

Improved Diagnostic by analyzing Electrical Biosignals with Deep Learning

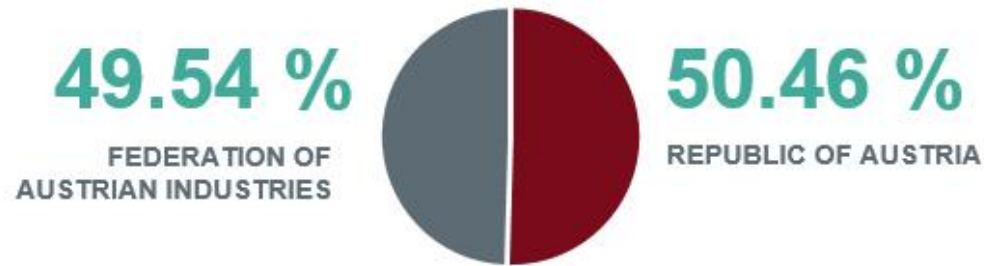


Dr. Franz Furbass
franz.fuerbass@ait.ac.at

AIT Austrian Institute of
Technology

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY

OWNERSHIP STRUCTURE



Seibersdorf Labor GmbH	Nuclear Engineering Seibersdorf GmbH
Energy	Health & Bioresources
Mobility Systems	Low-Emission Transport
Digital Safety & Security	Vision, Automation & Control
Technology Experience	Innovation Systems & Policy

over
1.300
employees



Medical Software for EEG Analysis



CE FDA



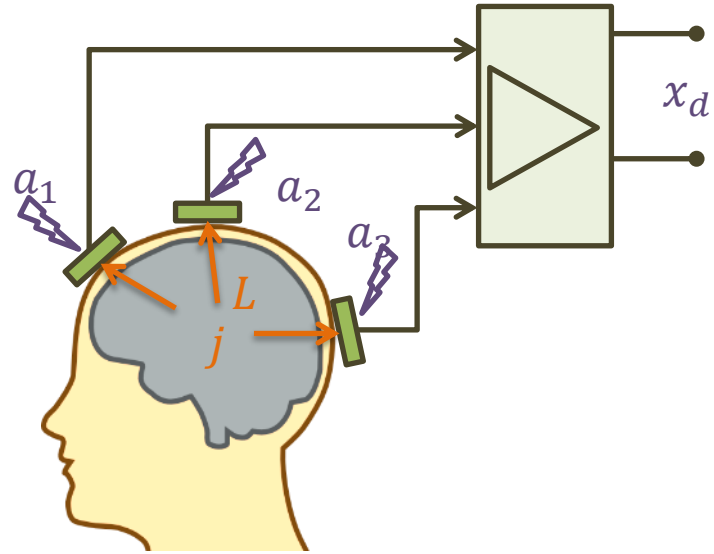
Content

- AI solving a new problem
- AI projects at AIT
- AI driven neurophysiology devices

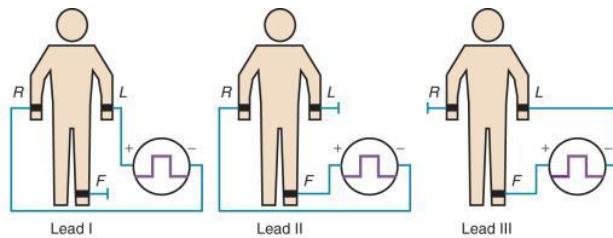
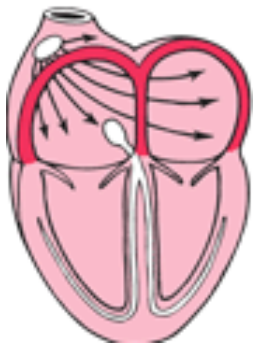
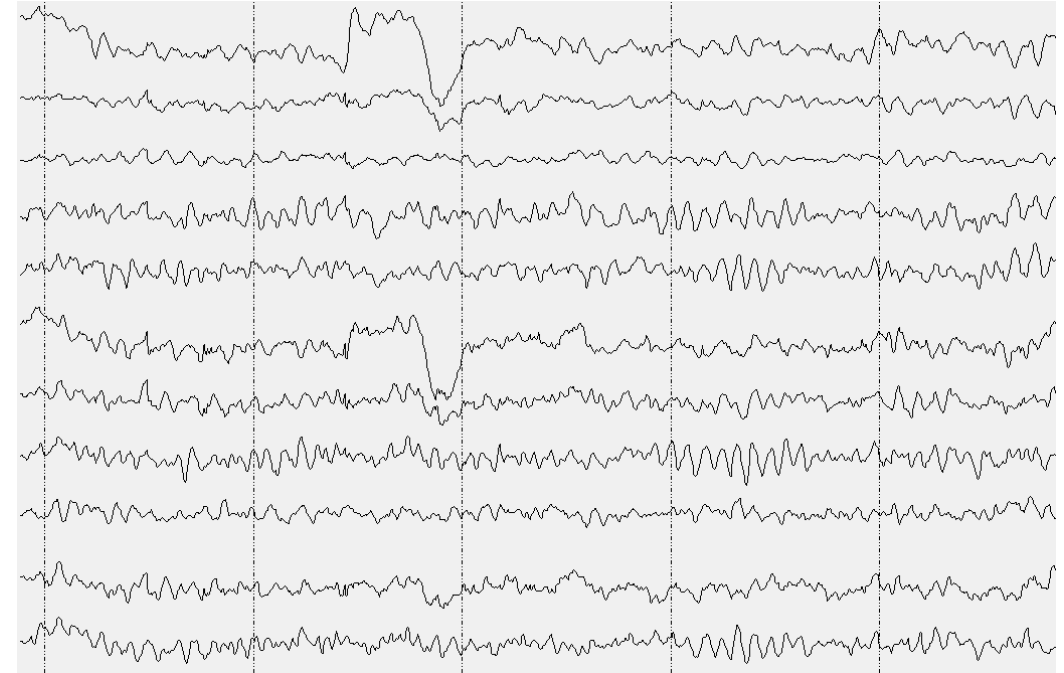
Artificial Intelligence solving a new problem



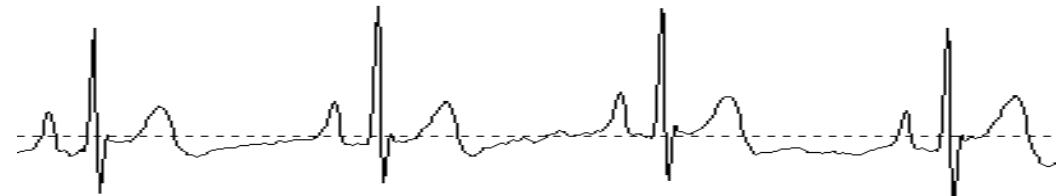
Capture Electric Biosignals



EEG

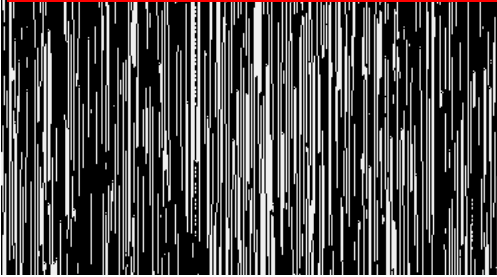


ECG

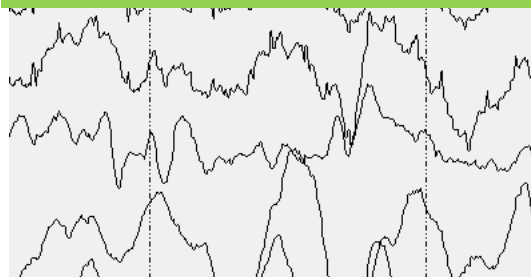


Interpretation of Electroencephalogram (EEG)

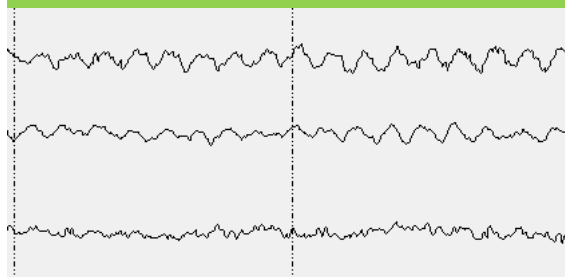
epileptic seizure:
time: < 3 minutes to
ensure life support



