Self Sustaining Cost Effective Wearable for Monitoring Sun Exposure

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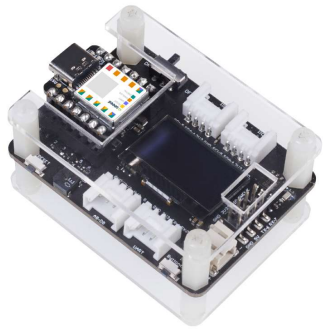CSCE 5280 – AI for Healthcare and Wearables

Why?

- This project addresses the global issue of skin cancer - specifically melanoma, which is linked to UV over-exposure.

- Current UV wearables are either imprecise (dye-based) or too costly and bulky (electronic dosimeters), limiting widespread adoption and not self sustaining.

Specific Aims

- Use a self-sustainable solar panel instead of specialized UV sensor that works with a battery to monitor for UV exposure.

- Collect and analyze multi-condition sensor data to understand how solar-panel readings relate to UV radiation.

- Train and compare machine-learning models to classify UV exposure levels using engineered solar-based features.
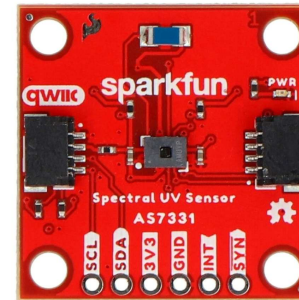
Device Design – Components Used

