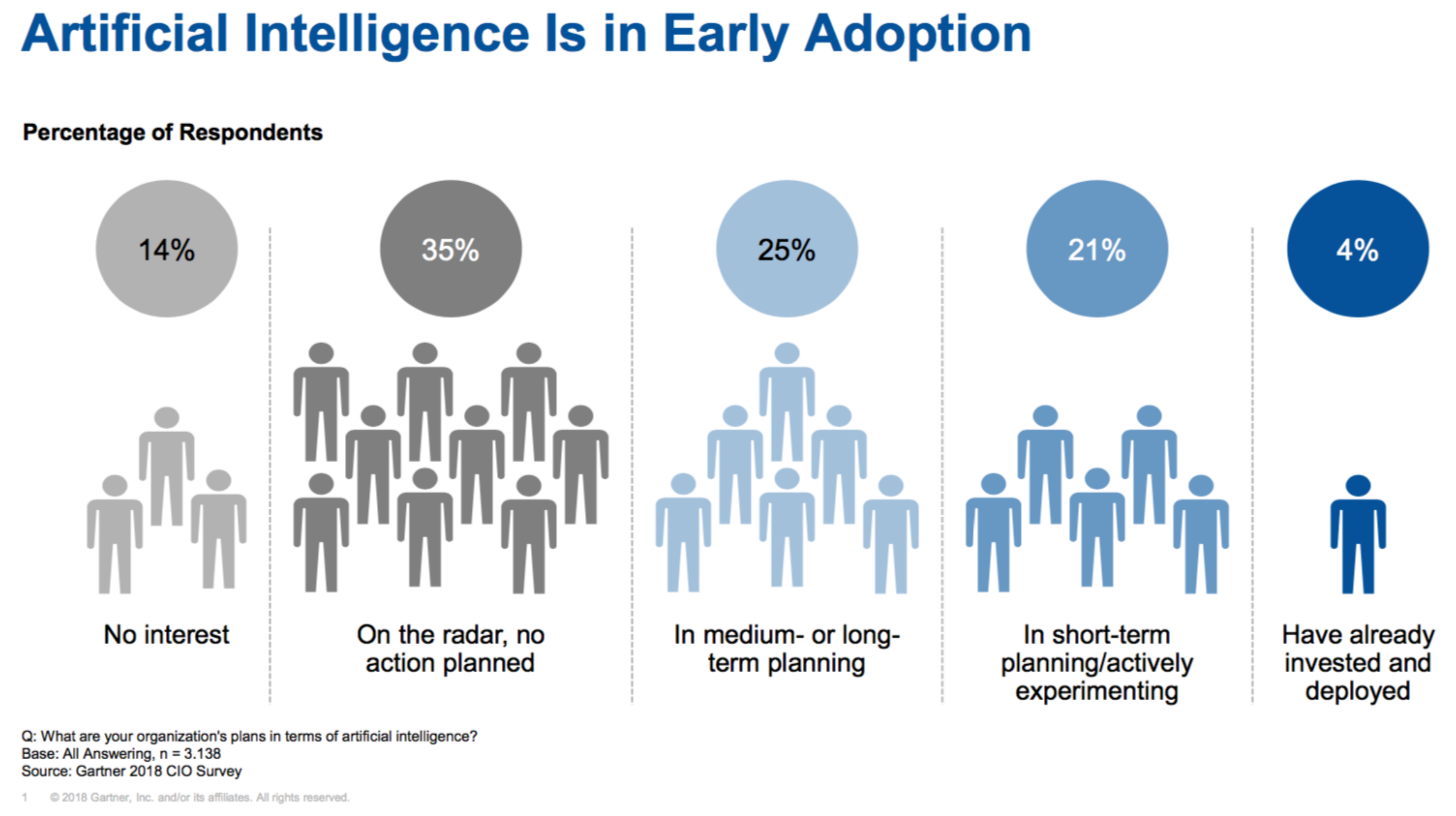
MATLAB EXPO 2018

Are you ready for AI?
Is AI ready for you?

Dr. Mischa Kim

Alexa – Write my Expo keynote for me

Alexa –
Play Mozart ♩♪♪



Artificial Intelligence Is in Early Adoption

Percentage of Respondents

14%
No interest

35%
On the radar, no action planned

25%
In medium- or long-term planning

21%
In short-term planning/actively experimenting

4%
Have already invested and deployed

Q: What are your organization's plans in terms of artificial intelligence?
Base: All Answering, n = 3.138
Source: Gartner 2018 CIO Survey

© 2018 Gartner, Inc. and/or its affiliates. All rights reserved.

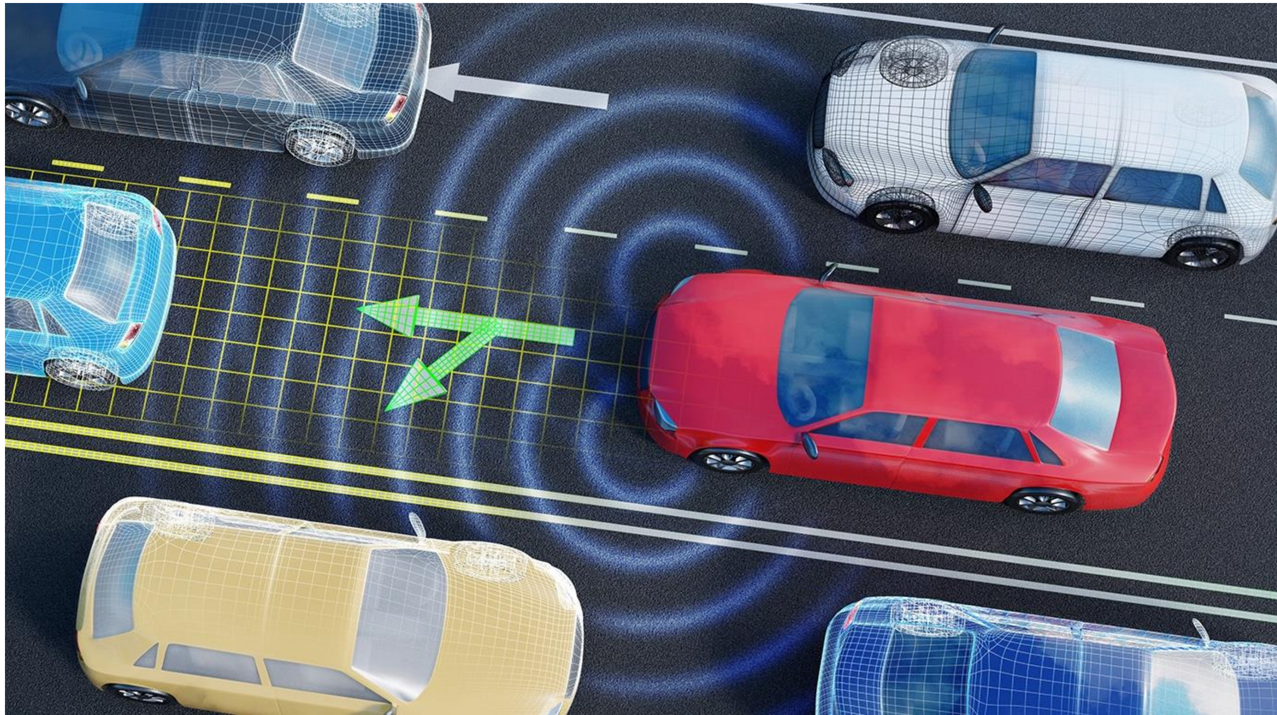
Source: Gartner, *Real Truth of Artificial Intelligence* by Whit Andrews

Presented at Gartner Data & Analytics Summit 2018, March 2018

amazon

Luke Skywalker
94.5%

ВЫХОД В ГОРОД
ACCESS TO CITY



SPEED LIMIT
45

Dream
dw drums

Artificial Intelligence

The capability of a machine to imitate intelligent human behavior

Artificial Intelligence

The capability of a machine to match or exceed intelligent human behavior

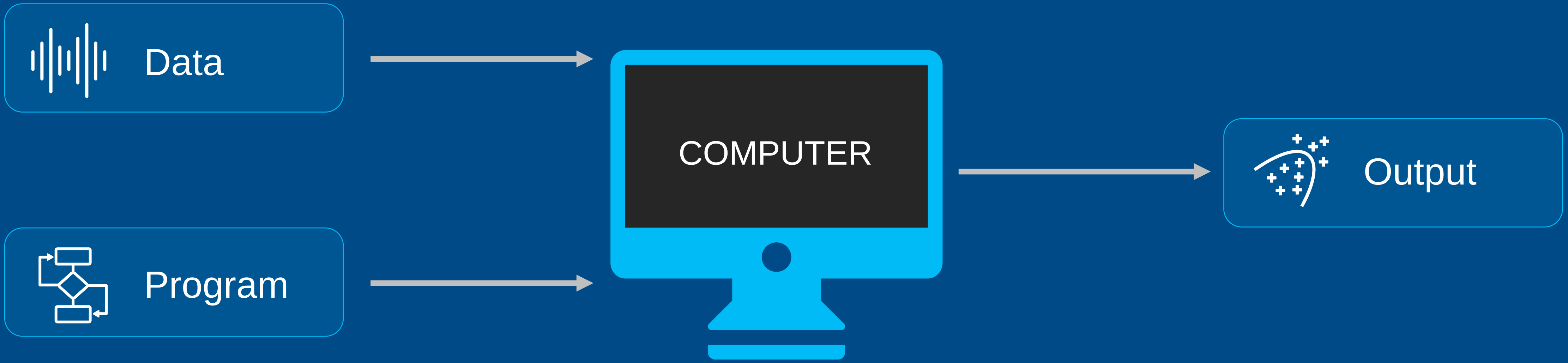
Artificial Intelligence Today

The capability of a machine to match or exceed intelligent human behavior

by training a machine to learn the desired behavior

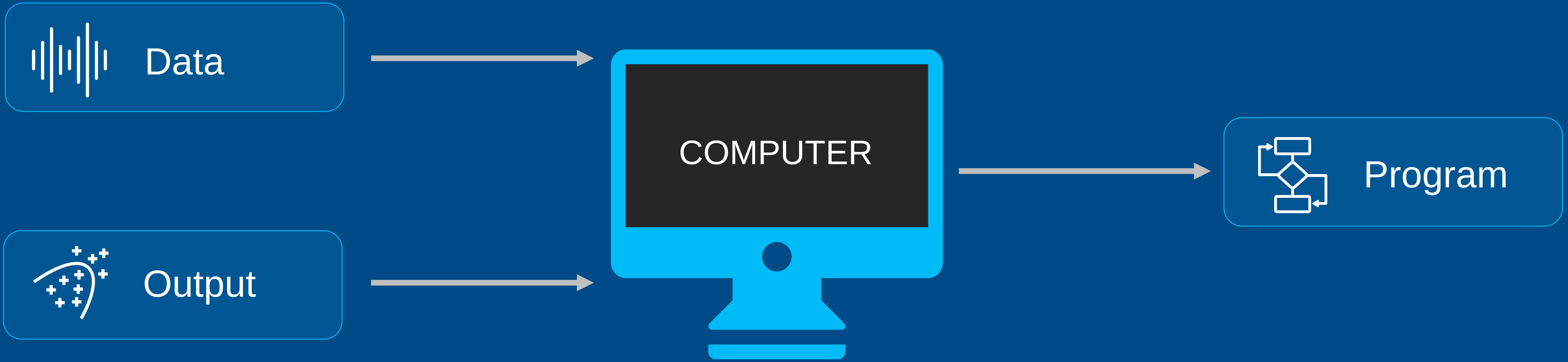
There are two ways to get a computer to do what you want

Traditional Programming


Data
Program
COMPUTER
Output

There are two ways to get a computer to do what you want

Machine Learning



Data

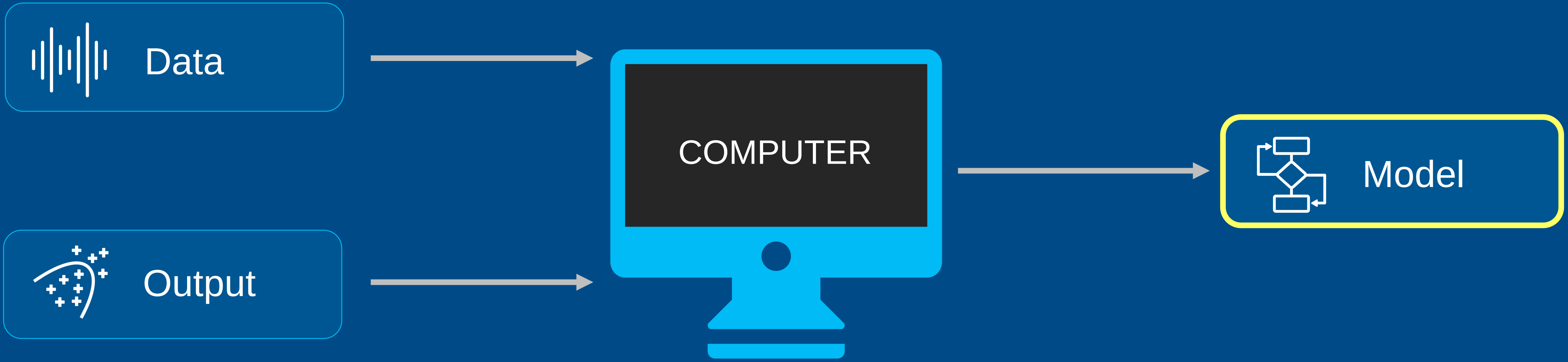
Output

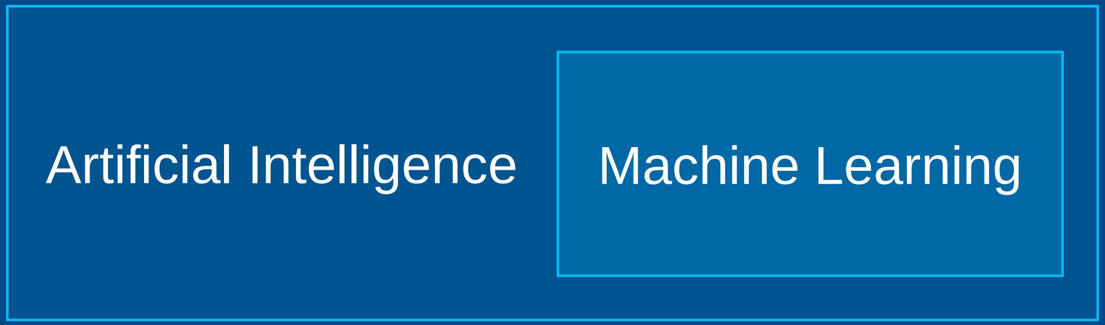
COMPUTER

Program

There are two ways to get a computer to do what you want

Machine Learning


Data
Output
COMPUTER
Model


Artificial Intelligence
Machine Learning

Are you ready for AI?