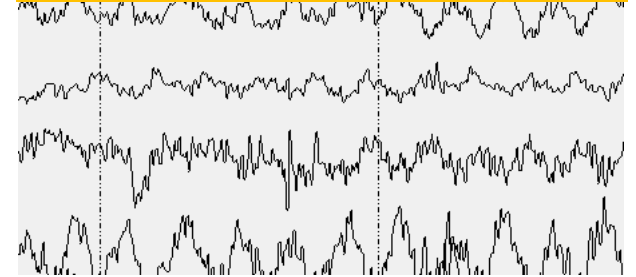
deep sleep, all well



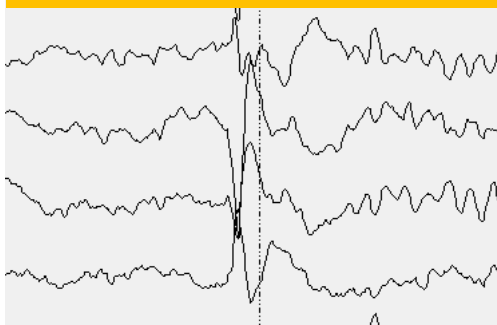
eyes closed. OK



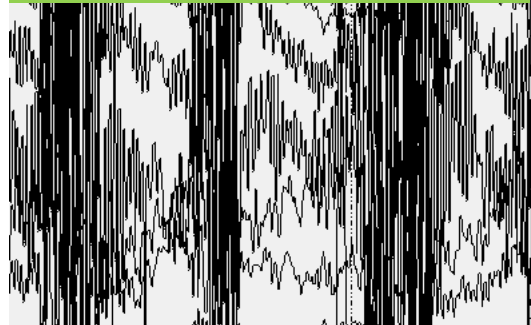
focal seizure:
time: < 3 min. for neuro tests
medication or brain surgery



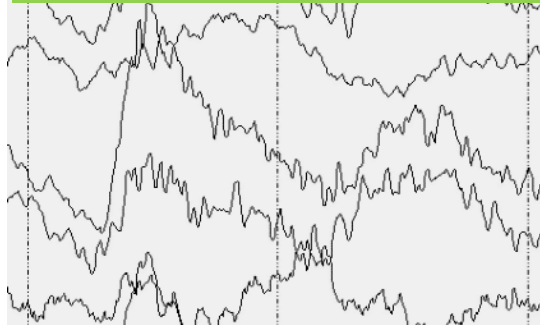
lateral focal spike
medication or
surgical intervention



