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Scrutiny of Academic Performance of Students using Eigenvalue and Eigenvectors: A case study.

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Abstract: The eigenvalue problems arise in a variety of Science and Engineering applications. This paper is significantly concerned with the students' academic performance using Eigen values and Eigen vectors of covariant matrix .A case study of two departments i.e Electronics and Electrical Engineering for 13 and 14 batches is taken into consideration. It aims at analyzing performance of students on the basis of their results in various subjects. Covariance matrix has been developed from the data and the sample size of each batch has been taken 100 for the better testing hypothesis. From the results it has been analyzed that the performance of 14electrical engineering students is better in the subject of Applied Calculus whereas poor performance of 13 Electrical students in the subject of applied physics has been noticed.

Keywords: ***eigenvalues; eigenvectors; covariance; Tendency.***

I. INTRODUCTION

Mathematics is the unique resource to calculate any type of numbers, therefore, it is assumed that mathematics is the foundation of science. However, computer science is the physical shape of mathematics, although, mathematics computes huge amount of data using formulation and compute scientifically data of the whole areas. This paper has analyzed the academic performance of the students via eigenvalue and eigenvector with respect to covariance matrix. In this method, a manipulated data of students' marks of Electrical and Electronics Departments are compared for various using Principal components analysis (PCA). Edoardo Di Napoli and Eric Polizzi [4] also studied, the approach that involves an estimated information of the number of eigenvalues involved in each of these intermissions. The algorithm based on a form of subspace repetition for computing eigenvalues in a given interim has beenbeneficial towards the estimated number of eigenvalues classifying that interval. This is addressed by S.Abro and M.A. Solangi [1] that the better performance of subjects, to develop a positive approach in the direction of the subject is expressively important. The study also discovered that the performance of the students in the different subjects are self-governing of their skills. Mohammad Perani and Shreyas Sundaram [7] have provided a theoretic graphs on certain ratio, and then obtain a constricted classification of the smallest eigenvalue for convinced classes of graphs. We have analyzed performance of the students' academic performance using eigenvalue and eigenvectors. This data collected from Mehran University of Engineering and Technology, Jamshoro. Electrical and Electronics departments are focused for the present study.

II. METHODOLOGY

The average values of each column used the equation as mentioned in (1).
The covariance matrix has been developed from the data using (5). The present study has collected and analyzed data of students' marks in the different subjects of two batches and four semesters. The total number of students in first semester is hundred and in the second semester it is also hundred. Therefore, various subject's marks have been interpreted using strategy to measure the performance of the students. The data is analyzed by applying eigenvalue and eigenvectors with respect to covariance matrix. In this scenario we have applied different formulation. Therefore, these equations are noted and applied by different strategies.

$$\bar{X} = \frac{\Box x_{100}}{100} \tag{1}$$

Each column marks its own Average value (2). Each student's subject wise number of marks have been subtracted from given average value as subtracted from each column its individual average value. This covariance matrix has been denoted in current table. After this we have got a covariance matrix as: [m × n]. Then we have applied the equation of transpose matrix as given above, matrix of [100 rows and 4 columns] the equation as given bellow.

$$X = X^T \tag{3}$$

Consequently, we have applied equation (05) to find the Symantec matrix as bellow.

$$[\mathrm{C}] = \frac{1}{(m-1)} X^T X \tag{4}$$

Subsequently we have found the matrixes as named Symantec; in this matrix all values found are positive. This shows the 4×4 matrix which show columns and rows. The variance for the variable is equal to the i^{th} diagonal element of data as each discipline has been converted into covariance matrix.

$$C_{ii} = \frac{1}{m-1} \sum_{k=1}^{m} x^2{}_{ki} \tag{5}$$

The covariance for variable i and j is equal to the 0ff-diagonal element

$$C_{ij} = \frac{1}{m-1} \sum_{k=1}^{m} x_{ki} x_{kj} \tag{6}$$

The covariance gives a measure of the correlation between the data for variables i and relevant feature of the covariance matrix are as follows: If all of the off-diagonal terms are positive, signified that there is a positive correlation between the results. In all the subjects ‘i‘is a tendency for student doing well/badly in both the subjects.

$$Q = q_1 q_{2.....then} \tag{7}$$

$$\left(\frac{1}{m-1} x^T x \right) [Q] = Q \tag{8}$$

From the data the Eigen values and Eigen vectors have been determined and analyzed the performance of students in various subjects.

