

Building AI Systems

GLOBAL PRODUCT DATA
INTEROPERABILITY
S U M M I T
2020



Presenter Bio

Global Product Data Interoperability Summit | 2020



Abhijit Bhattacharjee
Senior Application Engineer
Deep Learning and AI
MathWorks, Inc.
At MathWorks for 9 years

Agenda

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- 1. Deep learning in engineering and science**
- 2. Developing a deep learning solution in MATLAB**
- 3. MathWorks deep learning support**

Agenda

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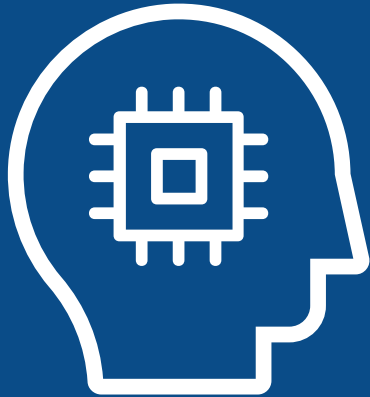
- 1. Deep learning in engineering and science**
- 2. Developing a deep learning solution in MATLAB**
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Deep learning is a key technology driving the AI megatrend

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ARTIFICIAL INTELLIGENCE

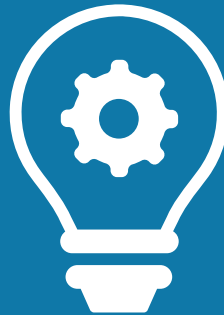
Any technique that enables machines to mimic human intelligence



1950s

MACHINE LEARNING

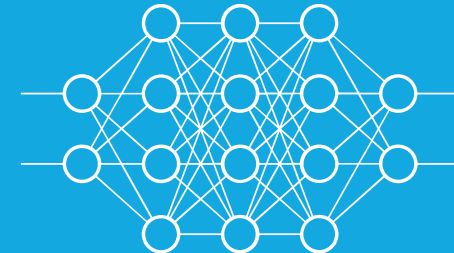
Statistical methods that enable machines to “learn” tasks from data without explicitly programming



1980s

DEEP LEARNING

Neural networks with many layers that learn representations and tasks “directly” from data



2010s

AI-driven system design

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Data Preparation



Data cleansing and preparation



Human insight

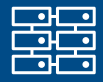


Simulation-generated data

AI Modeling



Model design and tuning



Hardware accelerated training



Interoperability

Simulation & Test



Integration with complex systems



System simulation



System verification and validation

Deployment



Embedded devices



Enterprise systems



Edge, cloud, desktop

Agenda

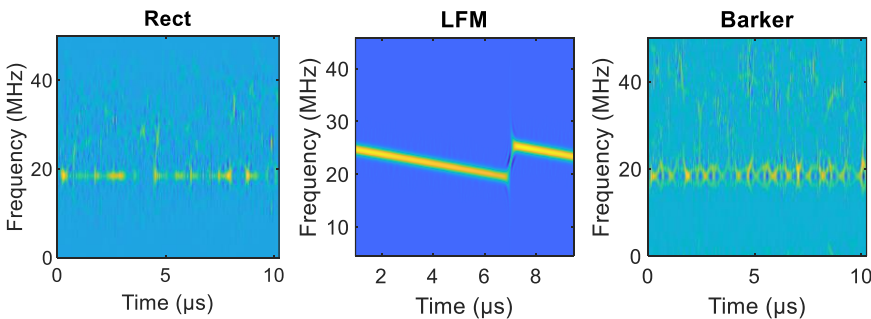
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Featured Example: Radar Waveform Classification

