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ScheduleME - Smart Digital Personal Assistant for Automatic Priority Based Task Scheduling and Time Management

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***Abstract*— At present, it has become challenging for university students to manage the university workload (assignments, projects etc.) among their day-to-day tasks and personal chores. It has become hard to spend time efficiently on the tasks that should be prioritized, and to decide what the best way to spend their remaining time is. Even though integration methods and multi-functional Time Management Tools (TMTs) such as Trello and Asana exist, finding, following, and implementing them is time consuming and monotonous. ScheduleME is a smart digital personal assistant which will be in a form of a mobile app that collects and stores all the tasks the student has to do, prioritize them according to their importance, schedule them intelligently across the student's remaining time considering his/her existing academic and personal timetables and daily routines. A user-friendly and comprehensible mobile app is designed where the right amount of information is presented to the user without important details that user could configure and override and not show too much information such that the user becomes overwhelmed. This overcomes the weakness found in many time management and to do list apps. (e.g. - Trello, Microsoft Tasks, Todoist) where the user has to enter all the details of the tasks manually and set the priority manually. The main emphasis of our suggested system is four primary components. They are Data engineering, Intelligent task breakdown and scheduling, Personalized task scheduling and User-centered interaction design. Aside from that, this system employs a variety of technologies and algorithms to improve the research's accuracy and efficiency.**

Keywords*— *Time management, data engineering, constraint programming, reinforcement learning, UCID

I. INTRODUCTION

Living in an information overload era, university students are facing increasing challenges concerning managing time. Primary time management duties for university students are no longer restricted to lectures and timetables, but increasingly encompass additional dynamic chores such as online education, social networking, online group gatherings, holiday reservations and fitness management. It is emphasized that time management plays a more significant role in students' lives [4]. In this research project the targeted people are undergraduate university students in SLIIT. According to [5] to [7] there are no research has been done or time management tools have been designed to fulfill university students' needs and requirements.

Our proposed system will provide a solution above problems, catering university students needs by presenting an effective time management and task prioritizing system that is simple and straight forward to use thus it does not occupy unnecessary amount of time to learn, use and meets the needs of students of SLIIT. There are four major components in the research. They are,

- Automatically scrapes the data from relevant data sources using the few details user enters using data engineering.
- Breaks down large tasks into smaller components and allocates these based on the remaining time the user has on their schedule, once their compulsory elements are reserved using constraint programming.
- Keeps track of the user's routine and give suggestions on how best to divide a user's upcoming

tasks among the user's spare time using reinforcement learning.
- Presenting an effective time management and task prioritizing system that is simple and straight forward to use thus it does not occupy unnecessary amount of time to learn, use and meets the needs of students of SLIIT using user centered interaction design

II. LITRETURE SURVEY

Among the researches that has been done using data engineering, Kumaresan, Umamageswari & Ramanujam, Kalpana has conducted a research in 2018 about Automated scraping of structured data records from health discussion forums using semantic analysis system. It says the amount of information available on the Internet has an exponential growth and therefore, obtaining appropriate information from such a huge repository is an indispensable yet complicated task. As the structuring of web pages is diverse across websites, there is no "one size fits all" technique to perform web data extraction. It results in the need for devising a technique that is independent of structuring of web pages, which is addressed in this paper by identifying informative content through semantic analysis rather than syntactic structure. In this paper, a fully automated technique for extracting posts from various Medical Forum Websites has been devised and it performs well for differently structured web pages belonging to diverse forum websites [11].

There are various researches have been done in recent years regarding Intelligent Task Breakdown and Scheduling Using Constrains Programming but none of them have done as our system propose. Yossi Bukchin and Tai Raviv were done the research using constraint programming for solving various assembly line balancing problems [8]. In this research, they suggest new constraint programming-based formulations for several variations of assembly line balancing problems. They choose a SALOME is an open-source numerical simulation platform. The main contribution of this study is first in demonstrating that, by exploiting certain special properties of the problem, Constraint Programming is a general solution method that can be competitive with a state-of-the-art customized algorithm for the simple assembly line balancing problems**.** Next, they show that Constraint Programming also performs well in solving various generalized assembly line balancing problems, when compared with mixed integer approach**.** /But it is not clear definition how far successful they were in using this SLAME platform [8].

