Karlsruhe Institute of Technology

Institute of Biomedical Engineering

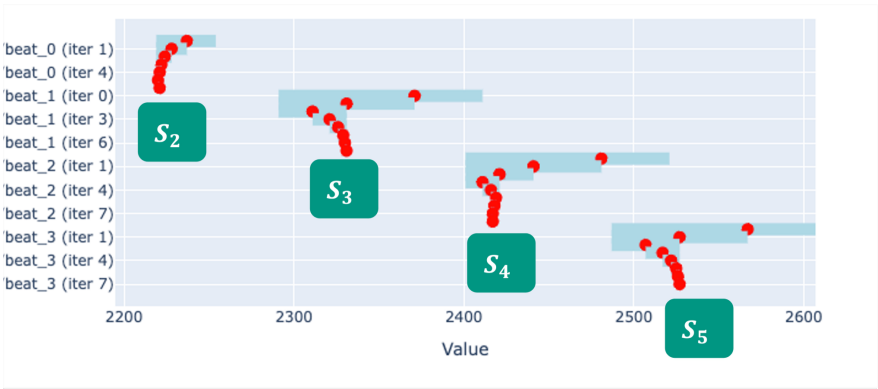
Improving the Search Algorithm to determine the ERP within PEERP

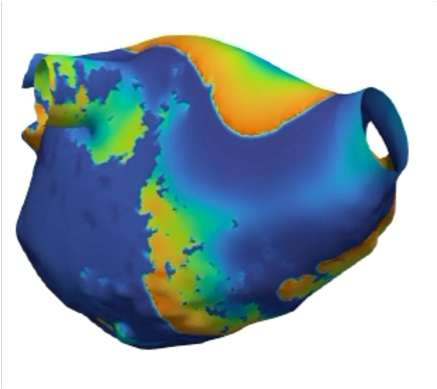
Bachelor Thesis / Master Thesis

Motivation

Atrial fibrillation is among the most prevalent cardiac arrhythmias worldwide. Personalized digital twins offer a promising approach to study underlying mechanisms and evaluating potential treatments. A well-established method for comparing different models is the quantification of atrial fibrillation vulnerability. This involves determining, for a defined set of pacing sites within the atrium, how many of these sites can initiate atrial fibrillation through electrical stimulation. The protocol and timing of stimulation are crucial for ensuring comparability across different models.

The PEERP protocol (Pacing at the End of the Effective Refractory Period) is used as a standardized method to induce atrial fibrillation episodes efficiently. However, its accuracy depends critically on the precise determination of the effective refractory period (ERP). Within a predefined time window, the ERP is estimated using a binary search approach (O(log(n)) steps, where n is the initial window size). Each iteration of this halving procedure corresponds to an electrophysiological simulation performed on high-performance computing systems. Consequently, minimizing the number of simulation steps is essential to enhance the protocol's efficiency.





left: Example of the interval halving process for 4 ERP searches (search window in blue, stimulation point in red); right: electrical wave of a stimulation on the left atrium

Project

The objective of this project is to optimize the binary search algorithm used for determining the effective refractory period (ERP). To this end, existing approaches will first be systematically reviewed and analyzed before novel methods will be developed based on the old approaches. The evaluation will be conducted using an existing dataset.

Source

L. Azzolin et al., "A Reproducible Protocol to Assess Arrhythmia Vulnerability in silico: Pacing at the End of the Effective Refractory Period," Front. Physiol., Jan. 2021, doi: 10.3389/fphys.2021.656411.

Notes

Programming experience (in Python) is advantageous but not required.

Research Area

Computational Cardiac Modeling

Course of Studies

Computer Science, Computational Engineering, BME, ETIT,...

Starting Date

As soon as possible

Posted Date

20.07.2026

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