National project (FPI) PhD position

Title: PhD scholarship in "Generation of synthetic data and fast fluid simulations with artificial intelligence for the improvement of left atrial appendage occlusion therapies" (GENERALITAAT)

Abstract:

The left atrial appendage (LAA) remains an enigmatic feature in the human anatomy, with numerous unknowns regarding its structure and function. Despite ongoing research, it is still uncertain which patients with atrial fibrillation (AF) possess a higher risk of developing thrombi. A recently granted national project, GENERALITAAT (follow-up of the ones funding our research during the last 7 years), will usher in a new era for interventional cardiology and LAA therapies, leveraging the most cutting-edge computational technologies such as generative artificial intelligence (AI) algorithms, natural language processing, visual analytics, and in-silico simulations in a clinical setting.

The difficulties of data sharing have resulted in incomplete databases for training AI algorithms, with biases, lack of generalization and robustness due to the absence of multi-centric studies. The **generative and federated AI-based techniques** to be developed in the GENERALITAAT project aim (objective 1) to partially solve these problems, utilizing cutting-edge methodologies, and contributing to democratise the access to advanced computational tools to hospitals with less resources. At the same time, digital twins of the heart are finally making their way into the clinical field and are even included in medical product certifications by regulatory bodies. However, these models still require large computational times to produce simulation results that are incompatible with the time constraints of clinical routine, hindering their clinical translation. At GENERALITAAT, we aim (objective 2) to develop **fast fluid computational models** that can simulate crucial factors for atrial fibrillation, enabling their integration into a decision-support system that is compatible with clinical timeframes. Finally, we aim (objective 3) to develop **advanced interactive visualisation interfaces** tailored to enhance medical decisions related to LAA therapies, integrating patient-specific data, structural and haemodynamics information obtained from medical images, and fast computational models to generate therapy recommendations and personalise patient treatment.

A predoctoral (FPI-type) contract has been granted for the development of a PhD thesis in the framework of the GENERALITAAT project. The candidate will be enrolled in the PhD programme of Information and Communication Technologies (DTIC) of the Universitat Pompeu Fabra (UPF). Her/his mission will be to developing state-of-the-art algorithms for creating synthetic medical images, finite element meshes, and fluid simulations significantly contributing to the objectives 1 and 2 described above.

Training plan

The training plan will include the three following pillars.

Training in in-silico medicine technologies: Specific training will be offered during the annual Virtual Physiological Human Summer School, organised at UPF (www.bcnvph.org). The summer school comprises keynote lectures, who provide an integrative view of state-of-the-art research for in silico medicine. These keynotes are complemented by hands-on sessions guided by expert instructors.

Specific training: The specific training will be the PhD project itself. The candidate will be supervised scientifically by the GENERALITAAT PI (Pr Oscar Camara from UPF). The primary workplace will be the DTIC department at UPF. However, the student will be asked to spend at least one day per week at the local hospitals involved in GENERALITAAT. The scientific follow-up of the student will consist of weekly meetings and will be supplemented by periodic revisions of a career development plan. The specific training will also comprise the active participation in international congresses and strong guidance for scientific publishing. It will also include a short one-month stay during the first year at the research group of Pr Rasmus Paulsen at DTU (Denmark), to collaborate on the AI-based generation of medical images and federated learning. Additionally, during the third year, the PhD will undertake a five-month stay at the ABI on the development of fast fluid models.

Scientific training from the doctoral school: the candidate will also benefit from the comprehensive training provided by the doctoral program at DTIC-UPF, which encompasses regular interdisciplinary scientific seminars and formal coursework in data science and statistics, research ethics, technology transfer, business development, and scientific dissemination and communication. Furthermore, the doctoral school training encourages active participation in scientific communication for the general public, through means such as interactions with primary and secondary schools.

Open position for a predoctoral researcher:

This position includes a teaching commitment load of 30 hours per academic year.

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Requirements:

We are looking for a highly motivated young researcher with a master's degree in biomedical engineering, Physics, Mechanical Engineering, Applied Mathematics, Computational Science, or related disciplines. Knowledge on advanced artificial intelligence algorithms is required, ideally at least for medical image processing or for the acceleration of finite-element methods. Experience on generative AI algorithms (e.g., GANs, stable diffusion), federated learning, graph-neural networks, and reduced-order models will facilitate a fast start of the PhD. Having proven programming skills would be of importance. Candidates must have excellent teamwork and communication skills (fluency in English is a must). Admission in the PhD program of the Department of Information and Communication Technologies at UPF is a prerequisite to have the contract.

Starting date (planned): Academic course 2024-25

Application deadline: May 28th 2024

Gross yearly salary:

Gross monthly salary: 1680 €. (To increase to 2020 € during the fourth year of the PhD).

The PhySense group and the BCN-MedTech unit form an ideal environment for training early-stage researchers, as has been confirmed during the last years by Spanish and European agencies. All PhD students have large office spaces and their own desk with networked computers, appropriate software, access to state-of-the-art equipment, excellent library and information services, language and scientific communication training and cultural/sport services. Our PhD students usually get maximum thesis qualifications, with publications in high impact journals. We provide interdisciplinary doctoral training aimed at educating academic persons with the required skills and flexibility to function and perform in a broad range of employment opportunities in a clinical, academic, or industrial environment, in the field of Biomedicine and Bioengineering.

The PhD candidate will be surrounded by a large team of senior and junior researchers from different disciplines in the hosting group (PhySense, BCN-MedTech research unit at UPF). PhySense's research is focused on data science and modelling methods in a wide variety of medical fields, with emphasis on the clinical translation. This project will be complementary to existing research in our institution. For instance, to study haemodynamics and morphology in atrial fibrillation in relation with stroke, which is another interesting heart-brain axis application.

For application or further information, contact

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