MALAYSIA'S PRIVATE UNIVERSITY APPLICATION PLATFORM

By

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A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

in partial fulfilment of the requirements

for the degree of

BACHELOR OF COMPUTER SCIENCE (HONOURS)

Faculty of Information and Communication Technology

(Kampar Campus)

MAY 2022

UNIVERSITI TUNKU ABDUL RAHMAN

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FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Date: 9th September 2022

SUBMISSION OF FINAL YEAR PROJECT

It is hereby certified that Lai Kar Wai (ID No.: 19ACB06966) has completed this final year project entitle "MALAYSIA'S PRIVATE UNIVERSITY APPLICATION PLATFORM" under the supervision of Ts. Lai Siew Cheng (Supervisor) from the Faculty of Information and Communication Technology (FICT).

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ACKNOWLEDGEMENTS

I would like to express my sincere thanks and appreciation to my supervisor, Ts. Lai Siew Cheng has given me this brilliant opportunity to engage in a web application development project using web scraping technique and firmly guided me throughout the entire duration of this project. Also, I would like to appreciate to my moderator, Dr. Lim Seng Poh, for all the advises and support in this project. It is my first step to establishing a career in the web development field. A million thanks to you.

Finally, a special thanks to my parents and my family for their love, support, and continuous encouragement throughout the course.

ABSTRACT

This project is a web scraping project for Malaysia's private universities. Applying to a university programme is the first step to pursue tertiary studies, and it is the starting point of the journey to the future. Nowadays, each private university offers a comprehensive list of undergraduate and postgraduate programme options in various fields. Selecting a study direction is a significant decision. Besides, individuals often face difficulty searching for related information to pursue tertiary studies. Therefore, this project is motivated to develop an effective platform that collects information on educational institutions' programmes on a single website for students to ease the process of discovering universities and programmes. The platform is a web-based application that makes use of web scraping technology and the concept of data analysis to obtain required data from the universities' websites on a real-time basis. Features that related to the tertiary studies are implemented into the web application as well. The features mentioned are search programme, view programme, manage favourite list, view history list and request recommendation. Therefore, users are able to get a list of relevant programme by using search programme and view the detailed information of interested programme. Moreover, users are allowed to export the programme information to users' device. Different kinds of list are created to enhance conveniency as well as recommendation system is implemented to provide suggestion of area of studies. As a typical web application development project, Agile methodology has been adopted to focus more on coding and testing and thus develop an excellent quality and achieve project outcomes.

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LIST OF ABBREVIATIONS

AI **Artificial Intelligent** AJAX Asynchronous JavaScript and XML API **Application Programming Interface** BOS **Business Operating System** BS4 **Beautiful Soup 4** CORS **Cross-Origin Resource Sharing** CSS Cascading Style Sheets CSV **Comma-Separated Values** DOM Document Object Mode ERD Entity Relationship Diagram GUI Graphical User Interface HTML Hypertext Markup Language HTTP Hypertext Transfer Protocol **JSON** JavaScript Object Notation NLP Natural Language Processing OS **Operating System** PDF Portable Document Format **RDBMS** Relational Database Management System RAM Random Access Memory REST **Representational State Transfer** SQL Structured Query Language URL Uniform Resource Locator

XML Extensible Markup Language

XPath XML Path

1.1 Background Information

University is a place where individuals pursue tertiary studies in order to gain knowledge in a specific field. Applying to a university programme is the first step to pursue tertiary studies, and it is the start of the journey to the future. As a fast-growing and developing country, many private universities have emerged in Malaysia.

According to [1], many universities and programmes are available in Malaysia. Malaysia has around 30 public universities; however, the number of students for each intake is limited, and it means some students could not get any offers from public universities. In such cases, studying at a local private university is their alternative choice. It is one of the reasons that there are plenty of private universities in Malaysia. Moreover, Malaysia hosts more than 50 private universities, including university colleges and foreign university branch campuses [2].

Choosing the right programme to pursue is necessary, and it could be a difficult decision. Normally, every person has to gain knowledge in the selected field for a couple of years and then work in the area for years afterward. Therefore, it is essential to choose the programme that is really interested. Other than the programme itself, the programme content is also a vital factor in selecting a programme. Individuals should know about the course structure and outline before making any decisions. This is because the same programme offered by different universities would deliver different contents, so the comparison should be performed to choose the most suitable and interested one.

Each university provides a variety of available programmes. When students finish their secondary education and decide to pursue tertiary education, they will go through the process of looking for programmes and universities, followed by the admission process to the selected university. There is a need for technology to develop an effective platform for students to ease the process of looking for universities and programmes. In Malaysia, there have no similar platforms currently.

Furthermore, a Master's degree could make it much easier to qualify for the jobs we want and increases job security in the long run. As the same as choosing an undergraduate programme, it is difficult to decide on which program to enroll.

Therefore, the proposed system of Malaysia's Private University Application Platform is a web-based application that aims to provide the services mentioned above to individuals who want to pursue undergraduate or postgraduate studies in Malaysia's private universities. The primary key feature of the system is to provide convenience to individuals where they are able to look for the required information on the same website instead of going through different universities' websites. Next, it serves individuals with greater efficiency in discovering the private universities and programmes available in Malaysia. In other words, this platform can assist individuals in comparing and finding out their most desired selection from a collection of options.

1.2 Problem Statement and Motivation

At present, each private university offers a comprehensive list of undergraduate and postgraduate programme options in various fields. Selecting a study direction is a significant decision. This is why individuals often face difficulty selecting a programme, especially those who do not have a bright opinion on the field to study or what field they are interested in. There is a need to have some methods to help them when they are having trouble, such as providing some suggestions, allowing them to make comparisons easily, etc. Next, individuals who do not familiar with the tertiary education institution and programmes available might have to spend more time researching the relevant information. The process requires extra effort, and it is time-consuming.

Each university has its template to render the information on its website. Although the outline of the information is similar, the way and the layout to display is different. As an example, some universities show all the information on the same web page, but some other universities display the information of the same programme on different web pages. It could be trouble for users to explore and find the required information. Two examples illustrate the problem stated in the figure below. It shows the same information may be displayed on different web pages on different websites.



Figure 1.1: Ways of Information Rendering

There is a large amount of available information on the Internet, which could be potentially valuable information for individuals. However, it is troublesome for each individual to explore each university independently. This is because they at least need to know what private universities are available in the country. If they already know about the availability of local private universities, it would ease the process, but the discovery process might be limited based on their knowledge. In other words, they might miss out on other universities or other similar programmes. In short, a limited amount of knowledge would affect decision making for the right choice.

In addition, people tend to have a low cost but high functionality system in order to provide features to their users at a lower cost. Everything is costed such as workforce, storage system, etc. Therefore, it is required to utilise tools or ways to keep the cost at a minimum.

The motivation of this project is to provide an efficient, usable and informative platform for pulling required data out from the universities' websites to ease the research process on different websites. The web application will be the one-stop information centre to get access to information about universities' programmes. As a result, users can access the information needed through only a single website. It provides a convenient way for those users who wish to pursue tertiary studies in Malaysia's private universities. The project is to develop a platform using a web scraping tool to extract the information, perform data analysis on scraped data, and place the information in the web application. The extracted data will not be stored in a database, so it saves the storage space without affecting the availability to obtain the latest information from those university websites.

1.3 Project Objectives

i. To develop a web application platform that collects information on Malaysia private universities' programmes on a single website using a web scraping tool.

This project will be built in the form of a web application to display the scraped data based on user selection. Users are able to discover all programmes provided by Malaysia private universities in a single web application. A web application with simple UI and minimal interaction actions will be built. Beautiful Soup, a web scraping tool, will be implemented to perform web scraping, which will pull data out from a web page for data analysis in this project. The data analysis algorithm will be triggered based on the user interaction with the web application. The web application will be treated as a platform to display the final result of data analysis on scraped data.

ii. To perform data collection and data analysis for Malaysia's private universities.

The main effort of this project is to collect information from a web page on a real-time basis. Data analysis will be used to perform in collected data to inspect and compare the information provided by each website. Programme information such as programme name, university name, fee, duration, programme structure, entry requirements, career prospect, programme description, location will be collected. Thus, data analysis algorithm of each university will be formed and the result will be put into a uniform, and the model can be adopted into the web application.

iii. To implement a web application that provides various services related to tertiary studies.

This project is aimed to provide remarkable services to improve the usability and completeness of a web application. Services are search and view programme, export information, provide recommendation, perform enquiry and manage favourite list. With services implemented, users can enjoy an excellent user experience when using the web application. The services will be helpful for users to look for and provide suggestions on their studies' suitabilities.

1.4 Project Scope

The main concern of the proposed project is to develop an effective platform that is able to pull data out from Malaysia private universities' web page on a real-time basis. The pulled data will then be analysed and shown to the web application users. A web scraping tool will be used to perform the operations. The final product of this proposed project is a web application implemented with a web scraper to scrape required information from the website and display the analysed data to the end-users. As universities are ranked worldwide, the universities that exist in QS World University Rankings 2022 are the targets to be scraped in this project. There are 2 more universities that not in the list are scraped to increase the coverage of the project. Universities covered in this project are listed and attached in Appendix A.

Next, the user experience is also a concern of the project. The web application focus to be built with high user-friendliness and high usability. Therefore, the web application will have a simple but attractive UI as well as require the least interaction with users. The basic flow to use the web application is to search the result based on programmes, level of studies and location, followed by choosing interested programmes in the search result list, and lastly apply for the desired programme by redirecting users to the university's admission web page. Furthermore, a mechanism will be implemented to check whether the web scrape and data analysis algorithm apply to the latest design of the website or not in order to ensure the algorithm is workable and able to display the latest information to users. Also, the system will scrap the programme list of targeted universities and store the programmes into database. It will also check whether the web scrape and data analysis algorithm and any modification on universities' programme list once per week regularly. In addition, several APIs will be implemented in order to allow interactions between front end and back end of the system. All manipulation will be recorded in the log table of database.

There are a few steps to perform for analysing the data after web scraping. The first step is to study and define the data specifications and then utilized the scraped data into a uniform form. After that, inspect the data and perform cleaning if necessary. Lastly, an algorithm to analyse the scraped data is formed and ready to use. The targeted properties to be scraped for each programme are programme name, university name, course overview, intakes offered, duration of studies, faculty of the programme,

university location of the programme, fees, programme structure, entry requirements, deliver medium of studies and career prospects.

1.5 Impact, Significance and Contribution

Malaysia consists of public universities and private universities. Malaysia has around 30 public universities. However, the number of students for each intake is limited as well as there are race quotas in public universities. It means some students could not get any offers from public universities. In such cases, studying at a local private university is their alternative choice. Furthermore, many private universities are listed in some international rankings, such as QS World University Rankings and Times Higher Education (THE) World University Rankings that asses the performance of the institution worldwide and thus, it may attract international students to approach their tertiary studies in Malaysia.

Web scraping is a process to extract content or mining data from a website on a realtime basis. Scraped data is required to be analysed further in order to present only helpful information. By using web scraping technology, there is not only can access the data on a real-time basis but also save database storage. As the information is retrieved on a real-time basis which means the information does not require any manual updates. It can save the workforce on tracking whether the information shown to users is the latest. On top of that, it does not require exhaustive database storage to store all the information. Thus, it saves costs on workforce and storage.

Besides, using the web application to present the scraped data allows users to get a better experience, and greater convenience as the web application is accessible by any web browser. From a user perspective, the web application can be treated as one-stop information centre that can access all private universities' programmes on a single website. Moreover, users could explore other universities' programmes information, which the university the user may never think of. This will ease the process of discovering universities and programmes.

1.6 Report Organization

The first chapter describes the general overview of the project such as project background, project statement, motivation, project objectives, project scopes, impact of project, significance of project, and project contribution in detail.

In Chapter 2, some research works on the similar platforms, existing method and technologies have been done. The research works have been reviewed to highlight their strength and criticize its weakness. The possible improvements and refinement has been discussed in this chapter in the effort of overcoming its weaknesses. Brief description of the proposed system's methods used is included.

In Chapter 3, system methodology and approach have been covered. It will be illustrated by UML diagrams with explanations. Working principles, approaches, user requirements and timeline are discussed as well.

In Chapter 4, system design on block diagramS with explanation will be included in order to explain how the project is developed in detail.

In Chapter 5, system implementation will be discussed. Software setup, project setting, project configuration, system operation and implementation issues and challenges during the development process will be described.

In Chapter 6, system evaluation will be performed. It includes system tesing and performance metrics, testing setup and result, project challenges and objective evaluation.

The last chapter provides a conductive view of the project and recommendations for the project in order to improve and enhance the proposed system.

CHAPTER 2: LITERATURE REVIEW

2.1 Review on Similar Platforms

2.1.1 Common App

Common App is a non-profit web application platform that allows students to apply to college or transfer to complete degree studies [3]. It will enable students to get greater access to tertiary education opportunities and assist students in looking for the best educational path. It is developed to simplify and digitalise the course admission processes. The figure below is the main page of the website.



Figure 2.1: Common App [3]

There are more than 900 colleges and universities worldwide in the Common App. The application is mainly dealing with college application problems. It eases the college admission process, especially for first-year and degree transferring students. Besides, it collaborates with colleges and assists students to reach their inquiries to those supported colleges. The platform also provides recommendations and consultation in order to pursue higher education studies [3].

The admission process is easy and straightforward. First, students have to create an account and complete their profile with their personal information and achievements. Next, search through the college list and add the interested colleges to a selection list. Before applying, prepare the documents required by the college or university. Some

education institutions require their applicants to take some tests via the website. Then, the last step is submitting the application and waiting for the result.

This web application contains many articles that provide much knowledge about pursuing tertiary education, such as suggestions from specialists, the latest news of the universities, etc. Besides, since the application contains over 900 education institutions, it implements a filtering feature that can filter the desired education institutions based on special categories such as the location of the campus, education institution type, enrolment size, and so on. The figure below shows part of the options of their filtering feature. Users can easily look for education institutions that match their requirements with the filtering feature. Furthermore, the simplified admission process enables the process to perform quickly.



Figure 2.2: Filtering Feature of Common App [3]

However, the course content of each educational institution in the web application is limited. The web page of each education institution does not describe the course content in detail, and some of it even did not have any information above the courses provided. Figure 2.3 and figure 2.4 show an educational institution that offers academic programmes without any information. In addition, the course admission application available on this website is based on an education institution basis. Applicants cannot apply for a specific university programme but a specific educational institution, as shown in figure 2.5.

common	FIND A COLLEGE	Plan for college ▼	Apply to college 🔻	Suppc
Suburban Medium	(2,001 to 14,999) Co-Ed	Test Optional/Flex	ible – First Year	
Charges no application	fee – Transfer No letter o	of recommendation requi	ed – Transfer	
		•		
Virtual Tour				
Academic Pr	oarams			
Academic I i	ograms			
 Design 		 Art & Design 		
 Science 		 Economics 		
 Technology 		 Finance/Accounting 		
 Liberal Arts 		 Government/Politica 	I Science	
 Business 		 Health Science 		
Education		 Performing Arts 		
Nursing		 Social Science 		
Communication		 Visual Arts 		
Music				

Figure 2.3: The Education Institution with Academic Programmes [3]

common	FIND A CO	LLEGE	Plan for college 🔻	Apply to college 🔻	Support your stu
Test Optional/Flexible -	First Year Ch	arges no ap	oplication fee - Transfer		
No letter of recommend	ation required – Tra	ansfer			
Visit us					
Visit us					
Visit us) learn what make	es Monash	one of the top Austra	alian universities.	
Visit us Check out this video to) learn what make	es Monash	one of the top Austra	alian universities.	
Visit us Check out this video to) learn what make	es Monash	one of the top Austra	ilian universities.	

Figure 2.4: The Education Institution without Academic Programmes [3]

Application – In progress	
Writing Supplement – In progress	
	Show more details 🔺
Application Status	
Common Application – In progress	
✓ <u>Questions</u> – Complete	
Recommenders and FERPA – Comp	lete
Review and submit	
Writing Supplement Status	
✓ <u>Writing Questions</u> – Complete	
Writing Requirements	
<u>Common App Personal Essay</u>	

Figure 2.5: Application Status in Common App [3]

The platform could at least include the programme provided by the educational institution so that the applicants are able to know whether their desired programme is offered or not. Moreover, it would be better if the platform would provide the details of the course content. In the admission process, it would be better if the platform could enable the applicants to choose their desired courses so the applicants could know whether they are eligible for the selected course of the education institution.

2.1.2 University Admissions (Universityadmissions.se)

University Admissions is a platform for applying for tertiary education studies in Sweden. It provides all relevant information about studying in Sweden [4]. The targeted user of the platform is not only the local citizen of Sweden but also the individuals who would like to study abroad in Sweden. Besides, it consists of both undergraduate and postgraduate studies information. The figure below is the main page of the platform.



Figure 2.6: University Admissions [4]

More than a thousand programmes at 39 higher education institutions in Sweden. Users can search for their desired universities or courses. A list of matched results will be displayed in figure 2.7. Each result is displayed with basic information about the programme as well as users can view more details by clicking the "Show more" button. Figure 2.8 shows the detailed information of a programme. Therefore, the users can learn more about the course without further searching. In addition, users are able to apply for multiple programmes in different educational institutions at the same time as backup options [4].

 3D Modelling and Visibility Analysis 7.5 Credits, Umeå University, Location: Umeå Application period not open Show more ✓ 	\heartsuit
 A New Global Food Order? Global/Local Encounters, Contradictions, Tensions and Conflicts 15 Credits, Stockholm University, Location: Stockholm Application period 1 Jun - 16 Aug 	\heartsuit
Show more 🗸	ect

Figure 2.7: Programme Application Availability [4]

3D Modelling and Visibility Analy 7.5 Credits, Umeå University, Location: Un Application period 1 Jun - 16 Aug	/sis meå	\heartsuit	
Show less A		Select	
Tuition fee First tuition fee instalment: 13,700 SEK* Total tuition fee: 13,700 SEK* *EU/EEA Citizens are not required to p	ay fees		
*EU/EEA Citizens are not required to pay fees Period: Spring 2022 Period 1 Teaching form: Course, On-campus Course dates: 14 Feb - 27 Mar Pace of study: Full-time Level: Master's Instructional time: Daytime Language of instruction: English Location: Umeå Application code: UMU-F2913 English			
Subject Areas: Community Planning, Hur Information Technology	man Geography and Geography,		
Read the course/programme information Umeå University - about the course/prog	on the university's website. ramme 🖸		

Figure 2.8: Detailed Information of a Programme [4]

The admission process is similar to other platforms. Users have to create an account at the starting point. Then, look for the programmes provided by different universities. It is followed by adding the desired programmes to the selection list. The next step is submitting the required documents and waiting for the admission result. In addition, if the admission is failed, the user is able to reapply the admission. In contrast, if the user decides to discontinue the submitted admission, the user is able to withdraw the admission. The figure below shows part of the further filtering options.

