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Naive Bayes Classification for Intelligent Tutoring System for the Subject of Mathematics

Ishan Bhutani[1], Kalrav Chaniyara[2], Ms Pratiksha Meshram[3]

[1]*Student, Dept. of Computer Engineering, MPSTME, Shirpur*
[2]*Student, Dept. of Computer Engineering, MPSTME, Shirpur*
[3]*Assistant Professor, Dept. of Computer Engineering, MPSTME, Shirpur*

Abstract - *Intelligent tutoring system can be effectively used in everyday learning scenario such as courses can be designed to be taught in schools and educational institutions. When learners have freedom to use a variety of on-line resources, ITS can be used to increase the performance of learners by considering their differences in knowledge, expertise and preferences. This paper illustrates that how Naïve Bayes Classifier will be used to implement ITS for classifying a learner to the most appropriate class based on the learning results. This classification could be useful while forming an initial learning scenario of the learner.*

Key Words: **Naïve Bayes Classifier, Intelligent Tutoring Systems, Learning Scenario, Intelligent Computer-Aided Instruction, classification.**

1.INTRODUCTION

As per the groundwork Intelligent Tutoring Systems (ITS) are more popular and trending. ITS helps a beginner to improve learning from a computer system without human collaboration [1]. ITS is a computer system that aims to provide immediate and tailored instruction or feedback to beginners. Performance of pupils can be increased remarkably reducing the learning time [2]. Practices of artificial intelligence empowers the computer to be a contrivance to advance cognitive models and benefits the advent of communication and information technology [2]. Student is placed at the center of the learning scenario. ITS provides devotion to the detailed desires of the novice and performs a intellectual analysis of pupil errors and provides proper feedback.

This paper focusses on a idea that is, each learner in a row is epitomized as a set of figures which holds data such as: learner's demographic data like age, gender etc. Next, learner attempts a test for algebra, arithmetic and geometry. A database with values of aspects narrating a learner is generated from this process. According to the result of this test and the time taken for the same the learner is classified to an appropriate class.

For prediction of the student's performance Naïve Bayesian Classifier has been used; which foresees learning outcomes on the ground of training sets and student's profile. If novice rolls to an ITS, fills some necessary details and attempts a test then system can classify a learner using historical data. Learning Material will be offered to novices based on their performance. Learners belongs to excellent or good class could be advised with some supplementary teaching material; less capable learners should be given more enlightenments. The responses of a test given by learners will be utilized to extract different data patterns as well as calculating the median and modes of their responses to prepare a survey.

The paper ordering is as follows: segment II comprises the literature study, segment III contains the description of the proposed Intelligent Tutoring System and Naïve Bayes Classifier. Segment IV concludes this work.

2. REVIEW OF LITERATURE

User sculpting is of utmost importance for the provision of adaptivity [4]. In ITS an apprentice may be defined by the data like intellectual ability, knowledge in specific interests. These parameters help to make the system robust, customized and provide adaptivity which in turn calibrates the type of learning material based on learner's leaning and learning styles [4], [5] or endorsed courses.

Learner learning outcomes can be assessed in number of different ways such as surveys, multiple-choice tests, short answer tests [7]. The idea of conducting pre-tests is suggested in [6].

3. METHODOLOGY

3.1 Intelligent tutoring System

Artificial Intelligence is applied as to the educational system and instructional paradigm with the help of ITS. The extensively and excellently known phrase "Intelligent Computer-Aided Instruction" (ICAI) had been substituted by the abbreviation "ITS"; which has been used for numerous years with the similar intent [8]. The cerebral

and sensitive states of specific learners have been modelled using an ITS which is a type of computer-aided training software with the objective of familiarizing and engraving teaching. Number of subjects as well as several chunks of social science, the humanities, mathematics and science have been taught by ITS.

The basic of ITS is to provide facilities that provisions training. There are a extensive diversity of ways to intellectualize, plan and advance such amenities.

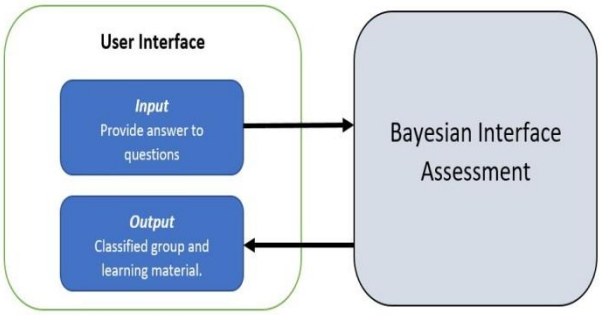

Fig -1 Overview of ITS

An ITS is constructed of four modules; which are (Fig 1): Student module, Domain module, Classification module and Tutoring module. [10]

3.2 Proposed ITS

The system comprises of four basic elements:

1. The Student module
2. The Domain module
3. The Classification module
4. The Tutoring module

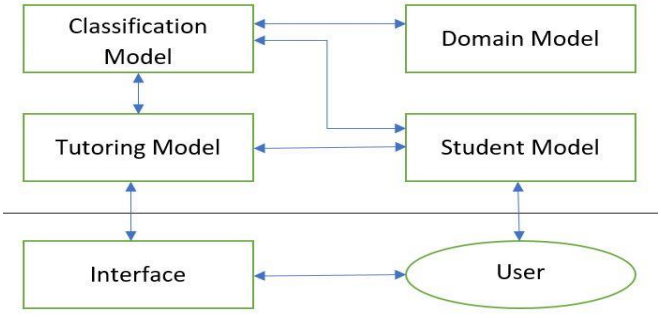

Fig -2 Architecture of ITS

The student module consists of learner's details such as name, gender, age, email id, which can be utilized to make the system cognitive.

The domain module consists of different questions related to various mathematical topics such as algebra, arithmetic, geometry. Based on the answers given for these questions total score of the learner will be calculated. Apart from this time taken to complete each section of the test is also taken into consideration.

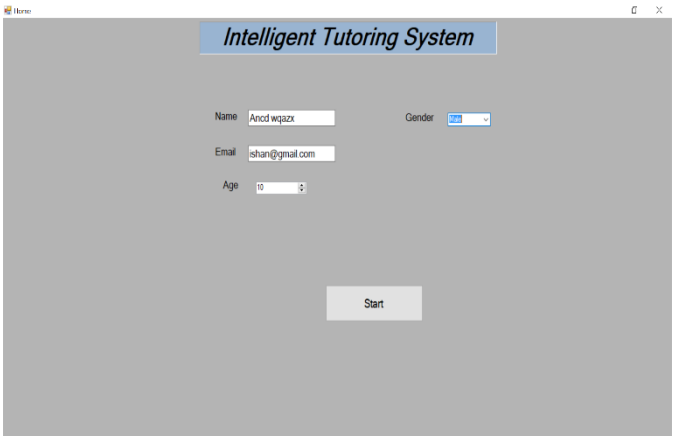

Fig -3 Registration Form

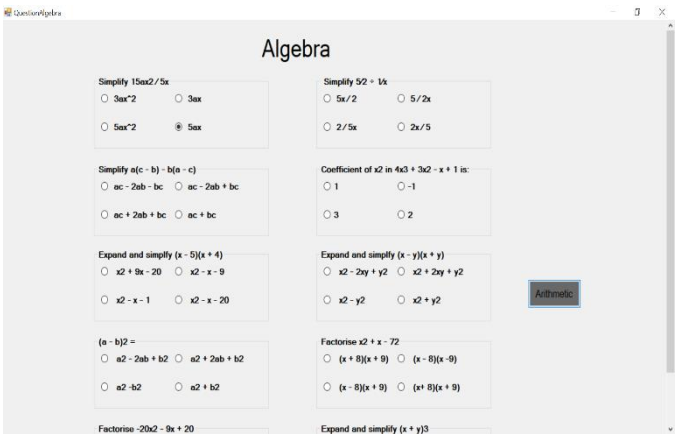

Fig -4 Algebra Question Set

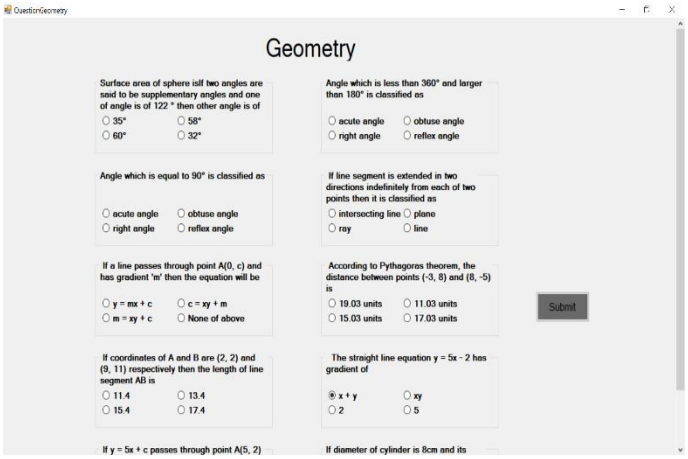

Fig -5 Geometry Question Set

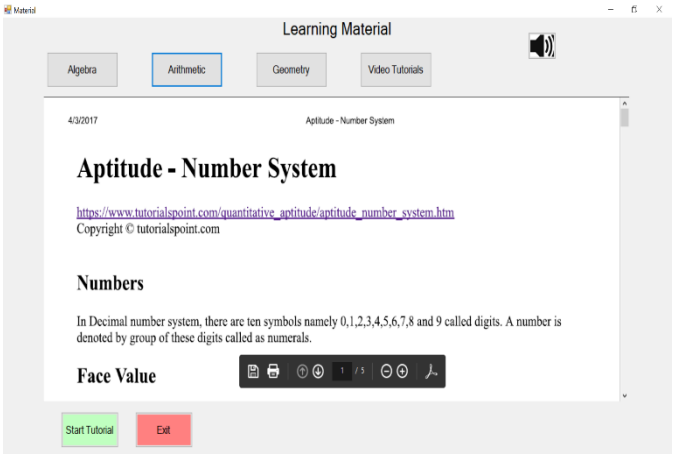

Fig -7 Learning Material

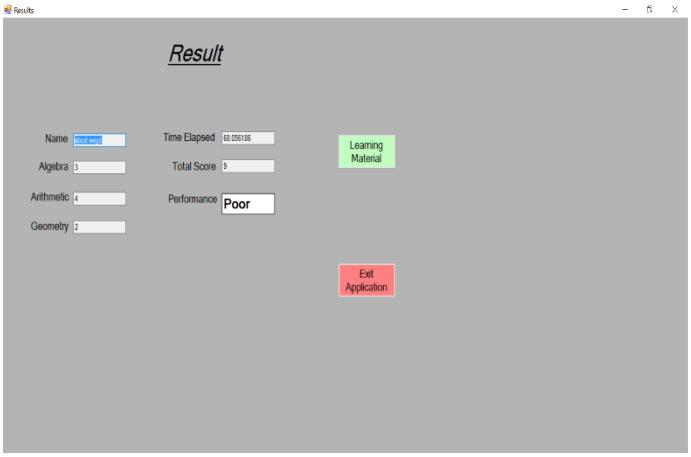

Fig -6 Results- Assigned Class (Performance: Poor)

Fig -8 Video Tutorial

The classification module uses Naïve Bayes Classifier with the input parameters – total score of the test, age of the student and time taken to complete the test, classifies a novice to the most suitable class and immediate feedback is provided to the user.

Tutoring Module is about how learning can be provided to the novice based on results classification module. The planning and delivery of content are part of the functions of the tutor module. Novice with excellent knowledge level can be provided with more comprehensive knowledge about the topic while novice with low knowledge level can be provided with more clues and examples and enlightenments.

If novices older than some specific age take more time in answering a section than he/she can be classified as moderate or weak while learners younger than some specific age take lesser time for the same can be classified as excellent or good.

3.3 Naïve Bayes Classifier

On the basis of Bayes rule of conditional probability Naïve Bayes Classifier has been proposed. Bayesian rule is widely used to evaluate the probability of an attribute when a set of data is given, as evidence.

Bayesian theorem is given by the following:

Likelihood — Class Prior Probability

$$P(c \mid x) = \frac{P(x \mid c) P(c)}{P(x)}$$

Posterior Probability — Predictor Prior Probability

$$P(c \mid X) = P(x_1 \mid c) \times P(x_2 \mid c) \times \cdots \times P(x_n \mid c) \times P(c)$$

As the tactic is based on the postulation that input values are independent of each other; it has been labelled naive. Naïve Bayes Classification technique can be observed as evocative as well as predictive type machine learning

