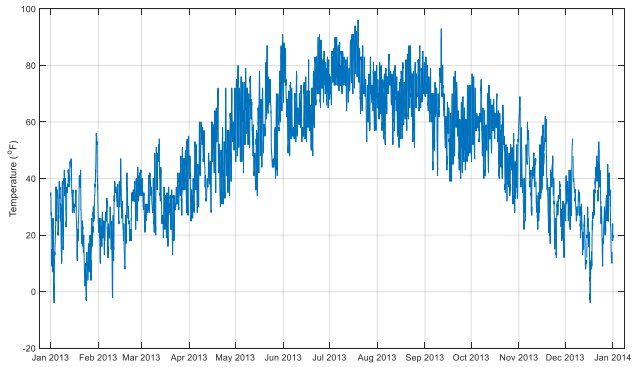
MATLAB EXPO 2016

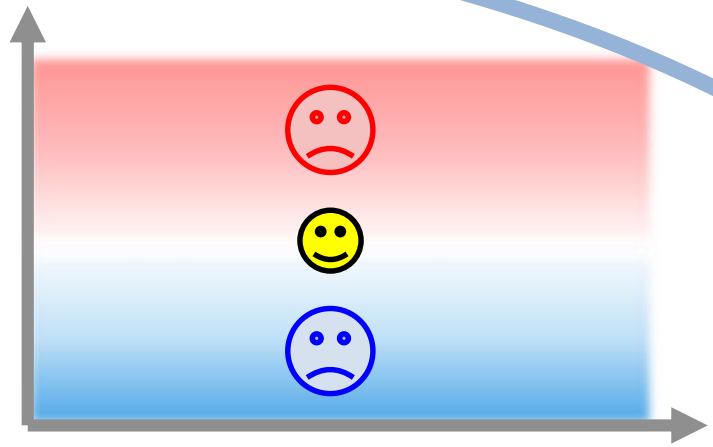
Modelle für die Zukunft dank prädiktiver Datenanalyse

Jérémy Huard, MathWorks


30%



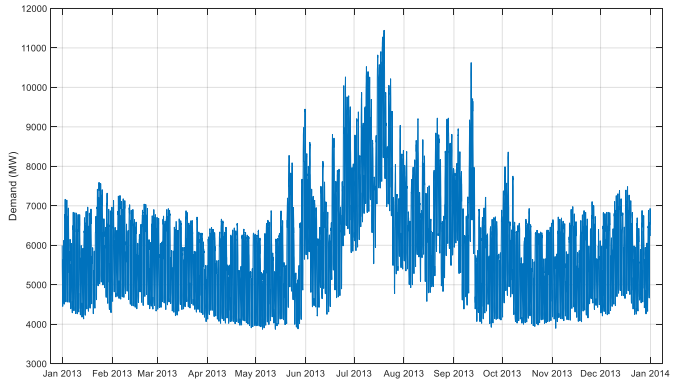
Temperatures change



Humans have comfort bounds

$$\frac{\partial u}{\partial t} - \alpha\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}\right) = 0$$

Thermodynamic properties



Electricity demand varies

BuildingIQ Develops Proactive Algorithms for HVAC Energy Optimization in Large-Scale Buildings

Large-scale commercial buildings can reduce energy costs by 10–25% with BuildingIQ's energy optimization system.

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 a

Traits of Data Analytics applications

1. **Diverse and/or Big Data**
2. **Advanced Algorithms**
3. **Deployment**

Why MATLAB?

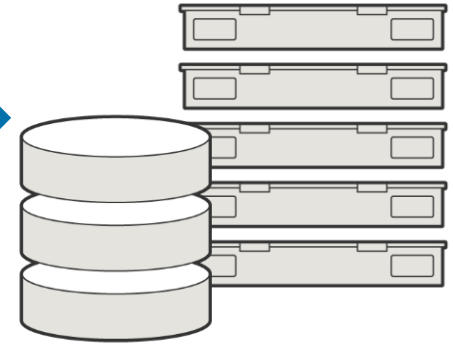
1. Analytics that increasingly require **both business and engineering data**

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

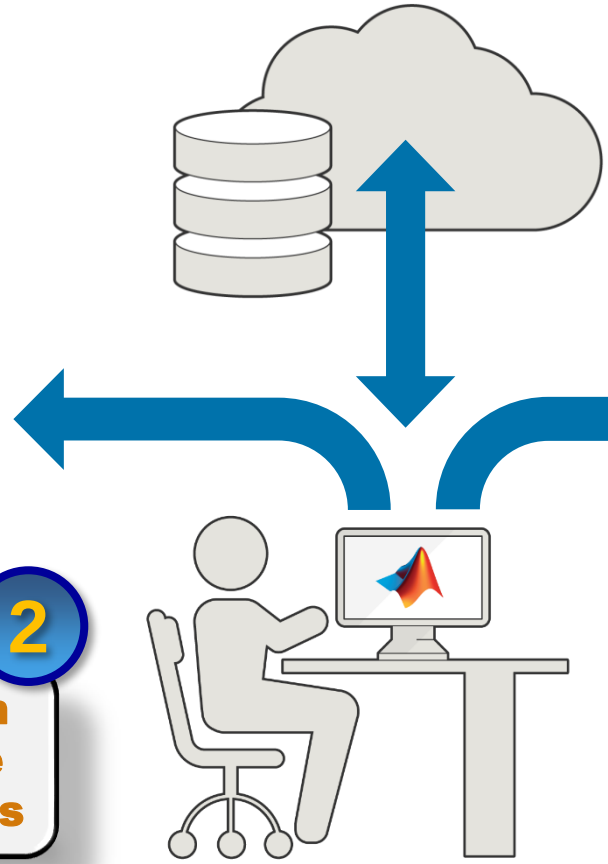
3. Develop **embedded systems** with analytics powered functionality

