A Primer on Student Growth Percentiles

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For Çiğdem

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Introduction

Why Student Growth?

Accountability systems constructed according to federal adequate yearly progress (AYP) requirements currently rely upon annual "snap-shots" of student achievement to make judgments about school quality. Since their adoption, such *status measures* have been the focus of persistent criticism (Linn, 2003; Linn, Baker, & Betebenner, 2002). Though appropriate for making judgments about the achievement level of students at a school for a given year, they are inappropriate for judgments about educational *effectiveness*. In this regard, status measures are blind to the possibility of low achieving students attending effective schools. It is this possibility that has led some critics of No Child Left Behind (NCLB) to label its accountability provisions as unfair and misguided and to demand the use of growth analyses as a better means of auditing school quality.

A fundamental premise associated with using student growth for school accountability is that "good" schools bring about student growth in excess of that found at "bad" schools. Students attending such schools—commonly referred to as highly effective/ineffective schools—tend to demonstrate extraordinary growth that is causally attributed to the school or teachers instructing the students. The inherent believability of this premise is at the heart of current enthusiasm to incorporate growth into accountability systems. It is not surprising that the November 2005 announcement by Secretary of Education Spellings for the Growth Model Pilot Program (GMPP) permitting states to use growth model results as a means for compliance with NCLB achievement mandates was met with great enthusiasm by states. (Spellings, 2005).

Consistent with current accountability systems that hold schools responsible for the assessment outcomes of their students, the primary thrust of growth analyses over the last decade has been to determine, using sophisticated statistical techniques, the amount of student progress/growth attributable to the school or teacher (Braun, 2005; Rubin, Stuart, & Zanutto, 2004; Ballou, Sanders, & Wright, 2004; Raudenbush, 2004). Such analyses, often called *value-added* analyses, attempt to estimate the teacher or school contribution to student achievement. This contribution, called the *school* or *teacher effect*, purports to quantify the impact on achievement that this school or teacher would have, on average, upon similar students assigned to them for instruction. Clearly, such analyses lend themselves to accountability systems that hold schools or teachers responsible for student achievement.

Despite their utility in high stakes accountability decisions, the causal claims of teacher or school effectiveness addressed by value-added models (VAM) often fail to address questions of primary interest to education stakeholders. For example, VAM analyses generally ignore a fundamental interest of stakeholders regarding student growth: How much growth did a student make? The disconnect reflects a mismatch between the questions of interest and the statistical model employed. In this direction, Harris (2007) distinguishes value-added for program evaluation (VAM-P) versus value-added for accountability (VAM-A). More broadly, the current climate of high-stakes test-based accountability combined with the emphasis of value-added toward school and teacher effects has skewed discussions about growth models toward causal claims at the expense of description. Research (Yen, 2007) and personal experience suggest stakeholders appear more interested in the reverse: description first that can be used secondarily as part of causal fact finding.

In a survey conducted by Yen (2007), supported by the author's own experience working with state departments of education to implement growth models, parents, teacher, and administrators were asked what "growth" questions were most of interest to them.

Parent Questions:

- Did my child make a year's worth of progress in a year?
- Is my child growing appropriately toward meeting state standards?
- Is my child growing as much in Math as Reading?
- Did my child grow as much this year as last year?

Teacher Questions:

- Did my students make a year's worth of progress in a year?
- Did my students grow appropriately toward meeting state standards?
- How close are my students to becoming Proficient?
- Are there students with unusually low growth who need special attention?

Administrator Questions:

- Did the students in our district/school make a year's worth of progress in all content areas?
- Are our students growing appropriately toward meeting state standards?
- Does this school/program show as much growth as that one?
- Can I measure student growth even for students who do not change proficiency categories?
- Can I pool together results from different grades to draw summary conclusions?

As Yen remarks, all these questions rest upon a desire to understand whether observed student progress is "reasonable or appropriate" (Yen, 2007, p. 281). More broadly, the questions seek a description rather than a parsing of responsibility for student growth.

Ultimately, questions may turn to who/what is responsible. However, as indicated by this list of questions, they are not the starting point for most stakeholders.

In the following student growth percentiles and percentile growth projections/trajectories are introduced as a means of understanding student growth in both a normative and a criterion referenced fashion. The calculation of these quantities for large scale state assessment data using the student growth percentile (SGP) library within the R statistical software environment is then described (R Development Core Team, 2009; Betebenner, 2009). With these values calculated we show how growth data can be utilized both normatively and in a criterion referenced manner to inform discussion about education quality. We assert that the establishment of a normative basis for student growth eliminates a number of the problems of incorporating growth into accountability systems providing needed insight to various stakeholders by addressing the basic question of how much a student has progressed.

Student Growth Percentiles

It is a common misconception that to measure student growth in education, the subject matter and grades over which growth is examined must be on the same scale—referred to as a vertical scale. Not only is a vertical scale not necessary, but its existence obscures concepts necessary to fully understand growth. Growth, fundamentally, requires change to be examined for a single construct like math achievement across time—*growth in what?* A single scale on which the construct is measured is not necessary.

