

The Rise of Engineering-Driven Analytics

MATLAB EXPO 2016

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MathWorks
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The Rise of Engineering-Driven Analytics



The Rise of Engineering-Driven **Analytics**



Analytics are now pervasive



Apply robust, statistically-motivated methods to data produced from complex systems to

understand what has happened,

- Desktop -
- Neural Networks

predict what will happen, and

- Multicore, GPU
- Classification

suggest decisions or actions.

- Clusters
- Clustering

- Cloud computing
- Regression

- Hadoop
- ...and much more...

Analytics in e-commerce



Engineering Data



Images

Social profile

Geolocation

Keystroke logs

Transactions

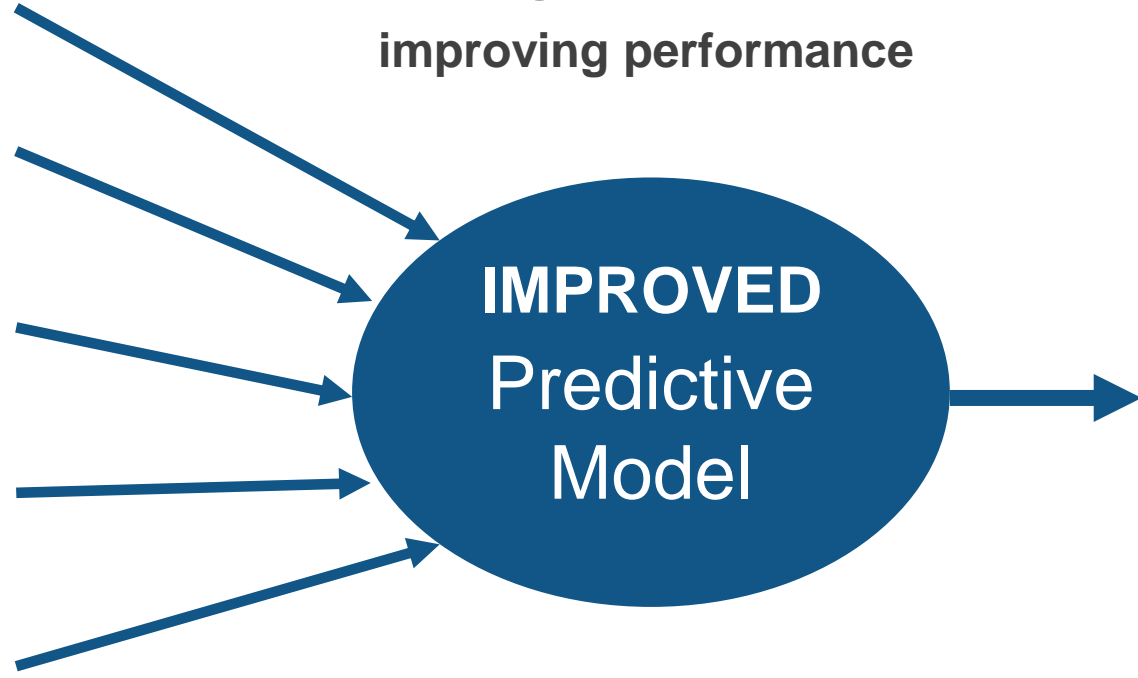


Business Data

Use **Image Processing**
to add image data to the model,
improving performance

**IMPROVED
Predictive
Model**

**Offer to
Customer**

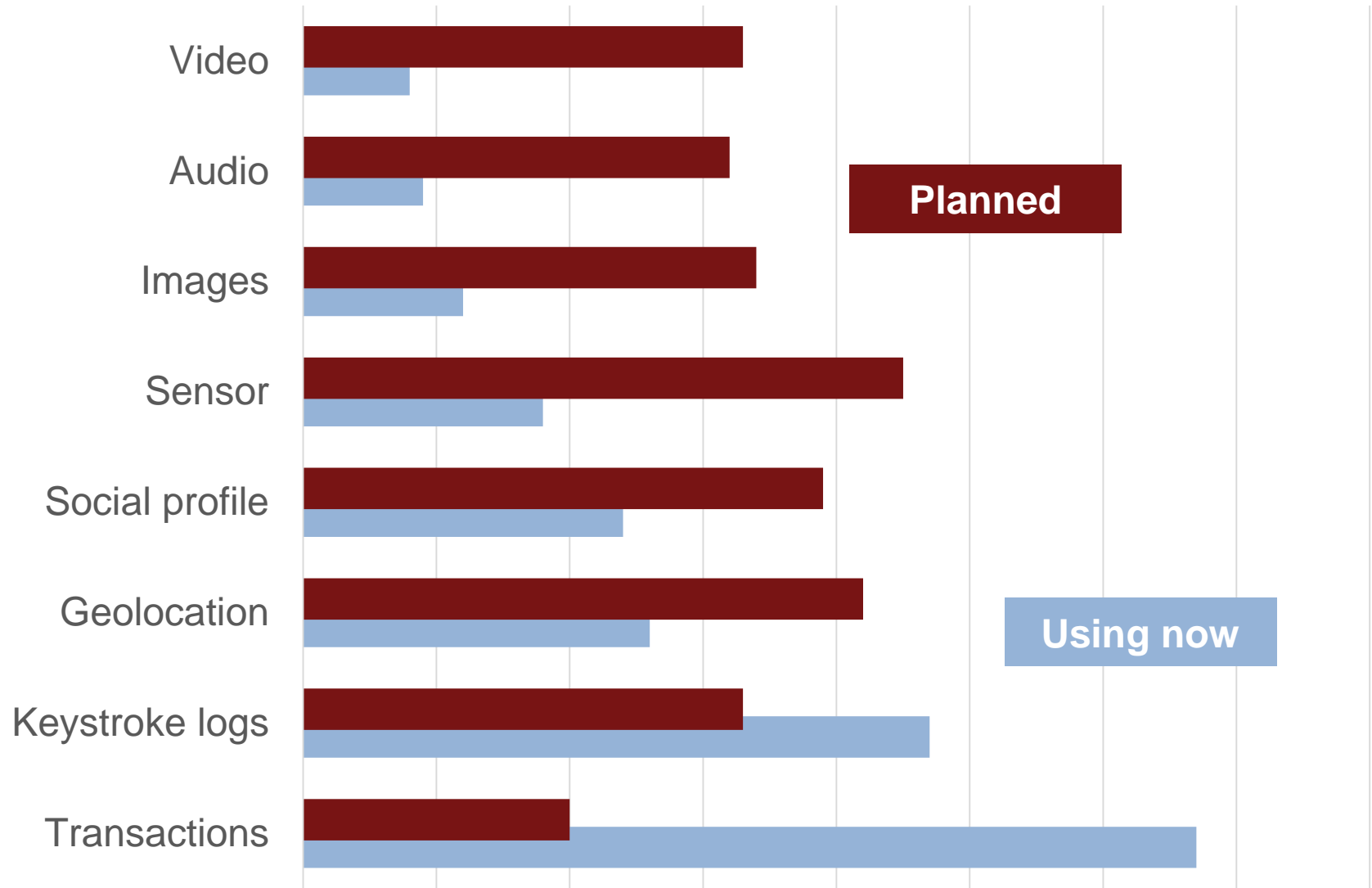




Engineering Data



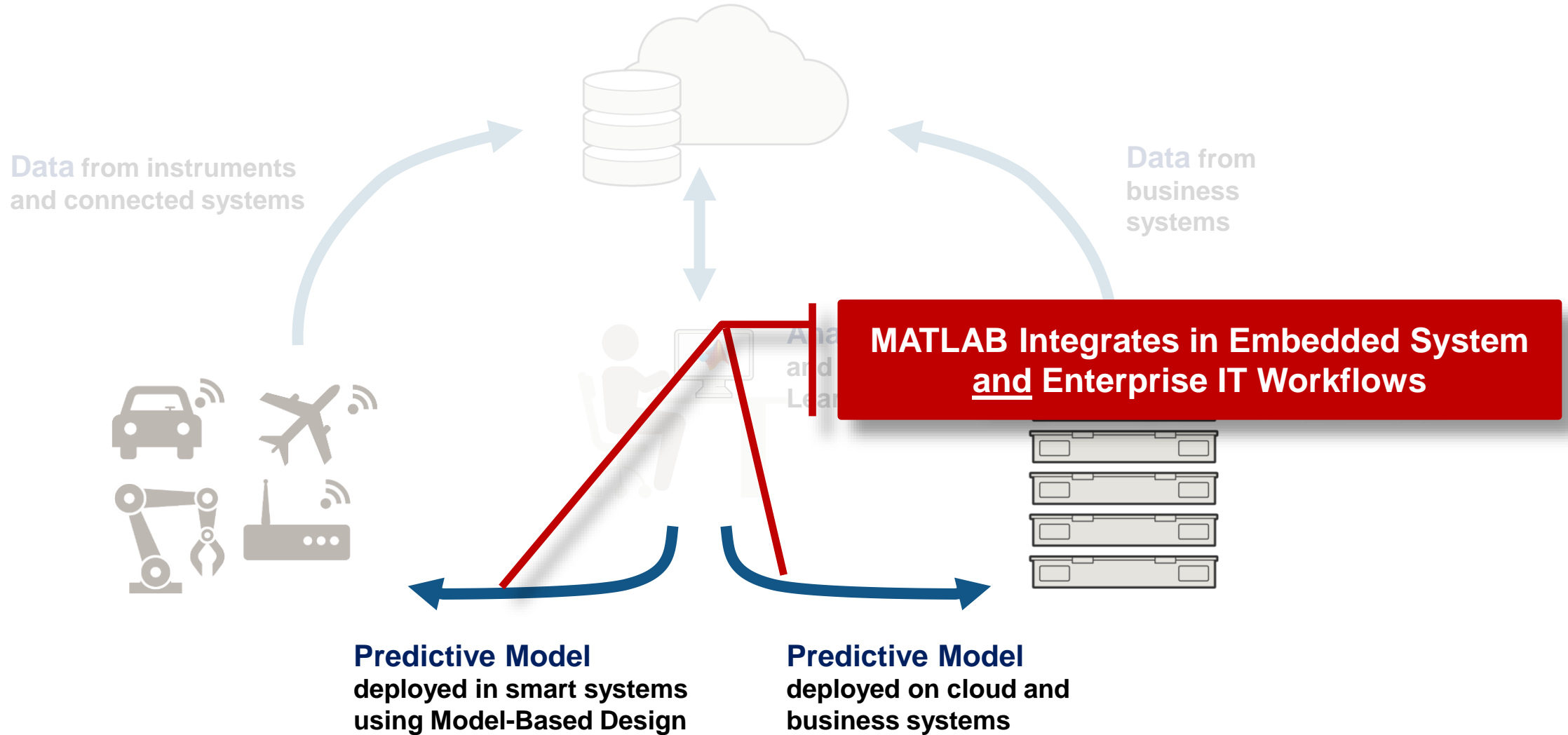
Business Data



Source: Gartner Big Data Industry Insights, March 2016

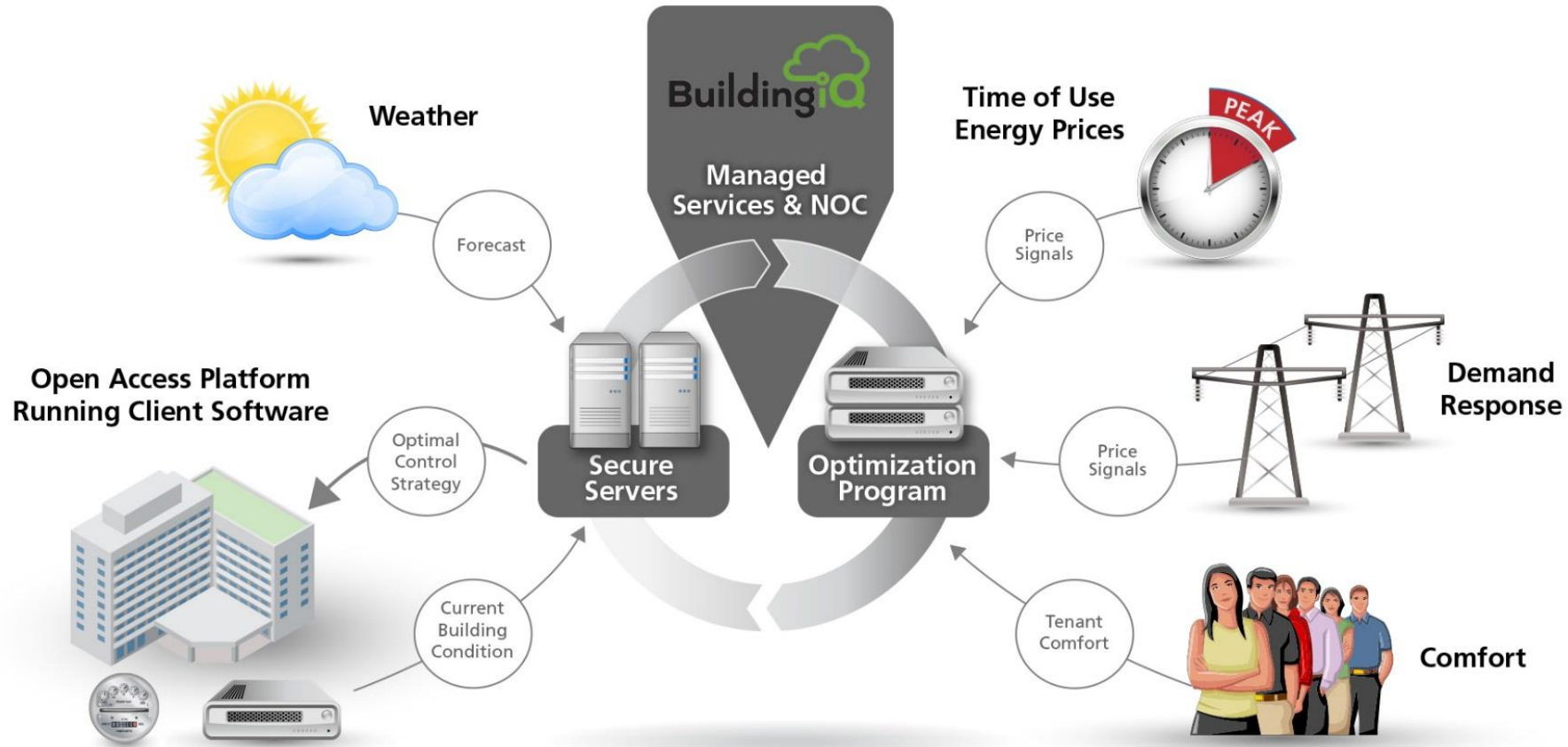
The Rise of **Engineering-Driven Analytics**

Architecture of an analytics system



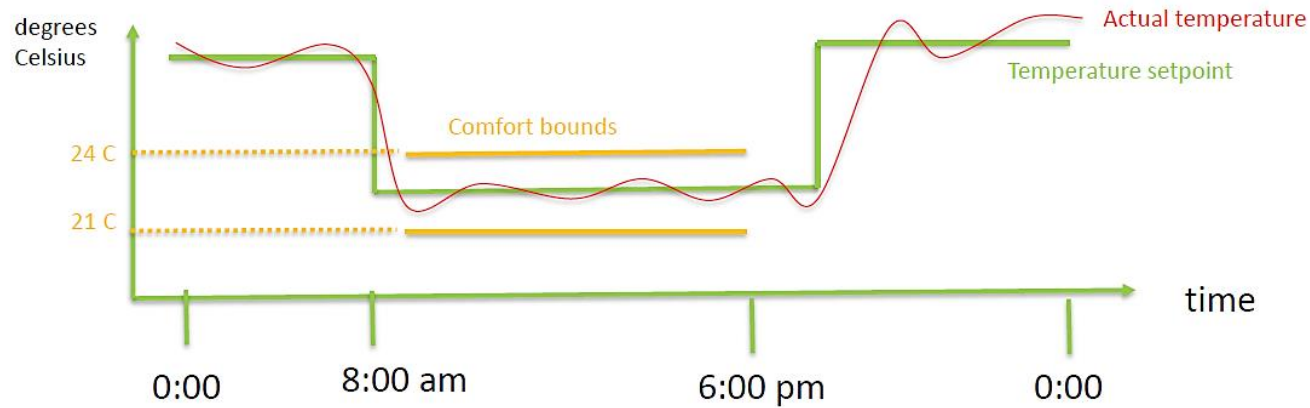
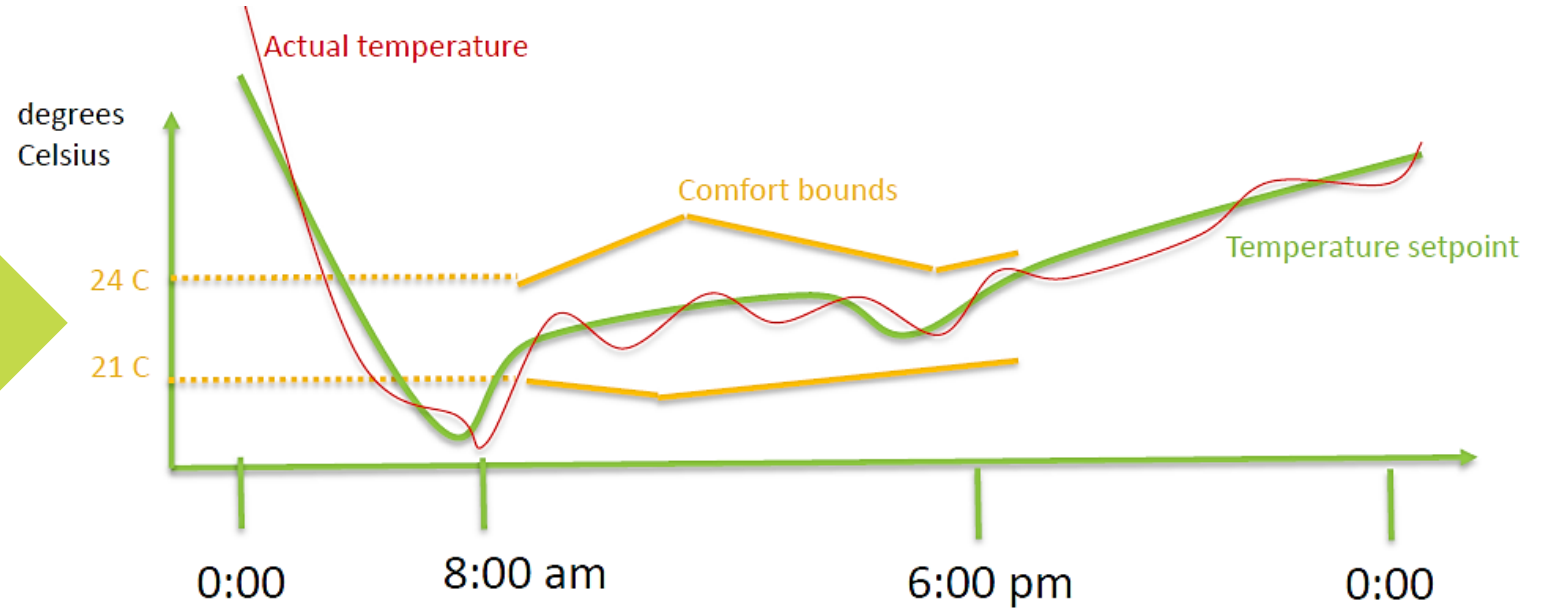
Example – BuildingIQ

