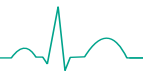
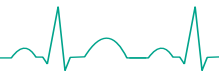

Multi-Channel Beat Detector for a mobile ECG Monitoring Device

Noack Alexander
24. September 2015

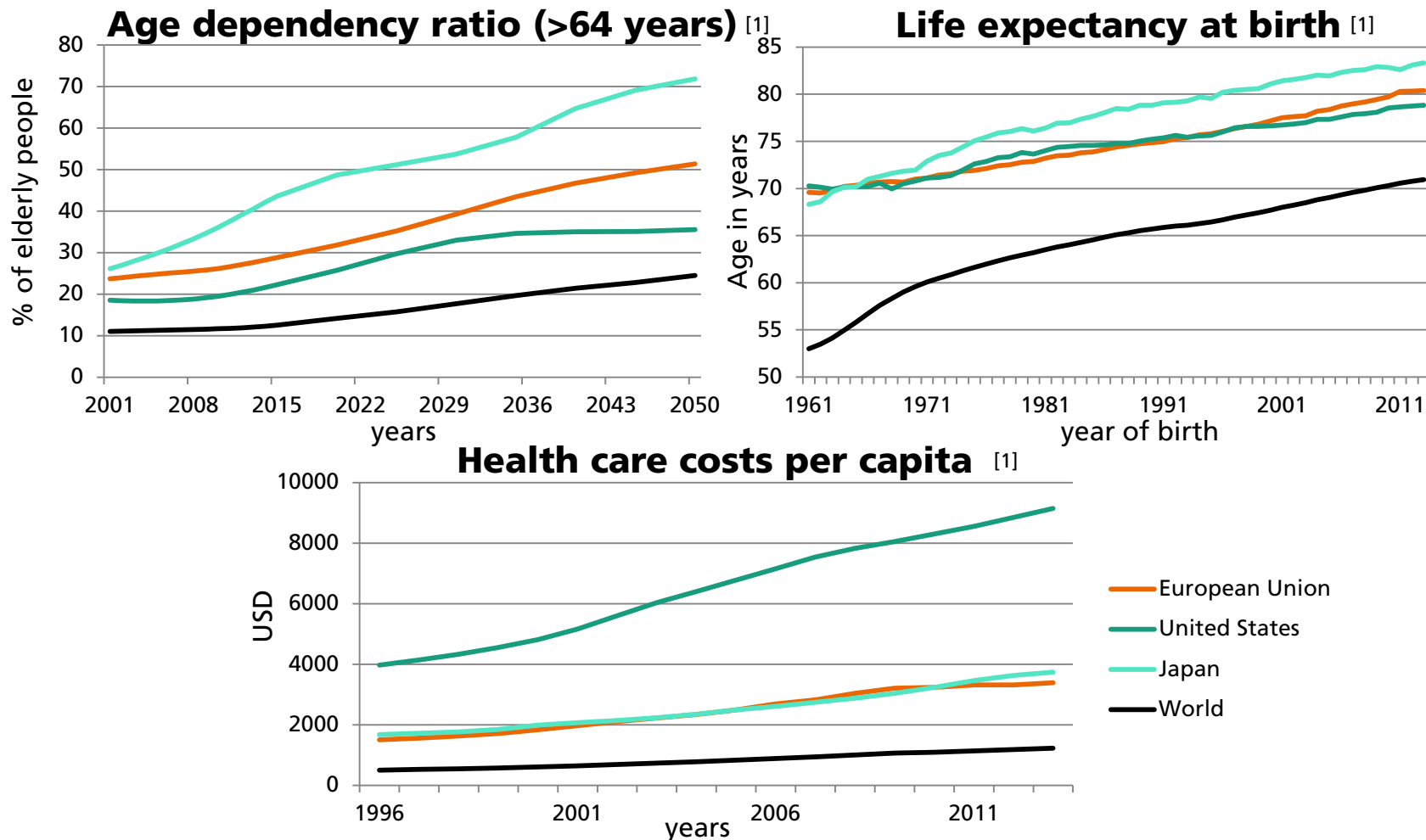


Synopsis

- Motivation – Why addressing the field of mobile monitoring?
- Methods – What did we do?
- Data acquisition – What are we working with?
- Results – What did we achieve?
- Conclusion – A glimpse of the future...



