Bioinformatics PhD Dissertation Defense

UNIVERSITY OF MICHIGAN MEDICAL SCHOOL
MICHIGAN MEDICINE

May 15 @ 9am - 2903 Taubman Health Sciences Library (THSL)

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"Time Representation and Observability of Repeated Measurement Processes with Applications to Spacekime Analytics"

Bioinformatics Graduate Program

Mentor:
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DCMB PhD Dissertation Defense – Yueyang Shen

Complex Time Representation and Observability of Repeated Measurement Processes with Applications to Spacekime Analytics

LOGISTICS

Thursday, May 15, 2025, 9 AM ET (3D View of Taubman Library 2nd floor: https://my.matterport.com/show/?m=tQjegaZqoHf)
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ABSTRACT

This work develops and validates mathematical, computational, statistical, and algorithmic techniques to represent observable processes as computable data objects, which are amenable to subsequent modeling, scientific inference, AI prediction, classification, forecasting, and spacekime analytics. Chapter 1 provides study motivation, an overview of current knowledge, and lays the foundation of complex-time (kime) representation of repeated measurement processes.

The core of this dissertation is organized in four integrated chapters with an overarching theme of observable process representation, computational modeling, scientific inference, AI prediction, classification, and statistical forecasting using high-dimensional spatiotemporal data and (spacekime) analytics. In Chapter 2 we introduce non-local constraints to solve ultrahyperbolic equations. In Chapter 3, we address a particular numerical strategy to convert repeated timeseries observations into richer mathematical objects, kime-surfaces, that can be used for novel statistical learning, computational inference, and artificial intelligence predictions. We show examples using neuroscience data to examine regional brain activation via tensor linear regression on kime-surfaces. We also develop a framework to analyze time-varying distribution modeling on differential equations using reproducing kernel Hilbert spaces (RKHS).

In Chapter 4, we develop a theoretical statistical foundation for building robust and generalizable neural networks (NN). Specifically, we use a string theory dataset to benchmark different NN architectures and discuss their group invariance. In Chapter 5, we develop a brain tumor segmentation method with attention and fractal encoding NN architecture. We also study spatiotemporal analytics using an fMRI music genre dataset. The final, Chapter 6 synthesizes the content of the whole dissertation, draws overall conclusions, and sets directions for future work.