# A Deep Neural Network in a Web-based Career Track Recommender System for Lower Secondary Education

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*Abstract*— In this paper, web-based career track recommender system was used to guide guidance counselor in assisting their students in choosing an appropriate career track. Many junior high school students struggled with track uncertainty and were perplexed when it came to deciding whether senior high school career track was appropriate and suitable for them. Increased in drop-out rate is also a bigger concern in the country, and students switching to another program can be a waste of government funds intended for free tuition at state universities. Given the current state of K-12 evaluation, adequate counseling of guidance counselor in the selection of relevant career tracks should be undertaken. This study included 1500 students from the first to third grades of the K-12 curriculum, and their grades and socio-demographic profiles were used as factors in determining their academic strand in Senior High School with the utilization of Deep Neural Network. The study's findings suggest that the DNN algorithm predicts the academic strand of students quite well with a prediction accuracy of 83.11%. Using the devised approach, guidance counselors' work became more efficient in dealing with student concerns. With the use of the DNN technique, it is concluded that the recommender system acts as a decision tool for counselors in advising their students to select which Senior High School track is appropriate for them. The web-based career track recommender system has effectively integrated the DNN predictive model.

*Keywords—career track recommender, deep neural network, counselor, career track prediction, performance classification.*

## I. INTRODUCTION

In the Philippines, the Department of Education implemented a new educational system known as the K-12 program, which prepares students and empowers them to enter the labor market with confidence. The new curriculum provides an additional two years of instruction for Senior High School students. Given the current state of K-12 evaluation, adequate counseling of guidance counselor in the selection of relevant career tracks should be undertaken [1] [2]. Moreover, it encourages global competency by allowing Filipino graduates and professionals in other countries to be recognized more quickly [3].

Meanwhile, career counseling can assist students in comparing their values, interests, aptitudes, abilities, and goals to the requirements of various occupations. Students who have been given this knowledge are better equipped to make educated decisions regarding their academic track and are more confident in pursuing their personal objectives. The guidance counselor must help students to decide whether or not they are suitable to the chosen career track for them. Meanwhile, teachers must regularly assess their students' current ability levels to ensure that they are learning and improving throughout the school year. In the K-12 curriculum, students are allowed to choose between four tracks which are academic track, sports track, arts and design track, and the technical-vocational track [4] [5]. This provides the students numerous job possibilities available in each track, exposing them to a variety of element related with career choices. Many junior high school students struggled with track uncertainty and were perplexed when it came to deciding whether senior high school career track was appropriate and suitable for them [6]. Students may also change programs after discovering that they are not well-suited for their selected college course [7][8]. Also, counselors find it difficult to dedicate more time counseling their students due to workload.

Student retention in Senior High School, especially in higher education, can lead to low student satisfaction, with students changing from one course to the next and eventually dropping out. Also, the Philippines government invested 3.2% of their gross domestic product in education last 2019. This finding is not bad, and it's on par with certain ASEAN countries like Indonesia (2.8%) and Thailand (2.9%), but it does not limit their potential. However, drop-out rate is a bigger concern in the country, and are greater than in other Asian countries (7% compared to 1% in Indonesia, 2% in Vietnam, and 4% in Thailand), and those who drop out are almost invariably consigned to a life of poverty, with the exception of a few fortunate ones. A country might easily become burdened by a huge unemployed and uneducated populace [9]. Moreover, increased in drop-out rate can be a waste of government funds intended for free tuition at state universities, as well as increased worry among students in the selection of career track. As a result, teachers and counselors must assess students' performance on a regular basis to determine which courses are their strengths and areas for improvement before recommending students on the suitable career track to avoid these issues.

Social anxiety can impact higher education and career choices of the students. That's why every student should receive career assistance in a variety of methods to help them gain the skills, knowledge, and experience they need to discover career opportunities, explore alternatives, and succeed in school and society. Students' increased anxiety and uncertainty may have an impact not only on their ability to learn, but also on their decision to pursue a different degree or career track than they would want [10] [11].

