Model Evaluation: Accuracy, Precision, Recall, ROC

Data Mining: Seminar 9

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AI Academy

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Confusion Matrices

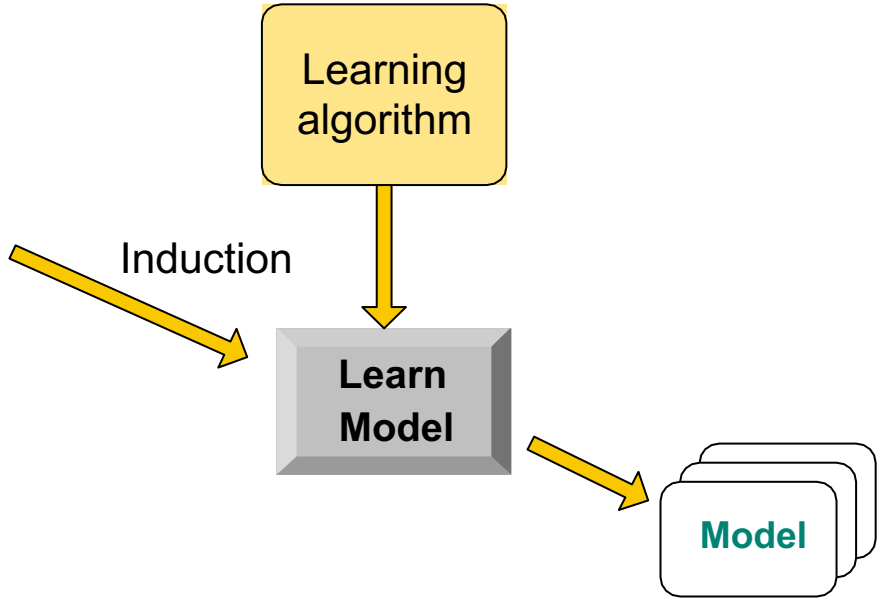
Lesson

AI Academy

Illustrating Classification Task

Tid	Attrib1	Attrib2	Attrib3	Class
1	Yes	Large	125K	No
2	No	Medium	100K	No
3	No	Small	70K	No
4	Yes	Medium	120K	No
5	No	Large	95K	Yes
6	No	Medium	60K	No
7	Yes	Large	220K	No
8	No	Small	85K	Yes
9	No	Medium	75K	No
10	No	Small	90K	Yes

Training Set



Tid	Attrib1	Attrib2	Attrib3	Class
11	No	Small	55K	?
12	Yes	Medium	80K	?
13	Yes	Large	110K	?
14	No	Small	95K	?
15	No	Large	67K	?

Test Set

The Confusion Matrix

		PREDICTED CLASS	
		Class=Yes	Class=No
ACTUAL CLASS	Class=Yes	TP	FN
	Class=No	FP	TN

TP (true positive)

FN (false negative)

FP (false positive)

TN (true negative)

Positive Class: The class we are *trying to predict* in a binary classification problem.

- Usually "Yes", "True", "+", "1", etc.

The Confusion Matrix

		PREDICTED CLASS	
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Case 1

Model M_1	PREDICTED		
ACTUAL CLASS		+	-
	+	150	40
	-	60	250

Model M_2	PREDICTED		
ACTUAL CLASS		+	-
	+	250	45
	-	5	200

Case 1

Model M_1	PREDICTED		
ACTUAL CLASS		+	-
	+	150	40
	-	60	250

Model M_2	PREDICTED		
ACTUAL CLASS		+	-
	+	250	45
	-	5	200

Case 2:

Model M_3	PREDICTED		
ACTUAL CLASS		+	-
	+	1	9
	-	5	9985

Model M_4	PREDICTED		
ACTUAL CLASS		+	-
	+	8	2
	-	50	9940

Metrics for Performance Evaluation

		PREDICTED CLASS	
		Class=Yes	Class=No
ACTUAL CLASS	Class=Yes	TP	FN
	Class=No	FP	TN

TP (true positive)

FN (false negative)

FP (false positive)

TN (true negative)

Metrics for Performance Evaluation

		PREDICTED CLASS	
		Class=Yes	Class=No
ACTUAL CLASS	Class=Yes	a (TP)	b (FN)
	Class=No	c (FP)	d (TN)

Most widely-used metric:

$$\text{Accuracy} = \frac{a+d}{a+b+c+d} = \frac{TP+TN}{TP+TN+FP+FN}$$

Metrics for Performance Evaluation

		PREDICTED CLASS	
		Class=Yes	Class=No
ACTUAL CLASS	Class=Yes	a (TP)	b (FN)
	Class=No	c (FP)	d (TN)

Most widely-used metric:

$$\text{Error Rate} = 1 - \text{Accuracy} = \frac{FP+FN}{TP+TN+FP+FN}$$

Limitation of Accuracy and Error

Consider a 2-class problem

- Number of Class 0 examples = 9990
- Number of Class 1 examples = 10

If a model always predicts Class 0…

- Accuracy is 9990/10000 = 99.9%
- Accuracy is misleading because model does not detect *any* Class 1 examples.

Limitation of Accuracy and Error

- Accuracy alone is not enough!
- It doesn't consider the **balance** of the class labels.
  - Same is true of Error Rate.

Learning Objectives: Confusion Matrices

You now should be able to:

- Interpret a confusion matrix to evaluate and compare classifier performance.
- Calculate accuracy and error rate.

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Exercises

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Confusion Matrices

Which are true of the confusion matrix for M1?

A. There were 40 False Positives.
B. There were 250 True Negatives.
C. The accuracy is 80%.
D. The error rate is 10%.

Model M_1	PREDICTED		
ACTUAL CLASS		+	-
	+	150	40
	-	60	250