How Fitbits are made!

fitbit

STEM NOLA x Fitbit

Welcome!

07/17/2021

Workshop Leads

Tracy Giest
Research Manager
Major: Biomechanics
Favorite HS Subject: Physiology

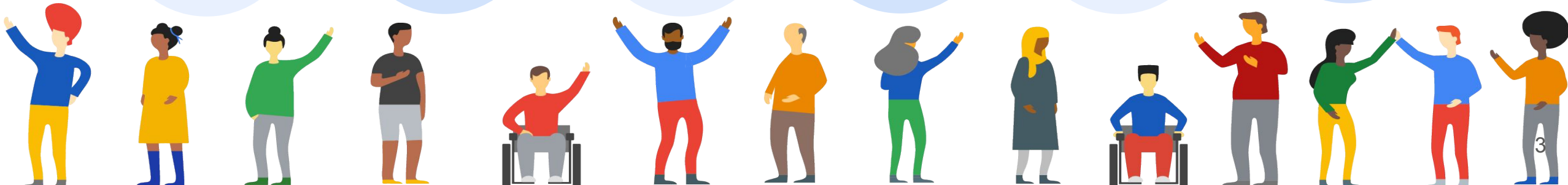
Alicia Kokoszka
Research Scientist
Major: Biomechanics
Favorite HS Subject: Biology, Anatomy & Photography

David Gutschick
Algorithm Research Scientist
Major: Mechanical Engineering and Materials
Favorite HS Subject: English & Physics

Naghmeh Rezaei
Research Data Scientist
Major: Physics, Protein Folding
Favorite HS Subject: Art, Physics, Calculus

Dan Howe
Research Scientist, Sensor Tech Lead
Major: Electrical Engineering
Favorite HS Subject: Physics and Electronics

Nathan Fritter
Capacity Engineer
Major: Applied Statistics
Favorite HS Subject: Chemistry



Workshop Leads

Herschel Watkins

Staff Research Scientist

Major: Biochemical Engineering

Favorite HS Subject: Chemistry

Scott Gilroy

Software Engineer

Major: Computer Engineering

Favorite HS Subject: Physics

Shiva Rajagopal

Senior Embedded Software Engineer

Studied: Computer Engineering

Favorite HS Subject: Chemistry

Ehsan Nourbakhsh

Systems Engineer

Studied: Computer Science

Favorite HS Subject: Algebra

Mahya Shahbazi

Senior R&D Engineer

Studied: Electrical Engineering

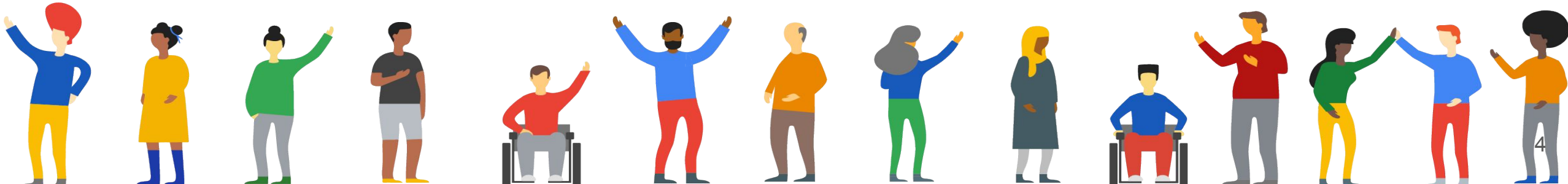
Favorite HS Subject: Art, Physics, Math

Aniket Deshpande

Research Associate

Major: Biomedical Engineering

Favorite HS Subject: Physics, Biology, Art



Agenda

- What is Fitbit
- Module 1: Using Sensors (45 min)

  [Short Break]

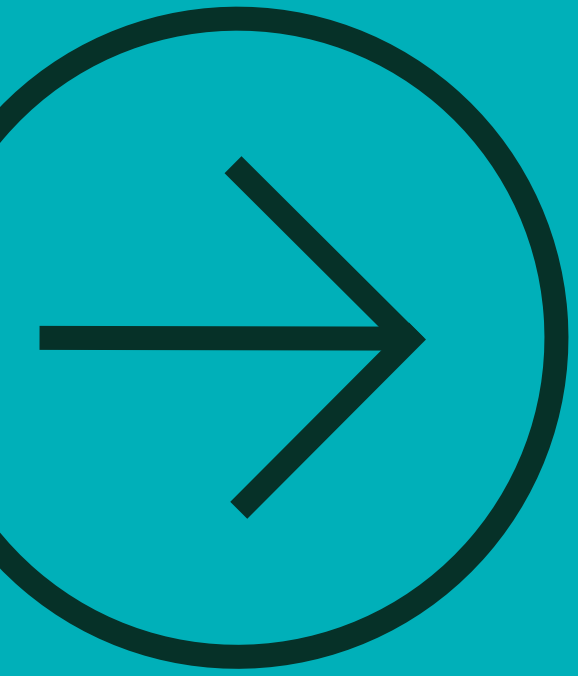
- Module 2: Working with Algorithms (1 hour)

  [Short Break]

- Module 3: Develop your own Product (25 min)

- Demos & Wrap-up (10 min)

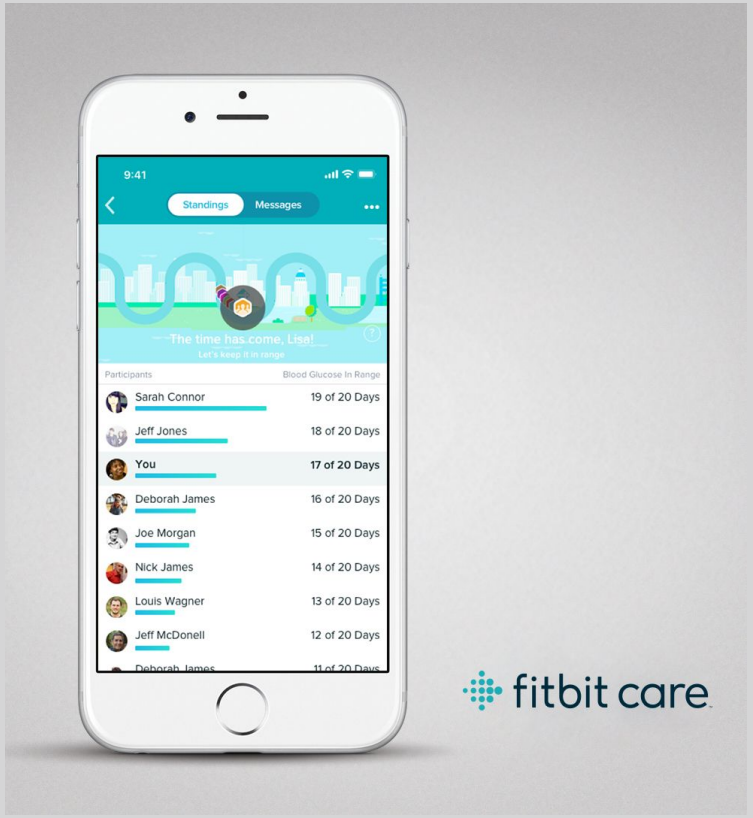
fitbit



Our mission is to help people lead healthier, more active lives by empowering them with data, inspiration and guidance to reach their goals.

DEVICES

User Experience

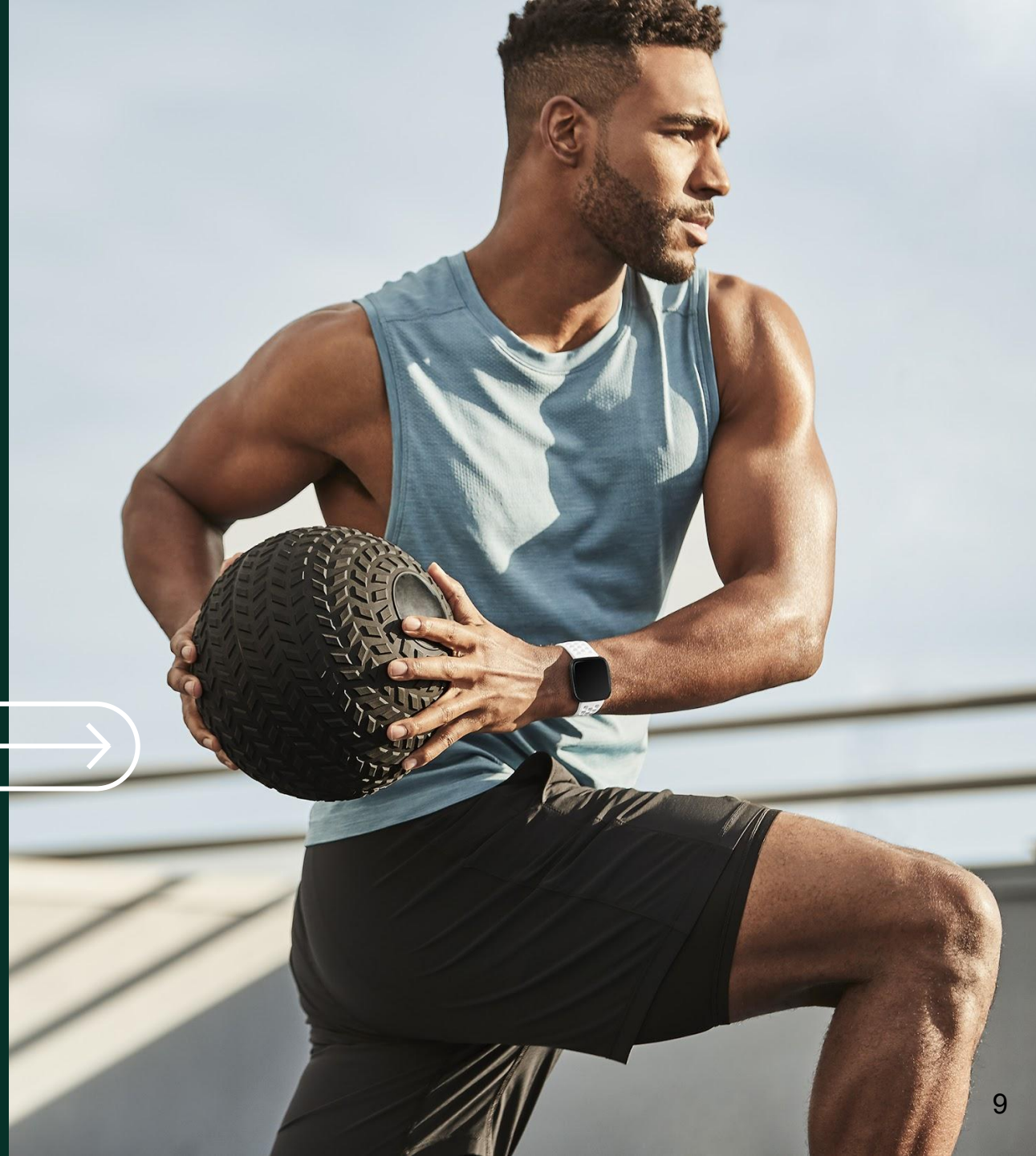


Health & Wellness Solutions

Questions

- Ask questions: Raise your hand to speak up or ask questions
- Use the chat option when prompted
- When in breakouts, ask questions often: we're here to learn

Module 1: Sensors



Have you ever wondered?

Pitch Perfect

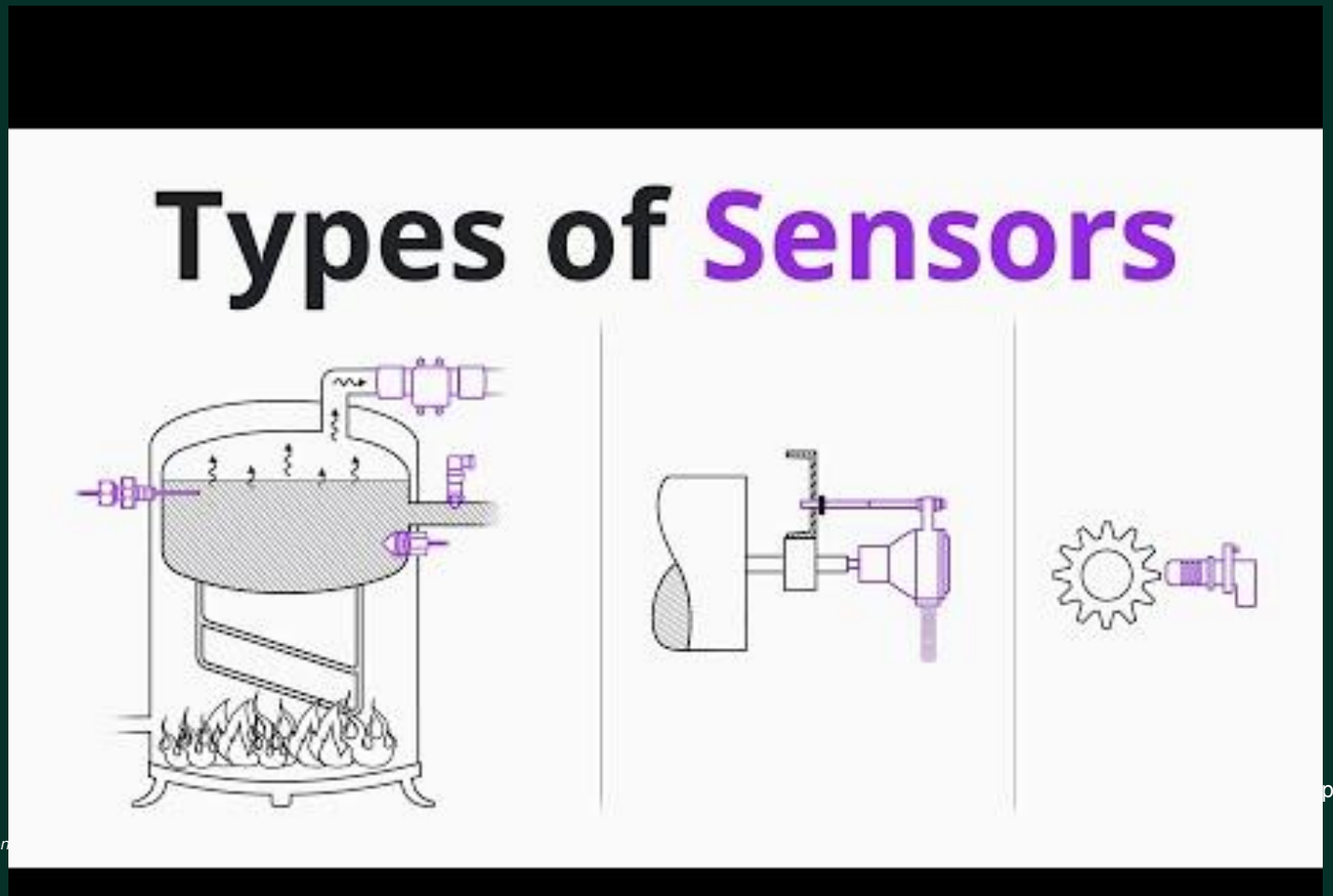
How does your phone know how you are holding it?

