# **Relation:** A Software Tool for Exploring the Relation between Diagnostic Accuracy and Measurement Uncertainty

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#### 1. Purpose/Problem

Although diagnostic accuracy is fundamental to clinical decision making and measurement uncertainty is critical to quality and risk management in laboratory medicine, there has been very limited research on their relation.

#### 2. Description of the Program

For this reason, the interactive program *Relation* was developed for calculating, optimizing, plotting and comparing various diagnostic accuracy measures and the corresponding risk of diagnostic or screening tests measuring a normally distributed measurand with differrnt measurement uncertainties, applied at a single point in time in non-diseased and diseased populations [1].

#### 3. Outcomes

The program demonstrates the relation between the diagnostic accuracy measures and the measurement uncertainty, for differing prevalence of the disease, mean and standard deviation of the measurand, diagnostic threshold, standard measurement uncertainty of the tests and expected loss (see Fig. 1 and 2). Furthermore, it provides calculators for the calculation of the effects of measurement uncertainty on the diagnostic accuracy measures and corresponding risk and for calculating the diagnostic threshold optimizing objective and loss functions. (see Fig. 3).



Figure 1. Plots of (a) sensitivity (Se), (b) specificity (Sp), (c) positive predictive value (PPV) and (d) negative predictive value (NPV) against standard measurement uncertainty (u)



ROC curves DAM plots DAM relations plots DAM calculator optimal DAM calculator

v _	0.067
nondiseased population	
mean	0
standard deviation —	🖽 1
diseased population	
mean	2.99
standard deviation	0.75
diagnostic threshold	
d	2.26
standard measurement und	outointy
standard measurement and	ertainty
first test	
first test	0.023
first test	□ 0.023 □ 0.23
first test second test second test	0.023
first test first first test first first test first first first test first fi	
first test first first test first first test first first test first fi	
first test second test second test second test testing true positive result false positive result	

calculation of diagnostic accuracy measures						
diagnostic threshold: 2.26						
diagnostic accuracy measure	es	first test	second test	relative difference		
sensitivity	Se	0.835	0.824	0.013		
specificity	Sp	0.988	0.986	0.002		
overall diagnostic accuracy	ODA	0.978	0.975	0.003		
positive predictive value	PPV	0.834	0.811	0.028		
negative predictive value	NPV	0.988	0.987	0.001		
diagnostic odds ratio	DOR	418.226	334.113	0.201		
likelihood ratio for a positive result	LR+	69.971	59.642	0.148		
ikelihood ratio for a negative result	LR-	0.167	0.179	-0.067		
Euclidean distance	ED	0.823	0.810	0.015		
Youden's index	J	0.166	0.177	-0.065		
concordance probability	CZ	0.825	0.813	0.015		
risk	R	2.664	2.824	-0.060		

The program *Relation* is freely available at: https://www.hcsl.com/Tools/Relation/ Figure 3. Calculated diagnostic accuracy measures of two screening or diagnostic tests measuring the same measurand with different uncertainties and their relative differences, with the settings at the left. Contact

#### 4. Discussion

The freely available program Relation provides 269 different types of plots of diagnostic accuracy measures, many of which are novel. To the best of my knowledge, this is the only program to provide this range of plots without advanced statistical programming.

Figure 2. Positive predictive value (PPV) of two screening or diagnostic tests measuring the same measurand with different uncertainties, against negative predictive value (NPV) curves plot, with the settings at the left.

## 5. Significance

The program *Relation* is user-friendly and can be used as an educational and research tool in medical decision-making, to explore the relation between measurement uncertainty and diagnostic accuracy.

#### 6. References

1. Chatzimichail T, Hatjimihail AT. A Software Tool for Exploring the Relation between Diagnostic Accuracy and Measurement Uncertainty. Diagnostics 2020, 10(9), 610. DOI: 10.3390/diagnostics10090610

### 7. Supplementary Materials



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