

MASTER COURSE SELECTION PREDICTION MODEL USING MODIFY HYBRID NEURO-FUZZY INFERENCE SYSTEM

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Abstract

Many of the students have completed their graduation, but they are not sure of their future course that will lead them to a good career as a professional. They are mystified or do not know an acceptable choice of higher education courses. This is a very key factor of their careers to encourage and improve awareness of the proper guidance for their career progression. This paper suggests a novel modify approach with the use of hybrid neural network and fuzzy system as "Fuzzy Inference System (FIS)" for the analysis of an IT Postgraduates student selection course. The prediction of course selection based on student academic performance and psychological factors are important students. Mainly for the performance prediction of course selection which is a very critical decision-making method to make the student's career path. This study is helpful for those students who want to enroll higher education study in specific course. However, previous techniques often considered by many researcher scholars using academic past performance data and personal data for prediction, leading to the creation of complicated predicting methods whose results are helpful to interpret. Also, this paper explores the use of highly effective psychological factors attributes with other factors such as student personal factors, academic factors and socioeconomic factors that are easily accessible and interpretation.

Keywords:

Course Selection, Fuzzy Inference System, Academic Factors, Socioeconomic Factors, Psychological Factors

1. INTRODUCTION

As said by famous mentor of our nation, a person to see the future, "An education should be imparted with a view to type of society that we wish to build." Technology trends are used to make rapid effort, precise mechanism and problem resolution of real life situation. Education data mining also obtains a lot from the techniques like data mining and machine learning [12].

Educational Data mining is one of the research fields which concerned with various stakeholders like students, parents, educational management and organization. Educational Data mining (EDM) is powerful techniques which use to extract knowledge based on huge data available related to education. This outcome is helpful for organizations, management and other stakeholders such as students, parents and related to educational field.

Data mining techniques like classification, prediction, clustering and association rules are used based of students' information Many data mining techniques are used by researchers to identified pattern, earlier prediction of performance, students achievements [23] and learning prototype.

As discussed by Cheng et al. [15], there are many areas in education as below which used Data Mining Techniques such as classification, clustering, Association rules etc.

- Admission process
- Course curriculum design
- Job employment
- Students' learning process
- Students' performance
- Evaluation of students
- Teaching- learning pattern
- Impact of social background to students.

Students' achieve a high grade based on their academic performance and uplift career in proper way. Surjeetkumar et al. [37] has used decision tree method to achieve the enrollment of students in specific course. They have many questions in their mind like how they choose course, location of study, parent income, market demand, and success ratio for that course. For this students have many more factors which impact on their decision making process of selection of Post-graduation course including personal factors and socio-economic factors. Few factors change their aspirations in life like external factors (Environment and society) and internal factors (self-crisis and family) are highly impact this decision [35]. Some graduate students gradually stop in their college career because of financial sustainability. It also play major role in alternation of career life so, a researcher discussed about data mining techniques are also helpful to predict the placement of students [38]

In this study, included factors such as personal, socio-demographic characteristics and psychological factors in terms of gender, caste, parents' income, highest qualification of family members, social community concerns, in-demand job, career counselor, learning pattern of students, motivation of course selection, awareness of recent trends by students, acquisition of knowledge using various methods: self-belief and understandability. These factors are most significant to make ideal decision for students to achieve the correct career path of students. These are more effective parameters explore and contribute for better outcome of decision making process smoother. After completion of Graduation many students are decided to what's next plan for their future life. Use of these parameters proposed a predictive model to help students choose postgraduate courses after graduation. Also undergraduate students considered as find out best course selection/prediction for their career path.

2. EDUCATIONAL DATA MINING

An education is hub of knowledge discovery. In this era, an education is build vital role of life. Through the literate of various knowledge, people are able to reach good perception of life and also make sense to live better with real world experience. Data

mining is one of the powerful trends which used in many areas like engineering, marketing, financial and so many. With this data mining techniques are helpful to extract hidden pattern, identify knowledge from data.

