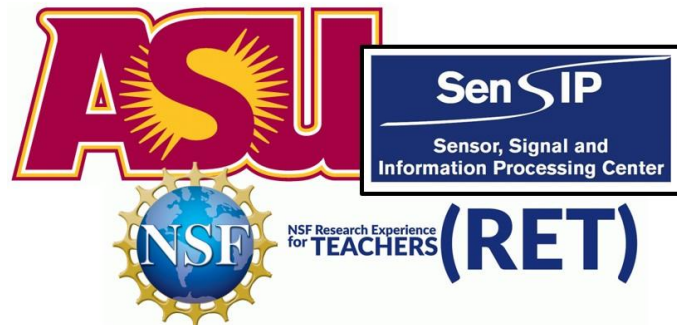


# iHeart Sensors

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Computer Information Systems + Graphic Design  
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June 29, 2023

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Jean Larson, Karl Ernsberger



**ESTRELLA MOUNTAIN  
COMMUNITY COLLEGE**

A MARICOPA COMMUNITY COLLEGE

NSF Award 1953745  
<https://sensip.engineering.asu.edu/ret/>

# **Data Storage Methods for Wireless Monitoring of Neonates for Prevention of Neurological Conditions**



## RESEARCH BACKGROUND

Identifying neurological conditions during the first few hours after birth is crucial for providing timely intervention. Wireless monitoring enhances neonatal care:

Enables healthcare providers to move freely while receiving real-time data.

Promotes a positive parental experience by facilitating uninterrupted skin-to-skin bonding.



# Data Storage Methods for Wireless Monitoring of Neonates for Prevention of Neurological Conditions

## RESEARCH OBJECTIVE

Research the best method to capture and store data wirelessly transmitted from sensors to a computer.

Fundamental for data gathering for next phase analysis, including Machine Learning (ML) techniques for fault detection and classification.

Past failed attempts to save the data to SD cards yielded 50%-90% data loss. SD cards were not fast enough





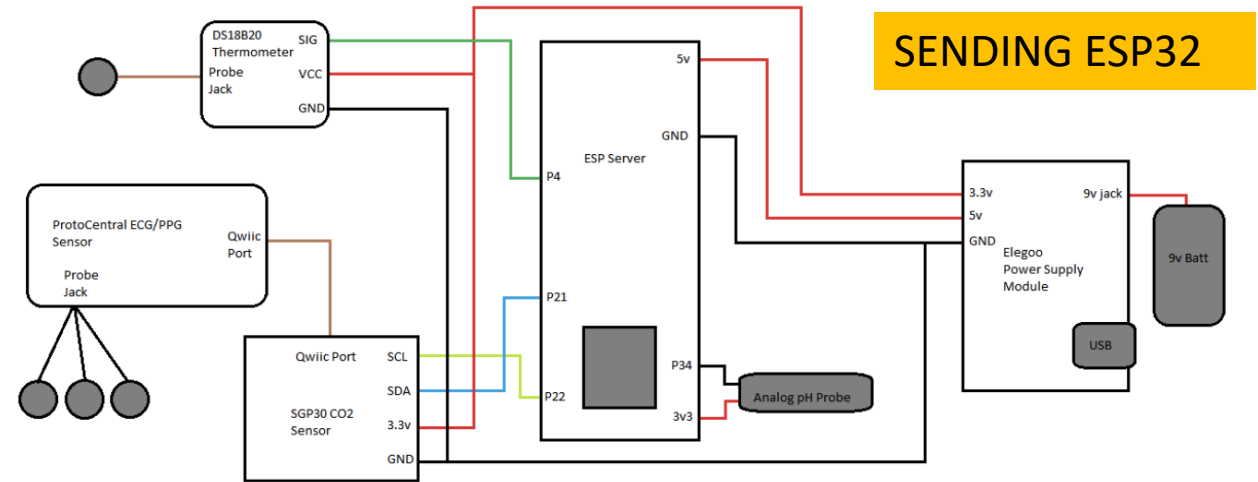
# Data Storage Methods for Wireless Monitoring of Neonates for Prevention of Neurological Conditions

## RESEARCH OBJECTIVE

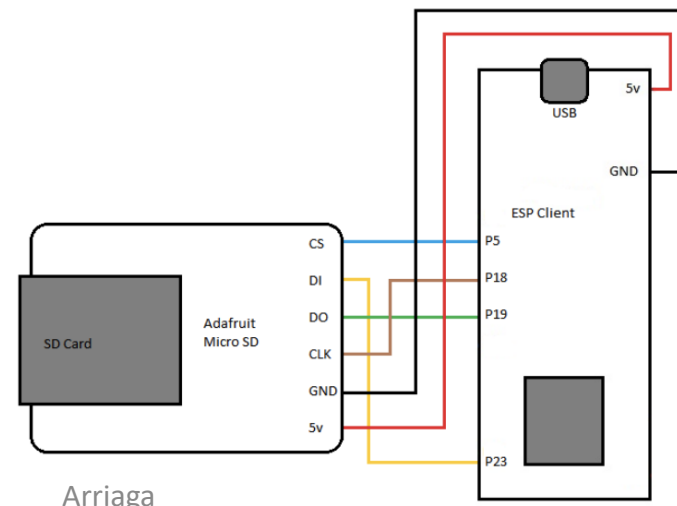
### Hardware Modification

This project explores the viability of eliminating the “receiving” ESP32 board and SD Card from the framework by testing the following:

1. The “sending” ESP32 and sensors connect via WIFI with the “receiving” ESP32, which is serially connected to the computer.
2. The “sending” ESP32 and sensors connect directly to the computer via WiFi.