- Data
- Output
- Model

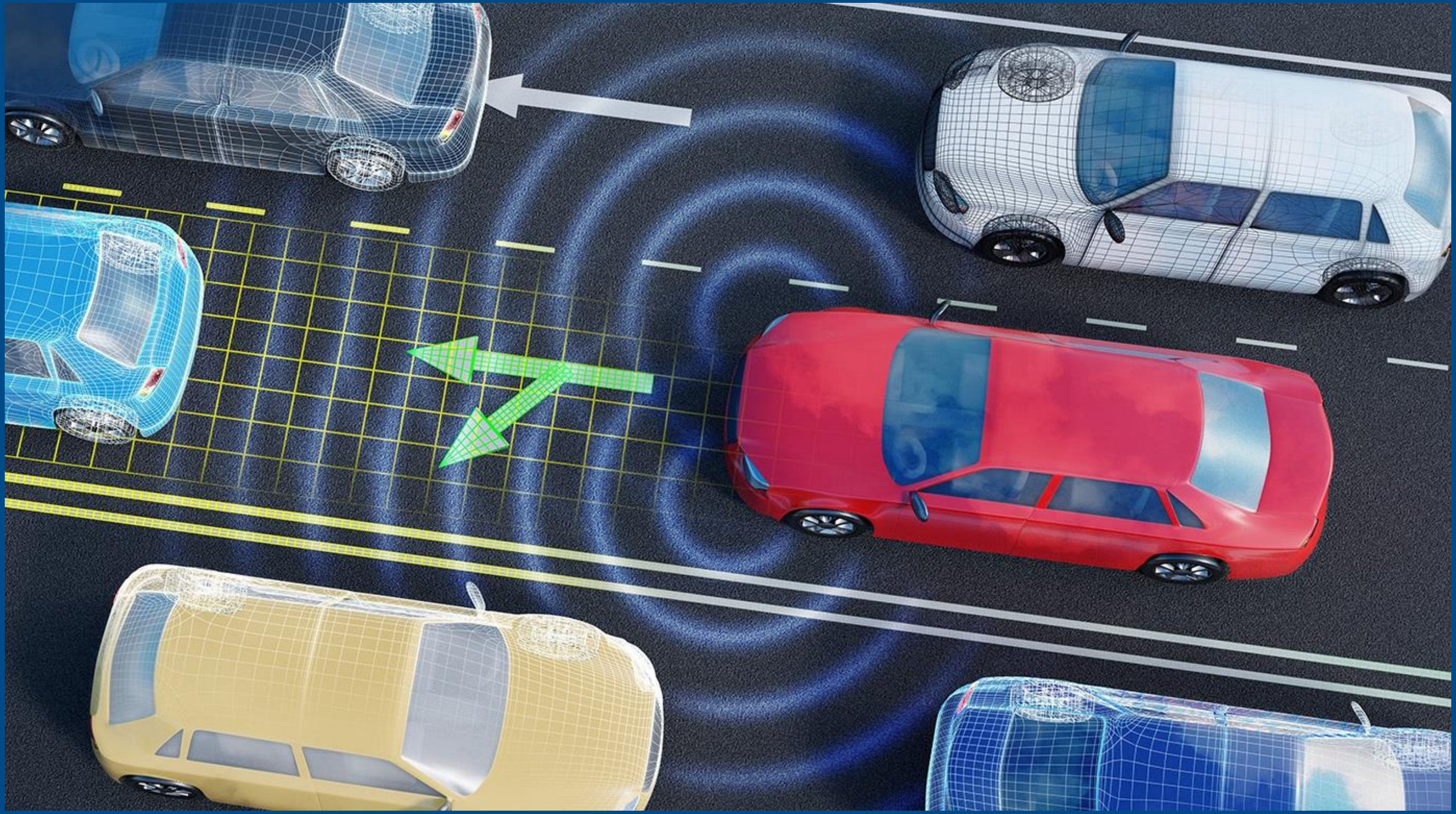
?

Are you ready for AI?

Data

Output

Model

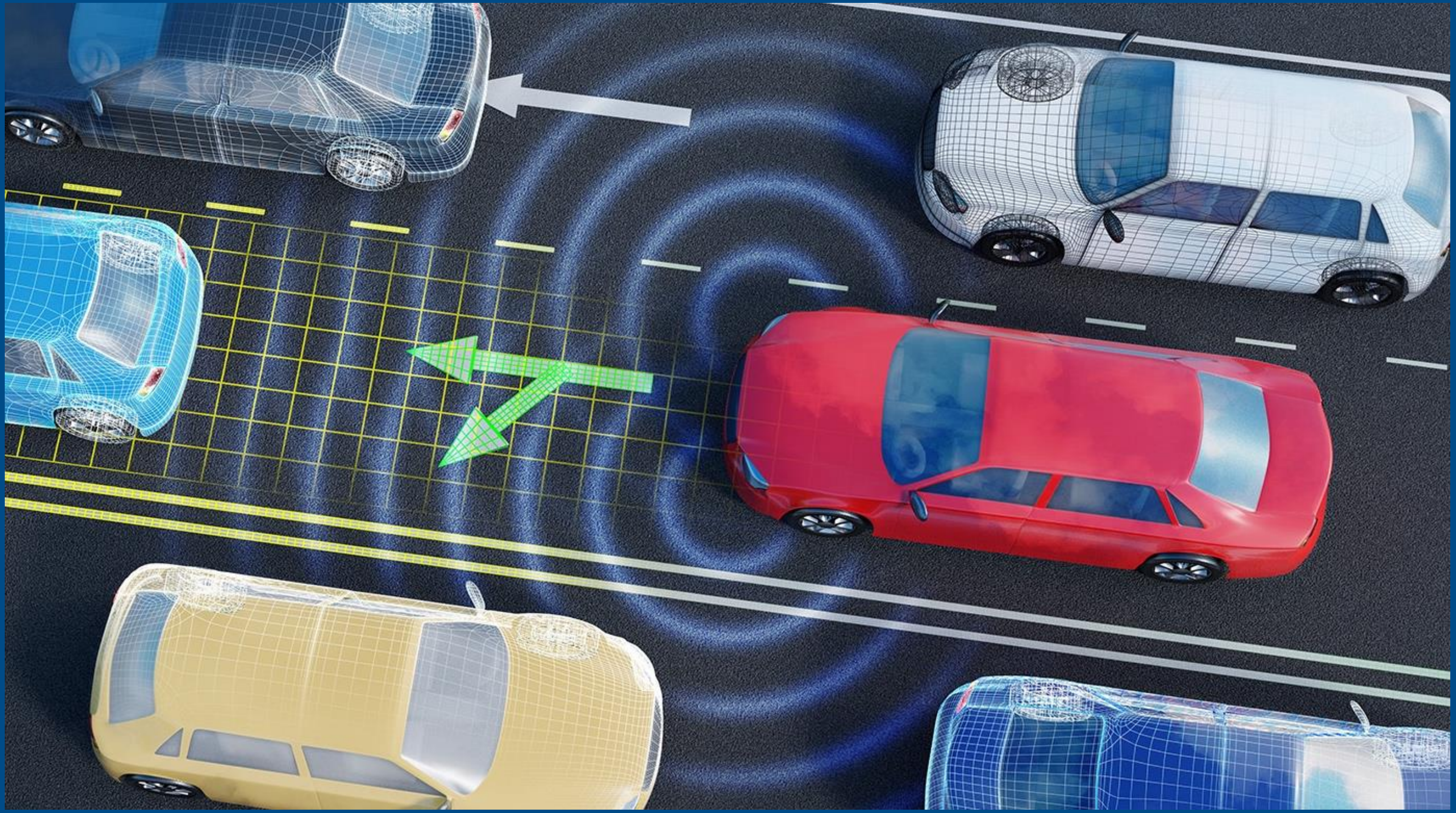


Are you ready for AI?

Access Data

Analyze Data

- Data
- Output
- Model



Are you ready for AI?

Access Data

Develop

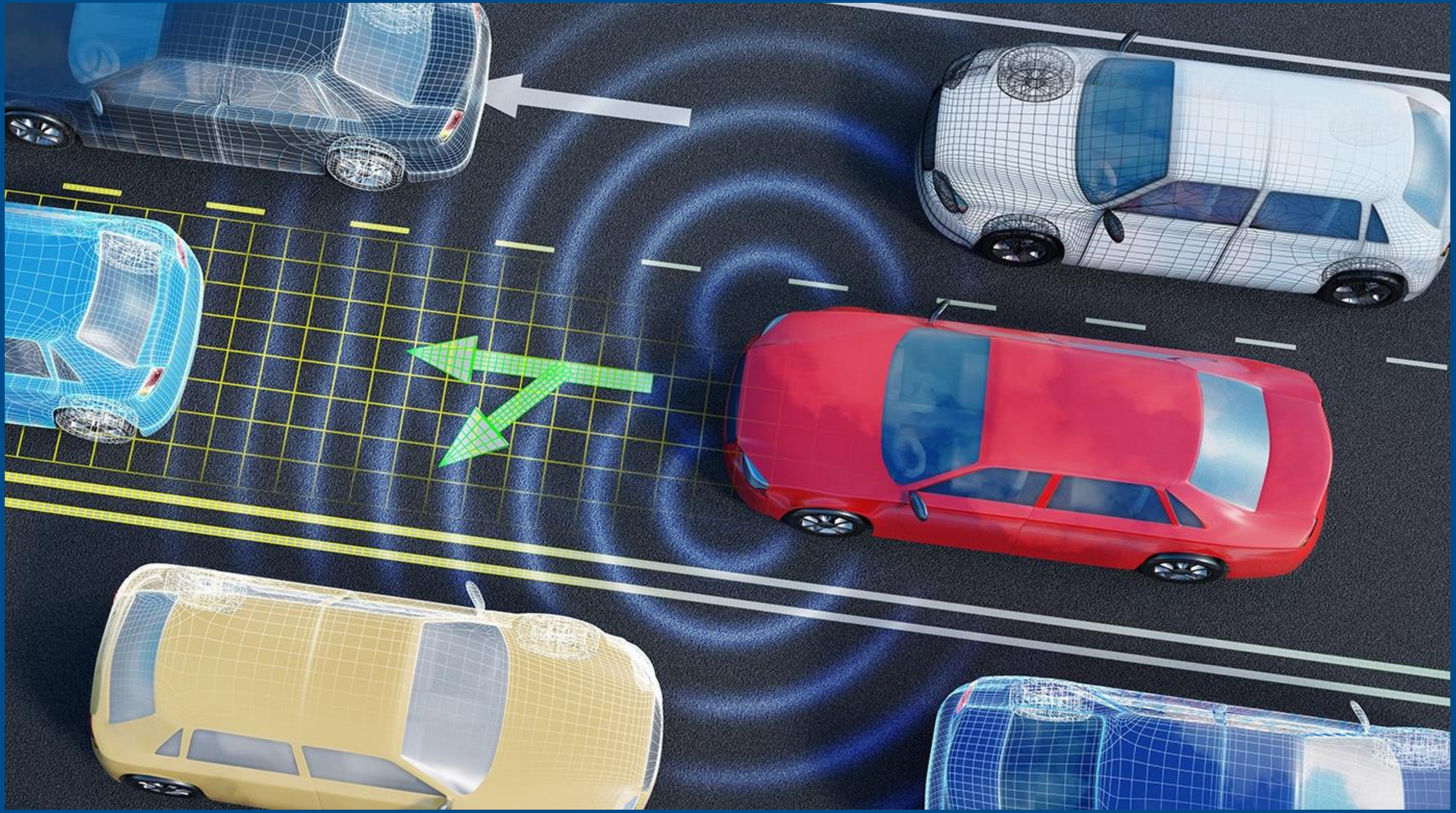
Analyze Data

Deploy

Data

Output

Model



Are you ready for AI?

Access Data

Analyze Data

Develop

Deploy

Data

Output

Model

EVERYTHING

ELSE

Are you ready for AI?

Access Data

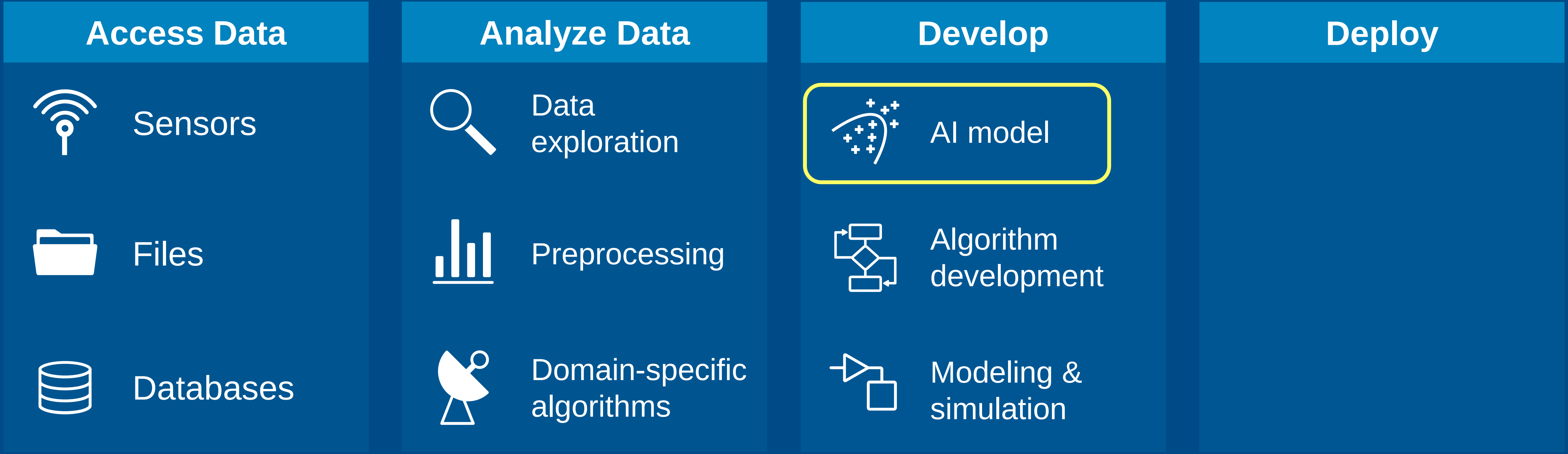
Analyze Data

Develop

- AI model
- Algorithm development
- Modeling & simulation

Deploy

Are you ready for AI?



