MATLAB EXPO 2018

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

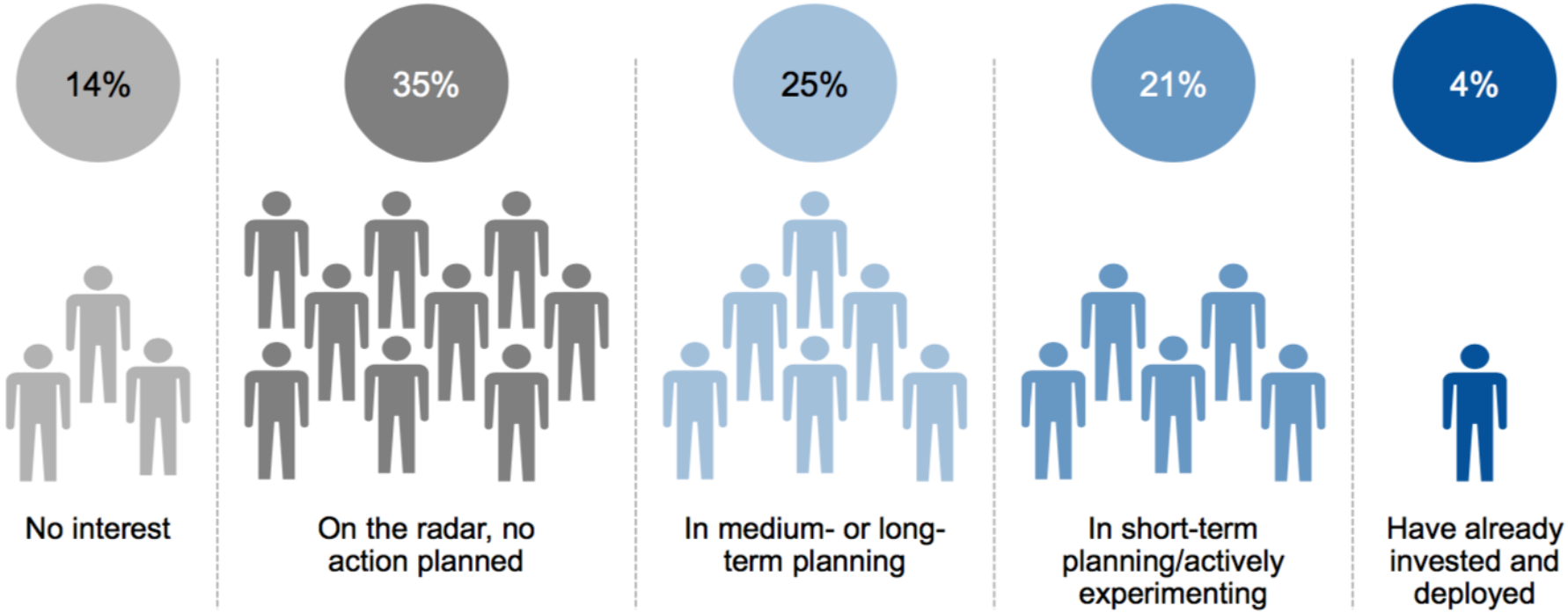
Jim Tung
MathWorks Fellow


Alexa –
Write my Expo keynote for me


Alexa –
Play soothing jazz

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

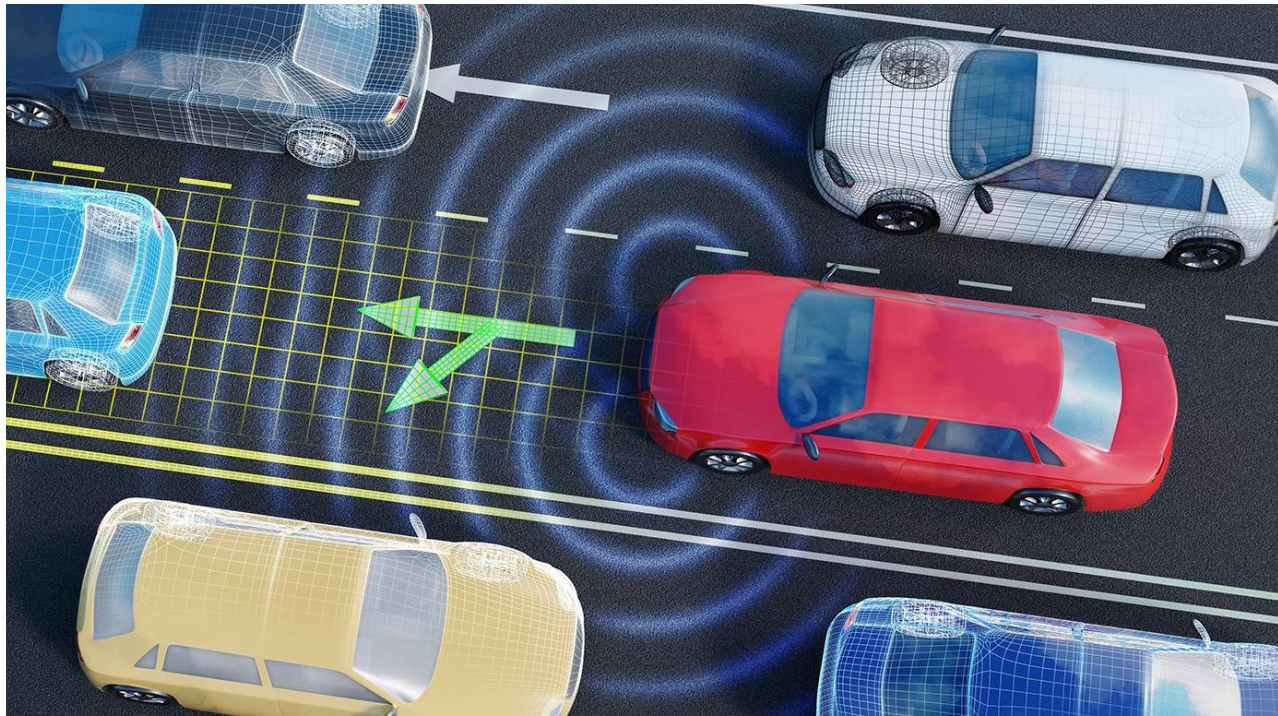
Source: Gartner, *Real Truth of Artificial Intelligence* by Whit Andrews

Presented at Gartner Data & Analytics Summit 2018, March 2018


amazon


Luke Skywalker
94.5%


ВЫХОД В ГОРОД
ACCESS TO CITY



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

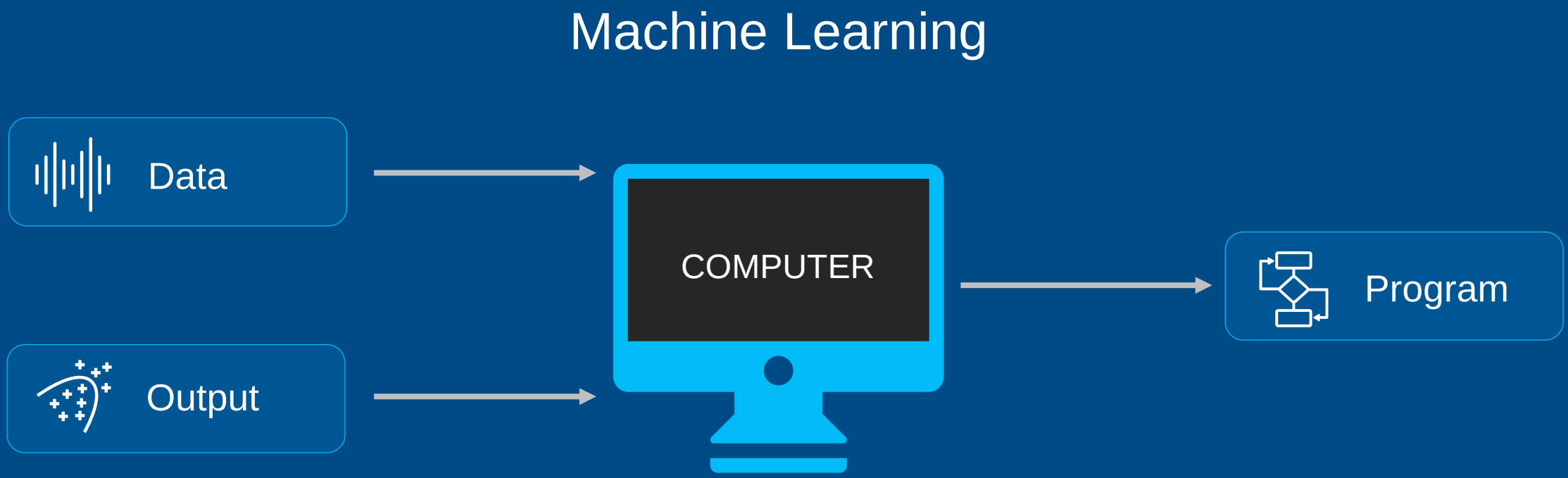
The capability of a machine to match or exceed intelligent human behavior

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



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

Machine Learning

Artificial Intelligence

Machine Learning

Are you ready for AI?

