
Institute of Computational Science (ICS)
Center for Computational Medicine in Cardiology (CCMC)

“Development of patient-specific prediction model of efficacy of antiarrhythmic drug therapy and ablation strategy in patients with atrial fibrillation”

The Center for Computational Medicine in Cardiology (CCMC), Università della Svizzera italiana, is seeking for a highly motivated PhD student in numerical analysis and computational science to develop innovative numerical methods for simulating atrial fibrillation and therapeutic options in patient-specific models.

The project

Atrial fibrillation (AF), the most common clinically relevant heart rhythm disorder, is characterized by multiple fibrillation waves randomly propagating through the atrial wall. AF initiation and perpetuation, determined by a complex interplay of anatomy, electric substrate and ectopic activity, are difficult to evaluate in the clinical context. Consequently, the efficacy of available therapeutic options is still limited. Therefore, mathematical models of AF capable of dealing with such complexity may offer to clinicians the unique possibility to improve the management of AF.

Mathematical models for AF pose significant challenges from a computational viewpoint. Simulating electrophysiology of the heart is a space-time, multi-physics and multi-scale problem. An incorrect or coarse discretization can have a tremendous effect on AF, possibly leading to non-physiological outcomes. AF episodes should last several seconds. Current numerical codes can only run on High-Performance Computing (HPC) infrastructure, limiting their applicability in the clinical context. Model personalization, which is fundamental for testing therapeutic outcome, includes anatomy segmentation and integration of electrophysiological clinical data in the model. In addition, simulating the therapeutic intervention is even more demanding: evaluating AF inducibility is essentially an uncertainty quantification problem (likelihood of triggering AF from a randomly chosen ectopic source).

The present project, therefore, aims at developing novel numerical methods to simulate AF, to personalize model parameters and to evaluate therapeutic options. To this aim, we plan to exploit multi-level and multi-fidelity methods in novel ways, using grid and model hierarchies to reduce the computational burden and accelerate the numerical convergence, without compromising the physiological accuracy.

Institutional environment

The position is funded by the Center for Computational Medicine in Cardiology (CCMC). CCMC is an interdisciplinary entity within the Institute of Computational Science (ICS) of the Università della Svizzera italiana, based in Lugano. This center has a highly international and interdisciplinary team with scientists whose background is in mathematics, computer science, biomedical engineering, and clinical cardiology. Projects are running both on the development of new methods and tools for large-scale cardiac simulations and on data analysis and simulation studies on clinically relevant questions.

Your challenges

- To strengthen and extend your knowledge of cardiac physiology and pathophysiology, and to establish a strong, daily basis collaboration with practitioners from Cardiocentro Ticino;
- To further develop our atrial model and simulation software (Propag-5, Propeiko), and to optimize them to run on Piz Daint (CSCS), one of the most powerful supercomputers in the world;
- To analyze unique clinical data provided by Cardiocentro which includes high-resolution intracardiac maps;
- To design a methodology to tailor the atrial model to the patient using the above data, by means of modern data assimilation and parameter identification techniques;
- To attend and to present your research activity at international conferences;
- To publish your findings in international, peer-reviewed journals;
- To assist in teaching activities in mathematics and computational science.

Your profile

- You have a solid background in applied mathematics;
- You have a strong interest in translational and clinical electrophysiology;
- You have experience in computational science with programming environments (C, C++, Python, Matlab, R) and HPC computing (MPI, OpenMP, CUDA);
- You wish to bridge the gap between mathematical modelling and clinical practice;
- You hold a master's degree in applied mathematics, physics or biomedical engineering;
- Experience in cardiac electrophysiology is an advantage but not strictly necessary.

We offer a 3-year PhD position in a multidisciplinary, international and inspiring environment. The position is full-time and salary in accordance to regulations of Università della Svizzera italiana.

The position opens on January 2019.

For further information, please don't hesitate to contact Dr. Simone Pezzuto (simone.pezzuto@usi.ch).

How to apply

Interested candidates must send their application documents (cover letter, CV, description of research interests and experience, names of at least two academic references), preferably as single PDF file, to Prof. Rolf Krause (rolf.krause@usi.ch) and Prof. Angelo Auricchio (angelo.auricchio@cardiocentro.org)