Student Growth Percentiles Calculations

Re-evaluating Annual Census Testing

November 2022

This appendix contains the code used to prepare and format the data required for each condition of the **"Re-evaluating the Efficiency and Efficacy of Annual Census Standardized Testing for Accountability Purposes"** study. Each condition requires the data to be formatted in a consistent manner, and addition variables to be created. With the properly formatted and amended data, we then proceed with the Student Growth Percentiles (SGP) analyses and results aggregations.

Report Contents

# Data cleaning and preparation

For this simulation analysis we will be using the *sgpData\_LONG\_COVID* data from the [SGPData](https://github.com/CenterForAssessment/SGPdata) package. It includes 7 years of annual assessment data in two content areas (ELA and Mathematics). As this data is typically used for testing and research purposes with the SGP ([Betebenner et al. 2022](#ref-sgp)) package, much of the data cleaning and formatting has already been done.

This section of the appendix assumes the user is operating with their working directory set to the state level directory (e.g., “*./State\_A/*”.

# setwd("./State\_A")

## Load packages and custom functions.

The following R packages are required for the data source, cleaning and augmentation.

require(SGPdata)  
require(data.table)

## General data setup and cleaning

This example dataset comes with a “built-in” impact in 2021 related to the pandemic as well as an unperturbed version - *SCALE\_SCORE\_without\_COVID\_IMPACT*. Here we will first subset the data to include only those years needed for the study, and then remove the perturbed score version and use the original scale score.

# First load and rename/remove SCALE\_SCORE\* variables included in the data  
State\_A\_Data\_LONG <- copy(SGPdata::sgpData\_LONG\_COVID)[YEAR < 2023]

***NOTE TO LESLIE & EMMA***

We will need to either come to an agreement on the longitudinal data naming or rename according to the SGP package conventions. Here I rename the demographic variables to match the “analysis specification” documents and remove some of the variables we will not be looking at or using.

setnames(  
 State\_A\_Data\_LONG,  
 c("ETHNICITY", "FREE\_REDUCED\_LUNCH\_STATUS", "ELL\_STATUS", "IEP\_STATUS",  
 "SCHOOL\_NUMBER"),  
 c("Race", "EconDis", "EL", "SWD", "SchoolID")  
)  
State\_A\_Data\_LONG[, Race := as.character(Race)]  
State\_A\_Data\_LONG[Race == "African American", Race := "Black"]  
State\_A\_Data\_LONG[Race == "Other", Race := "Multiracial"]  
  
State\_A\_Data\_LONG[, EconDis := gsub("Free Reduced Lunch", "FRL", EconDis)]  
State\_A\_Data\_LONG[, SWD := gsub("IEP", "SWD", SWD)]  
State\_A\_Data\_LONG[, EL := gsub("ELL", "EL", EL)]  
  
State\_A\_Data\_LONG[,  
 c("SCALE\_SCORE\_without\_COVID\_IMPACT", "GENDER",  
 "DISTRICT\_NUMBER", "DISTRICT\_NAME", "SCHOOL\_NAME"  
 ) := NULL  
]

### Create VALID\_CASE and invalidate duplicates

The SGP package requires a variable named VALID\_CASE with values set to either “VALID\_CASE” or “INVALID\_CASE”. This is helpful in identifying cases that are problematic for any number of reasons (duplicate records, invalid ID types, missing scores or subject/grade values, etc.). Any record flagged as an “INVALID\_CASE” will be excluded from any SGP analyses (but remain in the data for possible later use in other aggregations).

# Create `VALID\_CASE` if it does not exist:  
State\_A\_Data\_LONG[, VALID\_CASE := "VALID\_CASE"]  
  
# Check for record duplicates:  
setkey(State\_A\_Data\_LONG,  
 VALID\_CASE, CONTENT\_AREA, GRADE, YEAR, ID, SCALE\_SCORE)  
setkey(State\_A\_Data\_LONG,  
 VALID\_CASE, CONTENT\_AREA, GRADE, YEAR, ID)  
# Total Dups:  
State\_A\_Data\_LONG |> duplicated(by = key(State\_A\_Data\_LONG)) |> sum()  
# If duplicates, keep the highest score (if any non-NA exist)  
dupl <- duplicated(State\_A\_Data\_LONG, by = key(State\_A\_Data\_LONG))  
State\_A\_Data\_LONG[which(dupl)-1, VALID\_CASE := "INVALID\_CASE"]  
  
# Subset the data to remove invalid student records  
State\_A\_Data\_LONG <- State\_A\_Data\_LONG[VALID\_CASE == "VALID\_CASE"]

## Save data

fwrite(State\_A\_Data\_LONG,  
 file = "Data/Cleaned\_Data/Student\_LongTestData\_State\_A\_2016-2022\_AVI.csv"  
)

## Summary and notes

* “State A” uses the 2016 to 2022 subset of the *sgpData\_LONG\_COVID* dataset from the SGPData package.
  + Only required variables are retained.
* Variables required by the SGP packages were renamed and formatted as necessary.
* Student demographic variables were formatted to be consistent across all states in the study.
* A VALID\_CASE variable was created and used to identify duplicate records and other problematic cases.

# Student Growth Percentiles Analysis

This section presents and explains the code used to conduct the Student Growth Percentiles (SGP) analyses. Each simulated testing condition is applied via the R code to the same set of data, thus only producing growth measures for the appropriate grades, content areas and years. At the end of each condition-specific analysis, the SGP variable is renamed to indicate the simulated condition before proceeding to the next SGP analysis step. Only cohort-referenced SGPs are calculated (SGP projections and targets are omitted). The goal of this step is simply to create growth percentiles and merge them into the longitudinal data before aggregation and investigation of the impact non-census testing has on school accountability measures.

## Load SGP package and modify SGPstateData

The SGP package is required for all growth percentile analyses.

require(SGP)  
require(data.table)

We will use the assessment meta-data from the “Demonstration\_COVID” (abbreviated “DEMO\_COVID”) dataset stored in the SGPstateData object. This meta-data is required to use various functions in the SGP package.

