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University of Maryland MIND Lab Research Internship Journal

Resources

[MIND Lab Website](#)

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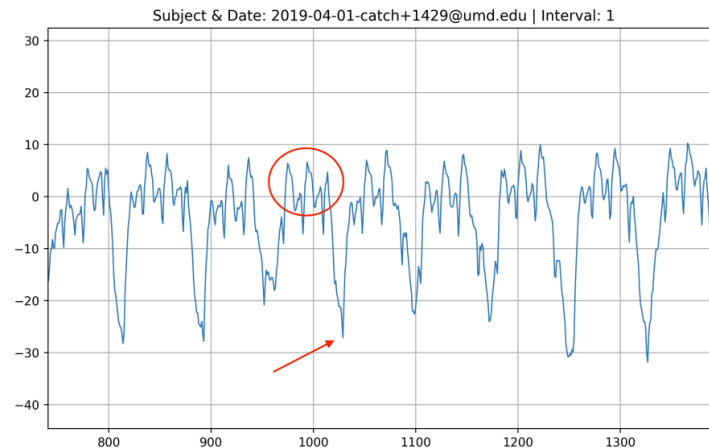
Mr. Wajid fwajid@umd.edu

Summer 2022

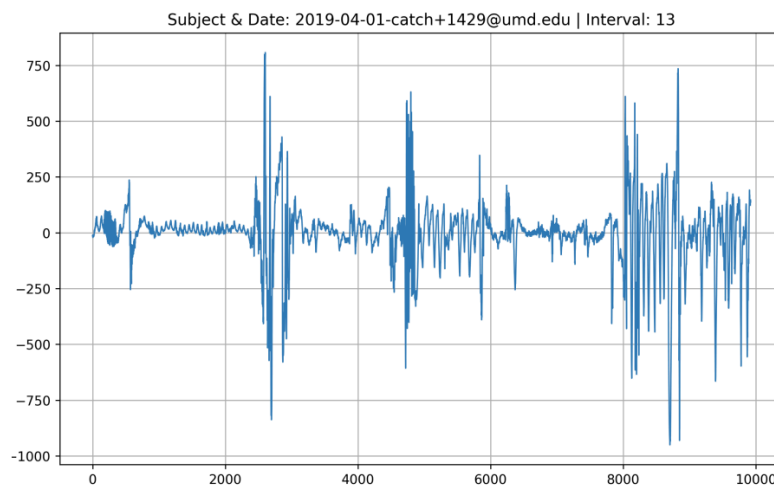
Week 1: 06/20/2022

On Monday 6/20/2022, I was introduced to the internship team and briefed on what we needed to know, what work to get started on and how the internship will go. I learned how to use the Jupyter Notebook. I will be working on the Breathing Analysis Project for Mr. Wajid here: <http://www.mindlab.cs.umd.edu/breathing-analysis> . More specifically, analyzing the data that is produced from the code in different intervals and making a judgment on whether it is inverted or not and noisy or not.

Inverted: Graph is flipped with sharp points on bottom and the sickle shaped crescent on the top (opposite of what we want)



Noisy: Graph does not show a clear pattern with sharp points and sickle shaped crescents



Code here: <https://jupyter.mind.cs.umd.edu/user/aarushop/tree/breathing>



More Examples Here for differentiation: [☰ segment_guidelines](#)

I completed 2019-04-03 and 2019-04-05 in Data Table: [+ IntervalNotes](#)

Final observation: The noisy intervals tend to be grouped nearby. Most data tends to be good.

Marco also needed some help with formatting problems so I fixed them for him:

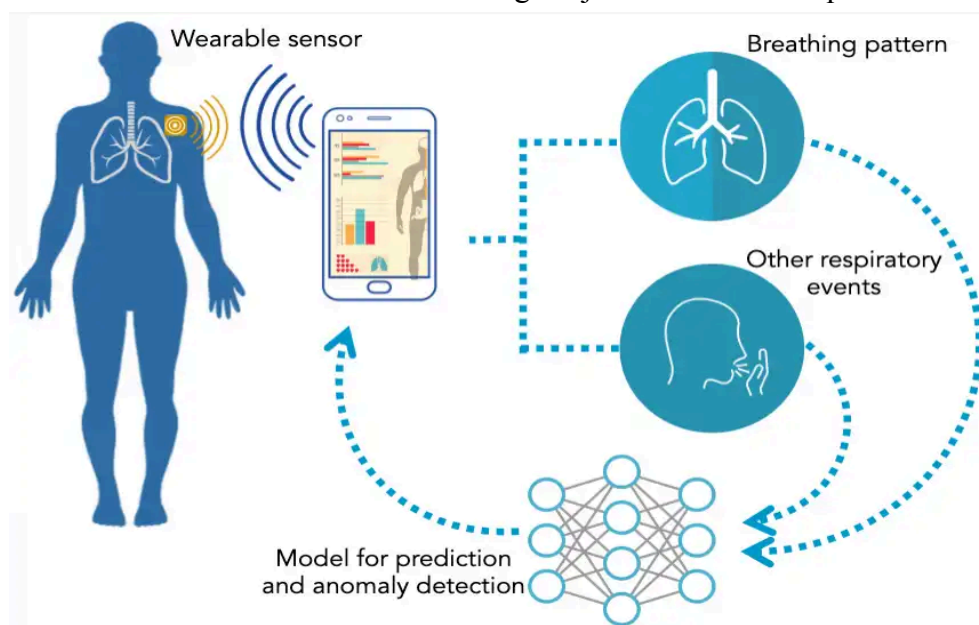
☐ Rust: a low level systems programming language built for safety and efficiency. - Marco

Week 2: 06/27/2022

This week I continued with my data analysis of deciding if the data in **IntervalNotes** is inverted, noisy and the relevant notes. This week, I completed segments 1-53 in 72_2019_02-15 and 1-3 in 1429_2019-04-08. Most of the data seemed to be relatively good. I reviewed file opening in python as well. I will also be a part of the MIND Labs blog on the website <http://www.mindlab.cs.umd.edu/> with Angie. I also talked about some potential ideas and wrote a bit about what we can do to stop algorithmic bias in MIND Labs. I will also be taking CSV files using pandas and iterating through them to do more data analysis in Jupyter Notebook.

IntervalNum	Inverted	Noisy	Notes
1	No	No	
2	No	Yes	Noisy in the beginning fine after the first parts
3	No	No	
4	No	No	mostly Not Noisy but 4 small portions were Noisy
5	No	Yes	
6	No	No	
7	No	No	
8	No	No	
9	No	No	extremely high frequency
10	No	No	high rate of change
11	No	No	a little Noisy in 2 areas 1 Noticeable other one is Not that Noticeable
12	No	No	breaths are shaped like a mountain instead of a parabola
13	No	No	extremely high frequency
14	No	No	
15	No	No	few areas a little Noisy and extremely high frequency
16	No	No	4 small areas a little Noisy
17	No	No	about 6 or 7 small areas are a little Noisy and the breaths have a high frequency
18	No	No	end is a little Noisy
19	No	No	
20	No	No	
21	maybe	No	half appears inverted half does Not and high frequency
22	No	No	
23	No	No	breaths appear mountain shape instead of something similar to a parabola
24	Yes	No	breaths appear mountain shape instead of something similar to a parabola
25	maybe	No	breaths do Not look that Normal but is Not Noisy
26	No	No	
27	No	No	few big spikes
28	No	No	few big spikes

I also reviewed the information from the Breathing Project to be better acquainted with it:



Week 3: 07/04/2022

This week, I continued work on the breathing project. I finished the following segments:

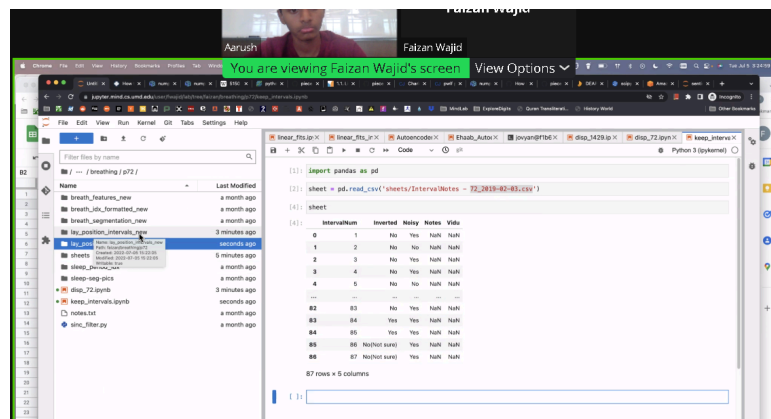
1. 1429_2019-03-25 1-44
2. 1429_2019-03-27 1-47
3. 1429_2019-03-29 1-41
4. 72_2019-02-05 34-65
5. 72_2019-02-06 1-54
6. 72_2019_02-13 34-55
7. 72_2019-02-16 45-81
8. 72_2019-02-21 1-34
9. 72_2019-02-26 1-71
10. 72_2019-02-28 1-31
11. 72_2019-03-01 1-17

As of 7/5/2022, I have completed all the 427 remaining segments' data analysis. Here is the data:

IntervalNotes .

