Smart Technologies for Long-Term Stress Monitoring at Work

Rafał Kocielnik
Natalia Sidorova
Fabrizio Maria Maggi
Martin Ouwerkerk
Joyce H.D.M. Westerink

Technische Universiteit
Eindhoven
University of Technology

Where innovation starts

PHILIPS

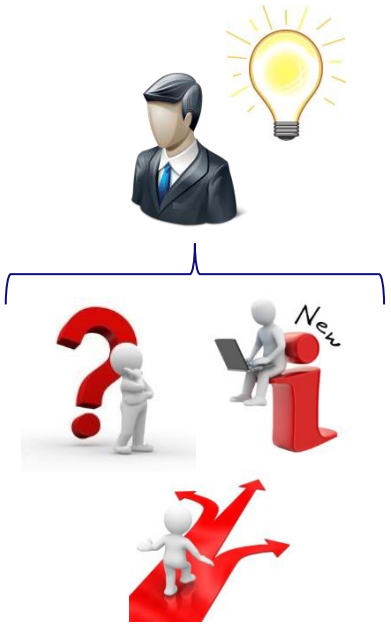
Motivation

By 2020 the top five diseases will be **stress related**
(WHO)

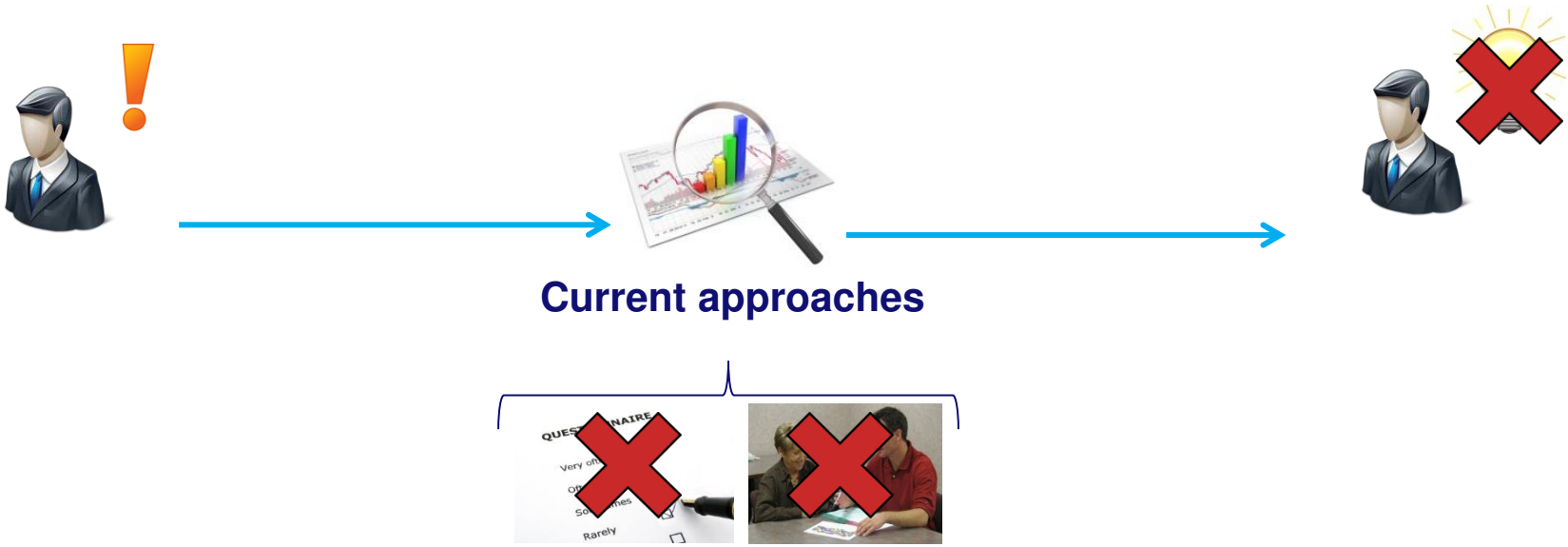
Health care expenditures 50% greater for **stressed workers**
(J Occup Environ Med, 40:843-854).

Costs of stress - 4 billion € per year
1 out of 7 disabled because of **stress**
(TNO, 2006)

