



## Stress@work

*What's your current stress level?*

*Detection of stress patterns from GSR sensor data*

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<http://www.win.tue.nl/stressatwork>

# Outline

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- What is stress?
- Acute stress detection as drift detection
- Preliminary experimental results
- Further work

# Impact of Stress at Work

**WHO:** by 2020 Top 5 diseases will be stress related.

**USA:** health care expenditures are ~50% greater for workers who report high levels of stress at work (J. Occup. Env. Med, 40:843-854).

**the Netherlands:** (TNO, 2006):

- The direct costs of stress are 4 billion Euro per year.
- Every year 150.000 – 300.000 employees become ill because of stress at work.
- 1 out of 7 disabled gets his condition because of stress at work.



# Parties Interested

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- Insurance companies
- Employers and employees
- Health and safety executives
- Medical specialists

# Types of Stress and Stressors

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## Three kinds of stress:

- Acute: caused by an acute short-term stress factor.
- Episodic acute: occurs more frequently & periodically.
- Chronic: caused by long-term stress factors - harmful.

## Factors causing stress@work:

- long work hours, work overload, time pressure, difficult, demanding or complex tasks, high responsibility, lack of breaks, lack of training
- conflicts, underpromotion, job insecurity, lack of variety, and poor physical work conditions (limited space, temperature and lighting conditions)

# It's Better to Prevent Than to Cure

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- Physical signals of acute stress can be observed:

- Skin conductivity
- Heart rate
- Facial expressions
- ...



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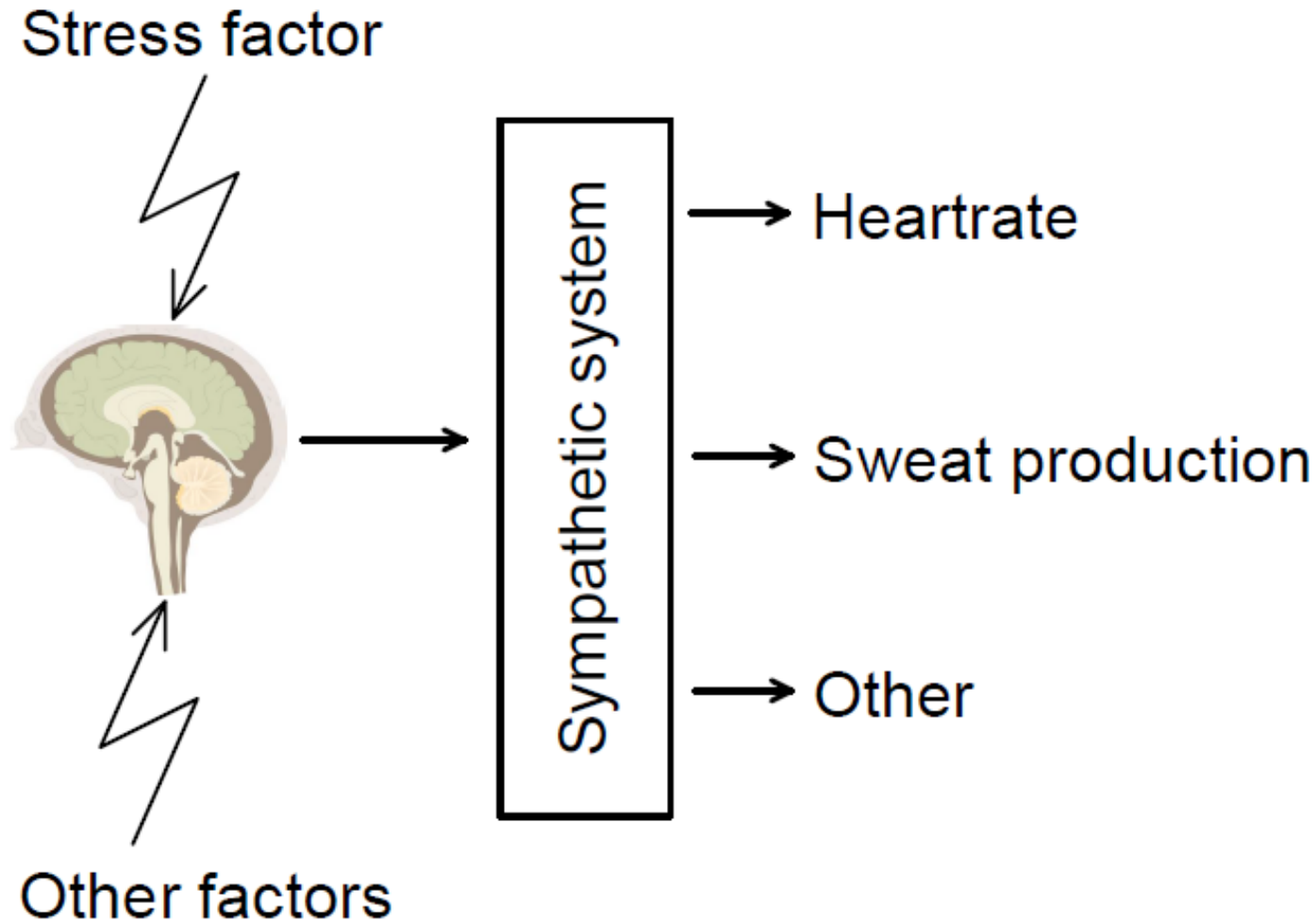
**Be-eep!**

You are getting stressed!

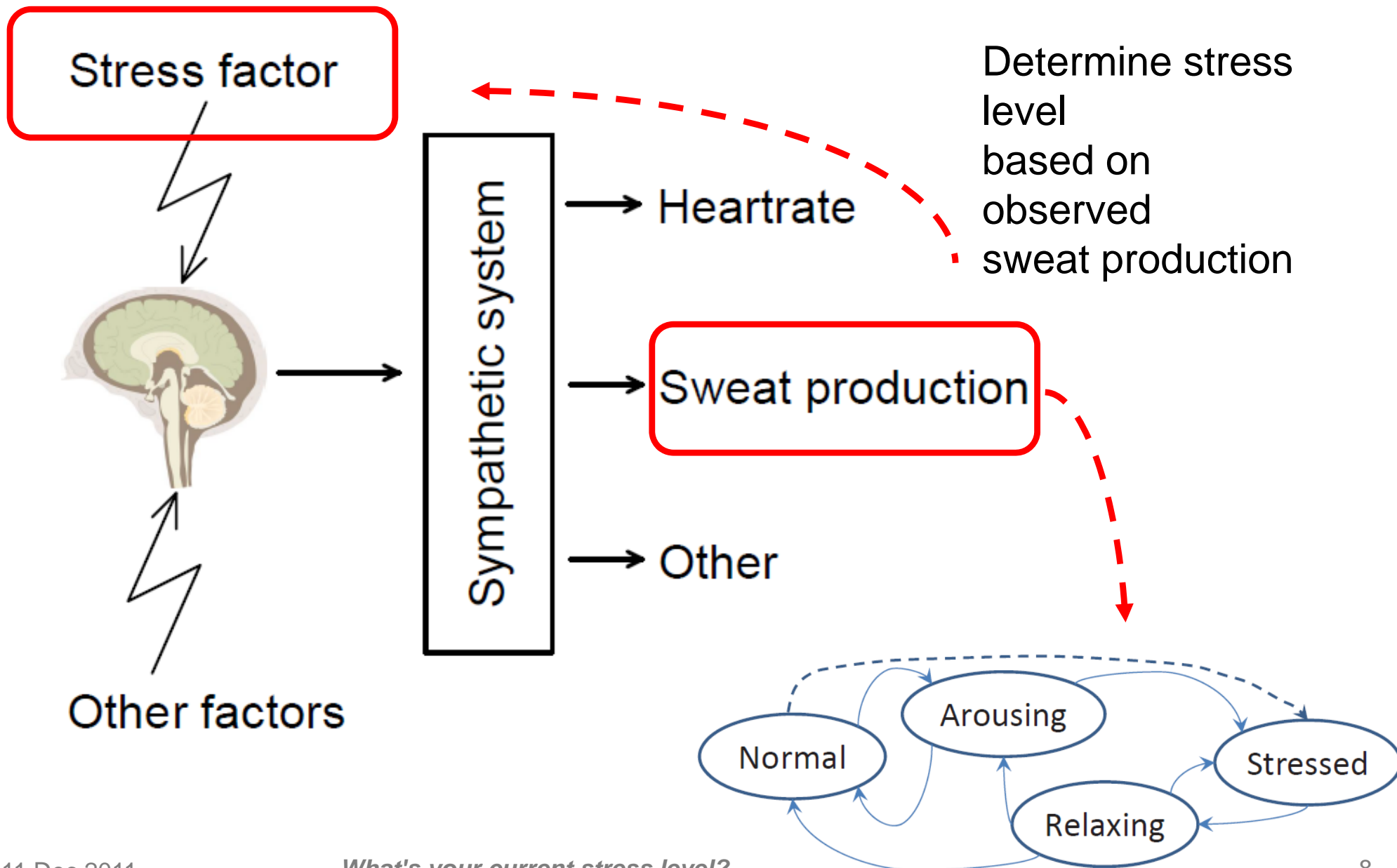
- Philips develops a device measuring and recording vital signs like skin conductivity (GSR) and heart rate, with a high frequency

