Project 2 Code

```r
getwd()
```

```
## [1] "C:/Users/Darian/Documents/Project2Files"
```

```r
wdir <- "C:\\Users\\Darian\\Documents\\Project2Files"
setwd(wdir)
Project2 <- read.csv('Project2File.csv', header = TRUE)
View(Project2)
library(mice)
```

```
##
## Attaching package: 'mice'

## The following object is masked from 'package:stats':
##
##     filter

## The following objects are masked from 'package:base':
##
##     cbind, rbind
```

```r
md.pattern(Project2)
```

```
##  /\     /\
## {  '---'  }
## {  O   O  }
## ==>  V <==  No need for mice. This data set is completely observed.
## \  \|/  /
##   '-----'
```

```
##       Y E1 E2 E3 E4 G1 G2 G3 G4 G5 G6 G7 G8 G9 G10 G11 G12 G13 G14 G15 G16 G17
## 1335 1  1  1  1  1  1  1  1  1  1  1  1  1  1   1   1   1   1   1   1   1   1
##       0  0  0  0  0  0  0  0  0  0  0  0  0  0   0   0   0   0   0   0   0   0
##       G18 G19 G20
## 1335   1   1   1 0
##        0   0   0 0
```

```r
# so there's no missing data!
#Fit a model with only environmental variables
M_E <- lm(Y ~ E1+E2+E3+E4, data=Project2)
summary(M_E)
```
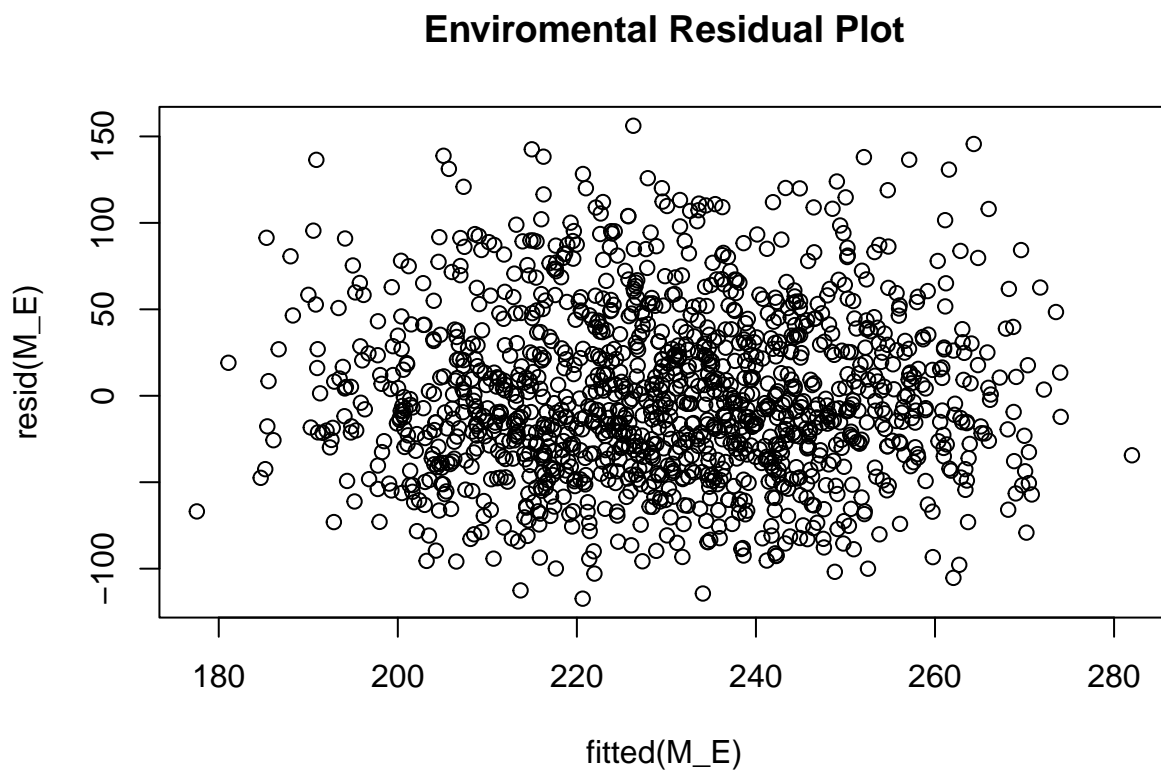
```
##
## Call:
## lm(formula = Y ~ E1 + E2 + E3 + E4, data = Project2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -117.340  -33.634   -6.576   30.291  156.161
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  52.4416    13.7526   3.813 0.000143 ***
## E1            5.4026     0.9497   5.689 1.57e-08 ***
## E2            8.5733     0.9323   9.196  < 2e-16 ***
```

```
## E3              7.5022      0.9292    8.074 1.51e-15 ***
## E4              2.1189      0.9379    2.259 0.024028 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 48.71 on 1330 degrees of freedom
## Multiple R-squared:   0.13,  Adjusted R-squared:  0.1274
## F-statistic: 49.69 on 4 and 1330 DF,  p-value: < 2.2e-16
```

```r
summary(M_E)$adj.r.squared
```
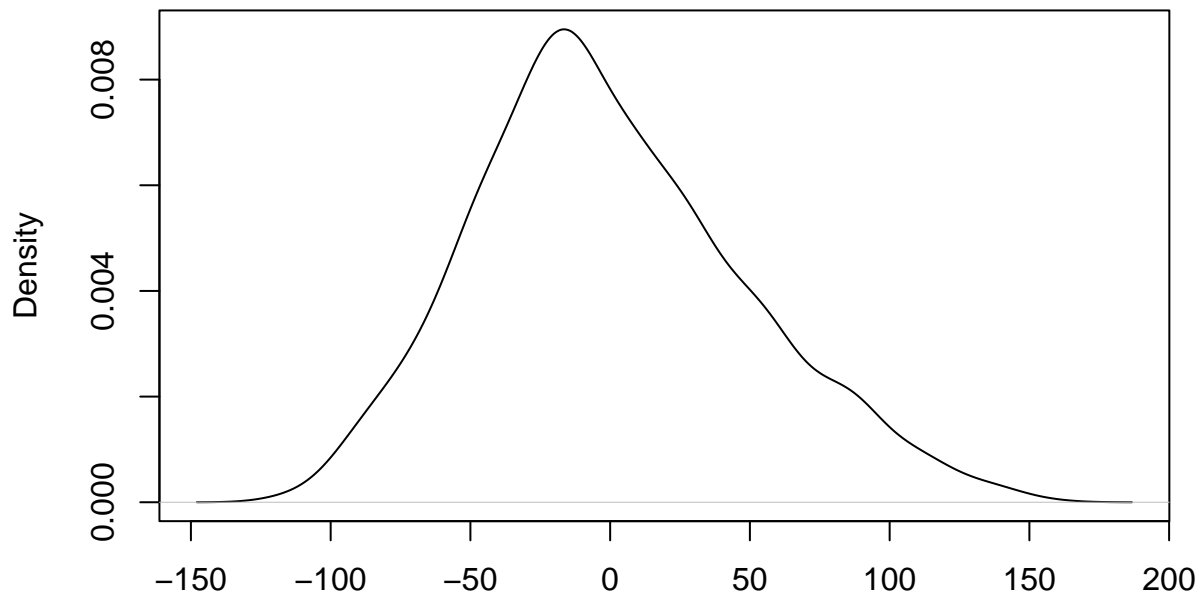
```
## [1] 0.1273887
```

```r
plot(resid(M_E) ~ fitted(M_E), main='Enviromental Residual Plot')
```