Seeed Studio XIAO : Expansion Board

Seeed Studio XIAO : ESP32-S3

Sparkfun Spectral UV Sensor : AS7331

100 Ohm Resistor – 5% Tolerance
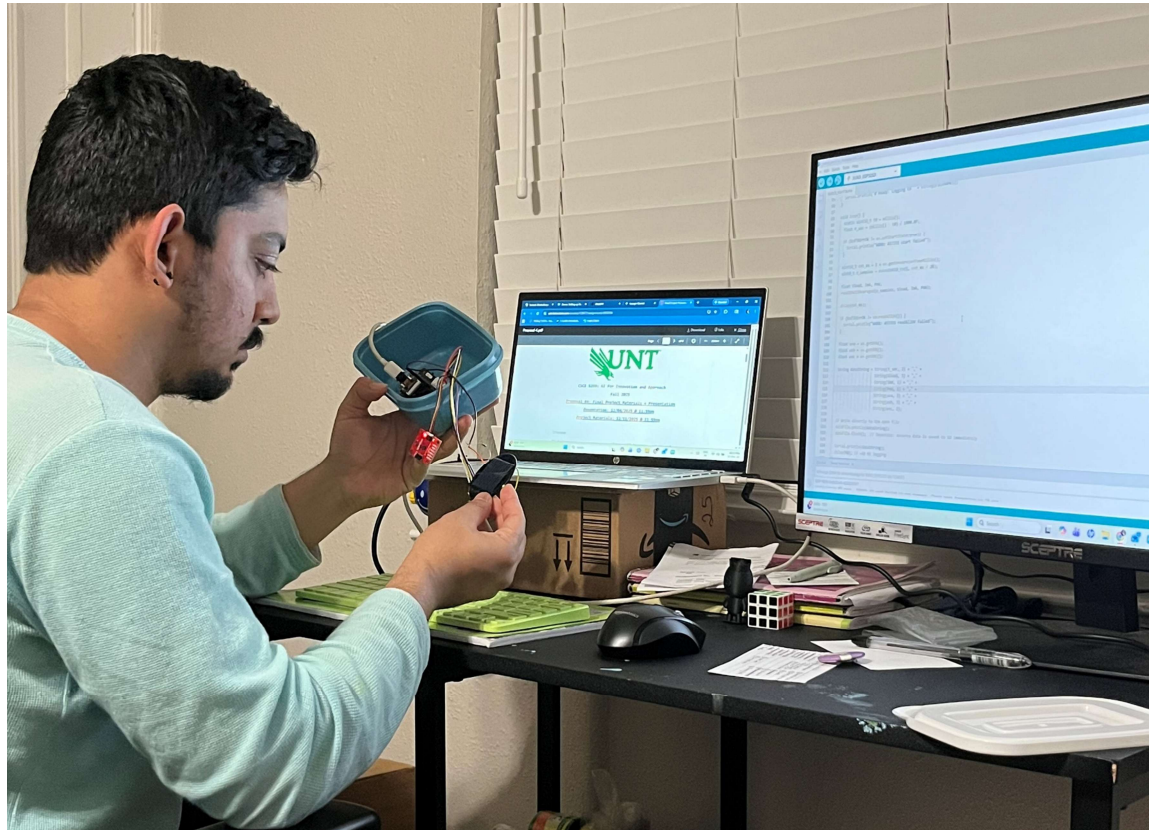
INA219

1 inch X 1 inch Solar Panel

PKCELL LiPo Battery : 3.7V 500mAh

CSCE 5280 – AI for Healthcare and Wearables

Data Collection

- We record sensor readings at 10 Hz while wearing the device on the wrist across four conditions—
    - Indoors : 1:30PM and 4:00PM
    - Indoors near window : 1:30PM and 4:00PM
    - Outdoor shade : 1:30PM and 4:00PM
    - Outdoors under direct sunlight : 1:30PM and 4:00PM

- Each sample stores time, voltage, current, power, and UVA/UVB/UVC values.
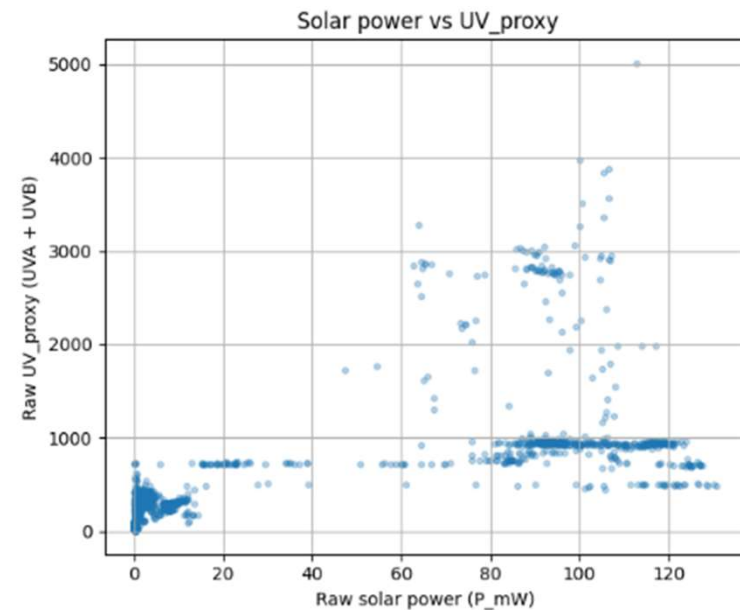
Data Collection

That's me!

Collecting Data for the condition :
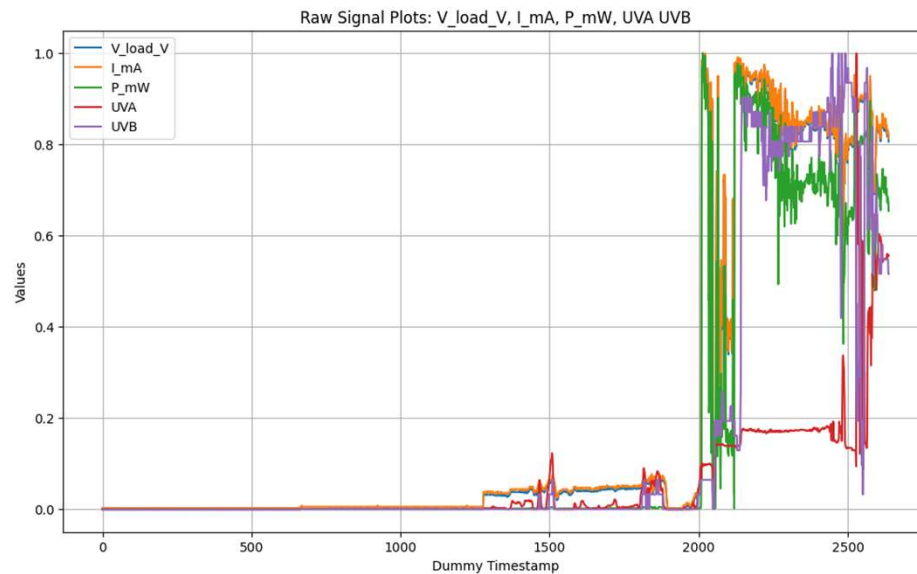**Indoor – Shade – 4PM**

