L'intelligence artificielle dans l'industrie avec MATLAB/Simulink: du mythe à la pratique

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MathWorks is the **leading provider of technical computing software**

- **4 million users**
- Installations at **100,000+ sites** in **185 countries**
- Used for teaching and research by **6500+ universities**
- **$1B+ revenue** in 2020
- **5000+ staff** including **2500+ engineers**
- **Private, profitable every year** since founding in 1984

Headquarters
Natick, MA USA

North America
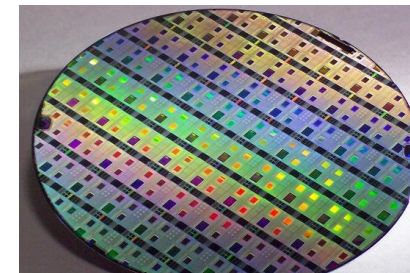United States

Europe
France
Germany
Ireland
Italy
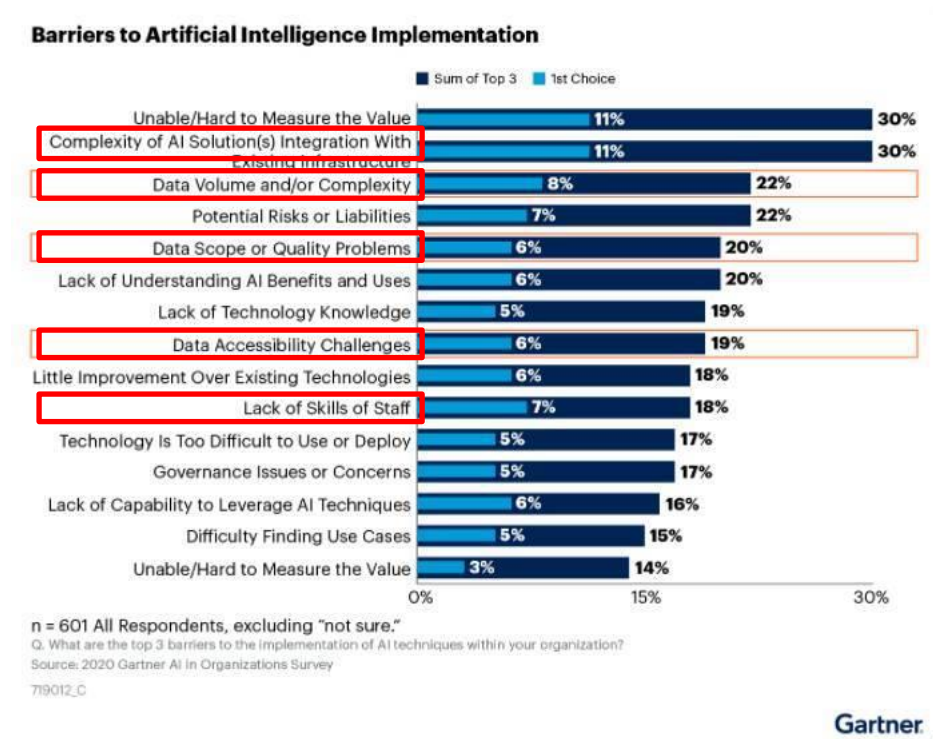Netherlands
Spain
Sweden
Switzerland
UK

Asia-Pacific
Australia
China
India
Japan
Korea

AI is transforming engineering

Integrating AI is a priority for companies today but...

Top Barriers to AI Implementation

Barriers to Artificial Intelligence Implementation

■ Sum of Top 3   ■ 1st Choice

Barrier	1st Choice	Sum of Top 3
Unable/Hard to Measure the Value	11%	30%
Complexity of AI Solution(s) Integration With Existing Infrastructure	11%	30%
Data Volume and/or Complexity	8%	22%
Potential Risks or Liabilities	7%	22%
Data Scope or Quality Problems	6%	20%
Lack of Understanding AI Benefits and Uses	6%	20%
Lack of Technology Knowledge	5%	19%
Data Accessibility Challenges	6%	19%
Little Improvement Over Existing Technologies	6%	18%
Lack of Skills of Staff	7%	18%
Technology Is Too Difficult to Use or Deploy	5%	17%
Governance Issues or Concerns	5%	17%
Lack of Capability to Leverage AI Techniques	6%	16%
Difficulty Finding Use Cases	5%	15%
Unable/Hard to Measure the Value	3%	14%

n = 601 All Respondents, excluding "not sure."
Q. What are the top 3 barriers to the implementation of AI techniques within your organization?
Source: 2020 Gartner AI in Organizations Survey

719012_C

Gartner

Top barriers to successful adoption of AI

1. Integration with existing technology

2. Data Complexity/Quality

3. Lack of Skills

n = 601
Gartner Research Circle members, excluding "unsure"
Source: 2020 Gartner AI in Organizations Survey
Q: What are the top three barrier to the implementation of AI techniques within your organization? *Rank up to three.*
ID: 719012_C

- *Source: "" How to Build Knowledge Graphs That Enable AI-Driven*
- *Enterprise Applications" Gartner Research Note, <D#>, published 27 May 2020*

is a **Leader** in the 2021 Gartner Magic Quadrant for Data Science and Machine Learning Platforms for the Second Year in a Row

Figure 1: Magic Quadrant for Data Science and Machine Learning Platforms
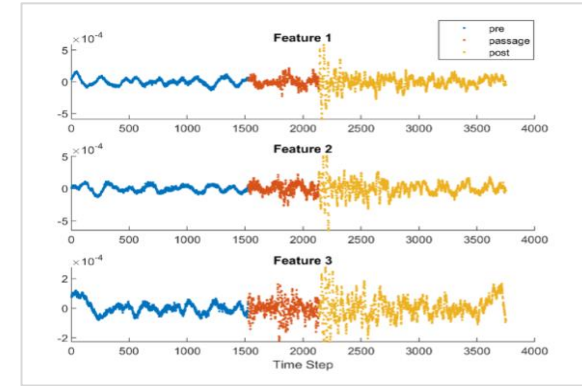
Source: Gartner (March 2021)

MATLAB AI is used everywhere in Industry & Research
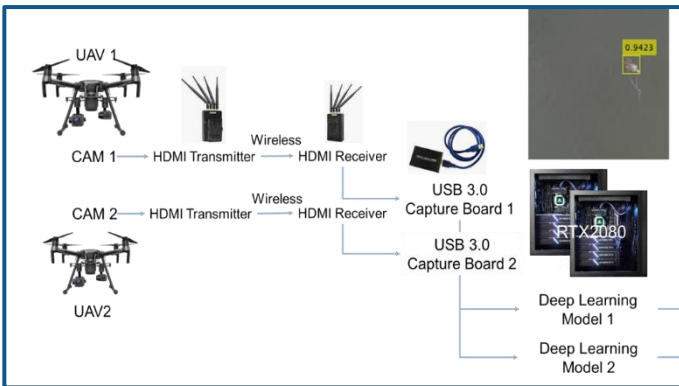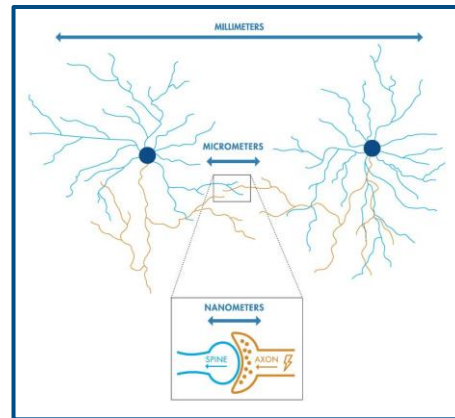

Automatic Defect Detection
Airbus
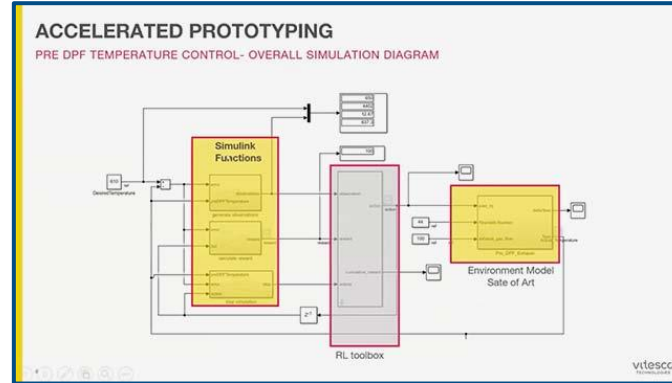
Powertrain Control
Vitesco

