Lab6: Logistic Regression and Metrics

DataLab

2025.09.25

Outline

- Brief Review: Logistic Regression

- Common Evaluation Metrics for Binary Classification
  - Confusion Matrix
  - Soft Classifiers – ROC Curve

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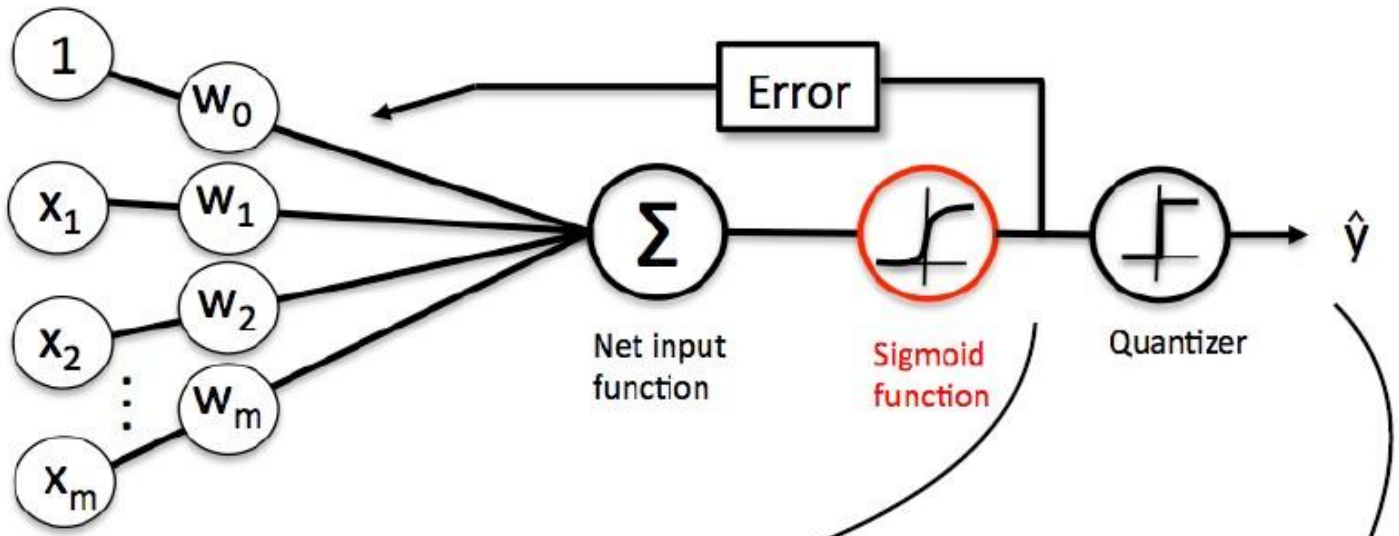
Logistic Regression



$$P(y \mid \boldsymbol{x}; \boldsymbol{w}) = \sigma(\boldsymbol{w}^\top \boldsymbol{x})^{y'}[1 - \sigma(\boldsymbol{w}^\top \boldsymbol{x})]^{(1-y')}$$

Soft prediction

$$\arg\max_y \{\sigma(\boldsymbol{w}^\top \boldsymbol{x}), 1 - \sigma(\boldsymbol{w}^\top \boldsymbol{x})\} = \text{sign}(\boldsymbol{w}^\top \boldsymbol{x})$$