Consider the familiar situation from pediatrics where the interest is on measuring the height and weight of children over time. The scales on which height and weight are measured possess properties that educational assessment scales aspire towards but can never meet.[1]

> An infant male toddler is measured at 2 and 3 years of age and is shown to have grown 4 inches. The magnitude of increase—4 inches—is a well understood quantity that any parent can grasp and measure at home using a simple yardstick. However, parents leaving their pediatrician's office knowing only how much their child has grown would likely be wanting for more information. In this situation, parents are not interested in an absolute criterion of growth, but instead in a normative criterion locating that 4 inch increase alongside the height increases of similar children. Examining this height increase relative to the increases of similar children permits one to diagnose how (ab)normal such an increase is.

Given this reality in the examination of change where scales of measurement are perfect, it is absurd to think that in education, where scales are quasi-interval, one can/should examine growth differently.[2]

[1]Height and weight scales are interval (actually, ratio scales) where a unit increase reflects an equivalent increase in the underlying quality being measured no matter where on the scale the increase occurs.

[2]The scales on which students are measured are often assumed to possess properties similar to height and

Suppose that scales did exist in education similar to height/weight scales that permitted the calculation of absolute measures of annual academic growth for students. A parent's query about, "How much did my child progress?", would be answered with some quantity of scale score points—an answer that would leave most parents confused wondering whether the number of points is good or bad. As in pediatrics, the search for a description regarding change in achievement over time (i.e., growth) is best served by considering a normative quantification of student growth—*a student growth percentile*.

A student's growth percentile describes how (ab)normal a student's growth is by examining their current achievement relative to their *academic peers*—those students beginning at the same place. That is, a student growth percentile examines the current achievement of a student relative to other students who have, in the past, "walked the same achievement path". Heuristically, if the state assessment data set were extremely large (in fact, infinite) in size, one could open the infinite data set and select out those students with the exact same prior scores and compare how the selected student's current year score compares to the current year scores of those students with the same prior year's scores—their academic peers. If the student's current year score exceeded the scores of most of their academic peers, in a normative sense they have done well. If the student's current year score was less than the scores of their academic peers, in a normative sense they have not done well.

The four panels of Figure 1.1 depict what a student growth percentile represents in a situation considering students having only two consecutive achievement test scores.

Upper Left Panel Considering all pairs of 2005 and 2006 scores for all students in the state yields a bivariate (two variable) distribution. The higher the distribution, the more frequent the pair of scores.

Upper Right Panel Taking account of prior achievement (i.e., conditioning upon prior achievement) fixes a the value of the 2005 scale score (in this case at 600) and is represented by the red slice taken out of the bivariate distribution.

Lower Left Panel Conditioning upon prior achievement defines a *conditional distribution* which represents the distribution of outcomes on the 2006 test assuming a 2005 score of 600. This distribution is indicating as the solid red curve.

Lower Right Panel The conditional distribution provides the context against which a student's 2006 achievement can be examined and understood normatively. Students with achievement in the upper tail of the conditional distribution have demonstrated high rates of growth relative to their academic peers whereas those students with achievement in the lower tail of the distribution have demonstrated low rates of growth. Students with current achievement in the middle of the distribution could be described as demonstrating "average" or "typical" growth. In the figure provided the student scores approximately 650 on the 2006 test. Within the conditional distribution, the value of 650 lies at approximately the 70th percentile. Thus the student's

weight but they don't. Specifically, scales are assumed to be interval where it is assumed that a difference of 100 points at the lower end of the scale refers to the same difference in ability/achievement as 100 points at the upper end of the scale. This assumption, however, fails to hold.

