Show message in browser

STADIUS
Center for Dynamical Systems, Signal Processing and Data Analytics

STADIUS Newsletter

April 2025

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

Research of the month by Amir Shahhosseini

"A Scalable Operator-Theoretic Simulation Framework for Neuromorphic Systems"

Work under the supervision of Rodolphe Sepulchre

The human brain offers a computational paradigm distinct from both digital and quantum. It can be orders of magnitude more energy-efficient than digital architectures and is better poised to handle the noisy, ill-conditioned inputs typical of biological sensing. These advantages have motivated the development of neuromorphic computing—a field that seeks to replicate the brain's computational principles. **Despite its potential, neuromorphic computing has yet to deliver the transformative breakthroughs it envisioned**. One major bottleneck is the prohibitive computational cost of simulating and analyzing spiking neurons. This makes the study and design of **large-scale spiking networks,** that are essential in capturing many interesting phenomena and behaviors, a resource-intensive task —as evidenced by the billion-euro Human Brain Project.

The most common method for simulating spiking dynamics is numerical integration algorithms. Nevertheless, this class of algorithms does not provide an adequate simulation and analysis framework for the design of large-scale neuromorphic systems. **These algorithms are not scalable, do not exploit the event-based structure of the behavior, and lack efficient tools for variability analysis—an essential component of any robust design framework.** In response to these limitations, we propose a departure from state-space representation and incremental numerical integration methods in favor of an operator-theoretic representational language and solver framework. This approach lays the foundation for a more principled, scalable, and efficient framework for simulating and analyzing neuromorphic systems.

In this new framework, the input-output behavior of neuromorphic systems is captured using an operator (e.g., a nonlinear mapping) defined on Hilbert space. Thus, given an input signal, the problem of simulating a neuromorphic system reduces to a zero-finding problem on

Hilbert space. This formalism is transformed into a fixed-point iteration problem enabling the use of modern proximal-gradient methods of convex optimization that are known for their efficiency. **This operator-theoretic framework resolves the scalability issue (through using first-order methods and restricting the search space) and offers an efficient variability analysis toolbox** [1].
A key promise of the proposed operator-theoretic framework is its ability to **modulate the *scale* at which neuromorphic systems are modeled, simulated and analyzed**. By adjusting this scale, it is possible to transition from coarse mean-field estimates of the network to fine-grained and accurate simulation at neuron level. In fact, this tunable resolution not only enables more flexible analysis but also bridges the micro- and macro-scale perspectives, offering a unified and principled understanding of complex neuromorphic dynamics. **This unification results in the emergence of mean-field behaviors of spiking systems that stem from the dynamics of the individual neurons, *and not their high-level abstractions*, an essential link that is missing from literature**.

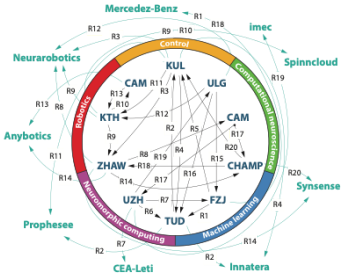
If you are interested to read more, check the following:
[1] Amir Shahhosseini, Thomas Chaffey, and Rodolphe Sepulchre. "An Operator-Theortic Framework to Simulate Neuromorphic Circuits" *2024 IEEE 63rd Conference on Decision and Control (CDC)*.

NEWS



Marc Moonen Elected IEEE SPS 2025 President-Elect

We are proud to announce that Prof. **Marc Moonen**, a professor from our STADIUS division, has been elected as the 2025 **President-Elect of the IEEE Signal Processing Society (SPS)**.
This special election was held to fill the vacant President-Elect position, with eligible members of the Society casting their votes for the next leader. As President-Elect, Prof. Moonen will join the SPS Board of Governors starting **1 April 2025** and will serve in this role until **31 December 2027**. He will then automatically assume the role of **President for the 2028–2029 term**, followed by a two-year term as **Chair of the SPS Nominations & Elections Committee** (2030–2031).
Warm congratulations to Marc on this prestigious recognition and new leadership role!



MSCA Doctoral Network ELEVATE Coordinated by Rodolphe Sepulchre Approved with Outstanding Score

We are delighted to announce that the MSCA Doctoral Network proposal ELEVATE – Event-based LEarning Vision and AcTuation for Edge applications, coordinated by **Rodolphe Sepulchre,** has been approved with an exceptional score of **98%.**
This ambitious initiative brings together **10 academic** partners from Belgium, Germany, the Netherlands, Portugal, Sweden, Switzerland, and the UK, alongside **10 industrial**

partners, including Intel, Prophesee, and Mercedes-Benz, to provide high-level doctoral training to **20 PhD candidates**. ELEVATE's research will harness the event-based nature of biological intelligence to enhance the efficiency, embodiement, and resilience of machine intelligence. Through its interdisciplinary training programme, ELEVATE will empower a new generation of researchers to drive digital transformation in a way that embraces the **energy efficiency, physical embodiement, and resource-awareness of bio-inspired, event-driven intelligence**.

