Researchers at two universities sought to enhance magnetic resonance imaging (MRI) scan analysis, to enable physicians to use huge amounts of data generated effectively while keeping scan times short.

**Transformation**

Washington University St. Louis and Vanderbilt University deployed IBM® solutions to accelerate creation and deployment of deep learning models that fill in the gaps in incomplete MRI brain scans.

**Business benefits:**
- 20x faster training of deep learning models than traditional PC environments
- Increases speed and accuracy of diagnosis, enhancing treatments and patient outcomes
- Lowers barriers to deep learning for physicians, addressing the big data skills gap

**Washington University in St. Louis and Vanderbilt University**

**Harnessing AI to transform diagnosis and treatment of brain cancer**

“Combined, our research and IBM technology brings cutting-edge deep learning capabilities within reach of physicians so that they can give patients better care.”

Yong Wang, PhD
Assistant Professor of Gynecology and Obstetrics, Radiology and Biomedical Engineering
Washington University St. Louis

Washington University in St. Louis is a private research university with more than 15,000 students from more than 100 countries.

Located in Nashville, TN, Vanderbilt University is a private research university offering undergraduate and graduate programs in the liberal arts and sciences, engineering, music, education and human development.
Each year, researchers at Washington University in St. Louis undertake more than 3,000 projects in areas including medical, environmental and energy, innovation and entrepreneurial, and plant science research. The Washington University School of Medicine in St. Louis is dedicated to advancing human health worldwide, and has contributed to many breakthroughs in science and medicine over the last century.

In 2017, Vanderbilt University received USD 230 million in sponsored research and project awards. The Vanderbilt University Institute of Imaging Science is a trans-institutional initiative within Vanderbilt University serving physicians, scientists, students and corporate affiliates.

**Pushing the boundaries of traditional medicine**

With medical imaging tools, physicians can see inside patients’ bodies without lifting a scalpel. By enabling clinicians to identify evidence of disease and injury non-invasively, it’s no surprise that advances in this field have had a revolutionary impact on the ability to diagnose and treat patients.

Recent gains in computing power have made it possible to capture more detailed medical images – but making sense of the growing volumes of data is a challenge. Applying artificial intelligence (AI) capabilities, and in particular, deep learning, could hold the potential to overcome these obstacles. However, deep learning is an area where skills are in short supply in every industry.

Also, capturing more detailed images often involves longer scanning times. This can be uncomfortable for patients, ties up hospital resources and slows down the delivery of healthcare. To get around this, clinical engineers have developed techniques to minimize scanning times by generating under-sampled, or incomplete, images. The trade-off is that these images can include distortions that prevent accurate diagnoses.

Researchers at the Washington University St. Louis School of Medicine and the Vanderbilt University Institute of Imaging Science wanted to bring high-performance analytics capabilities to the medical imaging fields, with low barriers to entry for physicians with little to no previous experience in this area.

Yong Wang, PhD, Assistant Professor of Gynecology and Obstetrics, Radiology and Biomedical Engineering at Washington University St. Louis and Xiaoyu Jiang, PhD, Research Fellow at Vanderbilt University Institute of Imaging Science, teamed up to extract insights from magnetic resonance imaging (MRI) scans more efficiently. The goal was to create an effective method for the use of under-sampled scans for medical imaging.
Yong Wang picks up the story: “We saw an opportunity to develop a predictive solution to fill in the gaps in incomplete MRI images. Because of the vast amounts of data involved, we knew that AI, and more specifically deep learning, held the key to success.”

To create a practical tool that would help rather than hinder physicians, the research team knew that the solution needed to incorporate sophisticated data analytics technologies alongside a short learning curve. Yong Wang adds: “Traditionally, AI innovation has been led by specialist computing engineers. But as relative newcomers to this field, we wanted to find an easy entry point for AI both for us, and for the eventual users of the solution: physicians.

“In other words, we needed a tool that could be used by someone with no prior coding knowledge to augment their ability to diagnose and treat patients immediately, which could be optimized once they got more familiar with the technology. On top of that, we needed a computing backbone with the processing power to provide results fast.”

**Diving into deep learning**

First on the agenda for the researchers: find an IT infrastructure that could enable them to fully exploit the value of big data. When analyzing MRI images, both patient outcomes and experiences are at stake, so insights are required as soon as possible.

