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Standard Performance Range for an Examination

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Abstract : The performance at an examination conducted over a period of about ten years is analysed. This is used to define a lower bound for a 'Standard Performance Range'. A theoretical upper bound is then obtained. These two are then used to determine a' Standard Performance Range'. Some recent examination performances are reviewed in the light of the 'Standard Performance Range'.

1. Introduction

The results of the Final Examination in Engineering Part I conducted by the University since 1960 till about the time of the change in regulations and syllabus at the Peradeniya Campus are examined. First the failure rate at these examinations is analysed and compared with that at Part I examinations under the new regulations. It is found that there is at present a trend towards a satisfactory pass rate. Performance at these examinations is also compared and a better performance is shown by the Part I New Regulations examinations. The failure rate at the Part II level under the two schemes is also compared.

From a study of the Part I Old Regulations examinations, a Lower Bound for the 'Standard Performance Range' defined in (1) is suggested. A percentile curve from a consideration of the Binomial Distribution is taken as the Upper Bound for the 'Standard Performance Range'. The performance in Parts I and II of the examinations under the new scheme fall almost within the 'Standard Performance Range'. The only exception is the Part I freak examination of July 1969 discussed in (1).

2. Failure Rate

The percentage failures at Part I Old Regulations every year since December 1960, is shown in column 3 of Table 1. These are calculated on the number of candidates attempting this examination for the first time each year. According to the Old Regulations all students proceed to Part II irrespective of their performance at the Part I examination. The failures can therefore sit the Part I examination the following year, and also attempt the Part II examination held about four months later, provided they are successful at the Part I examination. It is therefore possible for a student to complete his degree in the minimum time inspite of his failure at the Part I examination. Column 5 of Table 1 gives the percentage failure making allowance for those completing the degree in this manner. The failures at Part I who do not fall into this category can complete the degree with the loss of an year. If allowance is made for this category of students also, the percentage failure rate is as shown in column 7 of Table 1. It is seen that an average failure rate of about 37.4% in column 3 reduces to 24.2% in column 5 and to 18.4% in column 7. It

could be argued that students who were above average* had failed Part I Old Regulations examination and therefore they had been able to complete both examination—Parts I and II—held in close succession. This argument is supported by the high failure rate at the Part I examinations under the Old Scheme. When allowance is made for the loss of one year there is a further reduction in the failure rate. It could be said that at this stage allowance has been made for the average student* who has failed the Part I old regulations examination, and being average could not cope with two examinations held in close succession. On these arguments 18.4% would be a reasonable failure rate based on capacity and excluding accidents at the Part I Old Regulations examinations. Acceptance of this failure rate shows that for about 5.8% of the Part I Old Regulations students every year, the loss of an year could be deemed avoidable. This is about 6 students every year. The failure rate at the Part I New Regulations examinations, after the introduction of one and two references is around 18.4% (see Table 2). Thus the failure rate at these examinations are reasonable according to the above discussion, and it is encouraging to note that in the August 1971 examination, the failure rate was 13.1%.

TABLE 1.

Year	Failure	%	Column 4	%	Column 6	%
Dec. 1960	21/54	38.9	14/54	25.9	12/54	22.2
Dec. 1961	24/60	40.0	15/60	25.0	12/60	20.0
Dec. 1962	25/60	41.7	17/60	28.3	13/60	21.7
Dec. 1963	39/96	40.6	16/96	16.7	13/96	13.5
Mar. 1965	26/97	26.8	17/97	17.5	14/97	14.4
Apr. 1966	38/120	31.7	26/120	21.7	22/120	18.3
Mar. 1967	49/139	35.3	43/139	30.9	28/139	20.1
Mar. 1968	63/154	40.9	50/154	32.5	26/154	16.9
Mar. 1969	69/168	41.1	33/168	19.6		
Average		37.4		24.2		18.4

Failure rate at Part I Old Regulation Examinations.

Column 4 : Number of complete failures reduced by number of failures completing course in minimum time.

Column 6 : Number in column 4 reduced by number of failures completing course after losing an year.

TABLE 2.

Year	Column 2	Column 3
August 1970	44.1	18.9
August 1971	22.9	13.1
Average	33.5	16.0

Percentage failure rate at Part I New Regulation Examinations.

Column 2 : Complete failures and one and two references.

Column 3 : Complete failures only.