Embedded Systems

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



Business Systems



2. Enable **Domain Experts to be Data Scientists**

Data Scientist

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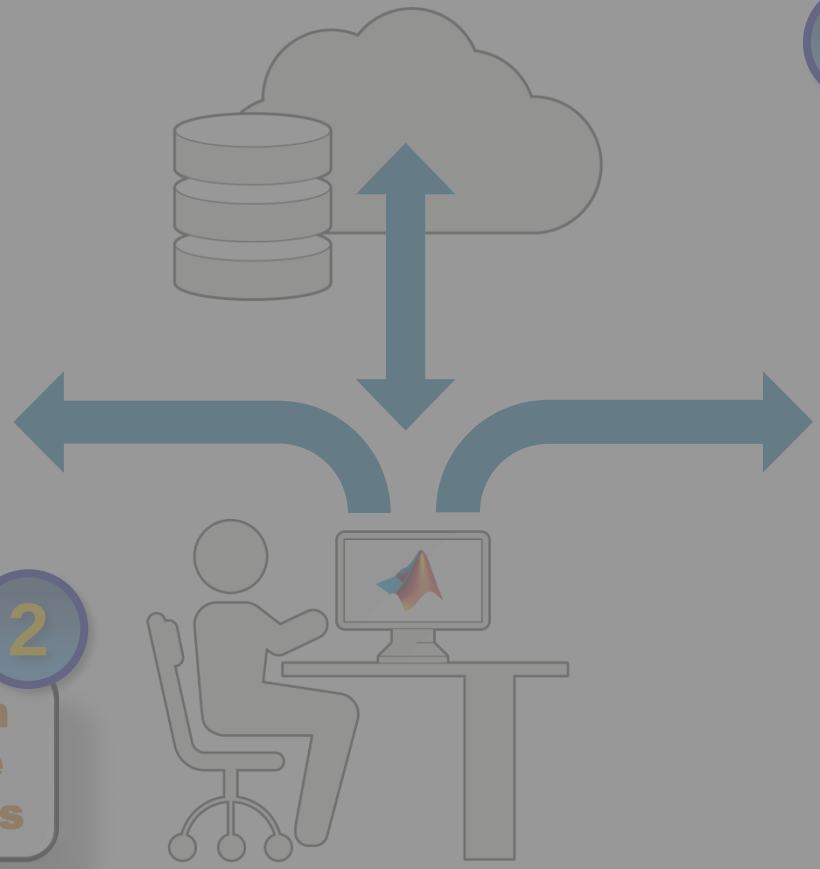
Smarter Embedded Systems



Data Scientist

Business Systems

2. Enable **Domain Experts to be Data Scientists**

Business and Engineering Data

Business and Transactional Data

Repositories
- Databases
- **Hadoop**

File I/O
- Text
- Spreadsheet
- XML

Web Sources
- HTML
- Mapping
- Financial datafeeds
- **RESTful**
- **JSON**

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

Engineering, Scientific, and Field Data

File I/O
- Text
- Spreadsheet
- XML
- CDF/HDF
- Image
- Audio
- Video
- Geospatial

