QS UNIVERSITY RANKING CALCULATION BY USING PYTHON PROGRAMMING LANGUAGE AND FUZZY LOGIC

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JUDUL: QS UNIVERSITY RANKING CALCULATION BY USING PYTHON PROGRAMMING LANGUAGE AND FUZZY LOGIC

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QS UNIVERSITY RANKING CALCULATION BY USING PYTHON PROGRAMMING LANGUAGE AND FUZZY LOGIC

LEE JIE YU

This report is submitted in partial fulfillment of the requirements for the Bachelor of Computer Science (Artificial Intelligence)

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA
AUGUST 2017

DECLARATION

I hereby declare that this project report entitled

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I hereby declare that I have read this project report and found this project report is sufficient in term of the scope and quality for the award of Bachelor of Computer Science (Artificial Intelligence) With Honours.

SUPERVISOR : _____ Date: 14/8/2017

(DR. SHARIFAH SAKINAH SYED AHMAD)

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ABSTRACT

QS university ranking works as a platform for benchmark and in order to improve the ranking, it required simulation and forecasting. In the other hands, there are various choice of programming language but python programming is chosen due to the huge community and huge library. There are various library that could help in data analytic and artificial intelligence technique. The objective of the system is to explore on strategy of improvement on university ranking using social network, design to be a dashboard for visualization result by using python programming language and stimulate the QS ranking by defined a formula based on the standard measurement by using fuzzy logic. In this system, there are 2 major roles which is visualize the result and give the strategy. This system is incorporated with artificial intelligence technique that is fuzzy inference system. In this system, there are a lot of formula is included in order to get the input from raw data. For the fuzzy logic, 4 inferences system is used and it is nested fuzzy inference system. There are 10 input from start and it will be categorize and go through their own inference system. Then, the output of those 10 categorize input will go through the final fuzzy inference system in order to get the final output. The strategy planning will based on the value of the output and give a precise strategy.

ABSTRAK

QS university ranking berfungsi sebagai platform bagi penanda aras dan untuk penambah baikkan kududukan yang mana ia memerlukan simulasi dan jangka. Oleh itu, terdapat pelbagai pilihan bahasa yang boleh digunakan untuk pengaturcaraan, tetapi bagi projek ini saya telah memilih pengaturcaraan dari Bahasa python kerana atas faktor kemudahan dalam mengendalikan Bahasa tersebut bagi di implikasikan dalam projek ini. Selain itu, ianya terdapat pelbagai maklumat yang boleh membantu dalam analisis data dan teknik kepintaran buatan. Manakala, objektif sistem ini pula adalah untuk meneroka strategi untuk penambahbaikan pada kedudukan sosial university yang menggunakan rangkaian. Ia nya akan di reka bentukan kedalam sebuah papan kenyataan yang maya bagi memaparkan keputusan visualisasi yang telah di reka dengan menggunakan bahasa pengaturcaraan python ini. Selain itu, ia juga dapat merangsangkan kedudukan QS dengan takrifan formula yang berdasarkan pengukuran standard dan penggunaan logik kabur. Dalam sistem ini, terdapat 2 peranan utama iaitu menggambarkan hasil kajian dan memberikan strategi. Sistem ini digabungkan dengan teknik kepintaran pembuatan yang mana sistem fuzzy logik telah di aplikasikan. Dalam sistem ini, terdapat banyak formula termasuk dalam rangka untuk mendapatkan input daripada data asli. Untuk fuzzy logik, terdapat 4 sistem kesimpulan yang digunakan iaitu nested fuzzy inference system. Terdapat 10 input dari permulaan yang akan dikategorikan dan melalui inference system. Kemudian, hasil bagi 10 input yang telah dikategorikan akan melalui final fuzzy inference system bagi mendapatkan hasil akhir. Perancangan strategi akan berdasarkan nilai hasil dan akan memberikan strategi yang tepat.

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CHAPTER I

INTRODUCTION

1.1 Introduction

"We can only see a short distance ahead, but we can see plenty there". These are the word once said before by Alan Turing. According to this word, it turns out to his Turing Test and become the father of artificial intelligence. Nowadays, our technologies are fully influenced by artificial intelligence. Whenever we try to simplified anything, we would use artificial intelligence. One of the fields that heavily depends on artificial intelligence is strategic planning.

Strategic planning is a very time-consuming job as we need to analysis the data and thinks out what could happen in every scenario and give the strategic to it. According to H. Mintzberg (2007), strategic planning isn't strategic thinking. One is analysis, and the other is synthesis. To put in a way, strategic planning is needed to follow with a lot of facts and proves while strategic thinking is just required a different combination of idea and produces it.

This project is to plan and execute different strategic for different rated score in university ranking by using artificial intelligence technique. By getting this project done, a dashboard is needed and different algorithm needed to try out in order to get a better accuracy planning. The data is getting the real data from our university and world ranking data is get on the website (https://www.topuniversities.com/).

1.2 Problem Statements

There are a lot of researchers found out that strategic planning is required in university as the goal is to achieve the better quality of student. According to El-Fattah M.A (2014), there is always 2 question in strategic planning which is has this strategy been performed the way it had been planned and does this strategy lead to its designated results?

Hence, the question of those 2 lead to the problem with strategic planning nowadays which is most of the time, human power is used to do the analytic and thinking. Apart from that, the accuracy of the human power is another issue that needs to be a concern.

There are a lot of strategy from many researchers that improve the quality of the university but those are just in form of words. As an analyst, the exact value of improvement from a stage to another stage is better and those involve in a lot of computational calculation. Hence, the system is needed for stimulation of scenario for easier visualization. Apart from that, currently there is no system in strategic planning for university scenario.

1.3 Objectives

- To design a dashboard for visualization result using python programming language.

  -The neat experience interface needs to be created to fully utilized the user experience and the right message needs to convey in order for easy understanding for the user.

- To stimulate the QS ranking by defined a formula based on the standard measurement by using fuzzy logic.

- Artificial intelligence is becoming a more demanding technique in any kind of platform or system. Artificial intelligence will be able to do the job easily and with a low mistake rate compares to human power.

1.4 Scope

- After doing research on QS university ranking, only QS University Asia ranking is used in the system. The reason why only this are used is because the other rankings are time consuming or too few aspect that could used for this project.

- The fuzzy rule and fuzzy membership that created in this project is based on my project supervisor, Dr Sharifah Sakinah, my own intuition and online resource. This is because there are no researcher using fuzzy logic to create strategic planning.

- The accuracy of this system and project cannot be tested as there are no other project like before this project. Most of the researcher only tell the important of strategic planning in university or give example in order to improve the university ranking.

1.5 Project Significance

This system could be beneficial to universities. For instance, university could use this system to stimulate their ranking and find the way to improve their university easily. As a lecturer, they could easily keep track on the performance of the university and making their career choices.

Apart from that, this project could help the analyst of the university easily to visualize the outcome of the criteria score. This could be a huge impact as they can

more easily to find the way of improvement compare to thinking all the strategy inside their head. In social network, the strategy may be a lot but there are also a lot of fraud that may lead to the worst outcome.

1.6 Expected Output

By the end of this project, the output expected would be a system consist of stimulation of the university ranking and strategy that stimulated based on the 10 criteria measurement based on the QS university ranking. These results will be given the form of text. The fuzzy logic models are used to achieve the objectives.

1.7 Conclusion

This chapter is the overview on how the research is going to be held. After the problem statement, objectives, scope and the rest are being focused on, the next chapter is literature review which is needed to be given extra attention as it is crucial parts on giving the facts and finding of this project done it smoothly. The understanding in this section is important as it is very essential for the whole project.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter focuses on the literature review that could be beneficial for the project. The purpose of this chapter is summarizing the main concerns; domain, existing systems, and techniques. The domain is focusing on QS university world ranking and strategic planning. While in the existing system, it focuses on the existing related system and last part is about the techniques which concentrate on the technique that could be used for the strategic planning.

2.2 Facts and Findings

This topic is focusing on reviewing the article, journals, research papers and other literature materials to find more information on the related problem and ideas. This topic also explains the details of the domain, techniques used in the project.

2.2.1 Domain

The domain focuses mainly on understanding the QS university ranking and strategy planning.

2.2.1.1 QS university ranking

Quacquarelli Symonds university ranking also refers as QS university ranking is

a system to rate university based on the methodology developed by QS. Based on QS, there is 6 indicators as the methodology for the QS university ranking which is academic peer review, faculty-student ratio, citation per faculty, employer reputation, international student ratio and international staff ratio. The weighting for the basic criteria may refer Table 2.1. These are the basic criteria for rating a university. But each different country has their own standard and measurement for the ranking, hence the weighting might be different. For the Asia university ranking, from the basic 6 indicators become 10 indicators which are academic reputation, employer reputation, faculty-student ratio, citations per paper, papers per faculty, the proportion of international faculty, the proportion of international student, the proportion of inbound exchange students and the proportion of outbound exchange student. Hence, the weighting will be different from the basic criteria. The weighting for the university Asia ranking may refer Table 2.2. According to the QS university website, the explanation for each criterion is given hence it will be provided in Table 2.3.

Table 2.1 Weighting for QS university world ranking

Criteria	Weighting
Academic peer review	40%
Faculty/Student ratio	20%
Citation per faculty	20%
Employer Reputation	10%
International student ratio	5%
International staff ratio	5%

Table 2.2 Weighting for QS university Asia ranking.

