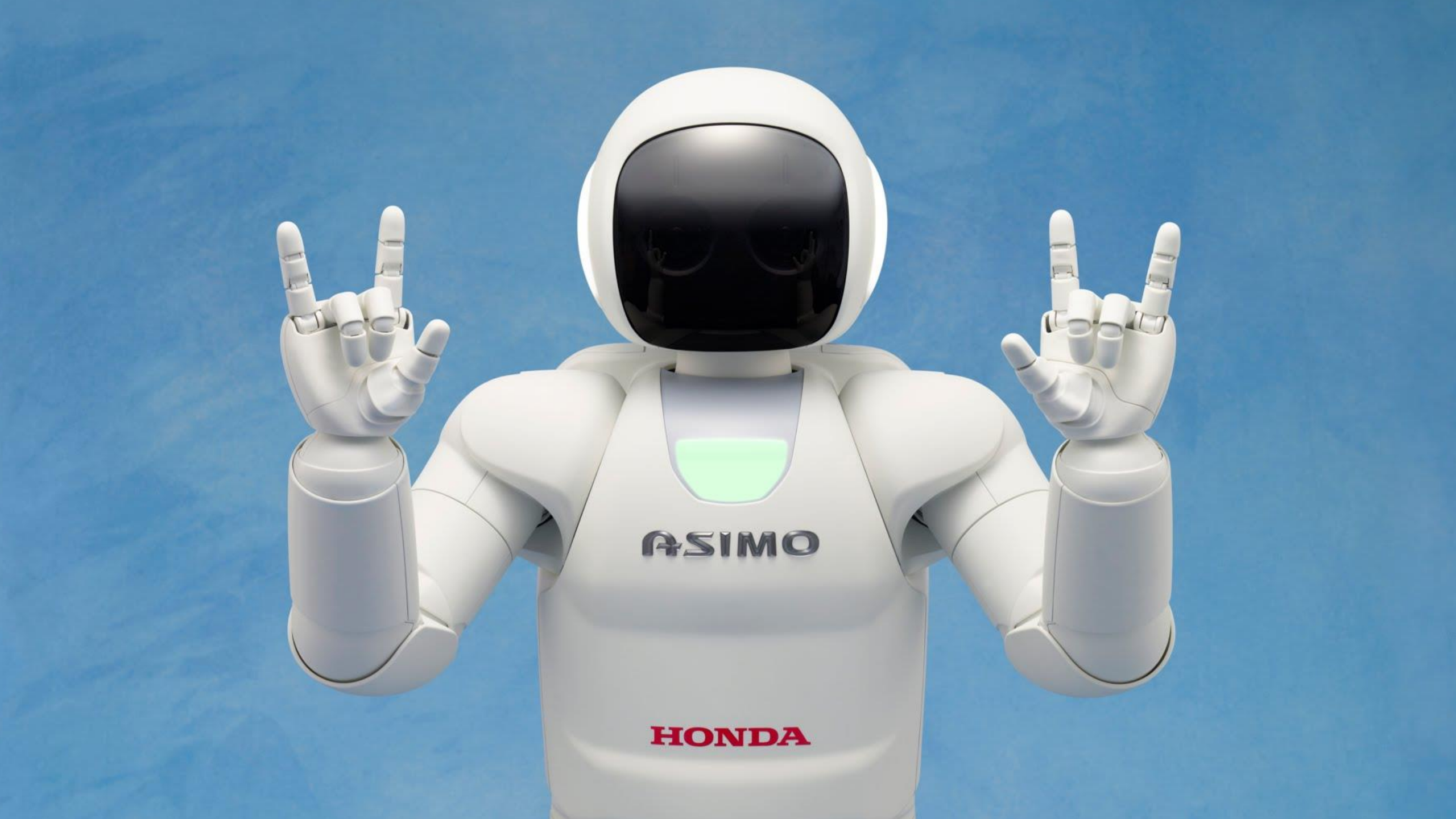
MATLAB CONFERENCE 2017

How to build an **autonomous** anything

Mischa Kim


ASIMO
HONDA


amazon


5" 12,000 PSI
5" 12,000 PSI
BAKER HUGHES


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

Autonomous Technology

Autonomous Technology

Having the power for self-governance

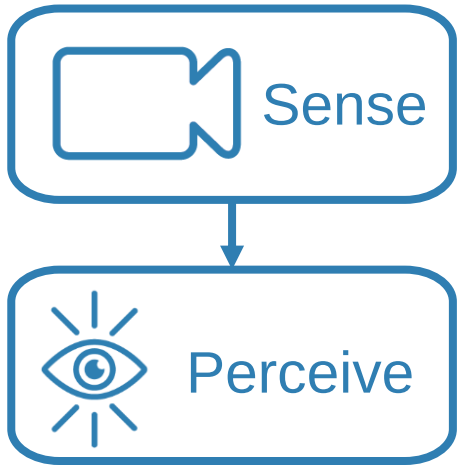
Autonomous Technology

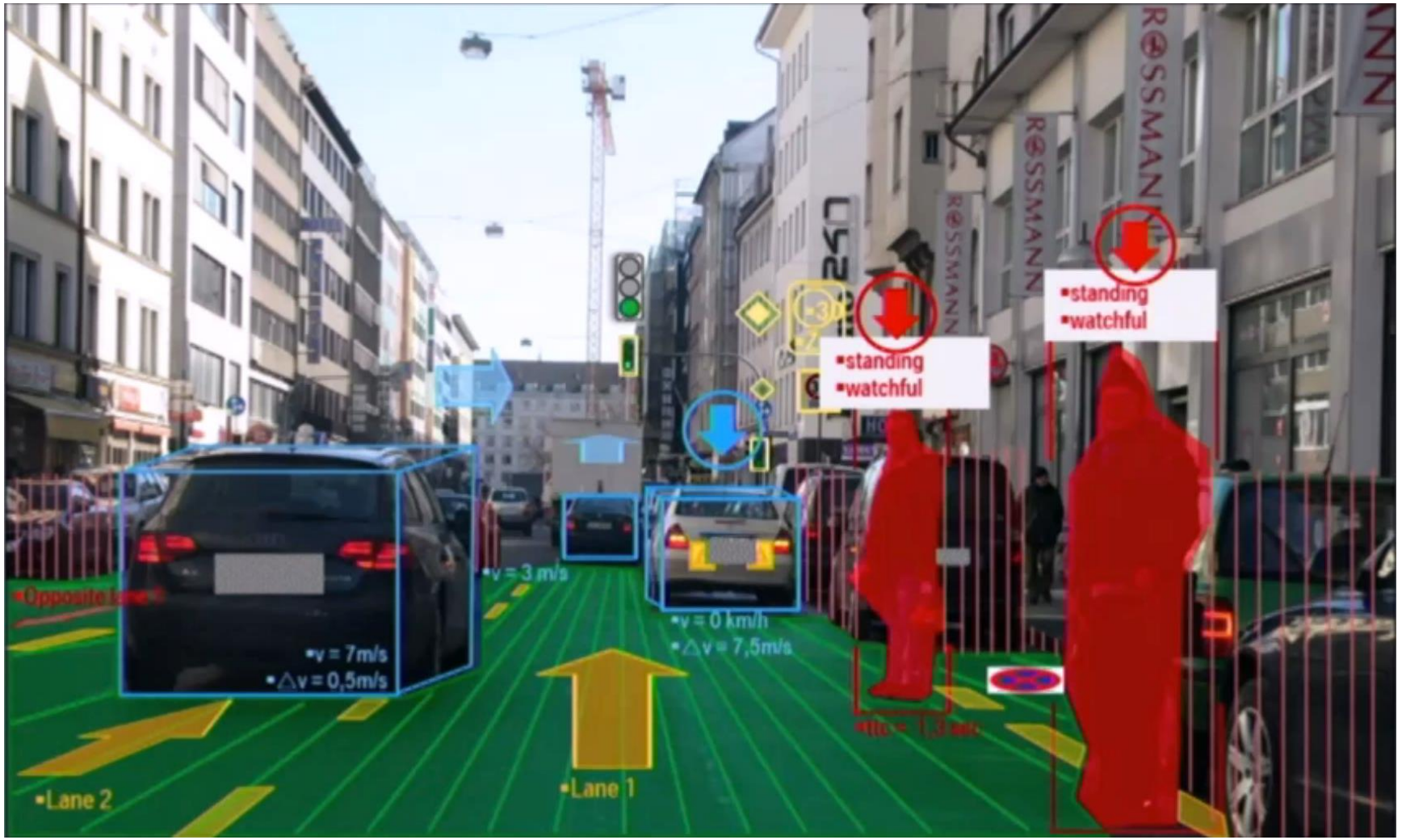
Provides the ability of a system to act independently of direct human control under unrehearsed conditions

