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STADIUS
Center for Dynamical Systems, Signal Processing and Data Analytics

STADIUS Newsletter

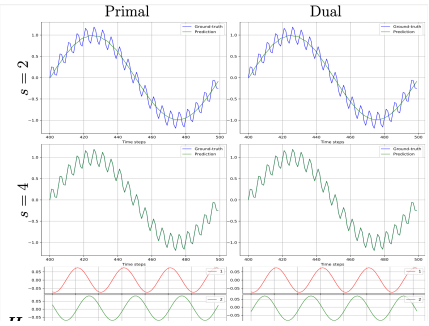
May 2023

AWARDS . EVENTS . STAFF UPDATE . PUBLICATIONS

Welcome to the May edition of the STADIUS Newsletter

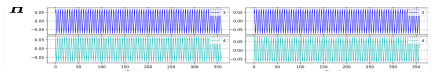
This month, we introduce you to the research of Arun Padney, a PhD student supervised by Johan Suykens.
You can also get to know a few new colleagues that joined STADIUS in May, see some newly approved projects and check the upcoming events.
Enjoy the read below.

Research of the month

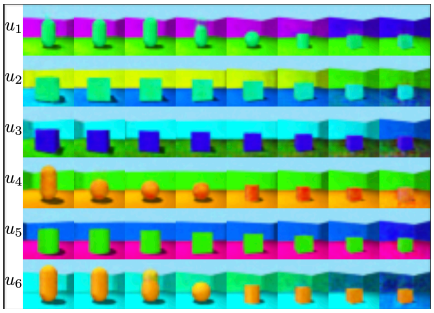


Arun Pandey: "From kernel eigenvalue problems to deep learning, generative models, and beyond"

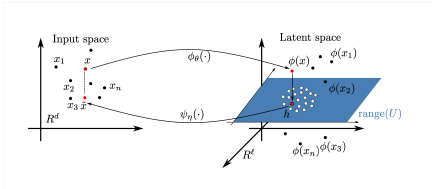
It is well-known that the eigenvalue problem is a



fundamental concept in linear algebra and has broad applications in various scientific disciplines. It allows researchers to uncover essential properties and characteristics of systems represented by matrices. Its applications span multiple disciplines, enabling scientists to gain deeper insights into phenomena, optimize processes, and make informed decisions based on the behavior of eigenvalues and eigenvectors. In the field of machine learning, statistics and data analysis, a prominent application of the eigenvalue problem is Principal Component Analysis (PCA). PCA plays a crucial role in dimensionality reduction by identifying the directions of maximum variance within a dataset.



In the context of Prof. Johan Suykens' ERC E-Duality project, we have extended the non-linear PCA, more specifically, Kernel PCA to enable multi-modal generation, disentangled representation learning, and time series forecasting. The methodology involves the Restricted Kernel Machine (RKM) formulation of Kernel PCA, which aligns its objective function with the energy function of a Restricted Boltzmann Machine (RBM). This connection draws inspiration from RBMs and enables the integration of deep learning techniques into the Kernel PCA framework. Such a connection helped us to build Multi-view Kernel PCA, where different views of the same data are used to learn a common representation. These views could be text, images, audio samples or simply input-output pairs. Depending on the application, the learned representation can be used to generate new data samples, perform classification, or regression.

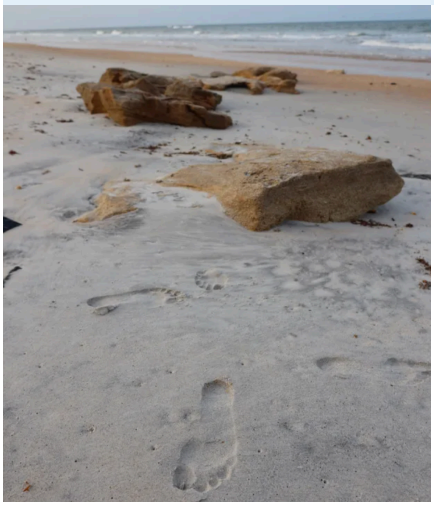


Furthermore, to address scenarios involving large datasets or high-dimensional data, we employ both the primal and dual formulations within the RKM framework. The primal formulation is suitable for handling large datasets efficiently and enables working with deep architectures such as e.g.

convolutional feature maps, while the dual formulation proves beneficial in situations where the data exhibits high dimensionality. Both formulations rely on solving the eigenvalue problem, contributing to the effective exploration and analysis of the data.

The continued insights and advancements related to such eigenvalue problems helps us to gain a deeper understanding of systems and enabling innovative solutions.

Learn more:
https://doi.org/10.1162/neco_a_01528
https://arxiv.org/abs/2305.17251
https://doi.org/10.1016/j.neunet.2020.12.010



Bycatch of human DNA causes new privacy concerns

In May two different researchers from disparate fields warned of the **dangers of misuse of human genomic 'bycatch'**: as it turns out, water, soil, and air samples collected in studies of plants and animals often come with significant amounts of human genes which researchers can use to pull information about people's sex, likely ancestry, certain disease risks, and sometimes even full identity. This means ecologists and environmental scientists might need to apply for a new set of ethics approvals concerning human DNA.
This also has consequences for the **'anonymized' genetic sequences posted to public databases**, as it seems these are **not as anonymous as claimed**.
This links to the research and awareness campaign of "our" **Yves Moreau on the abuse of police forces and governments of genetic databases**.

