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

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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

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

Let's consider sensors

Sensors

AI

IoT

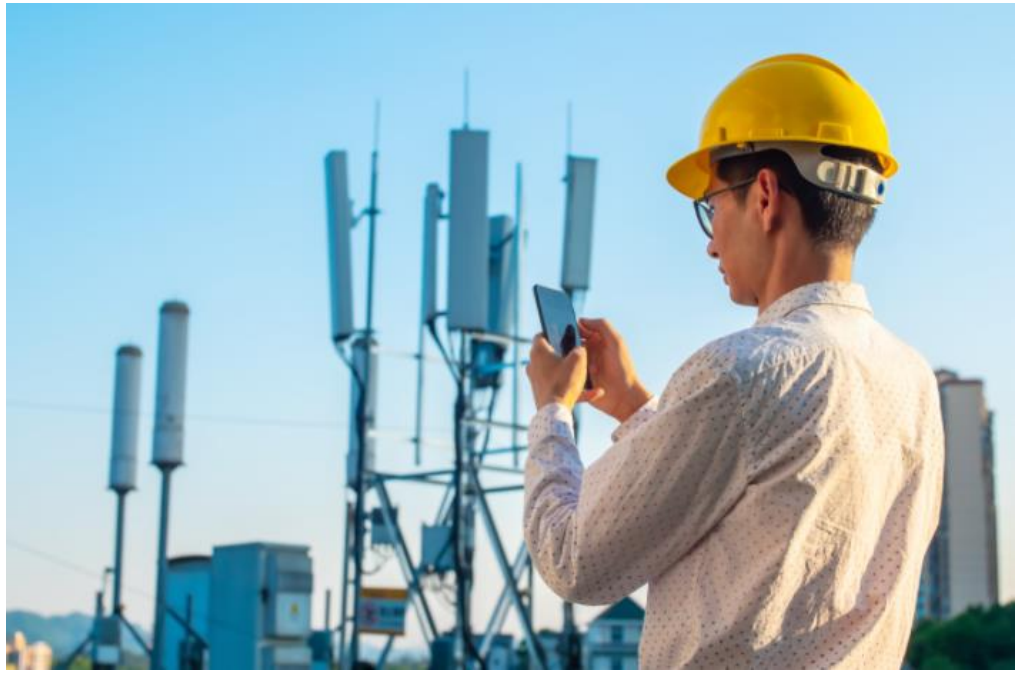
Sensors are everywhere!

What sensors have you used today?

How can we take measurements about our world?

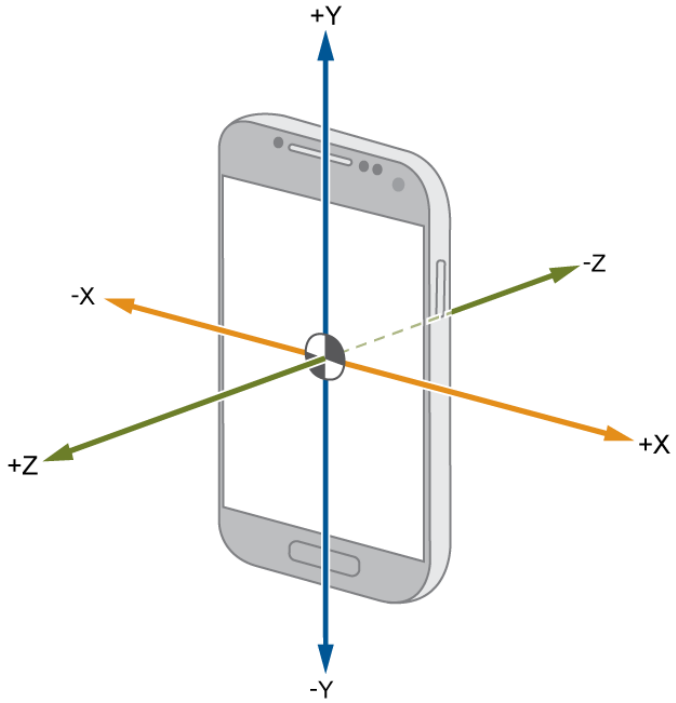
Remote Sensing

In-Situ



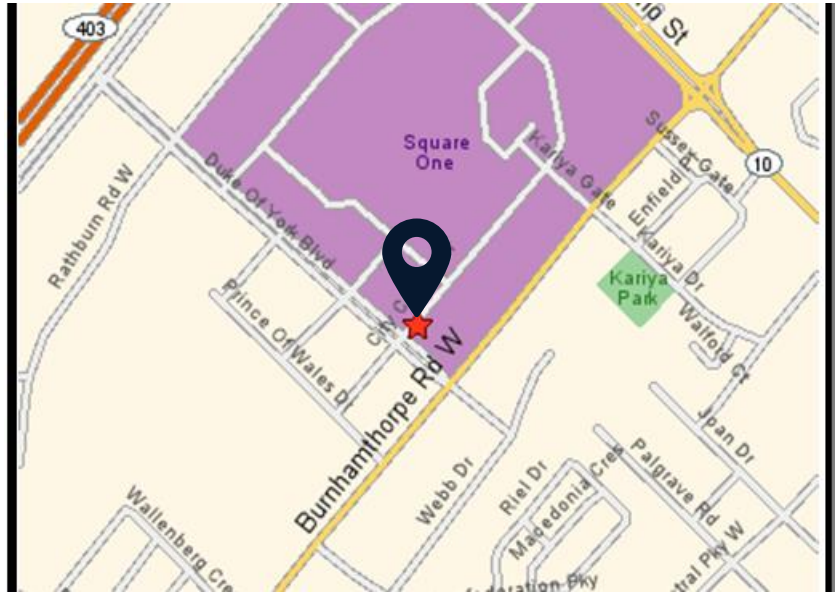
Magnetic field strength is used to determine the presence of metal

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



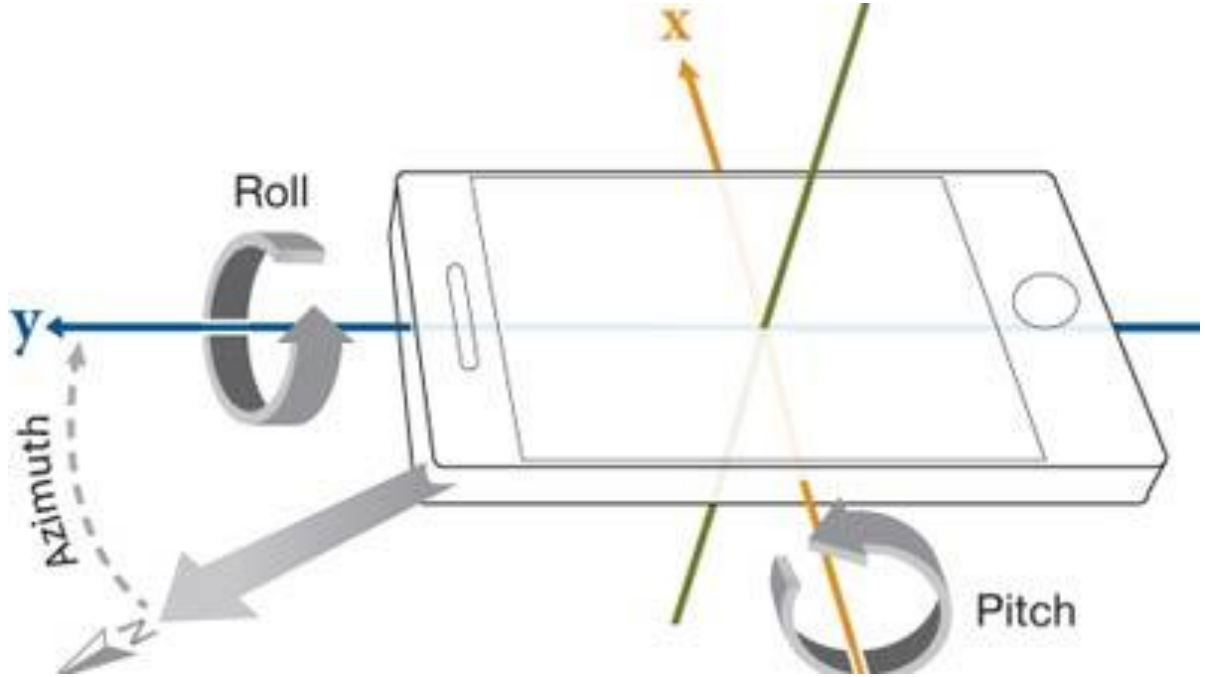
Magnetic field information is fed into applications on your phone