Considering the researches conducted in previous years using reinforcement learning Robert Glaubius, Terry Tidwell, Christopher Gill, and William D. Smart has conducted a research tilted "Real-Time Scheduling via Reinforcement Learning" in 2012. They have used reinforcements learning for real-time scheduling, and it is Cyber-physical systems, such as mobile robots, must respond adaptively to dynamic operating conditions. Effective operation of these systems is necessary to complete sensing and actuation activities in a timely manner. Furthermore, mission-specific tasks like imaging a space must be balanced against the need to complete more general tasks like obstacle avoidance. This issue was solved by keeping the relative utilization of shared resources among tasks close to a user-specified target level. In order to create optimal scheduling strategies, full prior knowledge of task actions is needed, which is unlikely to be available in practice. Instead, appropriate scheduling techniques must be learned by interacting with the system online, they also consider the sample complexity of reinforcement learning in this domain and show that, although the problem state space is countably infinite, they can use the structure of the problem to ensure efficient learning.

Existing Time Management Tools (TMTs)

- Time tracking tools - RescuTime, Toggle

These tools can track the time used on each task that the user carried out on the device and generate visualizations and reports to analyze the user's time distribution, thereby help the users understand their working time usage and improve productivity. A major shortcoming of time tracking tool is that it is prone to place unnecessary pressure to the users by visualizing the time of user engaging in distractions in a punishing manner [9].

- Note Taking Tools - Remember The Milk, TodoIst, Minima List, Evernote, Doris, Clear

They allow users to note down and organize tasks easily and timely. Apart from making to-do list and setting goals, task reminder is another commonly used function of these TMTs. They are useful for reminding appointments and to-dos and various time-based information such as colleagues' birthdays [6]. Inevitably, there are some limitations with these tools. One of the limitations is prioritizing. As most people prioritize their tasks in a way that is not easy to be computerized. The priority levels given by most of the tools are not useful since the users only need to know the most urgent task that should be dealt with first [6]. Another limitation is the expressiveness. Using a computer-based note taker can largely restrict writing styles and creativity, thereby reducing the expressiveness of the notes. Familiarity is also an issue [6].

- Scheduling Tools -DayViewer, Week Plan, Weekis, GQueues

Scheduling tools aid in the management of schedules and are often presented in the form of a calendar or a semi-structured note. Activities appear as blocks on the calendar and may be labeled in a variety of ways to distinguish between distinct tasks or projects. Because they take a lot of time and effort to set up, input, and maintain, these technologies are more commonly utilized by groups. They are less adaptable and accessible than paper planners. Present planning and scheduling systems aren't commonly used because they need too much input and work to maintain. [3].

- Group use- Trello, Asana, Slack, Timely

TMTs for group use mostly aim for business use as they offer more complex but powerful features such as real-time changes and third-party integrations. Though they have more functions for team collaboration, users who only need functions for individual use may find it ineffective to use. . The common issues include data security, steep learning curve and price [10]. Most of the tools offer full features with

a price, which in the context of university students is an inconvenience.

- Integrated platforms -Google Keep, Office365 Tasks, Google Calendar, Office365 Calendar, Google Drive, One Drive, SharePoint

Google and Microsoft Office are the two well-developed integrated platforms, which have multiple applications providing different functions such as calendars and to-do lists. Users can access to all functions with one account and the functions can synchronize with each other automatically. However, a major concern of using these tools is the data privacy. The dilemma exists between the convenience and the privacy. The more data you give to the service providers, the better they understand your needs, thereby providing a better designed service. Also, these tools are developed for general working purposes and do not contain any time management techniques.

TMTs' common drawbacks include "portability," "readily accessible," "visual salience in the workplace," "fluidity of visual structure," and "scarring" [6]. There are also issues regarding data security in general.

As a solution for limitations and shortcomings in existing TMTs and researches We propose a system that could enhance and encourage effective time management tasks prioritizing of students in SLIIT university by creating a smart digital personal assistant..

