

705604096_stats101c_hw5

Jade Gregory

2023-11-08

Question 1

```
births <- read.csv("birthsnewone.csv")
head(births)
```

```
##   X Institution.type Plurality.of.birth Gender Race.of.child Race
## 1 1                1                1     2          1 White
## 2 2                1                1     2          1 White
## 3 3                1                1     2          1 White
## 4 4                1                1     2          2 Black
## 5 5                1                1     1          2 Black
## 6 6                1                1     2          1 White
##   Age.of.father Age.of.mother Education.of.father..years.
## 1           50           24                      12
## 2           19           18                      9
## 3           37           35                      17
## 4           39           31                      11
## 5           20           19                      11
## 6           30           27                      16
##   Education.of.mother..years. Total.Preg BDead Terms Date.LBirth Month.LBirth
## 1                15             2    0    0          32004             3
## 2                9             1    0    0              0             0
## 3               17             2    0    0          112003            11
## 4               16             1    0    0              0             0
## 5               12             1    0    0              0             0
## 6               16             1    0    0              0             0
##   Year.LBirth LOutcome Weeks Prenatal Trimester.Prenatal Visits
## 1          2004         1   38         3              1    10
## 2              0         9   35         3              1     9
## 3          2003         1   38         1              1    20
## 4              0         9   38         6              2    12
## 5              0         9   36         4              2    10
## 6              0         9   40         1              1    20
##   Birth.weight.group Marital Birth.Attendant Numchild Month.Term Year.Term
## 1                5      2                1      1          0          0
## 2                6      2                1      0          0          0
## 3                5      1                1      1          0          0
## 4                5      2                1      0          0          0
## 5                6      2                1      0          0          0
## 6                6      1                1      0          0          0
```

```
##      Low.Birth RaceMom RaceDad Mother.Minority Father.Minority HispMom HispDad
## 1      Norm      1      2      White      Nonwhite      N      N
## 2      Norm      1      1      White      White      N      N
## 3      Norm      1      1      White      White      N      N
## 4      Norm      2      2      Nonwhite      Nonwhite      N      N
## 5      Norm      2      1      Nonwhite      White      N      M
## 6      Norm      1      1      White      White      N      N
##      AveCigs Smoker AveDrink Wt.Gain Birth.Weight..g.
## 1      0      No      0      50      2865.875
## 2     23     Cigs      0      35      3121.250
## 3      0      No      0      24      2667.250
## 4      0      No      0      30      2979.375
## 5      0      No      0      10      3036.125
## 6      0      No      0      37      3092.875
```

```
set.seed(123456789)
i = 1:dim(births)[1]
i.train <- sample(i, 5000, replace = FALSE)
B.train = births[i.train,]
B.test = births[-i.train, ]
head(B.train)
```

```
##      X Institution.type Plurality.of.birth Gender Race.of.child Race
## 4468 4468      1      1      1      8 Other
## 3138 3138      1      1      2      1 White
## 1895 1895      1      1      2      1 White
## 6160 6160      1      1      1      3 Other
## 3051 3051      1      1      2      1 White
## 1580 1580      1      1      1      1 White
##      Age.of.father Age.of.mother Education.of.father..years.
## 4468      36      33      14
## 3138      39      36      3
## 1895      37      42      16
## 6160      27      27      12
## 3051      43      34      6
## 1580      40      37      12
##      Education.of.mother..years. Total.Preg BDead Terms Date.LBirth
## 4468      16      5      0      0      42002
## 3138      3      4      1      0      62005
## 1895      16      2      0      0      72005
## 6160      14      2      0      0      41996
## 3051      6      5      0      2      122001
## 1580      12      1      0      0      0
##      Month.LBirth Year.LBirth LOutcome Weeks Prenatal Trimester.Prenatal Visits
## 4468      4      2002      1      43      2      1      20
## 3138      6      2005      1      38      5      2      10
## 1895      7      2005      1      40      1      1      12
## 6160      4      1996      1      39      4      2      5
## 3051     12      2001      1      42      3      1      11
## 1580      0      0      9      39      2      1      18
##      Birth.weight.group Marital Birth.Attendant Numchild Month.Term Year.Term
## 4468      9      1      1      4      0      0
## 3138      7      1      1      2      0      0
## 1895      7      1      1      1      0      0
```

```
## 6160          7      2          1      1          0          0
## 3051          6      1          1      2          12         1998
## 1580          6      1          1      0          0          0
##      Low.Birth RaceMom RaceDad Mother.Minority Father.Minority HispMom HispDad
## 4468      Norm      8      8      Nonwhite      Nonwhite      N      N
## 3138      Norm      1      1      White      White      M      M
## 1895      Norm      1      1      White      White      N      N
## 6160      Norm      3      3      Nonwhite      Nonwhite      N      N
## 3051      Norm      1      1      White      White      M      M
## 1580      Norm      1      1      White      White      N      N
##      AveCigs  Smoker AveDrink Wt.Gain Birth.Weight..g.
## 4468      0      No      0      11      4568.375
## 3138      0      No      0      15      3887.375
## 1895      0      No      0      26      3688.750
## 6160      0      No      0      40      3773.875
## 3051      0      No      0      28      3461.750
## 1580      0      No      0      27      3376.625
```

a)

```
# linear model
births_lm <- lm(Birth.Weight..g. ~ . - X, data = B.train)
summary(births_lm)
```

```
##
## Call:
## lm(formula = Birth.Weight..g. ~ . - X, data = B.train)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -341.28 -110.94   -0.63  110.16  640.26
##
## Coefficients: (4 not defined because of singularities)
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -1.569e+01  9.397e+01  -0.167  0.867428
## Institution.type -5.565e+00  5.676e+00  -0.980  0.326905
## Plurality.of.birth -4.018e+01  1.121e+01  -3.586  0.000340 ***
## Gender        -9.652e+00  3.937e+00  -2.451  0.014262 *
## Race.of.child  -1.377e+00  4.258e+00  -0.323  0.746361
## RaceOther       2.204e+01  1.777e+01   1.240  0.214853
## RaceWhite       2.323e+01  1.183e+01   1.963  0.049755 *
## Age.of.father   -1.028e-01  4.393e-01  -0.234  0.815029
## Age.of.mother    7.287e-01  5.505e-01   1.324  0.185642
## Education.of.father..years. 1.188e+00  1.033e+00   1.150  0.250132
## Education.of.mother..years. -2.254e-01  1.107e+00  -0.204  0.838683
## Total.Preg       8.398e-01  2.657e+00   0.316  0.751941
## BDead           5.814e+00  1.477e+01   0.394  0.693912
## Terms           8.581e-01  4.421e+00   0.194  0.846124
## Date.LBirth      1.379e-02  5.924e-03   2.329  0.019915 *
## Month.LBirth     -1.386e+02  5.954e+01  -2.328  0.019978 *
## Year.LBirth      NA         NA         NA      NA
## LOutcome         1.756e+00  1.378e+00   1.275  0.202339
## Weeks           1.163e+01  9.639e-01  12.063  < 2e-16 ***
```

```
## Prenatal 1.458e+00 2.879e+00 0.506 0.612723
## Trimester.Prenatal 6.580e-01 8.949e+00 0.074 0.941386
## Visits 6.323e-01 5.818e-01 1.087 0.277123
## Birth.weight.group 4.539e+02 2.337e+00 194.259 < 2e-16 ***
## Marital -6.245e+00 5.215e+00 -1.198 0.231145
## Birth.Attendant 3.349e+00 3.090e+00 1.084 0.278609
## Numchild NA NA NA NA
## Month.Term 2.398e+00 1.055e+00 2.272 0.023103 *
## Year.Term -5.243e-03 4.261e-03 -1.231 0.218502
## Low.BirthNorm 1.838e+01 9.943e+00 1.849 0.064545 .
## RaceMom NA NA NA NA
## RaceDad -2.754e+00 3.630e+00 -0.759 0.448096
## Mother.MinorityWhite NA NA NA NA
## Father.MinorityWhite -3.911e+00 1.186e+01 -0.330 0.741698
## HispMomM 5.205e+01 7.149e+01 0.728 0.466618
## HispMomN 4.028e+01 7.071e+01 0.570 0.568919
## HispMomO 5.914e+01 8.417e+01 0.703 0.482312
## HispMomP 4.567e+01 7.489e+01 0.610 0.542016
## HispMomS 1.337e+01 7.178e+01 0.186 0.852272
## HispMomU 1.277e+02 1.166e+02 1.096 0.273179
## HispDadM -1.439e+01 5.844e+01 -0.246 0.805502
## HispDadN -1.240e+01 5.798e+01 -0.214 0.830603
## HispDadO -2.687e+00 7.261e+01 -0.037 0.970485
## HispDadP -2.529e+01 6.130e+01 -0.413 0.679979
## HispDadS 7.445e+00 5.869e+01 0.127 0.899059
## HispDadU -9.437e+01 1.010e+02 -0.934 0.350319
## AveCigs 8.844e-01 1.140e+00 0.776 0.437911
## SmokerNo 3.159e+01 1.247e+01 2.533 0.011350 *
## AveDrink 5.356e+00 1.396e+01 0.384 0.701223
## Wt.Gain 5.599e-01 1.500e-01 3.734 0.000191 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 137.3 on 4955 degrees of freedom
## Multiple R-squared: 0.95, Adjusted R-squared: 0.9495
## F-statistic: 2138 on 44 and 4955 DF, p-value: < 2.2e-16
```

```
trainres <- residuals(births_lm)
msetrain <- mean(trainres^2)
testpred <- predict(births_lm, newdata = B.test, type = "response")
testres <- B.test$Birth.Weight..g. - testpred
msetest <- mean(testres^2)
print(c(msetrain, msetest))
```

```
## [1] 18691.16 19266.60
```