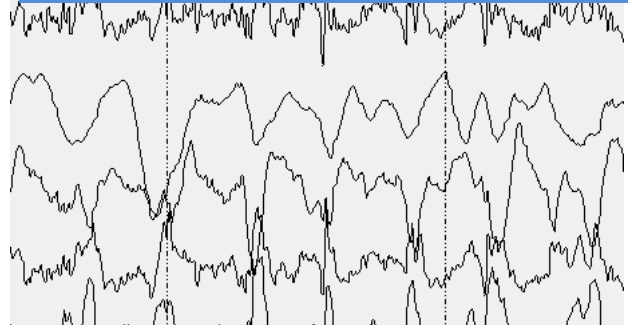
eating. OK



wake up: OK



status epilepticus:
Zeit: < 2 h to avoid irreversible
brain damage

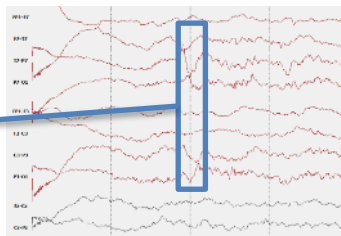


Goal: AI helps to diagnose

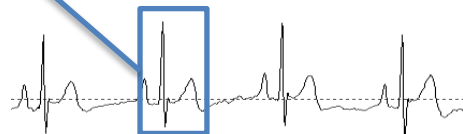


Visual patterns

EEG



ECG



10 sec – 5 days

Non-visual patterns: Biomarker, HFO, FC, SD



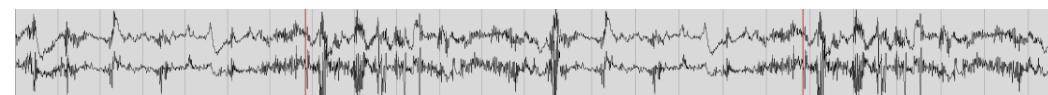
250 ms



5min

AI

Ultra long term with implants

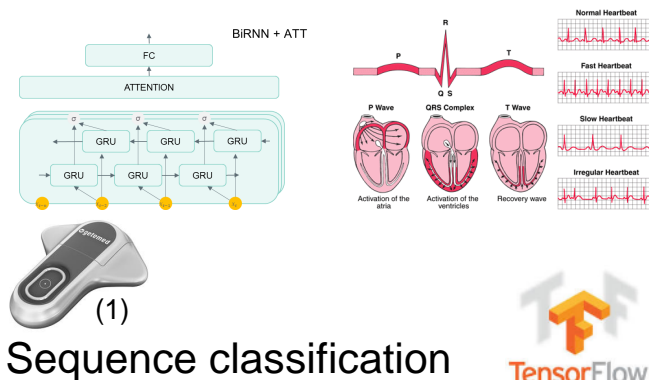


milliseconds to years

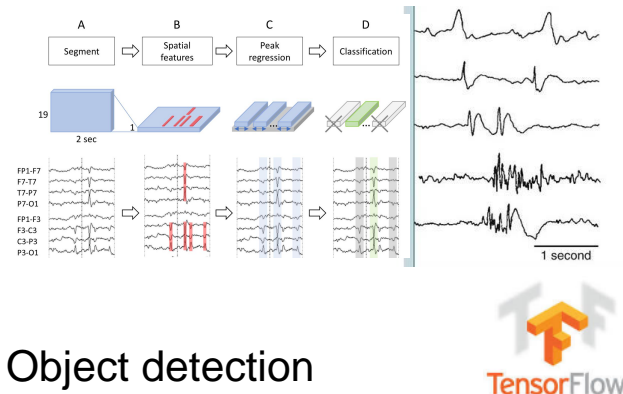
Projects at AIT



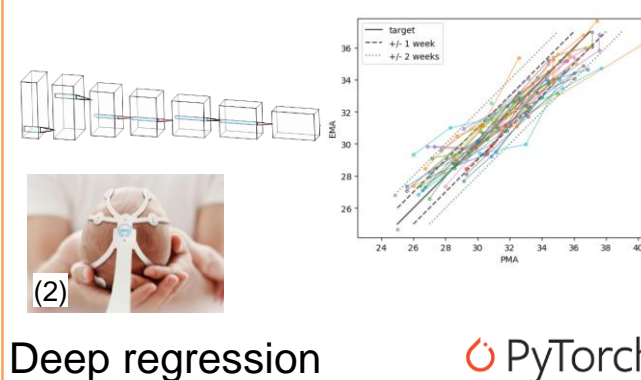
ECG Atrial Fibrillation Detection



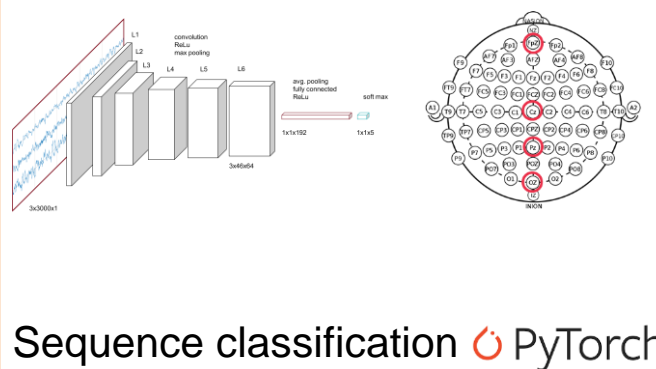
EEG Spike Detection



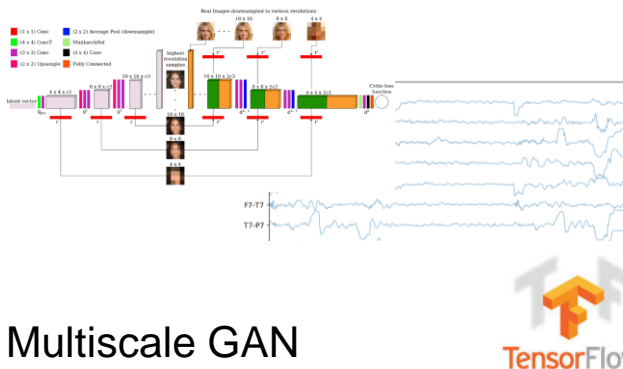
EEG Neonatal Age Estimation



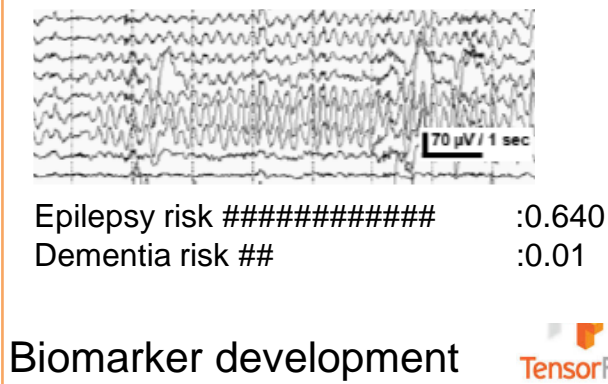
EEG Sleep Staging



EEG Generation

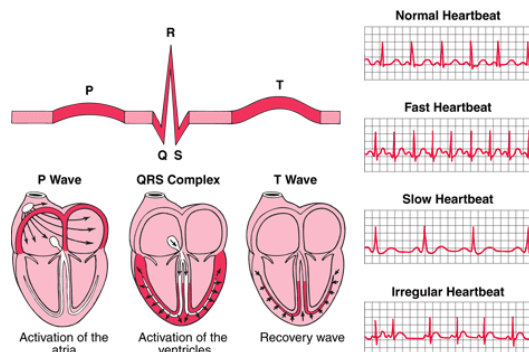


EEG Diagnosis



New ways in Cardiology: Outpatient monitoring using DL

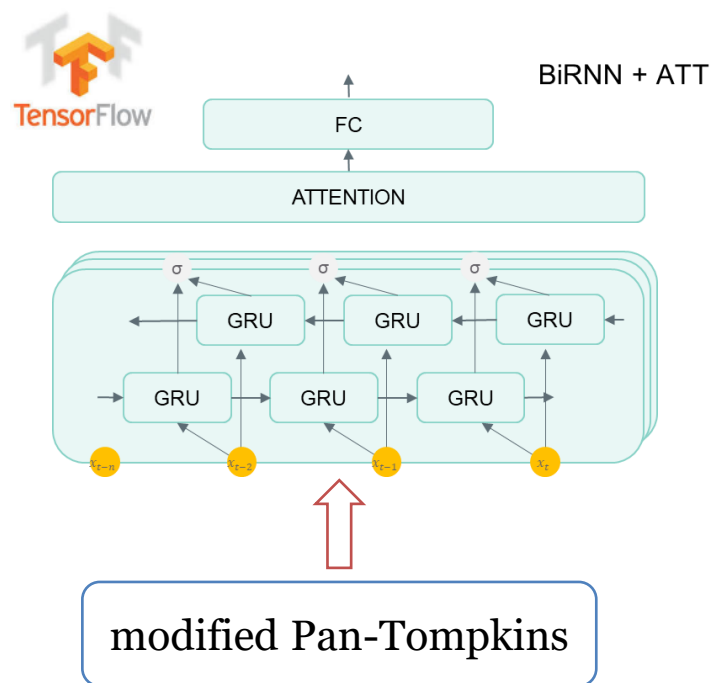
ECG Recording (Getemed)



getemed



Automatic ECG Analysis Server (AIT)

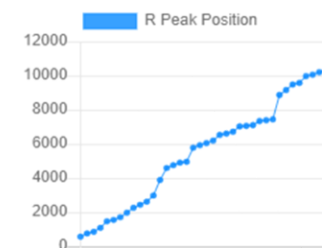
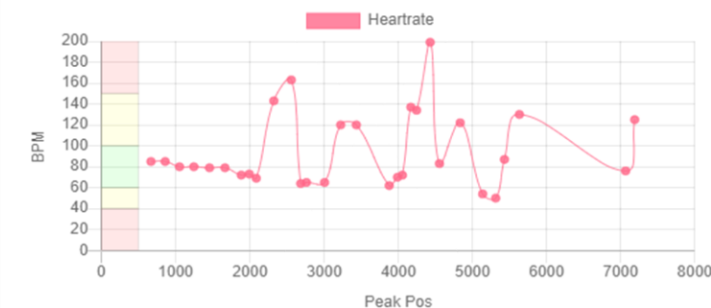


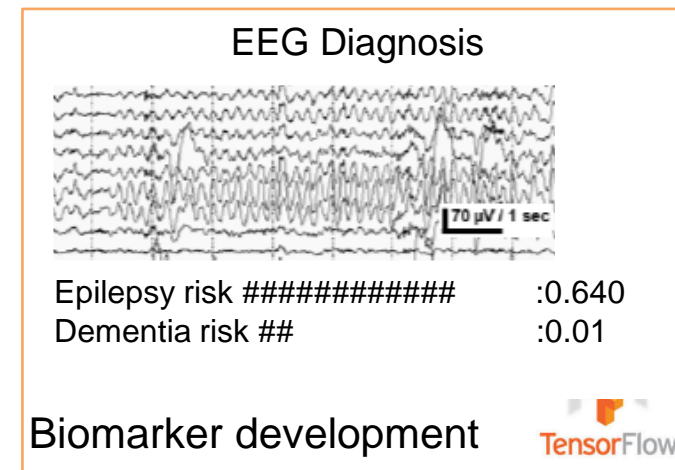
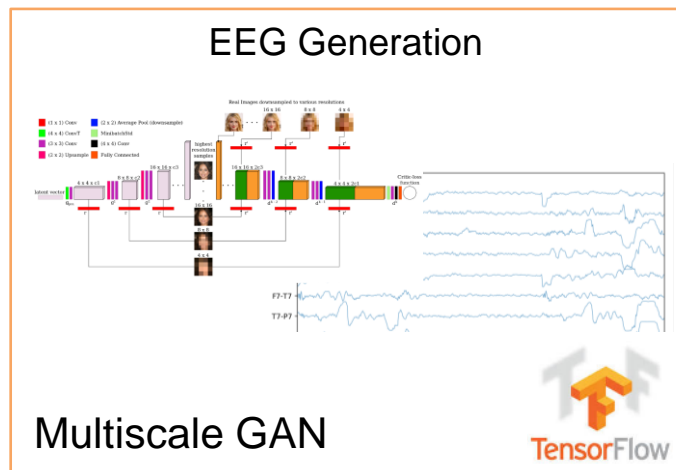
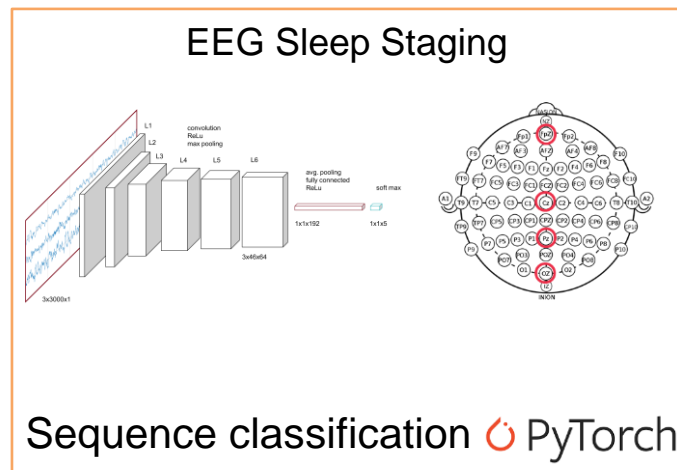
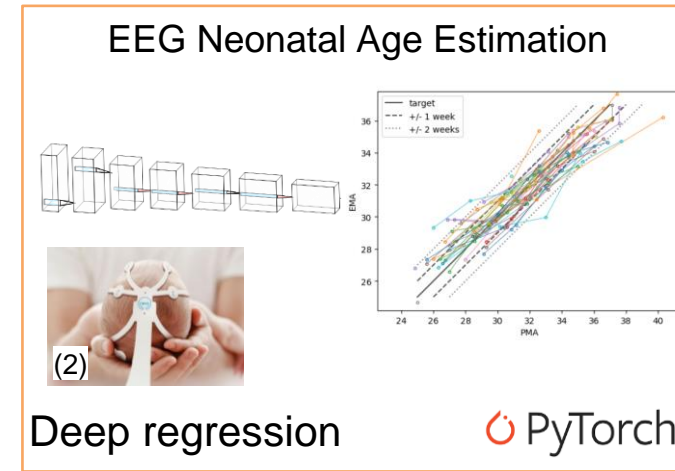
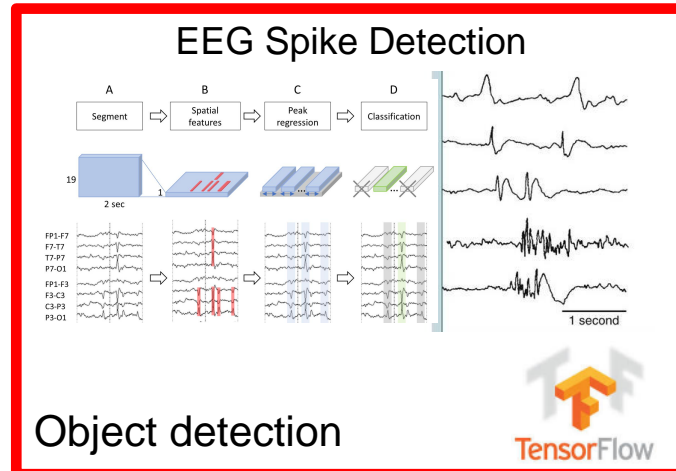
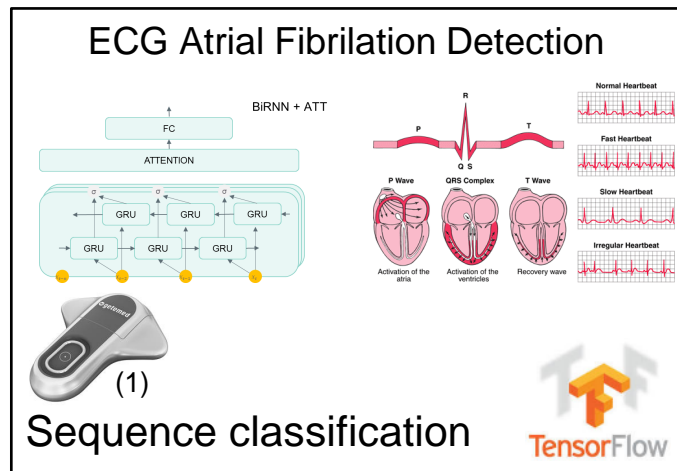
symptoma

