Weill Cornell Medicine

NerveAI: An ML-enabled Platform for Identification of Nerve Pain

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Background & Unmet Need

- Headache disorders (HD) affect around 40% of the global population, around 3.1 billion people in 2021[1]

- A large share of HD patients (>25% of HD patients in the US) also suffer from undiagnosed nerve pain, which often causes their HD

- Accurate identification of such nerve pain remains challenging due to the lack of standardized screening, delaying appropriate treatment and limiting access to care

- While some specialized providers can diagnose nerve pain through patient history and exams, most primary care physicians and general neurologists are not adequately trained to identify nerve pain

- Some HD experts use patient pain drawings to aid diagnosis, but this requires expertise in peripheral nerve anatomy, making it time-intensive, error-prone, and less accessible

- **Unmet Need:** Standardized screening for nerve pain among HD patients

Technology Overview

- **The Technology:** Platform for screening patients for nerve pain using a digital 3D model of the head on which patients draw their pain

- The platform leverages AI-based pattern recognition to automatically evaluate pain drawings to diagnose nerve pain and identify patients that are candidates for headache surgery

- A prototype of the platform has been developed and trained on 1,300 3D pain drawings

- **PoC Data:** The highest performing model, a multilayer perceptron (MLP) model, distinguished nerve pain from other types of head and neck pain with an AUROC of 0.879, precision of 0.943, specificity of 0.611, and sensitivity of 0.640

- Another model, XGBoost, performed exceptionally well in detecting different types of nerve pain such Trigeminal Neuralgia (AUROC: 0.954), occipital nerve pain (AUROC: 0.928), and frontal nerve pain (AUROC: 0.930)

Inventors:
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Patents:
PCT Application Filed

Publications:
Chartier et al. *Plast Reconstr Surg.* 2023.
Gfrerer et al. *Plast Reconstr Surg.* 2020.

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[1]"Migraine and other headache disorders." *World Health Organization*. March 6, 2024.

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Technology Applications

- Screen patients in specialist or non-specialist settings for nerve pain in the head and other areas of the body
- Stratify patients to non-surgical versus surgical treatment, such as nerve decompression surgery
- Predict treatment response to surgical interventions
- Differential diagnosis of nerve pain conditions, such as neuroma, thoracic outlet syndrome, sciatica, etc.

Technology Advantages

- Enables fast, inexpensive, & non-invasive screening
- Allows less specialized practitioners to assess candidacy for headache surgery
- Provides an intuitive system for patients to communicate their pain
- Early identification of nerve pain can prevent chronic pain and reduce risk of addiction to pain medication, substance abuse, and long-term disability
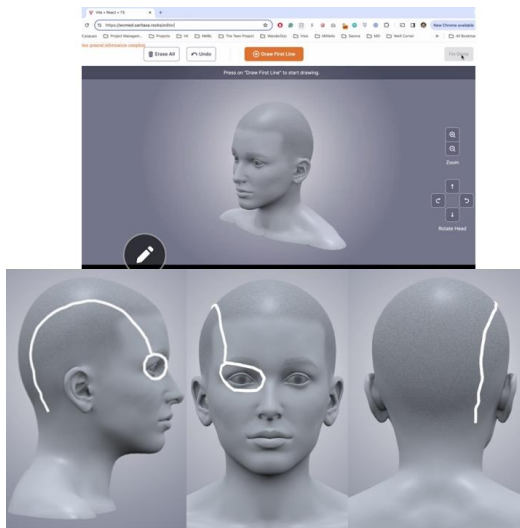
Supporting Data / Figures

Figure 1: Rendering of mobile screening application, which allows for touch-enabled creation of pain drawings.

