Nicolas Pinon, PhD

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Google scholar : NPinon scholar

Education

2020-2024 PhD in signal and image processing, *INSA Lyon*

2019-2020 M.S in Mathematics for vision and machine learning, *ENS Paris-Saclay*

2016-2020 B.S. and M.S. in Electrical Engineering, *ENS Paris-Saclay* (scholarship)

2014-2016 Technical diploma in Physical Measurements, *Strasbourg University* (valedictorian)

Research experience

Jan. 2024 – Nov. 2024
Research engineer

Hybridization of prostate cancer detection models
CREATIS laboratory, University of Lyon, France
Supervision: Carole Lartizien

Dec. 2020 – Dec. 2023
PhD student

Unsupervised anomaly detection in neuroimaging: contributions to representation learning and density support estimation in the latent space
CREATIS laboratory, University of Lyon, France
Supervision: Carole Lartizien

Apr. 2020 – Nov. 2020
Intern

Multi-planar U-Net for motion mask segmentation on abdominal CT scans (cancerous and COVID-19 cases)
CREATIS laboratory, University of Lyon, France
Supervision: Emmanuel Roux, Maciej Orkisz

Oct. 2018 – Jun. 2019
Intern

Automatic detection of symmetry axes in spinal cord MRI to improve registration robustness
Neuropoly Laboratory, Polytechnique Montréal, Canada
Supervision: Julien Cohen-Adad

May 2018 – Jul. 2028
Intern

Automatic segmentation of ovaries in MRI (in collaboration with a radiologist)
LTCI laboratory, Télécom Paris, France
Supervison: Pietro Gori, Isabelle Bloch

Publications

OCSVM-Guided Representation Learning for Unsupervised Anomaly Detection
Preprint, submitted to IEEE Transaction on Image Processing, 2025
Nicolas Pinon, Carole Lartizien

GAN-based synthetic FDG PET images from T1 brain MRI can serve to improve performance of deep unsupervised anomaly detection models
Published in Computer Methods and Programs in Biomedicine, 2025
Daria Zotova, Nicolas Pinon, Robin Trombetta, Romain Bouet, Julien Jung, Carole Lartizien

Unsupervised anomaly detection in neuroimaging: contributions to representation learning and density support estimation in the latent space
PhD thesis, 2024
Nicolas Pinon

Anomaly detection in image or latent space of patch-based auto-encoders for industrial image analysis
Published in GRETSI (french national signal processing conference), 2023
Nicolas Pinon, Robin Trombetta, Carole Lartizien

One-Class SVM on siamese neural network latent space for Unsupervised Anomaly Detection on brain MRI White Matter Hyperintensities
Published in MIDL (Medical Imaging with Deep Learning), 2023
Nicolas Pinon, Robin Trombetta, Carole Lartizien

Brain subtle anomaly detection based on auto-encoders latent space analysis: application to de novo parkinson patients
Published in ISBI (International Symposium on Biomedical Imaging), 2023
Nicolas Pinon, Geoffroy Oudoumanessah*, Robin Trombetta, Michel Dojat, Florence Forbes, Carole Lartizien*

Improving motion-mask segmentation in thoracic CT with multiplanar U-nets
Published in Medical Physics, 2022
Ludmilla Penarrubia, Nicolas Pinon*, Emmanuel Roux, Eduardo Enrique Dávila Serrano, Jean-Christophe Richard, Maciej Orkisz, David Sarrut*

Patch vs. global image-based unsupervised anomaly detection in MR brain scans of early Parkinsonian patients
Published in MLCN (Machine Learning in Clinical Neuroimaging, in conjonction with MICCAI), 2021
Verónica Muñoz-Ramírez, Nicolas Pinon*, Florence Forbes, Carole Lartizen, Michel Dojat*

Stain-free histology to validate quantitative MRI
Published in ISMRM (International Society for Magnetic Resonance in Medicine), 2019
Gabriel Mangeat, Harris Nami, Nicolas Pinon, Alexandru Foias, Nikola Stikov, Tobias Granberg, Julien Cohen-Adad

