Metrics for classification and regression

ML Instruction Team, Fall 2022

CE Department
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MNIST Dataset

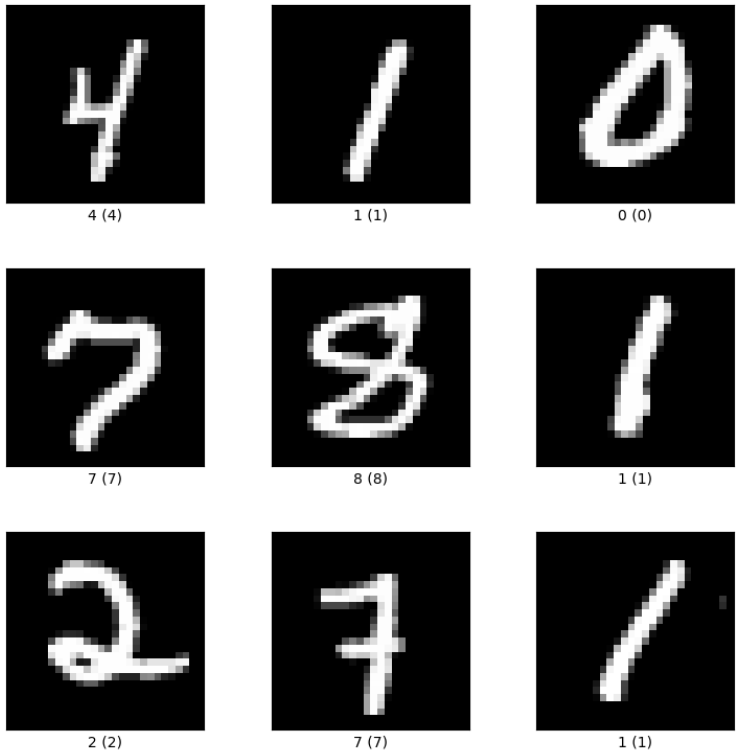

Figure: MNIST dataset

Never5 Classifier

- Suppose a very dumb classifier that just classifies every single image in the “not-5” class.
- It will achieve a accuracy around **90%**.
- Accuracy is not always a good measurment.

