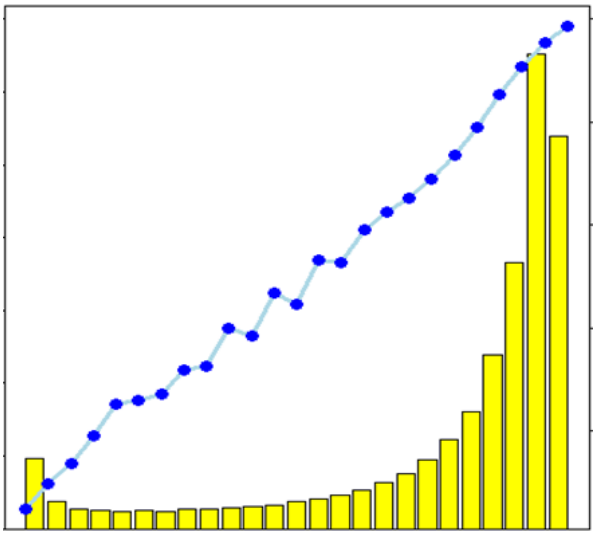
EWS Benchmark Development:

Initial Creation of Model

9/18/12



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Executive Summary

This brief reports the individual and aggregate risk indicators to be used in the initial version of the Early Warning System model being developed for RIDE. The aggregate risk equation is an amalgam of student demographic and performance data and it changes with student grade level. Benchmarks for this model are set at specified levels of predicitivity. The individual risk indicators (or the three most important predictive variables) are attend_percent, yearsoverage, and susp in that order. Benchmarks for these variables are set at specified levels of predicitivity.

In addition to the reported results, the statistical processes and decision rules used to choose particular indicators, benchmarks, and equations are explained in full in the text of this brief. Much space is also spent on the cross-validation of the aggregate risk model, for which the methodology is extremely thorough.

At the end of the document , next steps for implementation of this EWS benchmark system can be found.

Model Variables

Variables Used

The main unit of observation, as mentioned above, was the student year. For each student year, data was gathered in a number of fields. These fields became 'variables' in our aggregate risk equation, as well as individual indicators in their own right. Below is a dictionary of the fields for which data was (sometimes) available:

Field	Description
ada	Number of school days attended during school year.
adm	Number of days enrolled during the school year – Percent attendance can be calculated by dividing ada by adm.
attend_percent	Calculated by dividing ada by adm for a student year
cohort	9th grade cohort of student – equivalent for all observations of same sasid - represents ending year of student's first 9th grade school year.
credits	Number of credits achieved in a student year observation. Notes about gpa also apply to credits. Credits will usually be zero before 9th grade.
distcode	RI school district code – TM has csv connecting them to district names if needed
disttype	Classification of school district "Urban", "Urban Ring" or "Rural". Classification completed with help from RIDE definitions as well as population density figures. It is uncertain if this classification is the exact same as that in RIDE records, which we have not had access to, but it is relatively close. This classification is stable across time for all districts.
dob	Student date of birth – equivalent for all observations of same sasid
gdist	Classification of district as Providence ('p'), Chariho ('c'), or neither (Null). Providence and Chariho provided data for performance-based measures. The student year enrollment data coincided well, but not perfectly, with district assignments in student data (possibly due to some students changing districts during the year). Therefore, it is necessary to assign students to one of these gdist categories when using performance data (as opposed to just attendance, suspensions, etc)

gpa	Grade point average for observed student year. As this data was not collected by RIDE, this is only observed for two districts (Providence and Chariho) who complied with the data request this summer. Use of this data point therefore removes about 4/5 of the observations from the data set. Neither Providence nor Chariho calculate GPA on the standard 4.0 scale. Therefore, it is necessary to normalize by district to keep open the possibility of applying these findings to other districts in the future.
grade_level	Student grade level for student year observation
homeless	Homelessness status – may change within sasid due to different school years. N= With Home, Y = Homeless. Easily converted to binary.
idextract	Unique id # for each student year observation
iep	Individualized Education Program - may change within sasid due to different school years. This is an indication that a student is enrolled in the school's special education system. Y= Has IEP, N = Does not have IEP. Easily converted to binary.
lep	Limited English Proficiency – may change within sasid due to different school years. Y = Limited English Proficiency, N = Proficient in English. This is not a statement about a student's English class grades, but is instead usually a designation that English is not a student's first language. Easily converted to binary.
lunch	Free and Reduced price lunch status – may change within sasid due to different school years. N = Full pay, F= Free, R = Reduced. Suggested conversion to binary with F and R both equal to 1 and N equal to 0.
math_score	Most recent math NECAP score. The NECAP is a state test administered in RI since spring of 2006. Students take the test in multiple elementary years, 8th and 11th grade. If a student year observation is for a grade level that is less than 8th, this field is left blank, if a student year observation is for 8th, 9th, or 10th grade, the value represents their 8th grade score. If a student year observation is for 11th or 12th grade, the value represents their 11th grade score. NECAP score is given in the following format: 'xxyy', where 'xx' represents the test grade level and 'yy' represents the test score. Therefore, a student year observation with a score of 1127 indicates that the test was for 11th graders and the student scored a 27. To make the conversion to an ordinal score easier, the field is stored as a string.
number_of_fs	Number of semesterly Fs received for a student year observation. Notes about gpa also apply to number_of_fs.

otg	**On-time graduation - Dependent variable. Calculated by state. 0=Student did not graduate within 4 years of entering 9th grade, 1 = student graduated within 4 years of entering 9th grade. Equivalent for all observations of same sasid.**
reading_score	Most recent reading NECAP score. All notes above (in the definition for math_score) apply here as well. Both reading score and math score were normalized so that the score was expressed in standard deviations from the mean
sasid	State assigned student ID - repeats in this data set because observations are in units of student years
schcode	RI school code – TM can inquire as to connection between numbers and school names if needed
schtransfers	Number of school transfers within a year. Student year observations aggregated over a year – this is a database calculation of the number of times a student id appears in the records paired with a unique school id. This variable really should be called school enrollments, as the minimum is 1, meaning a student must have at least one enrollment in a year to be included in the data set.
schyear	School year of observation – takes form "200x_200y" where 'x' is the year in which the school year begins and 'y' is the year in which it ends
sec504	Student's family received federal financial assistance in paying for housing, in accordance with the Rehabilitation Act of 1973 - may change within sasid due to different school years. This generally is an indicator of lower socio-economic status. Y = Received Section 504 housing assistance, N = Did not receive assistance. Easily converted to binary.
sex	Sex – equivalent for all observations of same sasid. M = Male, F = Female. For this data set, M was translated to 1 and female to 0.
susp	Number of days suspended during the school year
title1	Student qualifies is federally classified as low income and contributes to the numerator in the proportion of students calculated to determine if a school receives federal assistance through Title I of the Elementary and Secondary Education Act of 1965 - may change within sasid due to different school years. This generally is an indicator of lower socio-economic status. Y = Federally classified as Title I eligible, N = Not federally classified as Title I eligible. Easily converted to binary.
years_overage	Calculated by finding student age at the end of the school year (5/31) and subtracting from it grade_level + 7
yrssqterm	Years overage had a non-linear relationship to graduation, so a squared term was added that better fit some of the patterns we were seeing.

Fields highlighted in orange were those used in this round of modeling. As can be seen, data on gpa, credits, and number of Fs was not used during this round of modeling. This was a calculated choice, because gpa, credit, and F data will not be available at the state level from districts in the coming year. Therefore, districts will be provided with this initial model for the 2012-2013 year, and an updated one

with gpa, credit, and F indicators sometime in the near future. That model is currently under construction.

Notes on Variables

Binary Variables

Homeless, iep, lep, lunch, sec504, sex, and title1 are all binary variables, taking a value of either 1 or 0. Please see the notes in the data dictionary for how each of these was transformed into binary form.

Disttype also takes the form of two binary variables, Urban and UrbanRing. When Urban=1, then a student's disttype is Urban, when UrbanRing=1, then a student's disttype is Urban Ring, and when neither is equal to 1, then a student's disttype is Suburban.

On-time graduation, ***the dependent variable,*** was also represented as binary. Students who graduated within four years of entering high school were considered on-time graduates (otg=1). Students who took longer than 4 years or who did not complete high school were considered non-on-time graduates (otg=0). Students who verifiably transferred out of state were dropped from the data set.

While the unit of observation was the student year, on-time graduation (like date of birth) was unique to a student instead of to a student year. Therefore, logically, on-time graduation status was equivalent for every student year possessing the same student id.

Calculated Variables

Multiple variables were calculated from other fields in the data set. Below are notes on these variables:

Attend_percent was calculated by dividing ada (aggregate days attendance) by adm (aggregate days membership). The few observations for which ada was greater than adm (which should be impossible) were dropped from the data set.

Schtransfers should be called schenrollments, as it represents the number of times a student id appears in the dataset with a distinct school identifier during the school year.

Yearsoverage was calculated by determining a student's age on the 31st of May of the date in question and subtracting their grade level plus 7 from it. This constant of 7 should probably be replaced with 6, as the distribution of yearsoverage is actually centered around -1 instead of 0.

Yrssqterm is an interaction of yearsoverage with itself, squaring that value for all students. Prior to squaring the value, however, 1 was added to yearsoverage for each student year, to center the distribution around 0 instead of 1. Therefore, the formula was $yrssqterm = (1 + yearsoverage)^2$. This variable was created when it became apparent that yearsoverage had a non-linear relationship with otg.

Decisions

While the excellent point was put forward by Project Tech Lead Jason Becker that adm may have only been representative of days enrolled in a school year before dropping out, and therefore could not be predictive, but instead reactive, we have decided to leave it in the aggregate equations. While we acknowledge the point, we believe that there is some part of adm (as of yet unisolated) that is predictive (i.e. a student who is only enrolled for a short period in 8th grade and returns for 9th grade is more likely to dropout than a student who is enrolled for all of 8th grade and returns for 9th grade). Taking heed of the warning, however, we have not used adm as an individual indicator, but have instead only included it in the aggregate risk equations.

The Individual Risk Indicators

Methodology: Identifying the Indicators

The viability of individual risk indicators was assessed in two different ways. The first method was a statistical command in R called StepAIC, which measured the deviance in residuals (variance not explained by the model) for the regression results when individual variables were systematically subtracted from and then re-added into the equation. The higher the negative change in residuals, the more explanatory power the variable possessed in the equation, and therefore the more important it was to the final prediction.

Below you can find the results of this command for each grade level's regression:

Grade 6				
Direction	Var	Df	Deviance	AIC
	<none>		8533.3	8557.3
-	title1	1	8535.5	8557.5
+	lep	1	8532.2	8558.2
+	adm	1	8533.3	8559.3
-	yrssqterm6	1	8539.9	8561.9
-	schtransfers	1	8552.5	8574.5
-	yearsoverage	1	8562.1	8584.1
-	disttype	2	8569.1	8589.1
-	sex	1	8588.1	8610.1
-	susp	1	8617.6	8639.6
-	iep	1	8643.3	8665.3
-	lunch	1	8680.5	8702.5
-	attend_percent	1	8740	8762

Grade 7				
Direction	Var	Df	Deviance	AIC
	<none>		18508	18534
-	lep	1	18511	18535
+	title1	1	18508	18536
-	adm	1	18512	18536
-	yrssqterm7	1	18537	18561
-	disttype	2	18541	18563
-	schtransfers	1	18561	18585
-	yearsoverage	1	18578	18602
-	sex	1	18624	18648
-	susp	1	18665	18689
-	iep	1	18672	18696
-	lunch	1	18728	18752
-	attend_percent	1	19170	19194

Grade 8				
Dir.	Var	Df	Deviance	AIC
	<none>		8405	8431
+	title1	1	8403.9	8431.9
+	adm	1	8404.2	8432.2
+	iep	1	8404.8	8432.8
-	disttype	2	8412.8	8434.8
-	yrssqterm	1	8411.4	8435.4
-	lep	1	8415.8	8439.8
-	yearsoverage	1	8424.7	8448.7
-	schtransfers	1	8425.2	8449.2
-	math_score_norm	1	8433.1	8457.1
-	lunch	1	8460.1	8484.1
-	reading_score_norm	1	8475.6	8499.6
-	susp	1	8484.8	8508.8
-	sex	1	8485.9	8509.9
-	attend_percent	1	8872.4	8896.4

Grade 9				
Dir	Var	Df	Deviance	AIC
	<none>		8515.9	8545.9
+	iep	1	8514.9	8546.9
-	math_score_norm	1	8533.4	8561.4
-	lep	1	8533.8	8561.8
-	yrssqterm	1	8541	8569
-	adm	1	8545.6	8573.6
-	schtransfers	1	8550.1	8578.1
-	yearsoverage	1	8553.5	8581.5
-	lunch	1	8556.6	8584.6
-	disttype	2	8559.8	8585.8
-	title1	1	8559.1	8587.1
-	reading_score_norm	1	8596.5	8624.5
-	sex	1	8622.1	8650.1
-	susp	1	8625.3	8653.3
-	attend_percent	1	9523.7	9551.7

Grade 10				
Dir.	Var	Df	Deviance	AIC
	<none>		6641.6	6673.6
-	reading_score_norm	1	6644	6674
-	title1	1	6644.3	6674.3
-	lep	1	6648.5	6678.5
-	iep	1	6651.1	6681.1
-	disttype	2	6654.6	6682.6
-	math_score_norm	1	6656.4	6686.4
-	schtransfers	1	6661.8	6691.8
-	yrssqterm	1	6673.8	6703.8
-	yearsoverage	1	6676.5	6706.5
-	lunch	1	6700.5	6730.5
-	sex	1	6721.7	6751.7
-	susp	1	6730.1	6760.1
-	adm	1	6770.4	6800.4
-	attend_percent	1	7346.4	7376.4

Grade 11				
Dir	Var	Df	Deviance	AIC
	<none>		8910.4	8940.4
-	iep	1	8913.7	8941.7
+	yrssqterm	1	8910.1	8942.1
-	lep	1	8917.3	8945.3
-	reading_score_norm	1	8919.4	8947.4
-	schtransfers	1	8932.8	8960.8
-	lunch	1	8939.3	8967.3
-	title1	1	8983.7	9011.7
-	disttype	2	8999.4	9025.4
-	math_score_norm	1	8998.2	9026.2
-	susp	1	9002.2	9030.2
-	sex	1	9054.9	9082.9
-	adm	1	9100.9	9128.9
-	yearsoverage	1	9637.3	9665.3
-	attend_percent	1	9959.1	9987.1

Grade 12				
Direction	Var	Df	Deviance	AIC
	<none>		6151.6	6179.6
+	yrssqterm	1	6150.3	6180.3
-	title1	1	6154.7	6180.7
+	reading_score_norm	1	6151.4	6181.4
-	disttype	2	6162.6	6186.6
-	lep	1	6161.4	6187.4
-	lunch	1	6164.3	6190.3
-	schtransfers	1	6165	6191
-	math_score_norm	1	6190.4	6216.4
-	susp	1	6191.9	6217.9
-	iep	1	6196.9	6222.9
-	sex	1	6200.2	6226.2
-	attend_percent	1	6492.6	6518.6
-	adm	1	6578.2	6604.2
-	yearsoverage	1	6969.7	6995.7

The tables read from bottom to top, with the variables at the bottom creating the most deviance in the model. As can be seen, this process identified attend_percent as being the most predictive variable at every grade level. Also extremely predictive were sex, suspensions, and lunch status (in the younger grades). However, this process has numerous difficulties. The first is that the effect of the yearsoverage variable is divided because of the use of a yrssqterm

as well. Therefore, it is difficult to identify the total effect of yrsoverage on the model. Second, this command is run before the outcome has been cross-validated (used to predict dropout and checked against what actually happened). Therefore, a second methodology was necessary and useful as well.

For the second method, a regression model was run for a grade and used to predict the dropout status of students whose student year records were identified with that grade. These predictions were then checked against fact (whether or not students did actually drop out) and an accuracy rate for the grade-based model was created (more on this in the section on Cross-Validation). The importance of each variable was checked by re-running the regression without each variable and then comparing the accuracy rate to the original accuracy rate. The variables whose omission caused the largest decrease in model accuracy are then, logically, those with the most importance to the model. Below are the results from this process:

		6th Grade	7th Grade	8th Grade	9th Grade	10th Grade	11th Grade	12th Grade
Predictivity with:	all vars	80.987%	80.447%	81.520%	83.720%	86.380%	85.830%	90.157%
Decrease Without:	w/o attend_percent and interactions	0.533%	0.917%	1.048%	2.480%	1.523%	1.923%	0.220%
	w/o susp	0.180%	0.107%	0.340%	0.313%	0.147%	0.203%	0.043%
	w/o yrsoverage and sqterm	0.277%	0.287%	0.270%	0.880%	0.400%	1.170%	0.853%
	w/o schtransfer	0.003%	0.047%	0.077%	0.007%	0.057%	0.000%	0.030%
	w/o reading score			0.013%	0.203%	-0.027%	-0.027%	-0.017%
	w/o math score			-0.090%	-0.083%	-0.050%	0.243%	0.030%
	w/o both test scores			-0.103%	-0.010%	-0.043%	-0.017%	0.017%
	w/o title1	-0.037%	-0.053%	0.003%	0.030%	-0.020%	0.153%	0.013%
	w/o lunch	-0.300%	-0.113%	-0.150%	-0.037%	-0.067%	-0.033%	-0.003%

As is clearly evident, attend_percent is by far the most predictive of the variables, and years_overage is clearly second. Susp is most likely the third most predictive, although in 11th grade, the omission of math_score_norm causes a slightly greater decrease in model accuracy.

Note that the removal of some variables actually slightly increased the predictive capabilities of the model, likely because they were over-identifying possible dropouts.

The variable of 'sex' was not tested in these calculations, because even though it apparently is strongly predictive of otg, it is not an actionable variable, in that nothing can be done to change, and little can be done to "treat" a child's sex.

From these two tests, with special emphasis on the latter of the two, it was determined that, for grades 8-12 the indicators used for the multi-flag indicator model would be ***years overage***, ***attendance percentage*** and ***number of suspensions***, with the exception of 11th grade, in which suspensions should be replaced as an indicator with normalized math test score.

Methodology: Setting the Benchmarks

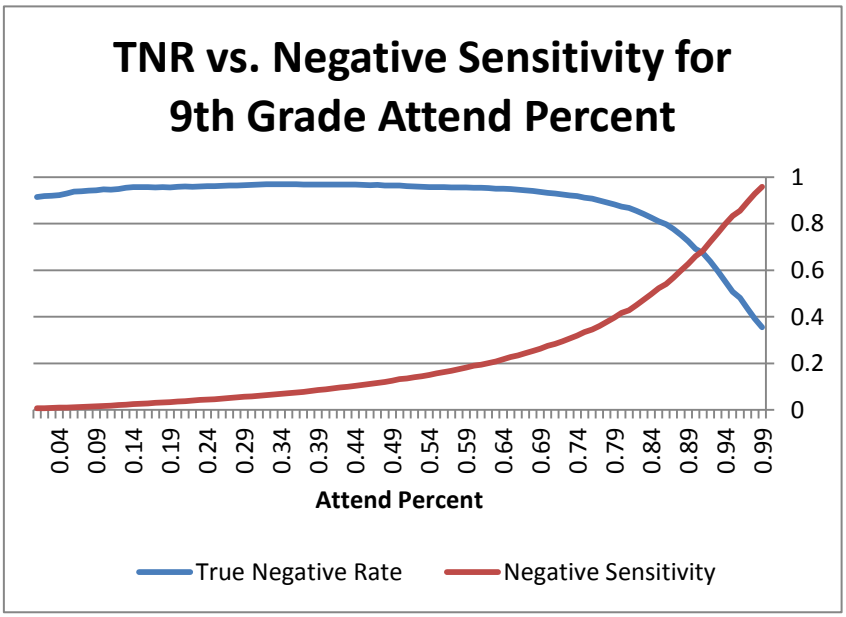
Benchmarks for each of these indicators must be set so that struggling students can be more-easily identified and intervened with. However, as intervention will be required of the schools and districts once a student is identified by the Early Warning System, it is also imperative to ensure that resources are not spent to intervene with students who otherwise would have graduated anyways. Therefore, proper benchmarks must adhere to two criteria:

a. There should be high accuracy amongst those who are marked as likely non-graduates (***accuracy)***.
b. Most non-graduates should be caught by the indicators ***(scope).***

Using these two criteria, it is possible to develop a decision rule. The rule decided upon for the purposes of this model is:

The benchmark will be the level at which the sensitivity rate is the highest, given that the true negative rate is ___ %.

There is a tradeoff between the criteria of accuracy and scope, as is demonstrated below by the graph of the true negative rate (accuracy) and the "negative" sensitivity (scope)[1] of using attend_percent at different benchmark levels in the 9th grade:



Therefore, appropriate true negative rate, or indeed the appropriate decision rule, is more of a policy decision than a statistical one. It is based on RIDE's tolerance for unnecessary expenditure versus its tolerance for dropout.

[1] "Negative" sensitivity is not a real statistical term, but instead has been created for the purposes of this brief. In the predictive field of medicine, a troublesome condition will be given the value of 1, and the absence of it will be given the value of zero. Therefore, a positive diagnosis on a patient with a condition is a "true positive" and the ratio of those caught to all with the condition is "sensitivity". In the case of this model, the variable of otg actually gives a value of 1 to those without the condition (graduates), and a value of 0 to those with the condition (dropouts). Therefore, for this screener, terminology is slightly awkward, with "true negative" and "negative sensitivity" being used instead of "true positive" and "sensitivity".