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- Generate synthetic radar waveforms using [Wigner-Ville Distribution \(WVD\)](#)
- Classify using a deep convolutional neural network (CNN)
- Recognize modulation types for cognitive radar and software-defined radio (SDR)



| True Class | B-FM | Barker | CPFSK | DSB-AM | GFSK | LFM | Rect | SSB-AM |
|-----------------|-------|--------|-------|--------|-------|-------|-------|--------|
| | 92.7% | | | | | | | |
| | | 99.3% | | 0.7% | | 0.3% | 3.7% | 0.7% |
| | 6.3% | | 97.3% | | 0.3% | | | |
| | 0.7% | 0.7% | | 90.7% | | 0.3% | 1.0% | 40.7% |
| | 0.3% | | 2.7% | | 99.7% | | | 0.3% |
| | | | | | | 97.7% | 0.3% | 0.3% |
| | | | | | | 0.7% | 93.7% | |
| Predicted Class | | | | 8.7% | | 1.0% | 1.3% | 58.0% |
| | B-FM | Barker | CPFSK | DSB-AM | GFSK | LFM | Rect | SSB-AM |

Data preparation represents most of your AI effort...

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Data Preparation



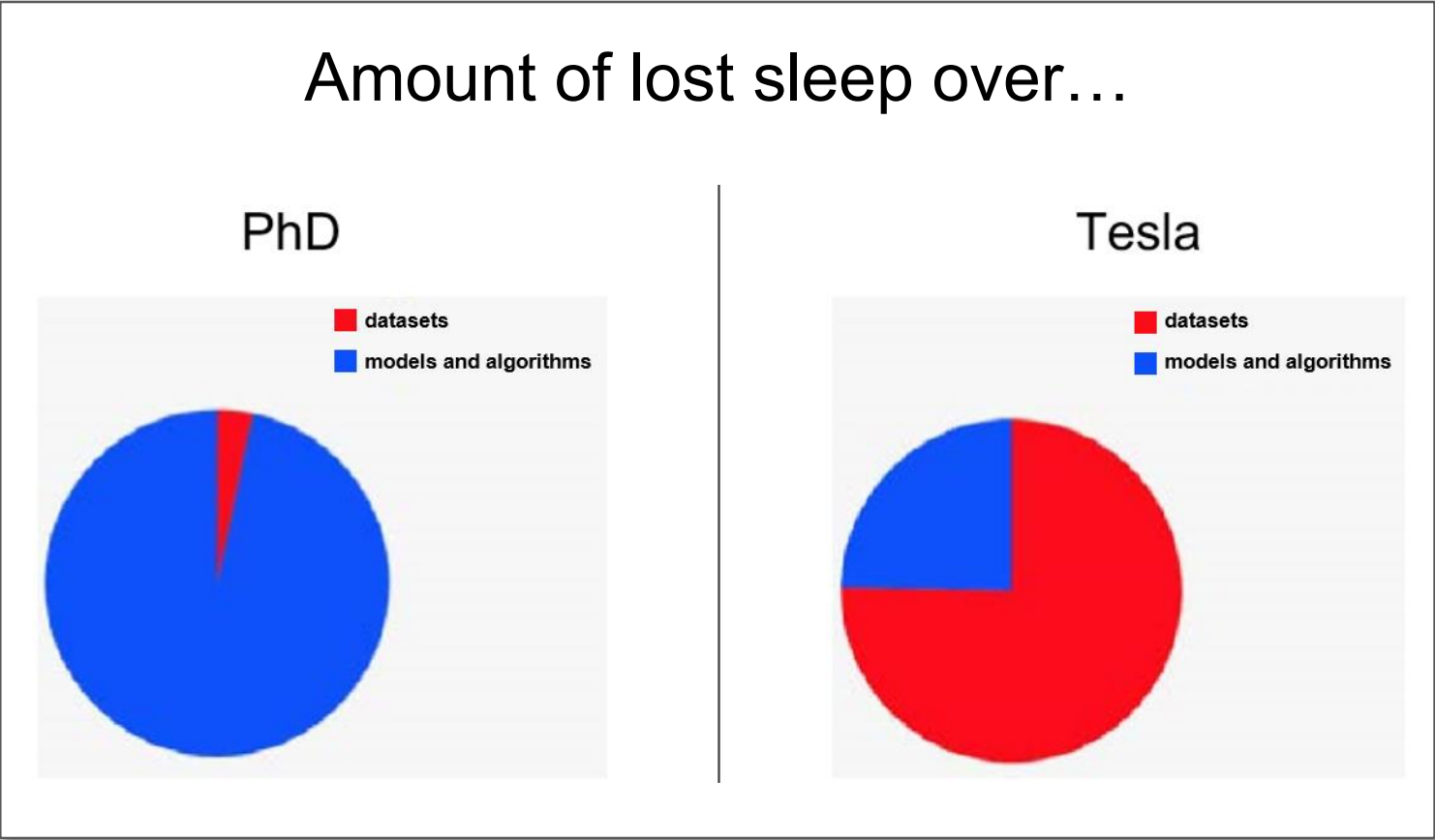
Data cleansing and preparation



Human insight



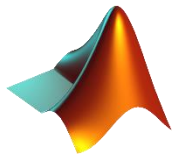
Simulation-generated data



Source: Andrej Karpathy slide from TrainAI 2018

Data Preparation Demo

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Open Script Part 1

Data Preparation



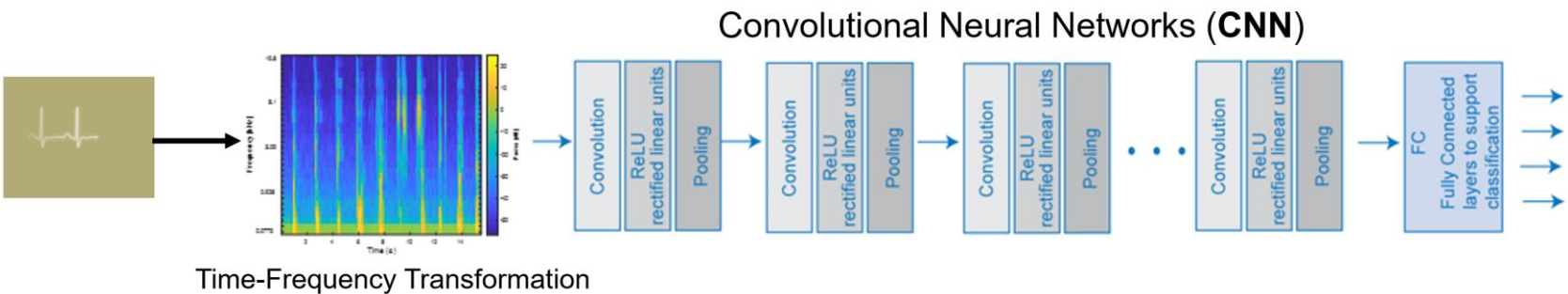
Data cleansing and
preparation



Human insight



Simulation-
generated data



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

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AI Modeling



Model design and tuning



Hardware accelerated training



Interoperability

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...


