

# Early Comparisons

*David Gerard*

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## Abstract

I perform early comparisons of cp-rank 1 FLASH against cp-rank 1 least squares and a cp-rank 1 Bayesian approach from Hoff (2011). T-FLASH performs the best.

## Data Generation and Simulation Study

$$\mathcal{Y}_{p_1 \times p_2 \times p_3} = \mathcal{X}_{p_1 \times p_2 \times p_3} + \mathcal{E}_{p_1 \times p_2 \times p_3} \quad (1)$$

$$\mathcal{X} = \mathbf{u}_1 \circ \mathbf{u}_2 \circ \mathbf{u}_3 \quad (2)$$

$$p(u_{ij}) = \pi_1 N(u_{ij}|0, \tau_1^2) + \pi_2 N(u_{ij}|0, \tau_2^2) + \pi_3 N(u_{ij}|0, \tau_3^2) \quad (3)$$

$$e_{ijk} \sim N(0, \sigma^2). \quad (4)$$

In this simulation study,

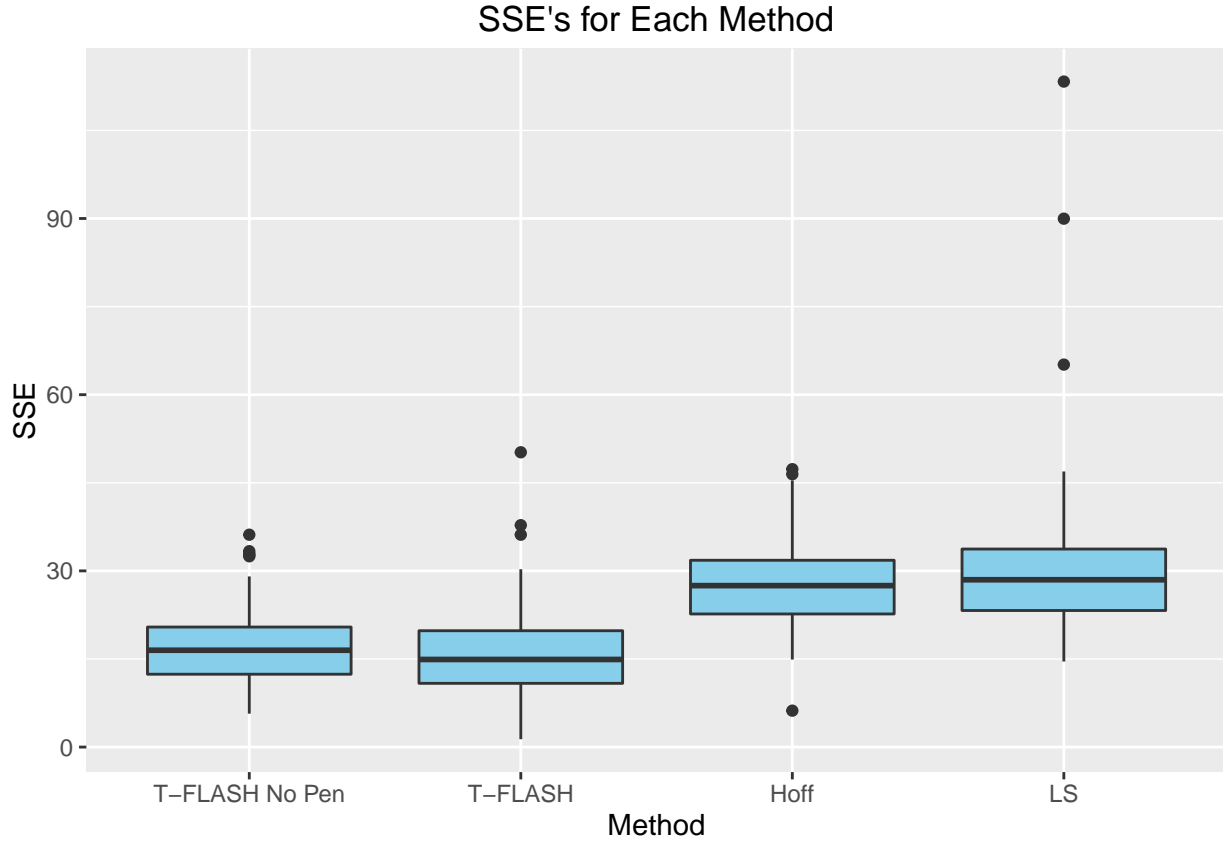
- $p_1 = p_2 = p_3 = 10$ ,
- $\sigma = 1$ ,
- $\tau_1 = 0, \tau_2 = 1, \tau_3 = 5$ ,
- $\pi_1 = 0.5, \pi_2 = 0.3, \pi_3 = 0.2$ .

I ran through 100 iterations of data generation and fitting four competing methods, generating a new mean  $\mathcal{X}$  at each iteration. The four methods were

- T-FLASH with `nullweight = 1`,
- T-FLASH with `nullweight = 10`,
- The least squares cp-rank 1 tensor, calculated using the `rTensor` package, and
- A hierarchical Bayesian cp-rank 1 tensor mean model as implemented in Hoff (2011).

At each iteration, I calculated the sum of squared errors for each method. A boxplot of these are below. T-FLASH performed the best.

For T-FLASH, I also calculated two-way tables at each iteration for whether or not a component was zero vs the indicator that the posterior probability that the component was zero was greater than 1/2. The mean of these two-way tables over the 100 iterations is in Table 1 for `nullweight = 10` and Table 2 for `nullweight = 1`. T-FLASH with `nullweight = 10` works really well. When `nullweight = 1`, T-FLASH tends to underestimate the number of zeros.



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	Not Zero	Zero
p < 0.5	0.45	0.00
p > 0.5	0.04	0.50

Table 1: Two way table for posterior-probability of being zero greater than 0.5 vs the truth being zero. nullweight was set to 10.

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	Not Zero	Zero
p < 0.5	0.48	0.16
p > 0.5	0.02	0.34

Table 2: Two way table for posterior-probability of being zero greater than 0.5 vs the truth being zero. nullweight was set to 1.

## References

Hoff, Peter D. 2011. “Hierarchical Multilinear Models for Multiway Data.” *Computational Statistics & Data Analysis* 55 (1). Elsevier: 530–43.