Adaptive building energy management

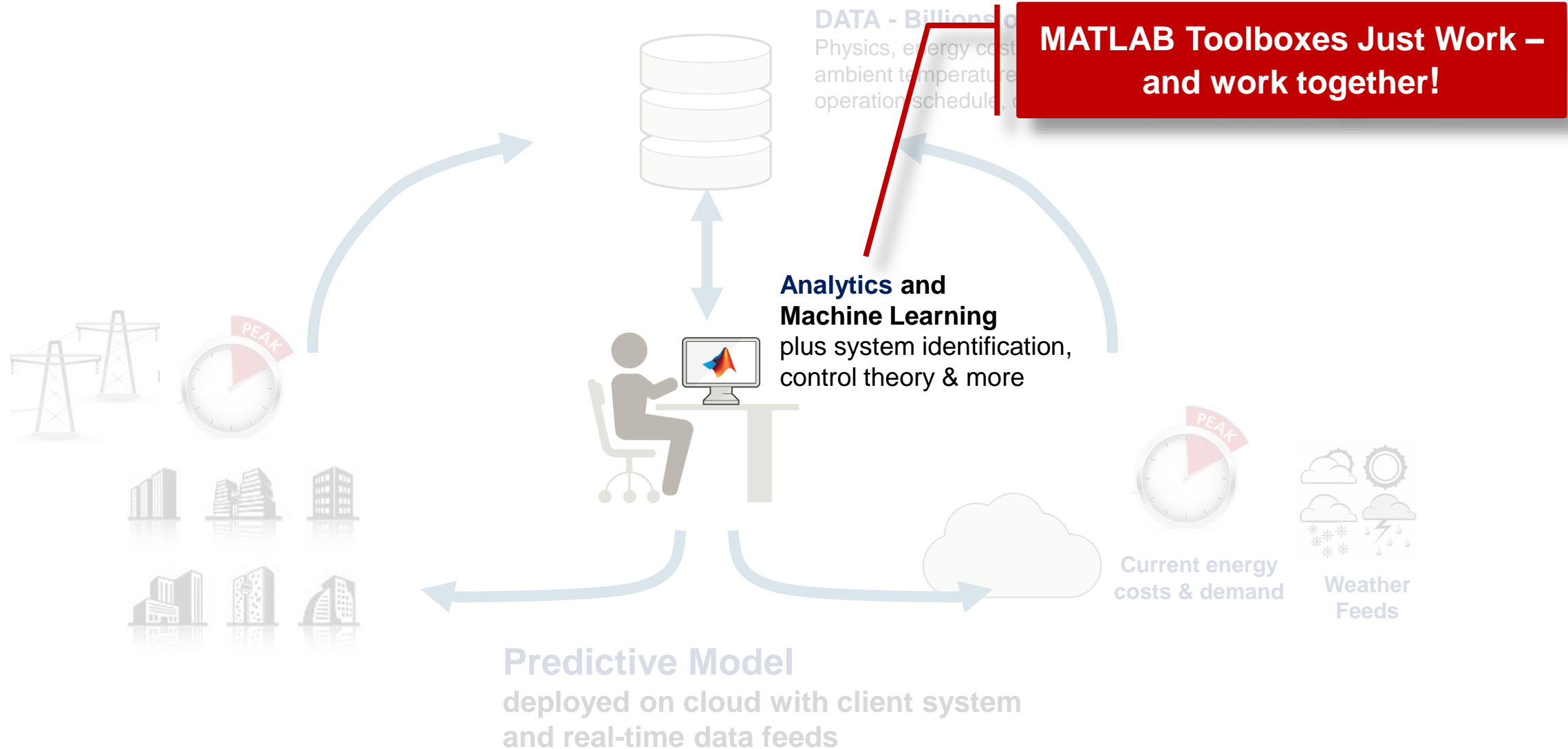


BuildingIQ

25% cost reduction



Real-time, closed-loop optimization algorithms



Why MATLAB?

- **Robust numerical algorithms**
- Extensive visualization and analytics tools
- Industry-robust and **reliable mathematical optimization** routines
- Good object-oriented framework
- Ability to interface with Java (for backend work)
- Running MATLAB in the cloud in **production**
- Unit-testing framework

**MATLAB Impeccable Numerics
for Trusted Results**

BuildingIQ



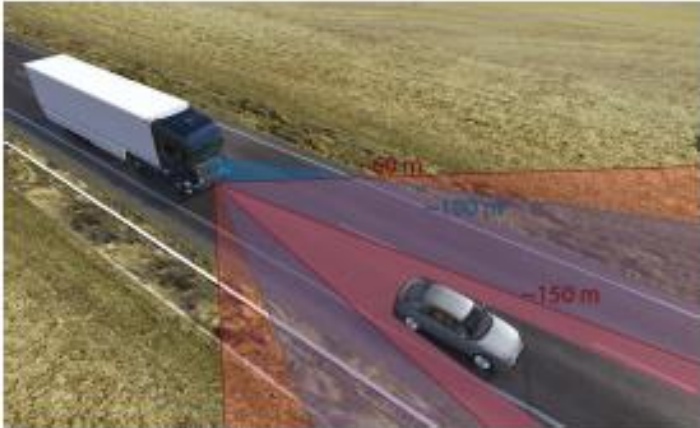
We could rapidly translate our prototypes into production algorithms that deal reliably with real-world noise and uncertainty

Borislav Savkovic, BuildingIQ

Example – Scania

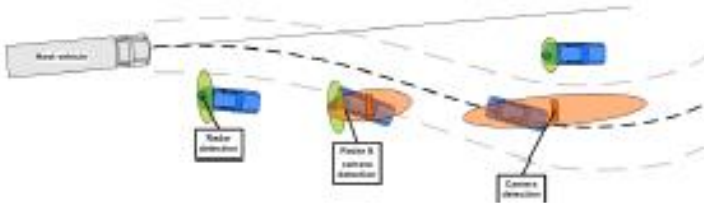
Automatic emergency braking using sensor fusion and analytics

Sensor fusion
Two sensors -> One "truth"




Sensors have different advantages

- Radar
 - + Range (longitudinal)
 - + Relative velocity
 - + Solid object reflection
 - No shapes
 - Lateral position
- Camera
 - + Object type
 - + Object width
 - + Lateral position
 - Range
 - Optical illusions



2015-09-24 Jonny Andersson

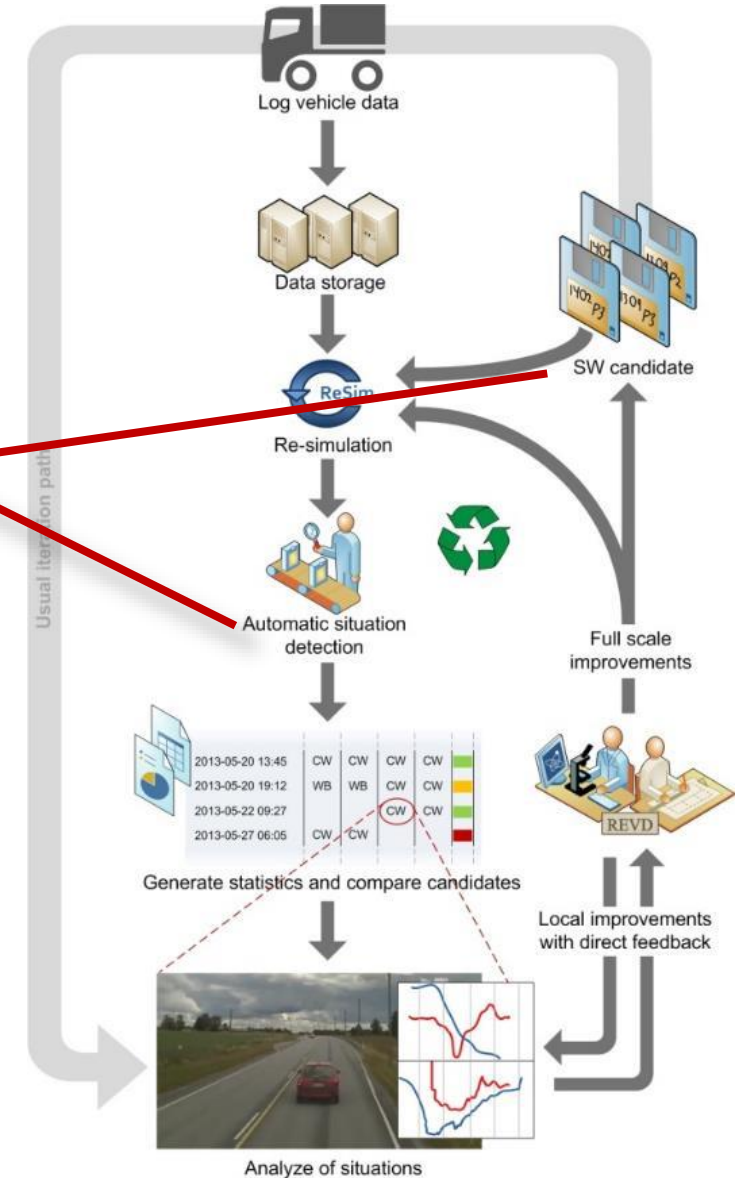
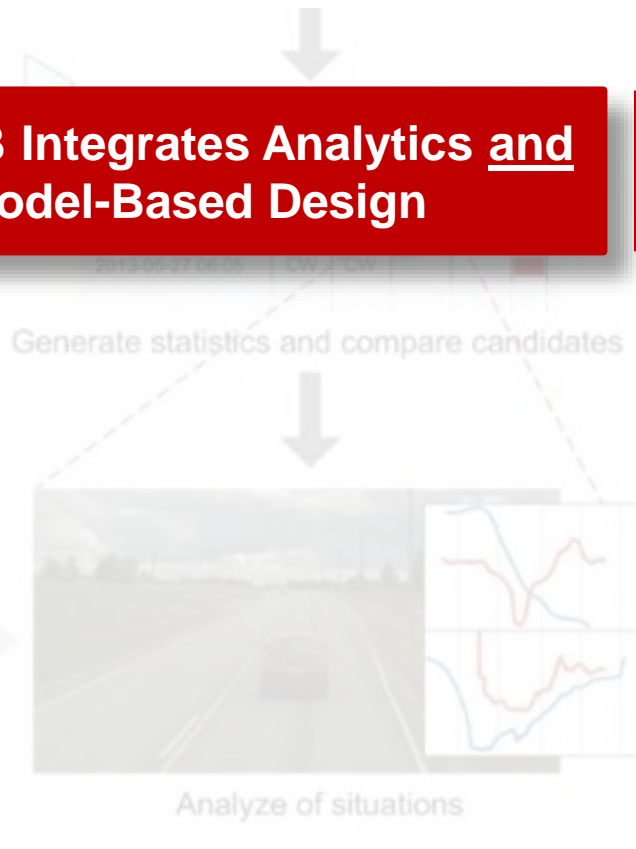


50 km/h - sudden brake

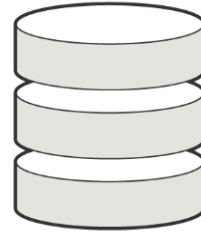


Using Model-Based Design to build and deploy the analytics in an embedded control system

MATLAB Integrates Analytics and Model-Based Design



Implementing Sensor Fusion at Scania



Machine learning
to develop fusion algorithms
for situation detection



Vehicle logs
of video and radar data



Predictive Model
deployed on vehicle

2013-05-20 13:45	CW	CW	CW	CW	Green
2013-05-20 19:12	WB	WB	CW	CW	Yellow
2013-05-22 09:27			CW	CW	Green
2013-05-27 06:05	CW	CW	CW	CW	Red

