SUCCESS STORY | SYDNEY NEUROIMAGING ANALYSIS CENTRE

SYDNEY NEUROIMAGING ANALYSIS CENTRE TRANSFORMS CLINICAL NEUROIMAGING WITH AI

Hundreds of millions of people across the globe are affected by neurological disorders. Advances in neuroimaging are a foundation for furthering our understanding of these disorders, developing new diagnostics, and improving patient care through the investigation of novel treatments.

CUSTOMER PROFILE

ORGANIZATION

The Sydney Neuroimaging Analysis Centre (SNAC) is a state-of-the-art facility that uniquely integrates neuro-imaging research with a dedicated, regulatory-compliant commercial image analysis facility. Located within the University of Sydney's Brain and Mind Centre, SNAC uses cutting edge technologies to provide novel insights into neurological disorders; and to develop biomarkers for disease diagnosis and monitoring.

INDUSTRY

Healthcare, Higher Education

LOCATION

SNAC, Brain and Mind Centre
94 Mallett Street, Camperdown,
NSW 2050,
Australia
Tel: +612 8005 6325
Email: info@snac.com.au

WEBSITE

snac.com.au
Linkedin

Embedded within the University of Sydney's Brain and Mind Centre is the Sydney Neuroimaging Analysis Centre (SNAC), a state-of-the-art facility that uniquely integrates neuroimaging research with a dedicated, regulatory-compliant commercial image analysis facility.

The medical imaging analysis company focuses on the development of novel biomarkers for diagnosis and monitoring of brain diseases, and the provision of central MRI analysis services to the pharmaceutical industry.

Backed by a US$1.67 million research grant from the Australian government with matched cash and in-kind funding from project participants, it is collaborating closely with the Brain and Mind Centre's Computational Neuroscience Team and industry partners such as I-MED Radiology Network (I-MED) to transform clinical neuroimaging with artificial intelligence (AI).

SNAC provides neuroimaging expertise, imaging biomarker development and translation to clinical trials for the pharmaceutical industry. Phase 2 and 3 clinical trials may entail reading and analysing patients' images that have been securely transferred to SNAC's web portal from up to 50 clinical sites from around the world.

PRODUCTS

> Deep Learning Framework
- PyTorch
- TensorFlow

> Software / SDK
- NVIDIA Clara Suite of medical imaging tools
- CUDA, cuDNN and TensorRT inference software

> Hardware
- NVIDIA DGX-1
- NVIDIA DGX Station
- NVIDIA V100 Tensor Core GPUs
- NVIDIA GeForce RTX 2080 Ti GPUs

"The provision of reproducible, quantitative information from MRI scans is SNAC's forte. We develop a range of structural and advanced imaging biomarkers for deployment in clinical trials and ultimately in clinical practice", said Michael Barnett, Professor of Neurology at the Brain and Mind Centre and Consulting Research Director, SNAC.

CHALLENGE - MASSIVE AMOUNT OF IMAGING DATA

Increasingly vast quantities of imaging data presents a major challenge for clinical radiologists: it is beyond human capacity to manually review thousands of images per scan in an efficient manner, and some information contained in these datasets is not amenable to visual interpretation. There is also an increasing demand for quantitative imaging metrics, which may require accurate image segmentation. Achieving these segmentations manually is inefficient, inaccurate and impacts productivity.

The rapid identification of critical abnormalities is also a difficult task for radiologists, who often review up to 100 scans in a day, only 1-2 of which will show abnormalities requiring urgent clinical attention.

One answer to these problems is to employ more radiologists, an expensive solution that is also limited by an increasing need for subspecialty training.

"An ever increasing volume of data is overwhelming clinicians. We are addressing this through our work – ultimately with the goal of facilitating more rapid diagnosis, more accurate diagnosis, and the capacity to provide quantitative imaging data in a timely fashion for a range of diseases," said Barnett. "We have traditionally relied completely on (well-trained) human labour and standard neuroimaging analysis (non-AI) tools to guide decision making in neuroradiology. Time, cost, efficiency, and accuracy are all compromised by conventional methods."

> "These algorithms, when deployed in clinical settings, will enhance patient safety, bring critical abnormalities to the attention of clinicians in a timely manner, and improve diagnostic yield and specificity."

Michael Barnett
Professor of Neurology,
Brain and Mind Centre
University of Sydney
Sydney, Australia

To solve this problem and improve its research workflow, SNAC developed an AI-based solution using three NVIDIA servers – including a DGX-1 and a DGX Station, and also with a workstation clusters running on several NVIDIA RTX 2080 Ti and GTX 1080 graphic cards.