III. METHODOLOGY

In this suggested system, four major sub-components are realized.

A. Data engineering
B. Intelligent task breakdown and Scheduling using constraint programming.
C. Reinforcement Learning for Personalized Task Scheduling
D. User Centered Interaction Design

A. .Data Engineering

in Data engineering component, User only has to enter minimal details such as his/her student number, password to the app. The system automatically scrapes the data from relevant data sources using the few details user enters. Courseweb is the learning management system of SLIIT university. It's where all the notices, assignments, exams, deadlines are published. The app takes into account the timetables and, deadlines that are already allocated through defined data sources from Courseweb.

With data engineering process required Data will be scrape/extract from data sources and will be add those data into a database. (e.g. Lecture timetables, exam timetables, special notices etc.) They are in different places and in different formats. Those data which are in different formats should be cleaned and taken in to one format. When all the data is getting into same format it will be add into a data model to the second member to develop it with constraint programming. a sub process of data mining concept is done by this component. It includes Identify raw data, Filter data, Clean and preprocess data.

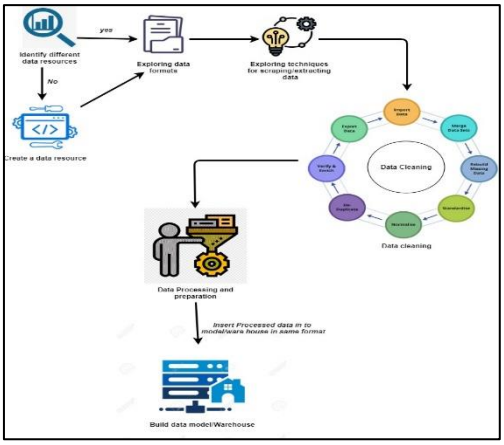

Fig. 1. Data Scraping Process

The first step is identifying and preparation of data sources where data can be extracted on demand. When student using the SheduleMe app, the relevant and required data must be displayed and extracted automatically and continuously from data sources. In that case correct and suitable data resources must be identified.

Second step is exploring the data formats. finding different data formats in data resources is the main thing done in this step. As an example, it may be a PDF document, XML document, or a HTML document. In here the system must recognize the correct data formats.

Third step is after exploring the different data formats in which the data sources exist, then exploring different techniques of scrapping/extracting the data. Different strategies are used for the data scraping/extraction process specific to the identified data formats.

Forth step is cleaning, processing, and preparation of data. This step is the most important step of this process. After the exploring scraping/extracting techniques, the system must clean the data. Data cleaning is the method of preparing information for investigation by removing or changing data that is inaccurate, insufficient, superfluous, duplicated, or poorly constructed. When it comes to breaking down information, this information is usually a little too much or welcoming, which may thwart the process or result in incorrect results. After the data cleaning system get the cleaned data and start to manipulation of items of data to produce meaningful information.

After the processing data there are different formats in the data sets. Using these processed data, it is hard to do the constraint programming. In this case a data model/warehouse must be built to get all different formatted data to a same format. As an example, we can insert same formatted data in to a MYSQL table.

B. Intelligent task breakdown and scheduling using constraint programming

The app automatically breaks down large tasks into smaller components, and allocates these based on the remaining time the user has on their schedule, once their compulsory

elements are reserved. If the user has a project that need to be completed before a deadline, ScheduleME predicts the time taken for the project, and the amount of hours to be allocated daily or weekly among upcoming tasks considering how much time will be spent to do each task, and the task's priority.

This component provides to students with a number of solutions to streamline their academic activities. The genetic algorithm is selected under optimization algorithm of constraint programming to provide these solutions. The genetic algorithm is a method for solving both constrained and unconstrained optimization problems that is based on natural selection, the process that drives biological evolution. The genetic algorithm repeatedly modifies a population of individual solutions.

