

# Intern Lab Notebook

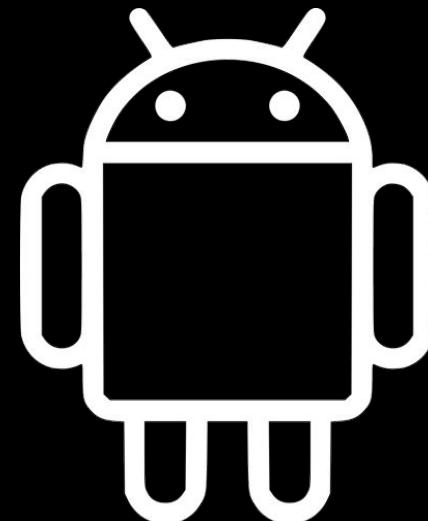
Ibrahim Al-Akash

# Objectives

Create a stress test apparatus to simulate  
long-term continuous use of the UrinDx  
device



Create the Android companion app

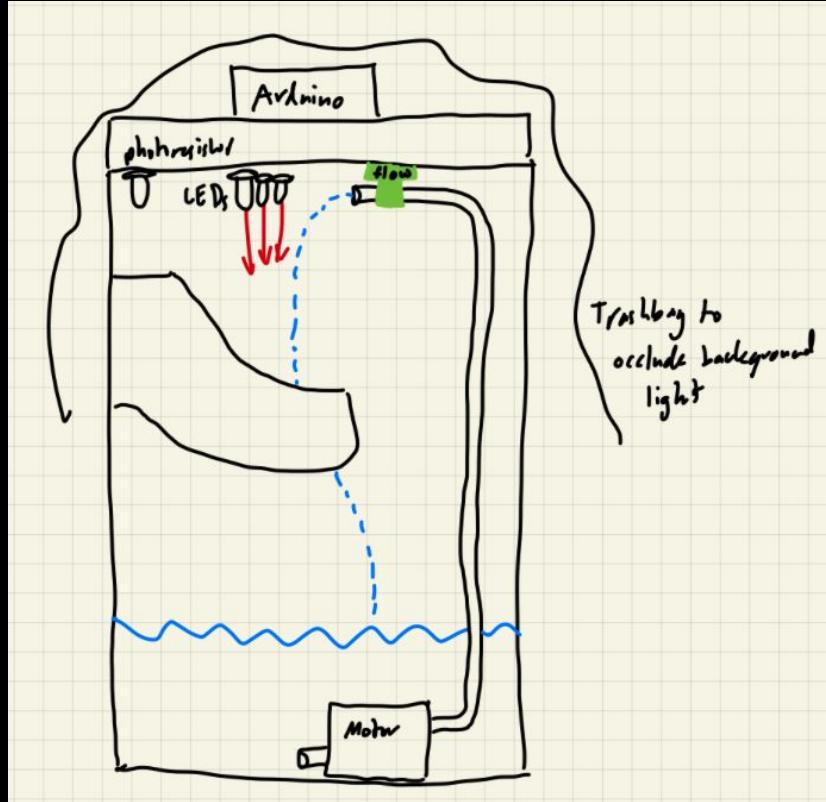


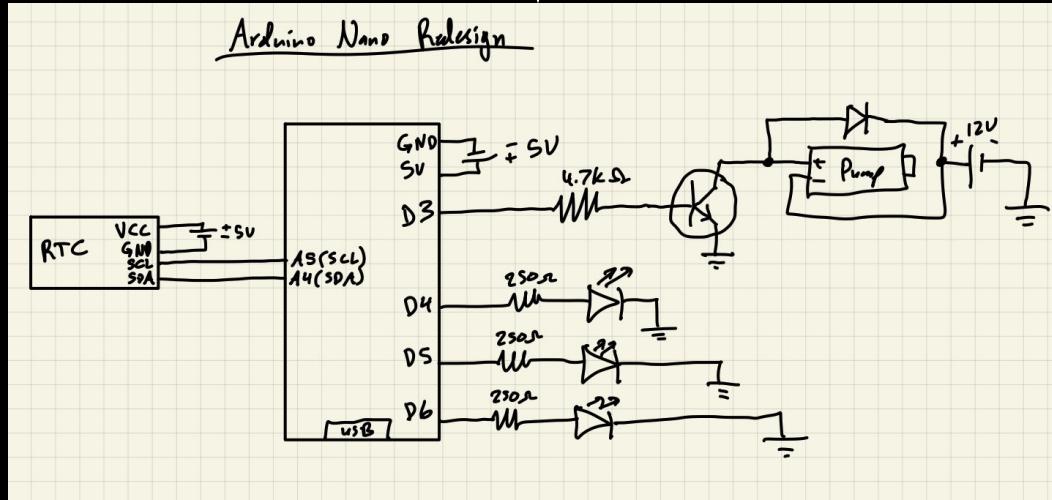
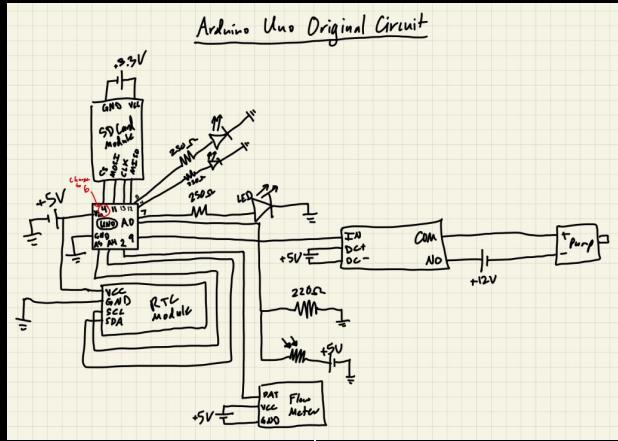
# First Weeks (5/13 - 5/24)

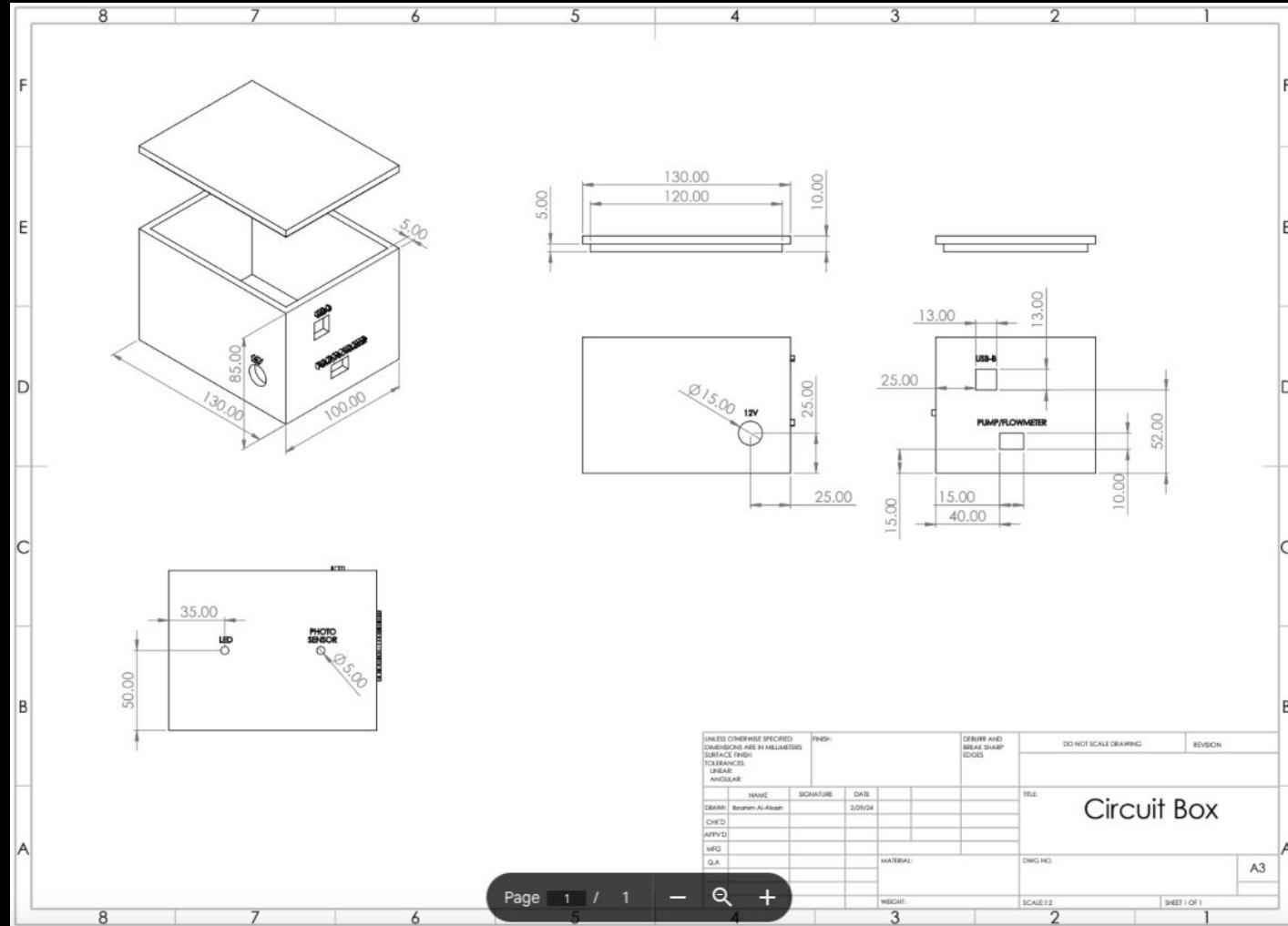


- **Completed refactoring the circuit for the 24/7 test apparatus**
  - Moved from Arduino Uno to Nano
  - Cut out extraneous sensors/modules to simplify circuit including the flowmeter, photoresistors, and SD card (*also not needed anymore since we can just check from the UrinDx measurements if the device is recording the readings at the correct time intervals*)
  - Moved from relay module to transistor to enable PWM adjustment of pump flow rate (used BJT since I found one in the lab)
  - Discovered the rusted RTC module was unreliable with the Nano, so replaced it
  - Added 2 more LEDs since the lone LED was not bright enough to trigger a reading

