Case Study

Healthcare
Intel® Processor, Intel® oneAPI Base and AI Toolkit

Maximizing the power of AI for timely and more accurate mental health diagnosis

HippoScreen transforms mental healthcare with the help of Intel® oneAPI Base and AI Analytics Toolkits to improve depression screening accuracy, accelerate turnaround times, and provide better patient care.

"We at HippoScreen have been able to take advantage of the software optimizations in Intel Extension for Scikit-learn and Intel Optimization for PyTorch to accelerate the build times for the AI models in our customized EEG Brain Waves analysis system by 2.4x."

Daniel Weng
Chief Technology Officer, HippoScreen NeuroTech Corp.

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HippoScreen Neurotech Corp

Depression represents a major global health issue, posing significant hurdles in diagnosis and treatment within the multifaceted landscape of mental health. Globally, an estimated 5% of adults,[1] 1.1% of adolescents aged 10-14 years, and 2.8% of 15-19-year-olds[2] suffer from depression. This equates to millions of people worldwide who are struggling with depression making it a significant public health concern.

Diagnosing depression is not a straightforward task and there is no universally applicable procedure. This is because depression manifests differently in different people. While there are clinical methods to diagnose certain cases of depression, these tools do not always provide a complete picture of the individual's mental health status. For the majority of assessments, healthcare providers rely heavily on patients' own descriptions of their feelings and experiences. This can be challenging as it requires patients to accurately articulate their internal emotional state, which can be particularly difficult for those experiencing mental distress.

In order to address this challenge, HippoScreen, developed the Stress EEG Assessment (SEA System, leveraging the Intel® AI Analytics Toolkit and Intel® oneAPI Base Toolkit, which helps healthcare providers diagnose mental health conditions more accurately and in a timely manner.

Addressing Challenges in Diagnosis and Treatment of Depression

According to recent statistics, approximately 50% of individuals with mental health conditions do not receive the proper diagnosis or treatment within the first year of seeking help.[3] This delay can have long-lasting consequences, as early intervention is crucial in managing and improving mental health outcomes.

A significant hurdle is the scarce availability of mental health professionals, especially in rural regions where specialized care is often limited. The demand for mental health assessments significantly exceeds the supply due to an insufficient number of psychiatrists and psychologists, resulting in long waitlists and diagnosis delays. Additionally, large caseloads for existing professionals can impede their ability to provide swift evaluations and accurate symptom interpretation.

Another challenge is ensuring that individuals receive an accurate diagnosis amid numerous factors such as misreported symptoms or multiple co-occurring conditions. Mental health conditions often have complex symptomatology that external factors like substance abuse or physical illnesses could influence. To complicate matters further, some symptoms may overlap across specific disorders making it challenging for healthcare providers to pinpoint an accurate diagnosis promptly.

These challenges underscore the need for innovative solutions to improve accessibility and shorten wait times for mental health assessments. Additionally, incorporating machine learning algorithms into diagnostic procedures could aid clinicians by more efficiently analyzing large data sets and providing personalized insights based on observed patterns across similar cases.