The project will launch on January 1st, 2026, and run for four years, with a total EU budget of **€4.5 million** (topped with a Swiss contribution of about €1.4 million).

We warmly congratulate **Rodolphe and his team** for this achievement and wish them good luck in running the project. Rodolphe wishes to emphasize that this success would not have happened without an outstanding support from the KU Leuven, and, most importantly, the unique experience of Aldona in managing such large projects.



EUSIPCO 2026 in Bruges

We are thrilled to announce that the Board of Directors of the **European Association for Signal Processing** (EURASIP) has approved KU Leuven's bid to host the 34th European Signal Processing Conference **(EUSIPCO 2026) in the marvellous city of Bruges, Belgium.**
The organising committee will include strong representation from current and former STADIUS colleagues, with **Toon van Waterschoot** serving as the general co-chair of the conference.

Stay tuned - **more information** coming soon!

Awards



STADIUS Shines at the Gouden Krijtjes 2024–2025!

We're proud to announce that STADIUS has been honored with not one, but **two Gouden Krijtjes i**n this year's VTK awards!
Johan Suykens received the award for "Beste Prof in Wiskundige Ingenieurstechnieken 24–25"
Simon Geirnaert was named "Best Teaching Assistant 24–25",

The Gouden Krijtjes (Golden Chalks) are annual awards presented by the **Vlaamse Technische Kring (VTK)**, the student association for engineering students at KU Leuven. These awards recognize excellence in teaching and are determined by student votes in categories such as Best Professor, Funniest Professor, Best Course Material, and Best Assistant. They serve as a way for students to express appreciation for educators who have made a significant impact on their learning experience.

Read more: https://www.vtk.be/nl/page/gouden-krijtjes/



CIAP Student Aid Award to Brent Sterckx

We are pleased to announce that Brent Sterckx has been selected for a $1,500 Student Aid Award to attend the Conference on Implantable Auditory Prostheses (CIAP), taking place in Lake Tahoe from July 13–18, 2025.
Brent was chosen from a competitive pool of applicants for his work in the field of cochlear implants.

Congratulations, Brent.

^

Klik op dit tekstelement om je tekst in te brengen.

STADIUS Colloquium Series

We are pleased to invite you for the 2 upcoming events!

- **07/05/2025: Yurii Nesterov**
  - Title: "**Asymmetric Long-Step Primal-Dual Interior-Point Methods with Dual Centering."**
  - 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

Other events @ STADIUS

For more information about STADIUS events

- Seminar by Yuanyuan Yao "Decoding Selective Visual Attention from Brain Signals"
When: **09/05/2025, 10:00 - 11:00**
Where: **B00.35**

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

Recently defended PhDs

03/04/2025: Nora Verplaetse: A Novel Neural Network Framework for Genome Interpretation in Complex Diseases, supervised by Yves Moreau.

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

Best of luck!

- **Zander Op de Beeck,** who worked with Johan Suykens, is moving to the Department of Chemical Engineering at Celestijnenlaan 200 to pursue his PhD on a new research topic.

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.

25-74
Tokcan N., Sofi S. S., Pham V. T., PrÃ©vost C., Kharbech S., Magnier B., Nguyen T. P., Zniyed Y., De Lathauwer L., ``Tensor Decompositions for Signal Processing: Theory, Advances, and Applications'', Technical Report 25-74, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025.

25-75
Sofi S. S., Vermeylen C., De Lathauwer L., ``Tensor Train Quantum State Tomography using Compressed Sensing'', Technical Report 25-75, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025.

25-76

Jaramillo Rodriguez M. A., Ali R., van Waterschoot T., ``Direction-of-Arrival Data Association for Wildlife Ac'', Technical Report 25-76, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025.

25-77

Alsalti M., Markovsky I., Lopez V.G., Muller M.A., ``Data-based system representations from irregularly measured data'', *IEEE Transactions on Automatic Control*, vol. 70, no. 1, Jan. 2025, pp. 143-158.
Lirias number: 4228963.

25-78

Markovsky I., Alsalti M., Lopez V.G., Mullre M.A., ``Identification from data with periodically missing output samples'', *Automatica*, vol. 169, 2024, art. nb. 111869 p.
Lirias number: 4185286.

25-79

Markovsky I., Ossareh H., ``Finite-data nonparametric frequency response evaluation without leakage'',*Automatica*, vol. 159, 2024, art. nb. 111351 p.
Lirias number: 4168927.

25-80

Markovsky I., Dorfler F., ``Identifiability in the behavorial setting'', *IEEE Transactions on Automatic Control*, vol. 68, no. 2, Mar. 2023, pp. 1667-1677.
Lirias number: 4228968.

