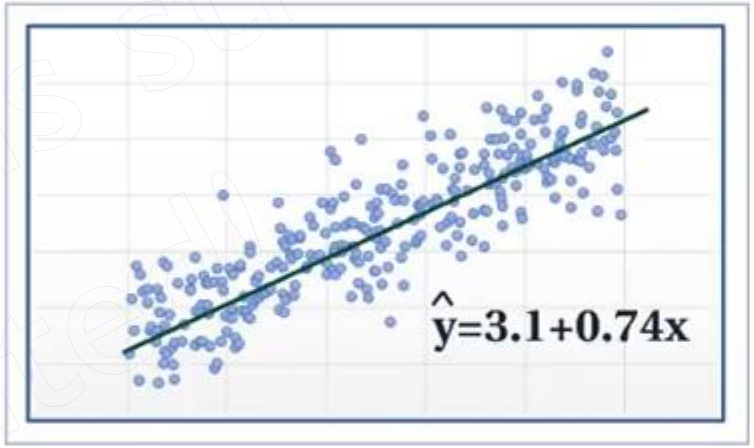
Regression Assumptions

1. Linearity
2. Constant Error Variance
3. Independent Error Terms
4. Normal errors
5. No multi-collinearity
6. Exogeneity

$$Y = \beta_0 + \beta_1 X + \varepsilon$$

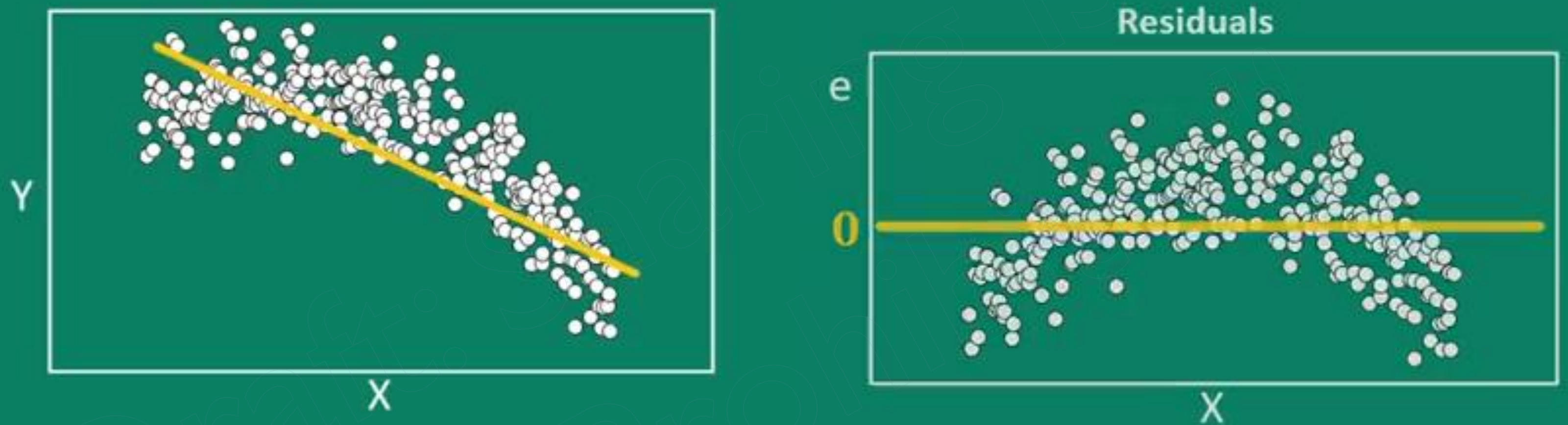


	Coef	Std Err	t Stat	P-value
Intercept	3.0605	1.4024	2.1823	0.02909
X	0.7393	0.2308	3.20339	0.00136

1. Linearity (Correct functional form)

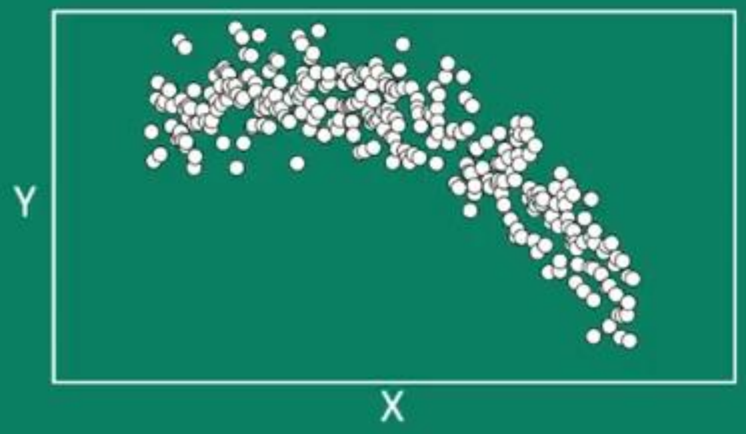
Consider the following model:

