E-BOOK

AI in Healthcare

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Make Your Organization AI Ready

Healthcare costs are rising. Clinicians are overworked. Data privacy, security, and compliance are ongoing concerns. Constrained by shrinking margins, healthcare organizations must find new ways to improve operational efficiency while meeting—or exceeding—the highest standards of patient care.

In this highly competitive environment, data is a differentiator. For many in healthcare, digital transformation is no longer an "if" or even a "when." It is simply reality. Around the world, healthcare organizations are turning to artificial intelligence (AI) to help meet their challenges while pushing innovation to the limit.

From medical imaging to genomic analysis to drug discovery, AI is getting better and more sophisticated at doing what humans do—and doing it more accurately, more quickly, and at lower cost. As a result of AI, healthcare costs are falling and health outcomes are improving.

Accenture estimates that AI applications in healthcare could save up to $150 billion annually by 2026. Clinicians can now make faster, more accurate diagnoses. Caregivers in remote locations and developing countries can more quickly diagnose rare diseases and treat more patients with limited resources. Drug researchers can expedite discovery and development and reduce the cost of bringing new drugs to market. Insurers can more easily identify and prevent fraud.

AI has immense potential. But taking AI from concept to implementation in clinical workflows and research and development (R&D) requires much more than just a large dataset. It requires an effective and efficient data pipeline. To unlock the potential of AI, you need the ability to capture, prepare, access, move, and protect large volumes of data from multiple sources—potentially thousands of tables across hundreds of databases. Whether you choose to develop AI applications on public clouds or on your premises, you also need the ability to seamlessly move data from devices at the edge to the core compute and to the cloud.

This e-book discusses some of the top use cases for AI in healthcare, including medical imaging, patient care, management, and R&D. You'll learn the importance of building an AI-ready data pipeline. And you'll learn key architectural considerations for designing a multistage data pipeline to fuel your AI implementation.

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Types of Artificial Intelligence

Artificial Intelligence

Artificial intelligence (AI) is a category of computer science engaged in engineering computers to perform tasks that have traditionally been considered impossible without human thought.

For example, in medical imaging, AI can quickly identify anomalies too small for the human eye to distinguish, helping radiologists quickly identify exceptions. AI chatbots and nursing assistants can help monitor and triage patients. And AI-powered robots are assisting surgeons with surgeries that require a microscopic scale.

Machine Learning

Machine learning (ML) is the scientific study of algorithms that empower software to improve methodically over time, in response to collected data.

Surgeons can use ML to prepare for an orthopedic intervention to address a sports injury. ML can offer greater understanding of ligament repair specific to older tennis players or can clarify the differences between knee injuries that present in different sports. This information empowers the surgeon to make the most informed decisions for treatment.

Deep Learning

Deep learning (DL) is a branch of ML that is based on the concept of artificial neural networks. Neural networks efficiently digest vast amounts of data, learn from it, and offer researchers new insights as a result.

Because of its capacity for analyzing massive quantities of data, DL can reveal new connections between certain genomic indicators, demographics, and various diseases. These connections might not be clear to researchers manually looking for correlations between “factor X” and the presentation of a particular disease.

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Medical Imaging

With the growing focus on early intervention and preventive health, healthcare organizations are increasing their adoption of medical imaging technologies. Advances in these technologies, including 3D and 4D capabilities, real-time analytics, and processing accelerated by graphics processing units (GPUs), give radiologists powerful tools to make faster and more accurate diagnoses and recommendations for care.

Preventing Radiologist Burnout

Modern imaging technologies generate an overwhelming amount of information that can be difficult and time consuming for radiologists to process manually. For example, CT machines can generate 64 to 640 slices per scan. With 10 times the number of images, a 640-slice CT scanner can help radiologists improve accuracy, but these images also take more time to review and evaluate.

Specialized AI applications can support radiologists and prevent burnout by "triaging" stacks of images. By quickly sorting out normal images and flagging exceptions, the radiologist can focus on the images that show anomalies or indicators of disease. This triage allows them to focus on diagnosing and treating disease rather than screening images.

