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Multi-Dimensional Data Analysis in Education: Accumulation and Comparison among Variables

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ABSTRACT

Users of multi-dimensional analysis have access to a wide range of perspectives on the data. They can spot anomalies or trends in the data. A hierarchy is a connected group of structured dimensions. In the area of educational research, cluster analysis and the use of Mahalanobis Distance are two fresh and useful methods of data analysis. Two-step cluster analysis is a technique that can be applied to both categorical and continuous variables when there are categorical variables with three or more categories. The Mahalanobis Distance is used to compare two data sets in the vicinity of key characteristics. This paper deals with reviewing Cluster Analysis and the use of Mahalanobis Distance as two new and effective means of data analysis in the field of educational research.

Keywords: Cluster Analysis, Mahalanobis Distance, Multi-Dimensional Data Analysis,

Introduction

Users using multi-dimensional analysis can view data from a variety of angles. They can identify patterns or outliers in the data. A hierarchy is a set of connected dimensions that are organised. Cluster Analysis and the use of Mahalanobis Distance are two new and effective means of data analysis in the field of educational research.

Two step cluster analysis is a method of the statistical software package SPSS used for large data bases. This analysis is applicable when there are categorical variables with three or more categories and can be used for both categorical and continuous variables. Two-step cluster analysis is a method that only requires one pass through the data. The distance criteria are used to determine whether an observation should be added to an existing cluster or whether a new cluster should be formed. The hierarchical cluster method is used to group these new observations. The algorithm of the two-step cluster analysis can determine the number of clusters, or the number of clusters can be designated beforehand. If there are more subclusters, the method becomes more precise.

A measure of the distance or divergence between groups in terms of particular criteria can be done by Mahalanobis Distance. It has been extensively measured and has contributed significantly to statistics and data analysis. Two data sets are compared using the Mahalanobis Distance in the area bounded by relevant qualities. Since it takes into account a variety of variances as well as covariance between characters, it will accurately estimate the distance by providing various significant elements to the features of data points. If a proper Mahalanobis Distance metric is provided, such benefits can be exploited to carry out specific tasks on a particular data set. Both of these are used in educational research and are very effective means of statistical analysis.

Review of Literature

Reviewing Cluster Analysis

Saha et al. (2021) in their research paper *Analysis of Attitude Towards Yoga Among College Students Using Clustering Techniques* discusses views regarding yoga practice and are examined among college students in the Purulia, India. To conduct the research, a two-step cluster analysis is used to establish five clusters.

Gorain et al. (2022) in their research paper *A Study on Relationship and Cluster Analysis among Internet Dependency, Social Isolation and Personality* presents unreliable relationships between these elements, three clusters are produced. In order to achieve the aforementioned objectives, correlations between Internet Dependency, Social Isolation, and five distinct personality factors are looked into for art, science, and all art and science learners. Male and female students in the arts formed two distinct clusters, whereas science students formed a single cluster.

Mohanta et al. (2023) in their research work *Introspecting Institutional Commitment Using Cluster Analysis* attempts to study the likeness of the responses given by secondary school teachers regarding Institutional Commitment. The study uses a two-step cluster analysis technique, and various clusters are produced in relation to the gender of the teachers and the locations of the institutions. The impact of the Predictors on cluster formation is also examined.

Mohanta et al. (2023) in their research work *Perceptional Environment: A Study on Organizational Climate Using Cluster Analysis* has under taken 400 Secondary School Teachers through Stratified Random Sampling. The results showed that gender effects the conclusions about the institutional atmosphere. It is conceivable to infer from the aforementioned two facts that reactions to institutional environment vary on both gender and location of the institution.

Sen et al. (2023) in their research*Clustering Technique for Analyzing Leadership Style of the Head of the Institutions* compares the responses provided by Head of the Institutions on Leadership style. The study uses a two-step Cluster Analysis technique, and a number of clusters are produced with the location of the institutions serving as a key predictor of the clusters. The impact of the Predictors on cluster formation is also examined. Each cluster has a different formation in relation to the predictors. The result showed that, whenever the number of Clusters was increased, the number of predictors also increased. It was also found that Location becomes the most important predictor. Similar views about Leadership styles have been recorded depending on the Location of the Institutions.

Reviewing Mahalanobis Distance

Sen and Pal (2020) conducted a study *"Mahalanobis distance: A study on achievement of Science and Mathematics"* to study the group performance in arithmetic, physical science, and life science for two student groups, namely seventh grade and eighth grade, in three different types of schools. Mahalanobis Distance is thought to measure the dynamic character of student achievement in three topics for two groups of learners. It has been discovered that in the majority of situations, distances have a substantial impact on how pupils perform in a group of topics.

Ahmed et al. (2020) conducted a study *"Application of Mahalanobis Δ^2 on achievement tests on mathematics: A study on higher secondary level students"* to study the challenge of the nature of mathematical accomplishment for two groups of higher secondary level students and found that there is a comparable downward trend in mathematical achievement for two groups of students from various universities.