Seismic Event Detection
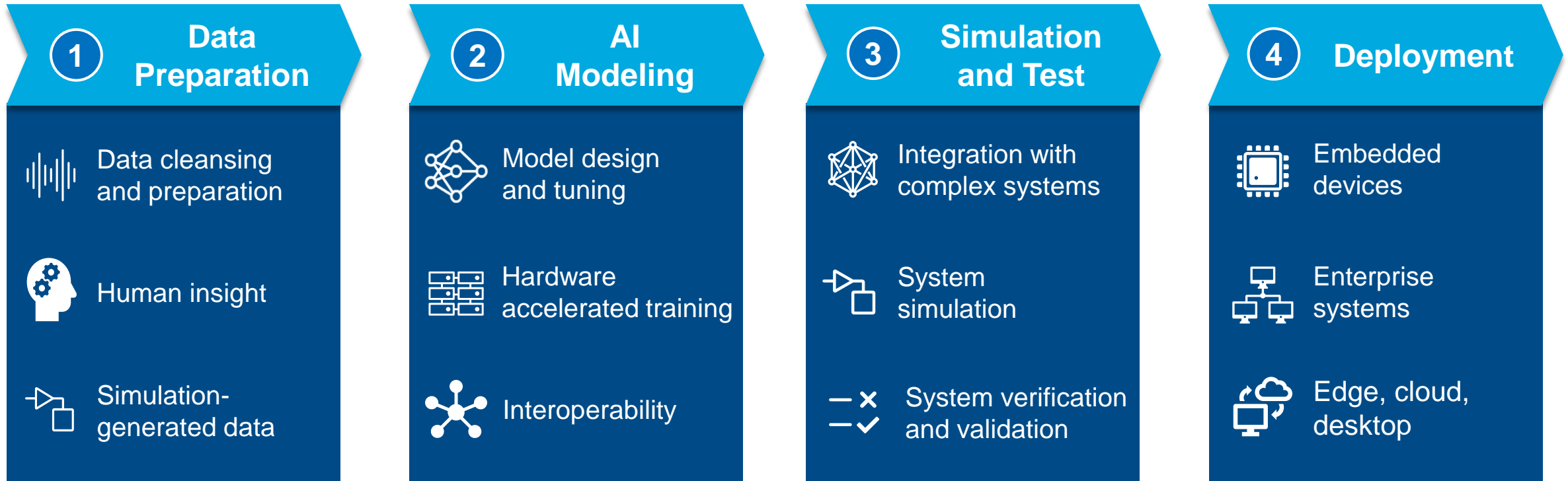Shell

Drone Based Survivor Search
KRISO

Reconstructing Neural Maps from Electron Microscopy
Max Plank Institute
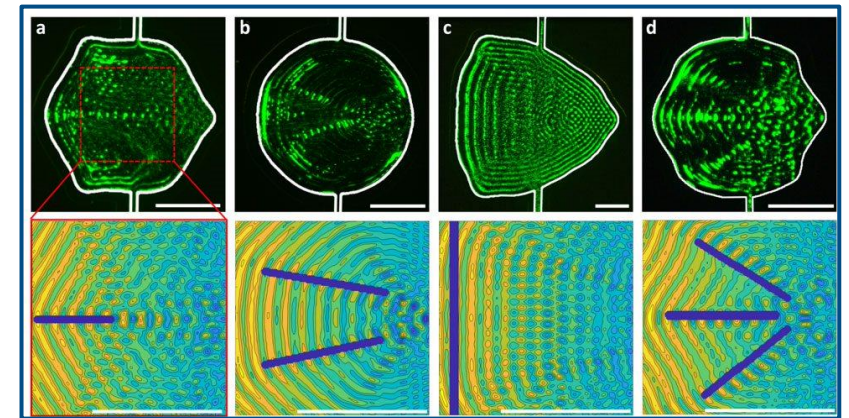
Deep Learning and Acoustic Patterning in Organ Cell Growth Research
Massachusetts Institute of Technology (MIT)

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AI-driven system design workflow

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

2 AI Modeling
- Model design and tuning
- Hardware accelerated training
- Interoperability

3 Simulation and Test
- Integration with complex systems
- System simulation
- System verification and validation

4 Deployment
- Embedded devices
- Enterprise systems
- Edge, cloud, desktop

Data preparation represents most of your AI effort
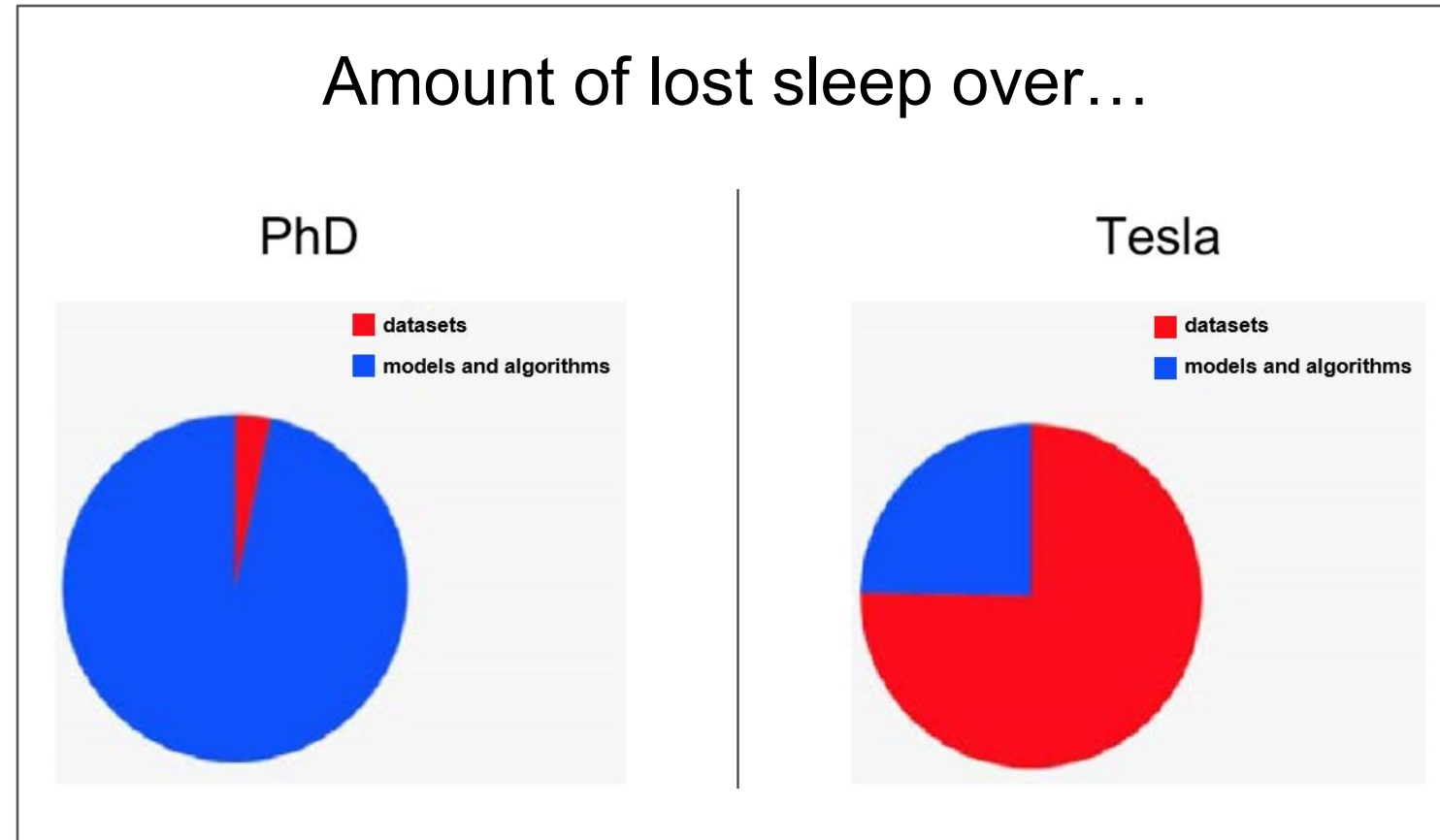
Source: Andrej Karpathy slide from TrainAI 2018

