

# Data Analytics with MATLAB

**Antti Löytynoja**, *Application Engineer*

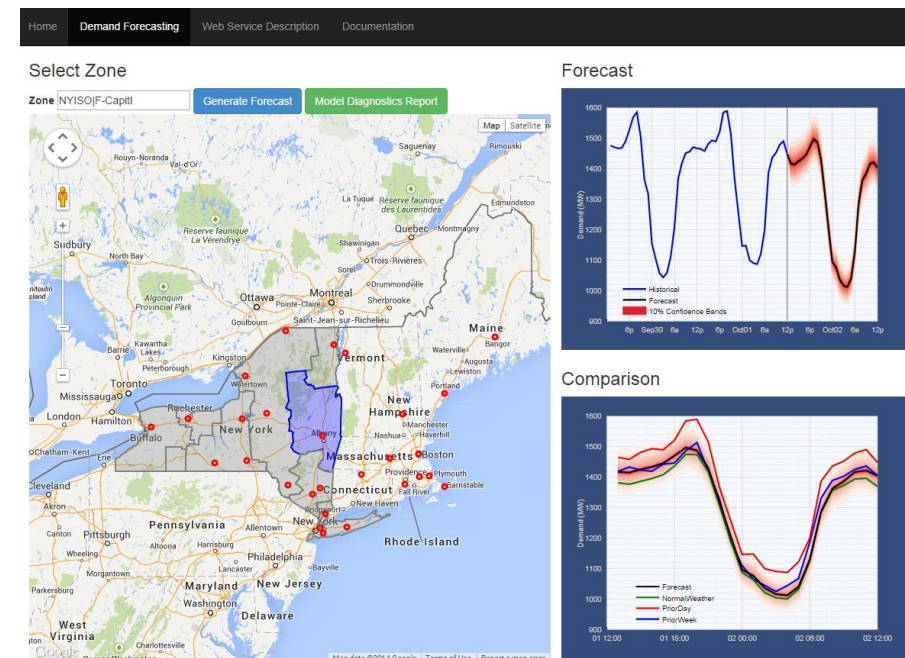
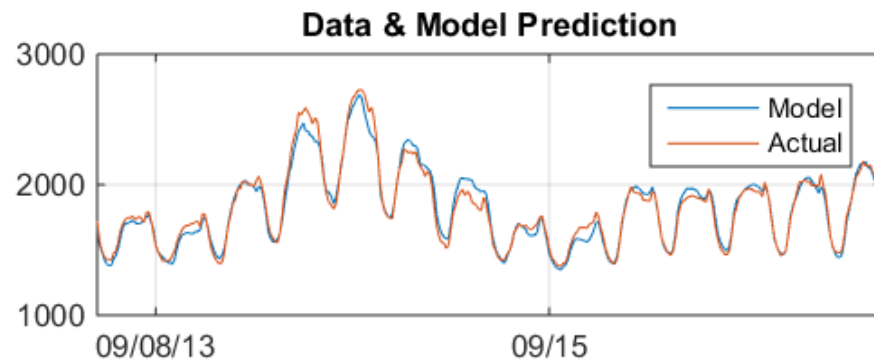
NORDIC  
MATLAB EXPO 2016

