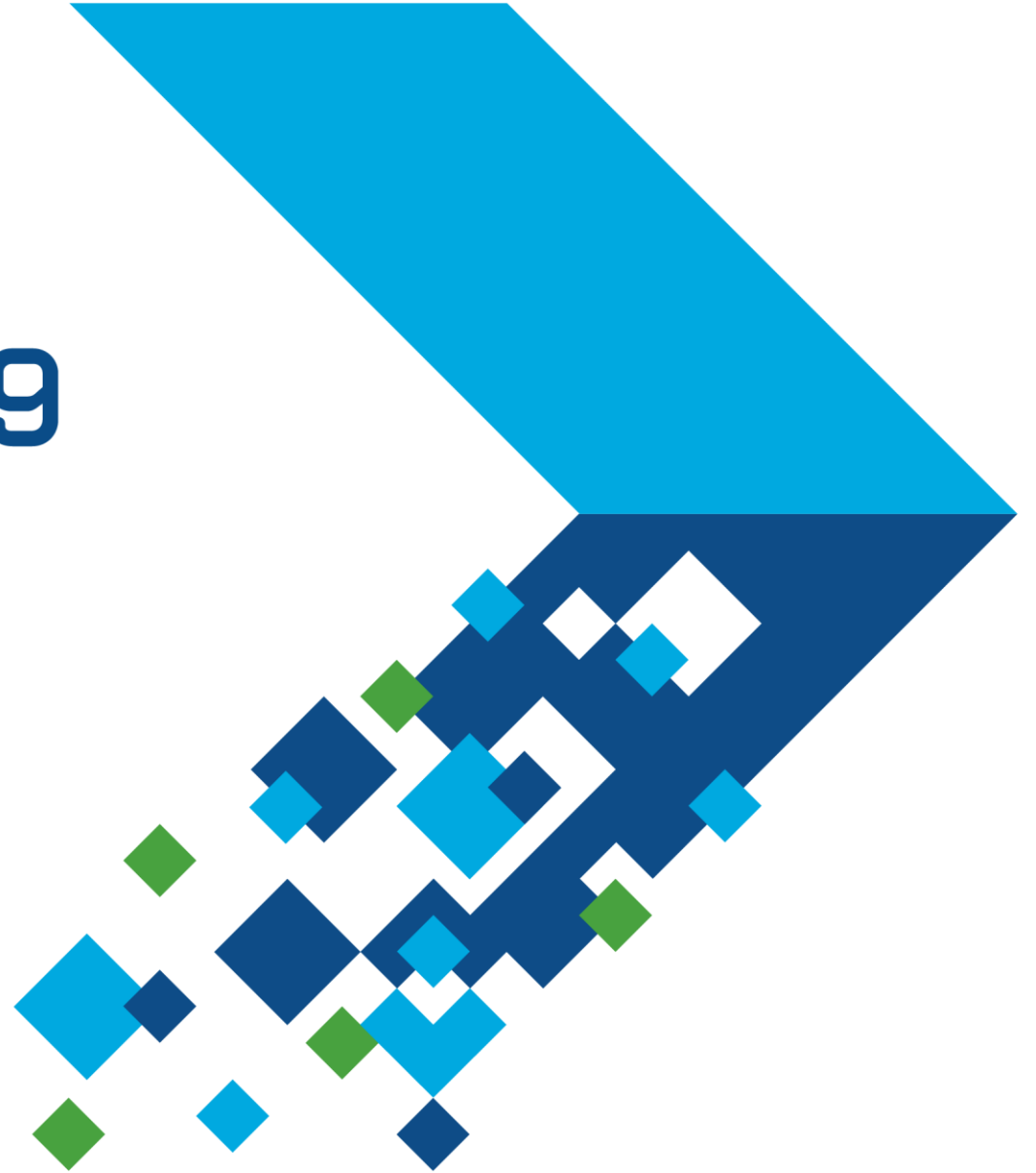# MATLAB EXPO 2019

Introduction to MATLAB

Laura Dempsey

Agenda

- What is MATLAB?

- Analysis Example: Bike Count Data
  – Importing
  – Exploring
  – Sharing Results

- Signal Processing Example: Quick Start

- Where to get Help and Learn MATLAB

Key Takeaways

- **INTEGRATION:** MATLAB can be used at all stages of your work.

- **AUTOMATION:** Save time and avoid repetition.

- **INFORMATION:** Many resources available to help you to learn basic and advanced MATLAB concepts.

What is MATLAB?

- High-level computer language **designed for scientists and engineers**.

- Combination of an **easy-to-use,** interactive desktop environment with **matrix-based** language.

- **Extendable** using toolboxes that provide targeted functionality for specific types of analysis or area of expertise.

