
The Relationship Between Precision-Recall and ROC Curves

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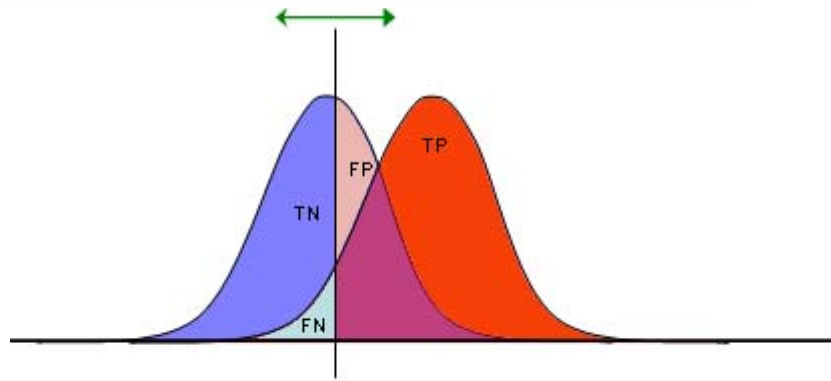
ICML 2006

ROC curves

	actual positive	actual negative
predicted positive	TP	FP
predicted negative	FN	TN

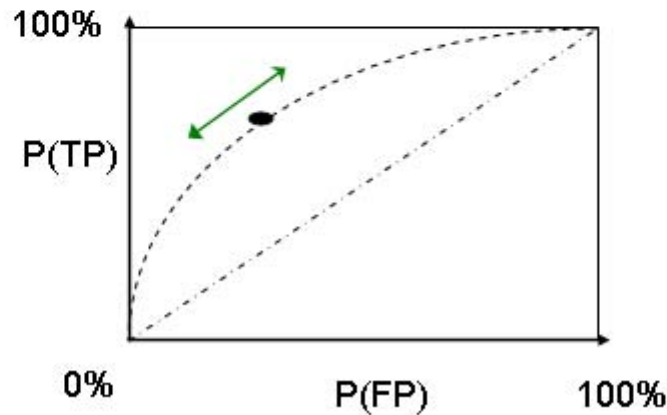
$$\text{True Positive Rate} = \frac{TP}{TP+FN}$$

