

# Example

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Growth of Hudson River striped bass; years 1965–1976.

$y_t$  = incremental growth rate in year t

$x_{1t}$  = population density in year t

$x_{2t}$  = rise in temperature in year t

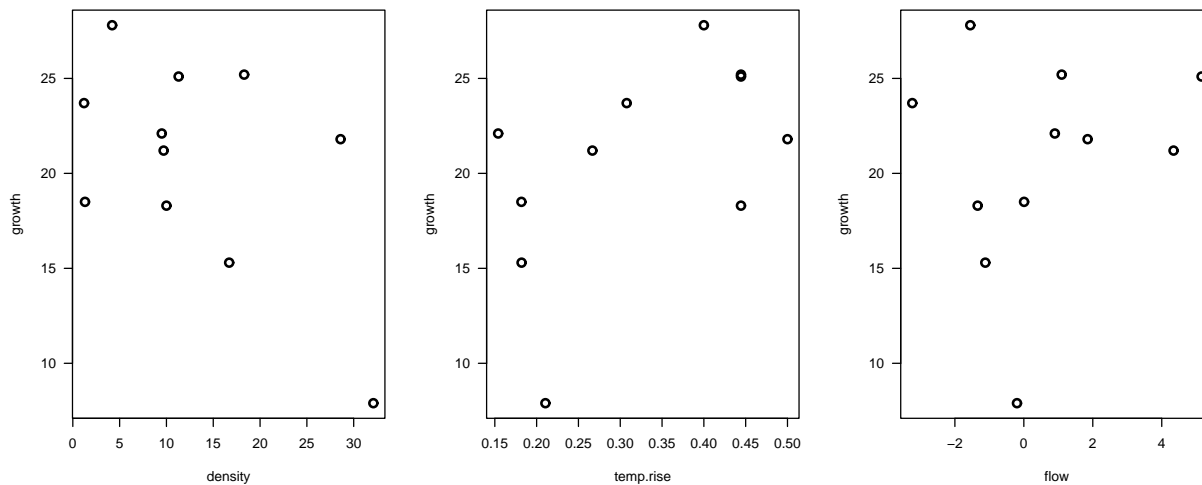
$x_{3t}$  = a measure of river flow in year t

Fit the model

$$y_t = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \beta_3 x_{3t} + \epsilon_t \quad \text{where } \epsilon_t \sim \text{iid Normal}(0, \sigma^2)$$

Plot y vs each x

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# Results

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	Est	SE	t-value	P value
Intercept	17.00	3.22	5.3	0.001
density	-0.37	0.11	-3.2	0.015
temp.rise	25.36	9.01	2.8	0.026
flow	0.45	0.47	1.0	0.362

# Diagnostics

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## Assumptions

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$\epsilon$ 's independent  
 $\epsilon$ 's normally distributed  
 $\epsilon$ 's have constant SD  
 $y$ 's linear in each of the  $x$ 's  
No other  $x$ 's belong in the model