How can a car drive itself?

How does a Fitbit count your steps?

What is a sensor?

A sensor is a device that senses something...
... it converts a physical quantity into an electrical signal.



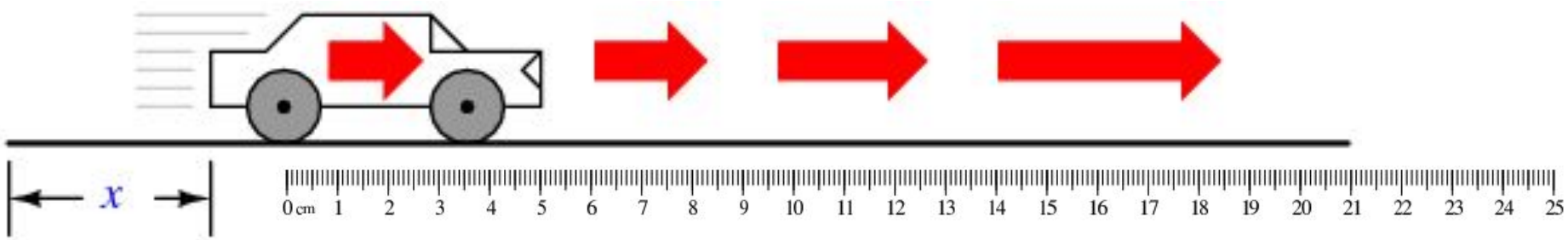
ps://www.electronicshub.org/different-types-sensors/

How to count steps?

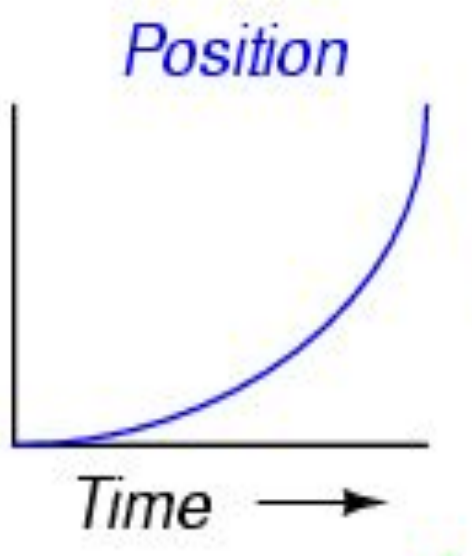
Option 1 Manually count them

Option 2 Use a motion sensor!

Motion Sensors

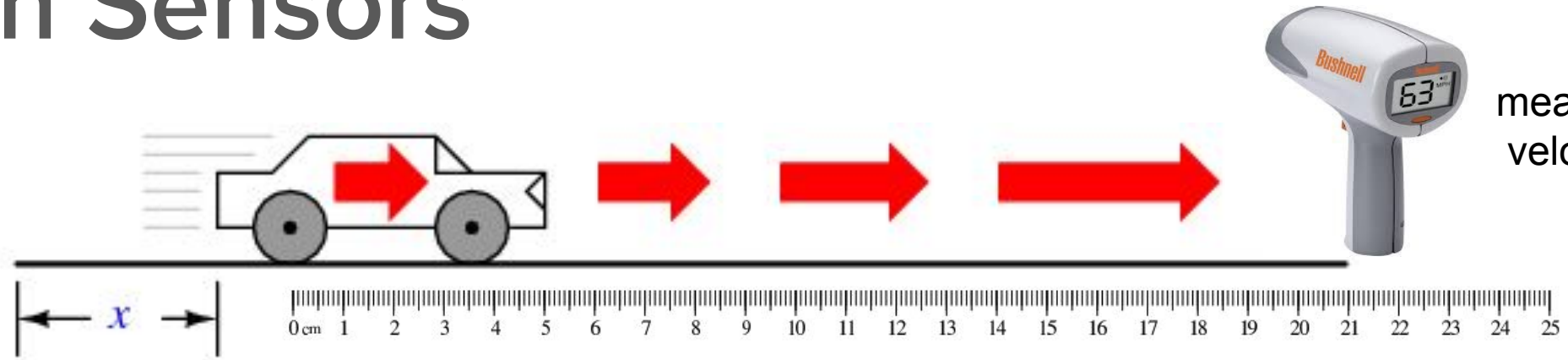


measure position



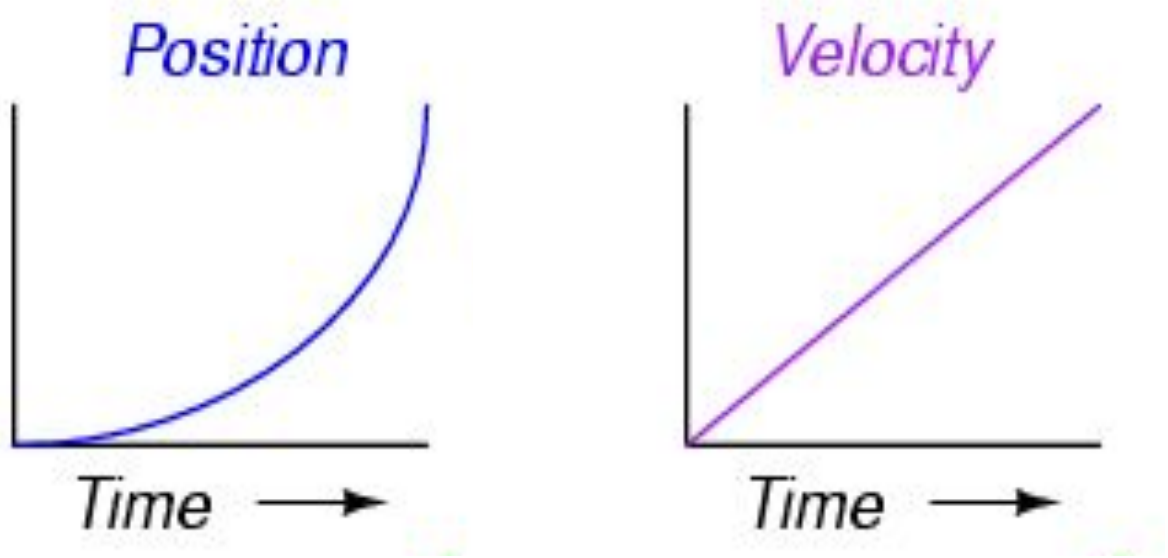
http://maretbccalculus2007-2008.pbworks.com/w/page/20301418/Interpretation-of-the-derivative-as-a-rate-of-change-velocity%2C-speed%2C-and-acceleration

Motion Sensors



measure velocity

measure position



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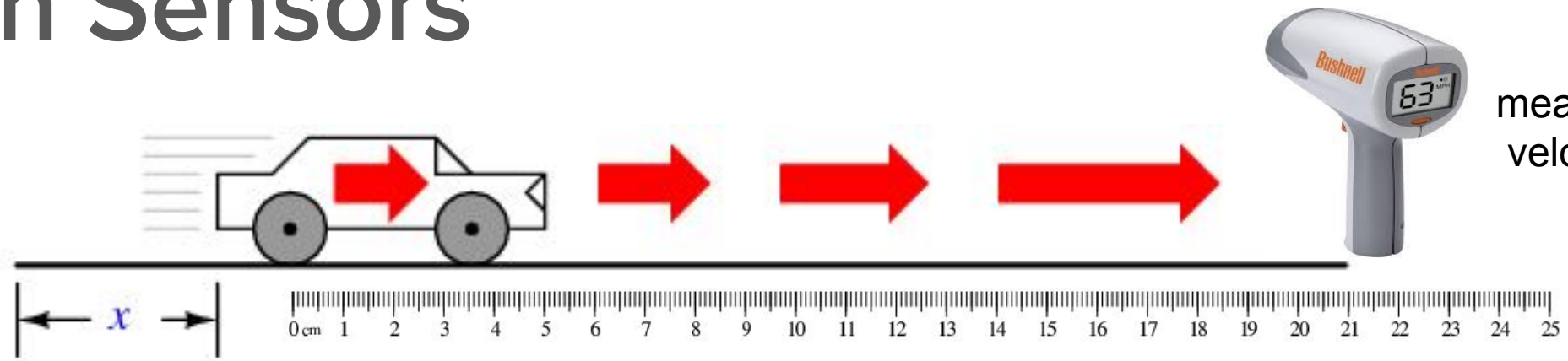
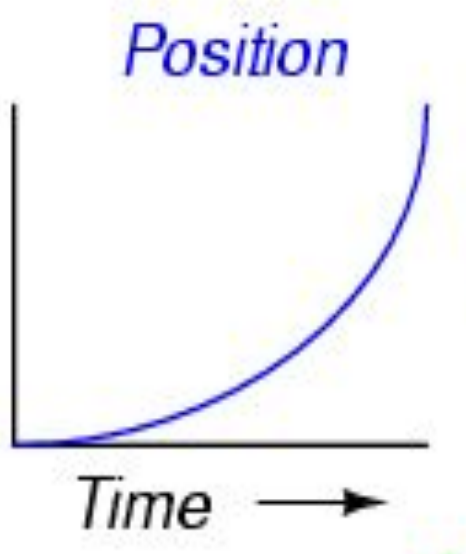
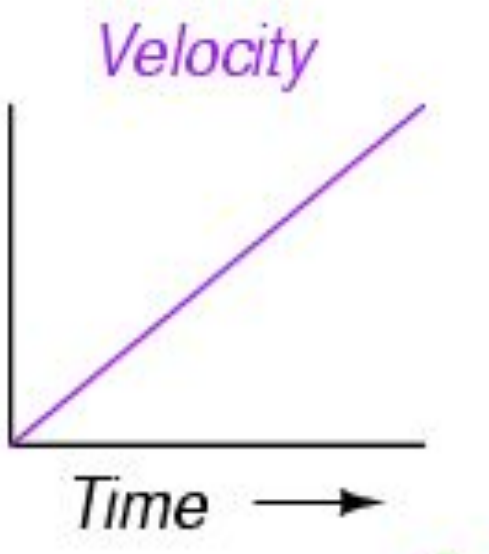
Motion Sensors

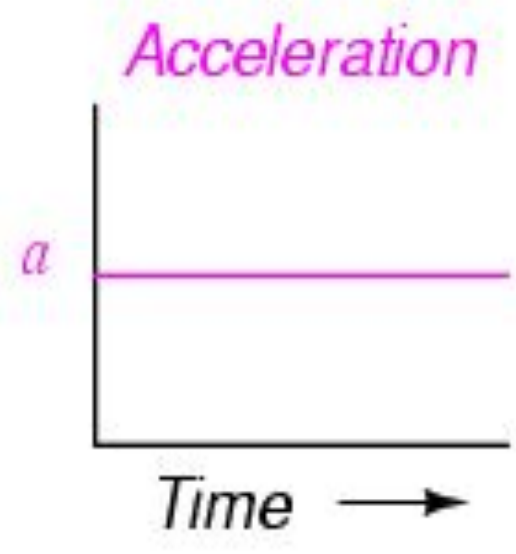


measure velocity

measure position







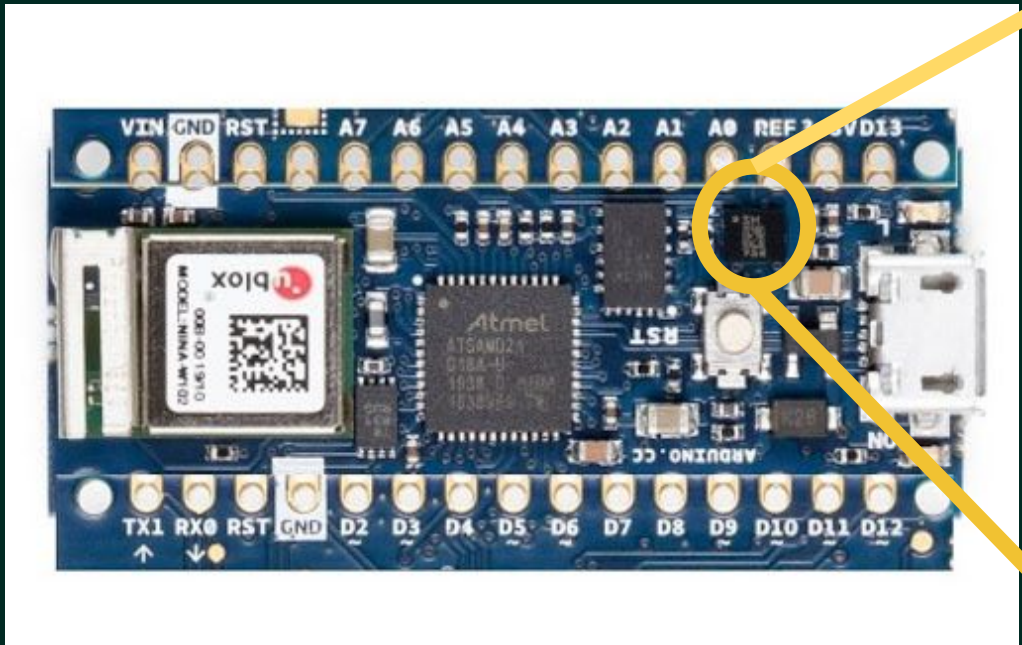
measure acceleration

http://maretbccalculus2007-2008.pbworks.com/w/page/20301418/Interpretation-of-the-derivative-as-a-rate-of-change-velocity%2C-speed%2C-and-acceleration

