



Statistics and Actuarial Science Seminar

Title: Hierarchical additive interaction modelling with Gaussian process prior

Speaker: Sahoko Ishida (University of Oxford)

Date: Thu 30th October 2025 at 3:00PM

Location: E0.32 (beside Pi restaurant)

Abstract: Additive Gaussian process (GP) models offer flexible tools for modelling complex nonlinear relationships and interaction effects among covariates. While many works in the literature have focused on predictive performance, relatively little attention has been given to identifying the underlying interaction structure, which may be of scientific interest in many applications. In practice, the use of additive GP models for this purpose has been limited by the cubic computational cost and quadratic storage requirements of GP inference. This work presents a fast hierarchical additive interaction GP model for multi-dimensional grid data. A hierarchical ANOVA decomposition kernel forms the foundation of our model, which incorporates main and interaction effects under the principle of marginality. Kernel centring ensures identifiability and provides a unique, interpretable decomposition of lower- and higher-order effects. For datasets forming a multi-dimensional grid or panel, efficient implementation is achieved by exploiting the Kronecker product structure of the covariance matrix. One of our contributions is the extension of Kronecker-based computation to handle any interaction structure within the proposed class of hierarchical additive GP models, whereas previous methods were limited to separable or fully saturated cases. The benefits of the approach are demonstrated through simulation studies and an application to high-frequency nitrogen dioxide concentration data in London. The

talk also addresses strategies for handling missing and censored values within this computational framework.