$$\text{False Positive Rate} = \frac{FP}{FP+TN}$$



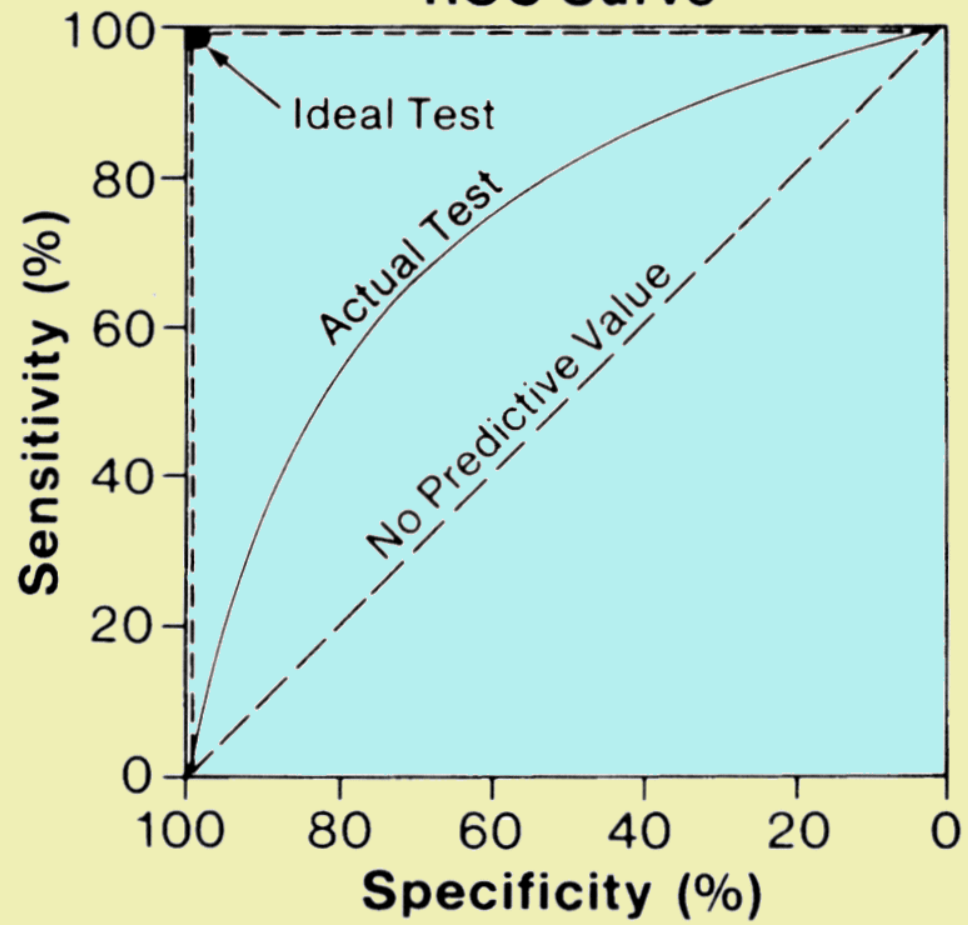
TP	FP
FN	TN

True positive rate
Sensitivity



False positive rate
Complementary specificity

ROC Curve



Proportion of recovered true edges

Proportion of avoided non-edges

Definition of metrics

	actual positive	actual negative
predicted positive	TP	FP
predicted negative	FN	TN

(a) Confusion Matrix

Recall = $\frac{TP}{TP+FN}$ ← Total number of true edges

Precision = $\frac{TP}{TP+FP}$ ← Total number of predicted edges

True Positive Rate = $\frac{TP}{TP+FN}$ ← Total number of true edges

False Positive Rate = $\frac{FP}{FP+TN}$ ← Total number of non-edges

A red curved arrow on the left points from the 'True Positive Rate' label up to 'Recall' and down to 'Precision'.