Confusion Matrix

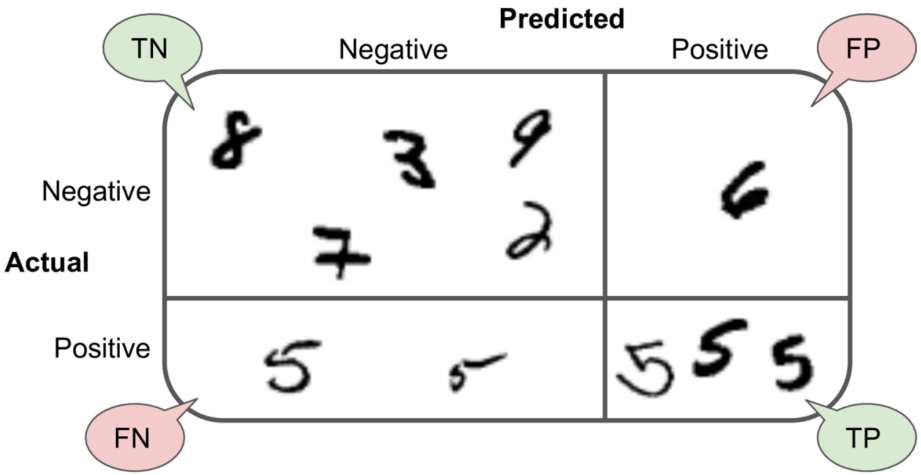

Figure: Confusion Matrix For a Classifier

$$ERR = \frac{FP + FN}{FP + FN + TP + TN} = 1 - ACC \tag{1}$$

$$ACC = \frac{TP + TN}{FP + FN + TP + TN} = 1 - ERR \tag{2}$$

False Positive Rate and False Negative Rate

$$TPR = \frac{TP}{P} = \frac{TP}{TP + FN} = 1 - FNR \tag{3}$$

$$FPR = \frac{FP}{N} = \frac{FP}{FP + TN} = 1 - TNR \tag{4}$$

$$FNR = \frac{FP}{N} = \frac{FN}{FN + TP} = 1 - TPR \tag{5}$$

$$TNR = \frac{TN}{N} = \frac{TN}{TN + FP} = 1 - FPR \tag{6}$$

