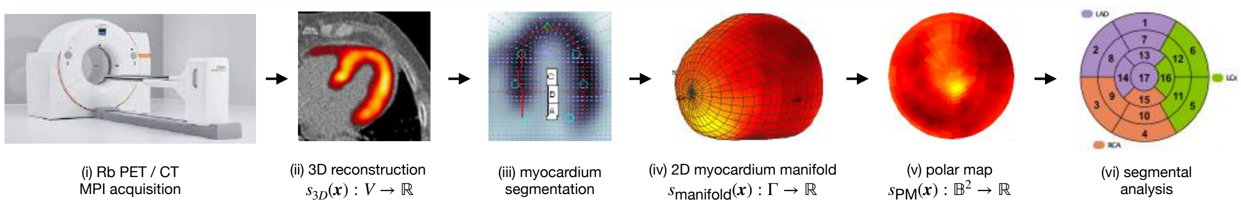
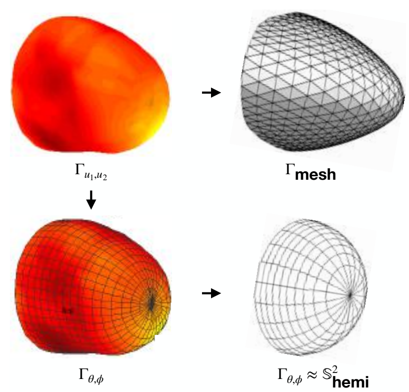
Cardiac perfusion analysis on myocardium manifolds using geometric deep learning and quantitative [82Rb] PET imaging (CADENCE): Fully funded PhD and Postdoc positions

Location: This project is a collaboration between the MedGIFT research group at the University of Applied Sciences Western Switzerland (HES-SO), Institute of Informatics, Sierre and the Service of Nuclear Medicine and Molecular Imaging (SNMMI) at the University Hospital Center (CHUV), Lausanne. EPFL and Inselspital are also partners of the project. Working locations are both Sierre and Lausanne. The project is funded by the Swiss National Science Foundation (SNSF).

Start date: As soon as possible.



Project Description: Cardiovascular atherosclerotic disease remained the leading cause of death worldwide in 2020, with an estimated to cost of €210 billion each year. Modern multimodal imaging technologies based on [82Rb] Positron Emission Tomography (PET) constitute a set of powerful non-invasive tools to assess myocardial health and is called Myocardial Perfusion Imaging (MPI). MPI can determine the risk of major adverse cardiac events as well as their consequences with unprecedented performance when compared to other non-quantitative modalities. They also contain subtle spatial perfusion patterns that are challenging to identify with the naked eye. In this context, modern Artificial Intelligence (AI) has the potential to be of high added value due to its ability to fully exploit and aggregate the wealth of modern MPI to robustly address clinically relevant endpoints. While many studies already demonstrated the feasibility and promises of AI for MPI analysis, few of them were based on [82Rb] PET. In addition, most existing AI methods neglected the geometric peculiarities of the MPI signal, resulting in suboptimal exploitation of the latter.



In this project, we plan to further develop the latest advances in Geometric Deep Learning (GDL) to adequately analyze the MPI signal over various geometric representations including polar maps, 3D space as well as on myocardium surface manifolds, the native space of the MPI signal. In addition, GDL encoder-decoder models will be developed to generate virtual images of other relevant PET markers (e.g. [18F]FDG from dynamic [82Rb]). The investigation of this vast and unexplored research space is expected to significantly push the boundaries of how MPI can be used for clinical purposes. The proposed models are expected to outperform current AI methods for the analysis of [82Rb] PET/CT, which could be easily implemented in clinical practice.

1 PhD student researcher

We look for a highly-motivated student for a PhD position in medical imaging (fully funded for four years with annual renewal of the contract) at the MedGIFT group, HES-SO Valais-Wallis, with workplaces both in Sierre and in Lausanne at CHUV.

Description: We look for one PhD student that will work jointly with the MedGIFT group and the Service of Nuclear Medicine and Molecular Imaging (SNMMI) under the supervision of Prof. Dr. Adrien Depeursinge and Prof. Dr. John O. Prior. The PhD thesis project is the development of Geometric Deep Learning (GDL) methods to best leverage Myocardial Perfusion Imaging (MPI) based on [82Rb] PET. These include polar/spherical/mesh CNNs and comparison to already available traditional Artificial Intelligence (AI) models. Three important clinical aims will be addressed: (i) risk prediction for major adverse cardiac events, (ii) the diagnosis of coronary microvascular disease, and (iii) the assessment of myocardium viability after a myocardial damage related to the persistence of ischemia. Close interactions are planned with clinicians to adequately interpret the scientific insights and clinical significance related to AI models' performances. The tasks involve conducting experiments, developing novel algorithms, publishing research findings in reputable academic journals and top-tier machine learning conferences, as well as involvement in the supervision of students.