Maximizing AI for a Better Mental Depression Diagnosis

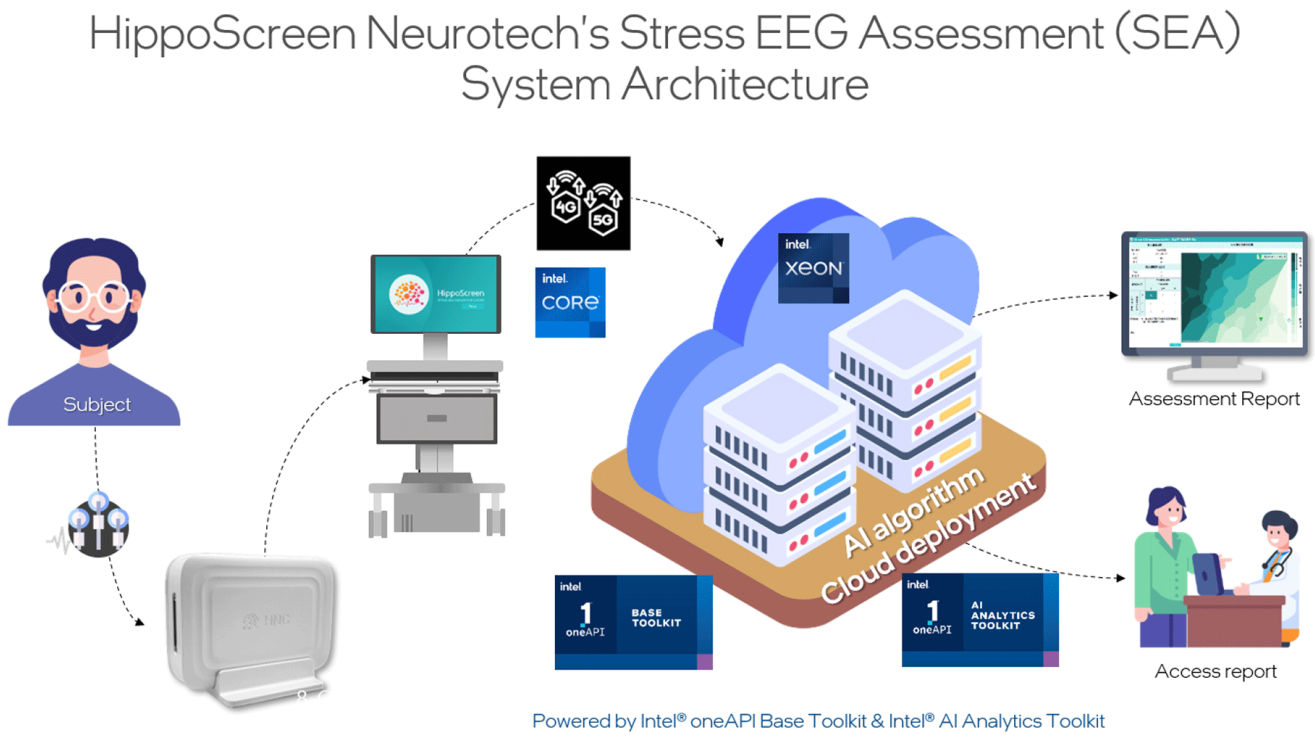
HippoScreen's Stress EEG Assessment (SEA) system was designed to provide a solution to these challenges. The SEA system helps healthcare providers diagnose mental health conditions more accurately. Unlike traditional methods that rely solely on patients' self-assessment, HippoScreen takes a unique approach by using brainwave technology. This approach maximizes real-time behavior processing to identify the user's cognitive state through brainwaves analysis of the individual. The SEA system combines an EEG amplifier for data capture and signal processing, a GUI (Graphical User Interface) for managing the test process, and an AI algorithm for data analysis. By analyzing 90-second segments of brainwave signals, SEA provides a numerical evaluation index, which objectively and quantifiably represents the likelihood of an individual experiencing depression.

The solution is designed to achieve the desired outcome by maximizing various algorithms used in data preprocessing, feature extraction, feature selections, and classifiers. To achieve this, HippoScreen needed to address a few challenges that are also faced by other AI solutions for healthcare. The challenges primarily encompassed the generalization of the AI model to ensure its applicability in real clinical usages, the design of a well-controlled test process to uphold the data quality, and the assurance that the AI model could handle data variation, which is crucial for successful outcomes. As a result, locating the optimal parameters and the perfect feature set within these algorithm combinations could take several days. In this context, the enhancement of these algorithms' efficiency is crucial, and it could potentially be the key to achieving timely delivery of these optimized results.

This is where Intel played a crucial role in aiding HippoScreen to improve efficiency and build times of deep-learning models used in its brainwave AI based SEA system.

Improving Algorithm Efficiency and Diagnostic Accuracy with Intel

HippoScreen was able to optimize their SEA solution and improve the efficiency, performance, and accuracy of their deep learning models, while reducing the delivery times of critical diagnostic results, by using Intel AI Analytics Toolkit and Intel oneAPI Base Toolkit.



HippoScreen's development process incorporates a blend of various algorithms and models to create a unique decision factor. Central to this process is the utilization of HippoScreen's proprietary algorithms designed specifically for their unique needs. In addition to their own algorithms, HippoScreen integrates the deep learning models of Intel-optimized PyTorch. This includes models such as SCCNet, EEGNet, and Shallow ConvNet. These sophisticated models are designed to process vast amounts of information and identify patterns that may not be apparent with traditional analysis methods.

