ExploratoryAnalyses

MRB

October 27, 2017

Purpose

Document for data exploration for **Data Challenge 2017**!

Look at the data

Table 1: **Overall Data Summary**

	Overall (N=400)
Y	
Mean (SD)	6.26 (3.47)
Q1, Q3	3.62, 8.43
Range	0.042 - 16.6
A	
0	215 (53.8%)
1	185 (46.2%)
W1	
A	42 (10.5%)
B	75 (18.8%)
C	263 (65.8%)
D	20 (5%)
W2	
A	252 (63%)
B	71 (17.8%)
C	37 (9.25%)
D	40 (10%)
W3	
A	115 (28.8%)
B	115 (28.8%)
C	170 (42.5%)
W4	
A	289 (72.2%)
B	34 (8.5%)
C	77 (19.2%)
W5	
0	232 (58%)
1	168 (42%)
W6	
0	279 (69.8%)
1	121 (30.2%)
W7	
Mean (SD)	2.29 (2.99)
Q1, Q3	0.028, 4.33
Range	-5.2 - 11.5

	Overall (N=400)
W8	
Mean (SD)	2.36 (3.68)
Q1, Q3	-0.22, 4.87
Range	-7.7 - 14.3
W9	
Mean (SD)	2.93 (3.14)
Q1, Q3	0, 5
Range	0 - 11
W10	
Mean (SD)	0.089 (3.03)
Q1, Q3	-1.9, 2.02
Range	-9.1 - 9.27
W11	
Mean (SD)	0.307 (4.47)
Q1, Q3	-2.6, 3.11
Range	-14 - 14.9
W12	
Mean (SD)	1.55 (7.67)
Q1, Q3	-3.4, 6.65
Range	-19 - 28.1
W13	
Mean (SD)	3.02 (4.67)
Q1, Q3	-0.152, 5.93
Range	-7.7 - 17.1
W14	
Mean (SD)	5.68 (6.6)
Q1, Q3	0.478, 9.04
Range	-2.7 - 27.4
W15	
Mean (SD)	2.01 (5.69)
Q1, Q3	-1.7, 5.29
Range	-14 - 27.2
W16	
Mean (SD)	3.8 (5)
Q1, Q3	0.297, 6.11
Range	-3.4 - 16.9
W17	
Mean (SD)	4.66 (5.14)
Q1, Q3	0.817, 8.17
Range	-7.9 - 20.3
W18	
Mean (SD)	5.54 (3.61)
Q1, Q3	2.92, 8.32
Range	-3 - 14.9
W19	
Mean (SD)	9.09 (9.26)
Q1, Q3	2.67, 12.6
Range	-5.2 - 57.6
W20	
Mean (SD)	-0.079 (3.11)
Q1, Q3	-2.4, 1.86
Range	-13 - 9.71

	Overall (N=400)
W21	
Mean (SD)	3.79 (4.31)
Q1, Q3	0.321, 7.3
Range	-8.4 - 15.6
W22	
Mean (SD)	4.73 (2.01)
Q1, Q3	3.21, 6.03
Range	0.631 - 10.9
W23	
Mean (SD)	8.5 (4.26)
Q1, Q3	5.14, 11.5
Range	-0.232 - 23.5
W24	
Mean (SD)	2.89 (8.34)
Q1, Q3	-2.9, 8.1
Range	-17 - 38
W25	
Mean (SD)	9.81 (9.21)
Q1, Q3	2.86, 15.4
Range	-4.9 - 41.5

Table 2: **Overall Data Summary: By A**

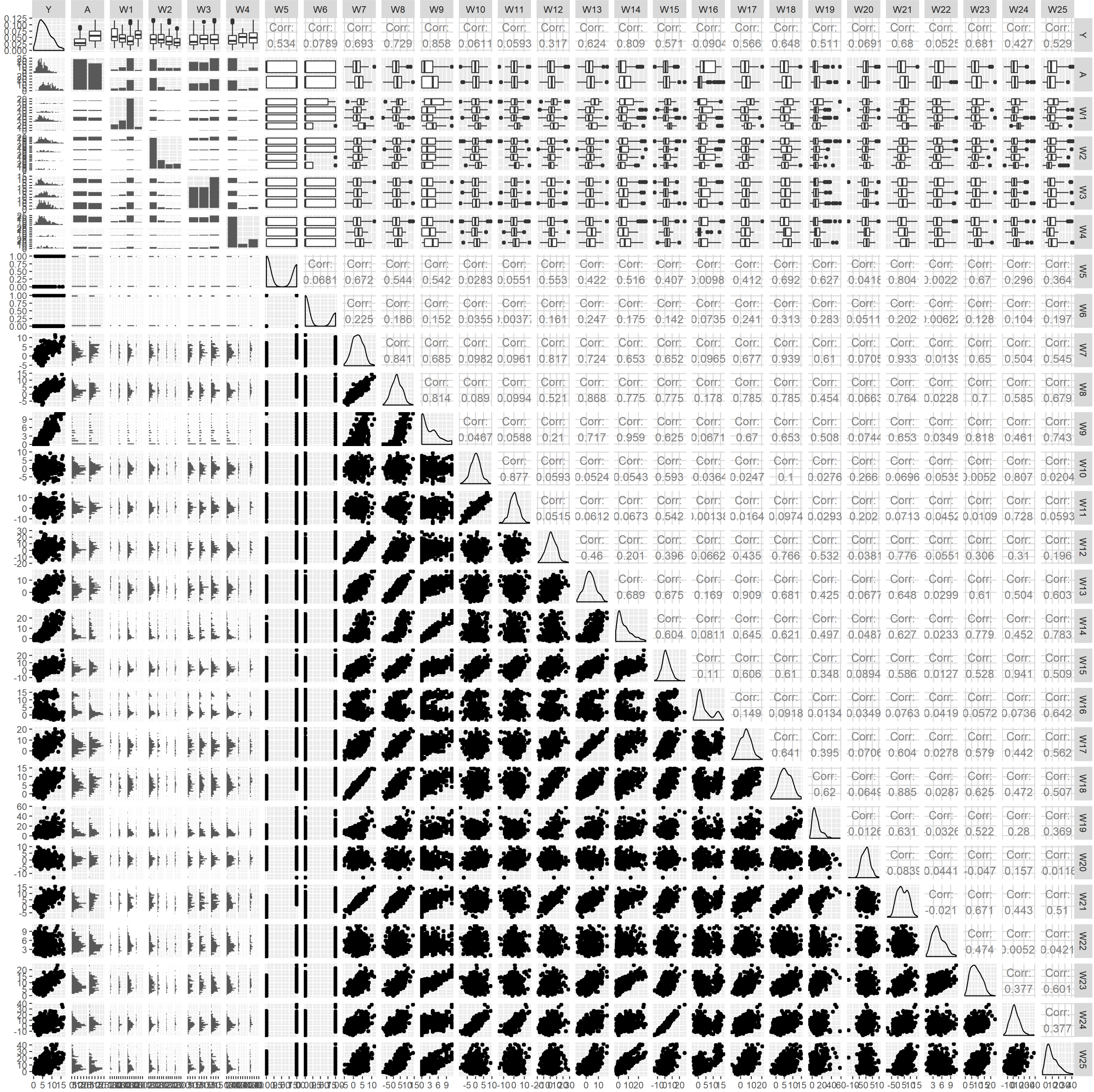
	0 (N=215)	1 (N=185)	Total (N=400)	p value
W1				0.378[1]
A	18 (8.37%)	24 (13%)	42 (10.5%)	
B	41 (19.1%)	34 (18.4%)	75 (18.8%)	
C	143 (66.5%)	120 (64.9%)	263 (65.8%)	
D	13 (6.05%)	7 (3.78%)	20 (5%)	
W2				<0.001[1]
A	121 (56.3%)	131 (70.8%)	252 (63%)	
B	34 (15.8%)	37 (20%)	71 (17.8%)	
C	30 (14%)	7 (3.78%)	37 (9.25%)	
D	30 (14%)	10 (5.41%)	40 (10%)	
W3				0.889[1]
A	64 (29.8%)	51 (27.6%)	115 (28.8%)	
B	61 (28.4%)	54 (29.2%)	115 (28.8%)	
C	90 (41.9%)	80 (43.2%)	170 (42.5%)	
W4				0.031[1]
A	160 (74.4%)	129 (69.7%)	289 (72.2%)	
B	11 (5.12%)	23 (12.4%)	34 (8.5%)	
C	44 (20.5%)	33 (17.8%)	77 (19.2%)	
W5				<0.001[2]
0	146 (67.9%)	86 (46.5%)	232 (58%)	
1	69 (32.1%)	99 (53.5%)	168 (42%)	
W6				0.580[2]
0	153 (71.2%)	126 (68.1%)	279 (69.8%)	
1	62 (28.8%)	59 (31.9%)	121 (30.2%)	
W7				<0.001[3]
Mean (SD)	1.82 (2.91)	2.83 (3)	2.29 (2.99)	
Q1, Q3	-0.216, 3.76	0.77, 5.18	0.028, 4.33	

