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Bayesian binary classification under label uncertainty with network-informed Gaussian Processes

In this work, we address the problem of binary classification under label uncertainty in settings where both feature-based and relational data are available. Motivated by applications in financial fraud detection, we propose a Bayesian Gaussian Process classification model that leverages covariate similarities and multilayer network structure. Our approach accounts for uncertainty in the observed labels during training, enabling robust inference and reliable out-of-sample prediction. We define a composite covariance function that integrates kernel representations over both covariates and network layers, effectively capturing different modes of similarity. To perform posterior inference, we use a first gradient marginal Metropolis-Hastings sampler, which improves sampling efficiency and reduces the need for tuning. The proposed methodology is validated on simulated data and applied to a real-world financial fraud detection task, demonstrating strong practical applicability with real financial data

Special/ Invited session

Classification

Both methodology and application

Keywords

Bayesian Classification, Gaussian Processes, Label Uncertainty, Multilayer Networks, Fraud Detection

Primary authors: Prof. ALEXOPOULOS, Angelos (Athens University of Economics and Business); BOURAZAS, Konstantinos (Athens University of Economics and Business); Prof. KALOGEROPOULOS, Konstantinos (London School of Economics); Prof. DELLAPORTAS, Petros (University College London & Athens University of Economics and Business)

Presenter: BOURAZAS, Konstantinos (Athens University of Economics and Business)

Track Classification: Statistical Computing