Bayesian Diagnostic Measures

A software tool for parametric estimation of Bayesian medical diagnostic measures and their uncertainty

Interface Documentation

v. 1.0.0

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1. Introduction

The *Bayesian Diagnostic Measures* program is a specialized computational tool developed to assist medical professionals and researchers in diagnostics. The program allows for the estimation, plotting and comparison of two Bayesian diagnostic measures: positive predictive value $P(D|T \geq t)$ and posterior probability for disease $P(D|T = t)$. Utilizing the principles of uncertainty propagation, the program allows for the estimation and plotting of the sampling, measurement, and combined uncertainty of these measures, and the associated confidence intervals.

a) System Requirements

1.a.1. Processor

Intel Core i9® or equivalent CPU.

1.a.2. System Memory (RAM)

32 GB+ recommended.

1.a.3. Operating Systems

Microsoft Windows, Linux, Apple iOS.

1.a.4. Software Requirements

Wolfram Player®, freely available at Wolfram Player or Wolfram Mathematica®.

2. Interface Overview

a) Tabbed Navigation

The program features an intuitive tabbed user interface, designed to streamline user interaction, and facilitate effortless navigation across its multiple modules and sub-modules. Each tab is clearly labeled to correspond with its respective module, allowing for quick access to various functionalities.

b) Numerical Settings: Sliders

The program offers controls for numerical settings, which can be adjusted through sliders.

2.b.1. Fine Manipulation

For more precise control, hold down the '*alt*' or '*opt*' key while dragging the mouse. For even finer adjustments, also hold the '*shift*' and/or '*ctrl*' keys.

c) Non-Numerical Settings

These settings are controlled using buttons. Each button is labeled clearly to indicate its function.

d) Plot Range

All the plots can be generated in both extended and limited range.

3. Input Parameters

The program allows users to input a variety of parameters, each with a specific range:

Measurement value t: $maximum(0, minimum(\mu_{\bar{D}} - 6\sigma_{\bar{D}}, \mu_D - 6\sigma_{\bar{D}})) - maximum(\mu_{\bar{D}} + 6\sigma_{\bar{D}}, \mu_D + 6\sigma_{\bar{D}})$

Size of diseased population n_D : 2 – 10,000

Mean of diseased population μ_D: 0.1 – 10,000

Standard deviation of diseased population σ_D: 0.01 – 1,000

Size of nondiseased population $n_{\bar{D}}$: 2 – 10,000

Mean of nondiseased population $\mu_{\bar{D}}$: 0.1 – 10,000

Standard deviation of nondiseased population $\sigma_{\bar{D}}$: 0.01 – 1,000

Prior probability for disease v : 0.001 – 0.999

Number of quality control measurements n_U : 20 – 10,000

Constant contribution to measurement uncertainty b_0 : 0 – $\sigma_{\bar{D}}$

Measurement uncertainty proportionality constant b_1: 0 – 0.1000

Confidence level p : 0.900 – 0.999

$t, \mu_D, \sigma_D, \mu_{\bar{D}}$, and $\sigma_{\bar{D}}$ are defined in arbitrary units.

4. Modules and Submodules

The program is organized into four primary modules, each with multiple submodules:

4.1. Diagnostic Measures Plots:

Plots $P(D|T \geq t)$, $P(D|T = t)$, and $P(D|T \geq t) \,/\, P(D|T = t)$ versus:

a) Measurement value t
b) Prior probability for disease v

4.2. Diagnostic Measures Tables:

For a measurement value t, are tabulated:

a) $P(D|T \geq t)$,
b) $P(D|T = t)$
c) $P(D|T \geq t) \,/\, P(D|T = t)$

The above modules allow users to define:

a) The prior probability for disease v.
b) The mean and standard deviation of a diseased and a nondiseased population.
c) The univariate distribution of each population (normal, lognormal or gamma).
d) A measurement value t.

4.3.Standard Uncertainty Plots:

Plots:

a) Standard sampling, measurement, and combined uncertainty,
b) Relative standard sampling, measurement, and combined uncertainty, and
c) Associated confidence intervals

of $P(D|T \geq t)$ and $P(D|T = t)$ versus:

a) Measurement value t,
b) Constant contribution b_0 to measurement uncertainty,
c) Measurement uncertainty proportionality constant b_1,
d) Total size of the population sample n, and
e) Prior probability for disease v.

4.4.Standard Uncertainty Tables:

The program tabulates the standard sampling, measurement, and combined uncertainty and relative uncertainty and the associated confidence intervals of $P(D|T > t)$ and $P(D|T = t)$, for a user defined value of the measurand t and all the possible combinations of the distributions.

Each of the above modules allows the user to define:

a) The size, mean, and standard deviation of a sample from each of a diseased and nondiseased populations.
b) The univariate distribution of each population (normal, lognormal, gamma).
c) A linear [$u_m(x) \cong b_0 + b_1 t$] or nonlinear [$u_m(x) = \sqrt{b_0^2 + b_1^2 t^2}$)] equation of the measurement uncertainty versus the measurement value t, and the number of the quality control measurements used to derive it.
d) A measurement value t.
e) The confidence level *p* of the confidence intervals.

5. Source Code

a) Programming language

Wolfram Language

b) Software source code file format

Wolfram Notebook

c) Availability

The updated source code is available at: https://www.hcsl.com/Tools/BayesianMeasures/BayesianMeasures.nb

d) License

6. Conclusion

The *Bayesian Diagnostic Measures* program offers a robust and user-friendly interface for medical professionals and researchers to estimate, plot and compare two Bayesian diagnostic measures: positive predictive value $P(D|T \geq t)$ and posterior probability for disease $P(D|T = t)$. Furthermore, the program allows estimating and plotting their sampling, measurement, and combined uncertainty, and their associated confidence intervals. Its modular design and comprehensive output options make it a valuable tool in the field of medical statistics and diagnostics.

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