	0 (N=215)	1 (N=185)	Total (N=400)	p value
Range	-5.2 - 11.5	-4.1 - 10.3	-5.2 - 11.5	
W8				0.010[3]
Mean (SD)	1.92 (3.49)	2.87 (3.84)	2.36 (3.68)	
Q1, Q3	-0.51, 3.83	0.293, 5.8	-0.22, 4.87	
Range	-5.7 - 12.4	-7.7 - 14.3	-7.7 - 14.3	
W9				<0.001[3]
Mean (SD)	2.28 (2.73)	3.68 (3.41)	2.93 (3.14)	
Q1, Q3	0, 4	0, 6	0, 5	
Range	0 - 11	0 - 11	0 - 11	
W10				0.404[3]
Mean (SD)	-0.028 (3.07)	0.225 (2.98)	0.089 (3.03)	
Q1, Q3	-2.2, 1.97	-1.6, 2.16	-1.9, 2.02	
Range	-9.1 - 7.57	-7.9 - 9.27	-9.1 - 9.27	
W11				0.851[3]
Mean (SD)	0.346 (4.47)	0.262 (4.48)	0.307 (4.47)	
Q1, Q3	-2.8, 2.93	-2.3, 3.2	-2.6, 3.11	
Range	-14 - 14.9	-13 - 12.2	-14 - 14.9	
W12				0.230[3]
Mean (SD)	1.12 (7.87)	2.04 (7.42)	1.55 (7.67)	
Q1, Q3	-4, 6.21	-3, 7.08	-3.4, 6.65	
Range	-19 - 28.1	-17 - 20.9	-19 - 28.1	
W13				0.026[3]
Mean (SD)	2.54 (4.58)	3.58 (4.73)	3.02 (4.67)	
Q1, Q3	-0.522, 5.29	0.567, 6.61	-0.152, 5.93	
Range	-7.1 - 17.1	-7.7 - 16.9	-7.7 - 17.1	
W14				<0.001[3]
Mean (SD)	4.52 (5.97)	7.02 (7.05)	5.68 (6.6)	
Q1, Q3	0.178, 7.21	0.914, 12.1	0.478, 9.04	
Range	-2.7 - 23.9	-2.7 - 27.4	-2.7 - 27.4	
W15				0.020[3]
Mean (SD)	1.39 (5.59)	2.73 (5.75)	2.01 (5.69)	
Q1, Q3	-1.9, 4.12	-1.5, 6.4	-1.7, 5.29	
Range	-14 - 17.7	-10 - 27.2	-14 - 27.2	
W16				<0.001[3]
Mean (SD)	5.59 (5.34)	1.71 (3.58)	3.8 (5)	
Q1, Q3	1.22, 11.4	-0.261, 2.31	0.297, 6.11	
Range	-2 - 15.7	-3.4 - 16.9	-3.4 - 16.9	
W17				0.039[3]
Mean (SD)	4.17 (5.08)	5.23 (5.17)	4.66 (5.14)	
Q1, Q3	0.32, 7.51	1.38, 9.03	0.817, 8.17	
Range	-7.9 - 20.3	-6.3 - 18	-7.9 - 20.3	
W18				0.002[3]
Mean (SD)	5.01 (3.52)	6.15 (3.64)	5.54 (3.61)	
Q1, Q3	2.6, 7.2	3.71, 9	2.92, 8.32	
Range	-3 - 14.5	-1.7 - 14.9	-3 - 14.9	
W19				<0.001[3]
Mean (SD)	7.62 (8.69)	10.8 (9.63)	9.09 (9.26)	
Q1, Q3	1.75, 11.2	4.16, 15.2	2.67, 12.6	
Range	-5.2 - 57.6	-3.1 - 50.9	-5.2 - 57.6	
W20				0.495[3]
Mean (SD)	0.02 (2.99)	-0.193 (3.24)	-0.079 (3.11)	
Q1, Q3	-2.1, 1.71	-2.6, 1.88	-2.4, 1.86	