Capabilities of an Autonomous System

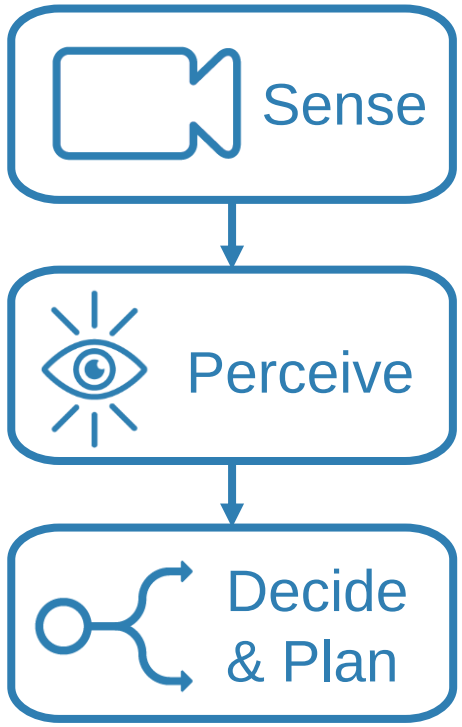
Sense

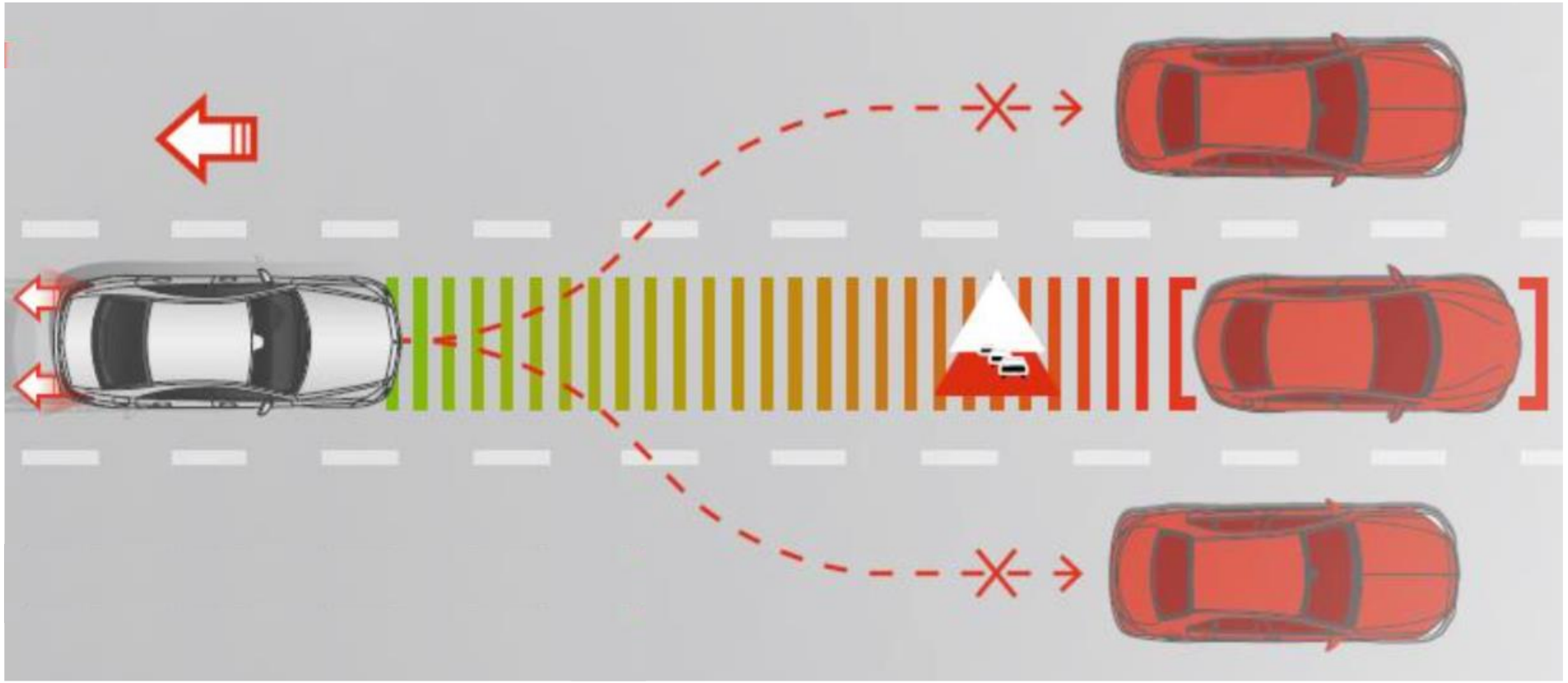
Capabilities of an Autonomous System



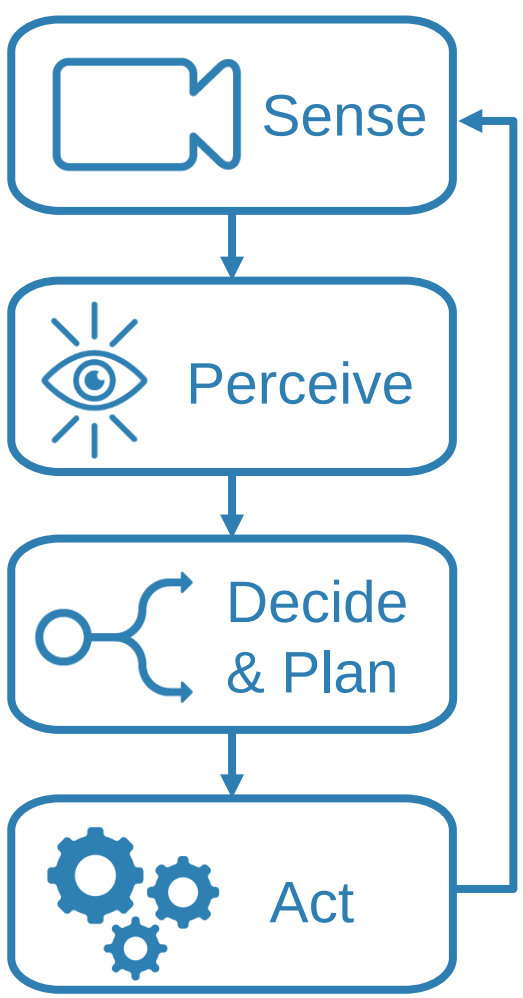


Capabilities of an Autonomous System

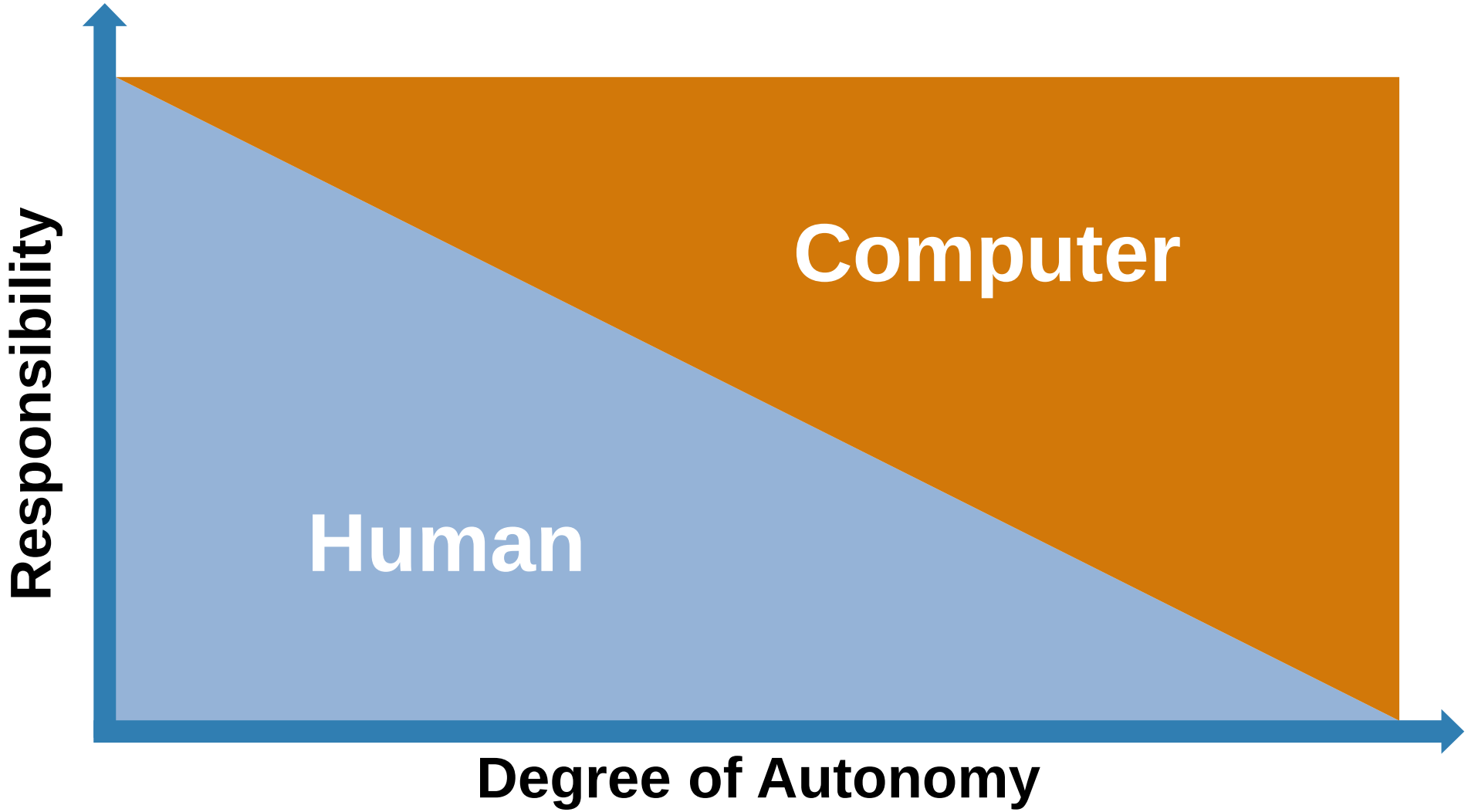


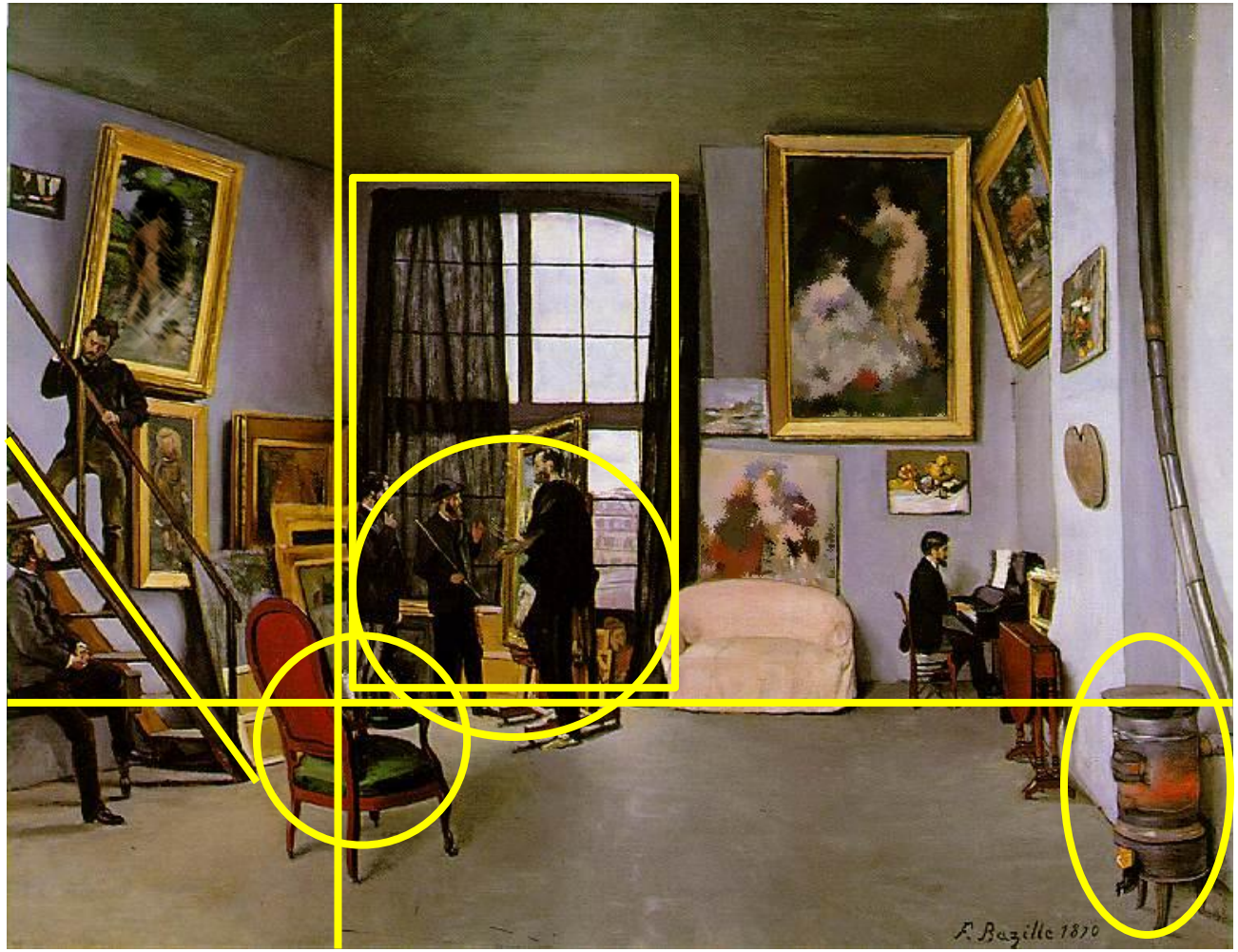


Capabilities of an Autonomous System



Autonomous Technology Transfers Responsibility to Computers





Bazille's Studio
Bazille 1870

Shuffleton's Barbershop
Rockwell 1950

Autonomous Artistic Style Classification
Rutgers University

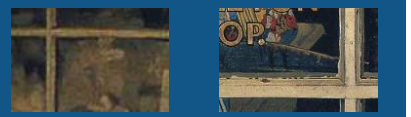
Sense

Perceive

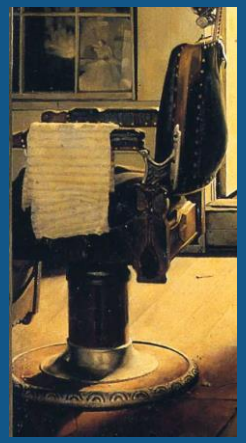
Decide & Plan

Act

