

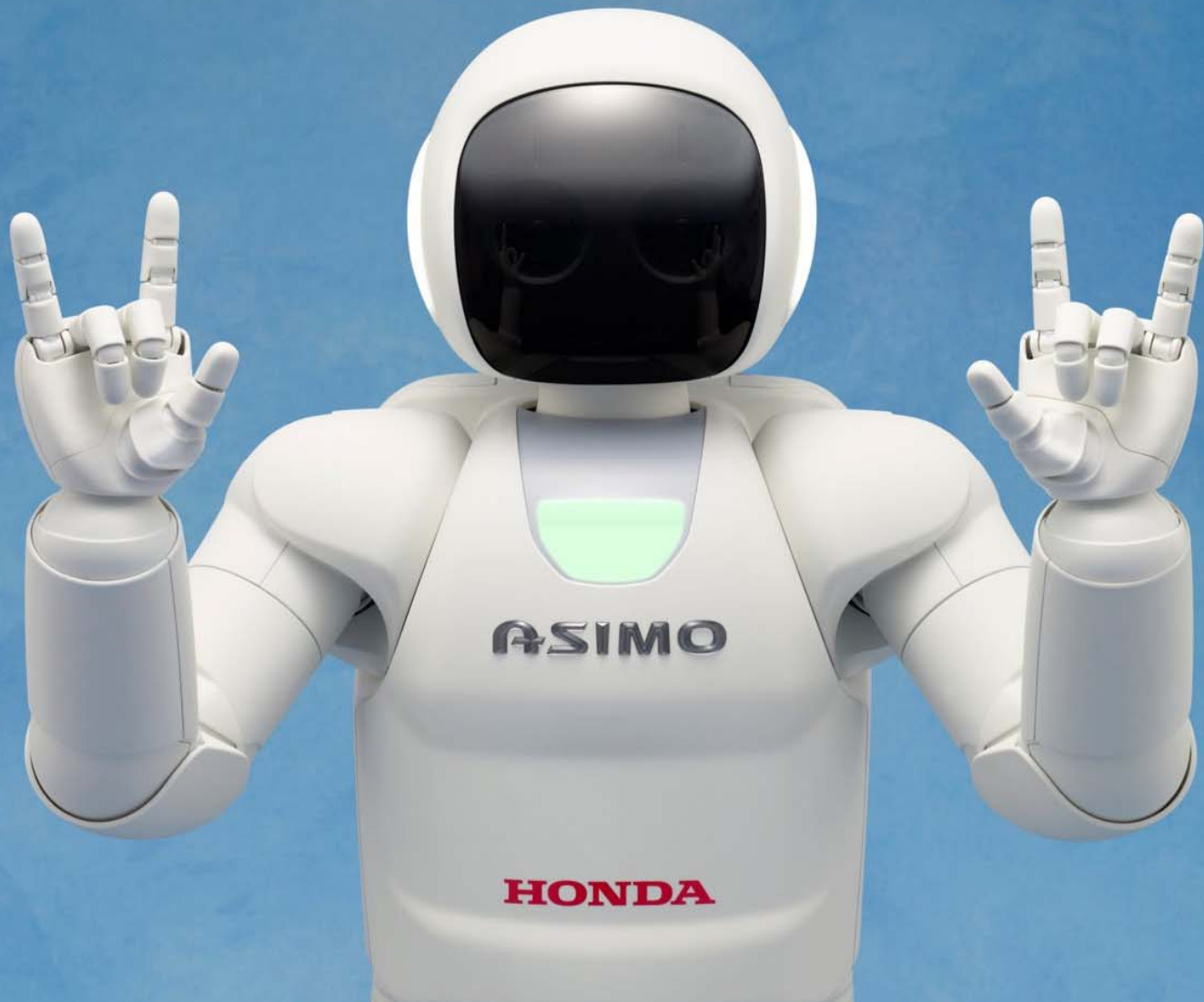
MATLAB EXPO 2017

How to build an **autonomous** anything

Michelle Hirsch

Head of MATLAB Product Management
MathWorks





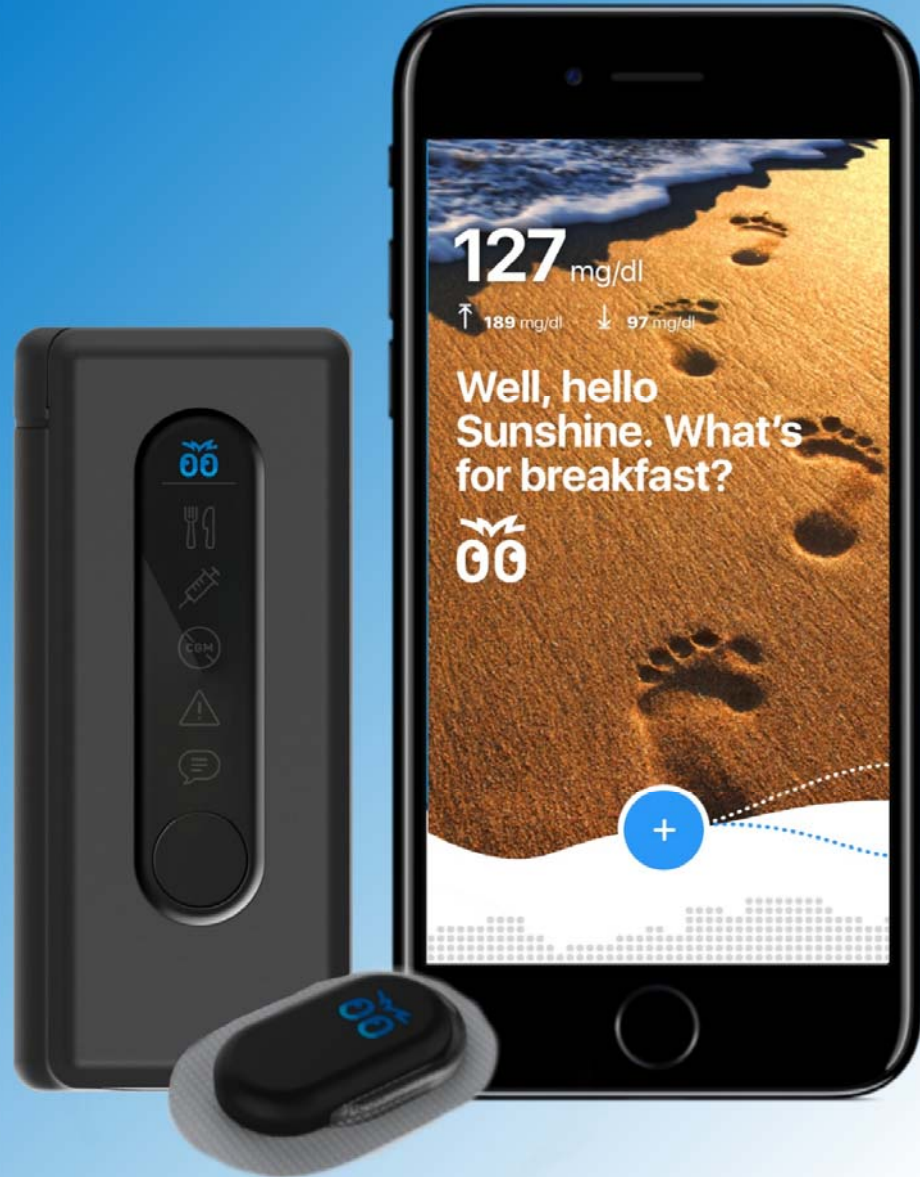
ASIMO

HONDA









127 mg/dl

↑ 189 mg/dl ↓ 97 mg/dl

Well, hello Sunshine. What's for breakfast?

00

+

00

Autonomous Technology

Autonomous

Having the power for self-governance

Autonomous Technology

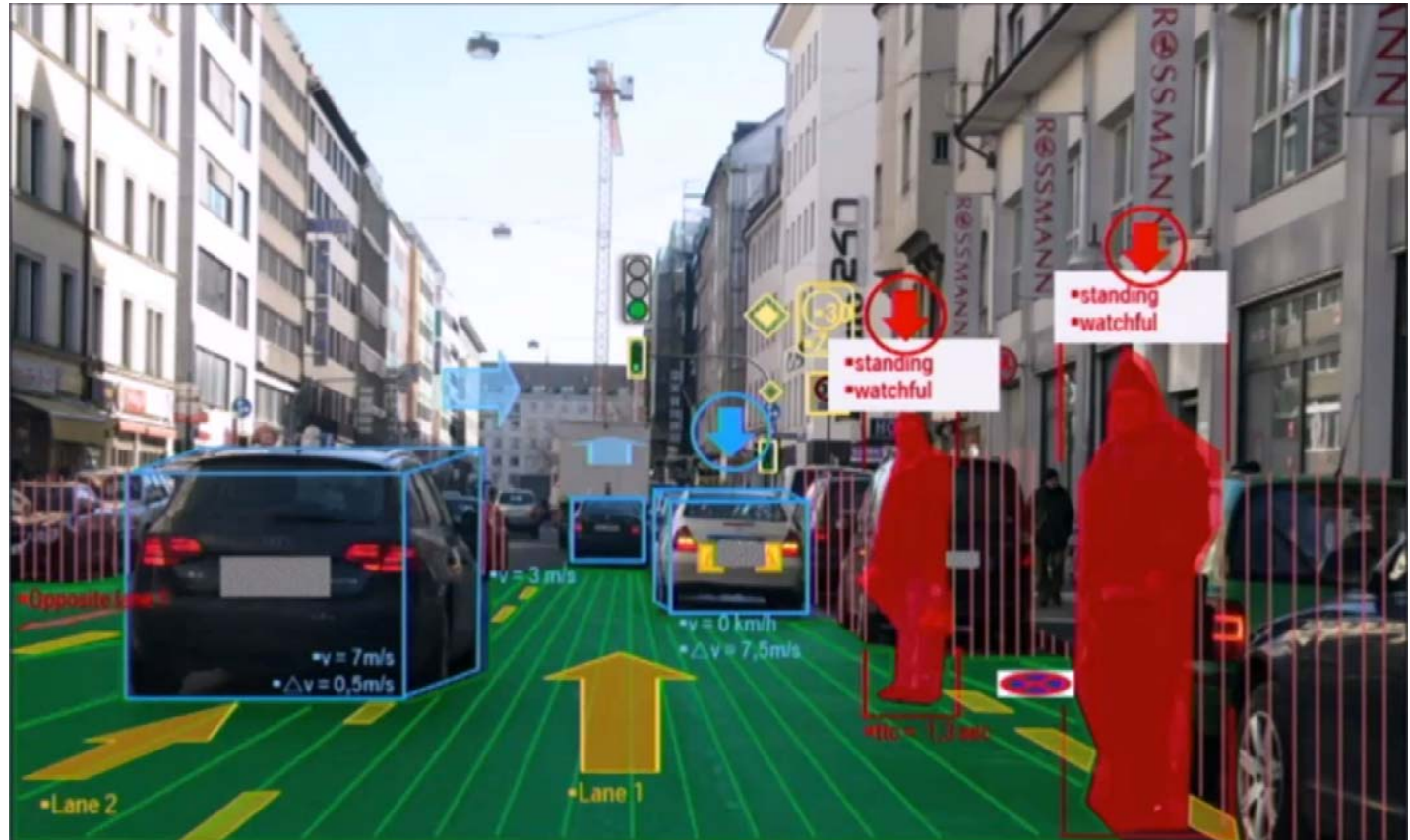
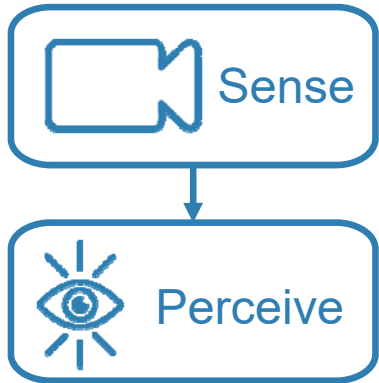
*Provides the ability of a system to act **independently** of direct human control under **unrehearsed** conditions*



