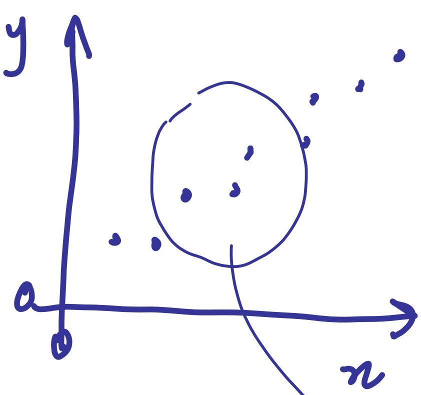
# LINEAR REGRESSION ANALYSIS w/ least squares method

| x | y |
|---|---|
| $x_1$ | $y_1$ |
| $x_2$ | $y_2$ |
| ⋮ | ⋮ |
| $x_i$ | $y_i$ |
| ⋮ | ⋮ |
| $x_n$ | $y_n$ |

$\bar{x}, \bar{y}$

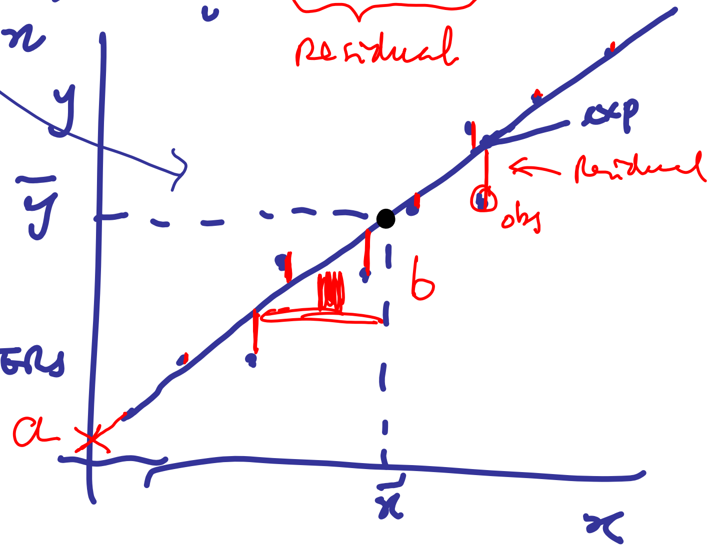
an pair of values




$$\boxed{y = a + b \cdot x}$$

intercept slope

$$\sum_i \underbrace{(obs_i - exp_i)}_{\text{residual}}^2 = \text{MIN}$$




ESTIMATION OF PARAMETERS by linear regression (of y against x) by the least squares method

$$b = \frac{s_{xy}}{s_{xx}} = \frac{\sum_i f_i (x_i - \bar{x})(y_i - \bar{y})}{\sum_i f_i (x_i - \bar{x})^2}$$

