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STADIUS
Center for Dynamical Systems, Signal Processing and Data Analytics



December 2024

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

Welcome to the December edition of the STADIUS Newsletter! Enjoy the Christmas break!

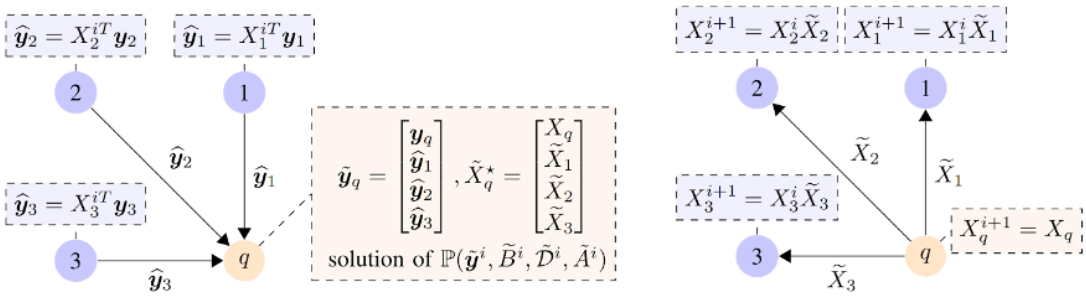


Research of the month by Charles Hovine

"Distributed adaptive spatial filtering in resource-constrained sensor networks"

Work under the supervision of Alexander Bertrand

Wireless sensor networks consist of a collection of battery-powered sensors able to gather, process and send data. Their usefulness is tied to their ability to work autonomously, with as little human intervention as possible, resulting in two design constraints: (i) bandwidth and on-board compute must be used sparingly, in order to extend battery-life as much as possible, and (ii) the system must be resilient to node failures and changing environment. This work focused on the design of distributed algorithms that compute so-called data-driven spatial filters (i.e., lower-dimensional linear combinations of the aggregated raw sensor signals, that are optimal in some sense) while satisfying the above design constraints.



(a) Data aggregation and local solution (b) Parameters update

This work builds up on the same algorithmic ideas as the well–established distributed adaptive node-specific signal estimation algorithm (DANSE), the distributed adaptive covariance matrix eigenvectors estimation algorithm (DACMEE) and similar "distributed signal fusion" (DSF) algorithms. We proposed several algorithms and algorithmic extensions that improve the energy-efficiency of the procedures introduced by the DSF algorithms. Noting that nodes observing uncorrelated signals do not gain from collaborating, and hence exchanging data, we first propose a DSF algorithm for the so-called MAXVAR problem, from which we derived an efficient procedure to evaluate the inter-node correlation structure, without the need to exchange the full raw signals to compute the network-wide correlation matrix. Secondly, we proved that the key algorithmic ideas underpinning the DSF algorithms, as formalized in the distributed adaptive signal fusion (DASF) framework (which abstracts away the particular problem) , lead general DSF algorithms to converge to optimal spatial filters, when applied to smooth and well-posed spatial filtering problems. Then, we extended the original scope of DASF to non-smooth spatial filtering problems, which notably allows the use of sparsity-inducing regularizers in the mathematical description of the spatial filters, opening the door to a network pruning that can be performed alongside the signal processing task, rather than as an ad-hoc step. Finally, we replaced the ideal exact solver assumed by DASF by a family of iterative inexact finite-time solvers, resulting in further energy savings, and relaxed computational requirements. In addition, this last extension allows DASF to produce more stable filters and to function under significantly relaxed assumptions. In particular, it was shown to converge even if the optimization problem associated with the target filter has a solution set that is discontinuous relative to the input signals.
Interested to read more, about the research of Charles? Click below:

C. Hovine and A. Bertrand, "A Distributed Adaptive Algorithm for Non-Smooth Spatial Filtering Problems in Wireless Sensor Networks," in IEEE Transactions on Signal Processing, vol. 72, pp. 4682-4697, 2024.

C. Hovine and A. Bertrand "Distributed Adaptive Spatial Filtering with Inexact Local Solvers, *"arXiv preprint arXiv:2405.03277*, 2024.

C. Hovine and A. Bertrand. "Distributed Adaptive Spatial Filtering in Resource-constrained Sensor Networks." (2024).

News



Keynote Speech by Toon van Waterschoot at IRCAM in Paris

On December 6, 2024, **Toon van Waterschoot** opened the "*Workshop on Methodological advances for Audio Augmented Reality and its applications*", organized by the **Institute for Research and Coordination in Acoustics/Music (IRCAM)** in Paris.
The IRCAM is an internationally renowned institute that has a long tradition of bringing together scientists, composers and musicians, aiming to explore the **creative use of technology in music**. It was founded in 1970 by composer and conductor Pierre Boulez, and has since then been housed in the Centre Pompidou in Paris. **Toon was invited to deliver the opening keynote** about the work that his team has conducted on spatial interpolation of room acoustics.



