Applied Text Analytics & Natural Language Processing

with Dr. Mahdi Roozbahani
& Wafa Louhichi

Classification Evaluation

These slides are inspired based on slides from Professors Guy Lebanon, Jeffrey Heer, John Stasko, Christos Faloutsos, Polo Chau, Mahdi Roozbahani

Learning Objectives

In this lesson, you will learn about the goodness of classification

- Confusion matrix
- Accuracy
- RoC-AUC curve

Classification Performance Confusion Matrix

		Predicted Class		
		Sport	**News**	**Politics**
Actual Class	**Sport**	**5**	**3**	**0**
	News	**2**	**3**	**1**
	Politics	**0**	**2**	**11**

https://en.wikipedia.org/wiki/Confusion_matrix

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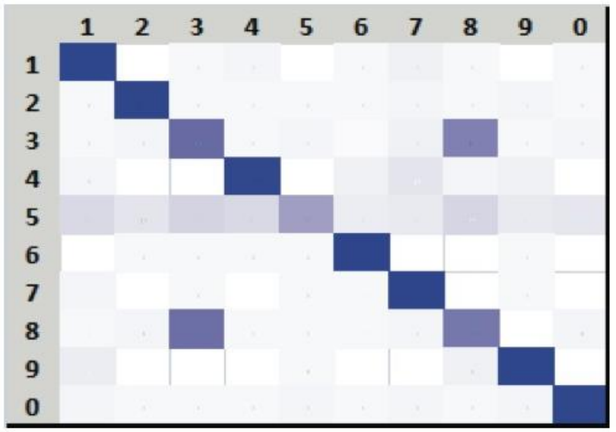
A better way to visualize Confusion Matrix

	1	2	3	4	5	6	7	8	9	0
1	91	0	1	2	0	1	3	1	0	1
2	1	89	1	1	1	1	2	1	2	1
3	1	2	48	1	2	0	3	40	1	2
4	2	0	0	83	0	3	7	2	3	0
5	10	7	12	10	30	4	5	11	5	6
6	0	1	1	1	1	95	0	0	1	0
7	2	0	1	0	1	1	94	0	1	0
8	1	2	47	1	1	1	2	43	0	2
9	4	0	0	0	1	0	0	3	92	0
0	2	1	1	1	2	1	2	1	2	87



Hard to spot trends and patterns

Much easier!

http://research.microsoft.com/en-us/um/redmond/groups/cue/publications/CHI2009-EnsembleMatrix.pdf

Confusion Matrix

- Very important: Find out what "**positive** and **negative**" means

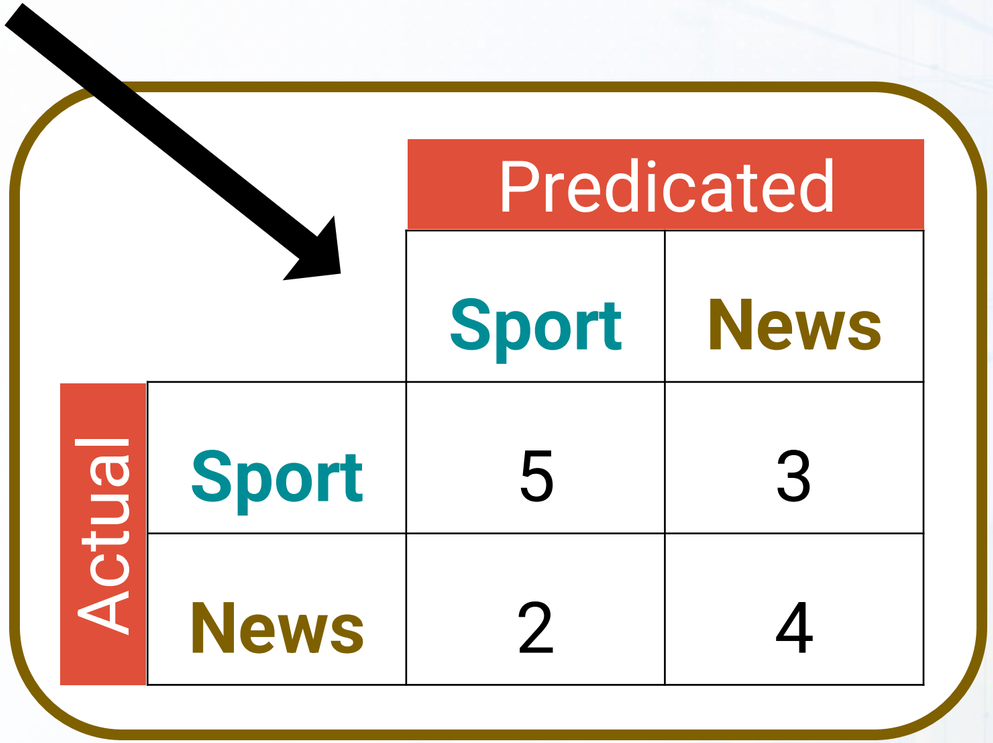
		Predicated: Sport	Predicated: News
Actual	Sport	5	3
Actual	News	2	4