Results: Attend Percent Benchmarks

For attend_percent, the following true negative rates were set for the decision rule:

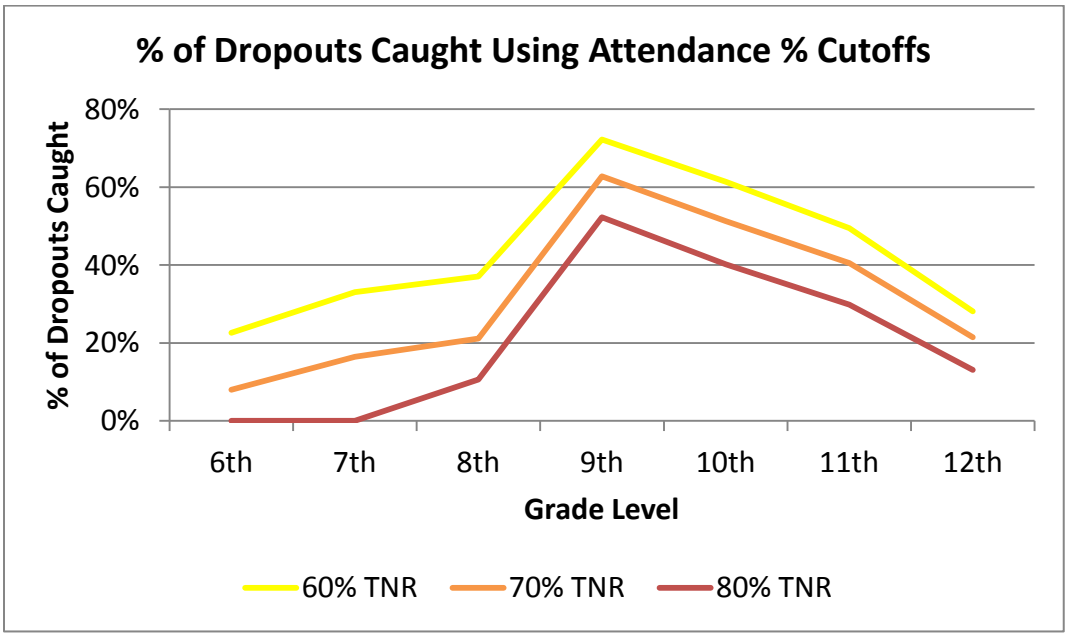
- Yellow Benchmark = 60% True negatives
- Orange Benchmark = 70% True negatives
- Red Benchmark = 80% True negatives

Utilizing this decision rule, the following benchmarks have been set:

- 6th: Yellow: 87% Orange: 79% Red: None
- 7th: Yellow: 88% Orange: 82% Red: None
- 8th: Yellow: 88% Orange: 83% Red: 76%
- 9th: Yellow: 92% Orange: 89% Red: 85%
- 10th: Yellow: 88% Orange: 84% Red: 78%
- 11th: Yellow: 82% Orange: 77% Red: 69%
- 12th: Yellow: 68% Orange: 61% Red: 49%

Note that the benchmark attendance rates are much higher for 8th-10th grade than they are for 11th and 12th grade, signaling that attendance affects otg less in later grades. Also note that for 7th and 8th grade there is no attendance rate at which the true negative rate reaches 80%, and thus there is no red benchmark.

These benchmarks catch varying percentages of dropouts, depending on grade level. The following is a graph demonstrating the "negative" sensitivity rate, given the yellow, orange and red true negative rates at varying grade levels:



See the Appendix 1 for a more thorough treatment of these indicator benchmarks.

Results: Years Overage Benchmarks

For yearsoverage, the following true negative rates were set for the decision rule:

- Yellow Benchmark = 50% True negatives
- Orange Benchmark = 60% True negatives
- Red Benchmark = 70% True negatives

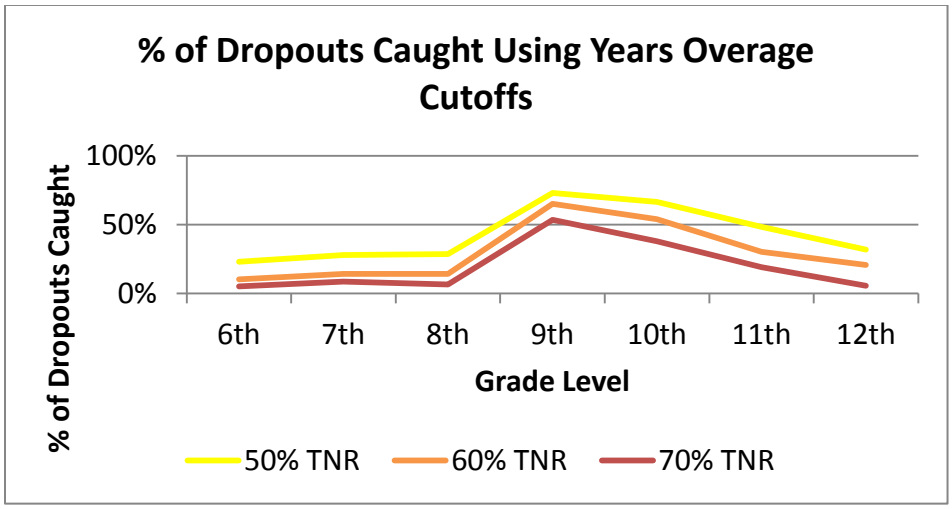
These true negative rates were set lower than for attend_percent because yearsoverage is not as good of a predictor of otg, and therefore it is impossible to find true negative rates higher than 70% for all grades, no matter the benchmarks.

Utilizing this decision rule, the following benchmarks have been set:

- 6th: Yellow: -0.1 Orange: 0.3 Red: 0.6
- 7th: Yellow: -0.2 Orange: 0.2 Red: 0.4
- 8th: Yellow: -0.2 Orange: 0.2 Red: 0.5
- 9th: Yellow: -0.7 Orange: -0.5 Red: -0.2
- 10th: Yellow: -0.5 Orange: -0.2 Red: 0.2
- 11th: Yellow: -0.2 Orange: 0.2 Red: 0.5
- 12th: Yellow: 0.2 Orange: 0.5 Red: 1.4

Once again, note that the benchmarks levels are higher across yellow orange and red for 11th and 12th graders than they are for earlier grades. This, again, signifies that as students progress in grade level, age is less likely to have an effect on otg.Also, note that yearsoverage is a calculated field, and would probably benefit from a recalculation in which (grade level + 6) is subtracted from age, instead of (grade level + 7). This recalculation should not change the level of the variable's importance, though, as the addition of a constant (1) will not affect its impact on otg.

Below is a graph demonstrating the "negative" sensitivity rate, given the yellow, orange and red true negative rates at varying grade levels:



Results: Suspension Benchmarks

For susp, the following true negative rates were set for the decision rule:

- Yellow Benchmark = 50% True negatives
- Orange Benchmark = 60% True negatives
- Red Benchmark = 70% True negatives

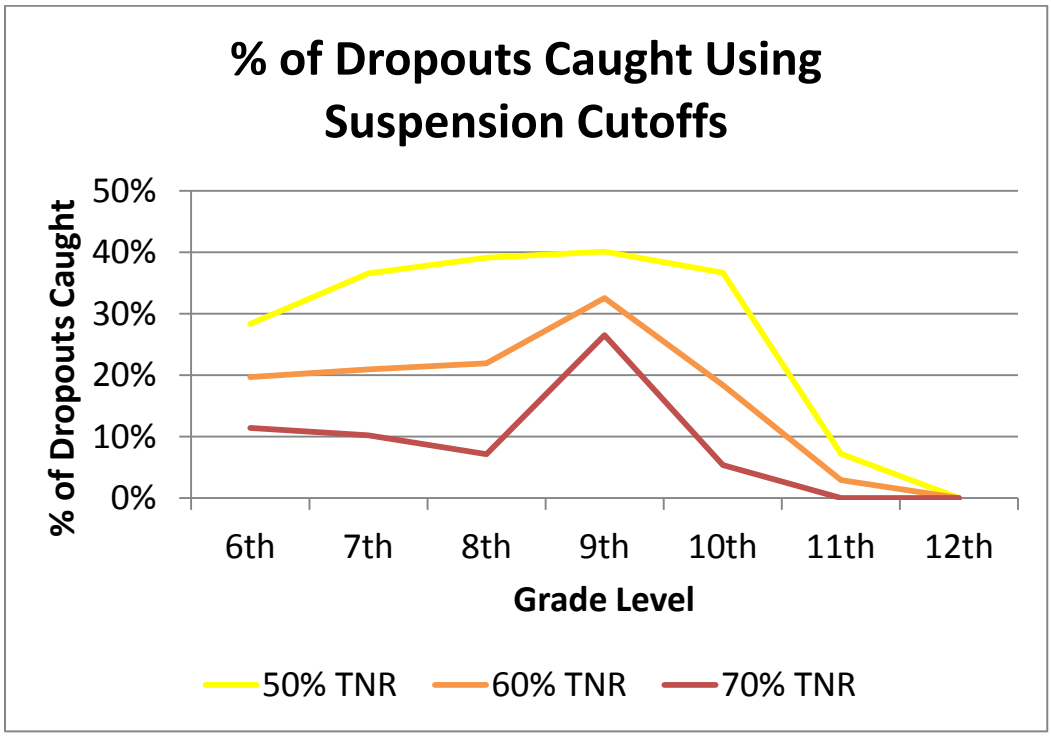
Again, negative rates were set lower than for attend_percent because susp is not as good of a predictor of otg, and therefore it is impossible to find true negative rates higher than 70% for grades 8-10, no matter the benchmarks.

Utilizing this decision rule, the following benchmarks have been set:

- 6th: Yellow: 1 Orange: 3 Red: 6
- 7th: Yellow: 1 Orange:4 Red: 9
- 8th: Yellow: 1 Orange: 4 Red: 11
- 9th: Yellow: 1 Orange: 2 Red: 3
- 10th: Yellow: 1 Orange: 4 Red: 11

Note how much lower the Red benchmark is for 9th graders than for 8th or 10th graders. This signifies that suspensions are a much more of otg in 9th grade than they are in 8th or 10th.

For 11th and 12th graders, the susp variable was not even predictive enough to be used as an individual indicator. See the graph of "negative" sensitivity below for evidence of this:



Results: Math Test Score As an Indicator

Math test score is more predictive than suspensions for 11th and 12th graders, but neither variable is very predictive. The true negative rate never exceeds 48%, at any benchmark level. It is possible to add Math Test Score to the set of indicators for 11th and 12th, but this is acknowledging that, at best, it will provide no better than a 50% chance of accurately predicting a dropout. It is, therefore, recommended that only two individual indicators are used in addition to the aggregate indicator for 11th and 12th grade.

The Aggregate Risk Indicator

Purpose

The aggregate risk indicator is intended to provide a percent likelihood that a student will graduate on time from high school, given the student's current year performance and demographic data.

Methodology: Variable Cleanup

Multiple variables, such as yearsoverage, attend_percent, and susp, contained outliers that were so far from the norm that they obscured true trends in the data. The distribution of each variable was mapped and then a strategic decision was made about whether the data should be artificially truncated by dropping observations with extreme outlying values for some variables. For example, yearsoverage was truncated at ± 4 years. R-code outlining the examining of these distributions and the making of these decisions is available upon request.

Methodology: The Logit Form

The equations developed to represent the probability that a student will graduate on time take on the following form:

$$logit\big(P(otg = 1|grade\ level = \gamma)\big) = \alpha + \beta x$$

where α is a constant, β is the coefficient on x, and x is a vector of a student year characteristics, including (but not limited to) sex, lunch, attend_percent, susp, most math_test_score or reading_test_score, and years_overage. The abbreviation $logit(P(otg = 1))$ is a shorthand way of describing the formula for the logarithm of the odds of an event occurring, in this case on time graduation. The full formula is:

$$logit\big(P(t)\big) = \log\left[\frac{P(otg = 1)}{1 - P(otg = 1)}\right]$$

All outputs of the logit model are between 0 and 1, and therefore take the form of a probability (in this case P(otg=1).

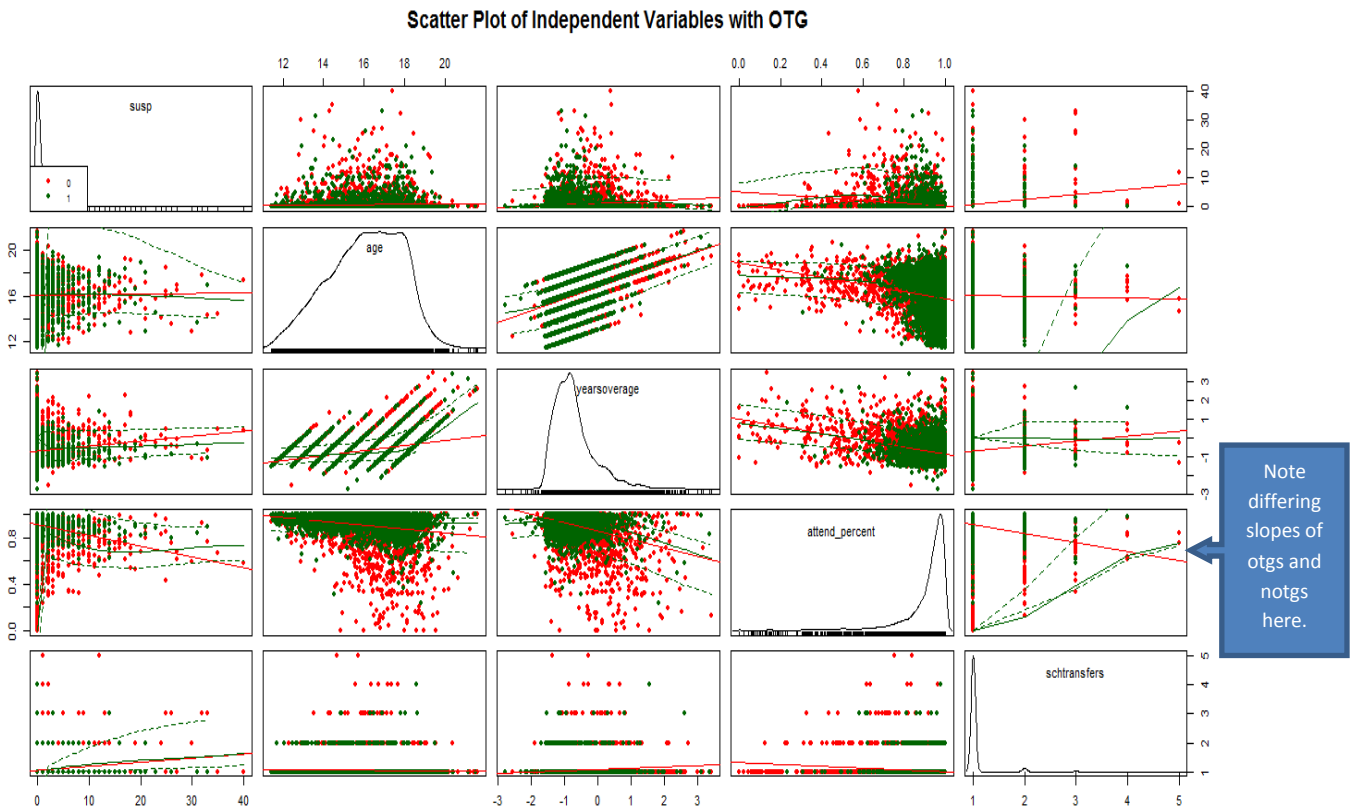
Multiple other forms were experimented with and the logit model was found to be the most predictive.

Methodology: Creating an Equation – Interactions and Quadratics

The variables listed in the "Variables" section were tested in a logit regression for their effect on otg. Following this, two measures were taken to explore possible interaction effects and quadratic terms.

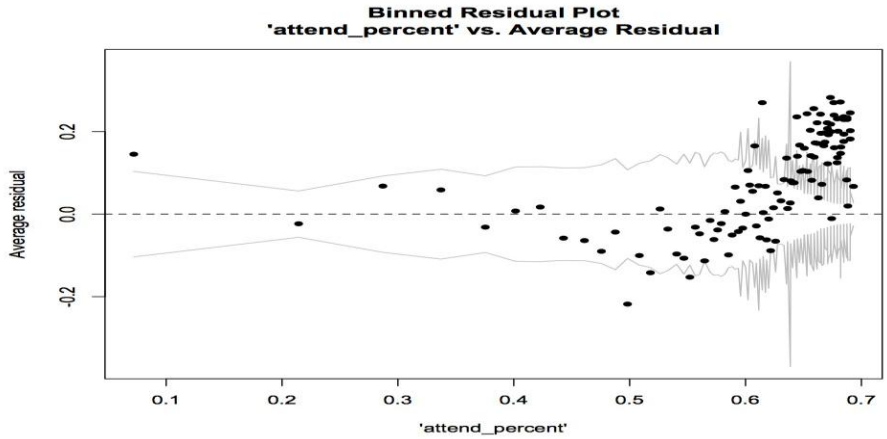
1. Continuous variables with a significant effect on otg were plotted against each other for both on-time and non-on-time graduates in order to examine their joint or conflicting dispersion. Differing slopes of the trend lines for otgs and notgs signified a pair of variables that may be

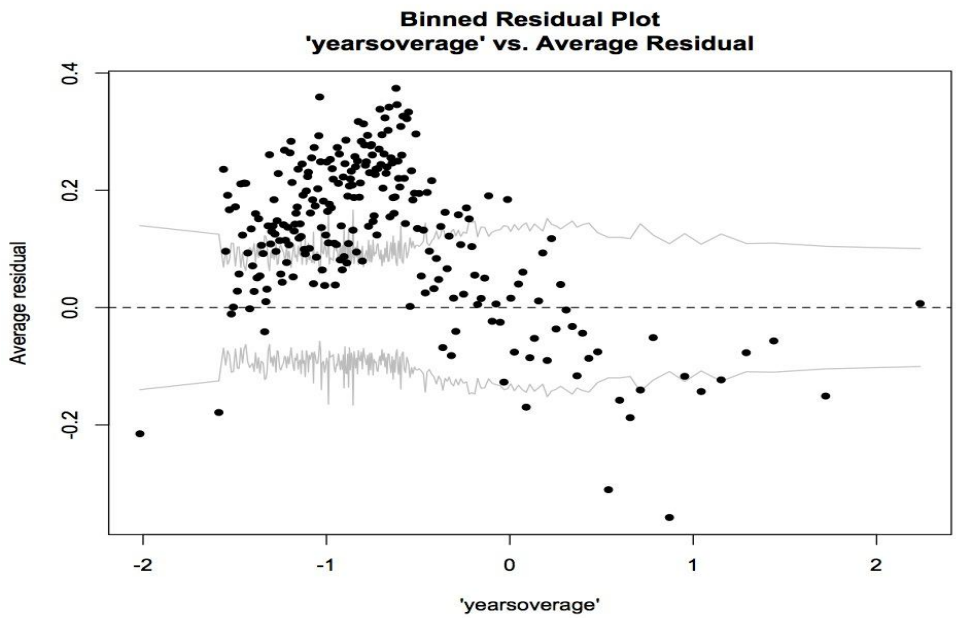
related to otg status both separately and through each other (interaction). Below, scatterplots can be found for five of the continuous variables investigated (green dots and trendlines represent otgs, red dots and trendlines represent notgs):



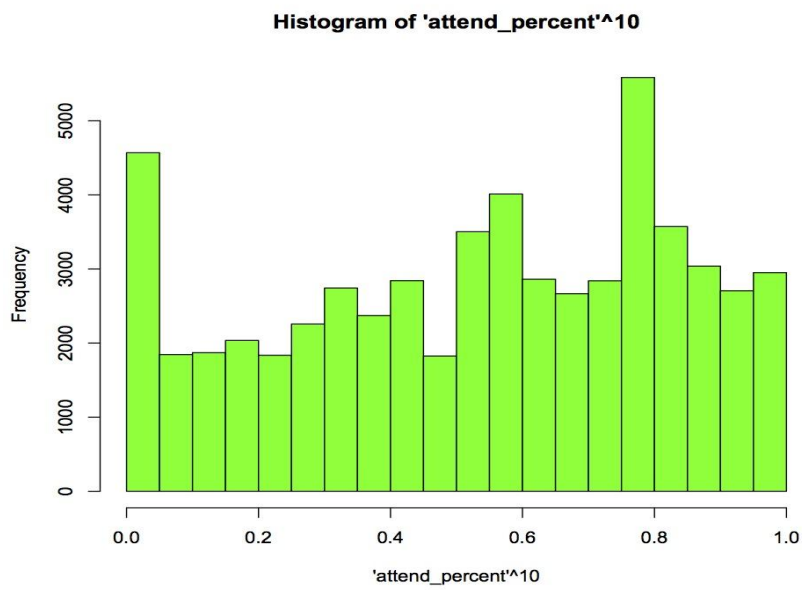
As can be seen above, attend percent displayed interesting initial results with multiple variables (note the difering slopes for notgs and otgs in the relationship of attend_percent to schtransfer).

2. In searching for both interactions and quadratic terms, the residuals of the predictive logit equation were plotted against the distributions of a number of variables. The following two diagrams demonstrate some of the more interesting results found in this process:





Note that in the binned residuals plots there are non-linear relationships between attend_percent and yearsoverage and the binned deviance residuals. This leads one to believe that a better-formed variable with a more normal distribution, or an interaction term through which some of that abnormal deviance can be accounted for, is likely possible.



The histogram shows the distribution of attend_percent^10, the exponent transforming it into a more evenly-dispersed variable.

However, nearly all attempts at finding effective interaction terms and quadratic transformations of variables were met in the end with the worsening of predictive results. For example, using attend_percent^10 instead of the non-transformed attend_percent actually decreased the predictivity of the model by ~4%.

In conclusion, despite efforts to capture the non-linearity reflected in the residual plots, we suspect the distributions of the variables (attend_percent in particular) are restricting our ability to model more interesting effects. More creative transformations of these variables might be tried to capture the non-linear relationships. With the exception of adding a the yearsoverage^2 term (yrssqterm) to the equation the addition of different interaction effects and variable transformations (^0.5,^2, ^3, etc.) did not improve the predictivity of the model, and so these transformations were omitted to preserve parsimony.

Methodology: Creating an Equation – Omitting Variables

While multiple variables were found to be significant at one grade level and then insignificant at the next, there were two variables that were always non-predictive, and thus were dropped from the models altogether. These two variables were ***homeless*** and ***sec504***.

It is probable that homeless was statistically insignificant because it occurred so few times throughout the course of the data set. Out of 288,323 student years observed, only in 375 were students categorized as homeless.

Sec504 exhibited a trend of being much more present in districts marked as suburban, leading us to believe that the data was misrepresenting the population. Regardless of this trend, sec504 showed itself to be a consistently insignificant indicator.

Results: The Aggregate Risk Equations

It should be noted, first that the aggregate risk equations actually measure aggregate likelihood of graduating, and therefore, students with ***lower*** scores are actually those who are at risk.