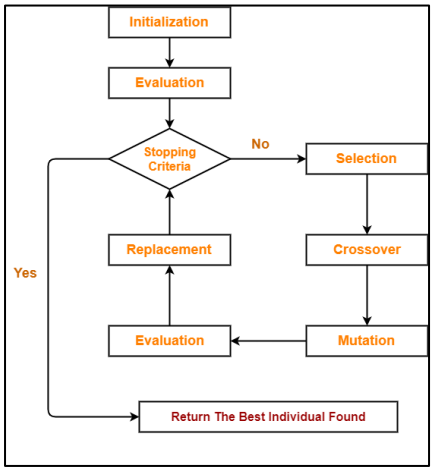

Fig 2. How genetic algorithm works

There is a process of the genetic algorithm. A Genetic algorithm is a local search technique used to find approximate solutions to Optimization and search problems. This algorithm is started with a set of solutions called population. The solutions from one population are taken and used to from a new population. Each new population is called as a generation. This is motivated by a hope, that the new population will be better than the old one. In each generation, the fitness of the whole population is evaluated, multiple individuals are stochastically selected from the current population based on their fitness and modified (mutated) to from a new population. This process is repeated until some condition is satisfied.

C. *Reinforcement Learning for Personalized Task Scheduling*

This section identifies the student's free time and selects the most suitable time slot for the user to perform a task from that free time slot. In this case, if the task sent to the time slot identified by the student system is not done at that moment, the task will be directed to the time slot in front of it and the task of that type will not be suggested again at the previous time. By doing so, our system learns about student behavior and manipulates an application that enables the student to gain greater productivity. For this, reinforcements learning has been used.

The agent and the environment are constantly interacting with one another. At each time step, the agent acts on the environment in accordance with its policy (at|st), where st is the current observation from the environment, and receives a reward rt+1 as well as the next observation st+1 from the environment. The goal is to improve the policy so that the total amount of rewards is maximized (return).

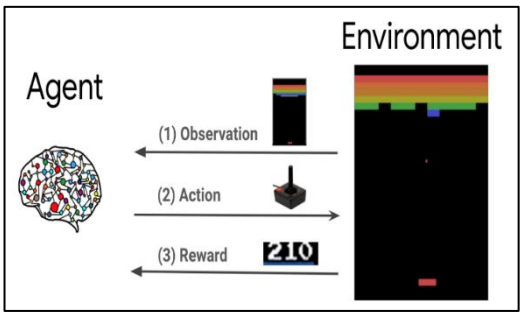

Fig 3. How reinforcement learning works

This is a very general framework that can model a wide range of sequential decision-making problems such as games, robotics, and so on, and we used it for our project.

C. *User Centered Interaction Design*

UCID approach is the optimized choice to carry out the project to ensure the outcomes are simple and straightforward to users as the products are completely designed upon the user's needs from requirements gathering to the implementation.

The first step is to analyze and understand students' work and needs using data gathering, data analysis and model building tasks (analyze). The first two stages of design thinking methodology are explained in this sub function. The first stage of the design thinking methodology is Empathize. It means gaining an empathic understanding of the matter that ought to be solved. The second stage in this step is define. This is when the researcher organizes and analyzes his or her findings to define the fundamental issues that have been uncovered thus far. In a human-centered approach, the researcher should try to characterize the problem as a problem statement. Methods used are questionaries, surveys, and interviews.

The second step is to Create interaction design concepts to create possible solutions rapidly to meet the specified requirements and UX goals. The aim of this stage is to create possible solutions rapidly to meet the specified requirements and UX goals. This involves the third step of the design thinking process, which is Ideate. It entails identifying fresh solutions to the issue statement that has been developed, as well as assisting in the search for different perspectives on the situation. Methods used Were focus group and brainstorm session.

