Implementing AI: From Exploration to Execution

Challenges and Successes on the Machine Learning Journey

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MIT SMR CONNECTIONS

Introduction

Artificial intelligence is becoming a key component of business transformation. Virtually any business leader seeking to unlock value and develop new capabilities using technology is at some stage of the AI journey. For example, those at the leading edge have incorporated machine learning insights into business processes and are building functionality such as natural language processing and preventative maintenance diagnostics into their products. Others are experimenting with pilot projects or developing plans to get started.

Many of these enterprises use Amazon Web Services (AWS) as their technology platform for AI initiatives and access NVIDIA GPUs to speed up their machine learning applications. This report aims to share learnings from businesses that are early adopters of AI in their industries as well as insights from experts working in the field. We hope you find it useful as you seek to drive value from AI in your organization.

Implementing AI:
From Exploration to Execution

Challenges and Successes on the Machine Learning Journey

Artificial intelligence — in particular, machine learning — is widely recognized as a transformative set of technologies that will fuel competitive advantage, innovation, and growth across a range of industries. How are leaders in AI adoption identifying their most promising use cases and choosing the most appropriate technology infrastructure? How are they confronting implementation challenges?

Interest and investment in artificial intelligence may be higher now than at any time since the field emerged in the mid-1950s. Research is thriving in both industry and academic settings, and applications are proliferating across market sectors. AI-fueled innovations can be found in a range of areas, such as virtual assistants, advanced analytics, smart devices, robots, and autonomous vehicles.

AI is also entering the business mainstream, and the mandate to formulate strategies to apply AI — and do so ahead of competitors — is high on the C-suite and board agenda. With cloud services offering on-demand access to advanced computing infrastructure and managed AI services, it's increasingly easy for companies of all sizes to experiment and innovate.

To stay in the vanguard, C-suite executives must not only understand their own business domain but also educate themselves on AI capabilities. This report aims to help, by giving leaders considering their own AI strategies an updated look at recommended approaches to AI in the enterprise and sharing learnings from three early adopter organizations.

Businesses Ramp Up Investment and Expectations

Experts consulting with businesses are seeing an increase in AI sophistication among executives, noting that many now have a high-level understanding of the kinds of AI most used in business applications.

"Businesses are becoming a lot more savvy and a lot more informed about adopting AI and machine learning," says Plamen Petrov, former cognitive technology director at KPMG and now vice president for AI at health insurer Anthem. Many companies are identifying the opportunity to advance their analytics practices with machine learning, which uses a collection of algorithms trained on data sets to identify patterns in data and learn from them to make predictions.

Successful AI implementations typically involve "a business leader who has both the vision and the clout to drive that solution — and who is also technically knowledgeable enough to understand the limitation of the technology and does not jump into something that may not be achieved," says Petrov.

Those leaders are increasing investments in AI. In a recent joint study by *MIT Sloan Management Review* and Boston Consulting Group (BCG), 88% of survey respondents identified as pioneers

"Businesses are becoming a lot more savvy and a lot more informed about adopting AI and machine learning."

PLAMEN PETROV, ANTHEM

— those most advanced in using AI in their offerings and internal processes — increased their investment in AI in the past year.[1] A large majority of the same group say they have already seen positive returns in business value from AI over the past three years, and most expect AI to change their business models.

"They want to build competitive advantage," says Philipp Gerbert, a coauthor of the study who is senior partner and managing director of BCG and leader of the global management consulting firm's initiative on digital strategy and AI. "If I miss out on a cost opportunity, I might limit my current profit — so be it. If I miss out on a new business model on the revenue side, however, I might not get a chance to catch up. Ultimately, you obviously want both: You want to achieve innovation and growth, and you want to achieve efficiency in cost and quality of service."

Like the leaders profiled in this case study report, advanced implementers of AI are focused on using the technology to deliver better experiences to their customers. In a Deloitte survey of executives identified as being at the leading edge of AI adoption, the top business benefit respondents cited was enhancing products and services, followed by making better decisions and creating new products.[2] (See Figure 1.)

Technology Choices Driving the Spread of AI

Organizations seeking to harness AI capabilities can take multiple pathways thanks to a growing array of technology options. A 2018 survey by Constellation Research found that 56% of respondents are developing applications in-house by building out data science teams and using open-source frameworks, 52% are developing applications using cloud-based machine learning and deep learning services, and 42% are adopting packaged applications with AI capabilities.[3] Those choices are not mutually exclusive: 20% use a mix of three modes and 26% use a mix of two modes.

