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

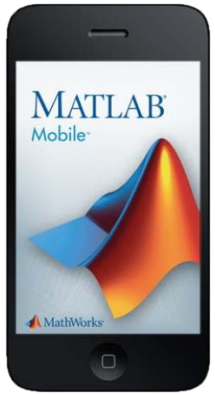
Logistics Overview

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

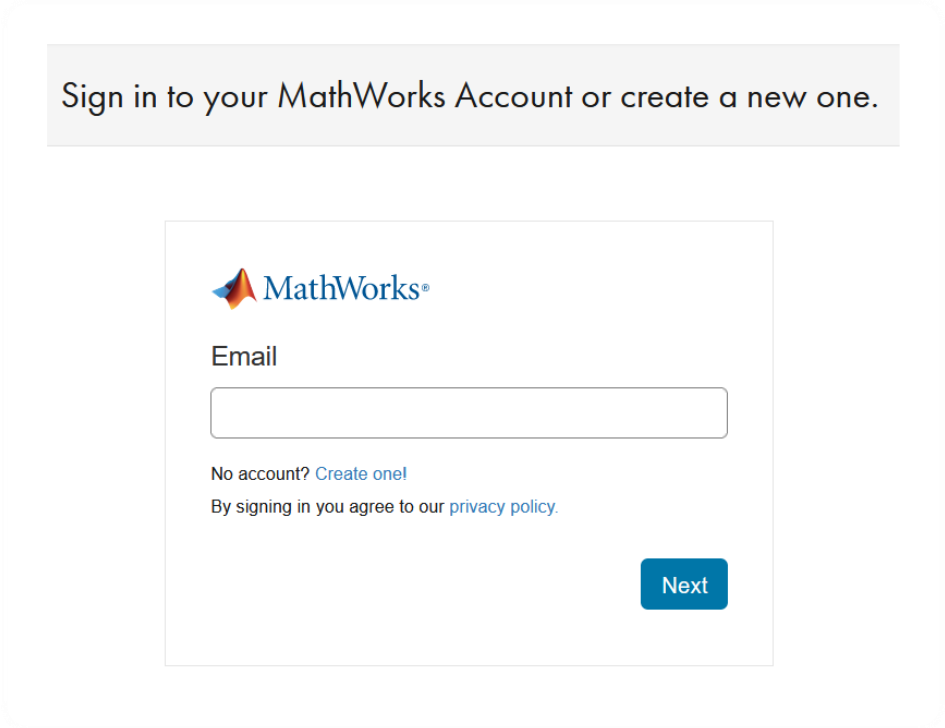
If you have questions, please ask them in the chat.

The exercises will be done using MATLAB Mobile.



Getting Access to MATLAB Online

1. Create a MathWorks Account

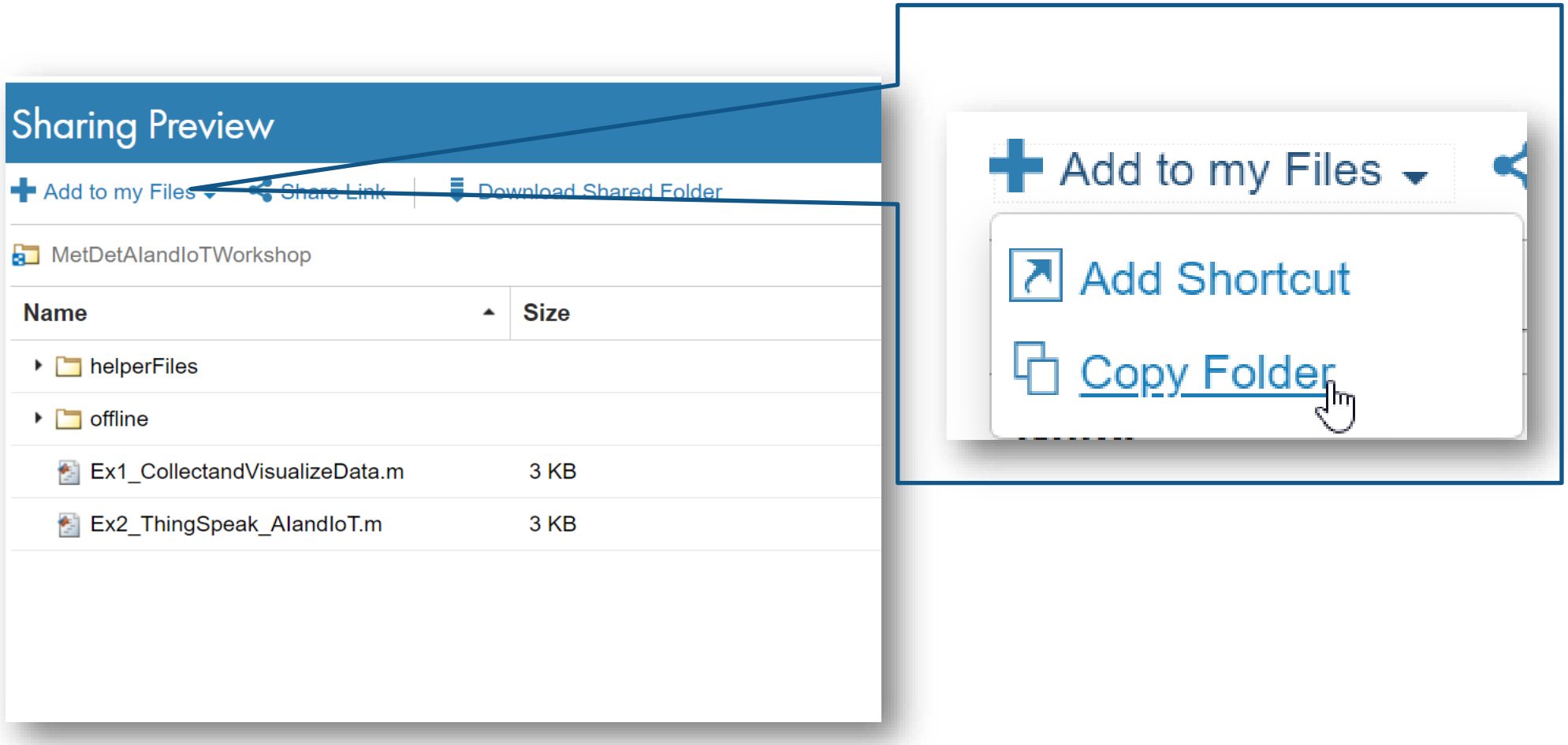


2. Access the license for this workshop

https://tinyurl.com/mlometdetaiandiot

Obtain Access to Workshop Files

https://tinyurl.com/metdetaiandiotfiles



Pre-Work and Other Resource Documents

https://github.com/LWHMW/MetAIandIoTWorkshop

*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

AI

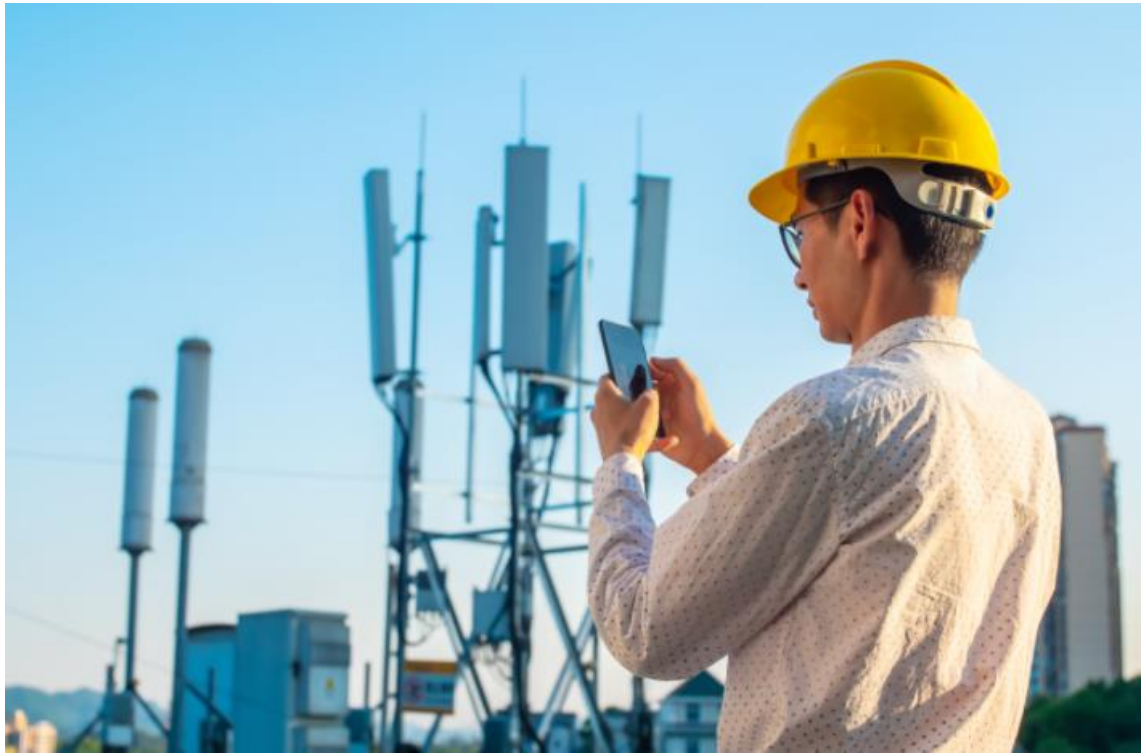
IoT

Sensors are everywhere!

How can we take measurements about our world?

