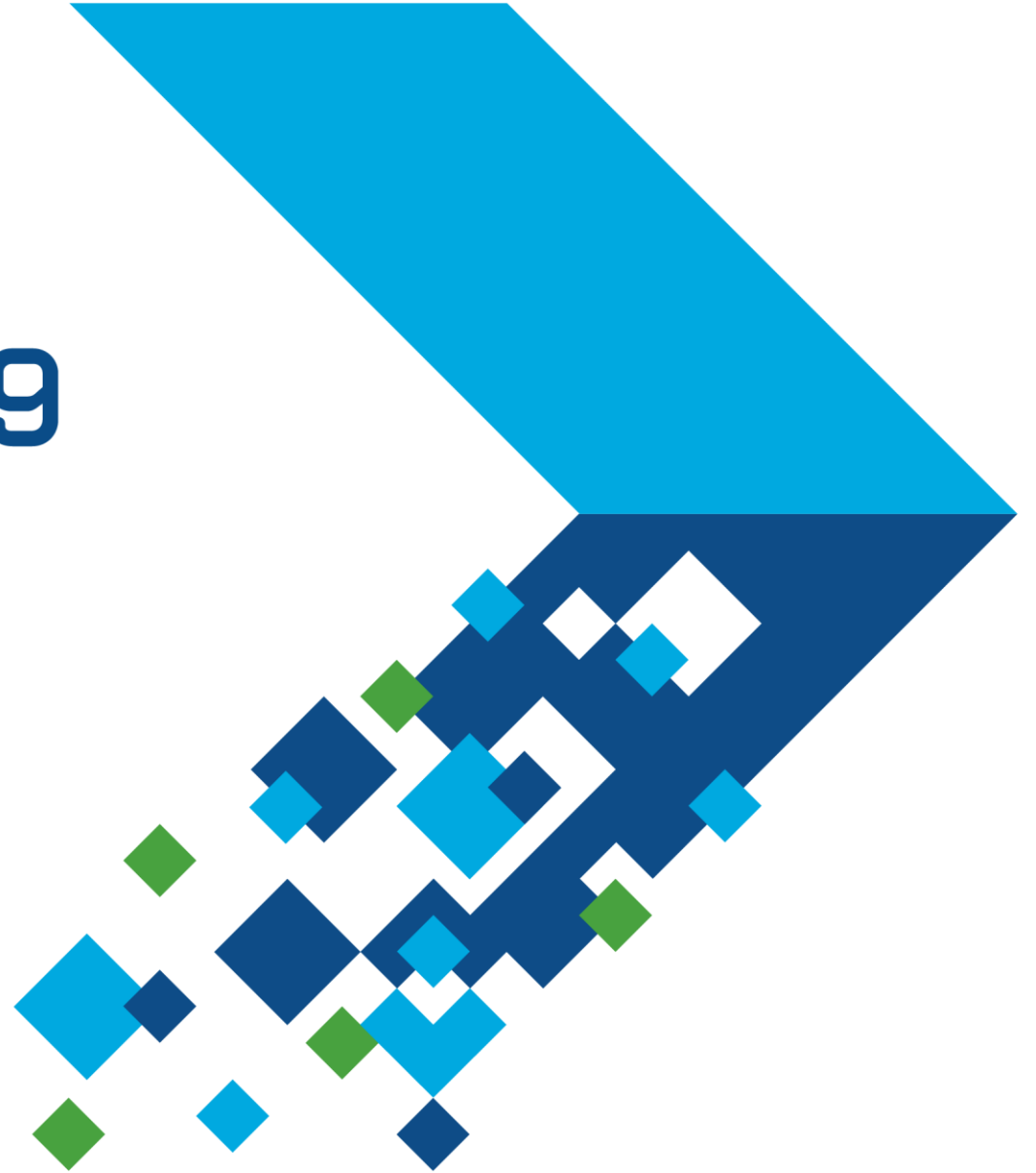


MATLAB EXPO 2019

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

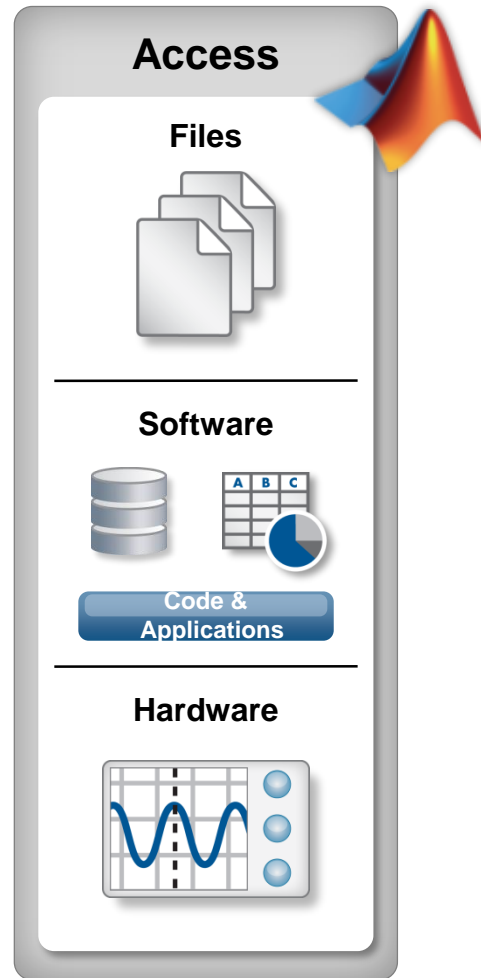
- **INTEGRATION:** MATLAB can be used at all stages of your work.
- **AUTOMATION:** Save time and avoid repetition.
- **INFORMATION:** Many resources available to help you to learn basic and advanced MATLAB concepts.

