Before we start …

now you are all together …
being experts …
let me ask you a question …

Just as an appetizer for today …

What are emotions? :P

Why?

because

“Everyone knows what an emotion is, until asked to give a definition. Then, it seems, no one knows.”

(Fehr & Russell, 1984; p. 464)

"*Emotion is a complex set of interactions among subjective and objective factors, mediated by neural/hormonal systems, which*

(a) give rise to affective experiences such as feelings of arousal, pleasure/displeasure;

(b) generate cognitive processes such as emotionally relevant perceptual effects, appraisals, labeling processes;

(c) activate widespread physiological adjustments to the arousing conditions; and

(d) lead to behavior that is often, but not always, expressive, goal-directed, and adaptive."

(Kleinginna & Kleinginna, 1981; p. 355)

Unveiling Affective Signals

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Why are affective signals interesting?

- Affect / emotions has / have major impact on health and cognition
- Enhance man-machine communication
- The path to true artificial intelligence (?)

Why this symposium?

From the abstract of the introducing paper:

"The ability to process and, subsequently, understand affective signals is the core of emotional intelligence and empathy. However, more than a decade of research in affective computing has shown that it is hard to develop computational models of this process. We pose that the solution for this problem lays in a better understanding of how to process these affective signals."

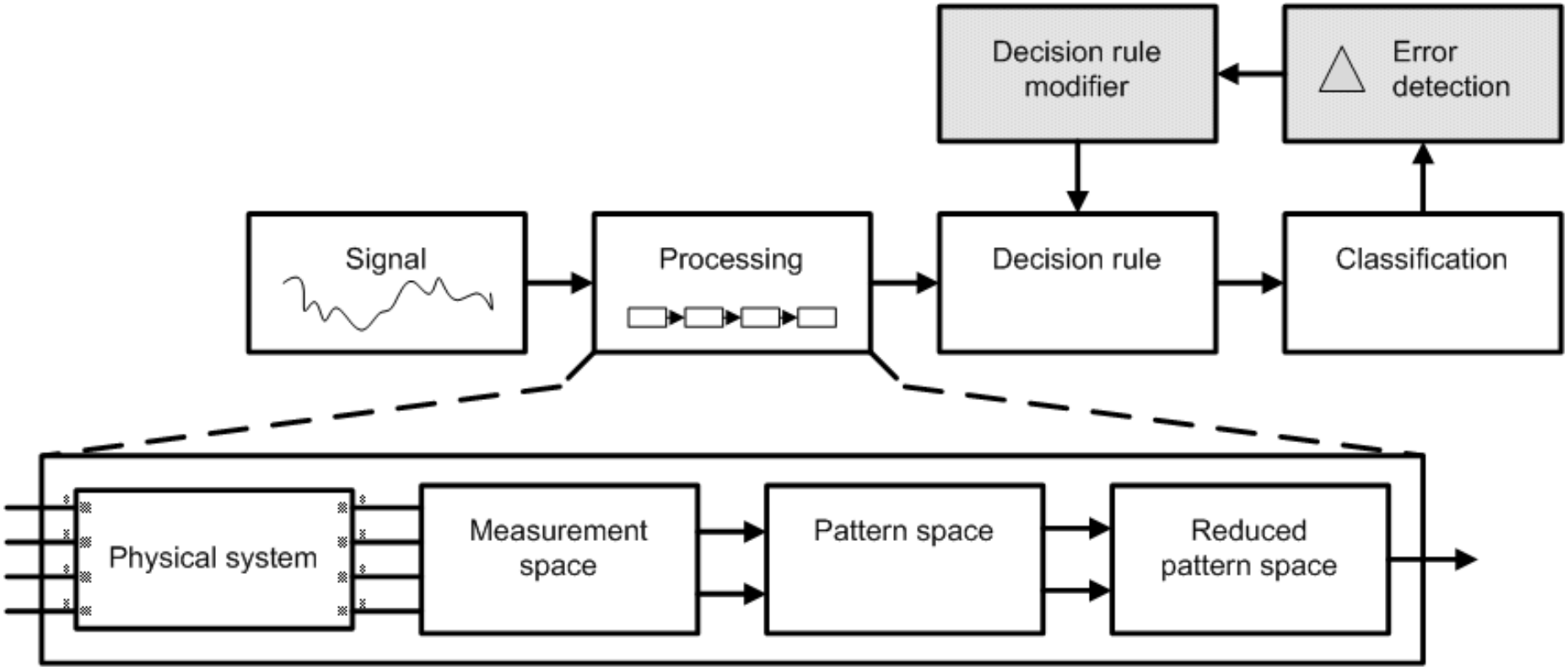
Pattern recognition by man and machine

- Recognition of affect, of emotions, either by man or machine is essentially a pattern recognition problem.

- Pattern recognition by man is not well understood, it is only known in global terms. Consequently, it cannot be modeled computationally.
- Pattern recognition by machines can be formally specified. Hence, excellent computational models can be defined.

- Goals of pattern recognition by machines:
  - Solving the problem
  - Modeling human pattern recognition (and solving the problem)

The pattern recognition pipeline



The start = the signal

- In our case: the affective signals, in all its modalities and variations

- Understanding the signal
  - its origin
  - its relation to its origin (i.e., the person) and its environment
  - its relation to other signals
  - its behavior
- Capturing the signal
- Processing the signal
  - Removing noise
  - Removing non-stationary elements
  - Calculate features from stationary elements

Martin Ouwerkerk et al. (Philips Research)