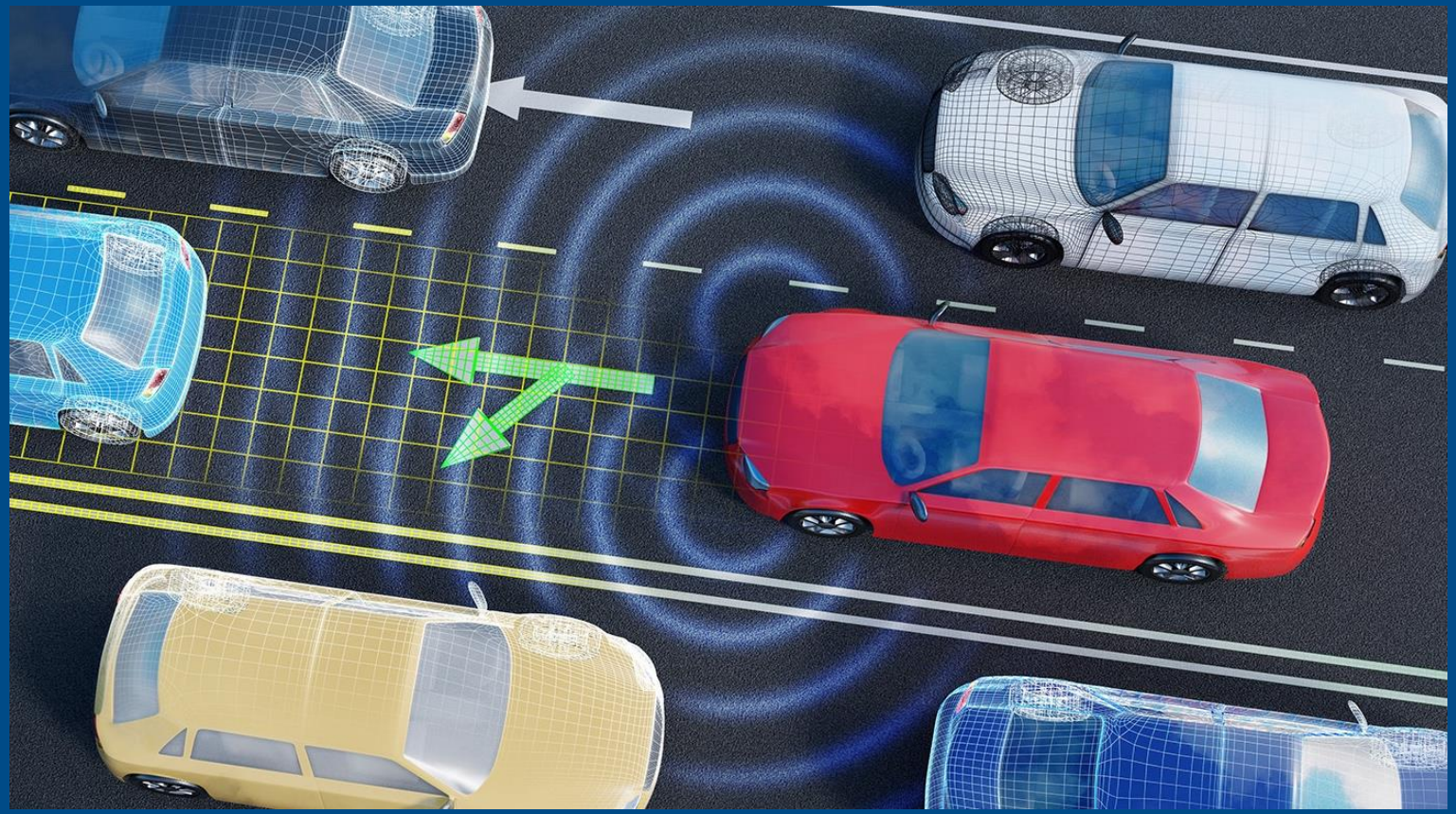
Data

Output

Model

Are you ready for AI?

- Data
- Output
- Model

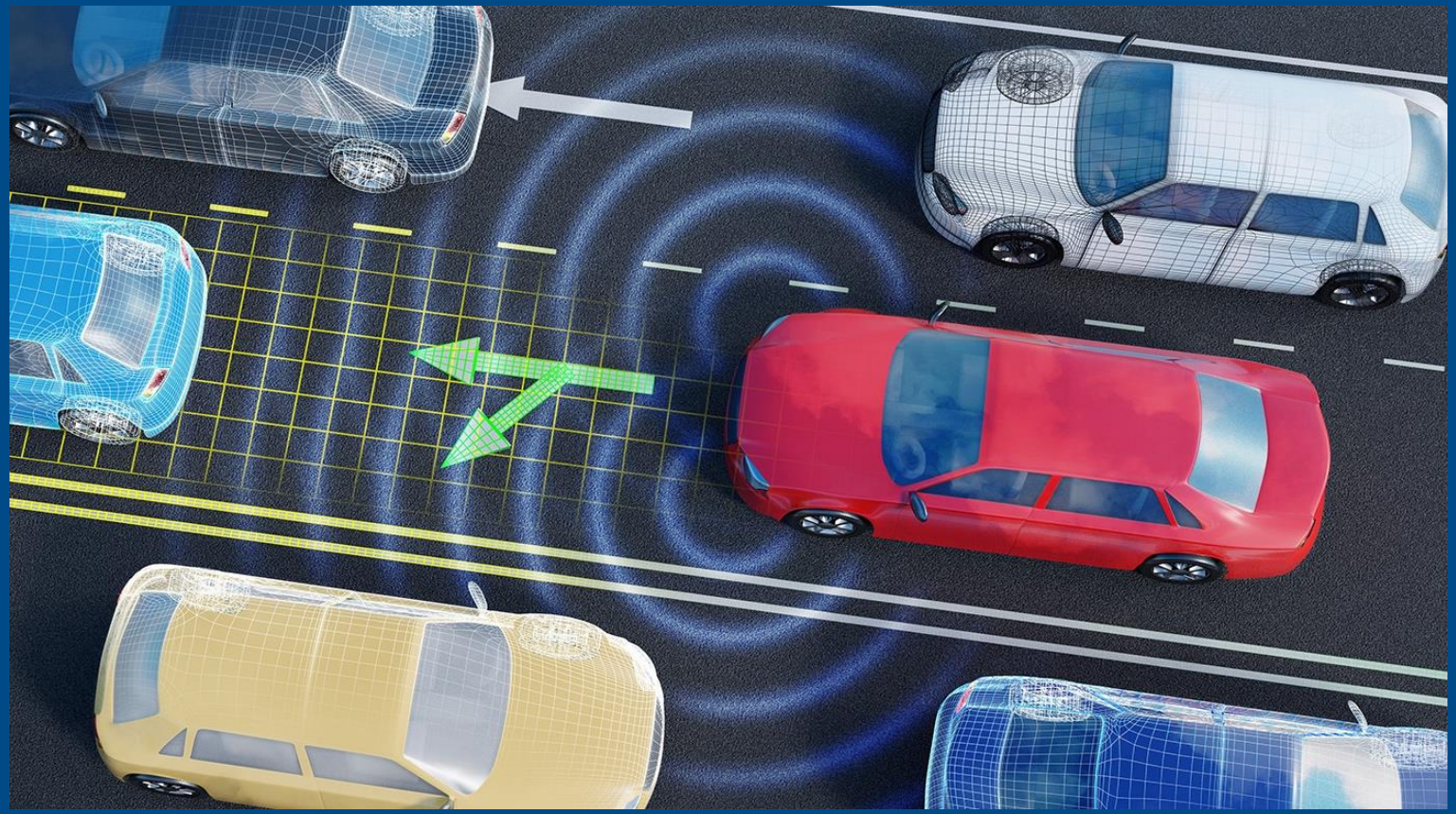


Are you ready for AI?

Access Data

Analyze Data

- Data
- Output
- Model



Are you ready for AI?