For those building applications, technology decisions may be driven by considerations such as compute power, scalability, and access to particular tools and services. While many use both on-premises equipment as well as cloud computing resources, the latter approach has become widespread.

"Cloud is the absolute dominant paradigm for the simple reason that you need a very modern architecture and you have to be able to scale very fast on demand," says Gerbert. At Liberty Mutual Insurance, the ability to scale compute resources on demand is important because it enables the company to easily pilot chatbot technology without knowing in advance whether a chatbot will attract just a few or thousands of simultaneous users (see "Applied Innovation Team Puts AI to Work at Liberty Mutual," page 8).

Access to high-performance technologies — for example, special-purpose GPUs that can speed computation of particular machine learning algorithms — can be costly to replicate in an

Figure 1:
Enterprises Are Focused on Driving Innovation With AI

Improving products and services is the top benefit sought by early AI implementors.

Source: Deloitte State of Cognitive Survey, August 2017

	Rank 1st	Rank 2nd	Rank 3rd	Total
Enhance the features, functions, and/or performance of our products and services	19%	15%	17%	51%
Make better decisions	14%	10%	11%	35%
Create new products	12%	12%	8%	32%
Optimize internal business operations	12%	14%	10%	36%
Free up workers to be more creative by automating tasks	10%	10%	16%	36%
Pursue new markets	8%	9%	8%	25%
Capture and apply scarce knowledge where needed	8%	9%	8%	25%
Optimize external processes like marketing and sales	7%	11%	12%	30%
Reduce headcount through automation	7%	8%	8%	23%
Don't know	2%			

[1] S. Ransbotham, P. Gerbert, M. Reeves et al., "Artificial Intelligence in Business Gets Real," MIT Sloan Management Review, September 2018.
[2] "Deloitte 2017 State of Cognitive Survey," August 2017.
[3] C. Sato and R. Wang, "Constellation Research 2018 Artificial Intelligence Study," June 2018.

Managed services eliminate the need to provision, maintain, and scale infrastructure. It's as much for the AI services that people turn to cloud providers as for any other reason.

THOMAS DAVENPORT, BABSON COLLEGE

on-premises data center. "It's just very expensive to try to keep up with all of that in any kind of proprietary infrastructure," adds Gerbert.

GPUs are making a particular impact on machine learning because the chips significantly speed up the process of training algorithms compared with using general-purpose CPUs. These specialized processors can employ thousands of cores operating in parallel and are designed to perform the kinds of mathematical operations typical of machine learning problems.

On-demand managed infrastructure and services are another driver to the cloud, with providers competing not only on the basis of compute resources but also by offering high-level API services and managed services. High-level API services free developers from worrying about the underlying models so they can focus on building their applications. Managed services eliminate the need to provision, maintain, and scale infrastructure. It's as much for the AI services that people turn to cloud providers as for any other reason, says Babson College professor Thomas Davenport.

Gillian McCann, head of cloud engineering and AI at Liberty Mutual Insurance's Workgrid Software subsidiary, says using cloud services can be a good way to get started quickly. If developers find they have more specific needs, they may choose to create their own models, she says.

"Are they good enough for what you're trying to implement? If so, thumbs up. If you think they're not — they're a bit too generic and you want to build your own models — then you sort of work your way down into, 'Will I use their deep learning services? Will I use the machine learning service as I build my model?'" McCann explains.

All About the Data

Powerful compute resources and machine learning frameworks can be used only when a company has relevant data assets and has taken steps to prepare and transform data to be used to train models. In fact, AI pioneers identified in the *MIT Sloan Management Review*-BCG study were far more likely than less advanced companies to report that data is on the senior management agenda and treated as an asset (Figure 2).

