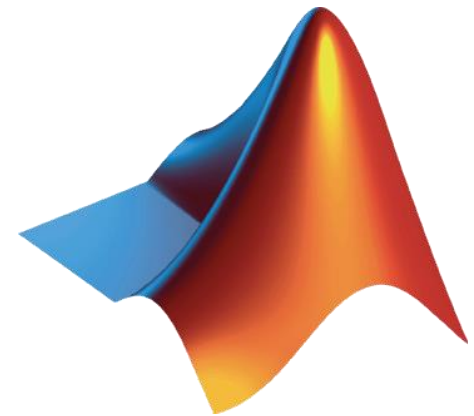
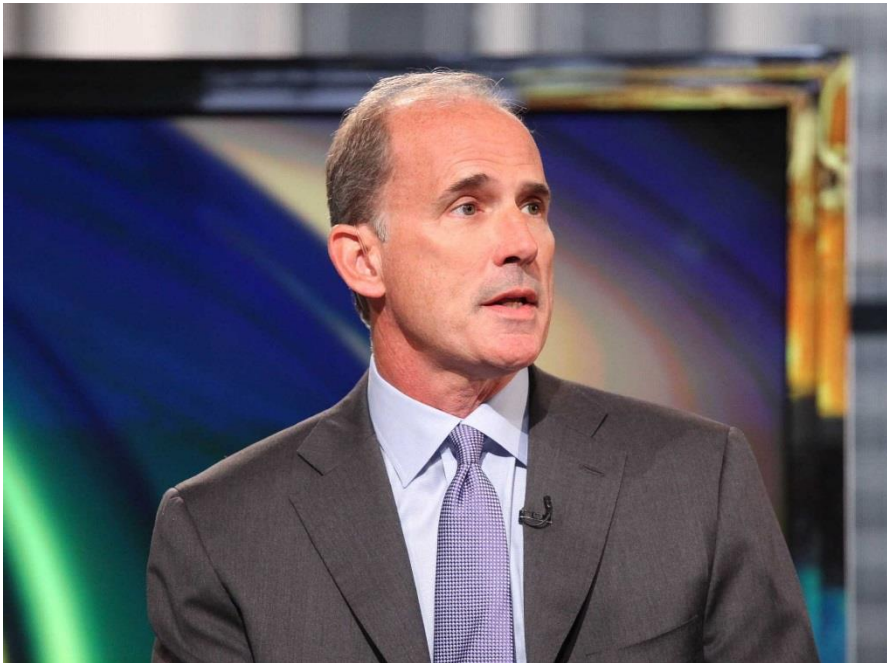


Beyond Excel: Enhancing Your Data Analysis with MATLAB

David Willingham
Senior Application Engineer – Data Analytics



“Data is the sword of the 21st century, those who wield it the samurai.”



Google's Former SVP - Jonathan Rosenberg

- Big data — how to create it, manipulate it, and put it to good use.
- “If you want to work at Google, make sure you can use MATLAB.”

