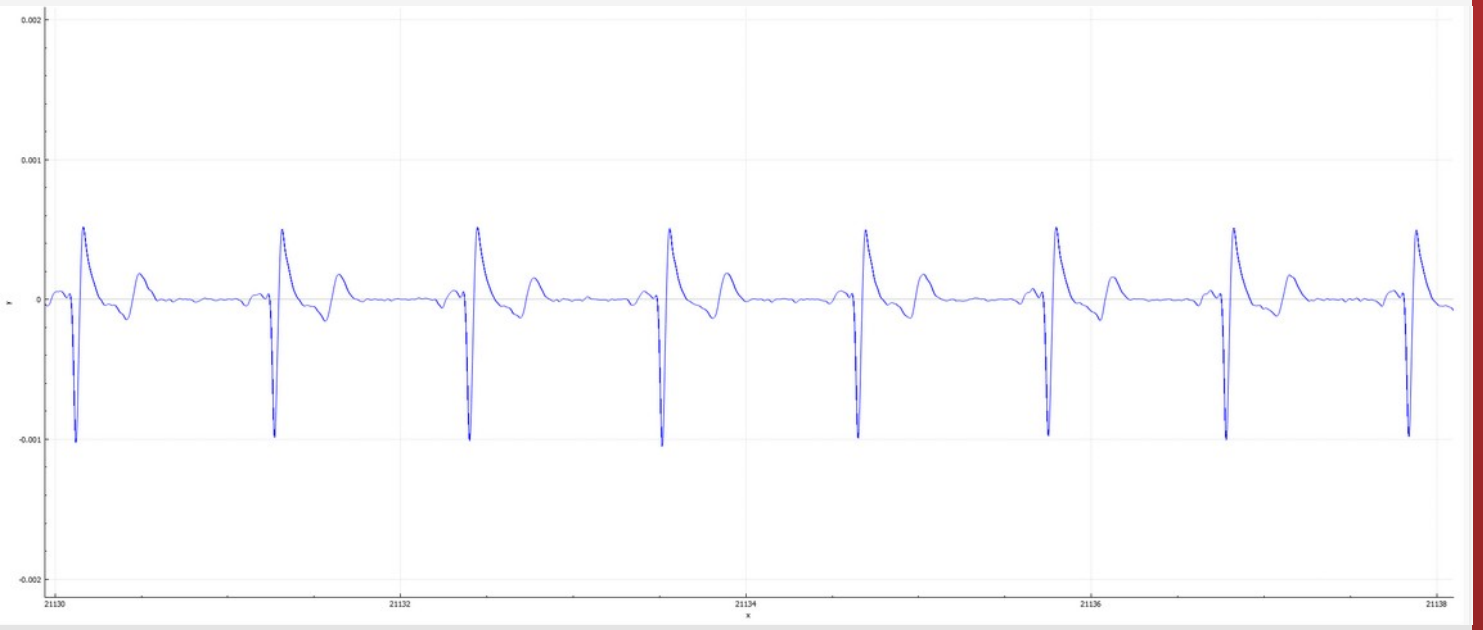
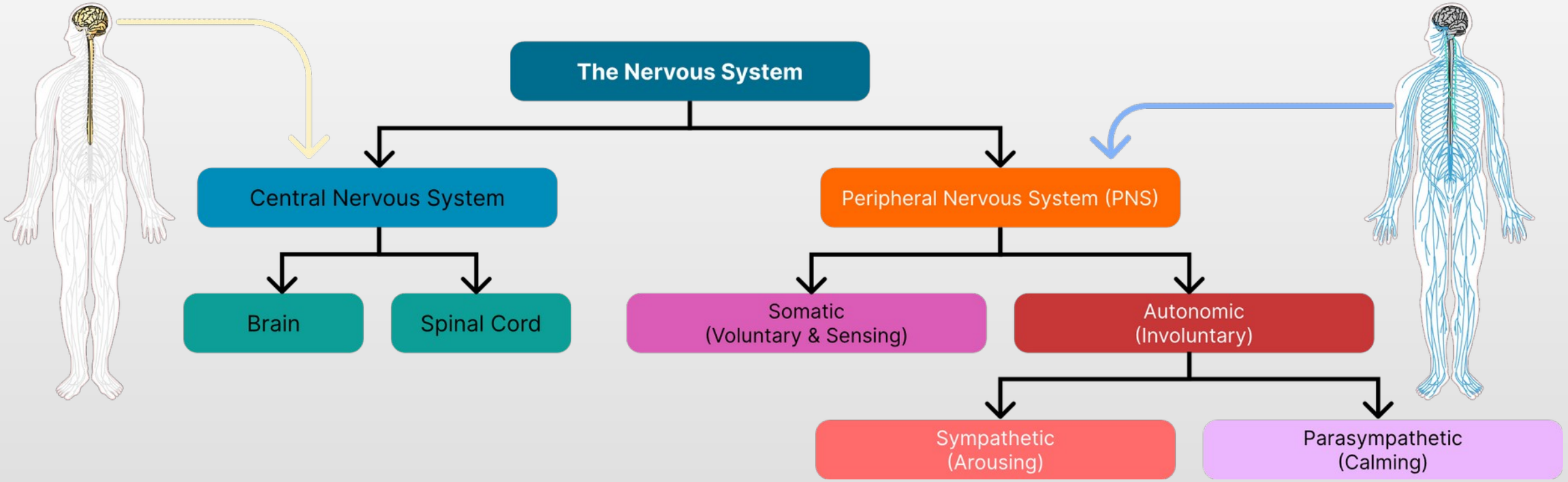
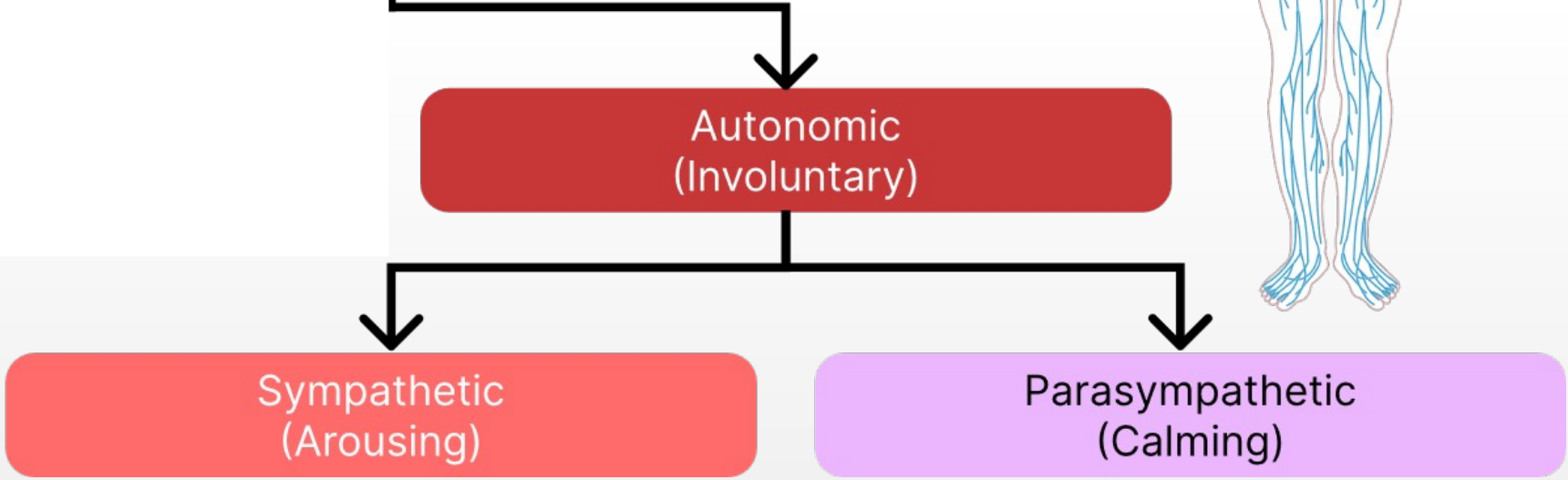


