Hellenic Complex Systems Laboratory

Analysis of Diagnostic Accuracy Measures

Technical Report IX

Theodora Chatzimichail

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WOLFRAM Demonstrations Project

Analysis of Diagnostic Accuracy Measures

Theodora Chatzimichail [a]

[a] **Hellenic Complex Systems Laboratory**

Based on the Demonstration *Uncertainty of Measurement and Diagnostic Accuracy Measures* by: Aristides T. Hatjimihail

Search Terms: sensitivity, specificity, diagnostic test, clinical accuracy, diagnostic accuracy, normal distribution, binormal distribution, positive predictive value, negative predictive value, likelihood ratio, odds ratio

Abstract

This Demonstration shows plots of various accuracy measures for diagnostic tests on normally distributed nondiseased and diseased populations. This is done for differing prevalence of the disease, taking into account mean and standard deviations of the populations. The mean and standard deviations are expressed in arbitrary units. The measures considered are the positive predictive value ("PPV"), the negative predictive value ("NPV"), the (diagnostic) odds ratio ("OR"), the likelihood ratio for a positive result ("LR+"), and the likelihood ratio for a negative result ("LR-"). The measures are plotted against the sensitivity or the specificity of the test, which can be selected by clicking the respective button.

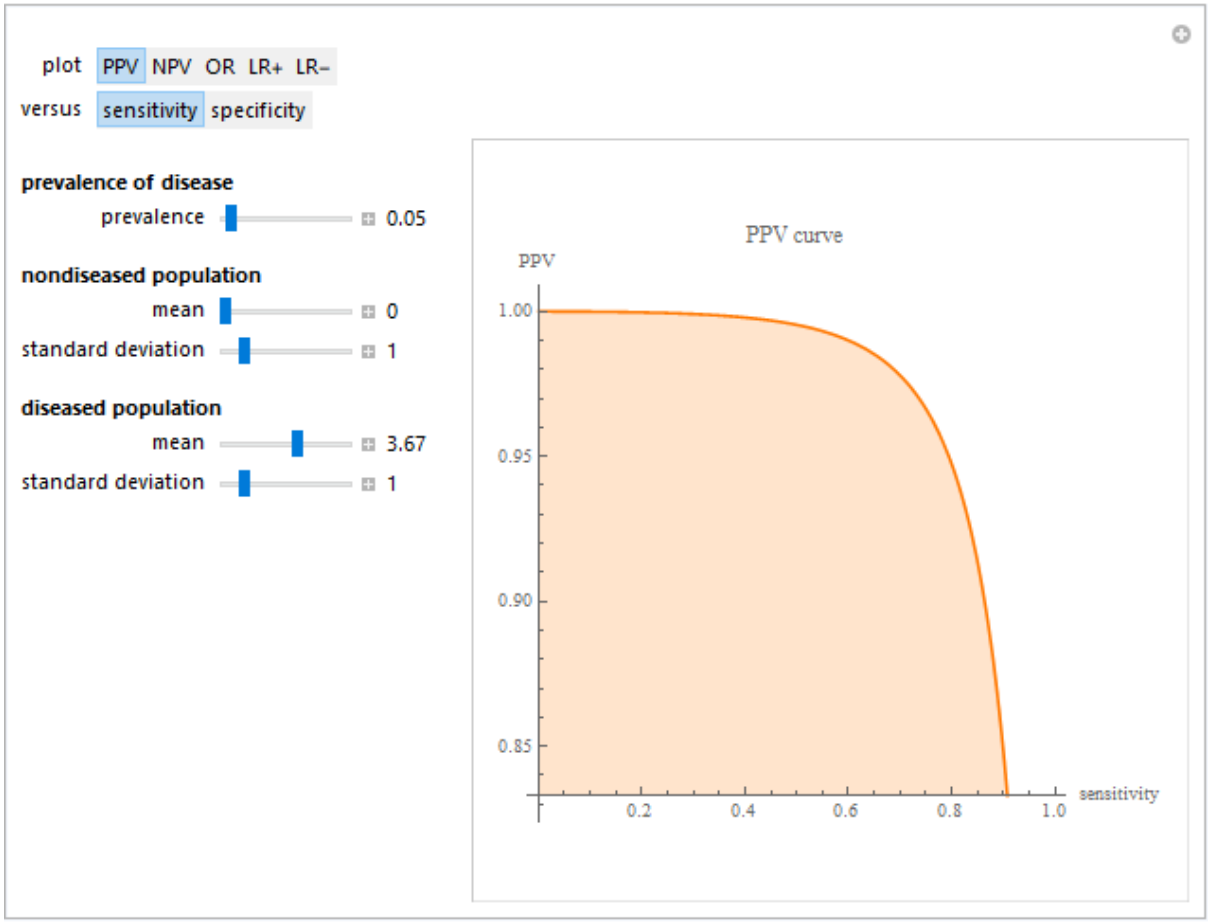

Figure 1: *Positive predictive value vs specificity curve plot of a diagnostic test. Prevalence of disease: 0.05, mean and standard deviation of the nondiseased population: 0.00 and 1.00 units respectively, mean and standard deviation of the diseased population: 3.67 and 1.00 units respectively.*

