

# ON NORMALIZATION PROCEDURE FOR NORMALIZING BOARD MARKS BASED ON DISTRIBUTION OF MARKS IN JEE-MAIN EXAMINATION

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Grading in different boards differ from each other due to subjective nature of evaluation, different syllabi and other local factors. In order to normalize marks of different boards it is appropriate that a large and heterogeneous population of students from the different boards is subjected to a common test. Since the students of various boards will be writing a common entrance examination, it makes sense to normalize their board marks based on the distribution of marks in the common entrance test. In view of the above, the following normalization scheme is proposed.

The proposed method uses a linear scaling method (z-scores) to adjust the mean and standard deviation levels of the aggregate marks of the students of different boards, with respect to the aggregate marks of the same group of students on the common test that these students have taken (i.e. the JEE-MAIN examination). Under this approach, on using the z-scores of a candidate in his/her board and the JEE-MAIN examination, the aggregate score obtained by the student in his board examination is transformed to a new scaled score. The steps followed for constructing the scaled score and final pooled score of a student based on his/her performance in both the examinations are given below:

- Step I:** Aggregate board and JEE-MAIN marks are mapped to an identical scale through a linear transformation (i.e. marks in both the examinations are converted to the same maximum, say, out of a maximum of 500). Let  $Y_X$  denote the transformed aggregate marks of a student in the board  $X$  and let  $Y_{AIEEE}$  be his/her transformed JEE-MAIN aggregate score.
- Step II:** The marks of the failed candidates, of the concerned board, are ignored for the purpose of evaluating parameters (mean and standard deviation) required for normalization. For a particular board (say, Board  $X$ ), let  $\mu_X$  and  $\sigma_X$ , respectively, denote the mean and standard deviation of aggregate marks obtained after discarding the aggregate marks of failed candidates in the board.
- Step III:** Records of students with positive aggregate scores in the JEE-MAIN examination are only considered for the purpose of evaluating parameters (mean and standard deviation) for normalization. Let  $\mu_S$  and  $\sigma_S$ , respectively, denote the mean and the standard deviation of the aggregate JEE-MAIN marks of students scoring positive aggregate marks in JEE-MAIN.

**Step IV:** Let  $Y_x$  denote the transformed aggregate marks (using Step I) of a student in the board X. Then his normalized board score will be given by

$$Y_{X(N)} = \mu_S + \frac{\sigma_S}{\sigma_X} (Y_x - \mu_X)$$

**Step V:** Let  $Y_{X(N)}$  be the normalized board score of a candidate (using Step IV) and let  $Y_{AIEEE}$  be his/her transformed JEE-MAIN aggregate score (using Step I). Then the combined score of the candidate is given by

$$Y_C = 0.4 \times Y_{X(N)} + 0.6 \times Y_{AIEEE} .$$

**Step VI:** Students are ranked based on the combined scores arrived at Step V.

#### **OBSERVATIONS BASED ON CBSE (Maharashtra Board) AND AIEEE SCORES OF 2010, 2011, 2012**

We report below the various correlations obtained using the above approach and percentile rank based score approach suggested by ISI.

	Year		
	2010	2011	2012
<b>AIEEE rank and <math>Y_C</math> rank</b>	0.8513	0.8570	0.8855* (0.8219)
<b>AIEEE rank and ISI rank</b>	0.6134	0.6361	0.7072 (0.5124)
<b><math>Y_C</math> rank and ISI rank</b>	0.9245	0.9320	0.9440 (0.8865)
<b>CBSE (Maharashtra Board) score and <math>Y_C</math> score</b>	0.8296	0.8403	0.8646 (0.7965)
<b>CBSE (Maharashtra Board) score and ISI score</b>	0.9902	0.9895	0.9895 (0.9938)
<b>AIEEE score and <math>Y_C</math> score</b>	0.9281	0.9324	0.9422 (0.9151)
<b>AIEEE score and ISI score</b>	0.6415	0.6778	0.7319 (0.5359)

**\*Entries within brackets correspond to Maharashtra Board**

**Notations:**

**AIEEE rank:** Absolute rank (not percentile rank) based on AIEEE score alone;

$Y_C$  **rank:** Absolute rank based on  $Y_C$  score alone (see Step V and Step VI above);

**ISI Score:**  $Y_{ISI} = 0.4 \times Y_P + 0.6 \times Y_{AIEEE}^S$ , where  $Y_P = (\text{percentile rank of student} - 75) \times 100 / (100 - 75)$  and  $Y_{AIEEE}^S$  is the aggregate score in the AIEEE, transformed to the scale 0–100 (through linear transformation);

**ISI rank:** Rank based on ISI score  $Y_{ISI}$  alone;

**CBSE (Maharashtra Board) score:** Aggregate marks (in five subjects) in CBSE (Maharashtra Board);

$Y_C$  **score:** Score based on  $Y_C$  (see Step V above);

**AIEEE score:** Aggregate marks in AIEEE;

We observe the following:

- ISI scheme gives significantly high weightage to CBSE (Maharashtra Board) score in comparison to the AIEEE score. This may not be desirable. However, this is not very surprising as ISI scheme pools percentiles (which will normally be on higher scale) and AIEEE aggregate marks (which will normally be on a lower scale).
- The proposed normalization scheme (based on  $Y_C$  scores) does not give undue high weightage to any one of the 2 components (AIEEE and CBSE/Maharashtra Board).

**REMARK:** It may be appropriate to have the JEE-main question paper out of a maximum of 300 marks so that the CBSE (Maharashtra Board) marks and the JEE-main marks can be transformed to the same scale by multiplication of factors of 3 and 5, respectively. This will help us in arriving at integer scores, rather than decimal score (as mentioned in Step I).

## **OBSERVATIONS BASED ON CBSE & Maharashtra Board Combined AND AIEEE SCORES OF 2012**

We report below the various correlations obtained using the combined data of CBSE and Maharashtra Board.

	Year 2012
<b>AIEEE rank and <i>YC</i> rank</b>	0.8612
<b>AIEEE rank and ISI rank</b>	0.7064
<b><i>YC</i> rank and ISI rank</b>	0.8846
<b>CBSE/Maharashtra Board score and <i>YC</i> score</b>	0.8541
<b>CBSE/Maharashtra Board score and ISI score</b>	0.9189
<b>AIEEE score and <i>YC</i> score</b>	0.9318
<b>AIEEE score and ISI score</b>	0.7363

It is evident that the results and observations drawn through the results in the above two tables are consistent.