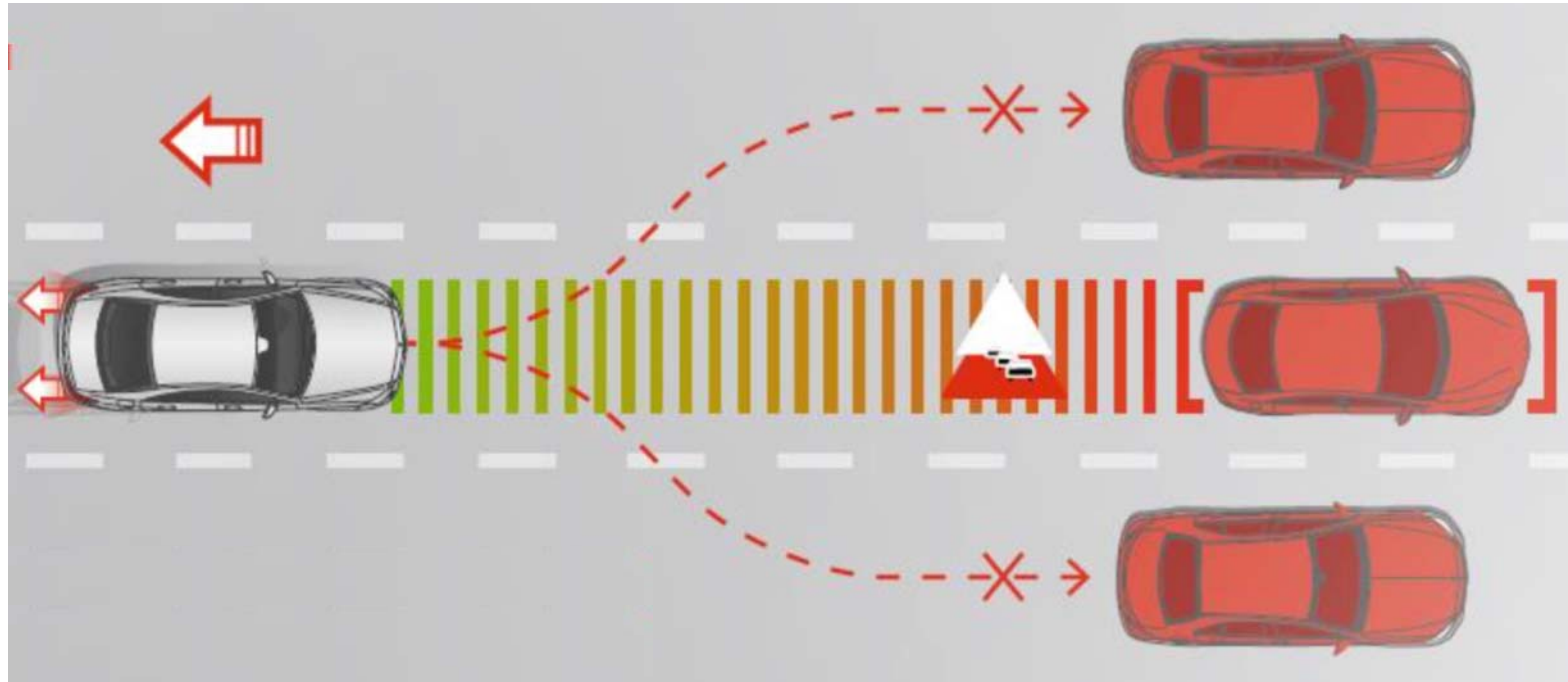
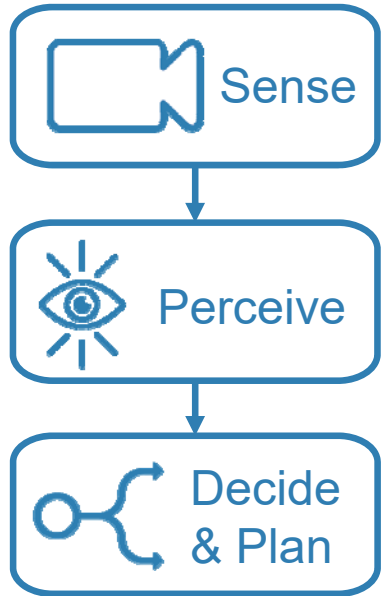
Capabilities of an Autonomous System



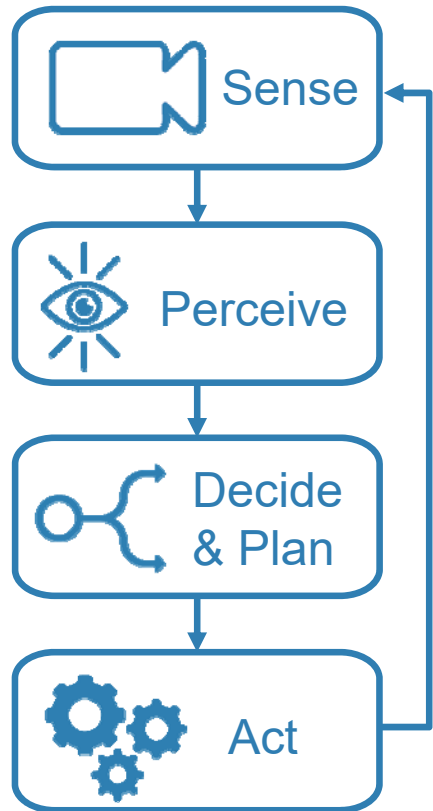
Capabilities of an Autonomous System



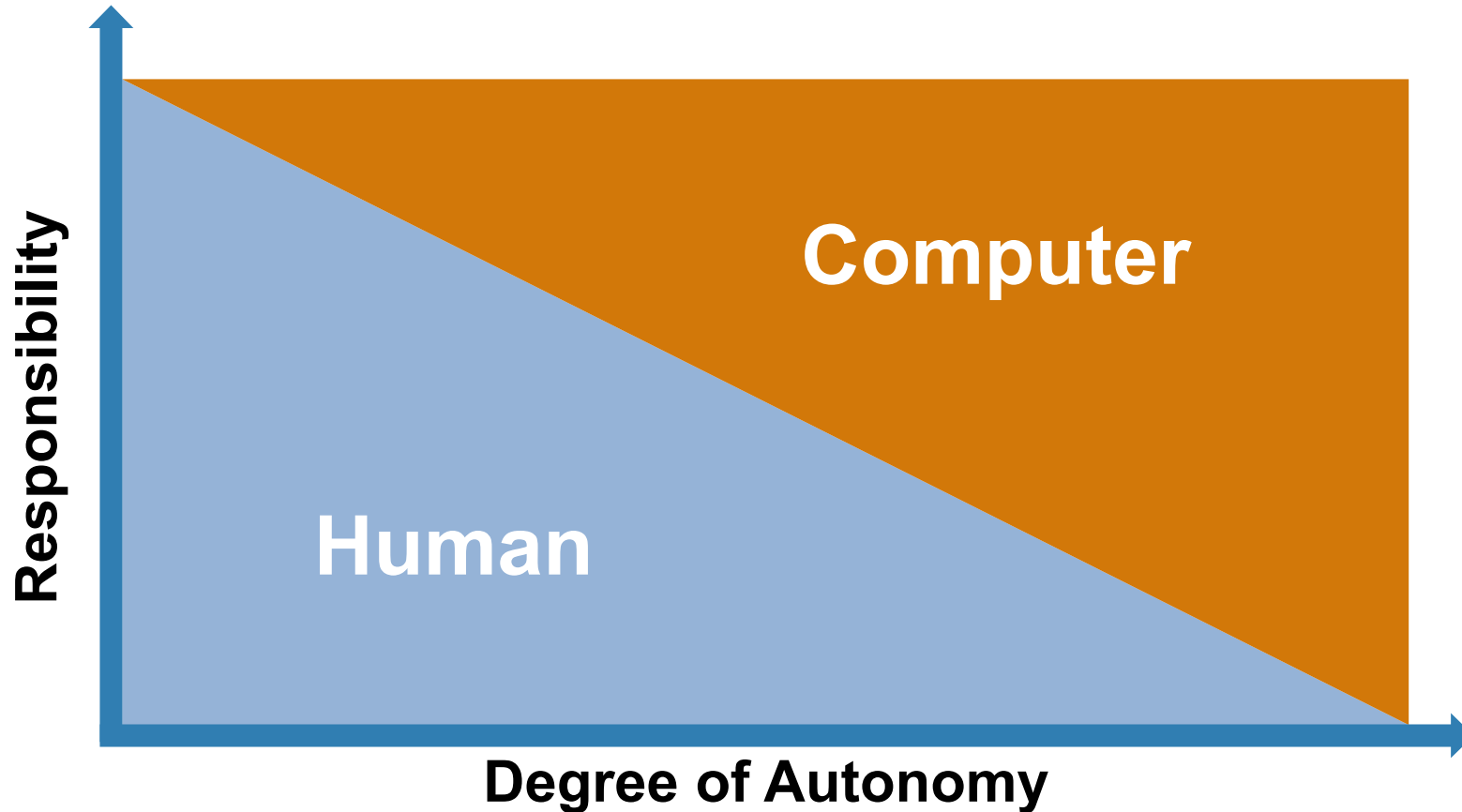
Capabilities of an Autonomous System



Capabilities of an Autonomous System



Autonomous Technology Transfers Responsibility to Computers



Cost of rig: >\$1M

Repair cost: \$100,000

Cost of valve: \$200



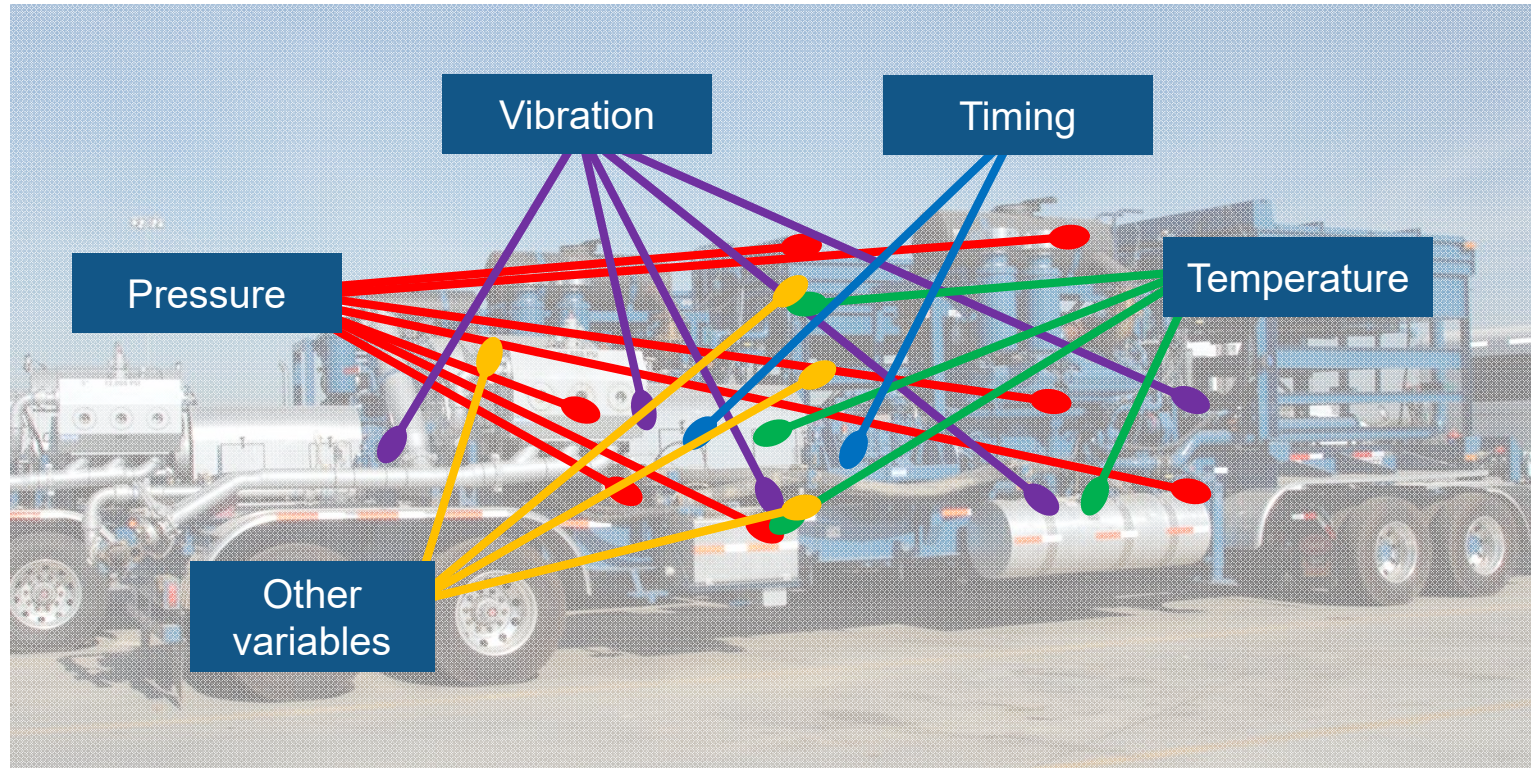




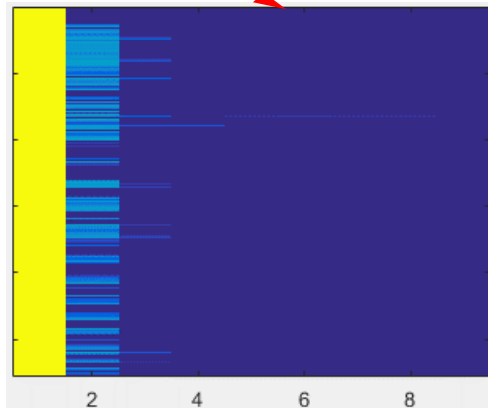
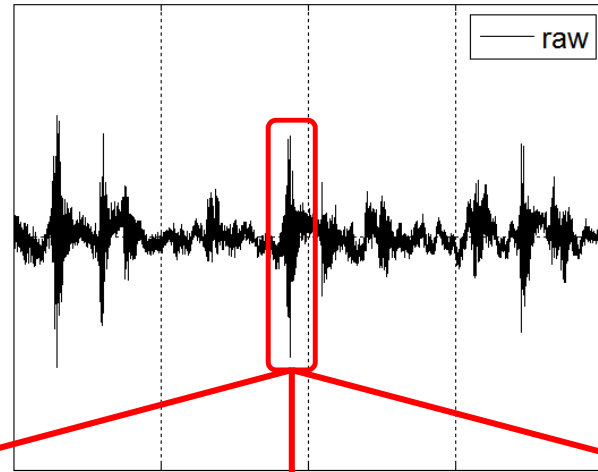


Autonomous Service for Predictive Maintenance

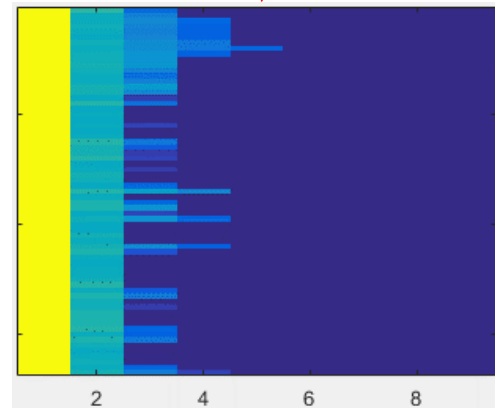
Which sensor values should they use?



