MTECH KE-4102 (ISBA) PROJECT REPORT

NUS STUDENT BUDGET RECOMMENDATION SYSTEM

TEAM MEMBERS

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MASTER OF TECHNOLOGY IN
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1.0 EXECUTIVE SUMMARY

The problem addressed in this project is that of international NUS students finding it difficult to estimate a budget plan for their life in Singapore and also the difficulty of finding the best suited housing solution.

This project uses a rule based system to simulate the knowledge of a housing agent and of current NUS students with stable budgets. This is used to provide instant and user-specific solutions for both housing and budgeting. The required knowledge has been acquired through interviews of housing agents and students, student surveys and online research. A key finding we had while building the system were that students often make budget decision based on a trade-off between minimizing cost and maximizing comfort.

The student budget recommendation system has been built as web app using Python for the user interface and CLIPS for the rule based system. The system takes the user's inputs on some questions regarding their priorities or constraints and provides a detailed housing and budget solution.

Future work that can be done on this system can include the addition of more housing areas into the knowledge base and use of supervised learning or other machine learning techniques to further improve the accuracy of the budget plan.

2.0 PROBLEM DESCRIPTION

Students come to NUS from various countries to study. Two of the main challenges faced by the foreign students is deciding on a suitable housing and planning their monthly expense budget. Currently, students rely on housing agents or websites for advice on housing. Students also lack knowledge on the cost of food and travel in Singapore and can only come up with a poor estimate based on online research.

The students' constraints on cost and comfort might not be satisfied by all locations. And the students' lack of knowledge on Singapore areas and the types of housing available makes it difficult for them to make a decision on housing.

Considering that housing has a direct impact on the students' monthly budget, which is also affected by factors like food and travel, it is problematic for a student to estimate their expenses earlier and procure the funds required ahead of time.

2.1 PROJECT OBJECTIVE

The objective of this project is to create a system that can recommend a housing solution as well as an estimate of the monthly budget for foreign students coming to NUS.

A rule based system is used for this. The knowledge required to decide the housing is obtained from current NUS students, housing agents and online sources. The current NUS students also serve as the main knowledge source for the monthly budget on housing, food and travel. In the estimation of monthly budget, the project only considers housing, food, travel and phone bill as the factors because they are the basic essentials for the students and all other expenses vary by a large amount.

The rule based system will ask questions to the user pertaining their preferences, constraints on cost and constraints on comfort. Based on the user's answers, the system maps a suitable area for the user to stay in. In building the system, only the areas in and around the NUS campus have been considered as this is where most students tend to stay. Based on other answers, the system also suggests a type of housing (HDB/Condo) and the suitable mode of travel to NUS.

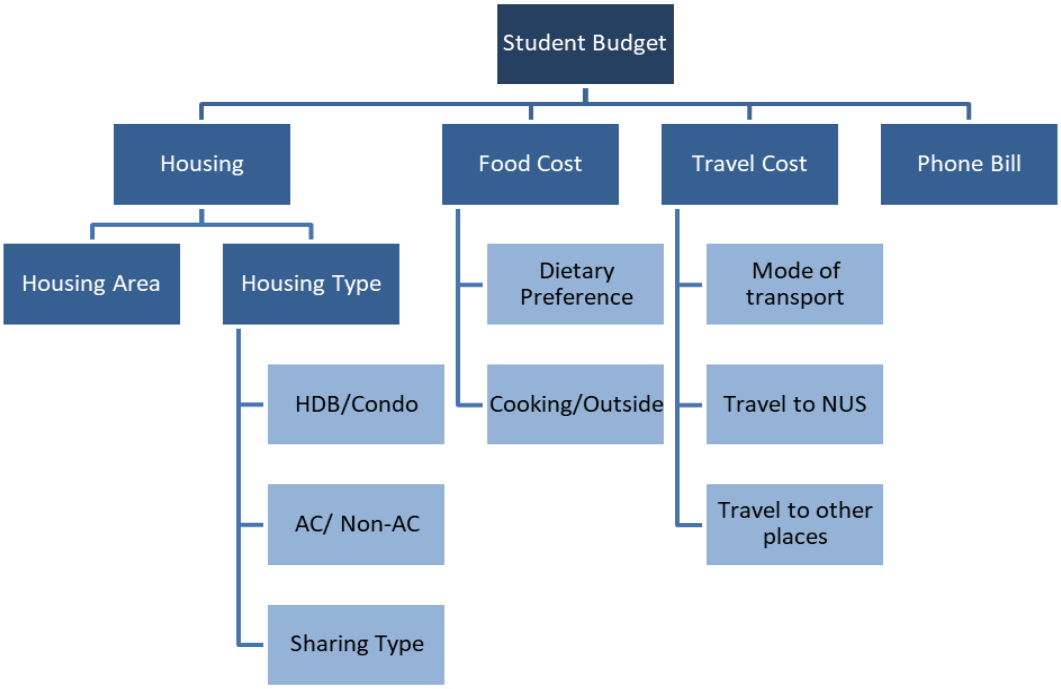
The system then calculates a monthly budget based on the suggestions of housing and travel and also the user's food preferences. The monthly budget and the split up across various spends is given as output to the user.