Enviromental Residual Plot

```r
EnviromentalDensityPlot <- resid(M_E)
plot(density(EnviromentalDensityPlot))
```

density(x = EnviromentalDensityPlot)

N = 1335 Bandwidth = 10.18

```
# Note: The above is for the model of solely environmental variables
M_raw <- lm(Y ~
            (E1+E2+E3+E4+G1+G2+G3+G4+G5+G6+G7+G8+G9+G10+G11+G12+G13+G14+G15+G16
             +G17+G18+G19+G20)^2, data=Project2)
summary(M_raw)
```

```
##
## Call:
## lm(formula = Y ~ (E1 + E2 + E3 + E4 + G1 + G2 + G3 + G4 + G5 +
##     G6 + G7 + G8 + G9 + G10 + G11 + G12 + G13 + G14 + G15 + G16 +
##     G17 + G18 + G19 + G20)^2, data = Project2)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -89.06 -19.67   0.14  19.98  89.81
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.080e+02  7.695e+01   1.403 0.160774
## E1          -4.813e+00  7.144e+00  -0.674 0.500644
## E2           5.721e+00  7.266e+00   0.787 0.431289
## E3           4.402e+00  7.216e+00   0.610 0.542026
## E4          -1.088e+00  7.059e+00  -0.154 0.877524
## G1           2.831e+01  2.472e+01   1.145 0.252284
## G2          -4.268e+01  2.629e+01  -1.624 0.104787
## G3          -1.187e+01  2.601e+01  -0.456 0.648295
```