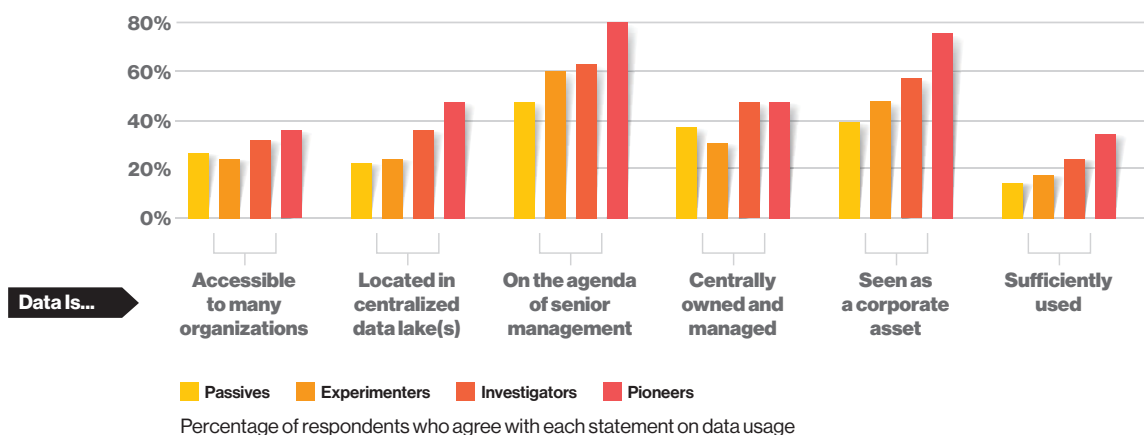**Figure 2:**
Advanced AI Practitioners Report More Data Maturity

Survey respondents with more advanced AI implementations are more likely to treat data as a corporate asset and put data issues on the senior management agenda.

Source: *MIT Sloan Management Review*

Data Is...

Passives | Experimenters | Investigators | Pioneers

Percentage of respondents who agree with each statement on data usage

In looking for innovative use cases for AI, Gerbert advises that businesses identify and examine data pools they haven't yet taken advantage of. "AI depends on data [for training the models], and these data pools may be internal and external. You may still have some structured data that you haven't used, but more — or most — commonly, you leverage novel ways to access unstructured data that's unused or entirely new sets of data that you get from IoT," he says.

Technology and logistics services provider Samsung SDS sees great potential in the combination of internet of things data and AI. There is a vast amount of data generated by the hundreds of thousands of IoT devices sold by global IT companies, and that is a fertile area to tap for AI applications, according to Seungjai Min, head of the company's Data Analytics Center (see "At Samsung SDS, Every Project Feeds Development of Its Brightics AI Platform," page 12).

Getting data into shape to work with is a particularly critical component of a successful machine learning project. "The vast bulk of commercial activity involves supervised learning, and that means you have to have some labeled data," Davenport notes. However, much valuable data may be unstructured — and it can be labor-intensive to prepare, he adds.

Data doesn't have to be perfect, says Bill Roberts, managing director of analytics and cognitive at Deloitte Consulting. If there is legitimate transactional data, even if it is incomplete or noisy, there's generally an approach available to extract the information needed for a machine learning model.

However, companies looking to implement AI at scale across their organization, such as Berlin-based online fashion retailer Zalando, are focusing on data governance as part of the journey. Their long-term view is to have data stores that enable not just machine learning but also deep learning applications (see "Zalando Scales Up Machine Learning to Fashion Growth," page 10).

The machine learning journey starts with data governance and recognizing roles, says Kshitij Kumar, Zalando's vice president of data infrastructure. "Did you produce the data? Did you

access the data? Do you own the data? What are the responsibilities that come with it?" he says. When businesses put in the time to establish governance early, "then two years down the road, when you are doing deep learning, you have enabled trusted use of data," he adds.

Challenges Ahead: Building Trust to Win Adoption

As with any new technology, maintaining momentum for AI in the enterprise depends on applications being adopted by the business.

"People who think that AI is a solution in itself usually have challenges," says Petrov. "Whatever business solution you build, it has to also involve all the other capabilities — databases, user interfaces, business processes, and change management."

Managing change in AI adoption includes educating managers to understand — and thus trust — outputs from AI models, as well as taking care to establish and communicate ethical guidelines. Cultural resistance and lack of managerial understanding emerged as top challenges in the SMR-BCG and Deloitte studies, respectively. Meanwhile, Constellation Research found that the resistance comes largely from lines of business, in which a top reason for concern is trust, with privacy also an issue cited by nearly a third of survey respondents.

