Importance of error/residuals plots

01 August 2025 15:18

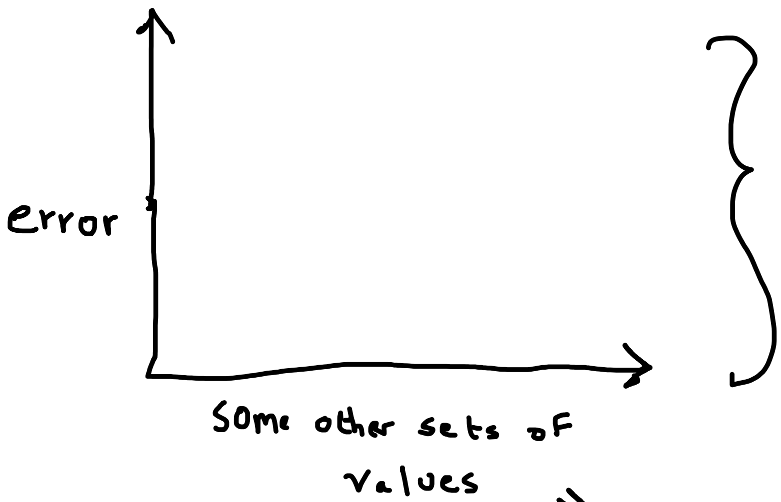
	y_actual	y_pred	error
0	50.000000	50.252809	0.252809
1	51.010101	53.509858	2.499757
2	52.020202	47.040657	-4.979545
3	53.030303	56.498296	3.467993
4	54.040404	51.948896	-2.091508

→ y pred - y actual

⇓

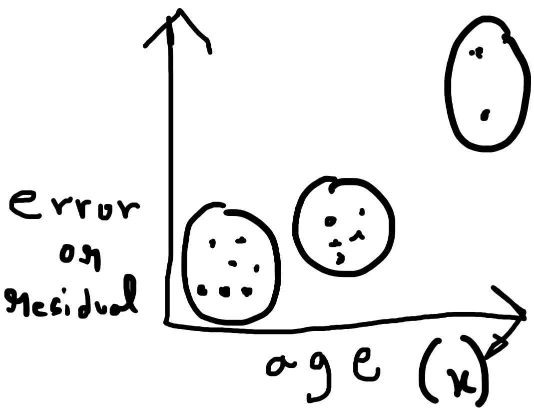
residual

the importance of error based plots !