University and Subject	
All universities	~
└─Subjects	
All subjects	~
Level	
Preparatory level	?
Bachelor's level	?
Master's level	?
Show only courses and programmes that do not require previous university studies	
Show only courses that are	
Open for application	
Distance courses	?
only distance courses without required meetings	

Figure 2.9: Further Filtering Options [4]

The platform has an effective and useful searching criterion. It searches the matched result based on the universities and courses, which are the options users care about the

most. No doubt about it, the matched result can be further filtered by its level of study, language used to deliver, area of study, and other related options. All the filter options are relevant to the studies so that it enables users to look for results that highly match their requirements. Besides, the results displayed included the course information where the users are able to know more details about the course as discussed before.

However, the semester field is mandatory in primary searching criteria, and it limits the matched searching results. It would be a disadvantage for those who plan to study abroad in Sweden. This is because they must look for the course provided based on semester instead of the programme itself, where they might misunderstand that the course is not offered in the education institution. In addition, the platform only displays the course available for the current year and the following year. It means that if the user would like to be in Sweden for a few years more, they could not find the related information and thus, they could not plan it earlier.

The suggested improvement of weakness is moving the semester searching criteria to the secondary filtering option. Then, the platform could include more semester duration in the semester field.

2.1.3 UCAS (Universities and Colleges Admissions Service)

UCAS is a web application that connects individuals to undergraduate studies and postgraduate studies, including educator training, apprenticeship, and internship in the United Kingdom (UK) [5]. It provides application services for all higher education courses in the UK. It is in charge of 2.5 million students' applications annually for over 350 education institutions. Most of the educational institutions in the UK require individuals to apply for a full-time undergraduate course with UCAS [6]. The figure below is the main page of UCAS.



Figure 2.10: UCAS [5]

Before the application, users have to choose the course and university and check whether the admission requirements are achieved. Next, log in to the UCAS account and fill in with personal information, education, and qualification. If the users need financial support, they have to fill in the relevant information. The service is available for UK and EU applicants only. After that, users can write a personal statement to increase the chance of success. Every applicant has to get a reference from a teacher or professional unless the applicant has got permission from the selected education institution. Lastly, submit the application and pay the application fee [5].

As a university and college admission service platform, it provides services more than that. Other than tertiary studies, it does provide extra services such as apprenticeships opportunities and career discovery services. Besides, it gives all contents of each course. The contents included are a course summary, application method, course properties, entry requirements, fee, etc. In other words, all information about the selected course can be found on the platform without additional research. Figure 2.11 shows the categories of the content provided for every course.



Figure 2.11: Course Content in UCAS [5]

However, the navigation of the website is messy. It isn't easy to navigate to the page visited before, where it requires users to re-perform the steps to visit the specific web page. Besides, since there are a lot of services provided on the platform, there is difficult to find the path to navigate to the page users want. For example, users want to visit the undergraduate programme list page, but the undergraduate in the navigation bar navigates users to the undergraduate student's blog. In addition, there is an annoying confirmation box displayed after applying the filter feature, as shown in the figure below.



Figure 2.12: Confirmation Box [5]

Nevertheless, the navigation bar can be improved based on native users' views. Otherwise, it consumes time to study how the navigation works on the platform. Next, it is recommended to remove the confirmation box since the filtering options are showing within the web page, as shown in the figure below. The confirmation box would be classified as a redundant confirmation and annoying notification for some users.

Ŧ Filters	Ξ List	器 Grid	†,	Sort by: University or college (A to Z)
Undergraduate 2021-2022 Course vacancies for England X Clear filters				
25802 courses from 313 providers				

Figure 2.13: Display of Filtering Options [5]
2.1.4 Comparison of Similar Platforms with the Proposed System

Similar Platform	Application Type	Strength	Weakness
Common App	Education institution	- Plenty of tertiary education-related	- Insufficient information
	based	articles	- Cannot apply based on a specific
		- Rich of filtering options	course of the selected education
			institution
University	Education institution's	- Effective searching criteria and filter	- The primary searching criteria
Admissions	programmes based	options	must be semester-based
(Universityad		- Provides extra information about each	- Limited semester options
missions.se)		programme	
UCAS	Education institution's	- Provide a variety of services	- Messy navigation
	programme based	- Detailed information for every course	- Annoying notification when
			clearing the sselection
Proposed	Education institution's	- Able to show detailed information for	- An algorithm formed through data
system	programme based	every course on a real-time basis	analysis on the web page is
		- Effective searching criteria and filter	unusable if the HTML structure of
		options	the website has changed
		- Implement related services	

Table 2.1: Comparison of Similar Platforms with Proposed System

The table above illustrates the comparisons among similar platforms with the proposed system. There are 2 out of 3 platforms having education institutions' programme-based application types. This ease for users to apply the programme they are interested in. There are strengths among these platforms, which are plenty of related articles, powerful search and filtering options, providing extra information about each programme, and providing a variety of services. However, it comes with several limitations, such as a platform reviewed cannot apply admission to a selected programme and does not provide sufficient information to users. Also, the primary searching criteria is based on the semester in which the information of specific programmes cannot be retrieved if it is not offered in the selected semester. Besides, the web application design has many annoying user interactions that affect user experience. By referring to the strengths and weaknesses of the reviewed platforms, the proposed system will use the education institution's programme-based application type. The proposed system will show the detailed information of each programme in which the information is obtained on a real-time basis, implement a powerful searching function to allow users to filter and get only matched results, and implement a variety of services into the web application in order to enhance user experience.

2.2 Method and Technology Used

2.2.1 Web Scraping Tool – Scrapy

According to [7], Scrapy is a Python-based open-source web scraping and web crawling framework. It is used to crawl websites in order to extract data from web pages. Scheduler, downloader, item pipeline, and Spiders are the components of Scrapy. Spiders is a primary component of Scrapy that can be used to crawl the web page automated. Firstly, the scheduler component of Scrapy will receive a request which is a URL. Then downloader will download the content of the web page in the passed URL and generate a response. The response is given to Spiders to extract the required information. Scraped data will be returned and filtered by the item pipeline before storing the final result. The figure below illustrates the web scraping process of Scrapy.



Figure 2.14: Web Scraping process of Scrapy [8]

Scrapy is an open-source framework. In other words, it is free, and it has good documentation and continuous community support. A significant advantage of Scrapy is the support by the major OS as well as its portability, where third parties can use it to write extension plug-ins without modifying any existing codes. Furthermore, it offers to parse with Xpath from HTML documents. Additionally, Scrapy has high performance where it takes less time to scrape a web page and is thus suitable for large projects [8].

However, Scrapy is unable to be used to download web pages that dynamically load content using AJAX. The issue can be fixed by using another library along with Scrapy,

but it takes plenty of time to load the contents. In short, Scrapy is able to scrape web pages well, except for web pages that interpret AJAX components [8].

2.2.2 Web Scraping Tool – Beautiful Soup

According to [9], Beautiful Soup is a Python library for scraping information out of HTML or XML files based on its DOM tree structure. It is a web scraping tool to clean up and parse a web page's contents. It helps remove HTML markup and save the scraped contents during the web scraping process. Unlike Scrapy, Beautiful Soup needs to combine with a library that can submit an HTTP request to a web page and return the HTML content of the web page. Then, the returned HTML content is passed to Beautiful Soup to perform scraping.

Beautiful Soup is beginner-friendly, where it is easy to learn as well as able to extract required information with simple codes syntax. Similar to Scrapy, it has good documentation and continuous community support. Its documentation consists of a lot of examples, and thus it is easy for a web scraper beginner to get a start and master it easily [10].

However, as mentioned above, Beautiful Soup needs to combine with a library that can submit HTTP requests to a web page and return the HTML content of the web page. Therefore, the urllib3 library and requests library is often used with Beautiful Soup to download the HTML content of the web page. In addition, Beautiful Soup is not suitable for handling complex operations and is usually used in small projects [11]. Therefore, a complex library such as Scrapy, Selenium, and so on shall be chosen to handle complex operations.

2.2.3 Web Scraping Tool – Puppeteer

According to [11], Puppeteer is a Node library that controls headless Chrome using a high-level API over DevTools Protocol. Other than web scraping, Puppeteer can be used to automate tests in modern web applications, screenshot web pages and automate web pages' interaction. Like web scrapers discussed before, it takes URL as an input and captures the HTML DOM structure web page. As optional, it can retrieve required information using selectors and save the scraped data to the desired format. It can be saved as any form of object available in JS, such as JSON.

As it is a Node library from Google that provides a high-level API to control headless Chrome, the common tasks such as clicking on a button, entering in inputs, and web scraping can be performed easily. The available operations stated would be useful for web scraping. Moreover, it is not only can use Xpath to scrape required information but also the CSS selector. It eases the developer to retrieve required data [11].

However, Puppeteer is not portable, and it supports the implementation on Node.js only. Furthermore, it limits to be used in headless Google browsers such as Chrome. For instance. Puppeteer is not supported by Firefox yet. The developer is working in progress to support Firefox nonetheless [12]. Thus, other web scraping tools such as Scrapy and Beautiful Soup should be adopted if the system's portability is an important factor.

2.2.4 Comparison among Web Scraping Tools

Basis	Scrapy	Beautiful Soup	Puppeteer
Structure	Framework	Library	Library
Performance	Fast	Medium	Fast
Extensibility	Large project	Small project	-
Beginner- friendly	No	Yes	Yes
Туре	Framework	Parser	API
Language	Python	Python	JavaScript (Node.js)
Browser	All	All	Chrome and Chromium
API/ standalone	Both	No	API
Extraction Format	 Regular expression Xpath 	- HTML parsed tree	 Regular expression Xpath CSS selectors
Other limitation	 Not workable in AJAX content rendered web pages 	- Required to combine with a library to get content of a web page	- Workable on Chrome and Chromium only
Suitable to use when	A large project that requires complex operation and high performance	Small projects and newbies for web scraping	Headless browser

Table 2.2:	Comparison	among	Web Sc	raping	Tools
		0			

2.2.5 Rule-based AI

A rule-based system is a system that uses human-made rules as the knowledge representation, which is widely explicated to construct a summary or conclusion from data. It requires a set of facts or data source compromise with defined rules to manipulate the data. In other words, the rule-based AI system is a system that utilises AI through the rule-based model. It is a logical system that makes use of predefined rules to automate actions on performing deduction and choice selection [13].



Figure 2.15: Rule-based AI Model

The figure above shows the concept of the rule-based model. The rule-based model is the rules that are coded in the form of the if-then-else statement. For example, "if" the person likes to play computer games, "then" he will most likely to buy a high-end laptop, "else" classic laptop will be chosen. The "if" statement is used to trigger the actions stated in the "then" statements. Therefore, if there is 50 actions need to be handled, then there are 50 different rules. In short, the system will do the action precisely according to the rules defined.

Forward chaining is a type of rule-based AI which is a data-driven technique thar reaches to the goal using the available data. It will be applied on building recommendation system in order to suggest area of studies based on answer provided.

There are some pros and cons of the system. The rule-based AI system can operate even even if only a few basic data and information. However, as the limited underlying rule base size, it has limited ability to perform intelligence tasks where it acts as instructed by humans. Besides, it is time-consuming and expensive to do maintenance of the system, such as update the system without introducing contradicting rules [13].

2.2.6 Learning-based System

In contrast to rule-based systems, learning-based systems have a very ambitious goal. It can be adopted to implement recommendation system as well. The system will be having the ability to adapt intelligence where the existing knowledge can be updated or acquire knowledge. It makes learning-based system different from rule-based AI systems. A neural network is an example of a learning-based system [41].

The system is using their own models which automates the process by implementing machine learning techniques. It utilise the ability of machine learning which defines own set of rules based on data outputs it has access to without human intervention. Machine learning models require to be trained by large datasets and it can achieve scalability. The larger the dataset, the more accurate to predict the output [41].

2.2.7 Application Programming Interface (API)

An API is a set of functions that enables data transmission, access data, and interaction between one application and another. It uses to build and integrate application software to enable applications to exchange data easily and securely [14].



Figure 2.16: API workflow

As shown in the figure above, an API sends the user application to initiate API calls, and the API will send requests with optional data to the system. Then the system will respond results to the user. In the detail of invoking an API call, an URL or an endpoint of the system is required, and then the request method has to be specified for the call. Next, the request header has to be defined where the content in the header can be authentication credentials, content type, etc. The request data is the information sent to the server. The data format of request data and response data is often JSON or XML throughout the data exchange and transmission process. These data formats come with key-value pairs, which are easy to read by humans and can be understood by application in different programming languages.

There are 4 basic request methods that can be made with API, which are GET, PUT, POST, and DELETE.

- GET: Information retrieval
- PUT: Update records
- POST: Create new records
- DELETE: Removing records

The strengths of the API are improving collaboration, easy innovation, data monetisation, and added security [14].

2.2.8 Programming Language – Python

Python has been used as the backend language of the project. Python is a computer programming language that is often used to develop web applications, automated tasks, perform data analysis and machine learning, software testing and prototyping. It is an interpreted, object-oriented, high-level programming language with dynamic semantics.

It has a simple syntax that mimics natural language which enhances the readability and easy to learn and understand the codes even for non—programmers. Python is versatile and it is a general-purpose language which can be used for a wide range purpose of programs, such as from web application development to machine learning. Most importantly, Python is beginner friendly which make itself popular for newbies. Furthermore, it is an open-source programming language and contain huge number of modules and libraries. Therefore, Python is free to use even for commercial purposes. Huge number of modules and libraries are able to import from codes that made by thirdparty users to expand Python's capabilities.

Besides, Python can be used on different platforms such as Windows, Mac, Linux, Raspberry Pi, etc. It allows programmers to write programs with fewer lines than some other programming languages. Python runs on interpreter system which the codes can be executed as soon as it is written. It can be treated in a procedural way, an objectoriented way and a functional way [15].

2.2.9 Web Framework (Backend) – Flask

Flask is the Python framework chosen for the project. It is a Python micro web framework that allows users to build web applications. Flask is lightweight and provides essential components for building a web application quickly and efficiently. Flask can be used with Jinja2, a template engine that allows users to write inline expressions in HTML files for rendering dynamic contents [16].

2.2.10 Database – MySQL

The database chosen for this project is MySQL. It is an open source Relational Database Management System(RDBMS) based on Structured Query Language. The database application can be used for a wide range of purposes, such as data warehousing, e-commerce, logging applications, and etc.

As MySQL is an open-source database, so it is cost free where the user does not have to spend any cost to pay for the license fee. It has good data security, compatibility, and reliability. Whenever a database is created, the next step will always to identify and formulate a security policy before giving access to the database users. Therefore, there is high rated in the area of data security. Besides, it is platform-independent and can run on any OS. Other than that, MySQL supports transactional processing with high performance and even deals with many queries. MySQL database is able to run 24/7 which is achieving high availability [17].

2.2.11 Frontend-AngularJS

AngularJS is a JavaScript framework that is mainly used for frontend development and it can extend HTML with Directives. It is open source which is completely free for everyone. AngularJS is easy to learn whereby developers need to know how to the basics of HTML, CSS and JS only. However, the framework relies on JS, so it is great if acquired prior knowledge of JS. It is working with components, so codes are reusable which is time-saving and reduce redundant codes. Also, it facilitates the Two-way Binding that helps to render correspondingly the amendments made to the view or the model [18].

In addition, AngularJS applications are cross-browser compliant which it will handle JS code that suitable for each browser automatically. It allows to provide a dynamic view and supports the MVC programming structure for web applications.

2.3 Proposed Solution

The problems stated in Chapter 1 illustrate the difficulty of individuals in searching for related information to pursue tertiary studies. Therefore, this project is proposed to solve the need for a platform that collects information on programmes offered by universities and enables users to access all required information through a single website. The platform will provide great convenience to target users and the programme discovery process. The figure below illustrates the convenience of having a platform to display all related information.



Figure 2.17: Browsing ways

Based on the limitations of reviewed systems and the nature of Malaysia's private university admission, the proposed project will focus on each university's programmes. In other words, the proposed platform will pay more attention to the information of programmes. Besides, only essential searching criteria will be implemented in order to avoid irrelevant and complex filtering options. Thereby, users can get the most directive results. The platform will be presented by developing a web application using Angular JS as front-end framework, Flask as backend web framework, Python programming language and MySQL database. In addition, a variety of services will be implemented to the web application to improve the usability, completeness, and user experience. For example, the service of recommendation system will be implemented using Rule-AI based concept. APIs will be created to enable interactions between front-end and backend.

Next, Beautiful Soup, a web scraping tool, will be utilized to extract data on a web page on a real-time basis. Based on the comparison in chapter 2.2.4, Beautiful Soup is suitable for small projects and newbies for web scraping. Also, it does not have the limitation of not being workable in AJAX content rendered web pages. It is the most appropriate library to perform web scraping. As a result of scraping, the information shown to the user is the latest. By using the web scraping tool, the system can benefit from saving database storage that is used to record information of every programme and the workforce to store and track the information of every programme, which is the tedious work that may lead to human error easily. The final result will be displayed on web application.



Figure 2.18: Web Scraping Concept

The figure above demonstrates the fundamental concept of web scraping. The vital part of web scraping has a link to tell the tool the location to scrape the data. After getting the link, the required information can be obtained after looking for the location of the target element. These are the basic concept of performing web scarping.

In addition, rule-based AI will be adopted to implement recommendation system. This is because it is suitable when using small amounts of data and simple, straightforward rules. It is also suitable when need to get output quickly as limited parameters of the systems enable quick result.

3.1 Design Specification

3.1.1 Methodology

Agile development methodology will be applied in this project. This project is not large and mission-critical. Therefore, coding and testing can be focused more on using the chosen methodology. Its flexibility allows amendments to the project and gives higher productivity throughout the development. It provides iterative and increment improvement, enabling the project to be developed in high quality simply and efficiently. Agile development can build a system faster because it requires less documentation. Besides, it is usual that cannot define more detailed project requirements at the beginning stage, and changes during the development stage are hard to avoid. Therefore, the nature of this methodology, which can tolerate the changes, is a better choice than other methodologies [19].



Figure 3.1: Agile development methodology [20]

According to [21], planning will be carried out to determine the project scope in the first phase. Research related to the project will be done to have more understanding on the existing systems and explore new ideas for the proposed system, as well as to study the technologies required to build the proposed system. Besides, requirement gathering will be conducted to perform feature analysis and define the requirements for the project. After the planning and analysis have been done, the project's development will start incrementally and iteratively. The sprint, development iteration, includes development, testing, and review tasks. The final product, the proposed system, will be delivered after completing all sprints.

3.1.2 Software Architecture Pattern

Three-Tier Client-Server Architecture will be applied in this project. It is a client-server architecture which separates applications into 3 layers or tiers. Functional process logic, data access, computer data storage and user interface are deployed and maintained as independent modules on separate platforms. In 3-tier architecture, any of 3 tiers can be upgraded or replaced independently without affecting other tiers.

