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EduMe – Student Guidance and Intelligent System for Personalized Learning Path

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***Abstract* - EduMe, a web application aimed at enhancing the e-learning experience for students. EduMe comprises four core components: an Automated Personalized Timetable Generator, a Student Behavior Tracking Unit, a Text Summarizer and an Automatic Question Generator and Answer Assessment. These components address challenges such as personalized time management, study focus tracking, efficient content summarization, and interactive question generation. The application provides students with an adaptive learning environment, empowering them to excel in their academic pursuits through personalized resources and guidance. The system is developed using a blend of cutting-edge technologies including image processing, Natural Language Processing, machine learning algorithms and reinforcement learning. Overall, EduMe serves as a valuable tool to support self-study methods for undergraduate students, providing them with the necessary resources and guidance to optimize their learning experiences.**

Keywords: Self Learning, Machine Learning, natural language processing, Personalized learning.

I. INTRODUCTION

The proliferation of web applications has significantly transformed the methods by which students engage in learning and studying activities. The advent of internet connectivity has revolutionized the educational landscape, granting students novel access to a vast array of educational resources at their convenience, regardless of geographical constraints. A wide array of Web applications for educational purposes exists, encompassing various levels of complexity. These applications span from basic tools such as flashcard applications to advanced platforms like learning management systems. The latter offers a comprehensive suite of features, including interactive multimedia content and assessments, thereby enhancing the learning experience. These educational programs facilitate the customization of students' learning experiences by providing them with the opportunity to choose materials that align with their unique preferences in terms of on top and preferred learning methods.

The most important factor for students preparing for approaching examinations, particularly in situations where temporal resources are constrained and the volume of material to be adopted is significant is the effective management of time. The provision of a tool to assist individuals in effectively managing their workload and attaining their personal academic objectives in accordance with their unique requirements would yield significant advantages.[1].

Significantly, it is worth noting that the majority of currently available timetable generators have been specifically developed to cater to the needs of expansive establishments, namely universities, colleges, and schools. These institutions rely on such software to effectively organize and administer their academic schedules, be it for an entire year or a single semester.[2] The ability for students to effectively manage their personal coursework and cater to their individual needs would undoubtedly be a significant accomplishment. This would empower students to engage in self-study with utmost efficiency and efficacy. The proposed solution holds significant potential as it offers users the opportunity to access a tailored, adjustable, and individualized schedule that aligns with their specific requirements.

Individuals experiencing challenges with maintaining focus during study sessions may find it advantageous to employ a diverse array of web-based applications that are readily accessible on the internet. The aforementioned applications often encompass a variety of advantageous features, such as functionalities for managing time, blockers for mitigating distractions, and trackers for enhancing productivity. The utilization of the Pomodoro timer, a time management technique that divides study sessions into structured intervals and promotes the inclusion of regular breaks, has been found to be advantageous for students in mitigating mental fatigue and sustaining concentration. The absence of software capable of monitoring study attention is a significant challenge encountered by numerous students and instructors in the present era. In the absence of appropriate software, the task of monitoring and assessing students' study habits becomes challenging, leading to the ability to ascertain whether they allocate a sufficient amount of time to their

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studies. The absence of sufficient supervision in the educational context may result in children acquiring suboptimal study habits, including tendencies towards procrastination, distraction, and inadequate time management. These adverse practices can ultimately have a negative impact on the academic performance and accomplishments of the students [3]. Hence, the development of efficient study methodologies and the attainment of academic achievement necessitate a prioritization of the advancement and utilization of study focus monitoring software.

Furthermore, it is important to note that text summarization refers to the systematic procedure of reducing the length of a given text while still preserving its important and relevant details [4]. The significance of this issue lies in the fact that university students frequently encounter a substantial quantity of reading materials, which can potentially overtake them and hinder their ability to effectively process and integrate the presented information. By equipping individuals with efficient text summarization tools, it becomes possible for them to expeditiously and effortlessly assimilate the fundamental concepts and concepts expressed within their educational resources, thereby conserving valuable time and working out. Individuals have the ability to use autonomy in determining important information and areas of concentration in preparation for assessments, thereby conferring an important benefit upon them.

