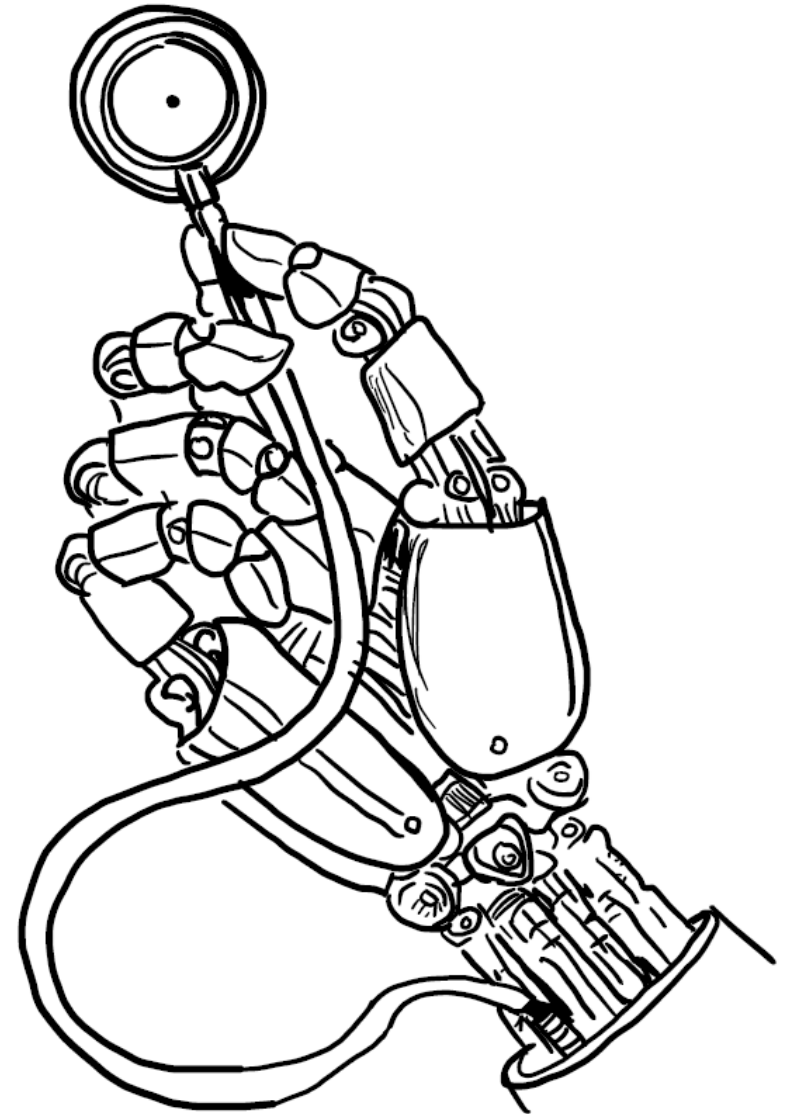# EMPOWER pre-webinar # 4 Wearables
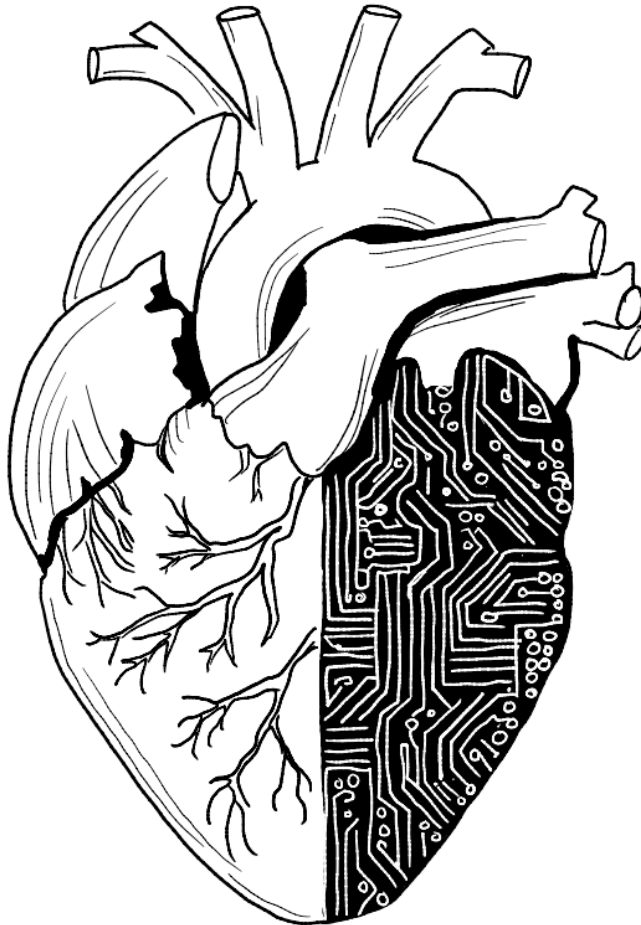
AI-based Telemonitoring | Medizinische Klinik und Poliklinik I
18.09.2024 | Dr. Christian Gölz & Prof. Dr. Solveig Vieluf

