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Statistics 516

Homework 02

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Oxygen Kinetic

1.

a. Code:

```
library("nlstools")
library(ggplot2)
library(trtools)

O2K$z <- ifelse(O2K$t < 5.83, 0, O2K$t - 5.83)
m <- nls(VO2 ~ b1 + (b2 - b1) * (1 - exp(-z/b3)), data = O2K, start
=c(b1 = 350, b2 = 1600, b3 = 1.5/log10(2)))
cbind(summary(m)$coefficient, confint(m))
```

b. Output:

```
   Estimate Std. Error t value  Pr(>|t|)     2.5%    97.5%
b1  354.341   11.80791   30.01 1.567e-25  330.374  378.298
b2 1638.058   23.00805   71.20 1.044e-37 1594.693 1685.270
b3    1.256    0.08336   15.06 2.393e-16    1.106    1.426
```

2.

a. Code:

```
d<-data.frame(t=seq(0,12, by=0.1))
O2K$yhat<-predict(m,newdata = d)
p <- ggplot(O2K, aes(x = t, y = VO2)) + geom_point()
p <- p + xlab("Time (min)") + ylab("Oxygen Uptake (mL/min)")
p <- p + geom_vline(xintercept = 5.83, linetype = 3) + theme_bw()
p <- p + geom_line(aes(y = yhat), data = O2K)
plot(p)
```

b. Output:

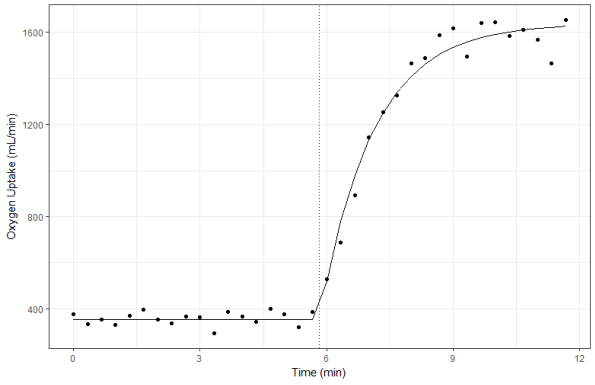

Figure 1 The observed oxygen uptake (solid points) and the expected oxygen uptake (solid line) of the patient at different time point.

3.

a. Code:

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```
lincon(m, a=c(-1,1,0),cnames=FALSE)
```

b. Output:

```
Estimate    SE Lower Upper t value df  Pr(>|t|)
    1284 24.96  1233  1334   51.43 33 4.336e-33
```

c. Discussion:

For $\theta_2 - \theta_1$:

Point estimate: 1284

Standard error: 24.96

Confidence interval: 1233 to 1334

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Iteratively Weighted Least Squares

1.

a. Code:

```
library("Sleuth3")
library(ggplot2)

#Using linear model to estimate the starting values for b0 and b1
m_l<-lm(log(Matings+1) ~ Age, data = case2201)
summary(m_l)$coefficient

#Using non-linear model to estimate the parameters (without weight)
m_nl_1<-nls(Matings ~ exp(b0)*exp(b1*Age), data = case2201, start
= c(b0= -0.70 , b1 = 0.05))
summary(m_nl_1)$coefficient
```

b. Output:

```
#estimated parameters from linear model
             Estimate Std. Error   t value     Pr(>|t|)
(Intercept) -0.69893442 0.45860572 -1.524042 0.1355669855
Age          0.05092569 0.01258602  4.046212 0.0002384544

#estimated parameters from non-linear model _ first iteration
     Estimate Std. Error   t value     Pr(>|t|)
b0 -1.58263684 0.61266676 -2.583194 1.365378e-02
b1  0.06867086 0.01433122  4.791698 2.411212e-05
```

c. Discussion:

From the estimation of linear model, the b0 and b1 were -0.69893442 and 0.05092569. These two value were used as the starting value for building non-linear model. The estimated b0 and b1 from the non-linear model (without weights) were -1.58263684 and 0.06867086.

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2.

a. Code:

```
#estimate the patameters by using Poisson regression model
m_p <- glm(Matings ~ Age, family = poisson, data = case2201)
summary(m_p)$coefficients

#Calculate the weights _ first iteration
d<-data.frame(t=seq(10,60, by=0.1))
case2201$yhat_1<-predict(m_nl_1,newdata = d)
case2201$w_1<-1/predict(m_nl_1,newdata = d)

