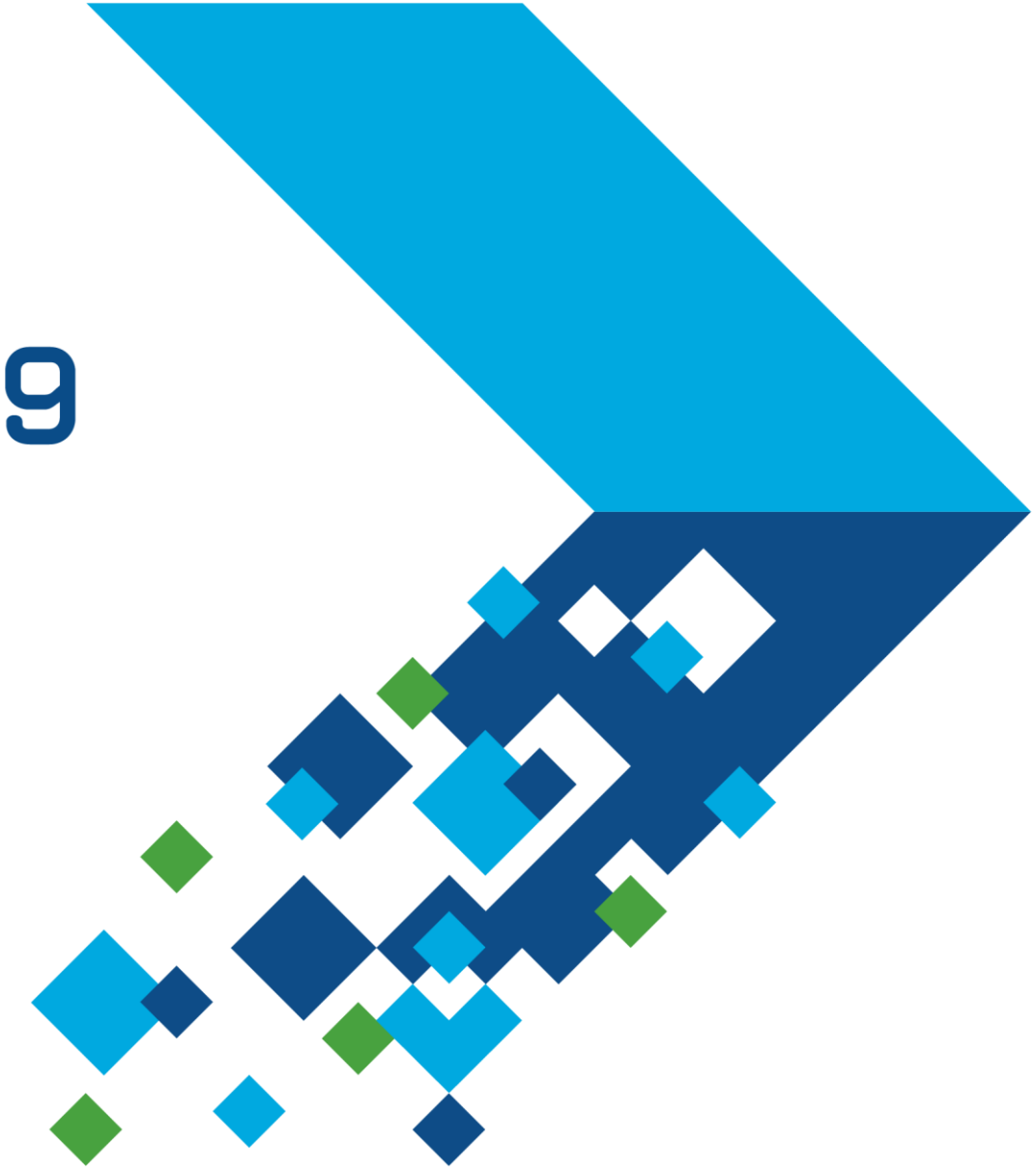
MATLAB EXPO 2019

Deep Learning and Reinforcement Learning Workflows in AI

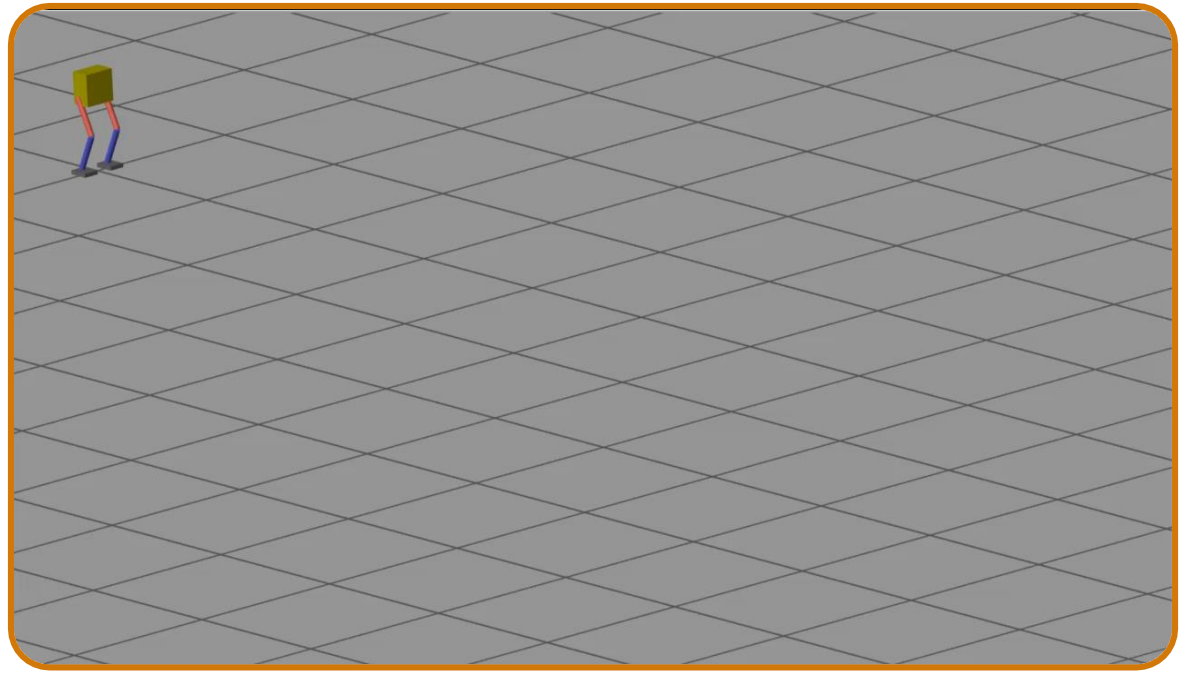
Valerie Leung



Why MATLAB for Artificial Intelligence?

