Machine Learning for Disease Prediction and Signal Processing

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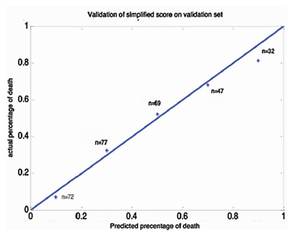
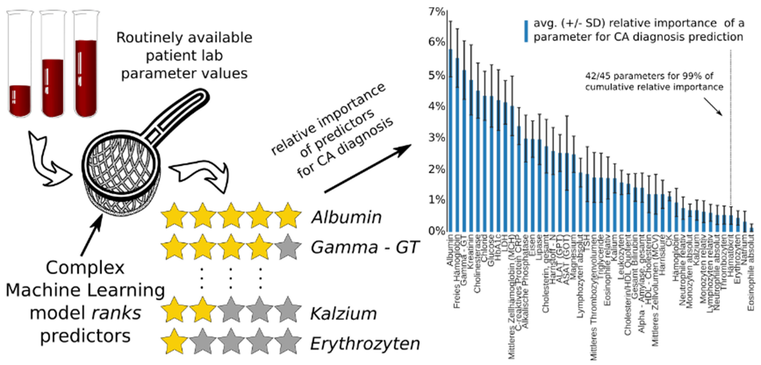
Prediction Models

Mortality prediction after cardiac arrest



Aschauer S. et al., Resuscitation, 2014

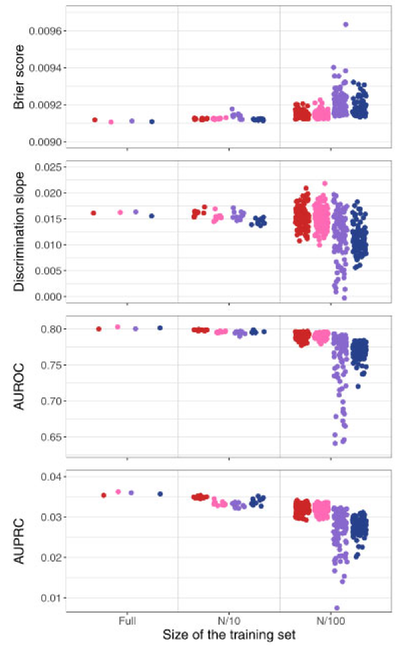
Predicting cardiac amyloidosis from lab paramters



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

Predicting cardiovascular disease,

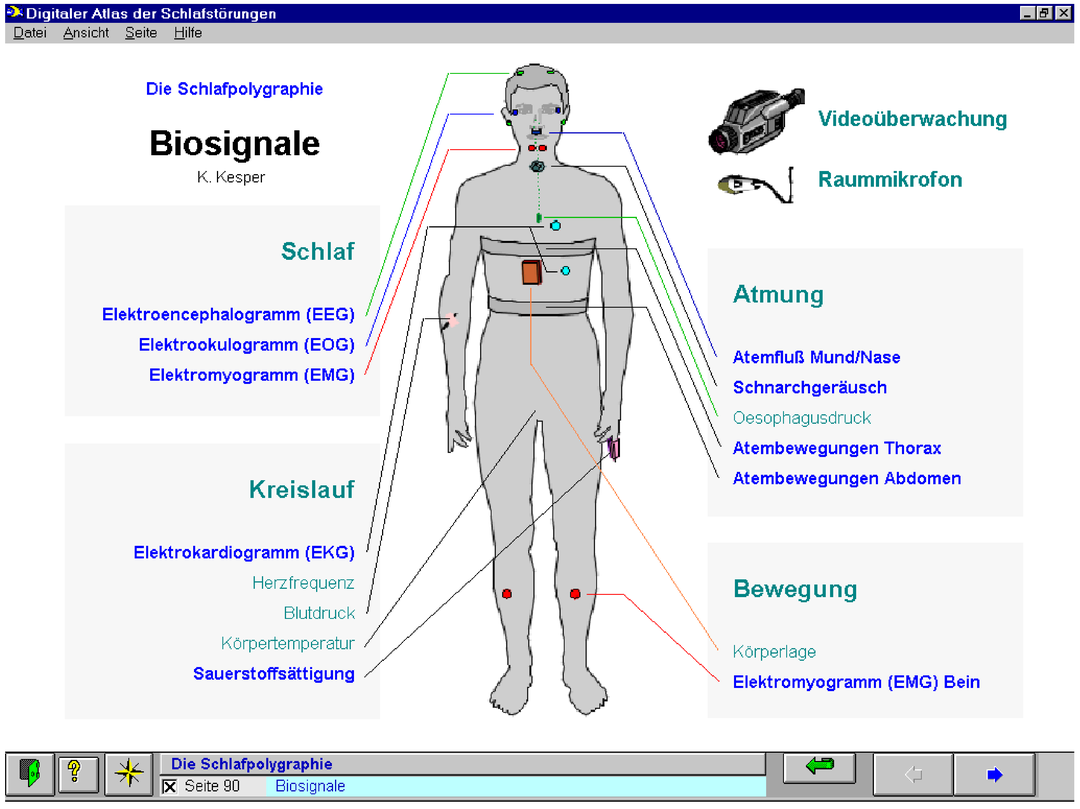
Benchmarking against more traditional statistics



