

Webinar

Semi-supervised Learning Methods to Correction of Partial Verification Bias in Diagnostic Accuracy Studies Using R

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Organized by

Epidemiological and Statistical Modelling Team, USM

Background

- Diagnostic test
 - Discriminate diseased vs non-diseased^{O'Sullivan et al. (2018)}
 - Extremely important role in medical care^{Kosinski & Barnhart (2003)}
 - Objective assessment^{Gotzsche (2007)}
- Requires evaluation^{Linnet et al. (2012)} → Diagnostic accuracy study.

Background

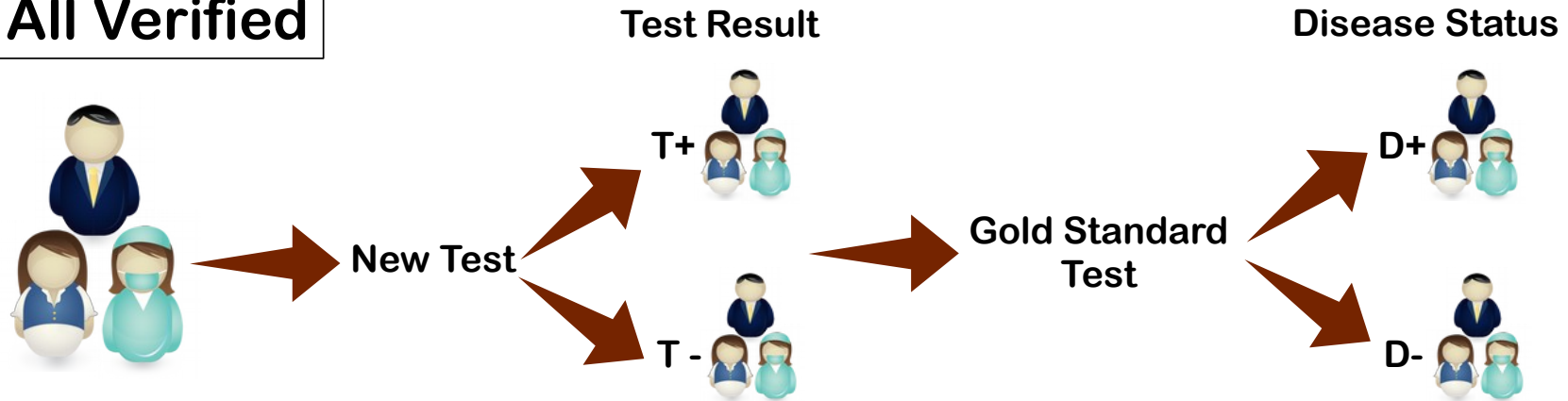
- Diagnostic accuracy study: New test vs Gold Standard^{Hall et al. (2019), O'Sullivan et al. (2018)}
 - Covid-19: RT-Ag vs RT-PCR
 - HIV: HIV Rapid Test vs ELISA
 - Breast CA: Mammogram vs Histology

Background

- Accuracy measures for binary test:
 - Sensitivity (True Positive Rate)
 - Specificity (True Negative Rate)
 - Positive Predictive Value (PPV)
 - Negative Predictive Value (NPV)

Background

All Verified



Test Result	Disease Status			
	D+	D-		
T+	TP	FP	PPV= $\frac{TP}{TP+FP}$	Positive Predictive Value
T-	FN	TN	NPV= $\frac{TN}{FN+TN}$	Negative Predictive Value
	Sn= $\frac{TP}{TP+FN}$	Sp= $\frac{TN}{TN+FP}$		
	Sensitivity	Specificity		