However, career counseling can be beneficial to the students. With this, students can be more aware of the career tracks suitable based on their previous and current academic performance. And as a result of the accessible educational data, a career track recommendation system and neural networks can be utilized to aid guidance counselors and students in choosing the best career track. Neural Networks such as Deep Neural Network. This DNN model simulates human brain activity, specifically pattern recognition and the flow of data through several levels of simulated neural connections [12], and it can be used to detect different objects in images, recognize face of a person in an image, classify information, voice recognition, and prediction of hazard level of air pollutants [13]. So, the recommender system with DNN algorithm can also be used to aid guidance counselor in conducting student performance evaluations and predict student's academic track.

Furthermore, having a decision tool that empirically presents the academic performance analysis of students [14] and recommends a career track for the them could also be advantageous for teachers and counselors. Neural networks could be used in the recommender system to address the problem of producing acceptable career track suggestions for senior high school students. Using Deep Neural Networks, this article intends to create and develop a website with a neural network-based career track for junior high school students (DNN). Every grading period, the algorithm utilized in this study will provide an update on students' progress in each grading period. The teacher uploads the students' grades in the system, and the developed system, using DNN, classifies the academic achievement prediction findings to determine which Senior High School track is best for the students. The students can request an appointment to the counselor to create a schedule for career counseling.

## II. RELATED LITERATURE

### A. Career Track Recommender System

The researchers addressed how the two-year extension might be implemented in the Philippine high school system. As part of the adopted K-12 program, students must choose one track among ten academic strands. With so many factors to consider, choosing a career path for a student can be difficult. The researcher presented a study that seeks to design a tool that will assist students in choosing a career path using Social Cognitive Career Theory (SCCT) and the analytic hierarchy method [4].

In another study of [14], choosing the right course for a student during his or her formative years is a crucial decision because their future is at stake. Students can use a recommender system to help them choose the correct course. This study makes credible forecasts for student course choices based on final grades and employment goals. Clustering was used to find structure and links in the data,

and the technique has been shown to function with unsupervised data.

Meanwhile, a proposed fuzzy logic-based career recommender system was presented. This study uses many filter methods to select the finest features [14], [15], [16]. After selecting the right attributes, these are now used as crisp inputs. The experiment produced a reasonable decision-making result [17][18]. The proposed approach for senior high school students is also quite timely, and it would be one of the most essential research projects in the Philippines' new educational period.

The researchers claim that an artificial neural network technique can be utilized to forecast the career path of incoming senior high school students [19] [20] [21]. This study uses an artificial neural network (ANN) to predict the career strand based on the grades of students in five primary fields. The models were trained and evaluated using a sample of 293 student data [22]. Out of all the models, the model with the best accuracy was 74.1 percent.

### B. Neural Network in Prediction

The literature on student academic performance prediction and classification is also addressed in this section.

Another study presented a neural network called the Deep Neural Network model, which shows students whose class category they belong to [23]. Relu and Soft-Max activation functions are implemented in two hidden layers. With an estimated 85 percent accuracy, the prediction of student failure is successful and outperforms other machine learning methods [24].

Furthermore, rising number of studies in the educational field are employing data mining techniques and anticipating student's academic performance is a critical concern in education [25] [26] [27] to prevent future problems to the students. Predicting a student's career track in senior high school would be useful to educational institutions since it gives data that can be used to develop crucial programs that will benefit students' education. Students' performance in each topic at school can be identified using the derived prediction model [28].

As a result, professors can classify students' academic performance and intervene early to assist them improve. To increase performance over time, systematic processes could be used. Early prediction and solutions are likely to result in better final exam results [29]. Students can get access to their academic information and updates at school.

Meanwhile, a decision tree algorithm was used in another study to suggest the best career track for school students [30] [31]. The model's accuracy was assessed using the 10-fold Cross Validation approach, and it was evaluated using a confusion matrix [32]. The machine learning model had an overall prediction accuracy of 87.9%.

In polytechnic system, a student must take at least three elective subjects to complete the study. For forecasting student success in elective subjects, the researchers chose the Decision Tree technique. The final test results for elective subjects have a big impact on students' prospects, thus predicting whether they will pass or fail the final examination is crucial [33] [34]. Furthermore, data mining techniques can be used to forecast and analyze students' academic performance based on their academic records and

forum participation, and results of these studies can assist teachers in helping students enhance their academic performance [35] [36] [37].