It has many techniques to discover the knowledge such as decision tree, apriori, clustering and neural network. This trend is applied in education field also which is well-known as Educational Data Mining (EDM). Educational data mining (EDM) is combining of education with computer science using data mining (DM). This method implemented with machine learning for statistic calculation show as per figure. EDM mainly contributes to the decision making of the educational institutions for improving the quality and learning analysis [2]. Many tasks or problems in educational environments have been managed or resolved through EDM.

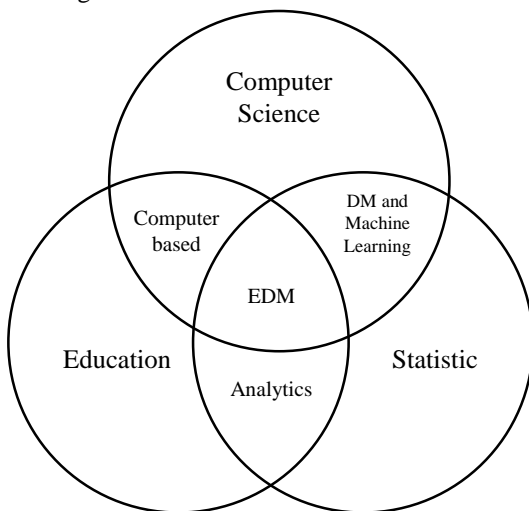


Fig.1. Educational Data Mining (EDM)

The higher education landscape is increasingly multipart requiring students to identify future career plans and pathways early in their academic career. Understandably, not all students are job-focused with the necessary insight and incentive to make creative career decisions. This is well familiar across the higher education sector with the vast majority of universities now offering career counseling and support services. While this approach offers much personal value there is limited scalability in practice. Not all students would or could avail themselves of these services. There simply are insufficient resources to cope with a large increase in demand. However, as the education sector increases its application of data and analytics to the decision making process. There is an opportunity to better align support resources to assist students in their career plans. Many of researchers are focus on various data mining techniques with many related students dataset in this field [32].

3. LITERATURE REVIEW

The literature review was carried out study of paper through which the requirement for determining the implementation of various data mining techniques by many of researchers. Many researchers given a brief idea about various data mining techniques such as classification, clustering, association rules used in education field [33] [34]. Also discussed the future scope

of it in education field [28]. Some of researchers are also discussed about important factors related to improvement of academic performance of students. Using implemented classification algorithms of DM such as decision tree, Naïve Bayes, random forest and Bayes network. These all techniques measure with different types of measures like 10-cross validation, percentage split and training set using WEKA platform. Different metrics like RMSE, RRSE, precision, recall, f-measure, ROC and MSE used by different researchers on their experiments to identify the accurate and better model to analysis on students data [21]

Nupur et al. [24] discussed about Predicting student's future learning behavior, Discovering or improving domain models, Advancing scientific knowledge about learning and learners and Studying the effects of educational support application area discussed with clustering, classification, prediction and association rule data mining techniques.

Using data mining, course recommender system which implemented with four different algorithms which used by Hana to enhance the feasibility on various aspects with suitability of proper algorithm. And found that students usually selected easier courses defined in their templates [11].

Parkavi et al. [27] carried out research study by devising a mathematical model and tool to determine effective course conduction strategy, for teaching the students regression analysis and goodness of fit test. The accuracy of prediction in this research is more as it is measured by using R^2 value which is near to one using Python and R programming. And concluded that to determine the effective course conduction strategy for a course based on students' performance using regression analysis and goodness of fit test.

William et al. [39] offered student course satisfaction is a multivariate nonlinear problem. Neural Network (NN) techniques have been successfully applied to approximating nonlinear functions in many disciplines. Statistical analysis and NN techniques are incorporated for establishing some dynamic models for analyzing and predicting student course satisfaction with final grading based on two most influential factors to student course satisfaction. The three-layer multilayer perceptron (MLP) models outperform the linear regressions in predicting student course satisfaction, with the best outcome being achieved by combining both NS and HD as the input to the networks.

