

MATLAB EXPO 2018

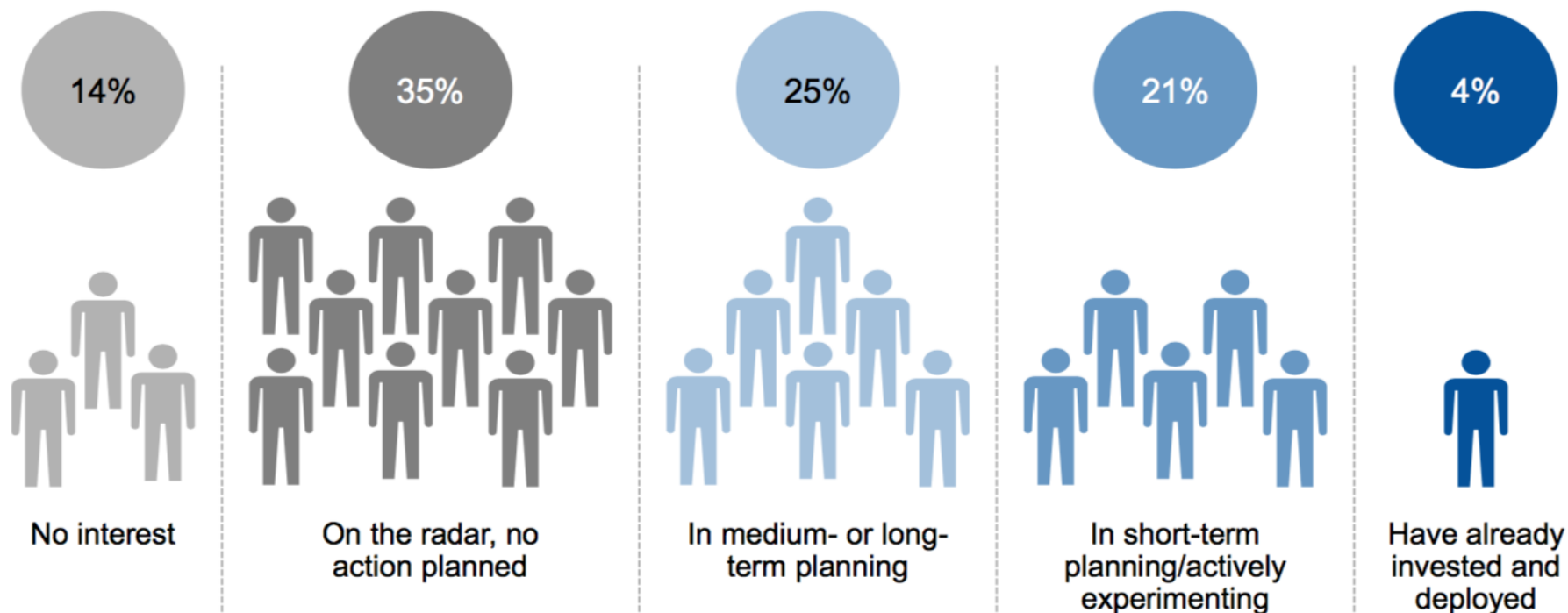
Are *you* ready for *AI*?
Is *AI* ready for *you*?

Chris Hayhurst



Artificial Intelligence Is in Early Adoption

Percentage of Respondents



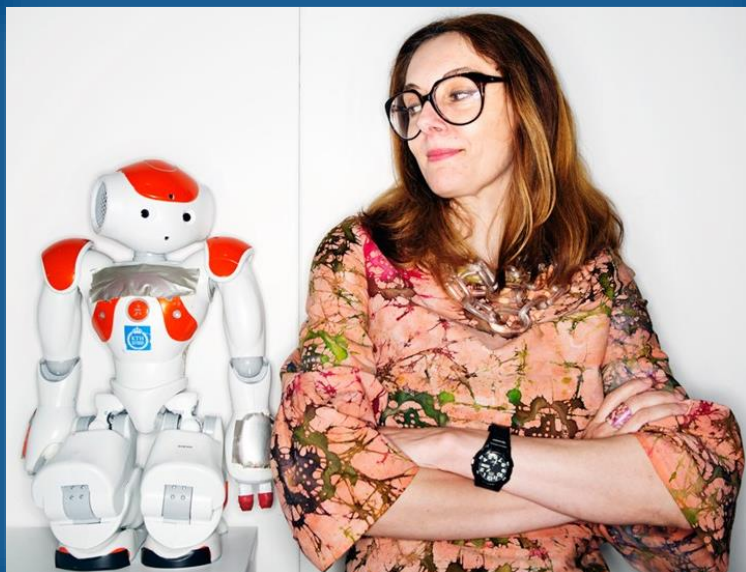
Q: What are your organization's plans in terms of artificial intelligence?

Base: All Answering, n = 3.138

Source: Gartner 2018 CIO Survey

1 © 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



“The development is rapid.
Sweden is falling behind when it comes to
artificial intelligence”

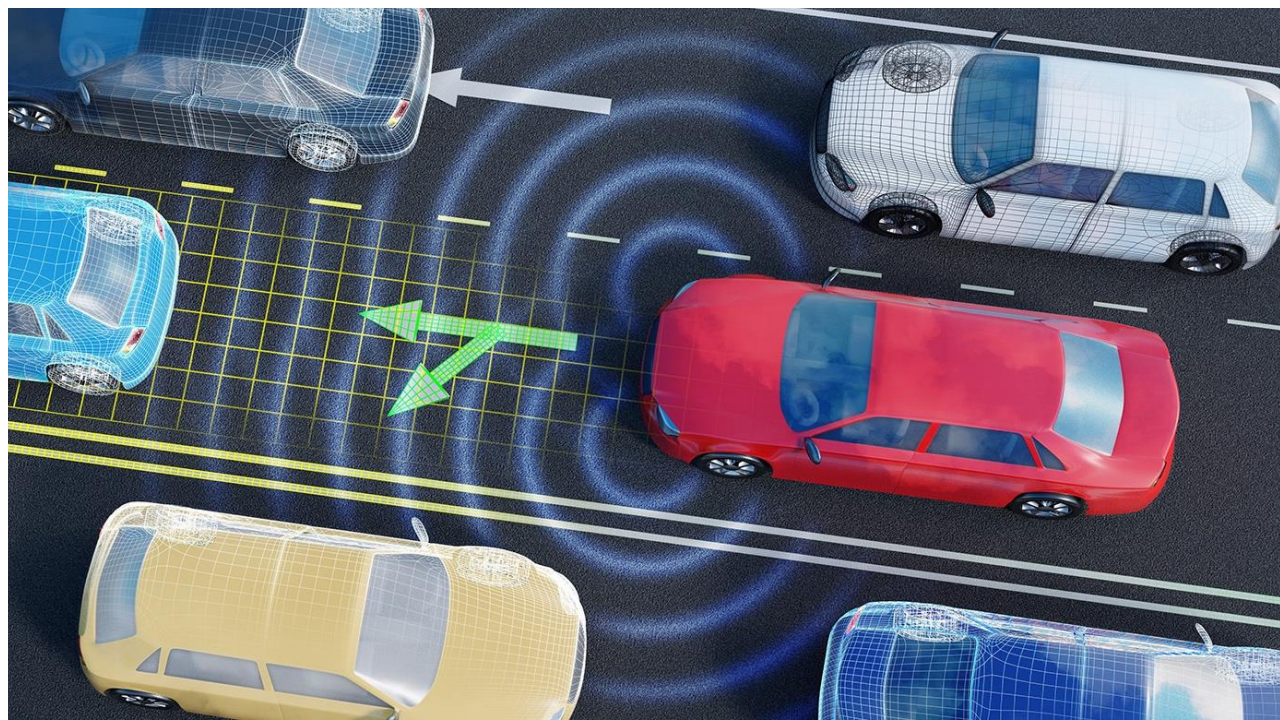
Professor Danica Kragic Jensfelt

“we aim to solve unsupervised
driving by 2020-2021 on
highway commute”

Dennis Nobelius, Zenuity

WASP

Additional billion Swedish kronor to extend
WASP into artificial intelligence





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



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

Machine Learning



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

Machine Learning



Artificial Intelligence

Machine Learning

Are you ready for AI?



Data



Output



Model



Are you ready for AI?