6th Grade:

$$logit(P(otg = 1|grade_{level} = 6) = \alpha + \beta_1 * sex + \beta_2 * susp + \beta_3 * lunch + \beta_4 * iep + \beta_5 * title1 + \beta_6 * Urban + \beta_7 * UrbanRing + \beta_8 * schtransfers + \beta_9 * yearsoverage + \beta_{10} * attend_{percent} + \beta_{11} * yrssqterm + \varepsilon$$

Notes: Lep and adm are omitted from the 6th grade equation as they did not have a statistically significant impact on otg. Math_test_score and Reading_test_score were also omitted, as only 8th and 11th grade test scores were used.

6th Grade Aggregate Risk Equation		
Symbol	Coefficient of:	Value
α	(constant)	-3.25108
β_1	sex	-0.41513
β_2	susp	-0.09816
β_3	lunch	-0.81608
β_4	iep	-0.67301
β_5	title1	0.12348
β_6	disttypeUrban	-0.64269
β_7	disttypeUrbanRing	-0.41554
β_8	schtransfers	-0.44183
β_9	yearsoverage	-0.43824
β_{10}	attend_percent	6.39227
β_{11}	yrssqterm	-0.14817
ε	(error term)	Deviance b/w model and reality

Standard errors and statistical significance for all variables in all models can be found in the appendix.

7th Grade:

$$logit(P(otg = 1|grade_{level} = 7) = \alpha + \beta_1 * sex + \beta_2 * adm + \beta_3 * susp + \beta_4 * lunch + \beta_5 * lep + \beta_6 * iep + \beta_7 * Urban + \beta_8 * UrbanRing + \beta_9 * schtransfers + \beta_{10} * attend_{percent} + \beta_{11} * yrsoverage + \beta_{12} * yrssqterm + \varepsilon$$

Notes: Lep and adm were added as they were found to be significant, but title1 was insignificant and was taken from the model. Again, no math or reading test scores were used.

7th Grade Aggregate Risk Equation		
Symbol	Coefficient of:	Value
α	(Intercept)	-4.967851
β_1	sexM	-0.40768
β_2	adm	0.002199
β_3	susp	-0.075825
β_4	lunchY	-0.659915
β_5	lepY	0.152943
β_6	iepY	-0.563417
β_7	disttypeUrban	-0.347234
β_8	disttypeUrbanRing	-0.270225
β_9	schtransfers	-0.497673
β_{10}	yearsoverage	-0.471301
β_{11}	yrssqterm	-0.236018
β_{12}	attend_percent	7.559849
ε	(error term)	Deviance b/w model and reality

8th Grade:

$$logit(P(otg = 1|grade_{level} = 8) = \alpha + \beta_1 * sex + \beta_2 * susp + \beta_3 * lunch + \beta_4 * lep + \beta_5 * Urban + \beta_6 * UrbanRing + \beta_7 * schtransfers + \beta_8 * yearsoverage + \beta_9 * yrssqterm + \beta_{10} * attend_percent + \beta_{11} * reading_score_norm + \beta_{12} * math_score_norm + \varepsilon$$

Notes: TitleI, iep, and adm were not significant predictors and thus were removed from the model. Reading_score_norm and math_score_norm were added to the model.

8th Grade Aggregate Risk Equation		
Symbol	Coefficient of:	Value
A	(Intercept)	-6.80866
β_1	sex	-0.51616
β_2	Susp	-0.0806
β_3	lunch	-0.47849
β_4	lep	0.485325
β_5	disttypeUrban	-0.12248
β_6	disttypeUrbanRing	-0.2199
β_7	Schtransfers	-0.46942
β_8	Yearsoverage	-0.38174
β_9	Yrssqterm	-0.18049
β_{10}	attend_percent	9.824853
β_{11}	reading_score_norm	0.382403
β_{12}	math_score_norm	0.228164
ε	(error term)	Deviance b/w model and reality

9th Grade:

$$logit(P(otg = 1|grade_{level} = 9) = \alpha + \beta_1 * sex + \beta_2 * adm + \beta_3 * susp + \beta_4 * lunch + \beta_5 * lep + \beta_6 * title1 + \beta_7 * Urban + \beta_8 * UrbanRing + \beta_9 * schtransfers + \beta_{10} * yearsoverage + \beta_{11} * yrssqterm + \beta_{12} * attend_percent + \beta_{13} * reading_score_norm + \beta_{14} * math_score_norm + \varepsilon$$

Notes: Title1 and adm were included in the equation, unlike for 8th grade, as they were found to be statistically significant.

9th Grade Aggregate Risk Equation		
Symbol	Coefficient of:	Value
α	(Intercept)	-8.288826
β_1	sex	-0.589577
β_2	adm	0.008465
β_3	susp	-0.138372
β_4	lunch	-0.40775
β_5	lep	0.669453
β_6	title1	-0.599603
β_7	disttypeUrban	0.003204
β_8	disttypeUrbanRing	-0.408501
β_9	schtransfers	-0.56055
β_{10}	yearsoverage	-0.502657
β_{11}	yrssqterm	-0.25053
β_{12}	attend_percent	10.072601
β_{13}	reading_score_norm	0.39742
β_{14}	math_score_norm	0.174647
ε	(error term)	Deviance b/w model and reality

10th Grade:

$$logit(P(otg = 1|grade_{level} = 9) = \alpha + \beta_1 * sex + \beta_2 * adm + \beta_3 * susp + \beta_4 * lunch + \beta_5 * lep + \beta_6 * iep + \beta_7 * title1 + \beta_8 * Urban + \beta_9 * UrbanRing + \beta_{10} * schtransfers + \beta_{11} * yearsoverage + \beta_{12} * yrssqterm + \beta_{13} * attend_percent + \beta_{14} * reading_score_norm + \beta_{15} * math_score_norm + \varepsilon$$

Notes: The iep variable was found to be statistically significant for the 10th grade year, unlike in 9th and 8th grade years.

10th Grade Aggregate Risk Equation		
Symbol	Coefficient of:	Value
α	(Intercept)	-8.781234
β_1	sex	-0.598354
β_2	adm	0.019499
β_3	susp	-0.092256
β_4	lunch	-0.571829
β_5	lep	0.625594
β_6	iep	-0.263494
β_7	title1	-0.188132
β_8	disttypeUrban	0.29075
β_9	disttypeUrbanRing	-0.131152
β_{10}	schtransfers	-0.443915
β_{11}	yearsoverage	-0.553437
β_{12}	yrssqterm	-0.33208
β_{13}	attend_percent	8.679162
β_{14}	reading_score_norm	0.076649
β_{15}	math_score_norm	0.185491
ε	(error term)	Deviance b/w model and reality

11th Grade:

$$logit(P(otg = 1|grade_{level} = 9) = \alpha + \beta_1 * sex + \beta_2 * adm + \beta_3 * susp + \beta_4 * lunch + \beta_5 * lep + \beta_6 * iep + \beta_7 * title1 + \beta_8 * Urban + \beta_9 * UrbanRing + \beta_{10} * schtransfers + \beta_{11} * yearsoverage + \beta_{12} * attend_percent + \beta_{13} * reading_score_norm + \beta_{14} * math_score_norm + \varepsilon$$

Notes: The yrssqterm is omitted from this model as it is not statistically significant.

11th Grade Aggregate Risk Equation		
Symbol	Coefficient of:	Value
α	(Intercept)	-8.025747
β_1	sex	-0.682771
β_2	adm	0.01715
β_3	susp	-0.114618
β_4	lunch	-0.34265
β_5	lep	0.32482
β_6	iep	-0.125676
β_7	title1	-0.706668
β_8	disttypeUrban	0.42358
β_9	disttypeUrbanRing	-0.293705
β_{10}	schtransfers	-0.485616
β_{11}	yearsoverage	-1.12521
β_{12}	attend_percent	8.016269
β_{13}	reading_score_norm	0.10955
β_{14}	math_score_norm	0.349393
ε	(error term)	Deviance b/w model and reality

12th Grade:

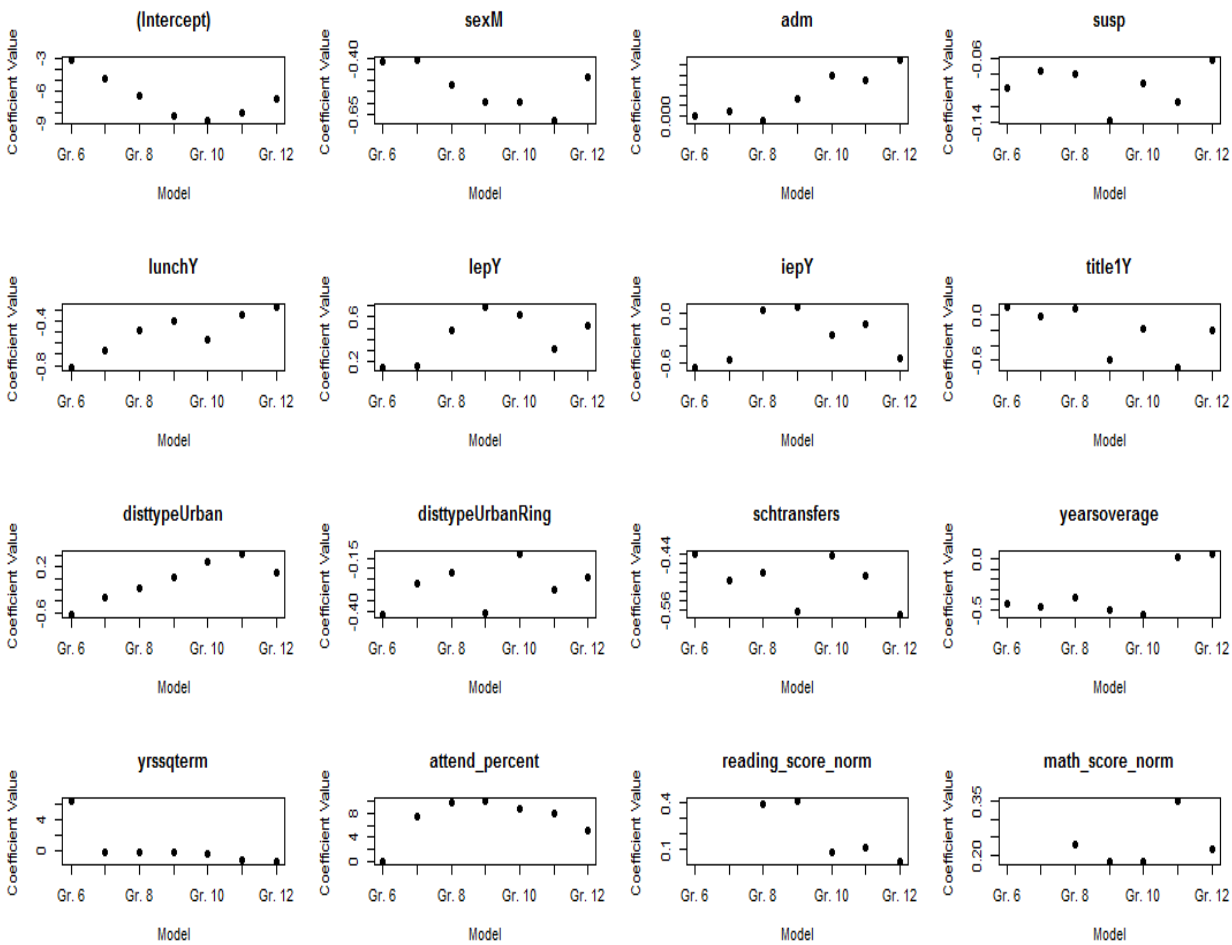
$$logit(P(otg = 1|grade_{level} = 9) = \alpha + \beta_1 * sex + \beta_2 * adm + \beta_3 * susp + \beta_4 * lunch + \beta_5 * lep + \beta_6 * iep + \beta_7 * title1 + \beta_8 * Urban + \beta_9 * UrbanRing + \beta_{10} * schtransfers + \beta_{11} * yearsoverage + \beta_{12} * attend_{percent} + \beta_{13} * math_score_norm + \varepsilon$$

Notes: Reading score was omitted from this model, as it was not statistically significant. This is probably because math and reading scores tend to be correlated, and therefore any impact of reading score may have been absorbed into math_score_norm's coefficient.

12th Grade Aggregate Risk Equation		
Symbol	Coefficient of:	Value
α	(Intercept)	-6.624431
β_1	sex	-0.490994
β_2	adm	0.027118
β_3	susp	-0.0621
β_4	lunch	-0.279692
β_5	lep	0.531904
β_6	iep	-0.556809
β_7	title1	-0.207502
β_8	disttypeUrban	0.102514
β_9	disttypeUrbanRing	-0.239034
β_{10}	schtransfers	-0.57057
β_{11}	yearsoverage	-1.385494
β_{12}	attend_percent	5.150763
β_{13}	math_score_norm	0.226354
ε	(error term)	Deviance b/w model and reality

Results: Mapping the Variable Coefficients across Grade Levels

Below is a matrix of diagrams that maps the significant indicators across grades 6 through 12:

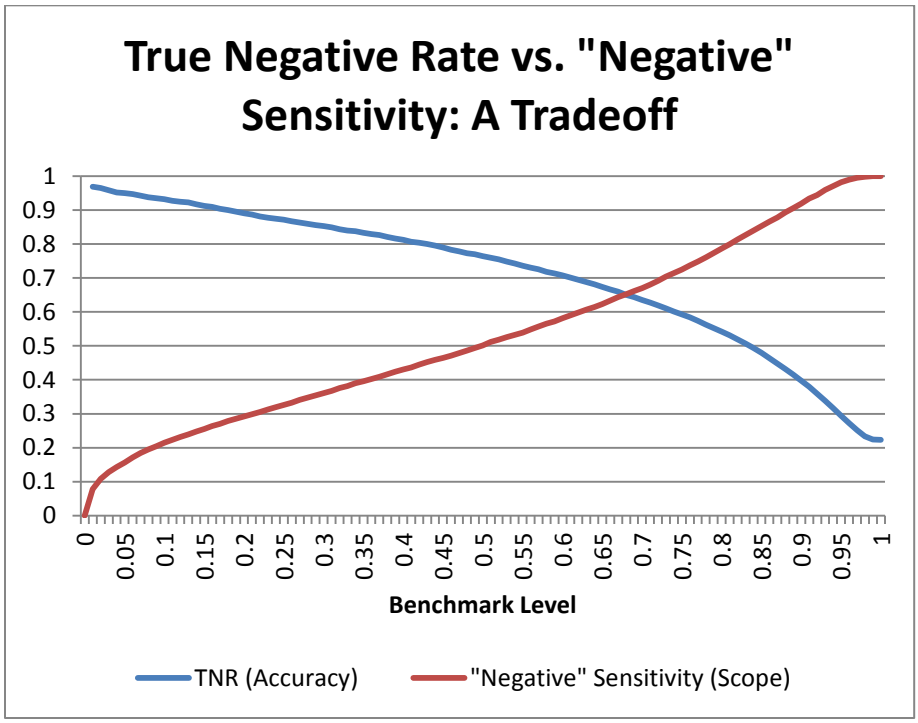


Note that some variables have linear or curvilinear patterns through the grade levels, while others are erratic in their levels. Of special note are:

- The binary variable for Urban district type, which actually migrates from a strong negative effect in earlier grades, to a slight positive effect in later ones
- Attend_percent, which follows a curved path over the grades, first increasing dramatically from 6th to 9th grade, and then falling off slightly in its effect from 10th to 12th.
- Free or reduced price lunch (lunchY), which steadily decreased in effect size as grade level rose.
- Sex (Male), whose negative effect size steadily increases over the grade levels, until it suddenly shrinks in 12th grade (perhaps because students who have made it as far as 12th grade are simply unlikely to drop out).

Results: Setting Aggregate Indicator Benchmarks

Similar to the process with the individual indicator benchmarks, a decision rule must be created in order to create the aggregate risk indicator benchmarks. Once again, this decision rule will reference the ***true negative rate*** (the percentage of those identified as dropouts who actually would have been dropouts – referred to interchangeably as ***accuracy***) and the ***"negative" sensitivity*** (the percentage of dropouts who are caught by the model – referred to interchangeably as ***scope***). As can be seen below, even with a model that is relatively accurate, there is a large tradeoff between accuracy and scope:



The decision rule to be used once again in this decision is:

The benchmark will be the level at which the sensitivity rate is the highest, given that the true negative rate is ___ %.

The levels of true negative rate chosen for the benchmarks are:

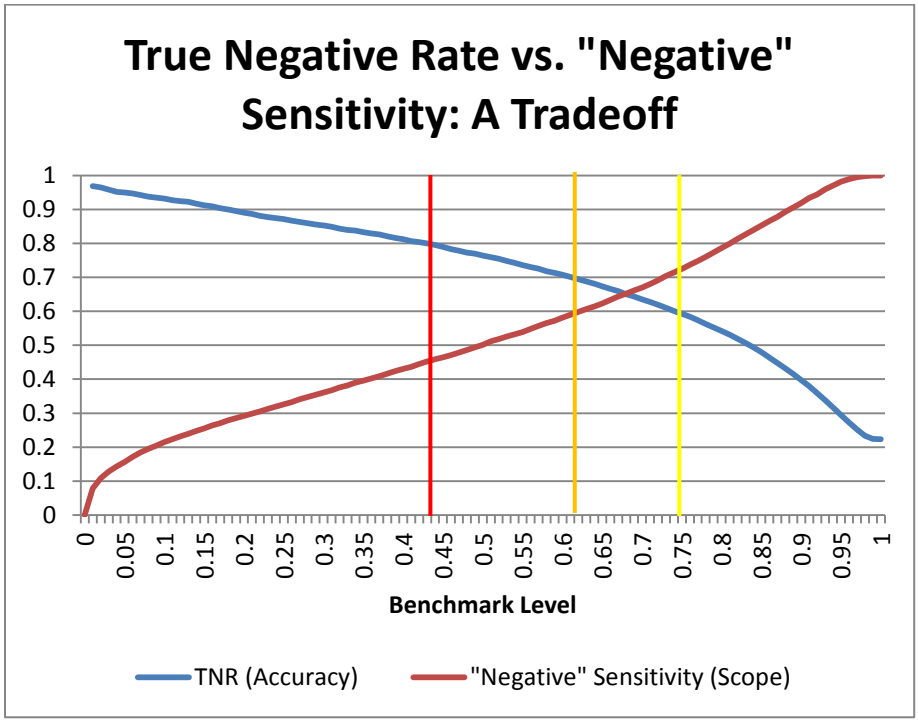
- Yellow Benchmark = 60% True negatives
- Orange Benchmark = 70% True negatives
- Red Benchmark = 80% True negatives

All-grade Benchmarks

Should the benchmarks be made at the aggregate level, instead of at the grade level, they would be as follows:

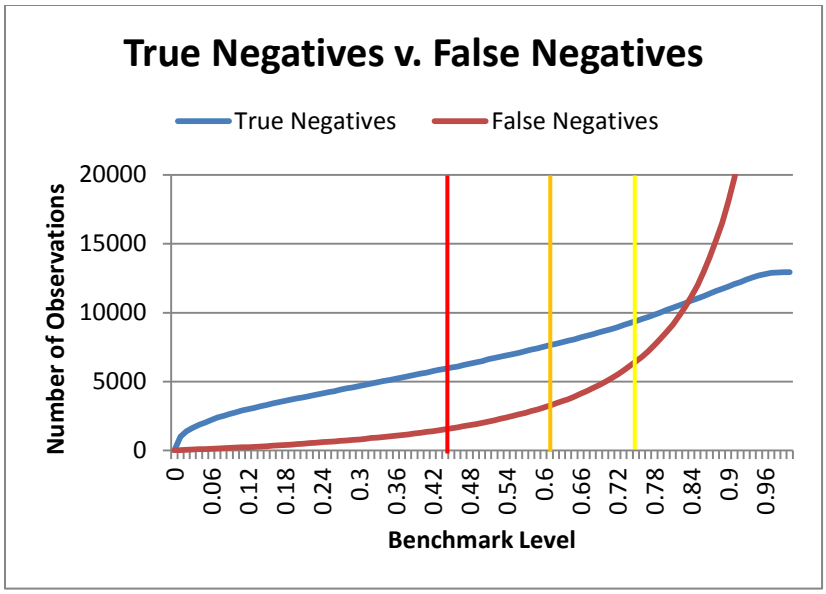
- Yellow: 0.74
- Orange: 0.61
- Red: 0.43

Below, these benchmarks are mapped onto the graph from above:



Note that only at the red benchmark is either the true negative rate or the “negative” sensitivity at below 50%.

This next graph shows the total number of true negatives verse the total number of false negatives and gives the viewer an idea of the total number of interventions that would take place with actual dropouts (true negative rate) vs. those that would take place those who would go on to graduate (false negative rate).



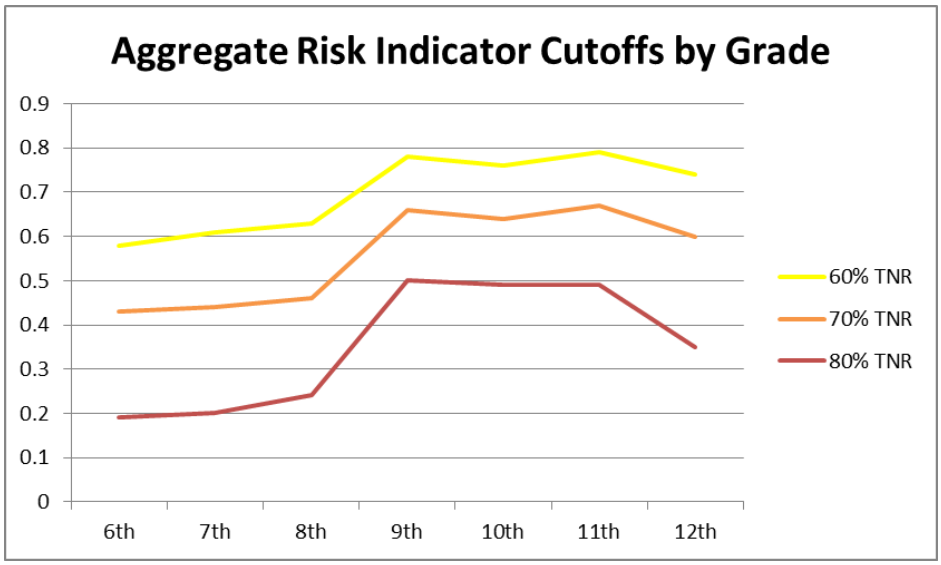
As is clear, each of the benchmark levels capture more true negatives (would-be dropouts) than false negatives (would-be graduates). In the case of the red level benchmark, the difference is stark, but in the case of the yellow benchmark, there are quite a few false negative students caught by the aggregate indicators.

