

Dr. Guido Gagliardi

Post-Doctoral Researcher

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🎓 scholar.google.com/citations?user=cHr99doAAAAJ



Research Interests

My research objective is to **bring AI into clinical practice through Explainable AI**, ensuring that deep learning models are accurate while remaining transparent to clinicians and useful for research. I pursue three complementary directions:

1. **Trustworthiness** — measuring AI performance beyond task accuracy by explaining the model's decision-making process, quantifying its uncertainty so that it can abstain when the evidence is weak, and validating it against established clinical guidelines, so that clinicians can understand, verify, and trust the system's reasoning before it enters the diagnostic workflow;
2. **Knowledge Discovery** — leveraging AI not merely as an automation tool but as a *scientific agent* that identifies complex, previously unknown correlations in clinical data, whose explanation can yield new domain knowledge about disease mechanisms;
3. **Foundation Models & Agentic AI** — engineering foundation models for neurophysiological signals (EEG-CLIP-style semantic embeddings) and *agentic* systems that ground large-language-model reasoning in verifiable clinical knowledge through retrieval, turning explainable representations into auditable, clinician-facing decision-support tools.

These principles have been validated in a clinical sleep profiling study at UZ Leuven in collaboration with KU Leuven, where we showed that deep learning combined with concept-based explainability can: (i) effectively stage sleep in both healthy subjects and patients with Parkinson's disease and Alzheimer's dementia through a pipeline benchmarked against the AASM Manual for the Scoring of Sleep; (ii) reveal how sleep macro- and micro-structure change due to neurological diseases; and (iii) leverage this newly discovered knowledge for disease detection and classification. The same pipeline is currently being applied to narcoleptic mouse models (with Prof. B.R. Kornum, Dept. of Neuroscience, University of Copenhagen) and to patients with Alzheimer's disease and REM Sleep Behaviour Disorder (J. Strøm, Center for Ear-EEG, Aarhus University), with promising preliminary results. So far this work has focused on physiological signals, but the methodology is domain-agnostic. My next step is to extend it to other clinical modalities, including medical imaging and the electronic health record, and to embed it in agentic decision-support tools for high-stakes settings such as neurocritical care.

Education

11/2021–05/2026 **Ph.D. in Engineering Science**, KU Leuven, Doctoral School of Engineering Science, Leuven, Belgium, *with honors*

Thesis: *Explainable Artificial Intelligence: from Model-based to Knowledge-driven Understanding*. Supervisors: Prof. Maarten De Vos (KU Leuven), Prof. Mario G.C.A. Cimino (University of Pisa).

11/2021–05/2026 **Ph.D. in Smart Computing**, Joint Ph.D. Program — Universities of Florence, Siena, and Pisa, Pisa, Italy, *with honors*

Joint doctoral degree obtained in parallel with the KU Leuven Ph.D.

- 09/2019–07/2021 **M.Sc. in Artificial Intelligence and Big Data Engineering**, *University of Pisa*, Pisa, Italy, 110/110 cum laude
Thesis: *A novel multimodal feature learning architecture for explainable affective computing*
- 09/2015–07/2019 **B.Sc. in Computer Engineering**, *University of Pisa*, Pisa, Italy, 105/110
Thesis: *Novelty data detection methods*

Professional Experience

- 06/2026–present **Post-Doctoral Researcher**, *KU Leuven, Department of Electrical Engineering (ESAT-STADIUS)*, Leuven, Belgium
Supervisor: Prof. Maarten De Vos. Designing and engineering EEG foundation models, with the goal of building an EEG-based CLIP-like model that produces semantic textual representations of neural signals. This includes multi-source data pipeline design, large-scale model training on HPC infrastructure, and integration of heterogeneous clinical datasets. Extends prior work on explainable sleep staging (PhysioEx library, clinical validation at UZ Leuven) toward a general-purpose framework for interpretable neural signal understanding.
- 12/2025–06/2026 **Visiting Researcher**, *Fraunhofer Heinrich Hertz Institute (HHI)*, Berlin, Germany, 6 months
FWO-funded research stay in Prof. Wojciech Samek's AI Department. Extended Concept Relevance Propagation (CRP) and the SemanticLens framework to EEG-based sleep staging architectures. Proposed a CLIP-surrogate model for PSG-to-text projection enabling semantic concept-based explanations of clinical sleep scoring.