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



Text files, spreadsheets



Images, Video and Audio



From the web, JSON, HTTP Messaging



Database or Datafeed

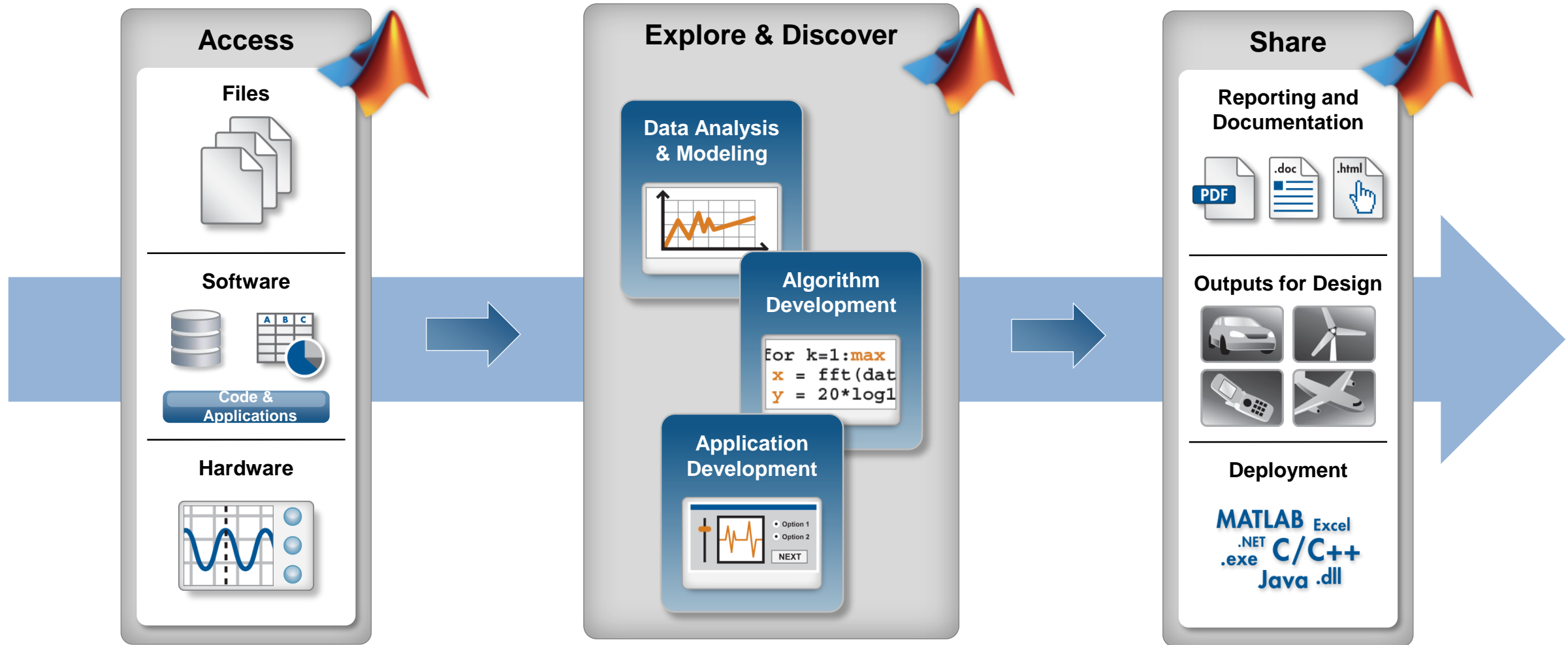


Devices



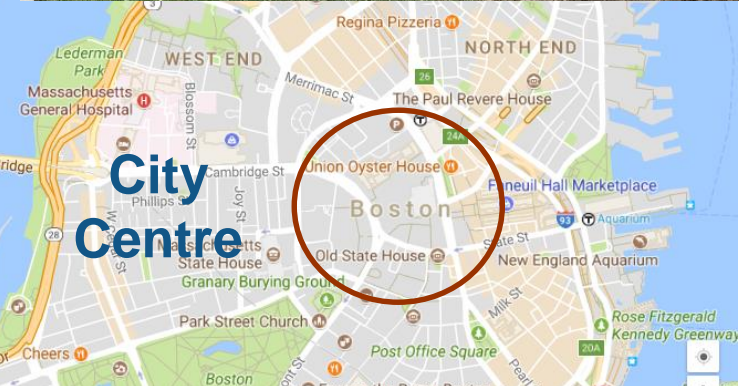
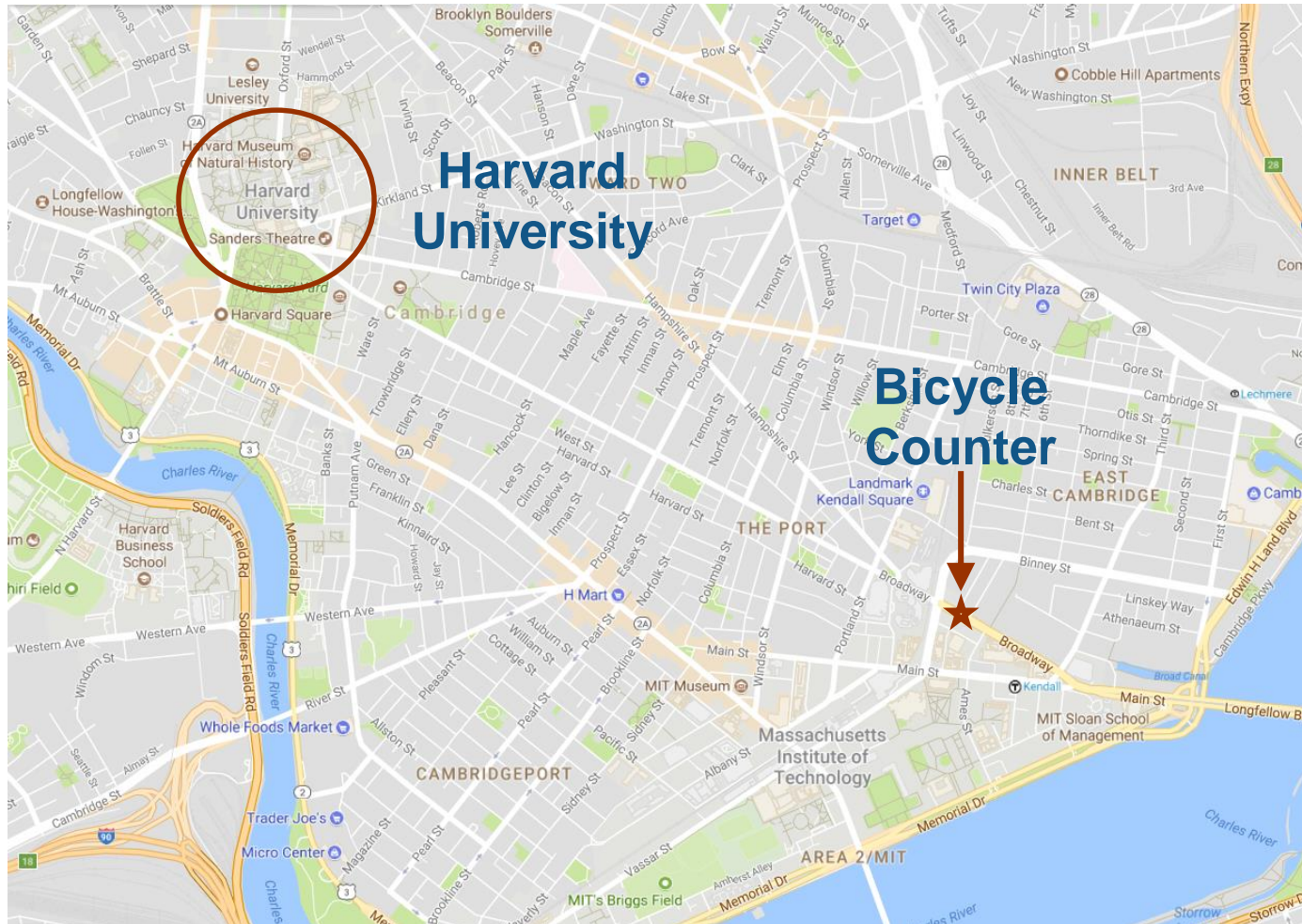
Out of Memory Data