SGPstateData[["State\_A"]] <- SGPstateData[["DEMO\_COVID"]]  
SGPstateData[["State\_A"]][["Growth"]][["Levels"]] <-  
 SGPstateData[["State\_A"]][["Growth"]][["Cutscores"]] <-  
 SGPstateData[["State\_A"]][["SGP\_Configuration"]][["percentile.cuts"]] <-  
 NULL

# Load cleaned, merged and formatted data  
if (!exists("State\_A\_Data\_LONG")) {  
 State\_A\_Data\_LONG <-  
 data.table::fread(  
 "Data/Cleaned\_Data/Student\_LongTestData\_State\_A\_2016-2022\_AVI.csv"  
 )[YEAR < 2020]  
} else {  
 State\_A\_Data\_LONG <- State\_A\_Data\_LONG[YEAR < 2020]  
}

## Simulation Condition 0

In this simulation condition, we want to replicate the base condition of typical census-level testing with the base data set. Growth analyses will include grades 4 to 8, with consecutive-year assessment patterns. Students with a valid score from the previous year and grade level in their historical data will be included in the growth calculations and receive a SGP. Up to two prior scores will be used as available in the data.

### Load and combine SGP config scripts

The growth calculation functions of the SGP software package allow users to manually specify which test progressions to run. That is, we can define the unique **year-by-grade-by-content area** cohorts of students included in each analysis.

As an example, the 2019 ELA analyses/cohorts are specified with this code:

ELA\_2019.config <- list(  
 ELA.2019 = list(  
 sgp.content.areas = rep("ELA", 3),  
 sgp.panel.years = c("2017", "2018", "2019"),  
 sgp.grade.sequences = list(  
 c("3", "4"), c("3", "4", "5"), # Elementary Grades  
 c("4", "5", "6"), c("5", "6", "7"), c("6", "7", "8") # Middle  
 )  
 )  
)

All configurations are housed in condition specific R code scripts. Here we read these in and combine them into a single list object, state.a.config, that will be supplied to the abcSGP function.

source("SGP\_CONFIG/Condition\_0.R")  
  
state.a.config <-  
 c(ELA\_2019.config,  
 MATHEMATICS\_2019.config,  
 ELA\_2018.config,  
 MATHEMATICS\_2018.config  
 )

### Calculate condition 0 SGPs

We use the abcSGP function from the SGP package to produce 2018 and 2019 student growth percentiles. We provide the function with the longitudinal data that was previously cleaned and formatted, as well as the list of analysis configurations and other relevant arguments to tailor the analyses to our specifications.

The SGP analysis section of the appendix assumes the user is operating with their working directory set to “*./Condition\_0*”.

setwd("./Condition\_0")  
State\_A\_SGP <-  
 abcSGP(  
 sgp\_object = State\_A\_Data\_LONG,  
 state = "State\_A",  
 steps = c("prepareSGP", "analyzeSGP", "combineSGP"),  
 sgp.config = state.a.config,  
 sgp.percentiles = TRUE,  
 sgp.projections = FALSE,  
 sgp.projections.lagged = FALSE,  
 sgp.percentiles.baseline = FALSE,  
 sgp.projections.baseline = FALSE,  
 sgp.projections.lagged.baseline = FALSE,  
 simulate.sgps = FALSE,  
 parallel.config = list(  
 BACKEND = "PARALLEL",  
 WORKERS = workers  
 )  
 )  
setwd("..")

### Re-name and remove the SGP variables as necessary

In order to keep all growth results in the same longitudinal dataset, we will add a Cnd\_0 tag to growth related variables of interest. Extraneous variables will be removed as well before moving on to the next simulation condition. We will save the coefficient matrices from all separate analyses in case we need to replicate or compare results from this condition analysis.

rm(State\_A\_Data\_LONG)  
State\_A\_Data\_LONG <- copy(State\_A\_SGP@Data)  
  
setnames(x = State\_A\_Data\_LONG, old = "SGP", new = "SGP\_Cnd\_0")  
State\_A\_Data\_LONG[,  
 c("SGP\_NORM\_GROUP", "SGP\_NORM\_GROUP\_SCALE\_SCORES",  
 "SCALE\_SCORE\_PRIOR", "SCALE\_SCORE\_PRIOR\_STANDARDIZED"  
 ) := NULL  
]  
  
Condition\_0\_CoefMatrices <- copy(State\_A\_SGP@SGP[["Coefficient\_Matrices"]])  
save(Condition\_0\_CoefMatrices,  
 file = "./Condition\_0/Condition\_0\_CoefMatrices.rda")

## Simulation Condition 1b

In this condition, students test twice per grade span (elementary and middle grades) in both subjects. Tests are administered every year in 3rd, 5th, 6th and 8th grades. Subsequently, all growth analyses will use a single prior score, and can be done with a either consecutive- or skipped-year assessment patterns.

### Load and combine SGP config scripts

In order to avoid errors in specification of our analysis configurations, we first remove all previous configuration related objects before reading in the code for condition 1b and proceeding as before. Unlike the other simulation conditions, 1b requires *both* consecutive- and skipped-year configuration scripts.

The 2019 ELA configuration code is provided here as an example and for comparison with the code provided above for condition 0:

ELA\_2019.config <- list(  
 ELA.SKIP.2019 = list(  
 sgp.content.areas = rep("ELA", 2),  
 sgp.panel.years = c("2017", "2019"),  
 sgp.grade.sequences = list(  
 c("3", "5"), # Elementary Grades  
 c("6", "8") # Middle Grades  
 )  
 ),  
 ELA.2019 = list(  
 sgp.content.areas = rep("ELA", 2),  
 sgp.panel.years = c("2018", "2019"),  
 sgp.grade.sequences = list(c("5", "6")) # Middle Only  
 )  
)

rm(list = grep(".config", ls(), value = TRUE))  
source("SGP\_CONFIG/Condition\_1b.R")  
  
state.a.config <-  
 c(ELA\_2019.config,  
 MATHEMATICS\_2019.config,  
 ELA\_2018.config,  
 MATHEMATICS\_2018.config  
 )