Background

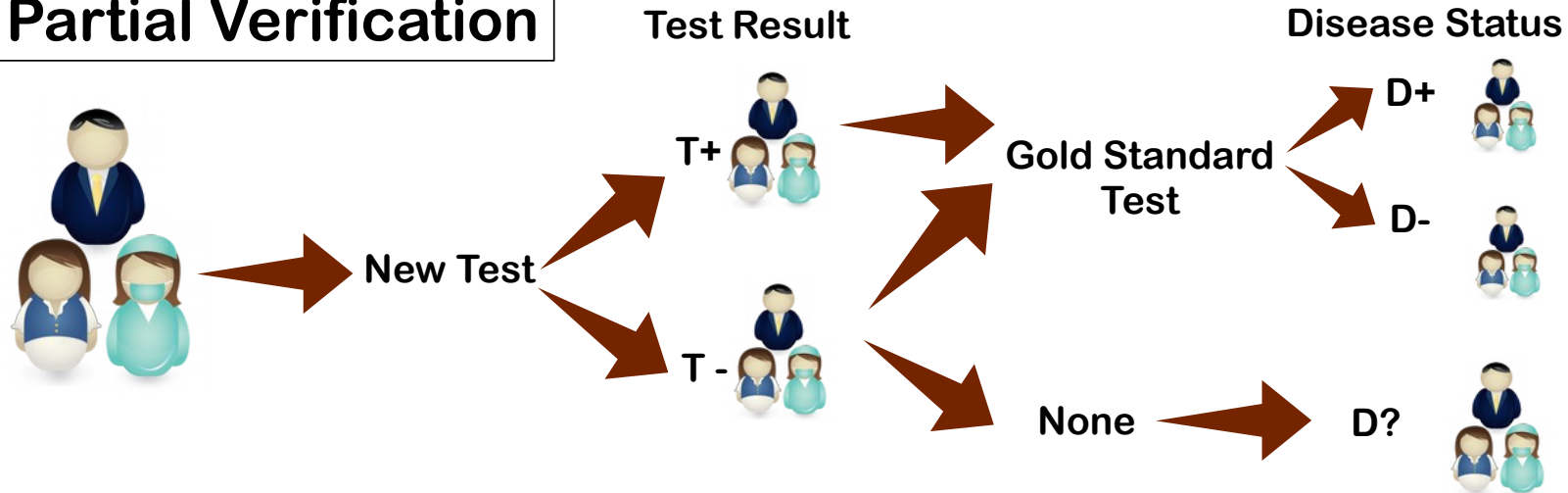
- Estimates, esp. Sensitivity and Specificity are often biased.
- Sampling bias in diagnostic accuracy study → Verification bias (VB) O'Sullivan et al. (2018)

Background

- Patients are selectively chosen for verification by gold standard.
- Test positive more likely selected + other clinical criteria O'Sullivan et al. (2018)
- Reasons Naaktgeboren et al (2016):
 - Study design: Efficiency, technical, ethical.
 - Clinical practice: Clinical likelihood.
 - Infeasibility: Invasive procedures, postmortem diagnosis.
- Partial and Differential Vb de Groot et al. (2011a)

Background

Partial Verification



Test Result	Disease Status		
	D+	D-	D?
T+	TP	FP	?
T-	FN	TN	?

Sensitivity?

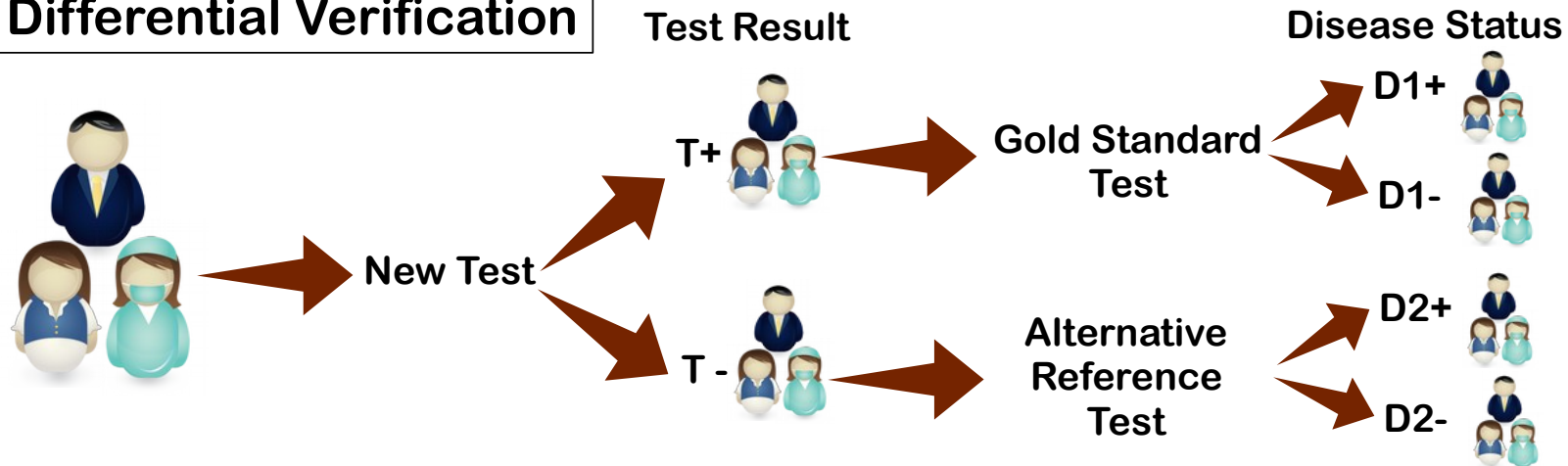
Specificity?