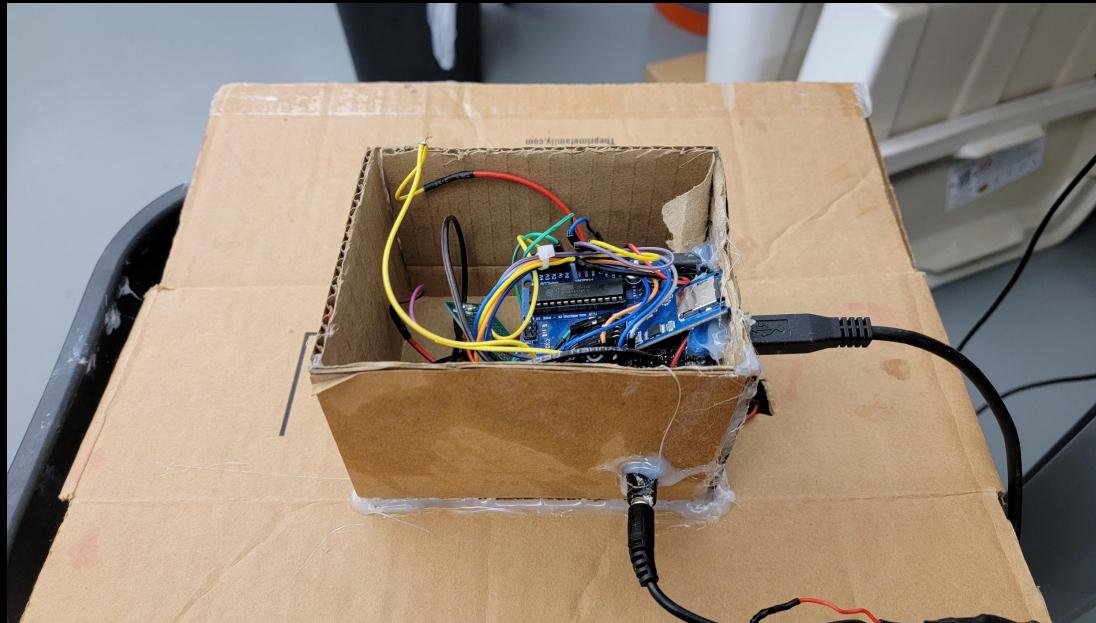
# Original Test Apparatus Design (Urinator 3000)



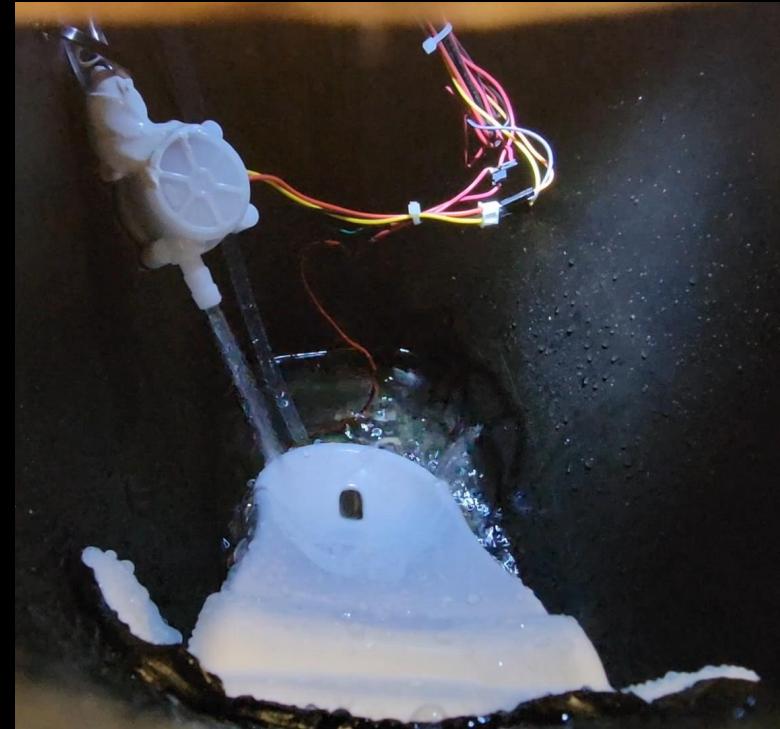
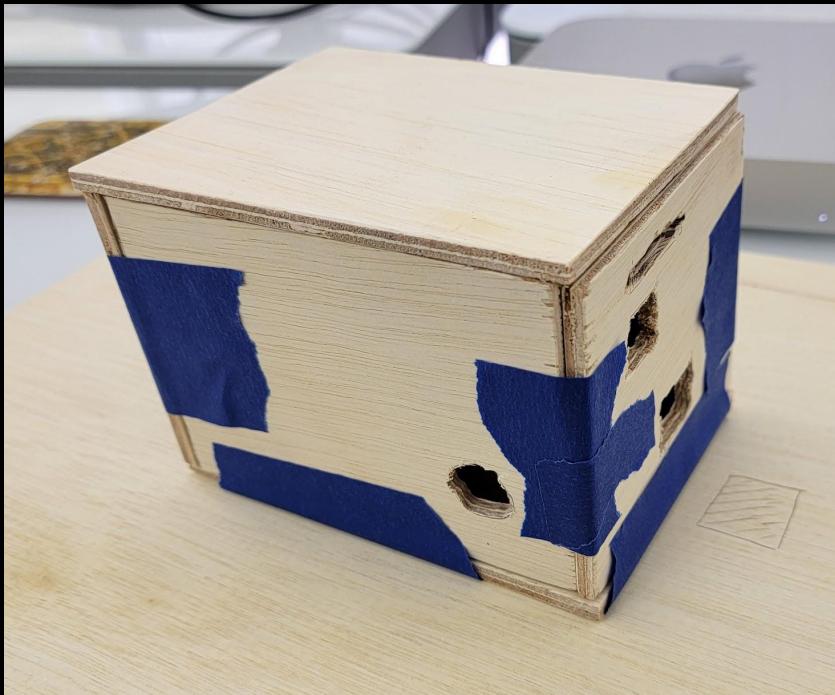




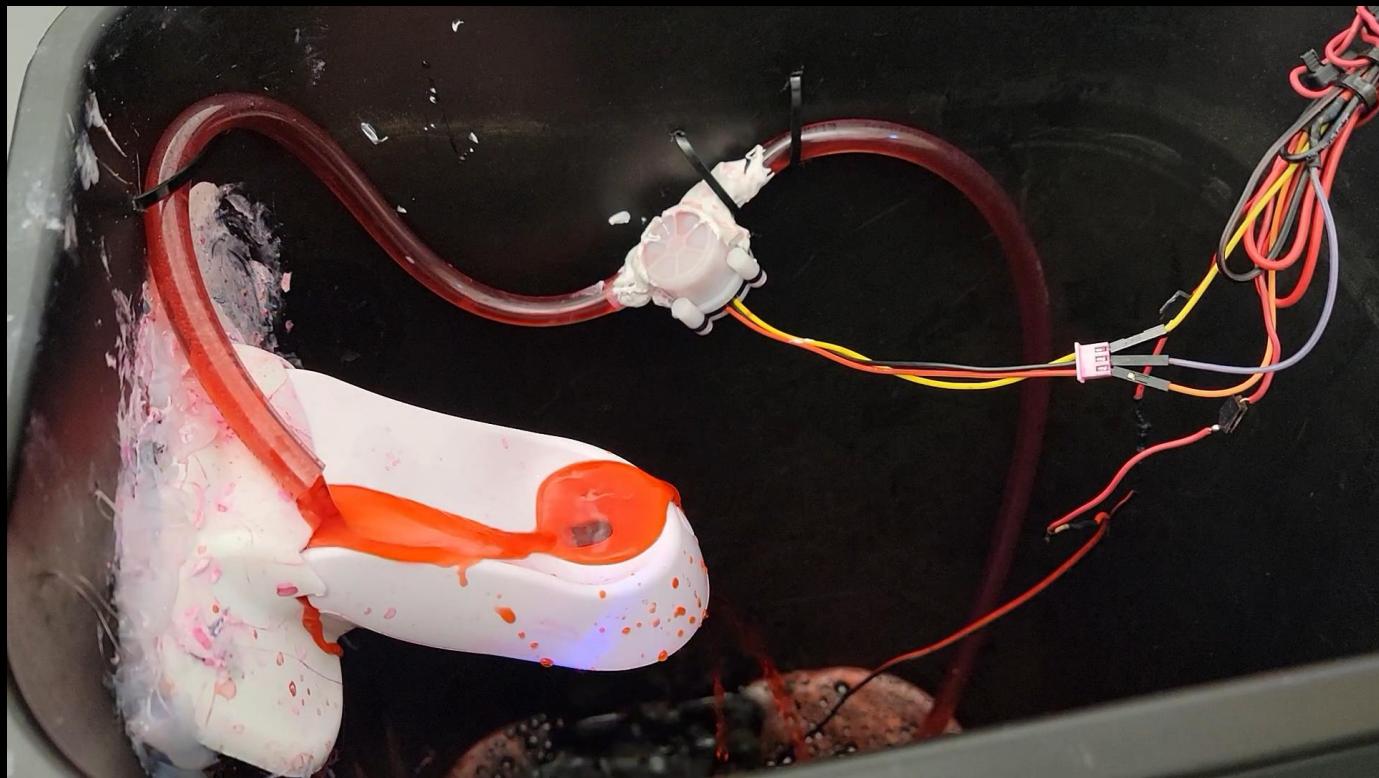
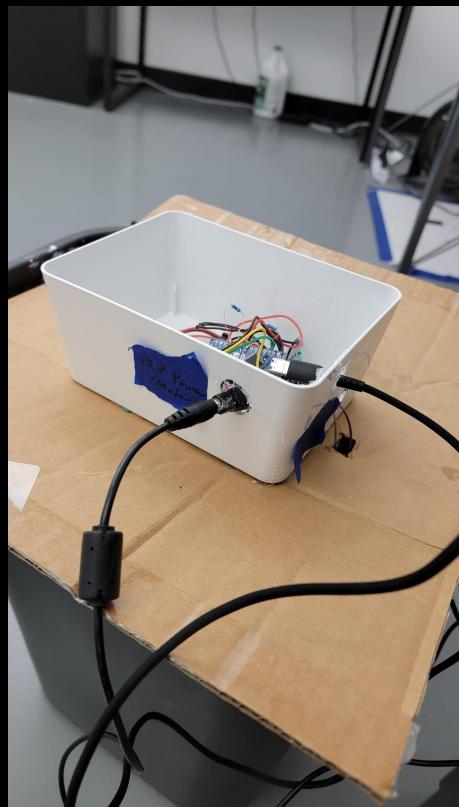
# Iteration V1 (Cardboard + Arduino Uno)



