Evaluation of Student Performance: An Outlier Detection Perspective

P. Ajith, M.S.S.Sai, B. Tejaswi

Abstract **: *Educational data mining is current growing research area and the main essence of data mining concepts are used in the educational field for extracting useful information of the students based on their behavior in the learning process. Prior approaches used decision tree classifications optimized with ID3 algorithms to obtain such patterns but discovering the implicative tendencies is valuable information for the decision-maker which is absent in tree based classifications. So we propose to use outlier detection for mining and evaluating educational data of students. In this paper, outlier detection mechanisms are used for identifying outliers which improve the quality of decision making. We used outlier analysis to detect outliers in the student data. In proposed system, clustering mechanism along with univariant analysis is implemented. Clustering is finding groups of objects such that the objects in one group will be similar to one another and different from the objects in another group. While clustering, the large data set is divide into clusters which consists of outliers. After Clustering, the data points which are present outside the clusters are identified and treated as outliers. Identification is done by using univariate analysis which is the simplest form of quantitative (statistical) analysis. A basic way of presenting univariate data is to create a frequency distribution of the individual cases Here, we analyze the performance of UG students of our college and present the results using outlier detection mechanism. The analyzed results are represented using histograms which are based on univariate analysis.***

Keywords: Outlier, Clustering, Univariate analysis, and Histograms.

I. INTRODUCTION

The topic of explanation and prediction of academic performance is widely researched. Data Mining Techniques is the promising methodology to extract valuable information in this objective. Now-a-days, there are increasing research interests in using data mining in education. These new emerging fields, called educational data mining, concerned with developing methods that extract knowledge from data come from the educational context. The main objective of higher education institutes is to provide quality education to its students and to improve the quality of managerial decisions. In this perspective, one way to achieve highest level of quality in higher education system is discovering and analyzing relevant information results and produce different perspectives to understand more about the students' activities so as to customize the course for student learning.

For optimally analyzing the student performance, the classification task is used on student database to predict the students division on the basis of previous database. As there are many approaches that are used for data classification, the decision tree method is used here. Information's like Attendance, Class test, Seminar and Assignment marks were collected from the student's previous database, to predict the performance at the end of the semester. This study will help the students and the teachers to improve the division of the student. This study will also work to identify those students which needed special attention to reduce fail percentages and taking appropriate action for the upcoming evaluations. This kind live performance monitoring and counter measures before the big evaluation definitely helps to improve students' performance.

In recent years, conventional database querying methods are inadequate to extract useful information, and hence researches nowadays are focused to develop new techniques to meet the raised requirements. Outlier detection is an important research problem that aims to find objects that are considerably dissimilar, exceptional and inconsistent in the database. Outliers are objects which do not correspond to an ideal model of the data. Outliers have extraordinary behavior comparing with other data objects. An object that is significantly different from other objects is called as outlier. These outliers lead us to wrong decision making. Efficient detection of outliers reduces the risk of making poor decisions based on erroneous data, and aids in identifying, preventing, and repairing the effects of malicious or faulty behavior.

In this paper, outlier detection mechanisms are used for identifying outliers which improve the quality of decision making. We used outlier analysis to detect outliers in the student data. In proposed system, clustering mechanism along with univariant analysis is implemented. Clustering is finding groups of objects such that the objects in one group will be similar to one another and different from the objects in another group. While clustering, the large data set is divide into clusters which consists of outliers. After Clustering, the data points which are present outside the clusters are identified and treated as outliers. Identification is done by using univariate analysis which is the simplest form of quantitative (statistical) analysis. A basic way of presenting univariate data is to create a frequency distribution of the individual cases Here, we analyze the performance of UG students of our college and present the results using outlier detection mechanism. The analyzed results are represented using histograms which are based on univariate analysis.

