Predictive Analysis of the Enrolment of Elementary Schools Using Regression Algorithms

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Abstract— By fitting a linear equation to observable values, linear regression determines the relationship between two variables. The Department of Education enrollment data in the Philippines, specifically in the School Division of Batangas, is needed to produce modules. The data collected is from the division office, where data cleaning was applied. Deep Learning, Decision Tree, Random Forest, Gradient Boosted Tree, Support Vector Machine, and Linear Regression were used to perform the prediction, and linear regression performed the best with an absolute value of 14.465 and a relative error of 84.81%.

Keywords— Prediction, Information Management, Linear Regression, Cloud Computing, LDM.

I. INTRODUCTION

Department of Education (DepEd) has established Learning Delivery Modalities for their clients. As part of this, synchronous and asynchronous mode of learning [1] is also presented to the parents and students. The LDM implementation has continuously met the gap for the learners and teachers to acquire knowledge in a modular arrangement. Most of the learning materials are gathered through a Cloud Computing (CC), the Information Management model [2]. However, the learning materials are still evaluated to see if the modules adequately assess students' understanding of a particular area. Moreover, there is a need to assess the learners' success in all grade levels and across domains.

In the presence of the COVID-19, the LDM produced a solution to continue the educations of the learners. The elementary and high school elementary and high school students implemented the distribution of modules to the learners that have to be accomplished per week. Other institution also prepared for the synchronous and asynchronous model of learning which depends on the type of system applied for upon enrollment.

Two major difficulties arise from the implementation of the program such as no means of computer or smartphone and some have difficulty in internet connection. For the implementation of learning modules; excessive or lacking number of printed learning modules, damaged modules due to wear and tear, and others.

A model will be proposed to evaluate the process of allocating learning resources and the resources required by the various schools in DepEd Region 4A [3], which comprises 21 Divisions. The study will concentrate on the prediction of the province of Batangas for the elementary education department, starting from Kindergarten to Grade 6 only with the coverage of the academic year of 2016-2017 until the academic year 2019-2020. A prediction based on linear regression was used to measure each institution's performance and success rate using cloud-based learning resources [4]. Furthermore, analyzing the trend of the different data collected from various sources and determining the acceptability of cloud-based learning.

Different predicting models had been used in different studies like gradient boosted tree [5], naive Bayes, random forest, and others; however, these models may not be appropriate in predicting enrollment of primary schools in region 4a. With the different trends and pandemics, it will be harder to predict this dilemma's enrollment pattern [6]. The research will be more accurate by determining the different parameters and the best fit predictive algorithm.

One of the leading predictive algorithms is Regression [7]; this algorithm has been used in medical, statistical, environmental predictions, and even enrollment analysis [8][9]. It has also been proven that the regression algorithm fits multidimensional datasets [10]. In this case, using this method would allow a broader scope with higher accuracy [11].

Linear regression is fitted for the dataset for it depends on other variables in line with time series. Works best with the enrollment prediction since each year creates a trend that would be the basis of a good predictor result.

Applying a regression approach in a cloud computing environment [12] would be a more significant challenge, but the possibility of integration would show the study's novelty.

II. DATA PREPARATION

The data was collected in the different district offices of the Cavite, Laguna, Batangas, Rizal, and Quezon (CALABARZON) Area but will only concentrate on the elementary education of the Schools Division of Batangas Province.

FIGURE 1. DISTRIBUTION OF THE POPULATION IN ELEMENTARY EDUCATION OF BATANGAS

The distribution of data for the province of Batangas for elementary education is for the three consecutive academic years. This data will be used to predict the next academic year by using the trend and linear regression.

