

Married
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Fakhrielddine BADER

Curriculum Vitae

Qualified by the French National Council of Universities (CNU), Section 26, for appointment as *Maître de conférences*

PhD in Applied Mathematics | Artificial Intelligence & 3D Medical Imaging

Postdoctoral researcher at Inserm working at the interface of artificial intelligence, 3D medical imaging, and numerical modelling. My research focuses on the automated detection and characterisation of intracranial aneurysms, their geometric modelling, and the analysis of the cerebral vascular tree. My background combines applied mathematics, biomedical modelling, scientific computing, and artificial intelligence.

Postdoctoral Researcher in AI, Modelling and 3D Medical Imaging (February 2026 – present)

Institution Inserm, Institut du Thorax (ITX), Human Genetics Team, Nantes, France.

Supervisor Florent Autrusseau

Research topic Artificial intelligence and modelling applied to 3D medical imaging (3DRA): automated detection and characterisation of intracranial aneurysms, analysis of the cerebral vascular tree from 3D segmentations, and generation of synthetic aneurysms (RHU [eCAN](#) project).

Main contributions

- Development of a 3DRA data analysis pipeline for the automated characterisation of intracranial aneurysms and their blebs, using NRRD volumes, 3D segmentations, and reference annotations.
- Design and improvement of the VAMOS geometric model for the generation and morphological characterisation of synthetic aneurysms through the optimisation of geometric candidates.
- Development of a bleb detection and labelling method based on local geometry, overlap, growth, volume, and position relative to the aneurysm neck and vascular branches.
- 3D spatial characterisation of blebs in a local anatomical coordinate system: azimuth, elevation, radial distance, branch–neck–aneurysm angles, and distance/direction metrics.
- Automation and validation of the pipeline on patient cohorts: quality control, handling of invalid cases, regression testing, calibration campaigns, and multiprocessing parallelisation.

Technologies Python, NumPy, SciPy, SimpleITK, 3D Slicer, Git/GitHub.

Code [GitHub – ICA_Caracterisation_Bleb](#)

Postdoctoral Researcher in Cardiac Numerical Modelling (February 2024 – March 2025)

Institutions Institute of Mathematics of Bordeaux (IMB) and Liryc University Hospital Institute (IHU Liryc), University of Bordeaux, France.

Supervisor Edward Vigmond

Research topic High-resolution numerical modelling of the human atria from patient medical imaging data for the study of atrial fibrillation ([MICROCARD](#) project).

- Main contributions**
- Reconstruction and validation of 3D anatomical atrial models from patient imaging data (CT scans and MRI), including identification and standardisation of the main anatomical structures.
 - Construction, optimisation, and quality control of high-resolution cardiac meshes for finite element simulations.
 - Development and standardisation of a model preparation pipeline: geometry and connectivity checks, anatomical labelling, and generation of simulation-ready models for [openCARP](#).
 - Setup and execution of electrophysiological simulations to investigate electrical propagation and atrial fibrillation, including analysis and visualisation of simulation results.
 - Development of a structured database of more than 30 patient-specific atrial models, together with pipeline standardisation to ensure traceability and reproducibility of the simulations.
- Technologies** [openCARP](#), CARPentry Studio, Meshalyzer, Epsimulator, finite element methods, medical image processing, and 3D meshing.
- Project** [Detailed research project presentation](#)

Lecturer

September 2023 – present
ESILV Graduate School of Engineering, Nantes Campus, France.

Lecturer

September 2023 – February 2024
Icam School of Engineering, Nantes campus, France.

Temporary Teaching and Research Fellow (ATER)

September 2022 – August 2023
Institut de recherche mathématique de Rennes (IRMAR), University of Rennes 1, France.

Temporary Teaching and Research Fellow (ATER)

September 2021 – August 2022
Mathematics, Image and Applications Laboratory (MIA), La Rochelle University, France.

PhD in Applied Mathematics (December 2018 – September 2021)

Thesis supervisors Mazen Saad (LMJL, Centrale Nantes, France), Mostafa Bendahmane (Institute of Mathematics of Bordeaux, University of Bordeaux, France), and Raafat Talhouk (EDST, Lebanese University, Lebanon).

Institutions Laboratoire de Mathématiques Jean Leray (LMJL), Mathematics, Computer Science and Biology Department (MIB), Centrale Nantes, France, and Doctoral School of Science and Technology (EDST), Lebanese University, Lebanon.