Criteria	Weighting
Academic reputation	30%
Employer reputation	20%
Faculty/Student ratio	15%
Citation per paper	10%
Paper per faculty	10%
Staff with PhD	5%
Proportion of international faculty	2.5%
Proportion of international students	2.5%
Proportion of inbound exchange students	2.5%
Proportion of outbound exchange students	2.5%

Table 2.3 Explanation for each criteria

Criteria	Explanation
Academic reputation	The criteria is using a global academic survey prepared by QS themselves. This survey later on convert into percentage and it is to determine which university hold the strongest reputation in the Asia academic community.
Employer reputation	This criteria is using a global survey on the graduate employers who are asked to rate their own university in order to show the importance of employability and employment
Faculty/Student ratio	This criteria is a ratio between full time academic staff and student. This is to

	show how much time can a student contact with the lecturer..
Citation per paper	This criteria is evaluate by using Scopus database. Scopus is a place where researcher publish their paper and cited by other researcher. Hence, for this criteria, QS is evaluating based on how many citation against the number of paper that published by university.
Paper per faculty	This criteria is also evaluate by using Scopus database. QS is evaluating this criteria based on the number of paper against the number of full time academic staff.
Staff with PhD	This criteria evaluates the proportion of academic staff with PhD level.
Proportion of international faculty	This criteria is evaluating by using proportion of international academic staffs with academic staffs
Proportion of international students	This criteria is evaluating by using proportion of international students with students
Proportion of inbound exchange students	This criteria is evaluating the relative size of each university inbound student exchange programs
Proportion of outbound exchange students	This criteria is evaluating the relative size of each university outbound student exchange programs

2.2.2 Existing System

Existing systems focus on the actual systems that could be related to the topic of this project. Though it is quite impossible to find a system with the same title and many of the system stated could somewhat help in completing this project. The system chosen need to have at least related to strategic planning.

2.2.2.1 PATH analysis

A research by L Luić (2010) use PATH analysis which is containing on 4 elements. Those elements are planning, attitude, financing, and knowledge. The path planning is using possible hypotheses and survey and testing with t-test and single factor analysis of variance. The elements are obtaining through survey. This result that the element might result with the stochastic result. Hence, the researcher produces the planning with 2 alignment which is short-term alignment and long-term alignment. According to the researcher, the planning provide the largest correlation hence planning is selected as the dependent variable for the model and attitude is on the first level which is short-term alignment. Knowledge and financing are on the second level which is long-term alignment. Based on the researcher, the model of this application is possible capable at both macro and micro levels of higher education, institutions, at the university, faculty, individual scientific branch or individual managerial function level.

2.2.3 Technique

This part concentrates on the technique that could be in consideration in getting this project done. Algorithms, tools, models and artificial intelligence technology that have been used or analyzed by other parties are being reviewed here. The best algorithm, model, tool and technique will be chosen based on the analysis done from this section besides considering objectives and final goal targeted.

2.2.3.1 Fuzzy Logic

Based on whatis.com, fuzzy logic is a kind of approach that based on “degree of truth”. This “degree of truth” hold the meaning of how much percentage of the truth be told in the range of 0-1 rather than Boolean logic which is either true or false. Based on the founder of Zadeh, L.A, fuzzy control system which is like the Figure 2 below. There are 4 main step of fuzzy logic which is fuzzification of the input variables, rule evaluation, aggregation of the rule outputs and defuzzification. The explanation of this 4 steps will show at Table 2.4 below.

Table 2.4 Steps of Fuzzy Inference System

Steps	Explanation
Fuzzification of the input	This steps is to turn the crisp input become fuzzy by determine the crisp input belong to which fuzzy set
Rule evaluation	This steps is put the fuzzified value which converted from crisp set and apply them to the rule that defined.
Aggregation of the rule outputs	This steps is to unify the all input into 1 fuzzy set.
Defuzzification	This is the last step and the output for the fuzzy inference system has to be crisp value. Hence, defuzzification is to turn the fuzzfied value into crisp value

2.2.3.2 Python

Python is a high-level programming created by Guido van Rossum and its first releases at 1991. Python is an object-oriented programming language and structured programming. According to the documentation of the python, there is 19 principal of python so-called Zen of Python show at Figure 2.2. The philosophy of the python is as shown as the Figure 2 and that is the reason of the popularity of python. Python has a wide range of library and community which include a lot of necessary tools for data analytic such as numpy library, pandas, data collections and fuzzy tools. According to the philosophy, python is emphasized on beautiful, neat, simple, easy to understand readability and maintainability. There are some features of python that make the code easy to understand such as the indentation. Indentation works in python like a block which anything in the same indent is mean the same group. It uses white space and delimits control flow block. Hence, it removes the use of curly braces to control flow block and make the user easily to maintain and read the code.

```
The Zen of Python, by Tim Peters

Beautiful is better than ugly.
Explicit is better than implicit.
Simple is better than complex.
Complex is better than complicated.
Flat is better than nested.
Sparse is better than dense.
Readability counts.
Special cases aren't special enough to break the rules.
Although practicality beats purity.
Errors should never pass silently.
Unless explicitly silenced.
In the face of ambiguity, refuse the temptation to guess.
There should be one-- and preferably only one --obvious way to do it.
Although that way may not be obvious at first unless you're Dutch.
Now is better than never.
Although never is often better than *right* now.
If the implementation is hard to explain, it's a bad idea.
If the implementation is easy to explain, it may be a good idea.
Namespaces are one honking great idea -- let's do more of those!
```

Figure 2.2 Philosophy of python

2.3 Conclusion

This chapter is about finding facts and information on what is going to be done to get this project completed smoothly. Skipping this section could cause confusion while developing this project. Knowing the meaning of every term, how each method works is a crucial part. Before using an artificial intelligence technique, one must first understand the model and its functionality. New ideas may also arise while doing facts and finding.

CHAPTER III

Methodology

3.1 Introduction

This chapter focuses on the methodology that is used to create a strategy and develop a system using strategic planning approach. The methodology is the application of specific procedures used to understand the research problem, therefore enable the researcher to evaluate their study. The methodology stated here are basic steps on what are the things that needed to be done which consist of six repetitive steps. Each of the steps is explained on what tasks need to be executed in general. The details on what shall be done in each step in details are described in the next chapter. Apart from that, project requirements such as hardware and software requirements needed are listed down in this section. The next part of this chapter consists of project schedule and project milestones. This is done to ensure that the project that is being executed will run smoothly and according to the right time.

3.2 Methodology

The methodology used in this project is software development life cycle (SDLC). SDLC is designed for software engineering to plan, build, test and deliver the information systems with the structural and methodical way (Hussung, 2016). This repetitive cycle consist of 6 stages as shown in Figure 3.1

Figure 3.1 Software Development Life Cycle

1. Planning

This phase is mainly about requirements analysis which gathers the input and data. It also helps to determine resources, cost, time and benefit that required to implement the new systems or develop the system.

2. Analysis

This stage involves with the project goals and determines the intended application platform. In this stage, it required interpreting the data and think the solutions of the problems. In this steps, there will be software requirement analysis (SRS) produced.

3. Design

In this phase, the developer will follow the SRS and design the structure prototype follow with the functional requirement, software requirement, and hardware requirement.

4. Implementation

This phase is the most important parts as a programmer where the real work begin. The programmer will base on the SRS and the prototype design to develop the whole system. This work usually includes flowchart to ensure the flow of the system smoothly and it is properly organized.

5. Testing & Integration

In this case usually, it will involve with a lot of question. For example, does the system meet its objective function, does the function fulfilled the function requirements, does it contains the bug. Hence, in this stages, it always refers back to the objective and problem statement for ensuring the system have produced the solution.

6. Maintenance

This phase is the stage where developers might want to further enchanting their system or boost the performance. This stage may also include the system further updates where optimization or produce a new function.

3.3 Project Requirements

Next part is the project requirements where the hardware and software requirements are being discussed. All the software and hardware that are being used throughout the whole project is being listed and briefly explained what it is functions.

3.3.1 Software Requirements

The list software that is being used in this project is as follows.

- Visual Studio Code

Visual Studio Code is an editor that published by Microsoft. It can use to code any programming language such as C++, C#, and Python.

- WPS office

WPS office was previously also known as Kingsoft office which is like Microsoft office but only it is free and can support in any operating system such as Linux.

- Draw.io

Draw.io is a web platform use to create any diagram such as flowchart

3.3.2 Hardware Requirements

The hardware that is being used in this project as follow

- Personal Computer F
  - Toshiba Satellite L755
  - Intel® Core™ i5-2450M CPU @ 2.50GHz
  - 4 GB Installed Ram
  - 64-Bit Operating System
  - Ubuntu 16.04 LTS

3.4 Project Schedule and Milestones

Project schedule and milestones discuss on actions plan prior to the end of the project. This part is important to get all work to be done in time. Stages of activities that needed to be done are being listed and described in this part. Gantt chart and Milestone are being attached where Gantt chart is for project schedule to ensure all work is done by the time estimated while milestone is an action marking the stage of Development.

