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STADIUS
Center for Dynamical Systems, Signal Processing and Data Analytics

STADIUS Newsletter

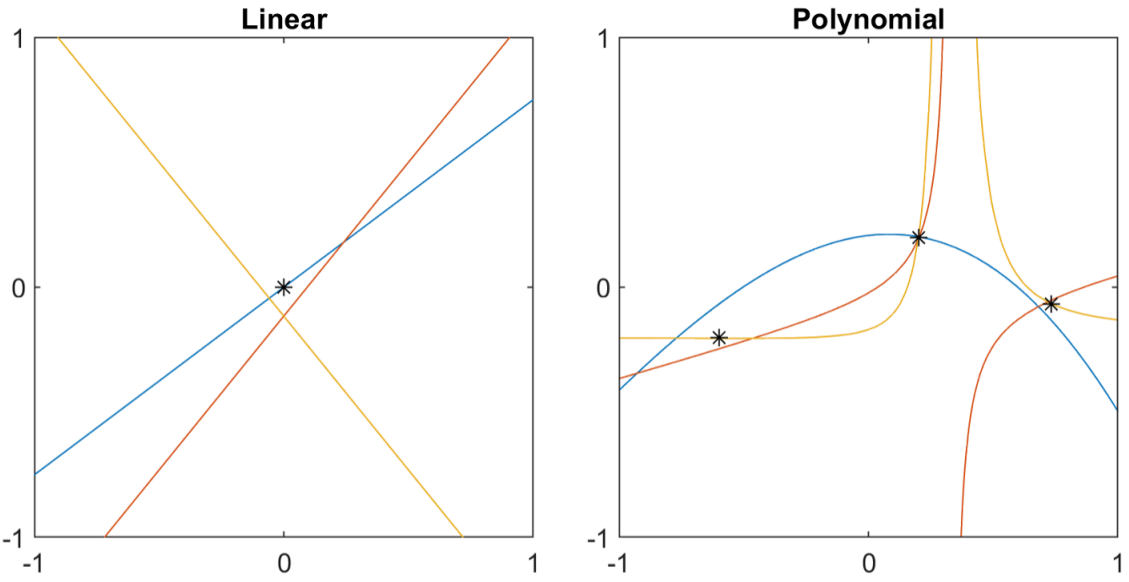
April 2024

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

Research of the month by Raphaël Widdershoven

"Solving noisy overdetermined systems of polynomial equations"
Work under the supervision of Lieven De Lathauwer

Solving (noisy, overdetermined) systems of linear equations is an essential practice in many scientific disciplines, with well-established solution tools from numerical linear algebra. Extending these tools to handle systems of **polynomial equations** could enable the solution of more intricate problems. However, existing methods for these polynomial systems are typically not designed for engineering applications, where noise is present but additional equations are provided to compensate.



The plots above show an example of both a noisy, overdetermined linear system (left) and a noisy, overdetermined polynomial system (right). Each curve represents the zero curve of an equation, with black crosses denoting exact solutions, which are the intersection of the (noiseless) curves. Linear equations are limited to straight lines with a single (approximate) intersection, while the polynomial systems allow for **more intricate curves** and **any number of solutions**.

Our objective is to develop fast and robust methods to determine all approximate roots of noisy, overdetermined systems of polynomial equations. In principle this can be done by forming a **generalized eigenvalue problem** (GEVD) and solving it. This GEVD can for instance be obtained by selecting parts of the nullspace of the **Macaulay** matrix or by constructing **Bézoutian** matrices. Instead of solving just one GEVD, multiple GEVDs can be solved in a coupled manner to improve accuracy, essentially reformulating the problem as a tensor decomposition, specifically the **canonical polyadic decomposition**.

