

Homework: (2 points for each question, 8 points totally)

課程網頁上有一檔案 growth.csv，若幼兒的體重 (weight,單位：公斤) 可能受到出生時的體重 (brthwtkg,單位：公斤)、性別 (gender, 1:male; 2:female，以 female 作為基準組)、年紀 (age,單位：年) 的影響，以 SAS proc mixed 分析之，請配適一個可與 G-side analysis 相等的 R-side analysis，並回答以下各小題：(顯著水準=0.05)

1. ICC=___0.1343___，如何由 Estimated R Matrix 求得？

Estimated R Matrix for id 45					
Row	Col1	Col2	Col3	Col4	Col5
1	1.8093	0.2430	0.2430	0.2430	0.2430
2	0.2430	1.8093	0.2430	0.2430	0.2430
3	0.2430	0.2430	1.8093	0.2430	0.2430
4	0.2430	0.2430	0.2430	1.8093	0.2430
5	0.2430	0.2430	0.2430	0.2430	1.8093

$$ICC = Cor(Y_{1j}, Y_{1l}) = \frac{Cov(Y_{1j}, Y_{1l})}{\sqrt{Var(Y_{1j})Var(Y_{1l})}} = \frac{\sigma_{jl}}{\sqrt{\sigma^2 \sigma^2}}$$

$$= \frac{0.2430}{\sqrt{1.8093 \times 1.8093}} = 0.1343$$

2. Covariance Parameter Estimates 部分，請寫出虛無假說與對立假說，有何結論？

Covariance Parameter Estimates								
Cov Parm	Subject	Estimate	Standard Error	Z Value	Pr > Z	Alpha	Lower	Upper
CS	id	0.2430	0.1566	1.55	0.1208	0.05	-0.06398	0.5499
Residual		1.5664	0.1947	8.04	<.0001	0.05	1.2452	2.0308

$$H_0: \sigma_{jl} = 0 \quad \text{vs.} \quad H_1: \sigma_{jl} \neq 0$$

p-value=0.1208 不拒絕 $H_0(\alpha=0.05)$

結論：重複測量的 covariance 與 0 未達顯著差異，所以可忽略重複測量間的相關性。(Wald's test)

3. 根據 Fit Statistics 第一列所提供的 -2 Res Log Likelihood，請自行計算出 AIC, AICC, BIC

Fit Statistics	
-2 Res Log Likelihood	679.4
AIC (Smaller is Better)	683.4
AICC (Smaller is Better)	683.4
BIC (Smaller is Better)	687.8

$$AIC = -2\log L_R + 2p$$

$$= 679.4 + 2 \times 2 = 683.4$$

$$AICC = -2\log L_R + 2p \left(\frac{N}{N-p} \right)$$

$$= 679.4 + 2 \times 2 \times \left(\frac{198}{198-2} \right) = 683.4$$

$$BIC = -2\log L_R + p\log(n)$$

$$= 679.4 + 2 \times \log(68) = 687.8$$

4. Null Model Likelihood Ratio Test 部分，請寫出虛無假說與對立假說，有何結論？與 Covariance Parameter Estimates 部分的結論一致嗎？

Null Model Likelihood Ratio Test		
DF	Chi-Square	Pr > ChiSq
1	3.15	0.0760

H0: Reduced model(小模式)

$$V = ZGZ' + R = \begin{bmatrix} \sigma^2 & 0 & 0 & \cdots & 0 \\ 0 & \sigma^2 & 0 & \cdots & 0 \\ 0 & 0 & \sigma^2 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & \sigma^2 \end{bmatrix} \quad 5 \times 5$$

(即使忽略重複測量間的相關性也無所謂)

H1: Larger model(大模式)

$$V = ZGZ' + R = \begin{bmatrix} \sigma^2 & \sigma_{jl} & \sigma_{jl} & \cdots & \sigma_{jl} \\ \sigma_{jl} & \sigma^2 & \sigma_{jl} & \cdots & \sigma_{jl} \\ \sigma_{jl} & \sigma_{jl} & \sigma^2 & \cdots & \sigma_{jl} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \sigma_{jl} & \sigma_{jl} & \sigma_{jl} & \cdots & \sigma^2 \end{bmatrix} \quad 5 \times 5$$

(不可忽略重複測量間的相關性)

p-value = 0.0760，不拒絕虛無假設，因此可忽略重複測量間的相關性，與 Covariance Parameter Estimates 部分的結論一致。(Wald's test)

SAS code:

```
proc mixed data=growth cl alpha=0.05 covtest;
class id Gender (ref="2");
model weight=brthwtkg gender age / s;
repeated / type=cs subject=id R rcorr;
run;
```