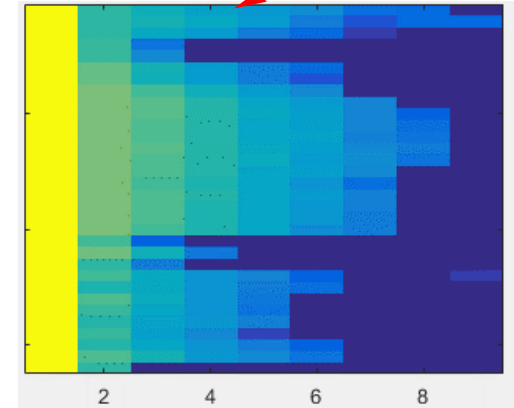
Autonomous Service for Predictive Maintenance



Normal Operation



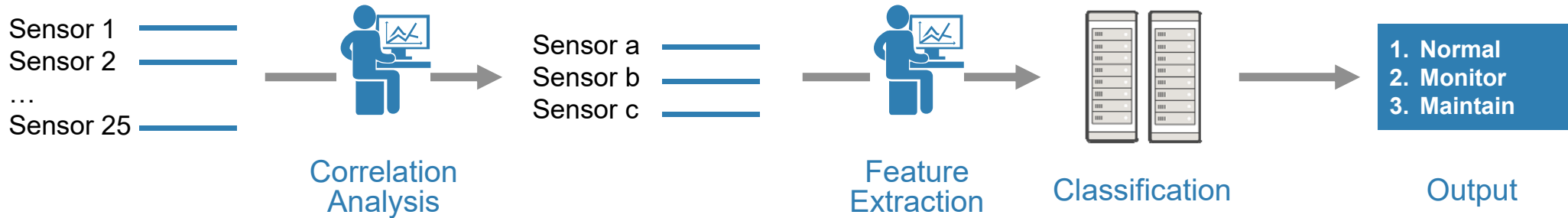
Monitor Closely



Maintenance Needed

Machine Learning or Deep Learning?

Machine Learning Approach



Deep Learning Approach



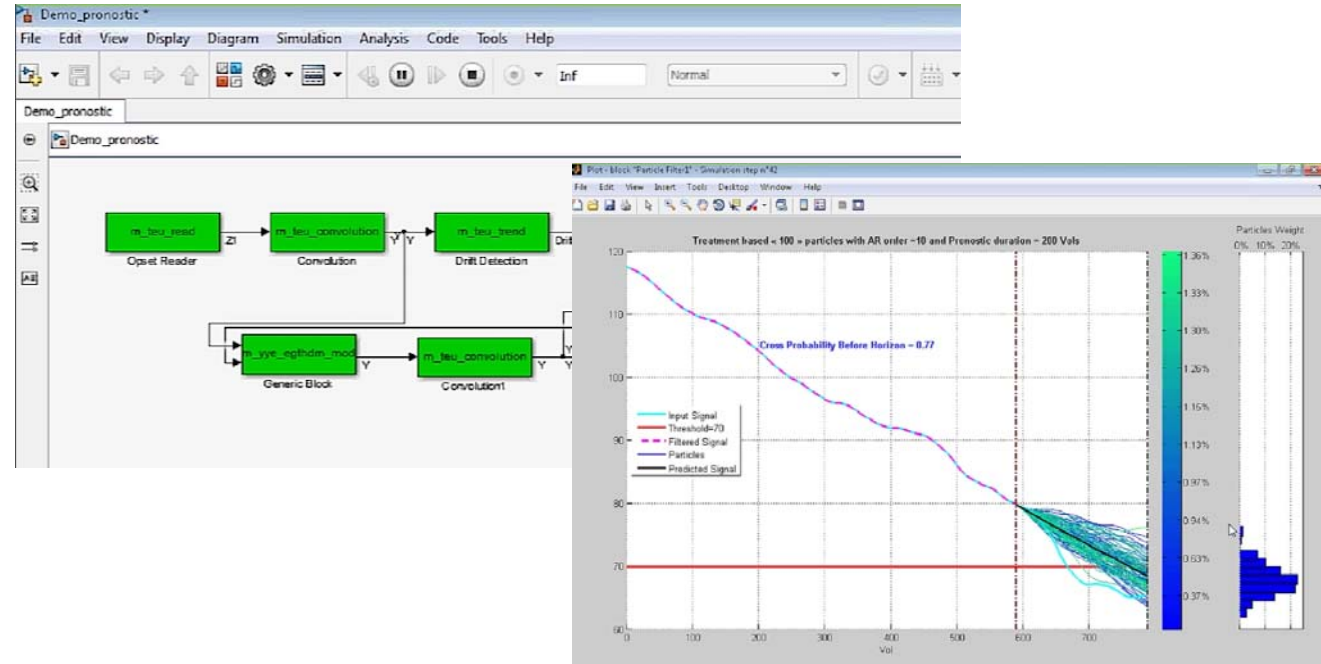
What are the best predictors?

- Data-driven

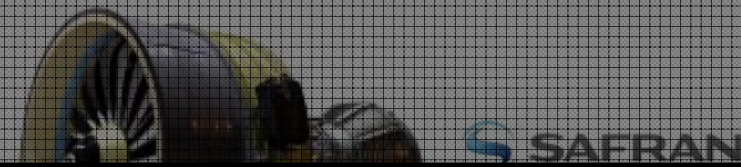
What are the best predictors?

- Data-driven
- Model-driven

Jet Engine Monitoring



What are the best predictors?

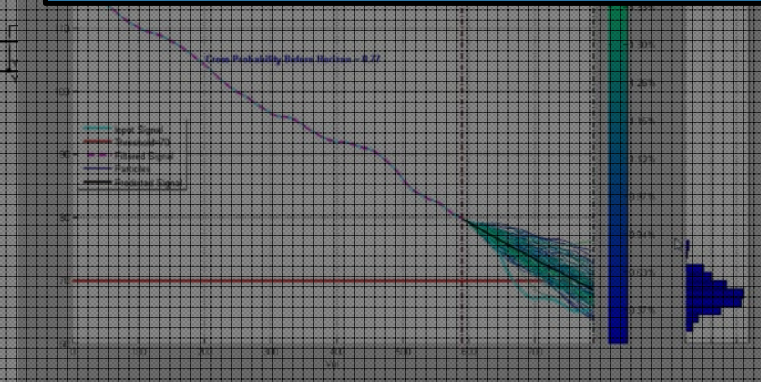
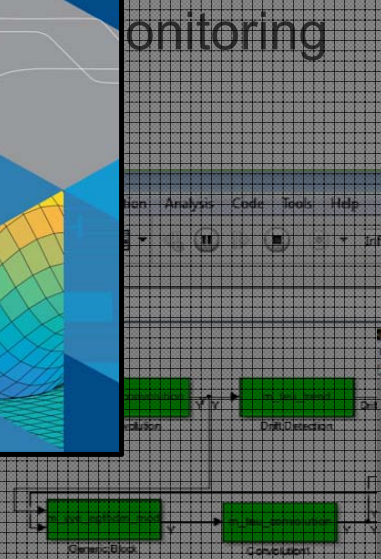


Find out more about machine learning:
Machine Learning Simplified

Paola Jaramillo
 Track B 13:15 – 13:45

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

Demo Station

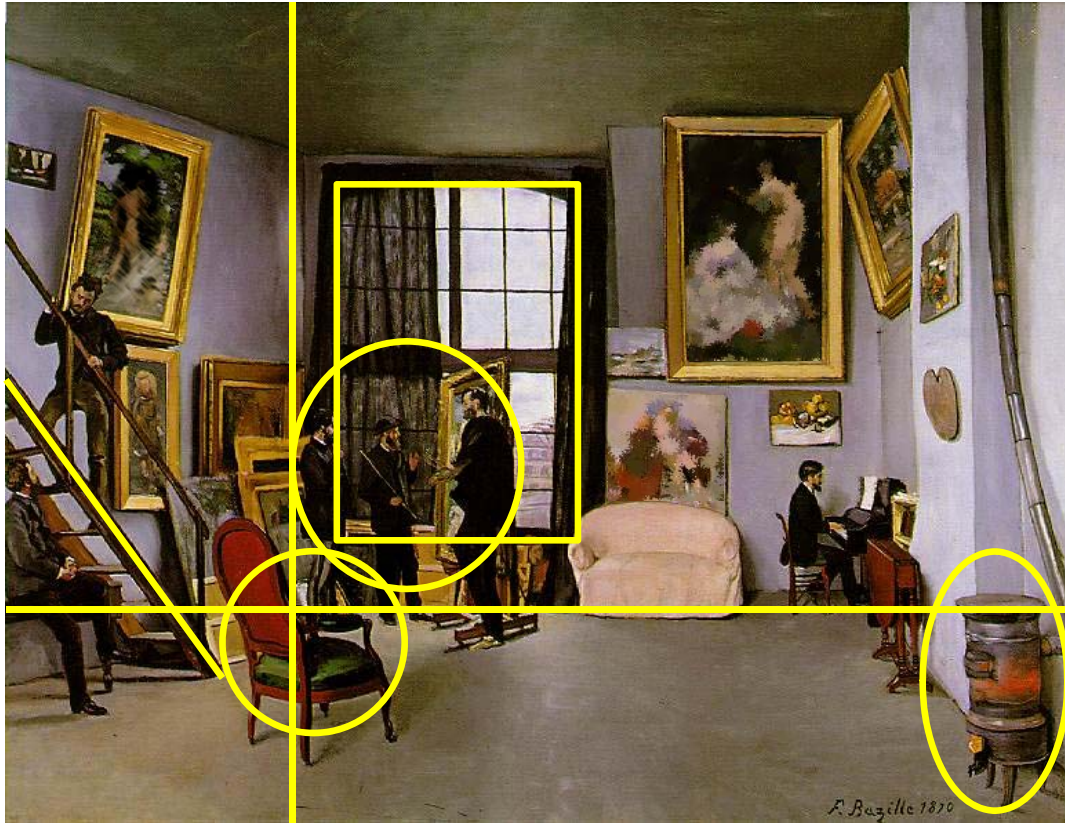




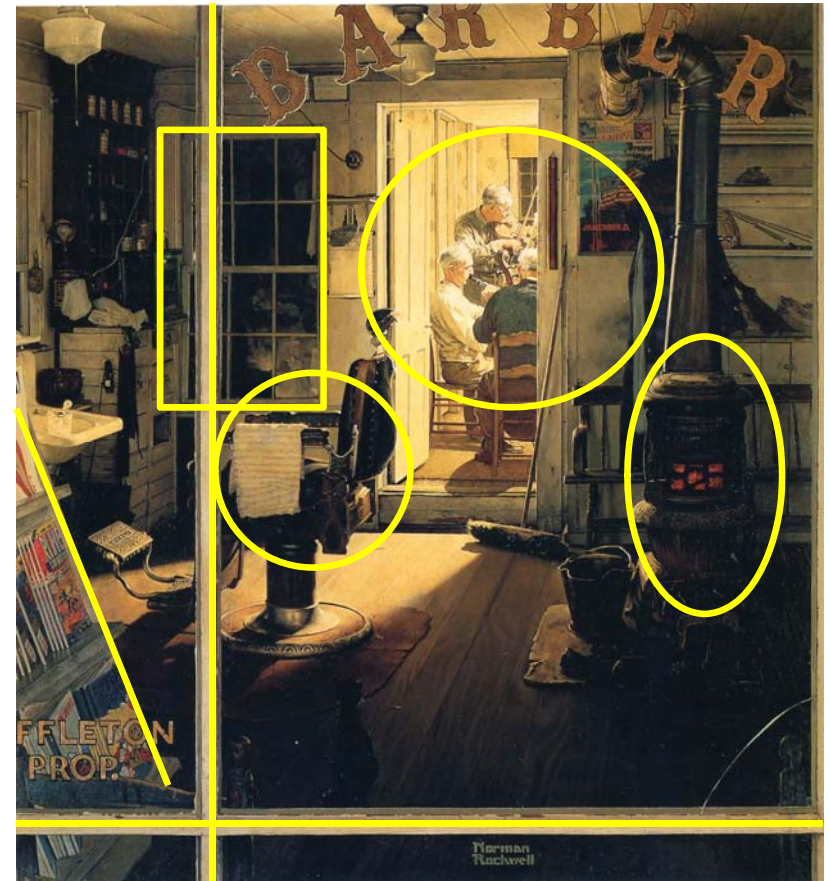
Bazille's Studio
Frederic Bazille (Paris, 1870)