Thesis title *Multi-scale unfolding homogenization method applied to bidomain and tridomain electrocardiology models* [[tel-03525302](tel:03525302)].

Thesis defence 15 November 2021

PhD committee	Chair:	Yves Coudière, Professor, University of Bordeaux, France
	Examiner:	Ayman Mourad, Professor, Lebanese University, Lebanon
	External reviewers:	Patrizia Donato, Professor, University of Rouen Normandy, France Claudia Timofte, Professor, University of Bucharest, Romania
Keywords and research themes	Analysis of partial differential equations (PDEs); homogenisation theory; cardiac electrophysiology models (bidomain and tridomain); multiscale mathematical modelling and analysis; gap junctions; three-scale unfolding homogenisation method.	

Academic Education

- 2018 – 2021 **PhD in Applied Mathematics**, Centrale Nantes & Lebanese University
- 2017 – 2018 **Master's Degree (M2) in Fundamental and Applied Mathematics**, 14.48/20 (*mention bien*), University of Nantes, France
Master's internship – March to July 2018: study of a macroscopic cardiac bidomain model, under the supervision of Mazen Saad, Laboratoire de Mathématiques Jean Leray (LMJL).
- 2016 – 2017 **Master's Degree (M1) in Pure Mathematics**, 13/20 (*mention assez bien*), Lebanese University, Hadath-Beirut, Lebanon
- 2013 – 2016 **Bachelor's Degree in Pure Mathematics**, 12/20 (*mention assez bien*), Lebanese University, Hadath-Beirut, Lebanon
- 2010 **Lebanese Baccalaureate – General Sciences**, 14/20 (*mention bien*), Lebanon

Additional Training in Artificial Intelligence

- 2026 – present **Professional Training Programme *Machine Learning Engineer – Liora (formerly DataScientest)***
 Training in Data Science, Machine Learning, Deep Learning, Data Engineering, and MLOps.
Capstone project – Compagnon Immobilier / Century 21: development of a Machine Learning decision-support tool for property price-per-square-metre estimation and comparative analysis across geographical areas.
 - Preparation and analysis of multi-source real-estate data: DVF, property listings, INSEE data, and geospatial data.
 - Exploratory data analysis (EDA) and pipeline design: preprocessing, feature engineering, geospatial enrichment, modelling, and evaluation.
 - Comparison of regression models: linear regression, Random Forest, and Gradient Boosting; XGBoost integration planned for the next stage of the project. Evaluation using MAE, RMSE, MAPE, and R^2 .
 - Planned model interpretability analysis using SHAP, feature importance, and Partial Dependence Plots.**Current technical environment:** Python, Pandas, NumPy, Scikit-learn, Matplotlib, Jupyter, Git/GitHub.
Code: [GitHub – Compagnon Immobilier / Century 21 Project](#)
- 2025 – present **Professional Training Programme *ML Pro – Machine Learnia***
 Training in Machine Learning Engineering and MLOps: Machine Learning, Deep Learning (CNNs, RNNs, Transformers, Autoencoders), Data Engineering, deployment, and generative AI (LLMs, RAG).
Technologies used during training: Python, PyTorch, TensorFlow, SQL, Git, Docker, Spark, Airflow, AWS, and GCP.

Publications

Submitted article

- ★ **Fakhrielddine Bader**, Jad Dabaghi and Hala Ghazi. A guaranteed a posteriori error estimate and adaptivity for a high-order discretization of the cardiac monodomain problem. *HAL preprint*, submitted for publication, 2025. [[HAL](#)]

Published articles

- Fakhrielddine Bader**, Mostafa Bendahmane, Mazen Saad and Raafat Talhouk. Microscopic tridomain model of electrical activity in the heart with dynamical gap junctions. Part 2 – Derivation of the macroscopic tridomain model by unfolding homogenization method. *Asymptotic Analysis*, **132**(3–4), 575–606, 2023. [[DOI](#)] [[HAL](#)]