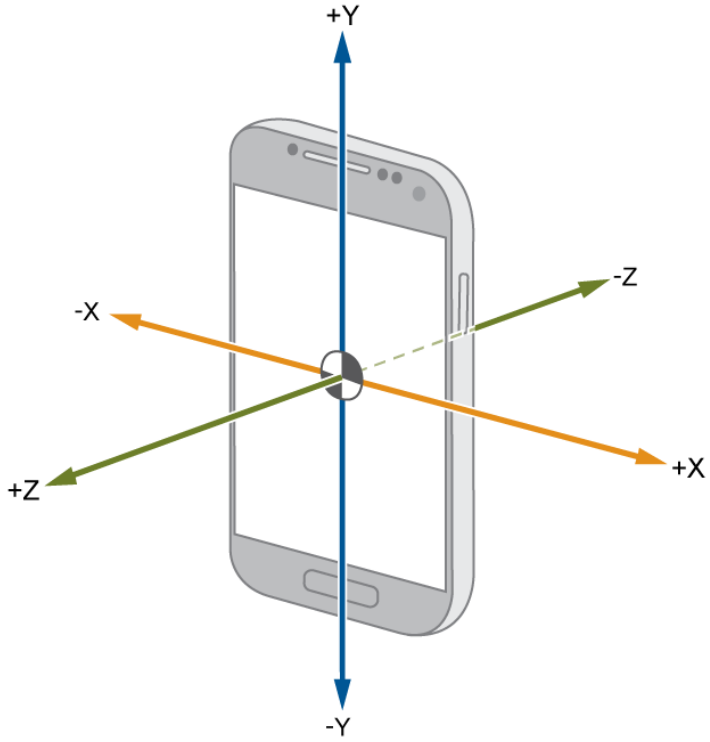
Remote Sensing

In-Situ

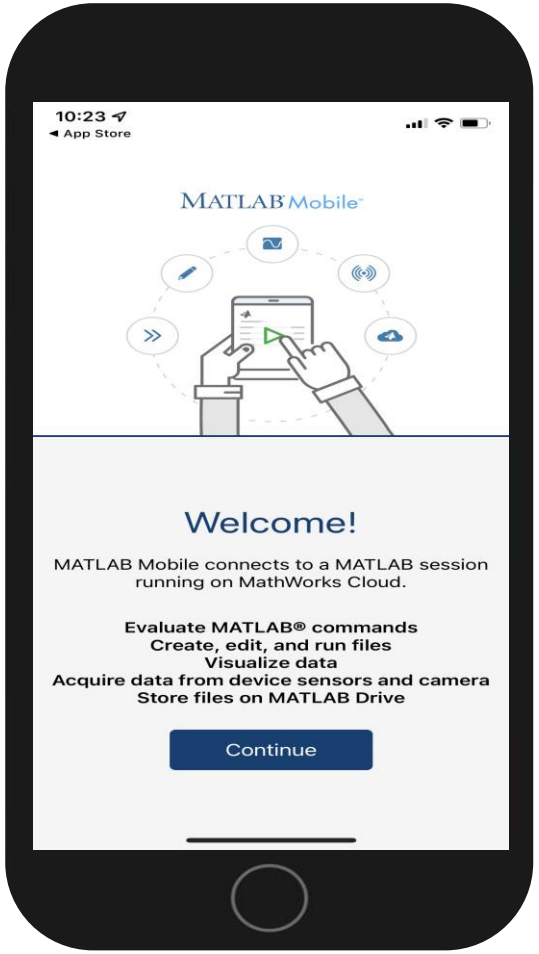


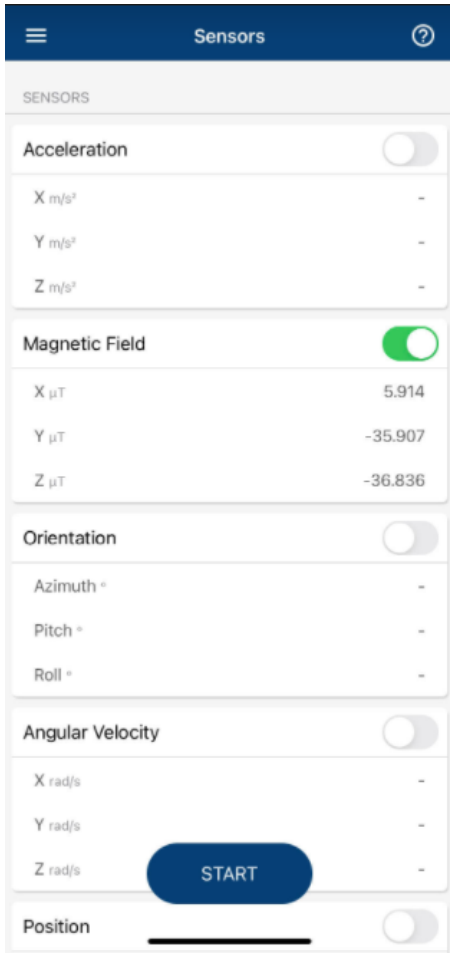
Magnetic field strength will be used to determine the presence of metal