### RECEIVING ESP32



## RESEARCH RESULTS

### *Method 1 – Coding a New Application*

The research first explored the feasibility of writing a new computer program with C# and Visual Studio.

- Too difficult to accomplish within the set timeframe
- Limited coding skills

### *Method 2 – Using an Existing Application*

Research pivoted to explore existing methods that could meet the objective.

**WINNER**



**CoolTerm**

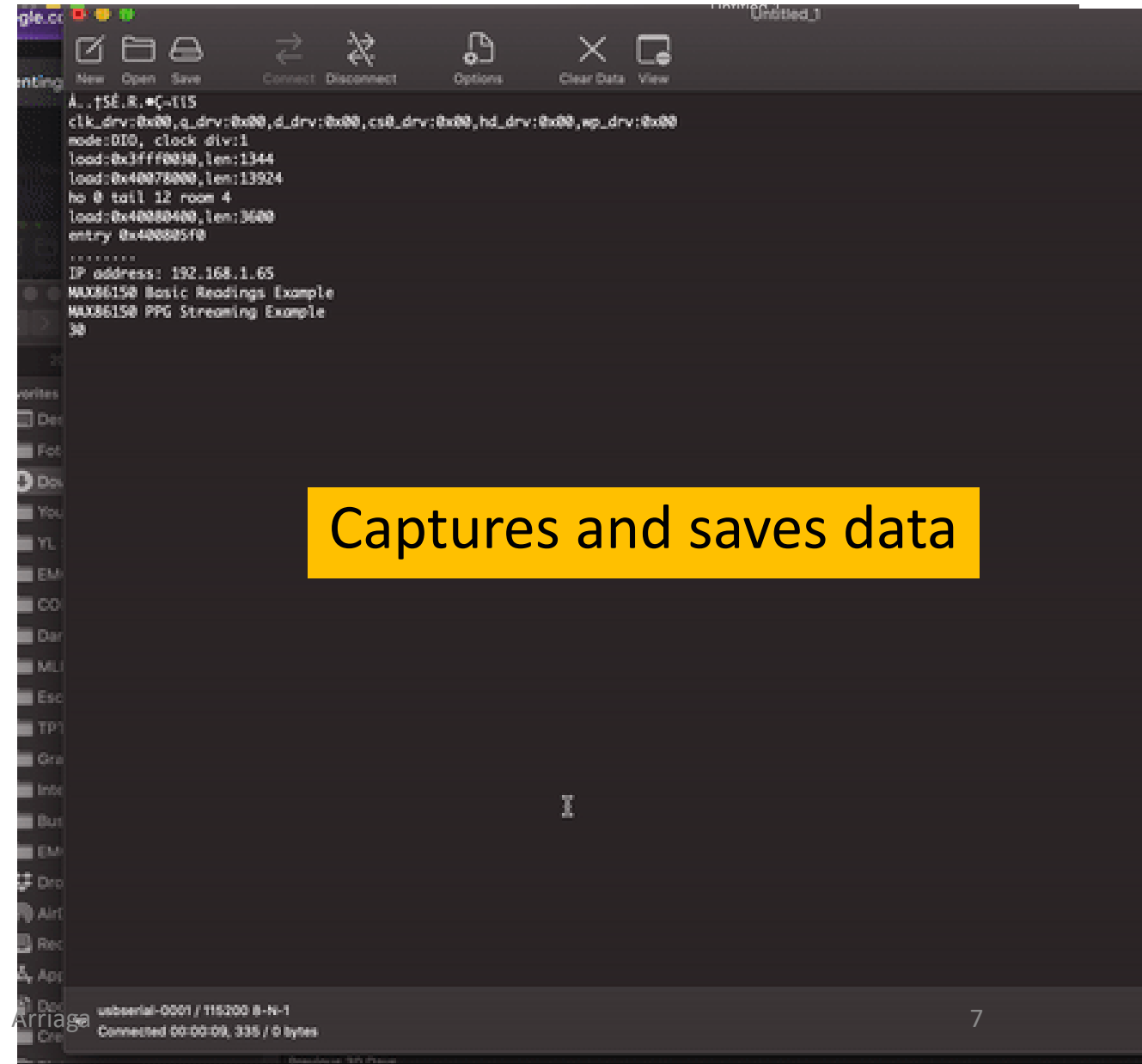
# Data Storage Methods for Wireless Monitoring of Neonates for Prevention of Neurological Conditions

## RESEARCH RESULTS

CoolTerm is a serial port terminal application geared towards hobbyists and professionals with a need to exchange data with hardware connected to serial ports.



**CoolTerm**



## RESEARCH RESULTS

### PREPARATION

- Installing the Arduino IDE
- Understanding the original JSON code installed in the ESP32 boards
- Update the code to include my new WiFi information

### COOLTERM SETUP

- Selecting the correct port – serial or WiFi
- Baudrate – 115,200 (matches ESP32 code)

#### First Goal

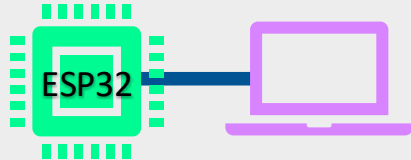
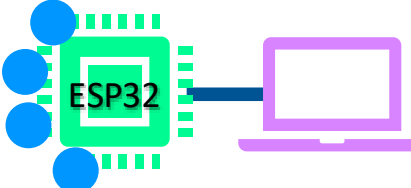
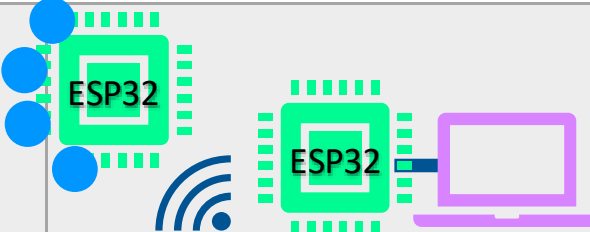
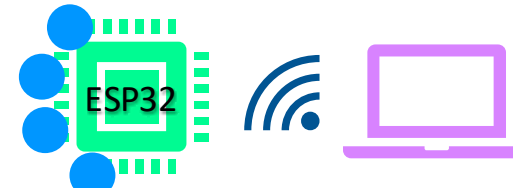
- Successful re-creation of the original hardware setup.



