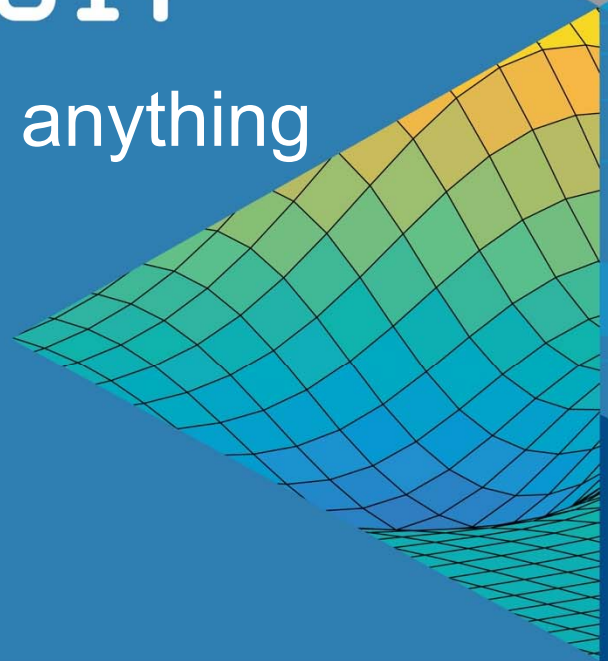
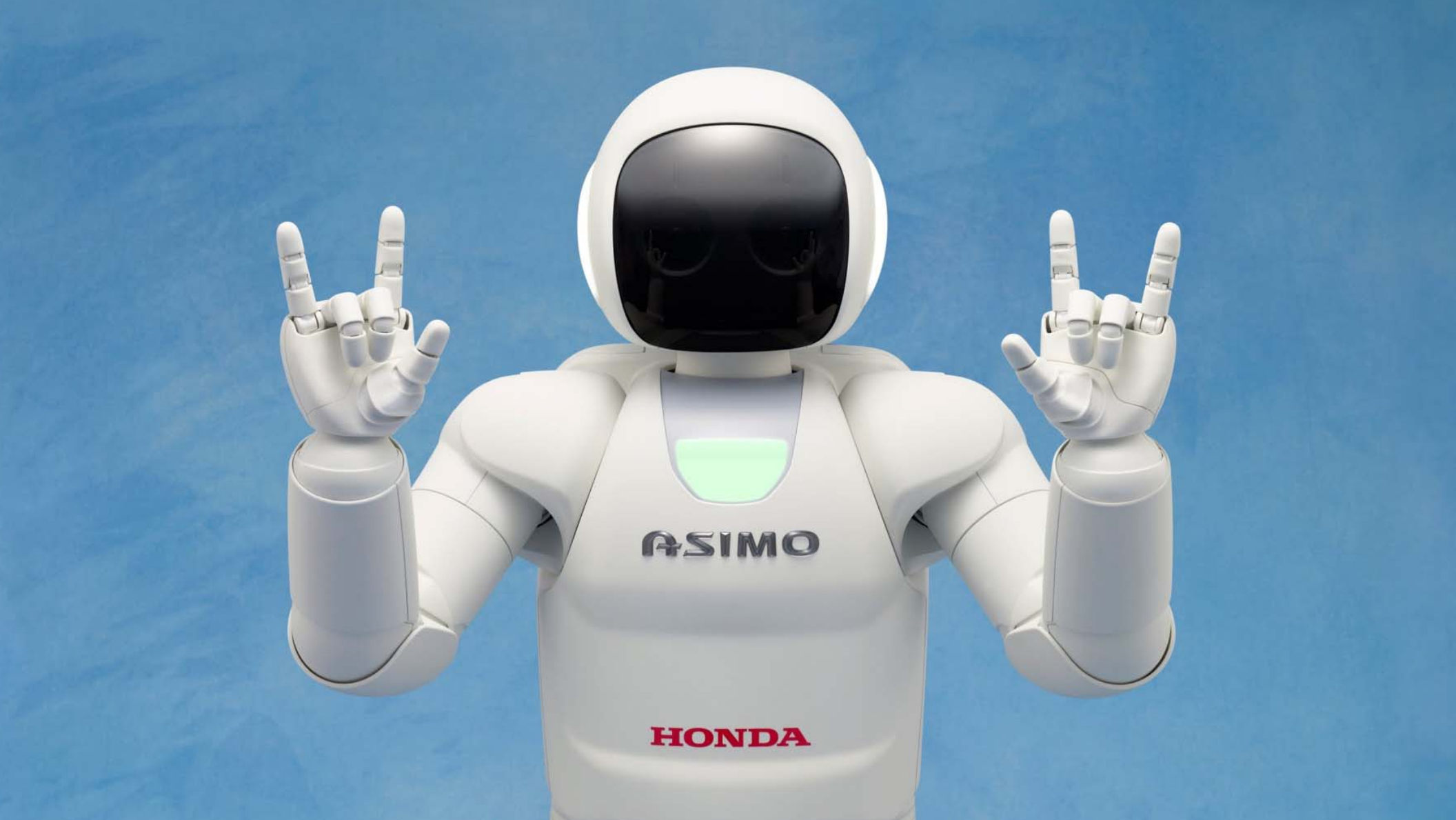
MATLAB EXPO 2017

How to build an **autonomous** anything

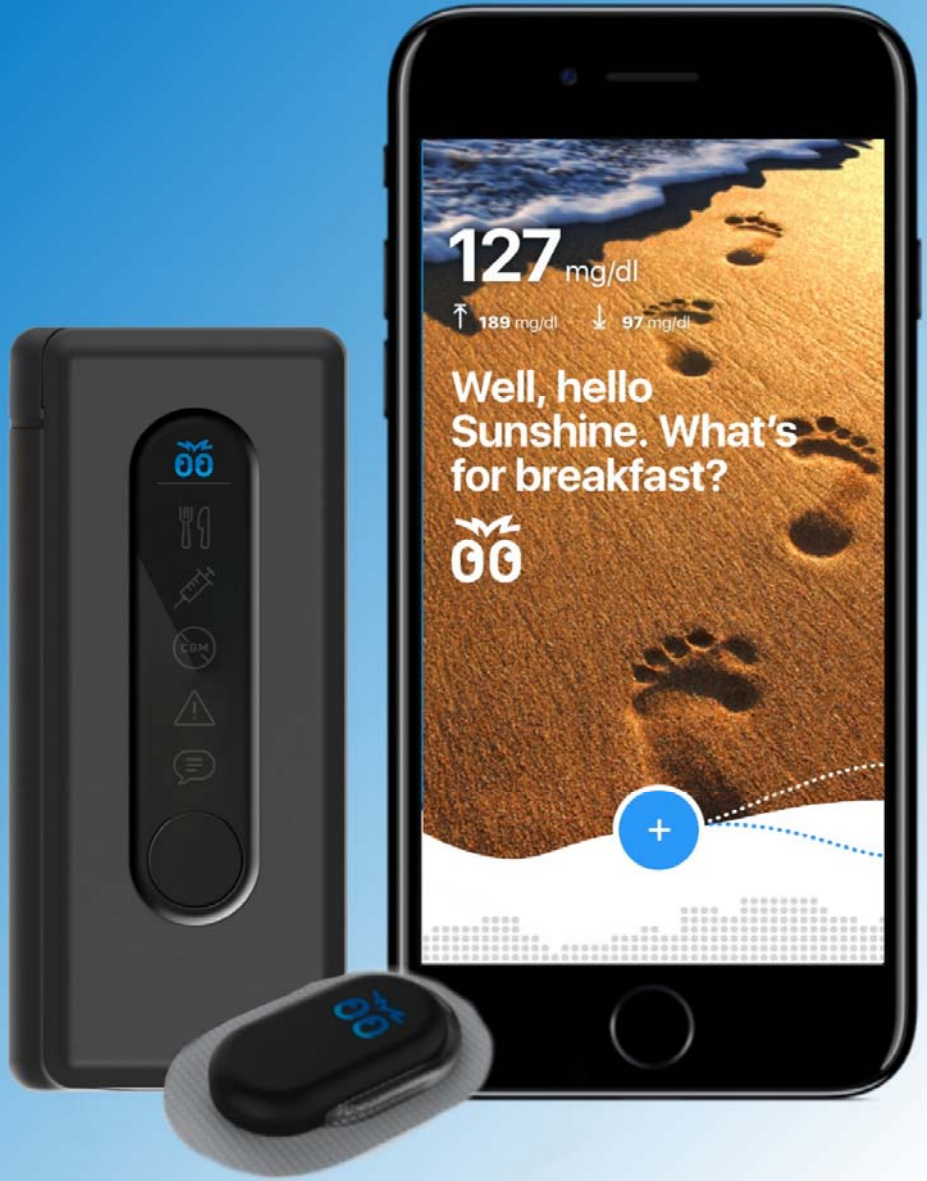


Michelle Hirsch
Head of MATLAB Product Management
MathWorks


ASIMO
HONDA


amazon


5" 12,000 PSI
5" 12,000 PSI


127 mg/dl
189 mg/dl
97 mg/dl
Well, hello Sunshine. What's for breakfast?