These methods can be used to solve some challenging problems, including **underdetermined blind source separation (BSS)** problems. For instance, we examined a constant modulus BSS problem and also a blind multi-source localization problem where the location of two users could be determined based solely on the power received at five or more surrounding antennas. In all applications, **noise can be mitigated by leveraging the overdetermined set** of equations to identify common (approximate) roots. The greater the number of equations provided, the more effective noise is mitigated, mirroring the behavior observed in linear systems.
For more information about this research read:
- Overdetermined systems of polynomial equations: tensor-based solution and application
- A Bézoutian-based method for solving overdetermined systems of polynomial equations

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News

Highlights from the SOUNDS Seasonal School in Leuven



From April 8th to 11th, **Toon van Waterschoot** hosted the Seasonal School on 'Machine Learning for Speech and Audio Processing' at the premises of Group T in Leuven. This event, jointly organized by the two MSCA European Training Networks **SOUNDS** and **I-SPOT**, attracted MSc and PhD students interested in audio, acoustics, and speech applications. The school provided an up-to-date exploration of how machine learning influences both academic research and industry practices in these fields. The curriculum began with a review of machine learning and deep learning fundamentals, followed by focused sessions on speech, audio, and acoustics.
The event concluded with a poster session where students presented their individual research topics.

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Awards



Gouden Krijtje for Sibren Lagauw

Sibren Lagauw (STADIUS researcher from Bart De Moor's group) was awarded the "Gouden Krijtje" at the VTK award ceremony last Thursday, April 25, 2024, for his educational contributions to the course "Systeemtheorie en Regeltechniek." This course is taught to second-year engineering bachelor's students majoring or minoring in electrical engineering.

Congratulations Sibren!

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Events @ STADIUS

Learning Against Modality Absence: State-of-the-Art Methods and Solution for Biomedical Applications
When: **03/05/2024:**
Where: **B00.35**
By: **Jingwei Zhang**

VSC - Computing resources - seminar/ training session
When: **17/05/2024**
Where: **AULA R (00.54)**
By: **Ehsan Moravveji**

ERC Back to the Roots Seminar: The Moment-SOS hierarchy
When: **11/06/2024, 17:00**

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

Where: **Thermotechnisch Instituut, Aula van de Tweede Hoofdwet**
By: **Guillaume Merecère**

Meet-the-Jury Symposium: "From Lab to Clinic: AI-Driven Musculoskeletal Image"
When: **12/06/2024, 16:00**
Where: **AULA L**
By: **Claudia Lindner**

PhD defense - Adriaan Lambrechts: "Automation of preoperative planning for total knee arthroplasty using machine learning"
When: **12/06/2024, 17:30**
Where: **AULA L**
By: **Adriaan Lambrechts**

New colleagues

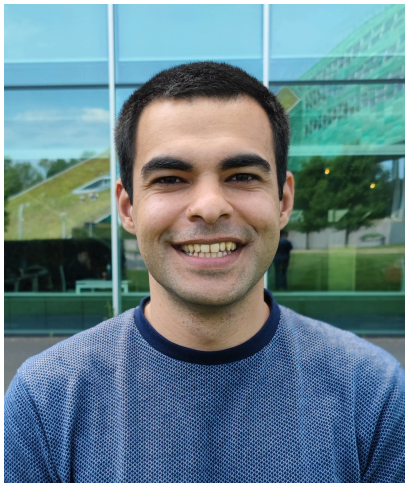
A warm welcome to new researchers and personnel at STADIUS!



Hello everyone,

I'm Tihol Donchev, and I'm excited to start as a postdoctoral researcher at STADIUS, under the guidance of Prof. **Rodolphe Sepulchre.** Previously, I completed my doctoral studies under his supervision at the University of Cambridge, working on stochastic processes applied to biological systems. My research has now shifted to exploring spatio-temporal systems with input-output kernel-based representation.
In my free time, I enjoy playing ping-pong and working out at the gym. I'm looking forward to meeting all of you in the lab.