Motivation



[1] source: <http://data.worldbank.org/> (21.09.2015)



Motivation

- improve the efficiency in health care

- Time
- Costs

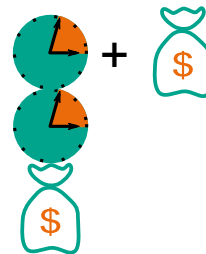


- focuses lies still on data acquisition only

- bottleneck nowadays: insufficient reaction

- automated signal analysis to support monitoring

- Intelligent prioritization
- Optimize reaction time
- Minimize financial effort



Norman J. Holter [2]

[2] source: CardioNetworks ECGpedia.org (21.09.2015)

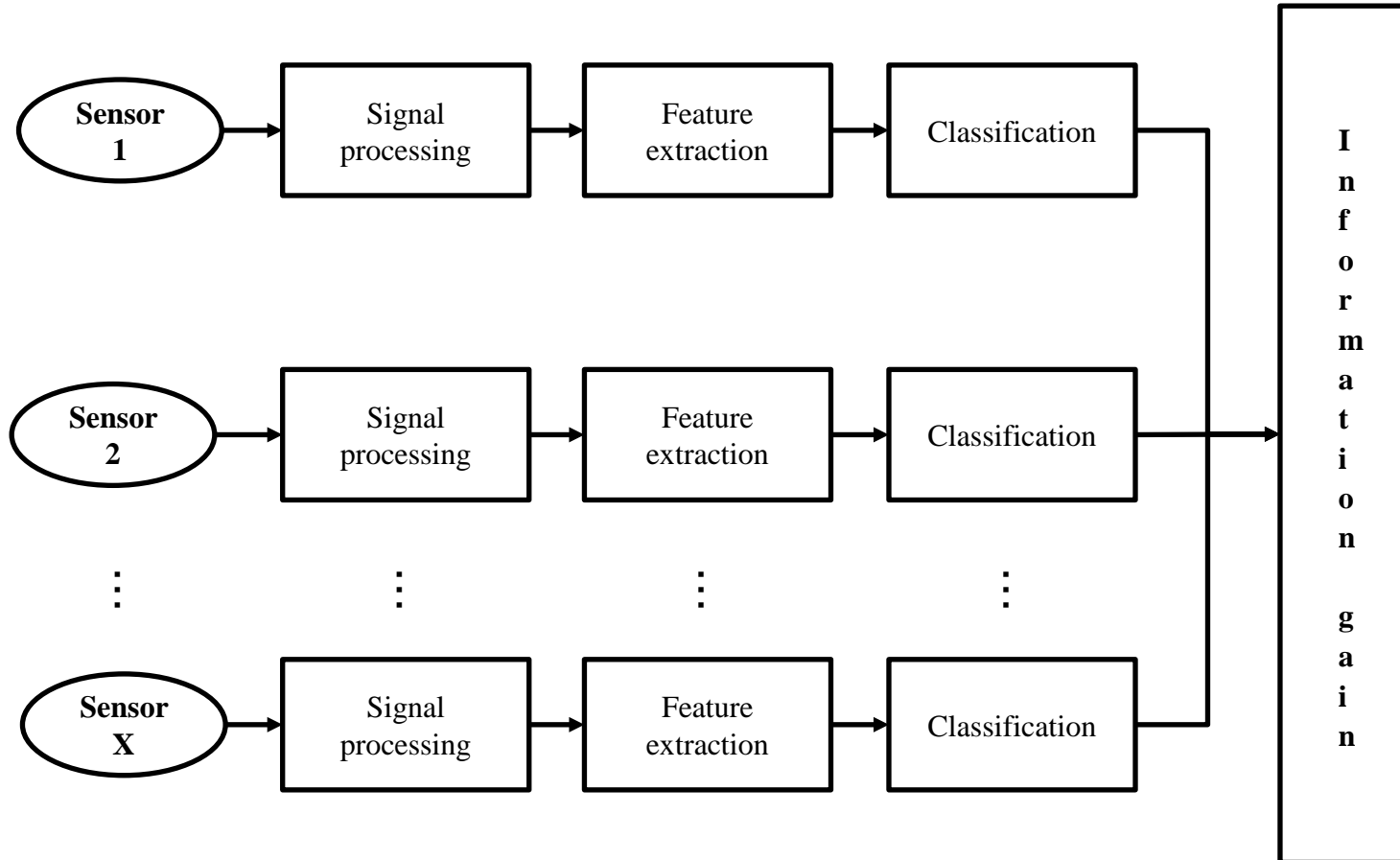


Motivation

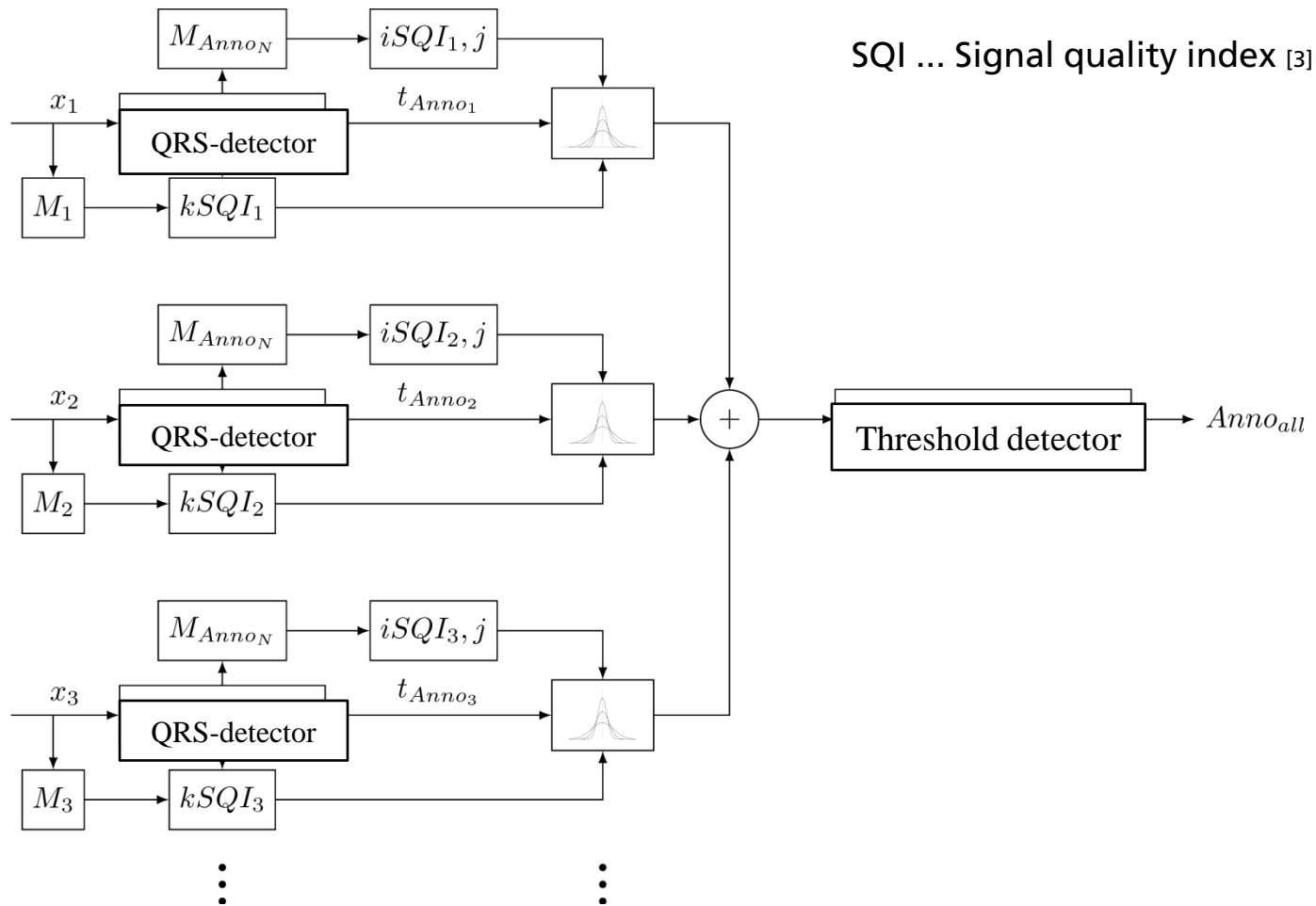
- In stationary devices already reality
- high number of false alarms is progressively leading to alarm fatigue
- systems fail to advance the current medical workflow
- First step for automated ECG analysis : QRS detection
- minimize false alarms by means of multichannel and multi-data cross validation