Autonomous Technology

Autonomous

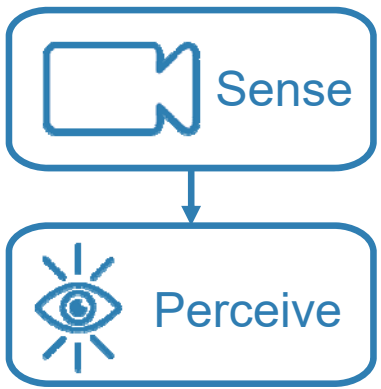
Having the power for self-governance

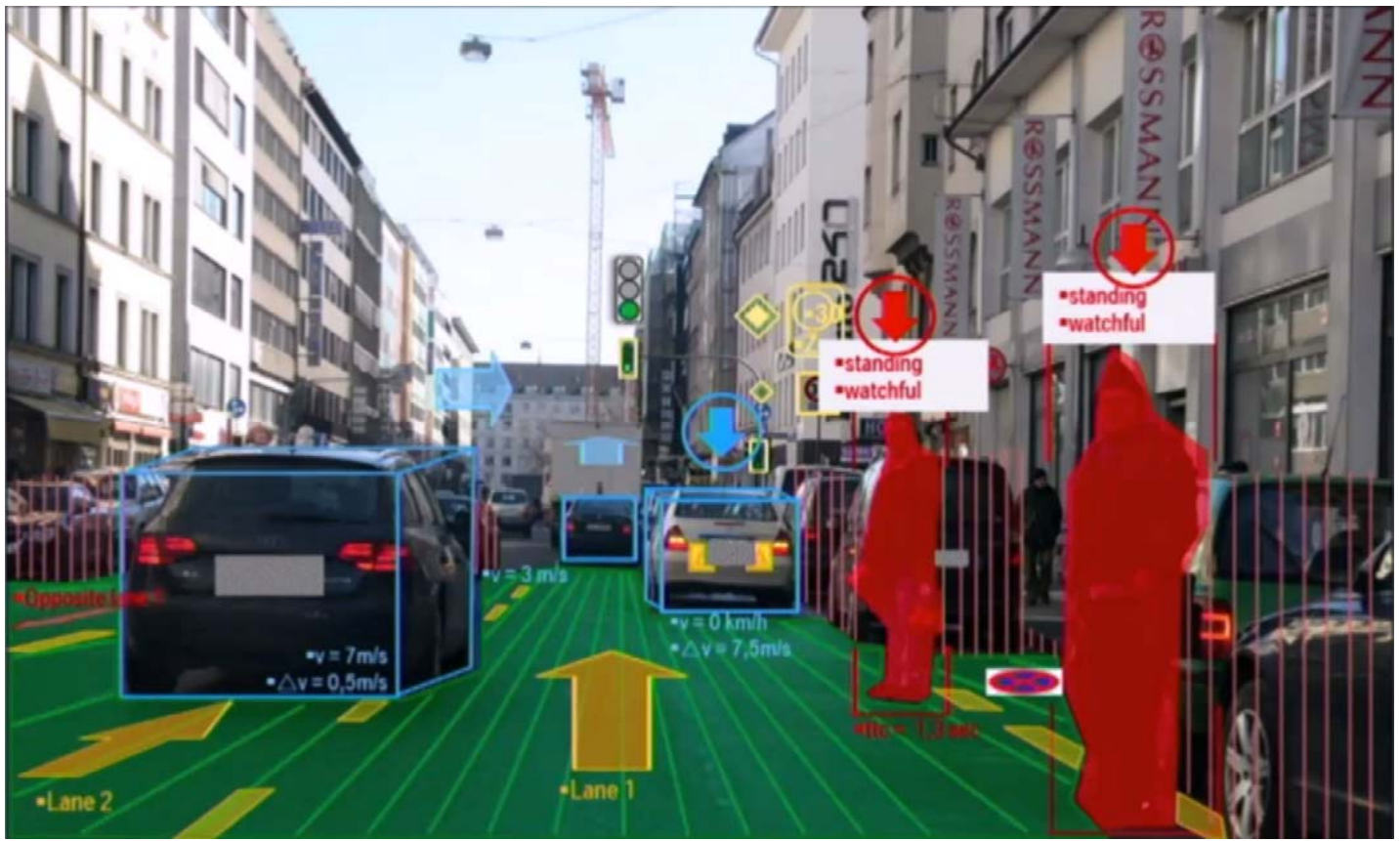
Autonomous Technology

Provides the ability of a system to act independently of direct human control under unrehearsed conditions