Railway Systems



Automotive



Aeronautics



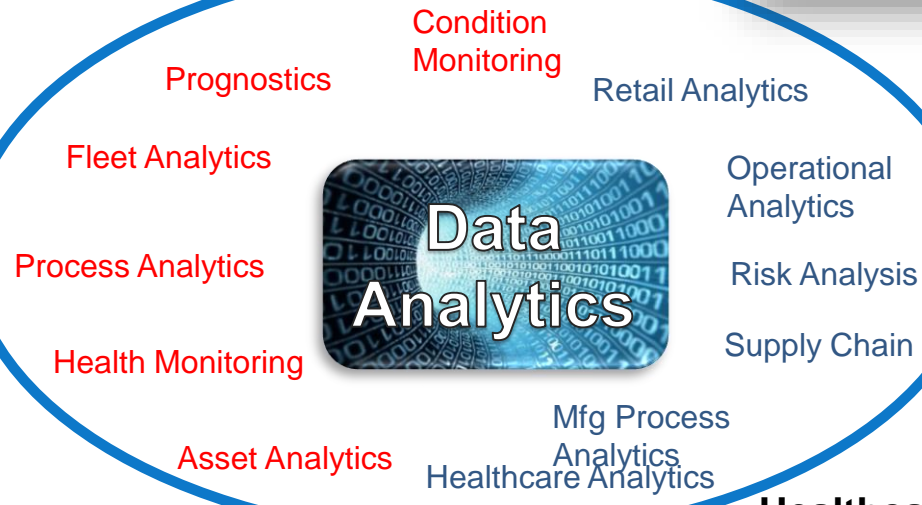
Retail



Finance



Off-highway vehicles



Internet



Logistics



Industrial Automation



Oil & Gas



Clean Energy



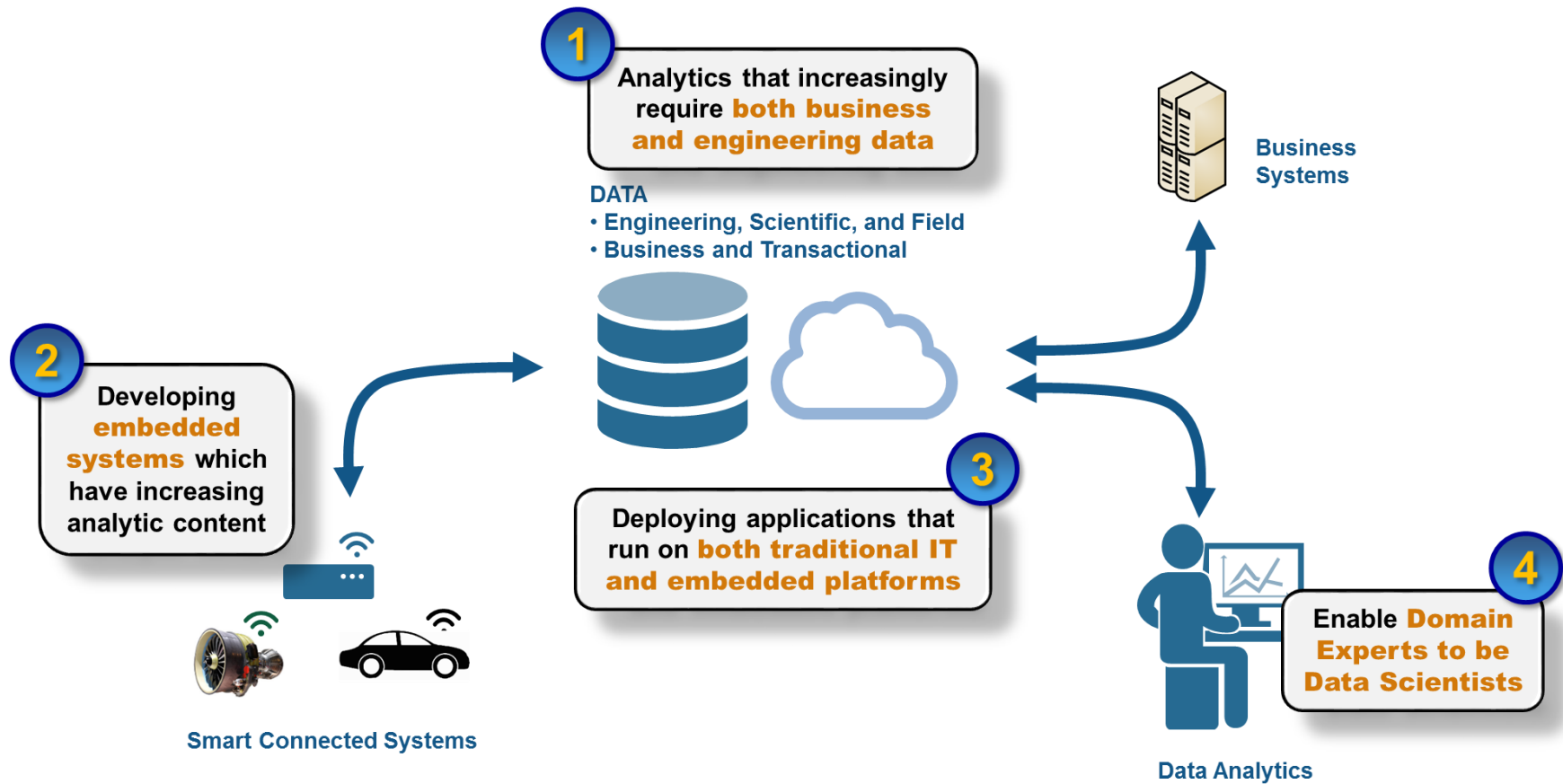
Medical Devices



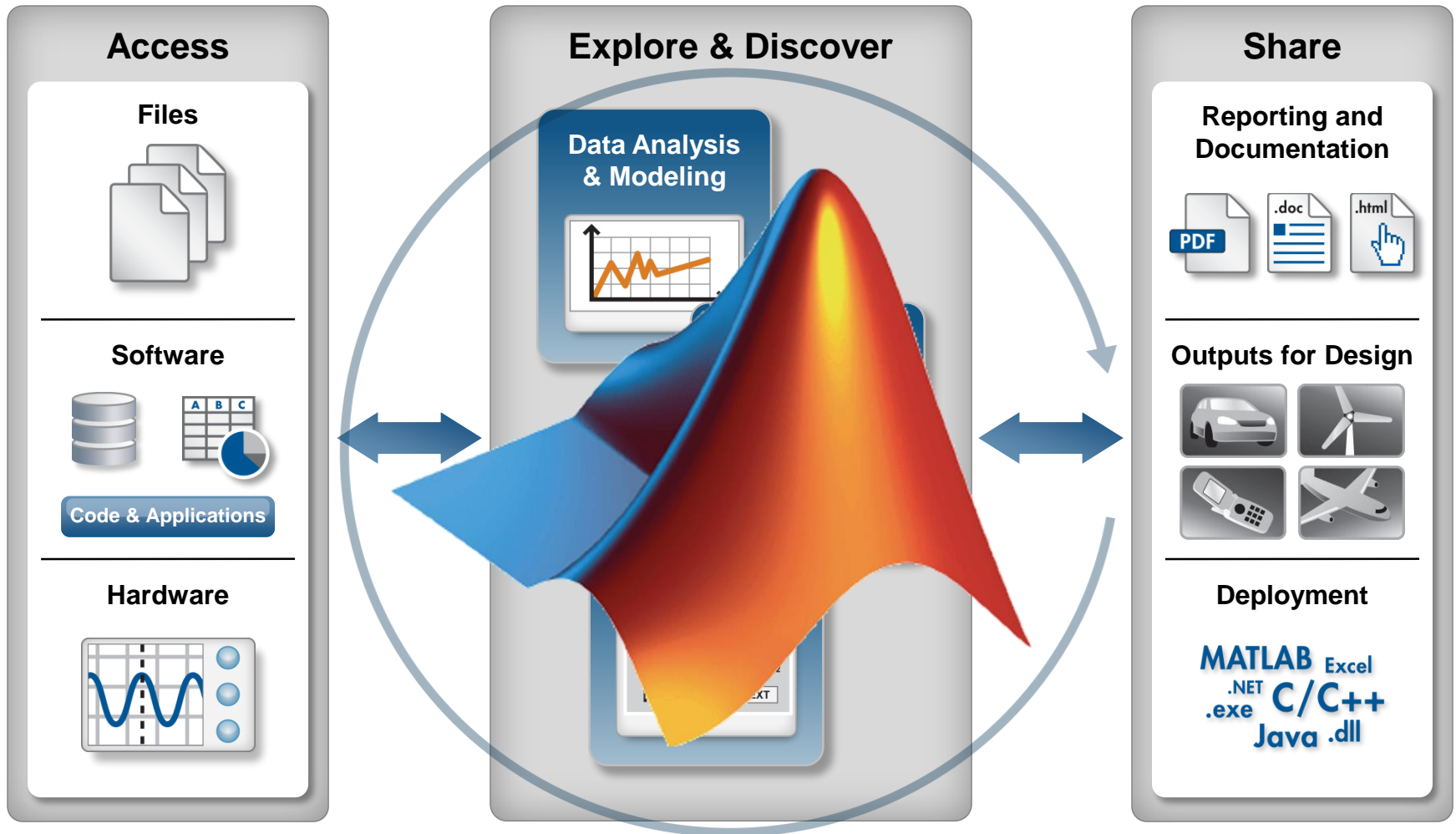
Healthcare Management



What Analytics Challenges are you facing?