Domain experts build better AI systems
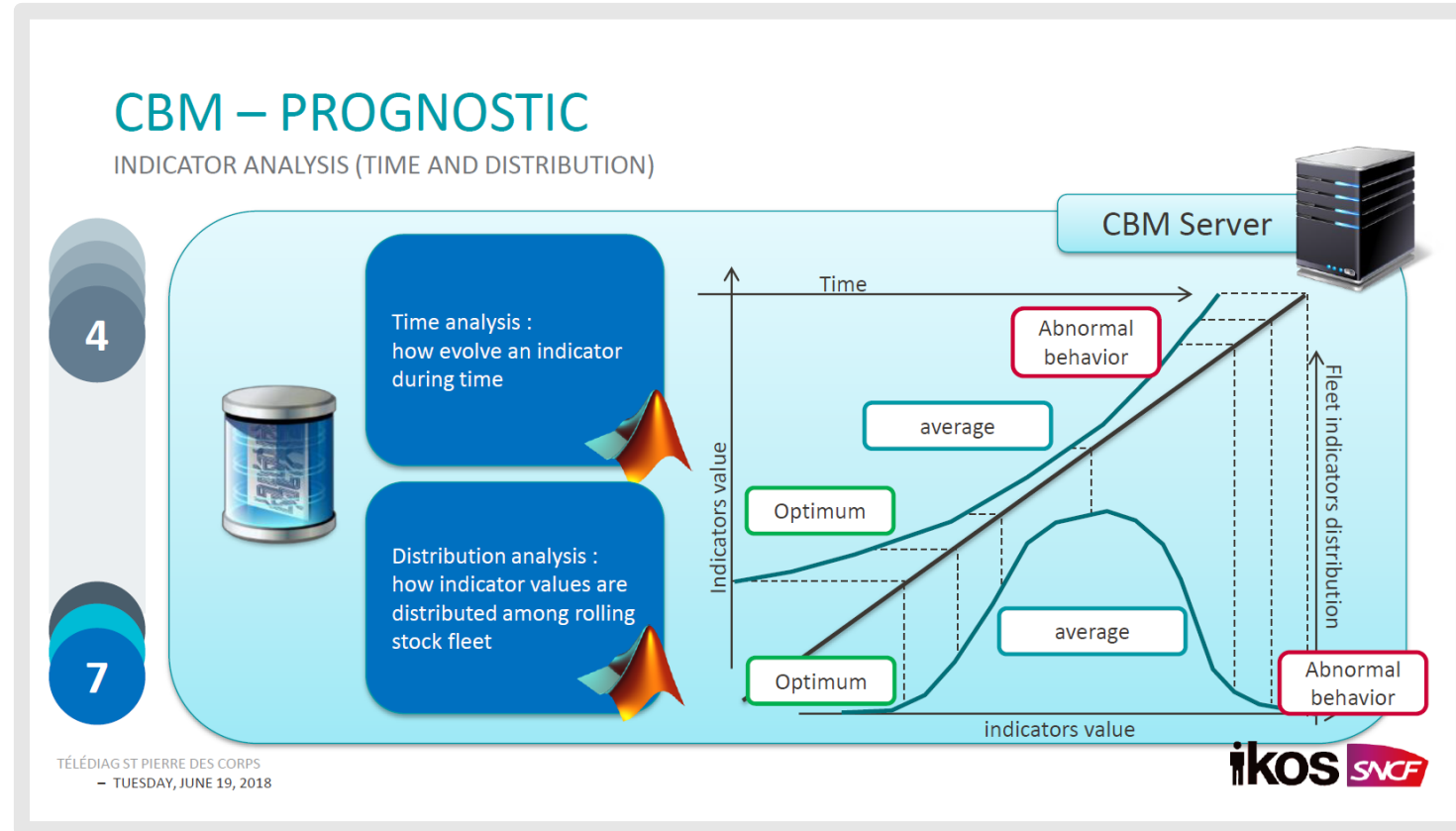
System monitors the health of trains in real time, anticipates failures, and identifies when critical maintenance is needed

Automated labeling Apps save you weeks to months

1 Data Preparation

2 AI Modeling

3 Simulation and Test

4 Deployment

Reduce human supervision and development time

"Even though I had limited knowledge on Image processing and Deep Learning, I could successfully adopt deep learning for my project. With evaluation support from MathWorks, we could prototype our approach easily with limited time bound."

- Created a custom labeling algorithm for automatic labelling material

- Improved predication accuracy using deep learning

- Partnered with MathWorks to leverage the full benefits of MATLAB
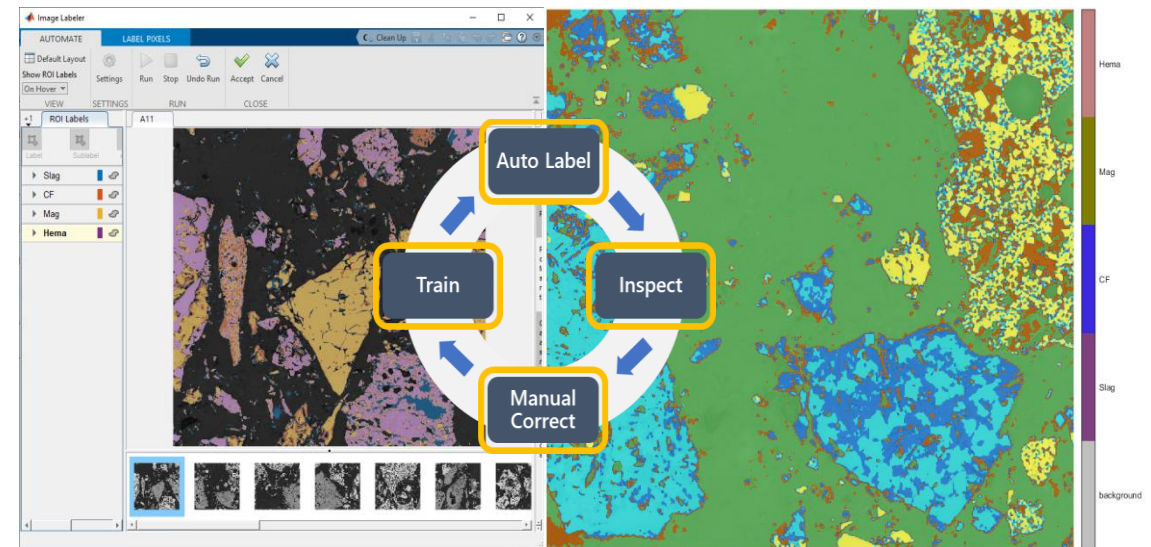
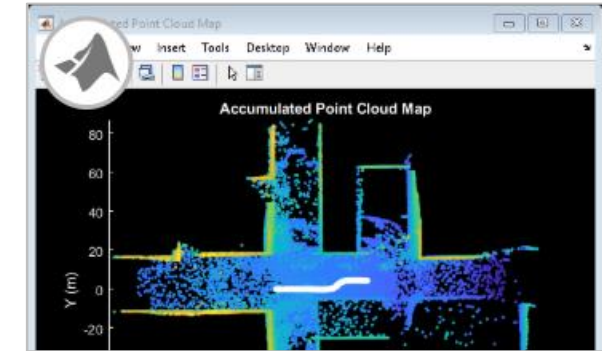# Generate synthetic data and simulate rare system failure
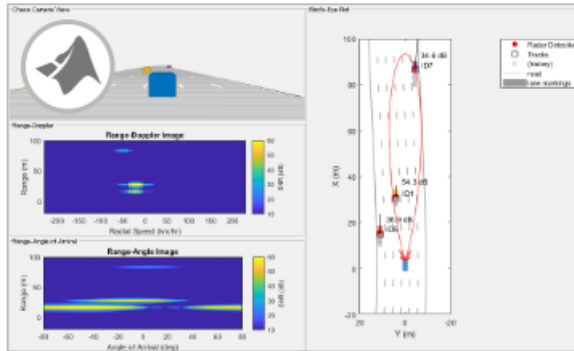
Radar Signal Simulation and Processing for Automated Driving

Automated Driving Toolbox

Phased Array System Toolbox

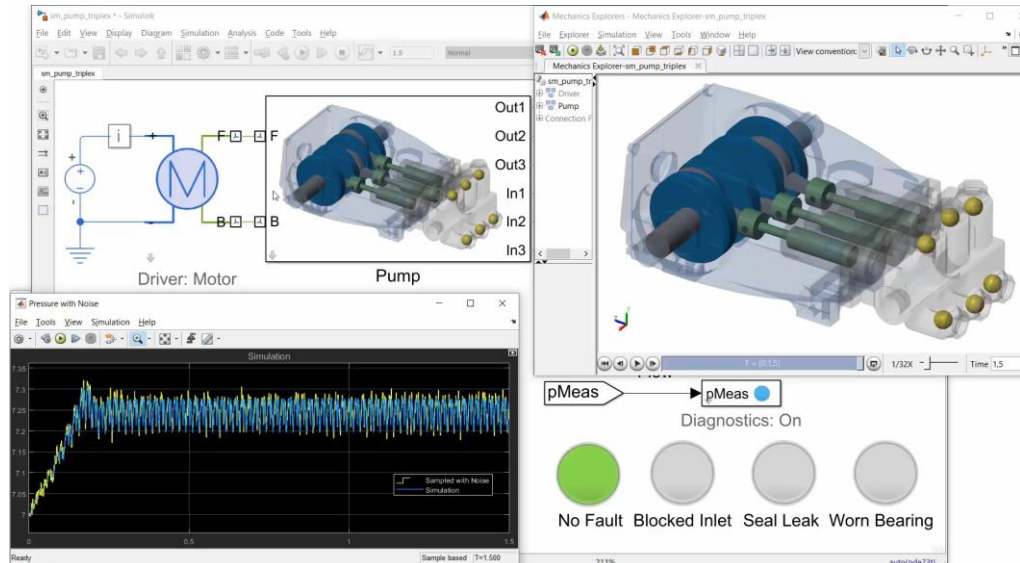**Visualize Automated Parking Valet Using 3D Simulation**