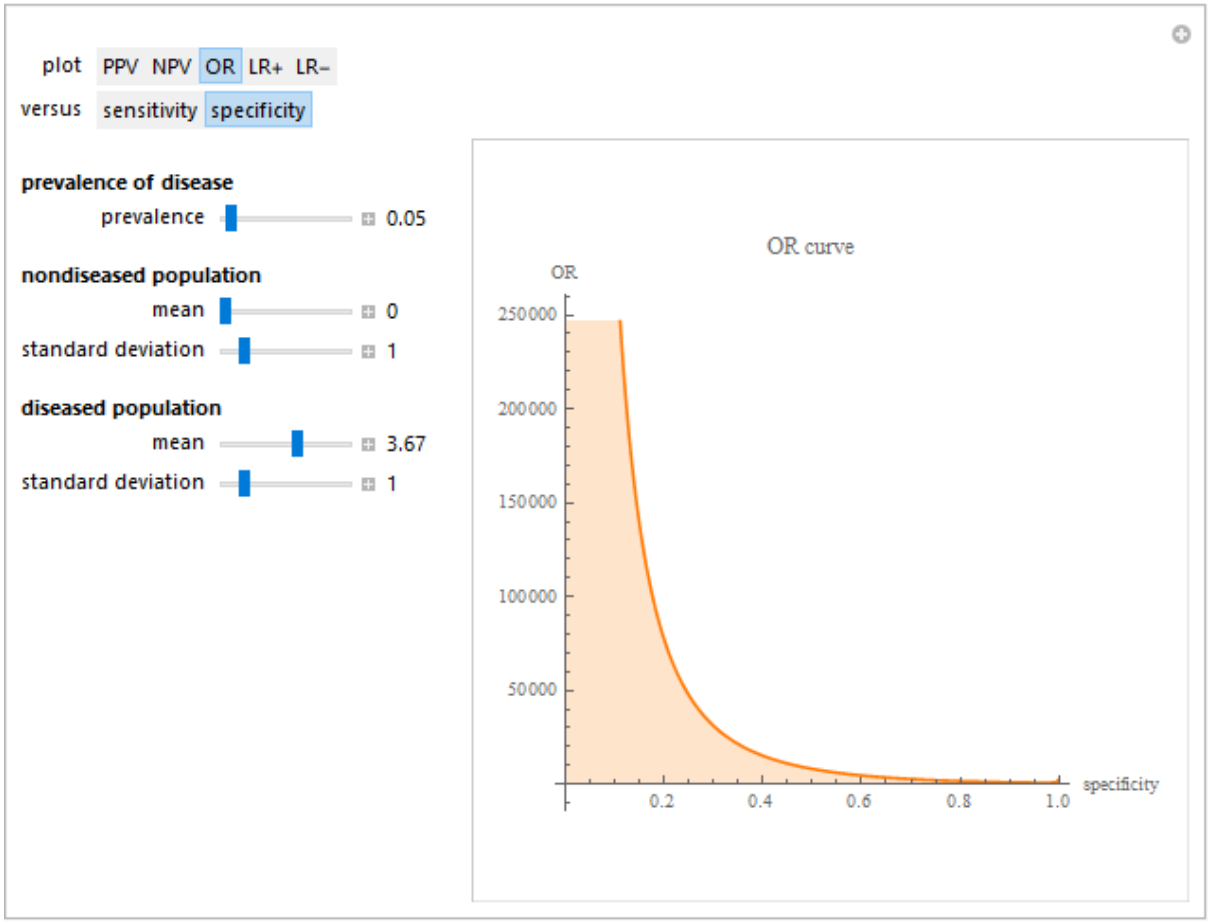

Figure 2: *Odds ratio vs specificity curve plot of a diagnostic test. Prevalence of disease: 0.05, mean and standard deviation of the nondiseased population: 0.00 and 1.00 units respectively, mean and standard deviation of the diseased population: 3.67 and 1.00 units respectively.*

