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STADIUS
Center for Dynamical Systems, Signal Processing and Data Analytics

STADIUS Newsletter

March 2024

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Wishing all STADIUSans a wonderful Easter Weekend filled with joy, peace and happiness.

Research of the month by Thomas Strypsteen

"Distributed deep neural networks for wireless neuro-sensor networks"

Work under the supervision of Alexander Bertrand

Electro-encephalography (EEG) is a physiological multi-channel signal, with each channel reflecting the electrical activity of the brain at a specific location. Today, it is a crucial tool in the analysis and diagnosis of several pathologies, ranging from epilepsy to sleep disorders to neurodegenerative diseases. Its big downside however, is that the current way to measure it involves a large, bulky EEG cap with many wires attached to an acquisition device, obstructing its adoption in daily life and limiting its usage to controlled hospital and laboratory environments. To address these issues, the concept of a **wireless EEG sensor network** (WESN) has been proposed. A WESN replaces the unwieldy EEG cap with a set of multiple concealable, miniaturized devices, attached to various locations on the scalp and organized in a sensor network.
While the WESN is far more amenable towards continuous neuromonitoring in daily life, it also introduces a major design challenge. In contrast to the EEG cap, the different EEG signals measured by a WESN are now not centralized on a single device, but rather **distributed across the different sensor nodes.** The straightforward solution of having each node just stream all its raw data to a fusion center where the different channels can be

aggregated unfortunately does not suffice. Due to their large degree of miniaturization, the batteries of the sensor nodes would not last very long if they would be continuously transmitting. Thus, the signal processing algorithms we use to jointly analyze the different EEG channels must instead be adapted to operate in an **energy-efficient and distributed way.**



In this project, we focused on the adaptation of **deep neural networks** (DNNs) towards this new setting. As the main energy bottleneck in the WESN is the transmission of the node data to a fusion center, our efforts were focused on reducing the amount of data to be transmitted, while retaining as much task accuracy as possible. More concretely, we covered the following problems:

- The WESN can only use a handful of nodes compared to the EEG cap which could measure op to 256 EEG channels. We thus proposed an **end-to-end learnable EEG channel selection** methodology, to optimize the locations of the nodes we could use in the WESN, given a specific task and DNN model.
- We then investigated how we could perform **dynamic channel selection**, i.e., find the optimal subset of nodes to use for inference for each input window of EEG data. By only having the nodes transmit when they are confident in how informative they are, we can reduce the transmission load.
- Thirdly, we proposed a framework to redesign a given neural network architecture such that the dimensionality of the features that need to be transmitted are reduced as much as possible, with minimal impact on the task accuracy.
- Finally, we investigated **neural source coding** (NSC) as a way to transform the data to be transmitted to a quantized space with minimal entropy, allowing us to directly minimize the transmission rate of the nodes during learning.

For more information about this research, read Distributed deep neural networks for wireless neuro-sensor networks

News



De humani corporis fabrica

KU Leuven acquired - supported by a donation of prof. Bart De Moor among others - an annotated 2nd edition of ***'De humani corporis fabrica'*** of Andreas Vesalius from 1555.
In this second edition, Vesalius, who was a professor of KU Leuven at that time, made extensive annotations to prepare for the third edition, that however never appeared.
This 'piece unique' will be on display in the new Vesalius museum, which will be integrated with Health House, and will open in December 2025, on the occasion of the 600th anniversary of the KU Leuven.



Vice-Prime Minister @Health House

On Sunday, March 17, Dr. Frank Vandenbroucke, vice-prime minister and minister of social affairs and health, visited Health House at the occasion of 'The Day of Care' in

Flanders. Bart De Moor was his guide, together with HH's CEO Dimitri Van Aeken.

Body of the Future

Professor **Bart De Moor,** together with his team of Health House, conceived and built the multimedia installation 'Body of the Future',
The installation took center stage at FTI Leuven from March 16th to 20th, 2024 and showcased revolutionary advancements ready to redefine healthcare as we know it.
See: https://www.youtube.com/watch?v=yLUarnbgTJk



Lecture by Nobel laureate physics Kip Thorne

On Friday, March 22, 2017 Nobel laureate physics Kip Thorne gave a lecture about Gravity Waves, also referring to the future Einstein Telescope, in which several researchers of Stadius (prof. Tjonnie Li, prof. **Bart De Moor** and their PhD students) are involved.
Afterwards there was a most enjoyable dinner in the Faculty Club.

Events @ STADIUS

Addressing label noise in imbalance dataset learning
When: **5/04 2024, 10:00**
Where: **B00.35**
By: **Jingwei Zhang**

EURASIP-SOUNDS-I-SPOT Seasonal School Machine Learning for Speech and Audio Processing
When: **8/04 - 11/04 2024**
Where: **Group T, Leuven**

Exploring the latent space of black-box sequence-to-sequence models for Length of Stay prediction using an interactive
When: **11/04 2024, 13:00**
Where: **B00.50**
By: **Naomi Wamba**

ERC Back to the Roots Seminar by Françoise Tisseur
When: **16/04/2024**, **17:00**
Where: **Aula Arenbergkasteel**

ERC Back to the Roots Seminar
Title: **Supervised machine learning with tensor network kernel machines**
When: **30/04/2024**, **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: **Kim Batselier**

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

Best of luck!

This month, three colleagues are leaving STADIUS, and we wish them all the best on their new career paths:

- **Martin Jälmby,** who defended his PhD thesis on 08/03 under the supervision of Toon van Waterschoot, will start his new job at Vlaams Instituut voor de Zee (VLIZ).
- **Martina Iannacito**, a researcher from the group of Lieven De Lathauwer moves to a postdoctoral position in the numerical analysis group of the mathematical department of the University of Bologna.
- **John Vos** will move to the Faculty of Law, where he will work in the Financial Support Services office.

Good luck to all!

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