Project 4: Human heat flow

MATH-516 Applied Statistics

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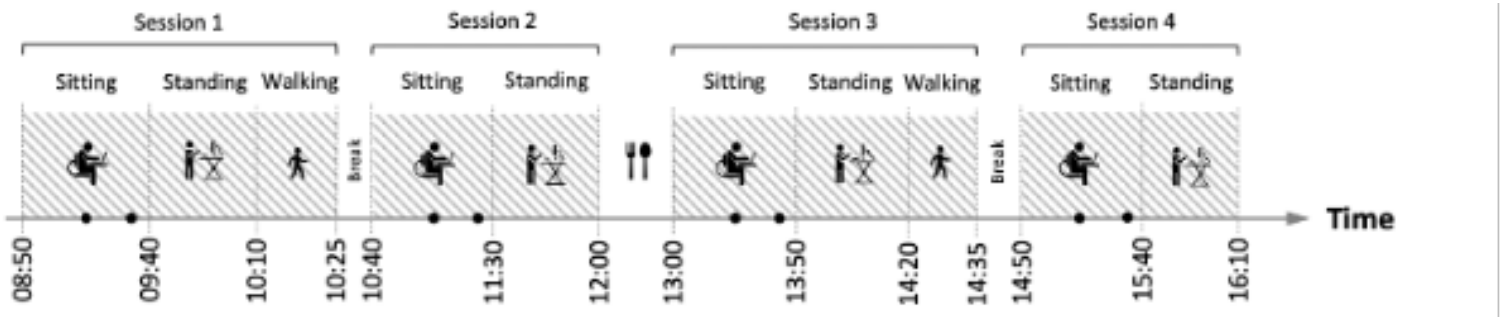
1 Introduction: Experiment

- Controlled experiments in the climatic chamber of the ICE lab at EPFL were conducted in 2023
- Multiple participants (12 females F1-F12 and 12 males M1-M12) were monitored using wearable sensors
- Each participant was monitored on two separate days while maintaining a consistent procedure, with the only variation being the room temperature (24°C on Day 1 and 18°C on Day 2)



