Working Group on Statistical Learning Seminar

Title: Efficient sequential Bayesian inference for state-space epidemic models using ensemble data assimilation

Speaker: Dhorasso Junior Temfack Nguefack (Trinity College Dublin)

Date: Thu 5th February 2026 at 3:00PM

Location: E0.32 (beside Pi restaurant)

Abstract: Estimating latent epidemic states and parameters from partial data is challenging. State-space models provide a probabilistic framework, but fully Bayesian estimation is computationally expensive because the likelihood requires integrating over all latent trajectories. Sequential Monte Carlo squared (SMC^2) enables joint state-parameter inference by combining an outer SMC sampler with an inner particle filter, but the nested structure is computationally prohibitive for real-time outbreak response. We propose Ensemble SMC^2 (eSMC^2), which replaces the inner particle filter with an Ensemble Kalman Filter (EnKF) to approximate the incremental likelihood. While this introduces bias via Gaussian approximation, we mitigate finite-sample effects using an unbiased Gaussian density estimator and adapt the EnKF for epidemic data through state-dependent observation variance. Simulations with known ground truth and application to 2022 U.S. monkeypox data show that eSMC^2 achieves substantial computational gains while producing posterior estimates comparable to SMC^2. The method offers an efficient framework for sequential Bayesian epidemic inference from imperfect surveillance data.