Manuscript published on 30 December 2012.
*****Correspondence Author(s)

P. Ajith, Research Scholar, KL University, India.
M.S.S.Sai, Professor. Department of CSE, KKR & KSR Institute of Technology & Sciences, Guntur, A P, India.
B. Tejaswi, Asst. Prof. Department of CSE, KKR & KSR Institute of Technology & Sciences, Guntur, AP, India.

II. DATA MINING TECHNIQUES

A. KNN: *k*-nearest neighbor classification:

A more sophisticated approach, *k*-nearest neighbor (*k*NN) classification, finds a group of *k* objects in the training set that are closest to the test object, and bases the assignment of a label on the predominance of a particular class in this neighborhood. There are three key elements of this approach: a set of labeled objects, e.g., a set of stored records, a distance or similarity metric to compute distance between objects, and the value of *k*, the number of nearest neighbors. To classify an unlabeled object, the distance of this object to the labeled objects is computed, its *k*-nearest neighbors are identified, and the class labels of these nearest neighbors are then used to determine the class label of the object.

B. The Apriori algorithm:

Apriori is a seminal algorithm for finding frequent itemsets using candidate generation. It is characterized as a level-wise complete search algorithm using anti- monotonicity of itemsets, “if an itemset is not frequent, any of its superset is never frequent”. Apriori first scans the database and searches for frequent itemsets of size 1 by accumulating the count for each item and collecting those that satisfy the minimum support requirement. It then iterates on the following three steps and extracts all the frequent itemsets.

1. Generate *Ck*+1, candidates of frequent itemsets of size *k* +1, from the frequent itemsets of size *k*.
2. Scan the database and calculate the support of each candidate of frequent itemsets.
3. Add those itemsets that satisfies the minimum support requirement to *Fk*+1.

C. Naive Bayes:

Naïve Bayes method is important for several reasons. It is very easy to construct, not needing any complicated iterative parameter estimation schemes. This means it may be readily applied to huge data sets. It is easy to interpret, so users unskilled in classifier technology can understand why it is making the classification it makes. And finally, it often does surprisingly well: it may not be the best possible classifier in any particular application, but it can usually be relied on to be robust and to do quite well. Here, the initial set of objects are used with known class memberships (the training set) to construct a score such that larger scores are associated with class 1 objects (say) and smaller scores with class 0 objects. Classification is then achieved by comparing this score with a threshold, *t*.

D. Naïve Bayes Updateable

This is the updateable version of Naïve Bayes. Naïve Bayes implements a Naïve Bayesian classifier, which produces probabilistic rules—that is, when presented with a new data item, the Naïve Bayes model indicates the probability that this item belongs to each of the possible class categories. The Bayesian classifier is ‘naïve’ in the sense that attributes are treated as though they are completely independent, and as if each attribute contributes equally to the model. If extraneous attributes are included in the dataset, then those attributes will skew the model. Despite its simplicity, Naïve Bayes, like OneR, can give surprisingly good results on many real world datasets.

E. J48 (C4.5 Decision Tree Revision 8)

J48 is an implementation of C4.5 release 8, a standard algorithm that is widely used for practical machine learning. This implementation produces decision tree models. This algorithm works by forming pruned partial decision trees (built using C4.5’s heuristics), and immediately converting them into a corresponding rule. C4.5 algorithm is the most popular tree classifier.

F. ONER (Onerules)

Onerules, are rules that classify an object on the basis of a single attribute (i.e. they are 1-level decision trees). ONER is a very simple classification rules performing well on most commonly used datasets. They use the minimum-error attribute for prediction, discretizing numeric attributes. They ranks attributes according to an error rate (on the training set). They treat all numerically valued attributes as continuous and use a straightforward method to divide the range of values into several disjoint intervals.

III. RELATED WORKS

Educational data mining is a promising area of research and it has a specific requirements not presented in other domains. Thus, work should be oriented towards educational domain of data mining. The goal of this study is to show how useful data mining can be used in higher education to improve student’ performance.

