SINAPSE

2019 Annual Report summary

This report summarises activities and achievements from the fifth year (January-December 2019) of the current funding period of SINAPSE – Scottish Imaging Network: A Platform for Scientific Excellence.

2019 was an eventful year for collaborative efforts that secured major funding for harnessing the power of medical imaging "big data" in Scotland. The **iCAIRD** project launched a Scottish centre of excellence in medical imaging and digital pathology with artificial intelligence (AI), backed by a £10M Industrial Strategy Challenge Fund investment from Innovate UK, and the **PICTURES** project leveraged £4.4M in funding from an MRC Industry Collaboration Agreement to begin enabling research access to routinely collected and linked Scottish medical imaging data. Objectives for both initiatives were presented at the 11th SINAPSE Annual Scientific Meeting, ensuring involvement across Scotland's medical imaging research community.

Enhanced people capacity

The SINAPSE network has helped to make Scotland a more attractive landscape for imaging researchers to work, reflected in SINAPSE-related posts created and outstanding talent recruited to new appointments across partner Universities this year. The number of registered SINAPSE members further increased from 657 at the start of the year to 767 at the year's end.

In December, a welcome event was held in Perth for 20 first-year PhD students beginning their imaging research projects, featuring scientific communication skill-building activities and presentations from recent PhD graduates on their experiences of involvement with SINAPSE during doctoral training.

A SINAPSE welcome event in December 2019 brought together PhD students undertaking imaging research training across Scotland

Improved facilities and infrastructure

Improvements to SINAPSE imaging facilities this year included two Siemens Symbia 16-slice Intivo Bold SPECT-CT cameras installed in Nuclear Medicine at Glasgow, a new cyclotron at Aberdeen, a GE Typhoon autoradiography system and Vevo 3100 ultrasound scanner for preclinical imaging at Edinburgh, and a TriSPIM system, contrast enhanced digital breast mammography unit, and conjunctival image analysis equipment at Dundee. Additionally, EEG equipment at Stirling was upgraded, there was a D-stream upgrade of the Phillips 3T MRI at Aberdeen and a CE marked upgrade to the Siemens 7T MRI at Glasgow, and the 7T preclinical MRI at Edinburgh was upgraded to 9.4T.

SINAPSE again participated in research networks and knowledge exchange partnerships this year on national and international levels. We joined SUPA and SULSA in a cross-pool initiative to develop and expand academic-industrial collaborations in Scotland around optical imaging, created a new SINAPSE topic group for neuro-oncology imaging, and integrated the Scottish Ultrasound Group into our longstanding topic group for ultrasound. Our ongoing diffusion MRI data analysis collaboration with researchers in Taiwan led to an abstract presented at the 2019 Organisation for Human Brain Mapping meeting. Separately, a SINAPSE molecular imaging expert gave an invited presentation at the National Taiwan University PET Centre on research from Scotland to develop novel radiotracers. Other collaborative projects progressed this year with international partners in India (NIHR Global Health Research programme with Dundee and GCRF project with Aberdeen), Germany (mobile brain imaging work with Stirling and 7T MRI technical development work with Glasgow), and Uruguay (where former SINAPSE PhD student Dr Victoria Gradin is establishing the country's first fMRI centre), among others.

Infrastructure for teaching and training in imaging research also had further development this year, with two successful Scottish bids for EPSRC-funded CDTs in which SINAPSE is a project partner: a newly funded Centre for Doctoral Training in Future Ultrasonic Engineering (FUSE), and renewal funding for the Centre for Doctoral Training in Applied Photonics having a new focus on Imaging, Sensing, and Analysis. In addition, a new BSc Honours Course on Anatomical Imaging Techniques was introduced at Glasgow, a "Researchers' toolkit" for the Dementias Platform UK

PET-MR Partnership was developed at Edinburgh, and SINAPSE hosted a student-organised workshop, with industry partner NVIDIA, to provide hands-on training in deep learning for medical image analysis.