Artificial Intelligence

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

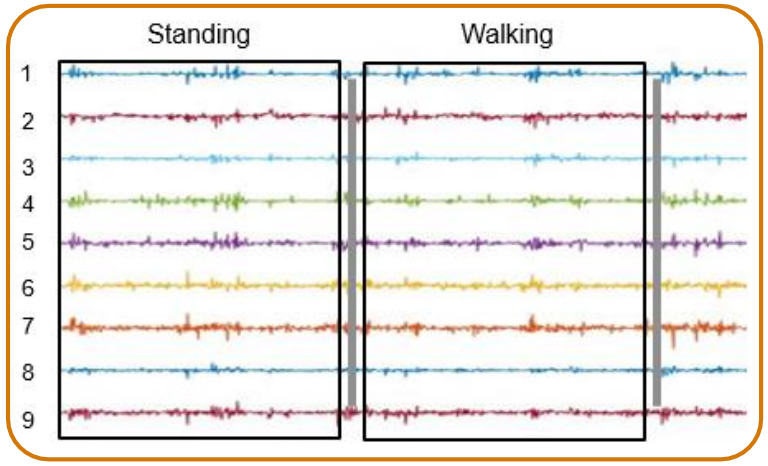


AI Applications

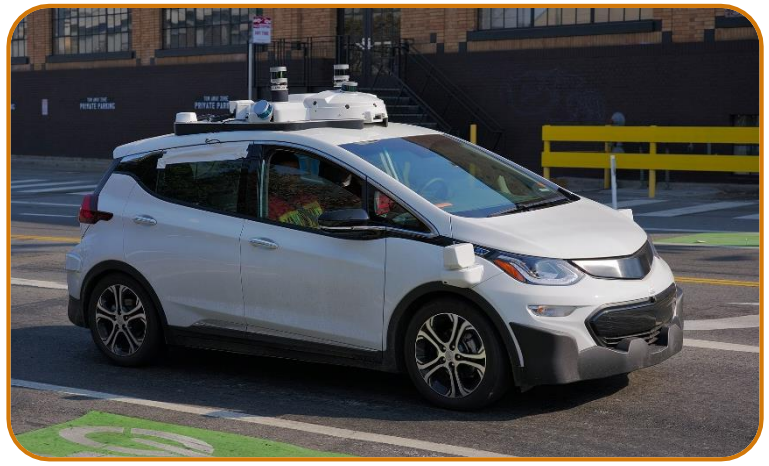
Object Classification

Speech Recognition

Predictive Maintenance



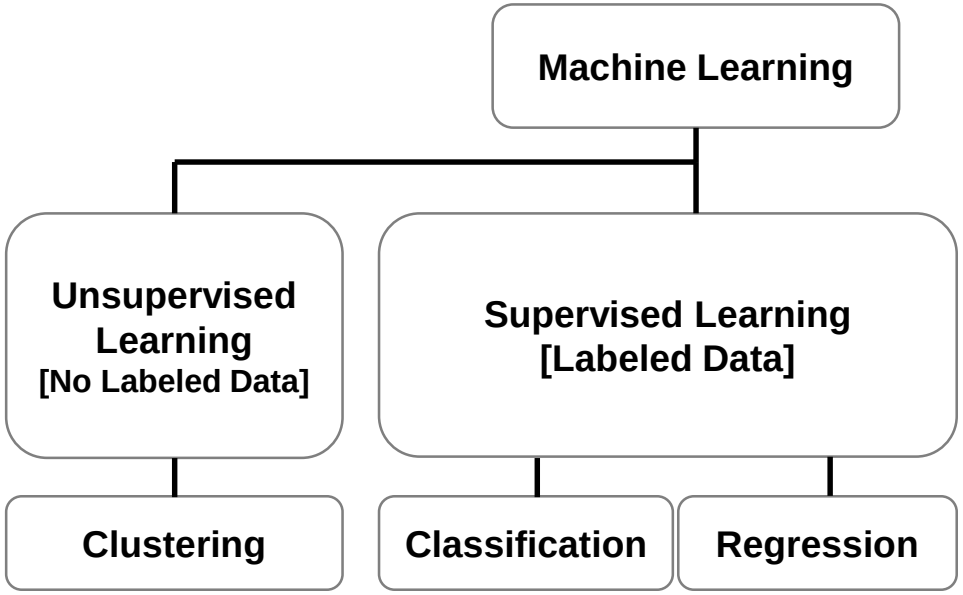
Signal Classification

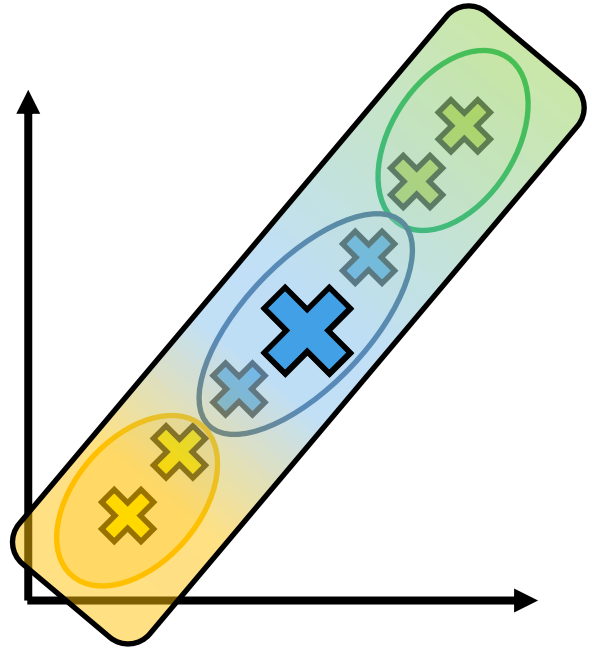


Automated Driving

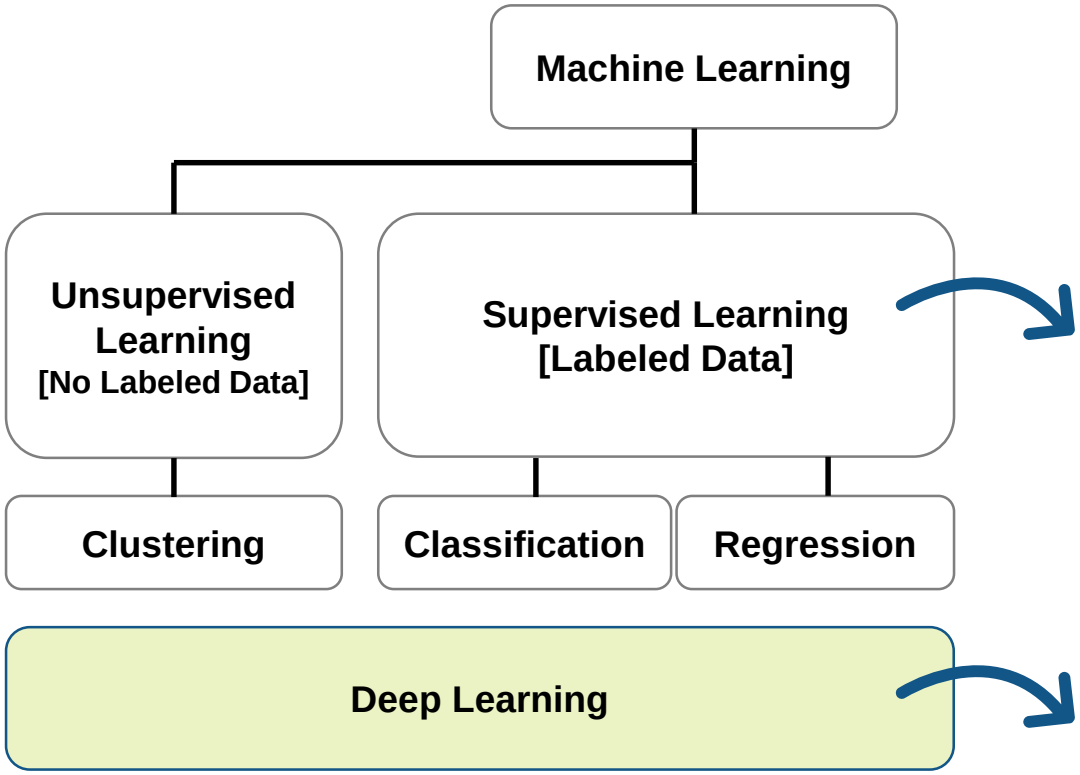
Stock Market Prediction

Machine Learning and Deep Learning





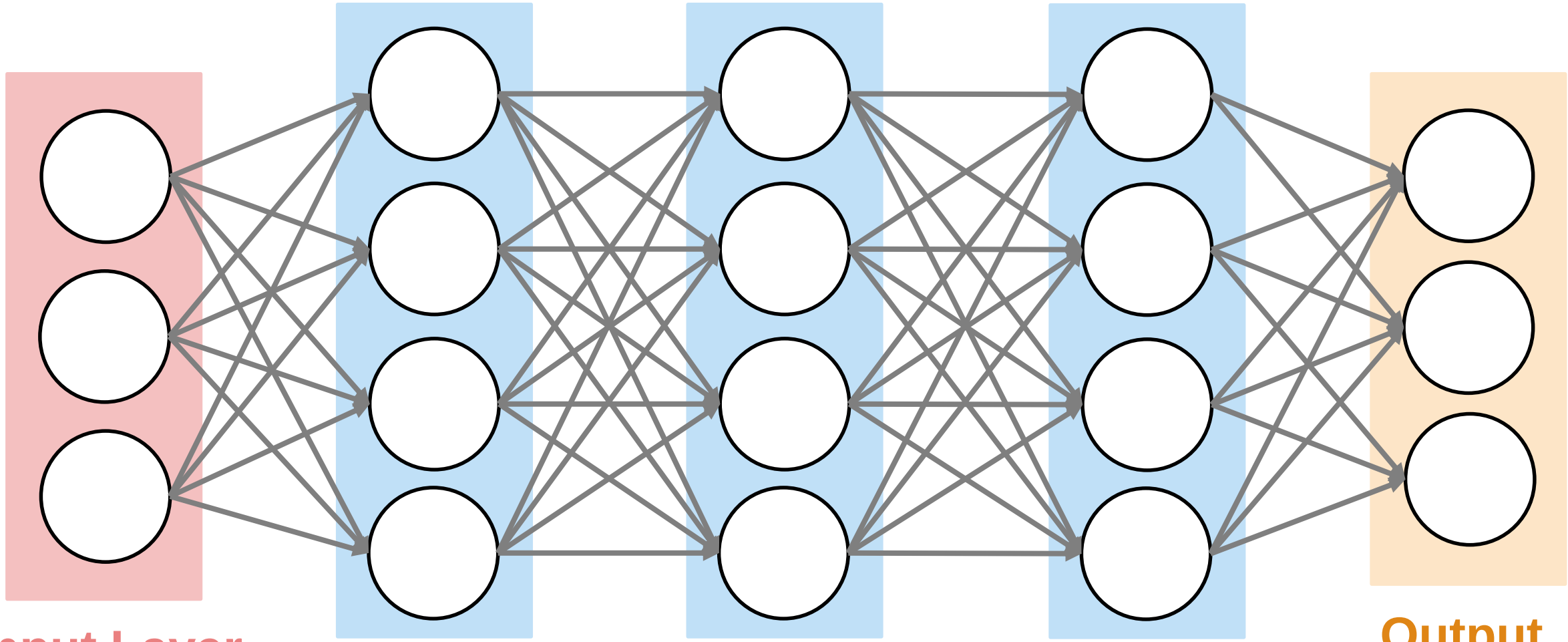
Machine Learning and Deep Learning



Machine learning typically involves feature extraction

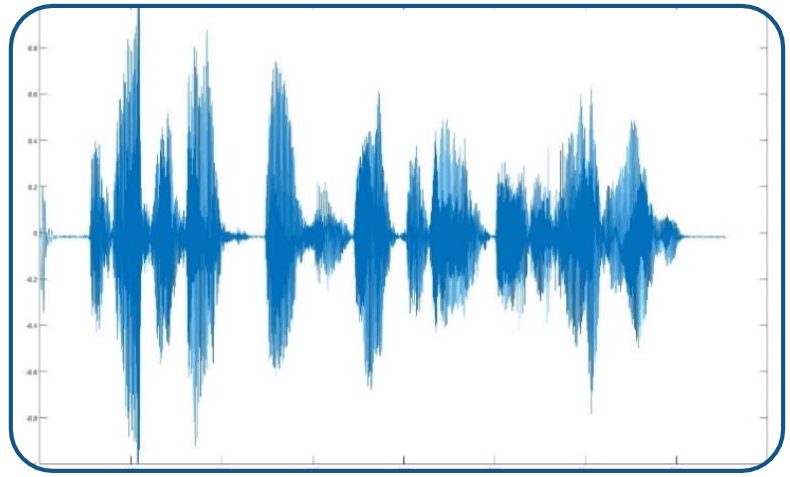
Deep learning typically does not involve feature extraction

Deep Learning Uses a Neural Network Architecture



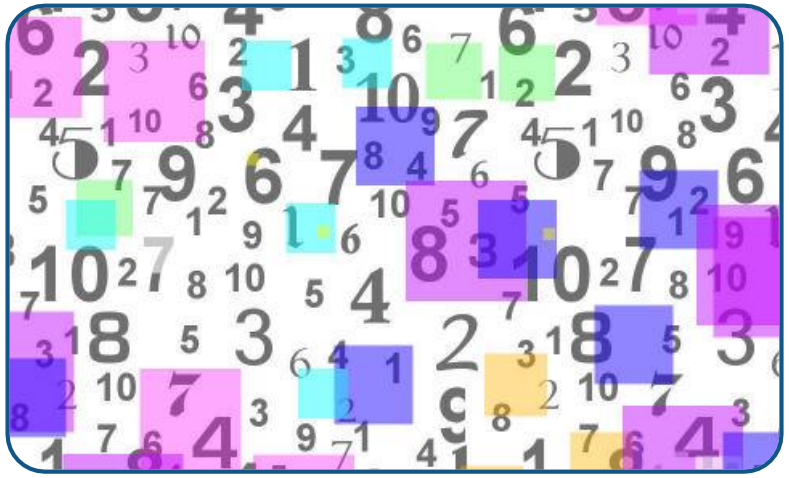
Deep Learning Datatypes

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 AI Tasks?

