MATLAB EXPO 2016
The Rise of Engineering-Driven Analytics

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MathWorks UK Consulting
The Rise of Engineering-Driven Analytics
Analysis

Apply robust, statistically-motivated methods to data produced from complex systems to understand what has happened and why,

predict what will happen
Analytics

Apply robust, statistically-motivated methods to data produced from complex systems to understand what has happened and why,

predict what will happen

suggest decisions or actions.
Analytics are pervasive – Why Now?

We have data
• Engineering
• Business
• Transactional

We have compute
• Desktop
  • Multicore, GPU
• Clusters
• Cloud computing
• Hadoop with Spark

We know how
• Neural Networks
• Classification
• Clustering
• Regression
• ...and much more…
Use **Image Processing** to add image data to the model, improving performance.

**Analytics in e-commerce**

- **Engineering Data**
  - Images
  - Social profile
  - Geolocation
  - Keystroke logs
  - Transactions

- **Business Data**

**IMPROVED Predictive Model**

**Improved Offer to Customer**
Consider the **Data** in Data Analytics

**Engineering Data**
- Video
- Audio
- Images
- Sensor

**Business Data**
- Social profile
- Geolocation
- Keystroke logs
- Transactions

**Level of Industry / User Adoption**

*Source: Gartner Big Data Industry Insights, March 2016*
Consider the **Data** in Data Analytics

### Engineering Data
- Video
- Audio
- Images
- Sensor

### Business Data
- Social profile
- Geolocation
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The Rise of Engineering-Driven Analytics
Architecture of an analytics system

Data from instruments and connected systems

Analytics and Machine Learning

Data from business systems
Architecture of an analytics system

Data from business systems

Data from instruments and connected systems

MATLAB & Simulink Integrates in Embedded Systems and Enterprise IT Workflows

Predictive Model deployed in smart and embedded systems

Predictive Model deployed on cloud and business systems
Example – BuildingIQ

Adaptive building energy management
Example – BuildingIQ

Adaptive building energy management

Degrees Celsius

24 C

21 C

Comfort bounds

Actual temperature

Temperature setpoint

Time

0:00

8:00 am

6:00 pm

0:00
Example – BuildingIQ

Adaptive building energy management
Real-time, closed-loop optimization algorithms

DATA - Billions of data points:
Physics, energy cost, power, internal temperatures, ambient temperatures, ambient humidity, building operation schedule, comfort bounds, etc.

Analytics and Machine Learning
plus signal processing, Control, optimization & more

Predictive Model
deployed on cloud with client system and real-time data feeds
Example – BuildingIQ

Adaptive building energy management

10% to 25% cost reduction
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

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

Borislav Savkovic, BuildingIQ
50 km/h - sudden brake
Example – Scania

Automatic emergency braking using sensor fusion and analytics
Example – Scania

Automatic emergency braking using sensor fusion and analytics
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

Vehicle logs of video and radar data

Predictive Model deployed on vehicle

Machine learning to develop fusion algorithms for situation detection
Predictive Maintenance for polymer-based production machines

Sensor Data (~1 minute)
10s-100s sensors/machine

Quality State (~40 minutes)

Classification using Statistics, Machine Learning, and Neural Networks

MATLAB EXPO 2016
Deployment – a MATLAB App used by machine operators
“Our financial control department determined that we are saving more than 50,000 euros per year by using MATLAB for predictive maintenance,” says Dr. Kohlert. “That total is based on just eight machines. We expect that to increase at least fourfold as we analyze the data from more of our machines.”
Architecture of an analytics system
The need for data scientists

- Domain expertise
- Coding and integration skills
- Statistical and mathematical knowledge
What they say

• Expand university programs
• Train existing analysts
IoT open data platform for students and makers

Built-in MATLAB analysis

Simulink support via Raspberry Pi
IoT open data platform for students and makers
MATLAB lets you be your own data scientist

“As a manufacturing company we don’t have data scientists with machine learning expertise, but MathWorks provided the tools and technical knowhow that enabled us to develop a production preventative maintenance system in a matter of months,”

Dr. Michael Kohlert, head of information management and process automation at Mondi.
Big Data

- Engineering
- Business
- Transactional

- Native support for engineering data
- Database interfaces
- Streaming

Compute Power

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

- Neural Networks
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- ...and much more...