Generate statistics and compare candidates



Analyze of situations

Automotive



Off-highway vehicles



Aeronautics



The Rise of Engineering-Driven **Analytics**

Retail



Finance



Healthcare



Internet



Industrial Automation



Oil & Gas



Medical Devices



Clean Energy

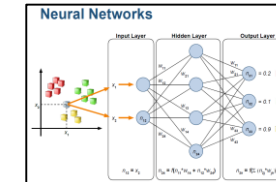
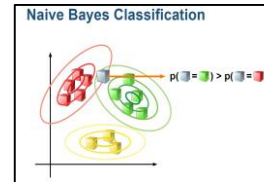
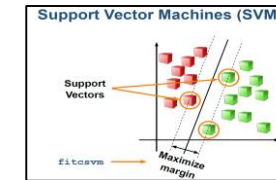


Predictive Maintenance for polymer-based production machines

Sensor Data (~1 minute)
10-100 sensors/machine
Quality State (~40 minutes)

1 TIMESTAMP	2 PARAMETER								3 STATE		
'2015-07-14 00:49:12.0'	160	160	160	160	1000	7	1000	9	33	32	1
'2015-07-14 00:50:12.0'	160	160	160	160	1000	8	1000	10	33	32	1
'2015-07-14 00:51:13.0'	160	160	160	160	1000	8	1000	10	33	32	1
'2015-07-14 00:52:12.0'	160	160	160	160	1000	8	1000	10	33	32	1
'2015-07-14 00:53:12.0'	160	160	160	160	1000	8	1000	11	33	32	2
'2015-07-14 00:54:12.0'	160	160	160	160	1000	8	1000	12	33	32	2
'2015-07-14 00:55:12.0'	160	160	160	160	1000	8	1000	10	33	32	2

Classification using Statistics, Machine Learning, and Neural Networks



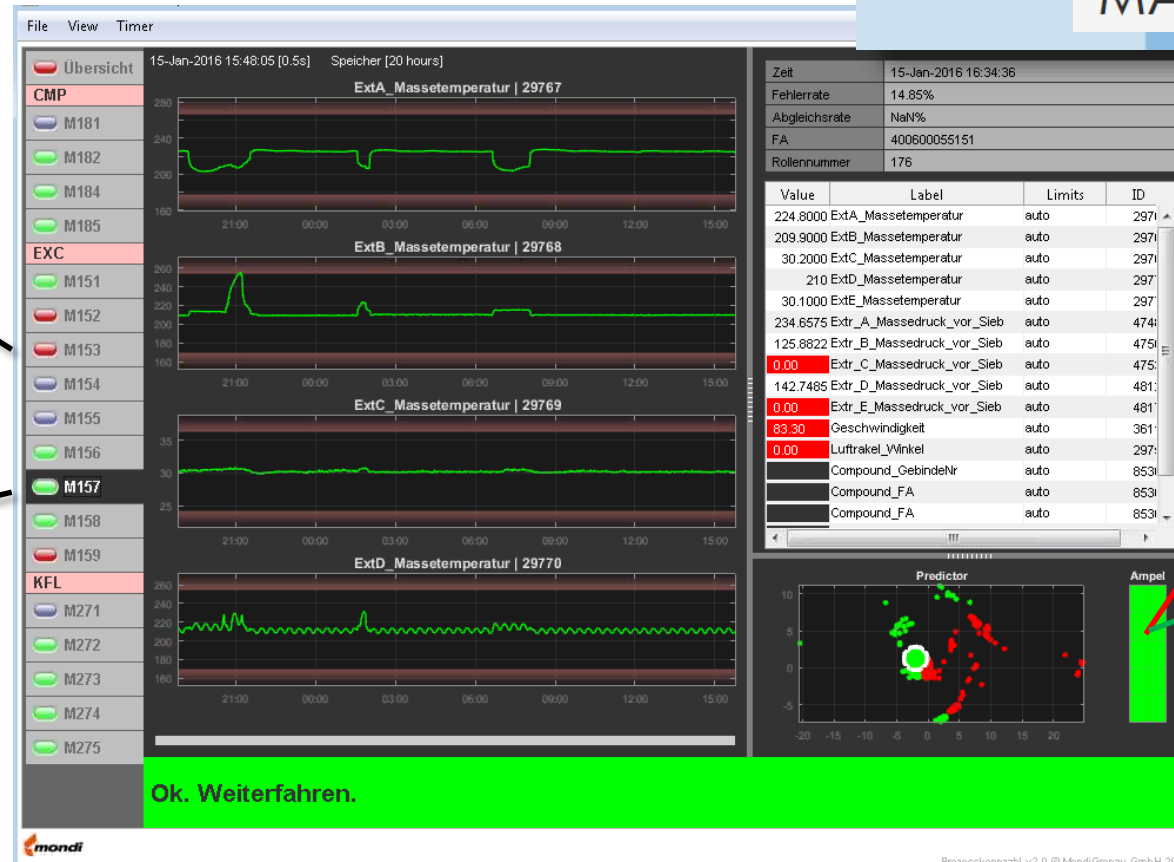
Deployment – a MATLAB App used by machine operators