3.4.1 Project Schedule

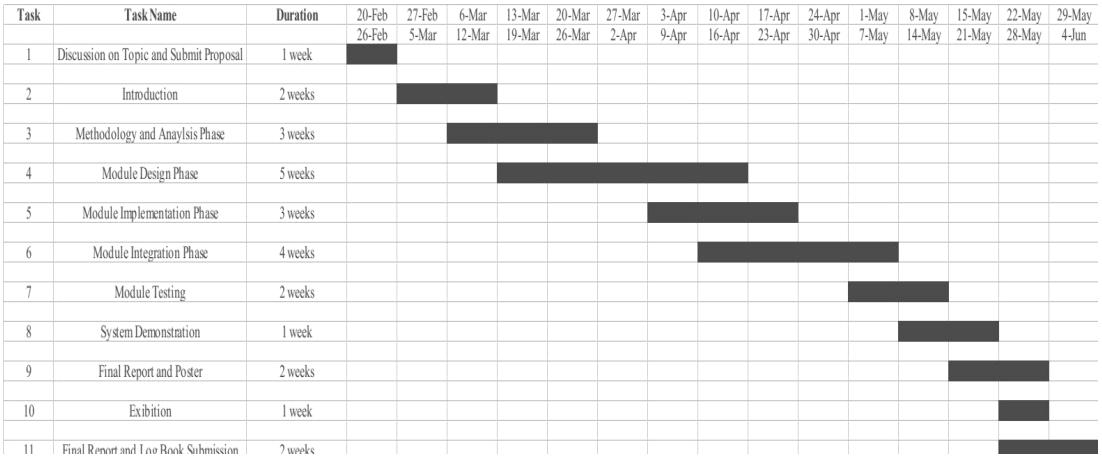


Figure 3.2: Project schedule of the project

3.4.2 Milestones

Week	Activity	Note / Action
1 13-17 Feb **Meeting 1**	Proposal PSM: Discussion	Deliverable – **Proposal** Action – Student
	Proposal assessment & verification	Action – Supervisor, Evaluator
2 20-24 Feb	Proposal Correction/Improvement	Action – Student
	List of supervisor/title	Action – PSM/PD Committee
3 27 Feb - 3 Mac **Meeting 2**	Proposal Presentation & Submission via PSM Online System Chapter 1 (System Development Begins)	Deliverable – **Proposal Presentation (PP)** Action – Student
4 6-10 Mac	Chapter 1 Chapter 2	Deliverable – **Chapter 1** Action – Student, Supervisor
5 13-17 Mac	Chapter 2	Action – Student
6 20-24 Mac **Meeting 3**	Chapter 2 Chapter 3	Deliverable – **Chapter 2** **Progress Presentation 1 / Pembentangan Kemajuan 1 (PK 1)** Action – Student, Supervisor
	Student Status	Warning Letter 1 Action – Supervisor, PSM/PD Committee
7 27-31 Mac	Chapter 3 Chapter 4	Action – Student
8 3-7 Apr	**MID SEMESTER BREAK**	
9 10-14 Apr	Chapter 4 Project Demo	Deliverable: **Chapter 3** Action – Student, Supervisor
10 17-21 Apr **Meeting 4**	Chapter 4 Project Demo	Deliverable – **Progress Presentation 2 / Pembentangan Kemajuan 2 (PK 2)** Action – Student, Supervisor
	Student Status	Warning Letter 2 Action – Supervisor, PSM/PD Committee
11 24-28 Apr **Demonstration**	Project Demo	Action – Student
	Determination of student status (Continue/Withdraw)	Submit student status to Committee Action – Supervisor, PSM/PD Committee
12 1-5 May	Project Demo PSM1 Report	Action – Student, Supervisor
13 8-12 May **Meeting 5**	Project Demo PSM1 Report PSM 1 Showcase Poster Submission	Action – Student, Supervisor
14 15-19 May	Project Demo Submission of the PSM1 Report onto the PSM e-Repository online system	Deliverable – **Complete PSM1 Draft Report** Action – Student, Supervisor
15 22-26 May **PSM 1 Showcase**	**PSM 1 SHOWCASE** **Wed, 24 May 2017; 8:00am - 5:00pm**	Action – Student, Supervisor, Evaluator, PSM/PD Committee
16 29 May - 2 Jun	**REVISION WEEK** Correction on the draft report based on the comments by the Supervisor and Evaluator during the final presentation session Submit PSM1 Logbooks to PSM Online System	Deliverable – **Complete PSM1 Logbooks** Action – Student, Supervisor
	Submission of overall marks to PSM/PD committee	Deliverable: **Overall PSM1 score sheet** Action – Supervisor, Evaluator, PSM/PD Committee
17 & 18 5-18 Jun	**FINAL EXAMINATION WEEKS**	

Figure 3.3 Milestone for PSM 1

PSM 2 MILESTONES, SEM 3 (8 weeks)

Week	Activity	Note / Action
1 **Meeting 1**	Chapter 4 Chapter 5	Deliverable – **Chapter 4** Action – Student, Supervisor
2 **Meeting 2**	Chapter 5 Project Demo	Deliverable – **Progress Presentation 1 / Pembentangan Kemajuan 1 (PK 1)** Action – Student, Supervisor
3	Chapter 5 Chapter 6	Deliverable – **Chapter 5** Action – Student
	Student Status	Warning Letter 1 Action – Supervisor, PSM/PD Committee
4 **Meeting 3**	Chapter 6 Project Demo	Deliverable – **Progress Presentation 2 / Pembentangan Kemajuan 2 (PK 2)** Action – Student, Supervisor
5 **Meeting 4**	Chapter 6 Chapter 7	Deliverable – **Chapter 6** Action – Student, Supervisor
	Presentation schedule	Action – PSM/PD Committee
	Student Status	Warning Letter 2 Action – Supervisor, PSM/PD Committee
6 **Meeting 5**	Chapter 7 Project Demo PSM2 Report	Deliverable – **Chapter 7 & Complete PSM2 Draft Report** Action – Student, Supervisor
	Determination of student status (Continue/Withdraw)	Submit student status to Committee Action – Supervisor, PSM/PD Committee
7 **Final Presentation**	**FINAL PRESENTATION & PROJECT DEMO**	Action – Student, Supervisor, Evaluator & PSM/PD Committee
8	**FINAL EXAMINATION WEEK** Correction on the draft report based on the comments by the Supervisor and Evaluator during the final presentation session Submit PSM2 Logbooks to PSM Online System	Deliverable – **Complete PSM2 Logbooks** Action – Student, Supervisor
	Submission of overall marks to PSM/PD committee	Deliverable: **Overall PSM2 score sheet** Action – Supervisor, Evaluator, PSM/PD Committee
9	**INTER-SEMESTER BREAK** Submission of the final complete report, which is the updated & corrected PSM2 report, onto the PSM e-Repository online system	Deliverable – **Complete Final PSM Report** Action – Student, Supervisor

Last Updated: 19 July 2017 (Dr. Sazalinsyah Razali)

Figure 3.4 Milestone for PSM 2

3.5 Conclusion

Planning is bringing the future into the present so that you can do something about it now. These actions could improve the performance and ensure there is enough time to get the tasks done. Making sure on what need to be done from the methodology chosen, the requirements of the projects and project schedule and milestone ensure that the project could be achieved in the given duration. Being on track on a project is crucial to show our dedication to the project.

Chapter IV

Propose Methodology

4.1 Introduction

This chapter focuses on the more detailed methods or steps that are being done in each phase stated in the project methodology in chapter 3. The planning phase focuses on gathering data for the project. The next part of this chapter is analysis phase. In analysis phase, the first step is to understand the data and ways to interpret the data. Design phase is next. This phase ensures that the vision of what needed to be done in solving the problem is already figured out. This is mean that the prototype of the system is out. Implementation phase is the stage that comes next where the design of the vision is finally being executed. The results are shown in this phase. However, the interpretation and deeper analysis of the results will be done in the following chapter.

4.2 Planning Phase

In this phase, finding the right data for the problem is very important. In order to build a good system, the input must be first collect. Hence, planning phase will be about gather the QS university input.

4.2.1 QS university ranking data.

Previously chapter QS university criteria have been mention but as for the criteria we need some data to transform it into the criteria. Hence, base on QS

themselves, the data requirement is listed in the their official website. The basic data will be number of student, number of lecturer, number of international student, number of international lecturer, number of outbound student, number of inbound student, number of lecturer with PhD, number of academic nomination, number of employee nomination, number of citation in Scopus database and number of paper that prepared by the university in Scopus database.

Phase

In this project, there are no databases due to the system is simulation and analysis system. The user required to load the comma-separated values (csv) file in order to do the simulation. The attribute and arrangement in the csv file is required to follow for the system to able work. Hence, the data will be arrange as in the Figure 4.1 for the raw input. Hence, from the raw input it will convert into the criteria that required for QS university ranking by using formula. The formula will be shown in Table 4.1.

Student	Lecturer	Internation	Internation	Outbound	Inbound St	Lecturer w	Academic	Employee	Citation	Paper
11760	899	514	24	14	41	613	36	10	36	50

Figure 4.1 Arrangement of the input in csv

Table 4.1 Formula for the criteria

Criteria	Formula
Academic reputation	Number of Academic Nomination / 200 * 30
Employer reputation	Number of Employer Nomination / 50 * 20
Faculty/Student ratio	Number of Academic Staff / Number of Student * 15
Citation per paper	Number of Citation / Number of paper * 10
Paper per faculty	Number of paper / Number of Academic Staff * 10
Staff with PhD	Number of Academic Staff with PhD / Number of Academic Staff * 5
Proportion of international faculty	Number of international Academic Staff / Number of Academic Staff * 2.5
Proportion of international students	Number of international Students / Number of Students * 2.5
Proportion of inbound exchange students	Number of inbound exchange students / Number of students * 2.5
Proportion of outbound exchange students	Number of outbound exchange Students / Number of Students * 2.5

4.4 Design Phase

In this phase, there are 3 parts of it. Those are the design of the interface, the flow of the system which will be the flowchart and explanation of it, and lastly will be the fuzzy inference system.

4.4.1 Design of the interface

The interface is designed by using one of the python library called tkinter. The flow of the interface and the steps of using it will be explain in below follow with 5 figures from Figure 4.2 to Figure 4.6.