Access Data	Analyze Data	Develop	Deploy
Sensors	Data exploration	AI model	
Files	Preprocessing	Algorithm development	
Databases	Domain-specific algorithms	Modeling & simulation	

Are you ready for AI?

Access Data

- Sensors
- Files
- Databases

Analyze Data

- Data exploration
- Preprocessing
- Domain-specific algorithms

Develop

- AI model
- Algorithm development
- Modeling & simulation

Deploy

- Desktop apps
- Enterprise systems
- Embedded devices

Are you ready for AI?

Caffe

TensorFlow

Access Data

- Sensors
- Files
- Databases

Analyze Data

- Data exploration
- Preprocessing
- Domain-specific algorithms

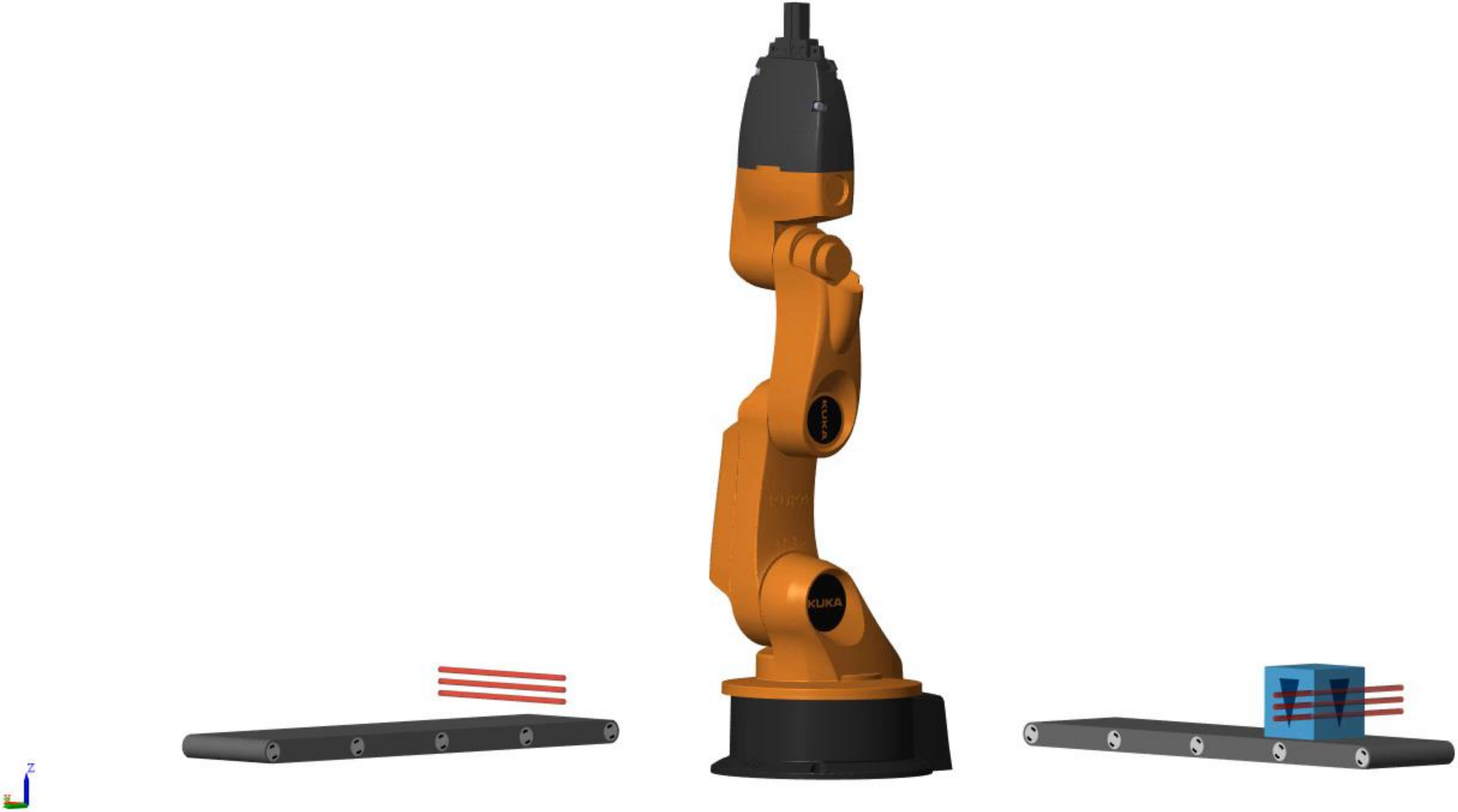
Develop

- AI model
- Algorithm development
- Modeling & simulation

Deploy

- Desktop apps
- Enterprise systems
- Embedded devices

Do you need AI?


KUKA
KUKA
Z

333-1
333-3
333-2

AI for Predictive Maintenance

- Measure the wear of each robot
- Predict and fix failures before they happen
- AI handles uncertainty and variability

Are you ready for AI if …

You’ve never used machine learning?

Twisties®
Cheese
FAT 6.3 g DI* 9%
SAT FAT 3.1 g DI* 13%
SUGARS 1.6 g DI* 2%
SODIUM 245 mg DI* 11%
90g e NET
flavoured snack
Twistie
Chicken
FAT 7.4 g DI* 11%
SAT FAT 3.6 g DI* 15%
SUGARS 0.7 g DI* 1%
SODIUM 213 mg DI* 9%
90g e NET
flavoured snack

What is crispiness?

Crushing Sound

+

Crushing Force

=

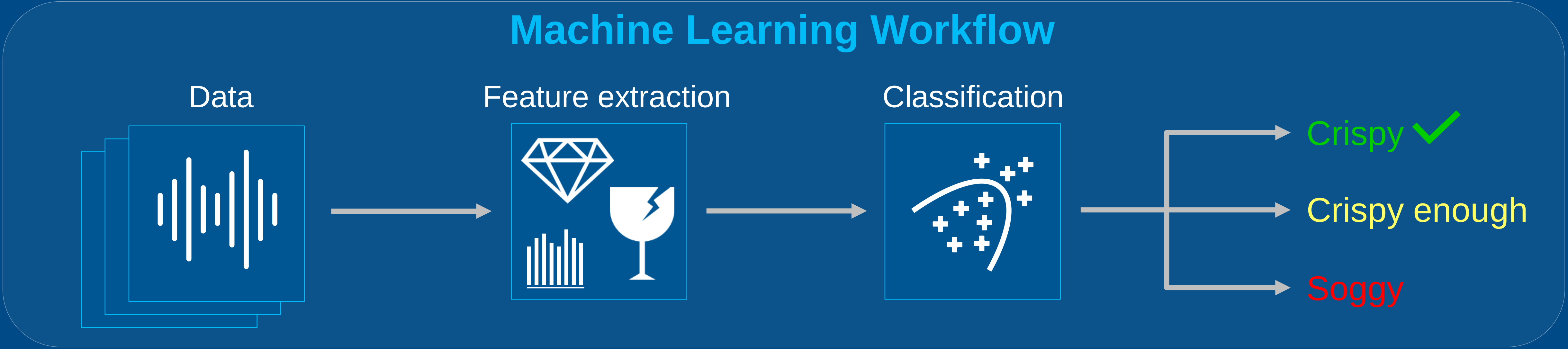
Crispy

Crispy Enough

Soggy

Replicating human perception with machine learning

Technical University of Munich



Machine Learning Workflow

Data

Feature extraction

Classification

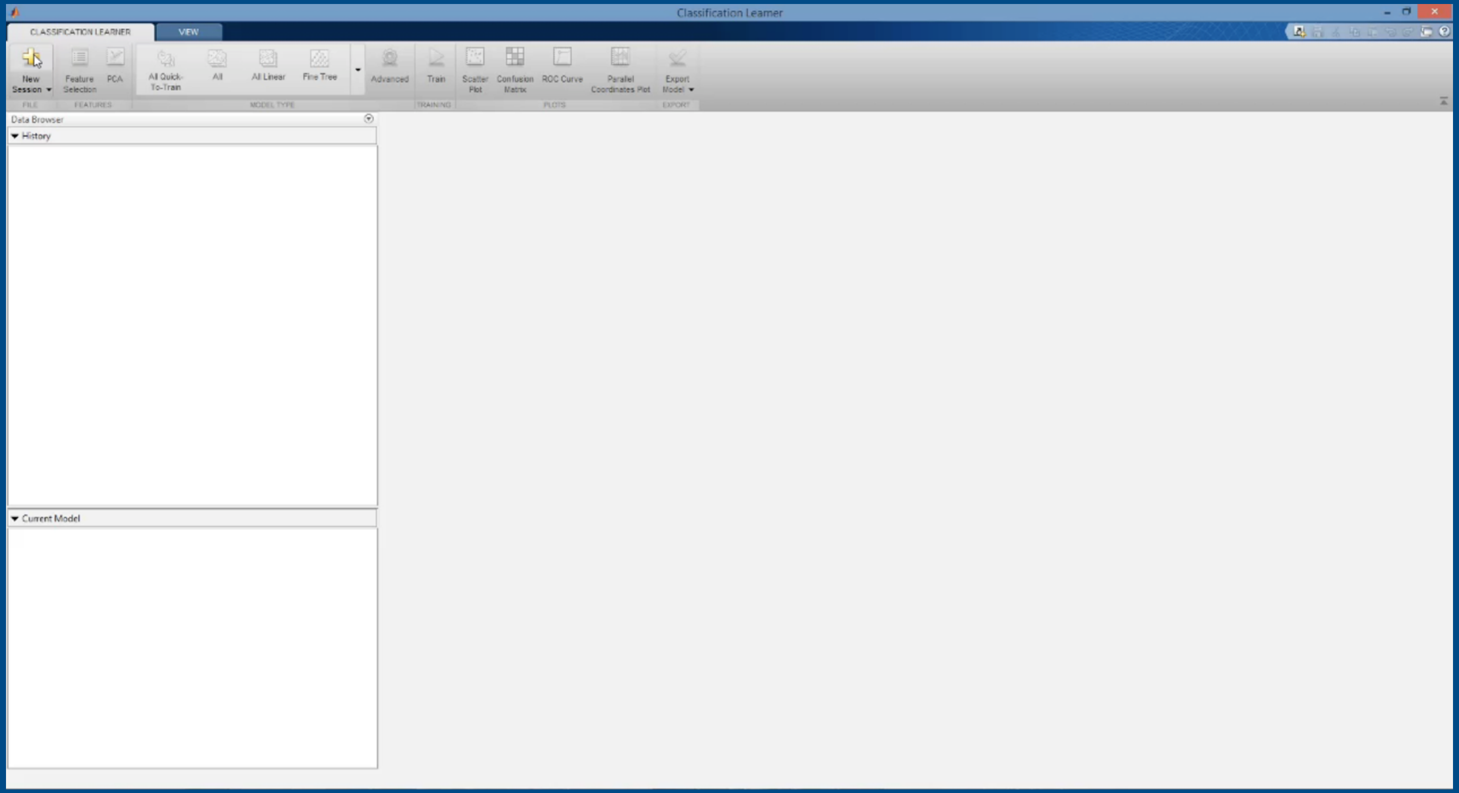
Crispy ✓

Crispy enough

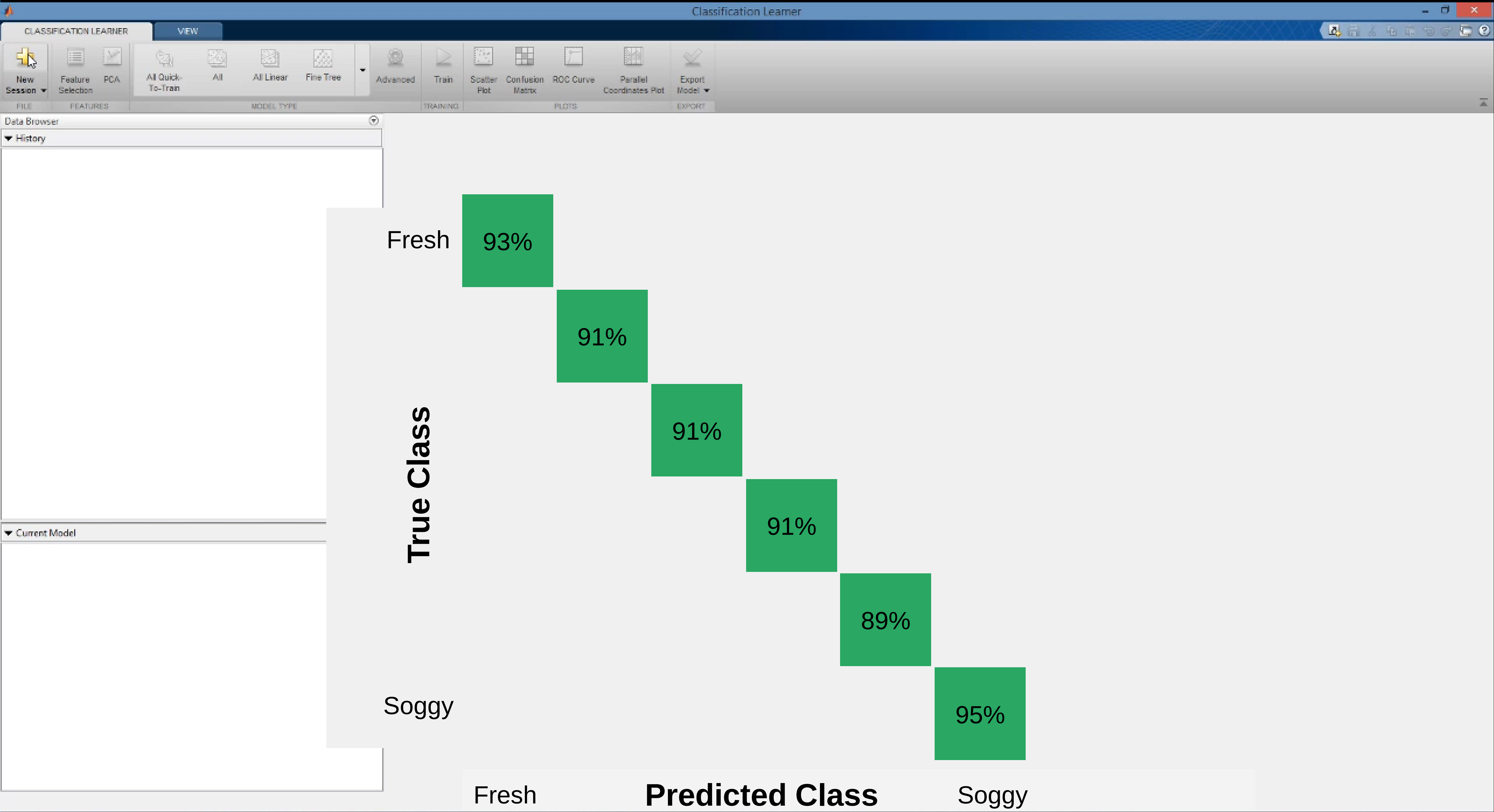
Soggy

Replicating human perception with machine learning

Technical University of Munich


Classification Learner
CLASSIFICATION LEARNER
VIEW
New Session
Feature Selection
PCA
All Quick-To-Train
All
All Linear
Fine Tree
Advanced
Train
Scatter Plot
Confusion Matrix
ROC Curve
Parallel Coordinates Plot
Export Model
FILE
FEATURES
MODEL TYPE
TRAINING
PLOTS
EXPORT
Data Browser
History
Current Model

Classification Learner


Classification Learner
CLASSIFICATION LEARNER
VIEW
New Session
Feature Selection
PCA
All Quick-To-Train
All
All Linear
Fine Tree
Advanced
Train
Scatter Plot
Confusion Matrix
ROC Curve
Parallel Coordinates Plot
Export Model
FILE
FEATURES
MODEL TYPE
TRAINING
PLOTS
EXPORT
Data Browser
History
Current Model
Fresh
93%
91%
91%
91%
89%
Soggy
95%
True Class
Fresh
Predicted Class
Soggy

Are you ready for AI if you’ve never used machine learning?