Dataset and Features

- Our dataset was collected across 8 recording sessions.
- Each file contains around 600–800 samples, totaling around 5,000 cleaned samples after trimming and smoothing.

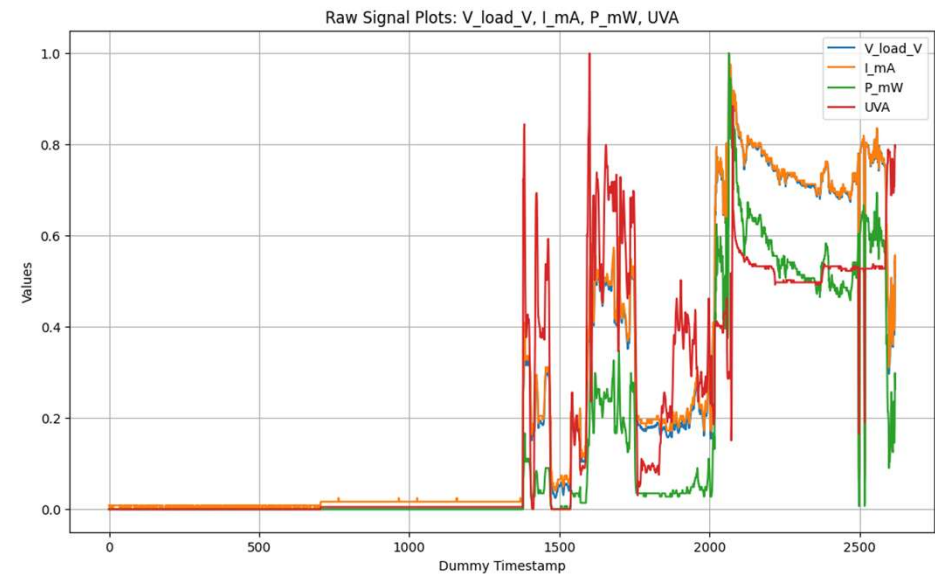| V_load_V	I_mA	P_mW	UVA	UVB	UVC
0.023	0.3	0	2.656	2.953	1.297
0.016	0.3	0	2.656	2.953	1.297
0.012	0.2	0	2.656	2.953	1.297
0.008	0.2	0	5.312	2.953	1.297
0.005	0.2	0	5.312	2.953	1.297
0.004	0.1	0	7.969	2.953	1.297
0.003	0.2	0	10.625	2.953	1.297
0.003	0.2	0	15.938	2.953	1.297
0.008	0.2	0	18.594	2.953	1.297
0.021	0.3	0	23.906	2.953	1.297
0.033	0.4	0	37.188	2.953	1.297
0.032	0.5	0	39.844	2.953	1.297
0.032	0.5	0	55.781	2.953	1.297
0.04	0.5	0	50.469	2.953	1.297
0.044	0.6	0	58.437	2.953	1.297
0.052	0.7	0	79.687	2.953	1.297
0.064	0.8	0.1	74.375	2.953	1.297
0.064	0.8	0.1	39.844	2.953	1.297
0.076	0.9	0.1	34.531	2.953	1.297
0.08	0.9	0.1	18.594	2.953	1.297
0.084	1	0.1	15.938	2.953	1.297