Sport **News**

$$\text{Accuracy} = \frac{\text{True positive} + \text{True negative}}{\text{total observations}}$$

Confusion Matrix

- Very important: Find out what "**positive** and **negative**" means



		Predicated: Sport	Predicated: News
Actual	Sport	5	3
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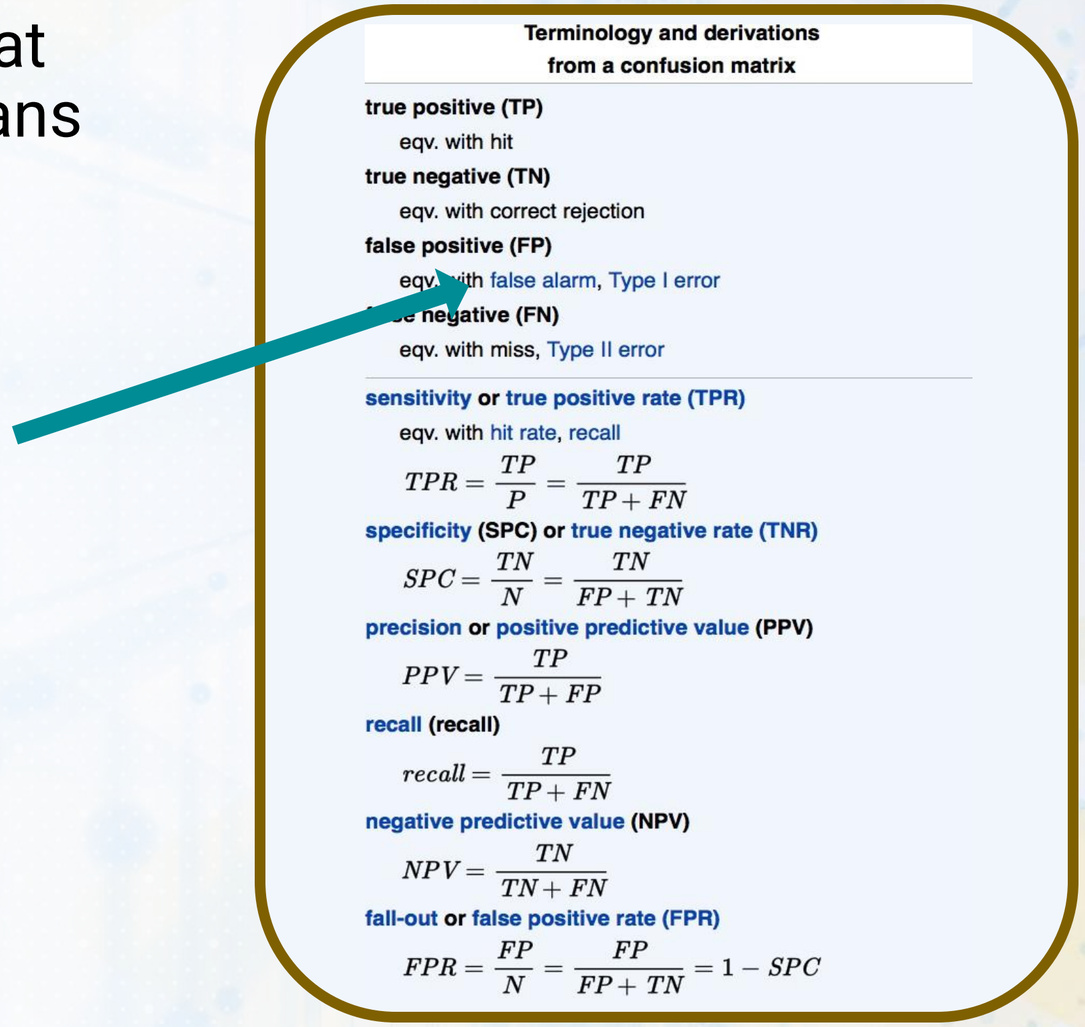
Sport **News**

$$\text{Accuracy} = \frac{\text{True positive} + \text{True negative}}{\text{total observations}}$$