# How to measure stress

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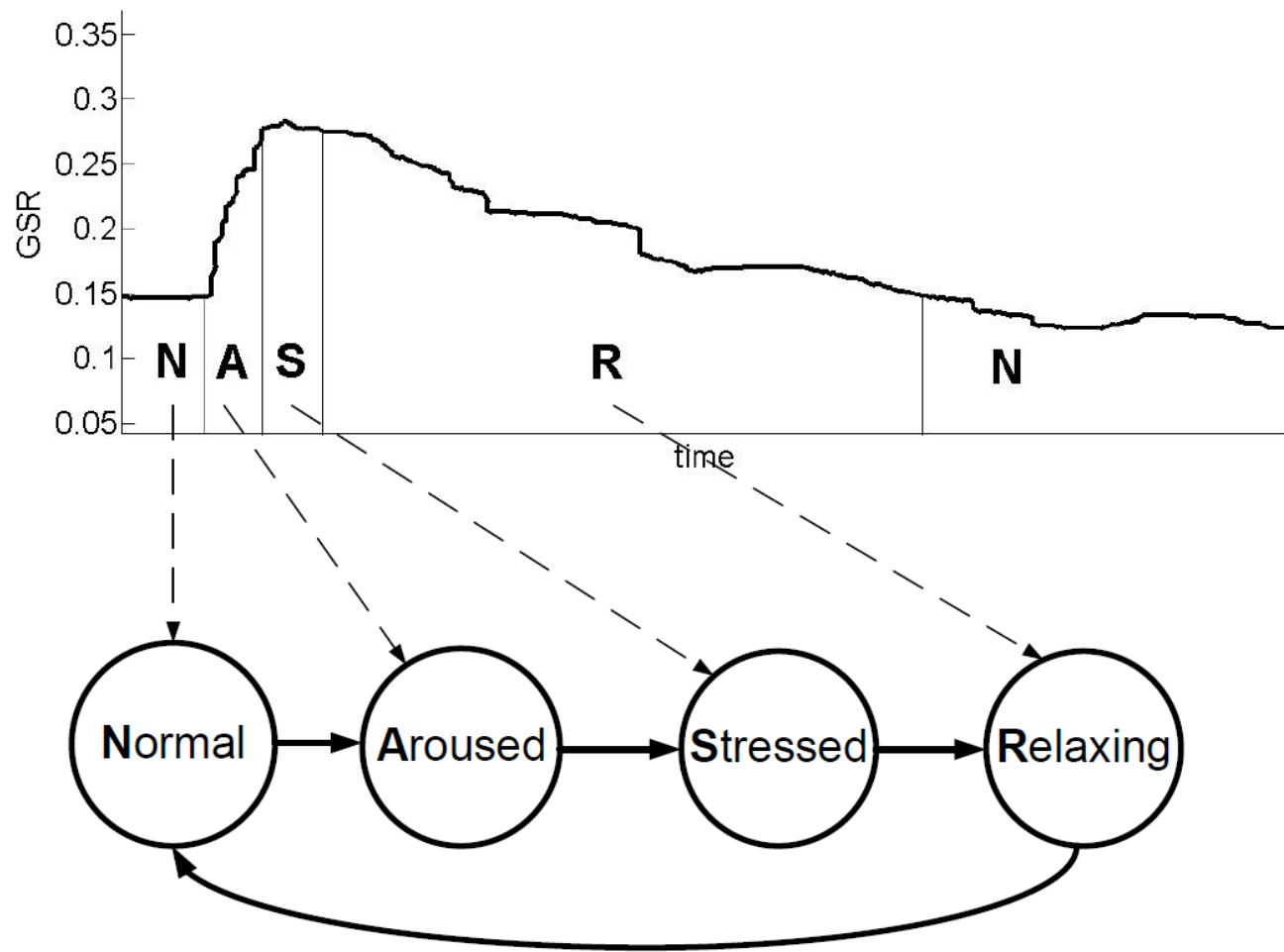


# How to measure stress



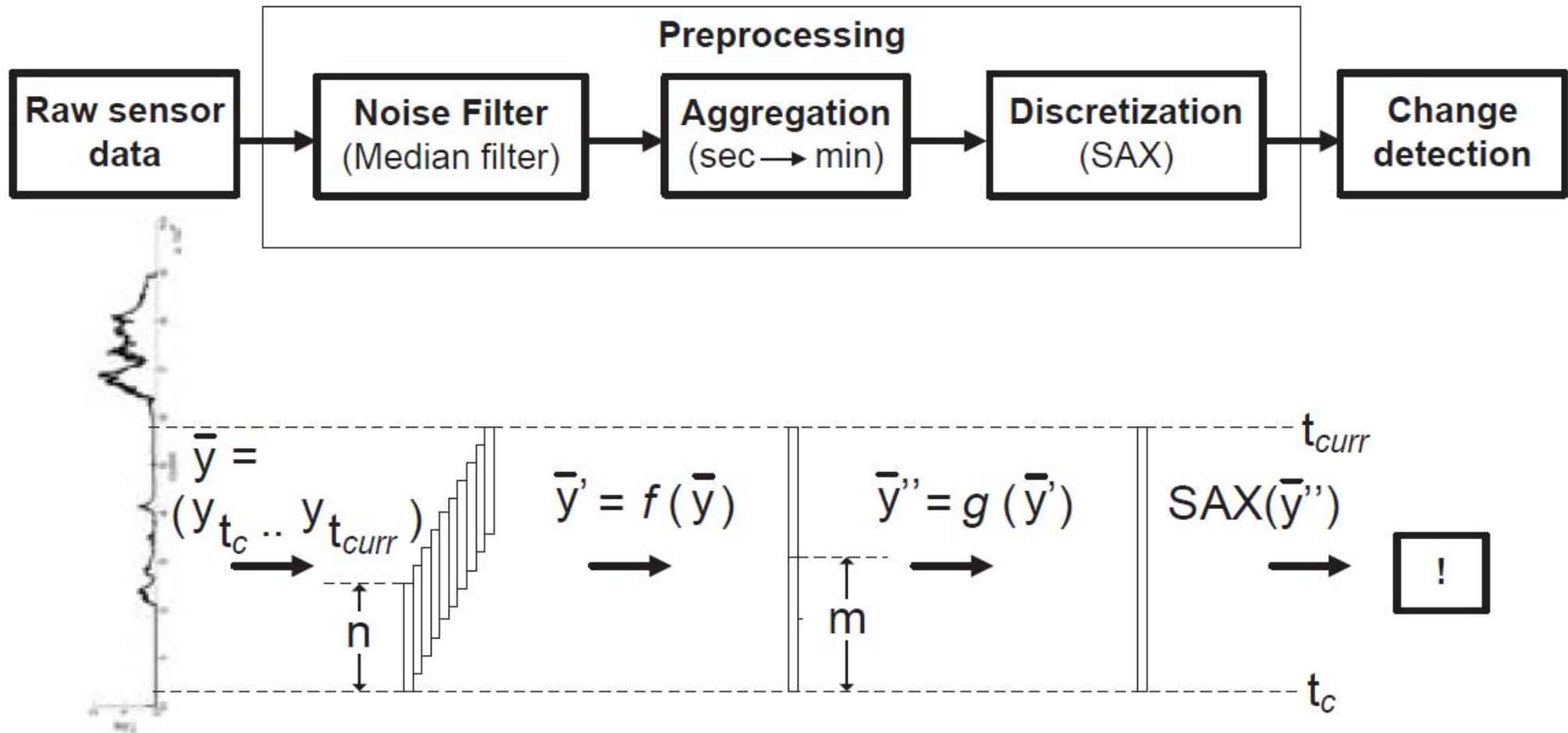
# Detection and Categorization of Stress

Based on GSR data alone - not as easy as the following figure may suggest:

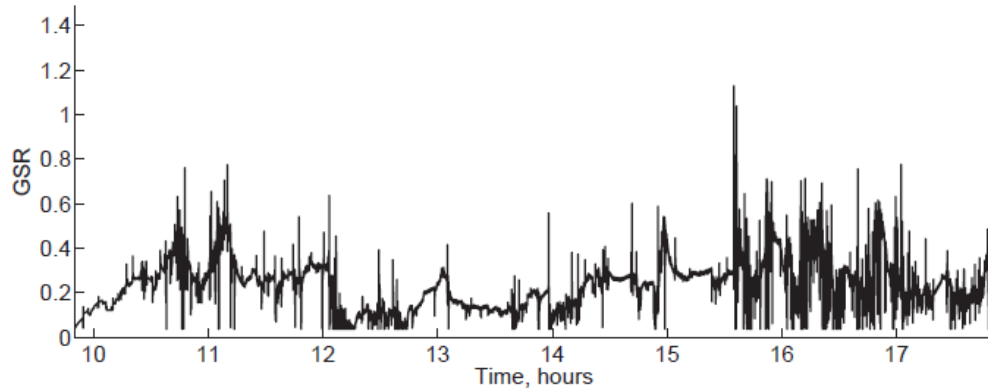


# Our current detection approach

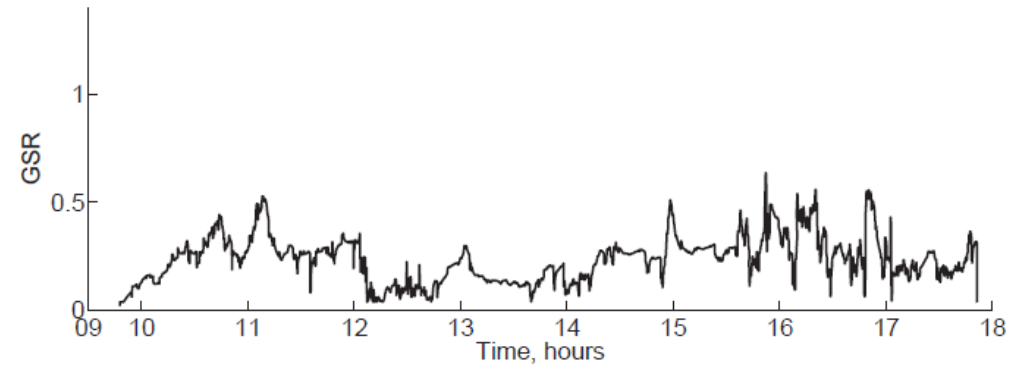
## Online settings



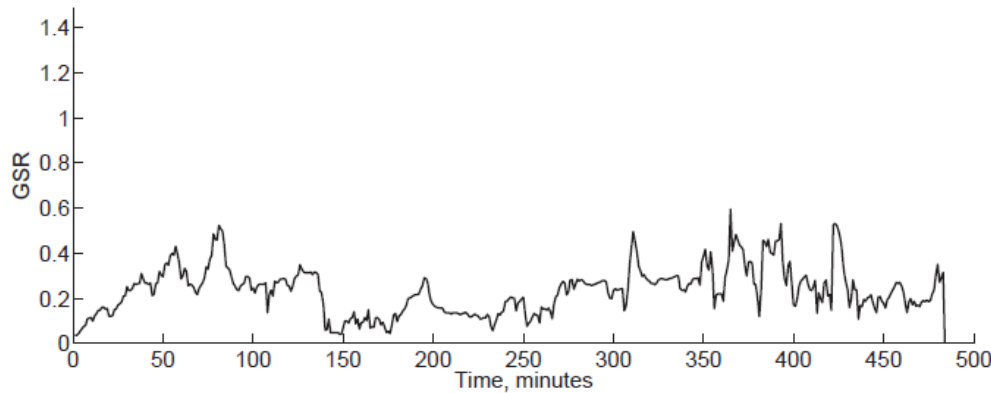
# Preprocessing steps



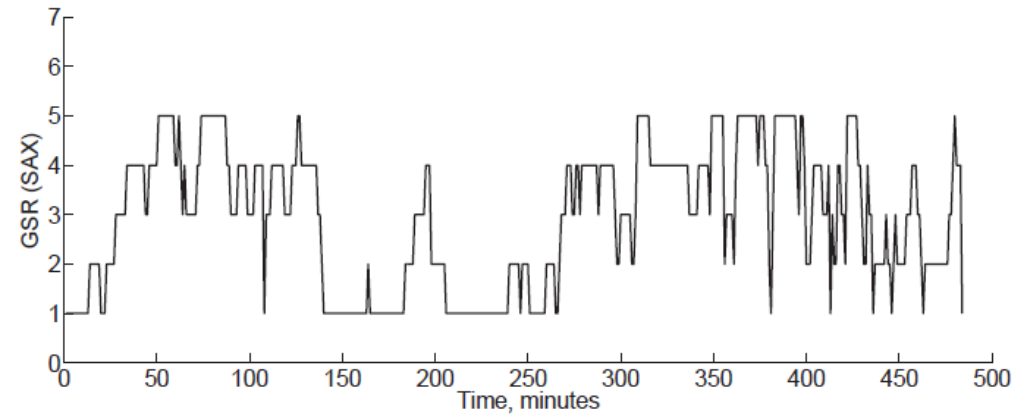
(a) Raw GSR signal



(b) Filtered GSR signal



(c) Aggregated GSR signal



(d) Discrete GSR data

# Experiment Setup

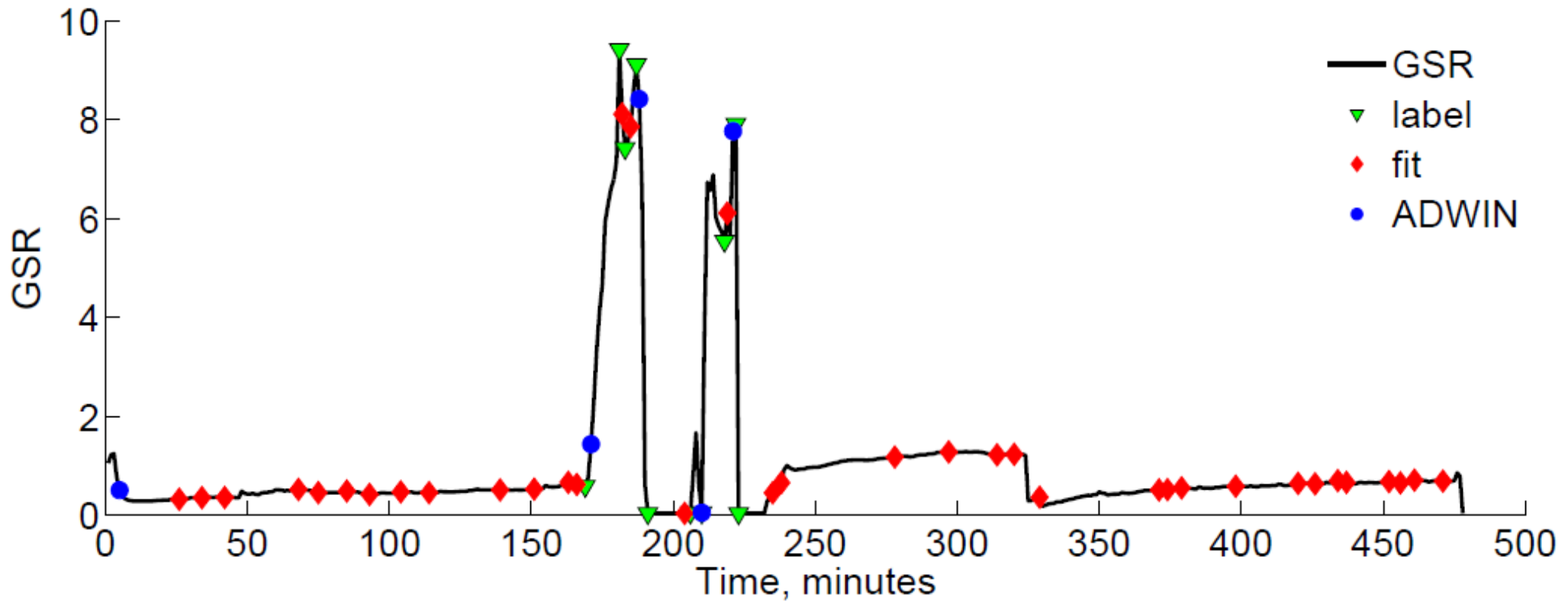
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## DATA SET SUMMARY.

