Solution Brief

Healthcare
Computer Vision Inferencing

Winning Health's Machine Learning-Based Bone Age Assessment (BAA) Solution Eases Clinician Workloads

Intel optimizations of Winning Health's BAA model reduce BAA image analysis to four seconds,[1] enabling large scalability of SaaS solution for hospitals and clinicians on cloud platforms

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卫宁健康 WINNING HEALTH

"There is a shortage of pediatricians and imaging doctors in our country, and there is a shortage of pediatric imaging doctors. Artificial intelligence can also help solve the problem of manpower shortage and subject development."

– Professor Yang Xiujun of Shanghai Children's Hospital

Bone age assessment (BAA) of unknown people is one of the most important topics in clinical procedure for evaluation of biological maturity of children.[2] A bone age study helps doctors estimate the maturity of a child's skeletal system. BAA is often requested by pediatricians and endocrinologists for comparison with chronological age for diagnosing diseases, which result in tall or short stature in children.

BAA is a decades-old method done by comparing an X-ray of a left hand and wrist with an atlas of known sample bones. Several such atlases exist as results of studies. Statistics have been compiled to indicate the percentage of height growth remaining at a given bone age. But this manual method is time-consuming, and, with variability of practitioners, it is prone to variability in age determination.

Figure 1. Child's left-hand X-ray for BAA. (courtesy of Winning Health).

Recently, BAA has been a focus of machine learning (ML). The Radiological Society of North America (RSNA) sponsored an ML challenge in 2019 using thousands of X-rays for training.[3] 48 teams participated, demonstrating machine learning methods that provided high accuracy, reduced the human rater variability, and offered a foundation for more research.

Winning Health has taken their expertise in ML, image analytics, and medical software solutions to develop an artificial intelligence- (AI) enabled BAA tool. Their software delivers highly accurate assessments very fast, enabling a platform for clinical diagnostic assistance for BAA in children. With Intel optimizations integrated into their software and models, they can offer an online service to clinicians that returns BAAs in mere seconds.

Winning Health's AI-based BAA Solution

Winning Health is a leading healthcare software and solutions provider in China. The company develops software systems to enable digital transformation of IT infrastructure in hospitals. Such solutions help customers integrate business functions, healthcare data, and service delivery on a connected digital platform. With the emergence of AI, Winning Health created its AI lab to focus on developing ML diagnostic medical solutions, such as BAA.

Winning Health developed its BAA algorithm using the RetinaNet Inception v4 model and a deep convolutional neural network based on feature extraction. Their method resulted in high performance and high prediction accuracy. (Winning Health's work is described in the Academic Journal of Second Military Medical University.[4])

The software was built on a PyTorch framework. The software is currently used in two children's hospitals in China, including deployment on a GPU-based solution at Shanghai Children's hospital. However, challenges limited its scalability for on-premises deployments across many hospitals.

To scale the solution easily and make it widely available to practitioners, the company is targeting it as a cloud-based Software as a Service (SaaS). Winning believes such a strategy not only improves scalability but also makes model maintenance and upgrade much easier, providing continuous enhancements and improvements to the model and service.

To enable scalable delivery on Intel® architecture-based cloud platforms, Winning developers worked with Intel to optimize their model. Developers targeted maximum inferencing latency of 30 seconds per image.