Technical Computing Workflow

Access

Files

Software

Code & Applications

Hardware
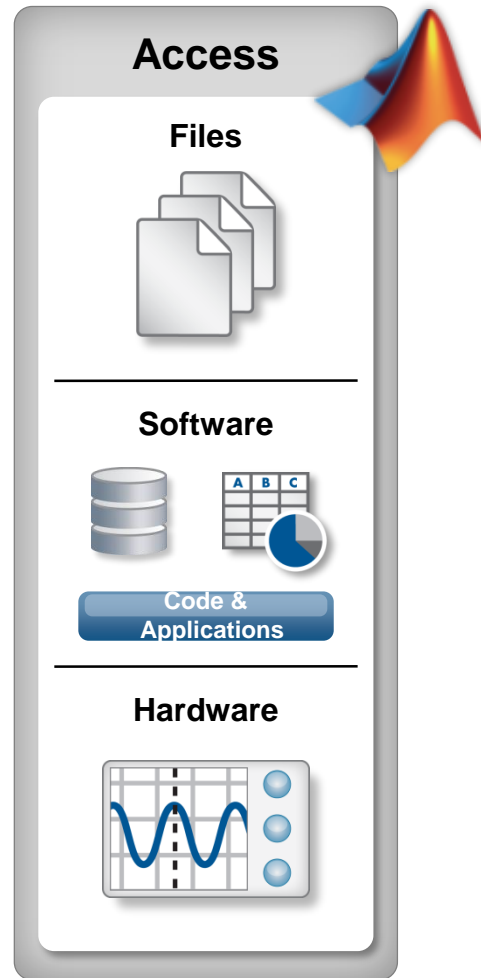
Text files, spreadsheets

Images, Video and Audio

From the web, JSON, HTTP Messaging

Database or Datafeed

Devices

Out of Memory Data

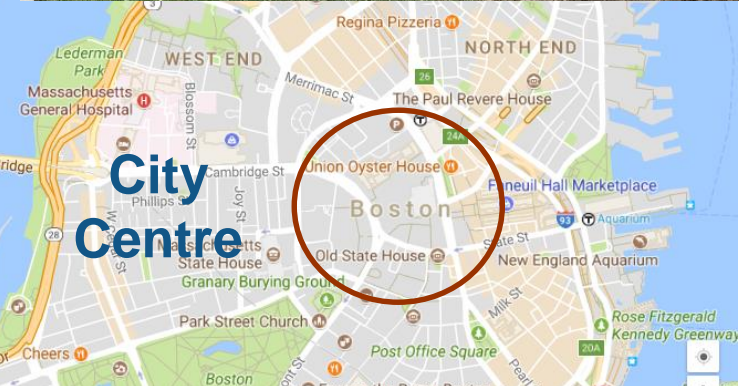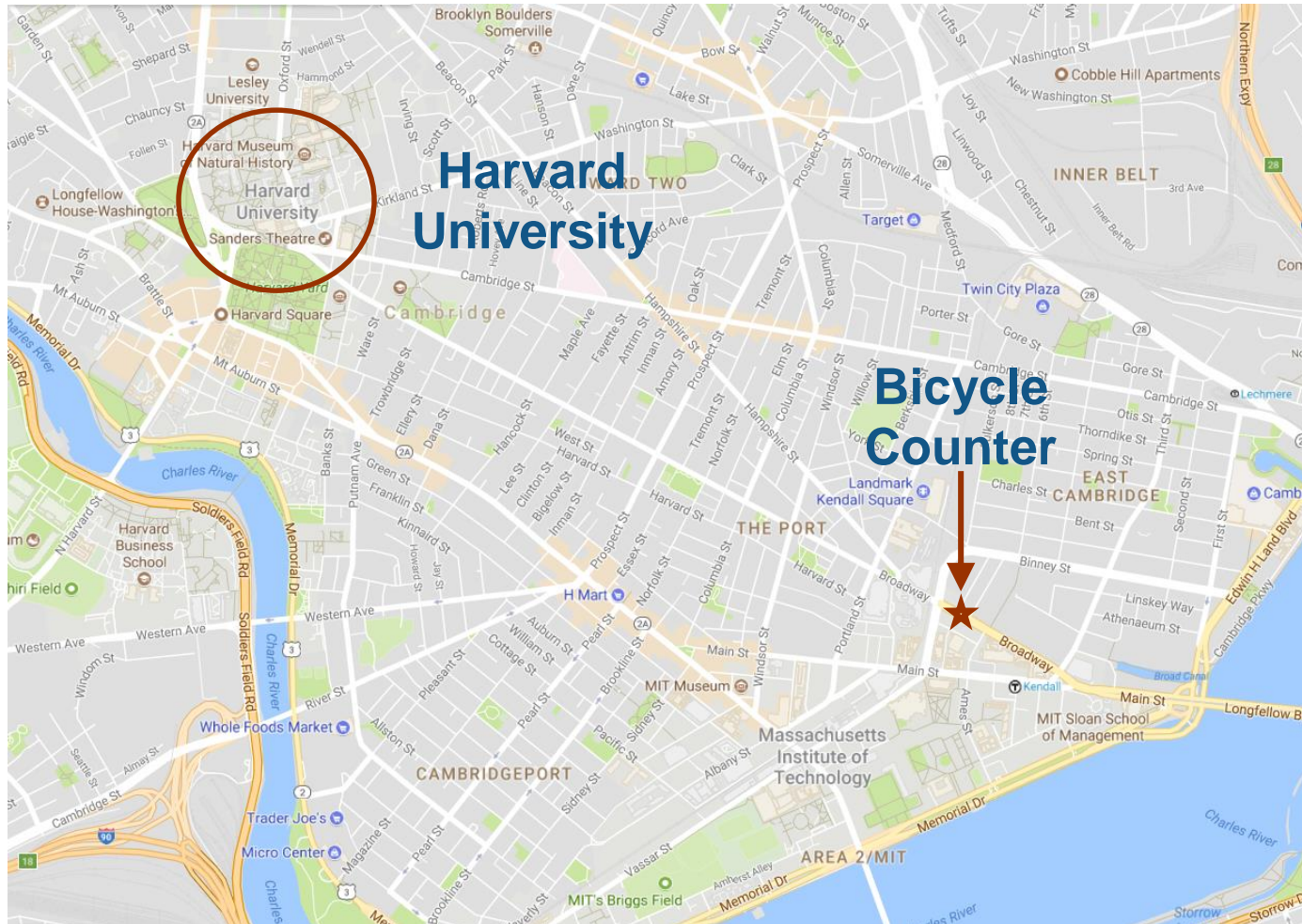# Technical Computing Workflow