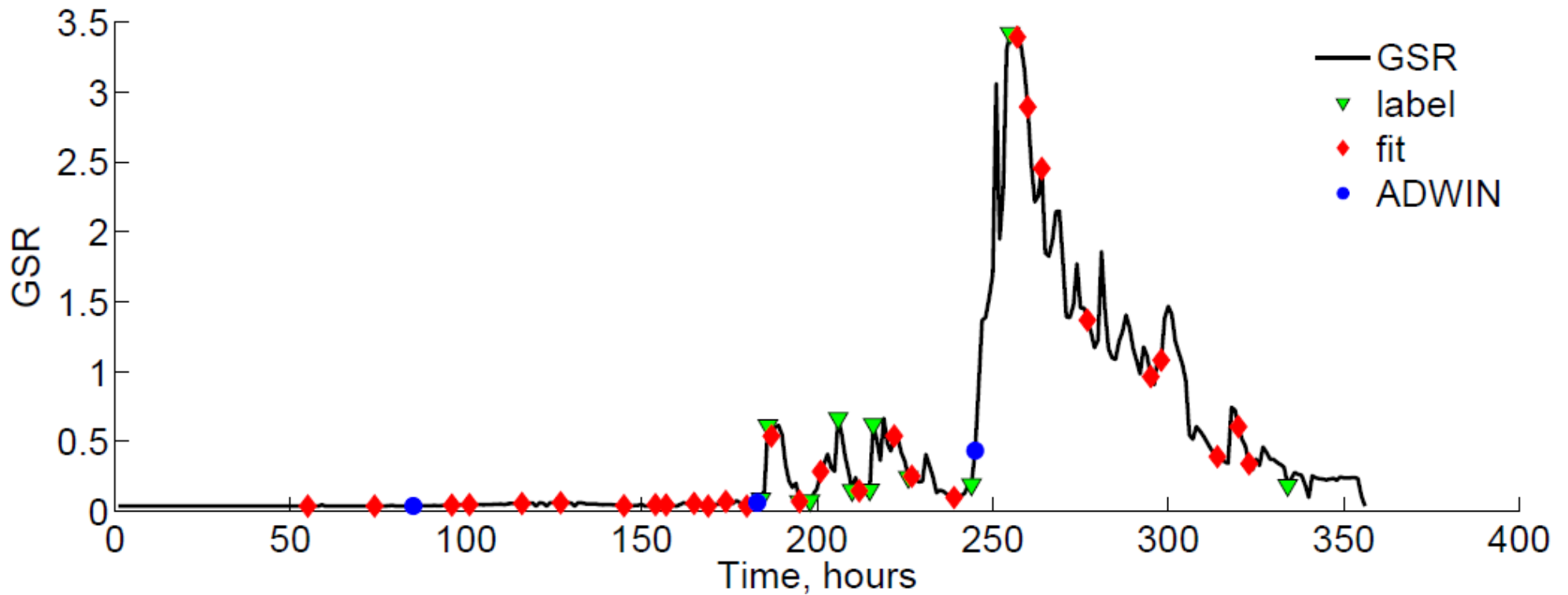
Number of users	5
Number of time series	72
Time series per user (mean)	14
Mean length (samples)	98721
Number of change points overall	368
Mean change points per series	6.5

- Change detection in online settings

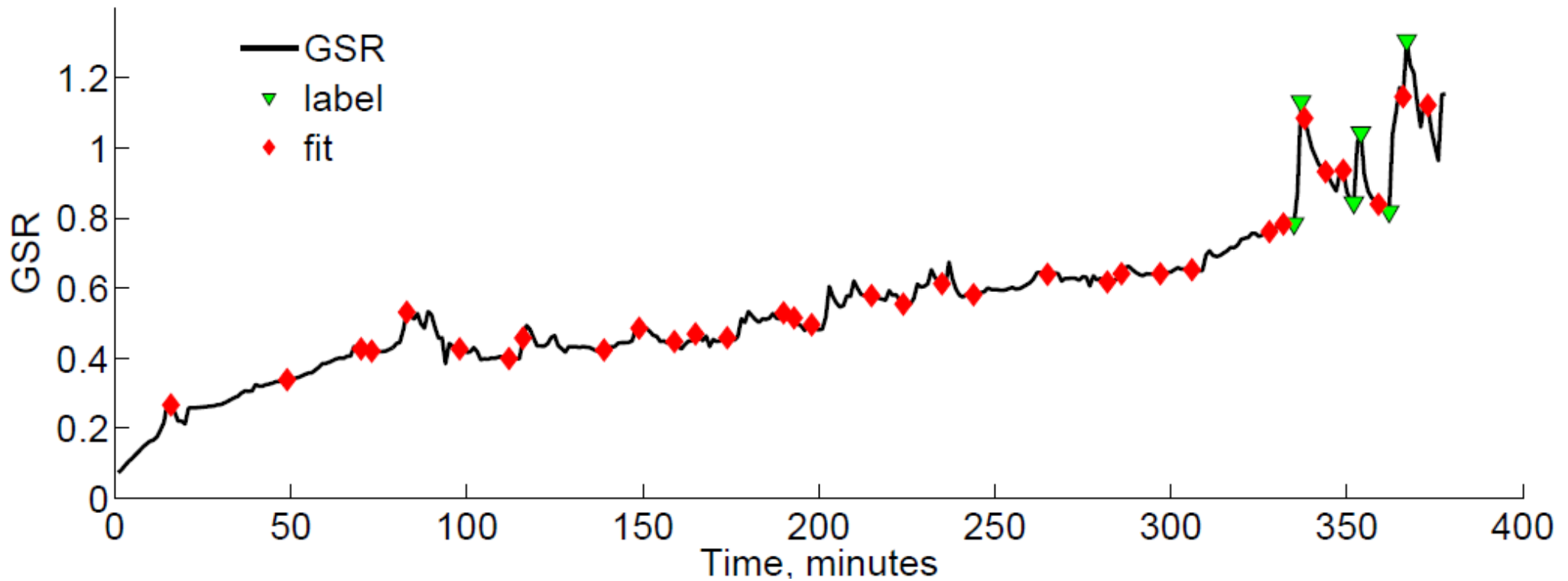
# Results



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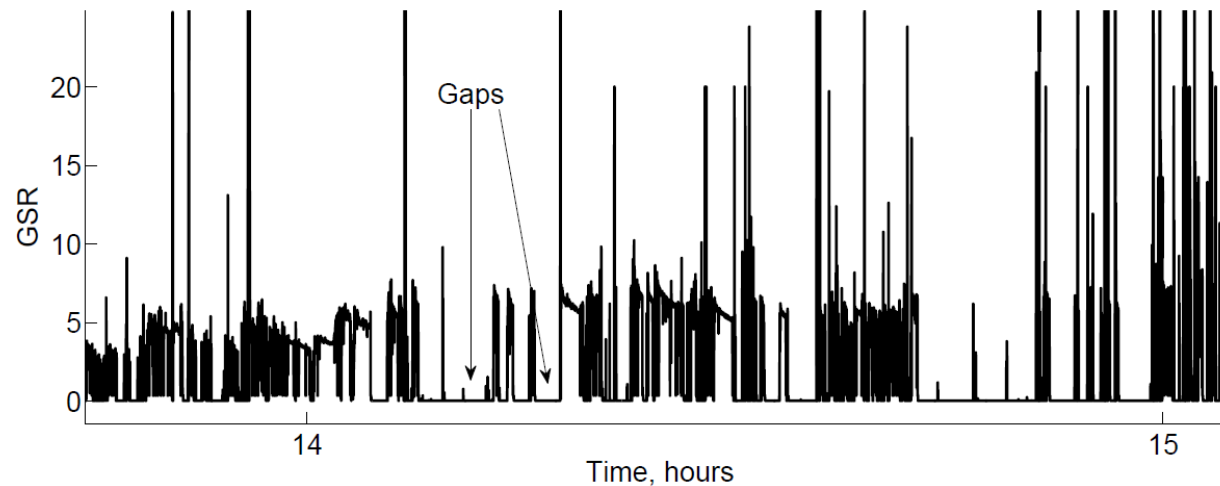