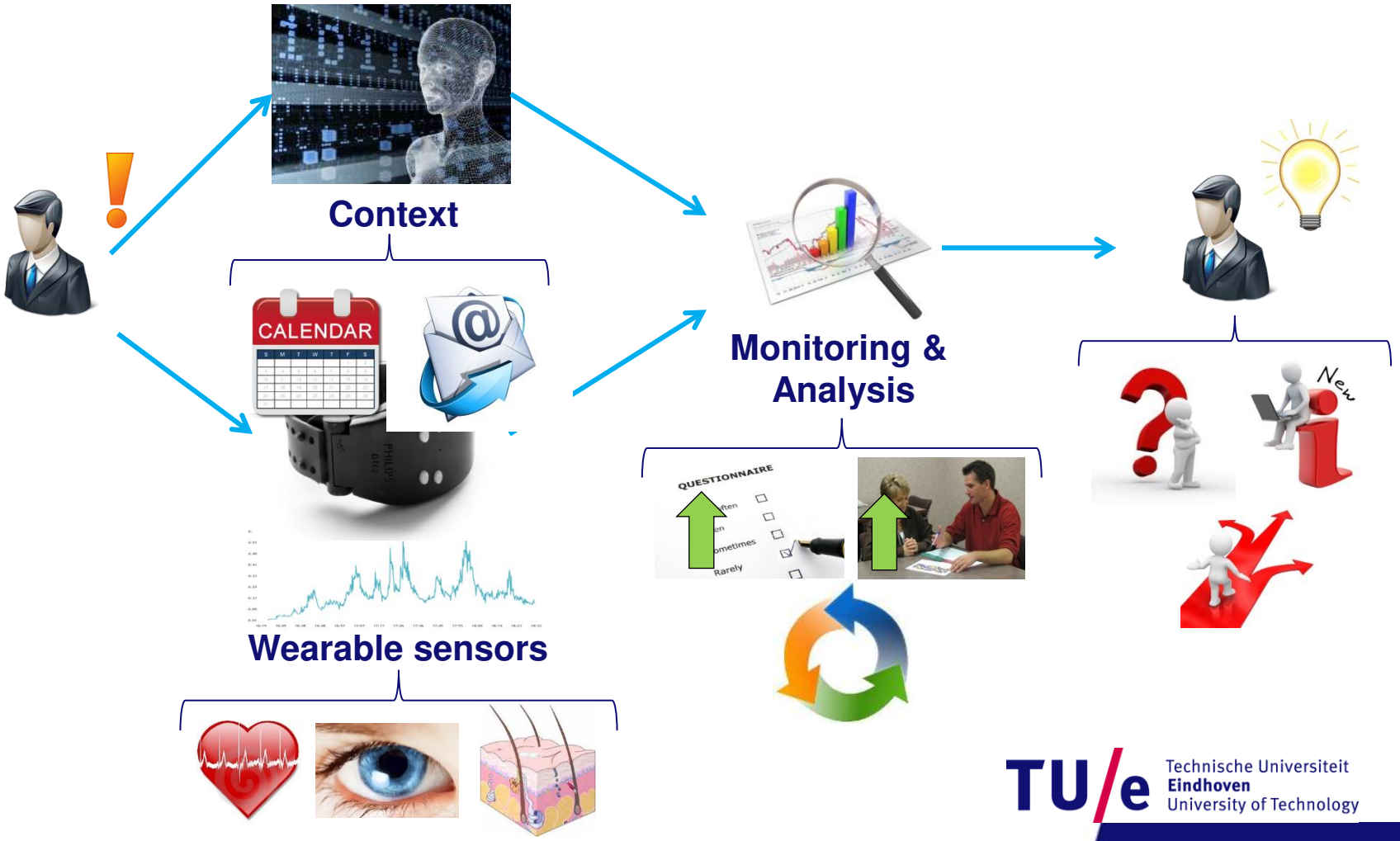
Research problem



Current approaches



Our approach



Approach implementation

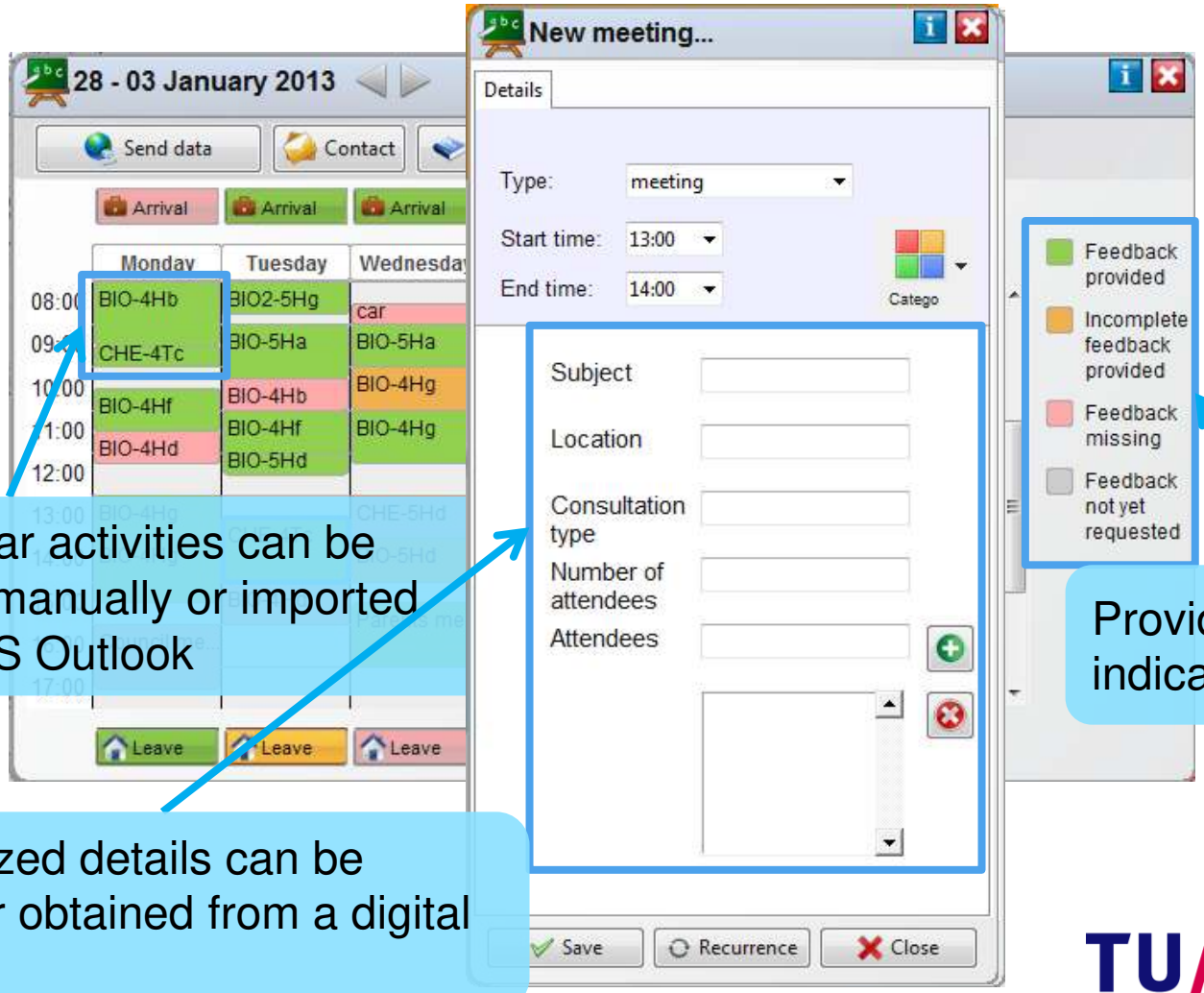
Wearable sensor

Discrete Tension Indicator (DTI-2)*

- accelerometers
- skin conductivity
- skin temperature
- ambient temperature
- ambient illumination

* J. Westerink et al. "*Emotion measurement platform for daily life situations*", ACII 2009

