

# Machine Learning for Disease Prediction and Signal Processing

Georg Dorffner

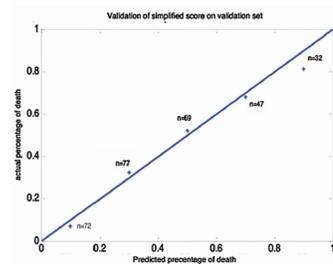
Institute of Artificial Intelligence, CeDAS

*Medical University of Vienna*

# Prediction Models

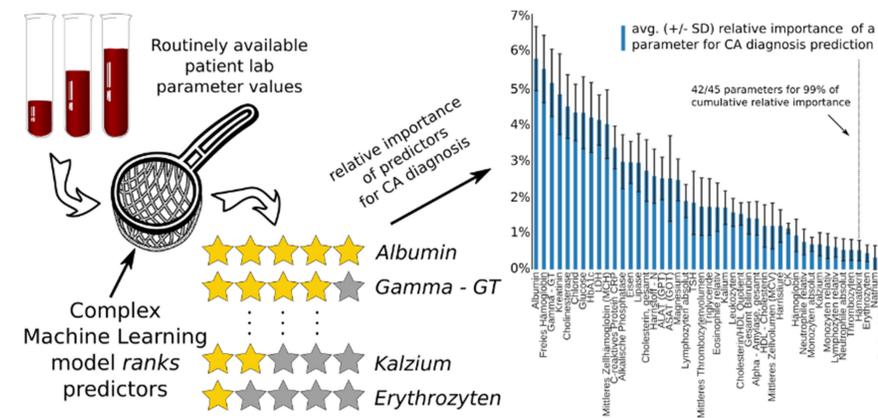
Predicting cardiovascular disease,  
Benchmarking against more traditional  
statistics

