# BayesError.com

*The End of 80 Years Struggle to Calculate the Exact Lowest Possible Prediction Error*

In machine learning, Bayes Error Rate (BER) is a lower bound for classification errors (lowest possible prediction error). Attaining the minimum of classification errors is the main objective of all prediction methods; however, calculating BER is difficult. In many classification problems, it is impossible to calculate BER. For example, in general, BER for Gaussian distribution has no closed form and cannot be computed numerically. For nearly a century, many researchers have been trying to provide a way to calculate or compute BER. However, their efforts have only found some upper bounds for BER. We calculate the Exact BER for any multivariate finite mixture model and improve the computation accuracy of the empirical BER for real data.

## Features

Traditional methods calculate BER by solving high-dimensional integrals or approximate it using upper bounds. This is computationally expensive, analytically complex, impossible for high-dimensional problems, or inaccurate. We proposed a new technique to calculate BER analytically, numerically very fast, or accurately using simulation. Relative ability of implementation of Traditional Methods and Proposed Method for Bivariate and Multivariate Gaussian, Non-Gaussian distributions and in the Non-Parametric case are compared as follows:

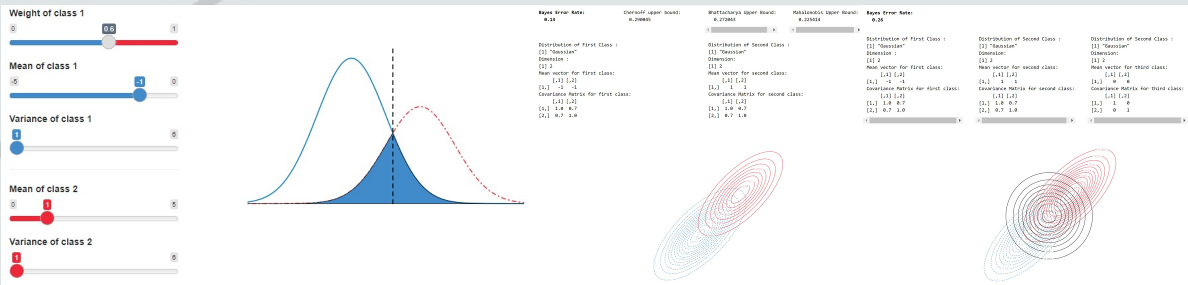
| | Analytic | Numerical | Simulation | Empirical |
|---|---|---|---|---|
| Bivariate G. | variances homogeneity | | | accuracy sample size |
| Multivariate G. | exchangeability | dimension < 7 & accuracy | computational time (ct) | accuracy sample size |
| Non-Gaussian | calculation complexity | dimension & accuracy | computational time | accuracy sample size |
| Non-Parametric | | accuracy & ct | computational time | accuracy sample size |

The main limitations of each method are engraved on the bar charts for two- and multi-class problems.

## System Requirements

We developed the software in R/Shiny and Mathematica and it can be extended to any language.

## Website Screenshots




## Applications in Machine Learning and Pattern Recognition

Feature extraction, Evaluation, Benchmark, Model selection, and Reinforcement learning.

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