Access

Files

Software

Code & Applications

Hardware

Explore & Discover

Data Analysis & Modeling

Algorithm Development

```
for k=1:max
x = fft(dat
y = 20*log1
```

Application Development

- Option 1
- Option 2

NEXT

Share

Reporting and Documentation

PDF   .doc   .html

Outputs for Design

Deployment

MATLAB Excel .NET C/C++ .exe Java .dll
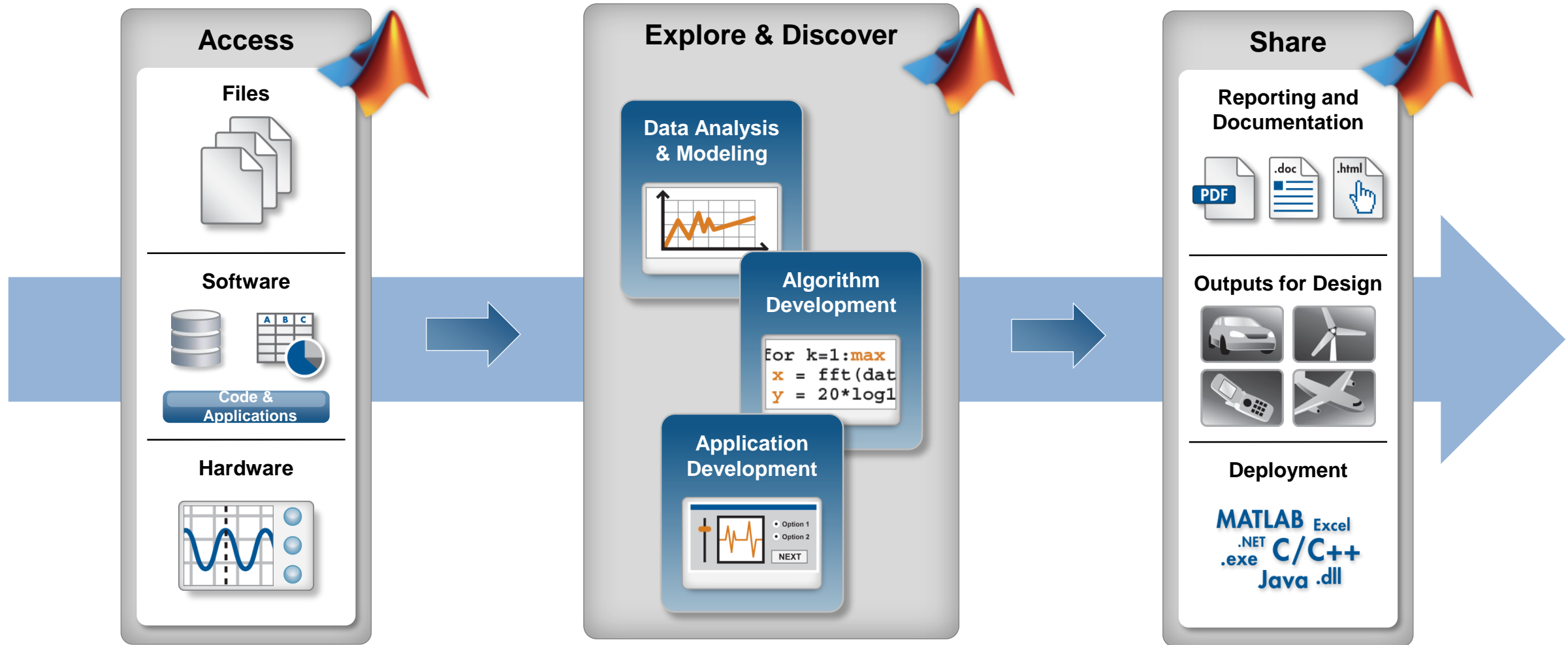
Automate

