Mayo Clinic helps radiologists pinpoint potential problems

Overview

The Need
Mayo Clinic sought to transform the way it processes and interprets medical imaging results to enable more accurate detection.

The Solution
Mayo Clinic worked with IBM to create new analytic algorithms and integrate them seamlessly into its radiology workflow.

What Makes it Smarter
Powerful algorithms pinpoint potential problem areas within medical images and flag them based on the probability of abnormality.

The Result
"Our imaging and radiology work will help provide faster and better information for our physicians and improved treatments for our patients."

– Bradley Erickson, M.D., Ph.D., head of Mayo Clinic's Radiology Informatics Lab, co-director MI3C

In the long upward trajectory of healthcare progress, technology has played a critical role at nearly every step. Incorporating technology into the delivery of healthcare services has enabled clinicians and researchers to look deeper, to see what couldn't be seen and to understand the role of factors like genetics in determining both the likelihood of illness and the response to various treatments. But for all the progress on the technology front, the human touch remains deeply embedded in the way hospitals care for patients. It's seen not only in the importance of compassion and bedside manner, but also in the ability to draw on judgment and experience to diagnose problems and determine the most effective course of treatment.

Medical imaging is perhaps the best example of advanced technology requiring the intervention of human expertise to realize its full clinical potential. Imaging technologies such as computed tomography (CT) scanning and magnetic resonance imaging (MRI) have revolutionized medicine by providing ultra-detailed—and noninvasive—tools to detect and diagnose internal abnormalities. This is generally done by comparing scans over two or more time periods to detect changes in either the size or location of an abnormal mass or condition. While these comparisons wouldn't be possible without advanced imaging technologies, the sheer magnitude of information they generate poses a challenge to the radiologists who analyze it. For example, in the case of CT scans, which produce a series of cross-sectional images, radiologists need to analyze each image, a time-consuming and exacting exercise. Facing this challenge, the world-renowned Mayo Clinic saw imaging informatics as a way to transform its medical imaging processes.

Moving closer to "individualized medicine"

In support of its vision of "individualized medicine," Mayo Clinic is integrating clinical and genomic data from across its organization to develop more targeted and effective treatments. In the medical imaging domain, Mayo Clinic saw an opportunity to move closer to this vision by addressing a different facet of the patient care experience.

Business Benefits

- 50 times reduction in motion correction processing, enabling radiologists to provide results in minutes, not hours
- Estimated 25 percentage point increase in diagnostic sensitivity for detection of brain aneurysms through intelligent flagging of high-risk areas
- Improved patient outcomes through improved diagnostic capabilities
- Improved radiologist productivity and effectiveness through the integration of detection testing into workflow
- Ability to extend the analytical model to other imaging modalities by virtue of SOA-based development approach

The Medical Imaging Informatics Innovation Center (MI3C) collaboration combines advanced computing and image processing capabilities with optimized algorithms to provide faster and more accurate image analysis.

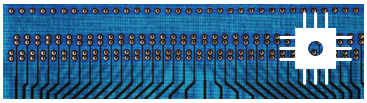
For radiologists to be able to detect subtle changes over time that can indicate problems, medical images need to not only be crisp, but also as close to "apples-to-apples" comparisons as possible. Getting them to this point generally requires special algorithms, some to correct image blur or distortion commonly caused by the patient's breathing, heartbeat or movement, others to properly align images when the patient's position or equipment differences caused a difference in image orientation. Given the complexity of these algorithms, it can take hours to run them and determine if the original images were correctable. This means patients would have to be rescheduled if images could not be electronically corrected.