Automated Driving Toolbox

Simulink

Simulate Lidar Sensor Perception Algorithm

Automated Driving Toolbox

Simulink

Computer Vision Toolbox

1. **Data Preparation**
2. **AI Modeling**
3. **Simulation and Test**
4. **Deployment**

Start with a complete set of algorithms and pre-built models

1 Data Preparation

2 AI Modeling

3 Simulation and Test

4 Deployment

Algorithms

Machine learning
Trees, Naïve Bayes, SVM…

Deep learning
CNNs, GANs, LSTM, MIMO…

Reinforcement learning
DQN, A2C, DDPG…

Regression
Linear, nonlinear, trees…

Unsupervised learning
K-means, PCA, GMM…

Predictive maintenance
RUL models, condition indicators…

Bayesian optimization

Pre-built models

Image classification models
AlexNet, GoogLeNet, VGG, SqueezeNet, ShuffleNet, ResNet, DenseNet, Inception…

Reference examples

Object detection
Vehicles, pedestrians, faces…

Semantic segmentation
Roadway detection, land cover classification, tumor detection…
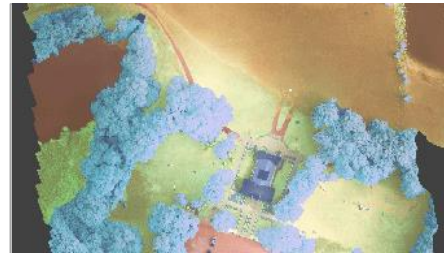
Signal and speech processing
Denoising, music genre recognition, keyword spotting, radar waveform classification…
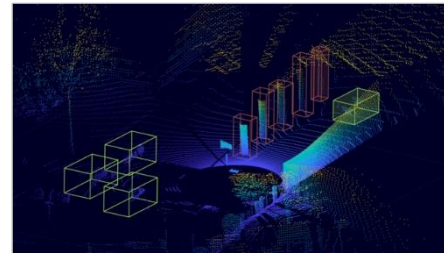
…and more…

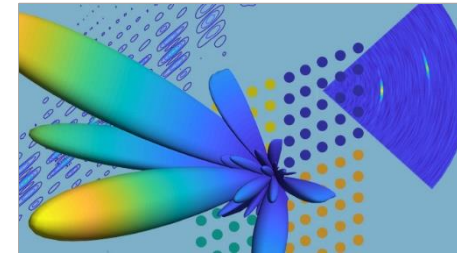# Domain-specialized reference examples

Predictive Maintenance
Anomaly Detection and Condition Monitoring
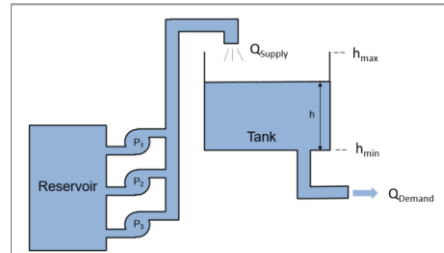

Geospatial Analysis
Hyperspectral Image Classification

Lidar
3-D Point Cloud Object Detection

Radar
Waveform Classification

Wireless Comms
Data Synthesis for 5G Channel Estimation

Controls Systems
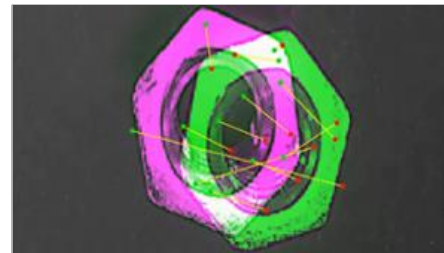PID Tuning & System Scheduling

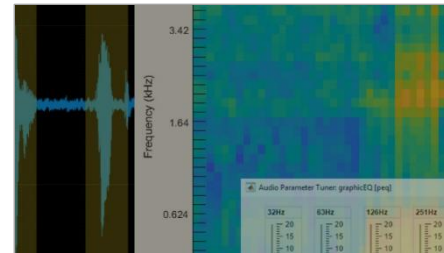**Computational Finance**
Trading & Risk Management

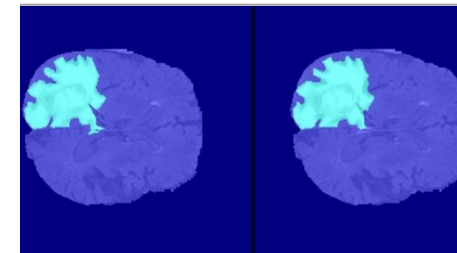**Automated Driving**
Pedestrian & Vehicle Detection

Robotics
Path Planning & Process Optimization
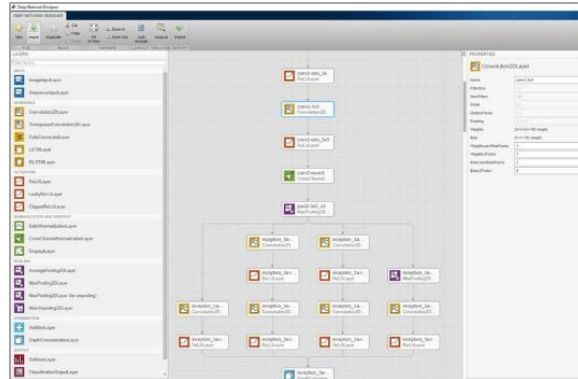

Visual Inspection
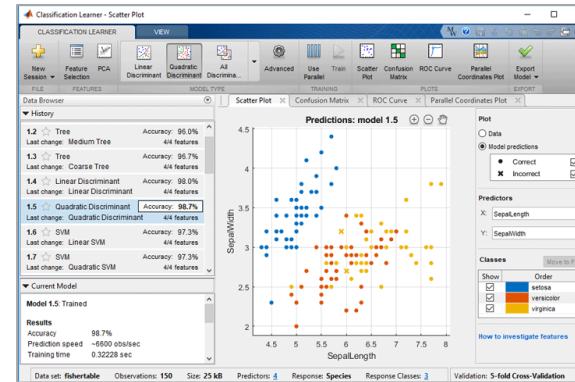Defect Detection

Audio
Speech Recognition

Medical Imaging
Tumor Detection
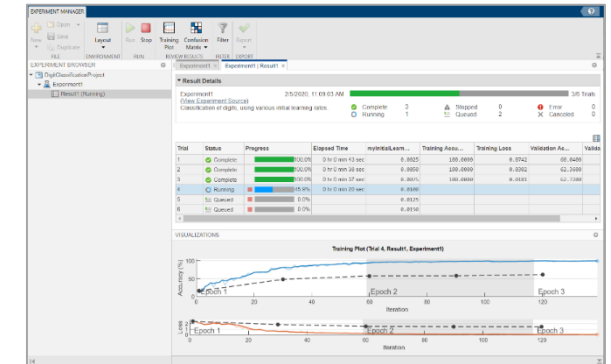
AI modeling Apps automate training, tuning, visualization...

1 Data Preparation

2 AI Modeling

3 Simulation and Test

4 Deployment

**Deep Network Designer** app to build, visualize, and edit deep learning networks.

Classification Learner app to try different classifiers and find the best fit for data sets.

Experiment Manager app to run deep learning experiments to train networks and compare results.