Al-Radaideh et al. [1], applied the data mining techniques, particularly classification to help in improving the quality of the higher educational system by evaluating student data to study the main attributes that may affect the student performance in courses. The extracted classification rules are based on the decision tree as a classification method; the extracted classification rules are studied and evaluated. It allows students to predict the final grade in a course under study. Ayesha et al. [2], used k-means clustering algorithm as a data mining technique to predict students’ learning activities in a students’ database including class quizzes, mid and final exam and assignments. The information generated after the implementation of data mining technique may be helpful for instructor as well as for students. These correlated information will be conveyed to the class teacher before the conduction of final exam. This study helps the teachers to reduce the failing ratio by taking appropriate steps at right time and improve the performance of students. Baradwaj and Pal [3], applied the classification as data mining technique to evaluate student’ performance, they used decision tree method for classification. The goal of their study is to extract knowledge that describes students’ performance in end semester examination. They used students’ data from the student’ previous database including Attendance, Class test, Seminar and Assignment marks. This study helps earlier in identifying the dropouts and students who need special attention and allow the teacher to provide appropriate advising. Chandra and Nandhini [4], applied the association rule mining analysis based on students’ failed courses to identifies students’ failure patterns. The goal of their study is to identify hidden relationship between the failed courses and suggests relevant causes of the failure to improve the low capacity students’ performances.

The extracted association rules reveal some hidden patterns of students' failed courses which could serve as a foundation stone for academic planners in making academic decisions and an aid in the curriculum re-structuring and modification with a view to improving students' performance and reducing failure rate.

Cesar *et al.* [5] proposed a recommendation system based on data mining techniques to help students to make decisions related to their academic track. The system supports students to better choose how many and which courses to enroll on. As a result, the authors developed a system that is capable of predicting the failure or success of a student in any course using a classifier obtained from the analysis of a set of historical data related to the academic field of other students who took the same course in the past.

Pathom *et al.* [6] proposed a classifier algorithm for building Course Registration Planning Model (CRPM) from historical dataset. The algorithm is selected by comparing the performance of four classifiers include Bayesian Network, C4.5, Decision Forest, and NBTree. The dataset were obtained from student enrollments including grade point average (GPA) and grades of undergraduate students. As a result, the NBTree was the best of the four classifiers. NaïveBayes classifier (NBTree) was used to generate the CRPM, which can be used to predict the student GPA and consider student course sequences for registration planning.

Ramaswami and Bhaskaran [7] have constructed a predictive model called CHAID with 7-class response variable by using highly influencing predictive variables obtained through feature selection so as to evaluate the academic achievement of students at higher secondary schools in India. Data were collected from different schools of Tamilnadu, 772 students' records were used for CHAID prediction model construction. As a result, set of rules were extracted from the CHAID prediction model and the efficiency was found.

Bray [8], in his study on private tutoring and its implications, observed that the percentage of students receiving private tutoring in India was relatively higher than in Malaysia, Singapore, Japan, China and Sri Lanka. It was also observed that there was an enhancement of academic performance with the intensity of private tutoring and this variation of intensity of private tutoring depends on the collective factor namely socio-economic conditions.

IV. DATA MINING PROCESS

Now-a-days, performance of individual student in educational system is evaluated based on the internal assessment and Final examination. The internal assessment is calculated based on the performance of student in educational activities such as internals, assignment, seminars presented, lab work, regularity, technology standards. The internal assessment is calculated by teachers. The Final examination is one that is scored by the student in semester examination.