Because many machine learning applications are powered by customer data, organizations with more advanced capabilities are keenly focused on using that data in ways that comply with regulations and maintain customer trust.
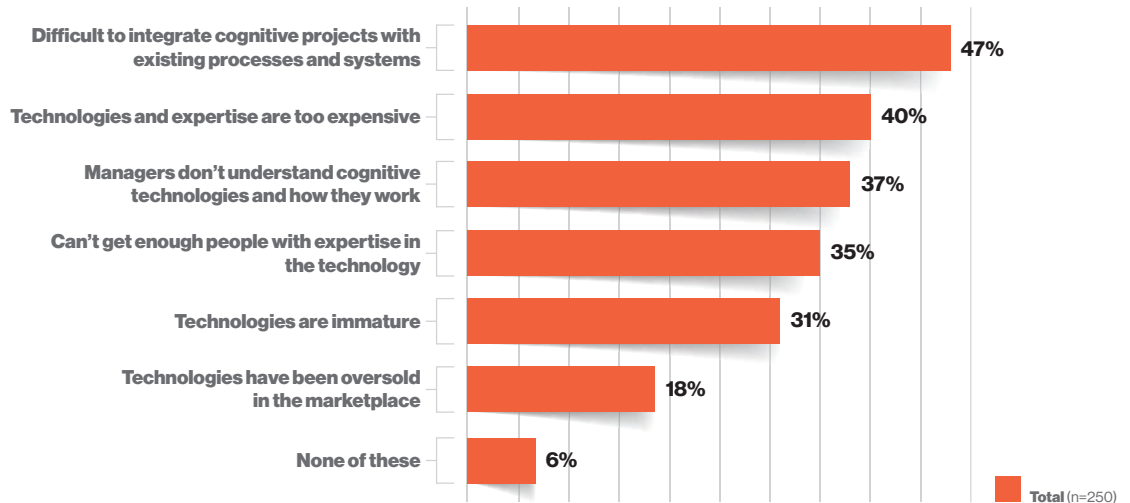
Liberty Mutual has strong data governance rules in place, says Gillian Armstrong, technologist on the insurer's cognitive computing team, and that means "you can't have all the data you maybe want to have as a developer, but that's a good thing." Her group seeks to advance AI but within the bounds of protecting individuals' privacy and using data appropriately.

The insurer is addressing ethics through a working group, Armstrong explains, asking questions such as, "How do we make sure that we're doing the right thing and that we don't

Figure 3:
Integration Is a Top Challenge
for AI in the Enterprise

Scaling AI across the enterprise
demands integration with existing
processes and systems — a top
challenge for implementors.

Source: Deloitte State of Cognitive Survey,
August 2017

Challenge	Total (n=250)
Difficult to integrate cognitive projects with existing processes and systems	47%
Technologies and expertise are too expensive	40%
Managers don't understand cognitive technologies and how they work	37%
Can't get enough people with expertise in the technology	35%
Technologies are immature	31%
Technologies have been oversold in the marketplace	18%
None of these	6%

have bias in our data? How do we put governance in place so that when we're using AI to make real decisions on the front end, we have a way of monitoring that and checking that it is making the right decision?"

The Next Frontier: Scaling Across the Enterprise

Organizations typically begin with AI by developing a pilot project in one area. When they look to put that work into production or expand AI across the organization, however, their challenges become more complex. When Deloitte surveyed 250 early adopters of cognitive technologies, it found that nearly half of the group reported that it was "difficult to integrate cognitive projects with existing processes and systems" (Figure 3).

"What distinguishes the more advanced companies that we see is that they clearly have the ambition to have a major impact on the bottom line and they start thinking about AI at scale. And that suddenly becomes very different from doing some use cases," says BCG's Gerbert.

Addressing this challenge requires attention to systems infrastructure, data governance, the organization, people, and skills, he says.

In scaling the use of machine learning across Zalando, Kumar is placing a heavy emphasis on a data architecture that can scale with the fashion retailer's increasing use of AI. And because scaling for him means democratization of AI, Kumar

is also cognizant of the need to serve a workforce where not everyone has an in-depth understanding of the technology. His goal is to provide access to data and analytics to both the AI experts doing very sophisticated deep learning algorithms as well as those close to the business. These latter individuals may not be sophisticated about data science, but they do understand their data and their domain. They must be able to use AI-based tools to create actionable insights and support the business, he says.

