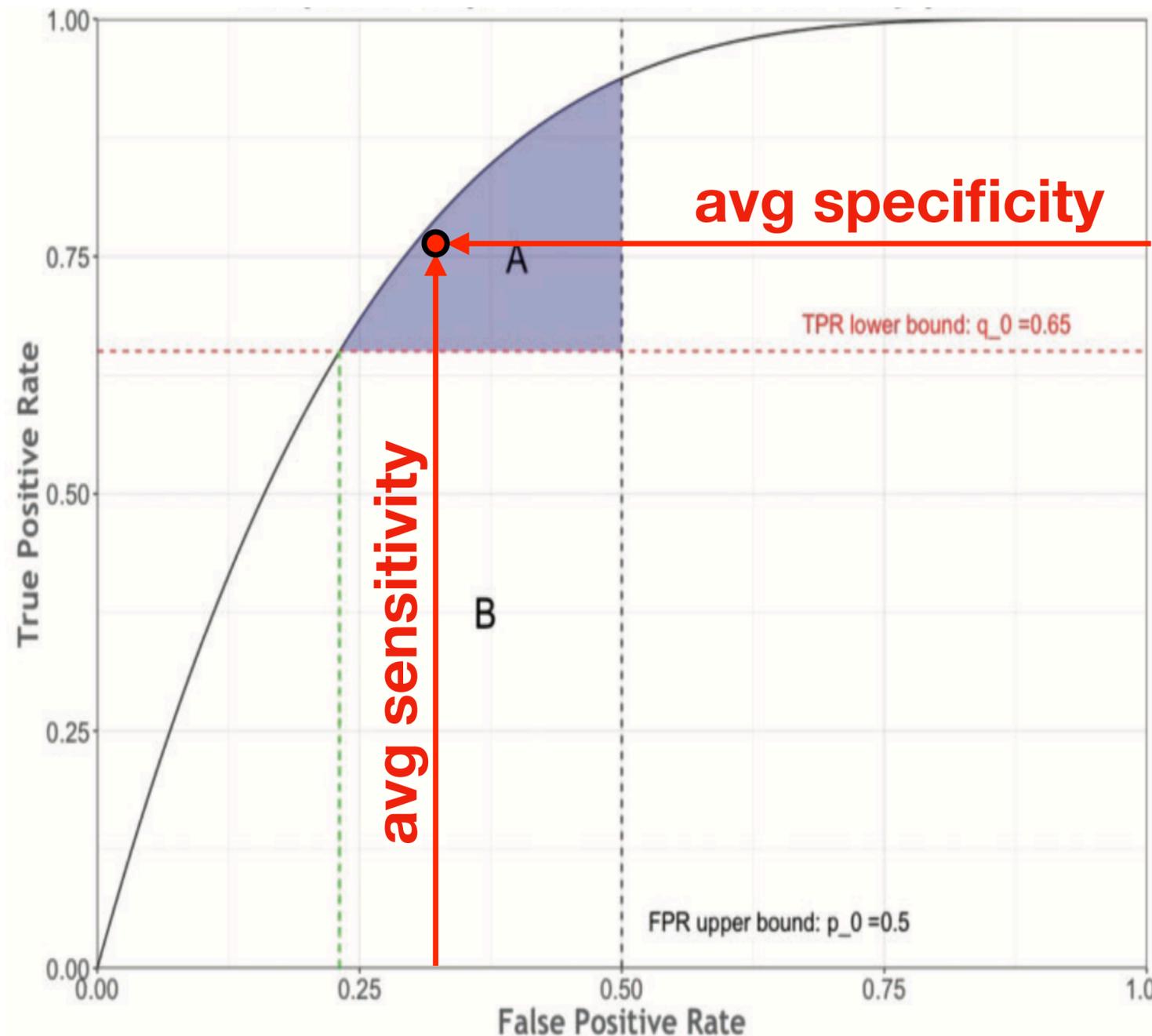




# **Problems with the two-way AUC resolved by the concordant partial AUC and deep ROC analysis**

# Problems with the Two-Way AUC<sup>1</sup>



For bounds on TPR and FPR, two-way AUC measures the probability of area A.