The training MSE value is 18691.16 and the testing MSE value is 19266.60. Our significant predictors are Plurality.of.birth, Gender, RaceWhite, Date.LBirth, Month.LBirth, Weeks, Birth.weight.group, Month.Term, SmokerNo, and Wt.Gain.

b)

```
baic <- step(births_lm, direction = "backward", data = B.train, k = log(nrow(B.train)))
```

```
## Start: AIC=49562.3
## Birth.Weight..g. ~ (X + Institution.type + Plurality.of.birth +
##   Gender + Race.of.child + Race + Age.of.father + Age.of.mother +
##   Education.of.father..years. + Education.of.mother..years. +
##   Total.Preg + BDead + Terms + Date.LBirth + Month.LBirth +
##   Year.LBirth + LOutcome + Weeks + Prenatal + Trimester.Prenatal +
##   Visits + Birth.weight.group + Marital + Birth.Attendant +
##   Numchild + Month.Term + Year.Term + Low.Birth + RaceMom +
##   RaceDad + Mother.Minority + Father.Minority + HispMom + HispDad +
##   AveCigs + Smoker + AveDrink + Wt.Gain) - X
##
##
## Step: AIC=49562.3
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
##   Race.of.child + Race + Age.of.father + Age.of.mother + Education.of.father..years. +
##   Education.of.mother..years. + Total.Preg + BDead + Terms +
##   Date.LBirth + Month.LBirth + Year.LBirth + LOutcome + Weeks +
##   Prenatal + Trimester.Prenatal + Visits + Birth.weight.group +
##   Marital + Birth.Attendant + Numchild + Month.Term + Year.Term +
##   Low.Birth + RaceMom + RaceDad + Father.Minority + HispMom +
##   HispDad + AveCigs + Smoker + AveDrink + Wt.Gain
##
##
## Step: AIC=49562.3
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
##   Race.of.child + Race + Age.of.father + Age.of.mother + Education.of.father..years. +
##   Education.of.mother..years. + Total.Preg + BDead + Terms +
##   Date.LBirth + Month.LBirth + Year.LBirth + LOutcome + Weeks +
##   Prenatal + Trimester.Prenatal + Visits + Birth.weight.group +
##   Marital + Birth.Attendant + Numchild + Month.Term + Year.Term +
##   Low.Birth + RaceDad + Father.Minority + HispMom + HispDad +
##   AveCigs + Smoker + AveDrink + Wt.Gain
##
##
## Step: AIC=49562.3
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
##   Race.of.child + Race + Age.of.father + Age.of.mother + Education.of.father..years. +
##   Education.of.mother..years. + Total.Preg + BDead + Terms +
##   Date.LBirth + Month.LBirth + Year.LBirth + LOutcome + Weeks +
##   Prenatal + Trimester.Prenatal + Visits + Birth.weight.group +
##   Marital + Birth.Attendant + Month.Term + Year.Term + Low.Birth +
##   RaceDad + Father.Minority + HispMom + HispDad + AveCigs +
##   Smoker + AveDrink + Wt.Gain
##
##
## Step: AIC=49562.3
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
##   Race.of.child + Race + Age.of.father + Age.of.mother + Education.of.father..years. +
##   Education.of.mother..years. + Total.Preg + BDead + Terms +
##   Date.LBirth + Month.LBirth + LOutcome + Weeks + Prenatal +
##   Trimester.Prenatal + Visits + Birth.weight.group + Marital +
```

```

##      Birth.Attendant + Month.Term + Year.Term + Low.Birth + RaceDad +
##      Father.Minority + HispMom + HispDad + AveCigs + Smoker +
##      AveDrink + Wt.Gain
##
##              Df Sum of Sq      RSS      AIC
## - HispDad          6      72187  93528006 49515
## - HispMom          6     144298  93600117 49519
## - Race             2      98359  93554178 49551
## - Trimester.Prenatal 1         102  93455921 49554
## - Terms            1         710  93456529 49554
## - Education.of.mother..years. 1         782  93456601 49554
## - Age.of.father     1        1032  93456851 49554
## - Total.Preg        1        1885  93457704 49554
## - Race.of.child     1        1973  93457792 49554
## - Father.Minority   1        2049  93457868 49554
## - AveDrink          1        2777  93458596 49554
## - BDead             1        2922  93458741 49554
## - Prenatal          1        4833  93460652 49554
## - RaceDad           1       10855  93466675 49554
## - AveCigs           1       11351  93467170 49554
## - Institution.type  1       18131  93473950 49555
## - Birth.Attendant   1       22145  93477964 49555
## - Visits            1       22282  93478101 49555
## - Education.of.father..years. 1       24951  93480770 49555
## - Marital           1       27049  93482868 49555
## - Year.Term         1       28566  93484385 49555
## - LOutcome          1       30665  93486484 49555
## - Age.of.mother     1       33051  93488870 49556
## - Low.Birth         1       64468  93520287 49557
## - Month.Term        1       97397  93553216 49559
## - Month.LBirth      1      102175  93557994 49559
## - Date.LBirth       1      102279  93558098 49559
## - Gender            1      113349  93569168 49560
## - Smoker            1      120984  93576803 49560
## <none>                                93455819 49562
## - Plurality.of.birth 1      242478  93698297 49567
## - Wt.Gain           1      262915  93718734 49568
## - Weeks             1     2744412  96200231 49699
## - Birth.weight.group 1  711743880  805199699 60322
##
## Step:  AIC=49515.06
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
##      Race.of.child + Race + Age.of.father + Age.of.mother + Education.of.father..years. +
##      Education.of.mother..years. + Total.Preg + BDead + Terms +
##      Date.LBirth + Month.LBirth + LOutcome + Weeks + Prenatal +
##      Trimester.Prenatal + Visits + Birth.weight.group + Marital +
##      Birth.Attendant + Month.Term + Year.Term + Low.Birth + RaceDad +
##      Father.Minority + HispMom + AveCigs + Smoker + AveDrink +
##      Wt.Gain
##
##              Df Sum of Sq      RSS      AIC
## - HispMom          6      107670  93635676 49470
## - Race             2      106430  93634437 49504
## - Trimester.Prenatal 1         419  93528426 49507

```

```

## - Terms 1 877 93528883 49507
## - Age.of.father 1 953 93528960 49507
## - Education.of.mother..years. 1 1167 93529174 49507
## - Race.of.child 1 1330 93529336 49507
## - Total.Preg 1 1835 93529841 49507
## - AveDrink 1 2825 93530831 49507
## - Father.Minority 1 3068 93531075 49507
## - BDead 1 3091 93531098 49507
## - Prenatal 1 3789 93531795 49507
## - AveCigs 1 11339 93539345 49507
## - RaceDad 1 12931 93540937 49507
## - Institution.type 1 18019 93546026 49508
## - Birth.Attendant 1 21028 93549035 49508
## - Education.of.father..years. 1 23327 93551334 49508
## - Visits 1 24634 93552640 49508
## - Marital 1 26474 93554481 49508
## - Year.Term 1 28722 93556728 49508
## - LOutcome 1 30161 93558167 49508
## - Age.of.mother 1 32793 93560799 49508
## - Low.Birth 1 66926 93594932 49510
## - Month.Term 1 95182 93623188 49512
## - Month.LBirth 1 101435 93629441 49512
## - Date.LBirth 1 101541 93629547 49512
## - Gender 1 112202 93640208 49513
## - Smoker 1 122868 93650874 49513
## <none> 93528006 49515
## - Plurality.of.birth 1 241320 93769327 49519
## - Wt.Gain 1 262516 93790522 49521
## - Weeks 1 2743592 96271598 49651
## - Birth.weight.group 1 712356771 805884778 60275
##
## Step: AIC=49469.71
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
## Race.of.child + Race + Age.of.father + Age.of.mother + Education.of.father..years. +
## Education.of.mother..years. + Total.Preg + BDead + Terms +
## Date.LBirth + Month.LBirth + LOutcome + Weeks + Prenatal +
## Trimester.Prenatal + Visits + Birth.weight.group + Marital +
## Birth.Attendant + Month.Term + Year.Term + Low.Birth + RaceDad +
## Father.Minority + AveCigs + Smoker + AveDrink + Wt.Gain
##
## Df Sum of Sq RSS AIC
## - Race 2 107021 93742698 49458
## - Trimester.Prenatal 1 288 93635965 49461
## - Age.of.father 1 475 93636151 49461
## - Race.of.child 1 734 93636410 49461
## - Terms 1 1132 93636808 49461
## - Total.Preg 1 1198 93636874 49461
## - Father.Minority 1 2037 93637714 49461
## - AveDrink 1 2387 93638063 49461
## - Education.of.mother..years. 1 3782 93639458 49461
## - BDead 1 4325 93640001 49461
## - Prenatal 1 5005 93640682 49461
## - AveCigs 1 10714 93646390 49462
## - RaceDad 1 12170 93647847 49462