By-Grade Benchmarks

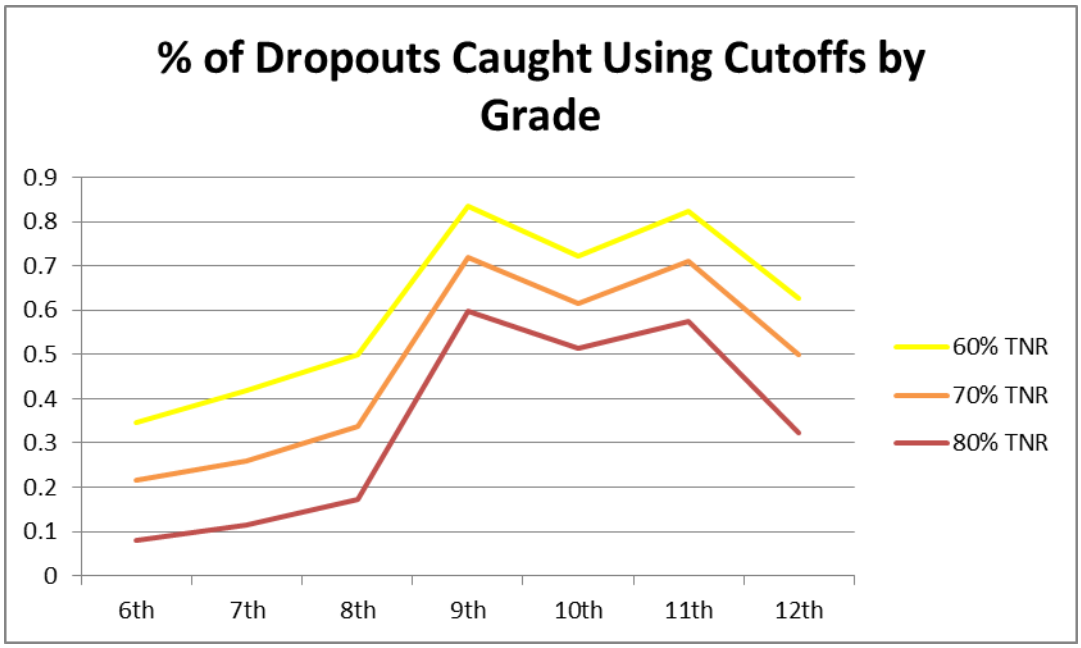
When the aggregate risk indicator is calculated by grade level, as it is in pages 19 through 21, each grade level has different benchmarks. They are as follows:

Benchmarks			
	60% TNR	**70% TNR**	**80% TNR**
6th	0.58	0.43	0.19
7th	0.61	0.44	0.2
8th	0.63	0.46	0.24
9th	0.78	0.66	0.5
10th	0.76	0.64	0.49
11th	0.79	0.67	0.49
12th	0.74	0.6	0.35

Note that the benchmarks rise from 6th through 9th grade, and then fall again from 10th through 12th. Below is a chart of those benchmarks:



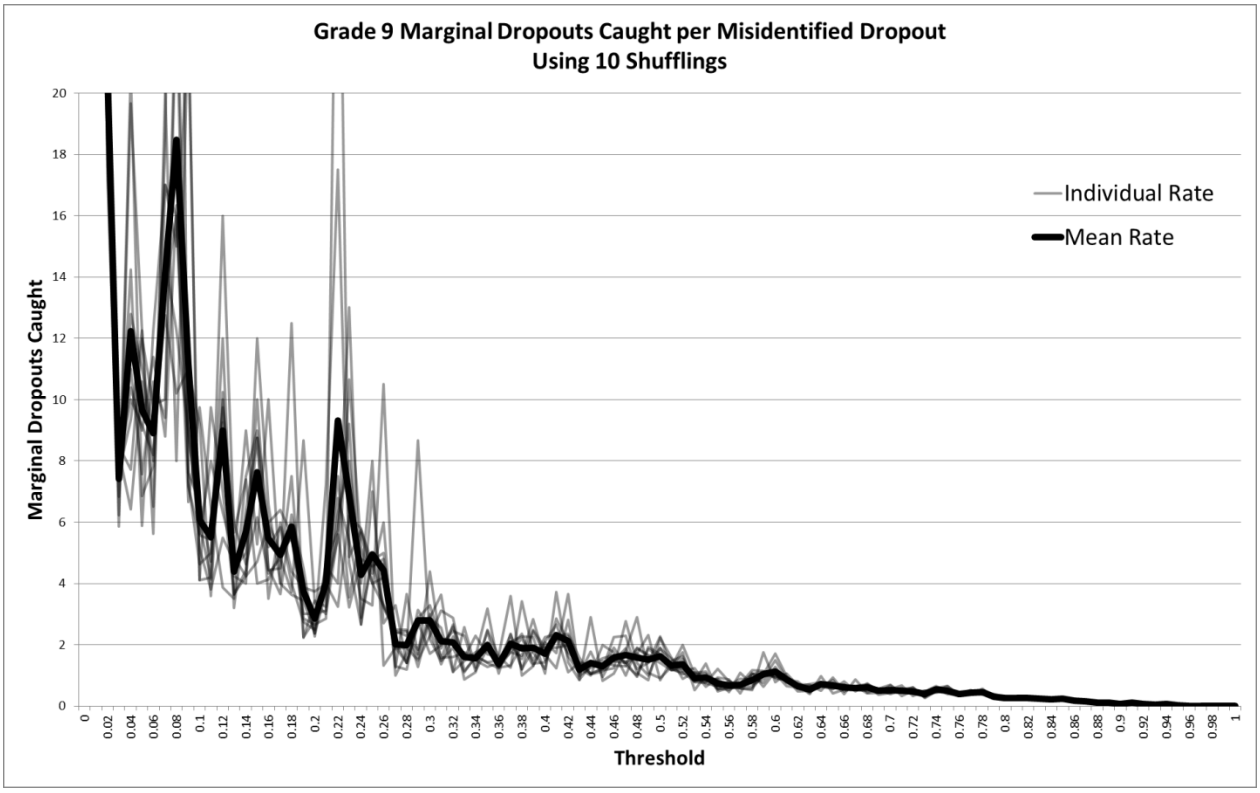
Under these benchmarks, the percentages of dropouts rise and fall with grade as well, taking the following shape:



Finally, it is necessary to re-emphasize that the tradeoffs involved in setting these benchmarks are policy rather than statistical. Appendix 3 includes multiple other calculations, including ratio of marginal dropout interventions to marginal non-dropout interventions, which can be used to make a final decision in setting these benchmarks.

Benchmark Creation: Another Possible Methodology

One other possible way to decide upon benchmarks is to examine the marginal ratio between true negatives (future dropouts) and false negatives (misidentified future graduates) caught. In other words, as the benchmark is moved from from 0 to .01, and mostly dropouts are caught, this marginal ratio will be fairly high (20:1 or higher). As the benchmark is moved higher, however, the model begins to mistakenly catch more and more future graduates. Each marginal increase in the benchmark brings with it a decreasing ratio of efficiency. It is possible to choose the benchmarks on these measures of efficiency, instead of using the decision rule formerly laid out. See the graph below for an example of the pattern of this ratio:



This is just one example of the multiple other methods available for the creation of benchmark levels. These charts for all grade levels can be found in Appendix 3.

Cross Validation: Assessing the Predictivity of the Model

Cross validation is a tool for assessing the predictivity of a model that has been created. The following, taken from Wikipedia's article on the topic, summarizes the topic extremely succinctly:

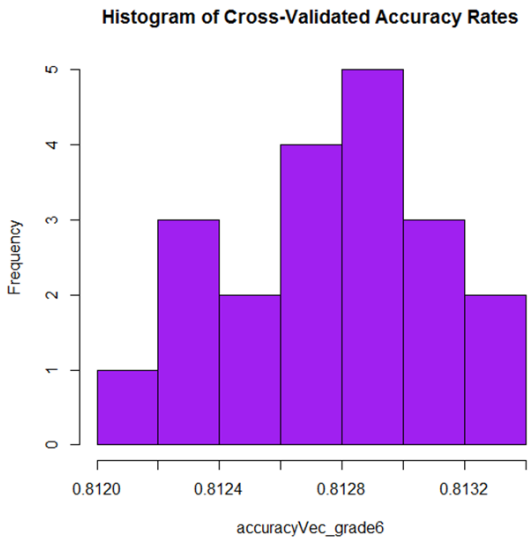
"Cross-validation, sometimes called rotation estimation,[1][2][3] is a technique for assessing how the results of a statistical analysis will generalize to an independent data set. It is mainly used in settings where the goal is prediction, and one wants to estimate how accurately a predictive model will perform

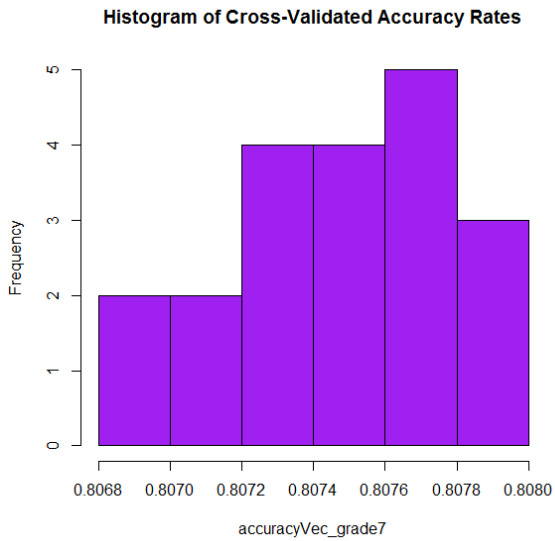
in practice. One round of cross-validation involves partitioning a sample of data into complementary subsets, performing the analysis on one subset (called the training set), and validating the analysis on the other subset (called the validation set or testing set). To reduce variability, multiple rounds of cross-validation are performed using different partitions, and the validation results are averaged over the rounds."[2]

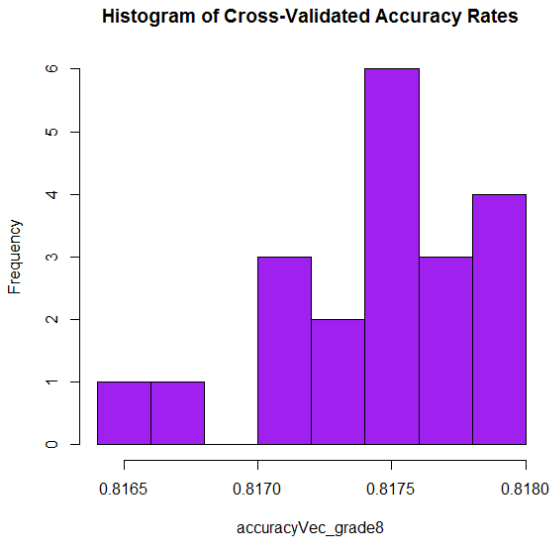
In this case, k-fold cross-validation was used. K-fold cross validation is conducted by dividing the original data set into a number (k) of sub-samples. One sub-sample is set aside for testing purposes, and the other (k-1) sub-samples are used to regress and create the model. The results of the model are then applied to the sub-sample that has been set aside and the predictivity of the model at different benchmark levels is assessed within that one subsample. The process is repeated until all k subsamples have been designated as the set-aside group.

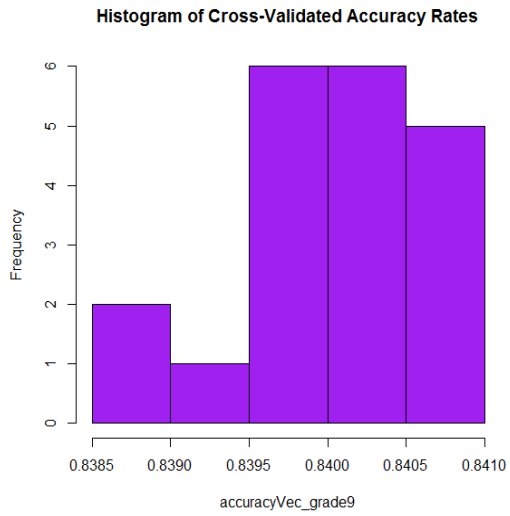
The models presented here have been cross-validated using 10 as the value for k. Furthermore, for each grade level, the entire k-fold cross-validation proces has been run 20 times. On the following page, one can find the distribution of 20 k-fold cross-validated accuracy rates for each grade level:

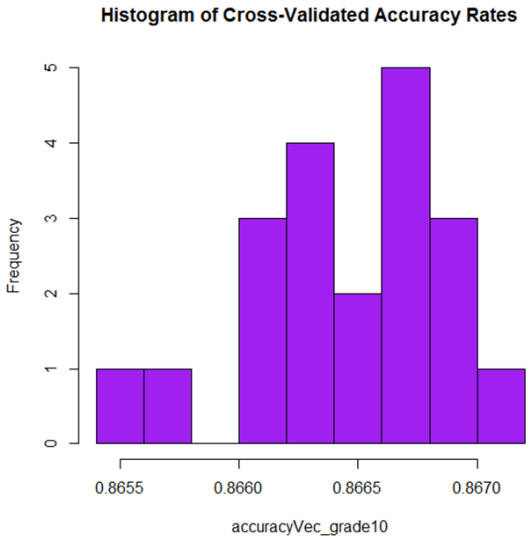
[2] "Cross-Validation (statistics)." www.wikipedia.org/cross-validation_(statistics). Last modified on 9/6/12. Accessed on 9/18/12.

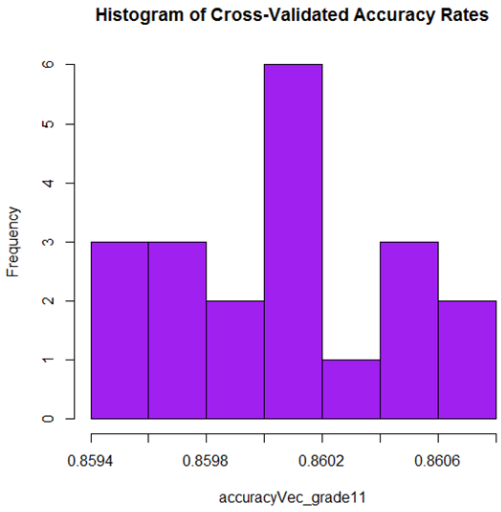

Histogram of Cross-Validated Accuracy Rates
Frequency
0
1
2
3
4
5
0.8120
0.8124
0.8128
0.8132
accuracyVec_grade6

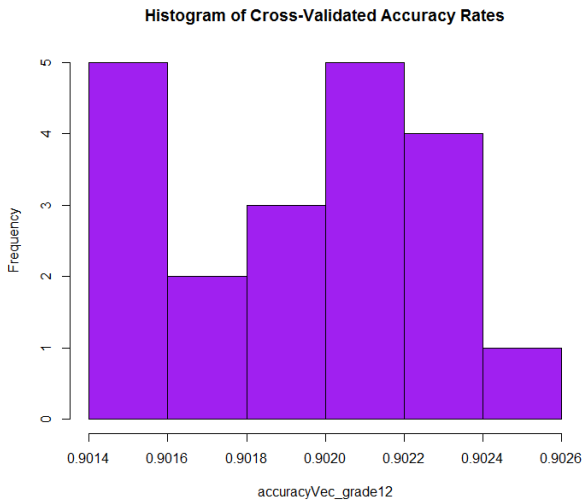

Histogram of Cross-Validated Accuracy Rates
Frequency
0
1
2
3
4
5
0.8068
0.8070
0.8072
0.8074
0.8076
0.8078
0.8080
accuracyVec_grade7


Histogram of Cross-Validated Accuracy Rates
Frequency
0
1
2
3
4
5
6
0.8165
0.8170
0.8175
0.8180
accuracyVec_grade8


Histogram of Cross-Validated Accuracy Rates
Frequency
0
1
2
3
4
5
6
0.8385
0.8390
0.8395
0.8400
0.8405
0.8410
accuracyVec_grade9

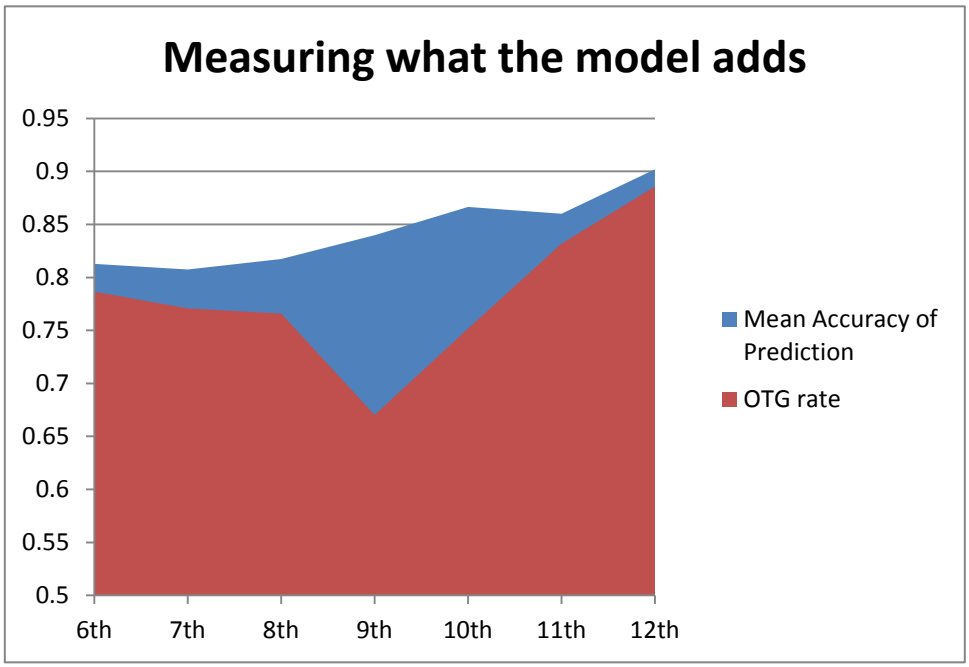

Histogram of Cross-Validated Accuracy Rates
Frequency
0
1
2
3
4
5
0.8655
0.8660
0.8665
0.8670
accuracyVec_grade10


Histogram of Cross-Validated Accuracy Rates
Frequency
0
1
2
3
4
5
6
0.8594
0.8598
0.8602
0.8606
accuracyVec_grade11

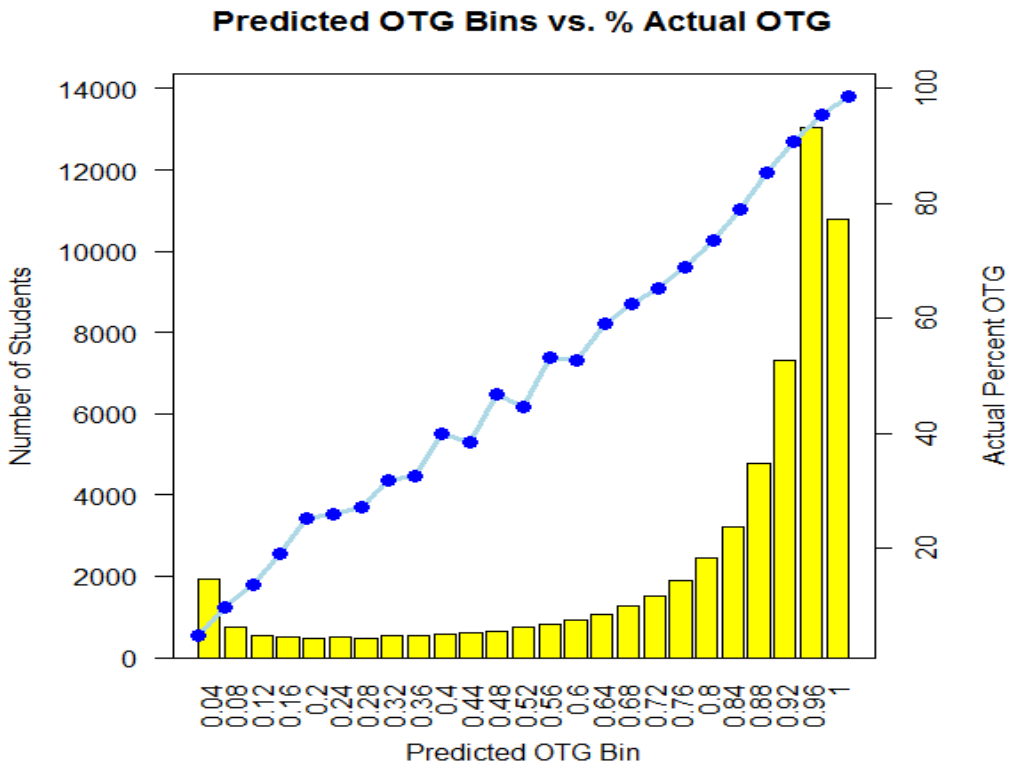


Note that the accuracy rate of the model rises with grade level. This is likely because higher percentages of students graduate at grade level increases. But it also likely has to do with the fact that in later grades, being proximally closer to graduation, there is a more direct and identifiable link between each of the variables and graduation.

Overall, the mean prediction accuracy at each grade level can be found below. When compared with the graduation rate (which is also equivalent to the overall accuracy rate without a model, where all students are judged to be on track), it is possible to see what level of predictivity is added by the model at each grade level. Note that the highest levels of predictivity are added to the model in 9th and 10th grade, and while the levels of predictivity for the model are highest in 11th and 12th grade, the additional predicitivity added is relatively low. The difference in predictive accuracy between the model and the assumption of otg for all students is subject to conflicting forces. The ability to identify likely notgs will make the predictive power of the model greater. However, the over-identification of notgs, and thus the intervention with students who would have otherwise graduated lessens the model's predictive accuracy. Therefore, what may be occurring in the 12th grade model is the over-identification of notgs, meaning that the model's predictive power is being damaged by its willingness to identify students as at-risk.



Finally, another method of observing the predictivity of the model is to examine actual otg levels agains cross-validated predicted otg levels. The graph on the next page does just this.



Note that the bins at 40% for predicted otg have very near 40% graduation rates, and so on. This cross-validation result signals that the model equations are indeed valid even data not used to create the models.