Compass



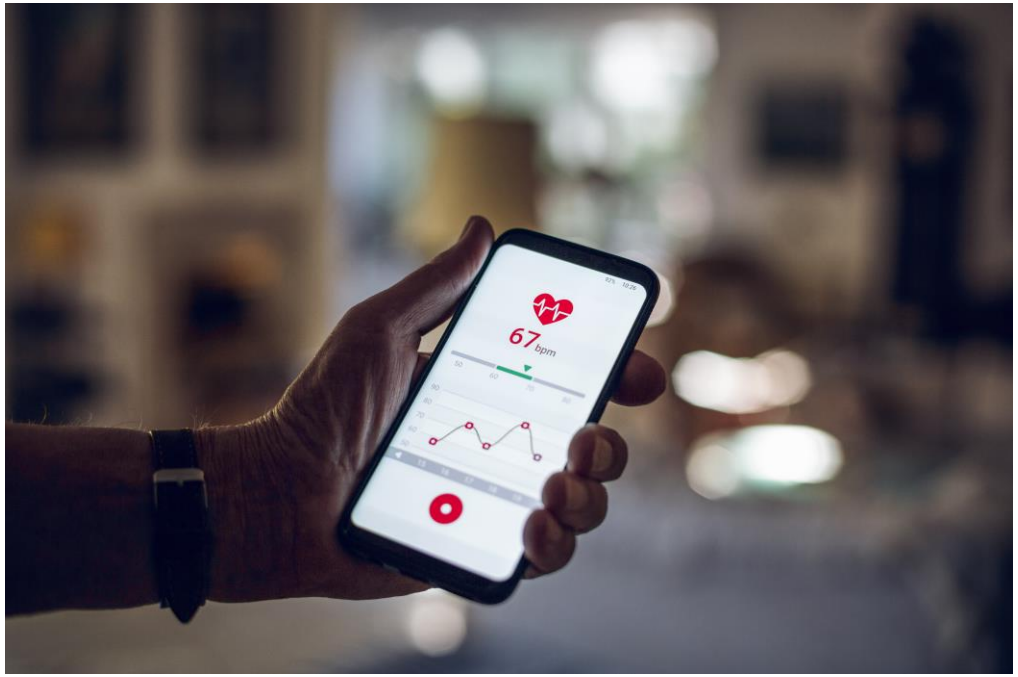
Location

An accelerometer detects acceleration, vibration, and tilt



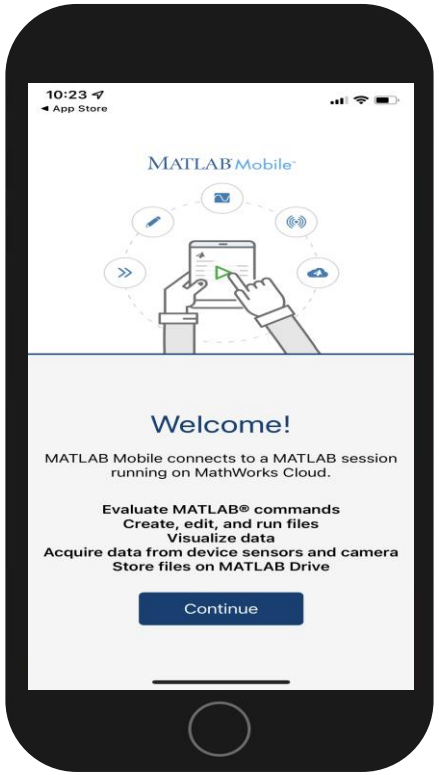
The accelerometer is used in motion input and orientation sensing applications

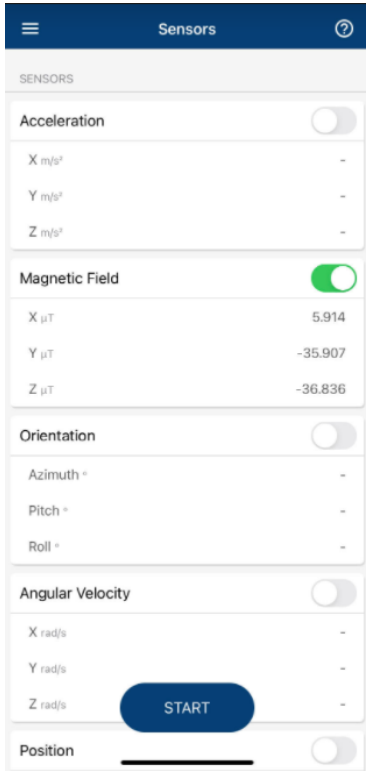
Phone orientation



Pedometer

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

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.

ThingSpeak™

Pre-Work and Other Resource Documents

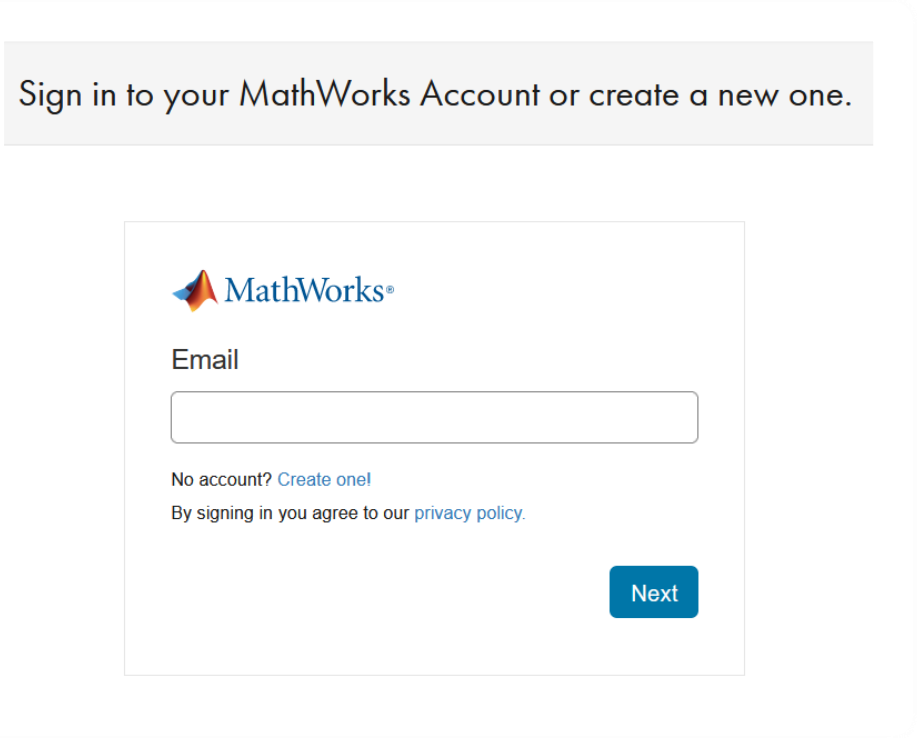
https://tinyurl.com/resourcesmakesenseghc22

