

## Project 2 Code

```
getwd()
```

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

```
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
```

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

```
## /\      /\
```

```
## { '---' }
```

```
## { 0 0 }
```

```
## ==> 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	G18	G19	G20
1335	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

```
##      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
```

```
# 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)
```

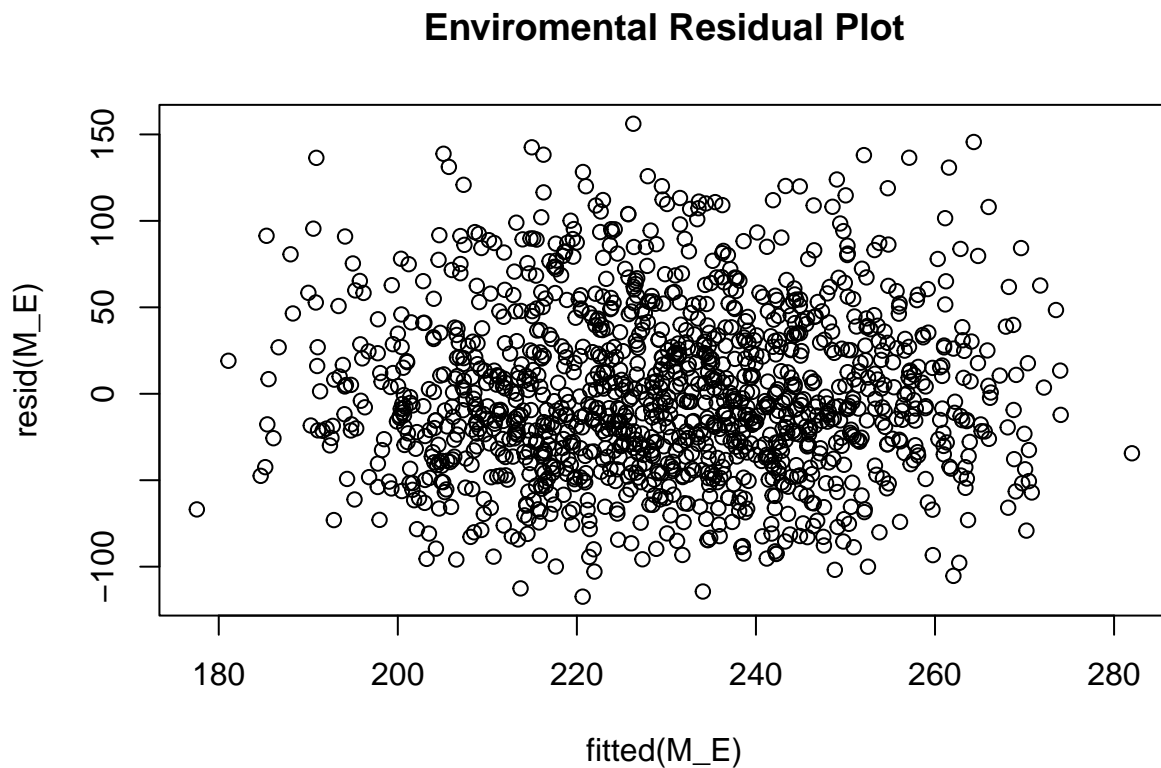
```
##
## Call:
## lm(formula = Y ~ E1 + E2 + E3 + E4, data = Project2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -117.340  -33.634   -6.576   30.291  156.161
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  52.4416    13.7526   3.813 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
```