Mortality prediction after cardiac arrest

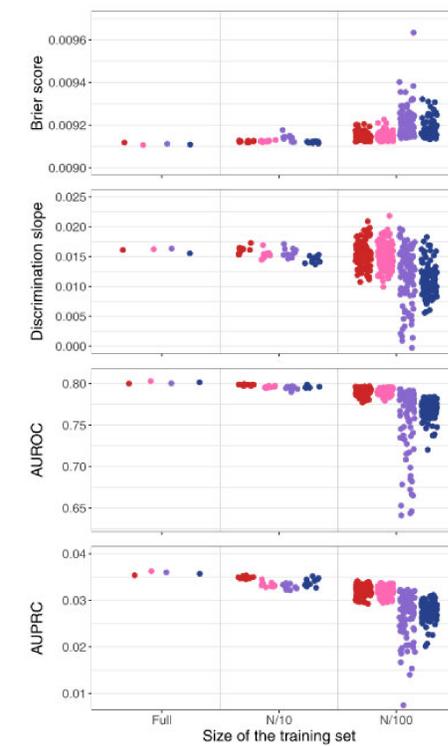


Aschauer S. et al.,  
*Resuscitation*, 2014

Predicting cardiac amyloidosis from  
lab paramters



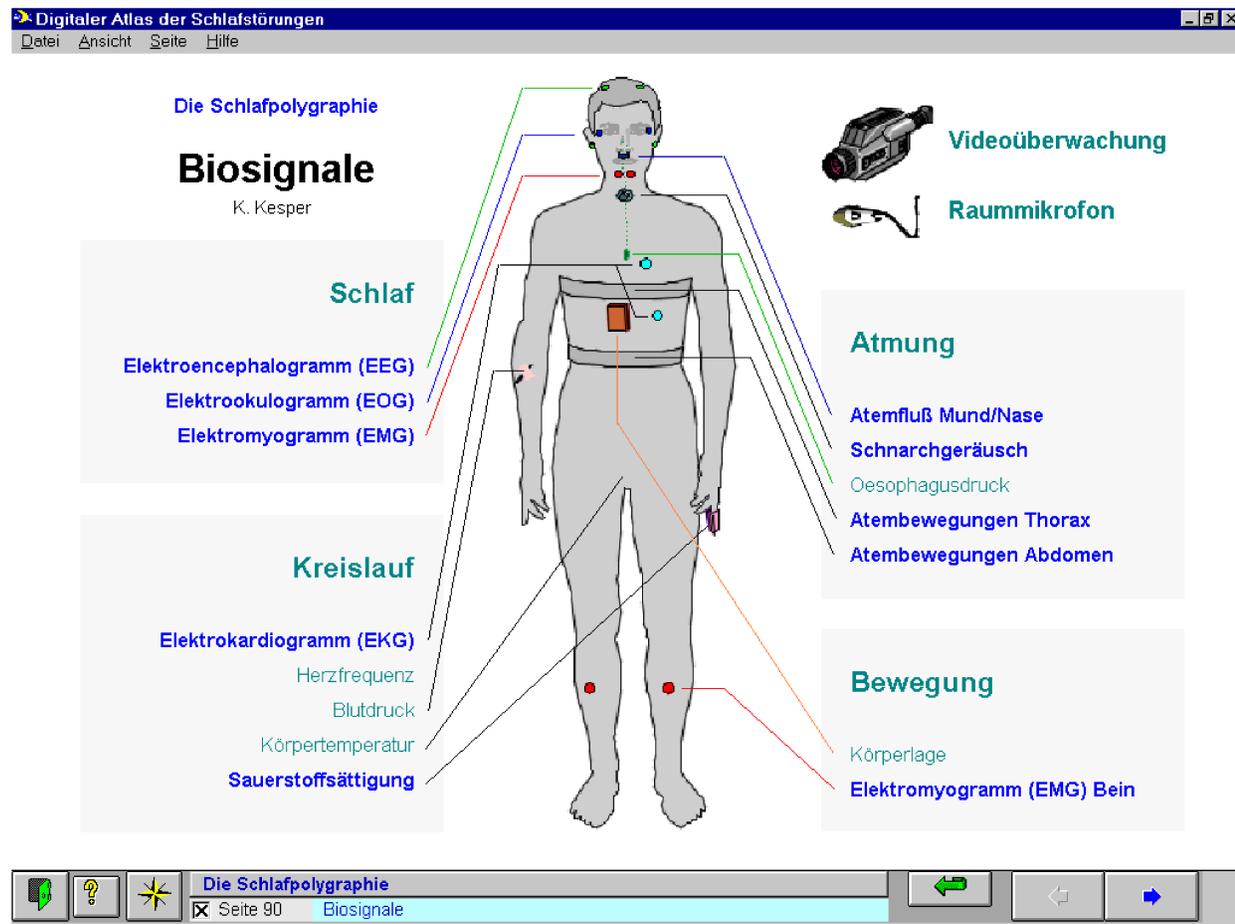
Agibetov et al., *J. Clin. Med.*, 2020



Wallisch et al., *BMC Med. Res. Tech.*,  
2021

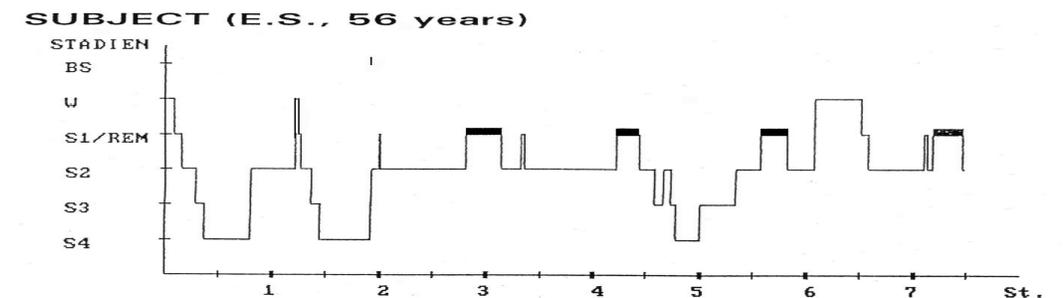
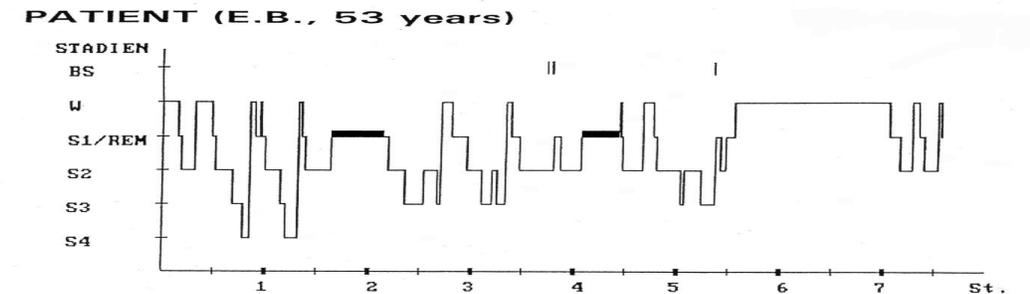
# Sleep EEG analysis