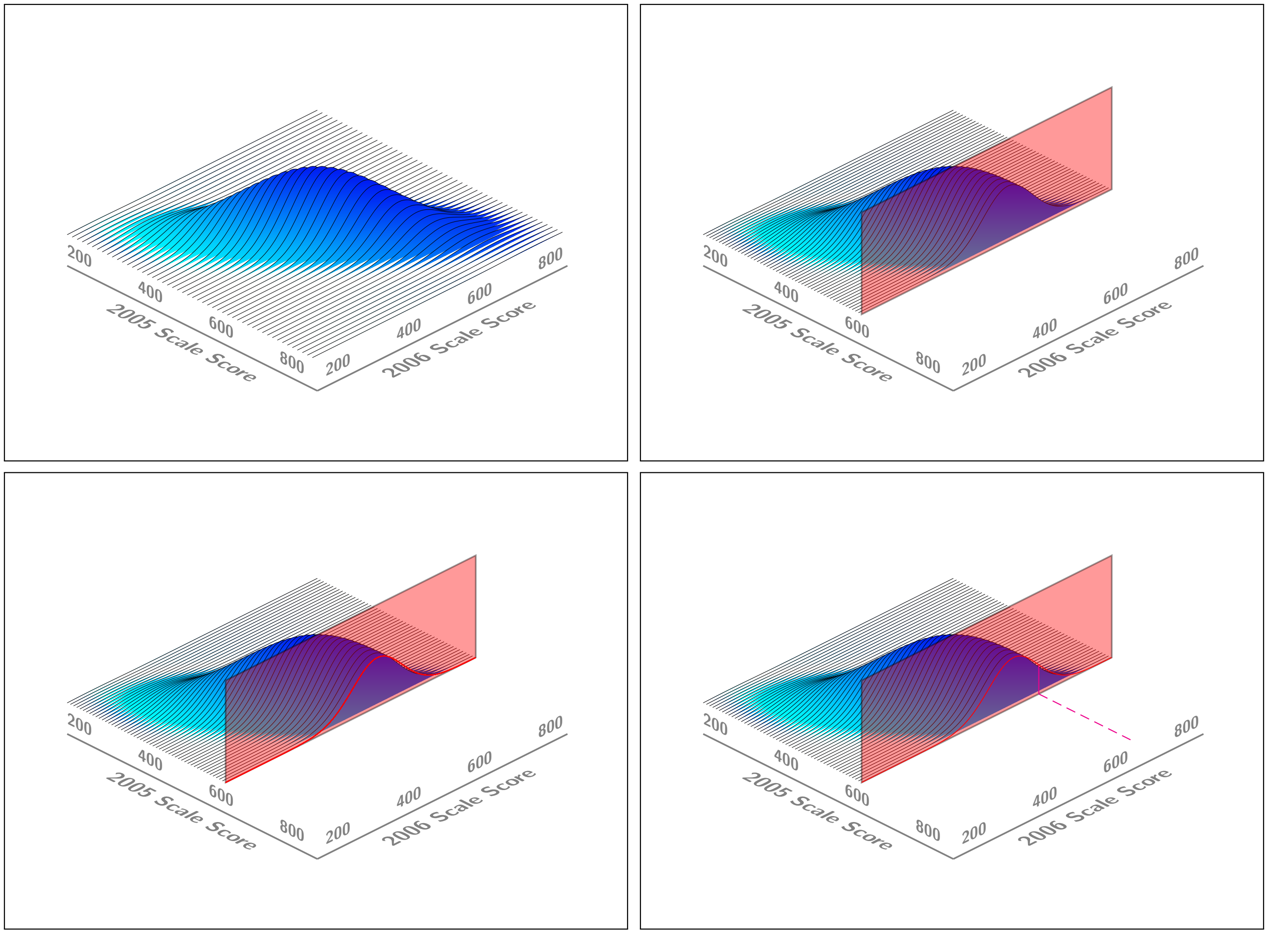

Figure 1.1: Figures depicting the distribution associated with 2005 and 2006 student scale scores together with the conditional distribution and associated growth percentile

> growth from 600 in 2005 to 650 in 2006 met or exceeded that of approximately 70 percent of students starting from the same place. This 50 point increase is above average. It is important to note that qualifying a student growth percentile as "adequate", "good", or "enough" is a standard setting procedure that requires stakeholders to examine a student's growth *vis-à-vis* external criteria such as performance standards/levels.

Figure 1.1 also serves to illustrate the relationship between a vertical scale and student growth percentiles. Using the vertical scale implied by Figure 1.1, the student grew 50 points (from 600 to 650) between 2005 and 2006. This 50 points represents the absolute magnitude of change. Quantifying the magnitude of change is scale dependent. For example, different vertical achievement scales in 2005 and 2006 would yield different annual scale score increases: A scale score increase of 50 could be changed to a scale score increase of 10 using a simple transformation of the vertical scale on which all the students are measured. However, relative to other students, their growth has not changed—their growth percentile is invariant to scale transformations common in educational assessment. Student growth percentiles normatively situate achievement change bypassing questions associated with the magnitude of change, and directing attention toward relative standing which, we would assert, is what stakeholders are most interested in.

School Level Results

An advantage of quantifying growth at the student level is that it is generally an easy task to combine the individual level growth results to retrieve a school level aggregate. For example, after growth percentiles are calculated for each of 500 students at a school, the distribution of growth percentiles for those 500 students represents how much the students at that school grew in the previous year. Summarizing this distribution's "average" would supply a single number describing the growth of a "typical" student at a given school. Because it is inappropriate to calculate the arithmetic average of a set of percentiles, the median is used as the single number which best describes where the middle of the distribution of student growth percentiles lies. It is important to note, however, that the median is a *summary* measure of the growth of *many* students at the school. In reality at almost all schools one can find students who grow slowly—students with low growth percentiles—as well as students who grow quickly—students with high growth percentiles. There is room for improvement in all schools.

