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Meta-analysis of studies of diagnostic accuracy: a unified approach

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Acknowledgements

- Co-authors
  - Jon Deeks
  - Lucas Bachmann
  - Matthias Egger
  - Penny Whiting
  - Jonathan Sterne
- Thanks also to Petra Macaskill

Aim

To clarify the theoretical relationship between methods for meta-analysing diagnostic accuracy studies

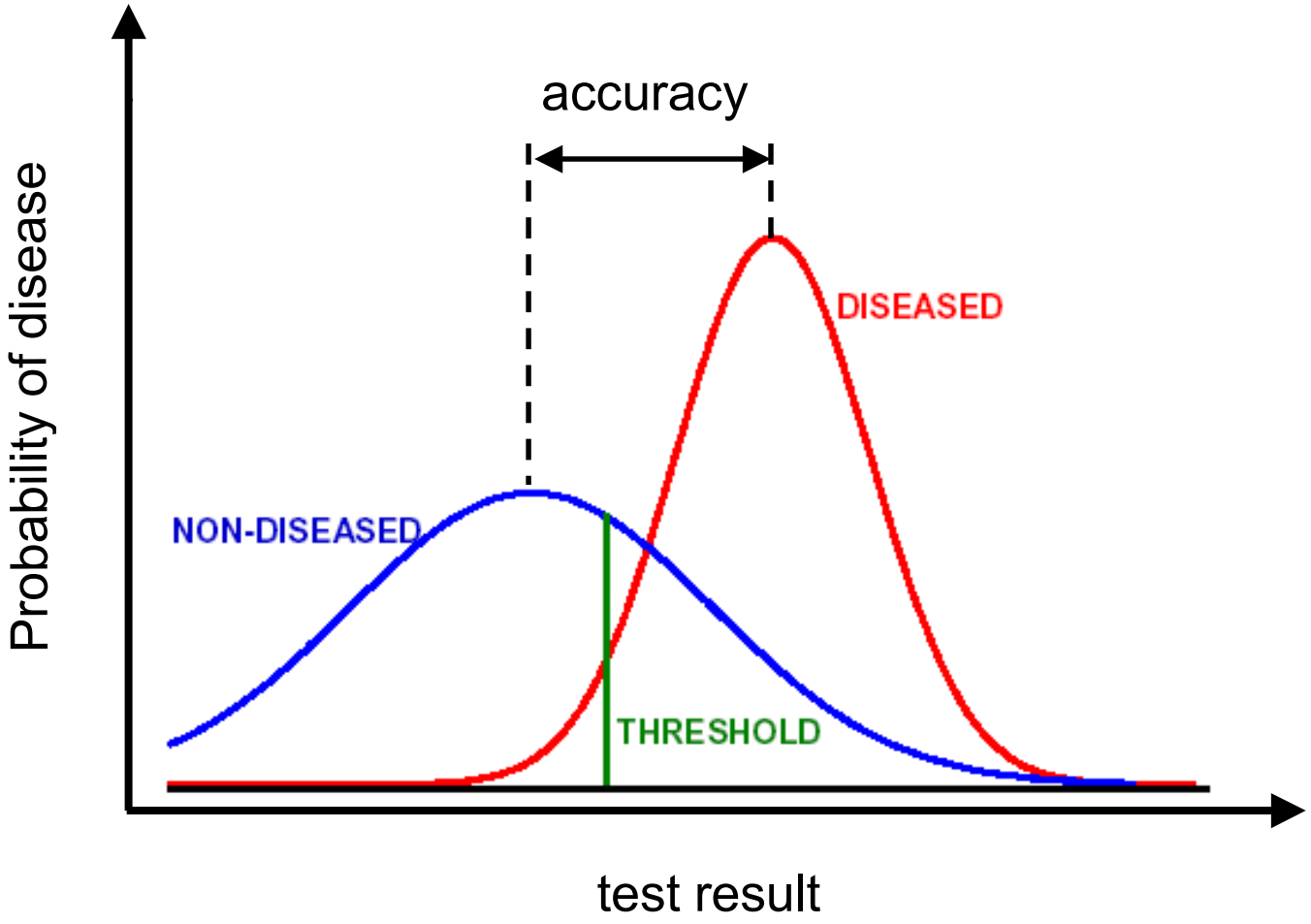
Outline

- What's different about meta-analysis of *diagnostic* studies?
- What methods are available?
- How are they related?
- How far can we get with conventional methods of meta-analysis?

