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STADIUS
Center for Dynamical Systems, Signal Processing and Data Analytics

STADIUS Newsletter

JANUARY 2025

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

Welcome to the first STADIUS Newsletter in 2025

A new year brings fresh beginnings, exciting news, and inspiring achievements. In this edition, you'll find interesting updates, a look at upcoming events, and the chance to meet new colleagues joining our research division.
We also celebrate recent PhD defenses, highlight new publications, and share insights into the latest research.
Take a moment to browse through. We hope you enjoy the read!

Research of the month by Jean-Pierre Allamaa

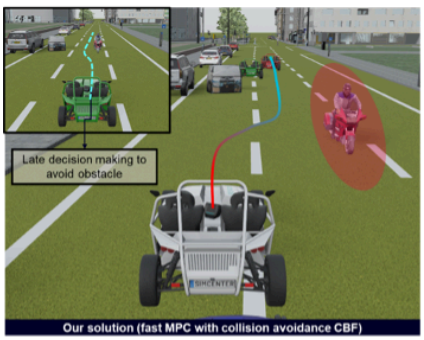
"Embedded learning and optimization for autonomous vehicle control "

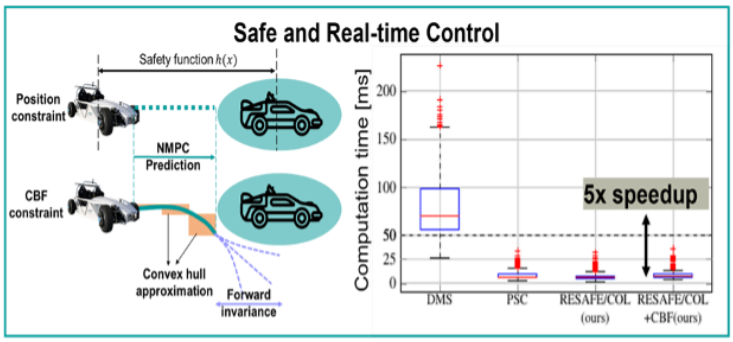
Work under the supervision of Panos Patrinos (KU Leuven) and Son Tong (Siemens)

Autonomous driving (AD) technology has been rapidly advancing in the automotive industry, with the goal of increasing safety, comfort, and environmental friendliness. A key component of autonomous vehicles is the controller or "decision-making brain". Nonlinear Model Predictive Control (NMPC) is an advanced control strategy that has shown promising results for autonomous systems by incorporating safety, comfort, and high performance into its design. However, two main challenges remain for real-world implementation of NMPC: 1) enabling critical real-time operation and easy prototyping, and 2) preventing catastrophic performance degradation due to differences between simulation and the real environment.

This project researches the efficient transfer of autonomous driving modules from simulation to the real world (**Sim2Real**), by reducing testing time & cost, data collection efforts, and manual tuning needs. We focus on three aspects:

1. Frameworks for fast verification and validation of controllers in simulation, hardware, and real-world physical testing.
2. Certifiable, safe and real-time capable optimal controllers.
3. Using **digital twins** (DTs) and data-driven approaches to adapt and robustify controllers against real-world uncertainties.