21 April | Stockholm

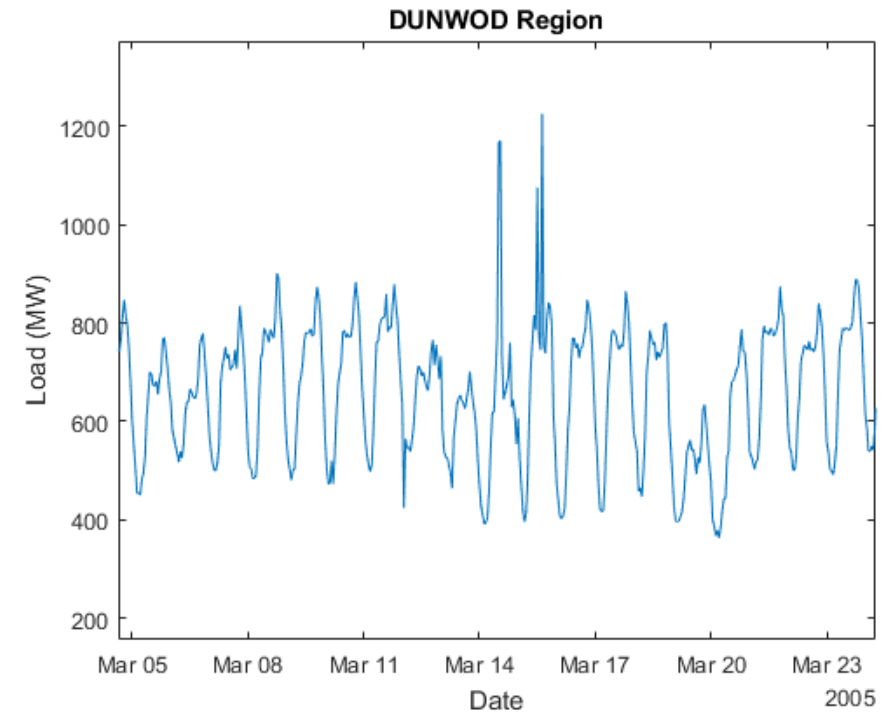
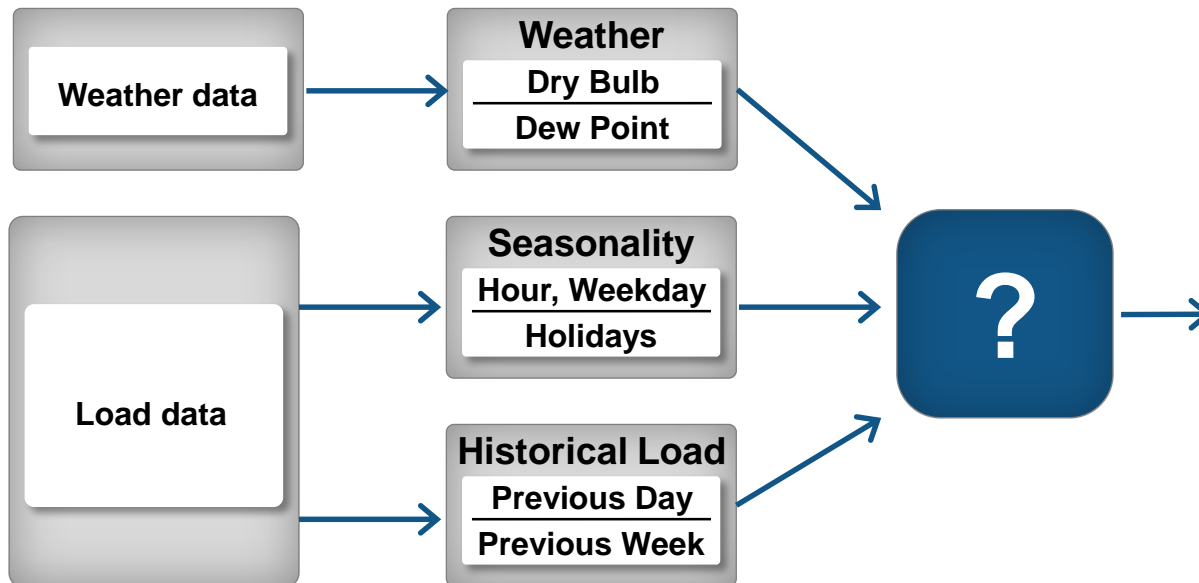


# Case Study: Day-Ahead Load Forecasting

- Goal:
  - Implement a tool for **easy** and **accurate** computation of day-ahead system load forecast
- Requirements:
  - Acquire and clean data from multiple sources
  - Accurate predictive model
  - Easily deploy to production environment