Decoding the Sympathetic Nervous System: An Introduction

Ulysse Côté-Allard

The nervous system





Increase heart rate	Heart rate	Decrease heart rate
Increase breathing rate	Lungs	Decrease breathing rate
Dilates pupils & Prepare for Far vision	Eyes	Constrict pupils & Prepare for Close vision
No effect on most	Blood vessels	Constricts blood vessels & increase BP
Increase	GI Track	Decrease
Produce perspiration	Sweat gland of skin	No Effect
Stimulate to release epinephrine (adrenaline) and Norepinephrine	Adrenal Medulla	No Effect
Response to cooldown-warmup of the body	Temperature	No Effect

Some impacts of imbalance

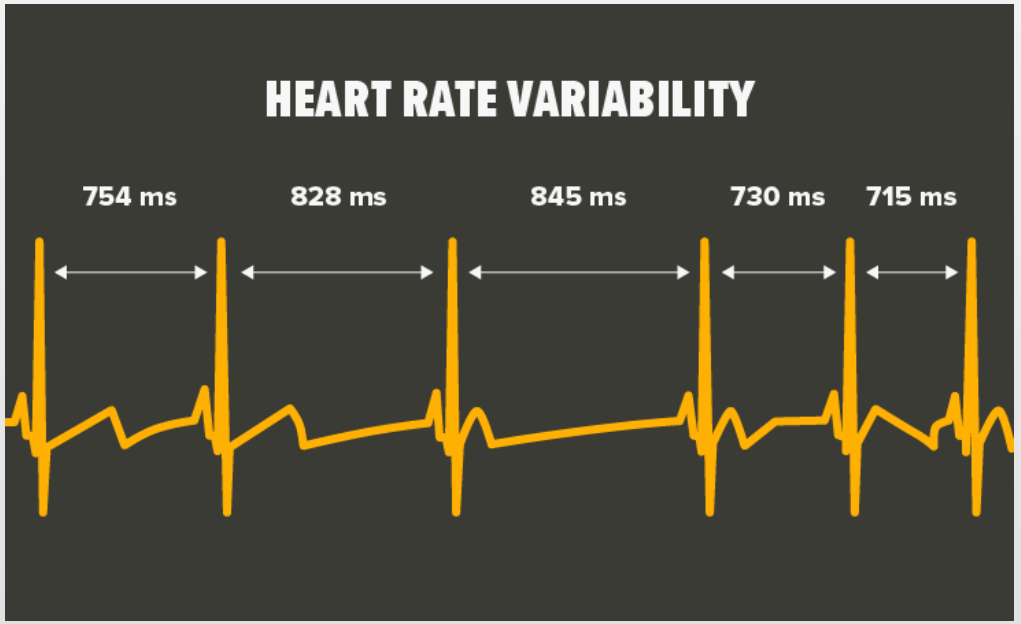
- High blood pressure -> Increased risk of heart attack, stroke, coronary artery disease, aneurysm, etc
- Trouble breathing/swallowing
- Impotence in men
- Hypo/Hyperthermia
- Tachycardia (high heart rate) -> Elevated risk of cardiovascular events such as heart failure and all-cause death

BUT
“Lower risk of future permanent pacemaker implantation [1]

[1] Ho, Jennifer E., et al. "Long-term cardiovascular risks associated with an elevated heart rate: the F ramingham Heart Study." *Journal of the American Heart Association* 3.3 (2014): e000668.

Heart Rate Variability (HRV)

- Heart rate -> Controlled by the Autonomic Nervous System
- Interplay between the parasympathetic and sympathetic nervous system -> beat-to-beat heart rate variation (HRV)
- HRV thus reflects autonomic nervous system activity



Meaning and characterisation of HRV

Infos

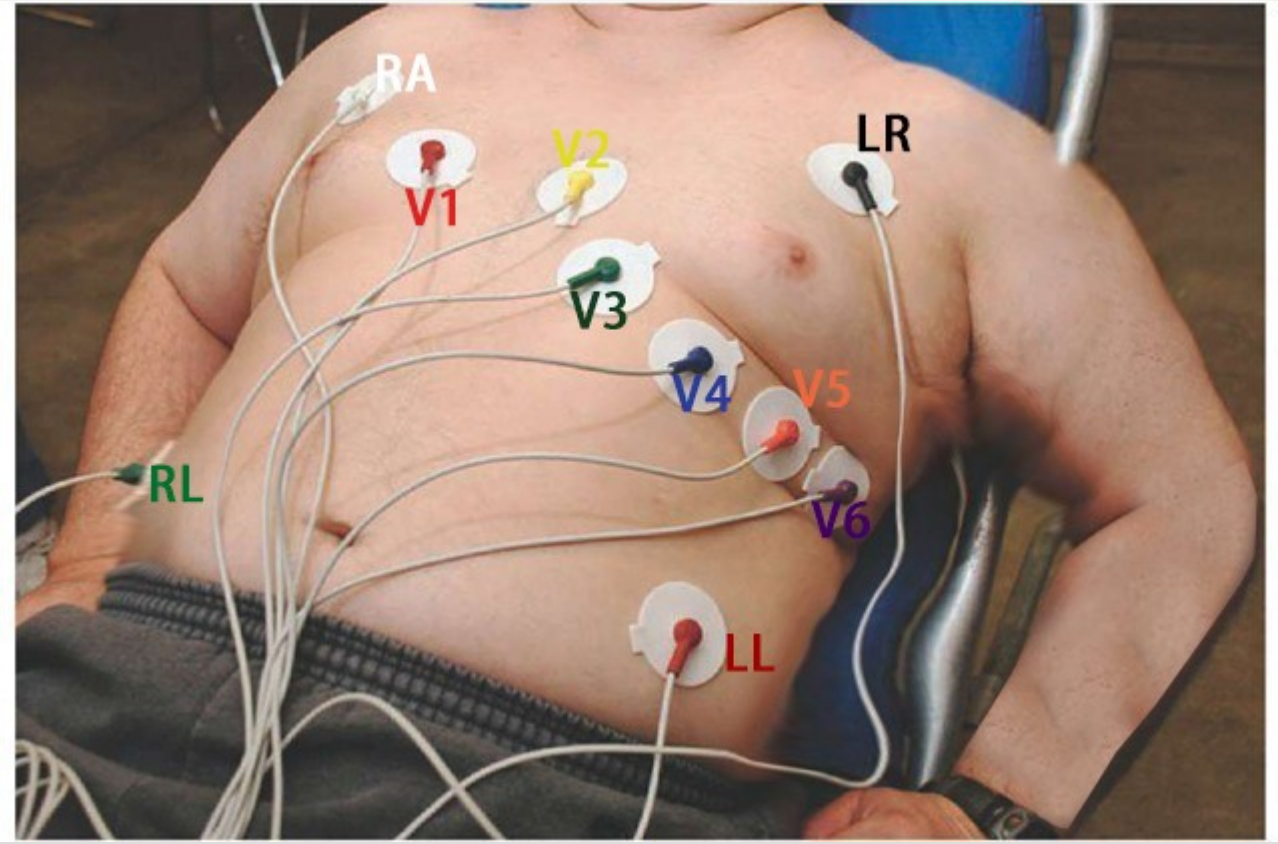
- Affected by age and fitness levels
- In general, decline with decreased health (Higher is better if not extreme)
- Useful to predict morbitdities from mental (e.g. stress, depression, anxiety, PTSD) and somatic disorders (e.g. inflammation, chronic pain, diabetes, insomnia, concussion).
- Normal HRV can range between ~30-110ms

