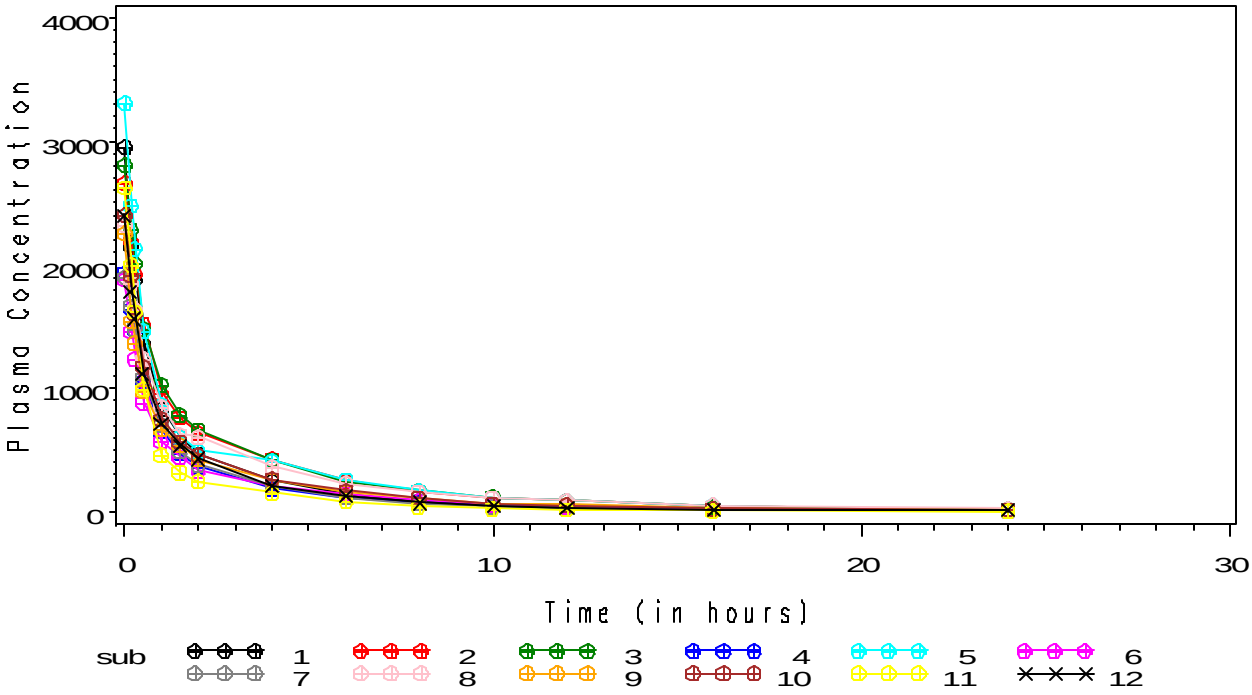
AB Final Exercise E: Data from Nguyen & Amaratunga (2001)

First NLMixed




```
data onea;
  sub=_n_; input gender $ age ht wt @@; age=age/10; male=(gender='m');
    ht=ht/10; wt=wt/10; datalines;
f 690 1570 637 m 668 1650 665 f 677 1630 571 m 737 1670 813 f 680 1490 614 m 736 1890 886
m 678 1690 826 f 732 1650 660 m 665 1780 804 m 656 1735 800 m 668 1700 579 m 735 1740 788
;
data oneb;
  do time=0,1/6,0.25,0.5,1,1.5,2,4,6,8,10,12,16,24;
  do sub=1 to 12;
    input conc @@; output;
  end; end; datalines;
2950 2661 2802 1944 3303 1882 1901 2316 2254 2409 2620 2404
2164 2200 2285 1646 2479 1459 1665 1857 1550 1919 1999 1789
1884 1924 2007 1473 2132 1244 1485 1641 1370 1607 1625 1561
1366 1525 1493 1057 1459  891 1079 1246  976 1185 1004 1122
 844  962 1033  660  863  574  700  856  672  757  457  722
 625  770  790  474  607  452  492  637  551  566  330  545
 478  642  669  366  500  341  386  611  422  461  247  437
 256  433  422  195  417  218  207  361  267  274  158  218
 147  256  243  116  266  150  123  235  165  181   90  136
  88  176  183   80  182   97   75  166  122  115   49   82
  58  119  128   45  124   62   50  122   74   70   35   53
  48   92   95   38   93   46   37   94   59   54   26   40
  26   46   46   18   53   22   20   51   31   32   13   21
  13   24   27   10   25   12   11   32   17   15    5   12
;
proc sort data=onea; by sub; run;
proc sort data=oneb; by sub; run;
data one; merge onea oneb; by sub;
proc nlmixed data=one;
  parms th1=3500 th2=2 se=200;
  mean=th1*exp(-th2*time); vare=se*se;
  model conc ~ normal(mean,vare); run;
```

```
                                The NLMIXED Procedure
                                    Specifications
                Data Set                                    WORK.ONE
                Dependent Variable                          conc
                Distribution for Dependent Variable         Normal
                Optimization Technique                      Dual Quasi-Newton
                Integration Method                          None
                                      Dimensions
                           Observations Used                     168
                           Observations Not Used                   0
                           Total Observations                    168
                           Parameters                              3

                                   Iteration History
                         NOTE: GCONV convergence criterion satisfied.

                                   Fit Statistics
                           -2 Log Likelihood                 2287.1
                           AIC (smaller is better)           2293.1
                           AICC (smaller is better)          2293.2
                           BIC (smaller is better)           2302.4

                                Parameter Estimates
                          Standard
    Parameter  Estimate     Error    DF  t Value  Pr > |t|   Alpha     Lower     Upper  Gradient
    th1         2291.97   49.4204   168    46.38    <.0001    0.05   2194.40   2389.53  3.651E-7
    th2          1.0378   0.05984   168    17.34    <.0001    0.05    0.9197    1.1559  -0.00072
    se           218.72   11.9324   168    18.33    <.0001    0.05    195.17    242.28   -4.6E-7
```