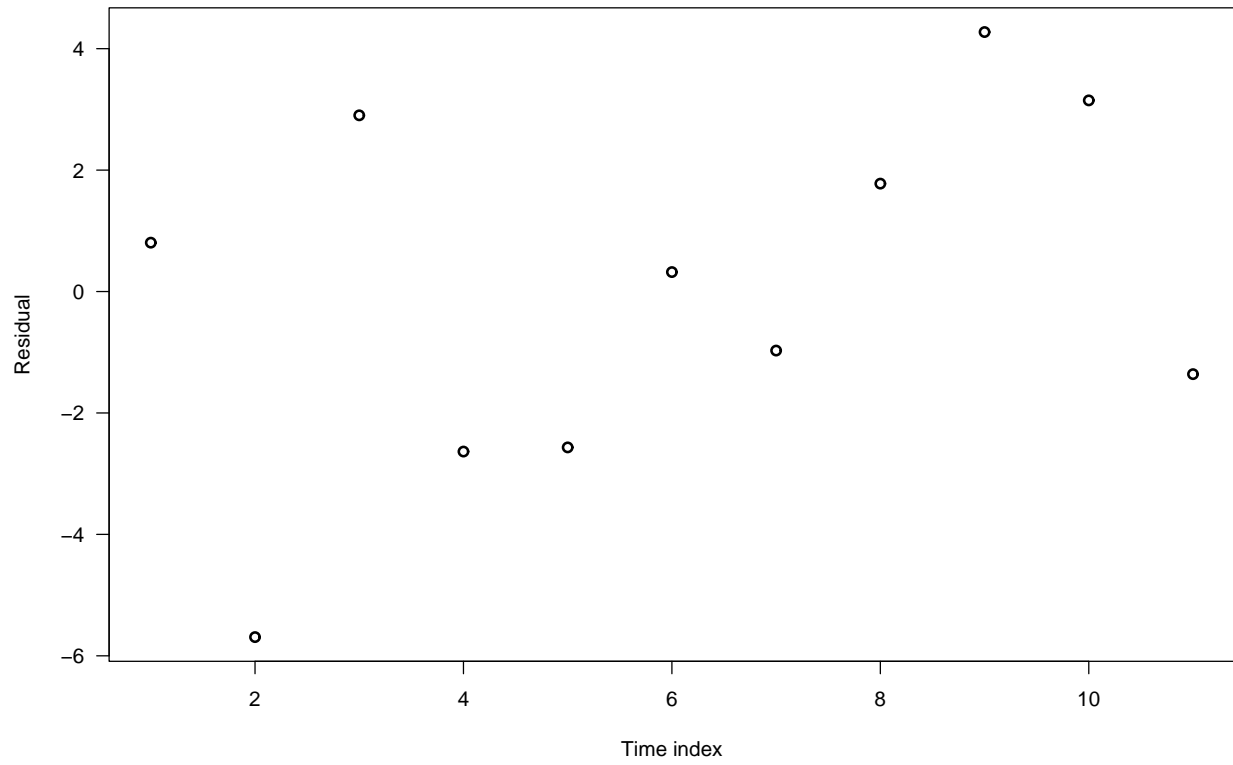
## Diagnostics

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Plot residuals vs time  
QQ plot of residuals  
Plot residuals vs fitted values  
Plot residuals vs each  $x$   
Plot residuals vs other  $x$ 's

