Least Squares or Least Circles?
Online Supplement:

Partial derivative with respect to the parameter a equal zero is

$$\frac{\partial E_{\perp}^2}{\partial a} = \frac{-2}{(1+b^2)}\sum_{i=1}^{n}(y_i - (a + bx_i)) = 0$$

which implies

$$\sum_{i=1}^{n}(y_i - (a + bx_i)) = 0$$

$$\sum_{i=1}^{n} y_i = na + b\sum_{i=1}^{n} x_i,$$

where

$$\bar{y} = a + b\bar{x} \quad \text{and} \quad a = \bar{y} - b\bar{x}$$

Partial derivative with respect to the parameter b equal zero is

$$\begin{aligned} \frac{\partial E_{\perp}^2}{\partial b} &= \frac{(1+b^2)[-2\sum_{i=1}^{n}(y_i - (a+bx_i)) - 2b\sum_{i=1}^{n}(y_i - (a+bx_i))]^2}{(1+b^2)^2} \\ &= \frac{-2b\sum_{i=1}^{n}(y_i - (a+bx_i))^2}{(1+b^2)} = 0 \end{aligned}$$

Since

$$\sum_{i=1}^{n}(y_i - (a + bx_i)) = 0$$

so

$$\begin{aligned} 0 = \sum_{i=1}^{n}(y_i - (a+bx_i))^2 &= \sum_{i=1}^{n}(y_i - (\bar{y} - b\bar{x} + bx_i))^2 \\ &= \sum_{i=1}^{n}[(y_i - \bar{y}) - b(x_i - \bar{x})]^2 \end{aligned}$$

Quadratic equation of b is:

$$b^2 S_{xx} - 2bS_xS_y + S_{yy} = 0$$

where

$$b_{1,2} = \frac{-S_xS_y \pm \sqrt{(S_xS_y)^2 - 4S_xS_y}}{S_{xx}^2}$$