### Calculate condition 1b SGPs

We again use the abcSGP function to compute the student growth percentiles for this simulation condition. Here we use the data with results from condition 0. The updated list of analysis configurations is now provided, and all other relevant arguments remain the same.

setwd("./Condition\_1b")  
State\_A\_SGP <-  
 abcSGP(  
 sgp\_object = State\_A\_Data\_LONG,  
 state = "State\_A",  
 steps = c("prepareSGP", "analyzeSGP", "combineSGP"),  
 sgp.config = state.a.config,  
 sgp.percentiles = TRUE,  
 sgp.projections = FALSE,  
 sgp.projections.lagged = FALSE,  
 sgp.percentiles.baseline = FALSE,  
 sgp.projections.baseline = FALSE,  
 sgp.projections.lagged.baseline = FALSE,  
 simulate.sgps = FALSE,  
 parallel.config = list(  
 BACKEND = "PARALLEL",  
 WORKERS = workers  
 )  
 )  
setwd("..")  
  
rm(State\_A\_Data\_LONG)  
State\_A\_Data\_LONG <- copy(State\_A\_SGP@Data)  
  
setnames(x = State\_A\_Data\_LONG, old = "SGP", new = "SGP\_Cnd\_1b")  
State\_A\_Data\_LONG[,  
 c("SGP\_NORM\_GROUP", "SGP\_NORM\_GROUP\_SCALE\_SCORES",  
 "SCALE\_SCORE\_PRIOR", "SCALE\_SCORE\_PRIOR\_STANDARDIZED"  
 ) := NULL  
]  
  
Condition\_1b\_CoefMatrices <- copy(State\_A\_SGP@SGP[["Coefficient\_Matrices"]])  
save(Condition\_1b\_CoefMatrices,  
 file = "./Condition\_1b/Condition\_1b\_CoefMatrices.rda")

## Simulation Condition 1c

In this condition, students alternate testing in each subject across grade levels. In this simulation, students in grades 3, 5, and 7 take ELA and students in grades 4, 6, 7 take mathematics each year. As with condition 1b, all growth analyses will be conditioned on a single prior score, but only skipped-year assessment patterns can be analyzed.

### Load and combine SGP config scripts

We again remove all previous configuration related objects before reading in the condition 1c course progression code. The 2019 ELA configurations are once again provided here for comparison with other simulation conditions.

ELA\_2019.config <- list(  
 ELA.SKIP.2019 = list(  
 sgp.content.areas = rep("ELA", 2),  
 sgp.panel.years = c("2017", "2019"),  
 sgp.grade.sequences = list(  
 c("3", "5"), # Elementary Grades  
 c("5", "7") # Middle Grades  
 )  
 )  
)

The mathematics configurations are nearly identical to the ELA code, with the exception of the sgp.grade.sequences element, which specifies the grades 4 to 6 and grades 6 to 8 progressions. Note that this particular testing pattern means traditional elementary schools will only have growth measures for grade 5 ELA, while traditional middle schools will have growth indicators in all three grades and both content areas. The only contribution mathematics makes to a school’s accountability calculation is through grade 4 proficiency (status).

rm(list = grep(".config", ls(), value = TRUE))  
source("SGP\_CONFIG/Condition\_1c.R")  
  
state.a.config <-  
 c(ELA\_2019.config,  
 MATHEMATICS\_2019.config,  
 ELA\_2018.config,  
 MATHEMATICS\_2018.config  
 )

### Calculate condition 1c SGPs

The call to theabcSGP function here is identical to that made for conditions 1b and 2. The data object State\_A\_Data\_LONG now includes the results from conditions 0 and 1b, and the configurations have been updated.

setwd("./Condition\_1c")  
State\_A\_SGP <-  
 abcSGP(  
 sgp\_object = State\_A\_Data\_LONG,  
 state = "State\_A",  
 steps = c("prepareSGP", "analyzeSGP", "combineSGP"),  
 sgp.config = state.a.config,  
 sgp.percentiles = TRUE,  
 sgp.projections = FALSE,  
 sgp.projections.lagged = FALSE,  
 sgp.percentiles.baseline = FALSE,  
 sgp.projections.baseline = FALSE,  
 sgp.projections.lagged.baseline = FALSE,  
 simulate.sgps = FALSE,  
 parallel.config = list(  
 BACKEND = "PARALLEL",  
 WORKERS = workers  
 )  
 )  
setwd("..")  
  
rm(State\_A\_Data\_LONG)  
State\_A\_Data\_LONG <- copy(State\_A\_SGP@Data)  
  
setnames(x = State\_A\_Data\_LONG, old = "SGP", new = "SGP\_Cnd\_1c")  
State\_A\_Data\_LONG[,  
 c("SGP\_NORM\_GROUP", "SGP\_NORM\_GROUP\_SCALE\_SCORES",  
 "SCALE\_SCORE\_PRIOR", "SCALE\_SCORE\_PRIOR\_STANDARDIZED"  
 ) := NULL  
]  
  
Condition\_1c\_CoefMatrices <- copy(State\_A\_SGP@SGP[["Coefficient\_Matrices"]])  
save(Condition\_1c\_CoefMatrices,  
 file = "./Condition\_1c/Condition\_1c\_CoefMatrices.rda")

## Simulation Condition 2

In this condition, all students are tested every two years in each grade and subject on the state’s assessments. There are two instances of this condition to simulate:

* Testing only occurs in even years - (e.g., 2016, 2018, etc.)
* Testing only occurs in even years - (e.g., 2017, 2019, etc.)

In both instances, in a year that testing occurs, all students are tested in every grade and subject. As with condition 1c, all growth analyses will be conditioned on a single prior score with skipped-year patterns.

### Load and combine SGP config scripts

We again remove all previous configuration related objects before reading in the condition 2 course progression code. The 2019 ELA configurations are once again provided here for comparison with other simulation conditions.