Data Analytics Workflow



Automate

Frontier Advisors Develops Web-Based Platform for Portfolio Analytics



Challenge

Provide clients with an industry-first web platform for portfolio modeling and analytics

Solution

Use MATLAB to develop and test analytics modules, and use MATLAB Compiler SDK to deploy them into a production .NET environment

Results

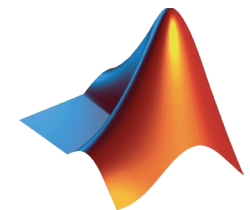
- Quantitative development decoupled from interface development
- Stable, responsive system deployed
- Rapid delivery of new features enabled

“MATLAB and MATLAB Compiler SDK enabled us to rapidly deliver a sophisticated portfolio analytics web application with confidence that it will return accurate results extremely quickly, ensuring a highly usable and stable platform for our clients.”

**Lee Eriera
Frontier Advisors**

Today's Objectives

- Introduce you to data analysis with MATLAB
- Show how you can overcome common data analysis challenges with MATLAB
- Demonstrate multiple ways of sharing your analysis and results with others



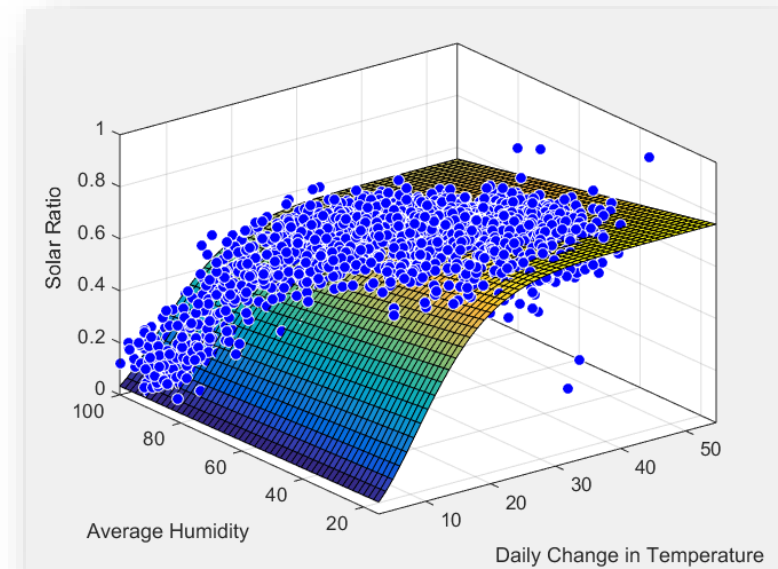
Common Data Analysis Challenges *using Excel*

- Complex calculations
- Messy Data
- Speed of Execution
- Automation
- Batch Processing
- Report Generation
- Deployment

Demo: Solar Radiation Estimation

Introduction to Data Analysis with MATLAB

- Goal:
 - Estimate daily mean global solar radiation given low cost and easily obtained measurements
- Approach:
 - Process historical measurements
 - Develop predictive model
 - Document analysis in a report
 - Apply analysis on multiple files



Modeling Global Solar Radiation

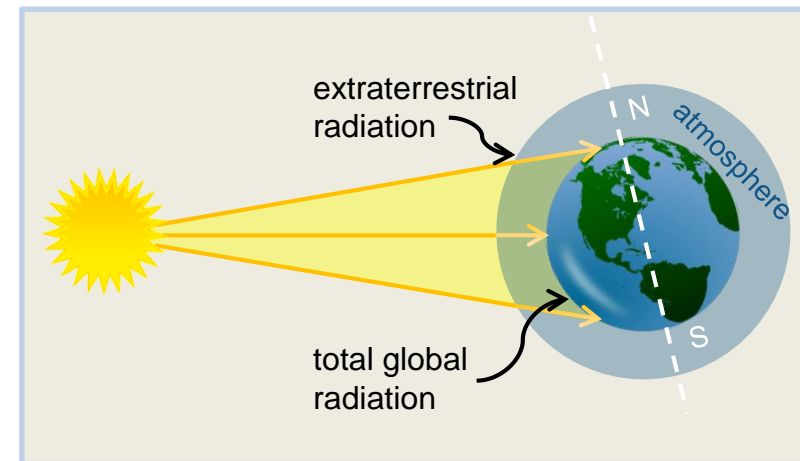
$$R_s = a (1 + bH)(1 - e^{-c \Delta T^n})$$

$$\text{Solar Ratio } (R_s) = \frac{\text{Global solar radiation}}{\text{Extraterrestrial solar radiation}}$$

$$\text{Daily Temperature Difference } (\Delta T) = T_{\text{DailyMax}} - T_{\text{DailyMin}}$$