I also have to start working on parsing some of the data. We have to filter out the noisy files and then make sure that

- Import all files as csv
- Then change module 2 from FALSE to True
- Then all the files will go into new file folder
- Now go to new notebook
- Take out all “Yes” Noisy Files
- Print those
- Put them into new folder



```

import pandas as pd
sheet = pd.read_csv('sheets/IntervalNotes - 72_2019-02-05.csv')
sheet

```

intervalnum	Inverted	Noisy	Notes	Vide
0	1	No	Yes	NaN
1	2	No	No	NaN
2	3	No	Yes	NaN
3	4	No	Yes	NaN
4	5	No	No	NaN
...
82	83	No	Yes	NaN
83	84	Yes	Yes	NaN
84	85	Yes	Yes	NaN
85	86	No/Not saved	Yes	NaN
86	87	No/Not saved	Yes	NaN

I also worked on finding new blog ideas and working on the current blog about Bias in Machine Learning with Angie Halle.



Week 4: 07/11/2022

This week, I finished Blog 4: About Breathing Project - general overview and talking about how we decide between good bad data & inverted or not Official Title: Breathing Project - Data Analysis. This was talking about the Data Analysis portion at the beginning that we are required to do in order to later process data and make results. I discussed the process step by step for the readers to gain a full understanding of it. I also worked with Jeffery Wei and Jay Yeung to try and fix the code with parceling. This is a draft and can be subject to changes.

Blog 4

Snippet below:

the Spire tag was worn upside down and thus needs to be manually accounted for. We can invert the data by adding a negative sign to segfiles_inspect and flipping it. If the data is decided to be inverted, then we record it. We continue this process for every single segment in all the files.

	A	B	C	D
1	IntervalNum	Inverted	Noisy	Notes
2		1 No	No	Large spike around 6500
3		2 No	No	Little Noisy and a large spike around 11000
4		3 No	Yes	Noisy and a few sharp spikes
5		4 No	Yes	Noisy and a few sharp spikes
6		5 No	Yes	Noisy and a few sharp spikes
7		6 No	Yes	Noisy and a few sharp spikes

This data analysis is necessary because of just how much data is unusable. As we can see from the graph below, most of the data in participant 72 on February, 8 2019 has unusable data which could completely skew the final results (out of 57 segments).

Count of Noisy in 72_2019-02-08



“In this project the first step we have to take once we receive the data from the Spire tag is to analyze this. This can be done in a multitude of ways but in this case, we decided to compare it to the models examples as to how to categorize the data. Our task is to take a segment from a file and judge whether that segment is noisy or not and inverted or not.

Segment - One graph of data from a particular file



When analyzing the data we make sure to refer to some guidelines to help us categorize the segment. First, we open up Python Jupyter to launch the code. Now we go to Module 2b in order to plot individual segments in the file for the data analysis. Now, we choose which interval we would like to work with out of how many are in the file by changing the value of the variable”

Week 5: 07/18/2022

This week I finished Blog 7: Talk about demographics in Mind Lab and how we are inclusive and full of diversity **Official Title: Diversity in Mindlab**. Here, I talked about the problems that the STEM community faces in terms of diversity and how we in contrast are very successful in this aspect. I cited various different resources as well. Here is a snippet below:

Blog 7

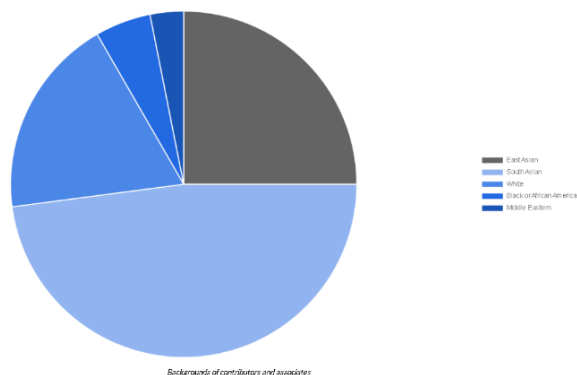
“Diversity in STEM is currently a huge pressing issue with recent events. STEM (Science, Technology, Engineering and Mathematics) is a rapidly growing field. We need to keep up with the demand for highly qualified individuals in the field of STEM. This comes as no surprise when almost every single aspect of our lives has been changed from the impact of technology. Everything from cars, phones, food, our houses and more have been improved through technological advances.


While STEM overall is a great field to be in, unfortunately it is not very diverse. According to the Pew Research Center, Black and Hispanic workers make up less than 10% of all STEM jobs. “

Here at Mindlab, we aim to be inclusive for all people regardless of race, gender, or disability status. We make sure that everyone is equal and treated fairly. We have a great environment to work in with professor Dr. Agrawala, the mentors Ms. Cai and Mr. Wajid as well as all the other interns.

For example, more than 80% of our team are an ethnic minority.

Ethnic Composition



I am also working on a personal project that I will pitch to Dr. Agrawala. I am going to be working on my idea **BUMP: A Novel Beta-Blocker Pump for patients with Crashing Bradycardia via Continuous BPM Monitoring**. I was hoping to get the professor's expertise on whether this idea has merit or not.  BUMP - presentation for dr. agrawala.pptx

 Mindlab Biweekly 7-20-2022 Meeting (1).pptx

It was a success as Dr. Agrawala said that he would be willing to enter me into the Davidson Fellows Scholarship for my idea

Week 6: 07/25/2022

This week I continued working on the blogs and finished Blog 1: General Overview of MIND Lab - how we work, structure of our team, about the team, main ideas/mission of mindlab (kind of like an introductory blog) along with Angie. We also discussed with the Web Dev Team about the methodology for getting the drafted blogs into the next phase of being on the Mindlab Website.

Blog Snippet:

“The MIND Lab team is led by Professor Dr. Ashok Agrawala and Professor Dr. Nirupam Roy along with research staff Mr. Faizan Wajid and Ms. Mara Cai. We work in the Brendan Iribe Center for Computer Science and Engineering at 8125 Paint Branch Dr, College Park, MD 20742, United States. We work on a hybrid schedule, meaning that some interns work in-person and some work online. This really gives us a great deal of flexibility for all the people involved because we are able to work on our own schedule and get more work done. Many interns also come to the building in order to engage in a collaborative environment. This really cultivates an engaging mindset for all interns and PHD students to grow. “

Week 7: 08/01/2022

This week I started working on Parsing through the different files in one folder of segments for the Breathing Project. The Master File of Data is `IntervalNotes`. I simply took one date in this case `IntervalNotes - 72_2019_02-15 (1).csv` and tried to iterate through every single file, check if it is inverted or noisy and if isn't then send the file to a new folder that has all the clean files. This is the code segment that I developed along with Jay Yeung.

```
import pandas as pd
import os
import csv
data = pd.read_csv('IntervalNotes - 72_2019_02-15 (1).csv')
result = []
for i in range(26):
    if(data['Noisy'][i].lower()=="no" and
data['Inverted'][i].lower()=="no"):
        result.append(i)
print(result)
```

The screenshot shows a Jupyter Notebook environment with the following components:

- Browser Tabs:** Multiple tabs are open, including 'jupyter.mind.cs.umd.edu', 'Stack', 'BUMP', 'MIND', 'Agraw', 'Spread', 'Interv', 'MIND', 'MIND', 'BUMP', 'how to', and 'App Math Precalc Read'.
- File Explorer:** The left sidebar shows a file tree for the directory '/breathing / p72 /'. It lists various files and folders such as 'breath_feature_new', 'breath_idx_formatted_new', 'breath_segmentation_new', 'lay_position_intervals_new', 'sheets', 'sleep_period_idx', 'sleep_seg_pics', 'disp_72.ipynb', 'IntervalNotes - 72_2019_02-15...', 'IntervalNotes.xlsx', 'keep_intervals.ipynb', 'modified.csv', 'modified2', 'notes.txt', 'ProcessingSheets.ipynb', 'sync_filters.py', and 'Spreadsheet Parsing.ipynb'.
- Code Editor:** The main area displays the Python code from the previous block. The execution output shows the result of the loop: `[0, 2, 4, 5, 6, 7, 9, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22]`.
- Comments:** Below the code, there are several comments in a lighter font: '#Import all files as csv into breath_idx_formatted_new', '#Then change module 2 from FALSE to True', '#Then all the files will go into new file folder (check which one)', '#Now go to new notebook', '#Take out all "Yes" Noisy Files', '#Print those', and '#Put them into new folder (lay_position_intervals_new)'. The status bar indicates the cursor is at 'Ln 7, Col 47'.
- Status Bar:** At the bottom, it shows 'Simple', 'Python 3 (ipykernel)', 'Idle', and 'Mode: Edit'.

Week 8: 08/08/2022

This week, I discussed with Jeffery about his method of doing the same thing and it seemed to be more extensive. I also came up with some more ideas for blog posts as listed below:

1. About how we collect Data for Breathing Project (P72 and P1429) and what we did for the recent in-person breathing experiment in the building
2. New Inspirations and motives for redesign of website
3. About the Spire Tag Sensor's accuracy in the Breathing Project
4. About the New Tool that Stephen built for the building project and how it helps the visualization of what is used, (has great potential for mass use by UMD facility members) <https://umd-meter-app-ui.netlify.app/>
5. Day in the life of Dr. Agrawala, Ms. Cai, Mr. Wajid, & one of the interns (Leo, Jefferey, Stephen, Angie, Alex)
6. Myths and Truths in the STEM/Computer Science field
7. Process from start to finish for a student to develop an idea in the STEM/Computer Science Field and tips along the way
8. Research about CS Schools (across the board and top ones) Acceptance Rates, how the graduates compare in terms of experience, where the graduates work, what to expect going into the field

I was also told by Jeffery that some files were missing and I found out that the data in them does not exist so I redid the data collection for days that it was in IntervalNotes which is:

1. 2019-02-13
2. 2019-02-15
3. 2019-02-06

```
File not found:
../p72/lay_position_intervals_new/2019-02-13-catch+72@umd.edu-50.csv
File not found:
../p72/lay_position_intervals_new/2019-02-13-catch+72@umd.edu-53.csv
File not found:
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-34.csv
File not found:
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-35.csv
File not found:
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-36.csv
File not found:
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-37.csv
File not found:
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-38.csv
```



```
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-39.csv
File not found:
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-42.csv
File not found:
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-43.csv
File not found:
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-45.csv
File not found:
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-46.csv
File not found:
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-47.csv
File not found:
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-48.csv
File not found:
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-49.csv
File not found:
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-50.csv
File not found:
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-51.csv
File not found:
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-52.csv
File not found:
../p72/lay_position_intervals_new/2019-02-15-catch+72@umd.edu-53.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-36.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-37.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-38.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-39.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-40.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-41.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-42.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-43.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-44.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-45.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-46.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-47.csv
```




```
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-48.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-49.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-50.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-51.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-52.csv
File not found:
../p72/lay_position_intervals_new/2019-02-06-catch+72@umd.edu-53.csv
```



Week 9: 08/15/2022

This is the last and final week of my internship with [MIND Lab](#). I am very grateful to have been working under Professor [Dr. Agrawala](#), mentors [Mr. Wajid](#) and Ms. Cai and along with my fellow interns here at [MIND Lab](#).

Summer 2022 Synopsis

- Conducted Data Analysis on 450+ Breathing Segment Data in the [Breathing Analysis Project](#) and employed Matplotlib, Pandas and NumPy to categorize each breath as inverted or noisy using Disp_72.ipynb Module 2B in the [MIND Lab Python Jupyter Notebook](#). Data:  IntervalNotes
- Wrote code to retrieve clean breath segment data, not inverted or noisy.

```
import pandas as pd
import os
import csv
data = pd.read_csv('IntervalNotes - 72_2019_02-15 (1).csv')
result = []
for i in range(26):
    if(data['Noisy'][i].lower()=="no" and data['Inverted'][i].lower()=="no"):
        result.append(i)
print(result)
```

- Wrote articles for MIND Lab:
<https://mindlab.cs.umd.edu/diversity-and-inclusion>
<https://mindlab.cs.umd.edu/algorithmic-bias>

Summer 2023

Week 1: 06/26/2022

This is my first week back to the summer internship for this year. This summer I plan on achieving a couple of goals by end of the internship:

1. Continue to help out and make good contributions to the Breathing Project.
2. Continue to learn data analysis, utilizing modules like Matplotlib, Pandas & Numpy, and developing my teamwork and collaboration skills.

This week I was mainly getting setup to all the different softwares that are used in this internship. This includes the Slack, Jupyter Notebook, Nextcloud Repository and possibly more depending on the necessity of which softwares I need to use. During this week I mainly got introduced to the new team, new software and reviewed what was going on in the breathing project.

Week 2: 07/03/2023

This week I reviewed my project I previously worked on called BUMP: A Novel Beta-Blocker Pump for patients with Crashing Bradycardia via Continuous BPM Monitoring. Here is a quick Abstract on my project:

“Crashing bradycardia is a condition in which a patient’s heart rate rapidly falls that can lead to severe health problems and even death. To address this issue we developed a novel, invasive, wearable beta-blocker pump for patients using Arduino components including a peristaltic pump and heart rate monitor with crashing bradycardia to pump in Atropine at the right dose – allowing the patient ample time to drive to a hospital and receive professional treatment. In this experiment we measured the accuracy of the pump at various recorded BPMs by calculating the expected vs actual Atropine dispensed. The pump has an accuracy of 92.5% from the data collected.”

I was also assigned to start marking the events at their respective timestamps for the Breathing Project MetaData files.

Experiment 5
 Subject - James T
 Camera - Ryan
 Sprire Tags -
 Note Taking - Nicholas and Tinu (this one is Tinu)
 Troubleshooting - David
 Proofreading - Ryan

6/20/2023
 Tag#: 512c13
 Under Right waistband

Notes:

034640 - Start
 034725 - Lips
 034800 - Little laughter from background sound + smile
 035050 - Little shake, shocked?
 035218 - End

During this time, I am also working on BUMP V2 that is more compact and more accurate at reading BPMs.

Week 3: 07/10/2023

This week we wanted to find out the optimal conditions before our trials to recognize how fast someone is breathing from the pace of their speech.

☰ MIND Lab Breathing Project Speech Pre-Trial Analysis

MIND Lab Breathing Project Speech Pre-Trial Analysis

Goal: Recognizing how fast someone is speaking from the rate of their breathing (Spire tag force data).

- Text: Hey there! I just wanted to take a moment to share some exciting news with you. I recently started a new job at a fantastic company, and I couldn't be happier. The work environment is incredible, and the team is so supportive and collaborative. Speaking of work, I've been given some really exciting projects to work on. They are challenging, but I love a good challenge. It's amazing how much I've been learning and growing in such a short amount of time. I feel like every day is an opportunity to expand my knowledge and skills. On a personal note, I recently went on a vacation to a tropical paradise, and it was absolutely breathtaking. The crystal-clear waters, the warm sand beneath my feet, and the stunning sunsets... I can still picture it all in my mind. It was the perfect getaway to recharge and rejuvenate. Lately, I've been exploring some new hobbies and interests. I've taken up painting, and I find it incredibly therapeutic. It allows me to express my creativity and emotions in a way that words sometimes can't capture. It's such a joy to see a blank canvas transform into a work of art. Oh, and have I mentioned the book I've been reading? It's a gripping thriller that keeps me on the edge of my seat. I find myself staying up late just to find out what happens next. It's one of those stories that pulls you in and won't let go until the very end. Anyway, I just wanted to share these snippets of my life with you. It feels good to reflect on the positive things and celebrate the little moments of joy. I hope you're doing well too and that life is treating you wonderfully. If you ever want to chat about anything, I'm here. Take care and talk to you soon!