- No experience required
- Use apps to try out all possible models
- Use domain expertise and familiar tools to prepare data

Find out more:

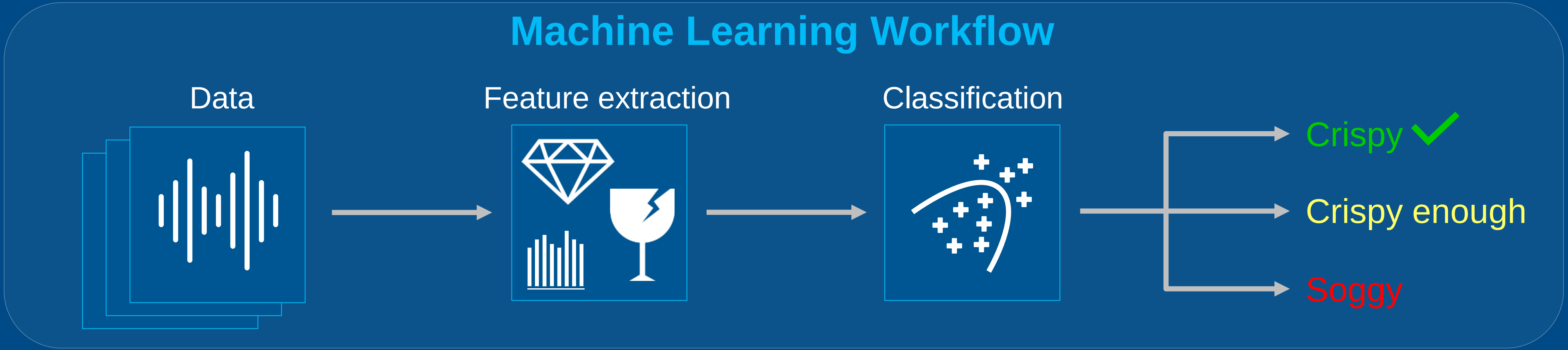
“MATLAB을 이용한 머신 러닝 (기본)”

“복잡한 문제를 단순하게 만드는 MATLAB환경에서의 머신 러닝 (중급)”

Are you ready for AI if …

You can’t identify features in your data?

Use deep learning to identify features automatically



Machine Learning Workflow

Data

Feature extraction

Classification

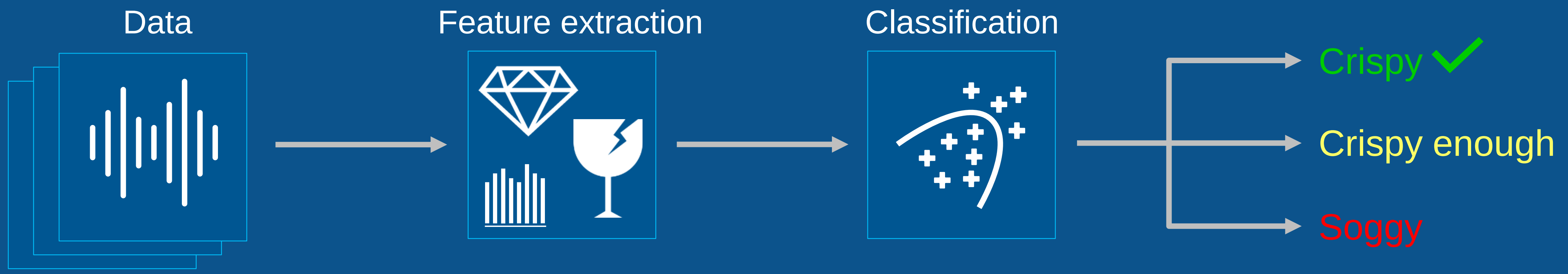
Crispy ✓

Crispy enough

Soggy

Use deep learning to identify features automatically

Machine Learning Workflow



Data

Feature extraction

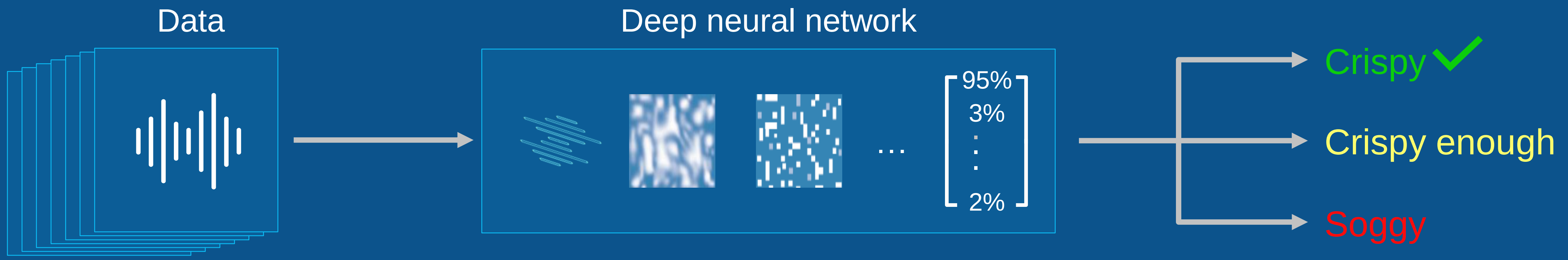
Classification

Crispy ✓

Crispy enough

Soggy

Deep Learning Workflow



Data

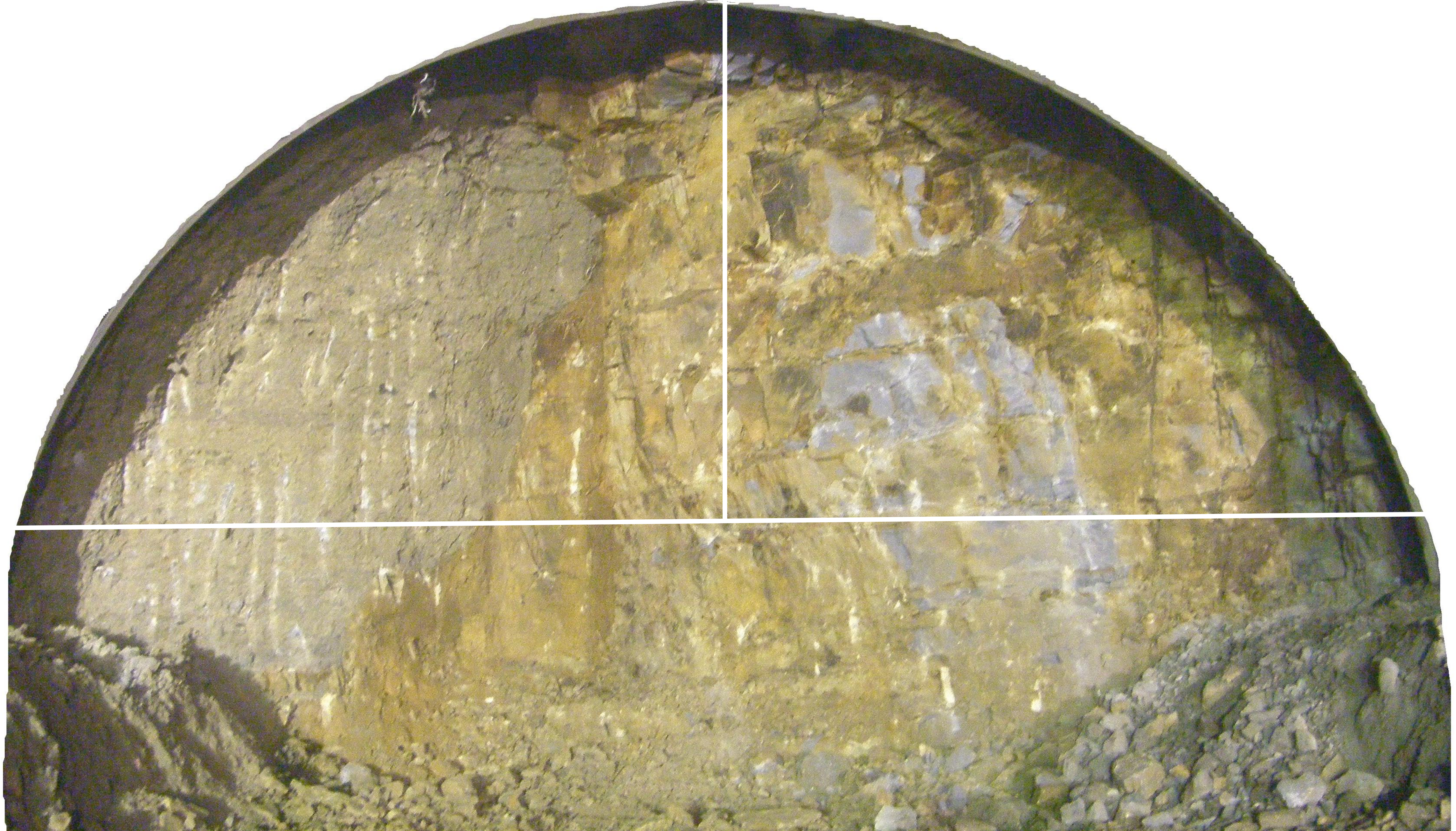
Deep neural network

Crispy ✓

Crispy enough

Soggy

TED WILLIAMS TUNNEL
SPEED LIMIT 45
STATE POLICE



Traditional Approach

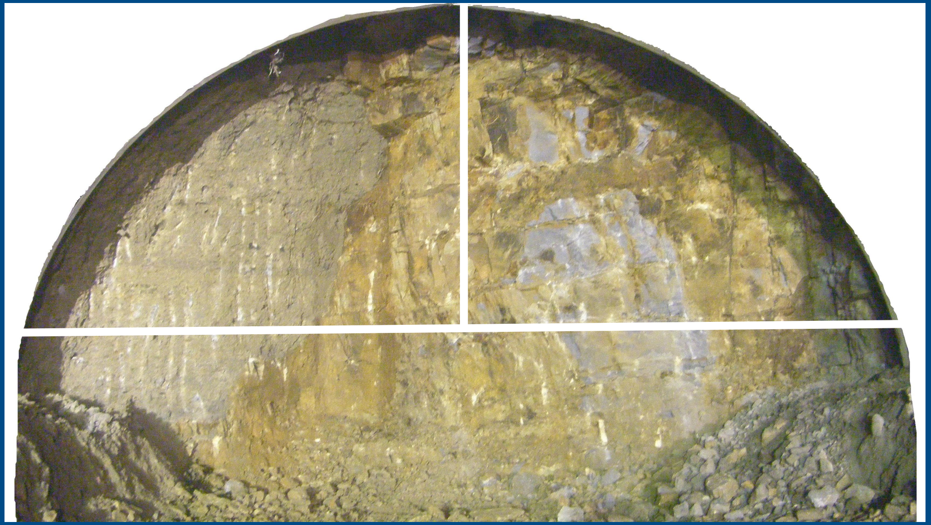
- Geologists assess seven different metrics
- Can take hours to analyze one site
- Critical shortage of geologists

New Approach

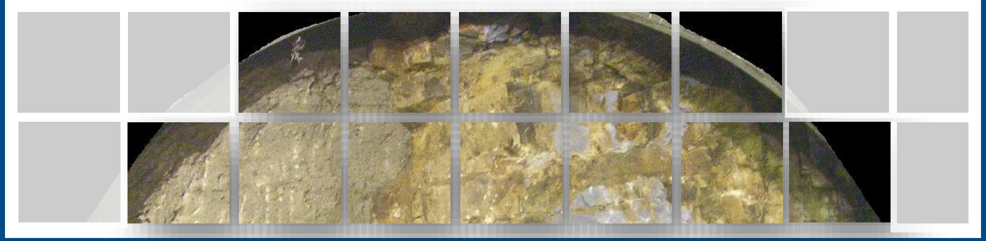
- Use deep learning to automatically recognize metrics based on images
- On-site evaluators decide with support from deep learning

Efficient tunnel drilling with deep learning

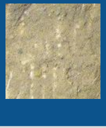
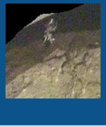
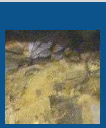
Obayashi Corporation