H is Relative Humidity

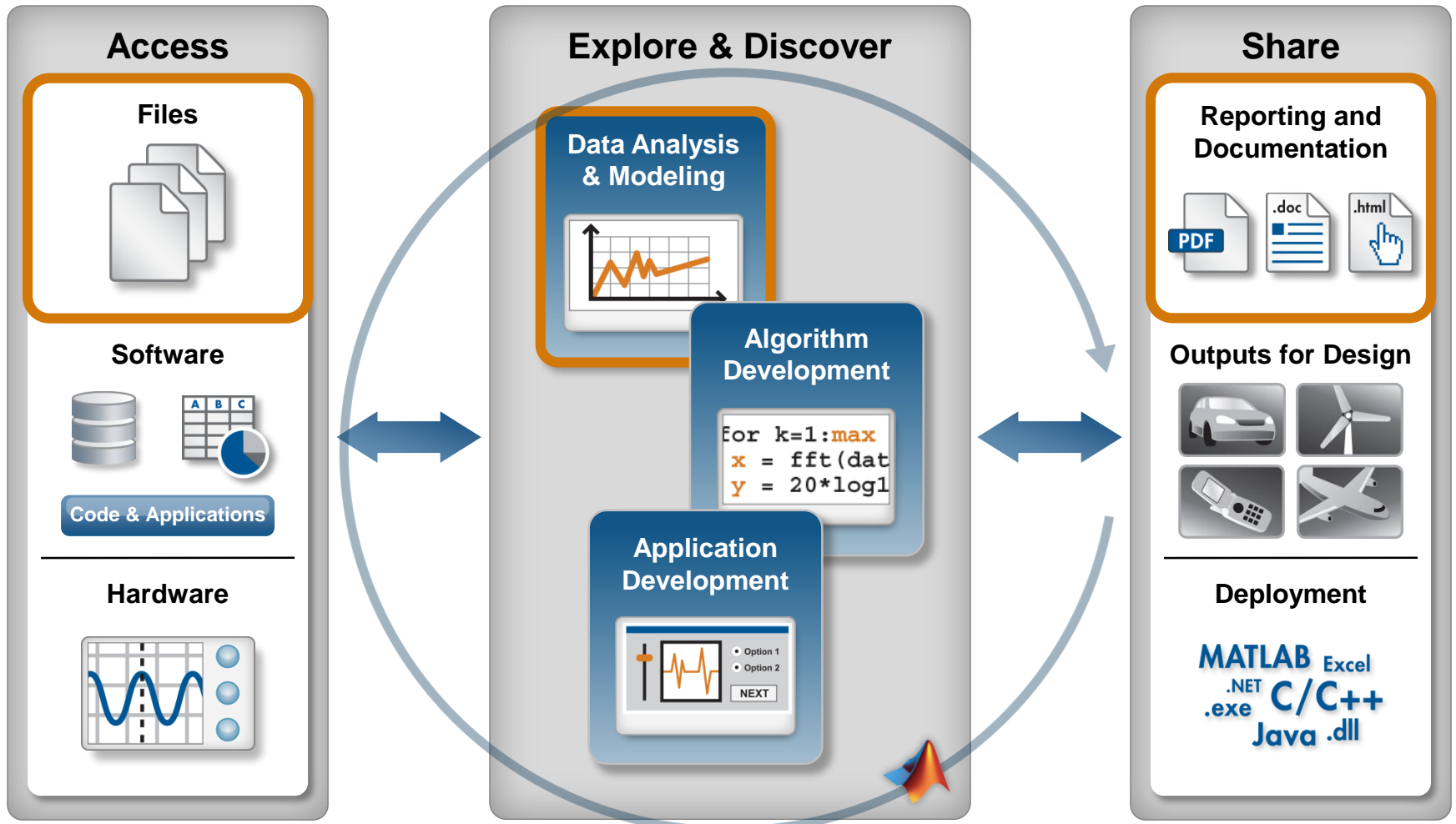
a, b, c, n are the model coefficients



Demo Summary

Solar Radiation Estimation

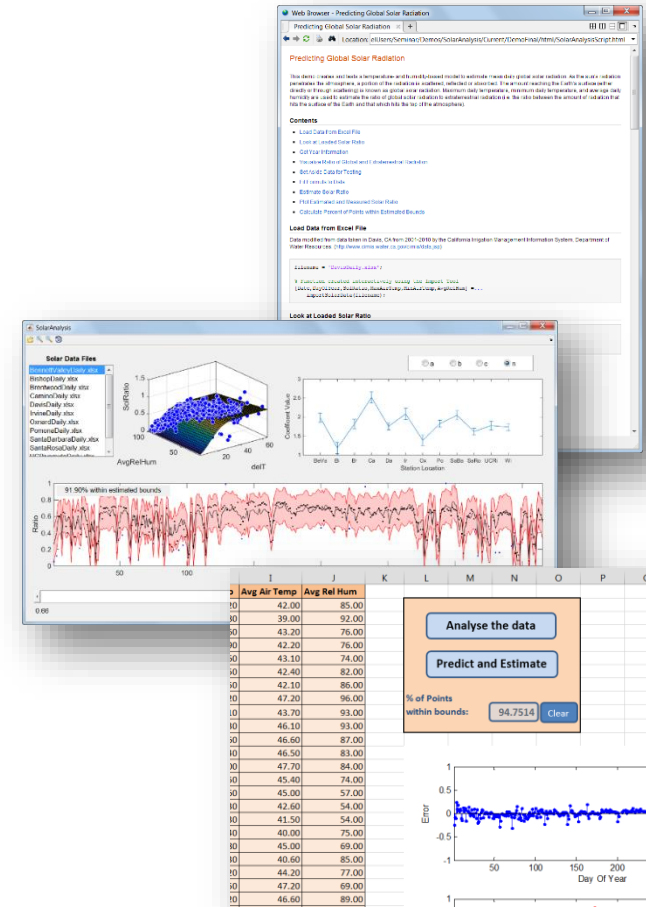
- Products Used
- MATLAB
 - Curve Fitting Toolbox



Automate

Sharing Results from MATLAB

- Automatically generate reports
- Create and package applications
- Deploy to other environments

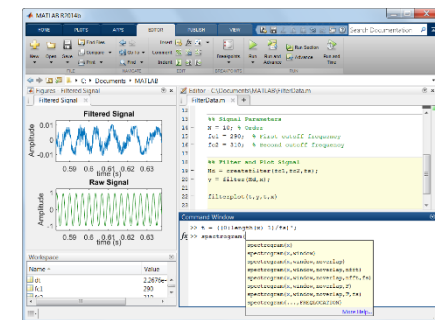
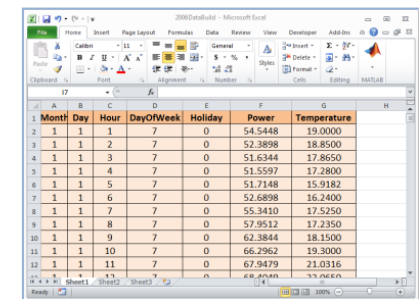


Using MATLAB with Excel

- Passing data between MATLAB and Excel
 - MATLAB

- Accessing MATLAB from an Excel spreadsheet
 - MATLAB
 - Spreadsheet Link EX

- Deploying MATLAB as an Excel add-in
 - MATLAB
 - MATLAB Compiler

The screenshot shows an Excel spreadsheet with a table of data. The table has columns for Month, Day, Hour, DayOfWeek, Holiday, Power, and Temperature. The data is organized into 12 rows, representing a sequence of days.