Second NLMixed

```
proc nlmixed data=one;
  *second NLMIXED;
  parms th1=2000 th2=5 th3=600 th4=0.40 se=200;
  mean=th1*exp(-th2*time)+th3*exp(-th4*time); vare=se*se;
  model conc ~ normal(mean,vare);
  predict mean out=two;
run;
data two; set two; res=conc-Pred;
proc plot; plot res*Pred; run;
```

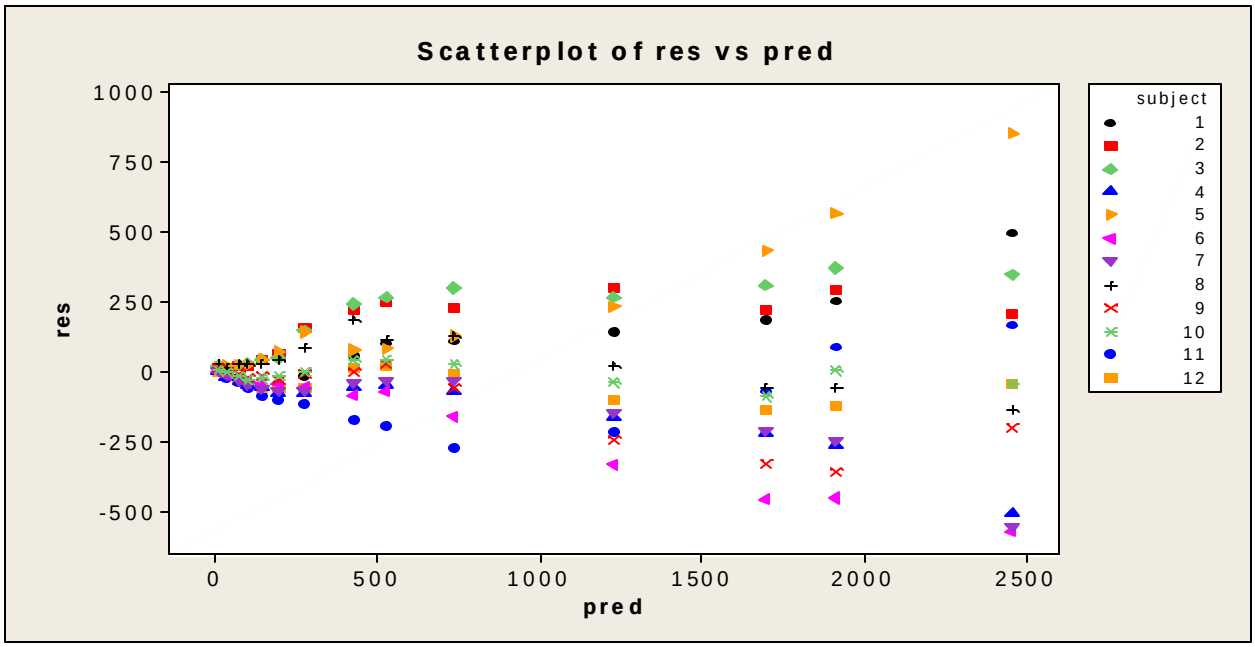
```
                                The NLMIXED Procedure
                                    Specifications
                Data Set                                    WORK.ONE
                Dependent Variable                          conc
                Distribution for Dependent Variable         Normal
                Optimization Technique                      Dual Quasi-Newton
                Integration Method                          None

                                      Dimensions
                           Observations Used                     168
                           Observations Not Used                   0
                           Total Observations                    168
                           Parameters                              5

                                    Parameters
                  th1         th2         th3         th4          se    NegLogLike
                 2000           5         600         0.4         200    1280.60627

                                   Iteration History
                         NOTE: GCONV convergence criterion satisfied.
```