What's different about meta-analysis of *diagnostic* studies?

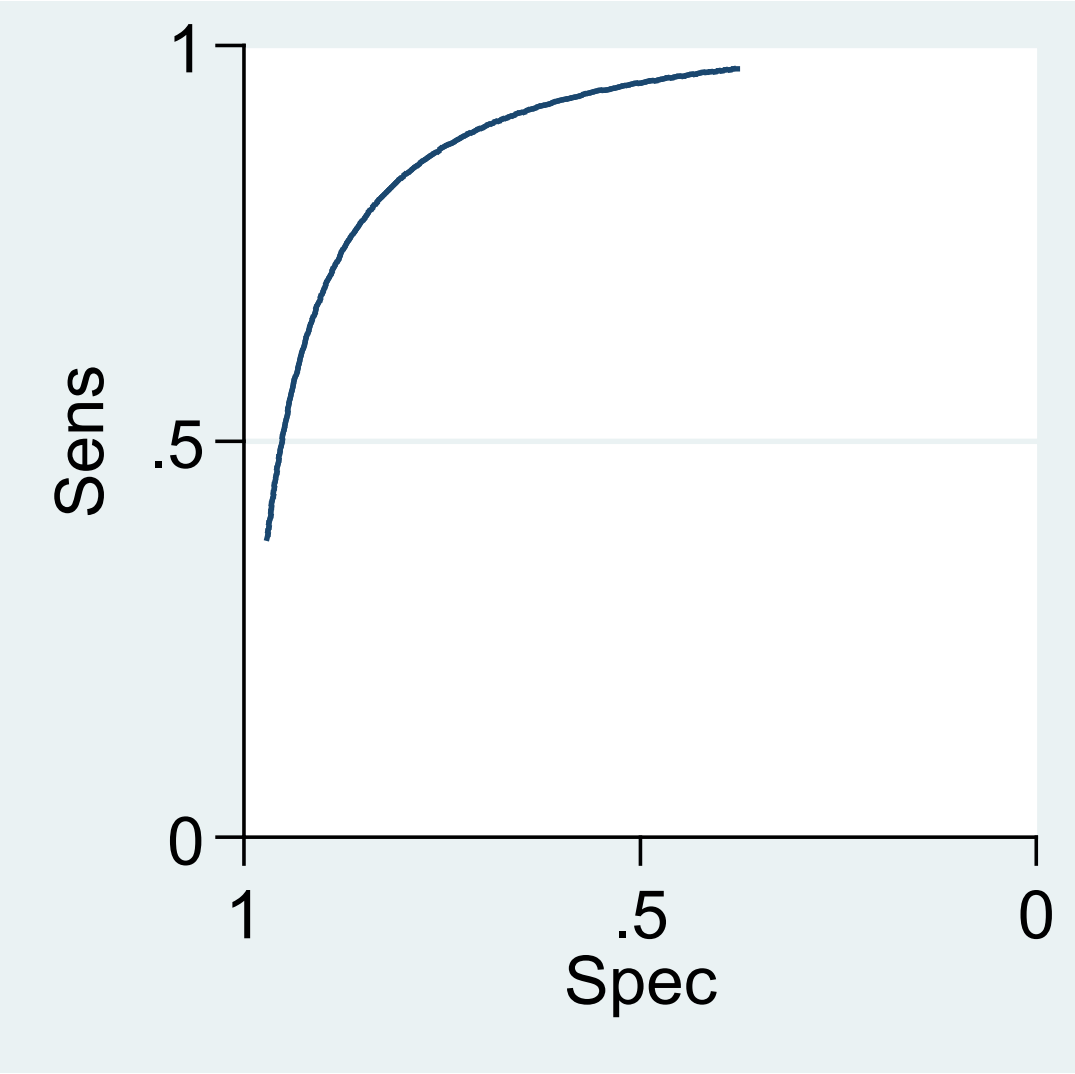
- Observational – not randomized
- Need to estimate sensitivity *and* specificity
  - These are often negatively correlated, e.g. because of threshold effects

Diagnostic threshold (*single* study)

