

An Application of Free Latin Squares to the Design of Experiments

Miguel G. Palomo and Francisco Ballesteros

Universidad Politécnica de Madrid

Abstract

Free Latin squares are combinatorial objects that generalize Latin squares. In this paper we compare both objects, as designs of an experiment that use the method of *Analysis of Variance* (ANOVA). We show how free Latin square designs create more efficient experiments in certain cases and require fewer initial assumptions for their application. For the sake of the comparison, we begin with a detailed description of a hypothetical experiment that uses a Latin square. This is followed by another example, this time using a free Latin square design. We conclude by generalizing the use of free Latin squares in experiment design by determining a set of relevant parameters.

Keywords: ANOVA, experimental design theory, free Latin square, hypothesis testing, Latin square, randomized block design.

1. Introduction

Studying causal links between phenomena is no easy task. The nice causal relations found in today's well-tested theories in Physics are the result of an enormous, sustained research effort. Outside Physics, agreement on the causal link between two events is anything but universal. For certain situations though, experiments and statistical inference may help to assess causality with an associated degree of certitude. Production managers are often confronted with situations in which the link between actions and outcomes is not fully understood. We can illustrate this with an example. Let's suppose that engineers in a semiconductor plant want to compare the effect of different doping processes on silicon wafer resistivity. As they do not have an analytical, well-tested model from which to draw conclusions, they decide to perform an experiment. They argue that variations in wafer thickness and wafer batch could mask the effect they want to study, and hence they would like to minimize their influence in the experiment. In what follows we will compare two ways to perform an experiment of this type, one of them will use Latin squares, the other will use its generalization, called *free Latin squares*.