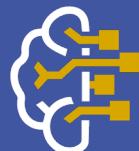


Multi-class Problems

Lesson



AI Academy

Multiple Classes

$$\text{Precision (p)} = \frac{\text{TP}}{\text{TP} + \text{FP}}$$

$$\text{Recall (r)} = \frac{\text{TP}}{\text{TP} + \text{FN}}$$

$$\text{F1 score (F)} = \frac{2rp}{r + p} = \frac{2\text{TP}}{2\text{TP} + \text{FN} + \text{FP}}$$

	PREDICTED			
ACTUAL	A	B	C	
	A	a	b	c
	B	d	e	f
	C	g	h	j

	PREDICTED		
ACTUAL	Yes	No	
	Yes	(TP)	(FN)
	No	(FP)	(TN)

Multiple Classes

$$\text{Accuracy} = (a + e + j) / \text{sum}(a \dots j)$$

	PREDICTED			
ACTUAL	A	B	C	
	A	a ✓	b	c
	B	d	e ✓	f
	C	g	h	j ✓

Multiple Classes

Accuracy = $(a + e + j) / \text{sum}(a \dots j)$

$$\text{Precision}_A (P_A) = \frac{a}{\text{sum(A-col)}} = \frac{a}{a+d+g}$$

		PREDICTED		
		A	B	C
ACTUAL	A	a	b	c
	B	d	e	f
	C	g	h	j

Multiple Classes

$$\text{Accuracy} = (a + e + j) / \text{sum}(a \dots j)$$

$$\text{Precision}_A (P_A) = \frac{a}{\text{sum}(A\text{-col})} = \frac{a}{a+d+g}$$

$$\text{Recall}_A (R_A) = \frac{a}{\text{sum}(A\text{-row})} = \frac{a}{a+b+c}$$

$$\text{F1 score } (F_A) = \frac{\underline{2P_A R_A}}{\underline{P_A} + \underline{R_A}}$$

	PREDICTED		
ACTUAL	A	B	C
	a	b	c
	d	e	f
	g	h	j

Multiple Classes

$$\text{Accuracy} = (a + e + j) / \text{sum}(a \dots j)$$

$$\text{Precision}_A (P_A) = \frac{a}{\text{sum}(A\text{-col})} = \frac{a}{a+d+g}$$

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	PREDICTED		
ACTUAL	A	B	C
	a	b	c
	d	e	f
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Multiple Classes

$$\text{Accuracy} = (a + e + j) / \text{sum}(a \dots j)$$

$$\text{Precision}_A (P_A) = \frac{a}{\text{sum}(A\text{-col})} = \frac{a}{a+d+g}$$

$$\text{Recall}_A (R_A) = \frac{a}{\text{sum}(A\text{-row})} = \frac{a}{a+b+c}$$

macro-average

$$\text{Precision} = \text{mean}(P_A, P_B, P_C)$$

		PREDICTED		
		A	B	C
ACTUAL	A	a	b	c
	B	d	e	f
	C	g	h	j

micro-average

$$\text{Precision} = \frac{(TP_A + TP_B + TP_C)}{(TP_A + FP_A + TP_B + FP_B + TP_C + FP_C)}$$

Micro vs Macro

- **Macro Average:** Use when each class is equally important to get right
 - Each class contributes to the average equally
- **Micro Average:** Use when overall performance is more important
 - **Note:** Micro-average precision/recall are equivalent to accuracy unless instances can have more than 1 label



Learning Objectives: Multi-class Problems

You now should be able to:

- Calculate macro- and micro- averaged evaluation metrics and explain their purpose



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