ELA\_2019.config <- list(  
 ELA.SKIP.2019 = list(  
 sgp.content.areas = rep("ELA", 2),  
 sgp.panel.years = c("2017", "2019"),  
 sgp.grade.sequences = list(  
 c("3", "5"), # Elementary Grades  
 c("4", "6"), c("5", "7"), c("6", "8") # Middle Grades  
 )  
 )  
)

rm(list = grep(".config", ls(), value = TRUE))  
source("SGP\_CONFIG/Condition\_2.R")  
  
state.a.config <-  
 c(ELA\_2019.config,  
 MATHEMATICS\_2019.config,  
 ELA\_2018.config,  
 MATHEMATICS\_2018.config  
 )

### Calculate condition 2 SGPs

The call to theabcSGP function here is identical to that made for conditions 1b and 1c. The data object State\_A\_Data\_LONG now includes the results from conditions 0 through 1c, and the configuration object, state.a.config, has been updated.

setwd("Condition\_2")  
State\_A\_SGP <-  
 abcSGP(  
 sgp\_object = State\_A\_Data\_LONG,  
 state = "State\_A",  
 steps = c("prepareSGP", "analyzeSGP", "combineSGP"),  
 sgp.config = state.a.config,  
 sgp.percentiles = TRUE,  
 sgp.projections = FALSE,  
 sgp.projections.lagged = FALSE,  
 sgp.percentiles.baseline = FALSE,  
 sgp.projections.baseline = FALSE,  
 sgp.projections.lagged.baseline = FALSE,  
 simulate.sgps = FALSE,  
 parallel.config = list(  
 BACKEND = "PARALLEL",  
 WORKERS = workers  
 )  
 )  
setwd("..")  
  
rm(State\_A\_Data\_LONG)  
State\_A\_Data\_LONG <- copy(State\_A\_SGP@Data)  
  
setnames(x = State\_A\_Data\_LONG, old = "SGP", new = "SGP\_Cnd\_2")  
State\_A\_Data\_LONG[,  
 c("SGP\_NORM\_GROUP", "SGP\_NORM\_GROUP\_SCALE\_SCORES",  
 "SCALE\_SCORE\_PRIOR", "SCALE\_SCORE\_PRIOR\_STANDARDIZED"  
 ) := NULL  
]  
  
Condition\_2\_CoefMatrices <- copy(State\_A\_SGP@SGP[["Coefficient\_Matrices"]])  
save(Condition\_2\_CoefMatrices,  
 file = "./Condition\_2/Condition\_2\_CoefMatrices.rda")

## Simulation Condition 3

In this condition, all students are tested every two years at specific grade and subject on the state’s assessments. As with Condition 2, there are two instances of this condition to simulate:

* Testing only occurs in even years - (e.g., 2016, 2018, etc.)
* Testing only occurs in even years - (e.g., 2017, 2019, etc.)

In both instances, when testing occurs, students are tested specific grades in both subject areas. As with condition 1c, all growth analyses will be conditioned on a single prior score with skipped-year patterns. ### SGP config scripts

The pattern of testing for this condition is identical to that of condition 1b, with the exception of skipping years. This means that we have already calculated the SGPs for these patterns and do not need to reanalyze the data to get these results. Instead we can simply copy the results from simulation condition 1b that use the skipped-year progressions (i.e. results for grades 5 and 8, but not 6th grade).

For the sake of completeness, however, the 2019 ELA configurations for this condition would be a subset of the condition 1b code, such as this:

ELA\_2019.config <- list(  
 ELA.SKIP.2019 = list(  
 sgp.content.areas = rep("ELA", 2),  
 sgp.panel.years = c("2017", "2019"),  
 sgp.grade.sequences = list(  
 c("3", "5"), # Elementary Grades  
 c("6", "8") # Middle Grades  
 )  
 )  
)

### Use condition 1b growth for condition 3

Here we will simply copy the results from condition 1b to a new variable for condition 3. The grade 6 SGPs, which were consecutive-year (grade 5 to grade 6) will be omitted.

State\_A\_Data\_LONG[  
 GRADE %in% c(5, 8),  
 SGP\_Cnd\_3 := SGP\_Cnd\_1b  
]

## Save data

if (!dir.exists("Data/Student\_Growth"))  
 dir.create("Data/Student\_Growth", recursive = TRUE)  
  
save("State\_A\_Data\_LONG", file = "Data/Student\_Growth/State\_A\_Data\_LONG.rda")  
  
fwrite(State\_A\_Data\_LONG,  
 file = "Data/Student\_Growth/Student\_LongTestData\_State\_A\_2016-2019\_AVI.csv"  
)

# Growth and Achievement Aggregations

To simplify the analysis and enable comparisons of results across participating states, we plan to simulate a standard “prototype” accountability model with the following features.

***Reporting***

* The minimum n-count for computing scores for schools and disaggregated student groups is varied depending on the simulated condition.
* The disaggregated student groups should include economically disadvantaged students, students from racial and ethnic groups, children with disabilities, and English learners, as long as they meet the minimum n-count threshold in the simulated condition.

***Indicators***

* **Academic achievement** is the percentage of students in the school meeting the proficiency in ELA and mathematics (as defined by the ‘Proficient’ cut score on the statewide assessment).
* The computation of the ELA and math proficiency rates are adjusted if a school or student group does not have at least 95% participation.
* For the other academic indicator, we apply the following rules:
  + If student-level academic growth (consecutive-year or skip-year) can be computed, then we will use it for this indicator. For consistency, we will calculate student growth percentiles (SGPs) using the student-level assessment data.
  + If student-level academic growth (consecutive-year or skip-year) cannot be computed, then we will use an improvement measure, defined as the change in average scale scores for each grade-level subject area test between administrations for the school or student group.