Image Feature Extraction



Visual Features



Machine Learning Classification

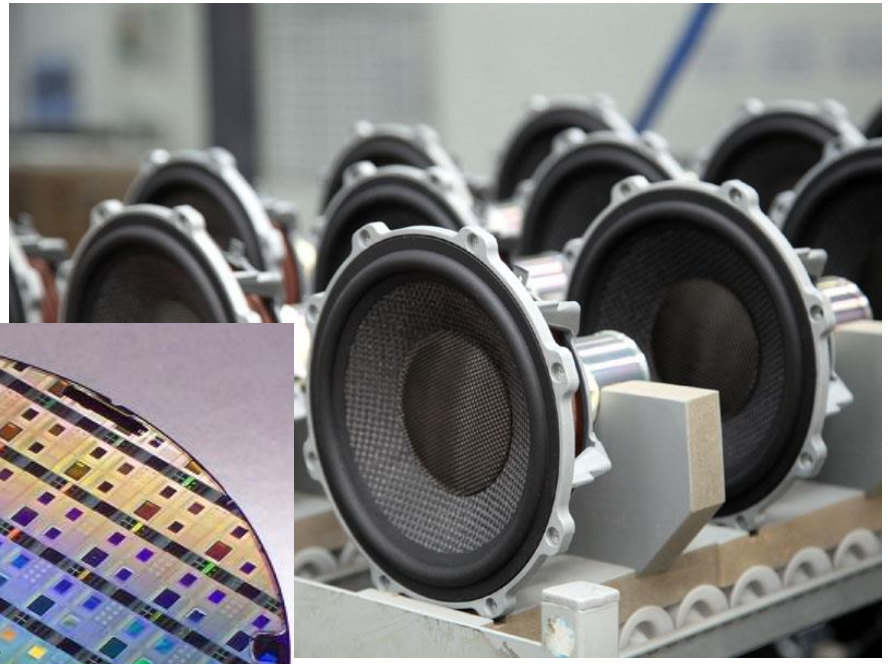
Style Classifier (SVM) → **Style:** Regionalism

Genre Classifier (SVM) → **Genre:** Interior

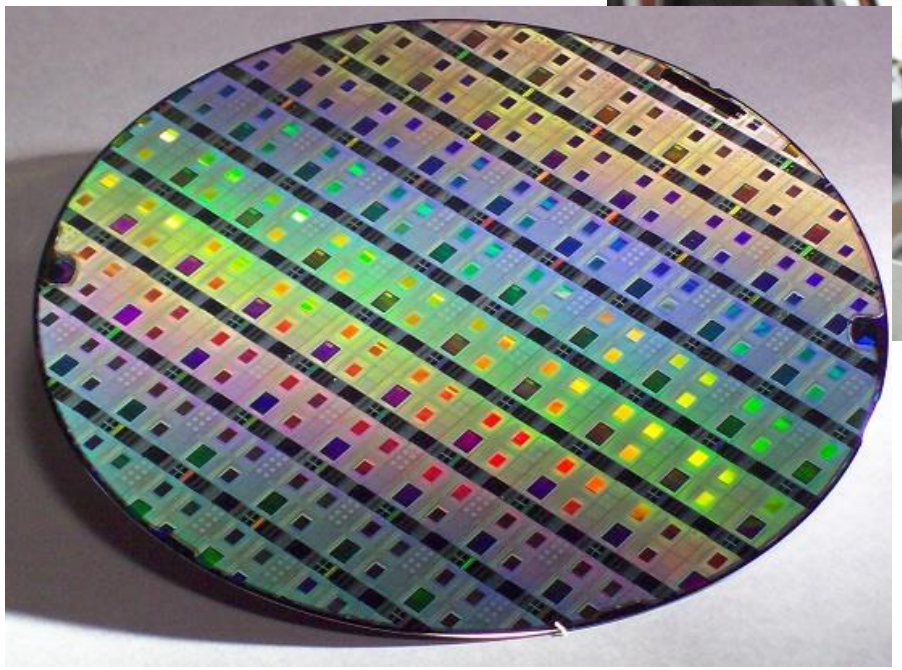
Artist Classifier (SVM) → **Artist:** Rockwell

Where to add autonomy with perception?

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



Determine Loudspeaker Quality



Virtual Semiconductor Manufacturing Calibration


5" 12,000 PSI
5" 12,000 PSI
BAKER HUGHES

Autonomous Service for Predictive Maintenance

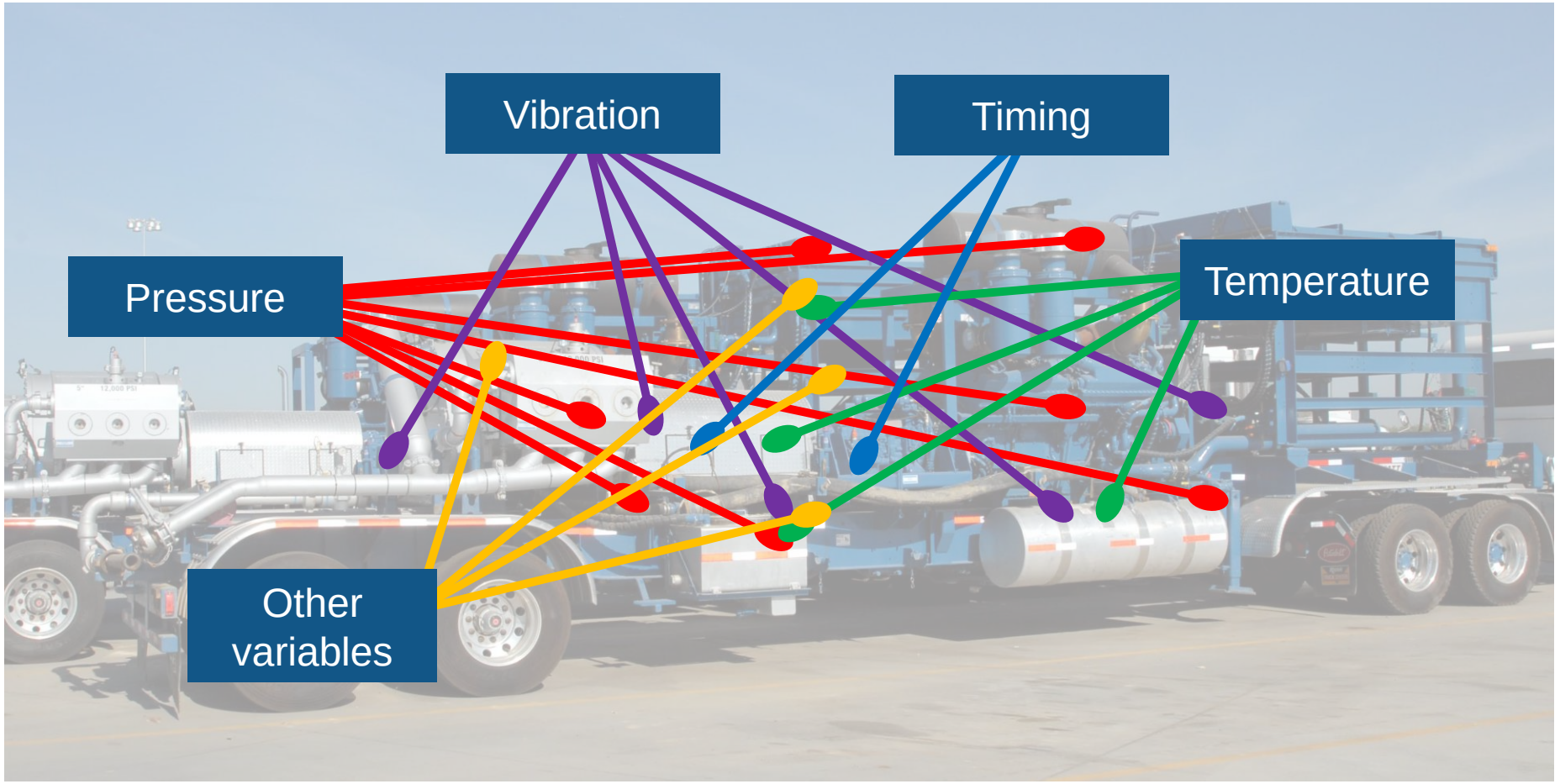
Sense

Perceive

Decide & Plan

Act

Which sensor values should they use?