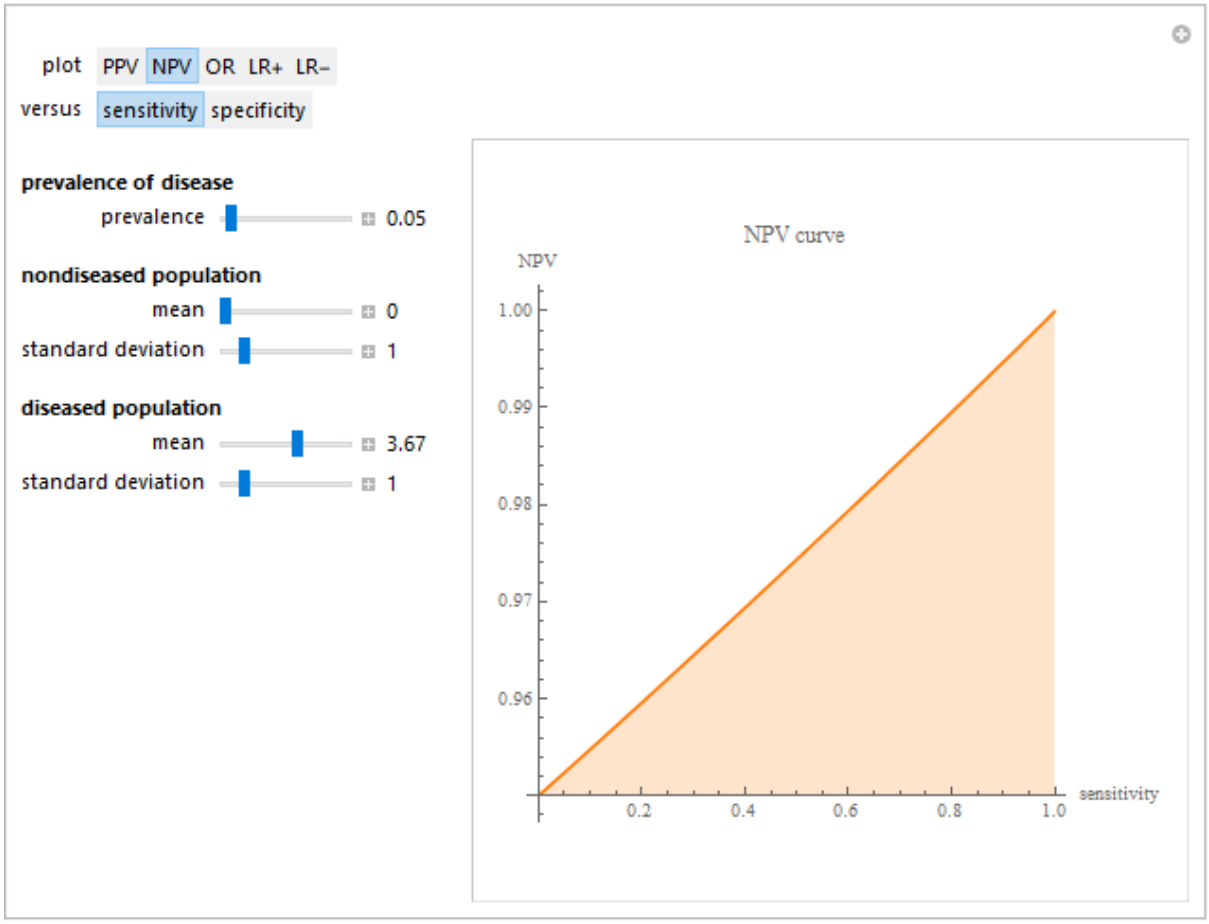

Figure 3: *Negative predictive value vs specificity curve plot of a diagnostic test. Prevalence of disease: 0.05, mean and standard deviation of the nondiseased population: 0.00 and 1.00 units respectively, mean and standard deviation of the diseased population: 3.67 and 1.00 units respectively.*

