ch2

idealy find cause-effect relationships.

But usually we get only OBSEVATION data, we can only make inference about its association.

Experimental unit: x "Apply treatment by randomization"

Reponse unit: y surragate reponse.

Experimental error:

prospective vs case-control (retro-spectie)

Cohort study

$\hat{\alpha}_i \pm t_{N-g}^{0.975}\, \hat{\sigma}\sqrt{\frac{1}{n_i}-\frac{1}{N}}$ $F_{1,n} = t_n^2$

ch3 Completely Randomized Designs.

Balanced if the # expreimental units are the same

cell-mean Model

each treatment group to have its own expectation.

Regression with a categorical reponse.

- sum to zero
- contr. treatment. compare to the reference group

Test: $SST = SS_{trt} + SSE$ $g-1$ $N-g$. $F \text{ ratio} = \frac{MS_{trt}}{MSE}$

F-test compare "Is a treatment effect or not"

Checking model assumption

Const. Error → TA

Error normaly → QQ

Error mean

T   Index-plot to check for serial structure.

Interpretation After transformation

ch4 contrasts and multiple testing

Each contrast can be made via the sum of squares

$\frac{MS_C}{MS_E} \sim F_{1,N-g}$.

Two contrast are orthogonal if

$\sum_{i=1}^{g} \frac{c_i c_i^*}{n_i} = 0$

- If we have g treatment => only $(g-1)$ different orthogonal

Multiple testing

$Prob[\geq 1 \text{ False rejection}] = 1-(1-\alpha)^m$

Family-wise error rate.

rejecting at least one of the true H_0:

$FWER = P[V \geq 1]$

Bonferroi

$\frac{\alpha}{m}$

Boferroni-Holm

1. Rank them
2. $P_{(j)} \leq \frac{\alpha}{m-j+1}$ Reject.
3. Stop until first insignificant

Scheffe' using $(g-1) F_{g-1,N-g}$

TKSD comparision of all possible combination

Multiple compare to control

ch5 Factorial Treatment Structure

crossed: Observed all of the combinations of the factors

Visulize using interaction plot

Two-way ANOVA 有两个组； [illegible] ($\alpha\beta$) 的 interaction

interaction: How much in reponse when we switch on another variables.

Additive without any interaction

Test for Two way anova:

$SS_T = SS_A + SS_B + SS_{AB} + SSE$

$ab(n-1)$

Interaction

$\frac{MS_{AB}}{MS_E}$ $F_{(a-1)(b-1),\, ab(n-1)}$

main effect A   B similiary

$F_{a-1,\, ab(n-1)}$

Single Replicates

Can not do inference due to we cannot estimate experimental error.

Can still fit a main-effect model

Change of scale by logrithm may drop the interaction

Unbalanced data.

Regression: still ok. coefficient a bit ugly.

Error: cannot attribute which part of error to which.

How: Reduction in residual sum of squares

$SS(B \mid 1, A)$

reduction in residual sum of squares

$(1, A, B)$ and $(1, A)$

Type I sequential	Type II hierachal
$SS(A \mid 1)$	$SS(A \mid 1, B)$
$SS(B \mid 1, A)$	$SS(B \mid 1, A)$
$SS(AB \mid 1, A, B)$	$SS(AB \mid 1, A, B)$

Type III fully adjusted

$SS(AB \mid 1, A, B)$ $SS(A \mid 1, \cancel{A}, AB)$ $SS(B \mid 1, A, AB)$

classical rule

dof of SSE ≥ 10

Incomplete Block → Balanced Block design   Variance

ch 6 Block Design

Idea: Apply different treatment on same "person" to remove the person to person variation.

"Block" on persons

RCBD

$\left\{ \begin{array}{c} 1 \\ \vdots \\ r \end{array} \right.$ groups $\left\{ \begin{array}{c} 1 \\ \vdots \\ g \end{array} \right.$ experimental unit

在每个 r 里面，treatments are randomized

complete: $\{1 \dots g\}$ cover all set of treatments.

- It can be the case where only 1 replicates { No interaction term can be fit

$$Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij}$$

If MS of the block factor >> MSE we can conclude blocking was effecient.

- More than one factor

Multiple Block Factors $Y \sim \text{Block} + A + B$

Latin square Design { 2 blocks factors, one treatment.

ch7 Random and mixed Effects Models

Not fixed $\alpha_i \sim N(\dots)$

For each i / treatment. α_i is a RV.

$$\mathrm{Var}(Y_{ij}) = \mathrm{Var}(\alpha) + \sigma^2$$

lmer(Y ~ (1 | X))

Two way ANOVA with random effects

lmer(Y ~ (1 | X) + (1 | Y) + (1 | X:Y))

$$F = \frac{MS_A}{MS_{AB}} \sim F_{a-1,\,(a-1)(b-1)}$$

Nesting

combing factors in different way

cask 1 batch 1 ≠

cask 1 batch 2

lmer(1 | batch/cask)

random effect per batch and per cask within cask

lmer((1 | batch) + (1 | cask : batch))

random effect per combination

CANNOT use

lmer((1 | batch) + (1 | cask))

Mixed Effects model.

ch8 Split plot design

fertiler → plot   whole plot fert

vary → subplot   split —— v

$$Y_{ijk} = \mu + \alpha_i + \underset{\text{whole plot error.}}{\eta_{k(i)}} + \beta_j + (\alpha\beta)_{ij} + \varepsilon$$

ensure we can get a whole plot error per plot

lmer(Y ~ fert * vary + (1 | plot))

Basically RCBD on the whole plot level.

Special case of Factorial treatment structure.

split-split

ch9. Incomple Block Design

disconnected design: Grouping/Blocking 会导致没有所有的比较

BIBM

$$N = b \cdot \underset{\text{units per block}}{k} = \underset{\text{treatment}}{g} \cdot \underset{\text{replicate}}{r}$$

Balanced：如果所有组合同样经常出现 (λ)

$r(k-1)/(g-1)$ 一定需要是整数

ch10. Power

Power = $1 - \beta$ = 1 - Type II 正确 Reject H_0 的概率

~~MS~~

F-test for fully nested model.

$$F = \frac{MS_A}{MS_{B(A)}}$$