4

```
## G4          -1.008e+01  2.577e+01  -0.391 0.695733
## G5           3.466e+01  2.599e+01   1.333 0.182703
## G6           4.258e+01  2.553e+01   1.668 0.095673 .
## G7           8.463e+00  2.674e+01   0.316 0.751714
## G8          -3.026e+01  2.606e+01  -1.161 0.245828
## G9           2.308e+01  2.638e+01   0.875 0.381901
## G10          3.376e+01  2.527e+01   1.336 0.181845
## G11          4.980e+01  2.748e+01   1.812 0.070222 .
## G12         -4.104e+01  2.750e+01  -1.492 0.135934
## G13          4.275e+01  2.778e+01   1.539 0.124183
## G14         -1.158e+00  2.799e+01  -0.041 0.967020
## G15          1.172e+01  2.667e+01   0.440 0.660347
## G16         -6.418e+01  2.631e+01  -2.439 0.014892 *
## G17         -2.828e+00  2.598e+01  -0.109 0.913350
## G18          1.038e+01  2.602e+01   0.399 0.690005
## G19         -5.651e+01  2.738e+01  -2.064 0.039269 *
## G20         -8.071e+00  2.699e+01  -0.299 0.764989
## E1:E2        5.544e-01  5.354e-01   1.036 0.300651
## E1:E3        8.948e-01  5.394e-01   1.659 0.097407 .
## E1:E4        1.702e-01  5.465e-01   0.311 0.755540
## E1:G1       -1.020e+00  1.770e+00  -0.577 0.564360
## E1:G2        1.319e+00  1.956e+00   0.674 0.500254
## E1:G3       -1.691e+00  1.774e+00  -0.954 0.340484
## E1:G4        1.066e+00  1.718e+00   0.621 0.534809
## E1:G5       -6.853e-01  1.760e+00  -0.389 0.697010
## E1:G6       -2.472e+00  1.822e+00  -1.357 0.175202
## E1:G7        1.328e+00  1.714e+00   0.775 0.438612
## E1:G8        1.673e+00  1.802e+00   0.928 0.353458
## E1:G9       -2.810e+00  1.739e+00  -1.616 0.106427
## E1:G10      -4.647e+00  1.776e+00  -2.617 0.009011 **
## E1:G11      -3.092e+00  1.798e+00  -1.720 0.085785 .
## E1:G12      -7.069e-01  1.856e+00  -0.381 0.703431
## E1:G13       8.584e-05  1.806e+00   0.000 0.999962
## E1:G14      -4.543e-01  1.770e+00  -0.257 0.797512
## E1:G15      -1.345e+00  1.800e+00  -0.747 0.455199
## E1:G16       3.008e+00  1.854e+00   1.623 0.104975
## E1:G17       4.894e-01  1.769e+00   0.277 0.782053
## E1:G18       2.857e+00  1.760e+00   1.623 0.104857
## E1:G19       8.562e-01  1.789e+00   0.478 0.632426
## E1:G20      -2.332e+00  1.811e+00  -1.288 0.198190
## E2:E3       -2.010e-01  5.310e-01  -0.379 0.705062
## E2:E4       -1.197e-01  5.387e-01  -0.222 0.824176
## E2:G1       -3.327e-01  1.664e+00  -0.200 0.841525
## E2:G2       -4.534e-01  1.893e+00  -0.240 0.810728
## E2:G3       -3.238e-01  1.806e+00  -0.179 0.857741
## E2:G4        1.206e+00  1.780e+00   0.678 0.498178
## E2:G5       -1.293e-01  1.736e+00  -0.074 0.940647
## E2:G6        6.614e-01  1.759e+00   0.376 0.706917
## E2:G7        2.055e+00  1.789e+00   1.149 0.250781
## E2:G8       -5.851e-01  1.823e+00  -0.321 0.748294
## E2:G9        3.107e+00  1.786e+00   1.739 0.082255 .
## E2:G10       3.430e+00  1.777e+00   1.930 0.053824 .
## E2:G11      -1.656e+00  1.745e+00  -0.949 0.342838
## E2:G12      -4.293e-01  1.849e+00  -0.232 0.816432
```

```
## E2:G13        -1.432e+00  1.816e+00  -0.789 0.430554
## E2:G14        -6.236e-01  1.752e+00  -0.356 0.722005
## E2:G15        -1.817e-01  1.834e+00  -0.099 0.921109
## E2:G16         1.326e+00  1.798e+00   0.737 0.461243
## E2:G17        -1.564e-01  1.762e+00  -0.089 0.929300
## E2:G18        -4.105e+00  1.710e+00  -2.401 0.016516 *
## E2:G19         2.006e+00  1.728e+00   1.161 0.245862
## E2:G20        -9.477e-01  1.842e+00  -0.515 0.606974
## E3:E4         -9.079e-02  5.154e-01  -0.176 0.860218
## E3:G1         -1.210e+00  1.703e+00  -0.711 0.477551
## E3:G2          3.773e-01  1.800e+00   0.210 0.834026
## E3:G3          3.272e+00  1.799e+00   1.819 0.069206 .
## E3:G4         -1.157e+00  1.759e+00  -0.658 0.510912
## E3:G5         -1.424e+00  1.698e+00  -0.839 0.401887
## E3:G6         -1.273e+00  1.749e+00  -0.727 0.467104
## E3:G7         -1.505e+00  1.738e+00  -0.866 0.386542
## E3:G8          2.180e+00  1.770e+00   1.231 0.218452
## E3:G9         -1.705e+00  1.757e+00  -0.970 0.332185
## E3:G10        -2.744e+00  1.731e+00  -1.585 0.113353
## E3:G11         1.086e+00  1.737e+00   0.625 0.531923
## E3:G12         1.442e+00  1.813e+00   0.795 0.426581
## E3:G13        -3.903e+00  1.878e+00  -2.079 0.037890 *
## E3:G14         1.633e+00  1.826e+00   0.894 0.371386
## E3:G15         1.197e+00  1.811e+00   0.661 0.508945
## E3:G16         1.165e+00  1.730e+00   0.673 0.500904
## E3:G17         6.982e-01  1.713e+00   0.408 0.683623
## E3:G18        -7.821e-01  1.714e+00  -0.456 0.648205
## E3:G19         4.636e-01  1.757e+00   0.264 0.791896
## E3:G20         2.628e+00  1.816e+00   1.447 0.148111
## E4:G1         -2.497e+00  1.718e+00  -1.454 0.146365
## E4:G2          3.647e+00  1.817e+00   2.007 0.044961 *
## E4:G3          3.310e-01  1.801e+00   0.184 0.854255
## E4:G4          1.524e+00  1.725e+00   0.884 0.377136
## E4:G5          8.257e+00  1.801e+00   4.584 5.13e-06 ***
## E4:G6         -1.533e+00  1.711e+00  -0.896 0.370611
## E4:G7         -7.419e-01  1.810e+00  -0.410 0.681993
## E4:G8          2.557e-01  1.744e+00   0.147 0.883445
## E4:G9         -7.231e-01  1.774e+00  -0.408 0.683569
## E4:G10        -6.259e-01  1.746e+00  -0.359 0.720012
## E4:G11        -1.350e+00  1.748e+00  -0.772 0.440085
## E4:G12         4.796e+00  1.812e+00   2.647 0.008255 **
## E4:G13        -1.258e-01  1.806e+00  -0.070 0.944444
## E4:G14        -2.042e-01  1.839e+00  -0.111 0.911625
## E4:G15         4.446e-02  1.774e+00   0.025 0.980015
## E4:G16         2.740e+00  1.830e+00   1.497 0.134617
## E4:G17         7.803e-01  1.757e+00   0.444 0.657047
## E4:G18         3.920e-01  1.820e+00   0.215 0.829447
## E4:G19         3.057e+00  1.771e+00   1.726 0.084576 .
## E4:G20         6.959e-01  1.794e+00   0.388 0.698109
## G1:G2          2.149e+00  6.188e+00   0.347 0.728421
## G1:G3         -5.943e+00  5.873e+00  -1.012 0.311799
## G1:G4          1.697e-01  5.540e+00   0.031 0.975576
## G1:G5          7.924e+00  5.672e+00   1.397 0.162706
## G1:G6         -6.301e-01  5.907e+00  -0.107 0.915066
```

```
## G1:G7     -7.373e-01  5.886e+00  -0.125 0.900342
## G1:G8     -8.978e+00  5.644e+00  -1.591 0.111974
## G1:G9      2.479e-01  5.672e+00   0.044 0.965144
## G1:G10     4.085e+00  5.712e+00   0.715 0.474659
## G1:G11    -1.010e+01  5.736e+00  -1.761 0.078476 .
## G1:G12    -8.038e+00  6.132e+00  -1.311 0.190212
## G1:G13    -4.158e+00  5.926e+00  -0.702 0.483030
## G1:G14     9.273e+00  5.743e+00   1.615 0.106683
## G1:G15    -8.438e+00  6.008e+00  -1.405 0.160464
## G1:G16     1.126e+01  5.926e+00   1.900 0.057676 .
## G1:G17    -2.588e+00  5.667e+00  -0.457 0.648031
## G1:G18     1.605e+01  5.940e+00   2.702 0.007009 **
## G1:G19     6.933e+00  5.964e+00   1.163 0.245300
## G1:G20     5.570e+00  5.770e+00   0.965 0.334568
## G2:G3      2.632e+00  6.212e+00   0.424 0.671877
## G2:G4      8.062e+00  5.965e+00   1.352 0.176806
## G2:G5      5.377e+00  6.015e+00   0.894 0.371546
## G2:G6     -2.682e+00  6.358e+00  -0.422 0.673308
## G2:G7     -1.478e+01  6.761e+00  -2.185 0.029081 *
## G2:G8      9.342e+00  6.144e+00   1.520 0.128695
## G2:G9     -4.003e+00  5.986e+00  -0.669 0.503785
## G2:G10     6.042e+00  6.238e+00   0.969 0.332972
## G2:G11    -3.579e-01  6.151e+00  -0.058 0.953615
## G2:G12     1.379e+01  6.594e+00   2.090 0.036821 *
## G2:G13     5.723e+00  6.785e+00   0.844 0.399128
## G2:G14     4.171e+00  6.268e+00   0.665 0.505960
## G2:G15    -4.527e+00  6.188e+00  -0.732 0.464620
## G2:G16    -8.021e+00  6.259e+00  -1.281 0.200311
## G2:G17     2.971e+00  6.522e+00   0.455 0.648860
## G2:G18     2.063e-01  6.780e+00   0.030 0.975726
## G2:G19    -5.082e-01  6.274e+00  -0.081 0.935452
## G2:G20     6.407e+00  6.269e+00   1.022 0.307012
## G3:G4      5.060e-02  6.236e+00   0.008 0.993528
## G3:G5      5.065e+00  6.249e+00   0.811 0.417818
## G3:G6     -6.345e+00  5.795e+00  -1.095 0.273799
## G3:G7     -4.631e-01  5.754e+00  -0.080 0.935866
## G3:G8      4.058e+00  6.373e+00   0.637 0.524361
## G3:G9     -2.087e+00  6.006e+00  -0.347 0.728366
## G3:G10     5.427e-01  5.754e+00   0.094 0.924864
## G3:G11    -6.848e+00  5.914e+00  -1.158 0.247163
## G3:G12    -4.750e+00  6.082e+00  -0.781 0.435011
## G3:G13    -1.210e+00  6.127e+00  -0.198 0.843442
## G3:G14    -4.493e+00  6.038e+00  -0.744 0.457024
## G3:G15    -2.827e+00  6.095e+00  -0.464 0.642859
## G3:G16    -6.615e+00  6.422e+00  -1.030 0.303250
## G3:G17    -9.871e+00  6.168e+00  -1.600 0.109800
## G3:G18     8.043e+00  5.841e+00   1.377 0.168859
## G3:G19     1.052e+01  5.955e+00   1.767 0.077587 .
## G3:G20     7.284e-01  6.298e+00   0.116 0.907953
## G4:G5      7.893e-01  5.670e+00   0.139 0.889320
## G4:G6     -4.104e+00  5.782e+00  -0.710 0.477927
## G4:G7     -3.736e+00  5.970e+00  -0.626 0.531551
## G4:G8     -1.167e+00  5.827e+00  -0.200 0.841308
## G4:G9     -8.843e+00  5.867e+00  -1.507 0.132034
```