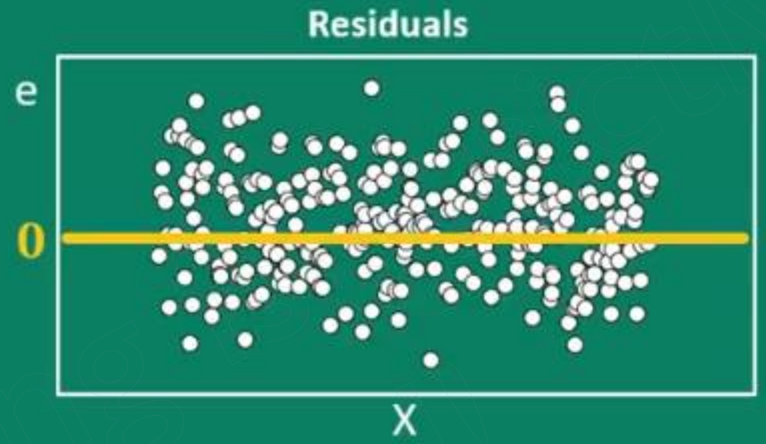
$$Lung\ Function_i = \beta_0 + \beta_1 (age)_i + \varepsilon_i$$



Consider the following model:

$$\boldsymbol{Lung\ Function_i = \beta_0 + \beta_1(age)_i + \beta_2(age^2)_i + \varepsilon_i}$$





What's the issue?

- If functional form is incorrect, both the coefficients and standard errors in your output are unreliable

Detection:

- Residual plots
- Likelihood ratio (LR) test

Remedies:

- Get the specification correct (trial and error)

1. Linearity

2. Constant Error Variance

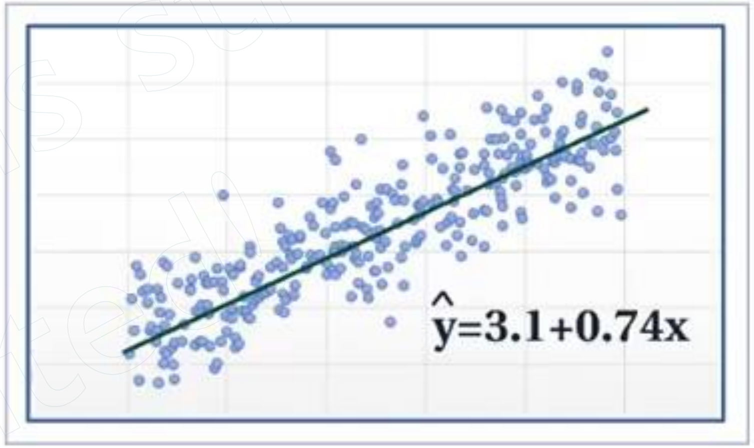
3. Independent Error Terms

4. Normal errors

5. No multi-collinearity

6. Exogeneity

$$Y = \beta_0 + \beta_1 X + \varepsilon$$



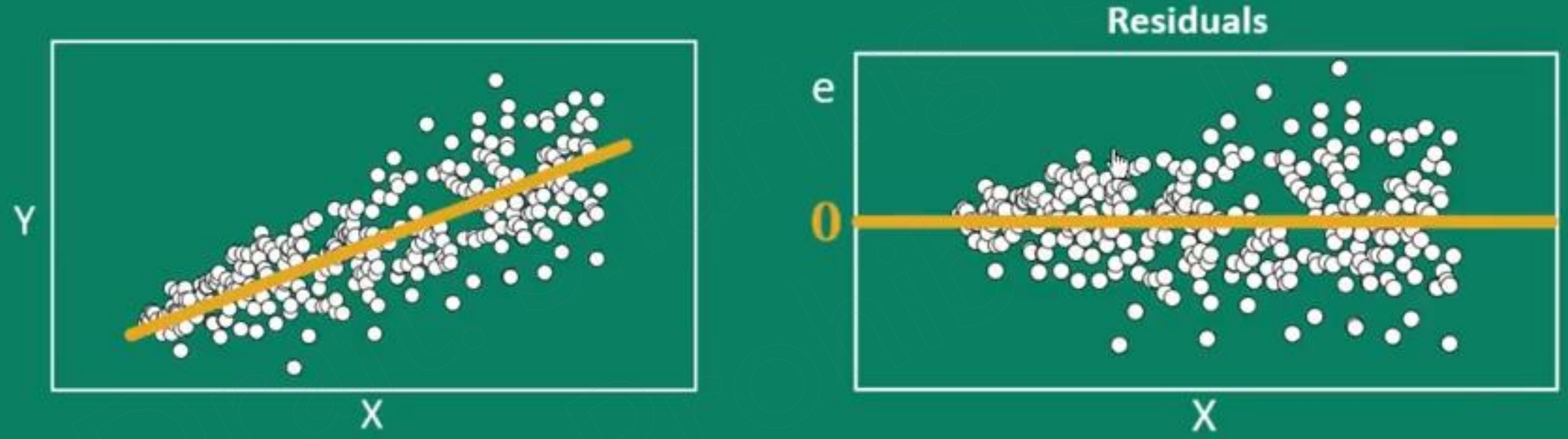
	Coef	*Std Err*	*t Stat*	*P-value*
Intercept	3.0605	1.4024	2.1823	0.02909
X	0.7393	0.2308	3.20339	0.00136