Increased productivity with interactive tools

Generate simulation data for complex models and systems

Ease of deployment and scaling to various platforms

Full AI workflows that cannot be easily replicated by other toolchains

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Labeling

Training

Model Exchange

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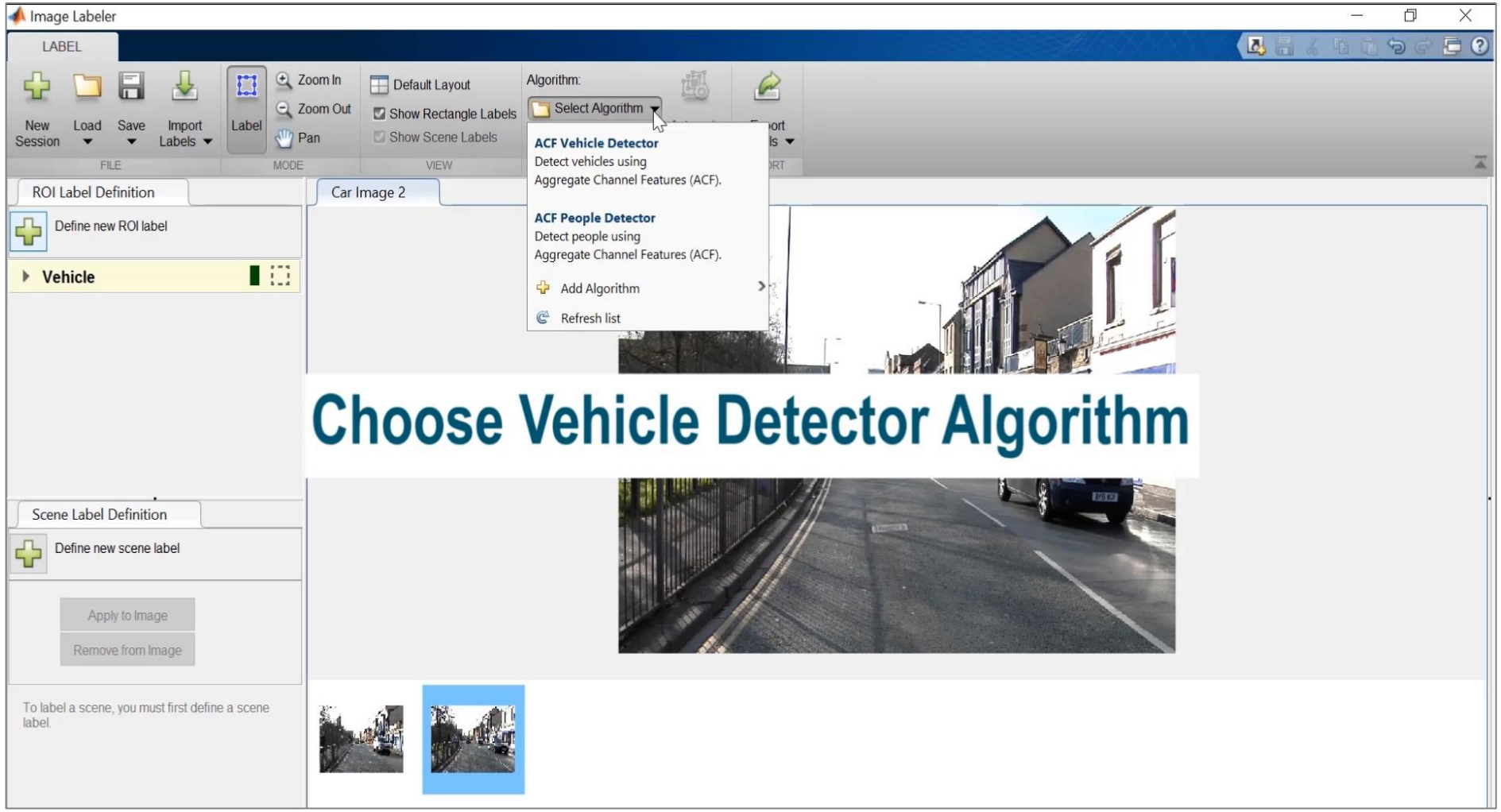
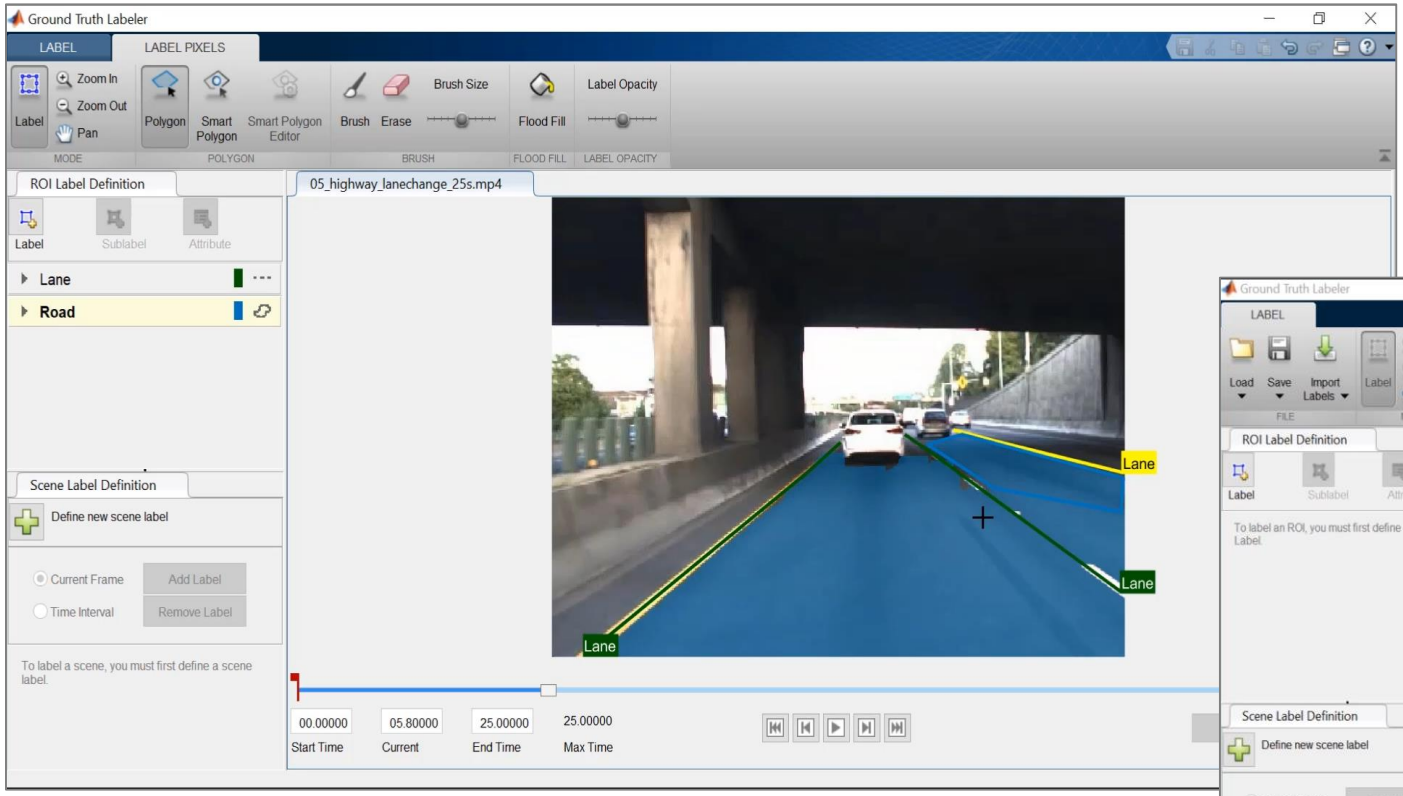
Labeling for deep learning is repetitive, tedious, and time-consuming…

but necessary

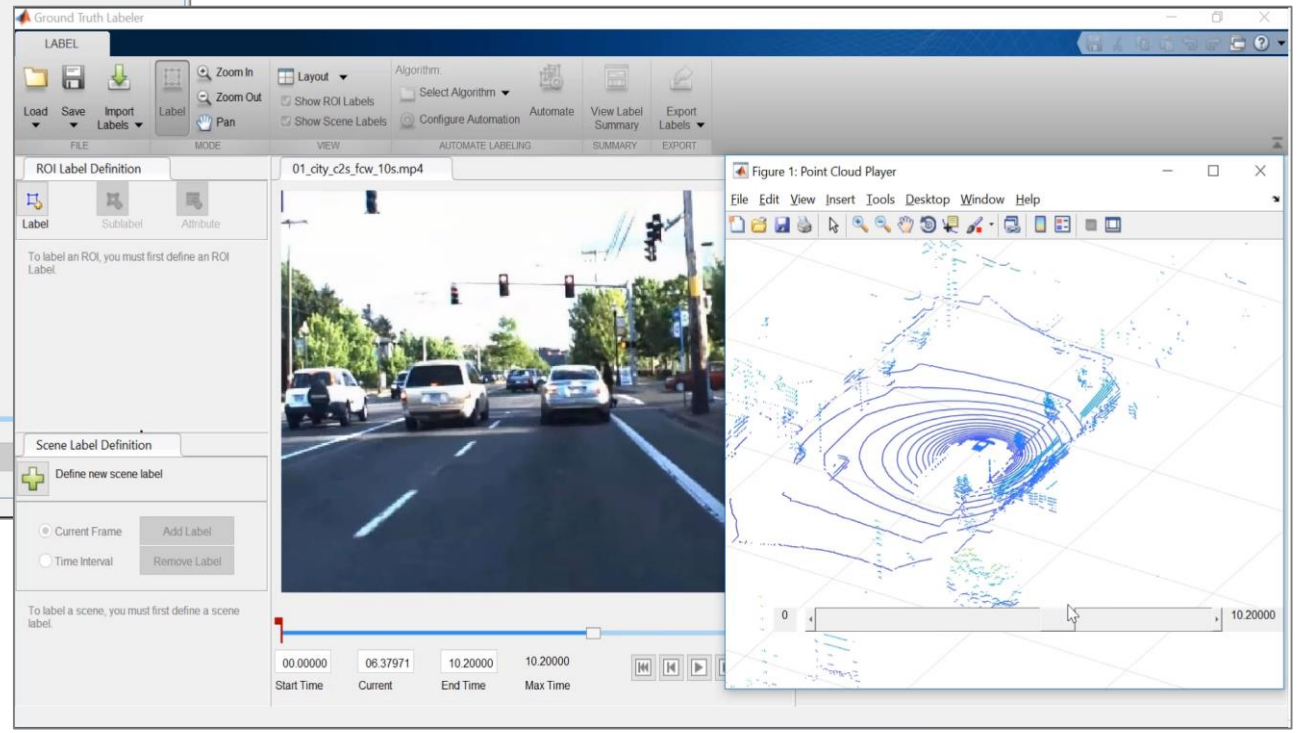
Partially automate ground truth labeling with Apps