ECG Overview

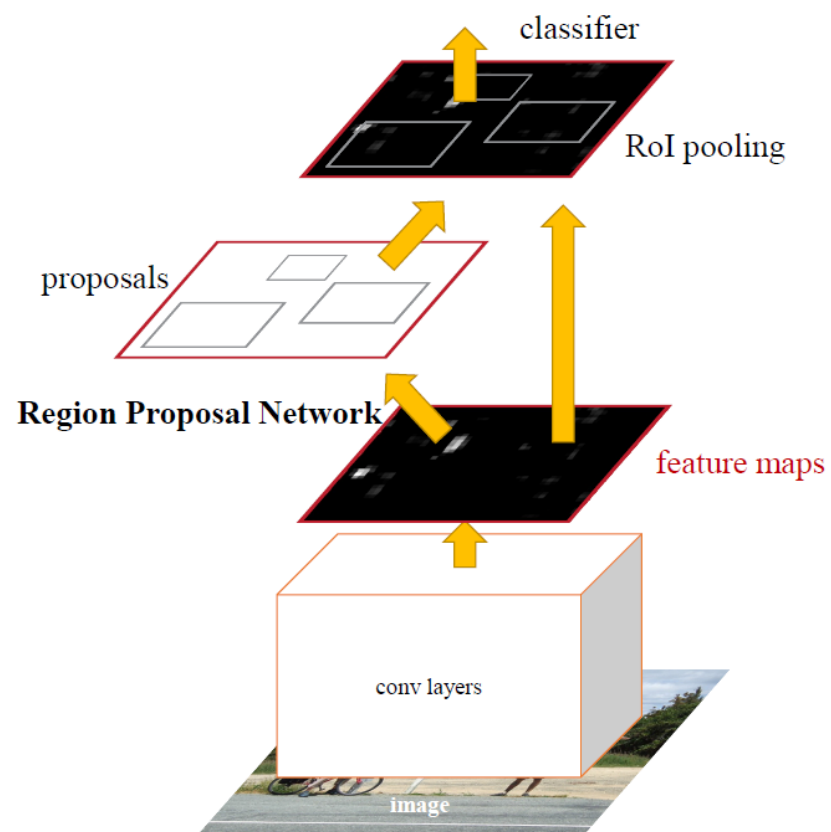
Atrial Fibrillation: **Not Detected**

Average Heartrate: **83**

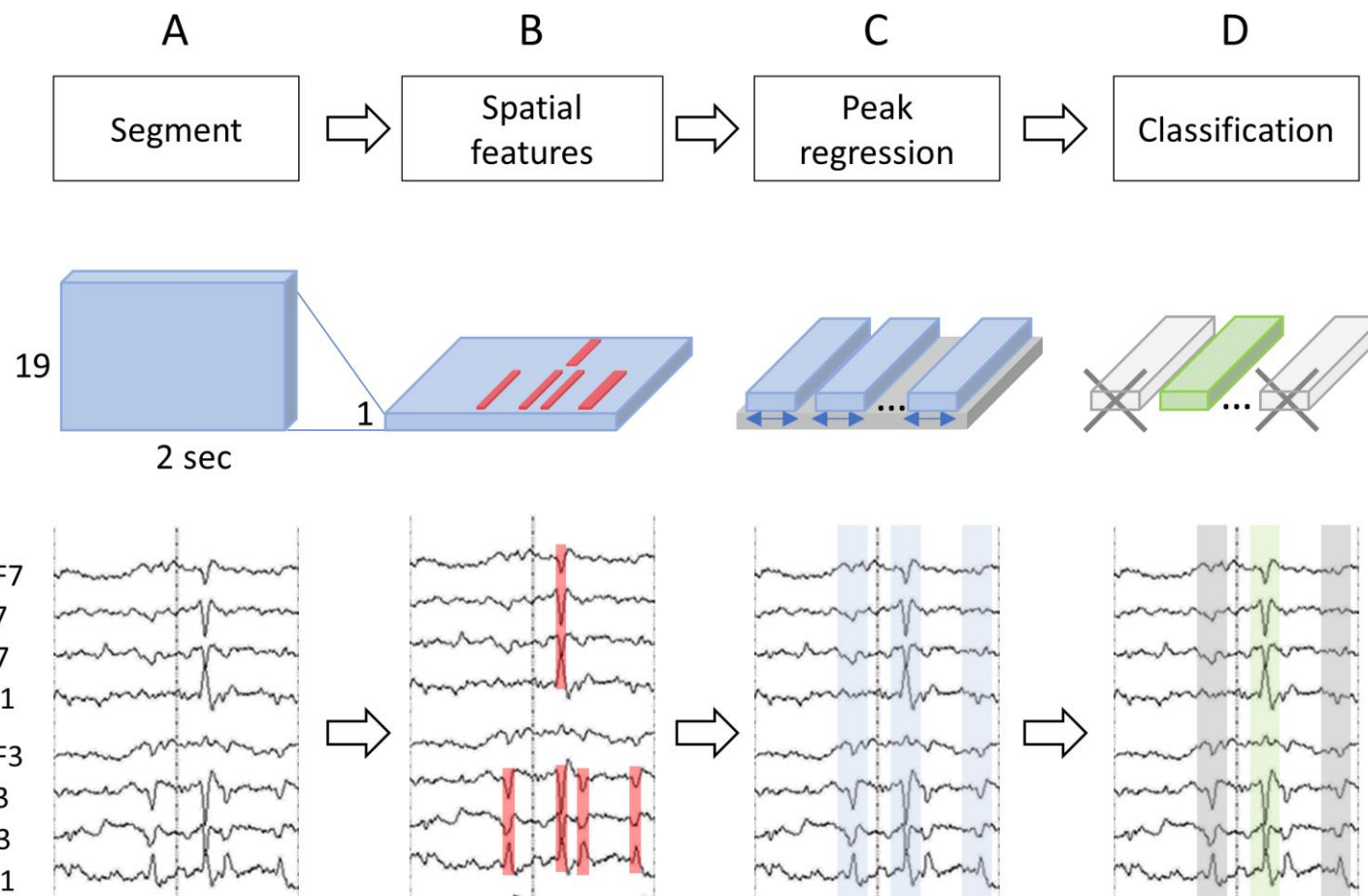


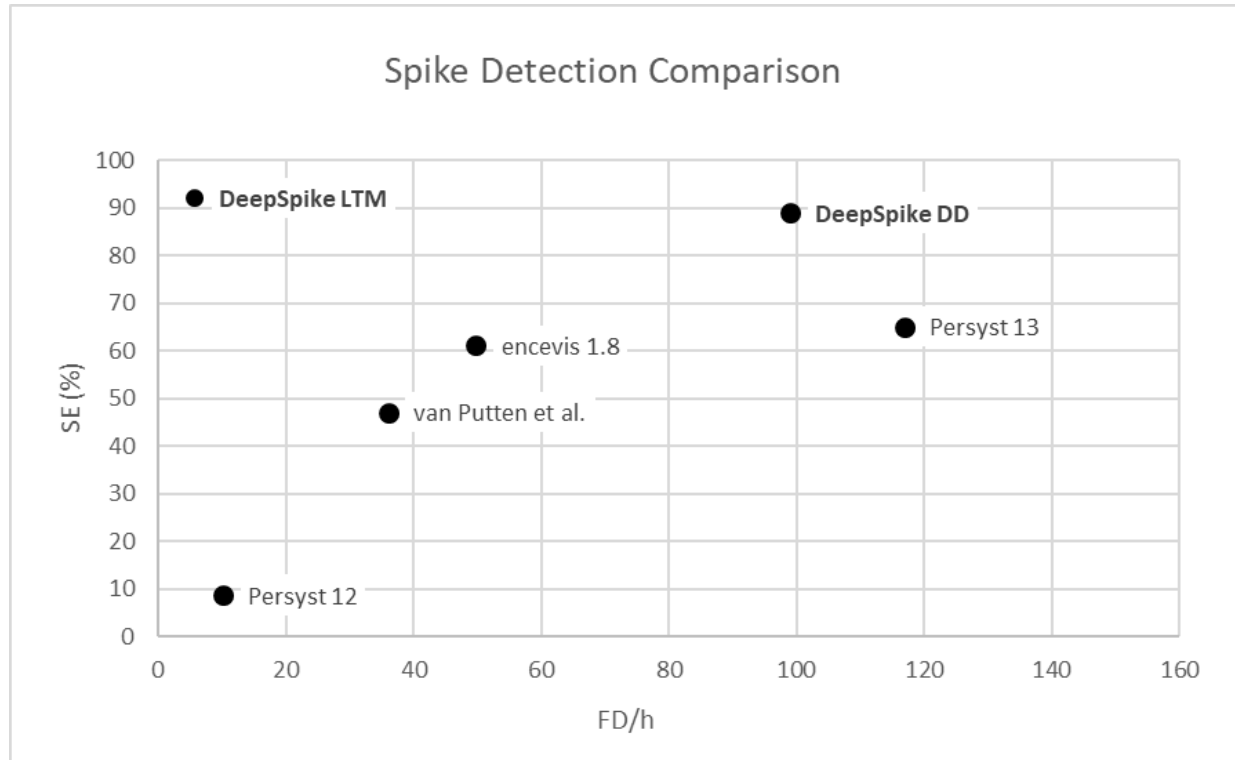


encevis DeepSpike to Diagnose Epilepsy



Source: <https://arxiv.org/pdf/1506.01497.pdf>





Clinical Neurophysiology

Available online 2 April 2020

In Press, Journal Pre-proof



An artificial intelligence-based EEG algorithm for detection of epileptiform EEG discharges: Validation against the diagnostic gold standard