3. **Fakhrielddine Bader**, Mostafa Bendahmane, Mazen Saad and Raafat Talhouk. Microscopic tridomain model of electrical activity in the heart with dynamical gap junctions. Part 1 – Modeling and Well-Posedness. *Acta Applicandae Mathematicae*, **179**(1), Article 11, 1–35, 2022. [DOI] [HAL]
2. **Fakhrielddine Bader**, Mostafa Bendahmane, Mazen Saad and Raafat Talhouk. Three Scale Unfolding Homogenization Method Applied to Cardiac Bidomain Model. *Acta Applicandae Mathematicae*, **176**(1), Article 14, 1–37, 2021. [DOI] [HAL]
1. **Fakhrielddine Bader**, Mostafa Bendahmane, Mazen Saad and Raafat Talhouk. Derivation of a new macroscopic bidomain model including three scales for the electrical activity of cardiac tissue. *Journal of Engineering Mathematics*, **131**(1), Article 3, 1–20, 2021. [DOI] [HAL]

Manuscript in preparation

- ★ **Fakhrielddine Bader**, Jad Dabaghi and Hala Ghazi. Cardiac bidomain model: a posteriori error estimates and adaptive stopping criteria. *Manuscript in preparation*.

PhD thesis

- ★ **Fakhrielddine Bader**. *Multi-scale unfolding homogenization method applied to bidomain and tridomain electrocardiology models*. Centrale Nantes and Lebanese University, November 2021. [TEL]

Scientific Communications

Talks

- 01/2025 **Scientific Computing and Modelling Seminar**, Institute of Mathematics of Bordeaux (IMB), University of Bordeaux, France. (Invited talk)
- 11/2022 **Numerical Analysis Seminar**, Institut de recherche mathématique de Rennes (IRMAR), University of Rennes 1, France.
- 10/2021 **MIA Seminar**, Mathematics, Image and Applications Laboratory (MIA), La Rochelle University, France.
- 02/2021 **MULTI-SCALE ANALYSIS: THEMATIC LECTURES AND MEETING (MATHLEC-2021)**, International Centre for Theoretical Sciences (ICTS), Bangalore, India.
- 12/2020 **Congrès d'Analyse Numérique pour les Jeunes (CAN-J 2020)**, online conference, France.
- 07/2020 **PhD Students Seminar**, Department of Mathematics, Orsay, Université Paris-Saclay, France (online).
- 06/2018 **PhD Students Seminar**, University of Nantes, France.

Poster presentation

- 06/2023 **Asymptotic Behaviors of Systems of PDEs Arising in Physics and Biology – 5th Edition**, Lille, France.

Conferences and Workshops Attended

- 06/2024 **Journée Maths Bio Santé**, Nantes, France.
- 06/2023 **Modèles mathématiques pour la biologie et la santé**, Rouen, France.
- 01/2023 **Conférence itinérante du GDR Analyse des Équations aux Dérivées Partielles**, Nantes, France.
- 10/2022 **Workshop on Mathematics for the Health Sciences**, Lebanon.
- 06/2022 **10th Annual Conference of the Lebanese Society for the Mathematical Sciences (LSMS 2022)**, Lebanon.
- 03/2021 **Lebesgue Doctoral Meetings (RDL 2020)**, Angers, France.
- 03/2021 **Mathematics and Artificial Intelligence Conference (Math & AI 2021)**, Paris, France.
- 11/2020–03/2021 **CAMS Thematic Program in Mathematical Physics (Online Mini-Courses)**, Center for Advanced Mathematical Sciences (CAMS), American University of Beirut (AUB), Lebanon.
- 06/2020 **Networked Complexity: The Case of COVID-19 (Online Conference)**, Center for Advanced Mathematical Sciences (CAMS), Beirut, Lebanon.

- 11/2019 **CAMS@20 Symposium**, Center for Advanced Mathematical Sciences (CAMS), American University of Beirut (AUB), Lebanon.
- 06/2019 **Small Scales and Homogenisation (SmaSH)**, Cardiff, Wales.
- 06/2019 **Numerical Methods for Multiscale Models Arising in Physics and Biology**, Nantes, France.
- 01/2019 **Journée Rennes–Nantes d'Analyse**, Nantes, France.
- 01/2019 **Journée Mathématiques et Transport – Rencontre avec l'IFSTTAR**, Nantes, France.
- 10/2018 **Lebesgue Doctoral Meetings 2018**, Brest, France.
- 06/2018 **Mathematical Models in Health Sciences**, Nantes, France.
- 05/2017 **Lebanese International Conference on Mathematics and Applications (LICMA'17)**, Lebanese University, Faculty of Science, Lebanon.
- 05/2015 **Lebanese International Conference on Mathematics and Applications (LICMA'15)**, Lebanese University, Faculty of Science, Lebanon.