```
summary(M_E)$adj.r.squared
```

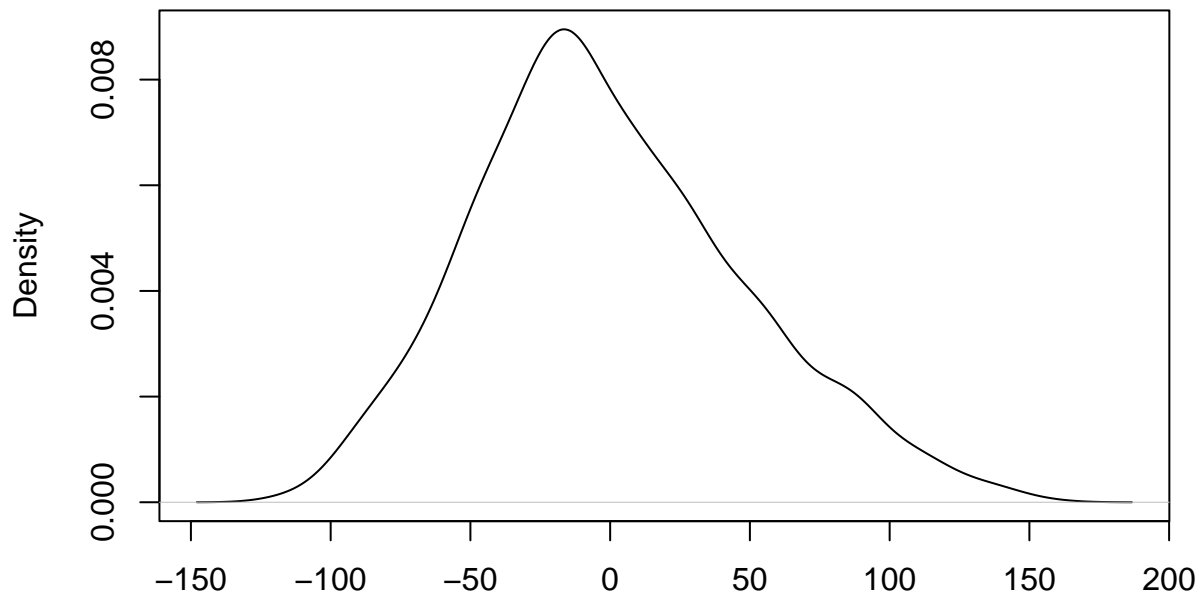
```
## [1] 0.1273887
```

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



```
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
```

## 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	*

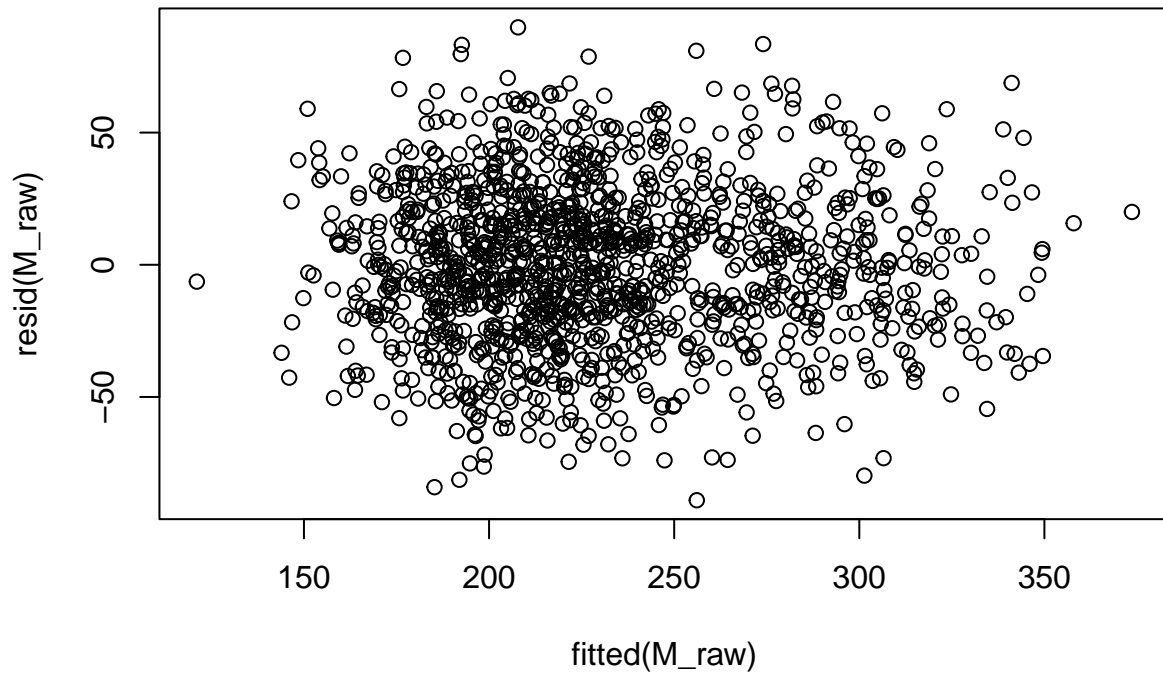
```
## G13:G19      5.577e+00  5.968e+00   0.934 0.350302
## G13:G20     -1.600e+00  6.206e+00  -0.258 0.796622
## G14:G15     -1.636e+00  5.794e+00  -0.282 0.777782
## G14:G16      4.161e+00  6.155e+00   0.676 0.499195
## G14:G17     -1.219e+00  5.792e+00  -0.211 0.833307
## G14:G18     -3.272e+00  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
```