The utilization of an automatic question generator and answer assessment system holds significant value in facilitating the self-study approach among undergraduate students. This system serves the purpose of generating subjective questions at regular intervals, which helps students in their learning process.

In the context of students' experience with exam anxiety, it is worth noting that this issue frequently arises due to feelings of uncertainty and a dearth of knowledge regarding the specific question formats that will be presented during the examination. The presence of uncertainty in academic settings has been observed to potentially result in feelings of fear and stress among students. These emotional states have been found to have a detrimental effect on students' performance during examinations. The research problem at the spot aims to tackle the prevalent issue of inadequate comprehension of the subject matter. The focus is on exploring the potential of question generator systems in alleviating this problem by offering students a more organized and tailored approach to preparing for examinations. The ability to identify challenging sections and prioritize specific lessons in preparation for examinations is a valuable asset for individuals. This capability greatly aids their academic progress and enhances their overall learning experience. Current question generation systems that rely on machine learning techniques have limitations in terms of generating original questions. The process involves utilizing a repository of questions, commonly referred to as a question bank, alongside a fundamental template to construct question papers that are stratified according to their respective difficulty levels. The provided visual representation depicts the distribution of student preferences regarding the generation of examination questions through the utilization of their personal lecture notes.

The proposed web application, EduMe has the potential to address the gaps that have been previously mentioned in the field of e-learning. EduMe offers students an adaptive learning environment that encompasses various tools aimed at enhancing their time management skills, encouraging student focus, summarizing lecture content, and generating automatic questions for assessment purposes. These features are designed to optimize student's learning capabilities and facilitate their academic progress.

II. LITERATURE REVIEW

Self-learning is an effective method of education that offers flexibility, motivation, and a reduction in the overall cost of education [5]. Individuals must also clearly define their objectives, maintain organization, actively seek feedback, and be receptive to collaboration. Individuals interested in self-directed learning can acquire enlightening knowledge from this paper's literature review. The purpose of the study was to highlight the benefits, difficulties, and best practices of self-learning.

The Department of Electrical & Computing Engineering at the National University of Singapore conducted research in 2002. Using an Evolutionary algorithm (EA)-based approach, it was proposed to resolve a highly constrained university scheduling issue. A problem-specific chromosome representation is utilized in this method [6].

Bhaduri presented his research paper entitled "University Timetable Scheduling Using Genetic Algorithm" at the ART Com '09 International Conference on Recent Advances in Communication and Computing [7] in 2009. This paper proposes an algorithm-based method for scheduling university class schedules. The author describes how the proposed algorithm can optimize resource allocation, including classrooms, instructors, and students, while accounting for various constraints, such as course availability, instructor preferences, and student course prerequisites. According to the aforementioned examination of the literature, it is evident that the concept of "Personalized timetable generation" is rarely discussed in the e-learning domain. Most academics have conducted research on the development of schedule generators for large institutions, such as universities and colleges.

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Various research organizations have developed a vast multitude of techniques and technologies for monitoring emotional states. Kwon et al. (2019) presented an electroencephalogram (EEG)-based machine learning method for emotion recognition[8]. Li et al. (2020) devised a deep learning strategy for facial expression recognition using convolutional neural networks (CNNs)[9]. Jiang et al. (2021) have developed a multimodal emotion recognition system that integrates facial expressions and physiological data[10].

Liu et al. (2019) designed a teleoperable robot limb that is commanded by head movement [11] using their technology. Lin et al. (2021) examined the viability of recording head movement as a method for diagnosing neurological diseases [12].In conclusion, algorithms and technologies that evaluate head movement could offer users more natural and immersive experiences in a variety of contexts.

