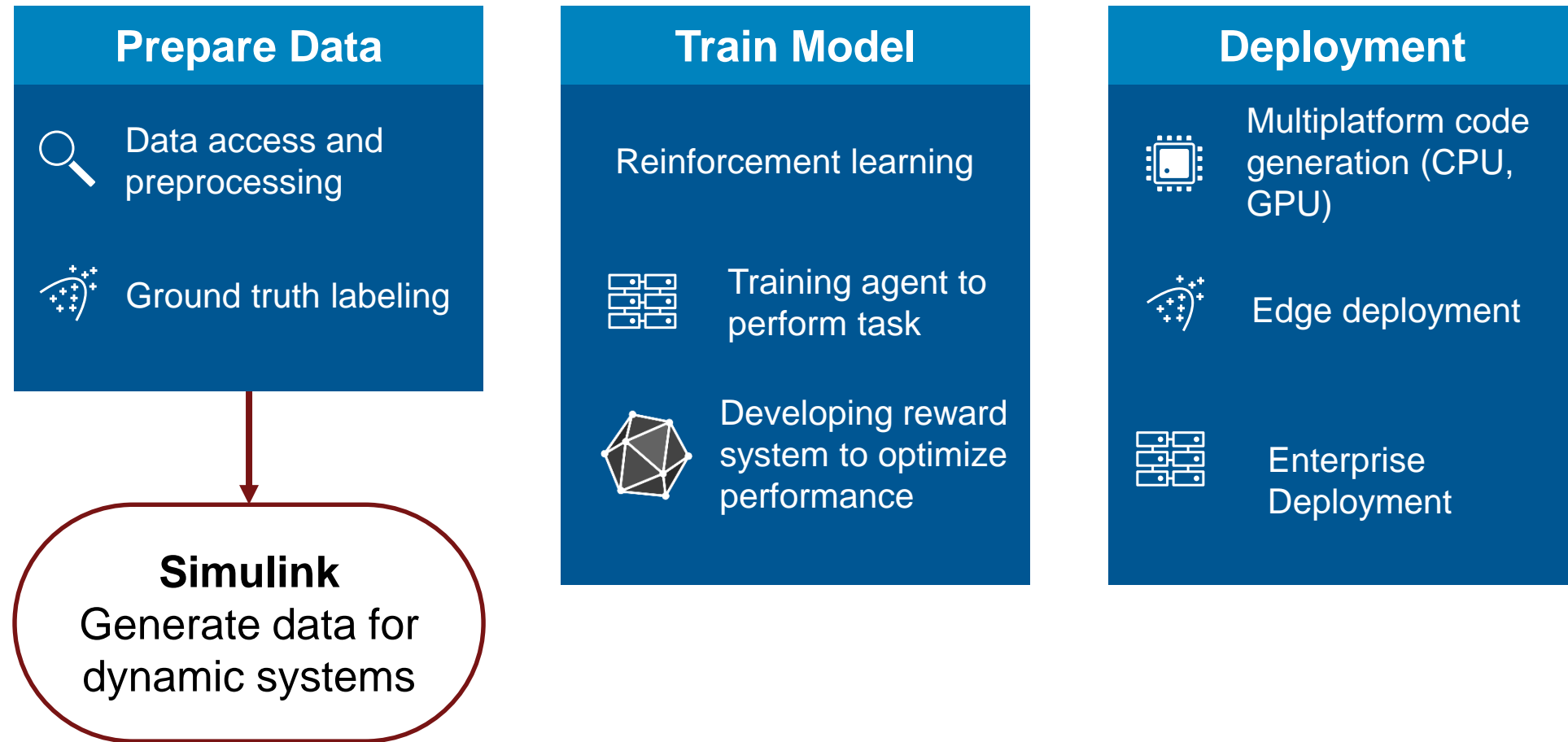
Why MATLAB and Simulink for Reinforcement Learning?

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

- Decision making problems
  – Financial trading, calibration, etc.