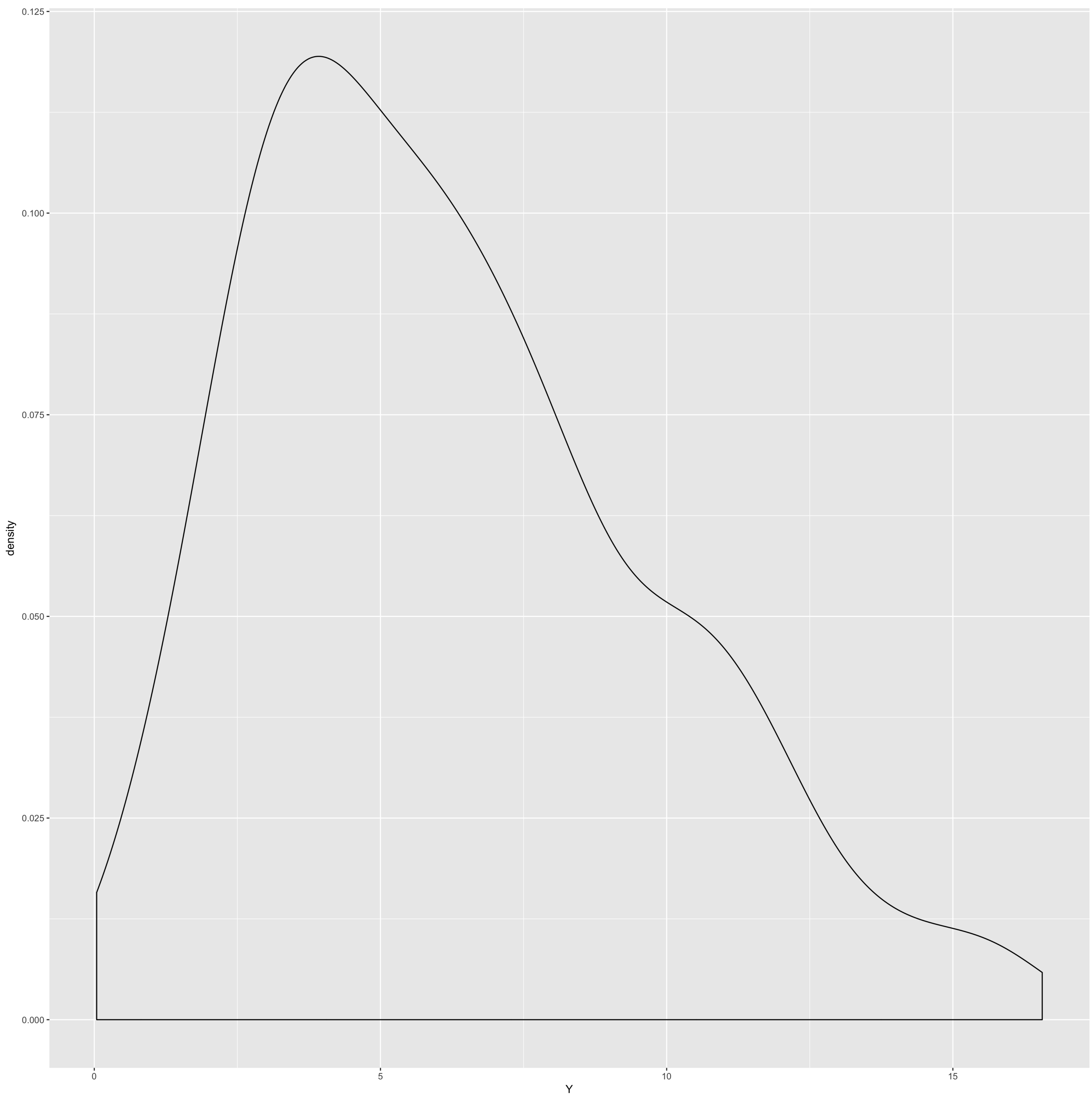
	0 (N=215)	1 (N=185)	Total (N=400)	p value
Range	-7 - 9.71	-13 - 9.49	-13 - 9.71	
W21				<0.001[3]
Mean (SD)	2.88 (4.16)	4.86 (4.24)	3.79 (4.31)	
Q1, Q3	-0.224, 6.02	1.67, 8.23	0.321, 7.3	
Range	-8.4 - 15.6	-4 - 14.2	-8.4 - 15.6	
W22				<0.001[3]
Mean (SD)	5.07 (2.03)	4.32 (1.92)	4.73 (2.01)	
Q1, Q3	3.6, 6.57	2.95, 5.42	3.21, 6.03	
Range	1.46 - 10.9	0.631 - 10.9	0.631 - 10.9	
W23				0.018[3]
Mean (SD)	8.03 (3.91)	9.04 (4.58)	8.5 (4.26)	
Q1, Q3	4.99, 10.5	5.27, 12.6	5.14, 11.5	
Range	1.33 - 21.1	-0.232 - 23.5	-0.232 - 23.5	
W24				0.071[3]
Mean (SD)	2.19 (8.21)	3.7 (8.45)	2.89 (8.34)	
Q1, Q3	-3.2, 7.9	-2.4, 8.7	-2.9, 8.1	
Range	-17 - 25.7	-13 - 38	-17 - 38	
W25				0.013[3]
Mean (SD)	10.9 (10)	8.58 (8.05)	9.81 (9.21)	
Q1, Q3	3.19, 16.7	2.56, 14.5	2.86, 15.4	
Range	-3.6 - 41.5	-4.9 - 34.1	-4.9 - 41.5	

1. Pearson's Chi-squared test
2. Pearson's Chi-squared test with Yates' continuity correction
3. Linear Model ANOVA

Scatterplot Matrix without Transformation



Scatterplot Matrix with log transform on response variable.