**It does not measure avg sensitivity nor avg specificity, like AUC.**

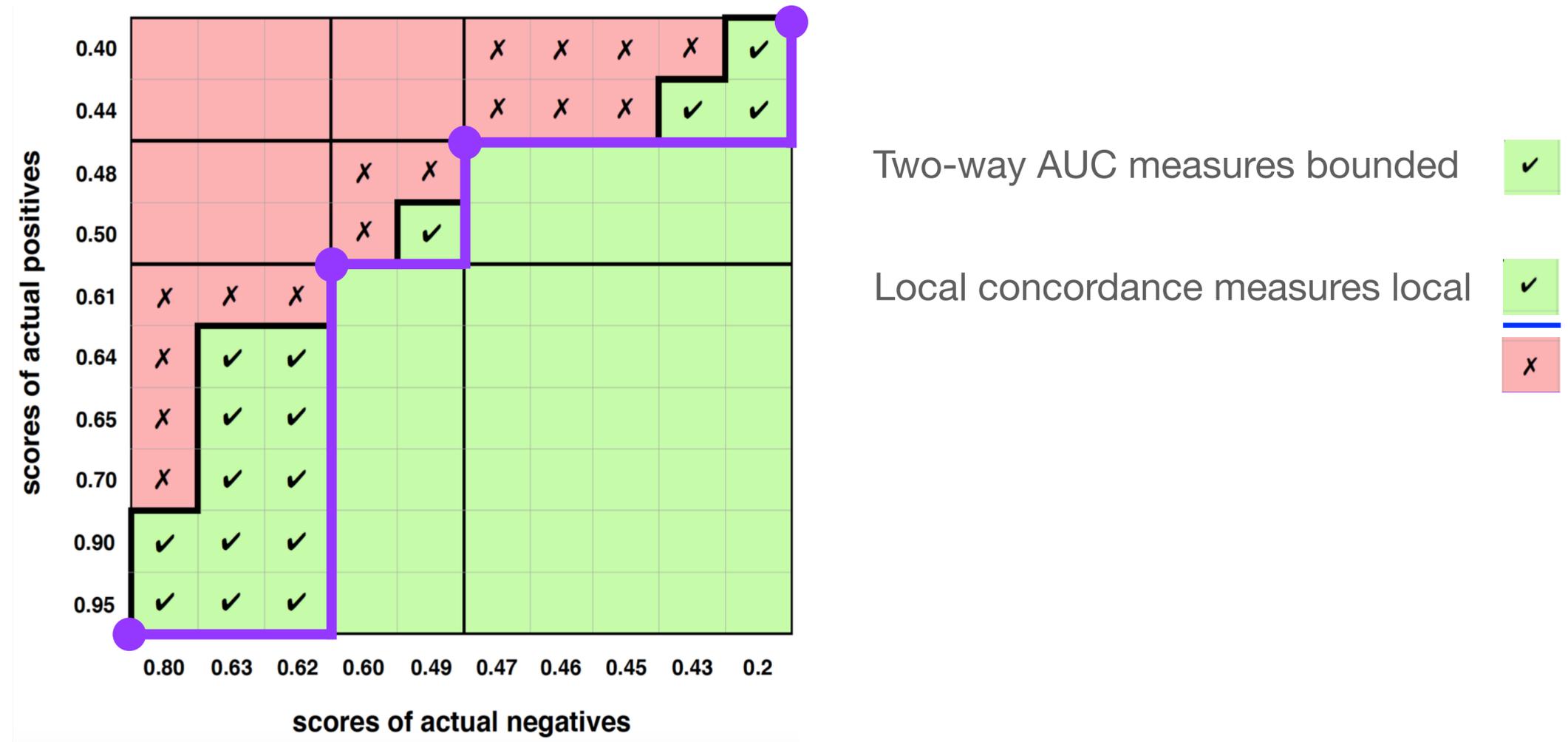
$$\text{AUC} = \text{avgSens} = \text{avgSpec}$$

# Problems with the Two-Way AUC<sup>1</sup>

- applies conditions to a normalized U statistic, **which do not match a partial C stat**
- is compared\* by the authors to **a biased measure**: the partial AUC
- is introduced to choose between two models, **not measure the performance of one**
- **is a variation of Carrington *et al.*'s local concordance<sup>2</sup>**--explained next, which is discarded as **flawed/insufficient** toward developing the concordant partial AUC
- **is a misleading special case: it measures a patient subgroup in isolation** (next)

\*Two-way AUC's result was better than partial AUC which only has a vertical perspective.