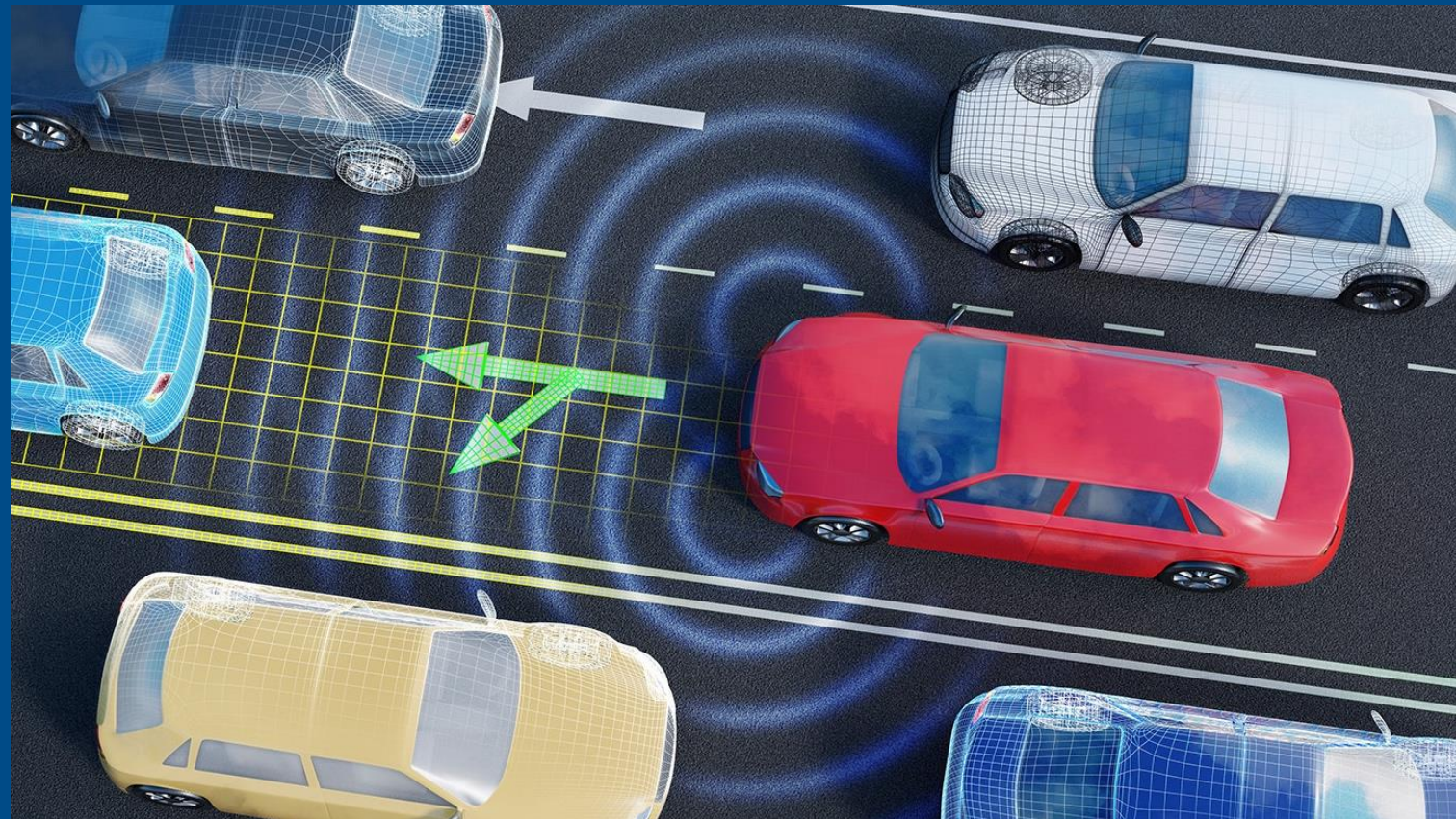
Data



Output



Model



Are you ready for AI?

Access Data

Analyze Data



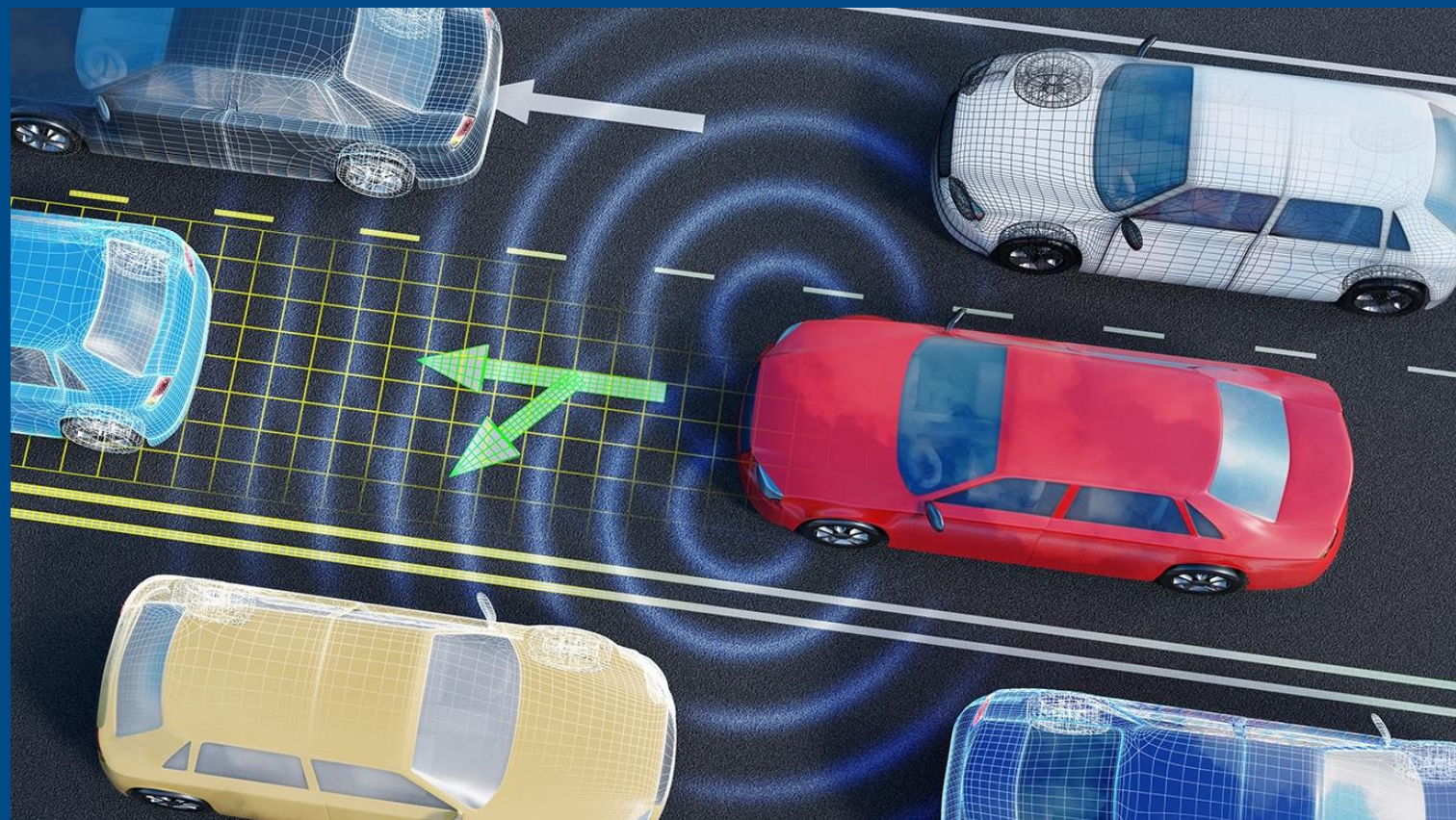
Data



Output



Model



Are you ready for AI?

Access Data

Analyze Data

Develop

Deploy



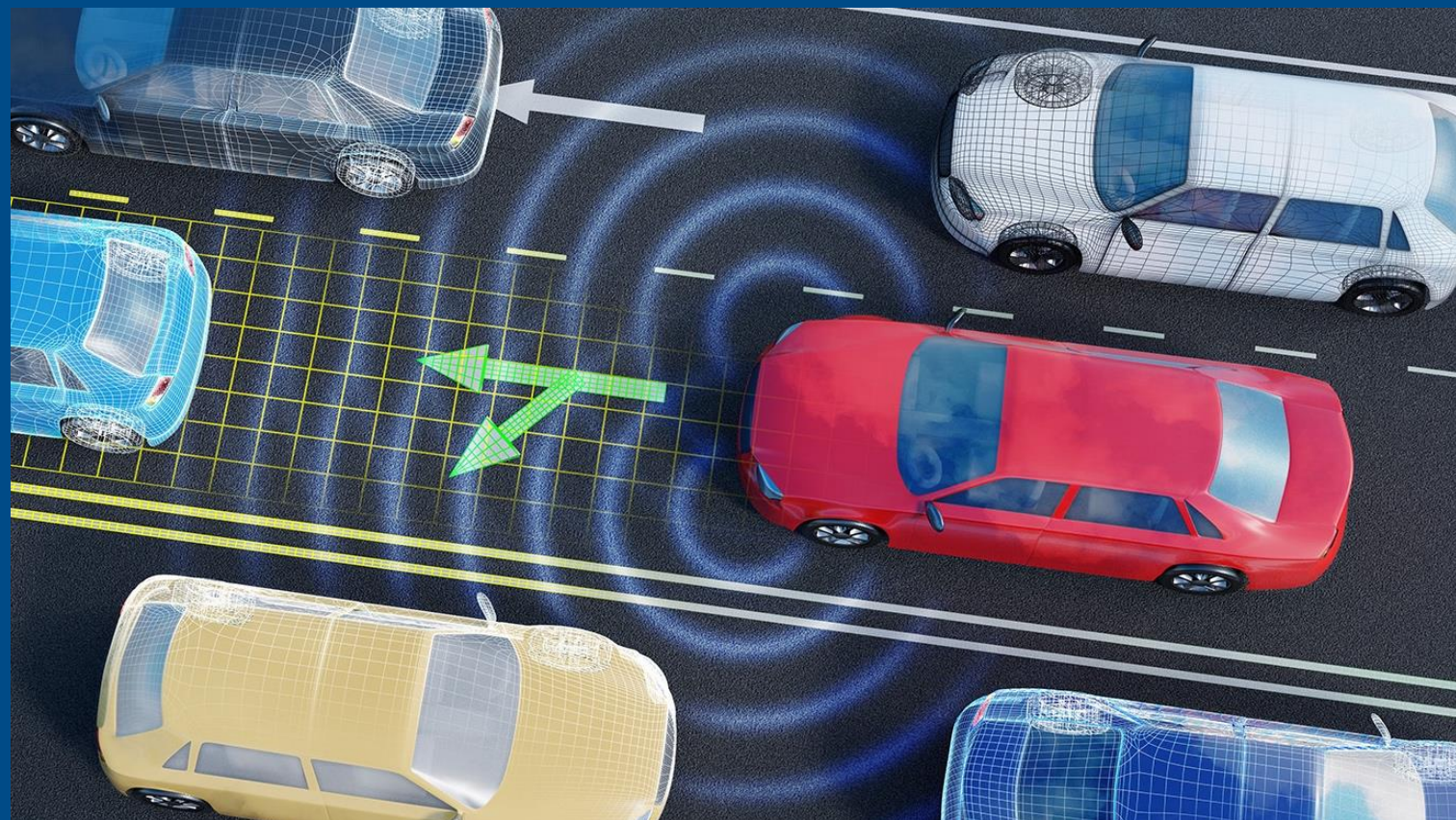
Data



Output



Model



Are you ready for AI?