0.125
0.100
0.075
0.050
0.025
0.000
density
0
5
10
15
Y

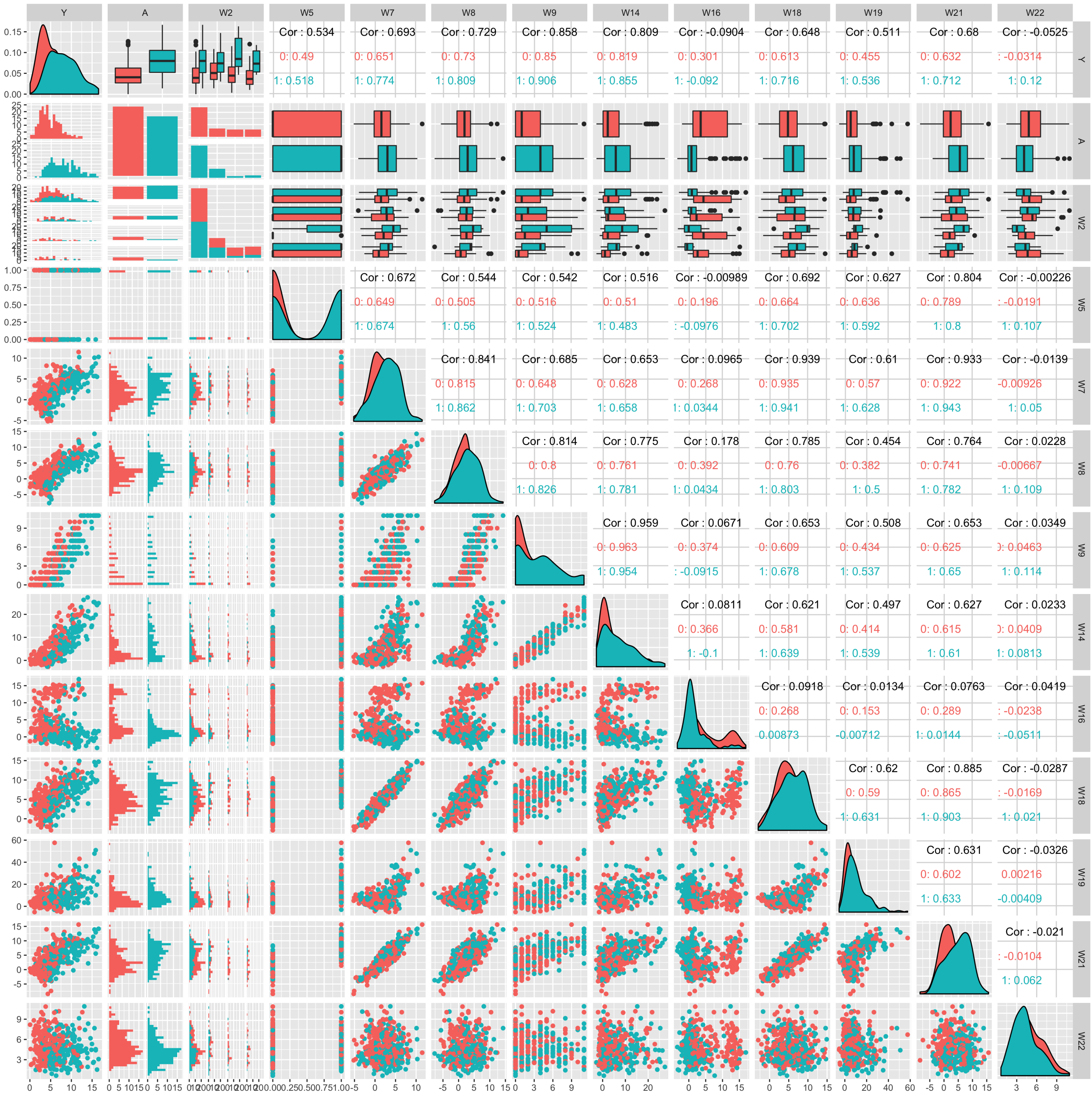


Table 3: **Model Summaries: Y = W_i + A, for i = 1, 2, . . . , 25**

	estimate	std.error	p.value	adj.r.squared
(Intercept)	6.58	0.469	<0.001	0.324
W1 B	-1.4	0.55	0.009	.
W1 C	-2.5	0.475	<0.001	.
W1 D	0.736	0.777	0.344	.
A 1	3.4	0.287	<0.001	.
(Intercept)	4.59	0.25	<0.001	0.242
W2 B	0.247	0.406	0.542	.
W2 C	0.634	0.541	0.242	.
W2 D	-0.342	0.521	0.512	.
A 1	3.46	0.312	<0.001	.

	estimate	std.error	p.value	adj.r.squared
(Intercept)	4.39	0.312	<0.001	0.242
W3 B	0.327	0.398	0.412	.
W3 C	0.436	0.365	0.232	.
A 1	3.43	0.303	<0.001	.
(Intercept)	4.42	0.222	<0.001	0.257
W4 B	0.112	0.546	0.838	.
W4 C	1.2	0.383	0.002	.
A 1	3.46	0.302	<0.001	.
(Intercept)	3.66	0.198	<0.001	0.433
W5 1	3.14	0.271	<0.001	.
A 1	2.76	0.268	<0.001	.
(Intercept)	4.53	0.226	<0.001	0.245
W6 1	0.471	0.328	0.152	.
A 1	3.42	0.302	<0.001	.
(Intercept)	3.34	0.159	<0.001	0.625
W7	0.727	0.036	<0.001	.
A 1	2.7	0.216	<0.001	.
(Intercept)	3.45	0.141	<0.001	0.692
W8	0.636	0.026	<0.001	.
A 1	2.83	0.194	<0.001	.
(Intercept)	2.69	0.111	<0.001	0.832
W9	0.869	0.023	<0.001	.
A 1	2.22	0.146	<0.001	.
(Intercept)	4.67	0.206	<0.001	0.242
W10	0.046	0.05	0.354	.
A 1	3.42	0.303	<0.001	.
(Intercept)	4.65	0.206	<0.001	0.245
W11	0.05	0.034	0.142	.
A 1	3.44	0.302	<0.001	.
(Intercept)	4.52	0.196	<0.001	0.324
W12	0.13	0.019	<0.001	.
A 1	3.31	0.286	<0.001	.
(Intercept)	3.58	0.167	<0.001	0.57
W13	0.427	0.024	<0.001	.
A 1	2.99	0.229	<0.001	.
(Intercept)	2.91	0.126	<0.001	0.775
W14	0.39	0.013	<0.001	.
A 1	2.46	0.168	<0.001	.
(Intercept)	4.23	0.168	<0.001	0.509
W15	0.317	0.021	<0.001	.
A 1	3.01	0.245	<0.001	.
(Intercept)	4.21	0.274	<0.001	0.253
W16	0.082	0.033	0.012	.
A 1	3.75	0.326	<0.001	.
(Intercept)	3.2	0.193	<0.001	0.51
W17	0.351	0.024	<0.001	.
A 1	3.06	0.245	<0.001	.
(Intercept)	1.86	0.221	<0.001	0.575
W18	0.56	0.032	<0.001	.
A 1	2.8	0.229	<0.001	.
(Intercept)	3.41	0.21	<0.001	0.429
W19	0.164	0.014	<0.001	.