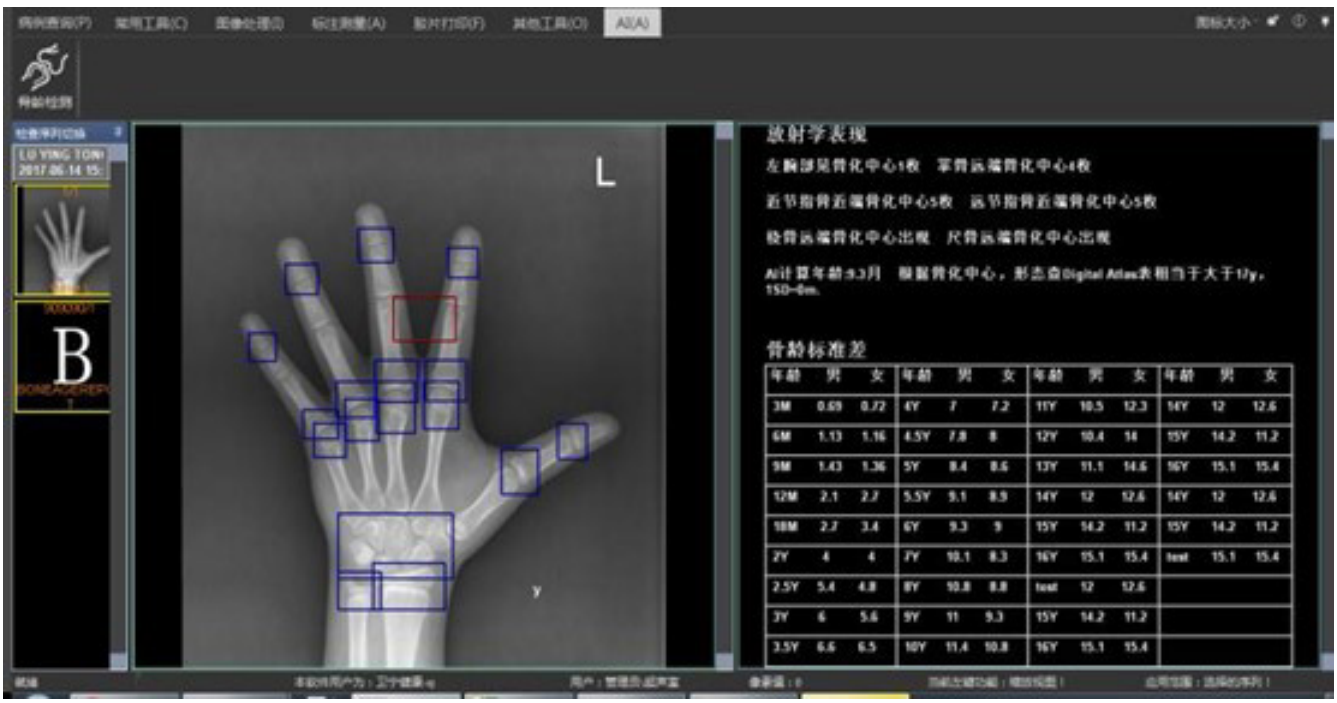

Figure 2. Example of BAA using computational software.

Optimizing Winning's BAA for Scalable, Cloud-Based SaaS

Intel AI technology advancements, such as Intel Deep Learning Boost and Intel Advanced Vector Extensions 512, are built into 2nd Gen Intel Xeon® Scalable processors. These technologies along with Intel AI software capabilities can drive improved training and inference performance for applications, such as Winning's BAA service.

To optimize the RetinaNet Inception v4 model for Intel architecture, engineers leveraged the Intel Distribution of OpenVINO™ toolkit to integrate the following into Winning's solution:

- Intel Optimizations for PyTorch
- Intel Math Kernel Libraries for Deep Neural Networks (Intel MKL-DNN) and oneDNN
- Intel Extension for PyTorch 1.0.1 (IPEX)
- PyTorch Just-in-Time (JIT) trace compilation

The optimizations were designed to support simultaneous multistream image detection to improve overall performance and time to solution.

Inferencing benchmarks (FP32) were run on two-socket servers with Intel Xeon Gold 6238M processors, 22 cores per socket. Testing illustrated the improvements in performance using various optimization methods. Testing and optimizations included:

- A baseline benchmark using PyTorch 1.5
- Convert Winning's code using the Intel Extension for PyTorch
- Applying PyTorch JIT trace compilation with previous optimizations

The results of the benchmarking are shown in Figure 3.

The combination of Intel Extension for PyTorch, Intel Optimizations for PyTorch, and PyTorch JIT trace compilation, performance was 2.8X faster than the baseline. These optimizations shortened assessment time from 11 seconds per image to four seconds per image, running on Intel Xeon Gold 6238M processors. Considering Winning's latency target was 30 seconds, the Intel optimizations delivered BAA image processing 7.5X faster than desired.

Faster assessments allow Winning to easily scale their SaaS solution across cloud platforms and process images quickly. Clinicians can receive results faster and make more diagnoses in less time, which can reduce backlogs of imaging diagnostics in hospitals and possibly accelerate treatment plans.

The average number of BAA examinations per day in China is about 127.[5] The calculation can save doctors 2,794 minutes per day. (22 minutes * 127 cases), calculated as 320 days a year, saving 894,080 minutes throughout the year, totaling about 14,901 hours.