Example: Bicycle Traffic Analysis

Harvard University
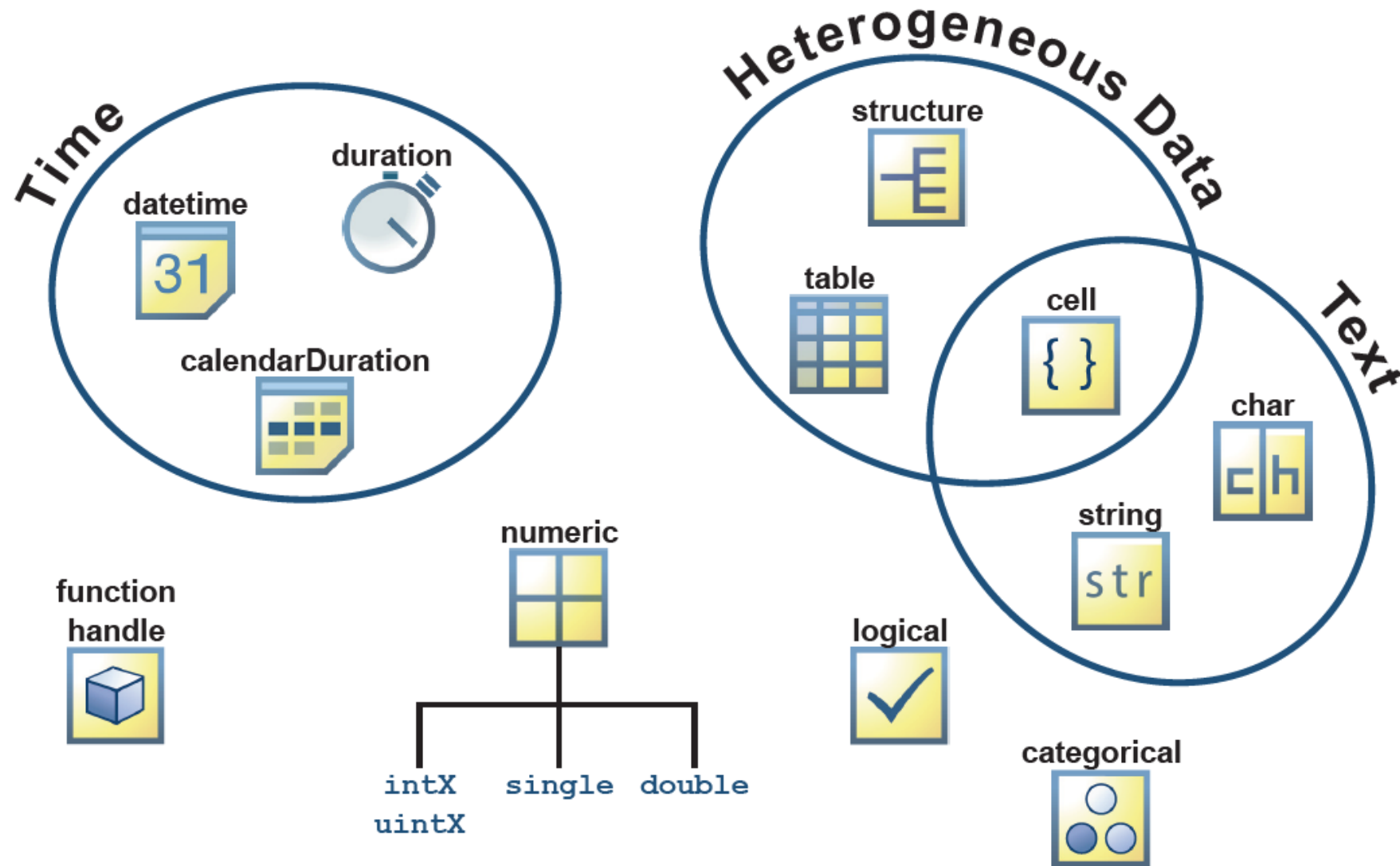
Bicycle Counter

City Centre

Example: Bicycle Traffic Analysis

- Bicycle count for journeys toward Harvard (**Westbound**) and toward City Centre (**Eastbound**).

- Counts recorded every 15 minutes

- Data contains:
  - Timestamp
  - Day of the week
  - Counts separated by journey direction
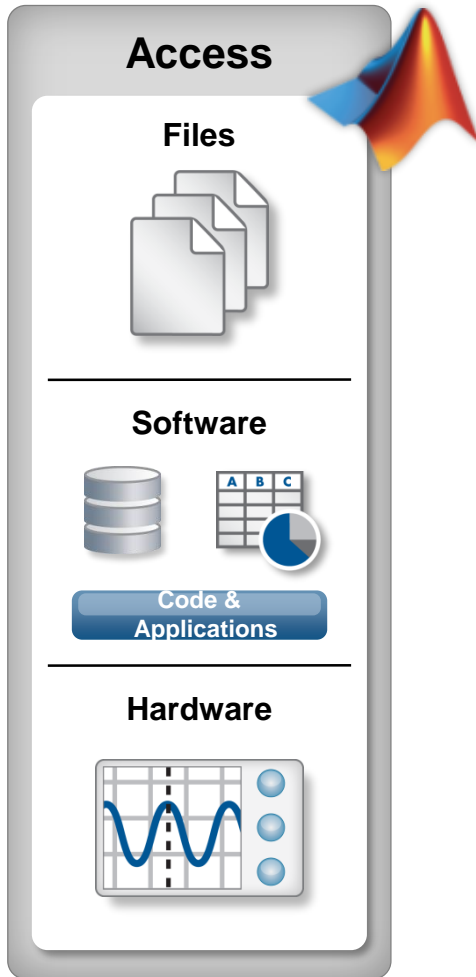 - Total bicycle counts per 15 minutes