Improved Diagnostics

According to the American Cancer Society, there are 4,830 new cancer cases diagnosed each day in the United States. Breast cancer—the most common—will impact 1 in 8 women. Many cancers start with changes so small that no human could detect them—even with current medical imaging technology. AI programs armed with DL, however, can be "trained" to see the very earliest changes in cell structure that typically lead to the development of cancerous cells. These programs can alert oncologists, who can then guide patient care protocols with greater accuracy and effectiveness.

5x

AI programs create MRI reconstructions with five times greater accuracy.[1]

85%

The use of AI is reducing diagnostic errors in breast cancer detection by 85%.[2]

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Patient Care

Nothing can replace the personalized care of a highly trained clinician engaged in a patient's well-being. AI can support human caregivers and mitigate the possibility of error to improve patient outcomes.

Robot-Assisted Surgery

Surgery of all types requires the utmost precision, patience, and skill. Surgical practices around the world are starting to use AI-enabled robots to assist in surgery and even perform procedures independently, thus allowing more surgeries to be done with greater accuracy. Robotic surgery is particularly exciting in the area of microsurgery, which requires minute, precise movements. The combination of computer vision software and ML can now be used to manipulate instruments on a scale so small that this surgery can't be done by hand.

Virtual Nursing Assistants

Whether they are analyzing symptoms or simply alerting hospital teams to the bedside needs of patients, virtual nursing assistants can ease the burden so that nurses can focus their attention when and where it's needed most.

Dosage Error Reduction

Medication errors such as improper dosage or adverse drug interactions can harm patients and lead to lawsuits. AI can act as a second set of eyes, verifying the work of nurses, doctors, and pharmacists to make sure that prescriptions are accurate and safe. AI can also look across patient records to identify relevant factors that might assist doctors in prescribing effective medications.

1 year

An AI program can predict 80 diseases up to 1 year before they present in patients.[3]

81%

In critical care conditons, AI can identify a stroke with 81% accuracy.[4]

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Healthcare Management

In addition to keeping people healthy, hospitals and clinical practices must run their businesses. Managing paperwork, finances, and the security of patient records while navigating a complex legal and ethical environment takes significant time and effort.

Natural Language Processing

Electronic health records (EHRs) can be both a blessing and a curse. Having patient information available at the click of a button has clear advantages. However, the time that it takes to enter data into these records is perceived as a clerical burden on caregivers. Clinicians report that they often spend as much time staring at a computer screen entering their observations and treatment plans as they do actually connecting with patients.

AI applications focused on natural language processing can help. These voice-to-text applications can speed up the record-keeping process without sacrificing accuracy, freeing up clinicians' valuable time and reducing frustration.

Data Security

Targeted use of ML can also help healthcare systems address security of patient records. Data must be protected from external and internal threats. ML applications can track access to patient records in a hospital and assess whether that access is appropriate—or suspicious. This tracking frees security personnel to pursue relevant leads and suspicious activity rather than trying to manually monitor thousands of access points every day.

Fraud Reduction

Healthcare, like other industries, is vulnerable to fraud—from billing for services that were never performed to upcoding for more expensive treatments, kickbacks, and corruption. According to the FBI, healthcare fraud can cost tens of billions of dollars each year.

AI can monitor behavior and transactions to detect anomalies that could represent fraudulent activity and can flag them for review. Those models can use ML to find hidden patterns or deviations from expected patterns among a wealth of disparate data, including clinician notes, EHR data, and insurance claims.

$3000

AI-supported EHRs save an average of $3000/month per physician.[5]

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Research and Development

Modern healthcare is about more than treating the patients of today. It is also about finding new—and better—ways to treat the patients of tomorrow. Research and development of new therapies, treatments, and drugs are crucially important.

Drug Discovery

For many reasons—including the costly pursuit of therapies that fail in trial, the cost of research facilities and staff, and the regulatory challenges of bringing new treatments to market—the investment and time associated with medical R&D is staggering.