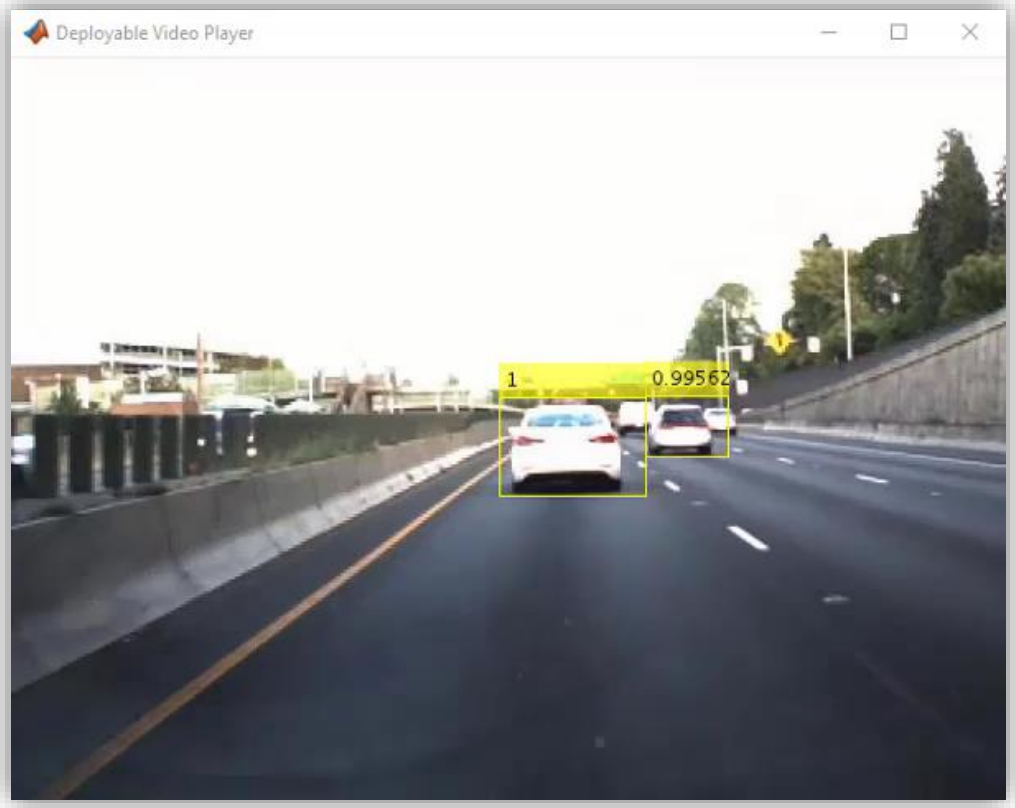
Partially automate ground truth labeling with Apps



App for ground truth labeling dedicated to automotive applications



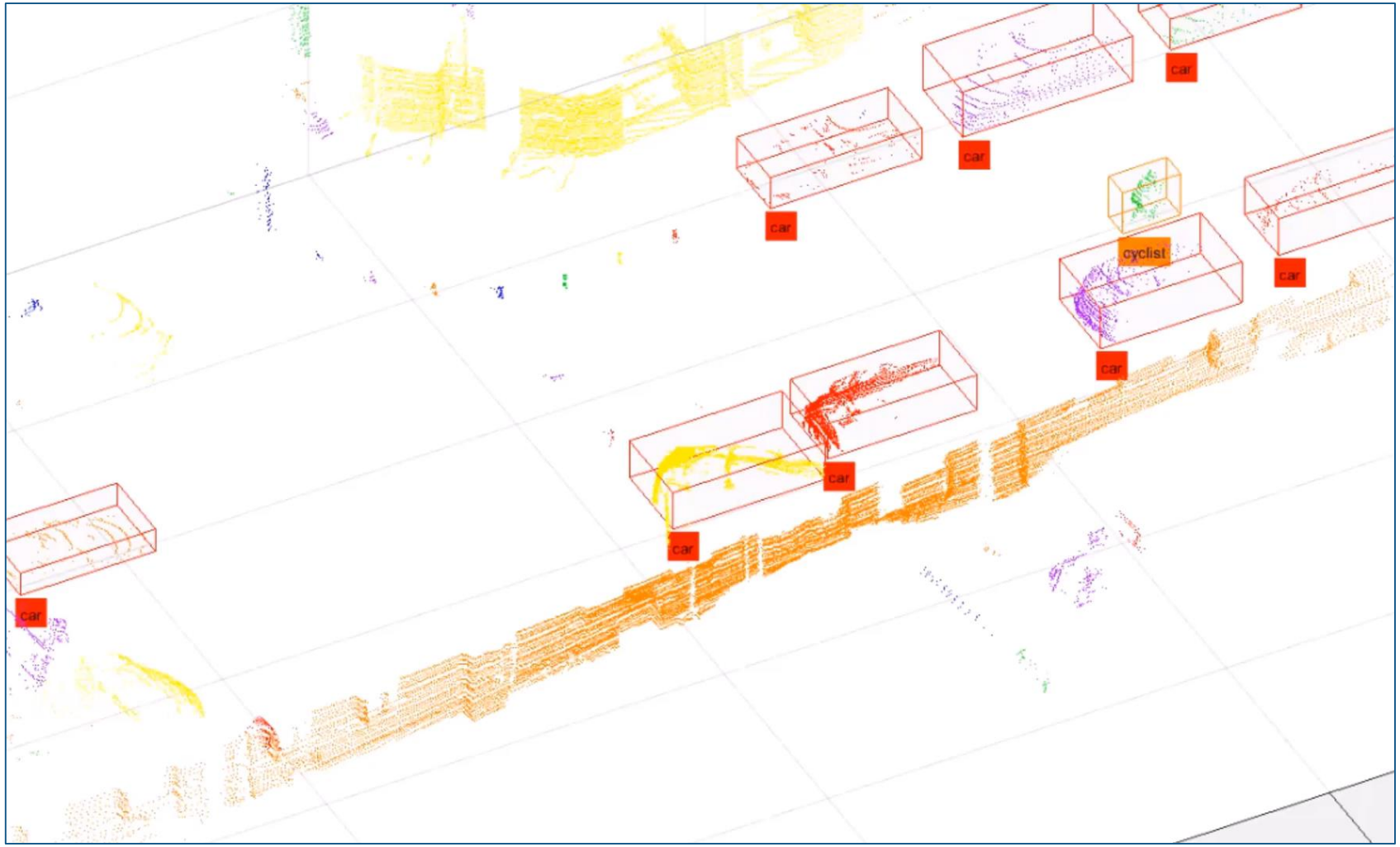
Applications developed using labeled data



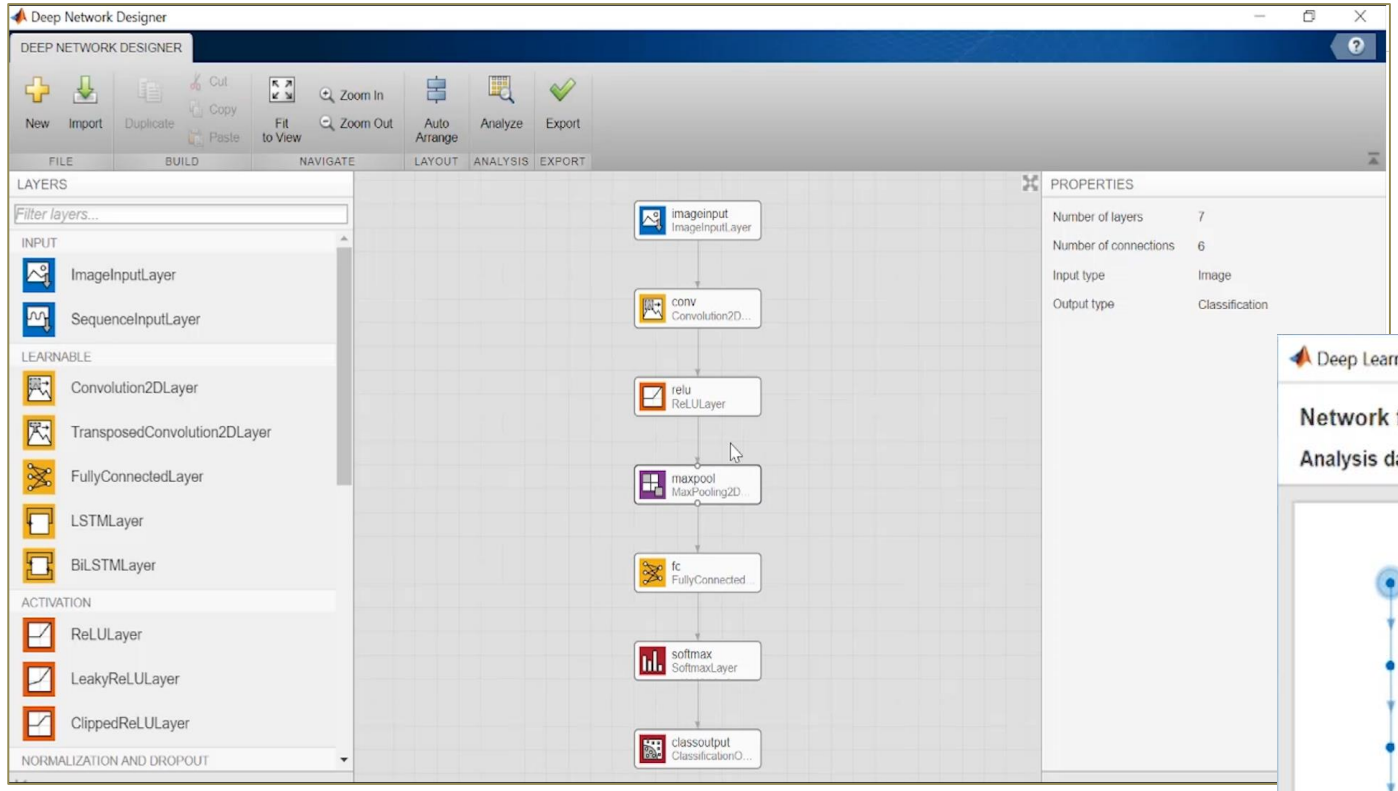
User Story – Veoneer (Autoliv)