LWHMW / PreWorkandResources_MakeSenseoftheUnseenWorld_Workshop_GHC22 Public

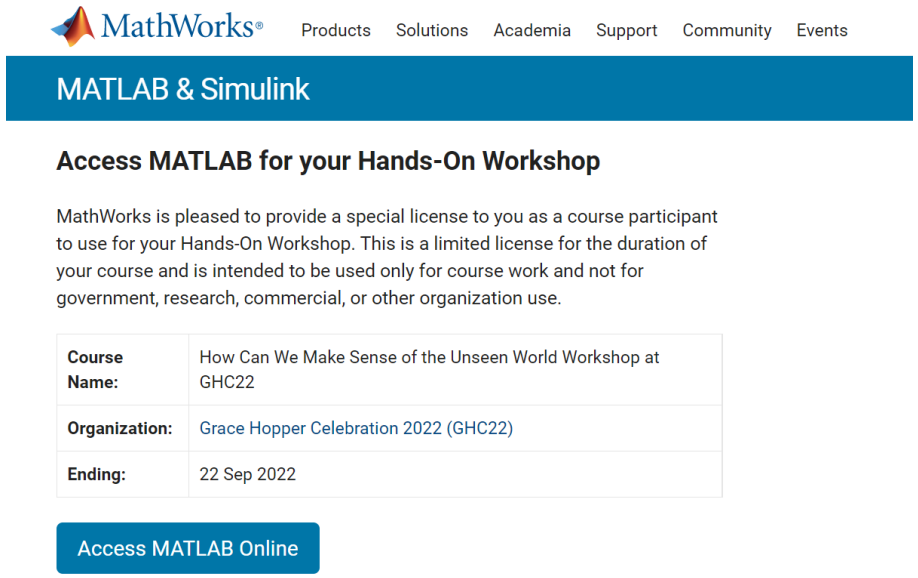
*Pre-work
*Link to Slack
*Handouts
-Mobile Devices
-Exercise Instructions
-Other Resources