## Measurement: Polysomnography

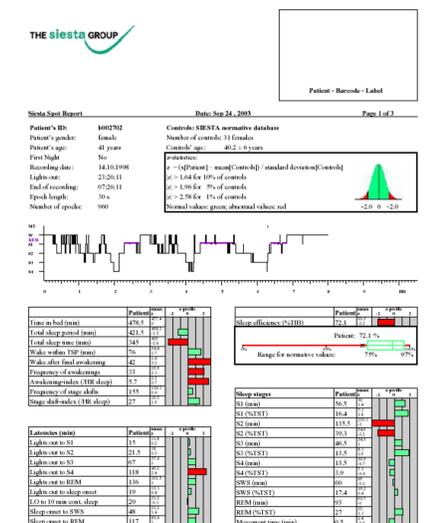


Source: DGSM

## Analysis: Sleep Profile



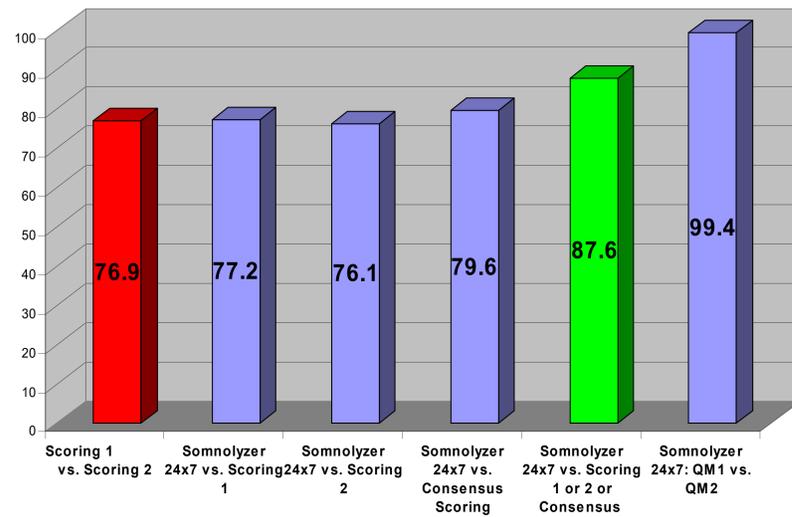
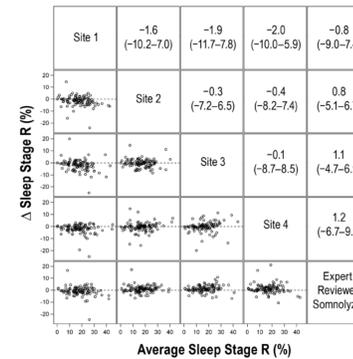
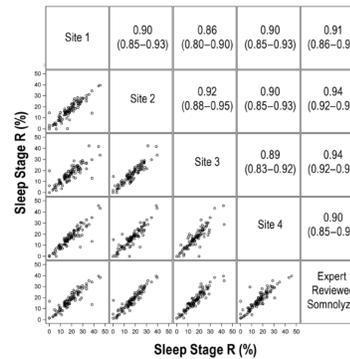
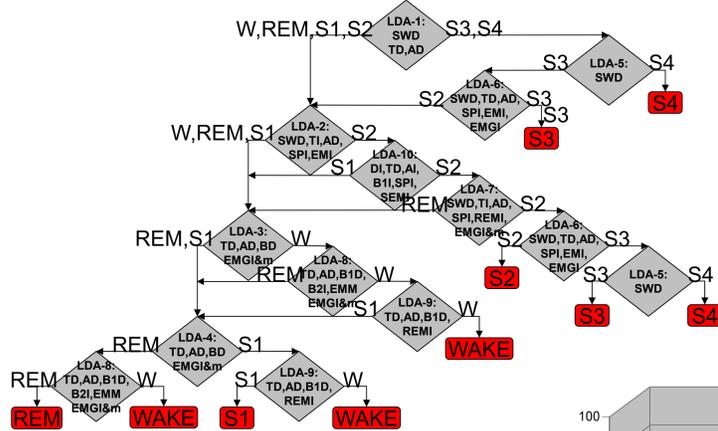
Report