# Iteration V2 (Wood + Arduino Uno)



# Iteration V3 (Plastic + Arduino Nano)

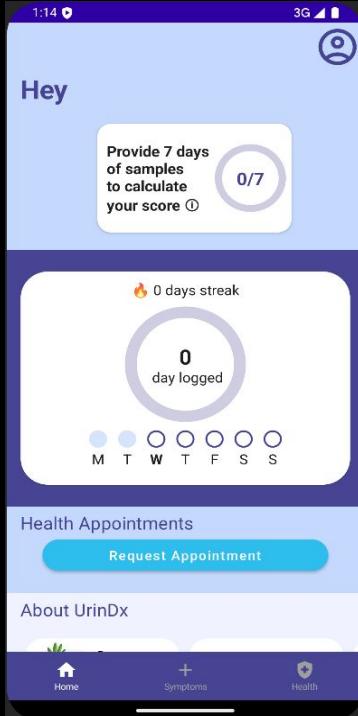


# First Weeks (5/13 - 5/24)

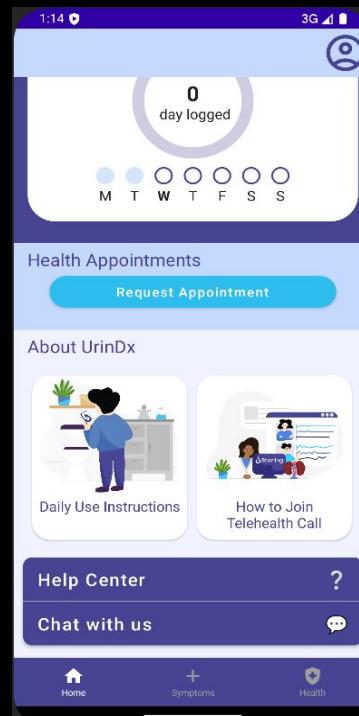


- **Started working on revamping the UI for the Android Application**
  - Learned Kotlin and Jetpack Compose
  - Created a brand new Android project for UI development, planning on incorporating to Starling Pete official GitHub once UI passes testing and debugging
  - Replicated the features from the iOS application in the Android project
  - Programmed graphing functionality from scratch to minimize dependencies

# Old Android UI Design



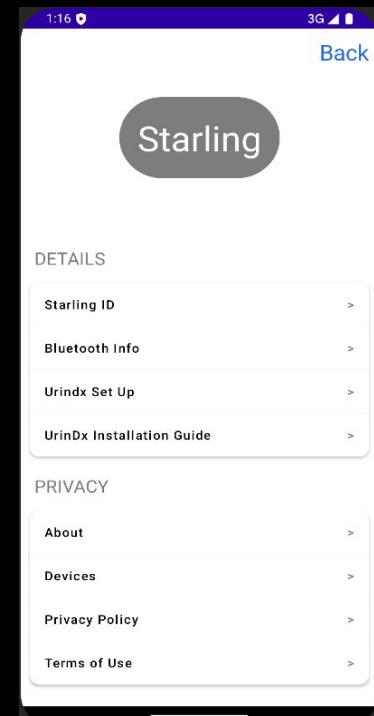
Homepage (1)



Homepage (2)

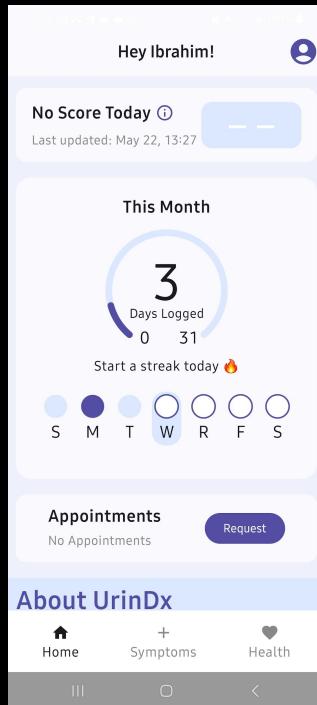


Health Page



Account Page

# New Android UI Design



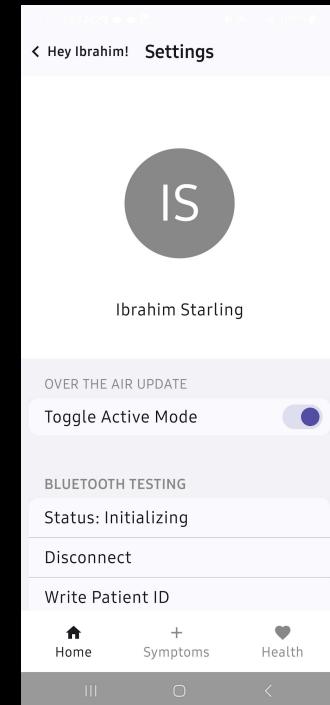
Homepage (1)



Homepage (2)



Health Page



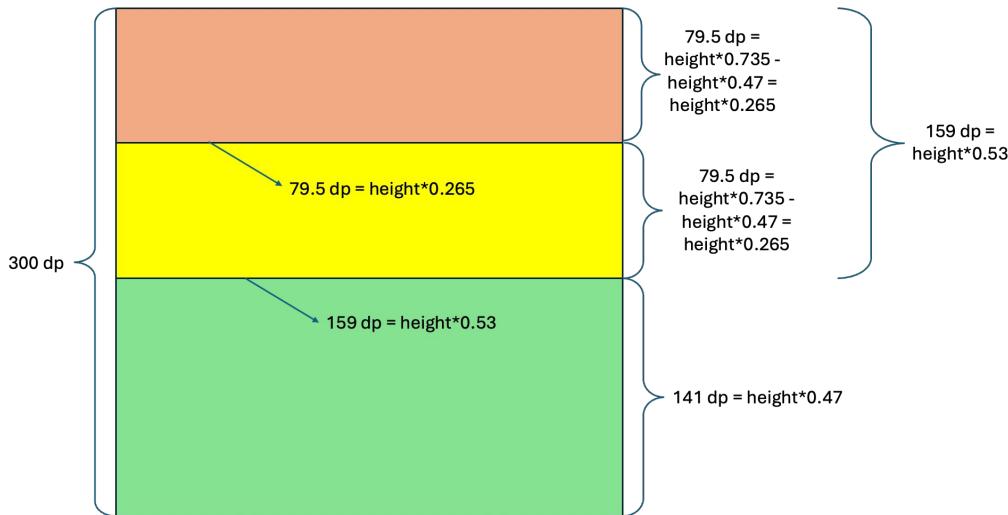
Account Page

# Algorithm for Graphing Functionality

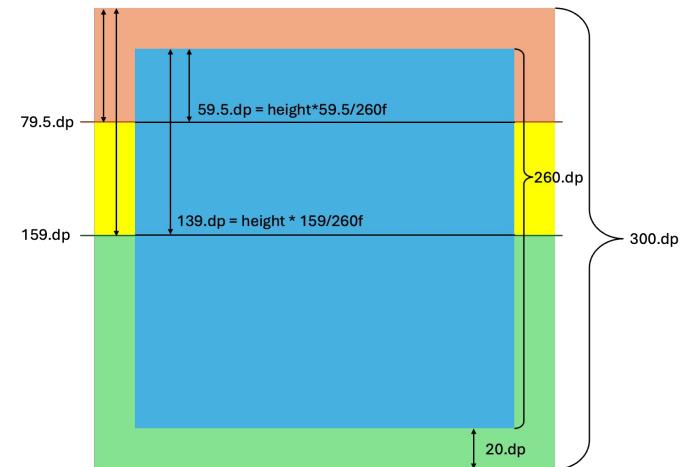
1. Calculate the correct dataset pairing of scores & dates with toggles (1 week, 1 month, 6 months)
2. Draw the demarcating lines according to type of toggle (1 week will have them at each day, 1 month will have them at beginning and end of the month, and 6 months will have them at the 1st of the last and first month)
3. Draw the lines connecting the points of the score values placed along the x-axis according to the date associated with that score
4. Draw the circles at each score value and fill in with appropriate color according to the risk level associated with that score