AI-based telemonitoring group
Digital tools for studying the integrated heart

- Cardiology implemented in the whole body approach

- Understanding the patients health better by monitoring the patient

  - Throughout the hospital stay (multimodal data)

  - Beyond the doctors visit (wearable data, questionnaires and diaries)

Definition of wearables

- Wearables are gadgets or accessories with integrated sensors that can be worn on the body to continuously collect user specific physiological data.
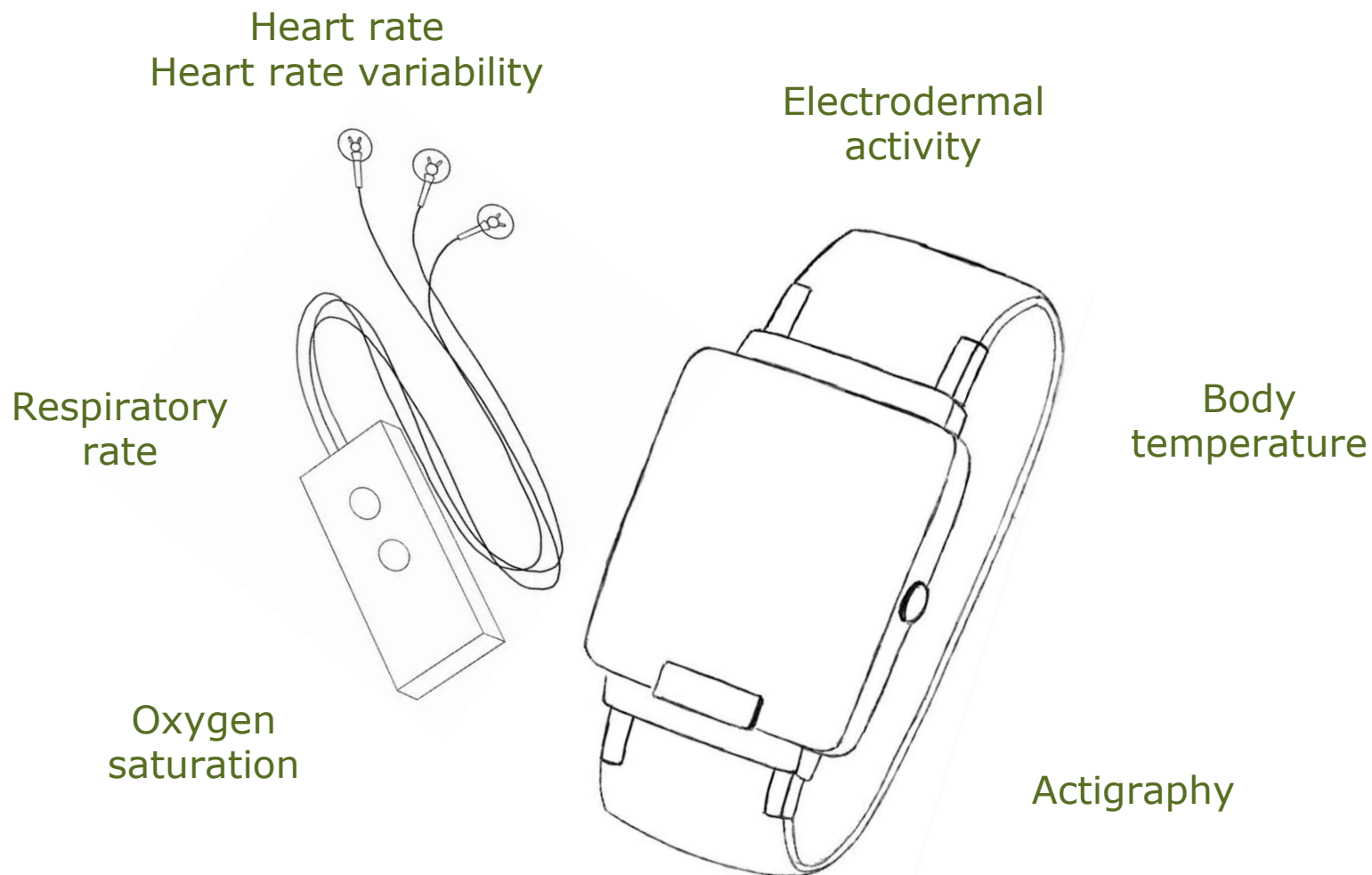
Wearables are popular