Mayo Clinic attracts patients from around the world. By necessity, such patients tend to compress a lot of activity—including multiple tests and specialist consultations—into a very short time. This dynamic is one reason the culture of speed and efficiency prevails within Mayo Clinic's operations. Pooling their complementary expertise, Mayo Clinic and IBM modified the image correction algorithms to take full advantage of the computational capabilities of the IBM BladeCenter® QS21 Cell Blade servers at the core of the MI3C solution. Leveraging the Cell Broadband Engine™—a powerful processing architecture developed by IBM, Sony and Mitsubishi—the MI3C executes the algorithms 50 times faster, enabling radiologists to interpret results within minutes of the patient's test.

Weaving intelligence into the imaging workflow

In addition to shortening the image processing cycle, Mayo Clinic also saw an opportunity to use the MI3C expertise to improve the efficiency of the image comparison and analysis process executed by radiologists. To prove the concept, Mayo Clinic and IBM targeted the especially

Smarter Healthcare: Leveraging algorithms to improve accuracy



Instrumented

Imaging results are captured and trigger execution of algorithms that identify and mark suspicious areas within image results.

Interconnected

Enhanced imaging results are seamlessly integrated into radiology process workflows and accessed for interpretation.

Intelligent

Embedded insights inserted by the algorithms improve radiologist visibility to hidden, potentially significant conditions.

Solution Components

Software
- IBM WebSphere® Process Server
- IBM DB2® for Linux®, UNIX® and Windows®

Hardware
- IBM System x®
- IBM BladeCenter® HS20
- IBM System Storage™ DS8100

Services
- IBM Systems and Technology Group

complex and manual process of identifying brain aneurysms, the abnormal bulging outward of arteries in the brain. Simply having the technical capability to perform this analysis wasn't enough. To maximize its clinical effectiveness, Mayo Clinic and IBM needed to weave this automatic "read" seamlessly into the radiology workflows.

Using IBM WebSphere® Process Server to model and orchestrate the process flow, IBM worked with Mayo Clinic radiologists to design a medical imaging workflow that enables radiologists to run detection algorithms in the course of their typical activities using the same equipment. While Mayo Clinic selected Magnetic Resonance Angiography (MRA), which produces pictures of blood vessels in the brain, the solution was designed to be easily configured to any type of imaging technology. Once MRA images are acquired, they are automatically routed to MI3C servers, where algorithms align the images properly and analyze them (based on Mayo Clinic criteria) to find and visually mark potential aneurysms. The results of the detection algorithm can then be routed to Mayo Clinic's PACS (Picture Archiving System) network, where they are viewable on the radiologist's workstation. Throughout the process, images are stored in an IBM DB2® for Linux®, UNIX® and Windows® data server, while workflow logic is run on IBM System x® servers and IBM System Storage™.

The impact on the new workflow is that radiologists are able to better verify their interpretation of MRA images. For Mayo Clinic, the benefit is neither time nor cost savings, but the improvement in diagnostic accuracy—and therefore the quality of patient care—that the new imaging workflow enables. In practice, the proof-of-concept solution generated a 95 percent accuracy rate in detecting aneurysms, compared with 70 percent for manual interpretation ("The Detection and Management of Unruptured Intracranial Aneurysms." Authors: Wardlaw JM, White PM … Brain 2000;123(pt2):205-21). On the heels of its brain aneurysm detection success, Mayo Clinic expects to apply the same approach for other tests with challenging radiology detection requirements such as better characterization of breast lesions with MRI.

The MRA solution was designed with this flexibility in mind. Emblematic of the SOA approach IBM followed, the solution employs a library of reusable Web Services that perform specific functions. The workflows at the heart of the solution, orchestrated by IBM WebSphere Process Server, invoke these services as needed. The solution's reliance on reusable assets will make it much easier for Mayo Clinic to extend this service model to other radiological processes. Bradley Erickson, M.D., Ph.D., head of Mayo Clinic's Radiology Informatics Lab and MI3C co-director, sees the clinic's medical imaging initiatives as reinforcing its constant and single-minded emphasis on improving patient care. "Our imaging and radiology work will help provide faster and better information for our physicians and improved treatments for our patients," says Erickson.

For more information

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