Access Data

Develop

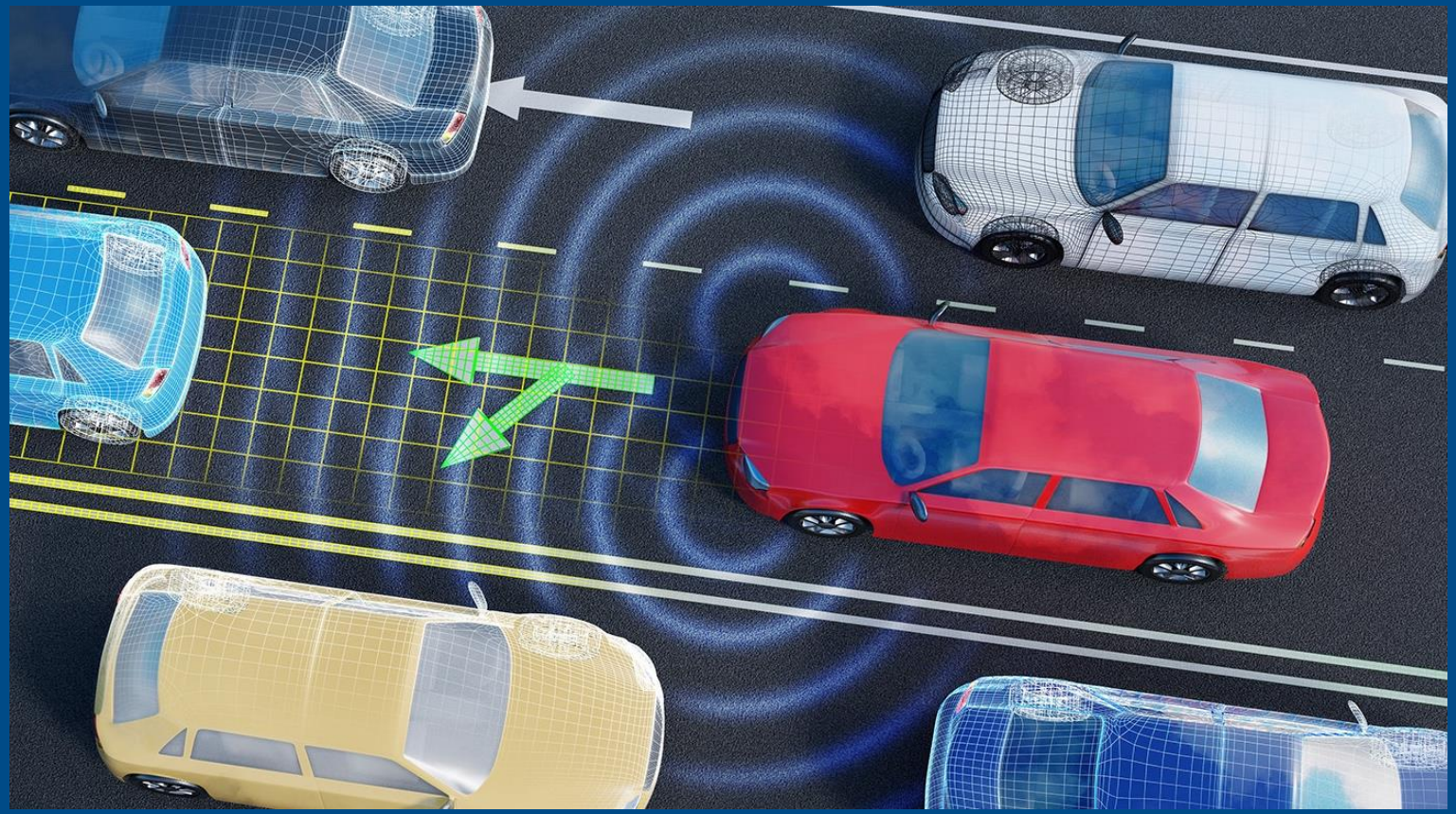
Analyze Data

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	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	Analyze Data	Develop	Deploy
Sensors	Data exploration	AI model	Desktop apps
Files	Preprocessing	Algorithm development	Enterprise systems
Databases	Domain-specific algorithms	Modeling & simulation	Embedded devices

Do you need AI?


KUKA
KUKA
Z

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 8.3 g DV 13%
SAT FAT 3.1 g DV 15%
SUGARS 1.6 g DV 2%
SODIUM 245 mg DV 11%
90g e NET
Flavoured snack
Twisties
Chicken
FAT 7.4 g DV 11%
SAT FAT 3.6 g DV 15%
SUGARS 0.7 g DV 1%
SODIUM 213 mg DV 9%

What is crispiness?

Crushing Sound

+

Crushing Force

=

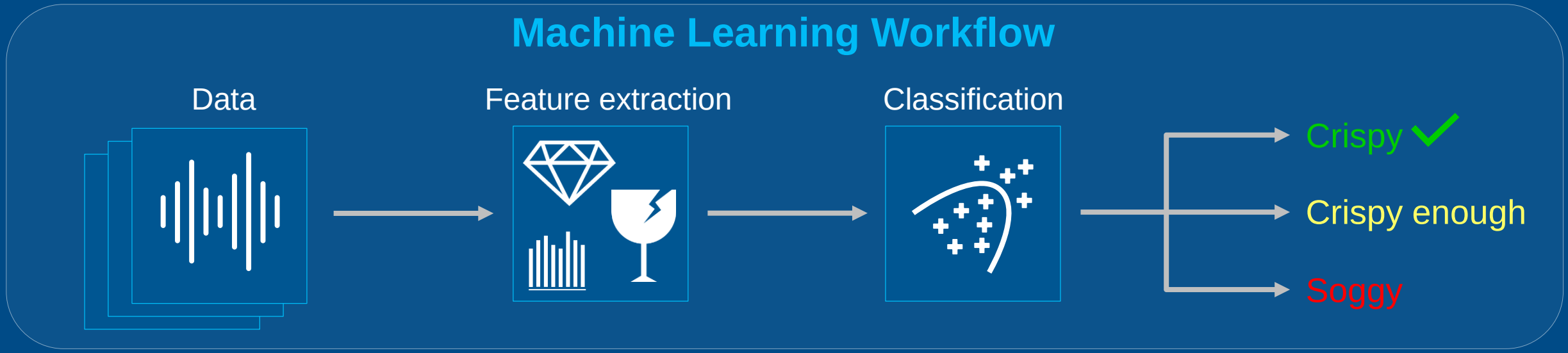
Crispy

Crispy Enough

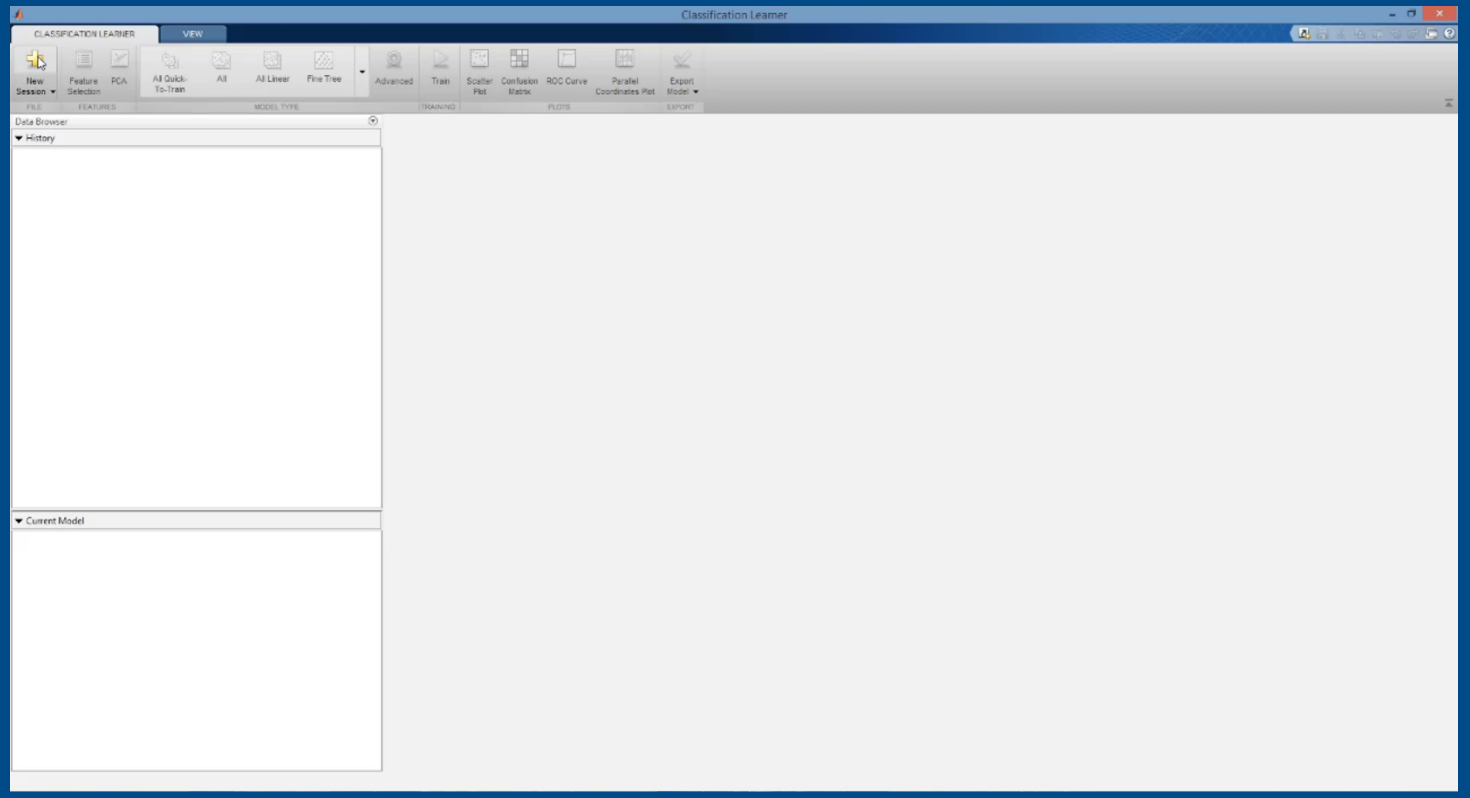
Soggy

Replicating human perception with machine learning

Technical University of Munich



Replicating human perception with machine learning
Technical University of Munich



Classification Learner

Classification Learner - Confusion Matrix

EARNER | VIEW

PCA | Linear SVM | Quadratic SVM | Cubic SVM | Fine Gaussian ... | Advanced | Train | Scatter Plot | Confusion Matrix | ROC Curve | Parallel Coordinates Plot | Export Model

MODEL TYPE | TRAINING | PLOTS | EXPORT

Scatter Plot | Confusion Matrix

Accuracy: 72.9% 68/68 features
Accuracy: 70.4% 68/68 features
Accuracy: 62.3% 68/68 features
Accuracy: 89.1% 68/68 features
Accuracy: 58.4% 68/68 features
Accuracy: 90.4% 68/68 features
Accuracy: 91.6% 68/68 features
Accuracy: 89.8% 68/68 features
Accuracy: 36.9% 68/68 features
Accuracy: 84.2% 68/68 features
Accuracy: 70.9% 68/68 features
Accuracy: 73.6%

91.6%
~4000 obs/sec
1.9345 sec

One-vs-One

Model 1.7

True Class \ Predicted Class	Fresh	Soggy					
Fresh	93%	5%	1%	1%			93% 7%
	7%	91%	2%				91% 9%
		3%	91%	6%			91% 9%
			8%	91%	1%		91% 9%
				5%	89%	6%	89% 11%
Soggy					5%	95%	95% 5%

Plot

- Number of observations
- True Positive Rates / False Negative Rates
- Positive Predictive Values / False Discovery Rates

What is the confusion matrix?