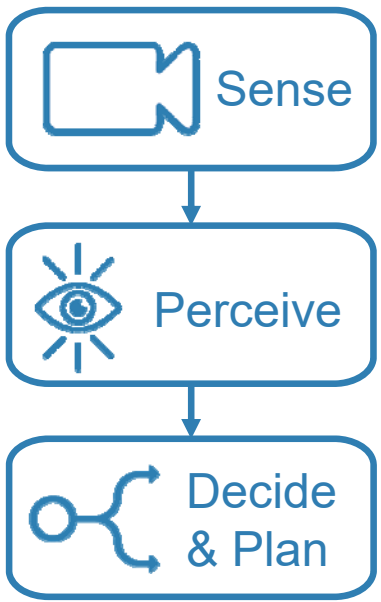
Capabilities of an Autonomous System

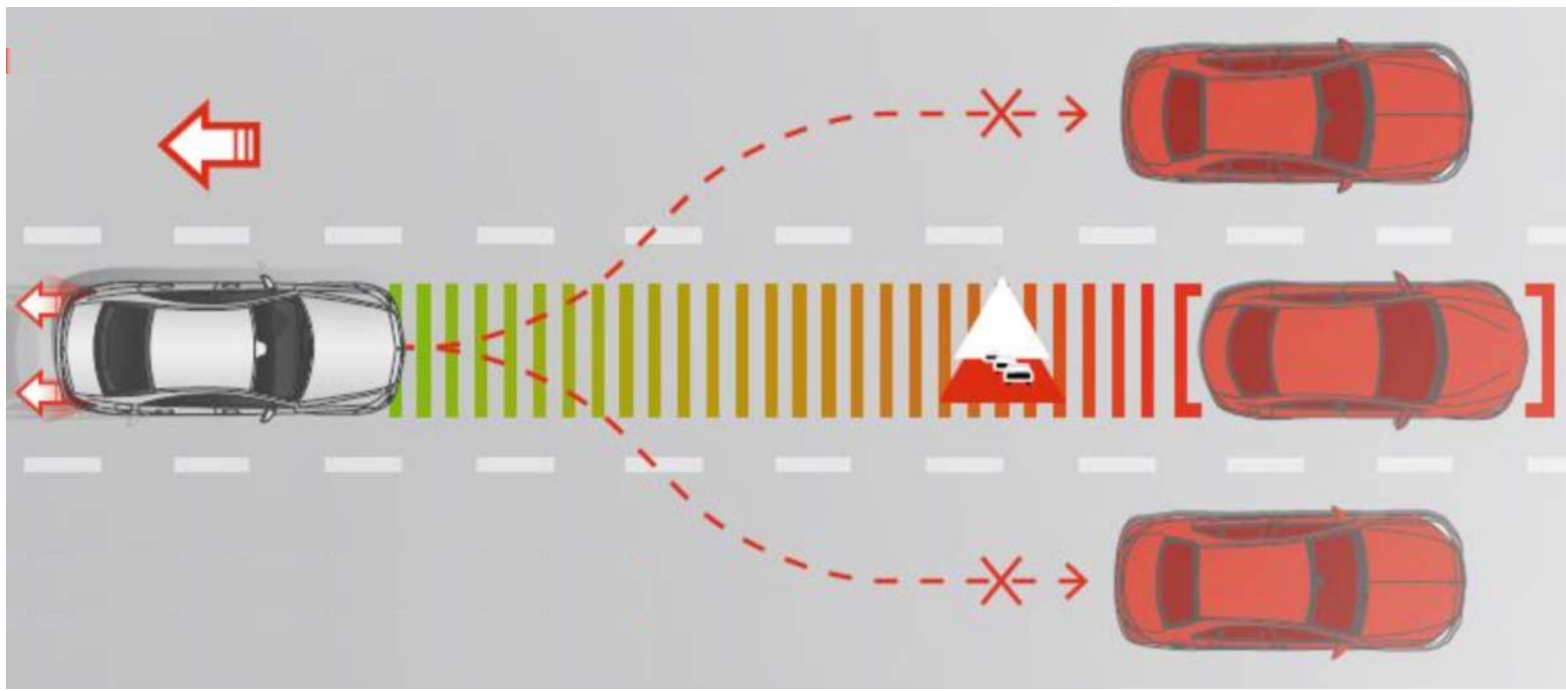
Capabilities of an Autonomous System



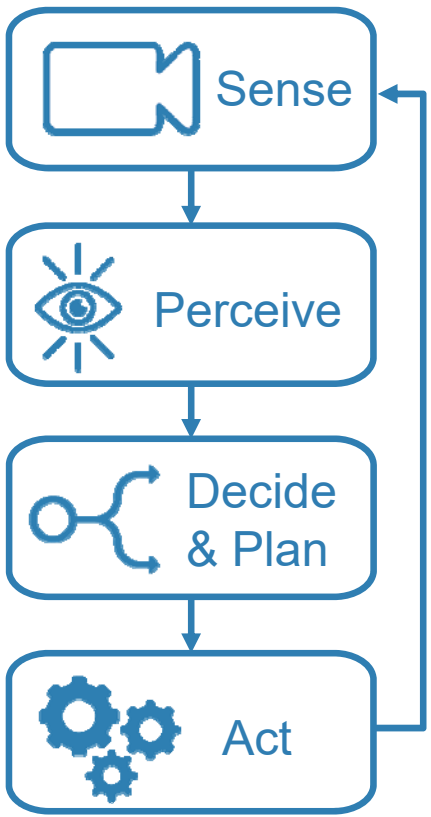


Capabilities of an Autonomous System

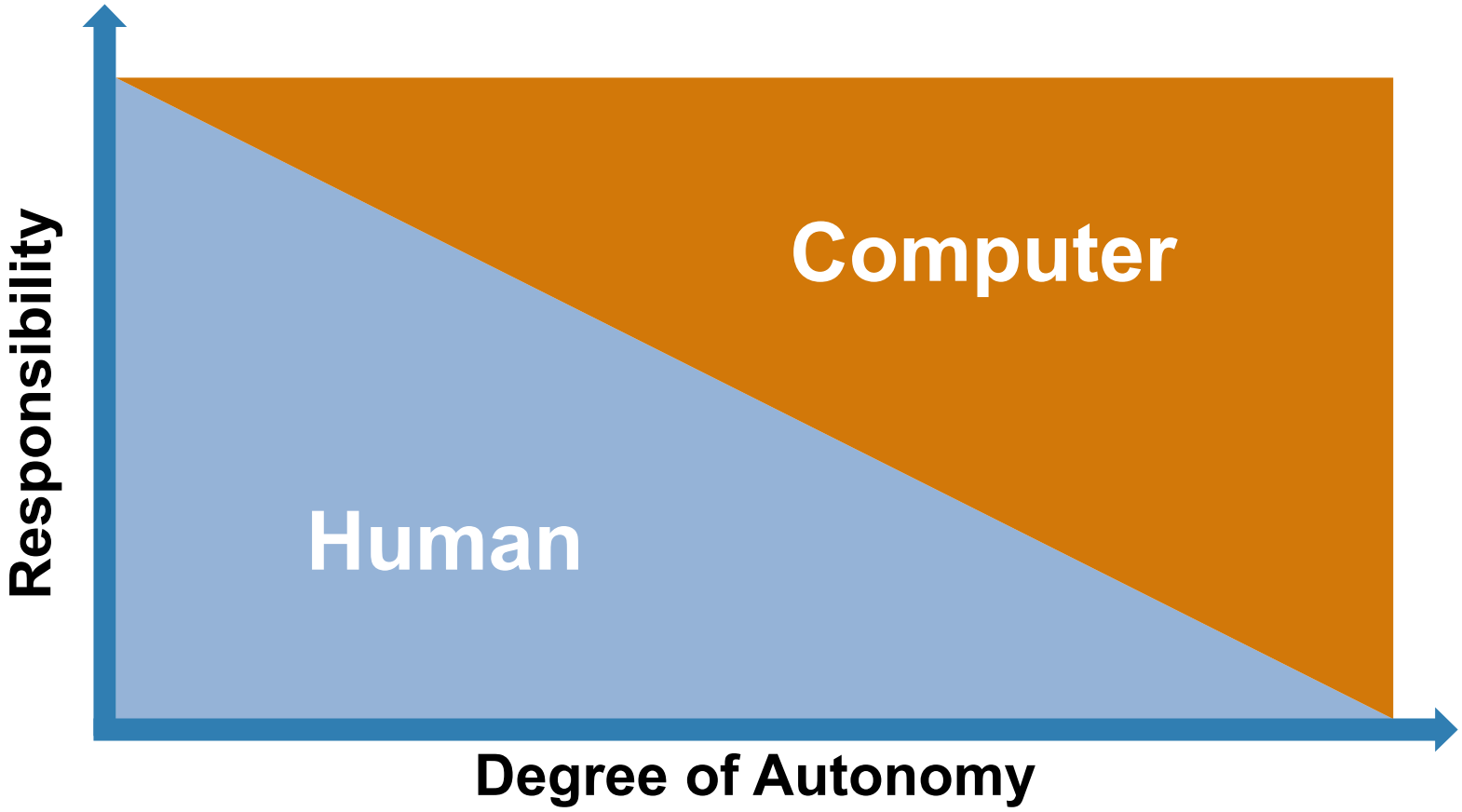




Capabilities of an Autonomous System



Autonomous Technology Transfers Responsibility to Computers




Cost of rig: >$1M
Repair cost: $100,000
Cost of valve: $200

Autonomous Service for Predictive Maintenance

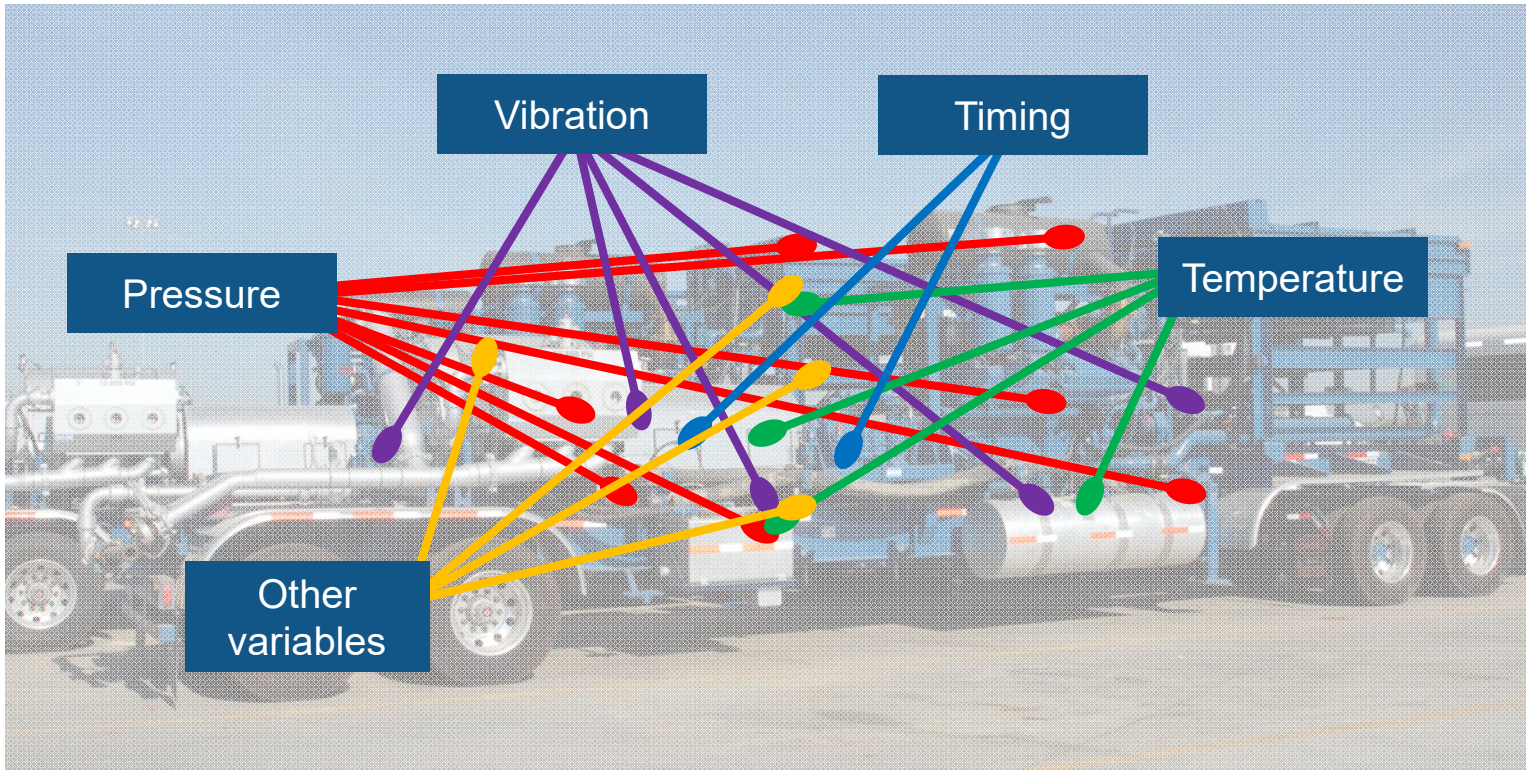
Sense

Perceive

Decide & Plan

Act

Which sensor values should they use?



Autonomous Service for Predictive Maintenance

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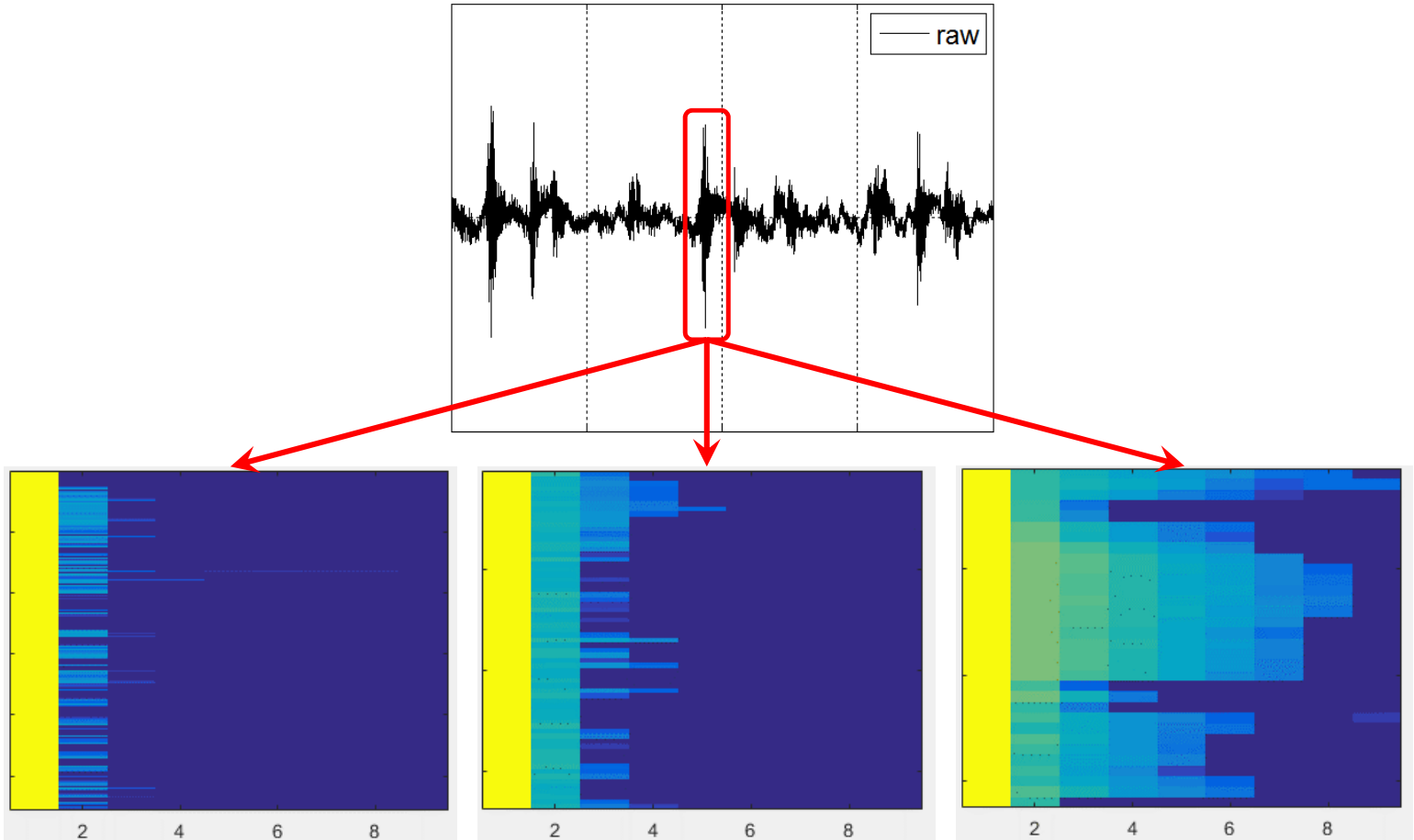


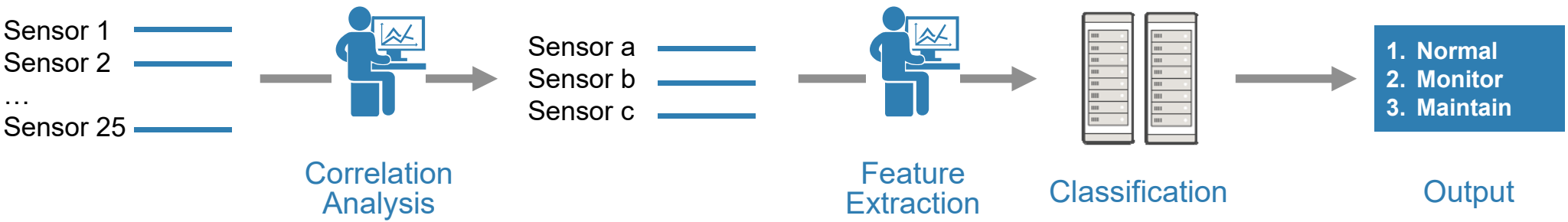
Normal Operation

Monitor Closely

Maintenance Needed

Machine Learning or Deep Learning?

Machine Learning Approach



Deep Learning Approach

What are the best predictors?

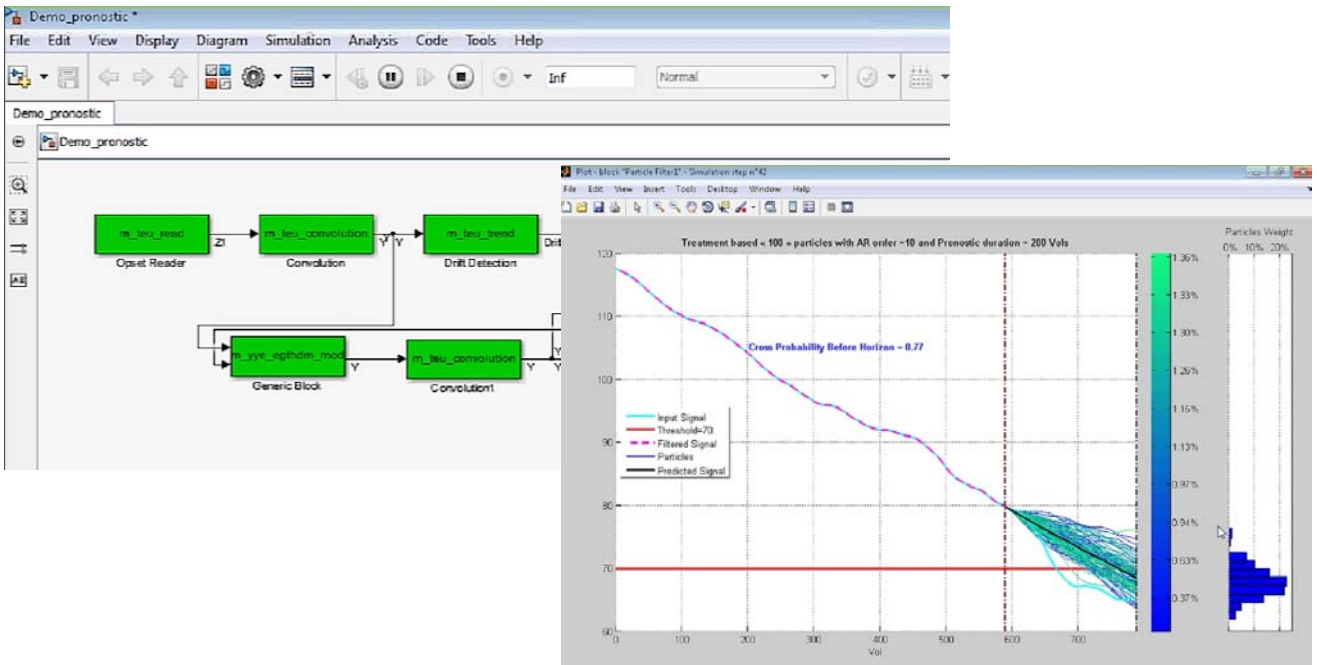
- Data-driven

What are the best predictors?