Diagnosis  
(Sleep apnea,  
Periodic leg movements,  
etc.)

# A very long journey

## Somnolyzer 24x7



Anderer et al., Neuropsychobiology, 2005, 2010

Punbjabi et al., Sleep, 2015



Clinical Resources Professional Development Membership Accreditation

Previous Next

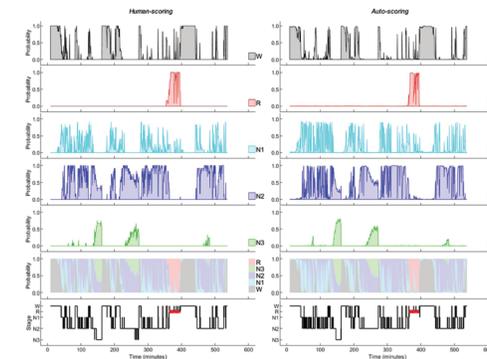


American Academy of Sleep Medicine announces first recipient of autoscoring software certification

DARIEN, IL – The American Academy of Sleep Medicine congratulates Philips RS North America LLC, which has earned stage-specific autoscoring software certification from the AASM. Its software, Sleepware G3 with Somnolyzer v4.0.2.0, is the first to be certified through the pilot program, which the AASM launched in 2023.

The AASM Autoscoring Certification program independently evaluates the real-world performance of autoscoring software that provides adult sleep stage scoring from the analysis of data gathered by polysomnography. This evaluation process uses private sleep study data scored by experts in the sleep field. Certification is a demonstration to accredited sleep facilities that the accuracy of an autoscoring solution is comparable to manual scoring by trained professionals.

"I congratulate Philips RS North America LLC for having the first software to be certified through the AASM Autoscoring Certification pilot program," said AASM Executive Director Steve Van Hout. "The American Academy of Sleep Medicine is committed to ensuring that technological advances support the provision of high-quality, patient-centered sleep care."