```
summary(M_raw)$adj.r.squared
```

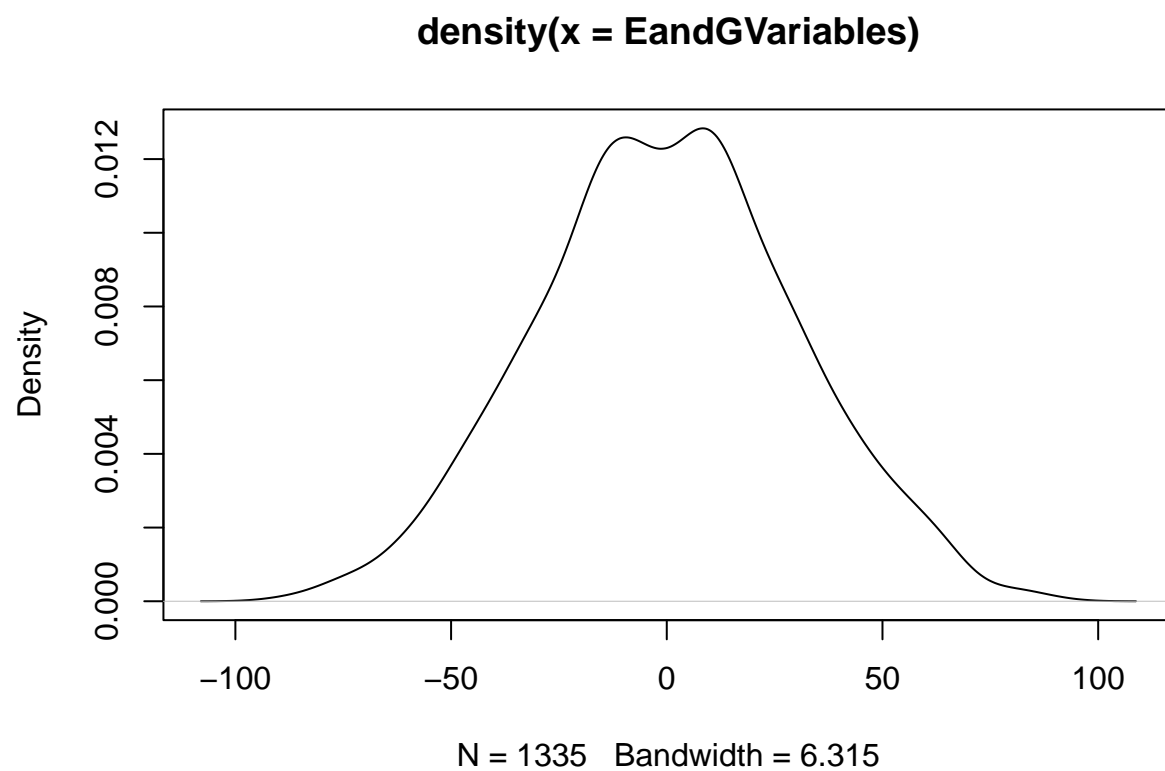
```
## [1] 0.5724978
```

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

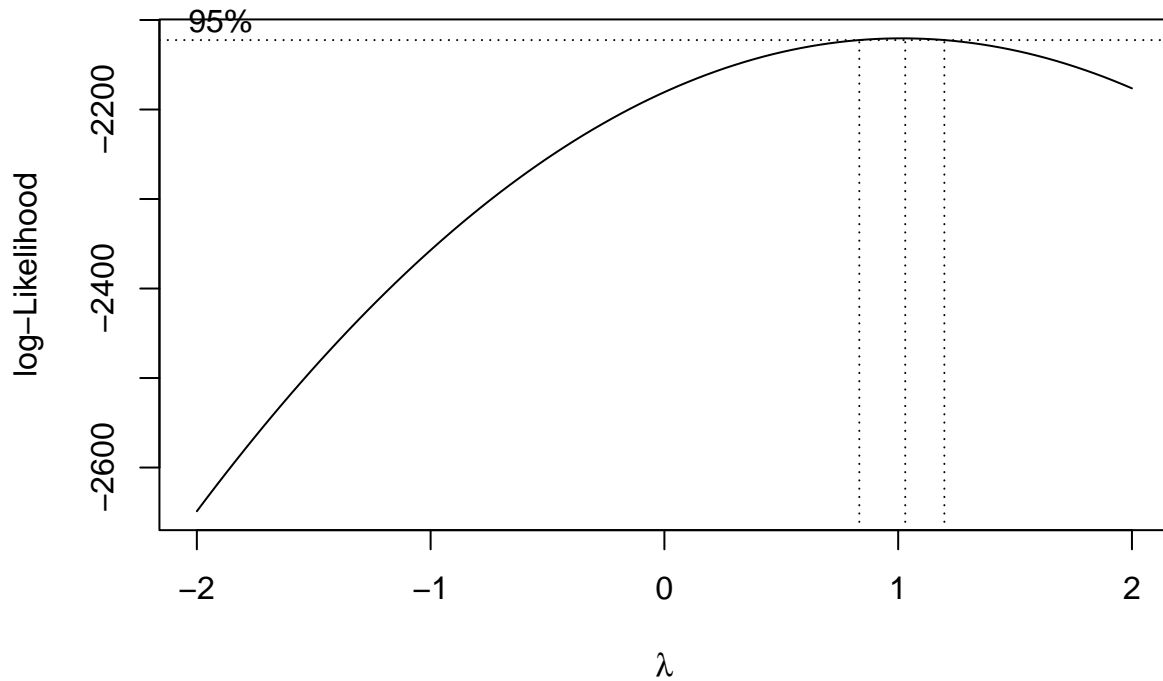
## Residual Plot of E and G variables



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