- Automotive:
  - Software and hardware for active safety, autonomous driving, occupant protection, and brake control
- Application:
  - Build radar sensor
  - Check accuracy using LiDAR-based verification
- Used MATLAB to semi-automate labeling and tracking of 3D LiDAR point clouds

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

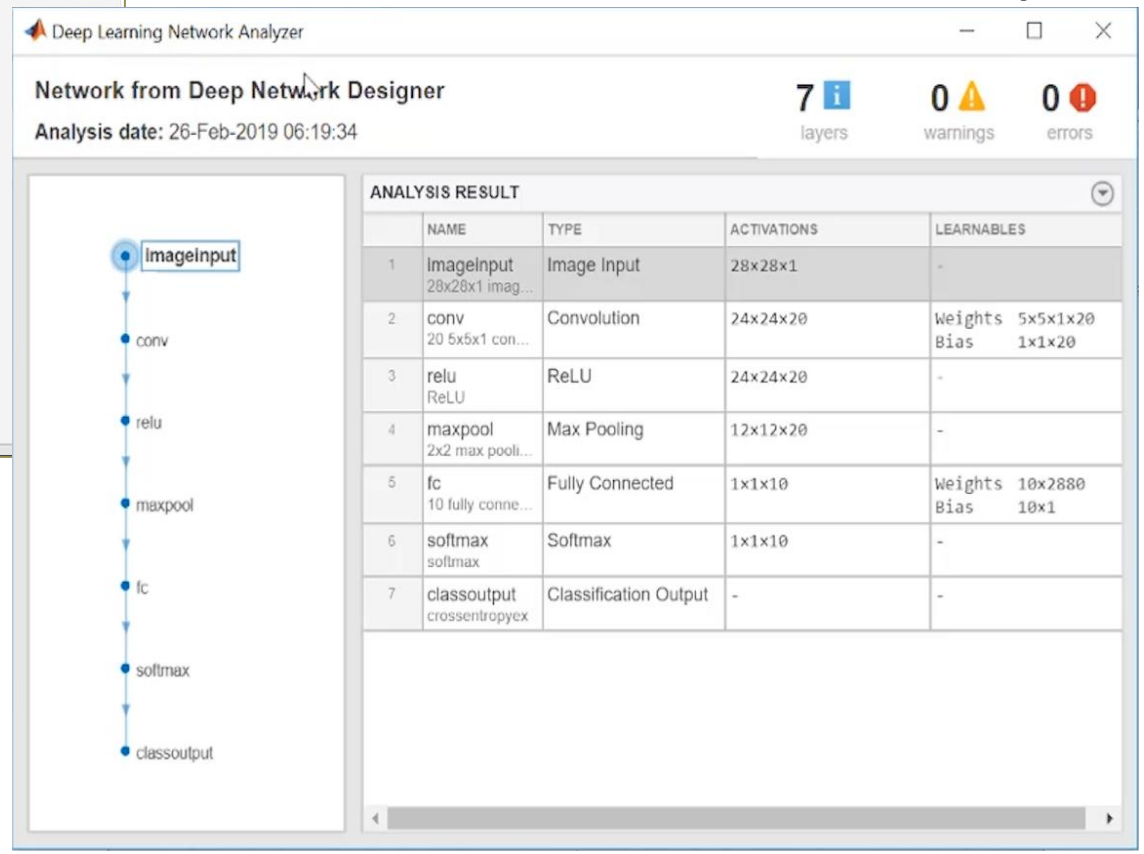


Design deep networks interactively



Design network with Deep Network Designer

Check for errors with Network Analyzer



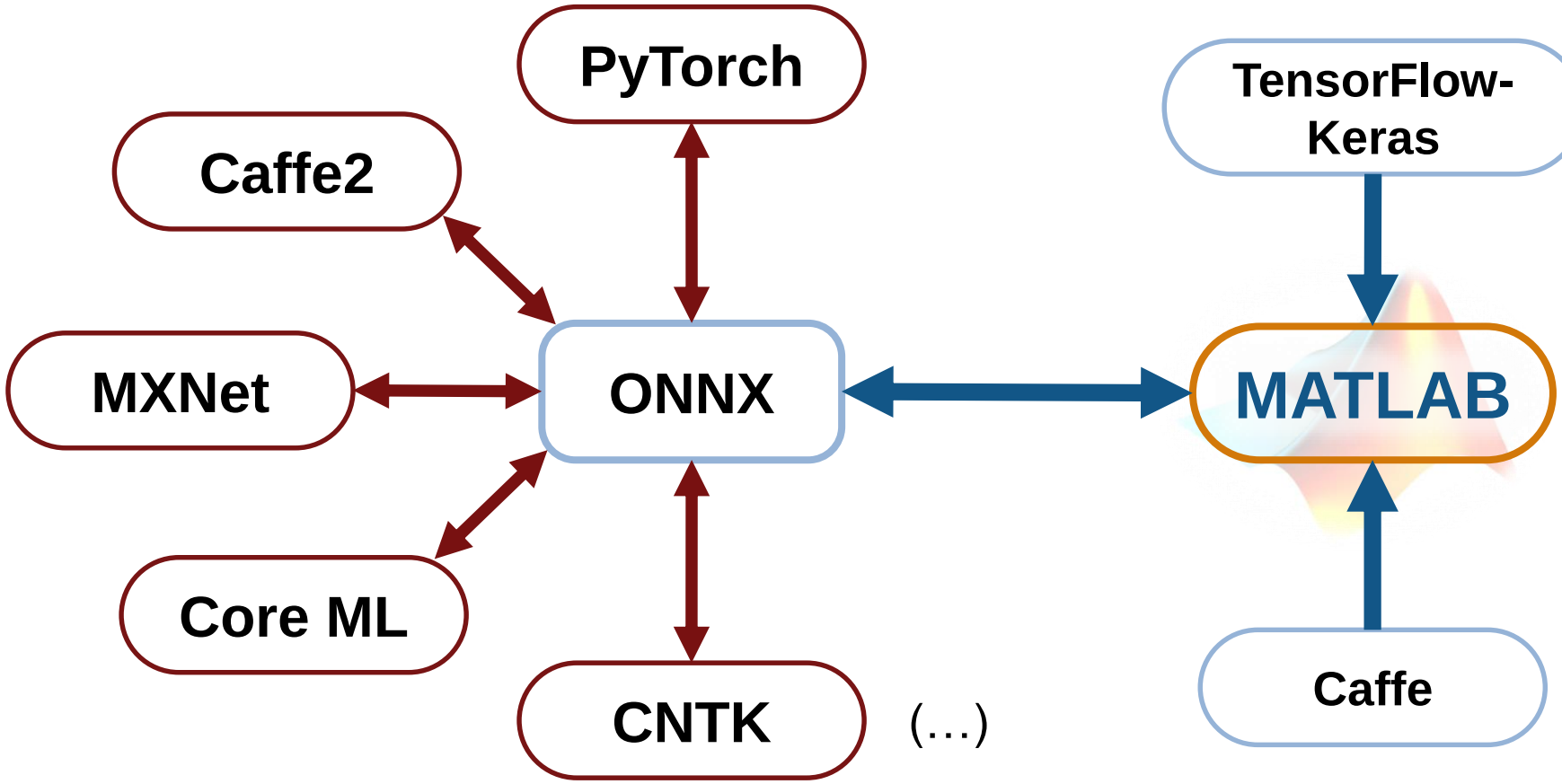
Transfer Learning with Pre-trained Models

- AlexNet
- VGG-16
- VGG-19
- SqueezeNet
- GoogLeNet
- Inception-v3
- DenseNet-201
- MobileNetV2
- ResNet-18
- ResNet-50
- ResNet-101
- Xception
- Inception-ResNet-v2