A1			f_x	Timestamp		
	A	B	C	D	E	
1	Timestamp	Day	Westbound	Eastbound	Total	
38	01/01/2017 09:00	Sunday	0	1	1	
39	01/01/2017 09:15	Sunday	0	1	1	
40	01/01/2017 09:30	Sunday	0	1	1	
41	01/01/2017 09:45	Sunday	0	0	0	
42	01/01/2017 10:00	Sunday	1	1	2	
43	01/01/2017 10:15	Sunday	0	1	1	
44	01/01/2017 10:30	Sunday	0	2	2	
45	01/01/2017 10:45	Sunday	2	1	3	
46	01/01/2017 11:00	Sunday	0	2	2	
47	01/01/2017 11:15	Sunday	0	4	4	
48	01/01/2017 11:30	Sunday	0	1	1	
49	01/01/2017 11:45	Sunday	1	0	1	
50	01/01/2017 12:00	Sunday	1	1	2	
51	01/01/2017 12:15	Sunday	0	1	1	
52	01/01/2017 12:30	Sunday	0	5	5	

BicycleCounts2017

Fundamental Data Types

Importing Data: Interactive or Generate Code

- Interactively import data with the Import Tool:

Compare with Weather Data
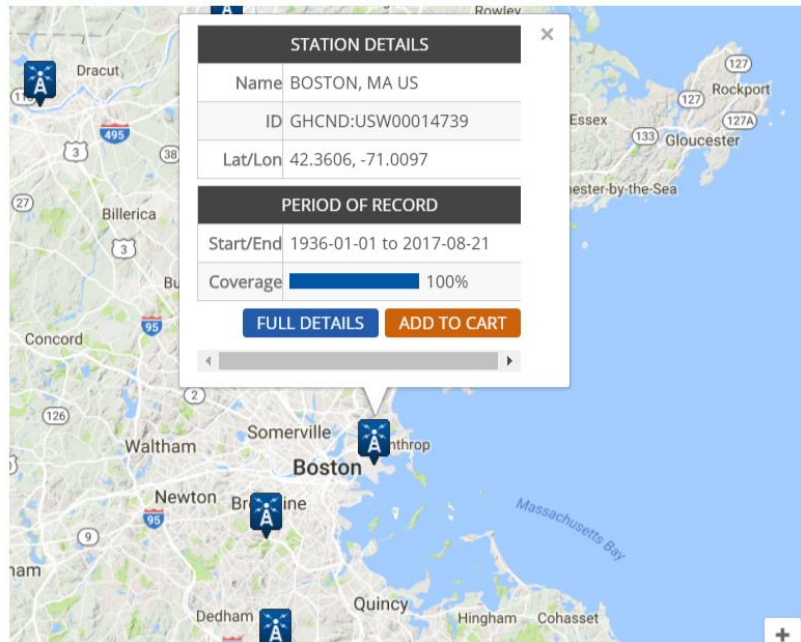
- Historical weather data for Boston, MA.

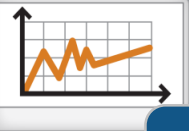|	A	B	C	D	E	F	G
1	DATE	AvWindSpeed	Precipitation	TAVG	TMAX	TMIN	
2	01/01/2017	14.09	0.07	40	44	33	
3	02/01/2017	4.47	0	35	41	28	
4	03/01/2017	18.12	0.89	41	44	40	
5	04/01/2017	12.53	0.06	43	48	33	
6	05/01/2017	14.76	0	32	34	27	
7	06/01/2017	8.05	0.06	29	31	24	
8	07/01/2017	14.32	0.53	23	24	17	
9	08/01/2017	13.42	0.01	18	22	13	
10	09/01/2017	14.18	0	15	20	11	

- Same time period as bicycle traffic data.

- We have data for:
  - Average wind speed (MPH)
  - Precipitation (inches per day)
  - Average daily temperature (°F)
  - Maximum daily temperature (°F)
  - Minimum daily temperature (°F)

Are bicycle counts related to the weather?

