Performance Metrics (Notes by Kanav Bansal)

Training

X_train, y_train → $\boxed{\text{Algorithm}}$ ⟶ Model

* After building the model, we will evaluate the models. For that, first predict on the unseen datapoints and then compare actual values with predicted values.

Testing

a. Prediction

X_test (unseen data) → Model ⟶ y_test_pred

b. Evaluation

y_test (Actual), y_test_pred (Predicted) → $\boxed{\text{Evaluation Metrics}}$ ⟶ Score

* Classification & Regression will have separate Evaluation Metrics.

CLASSIFICATION

1. Accuracy
2. Confusion Matrix
3. Precision & Recall
4. F1 - score
5. ROC - AUC
   Reciever Operating Characteristic Curve
   (Area under curve)
6. Log Loss

REGRESSION

1. Mean Absolute Error
2. Mean Squared Error
3. Root Mean Sq. Error
4. R - squared
5. Adjusted R - squared

FOR REGRESSION PROBLEM

1. MEAN ABSOLUTE ERROR (MAE)

$$MAE = \underbrace{\frac{\sum_{i=1}^{n}}{n}}_{\text{Mean}} \left\{ \underbrace{abs}_{\text{abs}} \left(\underbrace{y_{act\,i} - y_{pred\,i}}_{\text{Error}} \right) \right\}$$

2. MEAN SQUARED ERROR (MSE)

Squared

$$MSE = \frac{\sum_{i=1}^{n}}{n} \left\{ \underline{\left(y_{act\,i} - y_{pred\,i} \right)^2} \right\}$$

$$\text{MSE} = \underbrace{\frac{\sum_{i=1}^{n}}{n}}_{\text{Mean}} \left\{ \underbrace{(y_{act\,i} - y_{pred\,i})}_{\text{Error}}^2 \right\}$$

3. ROOT MEAN SQUARED ERROR (RMSE)

$$\text{RMSE} = \sqrt{\text{MSE}}$$

* Important pointers on MAE, MSE & RMSE]
  a. MSE is a differentiable function. Hence it is a goto choice of Loss Function when compared to MAE.
  b. MSE is more sensitive to Outliers.
  c. MAE, MSE & RMSE are the measures of average deviation of predictions from the actual values.
  d. MAE, MSE & RMSE are used to compare 2 or more models.

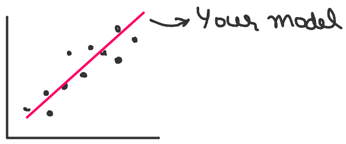
4. R-squared OR COEFFICIENT OF DETERMINATION

$$\boxed{R^2 = 1 - \frac{RSS}{TSS}} \quad \text{OR} \quad \boxed{R^2 = 1 - \frac{SS_{res}}{SS_{Tot}}}$$

• RSS OR SS_{res}
(Sum of Squared residuals)

$$RSS = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2$$

$y_i \rightarrow$ Actual value
$\hat{y}_i \rightarrow$ Predicted Value

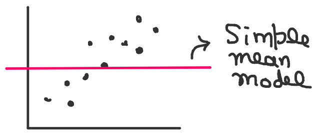


ie RSS is the measure of error done by your model

• TSS OR SS_{Tot}
(Total Sum of square)

$$TSS = \sum_{i=1}^{n} (y_i - \bar{y}_i)^2$$

$y_i \rightarrow$ Actual Value
$\bar{y}_i \rightarrow$ Mean of y_i's



ie TSS is the measure of error done by a simple mean model

CASE-1:	CASE-2:	CASE-3:
Your model behaves exactly like a simple mean model RSS = TSS { i.e Your models error is equal to the error's done by simple mean model } $\Rightarrow R^2 = 1 - \cancel{\frac{RSS}{TSS}}$ $\Rightarrow R^2 = 1 - 1$ $\Rightarrow \boxed{R^2 = 0}$	Your model behaves better than a simple mean model RSS < TSS { i.e Your models error is less than the error's done by simple mean model } $\Rightarrow R^2 = 1 - \frac{RSS}{TSS}$ $\Rightarrow R^2 = 1 - x$ here, $0 < x < 1$ $\Rightarrow \boxed{0 < R^2 < 1}$	Your model behaves worse than a simple mean model RSS > TSS { i.e Your models error is greater than the error's done by simple mean model } $\Rightarrow R^2 = 1 - \frac{RSS}{TSS}$ $\Rightarrow R^2 = 1 - x$ here, $1 < x < +\infty$ $\Rightarrow \boxed{-\infty < R^2 < 0}$

5. Adjusted R-squared

$$\bar{R}^2 = 1 - \left[\frac{(1-R^2)(n-1)}{(n-p-1)} \right]$$

$n \rightarrow$ No. of samples / rows in data
$p \rightarrow$ No. of predictors / independent features

Important Note:

a. R^2 & $\bar{R}^2$ are used for explaining how well the independent variables explains the variability in the dependent variable.

b. R^2 always increases with the addition of the independent variable which might lead to the existance of redundant variables in our model.

c. Adjusted R^2 solves the above problem. The value of adjusted R^2 decreases if the increase in the R^2 by the additional variable is not significant enough.

d. For comparing different regression models, RMSE is a better choice than R^2 or adj. R^2.