Precision, Recall, $F_1 Score$

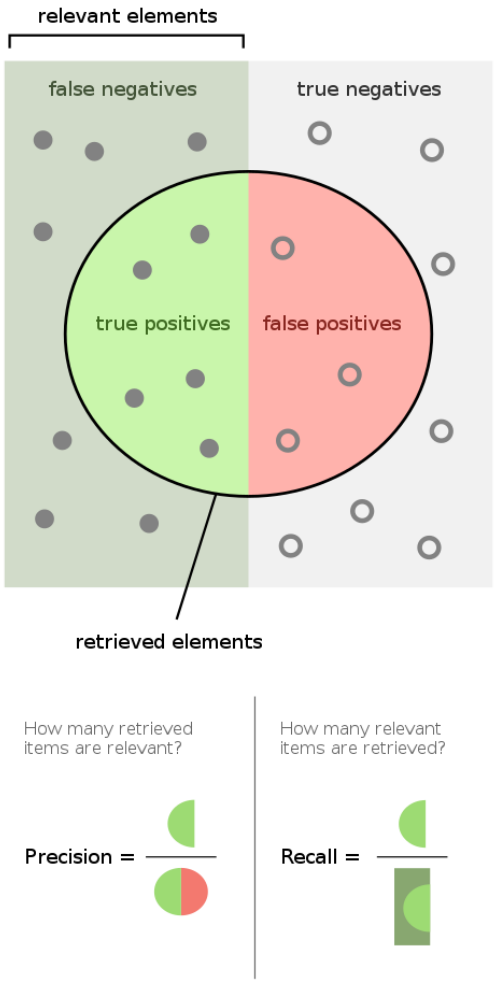

Figure: source

Precision, Recall, $F_1 Score$

$$PRE = \frac{TP}{TP + FP} \tag{7}$$

$$REC = TPR = \frac{TP}{FN + TP} \tag{8}$$

$$F_1 = 2.\frac{PRE.REC}{PRE + REC} \tag{9}$$

Decision Threshold

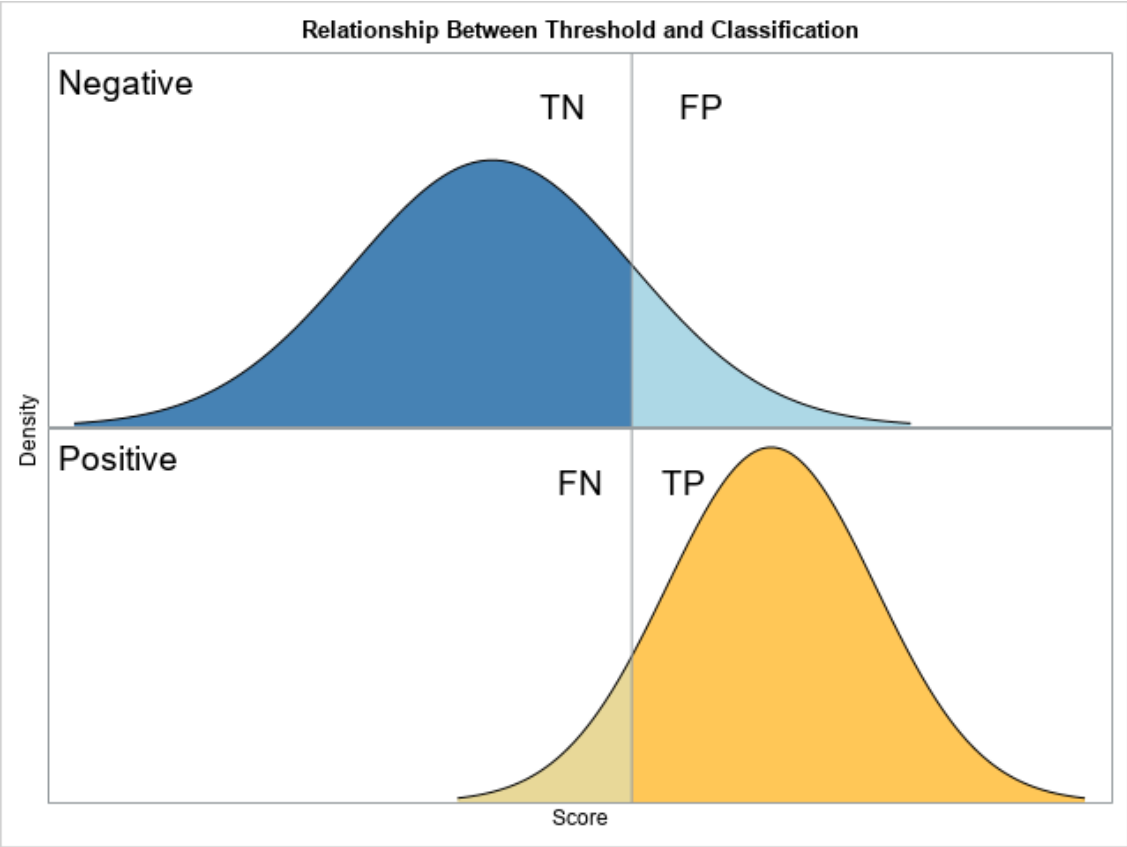

Figure: source

Precision/Recall Trade-off

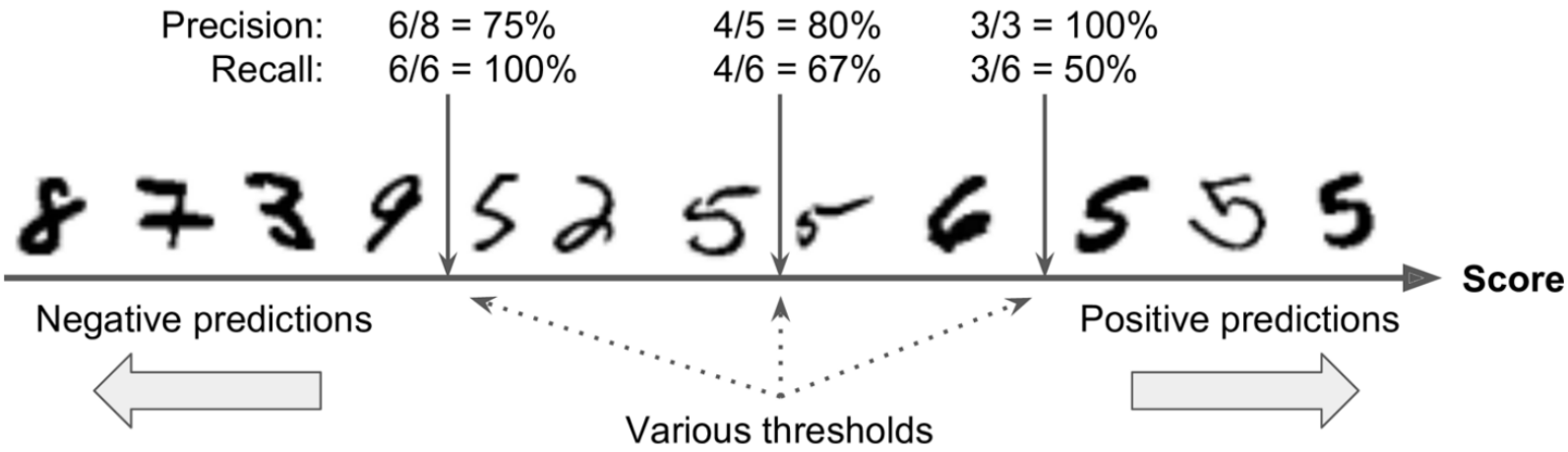

Figure: the higher the threshold, the lower the recall, but (in general) the higher the precision