Access Data

Develop

Analyze Data

Deploy



Data



Output



Model

EVERYTHING

ELSE

Are you ready for AI?

Access Data

Analyze Data

Develop

Deploy



AI model



Algorithm
development



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

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

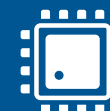
Deploy



Desktop apps

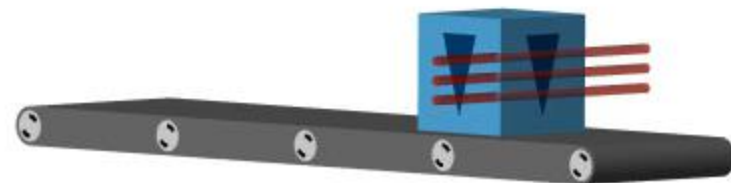


Enterprise systems



Embedded devices

Do you need AI?





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 16.5 g
Df 13%

SAT FAT 3.1 g
Df 13%

SUGARS 1.6 g
Df 3%

SODIUM 245 mg
Df 11%

90g e NET
Flavoured snack



Twisties

Chicken

FAT 7.4 g
Df 11%

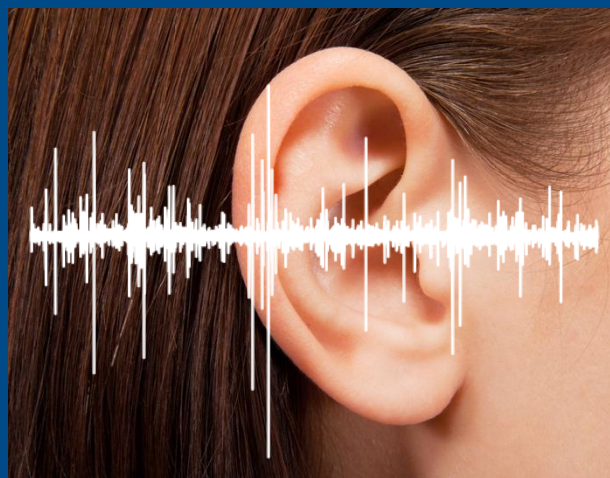
SAT FAT 3.6 g
Df 15%

SUGARS 0.7 g
Df 1%

SODIUM 213 mg
Df 9%

90g e NET
Flavoured snack

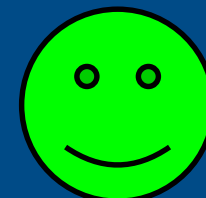
What is crispiness?