```
## G4:G10       -9.484e+00   5.655e+00   -1.677 0.093852 .
## G4:G11       -3.139e+00   5.805e+00   -0.541 0.588764
## G4:G12       -5.479e+00   6.326e+00   -0.866 0.386621
## G4:G13       -4.990e+00   5.875e+00   -0.849 0.395889
## G4:G14        7.257e-01   6.073e+00    0.120 0.904900
## G4:G15       -5.436e+00   6.026e+00   -0.902 0.367189
## G4:G16       -4.992e+00   5.861e+00   -0.852 0.394555
## G4:G17        1.735e+00   5.804e+00    0.299 0.765041
## G4:G18       -2.303e-01   6.000e+00   -0.038 0.969386
## G4:G19       -6.938e+00   6.046e+00   -1.147 0.251479
## G4:G20        4.159e+00   5.842e+00    0.712 0.476652
## G5:G6        -4.745e-01   6.085e+00   -0.078 0.937858
## G5:G7        -6.354e+00   6.075e+00   -1.046 0.295886
## G5:G8        -1.176e+00   5.763e+00   -0.204 0.838301
## G5:G9        -4.084e+00   5.887e+00   -0.694 0.488016
## G5:G10       -3.863e+00   5.711e+00   -0.676 0.498949
## G5:G11       -2.368e+00   6.276e+00   -0.377 0.706013
## G5:G12       -7.350e-01   6.093e+00   -0.121 0.903999
## G5:G13        1.274e-01   6.109e+00    0.021 0.983369
## G5:G14       -5.997e-01   6.144e+00   -0.098 0.922269
## G5:G15       -2.681e+00   6.140e+00   -0.437 0.662446
## G5:G16        6.539e+00   6.308e+00    1.037 0.300158
## G5:G17       -1.810e+00   6.197e+00   -0.292 0.770250
## G5:G18       -8.879e+00   6.210e+00   -1.430 0.153057
## G5:G19        9.053e+00   5.830e+00    1.553 0.120737
## G5:G20        8.215e-01   5.884e+00    0.140 0.888995
## G6:G7        -1.538e+01   5.968e+00   -2.577 0.010114 *
## G6:G8        -7.579e-01   5.942e+00   -0.128 0.898543
## G6:G9        -3.707e+00   5.775e+00   -0.642 0.521042
## G6:G10       -1.263e-01   5.722e+00   -0.022 0.982396
## G6:G11       -1.194e+01   5.959e+00   -2.003 0.045429 *
## G6:G12       -6.149e+00   6.103e+00   -1.007 0.313954
## G6:G13       -4.837e+00   6.264e+00   -0.772 0.440188
## G6:G14        2.295e+00   5.752e+00    0.399 0.690043
## G6:G15       -2.034e+00   5.985e+00   -0.340 0.734066
## G6:G16       -3.067e+00   5.999e+00   -0.511 0.609337
## G6:G17       -9.114e+00   5.915e+00   -1.541 0.123701
## G6:G18       -5.751e+00   5.741e+00   -1.002 0.316742
## G6:G19        1.227e+01   5.828e+00    2.106 0.035433 *
## G6:G20        9.568e+00   6.293e+00    1.520 0.128702
## G7:G8        -4.312e+00   5.670e+00   -0.761 0.447128
## G7:G9        -1.142e+00   5.700e+00   -0.200 0.841207
## G7:G10        2.295e+00   5.767e+00    0.398 0.690701
## G7:G11        3.878e+00   5.714e+00    0.679 0.497455
## G7:G12        4.036e+00   5.995e+00    0.673 0.500920
## G7:G13       -3.441e+00   5.931e+00   -0.580 0.561877
## G7:G14       -1.416e+01   5.620e+00   -2.520 0.011874 *
## G7:G15       -2.297e+00   5.924e+00   -0.388 0.698337
## G7:G16       -1.564e+00   5.960e+00   -0.262 0.793082
## G7:G17        3.621e+00   5.856e+00    0.618 0.536523
## G7:G18       -5.434e+00   5.861e+00   -0.927 0.354082
## G7:G19       -3.076e-03   5.988e+00   -0.001 0.999590
## G7:G20       -1.489e+00   6.273e+00   -0.237 0.812398
## G8:G9         1.482e+01   5.765e+00    2.570 0.010311 *
```

```
## G8:G10      -1.440e+01  6.031e+00   -2.387 0.017165 *
## G8:G11      -3.596e+00  5.869e+00   -0.613 0.540126
## G8:G12       7.272e+00  5.856e+00    1.242 0.214569
## G8:G13       1.710e+00  6.165e+00    0.277 0.781547
## G8:G14       5.826e+00  5.879e+00    0.991 0.321934
## G8:G15      -5.837e+00  6.143e+00   -0.950 0.342258
## G8:G16       4.542e+00  6.272e+00    0.724 0.469200
## G8:G17      -3.664e+00  6.078e+00   -0.603 0.546780
## G8:G18       1.062e+01  6.004e+00    1.769 0.077194 .
## G8:G19      -2.410e+00  6.108e+00   -0.395 0.693214
## G8:G20      -5.548e+00  6.141e+00   -0.903 0.366546
## G9:G10      -4.262e+00  5.750e+00   -0.741 0.458813
## G9:G11      -2.308e+00  5.709e+00   -0.404 0.686163
## G9:G12       4.027e+00  6.097e+00    0.660 0.509112
## G9:G13       8.747e+00  5.941e+00    1.472 0.141227
## G9:G14       1.966e+00  5.841e+00    0.337 0.736420
## G9:G15       3.539e+00  5.848e+00    0.605 0.545163
## G9:G16      -7.665e+00  5.854e+00   -1.309 0.190715
## G9:G17      -1.957e+00  5.884e+00   -0.333 0.739563
## G9:G18      -1.169e+00  5.800e+00   -0.201 0.840363
## G9:G19      -2.246e-01  5.793e+00   -0.039 0.969080
## G9:G20      -9.235e+00  5.921e+00   -1.560 0.119116
## G10:G11      1.222e+01  5.957e+00    2.052 0.040459 *
## G10:G12     -3.593e+00  6.330e+00   -0.568 0.570405
## G10:G13      5.799e+00  6.143e+00    0.944 0.345371
## G10:G14      1.305e+00  5.701e+00    0.229 0.818964
## G10:G15      4.161e+00  5.616e+00    0.741 0.458927
## G10:G16     -6.996e+00  6.158e+00   -1.136 0.256148
## G10:G17      1.322e+00  5.679e+00    0.233 0.816019
## G10:G18     -3.851e+00  5.550e+00   -0.694 0.487922
## G10:G19     -5.286e-01  6.099e+00   -0.087 0.930955
## G10:G20      3.206e+00  5.999e+00    0.534 0.593217
## G11:G12      3.865e-01  5.879e+00    0.066 0.947597
## G11:G13     -2.631e+00  5.872e+00   -0.448 0.654172
## G11:G14     -7.627e+00  5.849e+00   -1.304 0.192496
## G11:G15     -3.362e+00  6.084e+00   -0.553 0.580674
## G11:G16      8.907e+00  5.699e+00    1.563 0.118421
## G11:G17     -9.479e+00  5.967e+00   -1.589 0.112461
## G11:G18     -5.376e+00  6.361e+00   -0.845 0.398274
## G11:G19     -4.387e+00  5.703e+00   -0.769 0.441878
## G11:G20      3.656e+00  5.986e+00    0.611 0.541449
## G12:G13      8.192e+00  6.518e+00    1.257 0.209094
## G12:G14     -1.419e-01  6.014e+00   -0.024 0.981185
## G12:G15     -2.982e+00  6.069e+00   -0.491 0.623291
## G12:G16      1.577e-01  6.080e+00    0.026 0.979309
## G12:G17     -1.439e+00  6.346e+00   -0.227 0.820628
## G12:G18     -1.023e+01  6.152e+00   -1.664 0.096484 .
## G12:G19     -3.146e-01  5.736e+00   -0.055 0.956270
## G12:G20      1.002e+01  6.409e+00    1.563 0.118409
## G13:G14     -1.150e+01  6.230e+00   -1.846 0.065185 .
## G13:G15     -3.707e+00  6.122e+00   -0.606 0.544914
## G13:G16     -1.138e+00  6.580e+00   -0.173 0.862773
## G13:G17     -1.668e+00  6.261e+00   -0.266 0.790017
## G13:G18      1.276e+01  6.180e+00    2.064 0.039265 *
```

```
## G13:G19      5.577e+00  5.968e+00   0.934 0.350302
## G13:G20     -1.600e+00  6.206e+00  -0.258 0.796622
## G14:G15     -1.636e+00  5.794e+00  -0.282 0.777782
## G14:G16      4.161e+00  6.155e+00   0.676 0.499195
## G14:G17     -1.219e+00  5.792e+00  -0.211 0.833307
## G14:G18     -3.272e+00  6.003e+00  -0.545 0.585828
## G14:G19     -5.776e-01  6.001e+00  -0.096 0.923346
## G14:G20      1.886e+00  6.007e+00   0.314 0.753591
## G15:G16     -1.869e+00  6.203e+00  -0.301 0.763179
## G15:G17     -4.719e+00  5.867e+00  -0.804 0.421355
## G15:G18     -7.342e-01  5.760e+00  -0.127 0.898605
## G15:G19     -9.768e+00  6.346e+00  -1.539 0.124076
## G15:G20     -3.235e+00  6.176e+00  -0.524 0.600528
## G16:G17     -6.417e-01  6.040e+00  -0.106 0.915405
## G16:G18      2.352e+01  6.602e+00   3.563 0.000384 ***
## G16:G19      5.504e+00  6.153e+00   0.895 0.371254
## G16:G20     -2.586e-01  6.053e+00  -0.043 0.965935
## G17:G18     -5.580e+00  5.929e+00  -0.941 0.346881
## G17:G19      2.738e+00  5.964e+00   0.459 0.646346
## G17:G20     -1.025e+01  5.891e+00  -1.740 0.082130 .
## G18:G19      4.706e+00  5.960e+00   0.790 0.429918
## G18:G20      1.629e+00  6.192e+00   0.263 0.792533
## G19:G20      4.131e+00  6.286e+00   0.657 0.511179
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 34.1 on 1034 degrees of freedom
## Multiple R-squared:  0.6686, Adjusted R-squared:  0.5725
## F-statistic: 6.955 on 300 and 1034 DF,  p-value: < 2.2e-16
```

```r
summary(M_raw)$adj.r.squared
```
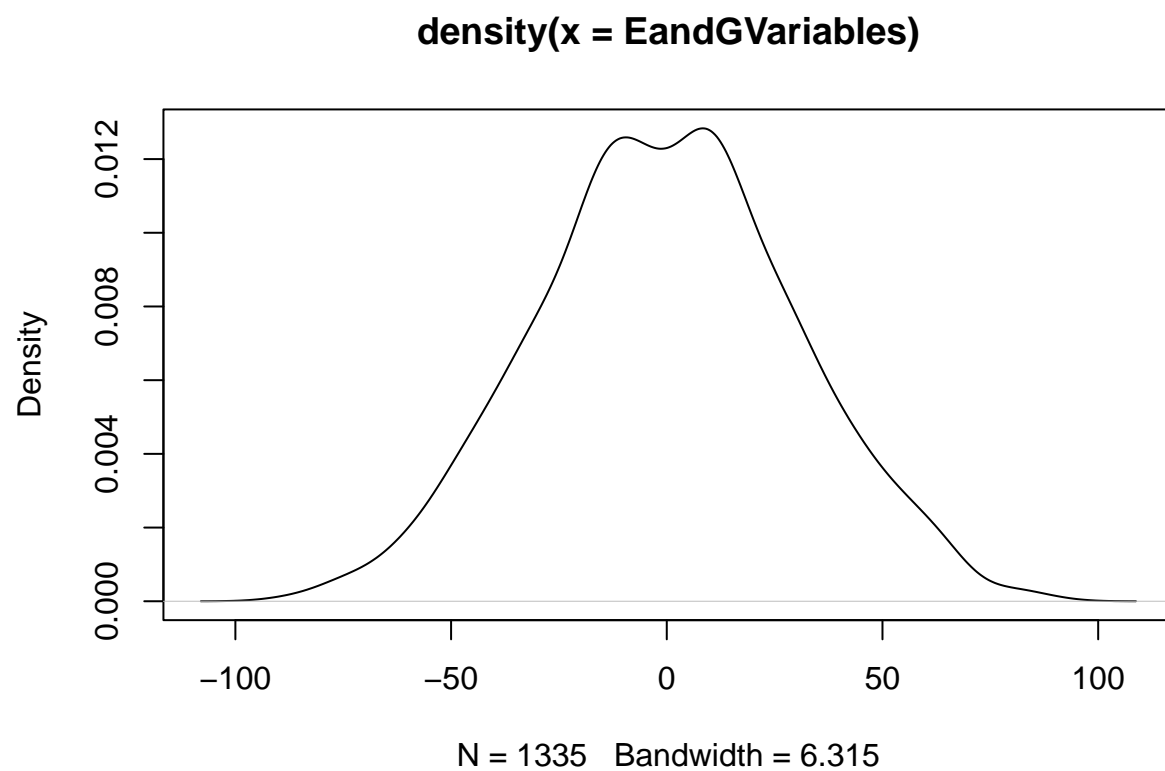
```
## [1] 0.5724978
```

```r
plot(resid(M_raw) ~ fitted(M_raw), main='Residual Plot of E and G variables')
```