Methods



Methods



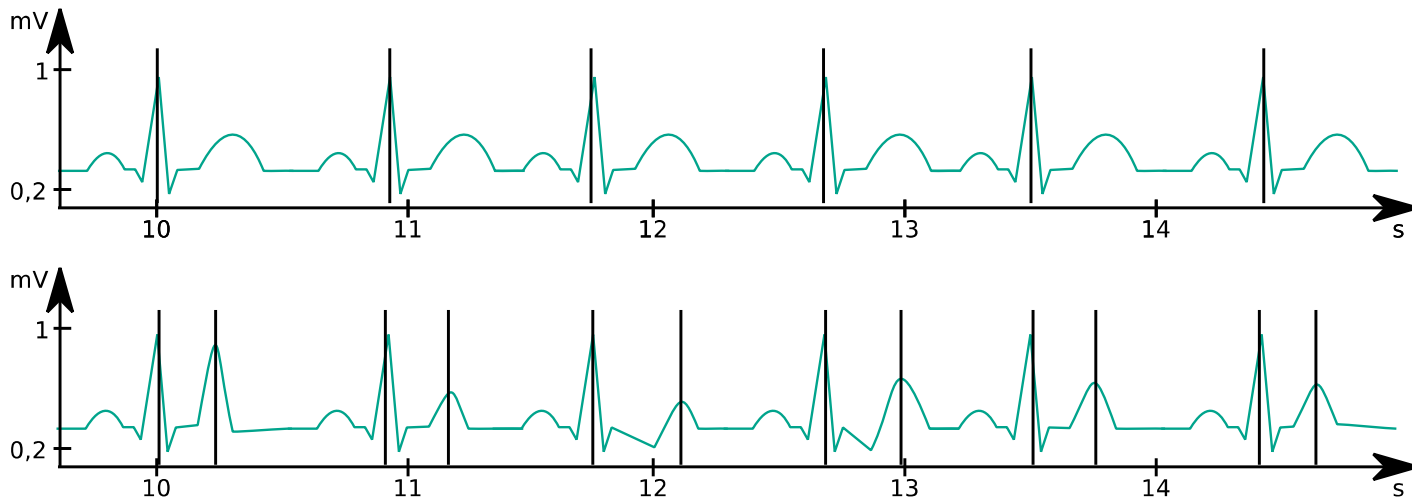
SQI ... Signal quality index [3]

[3] source: Li, Mark, Clifford: Robust heart rate estimation from multiple asynchronous noisy sources using signal quality indices and a Kalman filter. *Physiol Meas.* 29(1); 15-32;2008

Methods

iSQI (inter-channel-SQI) [3]

$$iSQI(m)_{i,j} = \frac{N_{same}(m, \omega)_{i,j}}{N_{alle}(m, \omega)_{i,j}} \quad i \neq j \quad [3]$$

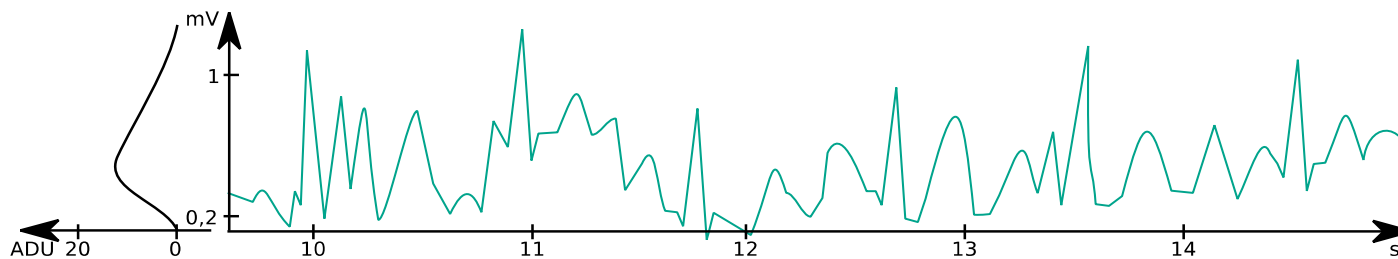
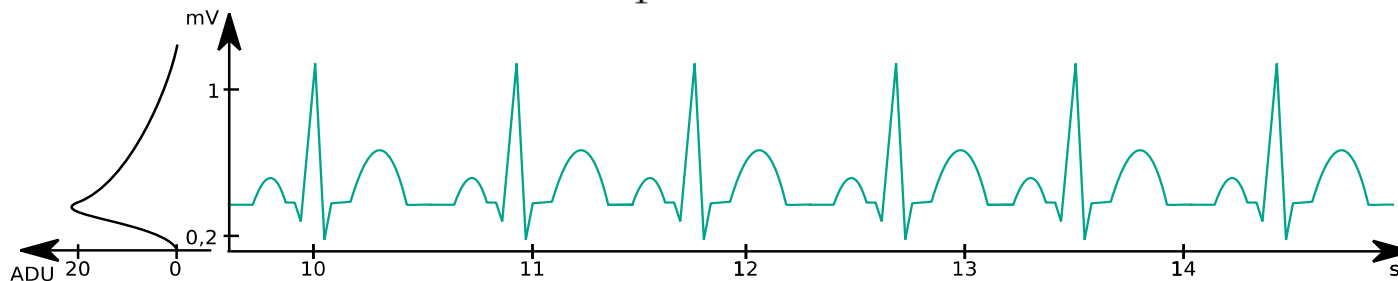


