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STADIUS
Center for Dynamical Systems, Signal Processing and Data Analytics



FEBRUARY 2025

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

Welcome to the February edition of the STADIUS Newsletter!

The schedule for the **STADIUS Colloquium Series** is fnalised for this semester.
We count on your participation!
Scroll down for the details!

Research of the month by Stefano Damiano

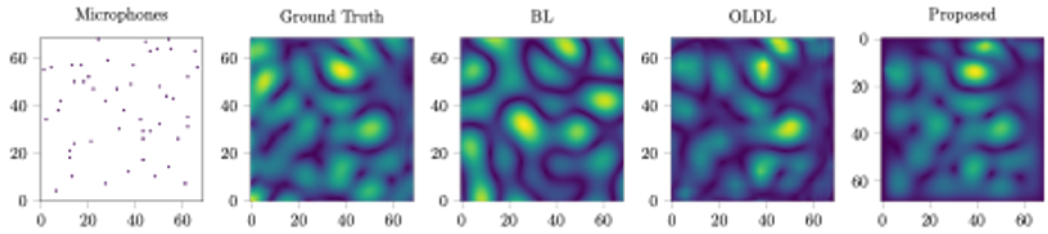
"A Zero-Shot Physics-Informed Dictionary Learning Approach for Sound Field Reconstruction"

Work under the supervision of Toon van Waterschoot

Sound field reconstruction is a fundamental task in acoustic engineering that focuses on estimating a pressure field in areas where direct measurements are unavailable. Directly measuring the acoustic field across a large volume and the entire audible frequency range requires a significant experimental effort. Instead, sound field reconstruction techniques provide a more feasible solution by using a limited set of observations to interpolate and extrapolate the acoustic field.

Most existing approaches are based on a parametric description of the acoustic scene or on models derived from the solutions to the wave equation, such as plane waves, spherical waves, or equivalent sources. While offering robust solutions, these techniques frequently fall short in accurately modeling real-world scenarios when some underlying assumptions are no longer valid.

Data-driven approaches, based on neural networks to model the acoustic field, try to overcome these limitations by leveraging on training processes carried out on data. Another class of data-driven methods is constituted by dictionary-learning techniques. These approaches assume that a signal can be represented as a sparse combination of functions, called atoms, learned from observed data, and have demonstrated good performance in sound field reconstruction. However, the amount of data required to train both deep learning and dictionary learning methods is substantial. Physics-informed neural networks have been recently introduced to combine the explicit modeling capabilities of traditional model-based techniques with the flexibility of neural networks, while minimizing the amount of data required. While they produce physically meaningful solutions, they often lack interpretability.



In this work we propose a zero-shot physics-informed dictionary learning approach for sound field reconstruction. As a zero-shot technique, our solution only relies on few sparse measurements of a pressure field to learn a dictionary of atoms, with no additional data used for training. The physics-informed nature of our approach guides the learning process by encouraging the dictionary atoms to satisfy the Helmholtz equation. By enforcing this acoustic prior information, the atoms do not need to be learned from additional training data other than the few observed measurements. Extensive evaluation on real-world data demonstrates the effectiveness of our method compared to a baseline based on a dictionary of Bessel functions and a state-of-the-art dictionary learning technique.

If you are interested to read more, check the pre-print of this work: https://arxiv.org/abs/2412.18348.

Awards



Research Council Award for Simon Geirnaert

We proudly announce that our STADIUS colleague, postdoc **Simon Geirnaert** (from the group of Alexander Bertrand), has received the **Research Council Award** (Group Science and Technology) from KU Leuven. This prestigious award honors young, promising researchers who have demonstrated high quality in their work. Simon was recognized for his research 'Listening to chaos: auditory attention decoding to natural speech in neuro-steered hearing devices', conducted in collaboration with STADIUS professor **Alexander Bertrand** and Tom Francart.

Simon will receive the award during an official ceremony on May 15 at 17.00.

News



Follow-up on the Doctorate Honoris Causa Ceremony for Yves Moreau

Yesterday, on February 27, our STADIUS professor, **Yves Moreau**, was officially honored with the Doctorate Honoris Causa by UCLouvain (Secteur des sciences et technologies). We extend our warmest congratulations to Yves Moreau on this well-deserved honor!