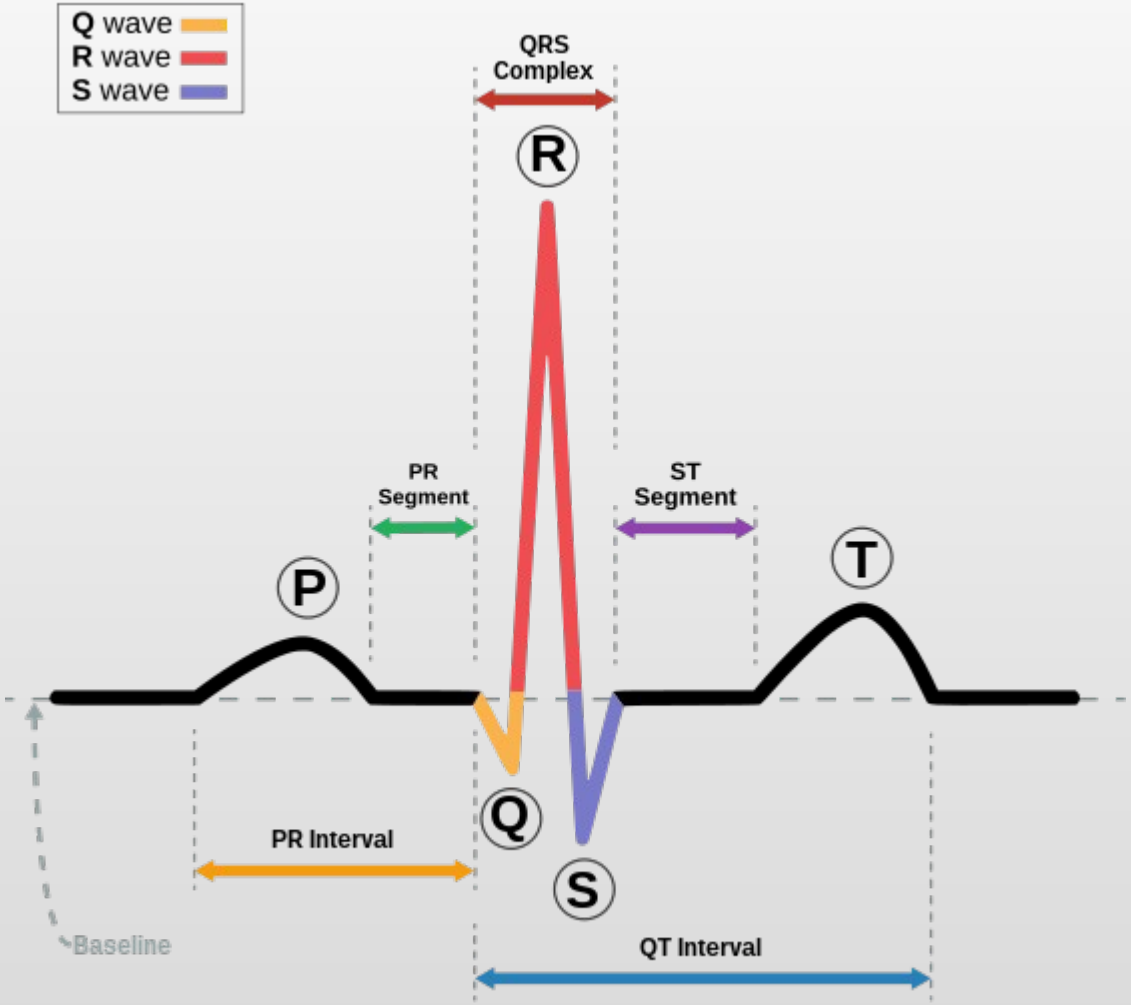
Features

- SDRR (Standard deviation of the interbeat intervals (IBI))
- SDNN (Standard deviation of the normal IBI)
  - “Gold standard for medical stratification of cardiac risk” [2]
- Power of different frequency bands (<0.003Hz, 0.04-0.15hz, 0.15-0.4Hz)
- Sample entropy

[2] Shaffer, Fred, and Jay P. Ginsberg. "An overview of heart rate variability metrics and norms." *Frontiers in public health* (2017): 258.

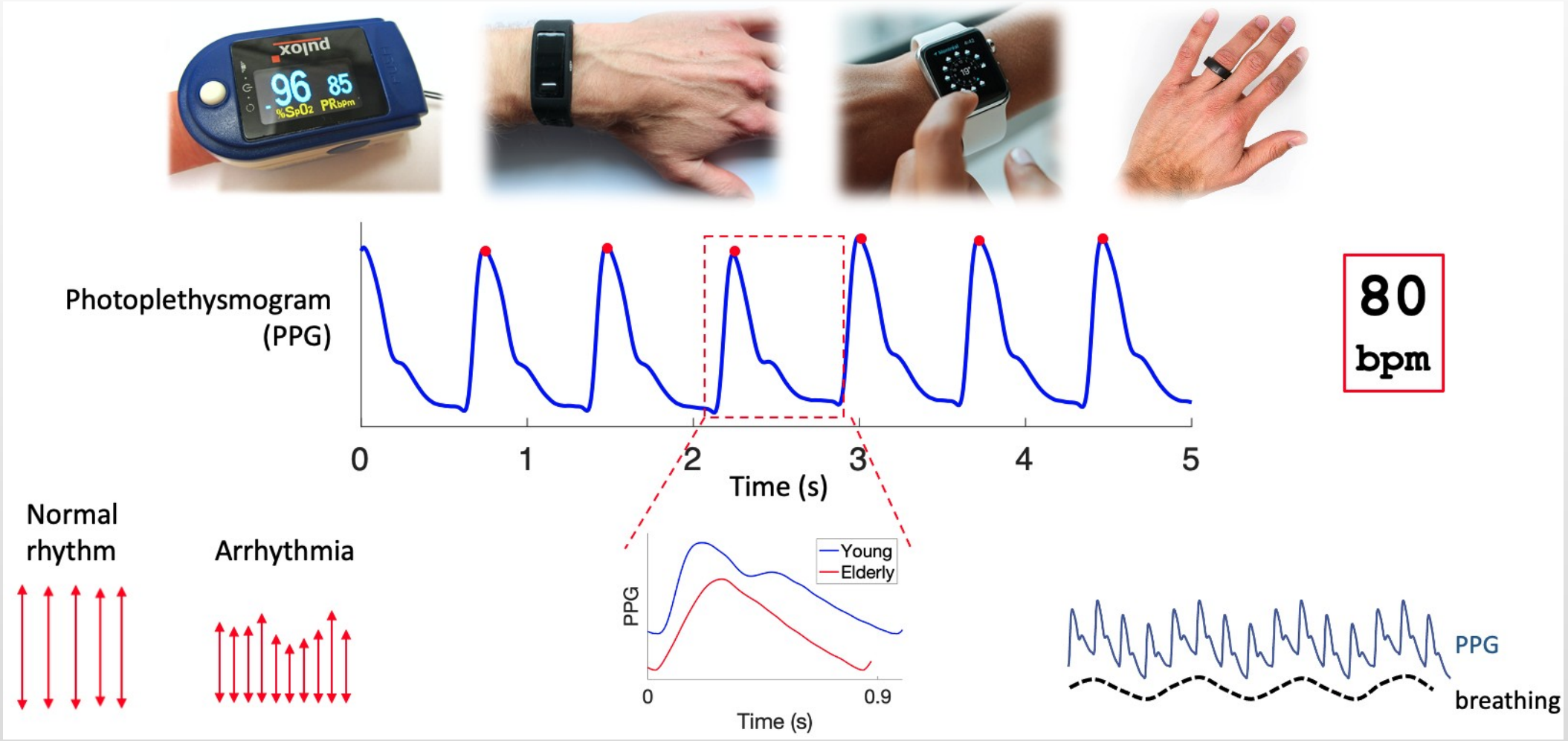
Heart Rate & Heart Rate Variability: Electrocardiography