Split into sub-images

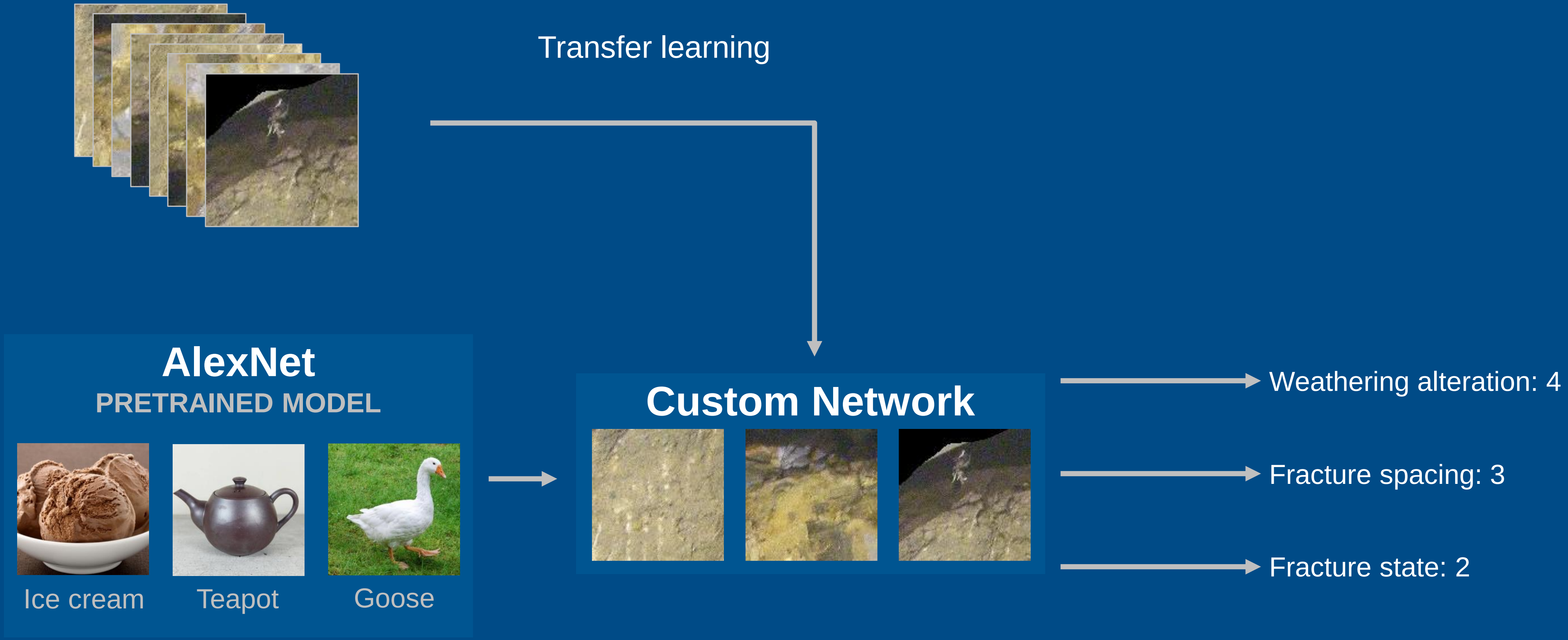


Label each sub-image

Image	Weathering Alteration (1-4)	Fracture Spacing (1-5)	Fracture State (1-5)
	3	3	2
	4	1	1
	2	3	2
	3	3	2
⋮	⋮	⋮	⋮

Efficient tunnel drilling with deep learning

Obayashi Corporation



Transfer learning

AlexNet

PRETRAINED MODEL

Ice cream
Teapot
Goose

Custom Network

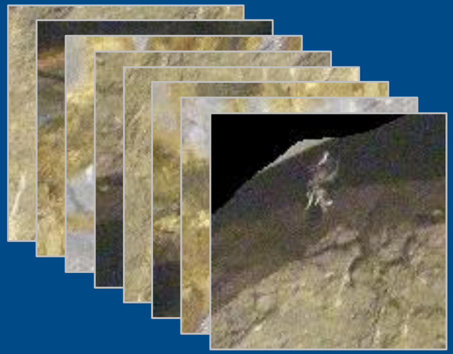
Weathering alteration: 4

Fracture spacing: 3

Fracture state: 2

Efficient tunnel drilling with deep learning

Obayashi Corporation



Transfer learning

MATLAB Production Server

AlexNet

PRETRAINED MODEL

Ice cream

Teapot

Goose

Custom Network

Weathering alteration: 4

Fracture spacing: 3

Fracture state: 2

Are you ready for AI if you can’t identify features in your data?

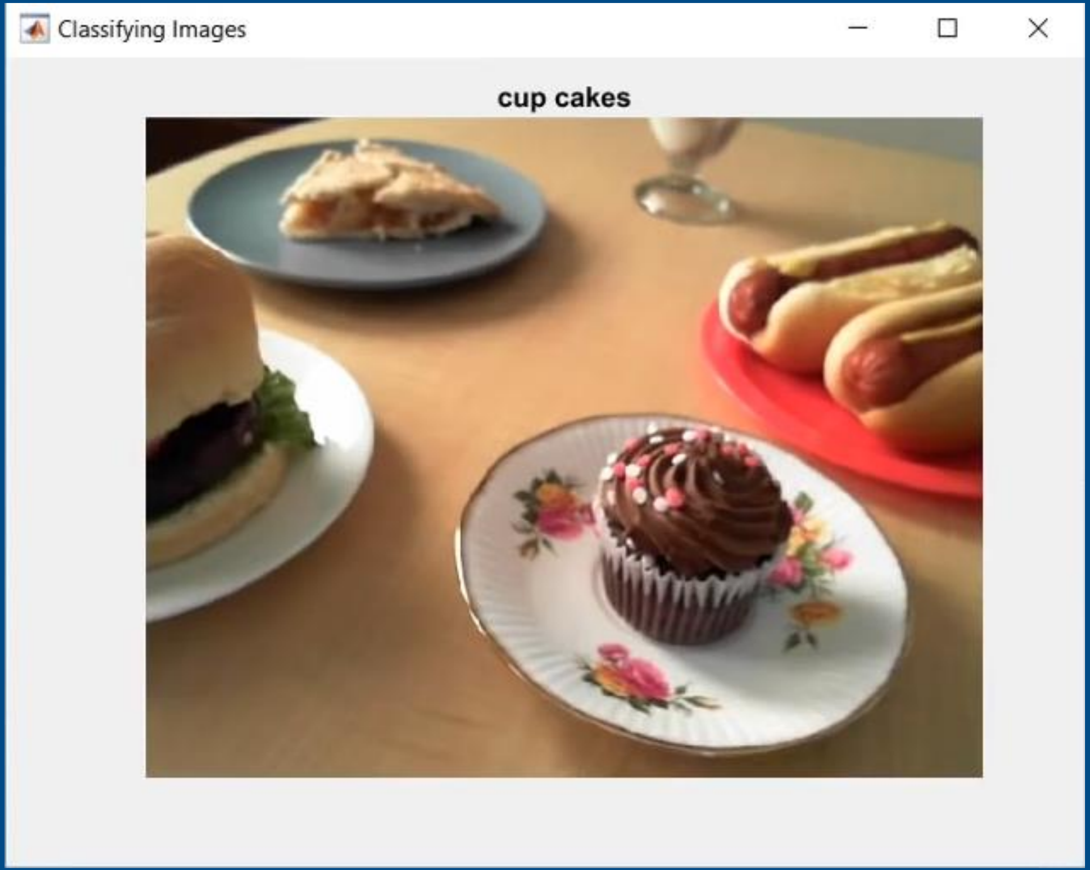
- Deep learning

```
nnet = alexnet;

cam = webcam;
picture = snapshot(cam);
picture = imresize(picture,[227 227]);

label = classify(nnet, picture)
```

Deep learning in 5 lines of code

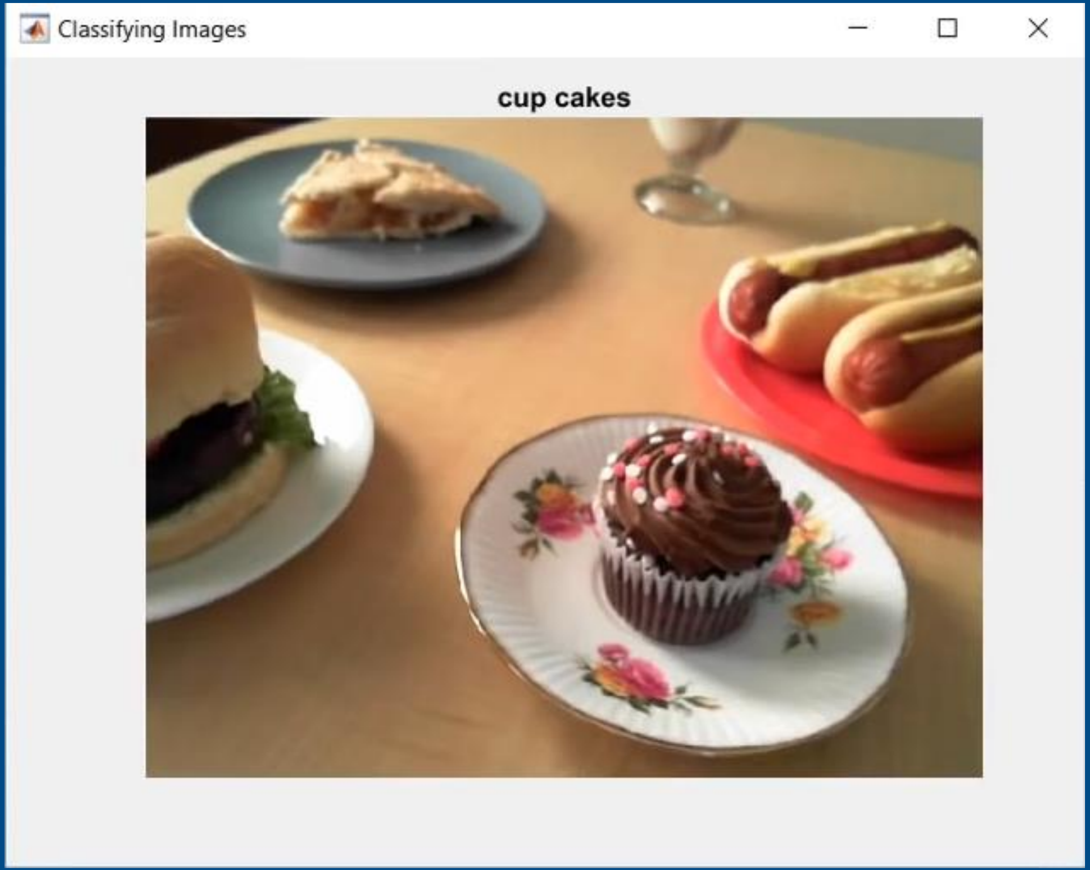


cup cakes

Are you ready for AI if you can’t identify features in your data?

- Deep learning
- Transfer learning

Deep learning in 5 lines of code


Classifying Images
cup cakes

Are you ready for AI if you can’t identify features in your data?

- Deep learning
- Transfer learning
- Automation and AI to label data

Autoliv

Classification

Car 🟥
Truck 🟧
Background 🟦
Ground 🟩

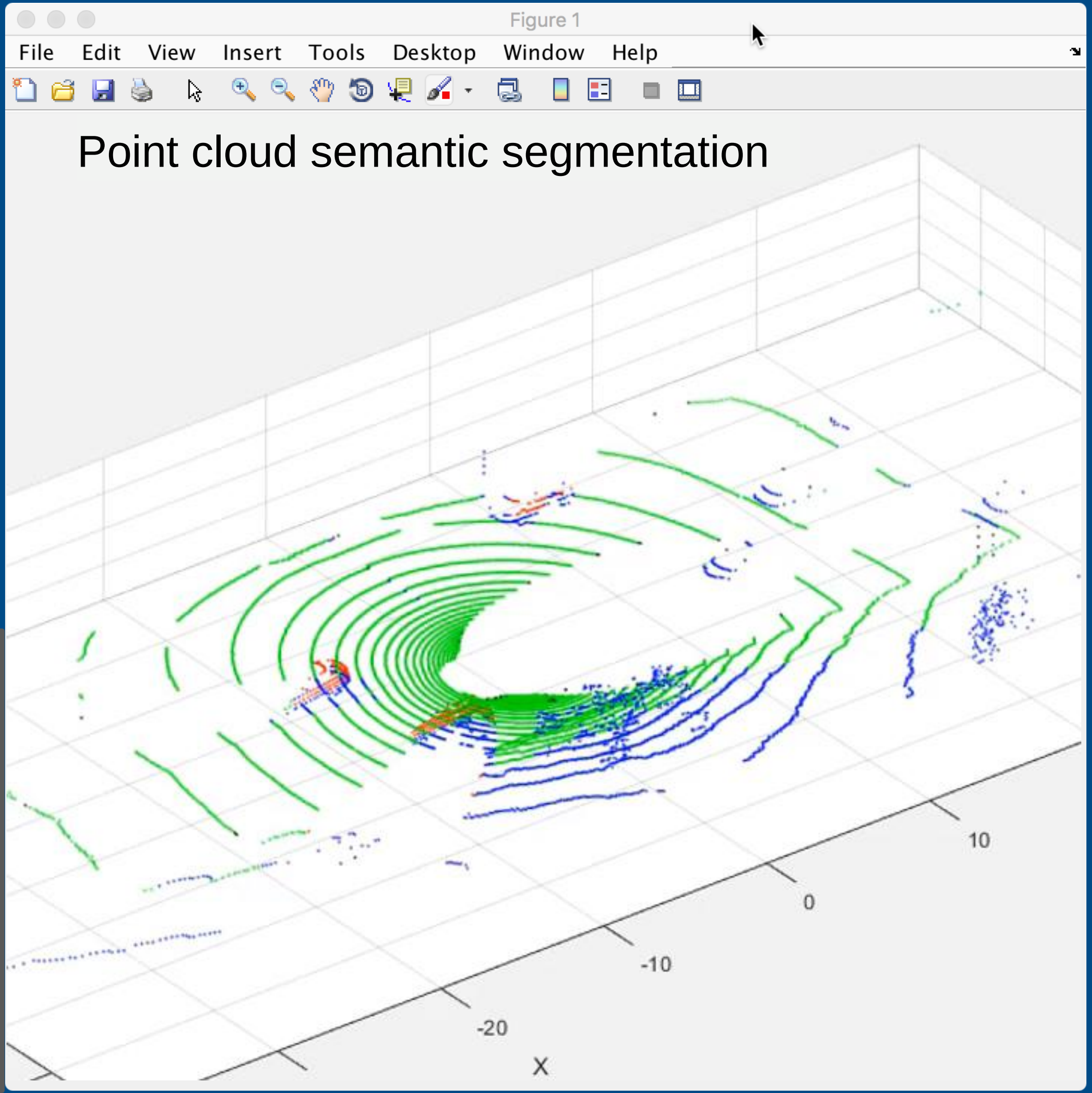


Figure 1
File
Edit
View
Insert
Tools
Desktop
Window
Help
Point cloud semantic segmentation
10
0
-10
-20
X

Are you ready for AI if you can’t identify features in your data?