To implement the system, we will firstly acquire knowledge from the various sources, i.e. current NUS students, housing agents and online sources. The knowledge is represented in a readable form for easy understanding of the dependencies between various factors like housing and travel or student's preferences and housing, etc. Then we decide on a set of rules based on the knowledge and the data is represented as facts. The rules and facts will be programmed using the CLIPS engine to create the RBS. We will also implement a web based GUI for the system using Python.

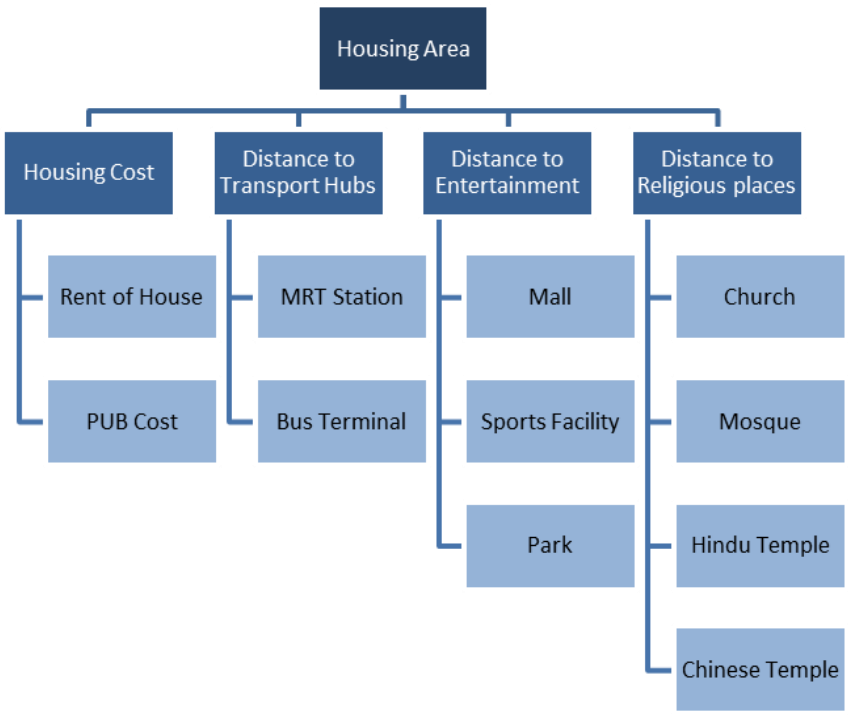
3.0 KNOWLEDGE MODELING

The knowledge was acquired from current NUS students, NUS alumni, housing agents and online sources. We have used interviews and surveys to obtain knowledge from NUS students.

The student budget is dependent on various factors. The dependency of the factors is shown in the diagram below:



The housing area is further dependent on various factors as illustrated below:



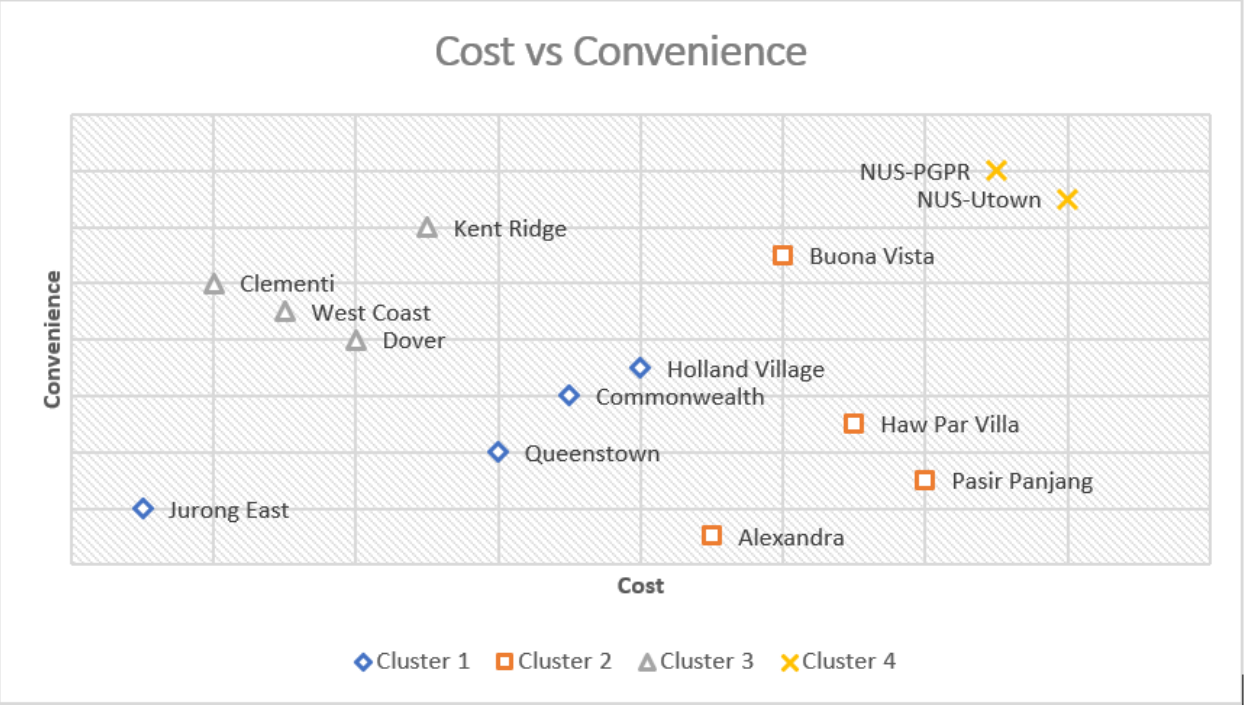
Housing Area

Based on the survey data and interviews, we found that most of the students stay in areas near the NUS campus. Based on the various areas that the current students are staying in, we chose only the following areas to be considered as recommendations:

Alexandra	Buona Vista	Clementi	Commonwealth	Dover
Haw Par Villa	Holland Village	Jurong East	Kent Ridge	NUS - PGPR
NUS - UTown	Pasir Panjang	Queenstown	West Coast	

Based on student interviews, we know that students select housing area based on two main factors, i.e. cost of living and convenience. For cost of living, we used the rental price of various apartments in the different areas and gave each area a score based on it. For convenience, we looked at whether the various facilities which students required are available in or nearby the areas and used this to give a weighted score.

Using the cost and convenience scores and also certain facts about the housing areas, we divided the areas into four clusters.



The clusters can be described as follows:

Cluster	Area	Cost & Convenience	Comments
Cluster 1	Holland Village, Commonwealth, Queenstown, Jurong East	Low cost & low convenience	These areas are far from the NUS campus compared to other areas
Cluster 2	Buona Vista, Haw par village, Pasir Panjang, Alexandra	High cost & high convenience	It is known that these areas are calm residential areas and most facilities are available within the apartment which makes them expensive
Cluster 3	Dover, Clementi, West cove, Kent Ridge	Low cost & high convenience	These areas are the ones closest to the NUS campus and where most students prefer to stay
Cluster 4	NUS-Utown, NUS-PGPR	Highest cost & most convenient	The NUS campus housing is comparatively costlier but have the best facilities which makes for easy living

Budget Estimate

Rental price for every type of apartment in all the areas was sourced from various housing websites and datasets containing median rental prices.

The cost for food was estimated using survey data, interviews and personal experience. Different estimates were calculated based on dietary preference and whether a person cooks or not.

The travel cost for bus/MRT was estimated using actual bus and MRT prices. The UBER pricing was used to estimate taxi cost. The price for cycle is estimated using mobike prices. The travel cost to other places was estimated using interviews and survey data.

