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STADIUS
Center for Dynamical Systems, Signal Processing and Data Analytics

STADIUS Newsletter

January 2024

RESEARCH ▪ AWARDS ▪ NEWS ▪ EVENTS ▪ STAFF UPDATE ▪ DEFENDED PHD ▪ PUBLICATIONS

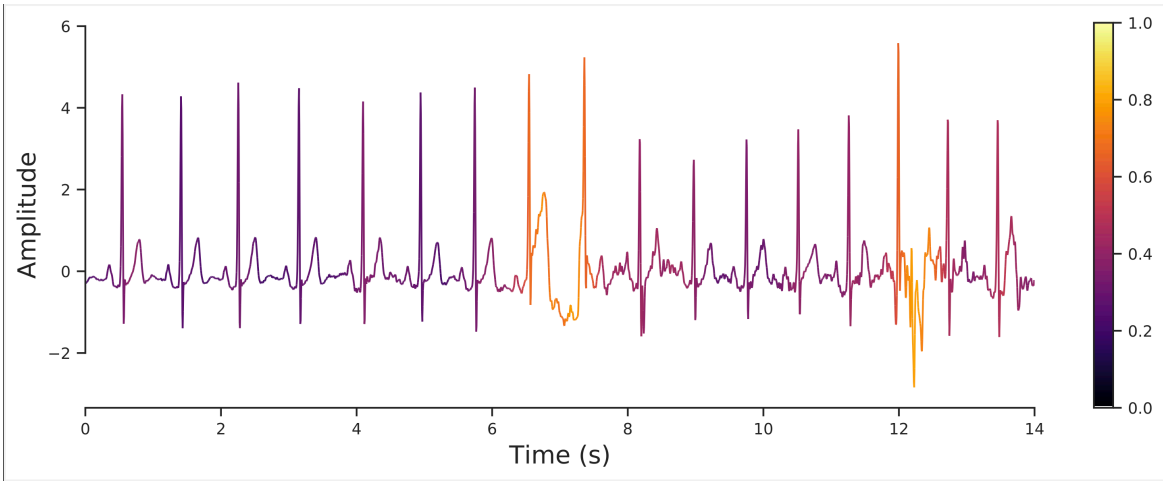
Welcome to the first STADIUS Newsletter in 2024

Research of the month by Nick Seeuws

"Detection of disturbances and events in biomedical signals with deep learning"

Work under supervision of Maarten De Vos and Alexander Bertrand

Biomedical signals are non-invasive data modalities that provide insight into processes taking place in the body and in specific organs. **Electrocardiography (ECG)** and **electroencephalography (EEG)** are two such modalities, meant to monitor the heart and brain respectively. Both provide **a key tool for clinical experts** in the diagnosis and follow-up of various pathologies, and for the general monitoring of the body. The signals capture changes in electric potential on the surface of the skin caused by specific physiological processes (such as the engagement of muscles or the firing of neurons). Part of the analysis of these signals is the **detection of important patterns,** often coming in the form of *events of interest* such as epileptic seizures which can be observed in the EEG. Unfortunately, sources outside of the organs under investigation can contribute to the potentials measured on the skin. Other muscles or electric interference outside of the body can interfere with the desired signal, causing disturbances. Many algorithms exist for the detection of such disturbances and signal events, tailor-made for specific types of targets and specific signal modalities. **Designing and applying the right algorithm for a novel setting takes substantial domain expertise and engineering effort**.



