# Bayesian Diagnostic Measures

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

*Interface Documentation*

*Version 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.

## 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. Additional Options

### 3.4.1. Plots

Users can select between an extended and limited plot range.

#### 3.4.1.1. Fine Manipulation

Dragging with the mouse while pressing the ctrl, alt, or opt keys zooms plots in or out.

#### 3.4.1.2. Highlighting

When the mouse cursor hovers over a point on a curve in a plot, the point is highlighted, its coordinates are displayed, and vertical drop lines are drawn to the respective axes.

### 3.4.2. Tables

Users can define the number of decimal digits for results, ranging from 1 to 10.

# 4. Input Parameters

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

Measurement value $t: maximum(0, minimum(m_{\bar{D}} - 6s, m_D - 6s_{\bar{D}})) - maximum(m_{\bar{D}} + 6s_{\bar{D}}, m_D + 6s_{\bar{D}})$

Size of diseased population $n_D$ : $2 - 10,000$

Mean of diseased population $m_D$: $0.1 - 10,000$

Standard deviation of diseased population $s_D$: $0.01 - 1,000$

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

Mean of nondiseased population $m_{\bar{D}}$ : $0.1 - 10,000$

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

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 $p$ : $0.900 - 0.999$

$t, m_D, s_D, m_{\bar{D}}$, and $s_{\bar{D}}$ are defined in arbitrary units.

# 5. Modules and Submodules

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

### 5.1. 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 $v$

### 5.2. 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 $t$.

### 5.3. 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 $v$.

### 5.4. 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 $u_m$ 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.

# 6. Source Code

### 6.1. Programming language

Wolfram Language

### 6.2. Software source code file format

Wolfram Notebook

### 6.3. Availability

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

### 6.4. License

## 7. 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.

## 8. Permanent Citation

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