Franz Ffurbass^a, Mustafa Aykut Kural^b, Gerhard Gritsch^a, Manfred Hartmann^a, Tilmann Kluge^a, Sándor Beniczky^{b,c}

^a Center for Health & Bioresources, AIT Austrian Institute of Technology GmbH, Vienna, Austria

^b Department of Clinical Neurophysiology, Aarhus University Hospital and Department of Clinical Medicine, Aarhus University, Aarhus, Denmark

^c Department of Clinical Neurophysiology, Danish Epilepsy Centre, Dianalund, Denmark

<https://doi.org/10.1016/j.clinph.2020.02.032>

External Validation: DD

Differential diagnosis data

n=100 patients, 15 sec

Daenisch Epilepsy Center

External Validation: LTM

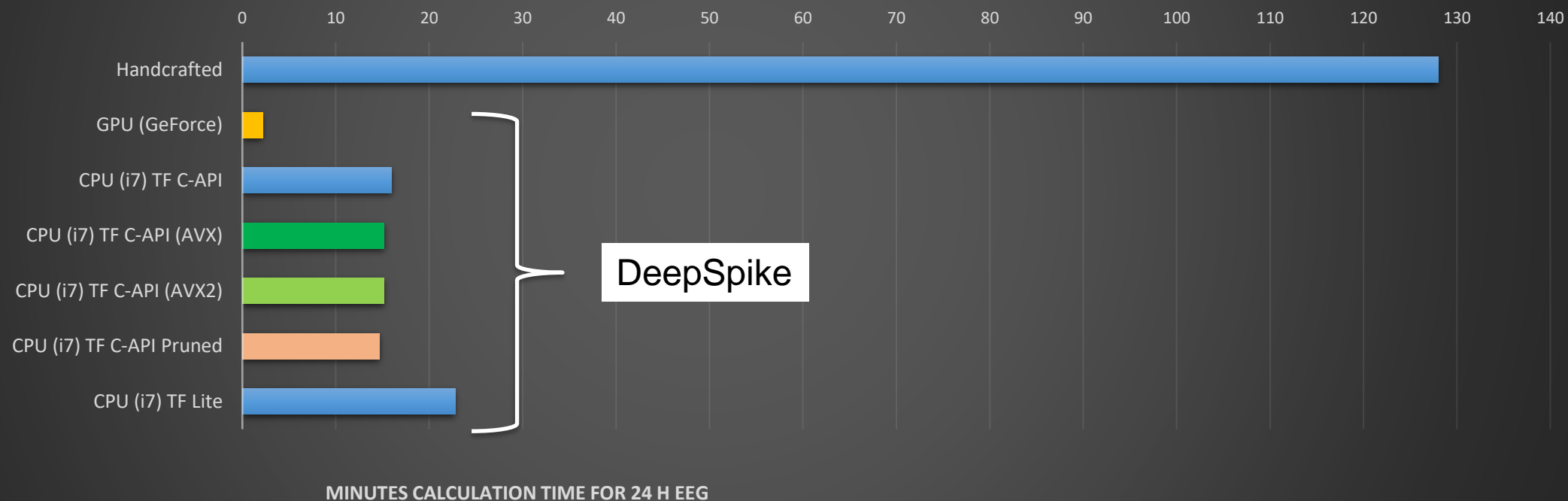
long term monitoring data

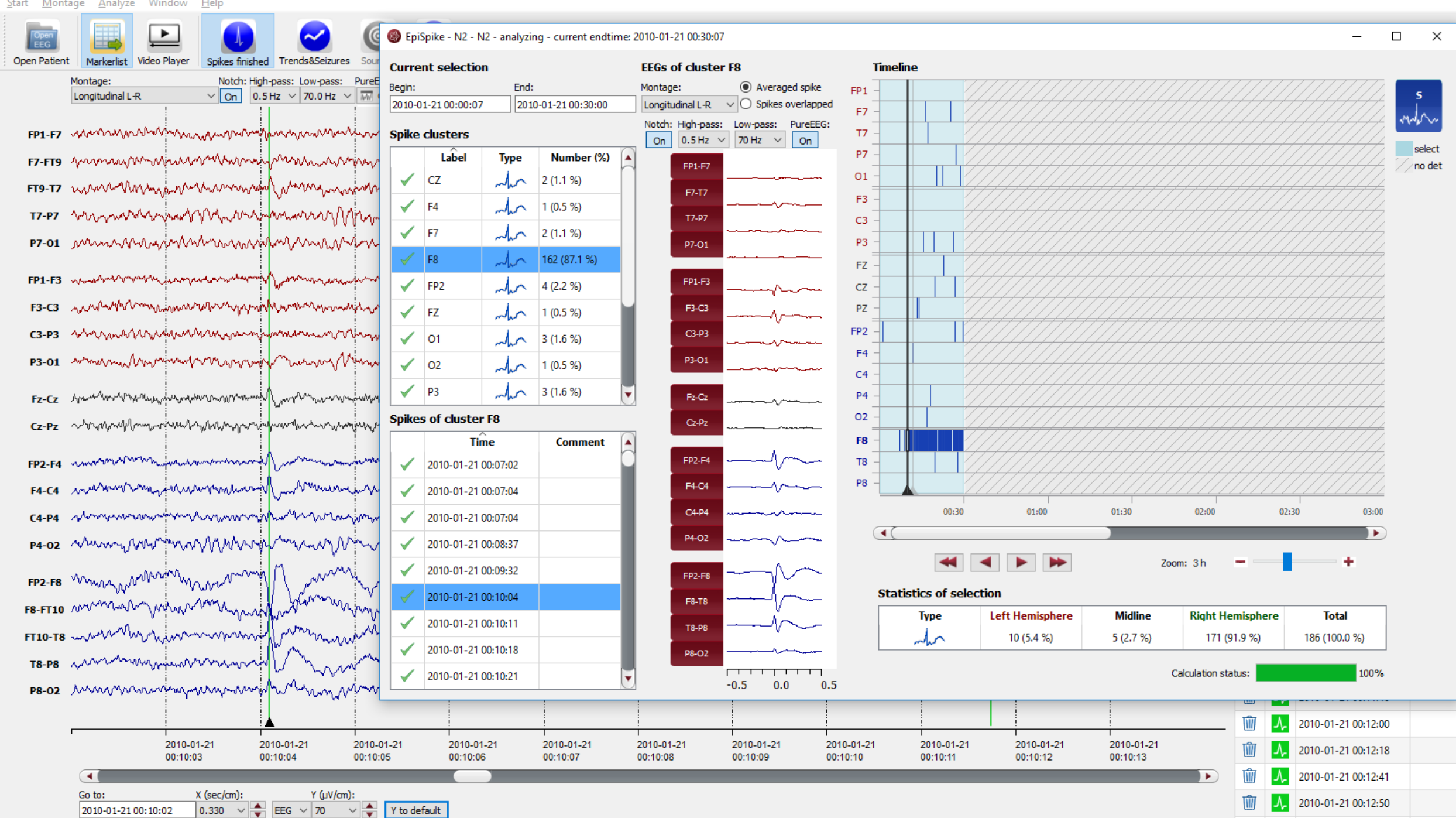
n=76 patients, 6770 hours

Neurology Department Hiezing

!! Don't rely on n-fold cross validation !!