The SINAPSE Image Analysis topic group organized a hands-on training session led by NVIDIA in June 2019, to architect and train a convolutional neural network for medical image classification

Further funding secured

Research income brought to Scotland by SINAPSE researchers this year includes funding from UKRI (such as BBSRC support for preclinical imaging research at Edinburgh and 7T clinical MRI research at Glasgow, over £11M from EPSRC to fund two imaging-related Scottish CDTs, £4.4M from MRC for the PICTURES project and £10M from Innovate UK for the iCAIRD project), from industry partners (£5M additional iCAIRD funding from Canon Medical Research Europe and Philips), from the Scottish Government (including a CSO Translational Clinical Studies Research grant at Edinburgh), from the UK Government (£7M to Dundee from the NIHR Global Health Research programme), and from charities (awards from the British Heart Foundation—including a £3M Research Excellence Award to Edinburgh, Wellcome Trust, Alzheimer's Society, Stroke Association, The Brain Tumour Charity, and several smaller trusts).

SINAPSE researchers also successfully secured funding from international sources this year, including the €6.7M EU Innovative Medicines Initiative CARDIATEAM project (£0.5M to Dundee), and £400K to Edinburgh from US-based Alzheimer's Drug Discovery Foundation.

New products and inventions created

A range of imaging research applications benefitted from new products and inventions created by SINAPSE researchers this year. A bespoke RF head coil was engineered at Glasgow for improved 7T MRI image acquisition, and a Brain Imaging Data Structure (BIDS) standard for EEG data was developed at Edinburgh, to improve data sharing practices. International Patent Applications were produced for 'Network methods for neurodegenerative disorders' from Aberdeen and for 'TSPO Binders' from a radiochemistry collaboration between Glasgow and Edinburgh supported by SINAPSE. A free virtual reality app for paediatric MRI was developed in NHS Highland, with data collected from its clinical implementation showing effectiveness in reducing anxiety and successfully preparing children for awake MRI without general anaesthetic.

Engagement with external stakeholders

Knowledge transfer from SINAPSE to wider audiences this year took the form of public events such as Bright Club in Glasgow, Pint of Science in Glasgow and Stirling, talks as part of the Edinburgh International Science Festival, iCAIRD launch events in Aberdeen and Glasgow as part of DataFest, participation in a Digital Health Product Forge event in Edinburgh, and a keynote presentation on neuroimaging research from SINAPSE Lead Scientist Dr Kristin Flegal at the CDT in Applied Photonics 2019 Annual Conference.

SINAPSE also was frequently engaged with industry partners and other Scottish networks. Exhibitors at the 2019 SINAPSE Annual Scientific Meeting were Bartec, Canon Medical, Holoxica, Kheiron Medical, NHS Research Scotland (NRS), NRS Mental Health Network, and Southern Scientific. SINAPSE and the Scottish Dementia Research Consortium co-organised a meeting on 'Neuroimaging in diseases that cause dementia' in August, with invited speakers from the UK Biobank Imaging Study and the EU Innovative Medicines Initiative EPAD project. Partnerships with researchers in physics and life sciences domains were strengthened through the Optical Imaging Crucible workshop organised with SUPA and SULSA. Outcomes from this cross-pool initiative include proof-of-principle funding awarded to stimulate research collaborations between academia and UK-based industry partners, and commercialisation opportunities for innovative Scottish optical imaging technologies identified by the project's 'Innovator-in-Residence'.

Relationship building beyond the imaging research community this year included SINAPSE participation in events such as an NHS Health & Social Care Innovation Network meeting in Aberdeen and a 'Women in Science' panel discussion at Scottish Parliament as part of Festival of Politics 2019. A BEIS Science and

Innovation Audit Report on Precision Medicine in Scotland, released by the UK Government in March, prominently mentioned imaging capabilities as a key asset in the Scottish 'Precision Medicine ecosystem' and directly acknowledged the value of SINAPSE in coordinating imaging collaborations across Scotland.