*In this paper, in order to facilitate the development of the argument, the phrase 'average student' is used to refer to one who is capable of obtaining an average between 40% and 45% at the examination under consideration.

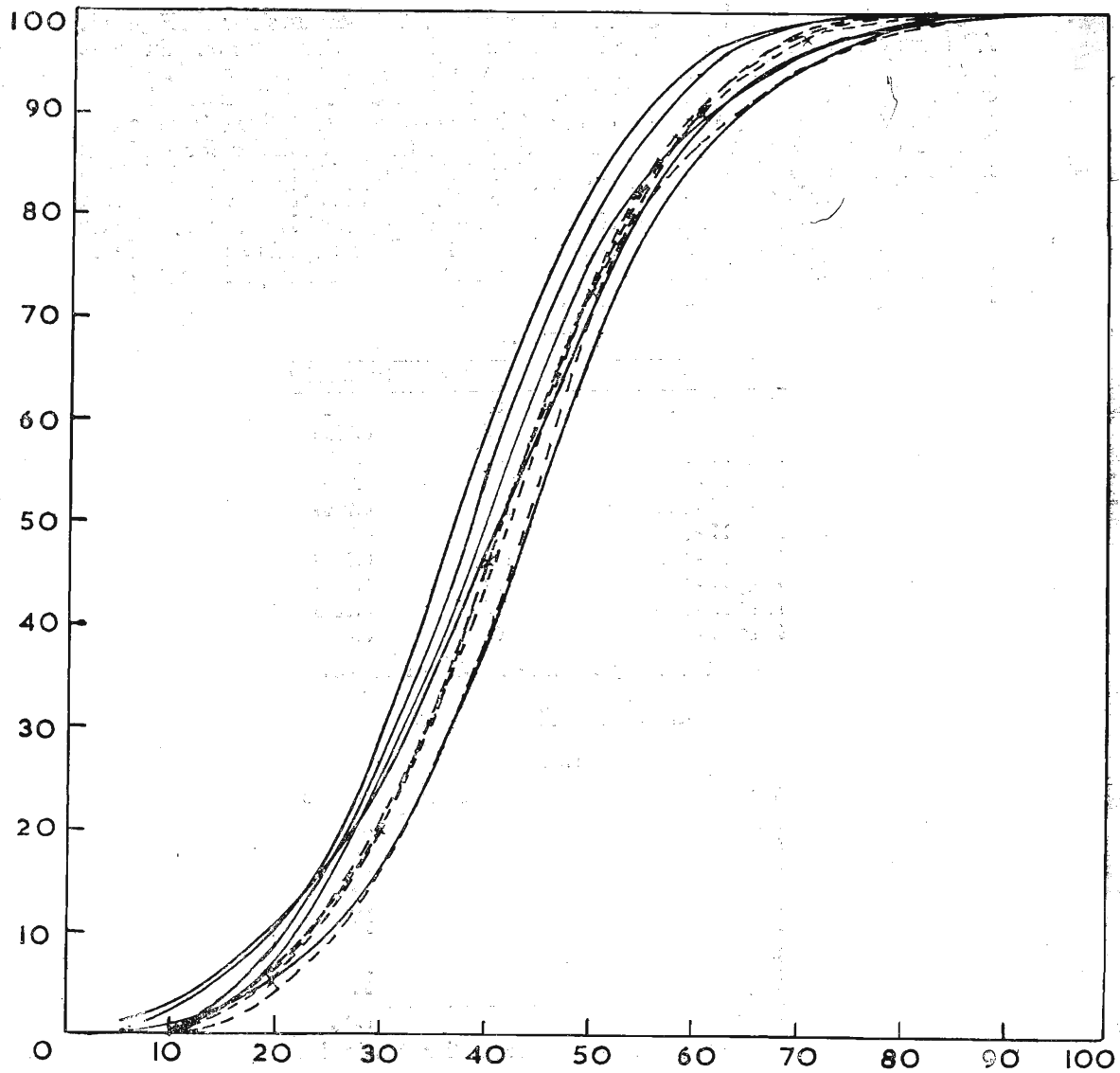

Figure 1. Percentile Curves for Part I Old Regulations 1960—69.