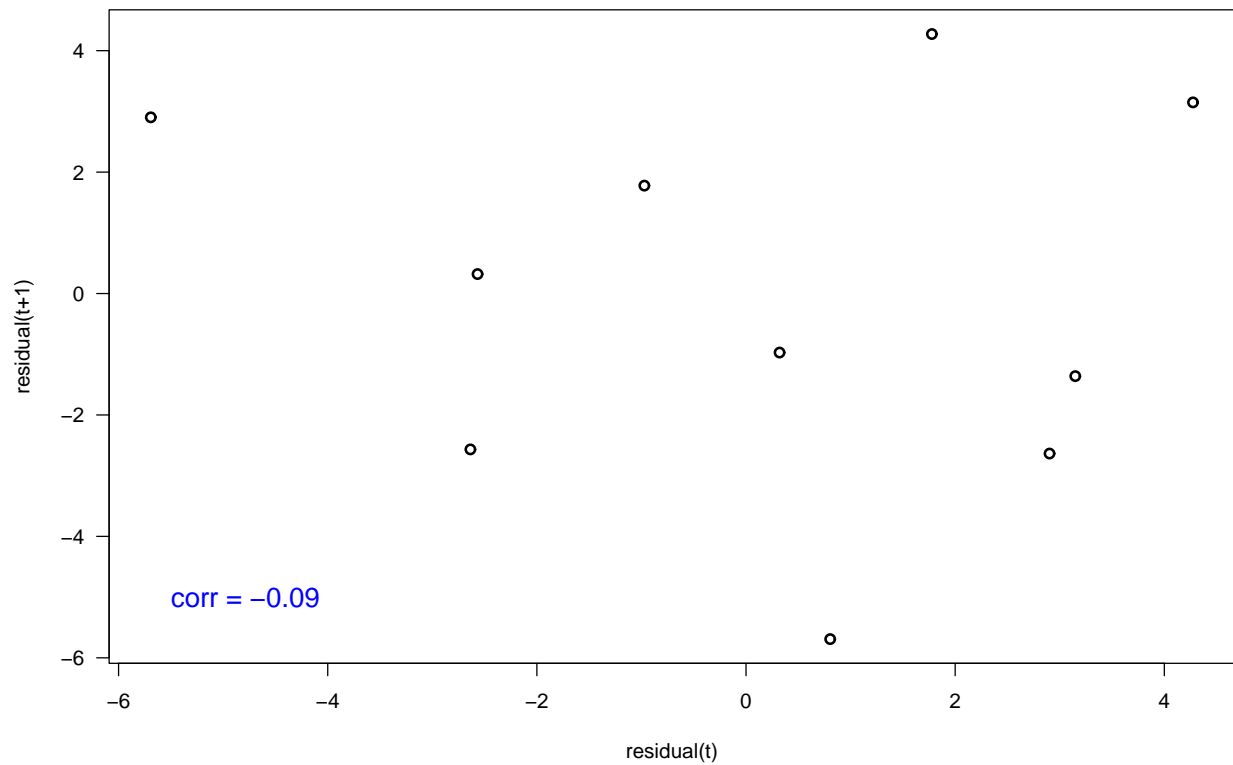
# residuals vs time

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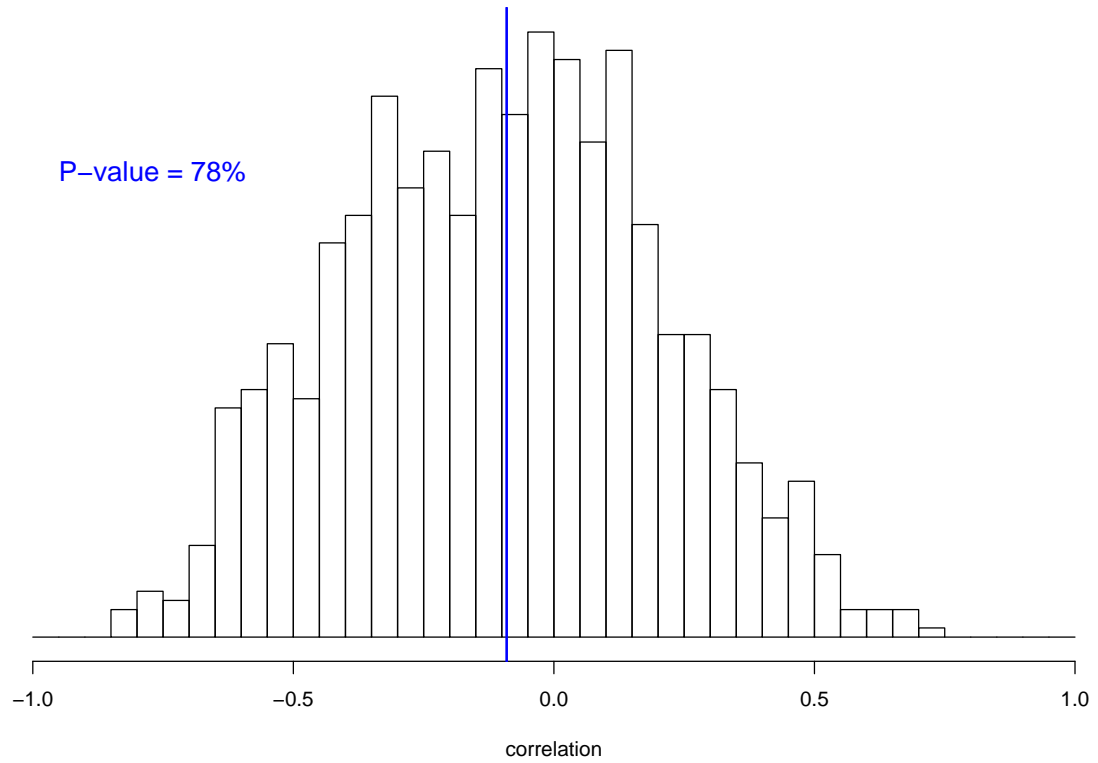
# residual(t) vs residual(t+1)