Research Funding & Grants

- 01/2023–present **FWO Strategic Basic Research (SBO) Fellowship**, *Research Foundation Flanders (FWO)*, Belgium, Mandate 1SH4Z24N, ~EUR 131,000 (4-year personal fellowship: salary + bench fee)
Competitive doctoral/postdoctoral fellowship for strategic basic research. Currently active FWO fellow.
- 12/2025 **FWO Travel Grant for Long Research Stay Abroad**, *Research Foundation Flanders (FWO)*, Belgium, Mandate V458425N, EUR 9,900 (6-month stipend + travel)
Research visit at Fraunhofer Heinrich Hertz Institute (HHI), Berlin, Germany.
- 11/2021–10/2023 **Pegaso Scholarship**, *Regione Toscana, Italy*, EUR 61,300
Competitive regional scholarship funding the joint Ph.D. programme in Smart Computing. Funded by Regione Toscana within the Giovanisi programme.
- HPC Compute Grants
- VSC Vlaams Supercomputer Centrum (Flanders, Belgium) — competitive GPU allocation.
 - LUMI LUMI European supercomputer (EuroHPC JU) — competitive GPU allocation.
 - Leonardo Leonardo supercomputer, CINECA (Italy) — competitive GPU allocation.

Awards & Distinctions

- 2026 Dual **Ph.D. with honors** (<5% of candidates), KU Leuven and Universities of Florence, Siena, and Pisa.
- 2023 **FWO Strategic Basic Research Fellowship** — competitive personal fellowship from the Research Foundation Flanders (success rate <20%).
- 2021 **Pegaso Scholarship** — competitive doctoral scholarship awarded by Regione Toscana, Italy.
- 2021 **M.Sc. cum laude** (110/110), University of Pisa.

Teaching Experience

- 04/2026 **Guest Lecturer — Explainable & Trustworthy Artificial Intelligence**, *Ghent University (UGain / VAIA)*, Ghent, Belgium, Professional course
Contributed lectures on explainability and interpretability techniques. Course coordinated by Prof. Dr. Femke De Backere.

11/2021–05/2026 **Teaching Assistant — Biomedical Signal Processing, KU Leuven, Leuven, Belgium, M.Sc. level**
M.Sc. programmes in Biomedical Engineering and Electrical Engineering. Responsibilities included exercise sessions, student support, and grading.

Supervision

Supervised 12 M.Sc. theses at Università di Pisa (2022–2026), 10 as principal advisor (*relatore*), one as co-advisor, one as tutor:

1. C. Daka, *Counterfactual rule extraction and generalization for interpretable ML*, Computer Engineering, 2024–25.
2. E. Tinghi, *A double quantization approach for autonomous concept learning in sleep staging*, AI & Data Engineering, 2024–25.
3. M. Manni, *Enabling Concept-Embedding Models for Sleep Staging through Automatic Prototype-Based Learning of Concepts*, AI & Data Engineering, 2024–25.
4. G. Barbieri, *Design and testing of a weighted aggregation method for a counterfactual-based feature importance measure*, Computer Engineering, 2024–25.
5. G. Canello Tortora, *Analyzing brain data for robust emotion recognition via conceptual decomposition based on autoencoder*, AI & Data Engineering, 2022–23.
6. F. Marabotto, *Explainable emotion recognition via a novel loss function based on informed contrastive learning*, AI & Data Engineering, 2022–23.
7. L. Turchetti, *Sleep stage recognition supported by instances-based explanation via contrastive learning*, AI & Data Engineering, 2022–23.
8. M. Martorana, *A Novel Feature Importance Measure To Explain The Quality Level Prediction In Smart Manufacturing*, AI & Data Engineering, 2021–22.
9. N. Mota, *Development of explainable ML architectures for affective computing*, Computer Engineering, 2021–22.
10. F. Ritorti, *Emotion detection via Explainable Affective Computing for physiological signals*, AI & Data Engineering, 2021–22.

Research Projects & International Collaborations

Funded Research Projects

- 01/2021–12/2026 **EXPERIENCE**, *EU Horizon 2020, Grant No. 101017727*
Automatic virtualization of extended personal reality through biomedical signal processing and explainable AI.
- 01/2023–present **FAIR — Future Artificial Intelligence Research, Spoke 1 “Human-Centered AI”**, *PNRR PE00000013, NextGeneration EU*
Italian national partnership for AI research.
- 01/2022–present **FoReLab**, *Italian Ministry of Education and Research (MIUR), Departments of Excellence*
PNRR–M4C2 funded research infrastructure at University of Pisa.
- 01/2023–present **Supporting the development of self-regulation in infants**, *FWO SBO Project S003524N*
Preventive mental health care through physiological signal analysis.
- 01/2023–present **Artificial Intelligence for data-driven personalized medicine**, *FWO Research Project G0C9623N*
- 01/2021–present **Deep, personalized epileptic seizure detection**, *FWO Research Project G0D8321N*

International Collaborations

Fraunhofer Heinrich Hertz Institute (HHI), Berlin, Germany — FWO-funded research visit.

