TECHNICAL REPORT

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Selected illustrations of response surface method — Central composite design

Illustrations choisies de méthodologie à surface de réponse — Plans composites centrés

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The committee responsible for this document is ISO/TC 69, *Applications of statistical methods*, Subcommittee SC 7, *Applications of statistical and related techniques for the implementation of Six Sigma*.

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Introduction

The present Technical Report takes one specific statistical tool (Central Composite Designs in Response Surface Methodology) and develops the topic somewhat generically (in the spirit of International Standards) but then illustrates it through the use of four detailed and distinct applications. The generic description focuses on the Central Composite Designs.

The annexes containing the four illustrations follow the basic framework but also identify the nuances and peculiarities in the specific applications. Each example offers at least one "wrinkle" to the problem, which is generally the case for real applications. It is hoped that practitioners can identify with at least one of the four examples, if only to remind them of the basic material on response surface method that was encountered during their training.

Each of the four examples is developed and analysed using statistical software of current vintage. The explanations throughout are devoid of mathematical detail—such material can be readily obtained from the many design and analysis of experiments textbooks (such as those given in References [1] to [7]).

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1 Scope

This Technical Report describes the steps necessary to understand the scope of Response Surface Methodology (RSM) and the method to analyse data collected using Central Composite Designs (CCD) through illustration with four distinct applications of this methodology.

Response surface methodology (RSM) is used in order to investigate a relation between the response and the set of quantitative predictor variables or factors. Especially after specifying the vital few controllable factors, RSM is used in order to find the factor setting which optimizes the response.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
experiment
purposive investigation of a system through selective adjustment of controllable conditions and allocation of resources

Note 1 to entry: Adapted from ISO 3534-3:2013, definition 3.1.1. (The notes are not reproduced here.)

2.2
response variable
variable representing the outcome of an *experiment* (2.1)

Note 1 to entry: Adapted from ISO 3534-3:2013, definition 3.1.3. (Except for NOTE 3 the notes are not reproduced here.)

Note 2 to entry: A common synonym is “output variable”.

Note 3 to entry: The response variable is likely to be influenced by one or more *predictor variables* (2.3), the nature of which can be useful in controlling or optimizing the response variable.

2.3
predictor variable
variable that can contribute to the explanation of the outcome of an *experiment* (2.1)

Note 1 to entry: Adapted from ISO 3534-3:2013, definition 3.1.4. (The notes are not reproduced here.)

Note 2 to entry: Natural predictor variables are expressed in natural units of measurement such as degrees Celcius (°C) or grams per liter, for example. In RSM work, it is convenient to transform the natural variables to coded variables which are dimensionless variables, symmetric around zero and all with the same spread.

2.4
model
<experiment> formalized representation of outcomes of an *experiment* (2.1)

Note 1 to entry: Adapted from ISO 3534-3:2013, definition 3.1.2. (The notes and examples are not reproduced here except for NOTE 2 which is NOTE 1 in ISO 3534-3.)

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