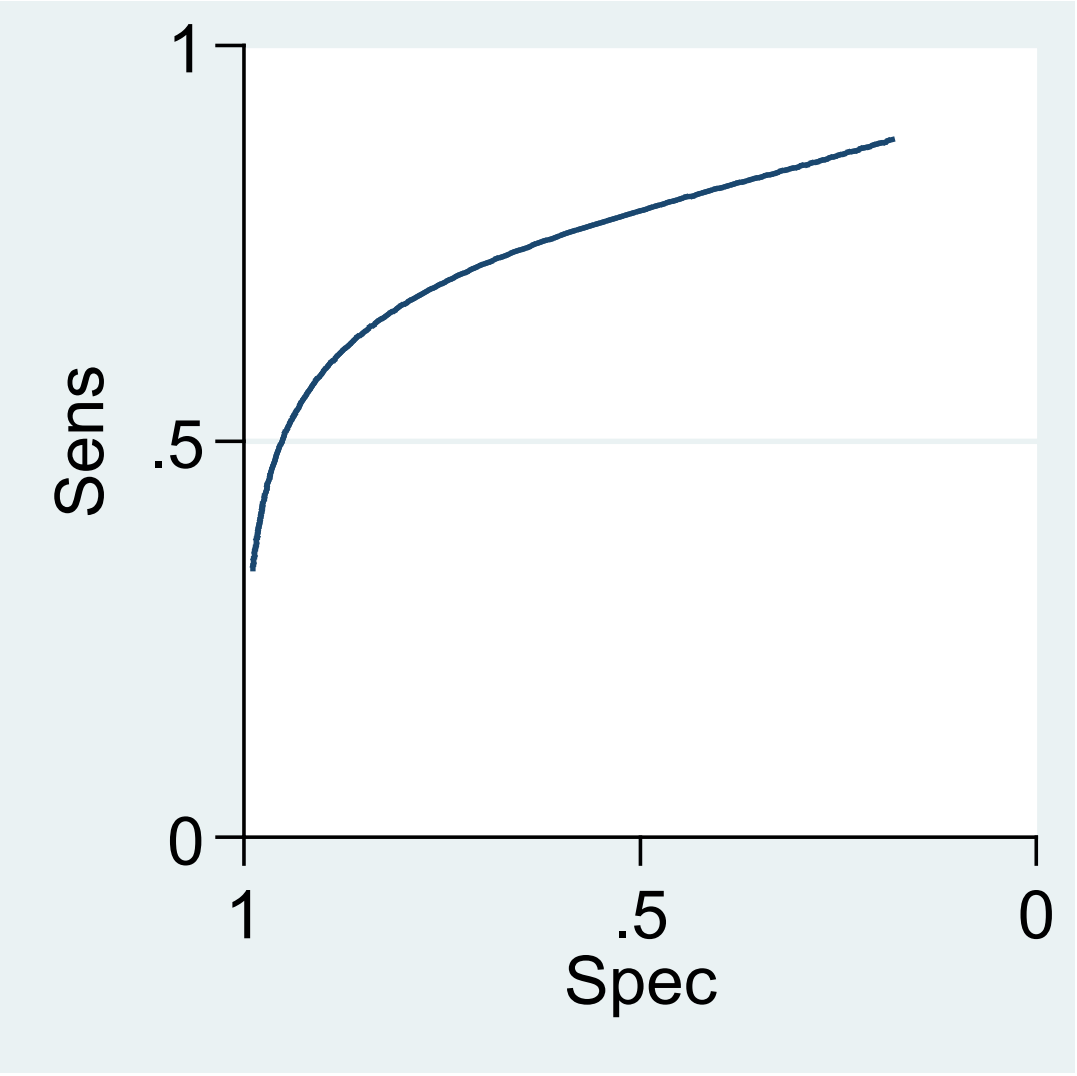


Adapted from draft Cochrane Diagnostic Reviewers' Handbook