Getting Access to MATLAB Online

1. Create a MathWorks Account

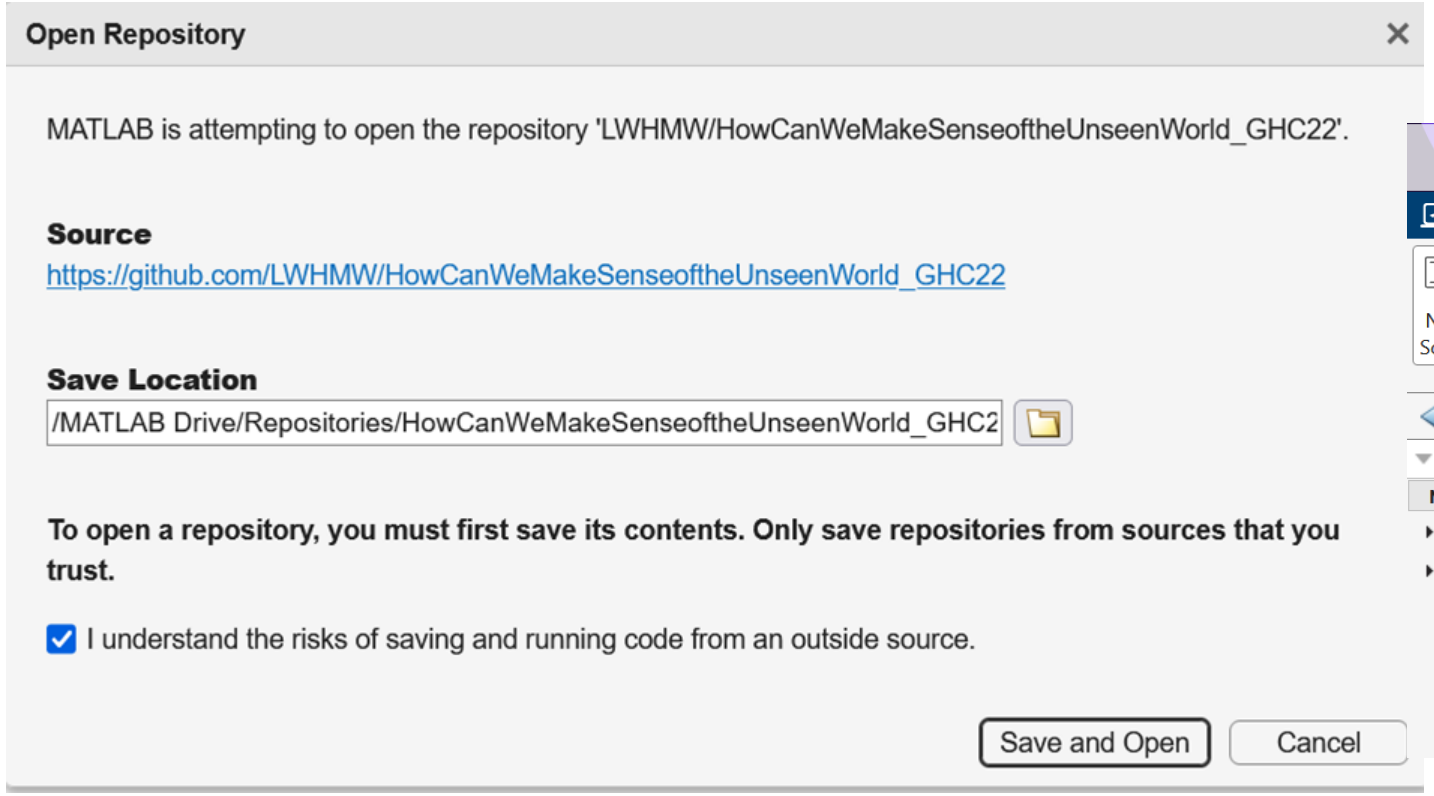


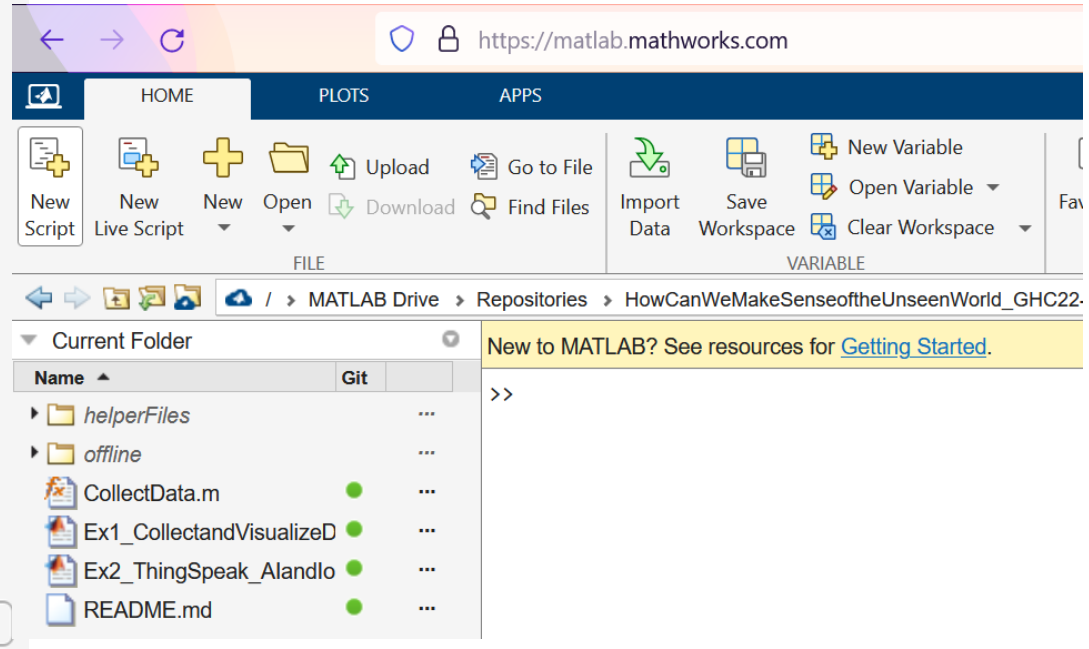
2. Access the license for this workshop



https://tinyurl.com/makesenseofunseenworldghc22

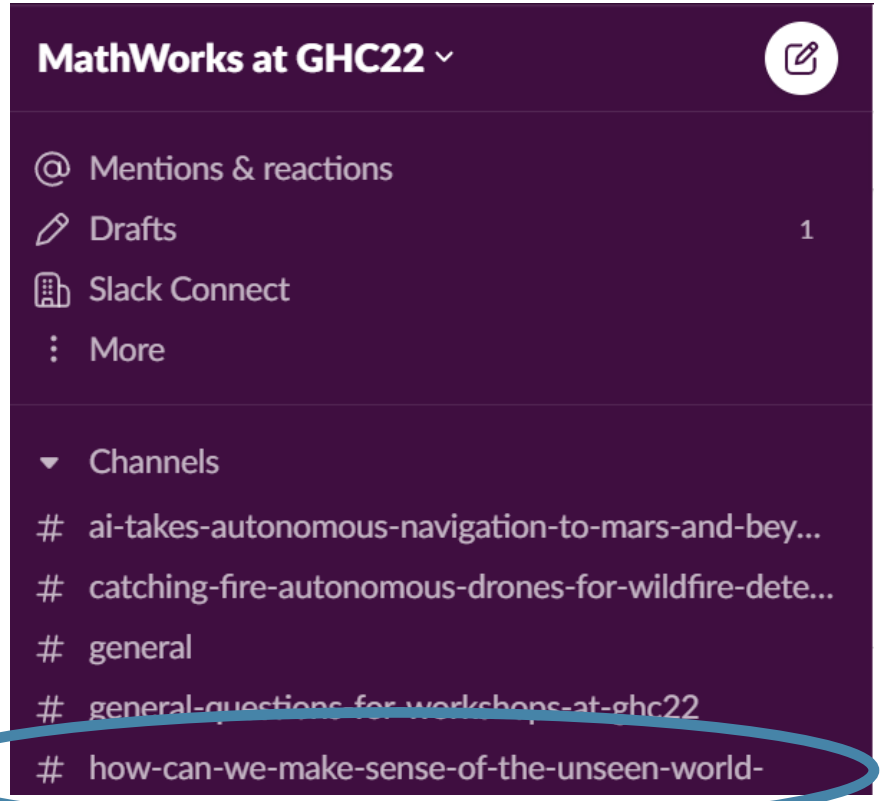
Obtain Access to Workshop Files





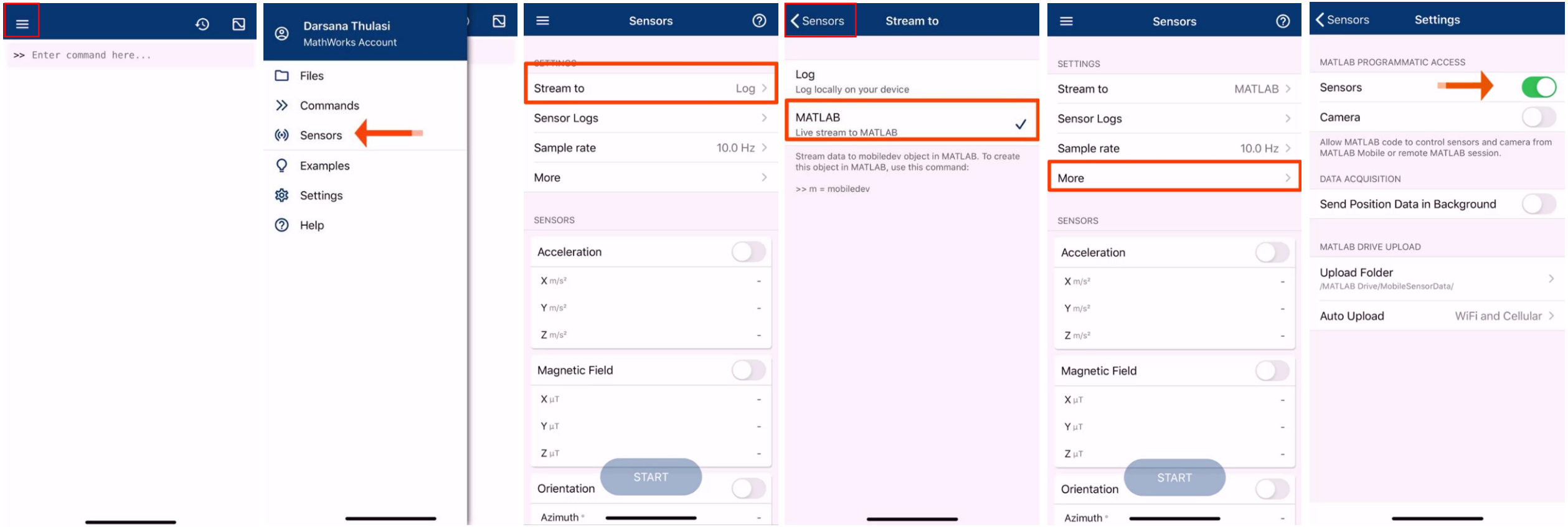
Slack Access for Troubleshooting

https://tinyurl.com/mwtechhelpghc22

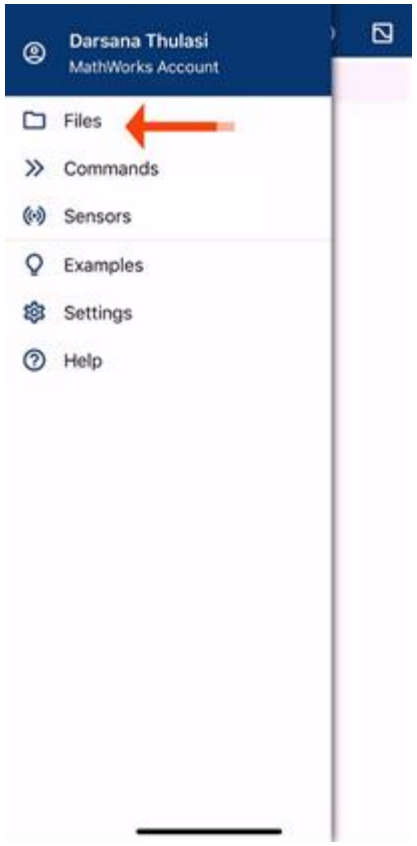


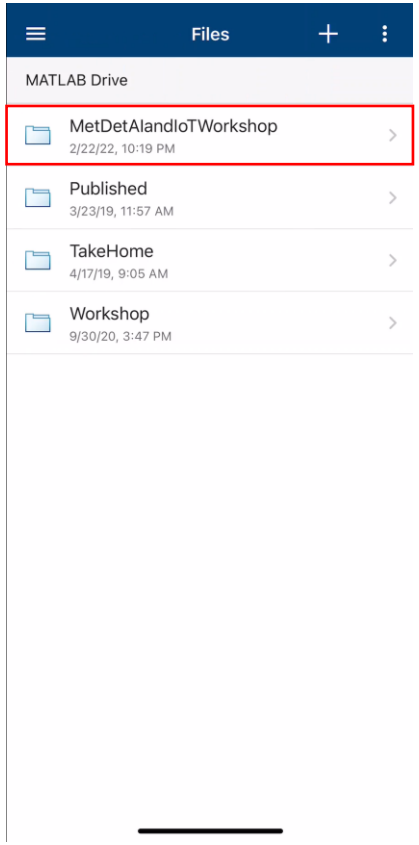
Content and Exercises

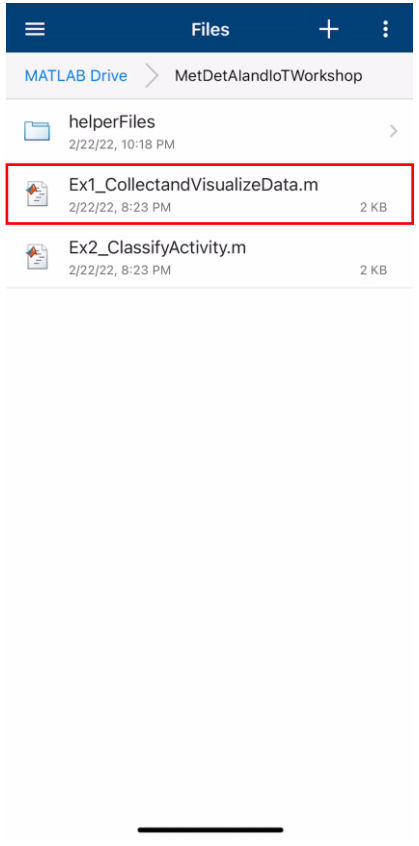
Enable the sensors in MATLAB Mobile

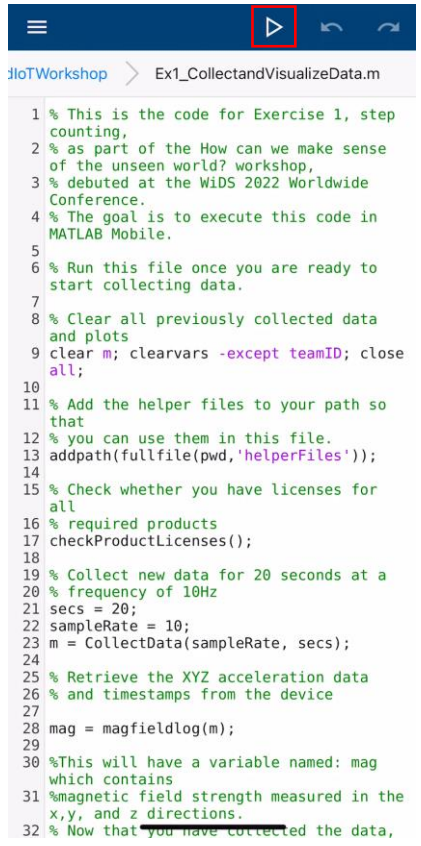


How to navigate and run code









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, summary statistics, and cluster analysis of the data

