

Bab 1

Perbandingan Ganda Untuk ANAVA 1 Jalan



Komparasi Ganda

- Analisis variansi hanya menentukan ada yang beda, tetapi tidak diketahui mana saja yang beda.
- Cara untuk mengetahuinya dilakukan melalui komparasi ganda
- Pada μ_1, μ_2, μ_3 misalnya, komparasi ganda memeriksa semua pasangan $\mu_1 - \mu_2$ $\mu_1 - \mu_3$ $\mu_2 - \mu_3$





Metoda Komparasi Ganda

Ada beberapa metoda komparansi ganda, berupa

- Uji LSD (least significant difference) Fisher
- Uji Scheffe
- Uji HSD (honestly significant difference) Tukey
- Uji Duncan
- Uji Newman-Keuls
- Uji Tukey

Hasilnya bisa berbeda.

Uji Scheffe paling konservatif.



Scheffe untuk membandingkan semua kontras

Montgomery (2001:108)

Misalkan ada sekumpulan m kontras

$$\Gamma_u = c_{1u}\mu_1 + c_{2u}\mu_2 + \cdots + c_{au}\mu_a, \quad u = 1, 2, \dots, m$$

maka rata-rata perlakuan $\bar{y}_{i\bullet}$ adalah :

$$C_u = c_{1u}\bar{y}_{1\bullet} + c_{2u}\bar{y}_{2\bullet} + \cdots + c_{au}\bar{y}_{a\bullet}, \quad u = 1, 2, \dots, m$$

dan sesatan baku dari kontras adalah :

$$S_{C_u} = \sqrt{RK_s \sum_{i=1}^a (c_{iu}^2 / n_i)}$$

dimana n_i adalah jumlah observasi dalam perlakuan ke - i

Jika $|C_u| > S_{\alpha,u}$ maka tolak $\Gamma_u = 0$

dengan

$$S_{\alpha,u} = S_{C_u} \sqrt{(a-1)F_{\alpha,a-1,N-a}}$$



$j=1$	$j=2$	$j=3$	
25.4	23.4	20	
26.31	21.8	22.2	
24.1	23.5	19.75	
23.74	22.75	20.6	
25.1	21.6	20.4	
$y_{1\bullet} = 124.65$	$y_{2\bullet} = 113.05$	$y_{3\bullet} = 102.95$	$y_{\bullet\bullet} = 340.65$
$\bar{y}_{1\bullet} = 24.93$	$\bar{y}_{2\bullet} = 22.61$	$\bar{y}_{3\bullet} = 20.59$	
$C_1 = 2.32$	$C_2 = 2.02$	$C_3 = 4.34$	

$$H_{0_{1-2}} : \mu_1 = \mu_2 \Rightarrow \Gamma_1 = \mu_1 - \mu_2, \quad C_1 = \bar{y}_{1\bullet} - \bar{y}_{2\bullet} = 2.32$$

$$H_{1_{1-2}} : \mu_1 \neq \mu_2$$

$$H_{0_{2-3}} : \mu_2 = \mu_3 \Rightarrow \Gamma_2 = \mu_2 - \mu_3, \quad C_2 = \bar{y}_{2\bullet} - \bar{y}_{3\bullet} = 2.02$$

$$H_{1_{2-3}} : \mu_2 \neq \mu_3$$

$$H_{0_{1-3}} : \mu_1 = \mu_3 \Rightarrow \Gamma_3 = \mu_1 - \mu_3, \quad C_3 = \bar{y}_{1\bullet} - \bar{y}_{3\bullet} = 4.34$$

$$H_{1_{1-3}} : \mu_1 \neq \mu_3$$



$$RK_s = 0.921 \text{ dengan } S_{C_u} = \sqrt{RK_s \sum_{i=1}^a (C_{i1}^2 / n_i)}$$

$$S_{C_1} = \sqrt{0.921(1+1)/5} = 2.789265 = S_{C_2} = S_{C_3}$$

$$S_{\alpha,u} = S_{C_u} \sqrt{(a-1)F_{\alpha,a-1,N-a}}$$

$$\begin{aligned} S_{0.05,1} &= S_{C_1} \sqrt{(3-1)F_{0.05,3-1,15-3}} \\ &= S_{C_1} \sqrt{2F_{0.05,2,12}} = 0.60696 \sqrt{2 \times 3.89} = 1.692971 \end{aligned}$$

$$S_{0.05,1} = S_{0.05,2} = S_{0.05,3} = 1.692971$$



karena $|C_1| = 2.32$, $|C_2| = 2.02$, $|C_3| = 4.34$

dan $S_{0.05,1} = S_{0.05,2} = S_{0.05,3} = 1.692971$

1. Karena $2.32 > 1.692971$ maka tolak $\mu_1 - \mu_2 = 0$ artinya $\mu_1 \neq \mu_2$
2. Karena $2.02 > 1.692971$ maka tolak $\mu_2 - \mu_3 = 0$ artinya $\mu_2 \neq \mu_3$
3. Karena $4.34 > 1.692971$ maka tolak $\mu_1 - \mu_3 = 0$ artinya $\mu_1 \neq \mu_3$