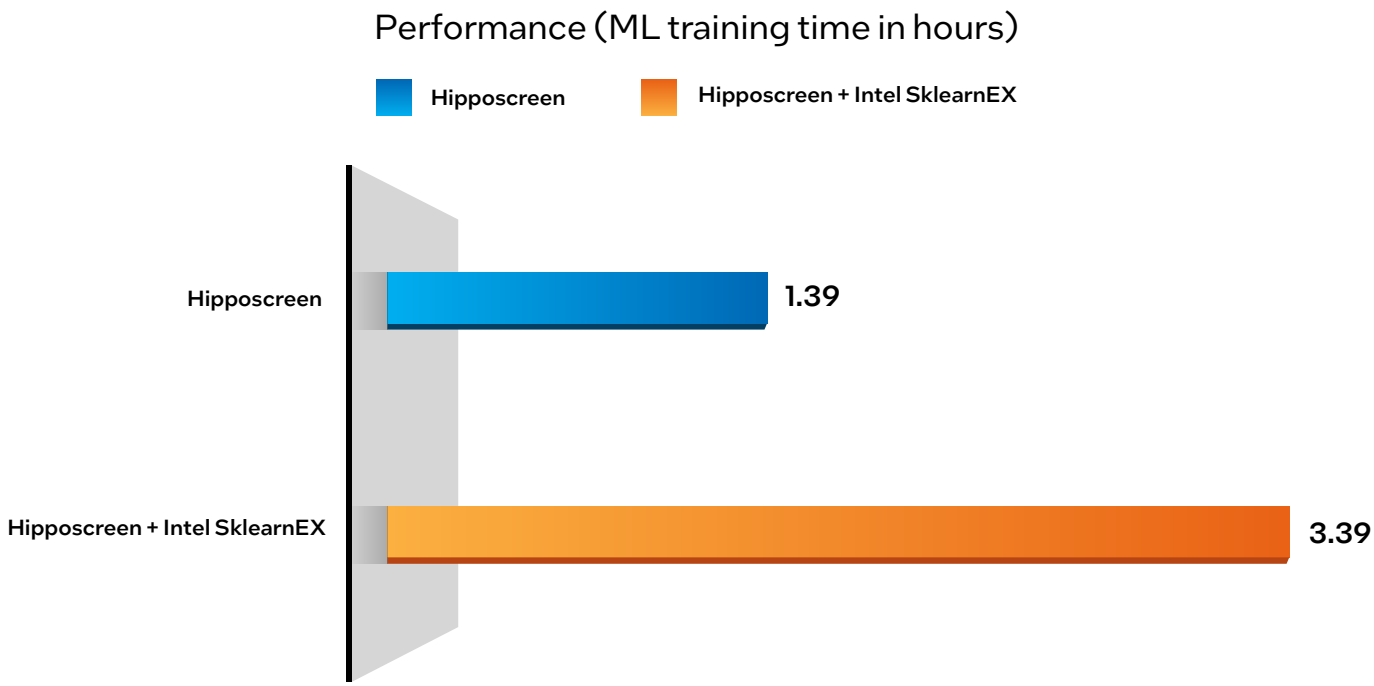
To further enhance the system's capabilities, traditional machine learning algorithms from Intel's scikit-learn are also incorporated. These algorithms, which include Kmeans, Support Vector Classification, and Support Vector Regression, provide robust and proven techniques for analyzing data. This diverse mix of algorithms and models is used to analyze EEG Data features. The integration of these various approaches allows for a more comprehensive and nuanced analysis, ultimately leading to the formulation of a unique decision factor. This decision factor, born out of the interplay of proprietary algorithms, deep learning models, and traditional machine learning algorithms, represents the culmination of HippoScreen's innovative approach to mental health diagnosis. This approach holds the promise of more accurate and timely diagnoses, potentially improving treatment outcomes for countless individuals.

Another key tool that has revolutionized HippoScreen's deep learning process is the Intel® oneAPI Math Kernel Library (oneMKL). This library provides highly optimized mathematical functions specifically designed for machine learning applications. With oneMKL, HippoScreen models are able to perform complex mathematical calculations faster. This saves valuable processing time and enables HippoScreen to build larger and more accurate deep learning architectures.

By using frameworks like Intel® Extension for TensorFlow* and PyTorch* Optimizations from Intel, HippoScreen has gained access to industry-leading libraries and pretrained models. These frameworks provide a solid foundation for developing advanced AI algorithms with high-level APIs, extensive documentation, and a vast community of developers actively contributing to their improvement. Using these well-established frameworks not only streamlined the development process but also ensured compatibility with a wide range of hardware configurations, making it easy for HippoScreen to integrate its AI solutions into diverse environments. Furthermore, predictive analytics capabilities enable HippoScreen to anticipate customer needs and behaviors, giving them a competitive edge.