A. Data Preparations

The data set used in this study was obtained from B.TECH students all branches of KITS college from session 2008 to 2012. Initially size of the data is 240. In this step data stored in different tables was joined in a single table after joining process errors were removed.The domain values for some of the variables were defined for the present investigation as follows:

Variable	Description	Possible Values
PR	Previous Results	{Distinction> 70% First > 60% & <70% Second >50 & <60% Third >40 & <50% Fail < 40%}
MTR	Mid Term Results	{Poor <40 , Average >40 & <60, Good >60 & < 70, Best >70}
LW P	Lab Work and Performance	{Poor, Average, Good}
TS	Technology Standards	{Poor , Average, Good}
ASS	Assignment	{Yes, No}
SP	Seminor Performance	{Yes, No}
REG	Regularity to class	{Regular, Irregular}
PUN	Puntuality	{Yes, No}
OAP	Overall Performance	{Poor , Average, Good}
FE	Final examination	{Distinction >70, First > 60% & <70% Second >50 & <60% Third >40 & <50% Fail < 40%}

PR: PR means previous results in B.Tech course. It is split into five class values: Distinction> 70%, First > 60% , Second >50 & <60% , Third >40 & <50% and Fail < 40%.

MTR: MTR means Mid Term Results conducted internally in college. In each semester, two written exams and two online exams are conducted and averages of four tests are used to calculate internal marks. It is split into three class values: Poor, Average, Good and Best.

SP: Seminar performance participated outside the campus. Seminar performance is split into two classes: yes- Students participated in seminars, No- Students does not participated in seminars.

ASS – Assignment performance. Assignment performance is divided into two classes: Yes – student submitted assignment, No – Student not submitted assignment.

LWP – Lab Work and Performance. Lab work means both internal and external lab work and exams. Lab work is divided into three classes: Poor, Average and Good.

PUN- Punctuality of student in college. It is split into two class values: yes- Student is punctual; No- Student is not punctual.

TS - Technology Standard of student and his/her interest. It is divided into three classes: poor- Students are not willing to know and accept the new technology; Average- Students are willing to know and not ready to accept or Students are not willing to know but if any chance ready to accept the technology; Good- Students are willing to know and accept the technology.

REG- Regularity of student in college. It is split into two class values: yes- Student is regularly attending to class; No- Student is not regularly attending to class.

FE – Final examinations obtained in B.Tech and it is declared as response variable. It is split into five class values: Distinction>70%, First > 60%&<70%, Second >50&<60%, Third >40&<50% and Fail < 40%.

OAP- Over All Performance of Student in class, sports and outside the campus. It is divided into three classes: Poor, Average and Good.

B. Clustering:

Clustering is finding groups of objects such that the objects in one group will be similar to one another and different from the objects in another group. In educational data mining, clustering has been used to group students according to their behavior. According to clustering, clusters distinguish student's performance according to their behavior and activates. In this paper, students are clustered into three groups according to their academics, punctuality, exams and soon.

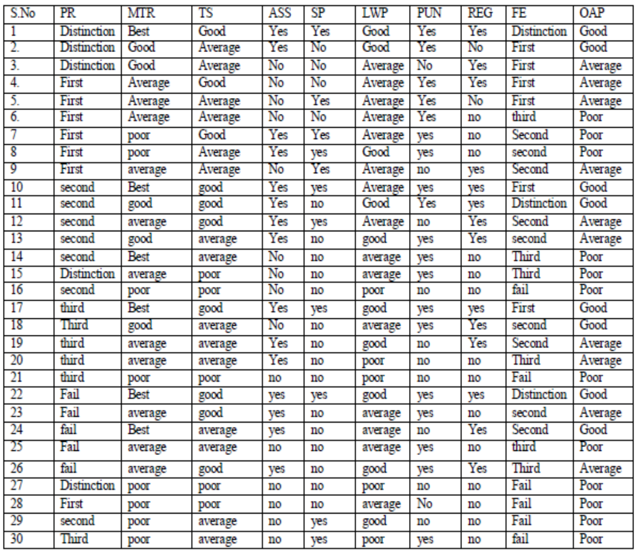
C. Outlier Detection

After performing clustering, Outlier detection discovers data points that are significantly different than the rest of the data. Outlier detection is a task that finds objects that are dissimilar or inconsistent with respect to the remaining data or which are far away from their cluster centroids. In outlier detection, data points which are significantly different than the rest of the data are discovered. In educational data mining, outlier analysis can be used to detect students who irregular, suffering with learning problems and soon. In our case study, we used outlier analysis to detect outliers in the student data. Based on the identified outliers, decision making is done effectively and efficiently which will result improvement in performance of student. For outlier detection, here we are using another technique called univariate analysis for detecting the outliers.