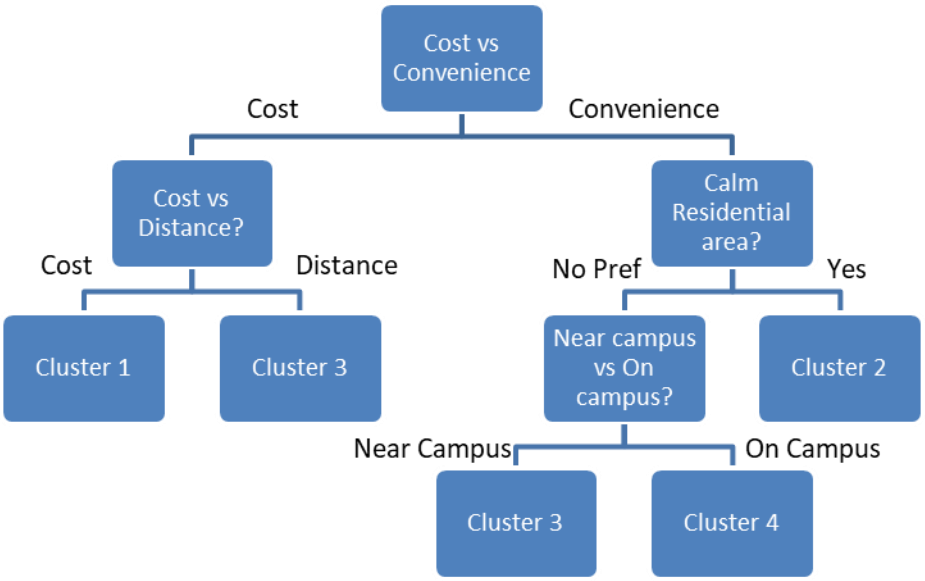
The phone bill cost was estimated using Singtel prices and personal experience.

4.0 SOLUTION OUTLINE

Solution Approach

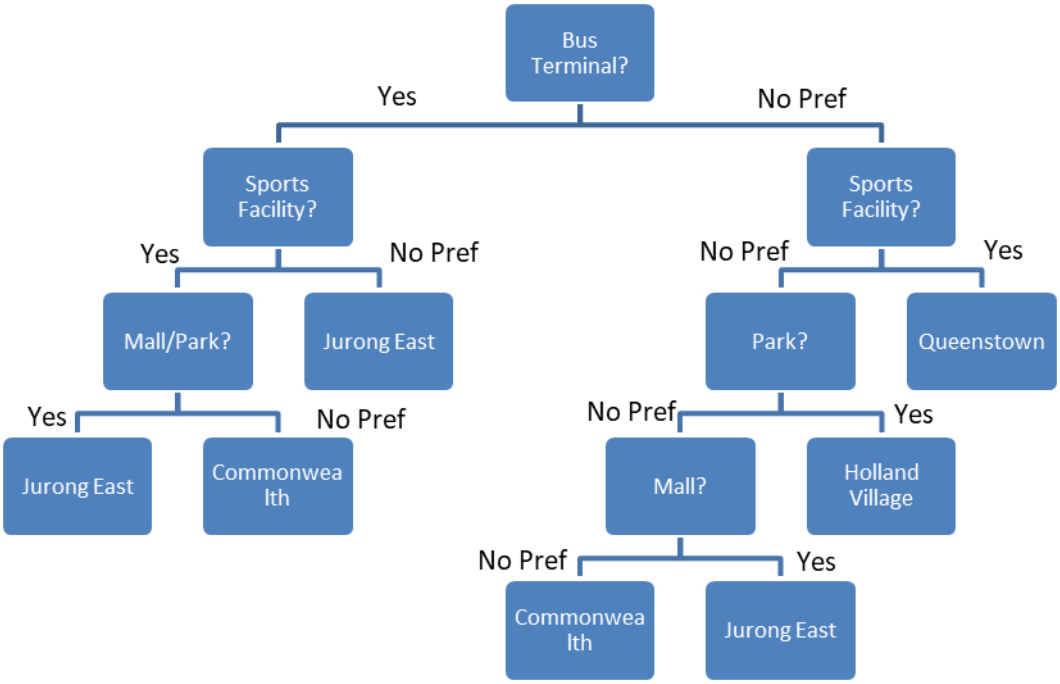
Our solution approach is divided into 5 stages. First, the system decides the best housing cluster based on a few questions. Then, the housing area is decided. The system then takes user input to estimate the rent component and the food cost. The housing area is used to decide the best mode of transport for the user. Finally, the system calculates the total cost of all components and gives the student budget.