M153

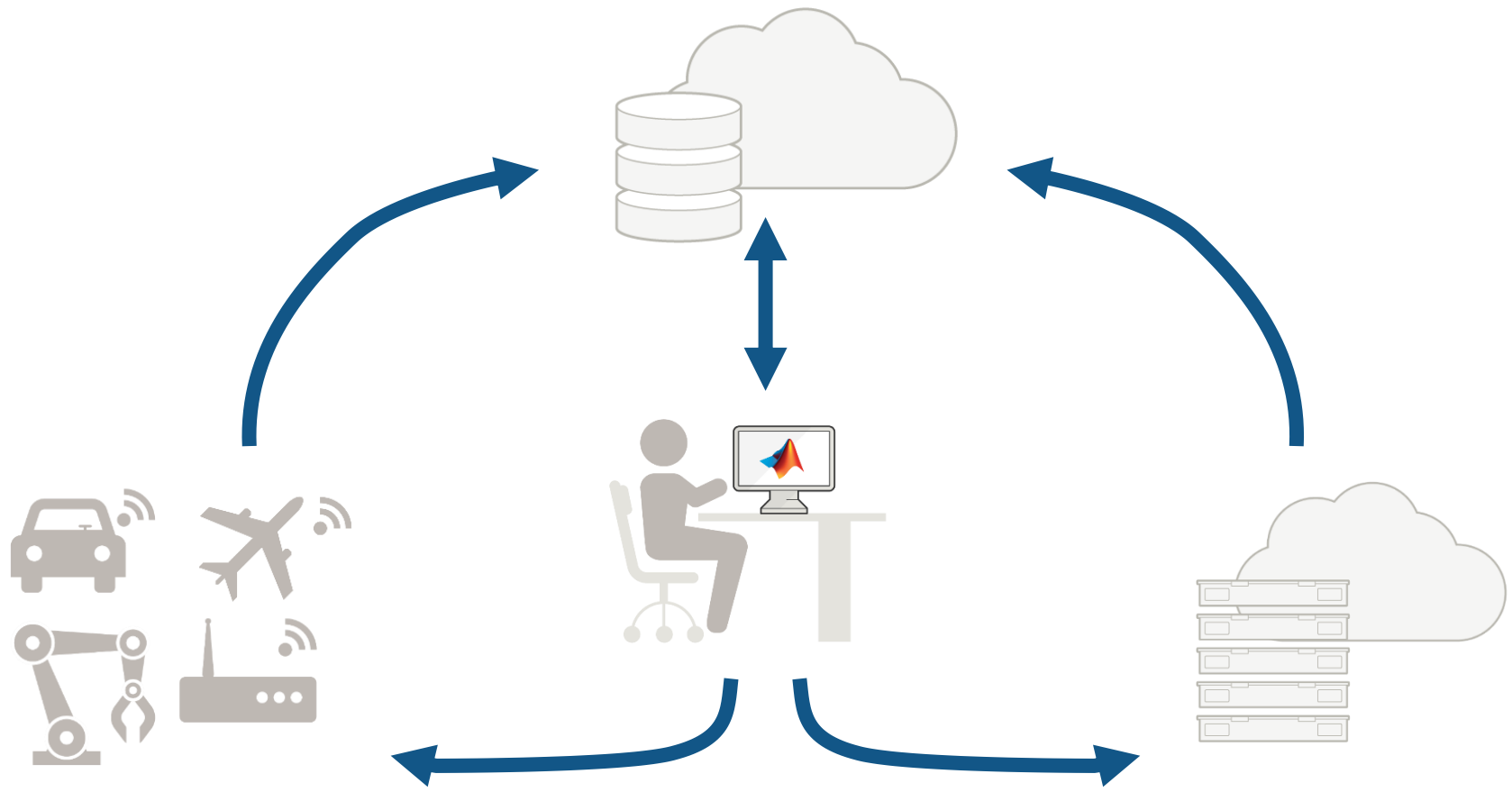


M157

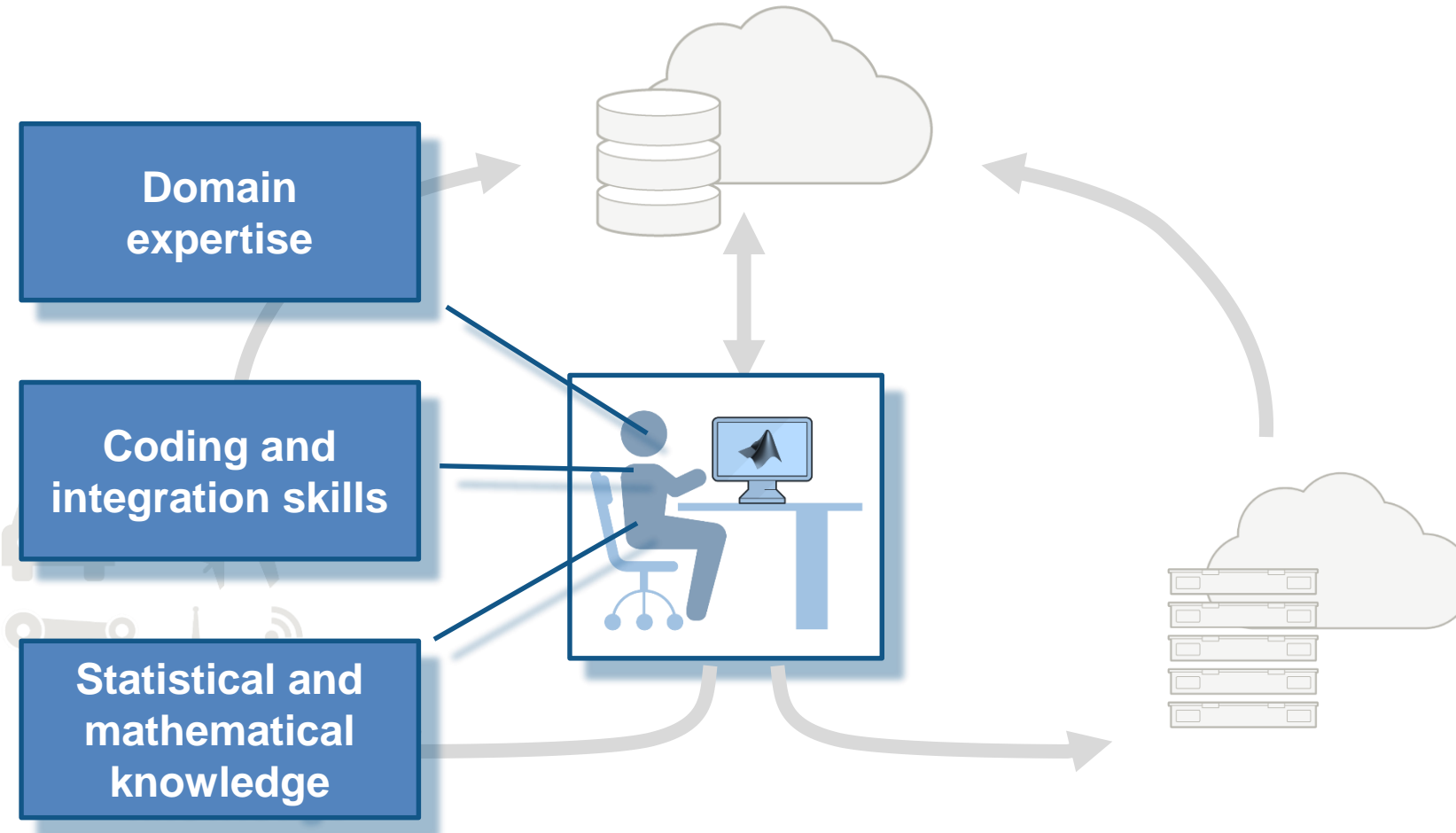


State **NOT OK**

State **OK**



The need for data scientists





Essential Guide

IoT analytics guide: Understanding Internet of Things data

A comprehensive collection of articles, videos and more, hand-picked by our editors

Shortage of data scientists, big data pros vexes IoT efforts

CRUNCH NETWORK

How To Stem The Global Shortage Of Data Scientists

Posted Dec 31, 2015 by [Amy Gershkoff \(@amygershkoff\)](#)

Big data talent shortage: How to bridge the gap?

By [Abhishek Raval](#) on May 29, 2015

What they say

- Expand university programs
- Train existing analysts

coursera [Catalog](#) [Institutions](#) [Log In](#) [Sign Up](#)

HIGHER SCHOOL OF ECONOMICS
Core Concepts in Data Analysis
 Learn both theory and application for basic methods that have been invented either for developing new concepts – principal components or clusters, or for finding interesting correlations – regression and classification. This is preceded by a thorough analysis of 1D and 2D data.

CALIFORNIA INSTITUTE OF TECHNOLOGY

LEARNING FROM DATA
 Machine Learning course - recorded at a live broadcast from Caltech

HIGHLIGHTS

A real Caltech course, not a watered-down version

Featured on

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Stanford University

Machine Learning
 Stanford University

[Course Info](#)

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BD2K-LINCS DATA COORDINATION AND INTEGRATION CENTER

Big Data Science with the BD2K-LINCS Data Coordination and Integration Center
 Learn various methods of analysis including: unsupervised clustering, gene-set enrichment analyses, Bayesian integration, network visualization, and supervised machine learning applications to LINCS data and other relevant Big Data from high content molecular and phenotype profiling of human cells.

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UNIVERSITY of WASHINGTON

Computational Methods for Data Analysis
 Exploratory and objective data analysis methods applied to the physical, engineering, and biological sciences.



IoT open data platform for students and makers

Built-in MATLAB analysis

Apps - ThingSpeak

https://thingspeak.com/apps/matlab_analyses/templates

ThingSpeak

Apps / MATLAB Analysis / New

Help

New MATLAB Analysis

Templates:

- Custom (no starter code)
- Get data from a private channel
- Get data from a public channel
- Get data from a webpage

Examples: Sample code to analyze and transform data

MATLAB Analysis Templates

Templates provide sample MATLAB code for analyzing data and writing it to a ThingSpeak channel. If you are new to MATLAB, you can interactively at [MATLAB Academy](#).

MATLAB Analysis Examples

To see MATLAB Analysis in action, select the example and click **Create**.

Simulink support via Raspberry Pi

Internet Of Things - ThingSpeak

Counting Cars and Analyze

makerzone.mathworks.com/blog/counting-cars-and-analyzing-traffic-ras

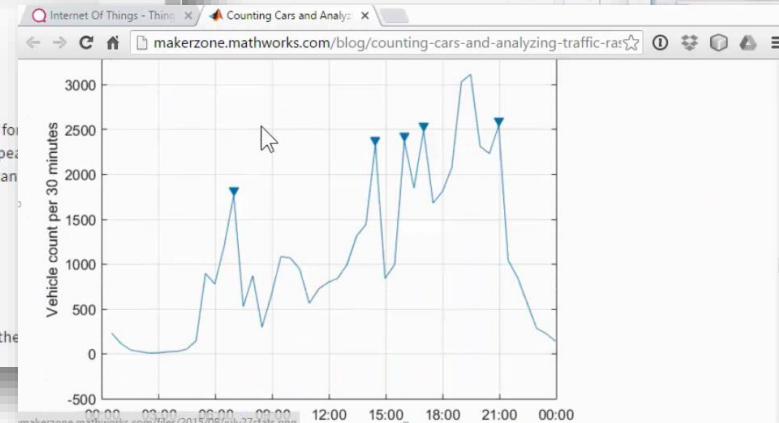
Live Car Counting with Raspberry Pi Hardware

To run this model on hardware, on the Simulink Editor toolbar, click the "Run" button. Note that the simulation mode is "External". This mode allows you to tune parameters and monitor signals in the model while the application is running on hardware.

Simulink block diagram showing: Image Input, Frame Rate Display, Image Filter, Foreground Mask, Motion Filter, Video Viewer, Video Filtered Foreground Mask, Blob Analysis, Car Counter, and Raspberry Pi hardware connection.

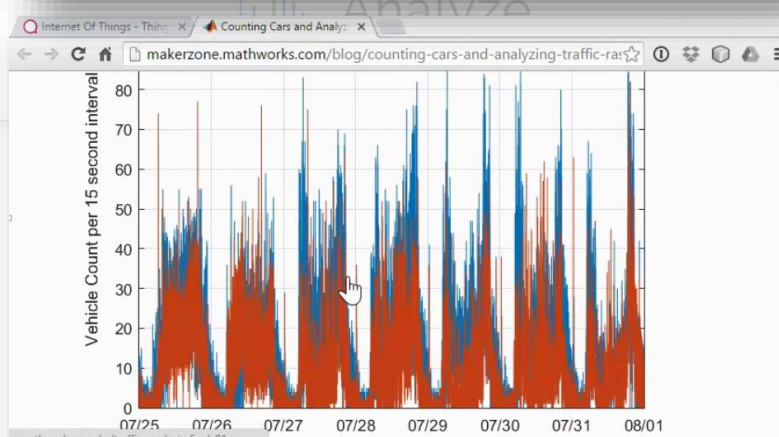
Collect

Send sensor data to the cloud.



Act

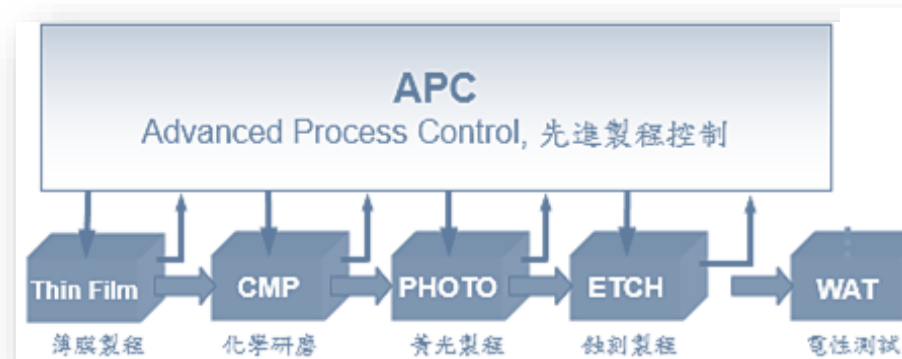
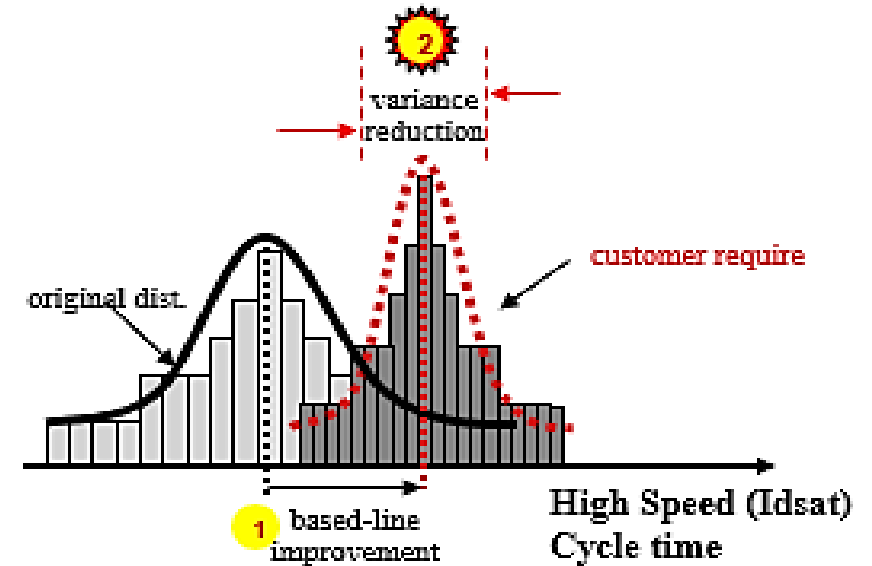
Trigger a reaction.