FIGURE 2. STEPS ON DATA CLEANING

In line with the data collection is the preparation for data cleaning. The different data representations collected will be merged to a single dataset that would represent the total students to receive a learning module. The data must be rebuilt to check if the fields are complete or has different datatypes, in this process, the completion of data is important for the data preparation. The data must be standardized so that it follows the same datatype and input patterns, having the same field size and determined values of input is important in the preparation of data. The data must be normalized to determine the significance of the data and relationship to each other. Deduplication is done to remove the redundant values in the table which would make the prediction process invalid. Verifying the legitimacy of each entry is done to determine if the values is a sustainable data that would support other data. Lastly, importation is needed in the process to establish the cleaned data and ready for prediction.

III. METHODS

The methods contain different stages, from the preparation of data to model generation for different predictions. The data will run in different algorithms; a simultaneous process will stimulate the best prediction model [13]. This strategy will compare the accuracy of each model that will be used.

FIGURE 3. METHODOLOGY OF PREDICTIVE MODEL GENERATION

The research will focus on the different layers of the process. The data collection process involves the Division office of CALABARZON collecting the number of enrollees per year and per level of the different districts. Data cleaning is the preparation of the data in terms of the process involving unique data per item. A data splitting technique was used to separate the training and testing dataset. The training data is set to seventy (70%) and the testing data is set to thirty (30%) [14]. Training is the processing of the data cleansed to create a model. This model will determine the flow of the data if it will obtain a higher accuracy rate specifying the relative error and the absolute value. The relative error is the measure of precision which is coordinated with the size of the item [15]. The model generation will accept two specific data, one is the trained dataset, and the other one is the testing dataset. It would test the model's absolute error with the leniency of plus/minus percentage, the computation of the [3]. The analysis phase is the generated predictive model; it has been noted that different algorithms have different results depending on the dataset used [16]. Determining the predictive model that would be used will be based on the accuracy rate of the algorithm as it was applied to the dataset. [17]

IV. RESULTS AND DISCUSSION

Linear regression must state that all values must be set to numerical counterparts evaluated to predict the enrollees for the academic year 2020-2021 for DepEd Batangas Province.

The data was split into a coefficient of 70 percent and 30 percent for training and testing dataset with random values. The result of the prediction with the average number of values is presented in the table below. The average values represent the closest prediction for the dataset.

TABLE 1.
THE STATISTIC AND AVERAGE OF THE VALUE AND PREDICTED VALUES.

Name	Min	Max	Average
Total	1	175	34.402
Prediction	3.304	139.773	34.591

The range of values for the total and the prediction is closely related but for the values of the minimum and the maximum values has a significant range. The specific values contain the prediction which varies from the three consecutive academic years; hence, the prediction follows the pattern of the assumption of the incoming kindergarten based on the trend.

Based on the findings, the actual data is represented by green in figure 4, while blue is the prediction. The prediction has overlapped the actual data based on the training data and assumed more students would enroll for the upcoming academic year.

Figure 4. Bell Curve Representation

Figure 5. Distribution of Enrollees

One of the main parameters in the prediction is gender. The viability of prediction is based on the statistical value of each parameter; thus, the strength of the dataset will show the relationship of each predictive value shown in figure 5.

**Table 2.
Comparative Results**

Model	Absolute Error	Relative Error (%)	Training Time (milli seconds)	Scoring Time (milli seconds)
Deep Learning	23.106	49	2000	10
Decision Tree	23.364	49	6	~0
Random Forest	23.368	49	1	~0
Gradient Boosted Tree	23.398	49	84	85
Support Vector Machine	21.615	47.4	1000	869
Linear Regression	14.465	84.81	320	100

The dataset had been tested to different algorithms to compare the best model to apply. Based on the results, linear regression has the lowest absolute error compared with five other algorithms. They are obtaining 14.465 and 7.15 points higher compared to the nearest algorithm, which supports vector machines. While the relative error shows that the support vector machine performed better than Linear regression, the values of the enrollees show small values making the difference minimal. The relative error of the linear regression is 84.81% which fits the prediction.

V. RECOMMENDATION

Integration of another neighboring municipality to predict the enrollment of the Region 4A is recommended. This is to determine the predicted number of the printed modules to be used in each school. Also include the junior high and Senior high of the region for future study.

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