An Introduction to ROC Analysis.

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Introduction

- ROC: Receiver Operating Characteristic.
- Started in electronic signal detection theory (1940s - 1950s).
- Has become very popular in biomedical applications, particularly radiology and imaging.
- Also used in machine learning applications to assess classifiers.
- Can be used to compare tests/procedures.

ROC Analysis

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- We going to start with the two-class prediction problem.

Confusion Matrix

1. Accuracy $= \frac{TP+TN}{P+N}$
2. Specificity $= \frac{TN}{FP+TN}$
3. Sensitivity $= \frac{TP}{TP+FN}$
4. Precision $= \frac{TP}{TP+FP}$
5. F-measure $= \frac{2}{\frac{1}{Precision}+\frac{1}{Sensitivity}}$

		prediction outcome		
		p	***n***	**total**
actual value	***p'***	True Positive	False Negative	P'
	n'	False Positive	True Negative	N'
	total	P	N	

where P are the predicted examples of the positive class and N are the predicted examples of the negative class.

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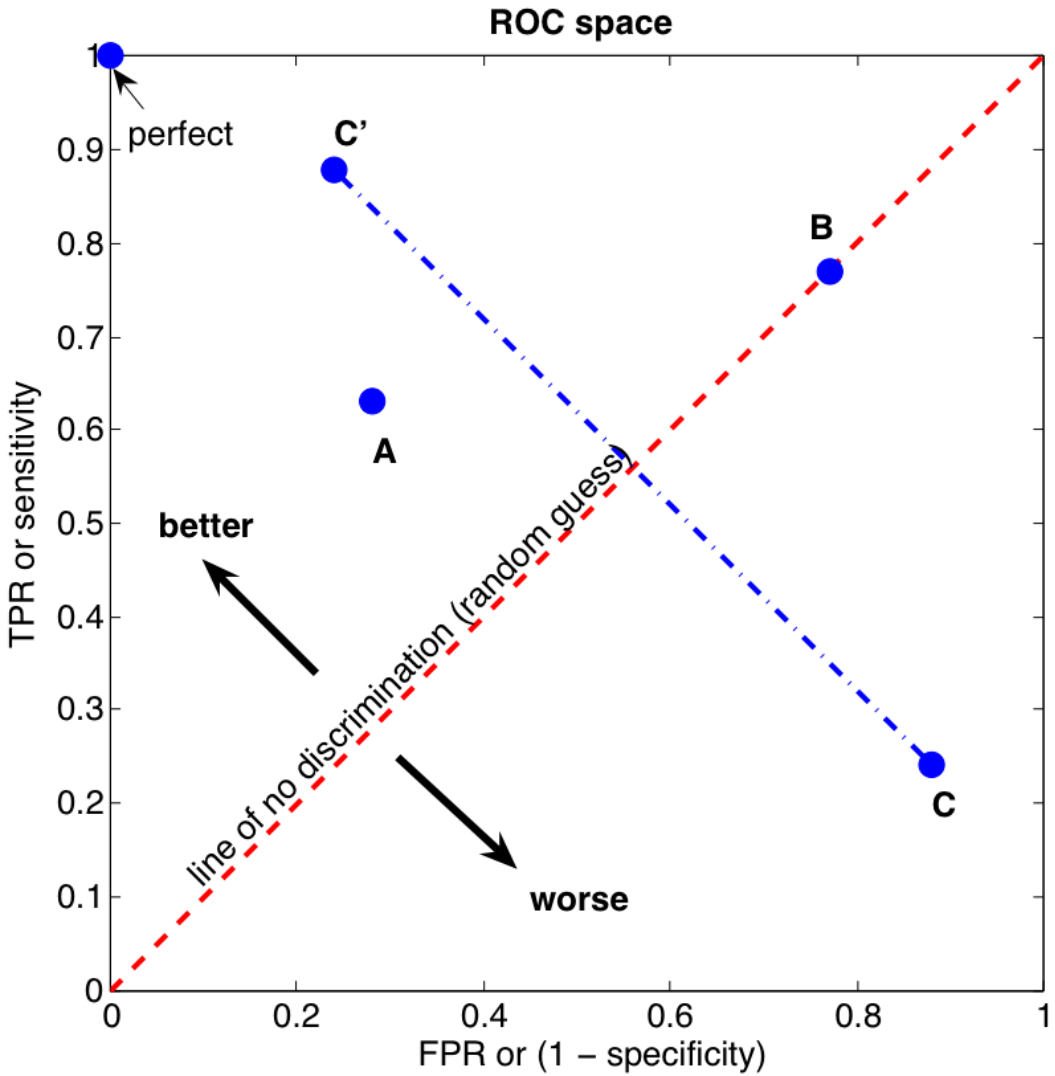
  2. $fpr = 1 - Specificity = \frac{FP}{FP+TN}$
- An ROC graph depicts relative tradeoffs between benefits (true positives) and costs (false positives).