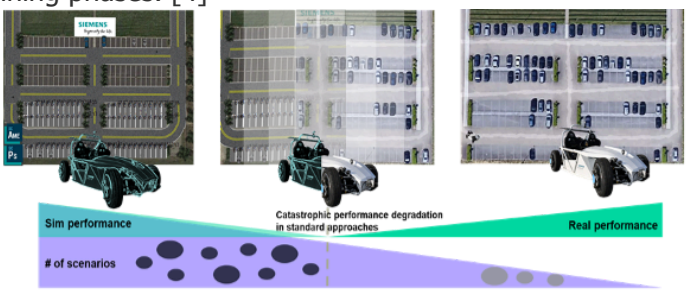


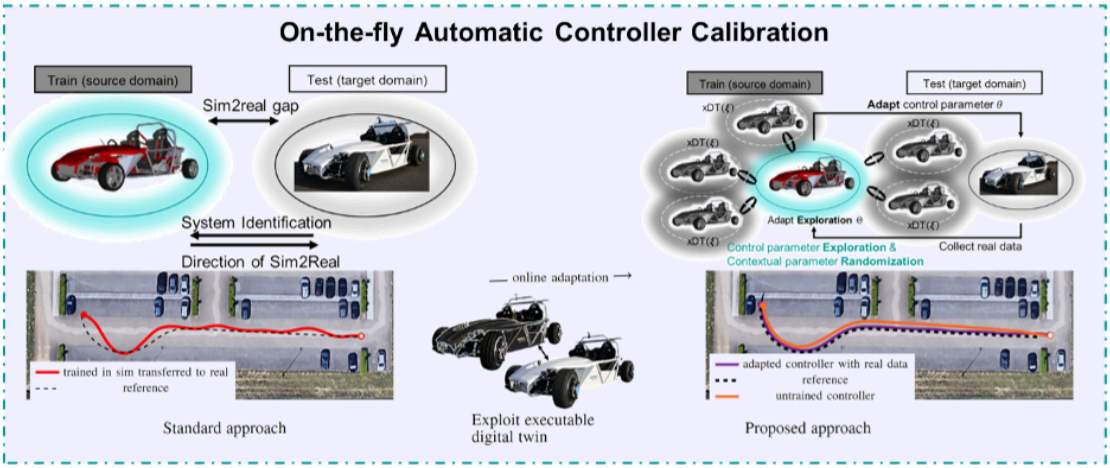


The first part establishes a framework for designing, validating, and implementing advanced AD controllers that meet automotive industry standards across different testing stages (model/hardware/vehicle-in-the-loop). This framework enables plug-and-play validation of algorithms like real-time NMPC and AI driver models such as Reinforcement Learning control using DTs. [1, 2]

The second part tackles the computational challenges of running **real-time NMPC** on electronic control units by presenting a novel formulation **(RESAFE/COL)** that speeds up onboard computations by 9x compared to state-of-practice methods. It also incorporates safe trajectory tracking and collision avoidance capabilities through **continuous-time constraint satisfaction**, demonstrating high performance in simulation and reality. [3]

The third part addresses transferring advanced controllers from Sim2Real by proposing a data-efficient learning-based adaptation method for parametric controllers. The method allows tuning blackbox controllers by automatically identifying and adapting critical control design parameters. It tunes the NMPC parameters in real-time using derivative-free optimization and executable DTs. Real-world experiments validated the ability to automatic calibrate the NMPC cost function parameters in **just under 10 minutes**, eliminating lengthy manual tuning and training phases. [4]





Publications

[1] J. P. Allamaa, P. Listov, H. Van Der Auweraer, C. Jones and T. D. Son, (2022), "Real-time Nonlinear MPC Strategy with Full Vehicle Validation for Autonomous Driving", 2022 American

Control Conference (ACC)
[2] K. Voogd, J.P. Allamaa, J. Alonso-Mora & T.D. Son, (2023), "Reinforcement Learning from Simulation to Real World Autonomous Driving using Digital Twin", 22nd IFAC World Congress
[3] J. P. Allamaa, P. Patrinos, T. Ohtsuka, T. D. Son (2024), "Real-time MPC with Control Barrier Functions for Autonomous Driving using Safety Enhanced Collocation", 2024 IFAC NMPC Conference
[4] J.P. Allamaa, P. Patrinos, H. Van Der Auweraer & T.D. Son (2024), "Learning Based NMPC Adaptation for Autonomous Driving using Parallelized Digital Twin", in IEEE Transactions on Control System Technology (TCST) Special Issue on Intelligent Decision Making, Motion Planning and Control of Automated Vehicles in Interaction-driven Traffic Scenarios

News



Yves Moreau Receives Doctorate Honoris Causa at UCLouvain

We are thrilled to announce that our STADIUS professor, **Yves Moreau,** will be honored with the Doctorate Honoris Causa by UCLouvain (Secteur des sciences et technologies). This prestigious recognition will be conferred on Thursday, February 27.
We warmly invite you to join the event! Please click the link below.

