University Alliance
Doctoral Training Alliance

DTA3/COFUND Programme Research Project Proforma

Page 1 – General Information

Project Code	NTAB05
Partner University	Nottingham Trent University
Faculty/School/Department/Research Centres	School of Science and Technology Department of Physics and Mathematics
First supervisor Please provide name and weblink	Archontis Giannakidis https://www.ntu.ac.uk/staff-profiles/science-technology/archontis-giannakidis
Second supervisor Please provide name and weblink	Jonathan Crofts https://www.ntu.ac.uk/staff-profiles/science-technology/jonathan-crofts
Third supervisor Please provide name and weblink	Laurence Shaw https://www.ntu.ac.uk/staff-profiles/science-technology/laurence-shaw
Fourth (external) supervisor	Professor Gerry McCann Department of Cardiovascular Sciences University of Leicester Cardiovascular Research Centre Glenfield General Hospital Leicester, LE3 9QP
External/industrial supervisor	-
Which of the supervisors listed above is an early-career-researcher	Laurence Shaw, PhD
Contact details for project for informal applicant queries	archontis.giannakidis@ntu.ac.uk
DTA Programme	DTA Applied Biosciences for Health
Project title	Fully automated quantification of myocardial infarct size using artificial intelligence methods

Co-funded by the Horizon 2020 programme of the European Union

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 801604.

Page 2 – Project Description

Scientific Excellence (500 words)	The world-class research community at NTU tackles society's biggest challenges with research that is transforming the world and saving lives. Research at NTU won the 2015 Queens Anniversary Prize –the highest honour for a UK university– and 90% of NTU's research was classed as world-leading, internationally excellent or internationally recognised in the 2014 Research Excellence Framework. The newly-established British Heart Foundation Cardiovascular Research Centre at Leicester houses state-of-the-art facilities that enable pioneering research on cardiovascular diseases to continue apace. The UK is uniquely placed to address many of the unanswered questions regarding myocardial infarction (MI).
Aim (400 words)	Myocardial infarction (MI) (a.k.a. heart attack) occurs when the supply of blood to the heart muscle is suddenly blocked. In 2013/14 over 80,000 patients were admitted to hospital with an acute MI in England and Wales. Cardiovascular Magnetic Resonance (CMR) can detect and quantify myocardial infarction with unique precision using the late gadolinium enhancement (LGE) technique. This can provide prognostic information independently of ejection fraction. However, CMR is currently dependent on the limited availability of qualified experts, subjective assessment and is too time-consuming for clinical practice. Semi-automated methods (such as Full-Width Half-Maximum, *N*-standard deviations, etc.) also rely on the subjective determination of endocardial/epicardial borders. On top of this, the above classifiers also fail to generalize to datasets acquired by different labs due to acquisition-related variation (imaging protocols, field strength, vendor etc.). The presence of artefacts is another challenge for this type of algorithms.

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	Deep learning (DL) is a rapidly growing trend in general data analysis that currently drives the artificial intelligence (AI) boom. Deep convolutional neural networks (CNNs) are DL architectures and related algorithms which are well-suited for image analysis tasks. The project will use DL to develop tools to enable fast, accurate, automatic 3D model generation of myocardial scar data. Data from 1,958 research patients who have had CMR following MI will be used. The datasets for this project were obtained at 7 leading CMR centres in UK. The tools developed in this project will allow multi-centre comparisons, which in turn, will facilitate the establishment of novel CMR-based biomarkers (infarct size) as predictors of hard clinical points. The proposed algorithms will also allow high-risk sub-groups to be identified for future interventional studies. The research will be driven by the following hypotheses: • CNNs will replicate a cardiac MRI expert manual labelling of myocardial scar tissue in cardiac MRI datasets of MI patients, but be faster and more robust. • AI-based techniques of scar quantification will be more strongly associated with clinical outcomes, compared with the standardised semi-automated techniques. • Deep learning can be used to learn CMR acquisition-invariant representations, so that a (scar tissue) classifier, that has been trained on data from a specific scanner vendor/field strength/protocol, can be applied to data that was differently acquired. • Deep learning architectures can be trained to recognise artefacts in the remote myocardium. Data Science at School of Science and Technology, NTU is equipped with powerful hardware for achieving incredible performance in deep learning problems.

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Strategic Relevance (300 words)	The specific DTA3/COFUND PhD Fellowship project is aligned with the NTU institutional research priorities, as it is directly linked with the NTU Strategic Research Theme 'Health and Wellbeing' and the research areas of strength within the School of Science and Technology.
Interdisciplinarity and fit with DTA3	This project involves inter-disciplinary research (bringing together Data Scientists, Clinicians, MRI physicists etc.) and is therefore collaborative in nature. It aims to produce an independent, highly-employable researcher with expertise and skills in the strategically-important research area of improving healthcare through artificial intelligence techniques. By participating in this project, the researcher will acquire interdisciplinary and inter-sectoral skills and experience and will be ready for industrial employment in the European and UK priority challenge area of healthcare. Excellent PhD student training will be provided, and the researcher, by the end of this programme, will be equipped to solve grand challenges. A main focus of this project will be the communication and translation of applied research. The successful candidate will participate in University Alliance training and networking events and programmes, and in cross-University Alliance research initiatives and opportunities. This project falls in with the DTA Applied Biosciences for Health research area, as it focuses on improving the treatment of cardiovascular diseases and, thus, increasing the likelihood of maintaining healthy aging.
Industrial Relevance (300 words) Detail external placement opportunities or collaborations available as part of the project	Valuable high-quality cross-institutional training opportunities to visit collaborators (Leicester and other sites in EU and USA) will be offered to the PhD student.

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Economic and Societal Impact (300 words)	Progress in CMR acquisition has been made but advanced image processing methods are now needed for translation to real world clinical workflow and practice. This project will develop patient-specific high spatial resolution models of myocardial scar tissue that will be capable of being easily integrated into clinical procedures. The developed tools will be fully-automatic, fast and robust, which coupled with the relatively low cost, will further accelerate their adoption to clinical routine. The proposed research will allow improved identification of high-risk sub-groups or therapy assessment, and thus have NHS cost benefits. This project aims at using artificial neural networks to learn MR acquisition invariant representations that minimize the between scanner variation. This will allow to generalize segmentations techniques to unseen data, which is one of the greatest challenges in biomedical image analysis at the moment. The new tools may facilitate new image biomarker discovery beyond our existing and simplistic conventional clinical measures, allowing to fully capitalise on the wealth of information still lying hidden within the exponentially rising store of CMR clinical data.

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Page 3 – Admission Requirements

Specific Admission Requirements Detail any subject specific degree qualifications or disciplines, relevant skills, experience	Entrants must have a Bachelors Honours degree with a Upper Second or First Class grade in Data Science, Applied Mathematics, Computer Science, Mathematics, Electrical Engineering, or Biomedical Engineering. Entrants with an Lower Second Class grade in their Bachelors Honours degree must also have a postgraduate Masters Degree at Merit or above. Experience with Deep Learning frameworks and Python programming language is desirable and would be considered as an advantage.
Minimum IELTS score	You will need an overall IELTS (International English Language Testing System) score of 6.5 with minimum sub-scores of 6.0 in all component sections (writing, reading, listening and speaking).

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