Precision/Recall Trade-off

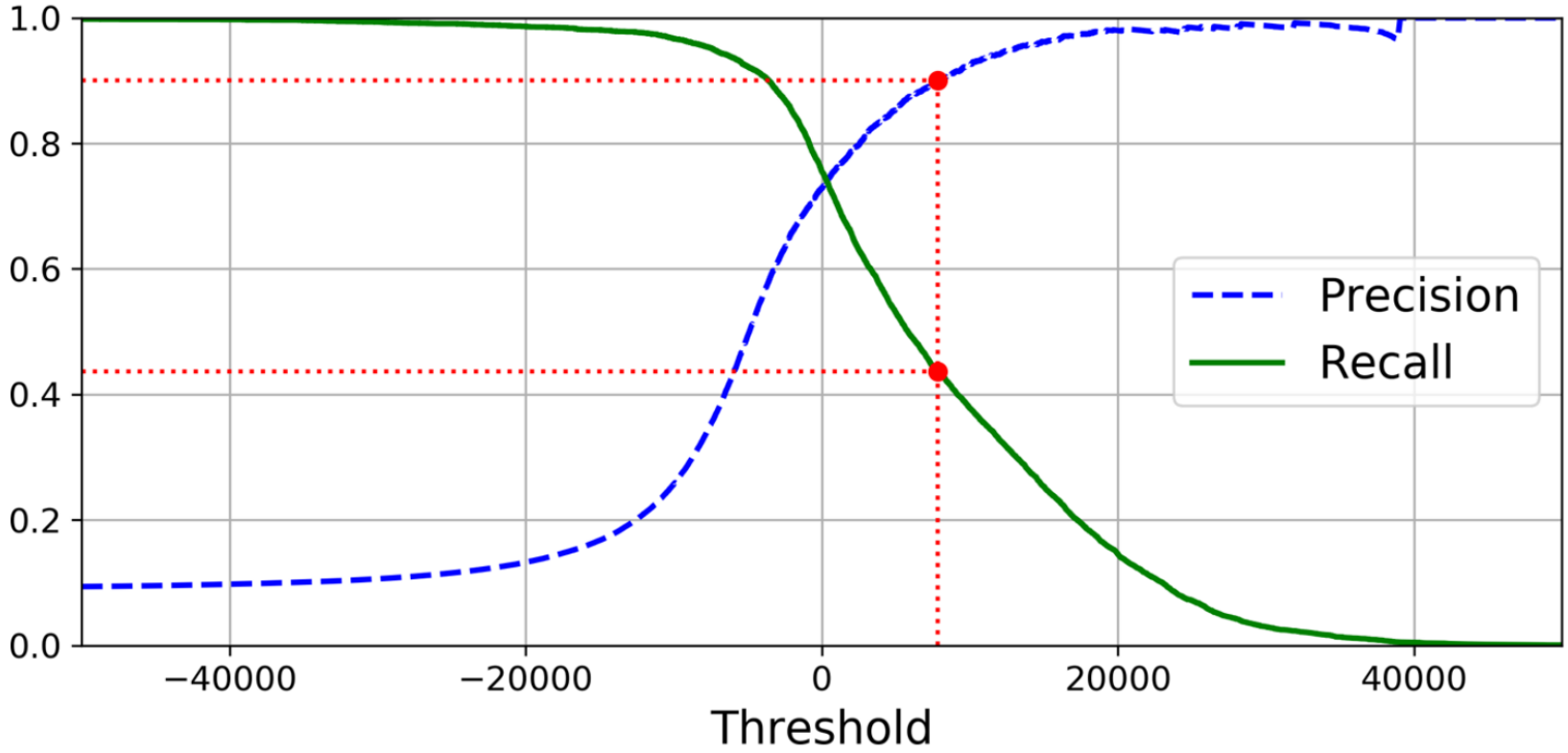

Figure: Precision and recall versus the decision threshold

Sensitivity and Specificity

$$SEN = TPR = \frac{TP}{P} = \frac{TP}{TP + FN} \tag{10}$$

$$SPC = TNR = \frac{TN}{N} = \frac{TN}{TN + FP} \tag{11}$$

- Sensitivity (SEN) measures the recovery rate of the Positives and complimentary.
- Specificity (SPC) measures the recovery rate of negatives.

ROC Curve

- plots the true positive rate against false positive rate.
- used with binary classifiers.