(b) Definitions of metrics

The relation between Precision-Recall (PR) and ROC curves

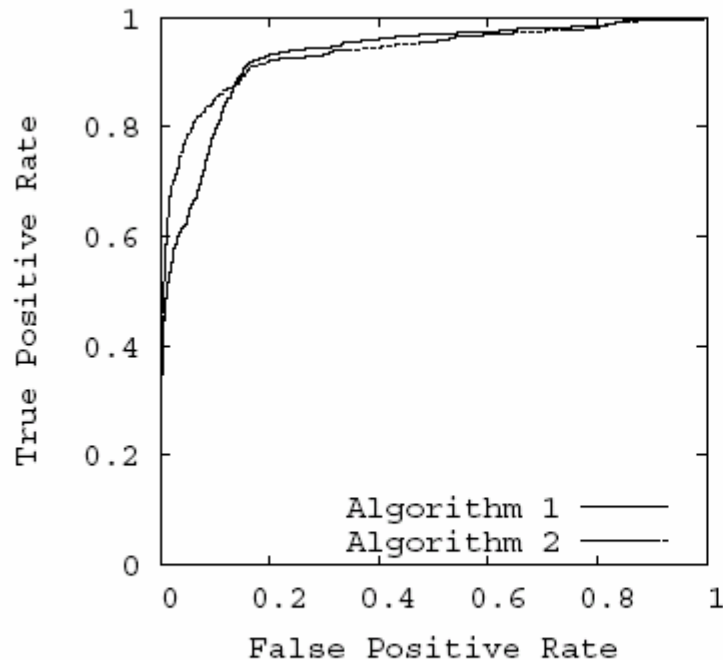
$$\text{Recall} = \frac{TP}{TP+FN}$$

$$\text{Precision} = \frac{TP}{TP+FP}$$

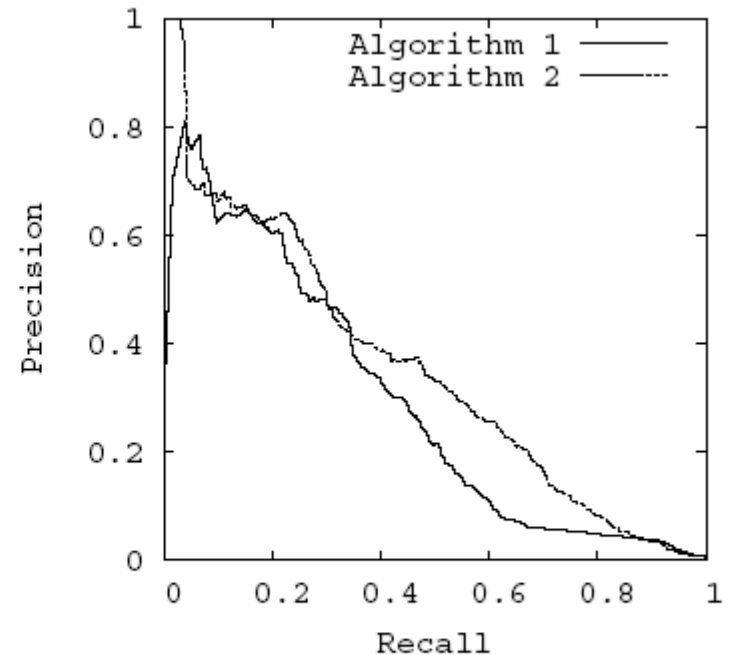
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	actual positive	actual negative
predicted positive	TP	FP
predicted negative	FN	TN



(a) Comparison in ROC space



(b) Comparison in PR space

The relation between Precision-Recall (PR) and ROC curves

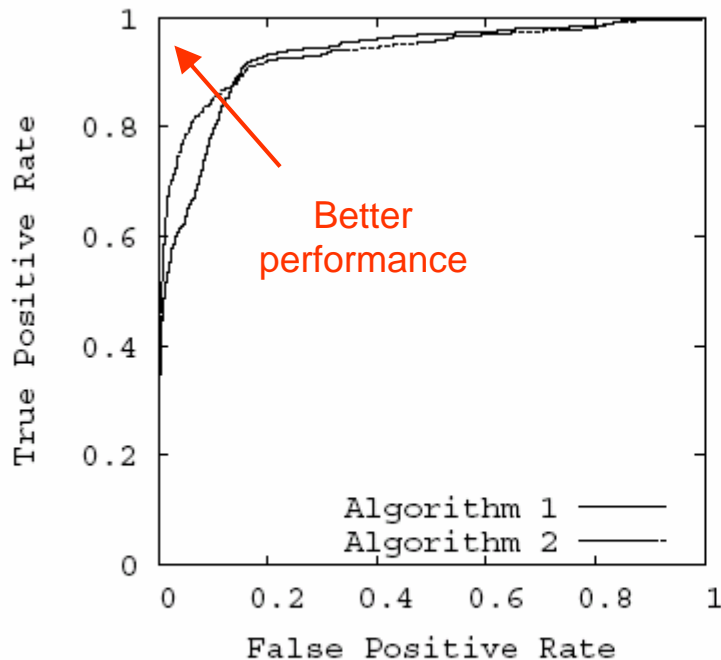
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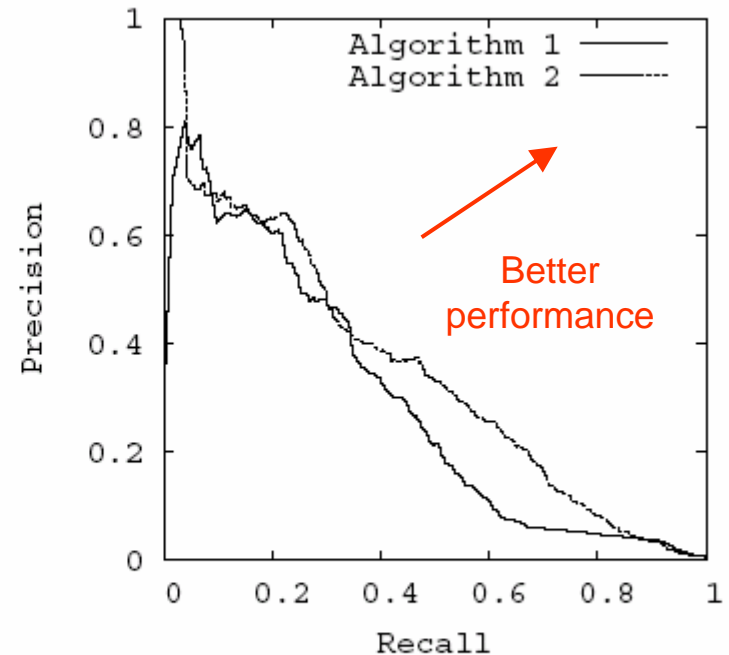
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	actual positive	actual negative
predicted positive	TP	FP
predicted negative	FN	TN