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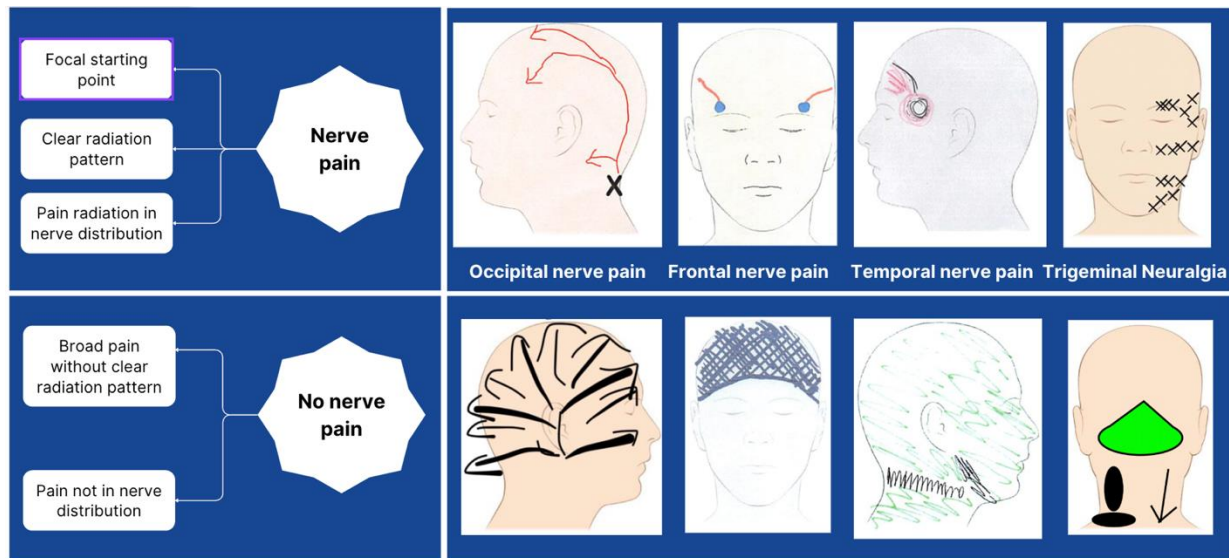
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Figure 2: Examples of Pain drawings depicting nerve pain versus no nerve pain.

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Patents:
Provisional Filed

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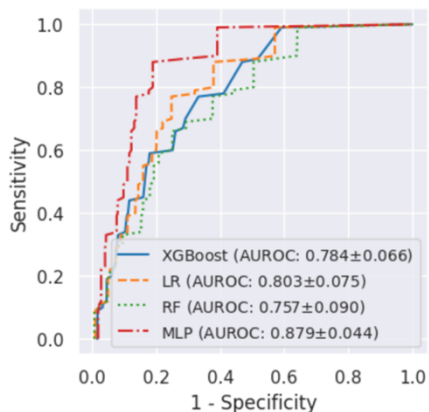**Biz Dev Contact:**
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Supporting Data / Figures

Classification of Nerve vs Non-nerve Pain
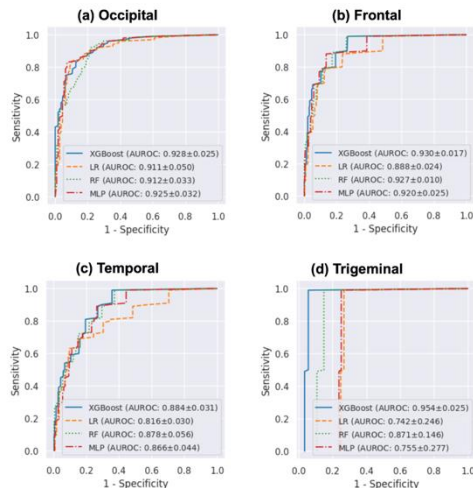

Classification Across Nerve Pain Types

Figure 3: AUROC curves for for four different machine learning models: XGBoost (extreme gradient boosting), LR (Logistic Regression), RF (Random Forest), and MLP (multilayer perceptron) classifying nerve pain versus no nerve pain **(left)** and across nerve pain types: Occipital, Frontal, Temporal, and Trigeminal Nerve **(right)**.

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