Fit Statistics

-2 Log Likelihood	2222.3
AIC (smaller is better)	2232.3
AICC (smaller is better)	2232.7
BIC (smaller is better)	2247.9

Parameter Estimates

Parameter	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper	Gradient
th1	1912.85	92.5652	168	20.66	<.0001	0.05	1730.11	2095.59	0.00653
th2	1.9308	0.2129	168	9.07	<.0001	0.05	1.5105	2.3510	0.008883
th3	539.75	96.7650	168	5.58	<.0001	0.05	348.72	730.78	-0.00948
th4	0.1701	0.03581	168	4.75	<.0001	0.05	0.09945	0.2408	-0.05658
se	180.38	9.9662	168	18.10	<.0001	0.05	160.71	200.06	-0.00007



Third NLMixed

```
proc nlmixed data=one;
  parms th1=3.5 th2=3.6 th3=.5 th4=.5 se=100 sa=1;
  mean=(th1+u1)*exp(-th2*time)+(th3)*exp(-th4*time);
  vare=se*se; vara=sa*sa;
  model conc ~ normal(mean,vare);
  random u1 ~ normal(0,vara) subject=sub;
run;
```

The NLMIXED Procedure

Specifications

Data Set	WORK.ONE
Dependent Variable	conc
Distribution for Dependent Variable	Normal
Random Effects	u1
Distribution for Random Effects	Normal
Subject Variable	sub
Optimization Technique	Dual Quasi-Newton
Integration Method	Adaptive Gaussian Quadrature

Dimensions

```
                          Observations Used                  168
                          Observations Not Used                0
                          Total Observations                 168
                          Subjects                            12
                          Max Obs Per Subject                 14
                          Parameters                           6
                          Quadrature Points                    1

                                        Parameters
      th1         th2         th3         th4          se          sa    NegLogLike
      3.5         3.6         0.5         0.5         100           1    10266.1595

                                   Iteration History
                        NOTE: GCONV convergence criterion satisfied.

                                    Fit Statistics
                          -2 Log Likelihood                2003.4
                          AIC (smaller is better)          2015.4
                          AICC (smaller is better)         2015.9
                          BIC (smaller is better)          2018.3

                                  Parameter Estimates
                            Standard
Parameter  Estimate        Error     DF  t Value  Pr > |t|   Alpha     Lower     Upper  Gradient
th1         1775.83       131.51     11    13.50    <.0001    0.05   1486.37   2065.28  -0.00137
th2          2.0652      0.09721     11    21.24    <.0001    0.05    1.8513    2.2792  0.003736
th3          647.85      45.1384     11    14.35    <.0001    0.05    548.50    747.20  0.003468
th4          0.2074      0.01810     11    11.46    <.0001    0.05    0.1675    0.2472  0.000283
se           81.4864      4.6146     11    17.66    <.0001    0.05   71.3298   91.6430  -0.00012
sa            426.24     90.0011     11     4.74    0.0006    0.05    228.15    624.34  0.000441
```

Fourth NLMixed

```
proc nlmixed data=one;
  parms th1=2000 th2=5 th3=600 th4=0.40 se=10 rho=2;
  mean=th1*exp(-th2*time)+th3*exp(-th4*time); vare=se*se*mean**rho;
  model conc ~ normal(mean,vare);
  predict mean out=three;
run;
data three; set three; res=conc-pred;
proc plot; plot res*(male age wt ht); run;
```

```
                                The NLMIXED Procedure
                                    Specifications
                Data Set                                    WORK.ONE
                Dependent Variable                          conc
                Distribution for Dependent Variable         Normal
                Optimization Technique                      Dual Quasi-Newton
                Integration Method                          None

                                    Dimensions
                          Observations Used                  168
                          Observations Not Used                0
                          Total Observations                 168
                          Parameters                           6

                                        Parameters
      th1         th2         th3         th4          se         rho    NegLogLike
     2000           5         600         0.4          10           2    13907.1002
```