(a) Comparison in ROC space



(b) Comparison in PR space

Potential advantage of Precision-Recall (PR) over ROC curves

$$\text{Recall} = \frac{TP}{TP+FN}$$

$$\text{Precision} = \frac{TP}{TP+FP}$$

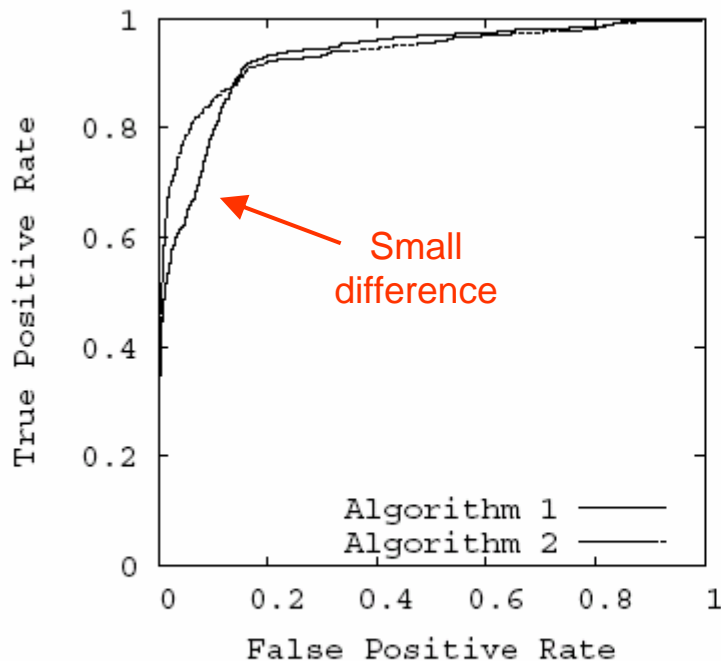
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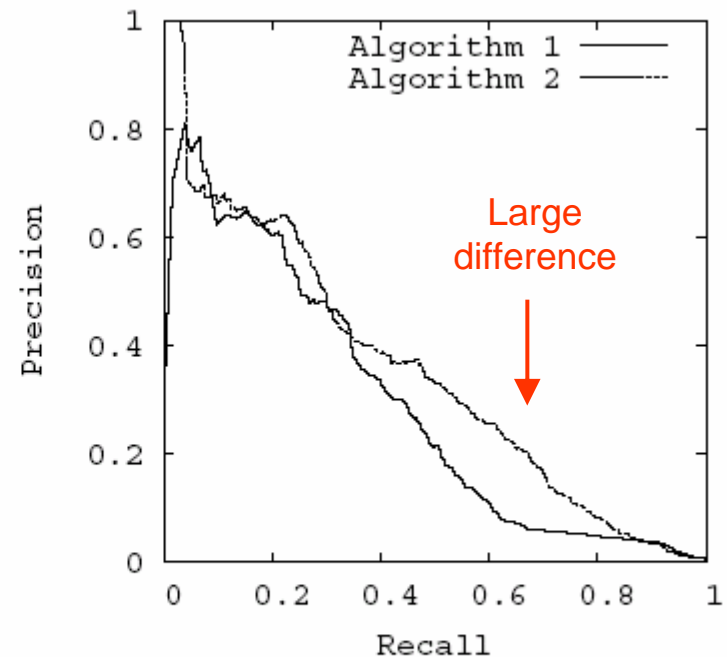
Large change in FP has a strong effect on the precision