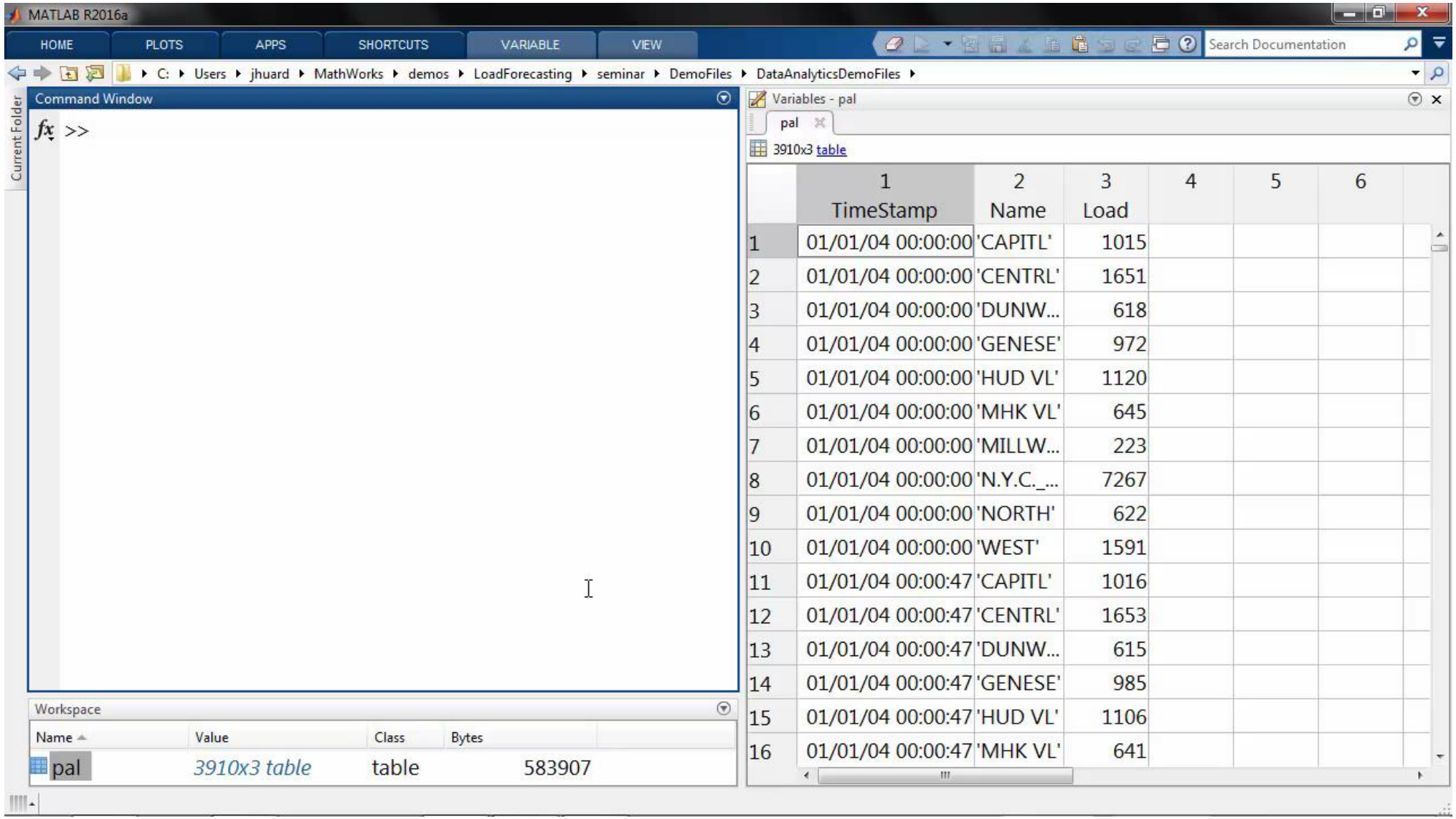
Communication Protocols
- CAN (Controller Area Network)
- DDS (Data Distribution Service)
- OPC (OLE for Process Control)
- XCP (eXplicit Control Protocol)

Real-Time Sources
- Sensors
- GPS
- Instrumentation
- Cameras
- Communication systems
- Machines (embedded 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

Data type	Common Techniques for Deriving Features
Sensor data	Signal Processing
Image and video data	Image Processing Computer Vision
Transactional data	Statistics

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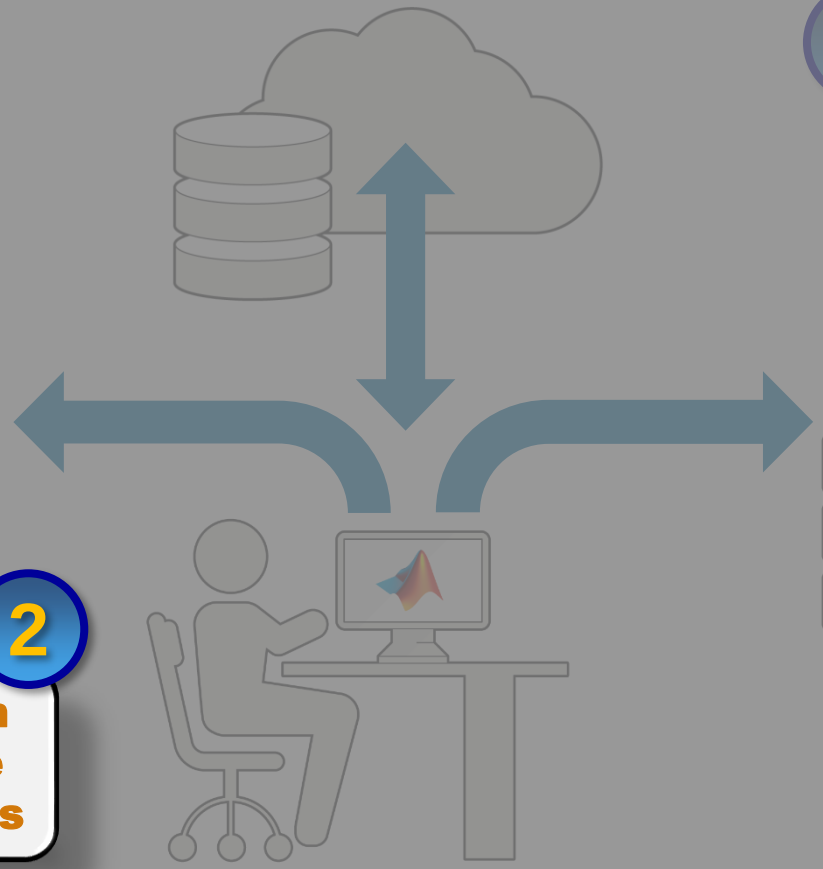