[3] source: Li, Mark, Clifford: Robust heart rate estimation from multiple asynchronous noisy sources using signal quality indices and a Kalman filter. *Physiol Meas.* 29(1); 15-32;2008

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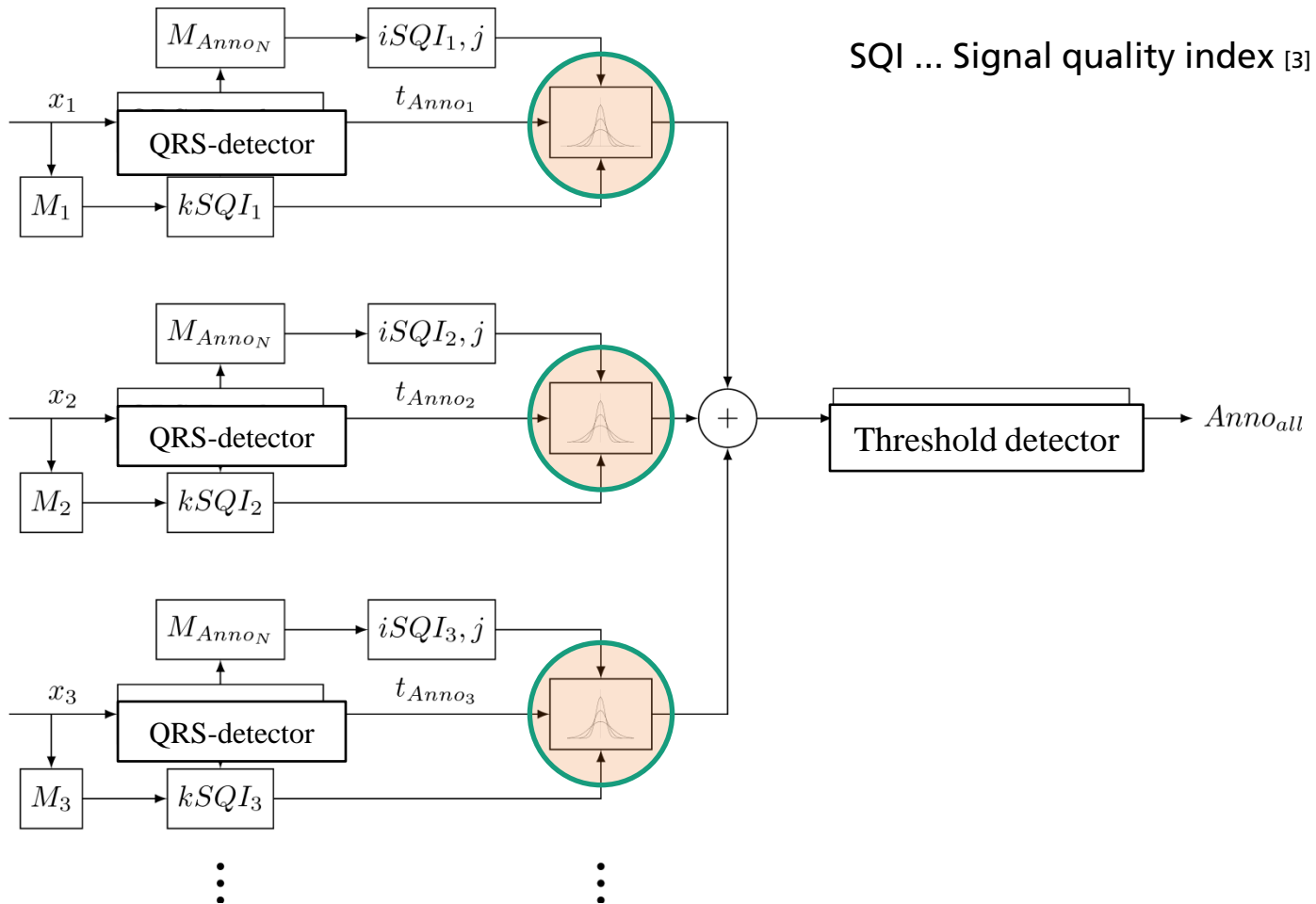
kSQI (kurtosis-SQI)^[3]

$$K = \frac{1}{k} \sum_{1}^k \left[\frac{x_n - \mu_x}{\sigma} \right]^4 \quad [3]$$