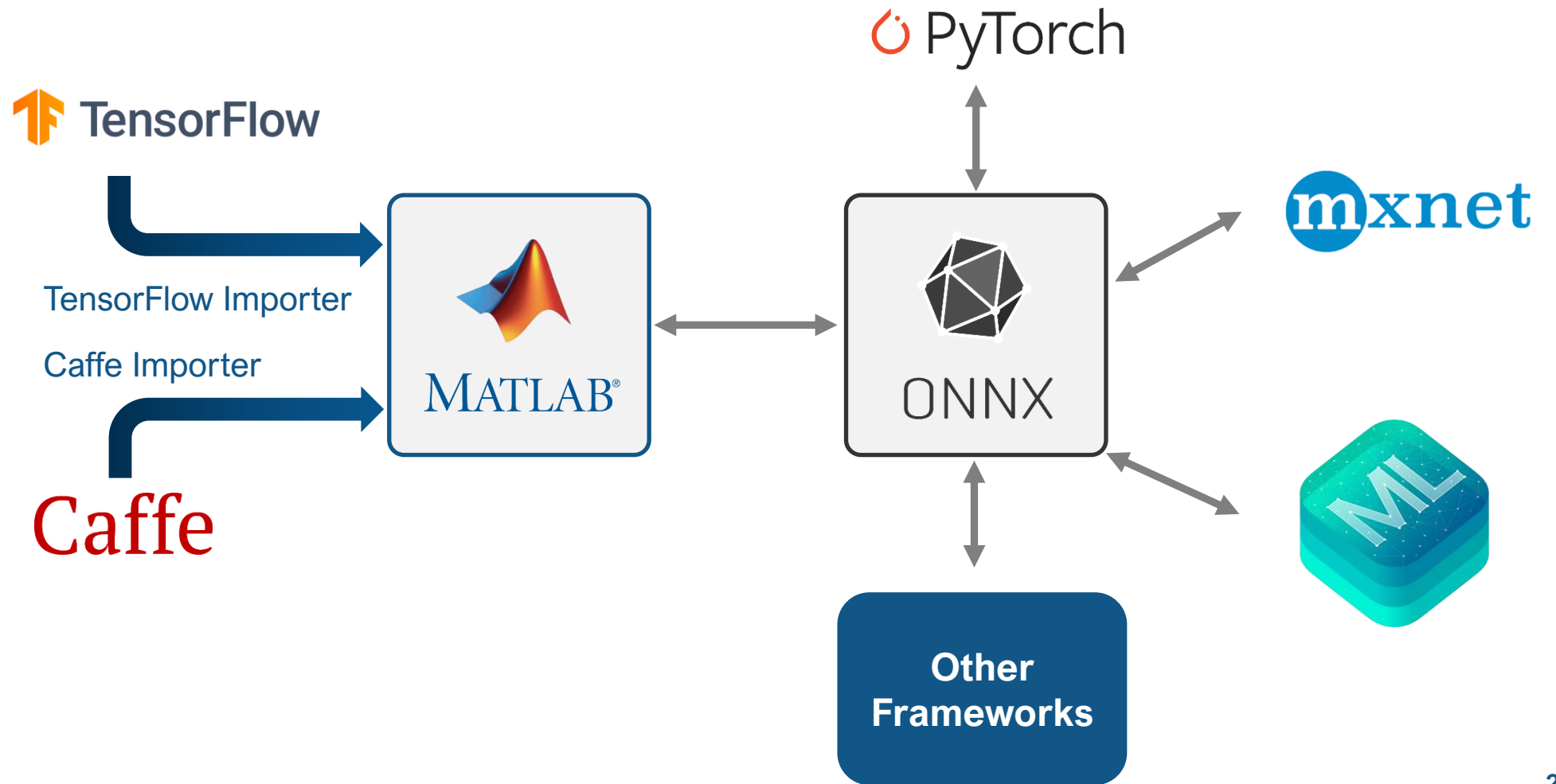# Accelerate AI training on GPUs, cloud, and datacenter resources without specialized programming
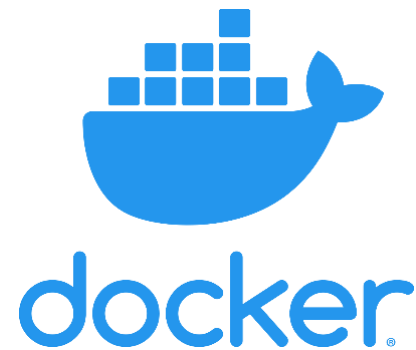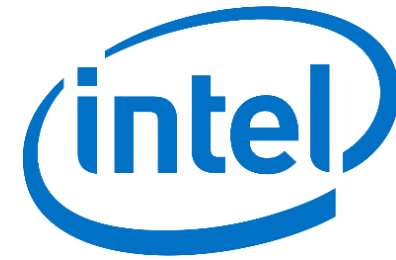
Access AI models from the broader AI community

Mitsui Chemicals Deploys AI and Automation Systems with TensorFlow and MATLAB

Mitsui Chemicals

> "MATLAB solved our problems on the field implementation and saved development time. That led to highly accurate development."
>
> *- Shintaro Maekawa, Mitsui Chemicals, Inc.*

- Uses AI and machine learning to develop factory automation solutions

- Automatically imported the trained TensorFlow-Keras model into MATLAB

- Developed and Deployed an application with a user interface that anyone can use

- Reduced visual inspection time by 80%
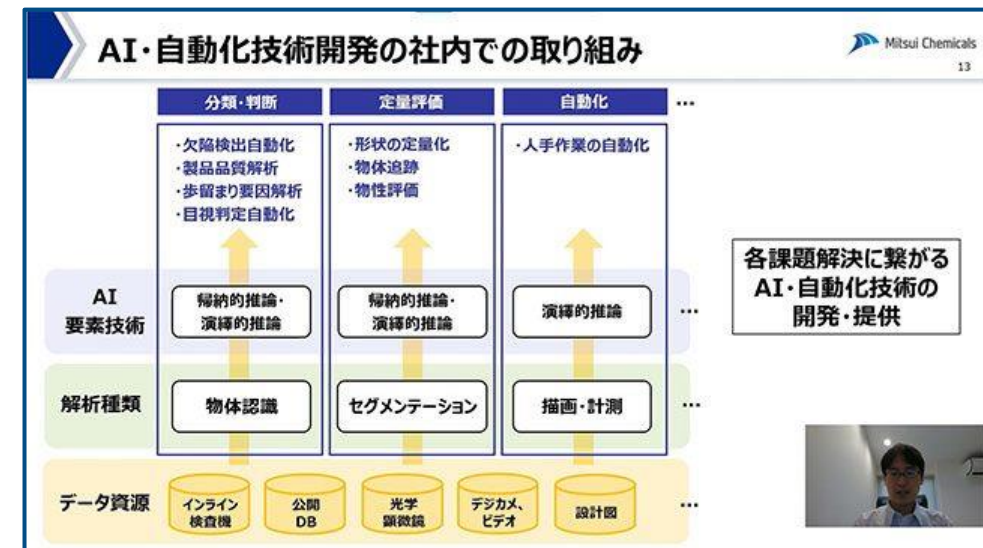
Model development with Python (TensorFlow-Keras) and efficient onsite implementation of models with MATLAB.