```

```

## - Education.of.father..years. 1 14944 93650620 49462
## - Institution.type 1 18300 93653977 49462
## - Birth.Attendant 1 21014 93656691 49462
## - Visits 1 23401 93659077 49462
## - Marital 1 27930 93663606 49463
## - Year.Term 1 28085 93663761 49463
## - LOutcome 1 28875 93664551 49463
## - Age.of.mother 1 31399 93667075 49463
## - Low.Birth 1 66788 93702464 49465
## - Month.Term 1 97479 93733156 49466
## - Month.LBirth 1 103453 93739130 49467
## - Date.LBirth 1 103574 93739251 49467
## - Gender 1 112599 93748275 49467
## - Smoker 1 134480 93770157 49468
## <none> 93635676 49470
## - Plurality.of.birth 1 240811 93876488 49474
## - Wt.Gain 1 255773 93891449 49475
## - Weeks 1 2761961 96397637 49607
## - Birth.weight.group 1 713057962 806693638 60229
##
## Step: AIC=49458.39
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
## Race.of.child + Age.of.father + Age.of.mother + Education.of.father..years. +
## Education.of.mother..years. + Total.Preg + BDead + Terms +
## Date.LBirth + Month.LBirth + LOutcome + Weeks + Prenatal +
## Trimester.Prenatal + Visits + Birth.weight.group + Marital +
## Birth.Attendant + Month.Term + Year.Term + Low.Birth + RaceDad +
## Father.Minority + AveCigs + Smoker + AveDrink + Wt.Gain
##
##
## Df Sum of Sq RSS AIC
## - Trimester.Prenatal 1 311 93743009 49450
## - Total.Preg 1 412 93743110 49450
## - Age.of.father 1 429 93743127 49450
## - Terms 1 1950 93744648 49450
## - AveDrink 1 2012 93744710 49450
## - RaceDad 1 3421 93746119 49450
## - Prenatal 1 3804 93746502 49450
## - BDead 1 4066 93746764 49450
## - Education.of.mother..years. 1 4645 93747343 49450
## - Education.of.father..years. 1 13769 93756467 49451
## - AveCigs 1 14660 93757358 49451
## - Race.of.child 1 16024 93758721 49451
## - Institution.type 1 17785 93760483 49451
## - Visits 1 19489 93762187 49451
## - Birth.Attendant 1 23628 93766326 49451
## - LOutcome 1 24680 93767378 49451
## - Year.Term 1 28663 93771361 49451
## - Age.of.mother 1 29169 93771867 49451
## - Marital 1 32409 93775107 49452
## - Low.Birth 1 65676 93808374 49453
## - Month.Term 1 97774 93840472 49455
## - Month.LBirth 1 98311 93841009 49455
## - Date.LBirth 1 98423 93841121 49455
## - Gender 1 106409 93849107 49456

```



```

## - Smoker 1 136372 93879070 49457
## <none> 93742698 49458
## - Father.Minority 1 170828 93913526 49459
## - Plurality.of.birth 1 229405 93972103 49462
## - Wt.Gain 1 257318 94000016 49464
## - Weeks 1 2752981 96495679 49595
## - Birth.weight.group 1 718702127 812444825 60247
##
## Step: AIC=49449.89
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
## Race.of.child + Age.of.father + Age.of.mother + Education.of.father..years. +
## Education.of.mother..years. + Total.Preg + BDead + Terms +
## Date.LBirth + Month.LBirth + LOutcome + Weeks + Prenatal +
## Visits + Birth.weight.group + Marital + Birth.Attendant +
## Month.Term + Year.Term + Low.Birth + RaceDad + Father.Minority +
## AveCigs + Smoker + AveDrink + Wt.Gain
##
## Df Sum of Sq RSS AIC
## - Total.Preg 1 418 93743427 49441
## - Age.of.father 1 436 93743444 49441
## - Terms 1 1954 93744963 49441
## - AveDrink 1 2012 93745021 49441
## - RaceDad 1 3374 93746383 49442
## - BDead 1 4106 93747115 49442
## - Education.of.mother..years. 1 4647 93747656 49442
## - Education.of.father..years. 1 13841 93756849 49442
## - AveCigs 1 14682 93757691 49442
## - Prenatal 1 15227 93758235 49442
## - Race.of.child 1 15984 93758993 49442
## - Institution.type 1 17908 93760917 49442
## - Visits 1 19305 93762314 49442
## - Birth.Attendant 1 23521 93766530 49443
## - LOutcome 1 24662 93767671 49443
## - Year.Term 1 28730 93771739 49443
## - Age.of.mother 1 29235 93772244 49443
## - Marital 1 32201 93775210 49443
## - Low.Birth 1 65704 93808712 49445
## - Month.Term 1 97778 93840787 49447
## - Month.LBirth 1 98200 93841209 49447
## - Date.LBirth 1 98315 93841324 49447
## - Gender 1 106355 93849364 49447
## - Smoker 1 136482 93879491 49449
## <none> 93743009 49450
## - Father.Minority 1 170786 93913795 49450
## - Plurality.of.birth 1 229113 93972121 49454
## - Wt.Gain 1 257165 94000174 49455
## - Weeks 1 2752723 96495732 49586
## - Birth.weight.group 1 718704405 812447414 60239
##
## Step: AIC=49441.39
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
## Race.of.child + Age.of.father + Age.of.mother + Education.of.father..years. +
## Education.of.mother..years. + BDead + Terms + Date.LBirth +
## Month.LBirth + LOutcome + Weeks + Prenatal + Visits + Birth.weight.group +

```

```

##      Marital + Birth.Attendant + Month.Term + Year.Term + Low.Birth +
##      RaceDad + Father.Minority + AveCigs + Smoker + AveDrink +
##      Wt.Gain
##
##
##              Df Sum of Sq      RSS      AIC
## - Age.of.father      1         409  93743835 49433
## - AveDrink           1        1992  93745419 49433
## - RaceDad           1        3364  93746791 49433
## - BDead             1        4931  93748358 49433
## - Education.of.mother..years. 1        5448  93748875 49433
## - Terms             1        5450  93748877 49433
## - Education.of.father..years. 1       13864  93757291 49434
## - AveCigs           1       14620  93758047 49434
## - Prenatal          1       15554  93758981 49434
## - Race.of.child      1       16012  93759439 49434
## - Institution.type   1       17965  93761392 49434
## - Visits            1       19086  93762513 49434
## - Birth.Attendant    1       23844  93767270 49434
## - LOutcome          1       24881  93768308 49434
## - Year.Term          1       28698  93772125 49434
## - Age.of.mother      1       31679  93775106 49435
## - Marital           1       32355  93775782 49435
## - Low.Birth         1       65655  93809082 49436
## - Month.Term        1       97638  93841065 49438
## - Gender            1      106026  93849453 49439
## - Month.LBirth      1      114824  93858251 49439
## - Date.LBirth       1      115131  93858558 49439
## - Smoker            1      136147  93879573 49440
## <none>                                93743427 49441
## - Father.Minority   1      170627  93914054 49442
## - Plurality.of.birth 1      228755  93972182 49445
## - Wt.Gain           1      256913  94000340 49447
## - Weeks             1     2752362  96495789 49578
## - Birth.weight.group 1  719960802  813704229 60238
##
## Step:  AIC=49432.9
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
##      Race.of.child + Age.of.mother + Education.of.father..years. +
##      Education.of.mother..years. + BDead + Terms + Date.LBirth +
##      Month.LBirth + LOutcome + Weeks + Prenatal + Visits + Birth.weight.group +
##      Marital + Birth.Attendant + Month.Term + Year.Term + Low.Birth +
##      RaceDad + Father.Minority + AveCigs + Smoker + AveDrink +
##      Wt.Gain
##
##
##              Df Sum of Sq      RSS      AIC
## - AveDrink           1        2042  93745877 49424
## - RaceDad           1        3331  93747166 49425
## - BDead             1        4901  93748736 49425
## - Education.of.mother..years. 1        5317  93749152 49425
## - Terms             1        5492  93749327 49425
## - Education.of.father..years. 1       13637  93757472 49425
## - AveCigs           1       14580  93758415 49425
## - Prenatal          1       15612  93759447 49425
## - Race.of.child      1       16021  93759856 49425