Performance Metrics

- Very important: Find out what "**positive** and **negative**" means

"**False Alarm**" easy to remember in security applications



Terminology and derivations from a confusion matrix

true positive (TP)
eqv. with hit

true negative (TN)
eqv. with correct rejection

false positive (FP)
eqv. with false alarm, Type I error

false negative (FN)
eqv. with miss, Type II error

sensitivity or true positive rate (TPR)
eqv. with hit rate, recall

$$TPR = \frac{TP}{P} = \frac{TP}{TP + FN}$$

specificity (SPC) or true negative rate (TNR)

$$SPC = \frac{TN}{N} = \frac{TN}{FP + TN}$$

precision or positive predictive value (PPV)

$$PPV = \frac{TP}{TP + FP}$$

recall (recall)

$$recall = \frac{TP}{TP + FN}$$

negative predictive value (NPV)

$$NPV = \frac{TN}{TN + FN}$$

fall-out or false positive rate (FPR)

$$FPR = \frac{FP}{N} = \frac{FP}{FP + TN} = 1 - SPC$$

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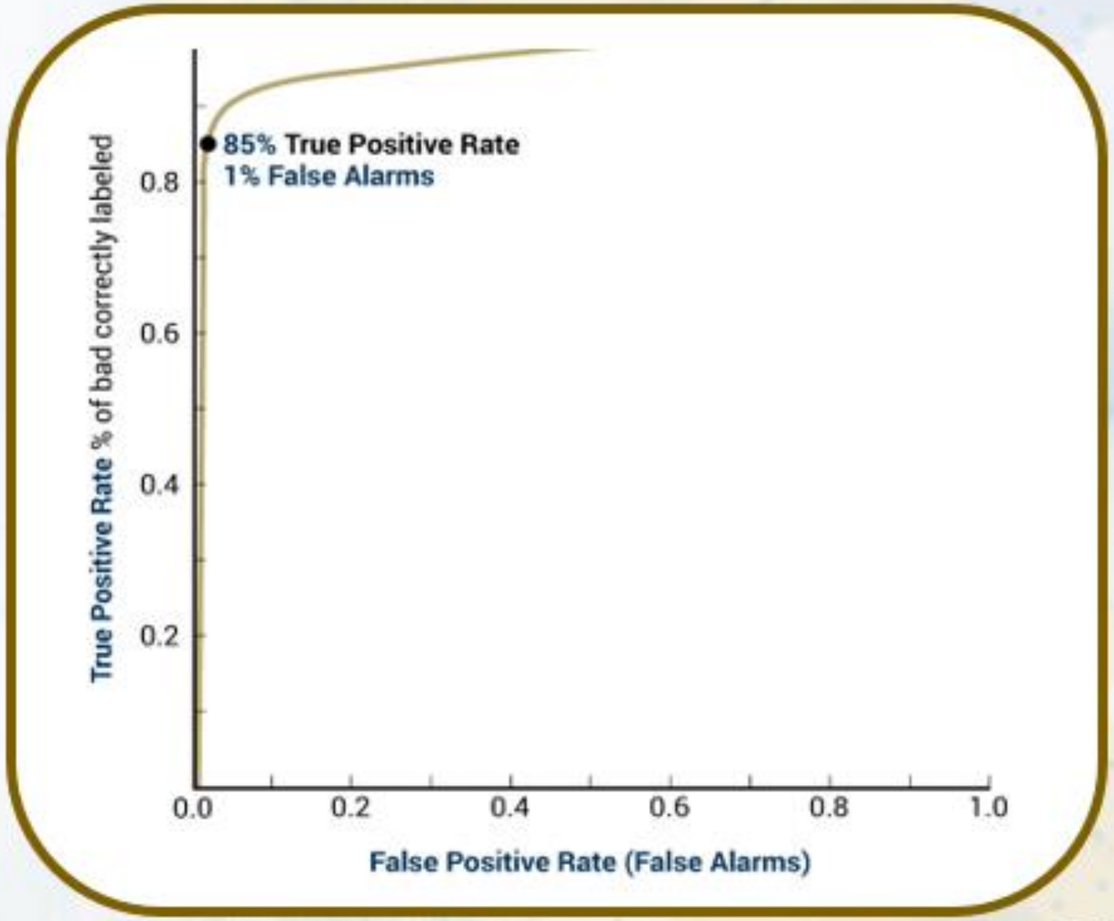
Visualizing Classification Performance
using
ROC curve
(Receiver Operating Characteristic)