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





Magnetometer

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

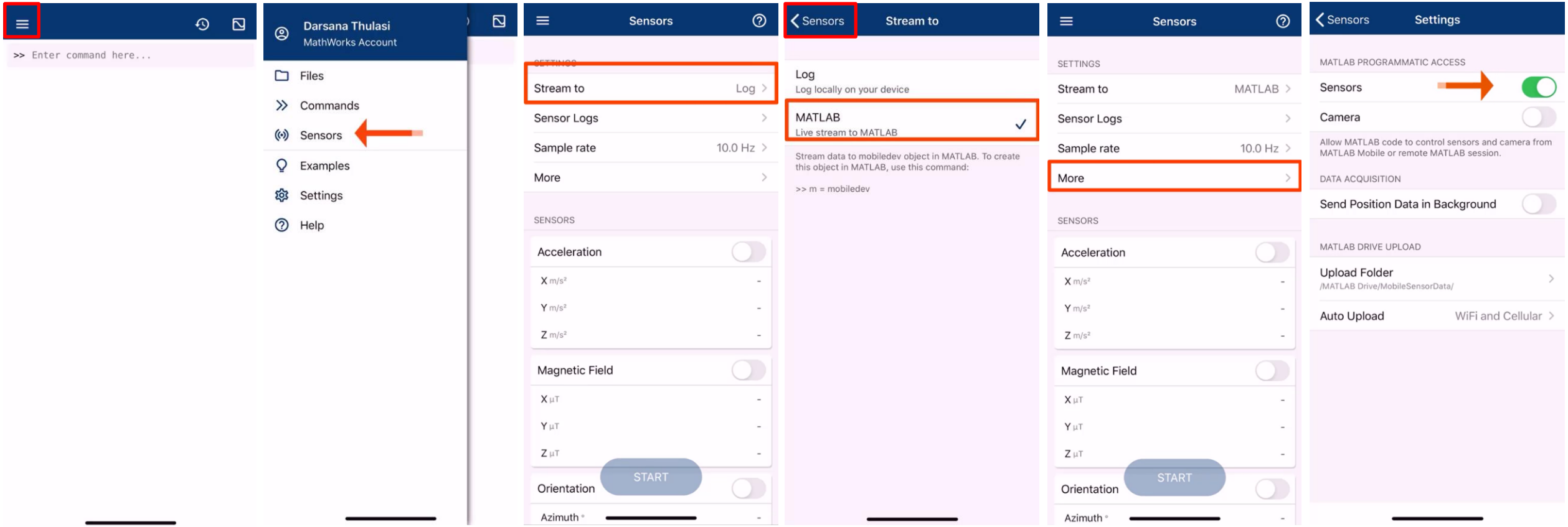
Sensors

Exercise 1

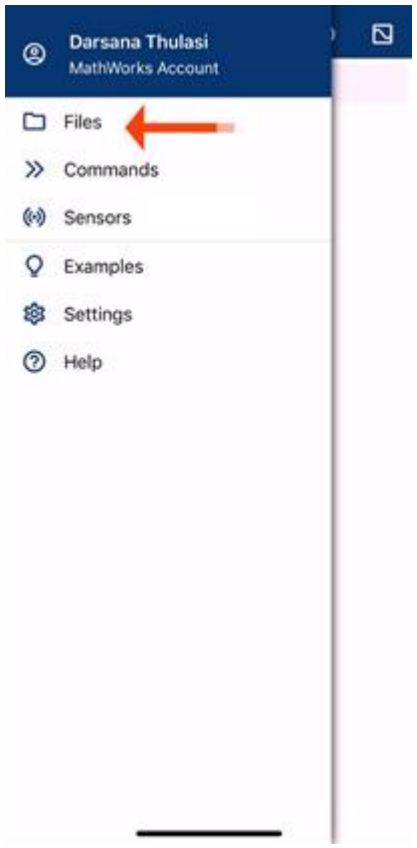
AI and IoT

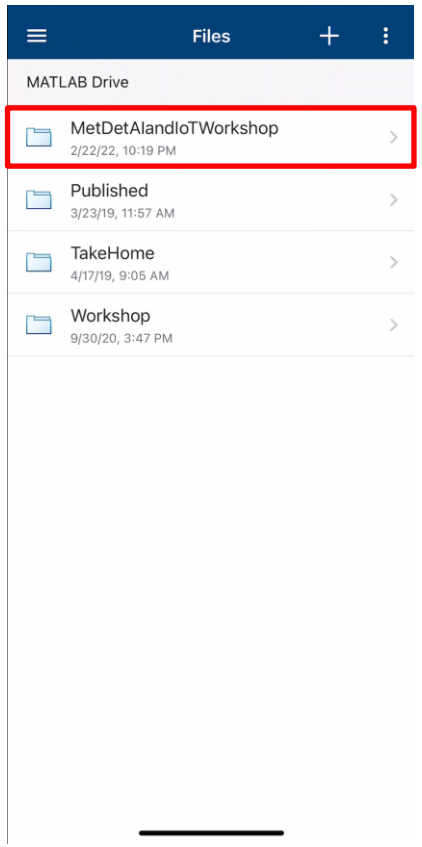
Exercise 2

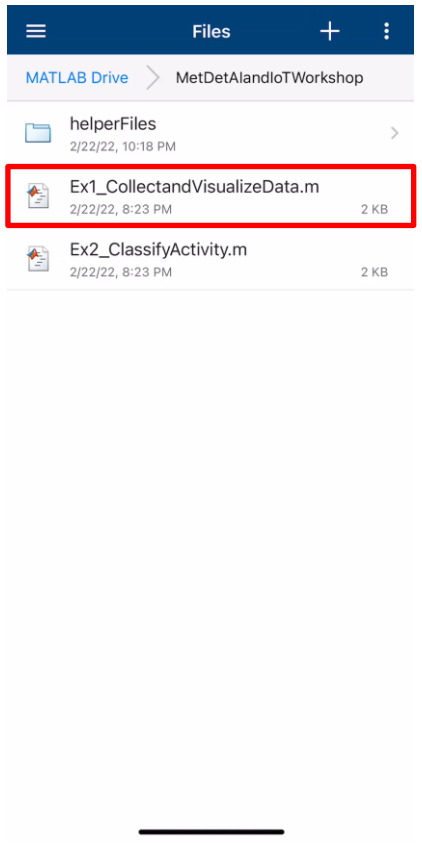
Enable the sensors in MATLAB Mobile

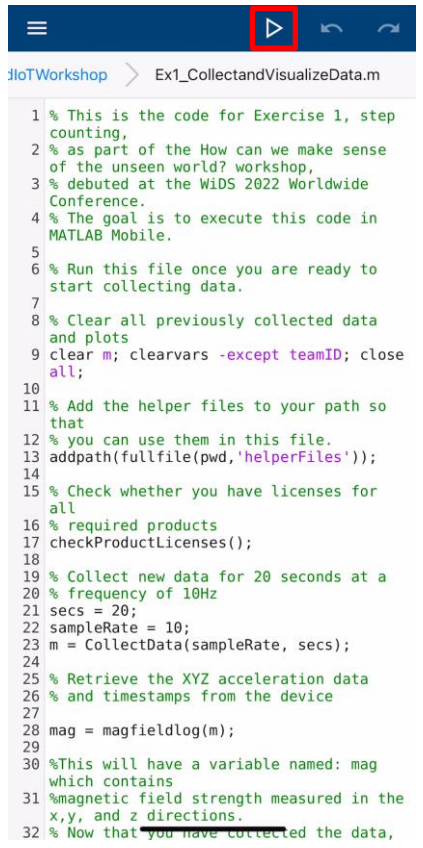


How to navigate and run code









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

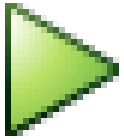
Ex1_CollectandVisualizeData.m

```
% 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 

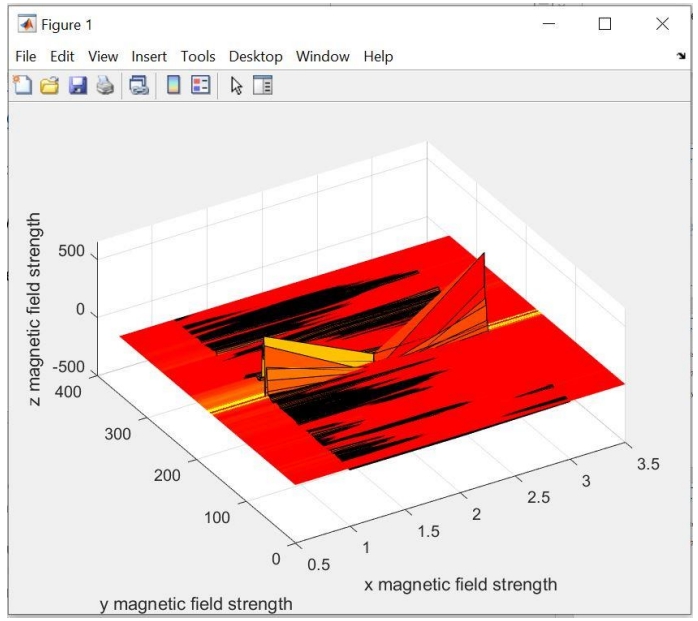
2. Wait for the prompt to start walking

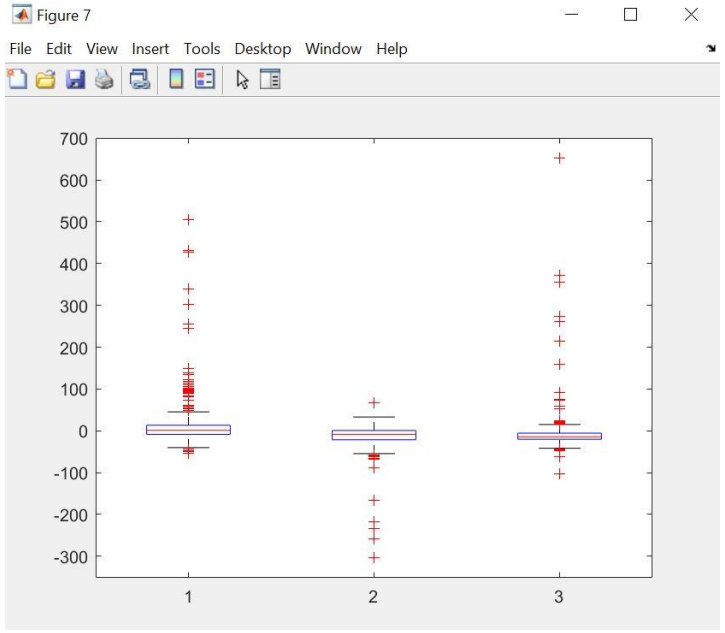
3. WALK for 20 seconds

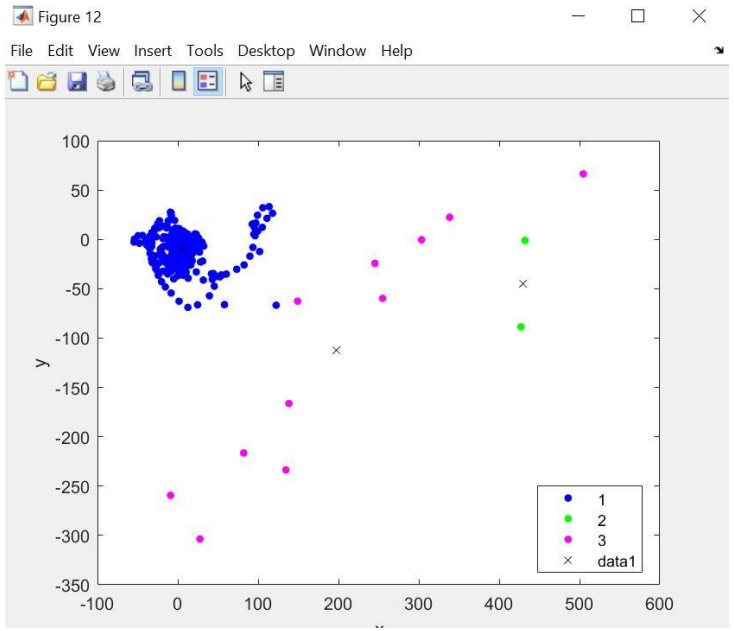
4. View the visualizations

If you have time, try again and review the code

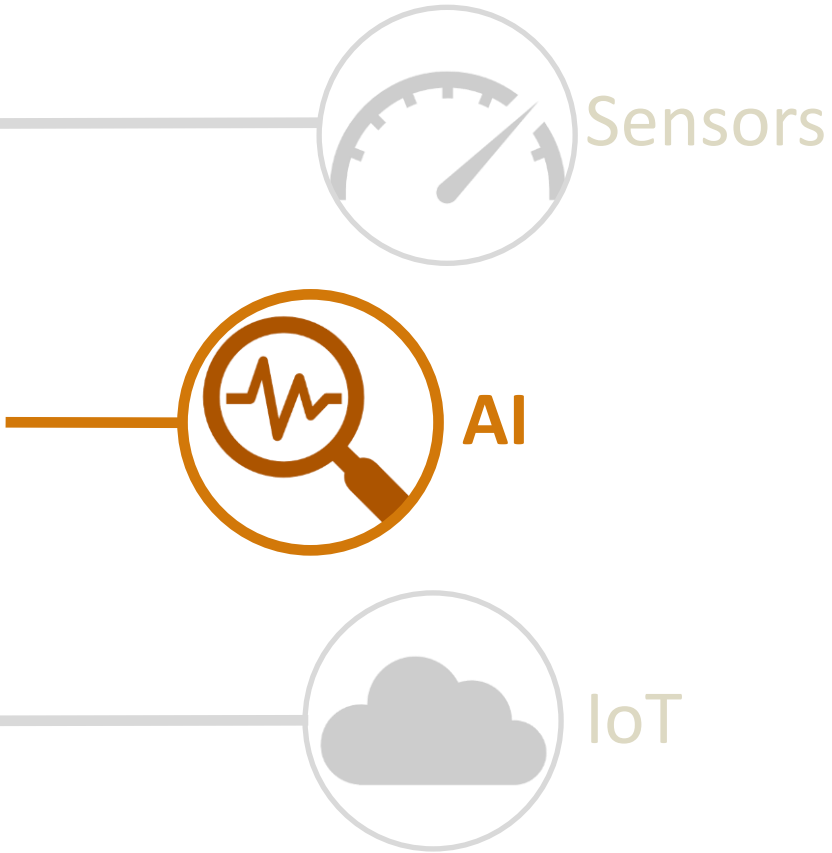