Integrate AI into system-wide context, simulate before moving to hardware, and verify effectiveness
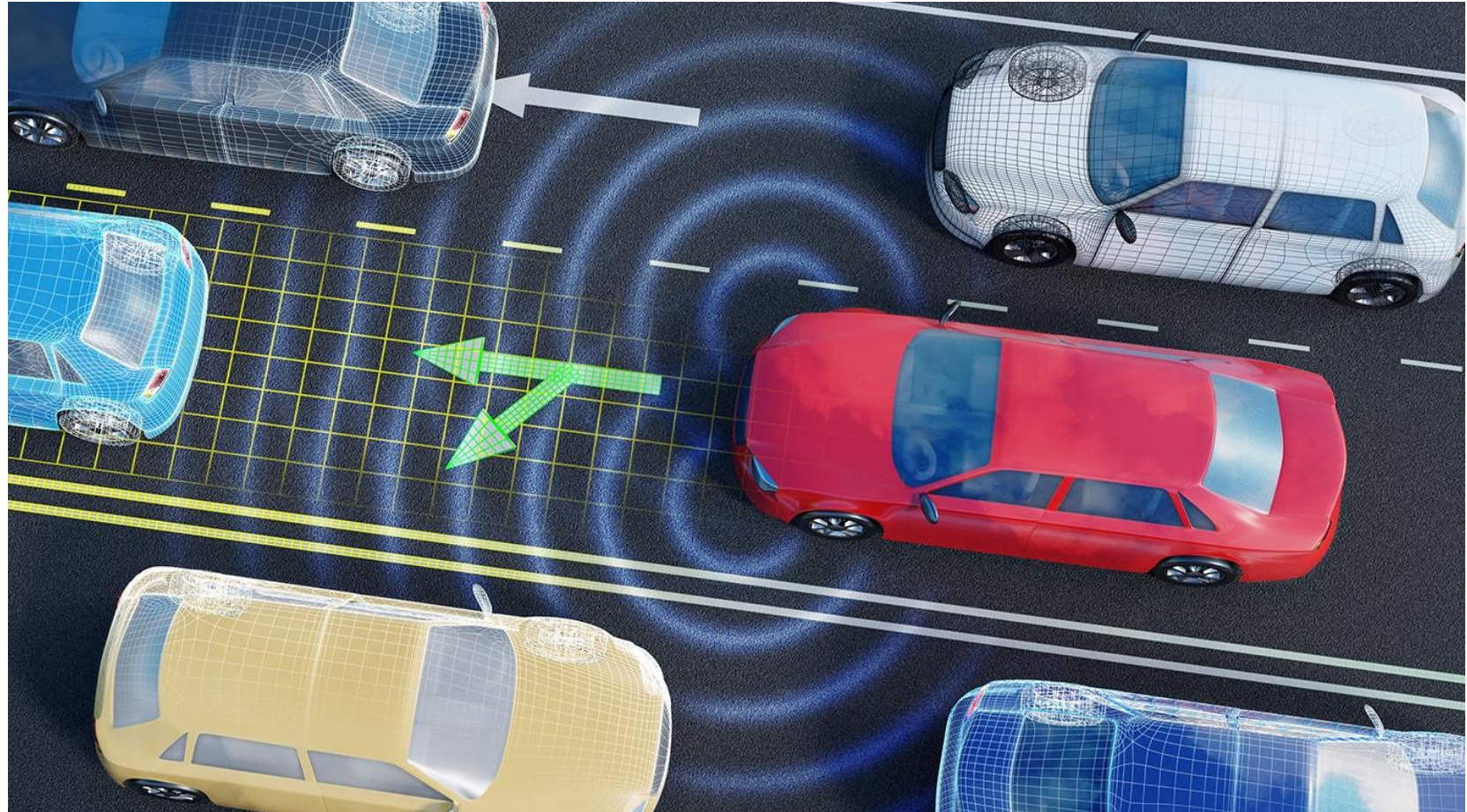
1. **Data Preparation**
2. **AI Modeling**
3. **Simulation and Test**
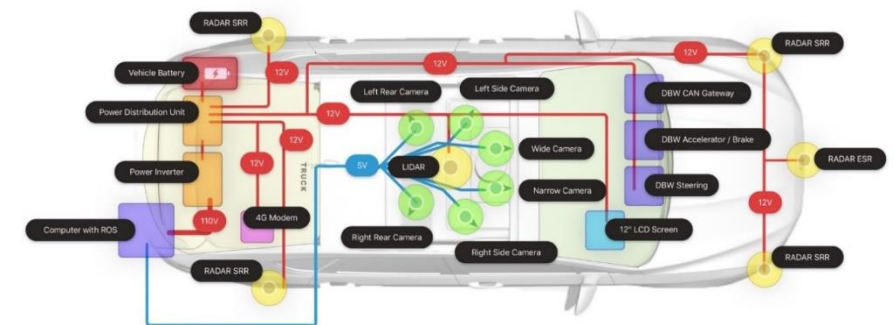4. **Deployment**

Use Simulink for rapid design iteration and testing

voyage

> "Simulink + ROS allowed us to deploy a Level 3 autonomous vehicle in less than three months."
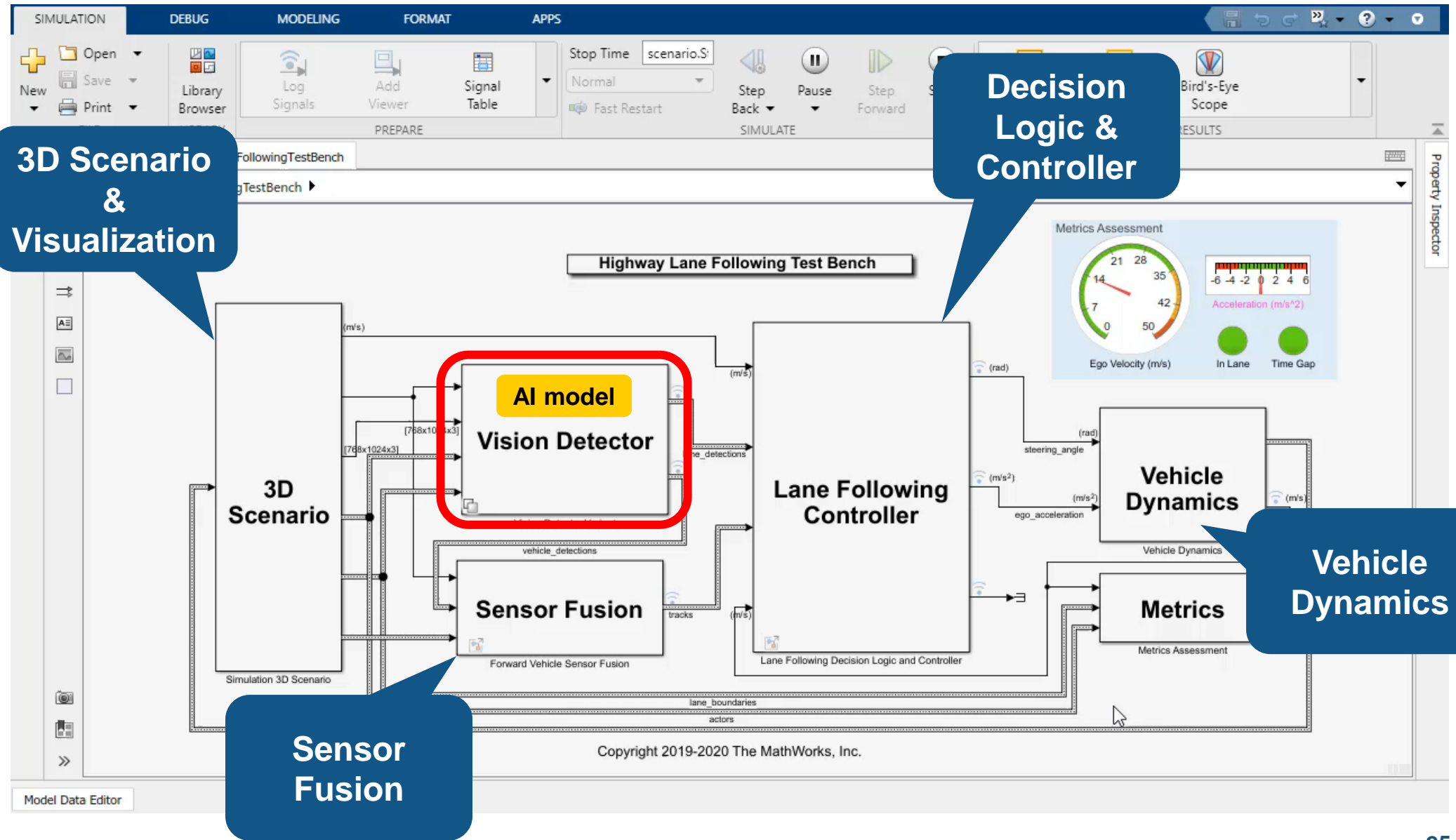>
> — **Alan Mond, Voyage**

1. **Data Preparation**
2. **AI Modeling**
3. **Simulation and Test**
4. **Deployment**

Use AI within *Entire Systems*

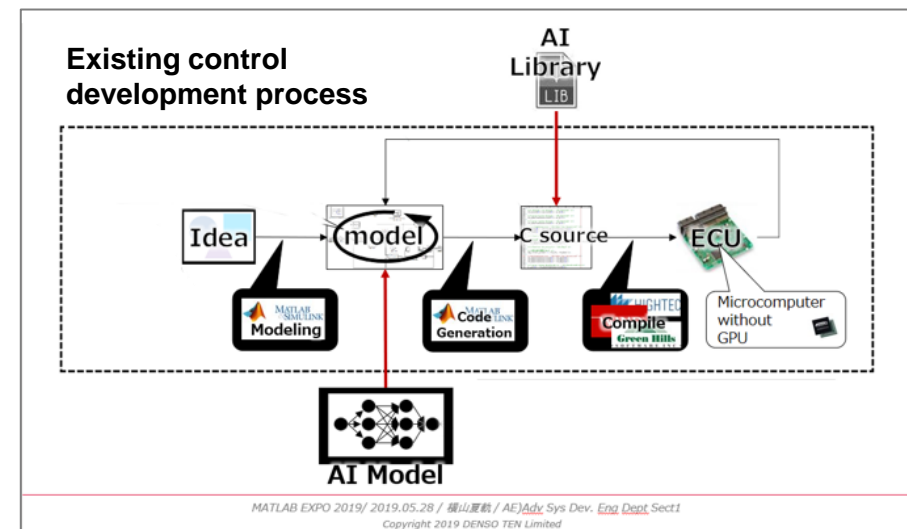# Use AI to improve engine control unit development efficiency

DENSO TEN

- Used Deep Learning to formulate a model for complex vehicle control issues

- Applied model-based development to integrate AI model into existing control model