Calendar application

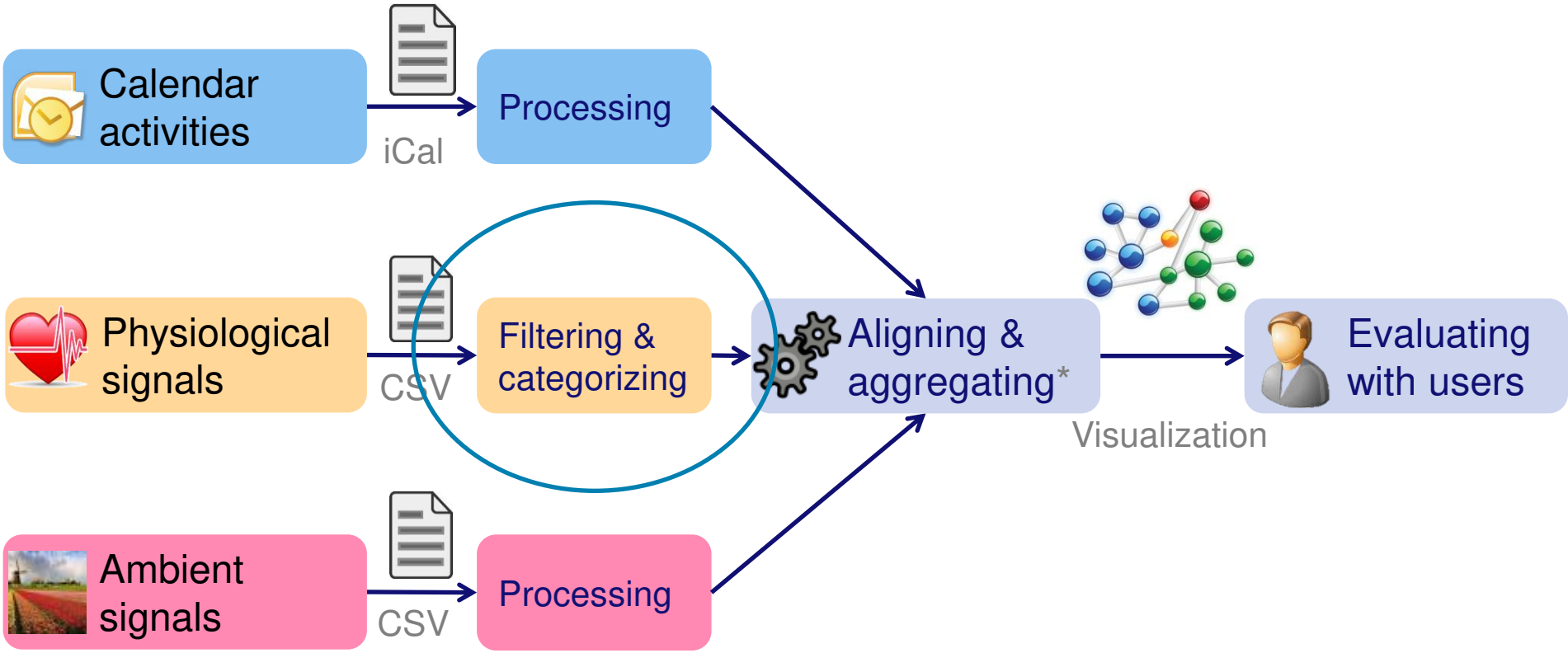


Calendar activities can be added manually or imported from MS Outlook

Customized details can be added or obtained from a digital calendar

Provided feedback is indicated with colors

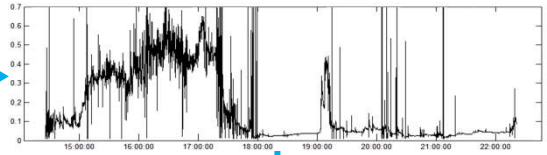
From raw data to useful information



* R. Kocielnik et al. „*Enabling self-reflection with LifelogExplorer: Generating simple views from complex data*", PervasiveHealth 2013

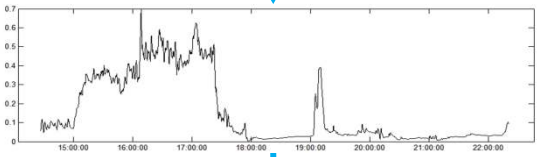
Data Analysis

Analysis of GSR



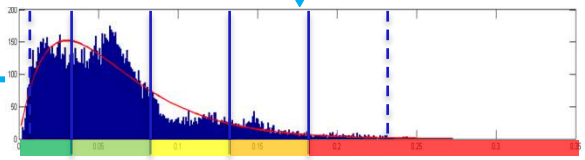
Raw GSR

Filtering & smoothing



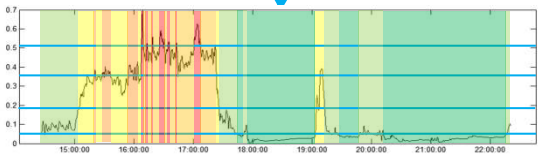
Filtered & smoothed GSR

Aggregating



Histogram over all measurements

Discretizing into arousal labels



GSR with arousal labels

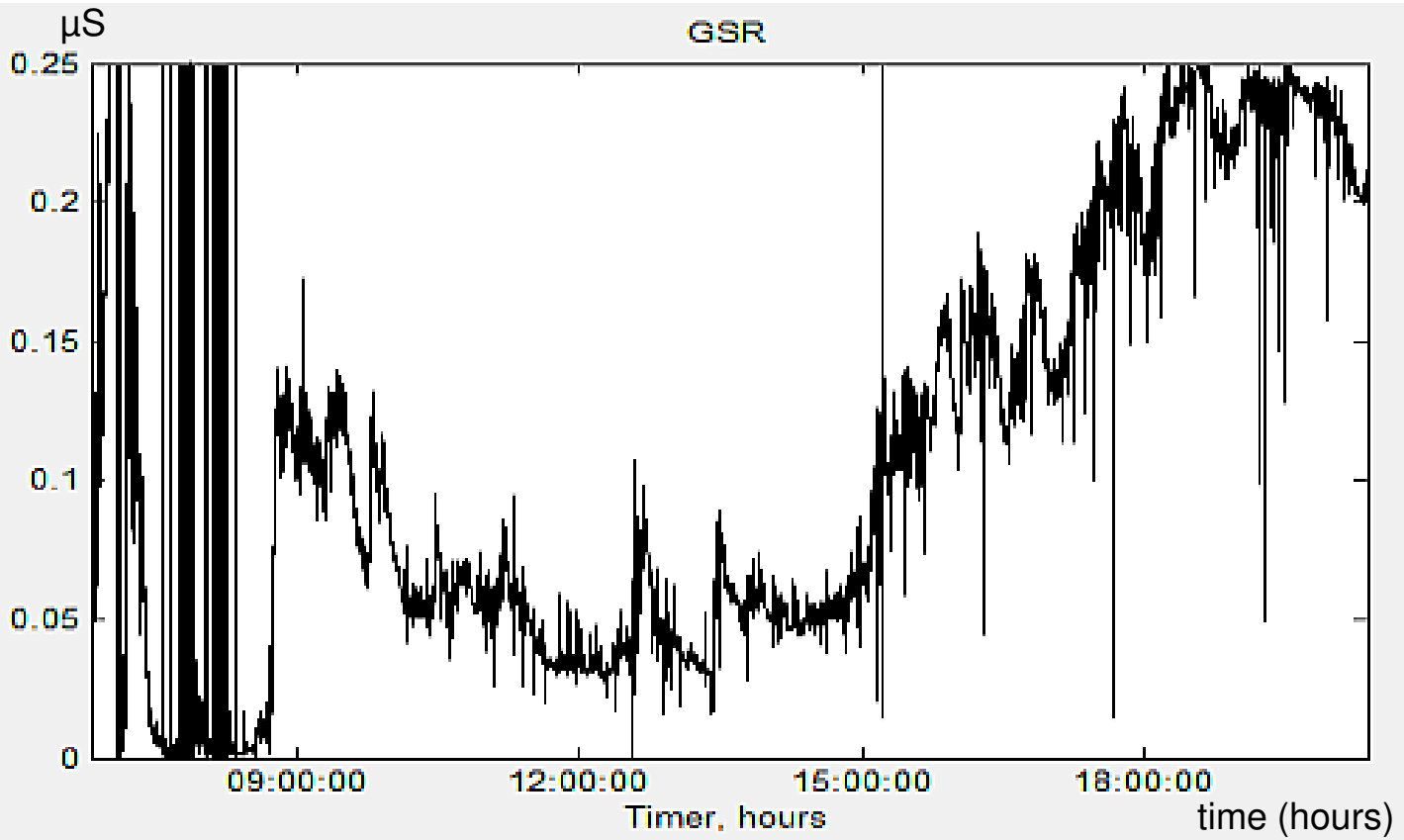
Technische Universiteit Eindhoven University of Technology