Solar power vs UV_proxy

Data Visualization
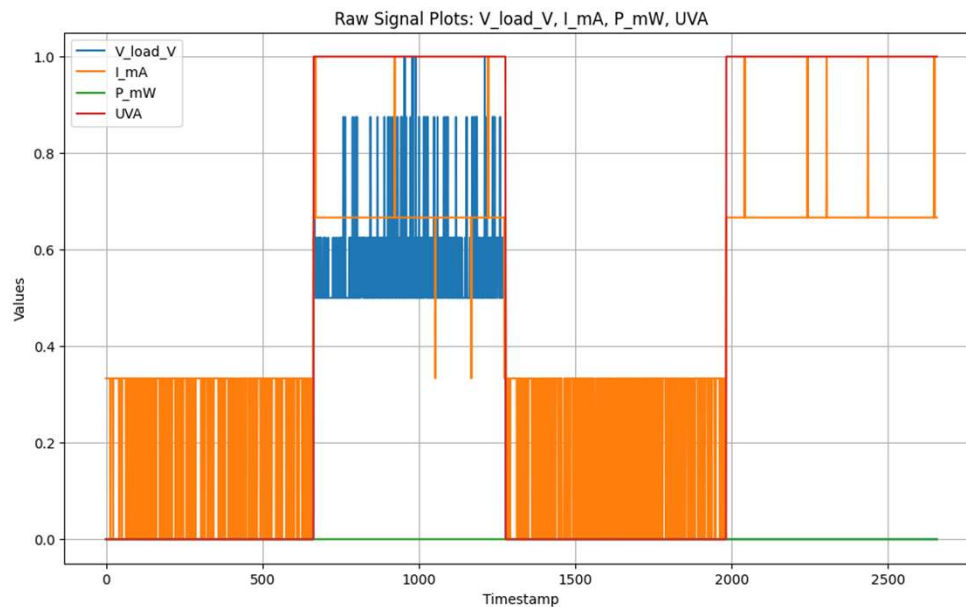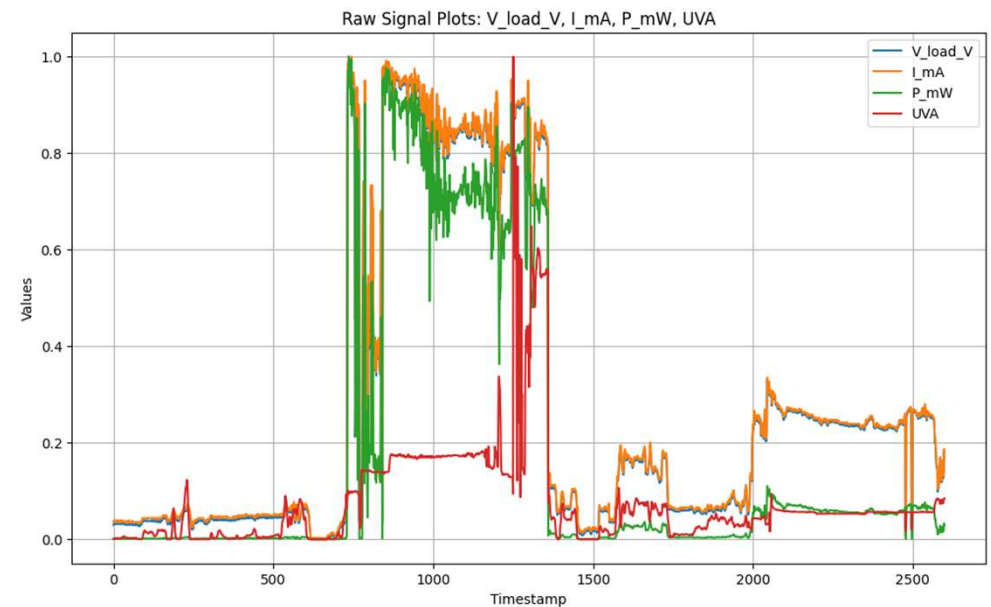
- Pattern at 1:30PM