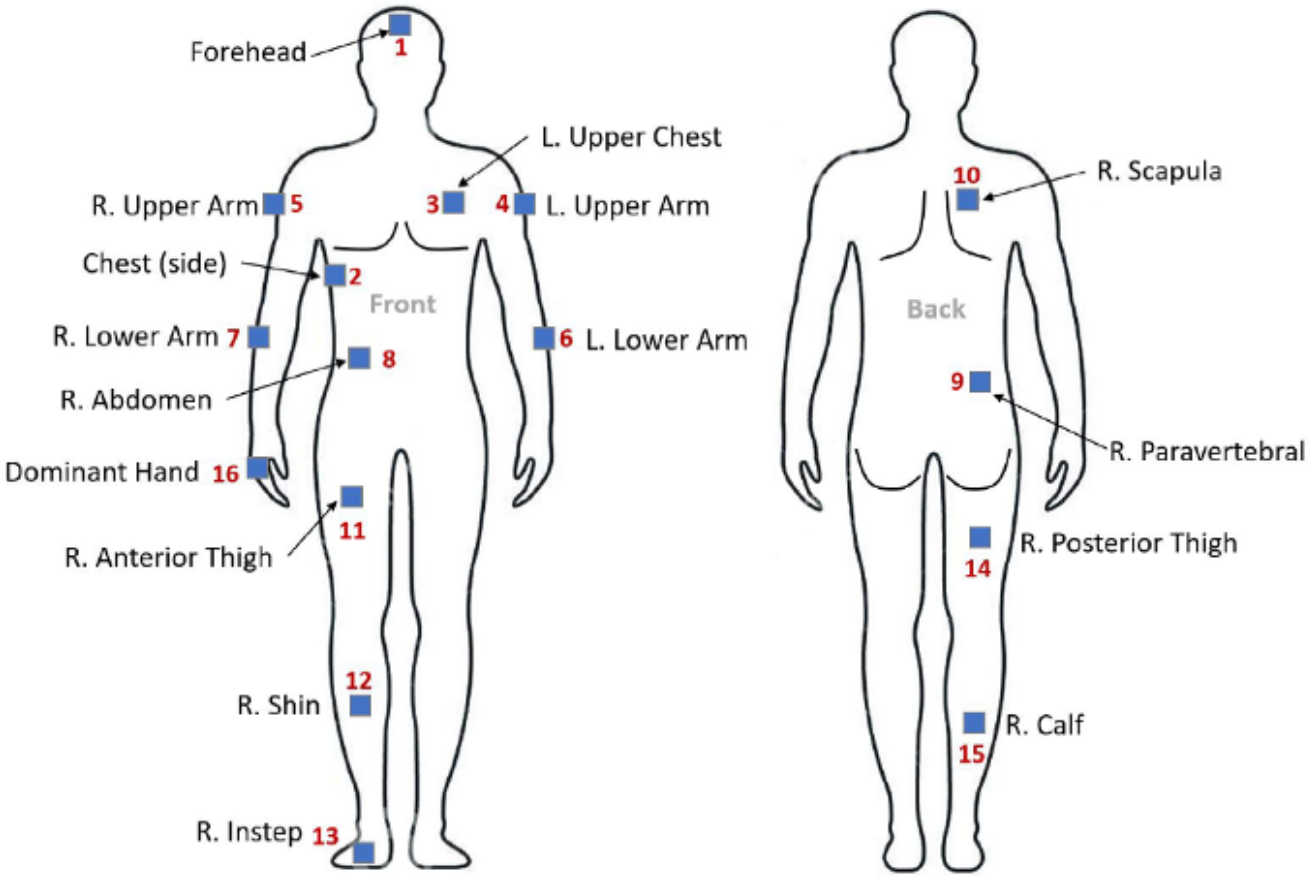
Courtesy of Prof. Khovalyg

2 Introduction: Experiment

- During each activity, participants had 16 wearable sensors, each capable of capturing skin heat flux (heat flow) data
  - human body thermal regulation helps the organism maintain stable internal temperature
  - heat loss through the skin contributes to such thermoregulation
  - heat flow depends on physiological characteristic, the activity level, the heating and cooling conditions, clothing, etc

The ICE (Integrated Comfort Engineering) lab at EPFL is concerned with energy sufficiency of buildings by focusing on indoor thermal comfort of occupants, which depends (partially) on their thermal sensations. The ultimate goal would be to create personalized thermal comfort profiles

3 Introduction: Experiment



Courtesy of Prof. Khovalyg

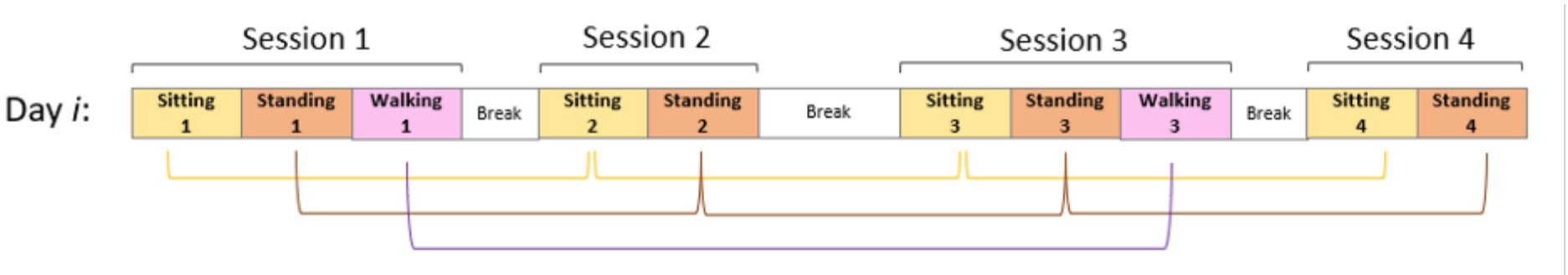
4 Data

- measurements were made every second during each session
- we will disregard the functional aspect of the data and work with the mean measure of heat flow over each session
- we will only work with six sensors to reduce the dimensionality of the problem: sensors 2, 3, 5, 7, 8, and 16