Click here to register to the ceremony



Marc Moonen Receives IEEE SPS Claude Shannon-Harry Nyquist Technical Achievement Award

We are proud to announce that **Marc Moonen** has been honored by the IEEE Signal Processing Society with the **Claude Shannon-Harry Nyquist Technical Achievement Award** ("for outstanding contributions to the theory and practice of statistical signal processing and optimal communication systems").
The Claude Shannon-Harry Nyquist Technical Achievement Award "honors a person who, over a period of years, has made outstanding technical contributions to theory and/or practice in technical areas within the scope of the Society, as demonstrated by publications, patents, or recognized impact on the field".
The award will be presented in the IEEE SPS Awards Ceremony at ICASSP-2025 in Hyderabad, India.

Please join us in congratulating Marc Moonen on this well-deserved achievement!

Read more about Signal Processing Society Awardees of 2025



Bart De Moor Elected Chairman of the Leuven Gravity Institute

We are excited to share that **Bart De Moor** has been elected as the **Chairman of the Leuven Gravity Institute** (LGI)!
You can learn more about the institute by clicking here.

This nomination comes at an exciting time for Flanders as we compete to host the Einstein Telescope, a major scientific project, alongside two other contenders.

STADIUS Colloquium Series

The schedule for the **STADIUS Colloquium Series** is almost finalised for this semester. We are pleased to invite you for the 3 upcoming events (more info will follow):

- **12/03/2025**: **Nicolas Gillis**
  - Title: **"Non-negative Matrix Factorization"**
  - Time: **15:00 - 16:00**
  - Location: **ELEC B91.300**

- **23/04/2025: Kaze W. K. Wong**
  - Title: **"Machine learning in Gravitational wave data analysis"**
  - Time: **14:30 - 15:30**
  - Location: **ESAT, Aula C**

- **07/05/2025: Yurii Nesterov**
  - Title: "**Optimization, the philosophical background of artificial intelligence"**
  - Time: **15:00 - 16:00**
  - Location: **ELEC B91.300**

For more detailed abstract and biographies, please stay tuned and consult the STADIUS Event website

Other events @ STADIUS

Meet-the-Jury Symposium: *"Does God play dice with DNA? The origin of the Chargaff's second parity rule"*
When: **26/02/2025, 14:00 - 15:00**
Where: **B91.100**
By: **Piero Fariselli**

PhD defense - Pourya Behmandpoor
When: **19/02/2025, 13:30 - 16:00**
Where: **TI 01.02, Thermotechnisch Instituut**
By: **Pourya Behmandpoor**

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

New colleagues

A warm welcome to new personnel at STADIUS!



Hello everyone,

My name is **Stylianos Mouslech**. I was born and raised in Greece, where I received my Electrical and Computer Engineering diploma before joining KU Leuven for an MSc in Artificial Intelligence. I recently joined Biomed under the supervision of Prof. De Vos for a joint PhD between KU Leuven and FAU. My research will focus on developing computational models to estimate functional brain age by combining model-driven and data-driven approaches. The goal is to create tools to help health professionals distinguish healthy ageing from neurodegenerative disorders. In my free time, I enjoy watching and discussing films and watching and playing football. Looking forward to meeting everyone!
-Stylianos



"Hi everyone,

I am **Diwas Lamsal.** I completed my master's degree in computer science from the Asian Institute of Technology (AIT) in Thailand, where I later worked at the AI Center for about 14 months. During this time, I worked on several deep learning projects, including activity monitoring and fall detection systems for elderly people and wheelchair users. Now, I'm a PhD researcher at the eMedia Lab under Professor Bart Vanrumste's supervision. My research focuses on integrating data from body-worn sensors with egocentric vision to understand human actions, predict intentions, and estimate fatigue levels, while exploring efficient ways to run these multimodal models on edge devices.
In my free time, I enjoy traveling, playing video games, and learning about new tech. I look forward to meeting everyone here."