```

```

## - Institution.type          1      17984  93761819 49425
## - Visits                    1      19094  93762929 49425
## - Birth.Attendant           1      24134  93767969 49426
## - LOutcome                  1      24844  93768679 49426
## - Year.Term                 1      28851  93772686 49426
## - Marital                   1      32287  93776122 49426
## - Age.of.mother             1      49416  93793251 49427
## - Low.Birth                 1      65560  93809395 49428
## - Month.Term                1      97762  93841597 49430
## - Gender                    1     106187  93850022 49430
## - Month.LBirth              1     114588  93858424 49430
## - Date.LBirth               1     114894  93858729 49431
## - Smoker                    1     136389  93880224 49432
## <none>                      1          93743835 49433
## - Father.Minority           1     170749  93914584 49433
## - Plurality.of.birth        1     229072  93972907 49437
## - Wt.Gain                   1     257329  94001164 49438
## - Weeks                     1     2752287  96496122 49569
## - Birth.weight.group        1 720072983 813816818 60230
##
## Step: AIC=49424.49
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
##   Race.of.child + Age.of.mother + Education.of.father..years. +
##   Education.of.mother..years. + BDead + Terms + Date.LBirth +
##   Month.LBirth + LOutcome + Weeks + Prenatal + Visits + Birth.weight.group +
##   Marital + Birth.Attendant + Month.Term + Year.Term + Low.Birth +
##   RaceDad + Father.Minority + AveCigs + Smoker + Wt.Gain
##
##              Df Sum of Sq      RSS      AIC
## - RaceDad      1      3319  93749196 49416
## - BDead         1      4865  93750742 49416
## - Education.of.mother..years.  1      5475  93751352 49416
## - Terms         1      5551  93751428 49416
## - Education.of.father..years.  1     13785  93759662 49417
## - AveCigs       1     14594  93760470 49417
## - Prenatal      1     15799  93761676 49417
## - Race.of.child  1     16012  93761889 49417
## - Institution.type  1     17991  93763868 49417
## - Visits        1     19452  93765328 49417
## - Birth.Attendant  1     24071  93769948 49417
## - LOutcome      1     24987  93770864 49417
## - Year.Term     1     28720  93774597 49418
## - Marital       1     32146  93778023 49418
## - Age.of.mother  1     49327  93795204 49419
## - Low.Birth     1     65568  93811445 49419
## - Month.Term    1     97686  93843563 49421
## - Gender        1    106068  93851945 49422
## - Month.LBirth  1    114726  93860603 49422
## - Date.LBirth   1    115037  93860914 49422
## - Smoker        1    135545  93881422 49423
## <none>          1          93745877 49424
## - Father.Minority  1    170753  93916629 49425
## - Plurality.of.birth  1    229292  93975169 49428
## - Wt.Gain       1    257293  94003170 49430

```

```

## - Weeks          1  2751620  96497497 49561
## - Birth.weight.group 1 720144727 813890604 60222
##
## Step: AIC=49416.15
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
##   Race.of.child + Age.of.mother + Education.of.father..years. +
##   Education.of.mother..years. + BDead + Terms + Date.LBirth +
##   Month.LBirth + LOutcome + Weeks + Prenatal + Visits + Birth.weight.group +
##   Marital + Birth.Attendant + Month.Term + Year.Term + Low.Birth +
##   Father.Minority + AveCigs + Smoker + Wt.Gain
##
##
##           Df Sum of Sq      RSS      AIC
## - BDead      1      4749  93753945 49408
## - Terms      1      5360  93754556 49408
## - Education.of.mother..years. 1      5638  93754834 49408
## - Education.of.father..years. 1     14171  93763367 49408
## - AveCigs     1     14597  93763793 49408
## - Race.of.child 1     14598  93763794 49408
## - Prenatal    1     16013  93765209 49408
## - Institution.type 1     17827  93767024 49409
## - Visits      1     19441  93768637 49409
## - Birth.Attendant 1     24414  93773610 49409
## - LOutcome    1     24881  93774077 49409
## - Year.Term   1     29215  93778411 49409
## - Marital     1     34213  93783409 49409
## - Age.of.mother 1     49665  93798861 49410
## - Low.Birth   1     65751  93814947 49411
## - Month.Term  1     98098  93847294 49413
## - Gender      1    106597  93855793 49413
## - Month.LBirth 1    114411  93863607 49414
## - Date.LBirth 1    114718  93863914 49414
## - Smoker      1    134920  93884116 49415
## <none>                93749196 49416
## - Father.Minority 1    188450  93937646 49418
## - Plurality.of.birth 1    229269  93978465 49420
## - Wt.Gain     1    257736  94006932 49421
## - Weeks      1    2760434  96509630 49553
## - Birth.weight.group 1 720144973 813894169 60214
##
## Step: AIC=49407.89
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
##   Race.of.child + Age.of.mother + Education.of.father..years. +
##   Education.of.mother..years. + Terms + Date.LBirth + Month.LBirth +
##   LOutcome + Weeks + Prenatal + Visits + Birth.weight.group +
##   Marital + Birth.Attendant + Month.Term + Year.Term + Low.Birth +
##   Father.Minority + AveCigs + Smoker + Wt.Gain
##
##
##           Df Sum of Sq      RSS      AIC
## - Terms      1      5312  93759257 49400
## - Education.of.mother..years. 1      5928  93759873 49400
## - Education.of.father..years. 1     14167  93768112 49400
## - AveCigs     1     14276  93768221 49400
## - Race.of.child 1     14695  93768640 49400
## - Prenatal    1     15874  93769819 49400

```

```

## - Institution.type          1      17854  93771799 49400
## - Visits                    1      19618  93773563 49400
## - Birth.Attendant          1      24257  93778202 49401
## - LOutcome                  1      24916  93778862 49401
## - Year.Term                 1      29546  93783491 49401
## - Marital                   1      33994  93787939 49401
## - Age.of.mother             1      49944  93803889 49402
## - Low.Birth                 1      66222  93820167 49403
## - Month.Term                1      99633  93853578 49405
## - Gender                    1     106681  93860626 49405
## - Month.LBirth              1     115946  93869891 49406
## - Date.LBirth               1     116268  93870213 49406
## - Smoker                    1     134321  93888266 49407
## <none>                      1          93753945 49408
## - Father.Minority           1     187999  93941945 49409
## - Plurality.of.birth        1     230641  93984586 49412
## - Wt.Gain                    1     256202  94010147 49413
## - Weeks                     1     2758060  96512005 49544
## - Birth.weight.group        1 720729580 814483525 60209
##
## Step: AIC=49399.65
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
##   Race.of.child + Age.of.mother + Education.of.father..years. +
##   Education.of.mother..years. + Date.LBirth + Month.LBirth +
##   LOutcome + Weeks + Prenatal + Visits + Birth.weight.group +
##   Marital + Birth.Attendant + Month.Term + Year.Term + Low.Birth +
##   Father.Minority + AveCigs + Smoker + Wt.Gain
##
##
##      Df Sum of Sq      RSS      AIC
## - Education.of.mother..years.  1      6075  93765332 49391
## - Education.of.father..years.  1     14188  93773445 49392
## - AveCigs                       1     14516  93773773 49392
## - Race.of.child                 1     14818  93774075 49392
## - Prenatal                      1     16064  93775321 49392
## - Institution.type              1     17213  93776470 49392
## - Visits                        1     20245  93779502 49392
## - Birth.Attendant              1     24292  93783550 49392
## - Year.Term                    1     25483  93784740 49392
## - LOutcome                     1     26699  93785956 49393
## - Marital                      1     33840  93793097 49393
## - Age.of.mother                 1     52723  93811981 49394
## - Low.Birth                     1     65726  93824983 49395
## - Month.Term                   1     98744  93858001 49396
## - Gender                       1    106966  93866223 49397
## - Month.LBirth                 1    119492  93878750 49398
## - Date.LBirth                 1    119853  93879110 49398
## - Smoker                      1    132886  93892144 49398
## <none>                          1    93759257 49400
## - Father.Minority              1    185997  93945254 49401
## - Plurality.of.birth           1    230553  93989811 49403
## - Wt.Gain                      1    257252  94016509 49405
## - Weeks                       1    2755086  96514343 49536
## - Birth.weight.group           1 720816314 814575572 60201
##