Delivering the Performance Boost for Timely and More Efficient Depression Diagnosis

HippoScreen's SEA was able to achieve a **2.4x increase in performance**[4] by maximizing Intel AI Analytics Toolkit and Intel oneAPI Base Toolkit along with the power of Intel® processors for AI workloads. This played a critical role in enabling HippoScreen's SEA to achieve the optimal performance threshold required to enhance efficiency and reduce the diagnosis time significantly.

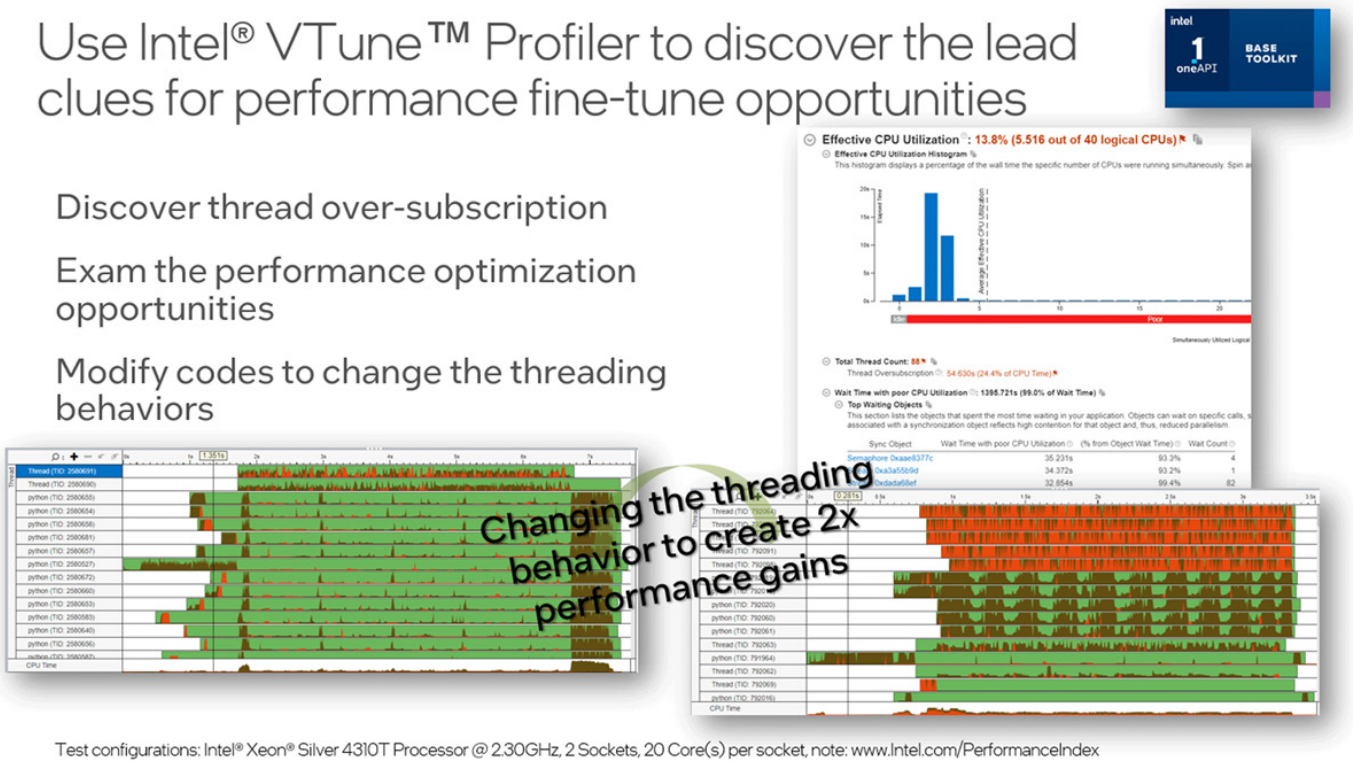


Test configurations: Intel® Xeon® Gold 6330 CPU @ 2.00GHz, 2 Sockets, 28 Core(s) socket, note: www.intel.com/PerformanceIndex

Overall, Intel's AI tools and frameworks have been instrumental in helping HippoScreen's SEA reach its full potential with advanced analytics capabilities. HippoScreen utilized Intel® VTune™ Profiler to gain in-depth insights into the total logical CPU count and software thread count in both their own and Intel's python* environment with different OpenMP libraries. This deep-dive analysis was instrumental in understanding the system's performance and identifying areas for optimization.