Ahmed et al. (2021) conducted a study *"Comparison of achievement of higher secondary subjects among tribal and non-tribal students of Bodoland Territorial Region, Assam, India using Mahalanobis distance"* to compare the academic performance of two groups of students from the Bodoland Territorial Region (BTR), Assam, India, in four different subjects: biology, physics, chemistry, and mathematics. Tribal versus non-tribal, males versus girls, and rural versus urban are the three different dichotomous sorts of groups that are created. The dynamical character of achievement for all the aforementioned groups shows no discernible variation.

Gorain et al. (2021) conducted a study *"A study on internet dependency, social isolation and personality using Mahalanobis distance"* to compare many psychological elements such as Internet Dependency, Social Isolation, and five different Personality Factors of Postgraduate Level Students with the use of Mahalanobis Distance and concluded that there are no appreciable disparities in the dynamical nature of male and female students, as well as students studying the arts and sciences.

Mahato and Sen (2021) conducted a study *"Application of Mahalanobis distance to determine the dynamical nature of academic stress, self-efficacy in mathematics and anxiety in Mathematics"* to measure the difference between the dependent variables Academic Stress, Self-efficacy in Mathematics, and Anxiety in Mathematics using Mahalanobis Distance and found that the dynamical character of the three dependent variables is not significantly different for various sets of independent variables.

Ahmed et al. (2022) conducted a study *"Comparison of scholastic attainment in English and Math amongst other studies at the higher secondary level: A study using Mahalanobis distance"* to compare the academic achievement of two groups of higher secondary students in the Bodoland Territorial Region (BTR) regions of Assam, India, across five different academic disciplines, including mathematics, English, biology, physics, and chemistry and found that despite the fact that urban students got superior conditions than rural students, there is no difference between urban and rural students in terms of the dynamic character of achievement.

Ahmed et al. (2022) conducted a study *"A comparative study on academic achievement of Mathematics and English with other subjects of secondary level in BTR of Assam, India, using Mahalanobis distance"* to compare the academic performance of two student groups in the Bodoland Territorial Region (BTR), Assam, India, in the four subject areas of mathematics, English, general sciences, and social studies. The findings showed that there is no statistically significant difference between boys and girls when the dynamic nature of achievement of various groups is taken into account, including students from tribal and nontribal communities, students from rural and urban schools, tribal boys and nontribal boys, and tribal girls and nontribal girls.

Mohanta et al. (2023) conducted a study *"Comparison among different dimensions of organizational climate of secondary school teachers of West Bengal by Mahalanobis distance"* to compare various aspects of organisational climate, including employees' perceptions of autonomy, manager trust, teamwork, rewards and recognition, fairness, and organisational support, when viewed as a branch for various groups of secondary level teachers using Mahalanobis Distance. The outcome showed that there is no discernible difference between the six dependent variables' dynamical properties for various sets of independent variables.

Mohanta et al. (2023) conducted a study *"Comparison among different dimensions of institutional commitment of secondary school teachers of West Bengal by Mahalanobis distance"* to compare the various aspects of institutional commitment, including affective commitment, professional commitment, commitment to the learner, and academic commitment applying Mahalanobis Distance. The outcome demonstrated that, when four dependent variables were gathered as a branch, there was no discernible variation in the dynamical nature of the dichotomous groupings.

Adhikari (2023) has conducted a study *"Application of Mahalanobis distance in education and educational psychology: A review"*. The research on Mahalanobis distance in education and its enormous potential in educational psychology as of 2020 is examined in this study. The combination of factors, i.e., internet dependence, social isolation, personality, academic stress, self-efficacy and anxiety, and Mahalanobis distance, is computed for drawing inferences in the context of educational psychology.

Sen et al. (2023) conducted a study *"Comparison among different leadership styles of head of the institution of West Bengal by Mahalanobis distance"* to compare several leadership philosophies such as dominant leadership, democratic leadership, visionary leadership, affiliative leadership,

and coaching leadership as a whole using Mahalanobis Distance. The findings showed that when five dependent variables were combined as a branch, there was no discernible change in the dynamic nature of the dichotomous groupings.

Sen et al. (2023) took up a study *"Comparison among self-efficacy, Depression, Anxiety and stress of postgraduate students by Mahalanobis Distance".* Three different dichotomous groups of students are considered for this study. Mahalanobis Distance is applied to compare the dynamical nature of five dependent variables (general self-efficacy, specific self-efficacy, depression, anxiety and stress) considered as a branch. It is found that there is no significant difference in dynamical nature of five dependent variables for different groups of independent variables.

Conclusion

In order to organise and combine the data in the data set, multidimensional data analysis uses multidimensional data represented in array and data aggregation technology. It then adopts online analysis and visual tools to swiftly analyse the data and provides users with the complicated analysis results. Cluster analysis can be a powerful data-mining tool for any organisation that needs to identify different groups of psychological measures, sociological measures, achievement analysis etc, or other types of behaviours or variables.Two data sets having multiple variables are compared using the Mahalanobis Distance. These two methods of statistical analysis are highly effective and has much efficient use, with greater prospect of future educational research.

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