For Liberty Mutual's small cognitive technologies group, one element of scaling AI is focusing on how the team can be an enabler for the rest of the organization, by helping grow other teams and capabilities across the company. That includes educating colleagues on what machine learning or conversational interfaces can deliver to enable the business, according to McCann.

The Liberty Mutual group is also taking a strategic view across the organization, looking at where it is using AI now and where it could be using it, as well as considering questions of ethics, law, and impact on the company's brand. "We have to think about all these concerns holistically and pull together the different parts of the organization to make sure that we are lined up and set up well to go forward," says Armstrong.

Transforming an organization with AI demands strategy, planning, and investment, but as the case studies on the following pages reveal, the payoff can be sustained innovation and competitive advantage. ●

Applied Innovation Team Puts AI to Work at Liberty Mutual

Gillian Armstrong,
Technologist,
Liberty Mutual Insurance

Gillian McCann,
Head of Cloud Engineering and AI,
Workgrid Software

The Opportunity

The applied innovation team at Liberty Mutual Insurance is at the forefront of exploring new technologies for the global insurer, and that mission is grounded by its mandate to stay close to the business and tackle real problems those technologies might solve, says Gillian Armstrong, a technologist on the company's Belfast-based team.

One such project involves using conversational AI in a digital assistant for employees. The assistant, which can answer common questions or help with simple tasks, is being integrated with an existing internal productivity suite.

"We've been exploring how we can use natural language to make it easier for employees to be more productive, since it means they don't have to learn a whole new system," Armstrong explains.

> " How does AI change the way we're able to sell insurance? How does it change our customer experience? How does that change everything about our business? And so, what do we need to be thinking about doing now? "

GILLIAN ARMSTRONG, LIBERTY MUTUAL

The Approach

While conversational AI holds great promise for improving the customer experience, tackling an employee-focused project first has allowed the team to work faster and be more innovative, Armstrong says.

Another factor enabling the relatively small, six-person team to progress quickly is access to AI services via the cloud. While the team considered building its own natural language processing (NLP) service, it was clear that taking advantage of something already developed

At a Glance
Liberty Mutual Insurance
www.libertymutual.com
Industry: Insurance
Headquarters: Boston
Founded: 1912
Employees: Approximately
50,000 worldwide

> ❝ It's really critical with all machine learning that you have the right data and you have enough of the right data. ❞

GILLIAN ARMSTRONG, LIBERTY MUTUAL

made more sense, says Gillian McCann, head of cloud engineering and AI at Liberty Mutual spinoff Workgrid Software. "It's very different from what you would have done three or four years ago," McCann says of working with conversational AI and NLP. "You would maybe have tried to build some things like that yourself to see whether it's the technology you want to use." Today, it's possible to go to the cloud and "click a few buttons and start experimenting with those AI technologies," she says.

Taking advantage of AI services available from Liberty Mutual's technology partners has been helpful, but it's important to keep in mind that what makes a machine learning project succeed is the data, Armstrong says.

"It's really critical with all machine learning that you have the right data and you have enough of the right data," says Armstrong. "How do we get it? How do we get it in the right format? How do we keep improving it?"

In developing the chatbot digital assistant for employees, there was not a great deal of existing data, so the team needed to sit down with users to research the kinds of issues and problems they were seeking help with. It also used some anonymized data to see how people were phrasing questions, a process that revealed how people in different geographic locations of the highly global company often use different words and phrases to express the same thing.

What's Next
The chatbot project has been so successful that it has been packaged into a software-as-a-service solution to be sold to other companies via Workgrid Software.

Some of the work on conversational technologies will also be applied in the call center sphere, Armstrong says. It's initially targeting such issues as helping customers quickly find answers to simple questions without waiting to speak to a representative — for example, finding out who may be responsible for a given claim or whether a customer's coverage includes a rental car.

Liberty Mutual is also looking at applying machine learning to improve analytics and make better use of data. That extends to solving the problem of how to better ingest data — using machine learning techniques to correct incomplete or inconsistent data at point of entry and save the manual labor of cleaning up data quality issues.

Beyond those examples, the applied innovation team will continue to think expansively and holistically about where AI fits into the company. "We're taking a strategic view across the organization: Where are we using it at the moment? Where could we be using it? What is the state of the technology?" says Armstrong. Addressing those questions — along with critical business, legal, ethical, and branding considerations — will help Liberty Mutual map out its AI strategy going forward.