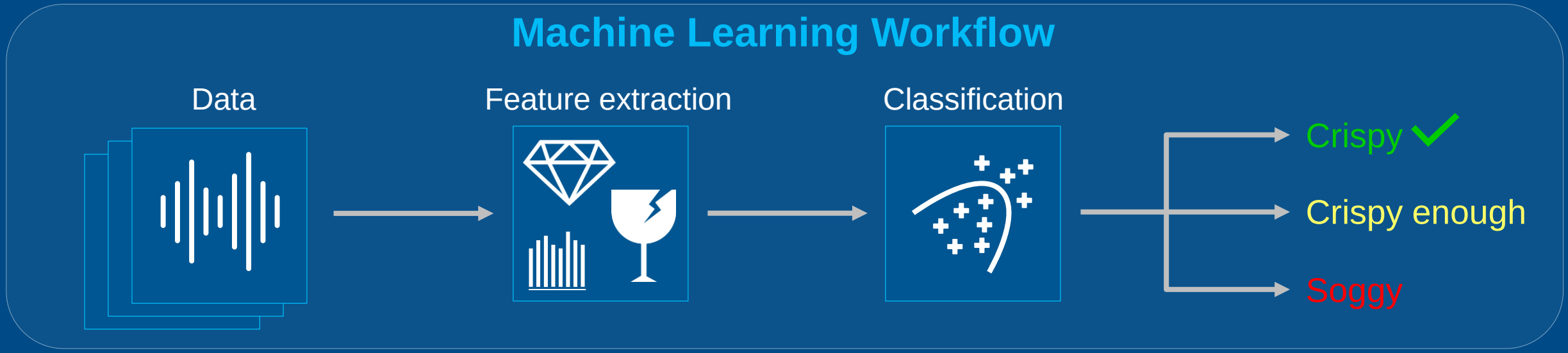
Are you ready for AI if you've never used machine learning?

- 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 …

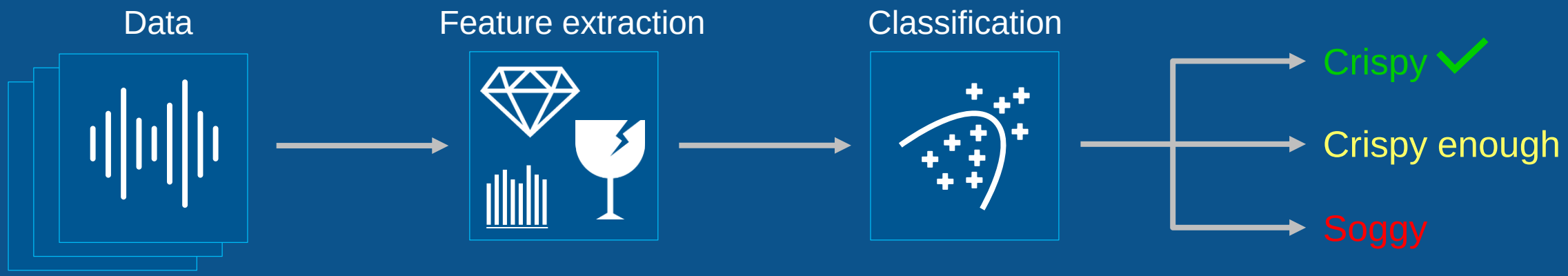
You can’t identify features in your data?

Use deep learning to identify features automatically

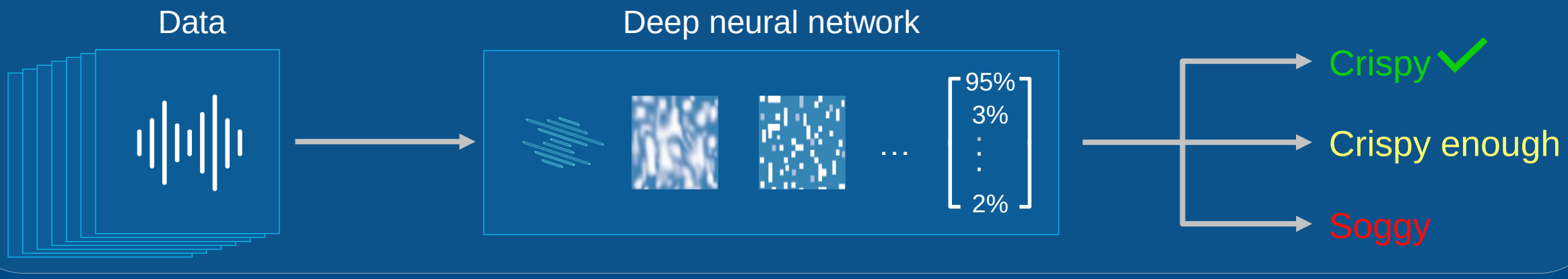


Use deep learning to identify features automatically

Machine Learning Workflow

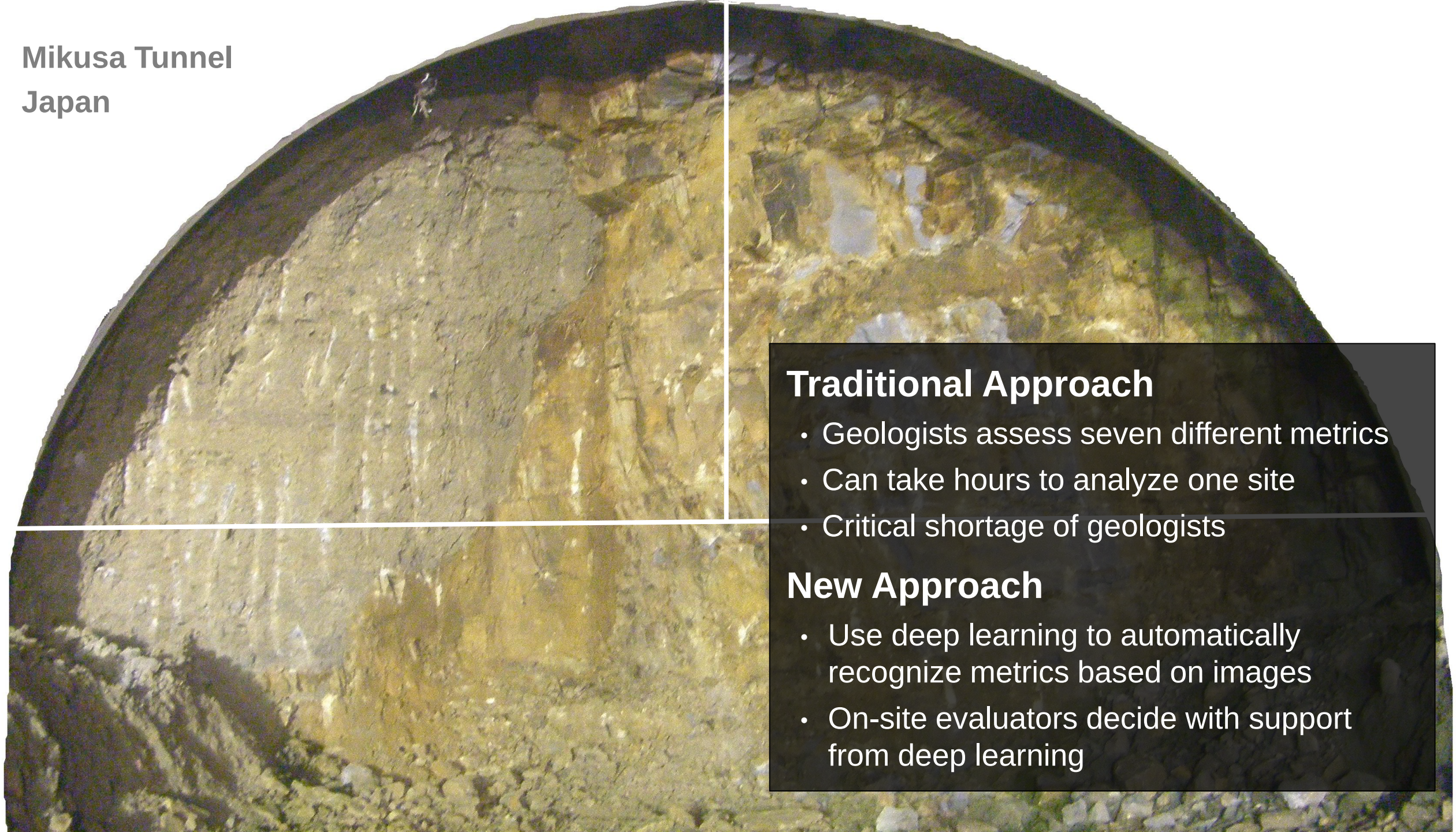


Deep Learning Workflow




SPEED
LIMIT
45

Mikusa Tunnel
Japan



Traditional Approach

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

New Approach

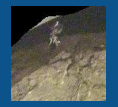
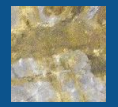
- Use deep learning to automatically recognize metrics based on images
- On-site evaluators decide with support from deep learning