Your profile:

- Master's (MSc) degree in physics, computer science, or electrical engineering, or similar degree with an equivalent academic level.
- A genuine interest in signal and image processing and machine learning techniques is a must.
- A strong will to develop clinically actionable methods and to interact with clinicians is required.
- Strong mathematical background and programing skills in Python, including DL frameworks.
- Prior exposure to graph signal processing and/or medical imaging is a plus.
- Good skills in English (oral and written) are required and knowledge in French is a plus.
- Rigorous work habits, a curious and critical mind, and a good sense of initiative.
- A high-level perseverance and a strong personal commitment are expected.

We offer:

- A multidisciplinary project between cutting-edge cardiac imaging and advanced image/graph processing, machine learning, and a clear clinical context.
- An extremely stimulating field of research within a highly specialized and qualified scientific environment.

Gross salary (pre-employer/employee tax): in compliance with Swiss National Science Foundation. Successful applications are subject to **academic approval from the Faculty of Biology and Medicine Doctoral School at the University of Lausanne**; the selected candidate will be enrolled in the Doctoral Degree (PhD) in Life Sciences.

To apply: If you recognize yourself in this profile and want to take up a new challenge, address your complete application (Cover letter, CV and 2 references) **before November 10th or until the position is filled** to: Adrien.Depeursinge@hevs.ch .

1 Postdoctoral researcher

We look for a highly skilled and motivated Postdoctoral researcher to work on a multidisciplinary, health-related medical imaging project (fully funded for two years with annual renewal of the contract) at the MedGIFT group, HES-SO Valais-Wallis, with workplaces both in Sierre and in Lausanne at CHUV.

Description: We look for one Postdoctoral researcher that will work jointly with the MedGIFT group and the Service of Nuclear Medicine and Molecular Imaging (SNMMI) under the supervision of Prof. Dr. Adrien Depeursinge. The primary responsibility of the postdoctoral researcher will be to lead and drive the development of Geometric Deep Learning (GDL) methods to best leverage Myocardial Perfusion Imaging (MPI) based on [82Rb] PET. These include graph CNNs and comparison with other GDL models developed by the PhD student, as well as already available traditional Artificial Intelligence (AI) models. Three important clinical aims will be addressed: (i) risk prediction for major adverse cardiac events, (ii) the diagnosis of coronary microvascular disease, and (iii) the assessment of myocardium viability after a myocardial damage related to the persistence of ischemia. For (iii), GDL encoder-decoders will be trained to both generate virtual [18F]FDG images from dynamic [82Rb] as well as an auxiliary task to predict viability scores. Close interactions are planned with clinicians to adequately interpret the scientific insights and clinical significance related to AI models' performances. The tasks involve conducting experiments, developing novel algorithms, publishing research findings in reputable academic journals and top-tier machine learning conferences, and involvement in the supervision of PhD students.

Your profile:

- You should have a PhD degree in physics, computer science, or electrical engineering, or similar degree with an equivalent academic level.
- Proven experience in conducting independent cutting-edge research in the field of deep learning, preferably including GDL and medical imaging, with a track record of publications in reputable journals and top-tier machine learning and/or medical imaging conferences.
- Extensive experience with DL frameworks and medical imaging.
- A strong will to develop clinically actionable methods and to interact with nuclear physicians and cardiologists is required.
- Good skills in English (oral and written) are required and knowledge in French is a plus.

We offer:

- A multidisciplinary project between cutting-edge cardiac imaging and advanced image/graph processing, machine learning, and a clear clinical context.
- An extremely stimulating field of research within a highly specialized and qualified scientific environment.

Gross salary (pre-employer/employee tax): in compliance with Swiss National Science Foundation.

To apply: If you recognize yourself in this profile and want to take up a new challenge while moving to the next step of your academic career, address your complete application (Cover letter, CV, list of publications and 3 references) **before November 10th or until the position is filled** to: Adrien.Depeursinge@hevs.ch
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