



Using AI to See What Eye Doctors Can't

Voxeleron is extending ophthalmology's diagnostic horizons with image analysis based on artificial intelligence (AI) models, trained using Dell Precision workstations with NVIDIA GPUs



Healthcare

United States

Business needs

In order to process 3D data sets in a deep-learning, convolutional neural network model, Voxeleron needed dramatically more computer processing power. Its goal? A tool to help ophthalmologists predict when patients with dry age-related macular degeneration might advance, leading to blindness.

Solutions at a glance

- [Dell Artificial Intelligence solutions](#)
- [Dell Precision 7920 Tower workstations](#)
- [NVIDIA Quadro GV100 graphics processing units](#)
- [NVIDIA Quadro RTX 6000 graphics processing units](#)

Business results

- Extends retinal patient diagnostic capabilities
- Enables extremely subtle pattern recognition
- Gains much greater AI-processing power
- Accommodates large 3D image data sets
- Allows more in-house experimentation

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Jonathan Oakley
Co-founder and Principal Scientist, Voxeleron

As the world's population ages, experts expect vision loss and complete blindness in elderly populations to grow, especially from incurable age-related macular degeneration (AMD). AMD destroys the macula, the area of the retina responsible for the sharp, central vision necessary to see objects clearly.

Today, AMD affects nearly 200 million people globally, making it the leading cause of blindness in people 60 years and older. The disease has two types: an early dry stage and an advanced wet stage when vision loss and blindness can rapidly follow.

Currently, ophthalmologists use optical coherence tomography (OCT) to generate 3D retinal images to diagnose and monitor the disease. Unfortunately, they can't tell which patients will convert from a dry to a wet stage, so they must monitor them regularly for changes in the condition.

Predicting probabilities

Although AMD is incurable, Voxeleron, a San Francisco-based company, aims to improve the ability of ophthalmologists to predict the probabilities of which patients with dry-stage AMD will turn wet. According to Daniel Russakoff, Voxeleron's co-founder and principal scientist, 3D retinal images may hold useful clues that can be discerned by artificial intelligence (AI) in the form of a deep-learning, convolutional neural network (CNN) model.

"Our hypothesis is that these images have subtle textures we can't see but that will indicate which patients will convert from dry- to wet-stage AMD," he says. "CNNs are great at identifying these textures in ways that the most trained human eye simply can't."

Voxeleron are at the intersection of computer vision. "We're combining these disciplines to build tools to help physicians improve lives," Russakoff says, adding that doctors can potentially use its 3D retinal imaging tools to also diagnose neurological disorders. "While the retina may sit in the back of the eye, it's actually at the front of the brain and a window into the central nervous system."

Russakoff explains how Voxeleron is changing the way AI can be applied. "In many cases, AI has been used to automate tasks humans are good at and for which there are clear success criteria," he says. "Examples include driving cars, playing complex games, recognizing objects in images and so on. But more interesting are tasks that humans are not so good at, such as finding complex patterns in vast data sets."

Data mining is one such application, Russakoff explains. "However, we also see that, in the case of imagery, diffuse textural patterns can be informative of subtle changes in a scene," he says. "If the scene is biological tissue, for example, then what do such changes mean? And as these are changes that cannot be picked up by a human observer, if the changes relate to pathology, they can be extremely informative."

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Co-founder and Principal Scientist, Voxeleron

Triage tool

In effect, the Voxeleron application is a triage tool. "Essentially we're talking about a way ophthalmologists can set intervals to see the people in greater danger of conversion more quickly or frequently," Oakley says. "And they can see the ones in less danger less frequently."

When Russakoff and Oakley began using deep learning, they started off using Dell XPS 7800 desktops with NVIDIA GTX graphics cards, upgrading the XPS power supplies to accommodate the GPU. But, in 2017, when they set their sights on the problem of AMD diagnostics and applying AI-driven deep learning to OCT 3D imaging, they upgraded to Dell Precision



workstations with NVIDIA GeForce GTX 1080 gaming graphics processing units (GPUs) for more data processing power.

“With the Dell Precision workstations with NVIDIA GPUs, we could better analyze a data set of patients with dry AMD and predict which ones would convert to wet and which wouldn’t” Russakoff says. “A widely read publication accepted and published our paper with the results of our investigation showing that it was possible to apply deep learning to this problem. That got the ball rolling for us.”

Deep learning at work

To further their investigation, however, the company needed to develop a CNN-based deep learning model that could be rapidly trained via machine learning to process OCT 3D imaging data sets. The team designed a retrospective study to follow a cohort of patients with dry AMD over two years in which some converted from dry to wet AMD while others didn’t.

“We trained a classifier in the baseline images to see if we could determine which ones would convert and which ones wouldn’t” Oakley says. “We added a proprietary normalization step to focus the classifiers specifically on the region of interest, but to accomplish this, we needed much more computing power.”

Voxeleron considered the parallel-processing power available via public clouds. They also explored the powerful workstations of AI-dedicated vendors. But they opted to stay with their on-premises Dell Precision computing platform, upgrading to Dell Precision 7920 Tower models and adding three NVIDIA Quadro GV100 GPUs to each one. The NVIDIA GV100 GPU features more than 5,000 cores, including 640 Tensor cores, and is capable of 118.5 teraflops of Tensor performance.

Saving money and time

“Our Dell Precision workstations running three NVIDIA GPUs simultaneously gave us the horsepower to fit a 3D OCT image data set into our AI investigations,” Russakoff says. “And by keeping our computing platform in-house with on-premises Dell Precision workstations and NVIDIA GPUs, we had the speed and flexibility to explore thousands of different AI model architectures to find the best one without worrying about cloud costs.”

Ultimately, the study’s results were most promising. “We showed a strong predictive power for AMD progression, which doctors just can’t do now,” says Russakoff. “What’s more, when we asked the classifier where it was looking to make its decision,

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Accelerates building
AI models by

3x

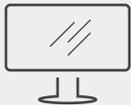
saving months



it indicated a region just below the retina called the choroid, echoing a growing body of literature that suggests subclinical indications of the disease in the very same place.”

The combined power of their Dell Precision workstations and NVIDIA GPU technologies also saved lots of time in making their application market-ready, reassuring investors. “We saved as much as three months by running our AI models on the Dell Precision 7920 Tower workstation with the NVIDIA Quadro GV100 versus our original setup, a single Dell XPS desktop with one NVIDIA GTX 1080 card,” says Oakley. “That’s about a fourfold improvement.”

He and Russakoff consider Dell Technologies and NVIDIA to be Voxeleron’s strategic partners. “To boost the Dell Precision 7920’s cooling capacity for the NVIDIA GPUs, Dell tweaked its Precision BIOS just for us,” he says. “And NVIDIA will soon be providing its latest Quadro RTX 6000 GPUs, which will extend our AI investigative frontiers even further.” And as Voxeleron moves into that future, extending retinal patient diagnostic capabilities is possible through the partnership with Dell Technologies.



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