CASE STUDY

Zalando Scales Up Machine Learning to Fashion Growth

Kshitij Kumar,
Vice President of Data
Infrastructure, Zalando

The Opportunity

Fashion is a fast-moving business, where customers' needs and desires change with the latest trends and the weather. Berlin-based Zalando has propelled itself to the premier position in Europe's online retail fashion market on the strength of cutting-edge use of data via machine learning-driven predictive analytics. This is helping Zalando better anticipate customers' demands and make the operational decisions required to meet them.

Now, the company is stepping up its efforts to personalize and optimize all aspects of the customer journey by taking an organization-wide approach to machine learning and AI. "My mandate is to democratize machine learning at Zalando," says Kshitij Kumar, Zalando's vice president of data infrastructure.

> " Being a fashion retailer, our biggest AI use case — our first use case — is everything about the customer, giving them a satisfying, happy experience. "
>
> **KSHITIJ KUMAR, ZALANDO**

The Approach

When Kumar speaks of democratizing machine learning, he really means it. "It should be available for every Zalando employee to use," he says. "How do we give them access to the data safely and help them actually use machine learning to drive Zalando's business?"

Kumar believes the first priority of a machine learning (ML) journey is to enable trustworthy use of data. "How do you make sure that engineers and analysts are able to trust the data that they have access to? How can they be sure that it's clean, reliable data that their machine learning folks will be able to use safely and securely, while ensuring privacy is protected? If you don't do it from day one, it becomes really hard to do it later on."

The biggest problem in the machine learning arena today is that there isn't a single technology that can be used end to end in the ML journey, and data scientists pick different tools

At a Glance
Zalando
www.zalando.com
Industry: Online retail fashion
Headquarters: Berlin
Founded: 2008
Employees: Approximately
15,000 across Europe

> " Data engineers need to build an infrastructure that is able to pull in the best-of-breed solutions — with a combination of open-source, internally developed, and third-party solutions — on a scalable cloud offering. "

KSHITIJ KUMAR, ZALANDO

depending on their preference and the problem they're trying to solve, Kumar says.

"Data engineers need to build an infrastructure that is able to pull in the best-of-breed solutions — with a combination of open-source, internally developed, and third-party solutions — on a scalable cloud offering," he says. "That will allow ML experts to build the models that will solve real-world business problems."

It's important not to tie that infrastructure too closely into a business problem, so that it can evolve, Kumar adds. "This technology changes fast. If it's a bespoke solution, then a year or two later, it can become difficult to take advantage of the next generation of technology that solves problems much better than the last generation did."

The cloud plays an important role in Zalando's machine learning ecosystem, thanks to the ability to scale both data and compute resources as needed. Each of the steps in a machine learning project requires varying amounts of storage, compute, and network bandwidth. "It has become much easier to scale these things when you're running them in the cloud than if you're running them inside your data center," Kumar says.

Some of the machine learning problems Zalando is tackling also benefit from the rapid access via cloud to more advanced technologies as they become available, in particular more powerful GPUs. "We do a lot of image recognition, for instance," Kumar says. "GPUs are good at that, so we use them as needed."

What's Next
As Zalando expands its AI and machine learning capabilities, it's gaining the ability to hyper-personalize the customer experience — helping shoppers find what fits and makes them feel good in their clothes.

As of August 2018, more than 24 million active Zalando shoppers were able to search 300,000-plus product choices from approximately 2,000 brands, purchase just the right items, have them shipped to any of 17 countries, and expect the items to be delivered as predicted.

"We are just getting started with using AI and ML for the good of fashion," says Kumar. Using those technologies, Zalando intends to intensify its customer focus to help shoppers get what they need, when they need it.

CASE STUDY

At Samsung SDS, Every Project Feeds Development of Its Brightics AI Platform

Seungjai Min,
Data Analytics Center Head,
Samsung SDS

The Opportunity

Samsung SDS is increasingly incorporating AI and machine learning capabilities into the IT services and solutions it delivers to its global customers across a diverse range of industries, including financial services, manufacturing, logistics, and retail. As the company's Data Analytics Center and AI Center apply technologies to solve problems for clients, they also turn those outputs into assets to be added to its Brightics AI platform.

