

Machine Learning Exercise

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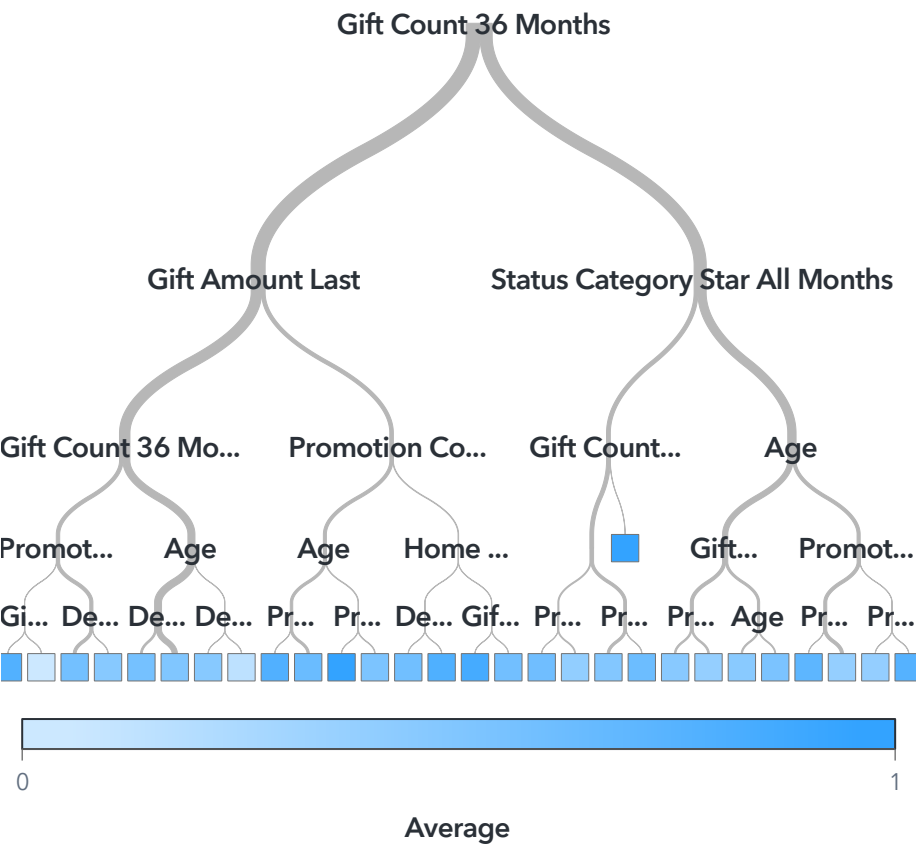
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DescTree



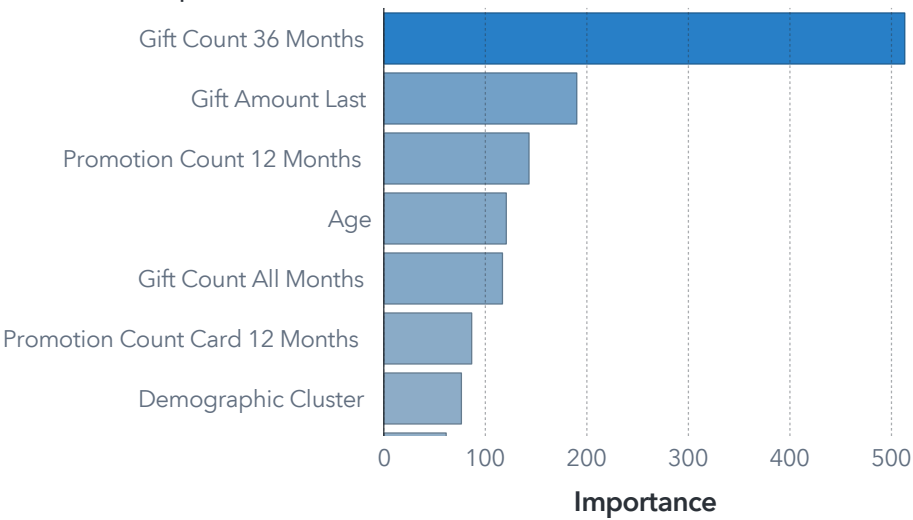
Decision Tree **Target Gift Flag** ASE **0.2373** Observations Used **106,546**

Tree

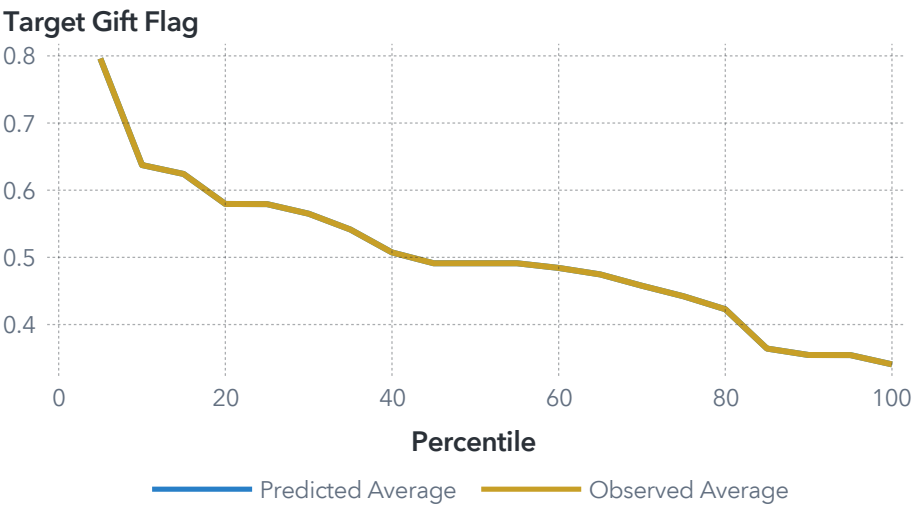


Gift Count 36 Months														
Gift Amount Last						Status Category Star All Months								
Gift Count 36 Months										Age				
		Age			Age				Age		Gift Amount Last			
		Demographic Cluster											Age	