# Measuring subgroups in isolation misses information: two-way AUC<sup>1</sup> does not add up to AUC<sup>2</sup> for sets spanning the ROC curve



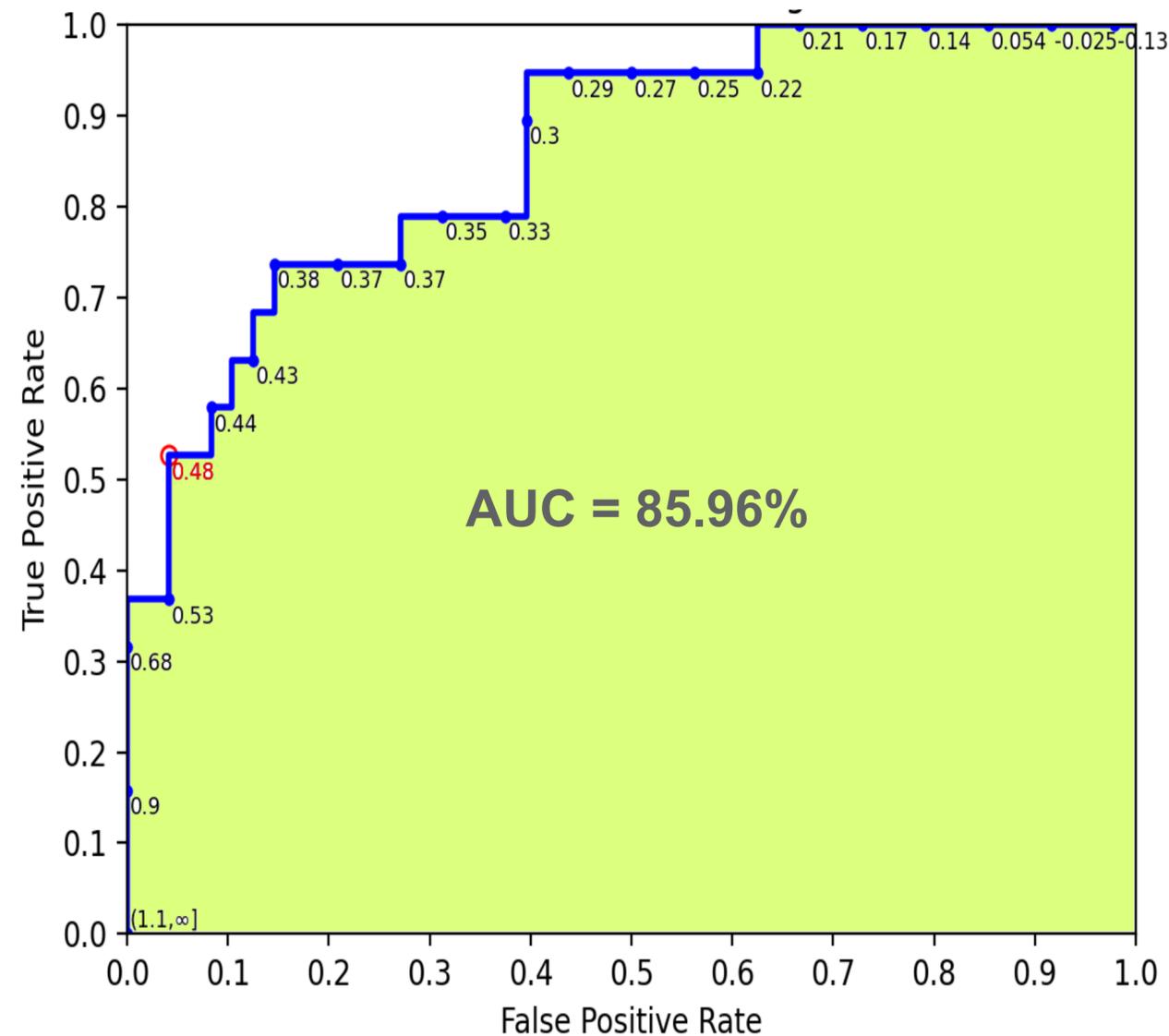
Two-way AUC (and local concordance) for three subgroups that span the ROC curve. They do not add up to the AUC or C statistic because they lack information from green cells without check marks. The figure above is from Carrington *et al.*<sup>15</sup> with a purple line added for enhancement.