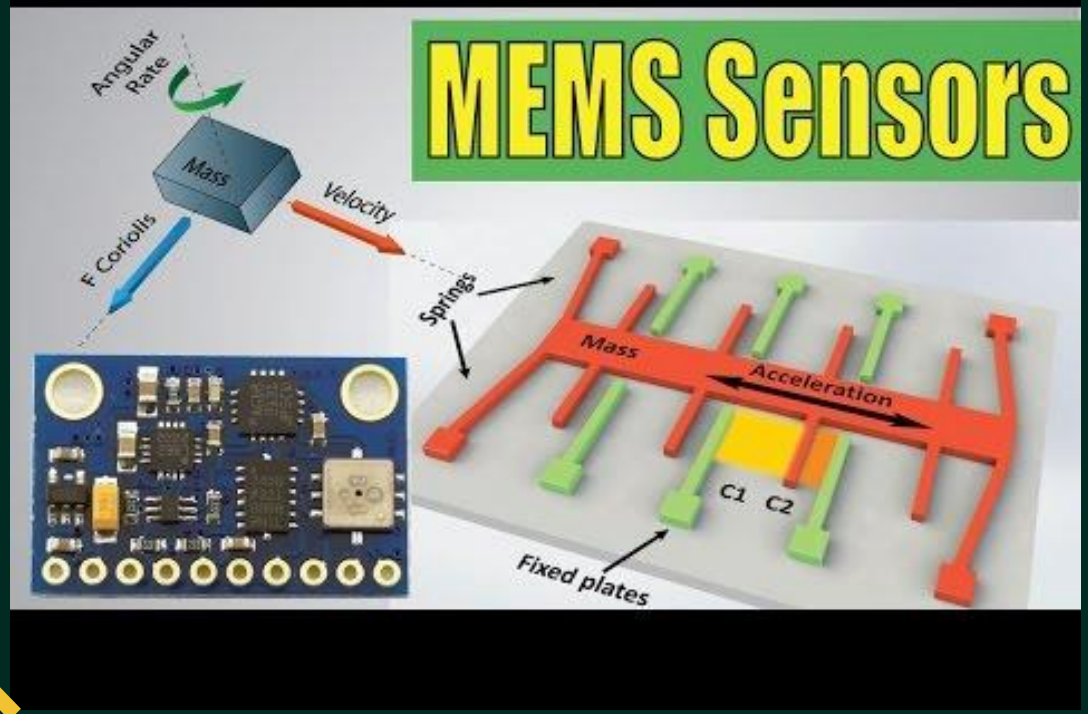
Accelerometer Motion Sensor

Convert acceleration (physical quantity) to electronic capacitance value (electrical signal).

Arduino



Micro Electro Mechanical System (MEMS) Sensor



Physics equations:

Weight: Force = mass * acceleration **(Newton's 2nd Law)**

Spring: Force = - k * distance

A = (-k*x)/m

https://howtomechatronics.com/how-it-works/electrical-engineering/mems-accelerometer-gyrocope-magnetometer-arduino/

The Code in a Jupyter Notebook

Jupyter notebooks run using a coding language called **Python**

Fun Fact: Python isn't named for a snake. It's named after Monty Python, a comedy group that happens to have Python in their name.

We'll guide you through the steps today, but you can always learn more!

Example Python Code:

```
trial_name = 'test_trial'
data_folder = 'test_data/'
num_samples = 100 # ~10-15 seconds
expected_cols = ['t','x','y','z']

# Note on collecting data:
# unplug / plug in arduino, or press reset button to reset buffer for each
# is there a better way?? otherwise the already queued data gets read rathe
port = Serial(port=arduino_port, baudrate=arduino_baudrate)
port.flushInput()
port.flushOutput()

# Read data
t0 = time.time()
data = []
for n in range(num_samples):
    entries = unpack_serial_line(port.readline(), expected_cols)
    if entries:
        data.append(entries)
print(f"Finished: {trial_name}\n"
      f"Collected {len(data)} samples in {time.time() - t0} seconds.")
```

🔥 🔥 🔥 ***HOT TIP:*** Adding a # before a line of text allows you to make comments in your code. Great for adding notes and directions.

fitbit

BREAKOUT 1!