Residual Plot of E and G variables
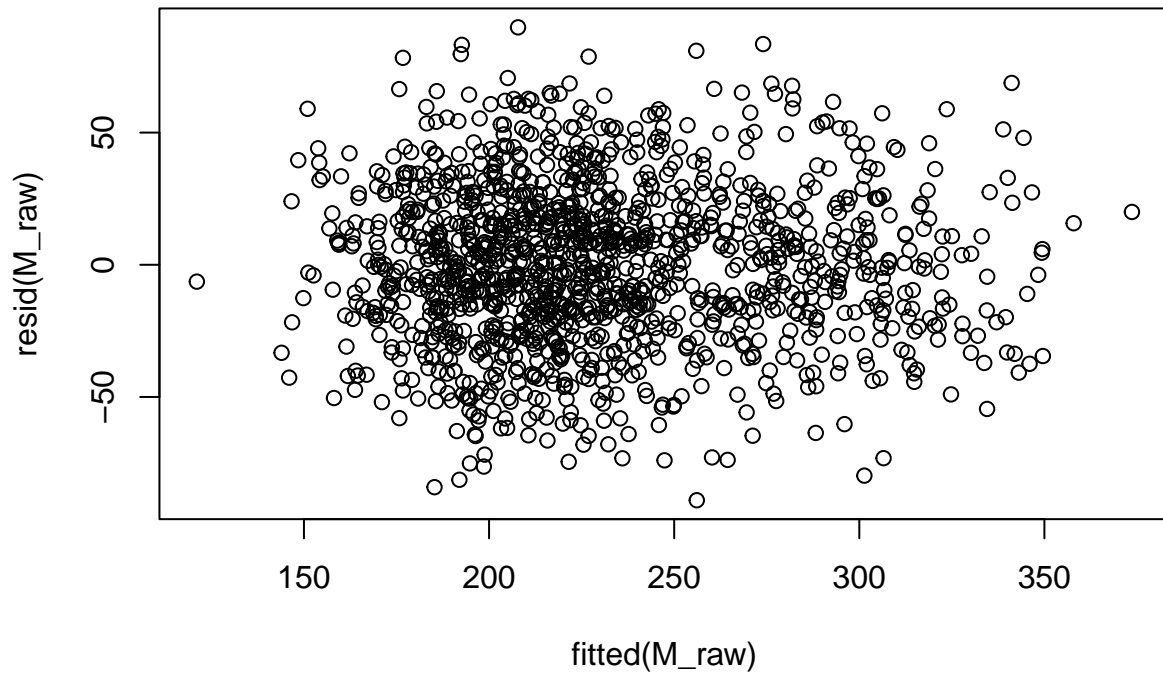

```
EandGVariables <- resid(M_raw)
plot(density(EandGVariables))
```