```

```

## Step: AIC=49391.46
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
## Race.of.child + Age.of.mother + Education.of.father..years. +
## Date.LBirth + Month.LBirth + LOutcome + Weeks + Prenatal +
## Visits + Birth.weight.group + Marital + Birth.Attendant +
## Month.Term + Year.Term + Low.Birth + Father.Minority + AveCigs +
## Smoker + Wt.Gain
##
##
## Df Sum of Sq RSS AIC
## - Education.of.father..years. 1 8115 93773447 49383
## - Race.of.child 1 14468 93779800 49384
## - AveCigs 1 14674 93780006 49384
## - Institution.type 1 17380 93782712 49384
## - Prenatal 1 17548 93782880 49384
## - Visits 1 19458 93784790 49384
## - Birth.Attendant 1 24208 93789540 49384
## - Year.Term 1 25403 93790735 49384
## - LOutcome 1 26096 93791428 49384
## - Marital 1 30796 93796128 49385
## - Age.of.mother 1 48090 93813422 49386
## - Low.Birth 1 65057 93830389 49386
## - Month.Term 1 98464 93863796 49388
## - Gender 1 106335 93871667 49389
## - Month.LBirth 1 122408 93887740 49389
## - Date.LBirth 1 122781 93888113 49389
## - Smoker 1 131729 93897061 49390
## <none> 93765332 49391
## - Father.Minority 1 190772 93956104 49393
## - Plurality.of.birth 1 232889 93998221 49395
## - Wt.Gain 1 253992 94019324 49396
## - Weeks 1 2758518 96523850 49528
## - Birth.weight.group 1 720846582 814611914 60193
##
## Step: AIC=49383.37
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
## Race.of.child + Age.of.mother + Date.LBirth + Month.LBirth +
## LOutcome + Weeks + Prenatal + Visits + Birth.weight.group +
## Marital + Birth.Attendant + Month.Term + Year.Term + Low.Birth +
## Father.Minority + AveCigs + Smoker + Wt.Gain
##
##
## Df Sum of Sq RSS AIC
## - Race.of.child 1 13685 93787132 49376
## - Prenatal 1 13899 93787347 49376
## - AveCigs 1 14308 93787755 49376
## - Institution.type 1 16512 93789959 49376
## - Visits 1 21034 93794481 49376
## - Birth.Attendant 1 24746 93798193 49376
## - Year.Term 1 25598 93799046 49376
## - LOutcome 1 26845 93800292 49376
## - Marital 1 41316 93814763 49377
## - Age.of.mother 1 63752 93837199 49378
## - Low.Birth 1 64453 93837900 49378
## - Month.Term 1 99403 93872850 49380
## - Gender 1 107083 93880531 49381

```

```

## - Month.LBirth      1      120015  93893462 49381
## - Date.LBirth       1      120379  93893826 49381
## - Smoker            1      131250  93904697 49382
## <none>              93773447 49383
## - Father.Minority   1      184276  93957723 49385
## - Plurality.of.birth 1      230833  94004280 49387
## - Wt.Gain           1      262915  94036362 49389
## - Weeks             1      2757559  96531006 49520
## - Birth.weight.group 1 721077915 814851363 60185
##
## Step: AIC=49375.59
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
##   Age.of.mother + Date.LBirth + Month.LBirth + LOutcome + Weeks +
##   Prenatal + Visits + Birth.weight.group + Marital + Birth.Attendant +
##   Month.Term + Year.Term + Low.Birth + Father.Minority + AveCigs +
##   Smoker + Wt.Gain
##
##              Df Sum of Sq      RSS      AIC
## - Prenatal      1      13581  93800713 49368
## - AveCigs       1      14762  93801894 49368
## - Institution.type 1      16199  93803332 49368
## - Visits        1      22104  93809237 49368
## - Birth.Attendant 1      25278  93812410 49368
## - Year.Term     1      25938  93813070 49368
## - LOutcome      1      26718  93813850 49368
## - Marital       1      36472  93823604 49369
## - Age.of.mother  1      61479  93848611 49370
## - Low.Birth     1      62842  93849975 49370
## - Month.Term    1     101497  93888629 49372
## - Gender        1     105691  93892823 49373
## - Month.LBirth  1     121426  93908559 49374
## - Date.LBirth   1     121778  93908910 49374
## - Smoker        1     131618  93918750 49374
## <none>          93787132 49376
## - Plurality.of.birth 1     230966  94018098 49379
## - Wt.Gain       1     264829  94051962 49381
## - Father.Minority 1     315606  94102738 49384
## - Weeks         1     2751432  96538564 49512
## - Birth.weight.group 1 721563829 815350961 60180
##
## Step: AIC=49367.79
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
##   Age.of.mother + Date.LBirth + Month.LBirth + LOutcome + Weeks +
##   Visits + Birth.weight.group + Marital + Birth.Attendant +
##   Month.Term + Year.Term + Low.Birth + Father.Minority + AveCigs +
##   Smoker + Wt.Gain
##
##              Df Sum of Sq      RSS      AIC
## - Visits        1      11844  93812557 49360
## - Institution.type 1      15130  93815843 49360
## - AveCigs       1      16239  93816953 49360
## - Year.Term     1      25037  93825750 49361
## - Birth.Attendant 1      25832  93826545 49361
## - LOutcome      1      27177  93827890 49361

```

```

## - Marital          1      31237  93831950 49361
## - Age.of.mother    1      57555  93858268 49362
## - Low.Birth        1      63031  93863744 49363
## - Month.Term       1     100204  93900917 49365
## - Gender           1     105247  93905960 49365
## - Month.LBirth     1     123752  93924465 49366
## - Date.LBirth      1     124150  93924863 49366
## - Smoker           1     133585  93934299 49366
## <none>              93800713 49368
## - Plurality.of.birth 1     226431  94027144 49371
## - Wt.Gain          1     259700  94060413 49373
## - Father.Minority  1     313555  94114268 49376
## - Weeks            1    2804811  96605524 49507
## - Birth.weight.group 1 721701489 815502202 60172
##
## Step:  AIC=49359.91
## Birth.Weight..g. ~ Institution.type + Plurality.of.birth + Gender +
##   Age.of.mother + Date.LBirth + Month.LBirth + LOutcome + Weeks +
##   Birth.weight.group + Marital + Birth.Attendant + Month.Term +
##   Year.Term + Low.Birth + Father.Minority + AveCigs + Smoker +
##   Wt.Gain
##
##              Df Sum of Sq      RSS    AIC
## - Institution.type    1      15387  93827945 49352
## - AveCigs              1      15589  93828146 49352
## - Year.Term            1      24067  93836624 49353
## - Birth.Attendant      1      24726  93837284 49353
## - LOutcome             1      27936  93840493 49353
## - Marital              1      35910  93848467 49353
## - Age.of.mother        1      62719  93875276 49355
## - Low.Birth            1      63883  93876440 49355
## - Month.Term           1     100944  93913501 49357
## - Gender               1     103729  93916287 49357
## - Month.LBirth         1     121854  93934411 49358
## - Date.LBirth          1     122248  93934805 49358
## - Smoker               1     132062  93944620 49358
## <none>                 93812557 49360
## - Plurality.of.birth  1     216492  94029049 49363
## - Wt.Gain              1     267238  94079795 49366
## - Father.Minority      1     308131  94120688 49368
## - Weeks                1    2840223  96652780 49501
## - Birth.weight.group   1 724336248 818148805 60180
##
## Step:  AIC=49352.21
## Birth.Weight..g. ~ Plurality.of.birth + Gender + Age.of.mother +
##   Date.LBirth + Month.LBirth + LOutcome + Weeks + Birth.weight.group +
##   Marital + Birth.Attendant + Month.Term + Year.Term + Low.Birth +
##   Father.Minority + AveCigs + Smoker + Wt.Gain
##
##              Df Sum of Sq      RSS    AIC
## - AveCigs              1      15461  93843406 49345
## - Birth.Attendant      1      20779  93848723 49345
## - Year.Term            1      24376  93852320 49345
## - LOutcome             1      28311  93856256 49345