If students were randomly assigned to schools, then the median growth percentile for a school is expected to be 50. Schools with median student growth percentiles above 50 have students demonstrating, on average, greater than expected growth. And schools with median student growth percentiles below 50 have students demonstrating, on average, less than expected growth. Figure 1.2 shows one way in which school performance can be illustrated using achievement and growth measures. In this way, student growth percentiles can be used to identify schools where student growth is extraordinarily good and bad. It is important to note, like with student achievement it is premature to conclude that a school is solely responsible for the growth demonstrated by its students.

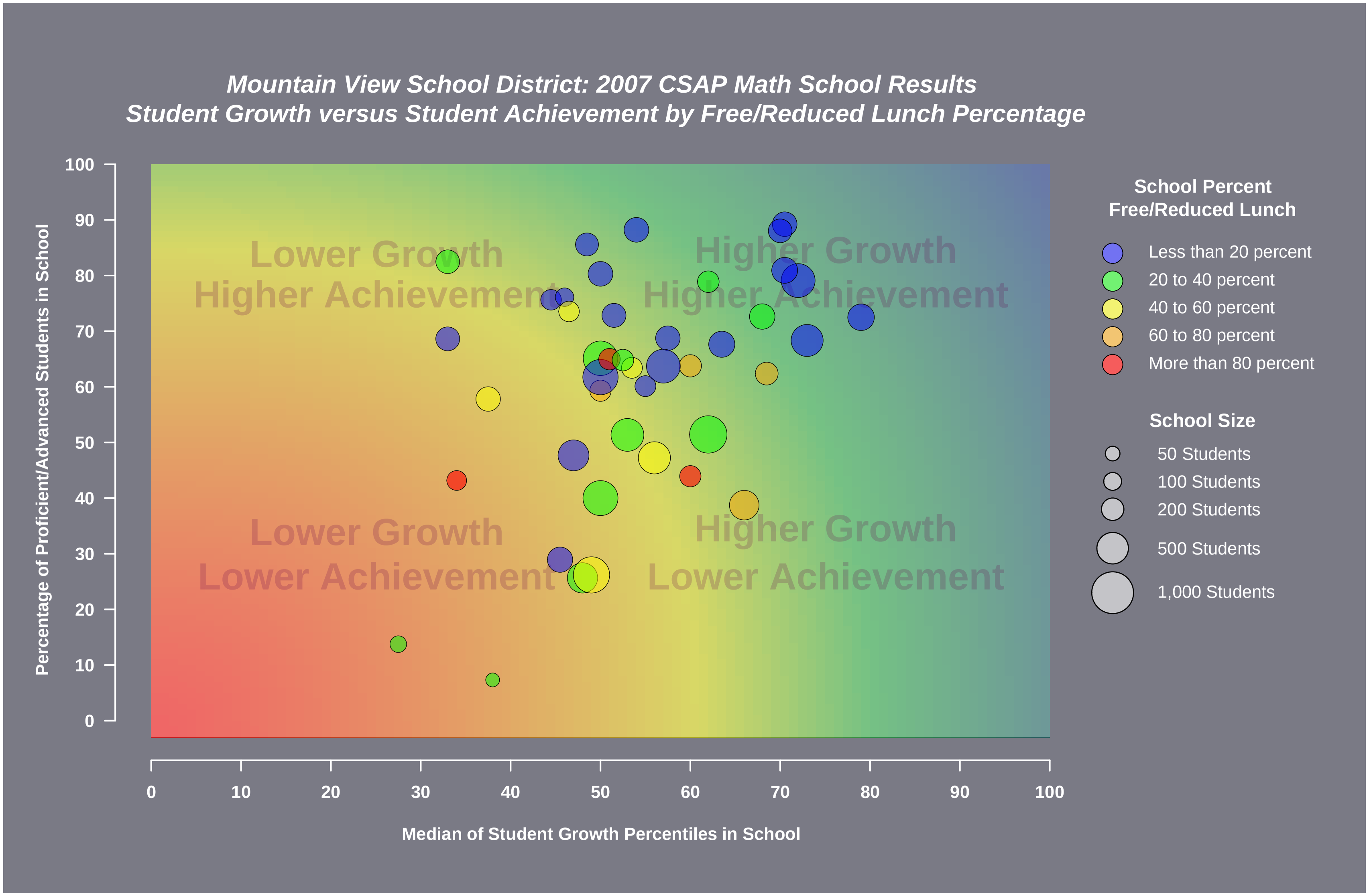

Figure 1.2: Depiction of median student growth percentile against percentage at/above proficient for schools in a school district

Measurement of student growth and assignment of responsibility for that growth involves answering two distinct but related questions:

- How much the the students at this school grow/progress?
- How much did this school contribute to student growth?