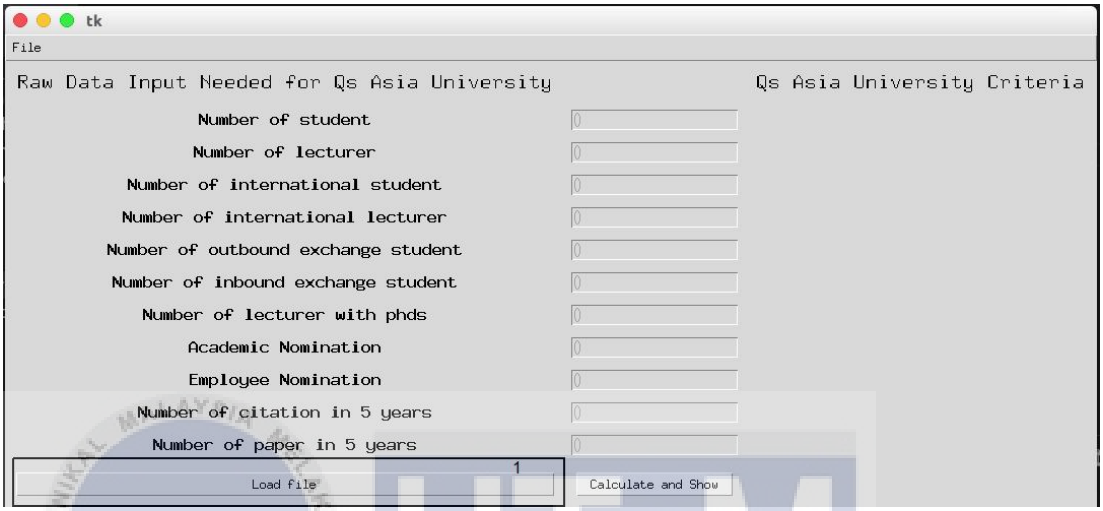


Figure 4.2 Interfaces of the system.

When the system start up it will be show up like Figure 4.2. There are 10 input that required user to input using CSV file that mention in analysis phase. Hence, the user first step need to load the file by pressing the load file label with 1. After press the load file button it will show up like Figure 4.3.

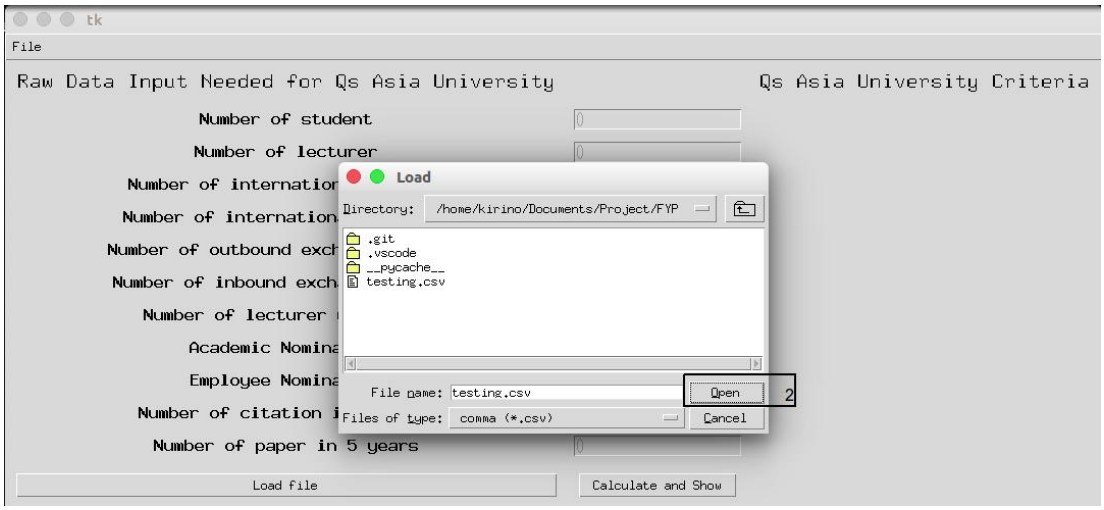


Figure 4.3 Load file interface

In this interface, user can choose the directory of their file location and it only accept CSV files. After user choosing the file, user can press open with the label 2. If user plan to cancel, user can press the cancel button. Then, if user press open button, they will see the interface like Figure 4.4.

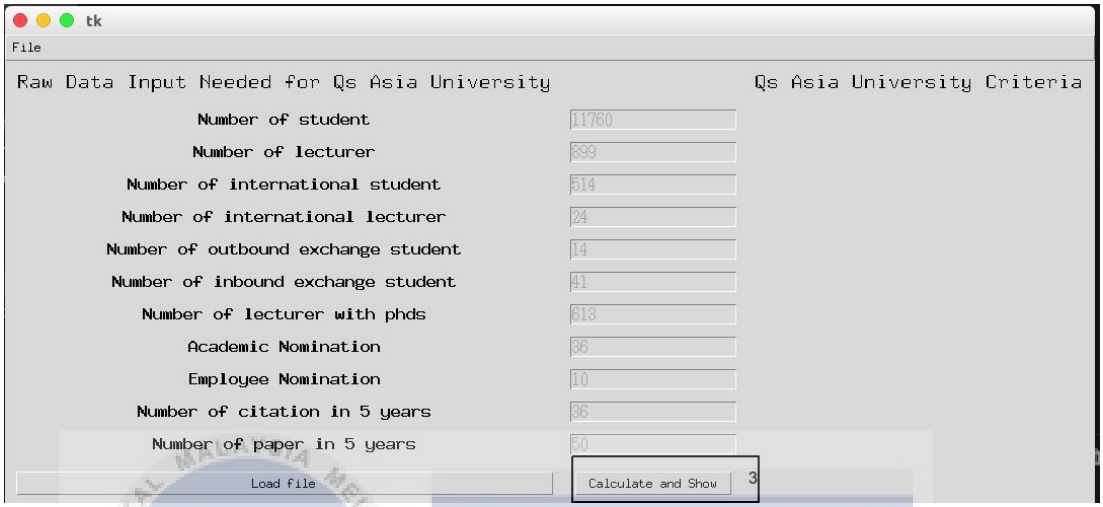


Figure 4.4 After get the data input

After load file, the data will go to their specific place and then user can process it by pressing calculate and show in the label 3. After pressing it, the system will show the calculated criteria as shown in Figure 4.5

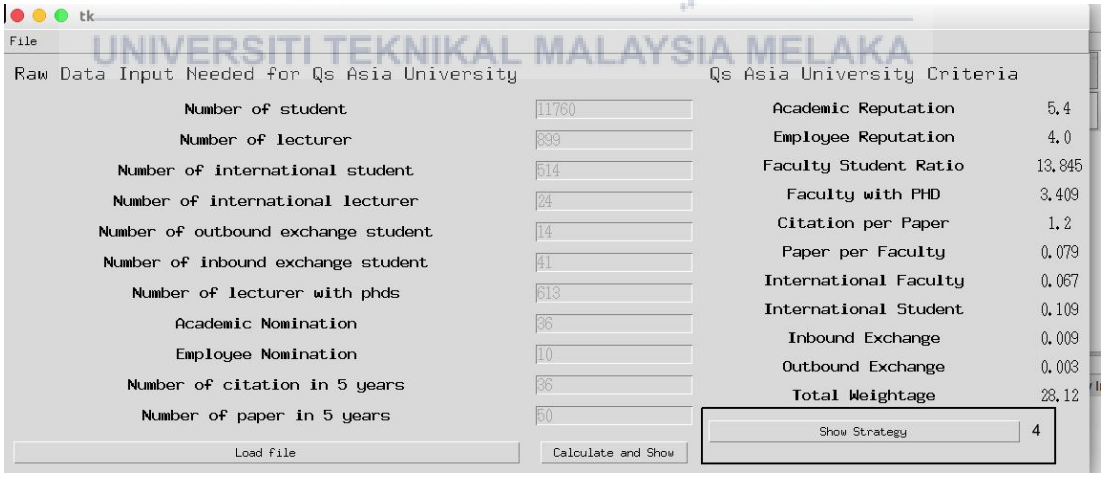
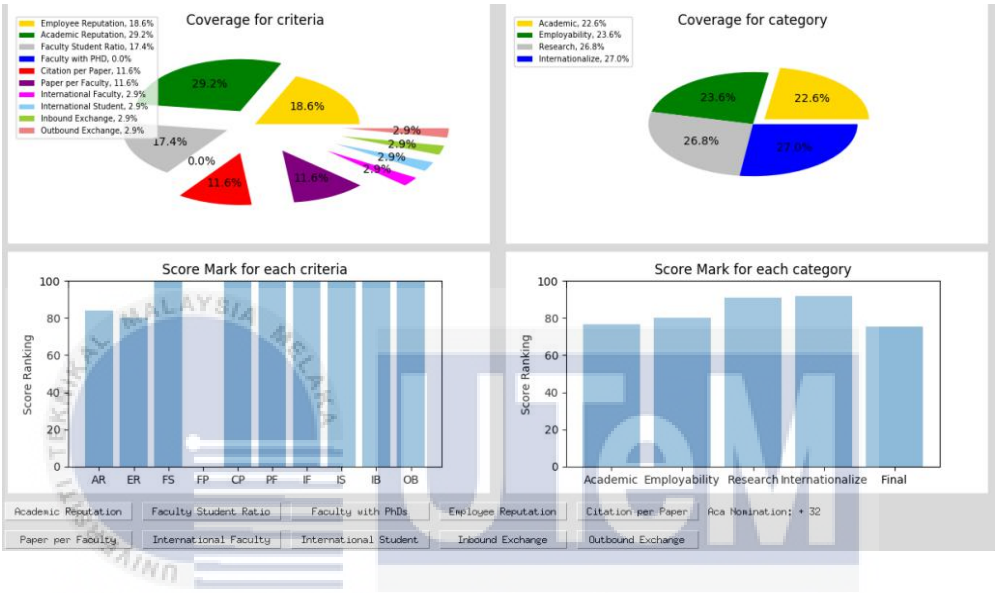


Figure 4.5 Criteria shown interface

The system will show the QS Asia University Criteria with the calculated value by using the formula stated in analysis phase. After this user can press show strategy in order to show the strategy stated by the system. The Figure 4.6 shows as below.