Large change in FP may have a small effect on the false positive rate

Large number of negative examples (TN+FP)



(a) Comparison in ROC space



(b) Comparison in PR space

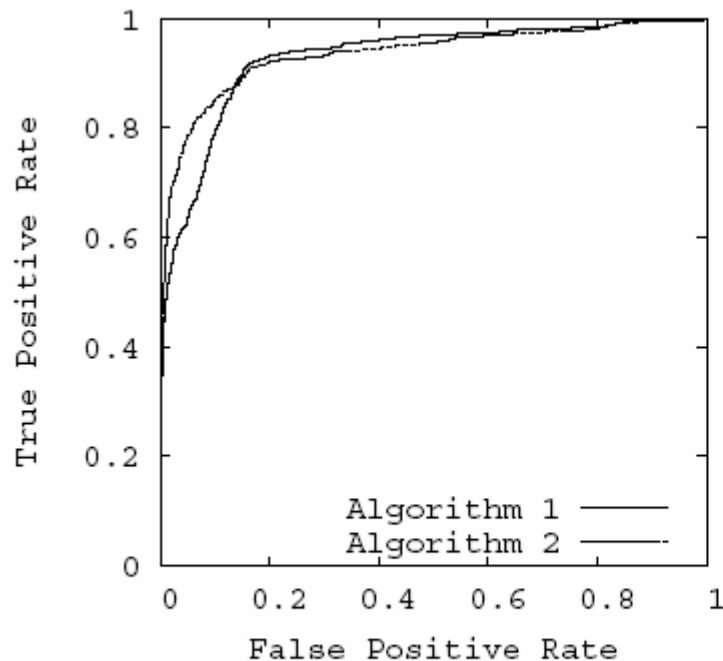
Linear interpolation: straightforward for ROC curves

$$\text{Recall} = \frac{TP}{TP+FN}$$

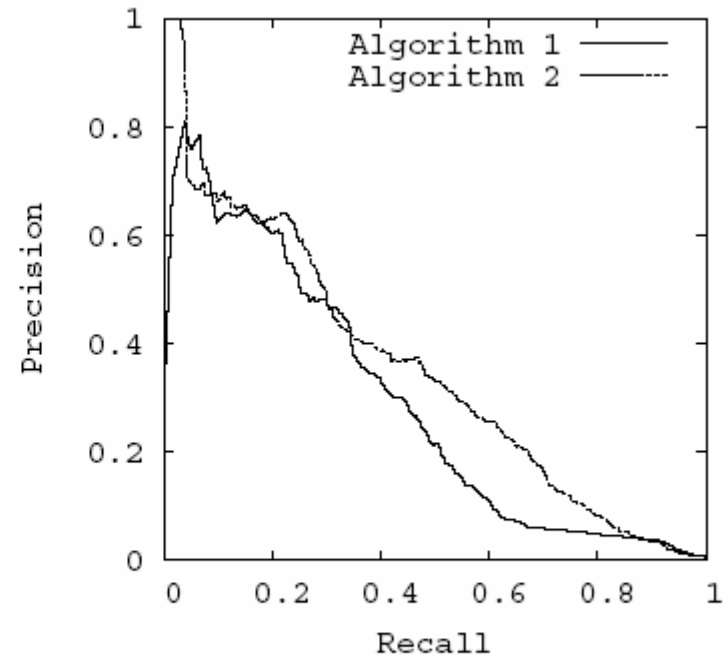
$$\text{Precision} = \frac{TP}{TP+FP}$$

$$\text{True Positive Rate} = \frac{TP}{TP+FN} \leftarrow \text{Total number of edges} = \text{const}$$

$$\text{False Positive Rate} = \frac{FP}{FP+TN} \leftarrow \text{Total number of non-edges} = \text{const}$$