⇒ Can be input variables or target variable

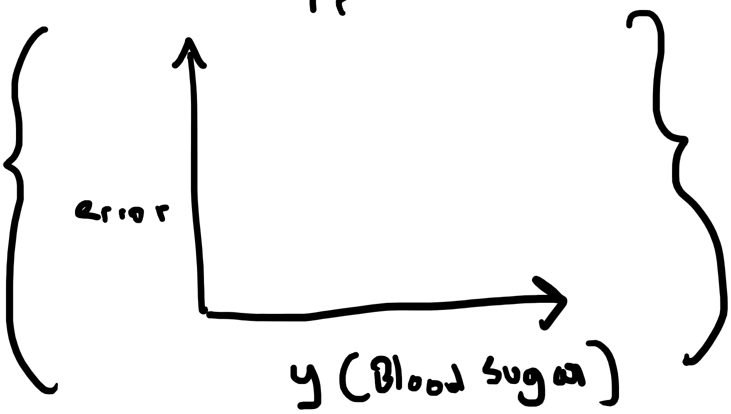
Assume age is a feature



⇒ compare errors at different of x variable

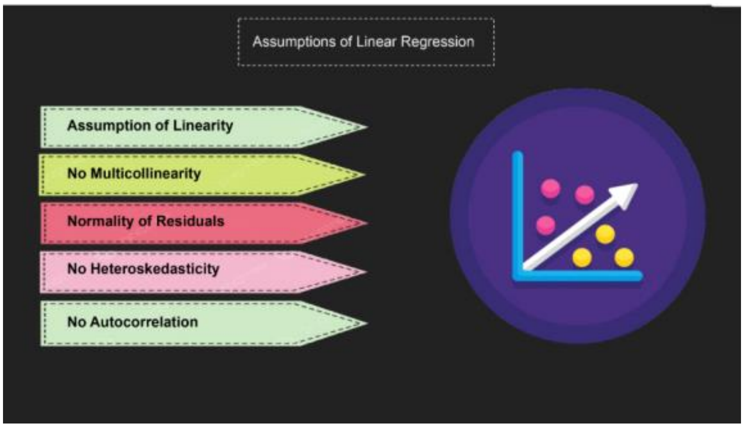
Throughout the session, we will look into importance of error vs y variable plots