# Results

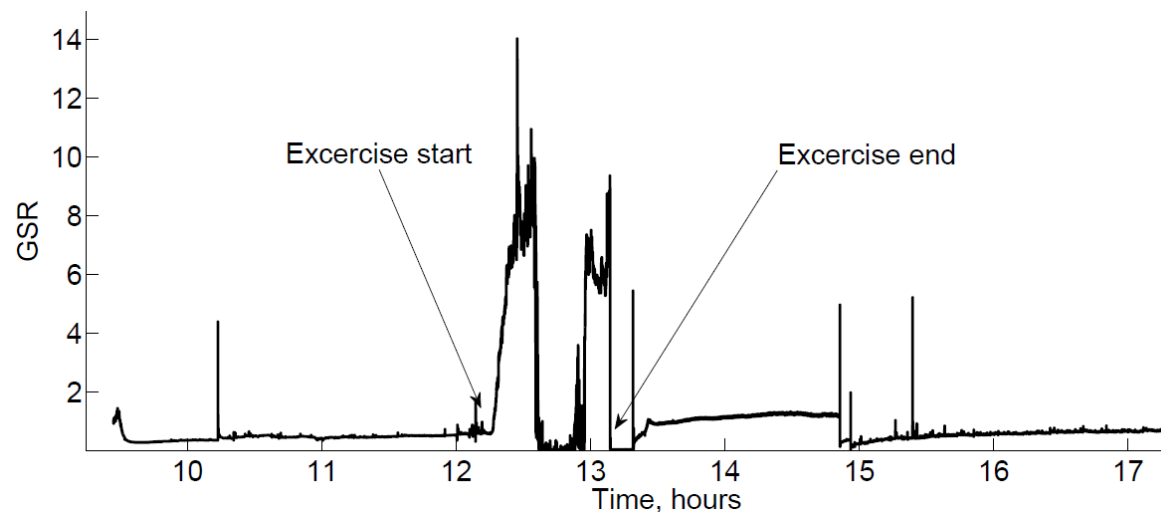


# Challenges in Stress Detection

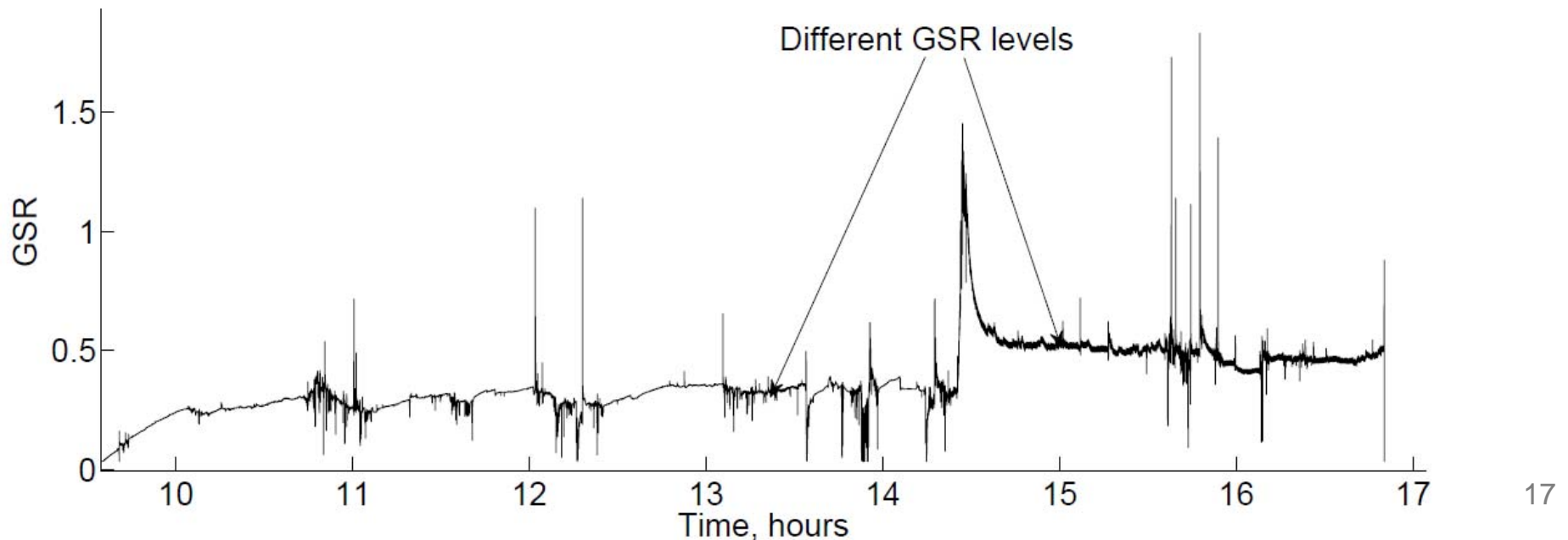
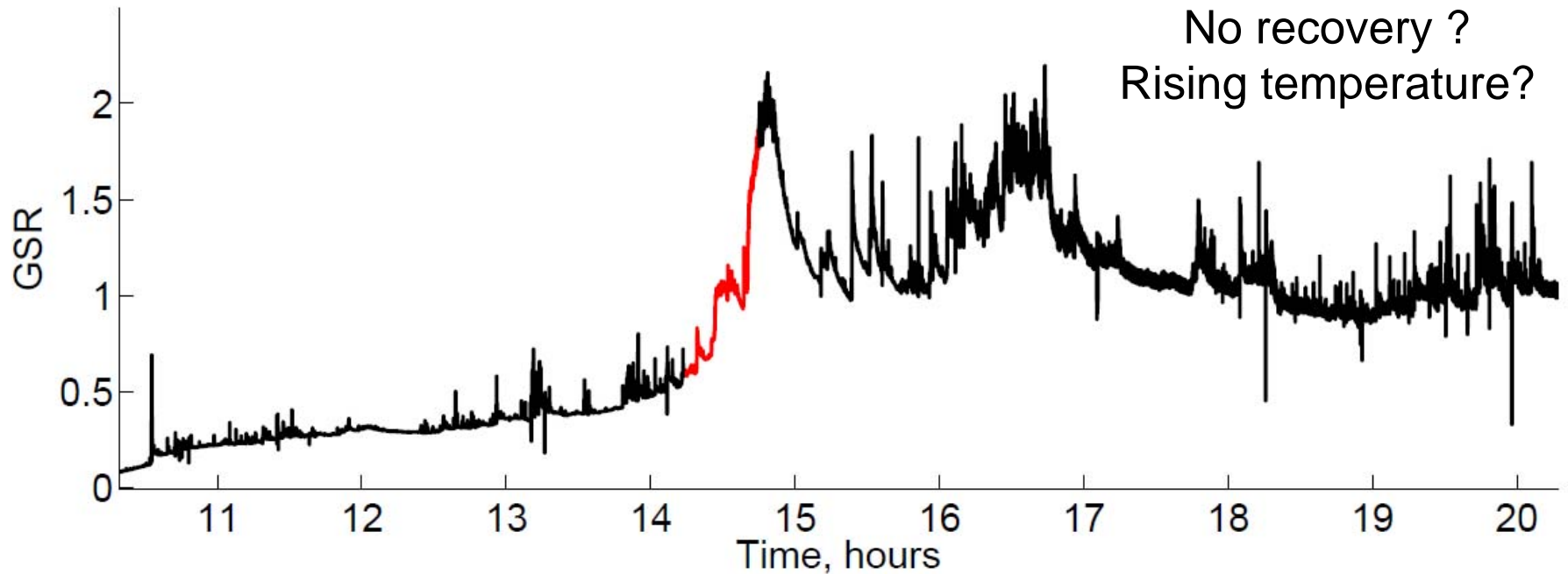
- All kinds of noise, e.g. loosing contact with the skin