Best,
Diwas

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

Best of luck!

- **Pourya Behmandpoor,** a researcher supervised by Marc Moonen.
  Pourya's defense is scheduled on 19/02/2025. Following his defense, he will continue his academic career as a postdoctoral researcher at VUB.
- **Antoine Passemiers**, a researcher from Yves Moreau's team.
  While finalizing his PhD, will work as a software developer in the private sector.

^

Recently defended PhDs

29/01/2025: Konstantinos Kontras, *Multimodal Fusion,* supervised by Maarten De Vos, Johan Suykens and Christos Chatzichristos.

^

New Projects Starting

MSCA ITN - Marie Sklodowska-Curie Actions International Training Networks
InSilicoHealth- Training the virtual twin professionals to support healthy ageing

- 01/01/2025 - 31/12/2029
- STADIUS PI: Maarten De Vos
- Coordinator: Ilse Jonkers (Biomedical Kinesiology)

FWO Senior Project
Task- and device- agnostic Artificial Intelligence (AI) for EEG analysis

- 01/01/2025 - 31/12/2028
- STADIUS PI: Maarten De Vos

FWO Junior Project
Sentience: Overcoming Cybersickness by Means of Subjective Perception of Time and Space

- 01/01/2025 - 31/12/2028
- STADIUS PI: Maria Torres Vega

FWO TBM
FLIPR - Creating a European law compliant clinical decision support software for risk prediction of chronic pain after inguinal hernia repair

- 01/01/2025 - 31/12/2028
- STADIUS PI: Bart De Moor
- Coordinator: Marc Miserez (Faculty of Medicine)

FWO TBM

Little NIRVANA: A new interactive pain management solution for children - towards a standard for pediatric pain managent

- 01/01/2025 - 31/12/2028
- STADIUS PI: Maarten De Vos
- Coordinator: Barbara Weyn (ESAT, PSI)

Seed Fund Call University of Helsinki
DAIBRAIN: Decentralized artificial intelligence for assessing clinical brain recordings

- 01/01/2025 - 31/12/2025
- STADIUS PI: Maarten De Vos

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.

24-182
Karamichailidou D., Gerolymatos G., Patrinos P., Sarimveis H., Alexandridis A., "Radial basis function neural network training using variable projection and fuzzy means", *Neural computing and applications*, vol. 36, 2024, pp. 21137-21151.
Lirias number: 4210017.

24-183
Latafat P., Themelis A., Villa S., Patrinos P., "On the convergence of proximal gradient methods for convex simple bilevel optimization", Technical Report 24-183, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2024. Accepted for publication in *Journal of Optimization Theory and Applications*.
Lirias number: 4210209.

24-184
Kenis R., Laude E., Patrinos P., "Convex relaxations for manifold-valued Markov random fields with approximation guarantees", in *Proc. of the European Conference on Computer Vision (ECCV)*, Milan, Italy, Sep. 2024, pp. 160-176.
Lirias number: 4210449.

24-185
Latafat P., Themelis A., Patrinos P., "On the convergence of adaptive first order methods : proximal gradient and alternating minimization algorithms.", in *Proc. of the 6th Annual Learning for Dynamics and Control Conference (L4DC 2024)*, Oxford, UK, Jul. 2024, pp. 197-208.
Lirias number: 4210461.

25-01
Chen C., Sepulchre R., "The Hilbert distance between LTI passive systems", in *Proc. of the 2024 IEEE 63rd Conference on Decision and Control (CDC)*, Milan, Italy, Dec. 2024, pp. 8138 - 8143.
Lirias number: 4212110.