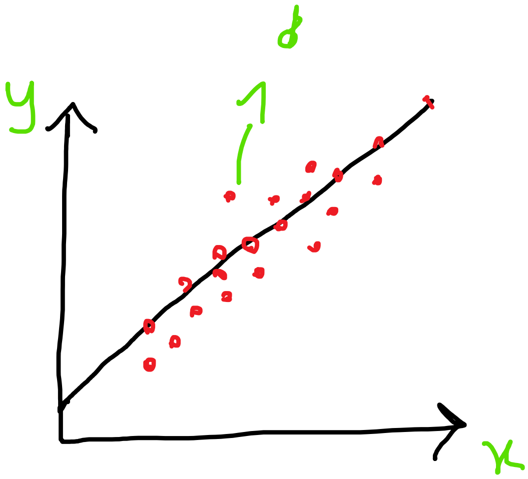
⇑

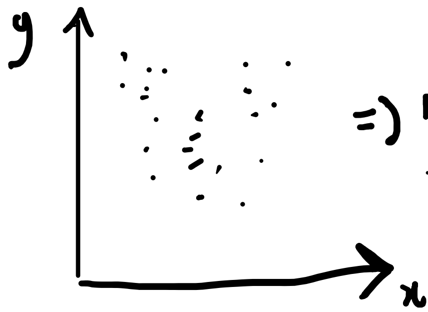


Assumption of Linearity

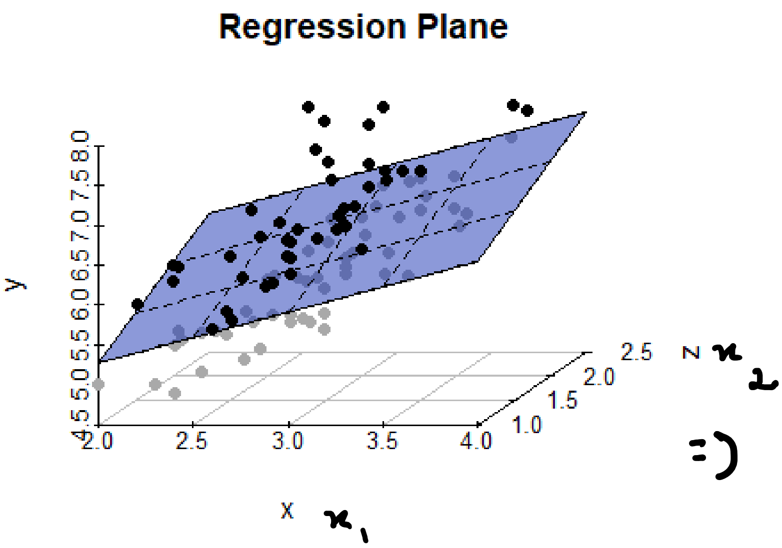
30 July 2025 16:02



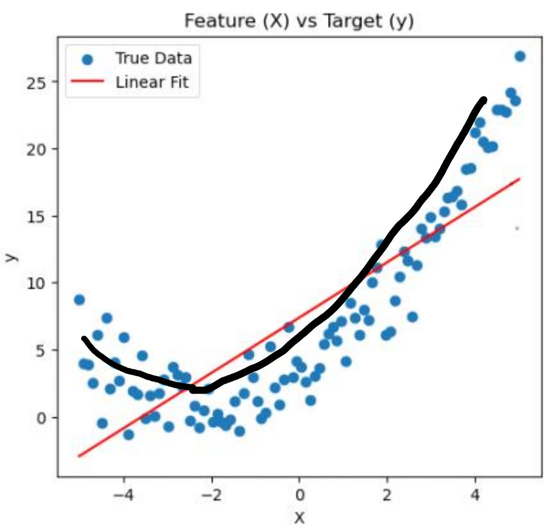


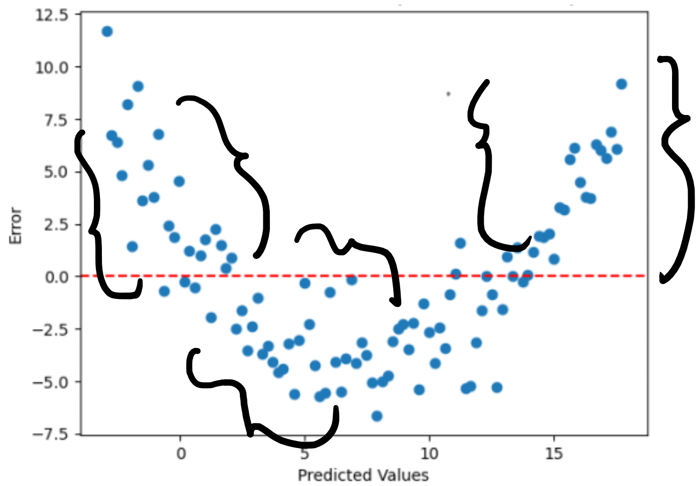


=) Not linear



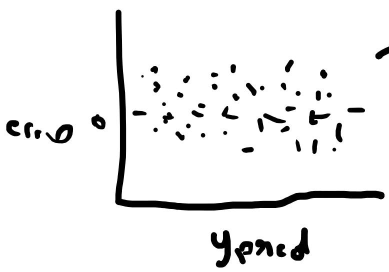
=) hyperplane also linear





When there is a noticeable relationship b/w ypred and error, linear regression is not suitable option

ideal Scenario



→ random plot } → linear regression working well

The trade off at times

01 August 2025 16:42

Statistical Correctness

vs

Predictive Correctness

Sometimes a trade-off with linear models

No Multi-collinearity

31 July 2025 22:58

What is Multi-collinearity?

Travel_expense $= \omega_1 \times Km + \omega_2 \times Fuel + \omega_0$

Features | | target

Km_Driven (X1)	Fuel_Consumed (X2)	Travel_Expense (Y)
1000	80	6400
800	64	5120
1200	96	7680
600	48	3840
900	72	5760

α

→ Are X_1 and X_2 related?

$$\{ x_1 = w x_2 + b \} \rightarrow \text{linearly related}$$

Why is it an issue?

→ Feature interpretability heavily impacted, Which is more important, x_1 or x_2? Both?

→ Sign flipping in co-efficients - Causes Confusion.

But it is not always a problem!

How can we avoid Multi-collinearity?

VIF! → Variance Inflation Factor

How to deal with multicollinearity?

We will use **Variance Inflation Factor (VIF)**

Say, we have 'd' features $< f_1, f_2, f_3 \ldots\ldots\ldots f_d >$

In, **(VIF)** we treat
- one feature as 'y'
- remaining features as 'x'

$f_1, f_2, f_3 \ldots\ldots\ldots f_d$	f_4
x_i	y

F_1, F_2, F_4 | F_3

F_3, F_1, F_4 | F_2

{ identify Multi-collinearity }

$x_1, x_2, x_3, x_4 \ldots\ y$

Now,

Train **linear regression** model with (x_i, y)

Find R^2 of the model

To Calculate VIF :

$$VIF = \frac{1}{1 - R_j^2},\ R_j^2 \ : R^2 \text{ for } j^{th} \text{ feature}$$