As you may have observed, the results of this cross validation process have been used multiple times throughout the body of this paper and they make up the majority of the work done in assessing the fit of the model.[3]

[3] R code for cross validation methods used is available upon request.

Next Steps

There are multiple next steps that must be taken in the creation of RIDE's EWS Benchmarks:

1. ***Approval of the individual indicators and benchmarks, as well as the aggregate indicator, by RIDE decision-makers.***
2. Cross-validation of model on the 2012 otg data set. The current 2012 otg data set (actually labeled as the 2009 cohort, for the year they first entered 9th grade) is incomplete, as the state usually takes until December of the following year to verify graduation status of its cohorts. However, approximately 60-70% of students in the data set have been assigned a graduation status, and are therefore useful as a quick check of the model. This cross-validation will begin in the coming weeks. When all graduation statuses are verified in December, a repeated cross-validation will provide RIDE with the best idea of the future predictivity of the aggregate risk indicator model.
3. Work with those constructing the EXCEED RTI data mart to input calculations for calculated fields such as yearsoverage, attend_percent, and the aggregate risk indicator. If there is a problem implementing one of these calculations, or the calculation is deemed to be unnecessary, it will be necessary to find workarounds for the installation of the system.
4. Entry of these indicators and benchmarks into the EWS screener within EXCEED. A sample screener environment has been provided and will be investigated throughout the coming week.
5. Development of communication plan surrounding the implementation and use of the aggregate risk indicator.
6. Creation of a model using grades, credits, and number of fs, in addition to the variables used within this model. This is less urgent, as districts do not provide this performance data to the state at this time. Eventually, however, it will be ideal to move to a performance-based model, as it will be both more predictive and more actionable than a model in which demographic criteria play a large role. The development of this model is currently underway, but would benefit greatly from the addition of data from Cranston school district, which has previously promised such a delivery.

Appendix 1: Decision-making on the Individual Indicators

8th Grade Attend_percent										
Benchmark	True Negative	False Negative	True Positive	False Positive	Marginal Dropout Caught Per Graduate MisIdentified	TNR	TPR	(Negative) Sensitivity	(Positive) Specificity	Prediction Accuracy
0.99	7393	21915	3363	334	0.101390645	0.252252	0.909656	0.95677494	0.13304059	0.325890017
0.98	6992	17960	7318	735	0.130624489	0.280218	0.90873	0.904879	0.28950075	0.433570671
0.97	6513	14293	10985	1214	0.156931964	0.313035	0.900484	0.84288857	0.43456761	0.530162097
0.96	6024	11177	14101	1703	0.198176292	0.350212	0.892242	0.77960399	0.55783685	0.609756098
0.95	5698	9532	15746	2029	0.236933798	0.37413	0.885851	0.73741426	0.62291321	0.649719739
0.94	5222	7523	17755	2505	0.2809871	0.409729	0.876357	0.67581209	0.70238943	0.696167247
0.93	4721	5740	19538	3006	0.326651819	0.451295	0.866661	0.6109745	0.77292507	0.735009847
0.92	4281	4393	20885	3446	0.422562141	0.493544	0.85837	0.55403132	0.82621252	0.762490532
0.91	3839	3347	21931	3888	0.496932515	0.534233	0.849413	0.4968293	0.86759237	0.780790789
0.9	3596	2858	22420	4131	0.63697479	0.557174	0.844413	0.46538113	0.88693726	0.788244205
0.89	3217	2263	23015	4510	0.706	0.587044	0.836149	0.41633234	0.91047551	0.794788668
0.88	2864	1763	23515	4863	0.910081744	0.618976	0.828635	0.37064838	0.93025556	0.799242539
0.87	2530	1396	23882	5197	1.077490775	0.644422	0.82128	0.32742332	0.94477411	0.800242388
0.86	2238	1125	24153	5489	1.184931507	0.665477	0.814824	0.28963375	0.9554949	0.79960612
0.85	2065	979	24299	5662	1.206896552	0.678384	0.811021	0.26724473	0.96127067	0.798788062
0.84	1855	805	24473	5872	1.534722222	0.697368	0.806492	0.2400673	0.96815413	0.797697319
0.83	1634	661	24617	6093	1.25203252	0.711983	0.801596	0.21146629	0.97385078	0.795364339
0.82	1480	538	24740	6247	1.860215054	0.733399	0.798399	0.19153617	0.97871667	0.794425087
0.81	1307	445	24833	6420	1.97826087	0.746005	0.79458	0.16914715	0.98239576	0.792001212
0.8	1216	399	24879	6511	1.75	0.752941	0.792577	0.15737026	0.98421552	0.790637782
0.79	1104	335	24943	6623	1.980769231	0.767199	0.790186	0.14287563	0.98674737	0.789183457
0.78	1001	283	24995	6726	2.136363636	0.779595	0.787964	0.12954575	0.98880449	0.787638237
0.77	907	239	25039	6820	2.558823529	0.791449	0.785932	0.11738061	0.99054514	0.786123315
0.76	820	205	25073	6907	2.722222222	0.8	0.784021	0.10612139	0.99189018	0.784517497
0.75	771	187	25091	6956	4.789473684	0.804802	0.782944	0.09977999	0.99260226	0.783578246
0.74	680	168	25110	7047	3.25	0.801887	0.780856	0.08800311	0.9933539	0.781396758
0.73	628	152	25126	7099	2.631578947	0.805128	0.779705	0.08127346	0.99398687	0.780306014
0.72	578	133	25145	7149	3.285714286	0.81294	0.778628	0.07480264	0.99473851	0.779366763
0.71	532	119	25159	7195	2.5	0.817204	0.777616	0.06884949	0.99529235	0.778397213
0.7	502	107	25171	7225	4.555555556	0.824302	0.776979	0.064967	0.99576707	0.777851841
0.69	461	98	25180	7266	7.8	0.824687	0.776059	0.05966093	0.99612311	0.776882291
0.68	422	93	25185	7305	4.111111111	0.819417	0.775162	0.05461369	0.99632091	0.775852144
0.67	385	84	25194	7342	3.444444444	0.820896	0.774342	0.04982529	0.99667695	0.775003787
0.66	354	75	25203	7373	3.166666667	0.825175	0.773668	0.04581338	0.99703299	0.774337222
0.65	335	69	25209	7392	5.6	0.829208	0.773258	0.04335447	0.99727035	0.773943342
0.64	307	64	25214	7420	1.666666667	0.827493	0.77263	0.03973081	0.99746815	0.773246478
0.63	292	55	25223	7435	10	0.841499	0.772338	0.03778957	0.99782419	0.773064687
0.62	262	52	25226	7465	8	0.834395	0.77165	0.03390708	0.99794288	0.772246629
0.61	246	50	25228	7481	4.666666667	0.831081	0.771286	0.03183642	0.998022	0.771822451
0.6	232	47	25231	7495	3	0.831541	0.770977	0.03002459	0.99814068	0.771489168
0.59	220	43	25235	7507	3.25	0.836502	0.770723	0.02847159	0.99829892	0.771246781
0.58	207	39	25239	7520	3	0.841463	0.770445	0.02678918	0.99845716	0.770974095
0.57	198	36	25242	7529	#DIV/0!	0.846154	0.770254	0.02562443	0.99857584	0.770792304
0.56	183	36	25242	7544	9	0.835616	0.769902	0.02368319	0.99857584	0.770337828
0.55	174	35	25243	7553	10	0.832536	0.769698	0.02251844	0.9986154	0.77009544
0.54	164	34	25244	7563	14	0.828283	0.76947	0.02122428	0.99865496	0.769822754
0.53	150	33	25245	7577	#DIV/0!	0.819672	0.769149	0.01941245	0.99869452	0.769428874
0.52	139	33	25245	7588	5.5	0.80814	0.768891	0.01798887	0.99869452	0.769095592
0.51	128	31	25247	7599	2.666666667	0.805031	0.768648	0.01656529	0.99877364	0.768822906
0.5	120	28	25250	7607	6	0.810811	0.768482	0.01552996	0.99889232	0.768671413
0.49	114	27	25251	7613	#DIV/0!	0.808511	0.768348	0.01475346	0.99893188	0.768519921

9th Graders Attend_Percent										
Benchmark	True Negative	False Negative	True Positive	False Positive	Marginal Dropout Caught Per Graduate MisIdentified	TNR	TPR	(Negative) Sensitivity	(Positive) Specificity	Prediction Accuracy
0.99	17424	31760	5203	764	0.095971352	0.354262	0.871962	0.9579943	0.1407624	0.41027361
0.98	16888	26175	10788	1300	0.127684498	0.39217	0.892455	0.9285243	0.2918594	0.50182227
0.97	16234	21053	15910	1954	0.156491228	0.43538	0.890618	0.8925665	0.4304304	0.58283621
0.96	15565	16778	20185	2623	0.198653199	0.481248	0.884996	0.855784	0.5460866	0.64822034
0.95	15152	14699	22264	3036	0.218414676	0.507588	0.88	0.8330768	0.6023321	0.67842831
0.94	14521	11810	25153	3667	0.290149007	0.551479	0.872762	0.7983835	0.6804913	0.71937046
0.93	13820	9394	27569	4368	0.35503876	0.59533	0.863231	0.7598417	0.745854	0.7504669
0.92	13133	7459	29504	5055	0.4889043	0.637772	0.853728	0.7220695	0.7982036	0.77309568
0.91	12428	6017	30946	5760	0.613803231	0.673787	0.843077	0.6833077	0.8372156	0.78645899
0.9	12010	5336	31627	6178	0.602030457	0.692379	0.836582	0.6603255	0.8556394	0.79122772
0.89	11417	4351	32612	6771	0.703800786	0.724061	0.828073	0.6277216	0.8822877	0.79833548
0.88	10880	3588	33375	7308	0.8704	0.752004	0.820367	0.5981966	0.90293	0.80243332
0.87	10336	2963	34000	7852	1.053191489	0.777201	0.812387	0.5682868	0.9198388	0.80390201
0.86	9841	2493	34470	8347	1.265917603	0.797876	0.805054	0.541071	0.9325542	0.80344871
0.85	9503	2226	34737	8685	1.44011976	0.810214	0.799986	0.5224874	0.9397776	0.80216134
0.84	9022	1892	35071	9166	1.567164179	0.826645	0.792798	0.4960413	0.9488137	0.79949593
0.83	8602	1624	35339	9586	1.74796748	0.841189	0.786622	0.4729492	0.9560642	0.79673986
0.82	8172	1378	35585	10016	2.11827957	0.855707	0.780356	0.4493072	0.9627195	0.79340356
0.81	7778	1192	35771	10410	2.103092784	0.867113	0.774583	0.4276446	0.9677515	0.7896321
0.8	7574	1095	35868	10614	2.807407407	0.873688	0.771654	0.4164284	0.9703758	0.78769197
0.79	7195	960	36003	10993	2.592	0.882281	0.766086	0.3955905	0.9740281	0.78326776
0.78	6871	835	36128	11317	3.212121212	0.891643	0.761471	0.3777766	0.9774098	0.77965948
0.77	6553	736	36227	11635	2.785714286	0.899026	0.756905	0.3602925	0.9800882	0.77568856
0.76	6280	638	36325	11908	4.085106383	0.907777	0.753115	0.3452826	0.9827395	0.77251546
0.75	6088	591	36372	12100	3.794520548	0.911514	0.750371	0.3347262	0.984011	0.76988631
0.74	5811	518	36445	12377	5.452380952	0.918155	0.746487	0.3194964	0.985986	0.76618738
0.73	5582	476	36487	12606	5.595238095	0.921426	0.743222	0.3069057	0.9871223	0.76279669
0.72	5347	434	36529	12841	4.658536585	0.924926	0.739903	0.293985	0.9882585	0.7592972
0.71	5156	393	36570	13032	5.166666667	0.929176	0.737269	0.2834836	0.9893677	0.7565774
0.7	5001	363	36600	13187	5.146341463	0.932327	0.735132	0.2749615	0.9901794	0.75431089
0.69	4790	322	36641	13398	6.206896552	0.937011	0.732249	0.2633605	0.9912886	0.75122845
0.68	4610	293	36670	13578	6.535714286	0.940241	0.72978	0.2534638	0.9920732	0.74849051
0.67	4427	265	36698	13761	7.32	0.943521	0.727284	0.2434022	0.9928307	0.74568004
0.66	4244	240	36723	13944	7.352941176	0.946476	0.724791	0.2333407	0.993507	0.74281518
0.65	4119	223	36740	14069	10.0625	0.948641	0.7231	0.226468	0.9939669	0.74085692
0.64	3958	207	36756	14230	21	0.9503	0.720904	0.217616	0.9943998	0.73822777
0.63	3790	199	36764	14398	8.5	0.950113	0.71858	0.2083792	0.9946162	0.73532665
0.62	3654	183	36780	14534	8.5	0.952306	0.716763	0.2009017	0.9950491	0.7331508
0.61	3535	169	36794	14653	18.8	0.954374	0.715183	0.1943589	0.9954279	0.73124694
0.6	3441	164	36799	14747	16.55555556	0.954508	0.713906	0.1891907	0.9955631	0.72963319
0.59	3292	155	36808	14896	17.66666667	0.955033	0.711898	0.1809985	0.9958066	0.7270947
0.58	3186	149	36814	15002	15	0.955322	0.710476	0.1751704	0.9959689	0.7252815
0.57	3051	140	36823	15137	16.5	0.956127	0.70868	0.167748	0.9962124	0.72299686
0.56	2952	134	36829	15236	15.14285714	0.956578	0.707366	0.1623048	0.9963748	0.72131058
0.55	2846	127	36836	15342	18.33333333	0.957282	0.705968	0.1564768	0.9965641	0.71951551
0.54	2736	121	36842	15452	13.85714286	0.957648	0.704517	0.1504289	0.9967265	0.71762978
0.53	2639	114	36849	15549	12.125	0.958591	0.703252	0.1450957	0.9969158	0.7159979
0.52	2542	106	36857	15646	11.75	0.95997	0.701998	0.1397625	0.9971323	0.71438415
0.51	2448	98	36865	15740	6.714285714	0.961508	0.700789	0.1345942	0.9973487	0.71282479
0.5	2401	91	36872	15787	19.14285714	0.963483	0.700203	0.1320101	0.9975381	0.71209951
0.49	2267	84	36879	15921	22	0.964271	0.698466	0.1246426	0.9977275	0.70979674

10th Grade Attend_percent									
Benchmark	True Negative	False Negative	True Positive	False Positive	TNR	TPR	(Negative) Sensitivity	(Positive) Specificity	Prediction Accuracy
0.99	14689	41330	5292	712	0.262215	0.881412	0.9537692	0.1135086	0.3221547
0.98	14264	35104	11518	1137	0.288932	0.910154	0.9261736	0.2470507	0.4156845
0.97	13791	29021	17601	1610	0.322129	0.916194	0.8954613	0.3775256	0.5061348
0.96	13304	23613	23009	2097	0.360376	0.916474	0.86384	0.4935224	0.5854764
0.95	12965	20941	25681	2436	0.382381	0.913362	0.8418285	0.5508344	0.6230914
0.94	12447	17300	29322	2954	0.418429	0.908477	0.8081943	0.6289305	0.6734437
0.93	11890	14107	32515	3511	0.45736	0.902543	0.7720278	0.6974175	0.7159441
0.92	11323	11464	35158	4078	0.496906	0.896065	0.735212	0.7541075	0.7494155
0.91	10809	9420	37202	4592	0.534332	0.890128	0.7018375	0.7979495	0.7740838
0.9	10445	8452	38170	4956	0.552733	0.885081	0.6782027	0.8187122	0.7838221
0.89	9946	7014	39608	5455	0.586439	0.878947	0.6458022	0.849556	0.7989617
0.88	9451	5906	40716	5950	0.61542	0.872498	0.6136615	0.8733216	0.8088451
0.87	9000	4960	41662	6401	0.644699	0.866821	0.5843776	0.8936125	0.816826
0.86	8586	4187	42435	6815	0.672199	0.861624	0.5574963	0.9101926	0.8226142
0.85	8292	3813	42809	7109	0.685006	0.857586	0.5384066	0.9182146	0.823904
0.84	7891	3258	43364	7510	0.707776	0.85238	0.5123693	0.9301188	0.826387
0.83	7546	2795	43827	7855	0.729717	0.848013	0.4899682	0.9400498	0.8282895
0.82	7218	2402	44220	8183	0.750312	0.843845	0.4686709	0.9484793	0.8293375
0.81	6918	2090	44532	8483	0.767984	0.839989	0.4491916	0.9551714	0.829531
0.8	6719	1928	44694	8682	0.777032	0.837343	0.4362704	0.9586461	0.8289344
0.79	6433	1652	44970	8968	0.795671	0.833735	0.4177001	0.9645661	0.8287732
0.78	6186	1449	45173	9215	0.810216	0.830569	0.4016622	0.9689203	0.8280638
0.77	5956	1284	45338	9445	0.822652	0.827593	0.3867281	0.9724594	0.8270158
0.76	5737	1138	45484	9664	0.834473	0.824762	0.3725083	0.9755909	0.8258388
0.75	5583	1028	45594	9818	0.844502	0.822818	0.3625089	0.9779503	0.8251294
0.74	5356	906	45716	10045	0.855318	0.819856	0.3477696	0.9805671	0.8234365
0.73	5116	816	45806	10285	0.862441	0.816637	0.3321862	0.9824975	0.821018
0.72	4921	730	45892	10480	0.870819	0.814092	0.3195247	0.9843422	0.8192606
0.71	4702	645	45977	10699	0.879372	0.811225	0.3053049	0.9861653	0.8171001
0.7	4568	597	46025	10833	0.884414	0.809473	0.2966041	0.9871949	0.8157135
0.69	4383	525	46097	11018	0.893032	0.807091	0.2845919	0.9887392	0.8138916
0.68	4205	475	46147	11196	0.898504	0.804754	0.2730342	0.9898117	0.8118279
0.67	4027	426	46196	11374	0.904334	0.802432	0.2614765	0.9908627	0.809748
0.66	3890	384	46238	11511	0.910154	0.800672	0.252581	0.9917635	0.8082163
0.65	3793	363	46259	11608	0.912656	0.799402	0.2462827	0.992214	0.806991
0.64	3659	334	46288	11742	0.916354	0.797656	0.237582	0.992836	0.805298
0.63	3518	307	46315	11883	0.919739	0.795818	0.2284267	0.9934151	0.80346
0.62	3376	270	46352	12025	0.925946	0.794011	0.2192065	0.9942087	0.8017671
0.61	3243	243	46379	12158	0.930293	0.792302	0.2105707	0.9947879	0.800058
0.6	3160	230	46392	12241	0.932153	0.791227	0.2051815	0.9950667	0.7989294
0.59	3016	212	46410	12385	0.934325	0.789353	0.1958314	0.9954528	0.7968979
0.58	2897	197	46425	12504	0.936328	0.787812	0.1881047	0.9957745	0.7952211
0.57	2778	187	46435	12623	0.936931	0.786261	0.1803779	0.995989	0.7934637
0.56	2679	165	46457	12722	0.941983	0.785025	0.1739497	0.9964609	0.7922222
0.55	2589	155	46467	12812	0.943513	0.783869	0.168106	0.9966754	0.7909324
0.54	2472	148	46474	12929	0.943511	0.782351	0.1605091	0.9968255	0.7891589
0.53	2386	135	46487	13015	0.94645	0.781268	0.154925	0.9971044	0.7879819
0.52	2304	127	46495	13097	0.947758	0.780222	0.1496007	0.997276	0.7867888
0.51	2220	115	46507	13181	0.950749	0.779168	0.1441465	0.9975334	0.7856279
0.5	2177	109	46513	13224	0.952318	0.77863	0.1413545	0.997662	0.7850314
0.49	2050	101	46521	13351	0.953045	0.777008	0.1331082	0.9978336	0.7831127

