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Case study

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DAIDO STEEL

DAIDO STEEL ACCELERATES ITS MATERIALS DEVELOPMENT PROCESS USING MACHINE LEARNING

Daido Steel's Corporate R & D Center built a deep learning development environment with HPE

Industry
Iron and steel

Objective
Promote the use of materials informatics in making specialty steel and magnetic materials, to speed up the development process and standardize inspections so production yields can increase

Approach
Build an integrated deep learning development environment using container technology to speed up setup time, simplify GPU resource allocation, and reduce researchers' workload so they can prioritize development activities

IT matters
- Integrates a deep learning development environment using the HPE Apollo 6500 Gen10 System mounted with eight GPUs
- Enables multiple researchers to use and share GPU resources flexibly through Docker containers and JupyterHub
- Reduces the time it takes to set up a deep learning development environment by at least 90%
- Frees researchers from infrastructure management, enabling them to prioritize development activities
- Superior NVIDIA® Tensor Core GPU performance greatly reduces training time for deep learning models and allows multiple model evaluations to be executed simultaneously

Business matters
- Enhances the efficiency of prototype and verification processes, speeding up the development of highly functional materials
- Through deep learning models, standardizes inspection processes that previously relied on researchers' experience and skills
- Supports the training and education of the Corporate R & D Center's staff members to become data scientists
- With HPE Pointnext Services, enables the center to start exploring techniques to optimize processes, including by collecting data at production sites via the Internet of Things, developing deep learning models, introducing inference processing at the edge, and using data lakes

Daido Steel adopted machine learning to accelerate its use of materials informatics in developing and inspecting highly functional specialty steel. The company worked with HPE Pointnext Services to install an HPE Apollo 6500 Gen10 System with eight NVIDIA V100 Tensor Core graphical processing units (GPUs), giving researchers a common platform to build deep learning models. By combining artificial intelligence (AI) and container technologies, the company has become more efficient in using GPU resources to help meet its diverse research needs.

CHALLENGE

Accelerating production with materials informatics

Daido Steel is one of the world's largest manufacturers of specialty steel. Based in Nagoya, Japan, the company operates in 14 other countries and has more than 12,000 employees across its offices and plants.

Through its specialty steel and magnetic materials, Daido Steel has enabled innovation in a diverse range of products, including automobiles, aircraft, power plants, industrial machinery, and IT equipment. The company has gained particular recognition for its high-performance magnets and magnetic powders, which are used for making electric vehicles, and heat- and corrosion-resistant stainless steel, which makes jet engines more efficient. Its strengths lie in its technical ability to respond to high demands in these niche areas—and in its meticulous and speedy responses.

"The use of container technology was more effective than we expected. It used to take hours to build our own development environment, but now it is as easy as selecting a container image registered in the library."

– Kohei Nozaki, Instrumentation Control and System Research Section, Corporate R & D Center, Daido Steel

Daido Steel's Corporate R & D Center has sped up its materials development process and improved inspections using the HPE Apollo 6500 Gen10 System for its deep learning development environment.

But to sustain and bolster this ability, Daido Steel knew it had to step up its adoption of technologies to accelerate its research and materials development processes.

"Demand for high functionality in a variety of products—not just specialty steel and magnetic materials—is increasingly growing," says Toshio Suzuki, Deputy General Manager of the Process Research Division at Daido Steel's Corporate R & D Center. "I feel strongly that new ideas and innovation are required even for our daily work in new materials development, manufacturing, and inspection. Above all, we need to speed up our development process, and improve the accuracy of inspections."

Daido Steel's Corporate R & D Center serves as the company's strategic base for developing knowledge and technology. Through its 100 researchers, the center has contributed significantly to the company by developing first-class materials and technologies that advance its processes.

"We started researching deep learning in 2017, and since 2018, we have fully taken up the challenge of accelerating our adoption of materials informatics," says Suzuki. "Our biggest aim is to strengthen the development and inspection processes that relied on researchers' skills by using a deep learning model. We have found that in developing new materials, it is possible to create combinations of materials that humans cannot think of."

Materials informatics has gained popularity as an efficient way of finding new materials using AI technology and material property databases. It is expected to transform the conventional process of developing materials—which repeats a huge number of prototypes and inspections—and to expedite the creation of new materials.

"As part of our adoption of materials informatics, in 2018 we built an integrated deep learning model development environment that researchers can use jointly. And with the advice of HPE Pointnext Services' consulting team, we aimed to establish a common platform for future new materials development," says Suzuki.

SOLUTION

A development environment that does not hamper researchers

HPE Pointnext Services helps enterprises accelerate digital transformation. The organization has a proven track record in AI advisory services, including machine learning and deep learning. It has earned a reputation for developing pipelines—from data collection to processing, analysis, and management—and building AI platforms using container technology.