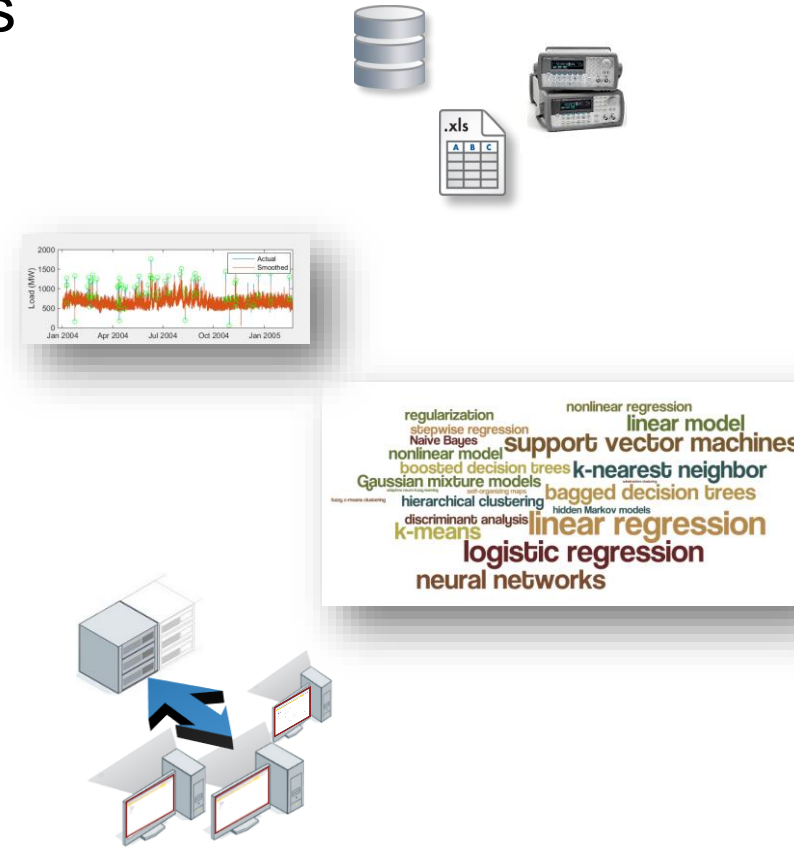


# Case Study: Day-Ahead Load Forecasting




# Challenges with Data Analytics

- Aggregating data from multiple sources
- Cleaning data
- Choosing a model
- Moving to production



# NYISO Energy Load Data

[mis.nyiso.com/public/](http://mis.nyiso.com/public/)


**OASIS (Open Access Same-Time Information System)**

[NYISO Reference Bus LBMP](#) P-28  
[NYISO Price Correction Logs](#) P-29

**Power Grid Data**

**Outages**

[Real-Time Scheduled Outages](#) P-54A  
[Real-Time Actual Outages](#) P-54B  
[Day-Ahead Scheduled Outages](#) P-54C  
[Outage Schedules](#) P-14  
[Outage Schedules CSV](#) P-14B  
[Generation Maintenance Report](#) P-15

**Constraints**

[Day-Ahead Limiting Constraints](#) P-511A  
[Limiting Constraints](#) P-33

**Interface Flows**

[Internal & External Interface Limits & Flows](#) P-32  
[Lake Erie Circulation - Day-Ahead](#) P-53B  
[Lake Erie Circulation - Real-Time](#) P-34A

**PARs**

[PAR Schedules](#) P-53A  
[PAR Flows](#) P-34

**ATC/TTC**

[ATC/TTC](#) P-8  
[Long Term ATC/TTC](#) P-8A  
[Transfer Limitations](#)

**Load Data**

**Load Forecast/Commitment**

[ISO Load Forecast](#) P-7  
[Zonal Bid Load](#) P-59  
[Weather Forecast](#) P-7A

**Actual Load**

[Real-Time Actual Load](#) P-58B  
[Integrated Real-Time Actual Load](#) P-58C

**Real-Time Actual Load**

CSV Files	Last Updated
<a href="#">10-21-2014</a>	10/21/14 23:02 EDT
<a href="#">10-20-2014</a>	10/21/14 00:07 EDT
<a href="#">10-19-2014</a>	10/20/14 00:01 EDT
<a href="#">10-18-2014</a>	10/18/14 23:59 EDT
<a href="#">10-17-2014</a>	10/18/14 00:00 EDT
<a href="#">10-16-2014</a>	10/16/14 23:59 EDT
<a href="#">10-15-2014</a>	10/15/14 23:59 EDT
<a href="#">10-14-2014</a>	10/14/14 23:59 EDT
<a href="#">10-13-2014</a>	10/13/14 23:59 EDT
<a href="#">10-12-2014</a>	10/12/14 23:59 EDT