Crushing Sound



Crushing Force



Crispy



Crispy Enough

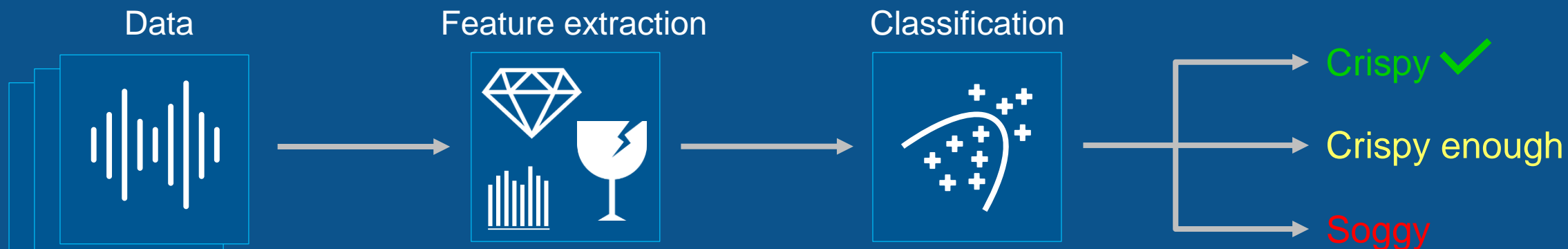


Soggy

Replicating human perception with machine learning

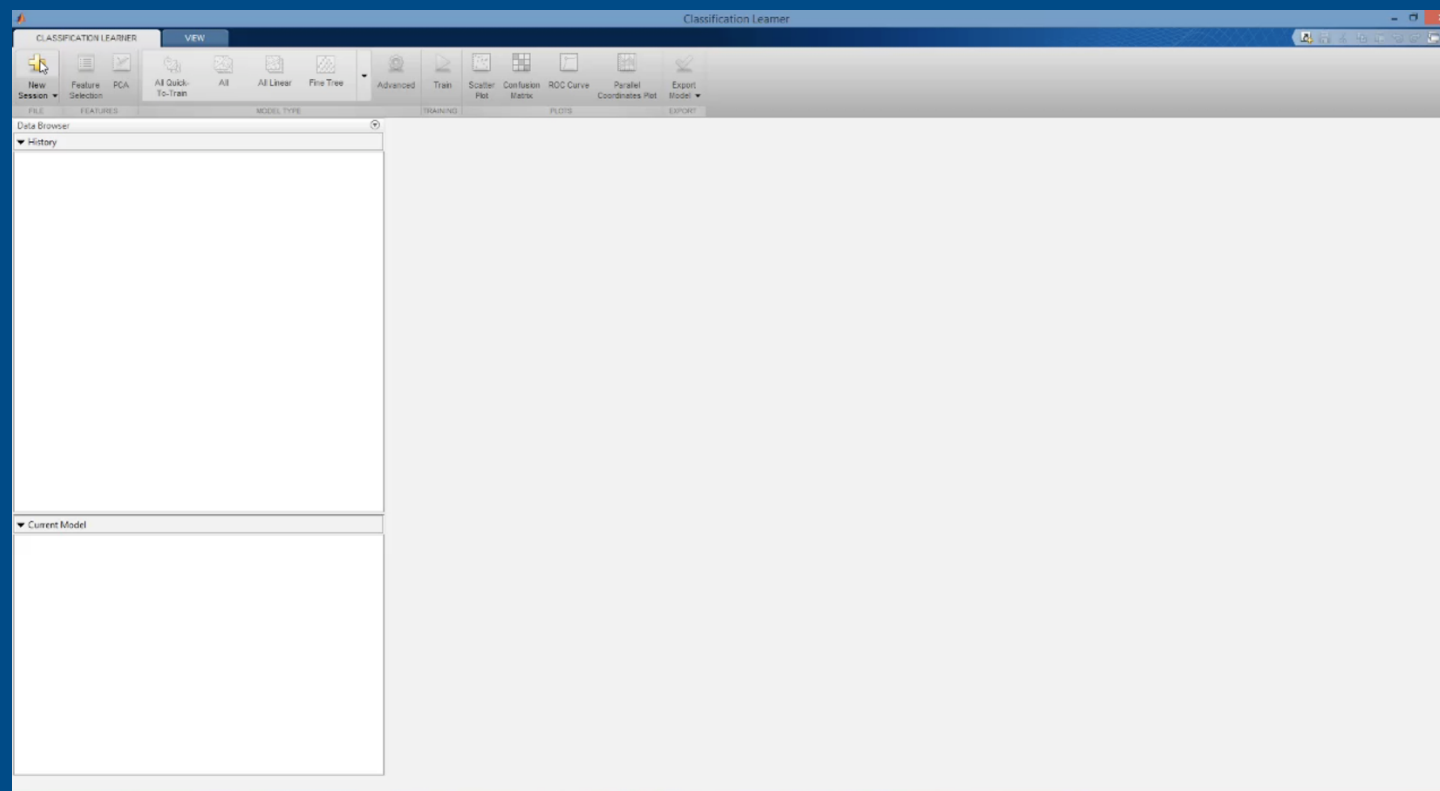
Technical University of Munich

Machine Learning Workflow

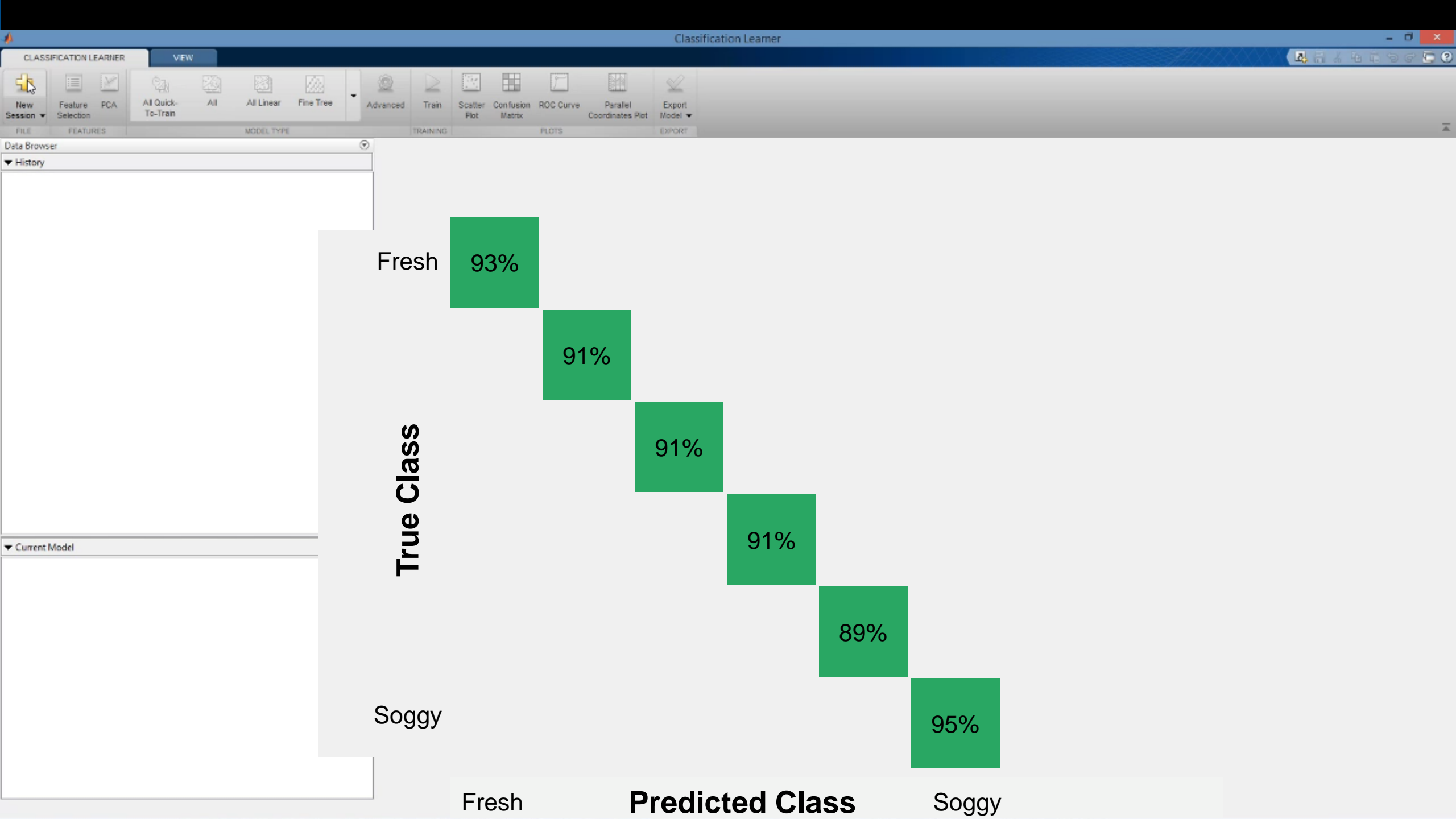


Replicating human perception with machine learning

Technical University of Munich



Classification Learner



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

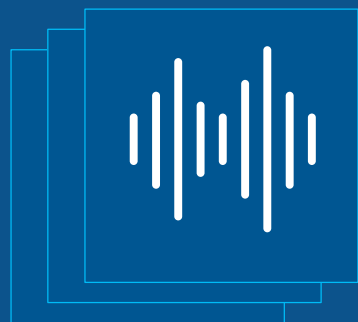
Are you ready for AI if ...

You can't identify features in your data?

Use deep learning to identify features automatically

Machine Learning Workflow

Data



Feature extraction



Classification



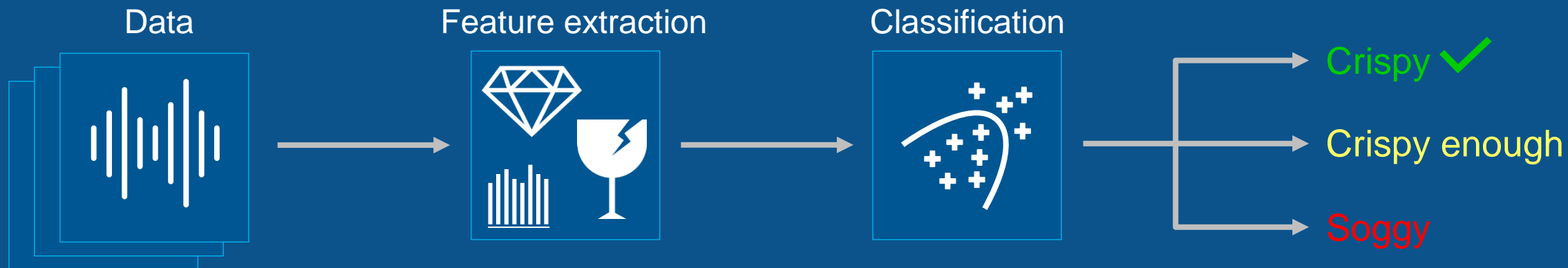
Crispy ✓

Crispy enough

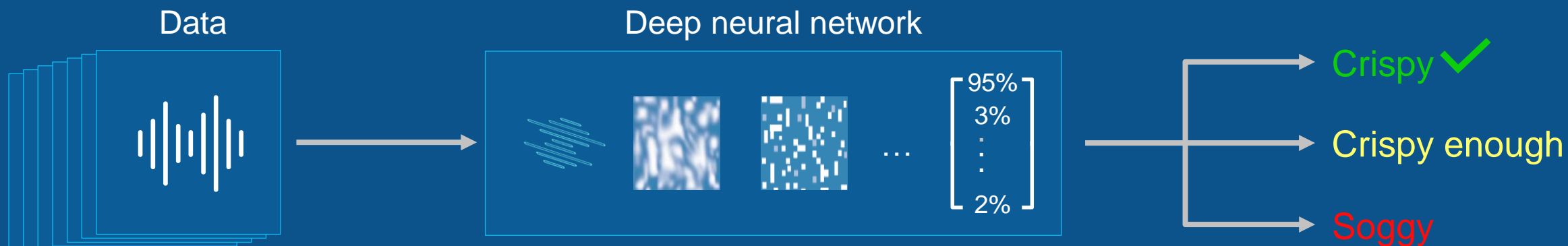
Soggy

Use deep learning to identify features automatically

Machine Learning Workflow



Deep Learning Workflow





SPEED
LIMIT
45



Mikusa Tunnel
Japan





Mikusa Tunnel
Japan

Traditional Approach

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

New Approach

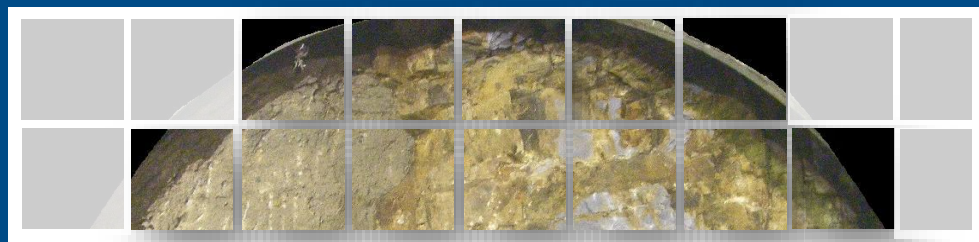
- Use deep learning to automatically recognize metrics based on images
- On-site evaluators decide with support from deep learning