GSR processing - example

Filtering

Smoothing

Discretizing



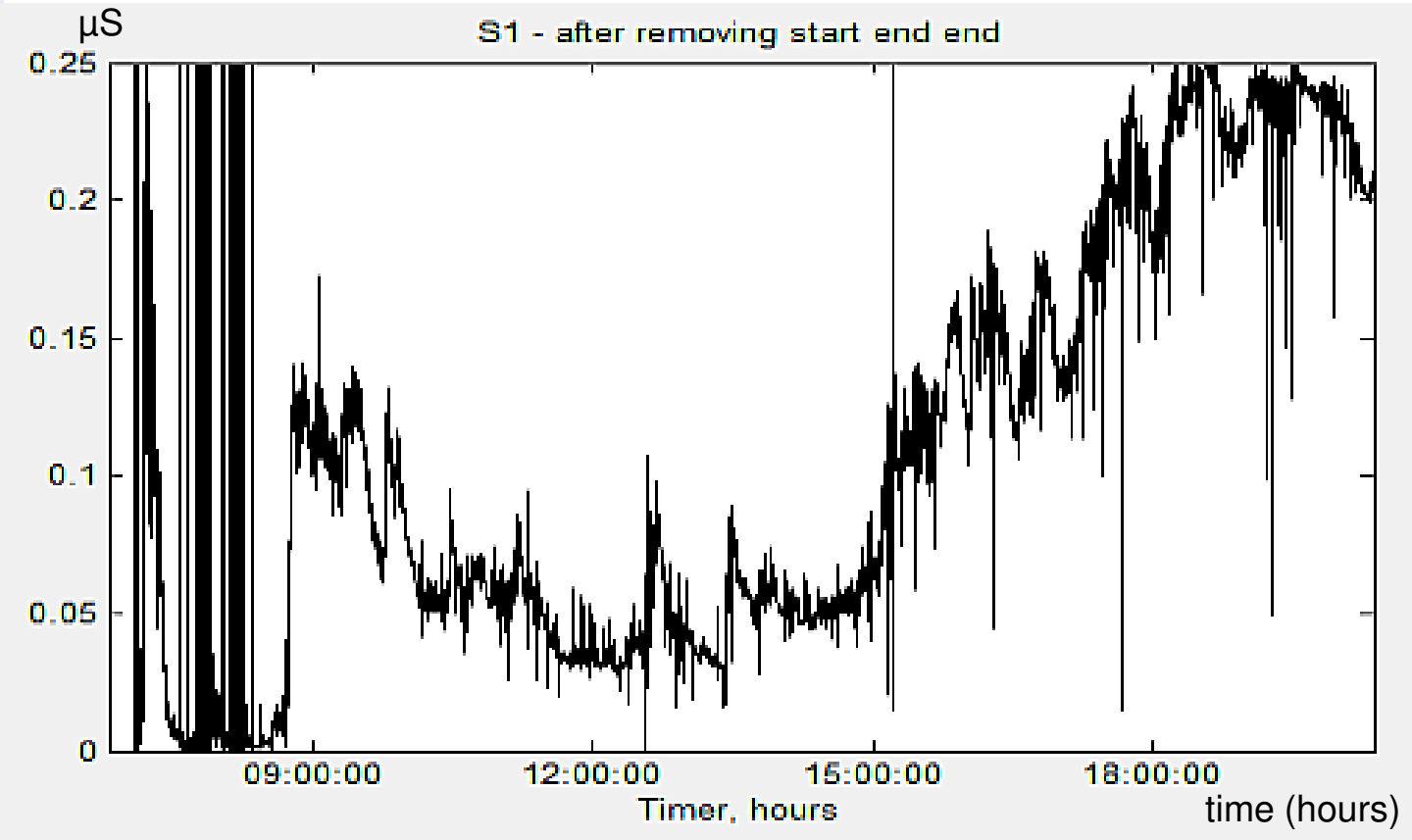
GSR processing - example

Trim signal

Filtering

Smoothing

Discretizing



GSR processing - example

Filtering

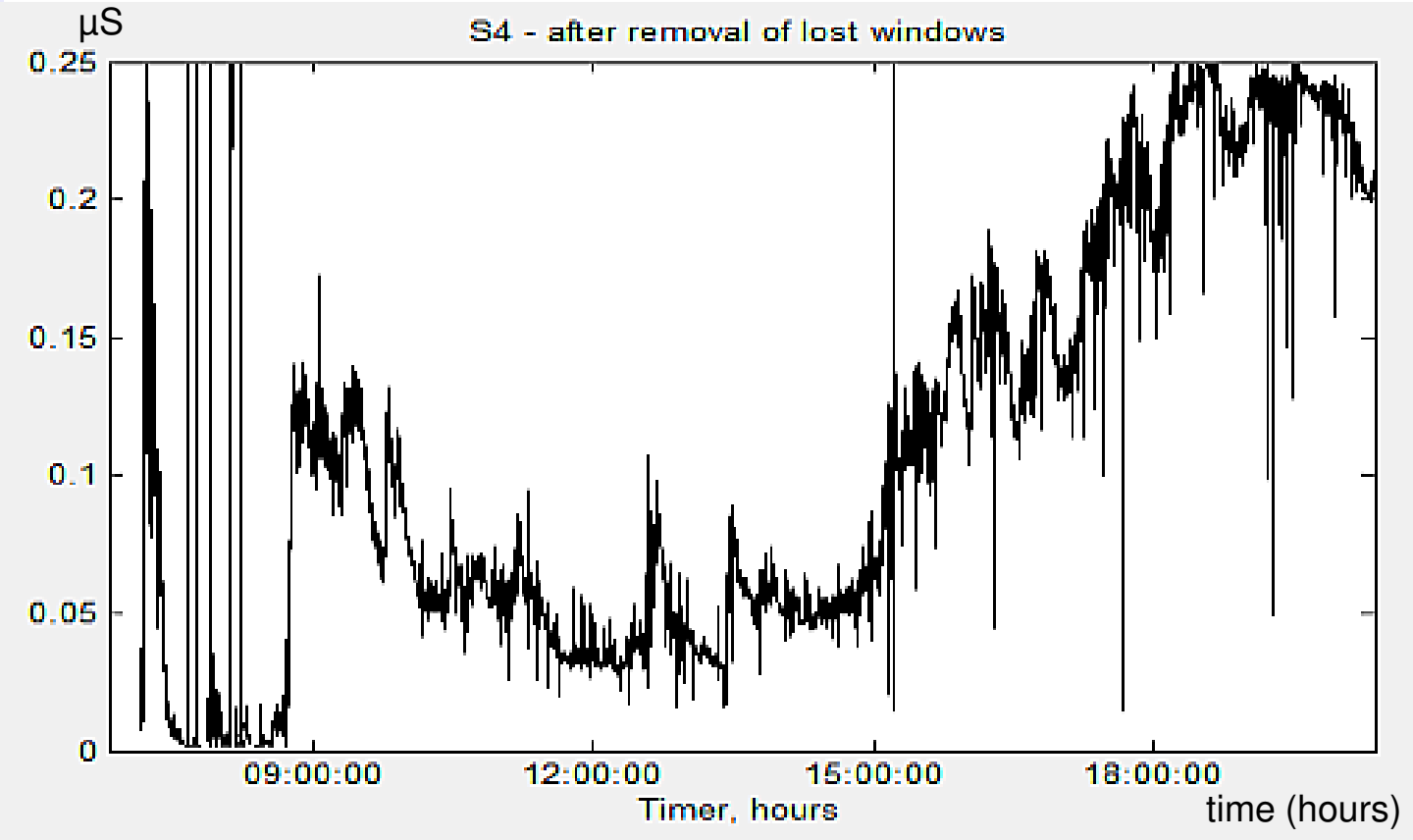
Trim signal

↓

Remove lost signal

Smoothing

Discretizing



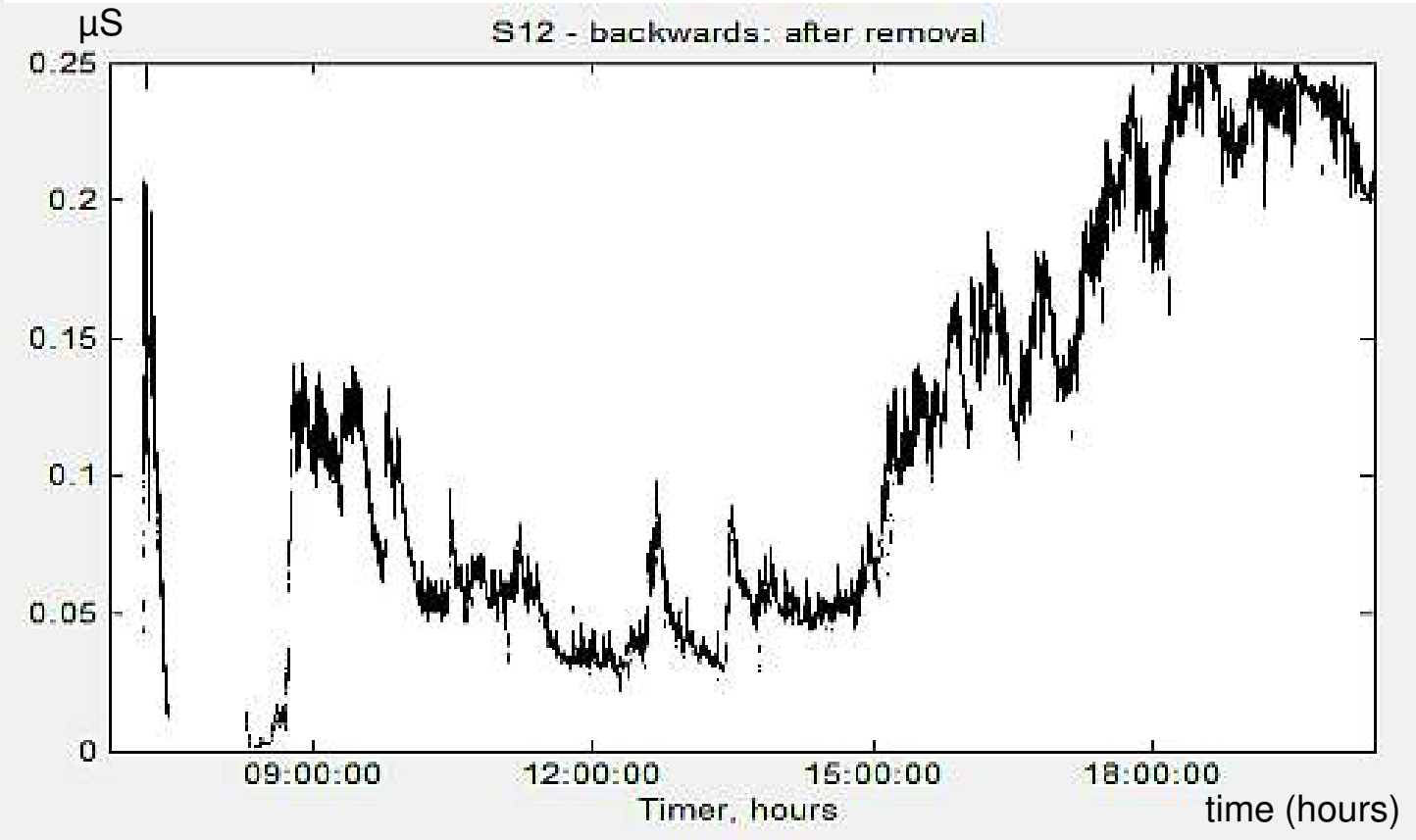
GSR processing - example

Filtering

- Trim signal
- Remove lost signal
- Remove anomalies

Smoothing

Discretizing



GSR processing - example

Filtering

Trim signal

↓

Remove lost signal

↓

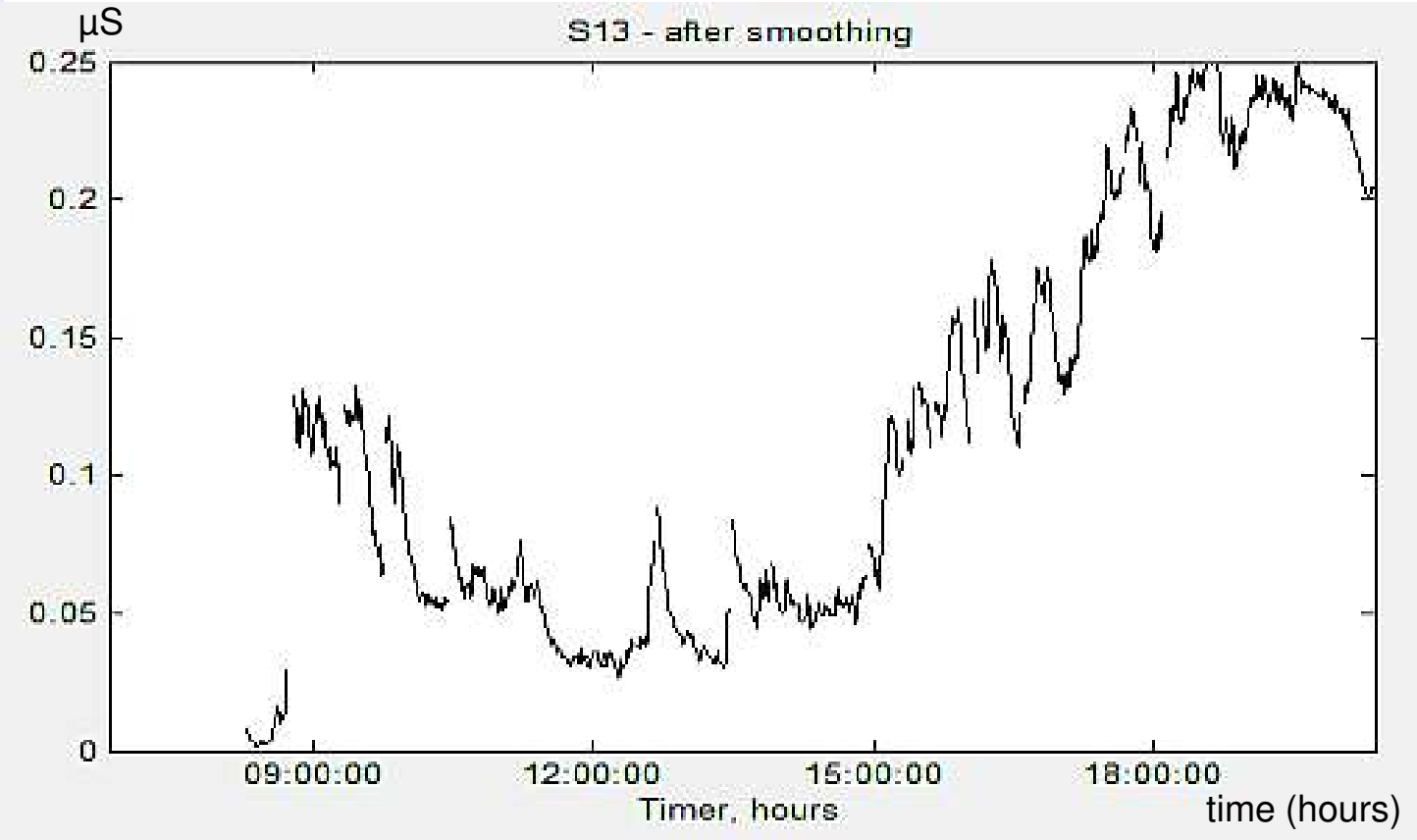
Remove anomalies

↓

Smoothing

Apply moving median

Discretizing