- Controls-based problems
  – Lane-keep assist, adaptive cruise control, robotics, etc.
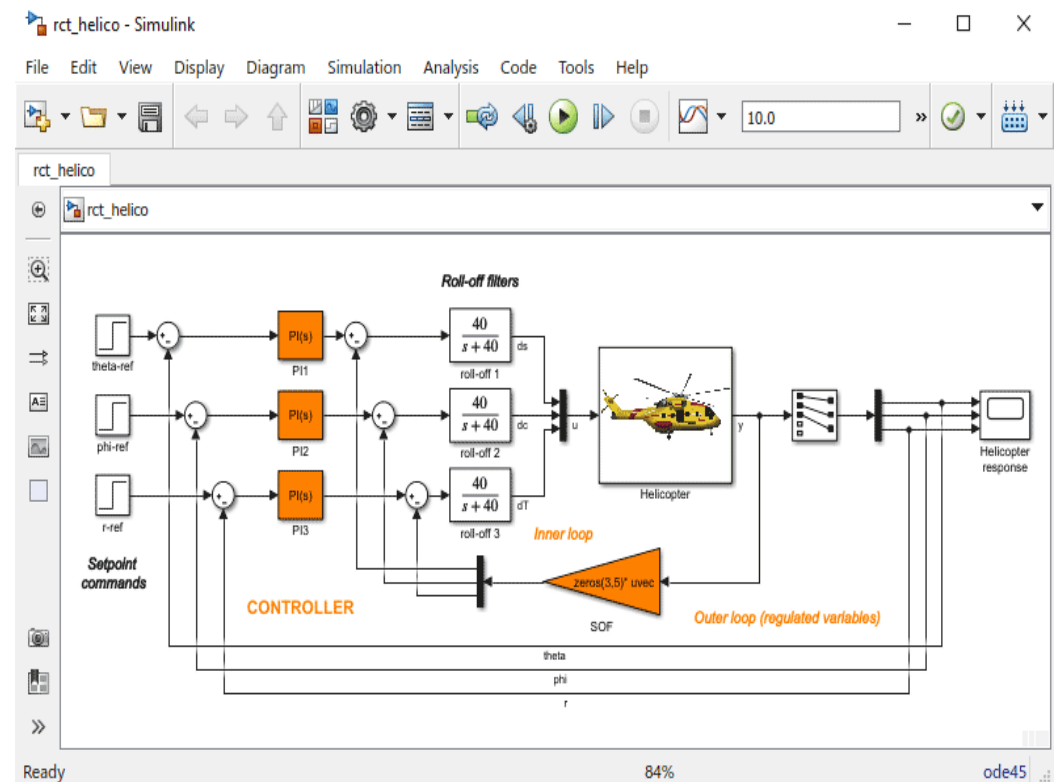
Why MATLAB for A.I. Tasks?

Increased productivity with interactive tools

Generate simulation data for complex models and systems

Ease of deployment and scaling to various platforms

Why MATLAB for A.I. Tasks?

Ease of deployment and scaling to various platforms

Code Generation

Embedded Devices

Enterprise Systems

Deployment and Scaling for A.I.