11th Grade Attend_percent									
Benchmark	True Negative	False Negative	True Positive	False Positive	TNR	TPR	(Negative) Sensitivity	(Positive) Specificity	Prediction Accuracy
0.99	8839	41691	4239	454	0.174926	0.90326	0.951146	0.0922926	0.2368216
0.98	8607	36231	9699	686	0.191958	0.933943	0.926181	0.2111692	0.3314923
0.97	8332	30736	15194	961	0.213269	0.940514	0.8965888	0.3308078	0.4260181
0.96	8060	25692	20238	1233	0.238801	0.942574	0.8673195	0.440627	0.5124314
0.95	7875	23149	22781	1418	0.253836	0.941403	0.847412	0.4959939	0.555131
0.94	7602	19391	26539	1691	0.281629	0.940099	0.8180351	0.5778141	0.6182388
0.93	7288	16124	29806	2005	0.311293	0.936971	0.7842462	0.648944	0.6717129
0.92	7000	13386	32544	2293	0.343373	0.934179	0.7532551	0.7085565	0.7160784
0.91	6708	11116	34814	2585	0.376346	0.930881	0.7218336	0.7579795	0.7518969
0.9	6522	10042	35888	2771	0.393745	0.928322	0.7018186	0.7813629	0.7679771
0.89	6262	8471	37459	3031	0.425032	0.925142	0.6738405	0.8155672	0.7917172
0.88	5993	7217	38713	3300	0.453671	0.921453	0.644894	0.8428696	0.809554
0.87	5703	6113	39817	3590	0.482651	0.917294	0.6136877	0.8669062	0.8242942
0.86	5423	5226	40704	3870	0.50925	0.913178	0.5835575	0.8862182	0.835286
0.85	5242	4724	41206	4051	0.525988	0.910489	0.5640805	0.8971478	0.8410988
0.84	5009	3989	41941	4284	0.556679	0.907323	0.5390079	0.9131504	0.8501892
0.83	4784	3410	42520	4509	0.583842	0.904123	0.5147961	0.9257566	0.8565996
0.82	4595	2968	42962	4698	0.607563	0.901427	0.4944582	0.9353799	0.861181
0.81	4403	2583	43347	4890	0.630261	0.898626	0.4737975	0.9437622	0.864676
0.8	4279	2348	43582	5014	0.645692	0.896823	0.4604541	0.9488787	0.866686
0.79	4094	2006	43924	5199	0.671148	0.894164	0.4405466	0.9563248	0.869529
0.78	3915	1770	44160	5378	0.688654	0.891437	0.4212848	0.9614631	0.8705612
0.77	3766	1570	44360	5527	0.705772	0.88921	0.4052513	0.9658175	0.8714847
0.76	3617	1384	44546	5676	0.723255	0.886982	0.3892177	0.9698672	0.8721547
0.75	3508	1265	44665	5785	0.734968	0.885332	0.3774884	0.9724581	0.8723358
0.74	3359	1112	44818	5934	0.751286	0.883078	0.3614549	0.9757892	0.8724082
0.73	3223	993	44937	6070	0.764469	0.880997	0.3468202	0.9783801	0.8721004
0.72	3096	897	45033	6197	0.775357	0.879036	0.333154	0.9804703	0.871539
0.71	2986	804	45126	6307	0.787863	0.877374	0.3213171	0.9824951	0.8712312
0.7	2883	757	45173	6410	0.792033	0.875734	0.3102335	0.9835184	0.8702171
0.69	2774	663	45267	6519	0.807099	0.874117	0.2985043	0.985565	0.8699455
0.68	2673	601	45329	6620	0.816432	0.872567	0.2876359	0.9869149	0.8692393
0.67	2572	538	45392	6721	0.82701	0.87103	0.2767675	0.9882865	0.8685511
0.66	2458	489	45441	6835	0.834069	0.869252	0.2645002	0.9893534	0.8673741
0.65	2379	462	45468	6914	0.837381	0.868008	0.2559991	0.9899412	0.8664325
0.64	2281	424	45506	7012	0.843253	0.866484	0.2454536	0.9907686	0.865346
0.63	2185	382	45548	7108	0.851188	0.865011	0.2351232	0.991683	0.8643681
0.62	2100	346	45584	7193	0.858545	0.86371	0.2259765	0.9924668	0.8634808
0.61	2005	314	45616	7288	0.864597	0.862241	0.2157538	0.9931635	0.86234
0.6	1936	296	45634	7357	0.867384	0.861165	0.2083288	0.9935554	0.8614164
0.59	1854	275	45655	7439	0.870831	0.85989	0.199505	0.9940126	0.8603118
0.58	1774	255	45675	7519	0.874322	0.858649	0.1908964	0.9944481	0.8592253
0.57	1706	237	45693	7587	0.878024	0.857601	0.183579	0.99484	0.8583199
0.56	1642	221	45709	7651	0.881374	0.856615	0.1766921	0.9951883	0.8574507
0.55	1588	212	45718	7705	0.882222	0.855774	0.1708813	0.9953843	0.8566358
0.54	1520	188	45742	7773	0.88993	0.854751	0.163564	0.9959068	0.8558391
0.53	1464	175	45755	7829	0.893228	0.853893	0.1575379	0.9961899	0.8550604
0.52	1400	162	45768	7893	0.896287	0.85291	0.150651	0.9964729	0.8541369
0.51	1348	154	45776	7945	0.89747	0.852106	0.1450554	0.9966471	0.8533401
0.5	1312	151	45779	7981	0.896787	0.851544	0.1411815	0.9967124	0.8527425
0.49	1218	139	45791	8075	0.897568	0.850091	0.1310664	0.9969737	0.8512576

12th Graders									
Benchmark	True Negative	False Negative	True Positive	False Positive	TNR	TPR	(Negative) Sensitivity	(Positive) Specificity	Prediction Accuracy
0.99	5428	44303	3389	726	0.109147	0.823572	0.882027949	0.0710601	0.16374475
0.98	5219	40502	7190	935	0.114149	0.884923	0.848066298	0.150759	0.23045352
0.97	5014	35998	11694	1140	0.122257	0.911173	0.814754631	0.2451984	0.31029232
0.96	4830	31549	16143	1324	0.132769	0.9242	0.784855379	0.3384844	0.38949968
0.95	4704	28994	18698	1450	0.139593	0.928033	0.76438089	0.3920574	0.43460981
0.94	4532	25105	22587	1622	0.152917	0.933	0.736431589	0.4736014	0.50364001
0.93	4347	21736	25956	1807	0.16666	0.934913	0.706369841	0.5442422	0.56277161
0.92	4173	18637	29055	1981	0.182946	0.936171	0.678095548	0.6092217	0.61709319
0.91	4023	16009	31683	2131	0.200829	0.936979	0.653721157	0.6643253	0.66311332
0.9	3902	14652	33040	2252	0.210305	0.93619	0.634059149	0.6927787	0.68606767
0.89	3767	12625	35067	2387	0.229807	0.936268	0.612122197	0.7352806	0.72120492
0.88	3612	10955	36737	2542	0.247958	0.935283	0.586935327	0.7702969	0.74934071
0.87	3464	9485	38207	2690	0.267511	0.934225	0.562885928	0.8011197	0.77389221
0.86	3325	8294	39398	2829	0.286169	0.933005	0.540298993	0.8260924	0.79342941
0.85	3225	7656	40036	2929	0.296388	0.931828	0.524049399	0.8394699	0.80342087
0.84	3107	6663	41029	3047	0.318014	0.930869	0.504874878	0.860291	0.81967091
0.83	2984	5801	41891	3170	0.33967	0.929651	0.484887878	0.8783653	0.83339524
0.82	2867	5104	42588	3287	0.359679	0.928349	0.465875853	0.89298	0.8441667
0.81	2778	4473	43219	3376	0.38312	0.927546	0.451413715	0.9062107	0.85423244
0.8	2705	4113	43579	3449	0.396744	0.926661	0.439551511	0.9137591	0.85956246
0.79	2605	3619	44073	3549	0.418541	0.925476	0.423301917	0.9241173	0.86687962
0.78	2518	3204	44488	3636	0.440056	0.924445	0.409164771	0.9328189	0.87297107
0.77	2416	2853	44839	3738	0.458531	0.92305	0.392590185	0.9401786	0.87759536
0.76	2335	2516	45176	3819	0.481344	0.922053	0.379428014	0.9472448	0.88234966
0.75	2268	2335	45357	3886	0.492722	0.921085	0.368540786	0.95104	0.88446681
0.74	2173	2065	45627	3981	0.512742	0.919751	0.353103672	0.9567013	0.88771682
0.73	2083	1834	45858	4071	0.531785	0.918464	0.338479038	0.9615449	0.8903354
0.72	2001	1652	46040	4153	0.547769	0.917259	0.325154371	0.9653611	0.89219255
0.71	1930	1471	46221	4224	0.56748	0.916265	0.31361716	0.9691563	0.89423541
0.7	1871	1370	46322	4283	0.577291	0.915364	0.304029899	0.971274	0.89501541
0.69	1801	1226	46466	4353	0.594979	0.914343	0.292655184	0.9742934	0.8963897
0.68	1727	1095	46597	4427	0.611977	0.913237	0.280630484	0.9770402	0.89744828
0.67	1664	990	46702	4490	0.626978	0.912291	0.27039324	0.9792418	0.89822828
0.66	1602	902	46790	4552	0.639776	0.91134	0.260318492	0.981087	0.89871114
0.65	1553	858	46834	4601	0.644131	0.910547	0.252356191	0.9820096	0.89861828
0.64	1497	756	46936	4657	0.664447	0.909736	0.243256419	0.9841483	0.89947257
0.63	1437	677	47015	4717	0.679754	0.908819	0.233506662	0.9858047	0.89982543
0.62	1376	617	47075	4778	0.690416	0.907855	0.22359441	0.9870628	0.89980686
0.61	1318	550	47142	4836	0.705567	0.906961	0.214169646	0.9884677	0.899974
0.6	1287	513	47179	4867	0.715	0.906487	0.209132272	0.9892435	0.90008543
0.59	1244	468	47224	4910	0.726636	0.90582	0.202144946	0.990187	0.90012257
0.58	1170	430	47262	4984	0.73125	0.904605	0.190120247	0.9909838	0.899454
0.57	1124	392	47300	5030	0.741425	0.903879	0.182645434	0.9917806	0.89930543
0.56	1081	349	47343	5073	0.755944	0.903217	0.175658109	0.9926822	0.89930543
0.55	1039	329	47363	5115	0.759503	0.902531	0.168833279	0.9931016	0.89889685
0.54	995	296	47396	5159	0.77072	0.901836	0.161683458	0.9937935	0.89869257
0.53	960	271	47421	5194	0.779854	0.901283	0.1559961	0.9943177	0.89850685
0.52	913	256	47436	5241	0.781009	0.900507	0.148358791	0.9946322	0.89791257
0.51	875	234	47458	5279	0.788999	0.8999	0.142183945	0.9950935	0.89761542
0.5	847	224	47468	5307	0.79085	0.899441	0.137634059	0.9953032	0.89728114
0.49	802	197	47495	5352	0.802803	0.898727	0.130321742	0.9958693	0.89694685

Spreadsheets and decision-making tools can be provided for each of the variables upon request.

Appendix 2: Aggregate Coefficient Details

6th Grade:

Var	Estimate	Std. Error	z value	Pr(>|z|)	Sig Level
(Intercept)	-3.25108	0.51732	-6.284	3.29E-10	***
sexM	-0.41513	0.05628	-7.376	1.64E-13	***
Susp	-0.09816	0.0119	-8.246	2.00E-16	***
lunchY	-0.81608	0.06696	-12.188	2.00E-16	***
iepY	-0.67301	0.06314	-10.659	2.00E-16	***
title1Y	0.12348	0.08351	1.479	0.1392	
disttypeUrban	-0.64269	0.11196	-5.74	9.45E-09	***
disttypeUrbanRing	-0.41554	0.08805	-4.719	2.37E-06	***
Schtransfers	-0.44183	0.10141	-4.357	1.32E-05	***
Yearsoverage	-0.43824	0.08206	-5.341	9.26E-08	***
attend_percent	6.39227	0.50062	12.769	2.00E-16	***
yrssqterm6	-0.14817	0.05975	-2.48	0.0131	*

otg ~ sex + susp + lunch + iep + title1 + disttype + schtransfers + yearsoverage + attend_percent + yrssqterm6 (binomial("logit"))

7th Grade:

Var	Estimate	Std. Error	z value	Pr(>|z|)	Sig Level
(Intercept)	-4.967851	0.365581	-13.589	2.00E-16	***
sexM	-0.40768	0.038064	-10.71	2.00E-16	***
adm	0.002199	0.00109	2.018	0.0436	*
susp	-0.075825	0.006492	-11.679	2.00E-16	***
lunchY	-0.659915	0.044306	-14.895	2.00E-16	***
lepY	0.152943	0.095074	1.609	0.1077	
iepY	-0.563417	0.043434	-12.972	2.00E-16	***
disttypeUrban	-0.347234	0.064396	-5.392	6.96E-08	***
disttypeUrbanRing	-0.270225	0.055688	-4.852	1.22E-06	***
schtransfers	-0.497673	0.069272	-7.184	6.75E-13	***
yearsoverage	-0.471301	0.057143	-8.248	2.00E-16	***
yrssqterm7	-0.236018	0.045009	-5.244	1.57E-07	***
attend_percent	7.559849	0.322054	23.474	2.00E-16	***

otg ~ sex + adm + susp + lunch + lep + iep + disttype + schtransfers + yearsoverage + yrssqterm7 + attend_percent (binomial("logit"))

8th Grade:

Var	Estimate	Std. error	z	P-value	Sig. Level
(Intercept)	-6.80866	0.506339	-13.447	2.00E-16	***
sexM	-0.51616	0.057808	-8.929	2.00E-16	***
Susp	-0.0806	0.009568	-8.423	2.00E-16	***
lunchY	-0.47849	0.064162	-7.458	8.81E-14	***
lepY	0.485325	0.150783	3.219	0.00129	**
disttypeUrban	-0.12248	0.095805	-1.278	0.20109	
disttypeUrbanRing	-0.2199	0.083467	-2.635	0.00842	**
Schtransfers	-0.46942	0.105065	-4.468	7.90E-06	***
Yearsoverage	-0.38174	0.086848	-4.396	1.11E-05	***
Yrssqterm	-0.18049	0.07218	-2.501	0.0124	*
attend_percent	9.824853	0.49723	19.759	2.00E-16	***
reading_score_norm	0.382403	0.045827	8.344	2.00E-16	***
math_score_norm	0.228164	0.042979	5.309	1.10E-07	***

otg ~ sex + susp + lunch + lep + disttype + schtransfers + yearsoverage + yrssqterm + attend_percent + reading_score_norm + math_score_norm (binomial("logit"))

9th Grade:

Var	**Estimate**	**Std. Error**	**z value**	**Pr(>|z|)**	**Sig Level**
(Intercept)	-8.288826	0.485796	-17.062	2.00E-16	***
sexM	-0.589577	0.057739	-10.211	2.00E-16	***
adm	0.008465	0.001586	5.337	9.43E-08	***
susp	-0.138372	0.014652	-9.444	2.00E-16	***
lunchY	-0.40775	0.063601	-6.411	1.45E-10	***
lepY	0.669453	0.161982	4.133	3.58E-05	***
title1Y	-0.599603	0.090562	-6.621	3.57E-11	***
disttypeUrban	0.003204	0.094393	0.034	0.973	
disttypeUrbanRing	-0.408501	0.08241	-4.957	7.16E-07	***
schtransfers	-0.56055	0.098857	-5.67	1.43E-08	***
yearsoverage	-0.502657	0.082331	-6.105	1.03E-09	***
yrssqterm	-0.25053	0.052163	-4.803	1.56E-06	***
attend_percent	10.072601	0.383545	26.262	2.00E-16	***
reading_score_norm	0.39742	0.044567	8.917	2.00E-16	***
math_score_norm	0.174647	0.041621	4.196	2.72E-05	***

otg ~ sex + adm + susp + lunch + lep + title1 + disttype + schtransfers + yearsoverage + yrssqterm + attend_percent + reading_score_norm + math_score_norm (binomial("logit"))

10th Grade

Var	Estimate	Std. Error	z value	Pr(>|z|)	Sig Level
(Intercept)	-8.781234	0.517254	-16.977	2.00E-16	***
sexM	-0.598354	0.067475	-8.868	2.00E-16	***
adm	0.019499	0.001944	10.033	2.00E-16	***
susp	-0.092256	0.010462	-8.818	2.00E-16	***
lunchY	-0.571829	0.074055	-7.722	1.15E-14	***
lepY	0.625594	0.246093	2.542	0.01102	*
iepY	-0.263494	0.084985	-3.1	0.00193	**
title1Y	-0.188132	0.115048	-1.635	0.102	
disttypeUrban	0.29075	0.124726	2.331	0.01975	*
disttypeUrbanRing	-0.131152	0.089049	-1.473	0.1408	
schtransfers	-0.443915	0.099731	-4.451	8.54E-06	***
yearsoverage	-0.553437	0.095765	-5.779	7.51E-09	***
yrssqterm	-0.33208	0.060047	-5.53	3.20E-08	***
attend_percent	8.679162	0.383108	22.655	2.00E-16	***
reading_score_norm	0.076649	0.049489	1.549	0.12143	
math_score_norm	0.185491	0.047954	3.868	0.00011	***

otg ~ sex + adm + susp + lunch + lep + iep + title1 + disttype + schtransfers + yearsoverage + yrssqterm + attend_percent + reading_score_norm + math_score_norm (binomial("logit"))

Grade 11

Var	Estimate	Std. Error	z value	Pr(>|z|)	Sig Level
(Intercept)	-8.025747	0.356247	-22.529	2.00E-16	***
sexM	-0.682771	0.057559	-11.862	2.00E-16	***
adm	0.01715	0.001372	12.498	2.00E-16	***
susp	-0.114618	0.013246	-8.653	2.00E-16	***
lunchY	-0.34265	0.063514	-5.395	6.86E-08	***
lepY	0.32482	0.124467	2.61	0.009063	**
iepY	-0.125676	0.068564	-1.833	0.066806	.
title1Y	-0.706668	0.082342	-8.582	2.00E-16	***
disttypeUrban	0.42358	0.091554	4.627	3.72E-06	***
disttypeUrbanRing	-0.293705	0.07891	-3.722	0.000198	***
schtransfers	-0.485616	0.103468	-4.693	2.69E-06	***
yearsoverage	-1.12521	0.043813	-25.682	2.00E-16	***
attend_percent	8.016269	0.278636	28.77	2.00E-16	***
reading_score_norm	0.10955	0.036487	3.002	0.002678	**
math_score_norm	0.349393	0.037265	9.376	2.00E-16	***

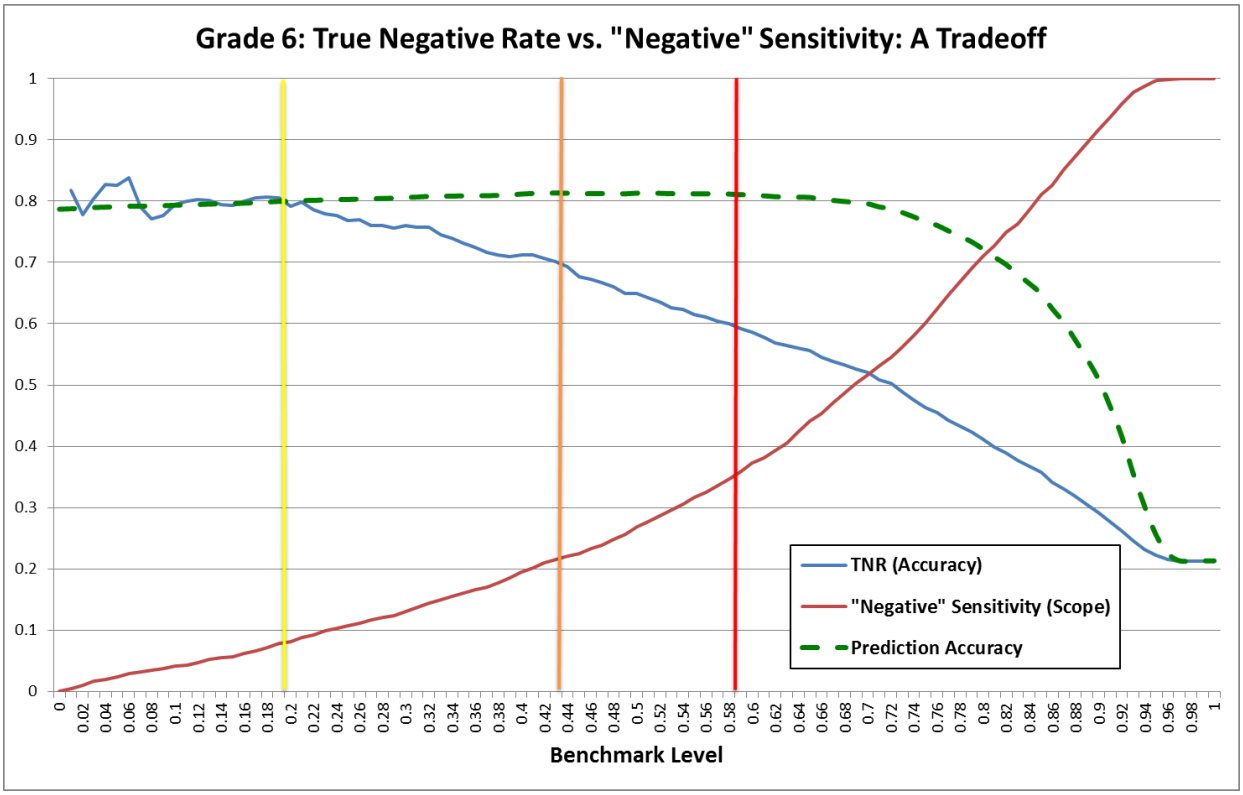
otg ~ sex + adm + susp + lunch + lep + iep + title1 + disttype + schtransfers + yearsoverage + attend_percent + reading_score_norm + math_score_norm

