

How can we make sense of the unseen world: Using AI, Sensors, and IoT for scene exploration.



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Logistics and Setup Information

Logistics Overview



Use a laptop first for setup and then use a mobile device for the exercises

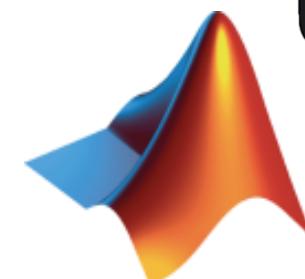
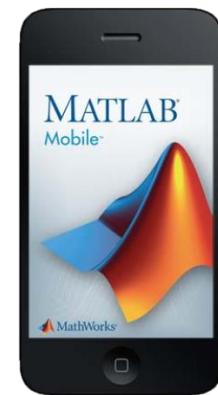


Follow the instructions in the pre-work step by step



If you have questions, please ask them in the chat.

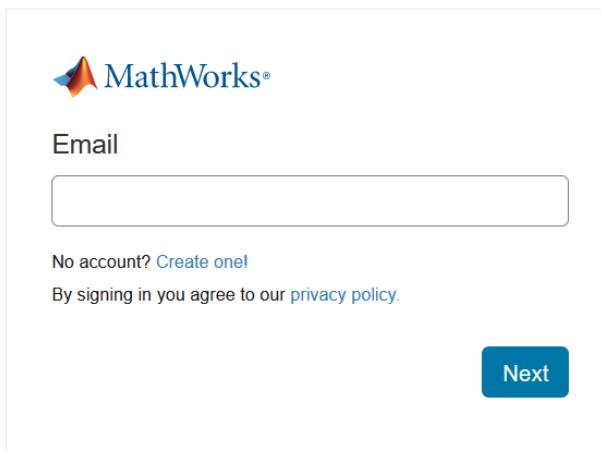
The exercises will be done using MATLAB Mobile.



Getting Access to MATLAB Online

1. Create a MathWorks Account
2. Access the license for this workshop

Sign in to your MathWorks Account or create a new one.



The image shows a sign-in form for MathWorks. It features the MathWorks logo at the top left. Below it is a text input field labeled "Email". Underneath the input field is a link "No account? [Create one!](#)". Below that is a smaller note "By signing in you agree to our [privacy policy](#)". At the bottom right of the form is a blue "Next" button.



The image shows a screenshot of the MathWorks website's MATLAB & Simulink section. At the top, there is a navigation bar with links for Products, Solutions, Academia, Support, Community, and Events. Below the navigation bar is a blue header bar with the text "MATLAB & Simulink". The main content area has a heading "Access MATLAB for your Hands-On Workshop". Below the heading is a paragraph of text explaining the purpose of the license. To the right of the text is a table containing workshop details. At the bottom of the table is a blue "Access MATLAB Online" button.

Access MATLAB for your Hands-On Workshop

MathWorks is pleased to provide a special license to you as a course participant to use for your Hands-On Workshop. This is a limited license for the duration of your course and is intended to be used only for course work and not for government, research, commercial, or other organization use.

Course Name:	Make Sense of the Unseen World WiDS Conference Workshop 2022
Organization:	MathWorks
Starting:	22 Feb 2022
Ending:	23 Mar 2022

[Access MATLAB Online](#)

<https://tinyurl.com/mlometdetaiandiot>

Obtain Access to Workshop Files

<https://tinyurl.com/metdetaiandiotfiles>

The image shows a 'Sharing Preview' window for a folder named 'MetDetAlandIoTWorkshop'. The window includes a toolbar with 'Add to my Files', 'Share Link', and 'Download Shared Folder' buttons. Below the toolbar is a table listing files and folders:

Name	Size
helperFiles	
offline	
Ex1_CollectandVisualizeData.m	3 KB
Ex2_ThingSpeak_AlandIoT.m	3 KB

A context menu is open over the 'Add to my Files' button, highlighting the 'Copy Folder' option. The menu also contains 'Add Shortcut'.

Pre-Work and Other Resource Documents

<https://github.com/LWHMW/MetAlandalIoTWorkshop>



- *Pre-work
- *Handouts
- Mobile Devices
- Exercise Instructions
- Other Resources

Content and Exercises

Sensors, Artificial Intelligence (AI), and Internet of Things (IoT) will be used for this workshop



Sensors



AI

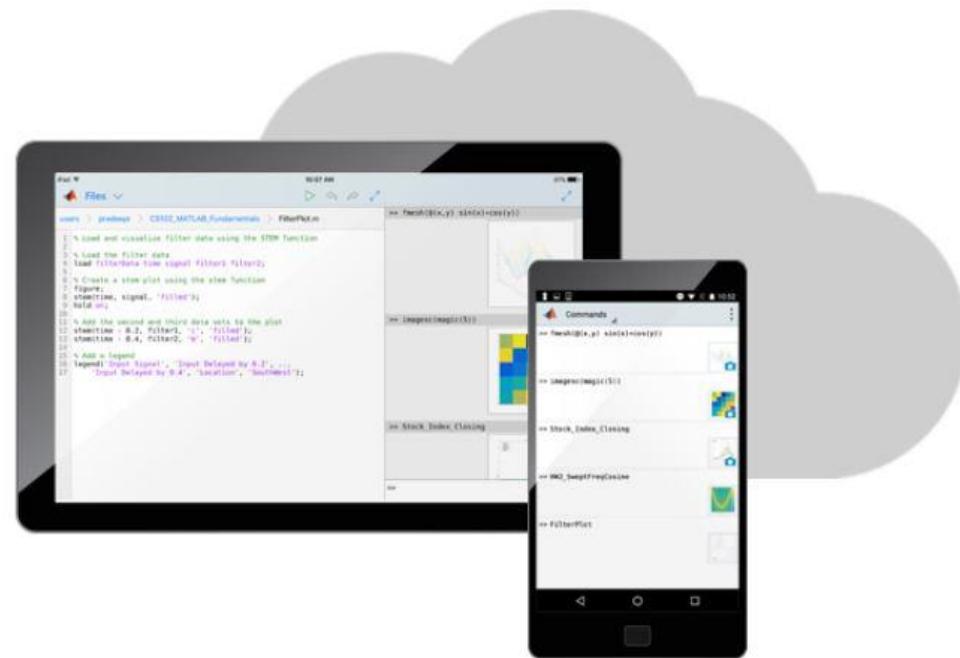


IoT

Collection, Analysis, and Visualization of Data will occur on a mobile device



Sensors



AI



IoT

Let's start with sensors



Sensors are everywhere!

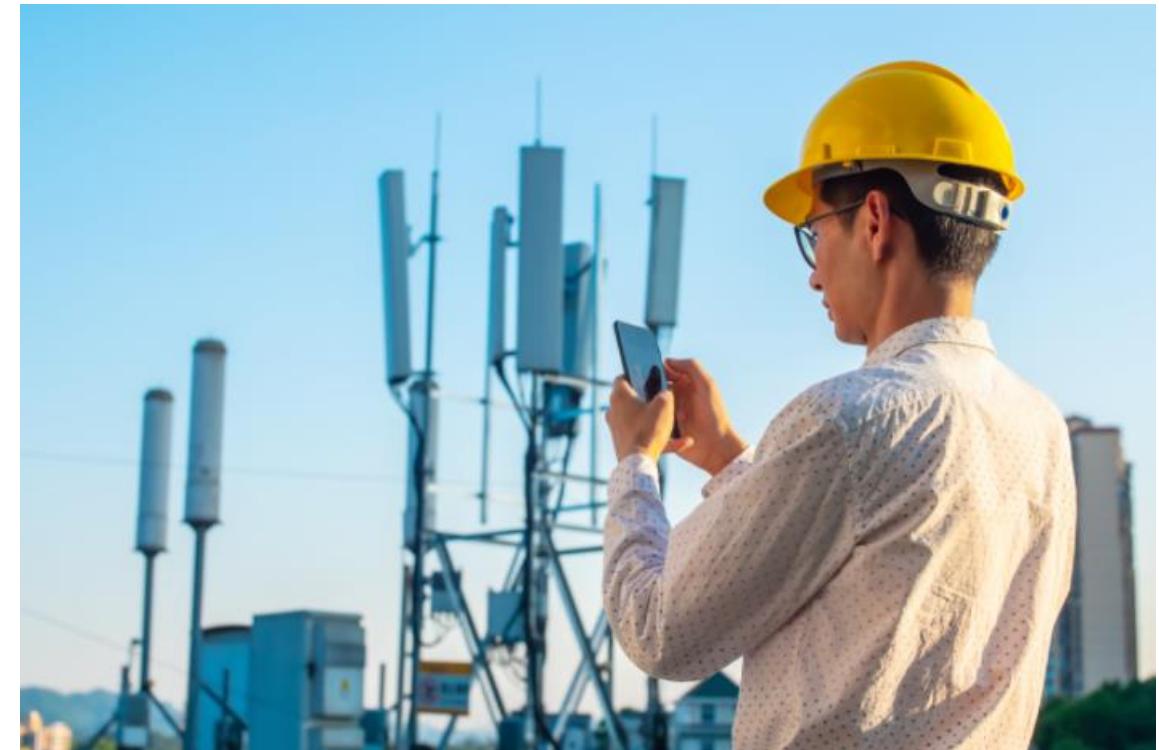


How can we take measurements about our world?