Label prediction

Logistic Regression + Regularization

- 把 regularization term 加到 loss 內，讓模型在學 weights 的時候，會傾向選擇比較簡單的模型。

$$\arg\max_{w} \log P(\mathbb{X} \mid w) - \frac{\alpha}{2}\|w\|^2$$

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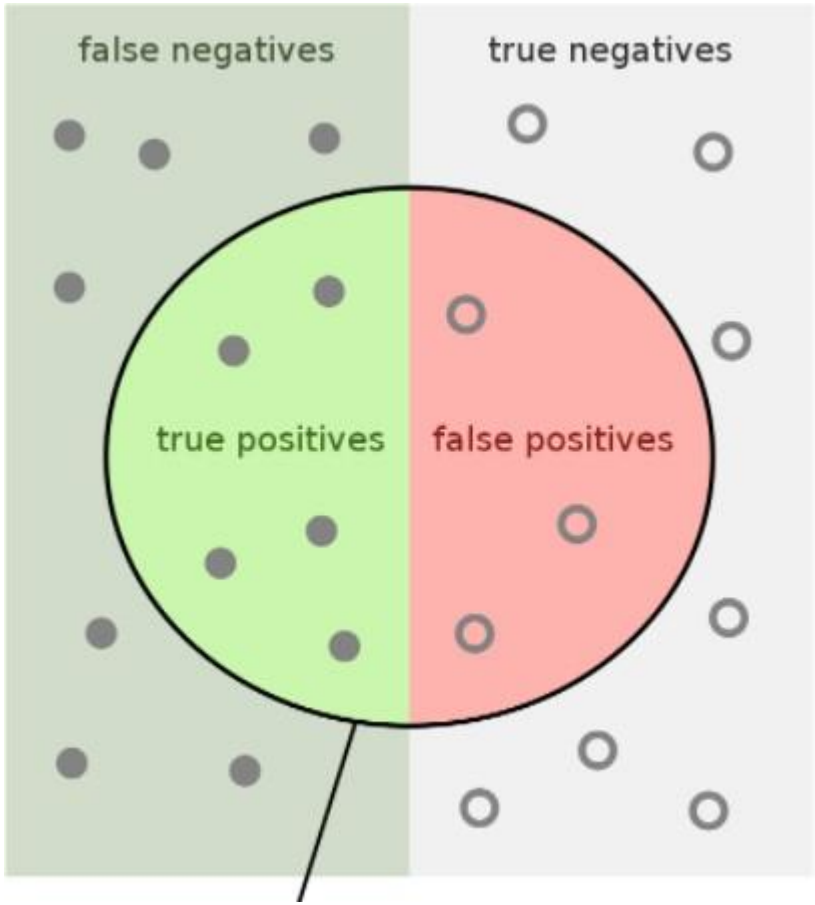
Confusion Matrix

- It is important to know how the model make wrong prediction

- In **binary classification**, confusion matrix is a common tool to analyze the predictions



Confusion Matrix

- It is important to know how the model make wrong prediction.
- e.g. 檢測絕症
  - 寧可讓多一點人到 TP & FP，也不要讓 FN 很高
  - i.e. TPR higher

$$TPR = \frac{TP}{TP + FN} \qquad FPR = \frac{FP}{FP + TN}$$

		Predicted class	
		P'	N'
Actual Class	P	True Positives (TP)	False Negatives (FN)
	N	False Positives (FP)	True Negatives (TN)

Confusion Matrix

- Precision(PRE) & Recall Rate(REC)

$$PRE = \frac{TP}{TP + FP}, \quad \text{(the higher, the better)}$$

$$REC = \frac{TP}{TP + FN} = TPR. \quad \text{(the higher, the better)}$$

- F-1 Score

$$F_1 = 2\frac{(PRE * REC)}{PRE + REC}, \quad \text{(the higher, the better)}$$

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ROC Curve

- ROC curve analyze the performance for **every threshold in soft classifiers**
- In X-axis $$FPR = \frac{FP}{FP + TN}$$
- In Y-axis $$TPR = \frac{TP}{TP + FN}$$

