

# Equating Error

## A Program for Computing Equating Error Using the Bootstrap

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This manual describes a program for computing bootstrap standard errors of equating for number correct raw scores, unrounded scale scores, and rounded scale scores. This manual describes versions of the program that runs under Unix and DOS. A separate manual describes a Macintosh version of this program.

This program can compute standard errors of equating for the random groups equating design using equipercentile equating with pre-smoothing or post-smoothing, unsmoothed equipercentile equating, linear equating, or mean equating. The procedure used is to draw pairs of random samples (with replacement) from the new and old form score distributions, and compute an equating function for each pair of samples. The standard deviation over replications of the equated score corresponding to each new form raw score is used as the standard error of equating.

To run the program type the executable file name followed by one or more spaces and the name of a control file. The control file contains the information needed to run the program. An example control file is given below.

```
# Example data from Kolen and Brennan equating book Table 2.5
# Results should be close to results in Table 7.1
Replications      500
Seed              285947671
Smooth            Presmooth
Parameter         6
Scale             1.0 36.0 1.0
Columns           2 3 4
Input             Kolen-Brennan.dat
Output            Kolen-Brennan.out
```

The first two lines of the control file are comments (any lines beginning with a pound sign are ignored by the program). Each of the remaining lines contains information needed by the program. The line label is given first (this indicates the type of information on the line), followed by one or more spaces or tabs and the information indicated by the line label. The line labels are not case sensitive (actually only the first and second characters of the line label is used to identify the information on the line).

The line labeled "Replications" contains the number of bootstrap replications to be used. The line labeled "Seed" is the seed used for the random number generator. If no line with a seed is given in the control file a seed is chosen based on the time. The line labeled "Smooth" gives the type of equating function to use. There are five possible types of equating function: Presmooth (equipercentile with pre-smoothing), Postsmooth (equipercentile with post-smoothing), Nosmooth (unsmoothed equipercentile), Linear (linear equating), and Mean (mean equating). Post-smoothing is implemented by smoothing the equipercentile equating function using cubic splines. Pre-smoothing is implemented by fitting polynomial loglinear models to each of the two univariate distributions and using the smoothed distributions to compute the equipercentile equating function. The line labeled "Parameter" contains the value of the smoothing parameter which determines the amount of smoothing for post-smoothing, and is the maximum degree of the polynomial used in the loglinear model for pre-smoothing (the same degree is used for both distributions). A parameter does not need to be specified for unsmoothed, linear and mean equating (if a parameter is specified it is ignored). The line labeled "Scale" contains three numbers separated by one or more blanks or tabs specifying scale score properties. The three

numbers are the minimum scale score, the maximum scale score, and the increment between consecutive scale scores (in that order).

There are three pieces of data that are read by the program: the number correct frequency distribution for the new test form, the number correct frequency distribution for the old test form, and the raw to scale score conversion for the old form (typically unrounded). It is assumed that the old and new forms have the same number of items. The line labeled "Columns" in the control file contains three numbers separated by one or more spaces or tabs which determine which columns of the input file contain these pieces of data. The first number is the column in the input file containing the new form distribution, the second number is the column in the input file containing the old form distribution, and the third number is the column in the input file containing the raw to scale score conversion for the old form. Columns in the input file should be separated by one or more space or tab characters.

The line in the control file labeled "Input" contains the name of the input file containing the frequency distributions and raw to scale score conversion for the old form. The line in the control file labeled "Output" contains the name of the output file where results will be written. If an output file is not specified the results are written to the standard output (the console).

A portion of an output file is shown below.

```
Input file: Kolen-Brennan.dat
Columns read:      2      3      4
Type of equating function:  Pre-Smoothing
Smoothing parameter:  6.000000
Number of replications: 500
Seed: 285947671
Scale min, max, inc:  1.000000  36.000000  1.000000
Sample sizes (new, old):  4329.000000  4152.000000

0      0.11646317  0.00000000  0.00000000  -0.40315626  0.50000000  1.00000000
1      0.35896946  0.00000000  0.00000000  0.13961611  0.50000000  1.00000000
2      0.34114993  0.00000000  0.00000000  0.96590711  0.50000000  1.00000000
3      0.27656227  0.00000000  0.00000000  1.84311137  0.50000000  1.00000000
4      0.21797366  0.00000000  0.00000000  2.74037093  0.50000000  1.00000000
5      0.18440344  0.00395140  0.00000000  3.64598101  0.50044807  1.00000000
. . .
39     0.23093707  0.31963075  0.41580765  39.03741640  34.22465374  34.15200000
40     0.13148307  0.16649701  0.49989999  40.00781650  35.47139803  35.49000000
Mean   0.25333393  0.23833453  0.35122219  18.98093324  16.51041187  16.51525479
```

The first 8 lines of the output file contain information describing the run. Following this are seven columns of numbers. The first column contains new form number correct raw scores. The second column is the standard error of equating for the raw score equating function. This is the standard deviation across bootstrap replications of the equated number correct score corresponding to each new form number correct score. The third column contains the bootstrap standard errors of equating for the unrounded raw to scale score conversion. The fourth column contains bootstrap standard errors of equating for the rounded raw to scale score conversions. The fifth through seventh columns contain means across bootstrap replications of the equated number correct score, unrounded raw to scale score conversion, and rounded raw to scale score conversion, respectively. In summary, the second through fourth columns contain standard deviations of equated scores, and the fifth through seventh columns contain means of equated scores, with both the standard deviations and means computed across bootstrap replications. After the results for the last raw score, the averages of the standard deviations and means of the equated scores across new form raw scores are reported using the new form distribution to compute the average.

The last result in the output file is a table giving the distribution of rounded scale score equivalents for each new form raw score. Each row of this table contains n+1 numbers if there

are n possible rounded scale score values. The first number is the new form number correct score for that row. Numbers after the first are the number of times in the bootstrap replications the corresponding scale score was produced as the rounded scale score equivalent to that number correct score. For example, the second number in each row is the frequency for the lowest possible scale score, the third number is the frequency for the second lowest scale score, etc.