```



```

## - Marital          1      36261  93864205 49346
## - Age.of.mother    1      61014  93888959 49347
## - Low.Birth        1      64188  93892133 49347
## - Month.Term       1     101963  93929907 49349
## - Gender           1     103883  93931827 49349
## - Month.LBirth     1     121652  93949597 49350
## - Date.LBirth      1     122067  93950012 49350
## - Smoker           1     131170  93959115 49351
## <none>              93827945 49352
## - Plurality.of.birth 1     216324  94044268 49355
## - Wt.Gain           1     265311  94093256 49358
## - Father.Minority  1     307797  94135742 49360
## - Weeks            1    2838418  96666363 49493
## - Birth.weight.group 1 724355555 818183500 60172
##
## Step:  AIC=49344.52
## Birth.Weight..g. ~ Plurality.of.birth + Gender + Age.of.mother +
##   Date.LBirth + Month.LBirth + LOutcome + Weeks + Birth.weight.group +
##   Marital + Birth.Attendant + Month.Term + Year.Term + Low.Birth +
##   Father.Minority + Smoker + Wt.Gain
##
##              Df Sum of Sq      RSS    AIC
## - Birth.Attendant    1      19197  93862602 49337
## - Year.Term          1      24467  93867873 49337
## - LOutcome           1      28055  93871461 49337
## - Marital            1      37939  93881345 49338
## - Age.of.mother      1      62194  93905600 49339
## - Low.Birth          1      64085  93907491 49339
## - Month.Term         1     101216  93944621 49341
## - Gender             1     104251  93947657 49342
## - Month.LBirth       1     123148  93966554 49343
## - Date.LBirth        1     123545  93966951 49343
## <none>               93843406 49345
## - Smoker             1     216903  94060309 49348
## - Plurality.of.birth 1     217380  94060786 49348
## - Wt.Gain            1     264732  94108138 49350
## - Father.Minority    1     311462  94154868 49353
## - Weeks              1    2839510  96682916 49485
## - Birth.weight.group 1 724659681 818503087 60165
##
## Step:  AIC=49337.02
## Birth.Weight..g. ~ Plurality.of.birth + Gender + Age.of.mother +
##   Date.LBirth + Month.LBirth + LOutcome + Weeks + Birth.weight.group +
##   Marital + Month.Term + Year.Term + Low.Birth + Father.Minority +
##   Smoker + Wt.Gain
##
##              Df Sum of Sq      RSS    AIC
## - Year.Term          1      24508  93887111 49330
## - LOutcome           1      27729  93890332 49330
## - Marital            1      40332  93902935 49331
## - Age.of.mother      1      58287  93920889 49332
## - Low.Birth          1      65040  93927643 49332
## - Month.Term         1     100160  93962763 49334
## - Gender             1     103241  93965843 49334

```

```

## - Month.LBirth      1      124932  93987534 49335
## - Date.LBirth       1      125313  93987915 49335
## <none>              93862602 49337
## - Smoker            1      215182  94077784 49340
## - Plurality.of.birth 1      221646  94084249 49340
## - Wt.Gain            1      265529  94128131 49343
## - Father.Minority    1      312185  94174787 49345
## - Weeks              1      2843149  96705751 49478
## - Birth.weight.group 1 724745910 818608512 60157
##
## Step: AIC=49329.81
## Birth.Weight..g. ~ Plurality.of.birth + Gender + Age.of.mother +
##      Date.LBirth + Month.LBirth + LOutcome + Weeks + Birth.weight.group +
##      Marital + Month.Term + Low.Birth + Father.Minority + Smoker +
##      Wt.Gain
##
##              Df Sum of Sq      RSS      AIC
## - Marital      1      43768  93930878 49324
## - Age.of.mother 1      50898  93938009 49324
## - LOutcome      1      53825  93940936 49324
## - Low.Birth     1      65220  93952331 49325
## - Month.Term    1      77059  93964170 49325
## - Gender        1     102449  93989560 49327
## <none>          93887111 49330
## - Month.LBirth  1     160747  94047858 49330
## - Date.LBirth   1     161547  94048658 49330
## - Plurality.of.birth 1     220439  94107549 49333
## - Smoker        1     224417  94111528 49333
## - Wt.Gain        1     265149  94152260 49335
## - Father.Minority 1     321839  94208949 49338
## - Weeks          1     2836720  96723830 49470
## - Birth.weight.group 1 724874363 818761474 60150
##
## Step: AIC=49323.62
## Birth.Weight..g. ~ Plurality.of.birth + Gender + Age.of.mother +
##      Date.LBirth + Month.LBirth + LOutcome + Weeks + Birth.weight.group +
##      Month.Term + Low.Birth + Father.Minority + Smoker + Wt.Gain
##
##              Df Sum of Sq      RSS      AIC
## - LOutcome      1      54634  93985512 49318
## - Low.Birth     1      67641  93998519 49319
## - Month.Term    1      79645  94010523 49319
## - Gender        1      98196  94029074 49320
## - Age.of.mother 1      98554  94029433 49320
## - Month.LBirth  1     158340  94089219 49324
## - Date.LBirth   1     159163  94090041 49324
## <none>          93930878 49324
## - Plurality.of.birth 1     219310  94150188 49327
## - Smoker        1     257866  94188744 49329
## - Wt.Gain        1     269634  94200513 49329
## - Father.Minority 1     417827  94348706 49337
## - Weeks          1     2823835  96754713 49463
## - Birth.weight.group 1 725474487 819405365 60145
##

```

```

## Step: AIC=49318.01
## Birth.Weight..g. ~ Plurality.of.birth + Gender + Age.of.mother +
##   Date.LBirth + Month.LBirth + Weeks + Birth.weight.group +
##   Month.Term + Low.Birth + Father.Minority + Smoker + Wt.Gain
##
##           Df Sum of Sq      RSS   AIC
## - Month.Term      1      44649  94030161 49312
## - Low.Birth       1      69639  94055151 49313
## - Age.of.mother   1      93137  94078649 49314
## - Gender          1      97946  94083458 49315
## - Month.LBirth    1     122913  94108425 49316
## - Date.LBirth     1     125494  94111007 49316
## <none>                        93985512 49318
## - Plurality.of.birth 1     219747  94205259 49321
## - Smoker          1     264548  94250060 49324
## - Wt.Gain         1     273825  94259337 49324
## - Father.Minority 1     418325  94403837 49332
## - Weeks           1     2838109  96823622 49458
## - Birth.weight.group 1 725494812 819480324 60137
##
## Step: AIC=49311.87
## Birth.Weight..g. ~ Plurality.of.birth + Gender + Age.of.mother +
##   Date.LBirth + Month.LBirth + Weeks + Birth.weight.group +
##   Low.Birth + Father.Minority + Smoker + Wt.Gain
##
##           Df Sum of Sq      RSS   AIC
## - Low.Birth      1      69359  94099520 49307
## - Gender         1      97951  94128111 49309
## - Age.of.mother  1     104716  94134876 49309
## - Month.LBirth   1     120773  94150933 49310
## - Date.LBirth    1     123388  94153548 49310
## <none>                        94030161 49312
## - Plurality.of.birth 1     221836  94251997 49315
## - Smoker         1     259368  94289529 49317
## - Wt.Gain        1     274804  94304965 49318
## - Father.Minority 1     413927  94444087 49325
## - Weeks          1     2846343  96876504 49452
## - Birth.weight.group 1 725471260 819501421 60129
##
## Step: AIC=49307.04
## Birth.Weight..g. ~ Plurality.of.birth + Gender + Age.of.mother +
##   Date.LBirth + Month.LBirth + Weeks + Birth.weight.group +
##   Father.Minority + Smoker + Wt.Gain
##
##           Df Sum of Sq      RSS   AIC
## - Gender         1      92568  94192087 49303
## - Age.of.mother  1     103500  94203020 49304
## - Month.LBirth   1     125520  94225039 49305
## - Date.LBirth    1     128173  94227692 49305
## <none>                        94099520 49307
## - Smoker        1     254582  94354102 49312
## - Wt.Gain        1     263837  94363356 49313
## - Plurality.of.birth 1     283464  94382984 49314
## - Father.Minority 1     410441  94509960 49320

```

```
## - Weeks          1    3124080    97223600 49462
## - Birth.weight.group 1  969829850 1063929370 61425
##
## Step: AIC=49303.44
## Birth.Weight..g. ~ Plurality.of.birth + Age.of.mother + Date.LBirth +
##      Month.LBirth + Weeks + Birth.weight.group + Father.Minority +
##      Smoker + Wt.Gain
##
##              Df Sum of Sq      RSS    AIC
## - Age.of.mother      1    109825   94301912 49301
## - Month.LBirth       1    126943   94319030 49302
## - Date.LBirth        1    129582   94321669 49302
## <none>                                94192087 49303
## - Smoker             1    246499   94438586 49308
## - Wt.Gain            1    262546   94454633 49309
## - Plurality.of.birth 1    272977   94465064 49309
## - Father.Minority    1    416028   94608116 49317
## - Weeks              1    3054509   97246596 49454
## - Birth.weight.group 1  987448021 1081640108 61499
##
## Step: AIC=49300.75
## Birth.Weight..g. ~ Plurality.of.birth + Date.LBirth + Month.LBirth +
##      Weeks + Birth.weight.group + Father.Minority + Smoker + Wt.Gain
##
##              Df Sum of Sq      RSS    AIC
## <none>                                94301912 49301
## - Month.LBirth       1    181007   94482919 49302
## - Date.LBirth        1    185172   94487084 49302
## - Wt.Gain            1    252564   94554475 49306
## - Plurality.of.birth 1    257421   94559333 49306
## - Smoker             1    300389   94602300 49308
## - Father.Minority    1    451275   94753187 49316
## - Weeks              1    2989685   97291597 49448
## - Birth.weight.group 1  992387326 1086689238 61514
```

