Stage de fin d'études / Master 2 – 2021-2022.

Title: Multi-view analysis of left-right ventricular interactions using representation learning.
Team: MYRIAD = « Modeling & analysis for medical imaging and Diagnosis »
Supervision: Nicolas DUCHATEAU (Associate Professor / U. Lyon 1), Gabriel BERNARDINO (post-doc fellow).

Context: Cardiac diseases progressively deteriorate the shape and deformation of the cardiac muscle (the myocardium) across the cycle. Both characteristics can be assessed using dynamic imaging modalities, such as 2D echocardiography, and quantification tools are used to track the myocardium across the cycle [AMZ-19]. However, due to the limited echocardiographic field of view, the two ventricles cannot be simultaneously imaged. Therefore, current analyses focus on a single ventricle, resulting in a suboptimal assessment of the interaction between left and right ventricles, despite its importance in several pathologies (pulmonary hypertension, athlete's heart, dyssychronous heart, etc.).

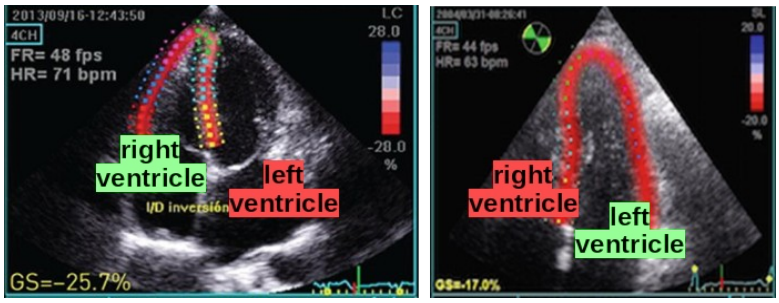

Figure: Speckle-tracking on left- or right-ventricular focused echocardiographic sequences. Adapted from [CIP-19]

Objectives: We target the analysis of **left-right ventricular interactions from multiple 2D echocardiographic sequences**, using machine learning approaches tailored for representing myocardial shape and deformation across populations [DUC-20]. This work is very complementary from our ongoing research on representation learning for the multi-parametric analysis of the cardiac function [SAN-17, DIF-21]. For this internship, we specifically aim at developing **novel representation learning** methods that exploit the link between the left and right ventricles:
- To compactly represent a population of healthy and diseased subjects from high-dimensional descriptors of the myocardial shape and deformation, and compare the results obtained by classical methods (PCA, manifold learning) and deep neural networks (potentially: variational autoencoders and graph neural networks).
- To develop novel methods that provide a consistent representation of the inter-ventricular septum, which is visible in both left- and right-ventricular focused images, and compare with methods that do not include such constraint.
- To use the previous representation to identify individuals presenting an abnormal behavior of the left and right ventricles, and characterize their abnormality.

We will use existing studies 2D echocardiographic from our clinical collaborators, with images focused on the left or the right ventricle. These images were processed with commercial speckle tracking algorithms, which provides a delineation of the ventricular contour and local deformation data attached at each point of the contour.

Practical information:
- Location: DOUA campus, CREATIS lab, Villeurbanne
- Duration: 6 months, starting February-March 2022
- Exploratory subject that can be continued within a PhD thesis

Profile:
- MSc student with an applied mathematics and/or computer science background.
- Good programming skills: Python (preferred). Complementary knowledge on Matlab and/or C++ may help.
- Good English
- Motivated to work on medical applications. Medical knowledge is not required.

Contact: Send your CV, motivation letter, and academic record to: nicolas.duchateau@creatis.insa-lyon.fr

---

Bibliography:
[AMZ-19] Amzulescu, De Craene, … Gerber. *Eur Heart J Cardiovasc Imaging*. 2019;20:605-19.
[CIP-19] Cipani, … Sarti. *Textbook of Echocardiography for Intensivists and Emergency Physicians, Springer.* 2019;71-8.
[DIF-21] Di Folco, Moceri, … Duchateau. *Med Image Anal*. 2021. In press.
[DUC-20] Duchateau, King, De Craene. *Front Cardiovasc Med*. 2020;6:190.
[SAN-17] Sanchez, Duchateau, … Piella. *Med Image Anal*. 2017;35:70-82.