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Reduced-order methods in cardiac electrophysiology

Application to long-time simulations and parameters identification

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The aim of the present work is to consider long-time simulations in cardiac electrophysiology. The purpose is to use the information contained in multiple heart beats to address parameter estimation problems from electrocardiograms (ECGs). Since we deal with the bidomain equations and realistic anatomies, the computational cost of a single heart beat is already high by itself. We therefore consider reduced-order models.

Our parameters identification strategy is based on the Restitution Curve (RC), i.e. the relationship between the duration of depolarization (Action Potential Duration, APD) and the duration of the previous polarization (Diastolic Interval, DI) of a cell. Previous works [Manriquez-Zhang-Medigue-Papelier-Sorine-2006] extended this definition to the heart as a whole, from the ECG.

We use two kinds of reduced order modeling techniques: the Proper Orthogonal Decomposition (POD), and a recently proposed method known as ALP, for Approximated Lax Pairs decomposition. We investigate how far reduced-order models are precise enough to obtain well approximated ECG and RC even for high heart frequency.

Keywords: Cardiac electrophysiology, reduced-order model, inverse problem, POD