Ivana et al. [13] discussed about prediction task studied in research question which produced the highest accuracy based on course characteristics and the GPA value for courses. Also compared the accuracy level of the AHP-based approach with those of other related published studies. Although, to date there have been limited investigations of this kind to undertake a comprehensive comparison and evaluation. However, in a similar study, Shubhangi et al. [36], discussed about to predict the student performance in the examination and also to predict the student will graduate or not by using statistical analytical method which is F1 score. To fulfill this requirement in machine learning, classification technique is used 395 student records, having attributes, such as age, health, internet, school, father job, mother job etc. Using support vector machines (SVM), Decision Tree and Naïve Bayes (NB) classification algorithms F1 score is calculated for each algorithm. Based on the analysis done the F1 score of

support vector machine is giving the better prediction compared to rest of the two algorithms.

Many researchers are used this techniques with applied of many classifiers available in WEKA, Rapid Miner, Orange and many open source tools available in market. Decision tree classifiers, Bayesian classifiers, classification by back propagation, support vector machines, nearest neighbors and case base reasoning are few of classifier [20] [6]. Mike et al. [19] discussed about questionnaires based on Course description only, Course description and student opinion of course and Course description and student opinion of course and professor applied on students' data.

Sumit et al. [8] has given review of data mining, apply and compare the classification algorithms like K-NN, Support Vector machine with radial basis kernel. They suggested DM approach using student open elective choices and identified prediction parameters using classification also the ambiguity in terms of Computer science engineering and civil engineering. Amongst this classifier Decision tree J48 algorithm was used to predict the post-graduation course using customized classification model with WEKA tool, obtained by 94.03% accuracy against 4 classes. [14]. Using of decision tree C.45 algorithm one of researcher Cut Fairni et al. [7] has proposed an academic decision support system which uses to select sub major recommendation based on student's interest and ability. They achieved result as 79.03% precision and 61.11% of recall for same.

Behdad et al. [4] propose a course recommendation system for students based on the assessment of their "graduate attributes" (i.e. attributes that describe the developing values of students). They suggested a GA based on course taken by fellow students and taken feedback from students. Using of this approach they rating the course and considered as multi criteria rating. Students rate the improvement in their graduating attributes after a course is finished and a collaborative filtering algorithm is utilized in order to suggest courses that were taken by fellow students and rated in a similar way.

A recommender system was generated by Grewal et al. [10] using clustering technique with the help of expert student's course selection based on their marks and choice of job interest factors used in PHP and mysql for develop a GUI application. They got 95% cases of Students' satisfaction using this recommender system. Karan et al. [17], supervised learning was carried out for established groups of students as best, average and worst in academic performance using the neural network (back propagation) and found that the neural network produces the most reliable results.

Zameer et al. [40] has developed a recommender system to predict the course for students as per their requirements with use of Hybrid approach: Opinion Mining and Social Interaction using Clustering Algorithms based on Ontology constructed on course domain.

Ahmad et al. [1] has focused on identifying the potential factors that affect student satisfaction concerning the online courses they select, modeling student course selection behavior and fitting a function to the training data using neural network approach. The experimental using neural network with sample data from 714 online graduate courses in 16 academic terms. By conducting substantial investigations and thorough reviews of the relevant literature, 8 influential factors like course characteristics,

instructor characteristics, course difficulty and student workload, course grade, course type in terms of required or elective, time of day of the course, number of time conflicts of the course with others, and final examination time in the process were determined and used as the inputs of the model. They detected as the best approach for employing machine learning techniques or a hybrid one may result in better prediction accuracy for other institutes.

José vieira et al. [16] discussed about characterized by a fuzzy system where fuzzy sets and fuzzy rules are adjusted using input output patterns. There are several different implementations of neuro-fuzzy systems, where each author defined its own model. This article summarizes a general vision of the area describing the most known hybrid neuro-fuzzy techniques, its advantages and disadvantages.

The prediction of student academic performance facilitates admission decisions and enhances educational services at tertiary institutions. This raises the need to have an effective model which predicts performance based on result and other influential factors such as socio-economic background. This approach proposed a model with use of Hierarchical Adaptive Neuro-Fuzzy Inference system (HANFIS) and compare result with ANN, GA-HANFIS and indicated that proposed model performance better than others [5].