Did you get similar results for your output?



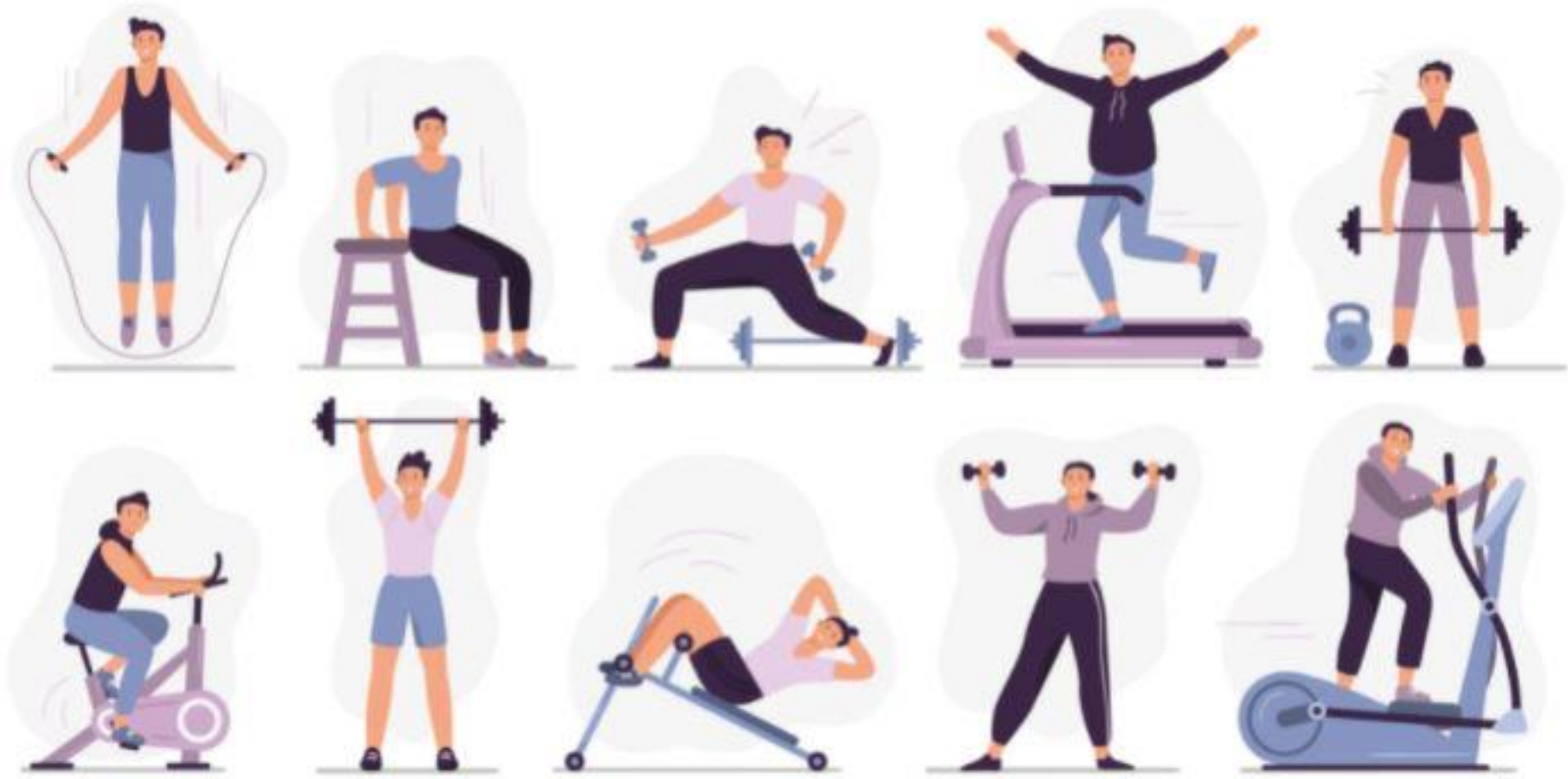




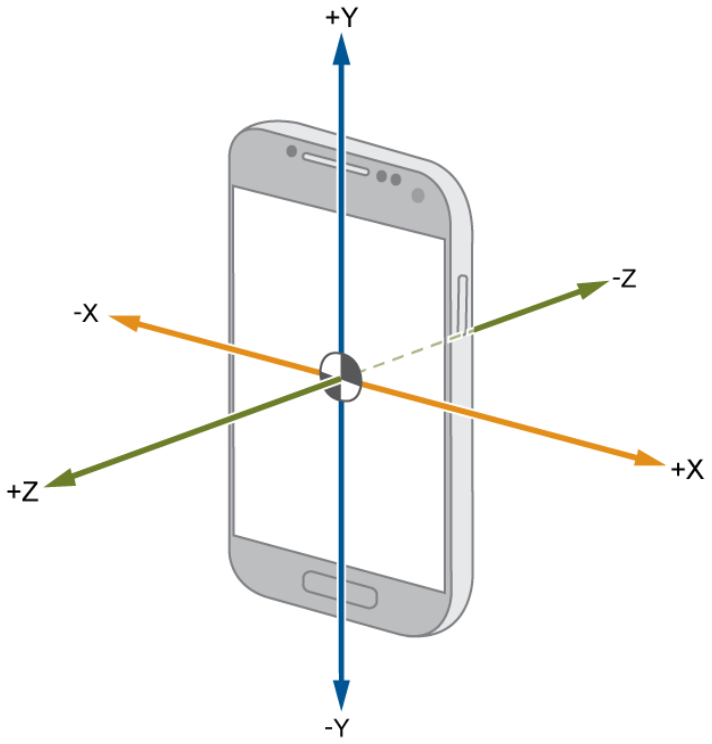
Now that you've collected data, can we explore what was occurring when the data was collected and how can this be analyzed?



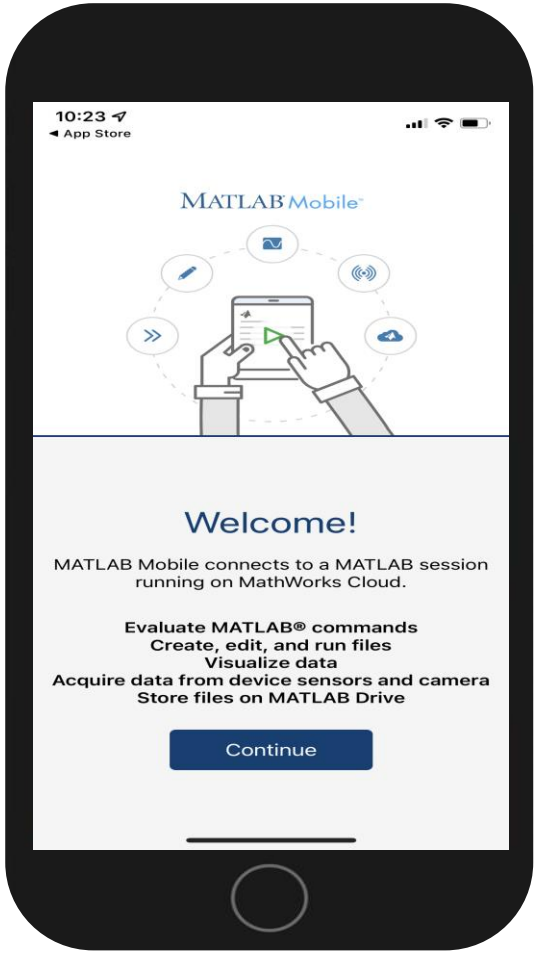
How can we determine what were you doing as the data was collected?

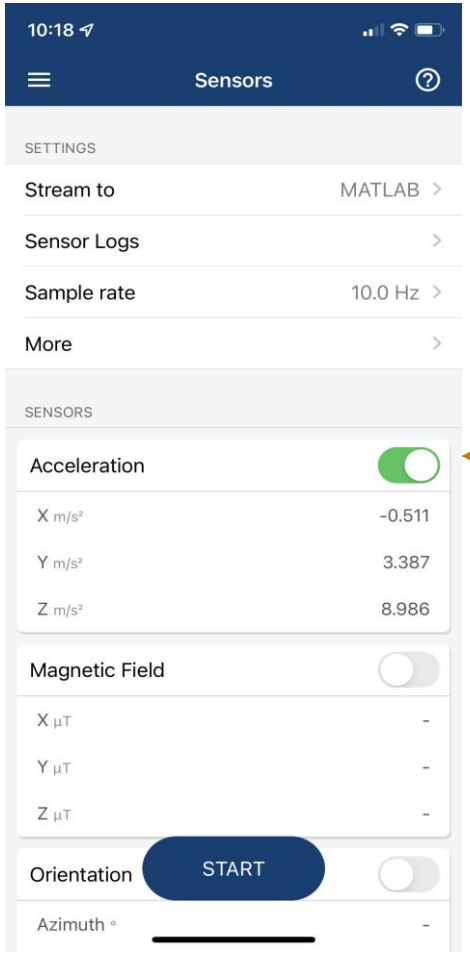


An accelerometer detects acceleration, vibration, and tilt



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

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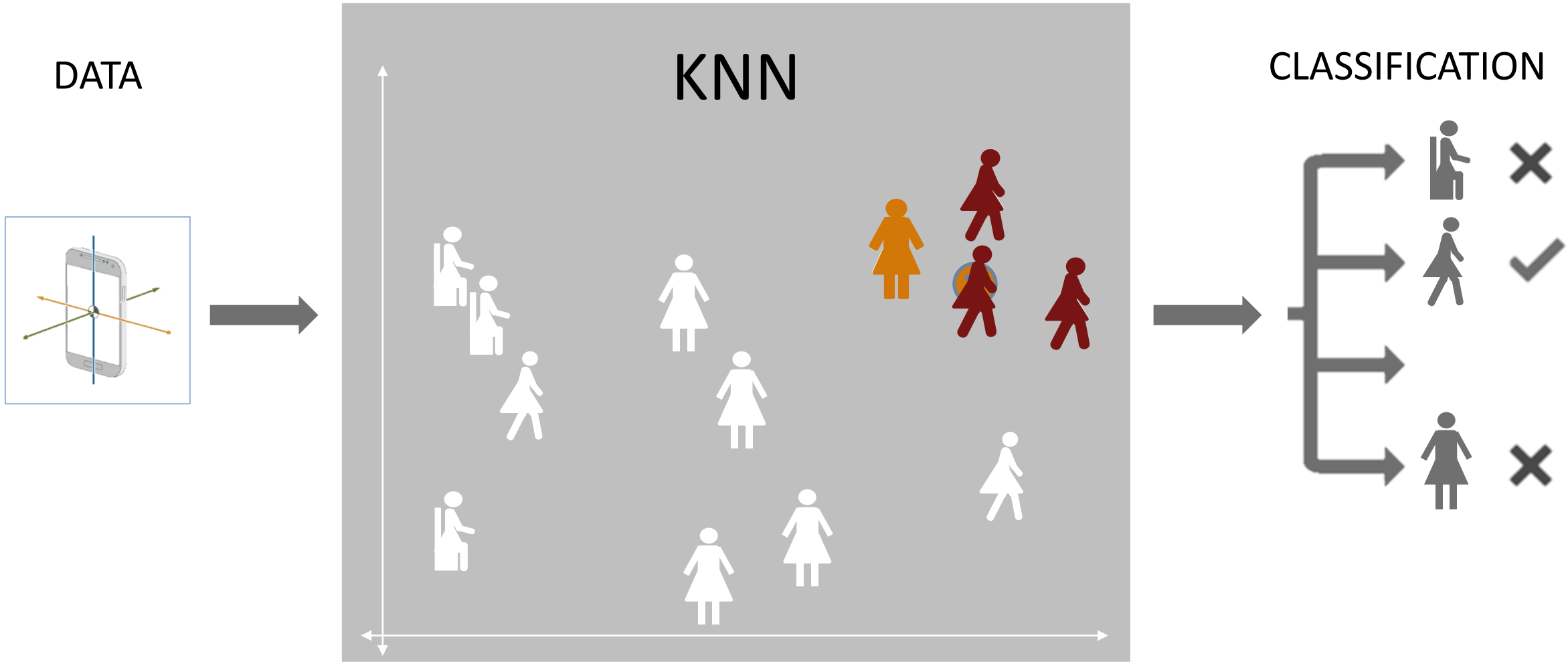
The accelerometer data was classified using the KNN algorithm



We will use machine learning to classify your activity

Sensors

AI

IoT

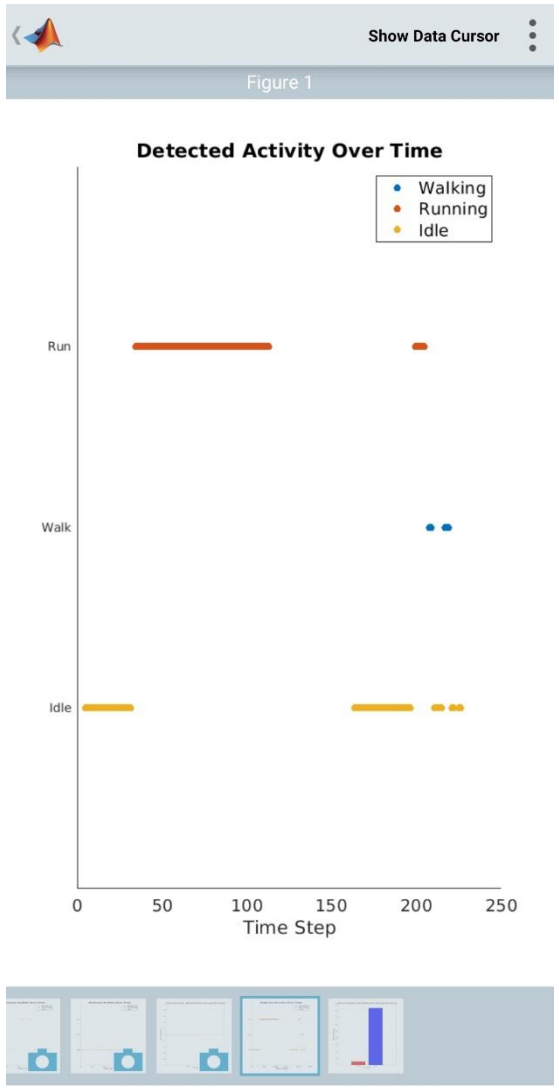
We will use training data to build a k-nearest neighbors model for classification

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