Technion — Israel Institute of Technology (Prof. J.A. Behar) — physiological time series analysis.

Universidade Federal de Minas Gerais, Brazil (Prof. A.L.P. Ribeiro) — multi-source domain adaptation.

University of Copenhagen, Denmark (Prof. B.R. Kornum) — sleep micro-structure analysis.

Publications

Google Scholar (June 2026): 90+ citations, h-index 6, i10-index 3.
scholar.google.com/citations?user=cHr99doAAAAJ

Preprints & Under Review

- [1] **G. Gagliardi**, J. Garcia Ciudad, L. Micca, B. R. Kornum, M. Gilat, A. L. Alfeo, M. G. C. A. Cimino, and M. De Vos. “Prototype-based sleep micro-structure learning for explainable and robust multimodal recognition of sleep-related conditions”. Under review at npj Digital Medicine. Research Square preprint, posted 1 April 2026. 2026. DOI: 10.21203/rs.3.rs-9169987/v1. URL: <https://doi.org/10.21203/rs.3.rs-9169987/v1>.
- [2] K. Kontras, T. Osselaer, S. G. Mouslech, A.-I. Karaïskou, **G. Gagliardi**, T. Strypsteen, M. H. Badiei, A. Rani, M. Vanmarcke, M. Bhagubai, C. Ekbote, J. Hwang, C. Chatzichristos, P. P. Liang, and M. De Vos. “NeuroAtlas: Benchmarking Foundation Models for Clinical EEG and Brain–Computer Interfaces”. Under review at NeurIPS 2026. arXiv:2605.14698. 2026. URL: <https://arxiv.org/abs/2605.14698>.

Journal Articles

- [3] E. Zvuloni, **G. Gagliardi**, A. H. Ribeiro, A. L. P. Ribeiro, M. De Vos, and J. A. Behar. “A multi-source domain fine-tuning framework for deep generalization performance in physiological time series analysis”. In: *Machine Learning: Health* 2.1 (2026), p. 015002. DOI: 10.1088/3049-477X/ae2ac5.
- [4] **G. Gagliardi**, A. L. Alfeo, V. Catrambone, M. G. C. A. Cimino, M. De Vos, and G. Valenza. “Model-driven validation of visual explanations for multimodal emotion recognition”. In: *Machine Learning* 114.12 (2025). (*) Selected as one of the three most important publications., p. 273. DOI: 10.1007/s10994-025-06921-y.
- [5] **G. Gagliardi**, A. L. Alfeo, M. G. C. A. Cimino, G. Valenza, and M. De Vos. “PhysioEx: a new Python library for explainable sleep staging through deep learning”. In: *Physiological Measurement* 46.2 (2025), p. 025006. DOI: 10.1088/1361-6579/adaf73.
- [6] **G. Gagliardi**, A. L. Alfeo, R. Guidotti, and M. G. C. A. Cimino. “Region-aware Minimal Counterfactual Rules for Model-agnostic Explainable Classification”. In: *Machine Learning* 114.10 (2025), p. 225. DOI: 10.1007/s10994-025-06847-5.
- [7] A. L. Alfeo, M. G. C. A. Cimino, and **G. Gagliardi**. “Recognizing bearings’ degradation stage using multimodal autoencoder to learn features from different time series”. In: *SN Computer Science* 5.4 (2024), p. 371. DOI: 10.1007/s42979-024-02635-5.
- [8] A. L. Alfeo, M. G. C. A. Cimino, and **G. Gagliardi**. “Concept-wise granular computing for explainable artificial intelligence”. In: *Granular Computing* 8.4 (2023). (*) Selected as one of the three most important publications., pp. 827–838. DOI: 10.1007/s41066-022-00357-8.
- [9] **G. Gagliardi**, A. L. Alfeo, V. Catrambone, D. Candia-Rivera, M. G. C. A. Cimino, and G. Valenza. “Improving emotion recognition systems by exploiting the spatial information of EEG sensors”. In: *IEEE Access* 11 (2023). (*) Selected as one of the three most important publications., pp. 39544–39554. DOI: 10.1109/ACCESS.2023.3268233.

Conference Papers

- [10] A. L. Alfeo, M. G. C. A. Cimino, and **G. Gagliardi**. “Matching the expert’s knowledge via a counterfactual-based feature importance measure”. In: *Machine Learning and Principles and Practice of Knowledge Discovery in Databases — International Workshops of ECML PKDD 2023, Turin, Italy, Revised Selected Papers, Part III*. Vol. 2135. Communications in Computer and Information Science. Workshop paper (post-proceedings), not the ECML PKDD main research track. Springer, 2025, pp. 71–86. DOI: 10.1007/978-3-031-74633-8_5.
- [11] **G. Gagliardi**, A. L. Alfeo, M. G. C. A. Cimino, G. Valenza, and M. De Vos. “Building neural networks’ latent space to extract instance-based explanations for sleep staging”. In: *IEEE International Conference on Systems, Man, and Cybernetics (SMC)*. 2025, pp. 3096–3101. DOI: 10.1109/SMC58881.2025.11342484.

