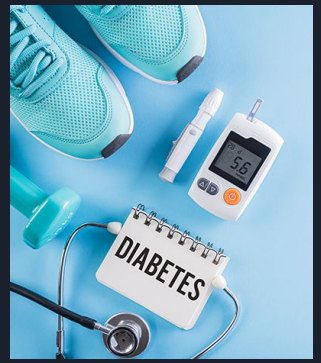
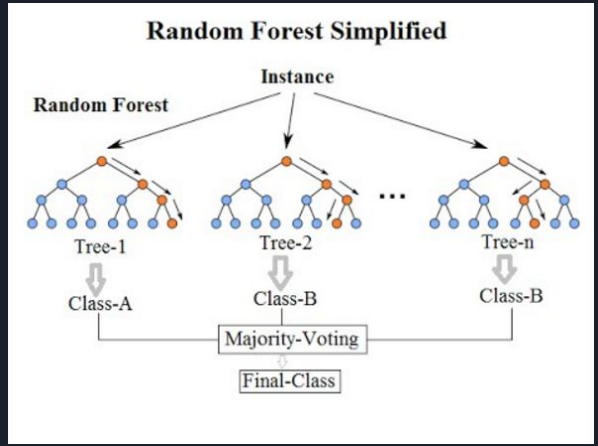
Random Forest Cross Validation Optimization

By Cara Drake, Stacy Deng, & Christopher Thornton

Introduction



- Affects over 11 % of our planet's population
- Nearly 40 % of adult US population has prediabetes
- Analyzing this data set to know which random forest tuning parameters are most essential to correctly predicting the binary data
- Random Forest:
  - Either or choice -> Decision Tree -> Random Forest
- There are seven factors involved in the Random Forest
  - Which carry the most weight in the decision making process



Methodology

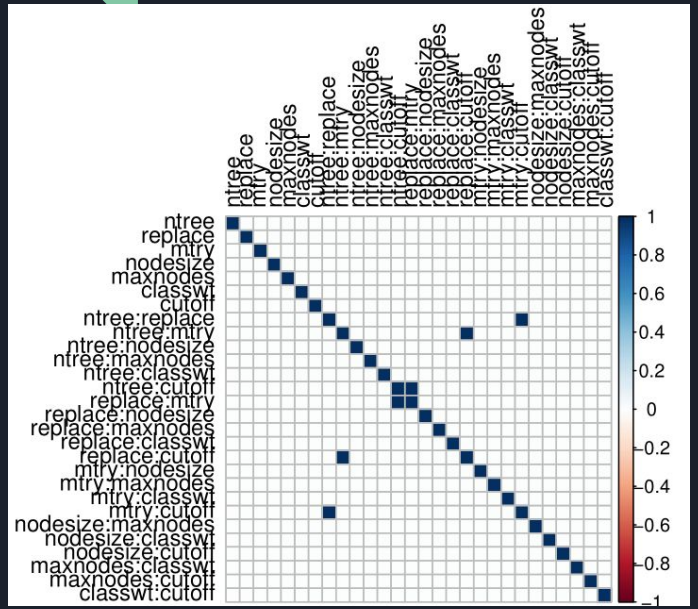
Factorial Fraction Design

- Number of runs must be a factor of 2, thus 32 trials
- Resolution IV because seven variables are used

