F5 Digital Twin Models to Infer Anatomical and Functional Parameters at Scale

HOST ORGANISATION

King's College London
(KCL), London, United Kingdom

PHD AWARDING INSTITUTION

King's College London
(KCL), London, United Kingdom

Supervisory Team

Lead Supervisor

- Prof. Pablo Lamata (King's College London)

Co-Supervisors

- Prof. Maja Cikes (University of Zagreb School of Medicine)
- Dr. Andreu M. Climent (Corify)

Extra application requirement:

please note that KCL requires to follow their institutional application process, you will need to also apply to the position that will be advertised in September.

Project Description

Cardiovascular digital twins have the potential to transform medicine by providing personalised models of anatomy and physiology that support diagnosis, prognosis and treatment planning. However, creating these models currently requires complex and time-consuming workflows that limit their use in large patient populations and routine clinical practice.

This project aims to develop new methods for personalising cardiovascular digital twins at scale. The doctoral candidate will create computational approaches capable of estimating anatomical, mechanical and electrophysiological parameters from large imaging datasets while addressing the challenges of limited patient-specific data and uncertainty in model predictions. A key objective is to identify the appropriate balance between model complexity and clinical applicability, allowing robust digital twins to be generated efficiently for large numbers of individuals.

The project will make extensive use of the UK Biobank, one of the world's largest health research resources, with access to imaging and functional data from about 100,000 participants. Using these data, the candidate will develop population-based reference values for cardiac anatomy and function, including parameters such as contractility, passive stiffness and electrical conduction properties. The project will also investigate how these parameters change over time by studying longitudinal data from thousands of participants and constructing digital twin trajectories that describe cardiovascular ageing and disease progression.

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An important aspect of the research will be the study of variability across populations, including differences related to sex and ethnicity. The resulting methodologies and datasets will support many of the other CDTnet projects by providing population-scale digital twin frameworks that can be applied to heart failure, arrhythmias and valve disease. Ultimately, the project aims to help make personalised cardiovascular modelling more accessible, scalable and clinically useful.

Planned Secondments

- Maastricht University, Netherlands (2 months): training in the CircAdapt cardiovascular modelling platform and large-scale model personalisation.
- University of Zagreb School of Medicine and IDIBAPS, Spain (short stays): exposure to clinical data and workflows related to heart failure, arrhythmias and valve disease.
- University of Zaragoza, Spain (short stay): integration of clinical datasets into digital twin pipelines and support for related CDTnet projects.
- GE Vingmed Ultrasound, Norway (2 months): investigation of digital twin personalisation from echocardiographic data.

Desirable Project-Specific Qualifications and Skills

- Evidence of ability to work with computational intensive analysis routines
- Evidence of skills in image or bio-signal (e.g. ECG) analysis
- Evidence of skills in model personalization: parameter estimation, uncertainty quantification, model identifiability