Data:

Experiment 1

60 WPM

Posture: Upright

Volume: Normal

Subject: Vrishin Hazari

Notetakers: Aarush Kandukoori, Tanvi Pedireddi

Light: Bright, white

Notes:

12:46:02 - start

12:47:59 - word repeat

12:48:49 - end

120 WPM

Posture: Constant Upright

Volume: Normal

Subject: Vrishin Hazari

Notetakers: Aarush Kandukoori, Tanvi Pedireddi

Posture: Upright Constant



Light: Bright, white

Notes:

12:51:00 - Start
 12:51:30 - stutter
 12:52:04 - stutter
 12:52:33 - end

180 WPM

Posture: Constant Upright

Volume: Normal

Subject: Vrishin Hazari

Notetakers: Aarush Kandukoori, Tanvi Pedireddi

Posture: Upright Constant

Light: Bright, white

Notes:

12:58:03 - start
 12:58:35 - breath
 12:58:47 - pause
 12:59:00 - stutter
 12:59:12 - stutter
 12:59:15 - end

Experiment 2

60 WPM

Posture: Constant Upright

Volume: Loud

Subject: Vrishin Hazari

Notetakers: Viduttama Gaur, Tanvi Pedireddi

Light: Bright, white

Text: Constant

Notes:

3:05:03-start
 3:05:09-stutter
 3:05:59-swallow
 3:06:27-ignore

120 WPM

Posture: Constant Upright

Volume: Loud

Subject: Vrishin Hazari



Notetakers: Viduttama Gaur, Tanvi Pedireddi

Light: Bright, white

Text: Constant

Notes:

3:27:30 - start

3:28:36 - stutter

3:29:04 - end

180 WPM

Posture: Constant Upright

Volume: Loud

Subject: Vrishin Hazari

Notetakers: Viduttama Gaur, Tanvi Pedireddi

Light: Bright, white

Text: Constant

Notes: - incomplete, need to restart

In experiment 1, we recorded data from the spire tag with Vrishin at:

- A normal speaking volume
- Sitting up right
- Straight Posture
- Bright lights

In experiment 2, we changed Vrishin's voice so the data was conducted when:

- A loud speaking volume
- Sitting up right
- Straight Posture
- Bright lights

Additionally, for recording the MetaData by the notetakers, we used this script to record at what intervals someone would make certain actions like coughing, yawning, etc..

```
import time
import pandas as pd

events = []

date = input("Date(Format: 7/14/2023 --> 20230714): ")
toB = input("Type of Breathing(Format: Normal Breathing --> NormalBr): ")
sub_name = input("Subject Name(Format: Ryan Zhao --> RyanZ): ")
team_num = input("Team Number: ")
exp_num = input("Experiment Number: ")
start_time = input("Start Time(Format: 14:23:17 --> 142317): ")
location = input("Location of SpireTag: ")
st_number = input("Spire Tag Number: ")
```



```

df = pd.DataFrame(columns = ["start", "end", "event", "", "Location", "ST Number"])
notes = []
metaCount = 0
while True:
    input("Press Enter when event starts!")
    start = time.time()-1
    input("Press Enter when event finished!")
    end = time.time()+1

    event = input("Event: ")
    if event == "n":
        notes.append([start, end, input("Type your notes below \n"), "", "", ""])
    if event == "end":
        break
    elif not event == "n" and not event == "end" and not event == "":
        events.append(f"{start} - {end} {event}")
        if(metaCount == 0):
            df.loc[len(df.index)] = [start, end, event, "", location, st_number]
            metaCount += 1
        else:
            df.loc[len(df.index)] = [start, end, event, "", "", ""]
df.loc[len(df.index)] = ["", "", "", "", "", ""]
if not len(notes) == 0:
    count = 0
    for note in notes:
        df.loc[len(df.index)+count] = note
        count+= 1

df.to_csv(sub_name+"_"+tOB+"_"+Team+team_num+"_"+exp_num+"_"+date+"_"+start_time+"_Metadat
a"+"_".csv", index=False)

```



Week 4: 07/17/2023

This week I worked on my presentation and presented **BUMP: A Novel Beta-Blocker Pump for Patients with Crashing Bradycardia via Continuous BPM Monitoring**

BUMP Presentation UMD



BUMP: A Novel Beta-Blocker Pump for Patients with Crashing Bradycardia via Continuous BPM Monitoring
 Aarush Kandukoori, Ethan Gracias | Faizan Wajid, Ashok Agrawala | University of Maryland MindLab



Abstract
 Crashing bradycardia is a condition in which a patient's heart rate rapidly falls that can lead to severe health problems and even death. To address this issue we developed a novel, invasive, wearable beta-blocker pump for patients using Arduino components including a peristaltic pump and heart rate monitor with crashing bradycardia to pump in Atropine at the right dose – allowing the patient ample time to drive to a hospital and receive professional treatment. In this experiment we measured the accuracy of the pump at various recorded BPMs by calculating the expected vs actual Atropine dispensed. The pump has an accuracy of 92.5% from the data collected.

Introduction

- **Crashing Bradycardia** - condition in which a patient's heartbeat drops rapidly to dangerous levels under 60 BPM risking long-term health issues and death.
- Our device aims to provide an **invasive, wearable and effective way** while integrating **heart rate monitoring, a medicinal delivery pump for Atropine and patient alert systems** to provide temporary treatment in emergencies and notify the user.
- Test the **accuracy** of BUMP by calculating the right amount of medicine to be dispensed and device's ability to pump out measured dose.
- **Hypothesis: BUMP will be able to sense the patient's BPM and pump the correct dosage of Atropine based on the equation at a deviation less than 5% implying a pump accuracy of 95%+.**

Methods

- Implemented the following components: Arduino Uno microcontroller, PulseSensor Arduino heart rate sensor, peristaltic pump, LCD display, LED, piezo buzzer, bluetooth module and vibration motor for our wiring schematic.
- Components are put together and coded for functionality with Arduino C++. Code structure:

```

    Importing: LCD, PulseSensor & Bluetooth, modules → Variables: Pins & Heart Rate Threshold (60 BPM) → Void Setup & Serial Monitor setup
    Methods: drawInitScreen() → Void Loop: Read BPM & Serial Print BPM, if BPM lower than 60 then LED, Pump (for calculated time), Vibration, Buzzer & LCD turns on
    
```

Methods

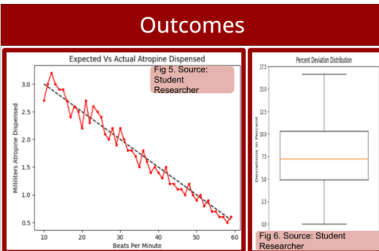
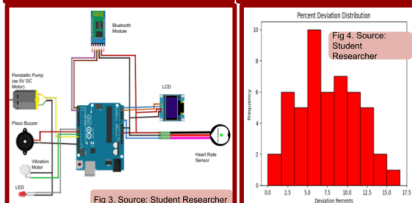
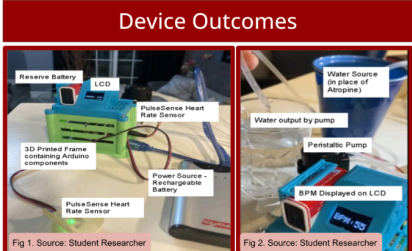
- Designed a 3D printed frame to keep components in place.
- Device calculates atropine dosage amount for the average male (5'9, 198 lbs) at different BPMs, with the equation:

$$f(x) = -0.05x + 3.5$$

With $f(x)$ = Atropine Dosage in mL and x = Recorded BPM by Sensor. This equation is only valid when the BPM is below 60.