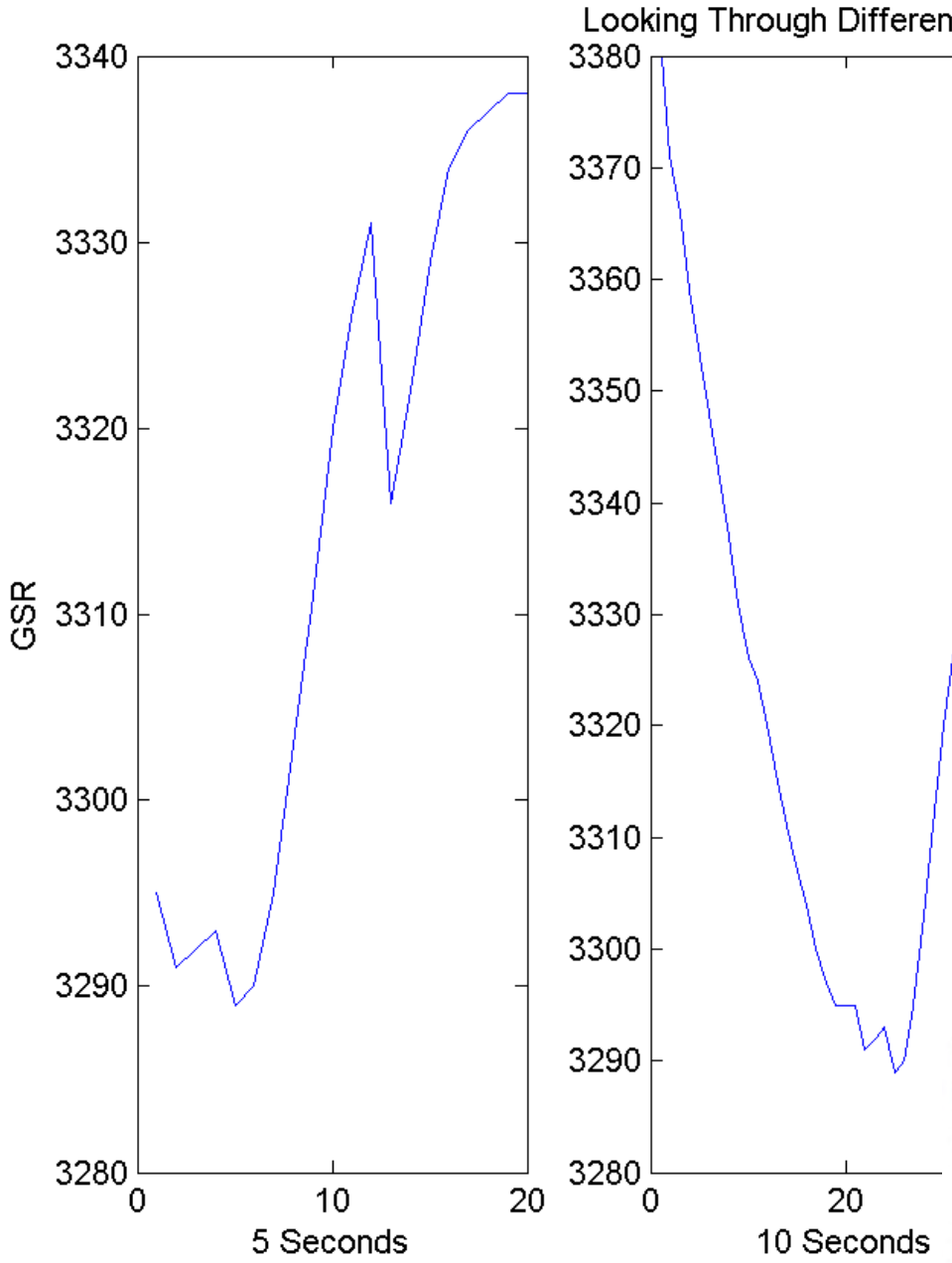


Table 3: Standard statistics on the three time windows of an EDA signal, as presented in Figure 1b.

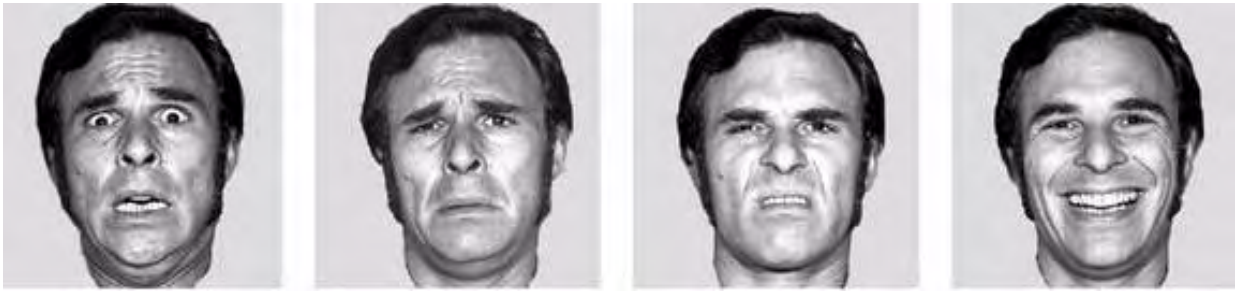
Statistic	Time window		
	5 sec.	10 sec.	sec.
mean	3314	3312	3083
standard deviation	19	23	217
slope	43	-69	697

Adaptive systems

- Man adapts smoothly, more or less automatically, to an impressive range of changing circumstances. They make ‘associations’ as it is called; i.e., they implicitly define relations between objects and events.

- Machines have a hard time adapting. They heavily depend on the scope of problems or which they are designed and rely on the data with which they are trained. Machines try to adapt through altering: normalization, distance measures, dimensionality, and the complexity of sample distributions, to mention a few.

State of the art



- Three modalities:
  - Computer vision / images
  - Speech
  - Physiological signals (e.g., EEG, ECG, EMG, EDA)

- Their problems …
  - Occlusion, light sources, and stereotype expressions
  - Environmental noise and acoustic features of environments
  - Obtrusive, movement artifacts, signal loss (e.g., sensors that fall off), and humidity

Table 1. An overview of 14 studies on automatic biosignal-driven classification of emotions of the last 5 years. In addition, the seminal work of Picard et al. [23] is provided as a baseline.