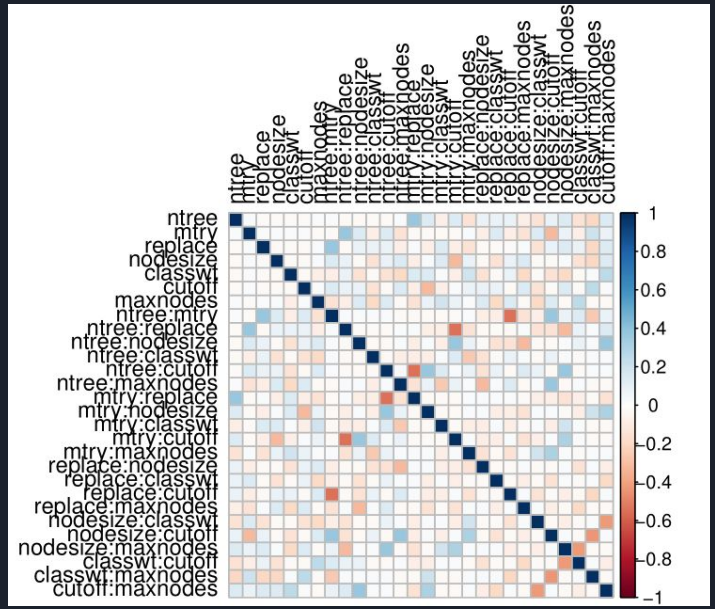
Optimal Design

- Only requires 29 trials for a resolution V model
- Can use all two parameter interactions

Design choice



Fractional Factorial Design



Optimal Design

Initial Model & Simplification

- Initial model contains all interaction terms between the seven terms of two parameter or less
- Simplifying based on p value and correlation plots

Analysis of Variance Table

Response: CV

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
ntree	1	0.000003	0.000003	0.0029	0.958656
mtry	1	0.000587	0.000587	0.6465	0.452040
replace	1	0.000296	0.000296	0.3256	0.588989
nodesize	1	0.001145	0.001145	1.2605	0.304464
classwt	1	0.122507	0.122507	134.8095	2.457e-05
cutoff	1	0.031043	0.031043	34.1607	0.001106
maxnodes	1	0.015311	0.015311	16.8485	0.006324
ntree:mtry	1	0.000018	0.000018	0.0193	0.893972
ntree:replace	1	0.000032	0.000032	0.0354	0.856881
ntree:nodesize	1	0.006771	0.006771	7.4511	0.034201
ntree:classwt	1	0.001623	0.001623	1.7861	0.229845
ntree:cutoff	1	0.000401	0.000401	0.4411	0.531269
ntree:maxnodes	1	0.000048	0.000048	0.0532	0.825266
mtry:replace	1	0.000714	0.000714	0.7852	0.409655
mtry:nodesize	1	0.011081	0.011081	12.1933	0.012954
mtry:classwt	1	0.000535	0.000535	0.5885	0.472099
mtry:cutoff	1	0.000094	0.000094	0.1030	0.759090
mtry:maxnodes	1	0.002227	0.002227	2.4502	0.168546
replace:nodesize	1	0.003645	0.003645	4.0111	0.092071
replace:classwt	1	0.000000	0.000000	0.0000	0.999665
replace:cutoff	1	0.003344	0.003344	3.6794	0.103529
replace:maxnodes	1	0.000007	0.000007	0.0078	0.932671
nodesize:classwt	1	0.002260	0.002260	2.4864	0.165905
nodesize:cutoff	1	0.013343	0.013343	14.6825	0.008641
nodesize:maxnodes	1	0.000846	0.000846	0.9311	0.371843
classwt:cutoff	1	0.010608	0.010608	11.6733	0.014202
classwt:maxnodes	1	0.005914	0.005914	6.5083	0.043423
cutoff:maxnodes	1	0.004722	0.004722	5.1961	0.062844
Residuals	6	0.005452	0.000909		

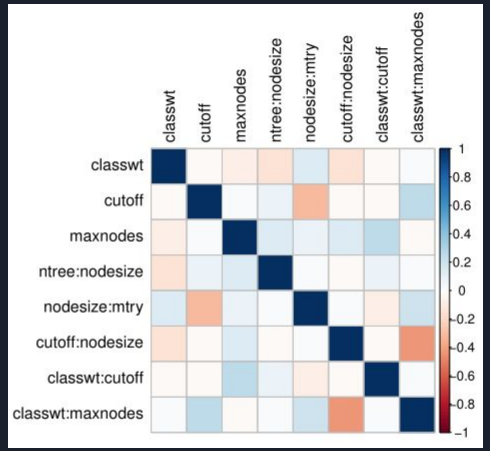
Analysis

Cross Validation Accuracy = .618271 − .057672 × classwt + .027108 × cutoff + .014352 × maxnodes + .012185 × ntree × nodesize +.011742 × nodesize × mtry − .007203 × cutoff × nodesize + .019271 × classwt × cutoff + .022981 × classwt × maxnodes