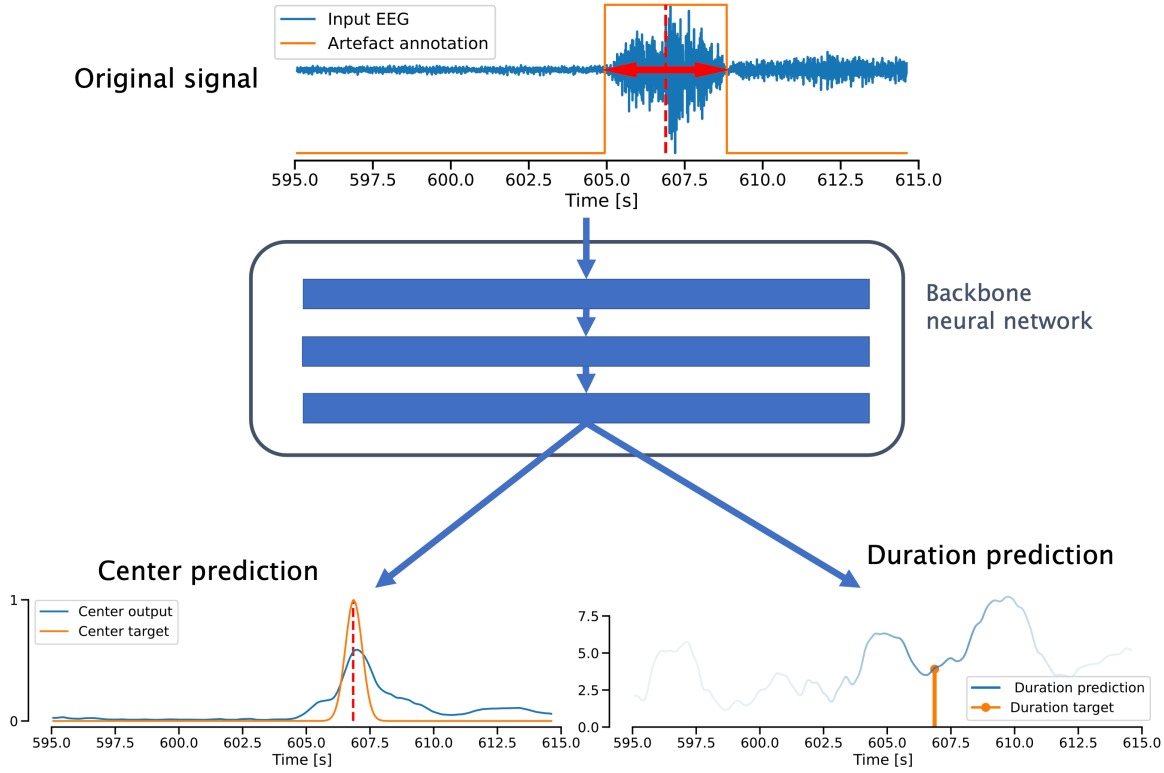
Concretely, this project covers the following problems.

• **Quantify the severity of signal disturbances.** A fully data-driven quality indicator can reveal new quality characteristics that are not covered by existing expert-driven quality indicators. We find that our novel quality indicator can work independently or complement existing indicators when assessing signal quality.

• **Build a signal event detector.** We propose a novel event-based framework that stands in contrast to the traditional epoch-based approaches for the detection of events in time series. Our proposed framework removes the need for extensive post-processing, simplifying the design of a machine learning solution for event detection in physiological signals and beyond.

• **Reduce the human effort required for the construction of massive data sets in supervised deep learning.** Supervised deep learning methods rely on a substantial amount of annotated examples to learn representations and infer relevant patterns. We propose an interactive event annotation support algorithm to build signal event data sets. The algorithm can start from a small set of pre-annotated events and provides substantial annotation efficiency gains compared to the manual exhaustive annotation process.

The generic nature of our proposed algorithms allows for a straightforward extension to novel tasks and data modalities. The data-driven quality indicator only relies on an underlying auto-encoder model, which can easily be applied to other signals. Domain-specific aspects of the event detection framework are contained in an underlying "backbone" architecture, which can be adapted for use in other applications. When applying the annotation support algorithm to new problems, one only needs to provide an event detection model for the setting in question (which can be constructed using our generic event detection framework).



For more information about this reasearch read:
- Avoiding Post-Processing with Event-Based Detection in Biomedical Signals
- Electrocardiogram Quality Assessment Using Unsupervised Deep Learning

News

Prof. Yves Moreau's Advocacy for Ethical Standards in Genetic Research and Human Rights

Acknowledged with the Individual Award from the Einstein Foundation in November 2023, Prof. Yves Moreau continues to uphold ethical standards, a commitment crucial in ongoing discussions surrounding artificial intelligence and big data.