Run

Walk

Idle

Time

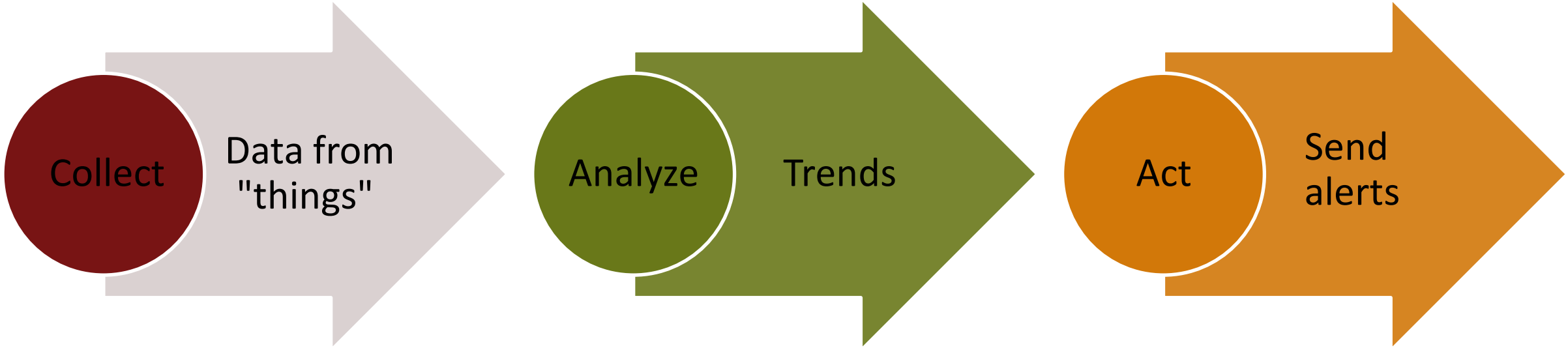
Background information: Use machine learning to classify your activity

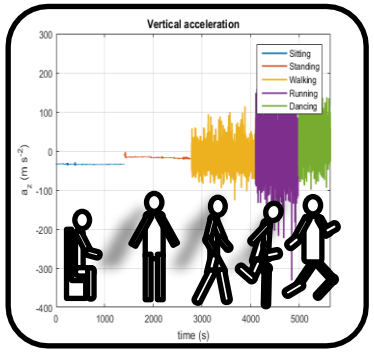
- The following file  **`Ex2_ClassifyActivity.m`** is executed as a part of the second exercise and below are the activities that occur in this file.
- A person does one of the activities for (Walk, Run, Idle) for 30 seconds
- After the 30 seconds then the person can view the breakdown of their activity

If you have time, try again and review the code

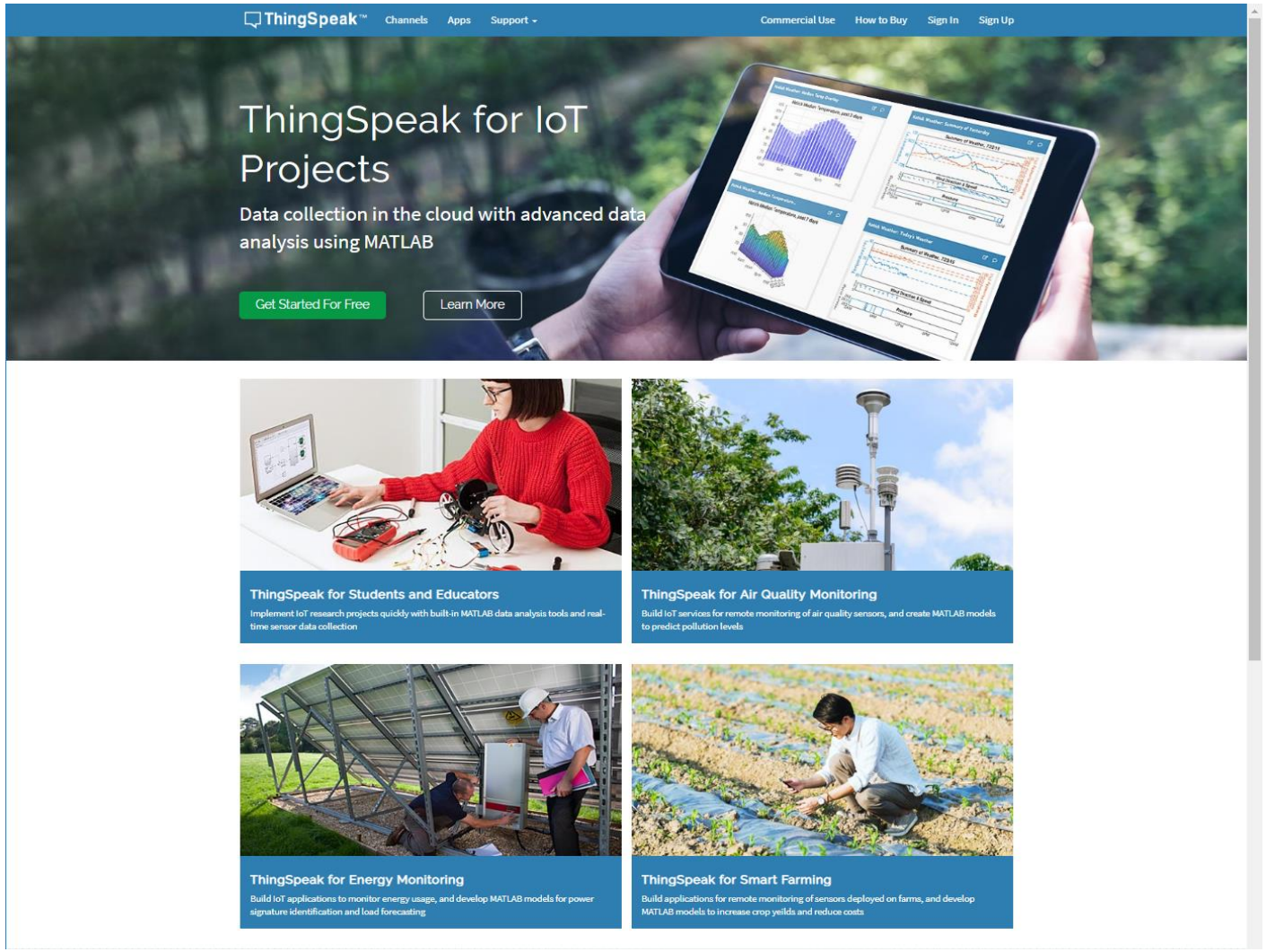
How can we aggregate our activity to the cloud?

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





You will use an open IoT platform



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

Sensors

Exercise 1

AI and IoT

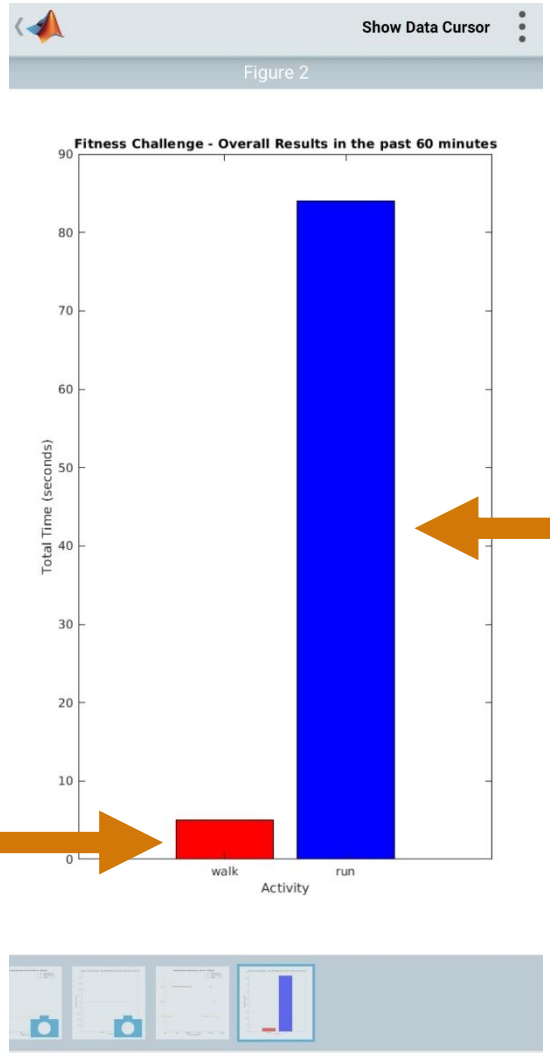
Exercise 2

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');
```