AI can help streamline the R&D process. A research team can spend months or even years isolating promising molecules. ML applications can quickly and efficiently work through many possibilities, freeing researchers to focus their attention on only the most promising opportunities. New drugs can be brought to market more quickly and at a lower cost. It is estimated that AI can save drug companies as much as $2.6 billion during the 12 to 14 years it takes to develop a drug.[6]

Complicated diseases require complicated treatments that are often accompanied by high costs and terrible side effects. DL programs can sift through mountains of patient data to cross-reference outcomes, side effects, and many other factors to help doctors choose the protocol most likely to be both effective and tolerable for a given patient. The fact that these programs can act quickly—in an automated process—saves time and money.

$2.6 billion

AI can reduce the cost of bringing new drugs to market during their 12 to 14 years of development by as much as 2.6 billion dollars.[6]

10x

AI can increase the productivity of research into drugs for Alzheimer's, cancer, and multiple sclerosis by as much as 10x.[7]

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Research and Development (cont.)

Genomics

Genomic discovery is one of the most exciting frontiers of modern science. Researchers are using genomic data to learn about the causes of disease and genetic disabilities. Clinicians can then use that information to inform care plans.

Today, genomic researchers can study complete gene sets quickly by relegating tedious sequencing and analysis tasks to computers. AI software can help identify patterns among the human genome's more than 3 billion base pairs. In the process, it can identify individual mutations, and, based on experience, it can then make predictions and recommendations for the best course of treatment.

Parabricks and NetApp Accelerate Genome Sequencing

The data generated by whole genome sequencing requires massive amounts of compute power, storage, and data management that can easily become a bottleneck. A single sample can take days to process. With thousands of subjects or patients, it could take years to get through every record.

Parabricks uses GPU-accelerated computing and DL to reduce genomics analysis time from days to minutes. The parallel processing power of GPUs enables the software to process DNA sequences separately. With Parabricks running on NetApp® ONTAP® AI software, you can process sequencing pipelines an average of 10 to 50 times faster than CPU-based solutions.

Parabricks

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Case Study: WuXi NextCODE

Inside the World's Largest Collection of Human Genomes

WuXi NextCODE offers a unique platform designed specifically to organize, mine, share, and apply genomic data to improve human health. Over the past 20 years, the company has amassed the world's largest database of human genome sequences. Through AI, WuXi is bringing genomics studies from the realm of theoretical benefits to the real world, in service of real patients.

In partnership with Rhythm Pharmaceuticals, WuXi NextCODE is breaking new ground in understanding genetic components of obesity and rare metabolic disorders. The company's AI laboratory is used to score rare sequence variations for their impact on obesity. This approach might soon make it possible to use targeted therapies to treat obese individuals who have these genomic variations.

WuXiNextCODE

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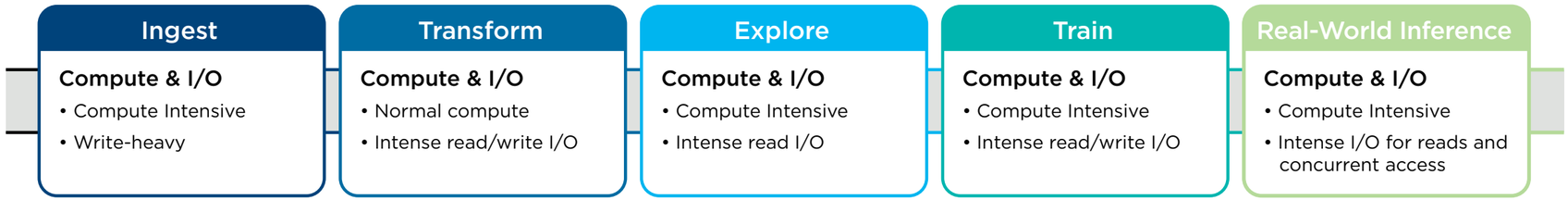
Becoming AI Ready

A successful deployment of AI in healthcare brings many components together. It starts with choosing an appropriate initial use case, putting a skilled team together, and building a solid infrastructure. In the process of building an AI-ready infrastructure, much of your time will be spent on data-related tasks such as gathering, labeling, loading, and augmenting data.

