HW4 Complex Data

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Exercise 1

$$E(\mathbf{Y}_1) = \begin{pmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 5 & 5 \\ 1 & 1 & 15 & 15 \\ 1 & 1 & 30 & 30 \\ 1 & 1 & 45 & 45 \end{pmatrix} \begin{pmatrix} 80.51 \\ 6.075 \\ -0.164 \\ 0.058 \end{pmatrix} = \begin{pmatrix} 86.585 \\ 86.479 \\ 86.055 \\ 84.995 \\ 83.405 \\ 81.815 \end{pmatrix}$$

$Cov(\mathbf{Y}_1):$

$$\begin{pmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 5 \\ 1 & 15 \\ 1 & 30 \\ 1 & 45 \end{pmatrix} \begin{pmatrix} 113.14 & -0.63 \\ -0.63 & 0.01 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 5 \\ 1 & 15 \\ 1 & 30 \\ 1 & 45 \end{pmatrix}' + 19 \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} = \begin{pmatrix} 132.1 & 112.5 & 110 & 103.7 & 94.2 & 84.8 \\ 112.5 & 130.9 & 109.4 & 103.2 & 93.9 & 84.6 \\ 110 & 109.4 & 126.1 & 101.3 & 92.6 & 83.9 \\ 103.7 & 103.2 & 101.3 & 115.5 & 89.3 & 82.1 \\ 94.2 & 93.9 & 92.6 & 89.3 & 103.3 & 79.4 \\ 84.8 & 84.6 & 83.9 & 82.1 & 79.4 & 95.7 \end{pmatrix}$$

$$E(\mathbf{Y}_2) = \begin{pmatrix} 1 & 1 & 0 & 0 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 5 & 5 \\ 1 & 1 & 15 & 15 \\ 1 & 1 & 22 & 22 \\ 1 & 1 & 60 & 60 \end{pmatrix} \begin{pmatrix} 80.51 \\ 6.075 \\ -0.164 \\ 0.058 \end{pmatrix} = \begin{pmatrix} 86.585 \\ 86.479 \\ 86.055 \\ 84.995 \\ 84.253 \\ 80.225 \end{pmatrix}$$

$Cov(\mathbf{Y}_2):$

$$\begin{pmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 5 \\ 1 & 15 \\ 1 & 22 \\ 1 & 60 \end{pmatrix} \begin{pmatrix} 113.14 & -0.63 \\ -0.63 & 0.01 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 5 \\ 1 & 15 \\ 1 & 22 \\ 1 & 60 \end{pmatrix}' + 19 \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} = \begin{pmatrix} 132.1 & 112.5 & 110 & 103.7 & 99.3 & 75.3 \\ 112.5 & 130.9 & 109.4 & 103.2 & 98.9 & 75.3 \\ 110 & 109.4 & 126.1 & 101.3 & 97.2 & 75.2 \\ 103.7 & 103.2 & 101.3 & 115.5 & 93.1 & 74.9 \\ 99.3 & 98.9 & 97.2 & 93.1 & 109.3 & 74.7 \\ 75.3 & 75.3 & 75.2 & 74.9 & 74.7 & 92.5 \end{pmatrix}$$

$$E(\mathbf{Y}_{13}) = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 \\ 1 & 0 & 15 & 0 \\ 1 & 0 & 60 & 0 \end{pmatrix} \begin{pmatrix} 80.51 \\ 6.075 \\ -0.164 \\ 0.058 \end{pmatrix} = \begin{pmatrix} 80.51 \\ 80.346 \\ 78.05 \\ 70.67 \end{pmatrix}$$

$Cov(\mathbf{Y}_{13}):$

$$\begin{pmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 15 \\ 1 & 60 \end{pmatrix} \begin{pmatrix} 113.14 & -0.63 \\ -0.63 & 0.01 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 15 \\ 1 & 60 \end{pmatrix}' + 19 \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} = \begin{pmatrix} 132.1 & 112.5 & 103.7 & 75.3 \\ 112.5 & 130.9 & 103.2 & 75.3 \\ 103.7 & 103.2 & 115.5 & 74.9 \\ 75.3 & 75.3 & 74.9 & 92.5 \end{pmatrix}$$

Exercise 2

```r
# Step 1

j <- 1
coef.hr <- matrix(NA, ncol=4, nrow=0)
for (i in unique(hrunbalanced$id)) {
   tjj <- lm(hr ~ time, data=hrunbalanced, subset = id == i)
   tjj.drug <- unique(hrunbalanced[hrunbalanced$id==i, "drug"])
   coef.hr <- rbind(coef.hr, c(i, tjj.drug, coef(tjj)))
   j <- j + 1
}
colnames(coef.hr) <- c("id", "drug", "Intercept", "Slope")
coef.hr <- data.frame(coef.hr)

# Step 2

hr.int <- lm(Intercept ~ drug, data=coef.hr)
hr.slp <- lm(Slope ~ drug, data=coef.hr)
```

```r
summary(hr.int)
```

```
##
## Call:
## lm(formula = Intercept ~ drug, data = coef.hr)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -27.3357  -4.6227   0.8607   6.2569  19.6306
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   80.451      3.155  25.498   <2e-16 ***
## drugb          6.098      4.462   1.367    0.186
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 10.93 on 22 degrees of freedom
## Multiple R-squared:  0.07825,    Adjusted R-squared:  0.03635
## F-statistic: 1.868 on 1 and 22 DF,  p-value: 0.1856
```

```r
summary(hr.slp)
```

```
##
## Call:
## lm(formula = Slope ~ drug, data = coef.hr)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.38592 -0.04489  0.02057  0.06470  0.23708
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.15903    0.04082  -3.896 0.000778 ***
## drugb        0.05332    0.05773   0.924 0.365737
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1414 on 22 degrees of freedom
## Multiple R-squared:  0.03732,    Adjusted R-squared:  -0.006434
## F-statistic: 0.853 on 1 and 22 DF,  p-value: 0.3657
```

We see that for significance level 0.05, both the mean slopes and the mean intercepts do not differ significantly as the p-values are equal to 0.1856 and 0.3657 respectively.

.	Two-Stage	Mixed Effects
Intercept	80.451(<2e-16)	80.51400(0)
Time	-0.15903(0.000778)	-0.16445(0.0001)
Drug	6.098(0.186)	6.07479(0.1860)
Drug*Time	0.05332(0.365737)	0.05824(0.3041)