III. RESULTS AND DISCUSSION

The generated feature of given mass of the data is presented in the table form. This shows that marks are obtained by the number of the students and the different subjects marks are selected in rows and columns. The departments selected are the department of Electrical (EL) and Electronics (ES)-two batches and total numbers of the students are 400. However, the total number of subjects are 21 and number of semester are 04.

Table 1: Hypothesis test results

Deparments	Students	Subjects	Tables	Total
EL-13-1^{1s}	100	04	01	105
EL-13-2nd	100	06	01	107
ES-13-1^{1s}	100	05	01	106
ES-13-2nd	100	06	01	107
Total	400	21	04	425

Above Table 1 shows the collected data of the students. In this table we have mentioned the number of students, subjects and tables according to department. Therefore, we have applied to Calculate conditional probabilities using two dimensions.

Table 2: Data interpretation

Department of Electrical 13 Batch 1st Semester				
Subject	Applied Calculus	Applied Physics	Functional English	Introduction to Computing and C++ Programming
Average value	58.67	50.43	63.76	66.84

This Table 2 shows the average of given subject column wise. Later the maximum diagonal value of symmetric matric was found which is given below Maximum value of diagonal position is no: [2] = 612.106

Eigen Values= 1461.017, 139.985,104.044, 60.471

$\sum$ = 1765.518

This is a tendency to account for 82.752 % of the total variance. The second eigenvalue suggested a secondary tendency for the performance in Applied Physics as compared to that of the performance in other subjects (7.928% of the total variance). The other eigenvalue together account for only 9.318% of the total variance and it is unlikely that any of them signify any importance trends.

Table 3: Data interpretation

DEPARTMENT OF ELECTRICAL 13 BATCH 2nd SEMESTER						
Subject	Applied Mechanics	Communication Skills	Islamic Studies / Ethics	Linear Algebra	Linear Circuit Analysis	Pakistan Studies.
Average value	51.98	35.91	40.22	58.76	58.41	36.41

The Table 3 shows the average of given subjects.
Maximum value of diagonal position is no: [5] = 709.517
Eigen Values = 1601.671, 102.270, 54.739, 30.095, 10.155, 5.935, $\sum$ = 1804.868

This has a tendency to account for 88.741 % of the total variance. The second eigenvalue suggested a secondary tendency for the performance in Linear Circuit. Analysis of the performance in other subjects (5.667% of the total variance). The other eigenvalue together account for only 10.929% of the total variance and it is unlikely that any of them signifies any importance trends.

Table 4: Data interpretation

Department of Electronics 13 Batch 1st Semester					
Subject	Applied Calculus	Applied Physics	Functional English	Introduction to Computing	Professional Ethics
Average value	64.6	70.6	69.48	34.71	39.12

However, the Table 4 calculates the average value of given columns.

Maximum value of diagonal position is no: [1] = 687.583
Eigen Values = 1261.314, 117.025,70.453, 27.949, 10.159, $\sum$ = 1486.902

It has a tendency to account for 84.828% of the total variance. The second eigenvalue suggested a secondary tendency for the performance in Applied Calculus to very much than the performance in other subjects (7.870% of the total variance). The other eigenvalue together accounts for only 7.301% of the total variance and it is unlikely that any of them signifies any importance trends.