Set up Arduino & Measure accelerations

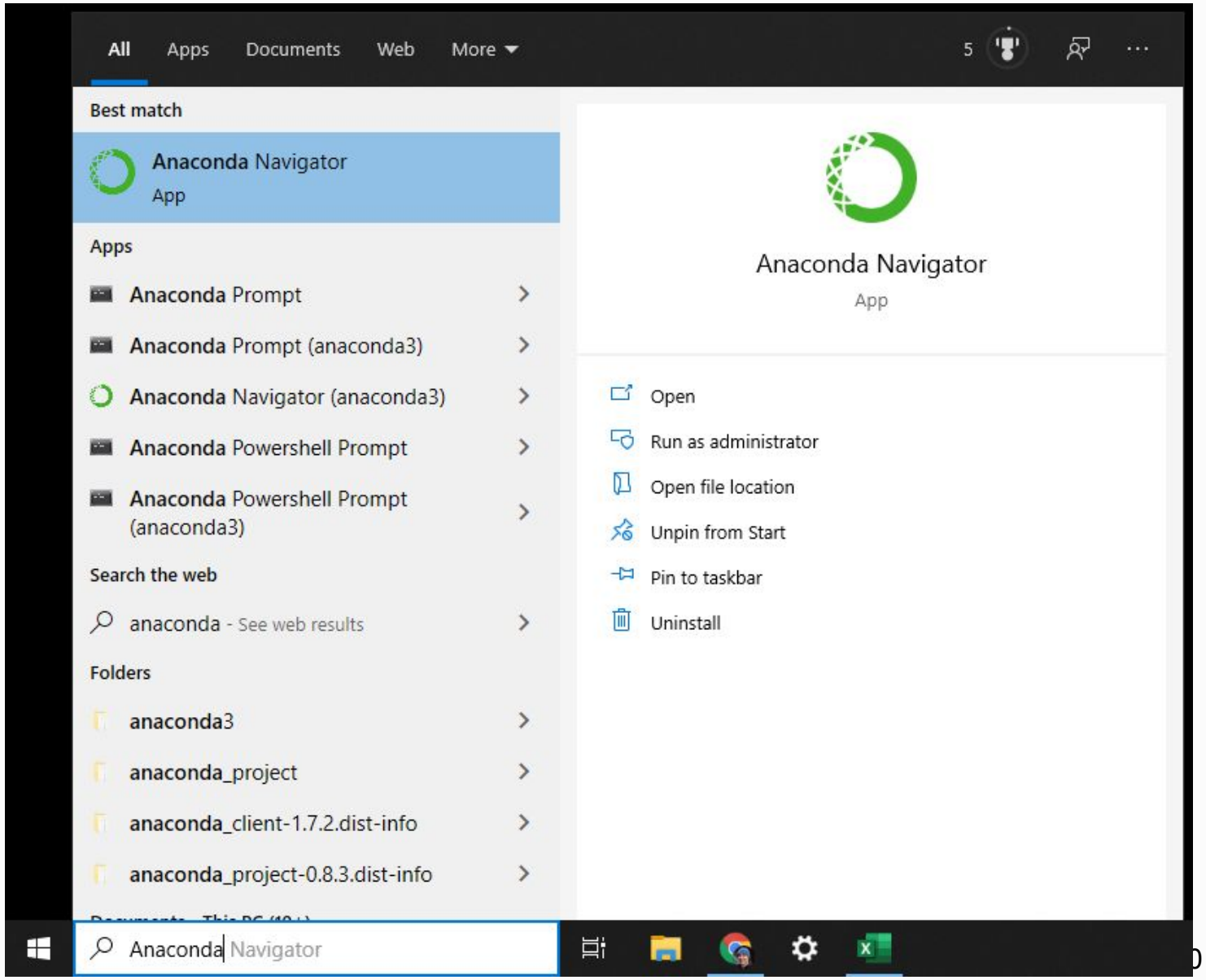
35 minutes

Break Out Instructions- 1. Set Up Anaconda

2. Download folder from git
3. Set Up Arduino
4. Launch Jupyter Notebook

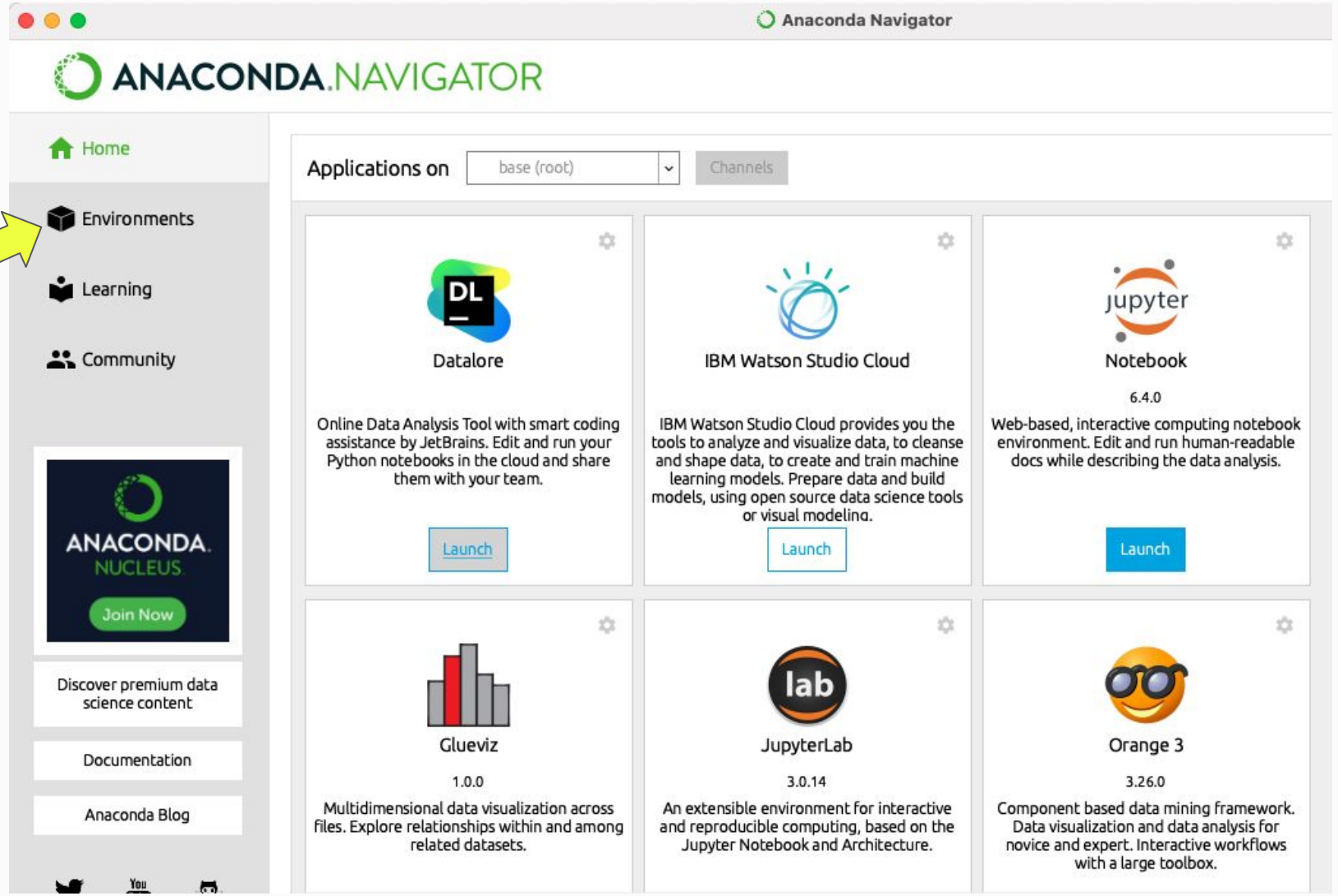
Break Out Instructions- Set Up Anaconda

1. Open *Anaconda Navigator* from the start menu



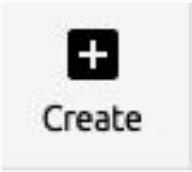
Break Out Instructions- Set Up Anaconda

2. Click on *Environments* on the left panel



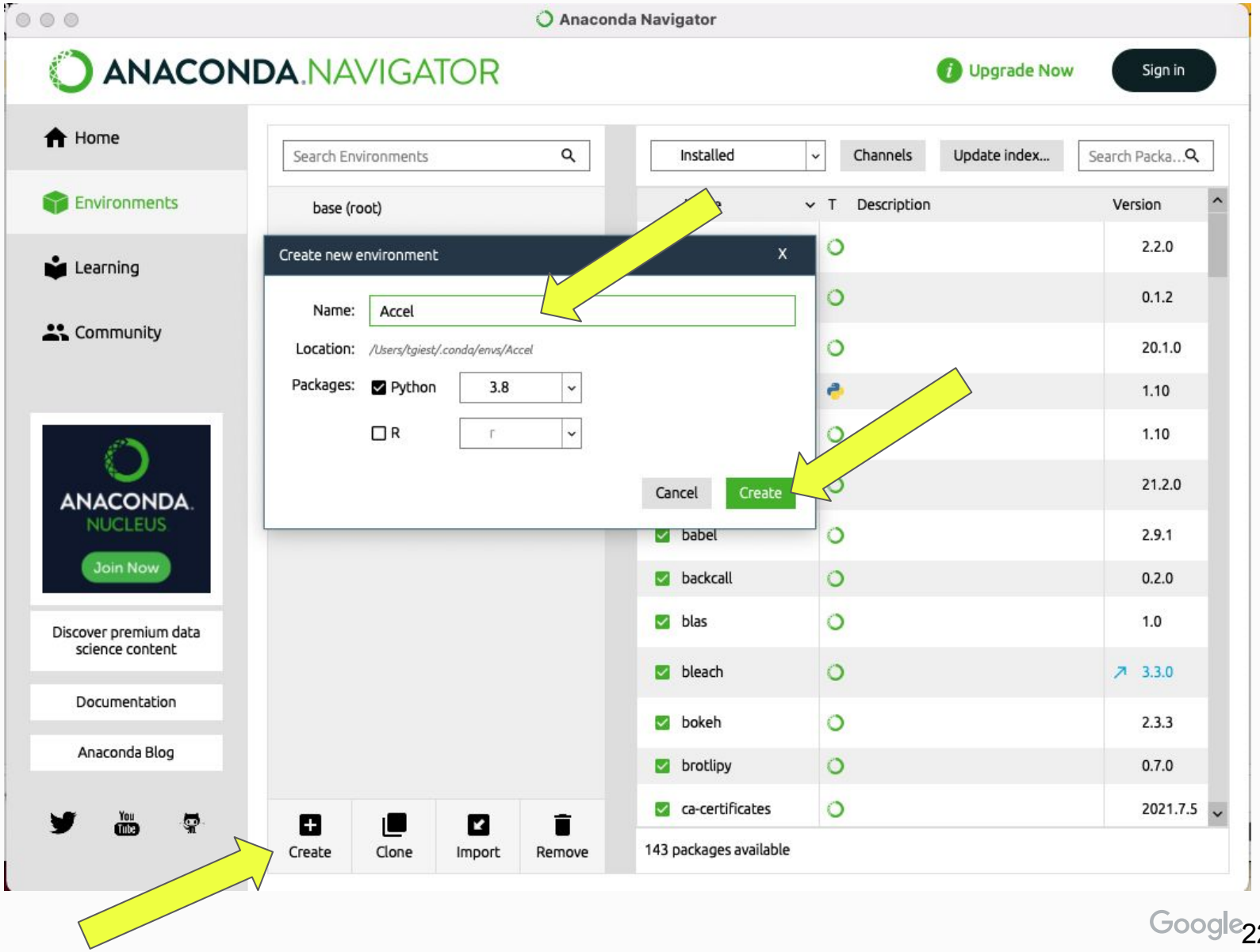
Break Out Instructions- Set Up Anaconda

3.

- Click on 

- Type in a name

- Click on 

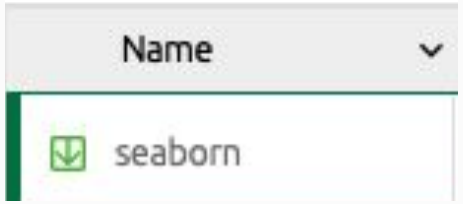


Break Out Instructions- Set Up Anaconda

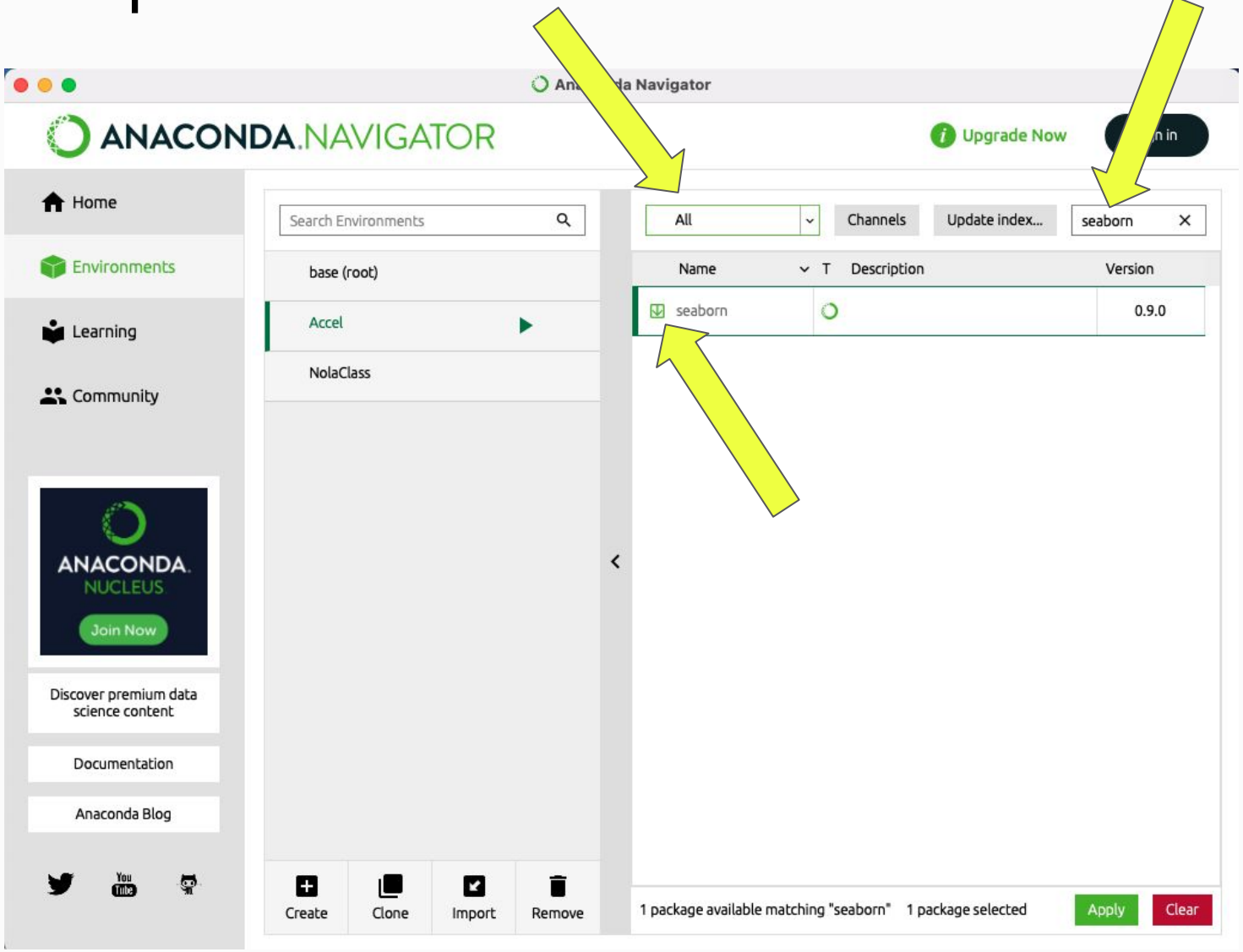
4.

- Select “All” from the drop down 

- Search for “seaborn” 

- Click the box 

- Repeat this for:
  - streamz
  - pyserial
  - hvplot



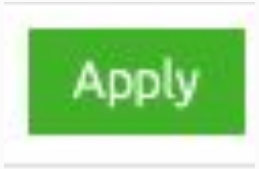
Break Out Instructions- Set Up Anaconda

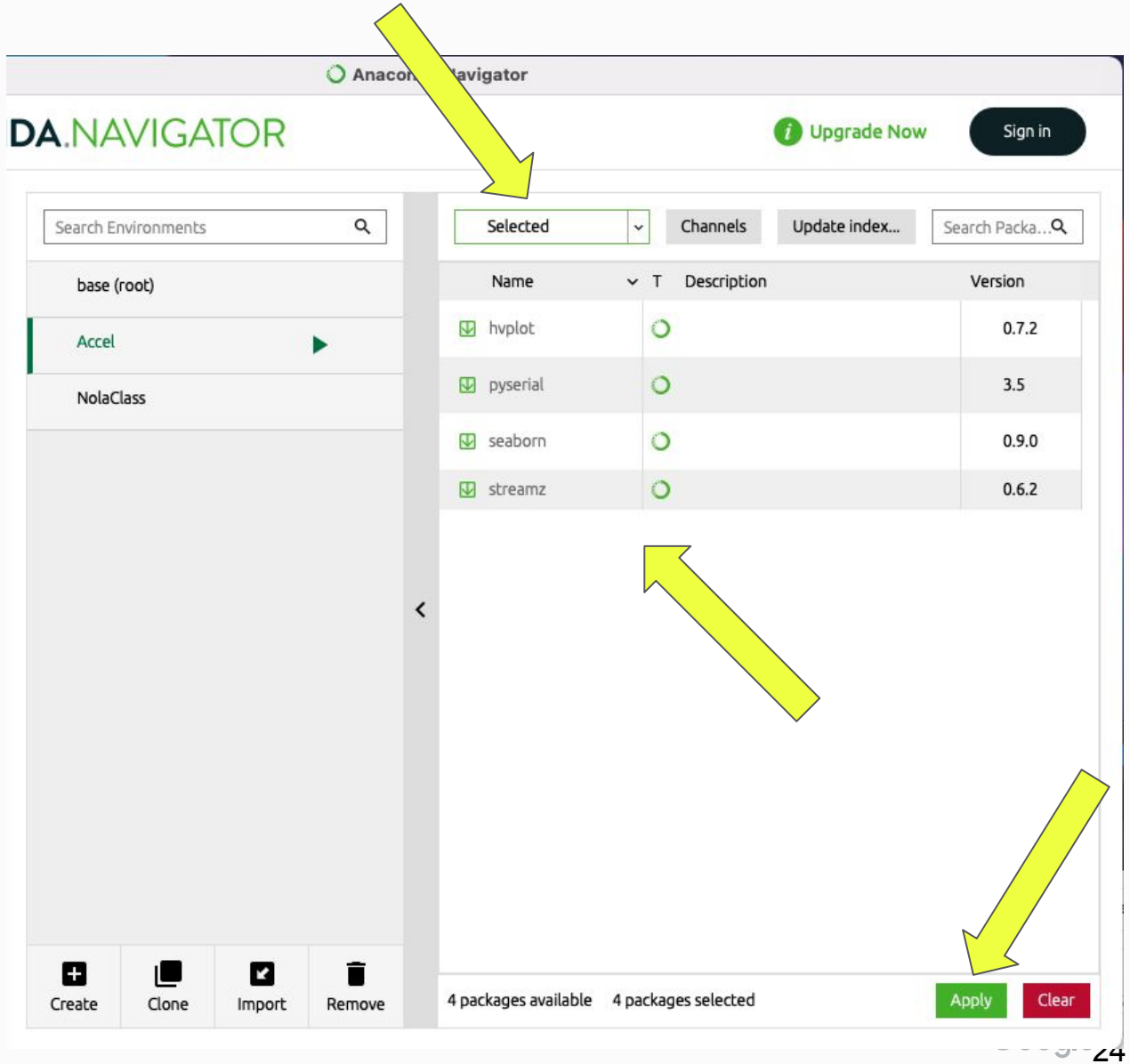
5.

- Select “Selected” from the drop down 

Make sure nothing is in the search bar

- Check that all 4 are selected 

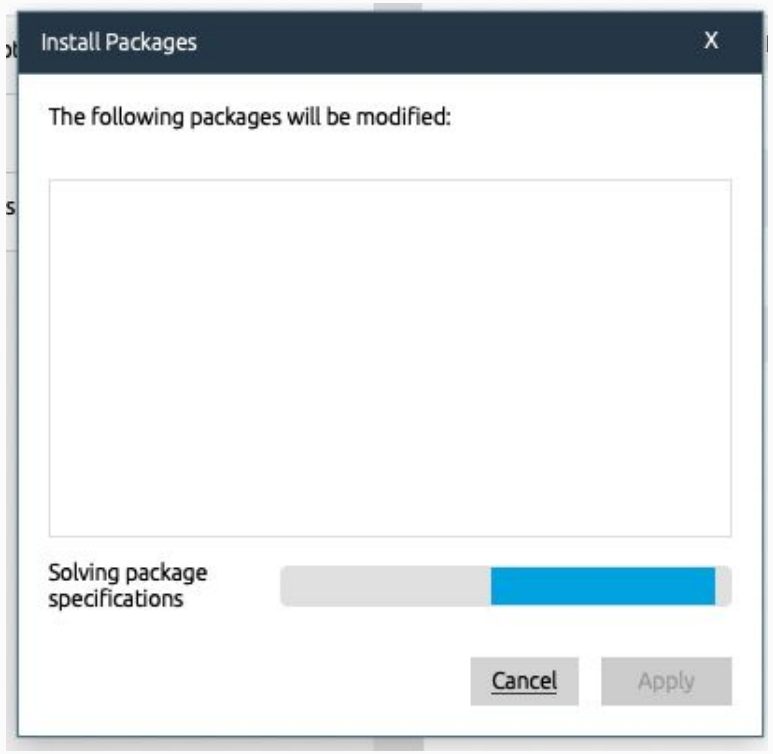
- Click 



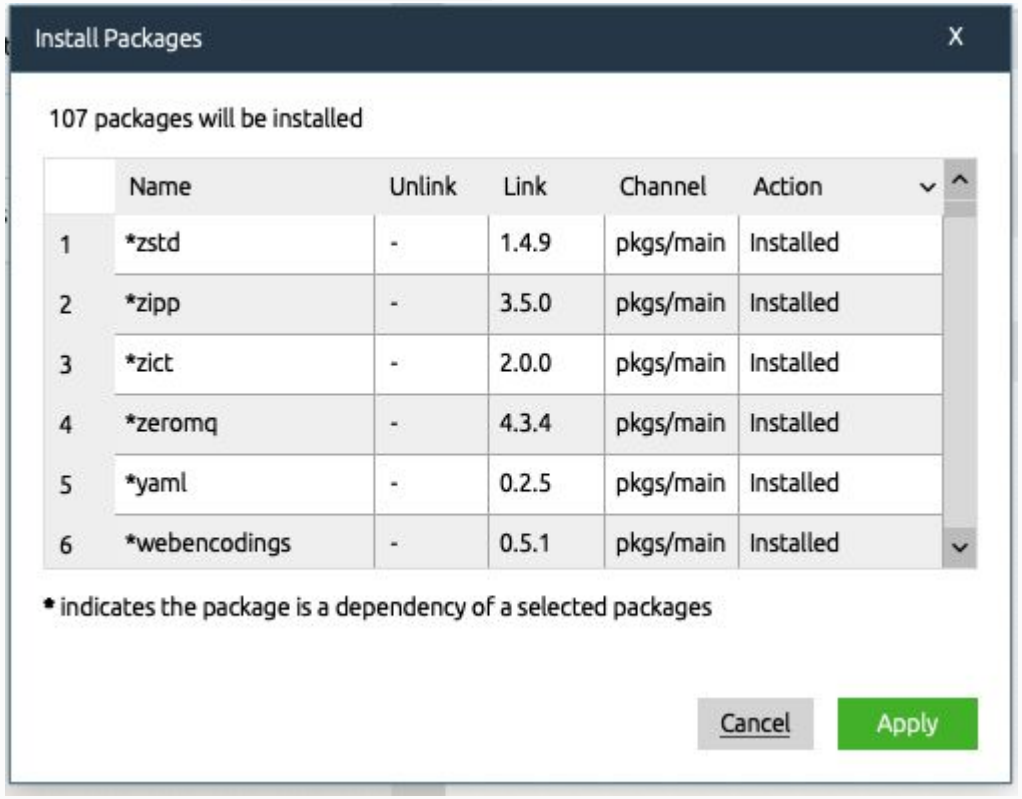
Break Out Instructions- Set Up Anaconda

6.