Efficient tunnel drilling with deep learning

Obayashi Corporation



Split into
sub-images



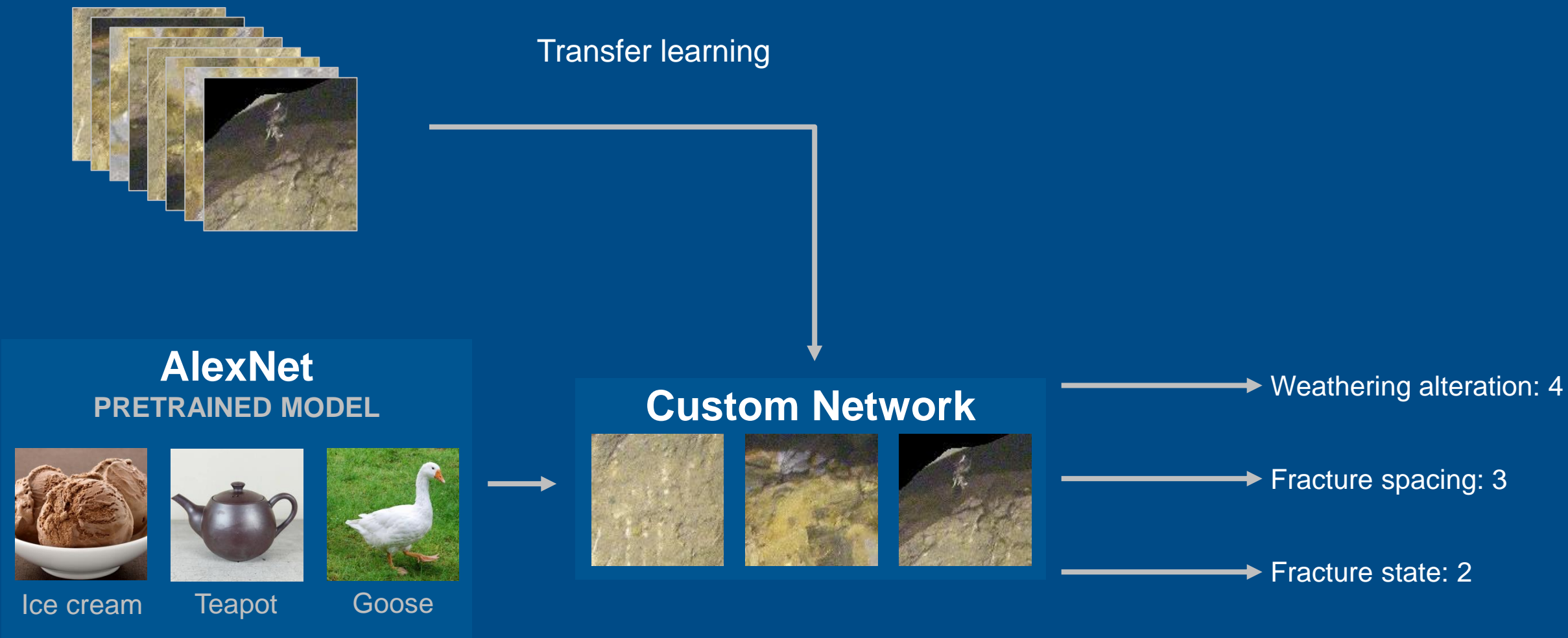
Label each
sub-image



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
⋮	⋮	⋮	⋮

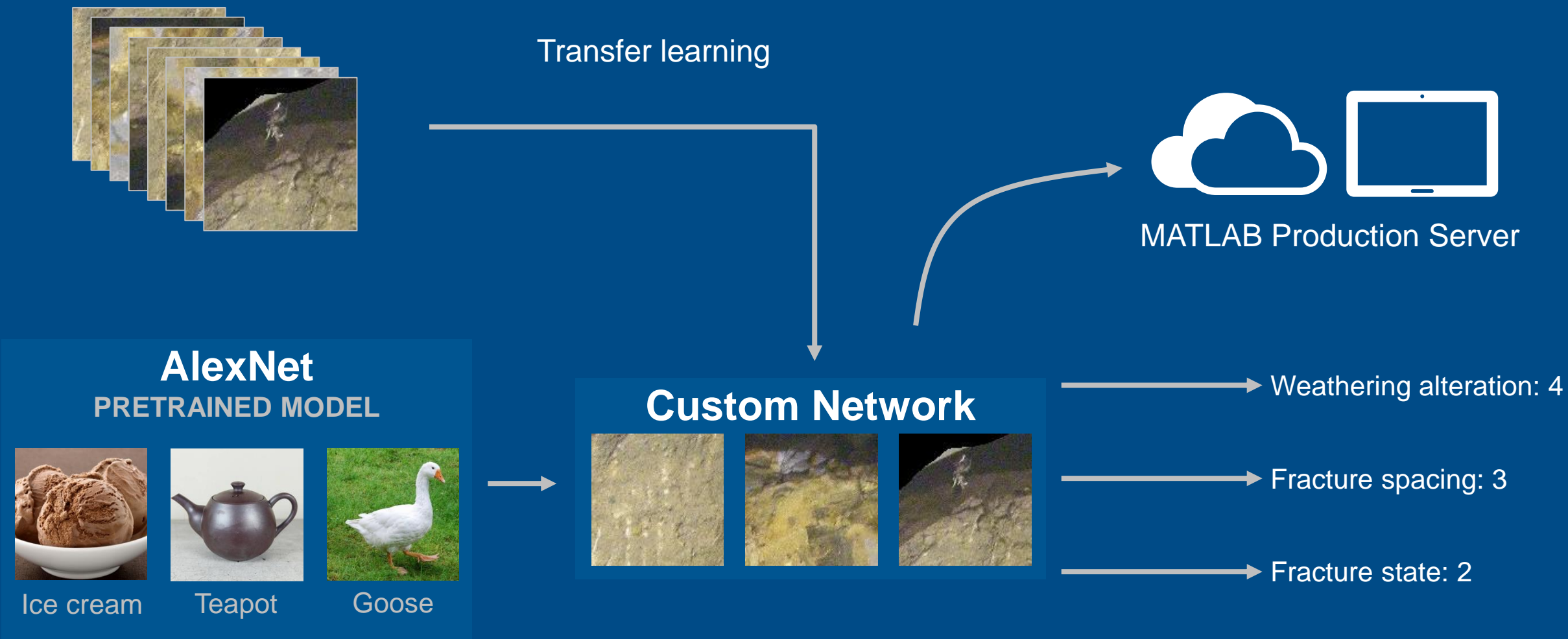
Efficient tunnel drilling with deep learning

Obayashi Corporation



Efficient tunnel drilling with deep learning

Obayashi Corporation



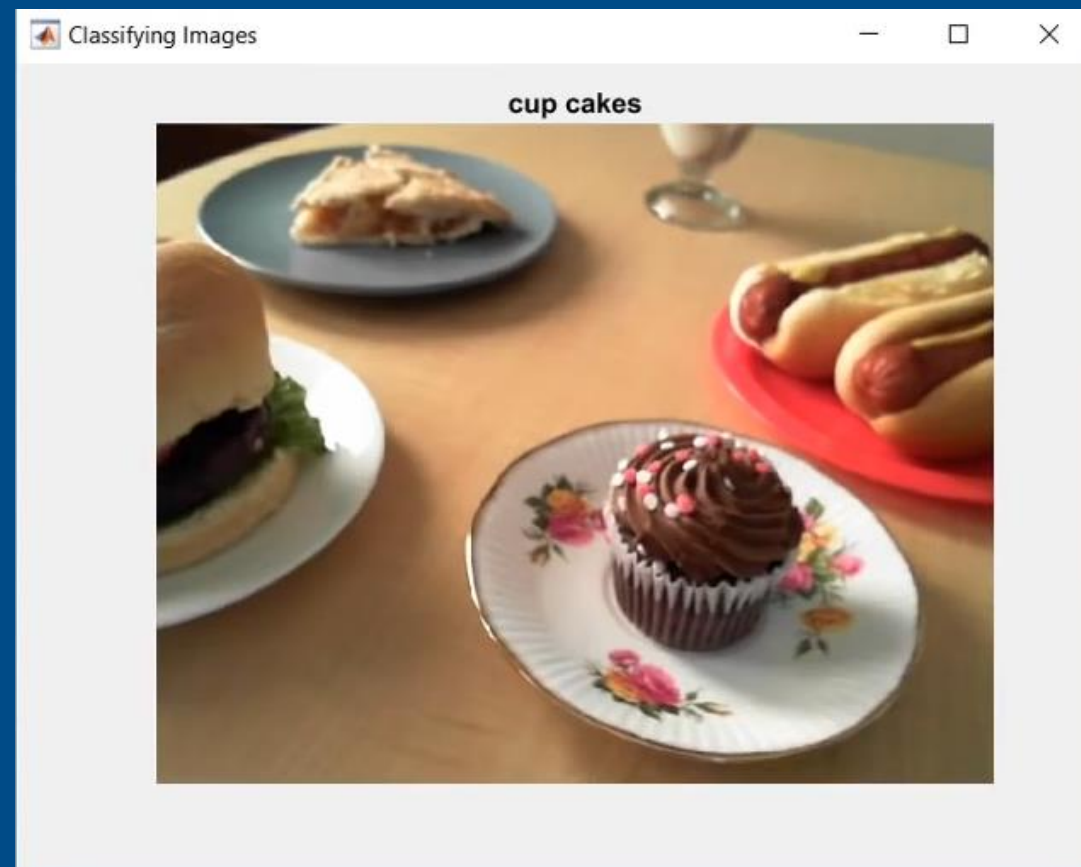
Are you ready for AI if you can't identify features in your data?

- Deep learning

```
nnet = alexnet;  
  
cam = webcam;  
picture = snapshot(cam);  
picture = imresize(picture,[227 227]);  
  
label = classify(nnet, picture)
```