Remote Sensing

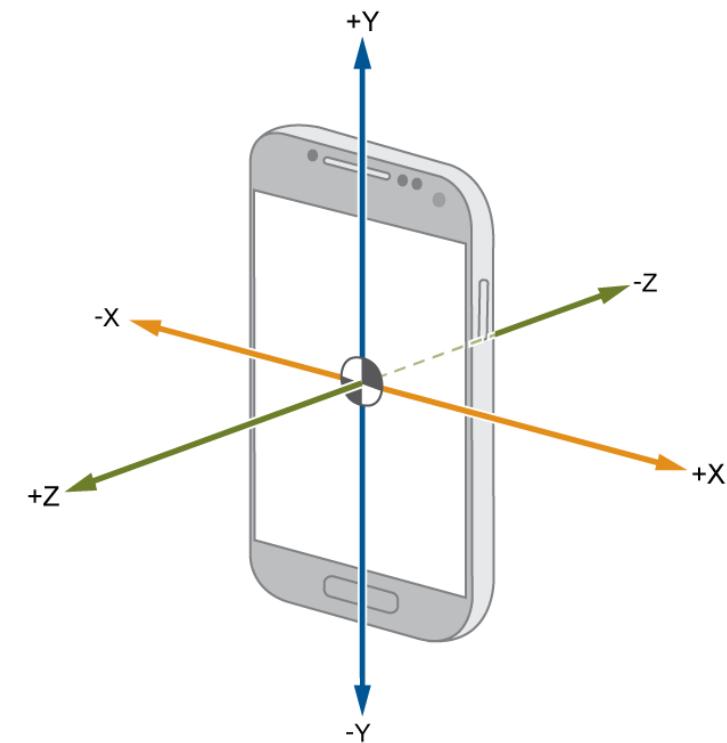


In-Situ

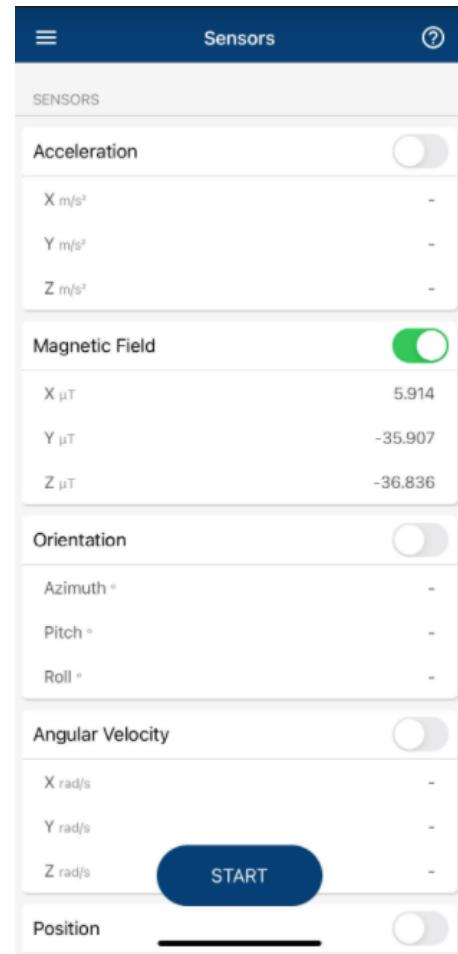
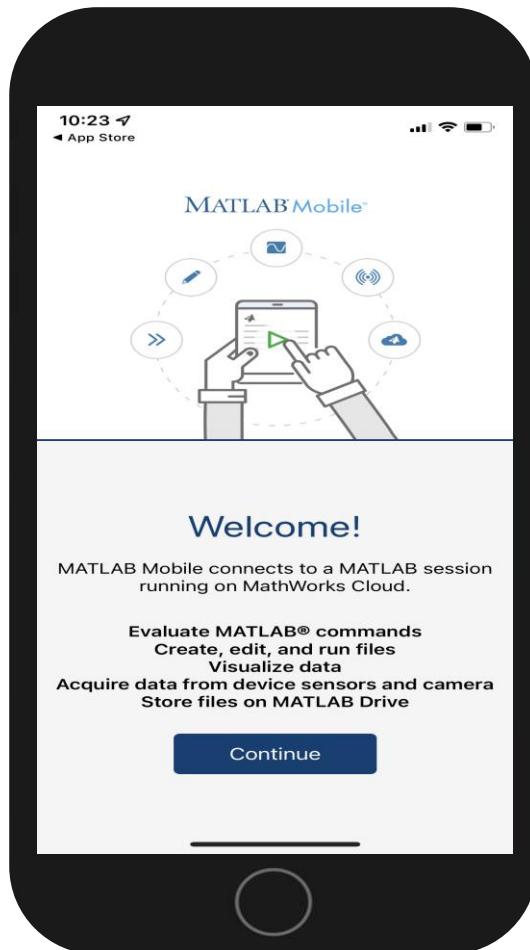


Magnetic field strength will be used to determine the presence of metal

The Magnetic Field sensor logs data in relation to the x, y, z axes.



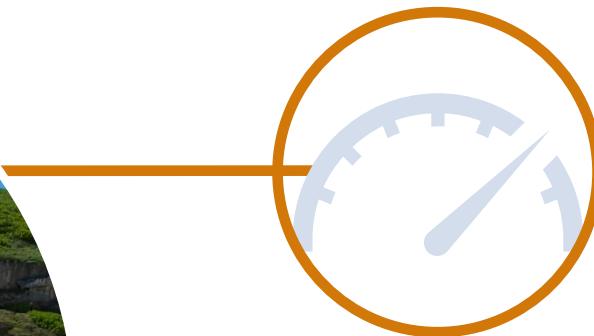
You will use MATLAB Mobile to record and analyze your magnetometer data



Android 8 or later

iOS 13 or later

You will use your phone's magnetometer and accelerometer to measure magnetic field strength and accelerometer data, respectively



Sensors

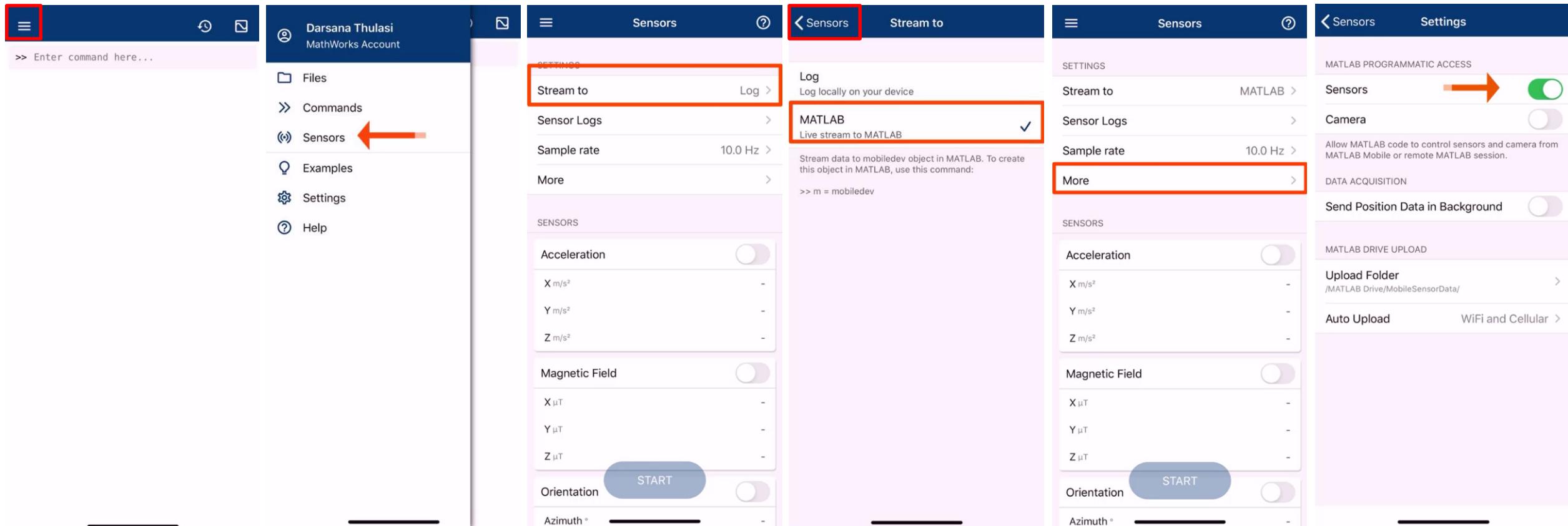
Exercise 1



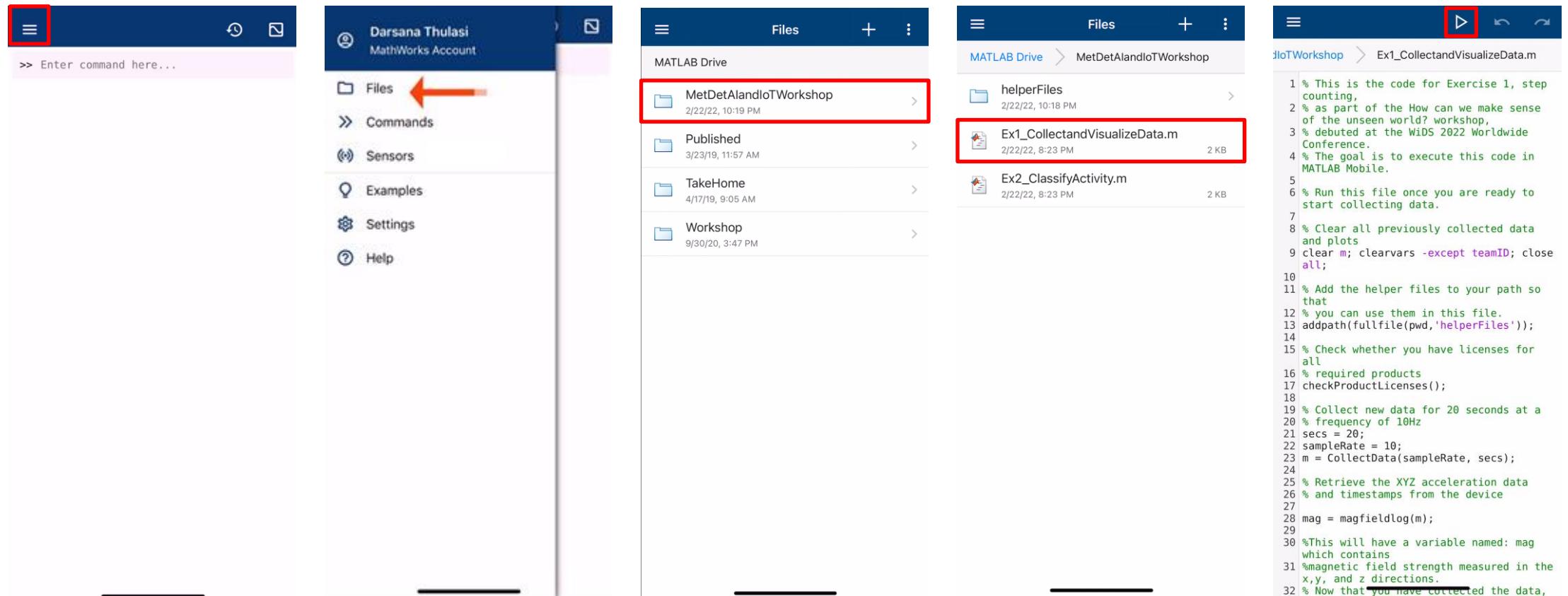
AI and IoT

Exercise 2

Enable the sensors in MATLAB Mobile



How to navigate and run code



Collect the magnetometer data as you walk



CollectData.m

```
% Use the mobiledev command to create an  
% object that links your mobile device.  
  
m = mobiledev;  
  
% Enable magnetic field sensor on the device.  
  
m.MagneticSensorEnabled = 1;
```