Technical Computing Workflow



Automate

Example: Bicycle Traffic Analysis

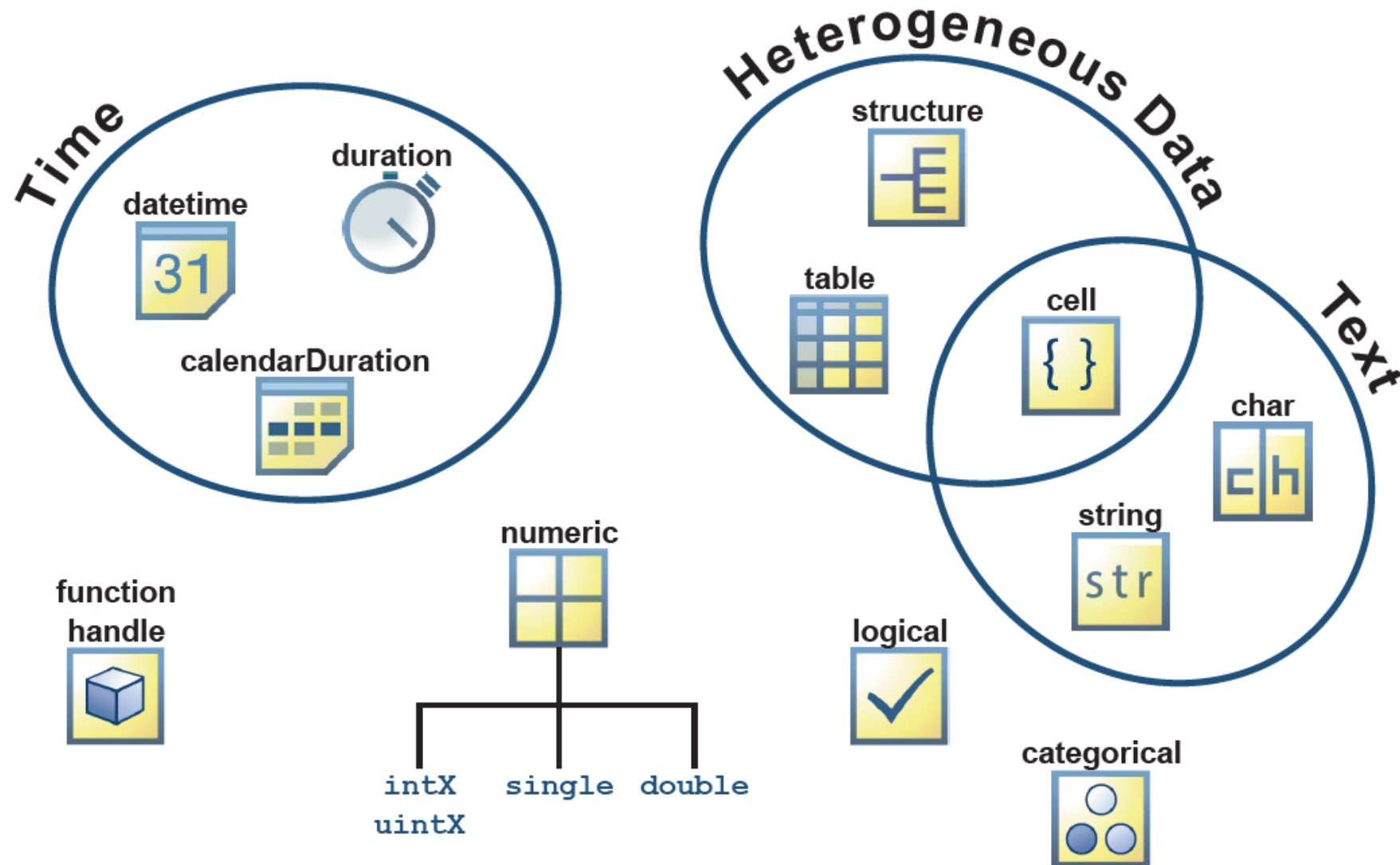


Example: Bicycle Traffic Analysis

- 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

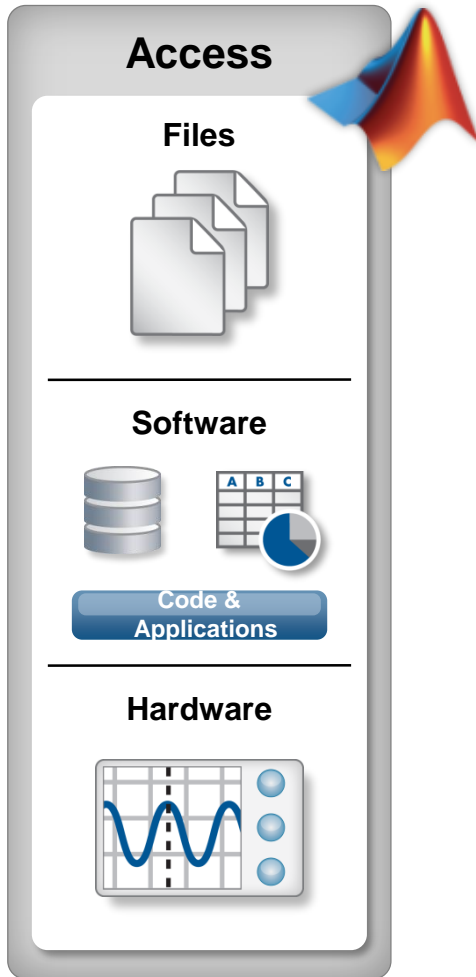
Timestamp					
	A	B	C	D	E
1	Timestamp	Day	Westbound	Eastbound	Total
38	01/01/2017 09:00	Sunday	0	1	1
39	01/01/2017 09:15	Sunday	0	1	1
40	01/01/2017 09:30	Sunday	0	1	1
41	01/01/2017 09:45	Sunday	0	0	0
42	01/01/2017 10:00	Sunday	1	1	2
43	01/01/2017 10:15	Sunday	0	1	1
44	01/01/2017 10:30	Sunday	0	2	2
45	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
53	01/01/2017 12:45	Sunday	0	1	1