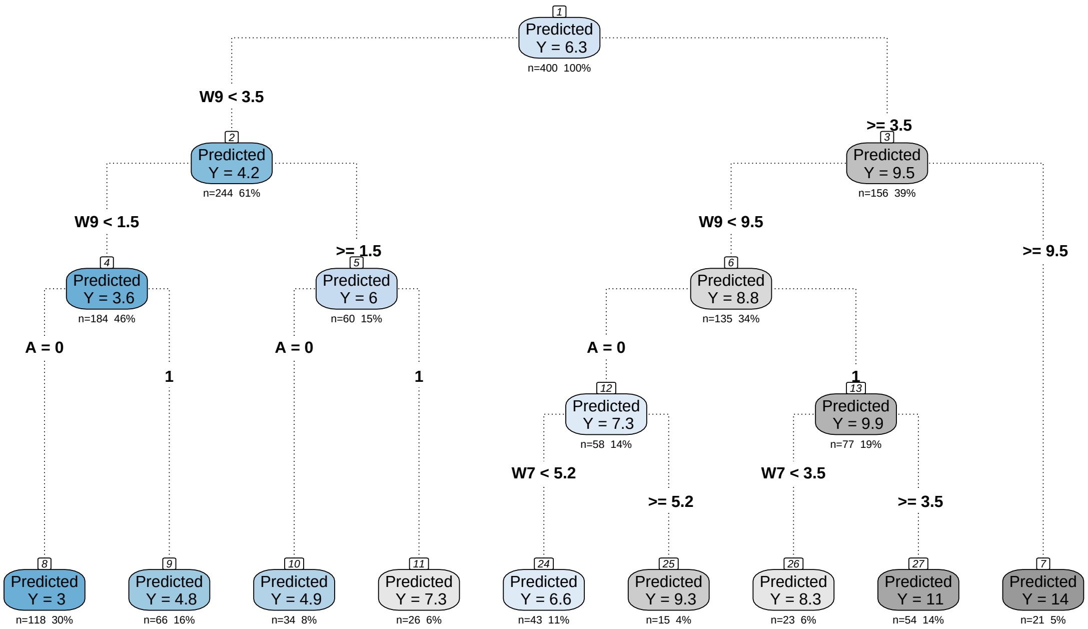
	estimate	std.error	p.value	adj.r.squared
A 1	2.91	0.267	<0.001	.
(Intercept)	4.67	0.206	<0.001	0.243
W20	-0.058	0.049	0.231	.
A 1	3.42	0.303	<0.001	.
(Intercept)	3.28	0.171	<0.001	0.581
W21	0.481	0.027	<0.001	.
A 1	2.48	0.231	<0.001	.
(Intercept)	4.31	0.439	<0.001	0.242
W22	0.07	0.076	0.361	.
A 1	3.49	0.308	<0.001	.
(Intercept)	0.538	0.245	0.029	0.635
W23	0.514	0.025	<0.001	.
A 1	2.92	0.211	<0.001	.
(Intercept)	4.32	0.188	<0.001	0.389
W24	0.16	0.016	<0.001	.
A 1	3.19	0.273	<0.001	.
(Intercept)	2.21	0.199	<0.001	0.597
W25	0.226	0.012	<0.001	.
A 1	3.95	0.222	<0.001	.

Playtime!

Different Methods of Variable Selection:

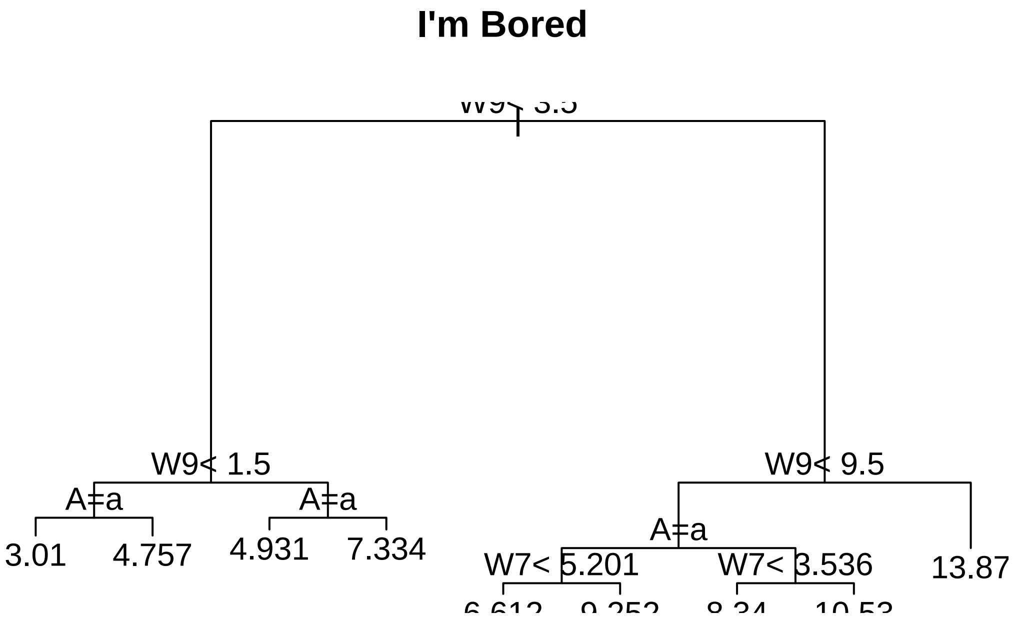
Decision Trees, Lasso, Forward, Stepwise, Manual (not backward)