Import & Export Models Between Frameworks

- TensorFlow-Keras Importer
- Caffe Model Importer
- ONNX Model Converter

Model Exchange with MATLAB



ONNX = Open Neural Network Exchange

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Reinforcement Learning

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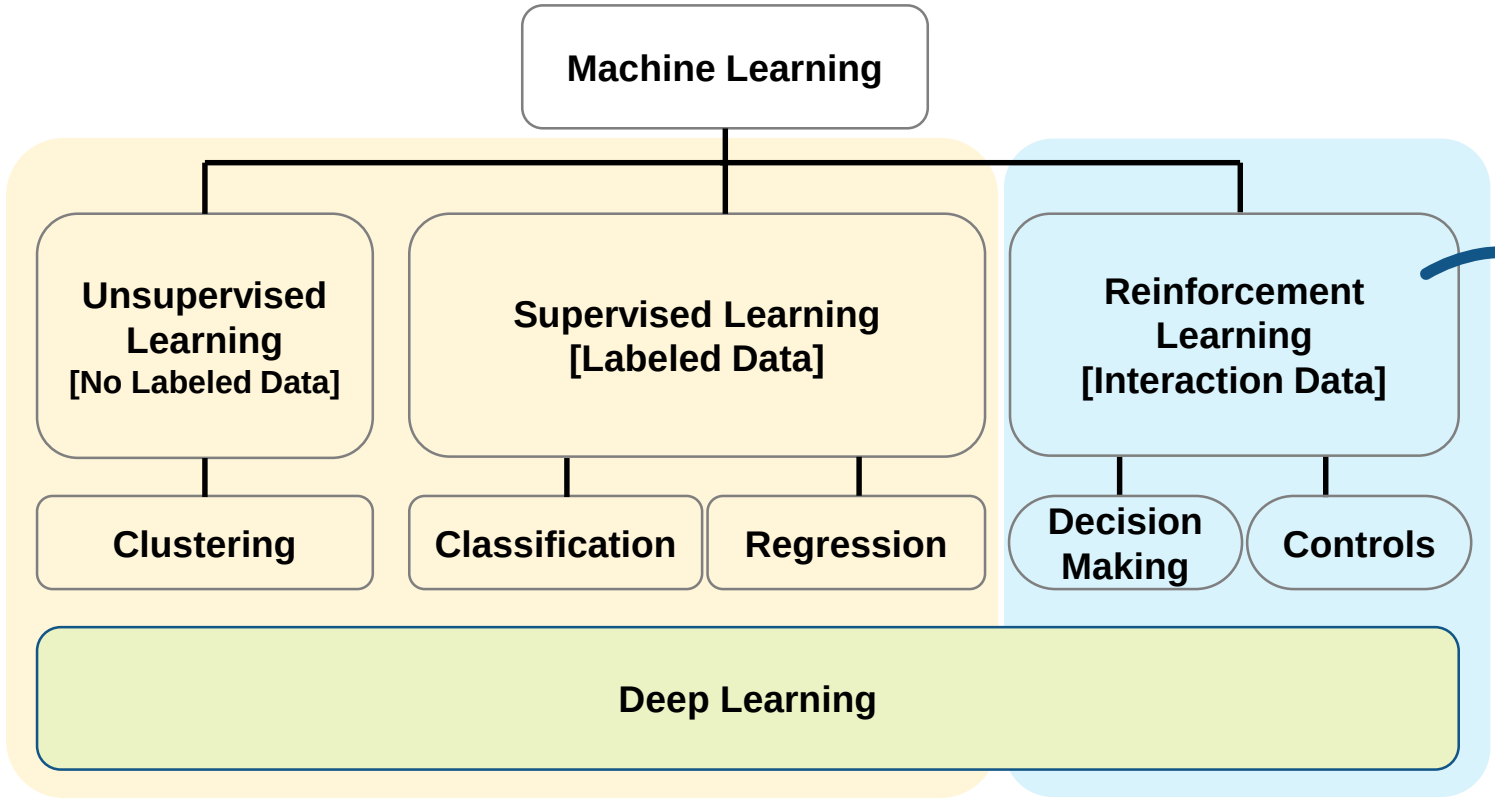
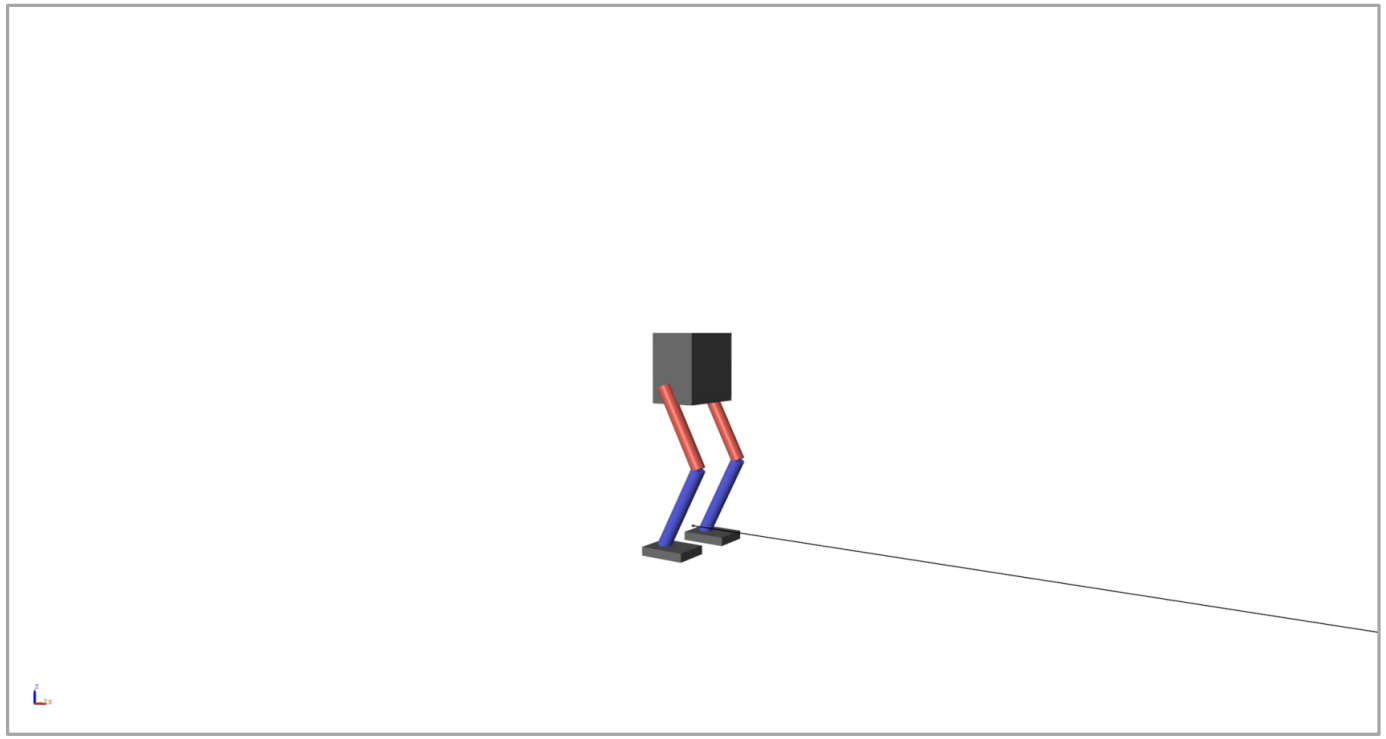
Reinforcement Learning vs Machine Learning vs Deep Learning



Reinforcement learning learns through trial and error, i.e. through interaction

It's about learning a behavior or accomplishing a task

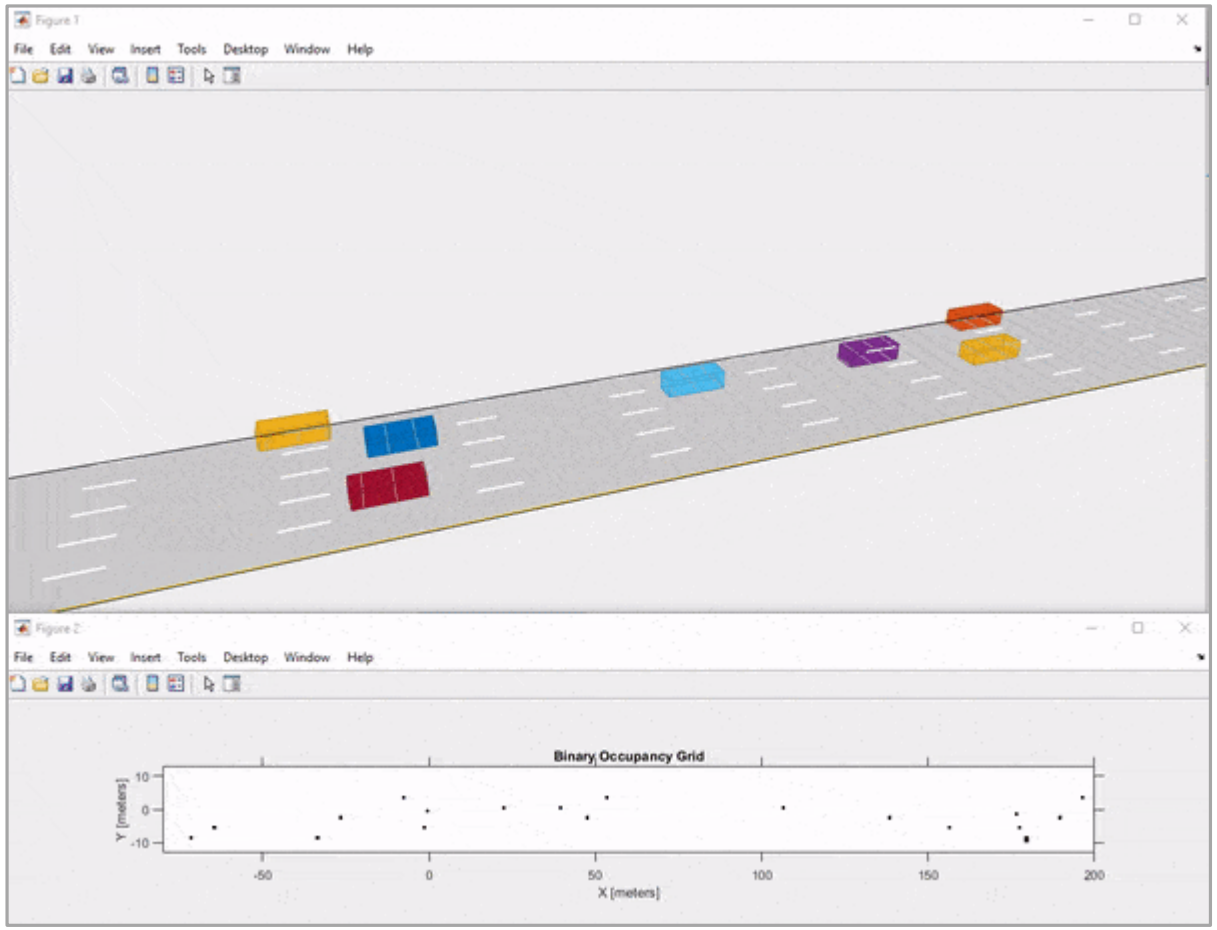
What is Reinforcement Learning?