```
#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='3rd Interaction')
```

Table 4: 3rd Interaction

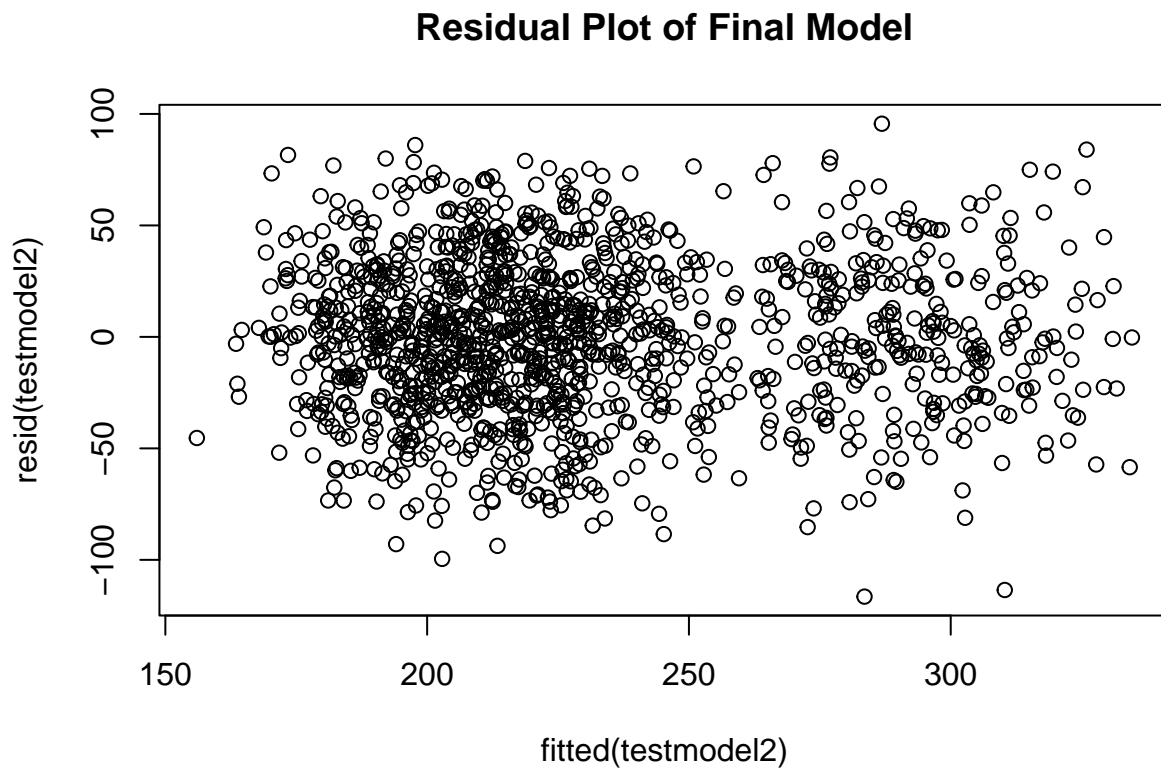
Estimate	Std. Error	t value	Pr(> t )
----------	------------	---------	----------