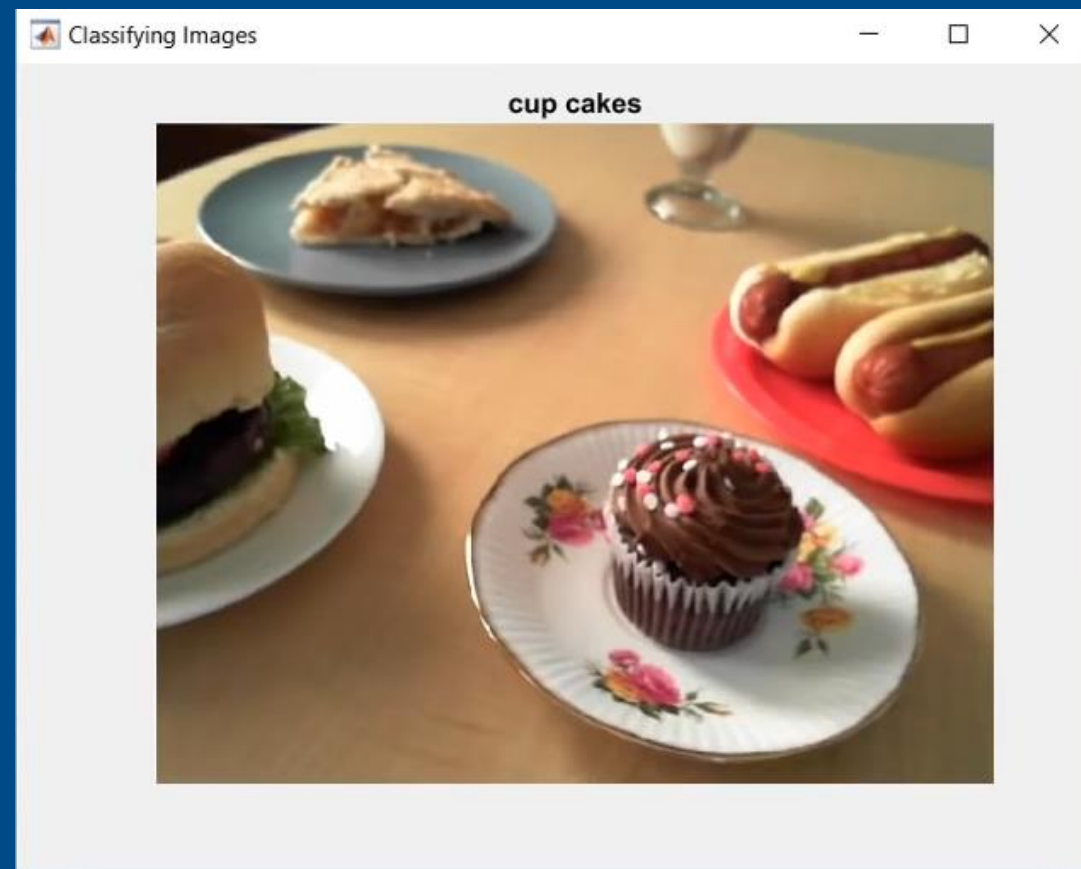
Deep learning in 5 lines of code



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

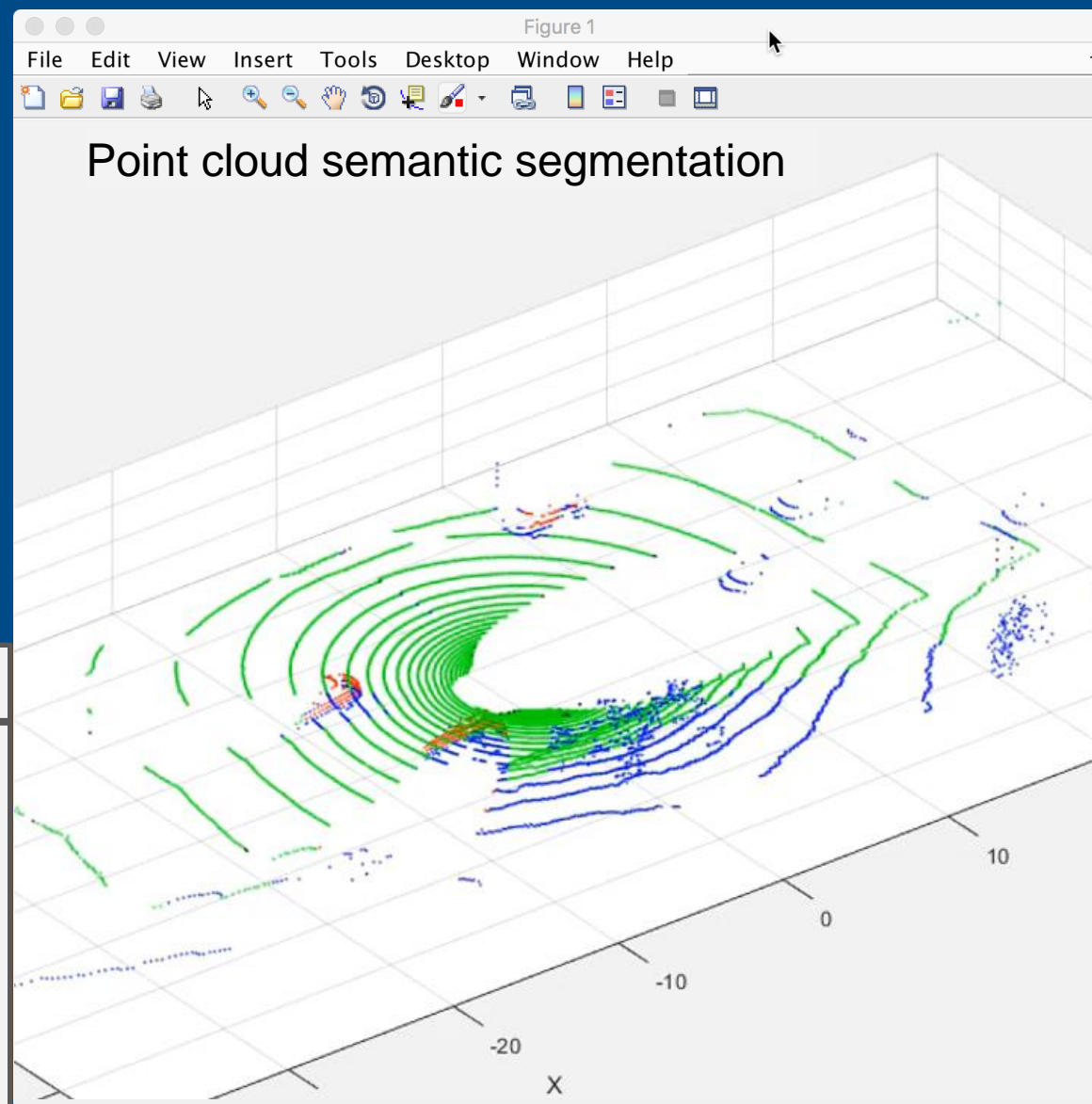


Are you ready for AI if you can't identify features in your data?

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







Classification	
Car	
Truck	
Background	
Ground	

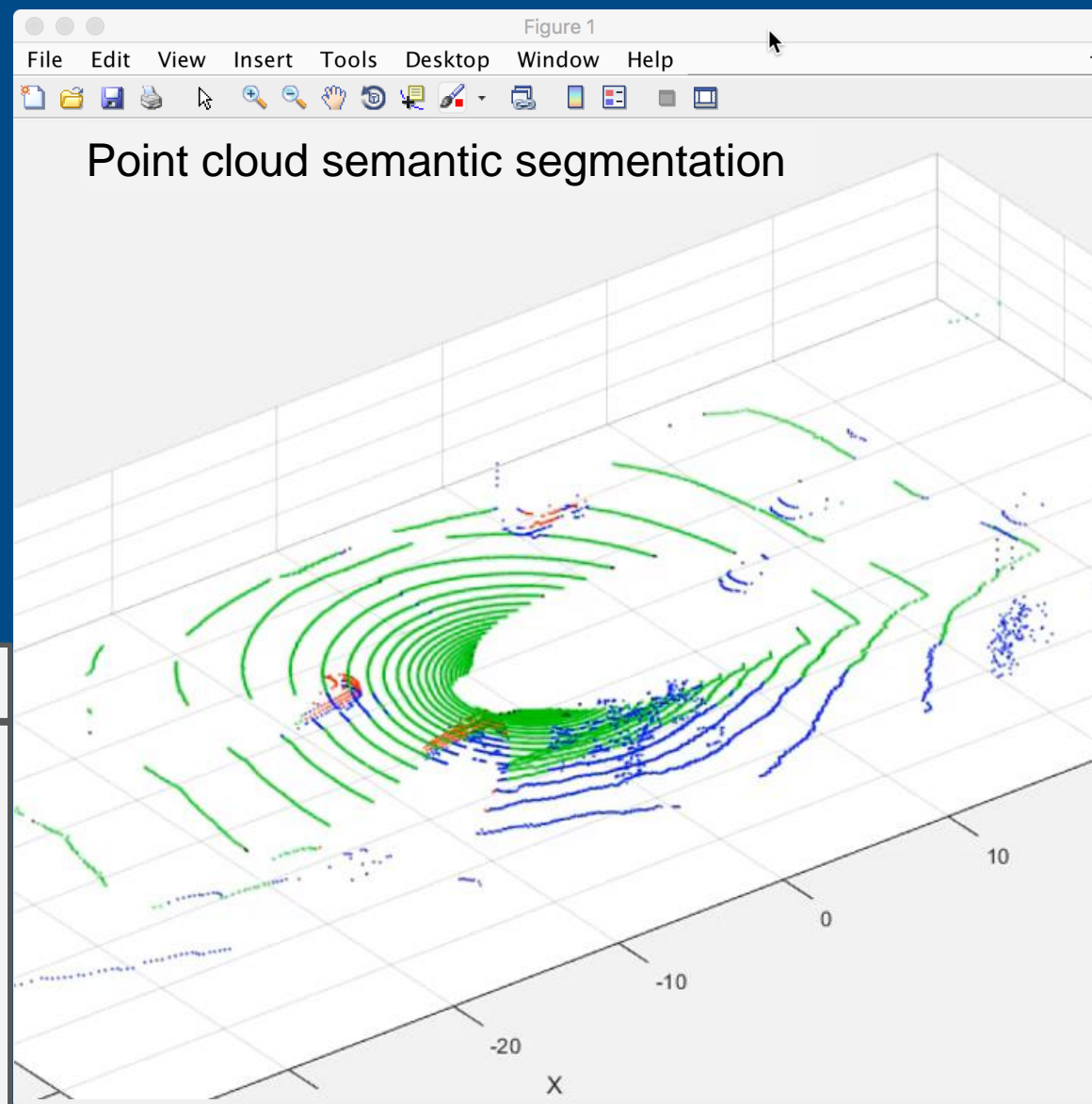


Are you ready for AI if you can't identify features in your data?

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



Classification	
Car	
Truck	
Background	
Ground	



Are you ready for AI if ...

