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A multi-objective coordinate-exchange two-phase local search algorithm for multi-stratum experiments. (English) [Zbl 06697668](#)

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Summary: A multi-stratum design is a useful tool for industrial experimentation, where factors that have levels which are harder to set than others, due to time or cost constraints, are frequently included. The number of different levels of hardness to set defines the number of strata that should be used. The simplest case is the split-plot design, which includes two strata and two sets of factors defined by their level of hardness-to-set. In this paper, we propose a novel computational algorithm which can be used to construct optimal multi-stratum designs for any number of strata and up to six optimality criteria simultaneously. Our algorithm allows the study of the entire Pareto front of the optimization problem and the selection of the designs representing the desired trade-off between the competing objectives. We apply our algorithm to several real case scenarios and we show that the efficiencies of the designs obtained present experimenters with several good options according to their objectives.

MSC:

62 Statistics

Keywords:

multi-objective optimization; Pareto-optimality; multi-stratum design

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References:

- [1] Das, I., Dennis, J.E.: A closer look at drawbacks of minimizing weighted sums of objectives for Pareto set generation in multicriteria optimization. *Struct. Optim. \textbf{14}*(1), 63-69 (1997) · [Zbl 1349.90751](#)
- [2] Dubois-Lacoste, J; López-Ibáñez, M; Stützle, T, Improving the anytime behavior of two-phase local search, *Ann. Math. Artif. Intell.*, 61, 125-154, (2011) · [Zbl 1234.68362](#)
- [3] Escouto, L.F.S.: Use of fermented cassava starch in the development of a formulation for bread without gluten. In *20th International Symposium of the Society for Tropical Root Crops, ISTRC 2000, Japan, 2000*
- [4] Ferryanto, L; Tollefson, N, A split-split-plot design of experiments for foil lidding of contact Lens packages, *Qual. Eng.*, 22, 317-327, (2010)
- [5] Gilmour, S; Trinca, LA, Optimum design of experiments for statistical inference, *J. R. Stat. Soc. Ser. C*, 61, 345-401, (2012)
- [6] Gilmour, SG; Trinca, LA, Some practical advice on polynomial regression analysis from blocked response surface designs, *Commun. Stat.*, 29, 2157-2180, (2000) · [Zbl 1061.62550](#)
- [7] Goos, P.: *The Optimal Design of Blocked and Split-plot Experiments*. Springer, New York (2002) · [Zbl 1008.62068](#)
- [8] Goos, P, Optimal versus orthogonal and equivalent-estimation design of blocked and split-plot experiments, *Stat. Neerl.*, 60, 361-378, (2006) · [Zbl 1108.62073](#)
- [9] Goos, P; Donev, AN, The D-optimal design of blocked experiments with mixture components, *J. Qual. Technol.*, 38, 319-332, (2006)
- [10] Goos, P; Vandebroek, M, Optimal split-plot designs, *J. Qual. Technol.*, 33, 436-450, (2001) · [Zbl 1079.62532](#)
- [11] Goos, P; Vandebroek, M, D-optimal split-plot designs with given numbers and sizes of whole plots, *Technometrics*, 45, 235-245, (2003)
- [12] Hardin, R.H., Sloane, N.J.A.: Computer-generated minimal (and larger) response-surface designs: (II) The cube. Technical report (1991). <http://www2.research.att.com/~njas/doc/meatball.pdf>
- [13] Hardin, RH; Sloane, NJA, A new approach to the construction of optimal designs, *J. Stat. Plan. Inference*, 37, 339-369, (1993) · [Zbl 0799.62082](#)
- [14] Jones, B; Goos, P, A candidate-set-free algorithm for generating D-optimal split-plot designs, *J. R. Stat. Soc. Ser. C*, 56, 347-364, (2007)
- [15] Jones, B; Goos, P, D-optimal design of split-split-plot experiments, *Biometrika*, 96, 67-82, (2009) · [Zbl 1162.62396](#)
- [16] Jones, B; Goos, P, I-optimal versus D-optimal split-plot response surface designs, *J. Qual. Technol.*, 44, 85-101, (2012)

- [17] Jones, B., Nachtsheim, C.J.: Split-plot designs: what, why, and how. *J. Qual. Technol.* **\textbf{41}**, 340-361 (2009) · [Zbl 0956.62061](#)
- [18] Lee Ho, L., Vivacqua, C.A., Santos de Pinho, A.L.: Split-plot type designs for physical prototype testing. Working Paper ni12024, University of Cambridge, Isaac Newton Institute for Mathematical Sciences (2012)
- [19] Letsinger, JD; Myers, RH; Lentner, M, Response surface methods for bi-randomization structures, *J. Qual. Technol.*, **28**, 381-397, (1996)
- [20] Lu, L; Anderson-Cook, CM, Balancing multiple criteria incorporating cost using Pareto front optimization for split-plot designed experiments, *Qual. Reliabil. Eng. Int.*, **30**, 37-55, (2014)
- [21] Lu, L; Anderson-Cook, CM; Robinson, TJ, Optimization of designed experiments based on multiple criteria utilizing a Pareto frontier, *Technometrics*, **53**, 353-365, (2011)
- [22] Lu, L; Robinson, TJ; Anderson-Cook, CM, A case study to select an optimal split-plot design for a mixture-process experiment based on multiple objectives, *Qual. Eng.*, **26**, 424-439, (2014)
- [23] Mylona, K; Goos, P; Jones, B, Optimal design of blocked and split-plot experiments for fixed effects and variance component estimation, *Technometrics*, **56**, 132-144, (2014)
- [24] Paquete, L., Stützle, T.: Stochastic local search algorithms for multiobjective combinatorial optimization: a review. In Gonzalez, T.F. (eds), *Handbook of Approximation Algorithms and Metaheuristics*. Computer and Information Science Series, pp. 29-1—29-15. Chapman & Hall/CRC, Boca Raton (2007) · [Zbl 1234.68362](#)
- [25] Sambo, F., Borrotti, M., Mylona, K.: A coordinate-exchange two-phase local search algorithm for the D- and I-optimal design of split-plot experiments. *Computat. Stat. Data Anal.* **\textbf{71}**, 1193-1207 (2014) · [Zbl 06975457](#)
- [26] Tricoire, F, Multi-directional local search, *Comput. Oper. Res.*, **39**, 3089-3101, (2012) · [Zbl 1349.90751](#)
- [27] Trinca, LA; Gilmour, SG, Difference variance dispersion graphs for comparing response surface designs with applications in food technology, *J. R. Stat. Soc. Ser. C*, **48**, 441-455, (1999) · [Zbl 0956.62061](#)
- [28] Trinca, LA; Gilmour, SG, Multi-stratum response surface designs, *Technometrics*, **43**, 25-33, (2001) · [Zbl 1072.62623](#)
- [29] Trinca, LA; Gilmour, SG, Improved split-plot and multi-stratum designs, *Technometrics*, **57**, 145-154, (2015)

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