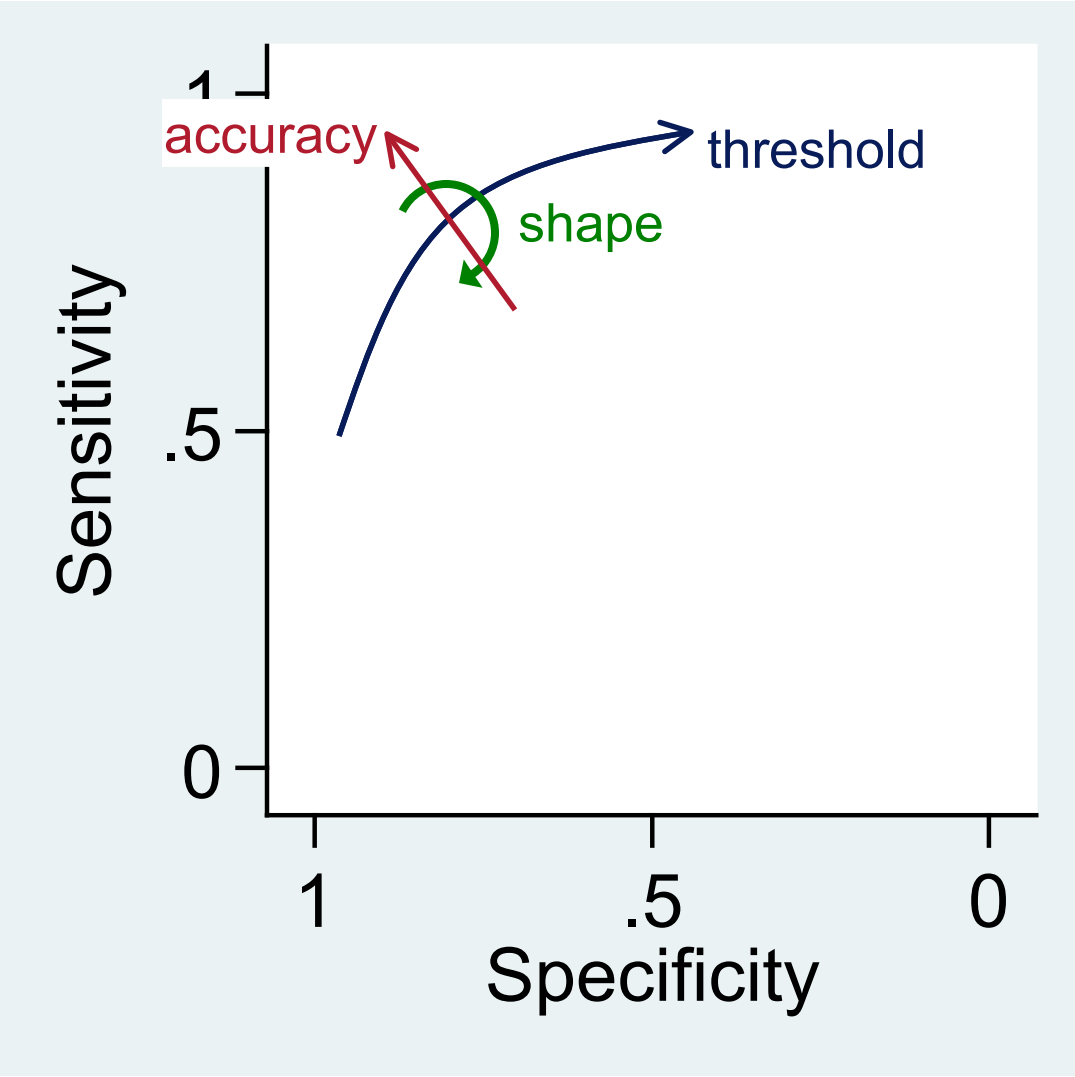
ROC curve: increase accuracy



ROC curve: Change shape parameter (different variances)