- Pattern at 4PM

Data Visualization
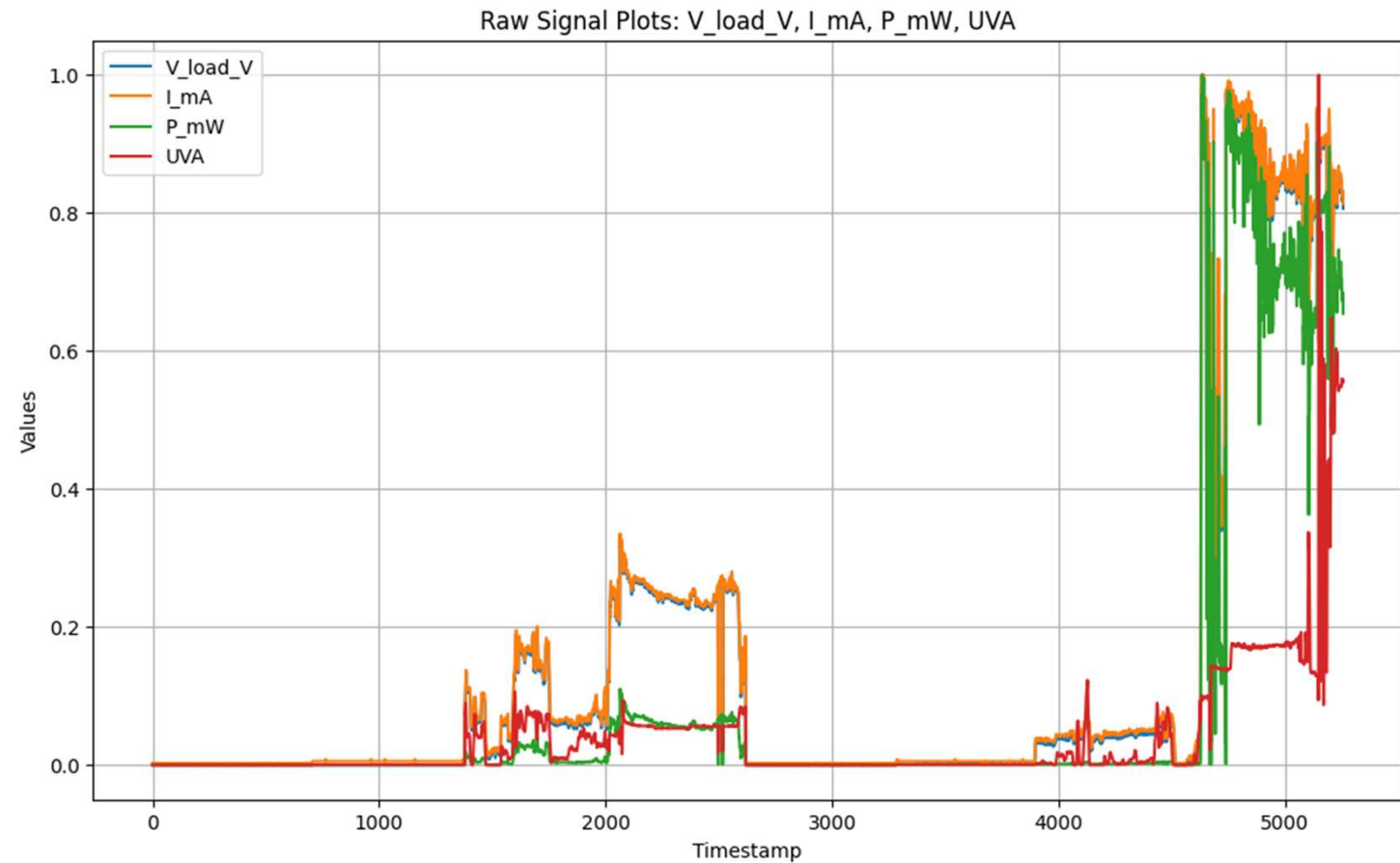
• Pattern at Indoors
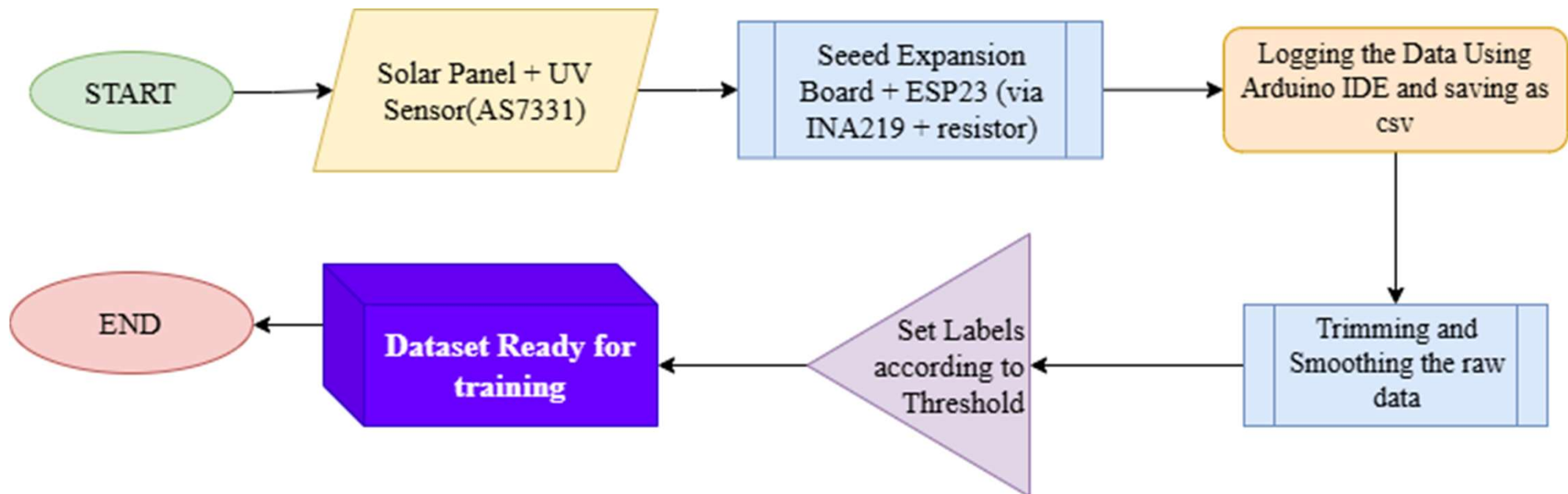
• Pattern at Outdoors

