

Least squares

Least squares is an optimization paradigm for matching data ('fitting') with a parametrised model equation. A famous example is the linear regression used for finding the linear equation that best matches a given set of data points.

The least squares measure for the goodness-of-fit is
$$\chi^2_{\text{red}} = \frac{1}{N-n_p} \sum_{i=1}^N \frac{\left(D(\text{model parameters}, t_i) - D_i^{\text{exp}} \right)^2}{w_i}$$

$D_i^{\text{exp}}|t_i$ is the i -th data point of an experimental data set consisting of N data points, $D(\text{model parameters}, t_i)$ is the model equation at the observed points t_i and n_p is the number of freely varying model parameters.

w_i is some weighting factor describing the experimental uncertainty of each individual data point. For TCSPC data w_i is defined as

$$w_i = \sqrt{D_i^{\text{exp}}}$$

Least squares is a maximum likelihood estimator if the following preconditions are met:

- All data points D_i^{exp} are independent observations.
- The number of data points is sufficient (i.e. the model parameters are overdetermined).
- The experimental noise follows a [Gaussian distribution](#).
- There are no systematic errors, resp. the model describes the data correctly.
- The experimental noise along the time axis is negligible.

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