The median student growth percentile is descriptive and makes no assertion about the cause of student growth. This differs from current value-added models where the purpose is to specify the contribution to student achievement provided by a given school or teacher. It is likely, and society would certainly like to believe, that schools and teachers have a significant impact upon student learning: That their efforts are reflected in the academic progress of students. The median student growth percentile is *one of many* indicators that stakeholders can use to judge the quality of the education students receive. It is hoped the as growth percentiles become more widely available, stakeholders will use this piece of data in combination with other data assess the progress of the student as well as the factors contributing to their progress.

The SGP Library

Overview

This chapter provides a *brief* and *complete* set of instructions on how to calculate **student growth percentiles** using the freely available R software combined with the SGP library (R Development Core Team, 2009; Betebenner, 2009). R is available from the Comprehensive R Archive Network (CRAN, http://www.cran.r-project.org/) for Windows, OSX, and Unix/Linux. After installing R, installation of SGP and other libraries is performed from the menu via downloads from CRAN. Begin by installing R and the SGP library. Comprehensive R and SGP library help documentation is available locally following the installation as well as online from CRAN.

Data requirements

The most onerous task in calculating growth percentiles is making sure that the data you supply to the growth percentile/projection functions are in the appropriate format. The growth percentile function requires data in what is typically called a *wide* format. The columns of the data file must conform to the following:

- The first column/variable indicates the unique student `ID`.
- The next set of columns/variables indicates the tested `GRADE` of the student for the years in the data.
- The final set of columns/variables indicates the `SCALE SCORES` for the student for the respective grades.

For example, given a data set spanning four years from 2004 to 2007, the data would be formatted as:

ID	GRADE_2004	GRADE_2005	GRADE_2006	GRADE_2007	SS_2004	SS_2005	SS_2006	SS_2007

Because the function internally renames variables, *variable names are **NOT** important, just their position within the data file.* Additionally, through the use of the foreign library (installed by default with R) one can easily read data into R prepared from a variety of statistical software packages. R also has can access directly from relational databases for more thorough integration into data warehouse structures.

Note that this is a versatile format in which to keep *all* your longitudinal data. All students ever enrolled in the system can be represented easily in this layout with system missing values used to indicate absence. Given a comprehensive file containing all students across all grades across all years for a single subject, it is possible to select appropriate pieces of this file and feed them to the growth percentile function for analysis. The function currently accepts up to 8 years of data.

Growth Percentile Calculation

The SGP library contains one sample data set, `sgpData`, and two functions, one for calculating student growth percentiles, `studentGrowthPercentiles`, and the other for calculating percentile growth projections/trajectories, `studentGrowthProjections`. The installed help pages for the SGP library give thorough details about all the function options together with examples that calculate student growth percentiles and percentile growth projections/trajectories using the data. Use the help pages for these functions to supplement the details provided in this primer.

Using `studentGrowthPercentiles`

The simplest way to perform analyses for an entire state data set is to construct a "master file" in your favorite text editor (e.g., Wordpad, Notepad, emacs, vi) containing Rsyntax specific for the user's state specific needs. With an appropriately constructed master file, growth analyses for an entire state can be performed using a single R file. The help pages for `studentGrowthPercentiles` and `studentGrowthProjections` contain examples of master files that are subsequently used in this primer. For a state that annually tests students in three subjects, three master files, one for each subject, could be used to conduct the analyses. To "run" a master file one typically uses the `source` command at the Rprompt:

```
> source("master_sgp_math_2007.r")
```

Here the master file in this case is for 2007 math. The help documentation associated with both the `studentGrowthPercentiles` and `studentGrowthProjections` functions contains example files that can be easily modified to accommodate the requirements of different large scale data sets. To help the user understand the Rsyntax contained within a master file, we consider the text provided in the `studentGrowthPercentiles` example.

```
###
### Load relevant libraries
###

require("SGP")
```

```
## Use the foreign library read in data in other (SPSS, SAS) formats
require("foreign")
```

the `require` command in R loads libraries that provide functions and data sets necessary to perform analyses. In this case the student growth percentile library, SGP, and the foreign library, are loaded. The SGP library, in turn, loads other libraries it requires automatically. Note that the # symbol is the comment symbol in R.

```
###
### Load relevant datasets
###

data(sgpData) ## Loads sgpData set from SGP library
## sgpData <- read.spss(file="/path/to/my/data/my_spss_file.sav",
   to.data.frame=T) ## SPSS
## sgpData <- read.xport(file="/path/to/my/data/my_sas_file.xport")
   ## SAS XPORT
```

These commands load the math panel data necessary to do the growth analyses. The data in this case are .Rdata, the R data files. As mentioned previously, it is easy to import other data formats into R. For example, if one wishes to load an SPSS or SAS Xport math file named `my_spss_file.sav` or textttmy_sas_file.xport, respectively, then one can uncomment the syntax above to import that file, replacing the `load` statement.