The Scottish Funding Council commissioned an independent review of the research pooling initiative this year, which involved consultation with individuals and organisations with knowledge of research pooling drawn from a variety of routes. A number of external stakeholders registered supportive commentary on engagement with SINAPSE, citing examples of funders and potential collaborators that found assurance in the demonstrated success of existing partnerships and existing environment of collaborative working in the SINAPSE network. Furthermore, as medical imaging research is cross-disciplinary by nature, SINAPSE can be seen to exemplify the review's recommendation for Scotland to secure "the cross-disciplinary capacity needed to compete effectively with emerging powerhouses in the modern research landscape."

Other significant achievements

Scottish Enterprise consulted with SINAPSE on plans for a series of industry-facing thought leadership seminars that were held in Japan in October, centered on medical imaging and AI as a tool for practitioner decision support. SINAPSE members invited to speak in these seminars as representatives from Scotland included leaders from the recently funded iCAIRD and PICTURES projects.

SINAPSE researchers visited Japan in October 2019 to speak about Scotland's world-leading work on medical imaging and AI, representing collaborative work across sectors and institutions.

Wider recognition for the work of SINAPSE members this year included former SINAPSE PhD student Dr Adriana Tavares (Edinburgh) being elected as co-chair of a new 'Standardization of Small Animal Imaging' study group in the European Society for Molecular Imaging, Prof Edwin van Beek (Edinburgh) being appointed Senior Fellow of the International Society for Magnetic Resonance in Medicine and Board Chairman for the International Workshop on Pulmonary Functional Imaging, Prof Sotirios Tsaftaris (Edinburgh) being awarded a Royal Academy of Engineering Senior Research Fellowship in Healthcare AI, and the EPSRC-funded Sonopill project (Glasgow) receiving a Humanitarian Award as part of the 2019 Global Engineering Impact Awards.

Based at Glasgow, SINAPSE Lead Scientist Dr Kristin Flegal had a publication in the journal NeuroImage reporting results from the first study of adaptivity-related effects on fMRI measures in cognitive training, and took up duties as co-supervisor on a PhD project using behavioural and fMRI methods for intervention evaluation in individuals with acquired brain injury and secondary supervisor on a PhD project including analysis of UK Biobank brain MRI data.

Learning and development

SINAPSE ensures access to high quality training and support for students and early career researchers. The 2019 SINAPSE Annual Scientific Meeting held at Dundee in June included presentations on the pan-Scotland iCAIRD and PICTURES projects, a special plenary session on the topic of 'AI in Medical Imaging' with three keynote speakers addressing academic, clinical, and industrial perspectives, and a wide array of proffered talks and poster presentations. The meeting this year had its best turnout yet, both in terms of abstracts submitted by SINAPSE members (74) and delegates in attendance (nearly 200).

SINAPSE also was proud to help create value for the Scottish economy, as well as enhance training and dissemination opportunities for our early career researchers, through involvement in high-profile scientific meetings hosted locally. Such events this year included the 2019 European Molecular Imaging Meeting and the 2019 IEEE International Ultrasonics Symposium, both held in Glasgow.

In September, a delegation of high school science teachers from across Scotland participating in the UK's STEM Learning programme Grand Challenge Teacher Placements visited the Imaging Center of Excellence (ICE) in Glasgow, where they met SINAPSE researchers

and learned about career opportunities involving medical imaging to inform discussions with their pupils.

PECRE funding awarded this year for international research exchanges supported valuable training and development opportunities for young investigators in the SINAPSE network. The exchange visits established and strengthened institutional collaborations between SINAPSE partner Universities and research centres in Canada and the USA, and outcomes of the exchanges were shared with the wider Scottish imaging research community (including industry partners) at the 2019 SINAPSE Annual Scientific Meeting.

Inspired by positive outcomes from the PECRE scheme year upon year, contemplating how similar initiatives *within* Scotland could continue to strengthen connections across the Scottish imaging research community led to the creation of Within-SINAPSE exchanges this year. Travel bursaries are now available for early career researchers to visit another SINAPSE-affiliated site in order to obtain imaging-related training and skills development not available locally. This new funding scheme has already supported four exchange visits within Scotland that provide beneficial training experience as well as directly increasing collaboration between SINAPSE partner institutions.

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