Variable Importance



Assessment

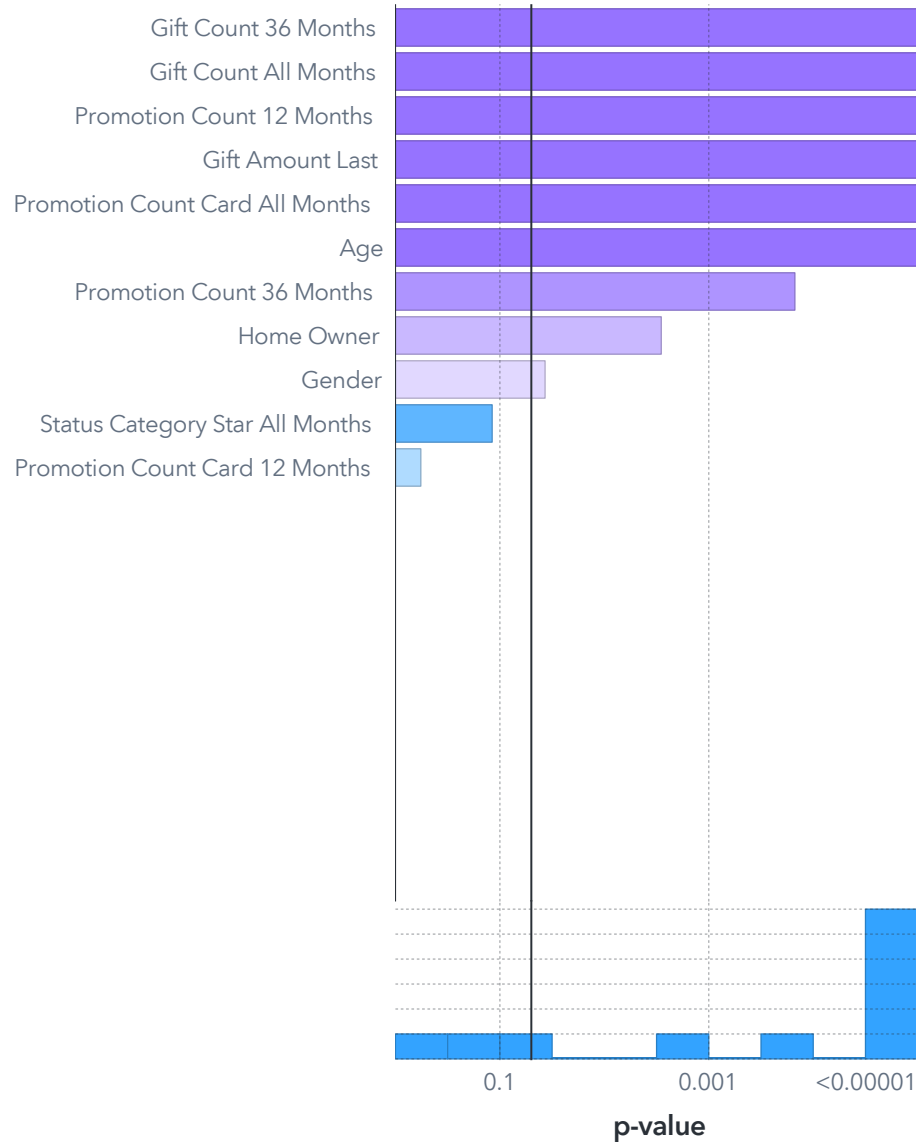


LogReg

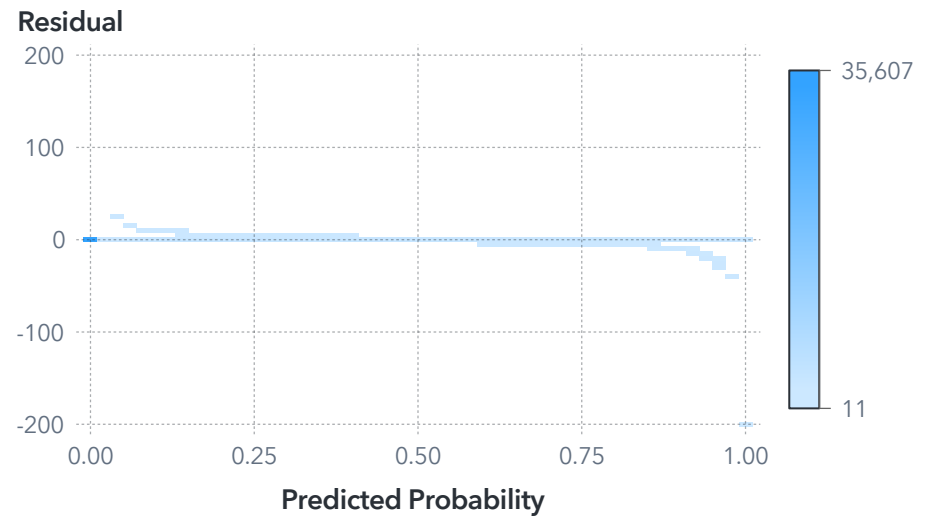


Logistic Regression **Status Category 96NK** (event=S) KS (Youden) **0.6809** Observations Used **80,069** Unused **26,477**