# RESEARCH RESULTS

## TESTING

4 different trials conducted to ensure data is captured and saved properly

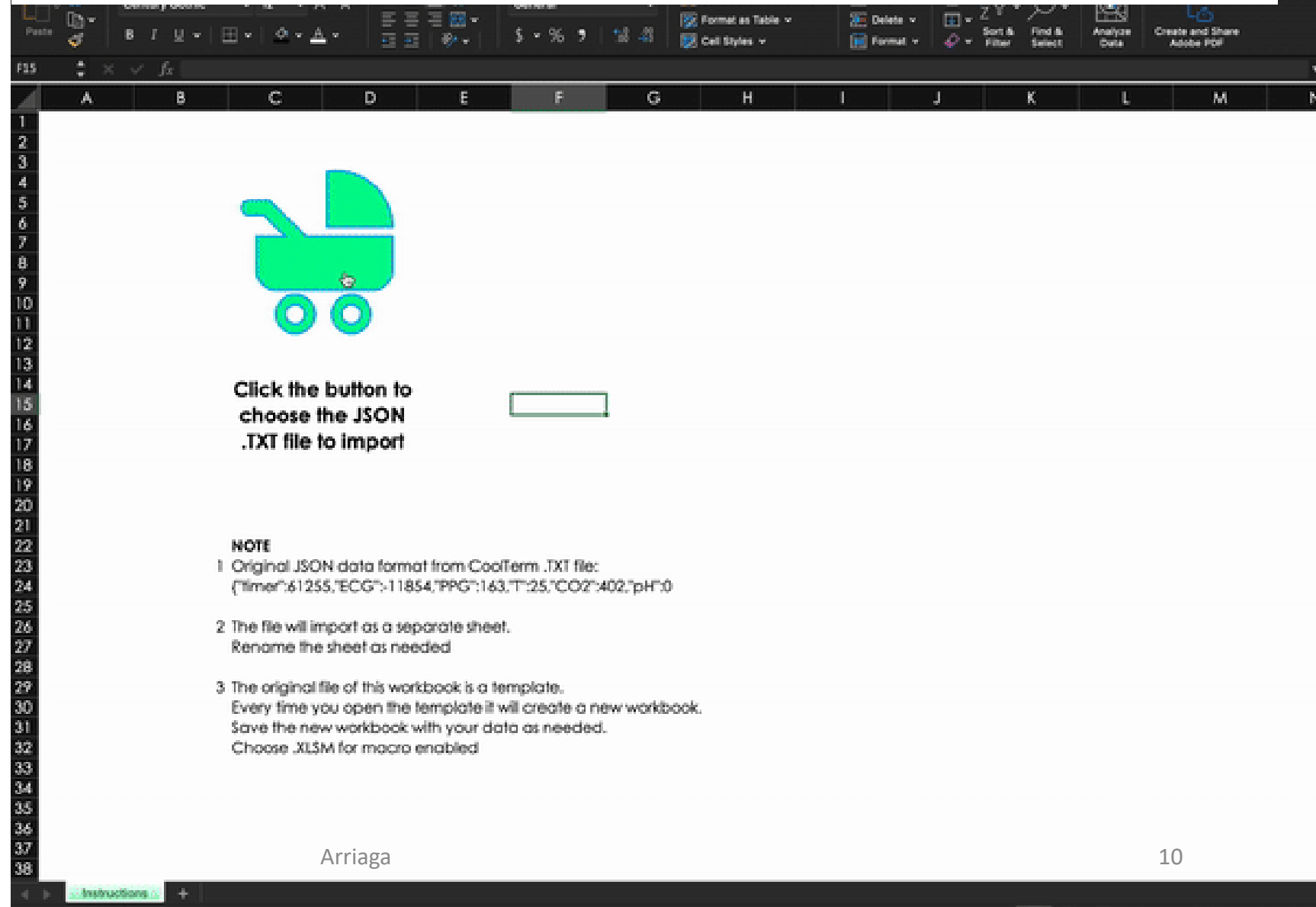
Test	Hardware	Code	Connection	Results	Visual
1	Single ESP32	Dummy code uploaded to ESP32 to simulate sensor information	ESP32 serially connects to the computer	Success CoolTerm captures and saves the data	
2	1 ESP32 connected to all sensors	Original JSON activating all sensors	ESP32 serially connects to the computer	Success	
3	2 ESP32 + all sensors	Original JSON on both ESP32s	Sensors+ESP32 wirelessly connects to receiving ESP32, serially connected to computer	Success	
4	1 ESP32 connected to all sensors	Original JSON activating all sensors	Sensor ESP32 wirelessly connects to the computer	TCP CoolTerm Connection failure	