Ex1_CollectandVisualizeData.m

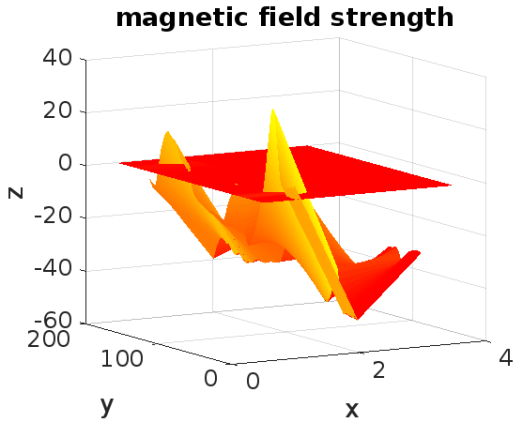
```
% Determining how the values maybe clustered (or not)

[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')
```

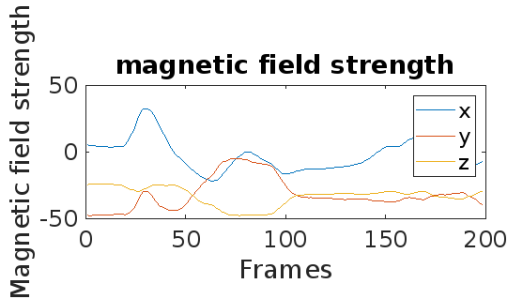
Exercise 1: Let's collect, visualize, and analyze statistics from the magnetometer data

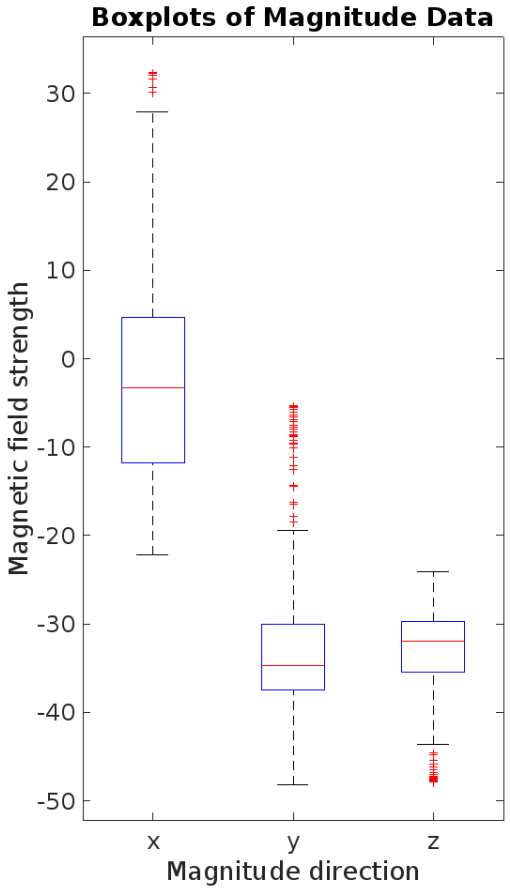
1. Open  **`Ex1_CollectandVisualizeData.m`** and press **Run** 
2. Wait for the prompt to start walking
3. WALK for 20 seconds
4. View the visualizations

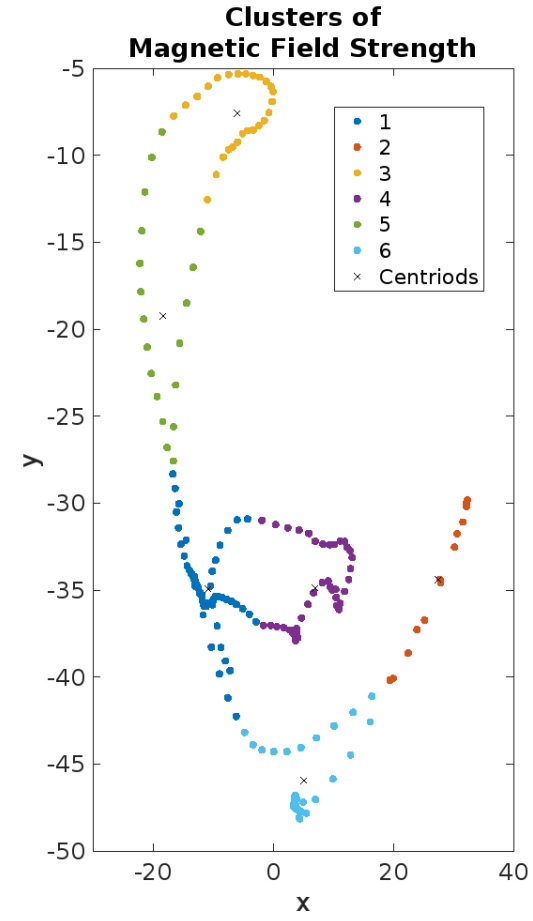
If you have time, try again and review the code

Did you get similar results for your output?