```
# There are no significant 3rd order interactions
#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)
```

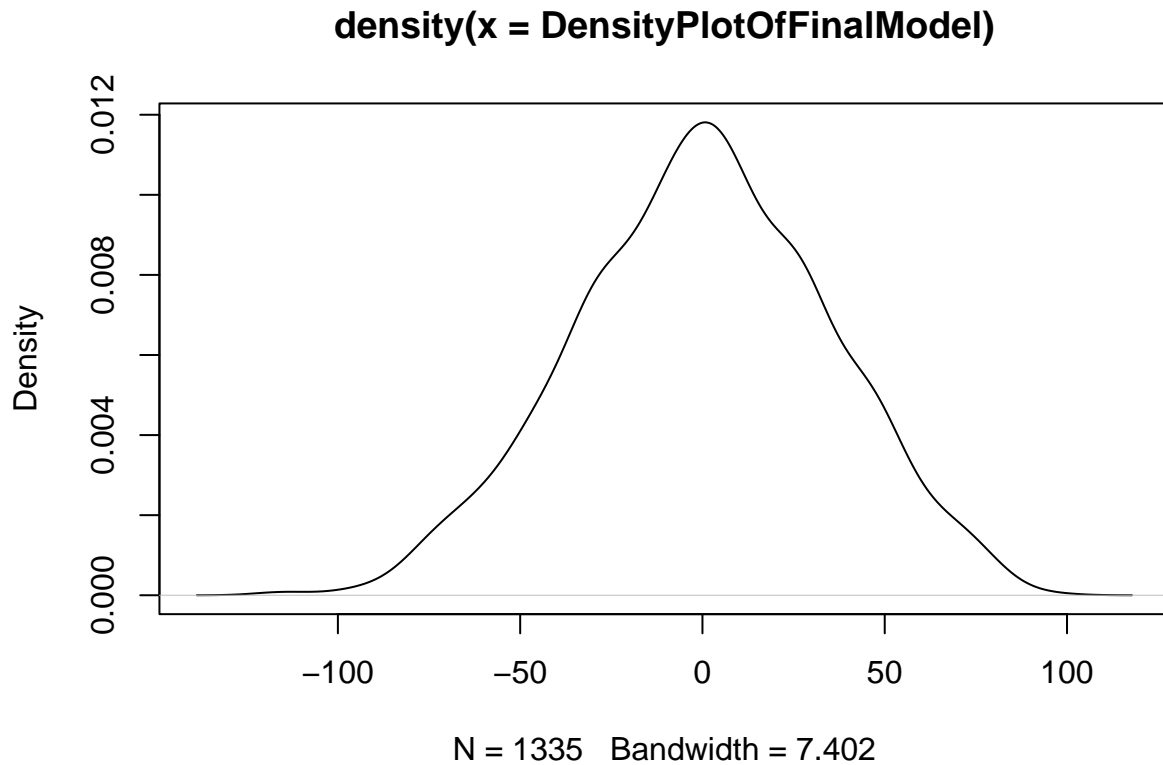
```
##
## Call:
## lm(formula = Y ~ (E1 + E2 + E3 + E4 + G5), data = Project2)
##
```