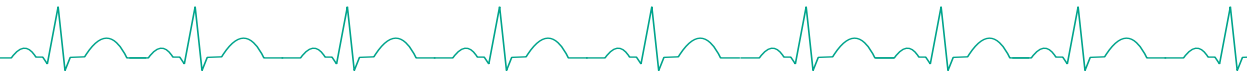


[3] source: Li, Mark, Clifford: Robust heart rate estimation from multiple asynchronous noisy sources using signal quality indices and a Kalman filter. *Physiol Meas.* 29(1); 15-32;2008

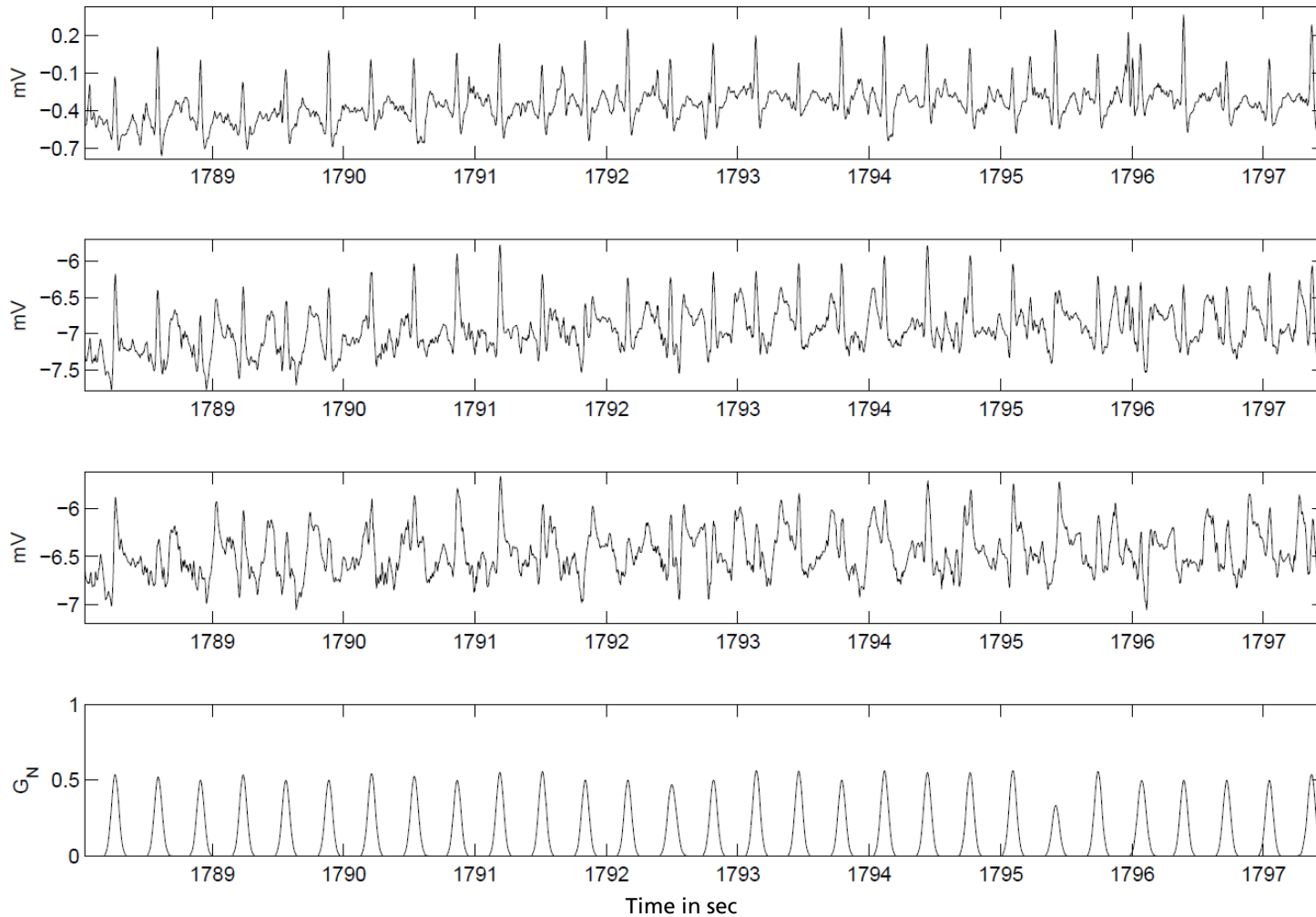
Methods



[3] source: Li, Mark, Clifford: Robust heart rate estimation from multiple asynchronous noisy sources using signal quality indices and a Kalman filter. *Physiol Meas.* 29(1); 15-32;2008