Data Visualization
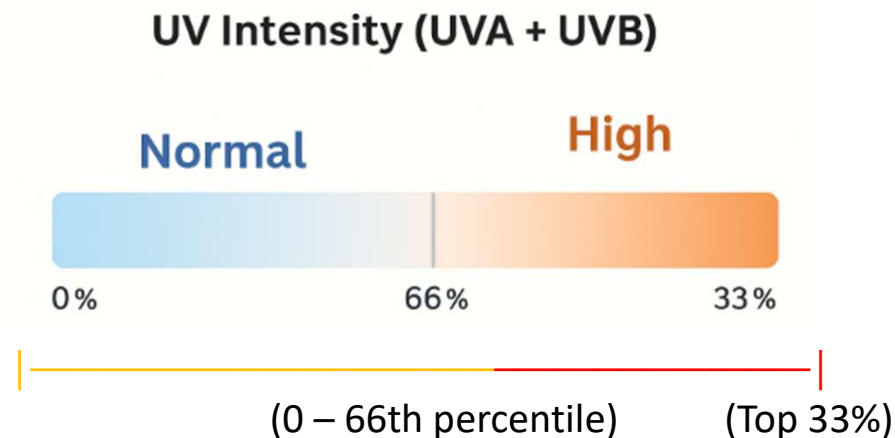
• Pattern of the Whole data

Pre-processing Pipeline

Label and Thresholds

- We label UV as High or Normal based on the upper 33% of UV values in the dataset.

- This ensures High means significant UV exposure where a user alert is necessary.