1	
1	
0.87	θ
0.64	$\Downarrow$
$\vdots$	
-0.88	
-0.93	
-1	

ROC Curve

- ROC curve analyze the performance for **every threshold in soft classifiers**
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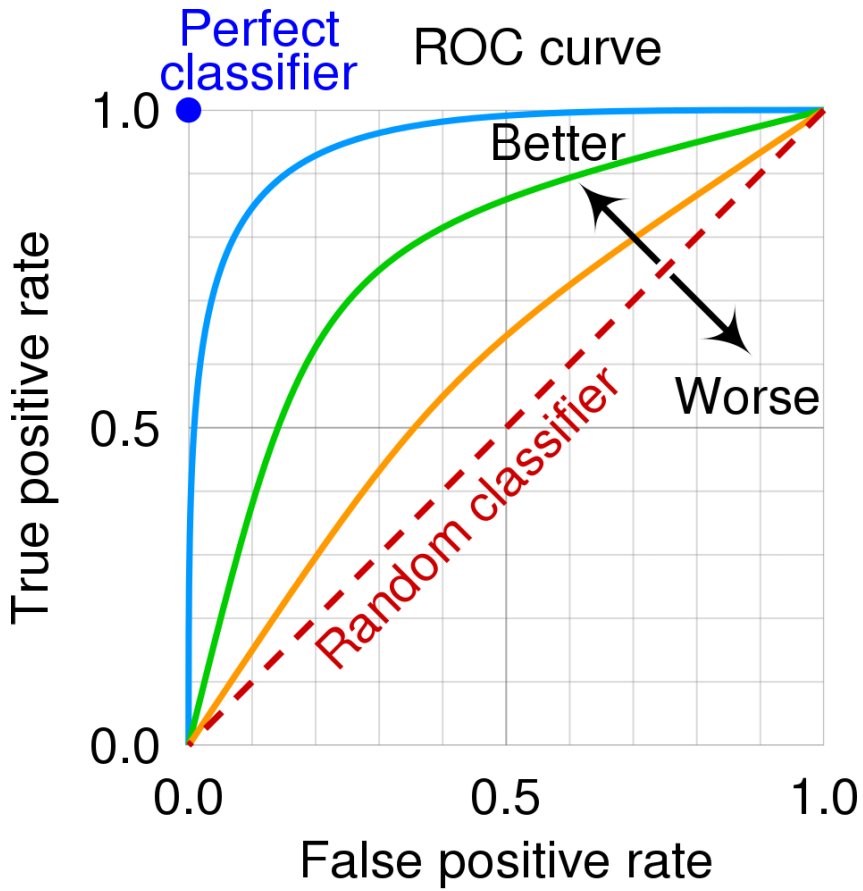
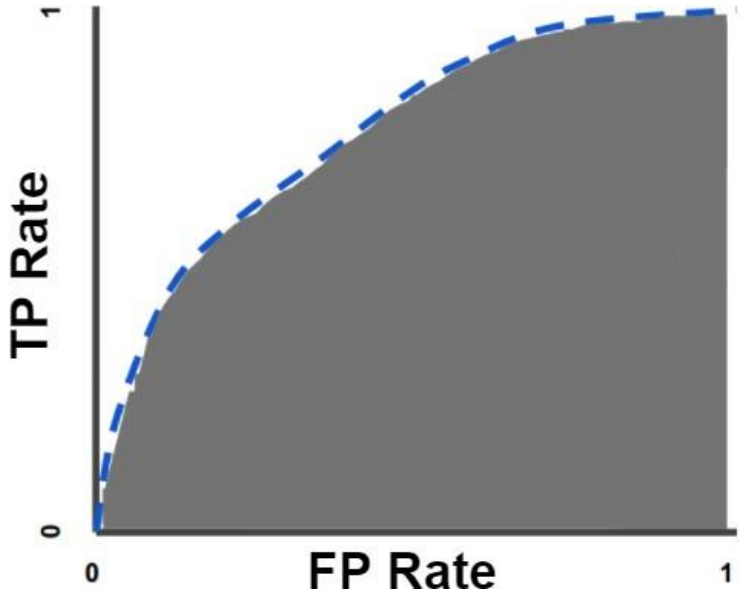
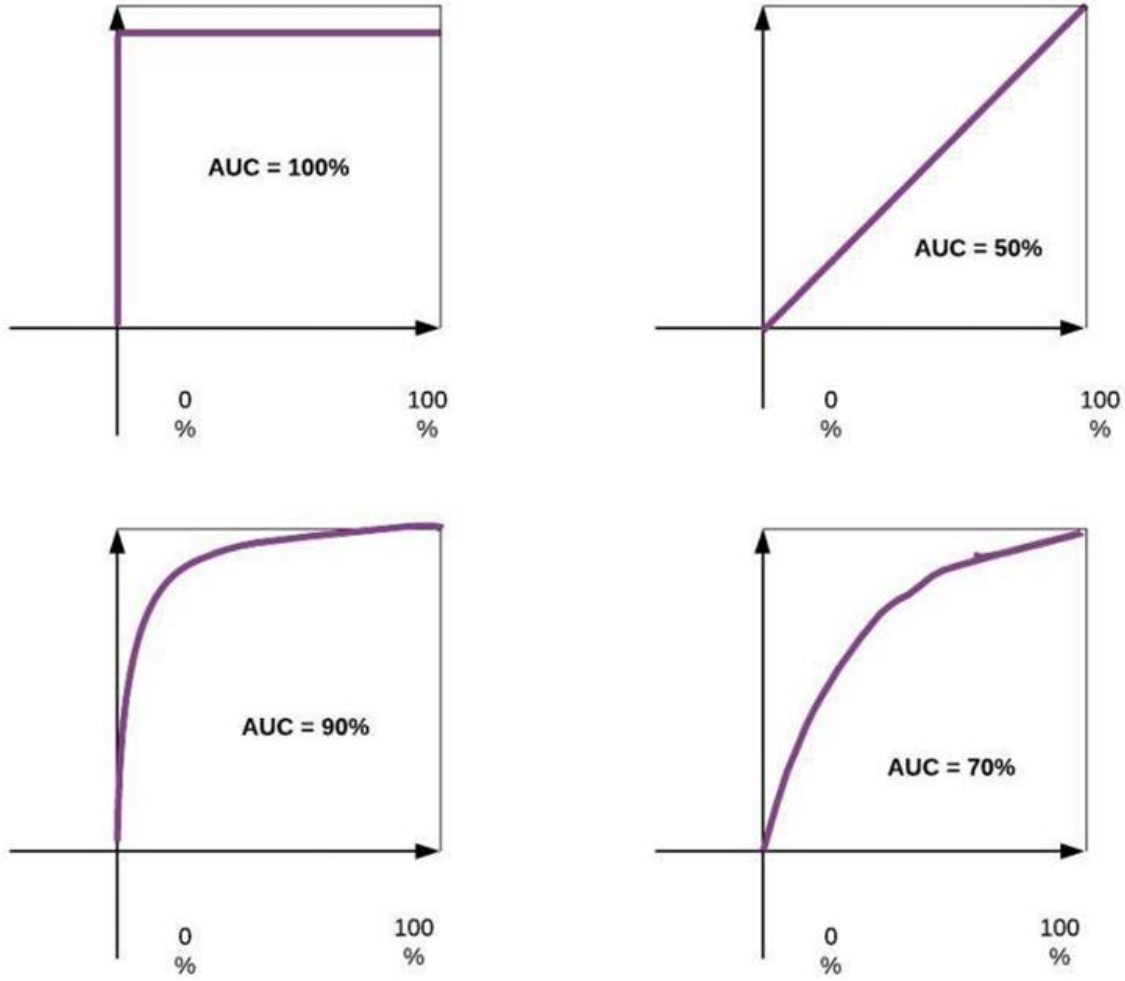


AUC

- AUC (Area Under the ROC Curve)
  - ROC can be quantified using AUC



Random guess



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https://medium.com/acing-ai/what-is-auc-446a71810df9

Homework

- Homework: Lab06
  - Lab06: Logistic Regression, Metrics

Reference

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