A data pipeline is the collection of software and supporting hardware that lets you efficiently collect, prepare, and manage data so that you can train, validate, and operationalize an AI algorithm. The need for a well-designed data pipeline might not be immediately evident in the early stages of AI planning and development, but its importance grows as data volumes increase and the trained model moves from prototype to production.



- Data creation often occurs at the edge of your network; intelligent point-of-sale devices are one example. IoT-connected devices and sensors are becoming increasingly important across all industries.
- Preprocessing is necessary to normalize your data before training can occur. Preprocessing takes place in a data lake, possibly an Amazon S3 object store in the cloud or a file store on premises.
- During the explore stage, you figure out which deep learning models are most promising based on your datasets and the outcome that you want.
- Data must be moved into the training cluster periodically to train inference models. Training is an iterative process that typically takes place at regular intervals throughout the life of a model.
- After an inference model has been trained and tested, it is deployed in the real world. Models are often stored in a DevOps-style repository where they benefit from ultralow-latency read access.

Figure 1) A well-designed data pipeline enables data to flow freely through multiple AI stages, meeting the unique I/O requirements of each stage and preventing bottlenecks.

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Accelerate Your Journey to AI

You can't satisfy your AI objectives without trusted advisors equipped to help you design and implement a strategy that supports innovation at scale. NetApp offers smart, powerful, and trusted solutions to help you unlock the potential of AI, ML, and DL.

Accelerate your AI journey from predictive analytics to autonomous decisions with a future-proof system that spans data management challenges from edge to core to cloud. Only NetApp enables customers to integrate their data fabric across edge, core, and cloud.

Edge Solutions	Core Data Center Solutions	Cloud Solutions
NetApp ONTAP® Select gives you the power of ONTAP software on your choice of commodity servers, hypervisors, and media. Available in ruggedized configurations, it can support the harshest environments.	NetApp AFF A800 all-flash storage systems deliver ultralow latency of less than 200 microseconds and massive throughput of up to 300GBps. The NetApp ONTAP AI proven architecture, powered by NVIDIA DGX supercomputers and NetApp cloud-connected storage, meets the most demanding AI training needs. FlexPod® AI is based on an industry-leading converged infrastructure, powered by NetApp AFF cloud-connected storage, Cisco Nexus switches and Cisco UCS ML M5 purpose-built, AI/ML servers. FlexPod AI provides a versatile, UCS-based platform for AI/ML innovation that is trusted worldwide.	NetApp's cloud data services deliver instant productivity. Bring NetApp's superior data management and NFS capabilities to Azure with Azure NetAppFiles, to Amazon Web Services with Cloud Volumes Service for AWS and to Google Cloud with Cloud Volumes Service for Google. The NetApp AI Control Plane provides full-stack data and experiment management across the hybrid cloud. NetApp FabricPool automatically tiers cold data to the public cloud or to on-premises object storage and automatically recalls data when needed, extending your available storage capacity.

Table 1) Key solution examples for the data pipeline.

Find Out More

To learn more about the entire NetApp AI solutions portfolio, including ONTAP AI, visit NetApp.com/AI.

Endnotes

[1] Source: NVIDIA, AI and Deep Learning Customer Stories

[2] Source: NVIDIA, AI and Deep Learning Customer Stories

[3] Source: NVIDIA, AI and Deep Learning Customer Stories

[4] Source: NVIDIA, AI and Deep Learning Customer Stories

[5] Source: Nuance, Nuance EHR Services Infographic

[6] Source: NVIDIA, AI and Deep Learning Customer Stories

[7] Source: NVIDIA, AI and Deep Learning Customer Stories