(a) Comparison in ROC space



(b) Comparison in PR space

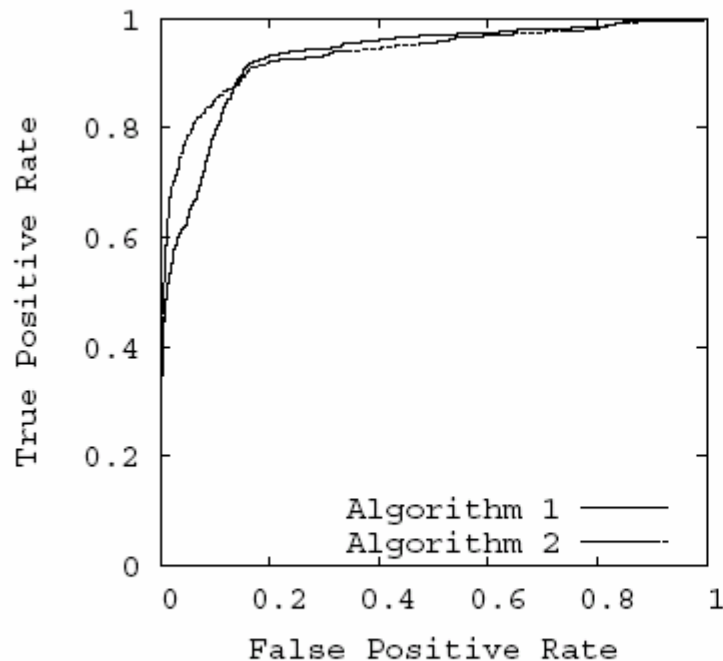
Linear interpolation: potential fallacy for Precision-Recall curves

$$\text{Recall} = \frac{TP}{TP+FN}$$

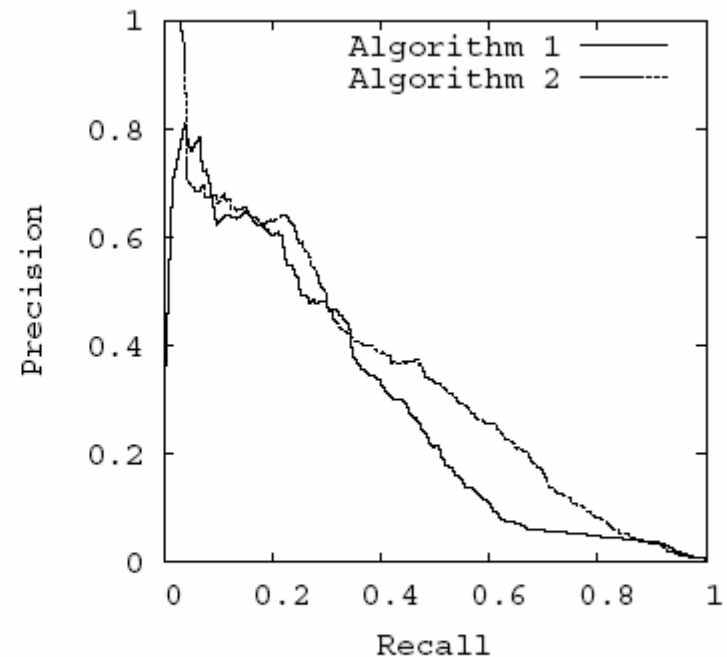
$$\text{Precision} = \frac{TP}{TP+FP} \leftarrow \text{NOT CONSTANT!}$$

$$\text{True Positive Rate} = \frac{TP}{TP+FN} \leftarrow \text{Total number of edges} = \text{const}$$

$$\text{False Positive Rate} = \frac{FP}{FP+TN} \leftarrow \text{Total number of non-edges} = \text{const}$$



