PhD thesis

Title: Fusion of multiparametric and longitudinal MRI data by representation learning: application to predictive models of chronic non-ischemic cardiomyopathy.

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Context: Chronic non-ischemic cardiomyopathies (in particular dilated and hypertrophic cardiomyopathies) are cardiac pathologies with complex etiology and accounting for ~40% of all hospitalized patients with heart failure [BEG-18, MAR-22]. Their multi-factorial nature, along with variable clinical presentation and evolution require better characterization using imaging data, in particular for risk stratification. This PhD, within the scope of the broader national project "ChroniCardio" (PEPR Digital Health), aims at improving this characterization by better exploiting multiple descriptors extracted from imaging data with advanced machine learning.

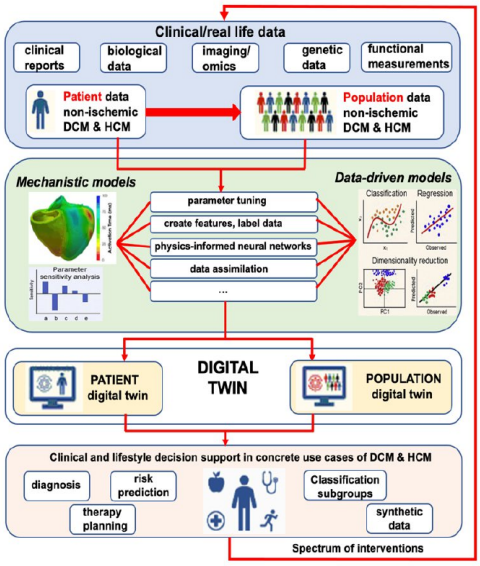

Figure: Overview of the integrated analysis targeted in the "ChroniCardio" project.

Objectives: We target the characterization of patient groups and potential patterns in the studied populations, using representation learning [BEN-13]. Our specific aim is to develop models that can incorporate multi-scale and heterogeneous data, as well as the dynamic nature of the data over time. To address this, we will deploy data-driven (statistical) models based on various biomarkers extracted from imaging. These will be in the longer term fused with virtual electrical & mechanical models (developed in other work packages of the "ChroniCardio" project) to predict the risk of sudden cardiac death, arrhythmia, and heart failure.

In this PhD, we will target the fusion of multi-scale / multi-modal data both from scalar variables extracted from high-dimensional MRI data, and high-dimensional variables (e.g. pixelized maps of myocardial patterns). Specifically, we will:
- align the data to a common reference by adapting computational anatomy tools available at CREATIS [DUC-23],
- develop multi-view and fusion learning models for the statistical analysis [LI-19],
- model the dynamics of multi-scale features from longitudinal studies [RAM-21].

Practical information:
- Location: Institut de Mathématiques de Marseille
- Duration: 3 years, starting September-October 2023

Profile:
- MSc student with applied mathematics and/or image processing background
- Good programming skills: Python (preferred). Complementary knowledge on Matlab and/or C++ may help.
- Good English
- Motivated to work on medical applications

Contact: Send your CV, motivation letter, recommendation letters, and academic record to:
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Bibliography:

[BEG-18] Beggs et al. Heart. 2018;104:144-50.
[BEN-13] Bengio et al. IEEE PAMI. 2013;35:1798-828.
[DUC-23] Duchateau et al. Front Cardiovasc Med. 2023;10.
[LI-19] Li et al. IEEE TKDE. 2018;31:1863-83.
[MAR-22] Maron et al. JACC. 2022;79:390-414.
[RAM-21] Ramchandran et al. Proc. AISTATS. 2021;130:3898-906.