In January 2024 Yves Moreau's contributions to the discourse on genetic research ethics and human rights were highlighted in five distinct articles:

Nature: Unethical studies on Chinese minority groups are being retracted — but not fast enough, critics say
The Guardian: Academic paper based on Uyghur genetic data retracted over ethical concerns
Radio Free Asia: Retracted study was based on unethically collected Uyghur DNA samples, experts contend
The Guardian: Thermo Fisher stops sale of DNA kits in Tibet after activists raised fears of rights abuses

The Hill: US company must stop supplying China’s regime with DNA surveillance tech

Across four distinct articles, Yves Moreau's vigilance comes to the forefront as he looks closely at studies about Uyghur genetic information, questions the informed consent process in Xinjiang, advocates for responsible corporate practices in genetic technology sales, and emphasizes the broader implications of mass DNA surveillance.
His strong commitment to ethical standards is clear in all these stories, reinforcing the importance of upholding human rights, particularly when conducting research involving vulnerable populations.

Explore the recent interview with Yves Moreau conducted by the KU Leuven SET Group. In this insightful discussion, Prof. Moreau shares his perspectives on his research, the challenges of handling sensitive genetic data, and reflects on the evolving role of researchers, emphasizing the paramount importance of engaging with the ethical aspects of technology and science.



A chair assigned for Maarten De Vos in Precision Health at ULille

Maarten De Vos, professor at STADIUS, Professor Celine Vens (KU Leuven, Kulak), and Professor Vincent Sobanski (ULille) have been appointed as international chairholders at the University of Lille ‘AI for Heterogeneity in Chronic Diseases’, which is part of the thematic hub ‘Precision Health. In this capacity, they will work on a four-year project that involves the application of **Artificial Intelligence in the context of chronic diseases**, with a specific focus on systemic sclerosis. Maarten De Vos's expertise in this area contributes to the research efforts aimed at advancing precision health and utilizing AI technologies for better understanding and managing health challenges related to chronic conditions.

Read more:
https://kulak.kuleuven.be/nl/onderzoek/onderzoeksnieuws/toekenning-international-chairs-versterkt-samenwerking-ULille-en-KU-Leuven

And more:

Two mini-symposium by STADIUS researchers at SIAM 2024:

- Sibren Lagauw and Christof Vermeersch & Bart De Moor: 'Numerical Linear Algebra Algorithms to Solve (Multivariate) Polynomial Systems.' on Tuesday, May 14.
- Nico Vervliet & Lieven De Lathauwer: "Tensor Decompositions and Applications" on Wednesday, May 15.

Both mini-symposiums take place during the SIAM conference at Sorbonne Université in Paris, France 13-17 May 2024.

Events @ STADIUS

ERC Back to the Roots Seminar: Fast and Stable Roots of Polynomials via Companion Matrices
When: **06/02/2024, 17:00**
Where: **Aula Arenbergkasteel**
By: **Prof. Raf Vandebril**

PhD defense - Lola Botman
When: **09/02/2024, 17:00**
Where: **Promotiezaal, Naamsestraat 22, Leuven**

ERC Back to the Roots Seminar: The Moment-SOS hierarchy
When: **20/02/2024, 17:00**
Where: **Thermotechnisch Instituut, Aula van de Tweede Hoofdwet**
By: **Didier Henrion**

STADIUS Seminar: Data Analysis and Signal Processing Challenges for the Einstein Telescope
When: **28/02/2024, 15:00**
Where: **ESAT B91.300**
By: **Tjonnie Li**

AI Driven Data Science - Kickoff Meeting FAIR 2.0 - GC1
When: **04/03/2024, 13:00 - 18:30**
Where: **Irish College, Leuven**

