

LECTURE 14 – RANDOM BLOCKS

STAT 350

Fall 2014

Announcements

- SAMSI Undergraduate Workshop - February 26-27, 2015
Held at SAMSI, Research Triangle Park, NC
Deadline for applications is January 9, 2015

This year's topic: **Mathematical and Statistical Ecology**

Randomized Complete Block

- RCB design
 - t treatment (factor) levels, r blocks
 - Every treatment level appears once in every block
- Hope to reduce experimental error, while keeping the inference base (scope of the study) as broad as possible
- Interesting questions
 - Does the treatment affect the response? (standard F-test)
 - Was blocking worthwhile?

Athletic clothing example

- Five male subjects were used for a study of the effect of fiber type and fabric moisture content on water loss from the skin.
- The five fabric treatments were cotton/dry, cotton/wet, polyester/dry, polyester/wet, soft polyester.
- The test was conducted by placing a piece of fabric directly on the subject's forearm skin surface under controlled temp/humidity.
- An instrument was used to measure the amount of water that evaporated from the subject's skin surface. Each subject was tested with each of the five fabric treatments.

Modifying the usual questions

- Five male subjects were used for a study of the effect of fiber type and fabric moisture content on water loss from the skin. The five fabric treatments were cotton/dry, cotton/wet, polyester/dry, polyester/wet, soft polyester. The test was conducted by placing a piece of fabric directly on the subject's forearm skin surface under controlled temp/humidity. An instrument was used to measure the amount of water that evaporated from the subject's skin surface. Each subject was tested with each of the five fabric treatments.
- Is the study design experimental or observational?
- What is the response variable?
- What is the treatment? What are its levels? Is it fixed or random?
- What are the experimental units?
- What are the observational units?
- What are the blocks? Are they fixed or random?
- How many ways are there to assign the five treatments within a block? How many ways are there to assign treatments in the experiment?

Random blocks

- Random blocks are common
- A blocking factor affects the variability of the response, but *its levels are not of real interest* in addressing the research hypothesis
- Blocks in a study *are often not all possible blocks*, but a sample from a population of blocks
 - sites in natural resources studies
 - batches of material in manufacturing studies
 - subjects in psychological or physiological studies

Model for random blocks RCB

- Recall fixed-effect RCB model:

$$y_{ij} = \mu + \tau_i + \rho_j + e_{ij}$$

- Random blocks RCB model is:

$$y_{ij} = \mu + \tau_i + b_j + e_{ij} \quad b_j \sim N(0, \sigma_b^2)$$

μ = overall mean

τ_i = fixed effect of level i of the treatment

b_j = random effect of the j th block

e_{ij} = experimental error $e_{ij} \sim N(0, \sigma^2)$

- Once again we are assuming no interaction between blocks and treatments

Same test for treatment

- **R.** Response variable is affected by the treatment
- **A.** $H_a : \tau_1, \tau_2, \dots, \tau_t$ are not all identical
- **N.** $H_0 : \tau_1 = \tau_2 = \dots = \tau_t$
- **T.** $F = \frac{MST}{MSE}$ (the usual F-statistic)
- **D.** F-distribution with $(t-1)$ and $(t-1)(r-1)$ degrees of freedom
- **R., C.**

Analysis of Variance – Athletic clothing

Five male subjects were used for a study of the effect of fiber type and fabric moisture content on water loss from the skin. The five fabric treatments were cotton/dry, cotton/wet, polyester/dry, polyester/wet, soft polyester. Each subject was tested with each of the five fabric treatments.

| Source | df | SS | MS | F | p-value |
|-----------------------|----|--------|-------|------|---------|
| Treatment = Fabric | 4 | 316.28 | 79.07 | 5.57 | 0.0053 |
| Block = Subject | 4 | 17.94 | 4.49 | 0.32 | 0.8631 |
| Error | 16 | 227.08 | 14.19 | | |
| Total | 24 | 561.31 | | | |

Treatment test for athletic clothing

| Source | df | SS | MS | F | p-value |
|--------------------|----|--------|-------|------|---------|
| Treatment = Fabric | 4 | 316.28 | 79.07 | 5.57 | 0.0053 |
| Block = Subject | 4 | 17.94 | 4.49 | 0.32 | 0.8631 |
| Error | 16 | 227.08 | 14.19 | | |
| Total | 24 | 561.31 | | | |

- **R.** The five fabric treatments lead to different evaporative water loss in male subjects.
- **A.**
- **N.**
- **T.** $F = MST/MSE = \underline{\hspace{2cm}}$
- **D.** F-distribution with $\underline{\hspace{1cm}}$ and $\underline{\hspace{1cm}}$ degrees of freedom
- **R.** p-value =
- **C.**

Blocking examples

- Ten schools randomly selected. In each school, one first grade class gets one teacher's aide, one gets two teacher's aides, and one serves as control.
- Four different drug treatments. Twenty litters of mice, each with four mice. In each litter, one mouse is randomly assigned one of four drug treatments.

Auto repair example

- An insurance company asks you to evaluate five auto shops for consistency in estimated repair costs.
- You have the time and resources to get 30 estimates.
- How would you conduct the experiment?

House assessment example

- County employs 3 real estate assessors. Are they consistent in their assessments?
- The next 5 houses due for assessment are evaluated (\$ value is recorded) by each of the 3 assessors.
- Write down a model for the house prices. Is assessor fixed or random? Is house fixed or random?

Analysis of variance – house assessment

County employs 3 real estate assessors. The next 5 houses due for assessment are evaluated (\$ value is recorded) by each of the 3 assessors.

| Source | df | SS | MS | F |
|-------------|----|-----|----|---|
| Treatment = | | | | |
| Block = | | 112 | | |
| Error | | | 3 | |
| Total | | 148 | | |

Treatment test for house assessment

- **R.** The three assessors are not consistent in their price assessments.
- **A.**
- **N.**
- **T.**
- **D.** F-distribution with ____ and ____ degrees of freedom (critical value is 4.46)
- **R.**
- **C.**

House assessment, continued

- What if assessors had been randomly sampled from 250 assessors employed by the county?
- What is the model?
- What is the test?
- What are your conclusions?