* : co-first authors

Service

Reviewer for the MIDL 2025 conference (Medical Imaging with Deep Learning) 8 pages proceedings, invited

Volunteer for the EUSIPCO 2024 conference (European Signal Processing Conference), ~850 attendees

Reviewer for the IEEE TMI journal (Transactions on Medical Imaging), invited, 2024

Reviewer for the MIDL 2025 conference (Medical Imaging with Deep Learning) 8 pages proceedings, invited, awarded outstanding reviewer

Elected student at the laboratory council, elected representative of PhD students and post-doc, regular participation in debates and voting, 2021-2024

Core member of LIFE (Laboratory Initiative For Environment), involved in community-building activities, laboratory life, environmental assessments (carbon footprint evaluation, carbon quota scenarios, etc.).

Member of the **admission jury** for engineering school (INSA group), in collaboration with alumni engineers, education psychologists, and INSA faculty.

Science outreach to primary school students on the topic of sound waves

Supervisor of industrial internships for four undergrad at INSA Lyon, including follow-up and contact with the host companies.

Mentor for middle school students within the the “Cordées de la réussite” (rope team of success) program.

Teaching

Image Processing – 16h, *Lecture + Practical sessions*, Bachelor level, INSA Lyon, 2024

Algorithms and Programming – 35h, *Tutorials*, Bachelor level, INSA Lyon, 2022–2023

Machine Learning and Deep Learning – 8h, *Practical sessions*, Master level, CPE Lyon, 2022–2023

Image Processing Projects – 16h, *Practical sessions*, Bachelor level, INSA Lyon, 2020–2022

Electromagnetism and Waves – 83h, *Tutorials*, Bachelor level, INSA Lyon, 2020–2022

Electricity and Electromagnetism – 23h, *Practical sessions*, Bachelor level, INSA Lyon, 2020–2022

Deep Learning for Medical Imaging – 12h, *Practical sessions*, Graduate level (Spring School), 2020–2022

Mathematics and Physics – 20h, *Mentorship* for middle school students, Cachan, 2017–2018

Miscellaneous

Technical skills: Python, Pytorch, Tensorflow, Scikit-learn, Git, Unix-based systems (Fedora, Ubuntu, Debian), HPC (slurm, PBS), LateX, medical image registration/preprocessing (FSL, ANTs, ITK)
Languages: French (native), English (Cambridge English Advanced, C1), German (Basic, B1)
Hobbies: Hiking (GR5 almost complete), running, reading (social science, politics, newspapers), music (trumpet, saxophone, transverse flute)

Detailed research activity

Engineer Contract

Title: *Hybridization of prostate cancer detection models*
Laboratory: CREATIS (Center for Research in Image Acquisition and Processing for Health), Lyon, France
Supervision: Carole Lartizien
Dates: 01/01/2024 – 30/11/2024 (10 months)

The objective of this project was to hybridize two prostate cancer detection machine learning models developed by two different laboratories. This engineering work involved training several models (supervised, weakly supervised, with lesion size constraints), validating their performance, and transferring expertise, code, and models to the partner laboratory, which had a more clinically oriented approach. This project was conducted with a clinical-oriented funding, with a large multicenter study as a final outcome. A publication is planned on this extensive dataset using models from both laboratories, achieving competitive performance compared to the state of the art.

PhD thesis

Title: *Unsupervised anomaly detection in neuroimaging: contributions to representation learning and density support estimation in the latent space*
Laboratory: CREATIS (Center for Research in Image Acquisition and Processing for Health), Lyon, France
Start date : 01/12/2020
Defense date: 11/04/2024 (3 years and 4 months)
Jury:

Schnabel Julia, Full Professor, *Technical University of Munich,* **Reviewer**
Bloch Isabelle, Full Professor, *Sorbonne Université,* **Reviewer**
Meriaudeau Fabrice, Full Professor, *Université de Bourgogne,* **Examiner, Chair**
Duchateau Nicolas, Associate Professor, *Université Lyon 1,* **Examiner**
Lartizien Carole, Tenured Researcher, *CNRS,* **PhD advisor**
Forbes Florence, Tenured Researcher, *INRIA,* **Invited**

My PhD focused on unsupervised anomaly detection (UAD) in neuroimaging. This work partly builds on the model proposed in [Alaverdyan, MEDIA 2020], whose novelty lies in performing the detection step in the latent representation space by estimating the probability density support of the normative distribution. The developed model was applied to the detection of subtle epileptogenic lesions (negative MRI) in multiparametric MRI and evaluated on a private dataset.