- Data-driven
- Model-driven

Jet Engine Monitoring

SAFRAN
Snecma

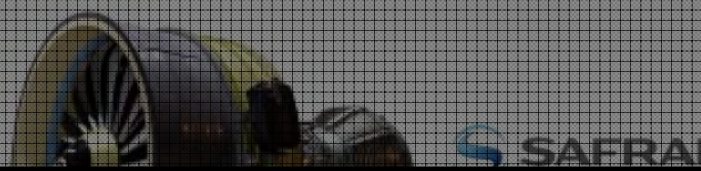


What are the best predictors?

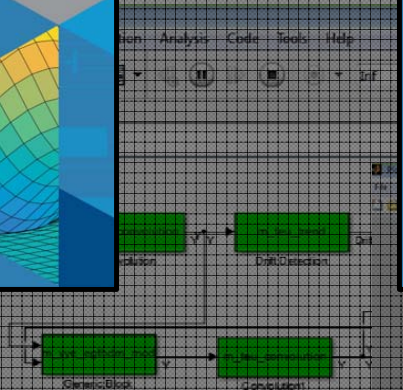
Find out more about machine learning:
Machine Learning Simplified

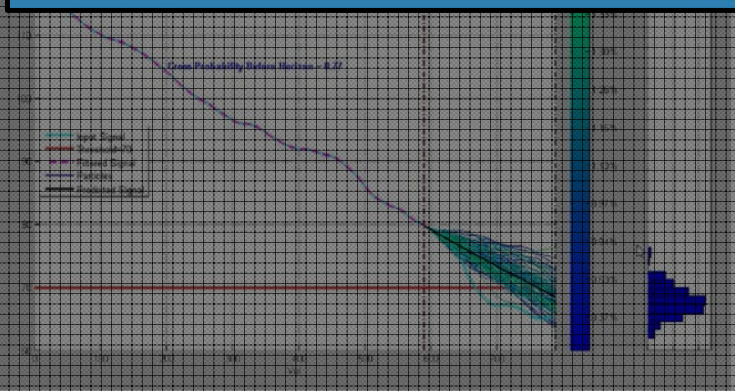
Paola Jaramillo

Track B 13:15 – 13:45



onitoring



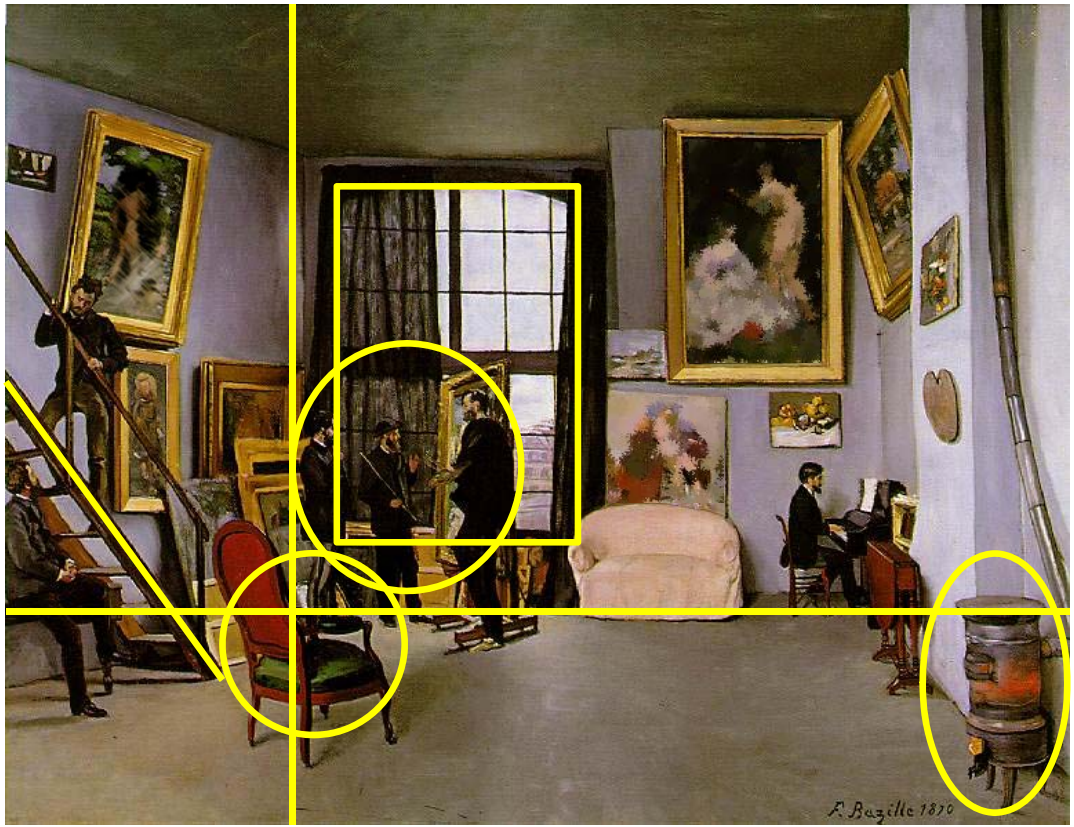


Find out more about predictive maintenance:
Build predictive maintenance algorithms using physical models

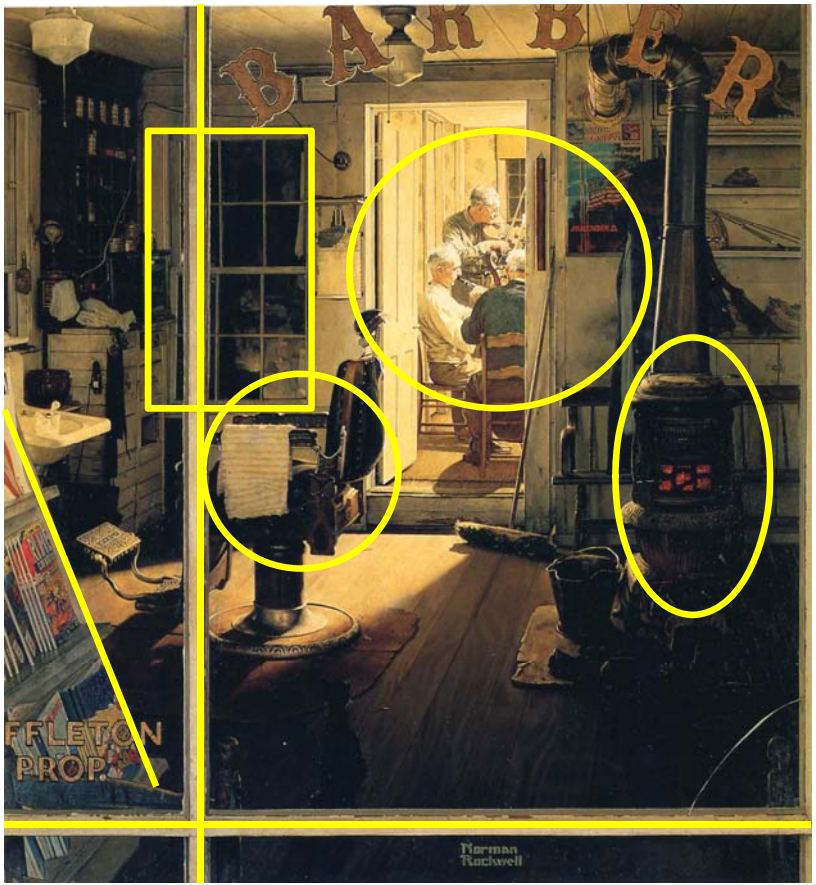
Demo Station

Bazille's Studio
Frederic Bazille (Paris, 1870)

Shuffleton's Barbershop
Norman Rockwell (Vermont, 1950)



Bazille's Studio
Frederic Bazille (Paris, 1870)



Shuffleton's Barbershop
Norman Rockwell (Vermont, 1950)

Autonomous Artistic Style Classification
Rutgers University

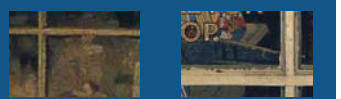
Sense

Perceive

Decide & Plan

Act

Image Feature Extraction



Visual Features

Machine Learning Classification

Style Classifier (SVM)

Genre Classifier (SVM)

Artist Classifier (SVM)

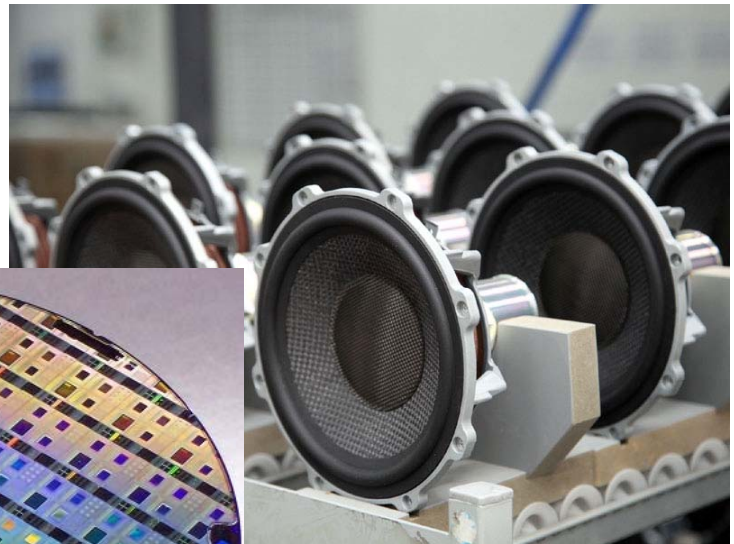
Style: Regionalism

Genre: Interior

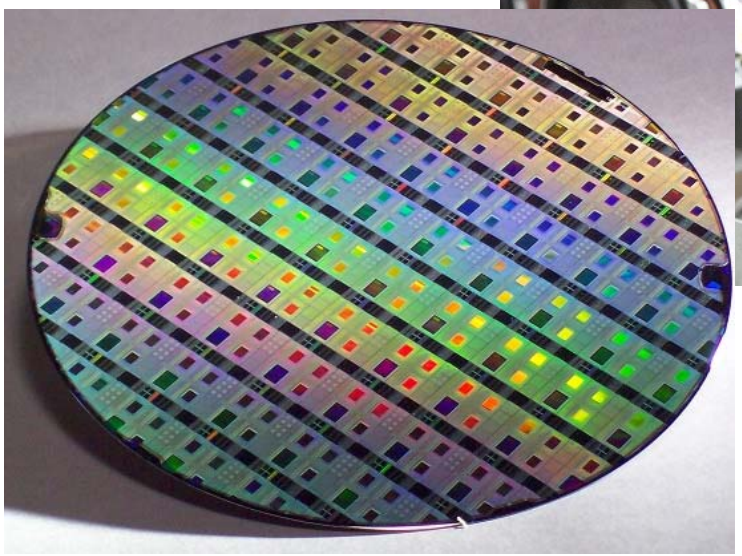
Artist: Rockwell

Where to add autonomy with perception?