5 Aim of the study

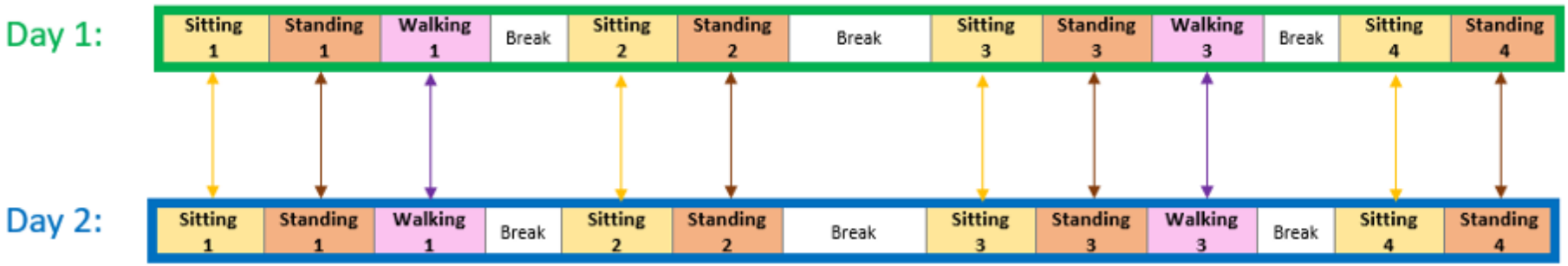
Aim of the study: Is there significant inter- and intra-individual variability in heat flow measurements in each of the sensors? How are measurements from different sensors related?

- To examine the intra-individual variability, it is necessary to analyze for the same person
  - Effect of the time: The difference between the same activities on the same day, but at different times (sessions)

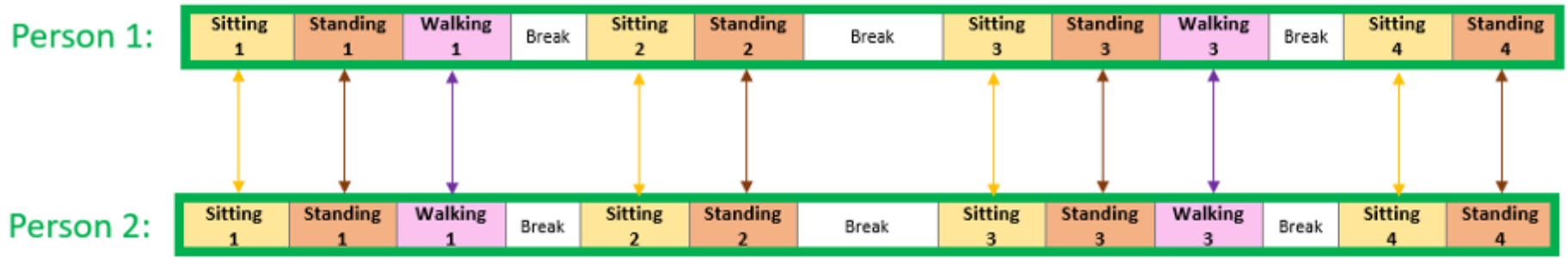


6 Aim of the study

- Temperature effect: The difference between the same activities but on different days



- To examine the inter-individual variability, it is necessary to examine the difference between the same activities on the same day, but across participants



7 Goals

- Motivate the use of mixed linear models in this project and build one to assess
  - the inter-variability in heat flow,
  - the intra-variability in heat flow, and
  - the covariance structure between the sensors
- Allow for different levels of grouping: allow observations for the same participant to be correlated, and observations within the same participant and the same activity to be correlated too. Check whether this is needed by looking at the proportion of variance explained by your different levels
- The context of the experiment is multivariate by nature. How will you use the univariate mixed model to model marginal and joint measurements from the different sensors?
- Provide interpretation of the most important parameters of your final model