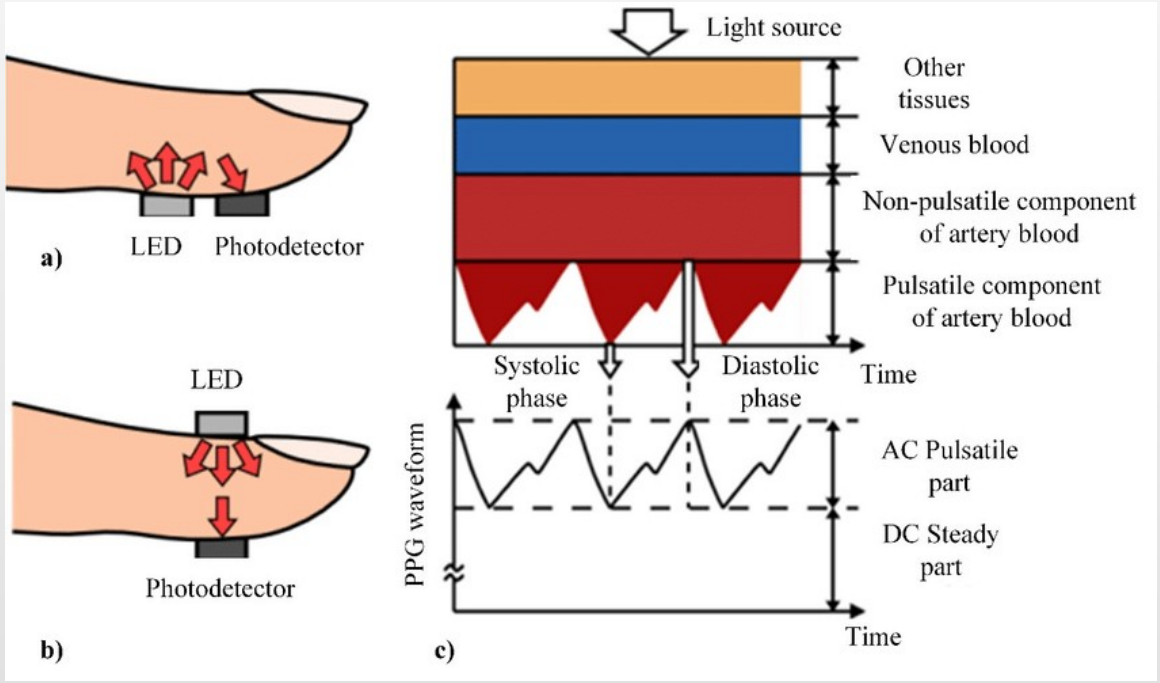
Source: https://www.youtube.com/watch?v=v3b-YhZmQ

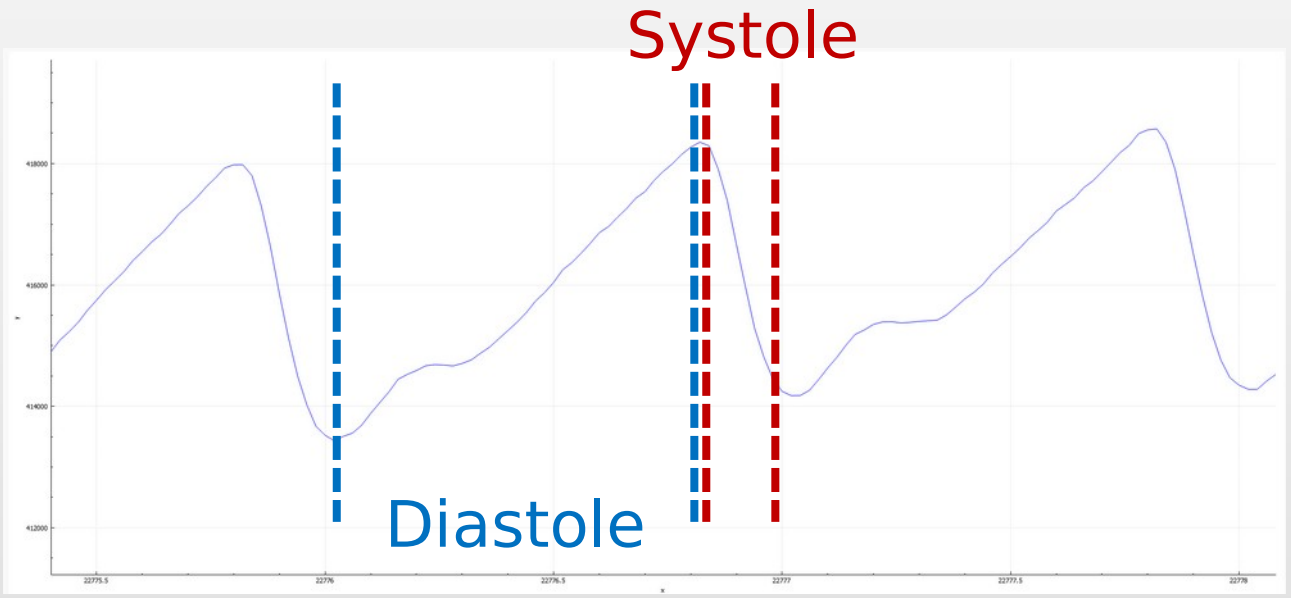
Heart Rate & Heart Rate Variability: photoplethysmography