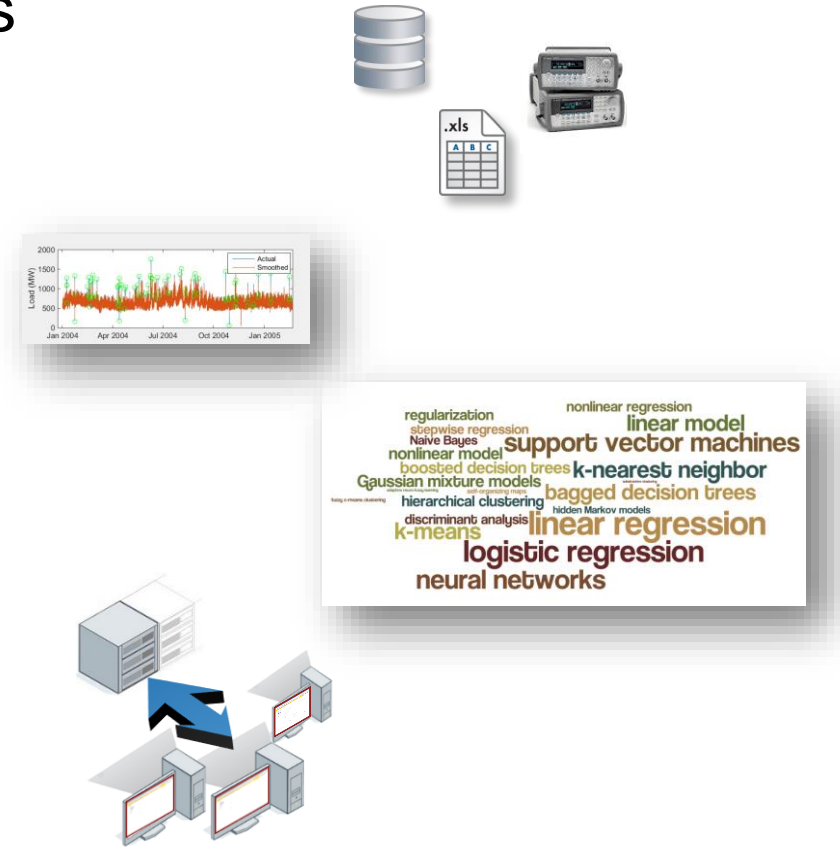
  

**Archived Files (zip format)**

CSV Files	Last Updated
<a href="#">10-2014</a>	10/21/14 23:02 EDT
<a href="#">09-2014</a>	09/30/14 23:59 EDT
<a href="#">08-2014</a>	09/01/14 00:01 EDT
<a href="#">07-2014</a>	08/01/14 00:00 EDT
<a href="#">06-2014</a>	07/01/14 00:00 EDT
<a href="#">05-2014</a>	06/01/14 00:00 EDT
<a href="#">04-2014</a>	04/30/14 23:59 EDT
<a href="#">03-2014</a>	03/31/14 23:59 EDT
<a href="#">02-2014</a>	02/28/14 23:58 EST
<a href="#">01-2014</a>	01/31/14 23:59 EST