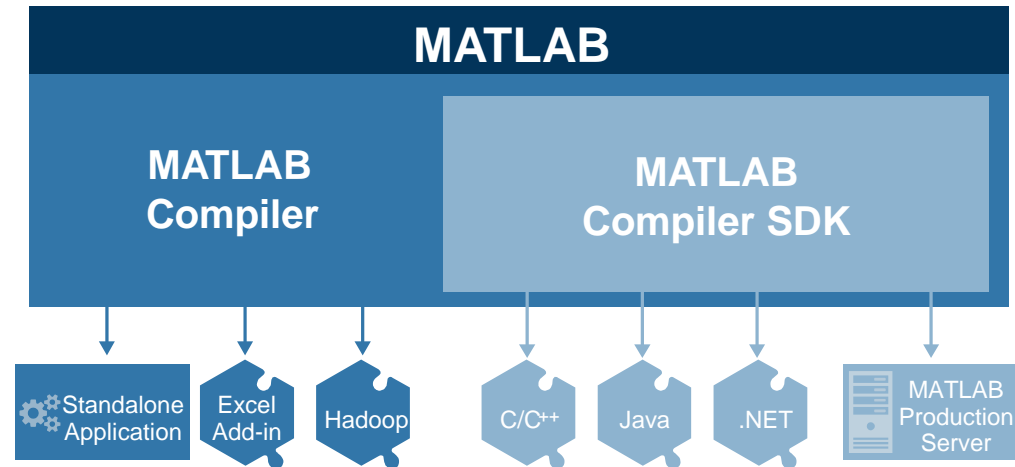
Month	Day	Hour	DayOfWeek	Holiday	Power	Temperature
1	1	1	7	0	54.5448	19.0000
1	1	2	7	0	52.3898	18.8500
1	1	3	7	0	51.6344	17.8650
1	1	4	7	0	51.5597	17.2800
1	1	5	7	0	51.7148	15.9182
1	1	6	7	0	52.6898	16.2400
1	1	7	7	0	55.3410	17.5250
1	1	8	7	0	57.9512	17.7350
1	1	9	7	0	62.3844	18.1500
1	1	10	7	0	66.2962	19.3000
1	1	11	7	0	67.9479	21.0316

MATLAB Application Deployment

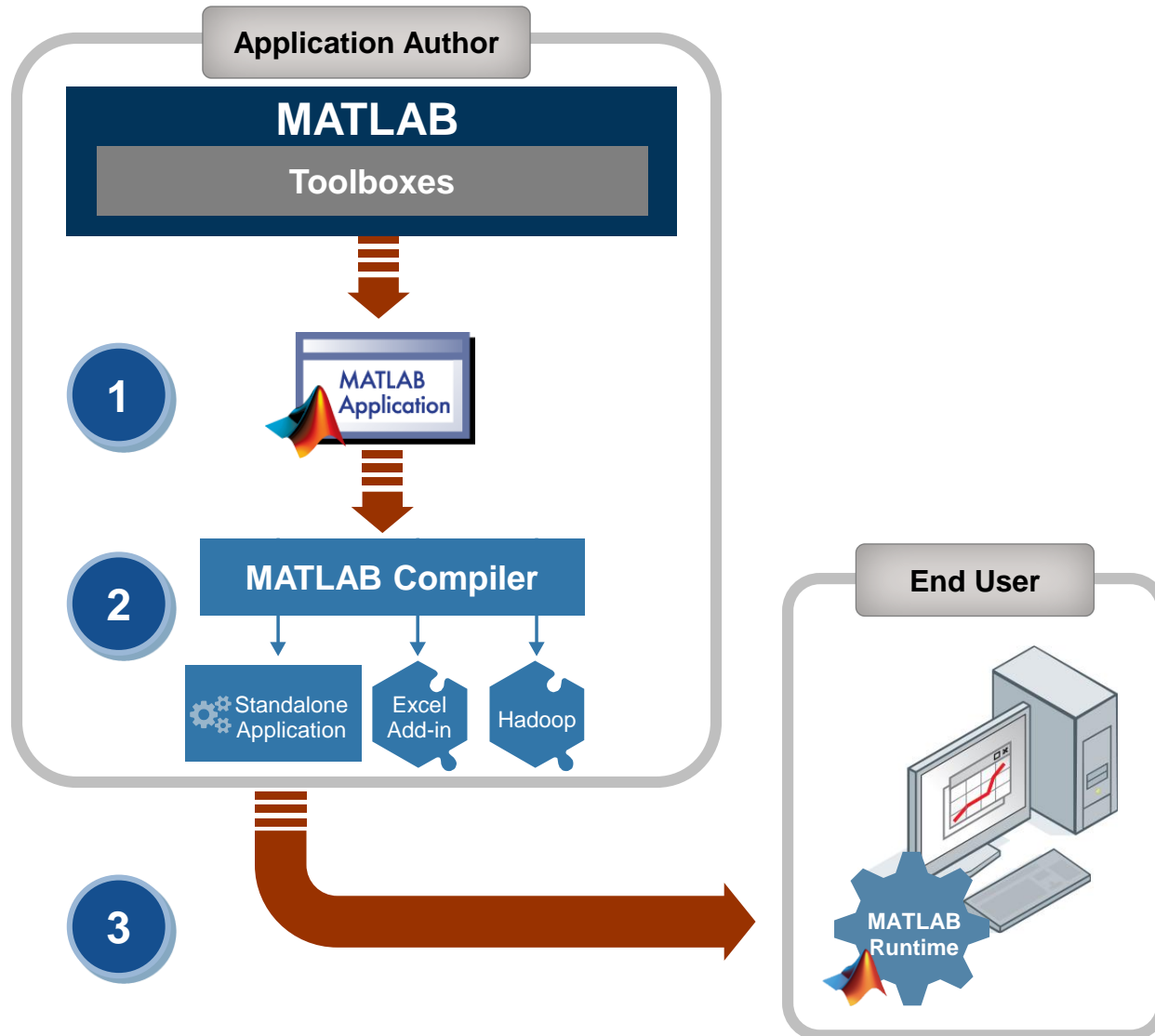
- Share MATLAB programs with people who do not have MATLAB
 - Royalty-free distribution
 - Encryption to protect your intellectual property