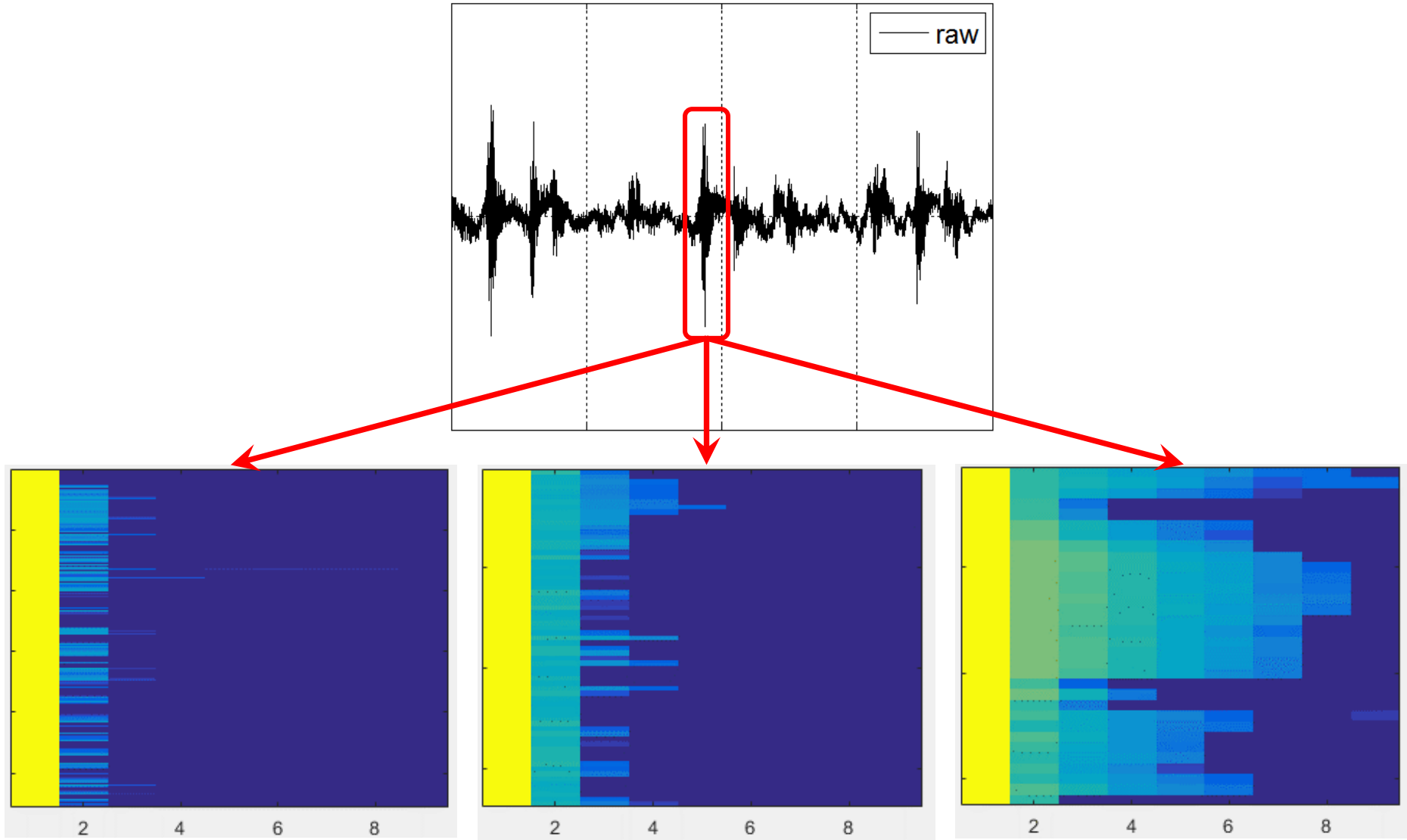
Autonomous Service for Predictive Maintenance

Sense

Perceive

Decide & Plan

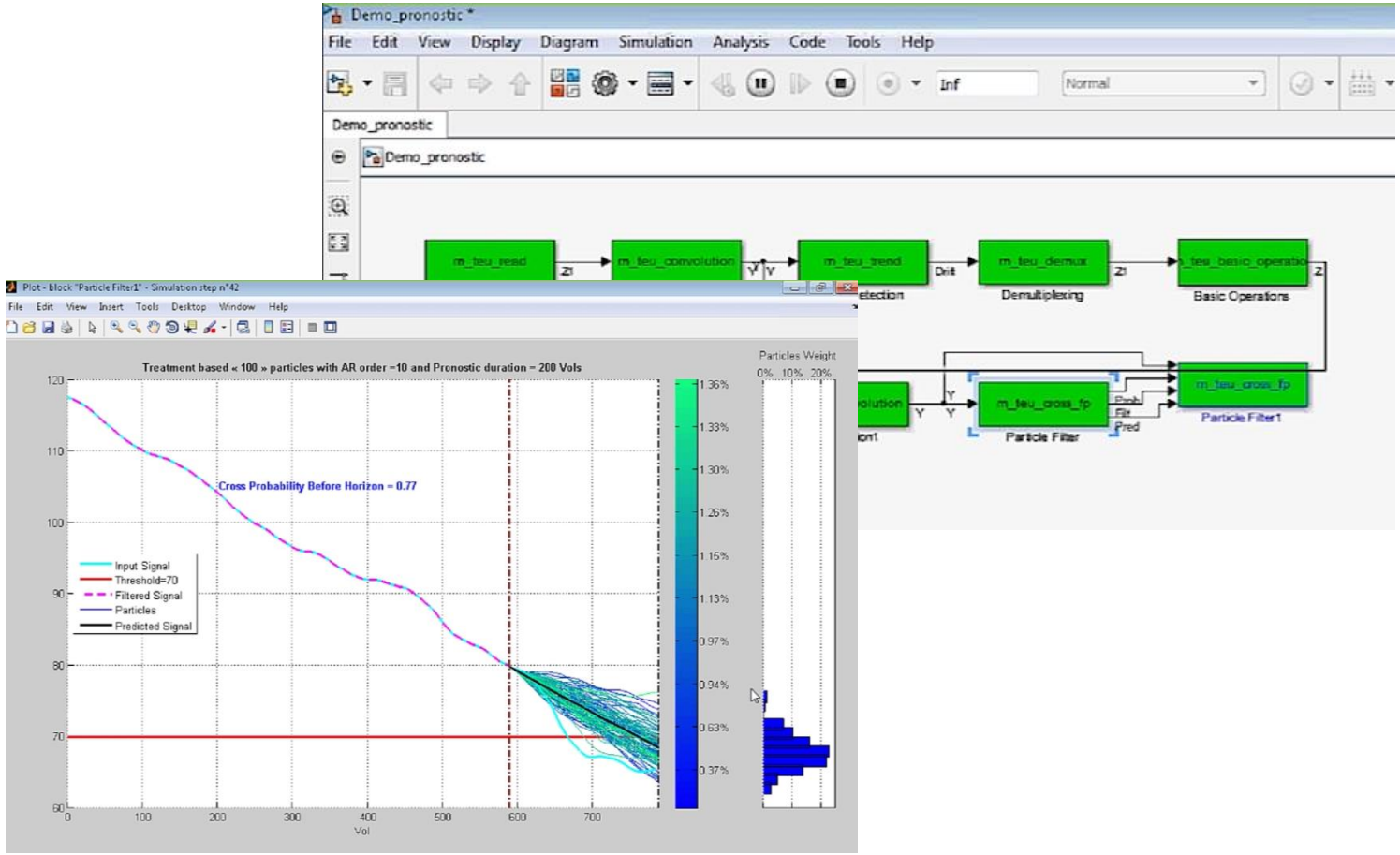
Act



Normal Operation | Monitor Closely | Maintenance Needed

What are the best predictors?