- Analyze more data
- Reduce bias
- Reduce variability
- Save time
- Improve performance



Determine Loudspeaker Quality



Virtual Semiconductor Manufacturing Calibration

ASML

Autonomous Glucose Level Management

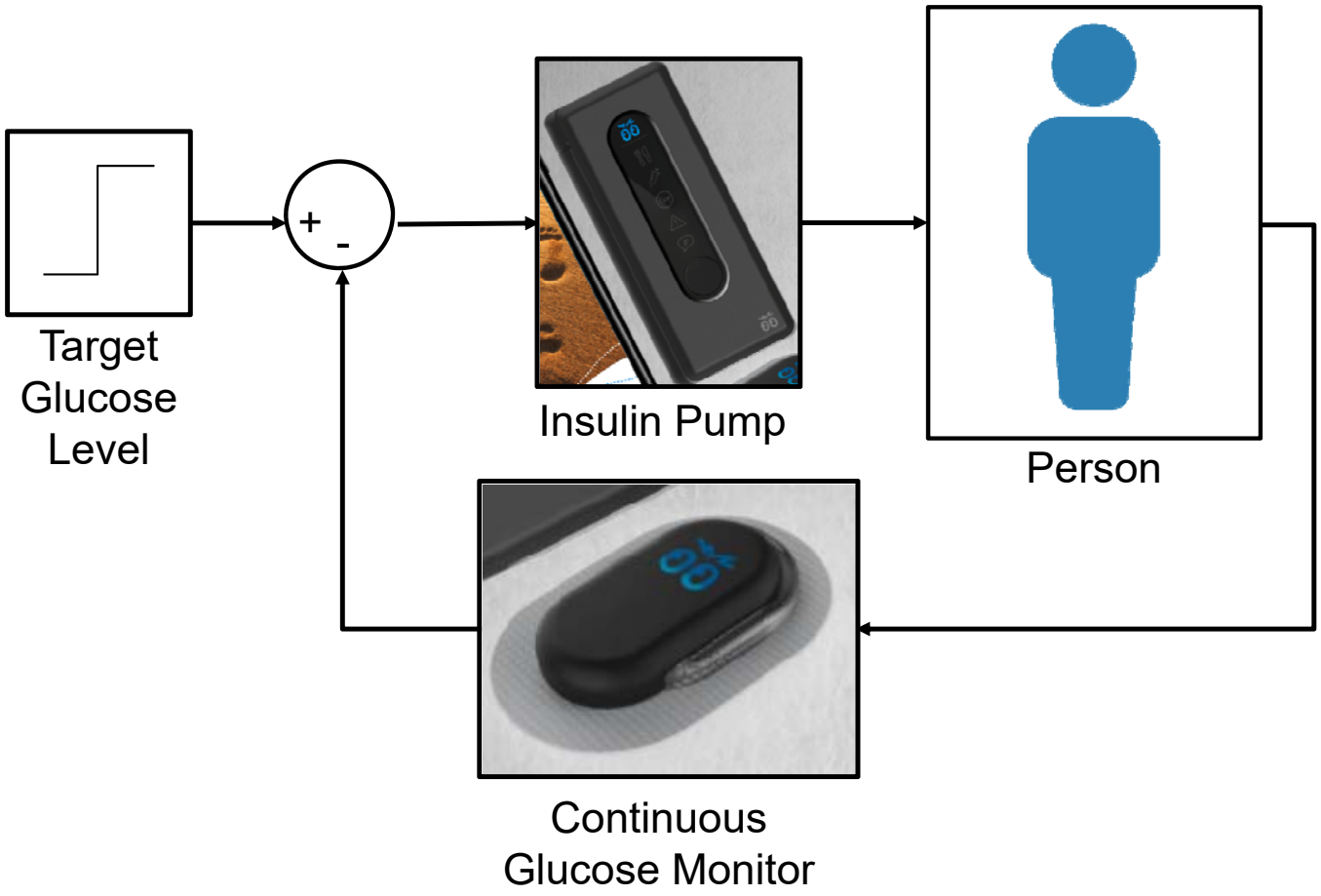
Autonomous Glucose Level Management
Bigfoot Biomedical

Sense

Perceive

Decide & Plan

Act



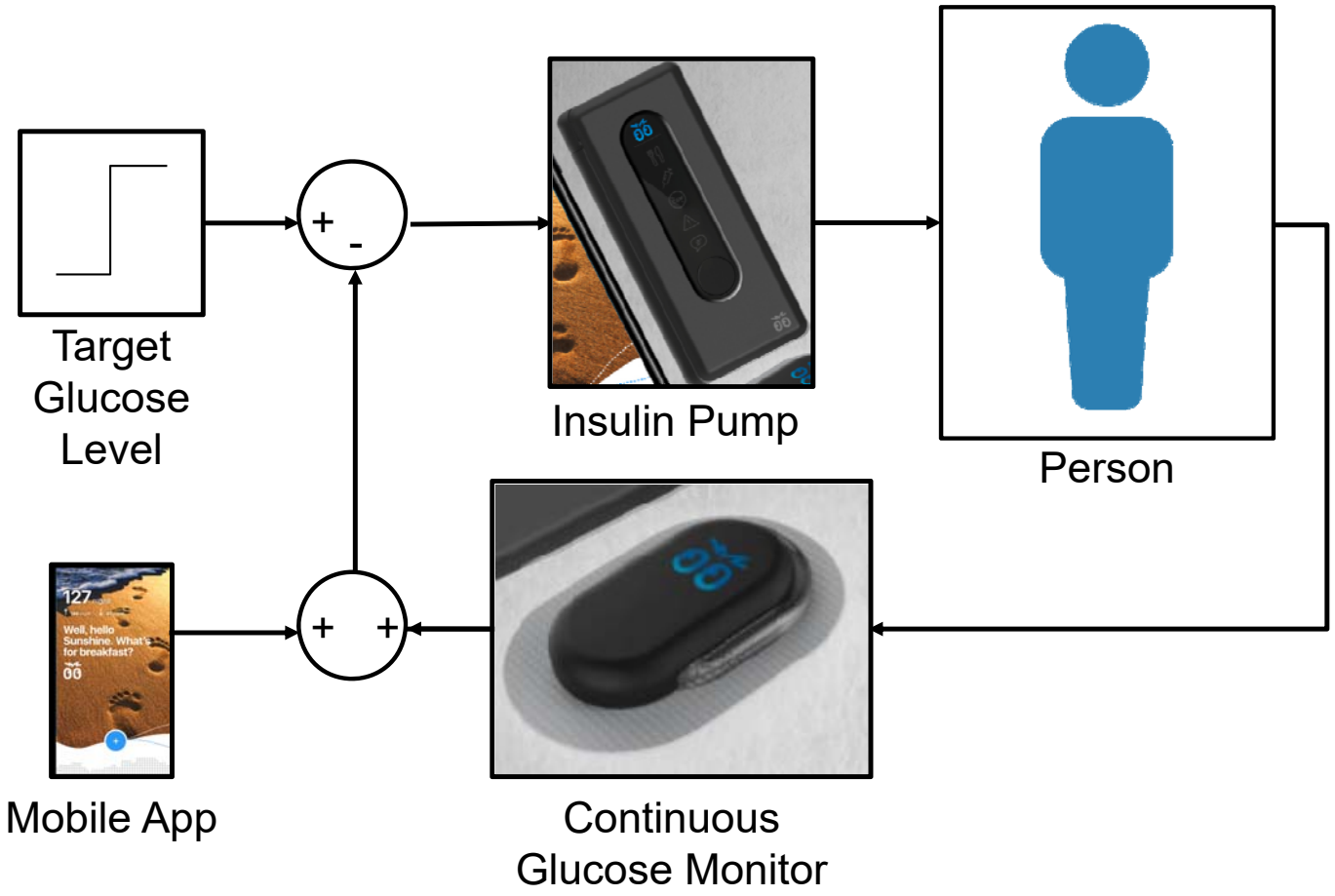
Autonomous Glucose Level Management
Bigfoot Biomedical