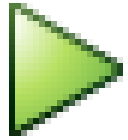
You can examine the figure to view everyone's combined time walking and running



Run

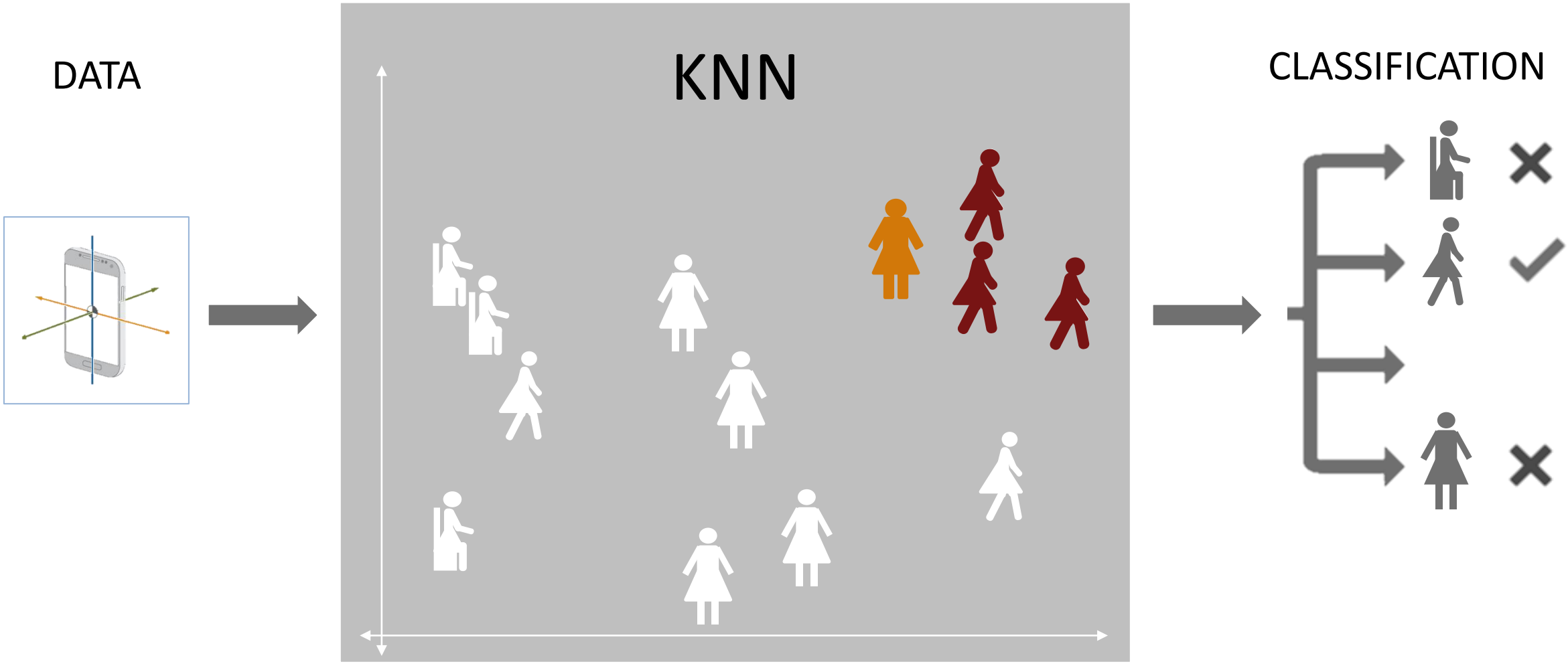
Walk

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

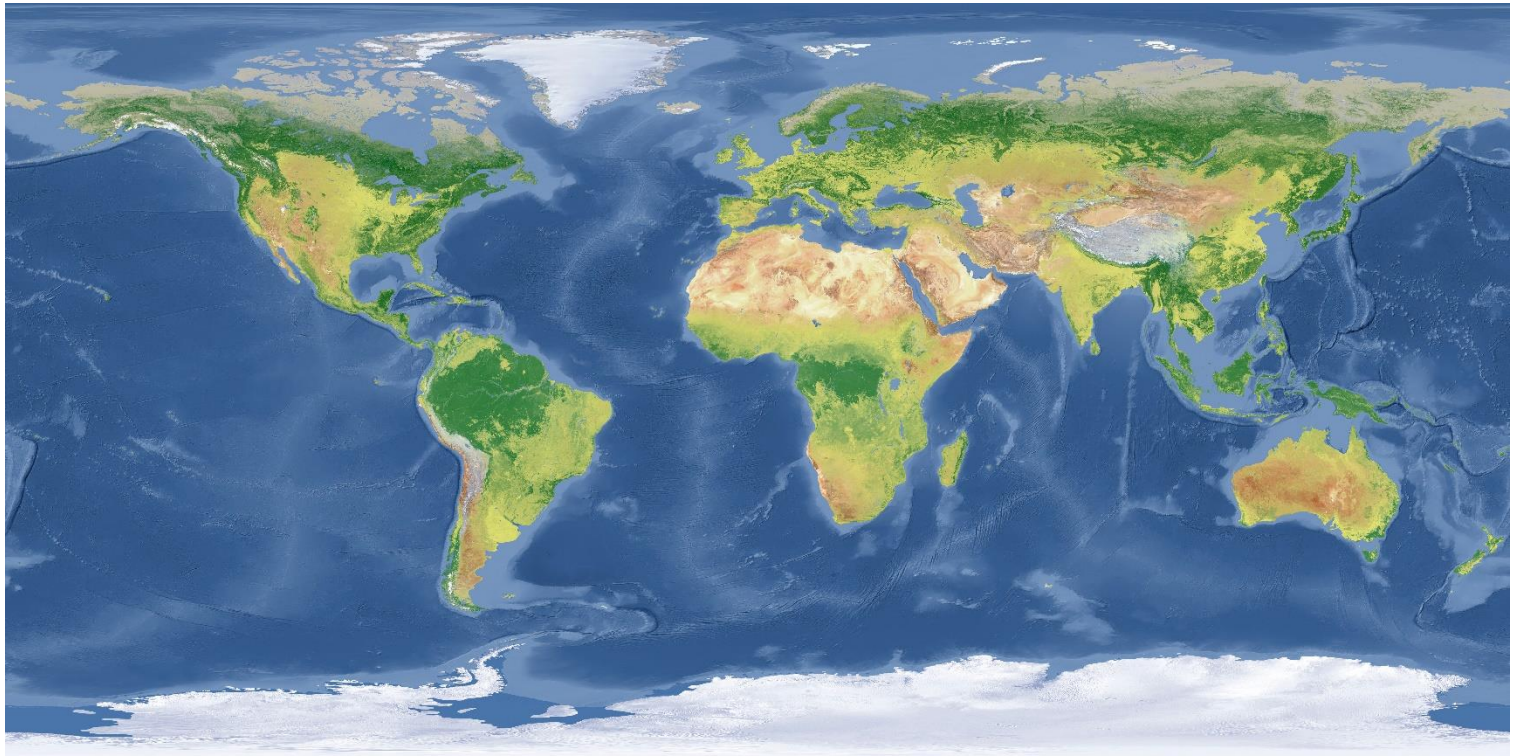
1. Open  **`Ex2_ThingSpeak_AIandIoT.m`** and press Run 
2. Type Team ID and press RETURN 
3. Press RETURN  when prompted to start logging
4. MOVE (Walk, Run, Idle) for 30 seconds
5. View the fitness activity from all teams

If you have time, log more data!