MATLAB

Embedded Devices

Enterprise Systems

Automatic Code Generation
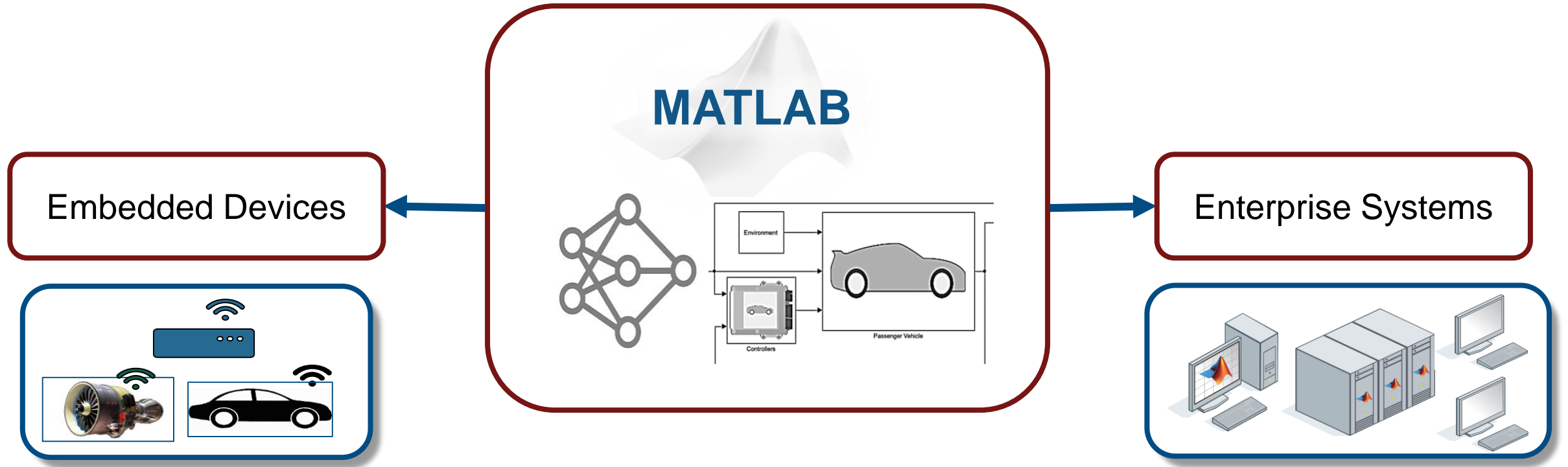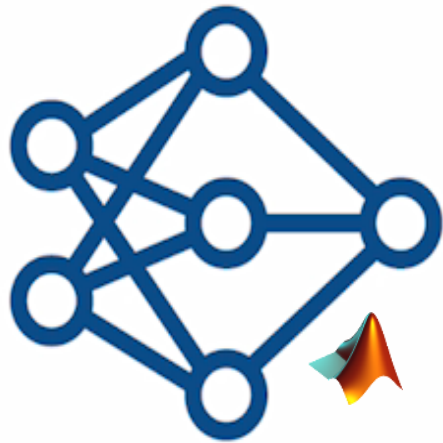

MATLAB Code
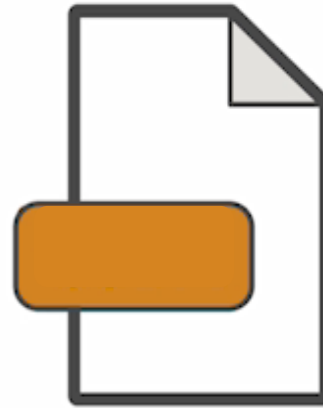
Auto-generated
Code
(C/C++/CUDA)
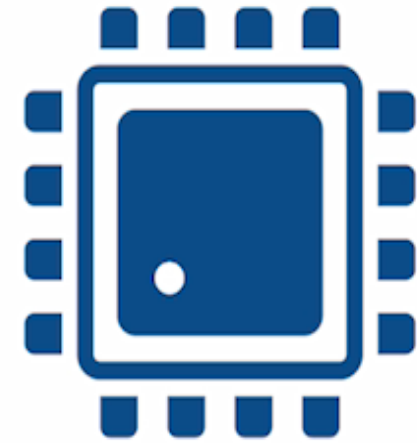
Deployment
Target