Features

target

$$x_1 = w_1x_2 + w_2x_3 + w_3x_4 + w_0 \Rightarrow$$

$\frac{1}{1 - R\,sq_{x_1}}$ For this model = VIF for x_1

$$x_2 = w_1x_1 + w_2x_3 + w_3x_4 + w_0$$

⋮

$$x_d = w_1x_1 + w_2x_2 \ldots\ldots w_0$$

$1 \rightarrow R^2 = 0.9$

$$\left\{ VIF = \frac{1}{1 - 0.9} = \frac{1}{0.1} = 10 \right\}$$

Higher the VIF For a Variable, higher the Multi-collinearity it shares with other variables.

VIF > 5 ⇒ think of dropping

VIF > 10 ⇒ {definitely drop}

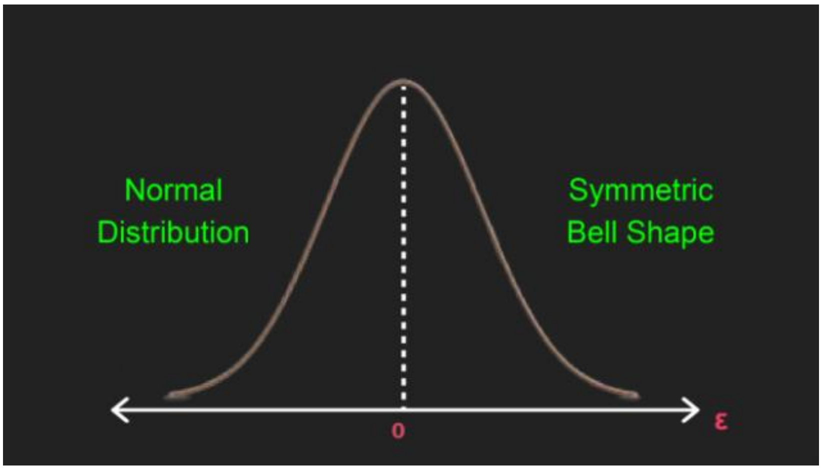
{ 0 to ∞ }

Errors are normally distributed

31 July 2025 22:58

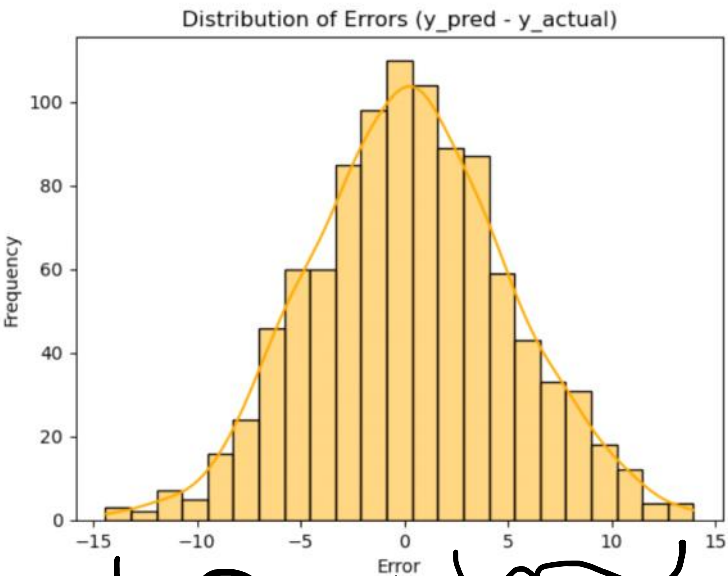
$$\text{error} = \underset{\text{Actual}}{y_i} - \underset{\text{Predicted}}{\hat{y}_i}$$

Frequency



Why ?

i)