- Deep learning
- Transfer learning
- Automation and AI to label data

Autoliv

Classification

Car 🟥
Truck 🟧
Background 🟦
Ground 🟩

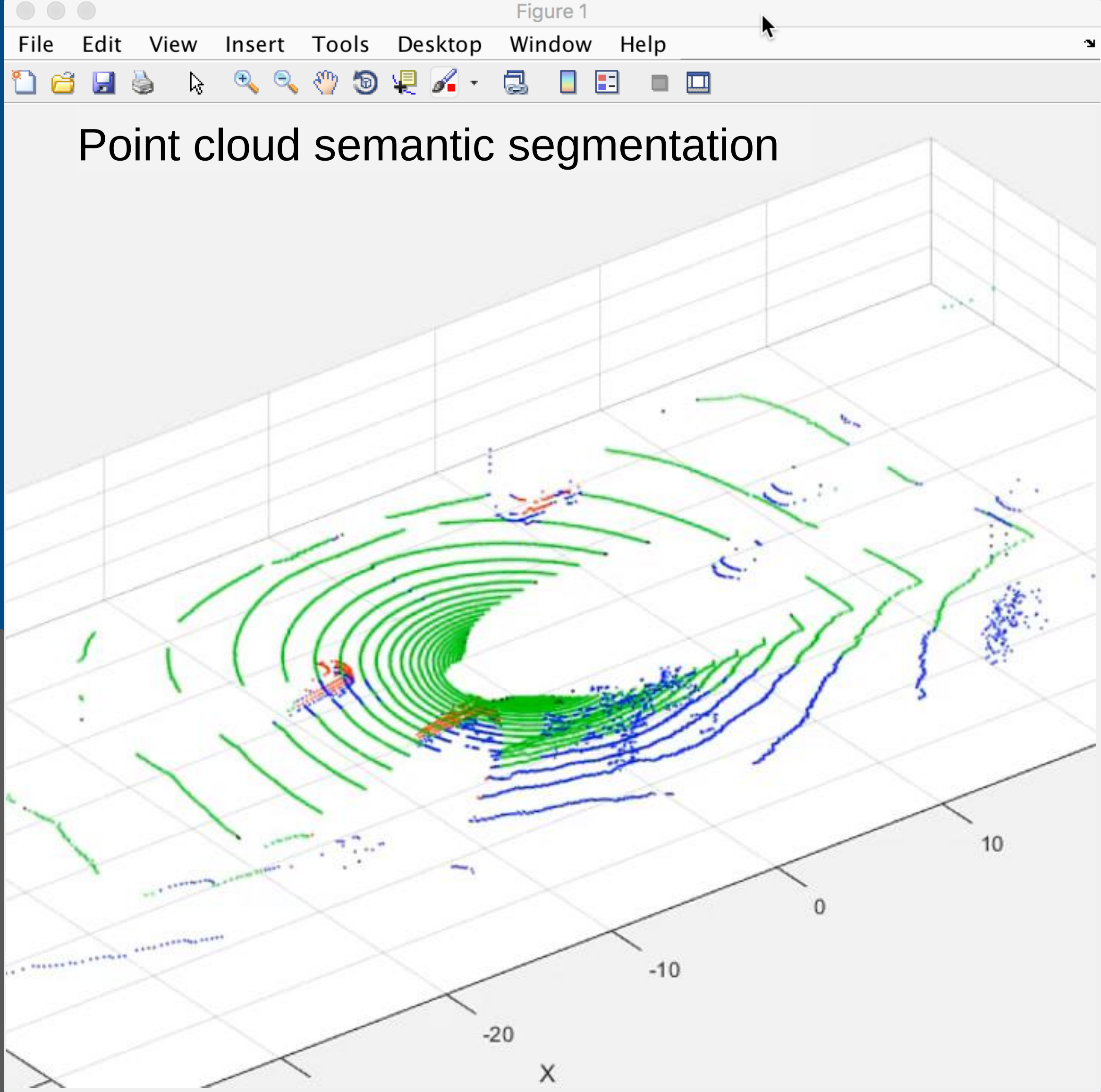


Figure 1
File
Edit
View
Insert
Tools
Desktop
Window
Help
Point cloud semantic segmentation
10
0
-10
-20
X

Find out more:

“개발에서 구현까지 MATLAB 환경에서의 딥러닝”

“딥러닝을 활용한 영상 인식 응용프로그램 개발 워크플로우”

“GPU 기반의 임베디드 하드웨어에서의 딥러닝 및 코드 생성 "

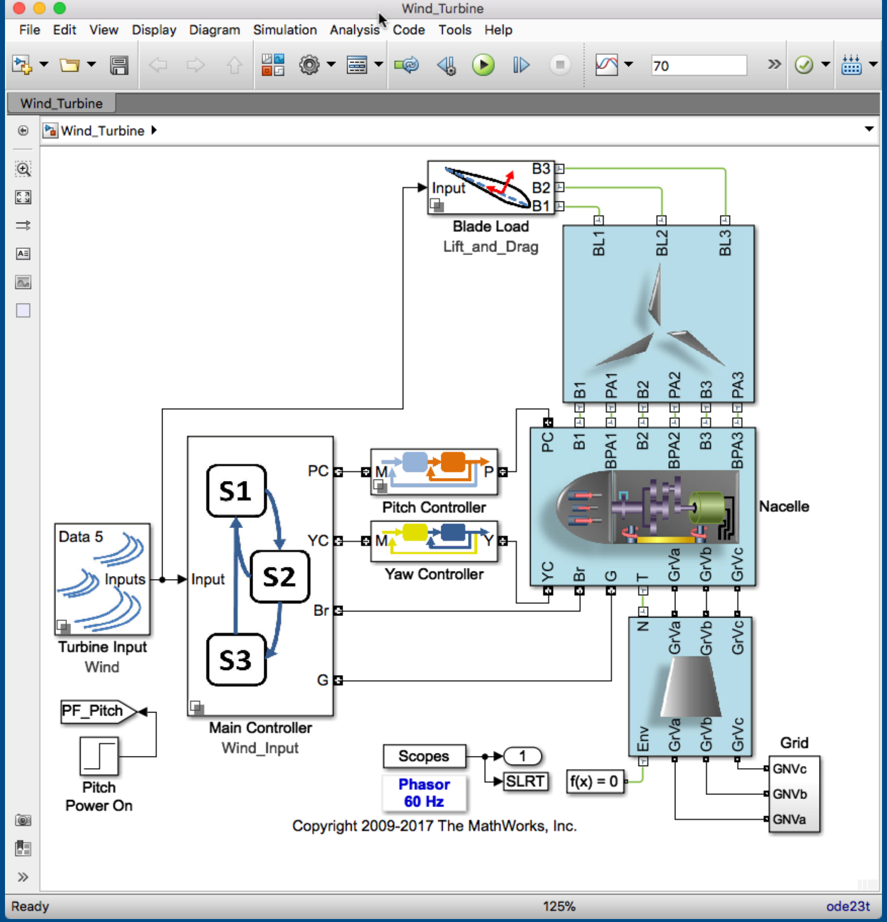
Are you ready for AI if …

If you don’t have the right data?

AI for Predictive Maintenance

- Measure the wear of each blade
- Predict and fix failures before they happen
- Can’t rely on failures in the field

Predictive maintenance with synthetic failure data with MATLAB & Simulink


Wind_Turbine
File Edit View Display Diagram Simulation Analysis Code Tools Help
70
Wind_Turbine
Wind_Turbine
Input
B3
B2
B1
Blade Load
Lift_and_Drag
BL1
BL2
BL3
B1
PA1
B2
PA2
B3
PA3
PC
B1
BPA1
B2
BPA2
B3
BPA3
Nacelle
YC
Br
G
T
GrVa
GrVb
GrVc
N
GrVa
GrVb
GrVc
Env
GrVa
GrVb
GrVc
Grid
GNVc
GNVb
GNVa
Data 5
Inputs
Turbine Input
Wind
Input
S1
S2
S3
PC
YC
Br
G
Main Controller
Wind_Input
M
P
Pitch Controller
M
Y
Yaw Controller
PF_Pitch
Pitch
Power On
Scopes
1
SLRT
f(x) = 0
Phasor
60 Hz
Copyright 2009-2017 The MathWorks, Inc.
Ready
125%
ode23t

Simulink model

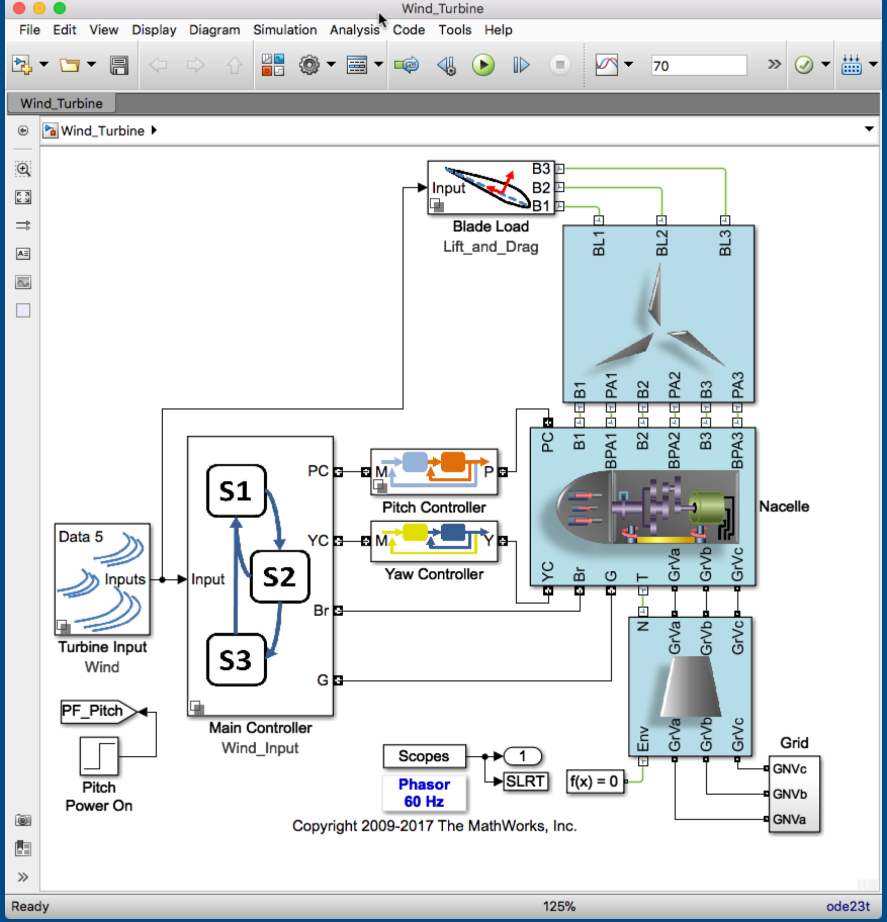
Predictive maintenance with synthetic failure data with MATLAB & Simulink

Measured data

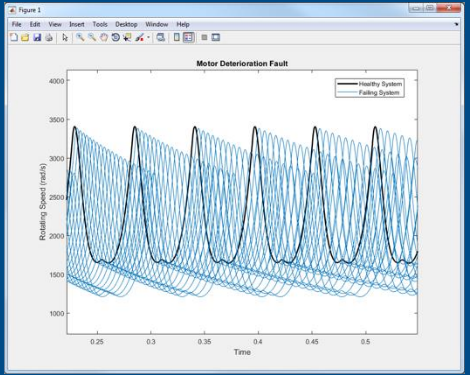
Refine model

Failure conditions

Inject failures


Wind_Turbine
File Edit View Display Diagram Simulation Analysis Code Tools Help
70
Wind_Turbine
Input
B3
B2
B1
Blade Load
Lift_and_Drag
BL1
BL2
BL3
B1
PA1
B2
PA2
B3
PA3
PC
B1
BPA1
B2
BPA2
B3
BPA3
Nacelle
YC
Br
G
T
GrVa
GrVb
GrVc
N
Env
Grid
GNVc
GNVb
GNVa
S1
S2
S3
PC
YC
Br
G
Input
Main Controller
Wind_Input
M
P
Pitch Controller
M
Y
Yaw Controller
Data 5
Inputs
Turbine Input
Wind
PF_Pitch
Pitch
Power On
Scopes
Phasor
60 Hz
1
SLRT
f(x) = 0
Copyright 2009-2017 The MathWorks, Inc.
Ready
125%
ode23t

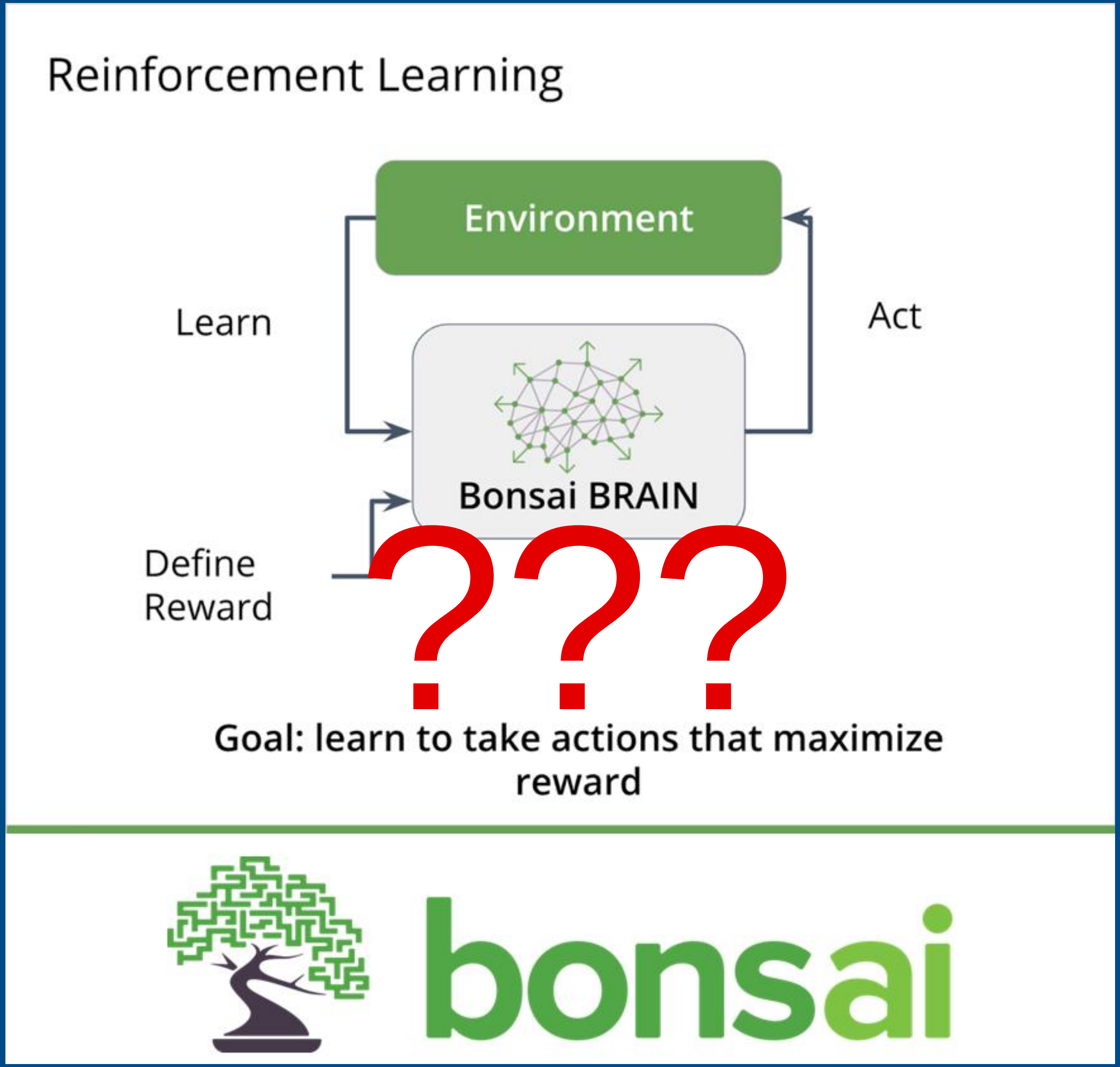
Simulink model



Failure data

Are you ready for AI if you don’t have the right data?