- Data
- Models



Jet Engine Monitoring

Autonomous Glucose Level Management

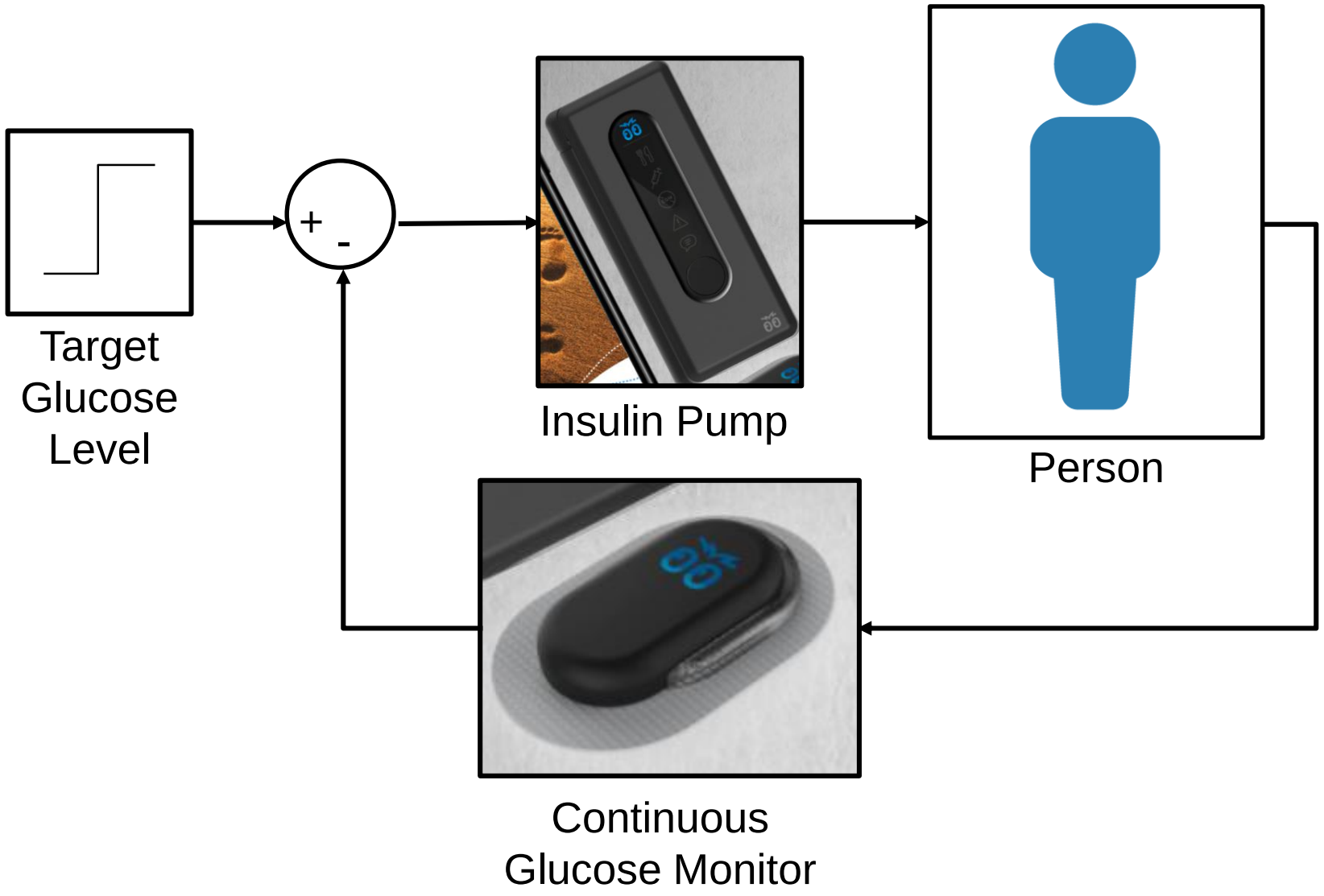
Autonomous Glucose Level Management
Bigfoot Biomedical

Sense

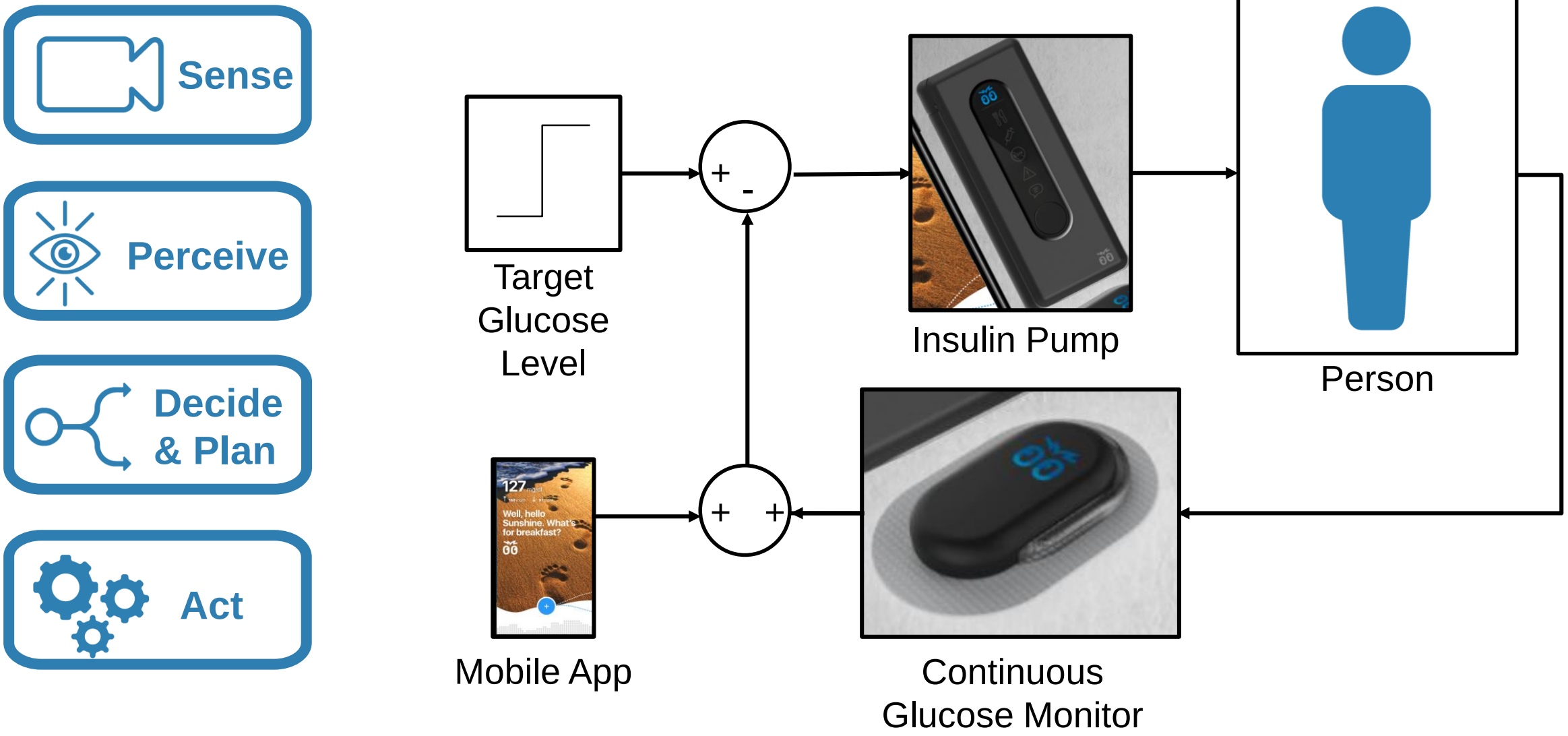
Perceive

Decide & Plan

Act



Autonomous Glucose Level Management
Bigfoot Biomedical



Autonomous Glucose Level Management
Bigfoot Biomedical

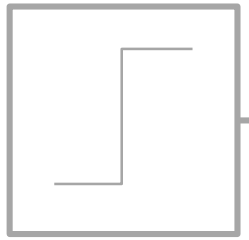
Virtual Lab
Simulink, Stateflow
Polyspace

Sense

Perceive

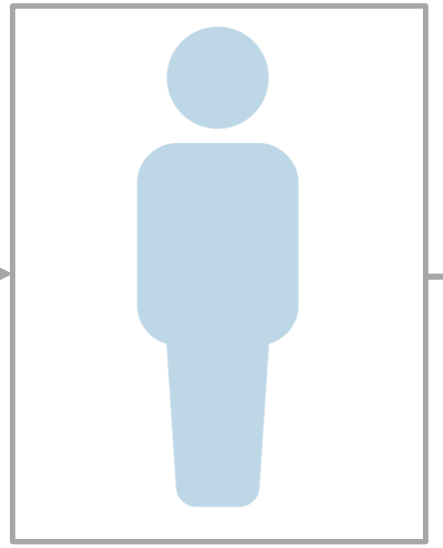
Decide & Plan

Act

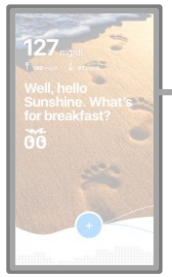


Target Glucose Level

Insulin Pump



Person



Mobile App

Continuous Glucose Monitor

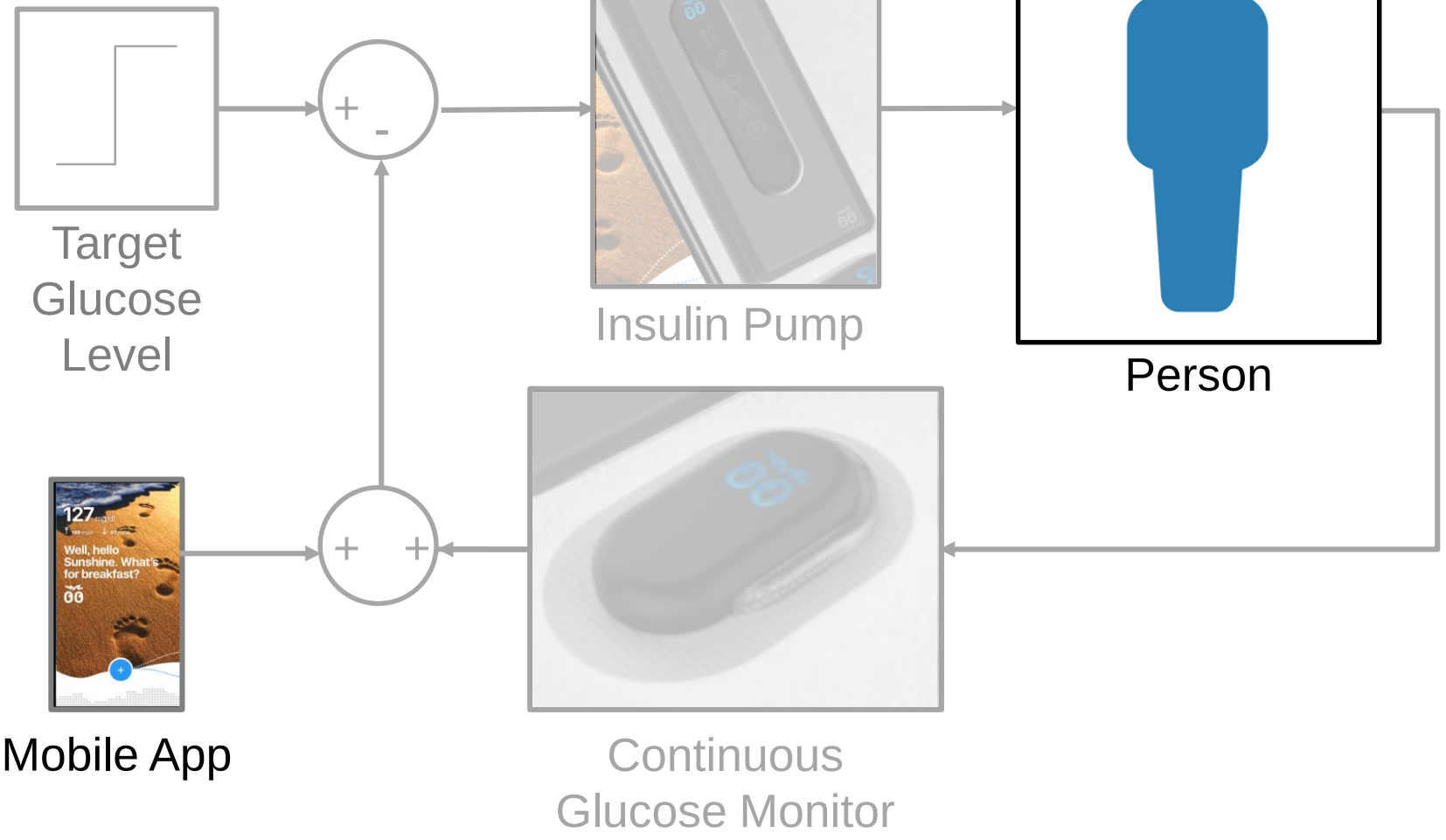
Autonomous Glucose Level Management
Bigfoot Biomedical