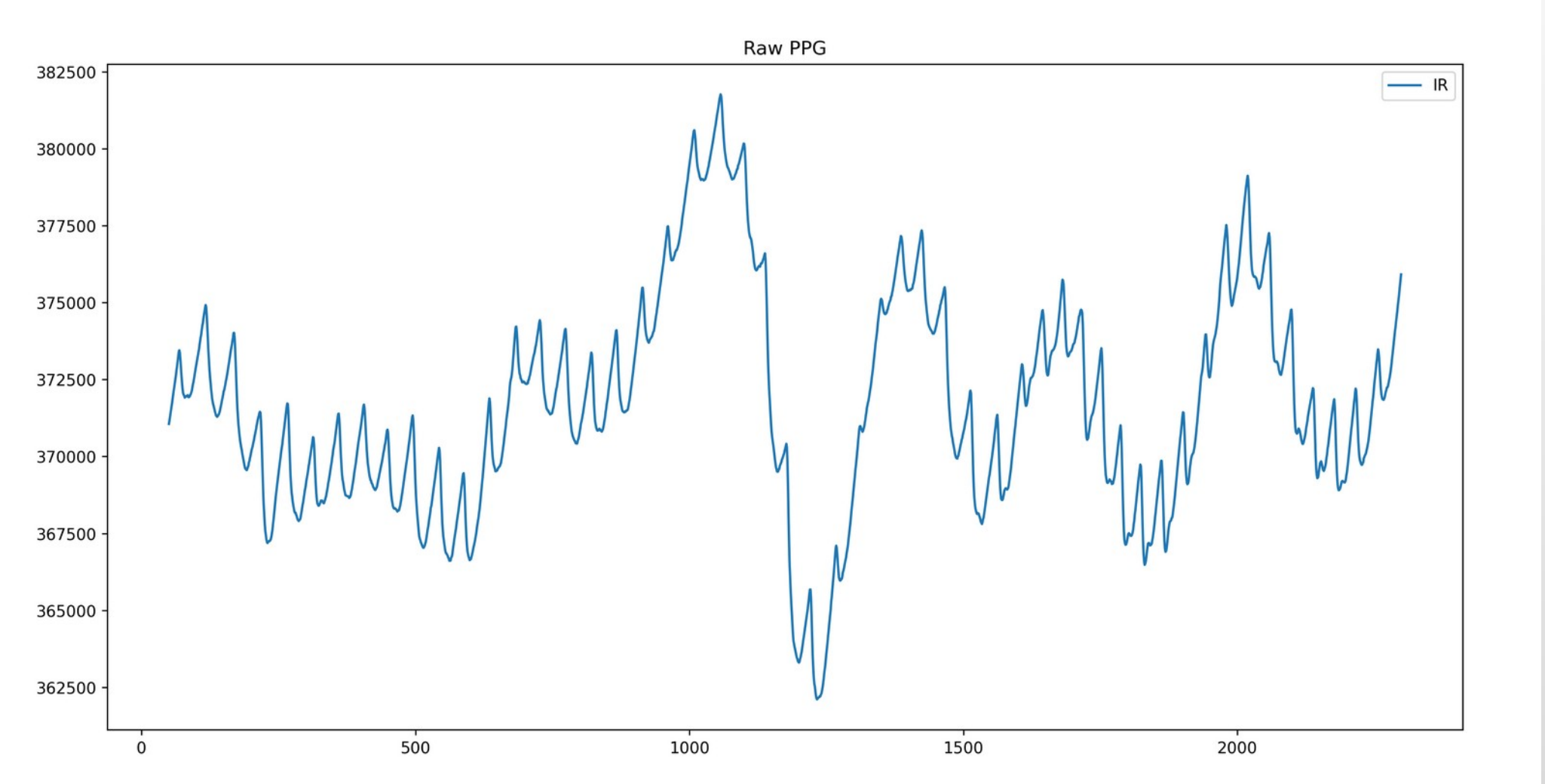
https://peterhcharlton.github.io/project/understanding-pp