Both centers look for opportunities to reduce operational costs and improve productivity for customers via machine learning and deep learning. One recent project applied deep learning to the problem of defect image classification, freeing engineers from having to manually and visually inspect the quality of their manufactured product, says Seungjai Min, head of the company's Seoul-based Data Analytics Center. Another example is using deep learning to save employees from having to manually enter information from sources such as medical receipts and blueprints. "Our customers really love this kind of thing. It wasn't that effective with traditional machine learning, but with the advent of deep learning, it's becoming more popular," Min says.

> " The first AI project success is just the beginning; maintaining it is important. You need to continuously monitor and provide feedback to the system to maintain accuracy. "
>
> **SEUNGJAI MIN, SAMSUNG SDS**

The Approach

Building expertise in customer domains has been an important part of the Samsung SDS team's machine and deep learning work, as has been tuning its approach to the client's maturity level. Some more sophisticated customers have set up their in-house data science teams but have found that moving from AI experiments to an operationalized AI pipeline is challenging. "Then they come back to us again and they ask us to solve the total life cycle of the AI process," Min says.

When Samsung SDS sits down to discuss solutions with customers, one of the important agenda items is data strategy: It may be the case that businesses have not identified the

At a Glance
Samsung SDS
www.samsungsds.com
Industry: Professional
services, technology,
and business
Headquarters: Seoul
Founded: 1985
Employees: Approximately
23,000 worldwide

❝ When we do a cloud implementation, both at the development stage and then later in the operational stage, we can provide more services due to the increased flexibility. ❞

SEUNGJAI MIN, SAMSUNG SDS

right data for a deep learning case or collected and thought about how to manage it in their data lake, Min says.

"You need to plan how to apply data, how to store data, and how to manage that process," Min says. Companies also need a strong commitment from top management to execute digital transformation across the whole company, so that for every process, data will be captured and stored in a systematic way.

While the Data Analytics Center uses both cloud and on-premises computing resources, some customers prefer the latter because of privacy considerations. Min expresses a preference for cloud implementations: "When we do a cloud implementation, both at the development stage and then later in the operational stage, we can provide more services due to the increased flexibility."

Min's team also takes advantage of the faster processing power of GPUs, especially in cases that use complex algorithms and images, speech, or large volumes of sensor data. In other cases, developers work to reduce the algorithmic complexity because the solution must be implemented on a chip used in a mobile phone or household appliance.

What's Next

The AI and data science team at Samsung SDS sees promising opportunities in delivering richer capabilities to global IT and manufacturing companies such as Samsung Electronics, which sells hundreds of millions of IoT-connected devices, from mobile phones to TVs and home appliances. "There are so many IoT things that can be connected to do more analyses," says Min. "We think there's a future for IoT and AI and machine learning combined to produce more accurate and better analyses."

The company's AI Center in San Jose, California, works on advanced research and serves as a base for recruiting AI talent and sensing and sourcing startup technologies in Silicon Valley. As it advances its use of deep learning, Samsung SDS is also contributing back to the open-source community, in particular to the Apache MXNet open-source, deep-learning software framework, Min says.

The benefits from Samsung SDS's work with AI, machine learning, and deep learning are twofold: By advancing its practice, it wins business and revenue, and with each engagement, it gains assets that make its Brightics AI platform richer.

SPONSOR'S VIEWPOINT

The Age of Intelligent Computing

AI has broken out of the lab. It's transforming industries. It's changing how we get to work and how doctors diagnose disease. And now it promises to help prevent illnesses and speed up relief efforts after natural disasters. AI is empowering organizations to extract deeper insights that improve the way they serve customers and stay competitive.

The AI transformation touches all industries. For example, in health care, image recognition, object detection, and genomics sequencing are helping improve the rate and quality of disease diagnosis and management. In retail, product recommendation engines and inventory management are making it easier for consumers to receive the best products for their needs, while retailers can streamline their supply chains. And in the industrial space, AI-driven automation is dramatically reducing maintenance costs, often preventing breakdowns before they happen using predictive analytics, thereby avoiding costly downtime and increasing production efficiency.