density(x = EandGVariables)

N = 1335   Bandwidth = 6.315

```r
#Note: The above is when you add the Genetic Risk variables (G1-G20)
#to the model of solely Environmental Variables (E1-E4)
library(MASS)
boxcox(M_raw)
```
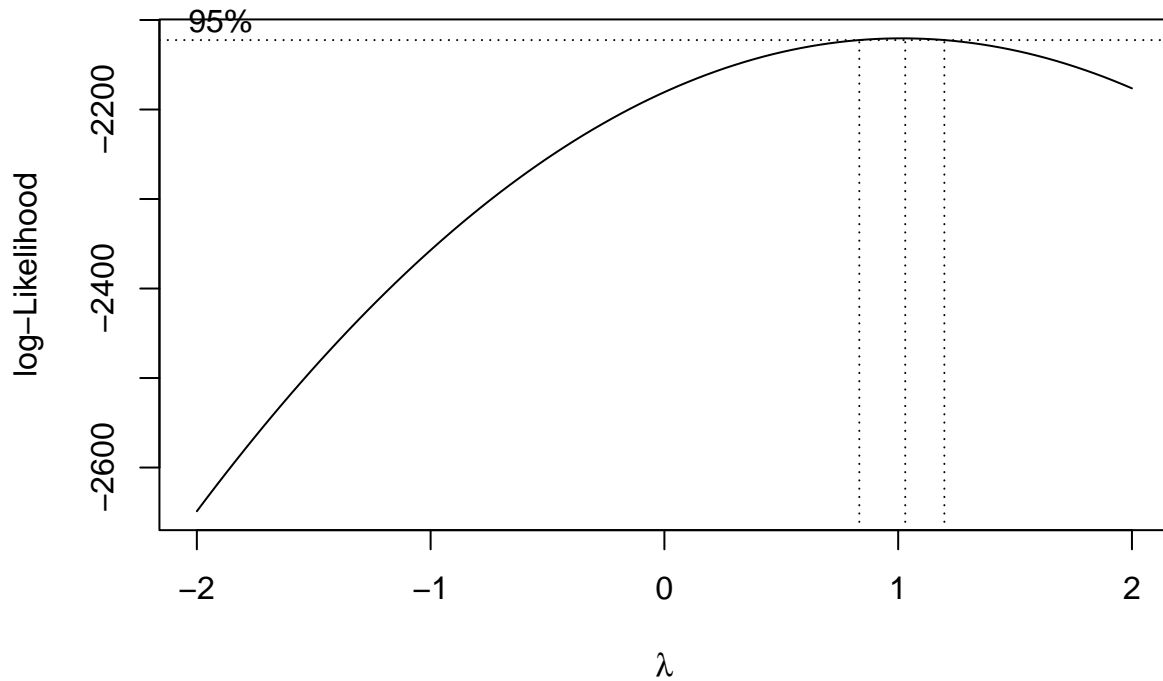
```
#95% C.I. for lambda is around .8-1.2 with an estimated lambda value of 1!
#So it seems that no transformation is necessary.
library(leaps)
M <- regsubsets( model.matrix(M_raw)[,-1], I((Project2$Y)),
                nbest = 1 , nvmax=5,
                method = 'forward', intercept = TRUE )
temp <- summary(M)
Var <- colnames(model.matrix(M_raw))
M_select <- apply(temp$which, 1,
                function(x) paste0(Var[x], collapse='+'))
library(knitr)
kable(data.frame(cbind( model = M_select, adjR2 = temp$adjr2, BIC = temp$bic)),
      caption='Model Summary')
```

Table 1: Model Summary

model	adjR2	BIC
(Intercept)+E4:G5	0.43196826092255	-741.654359289457
(Intercept)+E2:E3+E4:G5	0.545292974444172	-1032.52906776033
(Intercept)+E1+E2:E3+E4:G5	0.564726664912446	-1084.64663692343
(Intercept)+E1+E2:E3+E4:G5+G8:G10	0.569154992455663	-1092.10474370241
(Intercept)+E1+E2:E3+E4:G5+G8:G10+G16:G18	0.571429463384136	-1092.97845159909

```
#3rd model seems best
M_main <- lm( I(Y) ~ ., data=Project2)
# . here means include all variable from E1 to E4 and from G1 to G20 to the model
temp <- summary(M_main)
kable(temp$coefficients[ abs(temp$coefficients[,4]) <= 0.001,], caption='Significant
Coefficients')
```

Table 2: Significant Coefficients

	Estimate	Std. Error	t value	Pr(>|t|)
E1	5.302005	0.6801322	7.795551	0.00e+00
E2	8.425682	0.6679685	12.613891	0.00e+00
E3	8.681027	0.6681455	12.992719	0.00e+00
E4	2.650846	0.6721911	3.943590	8.45e-05
G5	80.129066	2.2351989	35.848740	0.00e+00

```
M_2nd <- lm(I(Y) ~ (.)^2, data=Project2)
temp <- summary(M_2nd)
kable(temp$coefficients[ abs(temp$coefficients[,4]) <= 0.001,], caption='2nd Interaction')
```

Table 3: 2nd Interaction

	Estimate	Std. Error	t value	Pr(>|t|)
E4:G5	8.256925	1.801432	4.583534	0.0000051
G16:G18	23.519912	6.601676	3.562718	0.0003838

```
#variables that have significant 2nd interaction effects
M_3rd <- lm(I(Y) ~ (E1+E2+E3+E4+G5)^3, data=Project2)
temp <- summary(M_3rd)
kable(temp$coefficients[ abs(temp$coefficients[,4]) <= 0.001,], caption='3nd Interaction')
```