They proposed a dynamic structure of AMM for multiple inputs multiple output (MIMO) problems based on dependency graph which clear cause and relationship between input and output based on pathology problems and its learning methods' performance are compared on a real well known dataset [9] Lebogang et al. [18] has focuses on the first year Computer Science students and their overall academic performance in first year based on that use of association rules in weka to identify whether the computer science and mathematics course combination perform well or not with additional courses. As discussed by Veeramuthu et al. [25], the data mining framework is used enrolled students based on academic applied classification model and then a generated rule using of many factors as student's loyalty and academic performance. The rules are generated using various evaluation methods.

These research and literature reviews are motivated to prepare for students who wish to enroll in a particular course. Many of the researchers were worked on classification, clustering and association rule mining based on student's data to improve the students' academic performance and course satisfaction level. But here is the most related factors for students' success of selections course are missing and also found that most of the techniques were used classification techniques. To achieve a better result apart from students' benefits and use of decision support system approach fuzzy inference system is very prominent and helpful for prediction model. For this reason, a prediction model proposed based on a fuzzy inference system with use of different parameters as personal, socioeconomic, academic and, most importantly, psychological factors.

4. DATA COLLECTION AND PREPARATION:

This questionnaire has been constructed based on theoretical and empirical grounds about factor affecting student's decision of selection of post graduate course. The questionnaire included socio-demographic indicators (gender, geographical location,

highest qualification of family, parents annual income, caste), Educational factors (performance in high school, academic grade on graduate degree, type of university/ board, stream of study, spent time for study, attendance etc.), psychological factors (knowledge acquisition, learning pattern, purpose of higher study, awareness of ICT, etc.).

The desired student information is present in the form of both manual and digital (Google form). All the needed information is converted into digital table form. The student information from multiple tables is integrated into a single distinct table.

Table.1. Factors details of study

Factors involved	Describe Factors
Institutional and Employability Factors	Course offering, Geographic location of the institution, Library and computer wi-fi facilities, Quality of teaching, placement of alumni. Course Information: stream of course, Size Of the course, Quality of students enrolled in course, Program structure & fees.
Academic Evaluation	12 th result, attendance, study spent hours, learning style, completion of assignment score, participation in co-curricular activities
Personal Information	Gender, locality to stay, transport used, family income, family education, language known, Social/cultural opportunities, Sensitivity to minorities and others, Opportunities for friendships, motivator programs
Psychological Factors	Learning pattern, motivation, self-confidence, acquisition of knowledge, perception

Psychological factors are more important in decision making process. With included these psychological factors, academic, personal and social economic factors will achieve a better decision making approach use for proposed model [29] [30]

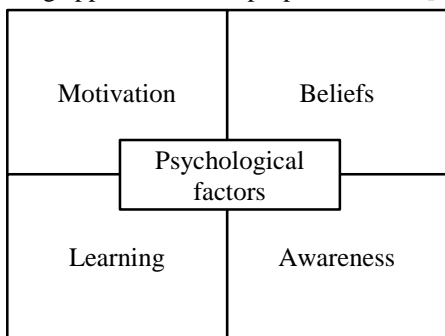


Fig.2. Psychological factors

Paisi et al. [26] discussed about academic performance depends on intellectual aptitudes and personality factors affect the academic success. Anne discussed about the curriculum decision making process effects with adequate psychological considerations [3].

4.1 COURSE PREDICTOR SYSTEM (CPS): FRAMEWORK OF CPS, IMPLEMENTATION AND RESULT

For the study, here proposed model which is used to implement modify hybrid neuro fuzzy inference system for predict the result of success ratio after selection of post graduate course by student using Rstudio tool.

CPS Algorithm:

Input: Input train dataset

Output: predict output class variable

Step 1: Identify the range of normalized train dataset.

Step 2: To build the names of linguistic values.

Step 3: Divide the Input and Output Spaces Into Fuzzy Regions.

- a. Make the depth on each linguistic value.
- b. Construct matrix of parameter of membership function on each variable for input with use of Gaussian function.

Step 4: 4: Generate Fuzzy Rules from Given Data Pairs.

- a. Determine the degree of data pairs. To get degree of membership by fuzzification.
- b. Get max value of degree on each variable to get one rule.