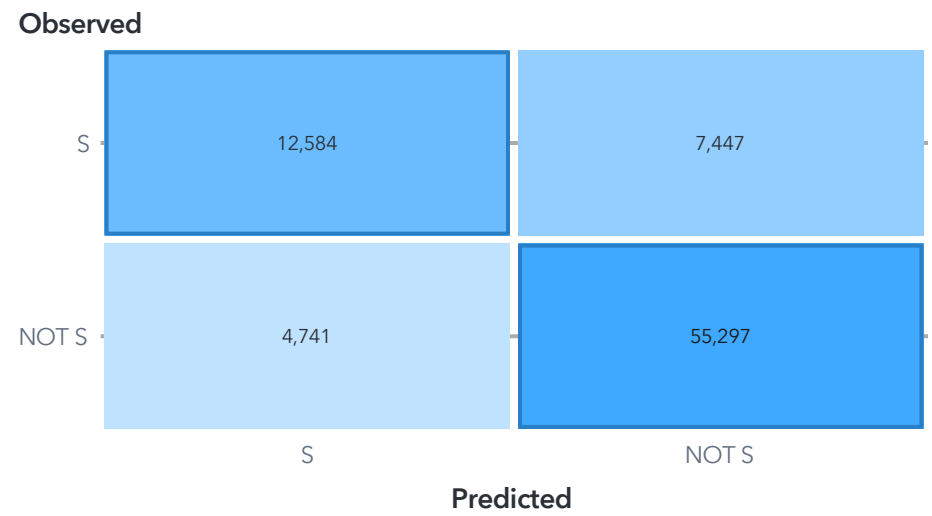
Fit Summary



Residual Plot



Confusion Matrix

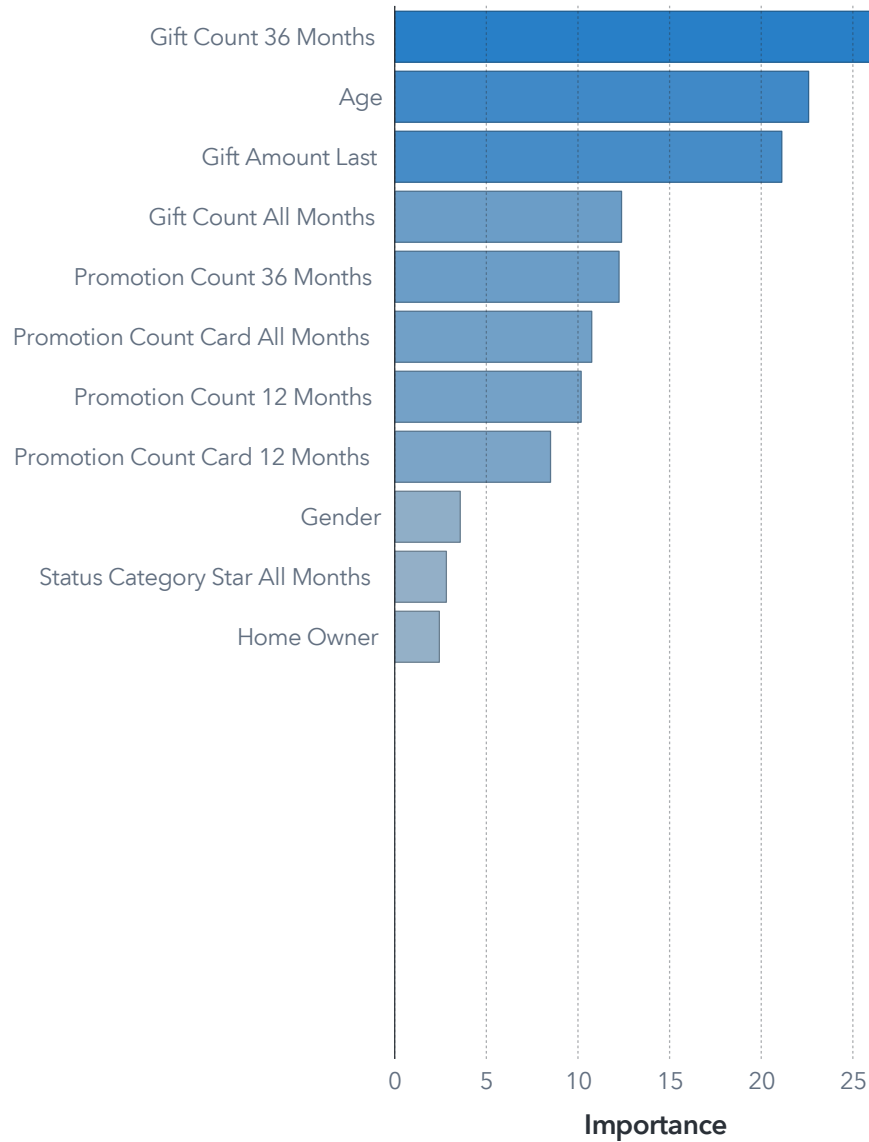


GradBoosting



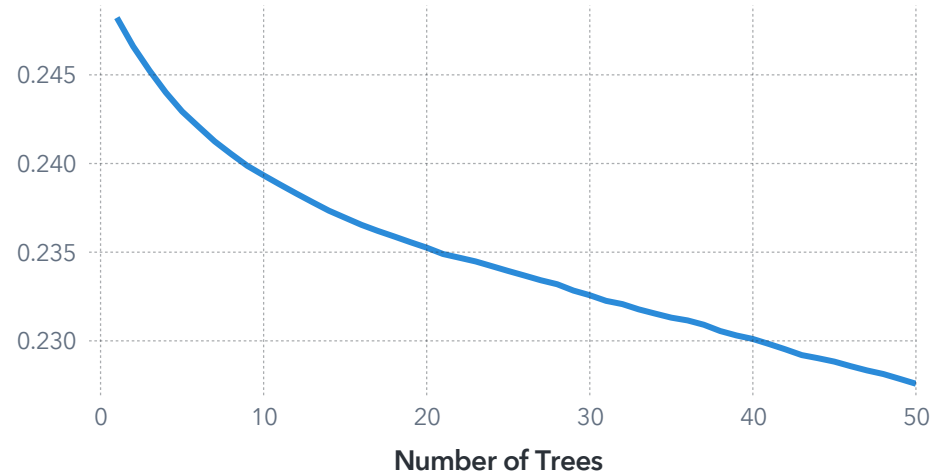
Gradient Boosting Target Gift Flag ASE 0.2276 Observations Used 106,546

Variable Importance



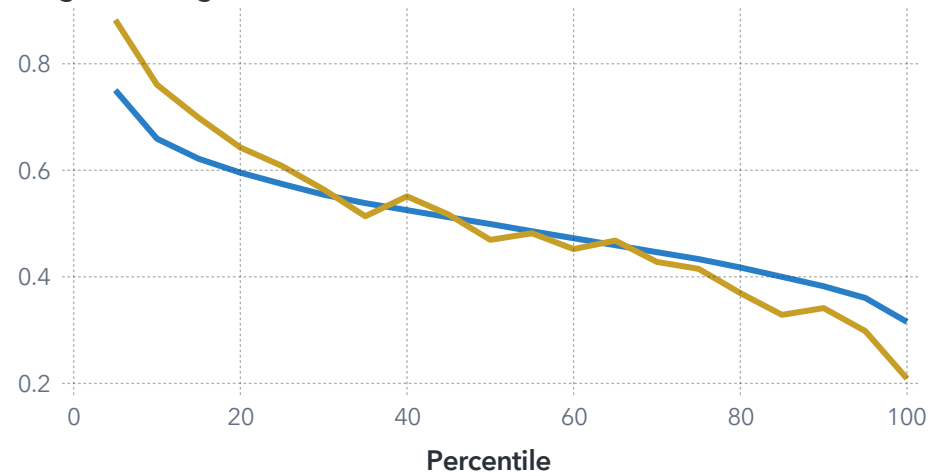
Iteration Plot

Average Squared Error



Assessment

Target Gift Flag



Neural ntw

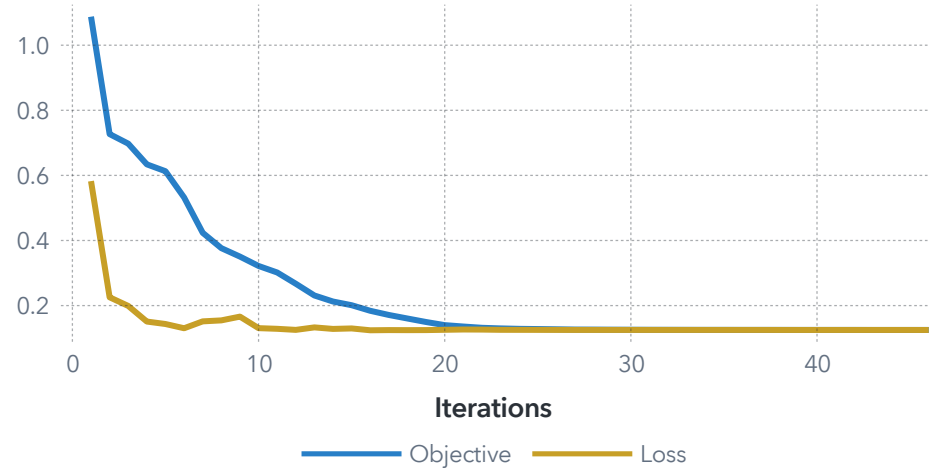


Neural Network **Target Gift Flag** ASE **0.2501** Observations Used **80,069** Unused **26,477**