We will explore visualizations of, summary statistics, and cluster analysis of the data



Ex1_CollectandVisualizeData.m

```
% Determining how the values maybe clustered (or not)

[idx,cc]=kmeans(mag,eva.OptimalK);

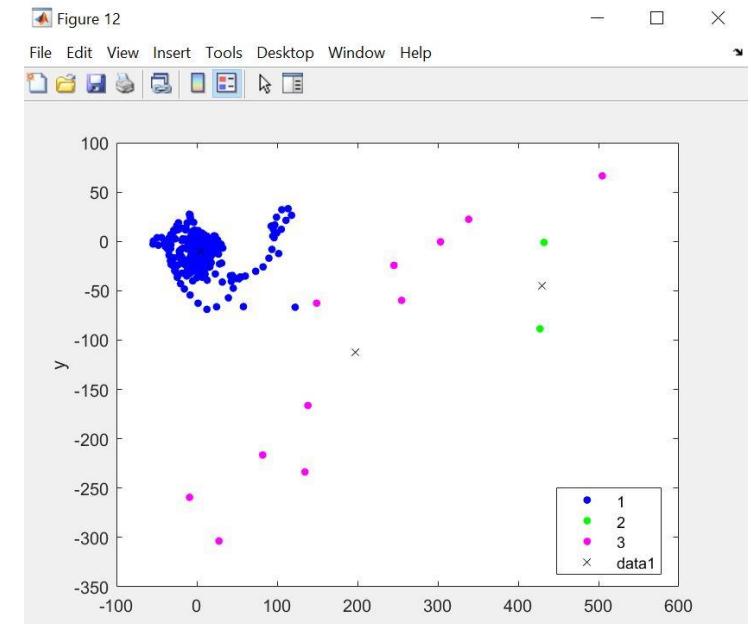
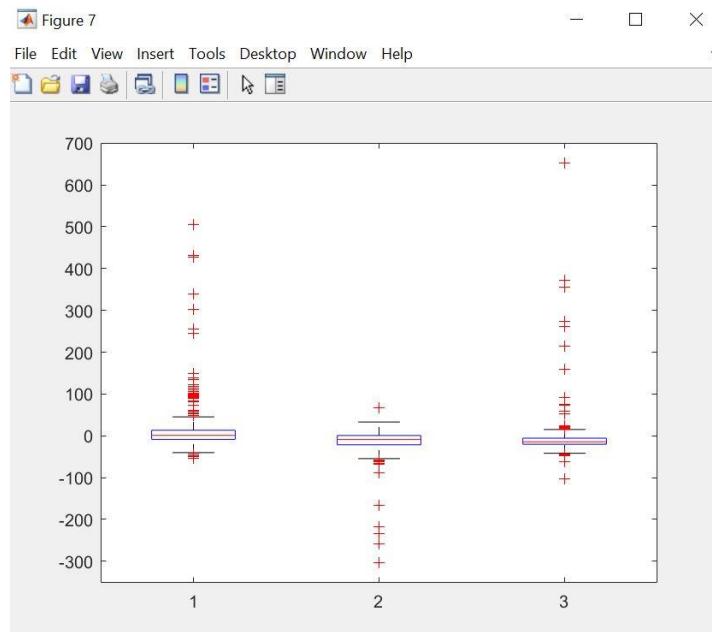
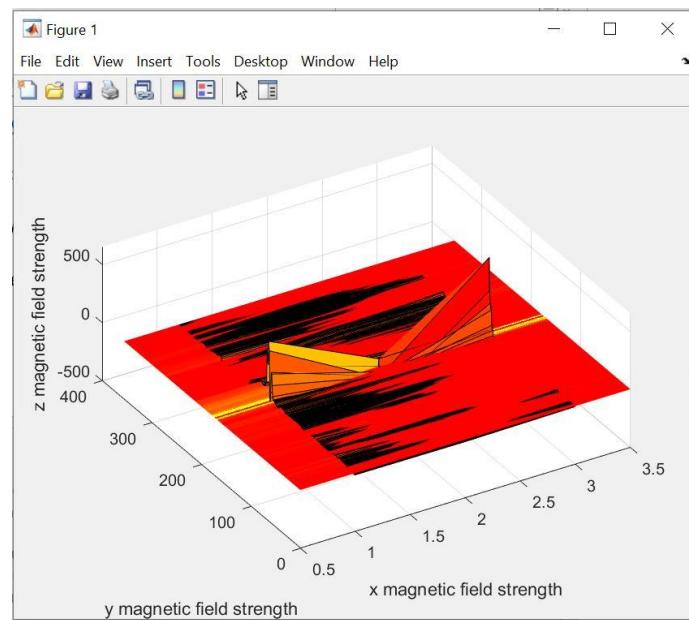
figure
gscatter(x,y,idx,[])
hold on
plot(cc(:,1),cc(:,2), 'kx')
title('Clusters of Magnetic Field Strength X and Y Values')
```

Exercise 1: Let's collect, visualize, and analyze statistics from the magnetometer data

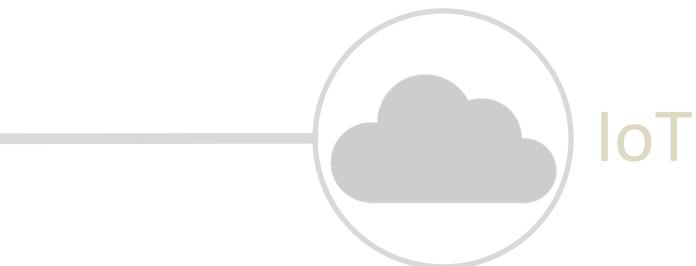
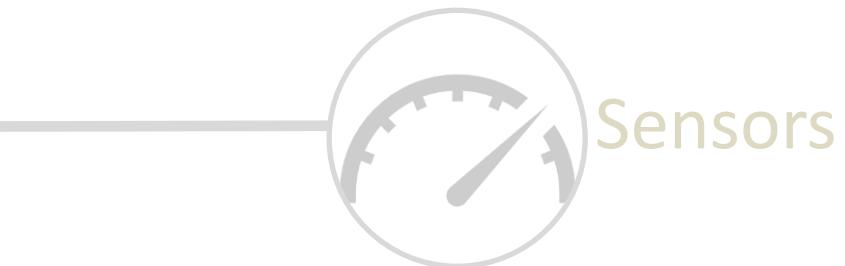
1. Open  `Ex1_CollectandVisualizeData.m` and press Run 
2. Wait for the prompt to start walking
3. WALK for 20 seconds
4. View the visualizations

If you have time, try again and review the code

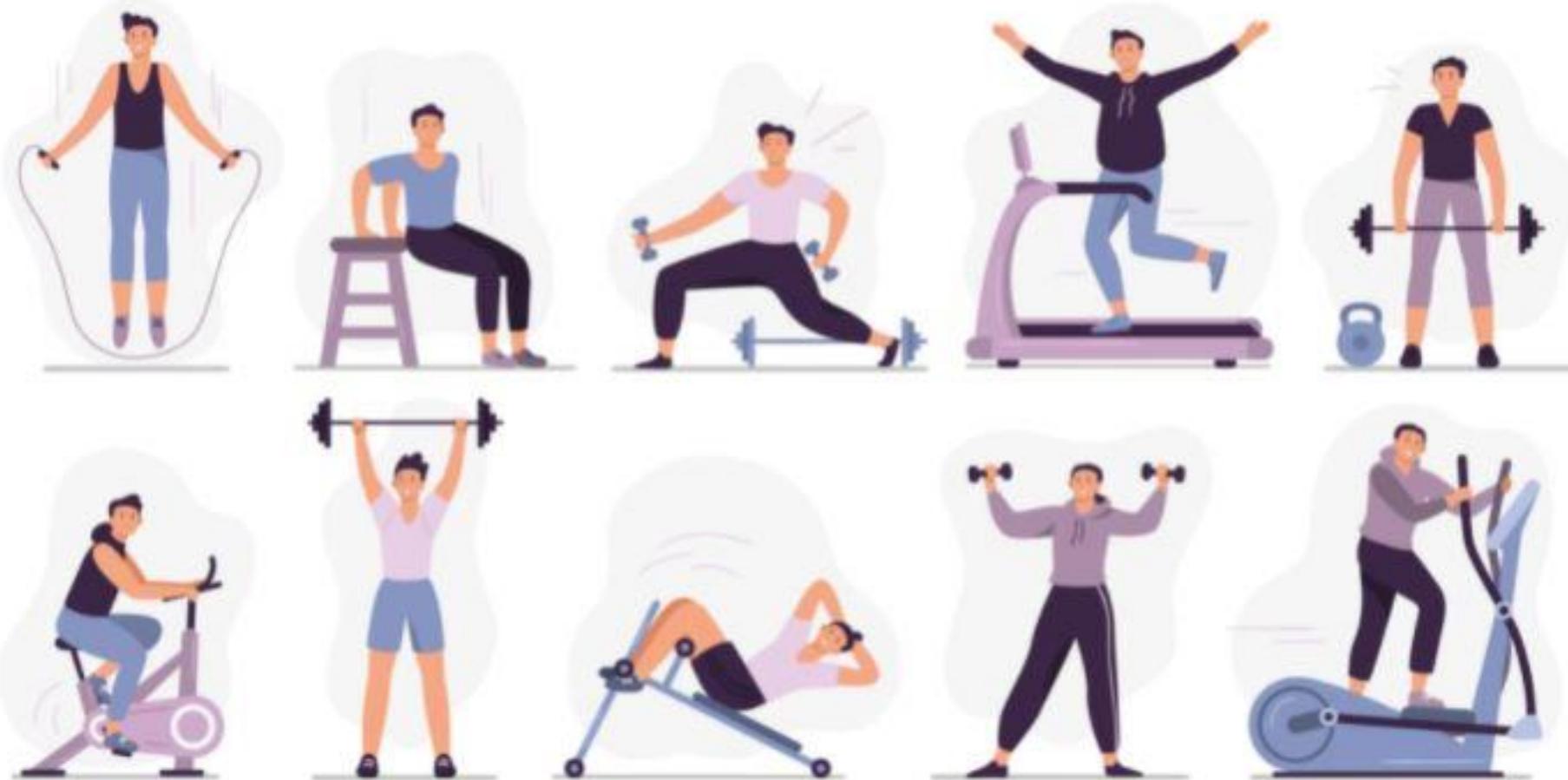
Did you get similar results for your output?