A Brief Survey" by Shivani P. Patil and Ujwal A. Lanjewar provides an overview of techniques for text summarization.[13] The authors categorize summarization techniques into two primary categories: extractive and abstractive. Extractive methods involve selecting key sentences or phrases from the original text and constructing a summary from those selections, whereas abstractive methods involve paraphrasing and restating the input text to generate a summary. The authors discuss various techniques used for extractive and abstractive summarization, such as statistical methods, graph-based methods, and machine learning techniques. In addition, they compare the benefits and drawbacks of various methods and provide examples of their applications. The paper provides a useful introduction to the field of text summarization and can serve as a starting point for interested researchers and practitioners.

The primary purpose of automatic question generation and answer assessment is to assist students pass college exams. In 2018, research was conducted at Assam Don Bosco University's Department of Information Technology & Computer Science & Engineering in Guwahati, India. The objective was to create an Android application that automatically generates a broad variety of multiple-choice aptitude questions based on minimal user input.[14]. This paper proposes a method for automatically generating aptitude-based queries with particular keywords. This method overcomes the primary drawbacks of the current automated systems, which generate question papers by randomly selecting questions from examiner-created question banks.

The proposed system offers an innovative approach to student support and motivation, providing students with a valuable tool for enhancing their study practices and academic performance. These innovative features are included in the system. In conclusion, the primary objective of a student guidance and intelligent system for personalized learning routes is to improve student outcomes and assist students in reaching their full potential through the provision of individualized support and guidance.

III. METHODOLOGY

The research outcome of this study is to guide and assist undergraduates by introducing solutions to organize and focus their studies on a given time period. This application consists of four core functions to enhance the learning experience. Separate algorithms were utilized in the development of the most accurate models for identifying learners. Python was the programming language, using different ML algorithms and the web application was developed using the MEAN stack. The system architecture can be seen in figure 1.

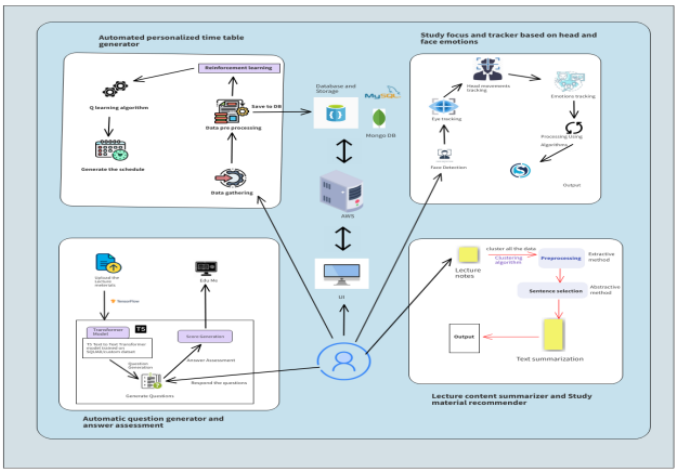

Figure 1: System diagram

A) Automated personalized timetable generator

The primary capability of an automated personalized timetable generator is to generate personalized timetables based on the individual requirements of students. This collects student requirements such as available time slots per day, lecture slides, pdfs, exam dates, daily free time, credit totals for each subject, learners' level in each subject and the content the student has covered in each subject to generate a personalized, customizable timetable to achieve their academic objectives. The Automated Personalized Timetable Generator is based on a reinforcement learning model.

In reinforcement learning, learning occurs naturally as a consequence of an agent's interaction with its environment.[15]. States and actions improve the natural environment. To optimize rewards sent during the learning process, the agent interacts in a specific and strategic way with the environment. Similar to other learning techniques, situations are mapped to actions. The learner or argent

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determines the optimal course of action given the environmental constraints. The agent must actively perceive its environment and choose the action that maximizes the reward function for a given state in that environment. When the appropriate action path has been chosen, the agent's state is updated, and a new state is acquired.

In this study, reinforcement learning is implemented using the Q-learning algorithm. According to Balasubramanian Velusamy, the Q-learning off-policy reinforcement learning technique seeks the optimal action given current conditions.[16]

Q-function returns a fixed value at the start of the processing; as it progresses through the transition, new values are computed as agents are rewarded, thereby updating the Q-table.