- Developed a pathway to c-code generation for ECU implementation

"A model-based development workflow is essential in order to use AI for control ECUs. Combining the existing control model and the AI model enables us to establish a simulation environment and accelerate product development."
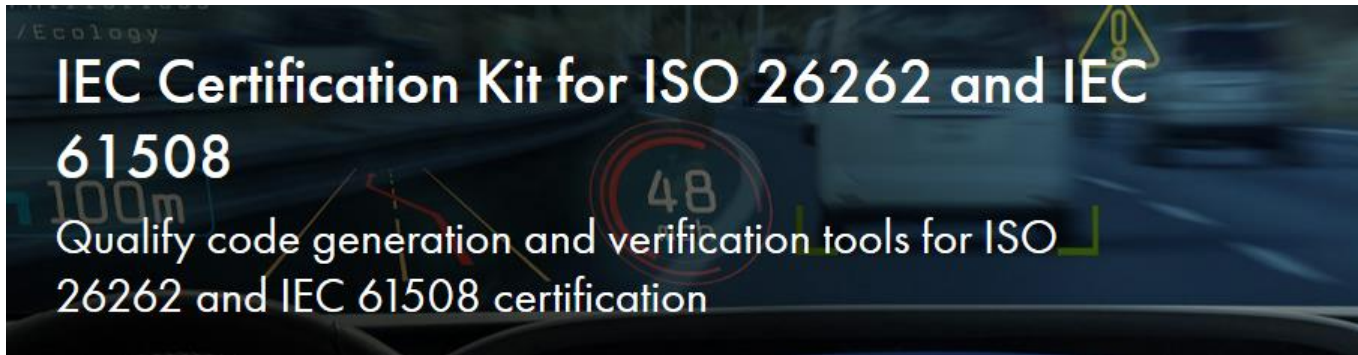
- Natsuki Yokoyama, Denso Ten

Model-Based Development Workflow

MATLAB EXPO 2019/ 2019.05.28 / 横山夏載 / AE)Adv Sys Dev. Eng Dept Sect1
Copyright 2019 DENSO TEN Limited

Deep experience in safety-critical certification enables us to drive new standards for AI

Today

In process

IEC Certification Kit for ISO 26262 and IEC 61508
Qualify code generation and verification tools for ISO 26262 and IEC 61508 certification

EUROCAE WG-114 "Artificial Intelligence"

DO Qualification Kit (for DO-178 and DO-254)
Qualify Simulink and Polyspace verification tools for DO-178, DO-278, and DO-254

SAE G-34 "Artificial Intelligence in Aviation"

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AI models are useful everywhere
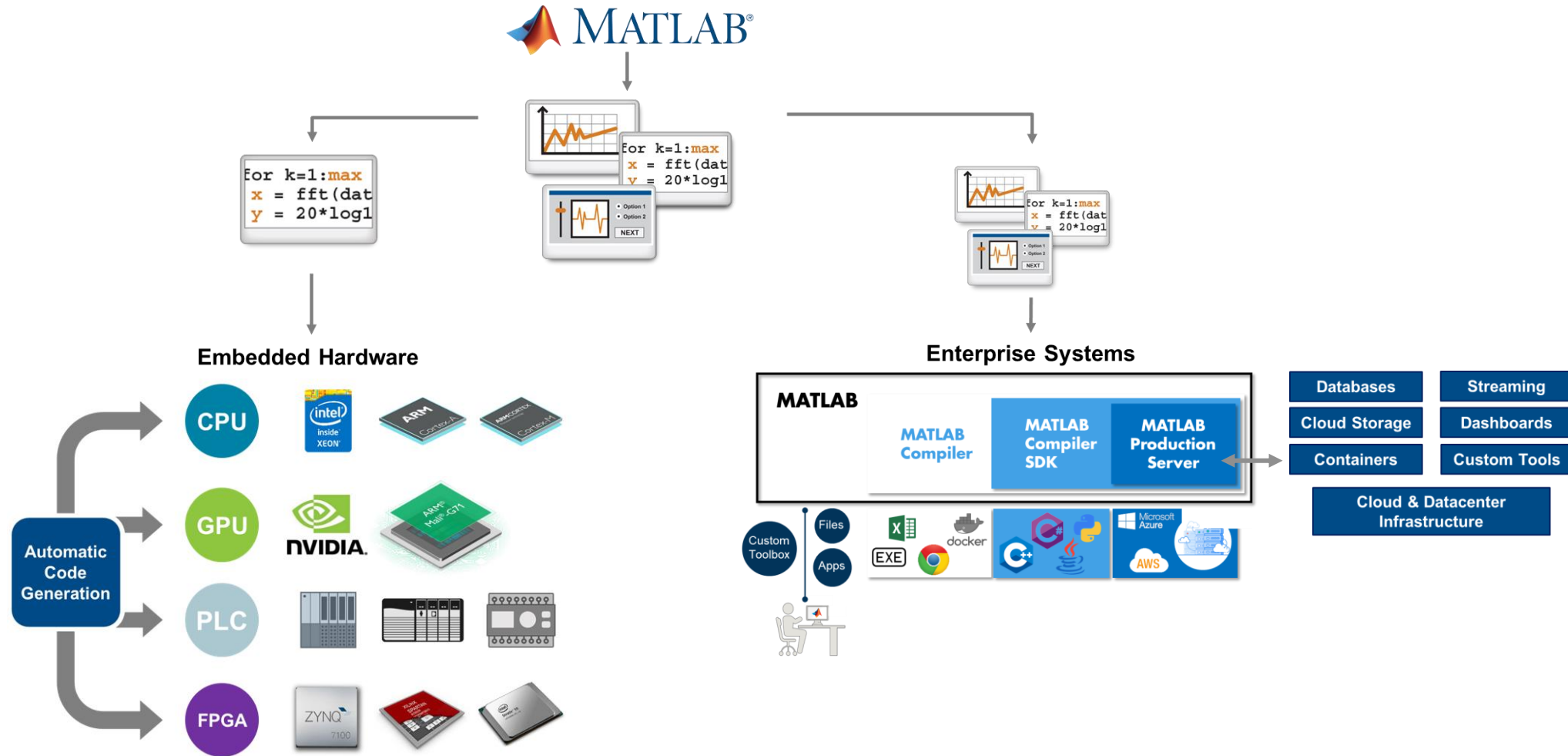
1. **Data Preparation**
2. **AI Modeling**
3. **Simulation and Test**
4. **Deployment**

Deploy your analytics in many ways

Fully-optimized maintenance strategies for 120,000+ connected machines

> "We use MATLAB as a platform to standardize on our tools, to develop standardized models that anyone can use, and to avoid duplication of effort."
>
> **— Carl Wouters, Atlas Copco**

- High-quality continuously-updated digital twins used throughout product lifecycle