Network

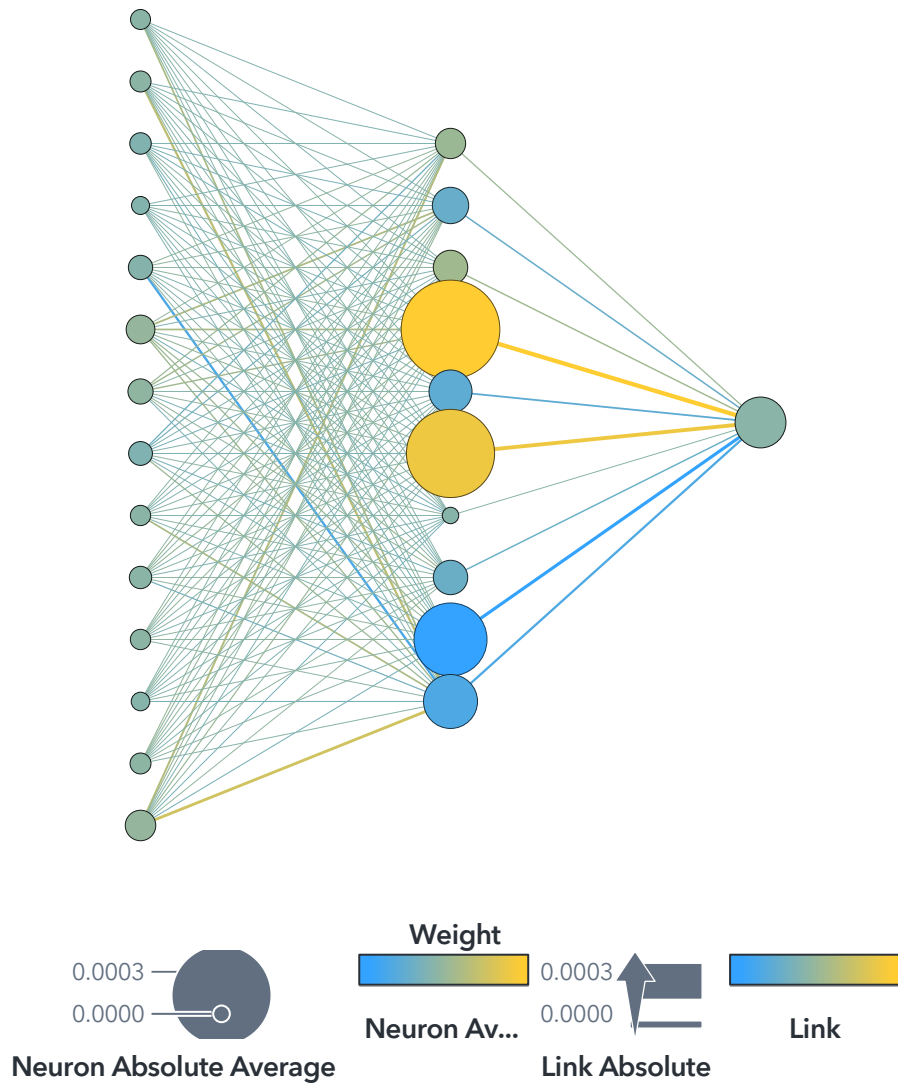
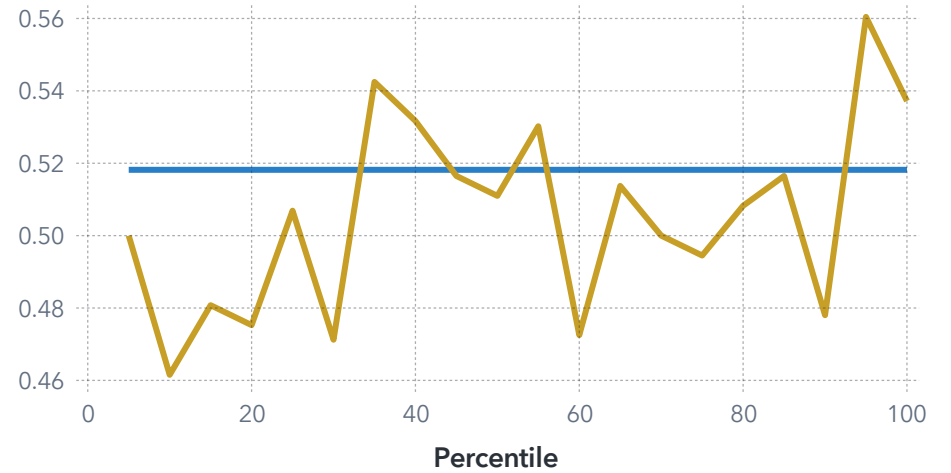
Iteration Plot