(a) Comparison in ROC space



(b) Comparison in PR space

Linear interpolation: potential fallacy for Precision-Recall curves

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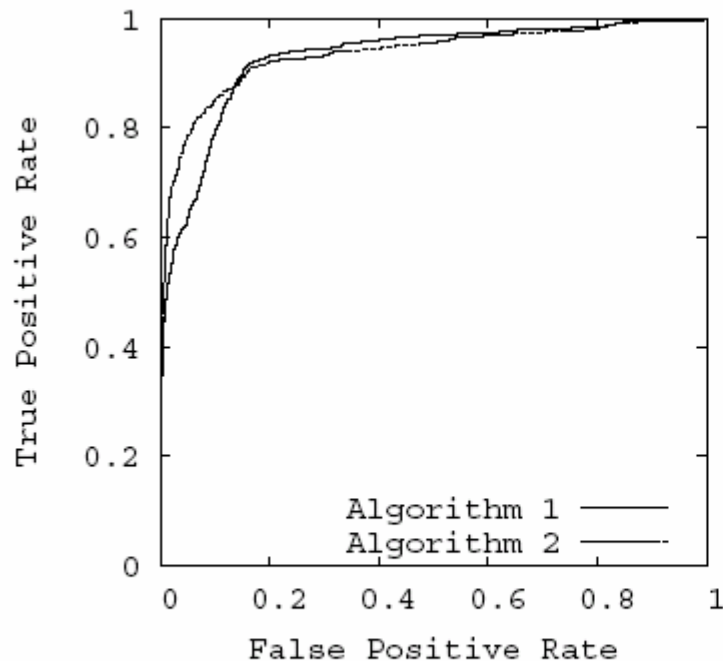
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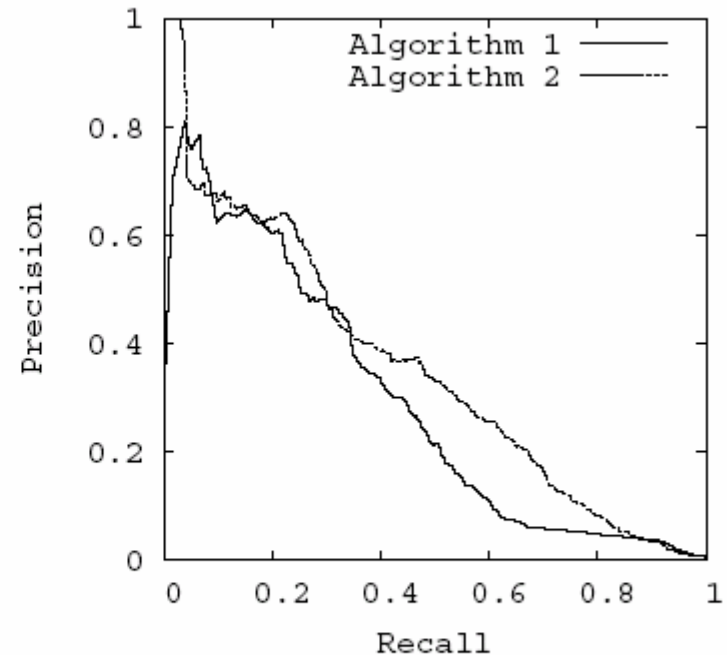
$$\text{False Positive Rate} = \frac{FP}{FP+TN}$$

Correct interpolation:

$$\left(\frac{TP_A + x}{\text{Total Pos}}, \frac{TP_A + x}{TP_A + x + FP_A + \frac{FP_B - FP_A}{TP_B - TP_A} x} \right)$$