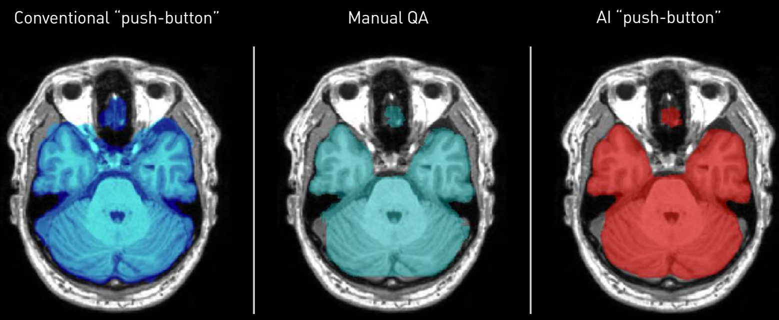
On top of software such as CUDA, cuDNN and TensorRT, the NVIDIA Clara collection of healthcare specific developer tools built on NVIDIA's compute platform was used for deployment and training.

Thanks to its collaborations with Brain and Mind Centre and I-MED Radiology, the centre had access to a vast neuroimaging database and the expertise of neuroradiologists, neurologists and imaging analysts, who provide gold labelling of the dataset.

A team of skilled AI scientists at SNAC have developed algorithms based on deep neural networks for classification/segmentation problems in medical images, while a group of system engineers manage data flow to inject inferencing systems directly into routine clinical and research workflows. Also involved in the project are scientists and medical image IT specialists from both the University of Sydney and I-MED Radiology teams.

"Currently, we have four AI scientists, three neuroimaging scientists and several research students working on a variety of projects. We allocate hardware/compute resources according to analysis requirements," said Dr Chenyu Wang, SNAC's Director of Operations and Senior Lecturer at the Brain and Mind Centre.

The NVIDIA DGX Station handles most of the tasks related to quality control in the middle of the training. With both user and desktop interfaces, it is very convenient to use for visualizing results and data. TensorRT and NVIDIA Clara SDK are used for inferencing.



A deep CNN with 3D encoder - decoder architecture for brain extraction

Brain Extraction is a critical preprocessing step in many neuroimaging applications including volumetric analysis and imaging coregistration. The heterogeneity of imaging acquisitions often challenges conventional automated brain extraction tools and requires extensive manual QA for the accurate exclusion of sinuses, orbit and optic nerves. Fully automated, AI assisted brain extraction provides an ideal solution to this task and achieves higher reproducibility and accuracy than manual QA.

"NVIDIA DGXs and GPUs are the core of our AI platform and are transforming the delivery of clinical and research radiology."

Tim Wang

PhD, Director of Operations at SNAC

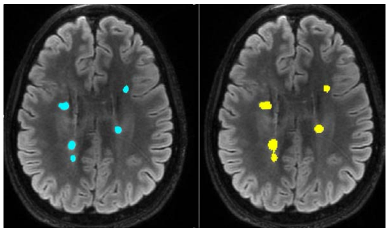
SOLUTION - DRAMATIC RESULTS

Leveraging AI has yielded dramatic results. Productivity for segmentation tasks has been increased by 20x. For example, whole brain 'extraction' from MRI images, which would previously take 20 to 30 minutes including manual cleaning of every image, now takes just two to three minutes with more consistent results that's up to 15x faster and is fully automated!

SNAC uses three-dimensional nifti data, a standard data format for neuroimaging analysis. For training purposes for the brain extraction algorithm, more than 2,000 subjects in nifti format were used. Current SNAC algorithms for the detection of critical brain abnormalities in computed tomography images have been trained on more than 15,000 images.

"These algorithms, when deployed in clinical settings, will enhance patient safety, bring critical abnormalities to the attention of clinicians in a timely manner, and improve diagnostic yield and specificity," said Barnett

Another example is the segmentation of white matter lesions from multiple sclerosis brain scans. Previously, image analysts extracting important lesion metrics for MS clinical trials would manually segment lesions on each of approximately brain 200 slices per scan - a process that could take several hours in patients with a heavy disease burden. With the new



MS lesion segmentation

Left :
Manual lesion segmentation.

Right :
Fully automated lesion segmentation.

AI system, this process takes only three seconds and without human intervention / labour, even in cases with up to 300 brain lesions.

"We frequently refer to manual annotation as the gold standard. But AI can perform more consistently than a human being, and keeps working after 5pm!

We have embedded this tool in our research pipelines - the next step is to push this into clinical practice, and have radiologists use these tools in real time to improve their productivity and add value for clinicians seeking reliable, quantitative disease metrics", said Barnett.

IMPACT - STRIDING AHEAD

SNAC is now working on an AI-driven application to accurately identify the differences between the baseline scan and follow up scans in patients with multiple sclerosis.

During a patient's routine annual review, the radiologist must meticulously compare the current and previous year's imaging to detect new, enlarging or active MS lesions. Changes on imaging, even when a patient is clinically well, can profoundly influence treatment decisions. With more than 200 slices in a single 3D acquisition, this comparison is tedious and time consuming.

A pipeline that automatically highlights and categorises differences between the scans for the reporting radiologist will dramatically improve productivity and accuracy.

"NVIDIA DGXs and GPUs are the core of our AI platform and are transforming the delivery of clinical and research radiology," said Wang.