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STADIUS
Center for Dynamical Systems, Signal Processing and Data Analytics

STADIUS Newsletter

November 2023

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

Welcome to the November edition of the STADIUS Newsletter!

Let me start with a word of thank you to all **Newcomers** for organising a nice event last week!
It was an unforgettable afternoon and evening.



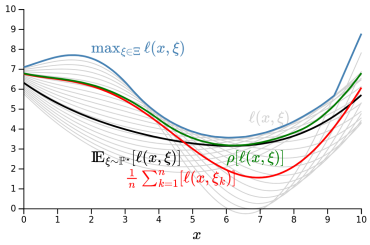
Research of the month by Mathijs Schuurmans

"Distributionally Robust Model Predictive Control for Safety-Critical Systems: with Applications in Autonomous Driving"

Work under supervision of prof. Panos Patrinos

The availability of reliable methods for data-driven, optimal decision making under uncertainty is of central importance in several fields of study, including operations research, control, machine learning, and many more specialized application domains.

Current (black-box) machine learning techniques, despite their many successes, still provide very few guarantees



regarding correctness and safety, impeding their adoption for many high-stakes and safety-critical applications. This drawback can be partially mitigated by further increases in computational power and dataset sizes, but nevertheless, such a remedy is insufficient for applications akin to robotics, where computational hardware or availability of informative data may be limited. This thesis aims to address this shortcoming by developing novel methodologies for data-driven decision-making and control, which are applicable in online settings, and which provide guarantees regarding performance and constraint satisfaction for finite sample sizes. To this end, distributionally robust optimization (DRO) serves as our main tool, as it provides many of these desirable guarantees by design, as illustrated in the figure.
There, the empirical risk (red), a robust surrogate (blue) and a DRO surrogate (green) cost are shown in comparison to the true expected cost (black). With high probability, the DRO cost provides an upper bound to the (unknown) true expected cost, resulting in generalization bounds by design. Furthermore, its conceptual simplicity makes it a versatile approach for many specific problems.
In particular, we highlight the following contributions: (i) We present distributionally robust techniques for synthesis of stabilizing controllers for Markov jump linear systems, where the distribution of the switching process is unknown; (ii) We develop a theoretical framework for distributionally robust model predictive control of general (nonlinear) Markov jump systems (also referred to as Markov switching systems). This gives rise to multi-stage risk-averse optimization problems, including nested risk measures in both the costs and the constraints; (iii) In order to efficiently solve these problems, we propose tractable reformulations and a tailored, massively parallellisable solver; (iv) We propose a novel DRO method, called Cost-Aware Distributionally Robust Optimization (Cadro), which, by exploiting the structure of the cost function in the design of its ambiguity set, results in less conservative solutions to data-driven DRO problems, while retaining the same guarantees; and (v) We apply our developments to case studies within automated driving, and demonstrate

empirically the effects of relevant design trade-offs in these examples.

See also:

- PhD Thesis: https://lirias.kuleuven.be/4111232&lang=en
- Slides public defense: https://homes.esat.kuleuven.be/~mschuurm/pubdef

Awards



Yves Moreau © Lies Willaert

Einstein Foundation Award 2023 for Yves Moreau

On the 14th of November 2023, the Einstein Foundation Berlin announced the winners of the Einstein Foundation Award 2023.

The winner of the individual award is **Yves Moreau** of the KU Leuven. Moreau is one of the most passionate advocates for ethical standards in the use of human DNA data in the age of artificial intelligence and big data.

Jury member Michel Cosnard, computer scientist at the Université Nice-Sophia-Antipolis, states: "**Moreau links deep research in DNA analysis and artificial intelligence with ethics, integrity, and human rights**. His work and achievements serve as a cornerstone to help us confront the difficult social questions that arise from rapid technological developments."



Team ALFA Modulation wins the SP Challenge

We are proud to announce that **Leander Hemelhof**, a PhD researcher from the group of Panos Patrinos, together with his teammates: Arno Hemelhof from VUB-imec, Freja Vandeputte from VUB, and Amedeo Varano from VUB-imec, have won the SP Challenge competition.

