P8110: Applied Regression II
Homework #9 [9 points]

Re-analyze the dataset in HW#8 using a random intercept model to assess whether patient's temperature changes with time and whether the trajectory of temperature differs between the two treatment groups conditional on the baseline APACHE score.

1. **Treat time as a categorical variable. Write a random intercept model with the covariates including time, treatment, the interaction term between time and treatment, and APACHE score. [2 points]**

   $Y_{ij} = \beta_0+\beta_1 X_{ij1}+\beta_2 X_{ij2}+\beta_3 X_{ij3}+\beta_4 X_{i4}+\beta_5 X_{i5}+\beta_6 X_{ij1}X_{i4}+\beta_7 X_{ij2}X_{i4}+\beta_8 X_{ij3}X_{i4}+ b_i + \epsilon_{ij}$

   Where

   $$Y_{ij} = \text{patient's temperature}, \qquad j = 1\cdots,4$$
   $$X_{ij1} = \begin{cases} 1, & \text{if time} = 2 \\ 0, & \text{otherwise} \end{cases}, \qquad X_{ij2} = \begin{cases} 1, & \text{if time} = 4 \\ 0, & \text{otherwise} \end{cases},$$
   $$X_{ij3} = \begin{cases} 1, & \text{if time} = 8 \\ 0, & \text{otherwise} \end{cases}, \qquad X_{i4} = \begin{cases} 1, & \text{if treatment B} \\ 0, & \text{if treatment A} \end{cases}$$
   $$X_{i5} = \text{patient's baseline APACHE score}$$

2. **Was the trajectory of change in patient's temperature over time different between the two treatment groups? Perform a statistical test. Show the hypotheses, test statistic, p-value, and conclusion. [3 points]**

   $$H_0 : \beta_6 = \beta_7 = \beta_8 = 0 \text{ vs. } H_\alpha : \text{ not } H_0$$

   The F statistics is $F = 40.32$ with 3 degrees of freedom.

   P-values and Conclusion: The p-value is less than .0001. We reject the null hypothesis and reach the conclusion that the trajectory of temperature over time is significantly different between the two treatments.

3. **Calculate the difference between the two treatment groups for the change in the mean temperature from baseline to 8 hours after entry into study. [2 points]**

The mean temperature at baseline in treatment A is

$$\begin{aligned} E(Y_{i1}|A, time = 0, X_{i5} = x) &= \beta_0 + \beta_1 \times 0 + \beta_2 \times 0 + \beta_3 \times 0 + \beta_4 \times 0 \\ &+ \beta_5 \times x + \beta_6 \times 0 + \beta_7 \times 0 + \beta_8 \times 0 \\ &= \beta_0 + \beta_5 \times x \end{aligned}$$

The mean temperature at 8 hours in treatment A is

$$\begin{aligned} E(Y_{i4}|A, time = 8, X_{i5} = x) &= \beta_0 + \beta_1 \times 0 + \beta_2 \times 0 + \beta_3 \times 1 + \beta_4 \times 0 \\ &+ \beta_5 \times x + \beta_6 \times 0 + \beta_7 \times 0 + \beta_8 \times 0 \\ &= \beta_0 + \beta_3 + \beta_5 \times x \end{aligned}$$

Solution for Fixed Effects

Effect	treatment	time	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept			100.66	0.2186	451	460.47	<.0001
time		2	-0.3228	0.09188	1231	-3.51	0.0005
time		4	-0.3638	0.09250	1231	-3.93	<.0001
time		8	-0.4486	0.09205	1231	-4.87	<.0001
time		0	0	.	.	.	.
treatment	1		-0.1362	0.1818	1231	-0.75	0.4538
treatment	0		0	.	.	.	.
apache			-0.01059	0.01169	1231	-0.91	0.3651
treatment*time	1	2	-0.5448	0.1305	1231	-4.17	<.0001
treatment*time	1	4	-1.0881	0.1326	1231	-8.21	<.0001
treatment*time	1	8	-1.3169	0.1308	1231	-10.07	<.0001
treatment*time	1	0	0	.	.	.	.
treatment*time	0	2	0	.	.	.	.
treatment*time	0	4	0	.	.	.	.
treatment*time	0	8	0	.	.	.	.
treatment*time	0	0	0	.	.	.	.