Increase productivity using Apps for design and analysis

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AI Modeling



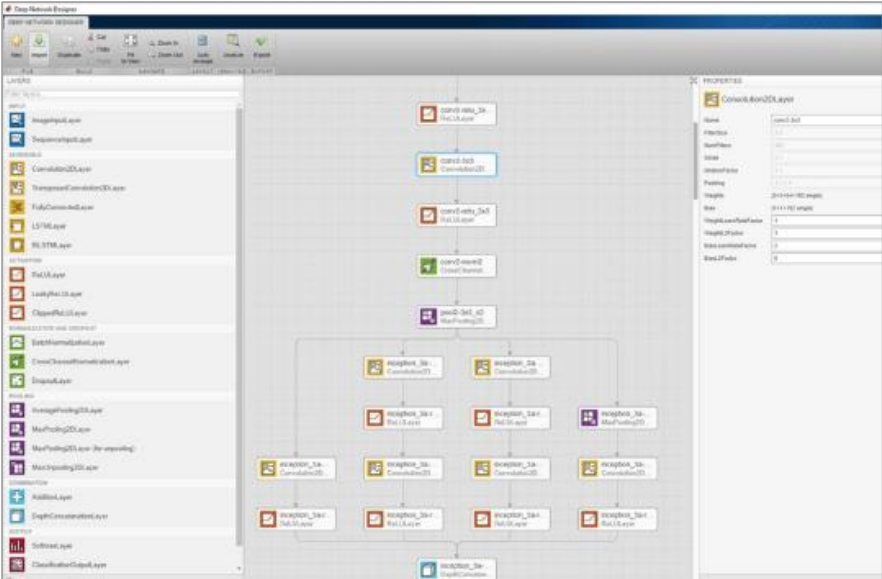
Model design and tuning



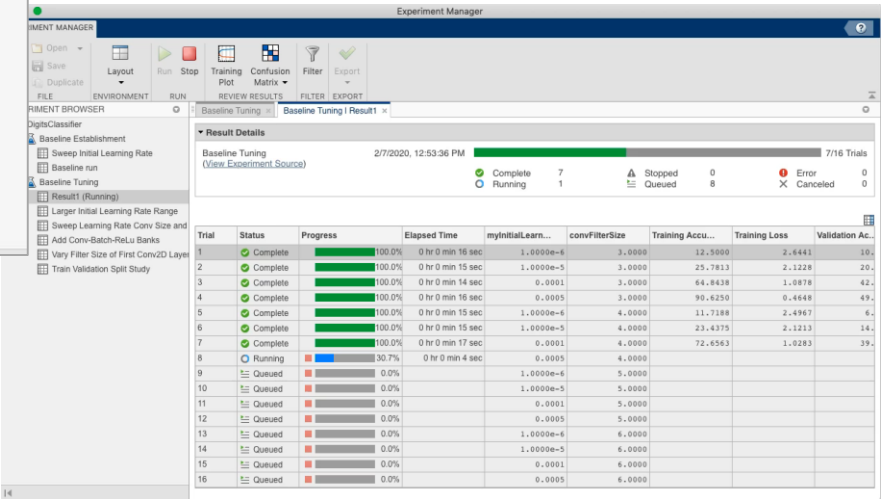
Hardware accelerated training



Interoperability



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



| Trial | Status | Progress | Elapsed Time | myInitialLearn... | convFilterSize | Training Accu... | Training Loss | Validation Ac... |
|-------|----------|----------|-------------------|-------------------|----------------|------------------|---------------|------------------|
| 1 | Complete | 100.0% | 0 hr 0 min 16 sec | 1.0000e-6 | 3.0000 | 12.5000 | 2.6441 | 10. |
| 2 | Complete | 100.0% | 0 hr 0 min 15 sec | 1.0000e-5 | 3.0000 | 25.7813 | 2.1228 | 20. |
| 3 | Complete | 100.0% | 0 hr 0 min 14 sec | 0.0001 | 3.0000 | 64.8438 | 1.0878 | 42. |
| 4 | Complete | 100.0% | 0 hr 0 min 16 sec | 0.0005 | 3.0000 | 90.4250 | 0.4648 | 49. |
| 5 | Complete | 100.0% | 0 hr 0 min 15 sec | 1.0000e-6 | 4.0000 | 11.7188 | 2.4967 | 6. |
| 6 | Complete | 100.0% | 0 hr 0 min 15 sec | 1.0000e-5 | 4.0000 | 23.4375 | 2.1233 | 14. |
| 7 | Complete | 100.0% | 0 hr 0 min 17 sec | 0.0001 | 4.0000 | 72.6563 | 1.0283 | 39. |
| 8 | Running | 30.7% | 0 hr 0 min 4 sec | 0.0005 | 4.0000 | | | |
| 9 | Queued | 0.0% | | 1.0000e-6 | 5.0000 | | | |
| 10 | Queued | 0.0% | | 1.0000e-5 | 5.0000 | | | |
| 11 | Queued | 0.0% | | 0.0001 | 5.0000 | | | |
| 12 | Queued | 0.0% | | 0.0005 | 5.0000 | | | |
| 13 | Queued | 0.0% | | 1.0000e-6 | 6.0000 | | | |
| 14 | Queued | 0.0% | | 1.0000e-5 | 6.0000 | | | |
| 15 | Queued | 0.0% | | 0.0001 | 6.0000 | | | |
| 16 | Queued | 0.0% | | 0.0005 | 6.0000 | | | |