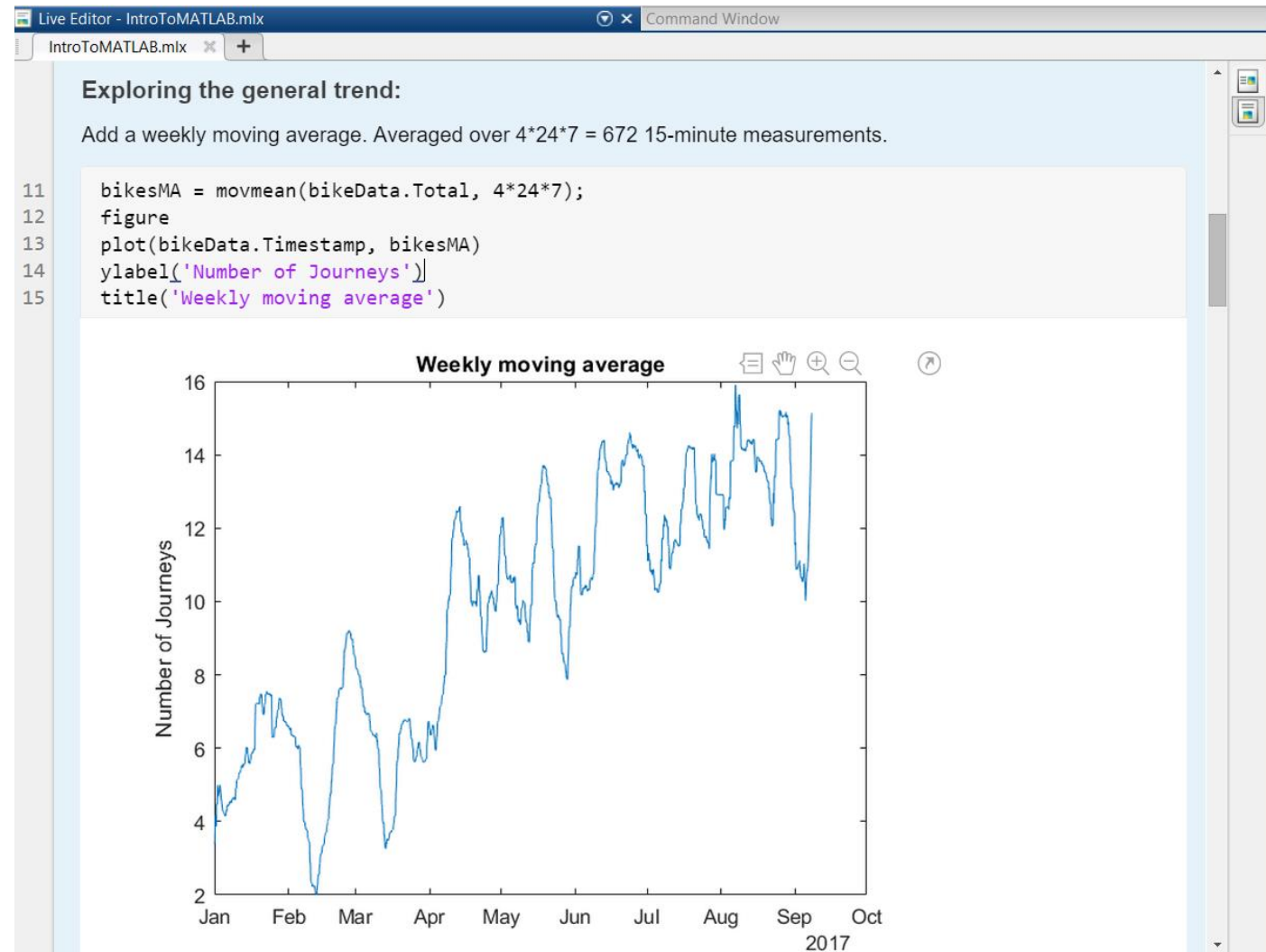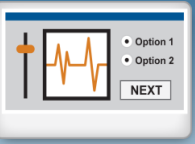- Live Editor allows for quick and easy exploration of data

Sharing Code and Applications

- Export script as DOCX/PDF/HTML/LaTeX

Share

Reporting and Documentation

PDF .doc .html

**Outputs for Design**

Deployment

MATLAB Excel
.NET C/C++
.exe
Java .dll

Introduction to MATLAB

In this script, we will import in data from `.csv` files interactively, and then generate code to bring in the data programmatically.