KU Leuven 600th anniversary - the opening weekend

On February 15 and 16, 2025, KU Leuven celebrated its 600th anniversary with the "KU Leuven Inside" event, offering the public an exclusive look behind the scenes of the university. The weekend attracted **30,000 visitors** who engaged with the latest scientific discoveries through various activities across Leuven's campuses.
As part of the festivities, STADIUS professors **Maarten De Vos** and **Toon van Waterschoot** provided insights into their research conducted in the labs of ESAT/STADIUS.

STADIUS Colloquium Series

The schedule for the **STADIUS Colloquium Series** is fnalised for this semester.
We are pleased to invite you for the 4 upcoming events!

- **12/03/2025**: **Nicolas Gillis**
  - Title: **"Non-negative Matrix Factorization"**
  - Time: **15:00 - 16:00**
  - Location: **Aula C (ELEC B91.300)**

- **23/04/2025: Kaze W. K. Wong**
  - Title: **"Machine learning in Gravitational wave data analysis"**
  - Time: **14:30 - 15:30**
  - Location: **Aula C (ELEC B91.300)**

- **07/05/2025: Yurii Nesterov**
  - Title: "**Optimization, the philosophical background of artificial intelligence"**
  - Time: **15:00 - 16:00**
  - Location: **Aula C (ELEC B91.300)**

- **04/06/2025: Masoud Ahookhosh**

- Title: "**Inexact two-level proximal smoothing framework for nonsmooth and nonconvex optimization"**
- Time: **15:00 - 16:00**
- Location: **Aula C (ELEC B91.300)**

For more detailed abstract and biographies, please stay tuned and consult the STADIUS Event website

New colleagues

A warm welcome to new personnel at STADIUS!



Hi everyone,

My name is **Koen Scheres**. I was born in The Netherlands and obtained both my Masters in mechanical engineering and my PhD in Control Systems from Eindhoven University of Technology. During my PhD I focussed on designing control and estimation systems with packet-based (e.g. wireless) networks in the loop. I stared recently as a PostDoc at KU Leuven under the supervision of prof. Sepulchre, where I will be working on the exciting and challenging field of neuromorphic control. In my spare time I like to travel, snowboard, ride my motorbike or go climbing/bouldering. Don't hesitate to reach out if you also enjoy these things ;-)

Talk to you soon!
Koen

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Best of luck!

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

- **Chao Chen,** a postdoctoral researcher in the group of Rodolphe Sepulchre has just started as a Lecturer at the University of Manchester, UK.
- **Zhijun Xiao,** a researcher from the group of Maarten De Vos returned to China
- **Yamini Chitale,** a researcher supervised by Bart De Moor, finished her STADIUS appointment.
- **Tao Qinghua**, a postdoctoral researcher from the group of Johan Suykens returned to China to pursue her career in academia.

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Recently defended PhDs

19/02/2025: Pourya Behmandpoor: *Distributed learning, optimization, and signal estimation with applications in multi-agent systems and communication networks*, supervised by Marc Moonen.

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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.

25-46
Kontras K., Strypsteen T., Chatzichristos C., Liang PP., Blaschko M., De Vos M., ``Balancing Multimodal Training Through Game-Theoretic Regularization'', Technical Report 25-46, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025.

25-47
Kontras K., *Multimodal Fusion*, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), Jan. 2025, 216 p.
Lirias number: 4208364.

25-48
Gagliardi G., Luca Alfeo A., Cimino M.G.C.A., Valenza G., De Vos M., ``PhysioEx: a new Python library for explainable sleep staging through deep learning'', *Physiol Meas*, vol. 13, no. 2, Feb. 2025.
Lirias number: 4216403.

25-49
Shahhosseini A., Chaffey T., Sepulchre R., ``Splitting algorithms for nonlinear RLC circuits'', *Proc. of the 26th International Symposium on Mathematical Theory of Networks and Systems (MTNS)*, Cambridge, UK, Aug. 2024, pp. 1-4.
Lirias number: 4222162.