```
## 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
```

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



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



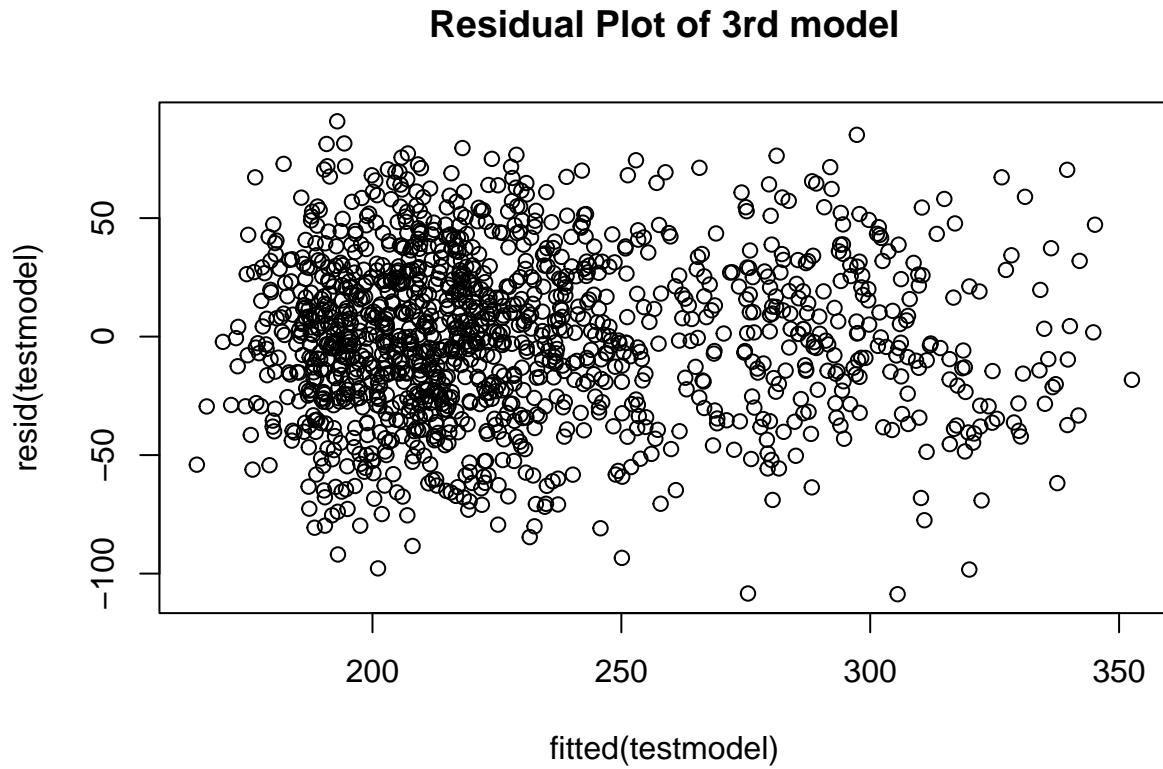
```
#adjusted r^2 is .5559
```