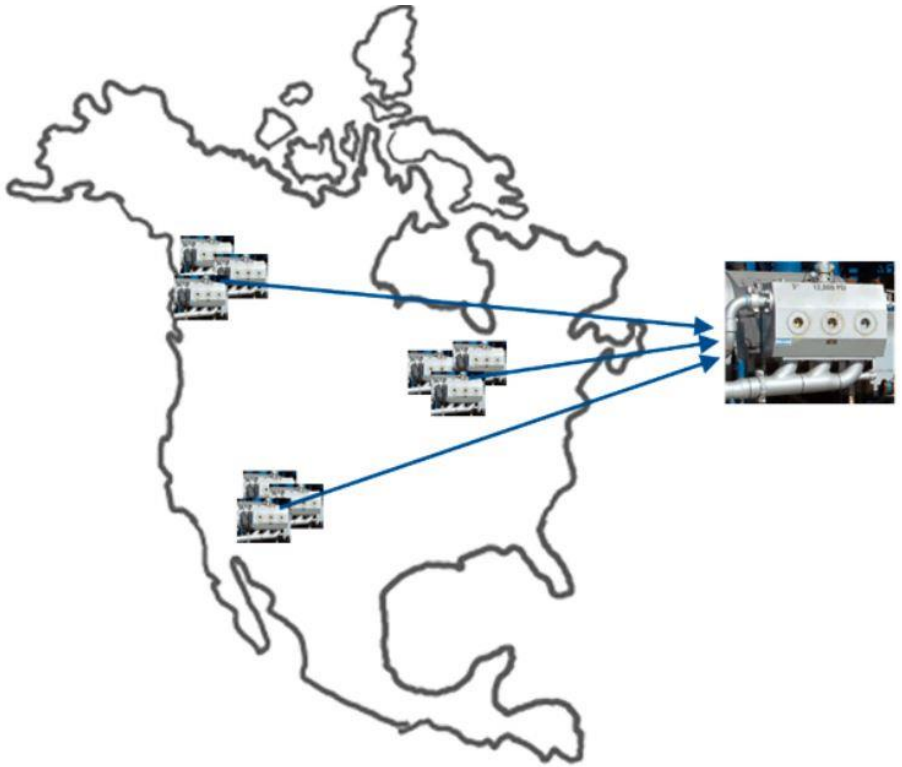
Did you get the results you expected?



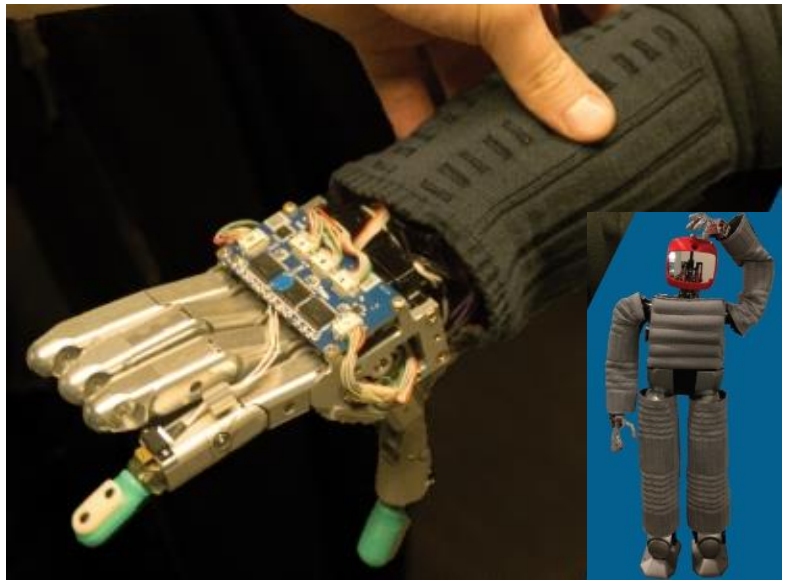
Should we explore collecting location data?

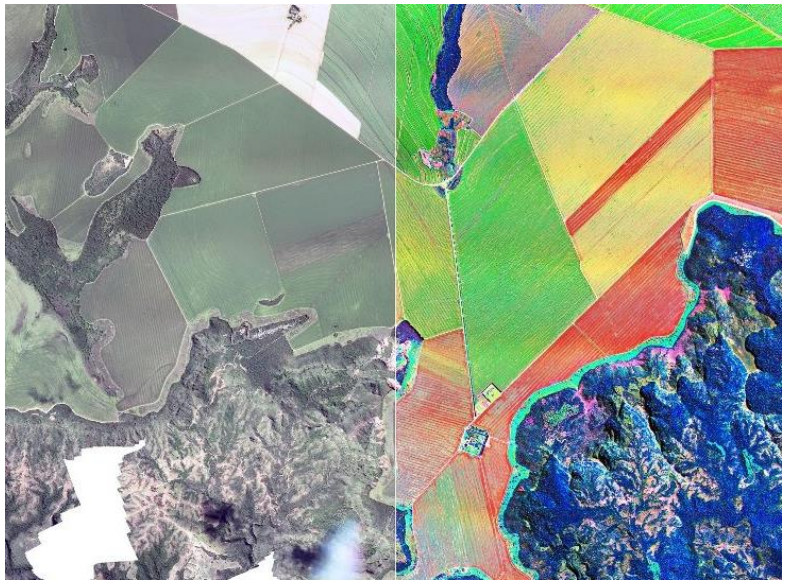


Location Data and Considerations



YOU + Sensors + AI + IoT = Innovation!





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Get started quickly with the basics of MATLAB®.

Details and launch

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Learn the basics of creating, editing, and simulating state machines in Stateflow®.

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https://matlabacademy.mathworks.com/

Pocket AI and IoT

#shelovesmatlab
#MetDetAIAndIoT

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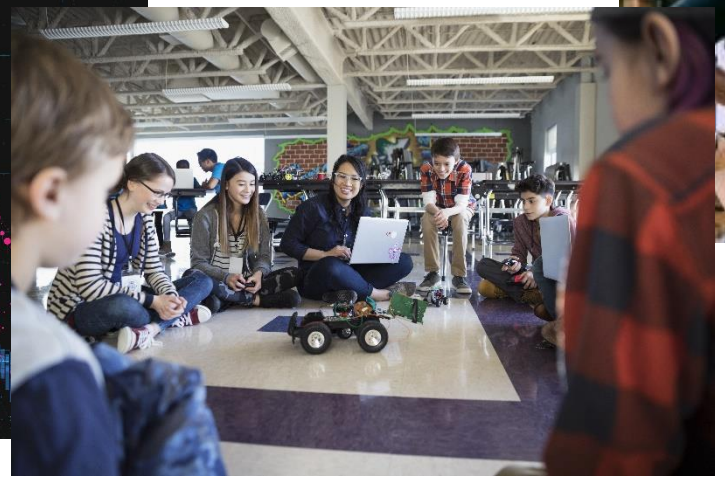
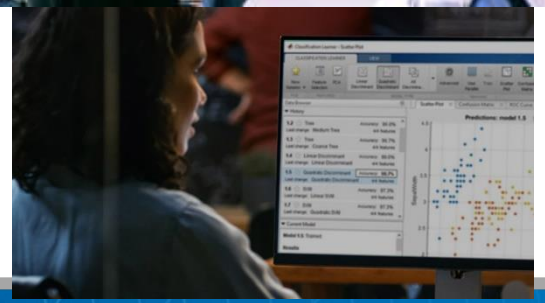
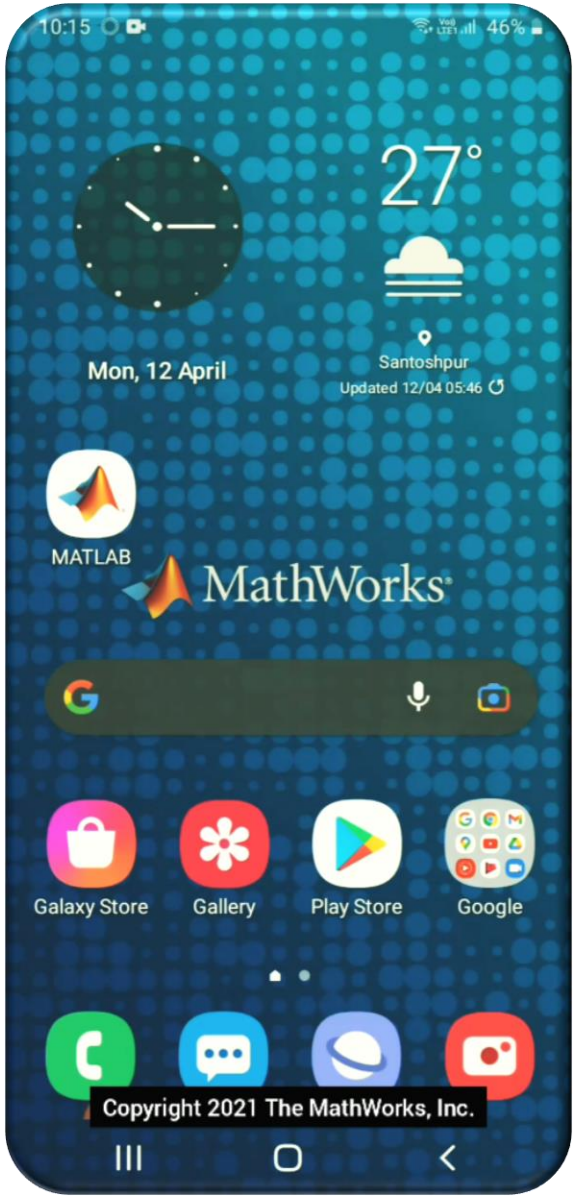
Resources