Deploying Deep Learning Models

Deep Learning Networks → **Coder Products** → Intel MKL-DNN Library / NVIDIA TensorRT & cuDNN Libraries / ARM Compute Library
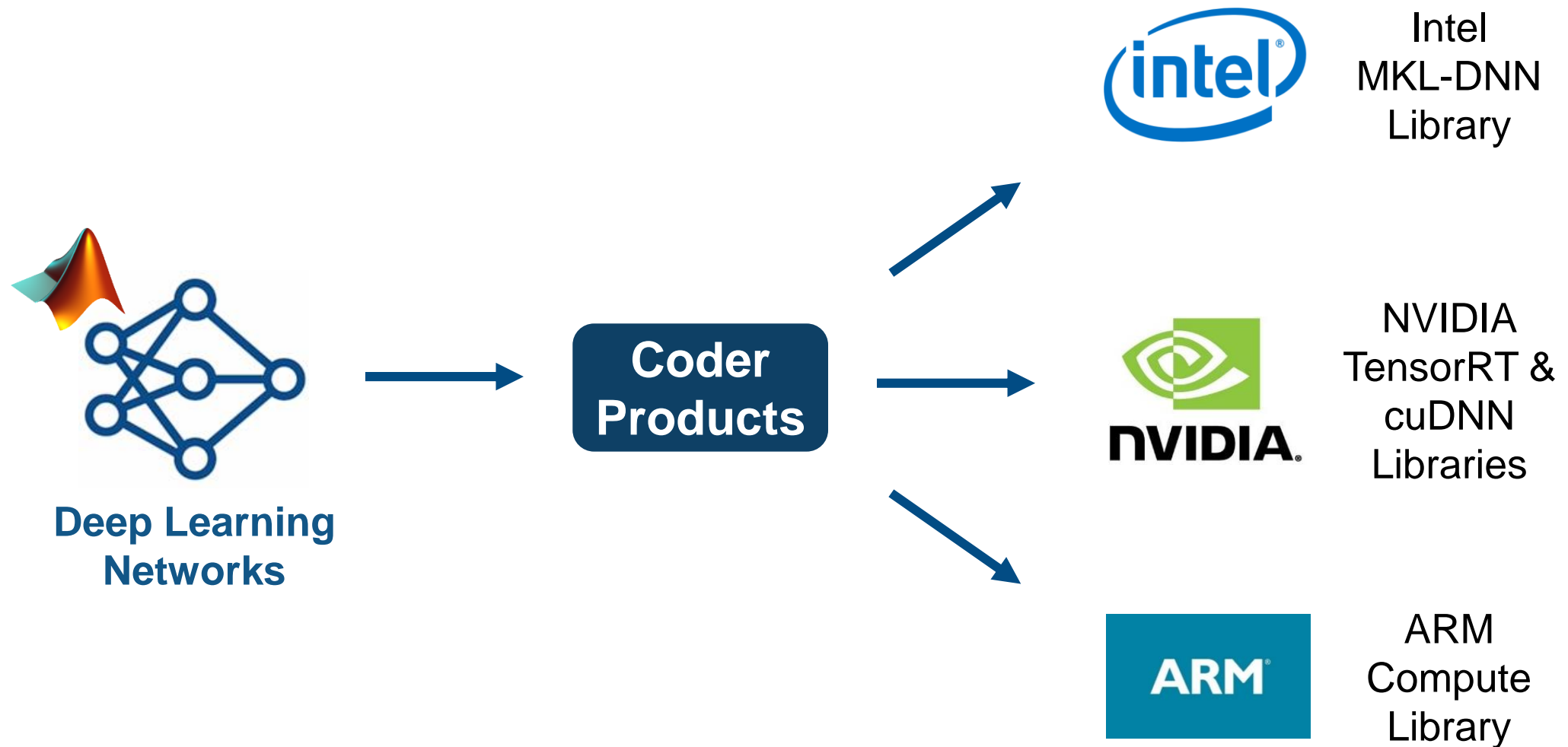
With GPU Coder MATLAB is fast
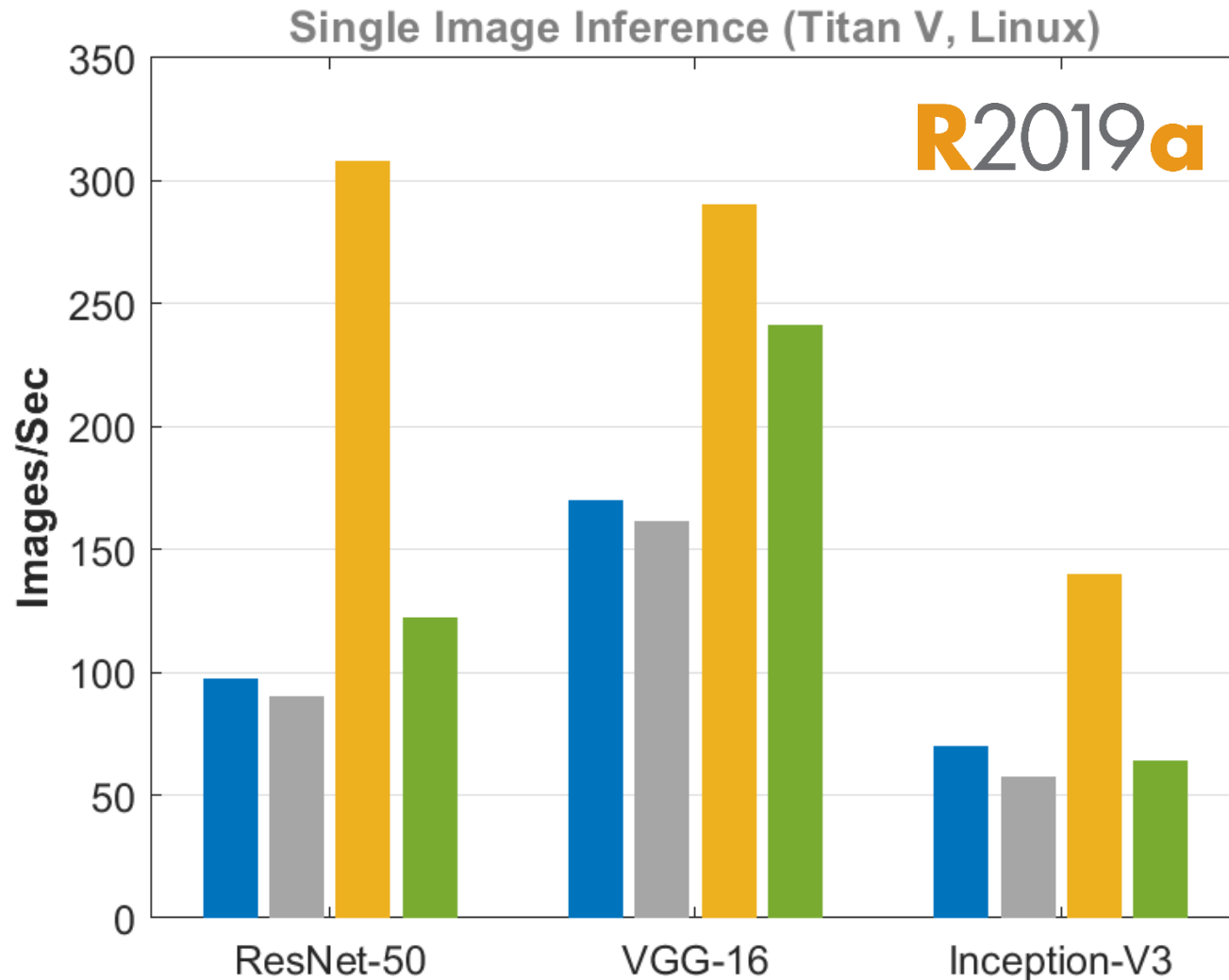
GPU Coder is faster than TensorFlow, MXNet and PyTorch