Regression Assumptions

Constant Variance (no heteroskedasticity)

Consider the following model:

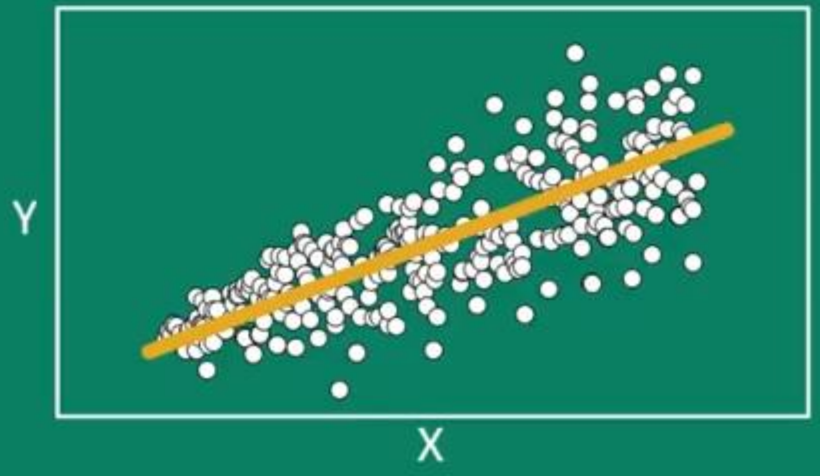
$$Expenditure_i = \beta_0 + \beta_1(Income)_i + \varepsilon_i$$

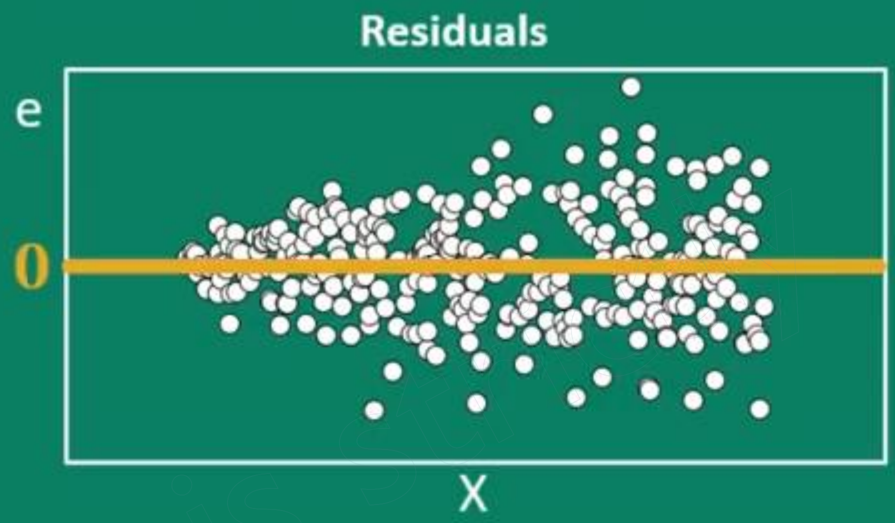


What's the issue?

- Under heteroskedasticity, standard errors in output cannot be relied upon

$$Expenditure_i = \beta_0 + \beta_1(Income)_i + e_i$$





What's the issue?

- Under heteroskedasticity, standard errors in output cannot be relied upon

Detection:

- Goldfeldt-Quant test
- Breusch-Pagan test

Remedies:

- White's standard errors
- Weighted least squares
- Log things!

