

Big Engineering Data Analytics with MATLAB

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How do you define Big Data?

“Any collection of data sets so large and complex that it becomes difficult to process using ... traditional data processing applications.”

(General Definition)

*“Any collection of data sets so large that it becomes **difficult** to process using traditional MATLAB functions, which assume all of the data is **in memory**.”*

(MATLAB)

Your Big Data Sources

Vehicle Component

Test or Simulation Method

	Engine Control Module (ECM)	Engine	Exhaust Gas Aftertreatment	Vehicle and Driver	Topographic Drive Route	Variability of Results
Fleet of Test Vehicles	Blue	Blue	Blue	Blue	Blue	
Vehicle in Loop	Blue	Blue	Blue	Blue	Yellow	
Aftertreatment in Loop	Blue	Blue	Blue	Yellow	Yellow	
Engine in Loop	Blue	Blue	Yellow	Yellow	Yellow	
ECM in Loop	Blue	Yellow	Yellow	Yellow	Yellow	
Pure Simulation	Yellow	Yellow	Yellow	Yellow	Yellow	

Hardware

Software

Challenges Analyzing Fleet Data

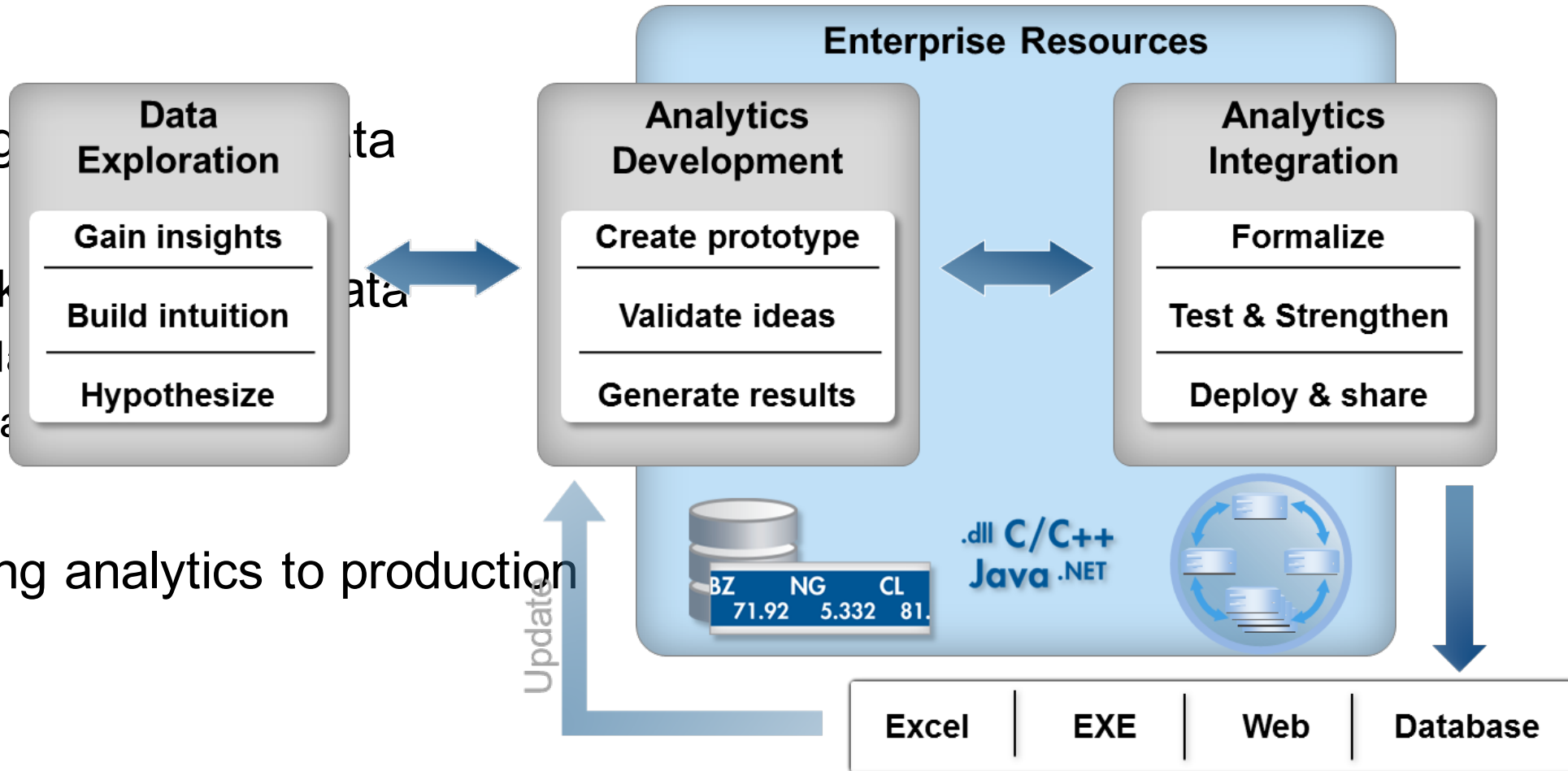
More Data ⇒ **Better Understanding of Field Conditions**
More Interesting Events