- TensorFlow
- MXNet
- GPU Coder
- PyTorch
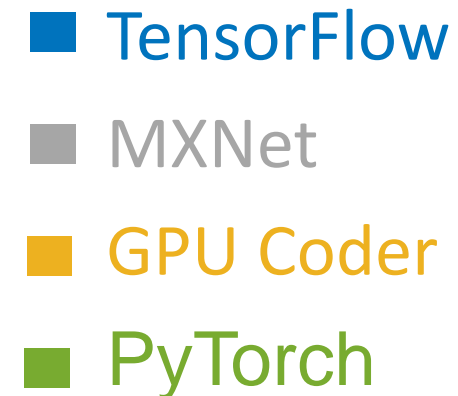
Intel® Xeon® CPU 3.6 GHz - NVIDIA libraries: CUDA10 - cuDNN 7 - Frameworks: TensorFlow 1.13.0, MXNet 1.4.0 PyTorch 1.0.0

Enterprise Deployment

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

**MATLAB
+
Parallel Computing
Toolbox**

**MATLAB Parallel
Server**

Cloud

GPU

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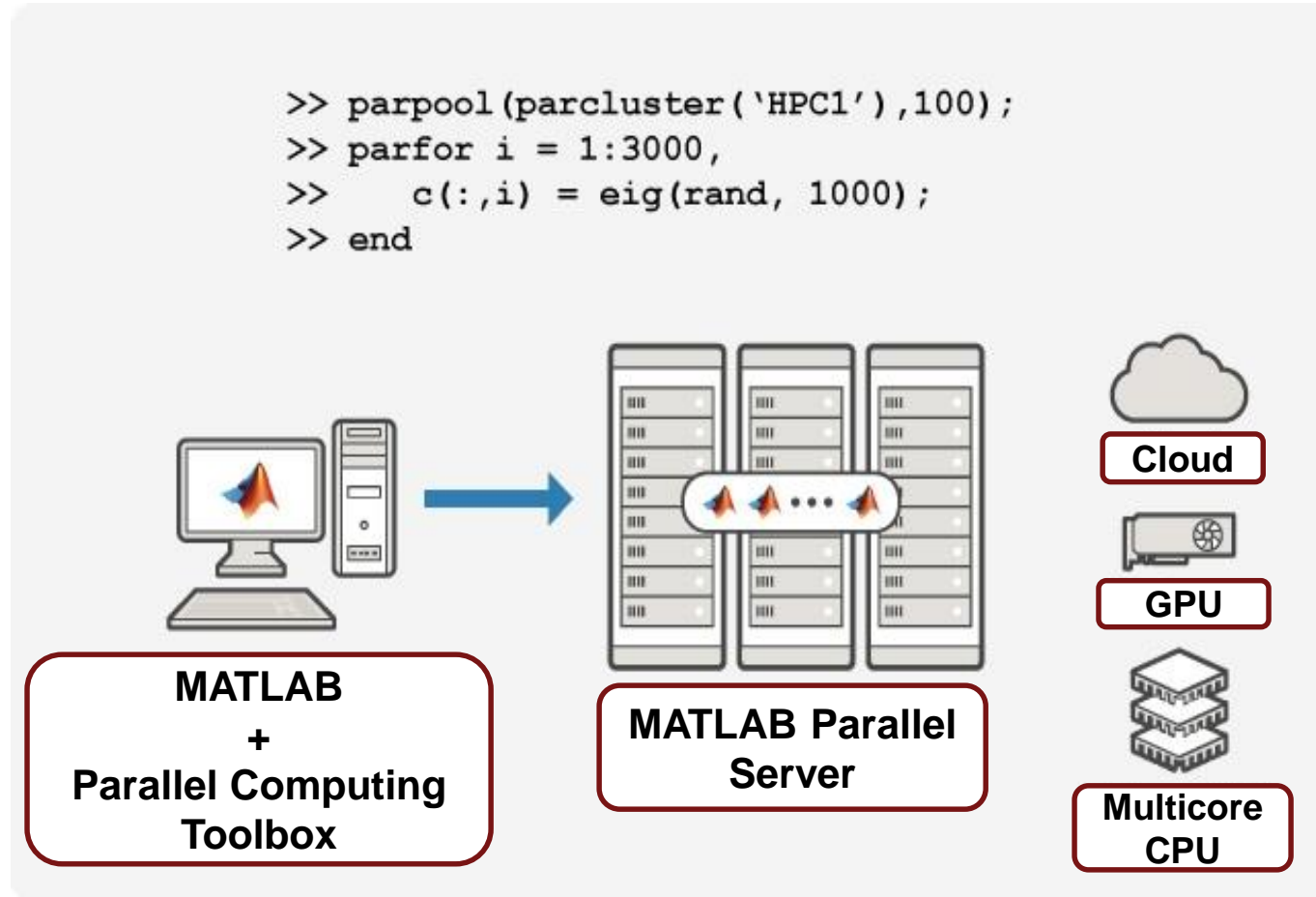
*Run thousands of simulations in parallel with MATLAB Parallel Server
to save hours of training time.*