With the libraries and data loaded, one can begin growth percentile calculations. Growth percentiles are generally calculated by a student's grade cohort. As will become apparent, there are repeated pieces of R syntax used. The syntax used to calculate growth percentiles using the `sgpData` provided in the SGP library in grades 4 through 7 using 2004 to 2007 data is:

```
###
### Calculate student growth percentiles
###

## 4444444444444444444444444444444444444444444444444444444444444

g4_sgp <- studentGrowthPercentiles(
             student.data = sgpData,
             num.panels = 4,
             num.prior = 1,
             subset.grade = 4,
             sgp.function.labels=list(my.year=2007, my.subject="read",
                 my.grade=4))

save(g4_sgp, file="Results_Data/sgp_read_2007_g4.Rdata")
```

```
## 5555555555555555555555555555555555555555555555555555555555555

g5_sgp <- studentGrowthPercentiles(
             student.data = sgpData,
             num.panels = 4,
             num.prior = 2,
             subset.grade = 5,
             use.my.knots.and.boundaries=TRUE,
             sgp.function.labels=list(my.year=2007, my.subject="read",
                 my.grade=5))

save(g5_sgp, file="Results_Data/sgp_read_2007_g5.Rdata")

## 6666666666666666666666666666666666666666666666666666666666666

g6_sgp <- studentGrowthPercentiles(
             student.data = sgpData,
             num.panels = 4,
             num.prior = 3,
             subset.grade = 6,
             use.my.knots.and.boundaries=TRUE,
             sgp.function.labels=list(my.year=2007, my.subject="read",
                 my.grade=6))

save(g6_sgp, file="Results_Data/sgp_read_2007_g6.Rdata")

## 7777777777777777777777777777777777777777777777777777777777777

g7_sgp <- studentGrowthPercentiles(
             student.data = sgpData,
             num.panels = 4,
             num.prior = 3,
             subset.grade = 7,
             use.my.knots.and.boundaries=TRUE,
             sgp.function.labels=list(my.year=2007, my.subject="read",
                 my.grade=7))

save(g7_sgp, file="Results_Data/sgp_read_2007_g7.Rdata")
```

The first command uses the `studentGrowthPercentiles` function and assigns the result (assigning a result in R is done using <- or =). Note that the result of running these commands are the creation of 5 objects, `g4_sgp`, `g5_sgp`, `g6_sgp`, `g7_sgp`, `g8_sgp` containing the student growth percentiles and cuts for each grade. If one doesn't wish to save each grade's results just comment out the `save` commands.

Growth percentile calculation produces a number of files that can be used in subsequent analyses involving growth projections. By default, the program saves the coefficient matrices associated with the quantile regression analyses. These are stored in the `Coefficient_Matrices` directory. If one doesn't need these matrices for subsequent analyses and doesn't want them produced, one can add the argument `save.matrices=FALSE` to the `studentGrowthPercentiles` function.

After calculating student growth percentiles for each grade cohort, the results are combined into a single object and saved to both an R file and to a comma separated `ascii` file using the syntax:

```
###
### Bind grade results and save output
###

sgp_math_2007_gall <- rbind(g4_sgp, g5_sgp, g6_sgp, g7_sgp)
save(sgp_math_2007_gall, file="Results_Data/sgp_math_2007_gall.Rdata")
write.table(sgp_math_2007_gall,
   file="Results_Data/sgp_math_2007_gall.dat", sep=",",
   row.names=FALSE, quote=FALSE)
```

If one doesn't want the results saved as an Rfile, the the `save` command can be removed from the above syntax. The `foreign` library provides some facility for exporting data into other formats as well.

Knots and Boundaries

Looking closely at the syntax used to calculate the 4th, 5th, 6th, and 7th grade growth percentiles, only in grades 5 through 7 do we specify that the function use our own knots and boundaries. To fit the state's data as well as possible, the growth percentile function uses polynomial splines (specifically, B-splines) to accommodate non-linearity and heteroscedasticity (see Betebenner (2008) for more details). These splines require the specification of knots and boundaries. By default, the growth percentile function calculates knots and boundaries for the user using all available data and saves those results to the `Knot_Boundaries` directory. In the 4th grade analyses the function automatically calculates knots and boundaries for the entire data set. In the 5th, 6th, and 7th grade analyses the function uses those already established values.

When calculating and making comparisons of growth percentiles results across years, it is preferable to remove any ambiguities from the data analysis process that might impact year-to-year comparisons. The knots and boundaries used in the growth percentile analyses are two such ambiguities that if allowed to vary might subtly change results. To fix the knots and boundaries, after performing growth percentile analyses in a base year, the user is encouraged to use the knots and boundaries calculated in subsequent analyses in following years.

