Bayesian Diagnostic Uncertainty

An Analytical Software for Assessing Uncertainty in Bayesian Parametric Diagnosis in Medicine

v. 1.0.1.5

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1. Introduction

The *Bayesian Diagnostic Uncertainty* program is a specialized computational tool developed to assist medical professionals and researchers in the field of diagnostics. Utilizing the principles of uncertainty propagation, the program allows for the calculation, and plotting of the sampling, measurement, and combined uncertainty of Bayesian posterior probabilities of disease.

2. System Requirements

2.1. Processor

Intel Core i9® or equivalent CPU

2.2. System Memory (RAM)

32 GB+ recommended

2.3. Operating Systems

Microsoft Windows, Linux, Apple iOS

2.4. Software Requirements

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

3. Interface Overview

3.1. 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.

3.2. Numerical Settings: Sliders

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

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.

3.3. Non-Numerical Settings

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

3.4. 3D Plot Navigation

Rotation

Users can rotate the three-dimensional plots by dragging with the mouse.

Zoom

To zoom in or out, drag the mouse while pressing the '*ctrl*', '*alt*', or '*opt*' key

4. Input Parameters

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

x: $maximum(\mu_{\bar{D}} - 5\sigma_{\bar{D}}, \mu_D + 5\sigma_{\bar{D}})$

n_D : 2 – 10,000

μ_D: 0.1 – 10,000

σ_D: 0.01 – 1,000

$n_{\bar{D}}$: 2 – 10,000

$\mu_{\bar{D}}$: 0.1 – 10,000

$\sigma_{\bar{D}}$: 0.01 – 1,000

n_U : 20 – 10.000

b_0 : 0 – $\sigma_{\bar{D}}$

u_1: 0 – 0.1

p : 0.900 – 0.999

5. Modules and Submodules

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

5.1. Plots Module:

Plots the sampling, measurement, and combined standard uncertainty and the resultant confidence intervals of the posterior probability for disease.

5.2. Tables Module

Plots the sampling, measurement, and combined standard uncertainty and the resultant confidence intervals of the posterior probability for disease.

Each module allows the user to define:

a. The size, mean and standard deviation of two samples of three univariate distributions (normal, lognormal, gamma).
b. A linear or nonlinear equation of the measurement uncertainty vs the value x of the measurand, and the number of the quality control measurements used to derive it.
c. A value x of the measurand.
d. The confidence level of confidence intervals.

6. Output

The program generates a comprehensive set of outputs to aid in the diagnostic process:

6.1. Plots

6.1.1. Standard Uncertainty of Posterior Probability for Disease Plots

These plots provide a visual representation of the standard sampling, measurement, and combined uncertainty of the posterior probabilities for disease, based on the selected distributions.

6.1.2. Relative Standard Uncertainty of Posterior Probability for Disease Plots

These plots provide a visual representation of the relative standard sampling, measurement, and combined uncertainty of the posterior probabilities for disease based on the selected distributions.

6.1.3. Confidence Intervals of Posterior Probability for Disease Plots

These plots provide a visual representation of the confidence intervals of the posterior probabilities for disease based on the selected distributions and the user defined confidence level.

6.2. Tables

6.2.1. Standard Uncertainty of Posterior Probability for Disease Tables:

These tables provide the standard sampling, measurement, and combined uncertainty of the posterior probabilities for disease, for a user defined value of the measurand and all the possible combinations of the distributions.

6.2.2. Relative Standard Uncertainty of Posterior Probability for Disease Tables:

These tables provide the relative standard sampling, measurement, and combined uncertainty of the posterior probabilities for disease, for the user defined value of the measurand and all the possible combinations of the distributions.

6.2.3. Confidence Intervals of Posterior Probability for Disease Tables:

These tables provide the confidence intervals of the posterior probabilities for disease, for a user defined value of the measurand and confidence level, and all the possible combinations of the distributions.

7. Source Code

7.1. Programming language

Wolfram Language

7.2. Software source code file format

Wolfram Notebook

7.3. Availability

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

7.4. License

8. Notation and Abbreviations

8.1. Parameters

n_D : size of diseased population

μ_D: mean of diseased population

σ_D: standard deviation of diseased population

$n_{\bar{D}}$: size of nondiseased population

$\mu_{\bar{D}}$: mean of nondiseased population

$\sigma_{\bar{D}}$: standard deviation of nondiseased population

r: prior probability for disease (prevalence rate)

n_U : number of quality control measurements

b_0 : constant contribution to measurement uncertainty

b_1: measurement uncertainty proportionality constant

p : confidence level

8.2. Functions

$P(D|T)$: posterior probability for disease given a test result

9. Conclusion

The *'Bayesian Diagnostic Uncertainty'* program offers a robust and user-friendly interface for medical professionals and researchers to calculate the uncertainty in Bayesian diagnosis. Its modular design and comprehensive output options make it a valuable tool in the field of medical statistics and diagnostics.

10. Permanent Citation:

Chatzimichail T., Hatjimihail AT. *Bayesian Diagnostic Uncertainty*: An Analytical Software for Assessing Uncertainty in Bayesian Parametric Diagnosis in Medicine. Ver. 1.0.1.5. Drama: Hellenic Complex Systems Laboratory, 2024. Available at: https://www.hcsl.com/Tools/BayesianDiagnosticUncertainty/

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