Table 4: 3nd Interaction

Estimate	Std. Error	t value	Pr(>|t|)

```
#The variables that I use as candidate variables for inclusion are: E1, E2, E3, E4, G5,
testmodel2 <- lm(Y ~ (E1 + E2 + E3 + E4 + G5), data=Project2)
summary(testmodel2)
```
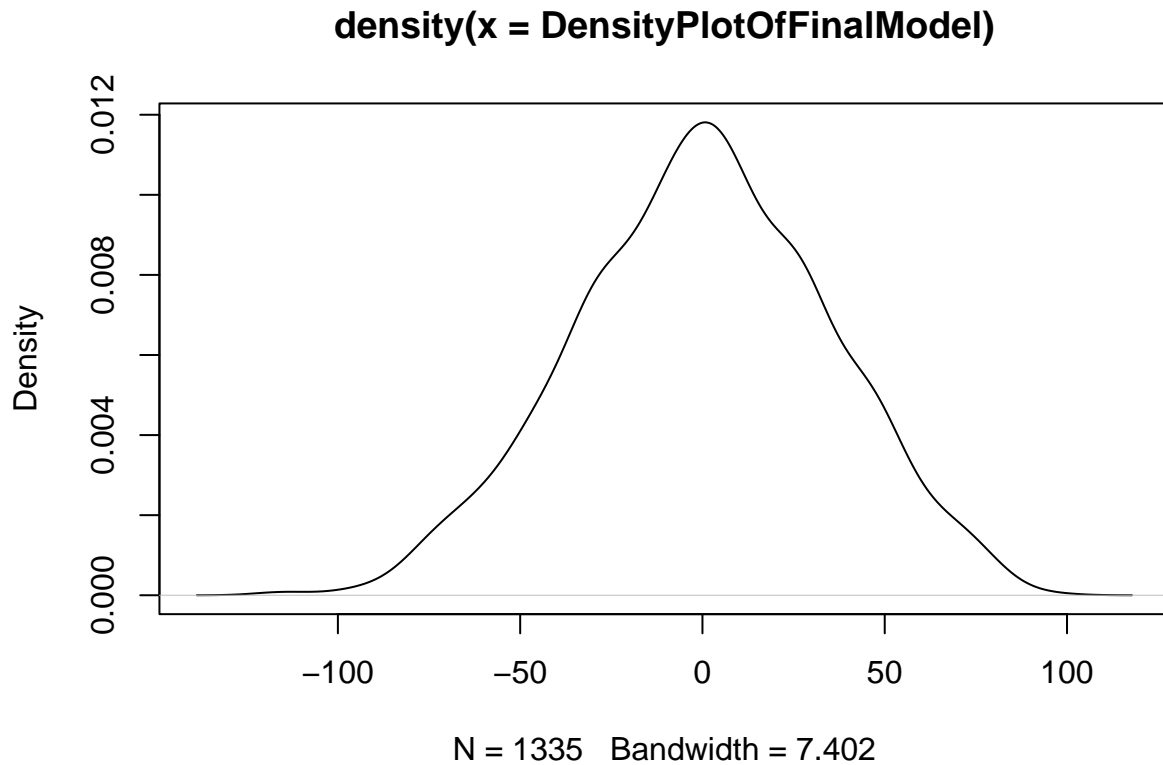
```
##
## Call:
## lm(formula = Y ~ (E1 + E2 + E3 + E4 + G5), data = Project2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -116.486  -24.094    0.589   24.560   95.609
##
```

```
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  22.4559     9.8470   2.280   0.0227 *
## E1            5.2817     0.6776   7.795 1.29e-14 ***
## E2            8.4961     0.6651  12.774  < 2e-16 ***
## E3            8.5514     0.6635  12.888  < 2e-16 ***
## E4            2.6919     0.6693   4.022 6.10e-05 ***
## G5           79.7722     2.2261  35.835  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 34.75 on 1329 degrees of freedom
## Multiple R-squared:  0.5575, Adjusted R-squared:  0.5559
## F-statistic: 334.9 on 5 and 1329 DF,  p-value: < 2.2e-16
```

```r
plot(resid(testmodel2)~fitted(testmodel2), main = 'Residual Plot of Final Model')
```

Residual Plot of Final Model
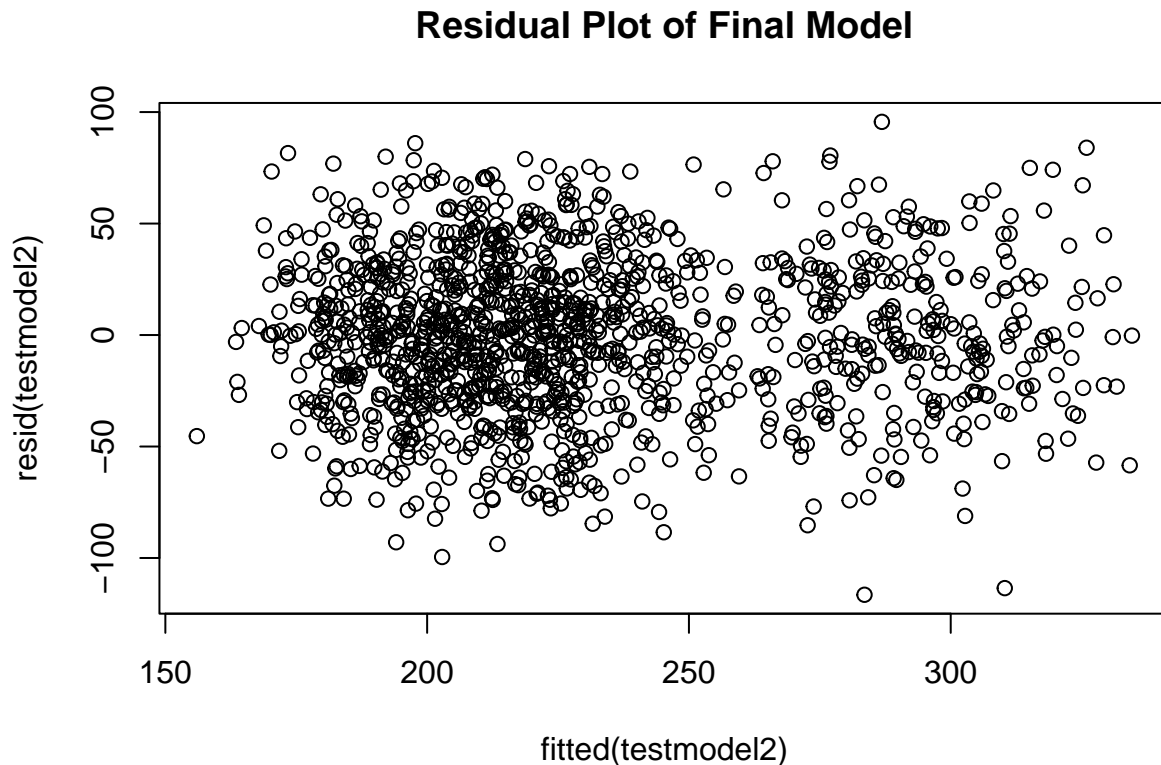

```r
DensityPlotOfFinalModel <- resid(testmodel2)
plot(density(DensityPlotOfFinalModel))
```

density(x = DensityPlotOfFinalModel)