Objective / Loss



Assessment

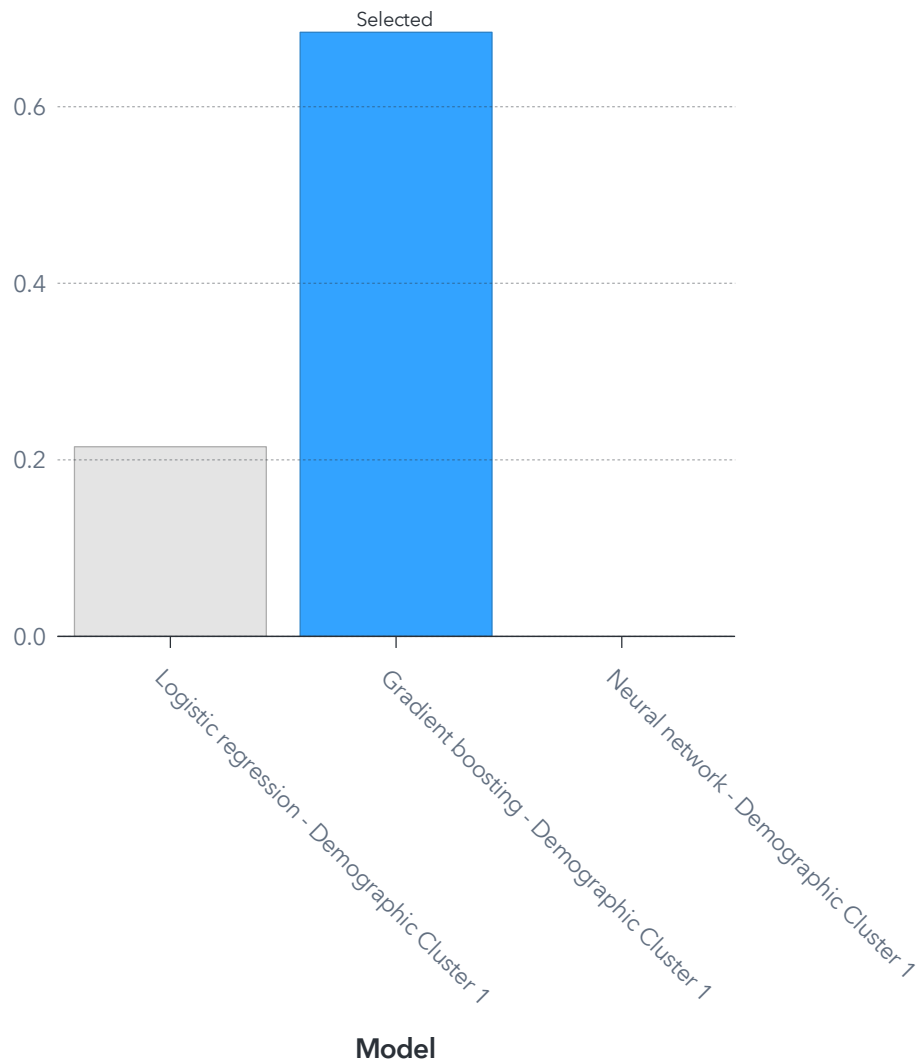
Target Gift Flag



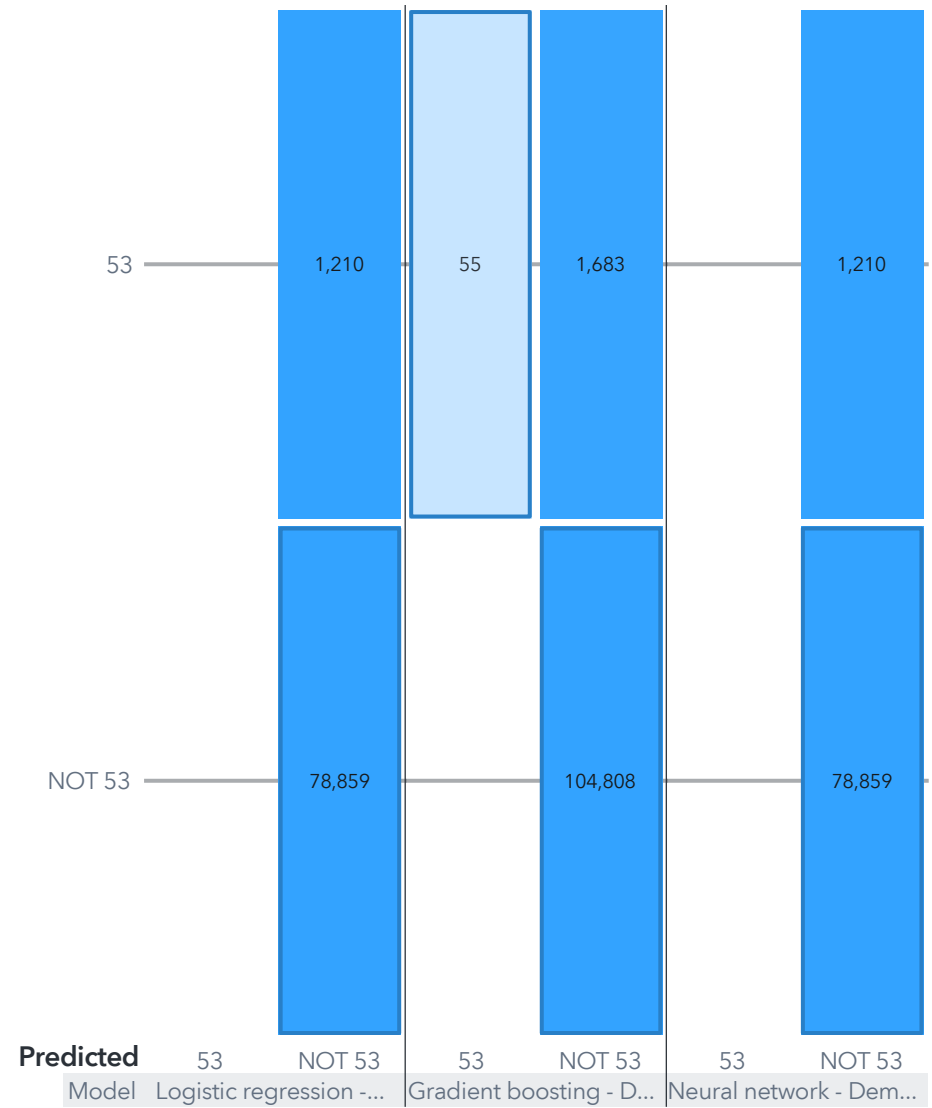


Model Comparison Demographic Cluster (event=53)

Fit Statistic
KS (Youden)



Confusion Matrix
Observed



⚠ A1.1

Appendix

A1.1 Fit Statistic

Warnings: Number of observations for all models do not match.

