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Experimental Design and Data Analysis: Methods for the Response Optimization and Applications Using R

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Abstract

Experimental Design is used by an increasing number of researchers to explore relationships between factors of interest. The factor levels are changed systematically according to the design, in order to evaluate their effects on the process. The aim is to reach a maximum amount of information with minimum cost in a minimal amount of time. This work presents a general review on Experimental Design techniques and a discussion of methods for the response optimization, followed by some applications to real data.

In Response Surface Methodology (RSM), a significant number of studies relates to a single response system or to responses analyzed one-by-one. However, for most of applications it is necessary and useful considering all responses simultaneously, since it is common to find optimization problems with several conflicting responses. The methodologies to multiple responses problems optimization, associated with the RSM, boil down to an informal overlap of contour maps of different responses to select the optimal solution. In most recent research, associated with the increasing computer capabilities, mathematical programming techniques were developed, including heuristic search methods, which allow locating the combinations of variables that lead to the best compromise between the different specifications of multivariate responses. The desirability function is a useful approach to simultaneous optimization of multiple responses.

Considering the experimental designs developed by Lima (2010) in forestry production and by Mondim (2014) in ceramic industry, we will use R to illustrate the role of RSM and of the methodology of genetic algorithms on the optimization of a problem. RSM will be used to optimizing one-response-at-a-time. The desirability function and the genetic algorithm will be used to optimizing one-response-at-a-time and all response simultaneously. Results will be compared and discussed.

Keywords: experimental design, response surface methodology, genetic algorithms, desirability, multiple response.

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