Efficient tunnel drilling with deep learning

Obayashi Corporation

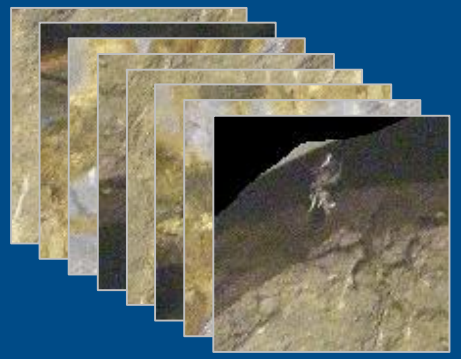
Split into sub-images

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



Transfer learning

AlexNet

PRETRAINED MODEL

Ice cream

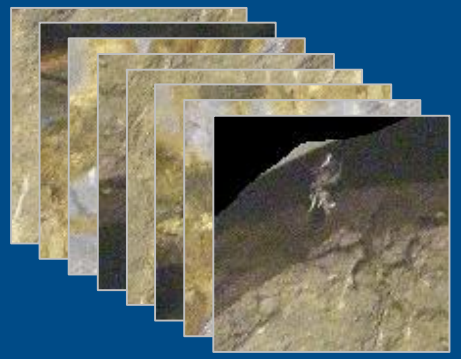
Teapot

Goose

Custom Network

Efficient tunnel drilling with deep learning

Obayashi Corporation



Transfer learning

MATLAB Production Server

AlexNet

PRETRAINED MODEL

Ice cream

Teapot

Goose

Custom Network

87% → Weathering alteration: 4

69% → Fracture spacing: 3

89% → Fracture state: 2

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

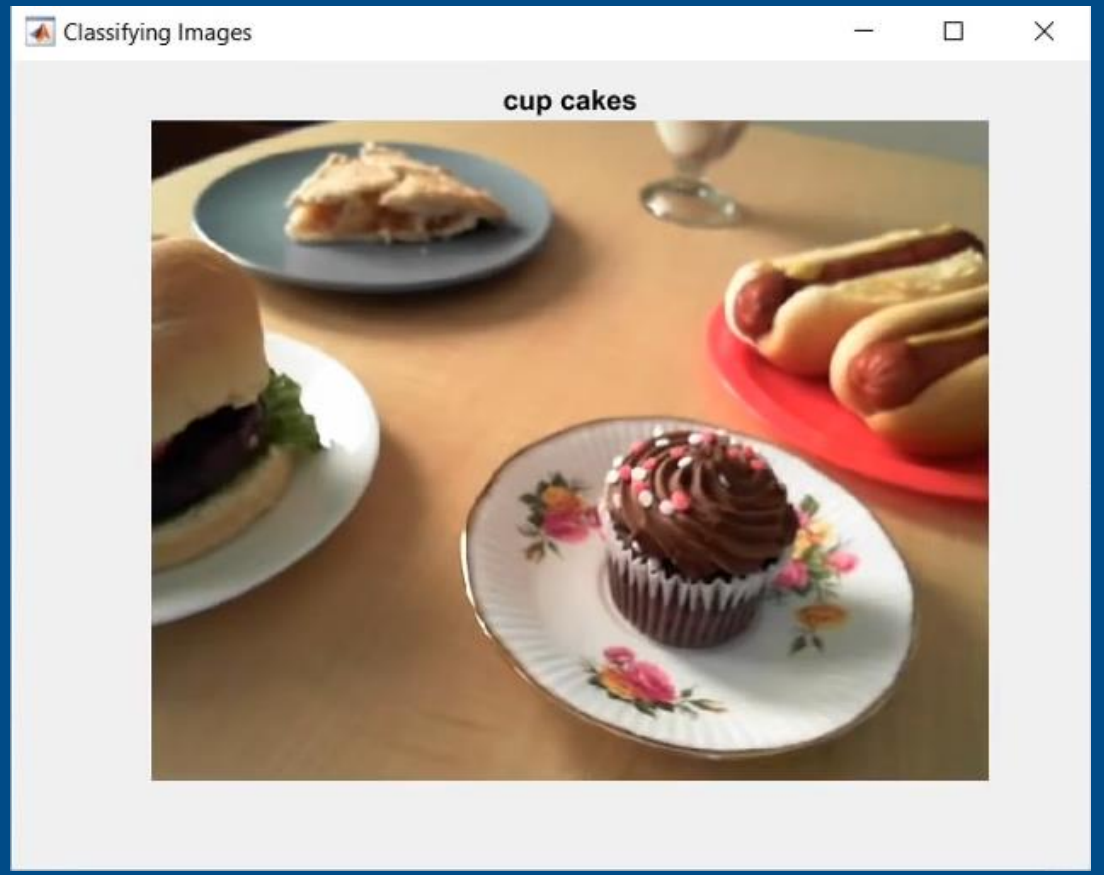
- Deep learning

```
nnet = alexnet;

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

label = classify(nnet, picture)
```

Deep learning in 5 lines of code



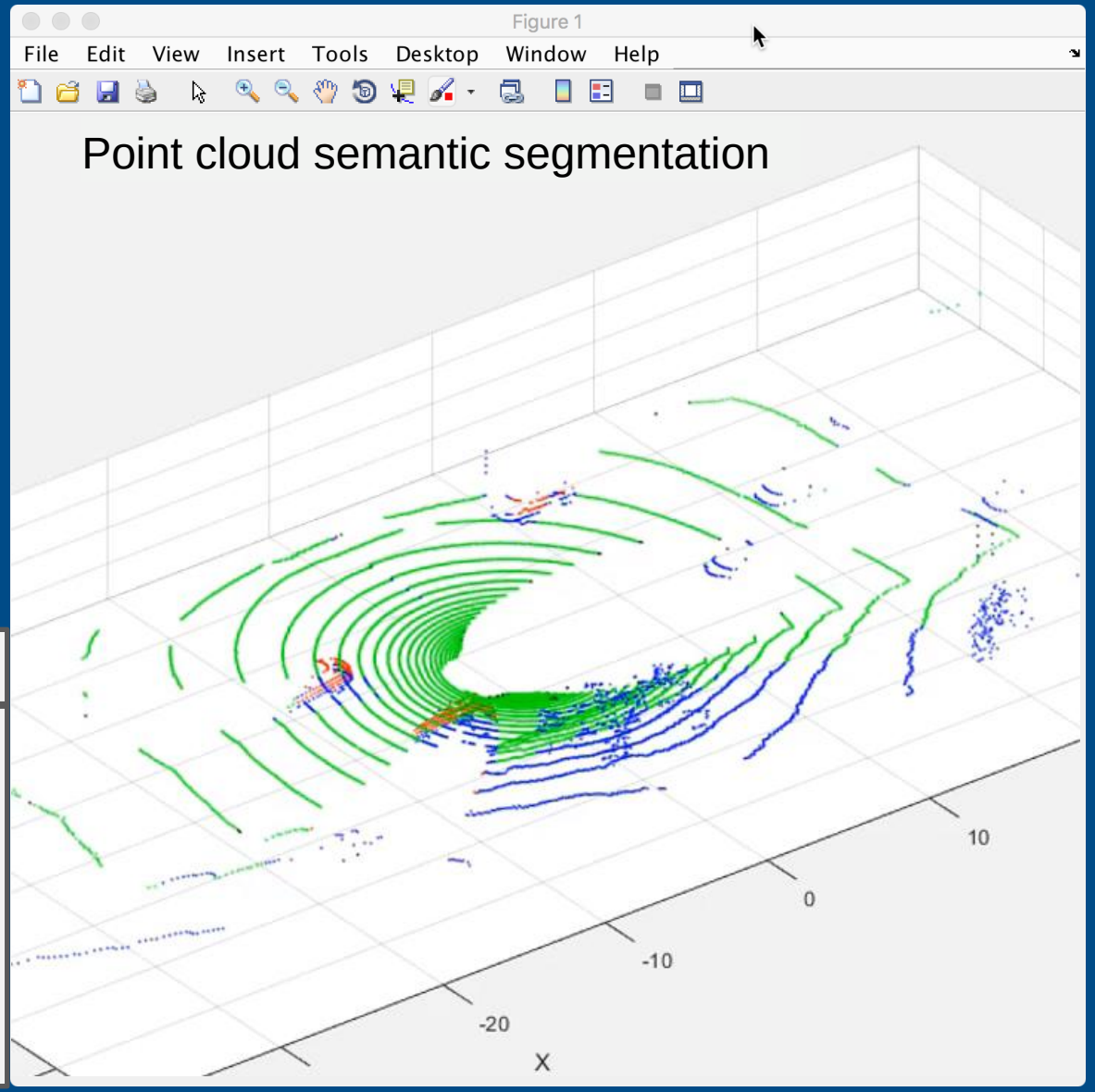
Are you ready for AI if you can’t identify features in your data?