The 3 tiers in the architecture are presentation tier, application tier and data tier.

a. Presentation Tier

Presentation tier is the top level. It is mainly used to display contents and collect information from users on a desktop application, web browser or web-based application in the form of a GUI. It facilitates the front-end layer of the application and it is also the interface that end-users can interact with. This tier is usually developed using HTML, CSS and JS for web application as well as it will interact with other tiers via API calls; a variety of languages used for desktop application which depends on the platform. A web server will be used to develop the user interface.

b. Application Tier

Application tier is the middle tier of the architecture. The main purpose is to control the applications' core functionality by executing the business logic coded. It can be coded in a variety of programming languages such as Java, Python, C++, etc. The processes or business logic will be deployed in an application server. This tier can communication with data tier, the lowest tier, using API calls in order to access and manage the data in the data tier.

c. Data Tier

Data tier is where the database server placed at. The information of the application will be stored and managed in the database. The database can be a SQL or NoSQL database. Examples of RDBMS are PostgreSQL, MySQL, Oracle, etc; Examples of NoSQL are MongoDB, CouchDB, Cassandra, etc.

In addition, all the communication must goes through the application tier in the architecture whereby the presentation tier and the data tier cannot communication directly with each other [22]. Figures below simplifies the communication of tiers.



Figure 3.2: Three-tier Client-Server Architecture [23]



Figure 3.3: Three-tier Client-Server Architecture of the proposed system

There are several benefits with 3-tier architecture. The largest benefit is the separation of functionality into logical and physical tiers. Each tier can only run on dedicated and separate platform such as web server, application server and database server. Therefore, there is no impact to other tiers if any modification was done on any tier which improves the scalability and reliability with the architecture. Besides, tiers of the architecture can be developed simultaneously by different development teams rather than work on full stack which facilitates faster development and efficiency improved. Since presentation tier and data tier cannot communicate directly with each other, the security can be improved by a well-designed application tier which can be acted as a sort of internal firewall and preventing malicious activities such as SQL injections [24].



3.1.3 Working Principle of Data Analysis on Scraped Data

Figure 3.4: Web Scraping Process

Web scraping is a process to extract content or mining data from a website on a realtime basis. The content extracted is unstructured. Data analysis will be performed in order to obtain valuable and specific information. As shown in the figure above, first and foremost, making a request to get the HTML content of the target website is the first and essential step for web scraping. Then, identify the examine the HTML structure and HTML element on the scraped HTML content. It is followed by obtaining the required content via writing a script. The processes are performed in iteration to validate content collected is valid and automated.

After extracting the information, the raw information is needed to transform it into structured data for further analysis. According to [25], the final result of data analysis is generally obtained from gathering specifications, organising, cleaning, re-analysing, and applying models and algorithms. The final result is then delivered to the users in a proper organisation. The figure below demonstrates the flow chart of the whole process.



Figure 3.5: Flowchart of Performing Data Analysis on Scraped Data



3.1.4 Working Principle of Rule-based AI

Figure 3.6: Workflow of Proposed System's Rule-based AI

According to [13], a rule-based AI system is a system that utilises AI through the rulebased model. The rule-based model is the rules coded in the form of the if-then-else statement. The rule-based AI will be applied to determine the field of the study suggested to the user. As shown in the figure above, the answers to the questionnaire are the input of the rule-based AI system. It is obtained after the user has answered the questionnaire. The answer will act as the data source to go through the defined rules or rule-based model in order to proceed with the output. As a result, after going through the rule-based model, the suggested field of study will be processed.

3.1.5 Working Principle of API



Figure 3.7: API workflow of the proposed system

Figure 3.5 elaborates the API workflow of the proposed system. API is a set of functions that enables data transmission, access data, and interaction between one application and another. It allows an application to interact with another application. API calls must be initiated by the client application. The target server will process the API request and respond to the client application with request information via the web API [14].

In the proposed system, web API is utilised to allow communication between the frontend and the backend system. The system's front-end is the web application used to present data and provide services to users, while the information required to process by the backend system is the result of web scraping and data retrieval. The data format during data transmission will be JSON. The backend will transfer the information to the front-end based on the data required by the front-end. Then, the front-end application is able to utilise the information received.

3.1.6 User Requirements

Individuals planning to pursue an undergraduate or postgraduate programme are the main targeted user group of the proposed system. Therefore, the core of this project is on scraping and analysing the data of each universities' programme. From a system perspective, the system shall be able to:

- Perform web scraping based on the algorithm defined for each university
- Perform regular checking on the web scraping algorithm in order to ensure the algorithm is working even the university website has updated the information or HTML DOM structure
- Perform web scraping on programme list of each university
- Perform regular checking on whether there is any updates on programme list of each university
- Provide access to the result after performing web scraping and analysis
- Record any errors occurred to a log
- Record any updates on database to a log
- Record report of regular checking

In addition, the web application is designed to present the final result of data analysis on scraped data. The web application's user interface should be easy to use and interact with the system. Users do not require any specific technical skill to access the functionalities of the web application. Furthermore, the web application will include some features in order to increase its usability. The features provided by the web application are as follows:

- Users can search and filter the programmes based on their searching criteria, and then users are able to get a list of matched result
- Users can view the information on the selected programme
- Users can export information about programmes in the forms of pdf
- Users can get recommendations on the field of studies they may be suitable for
- Users can manage their favourite list of programmes
- Users can request for their view history
- Users can perform enquiring to the customer service of the platform

3.2 System Design Diagram

3.2.1 System Architecture Diagram



Figure 3.8: System Architecture Diagram

The figure above illustrate the system architecture diagram. The front-end of the system using AngularJS while backend system using Python Flask with MySQL database.

The user is the end-user of the system who will be using the platform. Front-end or the browser will collect required data from the user and display the intended relevant result on user device. Browser in user device will be used to interact the application front-end by entering the URL. Then, the browser will render the user interface of the system which written in HTML, CSS, Bootstrap and JavaScript with AngularJS framework. Users are allowed to search programme, view programme, export programme, view favourite and viewed history list, perform enquiry and request recommendation on area of studies. Besides, users can add or remove favourite list and update viewed history list.

Backend consists of 2 sections which are application server and database server. Application server have APIs made of Flask framework ready for front-end to interact with and a set of business logic that written in Python which contain the code of functionalities of the system. Business logics are the core part of the whole system. It contains the web scraping algorithm, data analysis algorithm, and other codes for functional requirements. Database server is where the MySQL database reside at. The database will be storing university information, links of programmes and log data that describes errors occurred and the result of regular checking.

In addition, APIs are used to allow communication between front-end and backend. Front-end has to initiate request to the API in order to obtain data, then the API will execute the corresponding business logic to get the required data and response to the front-end. APIs are used to access the information of programme from backend; therefore, the web application is able to display the result to users. The data pass to and from API using JSON format.

3.2.2 Use Case Diagram



Figure 3.9: Use Case Diagram

Figure 3.8 elaborates the use case diagram for the system. It illustrates how users can interact with the web application. Users are permitted to search programmes, view information of selected programmes, request recommendations, view the favourite list, view viewed history list, and perform enquiry. Users can manage their favourite programme list by adding or removing the programme from the list while viewing the programme. When users have chosen the programme to view, users can choose to export information of the programme optionally as well as the system will automatically add the programme to viewed history list. If an error occurred, the system will record the programme error.

3.2.3 Use Case Description

Search Programme Use Case

Use Case ID	UCO	01	Version	1.0		
Use Case	Sear	ch Programme				
Importance	Higł	1				
Level						
Purpose	To s	earch for relevant programmes based	on a set of criterias			
Primary	User					
Actor						
Stakeholders	User	- want to search programme				
and Interests			_			
Use Case	Deta	il, Essential				
Туре						
Trigger	A us	A user wants to search for relevant programmes.				
Туре	Exte	External				
Precondition	The	The user is using the system.				
Relationship	Asso	ociation: User				
	Inclu	ıde: -				
	Exte	nd: Record Programme Error (UC01	1)			
	Gen	eralization: -				
Main Flow	1	System gets existing location from	database.			
	2	System puts only existing location	ons to drop-down	box of		
		location.	_			
	3	User enters programme name.				
	4	User selects specification level.				

	5	User selects location.
	6	User clicks search button.
	7	System retrieves relevant programmes based on the criteria.
	8	System adds the programme into a list of result.
	9	System displays the list of result.
Alternative	7a	System executes Record Programme Error use case if an error
flow		occurred when retrieving programme information.
	7b	System removes the programme from the search result list.
	7c	Back to main flow step 9.
Subflow	Not	Applicable

View Programme Use Case

Use Case ID	UCO	002	Version	1.0
Use Case	Viev	w Programme		I
Importance	Higl	1		
Level				
Purpose	То у	view details of the programme inform	ation.	
Primary	User	ſ		
Actor				
Stakeholders	User	r – want to view programme details		
and Interests				
Use Case	Deta	iil, Essential		
Туре				
Trigger	Aι	user wants to view detailed info	rmation of the s	elected
	prog	gramme.		
Туре	Exte	ernal		
Precondition	A us	ser has searched programme from the	system.	
Relationship	Asso	ociation: User		
	Incl	ude: Add to Viewed History List (UC	003)	
	Exte	end: Add to Favourite List (UC004), R	emove from Favour	rite List
	(UC	005), Export Programme Inform	ation (UC006),	Record
	Prog	gramme Error (UC011)		
	Gen	eralization: -		
Main Flow	1	User selects a programme to view for	or its details.	
	2	System gets the required informatio	n.	
	3	System executes Add to Viewed His	story List use case.	
	4	System displays programme inform	ation.	

Alternative	2a	System executes Record Programme Error use case if an error
flow		occurred when retrieving programme information.
	2b	System redirects user to error page.
	2c	System terminates the session.
Subflow	Not	Applicable

Add to Viewed History List Use Case

Use Case ID	U	2003	Version	1.0		
Use Case	Ac	dd to Viewed History List		1		
Importance	M	edium				
Level						
Purpose	Тс	add the programme to viewed history	/ list.			
Primary Actor	Us	ser				
Stakeholders	Us	ser – want to add programme to viewed	d history list			
and Interests						
Use Case	De	etail, Essential				
Туре						
Trigger	A	user viewed detailed information of a	programme.			
Туре	Ex	External				
Precondition	A	user has selected a programme to view	v its detailed inform	ation.		
Relationship	As	ssociation: User				
	Ine	clude: -				
	Ex	tend: -				
	Ge	eneralization: -				
Main Flow	1	User selects a programme.				
	2	System gets basic information of the	programme.			
	3	System checks the viewed history lis	it.			
		If the programme is not existed in	the viewed history	list		
		S-1: Add to viewed history list	subflow will be exe	ecuted		
		If the programme exists in the vie	wed history list			
		S-2: Update viewed history list	t subflow will be exe	ecuted		

Subflow (S-1:	1	System updates the viewed history list by adding the basic
Add to		information of the programme to the list.
viewed		
history list)		
Subflow (S-2:	1	System updates the viewed history list by modifying the search
Update		time of the programme in the list.
viewed		
history list)		

Add to Favourite List Use Case

Use Case ID	UC00	4	Version	1.0			
Use Case	Add to	Add to Favourite List					
Importance	Mediu	m					
Level							
Purpose	To add	d the programme to favourite lis	st.				
Primary Actor	User						
Stakeholders and	User –	- want to add programme to favo	ourite list				
Interests							
Use Case Type	Detail	Detail, Essential					
Trigger	A user	A user has selected a programme to view its detailed information.					
Туре	Extern	External					
Precondition	Auser	viewed programme information	n and the programm	e is not			
	exist in the favourite list.						
Relationship	Assoc	iation: User					
	Includ	e: -					
	Exten	d: -					
	Gener	alization: -					
Main Flow	1	User selects a programme.					
	2	User click to add programme t	to favourite list.				
	3	3 System gets basic information of the programme.					
	4	System updates the favourite	e list by adding the	e basic			
		information of the programme	to the list.				
Subflow	Not A	pplicable					
Alternative flow	Not A	pplicable					

<u>Remove to Favourite List Use Case</u>

Use Case ID	UC0	05	Version	1.0		
Use Case	Rem	ove from Favourite List	L	I		
Importance Level	Med	ium				
Purpose	To r	emove the programme from favo	ourite list.			
Primary Actor	User	•				
Stakeholders and	User	r – want to remove programme fr	rom favourite list			
Interests						
Use Case Type	Deta	Detail, Essential				
Trigger	Αu	iser has selected a programm	ne to view its c	letailed		
	info	information and the programme is in the favourite list.				
Туре	Exte	External				
Precondition	A us	A user viewed programme information.				
Relationship	Asso	ociation: User				
	Inclu	ıde: -				
	Exte	Extend: -				
	Generalization: -					
Main Flow	1	User selects a programme.				
	2	User click to remove programm	ne from favourite lis	st.		
	3	System gets basic information of the programme.				
	4	System finds the favourite prog	ramme in the favour	rite list.		
	5	System updates the favourite lis	st by removing the m	natched		
		programme information from the	he list.			
Subflow	Not	Applicable				
Alternative flow	Not	Applicable				

Export Programme Information Use Case

Use Case ID	UC00	6	Version	1.0	
Use Case	Expor	t Programme Information			
Importance Level	Mediu	im			
Purpose	To ex	port the programme informat	tion as a report to	user in	
	PDF.				
Primary Actor	User				
Stakeholders and	User –	- want to export programme d	etails		
Interests					
Use Case Type	Detail	, Essential			
Trigger	A user has selected a programme to view its detailed				
	inform	nation.			
Туре	Extern	nal			
Precondition	A user	viewed programme informat	ion.		
Relationship	Assoc	iation: User			
	Includ	e: -			
	Exten	d: -			
	Gener	alization: -			
Main Flow	1	User selects a programme.			
	2	User clicks export button.			
	3	System gets information of t	he programme.		
	4	System saves the informatio	n into a PDF file.		
Subflow	Not A	pplicable			
Alternative flow	Not A	pplicable			

Request Recommendation Use Case

Use Case ID	UC00	7	Version	1.0	
Use Case	Request Recommendation				
Importance Level	High				
Purpose	To request recommendation on area of studies.				
Primary Actor	User				
Stakeholders and Interests	User –	- want to request recommenda	tion on area of stud	ies	
Use Case Type	Detail, Essential				
Trigger	A user wants to get recommendation on area of studies.				
Туре	External				
Precondition	The user is using the system.				
Relationship	Association: User Include: - Extend: -				
	Generalization: -				
Main Flow	1	1 User answers the 50 questionnaire.			
	2	System determines suitable the area of studies.			
	3	System displays the result.			
Subflow	Not Applicable				
Alternative flow	Not Applicable				

View Favourite List Use Case

Use Case ID	UC00)8	Version	1.0
Use Case	View	Favourite List		
Importance Level	Medium			
Purpose	To vi	ew favourite programmes.		
Primary Actor	User			
Stakeholders and	User – want to view favourite list of programmes			
Interests				
Use Case Type	Detail, Essential			
Trigger	A user wants to view favourite programmes.			
Туре	External			
Precondition	The user is using the system.			
Relationship	Association: User Include: - Extend: -			
	Generalization: -			
Main Flow	1	User clicks to view favourite	list.	
	2	System gets the favourite list		
	3	System displays programmes	s in the favourite lis	t.
Subflow	Not Applicable			
Alternative flow	Not Applicable			

View Viewed History List Use Case

Use Case ID	UC00	9	Version	1.0
Use Case	View Viewed History Favourite List			
Importance Level	Mediu	im		
Purpose	To vie	w viewed history programme	s.	
Primary Actor	User			
Stakeholders and Interests	User –	- want to view viewed history	list of programmes	
Use Case Type	Detail, Essential			
Trigger	A user wants to view viewed history programmes.			
Туре	External			
Precondition	The user is using the system.			
Relationship	Association: User Include: -			
	Extend: -			
	Generalization: -			
Main Flow	1	User clicks to view viewed h	nistory list.	
	2	System gets the viewed histo	ory list.	
	3	System displays programme	s in the viewed histo	ory list.
Subflow	Not Applicable			
Alternative flow	Not Applicable			

Perform Enquiry Use Case

Use Case ID	UC01	0	Version	1.0
Use Case	Perform Enquiry			
Importance Level	High			
Purpose	To send enquiry to the system.			
Primary Actor	User			
Stakeholders and	User – want to perform enquiry			
Interests				
Use Case Type	Detail, Essential			
Trigger	A user wants to send enquiry to the system.			
Туре	External			
Precondition	The user is using the system.			
Relationship	hip Association: User			
	Includ	le: -		
	Extend: -			
	Generalization: -			
Main Flow	1	User enters the subject of the enquiry.		
	2	User enters his/her name.		
	3	User enters his/her email.		
	4	User enters the enquiry message.		
	5	User click on submit button.		
	6	System gets the user inputs.		
	7	System sends the enquiry details to system using email.		
	8	System displays the complet	te message.	
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Subflow	Not Applicable
Alternative flow	Not Applicable

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Record Programme Error Use Case

Use Case ID	UC01	UC011 Version 1.0											
Use Case	Record Programme Error												
Importance Level	High												
Purpose	To re	To record error of retrieving a programme.											
Primary Actor	User	User											
Stakeholders and Interests	User – want to record programme error												
Use Case Type	Detai	Detail, Essential											
Trigger	When errors occurring during retrieving information of a programme.												
Туре	External												
Precondition	The user is using the system.												
Relationship	Asso	ciation: User											
	Inclu	de: Search Programme, View I	Programme										
	Exter	nd: -											
	Gene	ralization: -											
Main Flow	1	User selects a programme.											
	 2 System gets the information and the error message of the programme that has errors. 3 System updates the condition of the programme to database. 												
	4 System records the error log into database.												
Subflow	Not Applicable												
Aalternative flow	Not Applicable												

3.2.4 Activity Diagram

Search Programme Use Case



Figure 3.10: Search Programme Activity Diagram

The figure above illustrates the search programme activity diagram. At first, the system will get the existing locations in database and put the locations in to location's dropdown box for users to select. Users can enter the searching criteria to let the system perform searching and filtering. The searching criteria are programme name, specification level, and location. After the user clicks search button, the system will retrieve all the relevant programmes matched to the criterias. Then, a list of matched results will display to the user. The list will include a summary of the programme and will also be shown to users. In addition, if there are errors occurred when getting the information of a programme, the system will record the programme error and remove the programme from the result list.

View Programme Use Case



Figure 3.11: View Programme Activity Diagram

Figure 3.11 demonstrates an activity diagram of view programme use case. After users have selected the programme, the system will get the programme information by performing web scraping and data analysis. This enables the information to be retrieved on a real-time basis. Then, there is checking on the current data analysis algorithm to ensure the algorithm is working and then information will be retrieved in order to displayed to users. Otherwise, if the algorithm is not working, the system will record the relevant information into the database to log the information to inform the developer of the issue. In such cases, users will be redirected to an error page. In addition, if no error occurred when retrieving the information, the programme will be added to viewed history list of the user.

