Overview of the Design of Experiments

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Part 1: Why and How

26 November 2018

Abstract

The statistical design and analysis of experiments is extremely important for modern scientific and engineering research. This approach maximizes the information learned, usually for much less cost, and quantifies the uncertainty in the resulting conclusions (the risk).

This lecture begins with a review of the scientific method. It provides a brief overview of the use of Taylor-Series approximations in scientific/engineering studies. It concludes with an overview of the general protocol used in planning experiments.

Part 2: Overview of the 2^k Factorial Design

29 November 2018

Abstract

The 2^k family of factorial experiments is an extremely powerful tool in scientific and engineering research. The analysis of these designs is simply a straight-forward extension of the two-sample *t*-test.

This lecture presents the 2^k family conducted as a completely randomized design. It illustrates the analysis when there is true replication and when the design is not replicated, which is a very common situation in engineering studies.

Overview of Response Surface Methodology

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Part 1: Introduction to Sequential Experimentation

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Abstract

Response surface methodology (RSM) is a powerful tool for optimizing product/process performance. RSM is a sequential approach to experimentation with each phase building upon what was learned from the previous phase. The specific experimental designs used in RSM are based on the 2^k family.

This lecture presents an overview of formal sequential experimentation. It then introduces the concept of design augmentation as a follow-up strategy. This lecture discusses a simple test for lack-of-fit. It then illustrates how to add design runs to fit a formal second-order model.

Part 2: Introduction to Second-Order Designs and Optimization

6 December 2018

Abstract

The second-order Taylor Series model provides a powerful basis for optimizing products and processes. This lecture discusses the basic requirements for designs to estimate this model efficiently and effectively. It then discusses the two common approaches for finding "optimal" settings for the factors: the Derringer and Suich desirability function and standard nonlinear programming (SOLVER in EXCEL).

Overview of Split-Plot Experiments

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Abstract

Many experiments in science and engineering involve two different sets of factors: some that are hard-to-change and some that are easy-to-change. A popular experimental protocol for such a situation is the split-plot design. The name comes from agriculture where these designs were first used.

This lecture explains the basic experimental protocol. It then discusses the subtle differences between this design and completely randomized designs. It then outlines the proper analysis.