The bicycle counts data comes from sensors on Broadway, Cambridge, Massachusetts, and counts the number of bikes travelling toward *Harvard* (**Westbound**) and toward the *city centre* (**Eastbound**) every 15 minutes.
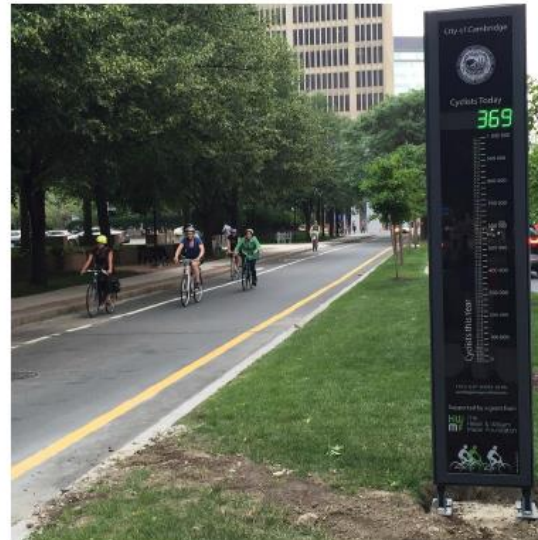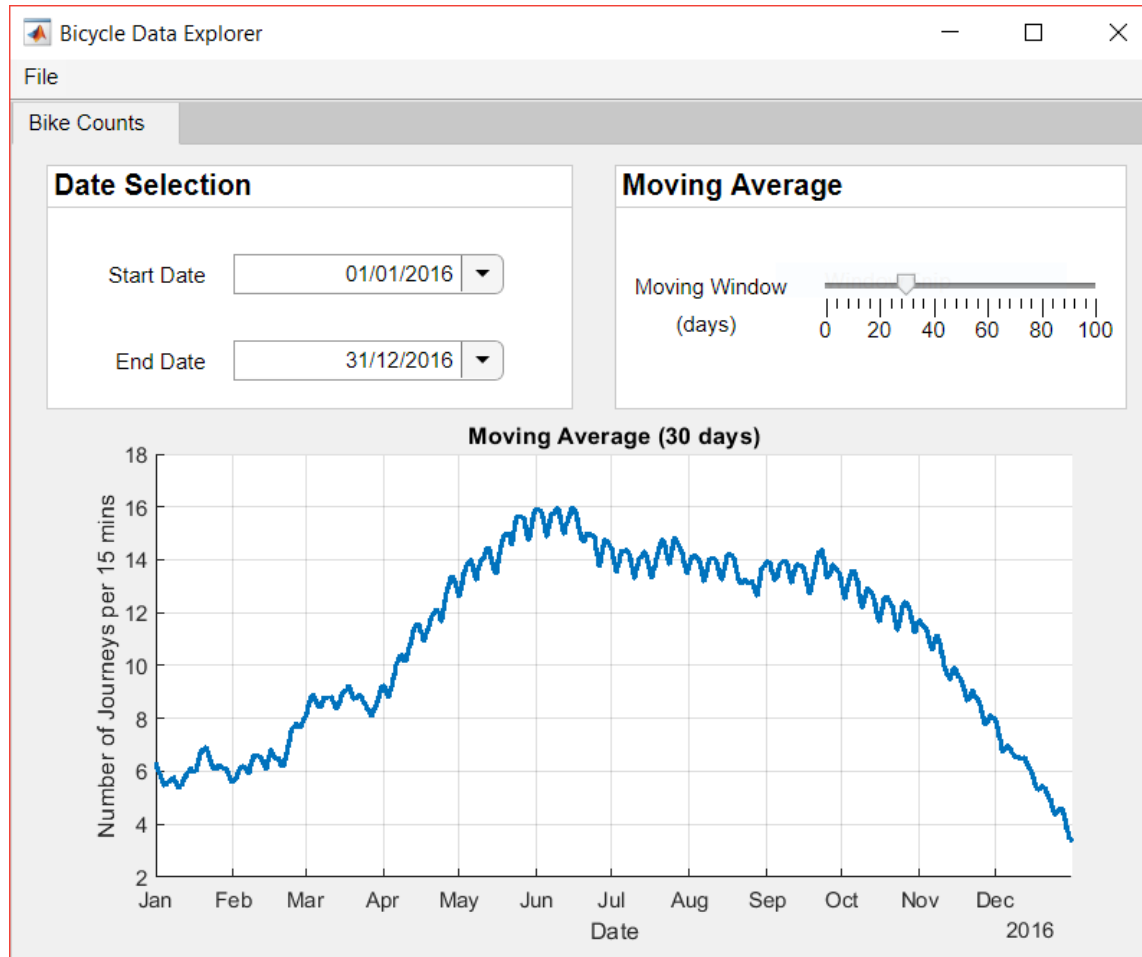
Importing Data

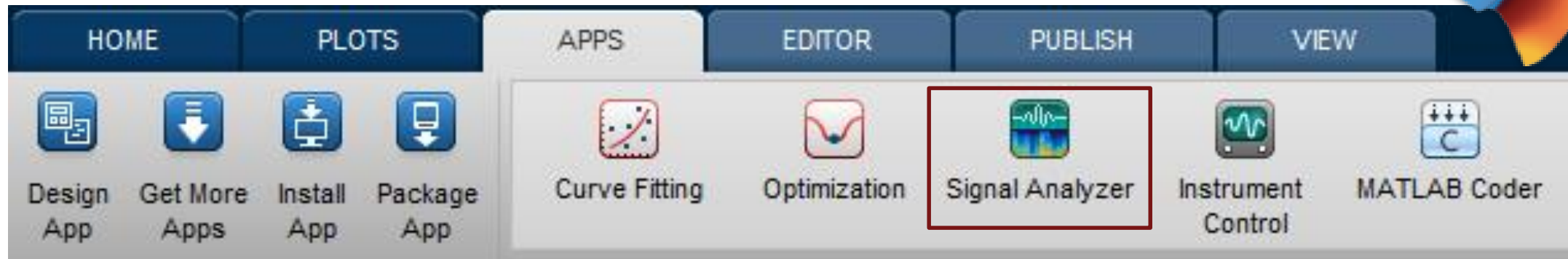Data can be imported interactively using the Import Tool.