In this thesis, we optimized the architecture and parameters of this UAD model and evaluated its performance on various public datasets, including non-medical anomaly detection. This contribution led to a publication at the national GRETSI conference [6], a national French conference recognized in signal and image processing. The evaluation was also carried out on the

WMH challenge dataset (brain MRI with hyperintense anomalies) and the Parkinson's Progression Markers Initiative dataset (PPMI). This latter contribution resulted in a publication at a MICCAI workshop [5] and a publication at the ISBI international conference [4], both highly recognized in medical image processing. These contributions enabled a comparison with the state of the art in UAD methods, particularly with the most common approaches based on reconstruction error in image space.

The subsequent part of this thesis builds upon the limitations of the [Alaverdyan, MEDIA 2020] model and proposes original methodological contributions to: 1) design patient-specific models by relaxing the strong constraint of precisely registering all controls and patients to an atlas, which resulted in a publication at the international MIDL conference [3], a highly recognized conference in medical imaging; 2) provide probability calibration to enable ensemble learning and the harmonization of score maps; and 3) merge the representation learning step with the anomaly detection step by proposing a novel end-to-end model for UAD. This last contribution, evaluated on both medical and non-medical images, has been submitted to IEEE Transaction in Image processing.

During my PhD, I also collaborated with a fellow doctoral student on synthetic PET image generation models used to enhance the performance of UAD models in epilepsy imaging. This contribution has been published in Computer Methods and Programs in Biomedicine [2].

Master's Thesis

Title: Multi-planar U-Net for Motion Mask Segmentation on Abdominal CT (Cancer and COVID)
Laboratory: (CREATIS Center for Research in Image Acquisition and Processing for Health), Lyon, France
Supervision: Emmanuel Roux, Maciej Orkisz
Dates : 01/05/2020 – 30/11/2020 (6 months)

This project, initiated during the pandemic, aimed to develop and evaluate a deep learning algorithm for motion mask segmentation on low-contrast lung CT scans (cancerous and COVID, collected during the internship) to improve segmentation quality, robustness, and speed over state-of-the-art methods. A multi-planar U-Net with majority voting was proposed and tested for generalization. The work led to a publication in Medical Physics [1]. The developed models have since been routinely used at the university hospital for lung segmentation (minutes vs. 3h manual segmentation).

Gap-Year Internship

Title: Automatic Detection of Symmetry Axes in Spinal Cord MRI to Improve Registration Robustness
Laboratory: Neuropoly, Polytechnique Montréal, Canada
Supervision: Julien Cohen-Adad
Dates: 01/10/2018 – 30/06/2019 (9 months)

The project aimed to develop an original algorithm for symmetry axis detection to improve spinal cord MRI registration robustness. Two enhancements to a gradient orientation histogram-based algorithm were proposed and evaluated: one using distance to the cord center and another using

edge detection. The work was integrated into the SCT (Spinal Cord Toolbox)*. Additionally, I contributed to an ISMRM conference paper [7] by producing quantitative spinal cord MRI maps in a porcine model.

* : Code mentioning my contribution is available here, last page of this document mention my contribution to the toolbox. I'm also mentioned in the acknowledgments Cohen-Adad et al. (2022) Comparison of multicenter MRI protocols for visualizing the spinal cord gray matter, Magnetic resonance in medicine.

1st year of Master's internship

Title: Automatic Segmentation of Ovaries in MRI (in collaboration with a radiologist)
Laboratory: LTCI, Telecom Paris, France
Supervision: Isabelle Bloch, Pietro Gori
Dates: 01/05/2020 – 30/07/2018 (3 months)

The goal was to design an algorithm for automatic ovary segmentation in female pelvic T2w MRI using classical image processing techniques (filtering, mathematical morphology, watershed, Hough transform, etc.). The work was carried out in collaboration with a radiologist.