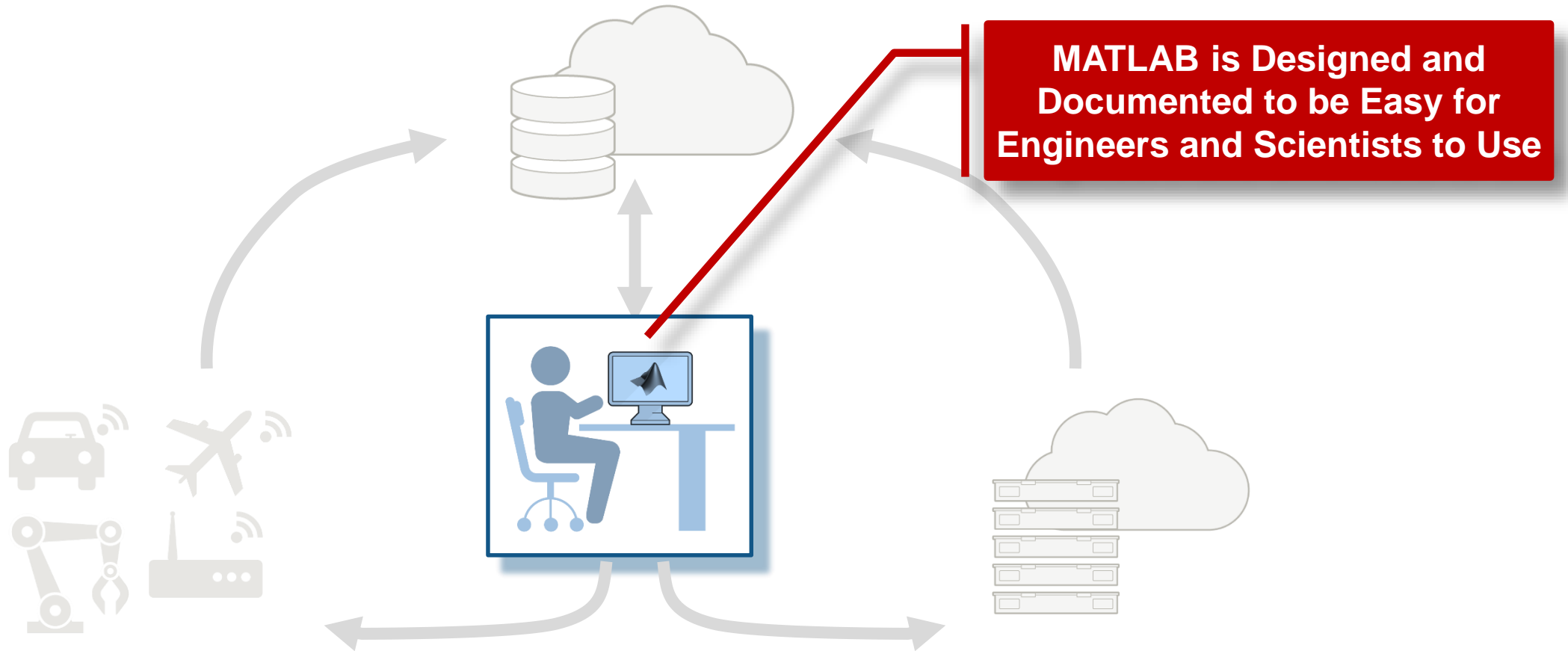
Student Contest

use process control data
to improve semiconductor yields

- 21 teams competed
- Wafer Big Data in Hadoop
- MATLAB used by winning team *and* 2nd place team



MATLAB lets you be your own data scientist

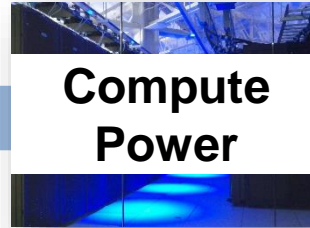


Limited users, scope, & technology



Big Data

- Engineering
- Business
- Transactional



Compute Power

- Desktop - Multicore, GPU
- Clusters
- Cloud computing
- Hadoop



Machine Learning

- Neural Networks
- Classification
- Clustering
- Regression
- ...and much more...

Pervasive users, scope, & technology

In MATLAB

- Native support for engineering data
- Database interfaces
- Streaming

NEW for MATLAB

Audio System Toolbox R2016a

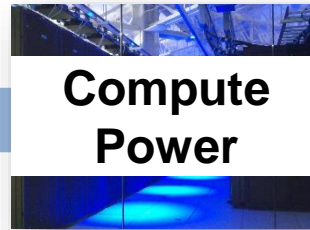
Vision HDL Toolbox R2015a

Limited users, scope, & technology



Big Data

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Pervasive users, scope, & technology

In MATLAB

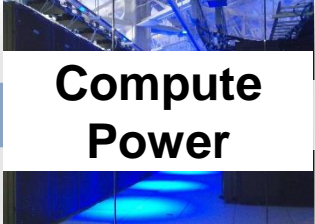
- Native support for engineering data
- Database interfaces
- Streaming
- **Datastore** R2014b text, image, video, Excel files, ...
- **Mapreduce** R2014b

Limited users, scope, & technology



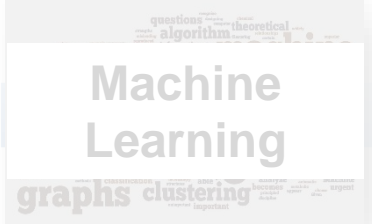
Big Data

- Engineering
- Business
- Transactional



Compute Power

- **Desktop** - Multicore, GPU
- **Clusters**
- **Cloud computing**
- **Hadoop**



Machine Learning

- Natural language processing
- Classification
- Clustering
- Regression

Pervasive users, scope, & technology

MATLAB is fast:

- heavily optimized libraries
- JIT compiled
- takes advantage of the compute power you have

In MATLAB

- Native support for engineering data
- Database interfaces
- Streaming
- **Datastore** R2014b text, image, video, Excel files, ...
- **Mapreduce** R2014b

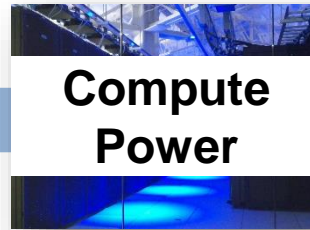
- **Multicore & GPU**
- **MATLAB Distributed Computing Server and EC2 Support**
- **Hadoop support** R2014b
- **MATLAB Production Server**

Limited users, scope, & technology



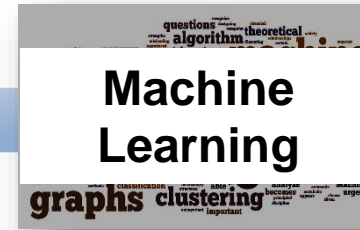
Big Data

- Engineering
- Business
- Transactional



Compute Power

- Desktop - Multicore, GPU
- Clusters
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- Hadoop



Machine Learning

- Neural Networks
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Pervasive users, scope, & technology

In MATLAB

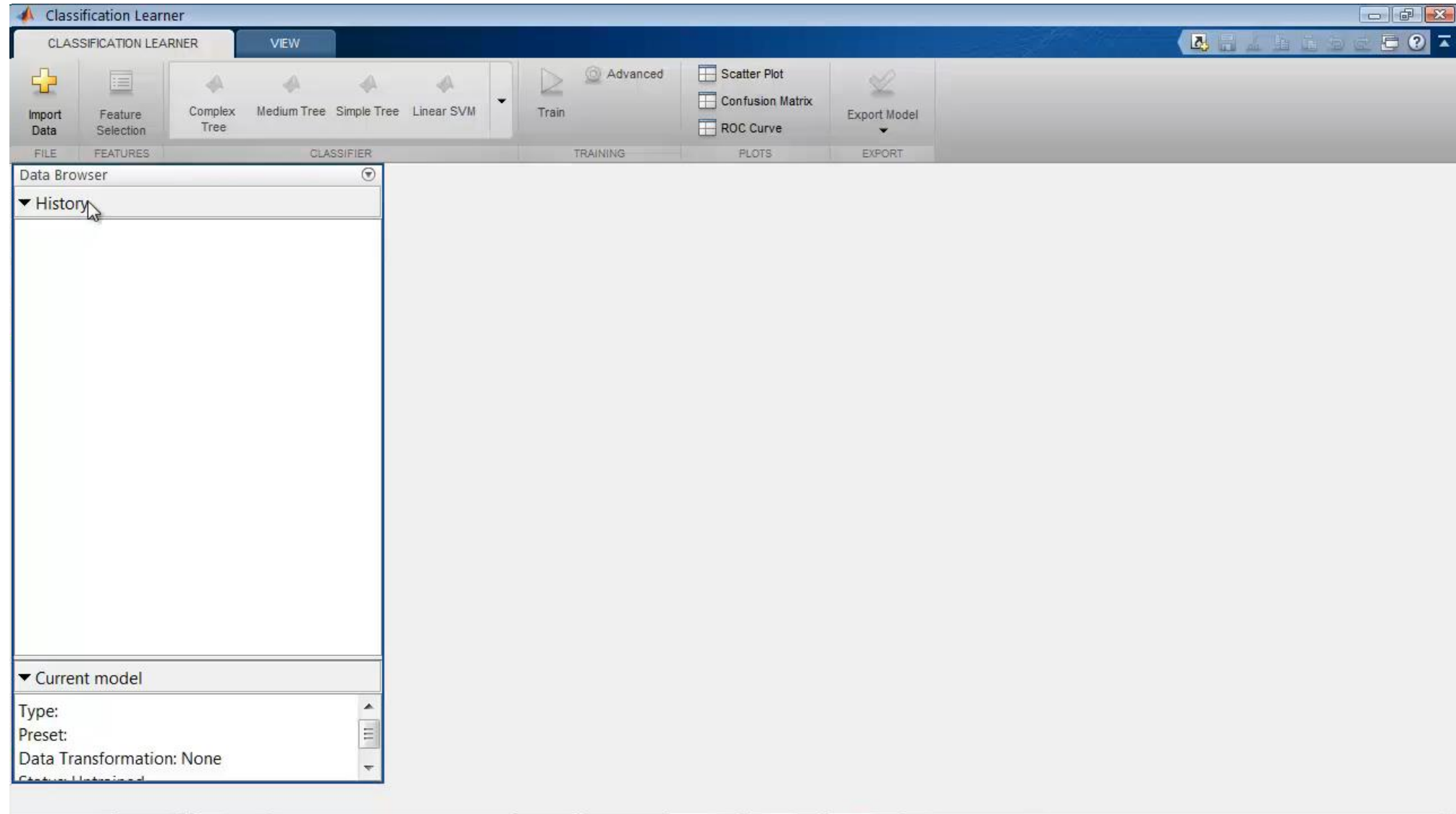
- Native support for engineering data
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- MATLAB Distributed Computing Server and EC2 Support
- **Hadoop support** R2014b
- MATLAB Production Server

