

Incorporating prior knowledge induced from stochastic differential equations in the classification of stochastic observations

Amin Zollanvari, Edward R. Dougherty

- Department of Electrical and Electronical Engineering

Abstract

In classification, prior knowledge is incorporated in a Bayesian framework by assuming that the feature-label distribution belongs to an uncertainty class of feature-label distributions governed by a prior distribution. A posterior distribution is then derived from the prior and the sample data. An optimal Bayesian classifier (OBC) minimizes the expected misclassification error relative to the posterior distribution. From an application perspective, prior construction is critical. The prior distribution is formed by mapping a set of mathematical relations among the features and labels, the prior knowledge, into a distribution governing the probability mass across the uncertainty class. In this paper, we consider prior knowledge in the form of stochastic differential equations (SDEs). We consider a vector SDE in integral form involving a drift vector and dispersion matrix. Having constructed the prior, we develop the optimal Bayesian classifier between two models and examine, via synthetic experiments, the effects of uncertainty in the drift vector and dispersion matrix. We apply the theory to a set of SDEs for the purpose of differentiating the evolutionary history between two species.

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