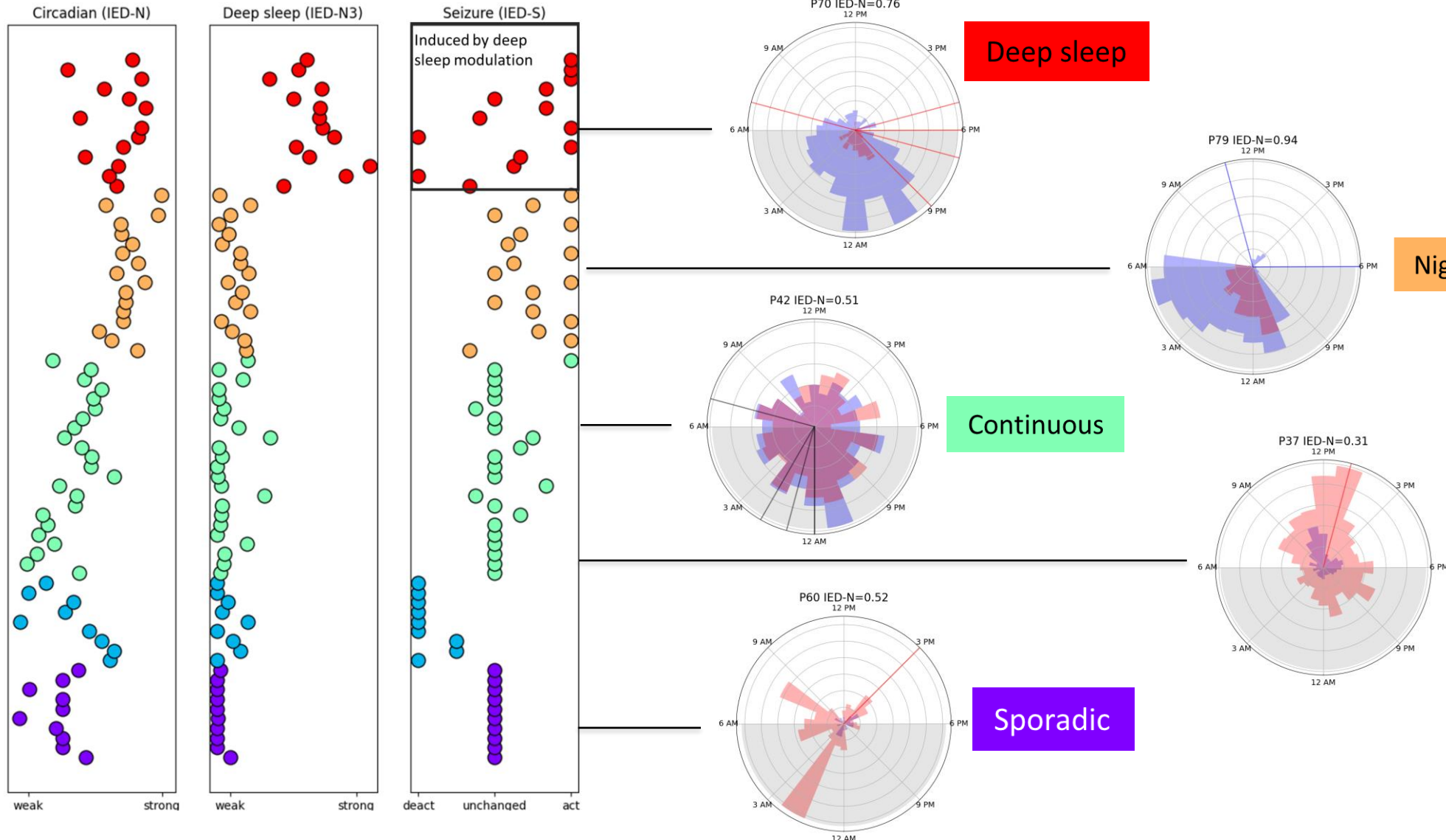
Spike detection calculation test, faster is better
N1.edf (30min)



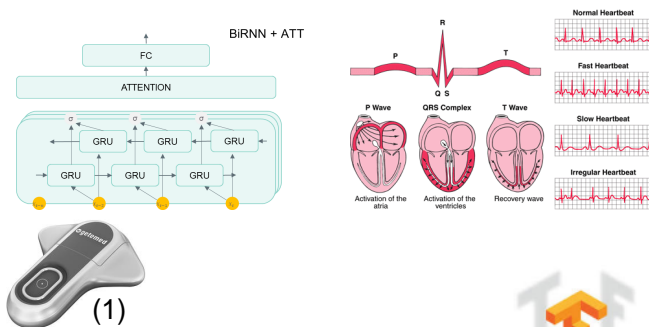


Spike Activation Patterns: DeepSpike

Circadian – Sleep – Seizure relation of spikes



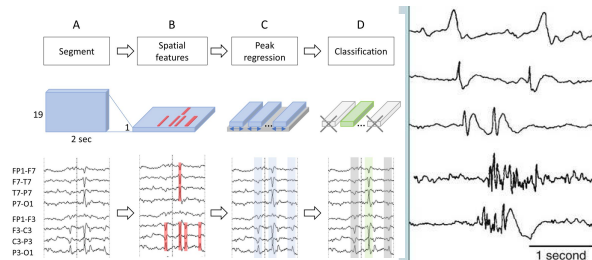
ECG Atrial Fibrillation Detection



Sequence classification



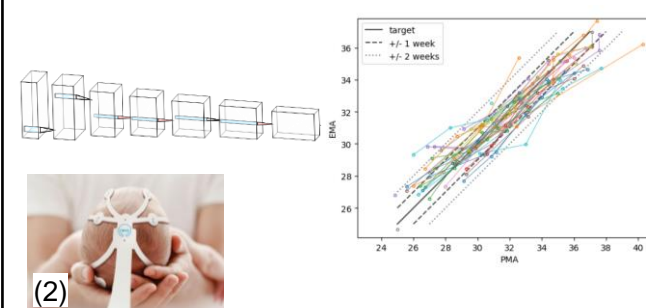
EEG Spike Detection



Object detection



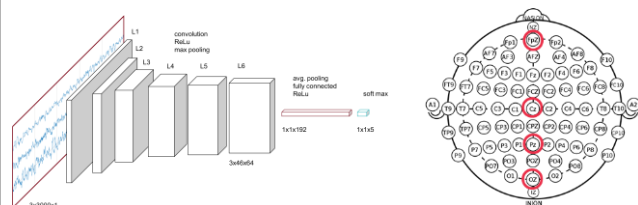
EEG Neonatal Age Estimation



Deep regression



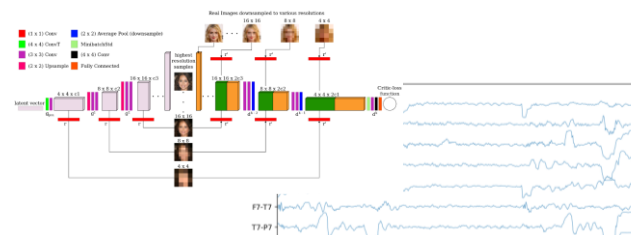
EEG Sleep Staging



Sequence classification



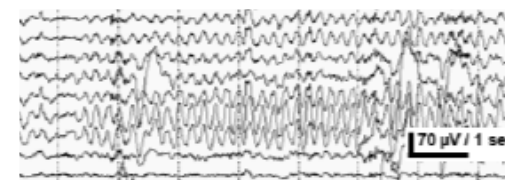
EEG Generation



Multiscale GAN



EEG Diagnosis

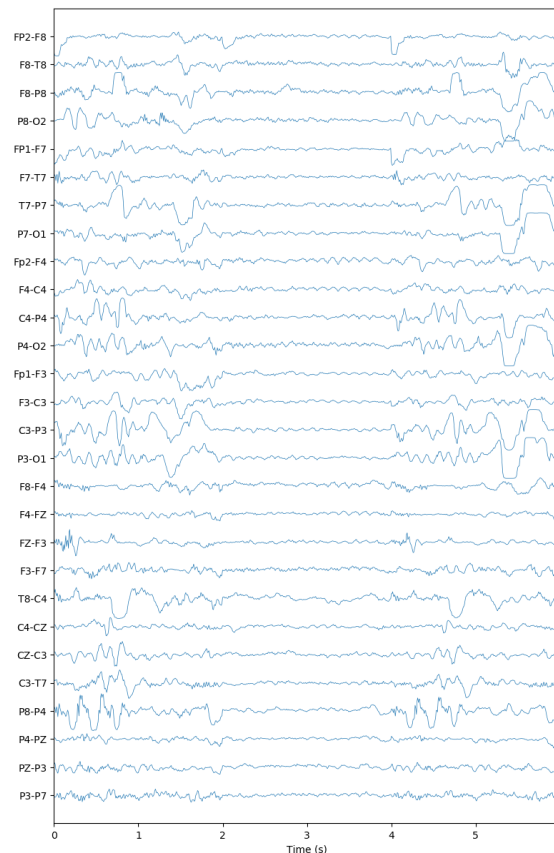


Epilepsy risk ##### :0.640
Dementia risk ## :0.01

Biomarker development



Artificial Data



EEG

MOSTLY.AI [PRODUCT](#) [SOLUTIONS](#) [USE CASES](#) [BLOG](#)