ROC Curve

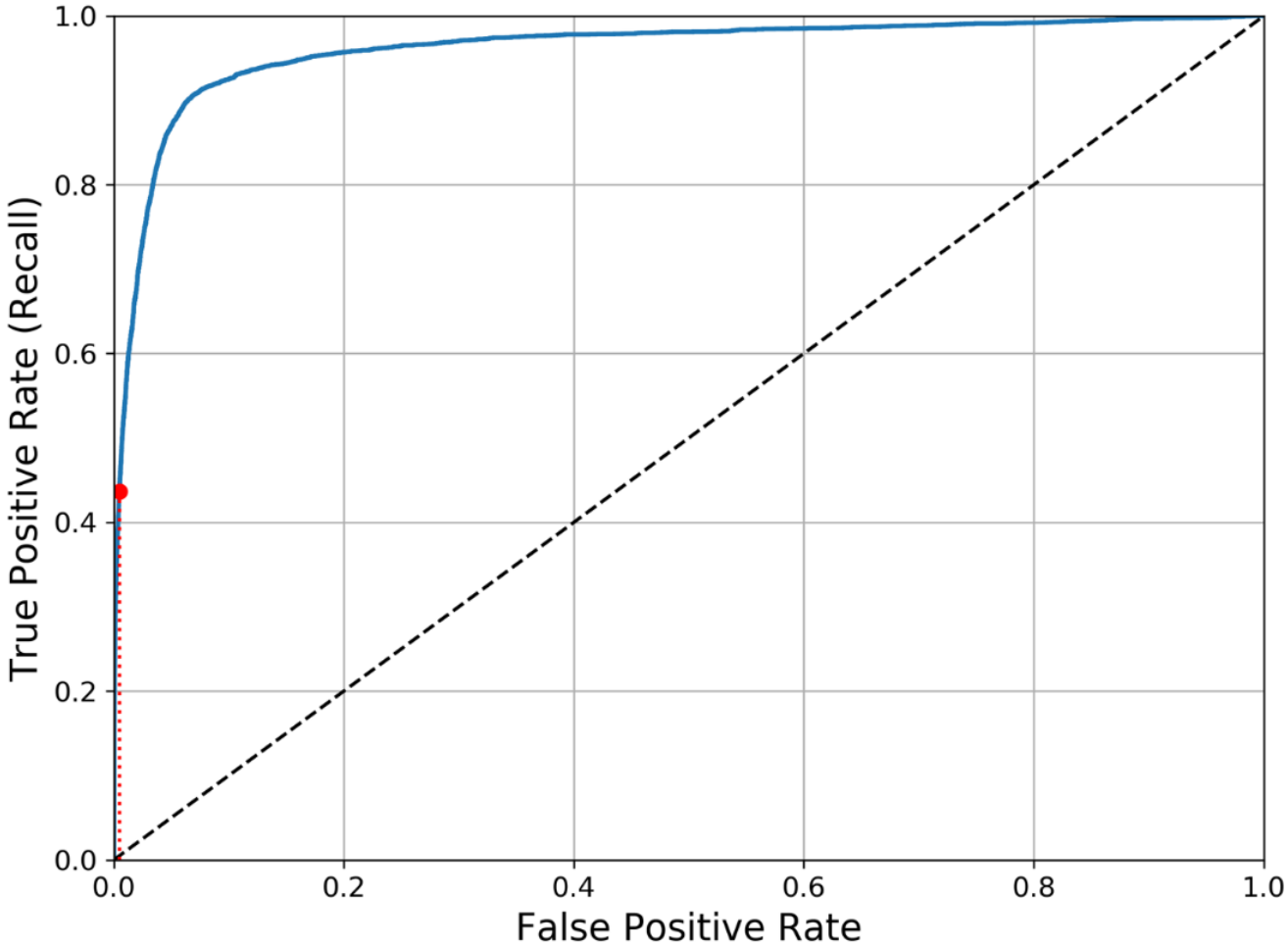

Figure: ROC Curve

Area Under The Curve (AUC)

- another way to compare classifiers.
- perfect classifier has a ROC AUC equal to 1.