- [12] J. Jiménez García, G. C. Gutiérrez Tobal, M. García Gadañón, J. Michiels, **G. Gagliardi**, D. Gozal, M. De Vos, and R. Hornero. “Inteligencia artificial explicable basada en Shapley values para interpretar modelos de deep learning orientados a detectar la apnea del sueño pediátrica usando flujo aéreo y oximetría”. In: *CASEIB 2024. Libro de Actas del XLII Congreso Anual de la Sociedad Española de Ingeniería Biomédica, Sevilla*. Editorial Universidad de Sevilla, 2024, pp. 605–608. ISBN: 978-84-09-67332-2. URL: <https://portaldelaciencia.uva.es/documentos/69c585c1265b310e56f3b00d>.
- [13] J. Jiménez-García, J. Michiels, **G. Gagliardi**, G. C. Gutiérrez-Tobal, M. García, et al. “An explainable artificial intelligence technique to interpret deep learning models aimed at detecting paediatric sleep apnoea from airflow and oximetry signals”. In: *27th Congress of the European Sleep Research Society (ESRS), Seville, Spain. Published in Journal of Sleep Research, vol. 33, suppl. S1*. 2024.
- [14] **G. Gagliardi**, A. L. Alfeo, V. Catrambone, M. G. C. A. Cimino, M. De Vos, and G. Valenza. “Fine-grained emotion recognition using brain–heart interplay measurements and explainable convolutional neural networks”. In: *11th International IEEE/EMBS Conference on Neural Engineering (NER)*. 2023, pp. 1–6. DOI: 10.1109/NER52421.2023.10123758.
- [15] **G. Gagliardi**, A. L. Alfeo, V. Catrambone, M. G. C. A. Cimino, M. De Vos, and G. Valenza. “Using contrastive learning to inject domain-knowledge into neural networks for recognizing emotions”. In: *IEEE Symposium Series on Computational Intelligence (SSCI)*. 2023, pp. 1587–1592. DOI: 10.1109/SSCI52147.2023.10371895.
- [16] A. L. Alfeo, M. G. C. A. Cimino, and **G. Gagliardi**. “Automatic Feature Extraction for Bearings’ Degradation Assessment using Minimally Pre-processed Time Series and Multi-modal Feature Learning”. In: *Proceedings of the 3rd International Conference on Innovative Intelligent Industrial Production and Logistics (IN4PL)*. 2022, pp. 94–103. DOI: 10.5220/0011548000003329.
- [17] A. L. Alfeo, M. G. C. A. Cimino, and **G. Gagliardi**. “Improving an Ensemble of Neural Networks via a Novel Multi-class Decomposition Schema”. In: *Proceedings of the 14th International Joint Conference on Computational Intelligence (IJCCI)*. 2022, pp. 389–395. DOI: 10.5220/0011547900003332.

Academic Service

- Committee Submission Chair, IEEE ICAI-TEMS 2026, Pisa, Italy.
- Reviewer AAAI Conference on Artificial Intelligence (AAAI 2026); Journal of Ambient Intelligence and Humanized Computing (Springer).
- Network Sleep Revolution — Horizon 2020 project (grant agreement 965417).

Open Source Software

- PhysioEx Physiological Signal Explainer** — modular Python/PyTorch library with CI/CD pipeline (GitHub Actions), automated testing, PyPI packaging, and API documentation. Models distributed through PhysioEx were used as external-validation baselines in Thapa et al., *Nature Medicine* (2026). Published in *Physiological Measurement* (2025).
github.com/guidogagl/physioex pypi.org/project/physioex

Technical Skills

- Programming Python (primary), $\text{\LaTeX}$
- ML/DL PyTorch, PyTorch Lightning, scikit-learn, HuggingFace Transformers, LLMs & retrieval-augmented generation (RAG)
- DevOps Git, GitHub Actions CI/CD, Docker, automated testing (pytest), PyPI packaging
- Infrastructure Linux, Slurm/HPC, containerized workflows
- Libraries MNE-Python, braindecode
- Biomedical signals EEG, PSG (polysomnography), ECG/HRV, BHI (brain–heart interactions), EMG, EOG, SpO₂, airflow



Languages

Italian Native speaker
English C1
German —

Willing to learn; committed to reaching B1 proficiency