Fundamental Data Types



Importing Data: Interactive or Generate Code

- Interactively import data with the Import Tool:



IMPORT VIEW

Delimited Column delimiters: Comma Range: A2:E18337 Output Type: Table Replace unimportable cells with NaN

Fixed Width Delimiter Opt... Variable Names Row: 1

DELIMITERS SELECTION IMPORTED DATA UNIMPORTABLE CELLS

BicycleCounts2017.csv BicycleCounts2015.csv

bikeData

	Timestamp	Day	Total	Westbound	Eastbound
	Datetime	Categorical	Number	Number	Number
1	Timestamp	Day	Total	Westbound	Eastbound
2	24/06/2015 00:00:00	Wednesday	4	1	3
3	24/06/2015 00:15:00	Wednesday	3	3	0
4	24/06/2015 00:30:00	Wednesday	4	3	1
5	24/06/2015 00:45:00	Wednesday	2	2	0
6	24/06/2015 01:00:00	Wednesday	2	2	0
7	24/06/2015 01:15:00	Wednesday	0	0	0
8	24/06/2015 01:30:00	Wednesday	0	0	0
9	24/06/2015 01:45:00	Wednesday	1	1	0
10	24/06/2015 02:00:00	Wednesday	1	1	0
11	24/06/2015 02:15:00	Wednesday	0	0	0
12	24/06/2015 02:30:00	Wednesday	0	0	0
13	24/06/2015 02:45:00	Wednesday	0	0	0
14	24/06/2015 03:00:00	Wednesday	1	1	0
15	24/06/2015 03:15:00	Wednesday	0	0	0
16	24/06/2015 03:30:00	Wednesday	0	0	0
17	24/06/2015 03:45:00	Wednesday	0	0	0
18	24/06/2015 04:00:00	Wednesday	0	0	0
19	24/06/2015 04:15:00	Wednesday	1	1	0
20	24/06/2015 04:30:00	Wednesday	0	0	0
21	24/06/2015 04:45:00	Wednesday	0	0	0

Import Selection

Import Data

Generate Script

Generate Function

Compare with Weather Data



Home Climate Information Data Access Customer Support Contact About Search

Home > Climate Data Online > Data Tools > Find a Station

Datasets Search Tool Mapping Tool Data Tools Help

Data Tools: Find a Station

Retrieve weather records from observing stations by entering the desired location, data set, data range, and data category. Location can be specified as city, county, state, country, or ZIP code.