Step 5: Determine the degree of the rule.

- a. Calculate t-norm in antecedent part and implication function with consequent part.
- b. Find the same elements on matrix rule considering degree of rules.

Step 6: Build the rule into list of string. And delete incomplete rule. And set index and range of the Input and output fuzzy objects.

- a. Set Index of output variable on number of labels and cut membership function of output variable.
- b. Get output variable of membership function and set range of original data.

Step 7: Store the list of rule,range of data, degree of rule, t-norm value and implication value to knowledge base.

Step 8: Input the test dataset and normalization of data using step 1.

Step 9: Use of step-2 to convert it into linguistics term and crisp values. And Implement method of Fuzzifier which use the object set and convert test data into crisp data.

Step 10: Use of reasoning operation which mapped the crisp values with objects and mapped with rules database from knowledge base.

Step 11: Applied defuzzifier method with use of Center of Gravity method for final output.

Step 12: Transform the crisp output into the linguistics term as final predict output class variable.

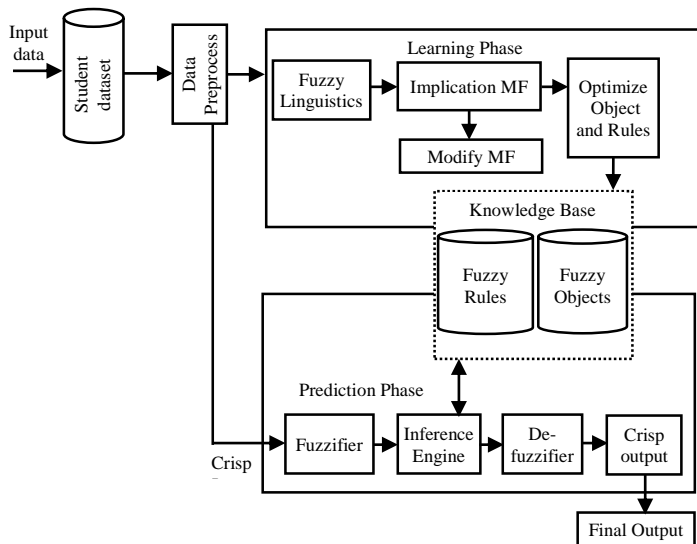


Fig.3. Framework of Proposed Model (CPS)

4.1.1 Data Preprocessing:

The dataset taken for study is the south Gujarat region IT related college and Computer Engineering institutes records of student information from academic year 2014 to 2018.

The dataset has the personal information, academic information and socio economic status. Feature extraction is done over the pre-processed and normalized dataset and the among the 23 parameters, the attributes that contributes less for the prediction accuracy or sensitive information like age, name, transport facilities are removed from the original dataset based on feature selection process.

Feature extraction is done over the pre-processed and normalized dataset that contributes less for the prediction accuracy or sensitive information like age, name, and transport facilities are removed from the original dataset based on feature selection process. The preprocessed dataset is represented as a single document in .csv format.

4.1.2 Learning Phase:

Use of normalized data and create linguistic fuzzy terms. This fuzzy terms are used in future study for create fuzzy rules.

- Number of input labels = 3
- Linguistics Fuzzy terms of input vector = {"Low", "Medium", "High"}
- Linguistics Fuzzy terms of output vector = {"Less", "Average", "Good"}

In this function, convert crisp value into linguistic value based on the data and parameter of membership function. The Gaussian membership function for calculate the degree of membership function. Here constructed a matrix of parameter of membership function on each variable for input with use of Gaussian function. Applied "Gaussian" membership function for mapping fuzzy region on fuzzy set using following formula:

$$Gaussian(x, c, \sigma) = e^{-0.5 \left(\frac{x-c}{\sigma} \right)^2}$$

The Fig.4 shown the degree of membership function which is derived after implemented method.

Finding the consequence of the rule by combining the rule strength and the output membership functions. Build the rule into list of string. And delete incomplete rule. Everything above the rule firing strength has been omitted. Finally these fuzzy rules and fuzzy objects are stores in the knowledge base field that are further used in the prediction process.