Shuffleton's Barbershop
Norman Rockwell (Vermont, 1950)



Bazille's Studio
 Frederic Bazille (Paris, 1870)



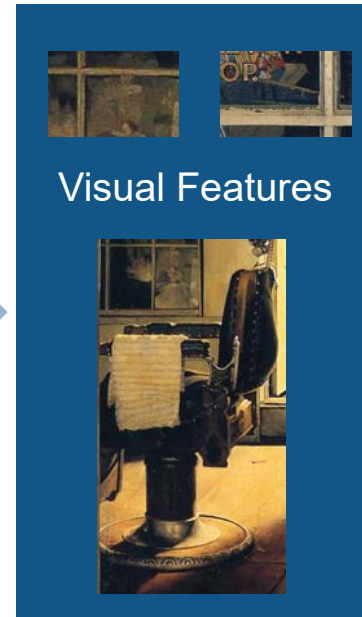
Shuffleton's Barbershop
 Norman Rockwell (Vermont, 1950)

Autonomous Artistic Style Classification

Rutgers University



Image
Feature
Extraction



Machine
Learning
Classification



Style:
Regionalism



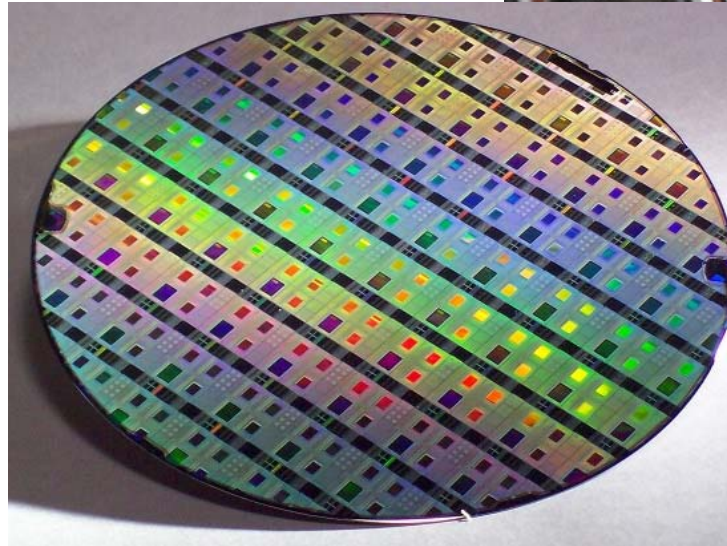
Genre:
Interior



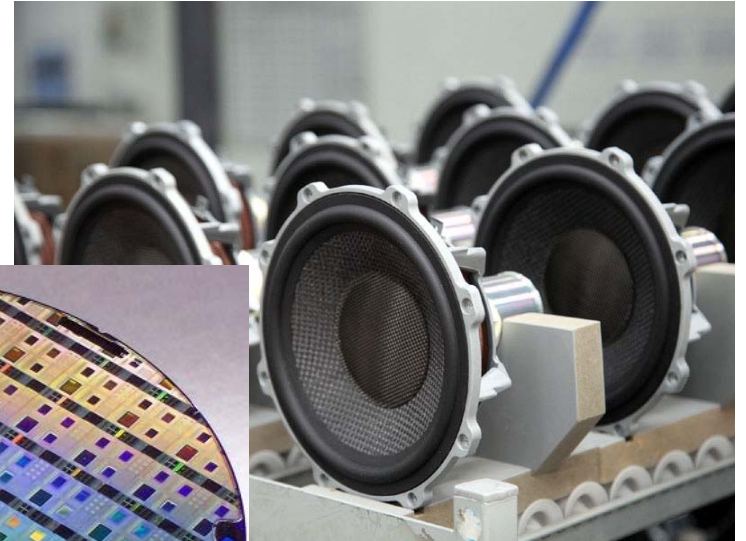
Artist:
Rockwell

Where to add autonomy with perception?