The technology of AI represents a new kind of software development, where software writes software that augments human capabilities. State-of-the-art AI requires a fully accelerated pipeline from data preparation to tuning hyperparameters for optimal model training and eventually deploying to end-user applications. Integrating AI into existing data centers and software development pipelines requires a new set of infrastructure, process, and guidelines. NVIDIA recognizes this need and supports all AI frameworks for training and inference, delivering an end-to-end platform for developers to innovate on applications and quickly achieve optimal levels of performance with little to no tuning. In addition, the NVIDIA Tesla deep learning platform includes tools to deploy those networks as market-ready products and services, accelerating time to market.

AI has been called the new electricity, and companies that quickly adopt it will gain first-mover advantages, as did companies that migrated from steam to electricity in the early 1900s. Today's market continues to demand more intelligent solutions, which in turn require fundamental upgrades. At NVIDIA, we continue to deliver the most comprehensive offerings to ease this transition and provide the best tools for companies to excel in this era of artificial intelligence.

— Ian Buck
Vice president, Accelerated Computing, NVIDIA

Ian Buck is General Manager and Vice President of Accelerated Computing at NVIDIA. He is responsible for the company's worldwide data center business, including server GPUs and enabling NVIDIA computing software for AI and high-performance computing used by millions of developers, researchers, and scientists.

About NVIDIA

NVIDIA's invention of the GPU in 1999 sparked the growth of the PC gaming market, redefined modern computer graphics, and revolutionized parallel computing. More recently, GPU deep learning ignited modern AI — the next era of computing — with the GPU acting as the brain of computers, robots, and self-driving cars that can perceive and understand the world. Learn more at nvidianews.nvidia.com.

Putting Machine Learning in the Hands of Every Developer

Artificial intelligence is driving innovation and enabling business benefits across industries. In fact, IDC estimates that 40% of digital transformation initiatives will be supported by AI this year. For early adopters, AI has had a profound impact on how they transform their business for higher-value gains such as competitive advantage and faster innovation by improving their ability to make better decisions and open up new opportunities.

Despite their enthusiasm for AI adoption, many decision makers don't know where to start. Should they begin with pilot projects or transformational initiatives? How do they select the use cases that are aligned to their business goals? What technology should they use to build AI applications? Last, are there industry best practices and sources of inspiration and education as they contemplate their AI journey?

At Amazon, we've been investing heavily in AI for more than 20 years. Machine learning is used in virtually every aspect of our business — from Amazon.com's recommendations engine and path optimization in our fulfillment centers to Echo powered by Alexa, our Prime Air drone initiative, and our new retail experience, Amazon Go. At AWS, our mission is to put machine learning in the hands of every developer so that everyone can benefit from this powerful technology.

We deliver this through a portfolio of AI/ML services that meets the needs of all developers. For expert practitioners, AWS takes an open and flexible approach to all major machine learning and deep learning tools and frameworks, and provides the highest performing environment for running TensorFlow. For ML developers and data scientists, Amazon SageMaker offers an end-to-end solution to build, train, and deploy machine learning applications substantially faster than traditional methods. Finally, for application developers, AWS provides a broad set of AI/ML services to accomplish a wide variety of use cases across image and video analysis, speech, language analysis, document analysis, forecasting, personalization and recommendations, and chatbots. The AWS customers featured in this report — Liberty Mutual, Samsung SDS, and Zalando — are great examples of how businesses are leveraging AWS services to put AI to use in their organizations.

AWS also offers unique learning tools to help customers get started quickly with AI: AWS DeepRacer, a fully autonomous $\frac{1}{18}$-scale race car designed to help you learn about machine learning in a fun way; AWS DeepLens, the world's first deep learning-enabled video camera for developers; Amazon ML Solutions Lab, which combines hands-on educational workshops with advisory professional services; and AWS Machine Learning Training and Certification, which offers structured courses for machine learning based on the same material Amazon uses to train its developers. Learn more about machine learning on AWS.

About Amazon Web Services

AWS offers a broad and deep set of machine learning and AI services for your business. On behalf of our customers, we are focused on solving some of the toughest challenges that hold back machine learning from being in the hands of every developer. You can choose from pretrained AI services for computer vision, language, recommendations, and forecasting, or Amazon SageMaker to quickly build, train, and deploy machine learning models at scale. Customers can also build custom models with support for all the popular open-source frameworks. Our capabilities are built on the most comprehensive cloud platform, optimized for machine learning with high-performance compute and no compromises on security and analytics. Learn more at aws.ai.