Symmetric

$\Downarrow$

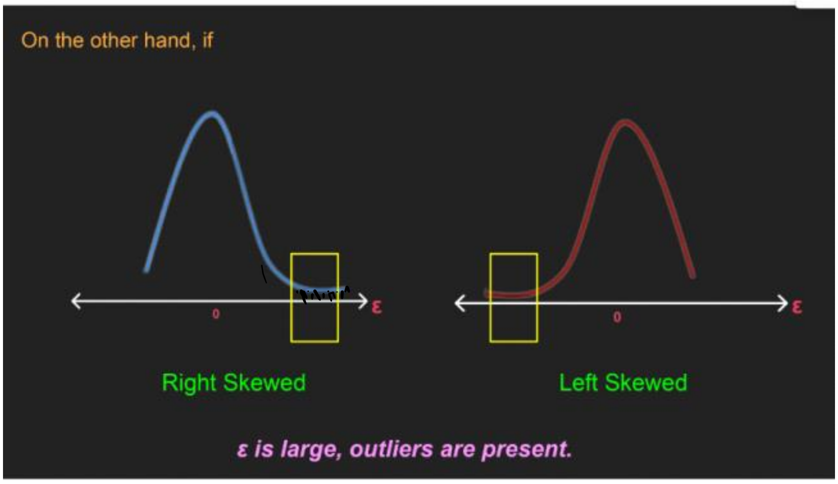
No. of overpredicted = No. of underpredicted

$\underbrace{\hphantom{xxxxxxxx}}_{\text{Underprediction}}$ $\underbrace{\hphantom{xxxxxxxx}}_{\text{overprediction}}$

{ypred - yactual}

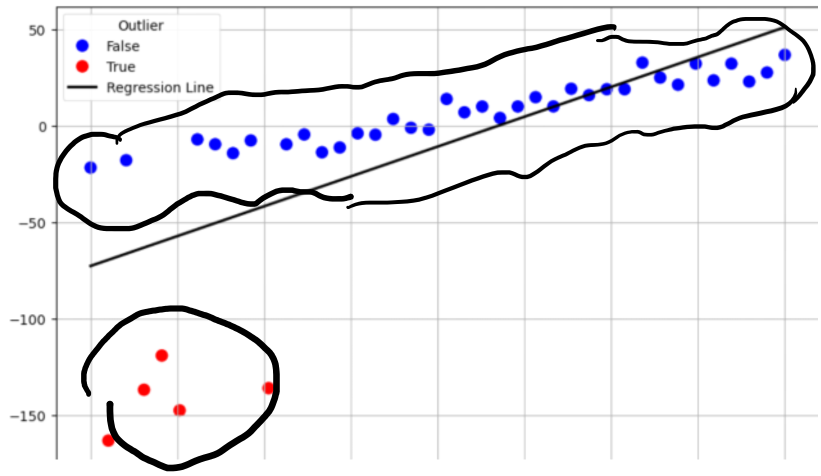
If my model is either o.p or u.p, heavily

On the other hand, if



i) Model is unable to capture sufficient information

ii) There are outliers in the data



No Heteroscedasticity

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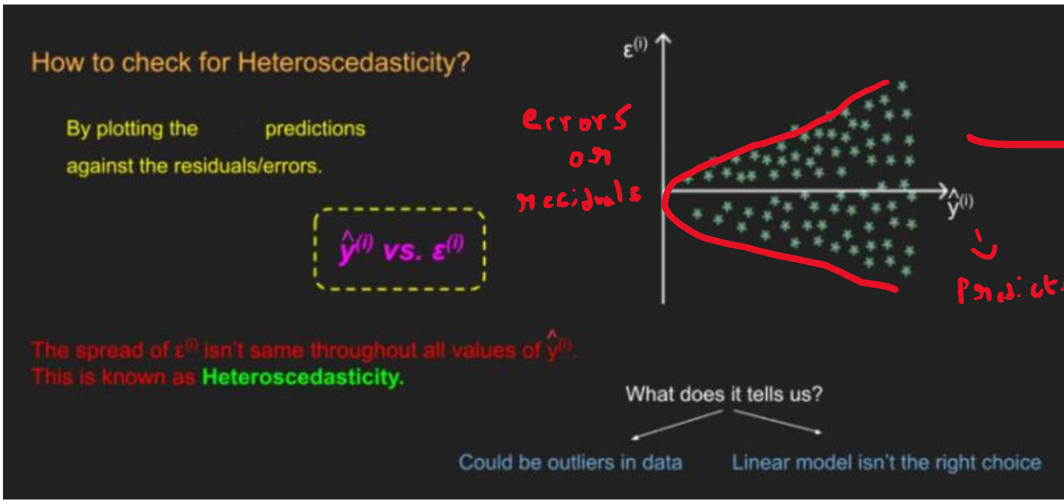
Variance of errors should be constant across y-predicted