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



Virtual Semiconductor
Manufacturing Calibration



Determine
Loudspeaker
Quality

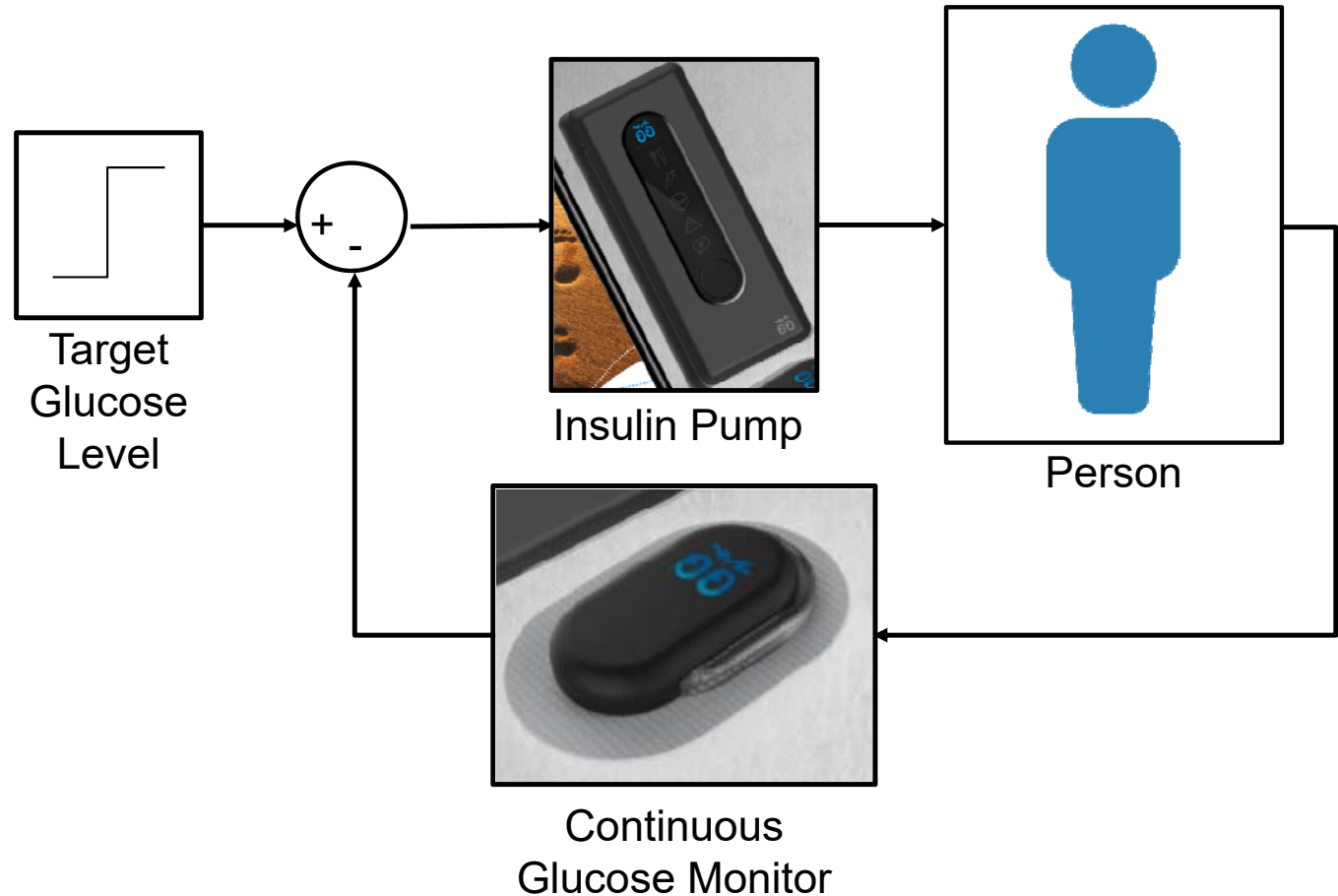
ASML

Autonomous Glucose Level Management



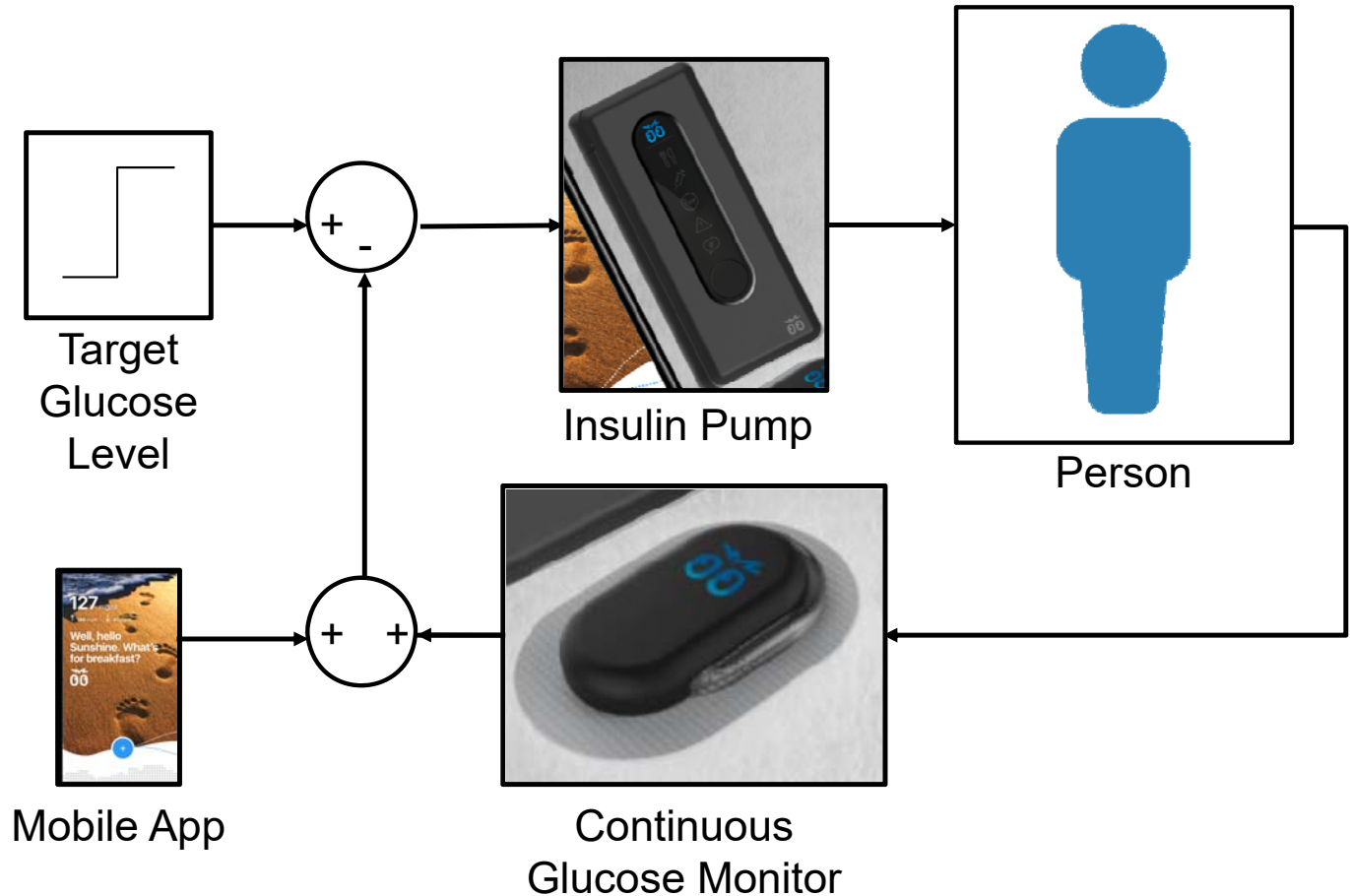
Autonomous Glucose Level Management

Bigfoot Biomedical



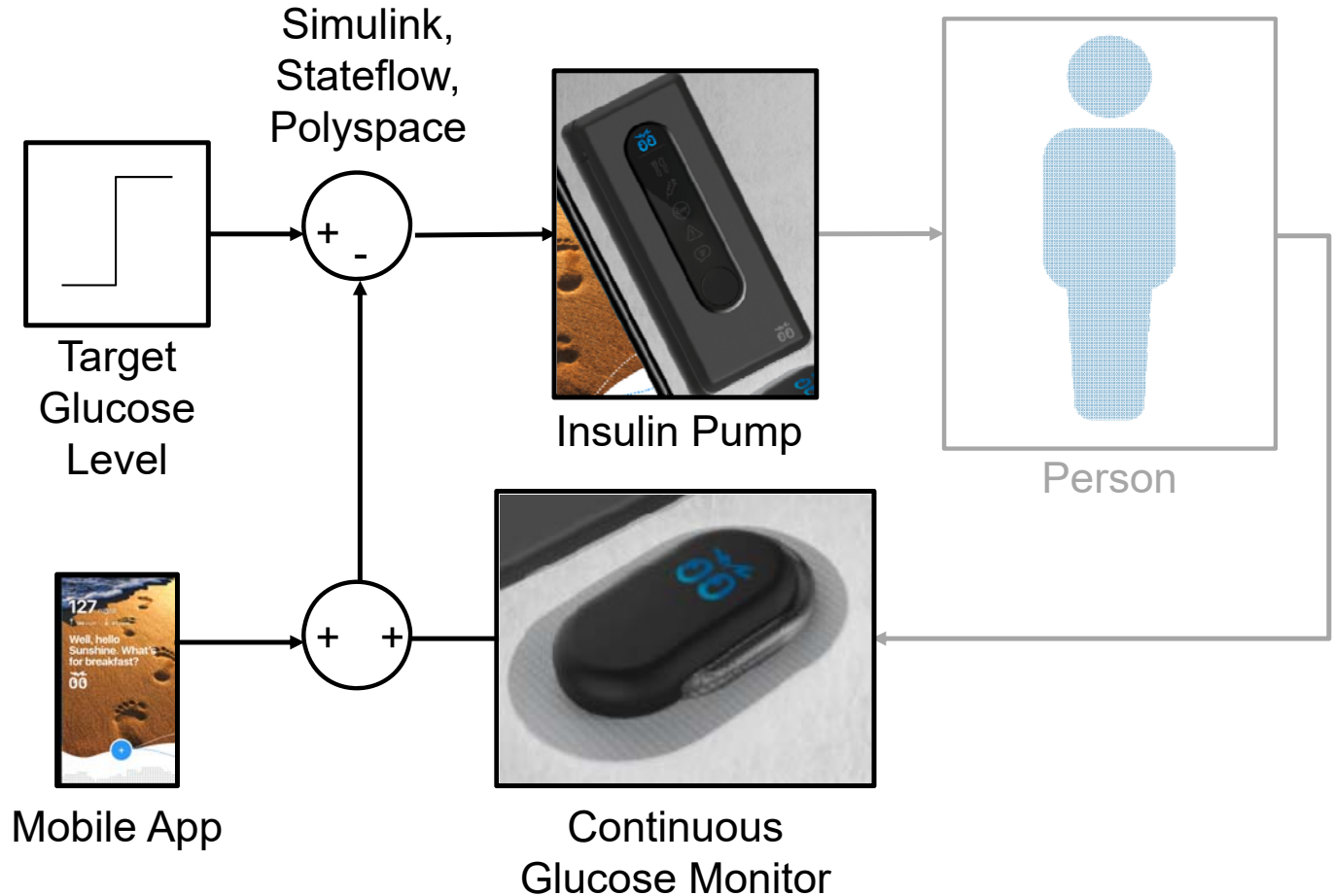
Autonomous Glucose Level Management

Bigfoot Biomedical



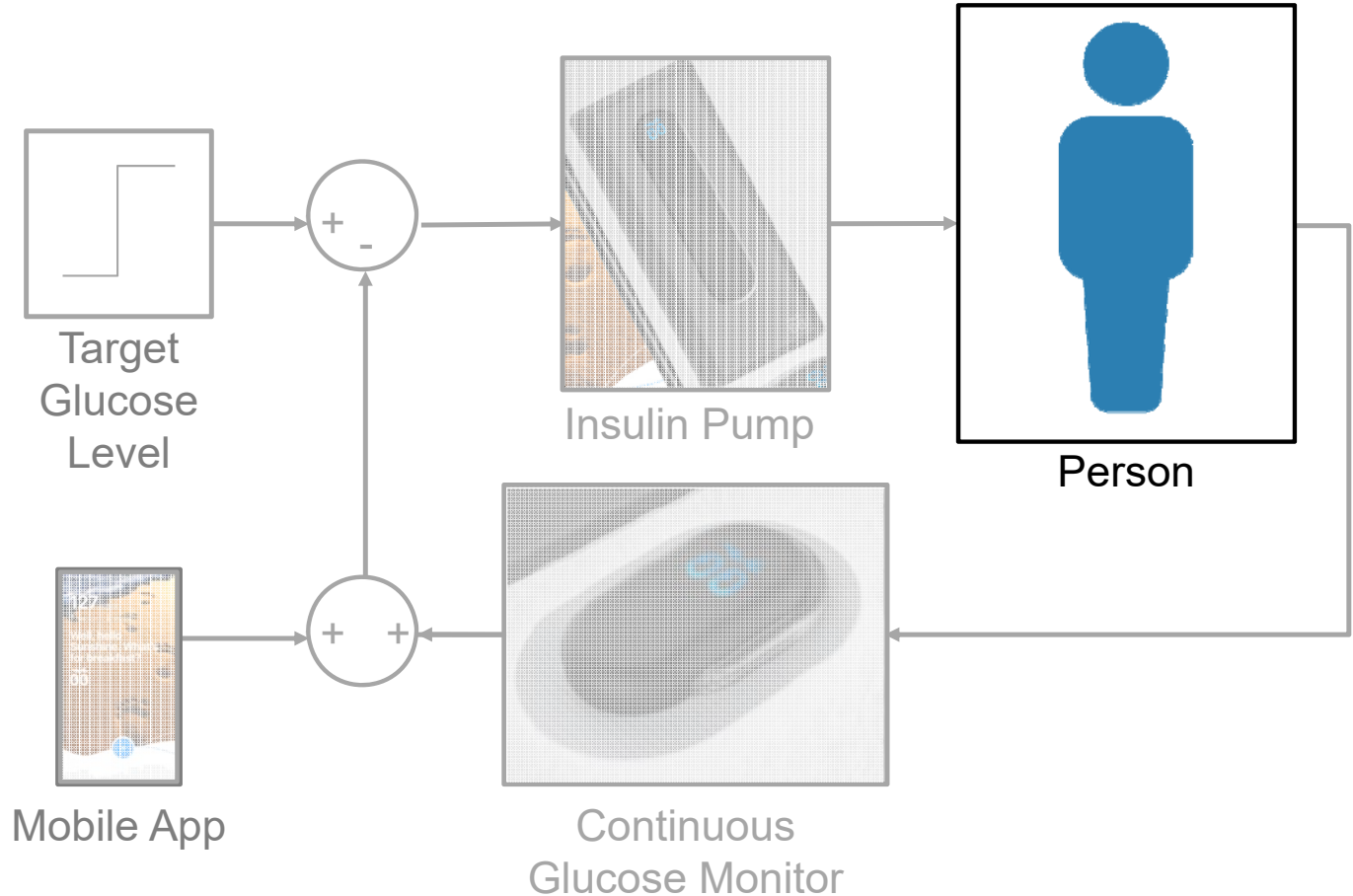
Autonomous Glucose Level Management

Bigfoot Biomedical



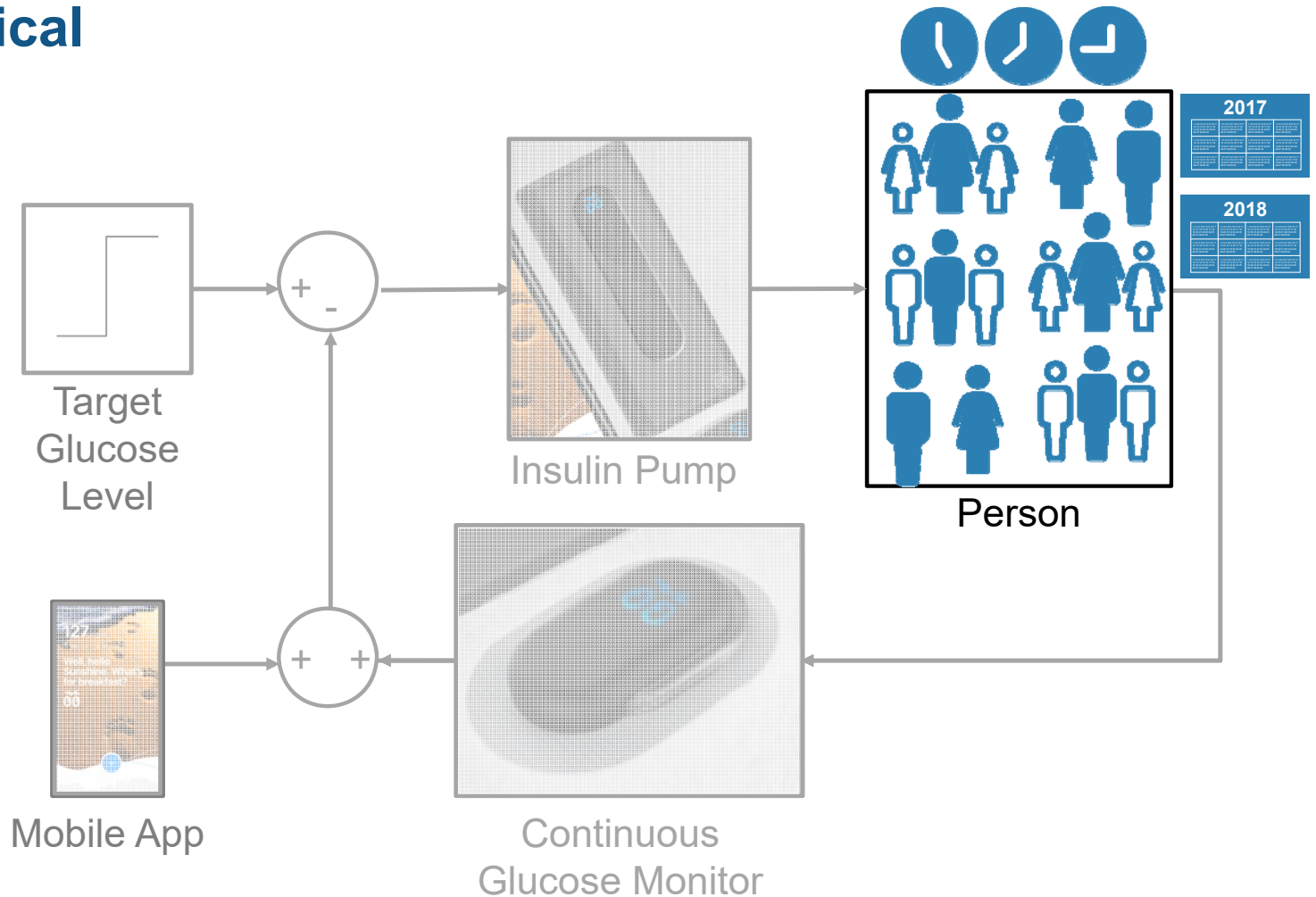
Autonomous Glucose Level Management

Bigfoot Biomedical



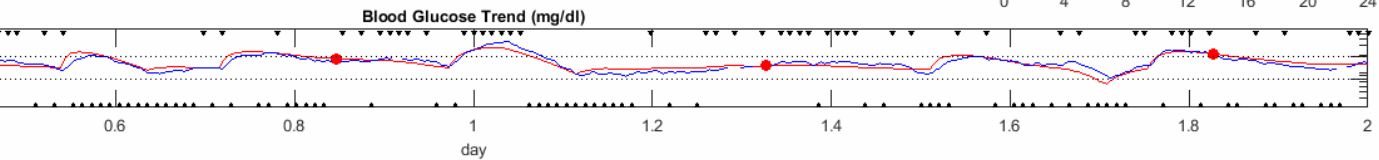
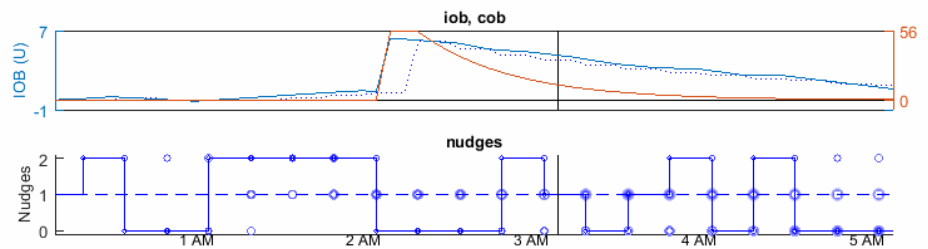
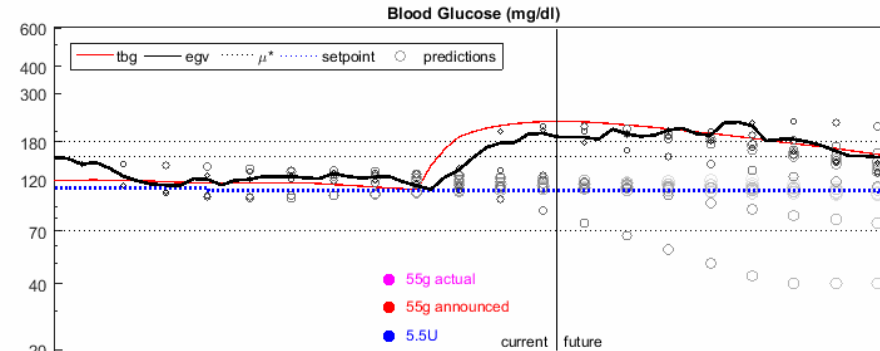
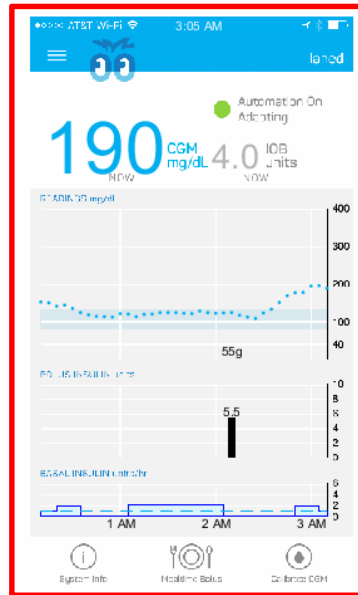
Autonomous Glucose Level Management