# Geometry for Graphing Functionality

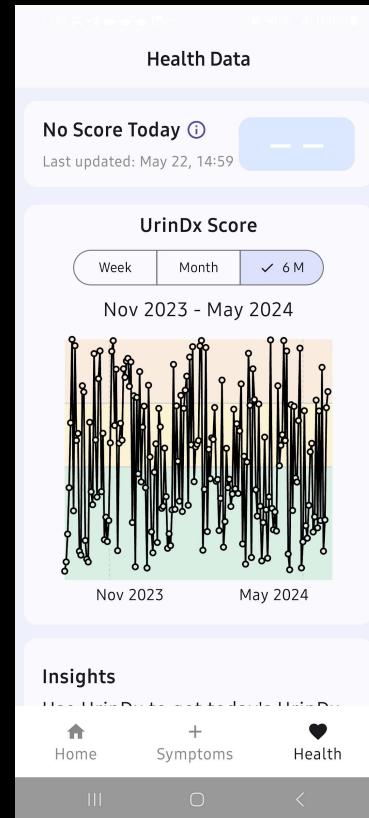
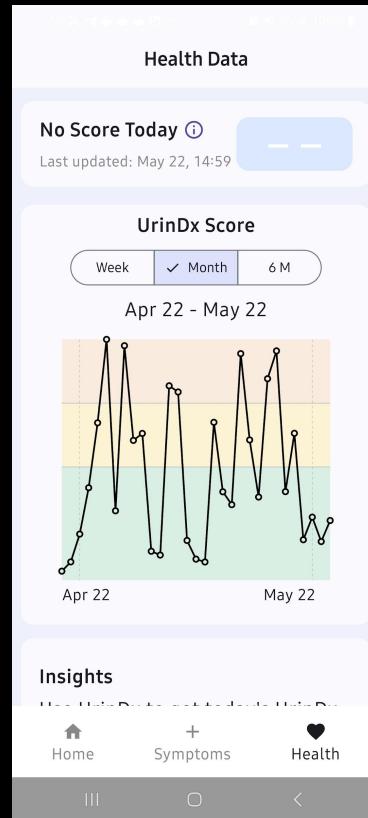
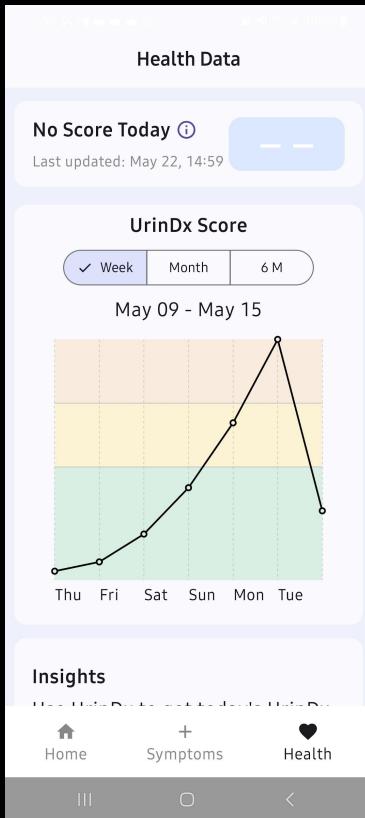
## Background Box



## Graph Chart Area



# Graph Examples



# Week 2 (5/27 - 6/1)



- **Started working on integrating Starstream API**
  - Successfully connects to API and is able to retrieve data via Retrofit
  - Updated home page UI to dynamically display data from the API
  - Working on dynamically displaying the graphs
  - Want to figure out how to cache API data in case internet connection is lost

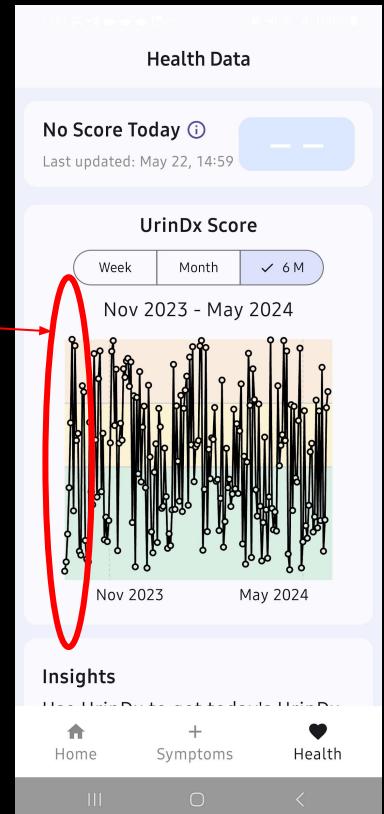
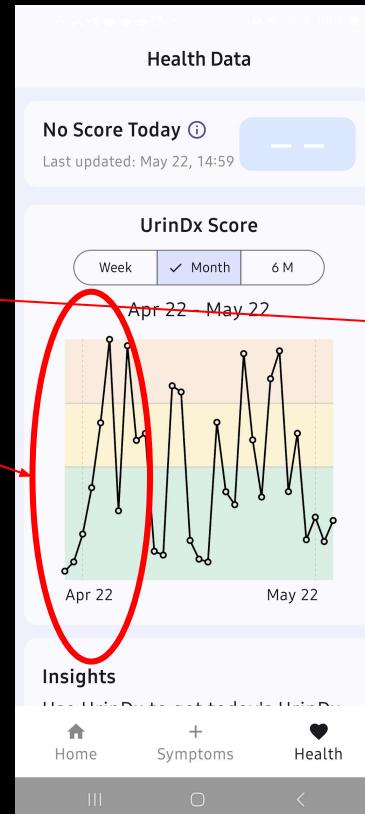
# Week 3 (6/3 - 6/7)



- **Integrated API Data with Graph**
  - Shows real-time starstream UrinDx score data on the graph
  - Solved issue with graph showing scores in reverse for the month and 6-month cases
  - Solved issue with graph showing wrong timeline on x-axis
  - Fixed graph showing the correct timerange of data
- **Implemented Symptom Tracker**
  - Allows user to post symptoms to startstream database
- **Implemented Appointment Scheduler**
  - Allows user to request to schedule new appointments
- **Pull Request 67**
  - Approved by Wassim and Benjamin

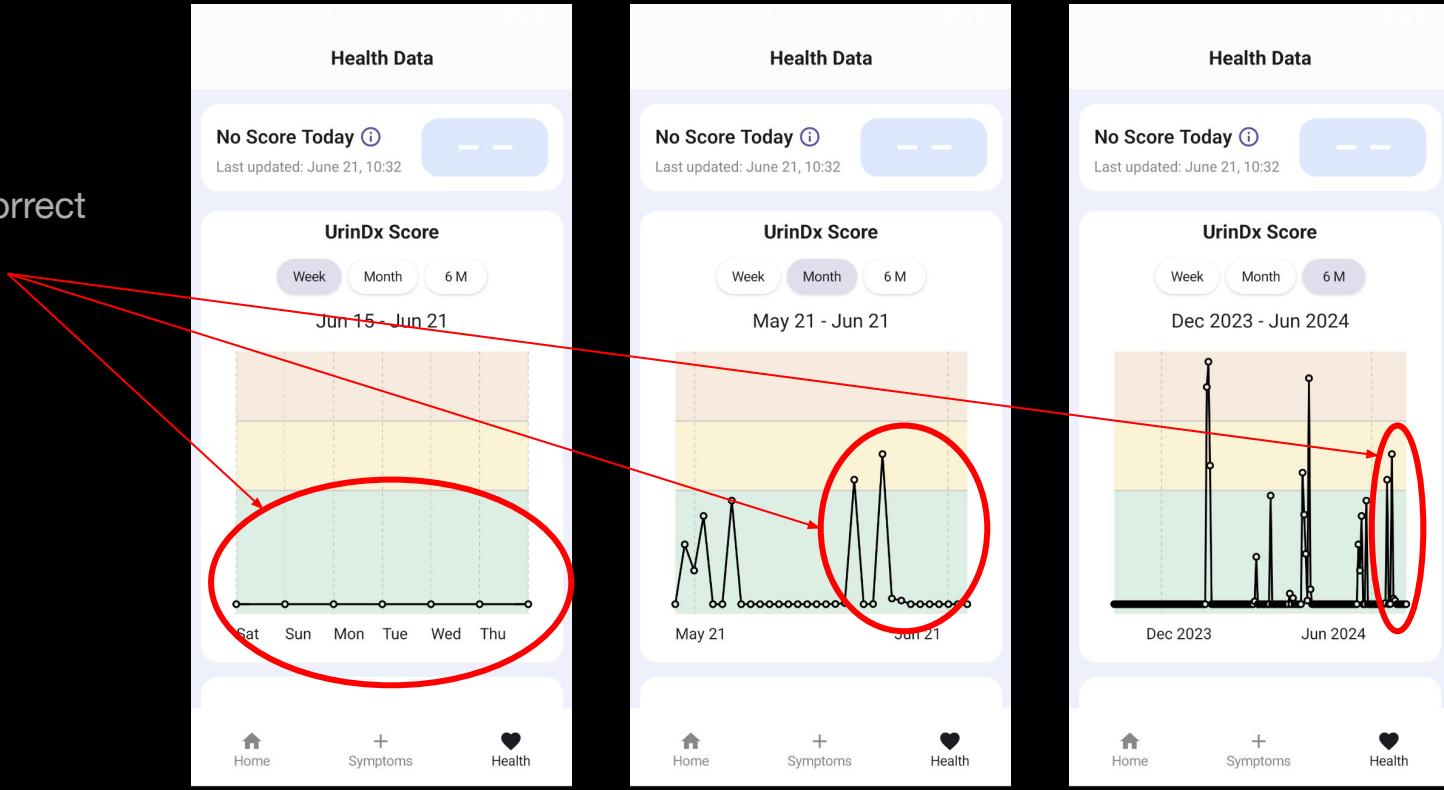
# Graph Issues

Chronologically incorrect timescales  
(The week data [parabolic curve] should show up at the end of the month and 6-month timeline not at the beginning)



# Fixed Graph

Chronologically correct timescales



# Symptom Tracker

## Base Screen

**Symptoms**

Please select all symptoms you are experiencing and type out any not included.