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User System Select programme Get programme information Check viewed history list [Programme exists in the list] Update the list Update the list Update the list

Add to Viewed History List Use Case

Figure 3.12: Add to Viewed History List Activity Diagram

The figure above illustrates the Add to Viewed History List activity diagram. The activity will be executed automatically when the user view detailed information of a programme. Users can select a programme, then the system will retrieve the programme information. The system will check on viewed history list about whether the programme is been viewed before. If yes, the system will update the viewed history list by modifying the search time of the programme in the list. Otherwise, the system will update the list by adding the programme to the list.

Add to Favourite List Use Case



Figure 3.13: Add to Favourite List Activity Diagram

The figure above illustrates the Add to Favourite List activity diagram. Users can click add to favourite list after selecting a programme. Then, the system will retrieve the programme information and followed by add the programme to user's favourite list.

Remove from Favourite List Use Case



Figure 3.14: Remove from Favourite List Activity Diagram

The figure above illustrates the Remove from Favourite List activity diagram. Users can click remove from favourite list after selecting a programme. Then, the system will retrieve the programme information and followed by search through the favourite list to get the programme. Then, the system will remove the programme to user's favourite list.

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Export Programme Information Use Case



Figure 3.15: Export Programme Information Activity Diagram

Figure 3.15 demonstrates an activity diagram of export programme information. After users have selected a programme, they can export the programme information. The system will collect the information and export the information as a file to user.



Request Recommendation Use Case

Figure 3.16: Request Recommendation Activity Diagram

The figure above elaborates the request recommendation activity diagram. Users can request a recommendation on the field that they are suitable to study or the field of interest. A questionnaire is required to answer then the system will trigger a rule-based AI approach to analyse based on the answers. The suggested field of studies will be displayed to users after analysing.

View Favourite List Use Case



Figure 3.17: View Favourite List Activity Diagram

The figure above describes the view favourite list activity diagram. Users are able to view their favourite list. The system will get the user's favourite list and display it.

View Viewed History List Use Case



Figure 3.18: View Viewed History List Activity Diagram

The figure above describes the view viewed history list activity diagram. Users are able to view their viewed history list. The system will get the user's viewed history list and display it.

Perform Enquiry Use Case



Figure 3.19: Perform Enquiry Activity Diagram

The figure above describes the Perform Enquiry activity diagram. Users are able to perform enquiry to the system by filling in all the fields and click on the submit button. The fields to fill in are enquiry subject, name, email and enquiry message. The system will get all the inputs and send the enquiry to the system in the form of email. Then, a complete message will be displayed.

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Record Programme Error Use Case



Figure 3.20: Record Programme Error Activity Diagram

The figure above describes the Record Programme Error activity diagram. The activity of the use case will be triggered if and only if errors occurred when retrieving a programme information. The system will gather the programme information and get the error message that cause the error. Then, the system will update condition of the programme in database in order to let the system skip on retrieving the error programme before the fixing has done. Then, the system will record the error log into database.

3.2.5 Database structure

Entity Relationship (ER) Diagram



Figure 3.21: Entity Relationship Diagram

The figure above demonstrates the Entity-Relationship Diagram (ERD) of the system. There are 3 database tables in the system, which are university, programme, and log.

Data Dictionary

*Remark: Primary Key Foreign Key Primary Key + Foreign Key

1. university

Attribute	Description	Data Type	Nullable	Sample Data
		(size)		
uni_key	The key used to	VARCHAR	No	utar
	define the	(20)		
	university name			
uni_name	University name	VARCHAR	No	UTAR
		(50)		
other_name	Other names of	VARCHAR	Yes	Universiti Tunku
	the university	(100)		Abdul Rahman
no_of_prog	Number of	int(3)	No	100
	programme			

Table 3.1: Data Dictionary of university Table

2. programme

Attribute	Description	Data Type	Nullable	Sample Data
		(size)		
uni_name	University name	VARCHAR	No	utar
		(50)		
prog_name	Programme	VARCHAR	No	Bachelor of
	name	(150)		Computer Science
link	Link to access	VARCHAR	No	https://study.utar.ed
	the program	(300)		u.my/computer-
				engineering .php
condition_prog	Whether the	int(1)	No	0 = error found and
	programme is			unfixed
	retrievable			1 = normal

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lvl_of_study	Specification	VARCHAR	No	Undergraduate					
	level of the	(20)		Or					
	programme			Postgraduate					
location	Location of the	VARCHAR	No	Kampar, Perak					
	programme	(100)							

Table 3.2: Data Dictionary of programme Table

3. log

Attribute	Description	Data Type	Nullable	Sample Data
		(size)		
id	System generated	BIGINT(7)	No	1
	ID (Auto increment)			
uni_name	University name	VARCHAR	No	utar
		(20)		
prog_name	Programme name	VARCHAR	Yes	Bachelor of
		(150)		Computer Science
link_prog	Link to access the	VARCHAR	Yes	https://study.utar.
	programme	(300)		edu.my/computer-
				engineering .php
error_msg	Error message	VARCHAR	Yes	Not found
		(300)		
remark	Remark on the	VARCHAR	Yes	New programme
	record	(10000)		added
is_checked	Whether the log has	INT(1)	No	0 = yet to check
	been checked			1 = checked
created_date	Record's created	TIMESTA	No	2021-08-08
	datetime	MP		00:00:01

Table 3.2: Data Dictionary of log Table

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Namo	Start D :	End Data	Duration	Jan, 22 Feb, 22		Mar	Mar, 22 Apr, 22							/lay, 22			Ju	n, 22			Jul,	22		Aug, 22					Sep, 22						
Name .	Start D	End Date .	Duration	02	09	16 2	3 30	06	13	20	27	06 13	3 20	27	03	10	17	24 0	1 08	15	22	29	05	12 1	9 26	6 03	10	17	24	31 07	14	21	28	04	11
Explore related work	Jan 17, 2022	Feb 03, 2022	14 days					Ч																											
Refine proect objective and project scope	Jan 17, 2022	Feb 03, 2022	14 days					H																											
Install require software and libraries	Feb 03, 2022	Feb 07, 2022	3 days				1																												
System Design	Feb 08, 2022	Feb 10, 2022	3 days					•																											
Study how to use the tools	Feb 11, 2022	Feb 24, 2022	10 days					-																											
✓ Development	Feb 25, 2022	Jul 26, 2022	108 days																																
Web scraping and data analysis	Feb 25, 2022	Mar 29, 2022	23 days							-																									
Database creation	Mar 28, 2022	Mar 28, 2022	1 day																																
RESTful API development	Mar 28, 2022	Mar 28, 2022	1 day	:																															
 Web application development 	Apr 01, 2022	Jul 26, 2022	83 days																																
Presentation of data	Apr 01, 2022	Apr 06, 2022	4 days											5																					
Favourite list module	Apr 06, 2022	Apr 08, 2022	3 days																																
Recommendation module	May 27, 2022	Jun 07, 2022	8 days																			_													
Searching and filtering module	Jun 03, 2022	Jun 21, 2022	13 days																																
Report generating	Jun 22, 2022	Jun 28, 2022	5 days																					1											
Regular check on programme	Jun 29, 2022	Jul 26, 2022	20 days																																
Testing and debug	Jul 27, 2022	Aug 09, 2022	10 days																																
FYP 1 report	Mar 30, 2022	Apr 15, 2022	13 days																																
FYP 2 report	Aug 10, 2022	Sep 09, 2022	23 days																																

3.3 Timeline



The above shows the tasks completed within the timeframe. This project is estimated to deliver by 15th April, 2022. Before development started, exploration of the project, installation and environment setup, and gaining knowledge to utilise related tools and libraries were carried out. Next, the entire development task took around 6 weeks. It includes web scraping, data analysis, creating RESTful API, data8base creation, and building a web application. FYP 1 report has done upon 15th April 2022. The implementation will be stopped temporarily until completing the final examination.

After the final examination, the implementation process will be resumed from 27th May 2022 until 26th July 2022. The total planned day for development is 108 days. Then, 10 days are allocated to do testing and debugging.

4.1 Project Flow Diagram



Figure 4.1: Project Flow Diagram

The initiation of the project will be crucially dependent on data analysis on analysing programmes offered by universities. By analysing programmes, similarities information structure of programmes will be found. The structure is then be used to create a class or model that describes the programme. It is followed by performing web scraping and apply data analysis on the targeted universities. Web scraping is used to obtain or scrap the data on a link provided; Data analysis is used to determine the important information on the scrap data. Then, testing on the algorithm is required to ensure it is working on all programmes of the particular university. Regular checking

feature is then implemented to perform regular check on if the university has updated their programme lists and the HTML DOM structure on displaying their programme information.

After all the core functions are done, API is developed to enable communication between frontend and backend. Several APIs are implemented to allow frontend to access different functions of backend.

The result will be shown on a web application, so web application development is the next step. During the web application development, it has to connect to API in order to access backend function and display to users. Then, it is needed to test whether the API connection is success. Next, there are several related features will be developed to the web application. Testing has to be done on these features.

4.2 Web Scraping and Data Analysis Flow



Figure 4.2: Web Scraping and Data Analysis Block Diagram

The figure above shows the flow diagram of web scraping and data analysis. University name and link to scrap must be provided to perform the operation. University name is used to determine which algorithm to use as different algorithm is applied to different university. The link has to be provided to the function in order to tell the function which link to scrap. Then, web scraping and data analysis will perform. After performing, the information will save into a class or model. The class or model is the final result of the operation.

4.3 Regular Checking Flow



Figure 4.3: Regular Checking Block Diagram

Figure 4.3 illustrates the flow of regular checking. The regular checking is using Scheduler library. The library will be running background all the time when the application is running. It will check the current date and current time based on defined interval which is 2 A.M. of the day. If it is the Monday of the week, jobs of the Scheduler will be run. Jobs are to perform checking on number of programme, compare programme list, and checking on the web scraping and data analysis algorithm. The result of the checking will be recorded into database.

4.4 API Flow



Figure 4.4: Overall API Block Diagram

The figure above demonstrates the overall API block diagram. The API will only be triggered when the front-end sends an API request with request data. The API function will be triggered based on the API address where the route is defined in the link. The functions in the API will be triggered and the program will run the functions. The program will then return the result to the API. If error exists within the function, the error will be recorded into database and the response of the function will be set as the error message with the error status code. Lastly, the API will return the result as the API response. In addition, the data in the request body and response body is in the form of JSON.

4.5 Web Application Flow

4.5.1 Application System Flow



Figure 4.5: Application System Flowchart

Figure 4.5 demonstrates on the operation of the web application and it includes important features.

As a web application, the starting point for users is the home page of the application. Users can choose the action to perform on home page. The actions are search programme, access recommendation system, view favourite list, view viewed history list and contact us.

For the search programme action, users have to enter searching criteria to perform searching operation. Then, a list of search result will be displayed. Users can choose to view the details of a programme. The detailed programme information will show to users in another webpage. If there is an error occurred when obtaining programme information, the system will record the error into database followed by redirecting users to error page. Otherwise, the system will automatically record the programme into viewed history list. Meanwhile, users can choose to export programme, add the programme to favourite and remove the programme from favourite list. The exported programme will be saved as a PDF file on users' device. In addition, the detailed flow of searching and viewing programme will be described in the following sections.

For the recommendation system, it will display a list of questions to let users to answer when users navigated to the webpage. Based on users' answer, the system will determine the suitable area of studies and the result will be displayed to users. The recommendation system is built using rule-based AI. It determines suitable area of studies based on the personal characteristic and hobbies.

There is the same for viewing favourite list and viewed history list. Once users choose to view the list, the system will redirect them to the particular webpage and show the list to users. No further actions required.

Users can choose to contact with the system by navigation to Contact Us webpage. The webpage will display the contact information to users. If users want to send enquiry, users have to fill in enquiry form and click the send button. Then, the system will send the enquiry in a form of email to the system email address. A complete message will be shown afterwards.

The following sub-chapters will describe about the design of core functions detailed especially the function that connecting with API by using block diagram for in-depth operation visualization.



4.5.2 Home Page - Get Location API Workflow

Figure 4.6: Get Location API Block Diagram

Based on the figure above, the web application will invoke API to get the locations that exists in the system database when users visit the web application. System backend will execute the functions stated in the related API and get the result. The result is then returned to the front-end. Front-end will put the locations into location drop-down box.



4.5.3 Search Programme Flow

Figure 4.7: Search Programme Block Diagram

Figure 4.7 elaborates the block diagram of search programme. Before searching the programme, the system will find the number of programme that match to the result. It is used to perform pagination function in order to enhance the system performance. After pagination has done, the front-end will invoke search programme API with users' search criteria as request body and the backend will receive the request. Therefore, the functions defined in search programme API will be invoked and the API will return the result get from the functions to front-end. Then, system front-end will display the list of result with programme summary which the information is the response returned by the API call.

4.5.4 View Programme Flow



Figure 4.8: View Programme Block Diagram

View programme flow is elaborating on the figure above. When users have chosen to view the detail information of a particular programmme, the system will invoke get programme information API with required parameters as request body which the parameter of the API will be process by the system automatically. The system backend will process the API request and return the information of the programme as the response data. The front-end will check the response status code to identify whether the request is success or failure. If it is failed, then users will be redirected to an error page. Otherwise, the front-end will try to render the API response data on the webpage. If no error exists, the programme information will be displayed to users in predefined template. However, if the front-end is failed to render the information, then it will invoke an API to record the error into database. After the action has done, users will be redirected to an error page.



4.5.5 Recommendation System – Rule Based AI System

Figure 4.9: Recommendation System Block Diagram

Recommendation system flow is elaborated on the figure above. Users has to answer the questionnaire. The answers are the input for the recommendation system. The recommendation system adopts rule-based AI system. Thus, it will determine the output based on the input in the if-else statements in the system. Based on rules, output or the area of studies will be produced.

CHAPTER 5: SYSTEM IMPLEMENTATION

CHAPTER 5: SYSTEM IMPLEMENTATION

5.1 Hardware Setup

The hardware used to develop the system as follows:

Operating System	Windows 10 64-bit
Processor	AMD Ryzen [™] 7 4800HS @ 4.2 GHz
RAM	16GB DDR4-3200
Graphic Card	NVIDIA® GeForce® GTX 1660Ti with Max-Q Design

Table 5.1 Laptop Hardware Specification

5.2 Software Setup

The database chosen for this project is MySQL. It is an open-source DBMS and has good data security, compatibility, and reliability. It is platform-independent and can run on any OS. Other than that, MySQL supports transactional processing with high performance and even deals with many queries [17]. The database will store the last updated date of each web page to ensure the web scraping algorithm is updated with the latest web page HTML DOM structure.

Next, the software and applications used to build the system are as follows:

i. Anaconda Navigator/ anaconda3

Anaconda Navigator is a GUI tool that consists of Anaconda distribution. It allows users to run their applications and allows the channels, packages, and environments to be managed in an easier way without using any command-line commands. The navigator is able to look for packages in Anaconda Cloud or in Anaconda's local repository [26]. The software will be used to manage the packages used in this project easily.

ii. Jupyter notebook

Jupyter notebook is an open-source web application that enables users to build Python-based programs. It can be used to perform machine learning, statistical modelling, data visualisation, etc. [27]. As it has a friendly interface, it will be used to demonstrate codes in this project.

iii. XAMPP

XAMPP is an open-source, cross-platform web server with abbreviations for cross-platform, Apache, MySQL, PHP and Perl. It helps programmers test their programs on a local web server [28]. XAMPP will be used to manage the local MySQL database server in this project.

iv. Visual Studio Code

Visual Studio Code is a lightweight source code editor that allows users to code debugging and work with Git. The library in Visual Studio Code is extensible and customisable. It provides high flexibility to developers to run their applications. Moreover, it allows developers to host the project in a variety of programming languages and frameworks and deploy the application on Microsoft Azure [29].

v. MySQL Workbench

MySQL Workbench is a visual database design tool that integrates the MySQL database system into a development environment. It permits for designing, developing, administrating, data migrating, etc [30]. In this project, a local database will be managed with the software.

vi. Postman

Postman is an API platform for creating and using APIs. Postman simplifies steps of the API lifecycle and streamlines collaboration so developers can build APIs faster [31].

In this project, Python programming language is chosen to develop the web application's backend, while Beautiful Soup library has been chosen to perform web scraping. Flask is the web framework chosen. The packages and libraries required to build the system are as follows:

i. Beautiful Soup – beautifulsoup4 (BS4)

Beautiful Soup is a Python library to perform real-time data pulling from HTML and XML files. It can be used to extract specific information from a web page [9]. BS4 is chosen to perform web scraping in this project. It allows for retrieval of the latest information from the web page and displays the information to users without saving a large volume of data in the database. This web scraping tool was chosen because it is beginner-friendly, and the size of the proposed project is small, so there is no need for an extensive library to support it.

ii. Flask

Flask is a Python micro web framework that allows users to build web applications. It is lightweight and provides essential components for building a web application quickly and efficiently. Flask is chosen due to its flexibility and simplicity in codes writing. Besides, it can be used with Jinja2, a template engine that allows users to write inline expressions in HTML files for rendering dynamic contents [16].

iii. Flask-RESTful

Flask-RESTful is a simple and easy extension for Flask that adds support for constructing REST APIs quickly. It allows users to parse arguments to their resources, format output, and manage the routing setting with a clean interface [32].

iv. Flask-CORS

Flask-CORS is a simple Flask extension to handle Cross-Origin Resource Sharing (CORS). Using this library allows users to enable CORS for all domains on all routes [33].

v. Requests

Requests library enables users to make HTTP requests in a simpler manner and is more human-friendly in Python. Therefore, users can focus on interacting services provided as the library abstracts the complexity of making HTTP requests [34].

vi. MySQL Connector - mysql

MySQL Connector enables a Python program to interact with a MySQL database. It offers all services required to handle the database [35]. There is a MySQL database in this project. Thus, it requires a connector to establish a connection between the Python program and the database.

vii. webdriver-manager

It is main to simplify management of binary drivers for different browsers. It can used to control the browser by directly communicating with it [36].

viii. Selenium

Selenium is an open-source automated testing framework used to validate web applications across different browsers and platforms. It is a heavy library so it is only be used to scrap the website that require to accept cookies and has to have JavaScript enabled when request library can't access website successfully due to lack of suitable header while it is rendering [37].

ix. Schedule

It is an easy-use API to schedule jobs including periodic jobs without any extra processes needed. It is a lightweight library and been used for scheduling system tasks to execute regularly [38].

Other than that, the project's front-end will be developed using HTML, CSS, and Bootstrap 5. The chosen front-end framework is AngularJS. No special software is required.