# Problems with the Two-Way AUC<sup>1</sup>

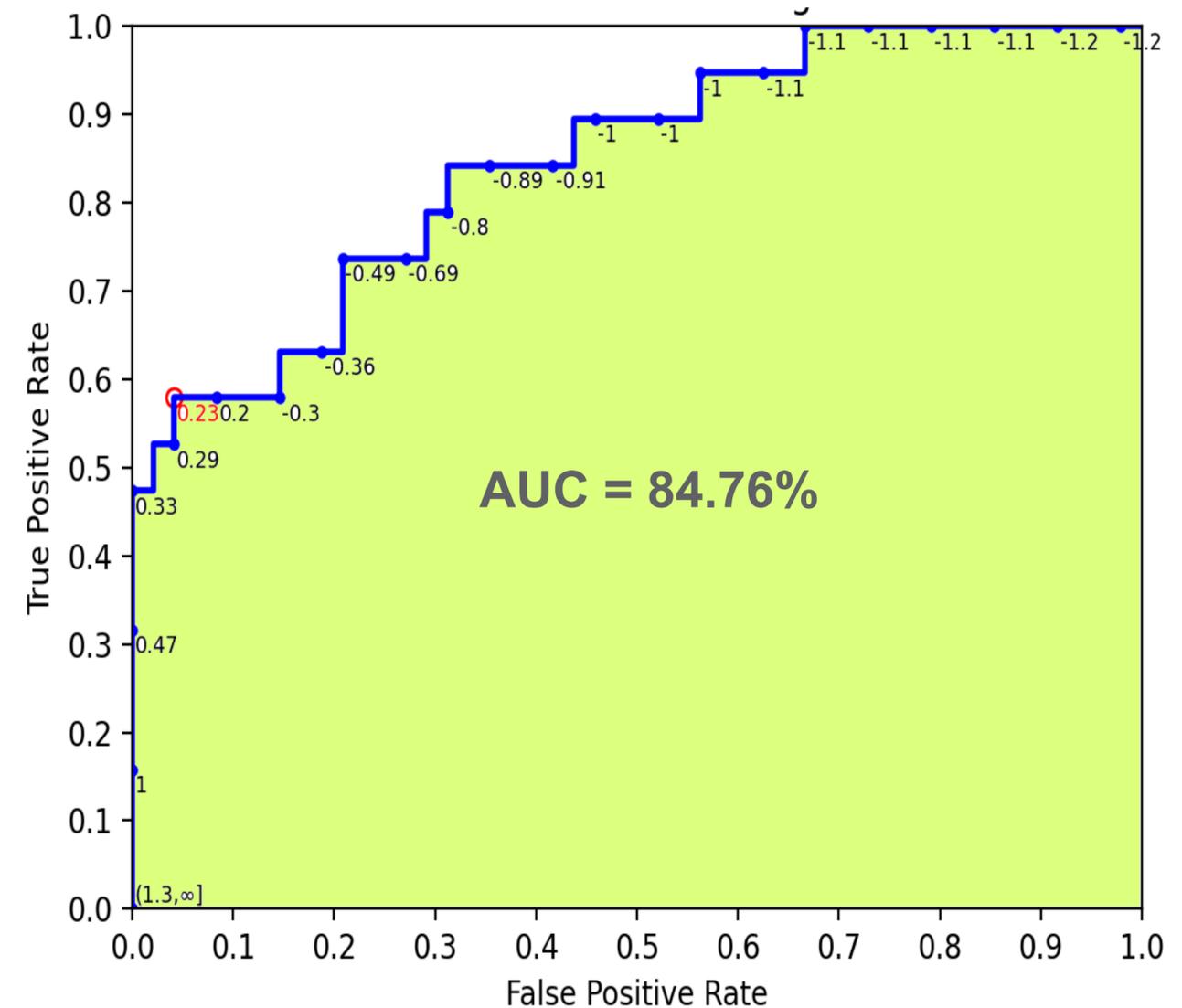
- **is not the general case (for the same bounds):** measuring how we discriminate between a subgroup of instances/patients **and all patients**<sup>2,3,4,5,6,7</sup>.
- the general case measures sensitivity and specificity, as in the ***concordant*** partial AUC. An area that two-way AUC claims to be redundant, is relevant\*.