Therefore, the mean temperature change from baseline to eight hours after entry into study for patients in treatment A group is $\beta_0 + \beta_3 + \beta_5 \times x - (\beta_0 + \beta_5 \times x) = \beta_3$. The estimate is $\hat{\beta}_3 = -0.4486$.

The mean temperature at baseline in treatment B is

$$\begin{aligned} E(Y_{i1}|B, time = 0, X_{i5} = x) &= \beta_0 + \beta_1 \times 0 + \beta_2 \times 0 + \beta_3 \times 0 + \beta_4 \times 1 \\ &+ \beta_5 \times x + \beta_6 \times 0 + \beta_7 \times 0 + \beta_8 \times 0 \\ &= \beta_0 + \beta_4 + \beta_5 \times x \end{aligned}$$

The mean temperature at 8 hours in treatment B is

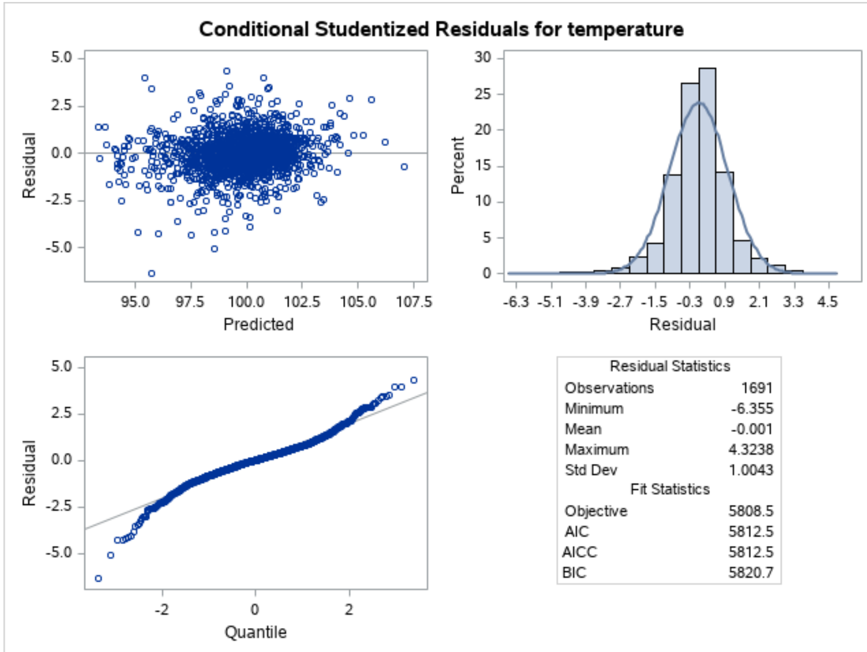
$$\begin{aligned} E(Y_{i4}|B, time = 8, X_{i5} = x) &= \beta_0 + \beta_1 \times 0 + \beta_2 \times 0 + \beta_3 \times 1 + \beta_4 \times 1 \\ &+ \beta_5 \times x + \beta_6 \times 0 + \beta_7 \times 0 + \beta_8 \times 1 \\ &= \beta_0 + \beta_3 + \beta_4 + \beta_5 \times x + \beta_8 \end{aligned}$$

Therefore, the mean temperature change from baseline to eight hours after entry into study for patients in treatment B group is $\beta_0+\beta_3+\beta_4+\beta_5\times x+\beta_8-(\beta_0+\beta_4+\beta_5\times x) = \beta_3 + \beta_8$. The estimate is $\hat{\beta}_3 + \hat{\beta}_8 = -0.4486 - 1.3169 = -1.7655$.

The difference between the two treatment groups for the change in the mean temperature from baseline to 8 hours after entry into study is $\beta_8 + \beta_3 - \beta_3 = \beta_8$, the estimate is $\hat{\beta}_8 = -1.3169$.