- The global wearable technology market size was estimated at USD 61.30 billion in 2022 and was expected to reach USD 71.91 billion in 2023.

- The global wearable technology market is expected to grow at a compound annual growth rate of 14.6% from 2023 to 2030 to reach USD 186.14 billion by 2030

- Some key players operating in the wearable technology market include Adidas; Apple Inc.; Fitbit, Inc.; Garmin Ltd.; SAMSUNG; Sony Corporation; and Xiaomi.

- Key factors that are driving the wearable technology market growth include increasing smartphones & multimedia device demand, infrastructure developments in the mobile industry, and rising disposable income in developing economies.

- https://www.grandviewresearch.com/industry-analysis/wearable-technology-market
- https://datareportal.com/reports/digital-2023-deep-dive-the-rise-of-wearables

Ash et al., 2020

Wearables

Heart rate
Heart rate variability

Electrodermal activity

Respiratory rate

Body temperature

Oxygen saturation

Actigraphy

Multimodal devices

Advantages
- Non-invasive
- Easy to use
- Comparably affordable
- Unobtrusive to wear
- Can detect multiple physiological signals from different modalities
- Allow for long-term recordings
- Data volume comparably small

Disadvantages
- Low signal quality
- mostly low resolution
- Measure at the body periphery
- Battery life
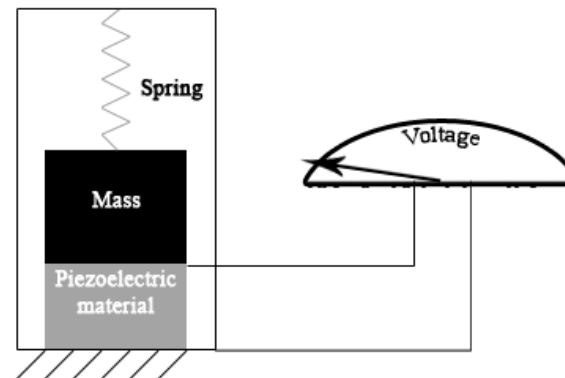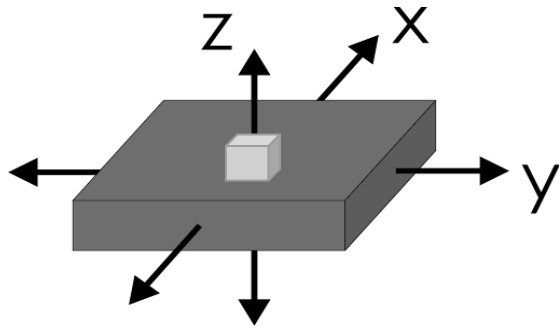- Data storage and processing capacities

LMU KLINIKUM

Actigraphy

- Records magnitude and frequency of movements over time
- Core sensor is typically a 3 axis accelerometer
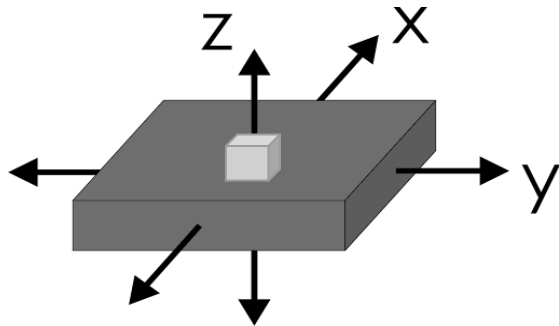
Actigraphy