Sense

Perceive

Decide & Plan

Act



Autonomous Glucose Level Management
Bigfoot Biomedical

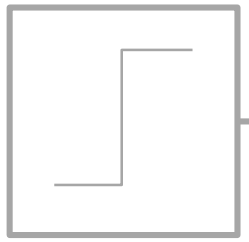
Virtual Clinic
MATLAB, Toolboxes

Sense

Perceive

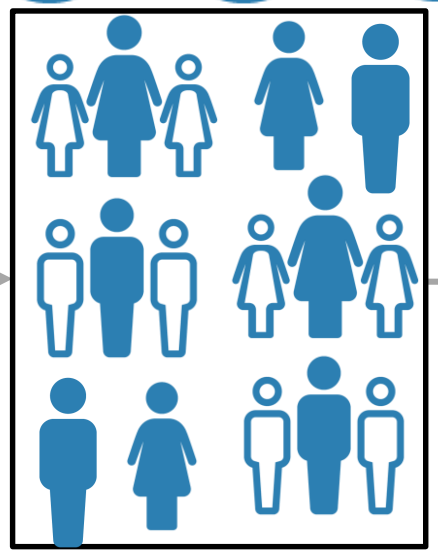
Decide & Plan

Act

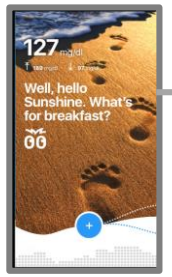


Target Glucose Level

Insulin Pump



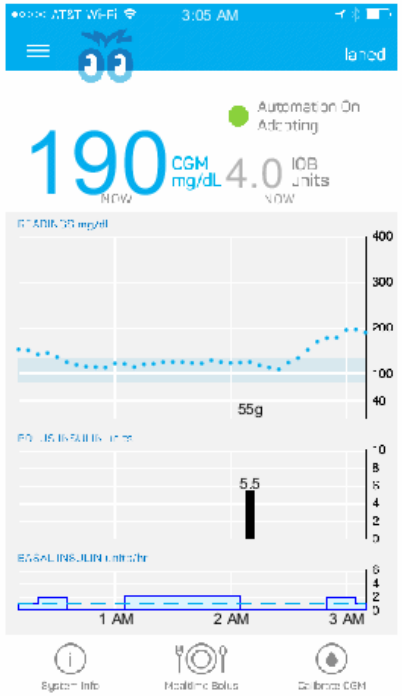
Person

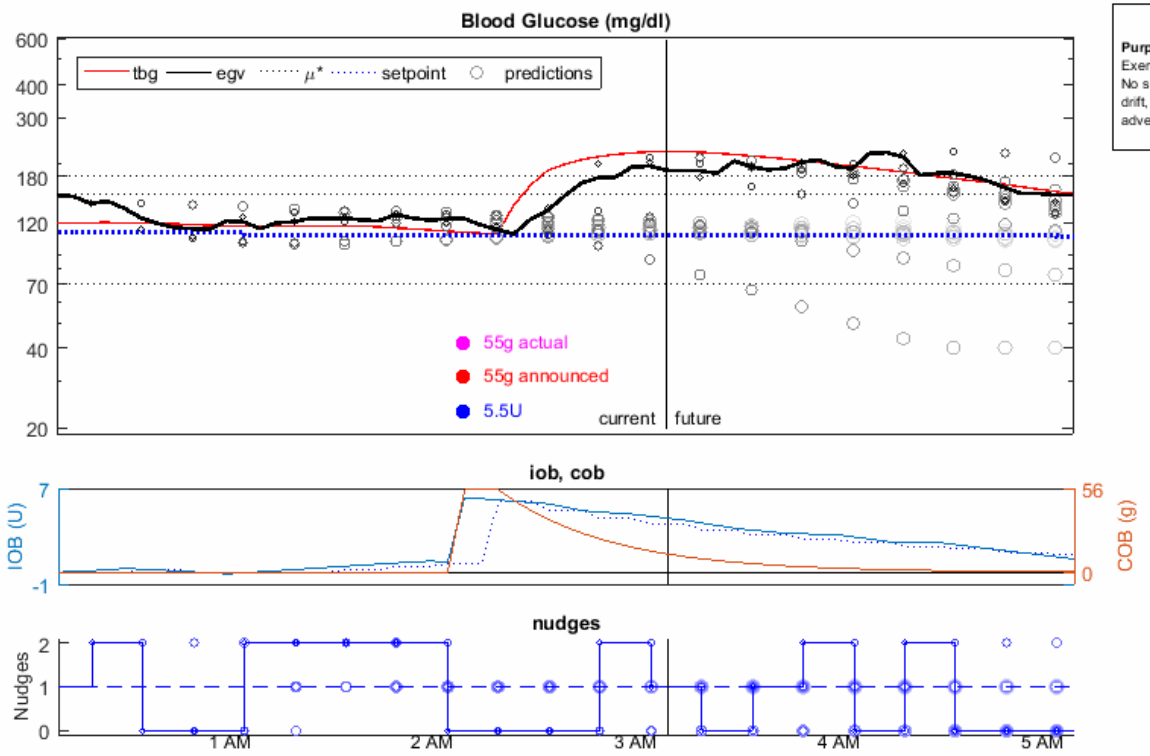


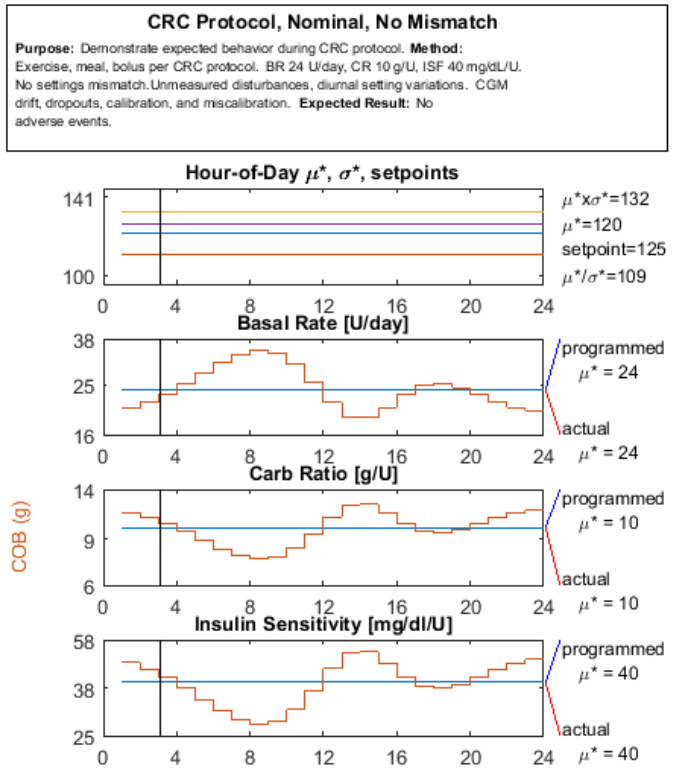
Mobile App

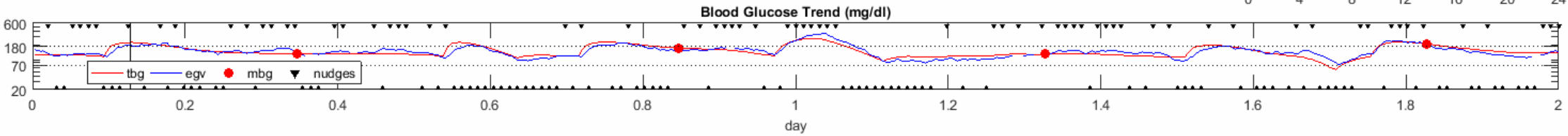
Continuous Glucose Monitor

Virtual Clinic
Generating data through simulation

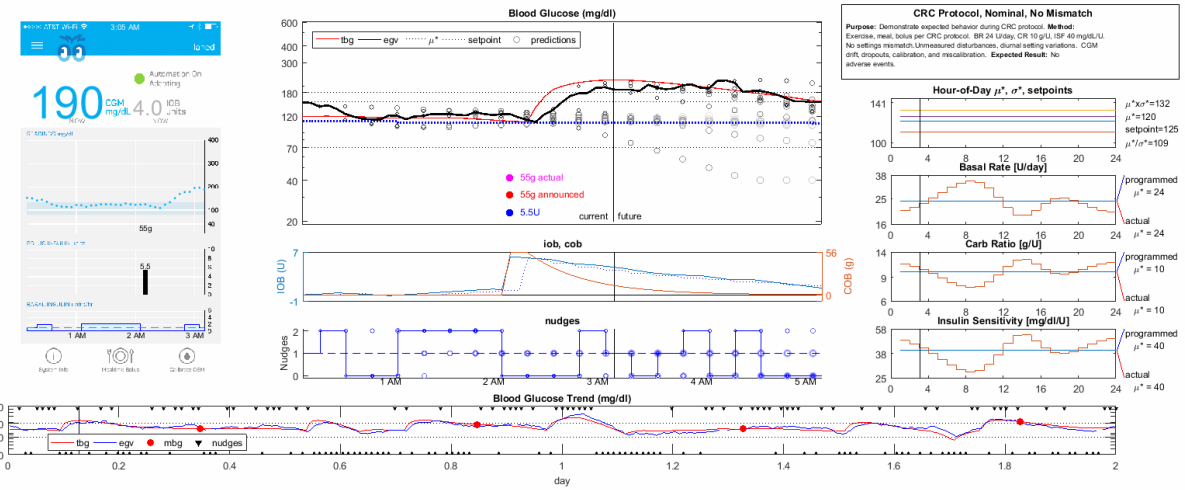








Virtual Clinic
Scaling computations to simulate 50 million patients a day



amazon web services

Where will you get your data?