Enter Location

Boston, MA, United States

Select Dataset

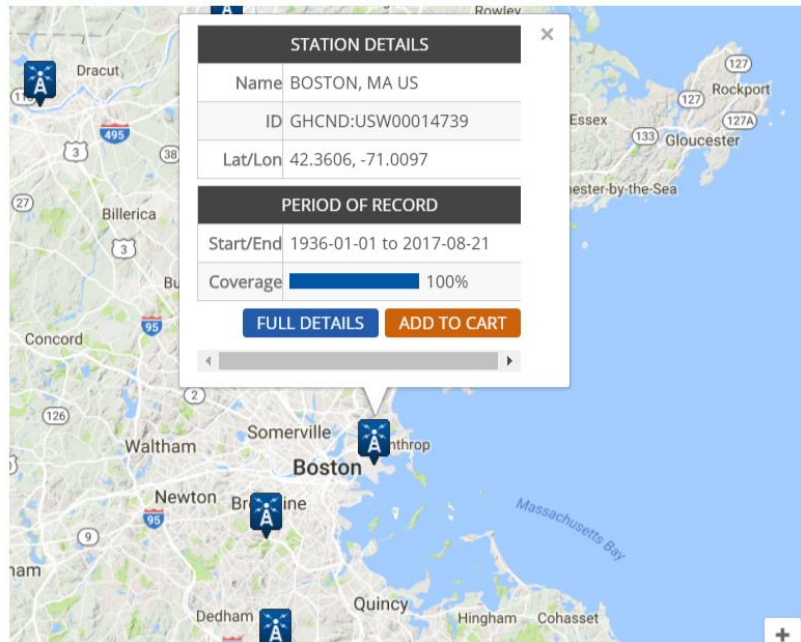
Daily Summaries

Select Date Range

2017-08-21

Data Categories

- ☐ Air Temperature
- ☐ Evaporation
- ☐ Land
- ☐ Precipitation



- 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	11.10	0	15	20	11	

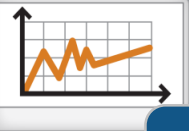
- Same time period as bicycle traffic data.
- We have data for:
 - Average wind speed (MPH)
 - Precipitation (inches per day)
 - Average daily temperature (°F)
 - Maximum daily temperature (°F)
 - Minimum daily temperature (°F)

Are bicycle counts related to the weather?