Sweet, Sweet Plot



```
## Call:
## rpart(formula = formulize("Y", c(names(dc1)[4:28], "A")), data = dc1)
##   n= 400
##
##           CP nsplit rel error    xerror       xstd
## 1 0.54543153      0 1.0000000 1.0035463 0.06921446
## 2 0.09872680      1 0.4545685 0.4584950 0.03280511
## 3 0.05146478      2 0.3558417 0.4070547 0.02683046
## 4 0.04592446      3 0.3043769 0.3887065 0.02588447
## 5 0.02691989      4 0.2584524 0.3462752 0.02281628
## 6 0.01774951      5 0.2315325 0.2938947 0.02013334
## 7 0.01617286      6 0.2137830 0.2681117 0.01825518
## 8 0.01610594      7 0.1976102 0.2603524 0.01806450
## 9 0.01000000      8 0.1815042 0.2470480 0.01756582
##
## Variable importance
##  W9 W14  W8 W23 W25 W13   A W16 W21  W7 W12 W17 W18 W19
##  24  18  13  13  11  10   3   1   1   1   1   1   1   1
##
## Node number 1: 400 observations,    complexity param=0.5454315
##   mean=6.255473, MSE=11.98608
##   left son=2 (244 obs) right son=3 (156 obs)
##   Primary splits:
##       W9  < 3.5        to the left,  improve=0.5454315, (0 missing)
##       W14 < 5.763803   to the left,  improve=0.5181421, (0 missing)
##       W8  < 2.992449   to the left,  improve=0.4821869, (0 missing)
##       W7  < 3.478499   to the left,  improve=0.4175468, (0 missing)
##       W21 < 4.90963    to the left,  improve=0.4038650, (0 missing)
##   Surrogate splits:
##       W14 < 5.262932   to the left,  agree=0.940, adj=0.846, (0 split)
##       W8  < 2.92829    to the left,  agree=0.872, adj=0.673, (0 split)
##       W23 < 9.745147   to the left,  agree=0.855, adj=0.628, (0 split)
##       W25 < 11.65137   to the left,  agree=0.805, adj=0.500, (0 split)
##       W13 < 3.613826   to the left,  agree=0.802, adj=0.494, (0 split)
##
## Node number 2: 244 observations,    complexity param=0.05146478
##   mean=4.211024, MSE=3.867181
##   left son=4 (184 obs) right son=5 (60 obs)
##   Primary splits:
##       W9  < 1.5        to the left,  improve=0.2614948, (0 missing)
##       A   splits as  LR, improve=0.2540243, (0 missing)
##       W7  < 1.591133   to the left,  improve=0.2526917, (0 missing)
##       W21 < 1.663075   to the left,  improve=0.2055047, (0 missing)
##       W8  < 2.017509   to the left,  improve=0.1808941, (0 missing)
##   Surrogate splits:
##       W14 < 2.53977    to the left,  agree=0.893, adj=0.567, (0 split)
##       W8  < 2.903125   to the left,  agree=0.836, adj=0.333, (0 split)
##       W25 < 13.25427   to the left,  agree=0.803, adj=0.200, (0 split)
##       W16 < 11.3988    to the left,  agree=0.799, adj=0.183, (0 split)
##       W13 < 4.309836   to the left,  agree=0.791, adj=0.150, (0 split)
##
## Node number 3: 156 observations,    complexity param=0.0987268
##   mean=9.4532, MSE=7.921833
##   left son=6 (135 obs) right son=7 (21 obs)
##   Primary splits:
##       W9  < 9.5        to the left,  improve=0.3830205, (0 missing)
##       W7  < 4.999441   to the left,  improve=0.3164421, (0 missing)
##       W14 < 13.03272   to the left,  improve=0.3133315, (0 missing)
##       A   splits as  LR, improve=0.2846859, (0 missing)
##       W21 < 4.90963    to the left,  improve=0.2515501, (0 missing)
##   Surrogate splits:
##       W14 < 20.21393   to the left,  agree=0.936, adj=0.524, (0 split)
##       W23 < 15.62551   to the left,  agree=0.910, adj=0.333, (0 split)
##       W11 < 10.56538   to the left,  agree=0.885, adj=0.143, (0 split)
##       W17 < 15.30834   to the left,  agree=0.885, adj=0.143, (0 split)
##       W13 < 13.02812   to the left,  agree=0.878, adj=0.095, (0 split)
##
## Node number 4: 184 observations,    complexity param=0.02691989
##   mean=3.636782, MSE=2.5425
##   left son=8 (118 obs) right son=9 (66 obs)
##   Primary splits:
##       A   splits as  LR, improve=0.27588740, (0 missing)
##       W7  < 1.39736    to the left,  improve=0.13836180, (0 missing)
##       W21 < 3.076161   to the left,  improve=0.10365300, (0 missing)
##       W12 < 1.487588   to the left,  improve=0.08995449, (0 missing)
##       W1  splits as  RRLR, improve=0.08627216, (0 missing)
##   Surrogate splits:
##       W16 < 0.7283739  to the right, agree=0.674, adj=0.091, (0 split)
##       W22 < 1.713776   to the right, agree=0.674, adj=0.091, (0 split)
##       W23 < 2.328696   to the right, agree=0.674, adj=0.091, (0 split)
##       W8  < -5.151453  to the right, agree=0.663, adj=0.061, (0 split)