Sharing Code and Applications

- Create stand-alone application for MATLAB and Non-MATLAB users.

Quick Starts to Complex Tasks

- MATLAB Apps

MATLAB Onramp

- Get started with MATLAB for free

- Two-hour interactive training course
  - Hands-on experience.
  - Work through examples and exercises.
  - Immediate feedback.

- Access directly from MATLAB:

MATLAB Training – Online and in the Classroom

- **Deep Learning Onramp**
  - 95 minutes of free material.
  - Get started with Deep Learning.

- **Other self-paced, online courses:**
  https://matlabacademy.mathworks.com/

- **Classroom training available:**
  - You come to us, or we come to you.

MATLAB Central

An open exchange for the MATLAB and Simulink user community

A place where you can get answers, challenge yourself and others, and share your knowledge.
Tap into the knowledge and experience of over 100,000 community members and MathWorks employees.

| Ask and Answer | Get & Share Code | Read and Learn | Play | Explore IoT Data |

CONTRIBUTORS	ANSWERS PER DAY	DOWNLOADS PER DAY	SOLVERS PER DAY
525,000	120	25,000	730

MATLAB Central

Summary and Benefits

- **INTEGRATION:** Single software for entire workflow

- **AUTOMATION:** Speed up repetitive tasks and generate code

- **INFORMATION:** MATLAB Central on MathWorks website, as well as online and classroom training is available

Upcoming Agenda

- **14:00-15:00**
  - Intro to Simulink and Stateflow
  - Software Development Practises with MATLAB

- **15:45-17:00**
  - Predictive Maintenance with MATLAB

	Technical Computing	Model-Based Design	Getting Started with MATLAB and Simulink	Master Classes	Innovation Auditorium
11:15	Brushing Off Old Data: Gleaning Insights from Manufacturing Process Data *Robert Sochon, GlaxoSmithKline Consumer Healthcare*	What's New in Simulink R2019a and R2019b *Jonathan Agg, MathWorks*	Introduction to MATLAB *Laura Dempsey, MathWorks*	AI Techniques in MATLAB for Signal, Time-Series, and Text Data *Sylvain Lacaze, MathWorks*	Preparing Future Engineers and Scientists for the Challenges of Digital Transformation *Martina Sciola, MathWorks*
11:45	Deep Learning and Reinforcement Learning Workflows in AI *Jon Cherrie, MathWorks*	Controlling Complexity at McLaren Automotive Using the Latest MATLAB Features *Matthew Chave, McLaren Automotive Ltd*			
12:15	Extreme Quantum Mechanics in MATLAB *Ilya Kuprov, University of Southampton*	Systems Engineering: Requirements to Architecture to Simulation *Mark Walker, MathWorks*	Pixels to Features to Models: Object Detection and Image Segmentation *Matthew Elliott, MathWorks*	Deploying Deep Neural Networks to Embedded GPUs and CPUs *Steven Thomsett, MathWorks*	Developing a User Community to Drive Sharing, Self-Learning, and Personal Development *Matthew Offredi and Rayner Saggers, BAE Systems*
12:45	**Lunch**				
	Women in Tech Ignite Lunch *Janet Macmillan, MathWorks*				
	Networking and Exhibition Time				
14:00	Big Data, Big Transformation: Big Benefits for Large-Scale Engineering Products *Martin McDonald and Andrew Gorrie, Leonardo*	Simulating Passenger Comfort and Motion Sickness in Autonomous Vehicles *Michael Wheeldon, Ricardo*	Introduction to Simulink and Stateflow *Tim Johns, MathWorks*	Software Development Practices with MATLAB *David Sampson, MathWorks*	Developing a Battery Management System Using Simulink *Chris Lim, MathWorks*
14:30	Becoming a Data-Centric Engineering Team: Catching Up to the Data Deluge *Paul Peeling, MathWorks*	Automated Driving System Design and Simulation Using MATLAB and Simulink *GianCarlo Pacitti, MathWorks*			Accelerating Embedded Software Verification with Polyspace Static Code Analysis *Stefan David, MathWorks*
15:15	**Break**				
15:45	Developing Smart IoT Sensors Using the MathWorks Toolchain *Samuel Bailey, Skyrad Consulting*	Synchronous Machine Modelling Using Simscape *Peenki Rani, Cummins Generator Technologies*	Sensor Fusion and Tracking for Autonomous Systems *Marc Willerton, MathWorks*	Simplifying Requirements-Based Verification with Model-Based Design *Fraser Macmillen, MathWorks*	Predictive Maintenance with MATLAB *Phil Rottier, MathWorks*
16:15	Industrial IoT and Digital Twins *Coorous Mohtadi, MathWorks*	Developing Fit-For-Purpose Simscape Models to Support System and Control Design *Rick Hyde, MathWorks*			
17:00	**End of Day**				