- Statistics and Machine Learning Toolbox
- **Classification Learner App** R2015a
- Neural Network Toolbox
- **CNNs for Deep learning** R2016a
- Machine learning with code generation

Classification Learner App

in Statistics and Machine Learning Toolbox



MATLAB Apps for Data Analytics

Distribution Fitting

System Identification

Signal Analysis

Wavelet Design and Analysis

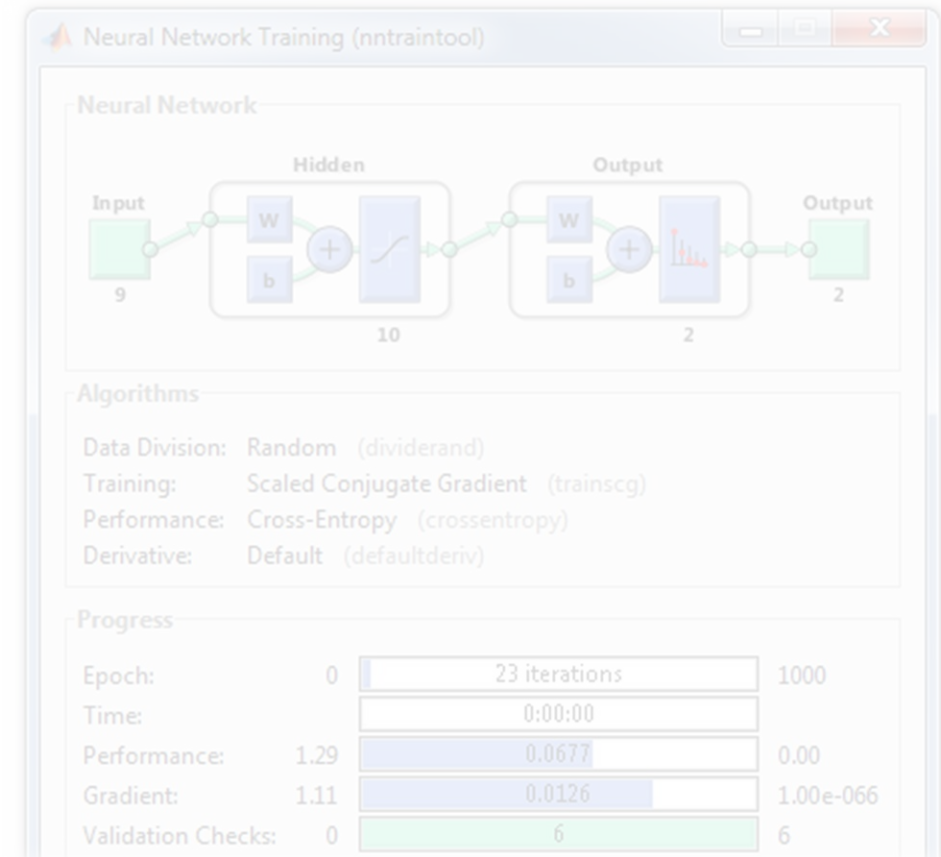
Neural Net Fitting

Neural Net Pattern Recognition

Training Image Labeler

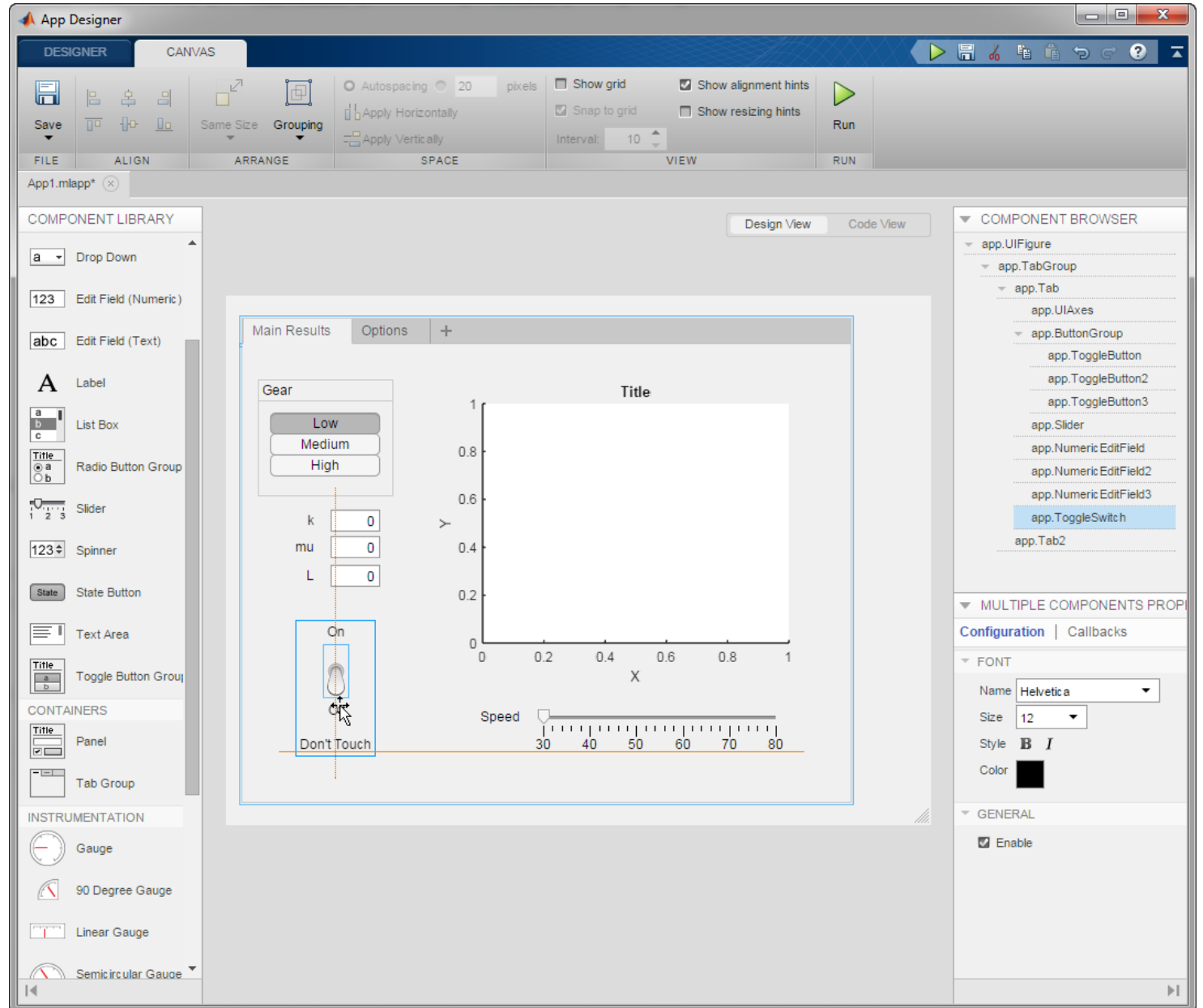
and many more...

With MATLAB Apps, you can complete data science tasks more quickly and easily than custom programming



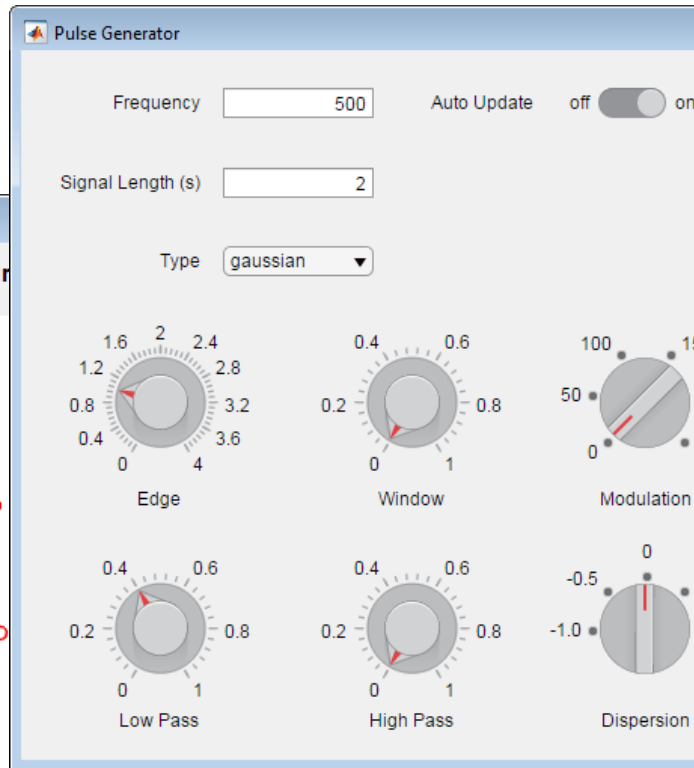
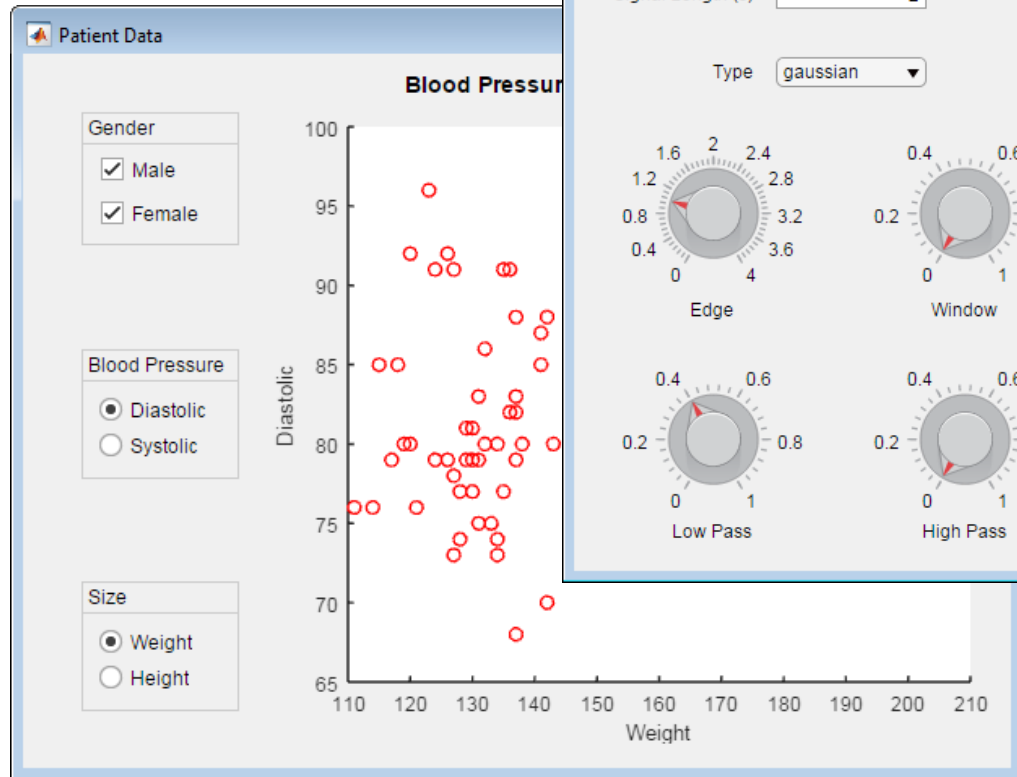
Using MATLAB R2016a