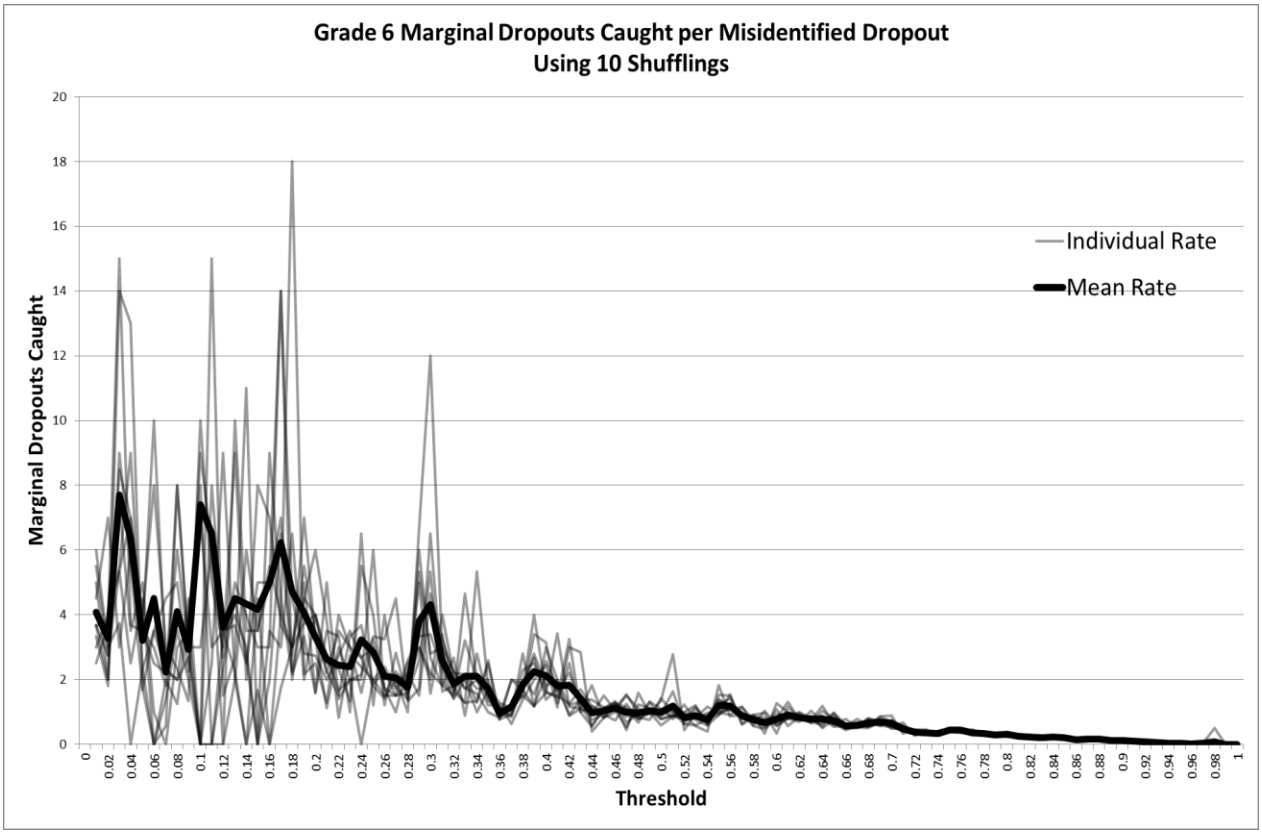
12th Grade

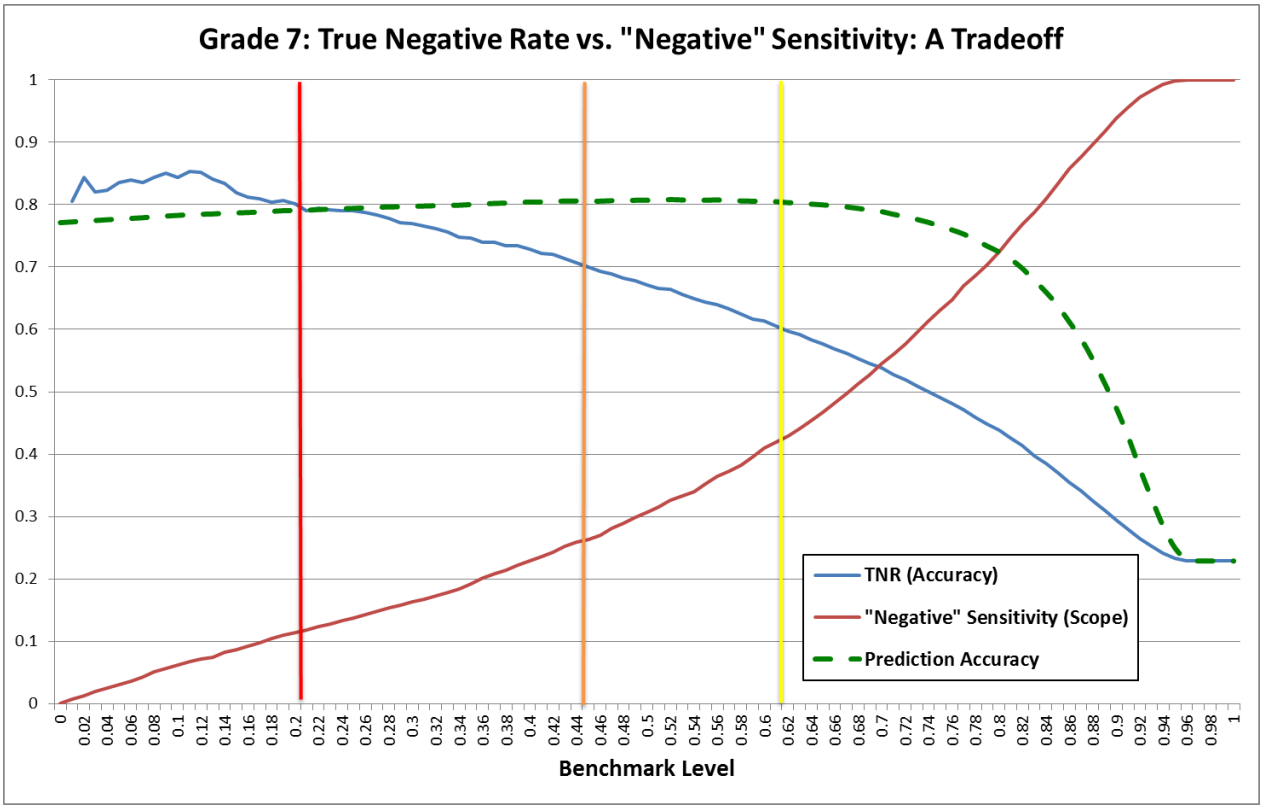
Var	Estimate	Std. Error	z value	Pr(>|z|)	Sig Level
(Intercept)	-6.624431	0.393535	-16.833	2.00E-16	***
sexM	-0.490994	0.071016	-6.914	4.72E-12	***
adm	0.027118	0.001578	17.183	2.00E-16	***
susp	-0.0621	0.009709	-6.396	1.59E-10	***
lunchY	-0.279692	0.078226	-3.575	0.00035	***
lepY	0.531904	0.174144	3.054	0.002255	**
iepY	-0.556809	0.081706	-6.815	9.44E-12	***
title1Y	-0.207502	0.118799	-1.747	0.080695	.
disttypeUrban	0.102514	0.130183	0.787	0.431014	
disttypeUrbanRing	-0.239034	0.098642	-2.423	0.015383	*
schtransfers	-0.57057	0.151838	-3.758	0.000171	***
yearsoverage	-1.385494	0.05179	-26.752	2.00E-16	***
attend_percent	5.150763	0.283614	18.161	2.00E-16	***
math_score_norm	0.226354	0.036048	6.279	3.40E-10	***

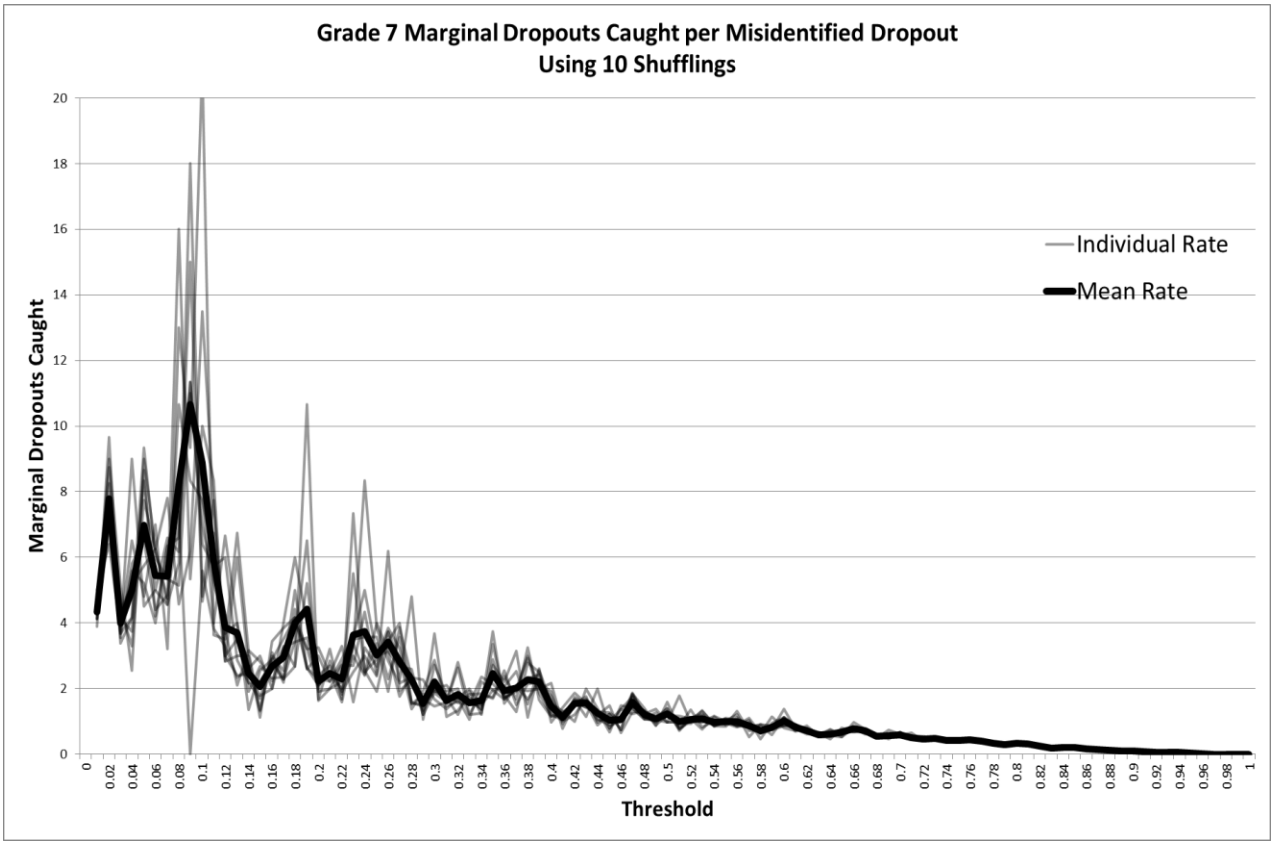
otg ~ sex + +adm+susp + lunch + lep + disttype + schtransfers + yearsoverage + attend_percent + math_score_norm (binomial("logit"))

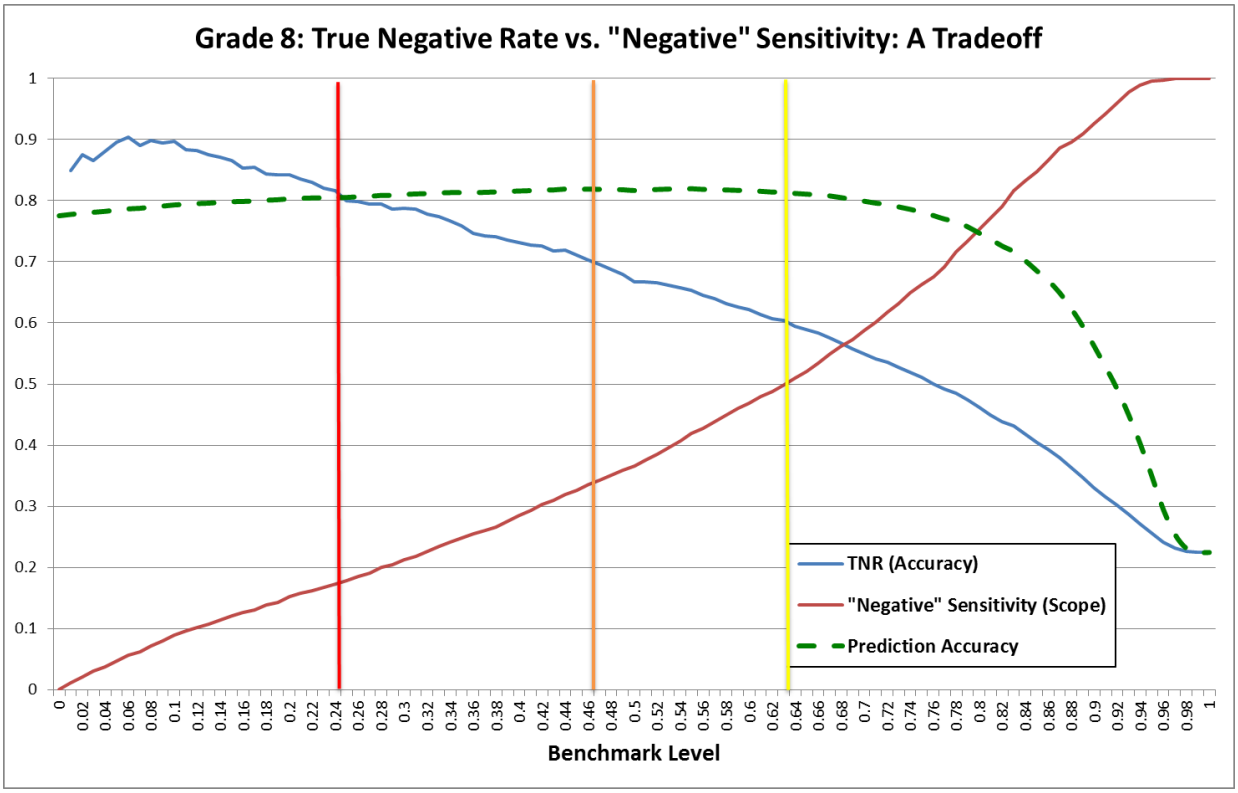
Appendix 3: Aggregate Indicator Benchmark Tools

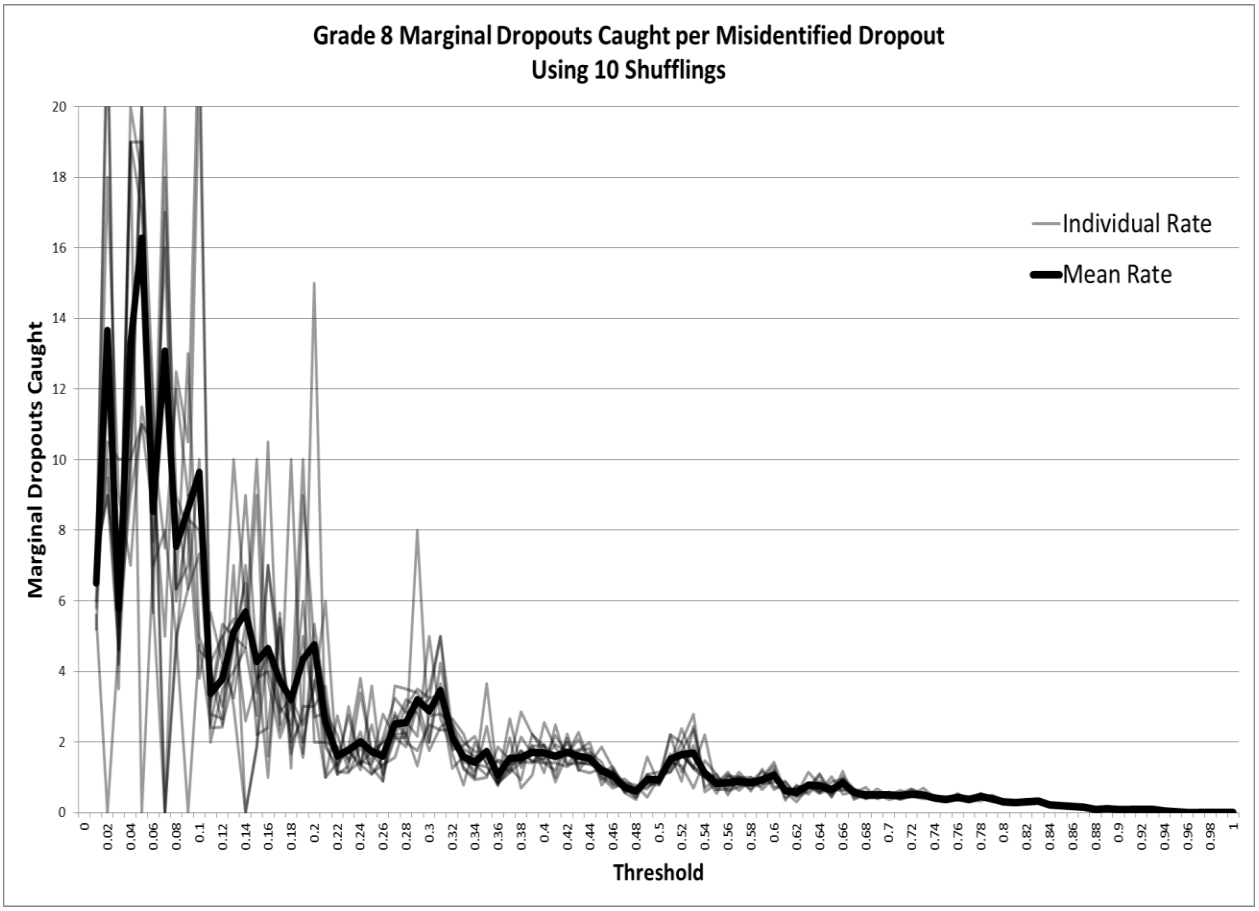


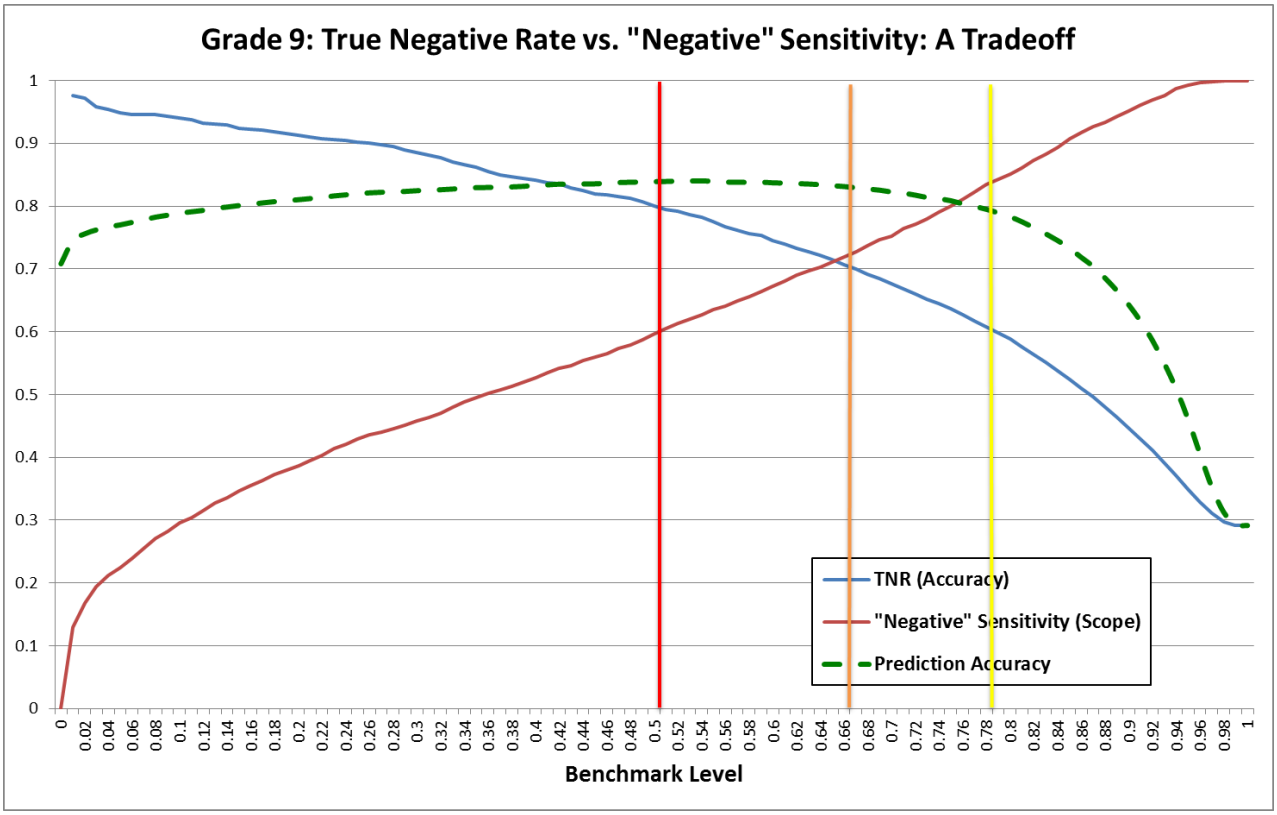


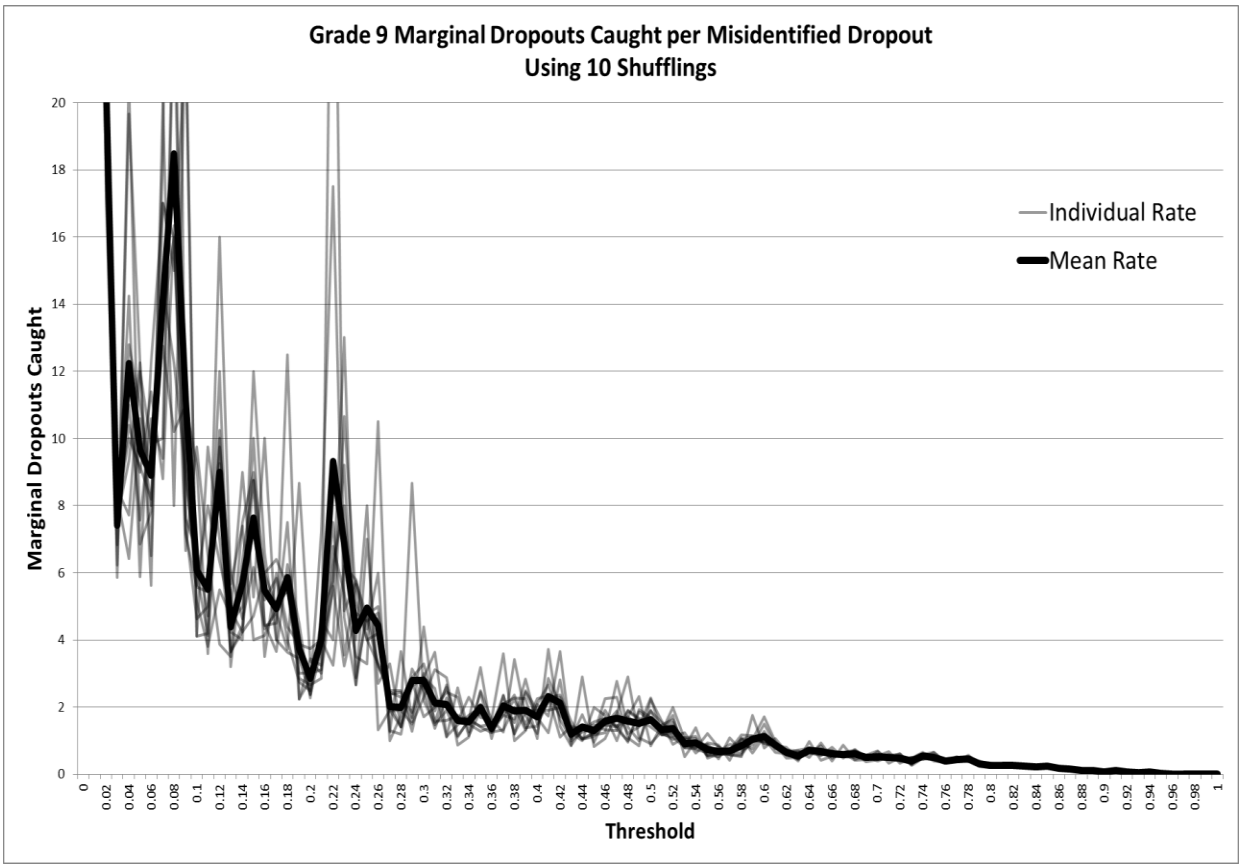

Grade 7: True Negative Rate vs. "Negative" Sensitivity: A Tradeoff
TNR (Accuracy)
"Negative" Sensitivity (Scope)
Prediction Accuracy
Benchmark Level

