

COMPLETE CONSECUTIVE ORDER-PAIRING DESIGN AND ITS DISTANCE-BASED LINEAR MODEL: DESIGN CONSTRUCTION AND ANALYSIS FOR ORDER-OF-ADDITION EXPERIMENTS

Jing-Wen Huang and Frederick Kin Hing Phoa*

Academia Sinica

Abstract: An order-of-addition (OofA) experiment investigates how the sequence of input factors influences the experimental response. This type of experiment has recently gained significant interest among practitioners in clinical trials and industrial processes. In this work, we introduce a new cost-efficient design called the Complete Consecutive Order-Pairing (CCOP) design. The CCOP design not only considers the effects of the component order on the response but also simultaneously accounts for the effects due to the component levels. We also propose a new statistical model associated with the CCOP design for identifying the optimal settings of both component order and levels. The CCOP design method evaluates the effects of two successive treatments by using the minimal number of runs, as each pair of level settings for two different components appears exactly once. Compared to recent studies on OofA experiments, our design effectively handles pure order experiments and multi-level experiments with a relatively small run size.

Key words and phrases: Clinical trials, cost-efficiency, order-of-addition experiments.

1. Introduction

The concept of order-of-addition (OofA) experiments arises in fields such as biochemistry, industry, agriculture, among many others. Different arrangements of components in an experiment can lead to varying effects on the response. The optimal order results in the best possible use of the components, yielding better prognoses, more stable products, or higher profits in different applications. Recent examples of using order effects in prognosis experiments are provided by Ding et al. (2015) and Bashkirtseva et al. (2021), both concluding that the sequential use of certain therapies contributed to the response.

To incorporate order effects in experimental analyses, OofA experiments have resurfaced among researches in the design and analysis of experiments. A major application of OofA experiments is to investigate how different orders of medicine intakes significantly affect the response value, enabling the determination of the optimal order of medicine intakes. However, this treatment involves not only the

*Corresponding author. E-mail: fredphoa@stat.sinica.edu.tw