Bigfoot Biomedical



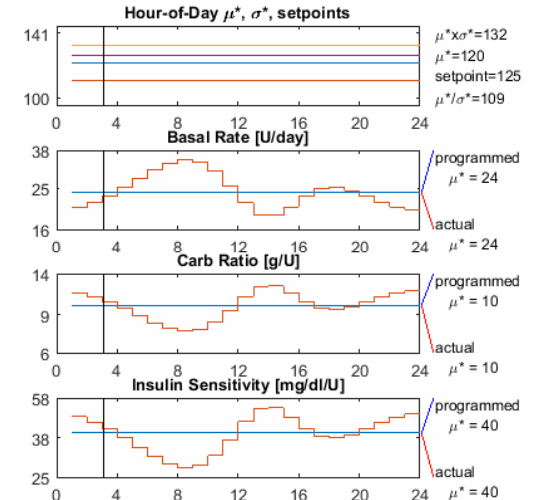
Virtual Clinic

Generating data through simulation



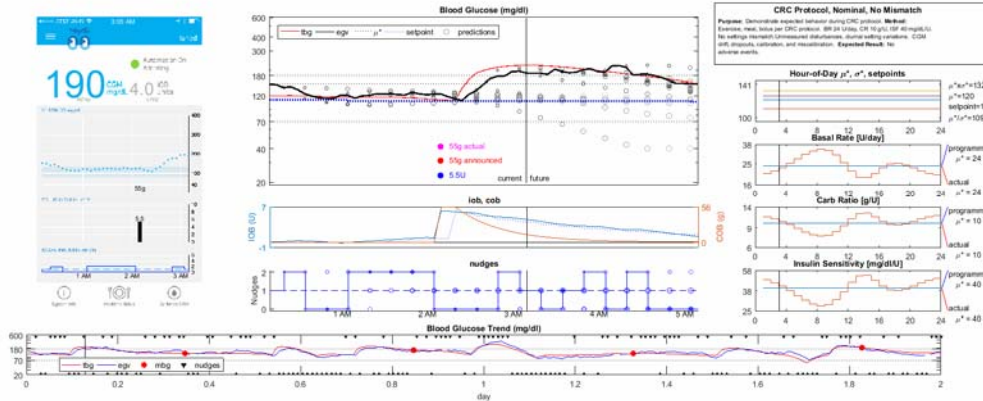
CRC Protocol, Nominal, No Mismatch

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.



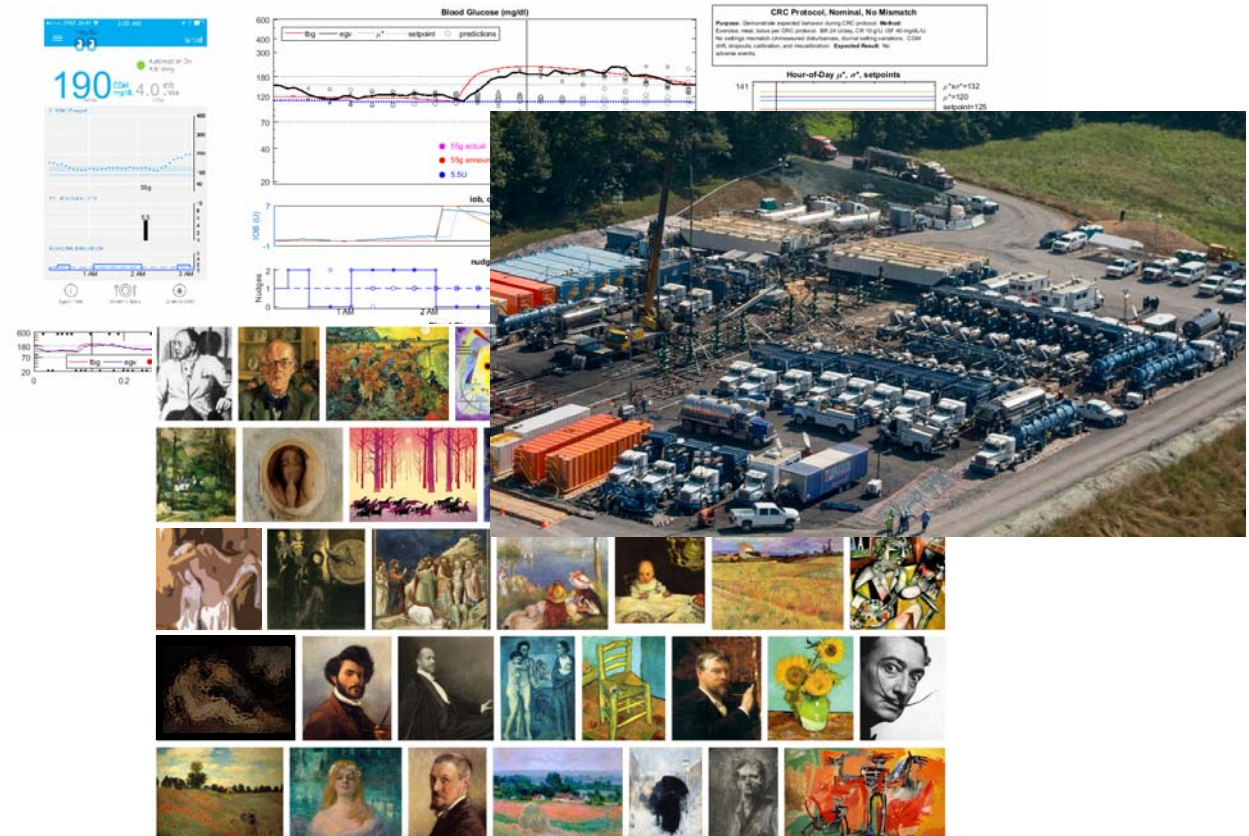
Virtual Clinic

Scaling computations to simulate 50 million patients a day



Where will you get your data?

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



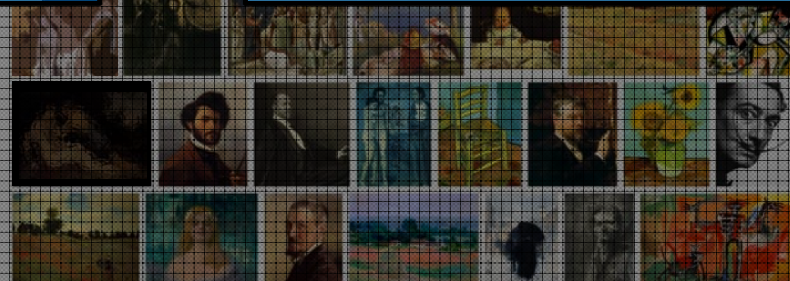
Where will you get your data?