4.1.3 Prediction Phase:

Now this train model is implemented the test dataset using prediction phase .Input the testing dataset. Here in this study as mention previously 25% of preprocessed data used.

Use of normalized data applies normalization function which applied on learning phase. Also convert the crisp input into fuzzy linguistics terms same as train data.

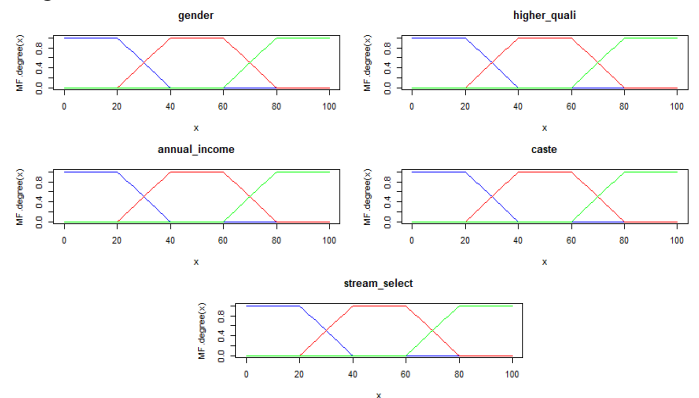


Fig.4. degree of membership function (MF)

Fuzzification (Fuzzifier) is a process which transforms the crisp inputs into degrees of membership functions of the linguistic term of each variable. Knowledge base consisting of a database (DB) and a rule base (RB). While the database includes the fuzzy set definitions, the rule base contains fuzzy IF-THEN rules. It will represent the knowledge as a set of rules.

- An inference engine which performs the inference operations on the fuzzy IF-THEN rules.
- Applied Fuzzy system maps the input into fuzzy input by using membership function.

There is used of mamdani inference for fuzzy systems based on linguistic rules. Inference engine is use for mapped the crisp values with objects and mapped with rules database using knowledge base. The process for determining the result or rule strength of the rule may be done by taking the minimum fuzzy input 1 AND input 2, min. This minimum result is equal to the corresponding rule strength. If there are any consequences that are the same, the maximum rule strength between similar results shall be taken as maximum or max. Inferencing, therefore, min./max. Inferencing. This infers that the rule that is most true is adopted. Such strength values are referred to as fuzzy outputs.

Defuzzification (Defuzzifier) is a method for converting a fuzzified output into a single crisp value with respect to a fuzzy set. There are several methods of defuzzification, such as Center of Sums Method (COS), Center of gravity (COG) / Centroid of Area (COA) Method, Center of Area / Bisector of Area Method (BOA), Weighted Average Method. Finally crisp output and translate it into linguistic terms.

The defuzzification COG method provides a crisp value based on the center of gravity of the fuzzy set. The total area of the membership function distribution used to represent the combined control action is divided into a number of sub-areas. The area and the center of gravity or centroid of each sub-area is calculated and then the summation of all these sub-areas is taken to find the defuzzified value for a discrete fuzzy set. The defuzzified value x^* using COG is defined as:

$$x^* = \frac{\sum_{i=1}^N A_i \sum_{i=1}^N \frac{x}{N}}{\sum_{i=1}^N A_i}$$

Here N indicates the number of sub-areas A_i , and X_i represents the area and centroid of area, respectively, of i^{th} sub-area. Convert the crisp values of output into the linguistics terms.

Table.2. Final output sample 10 records

Record No.	Actual Success PG data value	Predict Success PG
1	Good	Good
2	Average	Average
3	Average	Average
4	Average	Average
5	Average	Average
6	Good	Good
7	Good	Good
8	Good	Good
9	Average	Average
10	Good	Good

For 75% of records used for train a proposed model. Students’ from MCA, M.Sc. [Compute Application, ME, M.Sc. [ICT], MSc. [IT], B.Sc. [Computer science], BCA, B.Sc. [ICT] B.Sc. [IT] and BE (Computer Engineering) has taken. In research work study for selected course by respondent as M.C.A., M.Sc. [C.A.], M.Sc. [I.T.], M.Sc. [I.C.T.], M.B.A. [I.T.] and ME. Predicted results are “Good,” “Average” and “Less” for the selected course. Here, “Less” means that if a student chooses any of the postgraduate courses listed then the student will have less success in his or her career, “Average” means that the selected course will predict average success in his or her career and “Good” means that the chosen course will be well suited and successful in his or her career.