Procedures:

1. Using a potentiometer to manually change BPM, set the BPM to a given value and observe the amount of Atropine (water) that is pumped out when ends of peristaltic pump is in water supply and volumetric flask
2. Measure the amount of water dispensed in a volumetric flask and record the reading as the actual amount pumped out.
3. Calculate the expected amount of water that should be dispensed based off the equation above.



Data Analysis

- Based off our data (Fig 4.) we saw there was a mean of 7.5% deviation approximately therefore the accuracy of the pump is: **92.5%**
- We can see that more than 50% of the data (Fig 6.) is within a **5% deviation** from the expected value, with outliers ranging from **0%** which is a perfect dosage outputted, nearing **17%**. We can also see that the data does follow a **linear pattern** in accordance with the equation $f(x) = -0.05x + 3.5$.

Conclusions

In conclusion, our hypothesis was **incorrect** with the data showing the mean deviation to be 92.5%, 2.5% less than the expected 95%. We believe that a more accurate peristaltic pump, heart rate sensor, increased computing power, testing with atropine and more data can give us more validity on the device. Through iterative prototypes and precise testing, BUMP can revolutionize the wearable medical device market and ultimately save lives.

References

Shah, Shubham and Vaidya, S. "How to make an Arduino Uno with a 128Kbit EEPROM and a 128Kbit EEPROM." Accessed 11/11/2022. <https://www.instructables.com/Arduino-Uno-with-128Kbit-EEPROM/>

"Heart Rate Pump Therapy." MedlinePlus. Bethesda, MD: National Library of Medicine, 2019. <https://www.nlm.nih.gov/medlineplus/heart-rate-pump-therapy/>

Lee, Hyeon, et al. "The Role of the Heart Rate Sensor in the Development of a Smartwatch-Based Heart Rate Monitor." *Journal of Sensors*. Cambridge, UK: MDPI, 2020. <https://doi.org/10.3390/s20102408>

Week 5: 07/24/2023

This week we continued with the data collection and analysis for:

MIND Lab Breathing Project Speech Pre-Trial Analysis

Faizan told us that the text that was previously used is too long and instead we should use something easier like Dr. Suess’:

“One Fish,

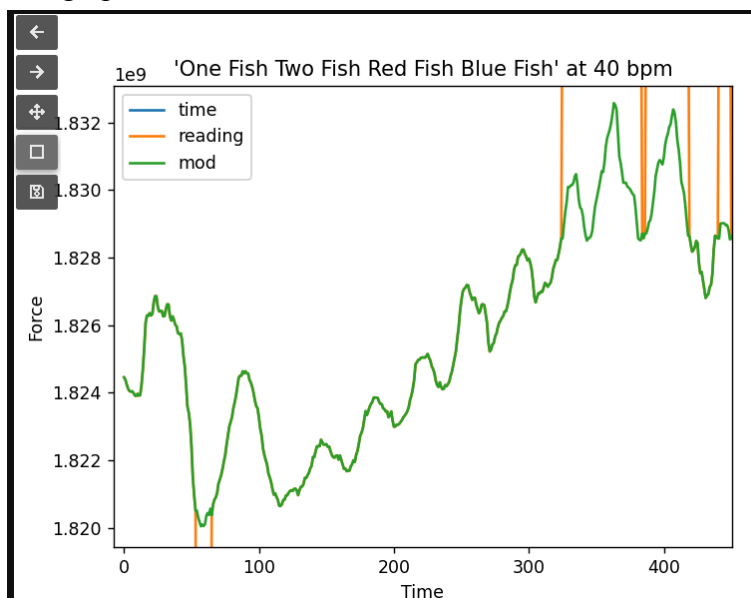
Two Fish,

Red Fish,

Blue Fish.”

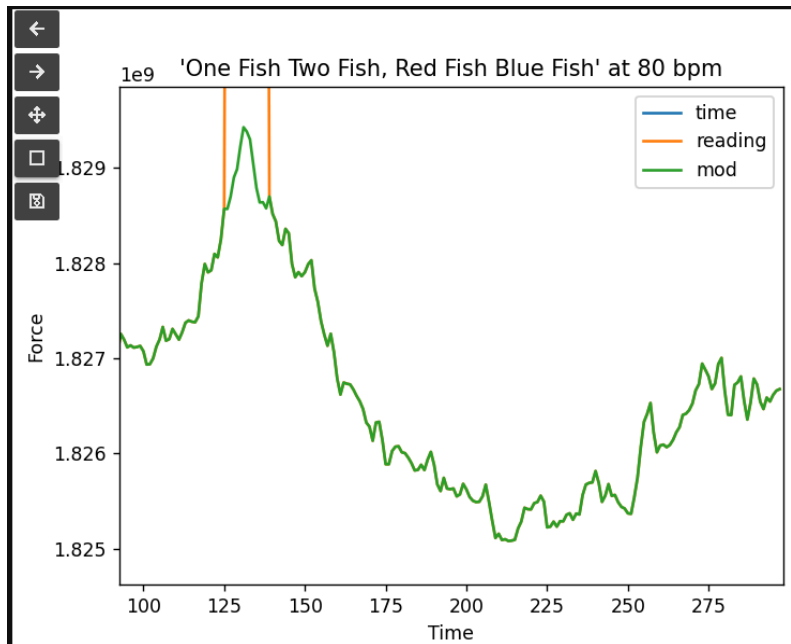
This would ensure more consistent data to achieve our goal of
For experiment 2, here is our data:

40 bpm trial 1 cleaned graph:



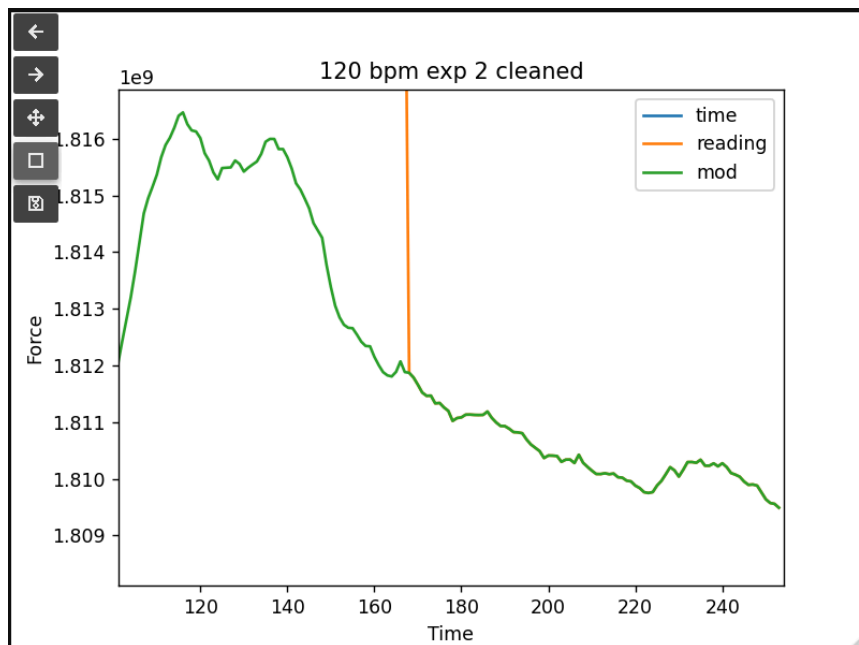
Notes: Can correlate each small “bump” to a word the subject says, where the first “bump” is at around time = 150. This is probably the clearest graph where we can easily correlate each peak in the graph to an event. However, the tag is backward/upside down as we should see the graph decrease as air is being pushed out (not inhaling as we speak each word).

80 bpm trial 1 cleaned:



Notes: The tag is on the right track this time, can see that downward trend we were looking for, but can't see the clarity of each word being spoken. Perhaps because we are inherently exhaling as we talk and not holding our breath after each word we speak. Can try holding breath after each word or strongly articulating words to be able to see individual words? Something to think about.

120 bpm trial 2 cleaned data



Notes: We see our downward trend again, which is what we are looking for. Data for 120 bpm exp 3 looks very similar to this as well.