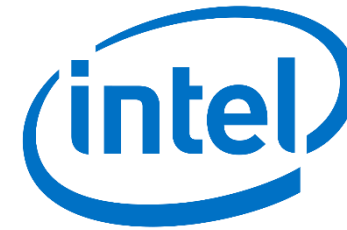
Experiment Manager app to manage multiple deep learning experiments, analyze and compare results and code

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Hardware acceleration and scaling are critical for training

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AI Modeling



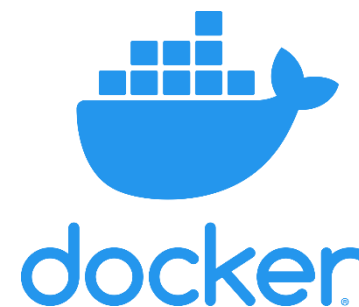
Model design and tuning



Hardware accelerated training

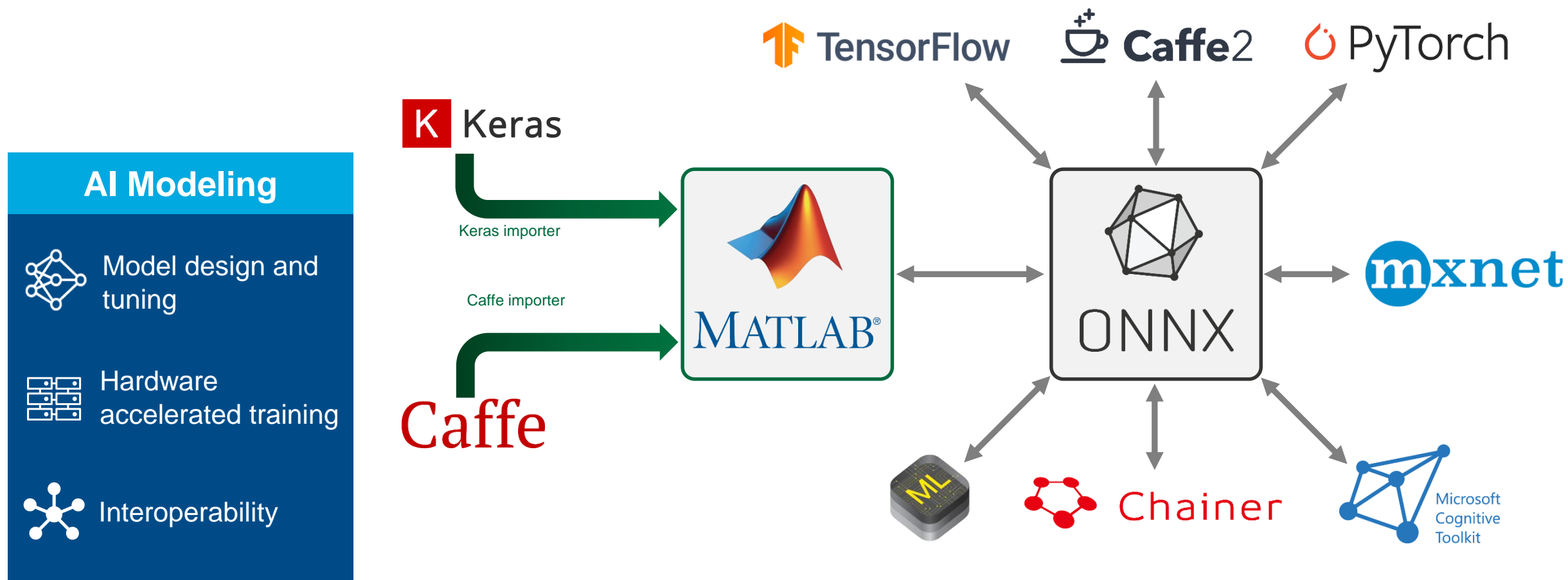


Interoperability



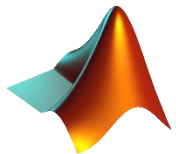
MATLAB interoperates with other frameworks