GSR processing - example

Filtering

Trim signal

Remove lost signal

Remove anomalies

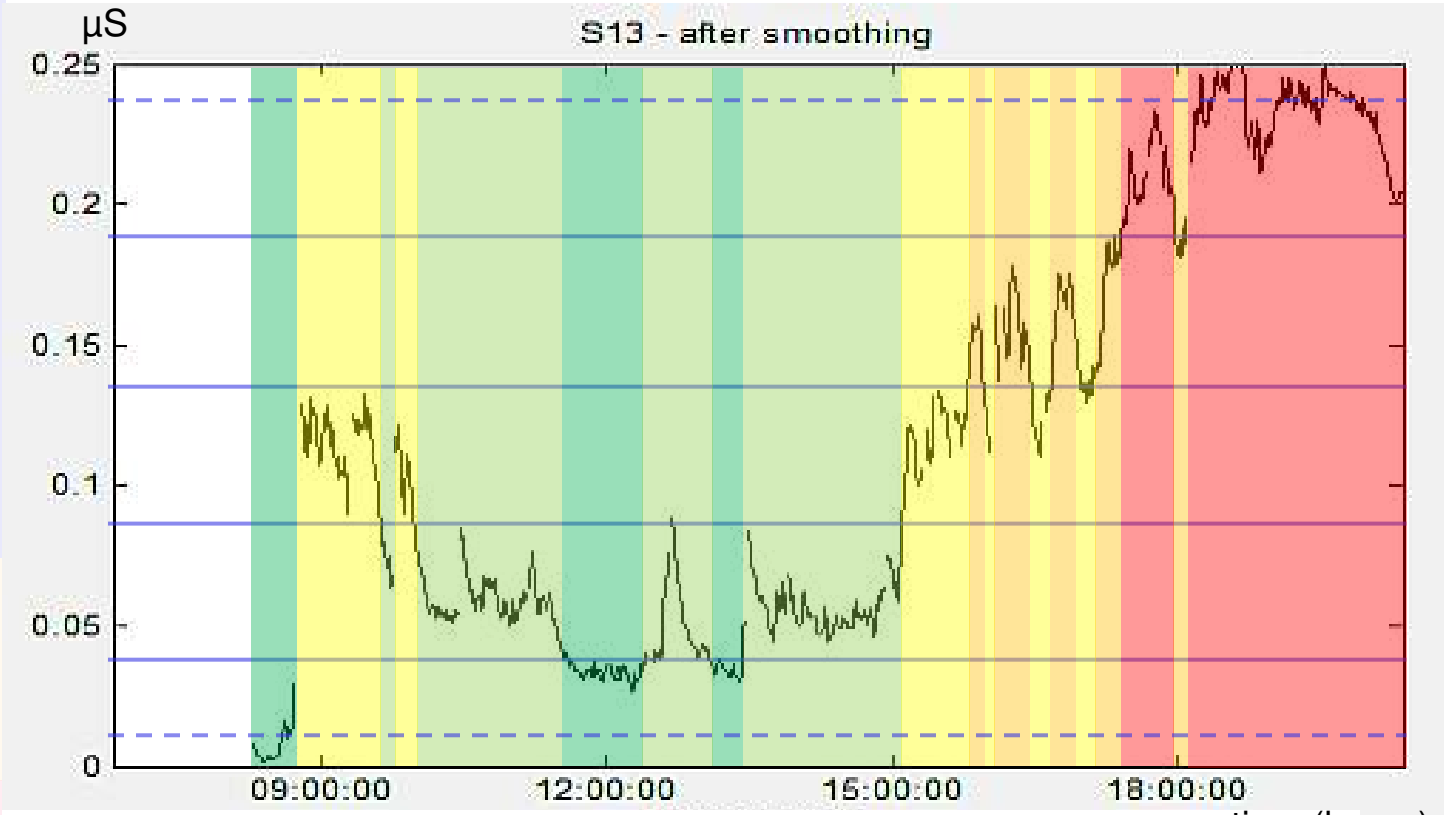
Smoothing

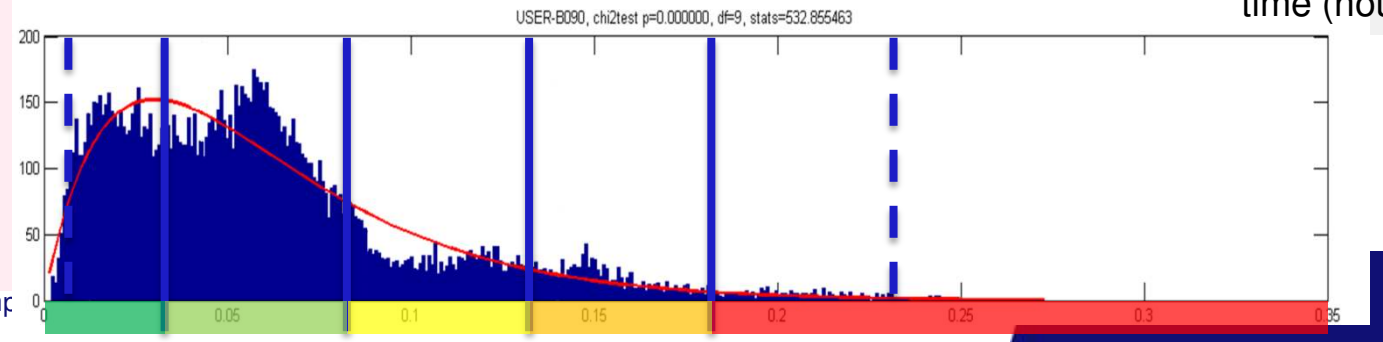
Apply moving median

Discretizing

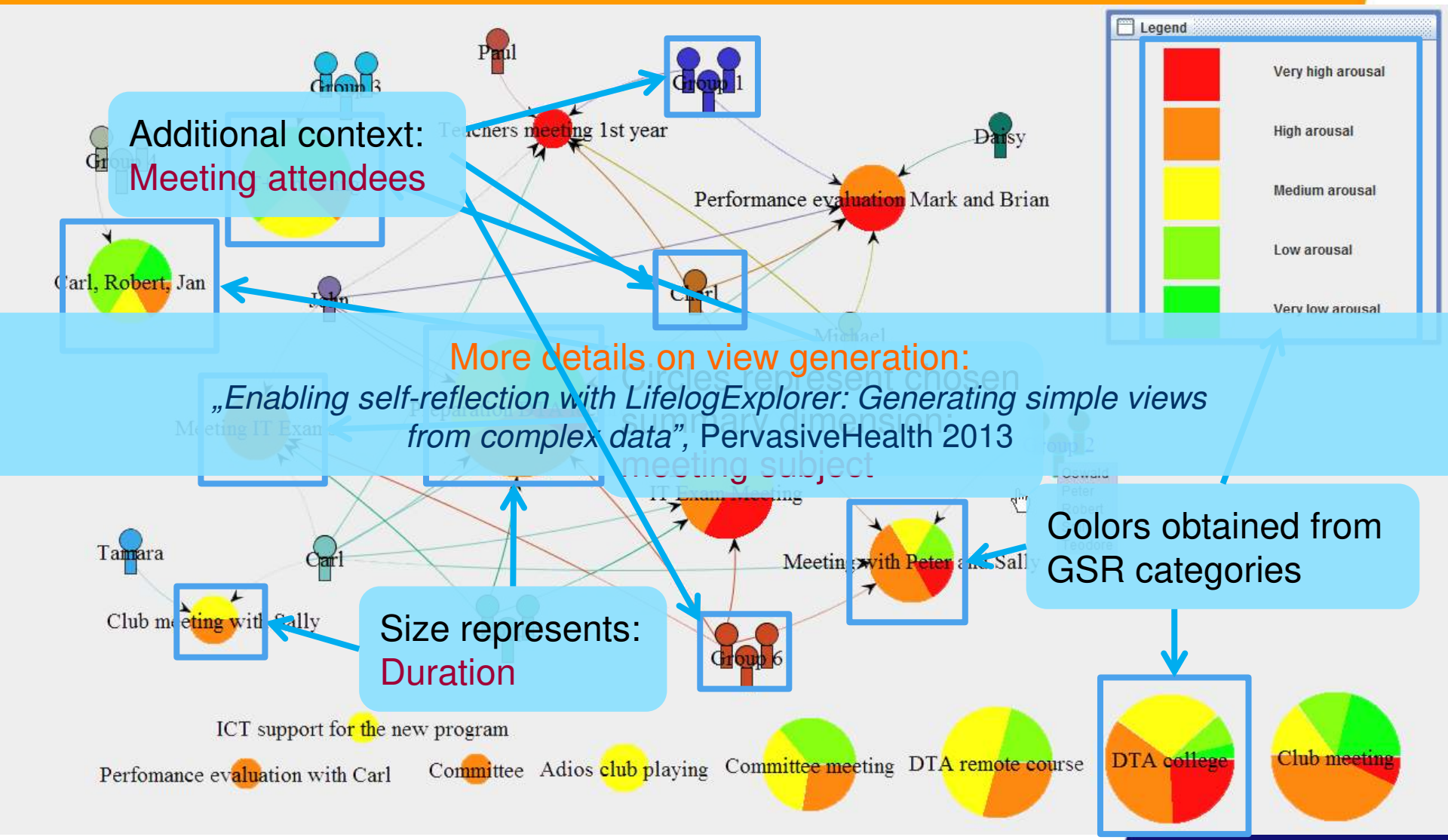
Define slicing

Categorize





Example view



Evaluation

Case study

University staff members

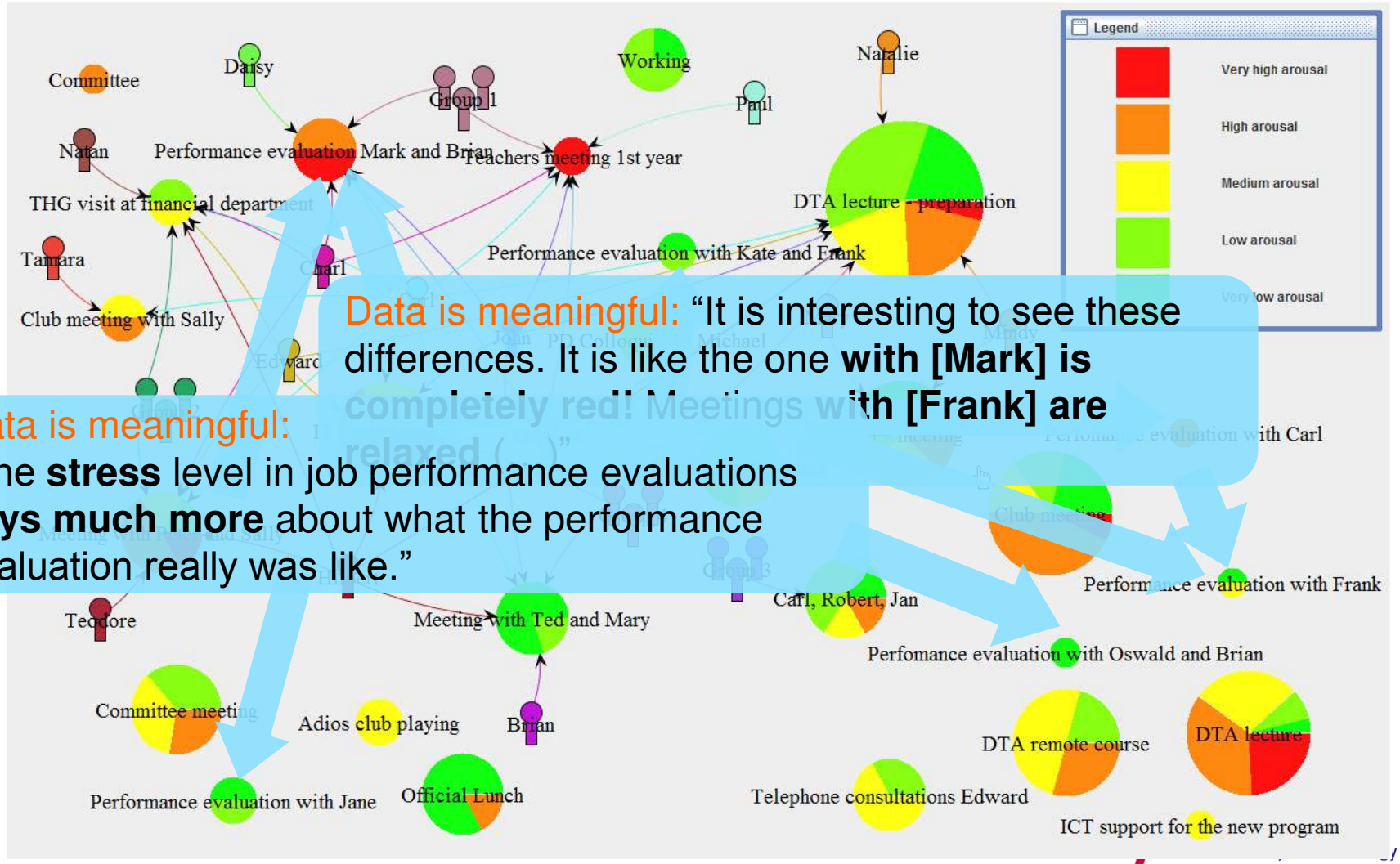
Study with university staff members

- 9 employees
- 7 weeks of data on average
- Calendar activities extracted from Outlook
  (188 entries on average, 44% with measurements)

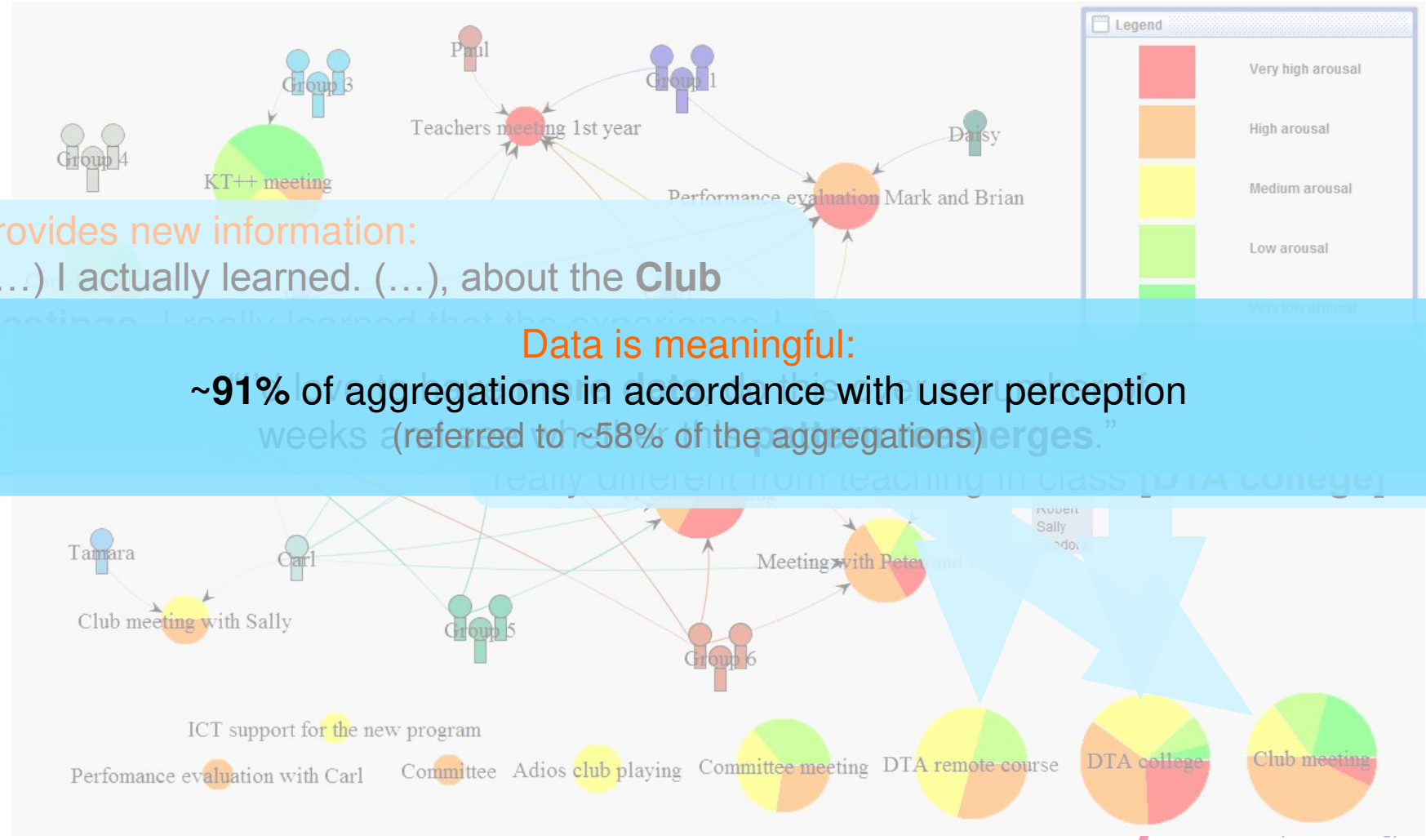
Evaluation

- Presented 6 different views
- Semi-structured interviews (purely qualitative)