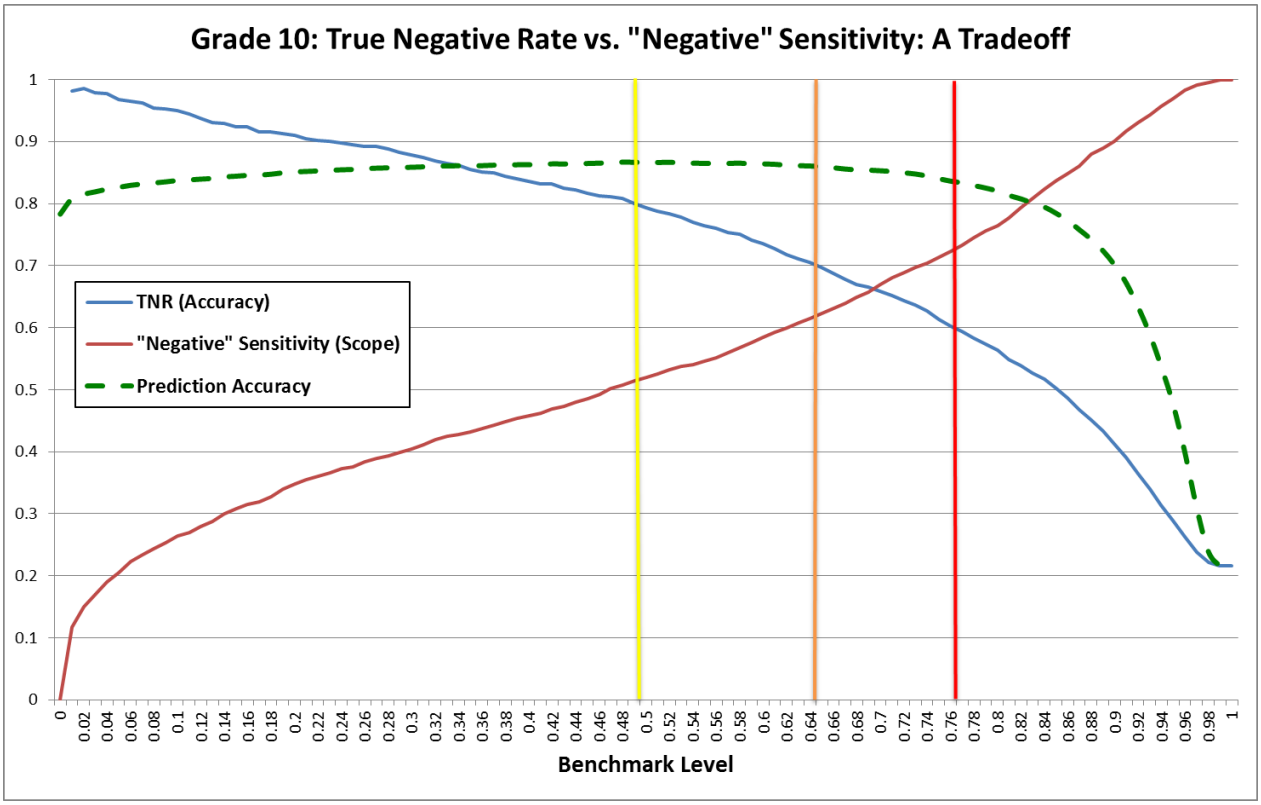

Grade 7 Marginal Dropouts Caught per Misidentified Dropout
Using 10 Shufflings
Individual Rate
Mean Rate
Marginal Dropouts Caught
Threshold

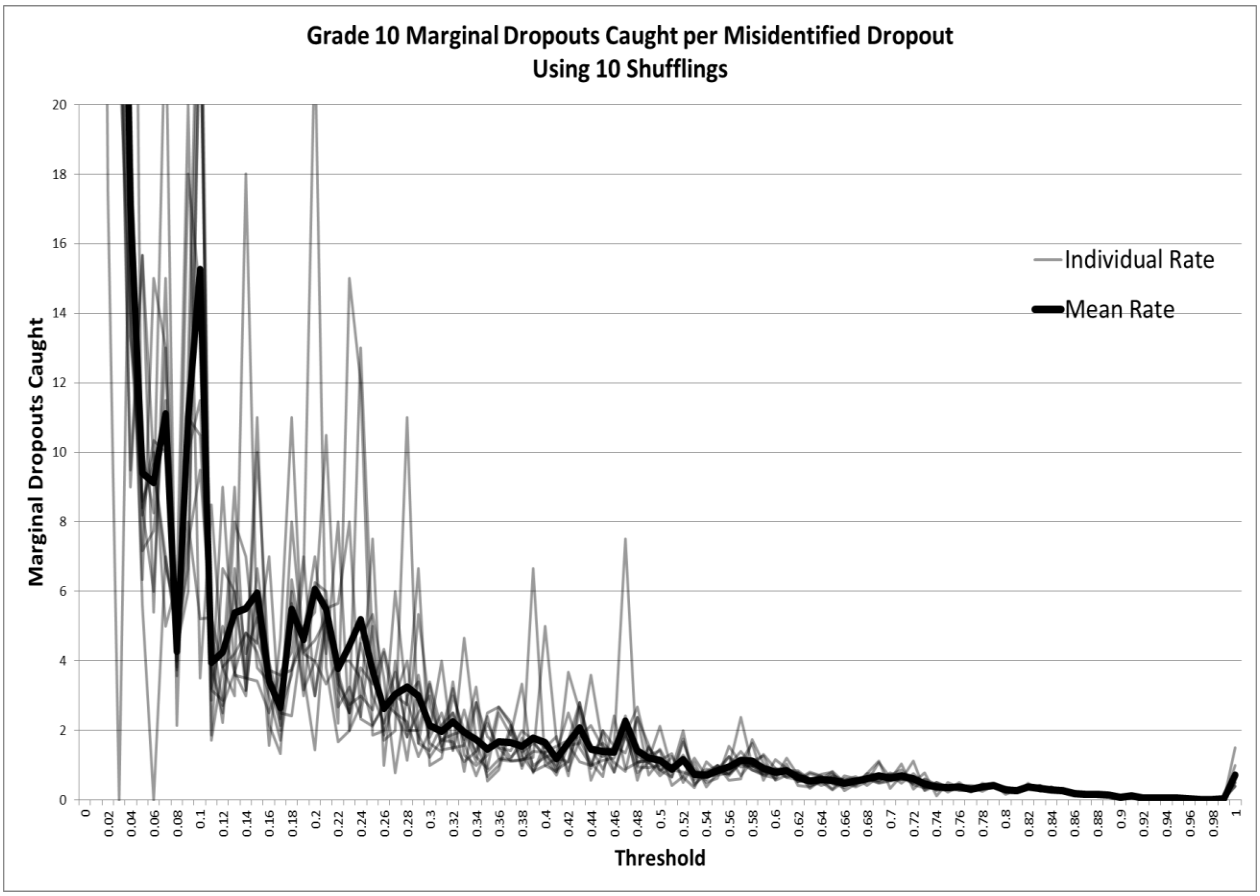

Grade 8: True Negative Rate vs. "Negative" Sensitivity: A Tradeoff
TNR (Accuracy)
"Negative" Sensitivity (Scope)
Prediction Accuracy
Benchmark Level

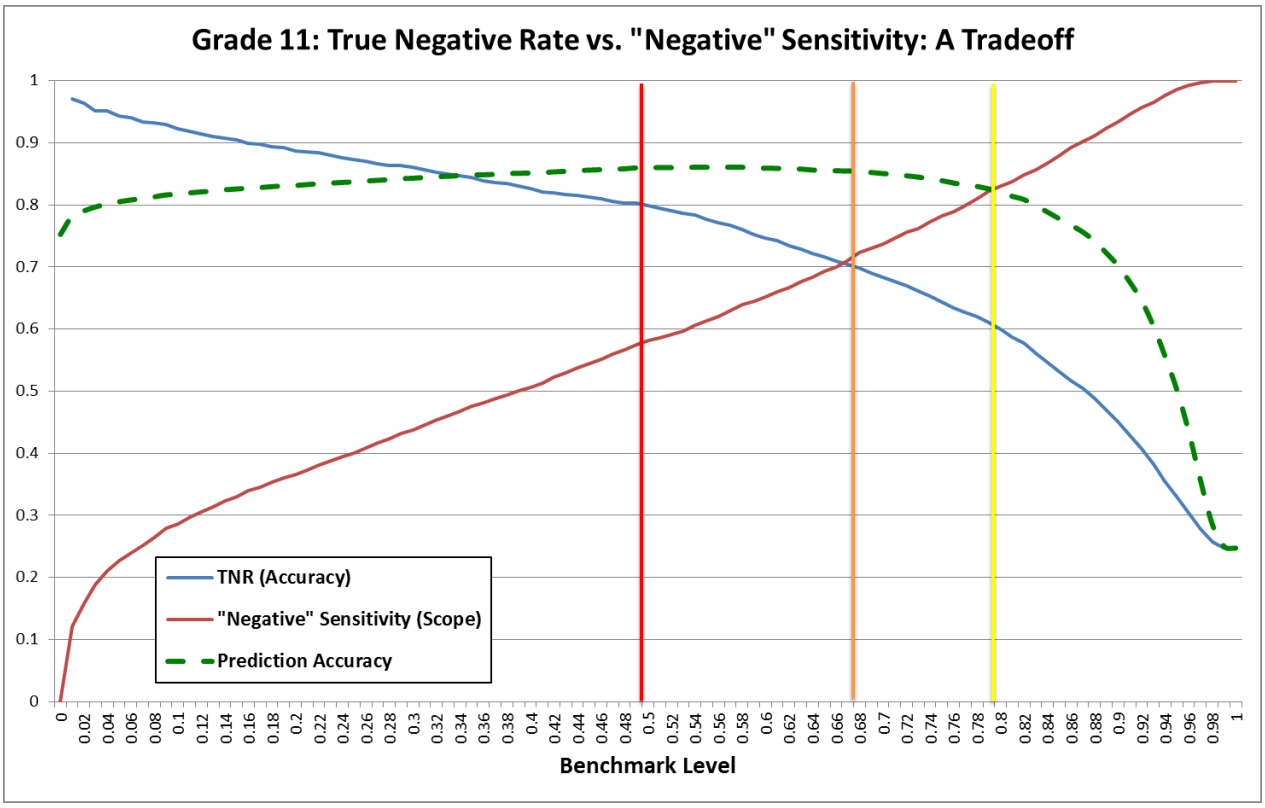

Grade 8 Marginal Dropouts Caught per Misidentified Dropout
Using 10 Shufflings
Individual Rate
Mean Rate
Marginal Dropouts Caught
Threshold

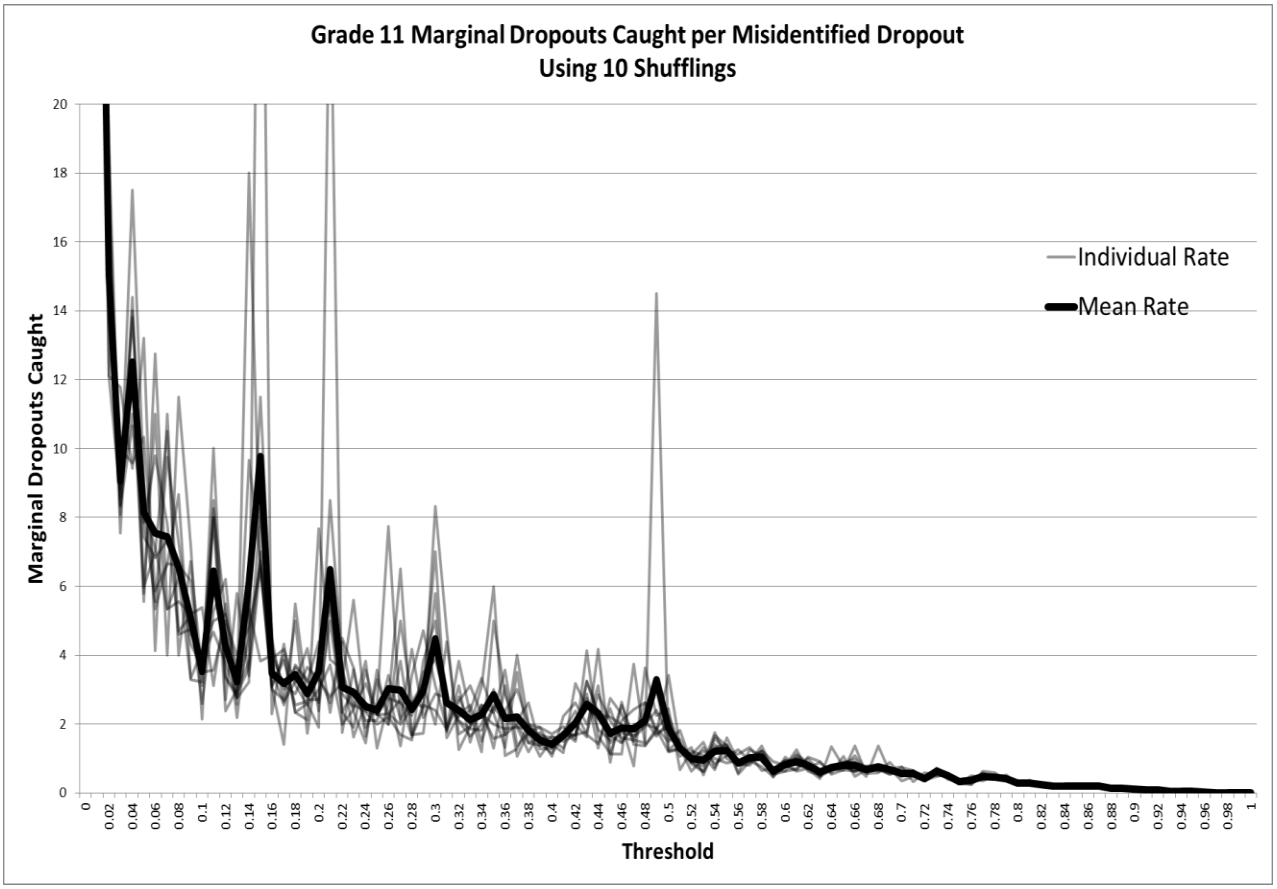

Grade 9: True Negative Rate vs. "Negative" Sensitivity: A Tradeoff
TNR (Accuracy)
"Negative" Sensitivity (Scope)
Prediction Accuracy
Benchmark Level

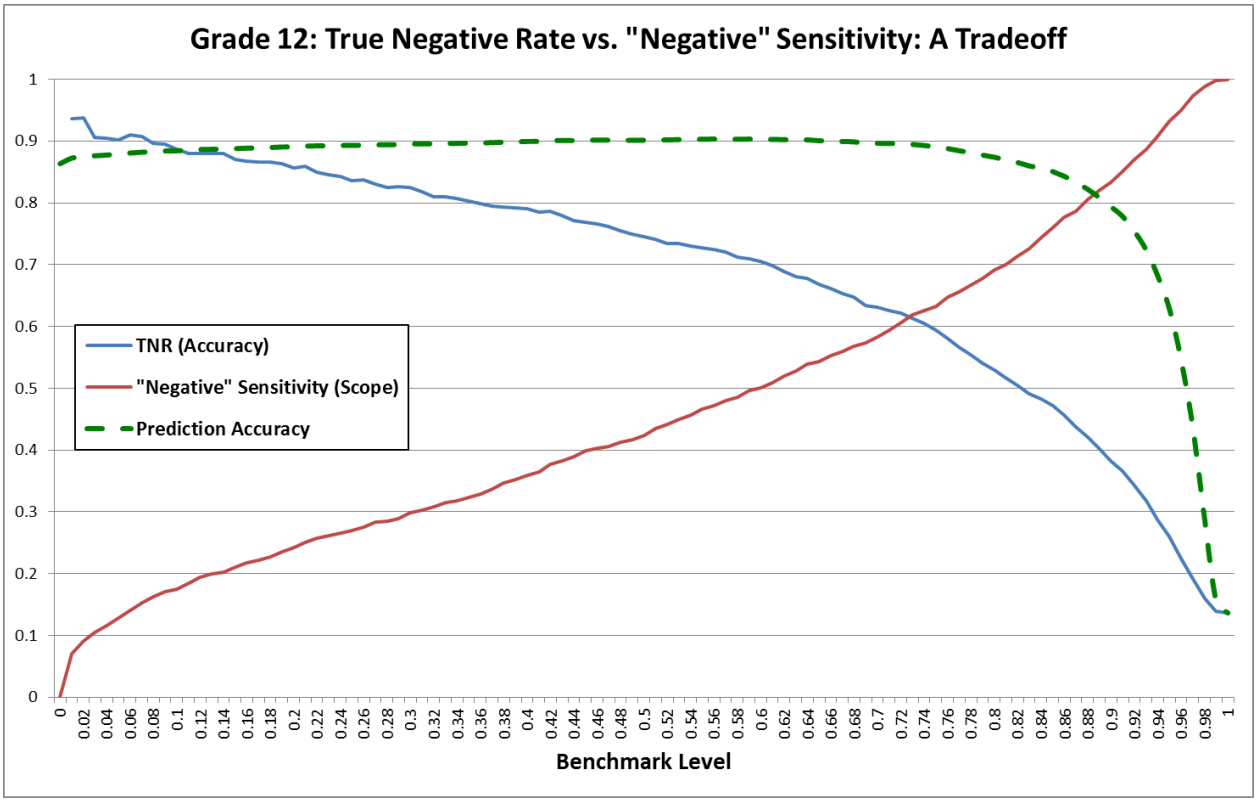

Grade 9 Marginal Dropouts Caught per Misidentified Dropout
Using 10 Shufflings
Individual Rate
Mean Rate
Marginal Dropouts Caught
Threshold

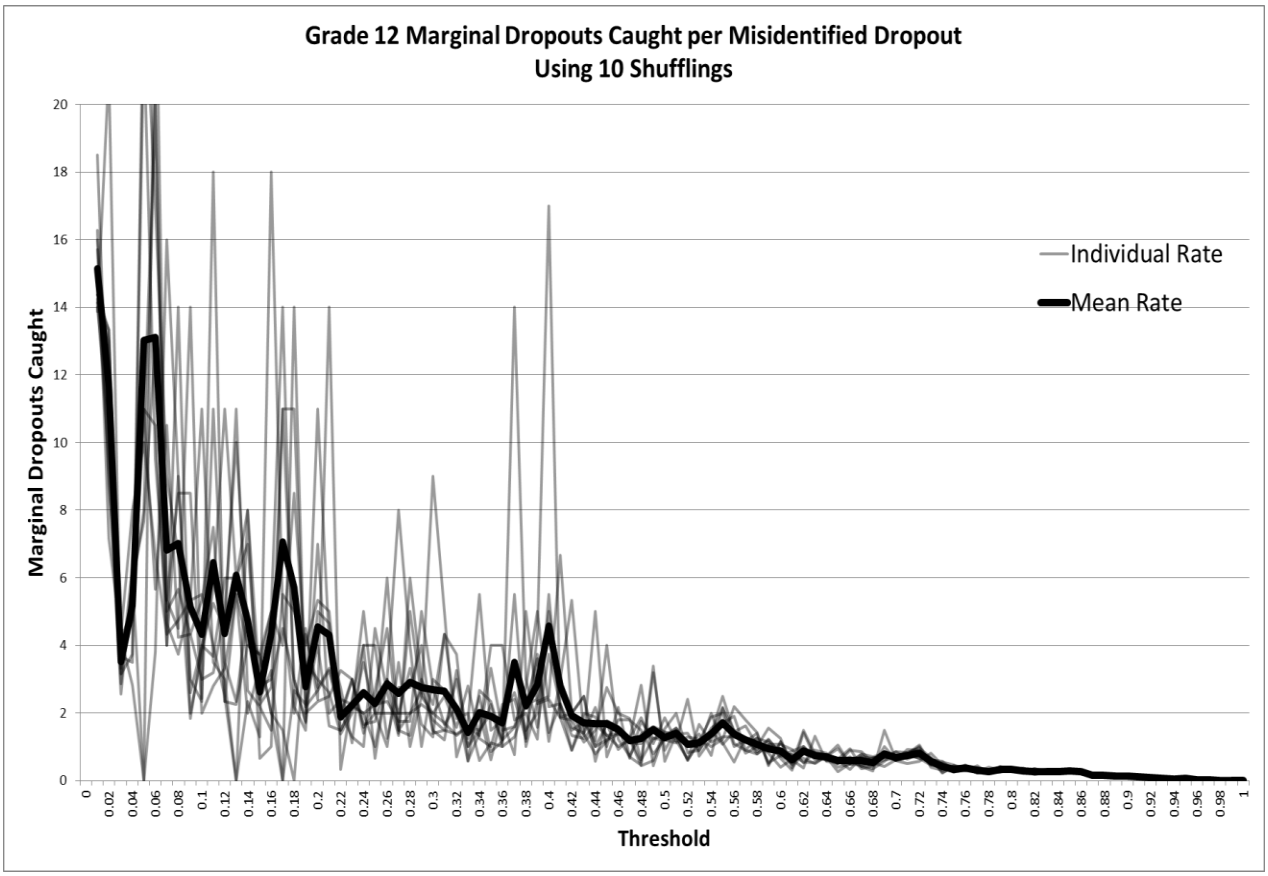

Grade 10: True Negative Rate vs. "Negative" Sensitivity: A Tradeoff
TNR (Accuracy)
"Negative" Sensitivity (Scope)
Prediction Accuracy
Benchmark Level


Grade 10 Marginal Dropouts Caught per Misidentified Dropout
Using 10 Shufflings
Individual Rate
Mean Rate
Marginal Dropouts Caught
Threshold


Grade 11: True Negative Rate vs. "Negative" Sensitivity: A Tradeoff
TNR (Accuracy)
"Negative" Sensitivity (Scope)
Prediction Accuracy
Benchmark Level


Grade 11 Marginal Dropouts Caught per Misidentified Dropout
Using 10 Shufflings
Individual Rate
Mean Rate
Marginal Dropouts Caught
Threshold


Grade 12: True Negative Rate vs. "Negative" Sensitivity: A Tradeoff
TNR (Accuracy)
"Negative" Sensitivity (Scope)
Prediction Accuracy
Benchmark Level


Grade 12 Marginal Dropouts Caught per Misidentified Dropout
Using 10 Shufflings
Individual Rate
Mean Rate
Marginal Dropouts Caught
Threshold