The outcome of CPS proposed model is 97.33% when it tested 15% of records. The outcome of the CPS model was 25% per cent of the tests performed data, with 97.5% accuracy. Increased test records have achieved accuracy of close to 98%. Also we observed less error rate form this experiment. The Fig.5 shows the accuracy on CPS model.

Few researchers are also studying the role of the neural network and the fuzzy system in education as well as other fields. Ravikumar et al. [30] used fuzzy inference system for prediction of placement training to identify performance of the students and also provides an opportunity to improve to performance for these they classified the student’s data set for placement and non-

placement classes. Norazah et al. [22] applied a concise fuzzy rule base to reason students’ performance based on rough fuzzy approach fuzzy inference system using students’ dataset. They implemented incremented the training data from 54 to 64 and found the results of the trained ANFIS up to 96.3%.

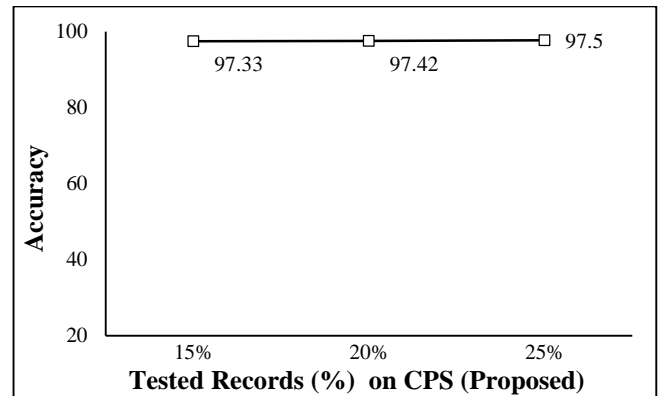


Fig.5. Accuracy of Proposed Model (CPS)

The neural network and fuzzy system approach has produces a great deal of predictive results in the decision-making process. Throughout our research, we applied the hybrid method of the neural network and the fuzzy model, part of which is known as the fuzzy inference System. The neuro-fuzzy approach gives the decision-making process a better outcome. The outcome of our analysis 97.5% accuracy of the Proposed Model (CPS) decision on the course selection process.

5. CONCLUSION AND FUTURE WORK

The research work presented in this study belongs to the wide area of discovering the use of data mining and machine learning techniques in building predicting system which could be based on hybrid approach of fuzzy logic and neural network for the success of students in higher education. It will help to improve the effectiveness of the decision-making process of education for students enrolled in postgraduate IT courses at Indian universities. In particular, research is relevant to the development of effective neuro fuzzy systems capable of adapting to the needs and challenges of the higher education community.

A great deal of work has been provided in the literature over the last few decades in order to provide access to key factors relevant to the student’s choice of course. We contribute to the recognition factors and have emerged as a major contributor to the psychological factors relevant to the perception of IT graduate students of related courses that have an impact on their course selection process. To classify the causes, an online survey was conducted for the thesis in which the students were granted the freedom to determine the true contributors to their opinions. Factor analysis was carried out to reduce the variables to more relevant underlying factors.

From this analysis, we derived a better selection strategy using the proposed model (CPS) after graduation. The system is helpful in choosing the right course. Students will achieve their career goal if the student chooses the appropriate postgraduate course.

The limit of study is collected data from computer science and engineering student’s data that after a clearer understanding of the

strengths and weaknesses of each method, consideration should be given to the possibility of combining two or more algorithms together to solve a problem. While dealing with hybrid approach, the main question is not whether a predictive model is superior to others, but under what circumstances a particular method will significantly outperform others on a given problem. The future research scope to include the curriculum or graduation attribute of the course will, of course, provide a good picture of a deeper understanding of the goal that the student would achieve after graduation or any course has passed. The investigator will also to enhance the research objective by investigating more parameters and techniques that are relevant to the study objective.

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