Iteration History

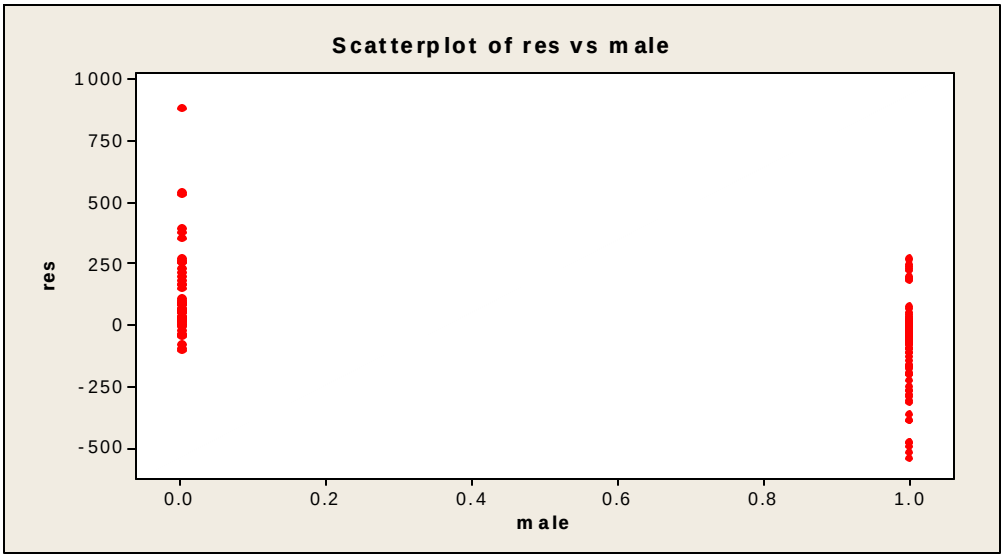
NOTE: GCONV convergence criterion satisfied.