UV Intensity (UVA + UVB)

Normal   High

0%   66%   33%
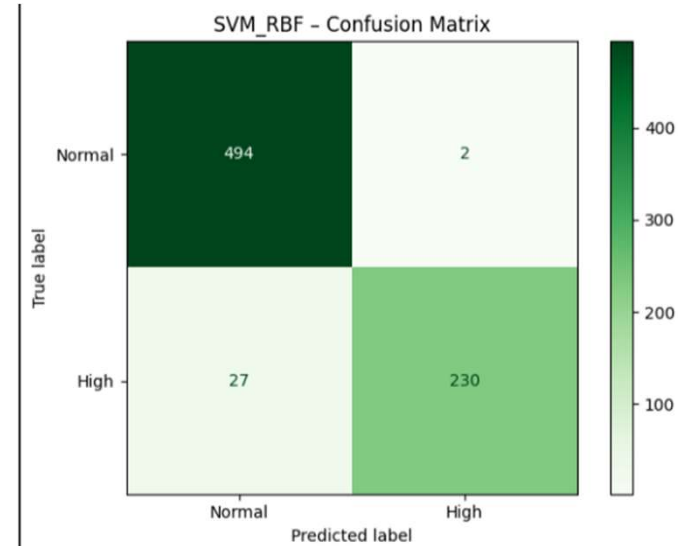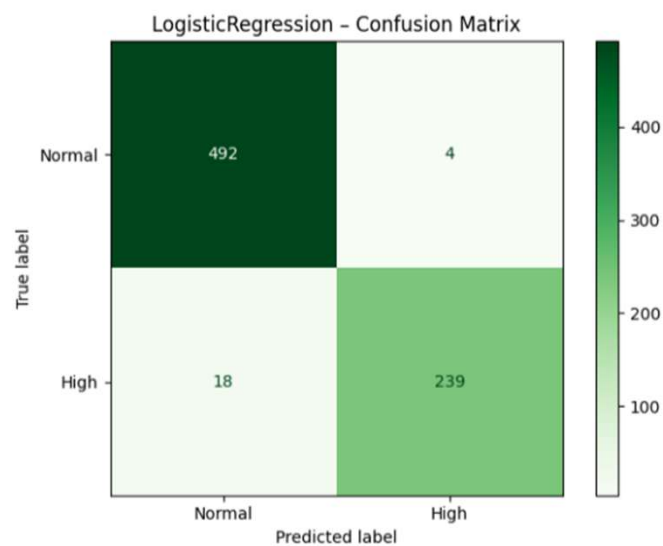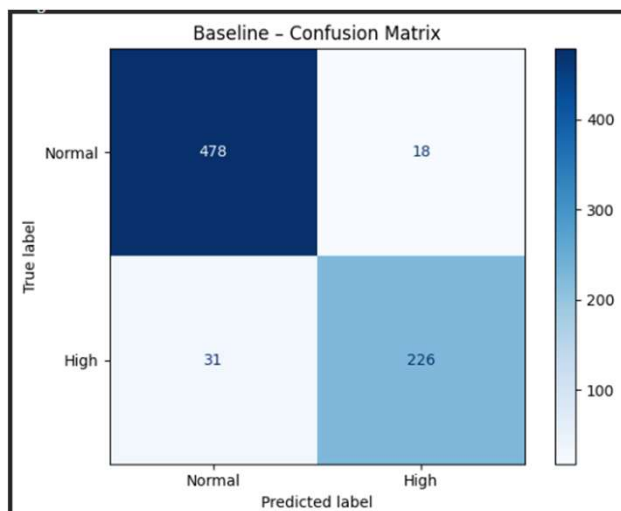
(0 – 66th percentile)   (Top 33%)

Models and Training

- We choose classification models since our goal is to provide actionable alerts (High vs Normal), not estimate exact UV values.

