Job title	**PhD Scholarship in deep learning for automatic detection and quantification of the disease areas of the myocardium from DE-MRI after myocardial infarction**
Ref	**2018-13-ADVANCES**
Job type (PhD, Post-doc, Engineer)	PhD
Contract duration (months)	36 months
Qualifications (Master degree, PhD…)	Master degree (completed or near completion) or equivalent
Job hours (full time/ part time)	Full time
Employer	UBFC – Université de Franche-Comté
Host Laboratory	FEMTO-ST Institute
URL Host Laboratory	www.femto-st.fr
Address Host Laboratory	15b avenue des Montboucons, 25030 Besançon, France Applicant will be hosted by the AND team of the DISC (Computer Science) department located in Belfort at IUT Belfort-Montbéliard
Job description	**Context:** the PhD grant is associated with ISITE-BFC/Industry project called ADVANCES: "Automatic Detection of Viable myocArdiac segmeNts Considering dEep networkS". The abstract of this project, which is managed by Alain Lalande, is below. **Abstract:** One crucial parameter to evaluate the state of the heart after myocardial infarction (MI) is the viability of the myocardial segment, i.e. if the segment can recover functionally upon revascularization. MRI acquired several minutes after injection of a contrast agent (DE-MRI) is a method of choice to evaluate the extent of MI, and by extension, to assess viable tissues after injury (in conjonction with the thickening of the muscle evaluated from cine-MRI). The main objective of the project ADVANCES is to automatically detect the different relevant areas (the myocardial contours, the infarcted area, the permanent microvascular obstruction area, and the border zone of the myocardial infarction) from a series of short-axis DE-MRI covering the left ventricle and then to make a quantification of the MI, in absolute value (mm3) or percentage of the myocardium. The segmentation and quantification methods would be based on deep learning approaches. For that, an existing expertised database (with manual contouring of the different areas on each image) will be enlarged by new examinations from the University Hospital of Dijon

	in order to be able to train the developed neural networks. Several networks will be designed to produce good segmentations. The border zone that cannot be manually segmented will be processed independently. After validation in a clinical environment of the developed proof of concept, the proposal will be integrated in a software dedicated to the automatic post-processing of cardiac MRI. This integration will be managed by the CASIS startup, localized in Dijon, which participates in the project. Threefold benefits are expected. First, from medical point of view we will provide a product usable in clinical practice that solves a major issue in cardiac MRI. The improved diagnostic will lead to a better patient healthcare outcome. Second, it will further broaden the use of deep learning for computer-aided diagnostic in medical imaging. Third, it will support the development of a local startup. **Main objective and proposed work during the thesis:** The objective of the thesis is to work on the detection of the different disease areas thanks to deep learning approaches. This work represents a major challenge in the project, since it is supposed to provide a clear understanding of the way the myocardial infarction has affected the heart muscle. To solve this issue, we propose to investigate deep learning approaches by focusing successively on the different kinds of disease areas. First a supervised approach will be considered using labeled data. After a state-of-the art on deep learning, more particularly in the context of medical imaging, the first task will be the design of a such neural network able to delineate both infarction and permanent microvascular obstruction (no-reflow) areas. Once a first experimental study has validated the proposal, its extension to the detection of the peri-infarct area will be performed. The second task will thus result in a neural network able to identify the different disease areas. Few adaptations to be able to treat the different kind of areas are expected, but in the worst case a further neural network will have to be built. A precise quantification of the different areas which can be detected will be done in the next task to assess the relevance and the suitability of the overall proposal. Finally, in the last task a three-dimensional representation highlighting the disease areas should be built from the different segmented images. Thanks to this volume rendering a medical doctor will visualize the different disease areas and easily understand how the infarction has affected the cardiac muscle. Having a clear view of the extent of the damage caused by the infarction is crucial to select the most appropriate treatment. To perform the 3D modelling, direct (one-pass) and indirect (two-pass) rendering methods are available. The well-known marching cubes algorithm, which is an indirect method, is a typical choice to be investigated.
Supervisor(s)	• Raphaël Couturier (Professor, UFC; FEMTO-ST/DISC/AND/Belfort) supervisor, raphael.couturier@univ-fcomte.fr • Alain Lalande (Senior Lecturer in Biophysics and Image Processing, UB, Le2i/Dijon) co-supervisor, alain.lalande@u-bourgogne.fr • Michel Salomon (Assistant Professor, UFC; FEMTO-ST/DISC/AND/Belfort) co-supervisor, michel.salomon@univ-fcomte.fr
Candidate profile	We are looking for a highly motivated student with outstanding or excellent Master's degree or equivalent qualification who is interested to work on deep learning for computer-aided diagnostic in medical imaging. Candidates should have experience with neural networks, more particularly deep networks, and computer programming frameworks for deep learning using Python (Google TensorFlow, PyTorch, or Keras). Knowledge in deep learning approaches for semantic segmentation and medical imaging would also be of advantage. Reasonable proficiency in English (written and spoken) is a requirement. Interpersonal skills, dynamism, rigor and teamwork abilities will be appreciated. Candidates can be fluent either in English and/or in French
Keywords	Deep learning, Semantic Segmentation, Medical Imaging, Heart
Application deadline	June 30th, 2018

Starting Job	October 1, 2018
Application	**PhD Position** Please send the following documents (all in one PDF file) by e-mail to job-application@ubfc.fr: 1) For EU candidates: Copy of your national ID card or of your passport page where your photo is printed. For non-EU candidates: Copy of your passport page where your photo is printed. 2) Curriculum Vitae (1 page). 3) Letter of motivation relatively to the position (1 page). 4) Copy of your Master degree and/or Engineer degree if already available. 5) Copy of your final marks and ranks. 6) Coordinates of reference persons (maximum 3, at least your master thesis supervisor): Title, Name, organization, e-mail. If you have questions regarding the application, please contact the supervisors.