# Challenges with Data Analytics

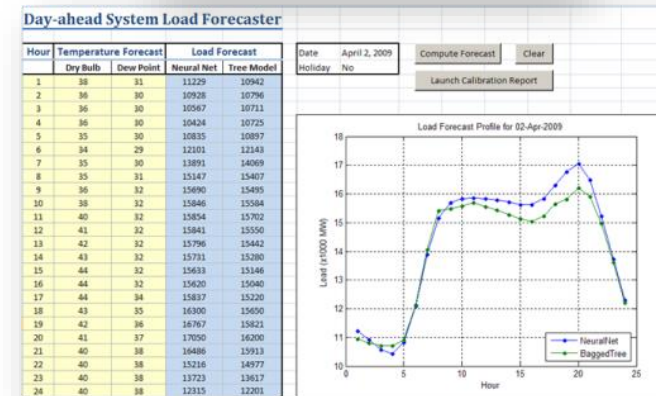
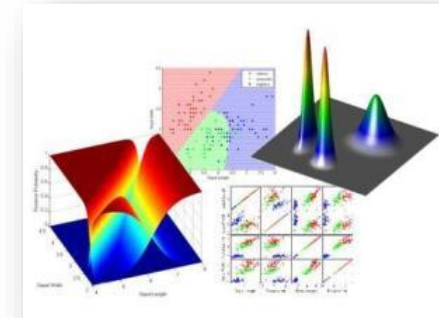
- ✓ Aggregating data from multiple sources
- ✓ Cleaning data
- Choosing a model
- Moving to production