Sense

Perceive

Decide & Plan

Act



Autonomous Glucose Level Management
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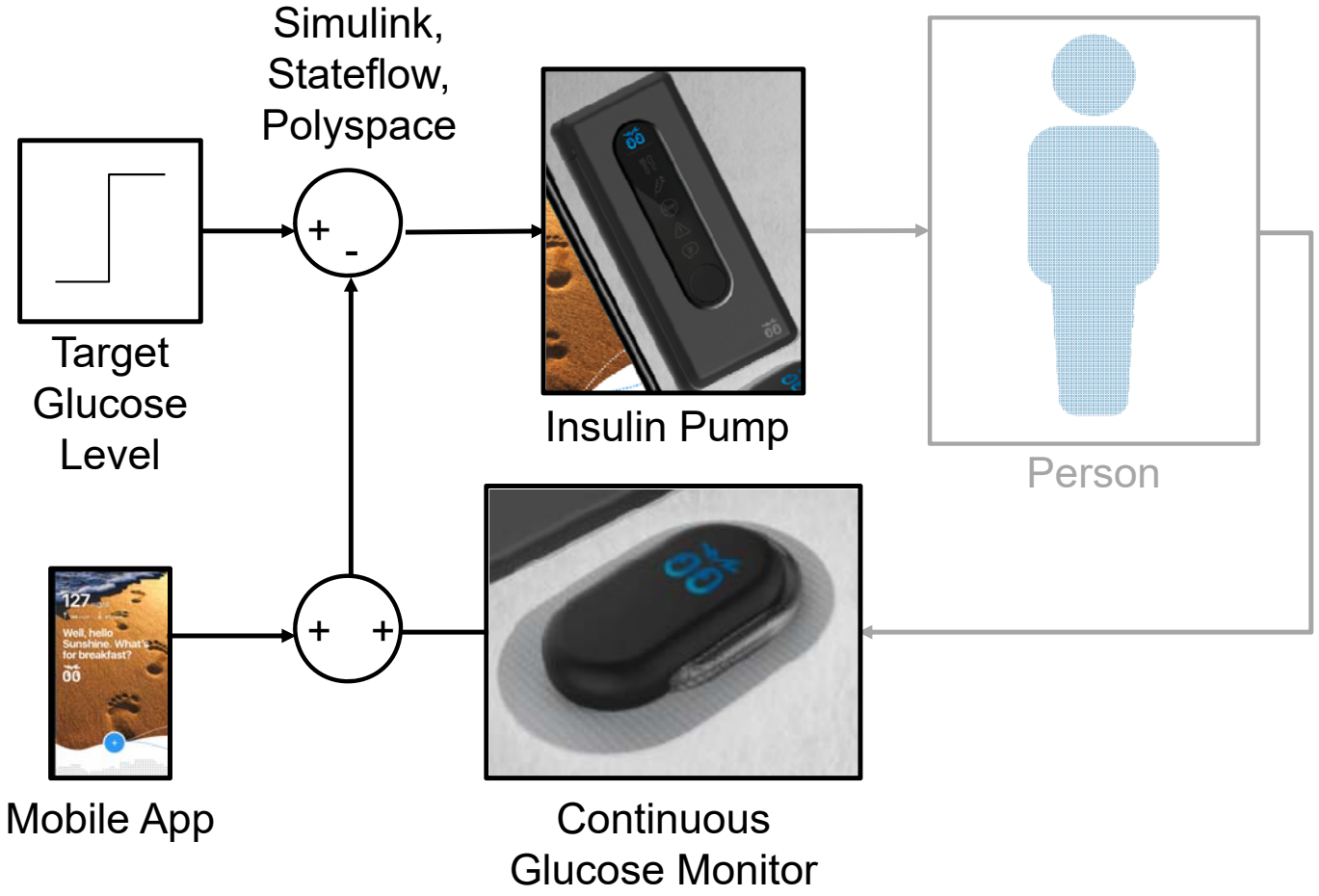
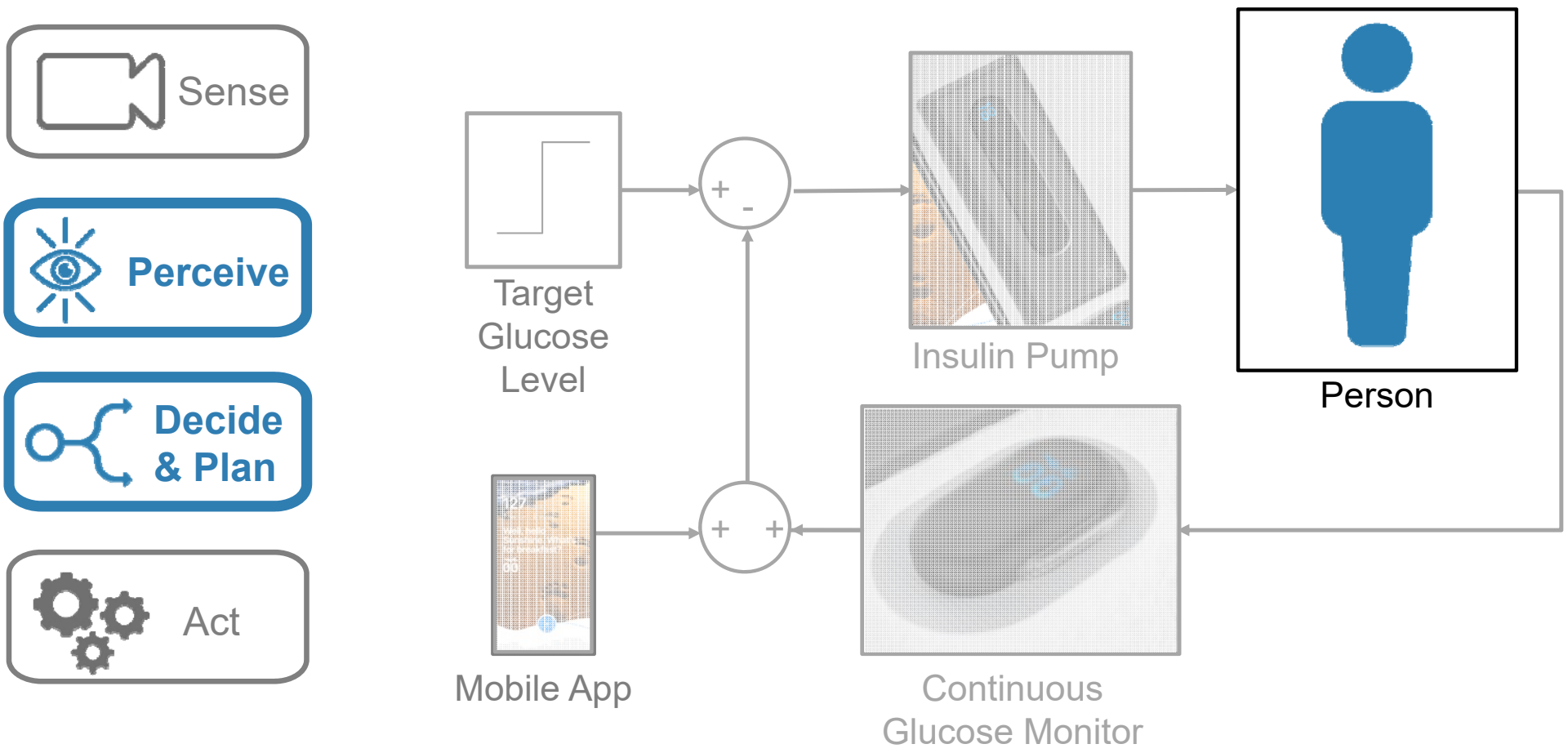


Autonomous Glucose Level Management
Bigfoot Biomedical



Autonomous Glucose Level Management
Bigfoot Biomedical

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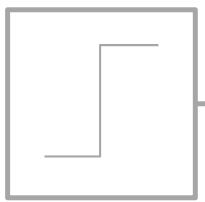
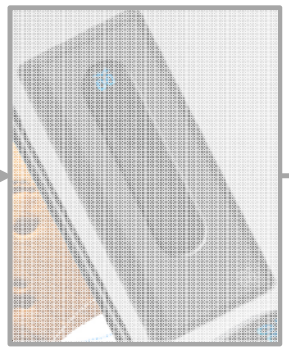
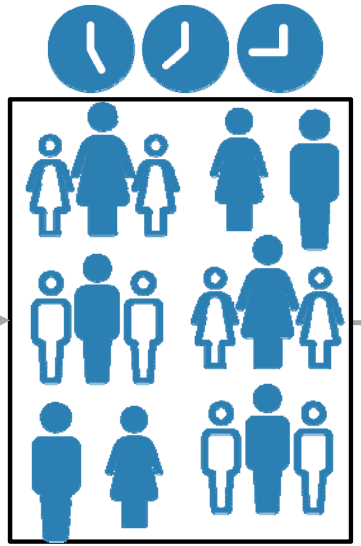


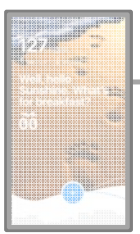
Target Glucose Level



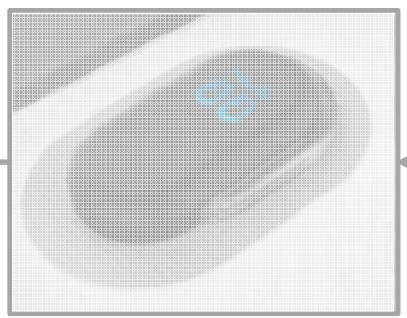
Insulin Pump



Person

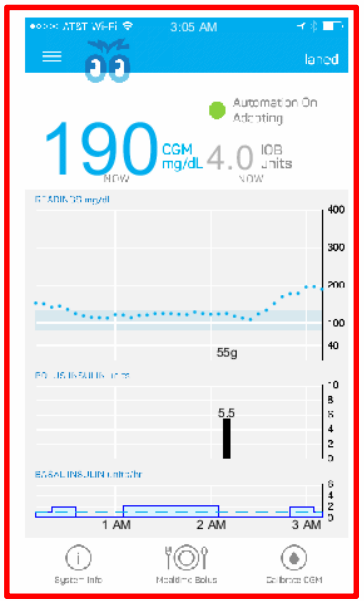


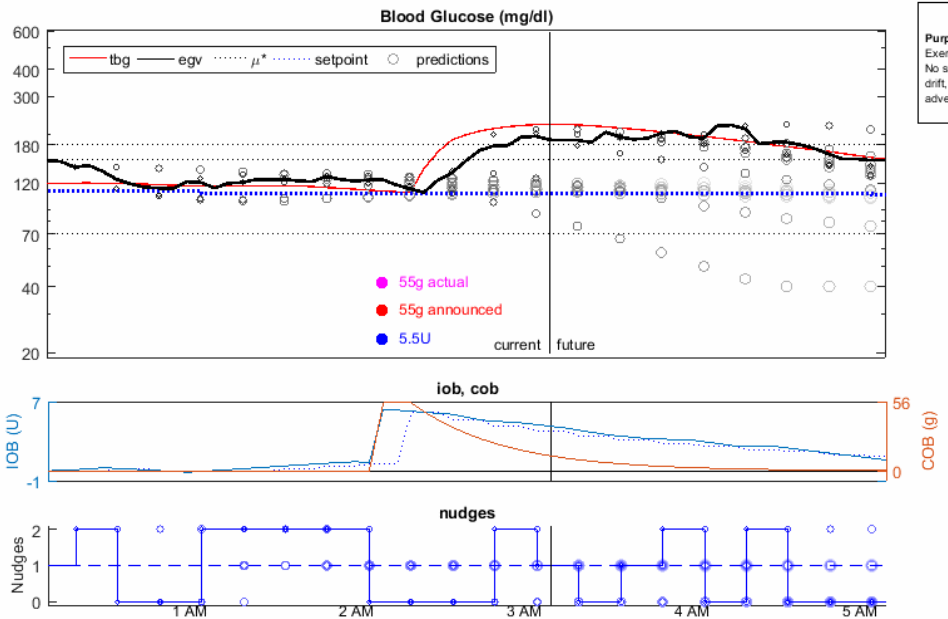
Mobile App



Continuous Glucose Monitor

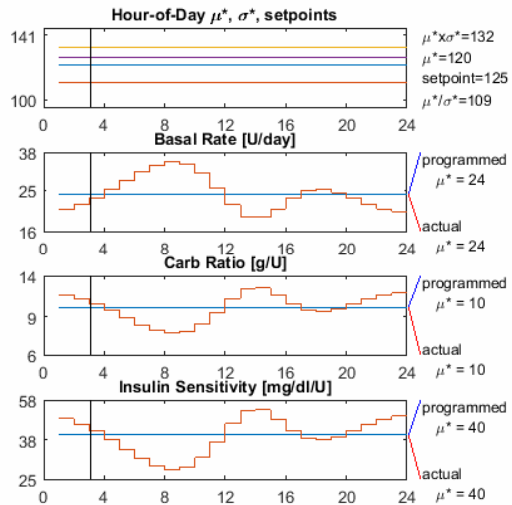
Virtual Clinic
Generating data through simulation

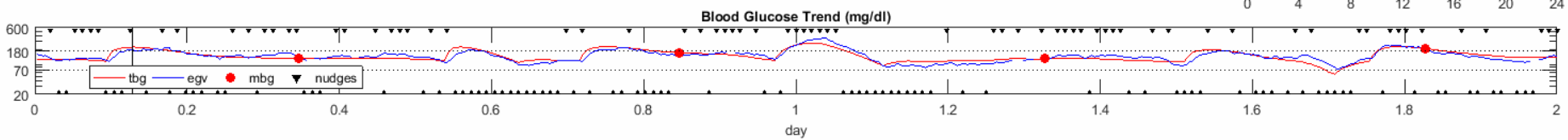




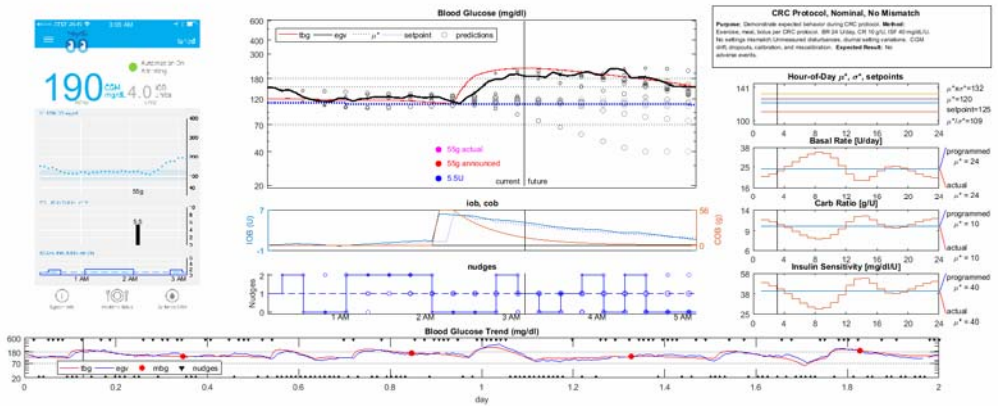
CRC Protocol, Nominal, No Mismatch

Purpose: Demonstrate expected behavior during CRC protocol. **Method:** Exercise, meal, bolus per CRC protocol. BR 24 U/day, CR 10 g/U, ISF 40 mg/dL/U. No settings mismatch. Unmeasured disturbances, diurnal setting variations. CGM drift, dropouts, calibration, and miscalibration. **Expected Result:** No adverse events.