Predicted

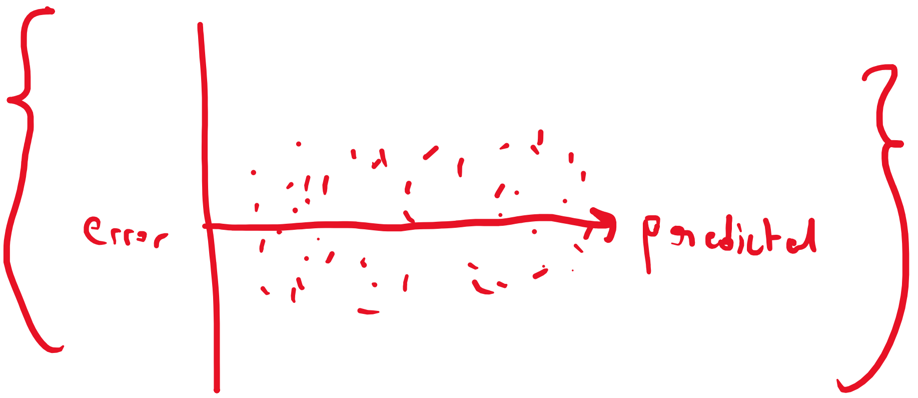
here it is not constant

What does Heteroscedasticity indicate?

i) Linear Model may not be suitable

ii) Use a non-linear Model

iii) Introduce other variables into your model



→ Homoscedasticity

No Autocorrelation of errors

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What is auto - correlation ?
self

in errors there should be no auto-correlation

Note : Assumption applicable only For time-series data

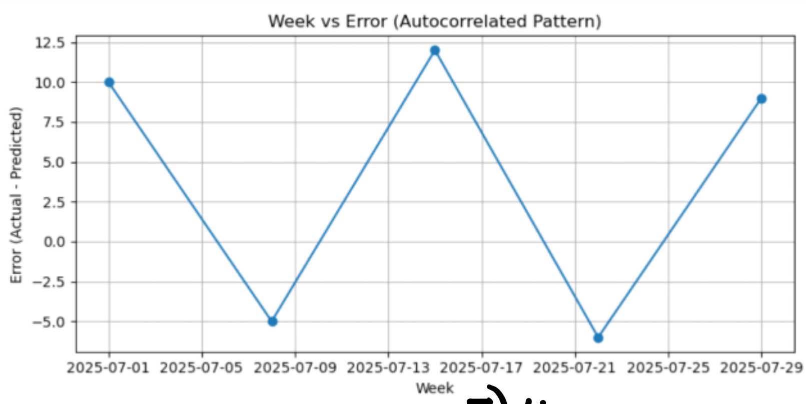
What is time-series data ?

Week	Sales (target)	Promotion	Temperature (°C)	Holiday
2025-07-01	200	1	30	0
2025-07-08	180	0	31	0
2025-07-15	220	1	29	0
2025-07-22	250	1	28	1
2025-07-29	190	0	32	0

} Predicting based on a time component is called time-series

📊 Final Table

Week	Sales (Actual y)	Predicted Sales (y_pred)	Error (y - y_pred)
2025-07-01	200	190	10
2025-07-08	180	185	-5
2025-07-15	220	208	12
2025-07-22	250	256	-6
2025-07-29	190	181	9



→ time component

Error
vs
time component

odd weeks errors are correlated

even week errors are correlated

How is this similar to heteroscedasticity?

trend in errors!!