algorithm. The probabilities in this method are used to forestall membership of class to a target tuple [12].

For specified training dataset, the algorithm calculates prior probabilities P(Cj) for every class by computing how frequently the classes appear in the train dataset. For each variable value, xi can be counted to deduce P(xi) (prob. of attribute value).

Similarly, the probability P(xi|Cj) (probability of attribute value X given class C) can be evaluated by totalling how frequently the values appear in class in training dataset. At the time of classification of target tuple, the prediction is made by the prior as well as conditional probabilities calculated from the training set. Then determines P (ti | Cj) by the formula:

$$P(t_i \mid c_j) = \prod_{k=1}^{P} (x_{ij} \mid c_j)$$

For the calculation of P(ti) evaluation of likelihood ti in each class is required. The product of conditional probabilities of each variable shows that probability ti is present in a class. The class that has maximum estimation value is selected and the target tuple assigned that selected class [11] [12].

Naïve Bayesian approach has numerous advantages: prediction of class of test dataset is easy and fast; Naive Bayes classification technique requires only a single scan of data which is not the case in other classification techniques.; works well with categorical data unlike numerical variables which require assumption of strong normal distribution [12].

Naïve Bayes Classifier require only trivial expanse of statistics to evaluate the parameter values. When training dataset has continuous variables, for the purpose of classification it is necessary to calculate the variance and mean of variables, as we then require normal distribution. Since the variables are assumed to be independent only the variance of the attributes need to be calculated. Naïve Bayes classifiers have performed pretty well in various intricate real-life circumstances, regardless of its Naïve strategy and speciously over-simplified assumptions, [12].

Our proposed model uses Naïve Bayes classifier as a method to classify the novice based on his/her performance in the test.

4. CONCLUSIONS

In this paper, to assess learner's performance, other than the score of different sections three other parameters such as time taken to answer a section and age are also studied. With the dependency relationships among the considered parameters, we could classify the learner's ability from the test and learning is provided accordingly.

In the future, we plan to consider more parameters such as time of the day when the test was taken, psychological state of the novice; add some specific courses related to math.

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