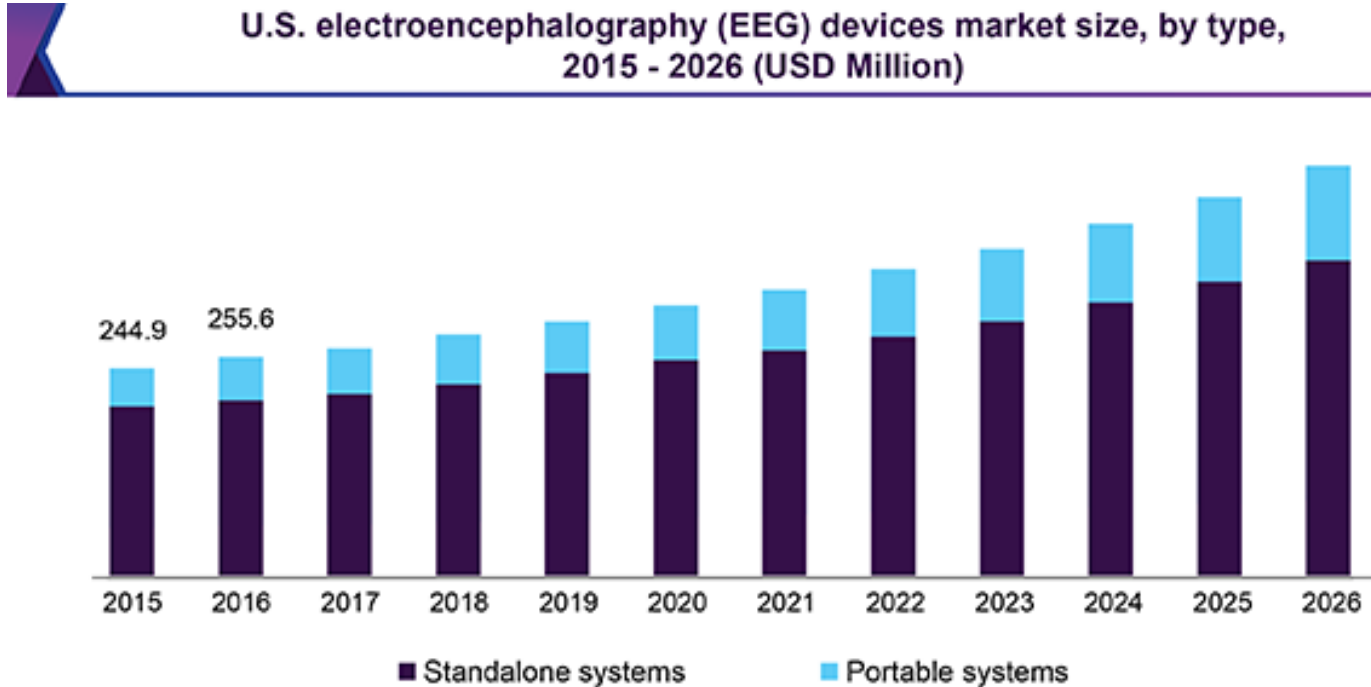
**Democratize your data access
with synthetic data!
No more **backlogs**.
Guaranteed.**

Create highly realistic, privacy-safe synthetic datasets proven to be compliant even with the strictest data protection laws.

Neurophysiology Devices & Software



Electrodiagnostic market is growing



Source: www.grandviewresearch.com



32

2017



27

2019

Royal Phillips aquired Electrical Geostatics Inc (EGI) for € 32 M

Alan Musk raised \$27 M for Neuralink (neuralink.com)

New ways to do EEG



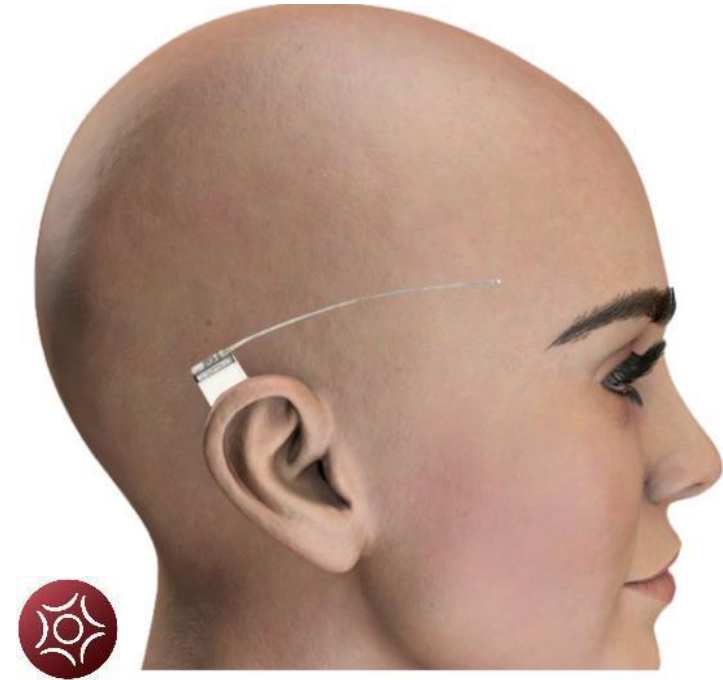
UNEED™ medical



Fast setup, dry, cloud computing

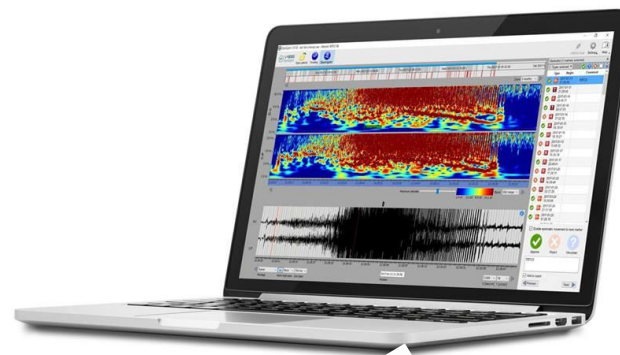


High spatial resolution

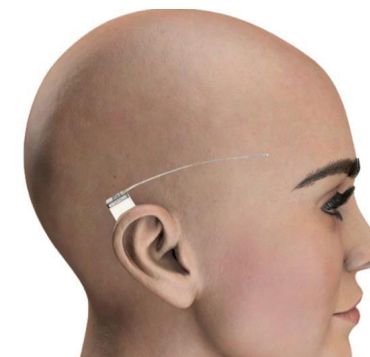


Ultra long-term subcutaneous implant
Seizure counting

AIT's Medical Software for EEG Analysis



UNEED™ medical

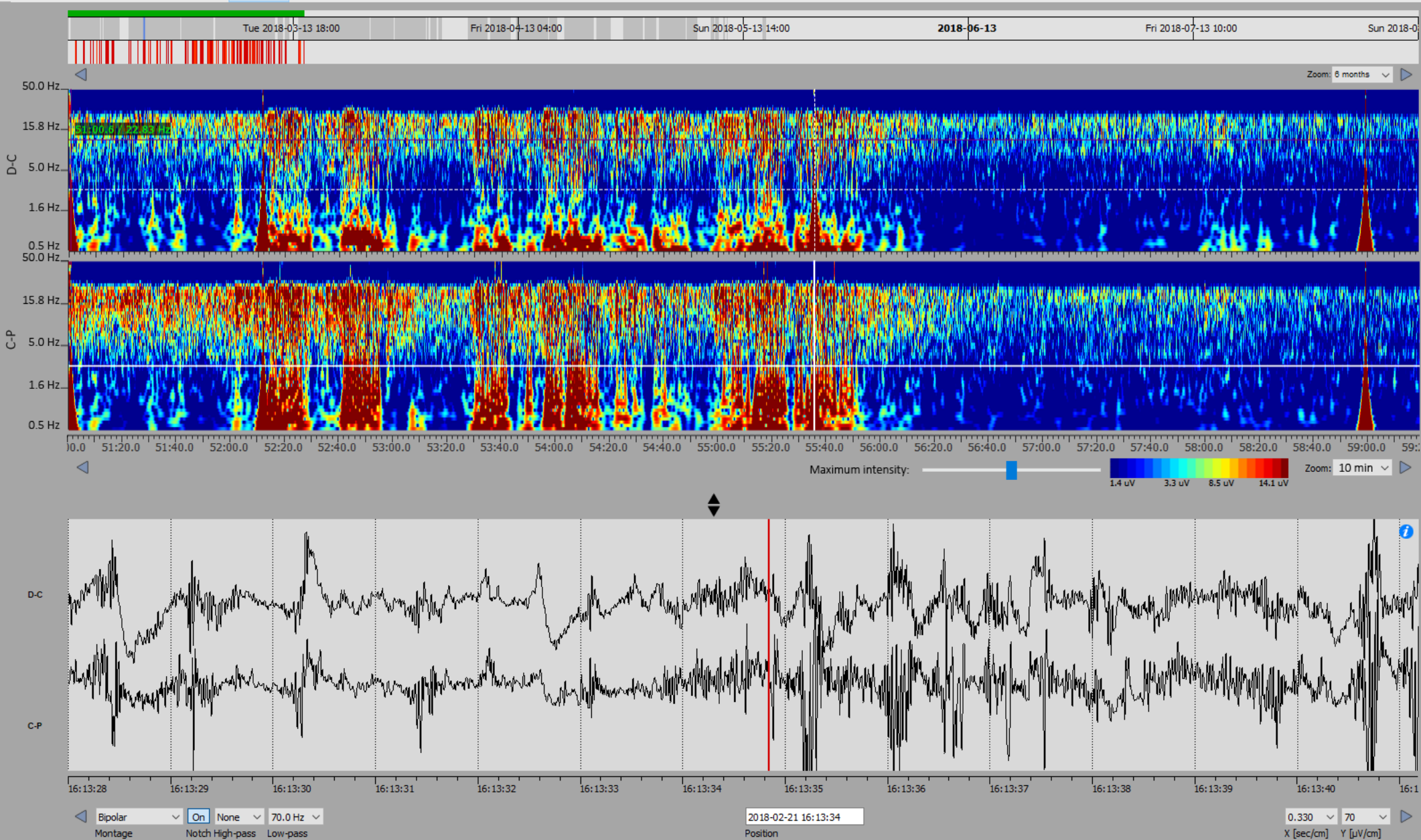


www.encevis.com



artifact reduction Spike/seizure detection
source localization EEG trending





Markerlist (1 markers selected)