Heart Rate & Heart Rate Variability: photoplethysmography

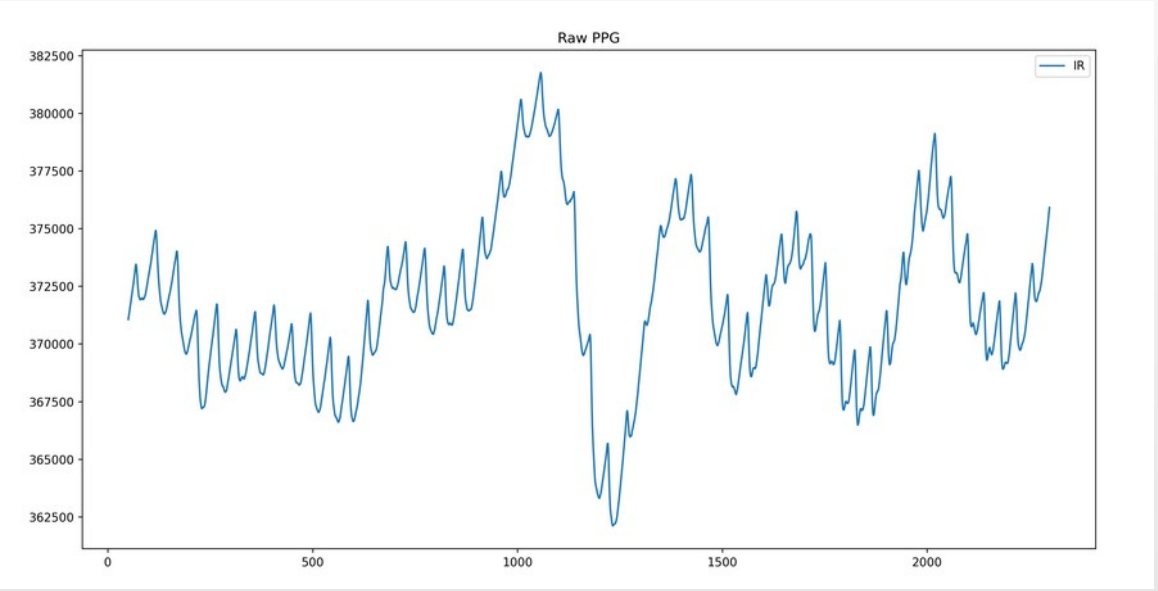


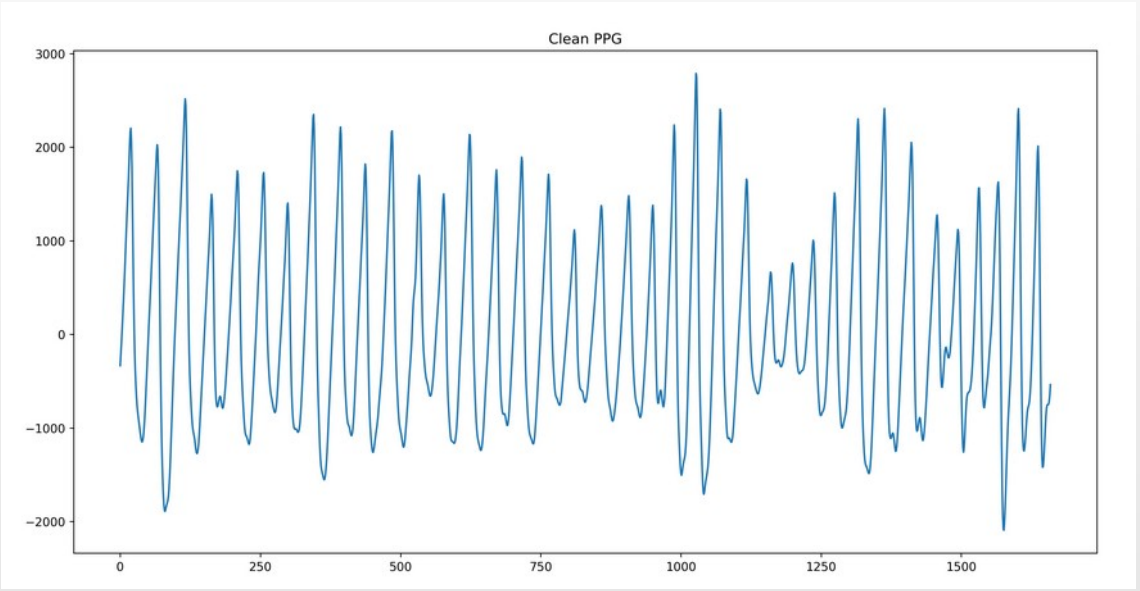


An example of heart rate extraction

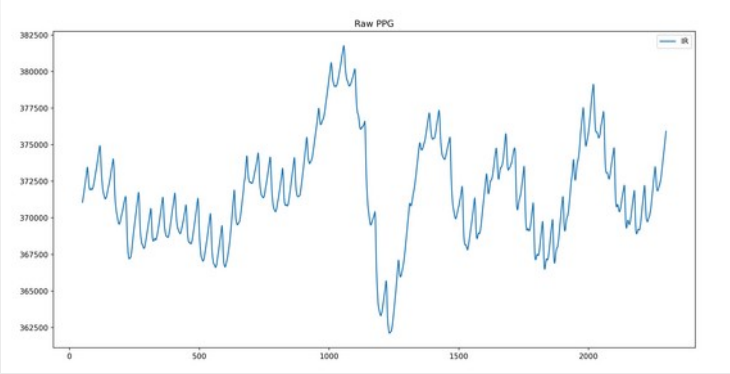


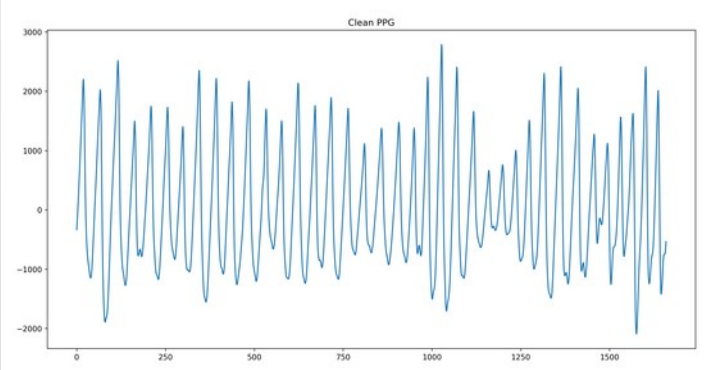
An example of heart rate extraction