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

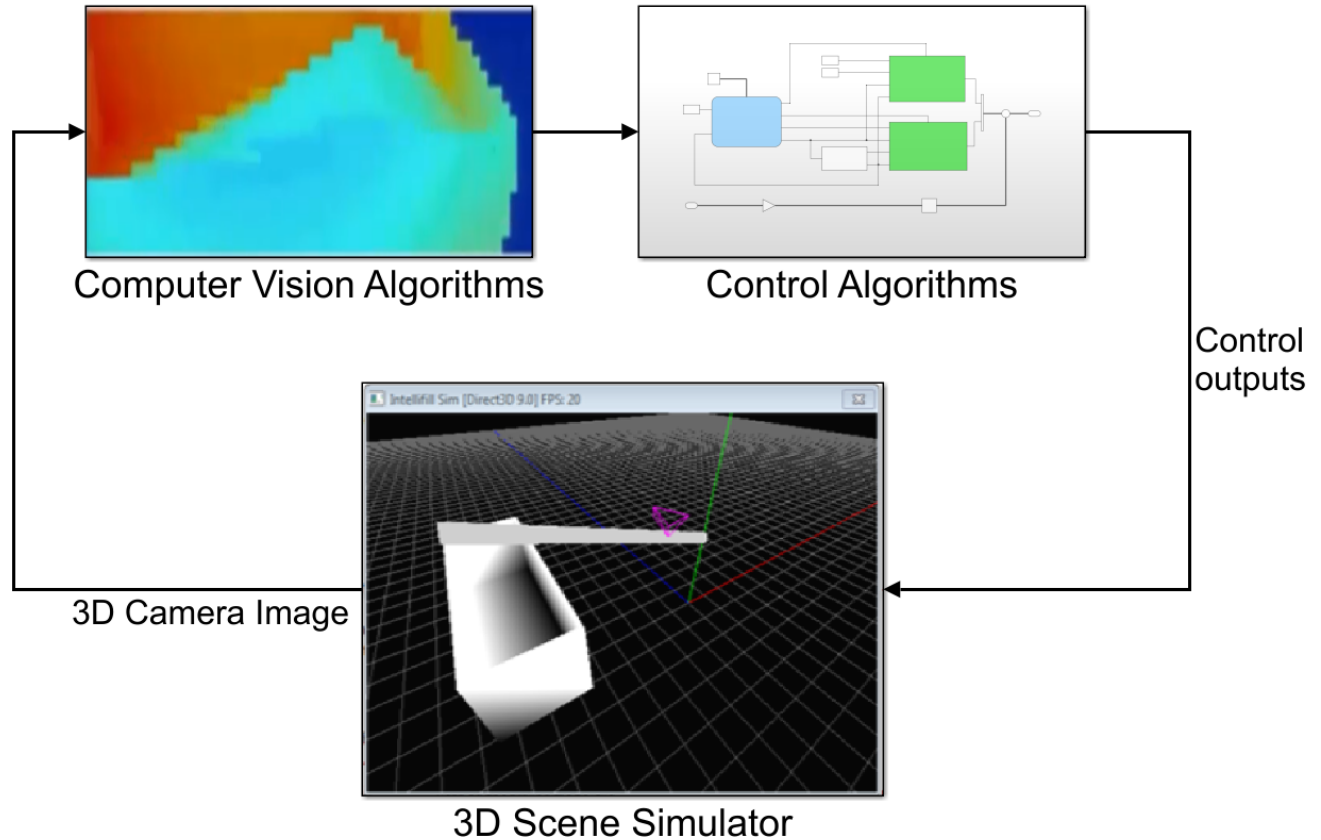


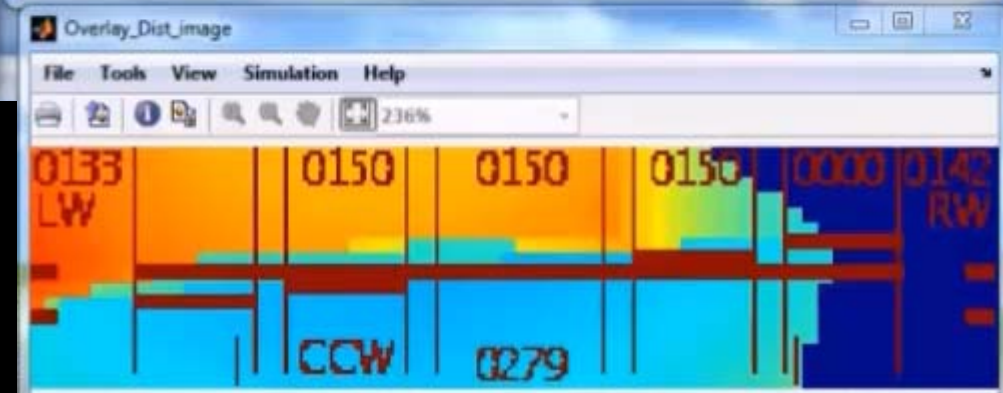
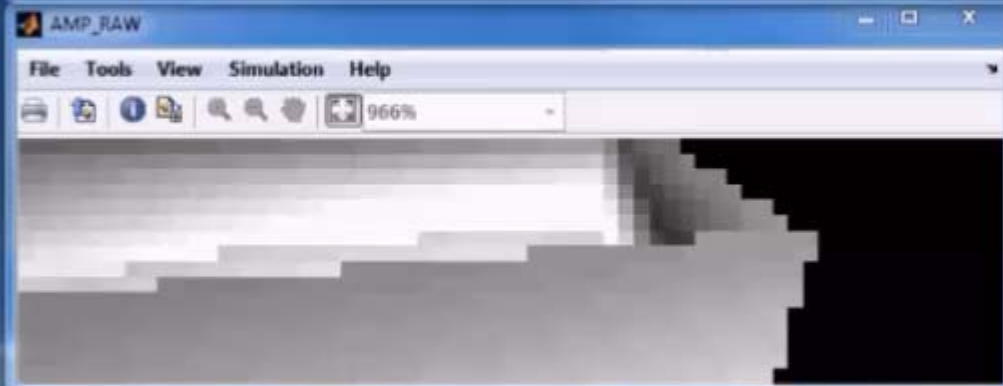
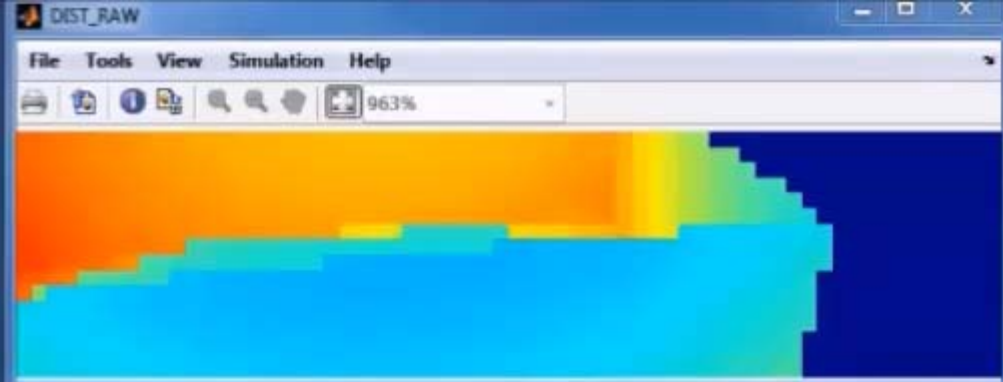
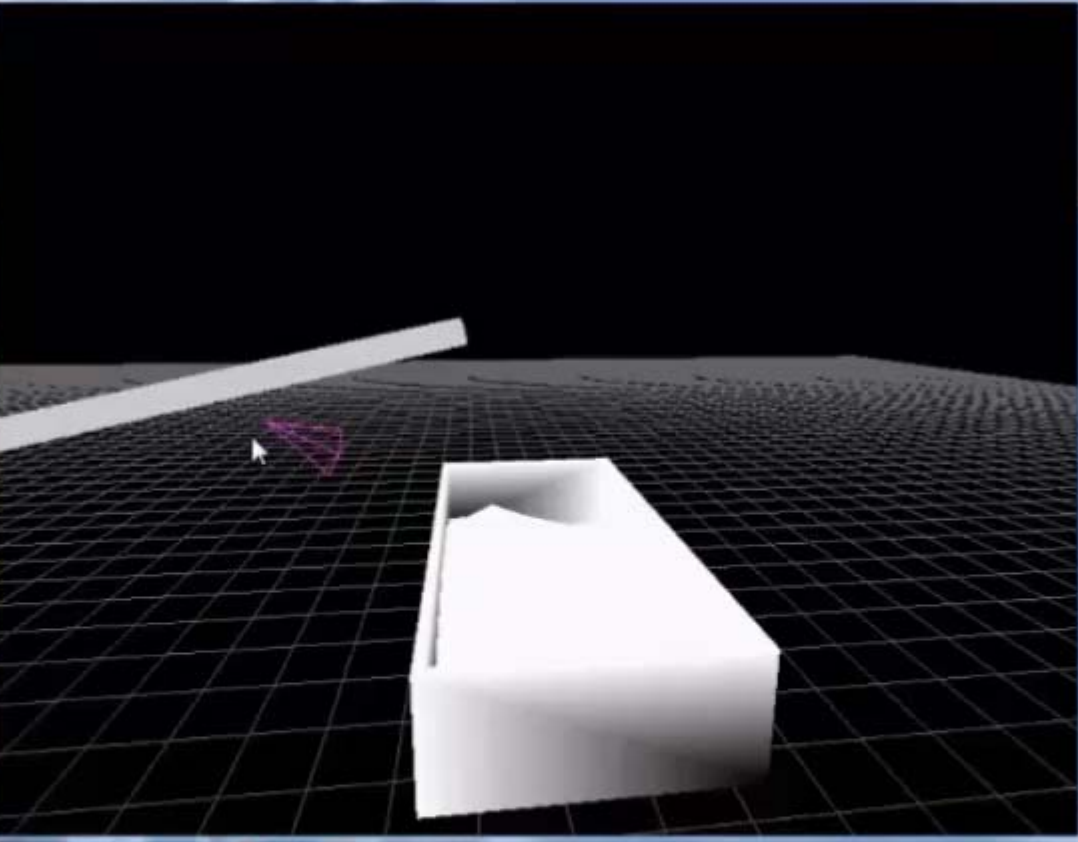


