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

Unsupervised Learning

Supervised Learning

Neural Networks

Shallow

Supervised Learning

Deep

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

but necessary!
Labeling
Labeling

[Description of the image: A screenshot of a software interface for labeling data, showing options for selecting labels, such as 'Car' and 'Lane'. The interface includes a timeline and options for defining labels and scenes.]
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
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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

Controls

Robotics

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

**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

Simulink
Generate data for dynamic systems
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.
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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

Single Image Inference (Titan V, Linux)

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

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

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