Install packages will pop up



Click Apply once it appears

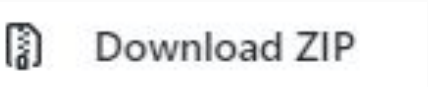


Break Out Instructions-

1. Set Up Anaconda
2. Download folder from git 
3. Set Up Arduino
4. Launch Jupyter Notebook

Break Out Instructions- Download from git

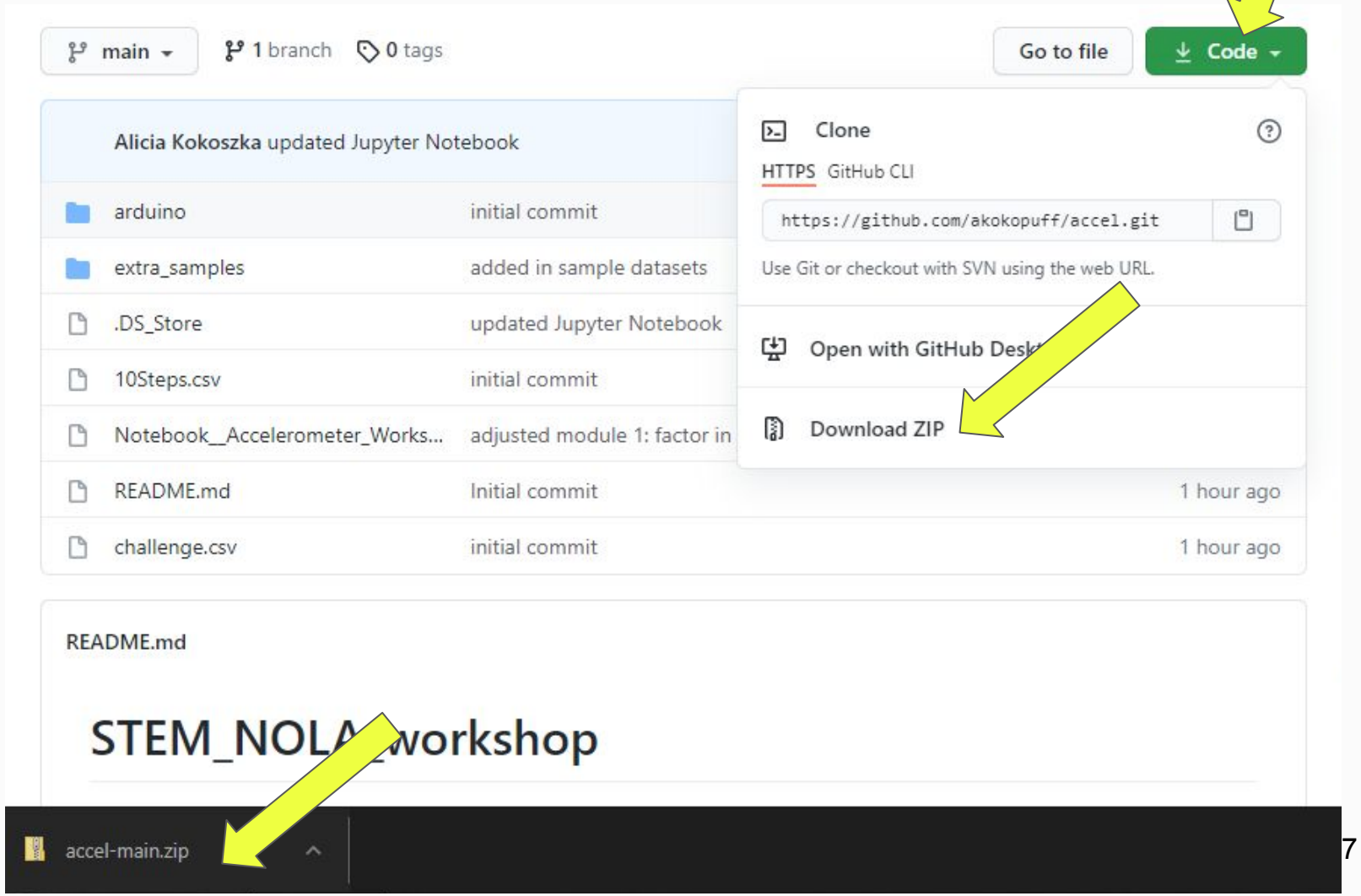
- Go to: https://github.com/akokopuff/accel
- Click on 

- Click on 

- Double Click on:
  

  to unzip the folder

**BONUS: Move the folder to your desktop to easily find it



Break Out Instructions-

1. Set Up Anaconda
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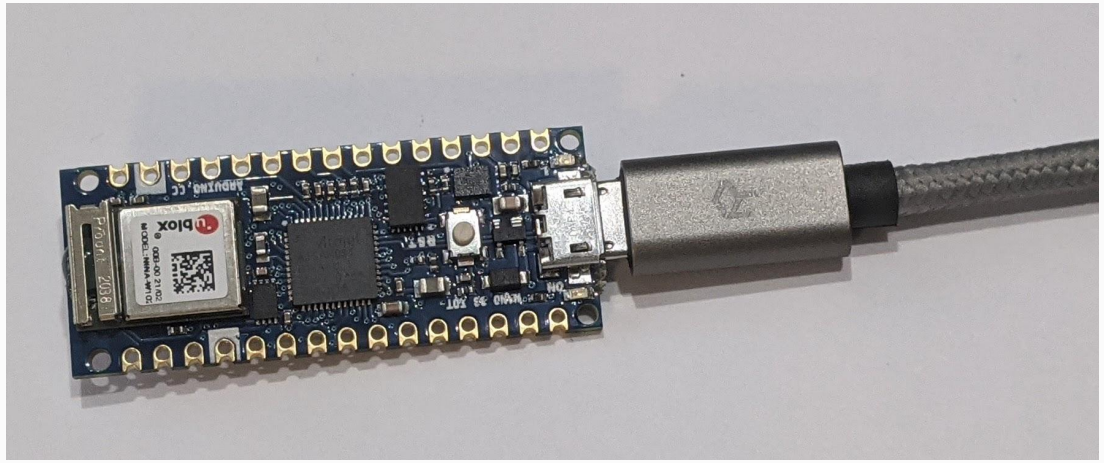
Break Out Instructions- Set Up Arduino

1.

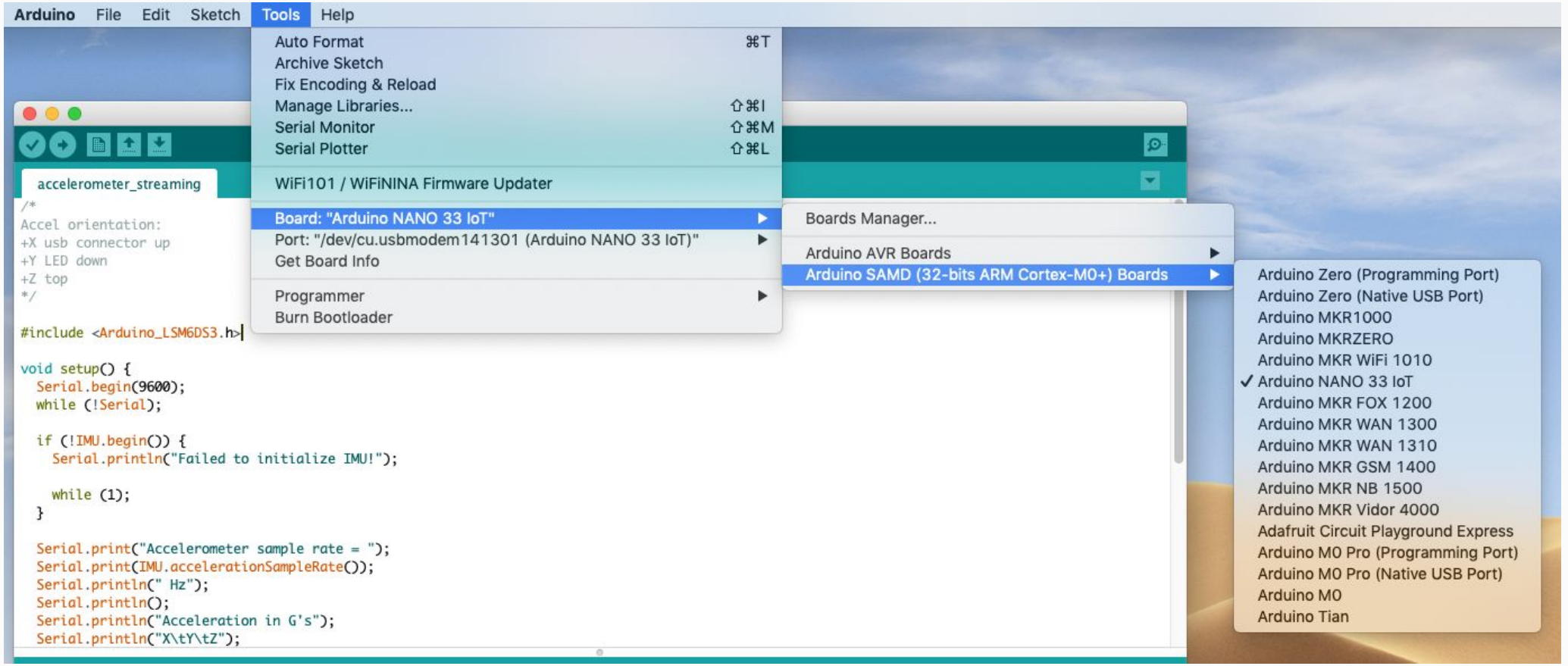


Plug the Arduino device into your computer

and open Arduino software from the Start menu

Break Out Instructions- Set Up Arduino

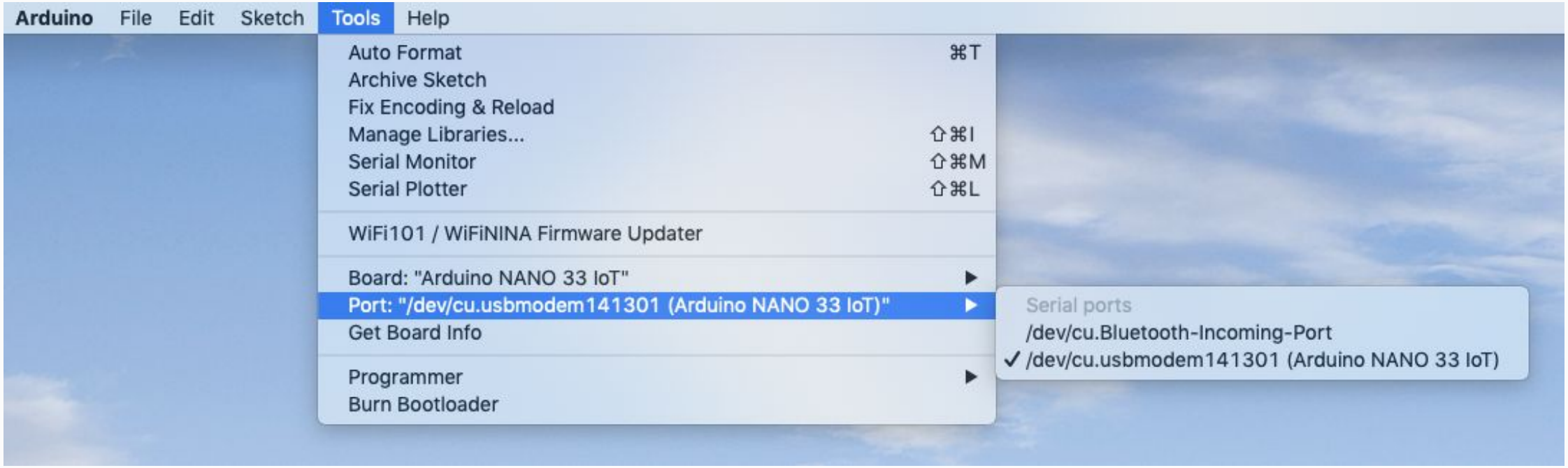
2.