Figure 4.6 Strategy interface



This is the last interface of the system and it has 4 different graph. The top left graph shows the coverage score for the criteria while the top right graph shows the coverage score for the category. The bottom left graph show the exact score mark for each criteria while the bottom right show the score mark for each category. The flow of the system will be stated more clear in the next sub chapter.

4.4.2 Flow of the system

In this part, the flowchart will be show in Figure 4.7 and every detail of the step will be further explain. The flowchart is to ensure the system architecture will be optimized and less bug appear. It also ensure they neat of the system and easily maintenance later on.

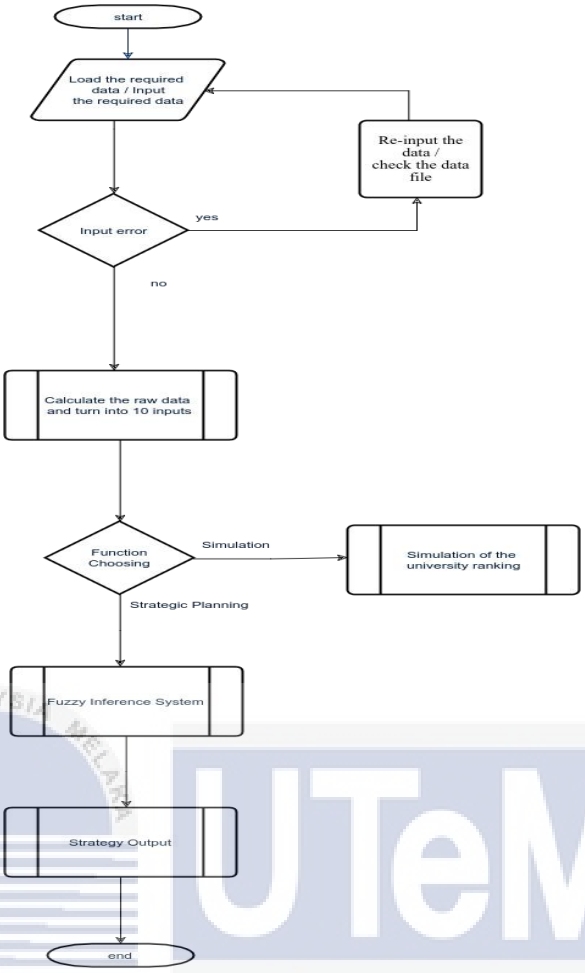


Figure 4.7 Flowchart of the system

According with the flowchart, the first step of the user can do is key in the required input or load the csv file. In here, the input is integer. Other than integer input, the system will be tell the error and ask user to re-input. After the user input, the system will show the criteria value by using the formula defined in analysis phase. After then, user can choose to use the simulate the university ranking or go to strategy phase. If user choose to use the simulate university ranking, they are required to load the ranking file in csv form. Otherwise, the strategy phase will be show the result of the strategy determined by the system using fuzzy inference system.

4.4.3 Fuzzy inference system

In this part, the design of the fuzzy inference system will be show. The fuzzy inference system that use in this project is nested fuzzy inference system and it will be further explain in below. The fuzzy inference system diagram will be shown as Figure 4.8.

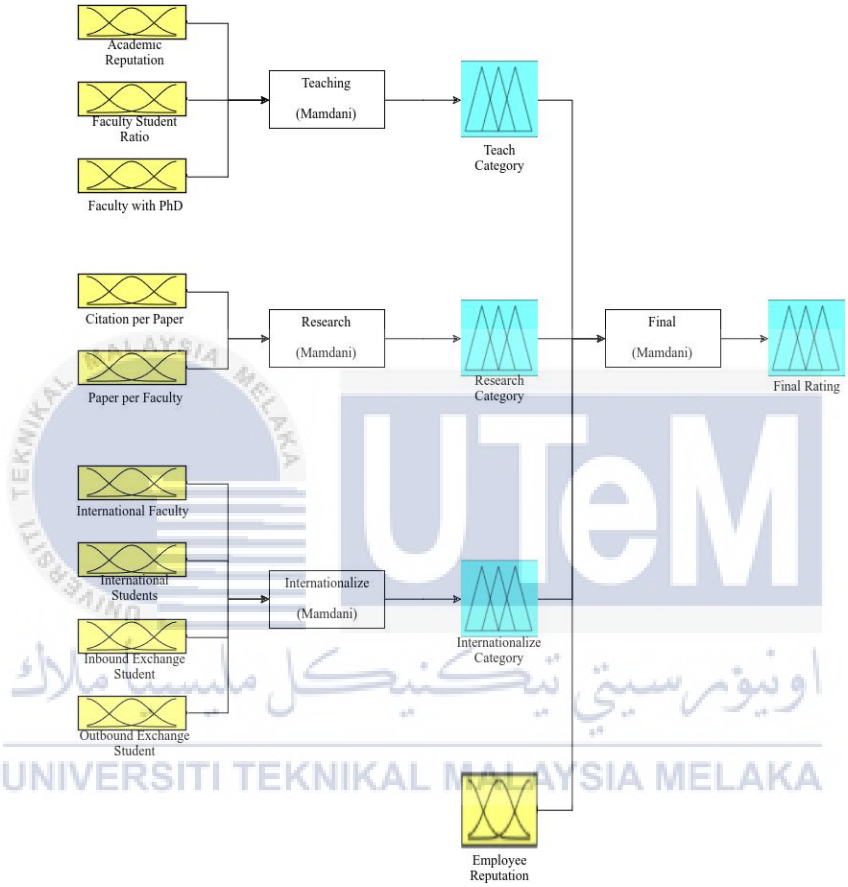


Figure 4.8 Fuzzy Inference System

For the fuzzy inference system, 10 criteria for the QS Asia university ranking are used to make the decision and from 10 criteria they will separate into 4 category which is teaching category, research category, internationalize category and employee category where employee category only consist of 1 input hence it does not required fuzzy inference system to make it into category. For teaching category, there are 3 input which is academic reputation, faculty student ratio and faculty with PhD. For the research category, there are 2 input which is citation per paper and paper per faculty. For the last category which is internationalize category, there are 4

input which is consist of international faculty, international student, inbound exchange student and outbound exchange student. From the input of those criteria they will pass through their own fuzzy inference system and get the output of their own category. Then later on, the output of it will become the next input of the fuzzy inference system which is the final rating. In this project, the fuzzy inference system that used is mamdani. The rules are define based on the experts advise.

4.5 Implementation Phase

In this phase, the details of every steps include the rules implementation of fuzzy, pseudo-code of the main interface and pseudo-code of the function page. In this project, there are 3 script which is gui.py, func.py and fuzzy.py.

4.5.1 Implementation of the interface

In this project, the interface does not has much since it is straightforward coding but there are a few notable where the widget of the interface is using looping. The general pseudo-code for creating the widget is show as below.

```
fields = name for the label

for field in fields
        create the label widget
        create the entry widget
        pack the widget
end
```

Figure 4.9 Pseudo-code for creating widget

This algorithm make the interface for easily to maintain and easily to read. For example, if the fields increase from 5 to 10, the only thing that need to tweak is the fields variable by adding the name of the fields and all will be done by this algorithm.

4.5.2 Implementation of the calculate function.

In this project, there are a lot of calculation. In this part, the calculation covers the formula that state in analysis phase. Hence, in order to make it neat and nicely, there are 10 function corresponding to 10 criteria. The algorithm defined here will be the general pseudo-code as shown as Figure 4.10. The full coding will show in Appendix.

```
function (varible)
        x = apply formula
        return x with 3 decimal places
```

Figure 4.10 General pseudo-code for calculation

4.5.3 Implementation of fuzzy inference system

In this part, the fuzzy inference system would be using one of the python library called sci-kit fuzzy. In this library, all fuzzy required function is pre-defined. Hence, the only thing that we need to define is the fuzzy rules and membership function. As for the fuzzy rules and code will be show at Appendix. In this part, the example of some fuzzy rules and pseudo-code will be show and explain. Figure 4.11 show one of the fuzzy rules and Figure 4.12 show pseudo-code on how to build the fuzzy inference system.


```
IF Academic Reputation is 5 star AND Faculty-Student Ratio is 5 star
AND Faculty with PhD is 5 star THEN Teaching Category is 5 star
```

Figure 4.11 Fuzzy Rules

```
set the membership function for all the input and output
create rule for each membership output using control system
pack the rule into the fuzzy inference system using control system
```

Figure 4.12 Pseudo-code for fuzzy inference system

In this system, the fuzzy inference system that used is mamdani. Hence, the to compute the output , there are 4 steps which is determined the fuzzy rules, evaluate

the value by using the rule, unify all the input into one output set and defuzzified the output distribution in order to get the crisp set value. The detail on implementation this 4 step to the system will explain in below.