##       W25 < -2.560438  to the right, agree=0.663, adj=0.061, (0 split)
##
## Node number 5: 60 observations,    complexity param=0.01774951
##   mean=5.972035, MSE=3.817129
##   left son=10 (34 obs) right son=11 (26 obs)
##   Primary splits:
##       A   splits as  LR, improve=0.3715656, (0 missing)
##       W7  < 1.590959   to the left,  improve=0.3063926, (0 missing)
##       W21 < 2.455516   to the left,  improve=0.2793826, (0 missing)
##       W12 < 0.9629807  to the left,  improve=0.2108504, (0 missing)
##       W8  < 1.879978   to the left,  improve=0.1933822, (0 missing)
##   Surrogate splits:
##       W25 < 4.990111   to the right, agree=0.800, adj=0.538, (0 split)
##       W16 < 1.168843   to the right, agree=0.783, adj=0.500, (0 split)
##       W17 < 5.369905   to the right, agree=0.733, adj=0.385, (0 split)
##       W22 < 3.75348    to the right, agree=0.683, adj=0.269, (0 split)
##       W2  splits as  LRLL, agree=0.667, adj=0.231, (0 split)
##
## Node number 6: 135 observations,    complexity param=0.04592446
##   mean=8.766184, MSE=5.145359
##   left son=12 (58 obs) right son=13 (77 obs)
##   Primary splits:
##       A   splits as  LR, improve=0.3169800, (0 missing)
##       W7  < 4.999441   to the left,  improve=0.2928541, (0 missing)
##       W21 < 4.90963    to the left,  improve=0.2803883, (0 missing)
##       W12 < 1.297934   to the left,  improve=0.2278584, (0 missing)
##       W9  < 5.5        to the left,  improve=0.2232378, (0 missing)
##   Surrogate splits:
##       W16 < 7.491763   to the right, agree=0.756, adj=0.431, (0 split)
##       W25 < 16.86896   to the right, agree=0.756, adj=0.431, (0 split)
##       W21 < 3.170922   to the left,  agree=0.681, adj=0.259, (0 split)
##       W19 < 4.571226   to the left,  agree=0.659, adj=0.207, (0 split)
##       W12 < 0.1056728  to the left,  agree=0.652, adj=0.190, (0 split)
##
## Node number 7: 21 observations
##   mean=13.86973, MSE=3.23064
##
## Node number 8: 118 observations
##   mean=3.010417, MSE=1.935495
##
## Node number 9: 66 observations
##   mean=4.756646, MSE=1.672211
##
## Node number 10: 34 observations
##   mean=4.930597, MSE=2.456896
##
## Node number 11: 26 observations
##   mean=7.333916, MSE=2.322863
##
## Node number 12: 58 observations,    complexity param=0.01617286
##   mean=7.294701, MSE=3.41116
##   left son=24 (43 obs) right son=25 (15 obs)
##   Primary splits:
##       W7  < 5.200705   to the left,  improve=0.3919170, (0 missing)
##       W14 < 15.69639   to the left,  improve=0.3720128, (0 missing)
##       W9  < 7.5        to the left,  improve=0.3720128, (0 missing)
##       W18 < 8.31034    to the left,  improve=0.3595877, (0 missing)
##       W19 < 12.06569   to the left,  improve=0.3563726, (0 missing)
##   Surrogate splits:
##       W18 < 9.142641   to the left,  agree=0.948, adj=0.800, (0 split)
##       W21 < 8.249895   to the left,  agree=0.948, adj=0.800, (0 split)
##       W19 < 15.61409   to the left,  agree=0.931, adj=0.733, (0 split)
##       W12 < 8.316907   to the left,  agree=0.897, adj=0.600, (0 split)
##       W9  < 7.5        to the left,  agree=0.862, adj=0.467, (0 split)
##
## Node number 13: 77 observations,    complexity param=0.01610594
##   mean=9.874574, MSE=3.592136
##   left son=26 (23 obs) right son=27 (54 obs)
##   Primary splits:
##       W7  < 3.536022   to the left,  improve=0.2791772, (0 missing)
##       W9  < 5.5        to the left,  improve=0.2493821, (0 missing)
##       W14 < 12.33164   to the left,  improve=0.2082537, (0 missing)
##       W21 < 4.786183   to the left,  improve=0.1811454, (0 missing)
##       W8  < 4.274089   to the left,  improve=0.1773352, (0 missing)
##   Surrogate splits:
##       W18 < 6.649654   to the left,  agree=0.896, adj=0.652, (0 split)
##       W8  < 3.479762   to the left,  agree=0.857, adj=0.522, (0 split)
##       W12 < -0.2520162 to the left,  agree=0.844, adj=0.478, (0 split)
##       W21 < 4.786183   to the left,  agree=0.844, adj=0.478, (0 split)
##       W17 < 5.275259   to the left,  agree=0.792, adj=0.304, (0 split)
##
```

```
## Node number 24: 43 observations
##   mean=6.611798, MSE=1.850068
##
## Node number 25: 15 observations
##   mean=9.252359, MSE=2.716976
##
## Node number 26: 23 observations
##   mean=8.340136, MSE=2.780899
##
## Node number 27: 54 observations
##   mean=10.52813, MSE=2.507683
```