Q-function is denoted by ,

$$Q(s_t, a_t) \leftarrow Q(s_t, a_t) + \alpha [r_{t+1} + y \max Q(s_{t+1}, a) - Q(s_t, a_t)]$$

Where,

t – Present or Current state
t + 1 – the Next state
Q (st, at) – the Q – values for the current state
R (St, at) – Reward after performing an action at in St
α – The rate of learning ($0 \leq \alpha \leq 1$)
γ – Discount factor deciding the significance of the future and upcoming possible rewards ($0 \leq \alpha \leq 1$)

The architecture for reinforcement learning begins with the extraction of distinct phases of the learner-uploaded content. These are noted as part of the learner logs, which are used for a variety of computations that inform reinforcement and, thus, the progression path. The model recognizes the learner's interactions and selects optimal resources based on the learner's activities at specific times and states.

In the Q learning model, the environment states are defined as a set of seven days of the week. The Q-learning model employed in this study will incorporate a total of 48 actions, which have been divided into half-hour sessions. In the present study, the determination of rewards is contingent upon several factors, namely credit points, student level, and chapter score. These variables collectively contribute to the overall assessment of the reward system. The computation of the chapter score is based on the chapters that have already been studied in relation to the total number of chapters. The utilization of chapter scores serves the purpose of enhancing the efficacy of the reward function by generating positive outcomes. In the context of allocating rewards to different subjects, it is worth considering the scenario where one subject is relatively easy but has a substantial amount of remaining content, while another subject is challenging but has a relatively low amount of remaining content. In such cases, it may be appropriate to assign a higher reward to the subject that encompasses a greater amount of content. The proposed model aims to offer individualized adaptability to learners by leveraging their unique characteristics. This adaptability is achieved by deriving an optimal policy from the learner profile records.

B) The student focus monitoring with Machine learning

The Student Focus and Tracking Unit is equipped with a camera and artificial intelligence technology for real-time monitoring and recording of student behavior. The component is intended to capture and transmit video footage to an AI unit for interpretation and analysis. The component is intended to continuously observe user behavior, including facial expressions.

Socket programming was used to obtain videos from the student webcam and upload them to the server, while OpenCV was used to access video frames from the live webcam. While students are viewing the lecture, real-time webcam footage is obtained, and the face region is extract using the MTCNN Algorithm. On the crucial frames, head pose estimation, drowsiness detection, and facial emotion recognition will be performed.

Head pose detection module aims to investigate the ability to determine the direction of a person's head, specifically whether they are looking left, right, up, down, or forward. The analysis of facial landmarks will be utilized as the primary method for determining head pose detection. By examining these facial landmarks, it is hypothesized that accurate predictions regarding the direction of a person's head can be made. The Media pip framework is commonly employed for the purpose of landmark identification. The present model is designed to accurately identify and locate crucial facial landmarks, including but not limited to the eyes, nose, and mouth. The fundamental principle that underlies the functionality in question revolves around the computation of the movement and orientation of the head with respect to a pre-established reference frame. The calculation of facial landmarks' positions is achieved by conducting a meticulous analysis of the angles formed by these landmarks.

Drowsiness detection module research employed the MediaPipe facial landmark detector to identify signs of drowsiness. Specifically, the detector was utilized to extract the eye regions and mouth regions for each of the faces that were detected. In this study, the eye aspect ratio (EAR) was

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computed and observed from the extracted regions in order to ascertain whether the value exhibited a consistent decrease, thereby signifying the closure of an individual's eyes. In a similar vein to the measurement of the eye aspect ratio, the mouth aspect ratio is also computed. In order to obtain the most precise and reliable outcomes, we have employed a comprehensive approach that incorporates the analysis of both eye and mouth aspect ratios.