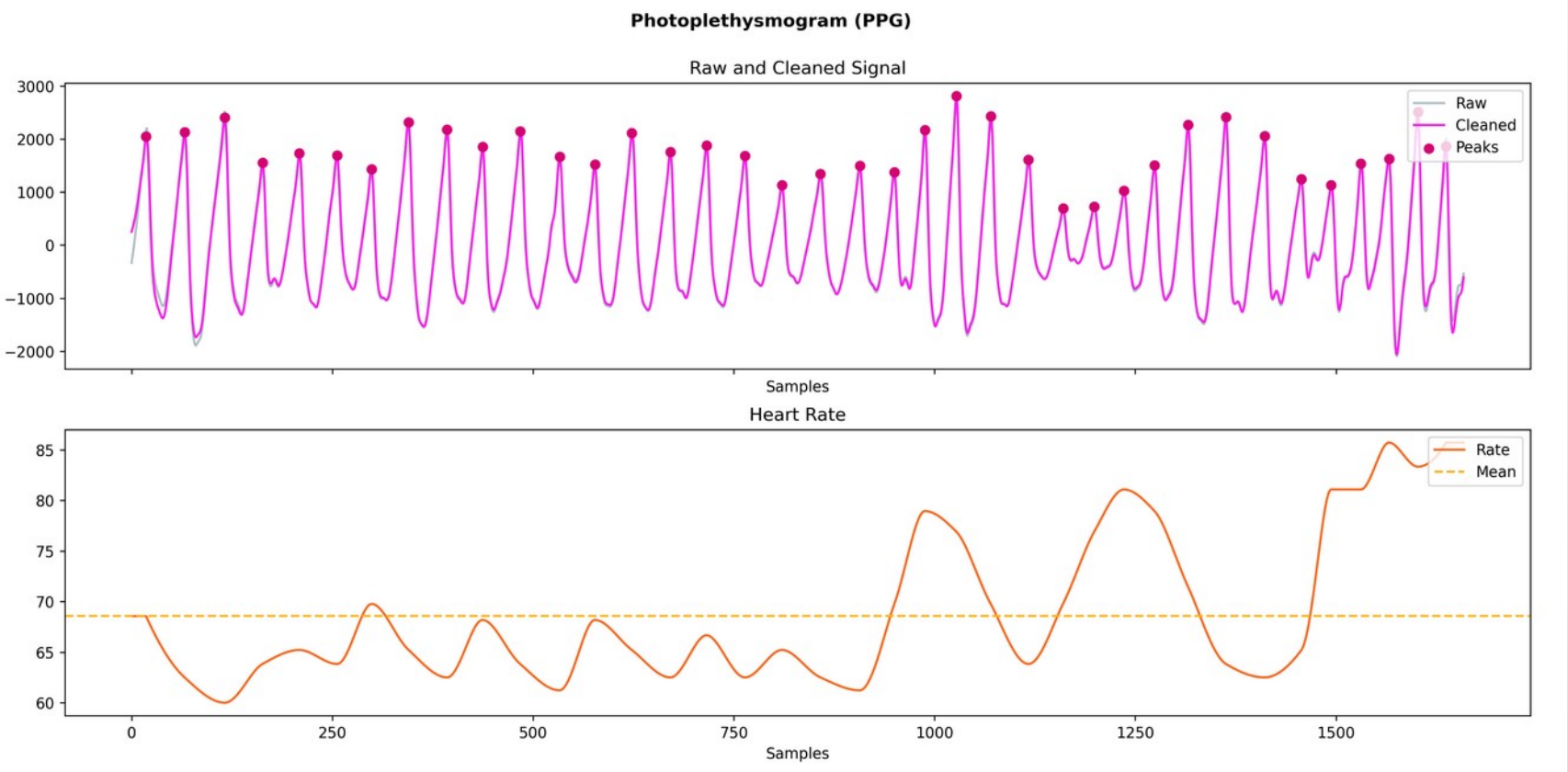




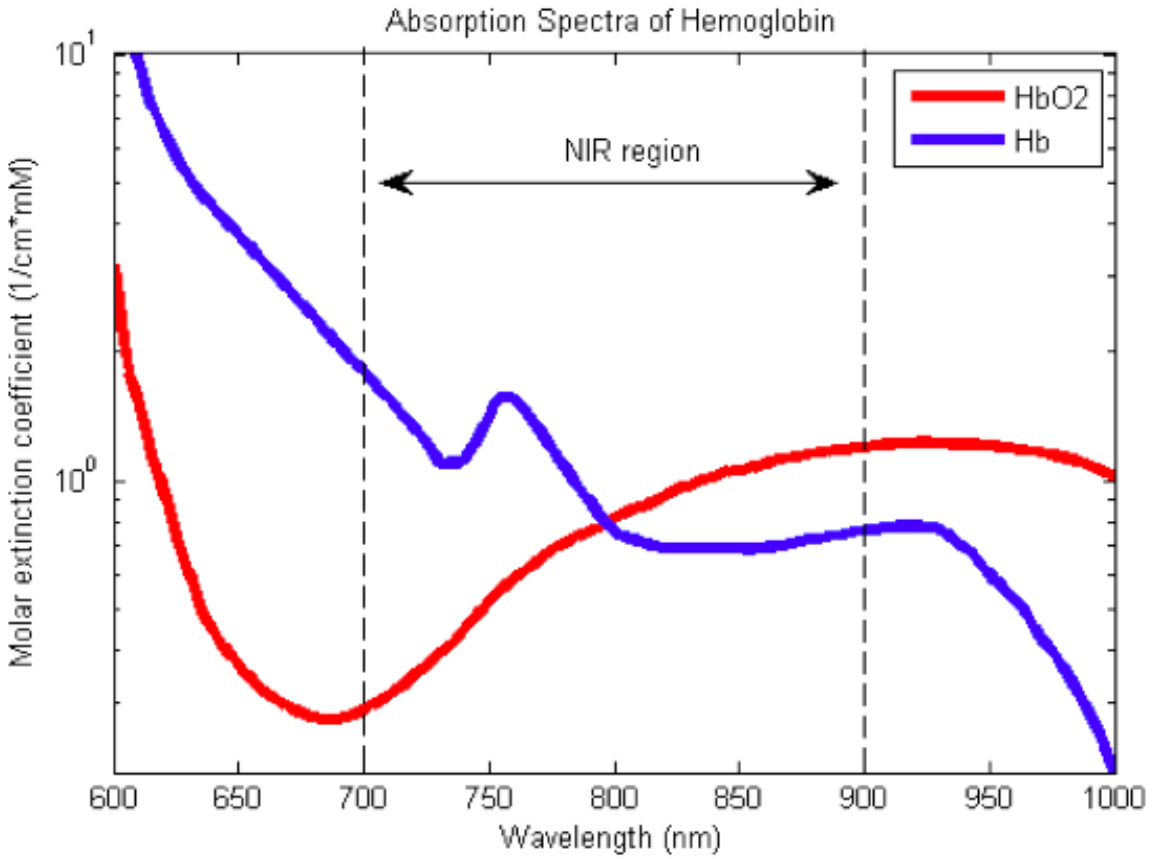
An example of heart rate extraction







PPG - SpO2



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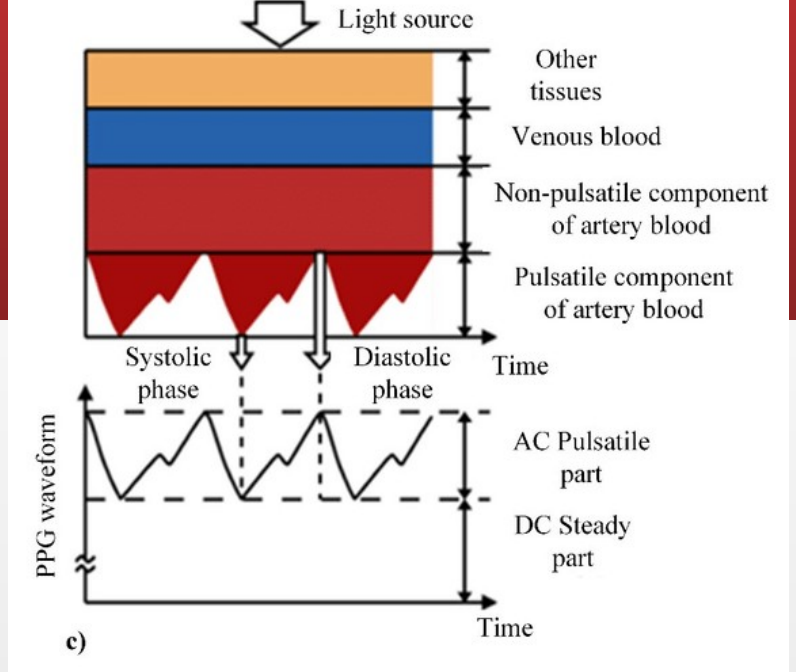
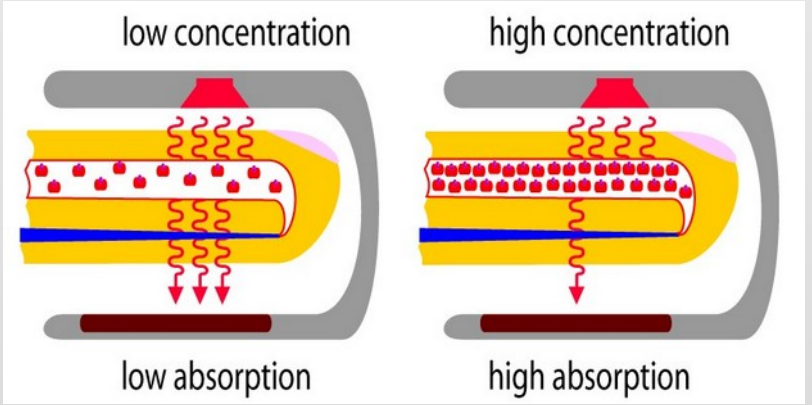
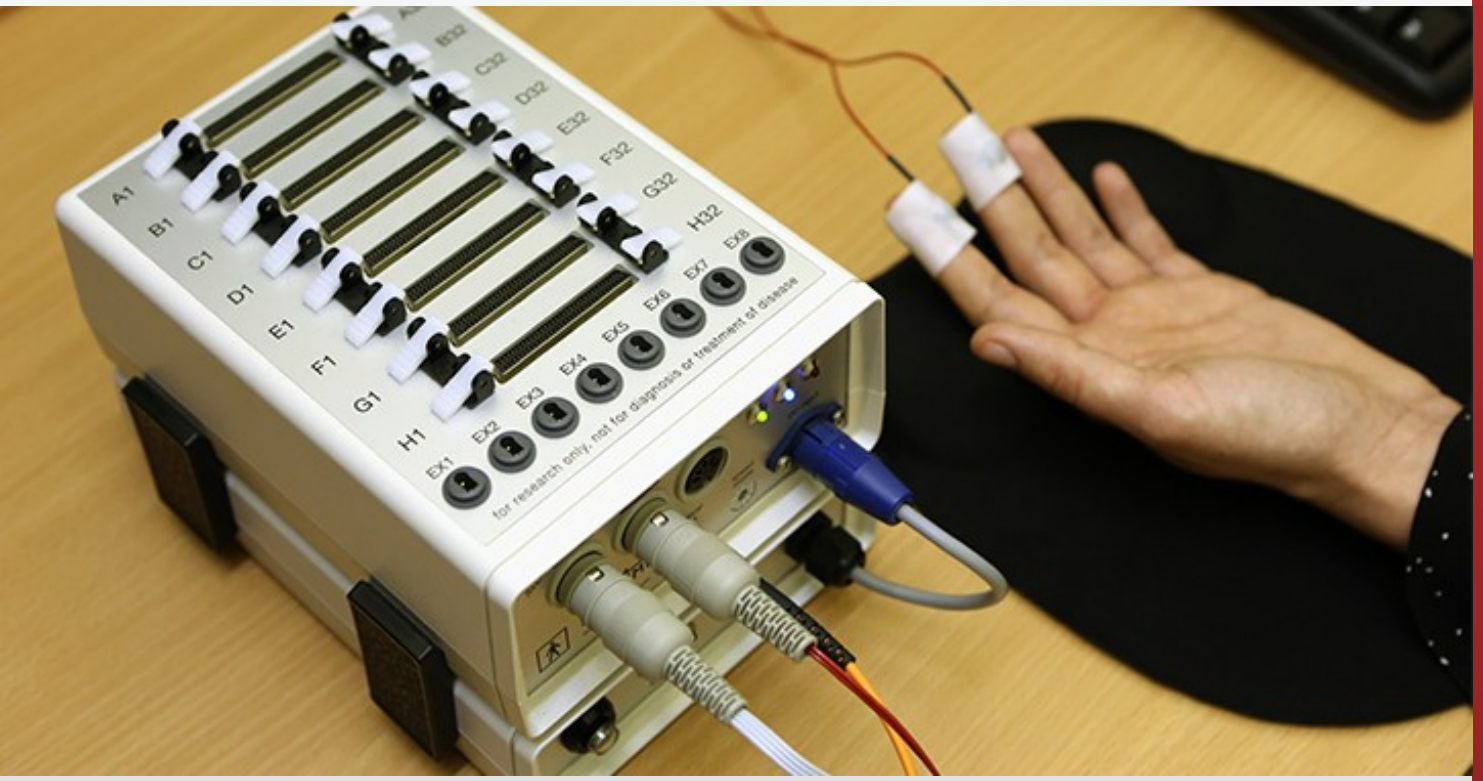