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

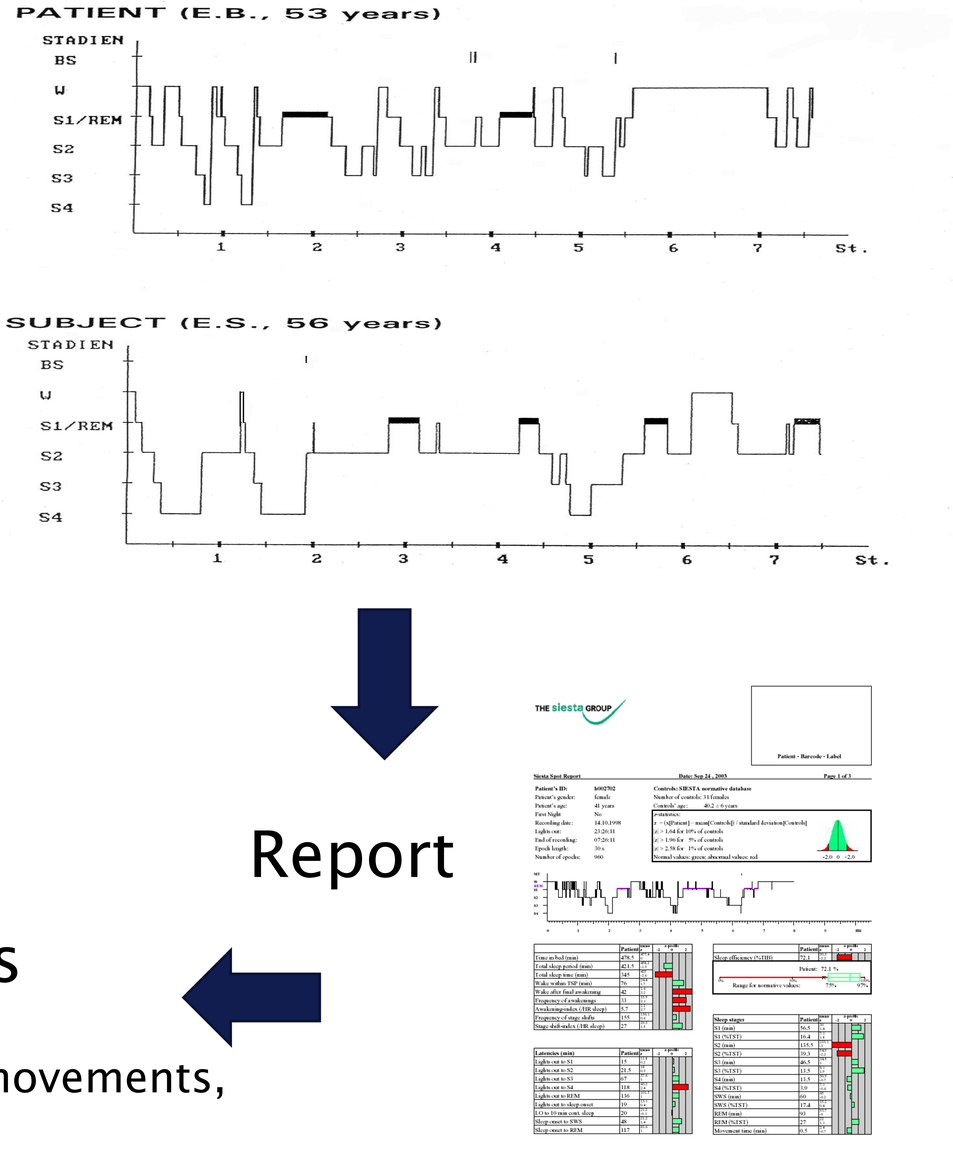
Sleep EEG analysis

Measurement: Polysomnography



Source: DGSM

Analysis: Sleep Profile



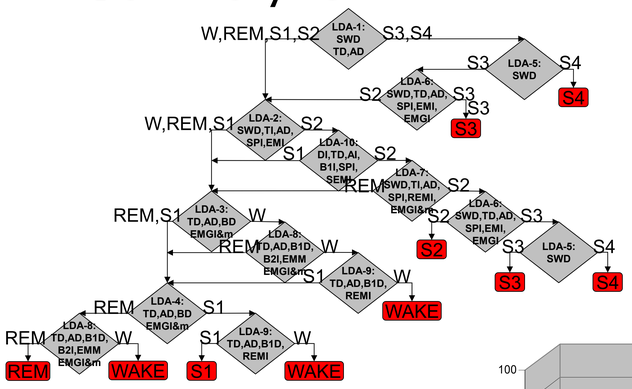
Report

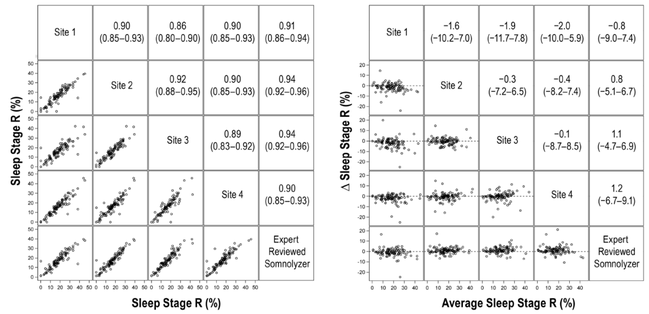
Diagnosis

(Sleep apnea,
Periodic leg movements,
etc.)