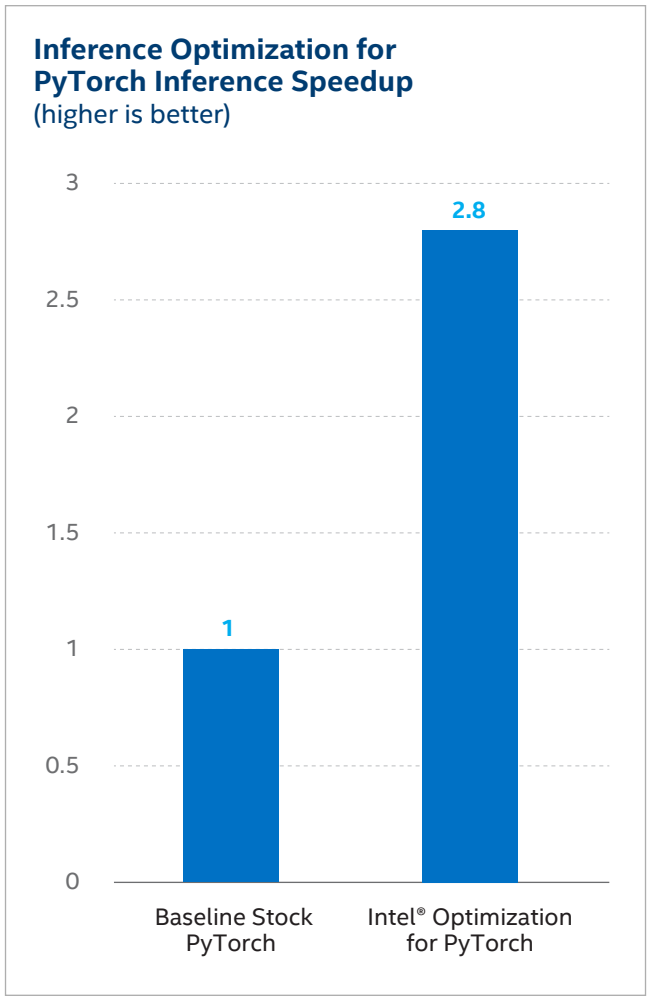

Figure 3. Benchmark results with Intel optimizations of Winning's BAA solution.

"The imaging physicians had a book of atlases. Due to frequent use, they had to change one in half a year, and they were all ripped apart. This kind of mechanical and tedious work is particularly suitable for artificial intelligence to complete."

– Professor Yang Xiujun of Shanghai Children's Hospital

Conclusion

BAA is a key diagnostic tool used by clinicians around the world. Manually completing BAAs takes time and introduces variability from observer to observer. Winning's original ML-based solution could analyze an X-ray image in seconds, but not fast enough to make the solution scalable as a SaaS to a wide market of clinical settings. By integrating Intel optimizations for Winning's BAA software, X-ray images could be processed 2.8X faster, reducing wait time for a BAA to a mere four seconds. These optimizations enable Winning to easily scale their solution across cloud platforms, making the service widely available without hospitals building out expensive and costly IT environments to support ML-based BAA.

"We are very thankful for the support we received from the Intel team throughout the engineering collaboration in this project. Intel team has offered not only the technical consultation to help us optimize the solution but also the professional training of the latest Intel AI technologies in general. The collaborative experience is productive and pleasant. The partnership paves the way for our future cooperation. Through this partnership, we aim to integrate our optimized AI solutions into Winning Health's current product offerings and enable the digital transformation of IT systems of hospitals in China. We hope our 5000 customers in China can benefit from these intelligent medical solutions and products we offer."

– Director LIU Mingqian of Winning Health AI Lab

For more information about the Winning Health, visit **winning.com.cn**
Learn more about the Intel AI Builders program at **builders.intel.com/ai**

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Winning Health Technology Group is a leading healthcare software and solution provider in China. The company develops software systems to enable digital transformation of IT infrastructure in hospitals and help them integrate business functions, healthcare data, and service delivery on a connected digital platform.

[1] BASELINE: Test by Intel as of 1/21/2021. 1-node, 2x Intel® Xeon® Gold 6238M CPU @ 2.10 GHz, 22 cores, HT On, Turbo ON. Total Memory 192 GB (12 slots/16 GB/2933 MHz), BIOS: 4.14 (ucode:0x5003003), Ubuntu 20.04.1 LTS, 5.8.0-38-generic, gcc 9.3.0 compiler, <Bonenet> PyTorch 1.5.0, score=1

Config-2: Test by Intel as of 1/22/2021. 1-node, 2x Intel® Xeon® Gold 6238M CPU @ 2.10 GHz, 22 cores HT On Turbo ON Total Memory 192 GB (12 slots/16 GB/2933 MHz), BIOS: 4.14 (ucode:0x5003003), Ubuntu 20.04.1 LTS, 5.8.0-38-generic, gcc 9.3.0 compiler, <Bonenet> PyTorch 1.5.0, Intel Extension for PyTorch 1.0.x build from PyTorch and IPEX branch 6e5288e, score=2.8

[2] https://pubmed.ncbi.nlm.nih.gov/24454534/

[3] Radiology: Volume 290: Number 2—February 2019 n radiology.rsna.org

[4] Academic Journal of Second Military Medical University, Aug. 2018, Vol. 39, No.8 Http://www.ajsmmu.cn

[5] SOURCE: Based on the data query for 66 working days before October 20, 2020

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