Facial emotion detection is utilized the FER+ dataset as the primary source for training the facial emotion recognition model. The dataset under consideration is an extended version of the initial FER2013 dataset. In this expanded dataset, the images have been reclassified and assigned one of seven distinct emotion labels: disgust, fear, happy, neutral, sad, and surprise. The ArcFace model is a widely utilized method for encoding facial images. Following the implementation of the classification model, the aforementioned process will involve the calculation of probabilities, which will subsequently be added to the emotion state list.

C) Text summarizer and additional material suggestor

The utilisation of text summarizer and additional material suggester is a widely employed approach in educational institutions, such as schools and colleges. This technique serves the purpose of generating concise summaries for individual chapters or sections of learning materials. Additionally, it aids in the acquisition of supplementary information related to the subject matter being studied. By employing this method, students are able to enhance their understanding of the material and further enrich their knowledge base. The objective of this study is to propose a method for effectively condensing vast quantities of information into a concise format consisting of a limited number of sentences and words. Additionally, this method aims to generate learning materials that facilitate the acquisition and retention of knowledge. By employing this approach, it is anticipated that learners will be able to grasp complex concepts more efficiently, thereby enhancing their overall understanding and retention of the subject matter. Natural Language Processing (NLP) libraries are essential tools for researchers and developers working in the field of computational linguistics. These libraries provide a wide range of functionalities and algorithms that enable the The EduMe platform utilises a pre-trained model called Text-to-text-transfer transformer (T5) for generating content. This model is fine-tuned using a SMALL dataset. The T5 model comprises an encoder and a decoder, which work together to carry out automatic summarization [17].The configuration of an encoder and decoder system involves two distinct phases: the training phase and the inference phase. The first step in the training phase involves the configuration of both the encoder and decoder components. Subsequently, the model ought to undergo training in order to make predictions for the target sequence that is offset by one time step. The implementation of the summarization model involved the utilisation of Keras, along with other Python libraries, for data preprocessing. During the inference phase, which occurs after the model has been trained, the performance of the model was assessed by evaluating its predictions on new source sequences. These source sequences were specifically chosen because the corresponding target sequences were unknown or undetermined.

D) Automatic Question generator and Answer assessment

Primarily Automatic Question Generator and Answer Evaluation Component The system generates queries based on the lecture notes inputted by the students. Once a query has been formulated, students may respond to it, and the system will immediately grade their responses.

In general, question-answering systems employ sophisticated technologies, such as pre-trained models such as T5 and Natural Language Processing (NLP) libraries. EduMe follows end-to-end pipeline for question generation using a pre-trained Text-to-text-transfer transformer (T5) model that is fine-tuned using the SQuAD dataset in order to generate multiple questions simultaneously by only providing the sentence[18]. Here we select informative sentences based on certain words that are important to define the domain or topic and parse structure similarity. Automatic Distractors Generation implementations revolve around similarity calculations between the distractor, the correct response and/or the context, lexical databases such as WordNet finding definition, synonym, antonym, hypernym and hyponym in order to generate the questions as well as the distractors. As the primary pre-trained model, Hugging Faces implementation is used, and T5 Tokenizer is used as the tokenizer. In this study, we trained a T5-based model, for selection of important keywords, easily repurposed for QG. This base model was pre-trained to generate queries utilizing the top-p nucleus sampling technique with $p = 0.90$. The method described above reduces the likelihood that particular tokens or token spans will recur endlessly. Sessions of generation that become stuck in token span cycles and do not reach the end-of-text token are manually terminated.

In order to address the research, a variety of models were employed for each component. After careful analysis and evaluation, it was determined that the aforementioned models were the most suitable for the study.

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IV. RESULTS & DISCUSSIONS

Prior research on the e-learning platform has rarely addressed the issue of time management that every student will encounter prior to each exam during self-study. This will provide each individual with a personalized, modifiable schedule to assist them in achieving their academic objectives. By analyzing user behavior and requirements, the primary output of the Personalized timetable generator is to provide the user with the best possible schedule for the following week.