Before starting the project, some libraries are required to install to Anaconda Navigator. The commands and details are in the table follows:

Library	Command	Remark						
Beautiful Soup / bs4	sudo pip install beautifulsoup4	Web scraping tool						
Flask	pip install Flask	Web application framework						
Requests	pip install requests	HTTP library						
Flask-CORS	pip install flask-cors	Flask extension for CORS						
Flask-RESTful	pip install flask-restful	Flask extension for RESTful						
		APIs						
pymysql	pip install pymysql	Pure python MySQL driver						
webdriver-manager	pip install webdriver-manager	Simplify management of binary						
		drivers for different browsers						
Selenium	pip install -U selenium	Automate web browser						
		interaction						
schedule	pip install schedule	For scheduling jobs						

Table 5.2: Python Libraries Require to Install

CHAPTER 5: SYSTEM IMPLEMENTATION

Installed	✓ Channels Update index Search Packages Q
Name 🗸	T Description
🗹 beautifulsoup4	O Python library designed for screen-scraping
🗹 flask	O A microframework based on werkzeug, jinja2 and good intentions.
flask-cors	N flask extension adding a decorator for cors support
🗹 flask-restful	÷
ymysql	O Pure python mysql driver
V requests	O Requests is an elegant and simple http library for python, built with •.
schedule	n
🗹 selenium	O Python bindings for the selenium webdriver for automating web browse
vebdriver-manager	e

Figure 5.1: Installed packages in Anaconda Navigator

The figure above shows the installed packages in Anaconda Navigator.

5.3 Setting and Configuration

5.3.1 Flask Configuration

```
if __name__ == '__main__':
    app.run()

* Serving Flask app "__main__" (lazy loading)
* Environment: production
    WARNING: This is a development server. Do not use it in a production deployment.
    Use a production WSGI server instead.
* Debug mode: off
* Running on http://127.0.0.1:5000/ (Press CTRL+C to quit)
```

Figure 5.2: Flask application URL

As the figure above, the URL and port number of the application is using the default one which is 127.0.0.1 as IP address with port number 5000. There is no additional setting on the hosting address and port number. If additional setting is needed, the code can be modified based on needed. For example, app.run(host="0.0.0.0", port=8080). The host parameter indicates the address and the port parameter indicates port number. Therefore, the address will be http://0.0.0.08080/ in the example given.

5.3.2 API Configurations



Figure 5.3: API Configutation

Figure above shows API configuration. CORS(app) is uses to enables CORS support on all routes. Therefore, all CORS headers on a per-resource level is able to parameterize. In short, it permits CORS for all domains on all routes.

API Route

i.

<pre>.add_resource(getProg, '/getProg')</pre>
<pre>.add_resource(getSearchProg, '/searchProg')</pre>
<pre>.add_resource(getLocation, '/getLocation')</pre>
<pre>.add_resource(getNoProg, '/getNoProg')</pre>
<pre>.add_resource(updateProgErr, '/updateProgErr')</pre>

Figure 5.4: API Route Configuration

Based on the figure above, there are 5 APIs created in the system. There are getProg, searchProg, getLocation, getNoProg and updateProgErr. Each API consists of its dedicated route, request data, response data and HTTP method.

- getProg
 Route: /getProg
 HTTP method: GET
 Request data: uni, link and summary
 Response data: Information of a programme
- ii. getSearchProg

Route: /getSearchProg HTTP method: GET Request data: lvl_of_study, location, search, page

CHAPTER 5: SYSTEM IMPLEMENTATION

Response data: List of programmes based of search terms

iii. getLocation

Route: /getLocation HTTP method: GET Request data: N/A Response data: Existing locations of programmes in the database

iv. getNoProg

Route: /getProg

HTTP method: GET

Request data: lvl_of_study, location, search, page

Response data: Number of programme based on search terms

v. updateProgErr

Route: /updateProgErr

HTTP method: POST

Request data: uni_name, prog_name, link_prog, error_msg

Action: record log of the error and update condition of the programme

5.3.3 Database Setup

```
CREATE DATABASE MPUAS;
  USE MPUAS;
CREATE TABLE university(
       uni_name VARCHAR(50),
       other_name VARCHAR(100),
no_of_prog INT(3) NOT NULL,
#new_no_of_prog INT(3),
       uni_key VARCHAR(20) PRIMARY KEY
 L);
CREATE TABLE programme(
       uni_name VARCHAR(50),
       prog_name VARCHAR(150),
        #hash_prog MEDIUMTEXT NOT NULL,
        #new_hash_MEDIUMTEXT
        condition_prog INT(1) NOT NULL DEFAULT 1,
        link VARCHAR(300),
        lvl_of_study VARCHAR(20),
        location VARCHAR(100),
        PRIMARY KEY(uni_name, prog_name, link),
        FOREIGN KEY (uni name) REFERENCES university(uni key)
   );
CREATE TABLE log(
id BIGINT(7) PRIMARY KEY AUTO_INCREMENT,
        uni_name VARCHAR(20) NOT NULL,
        prog_name VARCHAR(150),
       link_prog VARCHAR(300),
remark VARCHAR(10000),
       error_msg VARCHAR(300),
is_checked INT(1) NOT NULL DEFAULT 0,
created_date TIMESTAMP DEFAULT NOW(),
        FOREIGN KEY (uni_name) REFERENCES university(uni_key),
FOREIGN KEY (prog_name) REFERENCES programme(prog_name)
 L);
```

Figure 5.5: Database Creation

The figure above displays the SQL queries to a database and the entities required by system implementation. A database named "MPUAS" has been created and followed by 3 database tables.

5.4 Implementation of System

Based on the comparison performed in chapter 2.2.4, this project's chosen web scraping tool is Beautiful Soup. The web application is proposed to present the result of the product of analysed information on scraped data. The web application can provide much convenience to users. It is not device bundled and can be accessed on both mobile devices and computers according to needs and situations. In order to allow the web application to access the information, Flask RESTful API will be developed. Therefore, the web application is able to communicate with the backend functionality. MySQL database is chosen in the project. Furthermore, the web application will be built using Angular JS framework and Bootstrap framework.
5.5 System Operation

5.5.1 Web Scraping and Data Analysis Operation

Model Creation

```
class Programme:
    def __init__(self, uni, name, description, duration, intake, fee, medium, campus, faculty, career, requirement, progStruc, admission ="""):
        self.uni = uni
        self.name = name
        self.duration = duration
        self.duration = duration
        self.intake = intake
        self.intake = intake
        self.fee = fee
        self.medium = medium
        self.campus = campus
        self.faculty = faculty
        self.requirement = requirement
        self.requirement = requirement
        self.progStruc = progStruc
        self.admission = admission
```

Figure 5.6: Snippet of Programme Class/Model

The figure above shows the definition of Programme class which is the data structure for undergraduate programmes.

Web Scraping and Data Analysis Algorithm

There is a request handling function to handle user requests. It will determine which information of the university is requested and return it in the form of Dictionary data type.

The function of web scraping and data analysis algorithm of university's programme will be trigger when requesting to obtain information of UTAR undergraduate programme. Different universities have different algorithm to obtain required information. The execution of the function will be demonstrated in the following.

Successful Web Scraping Operation

<pre>from getProg import get_Prog get_Prog("utar", "https://study.utar.edu.my/computer-engineering.php", 0)</pre>
{'uni': 'UTAR', 'name': 'Bachelor of Information Technology\xa0(Honours) Computer Engineering', 'description': ['Embedded systems consist of "invisible" computer and related peripherals hidden inside a product, which exist in almost every aspect in our lives. We use embedded systems in washing machines, cars, factory automation machines, security alarm systems, smart phones, satellites and etc. Ubiquitous computing and Internet of Things (IoT) are future trend that greatl y enhances our life, due to the rapid advancement of embedded systems design technology.', 'The programme prepares graduates to be competent in the discipline of Electronic Systems Engineering with Computing, particu larly driving the information and communication technology (ICT). It emphasis design skills and knowledge that integrates both hardware and software into a system with application in Programming, Computer Architecture, Embedded System Design and Computin g,\xa0Digital Signal and Image Processing, Intelligent System and Networking, which supports Information Technology.', 'The programme is to produce graduates with skills in using sophisticated software design tools for designing electronic syst ems. To break away from the theory-based traditional learning style, we tend to emphasis more on practical design work, to put
<pre>theory into practice. j, 'duration': ['3 years (Full-time)'], 'intake': 'January, May, October', 'fee': ['RM45,950 (Malaysian)', 'RM62,550 (International)'], 'medium: ['Econjtech']</pre>
<pre>"ecutum : ['Inglish], 'campus': ['Kampar'], 'faculty': 'Faculty of Information and Communication Technology\xa0(FICT)', 'career': ['Computer Engineer', 'career': ['Computer Engineer',</pre>
<pre>impodudu System(Xadengineer', 'System-On-Chip Design Engineer', 'Validation Engineer Test Engineer', 'Software/Hardware Test Engineer', 'Software Programmer/Developer',</pre>
'Internet-of-Thing Developer', 'Firmware Engineer', 'Digital Design Engineer', 'IT Support Engineer', 'Maintenance & Project Engineer', 'IT Technical Customer Service Consultant'],
requirement : [SIPM WiTh 2 Grade CNDK\NA-Level WiTh 2 Grade D\NDK\NSOUTH AUSTRALIAN MATRICULATION (SAM) with an Australian Tertiary Admission Rank (ATAR) 70 and Grade B in 2 subjects\nOR\nCanadian Pre-University (CPU) with an average of 70% in 6 subj ects\nOR\nUnified Examination Certificate (UEC) with Grade B in 5 subjects\nOR\nFoundation in Science, Universiti Tunku Abdul R ahman (UTAR)\nOR\nFoundation from other Institutions of Higher Learning in the relevant field\nOR\nMatriculation Certificate, M

Figure 5.7: Successful Case of Web Scraping and Data Analysis Operation

The figure above illustrates the success web scraping and data analysis on a UTAR undergraduate programme. The primary information request to execute the algorithm is university name and programme name. The figure demonstrates the successful case with Bachelor of Information Technology\xa0(Honours) Computer Engineering subject which offered by UTAR. The function will return the analysed information in the form of Dictionary.

Unseccessful Web Scarping Operation



Figure 5.8: Unsuccessful Case of Web Scraping and Data Analysis Operation

The figure above shows the unsuccessful obtaining data using defined web scraping and data analysis algorithm. As per the figure, no information of the programme is returned as well as the error will be recorded into log table of database. As an example, the link given to scrap is invalid, therefore the web scraping library cannot get information of the programme. The correct link should be "https://study.utar.edu.my/cpmputer-engineering.php". An "o" is missing in the URL.

Errors may occur if:

- a. The link is invalid or inaccessible.
- b. No such university exist where either the name of the university is wrong or the university is not under the project coverage.
- c. The algorithm is outdated.
- d. The university website is currently down.

5.5.2 RESTful API operation

```
class getProg(Resource):
    def get(self):
             uni = request.args.get('uni')
link = request.args.get('link')
             summary = request.args.get('summary')
             isSummary = False
if(summary == "1"):
    isSummary = True
             try:
    response = get_Prog(uni, link, isSummary)
except Exception as e:
                       t exception as e:
data = {'uni_name': uni, 'prog_name' : "", "link_prog": link, "remark": "BACKEND - Get programme error", "error_msg
dbController("update_prog_error", data)
                    response = app.response_class(response={"success": 0, "message":"ERROR OCCURED", "error" : str(e)},
                                                        status=500,
                                                        mimetype='application/json')
             return response
api.add_resource(getProg, '/getProg')
api.add_resource(testing, '/testing')
api.add_resource(getSearchProg, '/searchProg')
api.add_resource(getLocation, '/getLocation')
api.add_resource(getNoProg, '/getNoProg')
api.add_resource(updateProgErr, '/updateProgErr')
                     -- '__main__':
if name
       app.run()
4
 * Serving Flask app "__main__" (lazy loading)
* Environment: production
WARNING: This is a development server. Do not use it in a production deployment.
      Use a production WSGI server instead.
  * Debug mode: off
* Running on http://127.0.0.1:5000/ (Press CTRL+C to quit)
127.0.0.1 - - [02/Sep/2022 22:26:03] "GET /getProg?uni=utar&link=https://study.utar.edu.my/computer-engineering.php&summary=0 H
TTP/1.1" 200 -
```

Figure 5.9: Snippet for /getProg API and its Route

The code snippet shown in the figure above is the API coding and a successful run of the /getProg route of the RESTful API with HTTP GET request type. When a user accesses the link, the API will return the response based on the request parameters given in the link. If the request processes failed, the API will response with fail status code with error message. In addition, the successful operation of API proves the successful implementation of flask framework.

Successful to process function in API



Figure 5.10: Successful Case of API Call to Get Programme Information

The figure above shows how to access the API via client side. It illustrates the successful case with /getProg route to obtain programme information. The API will trigger the web scraping and data analysis algorithm. The default localhost link of the Flask application is "http://127.0.0.1:5000". The link is followed by the API path "/getProg" and the parameter. The data after "?" in the link are the parameter sent to the API along with the request.

The scraped and analysed information is the API response which returned in JSON format. As a result, the API enables us to access and trigger the function using a URL and then we are able to access the desired information.

Unsuccessful to process function in API

POS	T h POST h GET htt	GET htt	No Environment 🔹 💿 🛬
▶ ht	tp://127.0.0.1:5000/getProg?uni=utar&link=ht	tps://study.utar.edu.my/computer-engineering.p.	Examples 0 🔻 🛛 BUILD 🥖 📮
GET	. v http://127.0.0.1:5000/getProg?uni	utar&link=https://study.utar.edu.my/cmputer-enginee	ring.php&su Send 🔻 Save 🔻
Para	ms • Authorization Headers (6) Bo	ly Pre-request Script Tests Settings	
Que	ry Params		
	KEY	VALUE DES	SCRIPTION •••• Bulk Edit
~	uni	utar	
~	link	https://study.utar.edu.my/cmputer-engineering	
~	summary	0	
Body	Cookies Headers (5) Test Results	Status: 500 INTERNAL SERVER ERROR	Time: 249 ms Size: 214 B Save Response 🔻
Pre	tty Raw Preview Visualize JSON	• III	E Q
1	successmessageerror		

Figure 5.11: Unsuccessful Case of API Call to Get Programme Information

The figure above shows the unsuccessful obtaining data from an API call. It will response will "500 Internal Server Error" status and status code with error message. As an example, the link value of the API call shown in the figure 5.7 is inaccessible where the correct link should be "https://study.utar.edu.my/cpmputer-engineering.php". An "o" is missing in the URL.

The API call might response error if:

- a. when using the service in Postman:
 - parameter value of uni does not exist in the system
 - parameter value of link is not accessible
 - parameter value of summary is not 0 or 1
 - web scraping and data analysis algorithm is not working
 - internal server error
- b. when using the service on the web application:
 - web scraping and data analysis algorithm is not working
 - internal server error

5.5.3 Database Operation

Database - MySQL

<pre>import mysql.connector</pre>
<pre>mydb = mysql.connector.connect(</pre>
user="root",
password="",
database="MPUAS"
)

Sample and testing

mycursor = mydb.cursor() mycursor.execute("SELECT * FROM log ORDER BY id DESC")										
<pre>myresult = mycursor.fetchall()</pre>										
<pre>for x in myresult: print(x)</pre>										
(27, 'utar', '', 'https://study.utar.edu.my/cmputer-engineering.php',	'BACKEND - Get programme error', "'NoneType' object has									
<pre>(26, 'utar', ', 'https://study.utar.edu.my/cmputer-engineering.php', no attribute 'text'", 0, datetime.datetime(2022, 9, 3, 1, 11, 17))</pre>	'BACKEND - Get programme error', "'NoneType' object has									
(25, 'utar', '', 'https://study.utar.edu.my/cmputer-engineering.php',	'BACKEND - Get programme error', "'NoneType' object has									
(24, 'utar', '', 'https://study.utar.edu.my/cmputer-engineering.php',	'BACKEND - Get programme error', "'NoneType' object has									
<pre>no attribute text", 0, datetime.datetime(2022, 9, 2, 22, 48, 52)) (23, 'utar', '', 'https://study.utar.edu.my/cmputer-engineering.php', no attribute 'text'", 0, datetime.datetime(2022, 9, 2, 22, 48, 43))</pre>	'BACKEND - Get programme error', "'NoneType' object has									

Figure 5.12: Database Operation

The figure above demonstrates the success database operation. As shown in the figure, the database username is root and no password. The database name of the system is MPUAS. Logs of the database is selected and arranged based on latest record to show the operation of the database. As the result, there are few records of the same error is shown. The error is unable to access to a UTAR programme with the error message. These errors or logs are being inserted in order to show the system operation above. In addition, there are 3 database table in the system which as described in chapter 3.2.5.

5.5.4 Recheck Operation

<pre>def job(): if date.today().day != 1: return</pre>	
<pre>get_proglist("utar",0,1) get_proglist("taylor",0,1) get_proglist("ucsi",0,1) get_proglist("segi",0,1) get_proglist("sunway",0,1) get_proglist("uniten",0,1) get_proglist("unikl",0,1) get_proglist("utp",0,1) get_proglist("nottingham",0,1)</pre>	

Figure 5.13: Code Snippet of Recheck Operation

The code snippet in the figure above shows the function of recheck operation. The operation will be triggered automatically on Monday of the week. If the function is triggered to recheck, it will perform the checking on each university one by one. The result of checking will be recorded into log table of database.

<pre>from getProgList import get_proglist get_proglist("utar",0,1)</pre>
SELECT * FROM programme WHERE uni_name = 'utar' Total number of rows in table: 78 MySQL connection is closed 78 78 scrap_not_in_list []
db_not_in_list []
INSERT INTO log (uni_name, prog_name, link_prog, remark, error_msg) VALUES (%s, %s, %s, %s, %s) 1 was inserted. MySQL connection is closed

Figure 5.14: Trigger Recheck Operation

The figure above shows the manual trigger of recheck operation on UTAR programmes. As the result of checking, the programme list of UTAR is the same with the system database as well as the information of every programme is scrapable where the algorithm is performing well. The report or result of the checking is recorded into database as shown in the figure below.

(21, 'utar', '', '2022-08-29 00:35:53.631757 | Compared programme list of utar,: Nothing has changed.', '', 0, datetime.d atetime(2022, 8, 29, 0, 35, 53))

Figure 5.15: Log Record of Checking Result



5.5.5 Programme Searching and Viewing Interface Operation

Figure 5.16: Home Page of System's Web Application

The figure above shows the home page of the web application. The home page consists of 3 textboxes which allows user to search programme. As in the figure, any programme having similar text as filled in value in programme textbox, "Computer Science", undergraduate specification level and the location of the campus is in Selangor will be the terms to search for related programmes. In addition, the locations exist in the database are the selection in the location drop-down box.

