

MR(A)I

*Combining Magnetic Resonance (MR)
and Artificial Intelligence (AI)*



REPORT

1. Background

The year, 2019, is the 25th year of the British Chapter of the International Society for Magnetic Resonance in Medicine (BC-ISMIRM). There have been many developments in magnetic resonance (MR) over these 25 years and MRI is now frequently used to non-invasively aid diagnosis, and monitor disease and therapies in the clinic, and in experimental basic biomedical research, facilitating (back)translation between basic biomedical research and the clinic. Advances continue to be made in the field of MR, more recently, by employing artificial intelligence (AI) methods, e.g., for automated analyzes of large datasets. Thus, MR(A)I, a one-



**Dr
Po-Wah So**

day satellite symposium to the MIDL (Medical Imaging-Deep Learning) conference, affiliated to Medical Image Computing and Computer Assisted Intervention (MICCAI), was organized in celebration of the 25th anniversary of the BC-ISMIRM by Dr Po-Wah So (KCL) and Prof Julia Schnabel (KCL), bringing together MR and AI communities.



**Prof
Julia Schnabel**

2. Date and Venue

MR(A)I was held on 11th July 2019 at the Institute of Education, Central London.

3. Sponsorship

The MR(A)I symposium was made possible by the generous sponsorship from the BC-ISMIRM, the Medical Imaging Analysis Network (MeDIAN), the Wellcome Trust-EPSCRC Centre for Medical Engineering (CME) and the EPSCRC Smart Medical Imaging Centre for Doctoral Training (CDT).



4. Programme

The symposium had sessions on cardiac (chaired by Prof Julia Schnabel, KCL), cancer (chaired by Prof Geoff Parker, UCL) and neurology (chaired by Prof Steve Williams, KCL) and comprised two plenaries, 9 invited talks and 6 proffered oral presentations.

The sessions were followed by a practical workshop.

4.1 Plenaries

Prof Polina Golland (MIT) gave an excellent plenary on state-of-the-art artificial intelligence (AI) methods to exploit the abundance of clinical, but sparsely sampled, imaging data to provide important/useful anatomical information for neurodegeneration studies, including white matter disease in stroke patients.



Prof Golland was presented with a memento of the event by Dr So.



Dr Summers was presented with a memento of the event by Prof Parker.

The application of AI in radiology has been ongoing for decades but has had a renaissance in recent times, Dr Ron Summers (NIH) spoke on the latest iteration of AI in computer-aided disease detection and diagnosis.

4.2 Invited Talks

Many of the invited talks were given by members of the CME and also are supervisors on the CDT.

Dr Claudia Prieto (KCL) began the cardiac session, explaining how novel machine-learning based reconstruction approaches can be used to accelerate acquisition of motion-compensated 3D whole-heart MRI. Prof Alistair Young (KCL) then showed statistical shape analyses of the heart can aid quantification of the subtle heart ventricular modifications associated with various cardiovascular risk factors. The potential of machine learning with imaging data to provide

insights into heart disease and predict patient outcomes was discussed by Dr Declan O'Regan (Imperial College London). He also showed how digital heart models can be combined with genetic and environmental data to accelerate new therapeutics. The last invited talk of the cardiac session was from Prof Jo Hajnal (KCL) showing state-of-the-art MRI of the fetal heart *in utero*, detailing the opportunities but the numerous technical challenges for AI.

The first invited talk from the cancer session was given by Dr Isabel Dregely (KCL), showing how novel MRI acquisitions for multi-dimensional tissue microstructure and image analysis can be combined to reveal cancer signatures to stratify patients and guide treatment. Prof Simon Samuel-Walker (newly promoted to Chair, UCL) then demonstrated deep learning applications to biophysical simulations of tumours to improve MRI acquisitions.

'How old is your brain?' was the question posed and discussed by Dr James Cole (KCL). He showed his brain-ageing biomarker, derived from machine learning analysis of brain MRI data, were associated with cognitive decline and increased risk of dementia. Dr Emma Robinson (KCL) then discussed deep learning approaches to increase accuracy of predictive models for cortical structure. The final invited lecture of the neurology session was given by Prof Danny Alexander (UCL), focusing on the progress and potential of AI to predict high quality images from lesser quality images, and modeling of disease progression from longitudinal imaging data sets to understand, stratify and predict brain disease.

4.3 Proffered talks

The first proffered talk was from Cian Scannell (KCL) in the cardiac session, who showed deep learning approaches to quantify myocardial perfusion from MRI data. In the cancer session, Dr Oliver Gurney-Champion (Institute of Cancer Research) spoke first, demonstrating how AI methods can be used to fit the intravoxel incoherent motion model to diffusion-weighted MRI. In the same session, Jonathan Shapey (UCL) illustrated how AI methods can be used to automatically segment vestibular Schwannoma from contrast enhanced MRI data, whereas Dadi Zhao (Birmingham) applied waveletomics to *in vivo* magnetic resonance spectra to identify pediatric brain tumours.

The first of the two proffered talks in the neurology session was given by Yassine T. Benchekroun (KCL), who demonstrated how deep neural networks of neonatal structural connectome can be used to predict age at scanning and at birth. The final proffered talk was given by Jack Highton (UCL), showing Support Vector Machine analysis of arterial spin labelling data applied to young onset Alzheimer's Disease

4.4 Tutorial/Workshop

An introduction to machine learning tutorial was led by Dr Esther Puyol Anton (KCL), with assistance from others, especially colleagues at KCL. Material for the workshop was made available on https://github.com/estherpuyol/MRAI_workshop, requiring Python and ran from Jupyter Notebooks via installed Anaconda/Miniconda or Google Colaboratory. Tutorial slides could also be viewed online, https://nbviewer.jupyter.org/github/estherpuyol/MRAI_workshop.



Dr Puyol Anton was presented with a memento of the event by Dr So.

5. Attendees

There were 140 registered delegates mainly from London, from both the MRI and AI communities, particularly new entrants into these research areas.

6. “Helpers”

Thanks to Dr Harry G. Parkes (ICR), and Dr Matthew Grech-Sollars and his group (ICL), in assisting symposium organizers, Dr Po-Wah So (KCL) and Prof Julia Schnabel (KCL).



Special thanks to Dr Esther Puyol Anton (KCL) for developing and providing tutorial materials and leading the tutorial, and also those that helped with the tutorial.

7. Feedback

A book was circulated at the event for feedback for attendees to provide their thoughts on the symposium, anonymized quoted included:

“Very interesting symposium that covered many aspects of machine learning and thank you!”

“The consistency of the cheesecake was delicious, everything else has been great! Very interesting talks and smoothly organized.”

“I was very interested in how people were using AI in medical imaging. The symposium gave a great taster! Thank you!”

“Thanks for the organization. I believe the event offers a good overview of the ongoing research on medical image analysis for different challenges. I particularly appreciate the tutorial to have hands-on experience.”

“Interesting programme. I’d like to have longer hands-on time for the workshop.”

“Thank you for organizing this great meeting. I specialize in MRI, AI/deep learning is a new field for me, it would be great if you could have more of a beginners friendly start to the meeting before we dive into the “hardcore” elements.”

“Very nice programme, I hope it happens again next year!”

In summary, the symposium was very well received, including the catering on the day. In the future, event(s) may be organized to include basic AI lectures and more clinical perspectives as well as increasing the time available for the tutorial.

8. Impact

The symposium brought together MR and AI researchers, facilitating cross-fertilization of ideas, and illustrated different AI approaches for various biomedical applications. Following the symposium, individuals, often in groups, have continued to utilize tutorial materials to learn how AI methods can be applied to imaging data.