Reinforcement learning is a type of machine learning that trains an agent through repeated interactions with an environment through a trial & error process that uses a reward system to maximize success

A Practical Example of Reinforcement Learning

Training a Self-Driving Car



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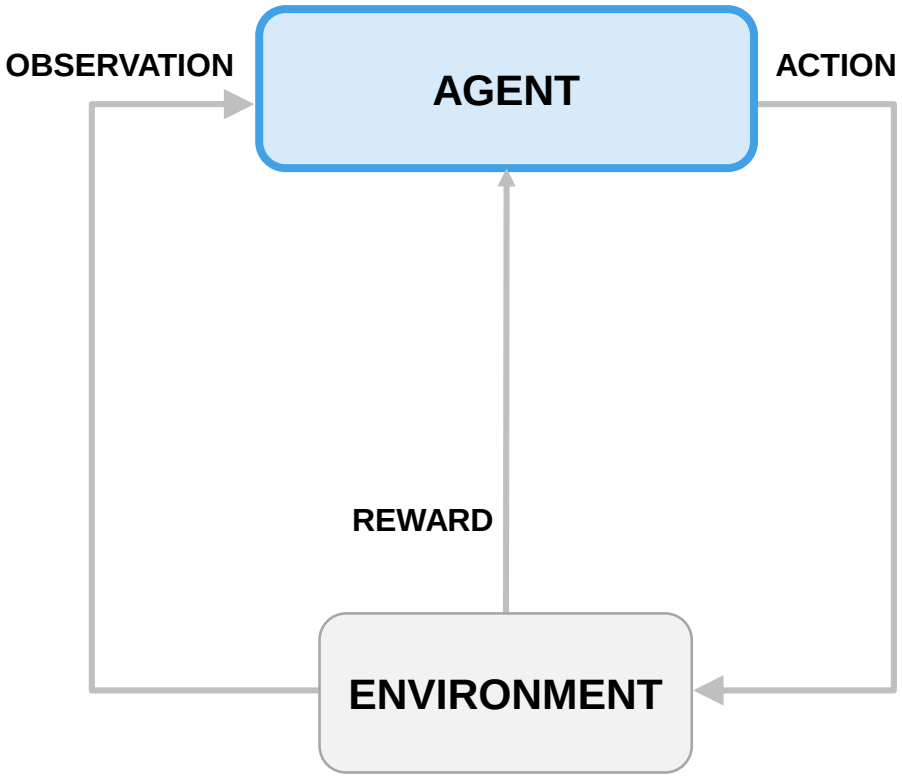
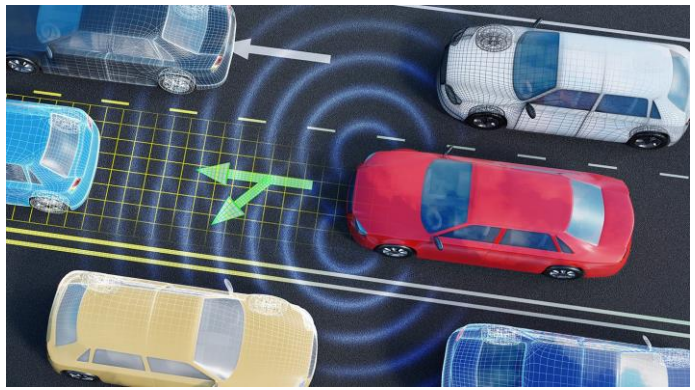
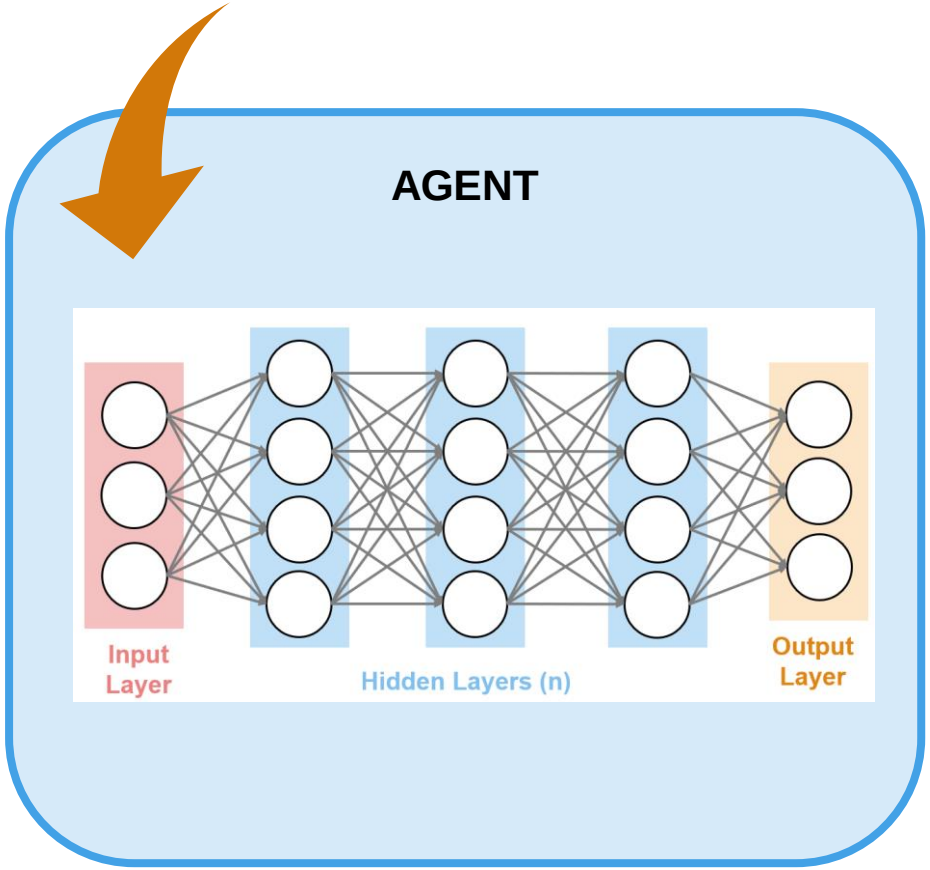


- Vehicle's computer learns how to drive [agent]
- using sensor readings from LIDAR, cameras [observation]
- that represent road conditions, vehicle position [environment]
- by generating steering, braking, throttle commands [action]
- to avoid collisions and lane deviation [reward].

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

Generate Data

- Scenario Design
- Simulation-based data generation

Simulink – generate data for dynamic systems (planes, cars, robots, etc.)

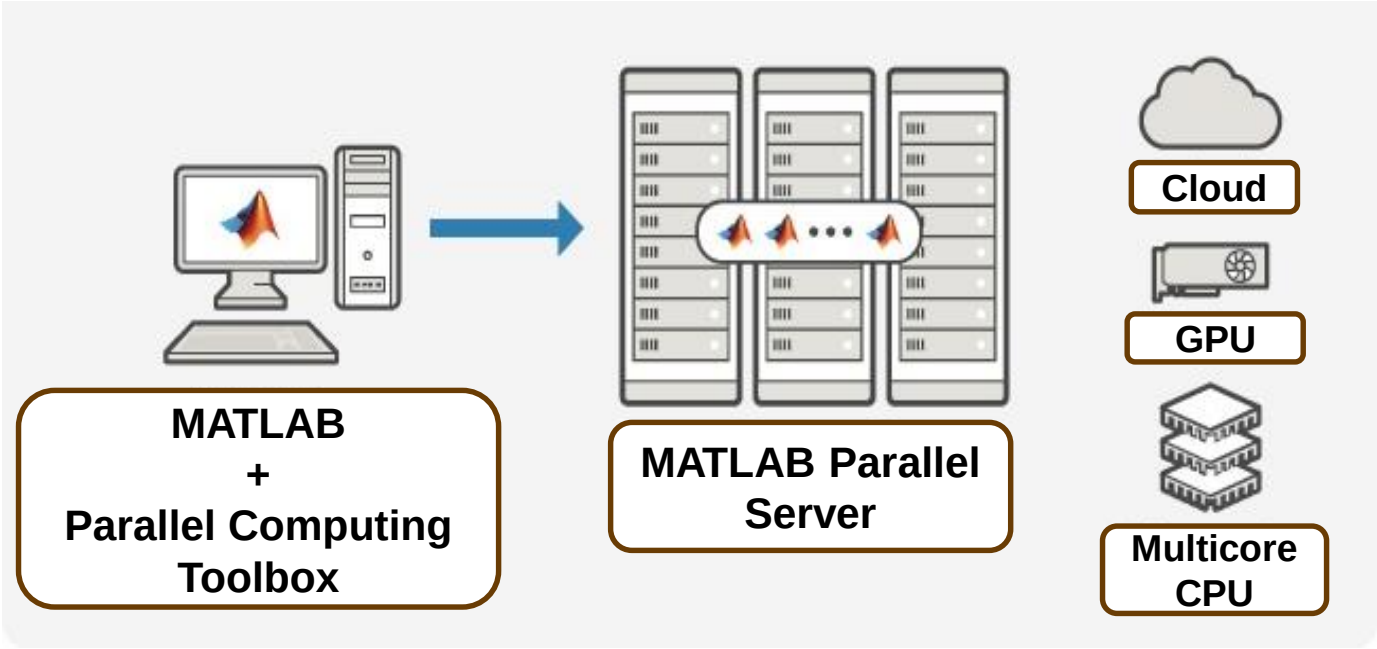
Train Model

- Reinforcement learning
- Training agent to perform task
- Developing reward system to optimize performance

Deployment

- Multiplatform code generation (CPU, GPU)
- Edge deployment
- Enterprise deployment

Scaling up deep learning in parallel and in the cloud



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

MATLAB and Simulink for Reinforcement Learning

- Reinforcement learning is a dynamic process
- MATLAB and Simulink virtual models allow you to simulate conditions that are difficult or dangerous to emulate in the real world
- Suitable for:
  - Control-based problems, e.g. automated driving (lane keep assist, adaptive cruise control), robotics, etc.
  - Decision-making problems, e.g. financial trading, games, etc.