Our predictors are Plurality.of.birth, Date.LBirth, Month.LBirth, Weeks, Birth.weight.group, Father.Minority, Smoker, and Wt.Gain.

```
biclm <- lm(Birth.Weight..g. ~ Plurality.of.birth + Date.LBirth + Month.LBirth + Weeks + Birth.weight.g
btrares <- residuals(biclm)
msebictra <- mean(btrares^2)
bictespred <- predict(biclm, newdata = B.test, type = "response")
bictesres <- B.test$Birth.Weight..g. - bictespred
msebictes <- mean(bictesres^2)
print(c(msebictra, msebictes))
```

```
## [1] 18860.38 19267.97
```

Our training MSE is 18860.38 and our testing MSE is 19267.97.

c)

```
library(tidyr)
```

```
i <- seq(10, -2, length = 100)
lambda.v <- 10^i
B.train2 <- na.omit(B.train)
x <- model.matrix(Birth.Weight..g. ~., data = B.train2)
y <- B.train2$Birth.Weight..g.
library(glmnet)
```

```
## Loading required package: Matrix
```

```
##
```

```
## Attaching package: 'Matrix'
```

```
## The following objects are masked from 'package:tidyr':
```

```
##
```

```
##      expand, pack, unpack
```

```
## Loaded glmnet 4.1-8
```

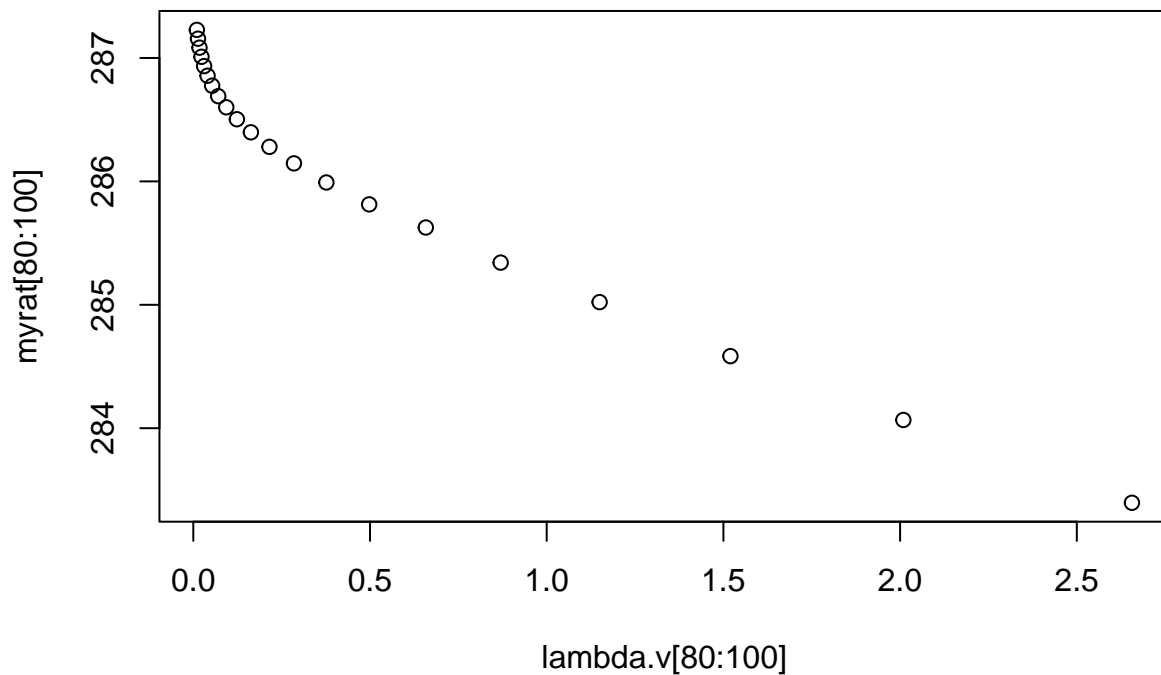
```
model.ridge <- glmnet(x, y, alpha = 0, lambda = lambda.v)
coeffs <- coef(model.ridge)
summary(model.ridge)
```

```
##           Length Class      Mode
## a0          100   -none-   numeric
## beta        5000 dgCMatrix S4
## df           100   -none-   numeric
## dim           2   -none-   numeric
## lambda       100   -none-   numeric
## dev.ratio    100   -none-   numeric
## nulldev       1   -none-   numeric
## npasses       1   -none-   numeric
## jerr          1   -none-   numeric
## offset        1   -none-   logical
## call          5   -none-    call
## nobs          1   -none-   numeric
```

```
my.l2=function(betas){#calculate l2 norm
  sqrt(sum(betas^2))}
ls2=c()
for (i in 1:100){
  ls2=c(ls2, my.l2(coeffs[-c(1,2),i]))
}
nvars <- sapply(B.train2, is.numeric)
B.train2[, nvars] <- scale(B.train2[, nvars])
cvars <- sapply(B.train2, is.factor)
B.train2[, cvars] <- lapply(B.train2[, cvars], as.factor)

ls1m2 <- lm(Birth.Weight..g. ~. - X, data = B.train2)
lscoeff <- coef(ls1m2)
```

```
ls2ls <- sqrt(sum(lscoeff^2, na.rm = TRUE))
myrat <- ls2 / ls2ls
plot(lambda.v[80:100], myrat[80:100])
```