- Live Editor allows for quick and easy exploration of data

Explore & Discover

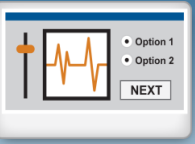
Data Analysis & Modeling



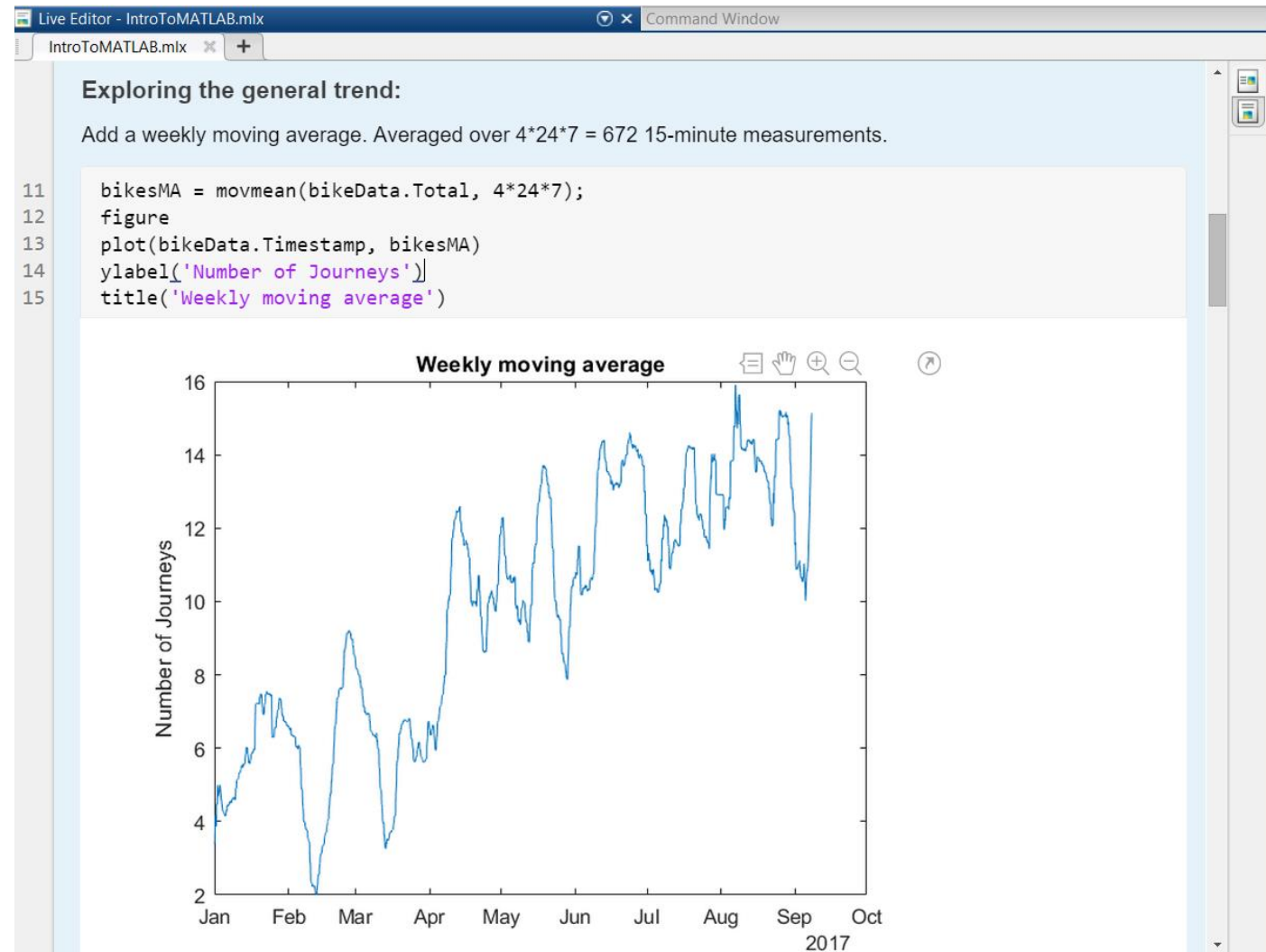
Algorithm Development

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

Application Development



Option 1
