

**Explainable Machine Learning for Biomedical
Diagnostics: Optical Imaging and EEG Signal Analysis**

a dissertation to be defended by

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Abstract—The increasing availability of complex biomedical data opens new avenues for improved disease detection and physiological understanding via artificial intelligence (AI). However, traditional analysis methods often rely on simplified metrics that overlook subtle biological differences, and many AI systems are difficult to interpret, limiting their clinical trustworthiness and practical use. There is a growing need for explainable, physiologically relevant computational models that can extract key biomarkers from diverse biomedical data sources. This dissertation addresses this issue by developing interpretable machine learning and deep learning techniques for analyzing biomedical signals and optical imaging data.

First, it examines how explainable machine learning can detect Hypopharyngeal cancer (HPC) using near-infrared fluorescence (NIR-I) imaging in mouse models. Quantitative texture features from these images help characterize tumor heterogeneity. Machine learning models outperform traditional methods based on the tumor-to-background ratio (TBR), demonstrating explainable AI's ability to identify subtle imaging biomarkers associated with changes in the tumor microenvironment.

Next, the work investigates neural responses to music perception using electroencephalography (EEG) to determine whether machine learning can reveal meaningful neurophysiological patterns of auditory processing. By combining signal processing, spectral analysis, and deep learning, this research offers insights into how brain states change in response to musical stimuli and demonstrates that explainable frameworks can deepen understanding of neural activity beyond standard EEG analysis.

Finally, it introduces an explainable convolutional channel ranking (ECCR) method for EEG-based detection of idiopathic absence seizures (IAS). ECCR combines deep neural representations with channel-level interpretability to identify bio-signatures associated with seizure activity. This approach not only improves classification accuracy but also enhances understanding by pinpointing neural sources relevant to seizures.

Overall, the studies in this dissertation build a unified, interpretable AI framework for multimodal biomedical data, including optical imaging and electrophysiological signals. By focusing on explainability, physiological relevance, and meaningful biomarker discovery, this work advances transparent, practical AI systems for biomedical use.

When: Tuesday, 7 July 2026, 9:30 - 10:30 (Public Portion)

Where: <https://lsu.zoom.us/j/7445907582>

Info: <https://www.lsu.edu/eng/ece/seminar>