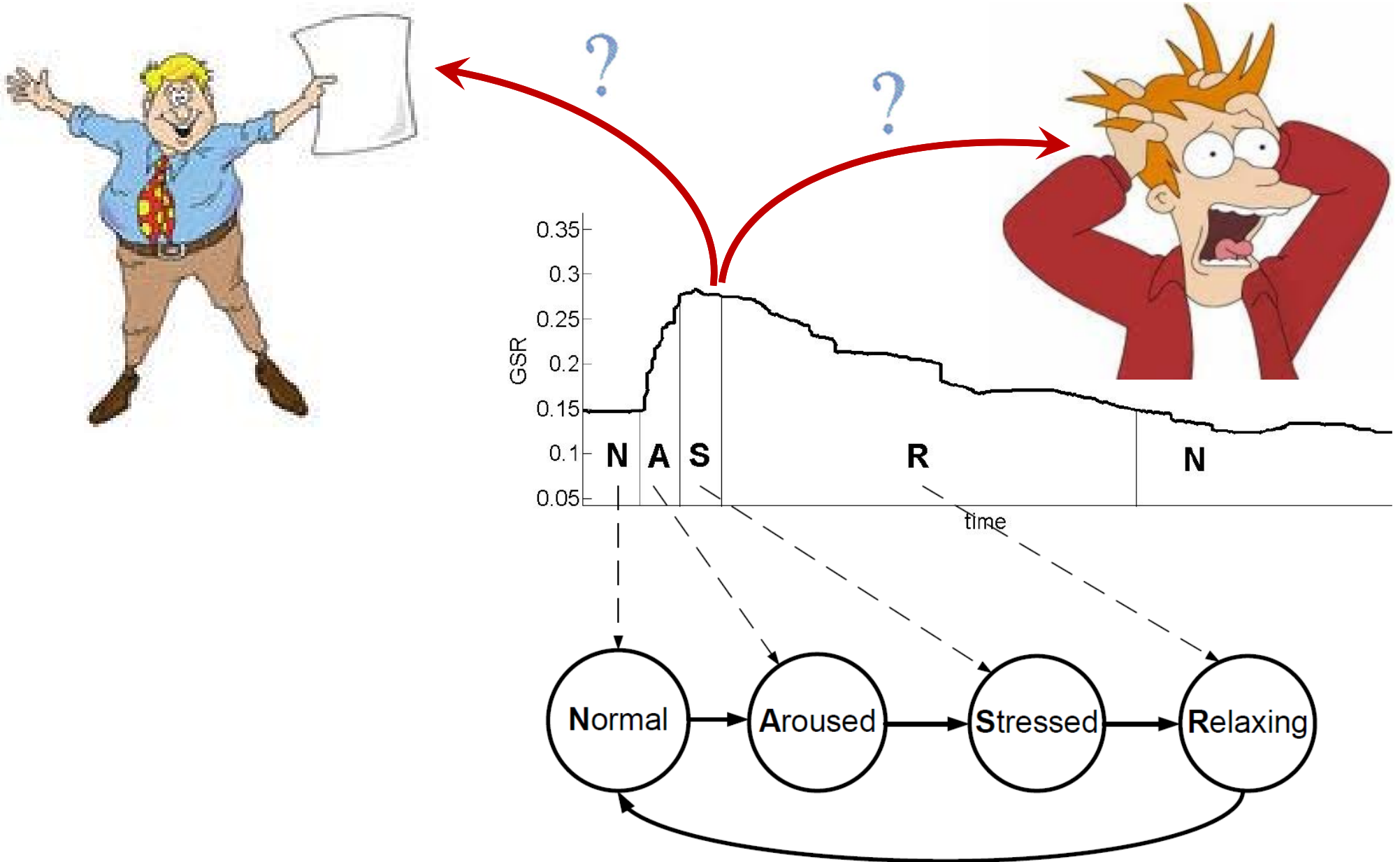
- Activity (exercising) , environment (cold/hot) context and personal differences may impact GSR we observe



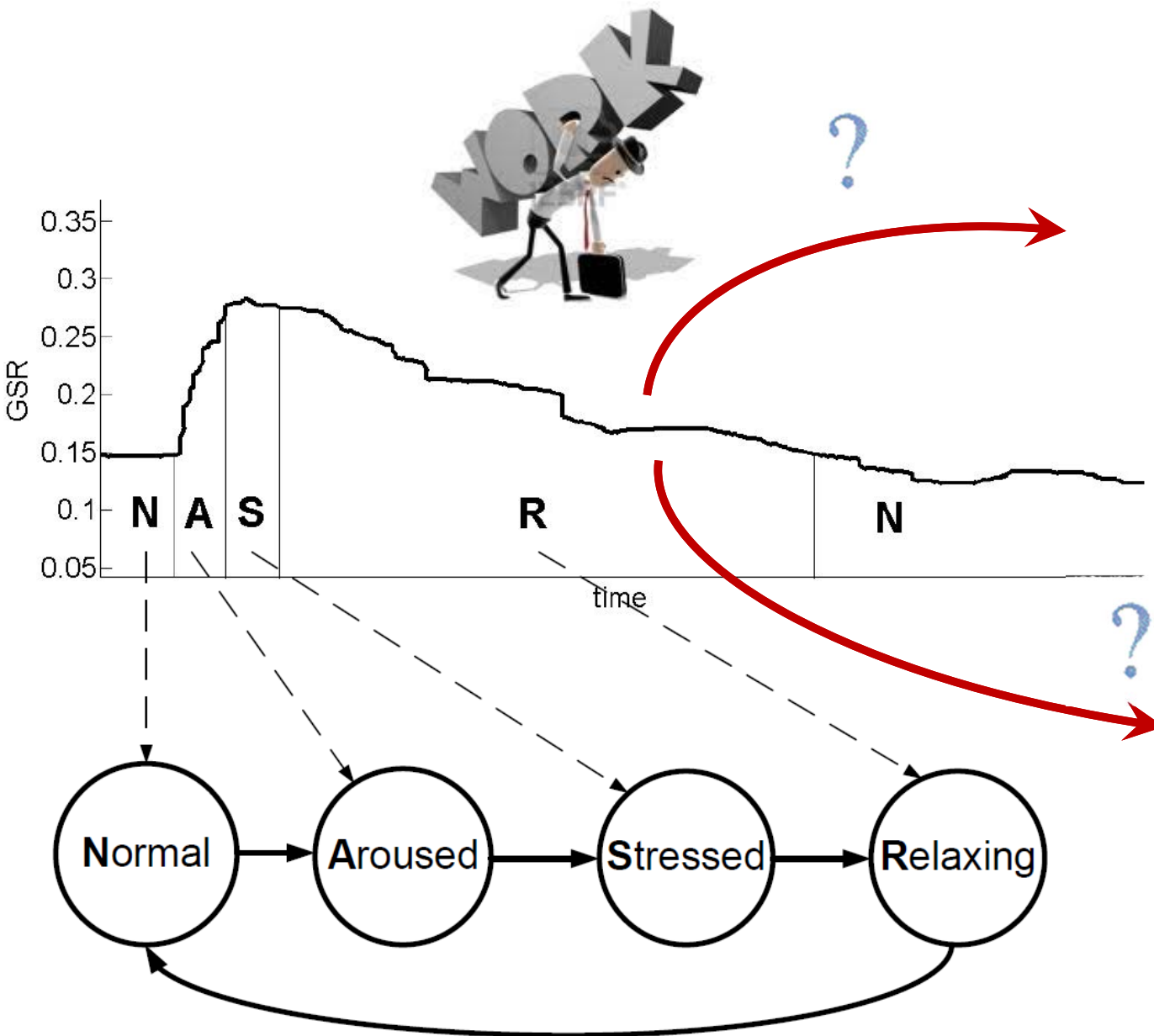
# Interpretation Isn't Straightforward



# Is Acute Stress Good or Bad?



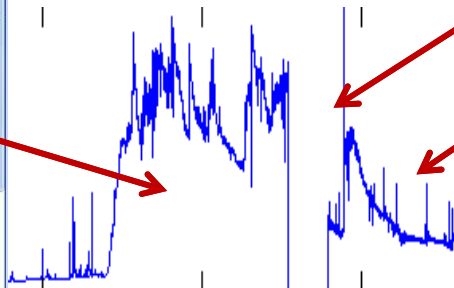
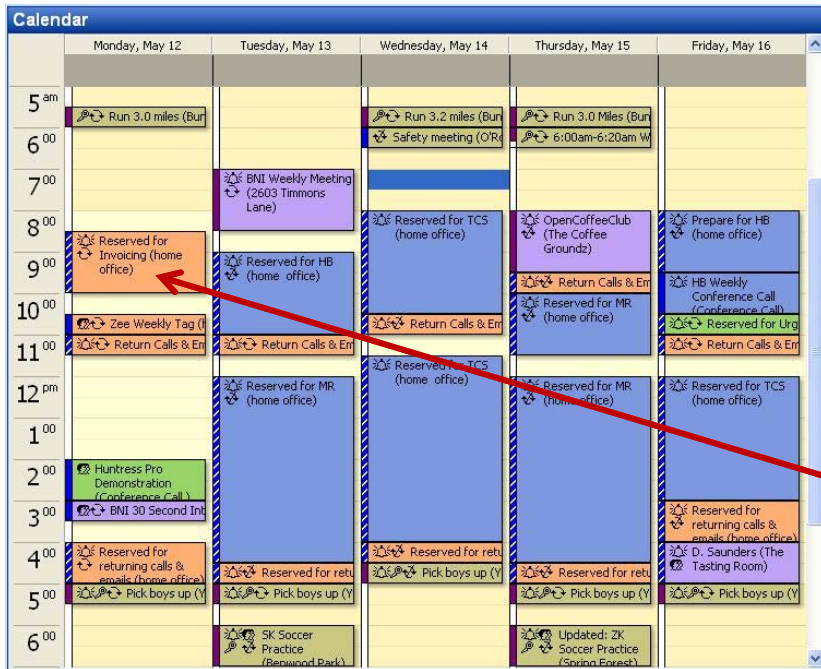
# What is the Relaxation Then?