All types

Type	Begin	Comment
✓ R	2018-02-16 15:23:51	
✓ R	2018-02-16 18:56:14	
? R	2018-02-17 07:22:40	
✓ R	2018-02-17 10:39:47	
? R	2018-02-17 10:43:52	
✗ R	2018-02-17 11:07:34	
✓ R	2018-02-17 12:26:33	
✓ R	2018-02-19 13:49:43	
✗ R	2018-02-19 18:27:29	
✓ R	2018-02-20 19:09:43	
✓ R	2018-02-21 11:55:29	
+	2018-02-21 16:13:34	
+	2018-02-21 16:29:02	
+	2018-02-21 18:28:32	
+	2018-02-22 06:16:50	
+	2018-02-22 11:48:47	
+	2018-02-22 11:58:43	
+	2018-02-22 12:08:35	
+	2018-02-23 06:16:11	
+	2018-02-23 09:45:07	
+	2018-02-23 20:03:15	
+	2018-02-24 16:11:37	

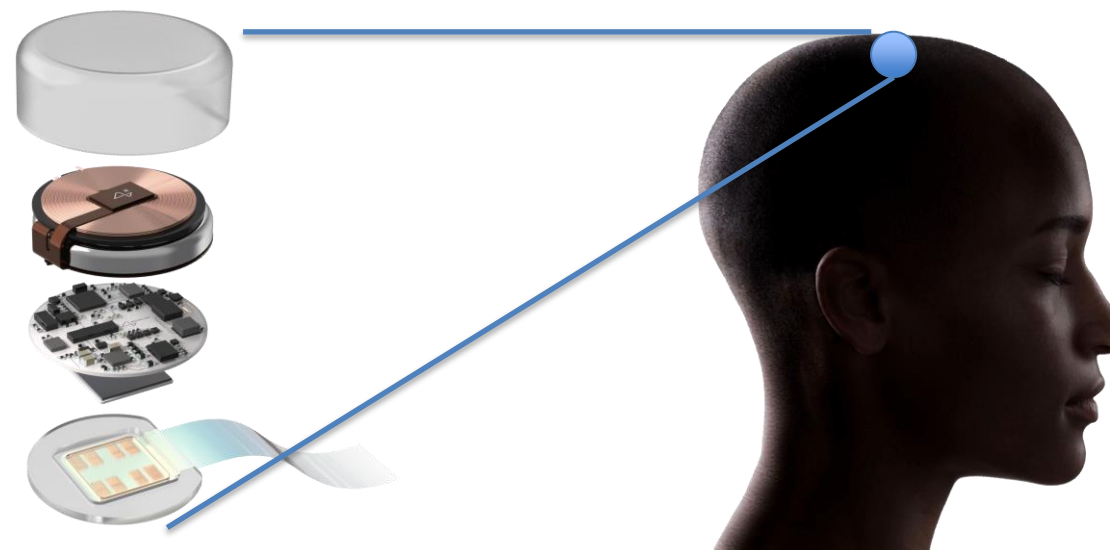
☒ Enable automatic movement to next marker

Approve Reject Uncertain

Some coment. Linked to comment field in maker list

Previous Next

Neuralink: Brain Computer Interface



New ways to do EEG



ceribell



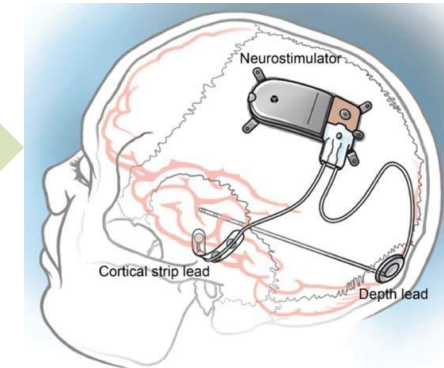
www.brainscientific.com/memorymd/

Fast setup, Disposable Cap

- ~ 2500 patients worldwide
- ~ 1900 patient years recorded

AI used to

- find similar patient
- find next parameter to try



Ultra-long + treatment

Apple Watch: ECG



Measures

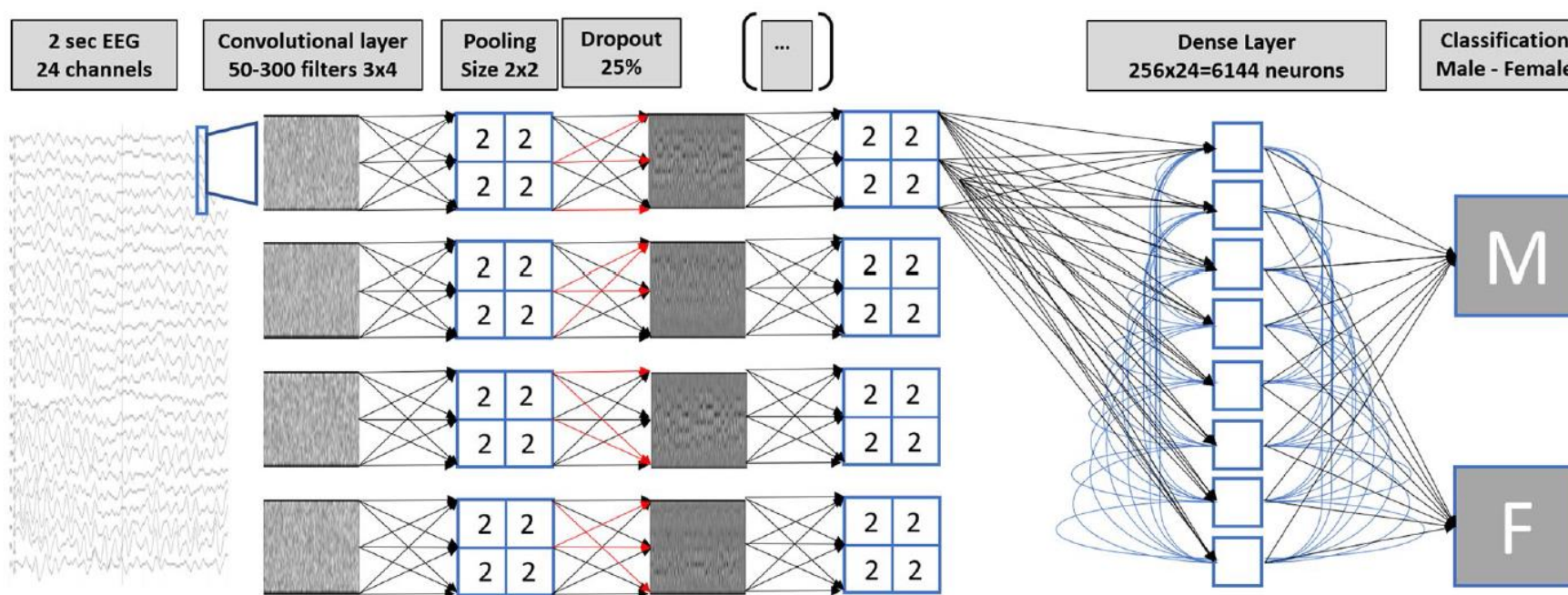
- heart rate (sine rhythm)
- warns about atrial fibrillation
- tachycardia
- FDA approved for SW only

Things that were impossible before DL

SCIENTIFIC REPORTS

OPEN Predicting sex from brain rhythms with deep learning

Michel J. A. M. van Putten¹, Sebastian Olbrich² & Martijn Arns³



accuracy = 83%

Source: <https://www.nature.com/articles/s41598-018-21495-7.pdf>

11/03/2021

Conclusion

- New needs for neuro-diagnostic
- emergence of AI-based solutions for biosignal analysis
- AI increases flexibility of medical device design

THANK YOU!



<https://www.linkedin.com/in/franz-f%C3%BCrbass-a519b713>

<https://open.spotify.com/episode/5OcfEziPxpXWPXsIKyRmlK>

Dick Moberg's Neural Network

Automating Spike and Seizure Detection

Dick Moberg's Neural Network

19. DEZ. · 17 MIN.

Franz Fürbass and Ana Skupch from Encevis discuss their company's solution for automatically identifying seizures in EEG recordings using deep learning. The views and opinions expressed on this podcast do not necessarily reflect those of Moberg Research, Inc. Moberg Research, Inc. makes no clinical claims or recommendations regarding the information described in this podcast. Music from <https://filmmusic.io> "Wholesome" by Kevin MacLeod (<https://incompetech.com>) License: CC BY (<http://creativecommons.org/licenses/by/4.0/>)

Dr. Franz Fürbass
franz.fuerbass@ait.ac.at

encevis

Home News Solutions Research About us Contact Downloads

The AIT team behind encevis

The basis of our success

Our team at AIT is working on outstanding solutions for computational EEG analysis. We develop both the algorithms and the software to run it. We offer fast response time should you ever experience problems.