Positive Predictive Value?

Negative Predictive Value?

Background

Differential Verification



Test Result	Disease Status (Gold)		Disease Status (Alternative)		
	D1+	D1-	D2+	D2-	
T+	TP	FP	TP?	FP?	Positive Predictive Value?
T-	FN	TN	FN?	TN?	Negative Predictive Value?

Sensitivity?

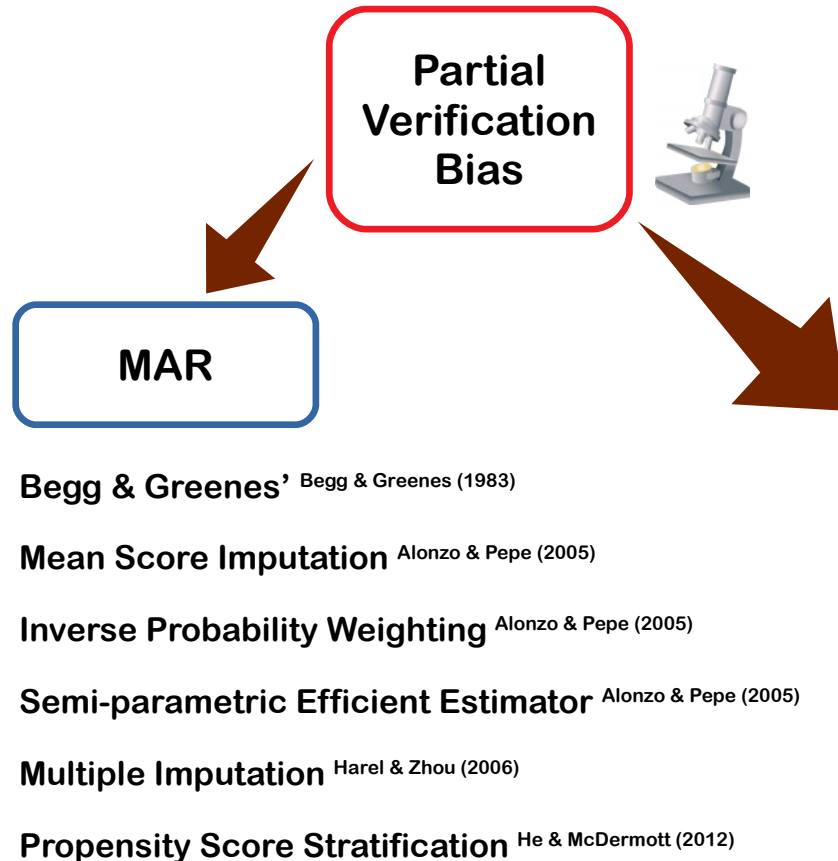
Specificity?

Background

- VBs → Inaccurate estimates of accuracy measures^{Naaktkeboren et al. (2016), Hall et al. (2019)}
- Impact on the clinical practice
 - Invalid diagnostic tests^{Chikere et al. (2019)}
 - Clinical errors^{Hall et al. (2019)}
- Cannot eliminate verification bias in medical data → Relies on methods to correct VB^{O'Sullivan (2018)}

Literature Review

Existing Correction Methods



Differential Verification Bias



Bayesian Approach Lu et al. (2010)

Bayesian Latent Class Approach de Groot et al. (2011c)

Zhou's Begg & Greenes' Extension Zhou (1993)

Logistic Regression Kosinski & Barnhart (2003a)

Global Sensitivity Analysis Kosinski & Barnhart (2003b)

Neural Networks Ünal & Burgut (2014)

Log-Linear Regression Rochani et al. (2015)

Bayesian Approaches Martinez et al. (2006), Buzoianu & Kadane (2008), Pennello (2011), Hajivandi et al. (2018)

Thank You

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