App Designer

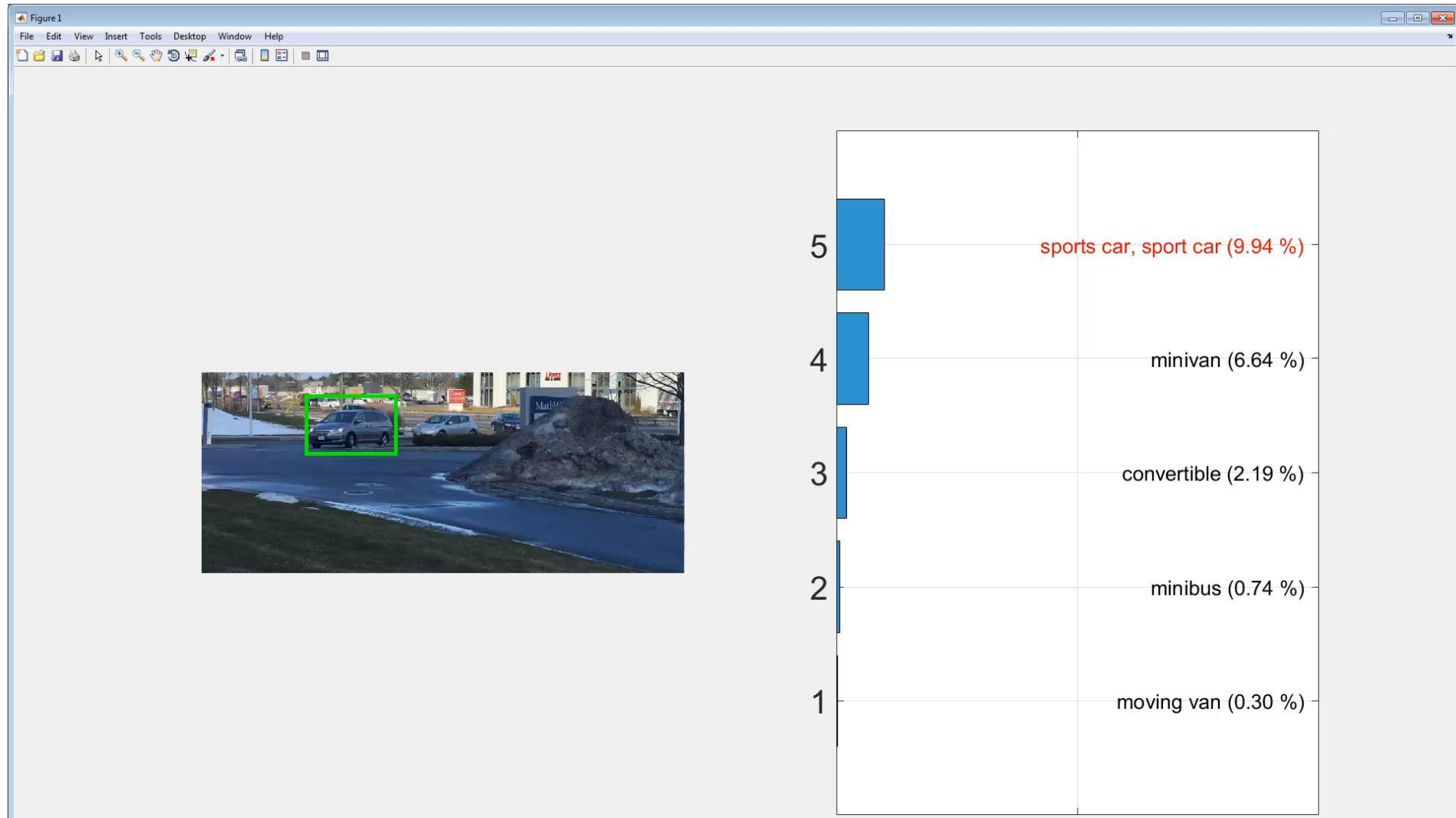


Using MATLAB R2016a

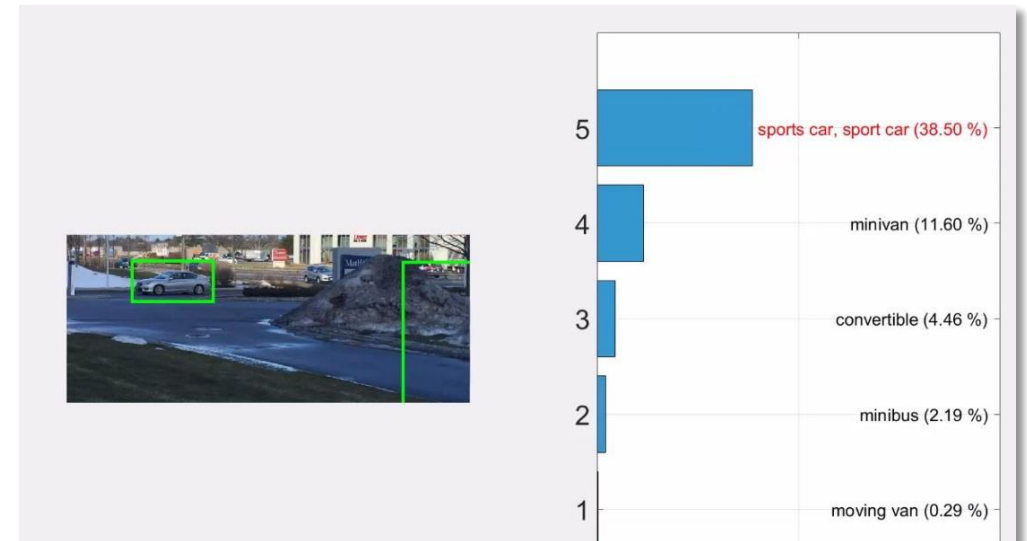
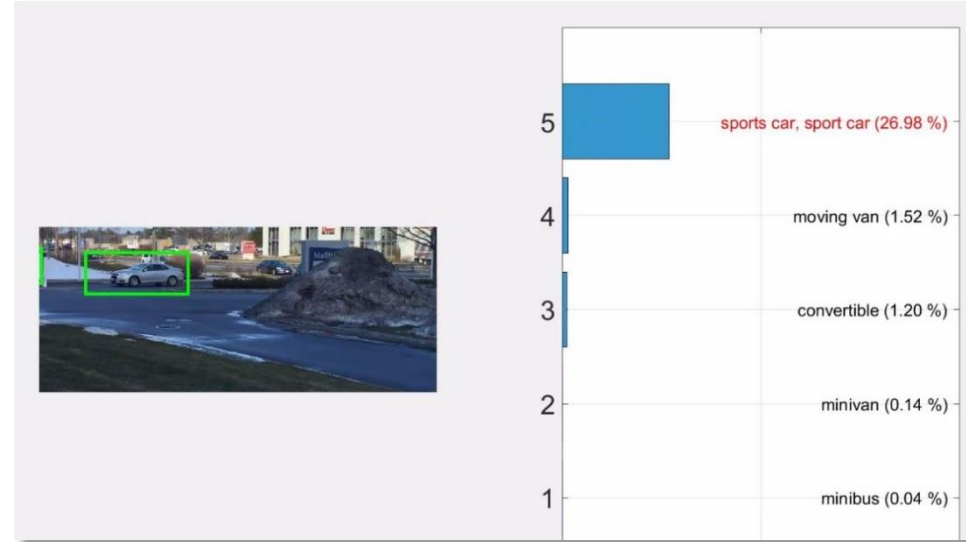
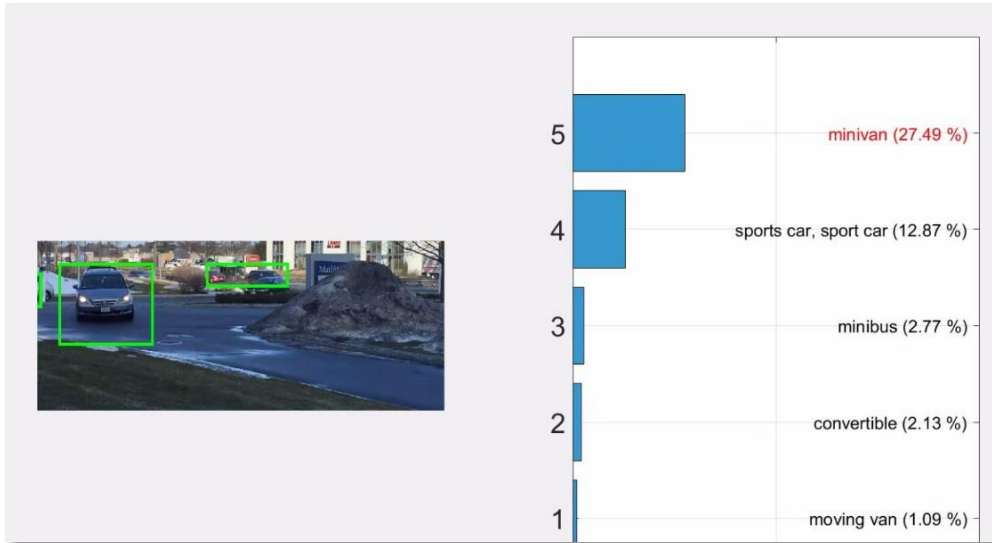
App Designer



Deep Learning with Neural Network Toolbox - New in R2016a



Deep Learning with Neural Network Toolbox - New in R2016a



Example – **cellscope**[®]

First consumer otoscope in a mobile device
machine learning and computer vision



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Limited
users, scope,
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Big Data



**Compute
Power**



**Machine
Learning**

Pervasive
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Be your own Data Scientist!