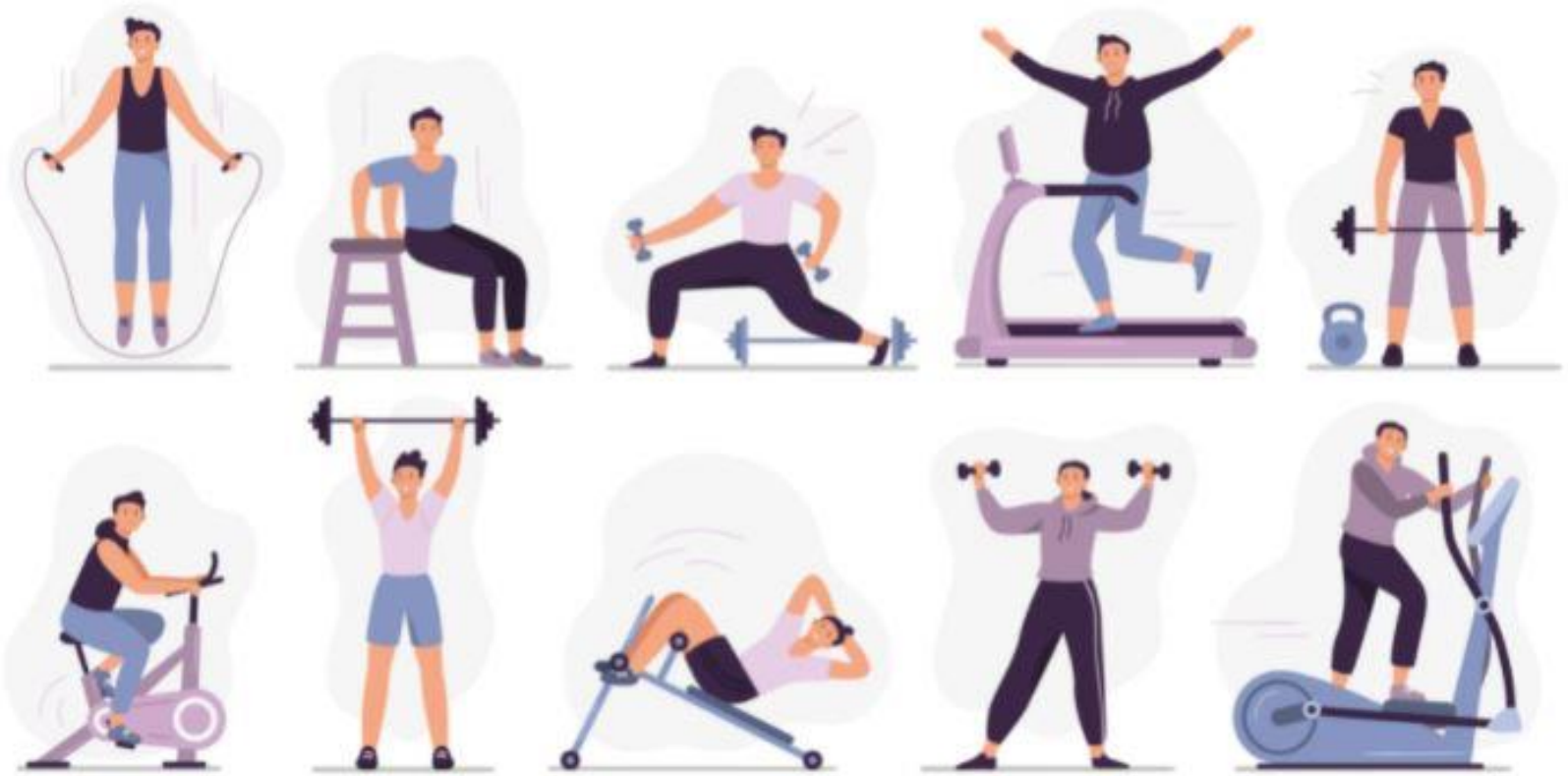




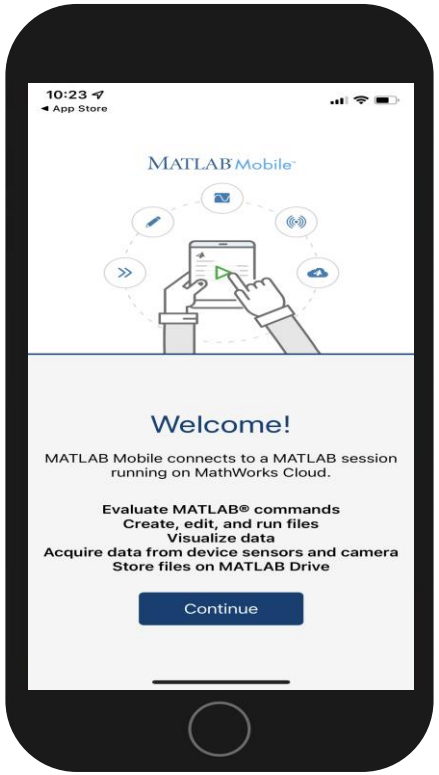


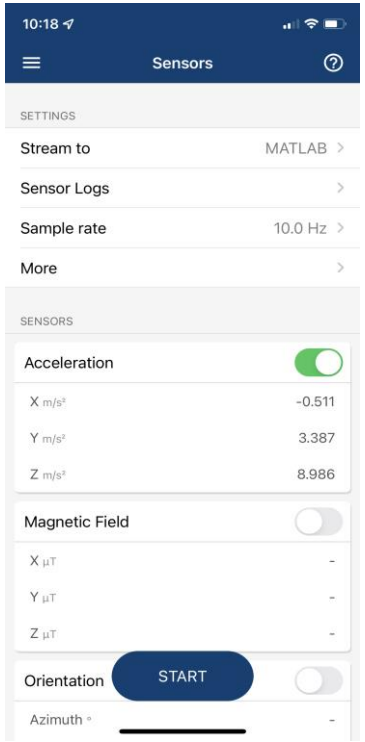
Now that you've collected data, can we explore what was occurring when the data was collected and how can this be analyzed?

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



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





Accelerometer

Android 8 or later

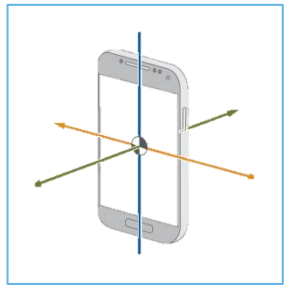
iOS 13 or later

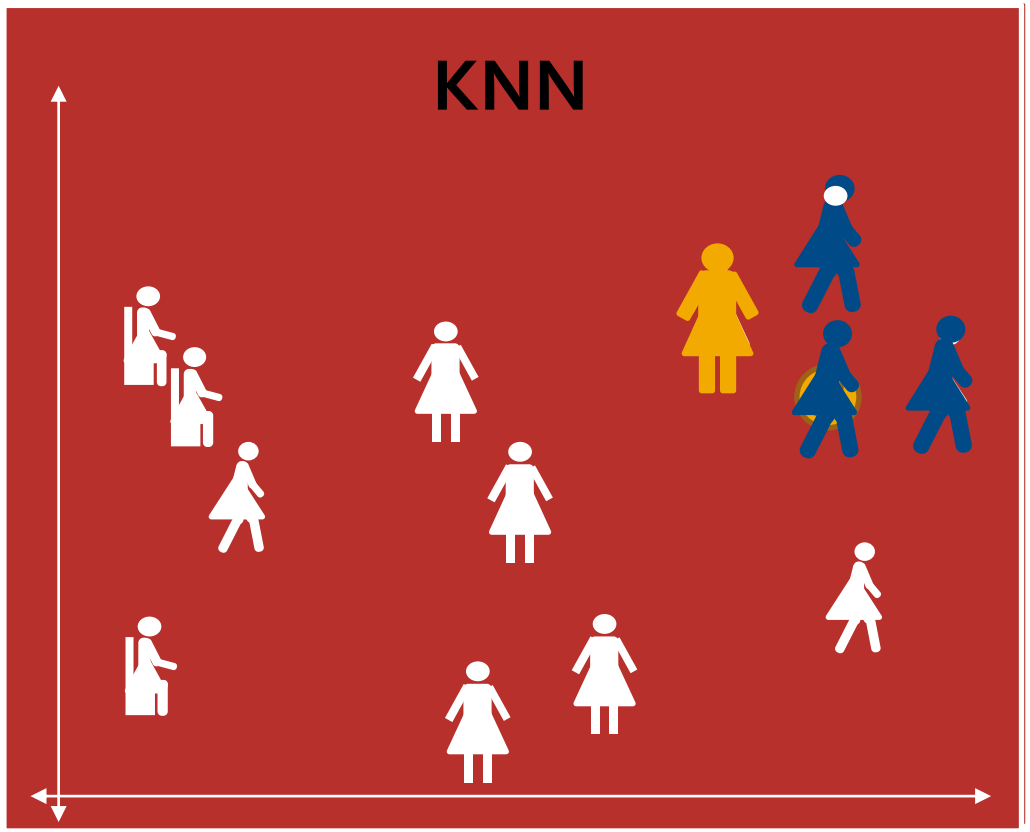
We will use Machine Learning to classify the accelerometer

Artificial Intelligence **Machine Learning**

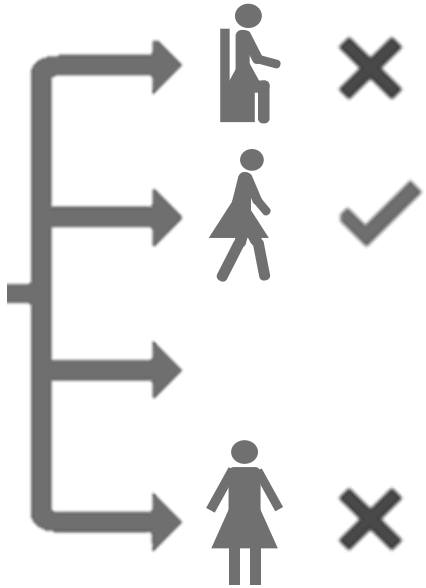
The accelerometer data was classified using the KNN algorithm