Press "submit" to inform our clinical team and will prompt them to schedule a call within the next business day to discuss next steps in treatment.

*Please call 911 if you are experiencing the following: fever >101.5, altered mental state, uncontrollable abdominal pain, vomiting.*

Painful urination  
 Fever < 101.5  
 Abdominal pain  
 Urgency  
 Frequency  
 Blood in urine (Brown color)  
 Taken oral UTI pain relief within the past 24 hours (Pyridium, Azo, Phenazopyridine)

**Other (Optional)**

Describe other symptoms or provide more information on reported symptoms

**Submit**

 Home    Symptoms    Health

**Symptoms**

*following: fever >101.5, altered mental state, uncontrollable abdominal pain, vomiting.*

Painful urination  
 Fever < 101.5  
 Abdominal pain  
 Urgency  
 Frequency  
 Blood in urine (Brown color)  
 Taken oral UTI pain relief within the past 24 hours (Pyridium, Azo, Phenazopyridine)

**Other (Optional)**

Describe other symptoms or provide more information on reported symptoms

**Submit**

 Home    Symptoms    Health

## No Symptoms Selected

10:37 ⓘ 🔍 ⌂

**Symptoms**

*following: fever >101.5, altered mental state, uncontrollable abdominal pain, vomiting.*

Painful urination  
 Fever < 101.5  
 Abdominal pain

**!**

**Symptom Report**

Please select symptoms from the list provided and/or type in any other symptoms to submit the symptom report

**Return**

**Submit**

 Home    Symptoms    Health

## Successfully Submitted

10:40 ⓘ 🔍 ⌂

**Symptoms**

*following: fever >101.5, altered mental state, uncontrollable abdominal pain, vomiting.*

Painful urination  
 Fever < 101.5  
 Abdominal pain

**!**

**Symptom Report**

Thank you, your symptoms have been reported to Starling Medical

**Return**

**Submit**

**Other (Optional)**

Describe other symptoms or provide more information on reported symptoms

 Home    Symptoms    Health

# Week 4 (6/10 - 6/14)



- **Implemented Intercom API**

- Created new Intercom API branch
- Successfully displays articles
- Does not work with the help center or messages functions, still need to fix this issue
  - App crashes immediately when launching either of these functions
  - Updating Intercom API to latest version breaks the app build, with the error indicating that the firebase API has version conflicts

# Week 5 (6/20 - 6/21)



- **Fixed Issue with Intercom API**

- Issue was with the notification feature causing version conflicts with Firebase API and breaking the build
- To solve it I used a different version of the Intercom SDK which does not include the notification feature
- I was able to use the Intercom API to send messages both as an unidentified user and as a registered Starling patient user

# Week 6 (6/24 - 6/28)



- **Launched Urinator3000 Code**

- Created new GitHub repository titled “internal-utilities” which houses the code for the stress testing Urinator3000 apparatus
- Cut down code to be more efficient on the Arduino Nano
- Adjusted code to flicker the LEDs when activating
- Fixed code for pump not activating

- **Started Making Intercom Login Dynamic**

- Discovered that the Intercom API must be fed the patient data from the patient/me GET request, so I must refactor the code to rearrange the order in which the startstream data is fetched
- Must use Singleton according to ChatGPT to allow for fetching the data for the Intercom API

# Demo Time!!!

# **2nd Half**

# Week 7 (7/1 - 7/5)



- **Fixed Urinator3000 Circuit**

- Discovered 4 problems with the circuit: 1) the wires to the pump were inverted, it is supposed to be red goes to black and black goes to red 2) the transistor control pin wire that broke off was soldered back to GND not to PIN 9 3) the code I uploaded when I was in Jordan used a different pinout since I forgot to update the circuit schematic on the iPad 4) the Nano SDA pin was fried
- Ordered new Nanos and redid circuit
- Thinking about adding some indicator LEDs to make testing more straightforward

- **Made Intercom Login Dynamic**

- Discovered that the Intercom API must be fed the patient data from the patient/me GET request, so I refactored the code to rearrange the order in which the starstream data is fetched

- **Made appointment rescheduling function**

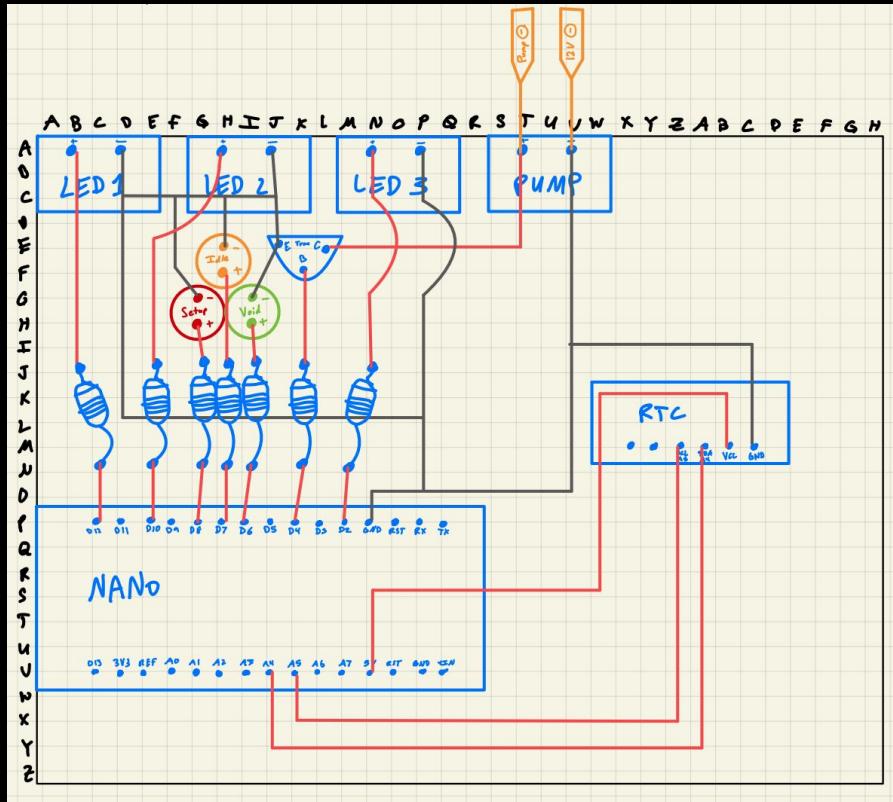
- Tested API request using Charles Proxy to confirm reschedule notes were sent

# Weeks 8-9 (7/8 - 7/18)

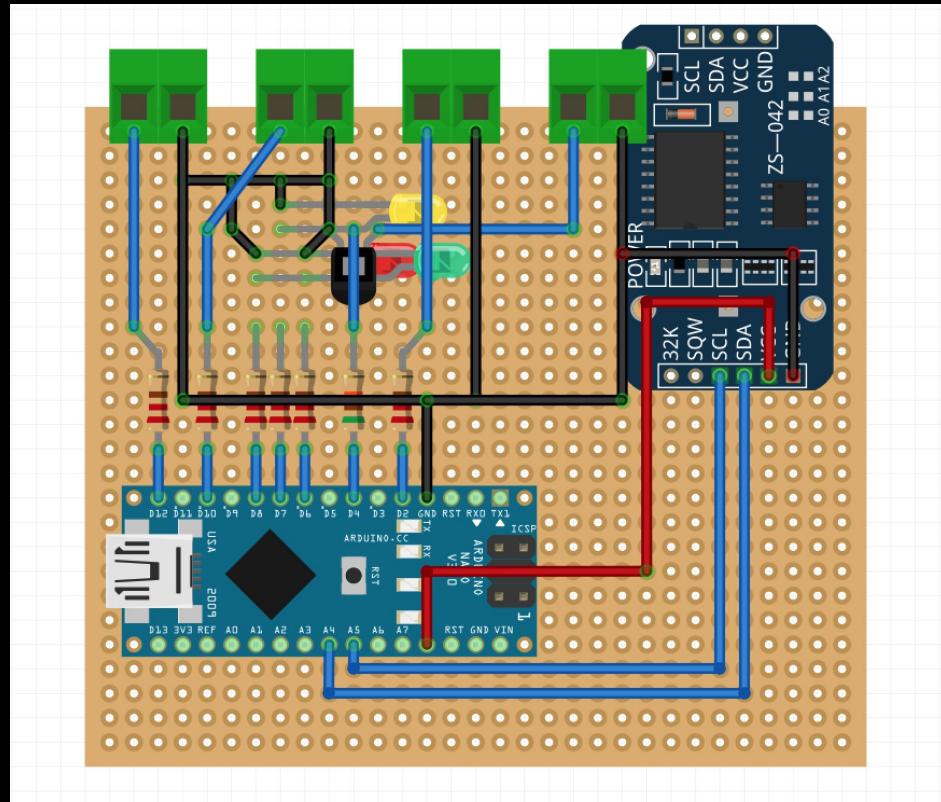


- **Made initial prototype for Urinator4000**
  - Got good idea for layout and areas for improvement in the next iteration
  - Cleaned circuit design
  - Rerouted the initial PCB layout to minimize wire overlap and potential for solder spillover causing shorts
- **Made availability preferences function**
  - App successfully records the user data and sends POST request with a 200 code, however, when I refetch the /me GET request the availability preferences don't update
  - Discussed problem with Jay and he addressed the bug in the API