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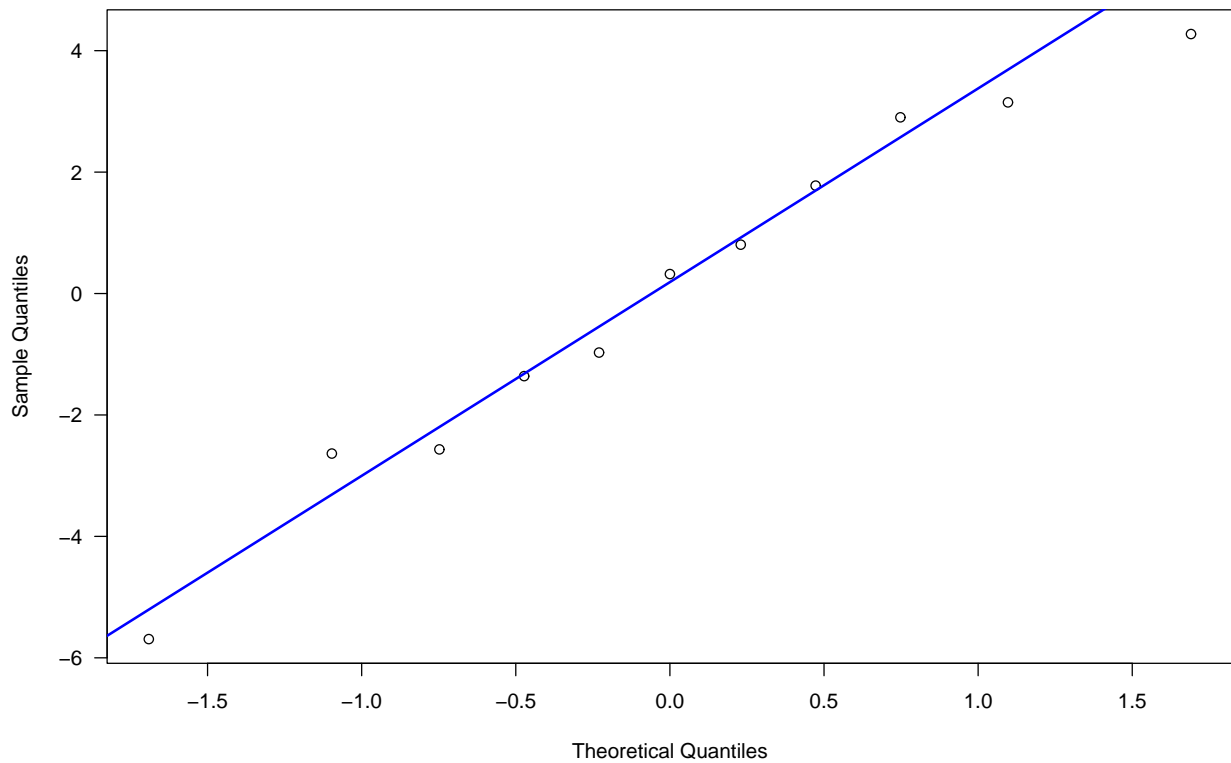
# Permutation test

