Trusting AI with Life

Highlights
- Artificial Intelligence for Cardiovascular Imaging
- Quantifiable AI systems
- Fast and real-time AI with error correction functionality

Overview
Artificial Intelligence (AI) systems have risen dramatically from being the subject of niche academic and practical interests to a commonly accepted and widely-spread facet of modern life. Industrial giants such as Google, Amazon, IBM, and Microsoft offer a broad range of AI-based services, including intelligent image and sound processing and recognition.

Deep Learning and related computational technologies are currently perceived as state-of-the-art tools for producing various AI systems. In visual recognition tasks, these systems deliver unprecedented accuracy at reasonable computational costs. Despite these advances, several fundamental challenges hinder further progress of these technologies.

All data-driven AI systems make mistakes, regardless of how well an AI system is trained. Some examples of these have already received global public attention. Mistakes may arise due to uncertainty in empirical data, data misrepresentation, and imprecise or inaccurate training. Conventional approaches to reducing spurious errors include altering training data and improving design procedures, transfer learning, and privileged learning. These approaches invoke extensive training procedures. The training itself, whilst eradicating some errors, may introduce new errors by the very nature of the steps involved (e.g. randomized sampling of mini-batches, randomized training sets etc).

In this project, we will aim at resolving this fundamental challenge. We will strive to develop a new-generation family of AI systems that are capable of learning on-the-fly and without the need for expensive and deep re-training.

Our main application will be detection and segmentation of pathologies in cardiac MRI images. Several commercial products for cardiac MRI annotations have been developed to date. They drastically improve efficiency of screening. And as such constitute an excellent proof-of-concept of AI in this area. The project will build on these developments.
and will create a radically new framework and a versatile AI system capable of continuous learning, under a light-touch guidance and supervision of a medical expert/clinician.

The project will be carried out at the Departments of Mathematics and Cardiovascular Sciences and will benefit from existing broader interdisciplinary environments and AI expertise in imaging and signal processing at the Departments of Informatics and Engineering in the College of Science and Engineering.

Methodology

Main methodological ingredients of the project are: state-of-the-art deep learning convolutional neural networks, numerical methods such as stochastic gradient (needed to train the core AI), stochastic separation theorems (stated and proved by the proposer jointly with A.N. Gorban), and algorithms for AI correction based on these theorems.

In addition to these, the project will rely on collections of annotated data. These collections have already been created by Prof. Gerry McCann and his team.

Theoretical core of the project will involve extending stochastic separation theorems to non i.i.d. settings and to kernel classifiers. This will allow to generalize the theory to a broad class of functions with universal approximation capabilities. We will also aim at establishing links to Vapnik-Chervonenkis dimension and investigate generalization capabilities of these systems. Practical focus will be on segmentation and automated annotation of cardiac MRI data.

Further Reading


Funding

This research project is one of a number of projects in the Department. It is in competition for funding with one or more of these projects. Usually the project which receives the best applicant will be awarded the funding.

Home/EU Applicants

This project is eligible for a fully funded College of Science and Engineering studentship which includes:

- A full UK/EU fee waiver for 3.5 years
- An annual tax free stipend of £14,777 (2018/19)
- Research Training Support Grant (RTSG)
International Applicants
This project is eligible for a fully funded College of Science and Engineering studentship which includes:

- A full international fee waiver for 3.5 years
- Research Training Support Grant (RTSG)

Application Instructions
The online application and supporting documents are due by **Monday 21st January 2019**.

Any applications submitted after the deadline will not be accepted for the studentship scheme.

References should arrive no later than **Monday 28th January 2019**.

Applicants are advised to apply well in advance of the deadline, so that we can let you know if anything is missing from your application.

Required Materials
1. Online application form
2. Two academic references
3. Transcripts
4. Degree certificate/s (if awarded)
5. Curriculum Vitae
6. CSE Studentship Form
7. English language qualification

Applications which are not complete by the deadline will not be considered for the studentship scheme. It is the responsibility of the applicant to ensure the application form and documents are received by the relevant deadlines.

All applications must be submitted online, along with the supporting documents as per the instructions on the website.

Please ensure that all email addresses, for yourself and your referees, are correct on the application form.

For more information, please visit our website at:
[https://www2.le.ac.uk/colleges/scieng/research/postgraduate-opportunities/cse-2019/instructions](https://www2.le.ac.uk/colleges/scieng/research/postgraduate-opportunities/cse-2019/instructions)