Fenômenos Mecânicos Laboratório: Fórmulas

Medidas múltiplas da mesma grandeza

Valor médio dos valores x_1 a x_N: $\bar{x} = \frac{1}{N}\Sigma_{i=1}^{N} x_i$
Desvio padrão da média: $\sigma_{\bar{x}} = \sqrt{\frac{1}{N(N-1)}\Sigma_{i=1}^{N}(x_i - \bar{x})^2}$

Propagação de erros

Caso geral ($F = F(x_1, x_2, x_3, ...)$): $\sigma_F = \sqrt{\left(\frac{\partial F}{\partial x_1}\right)^2 (\sigma_{x_1})^2 + \left(\frac{\partial F}{\partial x_2}\right)^2 (\sigma_{x_2})^2 + ...}$

Casos específicos ($w = w(x, y, ...)$):
$w = x \pm y$: $\sigma_w^2 = \sigma_x^2 + \sigma_y^2$
$w = axy$: $\left(\frac{\sigma_w}{w}\right)^2 = \left(\frac{\sigma_x}{x}\right)^2 + \left(\frac{\sigma_y}{y}\right)^2$
$w = a(y/x)$: $\left(\frac{\sigma_w}{w}\right)^2 = \left(\frac{\sigma_x}{x}\right)^2 + \left(\frac{\sigma_y}{y}\right)^2$
$w = x^m$: $|\frac{\sigma_w}{w}| = |m\frac{\sigma_x}{x}|$
$w = ax$: $|\frac{\sigma_w}{w}| = |\frac{\sigma_x}{x}|$ ou $\sigma_w = |a|\sigma_x$
$w = ax + b$: $|\frac{\sigma_w}{w}| = |\frac{\sigma_x}{x}|$ ou $\sigma_w = |a|\sigma_x$
$w = ax^p y^q$: $\left(\frac{\sigma_w}{w}\right)^2 = \left(p\frac{\sigma_x}{x}\right)^2 + \left(q\frac{\sigma_y}{y}\right)^2$
$w = a\ \mathrm{sen}(bx)$: $\sigma_w = |ab\ \cos(bx)|\sigma_x$ $\quad$ $b\sigma_x$ em radianos

Reta de melhor ajuste

Valores medidos de X: x_i, de Y: y_i, erros experimentais de y_i: σ_i
Coeficientes angular e linear da reta de melhor ajuste: a e b

Residual ("chi-quadrado"): $\chi^2(a, b) = \Sigma_i \left[\frac{y_i - (ax_i + b)}{\sigma_i}\right]^2$

Método de Mínimos Quadrados (MMQ)

$\langle\sigma^2\rangle := \Sigma_i \frac{1}{\sigma_i^2}$; $\langle x\rangle := \frac{1}{\langle\sigma^2\rangle}\Sigma_i \frac{x_i}{\sigma_i^2}$; $\langle x^2\rangle := \frac{1}{\langle\sigma^2\rangle}\Sigma_i \frac{x_i^2}{\sigma_i^2}$;
$\langle y\rangle := \frac{1}{\langle\sigma^2\rangle}\Sigma_i \frac{y_i}{\sigma_i^2}$; $\langle xy\rangle := \frac{1}{\langle\sigma^2\rangle}\Sigma_i \frac{x_i y_i}{\sigma_i^2}$
$a = \frac{\langle x\rangle\langle y\rangle - \langle xy\rangle}{\langle x\rangle^2 - \langle x^2\rangle}$
$b = \langle y\rangle - a\langle x\rangle$
$\Delta a = \sqrt{\frac{1/\langle\sigma^2\rangle}{\langle x^2\rangle - \langle x\rangle^2}}$
$\Delta b = \sqrt{\frac{\langle x^2\rangle/\langle\sigma^2\rangle}{\langle x^2\rangle - \langle x\rangle^2}}$