# RESEARCH RESULTS

## Excel Macro: File Prep Option 1

Two options to  
organize the original  
JSON data  
(highlighted above) in  
preparation for ML  
analysis.

```
{"timer":61291,"ECG":2955,"PPG":163,"T":25,"CO2":402,"pH":0}
```



The screenshot shows an Excel spreadsheet with a baby stroller icon in cell F15. Below the icon, the text reads: "Click the button to choose the JSON .TXT file to import". To the right of this text is a small rectangular button. Below the button, there is a "NOTE" section with three numbered points:

- 1 Original JSON data format from CoolTerm .TXT file:  
({"timer":61255,"ECG":11854,"PPG":163,"T":25,"CO2":402,"pH":0})
- 2 The file will import as a separate sheet.  
Rename the sheet as needed
- 3 The original file of this workbook is a template.  
Every time you open the template it will create a new workbook.  
Save the new workbook with your data as needed.  
Choose .XLSM for macro enabled

At the bottom of the spreadsheet, the name "Arriaga" is visible in the status bar.

# RESEARCH RESULTS

```
{"timer":61291,"ECG":2955,"PPG":163,"T":25,"CO2":402,"pH":0}
```

## Python: File Prep Option 2

Two options to  
organize the original  
JSON data  
(highlighted above) in  
preparation for ML  
analysis.

```
[6]: import pandas as pd
import json

file_path = 'text.txt' # Replace with the actual file path

data_list = [] # List to store individual JSON statements

with open(file_path, 'r') as file:
    for line in file:
        json_data = json.loads(line.strip()) # Load JSON from each line
        data_list.append(json_data) # Append JSON to the list

df = pd.DataFrame(data_list) # Create a DataFrame from the list of JSON statements

display(df)
```

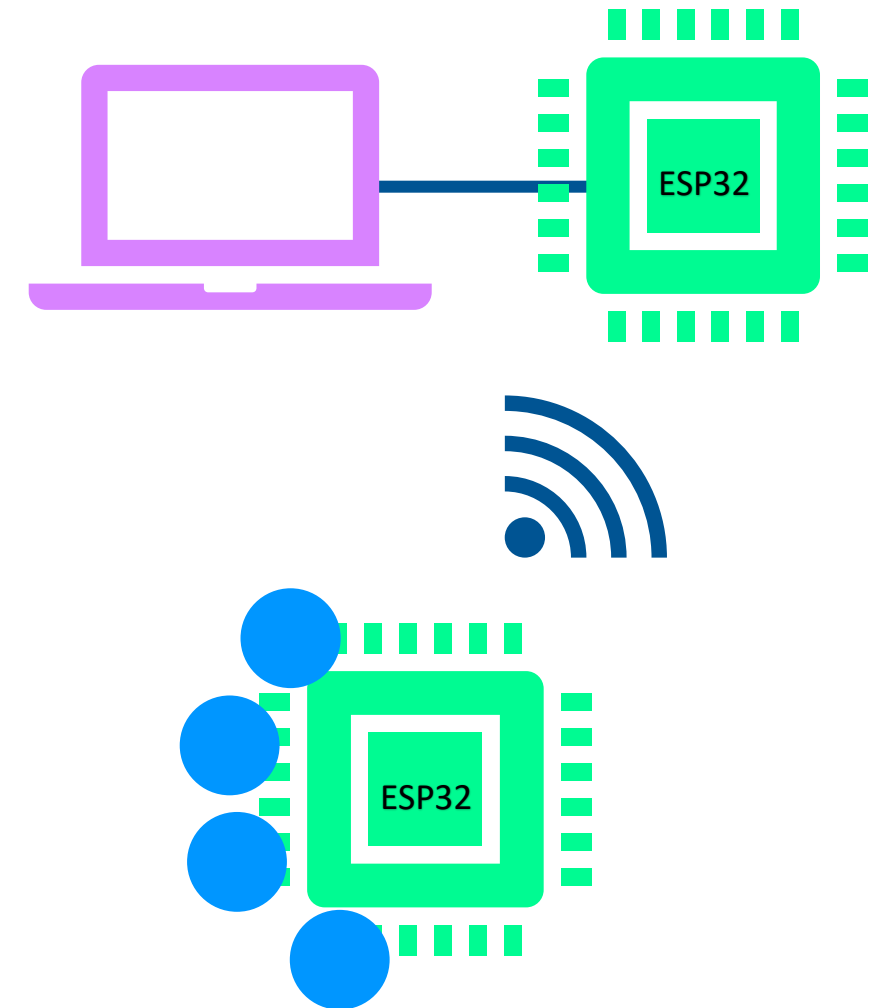
	timer	ECG	PPG	T	CO2	pH
0	61255	16878	163	25	402	0
1	61255	554	163	25	402	0
2	61255	-11854	163	25	402	0
3	61271	-17594	159	25	402	0
4	61271	-15088	159	25	402	0
...	...	...	...	...	...	...
732	69369	-12475	159	25	406	0
733	69369	-10764	159	25	406	0
734	69389	1985	163	25	406	0
735	69389	15617	163	25	406	0
736	69389	23915	163	25	406	0

737 rows × 6 columns

## RESEARCH CONCLUSION

### Objective accomplished!

1. CoolTerm captures and stores wirelessly transmitted data from the sensors (see diagram).
2. Unable to eliminate the second ESP32 board.
3. Both the Excel Macro and Python code developed are essential for future ML data analysis.



A person is shown from the chest up, wearing a white VR headset with the letters 'AI' in red on the front. They are also wearing a white lab coat over a white turtleneck. Their hands are raised in front of them, palms facing forward. The background is a dark blue with a glowing red grid pattern. In the top right corner, there is a glowing red ring. In the bottom right corner, there are three large, stylized red chevrons pointing to the right.