Growth Projection Calculation

Following the calculation of student growth percentiles, it is often desirable to use the results from these analyses to investigate what level of growth is necessary for the student to reach desirable levels of achievement in the future. These "growth projections" or "percentile growth trajectories" allow stakeholders to quantify and ultimately discuss what it will take for a student to reach desired levels of achievement. These analyses, sometimes referred to as growth-to-standard analyses, can form the basis for a criterion referenced growth model suitable for use with AYP determinations.[1]

Using studentGrowthProjections

Percentile growth projections/trajectories use the most recent quantile regression coefficient matrices, saved in the Coefficient_Matrices directory, derived in the calculation of student growth percentiles to estimate what future rates of growth, expressed in the percentile metric, lead to. The user can specify a set of cutpoints that the function uses to determine what (consecutive) percentile growth is required to reach these cutpoints. For example, users can specify cutpoints associated with state achievement levels. The function then calculates the individual (consecutive) growth percentiles necessary to reach these levels in 1, 2, 3 and 4 years. In addition, the user can specify a set of percentiles and the function will output the scale scores associated with consecutive growth for those percentiles in 1, 2, 3 and 4 years.

Like in calculation of student growth percentiles using the studentGrowthPercentiles function, the simplest way to calculate percentile growth projections/trajectories for an entire state data set is to construct a "master file" containing the necessary Rsyntax. The help pages for studentGrowthProjections contain an example of a master file that will be used in this section. Like with student growth percentiles, for a state that annually tests students in three subjects, three master files, one for each subject, could be used to conduct the projection analyses. The master files are "run" using the source command at the Rprompt:

```
> source("master_sgp_proj_math_2007.r")
```

Here the percentile growth projections master is for 2007 math. The following details the Rsyntax contained within a master file for calculating these quantities.

```
###
### Load relevant libraries
###
```

[1]The Colorado Growth Model which uses percentile growth projections/trajectories to determine whether a student is track to reach/maintain proficiency was approved in January, 2009, by the U.S. DOE for use in determining AYP as part of the Growth Model Pilot Program.

```
require("SGP")  ### Loads dummy sgpData by default
## Use the foreign library read in data in other (SPSS, SAS) formats
require("foreign")

###
### Load relevant datasets (example code for other
###

## sgpData <- load(file=''/path/to/my/data/my_Rdata_file.Rdata'') ##
   Rdata
## sgpData <- read.spss(file="/path/to/my/data/my_spss_file.sav",
   to.data.frame=T) ## SPSS
## sgpData <- read.xport(file="/path/to/my/data/my_sas_file.xport")
   ## SAS XPORT
```

Again, the `require` command in R loads libraries that provide functions and data sets necessary to perform analyses. The `load`, `read.spss`, or `read.xport` commands can be used to load the user's own data set. The following example uses the included toy data set, `sgpData`.

With the libraries and data loaded, one can begin percentile growth projection calculations. Like with growth percentiles, projections are generally calculated by a student's grade cohort. The syntax used to calculate percentile growth projections/trajectories using the `sgpData` provided in the SGP library in grades 3 through 6 using 2004 to 2007 data is:[2]

```
###
### Establish and Save Math Cut Scores
###

if (is.na(file.info("Cutscores")$isdir)) {
    dir.create("Cutscores")
}

cutscores_read_g4 <- c(516.5, 571.5, 670.5)
cutscores_read_g5 <- c(537.5, 587.5, 690.5)
cutscores_read_g6 <- c(542.5, 599.5, 695.5)
cutscores_read_g7 <- c(566.5, 619.5, 715.5)

save(cutscores_read_g4, file="Cutscores/cutscores_math_g4.Rdata")
save(cutscores_read_g5, file="Cutscores/cutscores_math_g5.Rdata")
save(cutscores_read_g6, file="Cutscores/cutscores_math_g6.Rdata")
save(cutscores_read_g7, file="Cutscores/cutscores_math_g7.Rdata")
```

[2]Note that projections are made for students with just one year of data but growth percentiles are not. Projections require only 1 year of data whereas student growth percentiles require 2 or more.