#Building the second model and re-calculate the weight _ second
iteration
m_nl_2<-nls(Matings ~ exp(b0)*exp(b1*Age), weights = w_1, data =
case2201, start = c(b0= -0.70 , b1 = 0.05))
summary(m_nl_2)$coefficient
case2201$yhat_2<-predict(m_nl_2,newdata = d)
case2201$w_2<-1/predict(m_nl_2,newdata = d)

# Building the third model and re-calculate the weight _ third iteration
m_nl_3<-nls(Matings ~ exp(b0)*exp(b1*Age), weights = w_2, data =
case2201, start = c(b0= -0.70 , b1 = 0.05))
summary(m_nl_3)$coefficient
case2201$w_3<-1/predict(m_nl_3,newdata = d)
```

b. Output:

```
#estimated parameters by using Poisson regression model
             Estimate Std. Error   z value     Pr(>|z|)
(Intercept) -1.58200796 0.54462132 -2.904785 3.675052e-03
Age          0.06869281 0.01374578  4.997375 5.811590e-07

#estimated parameters after third iteration
     Estimate Std. Error   t value     Pr(>|t|)
b0 -1.58200961 0.58590089 -2.700132 1.019847e-02
b1  0.06869285 0.01478762  4.645294 3.809097e-05
```

c. Discussion:

After three iterations, the b0 and b1 from generalized linear models were -1.58200961 and 0.06869285. These estimated parameters agreed with the result which used Poisson regression model, b0 = -1.58200796, b1 = 0.06869281.

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Linear Models by Nonlinear Regression

a. Code:

```
library(MASS)
options(digits = 4)
anorexia$Treat<-relevel(anorexia$Treat, ref="Cont")
anorexia$IfCont<-ifelse(anorexia$Treat=="Cont",1,0)
anorexia$IfCBT<-ifelse(anorexia$Treat=="CBT",1,0)
anorexia$IfFT<-ifelse(anorexia$Treat=="FT",1,0)

#1 Postwt~Treat
m_lm1<-lm(Postwt~Treat, data = anorexia)
summary(m_lm1)$coefficient

m_nls1<-nls(Postwt~b0 + b1*IfCBT + b2*IfFT, data = anorexia,start =
c(b0=81, b1=4.5,b2=10))
summary(m_nls1)$coefficient

#2
m_lm2<-lm(Postwt~Treat-1, data = anorexia)
summary(m_lm2)$coefficient

m_nls2<-nls(Postwt~b0*IfCont + b1*IfCBT + b2*IfFT, data =
anorexia,start = c(b0=81, b1=85,b2=90))
summary(m_nls2)$coefficient

#3
m_lm3<-lm(Postwt~Treat+Prewt, data = anorexia)
summary(m_lm3)$coefficient

m_nls3<-nls(Postwt~b0 + b1*IfCBT + b2*IfFT + b3*Prewt, data =
anorexia,start = c(b0=81, b1=85,b2=90,b3=0.5))
summary(m_nls3)$coefficient

#4
m_lm4<-lm(Postwt~Treat+Prewt-1, data = anorexia)
summary(m_lm4)$coefficient

m_nls4<-nls(Postwt~b0*IfCont + b1*IfCBT + b2*IfFT + b3*Prewt, data
= anorexia,start = c(b0=81, b1=85,b2=90,b3=0.5))
summary(m_nls4)$coefficient

#5
m_lm5<-lm(Postwt~Treat+Prewt+Treat:Prewt, data = anorexia)
summary(m_lm5)$coefficient
```

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```
m_nls5<-nls(Postwt~b0 + b1*IfCBT + b2*IfFT + b3*Prewt +
b4*IfCBT*Prewt + b5*IfFT*Prewt, data = anorexia,start = c(b0=81,
b1=85,b2=90,b3=0.5,b4=1,b5=1))
summary(m_nls5)$coefficient

#6
m_lm6<-lm(Postwt~Treat+Treat:Prewt-1, data = anorexia)
summary(m_lm6)$coefficient

m_nls6<-nls(Postwt~b0*IfCont + b1*IfCBT + b2*IfFT +
b3*IfCont*Prewt + b4*IfCBT*Prewt + b5*IfFT*Prewt, data =
anorexia,start = c(b0=92, b1=15,b2=15,b3=0,b4=1,b5=1))
summary(m_nls6)$coefficient
```