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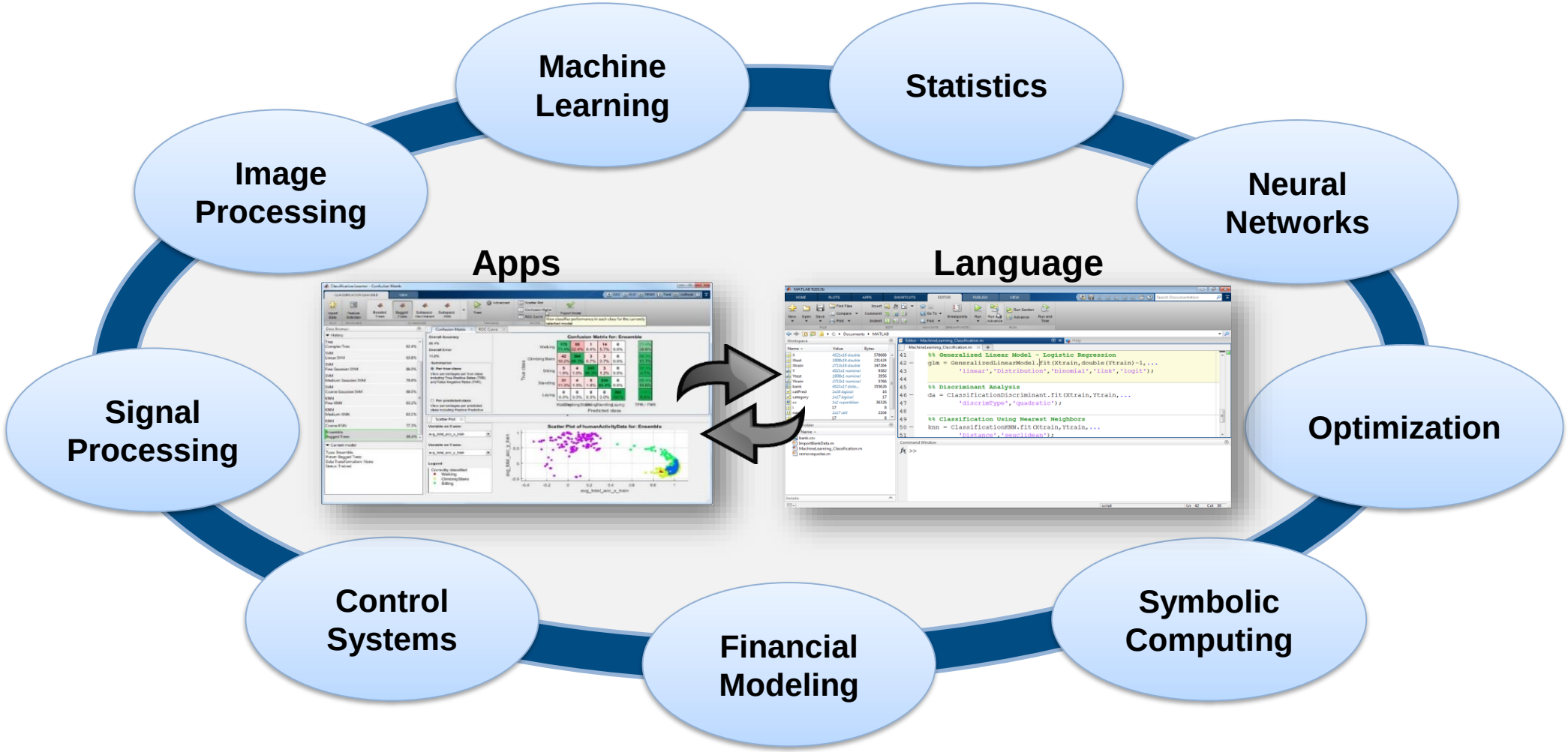
Enabling Domain Experts to be Data Scientists



Built-in algorithms

Clustering

Hierarchical Clustering
Produce nested sets of clusters

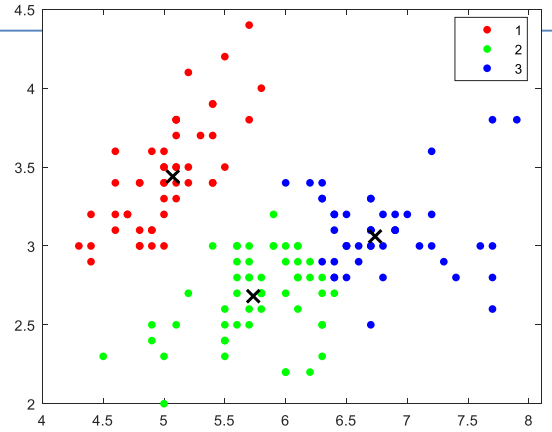
k-Means and k-Medoids Clustering
Cluster by minimizing mean or medoid distance, calculate Mahalan

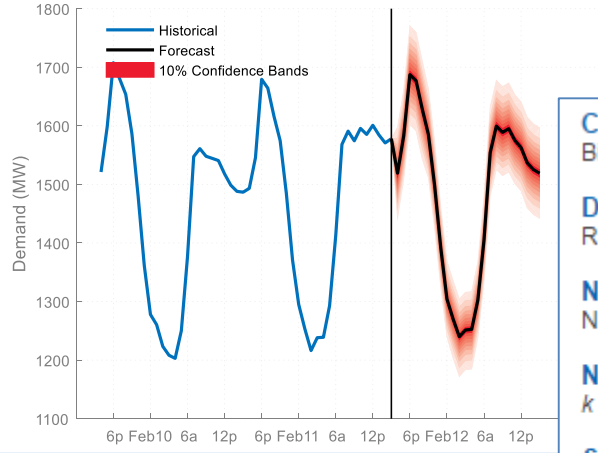
Gaussian Mixture Models
Cluster based on Gaussian mixture models using the EM algorithm

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

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 m

Generalized Linear Models
Logistic regression, multinomial regression, Poisson regre