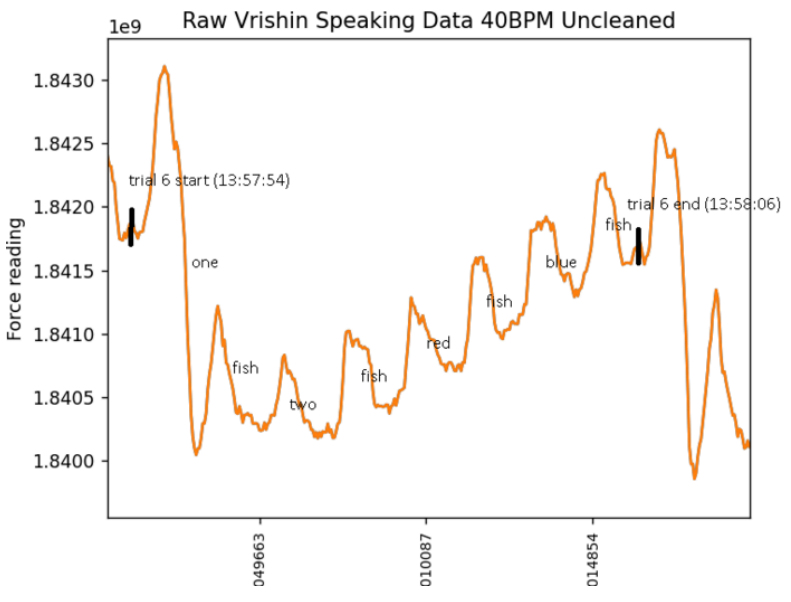
Other graphs did not turn out so well, where the reading gives us data that doesn't tell us much so we should devise a better trial design. Perhaps try not releasing air after each word, which could seem unnatural and might cause it to be trivial, but I think it would be really good if we could see exactly when words are being spoken. Because a lot of different things could indicate something like a downward trending graph, such as talking, or a prolonged exhale, it can be hard to define what talking looks like on a graph.



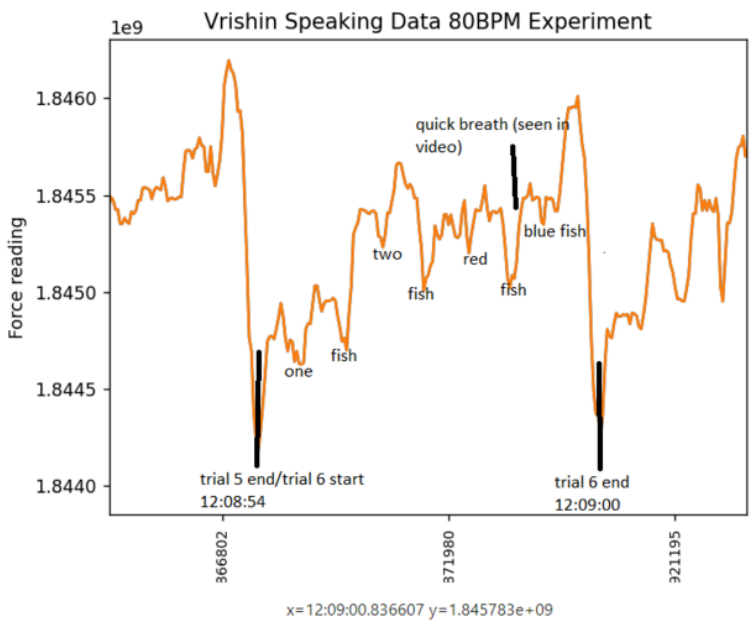
Week 6: 07/31/2023

This week we had our biweekly meeting with Dr. Agrawala in which we presented our data so far. We decided to annotate some of the graphs of Vrishin's breathing for experiment 2 in which he said the short Dr. Seuss text:

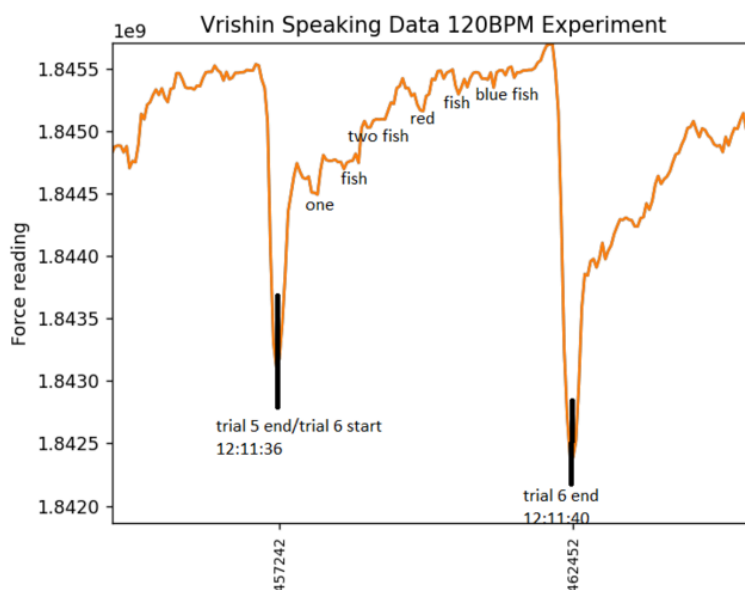
40 BPM



80 BPM



120 BPM



Dr. Agrawala pointed out a couple of things:

1. We should try with longer text and more natural speaking since this is with a metronome. He suggests we ditch the metronome.
2. Vrishin should stop taking a breath before saying each word as that is not normal conversational talking.

As a result we can re-incorporate experiment 1 into our data even though it is different from the rest.

Ms. Cai also wanted us to do some additional experiments with balanced breathing. Balanced breathing steps:

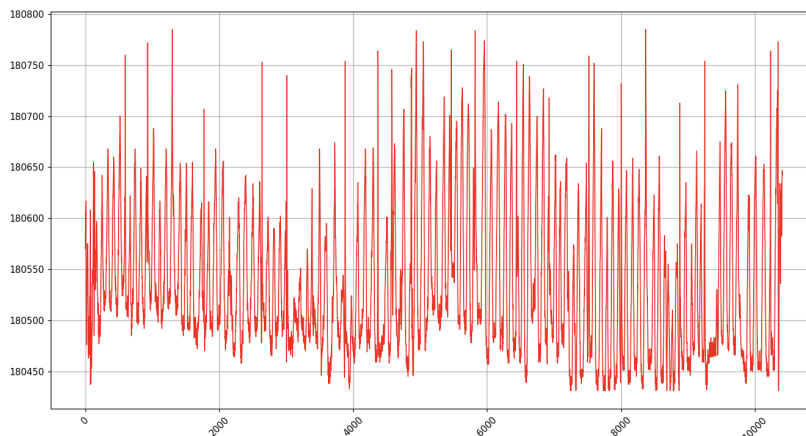
1. Close Left nostril, Open right Nostril
2. Breath in
3. Breath out
4. Open Left nostril, Close right Nostril
5. Breath in
6. Breath out
7. Repeat

We can incorporate this method of balanced breathing into our experiments. Note: All our experiments and videos are in the nextcloud.

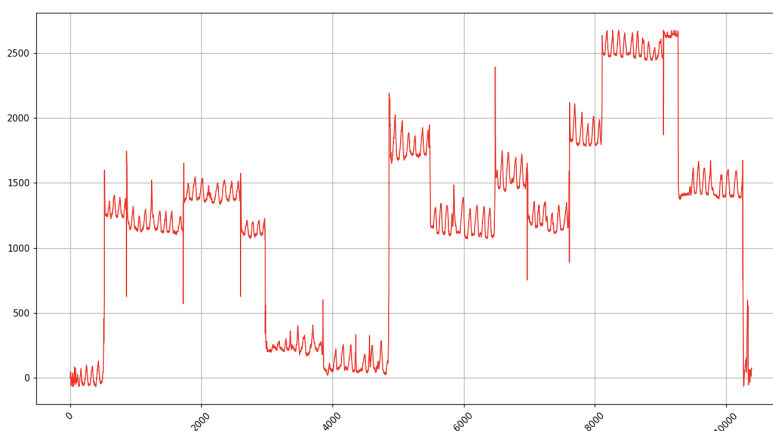
Week 7: 08/07/2023

This week we mainly continued with data collection for the pretrial analysis. However, Mrs. Qadri raised some concerns about the data that was cleaned.