***Summative Rating Computation***

All indicator scores are standardized by transforming into z-scores. Use the following means and standard deviations (SD) for the z-score computations (of all schools and student groups):

* *Academic achievement*
  + Mean: mean student-level proficiency rate for the focus year
  + SD: student-level proficiency rate SD for the focus year
  + standardized by year, subject and grade.
* *Other academic indicator -* ***growth***
  + SGPs, being percentiles, can be converted directly to a standardized metric[[1]](#footnote-45).
* *Other academic indicator -* ***improvement***
  + Mean: mean student-level scale score changes for the focus year, calculated separately for each grade level and subject area
  + SD: SD of student-level scale scores for the focus year, calculated separately for each grade level and subject area
  + standardized by year, subject and grade.
* *Graduation rates, progress in ELP, and SQSS*
  + Mean: mean school-level indicator scores for the focus year
  + SD: SD of school-level indicator scores for the focus year

## Additional variables for aggregated results

A standardized score variable and an achievement proficiency indicator are required for school level aggregations, final analyses and results comparisons. The standardized scale score variable is scaled by each ***year by subject by grade*** test mean and standard deviation[[2]](#footnote-47).

## Standardize SCALE\_SCORE by CONTENT\_AREA and GRADE using 2019 norms  
State\_A\_Data\_LONG[,  
 Z\_SCORE := scale(SCALE\_SCORE),  
 by = c("YEAR", "CONTENT\_AREA", "GRADE")  
]

A simple ‘1/0’ binary indicator for proficiency will allow us to compute descriptive statistics (e.g., percent proficient) easily and consistently across all states included in the report.

## Proficient/Not (1/0) binary indicator.  
State\_A\_Data\_LONG[,  
 PROFICIENCY := fcase(  
 ACHIEVEMENT\_LEVEL %in% c("Partially Proficient", "Unsatisfactory"), 0L,  
 ACHIEVEMENT\_LEVEL %in% c("Advanced", "Proficient"), 1L  
 )  
]  
  
State\_A\_Data\_LONG[,  
 Z\_PROFICIENCY := scale(PROFICIENCY),  
 by = c("YEAR", "CONTENT\_AREA", "GRADE")  
]

## Condition specific summary tables - all students by schools

***NOTE TO LESLIE & EMMA*** These tables and aggregations (as well as my variable additions such as Z\_PROFICIENCY and Z\_SCORE) are my first attempts to both interpret and implement what I’ve read in the “Analysis Specification” document. Since I have some extensive experience in aggregating growth and achievement data, this is how I would approach it at this early stage…

The following is an example of a preliminary school-level aggregation table for condition 0. Each condition will have a similar table, generally with only the appropriate SGP variable substituted for SGP\_Cnd\_0 and changes to the inclusion criteria (YEAR, GRADE and sometimes CONTENT\_AREA).

sch\_summary\_cnd\_0 <-  
 State\_A\_Data\_LONG[  
 YEAR %in% c(2018, 2019) &  
 GRADE %in% 3:8,  
 .(TotalN = .N,  
 ProfN = sum(PROFICIENCY==1L),  
 GrowthN = sum(!is.na(SGP\_Cnd\_0)),  
 MGP = round(mean(SGP\_Cnd\_0, na.rm = TRUE), 1),  
 MeanScore = round(mean(Z\_SCORE, na.rm = TRUE), 2),  
 PcntProf = round(mean(PROFICIENCY, na.rm = TRUE), 3)\*100,  
 StatusZ = round(mean(Z\_PROFICIENCY, na.rm = TRUE), 3),  
 GrowthZ = round(mean(qnorm(SGP\_Cnd\_0/100), na.rm = TRUE), 3)  
 ),  
 keyby = c("SchoolID", "YEAR", "CONTENT\_AREA")  
 ]

Per the specifications doc, this table would be widened to have a column for each subject. This can be achieved with this code (retaining all specified and my additional descriptive statistics).

sch\_summary\_cnd\_0w <-  
 dcast(  
 data = sch\_summary\_cnd\_0,  
 formula = SchoolID + YEAR ~ CONTENT\_AREA,  
 sep = "..",  
 value.var = names(sch\_summary\_cnd\_0) %w/o% key(sch\_summary\_cnd\_0)  
 )  
setnames(  
 sch\_summary\_cnd\_0w,  
 sapply(  
 names(sch\_summary\_cnd\_0w),  
 \(f) {  
 tmp.name <- strsplit(f, "[.][.]")[[1]] |> rev() |> paste(collapse = "\_")  
 gsub("MATHEMATICS", "Math", tmp.name)  
 }  
 ) |> unlist()  
)  
  
# Write files for each year separately as per the specifications:  
fwrite(sch\_summary\_cnd\_0w[YEAR == 2018][, YEAR := NULL],  
 file = "Data/School\_Summaries/School\_Condition\_0\_State\_A\_2018\_AVI.csv"  
)  
fwrite(sch\_summary\_cnd\_0w[YEAR == 2019][, YEAR := NULL],  
 file = "Data/School\_Summaries/School\_Condition\_0\_State\_A\_2019\_AVI.csv"  
)

You may notice that there are more summary calculations than what will be used (e.g., percent proficient and mean standardized scale scores). Those are included for our review - so we can easily see what a z-score, of for example 0.5, corresponds to in the actual percent proficient or mean SGP. Here are two schools from the condition 0 table:

sch\_summary\_cnd\_0[SchoolID %in% c(1001, 3801)] |>  
 setkey(SchoolID) |> print()

SchoolID YEAR CONTENT\_AREA TotalN ProfN GrowthN MGP MeanScore PcntProf StatusZ GrowthZ  
 1001 2018 ELA 120 109 73 49.7 0.62 90.8 0.511 -0.045  
 1001 2018 MATHEMATICS 120 107 73 61.5 0.79 89.2 0.553 0.386  
 1001 2019 ELA 162 146 90 54.0 0.66 90.1 0.501 0.151  
 1001 2019 MATHEMATICS 162 145 90 55.1 0.77 89.5 0.565 0.188  
 3801 2018 ELA 170 44 103 43.4 -0.89 25.9 -0.870 -0.264  
 3801 2018 MATHEMATICS 170 31 103 40.7 -0.91 18.2 -0.855 -0.317  
 3801 2019 ELA 151 67 101 53.4 -0.61 44.4 -0.467 0.142  
 3801 2019 MATHEMATICS 151 52 101 54.3 -0.66 34.4 -0.531 0.109

At some point we will want to combine the condition aggregations into a single table so that we can do direct condition comparisons. We can also clean up some of the extra descriptive statistics, re-order the columns or anything else.