D. Univariate Analysis

After analyzing the performance of UG students of our college, outliers are identified. The analyzed results are represented using histograms or pie charts which are based on univariate analysis. Univariate analysis is the simplest form of quantitative (statistical) analysis. A basic way of presenting univariate data is to create a frequency distribution of the individual cases, which involves presenting the number of attributes of the variable studied for each case observed in the sample. This can be done in a table format, with a histogram, bar chart or a similar form of graphical representation.

Table: Data Set



S.No	PR	MTR	TS	ASS	SP	LWP	PUN	REG	FE	OAP
1	Distinction	Best	Good	Yes	Yes	Good	Yes	Yes	Distinction	Good
2.	Distinction	Good	Average	Yes	No	Good	Yes	No	First	Good
3.	Distinction	Good	Average	No	No	Average	No	Yes	First	Average
4.	First	Average	Good	No	No	Average	Yes	Yes	First	Average
5.	First	Average	Average	No	Yes	Average	Yes	No	First	Average
6.	First	Average	Average	No	No	Average	Yes	no	third	Poor
7	First	poor	Good	Yes	Yes	Average	yes	no	Second	Poor
8	First	poor	Average	Yes	yes	Good	yes	no	second	Poor
9	First	average	Average	No	Yes	Average	no	yes	Second	Average
10	second	Best	good	Yes	yes	Average	yes	yes	First	Good
11	second	good	good	Yes	no	Good	Yes	yes	Distinction	Good
12	second	average	good	Yes	yes	Average	no	Yes	Second	Average
13	second	good	average	Yes	no	good	yes	Yes	second	Average
14	second	Best	average	No	no	average	yes	no	Third	Poor
15	Distinction	average	poor	No	no	average	yes	no	Third	Poor
16	second	poor	poor	No	no	poor	no	no	fail	Poor
17	third	Best	good	Yes	yes	good	yes	yes	First	Good
18	Third	good	average	No	no	average	yes	Yes	second	Good
19	third	average	average	Yes	no	good	no	Yes	Second	Average
20	third	average	average	Yes	no	poor	no	no	Third	Average
21	third	poor	poor	no	no	poor	no	no	Fail	Poor
22	Fail	Best	good	yes	yes	good	yes	yes	Distinction	Good
23	Fail	average	good	yes	no	average	yes	no	second	Average
24	fail	Best	average	yes	no	average	no	Yes	Second	Good
25	Fail	average	average	no	no	average	yes	no	third	Poor
26	fail	average	good	yes	no	good	yes	Yes	Third	Average
27	Distinction	poor	poor	no	no	poor	no	no	Fail	Poor
28	First	poor	poor	no	no	average	No	no	Fail	Poor
29	second	poor	average	no	yes	good	no	no	Fail	Poor
30	Third	poor	average	no	yes	poor	yes	no	fail	Poor

V. RESULTS AND DISCUSSION

The above sample data set consists of 30 students with domain values. Some of unclustered instances i.e., outliers are:

(1) Student who got first class in previous results, but overall performance is poor due to the student irregularity, average performance in labwork and midterm marks and also poor result in final examination.

(2) Student who was failed in previous results, but overall performance is good due to best performance in lab as well as in midterm, regular and punctual in class and also best result in final examination.

(3) Student who got distinction in previous result, but overall performance of student is average due to his/her unwillingness to know and accept the new technology and also not participating in seminars.

(4) Student who was interested in participating in every activity which are conducting in and outside college but overall performance is poor due to poor performance in midterm marks and final examination.

