MATLAB EXPO 2016
Modelle für die Zukunft dank prädiktiver Datenanalyse

Jérémy Huard, MathWorks
30%
\[ \frac{\partial u}{\partial t} - \alpha \left( \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} \right) = 0 \]
BuildingIQ Develops Proactive Algorithms for HVAC Energy Optimization in Large-Scale Buildings

Office buildings, hospitals, and other large-scale commercial buildings account for about 30% of the energy consumed worldwide. The heating, ventilation, and air-conditioning (HVAC) systems in these buildings are often inefficient because they do not take into account changing weather patterns, variable energy costs, or the building's thermal properties.

BuildingIQ has developed Predictive Energy Optimization™ (PEO), a cloud-based software platform that reduces HVAC energy consumption by 10–25% during normal operation. PEO was developed in cooperation with the Commonwealth Scientific and Industrial Research Organisation (CSIRO), HVAC pressure sensors, as well as weather and energy cost data. A single building often produces billions of data points, and the scientists and engineers needed tools for efficiently filtering, processing, and visualizing this data.

To run their optimization algorithms, the scientists and engineers had to create an accurate mathematical model of a building's thermal and power dynamics. The algorithms would use this calculated model to run constrained optimizations that maintained occupant comfort while minimizing energy costs.

BuildingIQ needed a way to rapidly develop mathematical models, test optimization algorithms, and clearly communicate the value of their system to large building owners.
Traits of Data Analytics applications

1. Diverse and/or Big Data

2. Advanced Algorithms

3. Deployment
Why MATLAB?

1. Analytics that increasingly require both business and engineering data

DATA
- Engineering, Scientific, and Field
- Business and Transactional

2. Enable Domain Experts to be Data Scientists

3. Develop embedded systems with analytics powered functionality

4. Develop analytics to run on both enterprise and embedded platforms

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Embedded Systems

Business Systems

Data Scientist

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Smarter Embedded Systems

Business Systems
“No matter what industry our client is in, and no matter what data they ask us to analyze—text, audio, images, or video—MATLAB enables us to provide clear results faster.”

Dr. G Subrahmanya VRK Rao, Cognizant
Data handling and visualization
# High-quality domain-specific libraries

<table>
<thead>
<tr>
<th>Data type</th>
<th>Common Techniques for Deriving Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor data</td>
<td>Peak analysis, Pulse and transition metrics, Spectral measurements (power, bandwidth, mean frequency, median frequency)</td>
</tr>
<tr>
<td>Image and video data</td>
<td>Bag of visual words, HOG (Histogram of Oriented Gradients), Minimum Eigenvalue algorithm, Local feature descriptors, Edge detection</td>
</tr>
<tr>
<td>Transactional data</td>
<td>Decomposing timestamps into components (day, month, day of week, etc.), Calculation of aggregate values, Complexity reduction</td>
</tr>
</tbody>
</table>

**Signal Processing**

**Image Processing**

**Computer Vision**

**Statistics**
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Enabling Domain Experts to be Data Scientists
Built-in algorithms

Clustering

Hierarchical Clustering
Produce nested sets of clusters

k-Means and k-Medoids Clustering
Cluster by minimizing mean or medoid distance, calculate Mahalanobis distance

Gaussian Mixture Models
Cluster based on Gaussian mixture models using the EM algorithm

Nearest Neighbors
Find nearest neighbors using exhaustive search or kd-tree search

Hidden Markov Models
Markov models for data generation

Cluster Visualization and Evaluation
Plot clusters of data and evaluate optimal number of clusters

Regression

Linear Regression
Multiple, stepwise, multivariate regression models, and more

Generalized Linear Models
Logistic regression, multinomial regression, Poisson regression

Nonlinear Regression
Nonlinear fixed- and mixed-effects regression models

Support Vector Machine Regression
Support vector machines for regression models

Gaussian Process Regression
Gaussian process regression models (kriging)

Regression Trees
Binary decision trees for regression

Regression Tree Ensembles
Random forests, boosted and bagged regression trees

Classification

Classification Trees
Binary decision trees for multiclass learning

Discriminant Analysis
Regularized linear and quadratic discriminant analysis

Naive Bayes
Naive Bayes model with Gaussian, multinomial, or kernel predictors

Nearest Neighbors
k nearest neighbors classification using Kd-tree search

Support Vector Machine Classification
Support vector machines for binary or multiclass classification

Classification Ensembles
Boosting, random forest, bagging, random subspace, and ECOC ensembles for multiclass learning

Model Building and Assessment
Feature selection, cross validation, predictive performance evaluation, classification accuracy comparison tests

Confusion Matrix

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Interactive Apps to focus on machine learning, not programing

Classification Learner App

Features
- Train models
- Assess results
- Export models to the MATLAB or generate MATLAB code

Neural network Apps

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RESEARCH

INTEGRATION

IMPLEMENTATION

DESIGN

TEST AND VERIFICATION

REQUIREMENTS

Environment Models
Physical Components
Algorithms

C, C++, VHDL, Verilog, Structured Text
MCU, DSP, FPGA, ASIC, PLC

Airbus
Battery management

GM
Climate control

Festo
Industrial robots

Sonova
Hearing implants

Weinmann
Transport ventilator

ABB
Smart Grid controller

manroland
Printing presses

FLIR
Thermal imaging

Daimler
Festo Industrial robots

MathWorks
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Deploying Algorithms to Enterprise Systems

MATLAB Compiler enables sharing MATLAB programs without integration programming

MATLAB Compiler SDK provides implementation and platform flexibility for software developers

MATLAB Production Server provides the most efficient development path for secure and scalable web and enterprise applications
Enterprise Integration – Forecasting Model
MATLAB Differentiators

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1.2. Data Science mit MATLAB
Session Chair: Dr. Alexander Diethert

15:15  Analyse von operationellen Flugdaten aus einem Hadoop System unter Verwendung von MapReduce und dem MATLAB Distributed Computing Server
Lukas Hohndorf, TU München

15:45  Mensch-Maschine-Interface zur multisensorischen Prozessüberwachung in der Polymerindustrie
Michael Kohlert, Mondi Gronau
Dr. Sarah Drewes und Elmar Tarajan, MathWorks

16:15  Algorithmen für Predictive Maintenance effizient entwickelt mit MATLAB
Dr. Sarah Drewes, MathWorks

mathworks.com/machine-learning

Consulting
Training

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