The desired output after cleaning would look something like this:



Here we can see that there are no drastic jumps from one point to another. Unlike this, when data is cleaned and the output is:



We can see sharp jumps at places like at $x \approx 500, 1000, 1900, 2500, 5000, 6500, 7500, 8500, 10500$. This is a result of data cleaning that is not well done. To combat this, Faizan recommended that we plot the raw data and the derivative of that graph to see points at which the derivative is extremely high and can tell us at what intervals the jumps were unexpected. In part of cleaning, the data that was changed drastically from the jump needs to be reconnected with the rest of the data (when cleaning) that would be predominantly team 1's responsibilities. Firstly, we need to figure out what data is not well cleaned so I wrote this script to graph the data:

#Data Analysis Script

```

%matplotlib widget
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import os
import glob
datafile =
pd.read_csv("JamesT_NormalBr_Team1_3_20230727_123530_Data.csv")
range = datafile.loc[1:8513]
range.plot()
plt.figure(figsize=(15, 15))
plt.show()

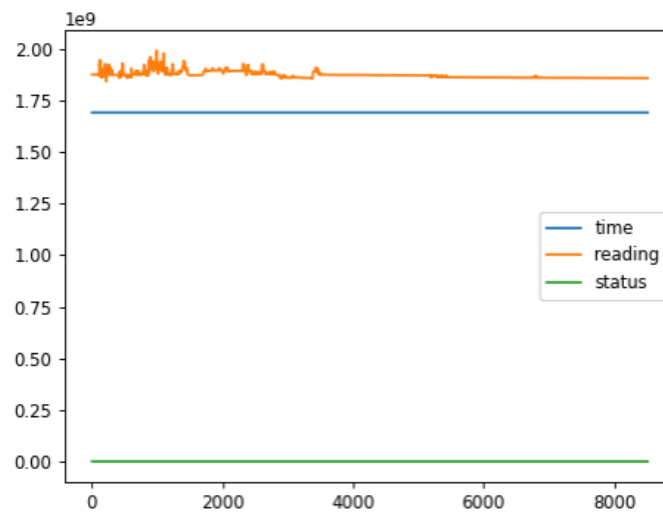
display(datafile.head(n=3))

```

Output:

	time	reading	status
0	1.690476e+09	1874646975	0
1	1.690476e+09	1874626551	0
2	1.690476e+09	1874587094	0

Figure 1



```
# first pieces of data - to make sure it is in right format before
```



```
graphing
datafile.head()
```

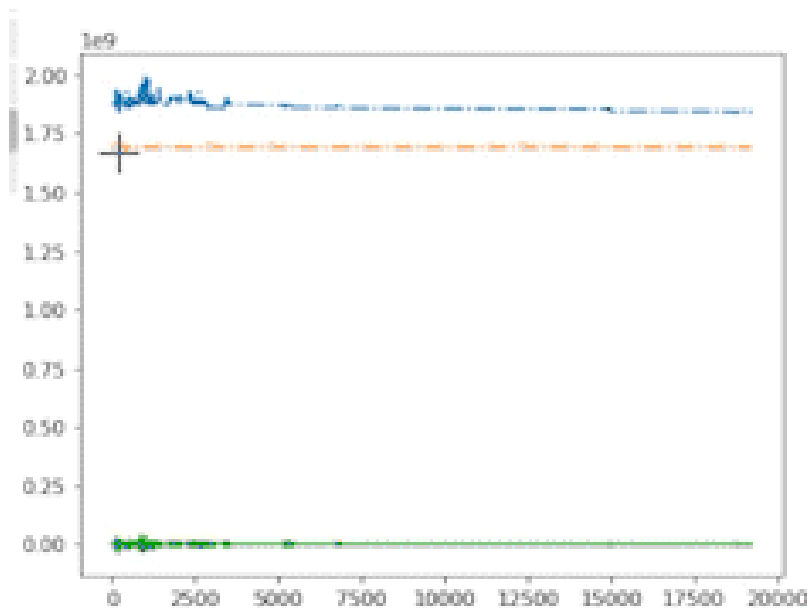
Output:

```
[85]:
```

	time	reading	status
0	1.690476e+09	1874646975	0
1	1.690476e+09	1874626551	0
2	1.690476e+09	1874587094	0
3	1.690476e+09	1874513889	0
4	1.690476e+09	1874714040	0

```
#Graph with dots to zoom in and manually see points with great jumps
%matplotlib widget
import numpy as np
plt.plot(datafile['reading'],'-.-')
plt.plot(datafile['time'],'-.-')
#plt.plot(datafile['status'],'-.-')
plt.plot(np.diff(datafile['reading']))
```

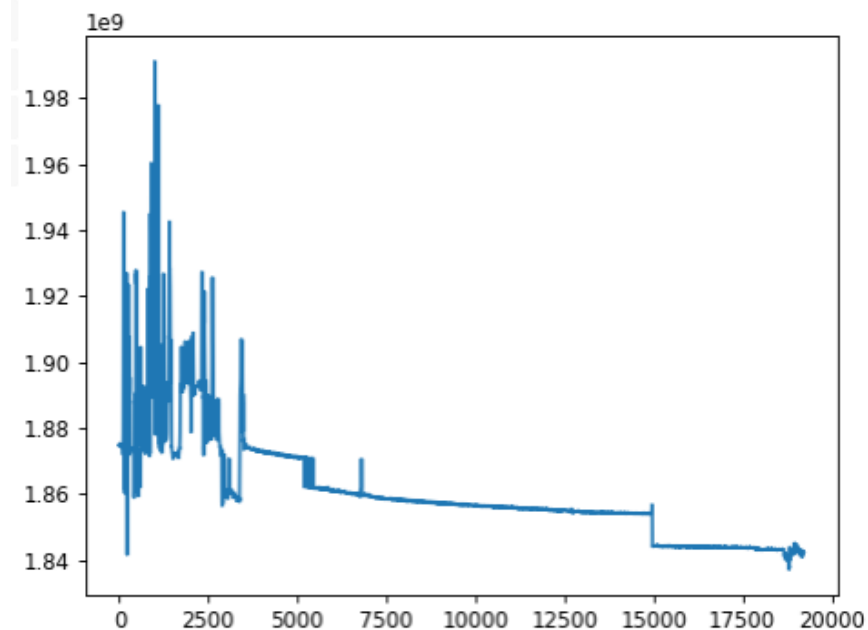
Output:



```
#Raw Breathing Data Graph
%matplotlib widget
import numpy as np
plt.plot(datafile['reading'])
```

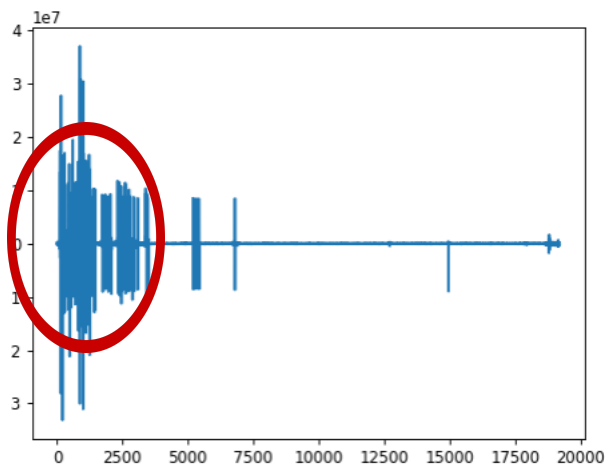


Output:



```
#d/dv graph of breathing data to figure out where there are weird
jumps for cleaning
%matplotlib widget
```

```
import numpy as np
plt.plot(np.diff(datafile['reading']))
```