In the first part of the competition, the groups had to decode a message with increasingly complex modulation schemes based on their measurements with a software-defined radio. Each decoded message gave the center frequency of the next. In the second part, groups were given synthetic EEG data sets corresponding to four people, and an equal number of epileptic spike patterns. The goal was to link the correct data set to the correct spike pattern and the correct person, using a message hidden at the locations of the spikes.

Congratulations!

News

Yves Moreau in The Guardian about the breach of trust in data-sharing

In an Observer investigation, it was revealed that **UK Biobank**, a biomedical database with sensitive health information from half a million UK citizens, shared this data with insurance companies, despite prior assurances.

In a recent article in **The Guardian** **Yves Moreau** criticized the data-sharing as a "serious breach of trust".

The violation of previous promises not to share data with insurance companies has sparked debates on transparency and ethical considerations in data sharing for health-related research.

Bart De Moor gives a talk about AI at the LERU Assembly meeting

On November 17, Bart De Moor delivered a presentation on the potential **impact of Artificial Intelligence** (AI) **on research, innovation, and educational activities** at research universities. This presentation took place during the **LERU** Rectors' Assembly held at Trinity College in Dublin. LERU, known as the League of European Research Universities, is a distinguished network comprising research-intensive universities. It actively shapes EU-level policies regarding research, innovation, and higher education through various means such as policy papers, statements, meetings, and events.
For a detailed overview of the entire assembly, you can read the recap here.

Events @ STADIUS

PhD Defense - Christof Vermeersch
When: **1/12, 16:30**
Where: **Jozef Heuts, LAND 00.215,**
By: **Christof Vermeersch**

PhD defense - Thomas Strypsteen
When: **7/12/2023, 17:00**
Where: **Auditorium Arenbergkasteel**

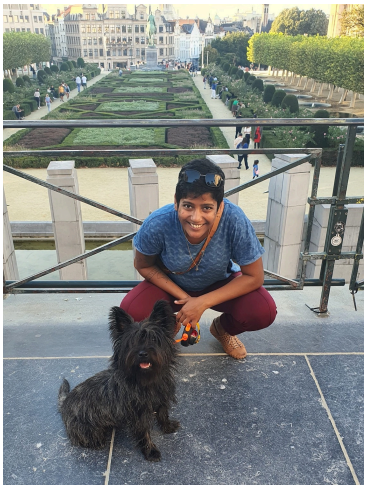
For more information about STADIUS events please visit the STADIUS Event webpages.

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

ERC Back to the Roots Seminar: Prof. Lieven De Lathauwer
When: **12/12/2023, 17:00**
Where: **ELEC B91.300 - aula C**
Organised by: **Bart De Moor**

New colleagues

A warm welcome to new researchers and personnel at STADIUS!



Hello all,

My name is **Apurva Kriti**, often referred to as Apu to make things easier. I started my PhD in October under the supervision of Professor Marc Moonen. The focus of my thesis is going to be exploring Per-Tone Processing for DSP. I did my post graduate in 'Communications and Multimedia Engineering' with focus on Audio Signal Processing in Erlangen, Germany and finished my degree in 2019. Since then I have been working as a Scientific Researcher in Fraunhofer IIS, also in Erlangen, Germany.
In my free time, I enjoy taking long walks with my dog and cooking new dishes. I am looking forward to any research collaboration in future.
Best,

Apu



Hi everyone,

My name is **Meixi Wang.** I currently study in the group of Prof. Johan Suykens as a joint Ph.D. student for one year. My research focuses on deep learning-based control methods design and data-driven control analysis. I am looking forward to this communication with you.

Meixi

Best of luck!

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

- **Santiago Ruiz** has just defended his PhD thesis on Distributed Signal Processing Algorithms For Combined Noise Reduction and Acoustic Echo and Feedback Cancellation. He is now moving to London, UK, to join CEDAR, a company that specialises in audio restoration and noise suppression

All the best on the new carreer path!

Recently defended PhD theses

In November 4 STADIUSans have defended their PhDs. Congratulatios!

