Additional note 9

Lecture 24

1. **Revision questions of L23**

   - What should be the optimal allocation of n EUs to t treatment?

     Answer: n/t each if variance is the same across treatments. If not, the sample size of each treatment should be proportional to standard deviation.

   - What is meant by completely randomised design?

     Answer: Every design or allocation of EUs to treatments is equally likely.

   - Does completely randomised design apply only to one-way ANOVA with one factor?

     Answer: Completely randomised design can be applied to two-way ANOVA when randomisation is applied to each factors combination (as one-way ANOVA with all factor combinations).

   - What is meant by systematic design? Is it the same as randomised complete block design?

     Answer: It systematically (instead of randomly) permutes treatment labels in each block. It is not the same as randomised complete block design as only designs with certain systematic pattern will be selected. So designs are not equally likely to be selected.

2. After introducing some basic experimental design concepts, we look about different designs. Last Friday, we start to talk about completely randomised design and today *randomised complete block design* in which there are b blocks and each has t treatments (*complete*). We look at main effect model from a data without replicates. If there are replicates, the model can have interaction term and this becomes *factorial design*.

3. For each design we study, you should know the model equation, ANOVA table, parameter estimates ($\hat{\mu}$, $\hat{\alpha}_i$, $\hat{\beta}_j$, etc) and pairwise comparison for treatment effect $\alpha_i - \alpha_k$ say estimated by $\bar{Y}_{i\bullet} - \bar{Y}_{k\bullet}$ or in the more general contrast forms $\sum_i c_i \bar{Y}_{i\bullet}$.

Lecture 25

1. **Revision questions of L24**

   - Why use randomized complete block design?

     Answer:

     1. grouping EU's into "blocks" of homogeneous units helps reduce the RSS,
     2. increase the power to detect differences among treatments, and
     3. can drop an entire block or treatment if necessary, without complicating the analysis

   - What are the important assumptions in the model/design?

     Answer: A "block" consists of a complete replication of the set of treatments. Blocks and treatments are assumed *not to interact*. An experimenter must guess what sources of variation will exist in order to construct the blocks.

   - What are the disadvantages of RCBD?

     Answer:

     1. Missing observations violate the requirement that each treatment is represented exactly once in each block and the missing mechanism can be complicated.

     2. Additional assumptions are required for the model (additivity and constant variance across blocks).

- Can we have multiple blocks? Or each block has unequal size?

  Answer: Yes.

  1. if we have very little control over the block sizes.

  2. Cost effectiveness - sometimes the cost of samples is different, and we may use larger sample sizes when the cost is less.

  3. We may start with a balanced design, but lose the balance when missing occurs.

  Disadvantages:

  1. Loss of balance brings "intercorrelation" among the predictors (i.e., variables are no longer orthogonal).

  2. Standard errors for cell means and for multiple comparisons will be different and so confidence intervals will have different widths.

2. *Latin square design* considers 2 block factor with treatment effects. It allows the minimal sample size of t^2 in which each level of block factor 1 and 2 contains all t treatments. Specifically, it is a square design with each treatment appears in every rows and columns without repeats. Because of having 3 factors, the design does not allow interaction term in the model. Read revision questions regarding the model and limitations.

Lecture 26

1. **Revision questions of L25**

   - Why consider Latin Square design?

     Answer:
     Allow 2 block factors apart from treatment factor at a smaller sample size of t^2.

   - How is the design?

     Answer: Each row and column should contain all treatments.The extension is the t^k $(k > 2)$ *hypercube Latin* design with more than 2 blocks.

   - Are there any limitations with LSD?

     Answer:
     Fixed sample size at t^2.
     Become complicated if there are missings and if the sample size is difficult to control.
     Can only consider main effect model (without repeats) with constant variance and additive assumption. To increase the sample size for providing more df to estimate the interaction terms, the Latin Squares can be repeated r times with different LSD at each repeat.
     The df for errors is less particularly for small t.

2. For two factors case with one for treatment and one for block, we need to distinguish *cross design* (eg randomised complete block design RCBD) and *nested design*.

3. *Nested factors* are the factors which are

   1. nested under treatment, similar to block and should be suppressed from the anova table. Read next lecture note on *Nested Design*.

   2. similar but not identical across levels of treatment.

   Note that block and treatment are assumed to be independent under RCBD.

4. When the main effect of the nested factor is to be suppressed, its SS goes to SS for A:B to give a pooled SS for A:B in the ANOVA table.

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last adjustments: May 7, 2021 by JC