Red color ~= 700nm
900nm -> Infrared



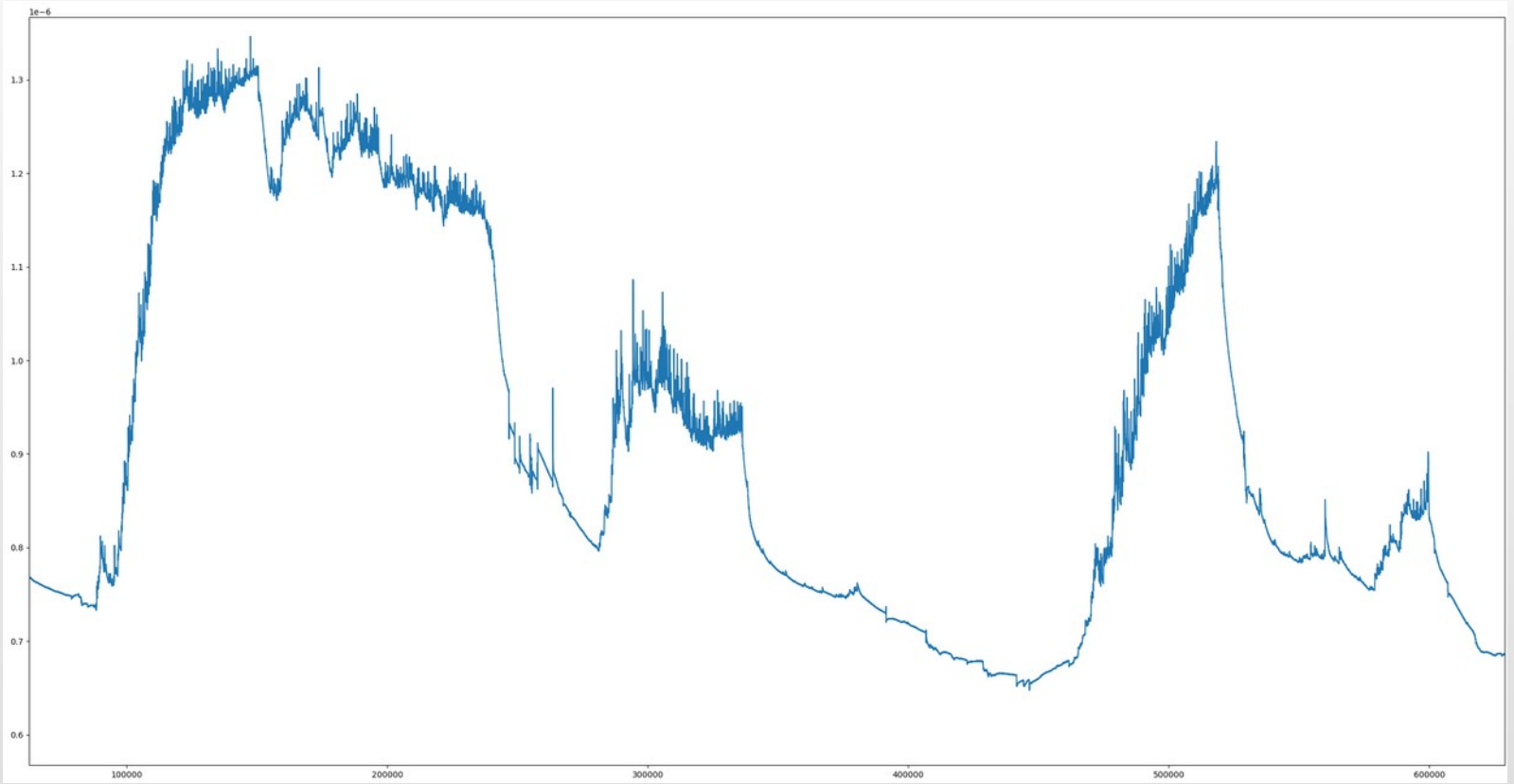


Electrodermal Activity (EDA)

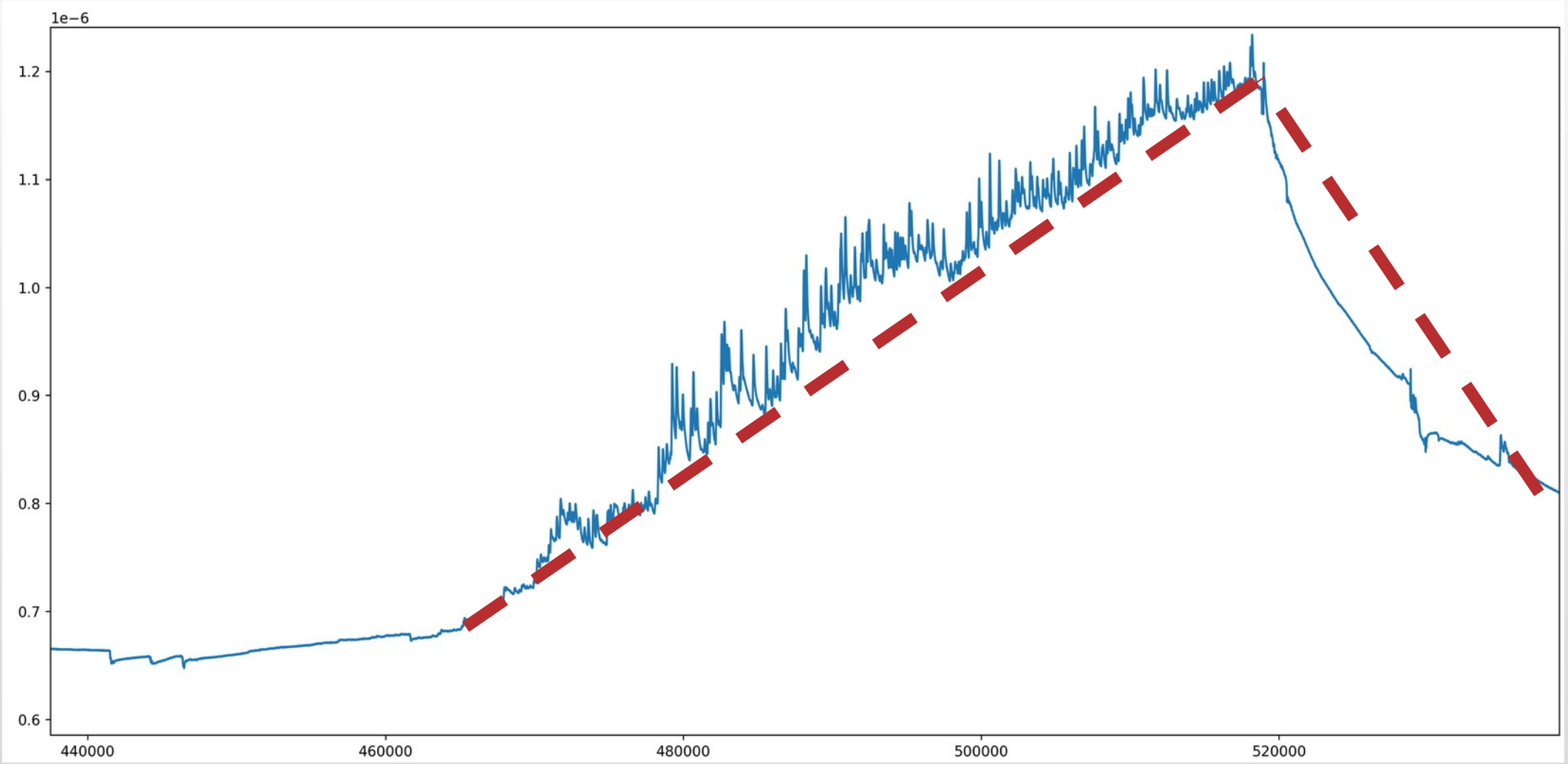
Sympathetic Nervous System responsible of producing perspiration

EDA, a measure of arousal

- Tonic: Slow change (Below 0.1Hz)
- Phasic: “Fast changes” (0.045 to a few Hz)



Tonic Component



Phasic Component