1. Linearity

2. Constant Error Variance

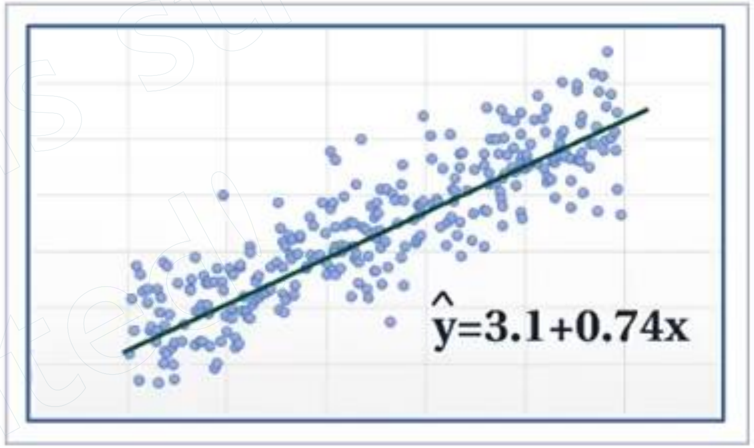
3. Independent Error Terms

4.Normal errors

5. No multi-collinearity

6. Exogeneity

$$Y = \beta_0 + \beta_1 X + \varepsilon$$



	Coef	*Std Err*	*t Stat*	*P-value*
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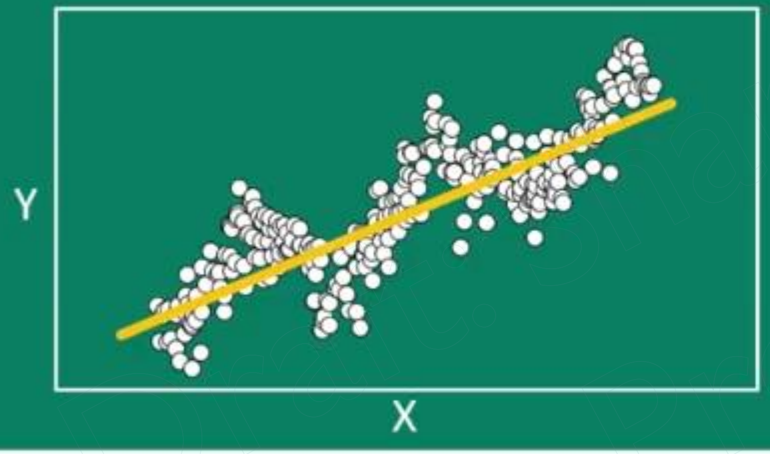
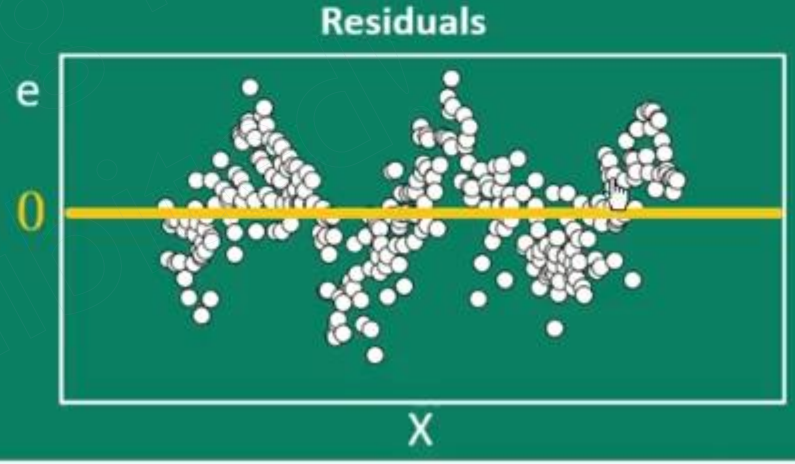
Regression Assumptions

Independent error terms (no autocorrelation)

Consider the following model:

$$Stock\ Index_i = \beta_0 + \beta_1(Time)_i + \varepsilon_i$$



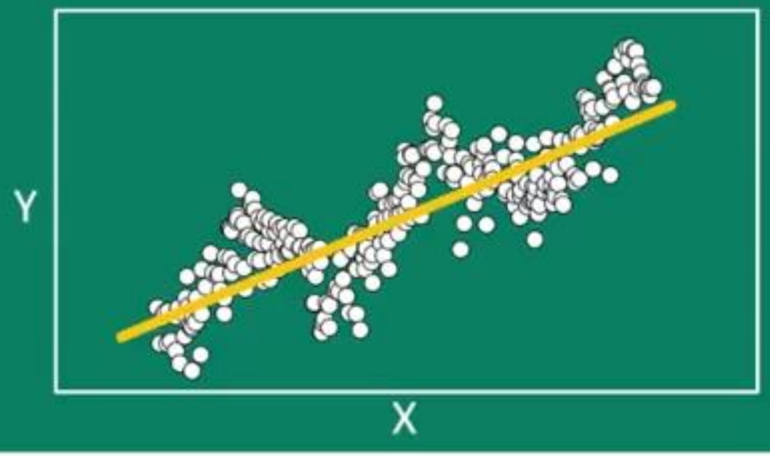


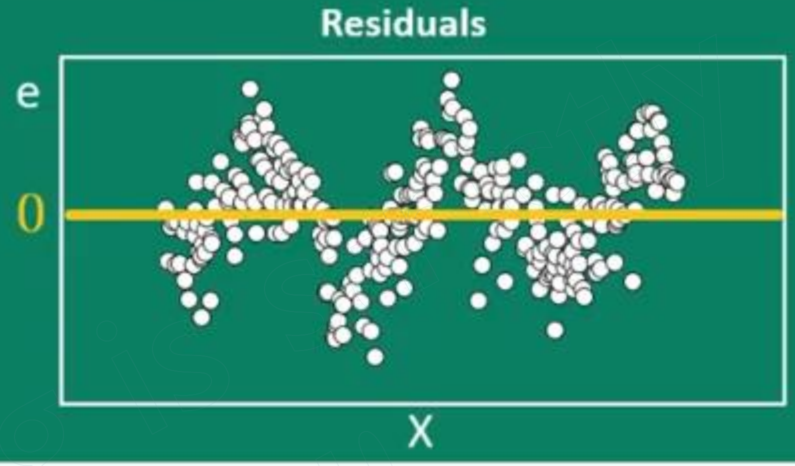
What's the issue?

- Under autocorrelation, standard errors in output cannot be relied upon

Consider the following model:

$$Stock\ Index_i = \beta_0 + \beta_1 (Time)_i + \varepsilon_i$$





What's the issue?

- Under autocorrelation, standard errors in output cannot be relied upon

Detection:

- Durbin-Watson test
- Breusch-Godfrey test

Remedies:

- Investigate omitted variables
- Generalised difference equation (Cochrane-Orchutt or AR(1) methods)

1. Linearity

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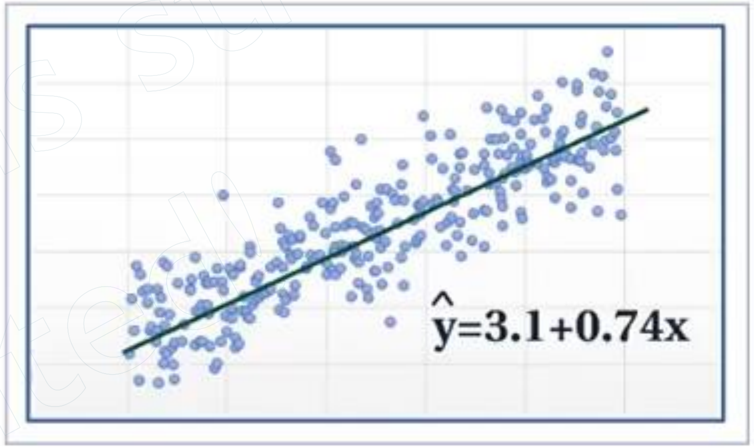

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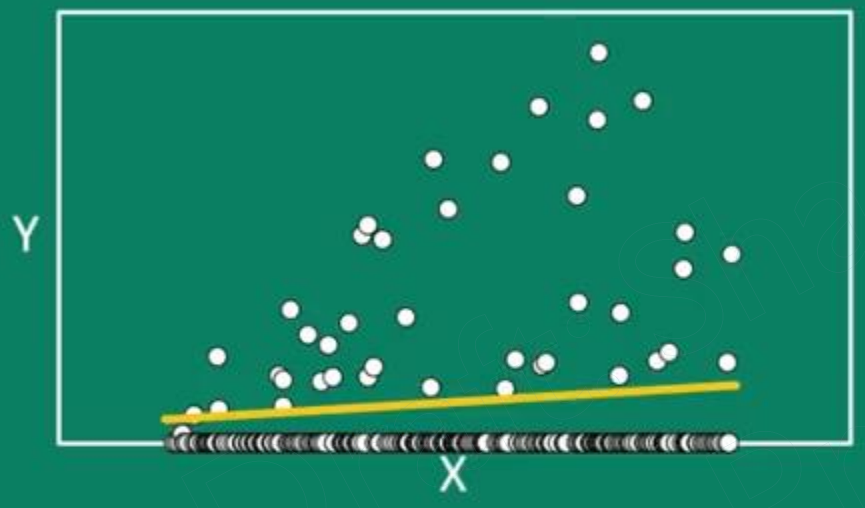
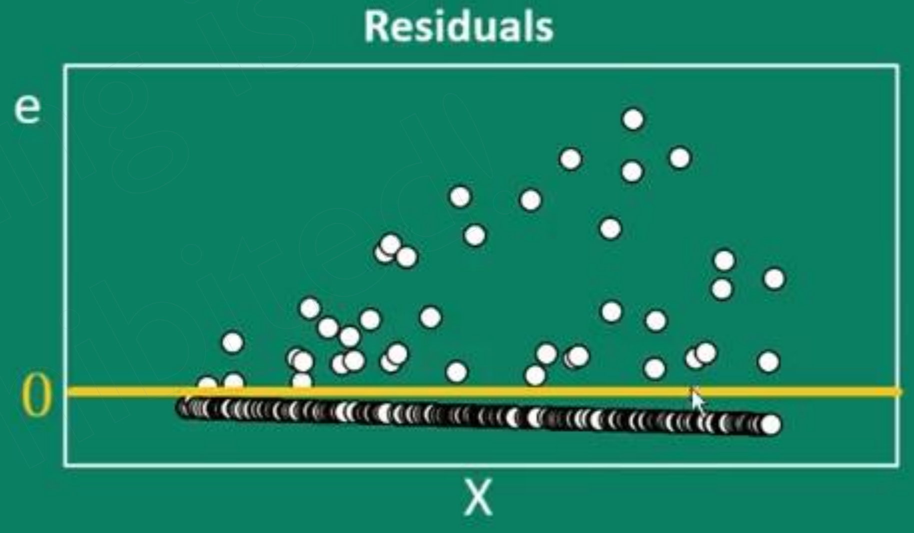
Regression Assumptions