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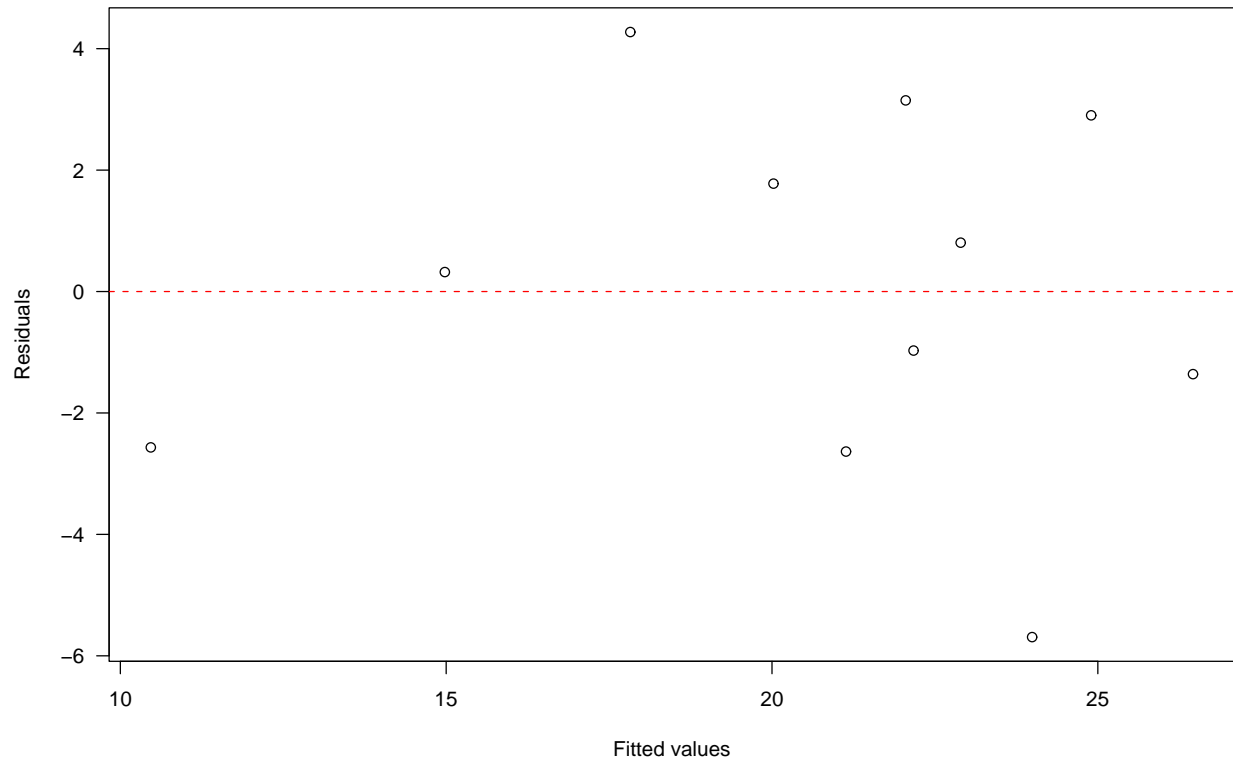


# QQ plot of residuals

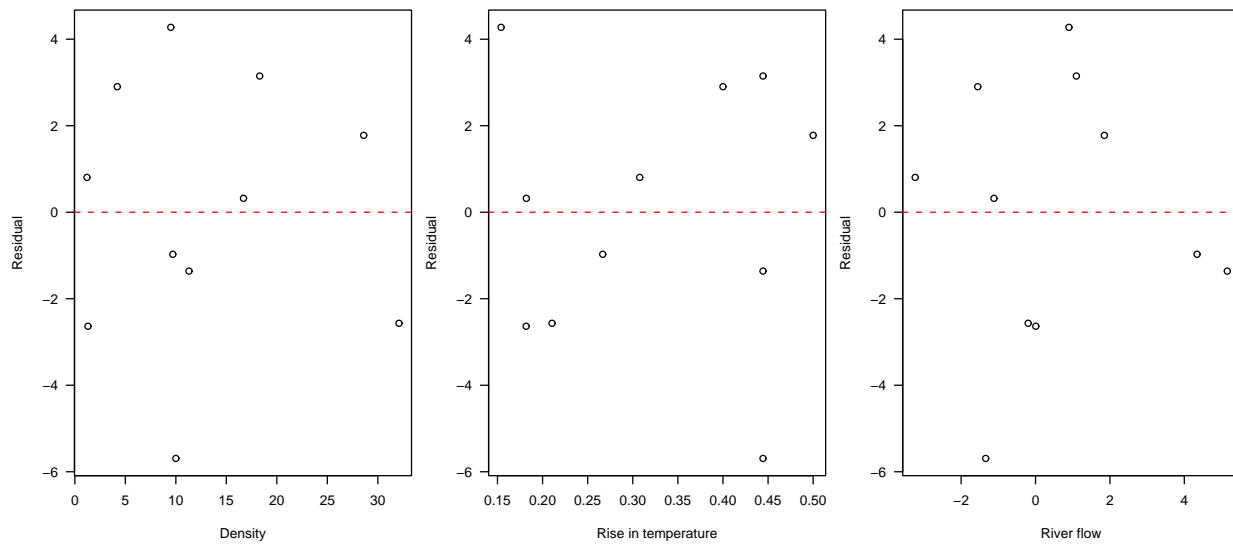
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# Residuals vs fitted values