AI

# IHEART SENSORS

INTRO TO EMBEDDED SENSORS

PROFESSOR LESLIE ARRIAGA  
CIS 105

## LESSON DESCRIPTION

# iHeart Sensors

Students are introduced to embedded sensors through a micro lecture and various hands-on activities/assignments.

#	Learning Outcome
1	Recall and define key vocabulary words related to embedded sensors.
2	Utilize the downloaded app to capture their own heartbeats using embedded sensors.
3	Explain the concept of at least one embedded sensor, its functionalities, and evaluate the limitations of using the embedded sensor in a real-life scenario.
4	Apply data visualization techniques in Excel to plot the captured heartbeat data.
5	Generate a 3D object and print it in the Makerspace.
6	Design and deliver a slide presentation showcasing their knowledge of embedded sensors, the heartbeat graph, and their 3D printed creation.



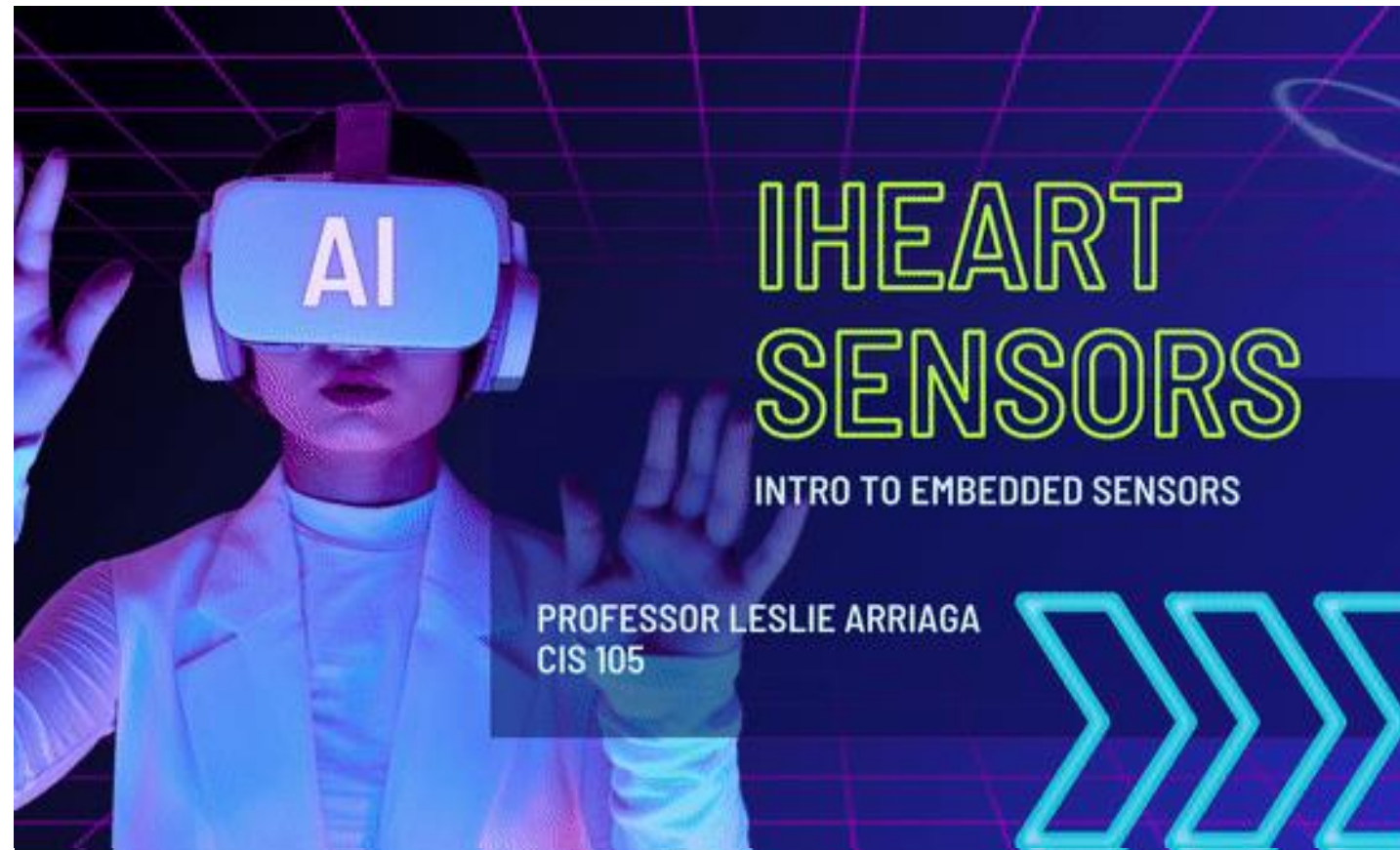
## LESSON OBJECTIVES

### In-Class Activities

#### #1 Micro Lecture

- What are sensors?
