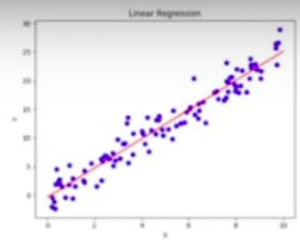
Regression Metrics



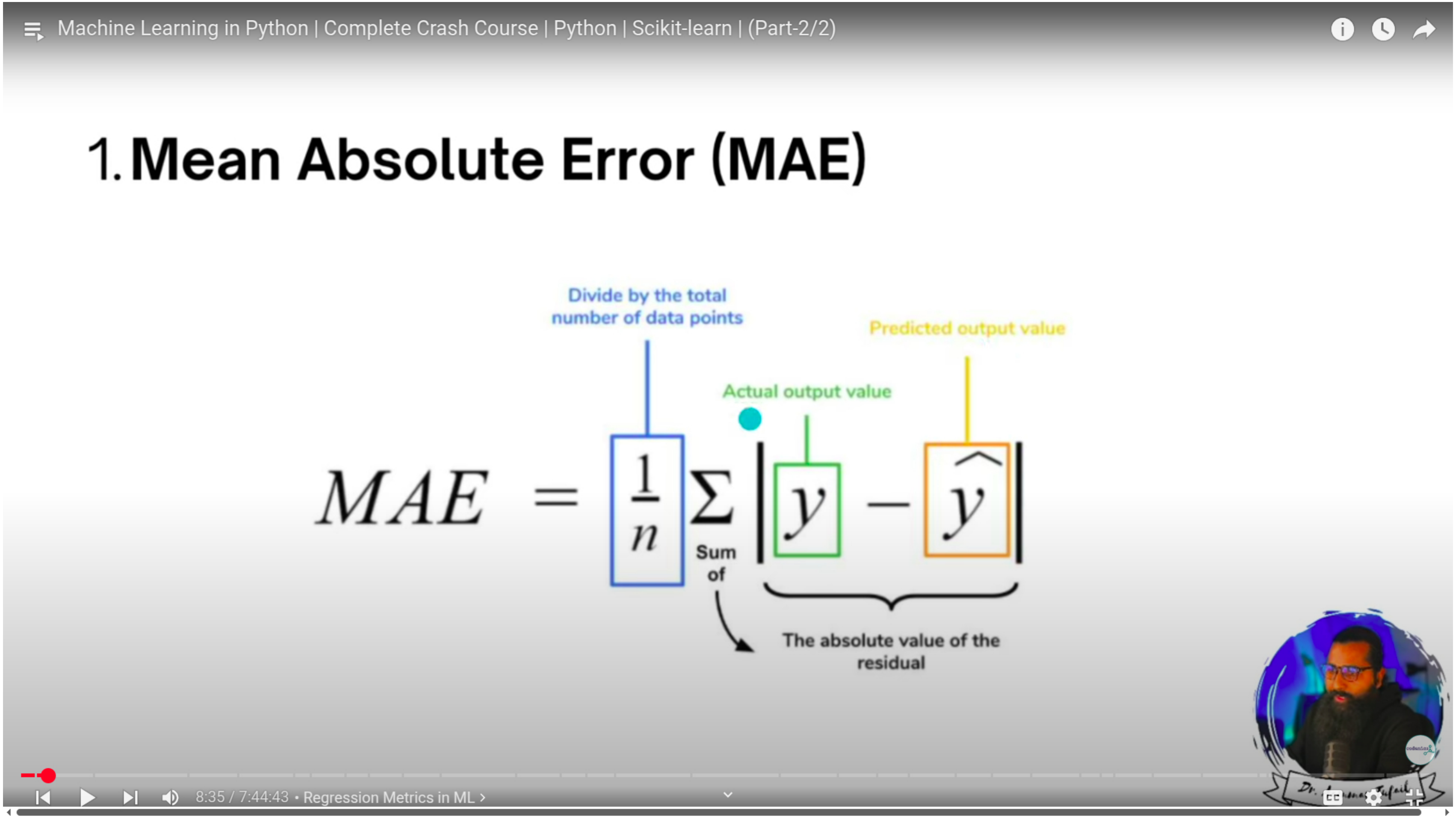
1. Mean Absolute Error (MAE)

Description:

- MAE measures the ***average magnitude*** of the errors in a set of predictions, without considering their direction.
- It's the average over the test sample of the **absolute differences between prediction and actual observation** where all individual differences have equal weight.

$$MAE = \frac{1}{n}\sum_{i=1}^{n}\left|y_i - \hat{y}_i\right|$$

Interpretation: Lower values are better. A value of 0 indicates n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1. Mean Absolute Error (MAE)
Divide by the total number of data points
Predicted output value
Actual output value
$MAE = \frac{1}{n} \sum \left| y - \hat{y} \right|$
Sum of
The absolute value of the residual
8:35 / 7:44:43 • Regression Metrics in ML ›