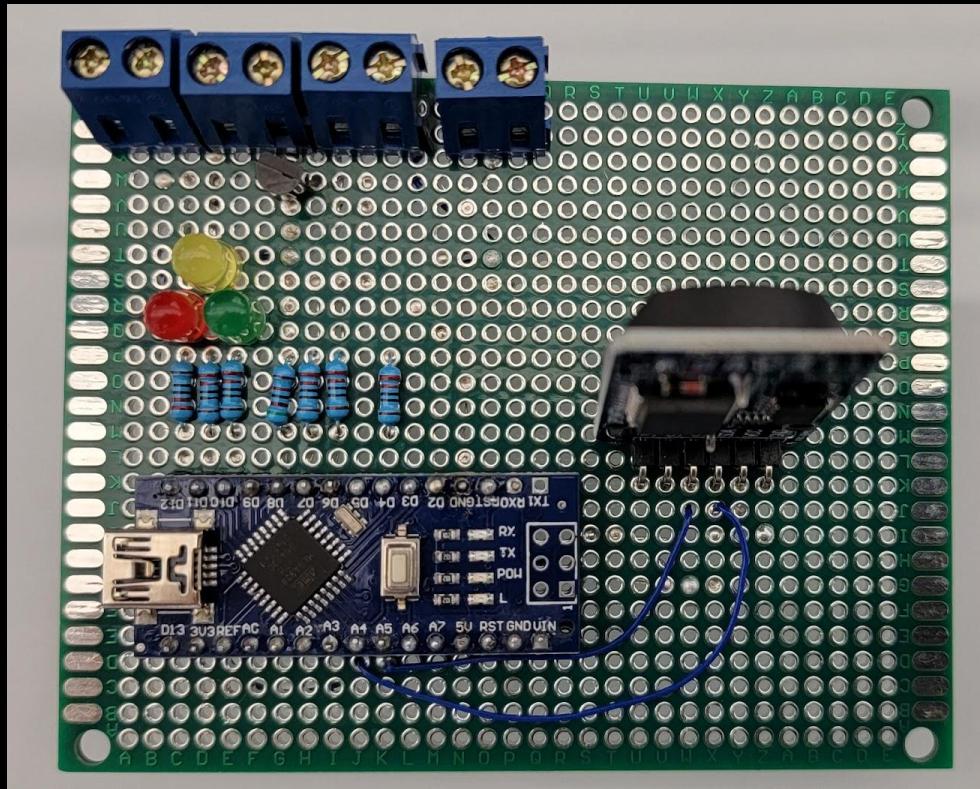
# Urinator4000 Prototype Design



# Urinator4000 Prototype Schematic



# Urinator4000 Prototype PCB Iteration 1



# Urinator4000 Prototype PCB Iteration 1

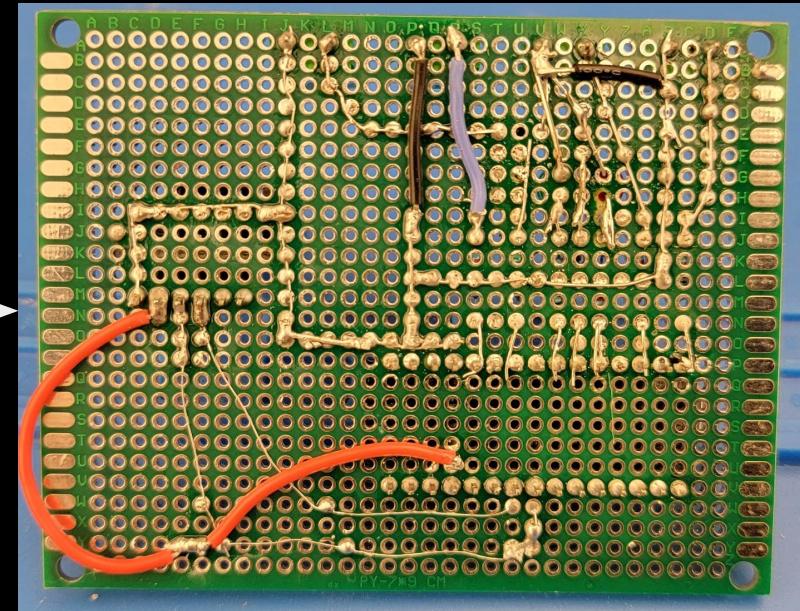
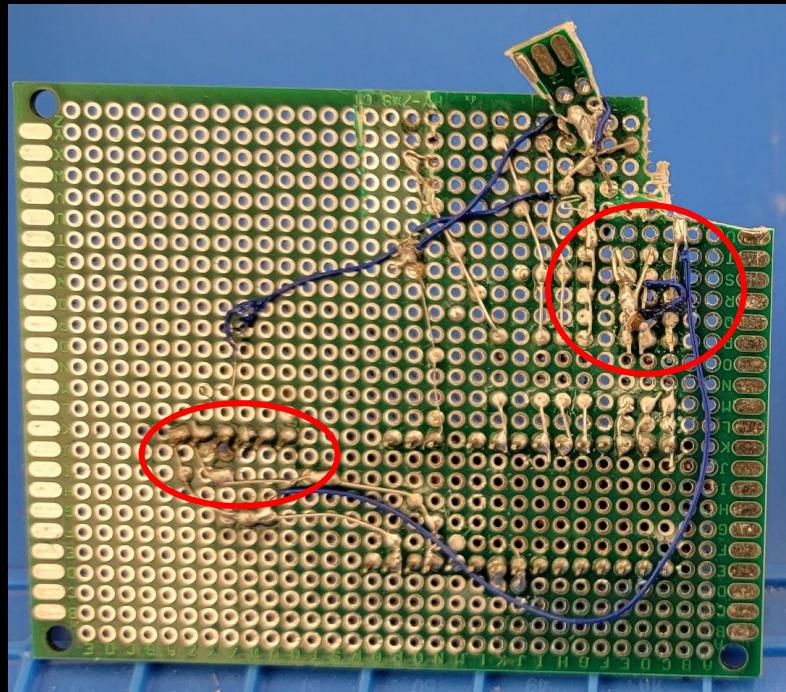
- **Problems**

- Some of the routed wires were too close to each other and were causing shorts to occur
- I had used a different Arduino Nano which had a fried GND pin so the LEDs weren't turning on
- A lot of overlapping wires due to tight routing
- Transistor works initially but then overheats and loses control of the pump so that it is continuously pumping water even when 0V is sent to the transistor

- **Solutions**

- Change the layout of the wiring and maybe the screw terminals to aid in reducing overlaps
- Change the transistor from the PN2222 model to the S8050 model since the 8050 is the one I had been using previously

# Urinator4000 Prototype PCB Iteration 2



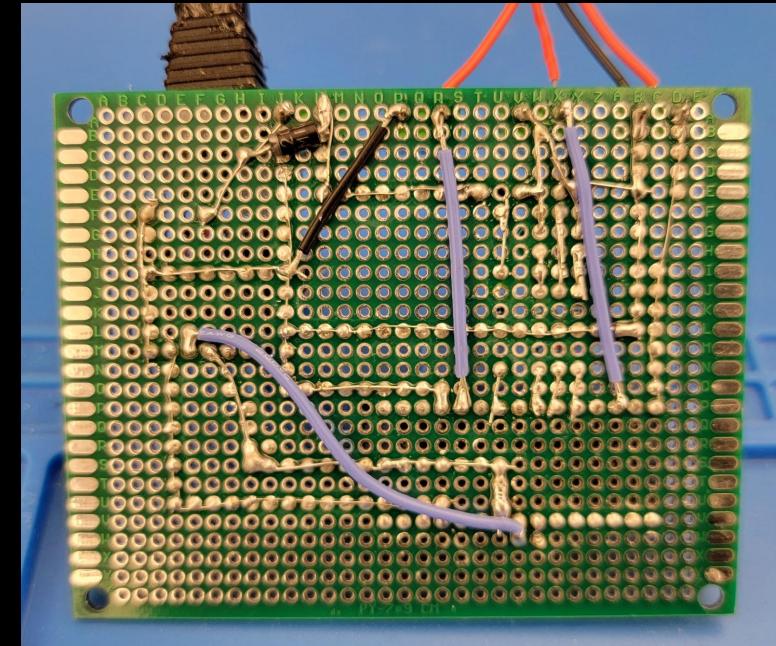
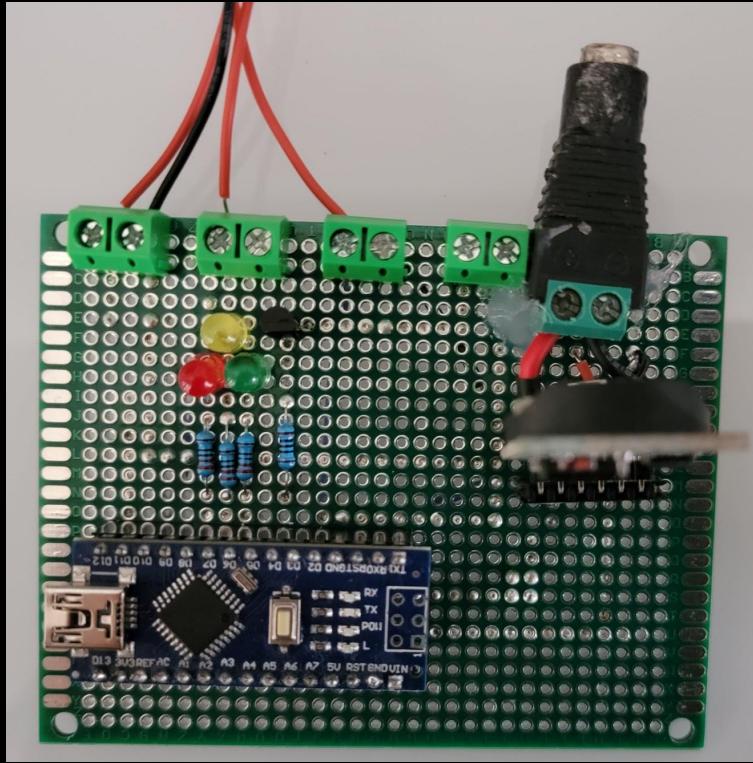
Iter 1

