The Hong Kong University of Science and Technology

Department of Mathematics

PhD THESIS EXAMINATION

Taming the Heterogeneous Dynamics in Multivariate Time Series Prediction with Deep Learning

By

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ABSTRACT

Accurate prediction of multivariate time series (MTS) is essential for a wide range of tasks and real applications. The inherent heterogeneous dynamics within MTS across both time series and temporal states pose substantial challenges. In this thesis, we propose a novel framework to tame the heterogeneous dynamics in MTS prediction. The core idea is to generate model parameters conditionally based on task-specific characteristics. The characteristics can be either learned directly from the data or specified a priori. Moreover, which parameters to be generated are flexibly aligned with the underlying model architecture. This approach strikes an optimal balance between effectively utilizing data and preserving idiosyncratic dynamics. We demonstrate the effectiveness of the proposed framework through two real applications in ocean science and finance.

First, we propose Spatiotemporal Dynamics Hunter (STD-Hunter) to facilitate long-term, large-scale prediction of chlorophyll-a (Chl_a) concentration in the South China Sea. To accommodate Chl_a's significant spatiotemporal variability, STD-Hunter forms a predictive model for each task by integrating commonly shared basis models with the specific spatiotemporal characteristics. STD-Hunter consistently outperforms other ML models across various prediction horizons. Moreover, by substantializing veiled heterogeneity into spatiotemporal characteristics, STD-Hunter builds a bridge between the underlying complex dynamics and the heterogeneous Chl_a observations. Second, we propose a novel framework for incorporating state variables into asset return prediction. To account for regime-dependent variability in factor behaviors, we use state variables to generate the parameters of predictive models. Based on fourteen well-documented anomalies in China A-share market, we leverage past factor returns as state variables and demonstrate that our framework consistently improves prediction accuracy across various settings. Moreover, by disentangling the roles of factors and state variables, the proposed framework offers a transparent view into the importance of factors, state variables, and their interactions.

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Time : 10:00 am

Venue : Room 4472 (Lifts 25/26)

***Thesis Examination Committee*:**

Chairman	**:**	**Prof. Jing WANG, ISOM/HKUST**
Thesis Supervisor	**:**	**Prof. Can YANG, MATH/HKUST**
Member	**:**	**Prof. Shiqing LING, MATH/HKUST**
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(Open to all faculty and students)

The student's thesis is now being displayed on the reception counter in the General Administration Office (Room 3461).