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Modeling Demo

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Open Script Part 2

AI Modeling



Model design and
tuning



Hardware
accelerated training



Interoperability

| True Class | B-FM | 99.7% | | | | | | | |
|-----------------|--------|-------|--------|-------|--------|-------|-------|-------|--------|
| | Barker | | 99.7% | | 0.3% | | 0.3% | 3.0% | 0.7% |
| | CPFSK | 0.3% | | 99.7% | | 0.7% | | | |
| | DSB-AM | | 0.3% | | 85.7% | | | | 23.3% |
| | GFSK | | | 0.3% | | 99.3% | | | 0.3% |
| | LFM | | | | | | 99.3% | | 0.3% |
| | Rect | | | | | | | 97.0% | |
| | SSB-AM | | | | 14.0% | | 0.3% | | 75.3% |
| | | B-FM | Barker | CPFSK | DSB-AM | GFSK | LFM | Rect | SSB-AM |
| Predicted Class | | | | | | | | | |

Models need to exist within a complete system

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Simulation & Test

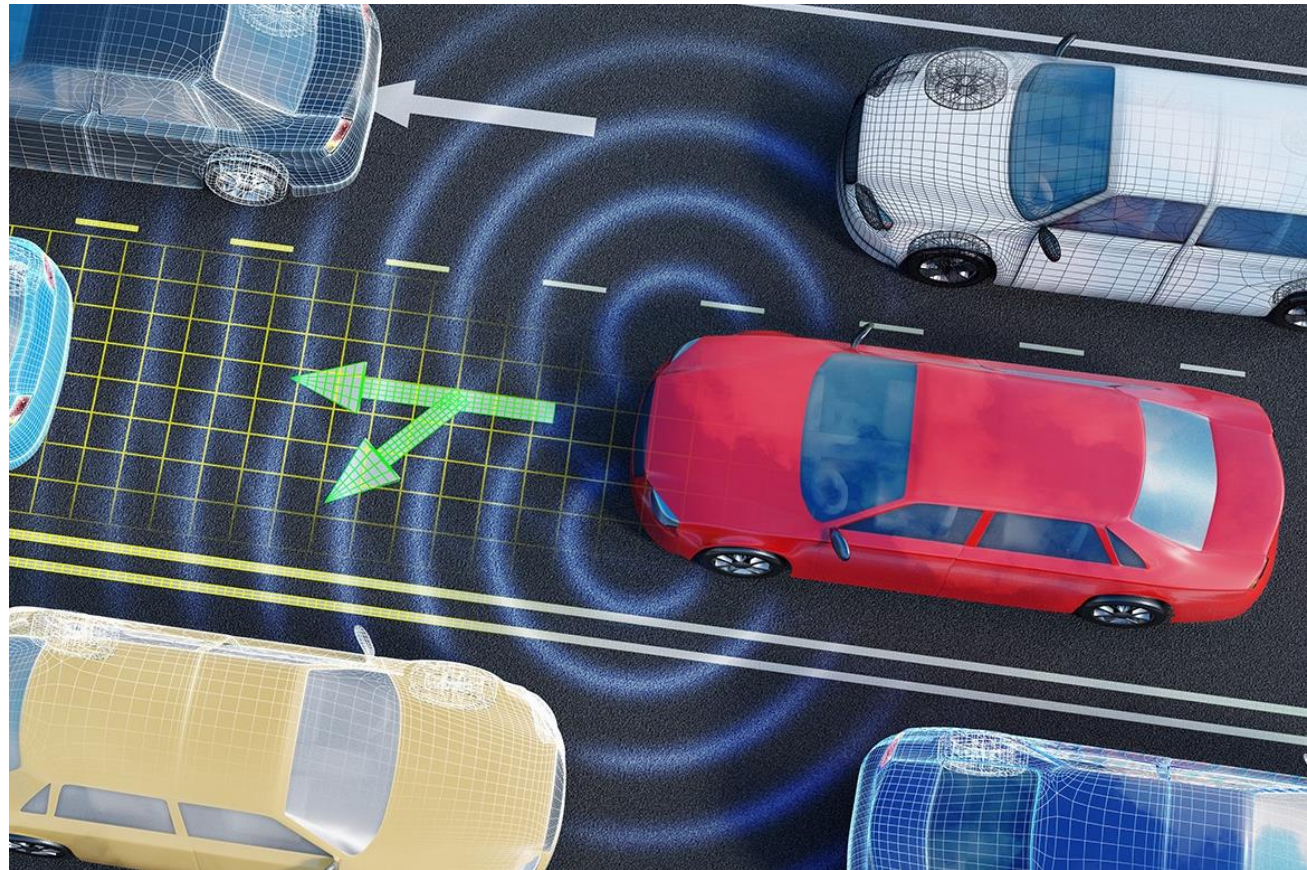