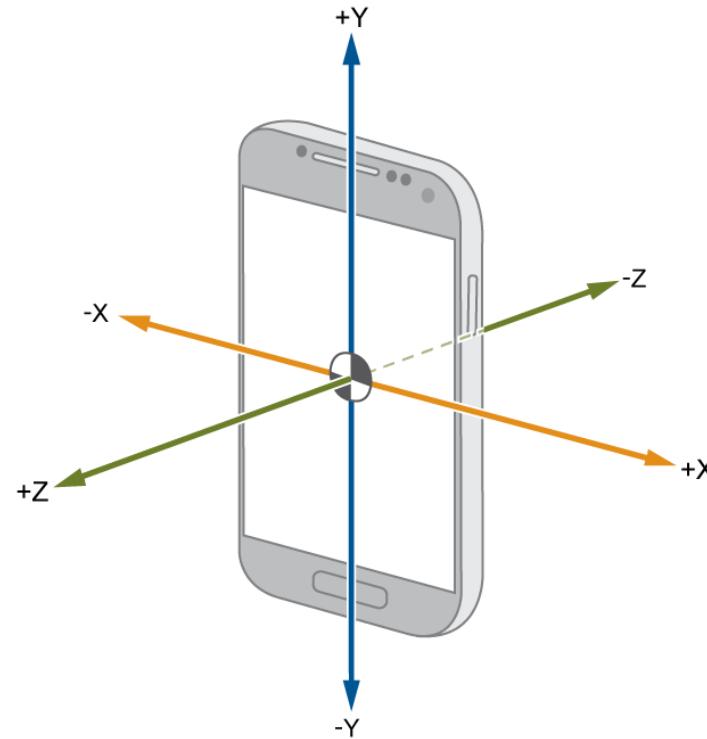
Now that you've collected data, can we explore what was occurring when the data was collected and how can this be analyzed?



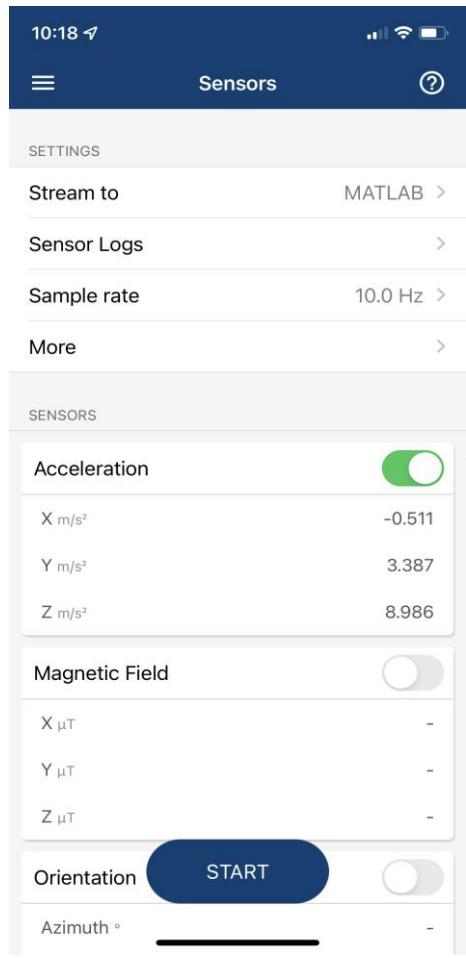
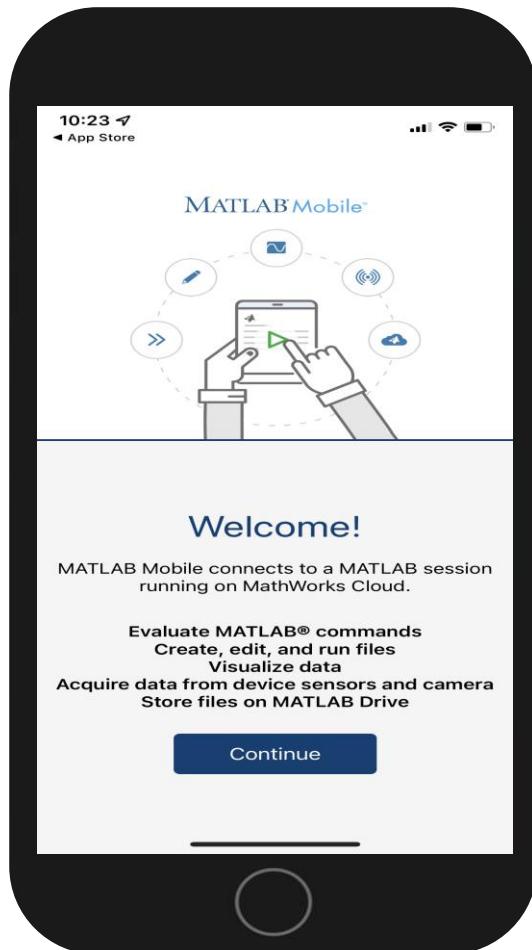
How can we determine what were you doing as the data was collected?



An accelerometer detects acceleration, vibration, and tilt



You will use MATLAB Mobile to record and analyze your accelerometer data



Accelerometer

Android 8 or later

iOS 13 or later

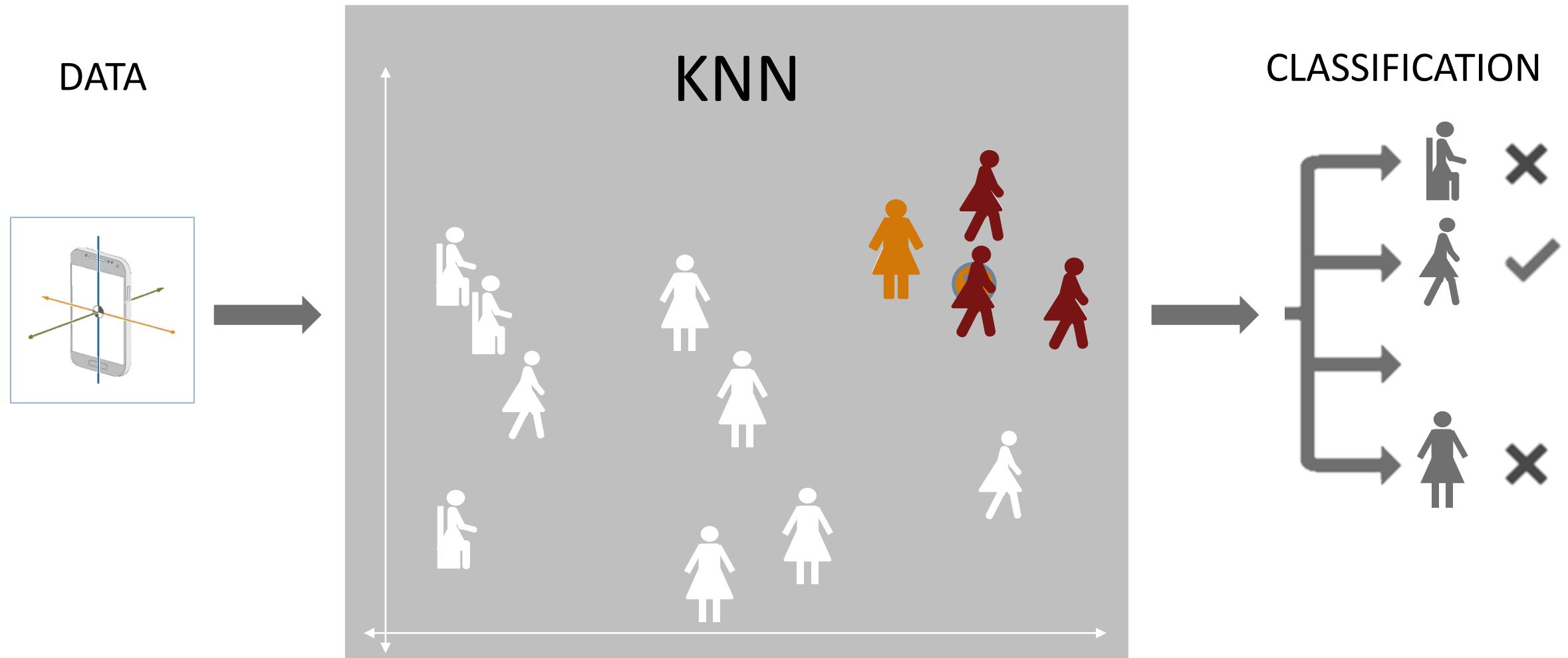
We will use Machine Learning to classify the accelerometer



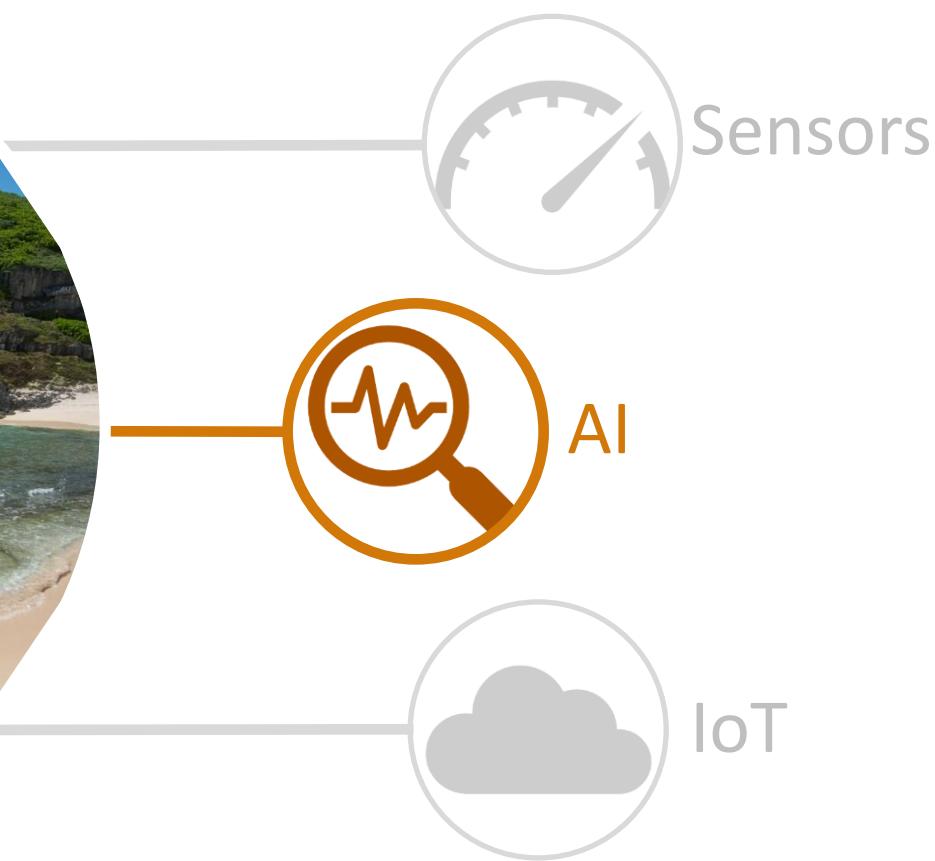
Artificial Intelligence

Machine Learning

The accelerometer data was classified using the KNN algorithm



We will use machine learning to classify your activity



We will use training data to build a k-nearest neighbors model for classification