4.5.3.1 Fuzzy rules

In this system, python programming is used. The fuzzy rules is determined together with the information gather from internet and some expertise member. The example of rule compute will be shown in figure 4.13 and figure 4.14

```
        # membership for setting up the rule for teaching
        # rule 1 sub
        t_rule1_sub1 = (academic_reputation['1s'] &
fac_stu['1s'] &
                        (fac_phd['1s'] | fac_phd['2s'] |
fac_phd['3s'] |
                         fac_phd['4s']))
        t_rule1_sub2 = (academic_reputation['1s'] &
fac_stu['2s'] &
                        fac_phd['1s'])

        # rule 2 sub
        t_rule2_sub1 = (academic_reputation['1s'] &
fac_stu['1s'] &
                         fac_phd['5s'])
        t_rule2_sub2 = (academic_reputation['1s'] &
fac_stu['2s'] &
                        (fac_phd['2s'] | fac_phd['3s'] |
fac_phd['4s'] |
                         fac_phd['5s']))
        t_rule2_sub3 = (academic_reputation['1s'] &
                        (fac_stu['3s'] | fac_stu['4s']) &
                        (fac_phd['1s'] | fac_phd['2s'] |
```

Figure 4.13 Sub rule implementation for the main rule in teaching category

```
t_rule1 = ctrl.Rule(antecedent=(t_rule1_sub1 | t_rule1_sub2),
                    consequent=output_teaching['1s'],
                    label='Teaching Value 1 Star')
t_rule2 = ctrl.Rule(antecedent=(t_rule2_sub1 | t_rule2_sub2 |
                                t_rule2_sub3 | t_rule2_sub4 |
                                t_rule2_sub5 | t_rule2_sub6 |
                                t_rule2_sub7),
                    consequent=output_teaching['2s'],
                    label='Teaching Value 2 Star')
t_rule3 = ctrl.Rule(antecedent=(t_rule3_sub1 | t_rule3_sub2 |
                                t_rule3_sub3 | t_rule3_sub4 |
                                t_rule3_sub5 | t_rule3_sub6 |
                                t_rule3_sub7 | t_rule3_sub8),
                    consequent=output_teaching['3s'],
                    label='Teaching Value 3 Star')
t_rule4 = ctrl.Rule(antecedent=(t_rule4_sub1 | t_rule4_sub2 |
                                t_rule4_sub3 | t_rule4_sub4 |
                                t_rule4_sub5 | t_rule4_sub6 |
                                t_rule4_sub7 | t_rule4_sub8),
                    consequent=output_teaching['4s'],
                    label='Teaching Value 4 Star')
t_rule5 = ctrl.Rule(antecedent=(t_rule5_sub1 | t_rule5_sub2 |
                                t_rule5_sub3 | t_rule5_sub4),
                    consequent=output_teaching['5s'],
                    label='Teaching Value 5 star')
```

Figure 4.14 Implementation of main rule for teaching category

Those implemented are using one of the python programming library called scikit fuzzy library. Those library have their own predefined function. Hence, those membership function act as the parameter for the predefined function. Due to the system have 11 input, hence they are grouping into their own category said in previous chapter.

4.5.3.2 Aggregation of rule

In this library, the aggregation of rule is simple due to the predefined function. Hence, the aggregation of rule is using one of the predefined function called control system. The figure 4.15 below shown the example of the aggregation of rule.

```
teaching_system = ctrl.ControlSystem(rules=[t_rule1, t_rule2,
                                            t_rule3,
                                           t_rule4, t_rule5])
```

Figure 4.15 Implementation of aggregation

4.5.3.3 Implementation of Output

For the output, the function is called control system simulation where. The control system simulation is to gather the input and translate it to the output by using compute function. Hence, the fuzzy inference system is done. The example is shown in figure 4.16.

```
        teaching_rating =
ctrl.ControlSystemSimulation(teaching_system)
        ar_values = kwargs['Academic Reputation'] / 30 * 100
        fs_values = kwargs['Faculty Student Ratio'] / 15 * 100
        fp_values = kwargs['Faculty with PHD'] / 5 * 100
        teaching_rating.input['Academic Reputation'] = ar_values
        teaching_rating.input['Faculty Student Ratio'] =
fs_values
        teaching_rating.input['Faculty PHD Ratio'] = fp_values
        teaching_rating.compute()
        teach = teaching_rating.output['Teaching Value']
```

Figure 4.16 Implementation of the output

4.6 Conclusion

This chapter shows step by step on the basic data of QS university data transform to the criteria data. Then later, transform into the input of fuzzy inference system. Next, the output obtained is then explained in general on what does it means and what details that can be seen in it. This part will then be described in the next chapter which is the analysis of the results.

CHAPTER V

TESTING

5.1 Introduction

This chapter focuses on the analysis of the result obtained from chapter 4 so that the meaning of the results can be analyze in details. This part is divided into several parts based on the objectives stated in chapter 1. The first objective is focusing on using python programming to design a better way relay the strategy message. The further detail will discuss in below. The second objective is to show how to use the formula and fuzzy algorithm to make the graph and relay the strategy to the user.

5.2 Testing

Testing is the 5th phase in the software development life-cycle. This phase of the phase where you testing if the project succeeded based upon the objectives. If the project is succeeded, the result will be either in graph or sentence.

5.3 Data

This section is showing the data use in this project. In this project, 3 university data is been used. The university that use in this project is University A, University B and University C. Figure below show the data.

	A	B	C	D	E	F	G	H	I	J	K
1	Student	Lecturer	Internation	Internation	Outbound S	Inbound Stu	Lecturer wit	Academic N	Employee N	Citation	Paper
2	13868	2807	3712	772	1500	2000	636	168	40	124528	20841

Figure 5.1 University A Data

	A	B	C	D	E	F	G	H	I	J	K
1	Student	Lecturer	Internation	Internation	Outbound S	Inbound Stu	Lecturer wit	Academic N	Employee N	Citation	Paper
2	11654	899	514	24	14	41	613	36	10	36	50

Figure 5.2 University B Data

	A	B	C	D	E	F	G	H	I	J	K
1	Student	Lecturer	Internation	Internation	Outbound S	Inbound Stu	Lecturer wit	Academic N	Employee N	Citation	Paper
2	15342	2222	480	18	100	40	487	33	25	150	879

Figure 5.3 Universiti C Data

5.3.1 Data Accessibility

After gather the data from the university website, change it into the format of csv as above then load into the system. The system will change the raw data input into criteria needed based on the formula that implemented into the system. As for the data, can be input by using csv format.

5.3.2 Limitation

In this project, not all data can be obtain from website since some of the data are confidential and sensitive data. Hence, some of the data are replace by dummy data after research on their website and use the most appropriate dummy data. The dummy data is calculate based on the assumption and a few year of performance shown in their website.

5.3.3 Transform of data

After having data in csv form, load it on the system and execute it. The step will show as below. The interface for 3 would be the same but the result might be different from each other. The diagram below is to show the transformation of the raw data to criteria needed using the formula that implemented in the system.