Option 2
NEXT



Sharing Code and Applications

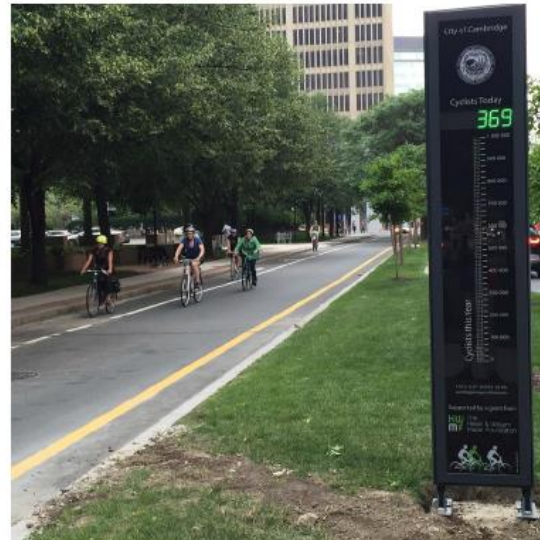
- Export script as DOCX/PDF/HTML/LaTeX



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.

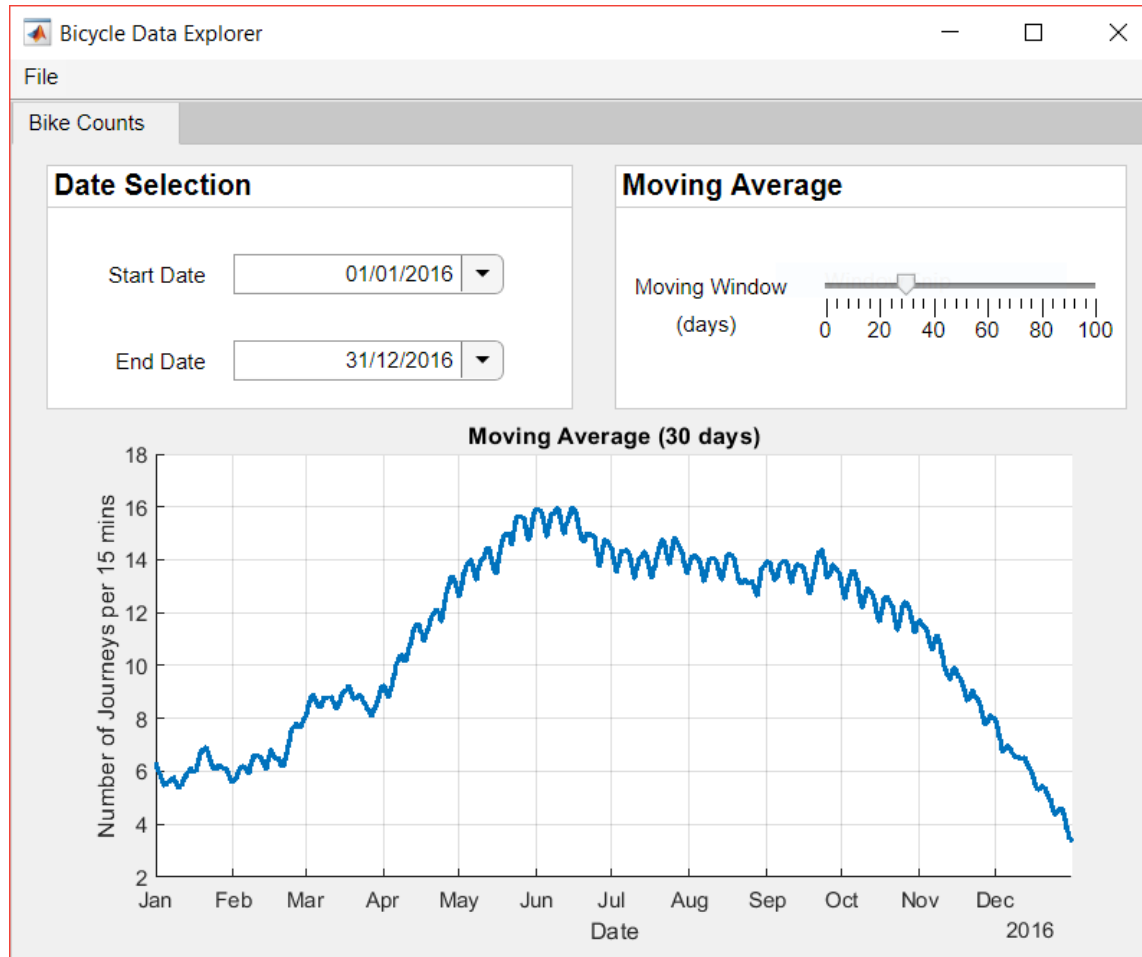


Importing Data

Data can be imported interactively using the Import Tool.