- Vocabulary
- Showcase my SenSip experience

#### #2 Activity – Vocab Game

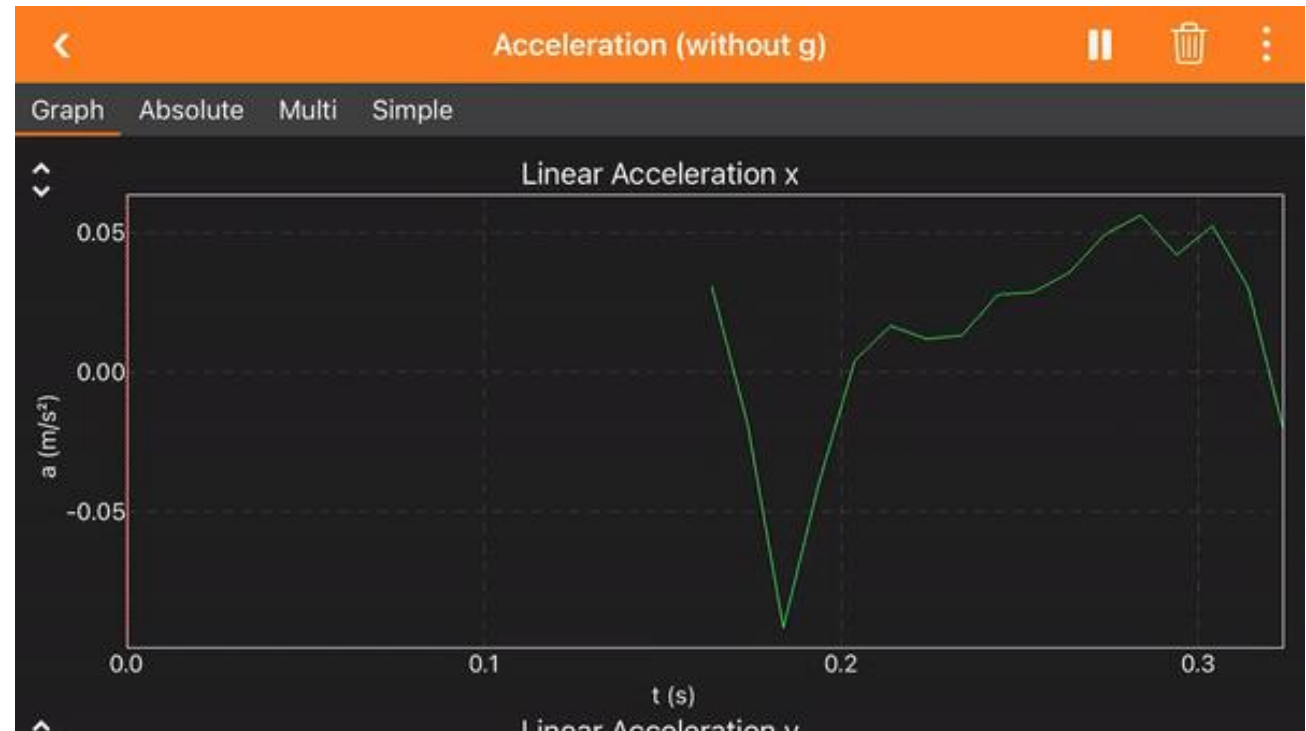


## LESSON OBJECTIVES

### In-Class Activities

#### #3 Activity - Heartrate

- Students download Phyphox App
- Students take own ECG with phone accelerometer
- Export data



## LESSON OBJECTIVES

### Assignments

# #1

## Real World Talk (RWT) – Show Me the Sensor

Flip App

### Real World Talk – Tech In Our Lives

Leslie A 22 347 0 4.1 hours of discussion

Week 2 – Real World Talk  
Let's connect our course learning to our everyday lives.

TOPIC  
How is technology changing our everyday lives? Make a video by using your camera (like the Welcome Video) and show us something technological that is changing the way you do life (fairly simple since it's all around us).

RULES  
Video must be taken by you (no uploaded online videos).  
You cannot post something someone else has posted. Make sure...