# Machine Learning

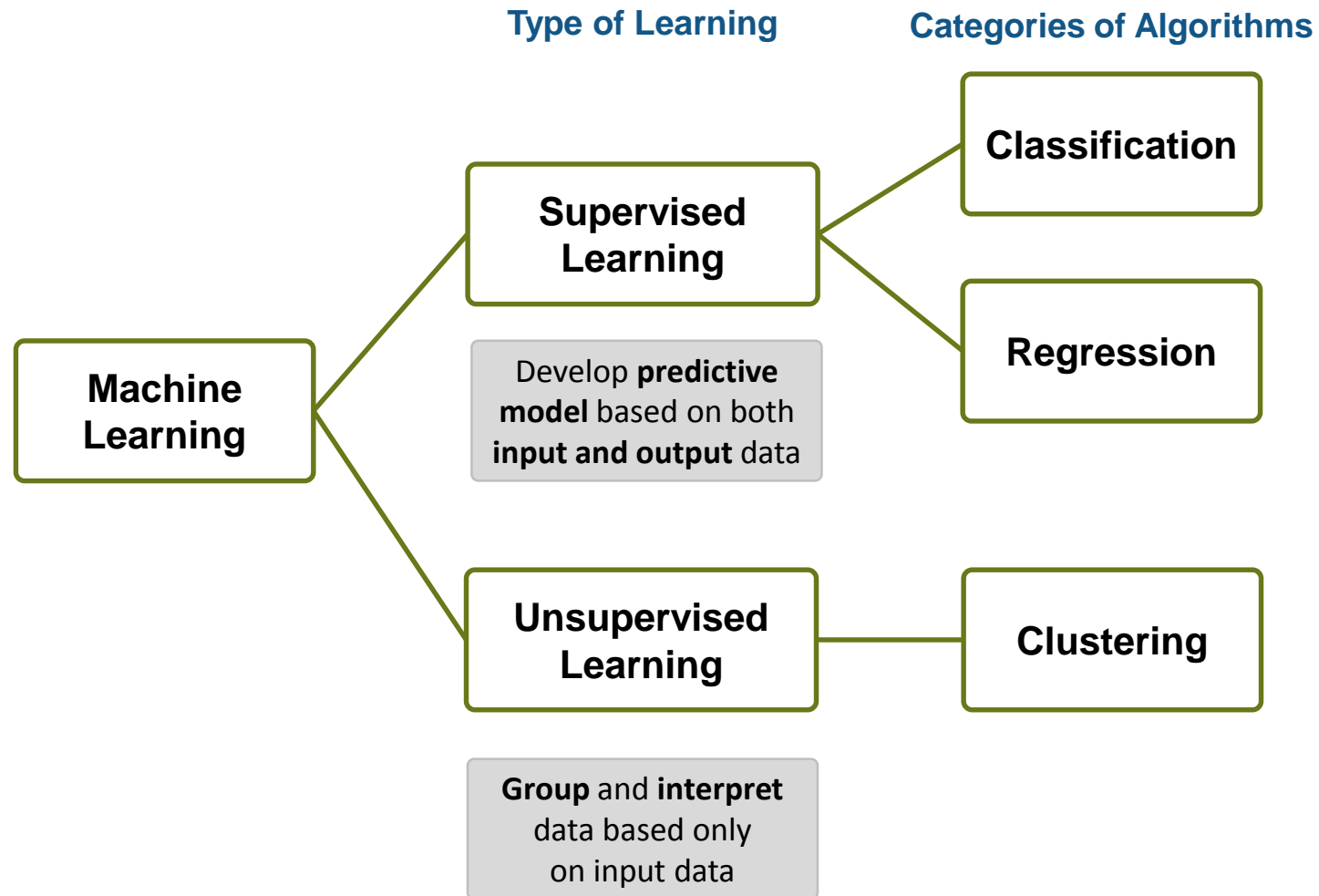
## Characteristics and Examples

- Characteristics
  - Lots of variables
  - System too complex to know the governing equation  
(*e.g., black-box modeling*)
  
- Examples
  - Pattern recognition (*speech, images*)
  - Financial algorithms (*credit scoring, algo trading*)
  - Energy forecasting (*load, price*)
  - Biology (*tumor detection, drug discovery*)



AAA	93.68%	5.55%	0.59%	0.18%	0.00%	0.00%	0.00%	0.00%
AA	2.44%	92.60%	4.03%	0.73%	0.15%	0.00%	0.00%	0.06%
A	0.14%	4.18%	91.02%	3.90%	0.60%	0.08%	0.00%	0.08%
BBB	0.03%	0.23%	7.49%	87.86%	3.78%	0.39%	0.06%	0.16%
BB	0.03%	0.12%	0.73%	8.27%	86.74%	3.28%	0.18%	0.64%
B	0.00%	0.00%	0.11%	0.82%	9.64%	85.37%	2.41%	1.64%
CCC	0.00%	0.00%	0.00%	0.37%	1.84%	6.24%	81.88%	9.67%
D	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
	AAA	AA	A	BBB	BB	B	CCC	D

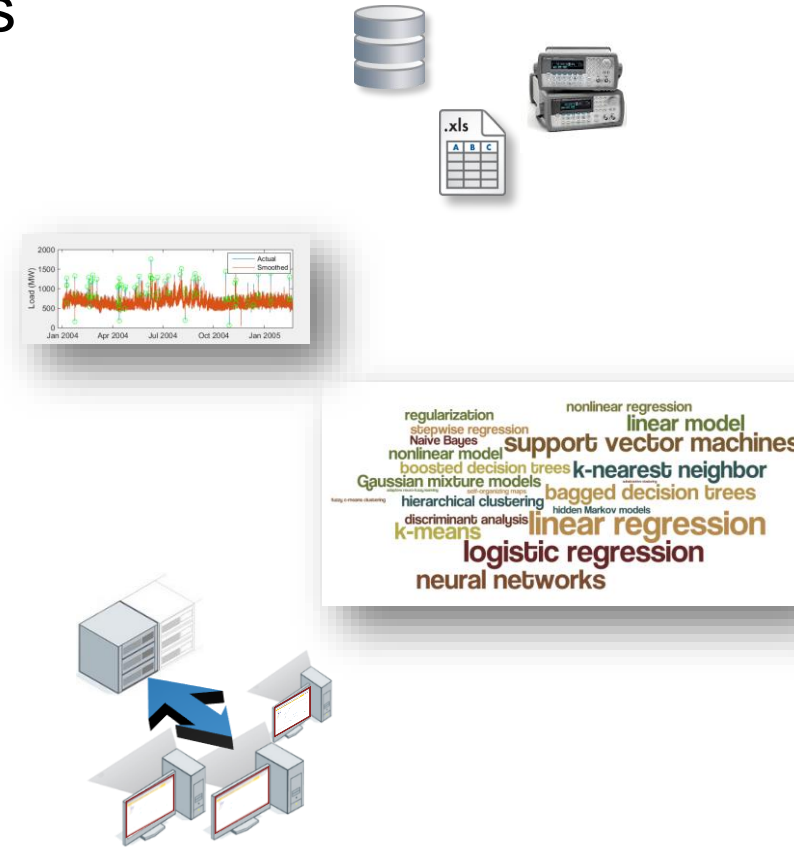
# Overview – Machine Learning





# Challenges with Data Analytics

- ✓ Aggregating data from multiple sources
- ✓ Cleaning data
- ✓ Choosing a model
  - Moving to production