Area Under The Curve (AUC)

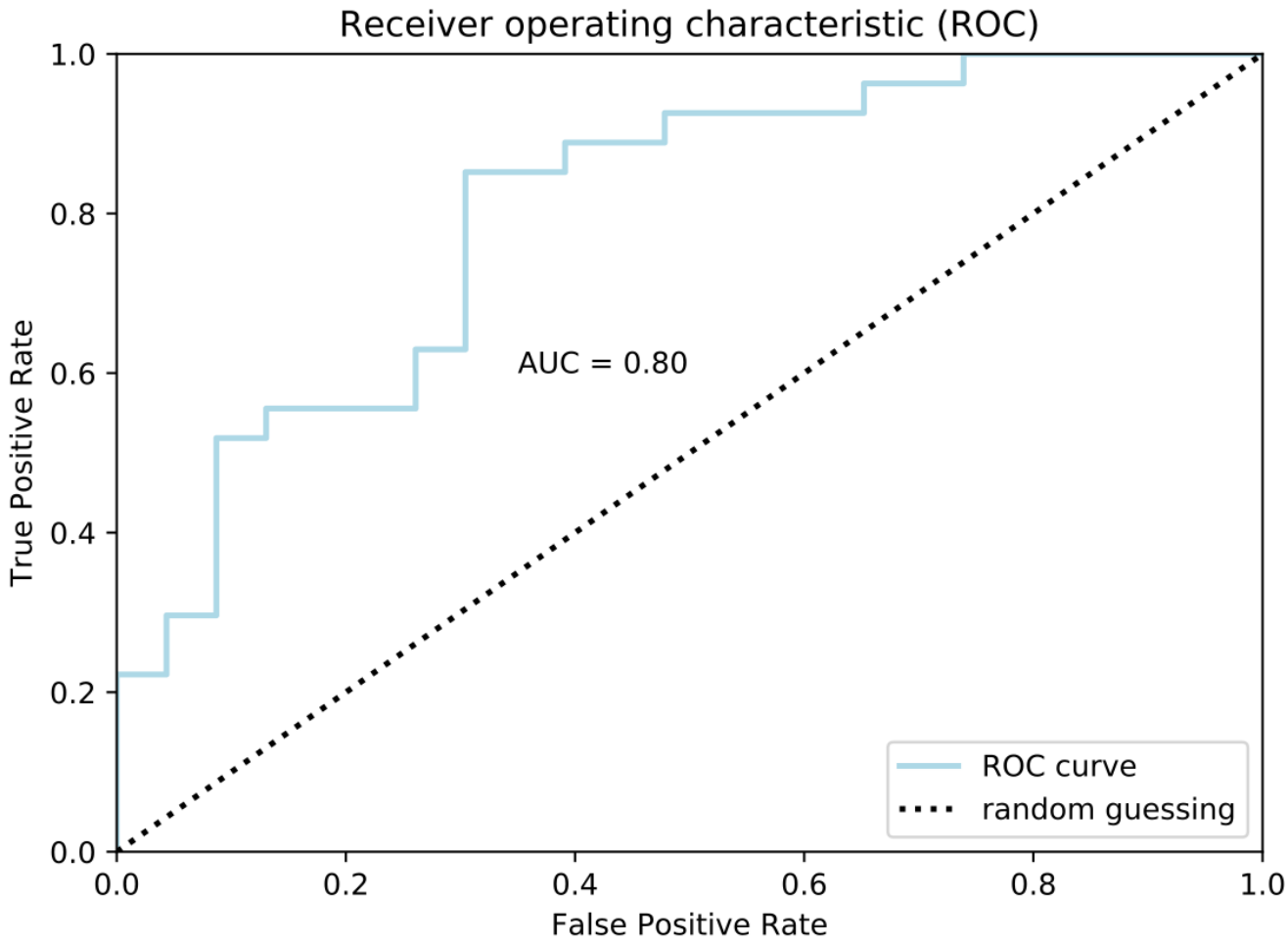

Figure: ROC AUC

Root Mean Squared Error (RMSE)

- a metric for regressors.
- perfect regressor has a RMSE equal to 0.

$$RMSE = \sqrt{(\frac{1}{n})\sum_{i=1}^{n}(y_i - \hat{y}_i)^2} \tag{12}$$

Thank You!

Any Question?