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

Autonomous Trailer Filling

Sense

Perceive

Decide & Plan

Act

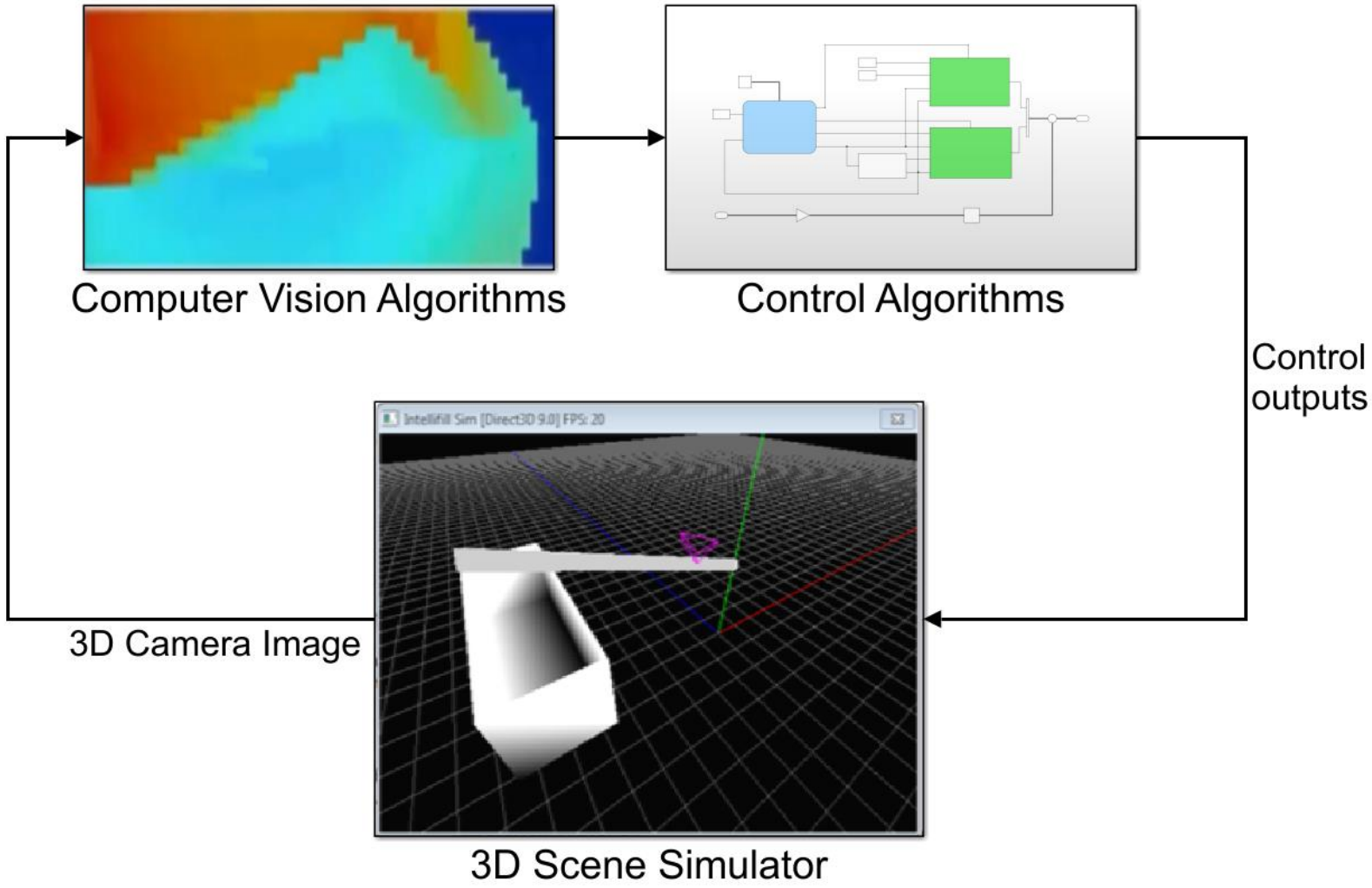
Autonomous Trailer Filling

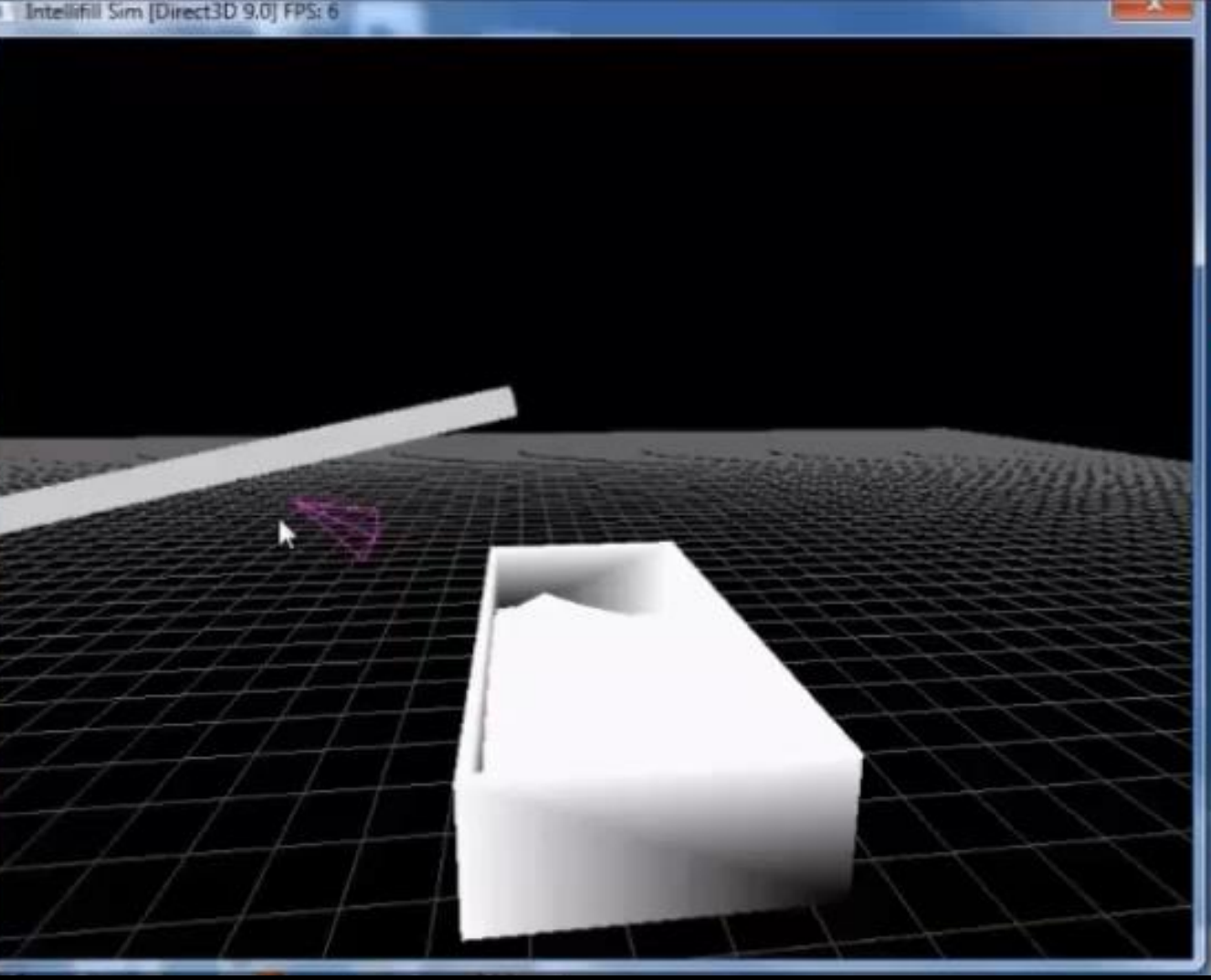
Sense

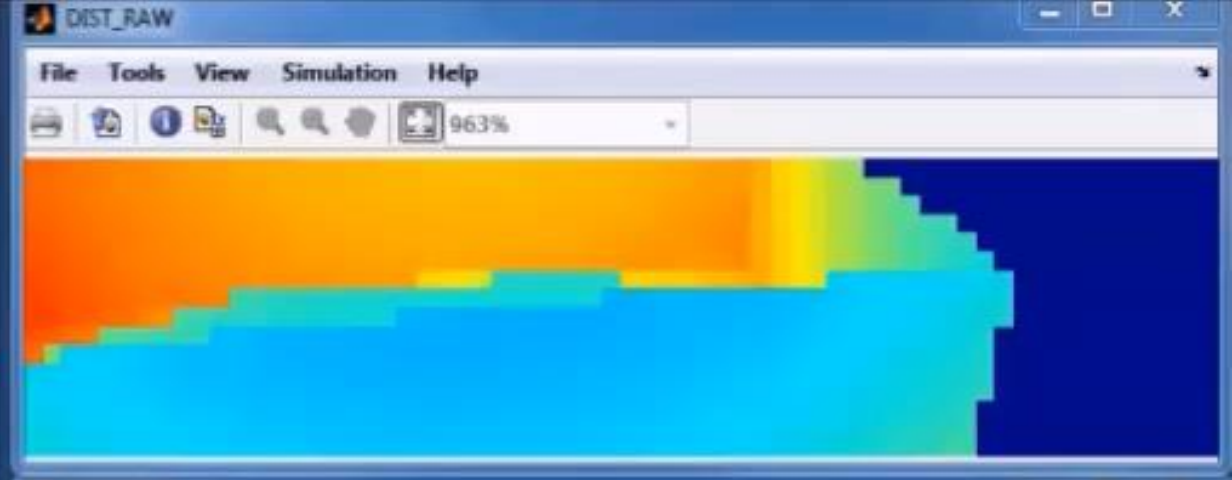
Perceive

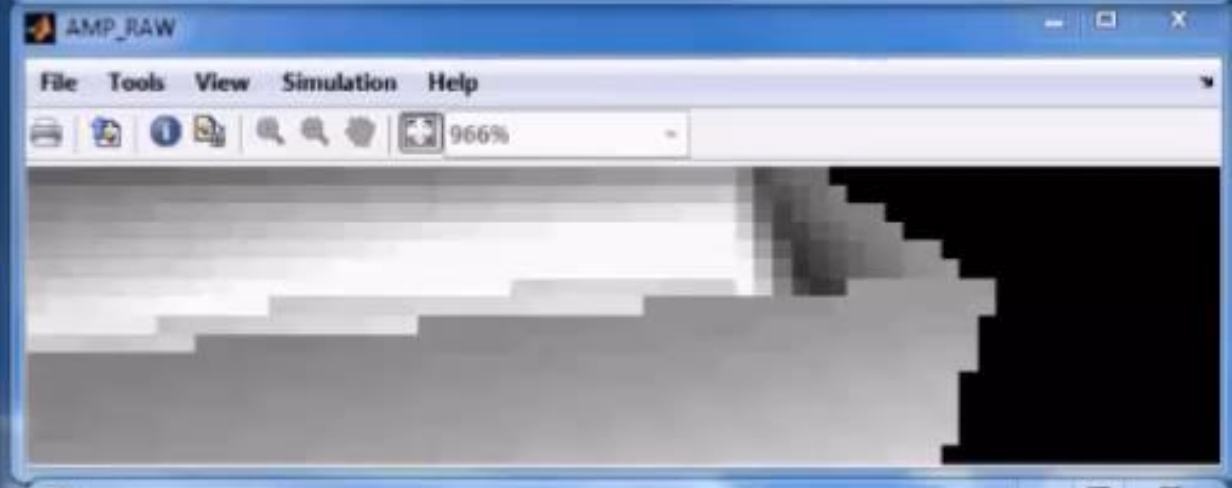
Decide & Plan

Act




Intellifill Sim [Direct3D 9.0] FPS: 6


DIST_RAW
File Tools View Simulation Help
963%


AMP_RAW
File Tools View Simulation Help
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File Tools View Simulation Help
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Autonomous Trailer Filling

Sense

Perceive

Decide & Plan

Act

3D Camera

Embedded Platform
MPC5121e