Bakker et al., Sleep, 2023



2004

2005

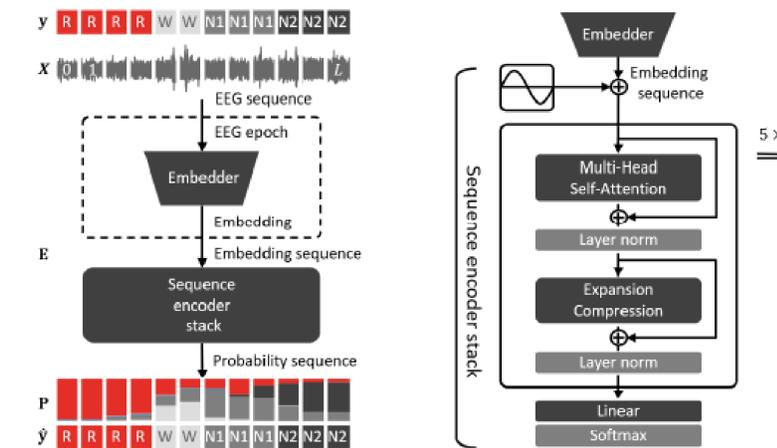
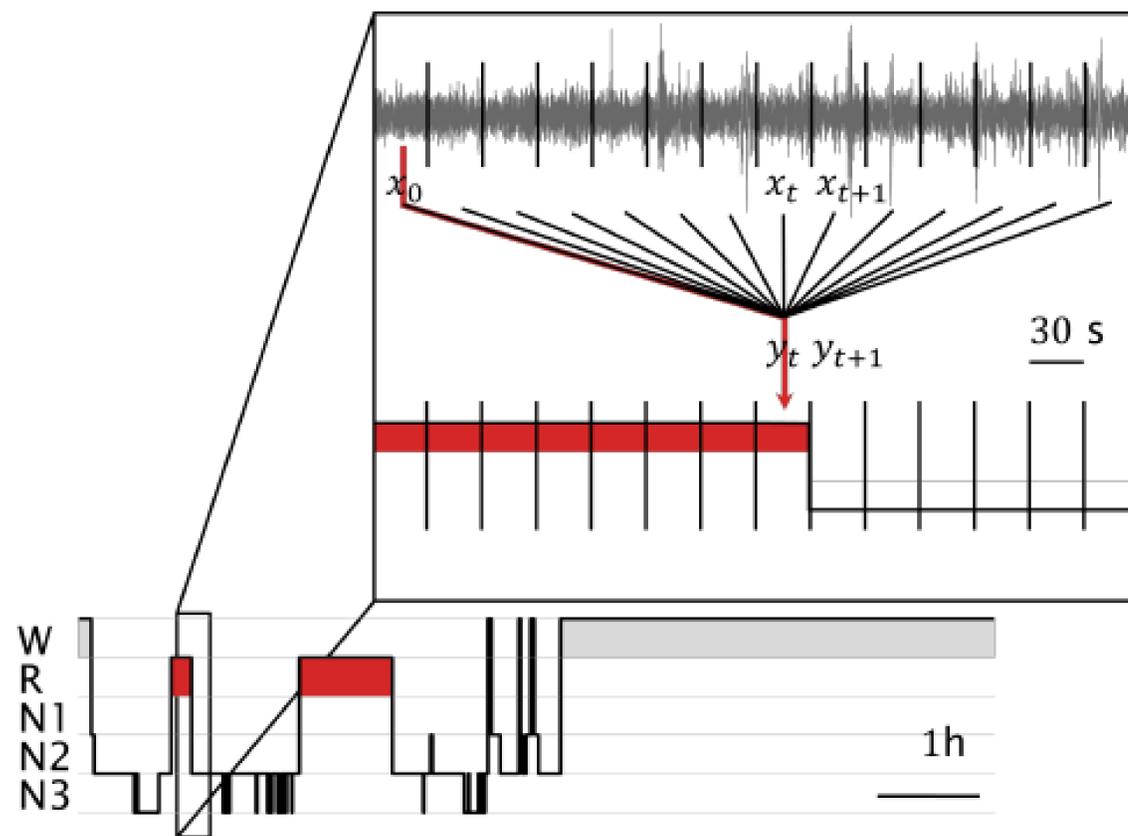
2010

2015

2024

# Long-term dependencies

- LSTM vs. Transformer vs. DeepSleepNet



Dataset	Model	Overall scores		Sleep stage F1-scores				
		$\kappa$	MF1	W	N1	N2	N3	R
MASS-SS3	SAM* (0.36 M)	<b>0.80</b>	<b>82%</b>	87%	56%	<b>91%</b>	85%	88%
EOGL-F4	DeepSleepNet*	<b>0.80</b>	<b>82%</b>	<b>88%</b>	58%	<b>91%</b>	84%	88%
	DeepSleepNet [21] (22 M)	<b>0.80</b>	<b>82%</b>	87%	<b>60%</b>	90%	82%	<b>89%</b>
	IIT [20]	0.79	81%	85%	54%	<b>91%</b>	<b>87%</b>	85%
SEDF-78	SAM*	<b>0.78</b>	<b>79%</b>	<b>93%</b>	49%	<b>86%</b>	<b>82%</b>	<b>84%</b>
Fpz-Cz	DeepSleepNet*	0.76	77%	92%	48%	84%	80%	79%
	CNN-LSTM [12]	0.77	-	-	-	-	-	-
	U-Time [18]	0.75	76%	92%	<b>51%</b>	83%	75%	80%