ROC curve – single study



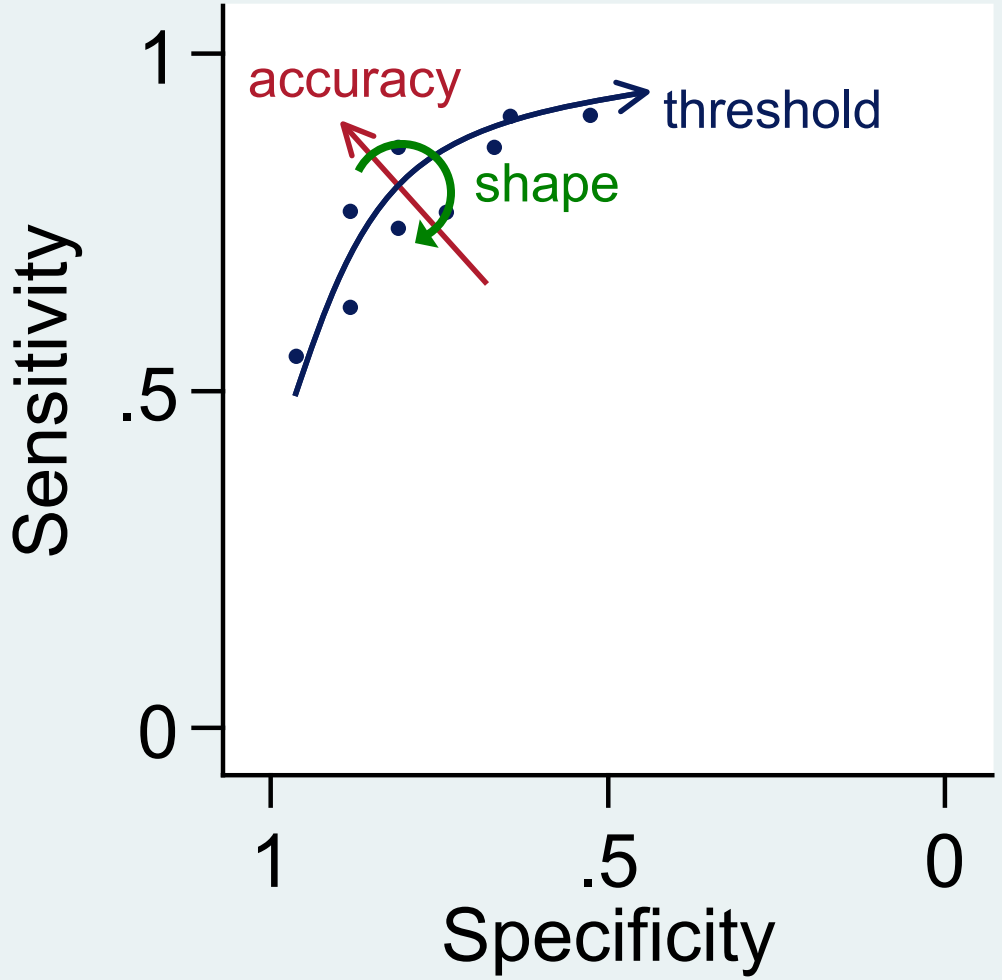
Methods for diagnostic meta-analysis

All based on 2×2 table from each study:

- Hierarchical SROC (HSROC) model
- Bivariate random-effects M-A

- Moses-Littenberg SROC curve
- M-A of (Diagnostic) Odds Ratios
- Separate M-A of Sensitivity & Specificity

HSROC model



5 parameters:

Mean + variance of both accuracy & threshold

Shape (scale, asymmetry) parameter

Rutter & Gatsonis. Statist. Med 2001; **20**:2865-84

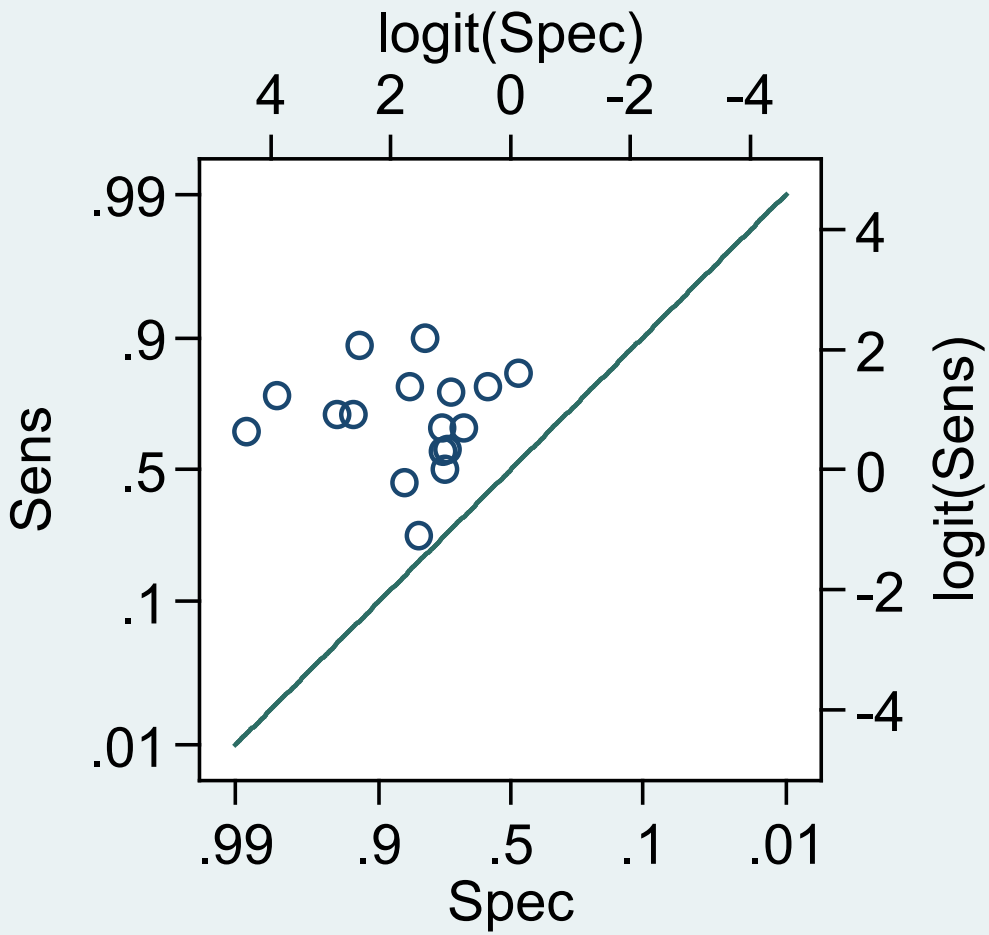
Bivariate model

- Based on logit-transform of sensitivity and specificity

- van Houwelingen, Arends & Stijnen. Statist. Med. 2002; **21**:589-624

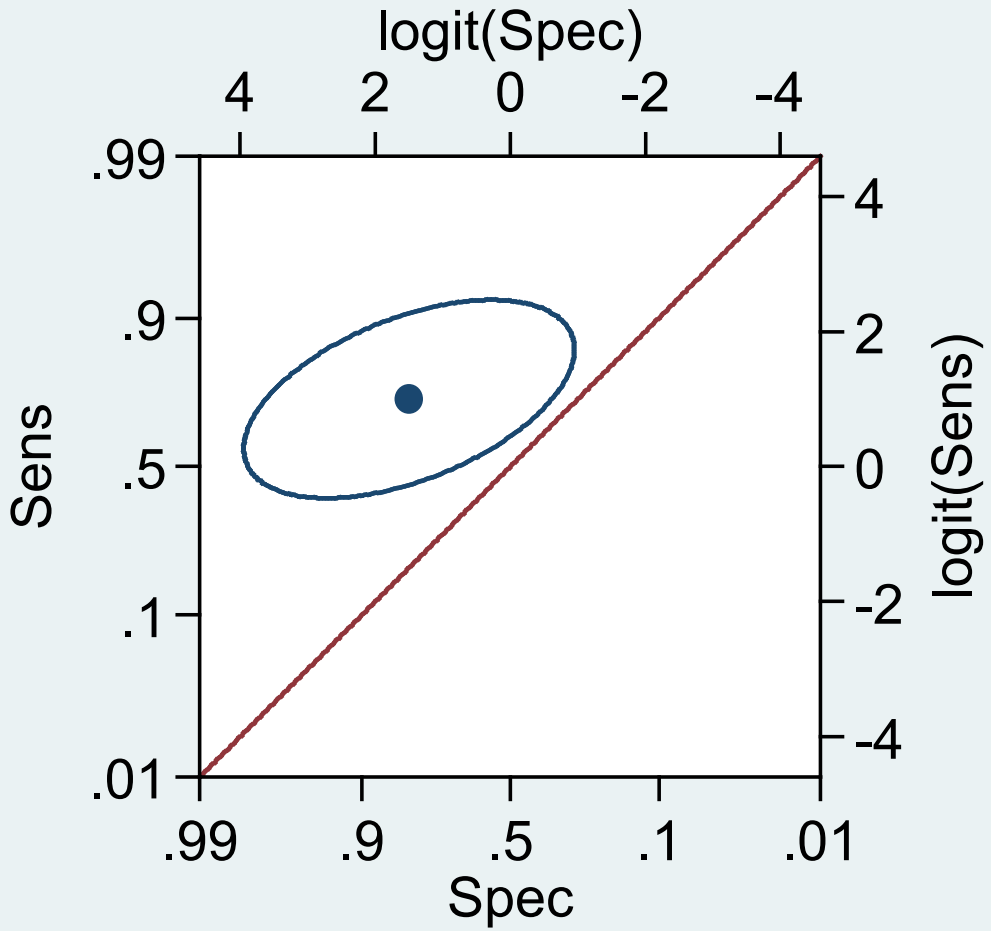
- Reitsma *et al.* J. Clin. Epidemiol. 2005; **58**: 982-990

logit ROC space



Kardaun & Kardaun
Meth. Inform. Med.
1990; **29**:12-22

Bivariate model



5 parameters:

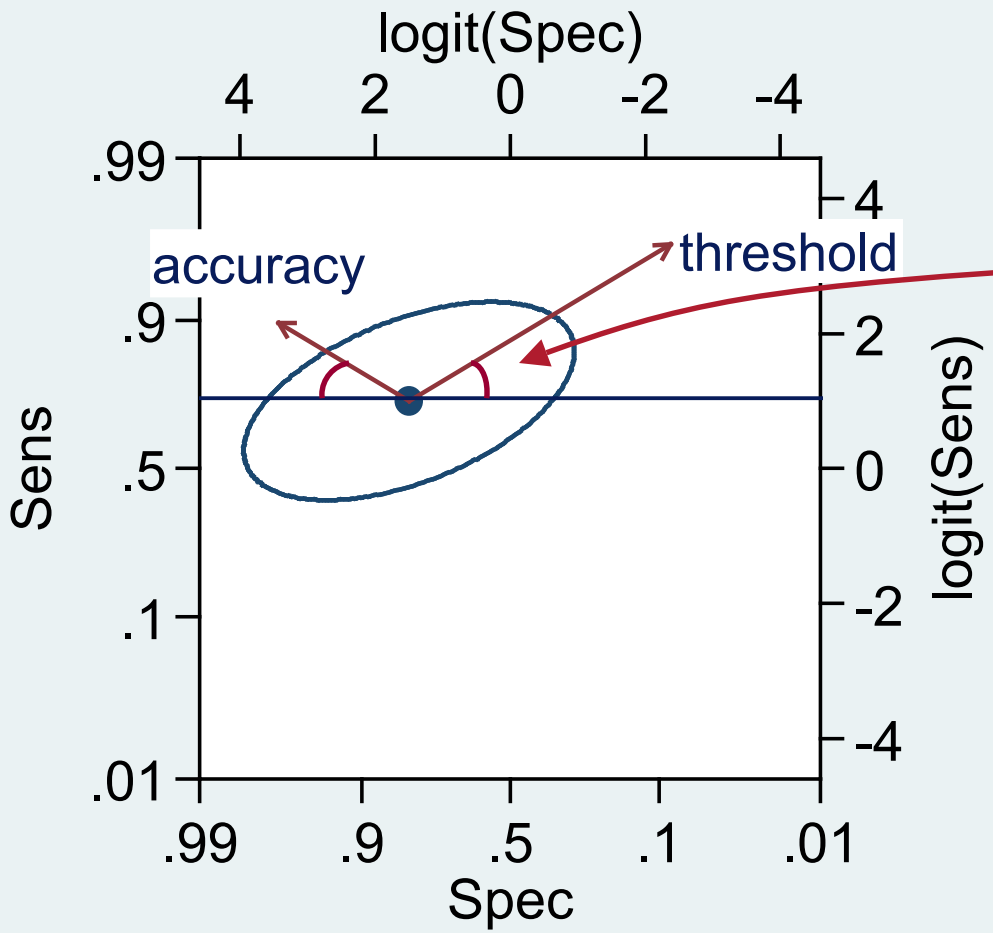
Mean + variance of logit(Sens) & logit(Spec)

1 covariance (correlation)

Equivalence of these two approaches

- HSROC also based on logits
- In many circumstances, the HSROC and bivariate models are precisely the same
  - just different parameterisations
- Happy to display algebraic relationships if asked!