Iter 2

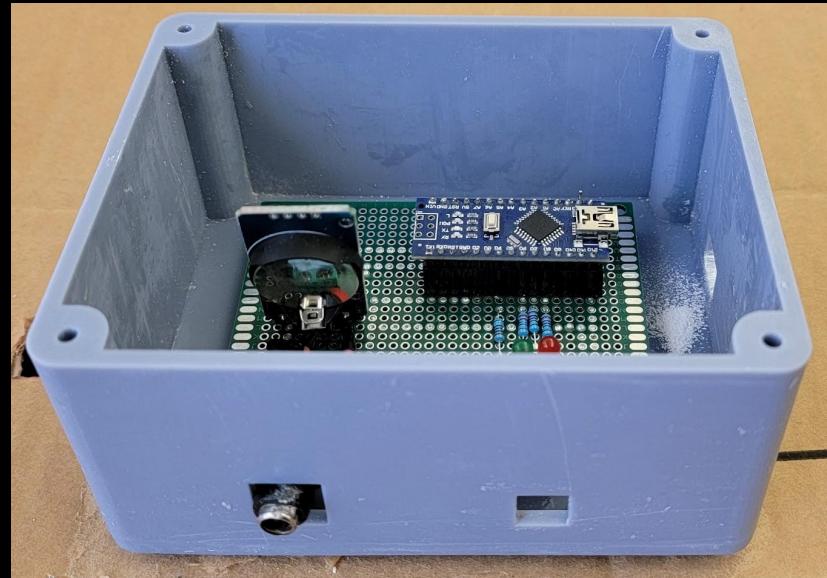
# Urinator4000 Prototype PCB Iteration 2

- **Improvements from Iteration 1**
  - Routing is much neater and there are only a few overlapping wires
  - No more shorting due to more spacing between routes
  - Replaced PN2222 transistor with S8050 transistor
  - LEDs are working perfectly
- **Problems**
  - The transistor still has the same issue with the overheating prior to cessation of function
- **Solutions**
  - Debug the transistor voltage/current flowing through the collector/emitter and base/emitter pins

# Urinator4000 Prototype PCB Iteration 3 🔥



# Urinator4000 Prototype PCB Iteration 3 🔥

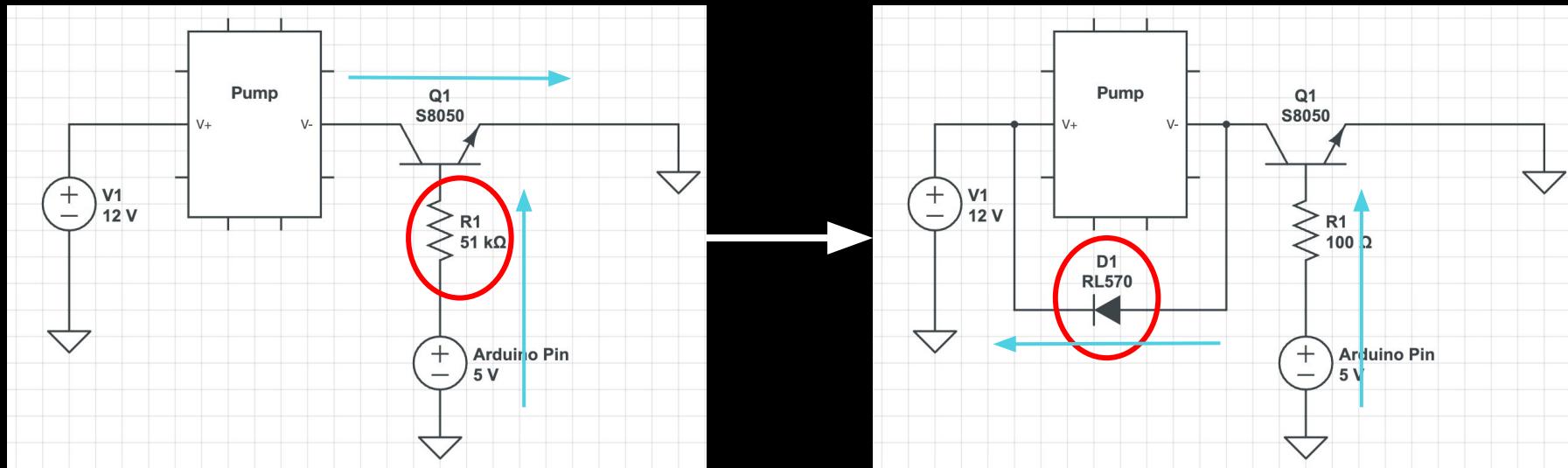


# Urinator4000 Prototype PCB Iteration 3

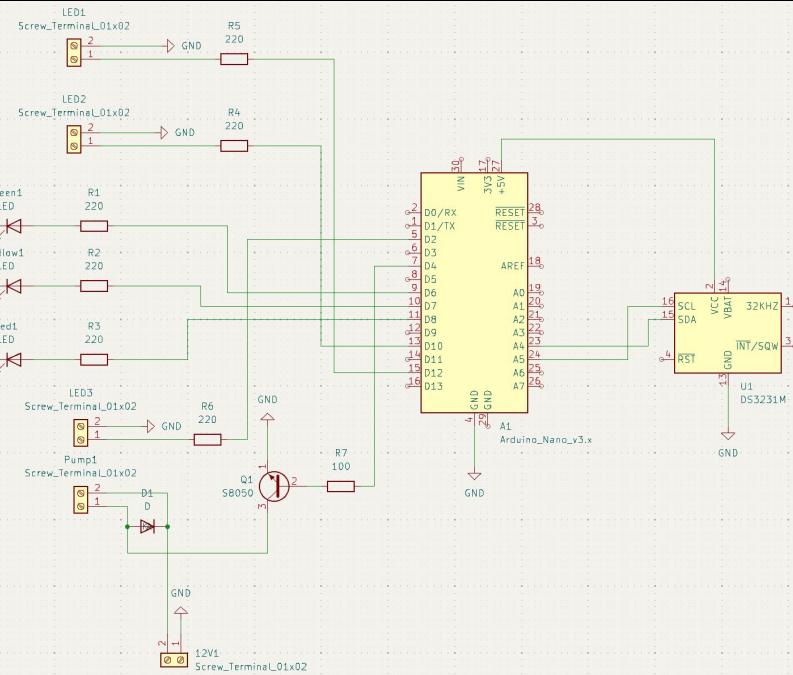
- **Improvements from Iteration 2**

- Attached the 12V power jack directly to the PCB to minimize free wires floating around
- Fixed the transistor issue 🔥
  - Added flyback diode to account for back EMF
  - Replaced  $51\text{k}\Omega$  resistor with  $100\Omega$  resistor
- Used female header pins for Arduino and RTC module to enable faster changes
- Rearranged screw terminal layout to keep all the LED terminals next to each other and keep final terminal close to 12V power jack

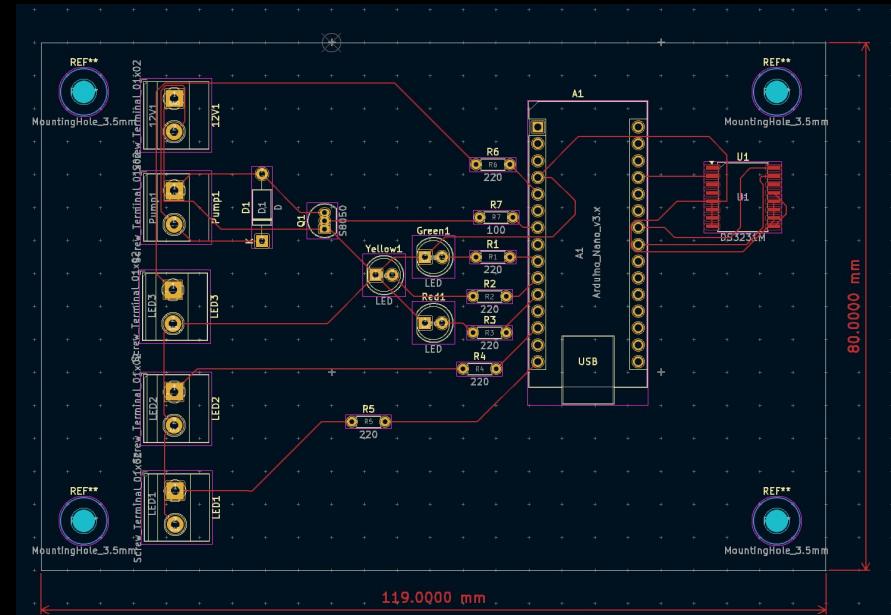
# What Happened?



