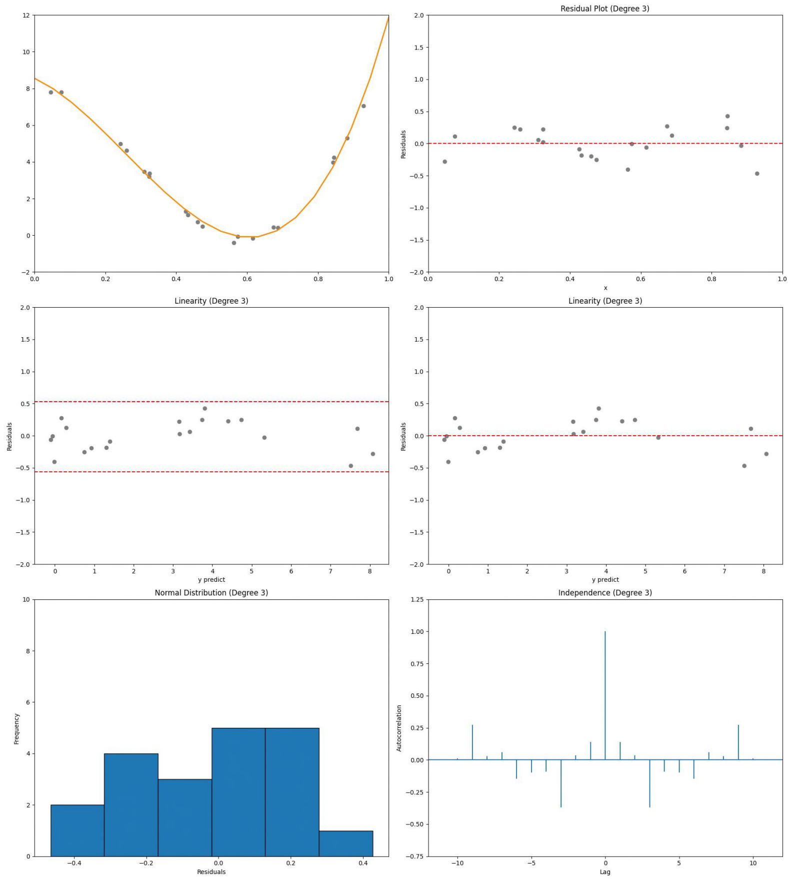
1. According to the degree 3 plot.

We can observe that the data is normal distribution by Residual Plot and Normal Distribution Plot

Compare different degrees' plots, we can infer that degree 3 most fits to the data by its Residual Plot.



2. $Y - E(Y) = (Xw - \varepsilon) - E[Xw + \varepsilon] = Xw + \varepsilon - E[Xw] = \varepsilon$

$$Var(Z) = E[(Z - E[Z])(Z - E[Z])^T]$$

$$Var(\hat{w}) = E[(\hat{w} - E[\hat{w}])(\hat{w} - E[\hat{w}])^T]$$

$$= E[((X^TX)^{-1}X^TY - E[(X^TX)^{-1}X^TY]) \times ((X^TX)^{-1}X^TY - E[(X^TX)^{-1}X^TY])^T]$$

$$= (X^TX)^{-1}X^T E[(Y - E[Y]) \times ((X^TX)^{-1}X^TY - E[(X^TX)^{-1}X^TY])^T]$$

$$= (X^TX)^{-1}X^T E[(Y - E[Y])(Y - E[Y])]((X^TX)^{-1}X^T)^T$$

$$= (X^TX)^{-1}X^T E(\varepsilon\varepsilon^T)((X^TX)^{-1}X^T)^T$$

$$= (X^TX)^{-1}X^T(\sigma^2 I)((X^TX)^{-1}X^T)^T$$

$$= (X^TX)^{-1}X^TX(X^TX)^{-1}\sigma^2$$

$$= (X^TX)^{-1}\sigma^2$$

3. (a) The yields increase as maturity when the maturity is over 50.

(b) The $R^2$ values increase slowly after the oder of 3.

(c) When maturity is small, the residual is large. But when the maturity is larger than 60, the residual becomes a stable level.

(d) By the two plots, we are able to infer that the data is normal distribution.