Table 5: Data interpretation

Department of Electronics 13 Batch 2nd Semester						
Subject	Basic Electronics	Communication Skills	Computer Programming	Electrical Circuits	Islamic Studies/Ethics	Linear Algebra & Analytical
Average value	60.44	38.4	32.98	54.39	35.13	65.17

The aforementioned table shows the average of each column.
Maximum value of diagonal position is no: [4] = 602.361.

Eigen Values = 1610.429, 102.990, 52.476, 31.604, 16.668, 7.646 $\sum$ = 1821.813. This has a tendency to account for 87.127 % of the total variance. The second eigenvalue suggested a secondary tendency for the performance in Electrical Circuits quite more than the performance in other subjects estimated as 5.653% of the total variance.The other eigenvalue together accounts for only 5.949% of the total variance so it is unlikely that any of them signify any importance trends.

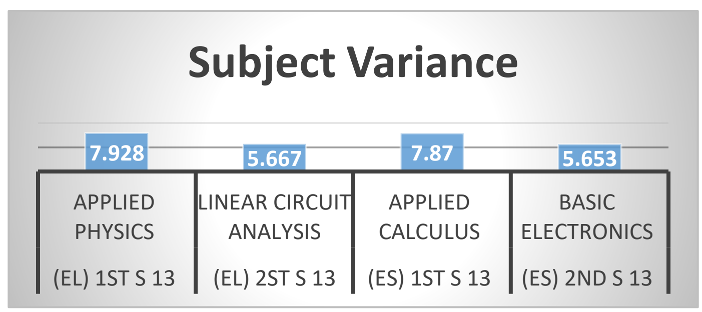

Figure 1: According to each subject's variance

Above Figure 1 shows values of various subjects that were found from different tables. Hence, the study helped to analyze that which subject is better performed in each department. Therefore, subject's tendency has been compared with each other and that shows the variance of performance.

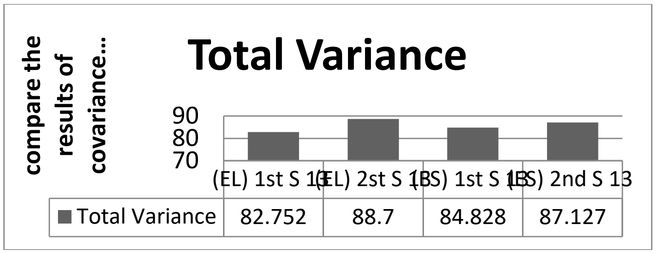

Figure 2: Total variance

In the Figure 2 the total variance of student performance is shown as bad, together with the variance of other subjects.

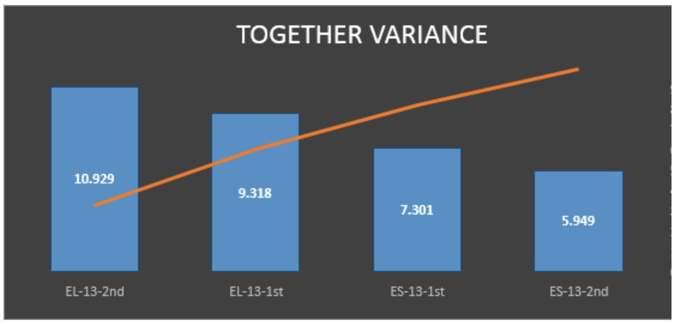

Figure 3: Together Variance

The Figure 3 shows the variance of together subjects exclude Figure 1 and Figure 2.

IV. CONCLUSION

This study analyzed the students' performance through academic marks of subjects and identyfiedthem as bad, good, poor, excellent or outstanding tendancy by principle component analysis (PCA) comparison.It was analyzed with Egienvalue through coveranice matrix .From the hypothesis test results, it has been observed that the performance of 14 Electrical Engineering students is better in the subject of Applied Calculus while the performance of 13 Electrical Department's students in the subject of Applied Physics has been identified poor.

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