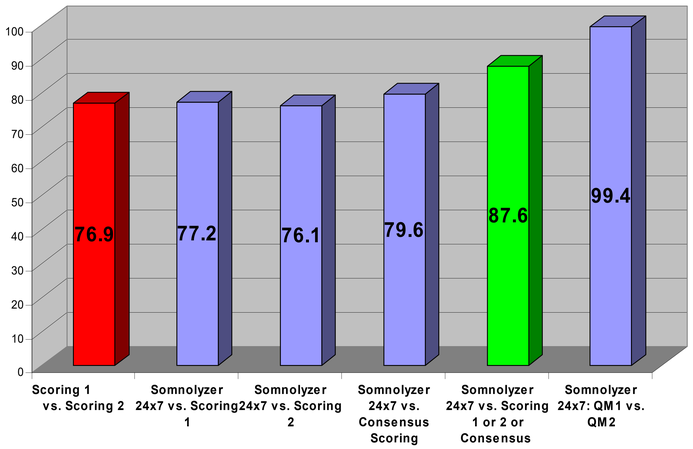
A very long journey

Somnolyzer 24x7

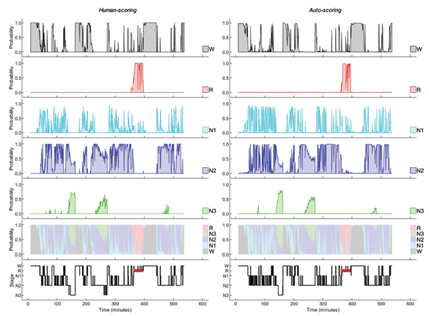




Punbjabi et al., Sleep, 2015



Anderer et al., Neuropsychobiology, 2005, 2010



Bakker et al., Sleep, 2023

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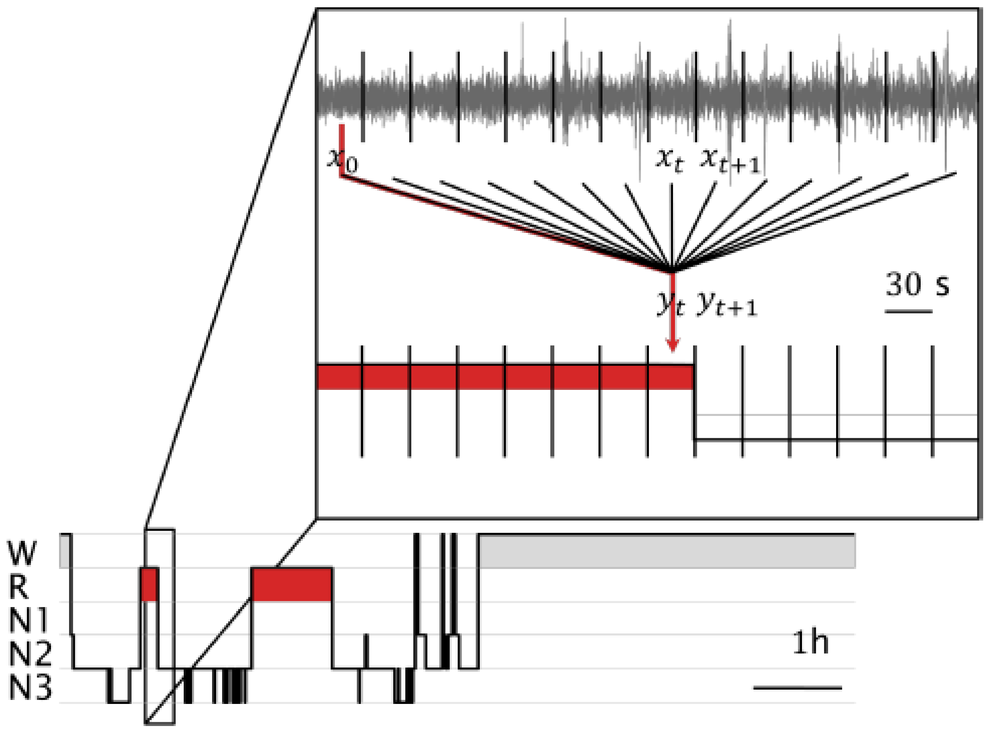
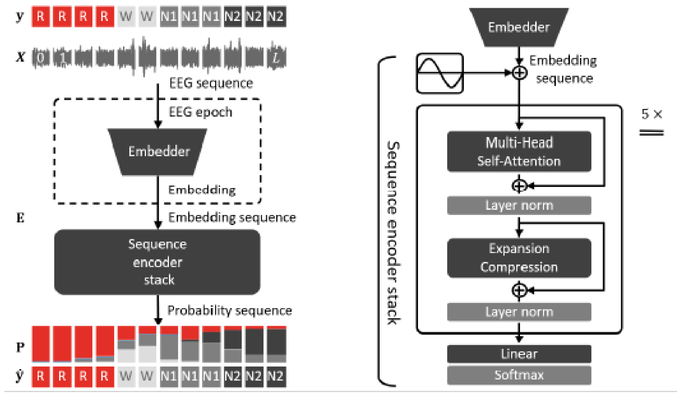
2004 2005 2010 2015 2024

Long-term dependencies