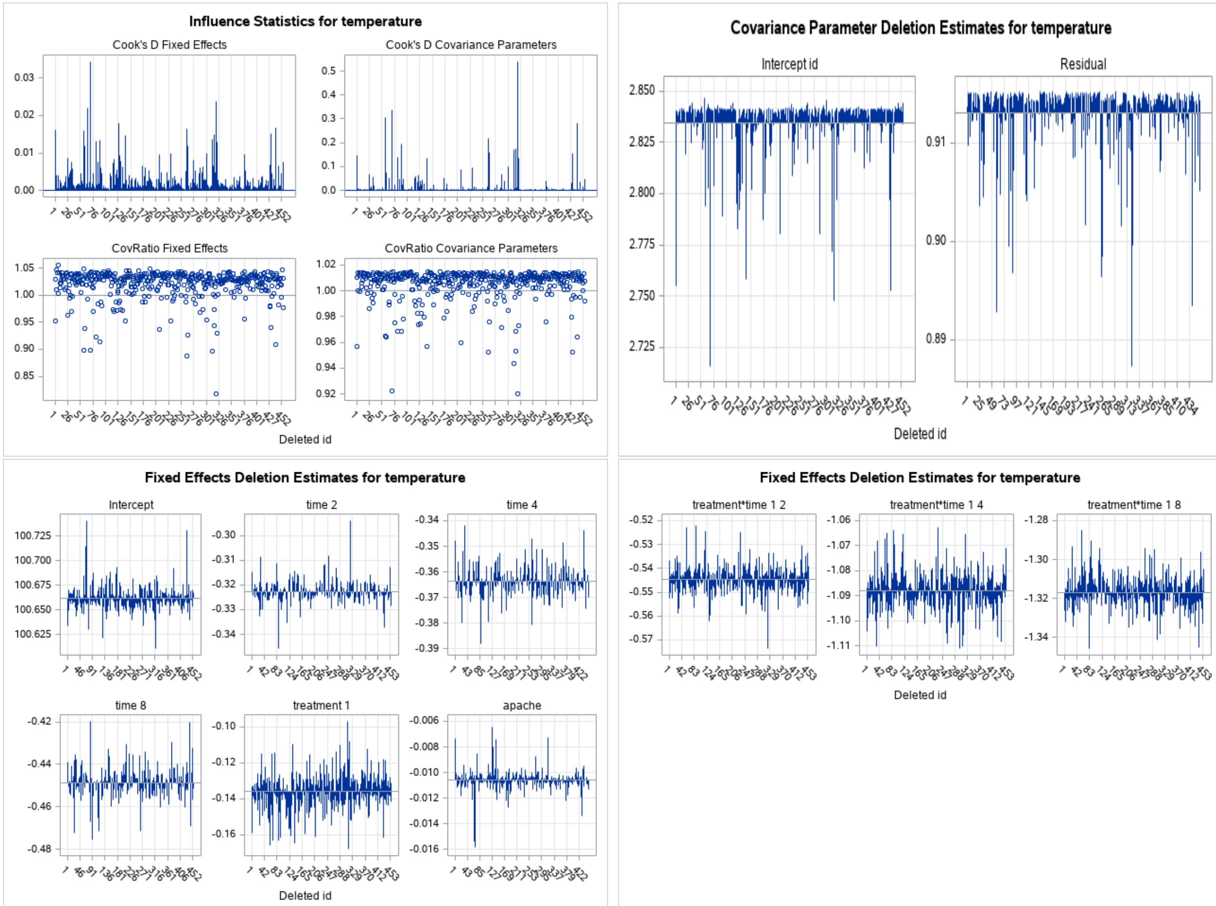
4. **Generate a residual plot with conditional studentized residuals versus predicted values. Is there any special trend between residuals and predicted values? [1 points]**

There does not appear to be a specific trend between residuals and predicted values.



5. **Generate panels of deletion estimates and influence statistics. Any influential observations? [1 points]**

Cook's D is relatively small for all patients, and the plots of deletion estimates show that the parameter estimates do not change much, so influential observations do not seem to be a problem in this analysis.



SAS Code:

```
data sepsis;
infile "HW8.csv" delimiter = ’,’ MISSOVER DSD;
input id Temperature treatment apache time;
run;

title "Temperature over time by Treatment group";
proc sgplot data=sepsis;
   series x=time y=Temperature / group= treatment transparency=0.5;
   xaxis display=(nolabel);
```

```
   keylegend / type=linecolor title="";
run;

proc mixed data = sepsis;
class treatment(ref = "0") id time(ref = "0");
model temperature = time treatment apache time*treatment/s
residual influence(iter=5 effect=id est);
random int / subject = id s;
run;
```