Node ID	Depth	Parent ID	N Children	Type	Observations	% Observations	Percent of Parent	N Missing	Gain	Predicted Value	Average	
0	0	-1	2	Class	106,546	100.00%	.	0	450.2782	0.5000	0.5000	
1	1	0	2	Class	57,156	53.64%	53.64%	0	162.1013	0.5604	0.5604	
2	1	0	2	Class	49,390	46.36%	46.36%	0	61.4338	0.4301	0.4301	
3	2	1	2	Class	42,603	39.99%	74.54%	0	52.7057	0.5293	0.5293	
4	2	1	2	Class	14,553	13.66%	25.46%	0	37.0136	0.6515	0.6515	
5	2	2	2	Class	15,587	14.63%	31.56%	0	96.6307	0.4820	0.4820	
6	2	2	2	Class	33,803	31.73%	68.44%	0	28.3190	0.4061	0.4061	
7	3	3	2	Class	13,926	13.07%	32.69%	0	41.7087	0.5798	0.5798	
8	3	3	2	Class	28,677	26.92%	67.31%	0	26.8691	0.5048	0.5048	
9	3	4	2	Class	12,199	11.45%	83.82%	0	25.8147	0.6294	0.6294	
10	3	4	2	Class	2,354	2.21%	16.18%	0	12.6389	0.7664	0.7664	
11	3	5	2	Class	15,235	14.30%	97.74%	0	21.9553	0.4700	0.4700	
12	3	5	0	Leaf	352	0.33%	2.26%	0	0.0000	1.0000	1.0000	
13	3	6	2	Class	21,208	19.91%	62.74%	0	27.9441	0.4284	0.4284	
14	3	6	2	Class	12,595	11.82%	37.26%	0	26.8067	0.3686	0.3686	
15	4	7	2	Class	1,056	0.99%	7.58%	0	20.2406	0.7708	0.7708	
16	4	7	2	Class	12,870	12.08%	92.42%	0	22.6105	0.5641	0.5641	
17	4	8	2	Class	28,248	26.51%	98.50%	0	26.2072	0.5086	0.5086	
18	4	8	2	Class	429	0.40%	1.50%	0	13.0012	0.2564	0.2564	
19	4	9	2	Class	9,911	9.30%	81.24%	0	20.2955	0.6515	0.6515	
20	4	9	2	Class	2,288	2.15%	18.76%	0	17.3291	0.5337	0.5337	
21	4	10	2	Class	1,232	1.16%	52.34%	0	14.6088	0.6964	0.6964	
22	4	10	2	Class	1,122	1.05%	47.66%	0	10.0977	0.8431	0.8431	
23	4	11	2	Class	4,103	3.85%	26.93%	0	26.2947	0.4075	0.4075	
24	4	11	2	Class	11,132	10.45%	73.07%	0	26.5688	0.4931	0.4931	
25	4	13	2	Class	12,287	11.53%	57.94%	0	24.5573	0.3975	0.3975	
26	4	13	2	Class	8,921	8.37%	42.06%	0	17.6680	0.4710	0.4710	
27	4	14	2	Class	12,232	11.48%	97.12%	0	26.3169	0.3606	0.3606	
28	4	14	2	Class	363	0.34%	2.88%	0	13.5000	0.6364	0.6364	



Std. Dev
0.5000
0.4963
0.4951
0.4991
0.4765
0.4997
0.4911
0.4936
0.5000
0.4830
0.4232
0.4991
.
0.4949
0.4824
0.4205
0.4959
0.4999
0.4372
0.4765
0.4990
0.4600
0.3638
0.4914
0.5000
0.4894
0.4992
0.4802
0.4817

Node ID	Depth	Parent ID	N Children	Type	Observations	% Observations	Percent of Parent	N Missing	Gain	Predicted Value	Average	
29	5	15	0	Leaf	1,023	0.96%	96.88%	0	0.0000	0.7957	0.7957	
30	5	15	0	Leaf	33	0.03%	3.13%	0	0.0000	0.0000	0.0000	
31	5	16	0	Leaf	11,374	10.68%	88.38%	0	0.0000	0.5793	0.5793	
32	5	16	0	Leaf	1,496	1.40%	11.62%	0	0.0000	0.4485	0.4485	
33	5	17	0	Leaf	6,908	6.48%	24.45%	0	0.0000	0.5621	0.5621	
34	5	17	0	Leaf	21,340	20.03%	75.55%	0	0.0000	0.4912	0.4912	
35	5	18	0	Leaf	198	0.19%	46.15%	0	0.0000	0.4444	0.4444	
36	5	18	0	Leaf	231	0.22%	53.85%	0	0.0000	0.0952	0.0952	
37	5	19	0	Leaf	869	0.82%	8.77%	0	0.0000	0.7975	0.7975	
38	5	19	0	Leaf	9,042	8.49%	91.23%	0	0.0000	0.6375	0.6375	
39	5	20	0	Leaf	77	0.07%	3.37%	0	0.0000	1.0000	1.0000	
40	5	20	0	Leaf	2,211	2.08%	96.63%	0	0.0000	0.5174	0.5174	
41	5	21	0	Leaf	649	0.61%	52.68%	0	0.0000	0.5932	0.5932	
42	5	21	0	Leaf	583	0.55%	47.32%	0	0.0000	0.8113	0.8113	
43	5	22	0	Leaf	990	0.93%	88.24%	0	0.0000	0.8778	0.8778	
44	5	22	0	Leaf	132	0.12%	11.76%	0	0.0000	0.5833	0.5833	
45	5	23	0	Leaf	605	0.57%	14.75%	0	0.0000	0.6000	0.6000	
46	5	23	0	Leaf	3,498	3.28%	85.25%	0	0.0000	0.3742	0.3742	
47	5	24	0	Leaf	9,735	9.14%	87.45%	0	0.0000	0.4746	0.4746	
48	5	24	0	Leaf	1,397	1.31%	12.55%	0	0.0000	0.6220	0.6220	
49	5	25	0	Leaf	5,951	5.59%	48.43%	0	0.0000	0.4436	0.4436	
50	5	25	0	Leaf	6,336	5.95%	51.57%	0	0.0000	0.3542	0.3542	
51	5	26	0	Leaf	5,203	4.88%	58.32%	0	0.0000	0.4334	0.4334	
52	5	26	0	Leaf	3,718	3.49%	41.68%	0	0.0000	0.5237	0.5237	
53	5	27	0	Leaf	198	0.19%	1.62%	0	0.0000	0.7222	0.7222	
54	5	27	0	Leaf	12,034	11.29%	98.38%	0	0.0000	0.3547	0.3547	
55	5	28	0	Leaf	121	0.11%	33.33%	0	0.0000	0.3636	0.3636	
56	5	28	0	Leaf	242	0.23%	66.67%	0	0.0000	0.7727	0.7727	



Std. Dev
0.4034
.
0.4937
0.4975
0.4962
0.4999
0.4982
0.2942
0.4021
0.4808
.
0.4998
0.4916
0.3916
0.3277
0.4949
0.4903
0.4840
0.4994
0.4850
0.4969
0.4783
0.4956
0.4995
0.4490
0.4784
0.4830
0.4199



Node ID	Parent ID	Type	Age
0	-1	Class	
1	0	Class	
2	0	Class	
3	1	Class	
4	1	Class	
5	2	Class	
6	2	Class	
7	3	Class	
8	3	Class	
9	4	Class	
10	4	Class	
11	5	Class	
12	5	Leaf	
13	6	Class	≥ 39
14	6	Class	0 to 39 or Missing
15	7	Class	
16	7	Class	
17	8	Class	≥ 26 or Missing
18	8	Class	0 to 26
19	9	Class	≥ 50 or Missing
20	9	Class	0 to 50
21	10	Class	
22	10	Class	
23	11	Class	≥ 83 or Missing
24	11	Class	0 to 83
25	13	Class	≥ 39
26	13	Class	≥ 39
27	14	Class	0 to 39 or Missing
28	14	Class	0 to 39 or Missing