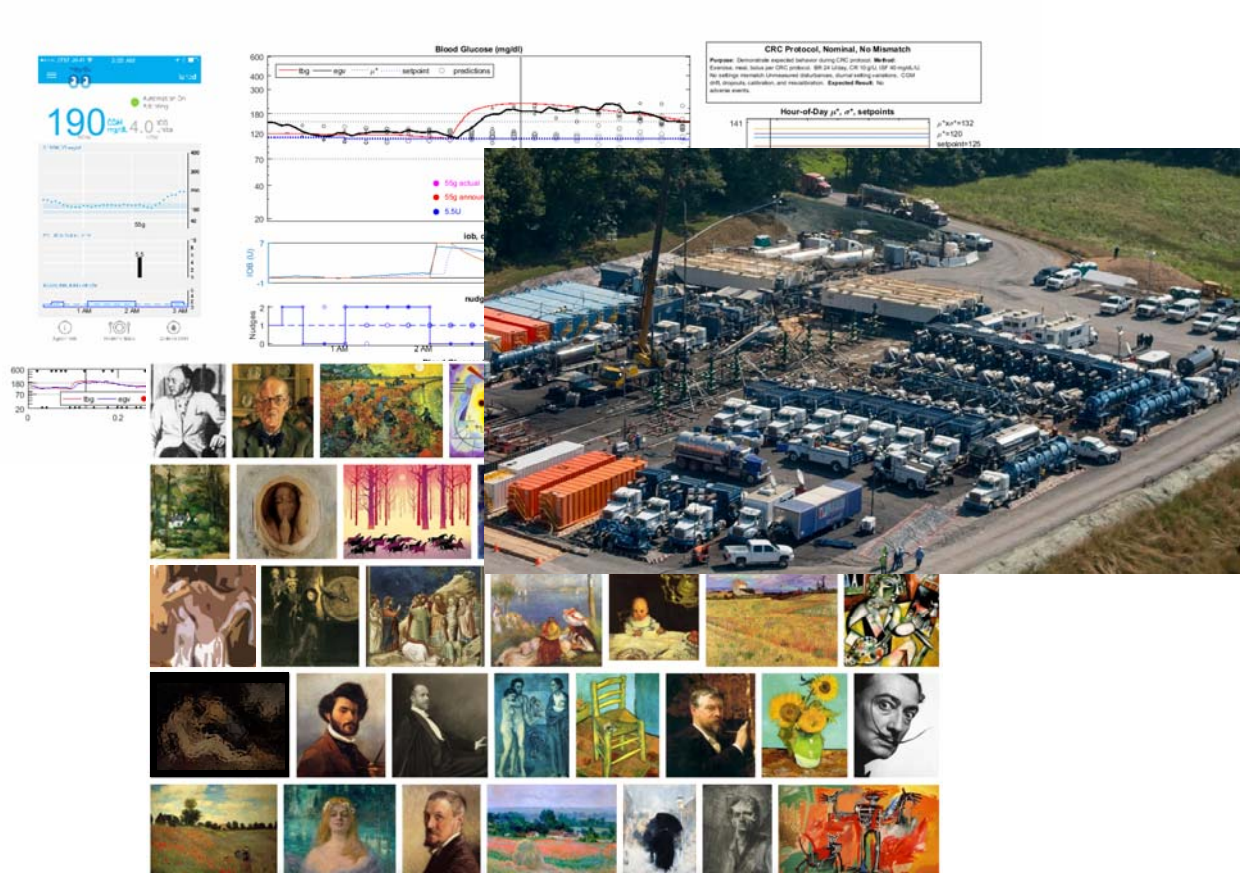
Virtual Clinic
Scaling computations to simulate 50 million patients a day



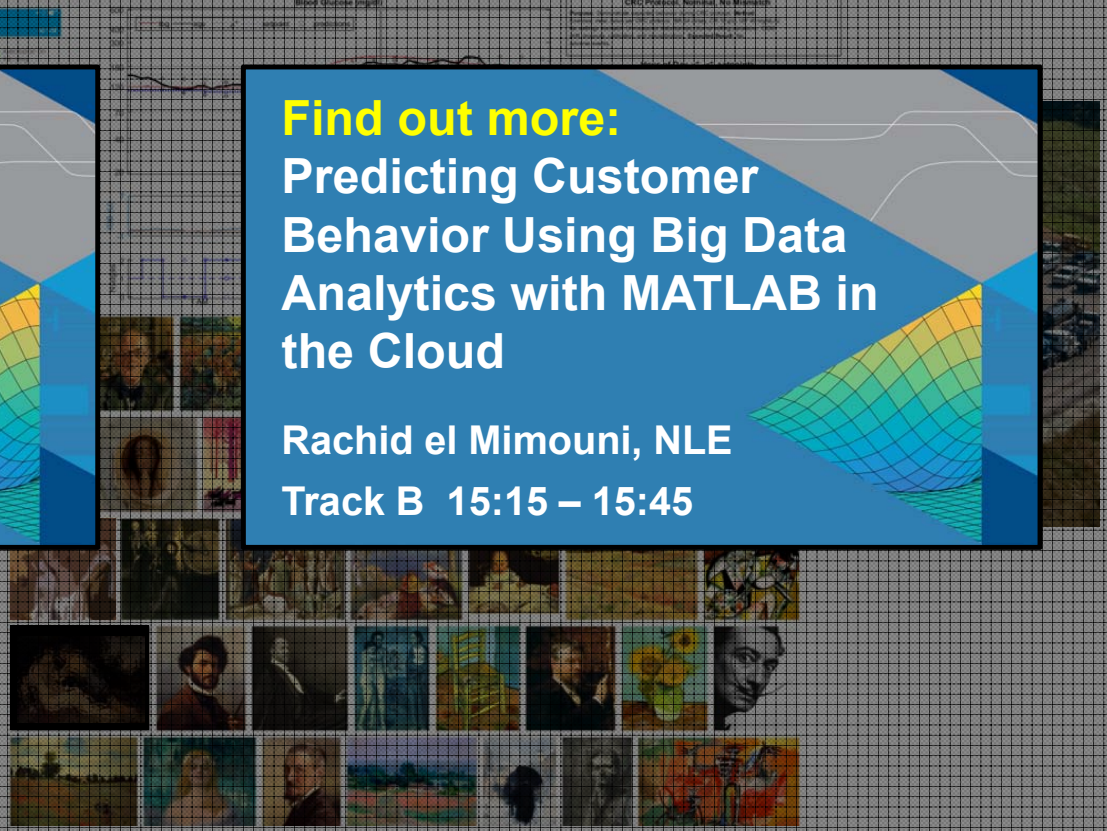
amazon web services

Where will you get your data?

- Simulation
- Public repositories
- In the lab
- In the field
- Internet of Things (IoT)



Where will you get your data?



Find out more:
Verification Techniques for Model and Code

Paul Lambrechts
Track A 15:15 – 15:45

Find out more:
Predicting Customer Behavior Using Big Data Analytics with MATLAB in the Cloud