Tihol



Hi everyone,

My name is **Brayan Shali**. I completed a BSc, MSc, and PhD in applied mathematics at the University of Groningen, The Netherlands. Now, I am a postdoc researcher working under the supervision of Henk van Waarde from the University of Groningen and **Rodolphe Sepulchre** from KU Leuven. My current research focuses on identifying an input-output operator from data generated by an unknown physical system while also incorporating the known physical properties of the system in the identification process.

In my free time, I enjoy going to the gym, watching TV series, exploring random topics in science, and diving into

the intricate details of my favourite fantasy worlds. After spending an extended period in one location, I am excited to now be in Leuven, to meet new people and (hopefully) establish great professional and personal relationships.

Kind regards,
Brayan



Hello!
I'm **Nguyen Xuan Phu.** I received a B.E. degree (2017) in Electronics and Telecommunication Engineering from Ho Chi Minh City University of Technology, Vietnam. In 2019, I finished my M.E. degree in Electronic Engineering from Soongsil University, South Korea. I am now pursuing a PhD degree under the supervision of **Prof. Maarten De Vos.** My research areas include machine learning/deep learning, optimization, signal processing, biomedical engineering, and speech/audio. I am currently focusing on developing a foundation model for ECG/EEG

Phu



Hi,

My name is **Charlotte Vermeylen** and I started a postdoc in April with the team of **Lieven De Lathauwer.** I did my PhD under the supervision of Marc Van Barel and co-supervision of Pierre-Antoine Absil (UCL) at the Department of Computer Science. My research is focused around tensors and optimization but in general any mathematical problem can get me fascinated :-). My PhD title was: "Tensor methods: fast matrix multiplication and rank adaptation".
In my free time I like to run (a lot). I am a member of the university running team and the local athletics club. If you are a little bit competitive, you can always join our training on Wednesdays at 18:15. We always start at the entrance of 'de Nayer'. Furthermore, I am a huge animal and nature lover and am the proud owner of a Labradoodle (dog). As a consequence and for environmental issues, I eat plant-based.

Best regards,
Charlotte

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Recently defended PhD theses

- 15/03/2024 Hannes De Meulemeester: Unsupervised representation learning and health insurance anomaly detection, supervised by Bart De Moor.
- 08/03/2024 Martin Jalmby: Low-rank modeling in room acoustics, supervised by Toon van Waterschoot.

Congratulations!

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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.

24-27
Nijs M., Waelkens E., De Moor B., ``Hierarchical bi-clustering of mass spectrometry imaging data using recursive rank-2 non-negative matrix factorization'', Technical Report 24-27, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-28
Kontras K., Chatzichchristos C., Phan H., Suykens J., De Vos M., ``CoRe-Sleep : A multimodal fusion Framework for Time Series Robust to Imperfect Modalities'', *IEEE Tranactions on Neural Systems and Rehabilitation Engineering*, vol. 32, 2024, pp. 840-849.
Lirias number: 4146863.

24-29
Chen O.Y., Bodelet J.S., Saraiva R.G., Phan H., Di J., Nagels G., Schwantje T., Cao H., Gou J., Reinen J.M., Xiong B., Zhi B., Wang X., De Vos M., ``The roles, challenges, and merits of the p value'', *Patterns*, vol. 4, Dec. 2023, pp. 1-22.
Lirias number: 413008.

24-30
Davidoff H., Van Helleputte N., Vandenbulcke M., De Vos M., Van Hoof C., Van Den Bossche M., ``Unraveling the relationship between heart rate and agitation in people with dementia'', *Alzheimer's & Dementia (Clinical Manifestations)*, vol. 19 (Suppl. 18), 2023, e078916 p.
Lirias number: 4147714.

24-31
Patil M., Qureshi A., Naydenova E., Bang A., Halbert J., De Vos M., Nair P., Patil M., Medvedev M.M., ``Assessing a digital technology-supported community child health programme in India using the Social Return on Investment framework'', *Plos Digital Health*, Nov. 2023, pp. 1-14.
Lirias number: 4147462.