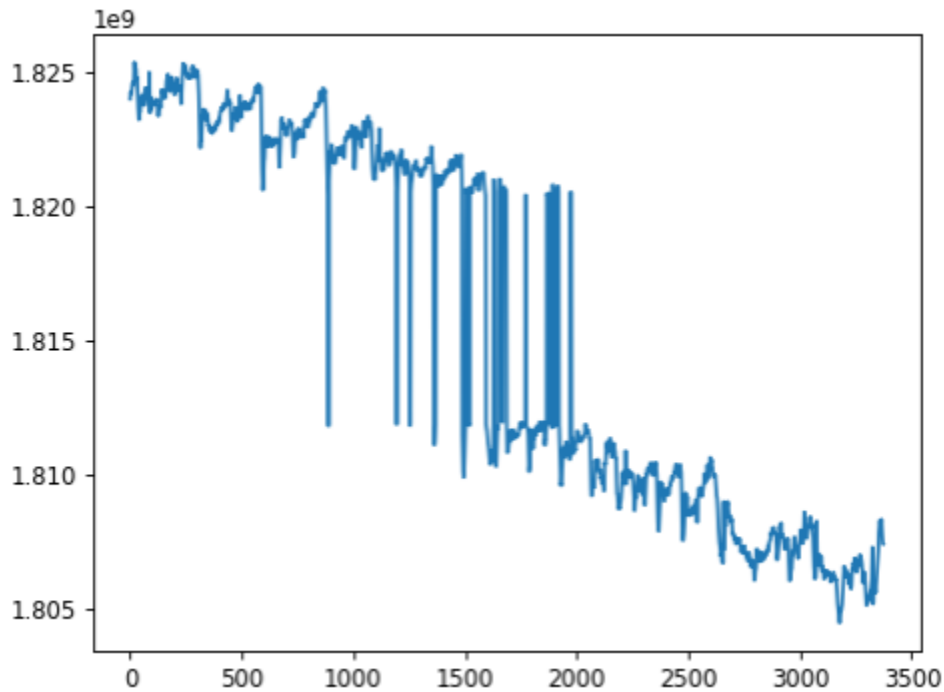
We can see with this graph, a lot of abnormal jumping between $x = 0-3000$ so this data here needs to be cleaned again.

We also decided to get more data for our

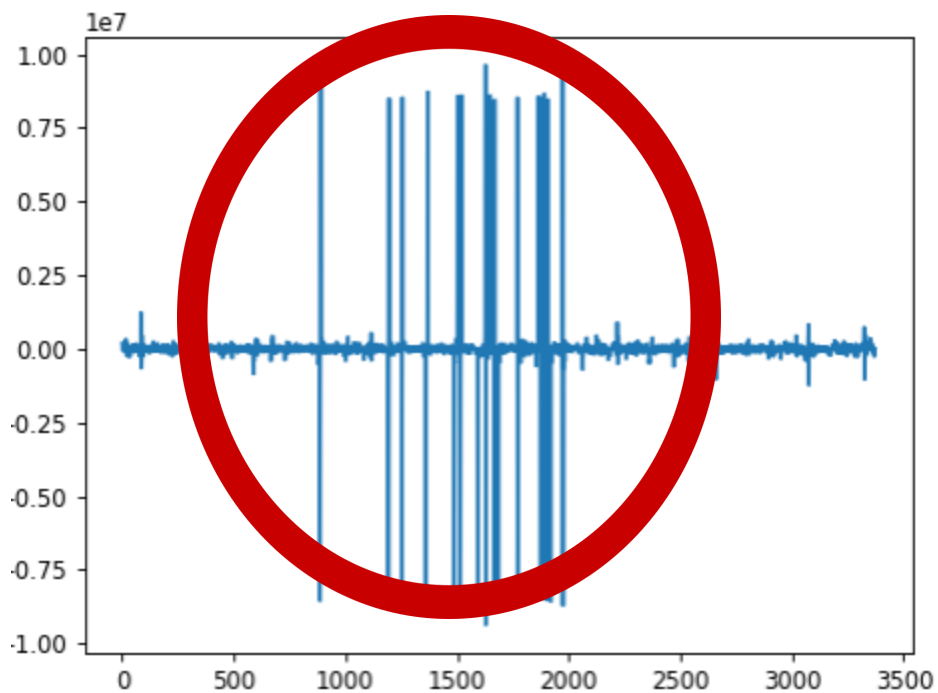
[MIND Lab Breathing Project Speech Pre-Trial Analysis](#) .

We got 2 regular breathings, 2 conversational breathings and 1 balanced breathing by Aarush (me).

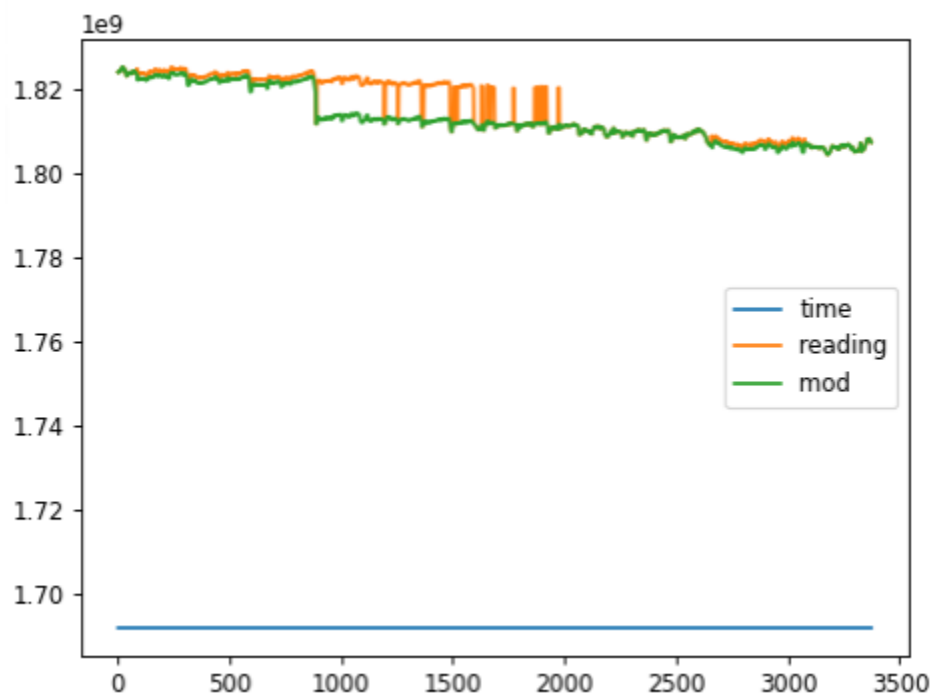
Vrishin was our test subject for the 2 regular breathings & 2 conversational breathings. Here is one of the raw data graphs.



When we take the derivative of the function, we see a lot of abnormal jumps in the middle.



So, some cleaning is required. After the cleaning, we get something like this:



Orange = Original Raw Data

Green = Modified Clean Data

We can see that the jumps are now back in place with the rest of the data after the script is done.

[University of Maryland MIND Lab Research Internship Journal - Aarush Kandukoori](#)



Week 8: 08/14/2023

This week, I predominantly worked on creating and presenting my final presentation to Dr. Agrawala, Mr. Wajid, Ms. Cai & Ms. Qadri.

 UMD MIND Lab Final Internship Presentation 2023 - Aarush Kandukoori

Week 9: 08/21/2023

This is the final week of my internship at [MIND Lab](#). I am very grateful to have been working under Professor [Dr. Agrawala](#), mentors: [Mr. Wajid](#), [Ms. Cai](#), [Ms. Qadri](#) and my fellow interns.

Summer 2023 Synopsis

Full Length Synopsis Here:

MIND Lab Summer 2023 Synopsis - Aarush Kandukoori

- Presented BUMP: A Novel Beta-Blocker Pump for Patients with Crashing Bradycardia via Continuous BPM Monitoring

BUMP Presentation UMD

BUMP: A Novel Beta-Blocker Pump for patients with Crashing Brady...

- Conducted 8 experiments in the

MIND Lab Breathing Project Speech Pre-Trial Analysis to analyze speech data from Spire Tag breathing force data

- Visualized the derivative of breath segments to highlight intervals in which data needed cleaning
- Concluded that lower BPMs such as 40 BPM while speaking, cause a slowing breath rate over time. Presentation:

UMD MIND Lab Presentation - Breathing Analysis 8/17/2023

Wrote 2 articles: Diversity & Inclusion and Algorithmic Bias; Analyzed 450+ Breath Segments & speech data to categorize data as inverted or noisy.