Machine Learning

In MATLAB

NEW for MATLAB

- Audio System Toolbox R2016a
- Vision HDL Toolbox R2015a
In MATLAB

**Big Data**
- Engineering
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- Database interfaces
- Streaming
- Datastore
  - text, image, video, Excel files
  - *Timetable, string, and tall arrays 2016b*

**Compute Power**
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- Neural Networks
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Limited users, scope, & technology

Pervasive users, scope, & technology

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- Multicore & GPU
- MATLAB Distributed Computing Server and EC2 Support
- Hadoop with Spark support R2016b
- 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
MATLAB Apps for Data Analytics

- Classification Learner
- Distribution Fitting
- System Identification
- Signal Analysis
- Wavelet Design and Analysis
- Neural Net Fitting
- Neural Net Pattern Recognition
- Training Image Labeler

and many more…
Using MATLAB R2016a

App Designer
Deep Learning with Neural Network Toolbox - New in R2016a

- sports car, sport car (9.94 %)
- minivan (6.64 %)
- convertible (2.19 %)
- minibus (0.74 %)
- moving van (0.30 %)
The Rise of Engineering-Driven Analytics

Limited users, scope, & technology

Big Data

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Be your own Data Scientist!
<table>
<thead>
<tr>
<th>Application Track 1</th>
<th>Application Track 2</th>
<th>Introductory Sessions</th>
<th>Master Classes</th>
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<tbody>
<tr>
<td>11:15  <strong>Big Data</strong></td>
<td><strong>What’s New in Simulink Release R2016a and R2016b</strong></td>
<td><strong>Introduction to MATLAB</strong></td>
<td><strong>Signal Processing</strong></td>
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<tr>
<td>11:45 <strong>MATLAB and Advanced Analytics at Shell</strong></td>
<td><strong>Fast-Paced Development in F1 Control and Analysis Systems</strong></td>
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<td>12:15 <strong>Machine Learning and Deep Learning</strong></td>
<td><strong>New Capabilities in Testing</strong></td>
<td><strong>Introduction to Parallel Computing</strong></td>
<td><strong>Hardware-in-the-Loop: Real-Time Simulation</strong></td>
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<td>12:45 <strong>Lunch</strong></td>
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<td>13:15 <strong>Lunchtime Talk - Science Capital</strong></td>
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<td>14:00 <strong>The Adoption of MATLAB Apps and Toolboxes at Jaguar Land Rover</strong></td>
<td><strong>Physical Modelling Integration and Cosimulation in a Real-Time Environment</strong></td>
<td><strong>Introduction to Simulink and Stateflow</strong></td>
<td><strong>Simulink for Teams: High-Productivity Workflows</strong></td>
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<td>14:30 <strong>Developing and Sharing MATLAB Apps and Toolboxes</strong></td>
<td><strong>Connecting to Hardware and Rapid Prototyping</strong></td>
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<td>15:15 <strong>Break</strong></td>
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<td>15:45 <strong>MATLAB Algorithm Development and Verification for Eurofighter Typhoon Praetorian</strong></td>
<td><strong>Applying MathWorks Tools to Automotive Embedded Software Development</strong></td>
<td><strong>Modelling Physical Systems in Simscape</strong></td>
<td><strong>Developing Robust MATLAB Code and Apps</strong></td>
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<td>16:15 <strong>Modelling and Simulating RF Sensor Systems</strong></td>
<td><strong>Verification of Automatically Generated Code</strong></td>
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Thankyou
More details on …

- **BuildingIQ: Adaptive building energy management**

- **Scania: Automatic emergency braking using sensor fusion and analytics**

- **Mondi: Predictive Maintenance for polymer-based production machines**