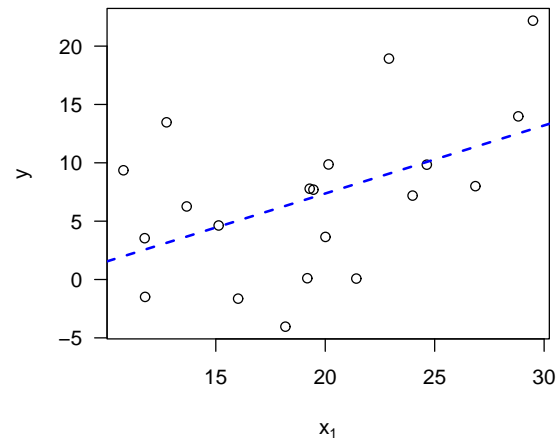


# Residuals vs x's



# A fake example

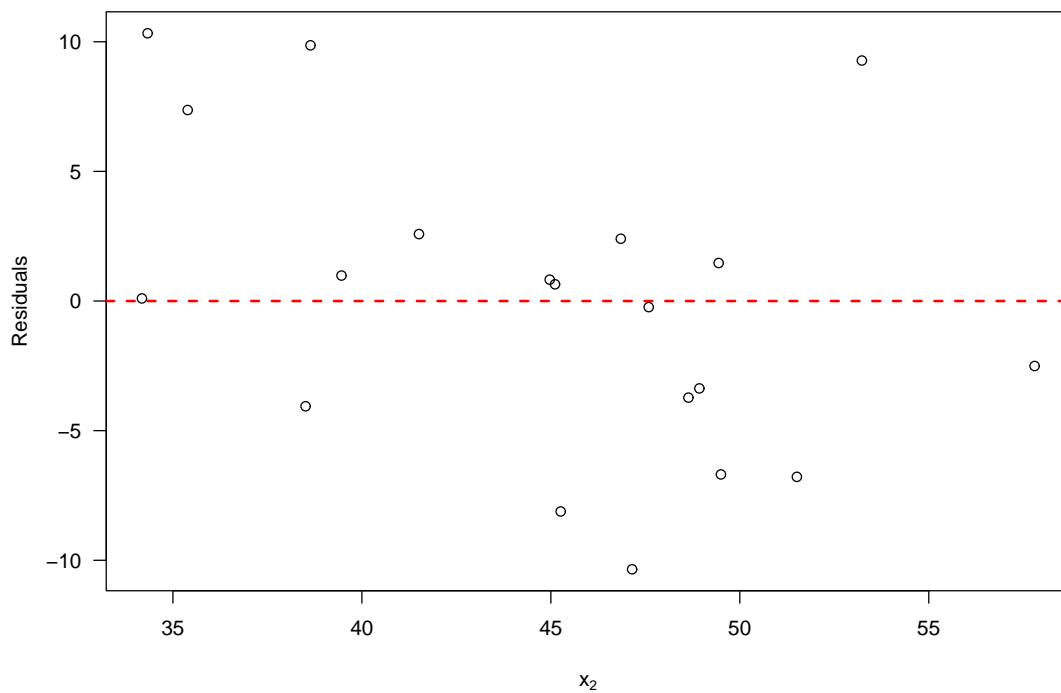
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	Est	SE	t-val	P-val
Intercept	-4.29	4.97	-0.86	0.40
$x_1$	0.58	0.25	2.36	0.03