Normality of errors

Consider the following model:

$$Medical\ Insurance\ Payout_i = \beta_0 + \beta_1 (Customer\ Age)_i + \varepsilon$$





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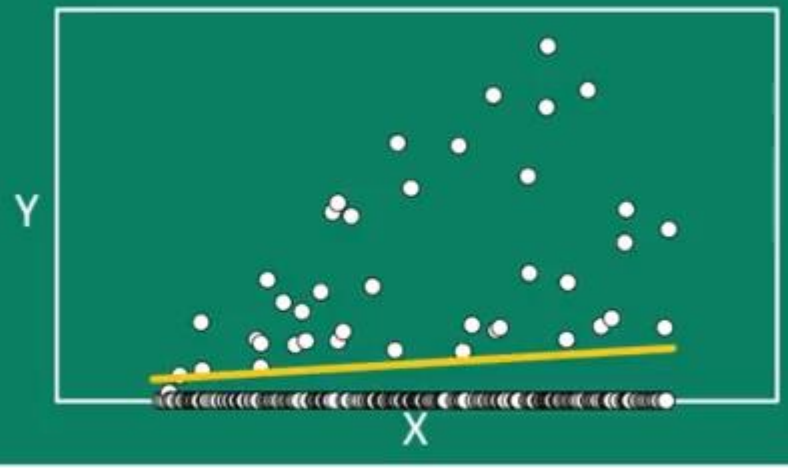
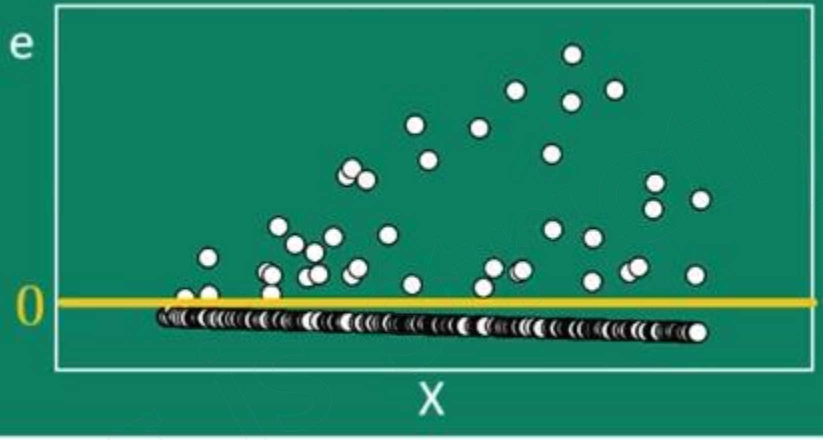


Residuals



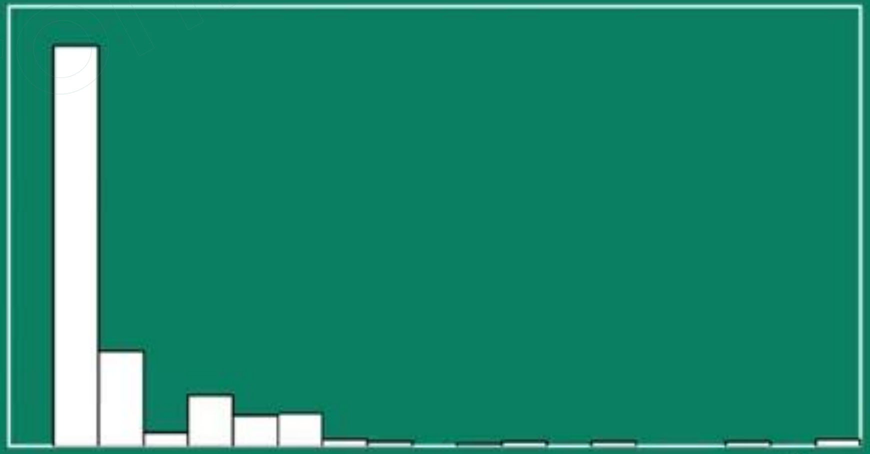
What's the issue?