DATA





CLASSIFICATION

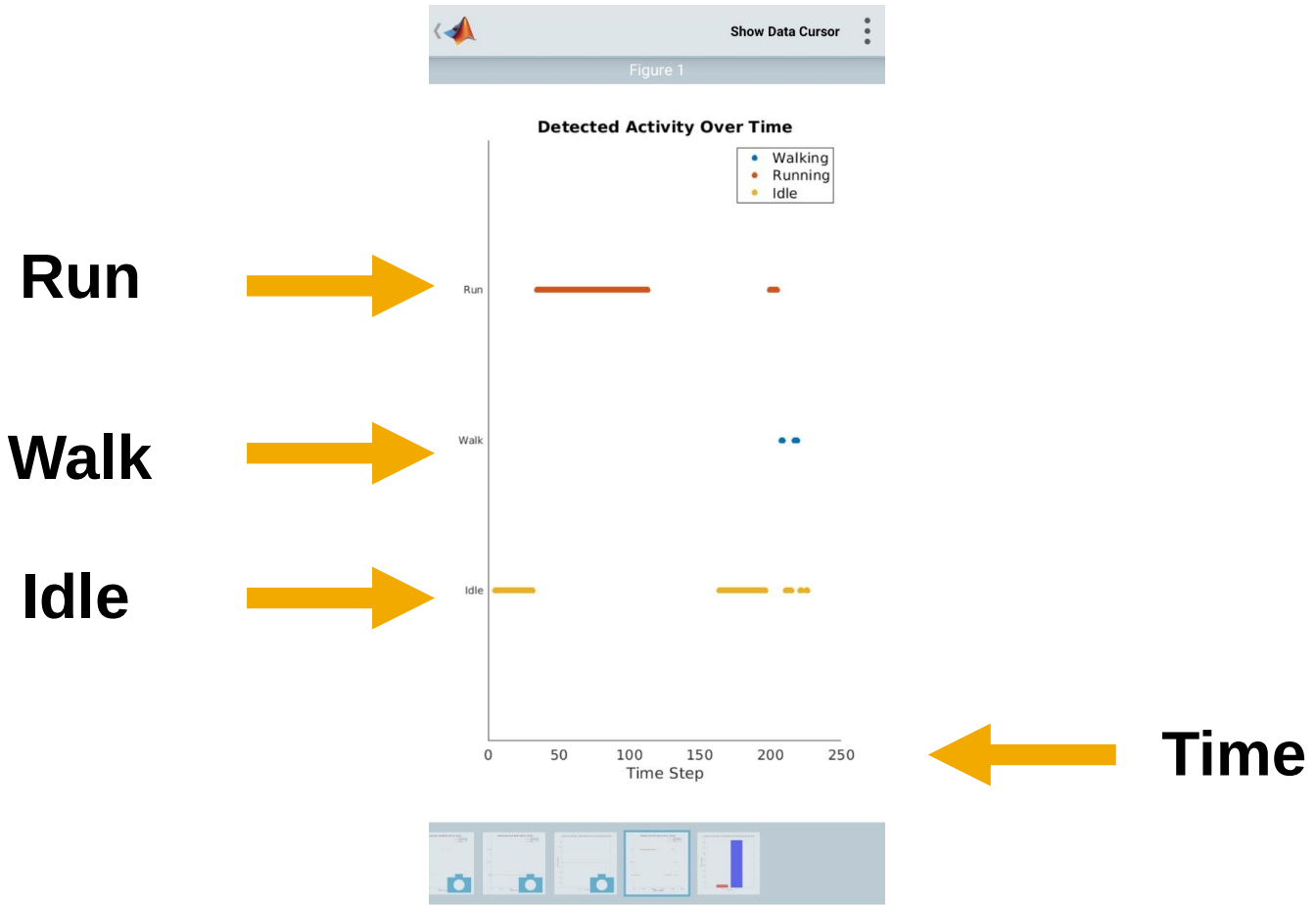


We will use training data to build a k-nearest neighbors model for classification

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);
```

The plot will show a breakdown of your activities over time



How can we aggregate our activity to the cloud?

Sensors

AI

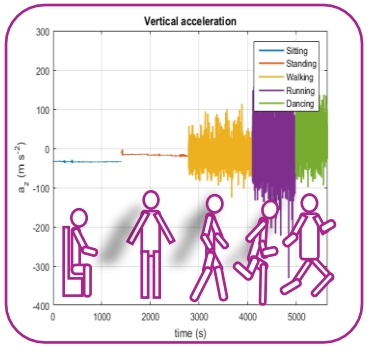
IoT

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

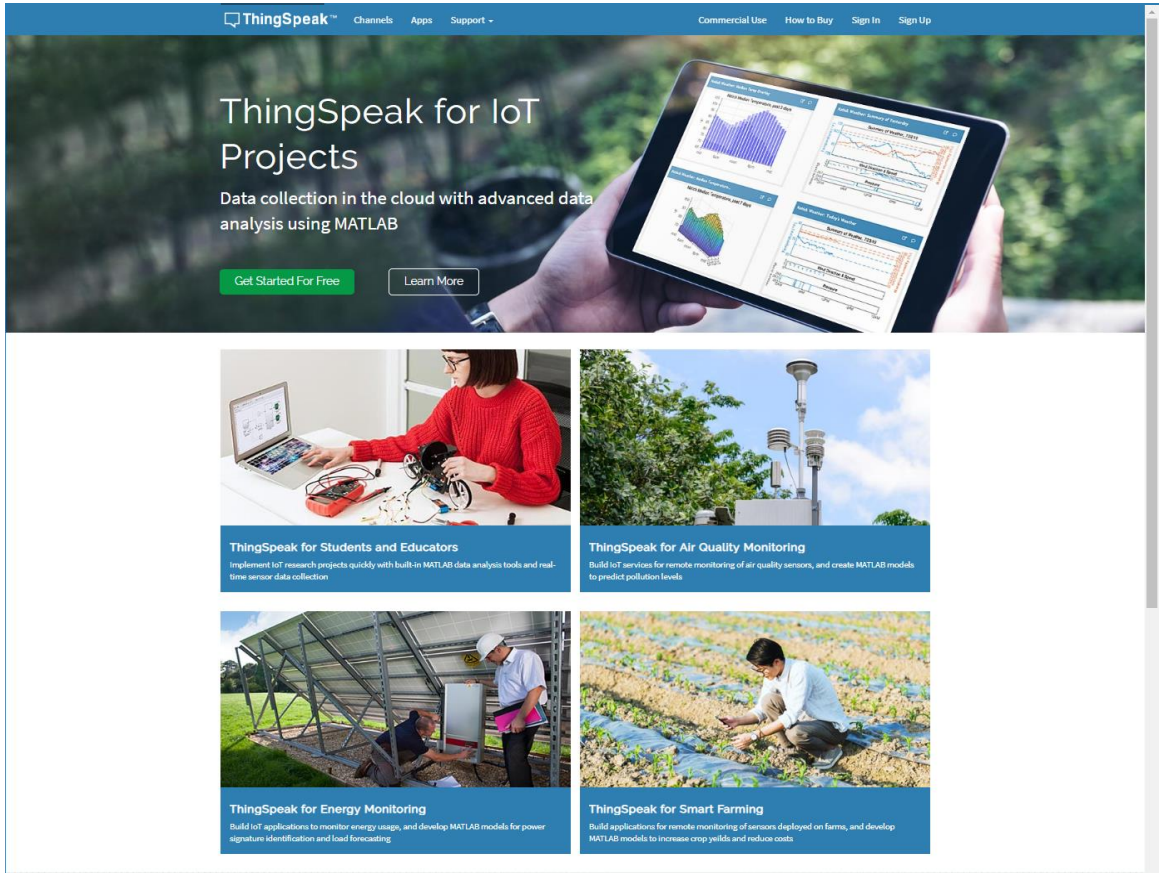
Collect — Data from "things"

Analyze — Trends

Act — Send alerts



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

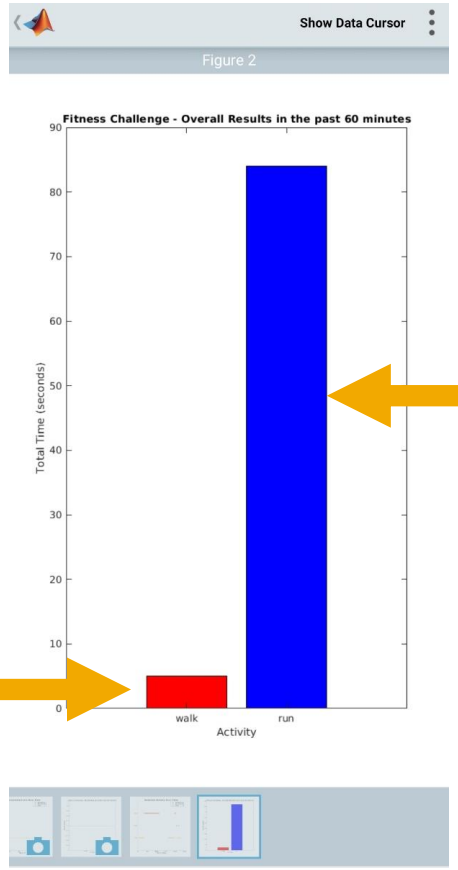
Exercise 2

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');
```