25-02
Chen C., Chen J., Zhao D., Qiu L., "A cyclic small phase theorem for nonlinear systems", in *Proc. of the 2024 IEEE 63rd Conference on Decision and Control (CDC)*, Milan, Italy, Dec. 2024, pp. 4405 - 4410.
Lirias number: 4212159.

25-03
Khong S. Z., Chen C., Lanzon A., "Feedback stability analysis via dissipativity with dynamic supply rates", *Automatica*, vol. 172, Feb. 2025, pp. 1 - 13, Art. 112000.

Lirias number: 4211491.

25-04

Zhao D., Chen C., Chen J., "Small-gain and small-angle conditions for feedback stability analysis of linear stochastic systems", *IEEE Transactions on Automatic Control*, vol. 69, no. 5, May 2024, pp. 3349 - 3356.
Lirias number: 4169110.

25-05

Chen J., Chen W., Chen C., Qiu L., "Phase preservation of N-port networks under general connections", Technical Report 25-05, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025. Accepted for publication in *IEEE Transactions on Automatic Control*, pp. 1 - 16.
Lirias number: 4212163.

25-06

Chen J., Mao Q., Zhao D., Chen C., "Robust stability and stabilizability conditions for time-delay systems under stochastic uncertainties", Technical Report 25-06, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025. Accepted for publication in *IEEE Transactions on Automatic Control*, pp. 1 - 8.
Lirias number: 4212165.

25-07

Iannacito M., De Lathauwer L., "An algebraic algorithm for blind source separation and tensor decomposition", Technical Report 25-07, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025.

25-08

Iannacito M., Vervliet N., De Lathauwer L., "Blind interference suppression", Technical Report 25-08, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025.

25-11

De Lathauwer L., "Professional Feature", *Dynamical Systems Web Magazine, Society for Industrial and Applied Mathematics (SIAM)*, About the Profession Series, Jul. 2024, online p.
Lirias number: 4211261.

25-13

De Lathauwer L., Moelans N., "Big Data", *Poster at IMAGINARY, Pracht en Kracht van Wiskunde*, 2022, pp. 42.
Lirias number: 4211632.

25-14

Vermeylen C., Van Barel M., "A Riemannian Rank-Adaptive Method for Higher-Order Tensor Completion in the Tensor-Train Format", Technical Report 25-14, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025. Numerical Linear Algebra with Applications.
Lirias number: 4212166.

25-15

Sepulchre R., "About this issue : A control look at Quantum Computing", *IEEE Control Systems*, Dec. 2024, pp. 5-6.
Lirias number: 4206819.

25-16

Sepulchre R., "From the editor : Control and Diversity", *IEEE Control Systems*, Dec. 2024, pp. 3-4.
Lirias number: 4206817.

25-17

Sepulchre R., "About this issue : Machine Learning for Control", *IEEE Control Systems*, Aug. 2024, pp. 4-7.
Lirias number: 4185761.

25-18

Burghi T.B., Sepulchre R., "Adaptive Observers for Biophysical Neuronal Circuits", *IEEE Transactions on Automatic Control*, vol. 69, no. 8, Aug. 2024, pp. 5020-5033.
Lirias number: 4185760.

25-19

Sepulchre R., "From the editor : The ethics of control", *IEEE Control Systems*, Jun. 2024, pp. 3-4.
Lirias number: 4169309.

25-20

Sepulchre R., "About this issue : Control for Societal-Scale Challenges : Roadmap 2030", *IEEE Control Systems*, Jun. 2024, pp. 5-8.
Lirias number: 4169308.

25-21

Jacobs L., Astudillo A., Lataire J., Sepulchre R., Swevers J., Pintelon A., Peumans D., Decre W., (eds.), *Book of Abstracts of the 43rd Benelux Meeting on Systems and Control*, Proc. of the 43rd Benelux Meeting, KU Leuven, VUB (Leuven, Brussels), 2024.
Lirias number: 4151531.