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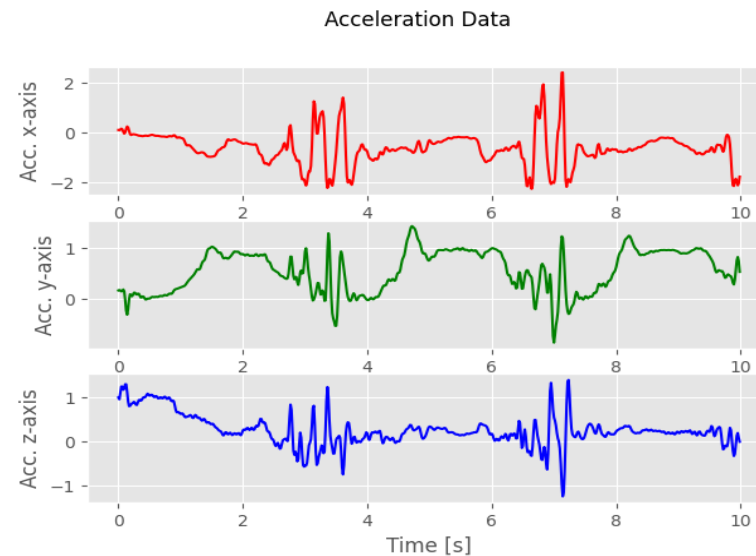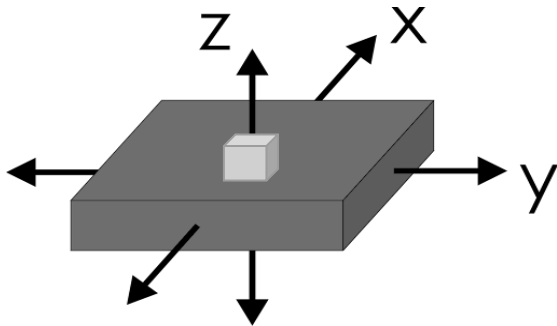
- Other sensors: Gyroscopes, Magnetometers, Barometer, GPS etc.

Measures derived from actigraphy

- Physical activity levels
  - Step counts, Stair counts, Activities…
- Monitoring rest/activity cycles
- Sleep monitoring
- Circadian and rest-activity patterns
- Seizure detection
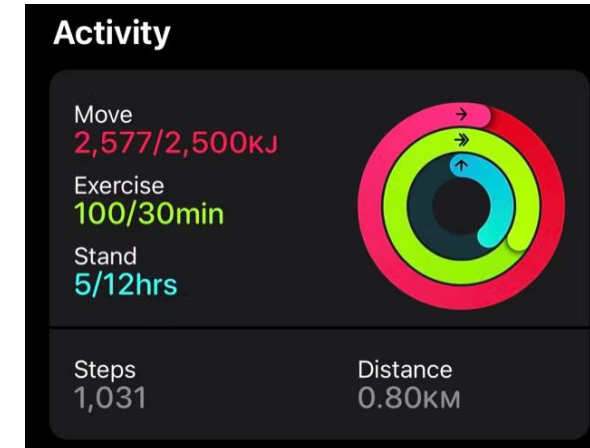
Photoplethysmography (PPG)

- PPG is a noninvasive optical technique used to measure blood volume changes in the microvascular tissue.

- It shines light into the skin (red, green, infrared) and detects the amount of light absorbed or reflected, respectively.

- Blood volume fluctuates during each heart cycle generating a characteristic PPG curve
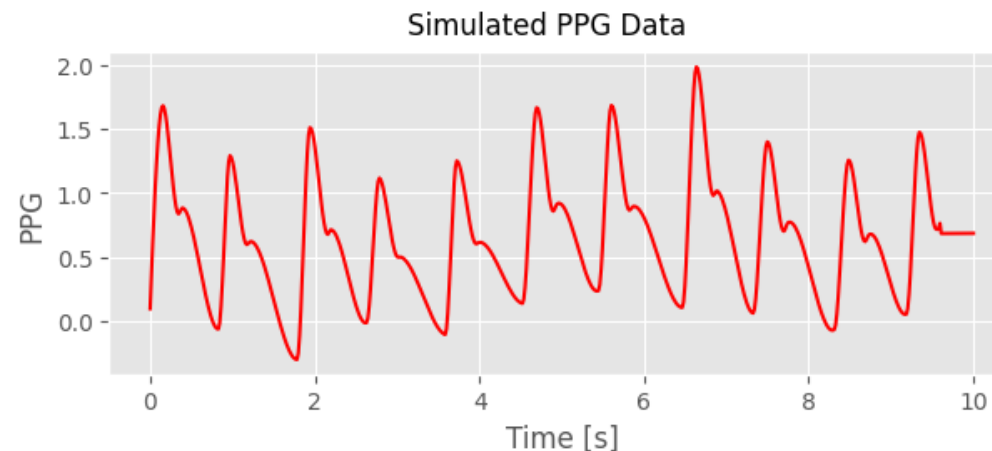
Measures typically derived from PPG

