Data Analytics and computer simulations for the study of cardiac disease

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Current pipeline: from images to simulations



From CMR scans to personalised ECG simulation: current pipeline



Aim: Discover the links between anatomy and electromechanics

Long processing times, need for manual interaction etc. prevents general use

A data-driven approach, using machine learning methods can be used to learn mechanisms

Specific focus on image analysis (e.g. learned shapes) or computer modelling

Application: analysis of ECG patterns





High Performance Computing Simulations



Anatomical models





Ana Minchole, Ernesto Zacur, Rina Ariga, Vicente Grau, Blanca Rodriguez. Frontiers in Physiology 2019

Same heart geometry placed in different orientations and torsos



- No change in QRS width
- Heart orientation affects QRS morphologies (leads V1 to V4)

Torso vol=44 dm³ - 35 - 54 - 27 - 23



Currently developing a similar approach for electromechanics





Francesc Levrero et al. CMAME, 2020

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Simulation results exploring healthy and pathological variability



Francesc Levrero et al. CMAME, 2020





Participants scanned so far



15/3/2020

The HCM Registry

Novel Predictors of Outcome in Hypertrophic Cardiomyopathy



People enrolled 2 7 5 0

11 April 2017

The HCMR study is well under way, with the first participant enrolled in April 2014 at research site 001. There are now 44 active sites; 22 sites in North America and 22 sites in Europe. The study is now following up the 2750 patients that were enrolled and is no longer recruiting.

Machine learning approaches for the analysis of electrophysiology





{Aurore Lyon et al, Frontiers in Physiology, 2018}

Identification of distinct HCM phenotypes: Clustering



4 HCM Phenotypic subgroups









{Aurore Lyon, et al, Frontiers in Physiology, 2018} Machine learning approaches for the analysis of cardiac mechanics



Results: comparison of predicted end systolic shapes versus ground truth





DICE

Moving forward

Completing machine learning-based pipelines for personalised simulations

Refining/complementing computer simulations with learned models

Analysing simulation results with machine learning models to generate biomarkers

Thank you!