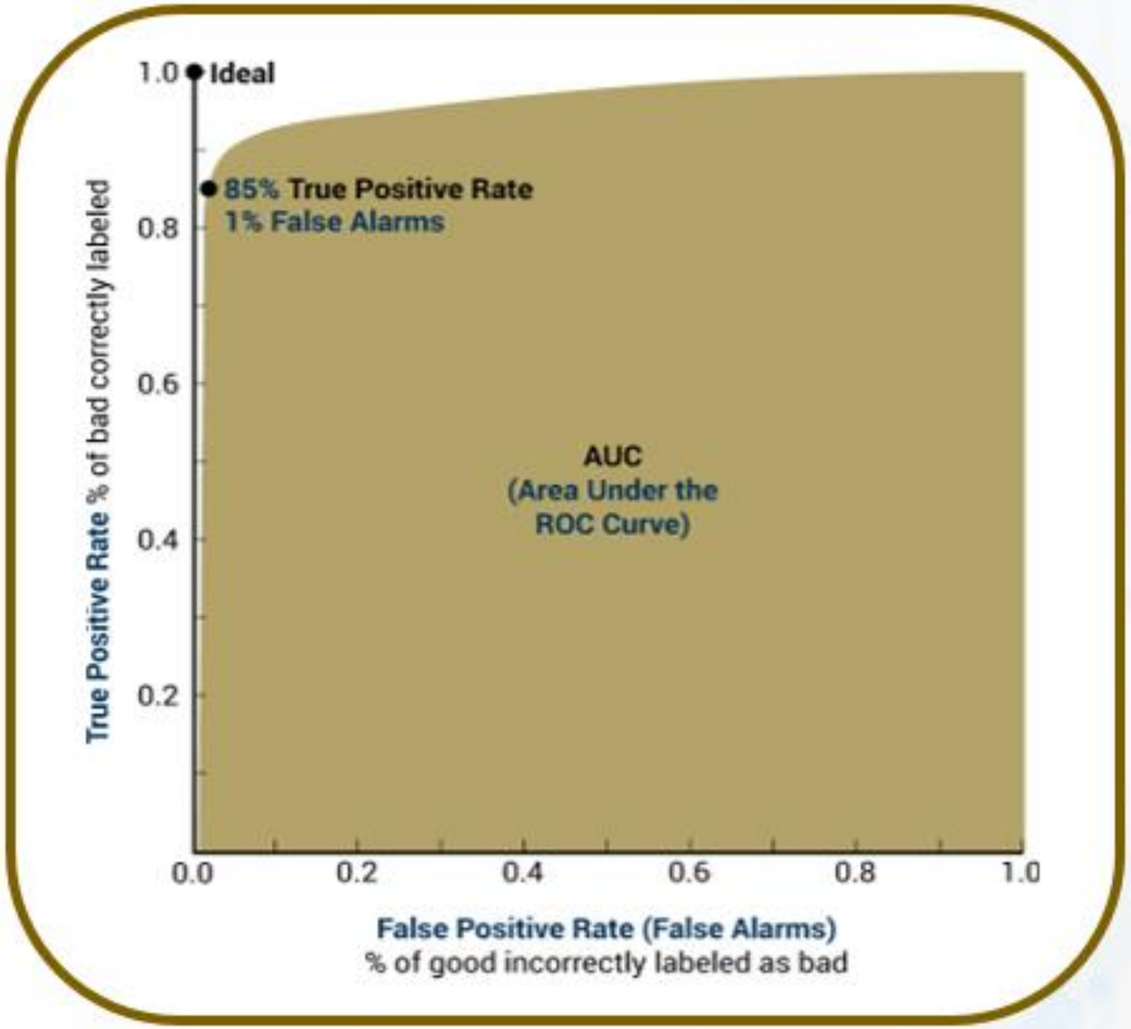
Polonium's ROC Curve

Positive class: malware

Negative class: benign



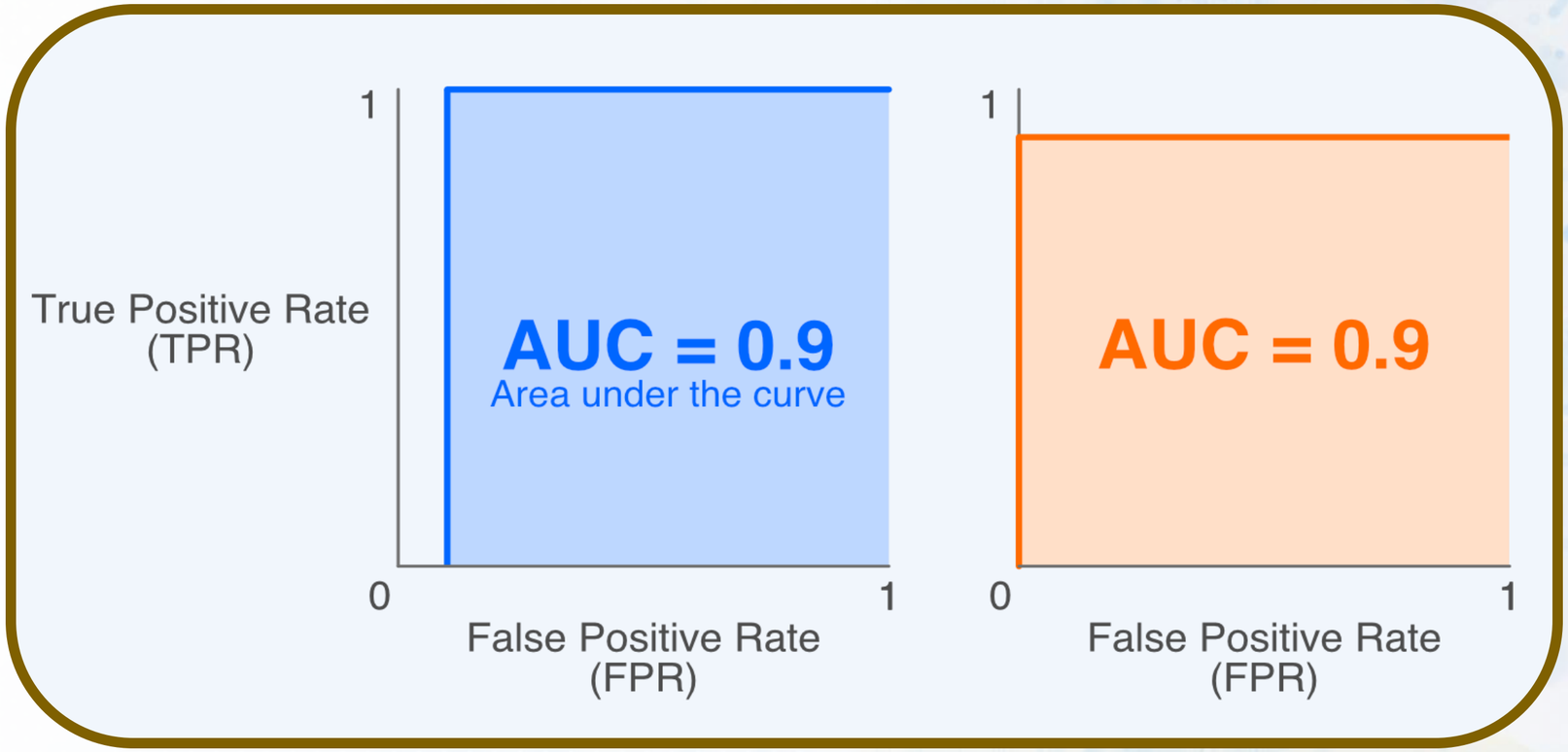
Measuring Classification Performance



If a machine learning algorithm achieves **0.9 AUC** (out of 1.0),

that’s a great algorithm, right?

Be Careful with AUC!



Summary

- Confusion matrix
- ROC and AUC curve