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

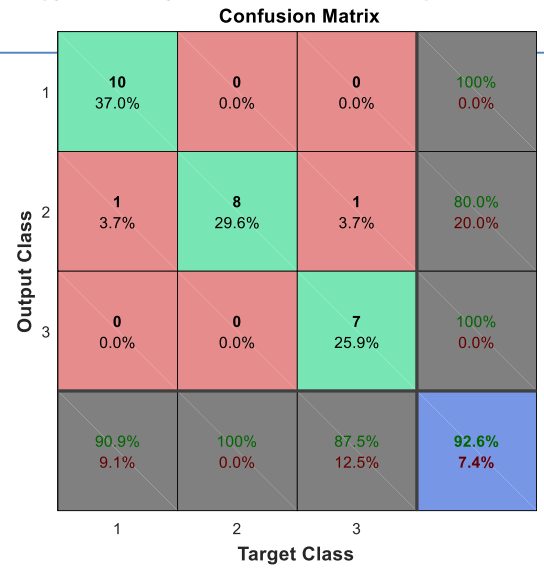
Naive Bayes
Naive Bayes model with Gaussian, multinomial, or kernel predictors

Nearest Neighbors
k nearest neighbors classification using *Kd*-tree search

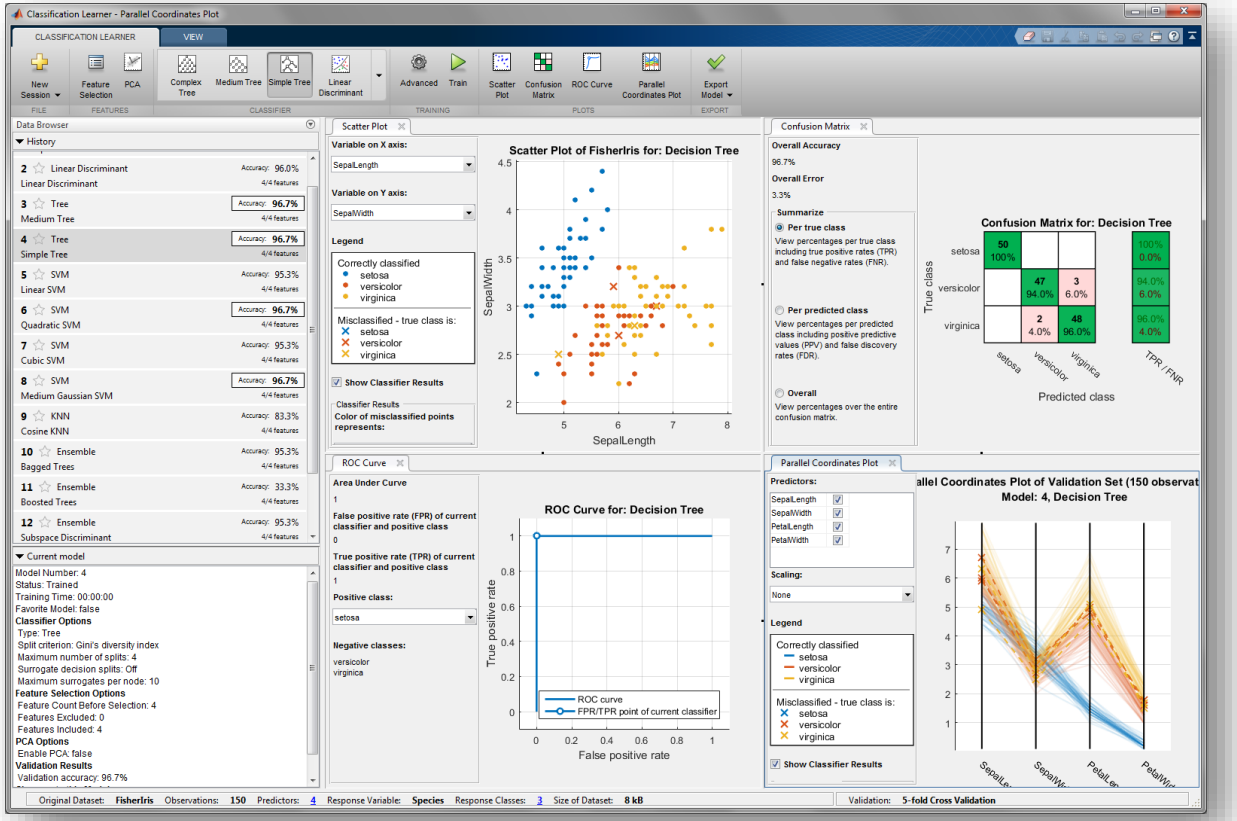
Support Vector Machine Classification
Support vector machines for binary or multiclass classification