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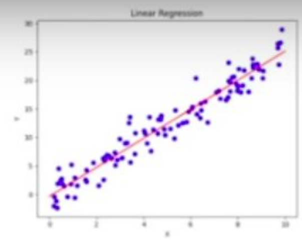

2. Mean Squared Error (MSE)

Description:

- MSE measures the average of the squares of the errors—that is, the **average squared difference between the estimated values and the actual value.**

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

Interpretation: Like MAE, lower values are bet
MSE is more sensitive to outliers than MA

2. Mean Squared Error (MSE)

$$\mathrm{MSE} = \overset{\text{Mean}}{\boxed{\frac{1}{n}\sum_{i=1}^{n}}}\Big(\overset{\text{Error}}{\boxed{Y_i - \hat{Y}_i}}\Big)^{\overset{\text{Squared}}{\boxed{2}}}$$

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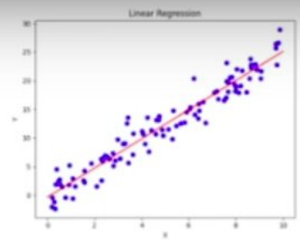


3. Root Mean Squared Error (RMSE)

Description:

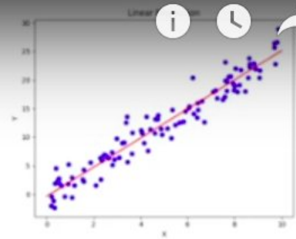
- RMSE is the square root of the **mean of the squared errors.** It's a way to quantify the size of the error made by the model.

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

Interpretation: Lower values indicate better fit. RMSE is more sensitive to outliers than MAE and often used when large errors are particularly undesirable.

14:30 / 7:44:43 • Regression Metrics in ML ›

Regression Metrics



4. R-squared (Coefficient of Determination)

Description:

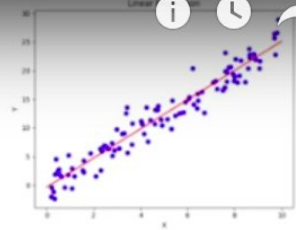
- R-squared represents the proportion of the variance for the dependent variable that's explained by the independent variables in a regression model.

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

where $\bar{y}$ is the mean of the observed data.

Interpretation: Values range from 0 to 1. A higher R-squared indicates a better fit between the model and the data.

Regression Metrics



5. Adjusted R-squared

Description:

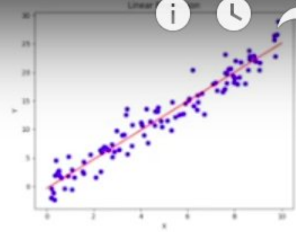
- Adjusted R-squared is a modified version of R-squared that has been adjusted for the number of predictors in the model. It accounts for the model complexity.

$$\text{Adjusted } R^2 = 1 - (1 - R^2)\frac{n-1}{n-p-1}$$

where n is the number of observations and p is the number of predictors.

Interpretation: Compares the explanatory power of regression models that contain different numbers of predictors.