Interview with Stanford Professor Olivier Gevaert (former PhD at STADIUS) about genomics tool for cancer diagnosis

In a recent interview, **Olivier Gevaert** (Stanford), a former **PhD student of Bart De Moor,** shares insights into his work on **genomics tools for cancer diagnosis**. Now leading research efforts at Stanford University, Gevaert combines data-driven approaches with advanced artificial intelligence to tackle some of the most pressing challenges in oncology.

Click here to watch the interview with Olivier.

Athumi's Real Estate Information Platform Wins Digital Society Award

Bart De Moor, Chairman of Athumi's Board of Directors, proudly shares the company's recent success:
Athumi's Real Estate Information Platform (VIP) has won **the Digital Society Award for Best #eGov Project** and also received recognition in the #Efficiency category.
Launched in early 2024 in Flanders, the VIP platform simplifies access to validated real estate information, making it quickly and easily available to businesses, governments, and citizens.
Within just six months, the platform reduced processing times by nearly 50%.
For more information, visit Agoria Digital Society Awards 2024.



1425 Masterfully Polyphonic: Celebrating the Origins of KU Leuven

We warmly invite you to join **the 1425 Masterfully Polyphonic** concert to celebrate KU Leuven's 600th anniversary. This extraordinary concert, organized by the **Alamire Foundation** and 30CC, will transport us back to the university's earliest days.
Date: Monday, 3 February 2025 |
Time: 20:00
Location: Sint-Pieterskerk, Leuven (Grote Markt 1, 3000 Leuven)
Price: €22.00

STADIUS Colloquium Series

The schedule for the STADIUS Colloquium Series in 2025 will be announced after the Christmas break. In the meantime, you can consult the materials and presentations from past events here:

2024 - December - Compact Binary Data Analys - by John Veitch
2024 - November - AI for Better Health Care - by Andre Dekker
2024 - October - Deep Short-Term Weather Elements Forecasting - by Siamak Mehrkanoon

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

Best of luck!

- **Lola Botman**, a postdoctoral researcher from Bart De Moor's group, has relocated to London to begin her career in the engineering sector.
- **Charles Hovine**, a recently graduated PhD researcher supervised by Alexander Bertrand, is embarking on a new chapter at Audinate following the successful defense of his PhD thesis.
- **Martijn Oldenhof,** having recently earned his PhD, is now joining Johnson & Johnson in Beerse.

Good luck to all of you!

Recently defended PhDs

02/12/2024 - Lyse Naomi Wamba Momo "Length of stay prediction for hospital management", supervised by Bart De Moor

19/12/2024 - Konstantinos Theodorakos "Time series analysis and modeling in data science application areas", PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium),

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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.

24-174
Geirnaert S., Rotaru I., Francart T., Bertrand A., ``Linear stimulus reconstruction works on the KU Leuven audiovisual, gaze-controlled auditory attention decoding dataset'', Technical Report 24-174, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-175
Wambo Momo L.N., *Length of stay prediction for hospital management*, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), Dec. 2024, 190 p.
Lirias number: 4192234.

24-176
Van Santvliet L., Zappon E., Gsell M., Thaler F., Blondeel M., Dymarkowski S., Claessen G., Willems R., Urschler M., Vandenberk B., Plank G., De Vos M., ``Integrating anatomy and electrophysiology in the healthy human heart: Insights from biventricular statistical shape analysis using universal coordinates'', Technical Report 24-176, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-177
Theodorakos K., *Time series analysis and modeling in data science application areas*, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), Dec. 2024
Lirias number: 4192333.

24-178
Botman L., Lago Garcia J., Becker T., Vanthournout K., De Moor B., ``A global probabilistic approach for short-term forecasting of individual households electricity concumption'', Technical Report 24-178, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024. Accepted for publication in *Applied Energy*.
Lirias number: 4207769.

24-179
Behmandpoor P., Eisen M., Patrinos P., Moonen M., ``A Deep Learning Based Resource Allocator for Communication Networks with Dynamic User Utility Demands'', Technical Report 24-179, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-180
Behmandpoor P., Moonen M., ``Cooperative Uplink Channel Estimation in Cell-free Massive MIMO Communication Networks'', Technical Report 24-180, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-181
Sofi S.S, De Lathauwer L., ``Tensor Train Completion of Multiway Data Observed Along One Mode'', Technical Report 24-181, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.



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