  - Talk-aloud protocol
  - Specific, open questions about the views

Results


Committee
Daisy
Group 1
Working
Natalie
Paul
Nanan
Performance evaluation Mark and Brian
Teachers meeting 1st year
THG visit at financial depart
DTA lecture - preparation
Tamara
Performance evaluation with Kate and Frank
Club meeting with Sally
Legend
Very high arousal
High arousal
Medium arousal
Low arousal
Very low arousal
Data is meaningful: "It is interesting to see these differences. It is like the one **with [Mark] is** **completely red!** Meetings **with [Frank] are** **relaxed**"
Data is meaningful:
"The **stress** level in job performance evaluations **says much more** about what the performance evaluation really was like."
Teodore
Meeting with Ted and Mary
Carl, Robert, Jan
Perfomance evaluation with Oswald and Brian
Committee meeting
Adios club playing
Brian
DTA remote course
DTA lecture
Performance evaluation with Jane
Official Lunch
Telephone consultations Edward
ICT support for the new program

Results



Provides new information:

"(…) I actually learned. (…), about the **Club**

Data is meaningful:

~91% of aggregations in accordance with user perception

(referred to ~58% of the aggregations)

Conclusions

Real time recording of **bodily responses** is feasible **in real life** conditions

Arousal information with context:

- Is **meaningful**
- Provides **new information**
- Triggers actionable **self-advices**

The results of long-term monitoring:

- Can be used **directly by the person**
- Can serve as **input for consultation** with psychologist

Future work

Improving analysis

Including other **influence factors** on GSR:

- temperature
- physical activity

Adding more **context information**:

- social media (sentiment analysis)
- e-mails
- GPS location

Further use of the information

Measuring **short-term** and **long-term effectiveness** of coping

Suggestion of coping strategies based on measurements

Acknowledgements

PHILIPS

Thank you for listening

Any questions?