# Residuals vs another x

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## Regress y on both x's

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	Est	SE	t-val	P-val
Intercept	18.02	8.50	2.12	0.0491
x1	1.21	0.29	4.13	0.0007
x2	-0.77	0.26	-3.00	0.0080

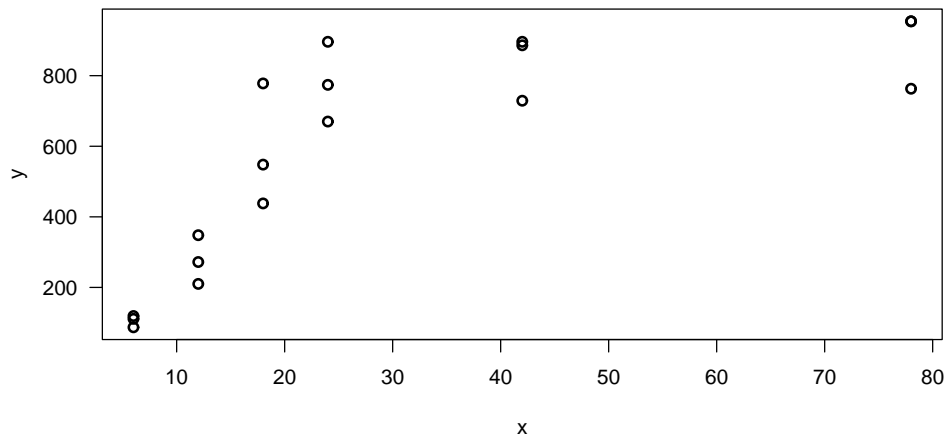
## One last example

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Sediment ingestion by the mud snail, *Hyrobia minuta*.

y = Amount ingested

x = Time allowed to eat

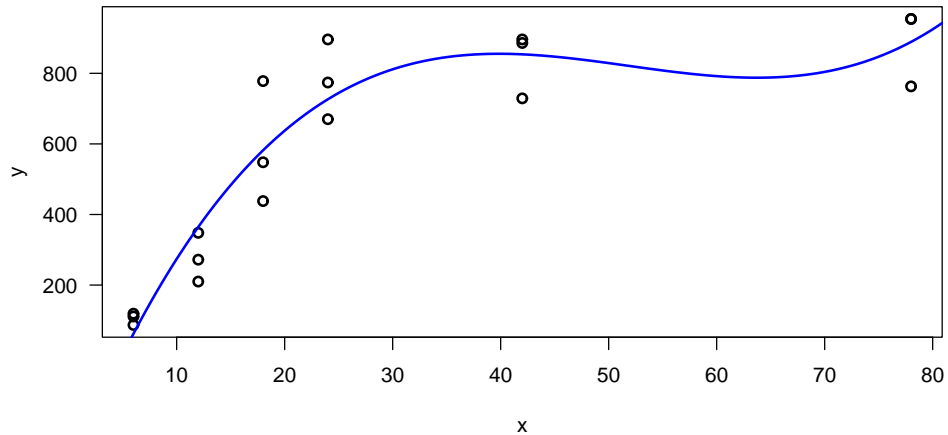


# A model

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Let's consider the model

$$y_i = \beta_0 + \beta_1 x_i + \beta_2 x_i^2 + \beta_3 x_i^3 + \epsilon_i \quad \text{where } \epsilon_t \sim \text{iid Normal}(0, \sigma^2)$$



## Estimated coefficients

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	Est	SE	t-val	P-val
Intercept	-339	127	-2.66	0.019
time	75.7	15.4	4.91	<0.001
time <sup>2</sup>	-1.55	0.48	-3.22	0.006
time <sup>3</sup>	0.010	0.004	2.52	0.024

# Diagnostic plots