25-22

Schmetterling R., Forni F., Franci A., Sepulchre R., "Neuromorphic Control of a Pendulum", *IEEE control systems letters*, vol. 8, 2024, pp. 1235-1240.
Lirias number: 4166835.

25-23

Mostajeran C., Da Costa N., Van Goffrier G., Sepulchre R., "Geometric statistics with subspace structure preservation for SPD matrices", in *IFAC PapersOnline, vol. 58, no. 17 (26th International Symposium on Mathematical Theory of Networks and Systems (MTNS))*, Cambridge, UK, Aug. 2024, pp. 398-403.
Lirias number: 4208954.

25-24

Mostajeran C., Da Costa N., Van Goffrier G., Sepulchre R., "Differential geometry with extreme eigenvalues in the positive semidefinite Cone", *SIAM J. Matrix. Anal. Appl.*, vol. 45, no. 2, 2024, pp. 1089-1113.
Lirias number: 4169307.

25-25

Schmetterling R., Burghi T.B., Sepulchre R., "Robust online estimation of biophysical neural circuits", in *Proc. of the 2023 62nd IEEE Conference on Decision and Control (CDC)*, Marina Bay Sands, Singapore, Dec. 2023, pp. 703-708.
Lirias number: 4150916.

25-26

Chaffey T., van Waarde H.J., Sepulchre C., "Relaxation systems and cyclic monotonicity", in *Proc. of the 2023 62nd IEEE Conference on Decision and Control (CDC)*, Marina Bay Sands, Singapore, Dec., pp. 1673-1679.
Lirias number: 41509147.

25-27

Bin M., Marconi L., Sepulchre R., "An internal model principle for open systems", in *Proc. of the 2023 62nd IEEE Conference on Decision and Control (CDC)*, Marina Bay Sands, Singapore, Dec. 2023, pp. 1919-1924.
Lirias number: 4150918.

25-28

van Waarde H.J., Sepulchre C., "Training Lipschitz continuous operators using reproducing kernels", in *Learning for Dynamics and Control (Proc. of the 4th Annual Conference on Learning to Dynamics and ControlL4DC 2022)*, Stanford, USA, Jun. 2022, 13 p.
Lirias number: 4169310.

25-29

Formanek A., De Brouwer E., Antal P., Moreau Y., Arany A., "Model based clustering of time series utilizing expert ODEs", in *Lecture Notes in Computer Science*, (N N., ed.), Proc. of the Artificial Neural Networks and Machine Learning (ICANN 2024), vol. 15019, Springer, 2024, pp. 230-245.
Lirias number: 4204042.

25-30

Passemiers A., Folco P., Raimondi D., Birolo G., Moreau Y., Fariselli P., "A quantitative benchmark of neural network feature selection methods for detecting nonlinear signals", *Nature. Scientific Reports*, vol. 14, 2024, 31180 p.
Lirias number: 4211870.

25-31

Viroux S., Lagauw S., De Moor B., "Least Squares Realization of Complex-Valued Multiple-Output Linear Time-Invariant Systems via the Riemannian Singular Value Decomposition", Technical Report 25-31, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025.

25-32

Kempen B., Klein S., De Sloovere V., De Vos M., Depreitere B., "Development of an Active Cerebrovascular Autoregulation Model Using Representation Learning : A Proof of Concept Study with Experimental Data", *Neurosurgery*, 2025, pp. 1-10.
Lirias number: 4212358.

25-33

Hovine C., Bertrand A., "A distributed adaptive algorithm for non-smooth spatial filtering problems in wireless sensor networks", *IEEE Transactions on Signal Provessing*, vol. 72, 2024, pp. 4682-4697.
Lirias number: 420171.

25-34

Lee J.G., Sepulchre R., "Rapid and robust synchronization via weak synaptic coupling", *Automatica*, vol. 160, 2024, 111416 p.
Lirias number: 4130461.