Brandmayr et al., ICONIP, 2021

# Sleep staging based on single EEG channel

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## Relational local electroencephalography representations for sleep scoring

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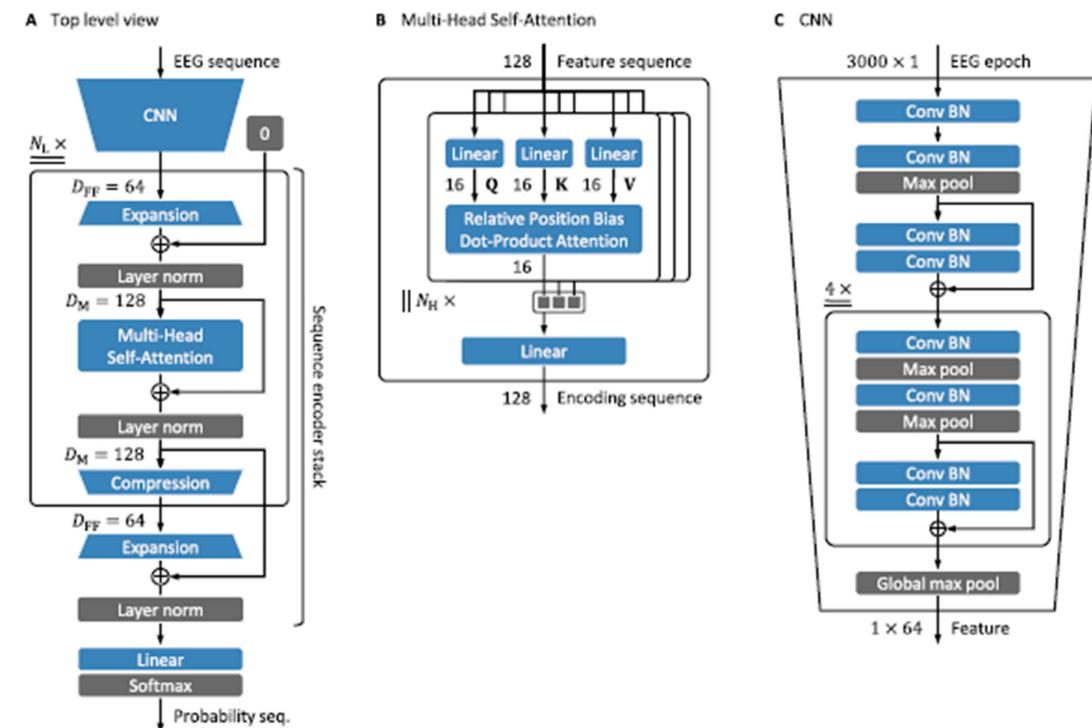
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REM

### ABSTRACT

Computational sleep scoring from multimodal neurophysiological time-series (polysomnography PSG) has achieved impressive clinical success. Models that use only a single electroencephalographic (EEG) channel from PSG have not yet received the same clinical recognition, since they lack Rapid Eye Movement (REM) scoring quality. The question whether this lack can be remedied at all remains an important one. We conjecture that predominant Long Short-Term Memory (LSTM) models do not adequately represent distant REM EEG segments (termed epochs), since LSTMs compress these to a fixed-size vector from separate past and future sequences. To this end, we introduce the EEG representation model ENGELBERT (electroEncephaloGraphic Epoch Local Bidirectional Encoder Representations from Transformer). It jointly attends to multiple EEG epochs from both past and future. Compared to typical token sequences in language, for which attention models have originally been conceived, overnight EEG sequences easily span more than 1000 30 s epochs. Local attention on overlapping windows reduces the critical quadratic computational complexity to linear, enabling versatile sub-one-hour to all-day scoring. ENGELBERT is at least one order of magnitude smaller than established LSTM models and is easy to train from scratch in a single phase. It surpassed state-of-the-art macro F1-scores in 3 single-EEG sleep scoring experiments. REM F1-scores were pushed to at least 86%. ENGELBERT virtually closed the gap to PSG-based methods from 4–5 percentage points (pp) to less than 1 pp F1-score.

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