Rata-rata waktu pengisian mesin 1 dan 2 berbeda signifikan

Rata-rata waktu pengisian mesin 2 dan 3 berbeda signifikan

Rata-rata waktu pengisian mesin 1 dan 3 berbeda signifikan



Multiple Comparisons

Dependent Variable:waktu

(I) mesin		(J) mesin	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Scheffe	mesin 1	mesin 2	2.320 [*]	.607	.008	.63	4.01
		mesin 3	4.340 [*]	.607	.000	2.65	6.03
	mesin 2	mesin 1	-2.320 [*]	.607	.008	-4.01	-.63
		mesin 3	2.020 [*]	.607	.020	.33	3.71
	mesin 3	mesin 1	-4.340 [*]	.607	.000	-6.03	-2.65
		mesin 2	-2.020 [*]	.607	.020	-3.71	-.33
LSD	mesin 1	mesin 2	2.320 [*]	.607	.002	1.00	3.64
		mesin 3	4.340 [*]	.607	.000	3.02	5.66
	mesin 2	mesin 1	-2.320 [*]	.607	.002	-3.64	-1.00
		mesin 3	2.020 [*]	.607	.006	.70	3.34
	mesin 3	mesin 1	-4.340 [*]	.607	.000	-5.66	-3.02
		mesin 2	-2.020 [*]	.607	.006	-3.34	-.70

*. The mean difference is significant at the 0.05 level.

Metode Fisher Least Significant Difference (LSD)

→ Untuk menguji $H_0 : \mu_i = \mu_j$

$$t_0 = \frac{\bar{y}_{i\bullet} - \bar{y}_{j\bullet}}{\sqrt{RK_s \left(\frac{1}{n_i} + \frac{1}{n_j} \right)}}$$

tolak H_0 jika $|\bar{y}_{i\bullet} - \bar{y}_{j\bullet}| > t_{\alpha/2, N-a} \sqrt{RK_s \left(\frac{1}{n_i} + \frac{1}{n_j} \right)} = \text{LSD}$

jika $n_1 = n_2 = \dots = n_a = n$ maka $\text{LSD} = t_{\alpha/2, N-a} \sqrt{\frac{2RK_s}{n}}$

Jika $|\bar{y}_{i\bullet} - \bar{y}_{j\bullet}| > \text{LSD}$ maka tolak H_0



$\bar{y}_{i\cdot}$	$\bar{y}_{j\cdot}$	$\bar{y}_{k\cdot}$	
25.4	23.4	20	
26.31	21.8	22.2	
24.1	23.5	19.75	
23.74	22.75	20.6	
25.1	21.6	20.4	
$y_{1\cdot}=124.65$	$y_{2\cdot}=113.05$	$y_{3\cdot}=102.95$	$y_{..}=340.65$
$\bar{y}_{1\cdot}=24.93$	$\bar{y}_{2\cdot}=22.61$	$\bar{y}_{3\cdot}=20.59$	
$C_1=2.32$	$C_2=2.02$	$C_3=4.34$	

$$\bar{y}_{1\cdot} - \bar{y}_{2\cdot} = 2.32$$

$$\bar{y}_{2\cdot} - \bar{y}_{3\cdot} = 2.02$$

$$\bar{y}_{1\cdot} - \bar{y}_{3\cdot} = 4.34$$

$$LSD = t_{\alpha/2, N-a} \sqrt{\frac{2RK_s}{n}} = t_{0.05/2, 12} = t_{0.025, 12} = 2.179 \sqrt{\frac{2 \times 0.921}{5}}$$

Jika $|\bar{y}_{i\cdot} - \bar{y}_{j\cdot}| > LSD$ maka tolak H_0

1. Karena $|2.32| > LSD = 1.322565$ maka H_{01-2} ditolak

2. Karena $|2.02| > LSD = 1.322565$ maka H_{02-3} ditolak

3. Karena $|4.34| > LSD = 1.322565$ maka H_{01-3} ditolak



Note : t 0.25