ROC Space



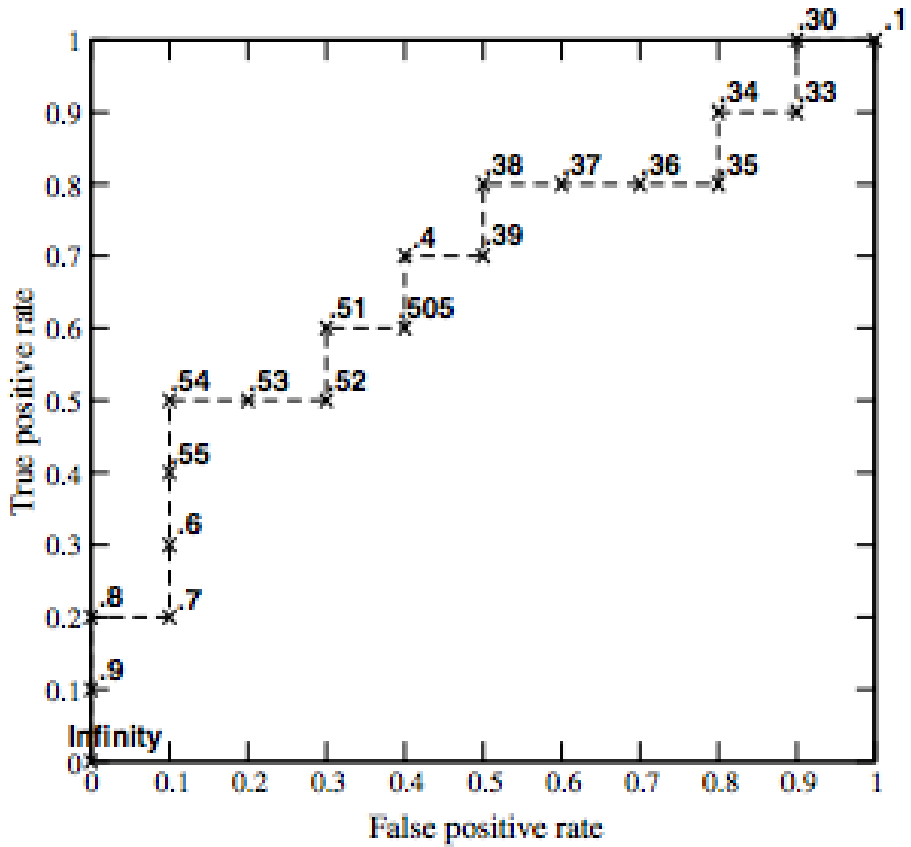
- What do the points mean?
- Which one is better?

Curves in ROC Space

- Many classifiers, are designed to produce only a class decision (1,-1; Y, N).
- These classifiers only produce one point in ROC space.
- But others classifiers such Naive Bayes or Neural Networks naturally yield an instance probability or score, a numeric value that represents the degree to which an instance is a member of a class.
- In these cases, we can use a threshold to produce a binary response. We can change the value of the threshold and gets different points on the ROC space.

Curves in ROC Space: example

Inst#	Class	Score	Inst#	Class	Score
1	p	.9	11	p	.4
2	p	.8	12	n	.39
3	n	.7	13	p	.38
4	p	.6	14	n	.37
5	p	.55	15	n	.36
6	p	.54	16	n	.35
7	n	.53	17	p	.34
8	n	.52	18	n	.33
9	p	.51	19	p	.30
10	n	.505	20	n	.1



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Some final questions:

1. Can I summarize the information of ROC space? How?
2. There are others metrics based on ROC Analysis?
3. Can be used ROC Analysis in multi-labels (> 2) problems? How?

References

Reference 1:

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An introduction to ROC analysis

Tom Fawcett

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journal homepage: www.elsevier.com/locate/infoproman

A systematic analysis of performance measures for classification tasks

Marina Sokolova [a,*], Guy Lapalme [b]

Thank you for your attention!