Show more

Record

22 Responses

Search responses

Jan 28  
Jorge M

Jan 28  
Klara B

Jan 28  
Ali M

Jan 28  
Daniel J

Jan 28  
Manuel L

Jan 28  
Edgar A

Jan 28  
Daniel H

Jan 28  
Vaquojahnae J

Jan 28  
Anthony P

Jan 28  
Tay S

Jan 28  
David S

Jan 28  
Amellea C

Jan 28  
Keegan H

Jan 28  
Jordan K

# iHEART SENSORS

## LESSON OBJECTIVES

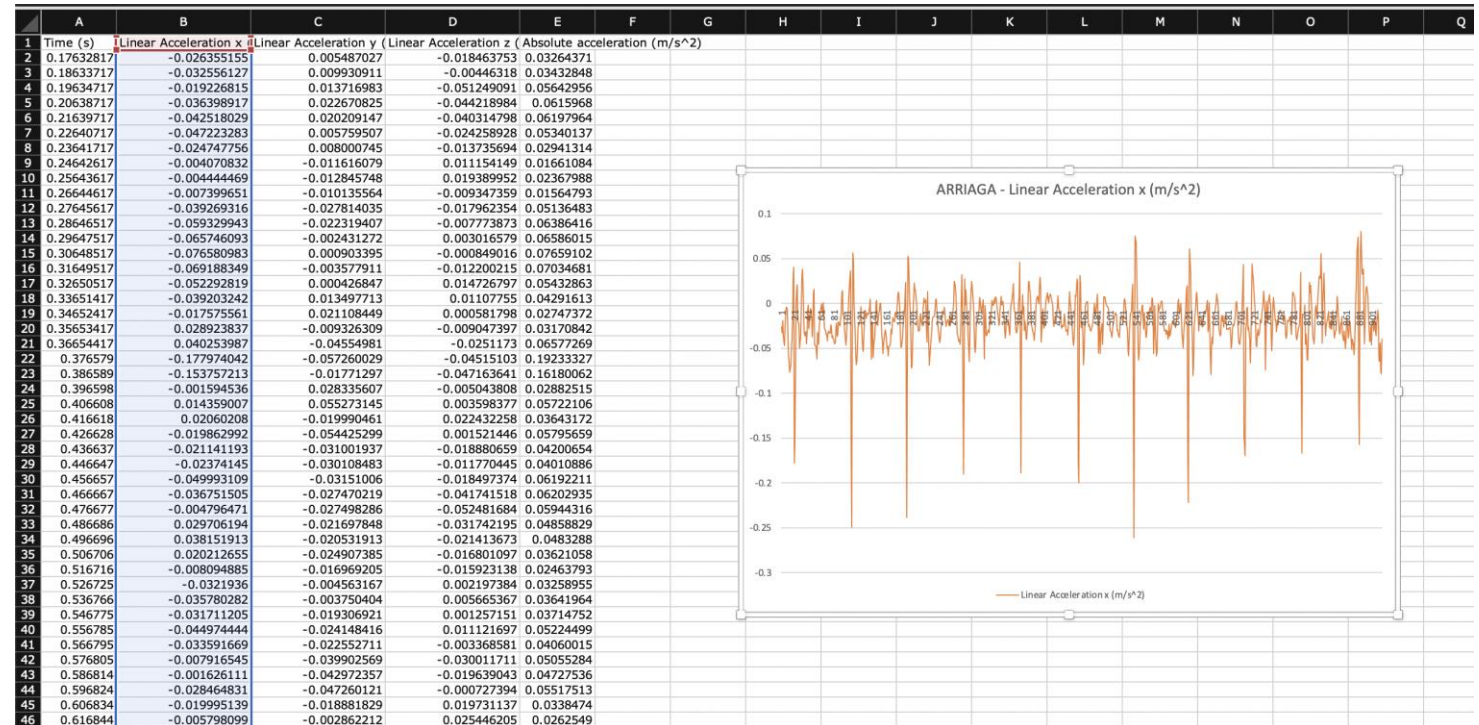
### Assignments

## #2 Graph heartrate data

Excel App



One cycle needed for 3D Print



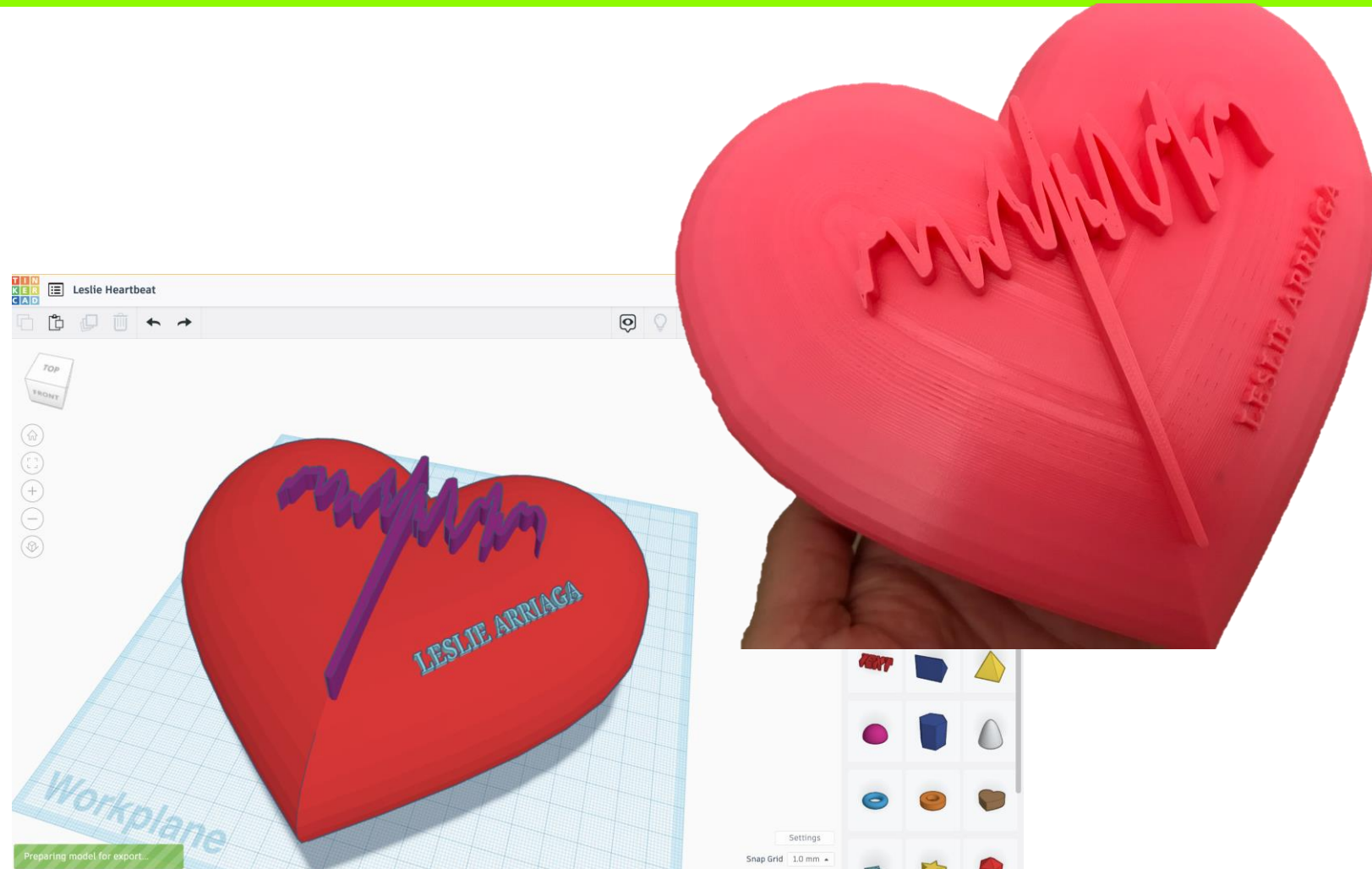


## LESSON OBJECTIVES

### Assignments

#3 (optional)  
Prepare Heartbeat  
Cycle to 3D print

Tinkercad App

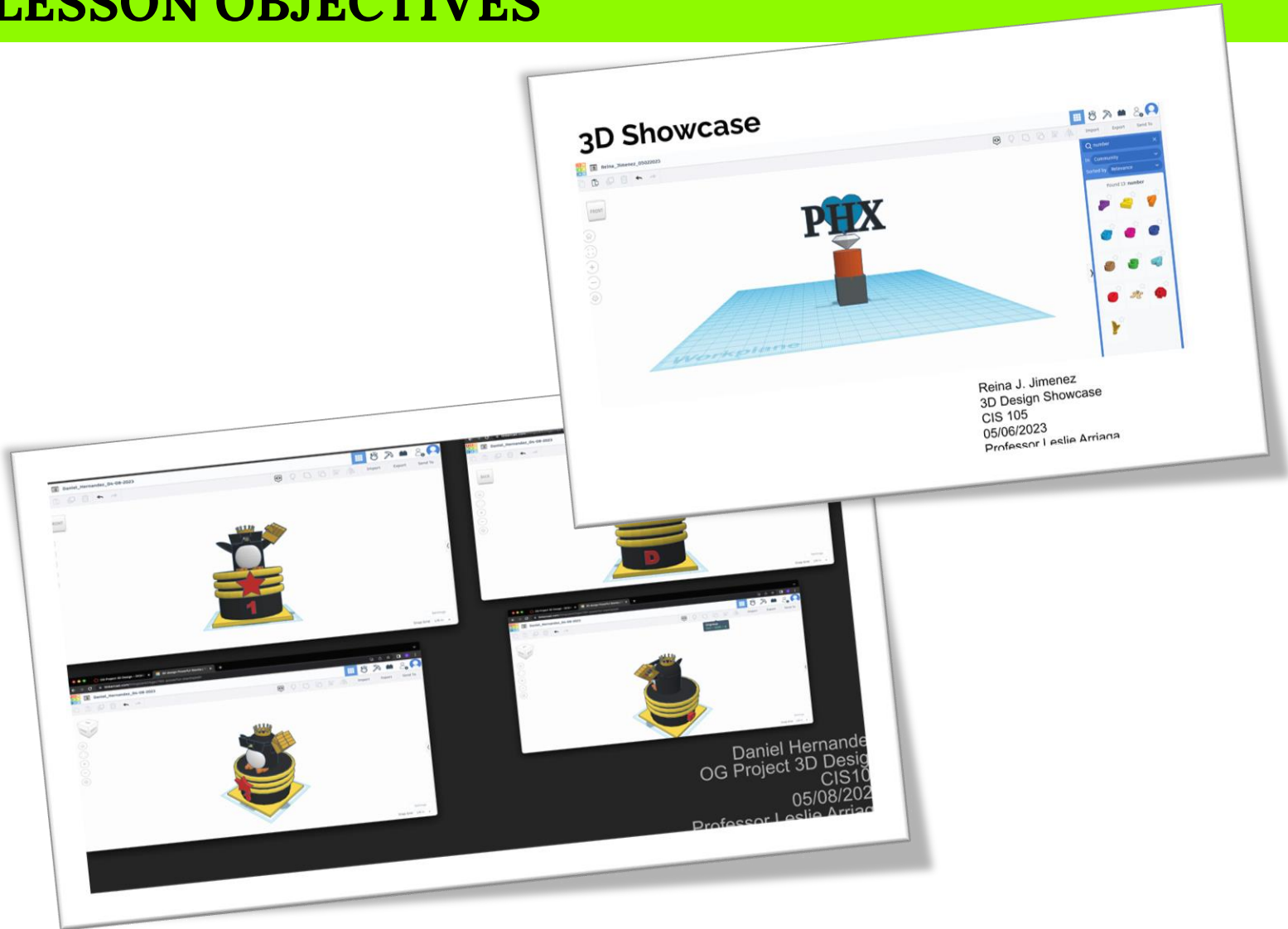


## LESSON OBJECTIVES

### Assignments

#### #4 Project Showcase

PowerPoint App





## CONCLUDING REMARKS

### Project Next Steps

- Sensors to send data wirelessly direct to the computer
- Use sensors to obtain vital signs data
- ML analysis

### Lesson Next Steps

- Transfer content to my LMS
- Teach the students and do the activities

## CONCLUDING REMARKS

### Key research - skills gained (theory/software)?

- Experience with Arduino IDE, JSON, Python, sensors, ESP32
- Understanding of sensors
- Introduction to machine learning

### Self-assessment – what did you get out of this experience?

- Research experience
- Learned about the other research at ASU
- Met some cool peeps in my cohort

## CONCLUDING REMARKS

### Program Observations/Recommendations

- Mentor introduction 1 week before start of program
- Assign projects on day 1 or before
  - Didn't know what we were doing for 2 weeks
  - Start project work on day 1
- 1st week of lectures – consider learning experience



**Thank you!**  
**Questions?**

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**Leslie.arriaga@estrellamountain.edu**