

October 7, 2024

Series 6: Plackett-Burman & Full factorial designs

1. Sensitivity of a Plackett-Burman design

To analyse the sensitivity of a Plackett-Burman design, the measurement of a linear system with first-order interactions is simulated and the impact of interactions and uncertainties on the main effects is observed. Proceed then the following way:

- a) Create a Matlab function $Y = \text{measurement}(E, s [, \text{alpha}])$ simulating a series of experiments whose *true* model is

$$y = a_o + \sum_{i=1}^5 a_i x_i + \sum_{i \leq j}^5 a_{ik} x_j x_i \quad (1)$$

and whose experimental uncertainty is modeled by the distribution $N(\mu = 0, \sigma^2)$. The parameters of this function must be the matrix of essays E and the standard error σ . The coefficients alpha of the true model can be given as parameters of the function or given by default within the function (use the logical variable *nargin* to test if you need to use the default values).

- b) In the main part of the script :
- prepare a Plackett-Burman design,
 - simulate the essays with the routine *measurement*,
 - analyze the results to determine the effets (*fitlm()*).
- c) Perform the analysis for a *true* model without interaction with important (10%), medium (5%) and small effects (1%) varying the uncertainty of the measurement between 1% and 10%. Observe the evolution of the estimated coefficients, of the confidence intervals and of the p-values of the ANOVA.
- d) Perform the analysis for a *true* model whose level of interaction varies and with the measurement uncertainty varying between 1% and 10%. Observe the evolution of the estimated coefficients and confront these results with the matrix of alias between the main effects and the interactions.
- e) Finally perform a *full foldover* to get rid of the influence of the interactions.

2 Analysis of a full factorial design

Table 1 presents the data of a full factorial design 2^4 with the results obtained for each experiment with four factors.

1. Determine the significant half-effects using a *normal plot* or a *half-normal plot*
2. Perform an analysis of the variance
3. Prepare conclusions based on these experimental evidences

Table 1: Data from a set of experiments following a design 2^4 on a process with four4 factors (standardized)

Run	x_1	x_2	x_3	x_4	Y
1	-1	-1	-1	-1	19.67
2	-1	-1	-1	1	-3.12
3	-1	-1	1	-1	23.55
4	-1	-1	1	1	2.46
5	-1	1	-1	-1	47.18
6	-1	1	-1	1	36.7
7	-1	1	1	-1	61.23
8	-1	1	1	1	19.25
9	1	-1	-1	-1	-18.59
10	1	-1	-1	1	40.72
11	1	-1	1	-1	-29.31
12	1	-1	1	1	42.6
13	1	1	-1	-1	-29.61
14	1	1	-1	1	-1.45
15	1	1	1	-1	-26.47
16	1	1	1	1	4.92