- Deep learning
- Transfer learning

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



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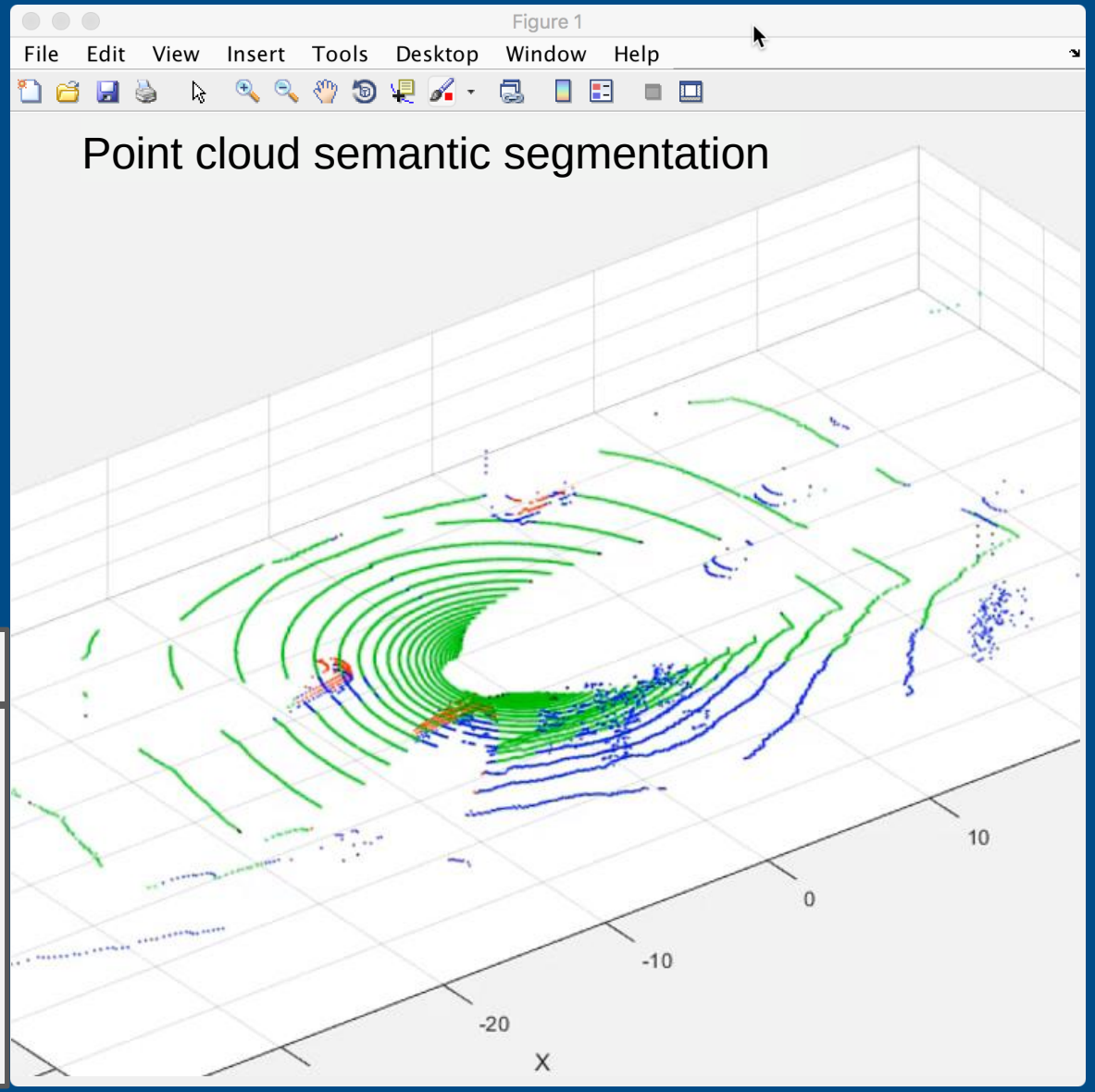
Autoliv



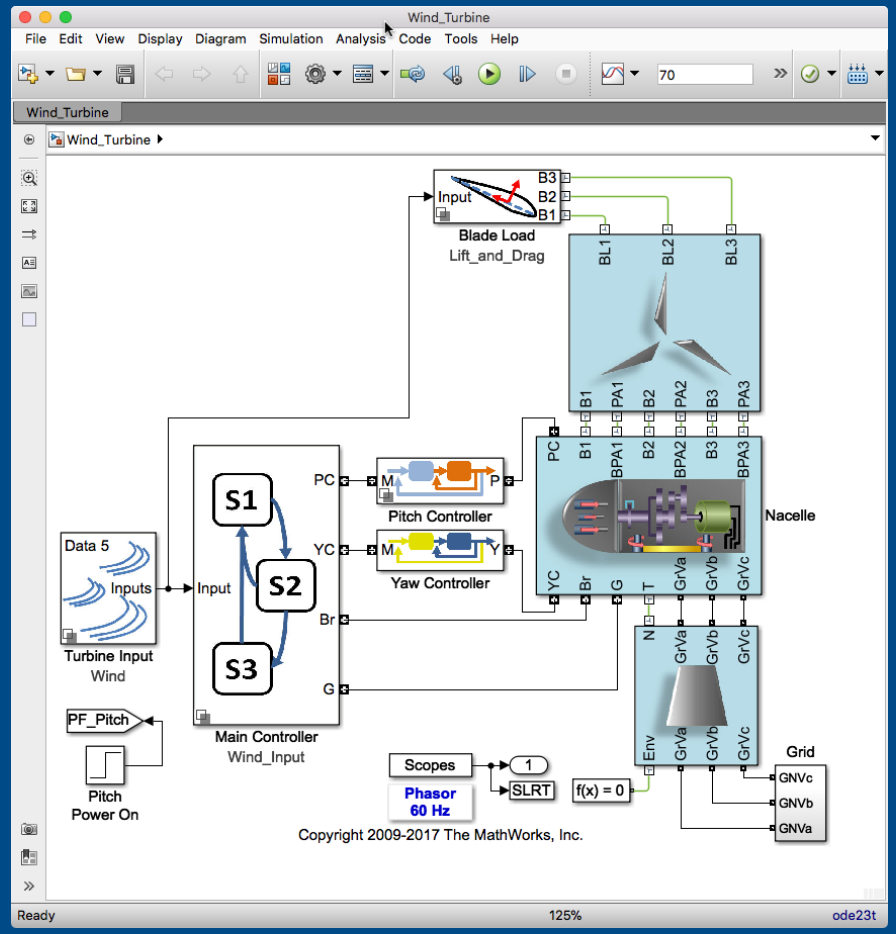
Are you ready for AI if …

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

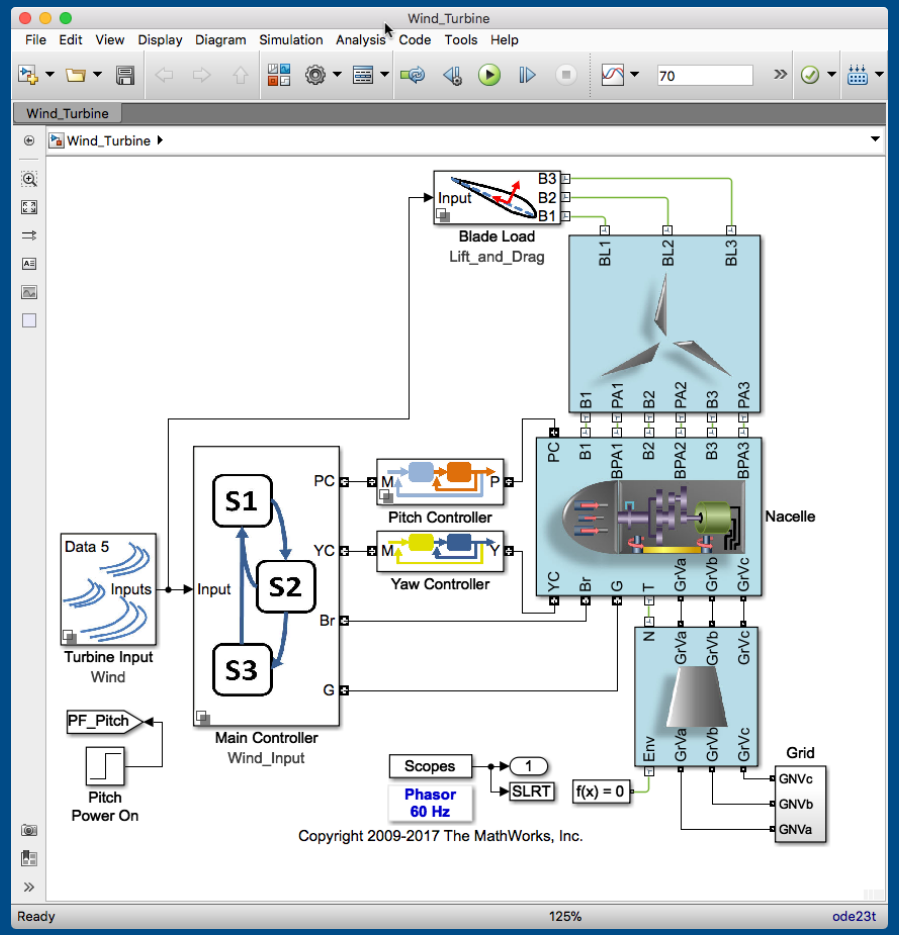


Simulink model

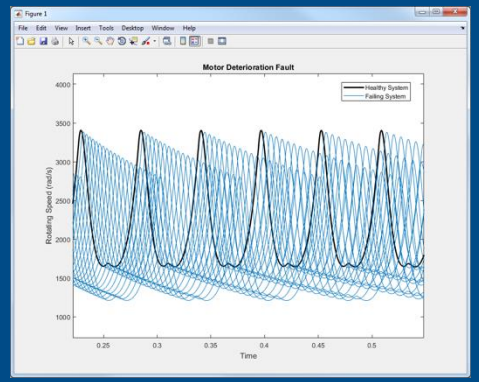
Predictive maintenance with synthetic failure data with MATLAB & Simulink