- Generate data with simulations
- Simulation environment for reinforcement learning


Reinforcement Learning
Environment
Learn
Act
Bonsai BRAIN
Define Reward
???
Goal: learn to take actions that maximize reward
bonsai

Find out more:

“고장 진단 및 건전성 관리 기술: 알고리즘 개발에서 사물인터넷 환경 구성까지”

“물리모델 시뮬레이션을 활용한 고장 예측”

Low-carbon homes

- Generate power with fuel cell and solar panels
- Store power in battery
- Buy power when needed; sell when extra
- Record data on environment and energy usage

Low-carbon homes

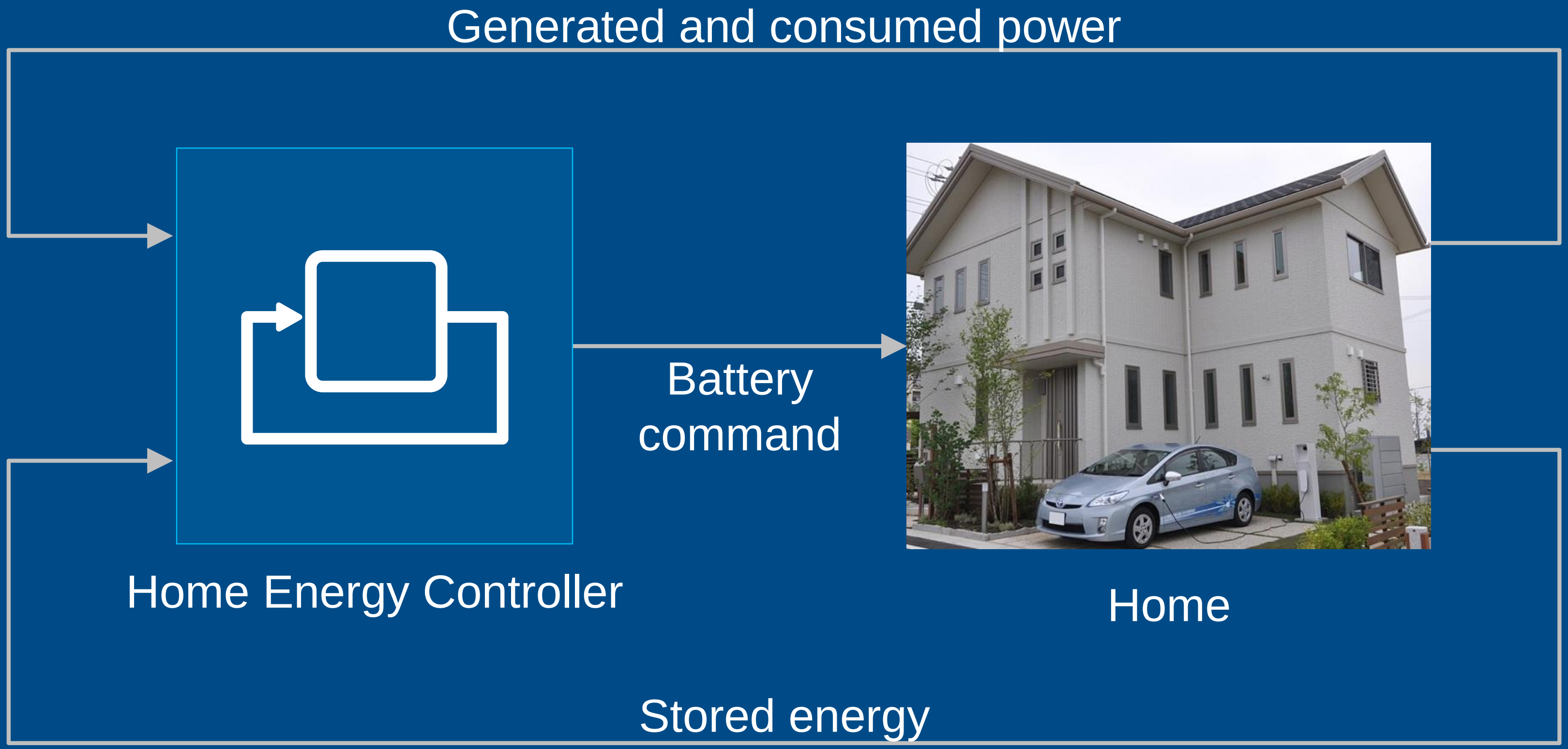
- Generate power with fuel cell and solar panels
- Store power in battery
- Buy power when needed; sell when extra
- Record data on environment and energy usage

Goals

- Minimize energy cost
- Use EV battery for additional storage

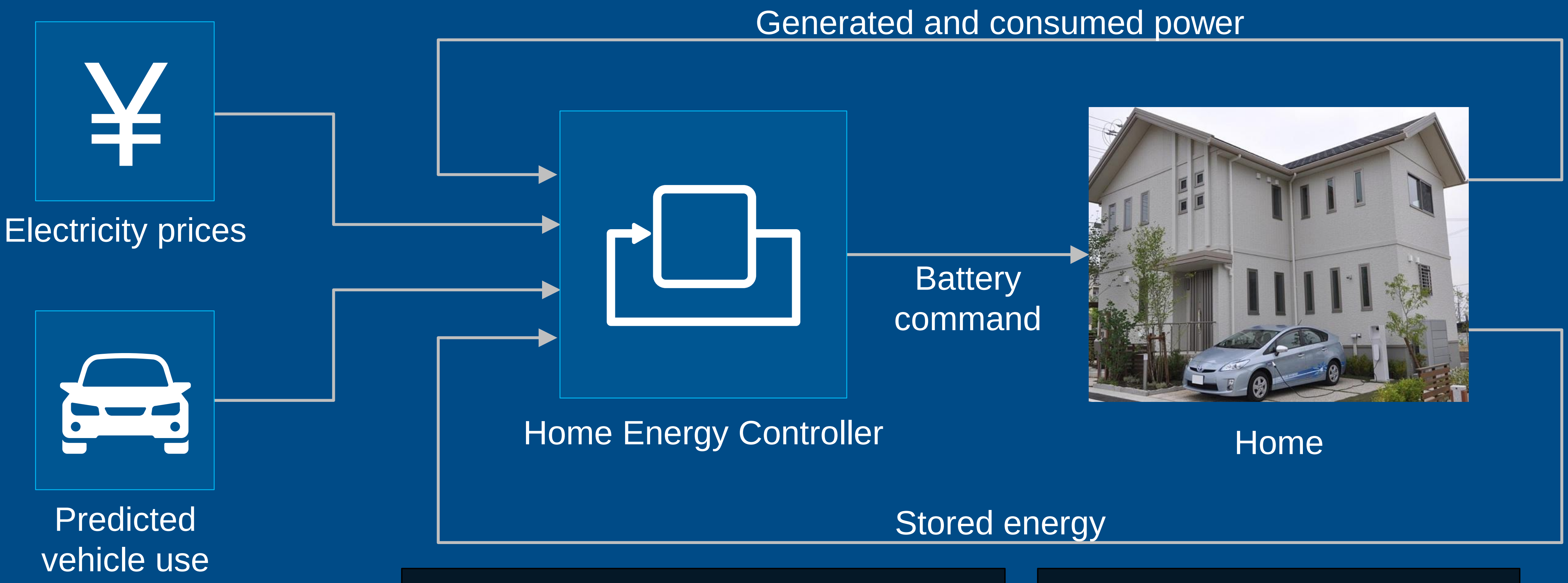
Optimizing home energy management system

Denso


Generated and consumed power
Battery
command
Home Energy Controller
Home
Stored energy

Optimizing home energy management system

Denso



Generated and consumed power

Electricity prices

Predicted vehicle use

Home Energy Controller

Battery command

Home

Stored energy

Model predictive control

Mixed integer linear programming

Simscape Power Systems

Optimizing home energy management system

Denso

Access Data

1000 CSV Files

Analyze Data

Preprocessing

Parallel computing

Develop

Classification Learner

Deploy

Optimizing home energy management system

Denso

Access Data

- 1000 CSV Files

Analyze Data

- Preprocessing
- Parallel computing

Develop

- Classification Learner
- Simulink
- Simscape Power Systems
- Control algorithms
- Optimization

Deploy

- Embedded devices

Optimizing home energy management system
Denso

DENSO

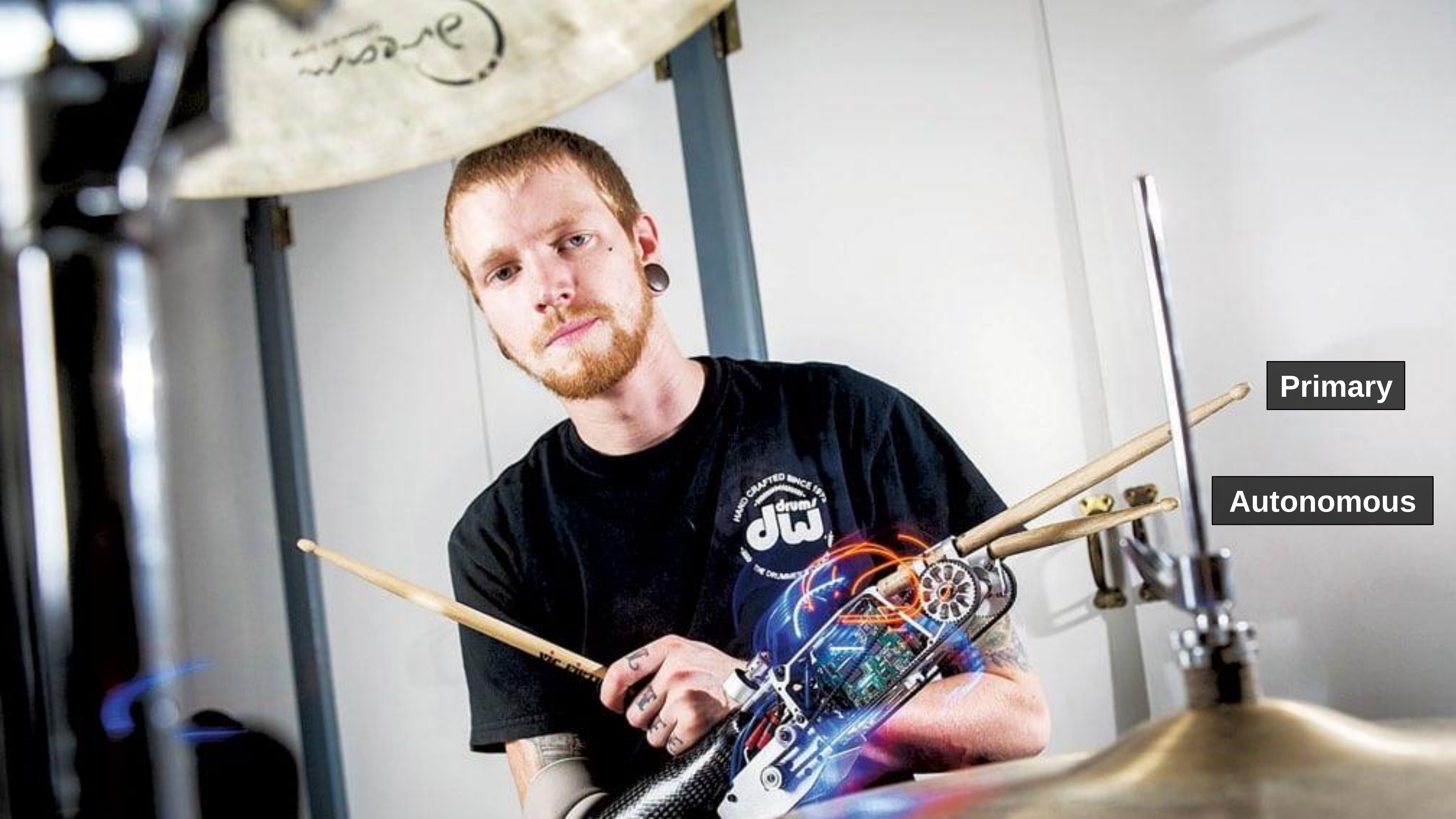
Akira Ito and Ryu Matsumoto

“The effort **would have taken significantly longer** if we had used disparate tools.

[MATLAB] enabled our team of domain experts, who lacked formal training in data science, machine learning, and parallel computing, to incorporate all these areas in our design process.”