- Heart rate

- Heart rate variability

- Respiratory rate

- Blood Oxygen Saturation (SpO2)

- Vascular Age

Simulated PPG Data

Code
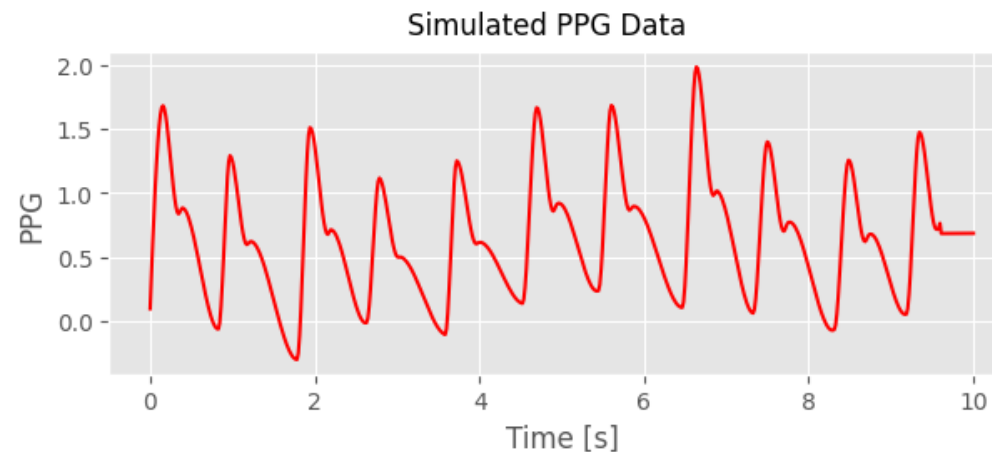
- To code along:
  - https://tinyurl.com/3f3tkzrs (Google account required)
  - https://tinyurl.com/yfdmtdd8 (No account required but slower)

Main challenges analyzing wearable

- User
  - Compliance
  - User Variability
- Data accuracy and device reliability
  - Signal quality, time shifts in internal clock
  - Data loss
  - Standardization across different devices and related to gold standards and testing protocols
- Interoperability
- Data access
- Data privacy, regulatory approvals
- Labeling for model training

Main findings generated from wearable data

- Heart rate and arrhythmia detection

  - Perez, Marco V., et al. "Large-scale assessment of a smartwatch to identify atrial fibrillation." *New England Journal of Medicine* 381.20 (2019): 1909-1917.

- COVID-19 Early Detection

  - Quer, Giorgio, et al. "Wearable sensor data and self-reported symptoms for COVID-19 detection." *Nature Medicine* 27.1 (2021): 73-77.

- Sleep and Circadian Rhythms

  - Lyall, Laura M., et al. "Association of disrupted circadian rhythmicity with mood disorders, subjective wellbeing, and cognitive function: a cross-sectional study of 91 105 participants from the UK Biobank." *The Lancet Psychiatry* 5.6 (2018): 507-514.

- Physical activity and mortality risk

  - Lee, I-Min, et al. "Association of step volume and intensity with all-cause mortality in older women." *JAMA internal medicine* 179.8 (2019): 1105-1112

Closing statements

- Wearables offer a valuable addition to multimodal research by providing continuous, real-time, physiological data outside the clinical setting.

- They enable researchers to monitor health metrics in natural environments, which is adding a unique perspective to whole body research.

- This allows for more personalized insights and early detection of health changes and thereby empower patients to act immediately.

Thank you!

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