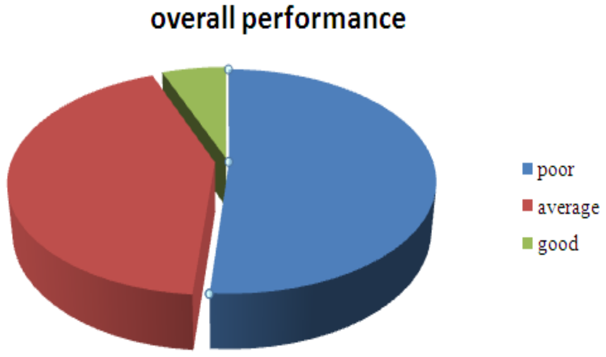


Fig 1: Pie Chart of Overall Performance variable

When clustering is performed based on the overall performance, then 3 clusters are formed i.e., poor, average and good as shown in fig 1.

Let Consider cluster " good" of over all performance field in the above chart of the data set. From that cluster, now identify the regularity of the student as shown below:

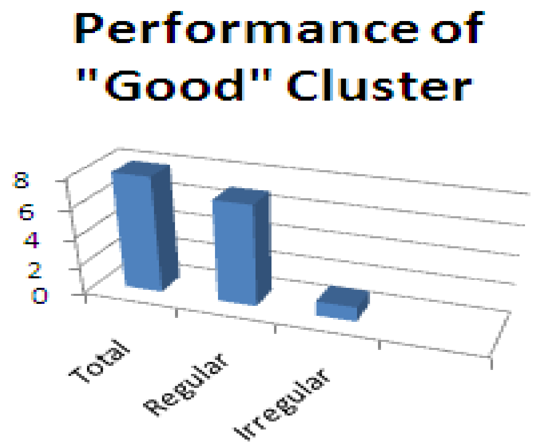


Fig 2: 3-D view for regularity of cluster "good"

From the above histogram, the student who is irregular is outlier of good cluster according regularity. Now, we considered mid-term marks as the key for already clustered groups. According mid-term marks clusters are divided into four groups as shown below:

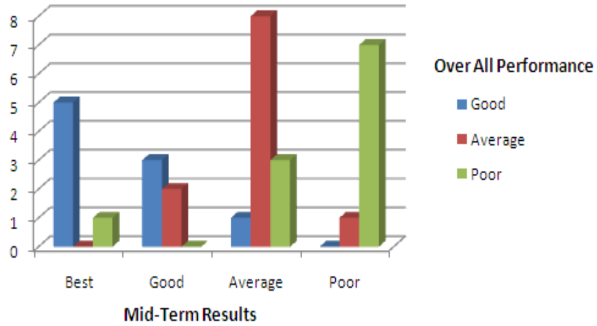


Fig 3: Histogram for Mid-term Results according to overall performance

From the above chart, the student who was best in mid-term results but poor in overall performance is an outlier. By combing the implementation of univariant analysis along with clustering, will results to outlier detection. Outliers are identified by recursively applying the proposed system. After gaining the information of different outliers as specified above, the entire performances of students are categorized. Later, Decision making is done based on the outlier's performance which results improvement in students educational standards.

VI.CONCLUSION

Now-a-days, there are increasing research interests in using data mining in education. The main objective of higher education institutes is to provide quality education to its students and to improve the quality of managerial decisions. In this paper, outlier detection mechanisms are used for identifying outliers which improve the quality of decision making. We used outlier analysis to detect outliers in the student data. In proposed system, clustering mechanism along with univariant analysis is implemented. Clustering is finding groups of objects such that the objects in one group will be similar to one another and different from the objects in another group. While clustering, the large data set is divide into clusters which consists of outliers. After Clustering, the data points which are present outside the clusters are identified and treated as outliers. Identification is done by using univariate analysis which is the simplest form of quantitative (statistical) analysis. A basic way of presenting univariate data is to create a frequency distribution of the individual cases Here, we analyze the performance of UG students of our college and present the results using outlier detection mechanism. The analyzed results are represented using histograms which are based on univariate analysis.