25-35

Abbasi-Esfeden R., Nurkanovic A., Diehl M., Patrinos P., Swevers J., "An Efficient Mixed-Integer Formulation and an Iterative Method for Optimal Control of Switched Systems Under Dwell Time Constraints", *arXiv*, Jan. 2025, pp. 1-12.
Lirias number: 4212010.

25-36

Konar A., Sidiropoulos N.D., "Mining Triangle-Dense Subgraphs of a Fixed Size : Hardness, Lovasz extension and Applications", Technical Report 25-36, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025. Accepted for publication in *IEEE Transactions on Knowledge and Data Engineering*, pp. 1-13.
Lirias number: 4210248.

25-37

Siridopoulos N., Karakasis P.A., Konar A., "Minimizing Low-Rank Models of High-Order Tensors : Hardness, Span, Tight Relaxation, and Applications", *IEEE Transactions on Signal Processing*, vol. 72, 2024, pp. 129-142.
Lirias number: 4136383.

25-38

Lu Q., Sidiropoulos N., Konar A., "Densest k-Subgraph Mining via a Provably Tight Relaxation", Technical Report 25-38, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025. Accepted for publication in *39th AAAI Conference on Artificial Intelligence, Feb-Mar 2025, Philadelphia*.
Lirias number: 4210256.

25-39

Karaaslanli A., Traganitis P., Konar A., "Identifying Adversarial Attacks in Crowdsourcing via Dense Subgraph Detection", Technical Report 25-39, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025. Accepted for publication in *50 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Hyderabad, India, Apr. 2025*.
Lirias number: 4212363.

25-40

Konar A., Sidiropoulos N.D., "Optimal Quasi-clique : Hardness, Equivalence with Densest-k-Subgraph, and Quasi-partitioned Community Mining", in *Proc. of the Thirty-Eigth AAAI Conference on Artificial Intelligence (AAAI-24)*, Vancouver, Canada, Feb. 2024, pp. 8608-8616.
Lirias number: 4137254.

25-41

Shang M., Dedeyne L., Dupont J., Vercauteren L., Amini N., Lapauw L., Gielen E., Verschueren S., Varon C., De Raedt W., Vanrumste B., "DS-MS-TCN : Otago Exercises Recognition With a Dual-Scale Multi-Stage Temporal Convolutional Network", *IEEE Journal of Biomedical and Health Informatics*, vol. 28, no. 12, Dec. 2024, pp. 7138-7150.
Lirias number: 4206601.

25-42

Yang P.K., Filtjens B., Ginis P., Goris M., Nieuwboer A., Gilat M., Slaets P., Vanrumste B., "Multimodal Freezing of Gait Detection : Analyzing the Benefits of Physiological Data", *MedRxiv*, 2024, pp. 1-10.
Lirias number: 4203620.

25-43

Chen B., Ji H., Wang Z., Filtjens B., Wang C., Ren W., Vanrumste B., Liu H., "Language-Assisted Human Part Motion Learning for Skeleton-Based Temporal Action Segmentation", *Journal of Latex Class Files*, vol. 14, no. 8, Aug. 2025, pp. 1-13.
Lirias number: 4203618.

25-44

De Ruyter G., Hallez H., Verbeke M., Vanrumste B., "PREDISTINE : A Privacy-Preserving and Resilient Framework for Distributed Modular Neural Networks on the Tiny Edge", Technical Report 25-44, ESAT-STADIUS, KU Leuven (Leuven, Belgium), 2025. Accepted for publication in *21st. International Conference on Embedded Wireless Systems and Networks*.
Lirias number: 4206081.

25-45

Grinstein E., Tengan E., Cakmak B., Dietzen T., Nunes L., van Waterschoot T., Brookes M., Naylor P.A., "Steered Response Power for Sound Source Localization : a tutorial review", *EURASIP Journal on Audio Speech and Music Processing*, vol. 59, 2024, pp. 1-27.
Lirias number: 4204091.

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