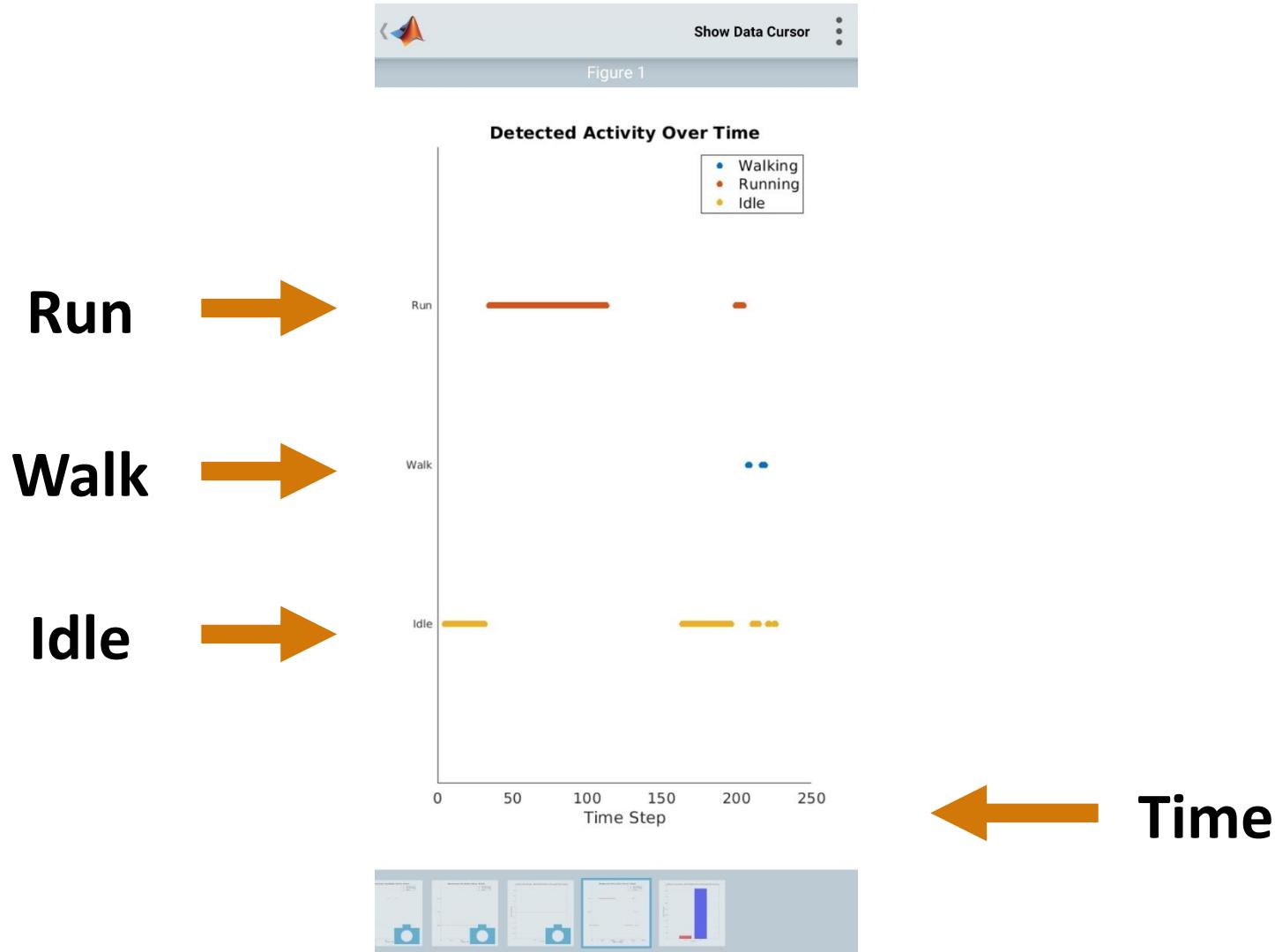


Ex2_ClassifyActivity.m

```
[X, Y, dataMin, dataRange] = getTrainingData();  
  
mdl = fitcknn(X, Y);  
knnK = 10; %num of nearest neighbors  
mdl.NumNeighbors = knnK;  
[frameActivity, frameScore] = ...  
    predict(mdl, frameFeatures);
```



Click on the plot to see a breakdown of your activities over time



Background information: Use machine learning to classify your activity

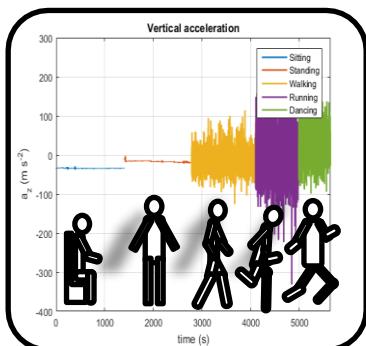
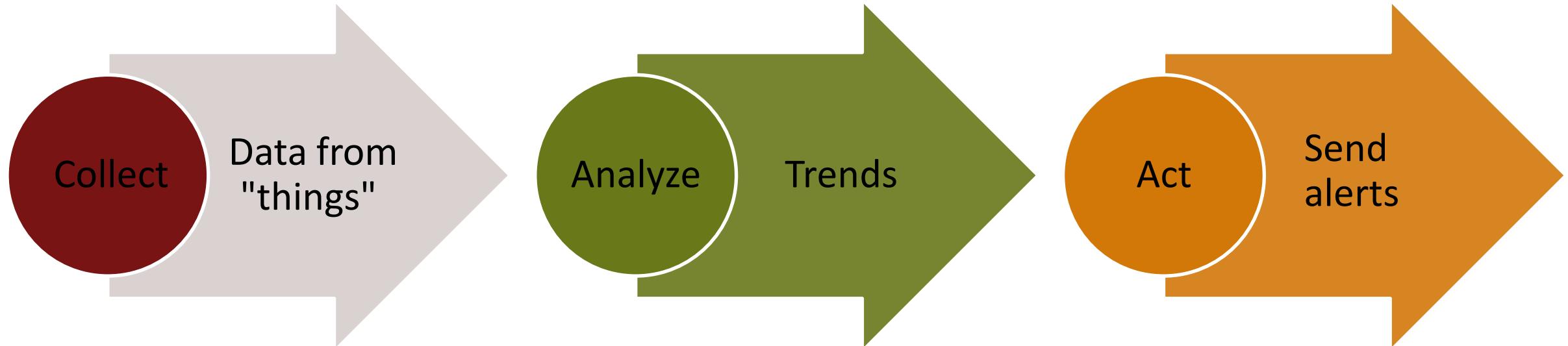
- The following file  `Ex2_ClassifyActivity.m` is executed as a part of the second exercise and below are the activities that occur in this file.
- A person does one of the activities for (Walk, Run, Idle) for 30 seconds
- After the 30 seconds then the person can view the breakdown of their activity

If you have time, try again and review the code

How can we aggregate our activity to the cloud?



Internet of Things (IoT) analyzes and acts on data from a network of devices

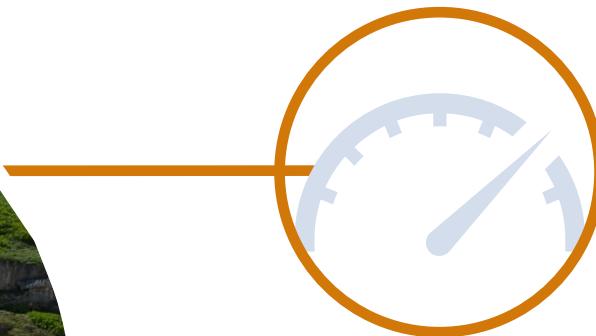


You will use an open IoT platform

The screenshot shows the ThingSpeak website homepage. At the top, there's a navigation bar with links for ThingSpeak™, Channels, Apps, Support, Commercial Use, How to Buy, Sign In, and Sign Up. The main header features the text "ThingSpeak for IoT Projects" and "Data collection in the cloud with advanced data analysis using MATLAB". Below this, there are two calls-to-action: "Get Started For Free" and "Learn More". A large image on the right shows a person holding a tablet displaying various IoT data visualizations, including line graphs and a heatmap. Below this main section, there are four smaller cards, each representing a different IoT application:

- ThingSpeak for Students and Educators**: Implement IoT research projects quickly with built-in MATLAB data analysis tools and real-time sensor data collection.
- ThingSpeak for Air Quality Monitoring**: Build IoT services for remote monitoring of air quality sensors, and create MATLAB models to predict pollution levels.
- ThingSpeak for Energy Monitoring**: Build IoT applications to monitor energy usage, and develop MATLAB models for power signature identification and load forecasting.
- ThingSpeak for Smart Farming**: Build applications for remote monitoring of sensors deployed on farms, and develop MATLAB models to increase crop yields and reduce costs.

