

Data Mining 2

Topic 03 : Review of Model Building

Lecture 02 : Regression Models

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Outline

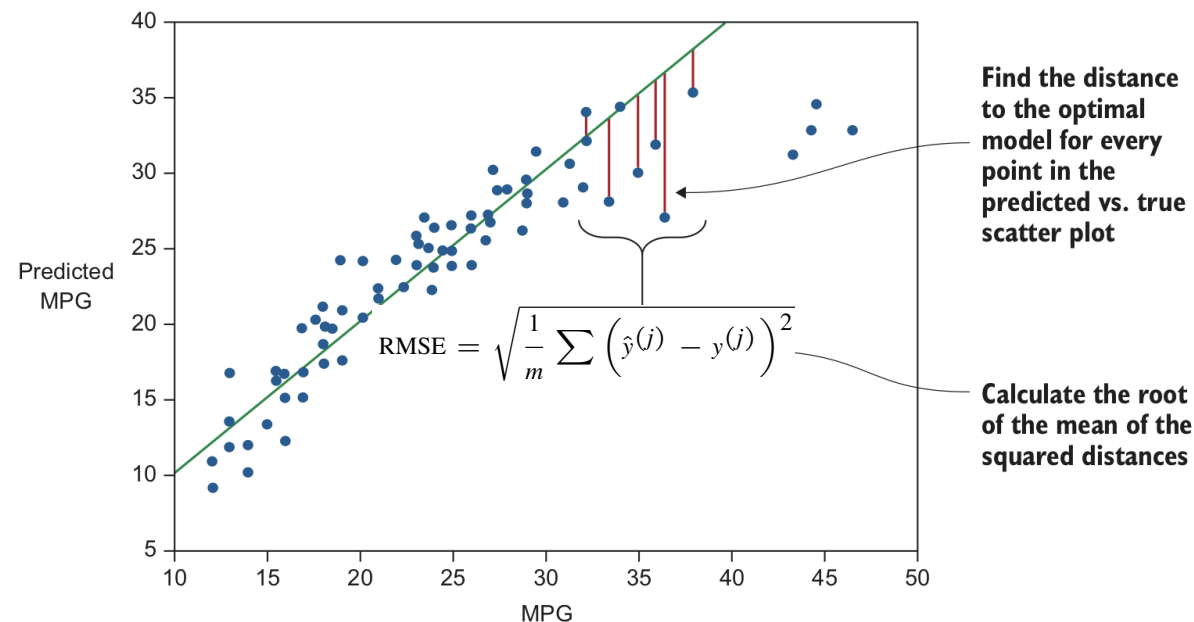
- Regression Models

Regression Models (Evaluating Numeric Prediction)

We have covered using the MSE

$$\text{MSE} = \frac{1}{m} \sum \left(f \left(\mathbf{x}^{(j)}; \boldsymbol{\theta} \right) - y^{(j)} \right)^2$$

as the cost function in our curve fitting example. Geometrically this is computed as follows*



*Diagram (from *Real World Machine Learning*) shows the $\text{RMSE} = \sqrt{\text{MSE}}$

Common Cost Functions in Regression Models

Measure	Definition	Purpose/Advantage
Mean square error (MSE)	$\frac{(p_1 - a_1)^2 + \dots + (p_m - a_m)^2}{m}$	Mathematically tractable but places greater emphasise on observations with large error
Root mean square error (RMSE)	$\sqrt{\frac{(p_1 - a_1)^2 + \dots + (p_m - a_m)^2}{m}}$	Has same units as data
Mean absolute error (MAE)	$\frac{ p_1 - a_1 + \dots + p_m - a_m }{m}$	Does not overemphasise observations with large error (as MSE does)
Relative square error (RSE)	$\frac{(p_1 - a_1)^2 + \dots + (p_m - a_m)^2}{(p_1 - \bar{a})^2 + \dots + (p_m - \bar{a})^2}$	Relative metric compares the error in the predictions with errors in the simplest model possible (a model just always predicting the average value of y)
Root Relative square error (RRSE)	$\sqrt{\frac{(p_1 - a_1)^2 + \dots + (p_m - a_m)^2}{(p_1 - \bar{a})^2 + \dots + (p_m - \bar{a})^2}}$	
Relative absolute error (RAE)	$\frac{ p_1 - a_1 + \dots + p_m - a_m }{ p_1 - \bar{a} + \dots + p_m - \bar{a} }$	

where a_j is the actual value, p_j is the predicted value, m is the number of observations, and \bar{a} represents the mean of the a_j .

Assumptions of (Linear) Regression Model

- **Multivariate normality** — each of the independent variables must be normally distributed.
 - Graphical: histograms, Q-Q plots,
 - Numerical: goodness of fit tests, e.g., the Kolmogorov-Smirnov test, ...
 - Fix: non-linear transformations such as log, power, Box-Cox, etc
- No or little **multicollinearity** — independent variables should not be too highly correlated with each other.
 - Numerical: correlation matrix using Pearson's bivariate correlation coefficient.
 - Fix: Centre the data, filter out some of the independent variables,
- No **auto-correlation** — the residuals should be independent, and normally distributed.
 - Graphical: residual plot.
 - Numerical: Durbin-Watson test.
- **homoscedasticity** — constant variance in residuals.
 - Graphical: residual plot.
 - : Fix: transform data or use non-linear model.

And, in addition, for linear regression

- **Linearity** — relationship between the independent variables and the dependent variable is linear.