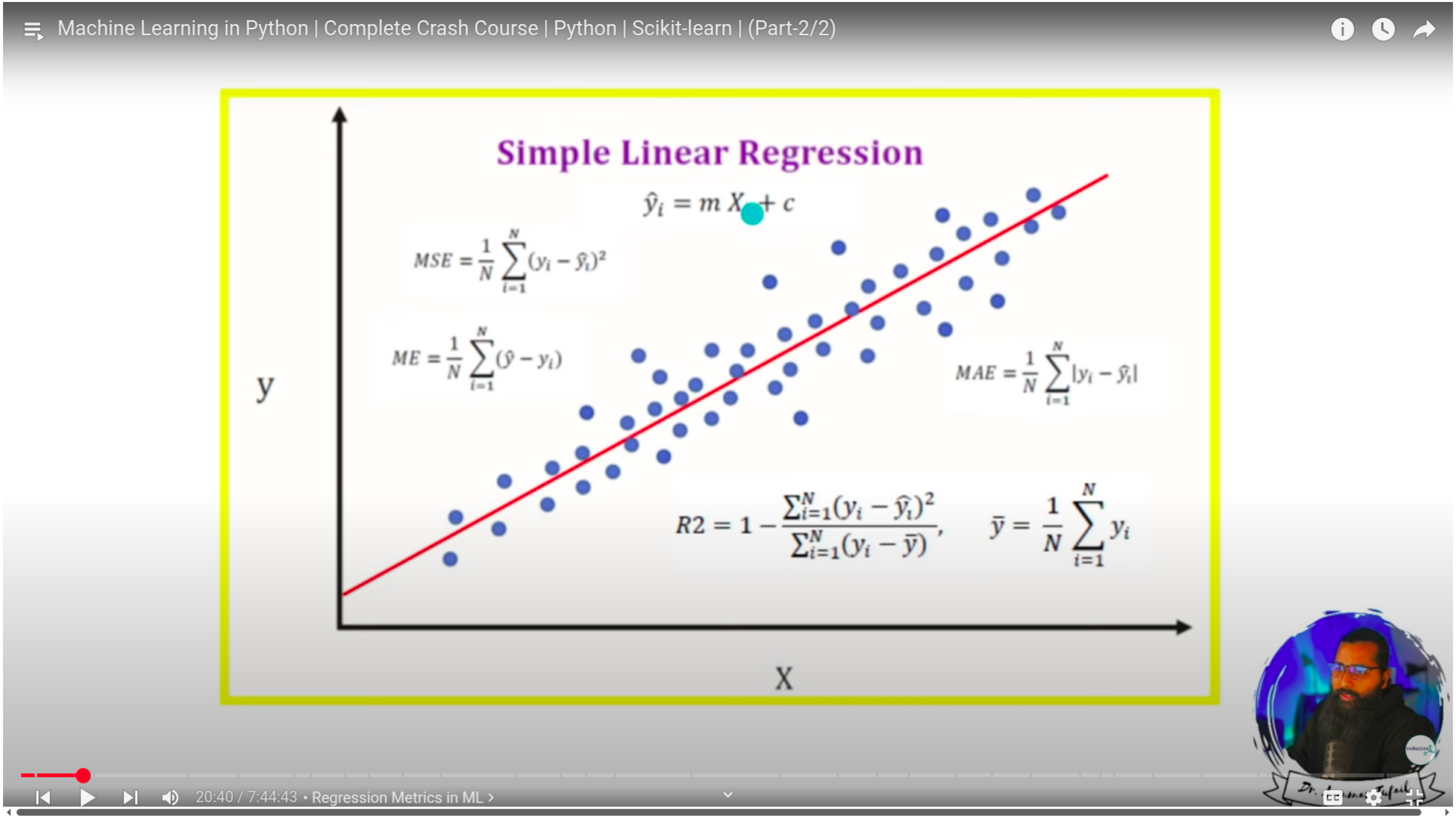
Regression Metrics



Choosing the Right Metric:

Description:

- The choice of metric depends on the specific requirements of your **analysis** and the **nature of the data**.
- For instance, if you are more concerned about outliers, **MSE or RMSE** might be more appropriate.
- R-squared and Adjusted R-squared are useful for understanding the **proportion of variance explained by the model**, but they don't necessarily imply that the model is accurate.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Simple Linear Regression
$\hat{y}_i = m X_i + c$
$MSE = \frac{1}{N}\sum_{i=1}^{N}(y_i - \hat{y}_i)^2$
$ME = \frac{1}{N}\sum_{i=1}^{N}(\hat{y} - y_i)$
$MAE = \frac{1}{N}\sum_{i=1}^{N}|y_i - \hat{y}_i|$
$R2 = 1 - \frac{\sum_{i=1}^{N}(y_i - \hat{y}_i)^2}{\sum_{i=1}^{N}(y_i - \bar{y})},$
$\bar{y} = \frac{1}{N}\sum_{i=1}^{N} y_i$
y
X
20:40 / 7:44:43 • Regression Metrics in ML ›

Metric	Pros	Cons	Example
Mean Absolute Error (MAE)	Simple to understand; treats all errors equally	Less sensitive to outliers	For true values [3, -0.5, 2, 7] and predicted [2.5, 0.0, 2, 8], MAE is (0.5 + 0.5 + 0 + 1)/4 = 0.5
Mean Squared Error (MSE)	Punishes larger errors more severely	Can be disproportionately influenced by outliers	For the same true and predicted values, MSE is [(0.5)^2 + (0.5)^2 + 0^2 + 1^2]/4 = 0.375
Root Mean Squared Error (RMSE)	More interpretable in the original units of the output variable	More sensitive to outliers than MAE	For the same values, RMSE is $\sqrt{0.375} \approx 0.612$
R-squared (Coefficient of Determination)	Measures how well future samples are likely to be predicted	Does not indicate if a regression model is adequate	If the total sum of squares is 10 and the sum of squared errors is 2, R^2 is 1 - 2/10 = 0.8
Adjusted R-squared	Adjusts for the number of predictors in the model	Can be more difficult to interpret	For an R^2 of 0.8, 100 observations, and 5 predictors, Adjusted R^2 is 1 - (1-0.8) * (100-1)/(100-5-1) = 0.793
Mean Absolute Percentage Error (MAPE)	Provides error in terms of percentage, making it scale-independent	Can be infinite or undefined for y_i = 0	For true values [3, -0.5, 2, 7] and pr 0.0, 2, 8], MAPE is [(0.5/3) + (0.5/0 (1/7)] * 25% ≈ 43.57%