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title: Expeditions in Modern Experimental Design: Partial Aliasing and Interference

Abstract:

Experimental design is of utmost importance in any investigation. A key aspect of my research agenda is the study and application of concepts in modern experimental design to address new issues that arise across scientific disciplines. This is illustrated with two problems, one theoretical and the other involving a cutting-edge application in engineering.

The first part of this talk will address partial aliasing relations under the linear-quadratic (LQ) system for fractional factorial designs. This system is important in applications because it yields partially aliased and interpretable interaction contrasts for quantitative factors. However, its mathematics are not yet transparent, and this inhibits a simple understanding of its partial aliasing relations. A better understanding is achieved with indicator functions, and we develop the theory of indicator functions under the LQ system. New algebraic operations for calculating indicator function coefficients are defined that facilitate derivations of partial aliasing relations for large classes of designs. They also yield a new connection between design constructions and their analyses under this system.

The second part will present a novel application of experimental design and the potential outcomes framework for quality control in 3D printing, a promising manufacturing technique marred by product deformation. Control of printed product deformation can be achieved by a compensation plan. However, little attention has been paid to interference in compensation, which is thought to result from the inevitable discretization of a compensation plan. We investigate interference with an experiment involving the application of discretized compensation plans to cylinders. Our treatment illustrates how the potential outcomes framework improves our ability to understand interference by means of graphical posterior predictive checks. Properly defining experimental units and understanding interference are critical for quality control in manufacturing. Our application of modern concepts in experimental design provides a step in that direction for 3D printing.