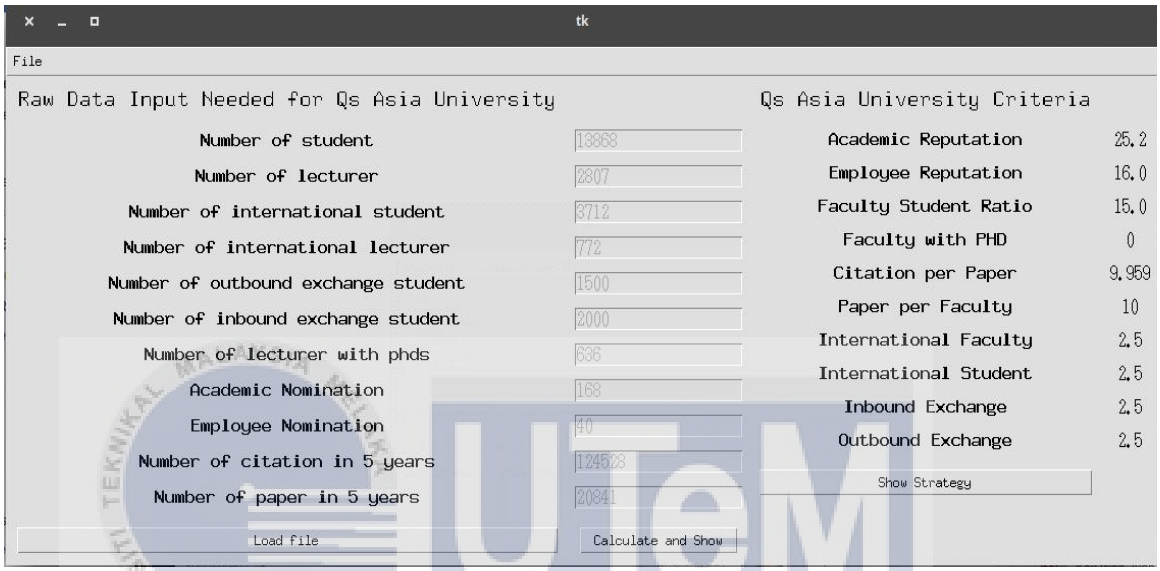


Figure 5.4 University A's data transform

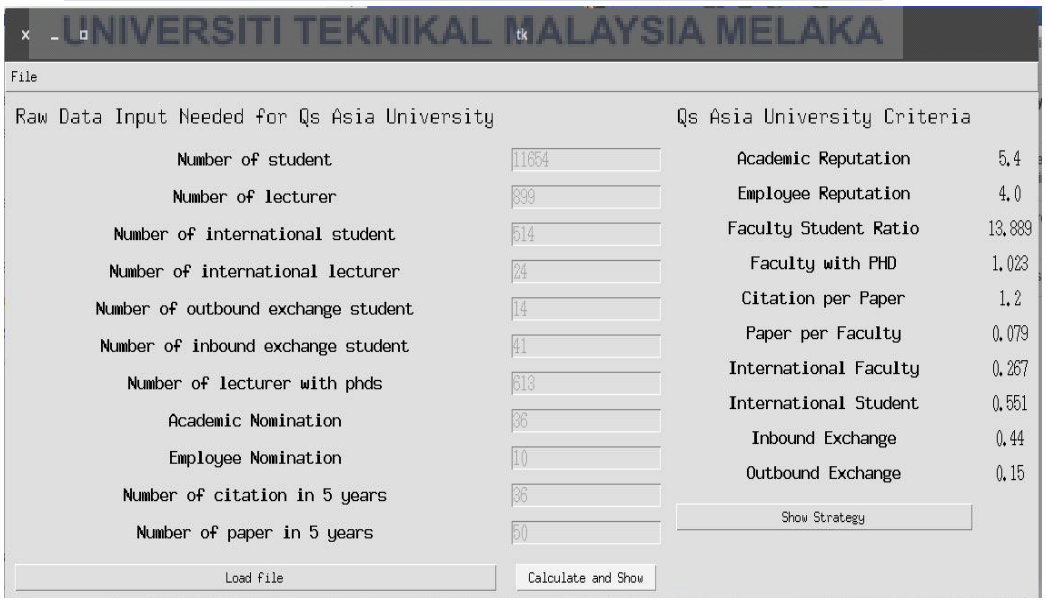


Figure 5.5 University B's data transform

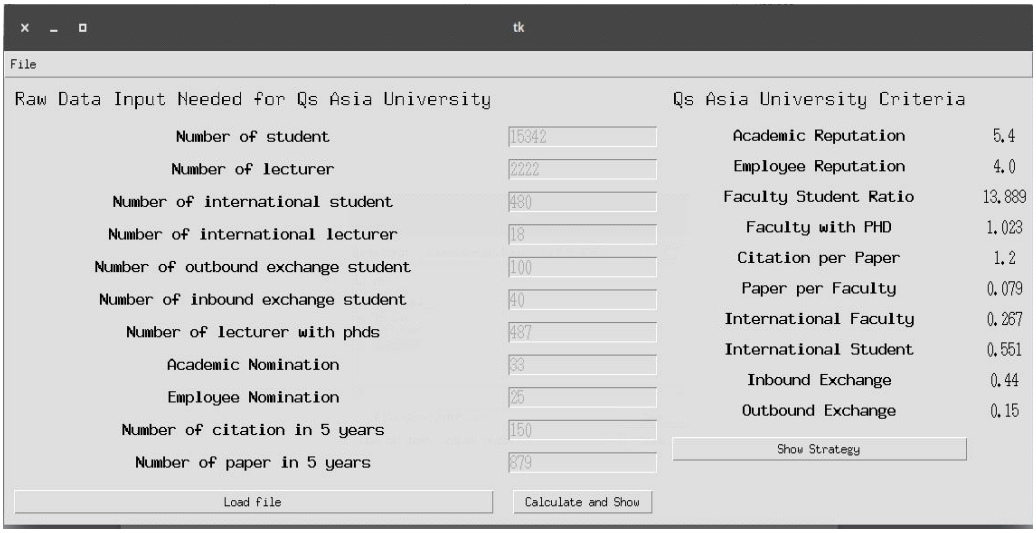


Figure 5.6 University C's data transform

The above each diagram show 3 different university with their own result. As we can see, the result above in the right side showing the criteria by using the input that in the csv. Those criteria are later use on the fuzzy logic inference system and showing the strategy result. The further discussion will show in the next sub-chapter.

5.4 Result

In this chapter, result will be discuss in below. The result of this project is very significant as it is to ensure the objective of this project is met. The result below will split into 2 part discuss which is the explanation of the graph and the predictive value given by the system. In this system there are 4 graph in one screen which will be discuss in below sub chapter. The predictive value is based on criteria which will be discuss in below.

5.4.1 Comparison result

In this part, each graph will be explained in detail for the 3 university and comparing their result. The discussion will be further describe in below in detail. In the graph, the color of pie chart of left side is represent the category in the right side.

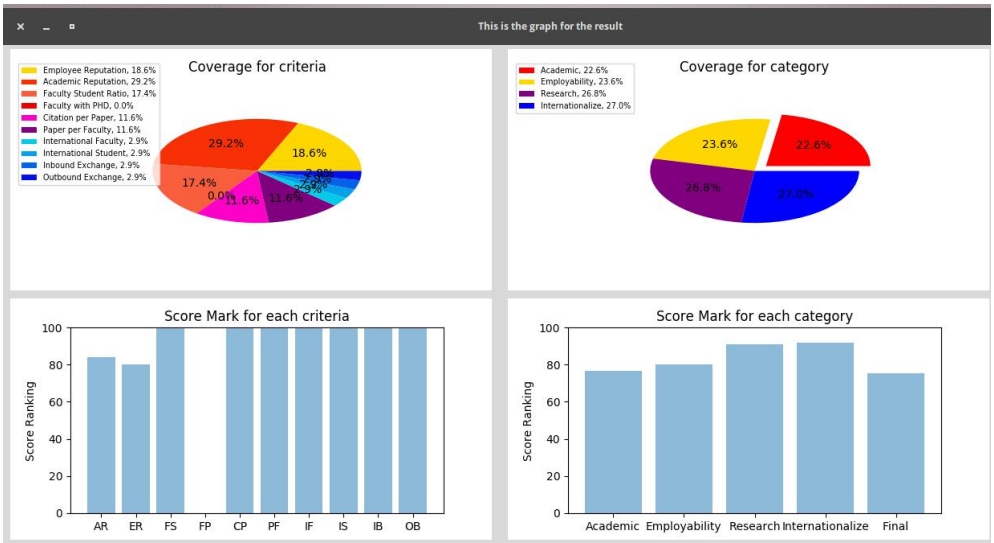


Figure 5.7 Result for University A

The figure 5.7 show the result for University A. The top left graph and bottom left graph is the pie chart for coverage the criteria and bar chart for the score mark in each criteria. In previously chapter, there are 10 criteria that fully explained. Hence, in the pie chart above, it show that the academic reputation has the large coverage but in the bar chart below the score mark for the academic reputation is around 80. Compare to other criteria such as citation per paper, paper per faculty and others that have 100 score mark but does not have that huge coverage compare to academic reputation. This is due to the weight-age for the academic reputation is much compare to other. Hence, from this we can conclude that the academic reputation have the important role in affecting the overall result. On the other hands, the faculty per PhD is 0 mark and coverage is 0%. This could effect the overall score score for the University A.

The top right graph and bottom right graph is the pie chart for category and bar chart for the score mark for each category. In previously chapter, there are 4 category which is explained. Hence, in the pie chart above it show that the internationalize category has the large coverage and this is because in the internationalize category the criteria is international faculty, international student, inbound exchange student and outbound exchange student which is score 100 mark respectively. In the other

hand the exploded pie chart is academic category which is academic reputation, faculty student ratio and faculty with PhD. Among this 3 criteria, although academic reputation has the highest coverage but faculty with PhD has the lowest coverage which result the academic category has the lowest coverage.

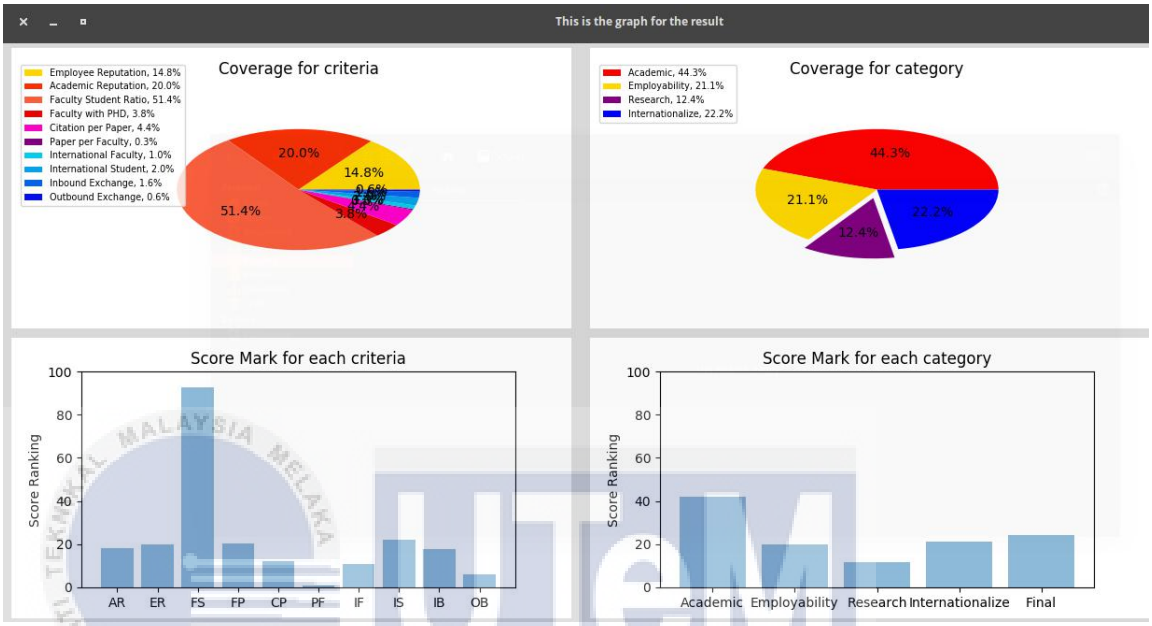


Figure 5.8 Result for University B

The figure 5.8 show the result for University B. The top left graph and bottom left graph is the pie chart for coverage the criteria and bar chart for the score mark in each criteria. In previously chapter, there are 10 criteria that fully explained. Hence, in the pie chart above, it show that the faculty student ratio has the large coverage and in bar chart it show that faculty student ratio has the highest score mark which is almost near 100%. But for University B other criteria are consistency around low score which which is in range from 0 to 25. The faculty student ratio is exponentially high compare to other. This unbalanced statistic is consider as a bad effect because it might show that the university only focus on one part only and drop off other part.