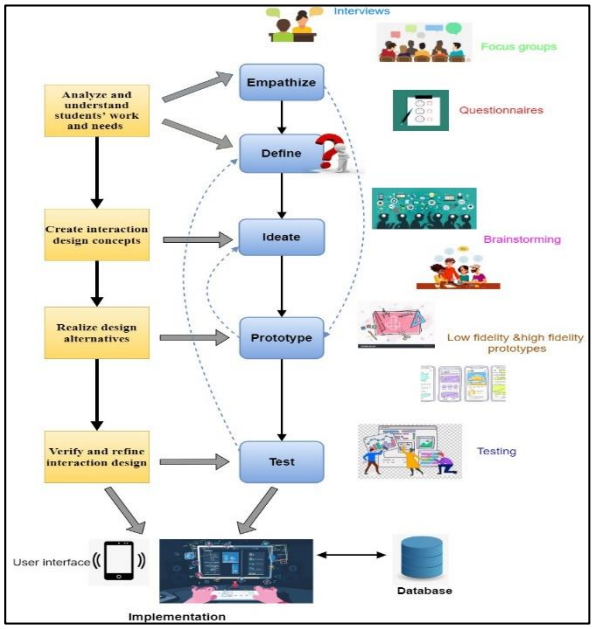

Fig 4. User centered interaction design and design thinking methodology

Third step is to Realize design alternatives. The fourth stage of design process called prototype is included in this step. A prototype is a pre-production sample, model, or release of a product designed to validate an idea or method. Prototypes are divided into two categories. Low-fidelity (lo-fi) prototyping is a simple and rapid technique to turn abstract design thoughts into physical and tested items. High-fidelity (hi-fi) prototypes are designed to look and work as closely as possible to the final product. Most or all of the material that will appear in the final design is included in the hi-fi prototypes. Prototypes were created using PowerPoint and Figma.

Fourth step is to verify and refine interaction design assessing the outcomes of the evaluation against the users' context and requirements to check how well a design is performing. (Evaluate). The prototypes created in last stage are evaluated in this stage and the process iterated back to design stage to do modifications and changes.

Implementation and development of the mobile application is the last step. This involves building the mobile application according to user requirements and details learned from previous stages. Technologies used were React-native, JavaScript.

IV. Results and Discussions

This portion of the article presents the findings of the four primary solutions that have been implemented, as well as discussions on the solutions. The findings and discussions for each of the four components are listed below.

A. *Data Engineering*

The backend of the system is connected to the courseweb (learning management system of SLIIT university). All the details which are relevant to the students (profile details, registered modules, assignments, mid exam schedules, final exam schedules) will be scraped and stored in the database. Timetable and important notices in the Courseweb will be sent to the user directly through the app after reading them, without storing in the database. Courseweb data are scraped once a day and informed to the user daily. Text summarization algorithm is used to summarize and shorten some notices and details in Courseweb, most relevant and the right amount of information will be passed to the user. Other scraped data will be filtered, preprocessed, and stored in the database. XML timetable is used for the backend of the system.

B. *Intelligent task breakdown and scheduling using constraint programming*

The main problem that arose during the implementation was how to get a 100% accurate output. Accordingly. During the data testing, training and implementation, it was concluded that the final result obtained by an algorithm could not be obtained 100% accurately. Accordingly, the demonstration of the accuracy and the loss of the model is shown in below.

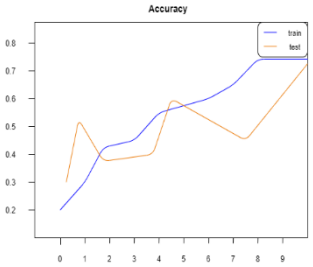

Fig 6. Accuracy

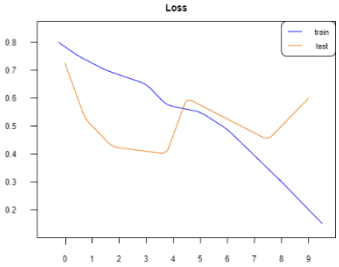

Fig 7. Loss

As shown in accuracy line chart around 0.5 and 0.6 were obtained respectively for values of high accuracy from trained and tested data, and around 0.2 and 0.3 obtained for values of low accuracy from both trained and tested data. As shown in loss line chart around 0.7 and 0.8 was obtained for values of high loss from both trained and tested data, and around 0.6 and 0.2 were obtained respectively for values of low loss from trained and tested data. The implication is that the accuracy of a solution by a genetic algorithm is between 90% - 99% as a percentage.

C. *Reinforcement Learning for personalized task scheduling*

The demonstration of the accuracy and the loss of the model is shown in figure 8,9 respectively.

