C2M4_peer_reviewed

March 1, 2024

1 C2M4: Peer Reviewed Assignment

1.0.1 Outline:

The objectives for this assignment:

1. Get a better understanding of Experimental design patterns.
2. Prove some of the background intuition in blocking and interblock interactions.
3. Understand how and when to apply different model strucutres for different experimental designs.

General tips:

1. Read the questions carefully to understand what is being asked.
2. This work will be reviewed by another human, so make sure that you are clear and concise in what your explanations and answers.

2 Problem 1: Experimental Design

This problem is to get you thinking about how experiments are designed and how data is collected, because those influence what models we end up using.

2.0.1 1. (a)

In your own words, define experimental design. Describe some negative effects of making an incorrect experimental design decision.

Experimental design is the determination of necessary processes and controls for testing a hypothesis efficiently. Some negative effects of making an incorrect experimental design decision include the squandering of resources and effort, limited ability to explain real-world phenomena or trends by being hyperspecific, or even undesirable consequences stemming from an ethical dilema.

2.0.2 1. (b)

In your own words, describe the difference between an experimental unit and a treatment unit. Why does this distinction matter?

An experimental unit is the primary object or unit of interest in a specific topic of research, whereas a treatment unit is an experimental unit to which experimental conditions are applied to elicit a response. This distinction matters because the dual of a treatment unit is a control unit, which is intended to record a baseline response under restricted conditions. Confusing an experimental unit and a treatment unit could lead to bad experimental design or severe error in data collection and analysis.

3 Problem 2: Proving the Intuition

Show that, for the randomized complete block design:

$$SS_{total} = SS_{treat} + SS_{block} + SS_R$$

$SS_{total} = \Sigma_i\Sigma_j(x_{ij} - \bar{x})^2$, where i is a block and j is a treatment. $SS_{treat} = \Sigma_i\Sigma_j(\bar{x}_{i.} - \bar{x})^2$ is the i^{th} treatment across all blocks. Also, $SS_{block} = \Sigma_i\Sigma_j(\bar{x}_{.j} - \bar{x})^2$ is the j^{th} treatment across all blocks. $SS_R = \Sigma i\Sigma j(x_{ij} - \bar{x}_{i.} - \bar{x}_{.j} + \bar{x})^2$ is the variation that is not explained by a block or treatment combination effect.

Then the sum $SS_{treat} + SS_{block} + SS_R = \Sigma_i\Sigma_j(\bar{x}_{i.} - \bar{x})^2 + \Sigma_i\Sigma_j(\bar{x}_{.j} - \bar{x})^2 + \Sigma i\Sigma j(x_{ij} - \bar{x}_{i.} - \bar{x}_{.j} + \bar{x})^2 = \Sigma_i\Sigma_j\left((\bar{x}_{i.} - \bar{x})^2 + (\bar{x}_{.j} - \bar{x})^2 + (x_{ij} - \bar{x}_{i.} - \bar{x}_{.j} + \bar{x})^2\right) = \Sigma_i\Sigma_j(x_{ij} - \bar{x})^2$ when factored. And $\Sigma_i\Sigma_j(x_{ij} - \bar{x})^2 = SS_{total}$. So, $SS_{total} = SS_{treat} + SS_{block} + SS_R$

4 Problem 3: Interblock Interactions

Describe why, in a randomized complete block design (RCBD), it is not possible to test whether interactions exist between the treatment and blocks.

In an RCBD model, it is not possible to test whether interactions exist between the treatment and blocks because the model is additive and assumes that treatments have the same effect within each block and occur only once.

5 Problem 4: 99 Designs for 99 Problems

For each of the following design patterns, give an example (that wasn't given in the videos) for an experiment that would best lend itself to the specified design pattern. Make sure to explain why the specified design is more applicable for your experiment than the other design patterns.

1. Complete Randomized Design (CRD)
2. Complete Randomized Block Design (CRBD)
3. Factorial Design

1. An experiment conducted to compare the effect of water salinity on the viability of golsfish using LD50 measurment where 9 equally sized schools of goldfish are subjected to 9 uniformly spaced salinities. The goldfish are assigned to a tank at random.

2. An experiment conducted to test the efficacy of various steroids on bodybuilders' ability to build muscle. The experiment can randomly stratify the sample population into blocks and randomly treat randomly picked individuals in each block with different steroids.

3. An experiment conducted to test the effects of Reishi mushroom on focus. Participants are given 1 of n different doeses and asked to complete 1 of m tasks that require varying levels of focus. This experiment is an example of m by n factorial design in which there is an interaction between dosage and task-difficulty.

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