25-81

Dorfler F., Coulson J., Markovsky I., ``Bridging direct and indirect data-driven control formulations via regularizations and relaxations'', *IEEE Transactions on Automatic Control*, vol. 68, no. 2, Feb. 2023, pp. 883-897.
Lirias number: 4168914.

25-82

Markovsky I., ``Data-driven simulation of generalized bilinear systems via linear time-invariant embedding'',*IEEE Transactions on Automatic Control*, vol. 68, no. 2, Feb. 2023, pp. 1101-1106.
Lirias number: 4168913.

25-83

Markovsky I., Prieto-Araujo E., Dorfler F., ``On the persistency of excitation'', *Automatica*, Technical Communique, vol. 147, 2023, art. nb. 110657 p.
Lirias number: 4168928.

25-84

Markovsky I., Huang L., Dorfler F., ``Data-driven control based on the behavioral approach. From theory to applications in power systems'', *IEEE Control Systems*, Oct. 2023, pp. 28-68.
Lirias number: 4124595.

25-85

Fazzi A., Markovsky I., ``Distance problems in the behavioral setting'', *European Journal of Control*, vol. 74, 2023, art.nb. 100832 p.
Lirias number: 4168911.

25-86

Fazzi A., Markovsky I., ``Addition and intersection of linear time-invariant behaviors'', *IFAC Journal of Systems and Control*, vol. 26, 2023, art. nb. 100233 p.
Lirias number: 4168910.

25-87

Karaiskou A.-I., Varon C., Musluoglu C., Alaerts K., De Vos M., ``EEG-Based Meditation Decoding: Tackling Subject Variability with Spatial and Temporal Alignment'', Technical Report 25-87, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025.

25-88

Geysels A., Garofalo G., Timmerman S., Barrenada L., De Moor B., Timmerman D., Froyman W., Van Calster B., ``Artificial intelligence applied to ultrasound diagnosis of pelvic gynecological tumors: a systematic review and meta-analysis'', Technical Report 25-88, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025. Accepted for publication in *Gynecologic and Obstetric Investigation*.

25-91

Shahhosseini A., Burger T., Sepulchre R., ``Simulating Neuromorphic Systems at Scale'', *44th Benelux Meeting on Systems and Control (BNL)*, Egmond aan Zee,

Netherlands, Mar. 2025, 62 p.
Lirias number: 4229215.

25-92

Macea J., Heremans E., Proost R., De Vos M., van Paesschen W., ``Automated sleep staging in epilepsy using deep learning on standard electroencephalogram and wearable data'', *Journal of sleep research*, 2025, pp. 1-8.
Lirias number: 4228665.

25-93

Macea J., Chatzichristos C., Bhagubai M., De Vos M., Van Paesschen W., ``Tailoring antiseizure treatment with a wearable device : A proof-of-concept study in absence epilepsy'', *Epilepsia*, 2025, pp. 1-12.
Lirias number: 4226050.

25-94

Shang M., De Bleecker C., Vanrenterghem J., De Ridder R., Verschueren S., Varon C., De Raedt W., Vanrumste B., ``A seq-to-seq temporal convolutional network for volleyball jump monitoring using a waist-mounted IMU'', *IEEE Access*, vol. 13, n2025, pp. 42986-42996.
Lirias number: 4228003.

25-95

Wroblowski R., Sepulchre R., ``Tuning the Entrainability of a Half-Center Oscillator'', *43rd Benelux Meeting on Systems and Control (BNL)*, Blankenberge, Belgium, Mar. 2024, 231 p.
Lirias number: 4229371.

25-96

Wroblowski R., Sepulchre R., ``Rebound Amplifiers for Discrete-Event Pattern Generation'', *44th Benelux Meeting on Systems and Control (BNL)*, Egmond-Aan-Zee, Netherlands, Mar. 2025, 171 p.
Lirias number: 4229373.

25-97

Codice F., Pancotti C., Rollo C., Moreau Y., Fariselli P., Raimondi D., ``The specification game : rethinking the evaluation of drug response prediction for precision oncology'', *Journal of Cheminformatics*, vol. 17, no. 33, 2025, pp. 1-16.
Lirias number: 4228152.

25-98

Passemiers A., Tuveri S., Jatsenko T., Vanderstichele A., Busschaert P., Coosemans A., Timmerman D., Tejpar S., Vandenberghe P., Lambrechts D., Raimondi D., Vermeersch J., Moreau Y., ``DAGIP : alleviating cell-free DNA sequencing biases with optimal transport'', *Genome Biology*, vol. 26, no. 49, 2025, pp. 1-30.
Lirias number: 4224046.