- User Input
- Visualization

CAN

Actuators

ECU

Computer vision and controls algorithms

Autonomous Trailer Filling

Sense

Perceive

Decide & Plan

Act

Embedded Platform
MPC5121e

3D Camera

- User Input
- Visualization
- Computer Vision
- Controls

Embedded Coder

CAN

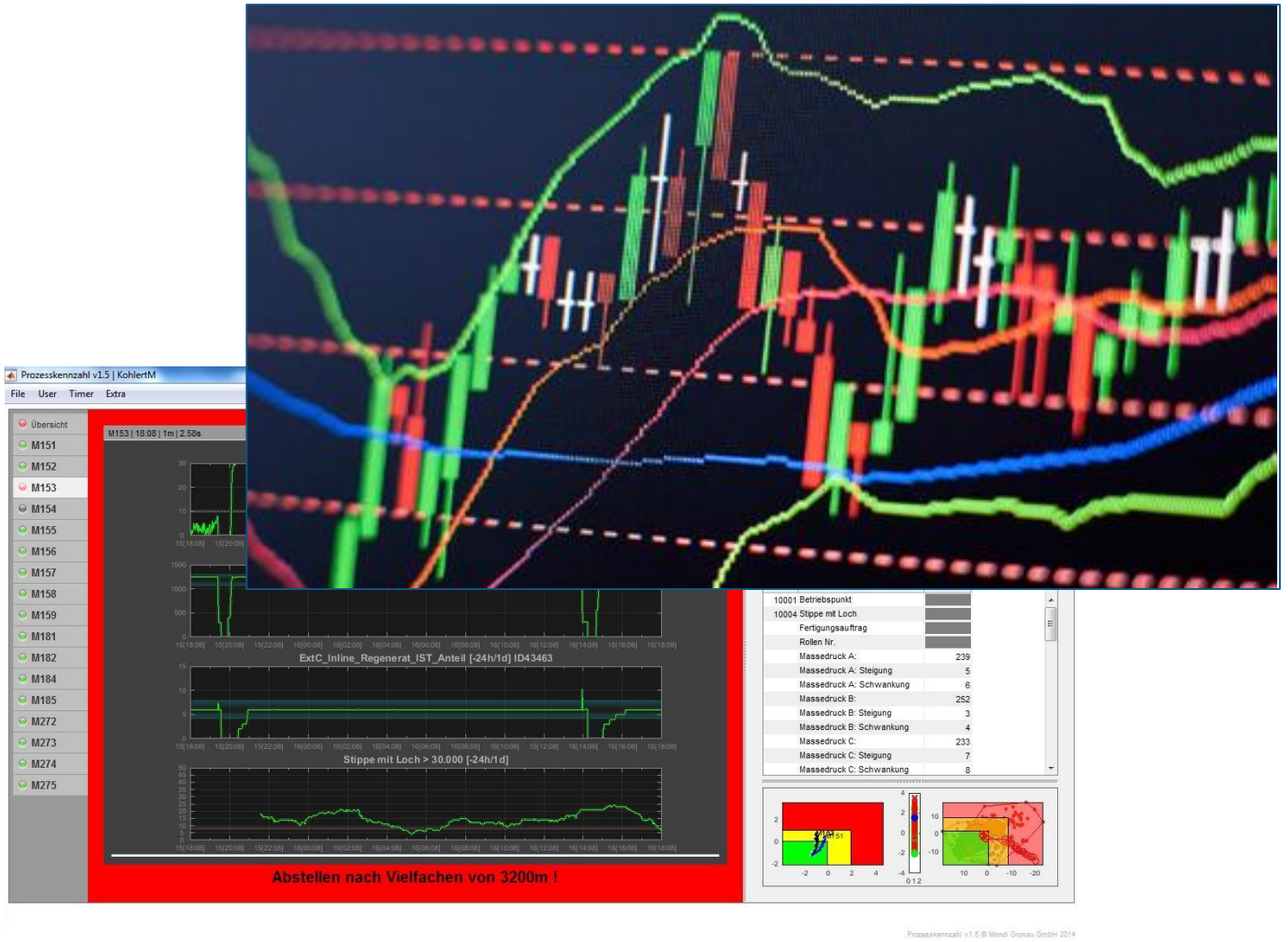
Actuators

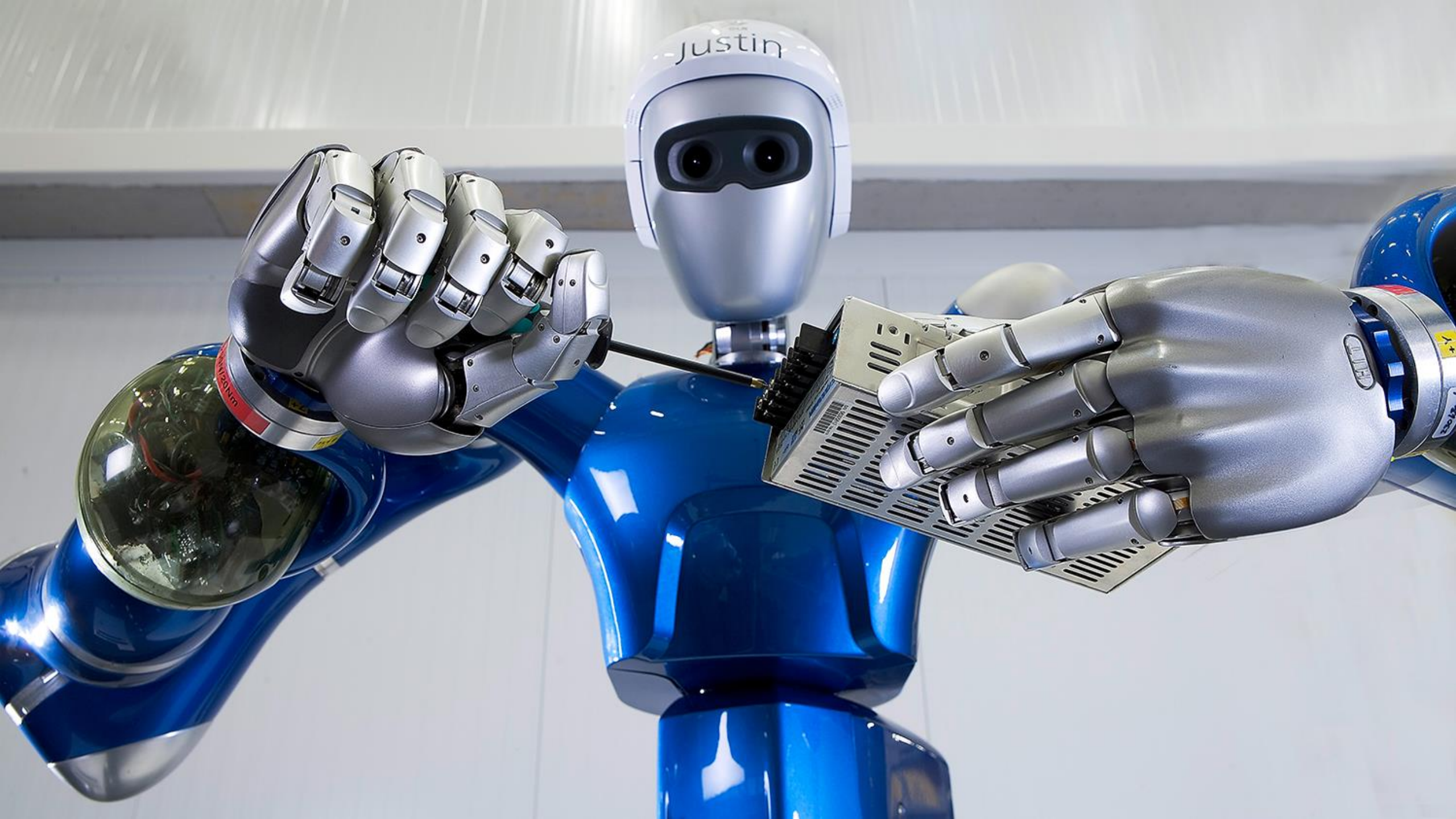
ECU

Monitoring

How will you put it into production?

- Embedded Systems
- IT Systems
- Desktop Apps




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
Flow to Production	• Address the architecture • Leverage Model-Based Design for embedded • Automate integration with enterprise IT systems

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