25-50
Shahhosseini A., Chaffey T., Sepulchre R., ``Time-Frequency Splitting Algorithms for Neuromorphic Circuits'', *Proc. of the 43rd Benelux Meeting on Systems and Control (BNL)*, Blankenberge, Belgium, Mar. 2024, 173 p.
Lirias number: 4222160.

25-51
Schott J., Verwaerde E., Gransier R., Moonen M., Wouters J., ``Semi-objective cochlear implant fitting with electrically evoked auditory steady-state responses results in good speech perception'', Technical Report 25-51, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025.

25-52
Schott J., Gransier R., Moonen M., Wouters J., ``Envelope-following responses in cochlear implant users: Effects of temporal envelope modulation complexity'', Technical Report 25-52, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025.

25-53
Li T., Geirnaert S., Van den Broek D., Bellon E., De Smedt B., Bertrand A., ``Temporal variation in the acoustic dynamic range is a confounding factor in EEG-based tracking of absolute auditory attention to speech'', Technical Report 25-53, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025.

25-54

Depoortere J., Driesen J., Suykens J.A.K., Kazmi H.S., ``So1Net : Open-source deep learning models for photovoltaic power forecasting across the globe'', Technical Report 25-54, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025. Accepted for publication in *International Journal of Forecasting*.
Lirias number: 4217202.

25-56

Widdershoven R., Govindarajan N., De Lathauwer L., ``Fast Macaulay null space through the intersection of shifted null spaces'', Technical Report 25-56, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025.

25-57

Heintz N., Geirnaert S., Van de Ryck I., Francart T., Bertrand A., ``Probabilistic gain control in a multi-speaker setting using EEG-based auditory attention decoding'', in *Proc. of the 32nd European Signal Processing Conference (EUSIPCO)*, Lyon, France, Aug. 2024, pp. 892-896.
Lirias number: 4208984.

25-58

Sepulchre R., Chaffey T., Forni F., Huo Y., ``On the relaxation property of nonlinear circuit elements'', in *Proc. of the 2024 IEEE 63rd Conference on Decision and Control (CDC 2024)*, Milan, Italy, Dec. 2024, pp. 1-6.
Lirias number: 4221075.

25-59

Van den Bulcke L., Willems A., Vansteelandt K., Peeters A.M., Davidoff H., Bono M., Liu Z., De Vos M., Vandenbulcke M., Van Den Bossche M., ``The Richmond Agitation-Sedation Scale for behavioral assessment in acute dementia care'', Technical Report 25-59, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025. Accepted for publication in *The American journal of geriatric psychiatry: Open science, education, and practice*.
Lirias number: 4220039.

25-60

Schmetterling R., Forni F., Franci A., Sepulchre R., ``Neuromorphic Control of a Pendulum'', in *Proc. of the 2024 IEEE 63rd Conference on Decision and Control (CDC 2024)*, Milan, Italy, Dec. 2024, pp. 1-6.
Lirias number: 4221080.

25-61

Behmandpoor P., *Distributed learning, optimization, and signal estimation with applications in multi-agent systems and communication networks*, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), Feb. 2025
Lirias number: 4221080.

25-62

Nourisa J., Passemiers A., Shakeri F., Omidi M., Helmholz H., Raimondi D., Moreau Y., Tomforde S., Schlueter H., Luthringer-Feyerabend B., Cyron C.J., Aydin R.C., Willumeit-Romer R., Zeller-Plumhoff B., ``Gene regulatory network analysis identifies MYL1, MDH2, GLS, and TRIM28 as the principal proteins in the response of mesenchymal stem cells to Mg2+ ions'',*Computational and structural biotechnology journal*, vol. 23, ec. 2024, pp. 1773-1785.
Lirias number: 4217767.

25-63

Oldenhof M., De Brouwer E., Arany A., Moreau Y., ``Atom-Level Optical Chemical Structure Recognition with Limited Supervision'', in *Proc. of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, Seattle, WA, Jun. 2024, pp. 17669-17678.
Lirias number: 4217904.

25-64

Gagliardi G., Luca Alfeo A., Cimino M.G.C.A., Valenza G., De Vos M., ``PhysioEx: a new Python library for explainable sleep staging through deep learning'', *Physiol Meas*, vol. 13, no. 2, Feb. 2025.
Lirias number: 4216403.



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