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Code Generation

Embedded Devices

Enterprise Systems

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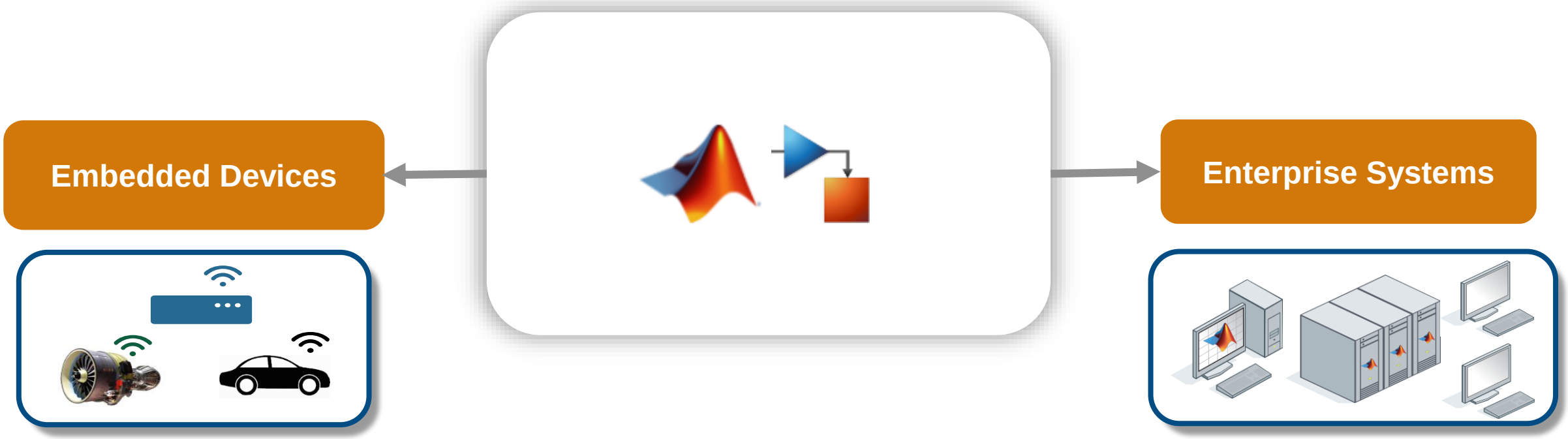
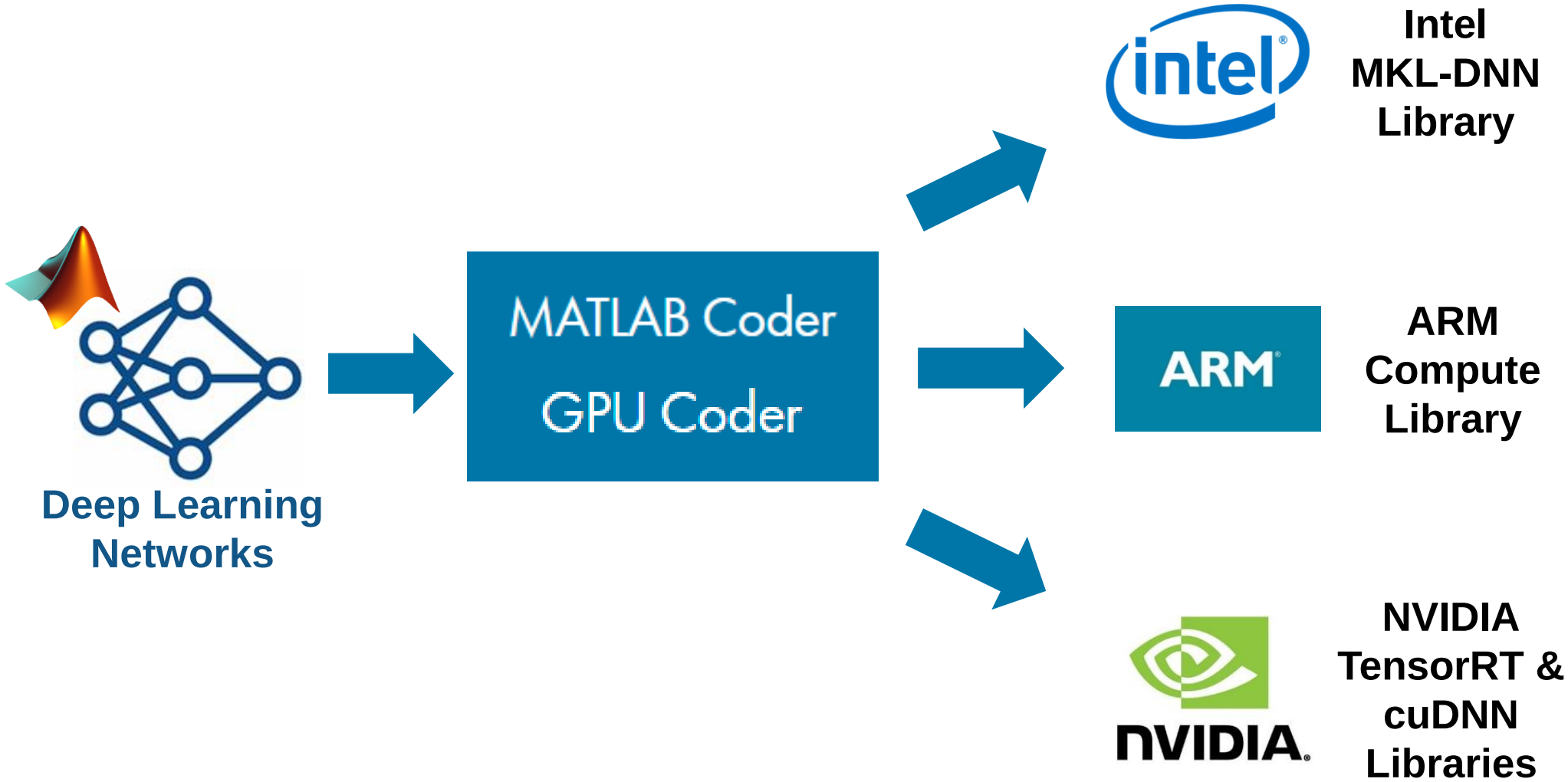
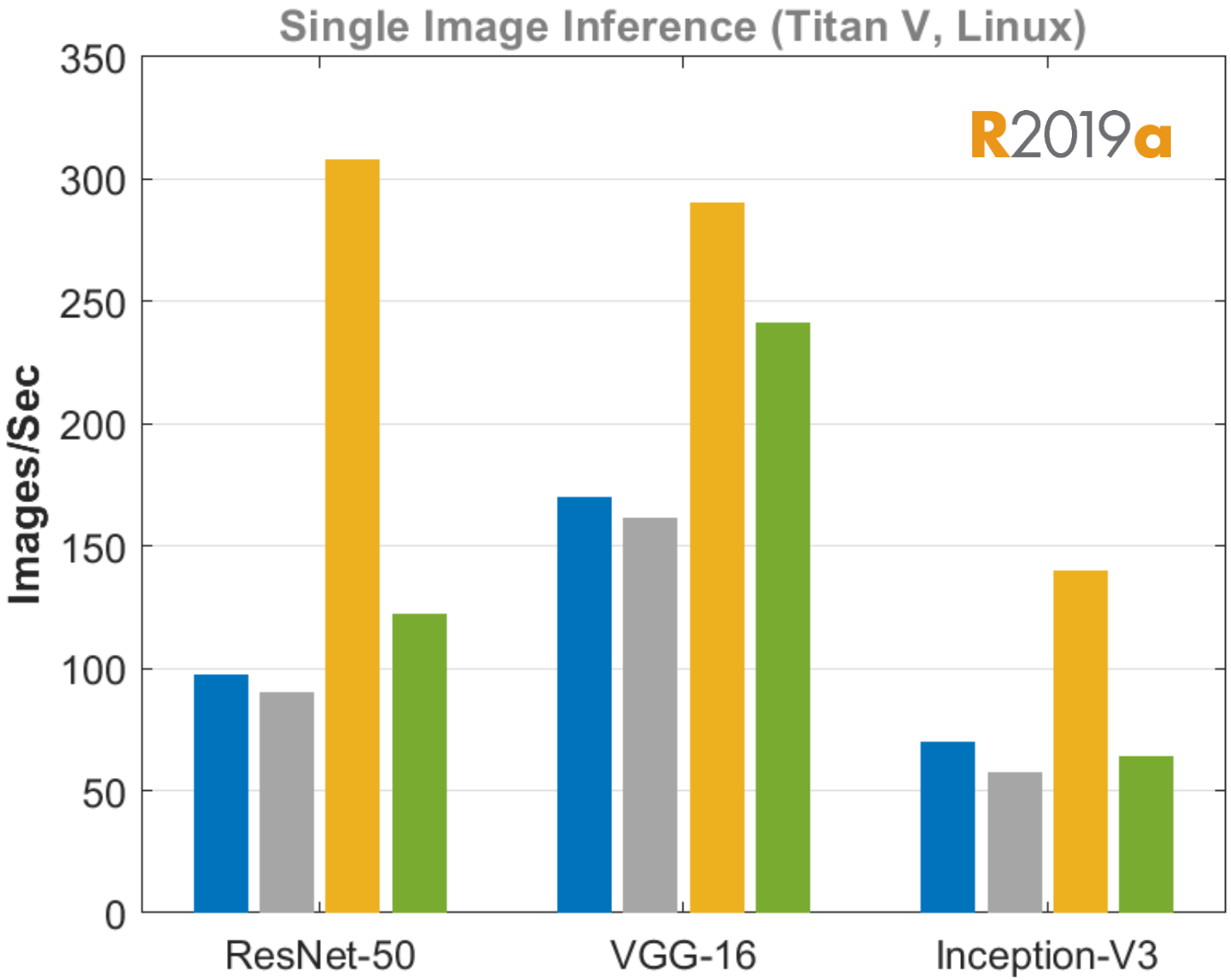
Deployment and Scaling for AI



Deploying Deep Learning Models for Inference



Benchmark of GPU Coder

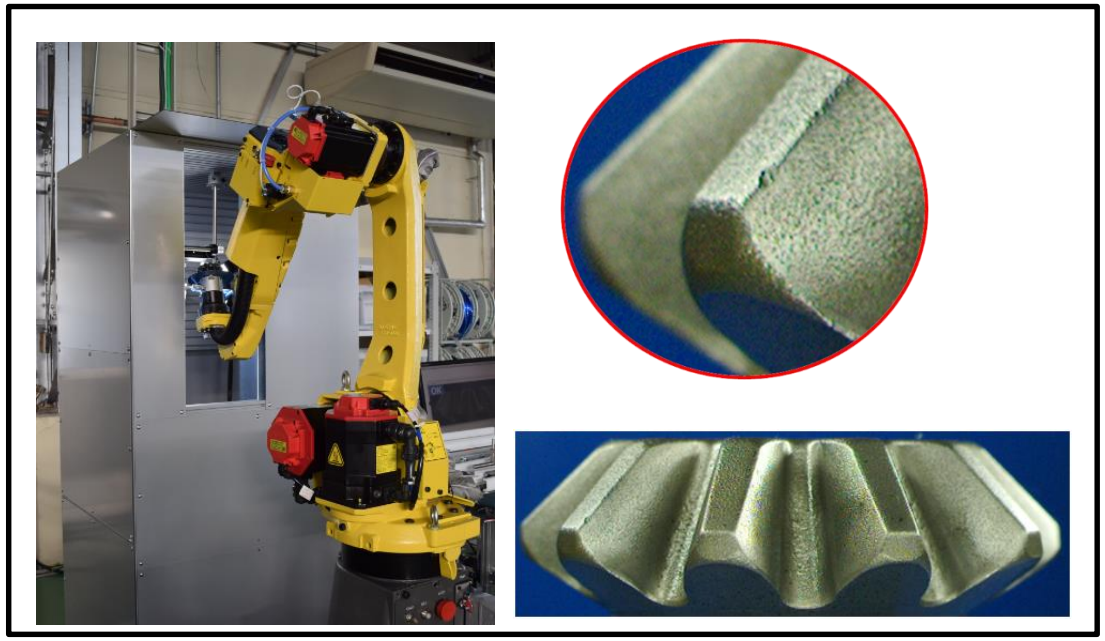


- TensorFlow
- MXNet
- GPU Coder
- PyTorch

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

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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