$$n = \sum_i f_i$$

$$a = \bar{y} - b\bar{x}$$

$$y = a + bx$$

$$\bar{y} = a + b\bar{x}$$

$$r^2 = \frac{(s_{xy})^2}{s_{xx} \times s_{yy}}$$

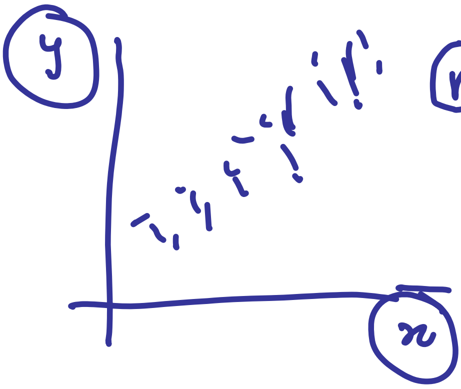
$s_{yy} = \sum_i f_i (y_i - \bar{y})^2$

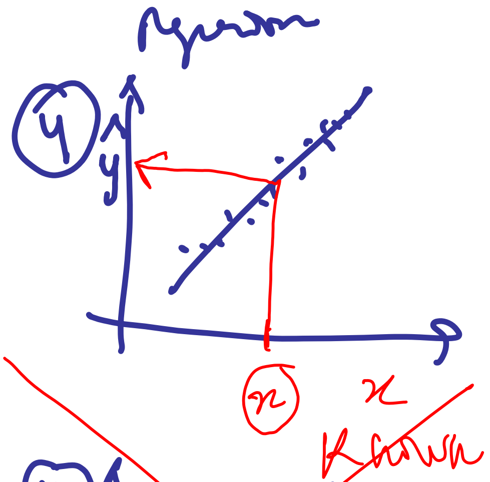
[coefficient of determination]

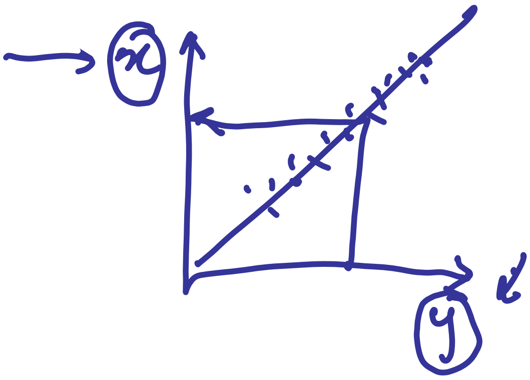
$$0 \le r^2 \le 1$$

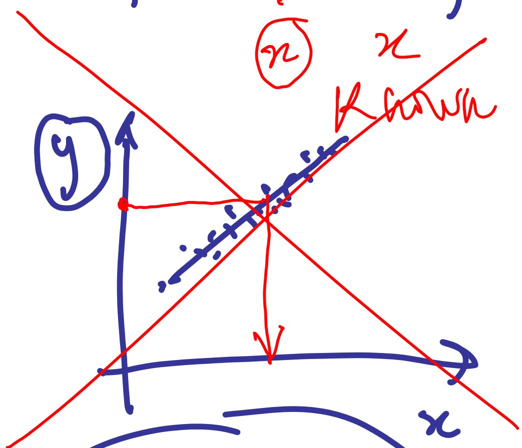
$r^2$ (Regression) = % of variation in yy data explained by the linear model (regression line)

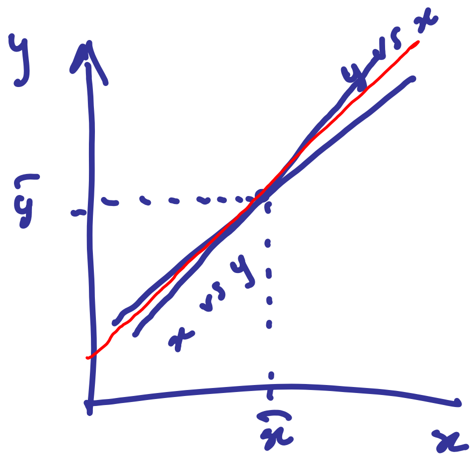
Note: r is the correlation coefficient




Geometric regression analysis?