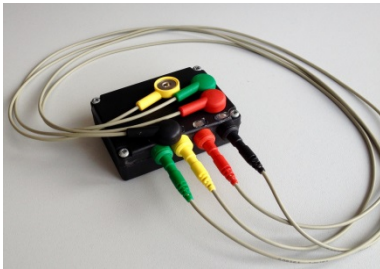
Methods



Data acquisition

Self-recorded data

3 channel ECG



10 records > 65 min

27,4 ± 3,7 years

Activity ↑

Signal quality ↑↓



Europäische Union

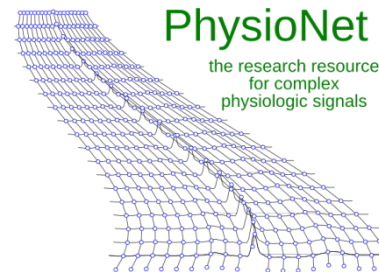
Europa fördert Sachsen.



Europäischer Fonds für regionale Entwicklung

Long-Term ST database

3 channel ECG



[4]

18 records ≈ 24h

70,6 ± 11,3 years

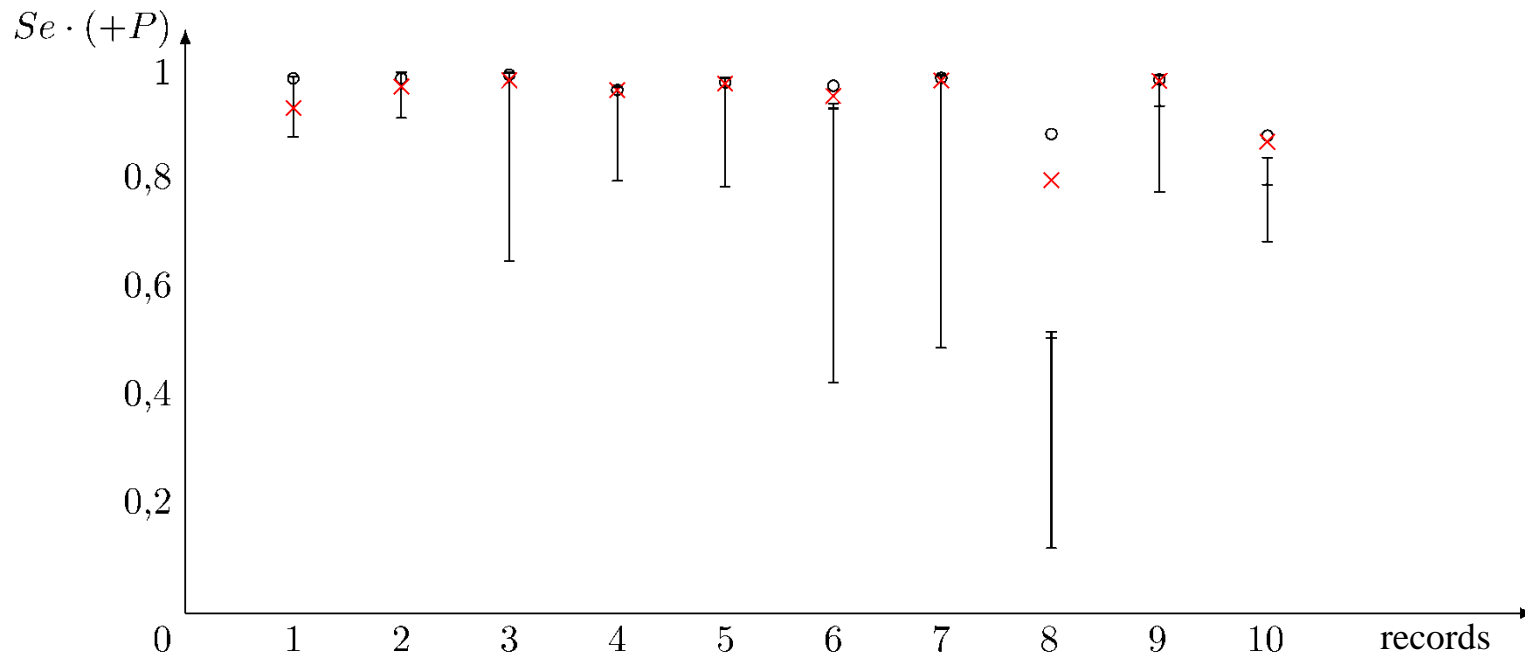
Activity •

Signal quality ↑

[4] source: <http://www.physionet.org/physionet-logo.png> (05.07.2015)