1st year of Master's project

Title: Numerical Acoustic Simulations for Ultrasound Image Reconstruction
Laboratory: Echopen (startup funded by the hospital), Hôtel-Dieu, AP-HP
Dates: Conducted in parallel with coursework over one semester

The objective was to simulate ultrasound images to test deconvolution algorithms. The forward problem was modeled both by filtering toy images and by simulating images using a numerical acoustic simulation toolbox.

Detailed supervision

During my PhD, I had the opportunity to co-supervise two Master's students (M2) alongside Carole Lartizien, my PhD supervisor: Robin Trombetta (50%) and Guillaume Perna (50%). My responsibilities included the daily/weekly follow-up and guidance of their work, reviewing internship reports, and preparing them for defenses and team presentations.

- **Spring 2022:** Robin Trombetta's work focused on the development of autoencoder networks for anomaly detection on industrial images and MRI scans of Parkinson's patients. The project specifically explored networks with a quantized latent space (VQ-VAE) and restoration methods based on probability density estimation (using transformers).

- **Spring 2023:** Guillaume Perna's work focused on the calibration of unbounded anomaly scores into probabilities, with evaluations conducted on both toy datasets and real datasets (MNIST and brain MRI). Several state-of-the-art methods were compared, including a re-implementation of a concentric SVDD (a variation of support vector machine) algorithm.

Detailed teaching

During my PhD and afterwards, I delivered a total of 193 hours of teaching across various subjects (physics, computer science, image processing), to different audiences (Bachelor of Engineering, Master of Engineering, spring school) and through diverse formats (tutorials, practical sessions, projects, lectures).

- **Electromagnetism**
  [83h] Tutorials (Bachelor level), INSA Lyon FIMI, 2020-2022

This bachelor course aimed to address the analytical resolution of problems in electromagnetism, using Maxwell's equations and the various classical theorems (Gauss, Ampère) of electromagnetism. Delivered during the COVID years, the teaching methods had to be adapted (online, hybrid, and in-person), using various pedagogical tools (audio-video recording for delayed viewing, Wooclap, group work).

- **Electricity and Electromagnetism**
  [23h] Laboratory Practicals (Bachelor level), INSA Lyon FIMI, 2020-2022

These practical sessions focused on applying theoretical concepts in electricity and electromagnetism: RLC circuits, filters, Fourier analysis, use of the oscilloscope, and modeling and measuring magnetic fields using Maxwell's equations. I designed the practical exam for the second year. This experience was also the subject of feedback and sharing in a pedagogical training session.

- **Image Processing**
  [16h] Project Supervision (Bachelor level), INSA Lyon FIMI, 2020-2022

These projects aimed to lead students to complete a small practical achievement in image processing, using classical tools in the field (histogram normalization, Fourier transform, filters, mathematical morphology, edge detection).

- **Deep Learning for Medical Imaging**
  [12h] Graduate level, DLMI Spring School, 2020-2022

These practical sessions, delivered in English as part of a spring school, aimed to familiarize participants with neural networks commonly used for segmentation and classification in medical imaging (U-Net, ResNet, VAE, etc.), and with specific pre/post-processing and analysis tools for medical imaging (management of spacing, modalities, contrast, etc.).

- **Algorithms and Programming**
  [35h] Tutorials (Bachelor level), INSA Lyon FIMI, 2022-2023

This bachelor course aimed to introduce programming and algorithmics through the Python language (both on computer and on paper), covering loops, lists, conditions, sorting, memory representation of numbers, cellular automata, and other fundamental concepts.

- **Machine Learning and Deep Learning**
  [8h] Laboratory Practicals (Master's level), CPE Lyon, 2022-2023

These practical sessions aimed to apply concepts (cross-validation, hyperparameter tuning, over/under-fitting, etc.) and basic methods in machine learning (SVM, random forests, etc.) and deep learning (CNN, ResNet, etc.).