## III. METHOD AND RESULT

### A. Research Model

Figure 1 shows the agile software development model that was used as guide in the development of this system. This method uses both incremental and rapid cycles.
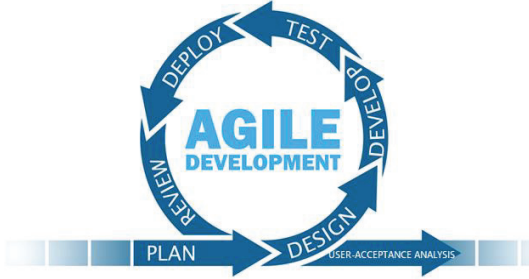


Fig. 1. SDLC model – Agile method

The phases in Figure 1 are repeated as required until a satisfactory and acceptable system is found. Thorough testing of each release was conducted to ensure that the quality of software was maintained. The Agile model shows the development lifecycle of the recommender system. It starts with planning, designing, developing, testing, deploying, reviewing, and the last phase is the user acceptance analysis.

### B. Planning

This is the phase where the researchers investigated information requirements of the target schools, and the problems identified in the current system. It involved the study of existing system's problems like: uncertainty of junior high school students to choose their most suitable career track; students shifting from one course to another due to lack of career counseling; evaluation of students' academic performance and attendance. From these the researchers determined the scope of the study, and planned to develop a system that would help remediate all those problems encountered by the students, teachers, and guidance counselor in their manual process. This stage also determined whether the costs of developing the system outweighs the benefits it could provide. The researchers secured a letter to gather the datasets of the first-to-third batch of K-12 students with prior approval from the academic heads of the target school. The students' grades and demographic data were collected using the Google Forms.

### C. Analysis

This phase determined the requirements of users, a neural web-based application that recommends career track for junior high school students. Requirements' determination is important because it helps satisfy the needs of the students as well as the teachers, guidance counselor, and school administrators.

In the careful study of the existing system, the students are part of the career plans incorporated in the K to 12 that helps students develop and refine their career plan. Hence, it is necessary for the teachers, parents, and school administrators to guide students in choosing the appropriate career for them to avoid being mismatched with the chosen career track. Also, the National Career Assessment Examination (NCAE) is administered to the junior high school students to help students determine which career track they should pursue in senior high school and in college. This standardized test measures the students' general scholastic knowledge, and the potential to pursue a career. But there are instances that NCAE results are not accurate in determining the best career track fit for the students, and students should not make major decisions based on NCAE results alone due to numerous factors such as goals, and interest in the course. There are also situational factors and other influences like parental and peer influences that can affect the students' decision on selecting a career track. With the problems or issues of the existing system discussed, the researcher developed a neural web-based recommender system that would suggest a suitable career track for junior high school students in order to help them in their career decision making process. The developed recommender system can analyze and predict the academic performance of the junior high school students using DNN algorithm. The students' socio-demographic data and grades were considered in the prediction of academic strand. In using the Deep Neural Network in this study, the system predicted the future academic performance of students, and showed students which academic track category they can belong to.

### D. Design

This section discusses the final design of the career track recommender system. The users of the system should register to the system using their ID as username, and password. The teachers need to input / upload the grades of the students in the system, and with the support of the system, the students were notified about their academic performance in each enrolled subject.

Figure 2 illustrates the class list of the teacher. The teacher has only one specialization and handles many sections.



Fig. 2. Teacher Form – Class List

The teacher can view the list of students in each section, and must click the subject sidebar. The class record or list of students appears after clicking the subject sidebar. In this form, the teacher shall be able upload the grades of the students. The editable and non-editable status of submission of grades is also indicated in this form. This feature of the system is to remind teacher to upload grades on the date of

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uploading after each grading period. If ever the teacher uploads the incorrect grades, then the teacher must request a grade correction form and the administrator of the system is the one to update the incorrect grade uploaded in the developed system. It also shows the subjects and sections handled by the teacher. The system provides the total number of students in each section, and the status whether all grades are uploaded in the system.

The counseling schedule sidebar provides the counselor an online viewing of counseling schedules and requests made by the students. The student request for career counselling is a necessary step before scheduling an appointment with the counselors.

### E. Development

The DNN model was created and tested using the Python programming language, with the Google Collaboratory serving as the Integrated Development Environment for analyzing and visualizing the dataset. Python is a very versatile programming language. Python provides a huge number of opensource libraries as well as practically all general-purpose machine learning libraries that may be used to train deep learning model and it is an established and quickly developing platform for scientific study and numerical computation. Meanwhile, Colab Notebooks are Jupyter notebooks that are excellent for creating and presenting interactive data science projects, and they support a range of programming languages, including Python. Furthermore, PHP was used to develop the website and can run efficiently on the server side. While the SQL was used as storage of the users' data.