# Combine all condition-specific tables into one:  
composite\_summary <-  
 sch\_summary\_cnd\_0[  
 sch\_summary\_cnd\_1b][  
 sch\_summary\_cnd\_1c][  
 sch\_summary\_cnd\_2][  
 sch\_summary\_cnd\_3]  
  
# Remove extraneous aggregations:  
composite\_summary[,  
 grep("PcntProf|Mean\_", names(composite\_summary), value = TRUE) :=  
 NULL  
]  
  
# School No. '1001' - changes in Growth N count  
composite\_summary[SchoolID == 1001,  
 c("YEAR", "CONTENT\_AREA",  
 grep("GrowthN", names(composite\_summary), value = TRUE)  
 ), with = FALSE  
]

YEAR CONTENT\_AREA GrowthN GrowthN\_1b GrowthN\_1c GrowthN\_2 GrowthN\_3  
 2018 ELA 73 40 40 40 40  
 2018 MATHEMATICS 73 40 0 40 40  
 2019 ELA 90 38 38 38 38  
 2019 MATHEMATICS 90 38 0 38 38

# School No. '1001' - Growth (Z-SGP) summaries  
composite\_summary[SchoolID == 1001,  
 c("YEAR", "CONTENT\_AREA",  
# All relevant aggregations at once:  
# sort(grep("GrowthZ|StatusZ", names(composite\_summary), value = TRUE))  
 grep("GrowthZ", names(composite\_summary), value = TRUE) # just z-growth  
 ), with = FALSE  
]

YEAR CONTENT\_AREA GrowthZ GrowthZ\_1b GrowthZ\_1c GrowthZ\_2 GrowthZ\_3  
 2018 ELA -0.045 0.214 0.214 0.214 0.214  
 2018 MATHEMATICS 0.386 0.459 NaN 0.459 0.459  
 2019 ELA 0.151 -0.128 -0.128 -0.128 -0.128  
 2019 MATHEMATICS 0.188 0.130 NaN 0.130 0.130

# School No. '1001' - Status (Z-proficient %) summaries  
composite\_summary[SchoolID == 1001,  
 c("YEAR", "CONTENT\_AREA",  
 grep("StatusZ", names(composite\_summary), value = TRUE)  
 ), with = FALSE  
]

YEAR CONTENT\_AREA StatusZ StatusZ\_1b StatusZ\_1c StatusZ\_2 StatusZ\_3  
 2018 ELA 0.511 0.533 0.533 0.511 0.533  
 2018 MATHEMATICS 0.553 0.513 0.657 0.553 0.513  
 2019 ELA 0.501 0.493 0.493 0.501 0.493  
 2019 MATHEMATICS 0.565 0.536 0.622 0.565 0.536

Another way to combine all the conditions is to create a long summary table with the same summary variable names for each condition and an added column indicating the condition they belong to.

Because creating summary tables for all growth conditions only requires changing the data records selected (year, grade and content areas as defined for each condition) and the growth variable specified in the aggregation code above, and we are going to be doing this numerous times, we will create a custom function to create these tables, rather than copying the code for each use case. This will also help in the demographic level summaries, which require the addition of the variable of interest into the keyby argument of the data.table aggregation.

schoolAggrGator =  
 function(  
 data\_table,  
 growth.var,  
 groups = c("SchoolID", "YEAR", "CONTENT\_AREA")  
 ) {  
 aggr.names <-  
 c("TotalN", "ProfN", "GrowthN", "MGP",  
 "GrowthZ", "MeanScore", "PcntProf", "StatusZ")  
 frmla <-  
 paste0(  
 paste(groups %w/o% "CONTENT\_AREA", collapse = " + "),  
 " ~ CONTENT\_AREA"  
 ) |> as.formula()  
 data\_table[,  
 # the list of summaries can be reduced/increased/amended as needed:  
 .(TotalN = .N,  
 ProfN = sum(PROFICIENCY==1L),  
 GrowthN = sum(!is.na(get(growth.var))),  
 MGP = round(mean(get(growth.var), na.rm = TRUE), 1),  
 GrowthZ = round(mean(qnorm(get(growth.var)/100), na.rm = TRUE), 3),  
 MeanScore = round(mean(Z\_SCORE, na.rm = TRUE), 2),  
 PcntProf = round(mean(PROFICIENCY, na.rm = TRUE), 3)\*100,  
 StatusZ = round(mean(Z\_PROFICIENCY, na.rm = TRUE), 3)  
 ),  
 keyby = groups  
 ] |>  
 dcast(  
 formula = frmla,  
 sep = "..",  
 value.var = aggr.names  
 ) |>  
 setnames(  
 sapply(  
 c(groups %w/o% "CONTENT\_AREA",  
 paste(  
 rep(c("ELA", "Math"), length(aggr.names)),  
 rep(aggr.names, each = 2),  
 sep = "\_"  
 )),  
 \(f) {  
 tmp.name <-  
 strsplit(f, "[.][.]")[[1]] |>  
 rev() |> paste(collapse = "\_")  
 gsub("MATHEMATICS", "Math", tmp.name)  
 }  
 ) |> unlist()  
 )  
 }

We can look at these tables in a number of ways to make sure we are getting what is expected. A simply cross-tab by year shows that many schools do not get a summary in condition 1c given the testing pattern:

table(school\_aggregation\_all\_students[, .(Condition, YEAR), is.na(Math\_GrowthZ)])

, , YEAR = 2018  
  
 Condition  
is.na 0 1b 1c 2 3  
 FALSE 231 231 149 231 231  
 TRUE 0 0 82 0 0  
  
, , YEAR = 2019  
  
 Condition  
is.na 0 1b 1c 2 3  
 FALSE 231 231 149 231 231  
 TRUE 0 0 82 0 0

fwrite(school\_aggregation\_all\_students,  
 file = "Data/School\_Summaries/School\_Condition\_AllGrowth\_AllStudents\_State\_A\_AllYears\_AVI.csv"  
)

## Achievement Improvement Aggregations

The simulation condition 1a does not allow for growth calculations and will instead use an indicator of status improvement. This **improvement** measure is defined as the change in average scale scores for each grade-level content area test between administrations for the school or student group.