25-99

Friesacher H.R., Engkvist O., Mervin L., Moreau Y., Arany A., ``Achieving well-informed decision-making in drug discovery : a comprehensive calibration study using neural network-based structure-activity models'', *Journal of Cheminformatics*, vol. 17, no. 29, 2025, pp. 1-24.
Lirias number: 4224944.

25-100

De Brouwer E., Becker T., Werthen-Brabants L., Dewulf P., Iliadis D., Dekeyser C., Laureys G., Van Wijmeersch B., Popescu V., Dhaene T., Deschrijver D., Waegeman W., De Baets B., Stock M., Horakova D., Patti F., Izquierdo G., Eichau S., Girard M., Prat A., Lugaresi A., Grammond P., Kalincik T., Alroughani R., Grand Maison F., Skibina O., Terzi M., Lechner-Scott J., Gerlach O., Khoury S.J., Cartechini E., Van Pesch V., Sa M.J., Weinstock-Guttman B., Blanco Y., Ampapa R., Spitaleri D., Solaro C., Maimone D., Soysal A., Iuliano G., Gouider R., Catillo-Trivino T., Sanchez-Menoyo J.L., Laureys G., van der Walt A., Oh J., Aguera-Morales E., Altintas A., Al-Asmi A., de Gans K., Fragoso Y., Csepany T., Hodgkinson S., Deri N., Al-Harbi T., Taylor B., Gray O., Lalive P., Rozsa C., McGuigan C., Kermode A., Perez Sempere A., Mihaela S., Simo M., Hardy T., Decoo D., Hughes S., Grigoriadis N., Sas A., Vella N., Moreau Y., Peeters L., ``Machine-learning-based prediction of disability progression in multiple sclerosis : An observational, international, multi-center study'', *Plos Digital Health*, Jul. 2024, pp. 1-25.
Lirias number: 4169875.

25-101

Dietzen T., De Sena E., van Waterschoot T., ``Scalable-complexity steered response power based on low-rank and sparse interpolation'', *IEEE/ACM Transactions on audio, speech and language processing*, vol. 32, 2024, pp. 5024-5039.
Lirias number: 4220224.

25-102

Brunnstrom J., Moller M. B., Ostergaard J., van Waterschoot T., Moonen M., Elvander F., ``Spatial covariance estimation for sound field reproduction using kernel ridge regression'', Technical Report 25-102, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025.

25-103

Brunnstrom J., Moller M. B., van Waterschoot T., Moonen M., Ostergaard J., ``Experimental validation of sound field estimation methods using moving microphones'', Technical Report 25-103, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025.

25-104

Widdershoven R., ``Optimal ordering of tensor operations for minimal flops'', Technical Report 25-104, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025.

25-105

Verplaetse N., *A Novel Neural Network Framework for Genome Interpretation in Complex Diseases*, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), Apr. 2025
Lirias number: 4222380.

25-106

Raimondi D., Verplaetse N., Passemiers A., Jans D.S., Cleynen I., Moreau Y., ``Genomic prediction with kinship-based multiple kernel learning produces hypothesis on the underlying inheritance mechanisms of phenotypic traits'', *Genome Biology*, vol. 26, no. 84, 2025, pp. 1-25.
Lirias number: 4228806.

25-107

Vanpoucke L., Legat B., De Moor B., ``Direct Numerical Computation of Polynomial Multiplication Maps'', *SIAM Conference on Applied Linear Algebra (LA24)*, Paris, May 2024.
Lirias number: 4232940.

25-108

Vanpoucke L., Lagauw S., De Moor B., ``Exploiting the Macaulay matrix structure for the globally optimal identification of autonomous systems'', *European Research Network System Identification 2024 (ERNSI 2024)*, Venice, Italy, Sep. 2024.
Lirias number: 4232941.

25-109

Hovine C., Bertrand A., ``Distributed Adaptive Spatial Filtering with Inexact Local Solvers'', *IEEE Transactions on Signal Processing*, vol. 73, 2025, pp. 1262-1277.
Lirias number: 4228394.

25-110

Kurten S., Winant D., Beullens K., ``Mothers matter : Using regression tree algorithms to predict adolescents' sharing of drunk references on social media'', *International Journal of Environmental Research and Public Health*, vol. 18, 2021, 11338 p.
Lirias number: 3622840.

25-111

Shahhoseini A., Chaffey T., Sepulchre R., ``An Operator-Theortic Framework to Simulate Neuromorphic Circuits'', in *Proc. of the 2024 IEEE 63rd Conference on Decision and Control*, Milan, Italy, Dec. 2024, pp. 6703-6708.
Lirias number: 4221076.



www.esat.kuleuven.be/stadius/ - Register for this newsletter
KU Leuven, ESAT/STADIUS, Kasteelpark Arenberg 10, bus 2446, B-3001 Leuven
ida.tassens@kuleuven.be .

.

Update your profile - Unsubscribe