### F. Made Learning Model

For the model construction, a deep neural network algorithm has been used to perform the classification and prediction of career track of incoming senior high school students. This study included 1500 students from the first to third grades of the K-12 curriculum. While the hyperparameters employed in this study were sigmoid activation function, epochs, input layer with eight nodes, hidden layer with eight nodes, and final layer with three nodes. The researcher used the hyperparameters acquired to create the DNN predictive model. Moreover, the exact parameters used in this DNN model were grades of student in each subject, sex, age, number of siblings, and salary bracket of parents.

Figure 5 illustrates how the trained model was integrated in the developed website.
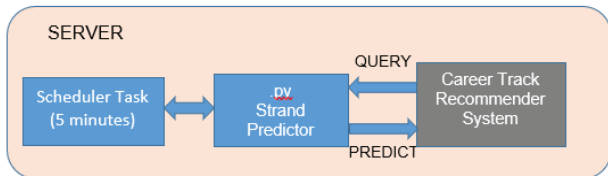


Fig. 5. Integration of DNN Model to Website

The scheduler task allowed running of the Python script to make strand prediction. When the teacher uploads the new data or grades of students, the script fetches the new data to create a prediction of strand that is based on the data retrieved from the website. In short, there are two procedures shown in this figure, first is the read procedure in which it

reads all the grades of the student who has not been given a prediction of the strand. Second, the write procedure in which it provides strand prediction from the student ID read. The task scheduler runs every five minutes because it is the minimum time of scheduler on Windows. Moreover, the predictor script runs every five minutes to give allowance for predicting academic strand in case there are many data to be predicted. The developed system provides guidance counselors online retrieval of information or updates about the students' records and predicted academic strand. Also, the system recommends which career track is applicable for the students based on their previous academic records.

### G. Testing and Evaluation

To evaluate the prediction model integrated in the website, the 5-fold cross-validation was used, and the percentage split method is applied. In the percentage split method, the dataset training set (70%) is used to train the model while the remaining 30% is for testing the model. the Root Means Square Root was used to compare the prediction model. The smaller the RMSE values the better as it is an indication of a good prediction of the target values.

TABLE I.          PREDICTION RESULT OF DNN ALGORITHM

| Prediction Method | Accuracy % | MSE | RMSE |
|---|---|---|---|
| Deep Neural Network | 0.8311 | 0.4555 | 0.6749 |

Table 1 illustrates the performance of DNN algorithm after the testing phase. With the 5-fold cross-validation test, the Deep Neural Network technique generated accurate prediction results, with 0.8311 accuracy, 0.4555 MSE, and 0.6749 RMSE values. It was observed that the DNN model performed reasonably well in classifying the academic strand of the student. Figure 6 depicts a graph of the predictive model's testing accuracy and loss. The loss in this graph is a number that represents the sum of the prediction model's errors. This metric indicates how well or poorly the model is performing. It's worth noting that if the mistakes are significant, the loss will be considerable, implying that the predictive model isn't performing properly.

Otherwise, the lower it is, the better the model performs in terms of forecasting kids' academic strand.
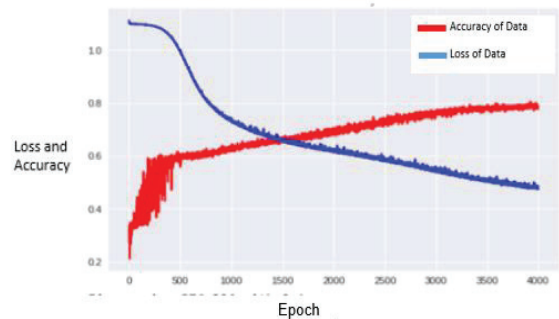


Fig. 6. Accuracy and Loss Graph

The loss data is diminishing, and we can see the learning process' expected trend, although with minor ups and downs. The predicted model is learning as the loss lowers over time. While the percentage of correctly classified test data in the graph represents accuracy, the higher it is, the better the

predictive model becomes. The suggested deep neural network was able to predict the academic strand of a student with an accuracy of 83.11 percent. Great accuracy with low loss indicates that the model produced few errors and is regarded the best-case scenario.