For this aggregation we will create status summaries in a similar way as the other conditions, but include all available years. Lagged values are then created and the change scores calculated.

sch\_summary\_cnd\_1a <-  
 State\_A\_Data\_LONG[  
 GRADE %in% c(5, 8),  
 .(TotalN = .N,  
 MeanScore = round(mean(Z\_SCORE, na.rm = TRUE), 2),  
 StatusZ = round(mean(Z\_PROFICIENCY, na.rm = TRUE), 3)  
 ),  
 keyby = c("YEAR", "CONTENT\_AREA", "GRADE", "SchoolID")  
 ]  
  
# Create lagged variables (1 year lag):  
setkeyv(  
 sch\_summary\_cnd\_1a,  
 c("SchoolID", "CONTENT\_AREA", "YEAR", "GRADE")  
)  
cfaTools::getShiftedValues(  
 sch\_summary\_cnd\_1a,  
 shift\_group = c("SchoolID", "CONTENT\_AREA"),  
 shift\_variable = c("TotalN", "MeanScore", "StatusZ"),  
 shift\_amount = 1L  
)  
  
# Subset the data for the two focus years:  
sch\_summary\_cnd\_1a <-  
 sch\_summary\_cnd\_1a[YEAR %in% c(2018, 2019)]  
  
# Calculate changes (current year minus 1 year lag)  
sch\_summary\_cnd\_1a[,  
 TotalN\_Change := TotalN - TotalN\_LAG\_1  
][,  
 MeanScore\_Change := MeanScore - MeanScore\_LAG\_1  
][,  
 StatusZ\_Change := StatusZ - StatusZ\_LAG\_1  
]

Here is our example school’s improvement numbers

sch\_summary\_cnd\_1a[SchoolID == 1001,  
 c(key(sch\_summary\_cnd\_1a)[-1],  
 grep("Change", names(sch\_summary\_cnd\_1a), value = TRUE)  
 ), with = FALSE  
]

CONTENT\_AREA YEAR GRADE TotalN\_Change MeanScore\_Change StatusZ\_Change  
 ELA 2018 5 24 0.56 0.307  
 ELA 2019 5 -3 -0.20 -0.113  
 MATHEMATICS 2018 5 24 0.54 0.059  
 MATHEMATICS 2019 5 -3 -0.41 0.164

Per the specifications doc, here is how we could reshape this summary table and output by year.

# Reshape by subject  
sch\_summary\_cnd\_1a <-  
 dcast(  
 data = sch\_summary\_cnd\_1a,  
 formula = SchoolID + YEAR + GRADE ~ CONTENT\_AREA,  
 sep = "..",  
 value.var = names(sch\_summary\_cnd\_1a) %w/o% key(sch\_summary\_cnd\_1a)  
 )  
setnames(  
 sch\_summary\_cnd\_1a,  
 sapply(  
 names(sch\_summary\_cnd\_1a),  
 \(f) {  
 tmp.name <- strsplit(f, "[.][.]")[[1]] |> rev() |> paste(collapse = "\_")  
 gsub("MATHEMATICS", "Math", tmp.name)  
 }  
 ) |> unlist()  
)  
  
fwrite(sch\_summary\_cnd\_1a[YEAR == 2018][, YEAR := NULL],  
 file = "Data/School\_Summaries/School\_Condition\_1a\_State\_A\_2018\_AVI.csv"  
)  
fwrite(sch\_summary\_cnd\_1a[YEAR == 2019][, YEAR := NULL],  
 file = "Data/School\_Summaries/School\_Condition\_1a\_State\_A\_2019\_AVI.csv"  
)

One thought before leaving the “school improvement” indicator section is that the issue of “regression to the mean” should be considered. There is a strong relationship between current/prior scores and change scores that may require a correction:

cor(  
 sch\_summary\_cnd\_1a[, Math\_MeanScore, Math\_MeanScore\_Change],  
 use = 'na.or.complete'  
) |> round(3)

Math\_MeanScore\_Change Math\_MeanScore  
Math\_MeanScore\_Change 1.000 0.493  
Math\_MeanScore 0.493 1.000

cor(  
 sch\_summary\_cnd\_1a[, Math\_MeanScore\_LAG\_1, Math\_MeanScore\_Change],  
 use = 'na.or.complete'  
) |> round(3)

Math\_MeanScore\_Change Math\_MeanScore\_LAG\_1  
Math\_MeanScore\_Change 1.000 -0.517  
Math\_MeanScore\_LAG\_1 -0.517 1.000

cor(  
 sch\_summary\_cnd\_1a[, ELA\_MeanScore\_LAG\_1, ELA\_MeanScore\_Change],  
 use = 'na.or.complete'  
) |> round(3)

ELA\_MeanScore\_Change ELA\_MeanScore\_LAG\_1  
ELA\_MeanScore\_Change 1.000 -0.466  
ELA\_MeanScore\_LAG\_1 -0.466 1.000

## School level aggregations by demographics

Adding in the demographic variables is a simple addition of the variable of interest into the keyby argument of the data.table aggregation.

Our original “base” condition table can be reproduced now with this call to our function:

An example of our function used for (dis)aggregation by student demographics (Economic Disadvantage) for condition 0 results:

schoolAggrGator(  
 data\_table =  
 State\_A\_Data\_LONG[YEAR %in% c(2018, 2019) & GRADE %in% 3:8,],  
 growth.var = "SGP\_Cnd\_0",  
 groups = c("SchoolID", "YEAR", "CONTENT\_AREA", "EconDis")  
)