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

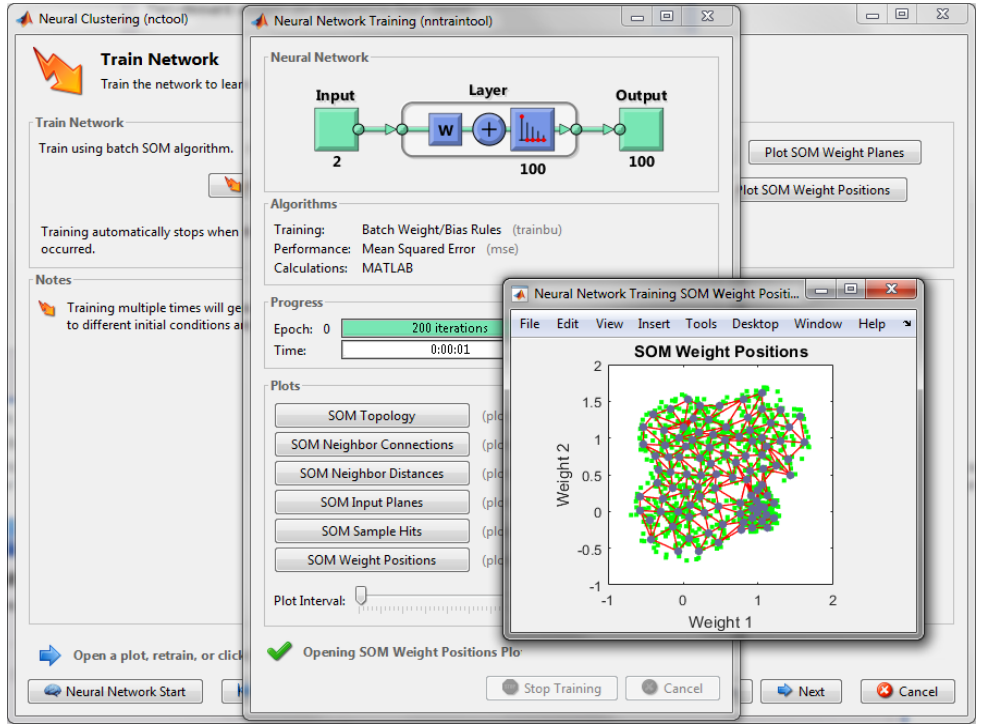
Model Building and Assessment
Feature selection, cross validation, predictive performance evaluation, classification accuracy comparison tests



Interactive Apps to focus on machine learning, not programing



Classification Learner App



Neural network Apps

Features

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

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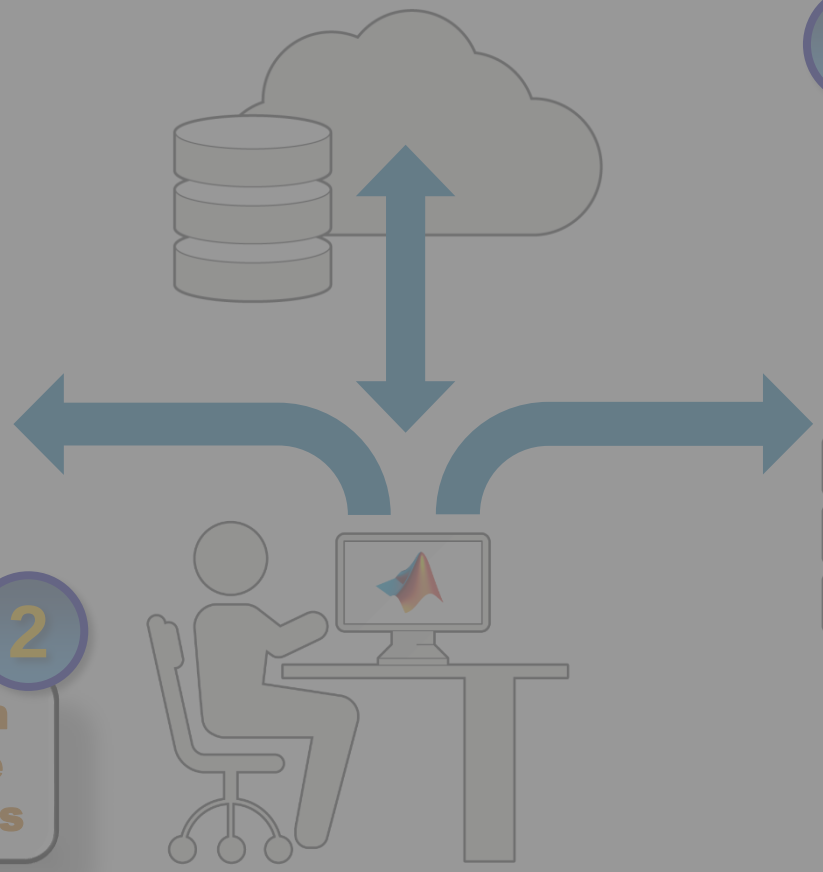