- Create both standalone applications and components for integration

- Deploy to desktop, web, and enterprise applications

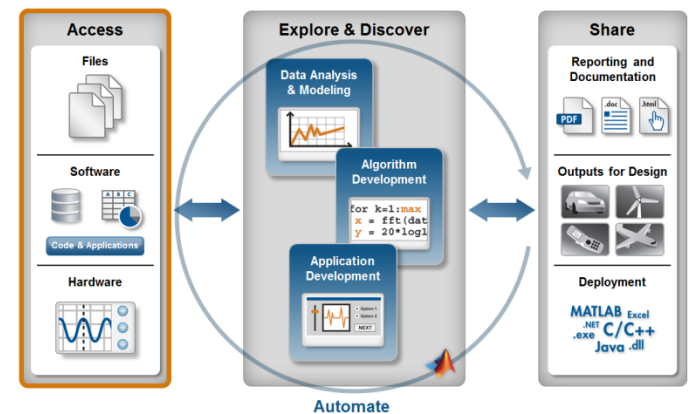


Sharing Standalone Applications



Common Data Analysis Challenges

- Handling complex and messy data
- Modeling with many predictors

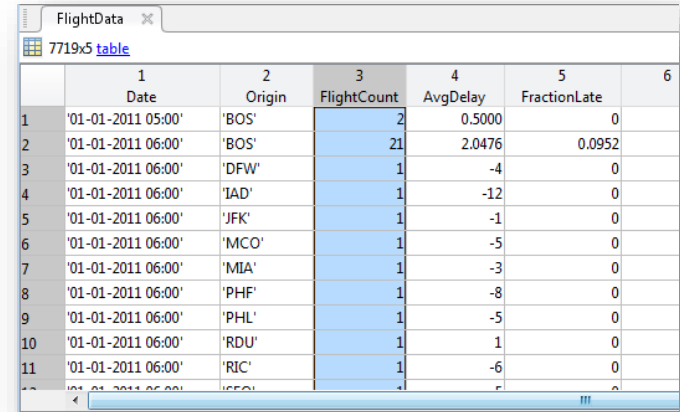


Demo: Preparing Late Plane Data

Handling Complex and Messy Data

- Goal:
 - Prepare late plane data for further analysis

- Approach:
 - Load mixed data from files
 - Filter data and replace missing data
 - Merge observations from different time intervals into a single data set



	1	2	3	4	5	6
	Date	Origin	FlightCount	AvgDelay	FractionLate	
1	'01-01-2011 05:00'	'BOS'	2	0.5000	0	
2	'01-01-2011 06:00'	'BOS'	21	2.0476	0.0952	
3	'01-01-2011 06:00'	'DFW'	1	-4	0	
4	'01-01-2011 06:00'	'IAD'	1	-12	0	
5	'01-01-2011 06:00'	'JFK'	1	-1	0	
6	'01-01-2011 06:00'	'MCO'	1	-5	0	
7	'01-01-2011 06:00'	'MIA'	1	-3	0	
8	'01-01-2011 06:00'	'PHF'	1	-8	0	
9	'01-01-2011 06:00'	'PHL'	1	-5	0	
10	'01-01-2011 06:00'	'RDU'	1	1	0	
11	'01-01-2011 06:00'	'RIC'	1	-6	0	

Accessing Data from MATLAB

Access

Explore & Discover

Share

Files

- Excel, text, or binary
- Audio and video, image
- Scientific formats and XML

Web Services

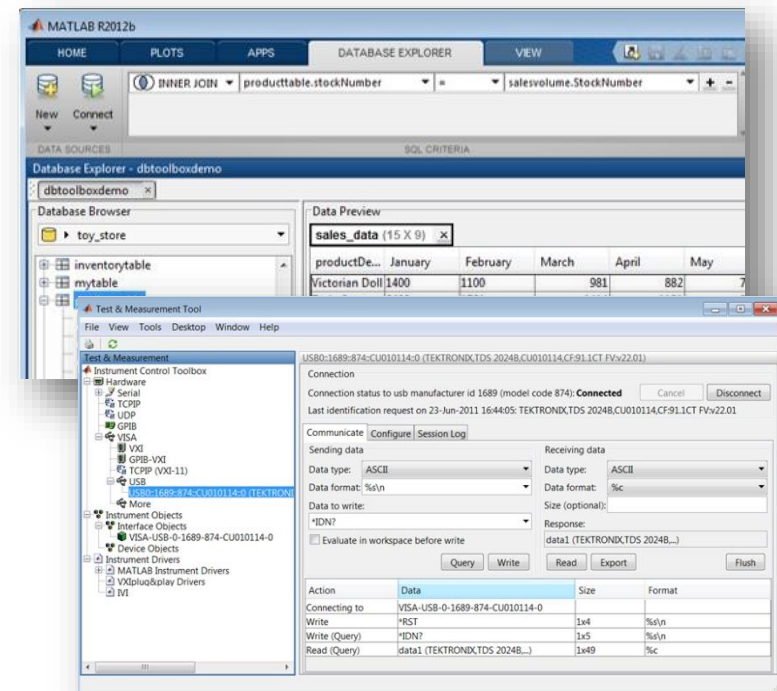
- JSON, CSV, and image data

Applications and languages

- C/C++, Java, FORTRAN
- COM, .NET, shared libraries
- Databases (*Database Toolbox*)