24-32
Karaiskou A.I., Varon C., Alaerts K., De Vos M., ``Cross-subject Mindfulness Meditation EEG Decoding'', in *Proc. of the 2023 IEEE International Conference on Metrology for eXtended Reality, Artificial Intelligence and Neural Engineering (MetroXRAINE)*, Milan, Italy, Oct. 2023, pp. 781-786.
Lirias number: 4146556.

24-33
Seeuws N., De Vos M., Bertrand A., ``Avoiding post-processing with event-based detection in biomedical signals'', *IEEE Transactions on Biomedical Engineering*, vol. 1, Mar. 2024, pp. 1-12.
Lirias number: 4154156.

24-34

Sofi S. S., Hendrikx S., De Lathauwer L., ``Tensor train completion of multi-way data observed along one mode'', Technical Report 24-34, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-35

Vanpoucke L., De Moor B., ``Constructing multidimensional difference equations from a state-space representation through the generalized Cayley-Hamilton theorem'', Technical Report 24-35, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-36

Rosseel H., Jalmby M., van Waterschoot T., ``Low-Rank Multi-Channel Fast Convolution for Real-Time Auralization of Church Acoustics'', Technical Report 24-36, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-37

Phan H., Lorenzen K.P., Heremans E., Chen O.Y., Tran M.C., Koch P., Mertins A., Baumert M., Mikkelsen K.B., De Vos M., ``L-SeqSleepNet : Whole-cycle Long Sequence Modeling for Automatic Sleep Staging'', *IEEE Journal of Biomedical and Health Informatics*, vol. 27, no. 10, Oct. 2023, pp. 4748-4757.
Lirias number: 4140748.

24-38

Beverin L., Topalovic M., Halilovic A., Desbordes P., Janssens W., De Vos M., ``Predicting total lung capacity from spirometry : a machine learning approach'', *Frontiers in Medicine*, May 2023, pp. 1-7.
Lirias number: 4087351.

24-39

Cretot-Richert G., De Vos M., Debener S., Bleichner M.G., Voix J., ``Assessing focus through ear-EEG : a comparative study between conventional cap EEG and mobile in- and around-the-ear EEG systems'', *Frontier in Neuroscience*, Sep. 2023, pp. 1-22.
Lirias number: 4121107.

24-40

De Meulemeester H., *Unsupervised representation learning and health insurance anomaly detection*, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), Mar. 2024, 214 p.
Lirias number: 4139875.

24-41

Creagh A.P., Dondelinger F., Lipsmeier F., Lindemann M., De Vos M., ``Longitudinal trend monitoring of multiple sclerosis ambulation using smartphones'', *IEEE Open Journal of Engineering in Medicine and Biology*, vol. 3, no. *, 2022, pp. 202-210.
Lirias number: 4030100.

24-42

Chen O.Y., Phan H., Cao H., Qian T., Nagels G., De Vos M., ``Probin potential priming: Defining, quantifying, and testing the causal priming effect using the potential outcomes framework'', *Frontiers in Psychology*, Nov. 2022, pp. 1-17.
Lirias number: 4153104.

24-43

Do W., Russell R., Wheeler C., Lockwood M., De Vos M., Pavord I., Bafadhel M., ``Performance of contactless respiratory rate monitoring by Albus HomeTM, an Automated system for nocturnal monitoring at home : A validation study'', *Sensors*, vol. 22, 2022, pp. 1-10 7142.
Lirias number: 3940065.

24-44

Viceconti M., De Vos M., Mellone S., Geris L., ``Position paper from the digital twins in healthcare to the virtual human twin : A moon-shot project for digital health research'', *IEEE Journal of Biomedical and Health Informatics*, vol. 28, no. 1, Jan. 2024, pp. 491-501.
Lirias number: 4143278.

24-45

De Cooman B., Suykens J., ``A Dual Perspective of Reinforcement Learning for Imposing Policy Constraints'', Technical Report 24-45, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-46

Lagauw S., Vanpoucke L., De Moor B., ``Exact Characterization of the Global Optima of Least Squares Realization of an Autonomous LTI Model as a Multiparameter Eigenvalue Problem'', Technical Report 24-46, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.