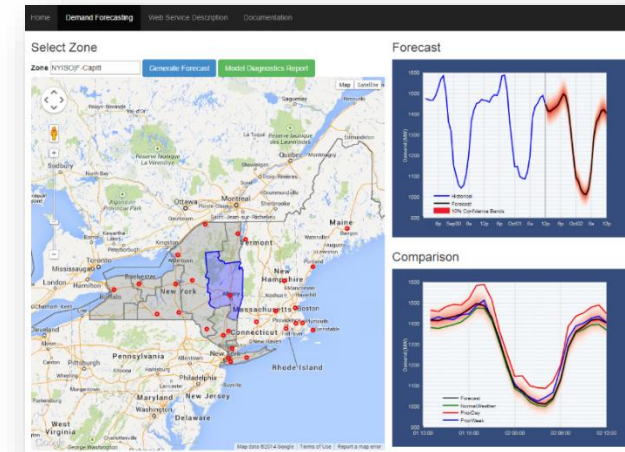


# Moving to production

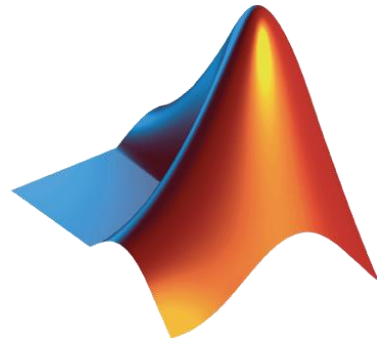
15:00–15:30	Data Analytics with MATLAB <i>Antti Löytynoja, MathWorks</i>	Model-Based Development of Waste Heat Recovery Systems for Container Ships <i>Kalevi Tervo, ABB Marine</i>	Accelerate the Design and Prototyping of Signal Processing Algorithms <i>Daniel Aronsson, MathWorks</i>	Algorithms and Numerical Methods for Motion Planning and Motion Control: Dynamic Manipulation Assignments <i>Anton Shiriaev, NTNU</i>
15:30–16:00	Using MATLAB for Advanced Materials Design: Describing the Grain Orientation in Metals <i>Claes Olsson, Sandvik Materials Technology</i>	Model-Based Design in Industrial Automation <i>Ashraf Zarur, Tetra Pak</i>	Rapid Prototyping of Unknown Solutions to Only Partially Known Problems Using Simulink and the SoC Design Flow <i>Lars Risbo, Purifi</i>	My Way: How to Teach Computer Simulation <i>Heikki Koivo, Aalto University</i>
16:00–16:30	Introduction to Object-Oriented Programming in MATLAB <i>Antti Löytynoja, MathWorks</i>	Introduction to Formal Methods for Verification of Embedded Code <i>Kristian Lindqvist, MathWorks</i>		
16:30–17:00	Introduction to MATLAB Application Deployment <i>Antti Löytynoja, MathWorks</i>	Supervisory Logic and Fault Management in Simulink <i>Hossein Mousavi, MathWorks</i>		
16:00–17:00	Master Class: Optimizing and Accelerating Your MATLAB Code <i>Sofia Mosesson, MathWorks</i>	Master Class: Verification, Validation, and Testing Techniques with Model-Based Design <i>Fredrik Häbring, MathWorks</i>	Optimization and Implementation of Embedded Signal Processing Algorithms <i>Jonas Rutström, MathWorks</i>	Interactive Session: Requirements on a Learning and Knowledge Platform: What Do Thought Leaders Say? <i>Moderator: Gareth Thomas, MathWorks</i>

# Key Takeaways

- Data preparation can be a big job; leverage built-in MATLAB tools and spend more time on the analysis
- Rapidly iterate through different predictive models, and find the one that's best for your application
- Leverage parallel computing to scale-up your analysis to large datasets



# Thank You!



Antti Löytynoja, [antti.loytynoja@mathworks.com](mailto:antti.loytynoja@mathworks.com)