Challenges:

- Big Data**
- Needle in the Haystack**
- Testing Ideas**
- Knowledge Transfer**

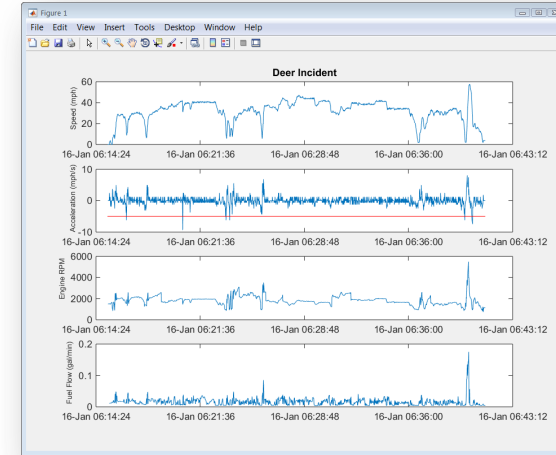
Data Analytics with MATLAB

- Merge data
- Work with data
 - Merge
 - Handle
- Taking analytics to production



Fleet Data Event Detection

- Parse data, find sudden deceleration
- MapReduce workflow



Datastore

Device Time	Engine RPM	Fuel flow rate	Torque	Speed (ODB)
15-Jan-XXXX 15:37:24	1445.75	0.0537	5.26	3.10
15-Jan-XXXX 15:37:25	1445.75	0.0537	5.74	0.48
15-Jan-XXXX 15:37:26	1445.75	0.0537	17.80	4.97
15-Jan-XXXX 15:37:27	1458.5	0.0107	11.10	6.21
15-Jan-XXXX 15:37:28	1458.5	0.0107	11.10	0.59

Map

Acceleration	Decelaration
-2.62	0
4.49	0
1.24	0
-5.62	1

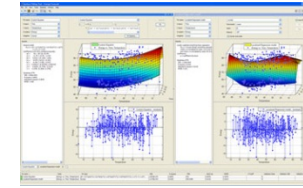
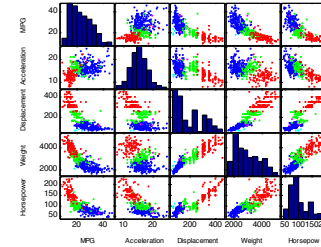
Reduce

Acceleration
-5.62

Analysis Domains

Statistics

- Summary Statistics
- Regression, ANOVA, Machine Learning



Signal Processing

- Sound quality analysis
- LIDAR analysis

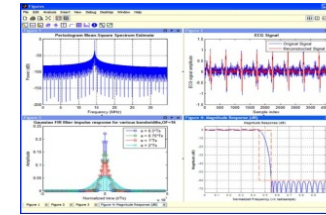


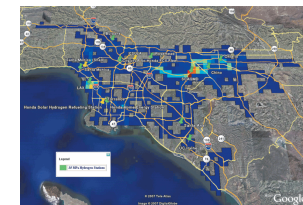
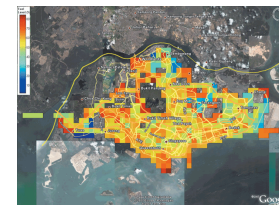
Image Processing