24-47

Scheltjens V., Wamba Momo L.N., Verbeke W., De Moor B., ``Augmented Medical Image Captioning: Leveraging Class-Dependent Activation Maps for Enhanced Radiology Report Generation'', *Proc. of the IEEE/CVF Conference on Computer Vision and Pattern Recognition 2024 (CVPR)*, Seattle, United States, Jun. 2024.
Lirias number: 4154208.

24-50

Vanhemel T., Nijs M., Birmpili A. Hendriks T., Cuypers E., De Moor B., ``Predicting REIMS from MALDI for glioblastoma sections using deep learning'', *VIB - Applied Bioinformatics in Life Sciences (5th edition) (ABLS24)*, Leuven, Belgium, Mar. 2024.

24-51

Jalmby M., *Low-rank modeling in room acoustics*, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), Mar. 2024
Lirias number: 4142764.

24-52

Zandvoort C.S., van der Vaart M., Robinson S., Usman F., Schmidt Mellado G., Evans Fry R., Worley A., Adams E., Slater R., Baxter L., De Vos M., Hartley C., ``Sensory event-related potential morphology predicts age in premature infants'', *Clinical Neurophysiology*, vol. 157, 2024, pp. 61-72.
Lirias number: 4129839.

24-53

Ranjbar V., Beerten R., Moonen M., Pollin S., ``Joint Sequential Fronthaul Quantization and Hardware Complexity Reduction in Uplink Cell-Free Massive MIMO Networks'', Technical Report 24-53, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024. Accepted for publication in *2024 EuCNC & 6G Summit - PHY*.
Lirias number: 4154457.

24-54

Ranjbar V., Beerten R., Moonen M., Pollin S., ``Sequential Processing in Cell-Free Massive MIMO Uplink with Limited Memory Access Points'', in *Proc. of the IEEE Global Communications Conference*, Kuala Lumpur, Malaysia, Dec. 2023, 6 p.
Lirias number: 4154458.

24-55

Raimondi D., Chizari H., Verplaetse N., Loscher B.S., Franke A., Moreau Y., ``Genome interpretation in a federated learning context allows the multi-center exome-based risk prediction of Crohn's disease patients'', *Nature*, Scientific Reports, vol. 13, 2023, 19449 p.
Lirias number: 4127950.

24-56

Yang P.K., Filtjens B., Ginis P., Goris M., Nieuwboer A., Gilat M., Slaets P., Vanrumste B., ``Freezing of gait assessment with inertial measurement units and deep learning : effect of tasks, medication states, and stops'', *Journal of NeuroEngineering and Rehabilitation*, vol. 21, no. 24, 2024, pp. 1-22.
Lirias number: 4143087.

24-57

Shang M., Dedeyne L., Dupont J., Vercauteren L., Amini N., Lapauw L., Gielen E., Verschueren S., Varon C., De Raedt W., Vanrumste B., ``Otago Exercises Monitoring for Older Adults by a Single IMU and Hierarchical Machine Learning Models'', *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, vol. 32, no. *, 2024, pp. 462-471.
Lirias number: 4142032.

24-58

Wang C., Kumar S., De Raedt W., Camps G., Hallez H., Vanrumste B., ``Eating Speed Measurement Using Wrist-Worn IMU Sensors in Free-Living Environments'', Technical Report 24-58, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024.
Lirias number: 4138278.

24-59

Rogala J., Zygierewicz J., Malinowska U., Cygan H., Stawicka E., Kobus A., Vanrumste B., ``Enhancing autism spectrum disorder classification in children

through the integration of traditional statistics and classical machine learning techniques in EEG analysis'', *Nature*, Scientific Reports, vol. 13, no. *, 2023, pp. 217-48.
Lirias number: 4144132.



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