Filter options	Bachelor in Computer Science (Hons)
IAI Programme Computer Science	MSU Programme Summary
Specification Level Vundergraduate	Details
♥ Location Selangor	Computer Science BSc (Hons)
Search	Nottingham Programme Summary
	Details
	Computer Science with Artificial Intelligence BSc (Hons) Notingham Programme Summary Details
	Bachelor of Computer Science (Honours) in Cybersecurity SEGi Programme Summary Details

Figure 5.17: Search Result

The figure above depicts the search results. All the related programmes will be shown in the search result page. User can obtain detailed information of a programme by clicking the blue "Details" button. In addition, there are limited to show only 10 results in a page, while other results will be displayed on other pages which can be navigated by clicking the page number as shown in the figure below.



Figure 5.18: Search Result Page's Pagination



Figure 5.19: View Programme Page

The information of the programme will be shown in view programme page as the figure above. The scraped and analysed data will be obtained by utilizing API. Then, AngularJS, the frontend framework, will place the relevant information to their sections correspondingly.

Export Programme

Bachelor of Science ×								
Entry Requirement:								
STPM / Matriculation / A-Level / Pre-University / Foundation C (2.50 CGPA) in Biology/Physics and Chemistry								
SPM or equivalent CREDIT or equivalent in five (5) subjects including three (3) from Biology, Physics, Mathematics, Chemistry, English								
Diploma (MQF Level 4) in a related field 2.50 CGPA; CGPA below 2.50 may be supported by at least two (2) years (24 months) working experience in a relevant field OR								
South Australia Matriculation (SAM) At least 65-70% of the aggregate or TER / UAI 75 OR								
Canadian Pre-University (CPU) At least 80% aggregate OR								
Unified Examination Certificate (UEC) Grade B in five (5) subjects OR								
Other qualifications recognized as equivalent by the Government of Malaysia.								

Figure 5.20: Exported Programme File

Figure 5.20 displays the exported file of a programme. The information of the viewing programme will be exported as a PDF file if the user wants to export the programme information. The information that showing on the webpage will also be written in the PDF file. It demonstrates the successful operation of exporting function.

5.5.6 Recommendation Operation



Figure 5.21: Questionnaire

As shown in the figure above, there is a list of question to answer in order to use the recommendation system. The answers will be used to determine the suggested fields to study. Results of the recommendation will be shown in a Bootstrap modal as displayed as in the figure below. The sample programmes of the suggested area of studies will be displayed as well.



Figure 5.22: Result of Recommendation System

5.5.7 Enquiry Operation

Address: Ipoh, Perak, Malaysia	Agnes
Phone: +60-123456789	karwailai@ymail.com Test Operation - Title
Email: karwailai@1utar.my	Test Operation - Messgae
	Send Message

Figure 5.23: Enquiry Form

The figure above shows the enquiry form. After sending the enquiry, the system will receive an email about the enquiry as shown in the figure below. Then, a successful message will be shown to the user.

• CS MPUAP <karwailai@1utar.my> To: karwailai@1utar.my</karwailai@1utar.my>	
A message from Agnes Email: karwailai@ymail.com	
Subject: Test Operation - Title Test Operation - Messgae	

Figure 5.24: Email Received by the System

5.5.8 Favourite List Operation



Figure 5.25: Favourite List

The figure above illustrates the favourite list of the user. There are few programmes been added into the user's favourite list.

5.5.9 Viewed History List Operation

Logo	Keepvid video dow,	📕 intern 📕 Mining	Learning 'V Applair Validation , 🏚 2018/98/86/88. 1/P 💩 1976 av Home Recommendation Favourite List H	malCitatio, listory Co	ontact U:
Show 10 🗸	entries Programme Name	: Duration	Search: Fee :	Location	Search
Nottingham	Computer Science BSc.(Hons)	Full-time: 3 years Part-time: Not available	Malaysian fee: RM42,000 per year International fee: RM49,000 per year	Selangor	9/3/2022, 2:26:33 AM
UTAR	Bachelor of Arts (Honours) Chinese Studies.	3 years (Full-time) 6 years (Part-time)	RM43,650 (Malaysian); RM46,100 (Part-time, Malaysian) RM59,800 (International)	Kampar	8/29/2022, 1:43:57 AM
SEGi	Bachelor of Mass Communication (Hons)	N/A	RM 63,755	SEGi University	8/29/2022, 12:37:41 AM
MSU	Bachelor of Science in Pharmaceutical Technology (Honours)	3.5 years	RM80,000 - RM85,000 'The stated fees are estimation on overall completion of the program. In any cases where there are credit exemptions, offered rebates or approval of scholarship applications, there the considerable reduction in the fees The fees stated here are for Malaysians or local students roly. Kindly refer to NSU regarding the fees for international students The fees stated here are for Malaysians or local students only. Kindly refer to MSU regarding the fees for international addents only. Kindly refer to MSU regarding the fees for international	Shah Alam	8/28/2022, 3:54:04 AM

Figure 5.26: Viewed History List

The figure above illustrates the viewed history list of the user. There are a list of programmes been viewed and thus many programmes are added into the user's viewed history list.

6.1 System Testing Evaluation

Throughout the early phase of development, it has been found that the most common cause which will lead the program scraps incorrect data is due to the logical error within the code. The error is difficult to identify since logical errors will not throw or raise exceptions and will not terminate the program. Therefore, much of the time is spent on reviewing the code and test it for times with different input to ensure correctness of data and algorithms.

Besides, there is an exception that often encountered during the execution of the program which is "AttributeError: 'NoneType' object has no attribute <HTML tag>". The reason of the error is due to unsuccessful scrap of data on the URL given. This may due to either the website is currently down or the web scraping and data analysis algorithm is out to date where the website has updated their HTML DOM structure. In the latter case, the algorithm has to be updated to match the latest HTML DOM structure. The error will lead to termination of program. Therefore, catching exception is applied and counter action is implemented which is the system will record the error into database and redirect users to error page if such issue occurs. The recorded error is to let developers know about the error, so they can debug and fix the error.

Moreover, testing on each flow of the web application is required to ensure the web application can run smoothly. Testing on connection between frontend and backend is the essential testing has to be done for the web application. It is also to ensure the features implemented are performing well and ensure how well the web application can handle if error occurred.

6.2 Testing Setup and Result

6.2.1 Web Scraping and Data Analysis Algorithm Testing Result

This sub-section will describe the testing on web scraping and data analysis algorithm. The figures below will be showing the result of performing the operation with 10 universities that covered by this project. Since different universities having different interface to show information, testing for all universities is required. The testing will be done on Jupyter Notebook to invoke the operation directly. The testing results of each university are placed in Appendix B.

6.2.2 API Testing Result

There are few APIs are implemented in the system where the details been described in chapter 5.3.2. Testing for APIs will be done by invoking all APIs one by one using Postman. There are 5 APIs implemented. The figures below will be showing the testing result of performing the operation with all 5 APIs developed with different scenarios.

GE	г	→ http://	'127.0.0.1:5000/getL	ocation	1				Send	Save 🔻
Para	ims	Authorization	Headers (6)	Bod	y Pre-request Script	Tests	Settings			Cookies Code
Que	ry Para	ams								
	KEY				VALUE			DESCRIPTION		••• Bulk Edit
Body	Cook	kies Headers (5) Test Results				¢	🕽 200 ОК 1545		Save Response 🔻
Pr	etty	Raw Previ	ew Visualize							🖻 Q
[] "" Se	["Alor Gajah, Melaka", "Cheras, Kuala Lumpur, Selangor", "Dengkil, Selangor", "George Town, Penang", "Gombak, Selangor", "Ipoh, Perak", "Kajang, Selangor", "Kampar, Perak", "Kuala Lumpur", "Kuala Lumpur, Selangor", "Kuching", "Kuching, Sarawak", "Kulim, Kedah", "Masai, Johor", "Muadzam Shah, Pahang", "Petaling Jaya, Selangor", "Putrajaya", "Selangor", "Semenyih, Selangor", "Seri Iskandar, Perak", "Shah Alam, Selangor", "Sitiawan, Perak", "Springhill", "Subang Jaya, Selangor", "Sungai Long, Selangor", "Sunway City, Kuala Lumpur, Selangor"]									

Figure 6.1: Result of Invoking /getLocation API

GET		http://12	7.0.0.1:5000/getNo	oProg?lvl_of_:	study=undergraduate	&search=Compi	uter Science&locat	Send	•	Save	
Para	ms o Al	ithorization	Headers (6)	Body	Pre-request Script	Tests Se	ttings			Cookies	Code
	KEY			VALUE			DESCRIPTION			Bulk B	
~	lvl_of_study			under	graduate						
~	search			Comp	uter Science						
~	location			["Selar	ngor"]						
~	page			1							
Body	Cookies	Headers (5)	Test Results				🌐 200 ОК			e Respon	
Pre	tty Raw	Preview	Visualize	JSON 🔻	1						٩
1	45										

Figure 6.2: Result of Invoking /getNoProg API

GET			http://127.0).0.1:5000/searct	nProg?lvl_a	of_study=undergradu	ate&search=C	omputer	r Science&lo	Send	•		
Para	ms 🔵	A	uthorization	Headers (6)	Body	Pre-request Script	: Tests	Settin	gs				
	KEY				VALU	E			DESCRIPTION				
~	lvl_of_	study	,		unde	ergraduate							
~	search				Com	puter Science							
~	locatio	n			["Sel	angor"]							
~	page												
Body	Cooki	es	Headers (5)	Test Results					🌐 200 ОК 35			e Respon	
Pre	etty	Raw	<pre>/ Preview Incurct</pre>	Visualize ,000 - RM45,000 nah Alam, Selar ps://msu.edu.my	JSON ▼), *The st ngor", //faculty	tated fees are est	imation on o	overall ring/bac	completion of chelor-compute	the program. r-science.php		iny cases	Q s wher
11 12 13 14 15 16 17 18		{	"uni": "Nott: "name": " Cor "duration": ' "intake": "So "fee": "Malay "campus": "So "link": "http	ingham", mputer Science 'Full-time: 3 y eptember", /sian fee: RM42 emenyih, Selanq os://www.nottin	BSc (Hon: /ears, Pai 2,000 per gor", ngham.edu	s)", rt-time: Not avail year, Internation .my/ugstudy/course	able" , al fee: RM49 /computer-so	9,000 pe cience-t	er year", <u>bsc-hons</u> "				
19 20 21 22			"uni": "Nott: "name": " Cor	ingham", nputer Science	with Art:	ificial Intelligen		s)",					

Figure 6.3: Result of Invoking /searchProg API



Figure 6.4: Result of Invoking /getProg API

GET	r	•	http://127	7.0.0.1:5000/getP	rog?uni=	utar&l	ink=https://study.ut	ar.edu.my/	/cmputer-	engineering	Send	•	Save	•
Para	ms 🔍	Auth	orization	Headers (6)	Bod		Pre-request Script	Tests	Settin	gs				Code
	КЕҮ				v	ALUE				DESCRIPTION			Bulk Ed	
~	uni				ι	ıtar								
~	link				ł	ttps://	study.utar.edu.my/c	mputer-en	igineeri					
~	summa	ary			C									
Body	Cooki	es He	aders (5)	Test Results				500 I					Respons	
Pre	etty	Raw	Preview	Visualize	JSON		1							Q
1	suco	essme	ssageerror											

Figure 6.5 Exception Raised/Thrown During /getProg API Execution

The API will response error with 500 status code when the functions defined in the API are throwing an exception. The response notifies the failure of execution to front-end.



Figure 6.6: Result of Invoking /updateProgErr API

Qu	iery 1	SQL File	1	SQL File 2	Query 2 \times	Query 3	Query 4 (Query 5	programme	9	
		1 🖌 🛣	<u>A</u> () 🔝 🖽	0 8 5	3 🗹 🔍	1 7				
	1 • 2 3 4 5	SELECT	* FR	OM mpuas.log	LIMIT 30	, 10; = 4;					
<											>
Resu	ult Set Filte	r.			🚷 🛛 Edit:	🖌 🖦 🖦	Export/Import	Wrap	Cell Content:	👬 Fetch rows: 🔐 🖶	
	id	uni_name	prog	link_prog	remark			error_msg	is_checked	created_date	
►	31	utar		https://study.ut	BACKEND	- Get program	me error	'NoneTyp	0	2022-09-05 03:40:08	_
	32	utar		https://study.ut	FRONTEN	D API - Rende	r programme error	testing	0	2022-09-05 03:43:10	
	NULL	NULL	NULL	NULL	NULL			NULL	NULL	NULL	

Figure 6.7: Operation Done by Invoking /updateProgErr API

After update programme error API has been invoked, the error is recorded in the database as shown in the figure above. Since the API will only be invoked by frontend, so default remark information will be frontend error.

6.2.3 Regular Checking Testing Result

The checking is done by checking universities one by one. Since the regular checking has set to execute on 2.00 A.M. every Monday, so it will be tested by running the codes inside the Scheduler's tasks manually. The figures below show the testing result of performing the checking.



Figure 6.8: Test Run on Scheduler's Tasks

				💌 💌 🖄 💷 💌			
1 • SEL	ECT * FROM mp	uas.lo	g LIMIT	35, 20;			
sult Set Filter:			{}	idit: 🔏 🔜 🖶 Export/Import: 🏭 🌄 Wrap Cell Co	ntent: TA Fetch row	s 🗣 🐏	
id	uni_name	prog_n	link_prog	remark	error_msg	is_checked	created_date
36	utar			2022-09-05 14:50:08.070928 RECHECK Compared programme list of utar,: Nothing has changed.		0	2022-09-05 14:50:08
37	taylor			2022-09-05 14:50:17.521360 RECHECK Compared programme list of taylor,: Nothing has changed.		0	2022-09-05 14:50:17
38	ucsi			2022-09-05 14:51:49.290613 RECHECK Compared programme list of ucsi.: Nothing has changed.		0	2022-09-05 14:51:49
39	segi			2022-09-05 14:53:55.298474 RECHECK Compared programme list of segi,: Nothing has changed.		0	2022-09-05 14:53:55
40	sunway			2022-09-05 14:54:12.490053 RECHECK Compared programme list of sunway,: Nothing has changed.		0	2022-09-05 14:54:12
41	uniten			2022-09-05 14:54:20.454030 RECHECK Compared programme list of uniten,: Nothing has changed.		0	2022-09-05 14:54:20
42	unikl			2022-09-05 14:58:10.618545 RECHECK Compared programme list of unikl,: Nothing has changed.		0	2022-09-05 14:58:10
43	msu			2022-09-05 14:59:12.742508 RECHECK Compared programme list of msu.: Nothing has changed.		0	2022-09-05 14:59:12
44	utp			2022-09-05 14:59:14.335748 RECHECK Compared programme list of utp.; Nothing has changed.		0	2022-09-05 14:59:14
45	nottingham			2022-09-05 14:59:16.388589 RECHECK Compared programme list of nottingham,: Nothing has changed.		0	2022-09-05 14:59:16
NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

Figure 6.9: Log Recorded in Database

Figure 6.18 illustrates the test run on the tasks in Scheduler. All tasks in Scheduler are run. Figure 6.19 shows the result after running where the checking results are being recorded in the database one by one based on university.

6.2.4 Web Application Testing Result

Based on chapter 4.5.1, the web application has different flows based on user choice. Therefore, testing will be done on these flows in this section.



Programme Searching and Viewing Interface

Figure 6.10: Home Page of System's Web Application

The figure above shows the location is retrievable from database via API and the result has been added into drop-down list of location.

Filter options	Bachelor of Computer Science (Honours)						
In Programme Computer Science	UTAR V Programme Summary						
Undergraduate	Location: Kampar, Perak						
♥ Location Kampar, Perak	Intake: January, May, October Fee: RM45,950 (Malaysian),, RM62,550 (International)						
Search	Duration: 3 years (Full-time), 6 years (Part-time)						
	Details						
	Bachelor of Science (Honours) Agricultural Science						
	► Programme Summary						
	Details						
	Bachelor of Science (Honours) Biochemistry						
	► Programme Summary						
	Details						

Figure 6.11: Search Result

The figure above illustrates the search result. The web application success to get results from backend via API and show the result list in frontend in a proper view. Furthermore, the programme summary is retrievable for each programme.

Filter options	Details
IPI Programme Computer Science	Bachelor of Science (Honours) Food Science
Specification Level VIndergraduate	Programme Summ O top ▼ O top ♥ O O top ♥ O
♥ Location Kampar, Perak	Details http://127.0.0.1:5000/searchProg?lvl of study=undergraduate&search=Computer%20Science&location= ▶ Arrc (26) 15
Search	(1 2 » Perroy(10)
Home / Our Services / Search Pro	<pre>bgramme Result bgramme Result b</pre>

Figure 6.12: Search Result in DevTools

Figure 6.22 shows the search result in DevTools. The yellow circled part is the response from API which containing the search result list. The search result list is then used to render to user interface as described in figure 6.21. The red circled parts are about the pagination feature. There is a maximum number of 10 programmes can be shown in 1 page, so 15 programmes require 2 pages to show. It shows the correct operation of the pagination feature. UTAR's Bachelor of Computer Science (Honours) will be chosen to view.



Figure 6.13: View Programme Interface

Course Overview	Course Overview
Programme Structure	
Entry requirement	Computers are becoming part of our lives, changing virtually everything from the
Career Perspective	objects around us to the ways in which we communicate, travel, work, and play. The computer scientist of today will be the wizards of the future. They shape the future
Fee	by developing computational techniques, design systems, and develop solutions to build advance civilization. Computer science has now become a key enabler for
Duration	discovery and innovation in many other fields, making it a highly relevant course of study.
	The programme aims to prepare graduates who are technically competent in
	design, development and implementation of computing systems. Students will be
	equipped with suitable mathematical background and solid computing knowledge
	for analyzing, modeling and evaluating computing solutions. Student will be trained
	to possess strong analytical and critical thinking to solve problems by applying
	knowledge, principles and skills in Computer Science.

Figure 6.14: View Programme Interface

The figures above show the view programme interface. The information is being placed at the location in the template.



Figure 6.15: Programme Exists in Favourite List



Figure 6.16: Programme Not Exists in Favourite List

The circled star icon in figure 6.24 and figure 6.25 illustrates if the programme has been added to the user's favourite list. If the programme is not exist in the user's favourite list, the star icon is unfilled as in figure 6.25; If the star icon will be filled as in figure 6.24, the programme is in the user's favourite list. Users can simple add or remove the programme to or from favourite list by clicking the star icon. Programmes in the favourite list can be found in "favourtie.html" as shown as in the circled part of the figure below.