You will use your phone's accelerometer data,
will be classified and sent to the cloud



Sensors
Exercise 1



AI and IoT
Exercise 2

Exercise 2: You will aggregate your team's activity time

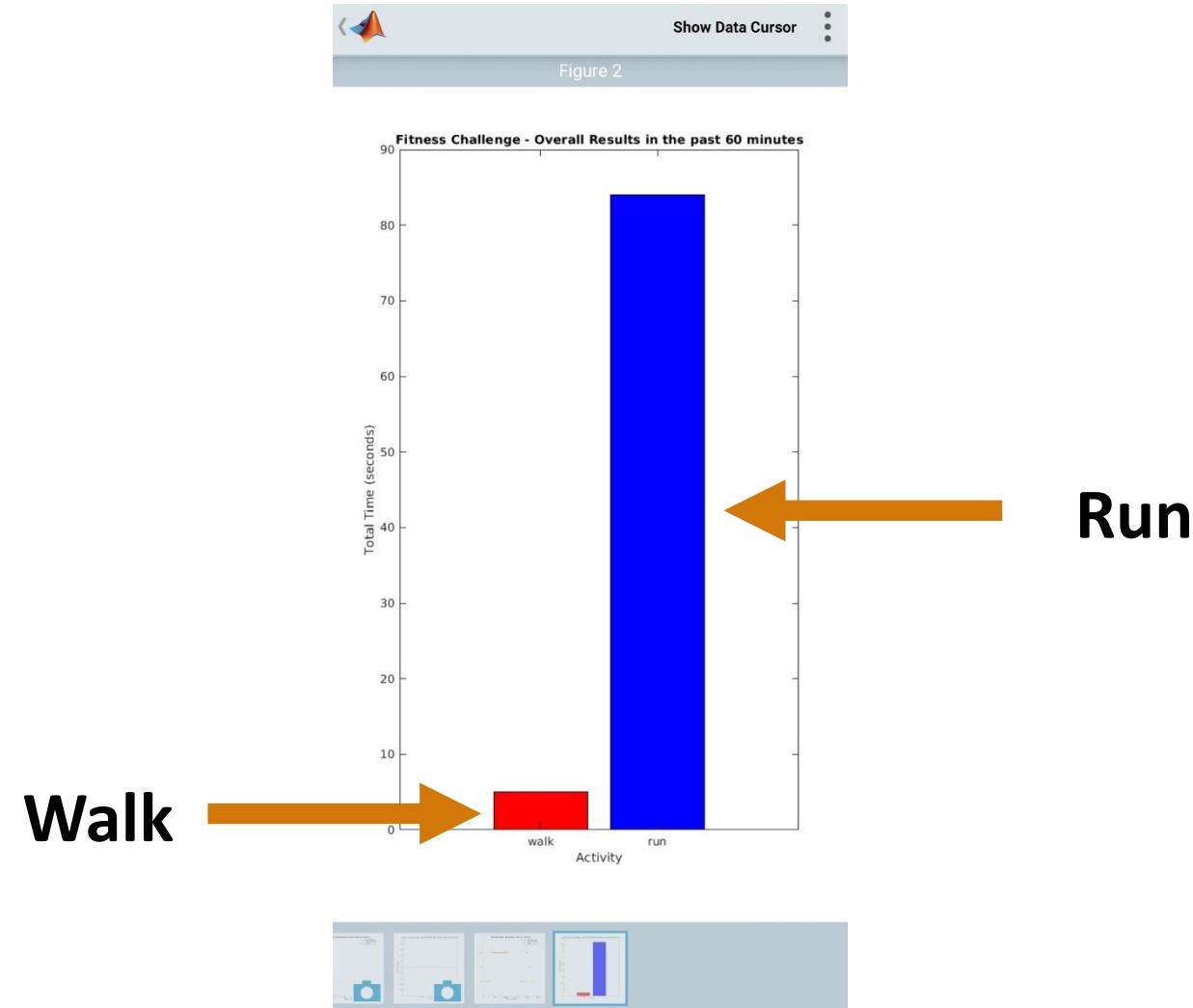


Ex2_ThingSpeak_AIandIoT.m

```
thingSpeakWrite(fitnessChallengeChannelID, ...
    {tWalkSum, tRunSum, tIdleSum, teamID}, ...
    'WriteKey',fitnessChallengeWriteAPIKey);
fitnessChallengeChannelID, ...
    'NumMinutes',numMins, ...
y = [ThisData.WalkData ThisData.RunData];
b = bar(sum(y,1), 'FaceColor', 'flat');
```



You can examine the figure to view everyone's combined time walking and running

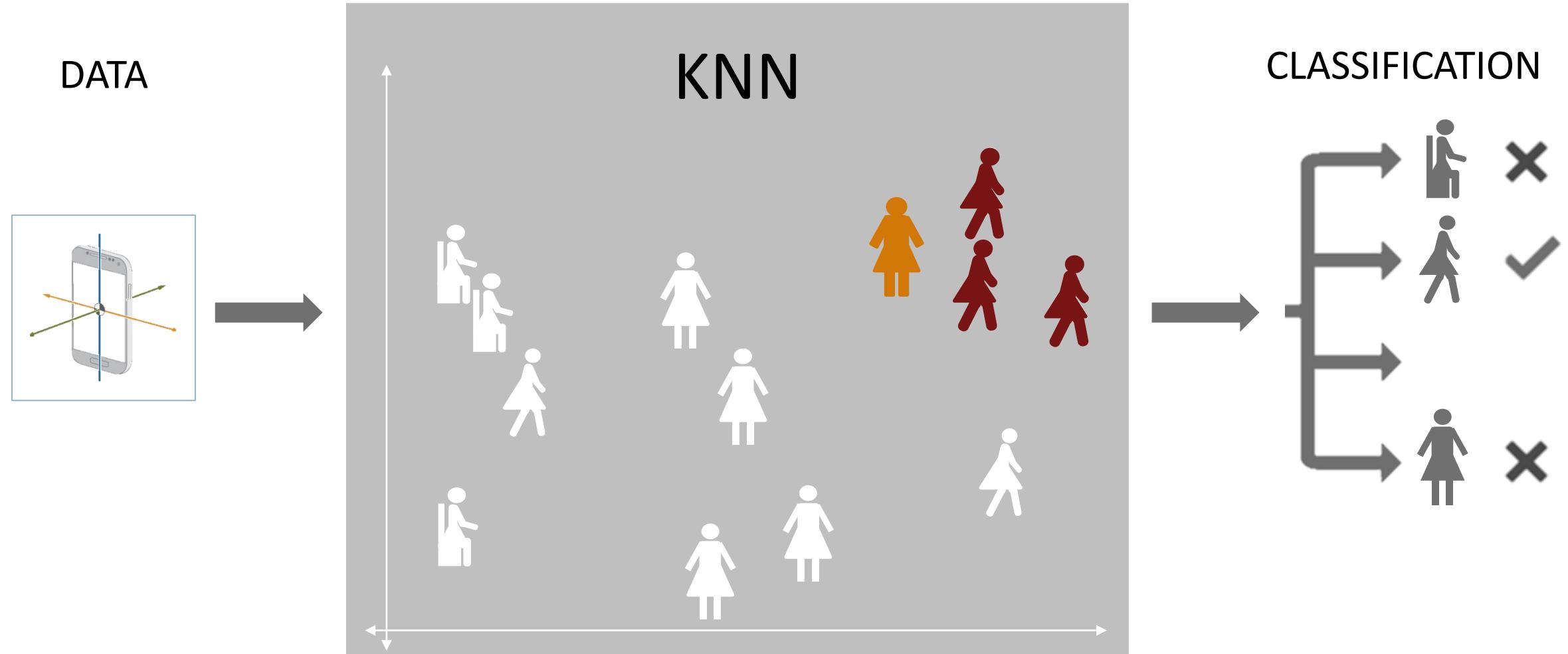


Exercise 2: Let's view yours and others total active time

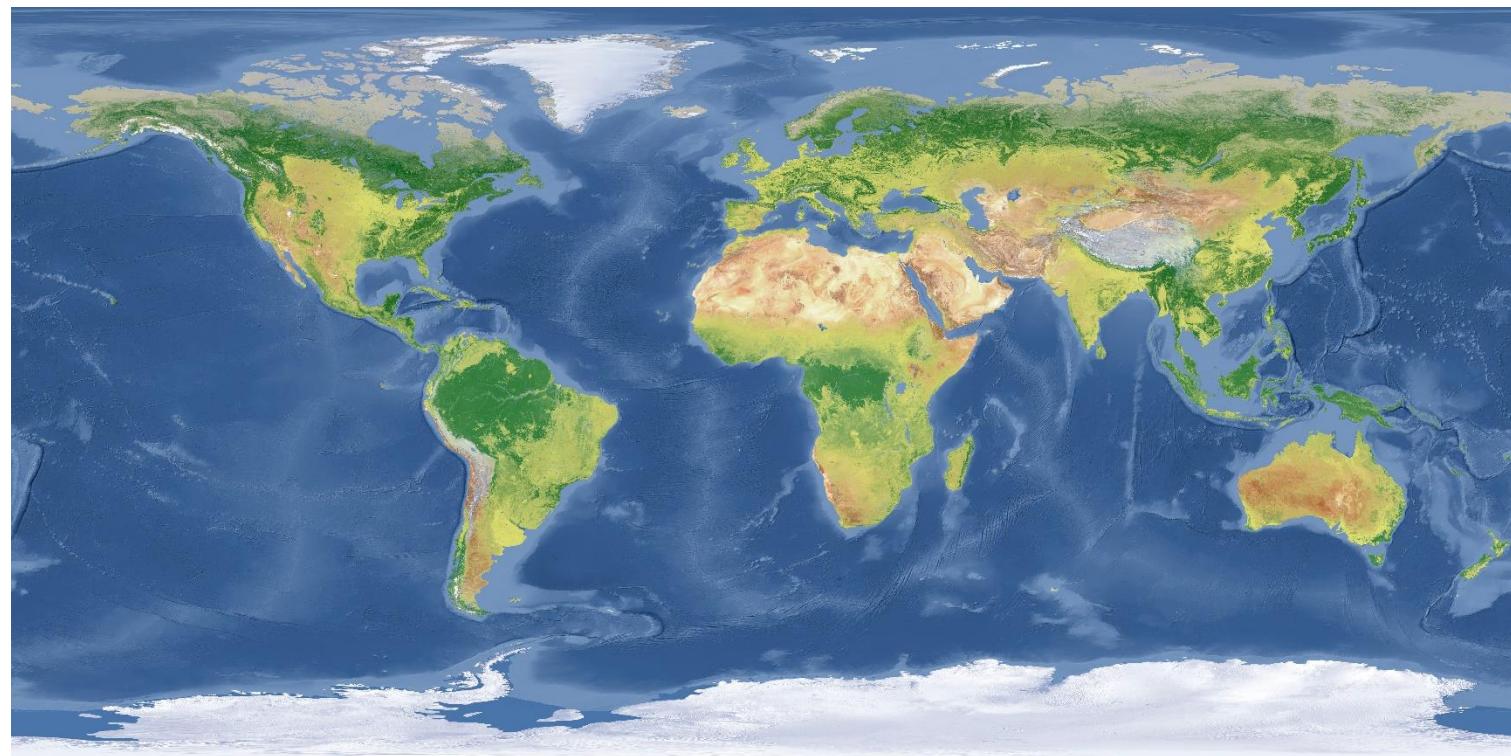
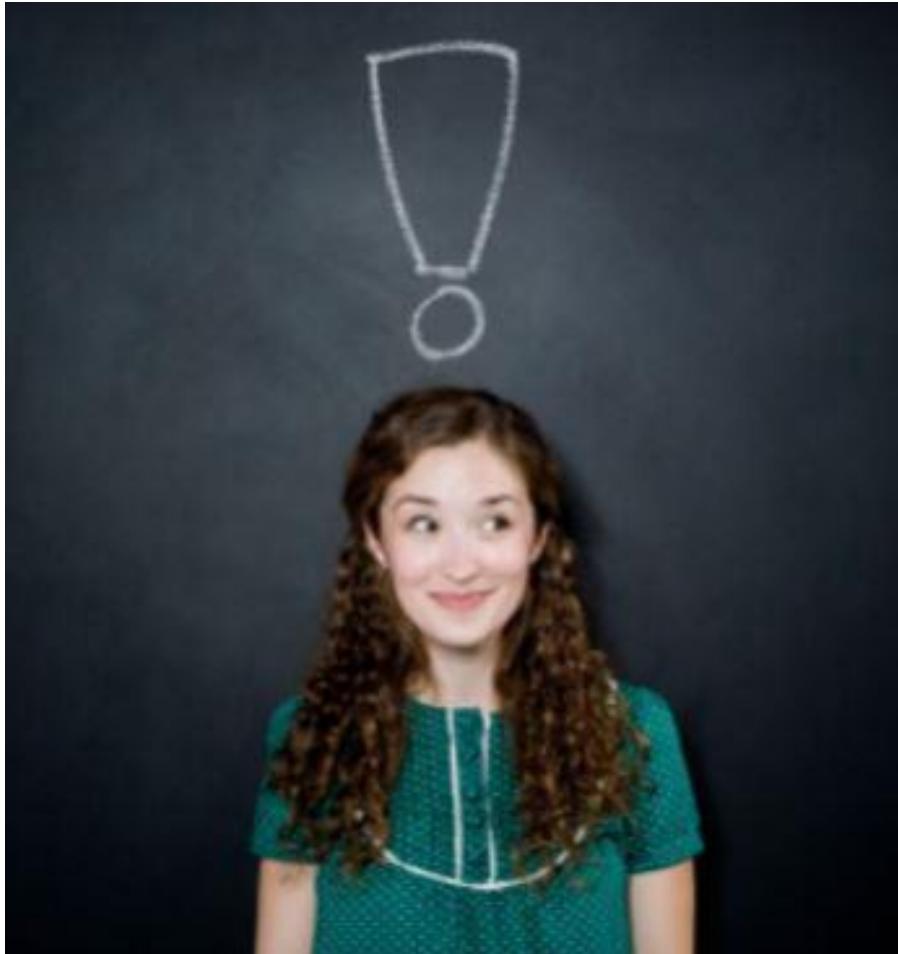
1. Open  **Ex2_ThingSpeak_AIandIoT.m** and press Run 
2. Type Team ID and press RETURN 
3. Press RETURN  when prompted to start logging
4. MOVE (Walk, Run, Idle) for 30 seconds
5. View the fitness activity from all teams