Results

Self-recorded data

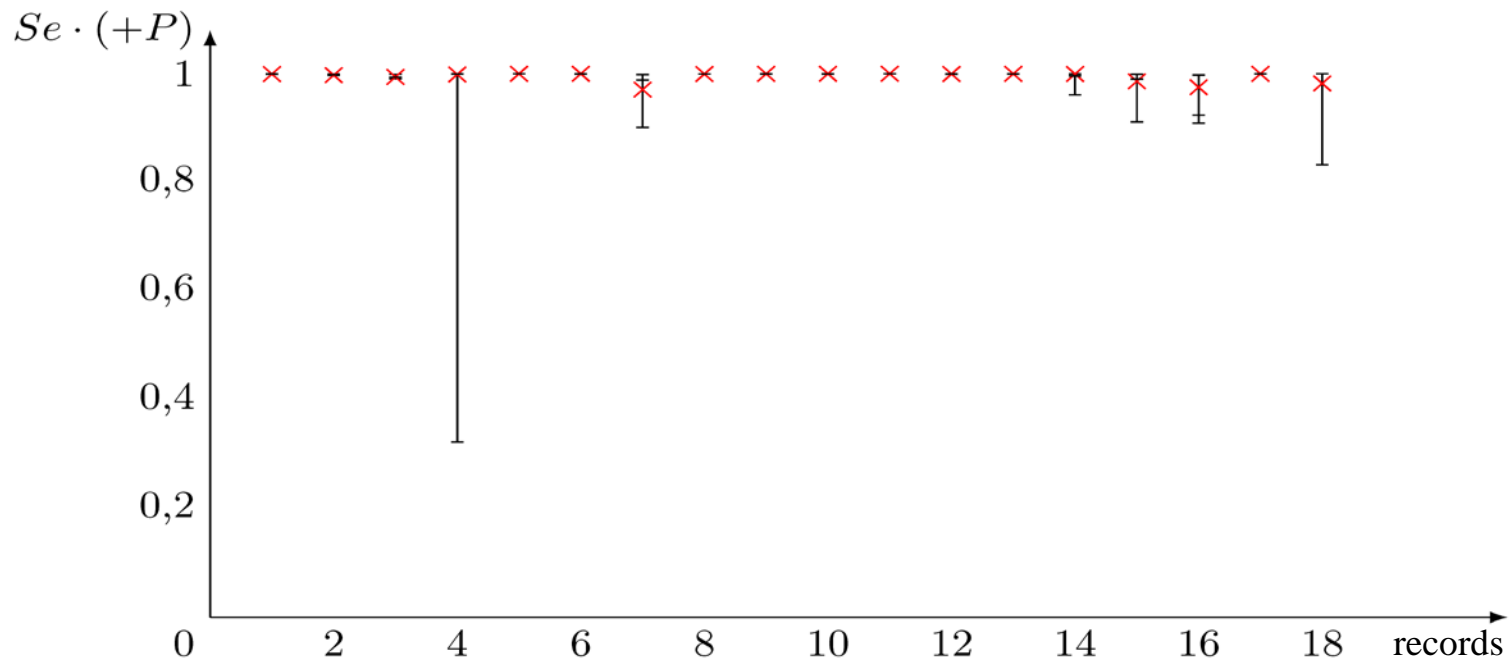


x - multi channel approach
single channel results

o - multi channel approach with
record specific threshold

Results

Long-Term ST database



x multi channel approach
- single channel results

Results

Overview in numbers

		channel 1	channel 2	channel 3	multi channel
self recorded data	Se in %	78,3	96,52	95,59	98,6
	+P in %	90,05	95,02	95,95	97,04
LTSTDB	Se in %	95,17	99,41	99,41	99,99
	+P in %	98,96	99,94	99,94	99,5

Improvements

Best channel (channel 3)
Worst channel(channel 1)

Se: 3% +P: 1%
Se: 26% +P: 8%

Conclusion

- Autonomous ECG analysis is not yet solved sufficiently
- Don't limit your test cases on the standard databases
- New recourses on mobile devices should be used to reduce false alarms
- A huge market for intelligent devices is emerging in the next 20 years
- Presented algorithmic approach is not yet optimized, but shows the potential which improvements are possible

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