b. Output:

```
#1 Postwt~Treat_lm
             Estimate Std. Error t value  Pr(>|t|)
(Intercept)   81.108      1.429  56.746 1.221e-59
TreatCBT       4.589      1.968   2.331 2.267e-02
TreatFT        9.386      2.273   4.129 1.004e-04

#1 Postwt~Treat_nls
   Estimate Std. Error t value  Pr(>|t|)
b0   81.108      1.429  56.746 1.221e-59
b1    4.589      1.968   2.331 2.267e-02
b2    9.386      2.273   4.129 1.004e-04


#2 Postwt~Treat-1_lm
            Estimate Std. Error t value  Pr(>|t|)
TreatCont    81.11      1.429   56.75 1.221e-59
TreatCBT     85.70      1.353   63.32 7.286e-63
TreatFT      90.49      1.768   51.20 1.261e-56

#2 Postwt~Treat-1_nls
   Estimate Std. Error t value  Pr(>|t|)
b0    81.11      1.429   56.75 1.221e-59
b1    85.70      1.353   63.32 7.286e-63
b2    90.49      1.768   51.20 1.261e-56


#3 Postwt~Treat+Prewt_lm
             Estimate Std. Error t value  Pr(>|t|)
(Intercept)  45.6740    13.2167   3.456 0.0009499
TreatCBT      4.0971     1.8935   2.164 0.0339993
TreatFT       8.6601     2.1931   3.949 0.0001890
Prewt         0.4345     0.1612   2.695 0.0088500

#3 Postwt~Treat+Prewt_nls
   Estimate Std. Error t value  Pr(>|t|)
b0  45.6740    13.2167   3.456 0.0009499
```

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```
b1   4.0971     1.8935   2.164 0.0339993
b2   8.6601     2.1931   3.949 0.0001890
b3   0.4345     0.1612   2.695 0.0088500

#4 Postwt~Treat+Prewt-1_lm
          Estimate Std. Error t value  Pr(>|t|)
TreatCont  45.6740    13.2167   3.456 0.0009499
TreatCBT   49.7711    13.3910   3.717 0.0004101
TreatFT    54.3342    13.5215   4.018 0.0001491
Prewt       0.4345     0.1612   2.695 0.0088500

#4 Postwt~Treat+Prewt-1_nls
b0  45.6740    13.2167   3.456 0.0009499
b1  49.7711    13.3910   3.717 0.0004101
b2  54.3342    13.5215   4.018 0.0001491
b3   0.4345     0.1612   2.695 0.0088500

#5 Postwt~Treat+Prewt+Treat:Prewt_lm
              Estimate Std. Error t value  Pr(>|t|)
(Intercept)     92.0515    18.8085  4.8941 6.672e-06
TreatCBT       -76.4742    28.3470 -2.6978 8.852e-03
TreatFT        -77.2317    33.1328 -2.3310 2.282e-02
Prewt          -0.1342     0.2301 -0.5832 5.617e-01
TreatCBT:Prewt   0.9822     0.3442  2.8532 5.776e-03
TreatFT:Prewt    1.0434     0.4000  2.6087 1.123e-02

#5 Postwt~Treat+Prewt+Treat:Prewt_nls
   Estimate Std. Error t value  Pr(>|t|)
b0  92.0515    18.8085  4.8941 6.672e-06
b1 -76.4742    28.3470 -2.6978 8.852e-03
b2 -77.2317    33.1328 -2.3310 2.282e-02
b3  -0.1342     0.2301 -0.5832 5.617e-01
b4   0.9822     0.3442  2.8532 5.776e-03
b5   1.0434     0.4000  2.6087 1.123e-02

#6 Postwt~Treat+Treat:Prewt-1_lm
               Estimate Std. Error t value  Pr(>|t|)
TreatCont       92.0515    18.8085  4.8941 6.672e-06
TreatCBT        15.5772    21.2083  0.7345 4.653e-01
TreatFT         14.8198    27.2768  0.5433 5.887e-01
TreatCont:Prewt  -0.1342     0.2301 -0.5832 5.617e-01
TreatCBT:Prewt    0.8480     0.2561  3.3117 1.507e-03
TreatFT:Prewt     0.9092     0.3272  2.7791 7.094e-03

#6 Postwt~Treat+Treat:Prewt-1_nls
   Estimate Std. Error t value  Pr(>|t|)
b0  92.0515    18.8085  4.8941 6.672e-06
b1  15.5772    21.2083  0.7345 4.653e-01
b2  14.8198    27.2768  0.5433 5.887e-01
b3  -0.1342     0.2301 -0.5832 5.617e-01
b4   0.8480     0.2561  3.3117 1.507e-03
b5   0.9092     0.3272  2.7791 7.094e-03
```

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c. Discussion:

For all of the six models, all of the estimated parameters (beta-values) from the nls() function were agreed with the parameters from the lm() function. The starting value of the parameters in nls() function used the estimated parameters from the lm() function.