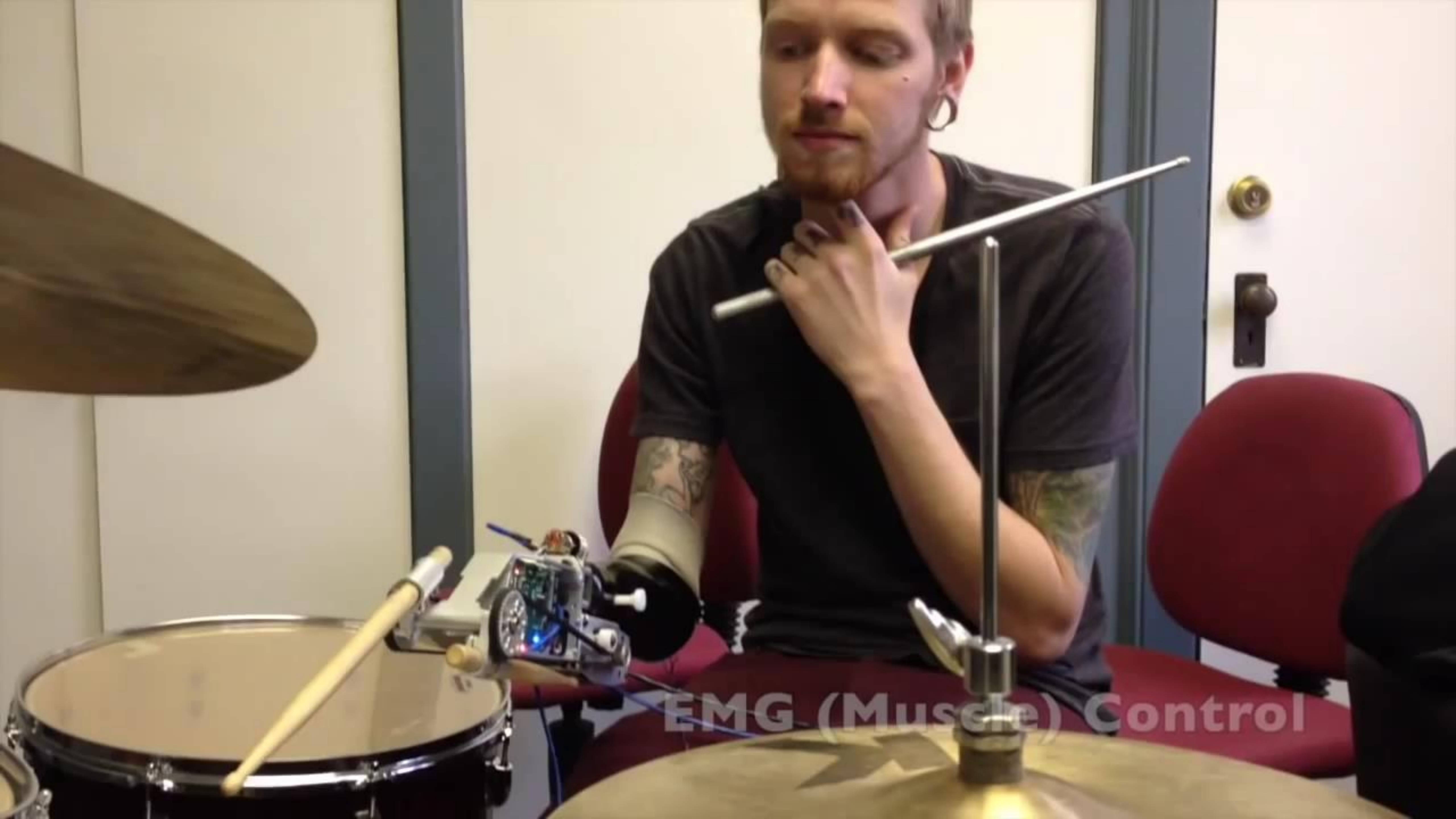
Control algorithms

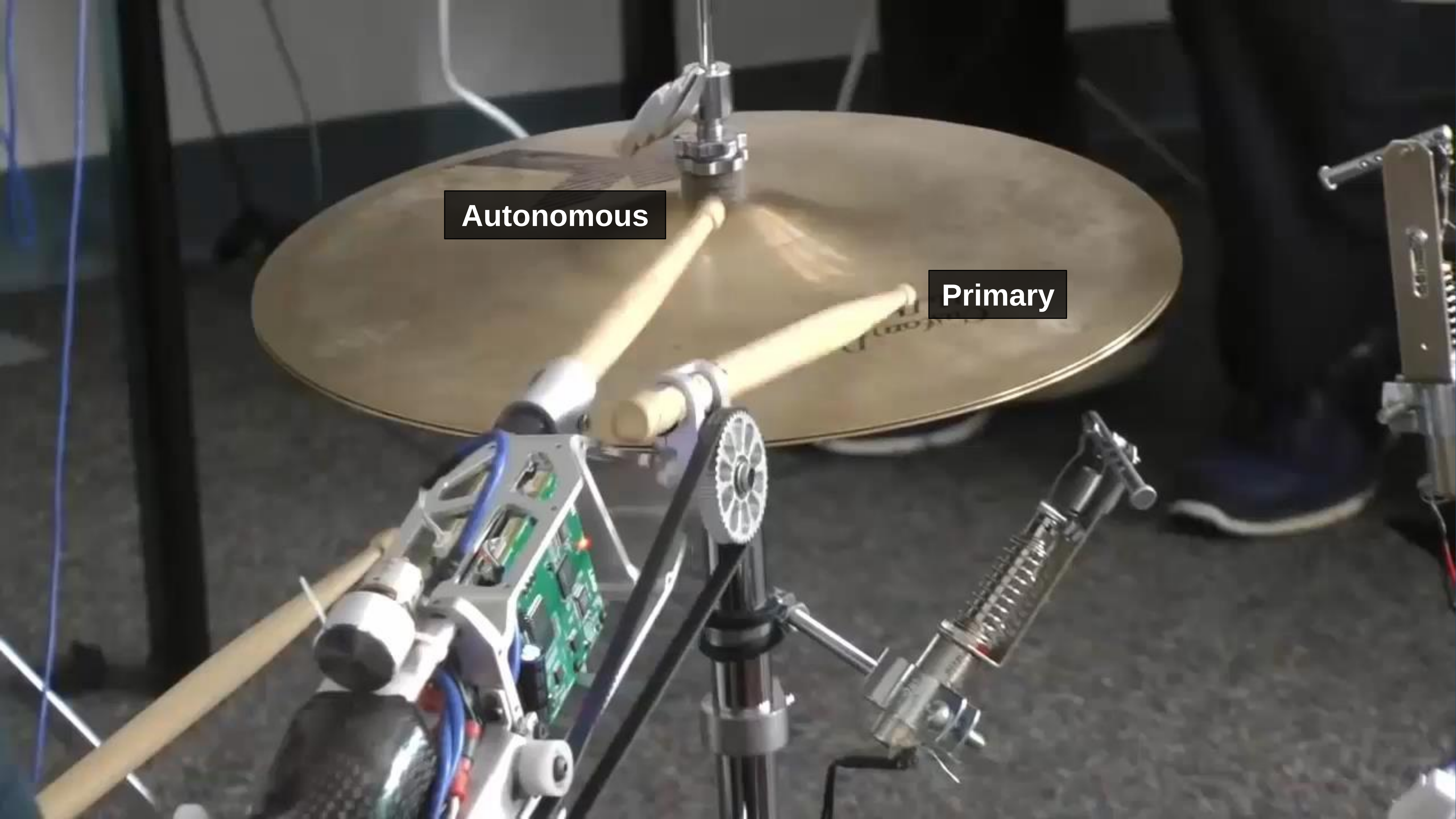
Optimization



Primary

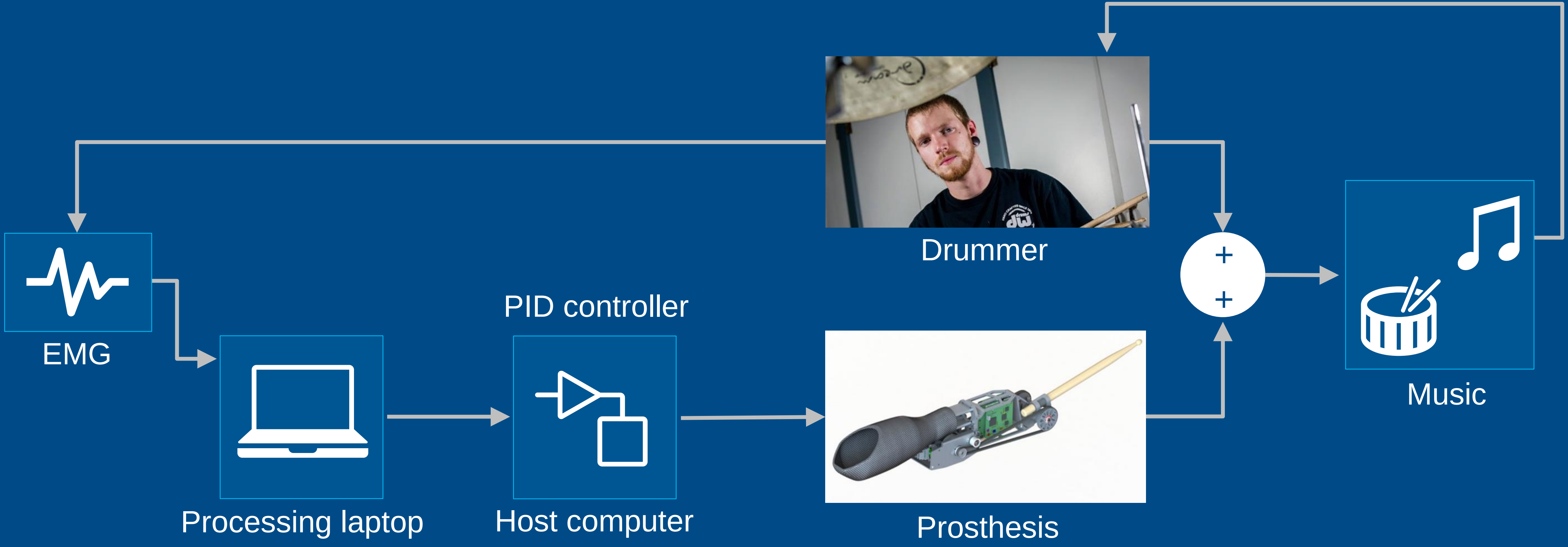
Autonomous


EMG (Muscle) Control


Autonomous
Primary

Exceeding human capabilities with a robotic drumming prosthesis

Georgia Tech Center for Music Technology



Drummer

EMG

PID controller

Processing laptop

Host computer

Prosthesis

Music

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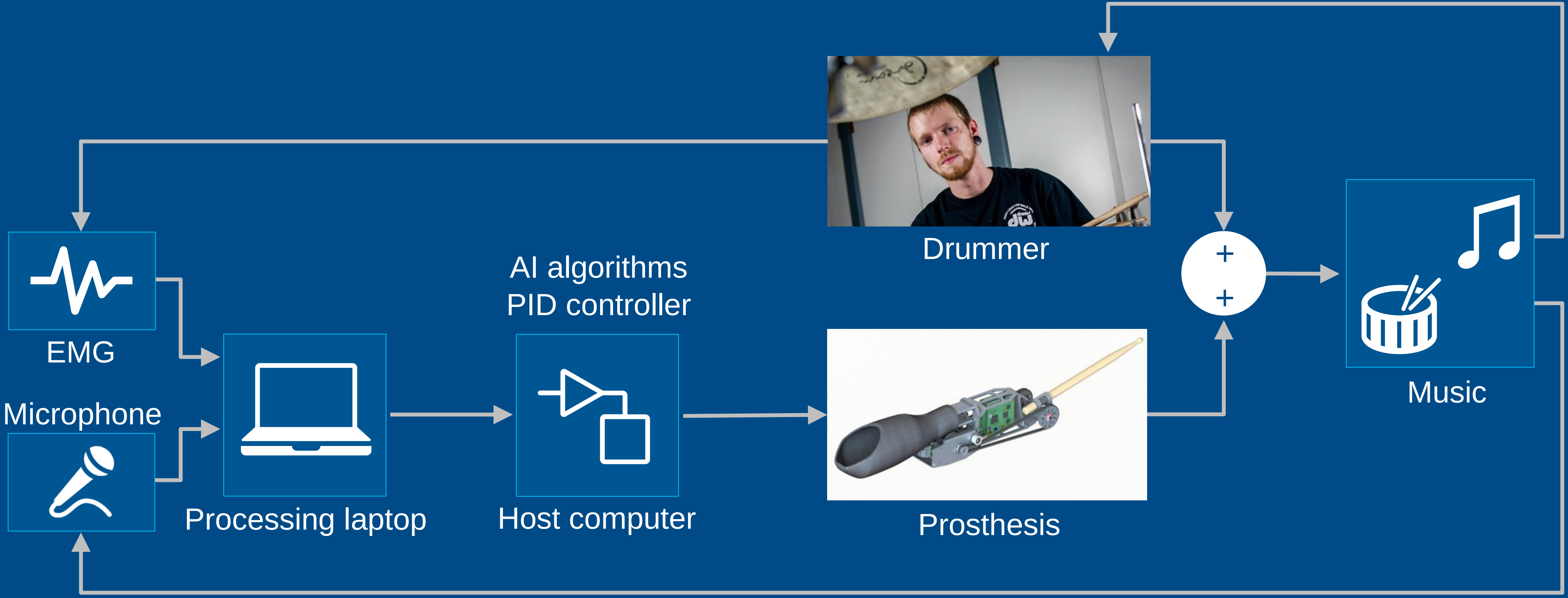

Drummer

EMG

Microphone

Processing laptop

AI algorithms
PID controller

Host computer

Prosthesis

+
+

Music

Are you ready for AI if …

You've never used machine learning?

Easy programming

Apps

Domain expertise to prepare data

Are you ready for AI if …

You've never used machine learning?	Easy programming Apps Domain expertise to prepare data
You can't identify features in your data?	Deep learning identifies features for you Transfer learning works with less data Use AI to label data

Are you ready for AI if …

You've never used machine learning?	Easy programming Apps Domain expertise to prepare data
You can't identify features in your data?	Deep learning identifies features for you Transfer learning works with less data Use AI to label data
You don't have the right data?	Generate failure data with simulations Simulate environment for reinforcement learning

With MATLAB and Simulink, you ARE ready for AI!