In order to do all the demographic summaries at once, we can combine calls to the function (rather than creating separate tables and THEN combining) using the rbindlist function from data.table. Note that the demographic subgroup indicator is changed (from the demographic variable name) to the generic “Group” for each individual table.:

demog\_cond\_0 <-  
 rbindlist(  
 list(  
 schoolAggrGator(  
 data\_table =  
 State\_A\_Data\_LONG[YEAR %in% c(2018, 2019) & GRADE %in% 3:8,],  
 growth.var = "SGP\_Cnd\_0",  
 groups = c("SchoolID", "YEAR", "CONTENT\_AREA", "Race")  
 ) |> setnames("Race", "Group"),  
 schoolAggrGator(  
 data\_table =  
 State\_A\_Data\_LONG[YEAR %in% c(2018, 2019) & GRADE %in% 3:8,],  
 growth.var = "SGP\_Cnd\_0",  
 groups = c("SchoolID", "YEAR", "CONTENT\_AREA", "EconDis")  
 ) |> setnames("EconDis", "Group"),  
 schoolAggrGator(  
 data\_table =  
 State\_A\_Data\_LONG[YEAR %in% c(2018, 2019) & GRADE %in% 3:8,],  
 growth.var = "SGP\_Cnd\_0",  
 groups = c("SchoolID", "YEAR", "CONTENT\_AREA", "EL")  
 ) |> setnames("EL", "Group"),  
 schoolAggrGator(  
 data\_table =  
 State\_A\_Data\_LONG[YEAR %in% c(2018, 2019) & GRADE %in% 3:8,],  
 growth.var = "SGP\_Cnd\_0",  
 groups = c("SchoolID", "YEAR", "CONTENT\_AREA", "SWD")  
 ) |> setnames("SWD", "Group")  
 )  
 )

Here a subset of the output from the example school:

demog\_cond\_0[  
 SchoolID == 1001 & YEAR == 2019  
][,  
 grep("YEAR|SchoolID|MGP|MeanScore", names(demog\_cond\_0), value = TRUE) := NULL  
][]

Group ELA\_TotalN Math\_TotalN ELA\_ProfN Math\_ProfN ELA\_GrowthN Math\_GrowthN ELA\_GrowthZ Math\_GrowthZ ELA\_PcntProf Math\_PcntProf ELA\_StatusZ Math\_StatusZ  
 Asian 30 30 27 23 21 21 0.225 0.064 90.0 76.7 0.499 0.316  
 Black 12 12 10 10 8 8 -0.274 -0.117 83.3 83.3 0.357 0.445  
 Hispanic 30 30 24 24 18 18 -0.046 -0.082 80.0 80.0 0.287 0.379  
 Multiracial 10 10 9 10 7 7 0.559 0.400 90.0 100.0 0.499 0.800  
 White 80 80 76 78 36 36 0.222 0.423 95.0 97.5 0.604 0.717  
 FRL: No 146 146 133 132 83 83 0.140 0.166 91.1 90.4 0.522 0.586  
 FRL: Yes 16 16 13 13 7 7 0.280 0.455 81.2 81.2 0.312 0.377  
 EL: No 159 159 143 142 89 89 0.143 0.199 89.9 89.3 0.497 0.562  
 EL: Yes 3 3 3 3 1 1 0.878 -0.739 100.0 100.0 0.709 0.753  
 SWD: No 152 152 146 143 83 83 0.215 0.265 96.1 94.1 0.627 0.660  
 SWD: Yes 10 10 0 2 7 7 -0.608 -0.725 0.0 20.0 -1.408 -0.869

Another example of how to combine the aggregations uses calls to the function via lapply over the demographic variables and piping the resulting list to rbindlist.

demog\_cond0 <-  
 lapply(  
 c("Race", "EconDis", "EL", "SWD"),  
 \(f) {  
 schoolAggrGator(  
 data\_table =  
 State\_A\_Data\_LONG[YEAR %in% c(2018, 2019) & GRADE %in% 3:8, ],  
 growth.var = "SGP\_Cnd\_0",  
 groups = c("SchoolID", "YEAR", "CONTENT\_AREA", f)  
 )[, Condition := "0"] |> setnames(f, "Group")  
 }  
 ) |> rbindlist()

Either of the demographic aggregation and combination code chunks above can be run for each of the SGP\_Cnd\* growth fields. At that point, we can then combine those objects in a wide format (similar to what was done for the composite\_summary object - this would require re-naming the aggregate variables), stacked into a long format (with an added “Condition” variable for each table - probably what I would do) or written to separate .csv files as described in the specification doc.

The example below shows how to create a stacked long format version with all conditions that contain growth.

## A single file with all aggregations

I may be missing something about why all the various .csv files are needed for this step, but if we wanted to save all the conditions and summaries as a single file, we could do something like this (and then save as a single .csv using fwrite or similar):

school\_aggregation\_all\_students[, Group := "All Students"]  
setcolorder(  
 school\_aggregation\_all\_students,  
 names(school\_aggregation\_student\_demogs)  
)  
school\_aggregation\_all <-  
 rbindlist(  
 list(  
 school\_aggregation\_all\_students,  
 school\_aggregation\_student\_demogs  
 )  
 )  
setkeyv(school\_aggregation\_all, c("Condition", "SchoolID", "YEAR"))  
  
fwrite(school\_aggregation\_all,  
 file = "Data/School\_Summaries/School\_Condition\_AllGrowth\_Demographics\_State\_A\_AllYears\_AVI.csv"  
)

## Summary and notes

* A standardized scale score variable is added (scaled by unique grade, content area and annual assessment).
* A binary indicator variable for proficiency status is added.
* Methods for using the data.table package for calculating school level aggregations for all students and by demographic subgroups were outlined and discussed with examples.

# References

Betebenner, Damian W., Adam VanIwaarden, Ben Domingue, and Yi Shang. 2022. *SGP: Student Growth Percentiles & Percentile Growth Trajectories.* [sgp.io](https://sgp.io).

1. **Ex. in R:** qnorm(c(1, 10, 25, 50, 75, 90, 99)/100) gives the z-score for the 1st, 10th, 25th, … etc., percentiles. For more on mapping percentiles on to the standard-normal distribution, [see this site](https://sphweb.bumc.bu.edu/otlt/MPH-Modules/PH717-QuantCore/PH717-Module6-RandomError/PH717-Module6-RandomError7.html) [↑](#footnote-ref-45)
2. The unstandardized SCALE\_SCORE variable is used in the SGP calculations. [↑](#footnote-ref-47)