3. Performance at the Part I Examinations

The percentile curves for Part I Old Regulations from 1960—69 are shown in Figure 1. All these curves remain close together inspite of the fact, that these examinations have produced a high failure rate. In other words, they have been consistent but consistenliy difficult. This is unlike the case of Part I New Regulations examination performance shown in (1). In order to obtain a curve representative of all the Old Scheme examination performance from 1960—69, the probabilities for different ranges of marks are calculated and they are given in Table 3. From these probabilities a percentile curve L is drawn (see Appendix). All the Part I New Scheme examination percentile curves except the July, 1969 one, lie to the right of L, showing a better performance at these examinations (see Figure 2). It is therefore reasonable to conclude that the New Examination Scheme is producing better performance and increased pass rate at the Part I level.

TABLE 3.

Marks	Frequency	Probability
$0 \leqslant X < 10$	02	0.0021
$10 \leqslant X < 20$	24	0.0256
$20 \leqslant X < 30$	102	0.1088
$30 \leqslant X < 40$	209	0.2230
$40 \leqslant X < 50$	240	0.2561
$50 \leqslant X < 60$	212	0.2262
$60 \leqslant X < 70$	102	0.1088
$70 \leqslant X < 80$	37	0.0394
$80 \leqslant X < 90$	08	0.0085
$90 \leqslant X < 100$	01	0.0010

Part I Old Regulation marks from 1960—69.

4. Part II Examinations

TABLE 4.

Year	Percentage failure
1961	24
1962	12
1963	08
1964	15
1965	08
1966	23
1967	16
1968	33
1969	32
Average	19%

Failure rate at Part II Old Regulation Examinations.

TABLE 5.

Year	Percentage failure
1970	06
1971	13
Average	9.5%

Failure rate at Part II New Regulation Examinations.

