EE23010: Grading on the Gaussian Curve

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To add: Histogram and Gaussian Approximation in Python (after grades are frozen)

I. Abstract

This document describes the 'grading on a bell curve' technique for grading students in the course 'EE23010: Probability and Random Processes' in Fall 2023, offered by Dr. G V V Sharma.

II. Grading at IITH:

Upon the completion of a course, the instructor can award a student any of the following eight passing grades:

Grade	Grade Points
A+	10
A	10
A-	9
B	8
B-	7
C	6
C-	5
D	4

TABLE 0
Grade Points Corresponding to Grades

III. Grading Constraints

While no strict constraints exist on grading, as customary at IITH, the average passing grade awarded is B-, corresponding to 7 grade points.

IV. Gaussian Statistics

The number of students enrolled in the course is 58. The mean and the standard deviation of the scores are:

$$\mu = 40.29$$
$$\sigma = 11.89$$

As the number of students is somewhat large, the distribution of scores can be approximated as a Gaussian distribution $X \sim \mathcal{N}\left(\mu, \sigma^2\right)$, as shown in the plot below:

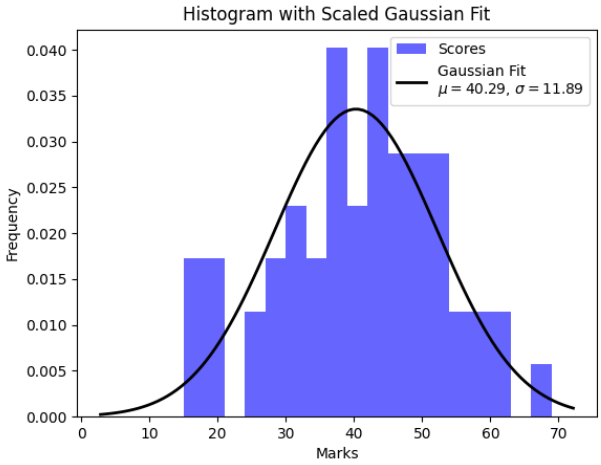

Fig. 0. Distribution

V. Methodology

The following boundaries had been used for defining the boundaries for the grades, keeping in mind the above constraint:

Grade	Lower Bound	Lower Bound
A	$\mu + 2.5k\sigma$	None
A-	$\mu + 1.5k\sigma$	$\mu + 2.5k\sigma$
B	$\mu + 0.5k\sigma$	$\mu + 1.5k\sigma$
B-	$\mu - 0.5k\sigma$	$\mu + 0.5k\sigma$
C	$\mu - 1.5k\sigma$	$\mu - 0.5k\sigma$
C-	$\mu - 2.5k\sigma$	$\mu - 1.5k\sigma$
D	None	$\mu - 2.5k\sigma$

TABLE 0
Grade Boundaries

This ensures that the average grade obtained is B- irrespective of the values of μ, σ or k. The value of k is a parameter chosen as described below.

While the grade 'A+' was avoided in this course, we can extrapolate the above-mentioned pattern as well as the transcript define its lower boundary as

$$\mu + 3.5k\sigma \tag{1}$$

The Academic Handbook and the transcript mention that A+ is awarded to those with "Outstanding

performance in the Course, typically in the top 2% of the class".

Thus, for an ideal Gaussian Distribution of scores, the minimum bound x above which a student scores 'A+' is such that:

$$1 - f_X(x) = 0.02 \tag{2}$$
$$\implies Q\left(\frac{x-\mu}{\sigma}\right) = 0.02 \tag{3}$$
$$\implies \frac{x-\mu}{\sigma} = Q^{-1}(0.02) \tag{4}$$
$$\implies x = \mu + Q^{-1}(0.02)\sigma \tag{5}$$
$$\implies x = \mu + 2.053749\sigma \tag{6}$$

Comparing (1) and (6),

$$2.053749 = 3.5k \tag{7}$$
$$\implies k = 0.586785 \tag{8}$$

The distribution of grades is as follows:

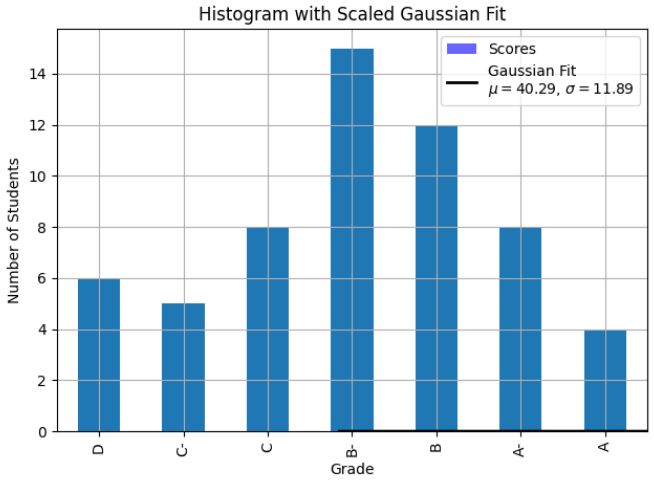

Fig. 0. Distribution

VI. Result

The average grade obtained in the course is 7.086, and the distribution is achieved. The grades are shown in the excel sheet.