- LSTM vs. Transformer vs. DeepSleepNet





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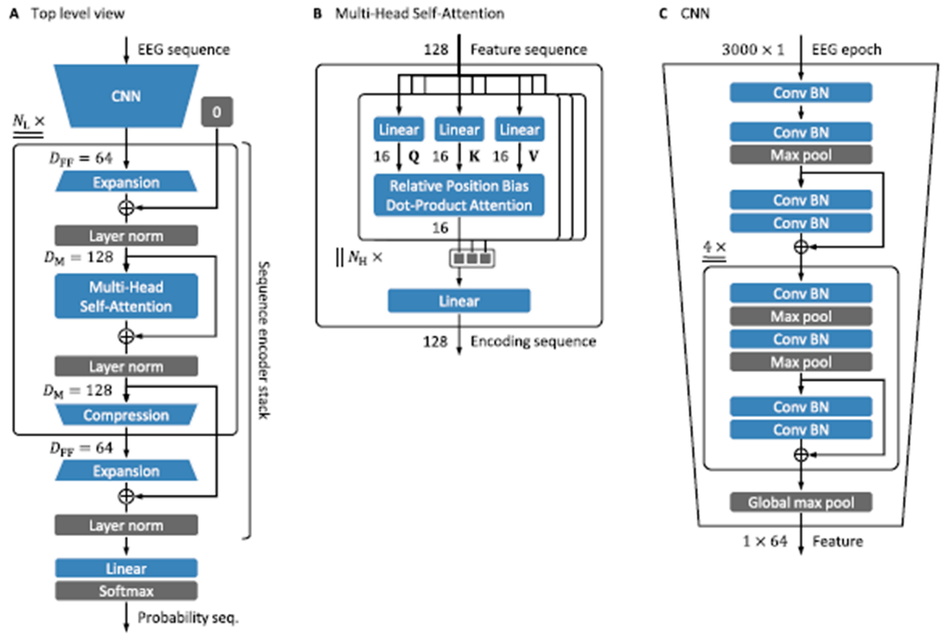
ABSTRACT

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 (electro**En**cephalo**G**raphic **E**poch **L**ocal **B**idirectional **E**ncoder **R**epresentations from **T**ransformer). 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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