information source		year	signals	#part.	#feat.	classifiers	#classes	result
[23]	Picard et al.	2001	$\mathcal{C}$,$\mathcal{E}$,$\mathcal{R}$,$\mathcal{M}$	1	40	LDA	8 emotions	81%
[35]	Wagner et al.	2005	$\mathcal{C}$,$\mathcal{E}$,$\mathcal{R}$,$\mathcal{M}$	1	32	kNN, LDA, MLP	4 emotions	92%
[40]	Yoo et al.	2005	$\mathcal{C}$,$\mathcal{E}$	6	5	MLP	4 emotions	80%
[5]	Choi & Woo	2005	$\mathcal{E}$	1	3	MLP	4 emotions	75%
[11]	Healey & Picard	2005	$\mathcal{C}$,$\mathcal{E}$,$\mathcal{R}$,$\mathcal{M}$	9	22	LDA	3 stress levels	97%
[20]	Liu et al.	2006	$\mathcal{C}$,$\mathcal{E}$,$\mathcal{M}$,$\mathcal{S}$	14	35	RT	3 anxiety levels	70%
[25]	Rani et al.	2006	$\mathcal{C}$,$\mathcal{E}$,$\mathcal{M}$,$\mathcal{S}$,$\mathcal{P}$	15	46	kNN, SVM, RT, BN	3 emotions	86%
[42]	Zhai & Barreto	2006	$\mathcal{C}$,$\mathcal{E}$,$\mathcal{S}$,$\mathcal{P}$	32	11	SVM	2 stress levels	90%
[14]	Jones & Troen	2007	$\mathcal{C}$,$\mathcal{E}$,$\mathcal{R}$	13	11	ANN	5 arousal levels	31 / 62%
							5 valence levels	26 / 57%
[18]	Leon et al.	2007	$\mathcal{C}$,$\mathcal{E}$	8	5	ANN	3 emotions	71%
[19]	Liu et al.	2008	$\mathcal{C}$,$\mathcal{E}$,$\mathcal{M}$,$\mathcal{S}$	6	35	SVM	3 affect states	83%
[15]	Katsis et al.	2008	$\mathcal{C}$,$\mathcal{E}$,$\mathcal{R}$,$\mathcal{M}$	10	15	SVM, ANFIS	4 affect states	79%
[39]	Yannakakis & Hallam	2008	$\mathcal{C}$,$\mathcal{E}$	72	20	SVM, MLP	2 fun levels	70%
[16]	Kim & André	2008	$\mathcal{C}$,$\mathcal{E}$,$\mathcal{R}$,$\mathcal{M}$	3	110	LDA, DC	4 emotions	70 / 95%
[4]	Chanel et al.	2009	$\mathcal{C}$,$\mathcal{E}$,$\mathcal{R}$	13	11	ANN	2 emotions	66%
							3 emotions	51%

Signals: $\mathcal{C}$: cardiovascular activity; $\mathcal{E}$: electrodermal activity; $\mathcal{R}$: respiration; $\mathcal{M}$: electromyogram; $\mathcal{S}$: skin temperature; and $\mathcal{P}$: pupil diameter.
Classifiers: MLP: MultiLayer Perceptron; RT: Regression Tree; BN: Bayesian Network; ANN: Artificial Neural Network; SVM: Support Vector Machine; LDA: Linear Discriminant Analysis; kNN: k-Nearest Neighbors; ANFIS: Adaptive Neuro-Fuzzy Inference System; and DC: Dichotomous Classification.
Additional abbreviations: #: number of; part.: participants; feat.: features; and result: classification result.

State-of-the-art results

- Recognitio[illegible]%
- Results diff
  - lack of
  - differer
  - different signals (1 to 5)
  - number of participants (1 to 72)
  - number of days (1 to 21)

- No general standards
- Low performance
- Inconsistent results

- More variability in data and targets >> lower classification performance

Caveats and limitations

- Many-to-many relationships: noisy
- Physiological and affective time windows vary
- Humans are *not* linear time invariant
  - Habituation
- Individual differences

Symposium's rationale

- Overview of (almost) all possible affective signals.
- Multi-disciplinary knowledge exchange
- Discuss conceptual issues (e.g., ground truth)
- Applied issues of filtering, signal processing, and machine learning
- Generic approaches special cases
- Going from lab to life

The end

The start

Questions?