ERC Back to the Roots Seminar by Nithin Govindarajan
Title: to be announced
When: **05/03/2024, 17:00**
Where: **Thermotechnisch Instituut, Aula van de Tweede Hoofdwet**

DEEPK 2024 International Workshop on Deep Learning and Kernel Machines
When: **07/03 - 08/03 2024, 17:00**
Where: **Arenberg Castle**
By: **Johan Suykens**

ERC Back to the Roots Seminar: A new symbolic-numeric method to solve the multiparemeter eigenvalue problem
When: **21/03/2024, 17:00**
Where: **ELEC B91.300 - aula C**
By: **Mathias Bender**

For more information about STADIUS events please visit the STADIUS Event webpages.

Don't forget to check the website of VAIA for a wide choice of courses on (aspects of) AI: www.vaia.be

New colleagues

A warm welcome to new researchers and personnel at STADIUS!



Hi everyone,

I'm **Michiel Ghesquiere**, and I'm thrilled to begin my interdisciplinary PhD journey at the intersection of the Research Group of Ophthalmology and STADIUS, under the guidance of Prof. Maarten De Vos. My academic background includes a Master's in Bioscience-Engineering, more specifically Human Health Engineering, complemented by an additional 'Manama' in Artificial Intelligence. My research is focused on identifying early bio-markers in the human retina related to Alzheimer's disease, employing hyperspectral imaging as a key tool.

Outside the office, I (try to) maintain an active lifestyle with regular running and gym sessions, and I'm always game for sports like beach volleyball and football. I also like to listen to various podcasts like the Huberman Lab podcast for my daily dose of fascinating health insights.

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We wish the best of luck to the researchers who are leaving STADIUS

Best of luck!

This month 3 colleagues finish their appoitment at STADIUS and we wish them all the best on their new career paths:

- **Nick Seeuws,** a PhD researcher supervised by Maarten De Vos & Alexander Bertrand is leaving STADIUS at the end of this month. He will continue his research at the KU Leuven Institute for Artificial Intelligence (Leuven.AI).
- **Stijn Hendrikx,** a researcher from the group of Lieven De Lathauwer. Stijn has just defended his PhD thesis (see below).
- **Peter Coppens,** a researcher supervised by Panos Patrinos. Peter will start working for Arcelor Mittal in Gent at the industrial automation and models division.

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Recently defended PhD theses

On January 25 **Stijn Hendrikx** has defended his PhD thesis entitled: Computing Tensor Decompositions from Incomplete and Implicit Data; Berekening van tensorontbindingen voor onvolledige en impliciete data under the supervision of Lieven De Lathauwer.

Publication Digest

Here's the monthly STADIUS Publications Digest, including new reports that have been added to the publications database.
Please remember to have your own reports added in the publications database and make sure your entries are kept up to date (status submitted/accepted/published) at all times.

Contact Ida for new additions and updates, do not add/update database content yourself.

23-168
Grinstein E., van Waterschoot T., Brookes M., Naylor P.A., ``The Neural-SRP method for positional sound source localisation'', Technical Report 23-168, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2023. Accepted for publication in *Proc. 2023 Asilomar Conf. Signals Syst. Computers*.
Lirias number: 4131286.

23-169
Grinstein E., Hicks C.M., van Waterschoot T., Brookes M., Naylor P.A., ``The Neural-SRP method for universal robust multi-source tracking'', Technical Report 23-169, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2023. Accepted for publication in *IEEE Open J. Signal Process.*.
Lirias number: 4131289.

23-170
Lohmann A., van Waterschoot T., Bitzer J., Doclo S., ``Microphone subset selection for the weighted prediction error algorithm using a group sparsity penalty'', Technical Report 23-170, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2023. Accepted for publication in *Proc. 2024 IEEE Int. Conf. Acoustics Speech Signal Processing (ICASSP 2024)*.
Lirias number: 4131293.

23-171
Coppens P., Patrinos P., ``Provably stable learning control of linear dynamics with multiplicative noise'', *IEEE Transactions on Automatic Control*, vol. *, no. *, Dec. 2023, pp. 1-16.
Lirias number: 4131342.