- **Models We Trained**
  We experimented with multiple models to find the best performer:
  - Logistic Regression
  - SVM
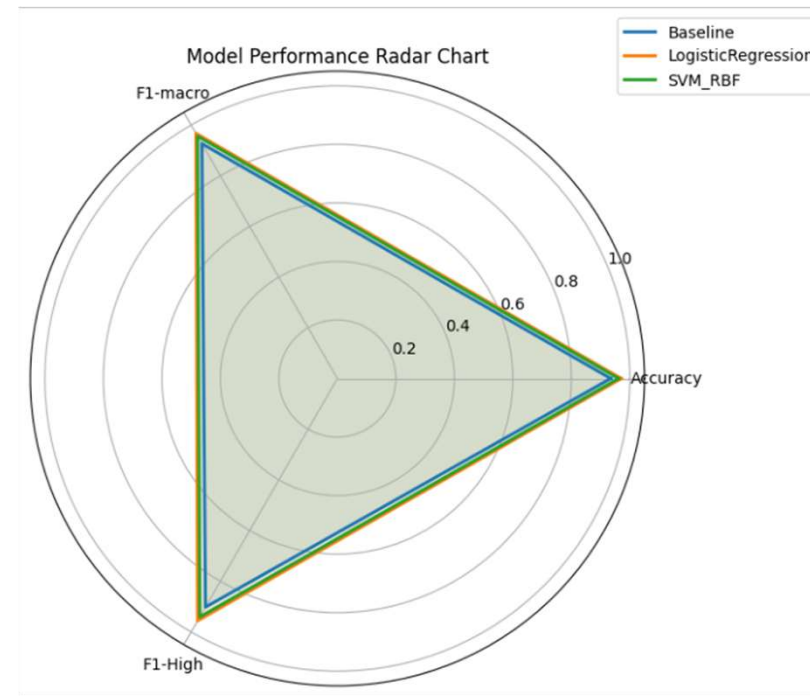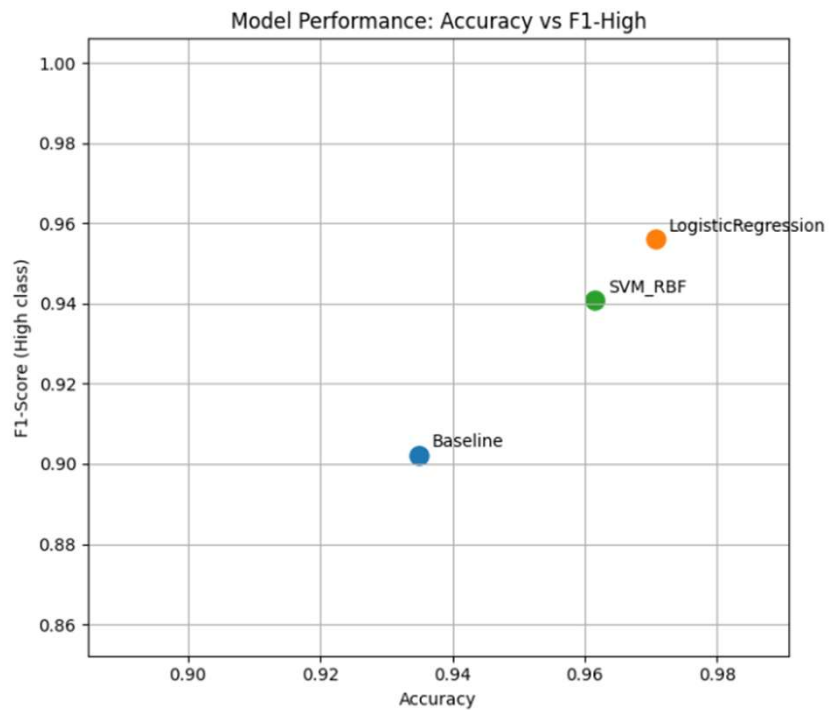 - Baseline Threshold Model without ML

Evaluation Metrics

- The dataset is split into 70% training, 15% validation, and 15% testing, ensuring the model is evaluated on data it has never seen before.

- Accuracy - Measures the percentage of total predictions the model gets correct.

- Precision - Measures how many predicted **High UV** cases were actually high, reducing false alarms.

- Recall - Measures how many true **High UV** cases the model successfully detects, reducing missed risks.

- F1 score - Combines precision and recall into a single score, useful when classes are imbalanced.

Outcomes

Outcomes

Future Work

- Turn this into a well-finished, end-to-end, usable device

- Add the feature of measuring hydration level of the person.

Solar Panel matches the UV sensor! The solar panel integrates UV detection, cutting costs while delivering a self-sustaining, lightweight device.

Questions and Feedbacks Please

THANK YOU