Demographic Cluster

Gender Home Owner



H
U



Gift Count 36 Months	Gift Count All Months	Promotion Count 36 Months	Promotion Count 12 Months	Promotion Count Card All Months	Status Category Star All Months	
≥ 3						
0 to 3						
≥ 3						
≥ 3						
0 to 3					= 1	
0 to 3					0 to 1	
≥ 5						
3 to 5						
≥ 3			≥ 11			
≥ 3			2 to 11			
0 to 3	≥ 4				= 1	
0 to 3	1 to 4				= 1	
0 to 3					0 to 1	
0 to 3					0 to 1	
≥ 5						
≥ 5						
3 to 5						
3 to 5						
≥ 3			≥ 11			
≥ 3			≥ 11			
≥ 3			2 to 11			
≥ 3			2 to 11			
0 to 3	≥ 4				= 1	
0 to 3	≥ 4				= 1	
0 to 3					0 to 1	
0 to 3					0 to 1	
0 to 3			≥ 7		0 to 1	
0 to 3			2 to 7		0 to 1	



Promotion Count
Card 12 Months

≥ 9
0 to 9



Node ID	Parent ID	Type	Age
29	15	Leaf	
30	15	Leaf	
31	16	Leaf	
32	16	Leaf	
33	17	Leaf	≥ 26 or Missing
34	17	Leaf	≥ 26 or Missing
35	18	Leaf	0 to 26
36	18	Leaf	0 to 26
37	19	Leaf	≥ 50 or Missing
38	19	Leaf	≥ 50 or Missing
39	20	Leaf	0 to 50
40	20	Leaf	0 to 50
41	21	Leaf	
42	21	Leaf	
43	22	Leaf	
44	22	Leaf	
45	23	Leaf	≥ 83 or Missing
46	23	Leaf	≥ 83 or Missing
47	24	Leaf	0 to 83
48	24	Leaf	0 to 83
49	25	Leaf	≥ 39
50	25	Leaf	≥ 39
51	26	Leaf	≥ 57
52	26	Leaf	39 to 57
53	27	Leaf	0 to 39 or Missing
54	27	Leaf	0 to 39 or Missing
55	28	Leaf	0 to 39 or Missing
56	28	Leaf	0 to 39 or Missing

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Gift Count 36 Months	Gift Count All Months	Promotion Count 36 Months	Promotion Count 12 Months	Promotion Count Card All Months	Status Category Star All Months	
≥ 5	≥ 9					
≥ 5	1 to 9					
≥ 5						
≥ 5						
3 to 5						
3 to 5						
3 to 5						
3 to 5						
≥ 3			≥ 11			
≥ 3			≥ 11			
≥ 3		≥ 44	≥ 11			
≥ 3		4 to 44	≥ 11			
≥ 3			2 to 11			
≥ 3			2 to 11			
≥ 4			2 to 11			
3 to 4			2 to 11			
0 to 3	≥ 4		≥ 15		= 1	
0 to 3	≥ 4		2 to 15		= 1	
0 to 3	≥ 4		≥ 10		= 1	
0 to 3	≥ 4		2 to 10		= 1	
0 to 3					0 to 1	
0 to 3					0 to 1	
0 to 3					0 to 1	
0 to 3					0 to 1	
0 to 3			≥ 26		0 to 1	
0 to 3			7 to 26		0 to 1	
0 to 3			2 to 7	≥ 10	0 to 1	
0 to 3			2 to 7	2 to 10	0 to 1	

Variable	Importance	Standard Deviation
Gift Count 36 Months	513.0817	198.2250
Gift Amount Last	190.0454	67.0786
Promotion Count 12 Months	143.0008	4.2109
Age	120.6261	3.8568
Gift Count All Months	116.8713	38.1951
Promotion Count Card 12 Months	86.5615	9.2548
Demographic Cluster	76.4278	5.4818
Status Category Star All Months	61.4338	0.0000
Promotion Count 36 Months	17.3291	0.0000
Promotion Count Card All Months	13.5000	0.0000
Home Owner	12.6389	0.0000
Gender	0.0000	0.0000






Description	Value
Data Source	SVSO35.PVA
Response Variable	Status Category 96NK
Distribution	Binary
Link Function	Logit
Optimization Technique	Newton-Raphson with Ridging
Predicted Response Level	I__va_d__E_Status_Category_96NK

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Ordered Value	Count	Status Category 96NK
1	20031	S
2	60038	NOT S





Reason	Status 
Convergence criterion (GCONV=1E-6) satisfied.	0

Statistic	Value
-2 Log Likelihood	47917.26
AIC	47943.26
AICC	47943.26
BIC	48064.04
Max-rescaled R-Square	0.606176
R-Square	0.409389



Parameter	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	-16.3539	8.424493	3.768375	0.05223
Gender F	-0.02889	0.058376	0.244859	0.62072
Gender M	0.030134	0.059089	0.260067	0.61007
Gender U	0	.	.	.
Home Owner H	-0.07046	0.023619	8.899972	0.00285
Home Owner U	0	.	.	.
Age	0.003234	0.000681	22.54679	<0.00001
Gift Amount Last	-0.01888	0.001421	176.6714	<0.00001
Gift Count 36 Months	0.435021	0.00773	3167.106	<0.00001
Gift Count All Months	0.064131	0.002464	677.6695	<0.00001
Promotion Count 36 Months	0.016589	0.004376	14.3744	0.00015
Promotion Count 12 Months	-0.07244	0.005219	192.6773	<0.00001
Promotion Count Card All Months	0.03384	0.002896	136.5603	<0.00001
Status Category Star All Months	13.14769	8.423917	2.435964	0.11858
Promotion Count Card 12 Months	0.007901	0.013957	0.320488	0.57131

Effect	DF	Chi-Square	Pr > ChiSq
Gender	2	6.597009	0.03694
Home Owner	1	8.899972	0.00285
Age	1	22.54679	<0.00001
Gift Amount Last	1	176.6714	<0.00001
Gift Count 36 Months	1	3167.106	<0.00001
Gift Count All Months	1	677.6695	<0.00001
Promotion Count 36 Months	1	14.3744	0.00015
Promotion Count 12 Months	1	192.6773	<0.00001
Promotion Count Card All Months	1	136.5603	<0.00001
Status Category Star All Months	1	2.435964	0.11858
Promotion Count Card 12 Months	1	0.320488	0.57131



Cutoff	Sensitivity	1 - Specificity
0.00	1.0000	1.000
0.01	1.0000	0.407
0.02	1.0000	0.407
0.03	1.0000	0.405
0.04	0.9995	0.404
0.05	0.9989	0.401
0.06	0.9984	0.399
0.07	0.9956	0.397
0.08	0.9956	0.392
0.09	0.9945	0.386
0.10	0.9929	0.382
0.11	0.9907	0.374
0.12	0.9890	0.366
0.13	0.9863	0.355
0.14	0.9824	0.344
0.15	0.9780	0.333
0.16	0.9736	0.323
0.17	0.9692	0.313
0.18	0.9665	0.301
0.19	0.9594	0.292
0.20	0.9550	0.281
0.21	0.9451	0.270
0.22	0.9357	0.261
0.23	0.9275	0.251
0.24	0.9187	0.241
0.25	0.9116	0.231
0.26	0.9001	0.221
0.27	0.8907	0.212
0.28	0.8786	0.203
0.29	0.8655	0.196