# Is “Normal” Condition Good or Bad?

What if someone's patterns looks like  
NNNNNNNNNNNNNNNNNNNN ..... → ?





Summary of sentiment analysis for this e-mail

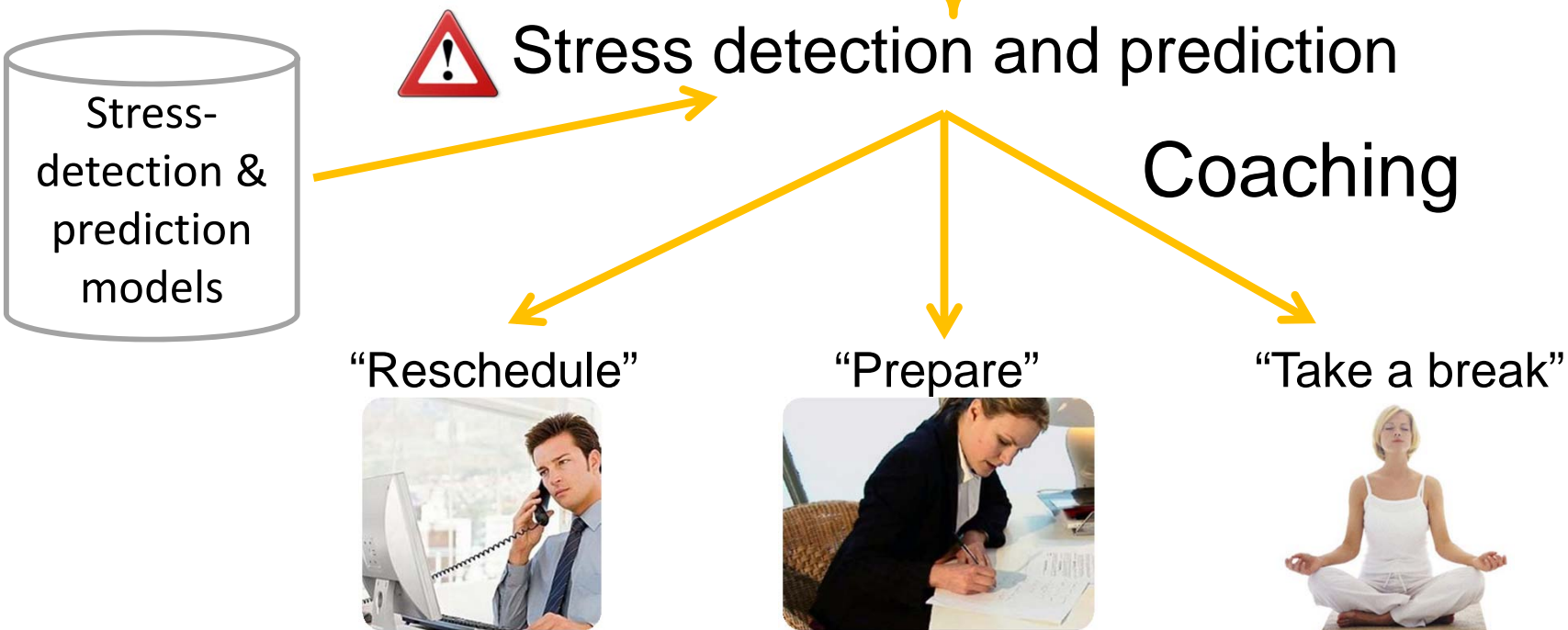
Positive sentences: 1  
Negative sentences: 0  
Objective sentences: 0

Negative sentences are highlighted in red.

What, When, Where, with Whom

vital signs

(non-) work-related content



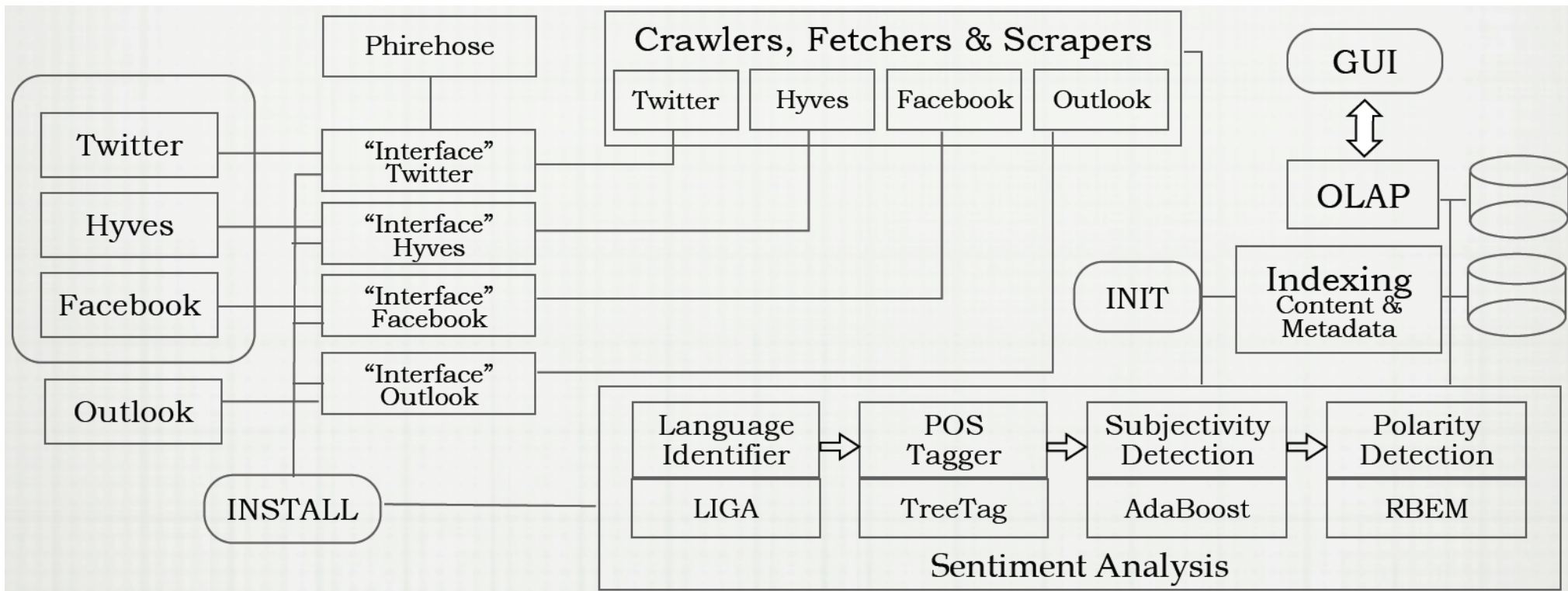
# Stress Analytics

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- Make a person aware of what is happening
  - how they spend their time and when and from where the stress comes in
- Provide valuable input for pattern mining/knowledge discovery
  - Much richer data
- Visual analytics
  - Interactive exploration of stress-related data
  - Collecting subjective data/labels from a person