Select Tools > Board > Arduino SAMD (32-bits ARM Cortex-MO+) Boards > Arduino NANO 33 IoT

Break Out Instructions- Set Up Arduino

3.



Select Tools > Board > Port > [select the port your device is connected to]

Break Out Instructions- Set Up Arduino

4.

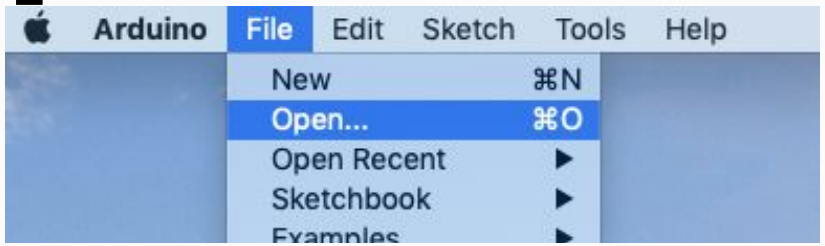
[CHECK] Tools > Get Board Info

Break Out Instructions- Set Up Arduino

5. Compile + Run Sketch

1 In Arduino IDE:

File>Open...

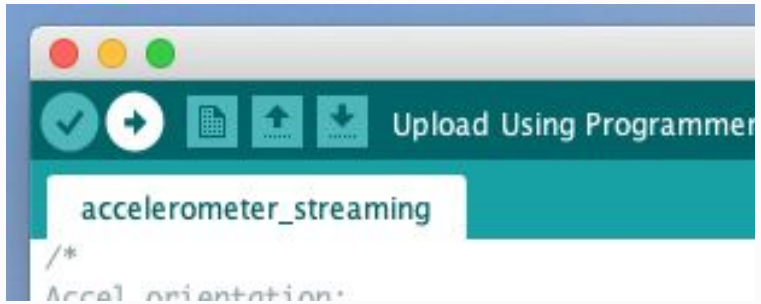


In the “accel-main” folder,

Open “accelerometer_streaming.ino”

“Accel” folder> arduino > accelerometer_streaming.ino

2 Click the arrow to upload



3 Click the magnifying glass to view data

Break Out Instructions-

1. Set Up Anaconda
2. Download folder from git
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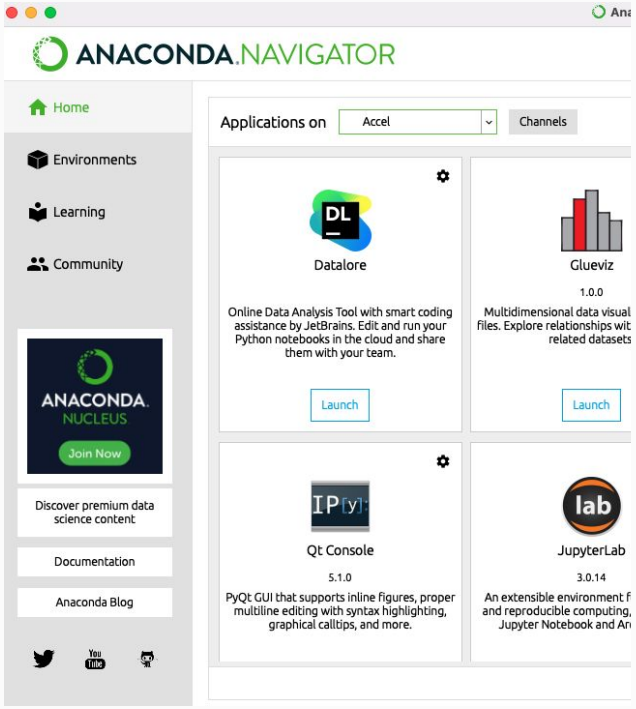
Break Out Instructions- Launch Jupyter Notebook

1 Go the the *Anaconda Navigator* Home

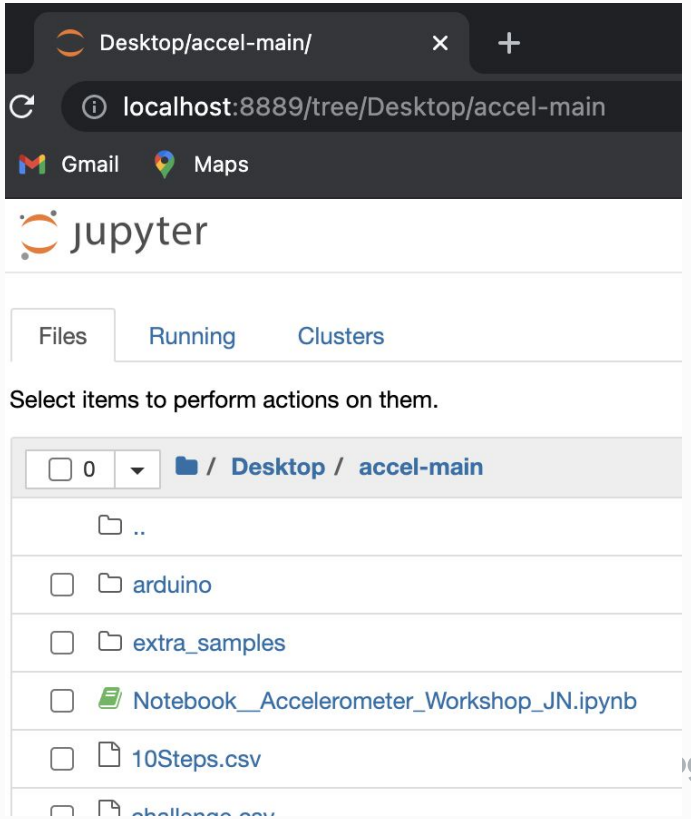


TIP: Make sure the environment you made is selected in the "Applications on" drop down (the example was called "Accel")

2 Install/Launch Jupyter Notebook

3 In Jupyter, navigate to the accel-main folder. Open:

"Notebook_Acceleromter_Workshop_JN.ipynb"



CONGRATULATIONS! You are all set up!
This is half the battle with new hardware!
Now work through Module 1 in your Jupyter Notebook with your groups

Module 2: Algorithms

BREAK TIME

Be back @

Module 2: Algorithms

What is an algorithm?

An algorithm is a set of mathematical steps (or other detailed instructions) for going from **a set of inputs** to a **set of desired outputs**.

Inputs → **Outputs**

Recipe
Mix eggs with milk, flour & sugar.
Bake 30 min.

An Algorithm for Counting Steps

Inputs

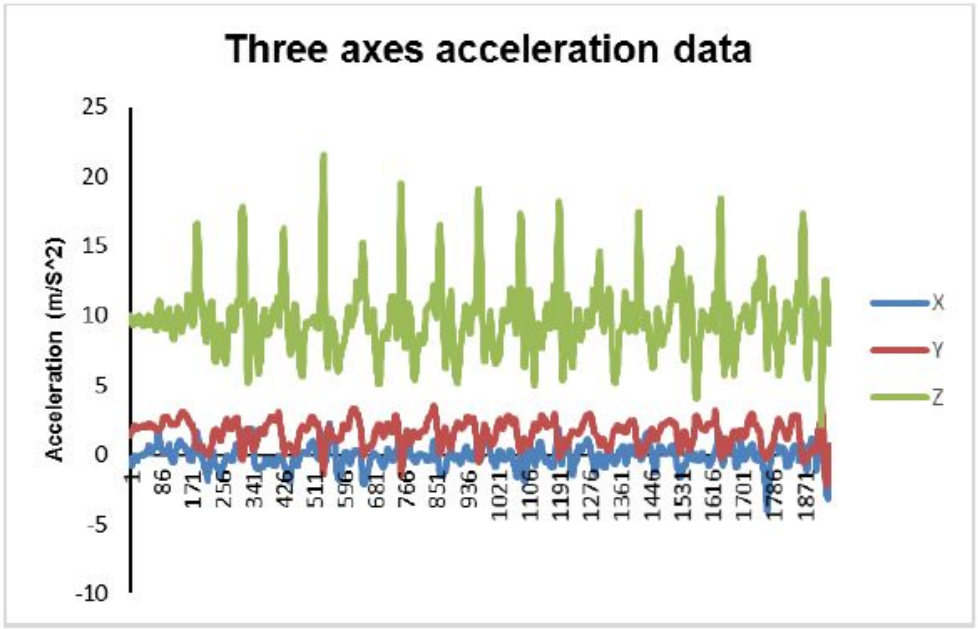


Fig. 1 Acceleration on three axes

Algorithm to Count Steps???

Outputs

16 steps

An Algorithm for Counting Steps

Inputs

Outputs

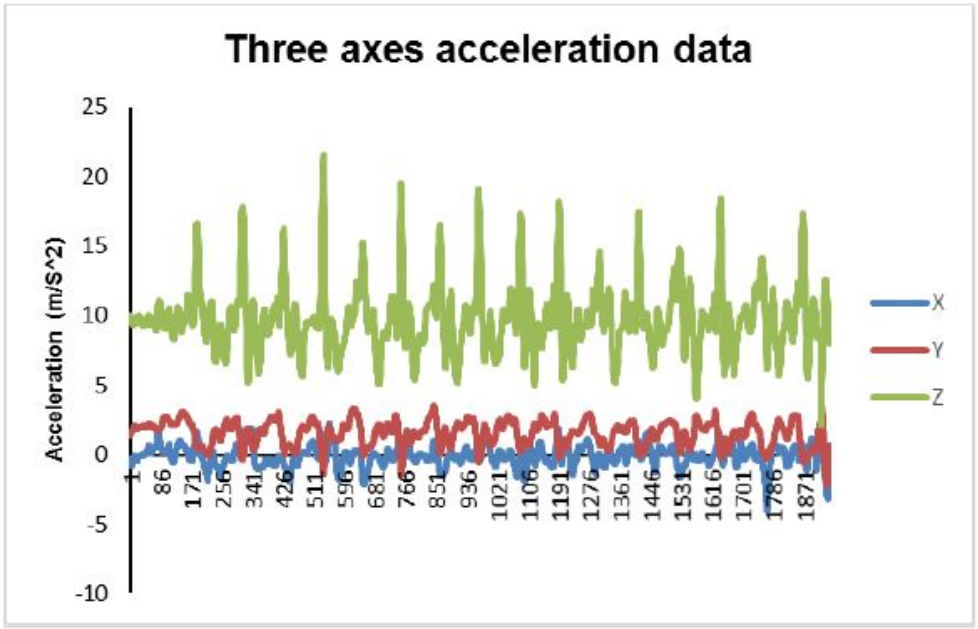
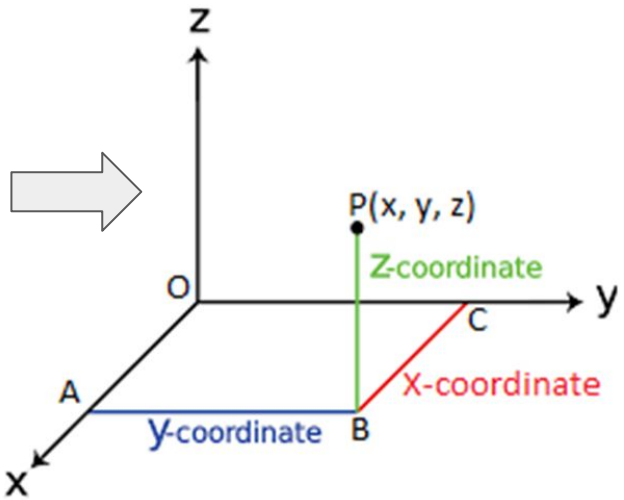


Fig. 1 Acceleration on three axes

Algorithm to Count Steps???

16 steps



Step 1: Convert the 3-axes information into single “magnitude”