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

MATLAB Mobile

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

***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

- Files
- Database
- Sensors

Preprocess Data

- Working with Messy Data
- Data Reduction/ Transformation
- Feature Extraction

Develop Predictive Models

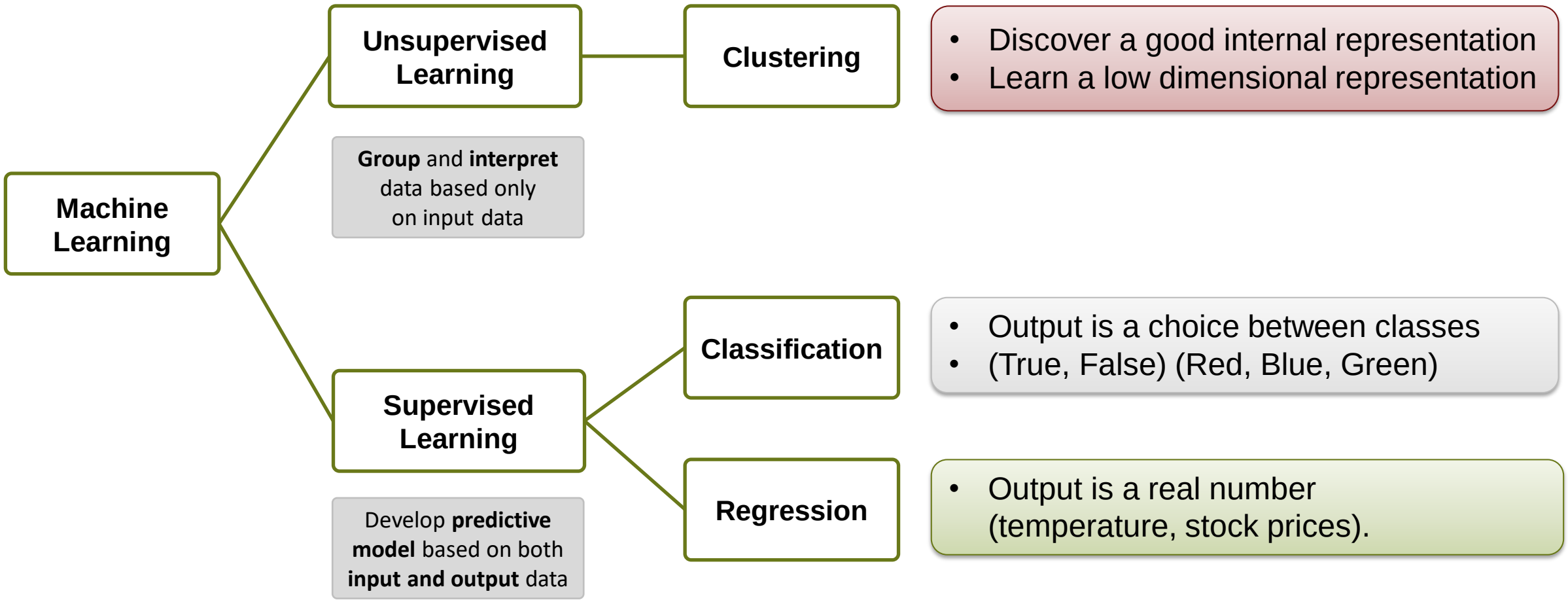
- Model Creation e.g. Machine Learning
- Parameter Optimization
- Model Validation

Integrate Analytics with Systems

- Desktop Apps
- Enterprise Scale Systems
- Embedded Devices and Hardware

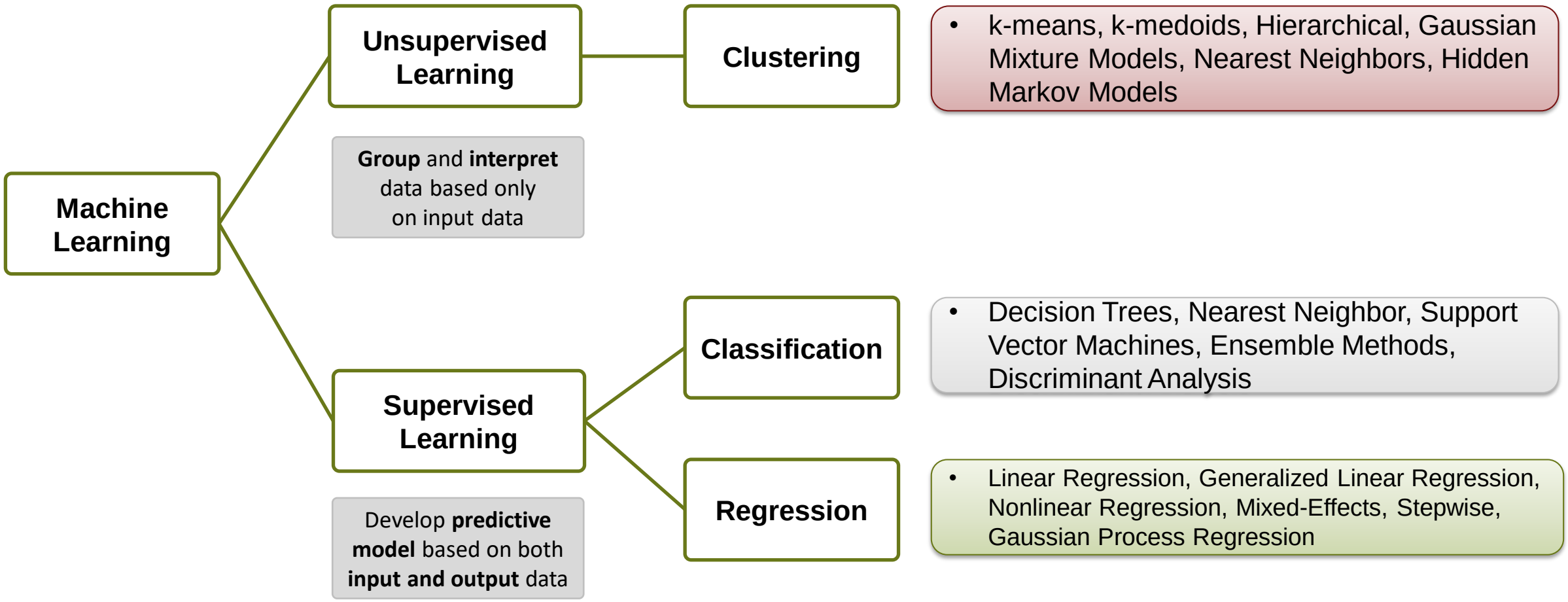
Different Types of Machine Learning

A 4-min Video on
Types of ML

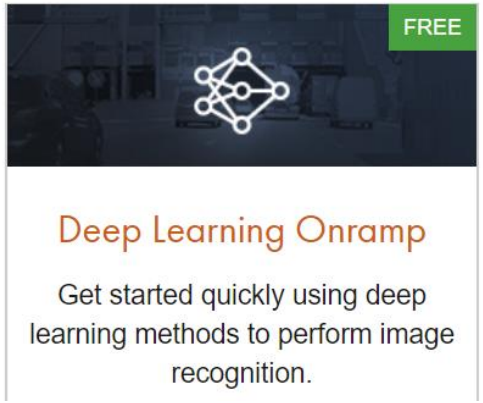


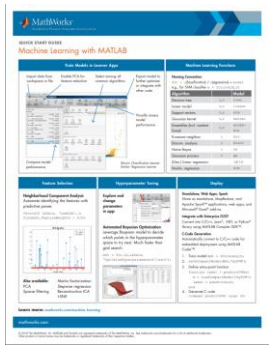
Different Types of Machine Learning

A 4-min Video on
Types of ML

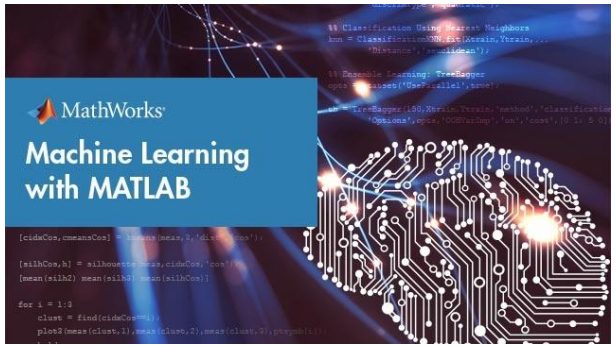


Where do you go from here?

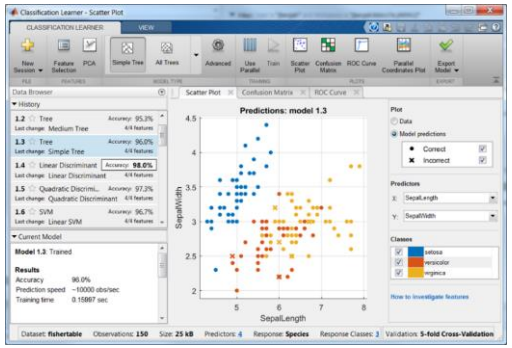




ML Cheat Sheet



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