

Computational Modelling for Biomedical Imaging - Coursework 1

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Q1.1.1

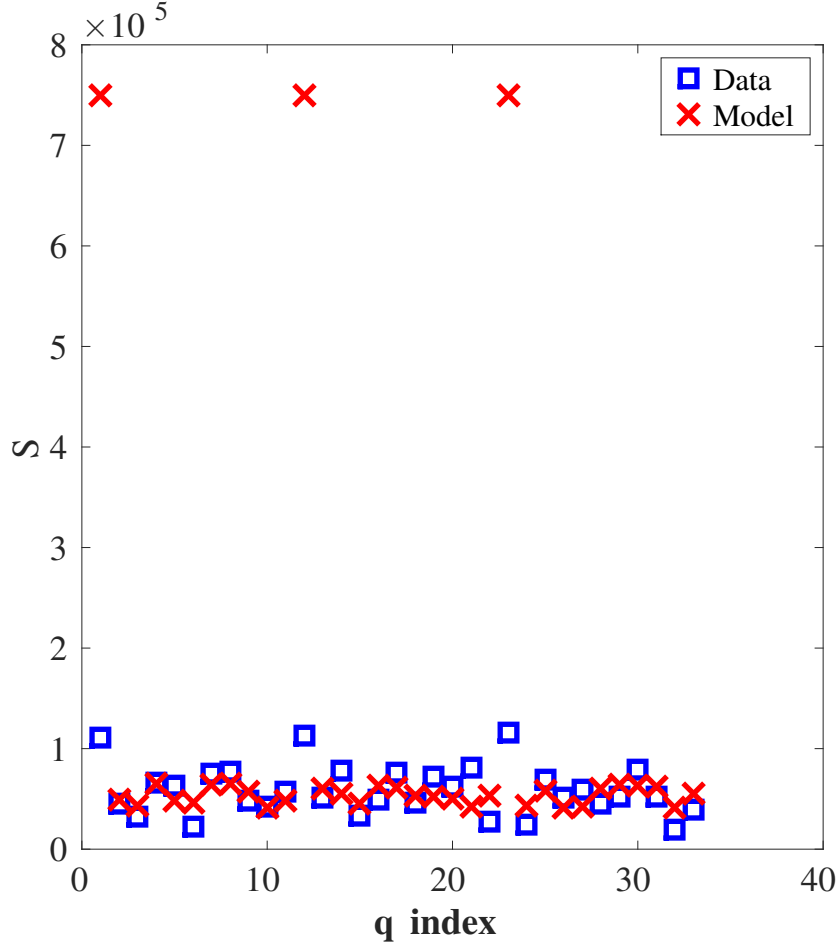


Figure 1: Data points for the voxel at position (52, 62, 25)

From eyeballing the data we notice that the fit is very poor, especially for the 3 entries where the b-value is 0, having a $\Delta S > 7 * 10^5$. The other entries don't fit the data well either.

The final value of RESNORM (1.2242e+12) is clearly above the kind of value we would normally expect. The fit is poor probably because the search strategy got stuck in a local minima.

The expected value of RESNORM would be given by the formula:

$$E \left[\sum_{i=1}^{33} (X_i - \bar{X}_i)^2 \right] = E \left[\sum_{i=1}^{33} \sigma_i^2 \right] = 33 * \sigma^2$$

Since sigma is between 5000-6000 this means that $8.25 * 10^8 < RESNORM < 1.188 * 10^9$.

Some of the parameter values we obtain are not sensible. For example, the value of f is negative, meaning that we give too much weight to the S_E component of the model, extrapolating outside the intended (0, 1) range. The value of S_0 is also really high, when in fact it should be around $1.1 * 10^5$.

Q1.1.2

We did the following transformations to ensure the parameters stayed within the required bounds:

- $S0 \rightarrow S0^2$
- $d \rightarrow d^2$
- $f \rightarrow \text{atan}(f)$

We apply the inverse transformation at the beginning in order to maintain the starting point. This time the algorithm converges to the following parameters: $S0 = 113204, d = 21521, f = -1.51, \theta = -12.89, \phi = -47.31$ with a RESNORM of $9.48\text{e}+10$. There is an 11-fold improvement from the unconstrained version and by eyeballing the data we find that the value for $S0$ is what we expected. However, the d parameter is too large while f is really close to zero, suggesting that the whole brain is mostly made of balls, with almost no sticks. The improvement in the SSD value is because of the fact that parameters were constrained to physically realistic bounds. However, the expected RESNORM (around 10^9) is still much lower than our current value, suggesting that the algorithm again got stuck in a local minima.

Q1.1.3