Homework 9: Standardized Testing and Bias

36-313, Fall 2022

Due at 6 pm on Thursday, 10 November 2022

Agenda: Examining the predictive validity of a score; more practice reading scientific reports.

For this assignment, you are going to have to read and interpret some results from the following report:

Brent Bridgeman, Laura McCamley-Jenkins and Nancy Ervin, "Predictions of Freshman Grade-Point Average From the Revised and Recentered SAT I", *ETS Research Reports* **00:1** (2000), https://doi.org/10.1002/j.2333-8504.2000.tb01824.x (also published as *College Board Research Report No. 2000-1* [New York: College Entrance Examination Board, 2000])

1. *Understanding*
   a. (5) What outcome for college students is the report trying to predict?
   b. (5) Describe the sample of colleges and of students being studied in this report. Is it a random sample? Is it a representative sample? How big is it, in terms of both colleges and of students?
   c. (5) In addition to the outcome and SAT scores, the report also looks at high school grades, race and ethnicity, sex, parental education levels, and family income. How are all of these measured? How reliable do these measurements seem?
2. *Comparisons* In answering each of the following questions, support your answer by referring to specific tables and figures in the report. Throughout, "SAT score" is short-hand for "combined verbal and math SAT scores". If you think the question can't be answered on the basis of the findings *in the report*, explain — what more would we need to know?
   a. (5) Which combinations of race and sex have their freshman grades *best* predicted by SAT scores? Which have their grades *worst* predicted by SAT scores?
   b. (5) For which level of *parental* education do SAT scores predict best? For which level do they predict worst? How large are the differences in predictability by sex and race *within* education levels, compared to differences *between* educational levels?
   c. (5) For which level of family income do SAT scores predict best? For which do they predict worst? How large are the differences in predictability by sex and race *within* income levels, compared to differences *between* income levels?
   d. (5) Which combinations of race and sex are have grades which are most *under*-predicted by their SAT score? (That is, their average grades are better than would be predicted from their SAT scores alone.) Which groups have grades which are most over-predicted?
   e. (5) All of the previous questions have asked about how well college grades can be predicted from SAT scores. Would the answers be any different if we were trying to predict college grades from high school GPA? Does it matter if it's self-reported high school GPA?
   f. (5) Which combinations of race and sex have the highest average SAT scores?
   g. (5) Which combinations of race and sex have the highest average freshman GPA?
   h. (5) Generally speaking, are the groups with highest correlations between SAT scores and grades also the ones with the highest average SAT scores?
3. *Range restriction and correlations* An important part of the report is correcting for "range restriction", the fact that GPAs are only available for admitted students, who have higher SAT scores than the typical test-taker. The exact way in which they correct for range restriction is somewhat technical and outside our scope, but it's easy to get a sense of how not correcting can be deeply misleading.
   a. (5) Using the `rnorm()` function, create a vector of 100,000 random Gaussian variables, all with mean 900 and standard deviation 150. Show the distribution of the draws using a histogram

(or other suitable plot) to check that it is, in fact, pretty close to Gaussian. Pretend that these are the SAT scores for all test takers.

b. (5) Create a GPA for each of your simulated test takers by multiplying the SAT score by 0.00347 and adding an independent Gaussian random variable with mean 0 and standard deviation 0.854. (Add a *different* Gaussian for each simulated test-taker.) Make a scatter-plot of GPA versus SAT score. (The numbers here are chosen to mimic some results in the report.)

c. (5) What's the correlation between SAT score and GPA in this full (simulated) population? What's the coefficient of a linear regression of GPA on SAT score? What's the R^2 of the regression?

d. (5) Re-do the calculation in the previous part only on those in the simulated population with an SAT score over 800.

e. (4) Re-do the calculations using only those with an SAT score over 900; only on those with scores over 1000; with scores over 1250.

f. (5) Make a plot of the correlation between SAT and GPA as a function of the minimum SAT score (using the previous questions).

g. (5) Explain, in your own words, why simply looking at the correlation between SAT and GPA for *admitted* students is misleading about how well the SAT can predict GPA.

4. *Timing* (1) How long, roughly, did you spend on this assignment?

Presentation rubric (10): The text is laid out cleanly, with clear divisions between problems and sub-problems. The writing itself is well-organized, free of grammatical and other mechanical errors, and easy to follow. Plots are carefully labeled, with informative and legible titles, axis labels, and (if called for) sub-titles and legends; they are placed near the text of the corresponding problem. All quantitative and mathematical claims are supported by appropriate derivations, included in the text, or calculations in code. Numerical results are reported to appropriate precision.