VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Brent De Weerdt**

The public defense will take place on **Friday 23rd October 2026 at 4:00pm** in **LIC.0.04 Learning Theatre**(Building LIC, VUB Main Campus)

To join the digital defense, please click here
Meeting ID: 356 825 686 864 280 1
Passcode: P4je2ej3

INTERPRETABLE TRANSFORMER NETWORKS FOR COMPRESSED SENSING, REPRESENTATION LEARNING, AND DISTRIBUTED SOURCE CODING

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Abstract of the PhD research

The current trend in artificial intelligence, and deep learning in particular, is to design increasingly large and complex models. Although these models achieve high accuracy, they require large datasets, high computational budgets, and often remain difficult to interpret. This thesis addresses these limitations by leveraging theoretical knowledge and data priors to design lightweight, performant, and inherently interpretable Transformer-based deep learning models.

The work first considers signal acquisition through compressed sensing. Using deep unfolding, the thesis designs neural networks for signal reconstruction from compressed measurements. By incorporating sparsity and temporal correlation, it develops interpretable Transformer models that reconstruct signals more accurately and efficiently than existing methods. The thesis then studies compact and privacy-preserving representations of human pose trajectories in video using contrastive learning and generative modelling, enabling anomaly detection through deviations from learned normal motion patterns. Finally, the thesis addresses distributed source coding, where correlated observations from multiple devices can be compressed more efficiently by exploiting inter-source dependencies. Building on LDPCA codes, it proposes a multirate Transformer decoder for Slepian-Wolf decoding that outperforms traditional decoders and reduces communication cost compared with alternative distributed compression methods.

Overall, the thesis develops deep learning architectures that incorporate signal processing, information theory, and data-specific prior knowledge, achieving state-of-the-art performance across several tasks while reducing the computational budget by at least an order of magnitude in most cases.