The first lines in the above syntax create a directory named `Cutscores` if it doesn't exist. Following that, four cutscore vectors, each consisting of three cutscores, for reading in grades 4 to 7 are created and then saved to the `Cutscores` directory. These values are used to calculate the (consecutive) growth percentiles necessary for the student to reach these scale score targets in 1, 2, and 3 years.

```
###
### Submit to Growth Projection Function
###

##
## 33333333333333333333333333333333333333333333333333333333
##

##
## 3rd graders receiving projections
##

sgp_proj_read_2007_g3 <- studentGrowthProjections(
             student.data = sgpData,
             num.panels = 4,
             max.num.scores = 1,
             num.prior.scores=list(c(1,2,3,3)),
             proj.function.labels = list(my.year=2007,
                my.subject="read", my.grade=3),
             subset.grade = 3,
             percentile.trajectories=c(1,35,65,99),
             projcuts.digits=0)

## save(sgp_proj_read_2007_g3,
   file="Results_Data/sgp_proj_read_2007_g3.Rdata")

##
## 44444444444444444444444444444444444444444444444444444444
##

sgp_proj_read_2007_g4 <- studentGrowthProjections(
             student.data = sgpData,
             num.panels = 4,
             max.num.scores = 2,
             num.prior.scores=list(c(1,2,3,NA), c(2,3,3,NA)),
             proj.function.labels = list(my.year=2007,
                my.subject="read", my.grade=4),
             subset.grade = 4,
             percentile.trajectories=c(1,35,65,99),
             projcuts.digits=0)
```

```
## save(sgp_proj_read_2007_g4,
   file="Results_Data/sgp_proj_read_2007_g4.Rdata")


##
## 55555555555555555555555555555555555555555555555555555555555
##

sgp_proj_read_2007_g5 <- studentGrowthProjections(
             student.data = sgpData,
             num.panels = 4,
             max.num.scores = 3,
             num.prior.scores=list(c(1,2,NA,NA), c(2,3,NA,NA),
                c(3,3,NA,NA)),
             proj.function.labels = list(my.year=2007,
                my.subject="read", my.grade=5),
             subset.grade = 5,
             percentile.trajectories=c(35,65),
             projcuts.digits=0)

## save(sgp_proj_read_2007_g5,
   file="Results_Data/sgp_proj_read_2007_g5.Rdata")

##
## 66666666666666666666666666666666666666666666666666666666666
##

sgp_proj_read_2007_g6 <- studentGrowthProjections(
             student.data = sgpData,
             num.panels = 4,
             max.num.scores = 3,
             num.prior.scores=list(c(1,NA,NA,NA), c(2,NA,NA,NA),
                c(3,NA,NA,NA)),
             proj.function.labels = list(my.year=2007,
                my.subject="read", my.grade=6),
             subset.grade = 6,
             percentile.trajectories=c(35,65),
             projcuts.digits=0)

## save(sgp_proj_read_2007_g6,
   file="Results_Data/sgp_proj_read_2007_g6.Rdata")
```

The arguments to the `studentGrowthProjections` functions used above are defined as follows.[3]

[3]For a complete description of all arguments please consult the help documentation associated with the

`student.data` Data frame containing longitudinal student data in same wide format as `studentGrowthPercentiles` data.

`num.panels` Number of panels in the data frame

`max.num.scores` The MAXIMUM number of scores one wishes to use in the FIRST YEAR projection analysis.

`num.prior.scores` Number of prior scores used to calculate each of the 1, 2, 3 and 4 year projections. A list of length `max.number.scores` consisting of vectors of length 4.

The first component of the list (a vector of length 4, a 4-tuple) indicates how many prior scores are used in the calculation of the 1, 2, 3 and 4 year projections, respectively, in the case when *1 prior score* is utilized. The first component of the 4-tuple is used to calculate the 1 year projection. The second component of the 4-tuple indicates how many scores are used to calculate the 2 year projections, the third component of the 4-tuple indicates how many scores are used to calculate the 3 year projections, and the fourth component of the 4-tuple indicates how many scores are used to calculate the 4 year projections.

If calculation of a given prediction is not appropriate, then the component of the vector should be `NA`. For example, for students currently in the penultimate grade that is assessed, only a 1 year projection is calculated. Thus, the latter two components of the vector are `NA, c(??,NA,NA,NA)`

The second component of the list (another 4-tuple) indicates the number of prior scores to be used in the calculation of the 1, 2, 3 and 4 year projections in the case when *2 prior scores* are utilized. Similarly, the third and fourth component of the list indicate how many prior scores are to be used in the calculation of the 1, 2, 3 and 4 year projections in the case when *3 and 4 priors scores*, respectively, are utilized.

`proj.function.labels` List of labels used to retrieve the appropriate coefficient matrices, knots, and boundaries for the projections/trajectories. The list corresponds to the list used to save the coefficient matrices and knots and boundaries in the growth percentile analyses.

`subset.grade` Student grade level for sub-setting.

`percentile.trajectories` Returns a vector of percentile trajectories (defaults to 1st, 35th, 65th, and 99th) associated with 1, 2, 3 and 4 year projections for each student in addition to the percentiles necessary to reach the performance thresholds.

`projcuts.digits` The number of digits (defaults to 2) percentile trajectories (if requested) are formatted.

growth projections function.

```
###
### Combine all the different grade growth projection files into a
   single file
### and write the results to a comma separated data set
###

sgp_proj_read_2007_gall <- rbind(sgp_proj_read_2007_g3,
                                sgp_proj_read_2007_g4,
                                sgp_proj_read_2007_g5,
                                sgp_proj_read_2007_g6)

save(sgp_proj_read_2007_gall,
   file="Results_Data/sgp_proj_read_2007_gall.Rdata")
write.table(sgp_proj_read_2007_gall,
   file="Results_Data/sgp_proj_read_2007_gall.dat",
            sep=" , ", row.names=FALSE, quote=FALSE)
```

Following calculation of each grade's projections, the grade specific files are bound together into a single data frame (`rbind`) and saved as both an `Rdata` file and as a comma separated variable `ascii` file.

`studentGrowthProjections` Results

The results from the percentile growth trajectories/projections analyses

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