If you have time, log more data!

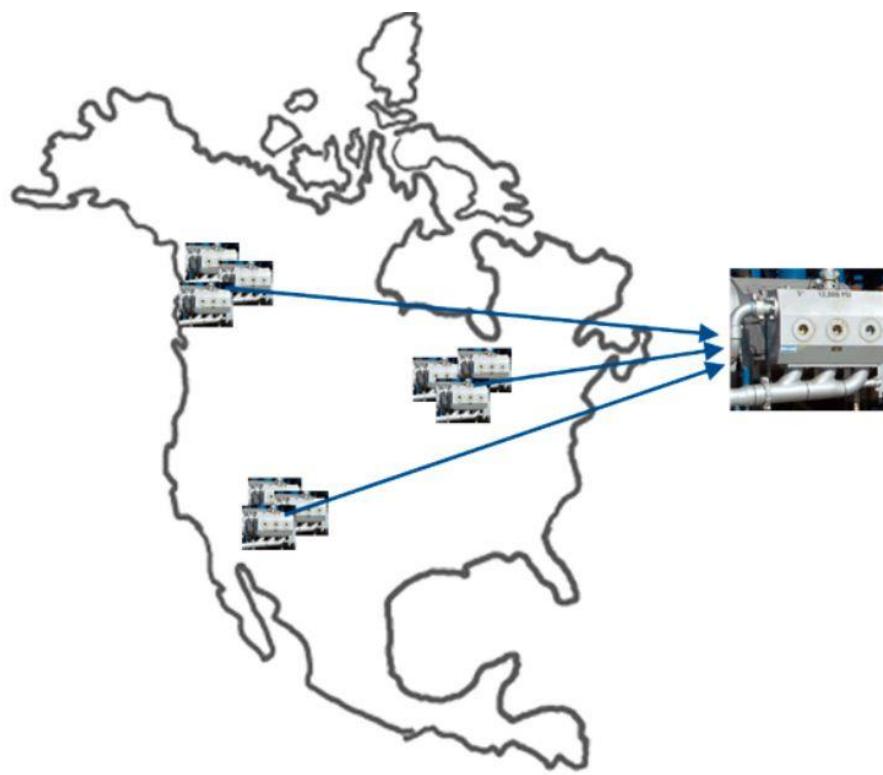
Did you get the results you expected?



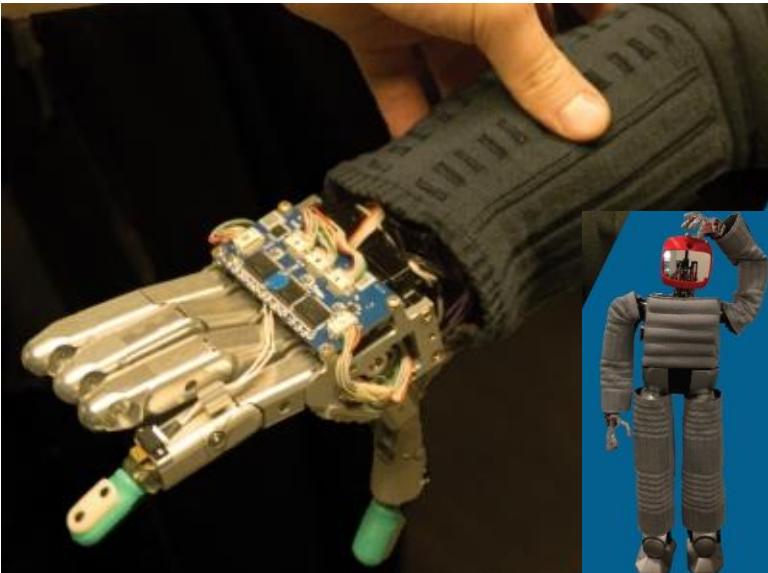
Should we explore collecting location data?



Location Data and Considerations



YOU + Sensors + AI + IoT = Innovation!



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Pocket AI and IoT

#shelovesmatlab
#MetDetAIAndIoT



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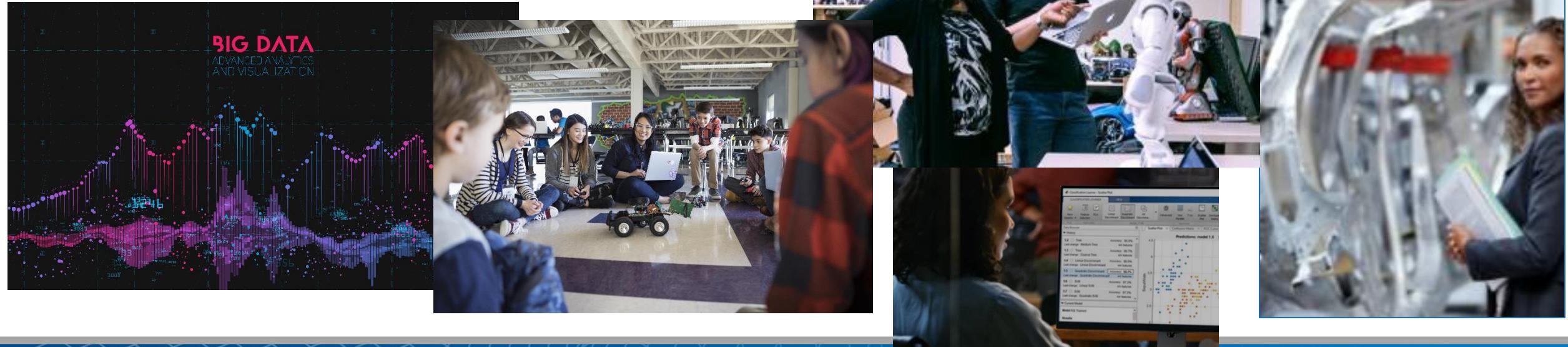
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Resources

Data Science Resources



March 7, 2022



Geo-tagging images
using MATLAB Mobile

A pocket-sized lab...

- 3-axis accelerometer
- 3-axis angular velocity
- 3-axis magnetometer
- Azimuth, pitch, roll
- GPS
- Camera

<https://www.mathworks.com/help/matlabmobile/ug/sensor-data-collection-with-matlab-mobile.html>

[MATLAB Mobile](#)

Call to action: Use Position
sensor data to create digital
elevation maps of your location