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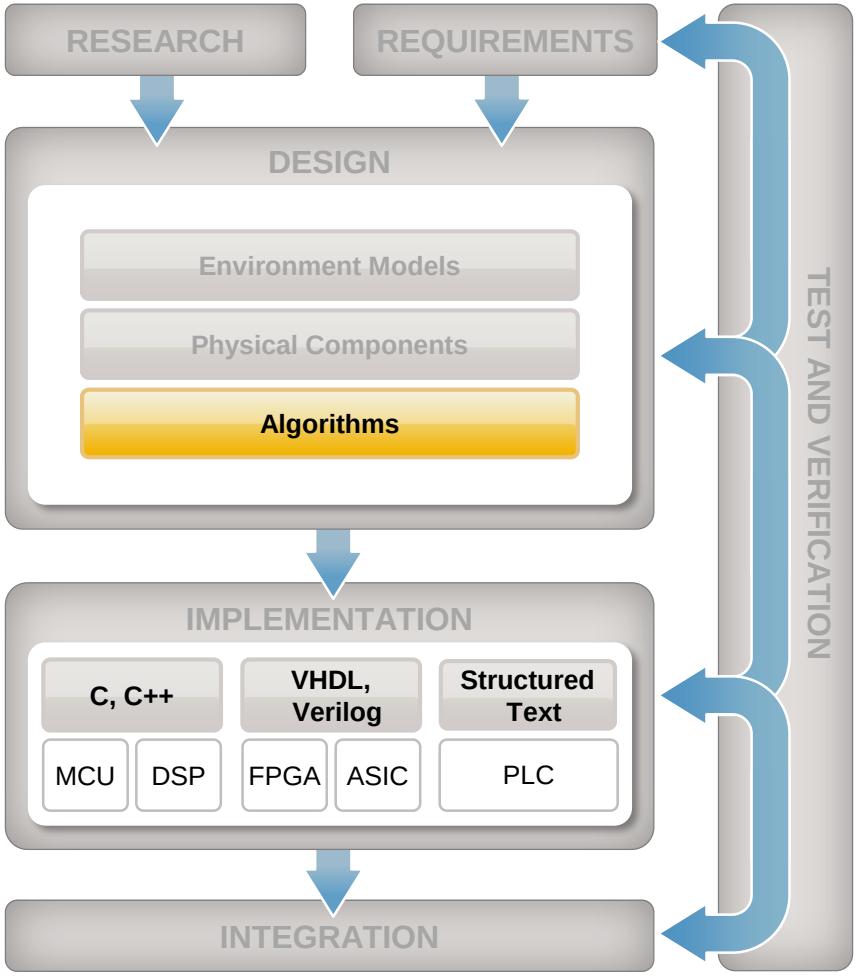

Airbus
Battery management

GM
Climate control

Festo
Industrial robots

Sonova
Hearing implants

Weinmann
Transport ventilator

ABB
Smart Grid controller

manroland
Printing presses

FLIR
Thermal imaging

Daimler
Cruise controller

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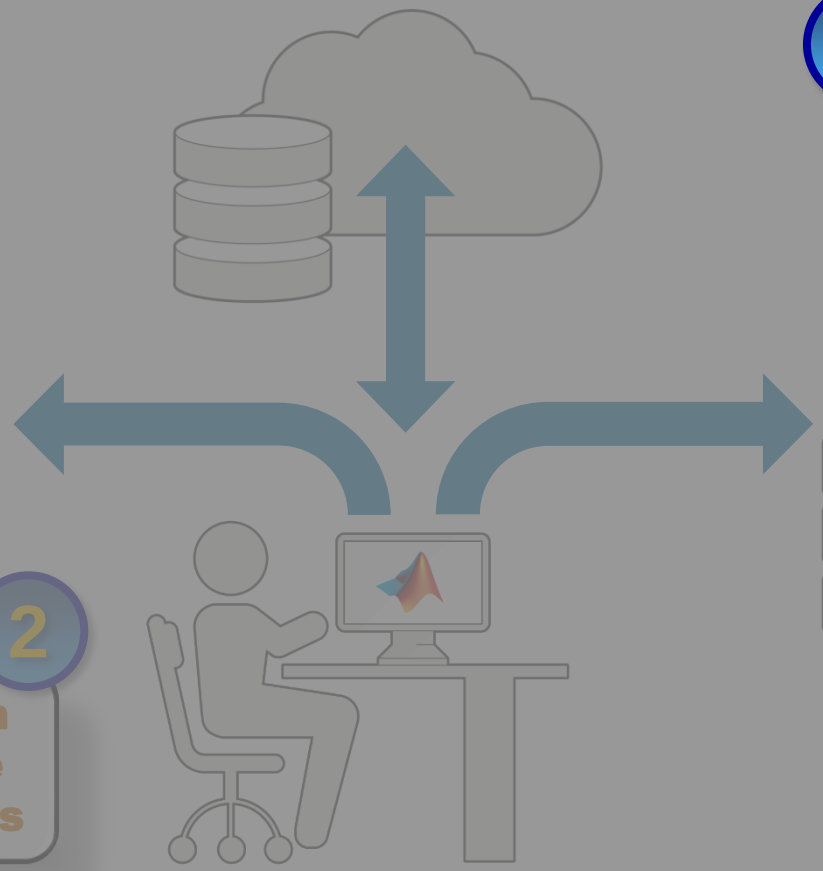

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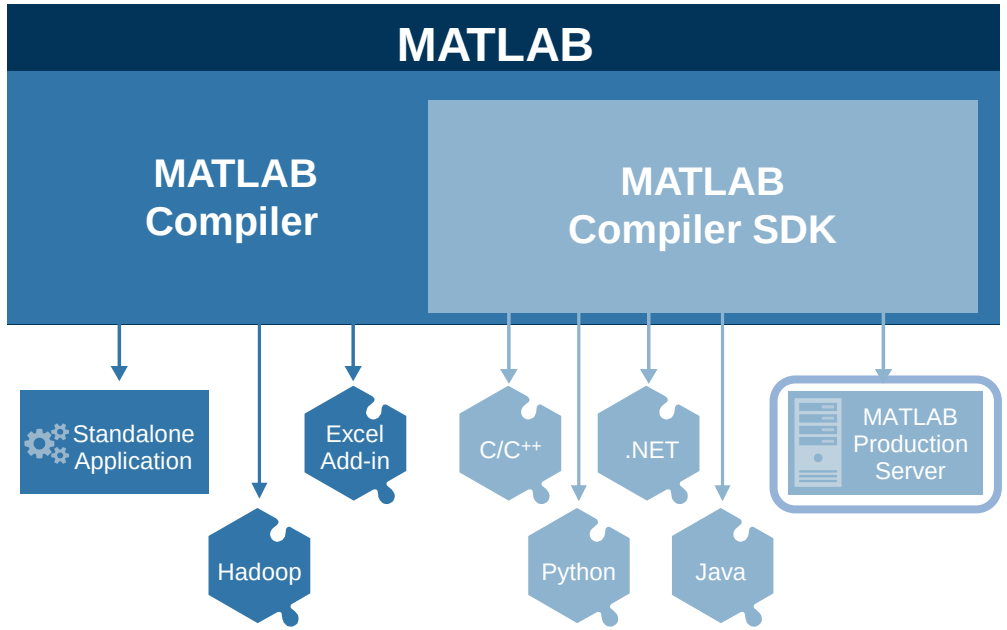
Deploying Algorithms to Enterprise Systems

