

Performance measures & kNN

Performance Measures

Performance measures for classification

Probabilities, thresholds and prediction for classification

$$y_i = \begin{cases} 1 & \text{if } p_i > c \\ 0 & \text{if } p_i \leq c \end{cases}$$

Table: Confusion matrix

		Prediction		
		0	1	
Reference	0	True Negatives (TN)	False Positives (FP)	N'
	1	False Negatives (FN)	True Positives (TP)	P'
		N	P	

Performance measures for classification

Confusion matrix metrics

- Global performance

- Accuracy: $\frac{TP+TN}{TP+FP+TN+FN}$
- Misclassification rate: $\frac{FP+FN}{TP+FP+TN+FN}$
- No Information rate

- Row / column performance

- Sensitivity (Recall): $\frac{TP}{TP+FN}$
- Specificity: $\frac{TN}{TN+FP}$
- Positive predictive value (Precision): $\frac{TP}{TP+FP}$
- Negative predictive value: $\frac{TN}{TN+FN}$
- False positive rate: $\frac{FP}{FP+TN}$
- False negative rate: $\frac{FN}{FN+TP}$

Table: Confusion matrix

		Prediction		
		0	1	
Reference	0	TN	FP	N'
	1	FN	TP	P'
		N	P	

Performance measures for classification

Combined measures

- Balanced Accuracy

$$(\text{Sensitivity} + \text{Specificity})/2$$

- F1

$$2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}$$

- Cohen's κ

- Compares observed (p_0) and random (p_e) accuracy

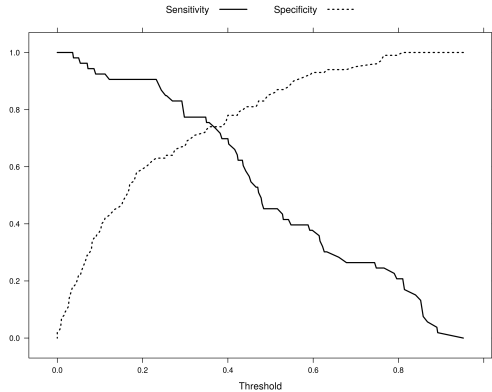
- $p_e = \frac{(N' \times N) + (P' \times P)}{(TP + FP + TN + FN)^2}$

$$1 - \frac{1 - p_0}{1 - p_e}$$

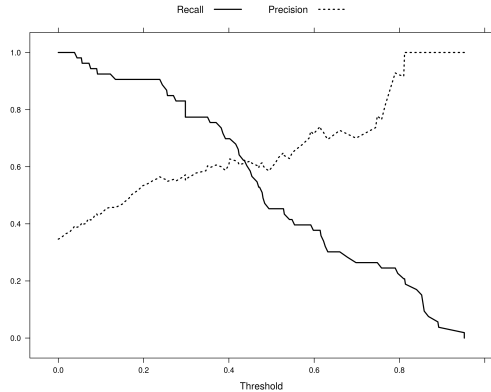
Performance measures for classification

Figure: Varying the classification threshold I

(a) Sensitivity and specificity

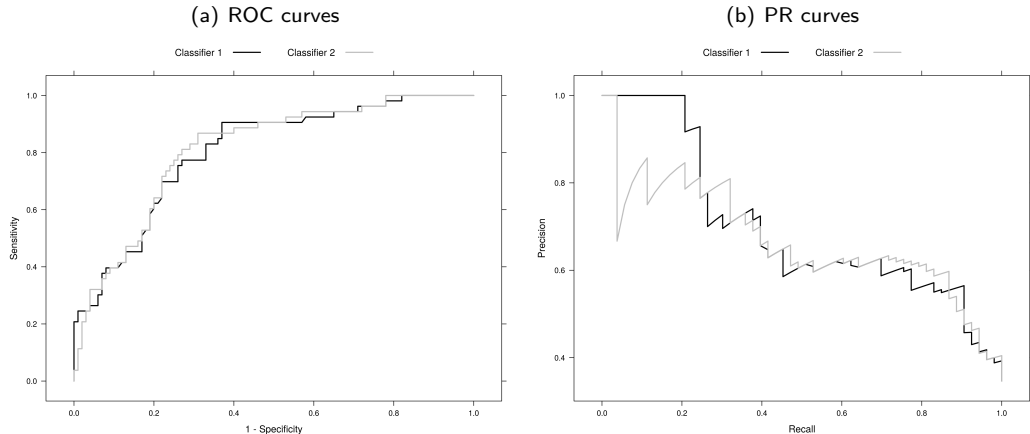


(b) Precision and recall



Performance measures for classification

Figure: Varying the classification threshold II



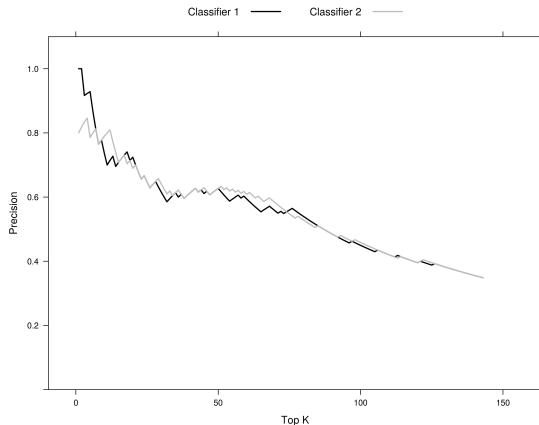
- AUC-ROC: Area under the receiver operating characteristic curve
- AUC-PR: Area under the precision–recall curve

Performance measures for classification

How many true positives are among the high risk observations?

- ① Rank observations by risk scores
- ② Classify top K % as positive/relevant
- ③ Compute precision

Figure: Precision at top K



Software Resources

Resources for R

- kNN classifier: `knn` in package `class`
 - Tune k using CV: `knn.cv`
 - Package `e1071`: `tune.knn`
- Performance evaluation
 - Collection of performance metrics: `MLmetrics`, `verification`
 - ROC and PR curves: e.g. `PRROC`, `pROC`

References

- Hossin, M., Sulaiman, M. N. (2015). A review on evaluation metrics for data classification evaluations. *International Journal of Data Mining & Knowledge Management Process*, 5(2): 1–11.
- James, G., Witten, D., Hastie, T., Tibshirani, R. (2013). *An Introduction to Statistical Learning*. New York, NY: Springer.
- Sokolova, M., Lapalme, G. (2009). A systematic analysis of performance measures for classification tasks. *Information Processing & Management*, 45(4): 427–437.