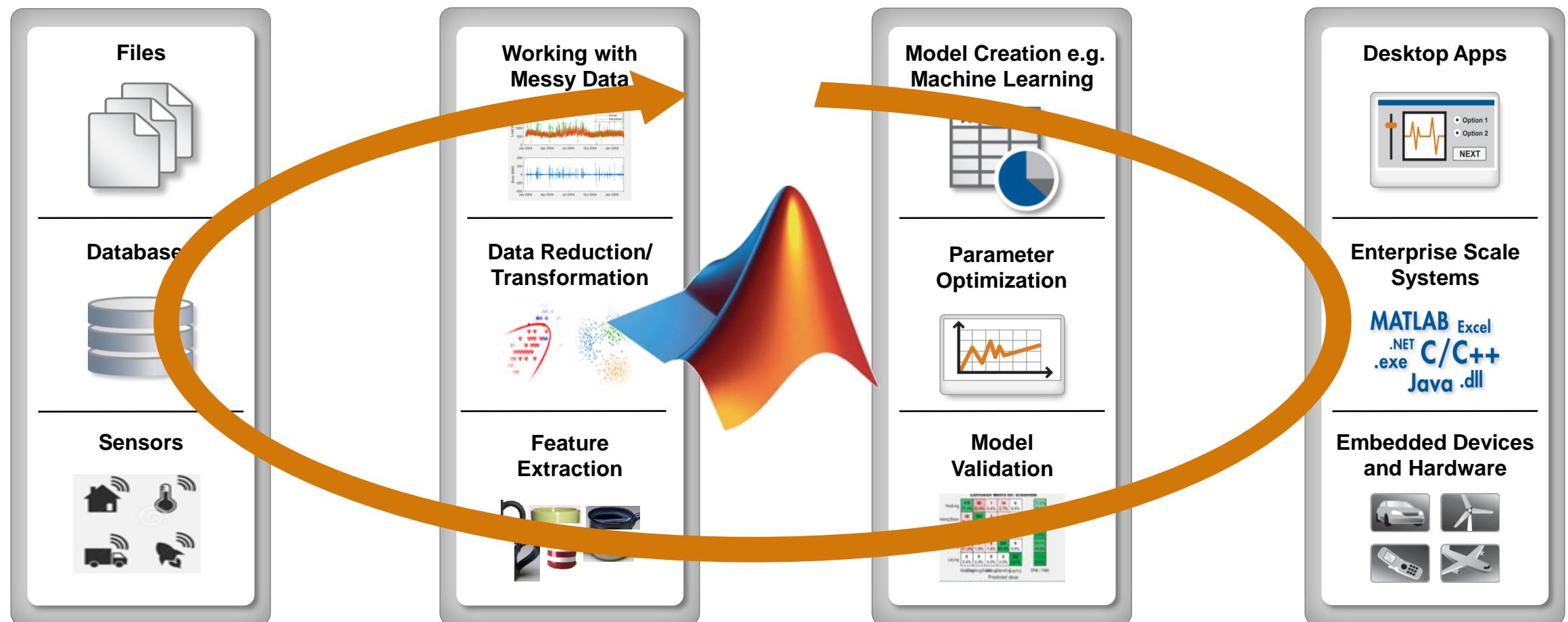
Data Science Workflow and the Connection to Machine Learning

Access and Explore Data

Preprocess Data

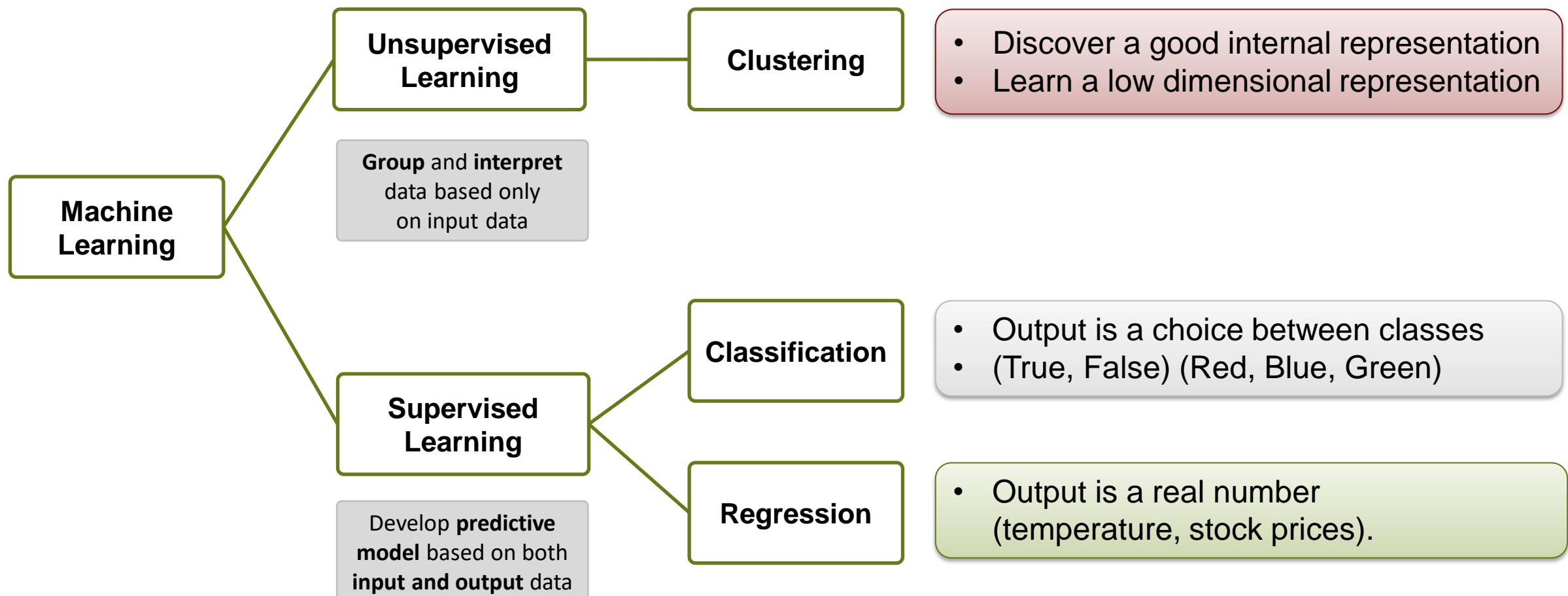
Develop Predictive Models

Integrate Analytics with Systems



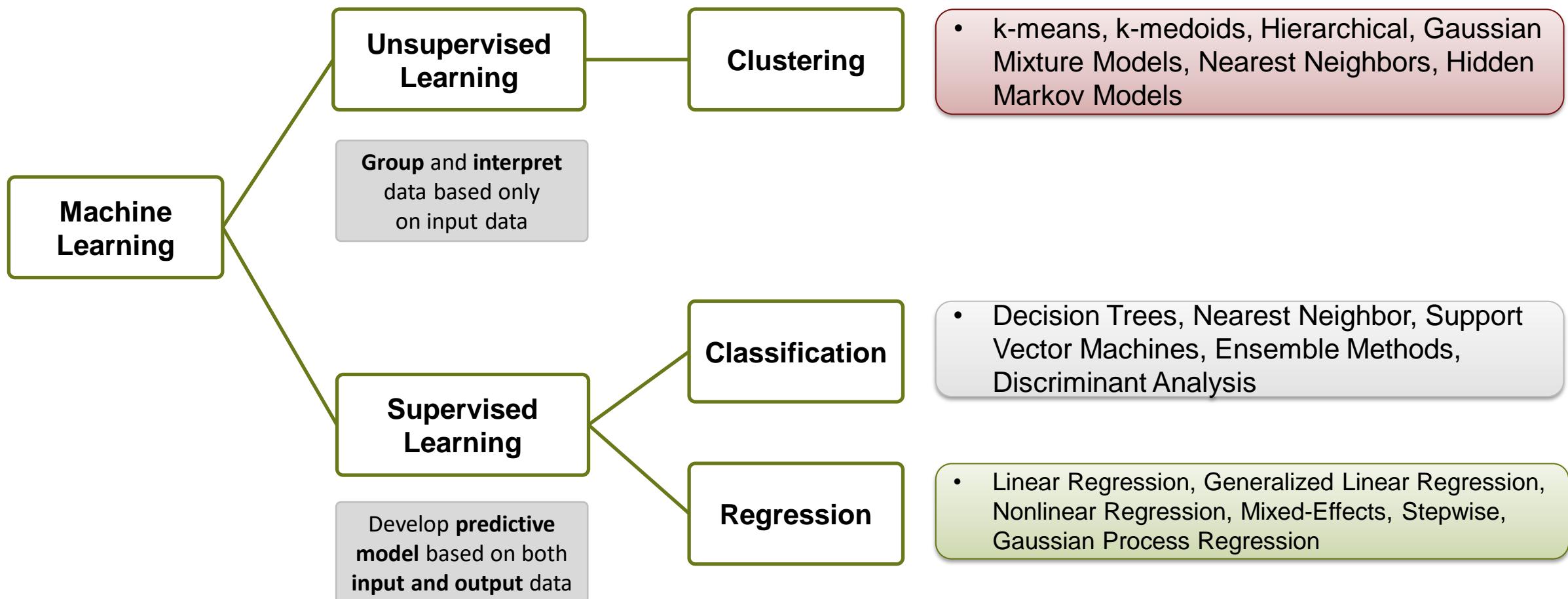
Different Types of Machine Learning

A 4-min Video on
[Types of ML](#)



Different Types of Machine Learning

A 4-min Video on
[Types of ML](#)



Where do you go from here?



MATLAB Onramp

Get started quickly with the basics of MATLAB.



Machine Learning Onramp

Learn the basics of practical machine learning methods for classification problems.



Deep Learning Onramp

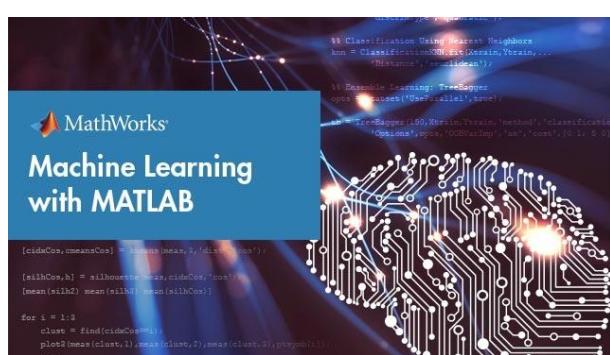
Get started quickly using deep learning methods to perform image recognition.

Browse > Data Science > Data Analysis

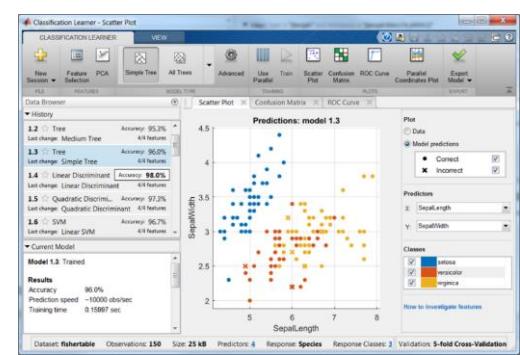
Practical Data Science with MATLAB Specialization



[ML Cheat Sheet](#)



E-Books: [Introductory ML](#) | [Mastering ML](#)



[Try Classification Learner in Browser](#)

Online Resources

ML and DL Onramps

- Free of Charge | No License Req.
- Available to all registered on MathWorks website
- Access to a Course Completion Certificate
- ML and DL with MATLAB (if you've CWS)

MOOC

- [Coursera Specialization](#)

Documents

- [Common machine learning challenges](#)
- [ML vs DL: Choosing the right approach](#)

Demos, webinars and blogs

- [Earthquakes and big data](#)
- [Air quality with Thingspeak](#)
- [Damage costs of weather events](#)
- Various energy forecasting demos