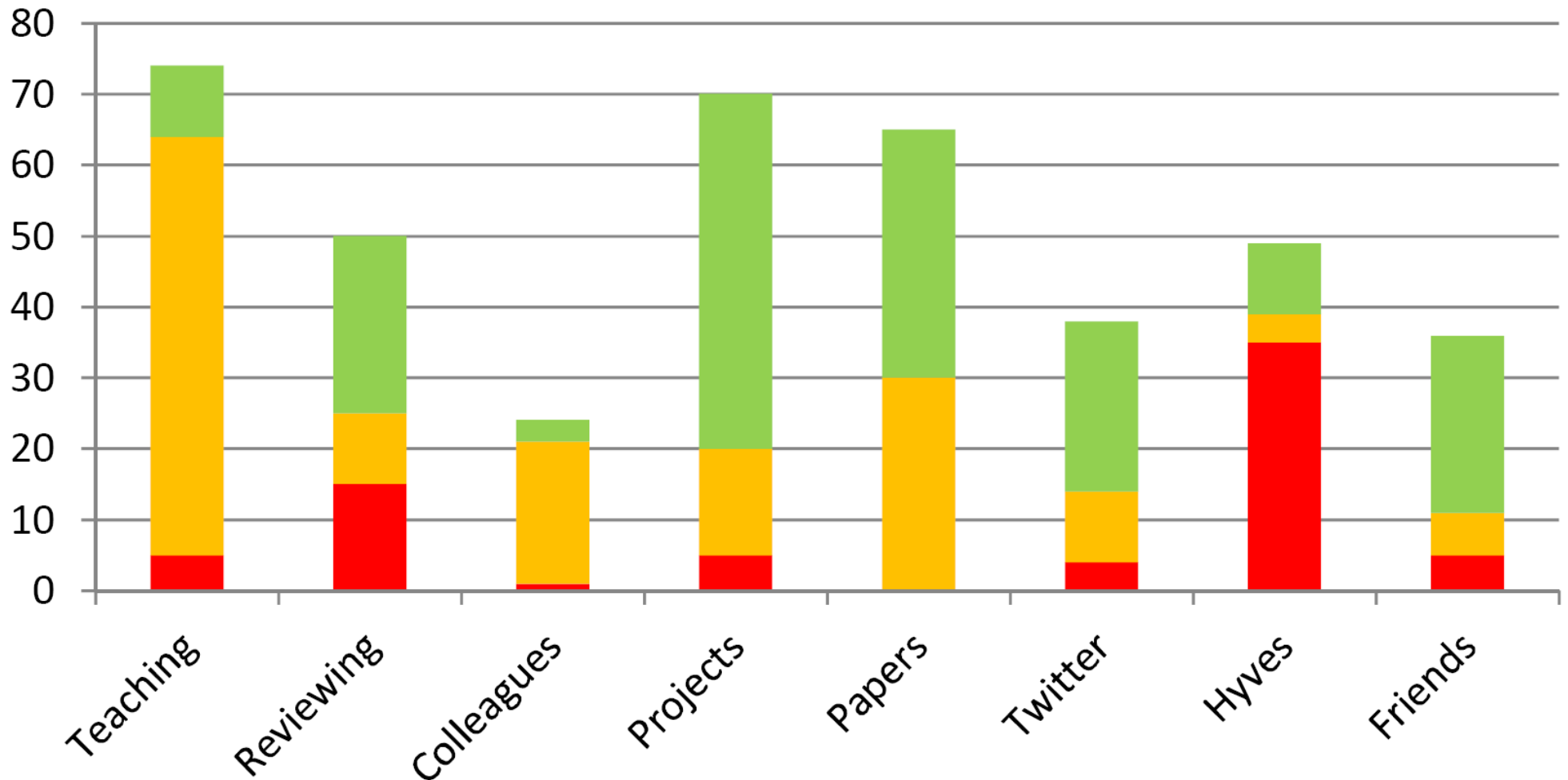
# SentiCorr – come to our demo on Monday

How much positive and negative content do we read or write?



# OLAP Style Exploration of Data Summaries

■ Negative ■ Objective ■ Positive



# Exploration of Individual Cases, e.g. e-Mails

The screenshot shows an Outlook window titled "[inf-sep-0809-projecto] E-mail met bijlage (attachment): presentatie.pdf - Message (HTML)". The interface includes a ribbon with "File", "Message", and "Adobe PDF" tabs, and various action buttons like "Ignore", "Delete", "Reply", "Forward", "Move", and "Zoom".

The email header shows the subject: "[inf-sep-0809-projecto] E-mail met bijlage (attachment): presentatie.pdf". Below the header, there is a summary table for the sentiment analysis:

SANA02010 Summary	
Positive sentences	2
Negative sentences	0
Objective sentences	5

A blue line points from the "Summary of sentiment analysis for this e-mail" text to the table.

The email body contains the following text:

Beste,

Voorname-lijk het verhaal van [redacted] is veranderd. Dat van [redacted] zijn voornamelijk notes voor de presenteerder (wel goede notes). Wel heb ik er modellen wat kleiner gemaakt (die profile en error\_viewer), dan zijn ze psychologisch minder belangrijk.

Verder wat spelregels voor verder commentaar:

- De begrippen Testrun en Testset wil ik absoluut niet introduceren,
- Sheets moeten steekwoorden bevatten, geen teksten,
- Sheets mogen op verkeerde been zetten: zolang verhaal maar klopt.

Ook:

Hoe staat het met demonstratie? Al wat mooie views en scenario's uitgewerkt en zo?  
Helaas heb ik dit weekend geen tijd door webtech en datamining, maar ik ben er morgen vroeg al om kwart voor 9, om de demonstratie voor te bereiden.

Met vriendelijke groet,

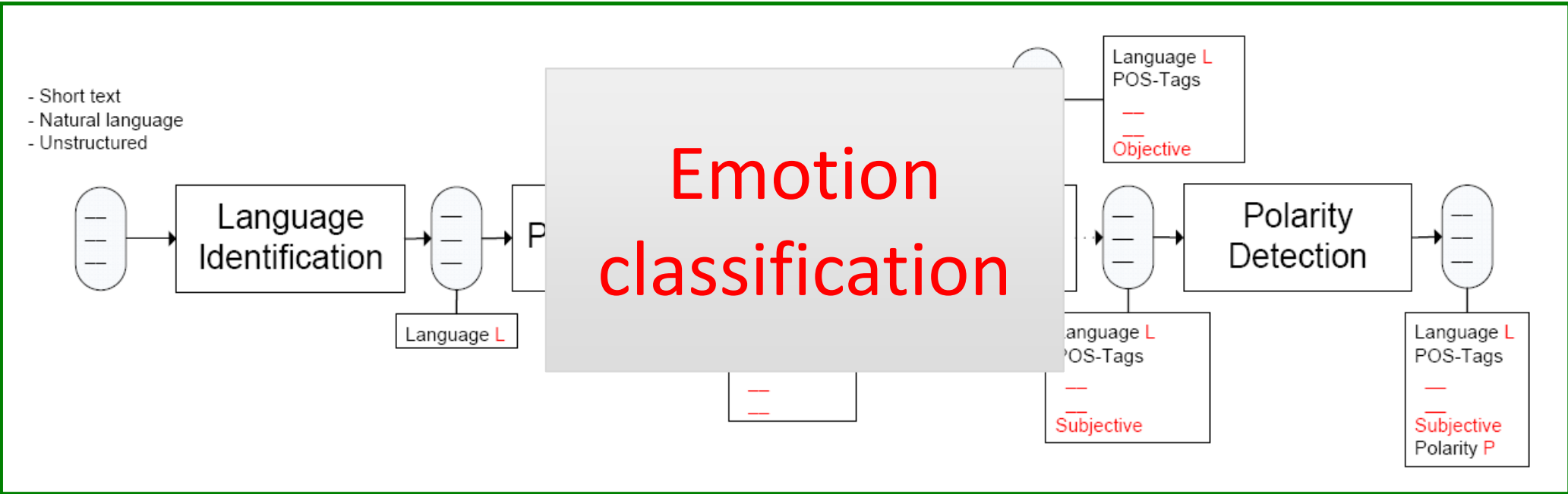
[redacted]

PS: [redacted], laat even weten vanaf hoelaat jij op TU bent: kan ik alles met jouw doornemen even :)

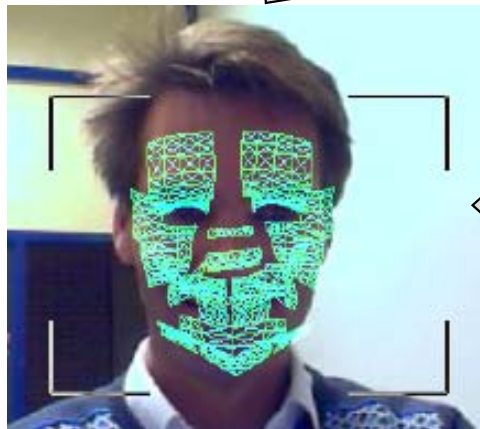
Annotations in the image:

- A green arrow points from the text "Positive sentences are highlighted in green" to the green-highlighted sentences in the email body.
- A red arrow points from the text "Negative sentences are highlighted in red" to the red-highlighted sentence in the email body.

# Multi-Source Emotion Classification



Facial  
expression  
analysis



GSR  
& other  
sensors

# Conclusions and Future Work

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- The detection of stress/arousal is a challenging task on itself:
  - varieties of noise and patterns in the data
- GSR data alone is highly ambiguous due to hidden contexts.
  - not clear whether certain peaks correspond to a significant physiological process, and
  - how to categorize these peaks further if they do
- Context-aware change detection and categorization; explanation of drifts