Experimental design

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[1] f test Mean μ

Source of variation	Sum of squares	degree of freedom $n =$	$n \neq$	Mean square $= \frac{\text{sum}}{df}$ $n =$	$n \neq$	f computed
treatment	SSA	$K-1$	$K-1$	$s_1^2 = \frac{SSA}{K-1}$	$s_1^2 = \frac{SSA}{K-1}$	$f = \frac{s_1^2}{s^2}$
Error	SSE	$K(n-1)$	$N-K$	$s^2 = \frac{SSE}{K(n-1)}$	$s^2 = \frac{SSE}{N-K}$	
total	SST	$Kn-1$	$Kn-1$			

f_{table} $n =$ $f_\alpha(K-1, K(n-1))$ from table A.6 فى اتجاه ال n و K

(Ex 13.1, 13.2) $n \neq$ $f_\alpha(K-1, N-K)$ $f_{comp} >$ reject H_0 — no. of n ↓, no. of K →

$H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 \dots$

H_a: at least two of the means are not equal

[2] Bartlett Test

Several equality variance بتاع ال (Ex 13.3)

$H_0: \sigma_1^2 = \sigma_2^2 = \sigma_3^2 \dots \sigma_K^2$ $b_{comp} < b_K(\alpha; n_i)$

H_1: all variances are not equal reject H_0

b_{table} $b_K(\alpha; n_1, \dots n_K) = \frac{1}{N}\left[n_1 b_K(\alpha; n_1) \dots n_K b_K(\alpha; n_K)\right]$

$$sp^2 = \frac{1}{N-K}\sum_{i=1}^{K}(n_i - 1)s_i^2$$

$$b_{comp} = \frac{1}{sp^2}\left[(s_1^2)^{n_1-1} * \dots (s_K^2)^{n_K-1}\right]^{1/N-K}$$

from table A.10

The sample sizes equal — Cochran's test نفس فرض الأحادية وكلة واشتغل بالـ G

$G = \frac{\text{largest } s_i^2}{\sum_{i=1} s_i^2} = \square$ $g_\alpha = \square$ from table A.11 (Ex 13.4)

$G > g_\alpha$ reject H_0

[3] Test $H_0: \mu_i = \mu_j$ $H_a: \mu_i \neq \mu_j$

Tukey test — Duncan test — Dunnett test

Dunnett test

$H_0: \mu_0 = \mu_i$ $H_a: \mu_0 \neq \mu_i$

(Ex 13.5)

$$|d_i| = \frac{\bar{y}_i - \bar{y}_0}{\sqrt{\frac{2s^2}{n}}}$$

$s^2 \to$ Mean square error

table A.14 reject H_0 ← ركبت | | للناتج لو بالسالب

$d_i \to$ $|d_i| > d(\frac{\alpha}{2}, K, \nu)$ $\nu = K(n-1)$ $K = K-1$ علشان فيه واحدة

Tukey test / Duncan test

Tukey test: كبرها - صغرها

Duncan test: رتب نايم وانزل واقف

Tukey: اكبر y_K فرقة من الكل ثم الاصغر وهكذا

Duncan: رتب تصاعدى صفا ← وننازلى عموديًا

$q_{comp} = q_{table} * \sqrt{\frac{s^2}{n}}$ ← ثم نحصل ع جدول الفروق ونحسب → $R_p = r_p \sqrt{\frac{s^2}{n}}$

table A.12 — table A.13

الفرق $> q_{comp}$ → reject H_0 ← الفرق $> R_p$

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Tukey test

$\bar{y}_2$	$\bar{y}_5$	$\bar{y}_1$	$\bar{y}_3$	$\bar{y}_6$	$\bar{y}_4$
14.50	16.75	19.84	21.12	22.90	23.20

$\bar{y}_4 - \bar{y}_2$ $\quad \bar{y}_6 - \bar{y}_2$ $\quad \bar{y}_3 - \bar{y}_2$ $\quad \bar{y}_1 - \bar{y}_2$ $\quad \bar{y}_5 - \bar{y}_2$

$\bar{y}_4 - \bar{y}_5$ $\quad \bar{y}_6 - \bar{y}_5$ $\quad \bar{y}_3 - \bar{y}_5$ $\quad \bar{y}_1 - \bar{y}_5$

$\bar{y}_4 - \bar{y}_1$ $\quad \bar{y}_6 - \bar{y}_1$ $\quad \bar{y}_3 - \bar{y}_1$

$\bar{y}_4 - \bar{y}_3$ $\quad \bar{y}_6 - \bar{y}_3$

$\bar{y}_4 - \bar{y}_6$

$q_{comp} = q_{table} * \sqrt{\frac{s^2}{n}}$ $\quad$ A.12 $\quad q_{table} \Rightarrow q(\alpha, K, \nu)$ $\quad \nu = K(n-1)$ $\quad n = K-1$

$H_0: m_i = m_j$ $\quad H_a: m_i \neq m_j$ $\quad H_0$ نرفض q_{comp} أكبر من q_{table}