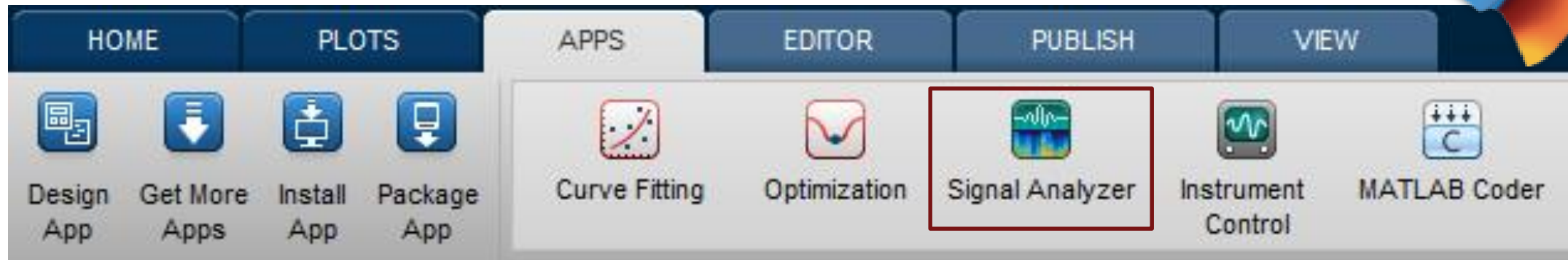
Sharing Code and Applications

- 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 Onramp 15% complete **>> MATLAB academy**

Chapter 9.1 Plotting Vectors

Practice
Complete the tasks below.

Task 1

Info: Two vectors of the same length can be plotted against each other using the `plot` function.

```
>> plot(x,y)
```

Try creating a plot with `sample` on the x-axis and `mass1` on the y-axis.

[Hint](#) [Get solution](#)

Task 2
Task 3
Task 4
Task 5
Task 6
Task 7
Task 8
Further practice

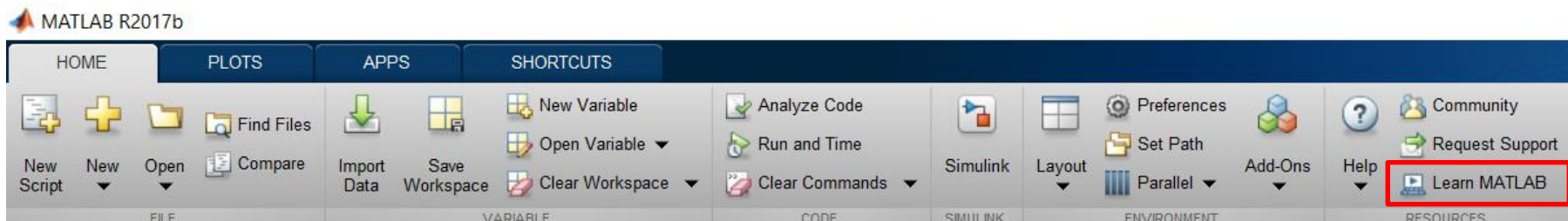
```
>> load datafile
>> sample = data(:,1);
>> density = data(:,2);
>> v1 = data(:,3);
>> v2 = data(:,4);
>> mass1 = density.*v1;
>> mass2 = density.*v2;
```

Task 1 ✓
`>> plot(sample,mass1,'*-.')`

Correct!

Press [Space](#) to continue, or [Esc](#) to try an alternative solution.

Figure 1



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 Courses Search MathWorks.com

Get Started

MATLAB Onramp
Get started quickly with the basics of MATLAB.
[Launch](#) [Details](#)

Deep Learning Onramp
Get started quickly using deep learning methods to perform image recognition.
[Launch](#) [Details](#)

Core MATLAB Functionality

MATLAB Fundamentals
Learn core MATLAB functionality for data analysis, modeling, and programming.
[Launch](#) [Details](#)

MATLAB Programming Techniques
Improve the robustness, flexibility, and efficiency of your MATLAB code.
[Launch](#) [Details](#)

MATLAB for Financial Applications
Learn MATLAB for financial data analysis and modeling.
[Launch](#) [Details](#)

MATLAB for Robotics
Create automated systems for robotics.
[Launch](#) [Details](#)

Prefer the classroom?
Check out our instructor-led courses, offered both in the classroom and live, online.
[Choose the course that's right for 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

525,000

ANSWERS PER DAY

120

DOWNLOADS PER DAY

25,000

SOLVERS PER DAY

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