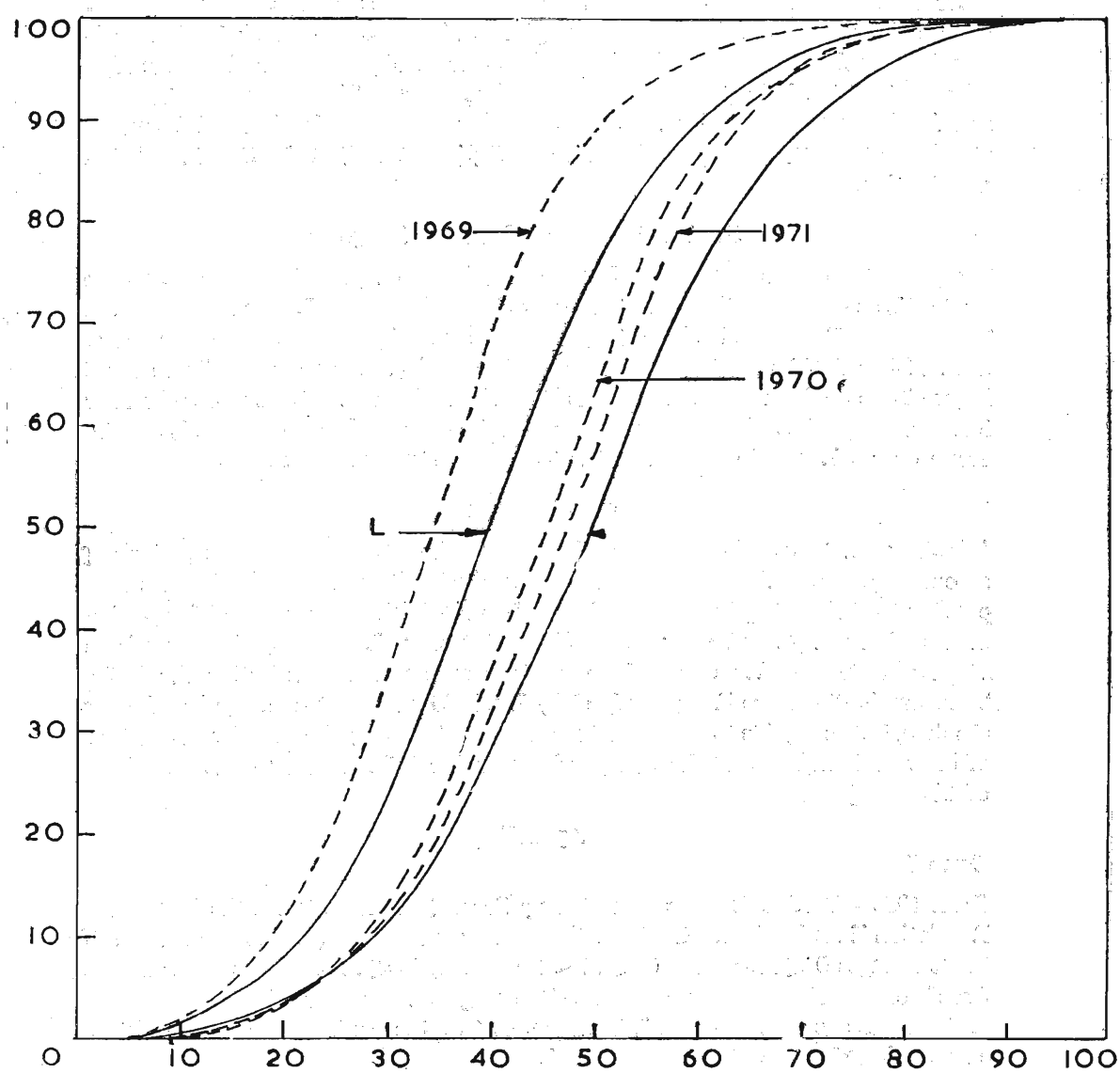

Figure 2. Part I New Regulation performance compared against 'Standard Performance Range'.

The Part II examinations in the two schemes have not been analysed like the Part I examinations. But the failure rates are given in Table 4 and Table 5. The 1970 Part II New Scheme examination low failure rate of 0% is as a result of the high failure rate at the 1969 Part I freak examination. The 13% failure rate at the 1971 examination is a decrease from the corresponding Part I examination of 1970 and is also lower than the average failure rate of 19% at the Part II Old Regulation examination.

5. The Normal Performance Range

The percentile curves at the Part II New Regulation examinations are also to the right of L as shown in Figure 3. This curve L is taken as the Lower Bound for the 'Performance Range' defined in (1). Then a theoretical percentile curve U is drawn from a Binomial Distribution (see Appendix for details). As shown in Figure 2 and Figure 3 the performance curves of the Parts I and II examinations under the New Scheme, except the July 1969 one, fall within the range defined by curves L and U. These curves L and U determine the 'Standard Performance Range'.

6. Conclusion

It is shown that a certain degree of objectivity can be introduced into the analysis of an end of year examination performance. In the institution considered, it has been possible to find an 'equivalent examination' to establish a lower bound for performance. This may not be always possible. But curve L may be taken over from another institution after a critical study of the system in that institution. Again the 'Standard Performance Range' defined by L and U should at no stage be taken as absolute, but as a guide to a board of examiners. It can also be used for the analysis of individual subjects and this can provide valuable information to the examiners of these subjects.

Appendix

Curve L

From 1960—69 Nine Hundred and Thirty Seven (937) have taken the Part I Old Regulation Examinations. Of these, the number whose averages are in each one of the ten ranges $0 \leqslant X < 10$, $10 \leqslant X < 20$,....., $90 \leqslant X < 100$ is known, and therefore the probablities for each one of the ranges can be determined. From these probabilities a percentile curve L is drawn, so that the performance at any future examination should be no worse than L.

Curve U

In order to obtain the corresponding results for Curve U, we consider the idealised experiment of "an examination with a tag X being tried on a candidate". X is any one of the integers 0, 1,....., 100. If we take $X = 0$, the trial performed on a candidate will be a success or a failure depending whether he gets a zero or not.