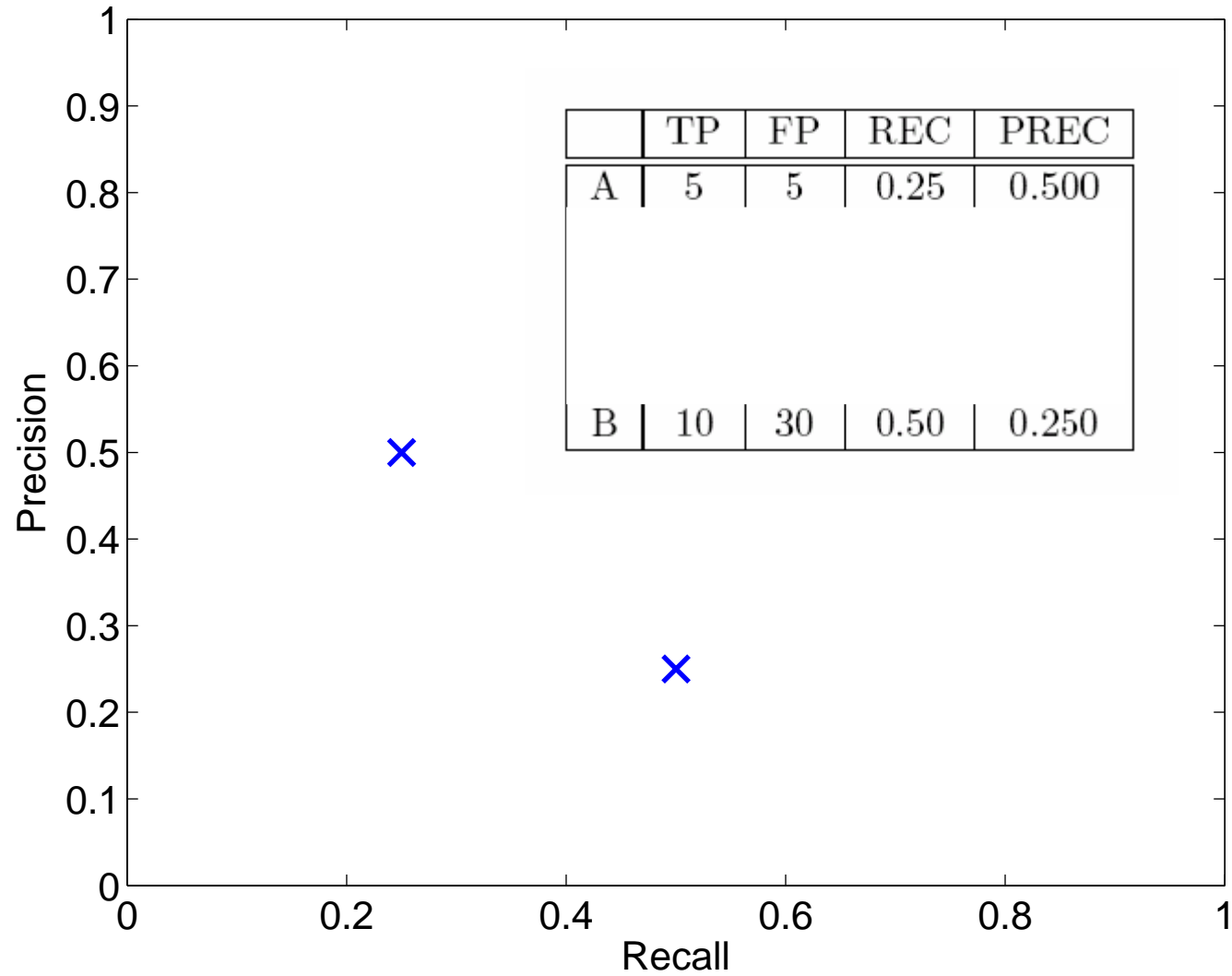


(a) Comparison in ROC space



(b) Comparison in PR space

Interpolation example: 20 edges



Interpolation example: 20 edges