\*The vertical area that two-way AUC ignores, is relevant, and the horizontal area is also required.

# Consider two ROC curves



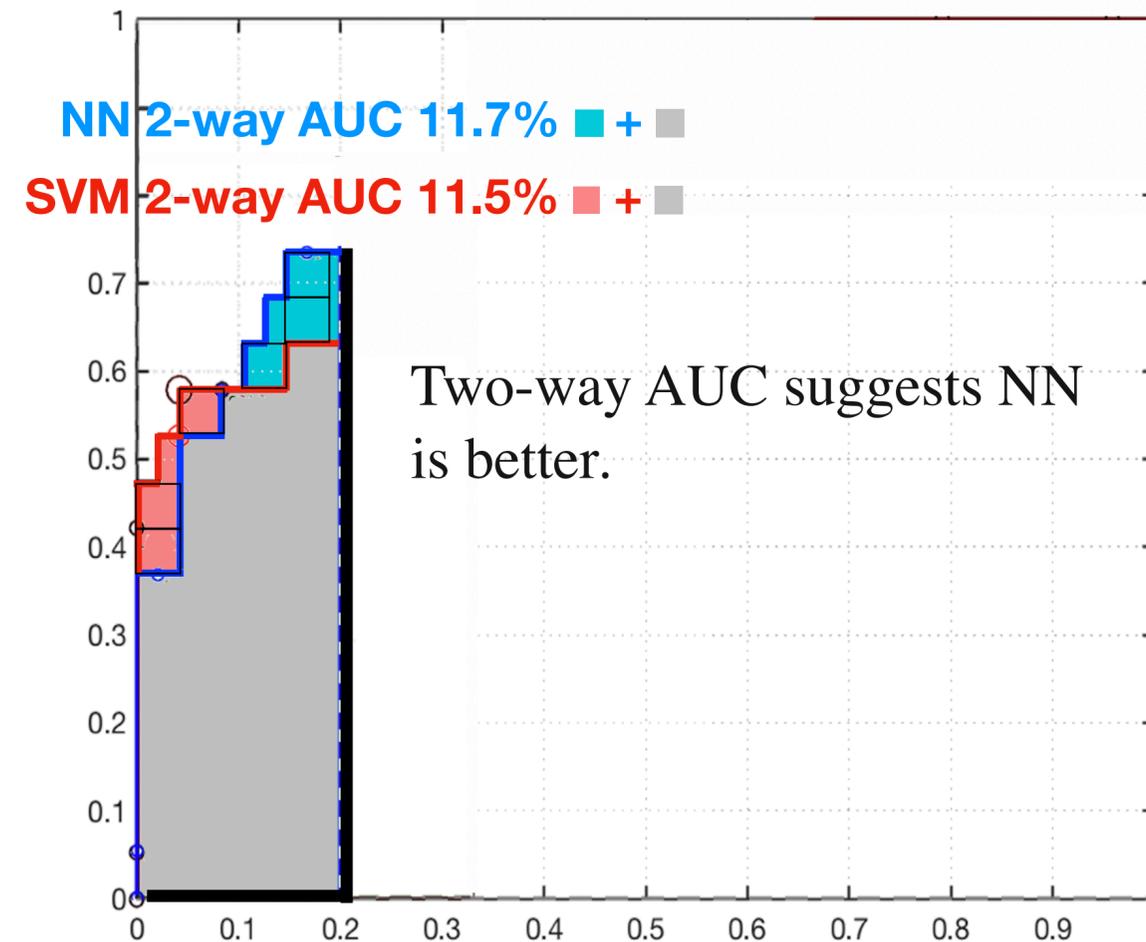
**Neural Network (NN)**



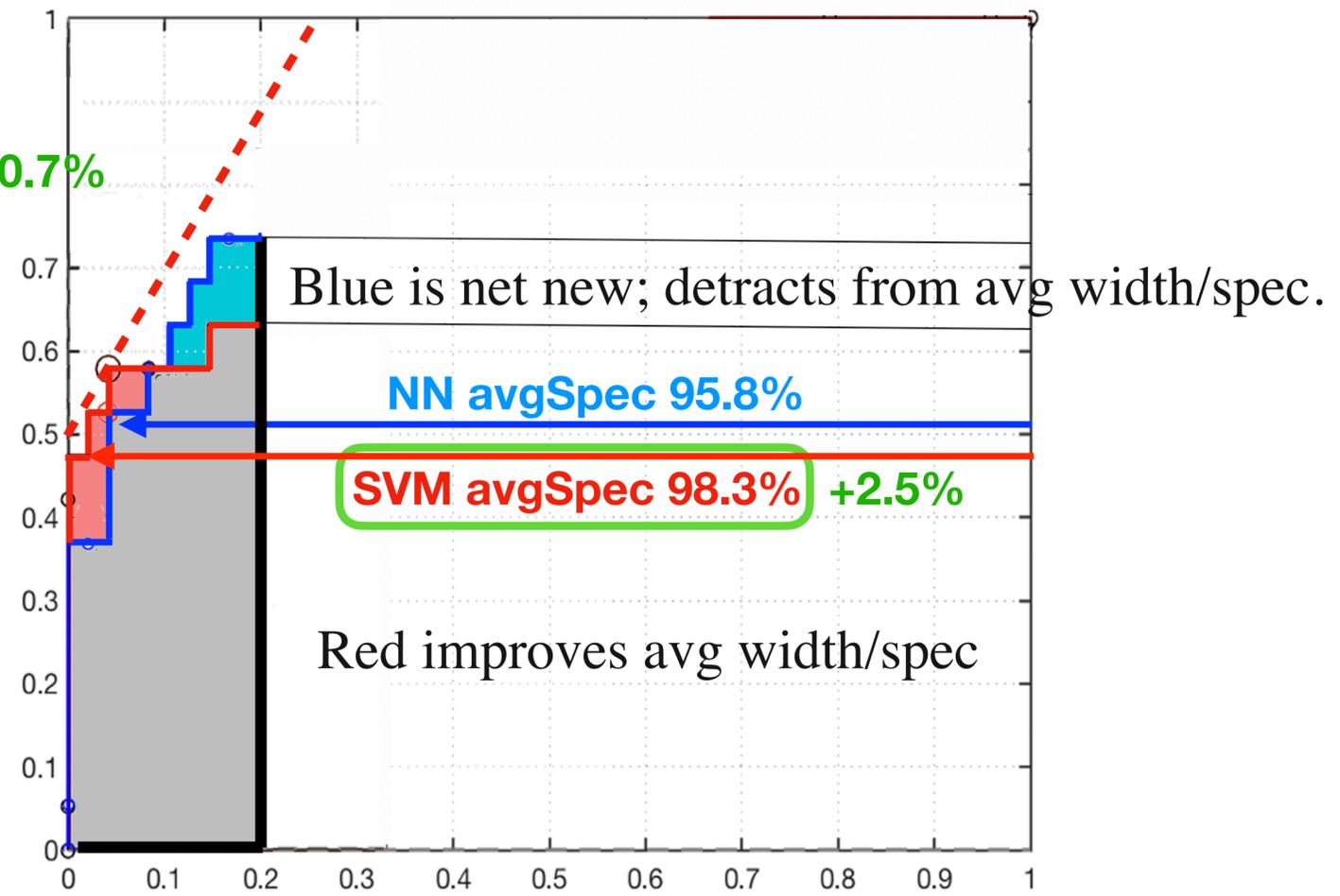
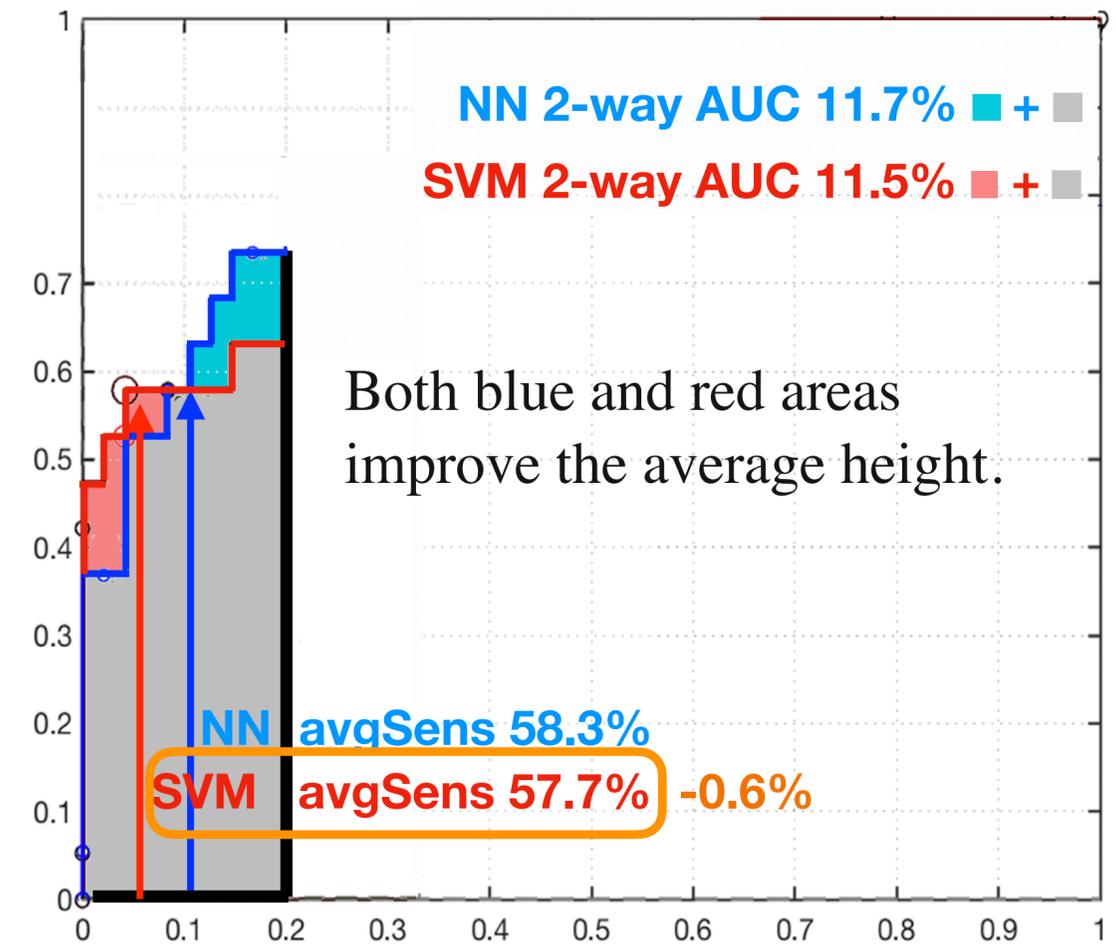
**Support Vector Machine (SVM)**

ROC curves are shown for predictions of 1-year remission of breast cancer in Ljubljana data [cite] with 30% prevalence. Assume equal costs of error to simplify ROC analysis. Which is better for FPR < 20%? We examine this next...

# Two-way AUC: NN has 0.2% more area than SVM, exceeding the constraints.



# Deep ROC and the concordant partial AUC: SVM is better in AUC<sub>n1</sub> +0.7% and average specificity +2.5%, but worse in average sensitivity -0.6%



Deep ROC analysis uses absolute measures instead with probabilistic meaning. SVM also has the better optimal ROC point (red dashed line).

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# The End

<http://www.deeproc.org>

<https://github.com/Big-Life-Lab/deepROC>

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