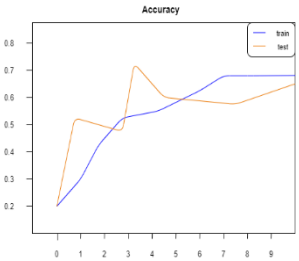

Fig 8. Accuracy

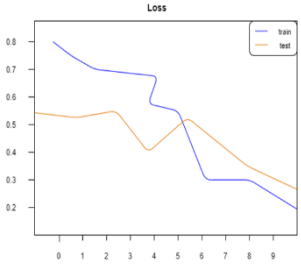

Fig 9. Loss

As illustrated in figure 4.1.1, values of high accuracy from trained and tested data were obtained at around 0.65 and 0.7, respectively, and values of low accuracy from both trained and tested data were obtained at around 0.2. As shown in figure 4.1.2, values of high loss from both trained and tested

data were obtained at around 0.6 and 0.7, respectively, and values of low loss from both trained and tested data were obtained at around 0.2 and 0.3.

D. User Centered Interaction Design

All stages of user centered interaction design process and design thinking methodology is implemented in this research component. For the empathize stage researcher used questionnaires and interviews to understand user and their needs by being in their position. An online survey with 15 main questions were distributed among undergraduate students in different universities. 101 responses were collected. More than 90% of participants are from students in SLIIT. And there were also few responses from other private and government universities in Sri Lanka.. The age of participants were between 19-26. Majority of them were 4th year and 1st year students. Five interviews were conducted with undergraduate students to discuss deeply about the common problems that an university student faces. those qualitative data which were gathered from interviews and the quantitative data gathered from the online survey were analyzed using analyzation techniques. Secondly all the core problems that have identified up to this point were defined in the define stage. Lot of user requirements were identified in this stage. Thirdly for the ideate stage, a brainstorming session and a focus group was conducted with the participation od 8 university students. There were discussions about the problems identified in the previous stages and new solutions were proposed to solve those problems. Fourthly for the prototype stage low-fidelity prototypes were creating using PowerPoint, and according to the feedback received for those prototypes, high-fidelity prototypes were created sing Figma. Usability testing for the hi-fi prototypes were done after getting the user feedback. According to all the user requirements and data gathered in the previous stages the ScheduleME mobile app was implemented using React-native and JavaScript integrating with other three research components mentioned above.

According to the above findings, this study discovered that the suggested method has reached a significant level of precision. According to [5] to [7] we understand there are no research has been done or time management tool has been designed to fulfill university students' needs and requirements. Everything which has been done so far is more applicable and suitable for proactive and organized students. Where they enter all the tasks and all the details manually and plan their day through time management tool. Those techniques won't work for majority of students who are reactive and unorganized. There has no research or TMT designed to manage students' tasks and allocate time and prioritize those tasks for them automatically. According to the questionnaires and interviews common limitations and shortcomings of the existing TMTs are, "having to enter all the details manually", "too much information or less information is shown in the app", "hard to prioritize the tasks", "does not make reminders" and "less user-friendly" etc. and also, there are general concerns about data security. Users tend to sense insecurity for the possibility of their information being exploited for other needs via technology [6]. Based on the research, portability, accessibility, shareability and updatability are the key attributes that users consider when making choices on TMTs [6]. Considering all of the above facts the research was completed and the ScheduleME app was developed achieving a good percentage of accuracy.

CONCLUSION

Our proposed system will provide a solution to time management problems and issues a university student faces such as, failing to prioritize, procrastination, hard to multitasking, ineffectively scheduling tasks etc. catering university student's needs by presenting an effective time management and task prioritizing system that is simple and straight forward to use thus it does not occupy unnecessary amount of time to learn, use and meets the needs of students of SLIIT. Four major components were implemented in the research. They are, Data engineering, Intelligent task breakdown and scheduling using constraint programing, reinforcement learning for personalized task scheduling and user centered interaction design. The research was implemented using technologies and tools such as react native, pycharm, php myAdmin, etc. The next stage of this study will focus on experimenting the ScheduleME app for other universities and school students as well using a larger size of the dataset.

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