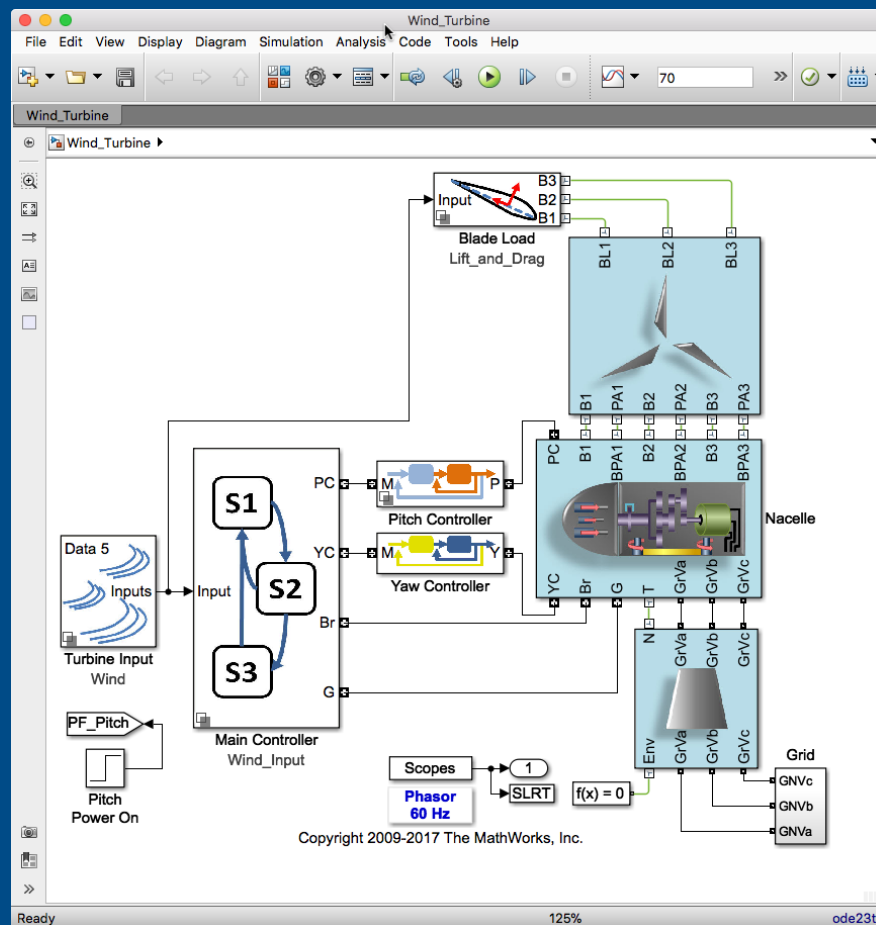
If you don't have the right data?



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



Simulink model

Predictive maintenance with synthetic failure data with MATLAB & Simulink



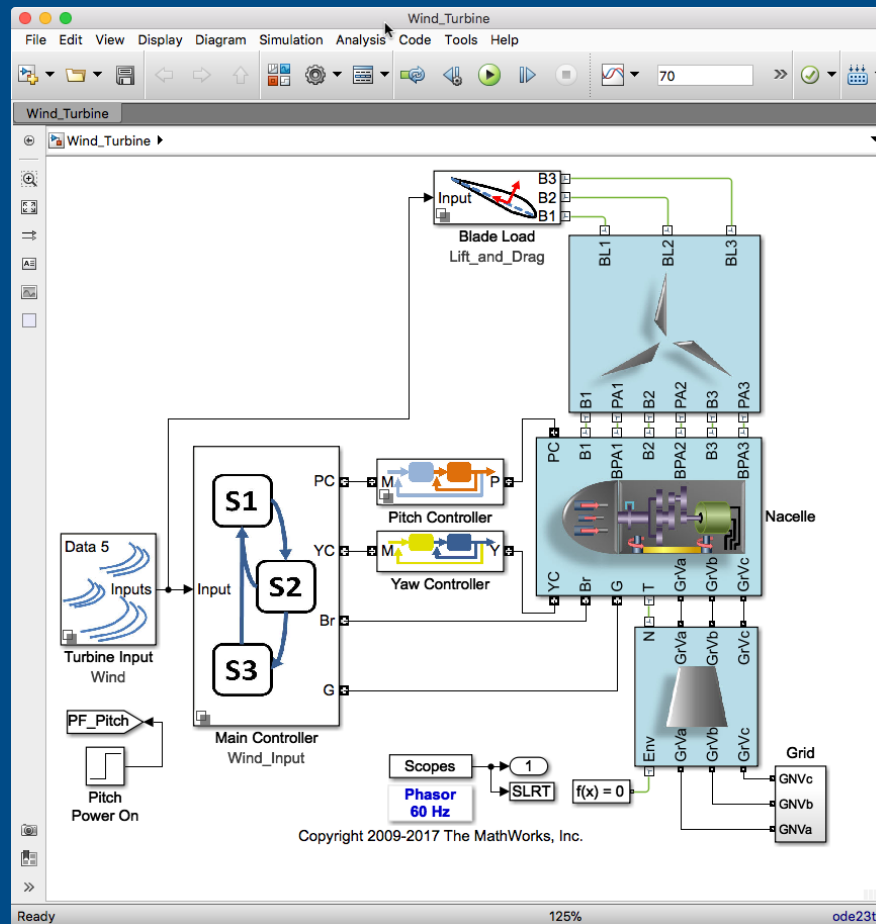
Measured data

Refine model

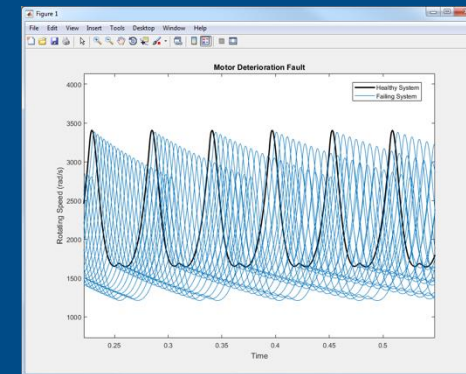


Failure conditions

Inject failures



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



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

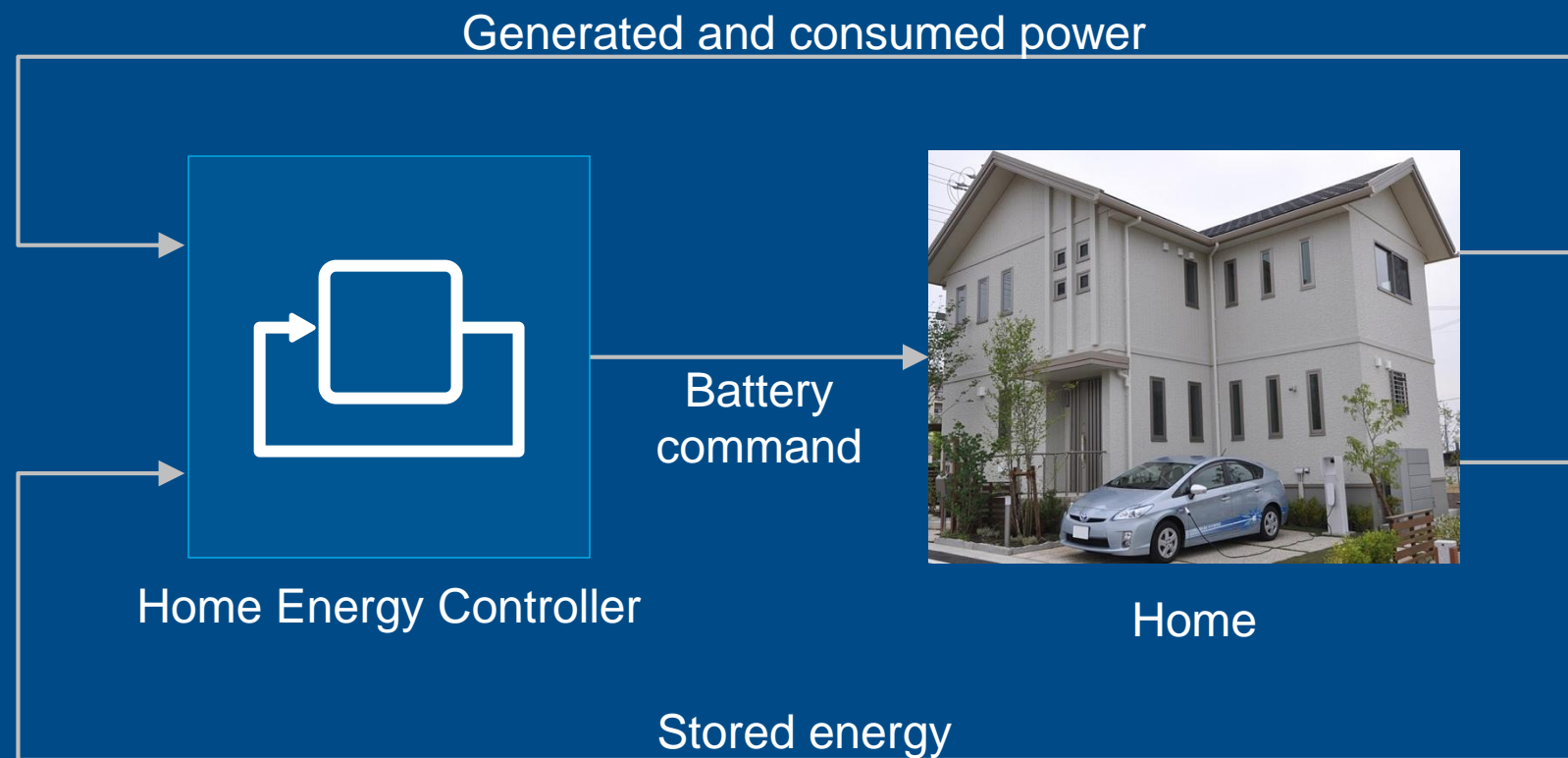
- Generate power with fuel cell and solar panels
- Store power in battery
- Buy power when needed; sell when extra
- Record data on environment and energy usage