Measurement hardware

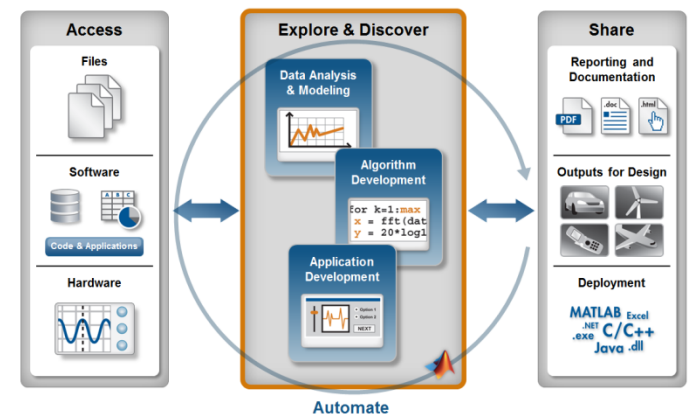
- Data acquisition hardware (*Data Acquisition Toolbox*)
- Stand-alone instruments and devices (*Instrument Control Toolbox*)



Common Data Analysis Challenges

- Handling complex and messy data

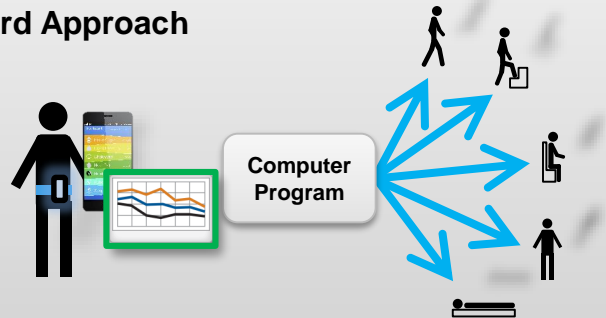
- Modeling with many predictors



Machine Learning

Machine learning uses **data** and produces a **program** to perform a **task**

Standard Approach



Hand Written Program

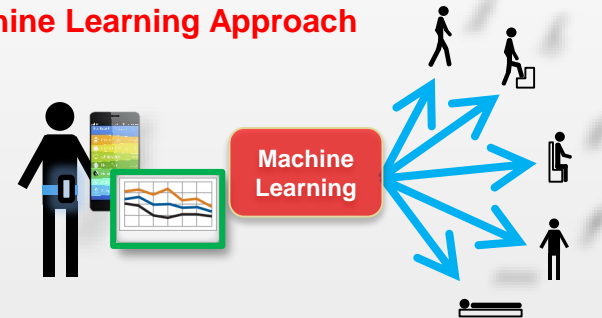
```

If X_acc > 0.5
  then "SITTING"
If Y_acc < 4 and Z_acc > 5
  then "STANDING"
...
    
```

Formula or Equation

$$\begin{aligned}
 Y_{activity} &= \beta_1 X_{acc} + \beta_2 Y_{acc} \\
 &+ \beta_3 Z_{acc} + \dots
 \end{aligned}$$

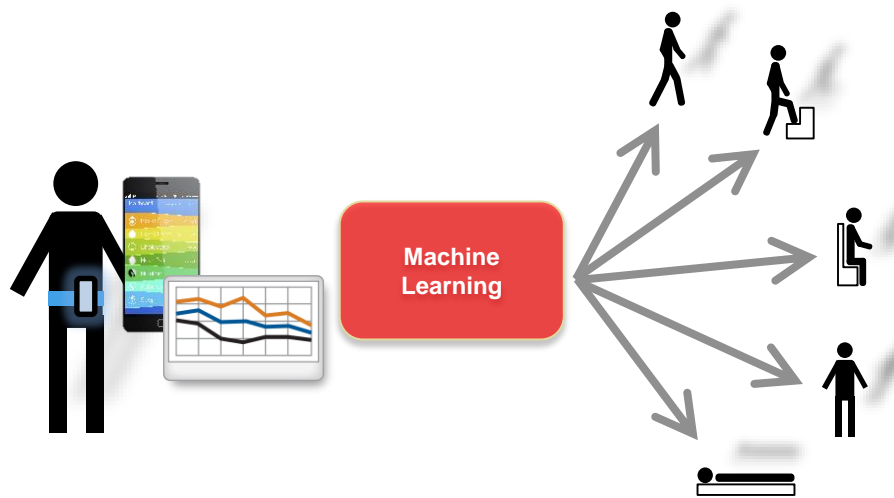
Machine Learning Approach



model: Inputs → Outputs

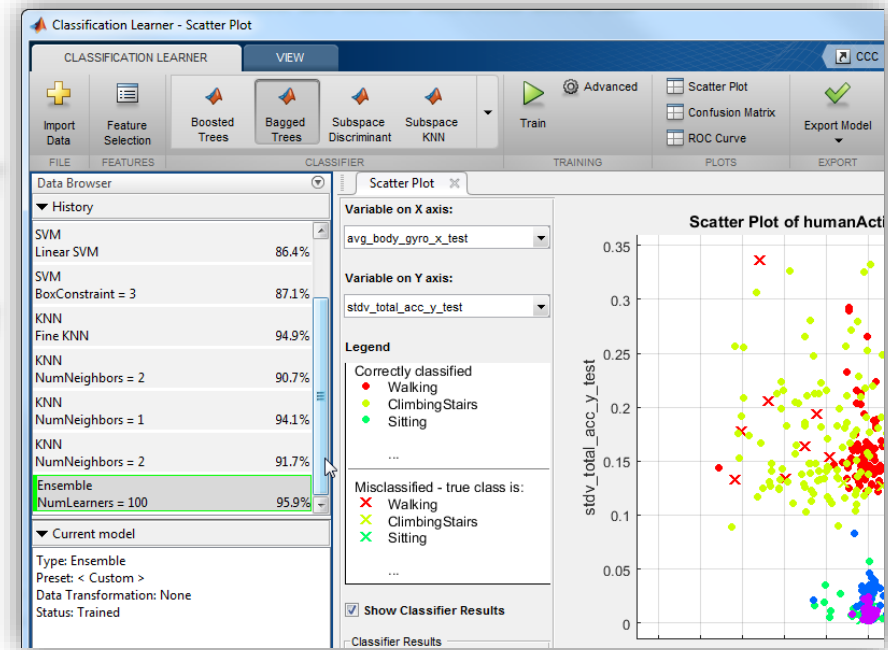
model = < Machine Learning Algorithm > (sensor_data, activity)

