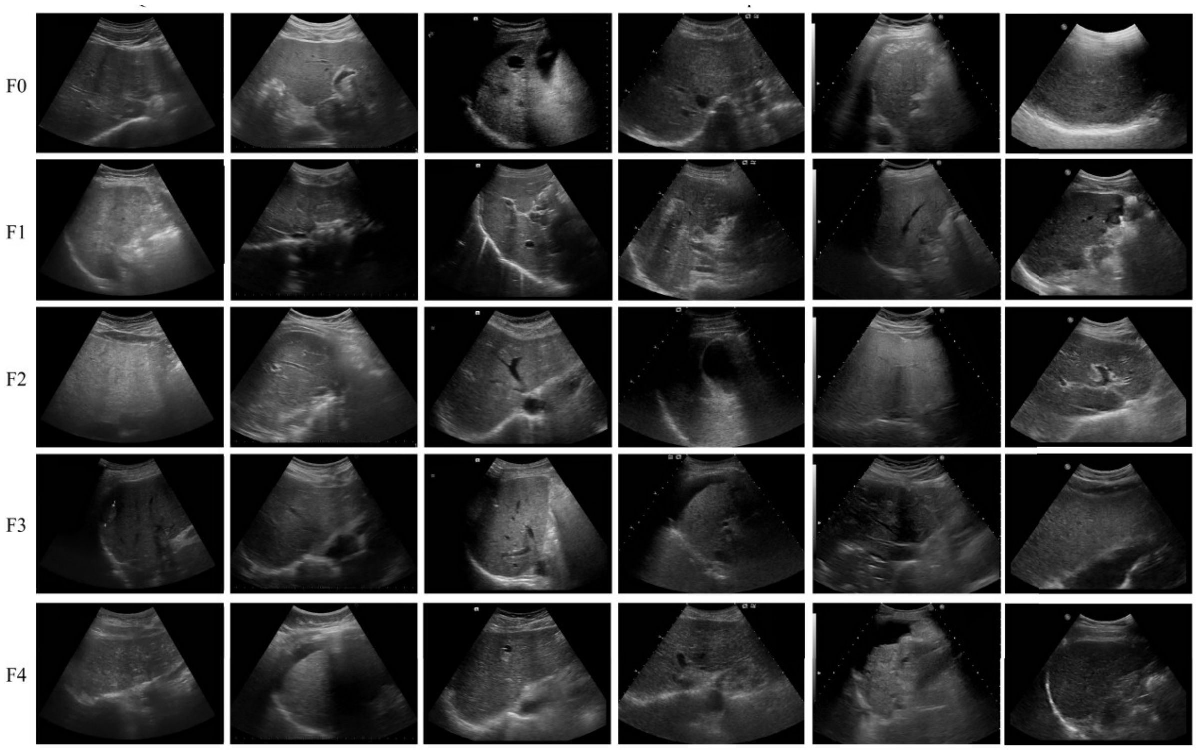
# PhD : Tissue characterization through speckle in ultrasound images with deep learning

Keywords: Tissue characterization, speckle, deep learning, interpretability

Location: CREATIS, Villeurbanne, France

Subject:




Example of US images for different grades of liver fibrosis [6].

**Clinical context.** Histopathology is currently the gold-standard technique for tissue characterization. It is used for a wide range of pathologies (cancer, fibrosis, steatosis, etc.). It can be used to identify and assess the stage of pathology, and thus to initiate appropriate treatment. Nevertheless, it is an invasive, time-consuming and costly method: a tissue sample has to be taken, prepared and observed under a microscope. In addition, the results are highly dependent on the chosen sample, and do not provide an overall view of the affected organ. Tissue characterization through imaging would enable a global assessment of the organ without invasiveness or additional cost. Ultrasound imaging is used for many organs. These images include speckle, which is linked to the scattering of acoustic waves by small structures within the tissue. This speckle therefore carries information on the acoustic properties and, in particular, the microstructure of the imaged tissues.

**Deep learning**, for its part, has revolutionized medical image analysis, helping practitioners to make the right diagnosis. Nevertheless, its lack of interpretability i restrains their diffusion in clinics , despite its remarkable performance and real-time results. It is therefore necessary to propose interpretable methods using clinically relevant elements while limiting the use of biases, for example by using the acoustic properties of the observed tissues on ultrasound images.

**The aim of this thesis** is to propose a deep learning method for tissue characterization from ultrasound data (B-mode image, RF signals) based on the speckle signature. The proposed method will enable tissue to be characterized locally over the entire imaged organ. By relying on the scattering properties of the tissue through speckle, we ensure that our method is based on relevant features. The method will be applied to non-alcoholic fatty liver disease, which affects 25% of the world's population, making it the leading cause of chronic liver pathology.

**More specifically**, we aim to:

- Automatically separate speckle-related information from the rest in ultrasound data using a neural network and latent space disentangling techniques. Generative models (notably VAE and diffusion models) will be used [1, 2].

- Predict a map providing the pathology grade locally with only global information when training the neural network, based on multi-instance and weakly supervised learning techniques.

- Propose an explainable method giving both the areas of interest for the neural network decision using attribution methods and image descriptors (texture, shape, etc.) through prototypes [3, .4, 5].

Experiments will be conducted on synthetic data, ex-vivo pre-clinical data and clinical data [6]. An additional objective will be to :

- Generate realistic ultrasound data for steatosis, in particular from histological images. Computational and deep learning models guided by the physics of wave propagation will be considered [7, 8].

<u>Student profile:</u> Master or engineering student in Computer Sciences/deep leaning/data sciences with strong programming skill in Python (Pytorch is a plus).

Application:

Please send your resume and your master or engineering school transcripts to: :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