REFERENCES

1. Al-Radaideh, Q., Al-Shawakfa, E. and Al-Najjar, M. (2006) 'Mining Student Data Using Decision Trees', The 2006 International Arab Conference on Information Technology (ACIT'2006) – Conference Proceedings.
2. Ayesha, S. , Mustafa, T. , Sattar, A. and Khan, I. (2010) 'Data Mining Model for Higher Education System', European Journal of Scientific Research, vol. 43, no. 1, pp. 24-29.
3. Baradwaj, B. and Pal, S. (2011) 'Mining Educational Data to Analyze Student s' Performance', International Journal of Advanced Computer Science and Applications, vol. 2, no. 6, pp. 63-69.
4. Chandra, E. and Nandhini, K. (2010) 'Knowledge Mining from Student Data', European Journal of Scientific Research, vol. 47, no. 1, pp. 156-163.
5. Cesar V., Javier B., liela S., and Alvaro O., Recommendation in Higher Education Using Data Mining Techniques, In Proceedings of the Educational Data Mining Conference, 2009.
6. Pathom P., Anongnart S., and Prasong P., Comparisons of Classifier Algorithms: Bayesian Network, C4.5, Decision Forest and NBTree for Course Registration Planning Model of Undergraduate Students, Sripatum University Chonburi Campus, Office of Computer Service, Chonburi Thailand, IEEE, 2008.
7. Ramaswami M., and Bhaskaran R., CHAID Based Performance Prediction Model in Educational Data Mining, IJCSI International Journal of Computer Science Issues, Vol. 7, Issue 1, No. 1, 2010.
8. M. Bray, The Shadow Education System: Private Tutoring And Its Implications For Planners, (2nd ed.), UNESCO, PARIS, France, 2007.
9. A. Moreira, M. Y. Santos and S. Carneiro, Density-based clustering algorithms-DBSCAN and SNN, July 2005
10. M. Ankerst, M. M. Breunig, H. P. Kriegel and J. Sander, OPTICS: Ordering Points To Identify Clustering Structure, at International Conference on Management of Data, Philadelphia, ACM 1999

AUTHOR PROFILE

Mr. P. AJITH , [Research Scholar , KL University] received B.Sc. degree from Nagarjuna University, Guntur, India in 1993, Master of Computer Applications from Sardar Patel University, Gujarat, India in 1996. MTech(CSE) from Bharat University, Chennai, India in 2006 and is currently pursuing Ph.D. at KL University, Vijayawada, A.P., India. He is currently working as Head & Associate Professor in the Department of Computer Science, in Sriji College, Ongole, A.P, India. His area of interests is Data Mining & its applications.

Dr. M. Srinivasa Sesha Sai , received B.Sc. degree from Nagarjuna University, India in 1994, Master of Computer Applications from Acharya Nagarjuna University, India in 1997, Master of Philosophy in Computer Science from Alagappa University, India in 2004,Master of Technology inComputer Science & Engineering from Dr. M.G.R. University, India in 2007 and Ph.D. in Computer Science & Engineering from Acharya Nagarjuna University, India in 2011. He is currently working as Head & Professor in the Department of Computer Science & Engineering, in KKR & KSR Institute of Technology & Sciences, Guntur, India. His area of interests are Data Mining & its applications, Image Processing and Pattern Recognitions and Digital Communications

B. Tejaswi , received Bachelor of Technology degree in Computer Science & Engineering from Jawaharlal Nehru Technological University, Kakinada, Andhra Pradesh, India in 2010, Master of Technology in Computer Science & Engineering from Jawaharlal Nehru Technological University , Kakinada, Andhra Pradesh India in 2012. She is currently working Asst. Professor in the Department of Computer Science & Engineering, in KKR & KSR Institute of Technology & Sciences, Guntur, India.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)