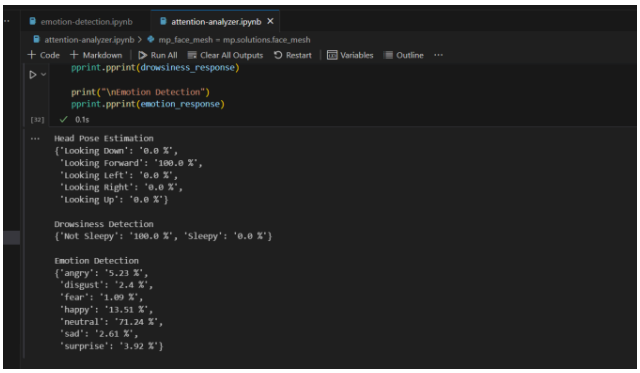

Figure 2: The student focus monitoring model output

A sample webcam video is provided as input for monitoring and evaluation. When head pose estimation was performed, it predicted that the pupil was looking forward and that he or she was looking away from the screen. As inputs for evaluating fatigue detection, images of a student yawning followed by an image of a student sleeping were provided. The figure 2 presented above illustrates the Actual Output, which has been obtained through an experimental study conducted to assess the accuracy of the module. In this experimental study, participants were instructed to view an educational video provided by the researchers. Following the video, the researchers aimed to assess the level of attention exhibited by the students. In addition, neutral emotion was predicted when facial emotion recognition was conducted on.

The purpose of this study is to investigate the effectiveness of a summarizer tool in improving text comprehension. The summarizer tool is designed to condense The generation of text summaries is a versatile process that can be tailored to various factors such as the content of chapters and learning materials, the storage and capabilities of the system, and the specific needs and preferences of the audience. This flexibility allows for the creation of an infinite number of unique summaries. EduMe offers a feature that enables the automatic generation of summaries. This functionality is powered by a T5 small model that has been trained to achieve a loss of 1.2035. The evaluation of the summary by EduMe yielded a similarity score of 72.05 percent. This score was determined by comparing the student-written summary with the auto-generated summary.

During the training process, a T5 base model with a sequence-to-sequence architecture was utilised. The objective was to train the model to generate summaries of original text. The training was considered successful when the model achieved a loss threshold of 1.9267 percent at the final epoch. After subjecting the model to an extensive and meticulous training process, we were able to obtain the subsequent results:

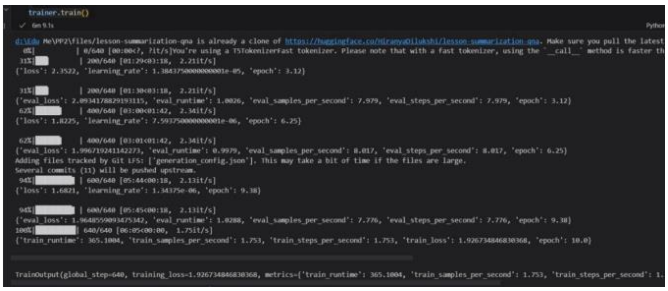

Figure 3: Automatic Question generator and Answer model accuracy

The training results highlight the high level of efficiency and effectiveness exhibited by the T5 base model when it comes to performing tasks related to summarization and question generation. The model's low training loss, along with its high processing speed, demonstrates its potential for generating precise and succinct summaries, as well as quickly generating questions.

V. CONCLUSION

In this research, we have presented EduMe, a comprehensive web application that addresses various challenges faced by undergraduate students in the e-learning domain. The application consists of four core components, namely the Automated Personalized Timetable Generator, Student Behavior Tracking Unit, Text Summarizer and Additional Material Suggester, and Automatic Question Generator and Answer Assessment. In conclusion, EduMe offers a comprehensive and adaptive learning environment for undergraduate students. By addressing these challenges, EduMe seeks to improve students' self-study capabilities and academic performance. Through its various functionalities, EduMe aims to foster a more engaging and productive e-learning experience, enabling students to reach their maximum potential and achieve academic success.

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