23-172
Behmandpoor P., Patrinos P., Moonen M., ``Federated learning under a digital communication model'', Technical Report 23-172, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2023. Accepted for publication in *IEEE Open Journal of Signal Processing*.
Lirias number: 4131345.

23-173
Scheltjens V., Lyse Naomi W. M., Verbeke W., De Moor B., ``Target Informed Client Recruitment for Federated Learning in Healthcare'', Technical Report 23-173, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2023.

23-174
Vermeersch C., Lagauw S., De Moor B., ``Multivariate Polynomial Optimization in Complex Variables Is a (Rectangular) Multiparameter Eigenvalue Problem'', *Presentation at the 62nd Conference on Decision and Control (CDC62)*, Marina Bay Sands, Singapore, Dec. 2023.
Lirias number: 4140121.

24-01
Uyttendaele Y., De Moor B., ``A comprehensive Optical Music Recognition pipeline for manuscripts in mensural notation'', Technical Report 24-01, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-02

Botman L., Lago J., Fu X., Chia K., Wolf J., Kleissl J., De Moor B., ``Building plug load mode detection, forecasting and scheduling'', Technical Report 24-02, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-03

Geirnaert S., Zink R., Francart T., Bertrand A., ``Fast, accurate, unsupervised, and time-adaptive EEG-based auditory attention decoding for neuro-steered hearing devices'', in Chapter 4 of *Brain-Computer Interface Research*, (Guger C., Allison B., Rutkowski T. M., and Korostenskaja M., eds.), Springer, 2024, pp. 29-40.
Lirias number: 4137534.

24-04

Andhari M., Rinaldi G., Nazari P., Vets J., Ostyn T., Vanmechelen M., Decraene B., Shankar G., Dubroja N., Arnould A., Mestdagh W., De Moor B., De Smet F., Bosisio F., Antoranz A., ``QUAL-IF-AI: Quality Control of Immunofluorescence Images using Artificial Intelligence'', Technical Report 24-04, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-05

Vanpoucke L., De Moor B., ``Globally optimal least-squares misfit identification of multidimensional autonomous systems'', *Proc. of the 30th ERNSI Workshop in System Identification (ERNSI22)*, Leuven, Belgium, Sep. 2022, 1 p.
Lirias number: 4140213.

24-06

Vanpoucke L., De Moor B., ``Globally optimal least-squares misfit identification of multidimensional autonomous systems'', *Poster presentation at the SeLMA Closing Event (SELMA)*, Leuven, Belgium, Jun. 2022, 1 p.
Lirias number: 4140214.

24-07

Vanpoucke L., De Moor B., ``Globally optimal misfit identification of multidimensional difference equations'', *Proc. of the 31th ERNSI Workshop in System Identification (ERNSI23)*, Stockholm, Sweden, Sep. 2023, 1 p.
Lirias number: 4140215.

24-08

Allamaa J.P., Patrinos P., Van der Auweraer H., Son T.D, ``Learning Based NMPC Adaptation for Autonomous Driving using Parallelized Digital Twin'', Technical Report 24-08, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-09

Allamaa J.P., Patrinos P., Ohtsuka T., Son T.D., ``Real-time MPC with Control Barrier Functions for Autonomous Driving using Safety Enhanced Collocation'', Technical Report 24-09, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-10

van Rooij H., De Cock K., De Moor B., ``Exploring the Critical Values of Multivariate Polynomial Optimization Problems in System Identification Applications'', *Poster presentation at ERNSI workshop (ERNSI 2023)*, Stockholm, Sweden, Sep. 2023, 1 p.
Lirias number: 4140216.

24-12

Tonin F., *Optimization Frameworks for Deep Kernel Machines*, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), Dec. 2023, 342 p.
Lirias number: 4124589.

24-13

Shi Z., Liu F., Cao Y., Suykens J.A.K., ``Can overfitted deep neural networks in adversarial training generalize? - An approximation viewpoint'', Technical Report 24-13, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

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