Integration with
complex systems



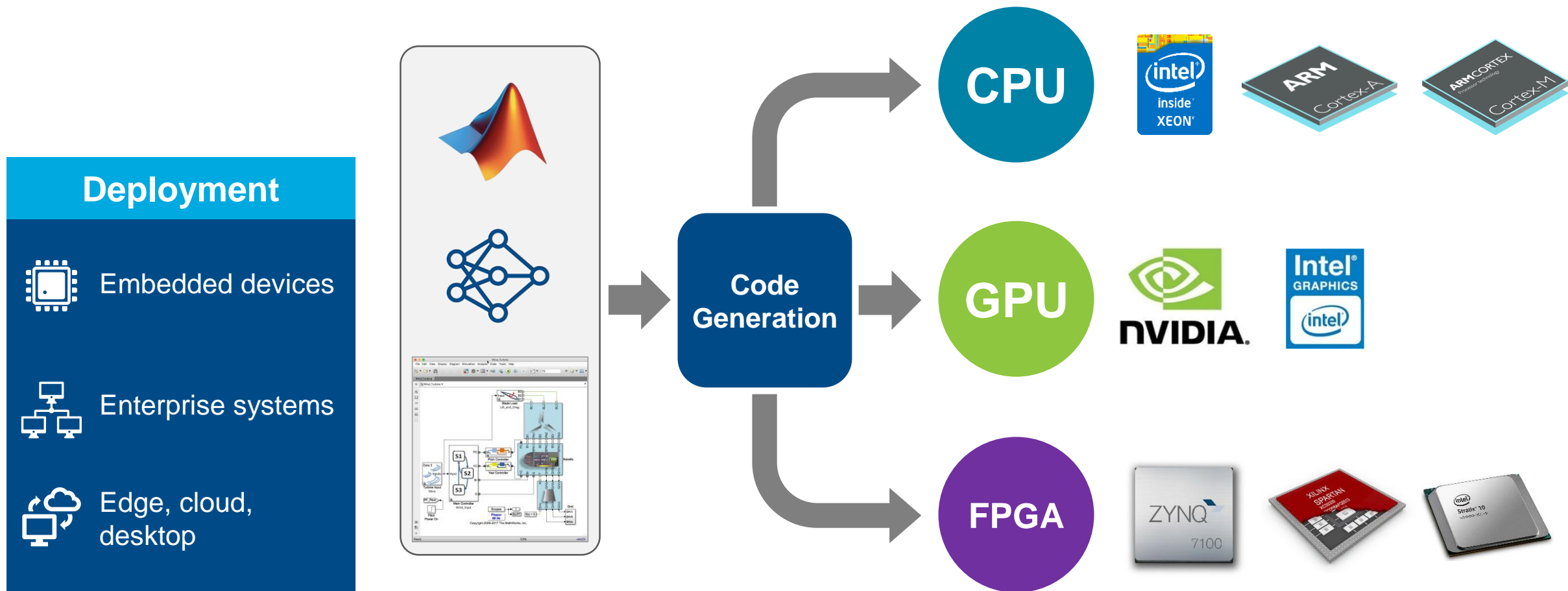
System simulation

— x System verification
— ✓ and validation



Deploy to any processor with best-in-class performance


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AI-driven system design

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Why MATLAB & MathWorks for Deep Learning?

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The Platform

MATLAB, Simulink, and over 100 add-on products for specialized applications



Your People

Helping you build an agile workforce today and preparing tomorrow's engineers



Our Expertise

From onboarding and implementation to solving advanced engineering challenges

MathWorks Engineering Support

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Training



Guided Evaluations



Onsite Workshops



Consulting



Technical Support

Thank You!



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