MATLAB EXPO 2016

The Rise of Engineering-Driven Analytics

Loren Shure
Consulting Application Engineer
Language of Technical Computing
The Rise of Engineering-Driven Analytics
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Apply robust, statistically-motivated methods to data produced from complex systems to understand what has happened and why,
predict what will happen, and
suggest decisions or actions.
Analytics are now pervasive

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

**predict** what will happen, and

**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...
Analytics in e-commerce

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

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

- **Business Data**

**IMPROVED Predictive Model**

**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

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The Rise of Engineering-Driven Analytics
Architecture of an analytics system

Data from instruments and connected systems

Data from business systems

Analytics and Machine Learning
Architecture of an analytics system

- Data from business systems
- Data from instruments and connected systems

**Predictive Model**
- Deployed in smart and embedded systems
- Deployed on cloud and business systems

MATLAB & Simulink Integrates in Embedded Systems and Enterprise IT Workflows
Example – BuildingIQ
Adaptive building energy management
BuildingIQ

25% cost reduction

Actual temperature

Comfort bounds

Temperature setpoint

degrees Celsius

24 C

21 C

0:00  8:00 am  6:00 pm  0:00

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Real-time, closed-loop optimization algorithms

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

DATA - Billions of data points: Physics, energy cost, ambient temperature, operation schedule, etc.

Analytics and Machine Learning plus system identification, control theory & more

MATLAB Toolboxes Just Work – and work together!

Current energy costs & demand

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

Borislav Savkovic, BuildingIQ

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**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
Example – Scania

Automatic emergency braking using sensor fusion and analytics
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

Vehicle logs of video and radar data

Predictive Model deployed on vehicle

Machine learning to develop fusion algorithms for situation detection
The Rise of Engineering-Driven Analytics
Sensor Data (~1 minute)  
10-100 sensors/machine

Quality State (~40 minutes)

Classification using Statistics, Machine Learning, and Neural Networks

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Deployment – a MATLAB App used by machine operators

(C2) Implementing machine learning algorithm using MATLAB for prognostics purpose of airplane hydraulic system
Mitsubishi Heavy Industry

State NOT OK
State OK
The need for data scientists

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

• Expand university programs
• Train existing analysts
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.

Learning From Data

A real Caltech course, not a watered-down version

Machine Learning

Stanford University

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.

Computational Methods for Data Analysis

< disclaimer text >
IoT open data platform for students and makers

Built-in MATLAB analysis

Simulink support via Raspberry Pi
ThingSpeak IoT open data platform for students and makers

(D1) Implementing machine learning algorithm using MATLAB for prognostics purpose of airplane hydraulic system

Hitachi Development of IOT system to detect anomaly operations of production system

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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

MATLAB & Simulink are Designed and Documented to be Easy for Engineers and Scientists to Use
In MATLAB

Big Data
- Engineering
- Business
- Transactional
- Native support for engineering data
- Database interfaces
- Streaming

Compute Power
- Desktop - Multicore, GPU
- Clusters
- Cloud computing
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Machine Learning
- Neural Networks
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- ...and much more...

NEW for MATLAB
- Audio System Toolbox R2016a
- Vision HDL Toolbox R2015a

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- Datastore
  - text, image, video, Excel files
- **Timetable, string, and tall arrays** 2016b

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- Multicore & GPU
- MATLAB Distributed Computing Server and EC2 Support
- Hadoop with Spark support R2016b
- MATLAB Production Server

MATLAB is fast:
- heavily optimized libraries
- JIT compiled
- takes advantage of the compute power you have
Limited users, scope, & technology

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

Pervasive users, scope, & technology

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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 using machine learning and computer vision
The Rise of Engineering-Driven Analytics

Big Data
Compute Power
Machine Learning

Limited users, scope, & technology

Pervasive users, scope, & technology

Be your own Data Scientist!