Space & Variance

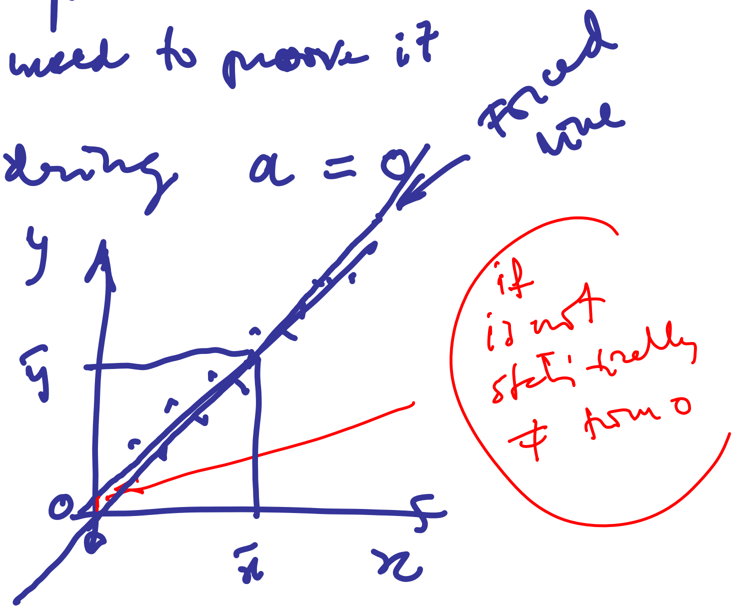
FORCED REGRESSION / THROUGH THE ORIGIN

when $\underline{\underline{a}}$ is not $\underline{\text{statistically}}$ $\neq$ from 0

$\Rightarrow$ you need to prove it

recalculate $\underline{b}$ considering $a = 0$

$$b' = \frac{\sum_i f_i x_i \cdot y_i}{\sum_i f_i x_i^2}$$




$$a = \bar{y} - b' \times \bar{x}$$

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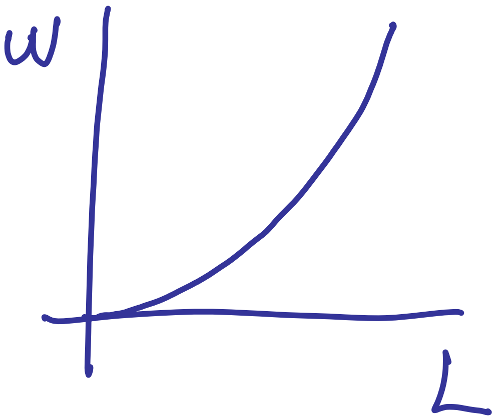
# Length-weight relationship




$$W = q \times L^{b}$$

PARAMETER

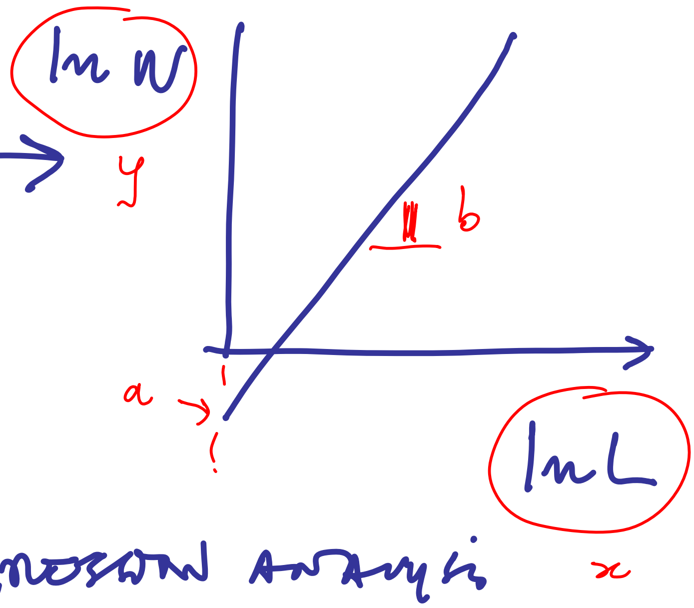
- $q$ : allometric condition factor
- $b$ : allometric coefficient

## PARAMETER ESTIMATION

$$W = q \times L^{b}$$

$$\ln W = \ln q + b \ln L$$

$$y = a + b \times x$$


→ By linear regression analysis (least squares method) → estimate $a$ and $b$

with a and b

$$q = e^{a}$$

ln or log

$$q = e^{a} \qquad q = 10^{a}$$

with $q$, $b$

for each $x \longrightarrow \hat{y}$ $\quad \hat{w} = q \times L^{b}$