		Educat Revisit site, clos Upprot to remove watermark ar 1 download plan + 1 more t	My Favourite ion is not the filling of a pail, but the lighting of a fire where or received the statements and get to ensure the statements and get	o l
Show 10 v University	entries Programme Name	Duration	Search:	Location
SEGi	Bachelor of Mass Communication (Hons)	N/A	RM 63,755	SEGi University
Taylor	BACHELOR OF SCIENCE (HONS) IN ARCHITECTURE	3-year	Approximate Total Fees (Local Students): RM 121,130 Approximate Total Fees (International Students): USD 34,525	Subang Jaya
UTAR	Bachelor of Arts (Honours) Chinese Studies	3 years (Full-time) 6 years (Part-time)	RM43,650 (Malaysian); RM46,100 (Part-time, Malaysian) RM59,800 (International)	Kampar
UTAR	Bachelor of Computer Science (Honours)	3 years (Full-time), 6 years (Part-time)	RM45,950 (Malaysian); RM62,550 (International)	Kampar

Figure 6.17: Favourite List

Show 10 v	entries		Searc	h:	
0 University	Programme Name	Duration	Fee	Location	Search at
UTAR	Bachelor of Computer Science (Honours)	3 years (Full-time), 6 years (Part-time)	RM45,950 (Malaysian); RM62,550 (International)	Kampar	9/5/2022, 3:11:35 PM
Nottingham	Computer Science BSc (Hons)	Full-time: 3 years Part-time: Not available	Malaysian fee: RM42,000 per year International fee: RM49,000 per year	Selangor	9/3/2022, 2:26:33 AM
UTAR	Bachelor of Arts (Honours).Chinese Studies.	3 years (Full-time) 6 years (Part-time)	RM43,650 (Malaysian); RM46,100 (Part-time, Malaysian) RM59,800 (International)	Kampar	8/29/2022, 1:43:57 AM
SEGi	Bachelor of Mass Communication (Hons)	N/A	RM 63,755	SEGi University	8/29/2022, 12:37:41 AM
MSU	Bachelor of Science in Pharmaceutical Technology.(Honours)	3.5 years	RM80,000 - RM85,000 "The stated fees are estimation on overall completion of the program. In any cases where there are credit exemptions, offered rebates or approval of scholarship applications, there will be considerable reduction in the fees The fees stated here are for Malaysians or local students only. Kindly refer to MSU regarding the fees for international students The fees stated here are for Malaysians or local students only. Kindly refer to MSU regarding the fees for international students	Shah Alam	8/28/2022, 3:54:04 AM
UTP	Bachelor of Petroleum Engineering with Honours	Engineering : 4 years Science: 3.5 years Computing: 3.5/4	Local Student - Registration Fee (Non-refundable) 1,300.00 (to be paid when you accept the offer - for new students only) Total tuition fees (including estimated hostel fee for the whole duration of studies): 93,200.00 for Engineering programmes, 81,200.00 for Petroleum	Seri Iskandar, Perak	8/28/2022, 3:22:20 AM

Figure 6.18: Viewed History List

The figure above displays viewed history list. Based on the figure, it can be read that UTAR's Bachelor of Computer Science (Honours) programe which is chosen in search result list of figure 6.11 and viewed the programme as in figure 6.13 is the most recent programme the user viewed. The list is arranged based on the search time which displaying from the latest to the oldest.

🔇 Malaysia Private University Applic 🗴 🔇 Bachelor of Computer Science (H 🗴 🕂	– 🗆 X
 C ① File C:/Users/KarWaiLai/Downloads/Bachelor%20of%20Computer A A Games Powtoon Keepvid video dow Intern Mining Learning A 	IJ I k
\equiv Bachelor of Computer Sci 1 / 5 - 100% + 🕄 🖏	± 🖶 :

Bachelor of Computer Science (Honours)

UTAR

Computers are becoming part of our lives, changing virtually everything from the objects around us to the ways in which we communicate, travel, work, and play. The computer scientist of today will be the wizards of the future. They shape the future by developing computational techniques, design systems, and develop solutions to build advance civilization. Computer science has now become a key enabler for discovery and innovation in many other fields, making it a highly relevant course of study. The programme aims to prepare graduates who are technically competent in design, development and implementation of computing systems. Students will be equipped with suitable mathematical background and solid computing knowledge for analyzing, modeling and evaluating computing solutions. Student will be trained to possess strong analytical and critical thinking to solve problems by applying knowledge, principles and skills in Computer Science. In addition to that, the programme is designed to prepare graduates to possess skills for lifelong learning, research and career development in the area of ICT which includes skills such as communication, team, leadership and interpersonal skills and awareness of the social, ethical and legal responsibilities. Last but not least, students will be provided with entrepreneurial skill and exposed to real world challenges to broaden their horizon and career prospects. The programme offers 3 areas of specialization in Computer Science for students: (i) Artificial Intelligence Option (ii) Software Engineering Option (ii) Mobile Application Development Option.

Figure 6.19: Exported File

The figure above presents the exported file of UTAR's Bachelor of Computer Science (Honours) programme. The file is being exported as PDF format and save in the client's device. The exported file is containing all the programme information.



Figure 6.20: Error Page

When there is an error occurred when retrieving or display the programme information, the web application will redirect the client to the error page as shown in the figure 6.30. The error is triggered by modifying API request body value and thus the backend system will throw an exception as invalid API request value. In addition, the error will be recorded in the database as the figure below.



Figure 6.21: Error Recorded

Recommendation System

The recommendation system requires users to answer a list of question as figures sown as follows and the figures of questionnaire are displayed in Appendix B.



Figure 6.22: Recommendation Interface

	Based on your choices, we recommend studying:
	Accounting and Economic Business
The r	elavent programmes are:
Bache	elor of Accounting
Bache	elor of Economics
Bache	elor of Finance
Bache	elor of Business Administration
Bache	elor of Entrepreneurship
Bache	elor of Business Administration in Logistic and Supply Chain
Mana	gement

Figure 6.23: Recommended Areas of Studies

The system will determine area of studies based on the answers in the questionnaire. Then, suggested areas of studies and the related programme will be shown to users.

Recommendation System Verification

Verification of recommendation system can be done by using decision coverage test of white box testing. The testing is to test all decisions on the code and test the code that is executed based on the decision outcomes. Test cases of decision coverage test follows the control flows that occur from a decision point such as IF statement.

Contact Us Interface

Address: Ipoh, Perak, Malaysia	Agnes
Phone: +60-123456789	karwailai@ymail.com Test Operation - Title
Email: karvailai@1utar.my	Test Operation - Messgae
	% Send Message

Figure 6.24: Enquiry Form

The figure above shows the enquiry form with filled in messages. After sending the enquiry, the system will receive an email about the enquiry as shown in the figure below. Then, a successful message will be shown to the user. The testing shows the operation of performing enquiry is running well.

• CS MPUAP <karwailai@1utar.my> To: karwailai@1utar.my</karwailai@1utar.my>
A message from Agnes Email: karwailai@ymail.com
Subject: Test Operation - Title Test Operation - Messgae

Figure 6.25: Email Received by the System

6.3 Project Challenges

6.3.1 Resolved Project Challenges

There are several challenges have increased the difficulty to build the project, but it has been resolved:

a. Unable to access the webpage's information due to JavaScript

The issue happened when accessing a website that is require to accept cookies and has to have JavaScript enabled. The reason of unable to access is also due to lack of suitable header while it is rendering. Few solutions have been tried but it was failed. The final solution is to use Selenium library to perform web scraping.

- b. Beautiful Soup 4 library understanding
 The study and famliarising of a new library do require a lot of practice and effort.
 Many practices have to be done to familiarise myself to the library. Also, many times of try and error have been faced when using the library.
- c. Enable to let Scheduler to run on background

The challenge is to enable the Scheduler that used for regular checking feature to run on background where allows the execution of other tasks of the program. Otherwise, the scheduler will keep holding the resource of the program. The solution is to apply multithreading to enable the Scheduler run on background.

d. Analysing the HTML DOM structure of each university

Another big project challenge is to analyse the HTML DOM structure of each university and develop the data analysis algorithm to extract the required information. This is because some universities have different HTML DOM structures to display the information. Another case is the information is allocated in other links, so a scarping to multiple links in a data analysis algorithm for particular universities is required. Therefore, consideration of these different conditions during the data extraction and analysis process has to be done. As a result, it consumes a lot of time to estimate and validate the correctness of the algorithm. e. Different forms of data presentation or interface

Different universities have different forms of data presentation, such as displaying the available intake by listing or by a single line using different HTML tag. Another example is a same element may locate at different section. A uniform presentation has to be decided and formed to show a consistent presentation of data to the user. A detailed data analysis for multiple universities must be conducted to analyse the common and most suitable form to present the data.

6.3.2 Unresolved Project Challenges

Nevertheless, there are some challenges are hard to resolve as follows:

a. System Performance

The system is may performing slow when searching programme on the web application. This may due to some programmes in the search result list has to be scraped by Selenium library which the library is a heavy library. Therefore, time is consumed by the library to perform web scraping. Pagination feature has implemented to reduce the number of programmes to retrieve in order to minimize the retrieval time. However, the system will still performing slow if there is a case that most of the programmes information in the search result list are require to be retrived by Selenium. The possible solution will be applying caching and multithreading which will be explained in chapter 7.2.

b. Unable to scrap some information

There is some information of some universities is unable to scrap. It may due to too many kinds or forms of data presentation to display programme information by a university. Therefore, those information skipped to scrap by the programme and will displaying "N/A" to users. However, a button that used to redirect users to the particular programme official webpage is included. Thus, users are able to read or check the information. In addition, algorithm of postgraduate programme for UTP does not be done due to complex interface.

6.4 Objectives Evaluation

The proposed system has achieved all the project objectives.

- To develop a web application platform that collects information on Malaysia private universities' programmes on a single website using a web scraping tool
 A web application has been developed to display the scraped information. The scraped information is done using BS4 library and the frontend or the web application can access the information using API service.
- To perform data collection and data analysis for Malaysia's private universities Data collection and data analysis have been done for 10 universities. Algorithms are coded for both undergraduate and postgraduate programmes. The algorithm is able to collect and analyse the data on real-time basis.
- iii. To implement a web application that provides various services related to tertiary studies

A web application has been developed with several features related to tertiary studies for users which are:

- Search programme
- View and export programme
- Add, remove and view favourite list
- Add and view viewed history list
- Recommend area of studies
- Perform enquiry

6.5 Legal and Ethical Issues

As the project core function is to scrap the information of websites automatically by web scraping tools, the most frequent asked question on it is the legibility and ethical issues.

As the result of researching, data scraping and web crawling is legal if the data is public accessible without any restrictions such as special permission from data owner. However, there are some circumferences that data scraping is illegal such as using the public accessible data for illegal activities and obtaining sensitive data such as personal information of people [39].

To sum up, using data scraping method to create web application is not illegal on its own, as long as do not use it in illegal activities and harming to others. For publically accessible data, it can be scraped by not invading anyone's privacy.

CHAPTER 7: CONCLUSION AND RECOMMENDATION

7.1 Conclusion on Project Achievements

As pursuing tertiary studies is an important and necessary process before working in a professional field, it is essential to have a platform to access and compare the information of each universities' programme. However, people have difficulties in selecting or even looking for a programme as well as require self-effort to explore the information on the Internet. Thus, a platform that can retrieve data from all of Malaysia's private universities on a real-time basis has been proposed to ease the research process on different websites. By using a web scraping tool and data analysis techniques, the extracted data will be analysed to obtain the most relevant information based on users' needs. Then, analysed data will be displayed in a proper organisation in the web application. Therefore, a greater user experience and better convenience are achieved by allowing users to discover and view the required information through a single web application.

The proposed system has successfully achieved its main functionality which is to build a web application that able to display information which is obtain by performing data collection and data analysis on Malaysia's private universities' programmes using web scraping tools.

There are a total of 500 undergraduate programmes and around 280 postgraduate programmes of 10 universities are recorded in the database to ease of the searching and filtering feature and increase performance of the system. Pagination feature is also been implemented to enhance the performance of searching and filtering feature. While the detailed information of each programme is obtained by web scraping technology in order to save database storage and the workforce to store and track the information of every programme as well as able to display the lastest information to users. In addition, the setup of the program which is to scrap the programmes from targeted universities' programme list and store it into system database has been done. Moreover, the system is able to perform checking on whether the programme list of each targeted university has updated and whether the data analysis and web scraping algorithm is working properly once per week regularly. A log record will be recorded if there are any issues.

System users can search programmes by using programme name, level of studies and location. The system will display a list of relevant results. Programme summary will be

CHAPTER 7: CONCLUSION AND RECOMMENDATION

included in each programme in search result. Users can look for more details by selecting interested programmes. If the user is interested with the programme, the user can download the information of the programme and direct apply the programme by redirecting the user to the university's admission web page. Besides, if there is an error to display the programme information, a log record will be recorded as well. Users can perform enquiry to the system via contact us webpage. In addition, users are able to get recommendations on area of fields to study. The system can also record and display the favourite list and viewed history list of users.

Nevertheless, there are many improvements can be done to enhance the functional and non-functional feature of the system which will be discussed later.

7.2 Recommendation

There are some improvements can be done to further enhance the system.

First of all, the foundation of this project is to display universities' programmes using web scraping tool. Therefore, another improvement will be increasing the available universities into the system. As a result, users can obtain search result in a wider range of Malaysia's private universities. It would increase the coverage of the system. Besides, new fields can be added to search criteria such as university name, range of fee, etc. New sections such as university profile can be included, so users can understand more about the desired university as well.

Next, NLP can be implemented to identify and understand the text content. It is recommended to use after performing data analysis. Therefore, the data content can be determined which is the important and display only the important part to avoid lengthy and unnecessary content.

Moreover, the recommendation system can be improved by suggesting the area of studies using the personality characteristic of the user. A set of question can be asked to detect the personality of the user. Also, based on the answer, we can determine the percentage of realistic, investigative, artistic, social, enterprising and conventional of the user and thus determine the suitable area field of studies based on the characteristics.

By implementing caching and multithreading are able to enhance the system performance. Multithreading enables more than one process of the system run simultaneously. It can be applied on searching and filtering feature which can reduce the retrieval time of the programme summary in the list of programmes. Caching is a technique to store data temporarily on the device. It can be implemented on search programme and view programme features. For search programming, caching can help to store the search result. Therefore, if the user search with the same criteria, the system can show the result instantly and run the search function at the backend, followed by updating the result in the cache. The same concept can be applied to view programme feature.

On the other hand, it is recommended to implement BOS which is specifically for system administrators. BOS is a collection of business processes which integrates every business process into 1 system. It allows users to manage the system, executes
CHAPTER 7: CONCLUSION AND RECOMMENDATION

operational objectives and monitor business performance. Therefore, it can be implemented to simplifies jobs of system admins. For instance, the BOS can include showing logs and its message and showing the programme which encounters error, thus, the developers or admins can view the information stated on a GUI instead of executing SQL queries on database. Furthermore, the admin can trigger recheck function on the BOS without waiting the specific time stated in scheduler function.

Furthermore, some features can be implemented to the web application to enhance completeness. A webpage about university profile can be added which describes the selected university's vision, mission, financial aid, etc. The search result page can implement a feature of allowing users to download the search results into a PDF file and save to users' device. Although the programme list will be updated to the latest one each week, it is also a possibility that the current search result does not include some new programmes. Thus, there can be an option that let users to search the result on real-time and inform that this action will take times at the same time.

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Appendix A: List of universities scraped

University	Ranking
Taylor's University	332
UCSI University	347
University of Technology, Petronas	414
Management and Science University	601-650
Sunway University	651-700
University of Tenaga Nasional	751-800
University of Kuala Lumpur	801-1000
University of Tunku Abdul Rahman	801-1000

Table A.1: Malaysia's Private Universities QS Ranking [40]

Two more universities that are not in the QS ranking have been scraped and analysed to increase the range of universities of the web application. The universities are SEGi University and The University of Nottingham Malaysia Campus. The latter institution is a foreign university branch campus in Malaysia.

Appendix B: Figures of Testing Result

Testing Result of Web Scraping

Result of Getting UTAR Programme Information

from getProg import get_Prog get_Prog("utar", "https://study.utar.edu.my/computer-engineering.php", 0)
<pre>('uni': 'UTAR', 'name': 'Bachelor of Information Technology\xa0(Honours) Computer Engineering', 'description': ['Embedded systems consist of "invisible" computer and related peripherals hidden inside a product, which exist in almost every aspect in our lives. We use embedded systems in washing machines, cars, factory automation machines, security alarm systems, smart phones, satellites and etc. Ubiquitous computing and Internet of Things (IoT) are future trend that greatl y enhances our life, due to the rapid advancement of embedded systems design technology.', 'The programme prepares graduates to be competent in the discipline of Electronic Systems Engineering with Computing, particu larly driving the information and communication technology (ICT). It emphasis design skills and knowledge that integrates both hardware and software into a system with application in Programming, Computer Architecture, Embedded System Design and Computing ,\xa00igital Signal and Image Processing, Intelligent System and Networking, which supports Information Technology.', 'The programme is to produce graduates with skills in using sophisticated software design tools for designing electronic syst To be here the the week development of the stress of the rest design tools for designing electronic syst To be here the stress of the there the stress of the the stress of the there exist the stress of the there the stress of the there exist the stress of the there exist the there exist the stress of the there exist the stress of the there exist the stress of the there exist the there exist the there exist the stress of the there exist the exist there exist the there exist the exist there exist the there exist the there exist the there exist the exist there exist the exist the exist there exist the exist there exist the exist there exist</pre>
ems. To break away from the theory-based traditional learning style, we tend to emphasis more on practical design work, to put theory into practice. [],
'duration': ['3 years (Full-time)'],
'intake': 'January, May, October',
'tee': ['RM45,950 (Malaysian)', 'RM62,550 (International)'],

Result of Getting MSU Programme Information

<pre>from getProg import get_Prog get_Prog("msu", "https://msu.edu.my/faculty-health-life-sciences/bachelor-bioinformatics.php", 0)</pre>
<pre>{'uni': 'NSU', 'name': 'Bachelor in Bioinformatics (Hons)', 'description': ['Bioinformatics is an area of study which intersects biotechnology and computing science. It applies computer science and information technology to processing of biological data. This is a field with enormous possibilities in advancing m edicine, agriculture and other biology-related areas. With the support of our lecturers, your analytical and problem-solving sk ills will be enhanced through collaborative, group-based assessments and projects. Expand your learning horizon by participatin g in the MSU Global Mobility Programme, which lets you study for one semester or more overseas at MSU's international partner u niversities. In your final year, you will undertake an industrial placement to gain real working experience.'], 'intake': 'fee': [RM40,000 - RM45,000',</pre>
'*The stated fees are estimation on overall completion of the program. In any cases where there are credit exemptions, offere d rebates or approval of scholarship applications, there will be considerable reduction in the fees', 'The fees stated here are for Malaysians or local students only. Kindly refer to MSU regarding the fees for international stu dents'.
'The fees stated here are for Malaysians or local students only.', 'Kindly refer to MSU regarding the fees for international students'], 'medium': [], 'camust' [Shah Alam']
'faculty': 'Faculty Of Health Life Sciences', 'career': ['Bioinformatics Research Scientist'], 'requirement': ['Updated 27 JUJ 2018]'], 'progStruct: ['Year One: E-Health and Ethics in Bioinformatics, Cell and Tissue Biology, General Genetics, Biochemistry', 'Year Two: Molecular Biology, Data Structure and Algorithm, JAVA Programming, Informatics Ecology and Environment', 'Year Three: Sequence and Structure Analysis, Biodiversity, Industrial Training'], 'admission:' 'https://www2.msu.edu.my/msu_oav2/',