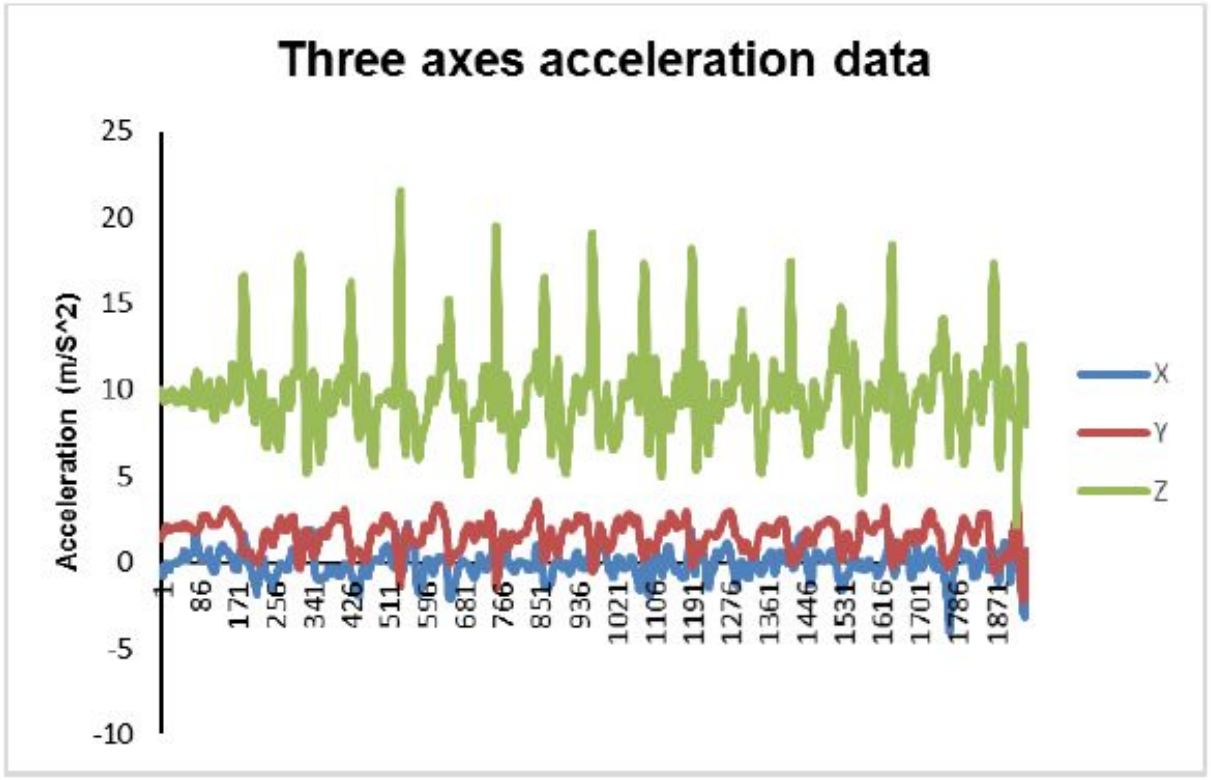


Fig. 1 Acceleration on three axes

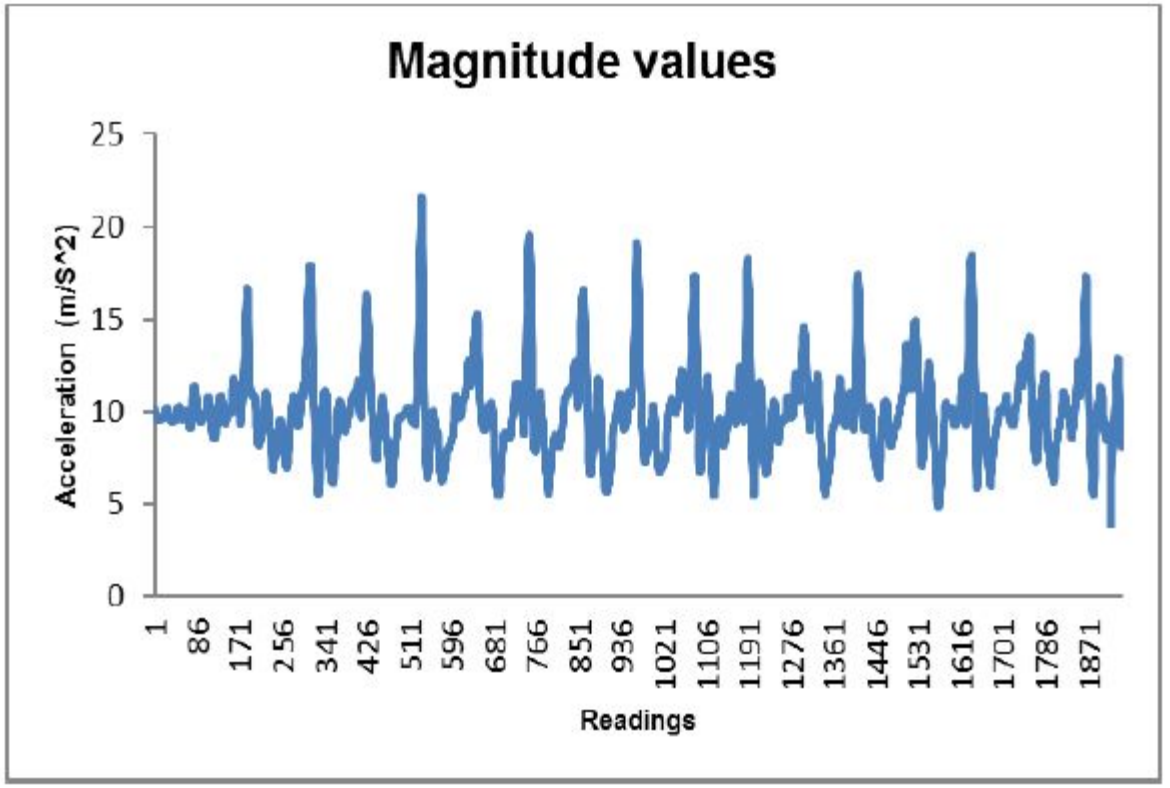


Fig. 2 Magnitude values

$$d = \sqrt{x^2 + y^2 + z^2}$$

Step 2: Find the peaks in the signal

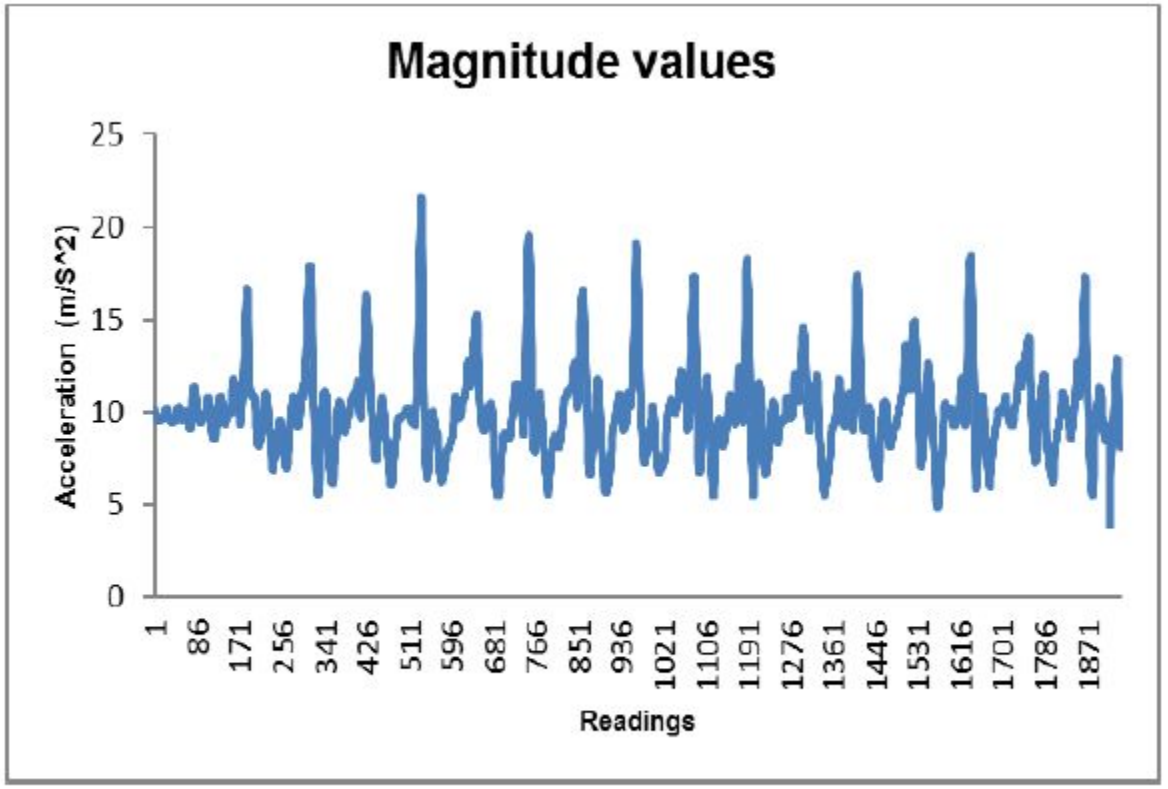


Fig. 2 Magnitude values

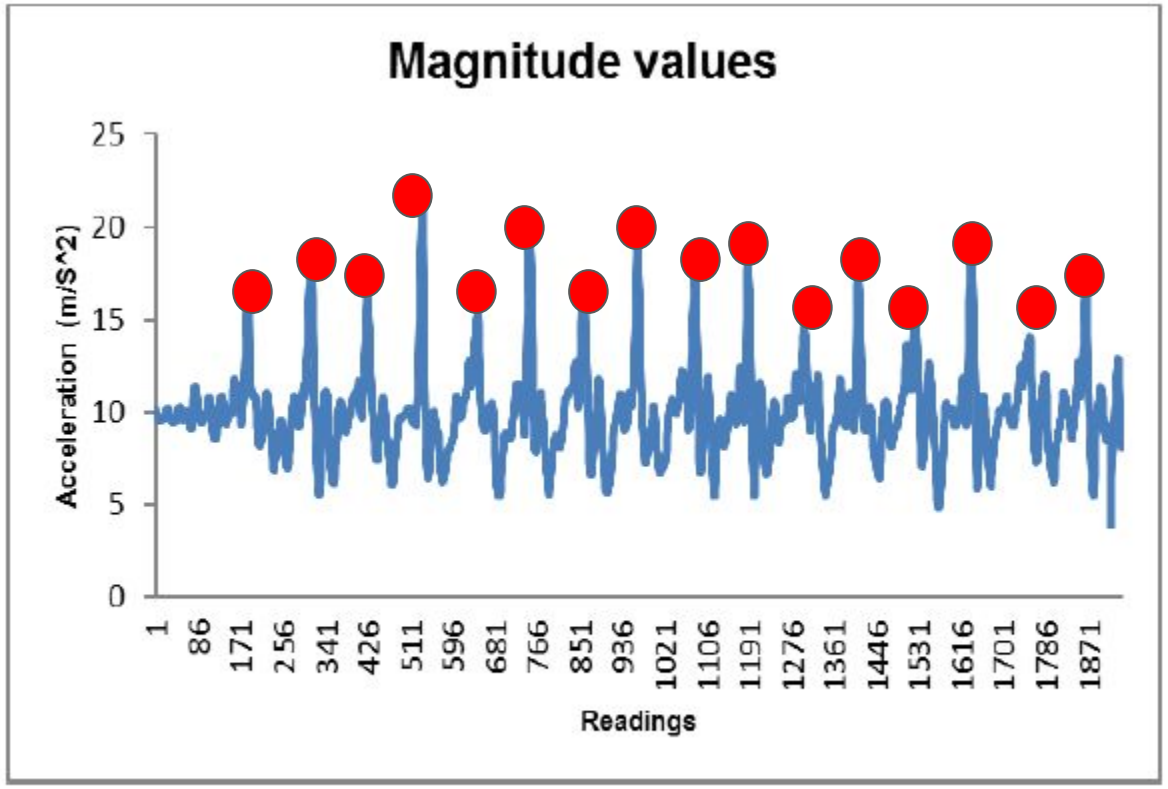


Fig. 2 Magnitude values

PEAK FINDING

↓

STEP DETECTION

What's the mathematical way to find a peak?

A list of 15 imaginary accelerometer values

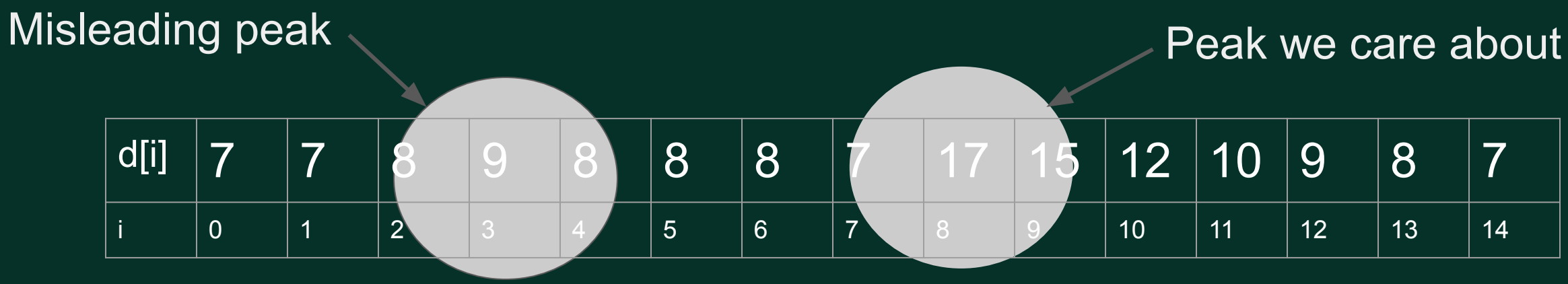
d[i]	7	7	8	9	9	8	8	7	17	15	12	10	9	8	7
i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

Python Code

```
d =[7,7,8,9,9,8,8,7,17,15,12,10,9,8,7]


for i in range(1,15):  # first i = 1, final i = 14
    if d[i-1] < d[i] and d[i] > d[i+1]:
        print("PEAK FOUND")
    else:
        continue
```

What can go wrong with algorithms?



d[i]	7	7	8	9	8	8	8	7	17	15	12	10	9	8	7
i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

Python code

```
d =[7,7,8,9,9,8,8,7,17,15,12,10,9,8,7]


for i in range(1,15):  # first i = 1, final i = 14
    if d[i-1] < d[i] and d[i] > d[i+1] and d[i] > 12:
        print("PEAK FOUND")
```