Teaching

★ [Functions and Numerical Sequences \(2026–2027, ESILV Nantes\)](#)

Teaching load 27 h – tutorials.

Students First year of the preparatory cycle.

Content Mappings and standard functions; injectivity, surjectivity, and bijectivity; numerical sequences, convergence, and adjacent sequences; limits, asymptotic equivalents, and continuity; Intermediate Value Theorem; differentiability and function analysis; suprema and infima, maxima and minima.

★ [Supplementary Mathematics \(2026–2027, ESILV Nantes\)](#)

Teaching load 21 h – integrated lectures and problem-solving sessions.

Students First year of the preparatory cycle.

Content Numerical sequences; sums and products; conic sections; linear systems; combinatorics; equations and inequalities; n th roots; trigonometry; differentiation; logarithmic and exponential functions; integration.

★ [Algebra \(2025–2026, ESILV Nantes\)](#)

Teaching load 24 h – tutorials.

Students First year of the preparatory cycle.

Content Elementary logic; sets; mappings.

★ [Probability 1 \(2023–2026, ESILV Nantes\)](#)

Teaching load 77 h – tutorials.

Students First year of the preparatory cycle.

Content Fundamentals of probability theory; discrete and continuous random variables.

★ [Probability \(2023–2026, ESILV Nantes\)](#)

Teaching load 63 h – tutorials.

Students Second year of the preparatory cycle.

Content Pairs of discrete and continuous random variables; convergence of random variables; central limit theorem and applications.

★ [Statistics \(2024–2025, ESILV Nantes\)](#)

Teaching load 18 h – tutorials and practical sessions using Python.

Students Second year of the preparatory cycle.

Content Univariate descriptive statistics (order statistics, measures of central tendency and dispersion); bivariate descriptive statistics (simple linear regression using least squares); multivariate descriptive and exploratory statistics (multiple linear regression and principal component analysis – PCA); Python libraries: NumPy, Pandas, Matplotlib, Seaborn, `scipy.linalg`, `scipy.stats`, `sklearn.linear_model.LinearRegression`, and `sklearn.decomposition.PCA`.

★ [Engineering Mathematics \(2023–2025, ESILV Nantes\)](#)

Teaching load 54 h – tutorials.

Students First year of the preparatory cycle.

Content Complex numbers; polynomials; rational functions; derivatives and antiderivatives; ordinary differential equations.

★ [Multivariable Analysis \(2023–2024, ESILV Nantes\)](#)

Teaching load 36 h – tutorials.

Students Second year of the preparatory cycle.

Content Continuous and differentiable functions; C^1 and C^2 functions; differential 1-forms and vector fields; double and triple integrals; integration over parametrised curves and surfaces; partial differential equations.

★ [Series \(2023–2024, ESILV Nantes\)](#)

Teaching load 27 h – tutorials.

Students Second year of the preparatory cycle.

Content Numerical series; sequences and series of functions; Fourier series.

★ [Differentiation & Integration \(2023–2024, ESILV Nantes\)](#)

Teaching load 18 h – tutorials.

Students First year of the preparatory cycle.

Content Continuity and comparison relations; Taylor expansions; integration and computation of antiderivatives; ordinary differential equations.

★ [Engineering Mathematics I3 \(2023–2024, ICAM Nantes\)](#)

Teaching load 6 h – practical sessions.

Students Third year of the general engineering programme.

★ [Engineering Mathematics O1 Exp4 \(2023–2024, ICAM Nantes\)](#)

Teaching load 21 h lectures + 28 h tutorials.

Students Second year of the general engineering programme.

Content First- and second-order differential equations; double and triple integrals; power series; Fourier series.

★ [Engineering Mathematics OP Exp1/Exp2 \(2023–2024, ICAM Nantes\)](#)

Teaching load	24 h lectures + 75 h tutorials + 26 h academic support.
Students	First year of the general engineering programme.
Content	Sets; mappings; complex numbers; algebraic computations; numerical sequences; statistics; probability; function analysis and vector geometry.

★ [Supplementary Mathematics for the Engineering Programme \(2022–2023, University of Rennes 1\)](#)

Teaching load	24 h lectures + 24 h tutorials/practical sessions using MATLAB.
Students	Second-year undergraduate students (L2), Mathematics–Physics–Computer Science.
Content	Numerical solution of nonlinear equations; polynomial interpolation.