Xiaoyu Jiang sums up the challenge: “From an IT perspective, we were seeking technology that could set new records for speed, scalability, flexibility and efficiency. It needed to help us deal with data that is growing fast, in volume, variety and complexity across siloed systems. And to provide usable results in the short timelines demanded by clinical settings, we wanted to be able to apply and automate deep learning workflows.”

Washington University St. Louis School of Medicine and the Vanderbilt University Institute of Imaging Science deployed IBM Spectrum Conductor® Deep Learning Impact (now part of IBM Watson® Machine Learning Accelerator) to get started with deep learning faster. A software-defined infrastructure solution, Spectrum Conductor Deep Learning Impact helps to automate and accelerate system resource management, distributed processing and prototyping. The team also implemented IBM Power® Systems S822LC servers to provide the performance required to support AI workloads.

Xiaoyu Jiang says: “IBM Spectrum Conductor Deep Learning Impact gives us a full workflow for deep learning, broken down step by step, making it as easy as ordering your shopping online. Even a beginner like me can use it to start exploring data immediately. It simplifies prototyping and hyperparameter tuning so you can get your models ready for production sooner. And IBM Power Architecture is the ideal platform for deep learning, allowing us to experiment at scale.”

Using IBM Spectrum Conductor Deep Learning Impact, the research team can upload data in multiple file formats. TFRecord from TensorFlow was the researchers’ format of choice, and they uploaded vast numbers of previous brain scan TFRecord image files to the system. The team took advantage of object detection and classification features to prepare the data, before uploading training models built using Python.

“With IBM Spectrum Conductor Deep Learning Impact, we can monitor and adjust our models in real-time, and optimize them very quickly,” explains Xiaoyu Jiang.

“We can also keep track of hardware utilization, which enables us to share resources more effectively across the team. Once we’ve finished refining our training models, we can apply them to under-sampled images to predict what the missing parts are, and reconstruct them with a high degree of accuracy.”

Xiaoyu Jiang, PhD, Research Fellow at Vanderbilt University Institute of Imaging Science
Giving physicians the tools to excel

Using the IBM platform, Washington University St. Louis School of Medicine and the Vanderbilt University Institute of Imaging Science developed an effective deep learning solution for the enhancement of MRI brain scans.

Xiaoyu Jiang comments: “IBM Spectrum Computing and Power Systems solutions made short work of training our models with 1,300 MRI images, finishing in just two hours. On a traditional PC, we estimate that this would have taken 20 times as long, so the IBM technology is directly responsible for helping us innovate faster.”

The research team’s solution increased the signal-to-noise ratio and reduced the number of artifacts in MRI images compared to existing under-sampling techniques. As a result, physicians will be able to identify cancerous brain tumors with greater precision.

Yong Wang says: “By filling in the gaps in under-sampled MRI images with help from IBM solutions, we can support better diagnosis and assessment of treatments.”

The research team expects to reduce time-to-diagnosis for patients using its deep learning models, yielding benefits for both patients and healthcare organizations. Next, the researchers will feed more data into the network, including images featuring a variety of brain structures and tumors.

“Supported by IBM solutions, we’ve been able to recalibrate under-sampled images so that they match the level of detail you would find in a scan that took twice the time,” explains Xiaoyu Jiang. “For patients, this means less time spent in MRI machines with no impact on the care they receive. It frees up healthcare equipment and staff, so they can accommodate more patients.”

Although the research study at Washington University St. Louis School of Medicine and the Vanderbilt University Institute of Imaging Science was focused on MRI scans, the project has broader relevance. For example, a similar approach could enhance ultrasound scanning to help prevent premature births.

Yong Wang sums up: “Combined, our research and IBM technology brings cutting-edge deep learning capabilities within reach of physicians so that they can give patients higher-quality care. We are inventing a whole new imaging system that directly enables better diagnosis and disease monitoring, so physicians can select the right treatment plans and evaluate patients’ progress. IBM provided a skilled team that supported us every step of the way, and their backing is essential to researchers like us that deal with data from hundreds of patients each and every day.”

Yong Wang says: “By filling in the gaps in under-sampled MRI images with help from IBM solutions, we can support better diagnosis and assessment of treatments.”