The top right graph and bottom right graph is the pie chart for category and bar chart for the score mark for each category. In previously chapter, there are 4 category which is explained. Hence, in the pie chart above it show that the academic category has the large coverage and this is because in the academic category the criteria is

academic reputation, faculty student ratio and faculty with PhD which the faculty student ratio is the outlier compare to other criteria. In the other hand the exploded pie chart is research category which is citation per paper and paper per faculty. Among this 2 criteria, the paper per faculty has the lowest score mark compare to other criteria which affect the category resulted in low coverage.

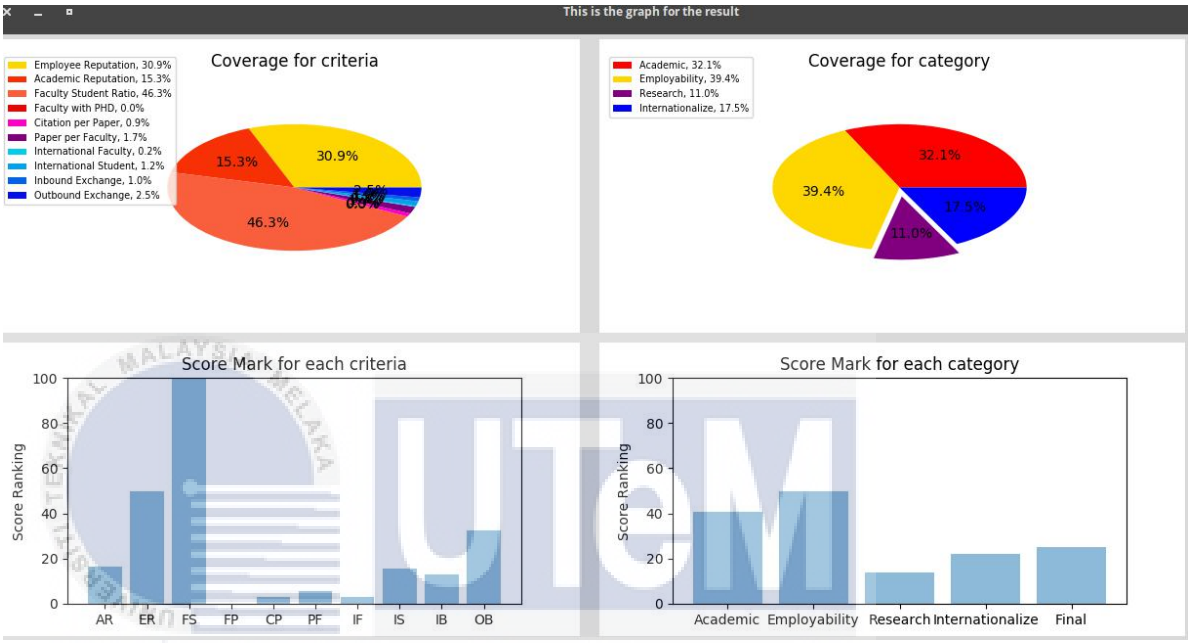


Figure 5.9 Result for University C

The figure 5.9 show the result for University C. The top left graph and bottom left graph is the pie chart for coverage the criteria and bar chart for the score mark in each criteria. In previously chapter, there are 10 criteria that fully explained. Hence, in the pie chart above, it show that the faculty student ratio has the large coverage and in bar chart it show that faculty student ratio has the highest score mark which is 100%. On the other hand the lowest score mark appear to be faculty with PhD which is 0%. As result, the University C appear to be more worse than University B due to the inconsistency among the 10 criteria.

The top right graph and bottom right graph is the pie chart for category and bar chart for the score mark for each category. In previously chapter, there are 4 category

which is explained. Hence, in the pie chart above it show that the employ-ability category has the large coverage and this is because in the employ-ability category the criteria, there are only 1 criteria which is employer reputation. In the other hand the exploded pie chart is research category which is citation per paper and paper per faculty. Among this 2 criteria, the paper per faculty has the lowest score mark compare to other criteria except faculty with PhD which affect the category resulted in low coverage. The reason why the academic category does not have the lowest coverage is because the highest criteria score mark and the lowest criteria score appear to be in the academic category as result the academic category does not have the lowest coverage.

5.4.2 Comparison prediction

In this part, the prediction of three university will be explain in the detail form. The prediction is based on the graph in order from 1 score rank to another score rank. For example, the academic reputation is 45% which is 15% more to score mark 60%. Hence, the amount of academic nomination which is the raw data input that required user key-in will be told by the system in order to improve the 15%.

Figure 5.10 Prediction of University A's academic reputation

In the figure 5.10, the prediction is made based on the graph, as result the academic reputation is over 80 score mark and prediction is made for achieving 100% score mark. Hence the system told 32 more academic nomination is required for the university in order to archive 100%.

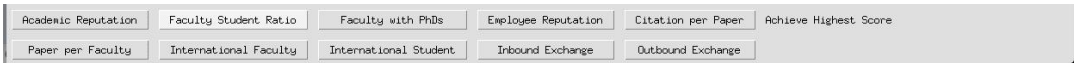


Figure 5.11 Prediction of University A's faculty student ratio

In the figure 5.11, the prediction is made based on the graph, as result the faculty student ratio is already 100% score mark. Hence, the system will told the highest score is archive.

Figure 5.12 Prediction of University A's faculty with PhD

In the figure 5.12, the prediction is made based on the graph, as result the faculty with PhD is lowest score mark in University A. The score mark for faculty with PhD is 0%. Hence, the prediction will make to archive 20% score mark. As result, the system will give the lecturer with PhD holder need to increase 1872 more in the existence lecturer.

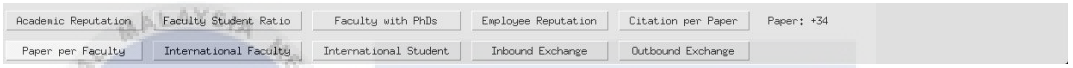


Figure 5.13 Prediction of University B's paper per faculty

Figure 5.14 Prediction of University B's citation per paper

In the figure 5.13 and figure 5.14, the prediction is made based on the graph, as result the research category is the lowest coverage. Hence the prediction will make from the both criteria which is paper per faculty and citation per paper. The paper that required for paper per faculty improve to 20% score mark is 34 while the number of citation required for citation per paper is 24.

Figure 5.15 Prediction of University C's citation per paper

Figure 5.16 Prediction of University C's paper per faculty

In the figure 5.15 and figure 5.16, the prediction is made based on the graph, as result the research category is the lowest coverage. Hence the prediction will make

from the both criteria which is paper per faculty and citation per paper. Although University C has the same criteria with University B but their score mark is different hence the result would be different. The paper that required for paper per faculty improve to 20% score mark is 1081 while the number of citation required for citation per paper is 905.

5.5 Conclusion

This chapter is focuses on the result obtained from the project and system based on the objectives. There are many new thing that learned through in project. Understanding the flow of the system and the resulted graph is important. The explanation of each graph such as why does the graph happened in this way is the most important part. Lastly, this phase could be the phase that proves whether this project could bring any help or convenient to other people such as institution.

CHAPTER VI

CONCLUSION

6.1 Observation on Weakness and Strength

There are a few weakness and strength that can be seen throughout of the project. First of all, the huge weakness in this project is that it is quite difficult to obtain the data for the criteria as some of the criteria required their own black-box survey question. Apart from that, due to the computational power not enough, there are a few technique that cannot run in this computer.

The strength of this project is that the dashboard truly show a lot of informative and easily understand. By using fuzzy logic algorithm, the graph is more informative and clearer than before.

6.2 Proposition for Improvement

The dashboard for QS university ranking could be improve further more by using neural network and genetic algorithm instead of solely using fuzzy logic. Beside, in the current prediction, it can only predict one criteria at one time. By using neural network and genetic algorithm, predicting multiple criteria simultaneously is possible.

There are problems with the dashboard loading with delay. By using better architecture or model might further improve the performance of the system. The example of architecture that could help is model-view-controller(MVC).

Apart from that , getting to know the QS trending could be give more informative data as it required more time to gather. A lot of data and analyses

could be done more with the data obtained.

6.3 Project Contribution

Project Contribution is a part of operationalize phase in the methodology where it could be used for other parties for their own purpose. This project could be used by other university or any education related organization to know the more about QS university ranking and visualize the result.

Apart from that, institution could use this project to use in further teaching or showing some interesting part to the student. This project could be a material for teaching in the basic of statistical analyses and python programming.

6.4 Conclusion

There are a lot of information that can be relay into graph by twisting and using more algorithm. In my opinion, Python programming is the easiest programming language to play around with data and relay the message from gathering the data. By understanding how it's work, the further work using python programming could be easier and this project might help other more understanding how the QS ranking world and the important of each criteria in this ranking system.

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