- **Image Processing**
  [16h] Integrated Course (Bachelor level), INSA Lyon FIMI, 2024

This bachelor course (alternating lecture and tutorial phases) was designed to introduce students to image processing, presenting the fundamental tools of the discipline: histogram normalization, Fourier transform, filters, mathematical morphology, edge detection, etc. The course's objective was to provide the foundations for a small project to be completed by the students afterwards.

Detailed bibliography

Articles in international peer-reviewed journals

[1] Penarrubia Ludmilla*, **Pinon, Nicolas***, Roux Emmanuel, Dávila Serrano Eduardo Enrique, Richard Jean-Christophe, Orkisz Maciej, Sarrut David (2022). Improving motion-mask segmentation in thoracic CT with multiplanar U-nets. *Medical Physics*, 49(1), 420-431.

[2] Zotova Daria, **Pinon Nicolas**, Trombetta Robin, Bouet Romain, Jung Julien, Lartizien Carole (2023). GAN-based synthetic FDG PET images from T1 brain MRI can serve to improve performance of deep unsupervised anomaly detection models. *Computer Methods and Programs in Biomedicine*

International conferences with proceedings and peer review

[3] **Pinon Nicolas,** Trombetta Robin Lartizien Carole (2023). One-Class SVM on siamese neural network latent space for Unsupervised Anomaly Detection on brain MRI White Matter Hyperintensities. 2023 *Medical Imaging with Deep Learning, Proceedings of Machine Learning Research* – 217:1–15, 2023. **Poster**

[4] **Pinon Nicolas***, Oudoumanessah Geoffroy*, Trombetta Robin, Dojat Michel, Forbes Florence, Lartizen Carole (2023). Brain subtle anomaly detection based on auto-encoders latent space analysis: application to de novo parkinson patients. *IEEE 20th International Symposium on Biomedical Imaging (ISBI), 2023*. **Oral**

[5] Muñoz-Ramírez Verónica*, **Pinon Nicolas***, Forbes Florence, Lartizien Carole, Dojat Michel (2021). Patch vs. global image-based unsupervised anomaly detection in MR brain scans of early Parkinsonian patients. *Machine Learning in Clinical Neuroimaging: 4th International Workshop, MLCN 2021, Held in Conjunction with MICCAI 2021*, Strasbourg, France, September 27, 2021, Proceedings 4. **Poster**

*** :** co-first authors

National conferences with proceedings and peer review

[6] **Pinon Nicolas**, Trombetta Robin, Lartizien Carole (2023). Anomaly detection in image or latent space of patch-based auto-encoders for industrial image analysis. *GRETSI 2023 : XXIXème Colloque Francophone de Traitement du Signal et des Images*, Aug 2023. **Poster**

Abstracts in international peer-reviewed conferences

[7] Mangeat Gabriel, Nami Harris, **Pinon Nicolas**, Foias Alexandru, Stikov, Nicolas, Granberg, Tobias, Cohen-Adad, Julien (2019). Stain-free histology to validate quantitative MRI. *International Society for Magnetic Resonance in Medicine (ISMRM)*. **Poster**

Abstracts in National Conferences

[8] **Pinon Nicolas**, Oudoumanessah Geoffroy, Trombetta Robin, Dojat Michel, Forbes Florence, Lartizen Carole (2023). Brain subtle anomaly detection based on auto-encoders latent space analysis: application to de novo parkinson patients. *Colloque Français d'Intelligence Artificielle en Imagerie Biomédicale (IABM 2023)*. **Poster**

[9] **Pinon Nicolas**, Trombetta Robin, Lartizen Carole (2024). Unsupervised anomaly detection of the white matter in MRI by estimation of the support of the normative distribution in siamese auto-encoder latent space. *Colloque Français d'Intelligence Artificielle en Imagerie Biomédicale (IABM 2024)*. **Poster**

Articles Under Review in International Peer-Reviewed Journals

[10] **Pinon Nicolas**, Lartizien Carole. OCSVM-Guided Representation Learning for Unsupervised Anomaly Detection. *Submitted to IEEE Transactions on Image Processing*