

東北大学大学院情報科学研究科
純粋・応用数学研究センター

情報数理談話会のお知らせ

日 時： 2026 年 6 月 29 日 (月) 16:30 より 17:30 まで

場 所： 東北大学大学院情報科学研究科棟 2 階大講義室

講演者： Sai Yao 氏 (東北大学情報科学研究科)

題 目： Statistical Modeling for Nonlinear Modal Interval Regression
(非線形モーダル区間回帰の統計的モデリング)

備 考： この情報数理談話会は課程博士予備審査会を兼ねています

[概 要] Understanding the variability and concentration of real data is essential in many fields, including life sciences, meteorology, economics, and environmental studies. In addition to central tendency, it is often important to describe where observations are most concentrated within a distribution. The modal interval (MI), defined as the shortest interval containing a specified probability, provides a natural way to represent such data concentration.

This work develops a unified framework for modal interval regression and its methodological extensions. First, the role of the MI as a descriptive statistic for data concentration is clarified, and its theoretical properties, including uniqueness, nestedness, convergence properties, and an information-theoretic interpretation, are investigated. Second, a reformulated nonlinear modal interval regression method is developed. The method estimates the conditional distribution using kernel density estimation, constructs the quantile levels corresponding to conditional MI bounds, and fits smooth lower and upper bound functions using quantile loss and splines. The resulting optimization problem is formulated as a convex optimization problem and solved using the alternating direction method of multipliers.

The framework is further extended to multilevel, spatial, and spatio-temporal settings. These extensions lead to multilevel modal interval regression, spatial modal interval regression, and spatio-temporal modal interval regression. Together, they allow conditional MIs to be estimated across multiple coverage levels, over spatial domains, and over spatio-temporal domains. Numerical experiments and real-data applications demonstrate that the proposed methods provide accurate estimates of conditional MI bounds and effectively visualize data concentration patterns in different settings. Overall, this work establishes a statistical modeling framework for nonlinear modal interval regression and demonstrates its usefulness for estimating conditional MIs and visualizing concentration regions in conditional distributions.