Autonomous Trailer Filling

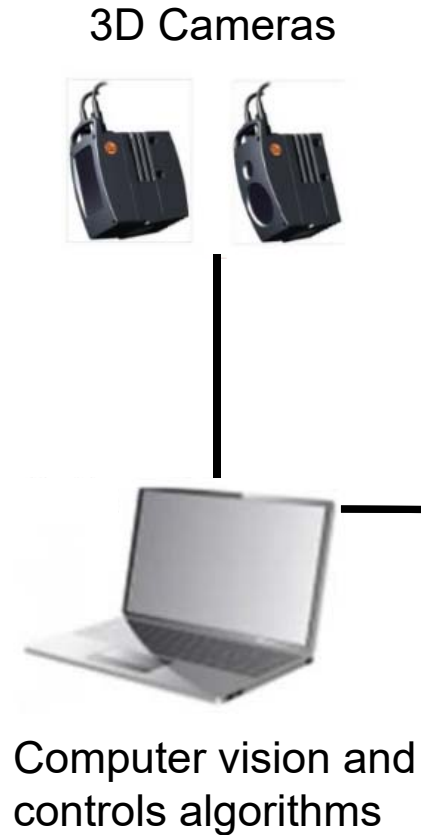


Autonomous Trailer Filling

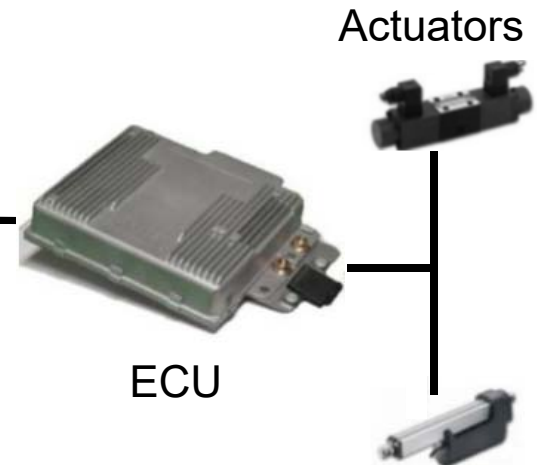




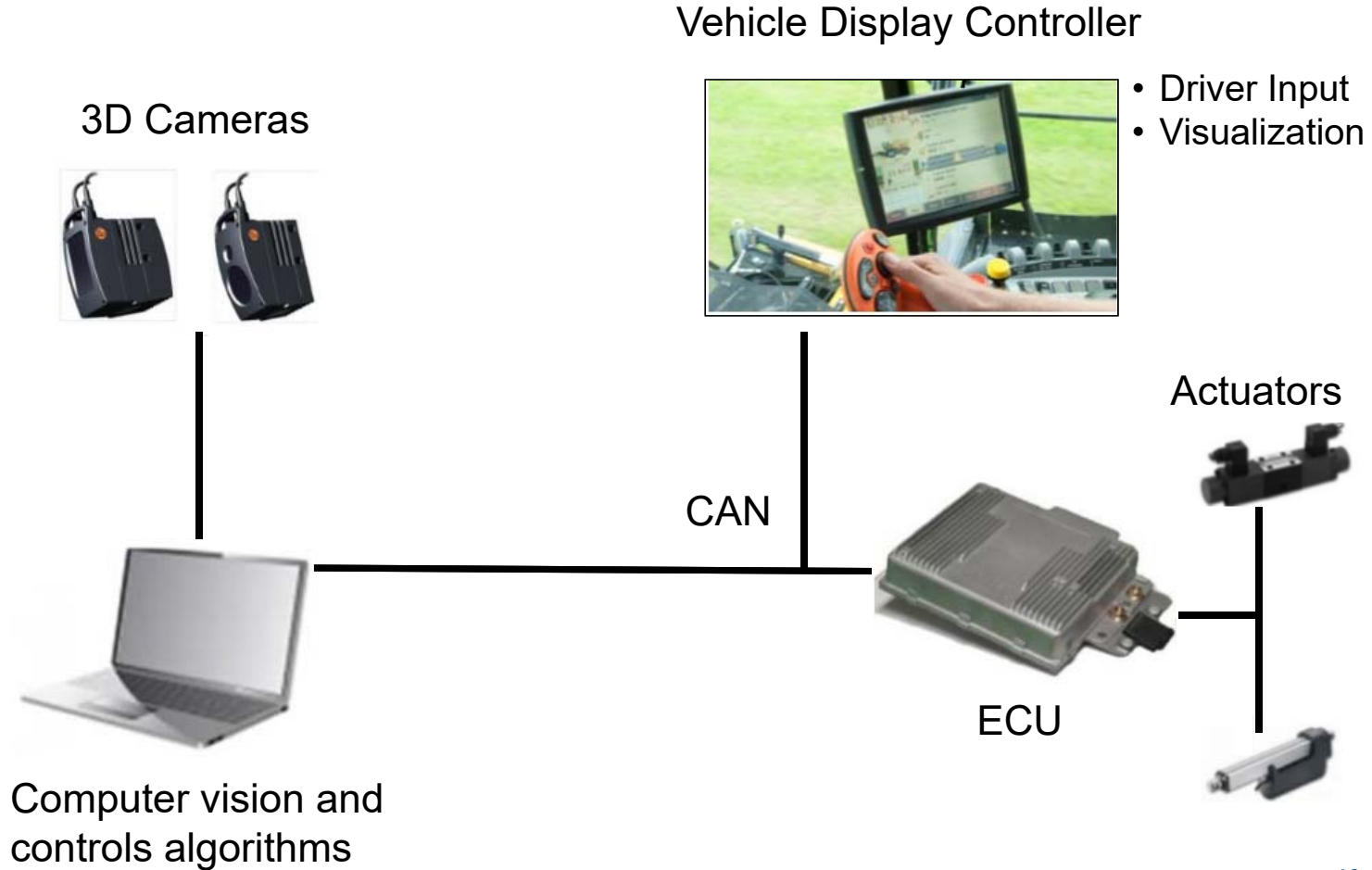
Autonomous Trailer Filling



CAN



Autonomous Trailer Filling



Autonomous Trailer Filling



Sense



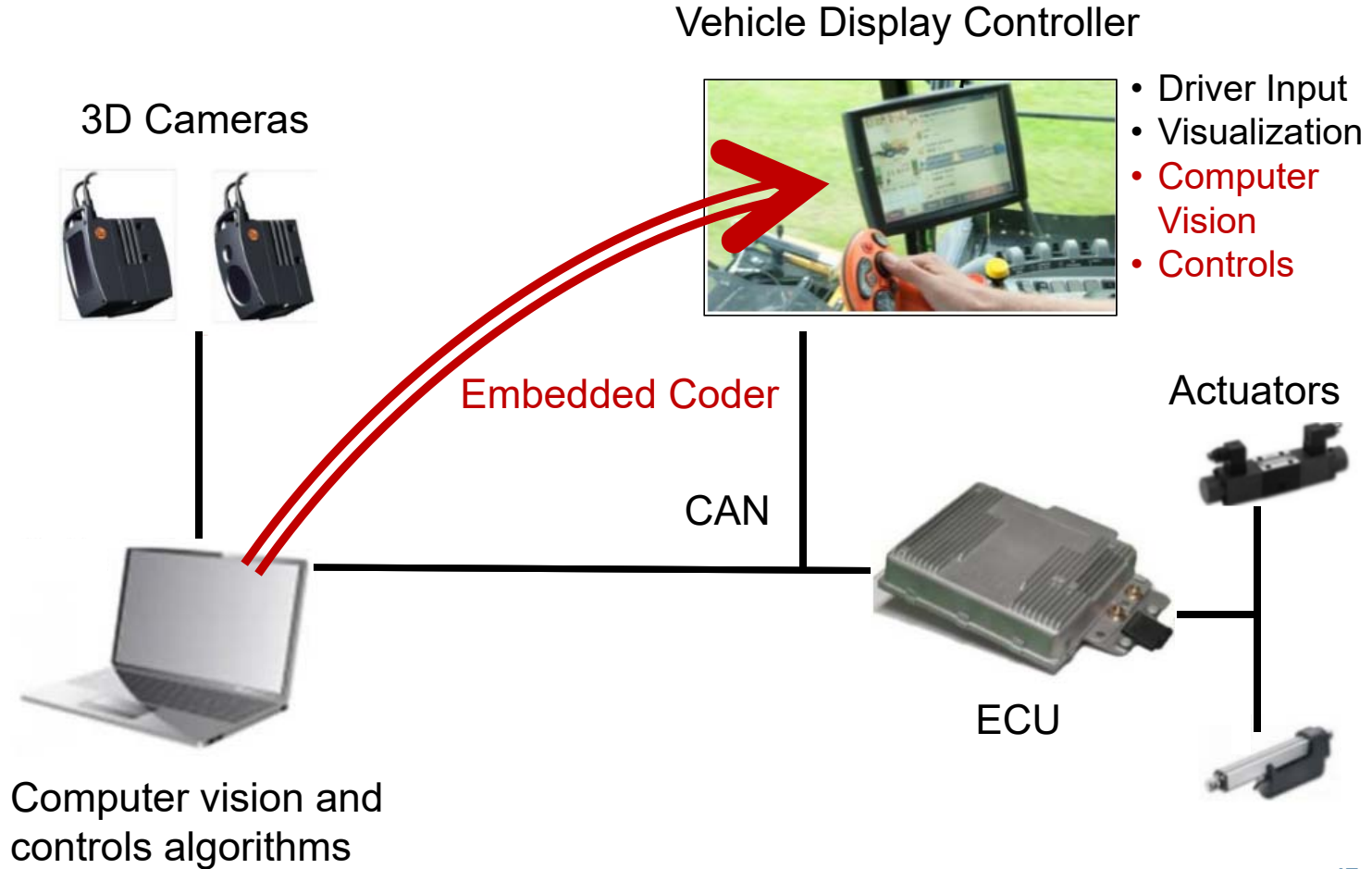
Perceive



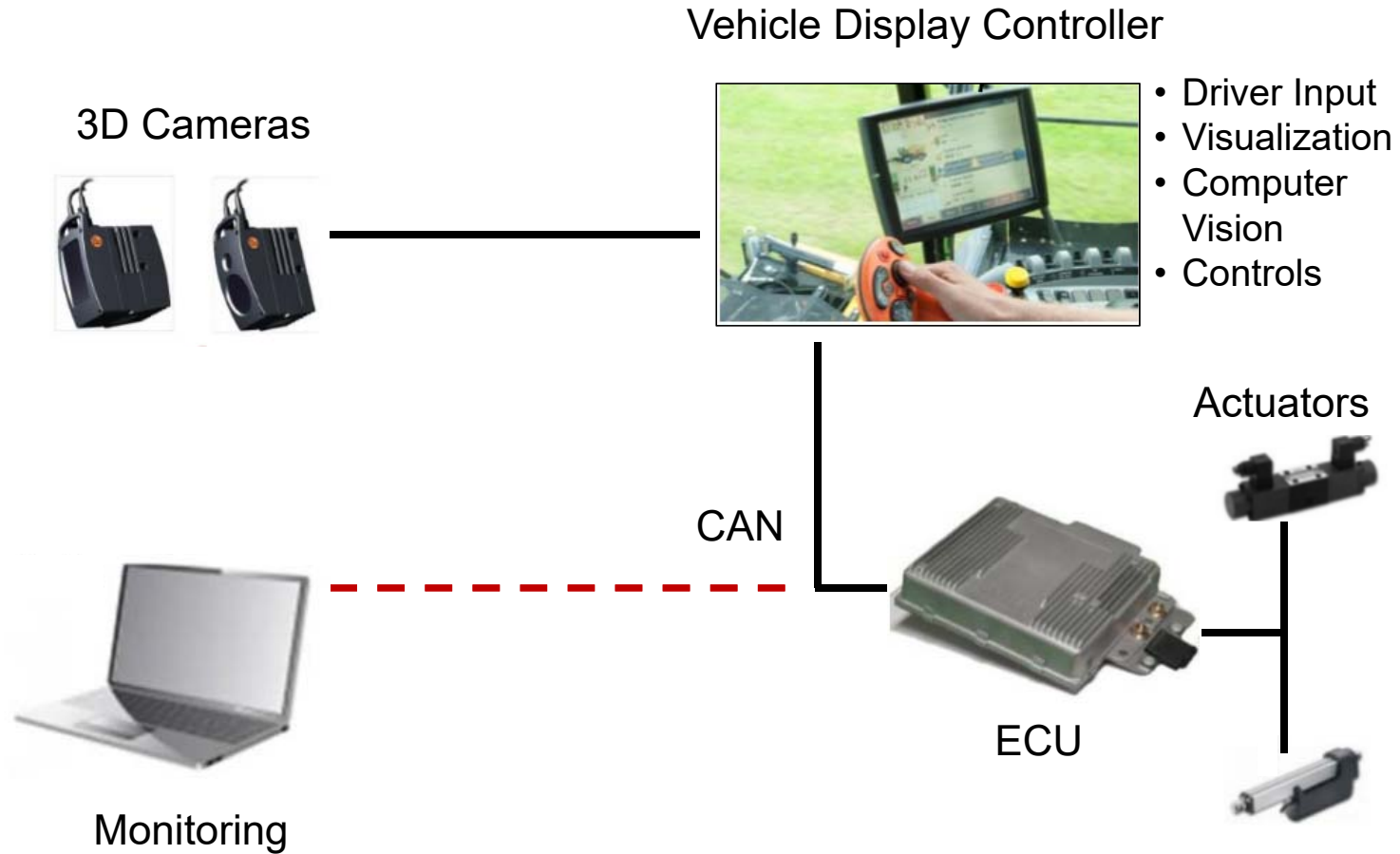
Decide
& Plan



Act



Autonomous Trailer Filling



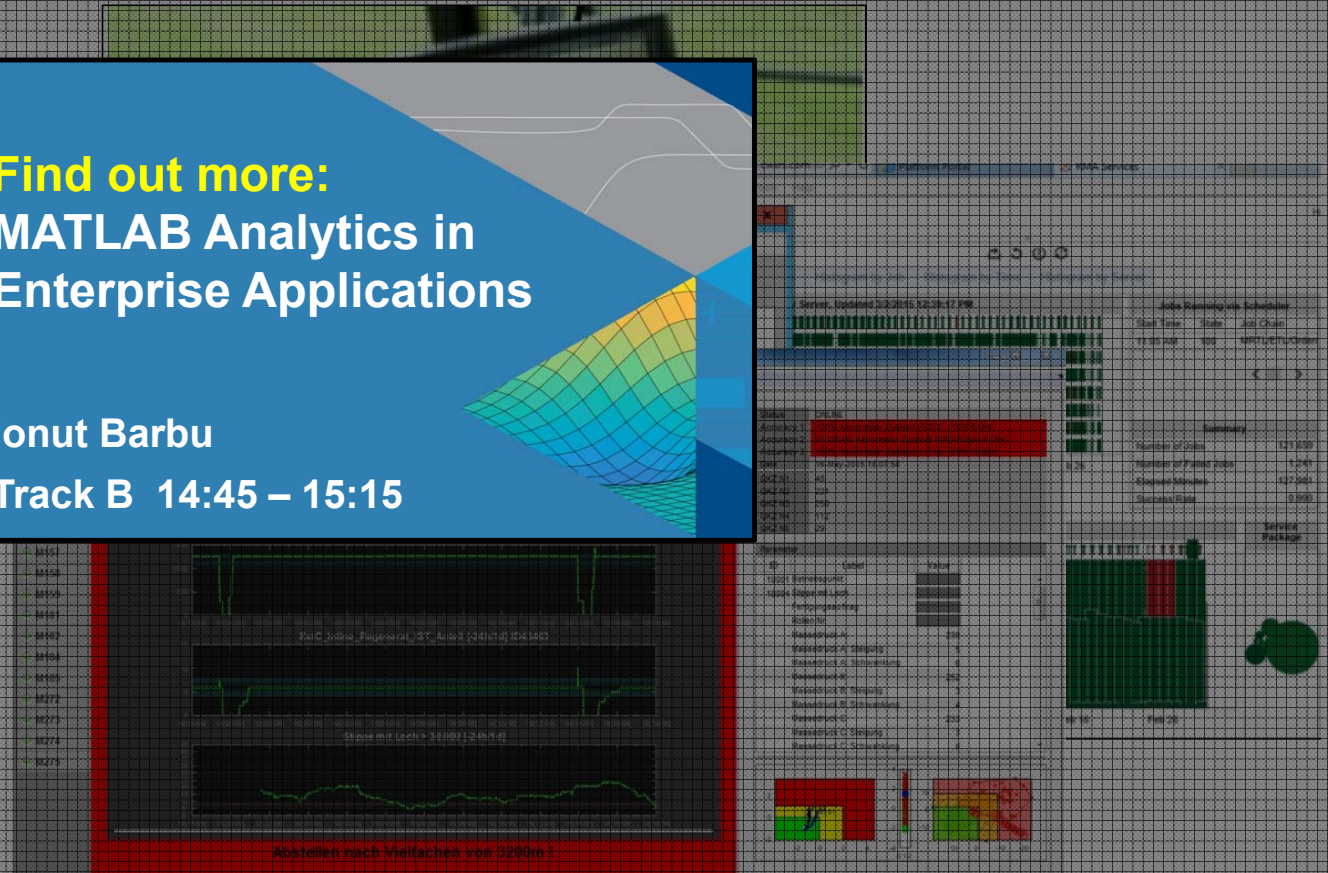
How will you put it into production?

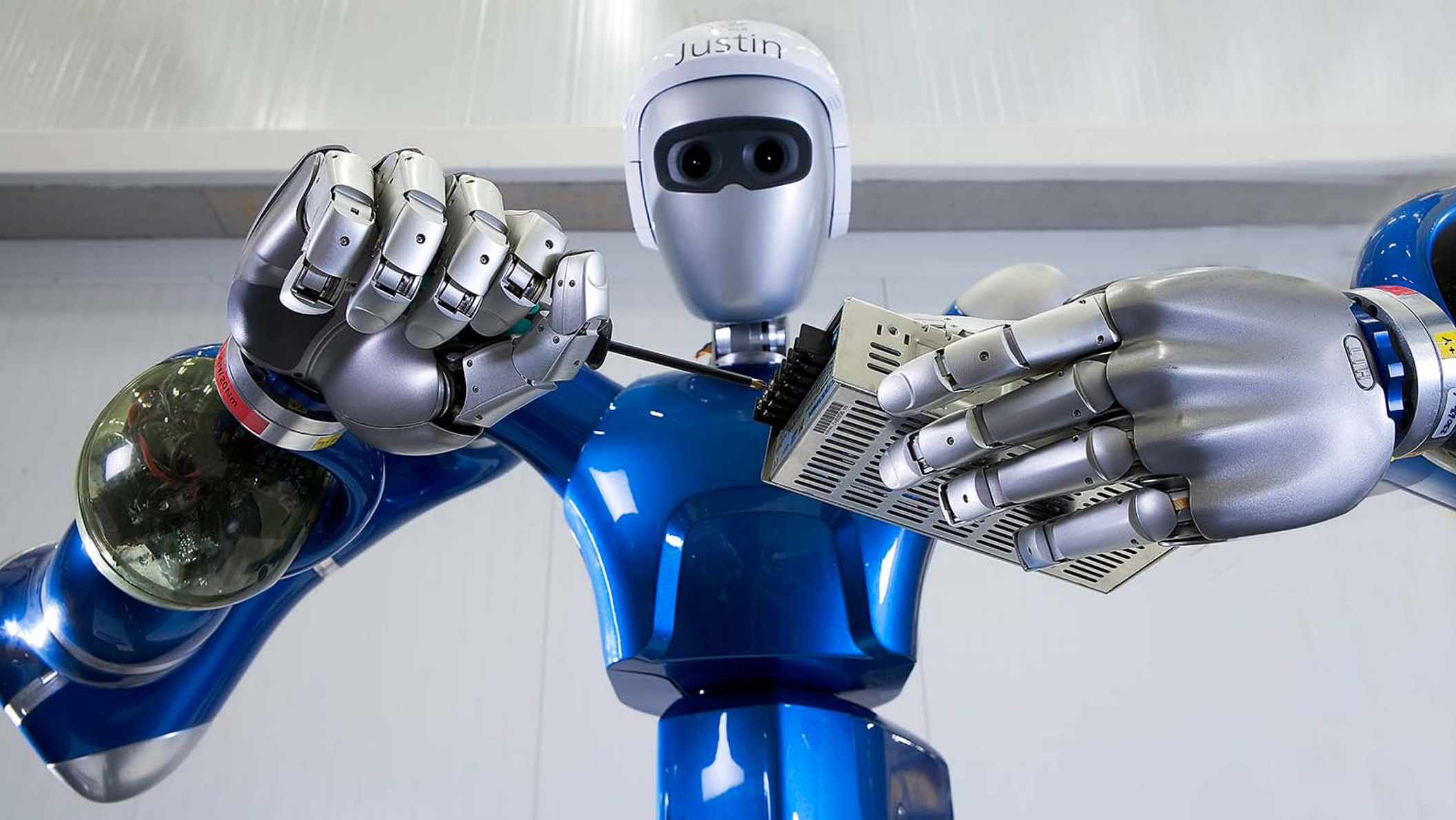
- System Architecture
- Embedded systems
- Enterprise systems
- HMIs

Find out more:
MATLAB Analytics in
Enterprise Applications

Ionut Barbu

Track B 14:45 – 15:15





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?