- Active Safety

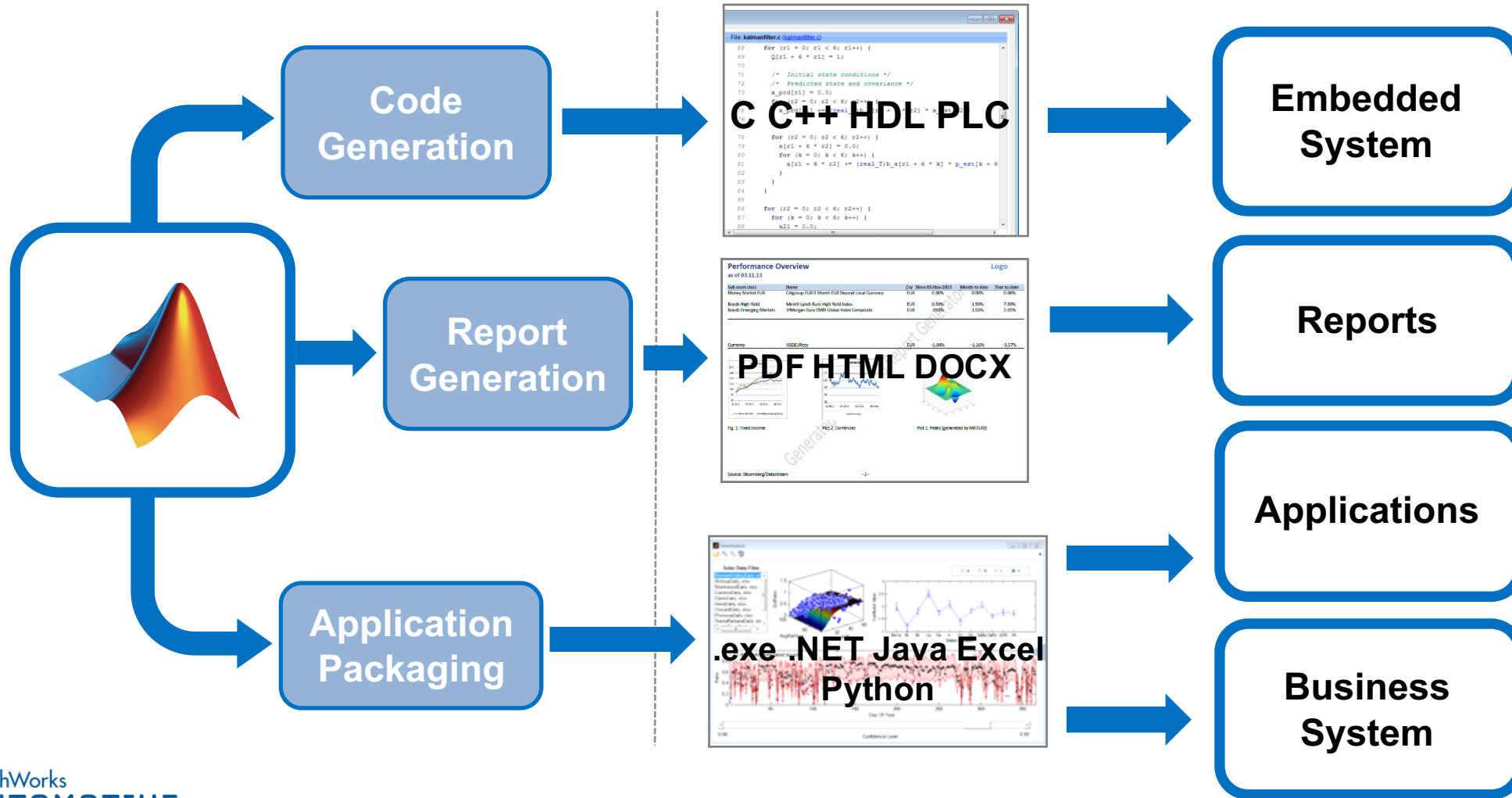


Location/Mapping

- Analyzing GPS Data
- Custom Visualizations



Taking MATLAB to Production



Analyzing Big Data using MATLAB

- Operate on Big Data from MATLAB with MapReduce
- Quickly try out an idea, then iterate
- Transfer your results by taking MATLAB to production



Additional Resources

Machine Learning

Machine Learning with MATLAB

Build predictive models and discover useful patterns from observed data.

[Watch video](#)

Machine learning algorithms use computational methods to "learn" information directly from data without assuming a predetermined equation as a model. They can adaptively improve their performance as you increase the number of samples available for learning.

Machine learning algorithms are used in applications such as computational finance (credit scoring and algorithmic trading), computational biology (tumor detection, drug discovery, and DNA sequencing), energy production (price and load forecasting), natural language processing, speech and image recognition, and advertising and recommendation systems.

Machine learning is often used in big data applications, which have large datasets with many predictors (features) and are too complex for a simple parametric model. Examples of big data applications include forecasting electricity load with a neural network, or bond rating classification for credit risk using an ensemble of decision trees.

Classification
Build models to classify data into different categories.

Regression
Build models to predict continuous data.

Clustering
Find natural groupings and patterns in data.

mathworks.com/machine-learning

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Parallel Computing

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MathWorks parallel computing products let you use these resources from MATLAB® and Simulink® without making major changes to your computing environment and workflows. Using parallel computing products, you can:

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<http://www.mathworks.com/solutions/parallel-computing/>

MapReduce

MATLAB MapReduce and Hadoop

Tackling Big Data with MATLAB

[Watch video](#)

MATLAB® has numerous capabilities for exploring and analyzing big data sets. Among them is MapReduce, a powerful, and established programming technique for applying filtering, statistics and other general analysis methods to big data.

The MapReduce functionality built into MATLAB lets you analyze data that does not fit into memory. By running your MapReduce based algorithms in parallel (using Parallel Computing Toolbox™), you can better utilize the processing resources on your desktop without changing your algorithms.

To analyze data in MATLAB using MapReduce:

1. Specify the data you want to analyze using datastore
2. Create your map and reduce functions in MATLAB
3. Execute your map and reduce functions using mapreduce

While MATLAB MapReduce is optimized for array-based analysis, it is fully compatible with Hadoop MapReduce, so you can run your MapReduce based algorithms within the Hadoop MapReduce framework.

- Execute MapReduce based algorithms on Hadoop directly from the MATLAB desktop, using MATLAB Distributed Computing Server™
- Package MapReduce based algorithms for deploying to production Hadoop systems, using MATLAB Compiler™

<http://www.mathworks.com/discovery/matlab-mapreduce-hadoop.html>

Questions?