Goals

- Minimize energy cost
- Use EV battery for additional storage

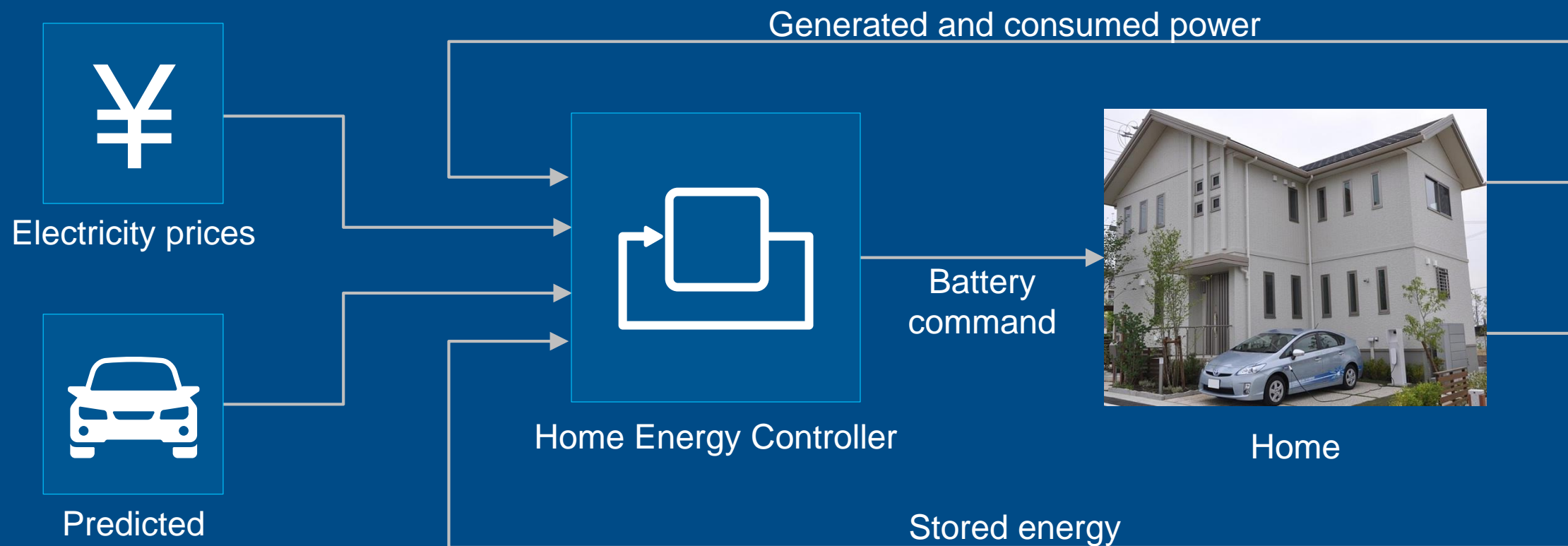
Optimizing home energy management system

Denso



Optimizing home energy management system

Denso



Model predictive control
Mixed integer linear programming

Simscape Power Systems

Optimizing home energy management system

Denso

Access Data

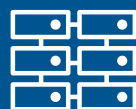


1000 CSV Files

Analyze Data



Preprocessing



Parallel
computing

Develop



Classification
Learner

Deploy

Optimizing home energy management system

Denso

Access Data

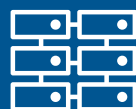


1000 CSV Files

Analyze Data



Preprocessing



Parallel
computing

Develop



Classification
Learner



Simulink



Simscape Power
Systems

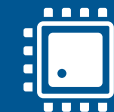


Control
algorithms



Optimization

Deploy



Embedded
devices

Optimizing home energy management system

Denso

The DENSO logo is displayed in a bold, italicized, red sans-serif font.

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

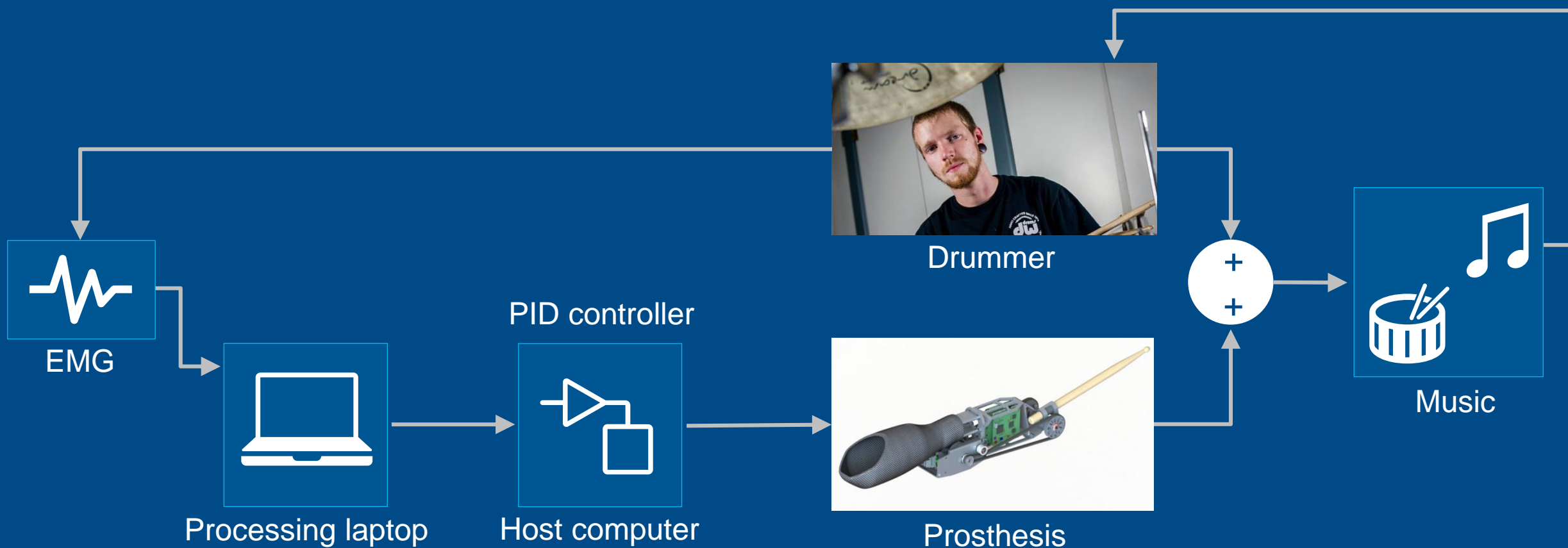


Autonomous

Primary

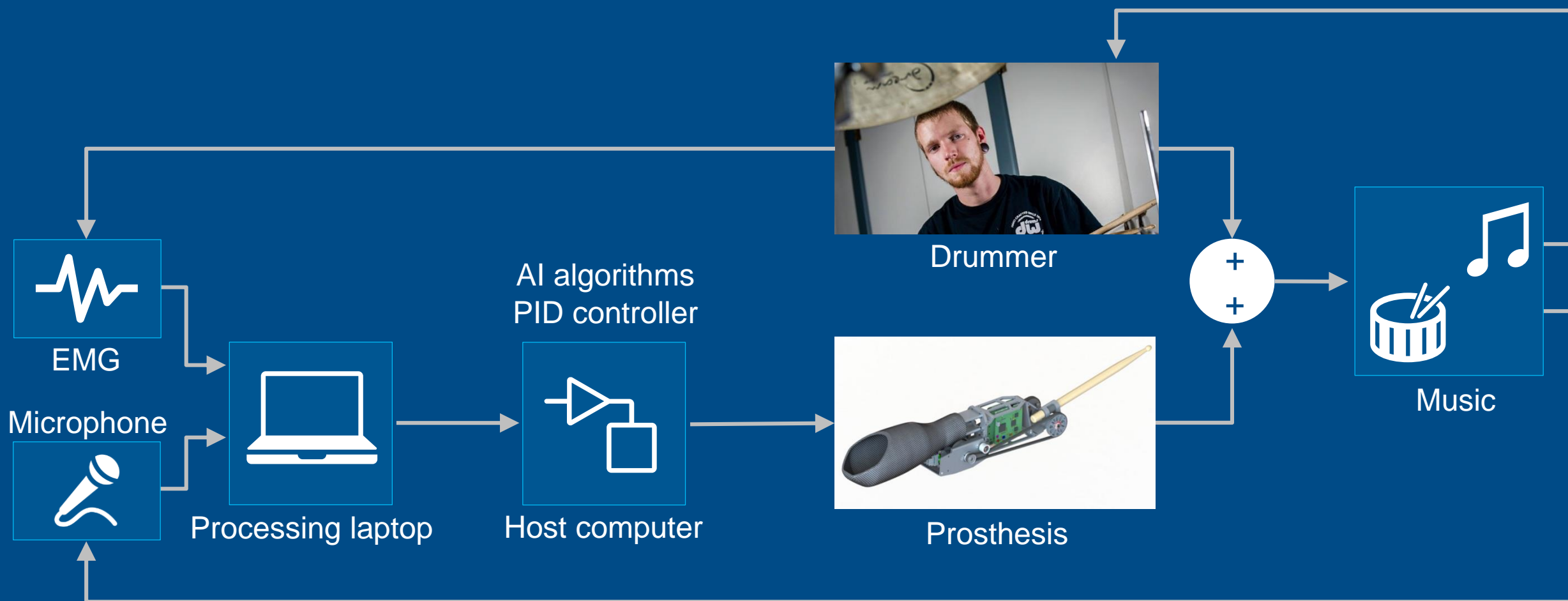
Exceeding human capabilities with a robotic drumming prosthesis

Georgia Tech Center for Music Technology



Exceeding human capabilities with a robotic drumming prosthesis

Georgia Tech Center for Music Technology





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!