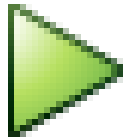
You can examine the figure to view everyone's combined time walking and running



Walk

Run

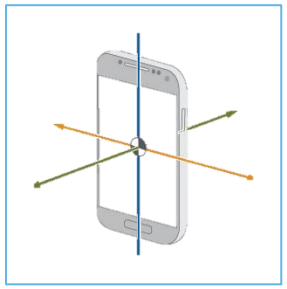
Exercise 2: Let's view yours and others total active time

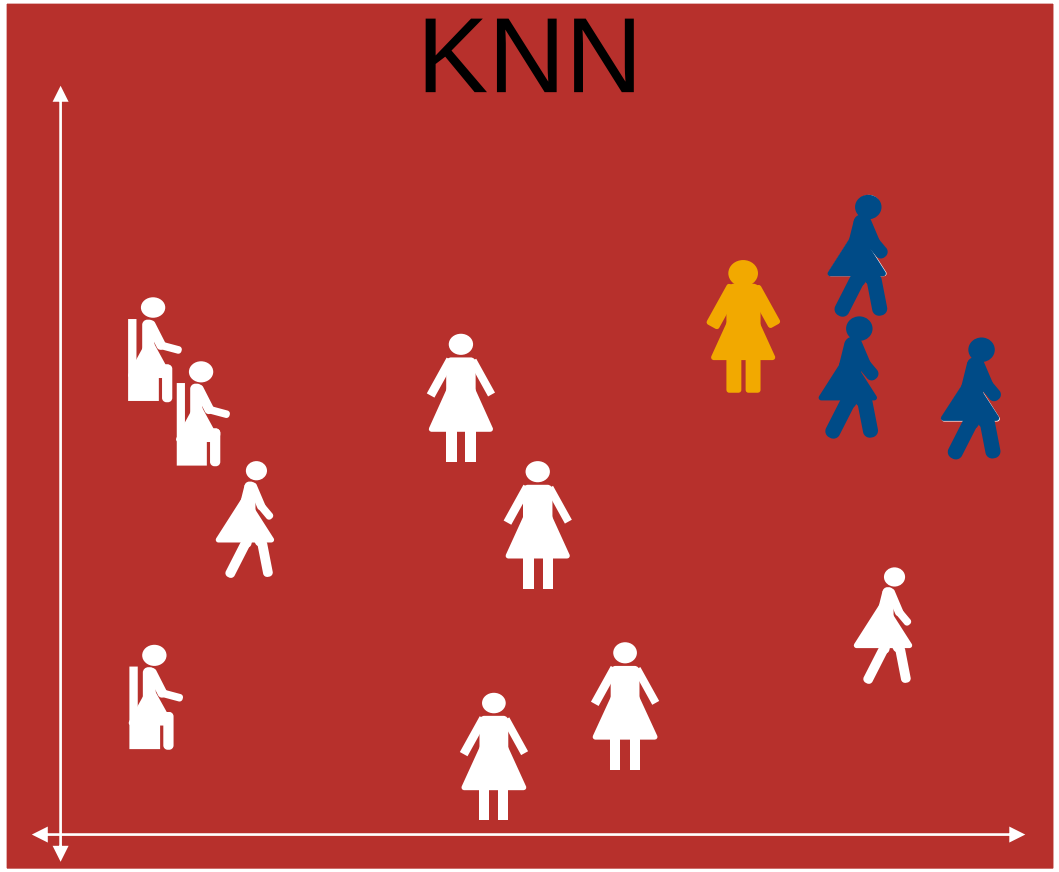
1. Open  **`Ex2_ThingSpeak_AIandIoT.m`** and press Run 
2. Type Team ID and press RETURN 
3. Press RETURN  when prompted to start logging
4. MOVE (Walk, Run, Idle) for 30 seconds
5. View the fitness activity from all teams

If you have time, log more data!

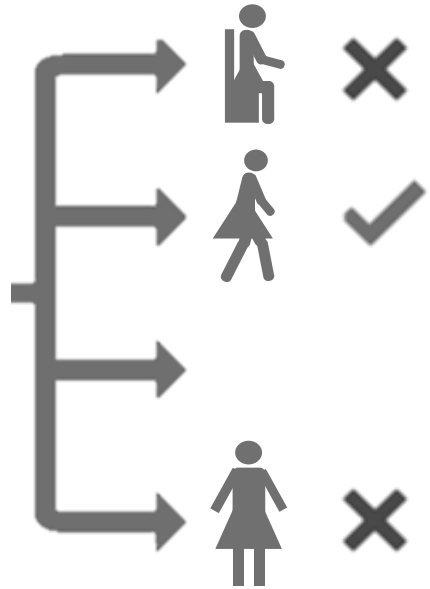
Did you get the results you expected?

DATA

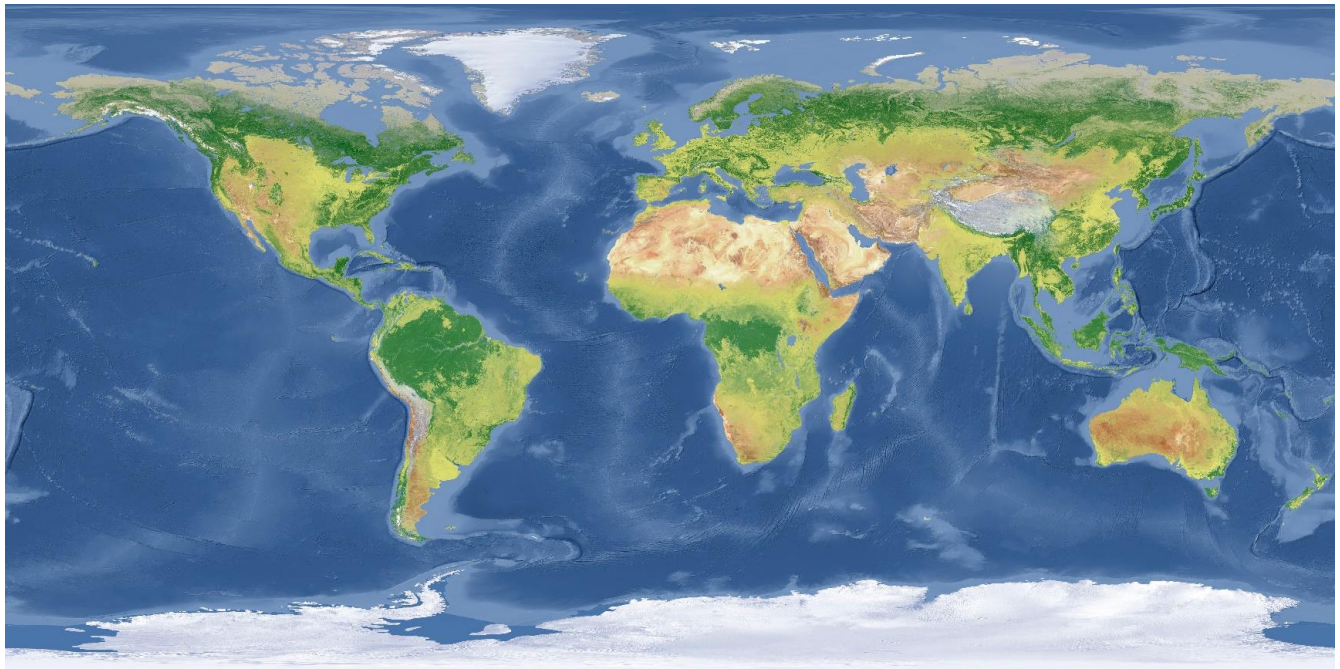




CLASSIFICATION



Should we explore collecting location data?



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