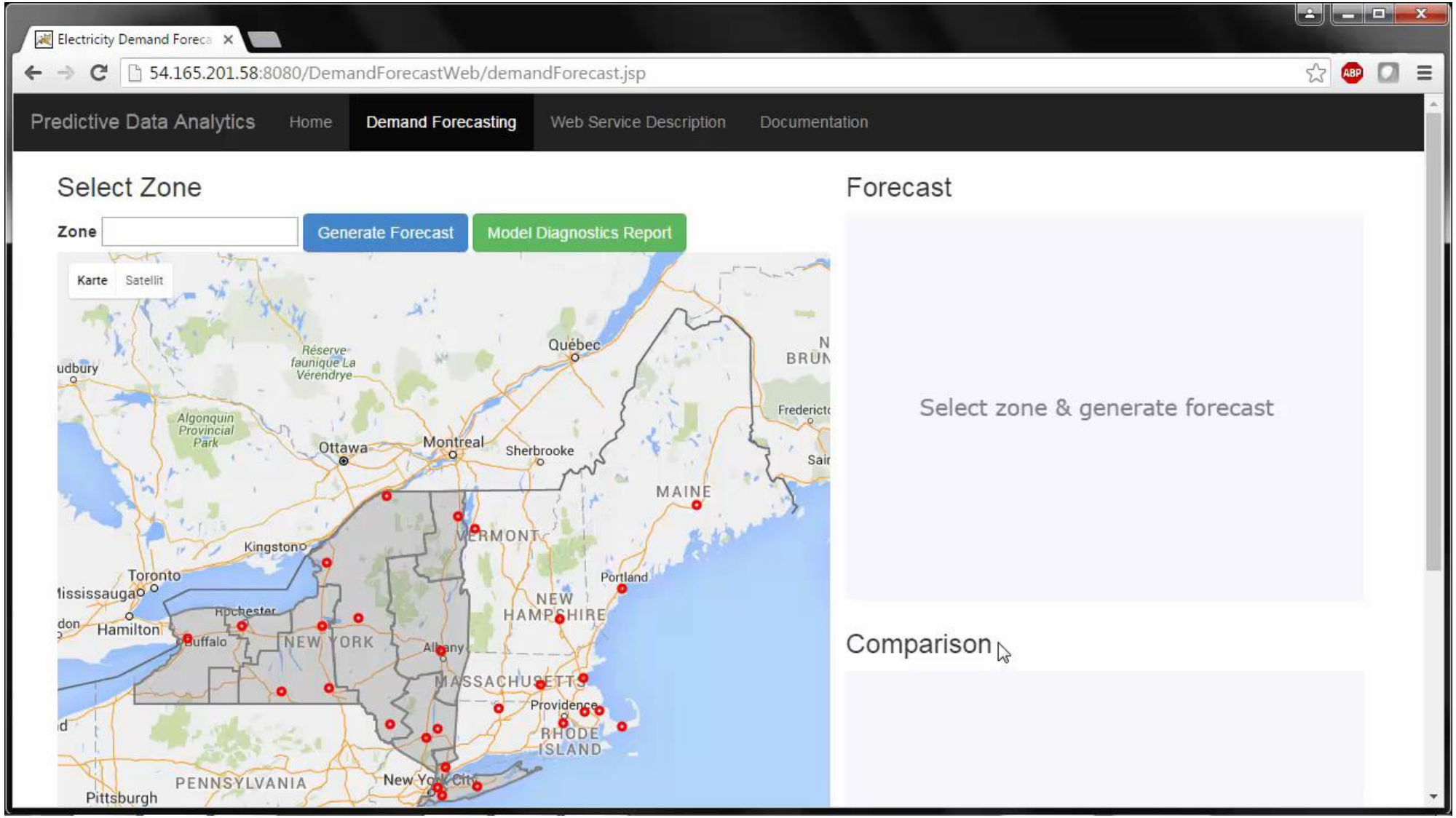


MATLAB Compiler enables sharing MATLAB programs without integration programming

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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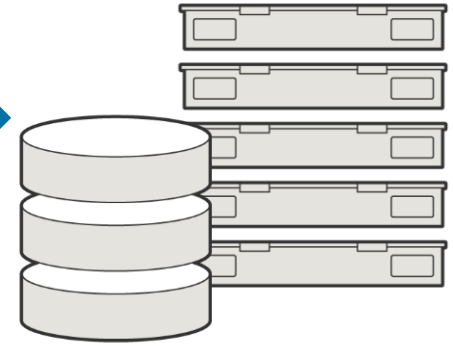

Business Systems

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Learn More

Presentations

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 Höhndorf, 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

Machine Learning

mathworks.com/machine-learning