Demo: Machine Learning Using Mobile Phone Data



Data:

- 3-axial Accelerometer data
- 3-axial Gyroscope data

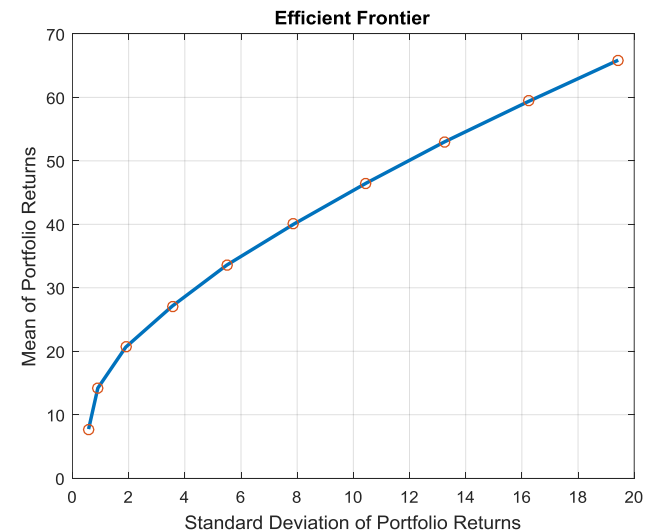


Demo: Portfolio Optimisation

Computing the Efficient Frontier

- Goal: Compute an Efficient Frontier in:
 - Excel Solver
 - MATLAB

- Compare the 2 approaches in:
 - Performance
 - Automation of Workflow

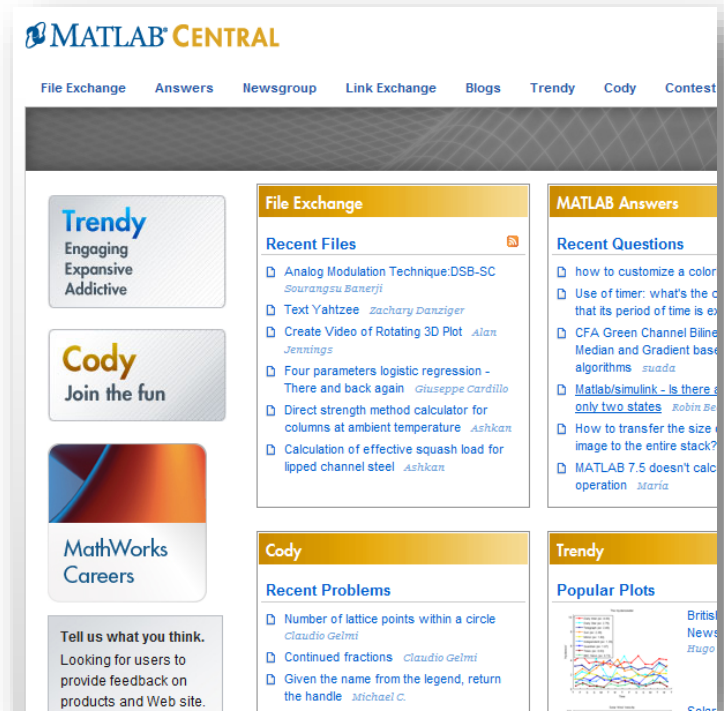


Workflow Portfolio Optimization

- Convert prices to returns.
- Expected Returns.
- Covariance matrices
- Calculate Efficient Frontier
 - Optimize to Maximise the return
 - Optimize to Minimise the risk
 - Optimize multiple times between Min Risk & Max Return

MATLAB Central

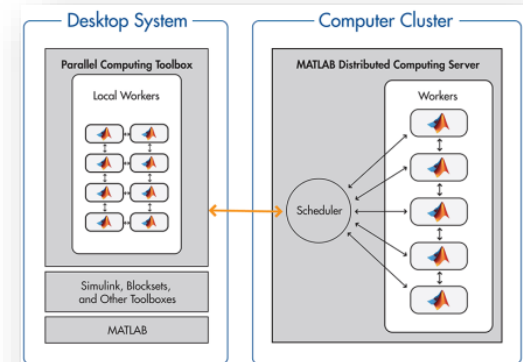
- Community for MATLAB and Simulink users
 - Over 70k daily visits
- File Exchange
 - Access more than 10k free files including functions, apps, examples, and models
- MATLAB Answers
 - Ask programming questions or search
 - 18k+ community-answered Questions
- Blogs
 - Read commentary from engineers who design, build, and support MATLAB and Simulink



Expand Your Analysis Capabilities

- **Machine learning**
(Statistics and Machine Learning Toolbox, Neural Networks Toolbox)
 - “Learn” from your data without assuming an equation as a model
 - www.mathworks.com/machine-learning

- **Parallel programming**
(Parallel Computing Toolbox)
 - Speed up your analysis using multicore computers, GPUs, and computer clusters
 - <http://www.mathworks.com/products/parallel-computing/>



Today's Objectives

- Introduce you to data analysis with MATLAB
- Show how you can overcome common data analysis challenges with MATLAB
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