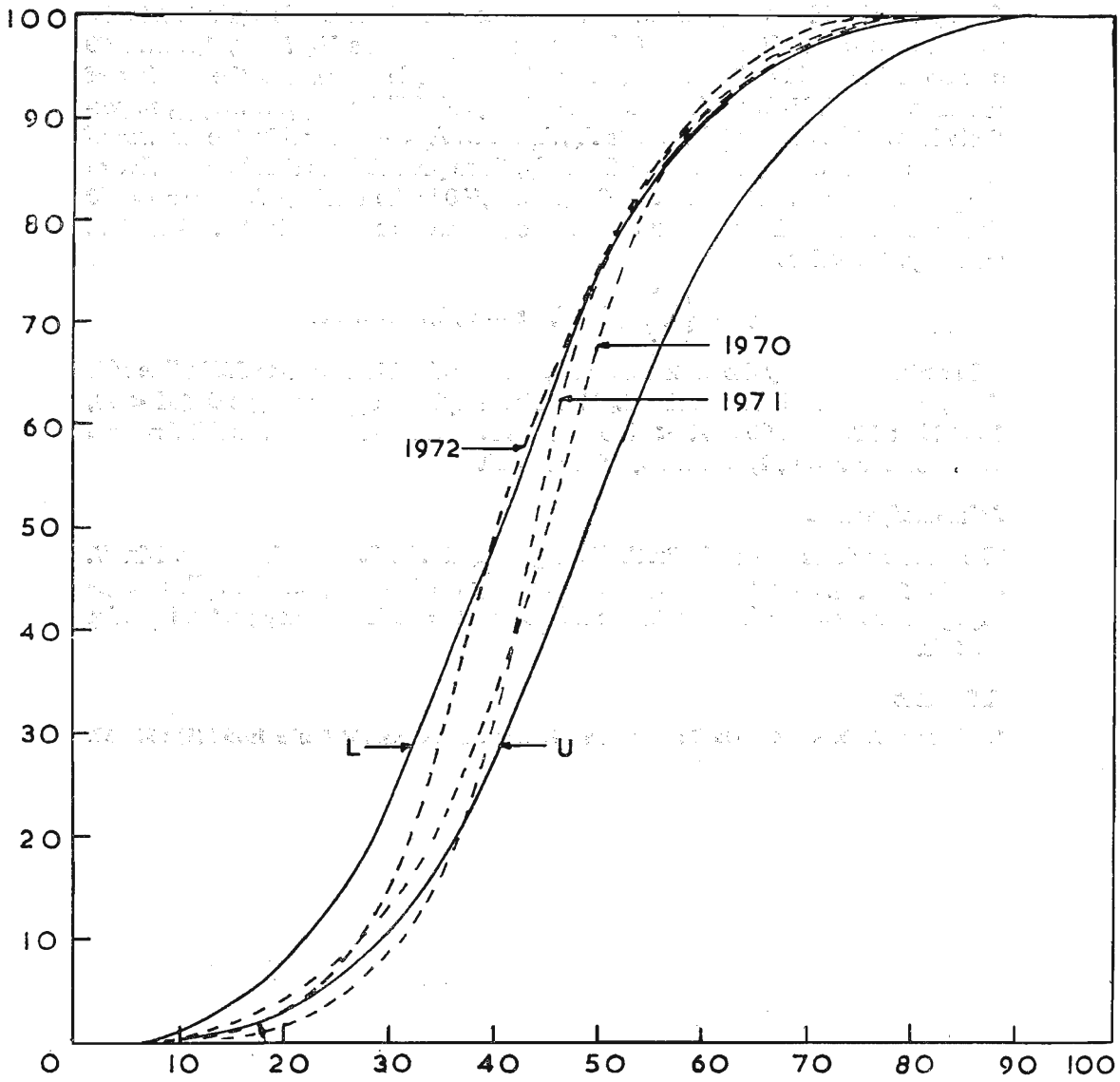

Figure 3. Part II New Regulation performance compared against 'Standard Performance Range'.

This is repeated n times, i.e., it is performed on n candidates. Similarly for different X we perform the trial on the same n candidates. The experiment described above for a particular X has only two events, a success or a failure and is equivalent to the tossing of a coin. Each one of the idealised experiments E_i, $i = 0, 1, \ldots\ldots 100$ corresponding to $X = 0, 1, \ldots\ldots, 100$ defines a sample space, and the number of successes in each E_i is not known. Therefore probabilities $p_0, p_1, \ldots\ldots p_{100}$ respectively have to be assigned for events $A_0, A_1, \ldots\ldots A_{100}$ which will be the number of successes in the experiments. Qualitatively, these probabilities should be similar to the probabilities for r successes $r = 0, 1, \ldots\ldots, 100$ in the tossing of a coin $n = 100$ times assuming an almost normal distribution of abilities of candidates. Therefore we assign the values

$$p_r = \binom{n}{r} p^{n-r} q^r, \quad r = 0, 1, \ldots\ldots 100.$$

In order to simplify the evaluation of p_r to determine U and also to fall in line with the proceedure used for drawing L, X has been replaced by the ranges $0 \leqslant X < 10$, $10 \leqslant X < 20, \ldots\ldots 90 \leqslant X < 100$ and the corresponding probabilities are evaluated for $r = 0, 1, \ldots\ldots 9$, with $n = 10$.

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