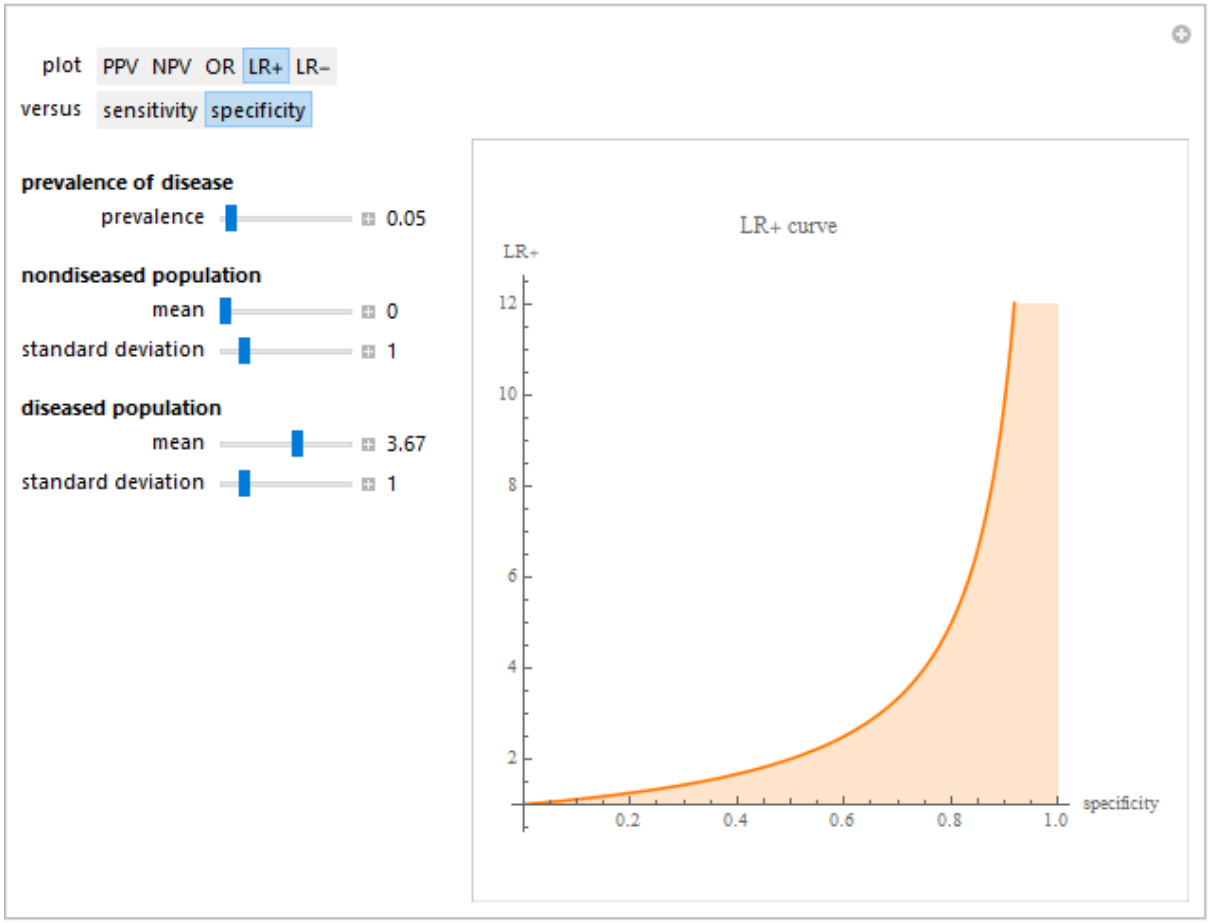

Figure 4: *Likelihood ratio for a positive result vs specificity curve plot of a diagnostic test. Prevalence of disease: 0.05, mean and standard deviation of the nondiseased population: 0.00 and 1.00 units respectively, mean and standard deviation of the diseased population: 3.67 and 1.00 units respectively.*

Details

The measures that are used in the evaluation of the clinical accuracy of a diagnostic test applied to a diseased or nondiseased population can be calculated as functions of the sensitivity or the specificity of the test. Sensitivity is the fraction of the diseased population with a positive test result, while specificity is the fraction of the nondiseased population with a negative test result. If we denote by $sens$ the sensitivity, $spec$ the specificity, and pr the prevalence, we have:

$$PPV = \frac{sens \times pr}{spec \times pr + (1 - spec)(1 - pr)}$$

$$NPV = \frac{spec\ (1 - pr)}{spec\ (1 - pr) + (1 - sens)\ pr}$$

$$OR = \frac{\frac{sens}{1 - sens}}{\frac{1 - spec}{spec}}$$

$$LR+ = \frac{sens}{1 - spec}$$

$$LR- = \frac{1 - sens}{spec}$$

In the figures, the population data describes a bimodal distribution of serum glucose measurements in nondiabetic and diabetic populations [2].

This Demonstration is a simplified version of another Demonstration [1], and is appropriate as an educational tool for medical students.

References

[1] A. T. Hatjimihail. Uncertainty of Measurement and Diagnostic Accuracy Measures. Wolfram Demonstrations Project, Champaign: Wolfram Research, Inc., 2009. Available at: http://demonstrations.wolfram.com/UncertaintyOfMeasurementAndDiagnosticAccuracyMeasures/

[2] T. O. Lim, R. Bakri, Z. Morad, and M. A. Hamid. Bimodality in Blood Glucose Distribution: Is It Universal? *Diabetes Care,* **25**(12), 2002 pp. 2212–2217.

Source Code

The updated Wolfram Mathematica© source code is available at:
https://www.hcsl.com/Tools/AnalysisOfDiagnosticAccuracyMeasures-author.nb

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