# Finalized Urinator4000 PCB Schematic

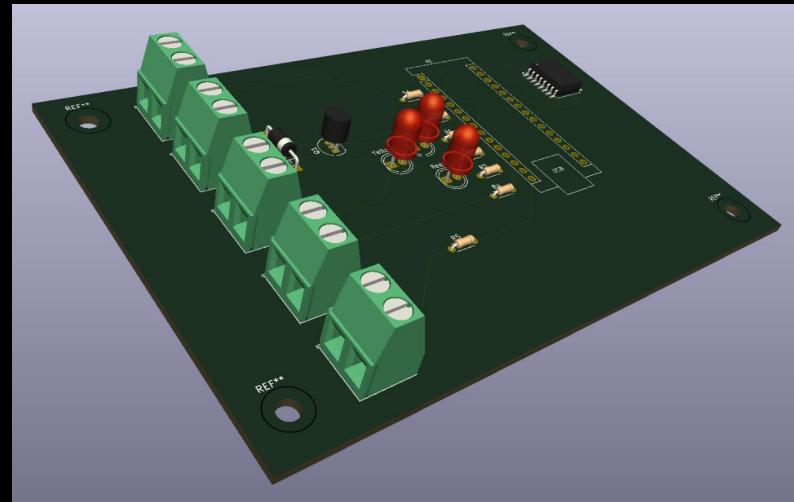
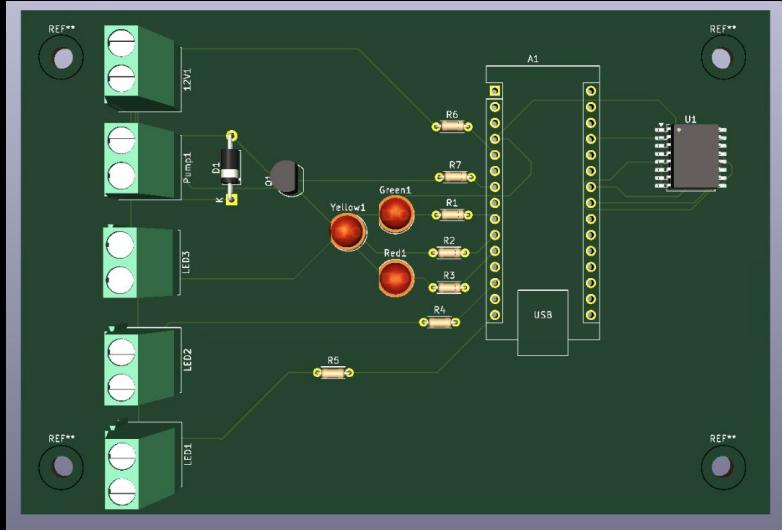


Circuit



Layout

# Finalized Urinator4000 PCB Schematic



## Urinator4000 PCB BOM

Item	Unit Cost	Quantity	Supplier
PCB	\$0.74	1	JLCPCB
220 Ohm Resistor	\$0.06	6	EDGELEC
100 Ohm Resistor	\$0.06	1	EDGELEC
RL207 Diode	\$0.04	1	ALLEGICIN
S8050 Transistor	\$0.06	1	Chanzon
Red LED	\$0.05	1	Chanzon
Yellow LED	\$0.05	1	Chanzon
Green LED	\$0.05	1	Chanzon
White LED	\$0.05	3	Chanzon
Arduino Nano	\$6.67	1	ELEGOO
DS3231 RTC	\$8.03	1	Mouser

Total

\$33.86

# Demo Time!!!

# Week 10 (7/22 - 7/26)



- **Finished testing the Urinator4000**
  - Indicator LEDs were working correctly, with the red LED indicating the device is in the cooldown setup period, yellow LED indicating the device is sleeping in between experiments, and the green LED indicating an experiment is running
- **Debugged UrinDx Hardware**
  - Measured voltages for the IR/R/G/B sensors and emitters using the oscilloscope
  - Measured voltages for the UVA/UVC sensors and emitters using the oscilloscope
  - Gained familiarity with the board schematics and circuit diagrams
- **Arduino BLE Meeting**
  - Met with Tom to discuss Android BLE development
  - Tom will use “Blessed” Android BLE library for initial prototype
  - I will transition to using the Nordic BLE library when he is done

# Debugging V2.2 and V2.1 Chips



# Week 10 (7/29 - 8/2)



- **Android BLE Integration**

- Reviewed Tom's BLE code into the main Starling Pete Android app
- Integrated BLE code into the BlueTooth settings page in Pete app

# Week 10 (8/5 - 8/9)



- **Android BLE Migration**

- Translating the BLE code to use the Nordic BLE library instead of Tom's Blessed library
- Don mentioned Blessed library can cause problems down the line
- Nordic is the company that makes the BlueTooth chip used in the UrinDx

# Next Steps

- **Urinator**
  - Elevate the pegs in the box to leave more space for LEDs
  - Raise the box opening for the USB and make it bigger
  - Make the lid for the device
- **Android App**
  - Finish migrating the BLE functionality to use Nordic's library instead of Blessed
  - Create onboarding feature
  - Release app to Play Store

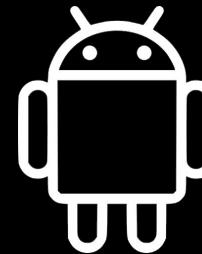
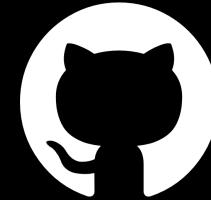
# Suggested Improvements

- **Urinator**
  - Print the CADed PCB using JLC PCB service
  - Could replace LEDs with SMD versions instead, but testing is required
- **Android App**
  - Health Data screen - instead of showing UrinDx score, transition to a calendar which color codes each day according to the classification of risk
  - Fix API fetching so that pulling down initiates a GET request
  - Add cache feature to save data locally when network is unavailable

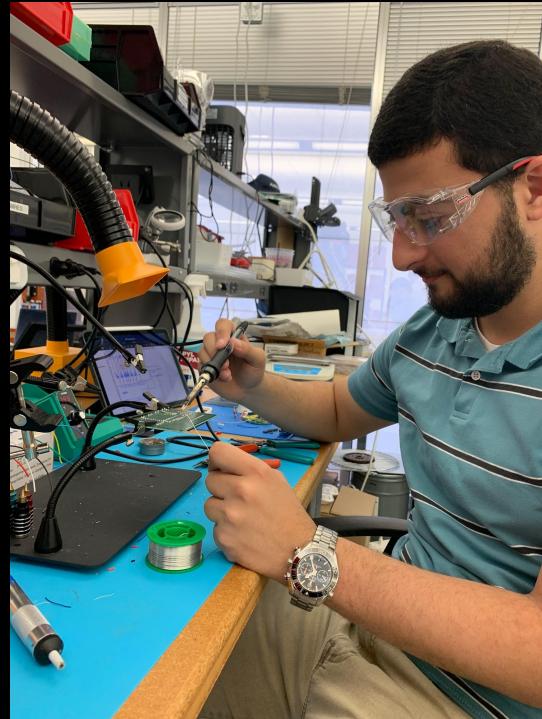
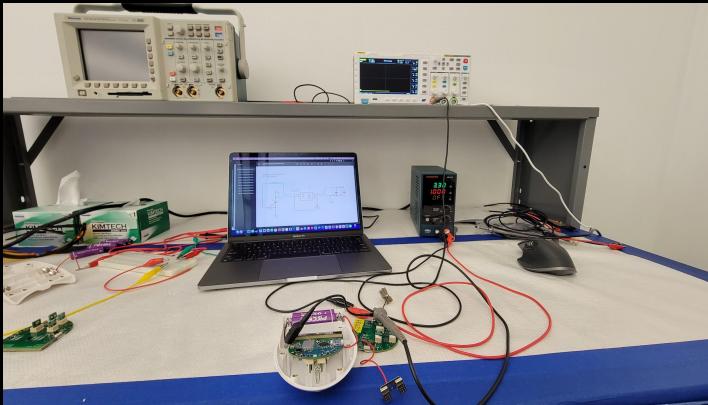
# Internship Reflection

## What I Learned:

- **Git Version Control**
  - Collaboration on software projects
  - Organization of software features and milestones
- **Android Kotlin + JetPack Compose Frameworks**
  - REST API interface
  - UI Design + Development
  - Library integrations (Intercom, Blessed, Nordic...)
  - BLE Development
- **Electronics Engineering**
  - Interpreting complex schematics
  - Testing and debugging hardware
  - Designing PCBs and rapid prototyping



# Highlights





Thank You!

The Starling logo icon is a stylized, symmetrical shape resembling a flame or a drop. It features a dark purple base layer, followed by a lighter blue layer, and a top layer with a gradient from light blue to white. The shape is roughly triangular with a curved, flame-like top.

Starling