★ [Computer Science Tools B \(2022–2023, University of Rennes 1\)](#)

Teaching load	24 h – practical sessions using Python.
Students	Second-year undergraduate students (L2), Mathematics–Physics–Computer Science.
Content	Numerical data types; containers (strings, lists, tuples); control structures (conditional statements and loops); functions; NumPy library; data visualisation; file handling; image processing; object-oriented programming.

★ [Linear Algebra 4 \(2022–2023, University of Rennes 1\)](#)

Teaching load	24 h – tutorials.
Students	Second-year undergraduate students (L2), Mathematics–Physics–Computer Science.
Content	Reduction of linear operators and spectral theory.

★ [Mathematics for Biology 2 \(2022–2023, University of Rennes 1\)](#)

Teaching load	18 h – tutorials.
Students	First-year undergraduate students (L1) in Biology, Environment, Chemistry and Life Sciences.
Content	Improper integrals; differential equations; stochastic models.

★ [Mathematics 1 \(2022–2023, University of Rennes 1\)](#)

Teaching load	40 h – tutorials.
Students	First-year undergraduate students (L1) in Computer Science and Electronics.
Content	Complex numbers; local and global analysis of functions; integration; probability.

★ [Mathematical Tools 1 \(2022–2023, University of Rennes 1\)](#)

Teaching load	30 h – tutorials.
Students	First-year undergraduate students (L1) in Physics–Chemistry, Earth Sciences and Mechanics.
Content	Real and complex numbers; function analysis; polynomials; rational functions; integration; ordinary differential equations.

★ [Linear Algebra 2 \(2021–2022, La Rochelle University\)](#)

Teaching load 10.5 h – tutorials.

Students Second-year undergraduate students (L2) in Civil Engineering.

Content Reduction of linear operators and matrix computations.

★ [General Mathematics \(2021–2022, La Rochelle University\)](#)

Teaching load 66 h – tutorials.

Students First-year undergraduate students (L1) in Mathematics.

Content Solution of linear systems; matrix computations; complex numbers; quadratic equations with complex coefficients; integration; solution of first- and second-order linear differential equations.

★ [Mathematics for Natural Sciences \(2021–2022, La Rochelle University\)](#)

Teaching load 16.5 h – tutorials.

Students First-year undergraduate students (L1) in Biology–Chemistry.

Content Elementary functions; integration; solution of first- and second-order linear differential equations.

★ [Mathematics 1 \(2021–2022, La Rochelle University\)](#)

Teaching load 16.5 h – tutorials.

Students First-year undergraduate students (L1) in Mathematics.

Content Solution of equations and inequalities; function analysis.

★ [Mathematics 2 \(2021–2022, La Rochelle University\)](#)

Teaching load 16.5 h – tutorials.

Students First-year undergraduate students (L1) in Mathematics.

Content Elementary logic and mathematical reasoning; set theory and mappings.

★ [Integration and Differential Equations \(2021–2022, La Rochelle University\)](#)

Teaching load 12 h – tutorials.

Students First-year undergraduate students (L1) in Civil Engineering.

Content Integration (change of variables and integration by parts); partial fraction decomposition of rational functions.

★ [Antiderivatives – Differential Equations \(2021–2022, La Rochelle University\)](#)

Teaching load 24 h – tutorials.

Students First-year undergraduate students (L1) in Mathematics.

Content Integration (change of variables and integration by parts); partial fraction decomposition of rational functions.

★ [Remedial Mathematics \(2021–2022, La Rochelle University\)](#)

Teaching load 30 h – tutorials.

Students First-year Mathematics students enrolled in the two-year L1 programme.

Skills

- Modelling** Numerical analysis, partial differential equations (PDEs), finite element methods, homogenisation, multiscale and biomedical modelling; MATLAB, Fortran 90, openCARP.
- 3D Medical Imaging** 3D medical imaging (3DRA), analysis of 3D segmentations, geometric and morphological characterisation of vascular structures; SimpleITK, 3D Slicer, ParaView, Meshalyzer, CARPentry Studio.
- AI / Data Science** Machine Learning (regression, classification, clustering, PCA); Deep Learning and CNNs; Python, NumPy, Pandas, SciPy, Scikit-learn; PyTorch and TensorFlow (used during training).
- Tools** Git (GitHub, GitLab), Jupyter, Linux, VS Code, $\LaTeX$, Matplotlib.

Languages

- Arabic** Native language
- French** Fluent
- English** Good proficiency (reading, writing and speaking)