From the scatterplot matrix there appears to be several variables that are very strongly correlated. Techniques to consider: lasso, pls, others?

Of the variables that are highly correlated, can select the variable(s) that appear to be most correlated with the response

Must not lose focus. The objective is to measure the treatment effect of A, not predict Y.

Use MARS to Pick Out Interaction Terms

```
## x[400,32] with colnames A1 W1B W1C W1D W2B W2C W2D W3B W3C W4B W4C W51 W61 W7 W8 ...
## y[400,1] with colname Y
## maxmem 0.0 GB
## malloc    128  B: nUses          *pnPreds 32 sizeof(int)
## malloc    160  B: nDegree        nMaxTerms 40 sizeof(int) 4
## calloc      4  B: iDirs          nMaxTerms 40 nPreds 32 sizeof(int) 4
## malloc    160  B: BoolFullSet        nMaxTerms 40 sizeof(bool) 4
## malloc     50 kB: xOrder     nRows 400 nCols 32 sizeof(int) 4
## malloc    400 kB: BetaCacheGlobal    nMaxTerms 40 nMaxTerms 40 nPreds 32 sizeof(double) 8
## malloc    125 kB: bxOrth     nCases 400 nMaxTerms 40 sizeof(double) 8
## malloc    125 kB: bxOrthCenteredT    nMaxTerms 40 nCases 400 sizeof(double) 8
## malloc    320  B: bxOrthMean     nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: yMean          nResp 1 sizeof(double) 8
## Forward pass term 1
## malloc      1 kB: Q          nMaxTerms 40 sizeof(tQueue) 32
## malloc      1 kB: SortedQ        nMaxTerms 40 sizeof(tQueue) 32
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 2
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 4
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 6
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 8
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 10
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 12
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 14
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 16
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
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## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 18
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 20
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 22
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
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## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 24
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
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## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 26
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
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## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 28
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
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## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 30
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
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## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 32
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
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## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 34
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
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## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 36
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 38
##
## Reached nk 40
## After forward pass GRSq 0.896 RSq 0.933
## malloc    160  B: iPivots        nTerms 40 sizeof(int) 4
## malloc    100 kB: xUsed          nCases 400 nUsedCols 32 sizeof(double) 8
## malloc      3 kB: Residuals      nCases 400 nResp 1 sizeof(double) 8
## malloc    256  B: qraux          nUsedCols 32 sizeof(double) 8
## malloc    100 kB: work           nCases 400 nUsedCols 32 sizeof(double) 8
## Prune method "backward" penalty 3 nprune null: selected 24 of 32 terms, and 14 of 32 preds
## After pruning pass GRSq 0.906 RSq 0.931
## Getting leverages
```

```
## Call: earth(formula=Y~., data=dc2, trace=1.5, degree=3, nk=40)
##
##                                   coefficients
## (Intercept)                          4.2591617
## A1                                   2.4264695
## W1C                                 -0.6599950
## h(-0.530967-W7)                      0.4505634
## h(W7- -0.530967)                     0.4906124
## h(2-W9)                             -0.9805526
## h(W9-2)                              0.5373457
## h(W9-8)                              0.5056333
## h(9.96584-W17)                       0.0660589
## A1 * W61                            -1.0748691
## A1 * h(2.78832-W7)                  -0.2742078
## W1C * h(W16-5.60908)                -0.1191151
## W1C * h(5.60908-W16)                -0.1130028
## W2D * h(W17-9.96584)                -1.0937951
## h(W7- -0.530967) * h(W18-2.12195)   -0.0151246
## h(W7- -0.530967) * h(2.12195-W18)   -1.3167697
## h(2.57375-W8) * h(W9-2)             -1.0004109
## h(W9-2) * h(2.12155-W13)             0.2006590
## h(2-W9) * h(-0.764684-W16)          -1.0086522
## h(W11-5.47256) * h(9.96584-W17)     -0.0312022
## h(W12-4.0743) * h(9.96584-W17)      -0.0115547
## A1 * W51 * W61                      -2.3061926
## A1 * W1C * h(5.60908-W16)            0.1328901
## A1 * W61 * h(W7- -0.0901544)         0.3354175
##
## Selected 24 of 32 terms, and 14 of 32 predictors
## Termination condition: Reached nk 40
## Importance: W9, A1, W7, W1C, W51, W61, W8, W13, W16, W17, W2D, W11, ...
## Number of terms at each degree of interaction: 1 8 12 3
## GCV 1.133263    RSS 330.4093    GRSq 0.9059239    RSq 0.9310848
```

What if hinge functions h(x) aren’t allowed and we had to use linear associations only?

```
## x[400,32] with colnames A1 W1B W1C W1D W2B W2C W2D W3B W3C W4B W4C W51 W61 W7 W8 ...
## y[400,1] with colname Y
## maxmem 0.0 GB
## malloc    128  B: nUses          *pnPreds 32 sizeof(int)
## malloc    160  B: nDegree        nMaxTerms 40 sizeof(int) 4
## calloc      4  B: iDirs          nMaxTerms 40 nPreds 32 sizeof(int) 4
## malloc    160  B: BoolFullSet        nMaxTerms 40 sizeof(bool) 4
## malloc     50 kB: xOrder     nRows 400 nCols 32 sizeof(int) 4
## malloc    400 kB: BetaCacheGlobal    nMaxTerms 40 nMaxTerms 40 nPreds 32 sizeof(double) 8
## malloc    125 kB: bxOrth     nCases 400 nMaxTerms 40 sizeof(double) 8
## malloc    125 kB: bxOrthCenteredT    nMaxTerms 40 nCases 400 sizeof(double) 8
## malloc    320  B: bxOrthMean     nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: yMean          nResp 1 sizeof(double) 8
## Forward pass term 1
## malloc      1 kB: Q          nMaxTerms 40 sizeof(tQueue) 32
## malloc      1 kB: SortedQ        nMaxTerms 40 sizeof(tQueue) 32
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 2
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 4
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 6
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 8
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 10
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 12
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 14
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 16
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 18
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 20
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 22
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 24
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 26
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 28
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 30
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 32
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 34
## malloc      3 kB: xbx            nCases 400 sizeof(double) 8
## malloc    320  B: CovSx          nMaxTerms 40 sizeof(double) 8
## calloc      8  B: CovCol     nMaxTerms 40 sizeof(double) 8
## calloc      8  B: ycboSum        nMaxTerms 40 nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## malloc      8  B: ybxSum     nResp 1 sizeof(double) 8
## Forward pass term 36
##
## RSq changed by less than 0.001 at 35 terms, 18 terms used (DeltaRSq 0.00098)
## After forward pass GRSq 0.889 RSq 0.913
## malloc    160  B: iPivots        nTerms 40 sizeof(int) 4
## malloc     56 kB: xUsed          nCases 400 nUsedCols 18 sizeof(double) 8
## malloc      3 kB: Residuals      nCases 400 nResp 1 sizeof(double) 8
## malloc    144  B: qraux          nUsedCols 18 sizeof(double) 8
## malloc     56 kB: work           nCases 400 nUsedCols 18 sizeof(double) 8
## Prune method "backward" penalty 3 nprune null: selected 15 of 18 terms, and 11 of 32 preds
## After pruning pass GRSq 0.89 RSq 0.908
## Getting leverages
```

```
## Call: earth(formula=Y~., data=dc2, trace=1.5, degree=3, nk=40,
##             linpreds=TRUE)
##
##                  coefficients
## (Intercept)         3.5225713
## A1                  1.2817632
## W1C                -1.1738625
## W7                  0.1558773
## W9                  0.7670360
## W17                -0.0435700
## A1 * W1C            0.6826550
## A1 * W7             0.2613782
## W1C * W19           0.0280239
## W1C * W25          -0.0314256
## W7 * W12            0.0135496
## W7 * W19           -0.0117085
## W9 * W19            0.0069741
## A1 * W51 * W61     -1.9141280
## W1C * W20 * W25    -0.0055586
##
## Selected 15 of 18 terms, and 11 of 32 predictors
## Termination condition: RSq changed by less than 0.001 at 18 terms
## Importance: W9, A1, W1C, W7, W51, W61, W12, W19, W17, W25, W20, ...
## Number of terms at each degree of interaction: 1 5 7 2
## GCV 1.330175    RSS 440.6072    GRSq 0.8895776    RSq 0.9081002
```

All Subset

Y = A + W2 + W4 + W5 + W7 + W8 + W9 + W13 + W14 + W15 + W16 + W19 + W21 + W22

Best Subset

Y = A + W2 + W4 + W5 + W7 + W8 + W9 + W13 + W14 + W15 + W16 + W19 + W21 + W22