In both HippoScreen's and Intel's python environment, Intel VTune Profiler made a recommendation to reduce the thread count. This recommendation was based on the observation that both cases involved thread oversubscription, a situation where more software threads are assigned than the total logical CPUs, resulting in inefficient CPU utilization. By following the recommendations, HippoScreen could adjust the thread count to strike a balance between performance and CPU utilization. This adjustment process involved careful testing and analysis to find the optimal thread count-the 'sweet spot' where the performance was maximized, and CPU utilization was minimized, resulting in **2x performance gain.**[4]

Finding this balance was a significant achievement, as it allowed HippoScreen to optimize the system's performance without overtaxing the CPU. This not only improved the efficiency of the system but also potentially extended the lifespan of the hardware by preventing unnecessary strain on the CPU.



Test configurations: Intel® Xeon® Silver 4310T Processor @ 2.30GHz, 2 Sockets, 20 Core(s) per socket, note: www.Intel.com/PerformanceIndex

Delivering Real-World Benefits

By effectively harnessing the power of Intel's AI tools and technologies, HippoScreen's SEA has reaped substantial benefits, marking a pivotal advancement in its operational capabilities and overall performance. One of the key benefits is the enhanced ability to study brainwave patterns and understand various cognitive states. By harnessing the power of AI, researchers can now delve deeper into deciphering complex neurological phenomena like attention, memory, and emotions. The fast-processing capabilities provided by Intel AI tools and technologies enable more efficient analysis of massive amounts of data, leading to breakthroughs in the understanding of how several factors impact the brain function.

Moreover, this integration has improved research capabilities, opening up exciting possibilities for practical applications in fields like healthcare and education. For instance, medical professionals can utilize this sophisticated analytics platform to diagnose cognitive disorders with greater accuracy or to precisely track patients' progress during treatments. The capability to accurately diagnose and monitor progress can lead to more effective treatment plans and potentially better patient outcomes. In the education sector, these newfound insights can be used to develop personalized learning experiences that cater more effectively to individual students' needs. By understanding how different factors impact cognitive function, educators can tailor teaching methods and strategies to better suit each student, potentially leading to improved learning outcomes.

Conclusion

Integrating AI tools from Intel into HippoScreen's SEA marks a transformative milestone in neurology diagnostics. The collaboration between HippoScreen AI and Intel demonstrates how emerging technologies can enhance our ability to monitor brainwaves effectively—an exciting advancement in neurology. By harnessing the power and intelligence offered by platforms like Intel Extension for PyTorch and scikit-learn, researchers, clinicians, and patients benefit from improved screening accuracy, quick turnaround times, and better patient care through early intervention strategies tailored to individual needs.

About HippoScreen

HippoScreen Neurotech Corp. (HNC) is a Taiwan-based startup company backed by Compal Electronics. With electroencephalogram (EEG) signal processing and artificial intelligence technology as the pillars, HippoScreen is developing EEG-assisted medical diagnosis tools. Their proprietary EEG amplifier cleared FDA 510(k) at the end of 2020, completed the TFDA review, and received official approval for use as a medical device in March 2021, becoming the first medical-grade EEG amplifier developed and manufactured in Taiwan. HippoScreen has collaborated with three medical centers in Taiwan to build the largest cross-center EEG-based database on clinical depression in the world. Their AI software, the Stress EEG Assessment System designed to aid in depression diagnosis, was also approved and registered by TFDA in November 2023.

intel.

1 Source: https://www2.deloitte.com/us/en/insights/industry/health-care/global-neuroscience-market-investment-report.html

2 Source: https://www.who.int/news-room/fact-sheets/detail/adolescent-mental-health#:~:text=It%20is%20estimated%20that%203.6,and%20unexpected%20changes%20in%20mood

3 Source: https://www.who.int/health-topics/depression#tab=tab_1

4 Source: https://www.intel.com/content/www/us/en/developer/articles/technical/supercharge-your-ai-with-ai-tools-from-intel.html

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