To guide the Daido Steel Corporate R & D Center's AI transformation, HPE Pointnext Services experts conducted a workshop for key research and technology professionals, enabling the center to find its best use cases and create a high-level plan.

The workshop was very effective, according to Naoki Fuse, Associate Chief Research Engineer at the center's Instrumentation Control and System Research Section.

"To use the integrated deep learning model development environment with great efficiency, we identified the issues and themes, and then formulated a policy," says Fuse. "I believe that even inexperienced researchers were able to deepen their understanding of deep learning and form a common understanding of what we do as a technology development laboratory."

HPE Pointnext Services demonstrated that having a common development platform allows researchers to immediately access the data and computational resources they need.

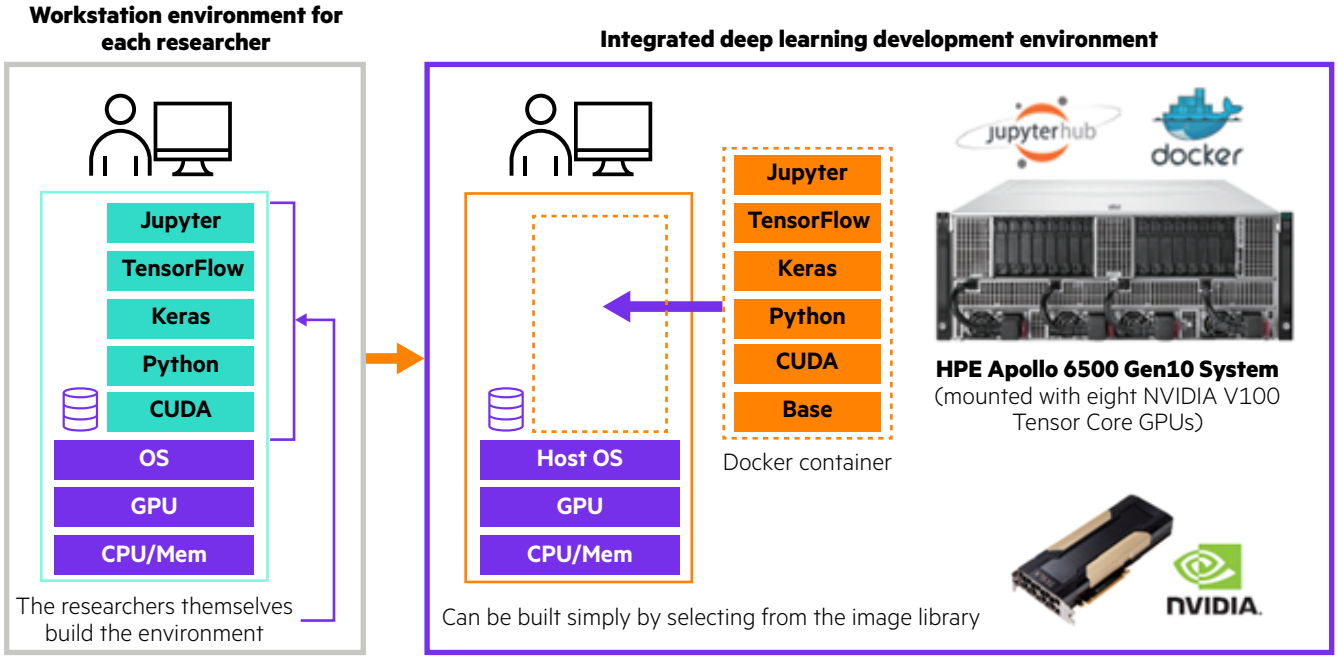
"The researchers cannot be burdened with the need to prepare and operate the development environment, and the efficiency of using shared computing resources must be maximized," says Junichi Yoshise, Lead Architect of HPE Pointnext Services Hybrid Cloud Center of Excellence at HPE Japan. "All of these are important. So we proposed an environment that combines AI technology with container technology to achieve this."

Specifically, HPE Pointnext Services proposed the following:

1. Integrate a deep learning development environment using the HPE Apollo 6500 Gen10 System.
2. Prepare an image library for the development environment using Docker containers, and eliminate the burden of setting up the environment.
3. Optimize the efficiency of multiple researchers' use of NVIDIA GPU technology with JupyterHub.

In December 2018, the Corporate R & D Center's deep learning platform based on the HPE Apollo 6500 Gen10 System went live. This marked its first foray into advanced deep learning development environment using container technology to achieve greater scalability, flexibility, and accessibility.