## IV. RESULT AND DISCUSSION

The modules were successfully integrated and expected outputs were displayed in the developed system. The students can be able to view their grades online, and teachers can upload grades of students in every grading period. Figure 7 shows the guidance counselor account where the user can view all the list of students who requested for counselling.
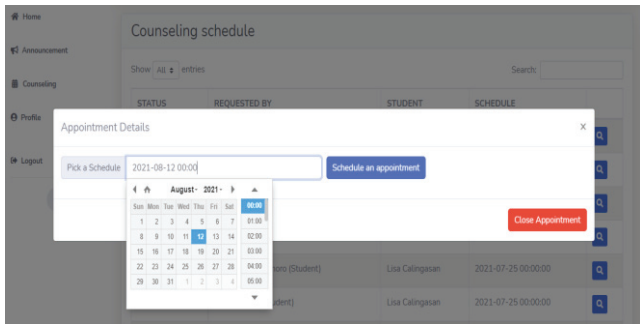


Fig. 7. Appointment Details of Student

This shows that the guidance counselor can view the overall records, and recommended career track of students. The counselor guides the junior high school students in the selection of suitable career track based on their academic performance. In addition, guidance counselor must click the blue view icon to schedule an appointment of the selected student. After clicking the schedule an appointment button, it was reflected in the system that the student is scheduled for counseling. While the close appointment button shall be clicked if the counseling was finished. The student list shows the list of students with scheduled appointment, and counselor must click the view icon to display the recommended track of the student. Figure 8 shows the output of the prediction of academic strand after the deep neural algorithm was integrated in the website.
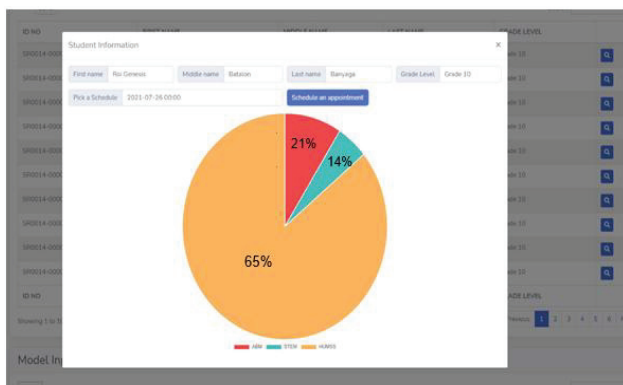


Fig. 8. Sample Output of the Recommended Academic Strand

The counselor can view the overall grades and recommended academic strand of the students during consultation hours. The result of the prediction of career track was illustrated in a pie chart. In addition, the guidance counselor and the student can be able to view the description on each strand and what are the possible jobs or career when it is selected by the student. It illustrates the example prediction of academic track, the HUMSS (65%) strand was the highest among the three academic strands while the STEM (14%) was the lowest. The final average of the students in each subject were the basis of the recommended academic strand. The researcher also evaluated the developed system according to ISO 20510:2019 criteria or with respect to its: Functionality, Reliability, and Usability. The testing was conducted to ensure that the developed system and machine learning model was working in the actual website.

## V. CONCLUSION

The algorithm used in the study gave updates about the performance of students in each subject every grading period. With the use of the DNN technique, it is concluded that the recommender system acts as a choice tool for counselors in advising their students to select which Senior High School track is appropriate for them. The web-based career track recommender system has effectively integrated the predictive model.

The study shows that it is possible to predict and classify the academic performance of the students, and DNN technique can be used efficiently in classifying students' academic performance in junior high school, and is working in the actual website. Also, the work of the guidance counselor became more efficient in handling student's concerns just by using the developed system in the school. The model can also be utilized to create a predictive tool for all career tracks in Senior High School, including Technical-Vocational Livelihood, Sports, and Arts & Design.

Furthermore, the system serves as a wake-up call for educational institutions to align themselves with the government's vision of globalization and competitiveness in the twenty-first century, or the information age. However, other machine learning methods can be utilized in the developed website to predict and classify the academic records of students according to the SHS career track. Future researchers can also design and develop a career track recommender system based on algorithms collecting data from students attending private schools.

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