PPG Analysis Walkthrough

I have successfully refactored the PPG analysis into a reusable module `ppg_analysis.py` and added Heart Rate Variability (HRV) analysis.

Reusable Module: `ppg_analysis.py`

This module exposes three main functions:

• `calculate_stiffness_index(data, fs)`: Returns Reflection Index (RI).

• `calculate_sdppg_index(data, fs)`: Returns SDPPG ratios (b/a, c/a, etc.) and Aging Index.

• `calculate_hrv(data, fs)`: Returns HRV metrics (SDNN, RMSSD, pNN50, BPM).

Analysis Results (from `run_analysis.py`)

The analysis was performed on `data_180s.txt` split into three 60-second segments.

1. Vascular Stiffness (Reflection Index)

Segment	Valid Beats	RI
0-60s	64	0.5592
60-120s	62	0.6190
120-180s	65	0.5330

2. Second Derivative PPG (SDPPG)

Segment	b/a	c/a	d/a	e/a	Aging Index
0-60s	-0.6410	0.5670	-0.6902	0.7073	-1.2251
60-120s	-0.6751	0.7059	-0.7869	0.7426	-1.3367
120-180s	-0.6619	0.6128	-0.6937	0.6425	-1.2235

3. Heart Rate Variability (HRV)

Segment	BPM	Mean NN (ms)	SDNN (ms)	RMSSD (ms)	pNN50 (%)
0-60s	65.05	922.36	143.04	125.18	61.90

60-120s	62.57	958.98	141.76	134.59	70.49
120-180s	65.47	916.48	129.19	120.67	59.38

4. Age Estimation Comparison

Segment	IPAD (Bae et al.)	Takazawa et al.	Vessel Age (IJBEM)
0-60s	-24.0 years	12.6 years	35.1 years
60-120s	-44.4 years	7.8 years	34.6 years
120-180s	5.4 years	12.7 years	34.6 years

> [!IMPORTANT]

> **Method Comparison**:

> * **Vessel Age (IJBEM)**: This method provided the most realistic and consistent estimates (~35 years), suggesting it might be more robust to the specific characteristics of this sensor/signal.

> * **Takazawa et al.**: Estimated a very young vascular age (7-13 years), consistent with the high arterial compliance indicated by the raw indices.

> * **IPAD**: Remained largely negative or extremely young, likely due to sensitivity to signal amplitude/scaling despite normalization.

> [!NOTE]

> **Conclusion**: The subject appears to have excellent vascular health (high compliance), which most algorithms interpret as a "young" vascular age. The IJBEM Vessel Age formula seems best calibrated for this type of data.

Visualization

The previous visualization scripts (`analyze_stiffness.py` and `analyze_sdppg.py`) are still available and can be used to generate plots. The new `run_analysis.py` focuses on numerical output using the reusable module.

How to Run

To run the full analysis using the new module:

```bash

python3 run_analysis.py
```

```
```