From having individual workstations, Daido Steel Corporate R & D Center's researchers now share a common platform



Adopting the HPE Apollo 6500 Gen10 System dedicated to deep learning

The HPE Apollo 6500 Gen10 System the center adopted is designed for deep learning and comes with eight NVIDIA V100 GPUs mounted in a 4U high rackmount enclosure. Equipped with HPE's Integrated Lights Out 5 (iLO 5) management processor, it provides hardware-level security and excellent management functions. Enterprise users particularly like the fact the system comes in a standard rack with general-purpose x86 servers, which makes operation and management easy.

"The integrated environment offers both performance and ease of management," says Kohei Nozaki of the Corporate R & D Center's Instrumentation Control and System Research Section. "In addition to simultaneous processing by up to eight GPUs, parallel processing by multiple GPUs is also possible. The degree of freedom for learning model evaluation has greatly increased."

Nozaki is responsible for developing inspection models that combine image recognition and deep learning. His main goals are to standardize and speed up inspection, and develop an inspection process that does not depend on researchers' skills.

"There is no compromise in meeting our customers' requirements, and in maintaining and improving the accuracy of our metallographic evaluation. Microstructure evaluation is a crucial step in determining the strength and performance of a product when it is commercialized. Manual organizational evaluation can be a bottleneck in the development of new materials with higher performance. That is why deep learning is so important."

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"If you observe a cross-section of a metal with a microscope, you can see that it is composed of multiple crystal grains," says Nozaki. "The size of these grains is the product specification. Because these grains are so small, there is typically a slight error in assessment when humans perform the visual inspection. The reason for our use of a deep learning model is to standardize our inspection and assessment."

"There is no compromise in meeting our customers' requirements, and in maintaining and improving the accuracy of our metallographic evaluation," says Suzuki. "Microstructure evaluation is a crucial step in determining the strength and performance of a product when it is commercialized. Manual organizational evaluation can be a bottleneck in the development of new materials with higher performance. That is why deep learning is so important."

Other researchers at Daido Steel now use the model Nozaki developed for inspection work. He and his team also now run multiple evaluations of learning models at the same time.

"In the past, we would run our learning model evaluation every day before the end of work and check the results the next morning. Now we can complete most of our evaluations within working hours," Nozaki says. "Our processes are smoother now, and our productivity has greatly improved."

BENEFITS

Achieving an ideal development environment using deep learning and container technologies

Following HPE Pointnext Services' advice, Daido Steel's Corporate R & D Center also implemented Docker containers and JupyterHub on the HPE Apollo 6500 Gen10 System. The center's Technology Development Laboratory had already used Jupyter Notebook as a standard environment, but installing JupyterHub has made it easier to create and manage work on a common platform.

"For the common platform, we ensured that multiple researchers can effectively use the shared GPU resources and data," says Yoku Torii, a consultant at HPE Pointnext Services in Japan. "Since we did interviews and workshops early on to understand the customer's challenges and needs, we believe we were able to propose an environment that the customer can optimize for its business."

"The use of container technology was more effective than we expected," says Nozaki. "It used to take hours to build our own development environment, but now it is as easy as selecting a container image registered in the library."

The Corporate R & D Center estimates it now only takes one-tenth of the time it previously took to build a deep learning development environment.

And with the expansion of its container image library, the center expects setup time to further shrink. With more researchers working on deep learning, data and libraries will only expand and the process of developing new materials will further accelerate.

As the Corporate R & D Center gains more knowledge and deep learning models, it plans to apply these to its production plants.

"Our main plants have been operating at full capacity the past few years. Production stagnation, including lost time, is unacceptable," says Fuse. "Even in such a severe environment, we must continue to provide high-quality products stably. It is inevitable to adopt deep learning not only to speed up the development of new materials, but also to stabilize the quality of mass-produced products and maintain manufacturing equipment."

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Customer at a glance

HPE Hardware
- HPE Apollo 6500 Gen10 System

HPE Pointnext Services
- HPE Pointnext Services for hybrid cloud

Optimizing processes

According to Suzuki, the Corporate R & D Center's immediate priority is to expedite its entire process. "But in the future, we will deploy the technology and know-how we have cultivated throughout the company to achieve higher efficiency while meeting our customers' requirements," he adds. "We hope to contribute to the increase in yields in our production lines."

Together with HPE Pointnext Services, the center's Technology Development Laboratory aims to optimize its processes through techniques such as data collection at production sites, deep learning model development, inference processing at the edge, and using data lakes.

"We have begun our education and training on materials informatics across the company," says Suzuki. "Our goal at Daido Steel's Corporate R & D Center is to grow our human resources in materials development and processes, and our data scientist skills by 2020. We look forward to HPE Pointnext Services' continued support in achieving this, including by giving us advice on latest technology implementations."

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