```
testmodel <- lm(Y ~ (E1+E2:E3+E4:G5), data=Project2)
summary(testmodel)
```

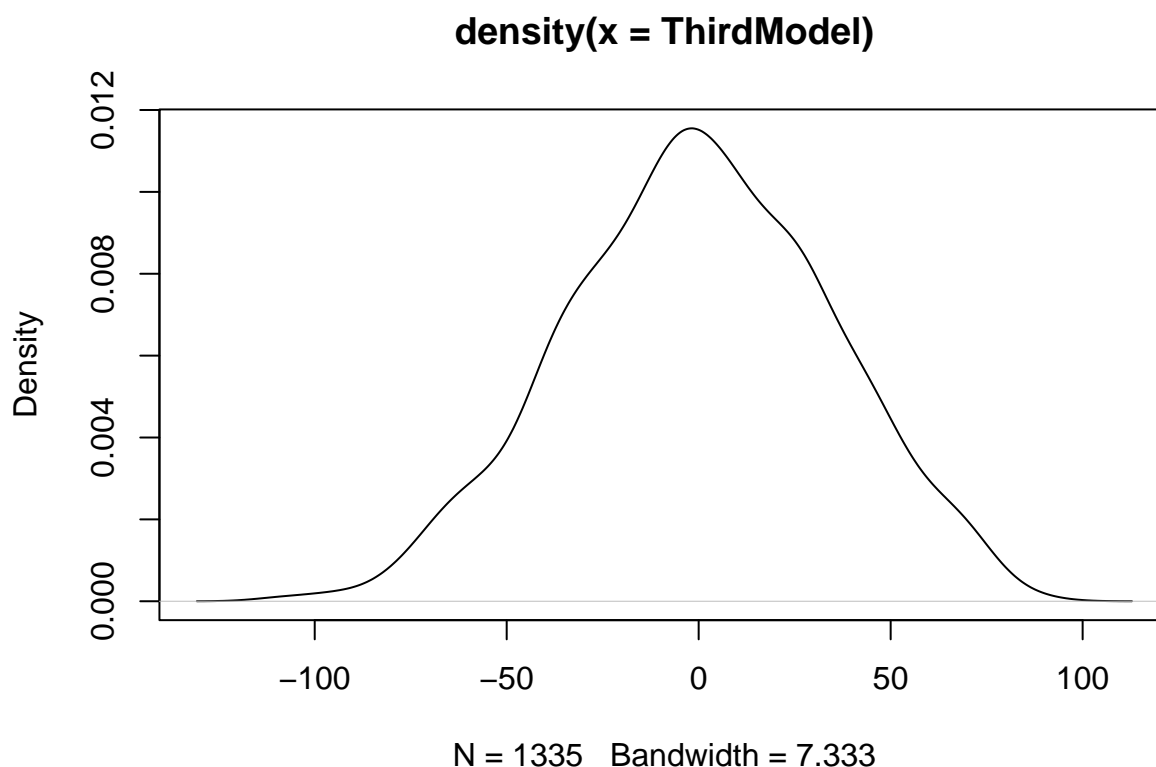
```
##
## Call:
## lm(formula = Y ~ (E1 + E2:E3 + E4:G5), data = Project2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -108.699  -24.004   -0.286    24.377    90.845
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 108.90384     6.07912   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')
```



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



```
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
```

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

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