Rachid el Mimouni, NLE
Track B 15:15 – 15:45

Autonomous Trailer Filling

Sense

Perceive

Decide & Plan

Act

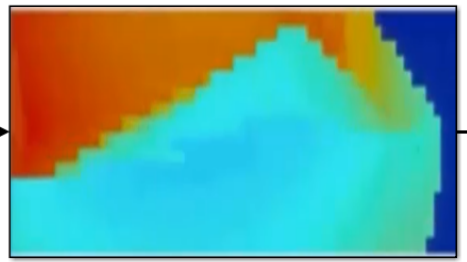
Autonomous Trailer Filling

Sense

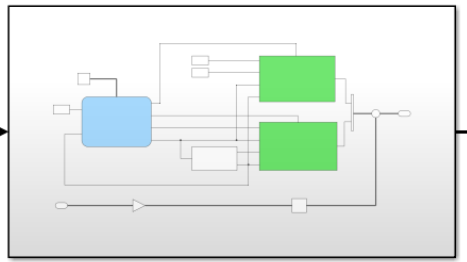
Perceive

Decide & Plan

Act

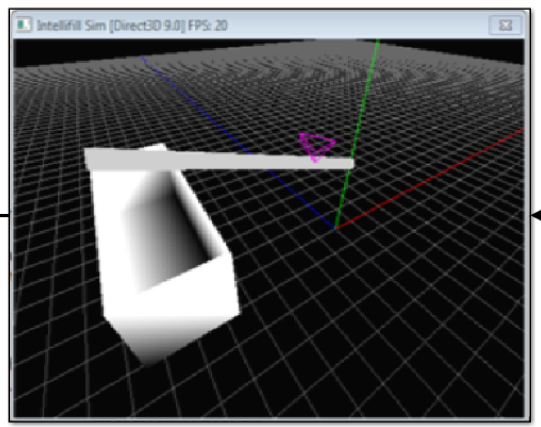


Computer Vision Algorithms



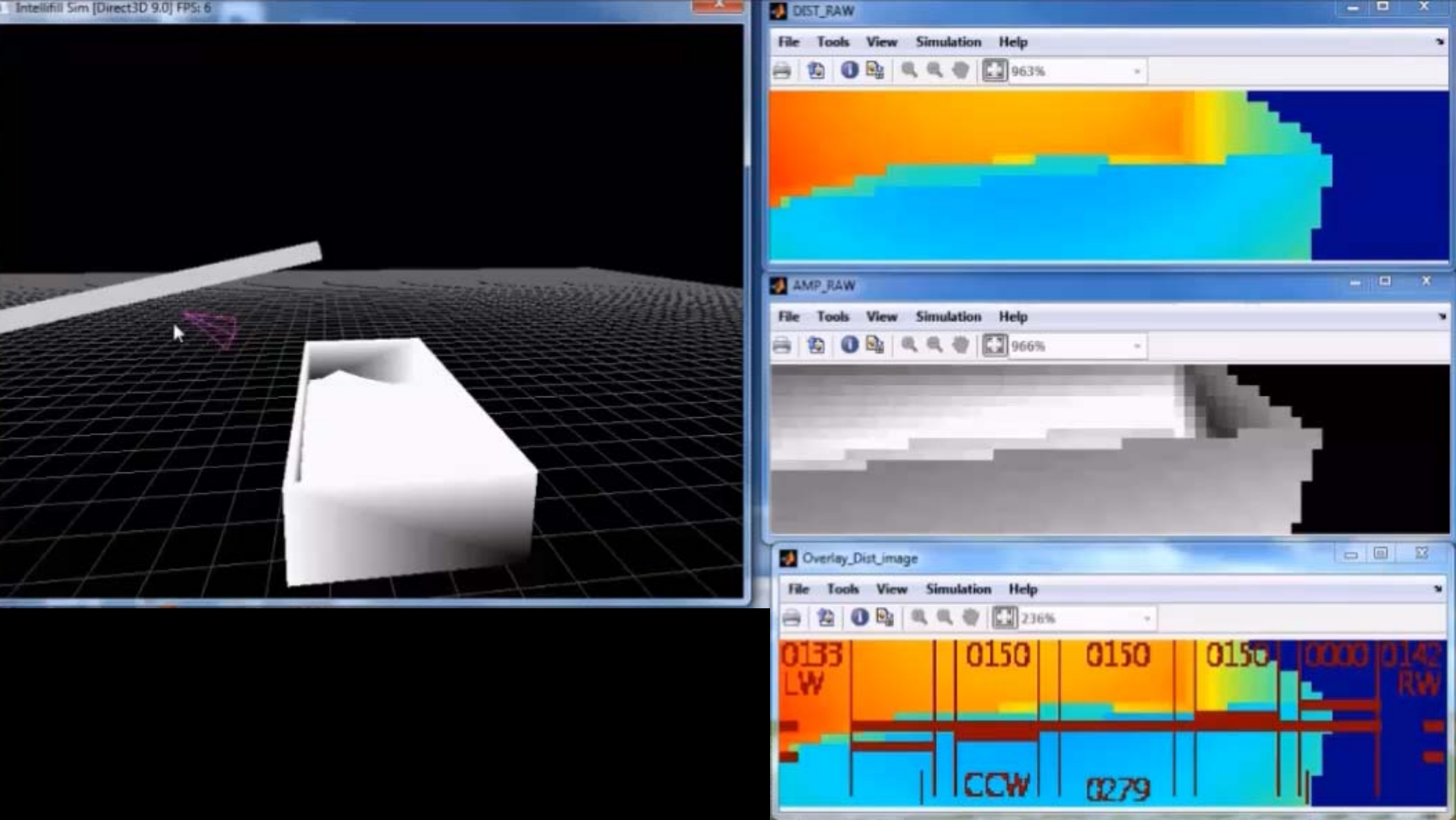
Control Algorithms

Control outputs



3D Scene Simulator

3D Camera Image


Intellifill Sim [Direct3D 9.0] FPS: 6
DIST_RAW
File Tools View Simulation Help
963%
AMP_RAW
File Tools View Simulation Help
966%
Overlay_Dist_image
File Tools View Simulation Help
236%
0133
LW
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0150
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0142
RW
CCW
0279

Autonomous Trailer Filling

Sense

Perceive

Decide & Plan

Act

3D Cameras

Computer vision and controls algorithms

CAN

ECU

Actuators

Autonomous Trailer Filling

Sense

Perceive

Decide & Plan

Act

3D Cameras

Vehicle Display Controller

- Driver Input
- Visualization

Actuators

CAN

ECU

Computer vision and controls algorithms

Autonomous Trailer Filling

Sense

Perceive

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Vehicle Display Controller

- Driver Input
- Visualization
- Computer Vision
- Controls

3D Cameras

Embedded Coder

CAN

Actuators

ECU

Computer vision and controls algorithms

Autonomous Trailer Filling

Sense

Perceive

Decide & Plan

Act

Vehicle Display Controller

- Driver Input
- Visualization
- Computer Vision
- Controls

3D Cameras

CAN

Monitoring

ECU

Actuators

How will you put it into production?

- System Architecture

- Embedded systems
- Enterprise systems
- HMIs

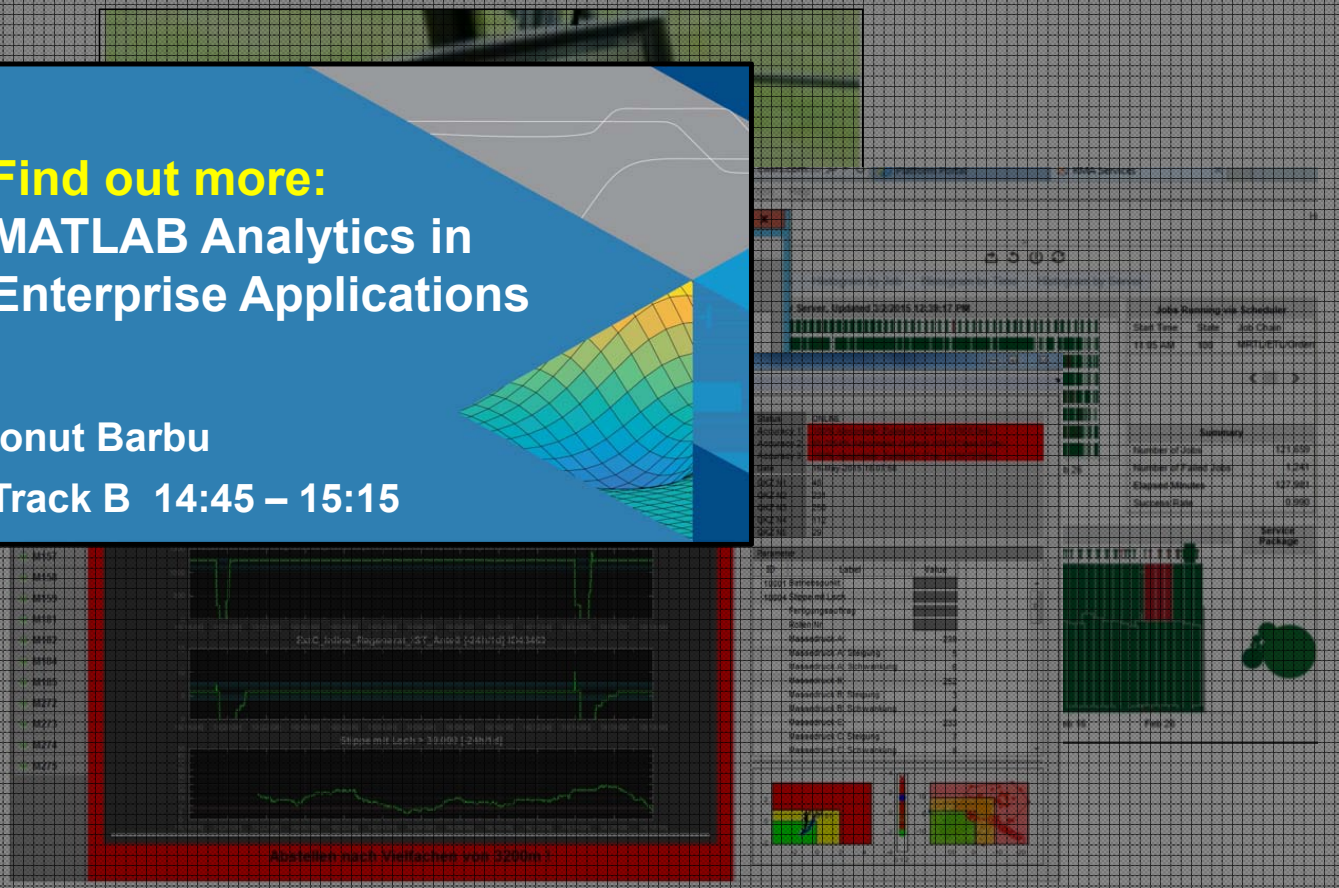
How will you put it into production?

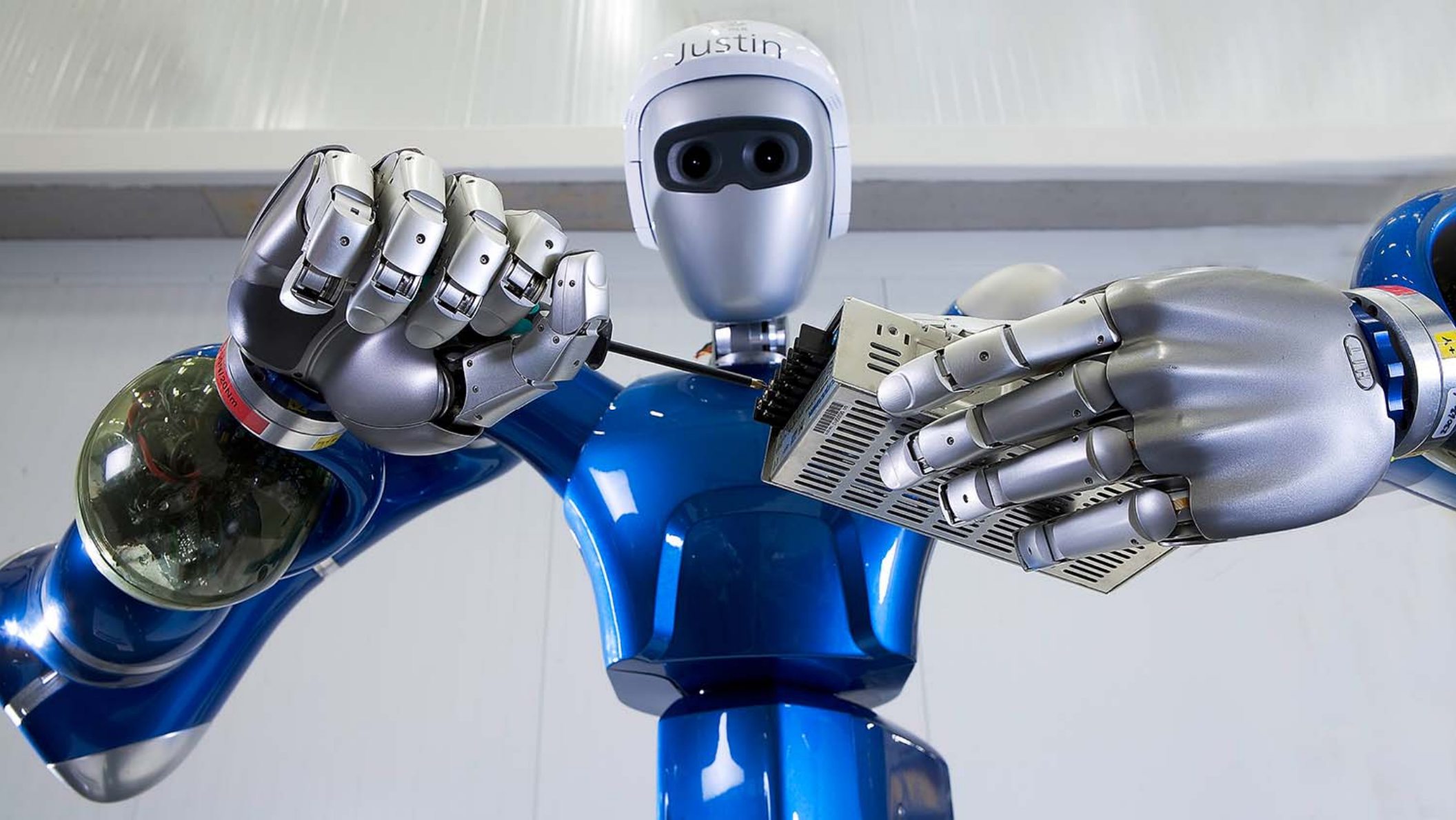
- System Architecture
- Embedded systems
- Enterprise systems
- HMIs

Find out more:
MATLAB Analytics in Enterprise Applications

Ionut Barbu

Track B 14:45 – 15:15




Justin

How to build an autonomous anything

Focus on Perception	• Look for autonomy in creative places • Do more than manually possible
Use the Best Predictors	• Data-driven • Model-driven
Get the Right Data	• Reduce to actionable data • Take advantage of Big Data • Use simulation to supplement available data
Go to Production	• Address the architecture • Leverage Model-Based Design for embedded • Automate integration with enterprise IT systems

What is ***your***
autonomous anything?