Measured data

Refine model



Simulink model



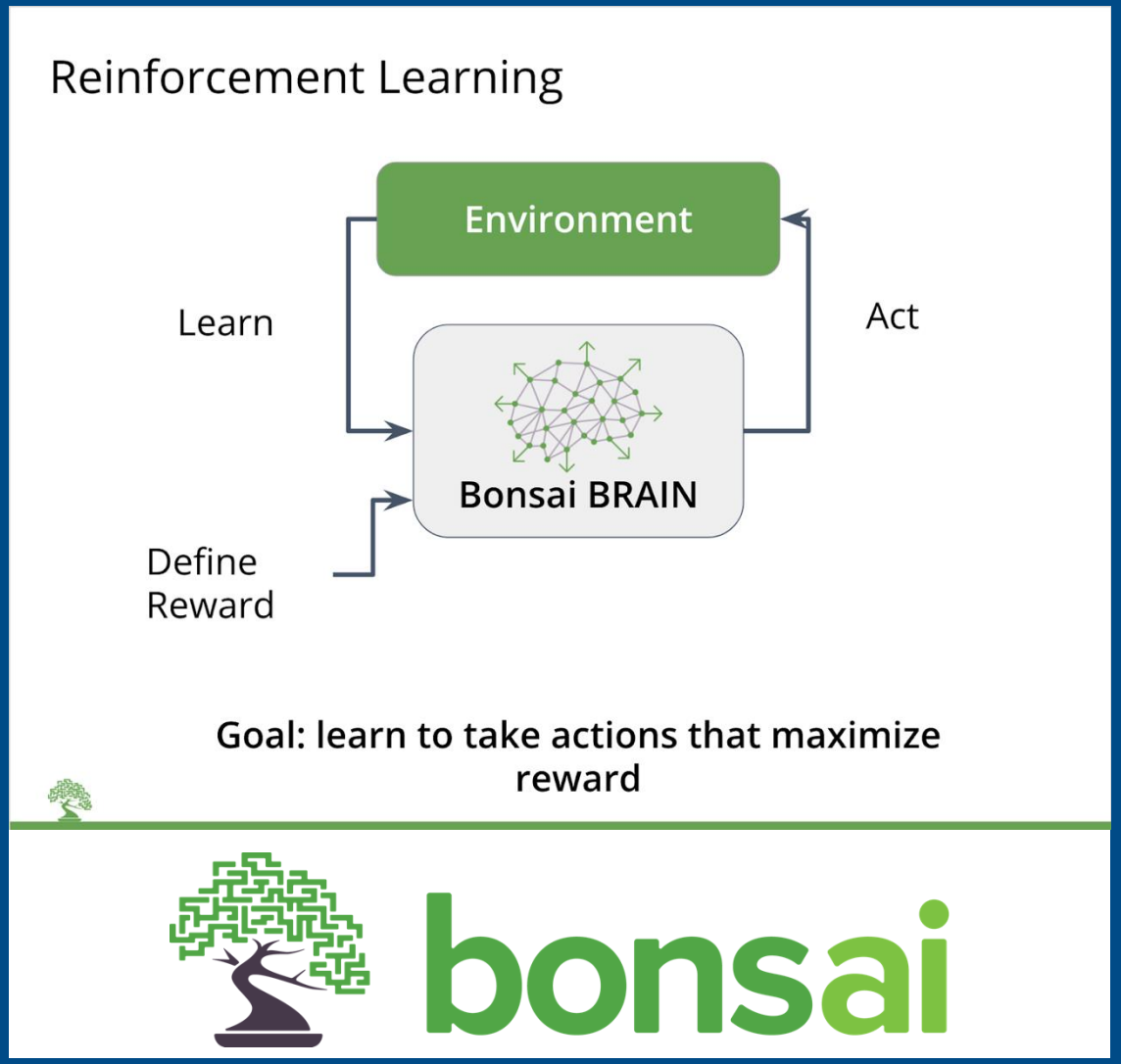
Failure data

Failure conditions

Inject failures

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

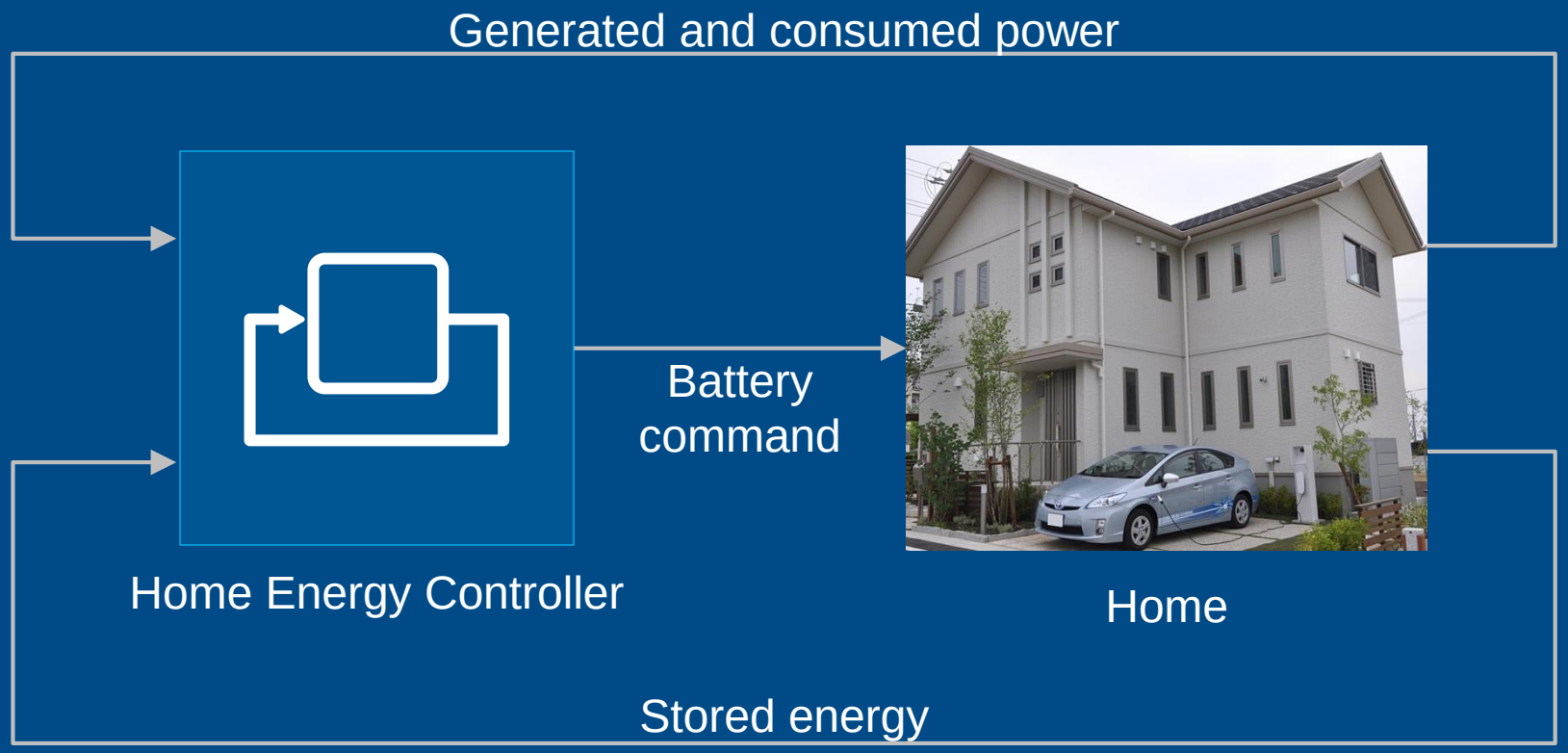
Low-carbon homes

- 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

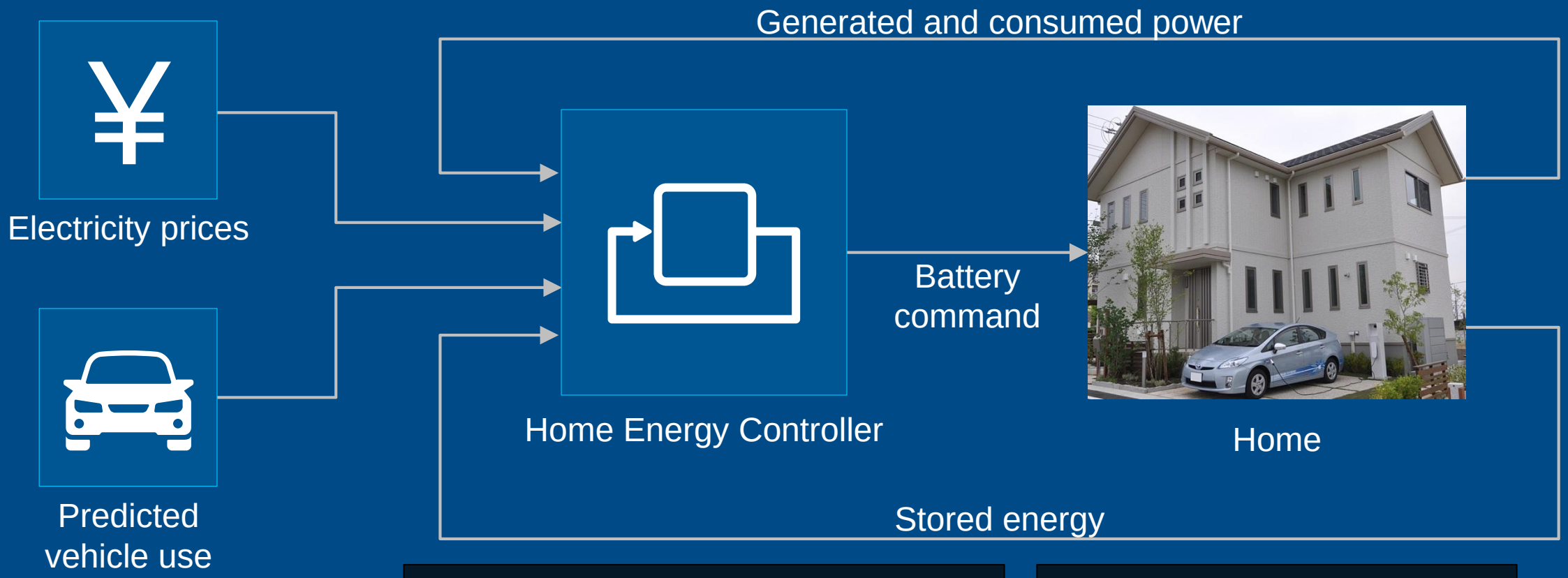
- Minimize energy cost
- Use EV battery for additional storage

Optimizing home energy management system
Denso



Optimizing home energy management system

Denso

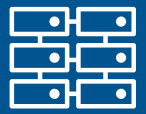


Model predictive control

Mixed integer linear programming

Simscape Power Systems

Optimizing home energy management system
Denso

Access Data	Analyze Data	Develop	Deploy