Cutoff	Sensitivity	1 - Specificity
0.30	0.8550	0.188
0.31	0.8462	0.179
0.32	0.8375	0.174
0.33	0.8287	0.168
0.34	0.8232	0.162
0.35	0.8111	0.154
0.36	0.7979	0.148
0.37	0.7858	0.141
0.38	0.7732	0.136
0.39	0.7622	0.129
0.40	0.7529	0.123
0.41	0.7403	0.117
0.42	0.7282	0.113
0.43	0.7177	0.108
0.44	0.7062	0.102
0.45	0.6941	0.098
0.46	0.6826	0.095
0.47	0.6722	0.091
0.48	0.6595	0.085
0.49	0.6425	0.082
0.50	0.6282	0.079
0.51	0.6189	0.074
0.52	0.6052	0.071
0.53	0.5953	0.065
0.54	0.5815	0.061
0.55	0.5662	0.059
0.56	0.5546	0.055
0.57	0.5437	0.052
0.58	0.5294	0.050
0.59	0.5173	0.047

Cutoff	Sensitivity	1 - Specificity
0.60	0.5096	0.044
0.61	0.4953	0.042
0.62	0.4794	0.040
0.63	0.4673	0.037
0.64	0.4530	0.036
0.65	0.4454	0.034
0.66	0.4371	0.032
0.67	0.4250	0.031
0.68	0.4135	0.029
0.69	0.4036	0.027
0.70	0.3850	0.025
0.71	0.3690	0.023
0.72	0.3597	0.022
0.73	0.3449	0.020
0.74	0.3328	0.019
0.75	0.3180	0.016
0.76	0.3070	0.016
0.77	0.2921	0.014
0.78	0.2779	0.013
0.79	0.2669	0.012
0.80	0.2565	0.011
0.81	0.2438	0.011
0.82	0.2323	0.010
0.83	0.2191	0.009
0.84	0.2092	0.008
0.85	0.1971	0.008
0.86	0.1851	0.007
0.87	0.1735	0.006
0.88	0.1598	0.006
0.89	0.1455	0.005

Cutoff	Sensitivity	1 - Specificity
0.90	0.1378	0.004
0.91	0.1296	0.004
0.92	0.1175	0.003
0.93	0.1021	0.003
0.94	0.0923	0.003
0.95	0.0791	0.002
0.96	0.0604	0.001
0.97	0.0467	0.001
0.98	0.0302	0.000
0.99	0.0192	0.000

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Number of Trees	Average Squared Error
1	0.2482
2	0.2466
3	0.2452
4	0.2440
5	0.2429
6	0.2421
7	0.2412
8	0.2405
9	0.2399
10	0.2393
11	0.2388
12	0.2383
13	0.2378
14	0.2373
15	0.2369
16	0.2365
17	0.2362
18	0.2359
19	0.2356
20	0.2353
21	0.2349
22	0.2347
23	0.2345
24	0.2342
25	0.2339
26	0.2337
27	0.2334
28	0.2332
29	0.2328
30	0.2326

Number of Trees	Average Squared Error
31	0.2323
32	0.2321
33	0.2318
34	0.2315
35	0.2313
36	0.2312
37	0.2309
38	0.2306
39	0.2303
40	0.2301
41	0.2298
42	0.2295
43	0.2292
44	0.2290
45	0.2288
46	0.2286
47	0.2283
48	0.2281
49	0.2279
50	0.2276

Percentile	Observations	Predicted Average	Observed Average
5	5328	0.7503858148	0.8823198198
10	5328	0.659213642	0.7605105105
15	5328	0.621627683	0.6985735736
20	5328	0.5955580733	0.6428303303
25	5328	0.5743650889	0.6081081081
30	5328	0.5542409343	0.5640015015
35	5328	0.5383316592	0.5137012012
40	5328	0.5251304885	0.5510510511
45	5328	0.5118967949	0.5168918919
50	5328	0.4991116969	0.4694069069
55	5328	0.4856121872	0.4817942943
60	5328	0.4724411	0.4521396396
65	5328	0.4594418311	0.4680930931
70	5328	0.4462713466	0.4279279279
75	5328	0.4333642067	0.4149774775
80	5328	0.4175180482	0.3695570571
85	5328	0.4000291925	0.3286411411
90	5328	0.3823474414	0.3414039039
95	5328	0.360365927	0.2982357357
100	5314	0.3153804667	0.2090703801





Description	Value
Model	Neural Net
Number of Observations Used	80,069
Number of Observations Read	106546
Target/Response Variable	Target Gift Flag
Number of Neurons	25
Number of Input Neurons	14
Number of Output Neurons	1
Number of Hidden Neurons	10
Number of Hidden Layers	1
Number of Weight Parameters	150
Number of Bias Parameters	11
Architecture	MLP
Number of Neural Nets	1
Objective Value	0.12513

Iterations	Objective	Loss
1	1.0877	0.5825
2	0.7269	0.2255
3	0.6976	0.1990
4	0.6339	0.1509
5	0.6129	0.1434
6	0.5322	0.1304
7	0.4236	0.1515
8	0.3765	0.1546
9	0.3505	0.1661
10	0.3217	0.1307
11	0.3017	0.1286
12	0.2671	0.1253
13	0.2310	0.1330
14	0.2124	0.1283
15	0.2012	0.1298
16	0.1840	0.1241
17	0.1712	0.1247
18	0.1603	0.1245
19	0.1496	0.1247
20	0.1400	0.1256
21	0.1357	0.1265
22	0.1318	0.1263
23	0.1299	0.1256
24	0.1285	0.1254
25	0.1279	0.1254
26	0.1272	0.1253
27	0.1264	0.1252
28	0.1262	0.1252
29	0.1260	0.1252
30	0.1258	0.1252

Iterations	Objective	Loss
31	0.1256	0.1252
32	0.1255	0.1252
33	0.1255	0.1252
34	0.1254	0.1252
35	0.1253	0.1252
36	0.1253	0.1252
37	0.1253	0.1252
38	0.1253	0.1252
39	0.1252	0.1252
40	0.1252	0.1251
41	0.1252	0.1251
42	0.1252	0.1251
43	0.1252	0.1251
44	0.1251	0.1251
45	0.1251	0.1251
46	0.1251	0.1251



Reason

The optimization achieved the desired objective value.

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Neural network -
Demographic Cluster
1 Importance