Duncan test

$H_0: m_i = m_j$ $\quad H_a: m_i \neq m_j$

$\bar{y}_2$	$\bar{y}_5$	$\bar{y}_1$	$\bar{y}_3$	$\bar{y}_6$
$\bar{y}_4$	$\pm R_6$	$\pm R_5$	$\pm R_4$	$\pm R_3$	$\pm R_2$
$\bar{y}_6$	$\pm R_5$	$\pm R_4$	$\pm R_3$	$\pm R_2$	
$\bar{y}_3$	$\pm R_4$	$\pm R_3$	$\pm R_2$		
$\bar{y}_1$	$\pm R_3$	$\pm R_2$			
$\bar{y}_5$	$\pm R_2$				

reject H_0 $\quad$ الفرق $\Rightarrow R_p \rightarrow r_p \sqrt{\frac{s^2}{n}} = R_p$

Note $p \rightarrow 2\ 3\ 4\ 5\ 6 \ldots K$ $\quad$ A.13 جدول r_p عند (α, ν)

4] Estimation of Variance Components

Estimation block $\quad s_\alpha^2 = \frac{s_1^2 - s^2}{b}$ $\quad s_\alpha^2 = \frac{s_1^2 - s^2}{n}$ $\quad s_\beta^2 = \frac{s_2^2 - s^2}{K}$ $\quad$ look Ex 13.7

Estimated Two factor $\quad$ Ex13.6 Estimation

$s_\alpha^2 = \frac{s_1^2 - s_3^2}{bn}$ $\quad s_\beta^2 = \frac{s_2^2 - s_3^2}{an}$ $\quad s_{\alpha\beta}^2 = \frac{s_3^2 - s^2}{n}$ $\quad$ look Ex 14.6

5] Randomized Compelet block design

Ex 13.6 $\quad$ no. of b $\quad$ no. of K

$H_0: m_1 = m_2 = \ldots m_K$

$H_a:$ The m_i are not equal

Source of variation	Sum of square	df	$MS = \frac{Sum}{df}$	f_{comp}
treatment	SSA	K-1	$s_1^2 = \frac{SSA}{K-1}$	$f = \frac{s_1^2}{s^2}$
blocks	SSB	b-1	$s_2^2 = \frac{SSB}{b-1}$	
Error	SSE	(K-1)(b-1)	$s^2 = \frac{SSE}{(K-1)(b-1)}$	
Total	SST			

$f_{comp} > f_{table}$ Reject H_0 $\quad$ A.6 $\quad F_\alpha(K-1, (K-1)(b-1))$

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6 Two factor test

$H_0: \alpha_1 = \alpha_2 \dots \alpha_a = 0$

H_a: at least one of the α_i is not equal

$H'_0: \beta_1 = \beta_2 \dots \beta_b = 0$

H'_a: at least one of the β_j is not equal

$H''_0: (\alpha\beta)_{11} = (\alpha\beta)_{12} \dots (\alpha\beta)_{ab} = 0$

H''_a: at least one of the $(\alpha\beta)_{ij}$ is not equal

$f_{comp} > f_{table}$ reject H_0

table A-6

EX 14.1

no. of → b, no. of a ↓, n → no. of all axb

S.o.V	SS	df	MS $\frac{SS}{df}$	f_{comp}	f_{table}
A	SSA	a-1	$S_1^2 = SSA/a-1$	$f_1 = S_1^2/S^2$	$\alpha, a-1, ab(n-1)$
B	SSB	b-1	$S_2^2 = SSB/b-1$	$f_2 = S_2^2/S^2$	$\alpha, b-1, ab(n-1)$
AB	SSAB	(a-1)(b-1)	$S_3^2 = SSAB/(a-1)(b-1)$	$f_3 = S_3^2/S^2$	$\alpha, (a-1)(b-1), ab(n-1)$
Error	SSE	ab(n-1)	$S^2 = SEE/ab(n-1)$		$\alpha, df, ab(n-1)$
Total	SST				A B AB

7 Three factor test

$f_{comp} > f_{table}$ reject H_0 no. of a, no. of c, no. of b

EX 14.4

S.o.V	SS	df	MS $\frac{SS}{df}$	f_{comp}	f_{table}
A	SSA	a-1	$S_1^2 = SSA/a-1$	$f_1 = S_1^2/S^2$	α
B	SSB	b-1	$S_2^2 = SSB/b-1$	$f_2 = S_2^2/S^2$	df
C	SSC	C-1	$S_3^2 = SSC/C-1$	$f_3 = S_3^2/S^2$	abc(n-1)
AB	SSAB	(a-1)(b-1)	$S_4^2 = SSAB/(a-1)(b-1)$	$f_4 = S_4^2/S^2$	df
AC	SSAC	(a-1)(C-1)	$S_5^2 = SSAC/(a-1)(C-1)$	$f_5 = S_5^2/S^2$	عدد
BC	SSBC	(b-1)(C-1)	$S_6^2 = SSBC/(b-1)(C-1)$	$f_6 = S_6^2/S^2$	A AB ABC
ABC	SSABC	(a-1)(b-1)(C-1)	$S_7^2 = SSABC/(a-1)(b-1)(C-1)$	$f_7 = S_7^2/S^2$	B AC
Error	SSE	abC(n-1)	$S^2 = SSE/abC(n-1)$		C BC
Total	SST				

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$W_1 = M_1 + M_2 - M_3 - M_5$ $\quad W_2 = M_1 + M_2 + M_3 - 4M_4 + M_5$

$\sum c_i = 1*1 + 1*1 + (-1)*1 + 0*(-4) + (-1)*1 - 1 = 0$

$SS_w = \frac{(\sum c_i y_i)^2}{n \sum c_i^2}$ $\quad SSW_1 =$ Continue look book EX 13.1

$SSW_2 =$

Mostafa Abdelkarem

Desha

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