N = 1335   Bandwidth = 7.402

```
#adjusted r^2 is .5559
testmodel <- lm(Y ~ (E1+E2:E3+E4:G5), data=Project2)
summary(testmodel)
```

```
##
## Call:
## lm(formula = Y ~ (E1 + E2:E3 + E4:G5), data = Project2)
##
## Residuals:
##      Min       1Q    Median       3Q      Max
## -108.699  -24.004   -0.286   24.377   90.845
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 108.90384    6.07912  17.914  < 2e-16 ***
## E1            5.20955    0.66993   7.776 1.49e-14 ***
## E2:E3         1.10583    0.06007  18.409  < 2e-16 ***
## E4:G5        10.64537    0.28905  36.829  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 34.4 on 1331 degrees of freedom
## Multiple R-squared:  0.5657, Adjusted R-squared:  0.5647
## F-statistic: 577.9 on 3 and 1331 DF,  p-value: < 2.2e-16
```
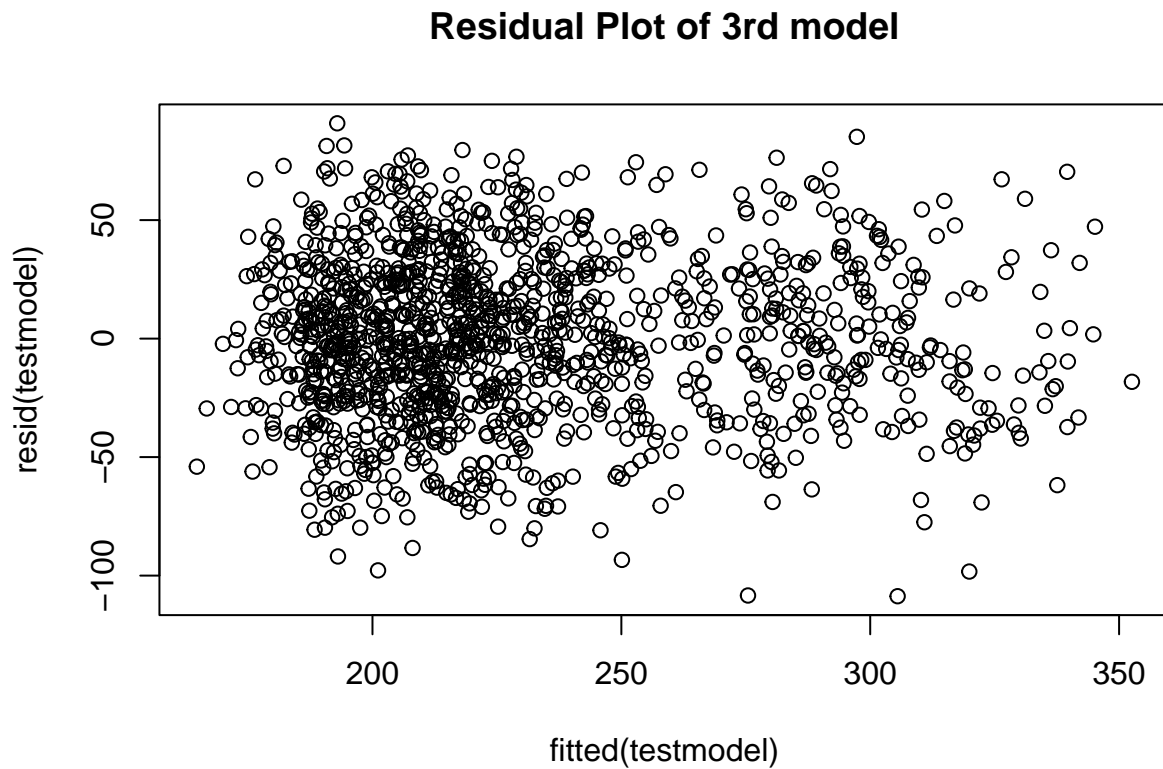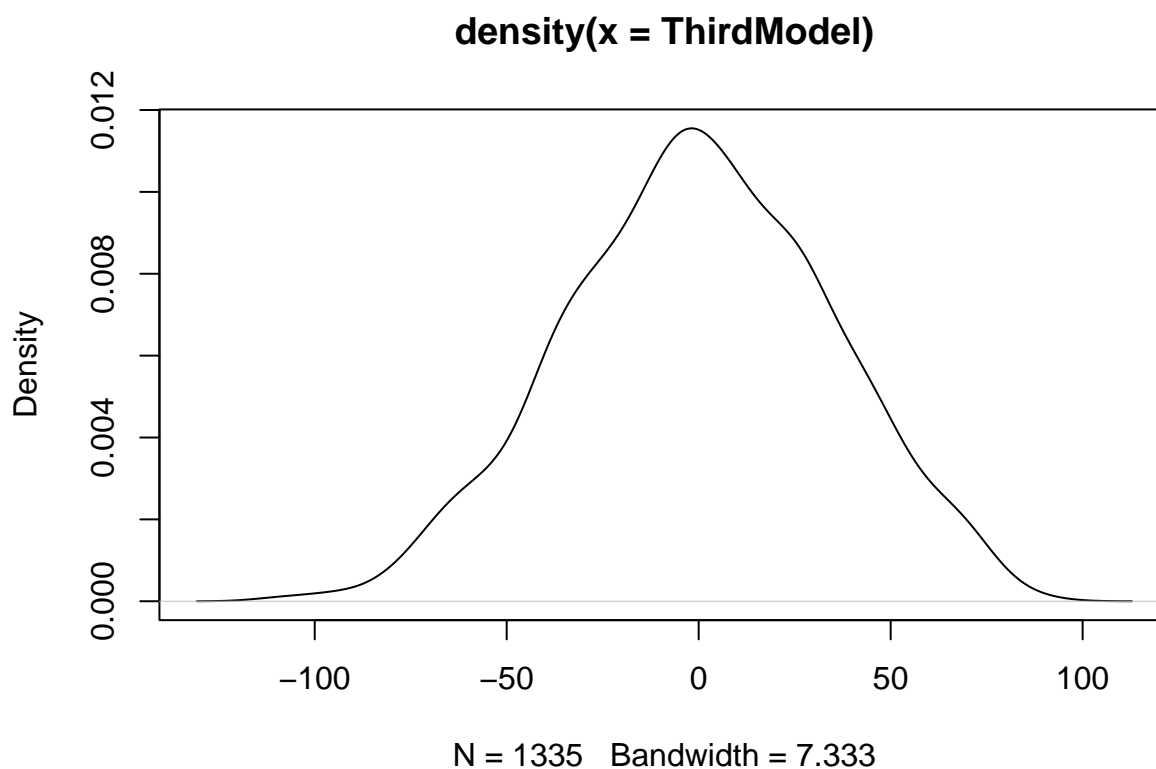
```
#adjusted r^2 is .5647
plot(resid(testmodel)~fitted(testmodel), main = 'Residual Plot of 3rd model')
```

Residual Plot of 3rd model


```
ThirdModel<- resid(testmodel)
plot(density(ThirdModel))
```

density(x = ThirdModel)

N = 1335   Bandwidth = 7.333

```
M_2stage <- lm( I(Y) ~ (E1+E2+E3+E4+G5)^3, data=Project2)
temp <- summary(M_2stage)
temp$coefficients
```

```
##                 Estimate  Std. Error      t value  Pr(>|t|)
## (Intercept) -48.38368484 299.6529535 -0.161465737 0.8717515
## E1           36.18423563  34.2392242  1.056806526 0.2907949
## E2           -2.72619425  34.8315815 -0.078267886 0.9376269
## E3           11.46773114  32.8523861  0.349068439 0.7270941
## E4           17.33802245  33.8415116  0.512330024 0.6085065
## G5          -24.26368451 148.8058183 -0.163056020 0.8704995
## E1:E2        -0.99824932   3.7428223 -0.266710317 0.7897342
## E1:E3        -3.15375325   3.6090690 -0.873841208 0.3823650
## E1:E4        -4.68161986   3.6336264 -1.288415295 0.1978291
## E1:G5         0.99838004  14.3483782  0.069581386 0.9445375
## E2:E3         2.36607300   3.5682169  0.663096736 0.5073853
## E2:E4         0.65171461   3.6708674  0.177536953 0.8591141
## E2:G5        18.38661933  13.8890572  1.323820549 0.1857938
## E3:E4        -0.14961669   3.5892511 -0.041684653 0.9667564
## E3:G5         3.00945323  13.9141246  0.216287644 0.8287972
## E4:G5         0.09331295  14.2699040  0.006539144 0.9947836
## E1:E2:E3      0.03958075   0.3336071  0.118644812 0.9055750
## E1:E2:E4      0.22578120   0.3501193  0.644869351 0.5191249
## E1:E2:G5     -1.78575436   1.1154576 -1.600916363 0.1096367
## E1:E3:E4      0.36856326   0.3332076  1.106107057 0.2688834
```

```
## E1:E3:G5      0.35640396    1.0722618   0.332385196 0.7396516
## E1:E4:G5      1.04094601    1.1997806   0.867613655 0.3857649
## E2:E3:E4     -0.33282663    0.3337105  -0.997351436 0.3187783
## E2:E3:G5     -0.91992062    1.0245983  -0.897835364 0.3694384
## E2:E4:G5      0.07409856    1.1039916   0.067118778 0.9464974
## E3:E4:G5      0.08974351    1.0598332   0.084677020 0.9325311
```

```r
temp$coefficients[abs(temp$coefficients[,3]) >= 4]
```

```
## numeric(0)
```