Equivalence – logit ROC space

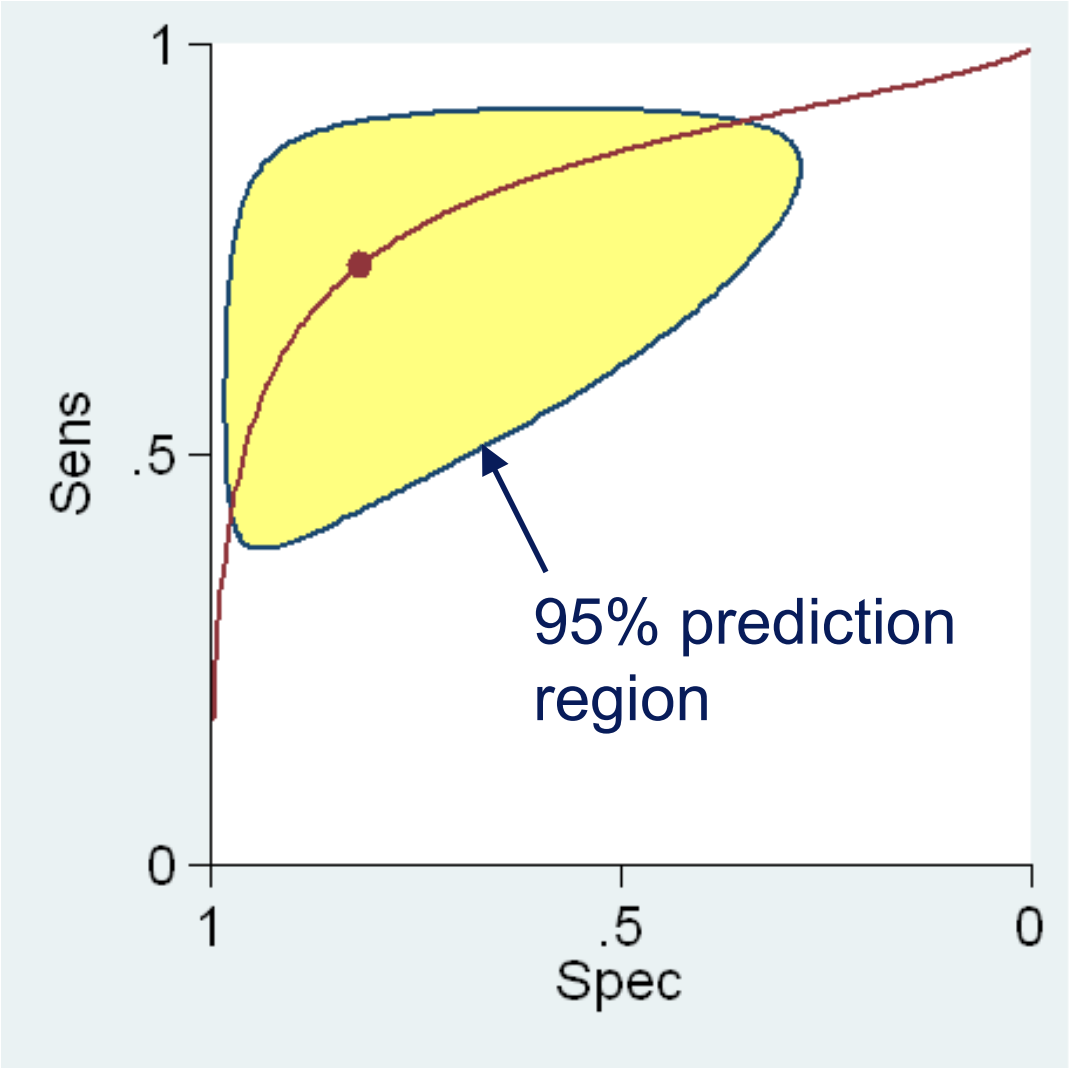


Angle depends on ratio of variances – *not* covariance

Comparison

	Bivariate	HSROC
Coordinates	Sensitivity & Specificity (logit-transformed)	Accuracy & Precision
Usual interpretation	Summary point and region	Summary ROC curve

Transform back to ordinary ROC space



Can get same point, line and region from either HSROC or bivariate parameter estimates

Covariates

- Can allow a covariate to affect:
  - sensitivity or specificity in bivariate model
  - threshold or accuracy in HSROC model
- If a covariate affects both, models are equivalent
- Only the HSROC model can allow a covariate to affect shape

Separate meta-analysis of Sensitivity & Specificity

- Don’t need covariance to get
  - Summary point
  - SROC curve

- Therefore can get these from separate meta-analyses of logit(Sensitivity) & logit(Specificity)

Discussion/Summary

- HSROC & bivariate models are identical in many circumstances
  - Apparent differences can arise because of different software and estimation procedures
- We need these methods in order to
  - derive confidence / prediction regions
  - formally compare tests
- Separate meta-analysis of sensitivity & specificity (logit-transformed) can give:
  - Summary point
  - SROC curve

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