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Steinhart–Hart Equation

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1. The Steinhart–Hart equation is a model of the resistance of a thermistor at different temperatures. The equation is given by

$$\frac{1}{\tau} = w_1 + w_2 \ln(R) + w_3[\ln(R)]^3 \tag{0.1}$$

Let

$$\mathbf{x}_1 = \begin{pmatrix} 1 \\ \ln(R_1) \\ [\ln(R_1)]^3 \end{pmatrix} \tag{0.2}$$

$$y_1 = \frac{1}{\tau_1} \tag{0.3}$$

$$\mathbf{w} = \begin{pmatrix} w_1 \\ w_2 \\ w_3 \end{pmatrix} \tag{0.4}$$

Show that

$$y_1 = \mathbf{x}_1^T \mathbf{w} \tag{0.5}$$

2. Suppose for $n > 3$

$$\mathbf{y} = \begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{pmatrix}, \mathbf{X}^T = \begin{pmatrix} \mathbf{x}_1 & \mathbf{x}_2 & \vdots & \mathbf{x}_n \end{pmatrix}, \tag{0.6}$$

show that

$$\mathbf{y} = \mathbf{X}\mathbf{w} \tag{0.7}$$

3. For $\tau = 10^{\circ}C - 100^{\circ}C$, use the PT-100 resistance table in

https://github.com/gadepall/EE1390/raw/master/refs/5pt100sensoren_e.pdf?raw=true

to estimate $\mathbf{w}$ using the relation

$$\hat{\mathbf{w}} = \left(\mathbf{X}^T\mathbf{X}\right)^{-1}\mathbf{X}^T\mathbf{y} \tag{0.8}$$

4. Verify your result by finding the temperature when the resistance is 175.86Ω.

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