Yves' quotes can be found in Nature and CNN:

- Science "Privacy concerns sparked by human DNA accidentally collected in studies of other species"
- CNN "Human DNA can now be pulled from thin air or a footprint on the beach. Here's what that could mean"

Events @ STADIUS

Moving towards the analysis of gravitational-wave data in the next-generation detector era

When: **02/06/2023, 11:00 - 12:00**

Where: **ESAT, Aula R**

By: **Justin Janquart** (Utrecht University)

SELMA Seminar

When: **15/06/2023, 14:00 - 17:00**

Where: **ESAT, Aula C**

By: Xiao Fu, Aritra Konar, and Raphaël Widdershoven

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

New colleagues

A warm welcome to new researchers and personnel at STADIUS!



Muhammad Quamber Ali

My name is Muhammad Quamber Ali, a seasoned professional with more than a decade of expertise in the software industry. Throughout my career, I have primarily dedicated myself to Engineering Management, particularly in the realm of AI-driven SaaS applications. Recently, I have embarked on a new endeavor by joining STADIUS as a PhD researcher under the guidance of **Prof. Dr. Yves Moreau**. My research focus revolves around the complexities of data heterogeneity within federated and



privacy-preserving analytics. When I'm not immersed in my work, I enjoy indulging in chess as a pastime and I look forward to meeting all of you.



Martina Iannacito

Hello everyone, I am Martina Iannacito, and I just joined as a postdoctoral fellow in the group of **Prof. Lieven De Lathauwer** in Kortrijk. My research at KU Leuven will focus on tensor decompositions and their related aspects. Since the Master course on 'Tensor decomposition for big data analysis' held by Prof. Alessandra Bernardi at the University of Trento, I have been fascinated by the possibilities offered by the tensor representation of data or mathematical objects if compared to the classical matrix ones.
Therefore, I started a PhD at the Inria research centre in Bordeaux (France) under the supervision of Prof. Olivier Coulaud and Luc Giraud. Last December, I defended my thesis about numerical linear algebra and data science techniques in low-rank tensor format.
My principal research interests concern the numerical and algorithmic aspects of tensor decomposition and the techniques using them.



Jia Wang

Hi, my name is Jia Wang and I recently started as a PhD student in the group of **Prof. Panos Patrinos**. My research will focus on data-driven control. Prior to this, I obtained my Master's degree in Dynamical Systems and Control at Peking University. In my spare time I enjoy jogging and reading. Looking forward to meeting you all!

Recently approved projects

We are glad to share the news that following projects were recently approved:

- **FWO SBO** *"Supporting the development of self-regulation in infants: a promising strategy in preventive mental health care"*
  - Coordinator: Bart Boets (Department of Neurosciences)
  - Involved @STADIUS: Maarten De Vos

- **C2** "*Dissecting agitation in dementia by multimodal sensing (DADS)*"
  - Coordinator: Maarten Van Den Bossche (UPC KU Leuven)
  - Involved @STADIUS: Maarten De Vos

- **FWO Postdoctoral Mandates:**
  - **Simon Geirnaert** "*Signal processing algorithms for attention decoding of brain responses to natural stimuli in brain-computer interfaces*" (prom. Alexander Bertrand)
  - **Susan Ghaderi** "*Highly efficient non-Euclidean optimization and MCMC methods for deep matrix completion*" (prom. Yves Moreau)

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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.

23-75
Evens B., "Convergence of the Preconditioned Proximal Point Method and Douglas-Rachford Splitting in the Absence of Monotonicity", Technical Report 23-75, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2023.

23-76
Latafat P., Themelis A., Stella L., Patrinos P., "Adaptive proximal algorithms for convex optimization under local Lipschitz continuity of the gradient", Technical Report 23-76, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2023.

23-77
Latafat P., Themelis A., Villa S., Patrinos P., "AdaBiM: An adaptive proximal gradient method for structured convex bilevel optimization", Technical Report 23-77, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2023.

23-78
Pethick T., Fercoq O., Latafat P., Patrinos P., Cevher V., "Solving stochastic weak Minty variational inequalities without increasing batch size", in *Proc. of the International Conference on Learning Representations (ICLR)*, Kigali, Rwanda , May 2023.
Lirias number: 4085551.

23-79
Rosseel H., van Waterschoot T., "Interactive Perceptual Evaluation of Auralized Acoustics in Rehearsal Spaces for Vocal Music", Technical Report 23-79, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2023.

23-80
Amoni M., Ingelaere S., Moeyersoons J., Wets D., Tanushi A., Van Huffel S., Varon C., Sipido K., Claus P., Willems R., "Regional beat-to-beat variability of repolarization increases during ischemia and predicts imminent arrhythmias in a pig model of

myocardial infarction", *Am. J. Physiol. Heart Circ. Physiol.*, May 2023.
Lirias number: 4082868.

23-81

Kiessling D., Astudillo Vigoya A., Pas P., Patrinos P., Swevers J., "Anderson Accelerated Feasible Sequential Linear Programming", Technical Report 23-81, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2023. Accepted for publication in *IFAC World Congress 2023, Yokohama*.
Lirias number: 4072609.

23-82

Khanh Hien L.T., Phan D.N., Gillis N., Ahookhosh M., Patrinos P., "Block Bregman Majorization Minimization with Extrapolation", *SIAM Journal of Data Science*, vol. 4, no. 1, 2022, pp. 1-25.
Lirias number: 4079328.

23-83

Achten S., Pandey A., De Meulemeester H., De Moor B., Suykens J., "Duality in Multi-View Restricted Kernel Machines", Technical Report 23-83, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2023.



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