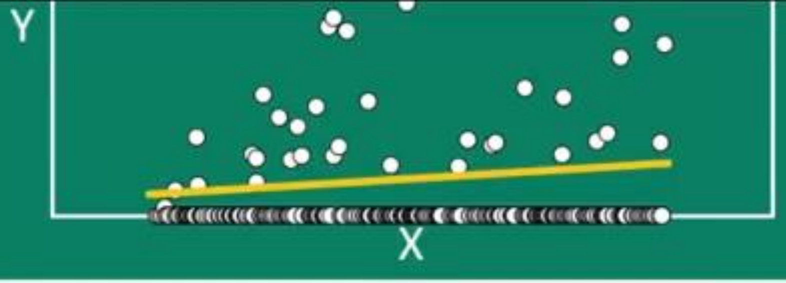
- If normality is violated and n is small, standard errors in output are affected

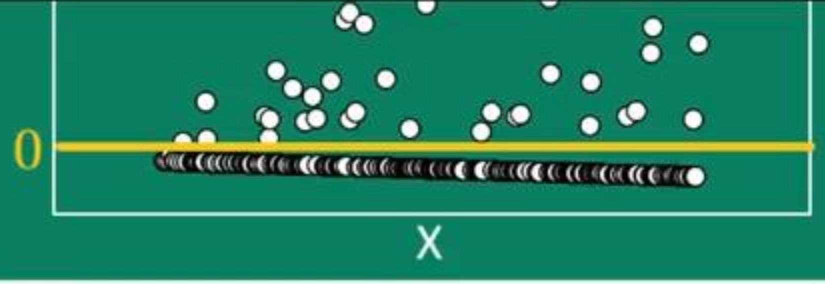
Detection:

- Histogram or Q-Q plot
- Shapiro-Wilk test
- Komolgorov-Smirnov test
- Anderson-Darling test

Histogram of residuals







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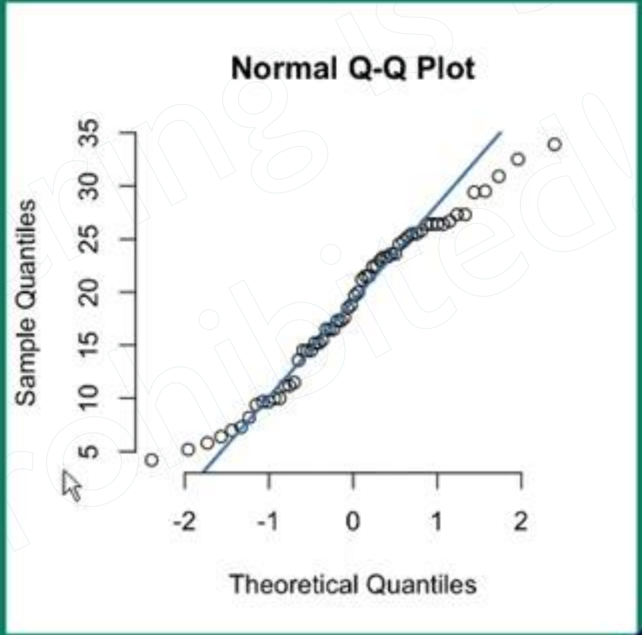
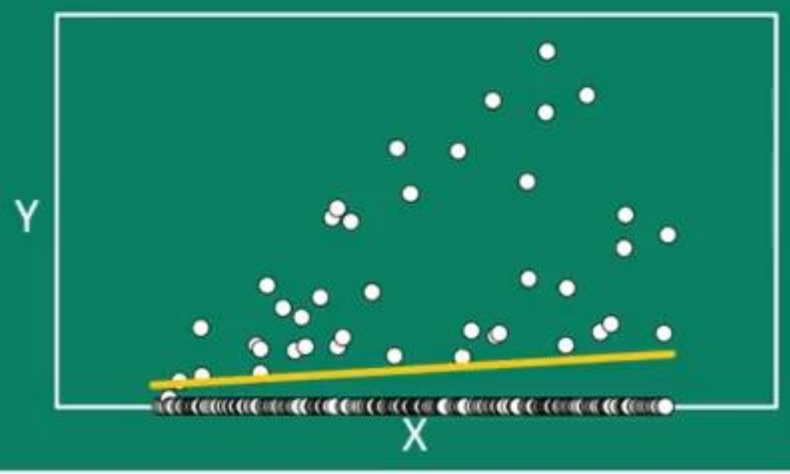
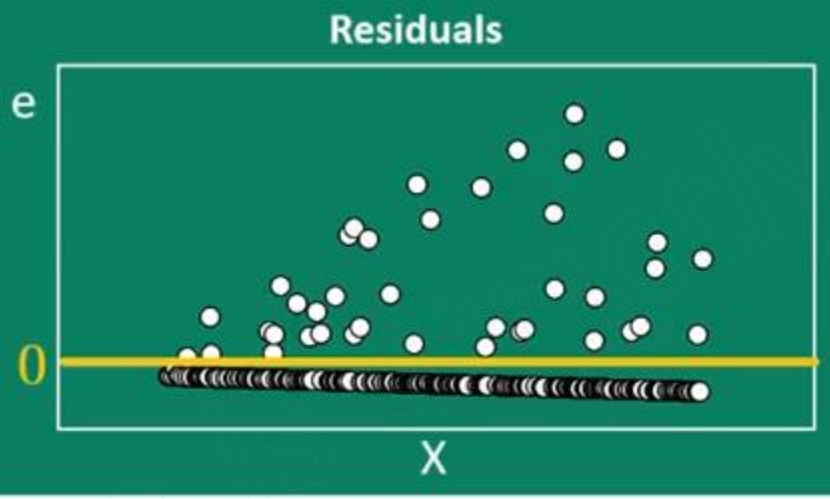