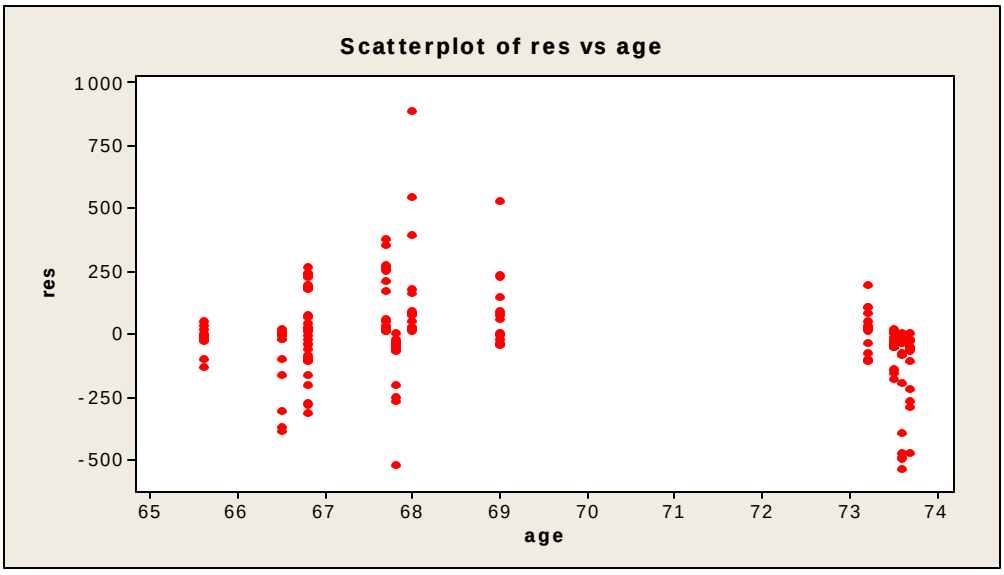
Fit Statistics

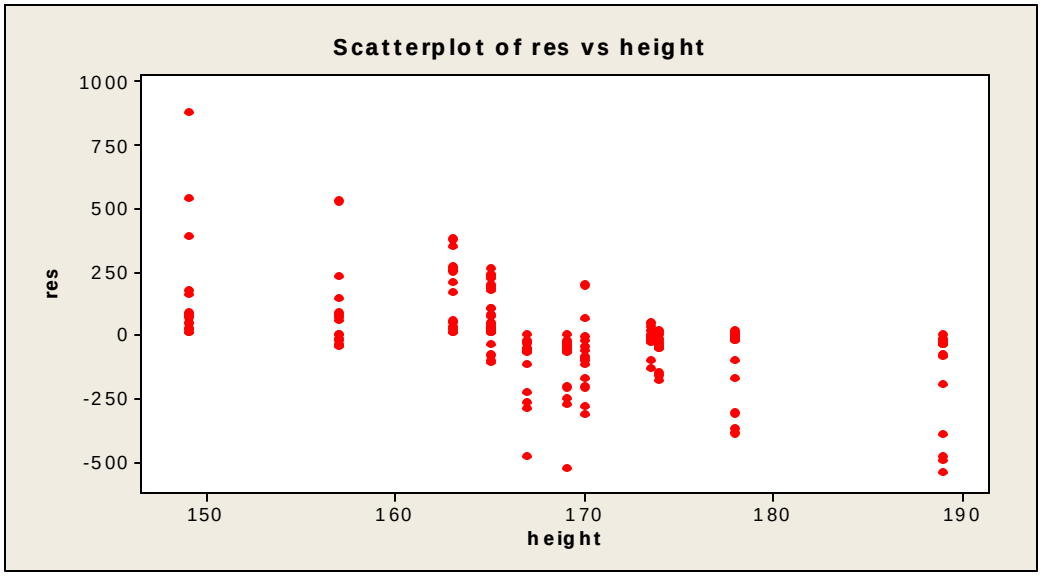
-2 Log Likelihood	1971.7
AIC (smaller is better)	1983.7
AICC (smaller is better)	1984.2
BIC (smaller is better)	2002.5

Parameter Estimates

Parameter	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper	Gradient
th1	1940.49	79.2506	168	24.49	<.0001	0.05	1784.03	2096.94	0.010223
th2	1.6798	0.1672	168	10.05	<.0001	0.05	1.3497	2.0099	-0.05399
th3	480.96	44.1425	168	10.90	<.0001	0.05	393.82	568.11	-0.00472
th4	0.1616	0.009422	168	17.16	<.0001	0.05	0.1430	0.1802	-0.91171
se	1.7592	0.4567	168	3.85	0.0002	0.05	0.8576	2.6608	-0.02292
rho	1.3725	0.08667	168	15.84	<.0001	0.05	1.2014	1.5436	-0.13144







Fifth NLMixed

```
proc nlmixed data=one;
  parms th1a=2000 th1c=0 th1e=0 th2a=5 th2b=0 th3a=600 th4a=0.40 th4b=0 se=10 rho=2;
  th1=th1a+th1c*age+th1e*wt;
  th3=th3a;
  th2=th2a+th2b*male;
  th4=th4a+th4b*male;
  mean=th1*exp(-th2*time)+th3*exp(-th4*time); vare=se*se*mean**rho;
  model conc ~ normal(mean,vare);
  predict mean out=three;
run;
```

The NLMIXED Procedure

Specifications

Data Set	WORK.ONE
Dependent Variable	conc
Distribution for Dependent Variable	Normal
Optimization Technique	Dual Quasi-Newton
Integration Method	None

Dimensions

Observations Used	168
Observations Not Used	0
Total Observations	168
Parameters	10

Iteration History

NOTE: GCONV convergence criterion satisfied.

Fit Statistics

-2 Log Likelihood	1892.1
AIC (smaller is better)	1912.1
AICC (smaller is better)	1913.5
BIC (smaller is better)	1943.3

Parameter Estimates

Parameter	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper	Gradient
th1a	2000.61	1271.17	168	1.57	0.1174	0.05	-508.92	4510.15	-0.00451
th1c	26.9684	18.9381	168	1.42	0.1563	0.05	-10.4189	64.3556	0.002363
th1e	-28.5018	4.5850	168	-6.22	<.0001	0.05	-37.5535	-19.4501	0.000928
th2a	1.6868	0.1636	168	10.31	<.0001	0.05	1.3640	2.0097	-0.00939
th2b	0.4303	0.1649	168	2.61	0.0099	0.05	0.1047	0.7558	-0.00682
th3a	598.16	49.1366	168	12.17	<.0001	0.05	501.15	695.16	0.017896
th4a	0.1599	0.01119	168	14.29	<.0001	0.05	0.1378	0.1820	0.077426
th4b	0.04558	0.009488	168	4.80	<.0001	0.05	0.02685	0.06431	0.006511
se	3.0583	0.9266	168	3.30	0.0012	0.05	1.2291	4.8875	-0.00319
rho	1.1048	0.1061	168	10.41	<.0001	0.05	0.8953	1.3143	-0.03498