- **10/11/2023 Mathijs Schuurmans:** "Distributionally Robust Model Predictive Control for Safety-Critical Systems: with Applications in Autonomous Drivin", PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium)
- **15/11/2023 Cem Musluoglu:** "Distributed Spatial Filtering in Wireless Sensor Networks", PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium)
- **21/11/2023 Ashtari Pooya**, Brain Lesion Segmentation and Detection on Multi-parametric MRI Data: Marrying Deep Learning with Low-rank Factorization, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium),
- **23/11/2023 Santiago Ruiz**, Distributed Signal Processing Algorithms For Combined Noise Reduction and Acoustic Echo and Feedback Cancellation, 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.

23-138
Vermeersch C., De Moor B., "Multivariate Polynomials (with MacaulayLab) for Beginners", *Open Flanders AI Research Day*, Mechelen, Belgium, Oct. 2023.
Lirias number: 4126644.

23-140
Lagauw S., Vanpoucke L., De Moor B., "Exact Characterization of the Global Optima of Least Squares Realization of Autonomous LTI Models as a Multiparameter Eigenvalue Problem", Technical Report 23-140, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2023.

23-143
Ghaderi S., Ahookhosh M., Patrinos P., Skupin A., Moreau Y., "Smoothing unadjusted Langevin algoritms for nonsmooth composite potential functions",*Applied Mathematics and Computation*, vol. 464, 2024, 128377 p.
Lirias number: 4122895.

23-144

Sampathirao A., Patrinos P., Bemporad A., Sopasakis P., "Massively parallelizable proximal algorithms for large-scale stochastic optimal control problems",*Optimal Control Applications and Methods*, 2023, pp. 1-19.
Lirias number: 4122896.

23-145

Laude E., Themelis A., Patrinos P., "Dualities for non-euclidean smoothness and strong convexity under the light of generalized conjugacy", *SIAM journal on Optimization*, vol. 33, no. 4, 2023, pp. 2721-2749.
Lirias number: 4122810.

23-146

Coppens P., Patrinos P., "Ordered risk minimization : Learning more from less data", in *Proc. of the IEEE 62nd Annual Conference on Decision and Control (CDC)*, Marina Bay Sands, Singapore, Dec. 2023.
Lirias number: 4122897.

23-147

El Bourkhissi L., Necoara I., Patrinos P., "Linearized ADMM for nonsmooth nonconvex optimization with nonlinear equality constraints", in *Proc. of the IEEE 62nd Annual Conference on Decision and Control (CDC)*, Marina Bay Sands, Singapore, Dec. 2023.
Lirias number: 4122898.

23-148

Behmandpoor P., Patrinos P., Moonen M., "Model-free decentralized training for deep learning based resource allocation in communication networks", in*Proc. of the 31st European Signal Processing Conference (EUSIPCO)*, Helsinki, Zweden, Sep. 2023, pp. 1494-1498.
Lirias number: 4122899.

23-151

Sharma M., Moonen M., Lefevre Y., Tsiaflakis P., "Resource sharing strategies for point-to-multipoint distribution in next-generation DSL networks", *IEEE Open Journal of the Communications Society* , vol. 4, Sep. 2023, pp. 2697 - 2716.
Lirias number: 4121486.

23-152

Schuurmans M., *Distributionally Robust Model Predictive Control for Safety-Critical Systems: with Applications in Autonomous Driving*, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), Nov. 2023
Lirias number: 4111232.

23-153

Musluoglu C., *Distributed Spatial Filtering in Wireless Sensor Networks*, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), Nov. 2023
Lirias number: 4115925.

23-154

Ashtari P., *Brain Lesion Segmentation and Detection on Multi-parametric MRI Data: Marrying Deep Learning with Low-rank Factorization*, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), Nov. 2023, 240 p.
Lirias number: 4118444.

23-155

Ruiz S., *Distributed Signal Processing Algorithms for Combined Noise Reduction and Acoustic Echo and Feedback Cancellation*, PhD thesis, Faculty of Engineering, KU Leuven (Leuven, Belgium), Nov. 2023
Lirias number: 4118069.

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