$$\textit{Medical Insurance Payout}_i = \beta_0 + \beta_1(\textit{Customer Age})_i + \varepsilon$$





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Detection:

- Histogram or Q-Q plot
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- Anderson-Darling test

Remedies:

- Change functional form (log?)

No multicollinearity

Consider the following model:

$$\boldsymbol{Motor\ Accidents_i = \beta_0 + \beta_1(Num\ cars)_i + \beta_2(Num\ residents)_i + \varepsilon}$$

$$i = suburb\ 1,2,3\ \ldots$$

Multi-collinearity occurs where the X variables are themselves related

---

What's the issue?

- Coefficients and standard errors of affected variables are unreliable.

Detection:

- Look at correlation (ρ) between X variables
- Look at Variance Inflation Factors (VIF)

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- Coefficients and standard errors of affected variables are unreliable.

Detection:

- Look at correlation (ρ) between X variables
- Look at Variance Inflation Factors (VIF)

Remedies:

- Remove one of the variables

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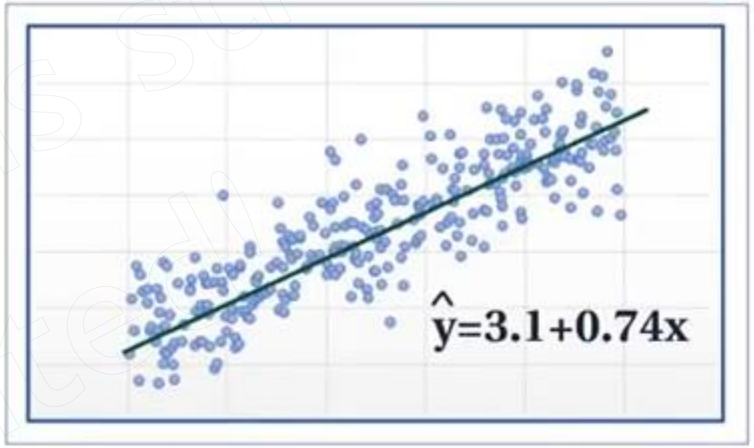
$$Y = \beta_0 + \beta_1 X + \varepsilon$$



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Regression Assumptions

Exogeneity
(no omitted variable bias)

Consider the following model:

$$Salary_i = \beta_0 + \beta_1(Years\ of\ education)_i + \varepsilon_i$$

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Socio-economic status affects **both** X and Y variables, thus would cause **omitted variable bias.**

TECHNICALLY - Socio-economic status would affect ε_i in the model, thus, Education is no longer wholly exogenous as it can be explained in part by the error term.

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Omitted variables contributes in error. If omitted variable is correlated with any independent variable, error becomes correlated with that variable. Error should not be correlated with the independent variable.

Consider the following model:

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Socio-economic status affects **both** X and Y variables, thus would cause **omitted variable bias.**

TECHNICALLY - Socio-economic status would affect $\boldsymbol{\varepsilon_i}$ in the model, thus, Education is no longer wholly exogenous as it can be explained in part by the error term.

What's the issue?

- Model can only be used for predictive purposes (can not infer causation)

Detection:

- Intuition
- Checking correlations

Remedy:

- Using instrumental variables

THANK YOU!