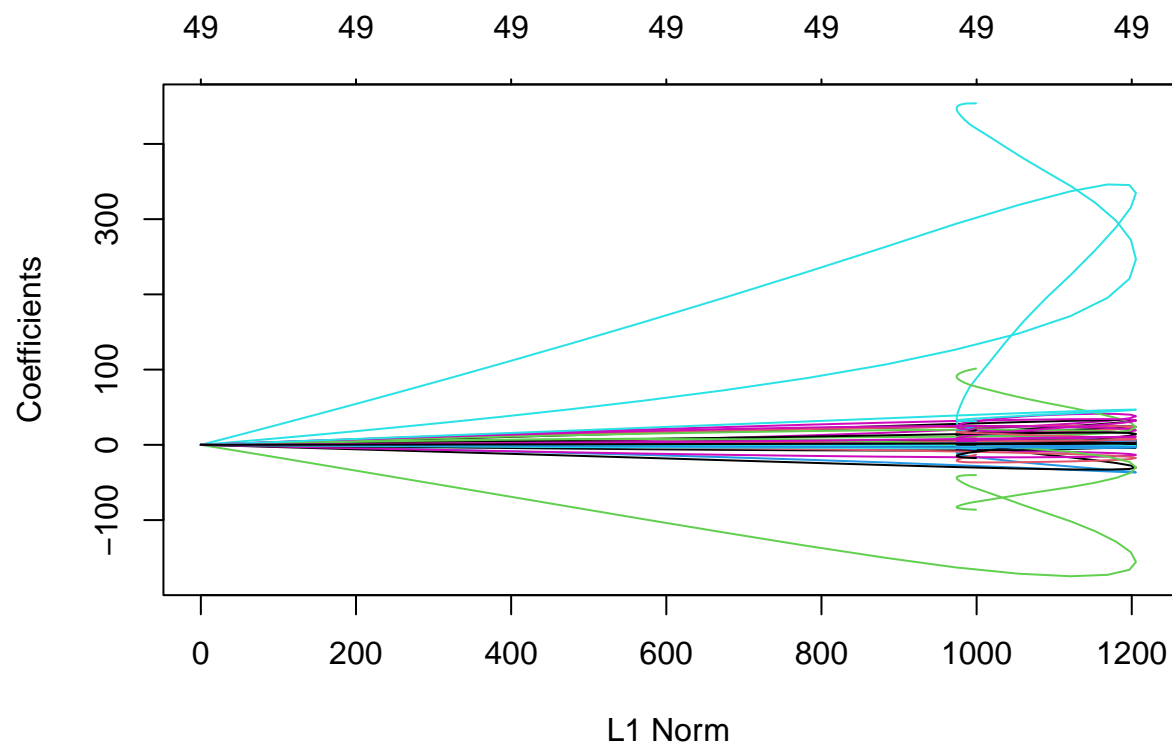
d)

```
births2 <- na.omit(births)
x2 <- model.matrix(Birth.Weight..g. ~., data = births2)
y2 <- births2$Birth.Weight..g.
model.ridgeD <- glmnet(x2, y2, alpha = 0, lambda = lambda.v)

cv.output <- cv.glmnet(x2, y2, alpha = 0)
bestlamb.cv <- cv.output$lambda.min
bestlamb.cv
```

```
## [1] 59.2054
```

```
plot(model.ridge)
```



```
predict(model.ridge, s = bestlamb.cv, type = "coefficients")
```

```
## 51 x 1 sparse Matrix of class "dgCMatrix"
##                                s1
## (Intercept)                   -2.060555e+01
## (Intercept)                    .
## X                              -4.609058e-04
## Institution.type                -2.782779e+00
## Plurality.of.birth              -8.126657e+01
## Gender                         -2.363450e+01
## Race.of.child                  -2.049804e+00
## RaceOther                      3.797995e+01
## RaceWhite                     1.826087e+01
## Age.of.father                  -1.412324e-01
## Age.of.mother                  9.368317e-01
## Education.of.father..years.    1.065590e+00
## Education.of.mother..years.    4.667246e-01
## Total.Preg                     1.670249e+00
## BDead                          -1.006281e+01
## Terms                          -8.302623e-02
## Date.LBirth                   -1.348135e-05
## Month.LBirth                  -1.785167e-01
## Year.LBirth                   9.546778e-03
## LOutcome                      -3.577580e-01
## Weeks                         2.100389e+01
```

```
## Prenatal 1.850477e+00
## Trimester.Prenatal 1.422657e+00
## Visits 1.685469e+00
## Birth.weight.group 3.790149e+02
## Marital -8.185507e+00
## Birth.Attendant 3.394173e+00
## Numchild 3.293045e+00
## Month.Term 1.472424e+00
## Year.Term -5.763737e-03
## Low.BirthNorm 1.671969e+02
## RaceMom -1.430640e+00
## RaceDad -3.657019e+00
## Mother.MinorityWhite 1.528483e+01
## Father.MinorityWhite 7.124797e-01
## HispMomM 1.112560e+01
## HispMomN 1.168769e+00
## HispMomO 1.669442e+01
## HispMomP 5.616878e+00
## HispMomS -2.297909e+01
## HispMomU 6.143068e+01
## HispDadM -4.490871e+00
## HispDadN -8.926580e-01
## HispDadO 1.912022e+01
## HispDadP -1.585868e+00
## HispDadS 1.324729e+01
## HispDadU -6.505606e+01
## AveCigs -8.349677e-01
## SmokerNo 3.882933e+01
## AveDrink 8.260591e+00
## Wt.Gain 1.299796e+00
```

Our best lambda is 59.2054. All 49 of our coefficients survived.

e)

```
model.lasso <- glmnet(x, y, alpha = 1, lambda = lambda.v)
summary(model.lasso)
```

```
##      Length Class      Mode
## a0      100  -none-    numeric
## beta    5000 dgCMatrix S4
## df       100  -none-    numeric
## dim        2  -none-    numeric
## lambda    100  -none-    numeric
## dev.ratio 100  -none-    numeric
## nulldev    1  -none-    numeric
## npasses    1  -none-    numeric
## jerr        1  -none-    numeric
## offset     1  -none-   logical
## call        5  -none-     call
## nobs        1  -none-    numeric
```

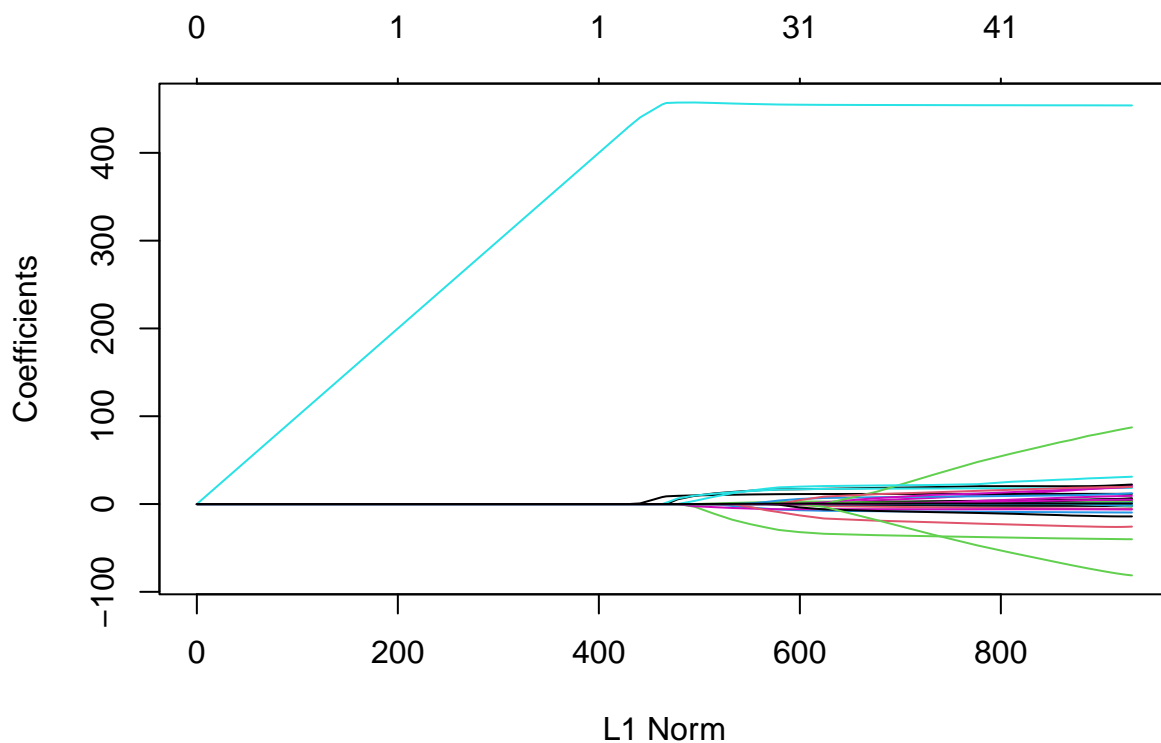
f)


```
lassocv.output <- cv.glmnet(x, y, alpha = 1)
bestlamb.lasso <- lassocv.output$lambda.min
bestlamb.lasso
```

```
## [1] 2.040796
```

```
plot(model.lasso)
```

```
## Warning in regularize.values(x, y, ties, missing(ties), na.rm = na.rm):
## collapsing to unique 'x' values
```



```
predict(model.lasso, s = bestlamb.lasso, type = "coefficients")
```

```
## 51 x 1 sparse Matrix of class "dgCMatrix"
##                                     s1
## (Intercept)                      66.700777616
## (Intercept)                       .
## X                                  .
## Institution.type                   .
## Plurality.of.birth                -26.387747604
## Gender                           -5.196197186
## Race.of.child                     .
## RaceOther                         .
```

## RaceWhite	16.106093752
## Age.of.father	.
## Age.of.mother	0.476217080
## Education.of.father..years.	.
## Education.of.mother..years.	.
## Total.Preg	.
## BDead	.
## Terms	.
## Date.LBirth	.
## Month.LBirth	.
## Year.LBirth	0.003977686
## LOutcome	.
## Weeks	11.082973930
## Prenatal	.
## Trimester.Prenatal	.
## Visits	.
## Birth.weight.group	455.344178464
## Marital	-5.680616939
## Birth.Attendant	.
## Numchild	.
## Month.Term	0.356460904
## Year.Term	.
## Low.BirthNorm	15.662864968
## RaceMom	.
## RaceDad	.
## Mother.MinorityWhite	0.139530453
## Father.MinorityWhite	2.038226328
## HispMomM	2.198330382
## HispMomN	.
## HispMomO	.
## HispMomP	.
## HispMomS	-6.756501604
## HispMomU	.
## HispDadM	.
## HispDadN	.
## HispDadO	.
## HispDadP	.
## HispDadS	.
## HispDadU	.
## AveCigs	.
## SmokerNo	17.333977044
## AveDrink	.
## Wt.Gain	0.367069557

Our best lambda is 2.040796. 26 predictors were removed in this model, leaving 23 predictors.

The Ridge Regression did not eliminate any predictors while the Lasso Regression eliminated around half of the predictors. The Lasso Regression model is more rigid than our Ridge Regression model, with the Ridge Regression Model being more flexible. Therefore, our Ridge Regression model will produce less accurate predictions but with less bias, while our Lasso Regression will produce more accurate predictions with higher bias.