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BREAKOUT #2

Use an algorithm to count steps

45 minutes

Module 3: Develop your own Product

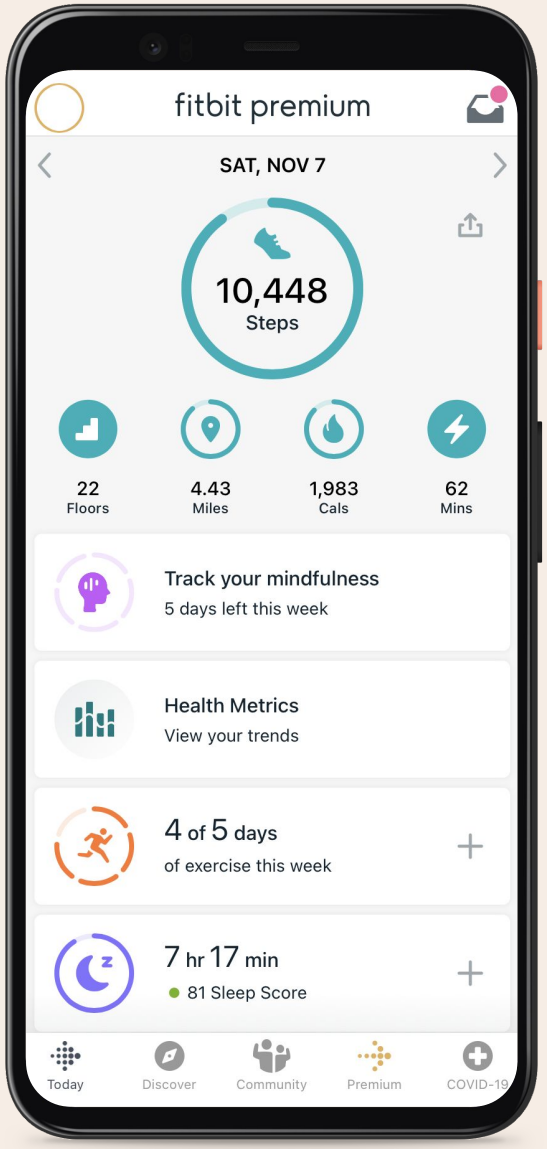
BREAK TIME

Be back @

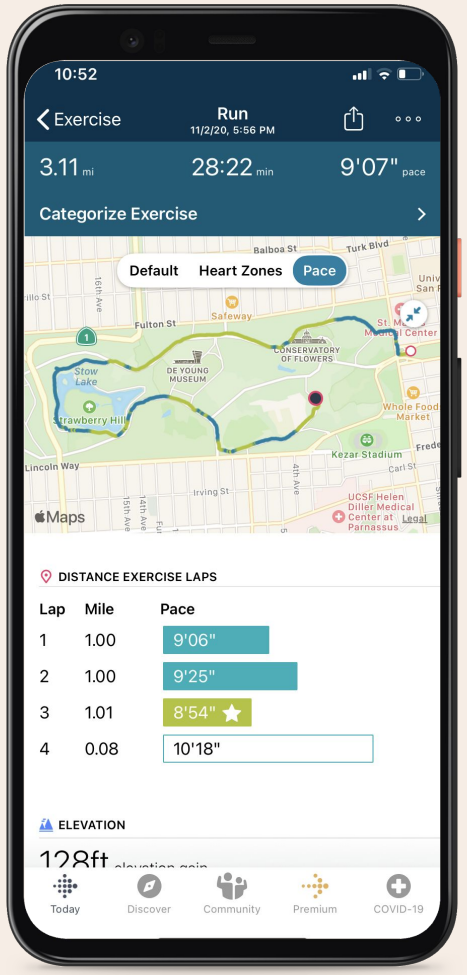
Module 3: Develop your own Product

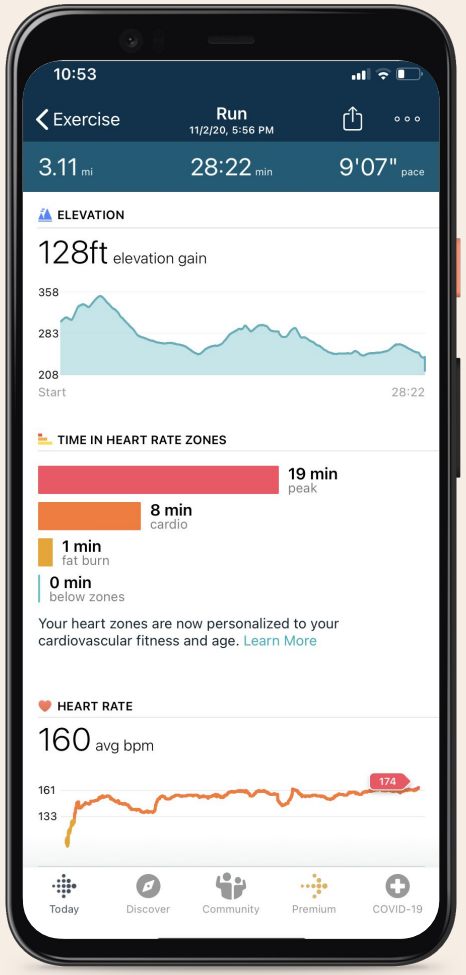
Goal of Fitbit Apps:

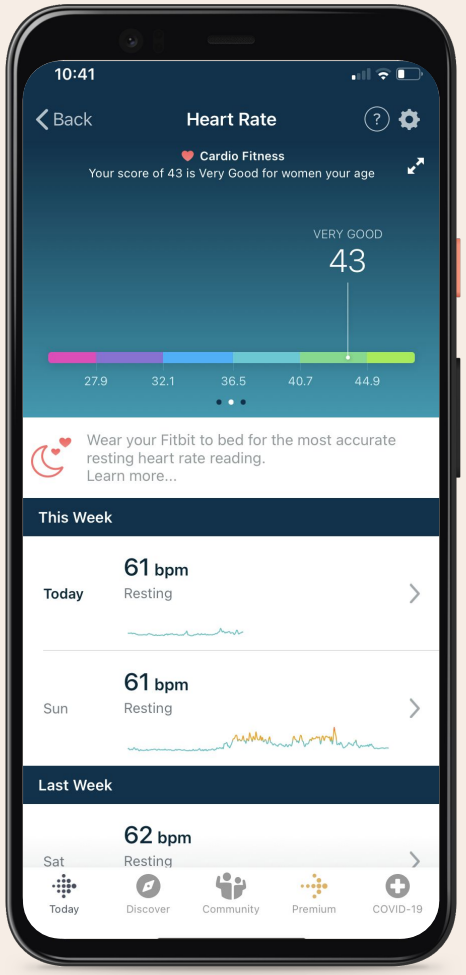
- Convert sensor data into digestible content
- Be interactive, informative and motivational
- Can either be on a wrist-based device or mobile device.



Quick easy-to-understand content: high-level view of steps counts, heart rate and sleep







Heart Health

Giving a user information in the moment about their run: heart rate, pace and use this in combination with daily information to give them an estimate of their heart health.

Getting these data to the user is a team effort:

1) **Market Research:** Creating content and products that are relevant
2) **UX design:** Creating content that is easy to navigate and user-friendly
3) **Design:** Content that is visually appealing
4) **Research:** Exploring new sensors, new data streams and ensuring the data is trustworthy

Choose your own Adventure

Create your own product!

- Write an algorithm using peak finding
- Pitch a new product & create a launch plan

Product Launch

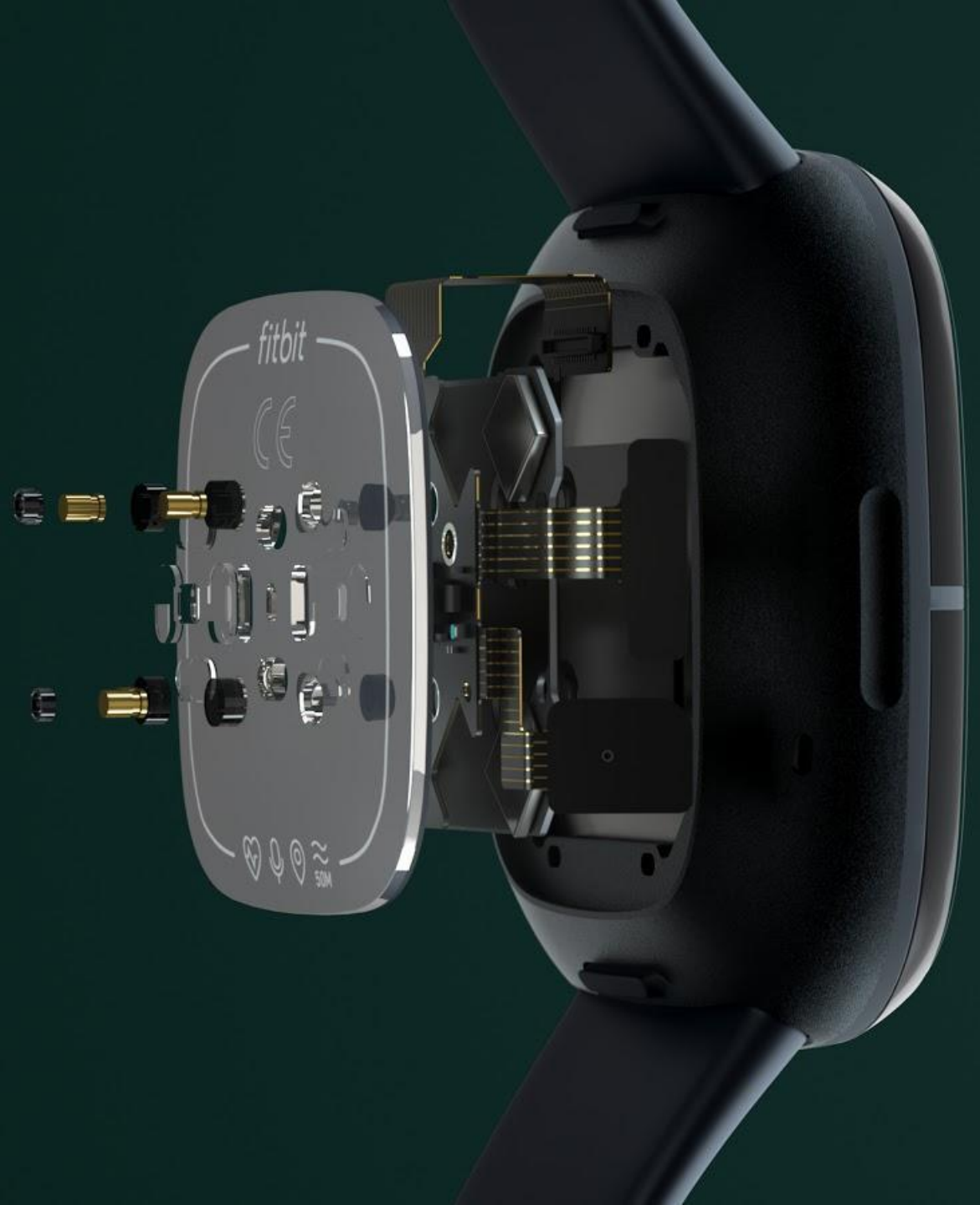
Come up with an accelerometer based product to help count, identify or improve.

Directions:

Clearly explain what your product does and what gap it fills in the market. You can integrate it with others products already available in the market.

How this product will address a specific need?
Who are you targeting?
What will you build?

Ideation > Presentation > Impact > Design



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BREAKOUT #3

Develop your own product

20 minutes

1 Ideation

Brainstorm

Come up with all the possible things you can build! Simple ideas to things that are way out there!

Be original and innovative!

2 Narrow it Down

Final Idea

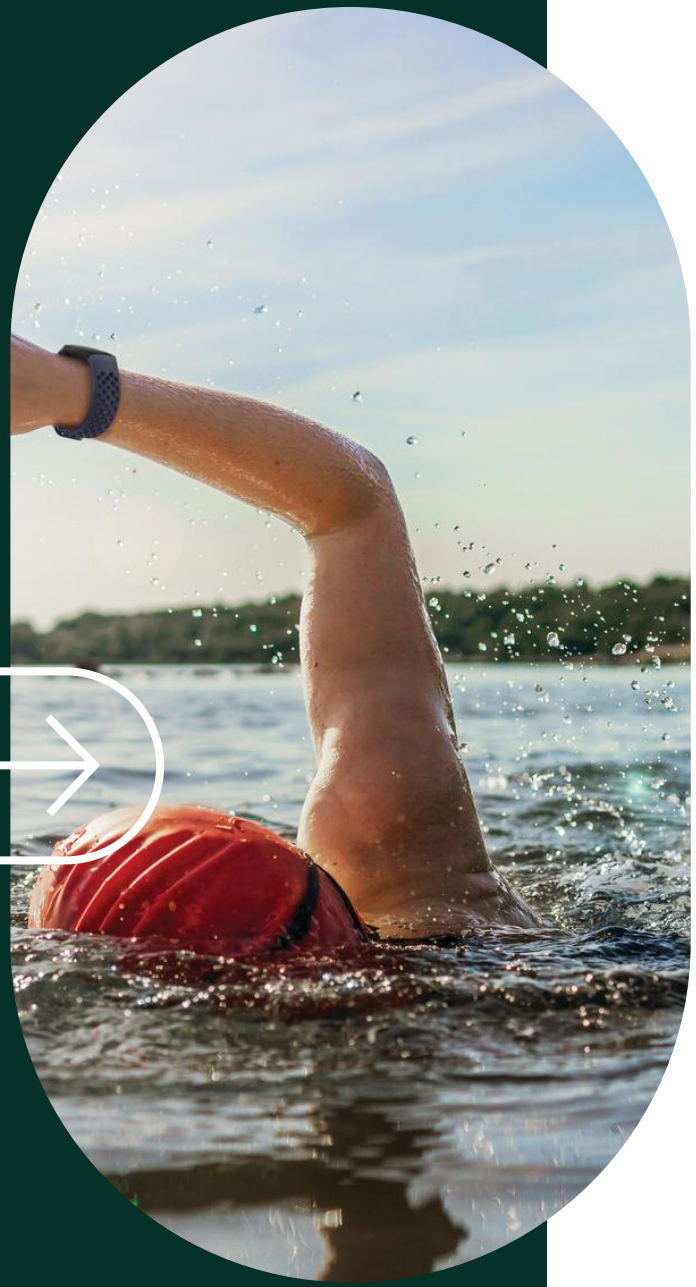
What are we building?
Who is our customer?
What is unique?
What is the impact?
What is the product name?

3 Pitch it!

Refine your message

Get your product pitch together for share out.

What's important to include?
How is your product different?
What is the impact your product will have on the market?



1 Ideation

Brainstorm

Think of an activity you want to detect that's *not* steps. Even with a 3-foot cord, there are a lot of motions you can do!

Where should the accelerometer be to detect the activity?

2 Do the activity

Gather accel data

Put the accelerometer in the appropriate location and record data while you do the activity.

How well does the original peak-finding algorithm work?

3 Make a better algorithm!

Tune parameters

Change peak-finding parameters to make it work for your activity, then share your results

Which parameters are important for your activity?
How well can you detect your activity with just peak finding?
Would another algorithm work better?

Share back:

- Did anything surprise you?
- What was the most challenging?
- What would you do next time?

Thank you

If you have any questions, please reach out to namehere@fitbit.com

APPENDIX

Using apps on the wrist allows us to provide similar information but bite-size.

For example:

Reminders to Move