Enterprise Deployment
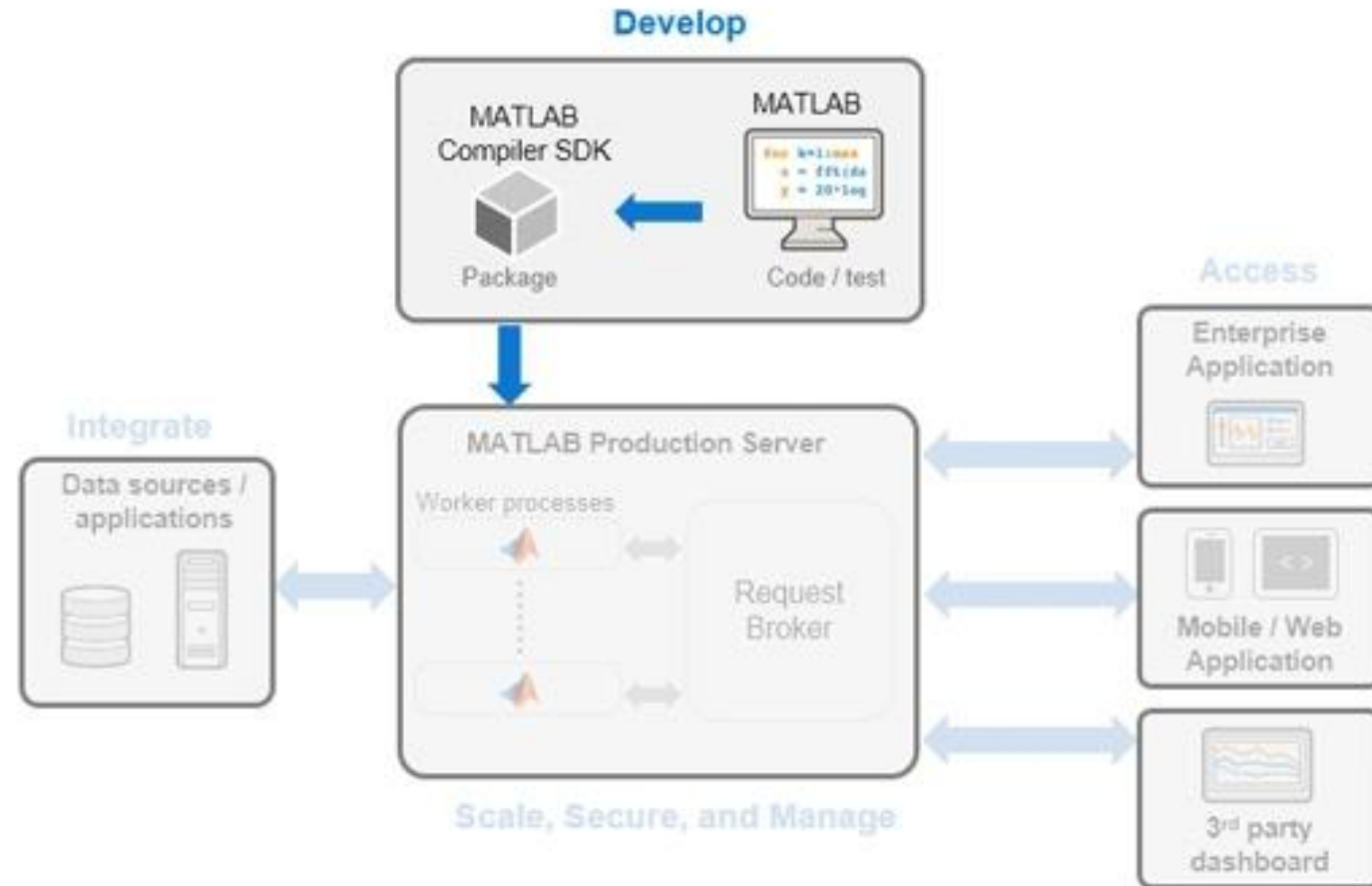
Deployment to the cloud with MATLAB Compiler and MATLAB Production Server.

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User Stories

Data Analytics in Produktionsumgebungen

- MLaaS (Machine Learning as a Service) mit
  MATLAB Production Server
  (Muhammad Faizan Aslam, Infineon Technologies AG)

- Neural Automation – Optimal Control durch Maschinelles Lernen
  (Dr. Fabian Bause, Beckhoff Automation GmbH & Co. KG)

Want to Do More?

Training

mathworks.com/services/training

- Deep Learning with MATLAB*
- Machine Learning with MATLAB*
- Computer Vision with MATLAB
- Automated Driving with MATLAB

*Also available as self-paced online course

Consulting

mathworks.com/services/consulting