Analysis of Variance Table

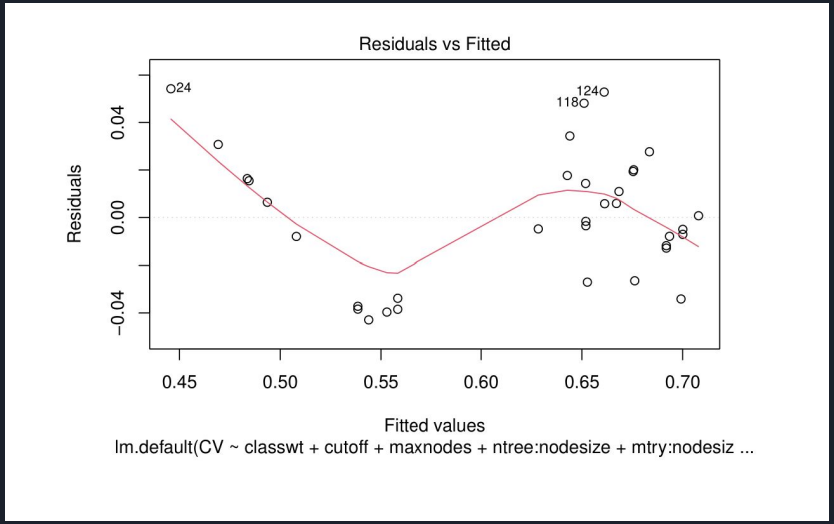
Response: CV

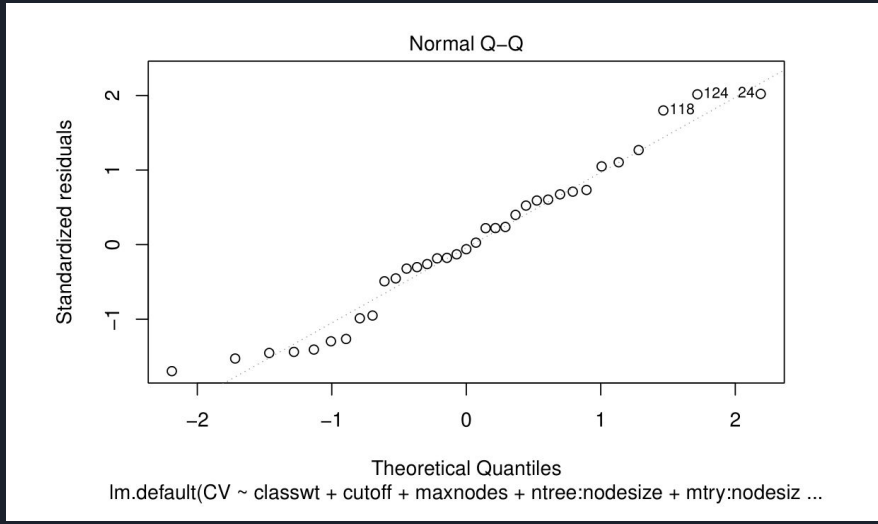
	Df	Sum Sq	Mean Sq	F value	Pr(>F)
classwt	1	0.120431	0.120431	125.1900	1.945e-11
cutoff	1	0.032252	0.032252	33.5263	4.237e-06
maxnodes	1	0.014576	0.014576	15.1521	0.0006183
ntree:nodesize	1	0.007270	0.007270	7.5569	0.0107258
nodesize:mtry	1	0.008011	0.008011	8.3272	0.0077534
cutoff:nodesize	1	0.011599	0.011599	12.0570	0.0018196
classwt:cutoff	1	0.013521	0.013521	14.0554	0.0008964
classwt:maxnodes	1	0.011905	0.011905	12.3757	0.0016207
Residuals	26	0.025012	0.000962		



Conclusion

- Resolution V
  - Evaluates all main effects and first order interactions
- Model meets assumptions for linear regression
- Adjusted R-squared of .87





Retrospective

- Recommend full factorial design in future experimentation given sufficient funding
- Experiment with additional levels
- Analyze the effects of alternative data sets

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