 1000 CSV Files	 Preprocessing  Parallel computing	 Classification Learner	

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.

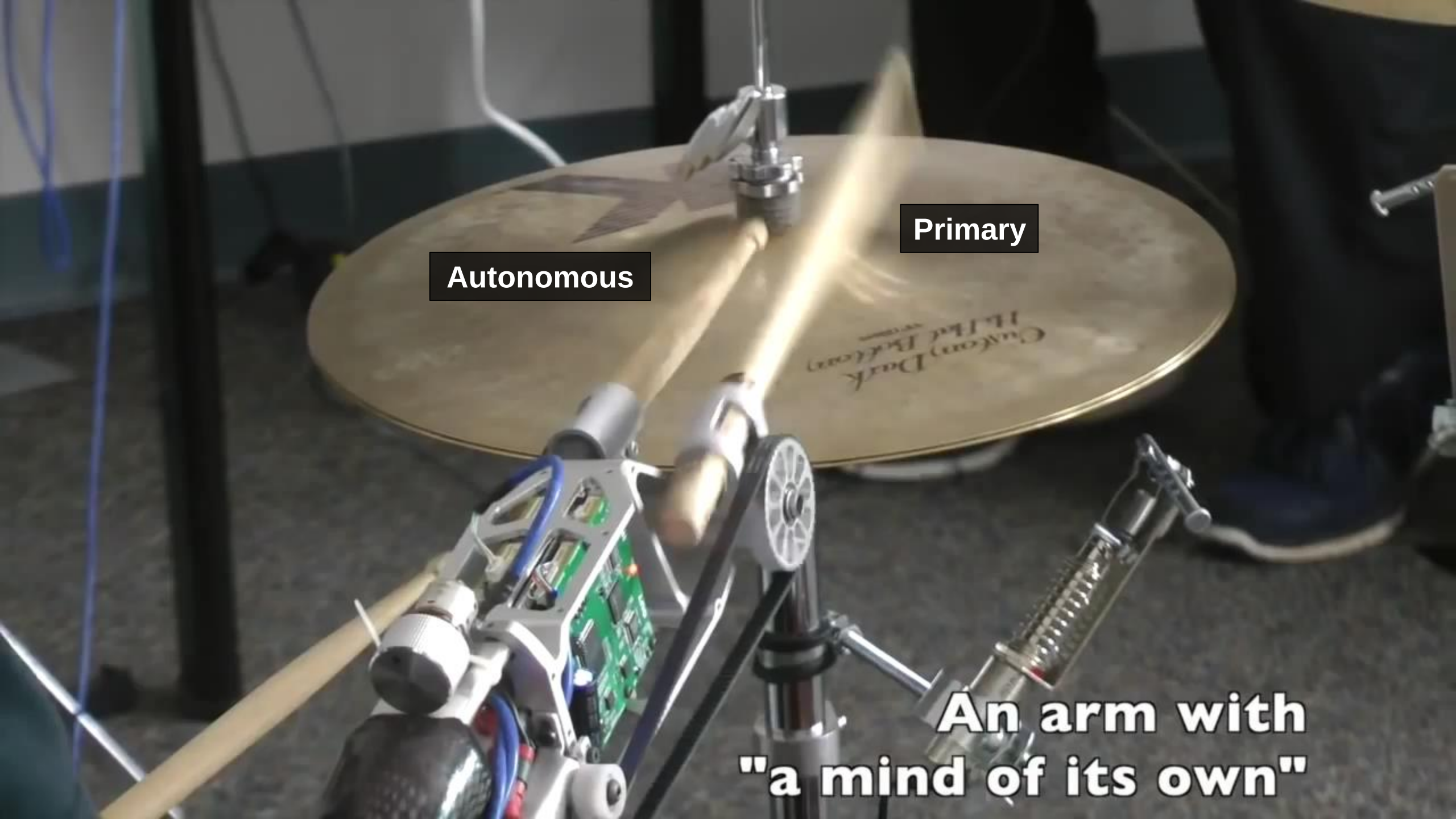
[MATLAB] enabled our team of domain experts, who lacked formal training in data science, machine learning, and parallel computing, to incorporate all these areas in our design process."

algorithms

Optimization

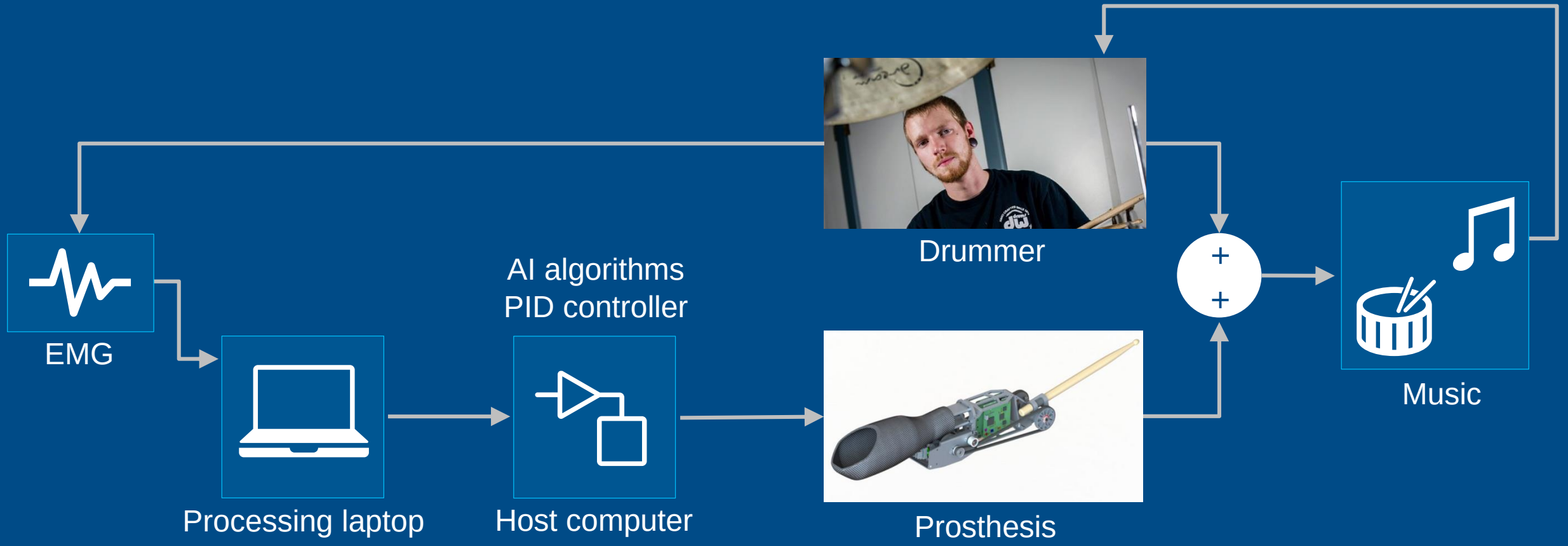

Primary
Autonomous


EMG (Muscle) Control


Primary
Autonomous
An arm with
"a mind of its own"

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

Drummer

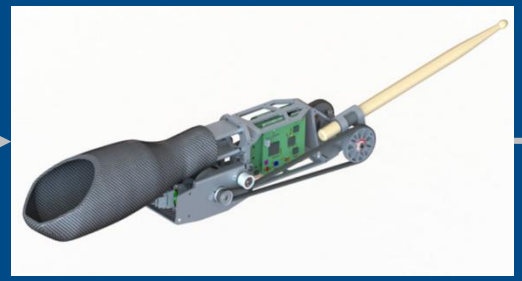
AI algorithms
PID controller

EMG

Microphone

Processing laptop

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!