Result of Getting Nottingham University Programme Information

In [2]:	<pre>from getProg import get_Prog get_Prog("nottingham", "https://www.nottingham.edu.my/ugstudy/course/economics-and-international-economics-bsc-hons", 0)</pre>
Out[2]:	<pre>{'uni': 'Nottingham', 'name': 'Economics and International Economics BSc (Hons)', 'description': ['A University of Nottingham Business School BSc (Hons) Economics degree will provide students with a solid gro unding in macroeconomics, microeconomics, mathematics, and statistics. The School of Economics offers a wide range of optional modules covering a diverse set of economics topics. Students will have the flexibility to select modules offered by other schoo ls and departments across the University. In addition, a BSc (Hons) Economics and International Economics degree allows student s to specialise in various aspects of international economics with strong emphasis on both international tacde and international l finance. This degree is ideal for students who would like to obtain a solid understanding of economic theory and how it is applied to 'real world' situations. Students will be familiar with the key analytical techniques that economics us an practic e with rigorous training in data analysis, problem solving, report writing, oral presentations and teamwork. Our graduates are proven to be highly sought after in the job market.', 'Our Economics degrees are among the few Bachelon of Science in Economics degrees offered in Malaysia.', 'Your individual interests and career aspirations are very important to us, students can build on their specialist modules in year 2 by taking advanced modules in year 3. These include modules on experimental and behavioural economics, an exciting field for which the School of Economics is a global leader.', 'In the final year of your degree, students complete a dissertation mentored by a member of our research taam. The dissertati on empowers students to explore an area of economics in which they are personally interested in giving all students the opportu inty to use the critical thinking and research skills that they have gained throughout the course.'], 'international fee: RMB3,400</pre>

Result of Getting SEGi University Programme Information

[3]:	<pre>from getProg import get_Prog get_Prog("segi", "https://colleges.segi.edu.my/subangjaya/course/ba-hons-business-and-marketing-management/", 0)</pre>
31:	/'uni'- 'SEGi'
×.	'name': 'RA (Hons) Business and Marketing Management (340)'
	'description's ['Marketing is an assential part of any histores and its discipling is required for enormous success in today
	modern business environment.'.
	'Understanding the basic and rising needs of an organisation and its target audience is a highly challenging skill: thus no
	ing great demands for graduates of Business and Marketing like you.'.
	'The BA (Hons) in Business and Marketing Management enables you to develop knowledge in understanding and analysing a busine
	s within a regional, national and international framework. The degree enhances communication and problem solving skills, ofter
	required in the marketing industry. As graduates, you'll be ready to fulfill expectations of the employers with the education
	nd practical skills gained throughout our programme.'],
	'dunation': [],
	'intake': '',
	'fee': [],
	'medium': [],
	'campus': ['SEGi College Subang Jaya'],
	'faculty': '',
	career': [This degree will prepare you for management positions within advertising and public relations agencies and various
	marketing roles. You may also pursue careers in sales promotion, direct marketing, media, digital communications, and other ad
	ertising fields.],
	requirement : [UEL WITH 5 creatssiph With grade C in 2 subjects (for Accounting and Finance, requires Grade C in 2 subjects) A low with respect to 2 subjects the subject of the subject SM (AUSMAT with rise ATAP 60 and 50 M lowal CPa
	s)A-Level with passes in 2 subjectsMatriculation / Foundation or equivalentsAM / AUSMAN with min ANAK OWRELATED SKM Level Ske.
	Led DiplomanQA-APEL TO ;
	Auduitional Requirements ,
	innestruc's (Vaan 1: Eccential Study and Employment Skille's Totroduction to Mankating's Introduction to Human Resource (
	progettat and Talent Devolution to Advantation to Advantation to Managing and Leading Reanaly in the Advantation to Managing Reanaly in the Advantatio
	reduction to Business Operations and Services\n. Business Economics\n. Business Management\n. English 1'.
	'Year 2: Personal and Professional Development\n, Quality Management for Organisational Excellence\n, Business Ethics, Resp
	sibility and Sustainability\n, Digital Marketing\n, Marketing Management and Metrics\n, Integrated Marketing Communications\n
	English 2\nMalaysian Studies 3 (International students), \nHubungan Etnik (Local students), \nBahasa Melayu Komunikasi 2 (Int
	national students), \nTamadun Islam & Tamadun Asia (Local students), \nStatistics for Managers\n, Managing Information System
	\n, Malaysia Society 5.0',
	'Year 3: Developing the Reflexive Practitioner\n, Strategic Marketing\n, Psychology of Consumers in a Digital Age\n, Critica
	and Emerging Themes in Marketing\n, Branding and Reputation Management\n, Marketing Research in Practice\n, English 3\nDesign
	hinking / Bahasa Kebangsaan A*\n, Community Engagement\nEntrepreneurship\nBusiness Placement (Internship), '],
	'admission': 'https://university.segi.edu.my/local-student/',
	'success': 1}

Result of Getting Sunway University Programme Information

In [4]: from getProg import get_Prog get_Prog("summay", "https://university.summay.edu.my/soa/ba-film-production", 0) Out[4]: from the summay', "https://university.summay.edu.my/soa/ba-film-production", 0) Out[4]: from the summay', "and the summay', scripturiting, sound design, acting, transmedia content creation, post-production, entrepreneu rship and internship with the widest and most value-added applications.Nnthe programme alias to produce versatile creative produ cers who are skilled in audio-visual production and transmedia application.Nnthe programme alias to produce versatile creative produ cers who are skilled in audio-visual production and transmedia application across multiple screens to enhance capability and co mpetency in Malayaid's ground creative econowy. The experime acquired in this programme will be relevant to a diverse range o f conventional and new career options within and beyond the current media landscape that has been revolutionized by digital ite choology.Nukit our innovative Hands-on Approach to teaching, you will find yourselves completely immersed in your course of stu dy, surrounded by award-winning faculty and working with up-to-date equipment and facilities. You will also be trained to foste r critical tinking and communication skills in order to fulfil your fill cacdemic potential. Upon completency in Malayaus, will be awarded two certificates, making them graduates will also be awarded with a degree from Lancaster University '.', 'intake: 'Warch & August', 'fee': [], 'induste: 'land to August', 'fee': [], 'induste': Take August', 'fee': [], 'induste': Take August', 'intex: Yanchay approach are calculated based on grades obtained for 2-3 subjects', '.'australian Matriculation: TAK 5', 'Canadiam Patriculation: TAK 5', 'induste': Minimum & points'Points are calculated based on grades obtained for 2-3 subjects', ''australian Matriculation: TAK 5', ''somay Foundation in Science technology; GPA 2.0', ''somay Foundation in Science technology; GPA 2.0', ''somay Foundation in Sci

Result of Getting Taylor University Programme Information



Result of Getting UCSI University Programme Information

in [7]: getProg import get_Prog			
Prog("ucsi", "https://www.ucsiuniversity.edu.my//programmes/ba-hons-event-and-tourism-management-dual-award-htmi-switzerland", 0)			
•			
<pre>Out[7]: { 'uni': 'UCSI', 'name': 'BA (Hons) In Event And Tourism Management (A Dual Award With HTM! Switzerland)', 'description': ['This three-year degree programme gain the competitive edge in the multi-million ringgit event and tourism ind ustry. Understand operational, supervisory and managerial knowledge and skills that are required for modern management of busin ess industry. This programme covers a vide range of areas from conventions, events to tourism'], 'duration': ['3 Years (14 weeks per semester, 7 weeks per short semester)'], 'intake': 'January, May and September (Kuching Campus only)', 'fee': ['Local Students: RM 50,726'], 'medium': [], 'campus': ['Kuching'], 'careuty': ', 'careuty': ', 'careuty': ['Career opportunities are wide and varied for graduates from this discipline. Students may expect to be employed b '''</pre>			
y:;, 'Travel Agency Manager', 'Tour Operator', 'Cruise Manager', 'Tomes Park Manager', 'Tourism Project Manager', 'Recreation Manager', 'Event Manager', 'Event Manager', 'Entertainment Specialist', 'Banuet Manager'],			
<pre>'requirement': ['\u200bFoundation Year: Pass with a minimum CGPA of 2.8', 'STPM: Pass STPM with Minimum 2 principals (C)', '\u200bA-Level: Minimum 2 principals (D)', '\u200bHational Matriculation: Minimum GCPA of 2.0', 'SAM: Minimum average of 60% in 6 subjects', 'SAM: Minimum average of 60% in 6 subjects', 'SAM: Minimum average of 60% in 6 subjects', 'Other qualifications deemed equivalent to STPM/A-Level by Malaysian Government: Minimum overall average of 60%', 'Diploma (business-related): Minimum GCPA of 2.0', 'Other equivalent qualifications: To be reviewed by the faculty on a case-to-case basis'], 'Defort: ['Year 1: Introduction to Accounting, Fundamentals of Hospitality and Tourism Industry, Introduction to Managemen t and Organisation Theory, Business Communication, Business Statistics, Customer Service, Cross Cultural Studies, Introduction</pre>			

Result of Getting UniKL Programme Information

In [8]:	<pre>from getProg import get_Prog get_Prog("unikl", "https://www.unikl.edu.my//programme/bachelor-of-engineering-technology-hons-in-marine-electrical-electronic/"</pre>
Out[8]:	{uni: 'Uniki', 'Un
	ship and professional practices.'],
	'duration': ['4 years'],
	'intake': 'January & September Only',
	'fee': [],
	'medium': [],
	Campus: [UNIKL MIMEI'],
	Tacuity : ,
	Career : [Electrical & electronics Engineer (marine/ Power plant/ Instrument) ;
	Hardie electrical & electronics required and evidences'
	Hardne electrical a electronics service and maintenance,
	'Education - Secialist/ Instructor/ Inton/ Trainer'l
	<pre>'requirement': ['Local Student refer to:- http s://www.unikl.edu.my/programmes/entry-requirements/#ER_Bachelor'.</pre>
	'International Student refer to:- <a href="https://www.unikl.edu.my/admission/international-students/international-student-en</th></tr><tr><th></th><th><pre>try-requirement/">https://www.unikl.edu.my/admission/international-students/international-student-entry-requirement//a>'], 'progStruc': ['Semester 1: Tamadun Islam & Tamadun Asia (TITAS)/ Pengajian Malaysia 3*, Fundamental English, Professional Engl
	ish 1, Mathematics 1, Technopreneurship', 'Semester 2: Mathematics 2, Mandarin 1/ Arabic 1, Hubungan Etnik/ Bahasa Melavu Komunikasi 2**. Engineering Science. Occupati
	onal Safety and Health, Digital Electronics System, Introduction to Programming, Principles of Electrical and Electronics', 'Semester 3: Innovation Management, Computer Aided Design (CAD) 2D, Study and Implementation of Project, Control Systems, Mat
	hematics 3, Ship Technology, Analogue Electronics, Electric Circuits', 'Semester 4: Network Analysis, Microprocessor, Introduction to Technical Computing, Industrial Automation, Electro-Technique

Result of Getting UniTEN Programme Information

In [9]: from getProg import get_Prog get_Prog("uniten", "https://www.uniten.edu.my/programmes/engineering/bachelor-of-mechanical-engineering-hons/", 0) sculty: ``, seer': ['These are popular career choices after graduation for this programme. There are also many other career choices bey engineering, which are proven adaptable by UNITEN students due to holistic personal and professional skills development dur ing the study.', 'Applances Engineer, Automotive Engineer, Communication Engineer, Computer Engineer, Construction Engineer, Consulting Engin eer, Control Engineer, Design Engineer, Instrumentation & Control Engineer, Maintenance Engineer, Manufacturing Engineer, Mecha tronic Engineer, Medical Engineer, Microalectronics Engineer, Operation Engineer, Power System Engineer, Power r, Project Engineer, Academician'], 'requirement': ['Sijil Tinggi Persekolahan Malaysia (STPM): Pass STPM with a minimum GGPA of 2.00 and at least Grade C for Mat hematics and ny 1 relevant Science Physical and Pass English in SPM Level.', 'Ac-Level: Pass A-Level with credit in Mathematics and 1 Science Physical subject.', ing the study

Result of Getting UTP Programme Information

In [10]: from getProg import get_Prog
get_Prog("utp", "https://www.utp.edu.my/Pages/Admission/Undergraduate/Bachelor-of-Mechanical-Engineering-with-Honours.aspx", 0)

Materlais, Fluid mechanics and intermonyments. New , In the third year of study, students are required to undertake Computer Aided Engineering, Mechanical Engineering Design and Vibrati ons. , In the final year of study, students are required to undertake Computer Aided Engineering, Mechatronics, Manufacturing Techn ology II, Integrated Design Project and Final Year Project.', Interstated States and S

Recommendation Questionnaire

























Appendix C: Poster



University is a place where individuals pursue tertiary studies to gain knowledge in a specific field. It is the start of the journey to the future.

METHODS



- The proposed methodology is the agile development methodology
- Web scraping tool (bs4) will be used to obtain data on real-time basic
- A web application is used to present the result
- AngularJS is used for the frontend; Flask used for the backend



A simple and user-friendly web application which serves as the platform to present the result of data analysis has been built. Other features have also been developed to improve the completeness of the web application.

DISCUSSION



The main effort of this project is to collect information from a webpage on a real-time basis. Data analysis will be used to collect data to inspect and compare the information provided by each website. Thus, a model uniform that resulted from the data analysis process was formed.

CONCLUSION

A one-stop information center is developed to enable users to get access to information on universities' programmes. Web scraping technology saves manpower and database storage on storing and retrieving information for users as well as being able to obtain the latest information using the defined data analysis algorithm.

Appendix D: Final Year Project Weekly Report

FINAL YEAR PROJECT BIWEEKLY REPORT

(Project II)

Trimester, Year: 3, 3Study week no.: 2Student Name & ID: Lai Kar Wai & 19ACB06966Supervisor: Ts. Lai Siew ChengProject Title: Malaysia's Private University Application Platform

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Scraped all universities programme list
- Inserted the scraped information into database

2. WORK TO BE DONE

- Implement the logic of recording log
- Implement search and filter function

3. PROBLEMS ENCOUNTERED

- N/A

4. SELF EVALUATION OF THE PROGRESS

- Done preparation to implement search and filter function

Supervisor's signature

lug

(Project II)

Study week no.: 4

Trimester, Year: 3, 3

Student Name & ID: Lai Kar Wai & 19ACB06966

Supervisor: Ts. Lai Siew Cheng

Project Title: Malaysia's Private University Application Platform

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Implemented the logic of recording log
- Implemented search and filter function
- Created APIs

2. WORK TO BE DONE

- Check on algorithm
- Regular checking

3. PROBLEMS ENCOUNTERED

- Some universities' algorithm encounter problem

4. SELF EVALUATION OF THE PROGRESS

- Search and filter feature is done for both frontend and backend parts
- Able to record if any errors exist

Supervisor's signature

(Project II)

Study week no.: 6

Trimester, Year: 3, 3

Student Name & ID: Lai Kar Wai & 19ACB06966

Supervisor: Ts. Lai Siew Cheng

Project Title: Malaysia's Private University Application Platform

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Check on algorithm and amendments are done
- Coded checking features for all universities in the system
- Created scheduler task to enable regular checking

2. WORK TO BE DONE

- Implement recommendation system

3. PROBLEMS ENCOUNTERED

- Unfamiliar on Scheduler library

4. SELF EVALUATION OF THE PROGRESS

- Implementation of regular checking feature done
- Refinement on algorithm done

lug

Supervisor's signature

(Project II)

Study week no.: 8

Trimester, Year: 3, 3

Student Name & ID: Lai Kar Wai & 19ACB06966

Supervisor: Ts. Lai Siew Cheng

Project Title: Malaysia's Private University Application Platform

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Done research on recommendation system
- Performed analysis on recommendation system
- Design on recommendation system done
- Implemented recommendation system

2. WORK TO BE DONE

- Redirection to error page if errors exist
- Generate report feature
- View viewed history list feature
- Add to viewed history list feature

3. PROBLEMS ENCOUNTERED

- Complex structure of rule-based AI

4. SELF EVALUATION OF THE PROGRESS

- Development of the system still in progress

luy

Supervisor's signature

Student's signature

(Project II)

Study week no.: 10

Trimester, Year: 3, 3

Student Name & ID: Lai Kar Wai & 19ACB06966

Supervisor: Ts. Lai Siew Cheng

Project Title: Malaysia's Private University Application Platform

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Redirection to error page if errors exist for both frontend and backend
- Generate report feature developed
- View viewed history list feature developed
- Add to viewed history list feature developed

2. WORK TO BE DONE

- Increase project scope by including postgraduate studies programme into the system

3. PROBLEMS ENCOUNTERED

- Progress behind on scheduled

4. SELF EVALUATION OF THE PROGRESS

- Done all necessary functions

lug

Supervisor's signature

(Project II)

Study week no.: 12

Trimester, Year: 3, 3

Student Name & ID: Lai Kar Wai & 19ACB06966

Supervisor: Ts. Lai Siew Cheng

Project Title: Malaysia's Private University Application Platform

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Included postgraduate programmes into system
- Testing on whole system

2. WORK TO BE DONE

- Prepare for the presentation
- Ensure the application is running well before demonstration

3. PROBLEMS ENCOUNTERED

- N/A

4. SELF EVALUATION OF THE PROGRESS

- N/A

Supervisor's signature

Student's signature

luy

Plagiarism Check Result

Appendix E: Plagiarism Check Result



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FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Full Name(s) of Candidate(s)	Lai Kar Wai
ID Number(s)	19ACB06966
Programme / Course	Bachelor of Computer Science (Honours)
Title of Final Year Project	Malaysia's Private University Application Platform

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Based on the above results, I hereby declare that I am satisfied with the originality of the Final Year Project Report submitted by my student(s) as named above.

lan	
Signature of Supervisor	Signature of Co-Supervisor
Name: Lai Siew Cheng	Name:
Date: 9/9/2022	Date:

Appendix F: FYP 2 CHECKLIST



UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF INFORMATION & COMMUNICATION TECHNOLOGY (KAMPAR CAMPUS)

CHECKLIST FOR FYP2 THESIS SUBMISSION

Student ID	19ACB06966
Student Name	Lai Kar Wai
Supervisor Name	Ts. Lai Siew Cheng

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