- >10% increase in efficiency across the full product range

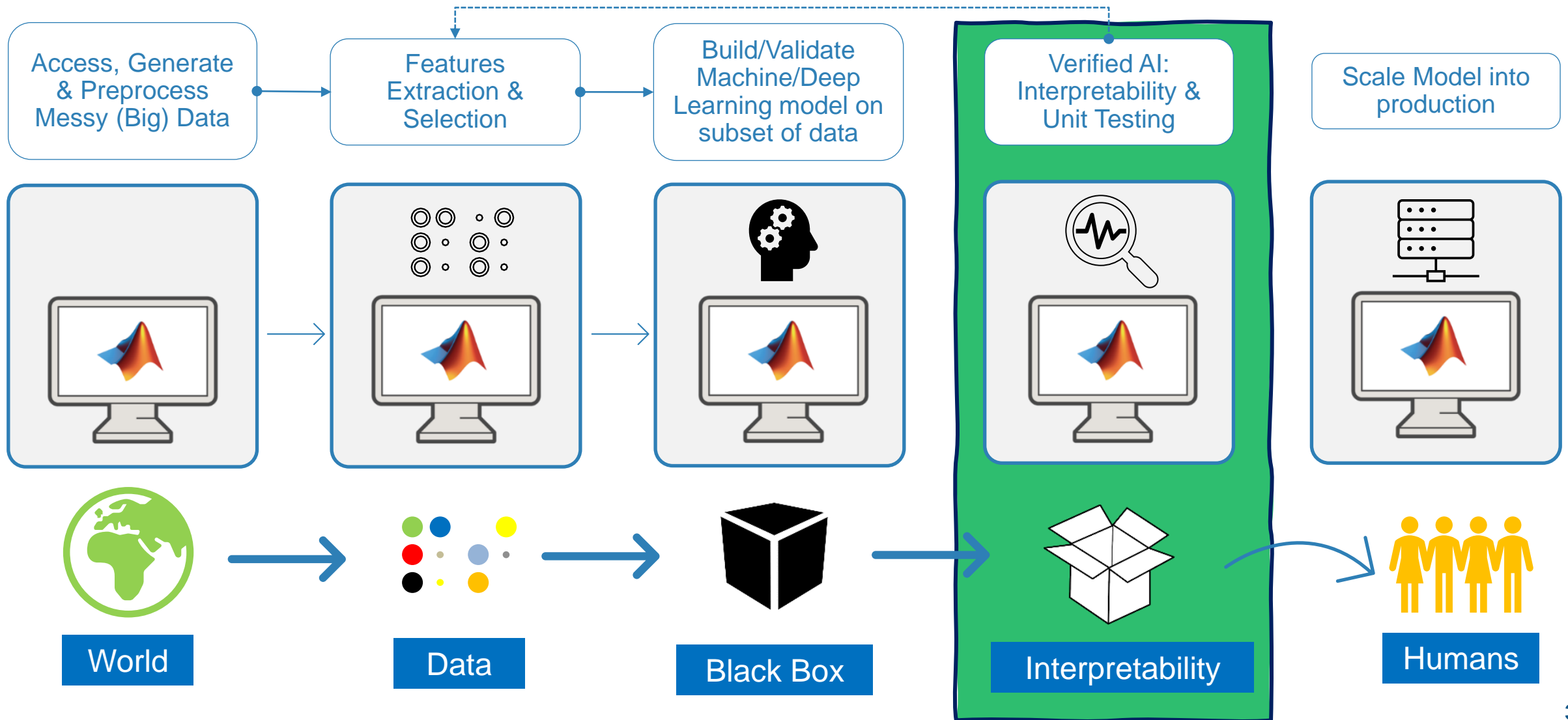- Enabled thousands of sales engineers to demonstrate reliable performance
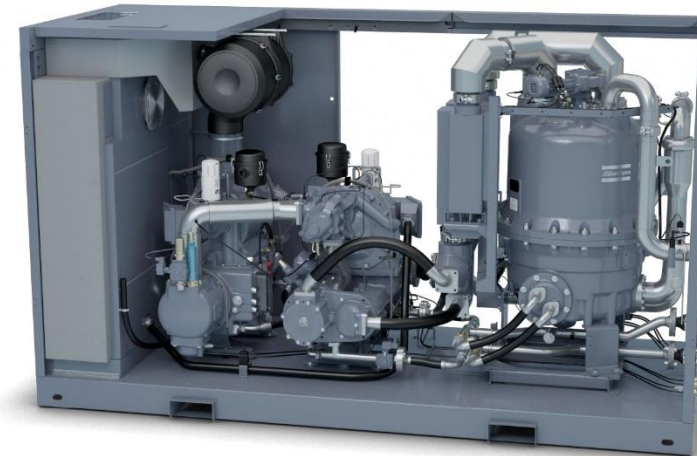
Workflow with interpretability: Validated & Verified AI

Until satisfied Accuracy & Explainability

Access, Generate & Preprocess Messy (Big) Data	Features Extraction & Selection	Build/Validate Machine/Deep Learning model on subset of data	Verified AI: Interpretability & Unit Testing	Scale Model into production

World → **Data** → **Black Box** → **Interpretability** → **Humans**

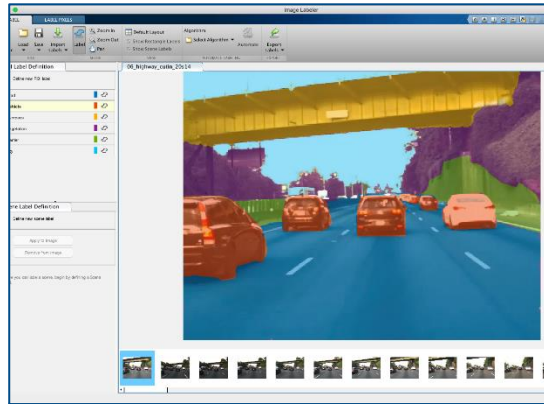MATLAB and Simulink integrate with the tools and systems IT manages on the Cloud or Edge
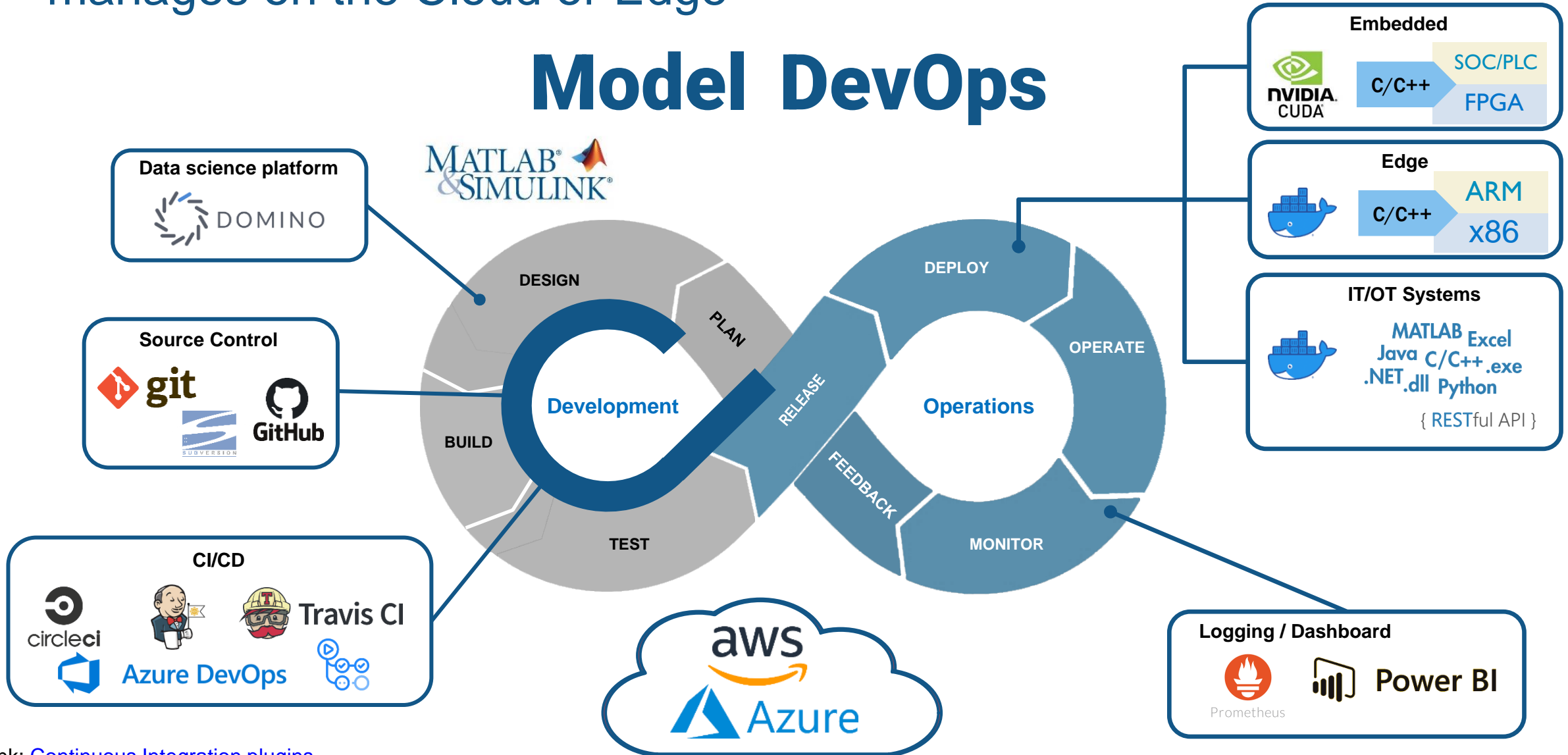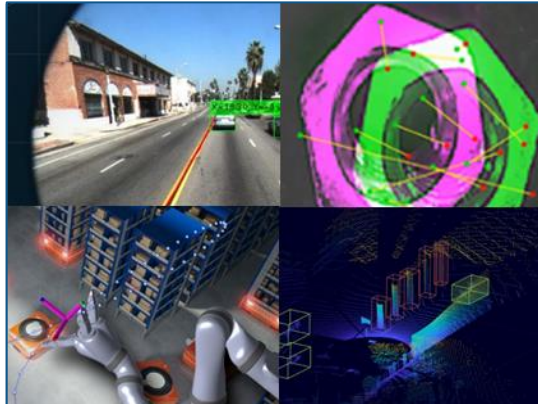
Empower domain experts to do their best work

Build Better Data sets

Leverage Domain Examples

Simulate AI within Systems

Deploy to any device

Thank You!

Q&A