Stage 1 – Cluster selection → this approach is used for selecting the housing cluster that will be suitable for the user based on the questions

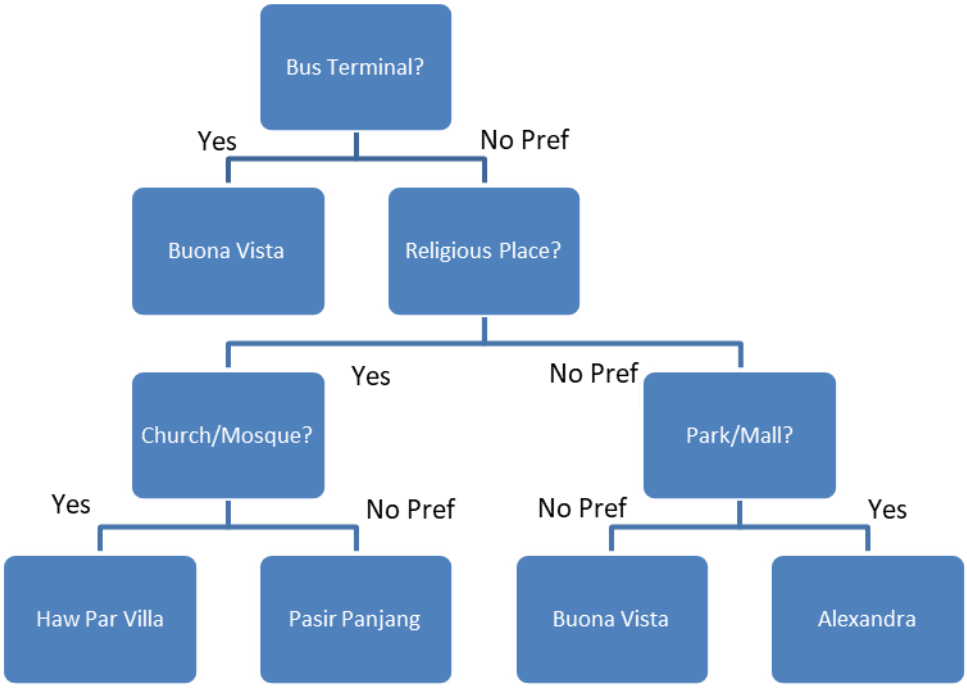


Stage 2 – Housing area selection → this approach is used for selecting the housing area that will be suitable for the user based on the questions. Different approaches are followed based on the selected housing cluster

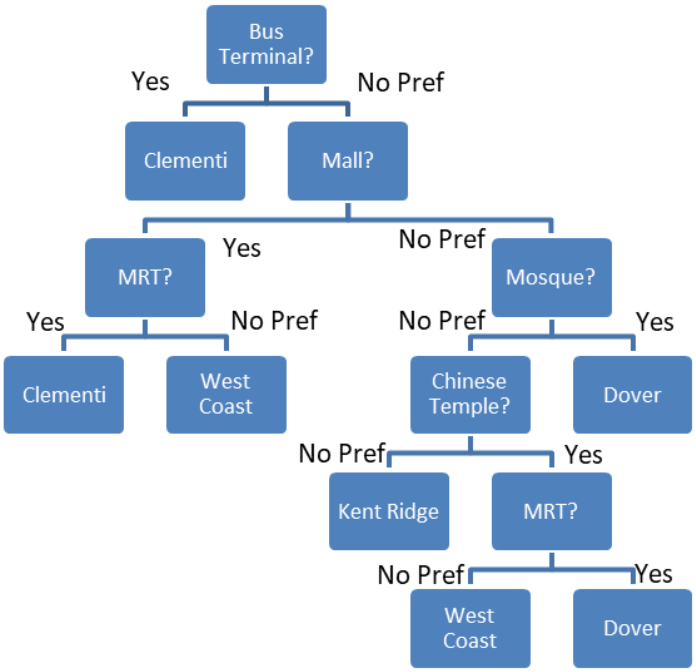
Cluster 1 – Jurong East, Commonwealth, Queenstown, Holland Village



Cluster 2 – Haw Par Villa, Pasir Panjang, Bouna Vista, Alexandra



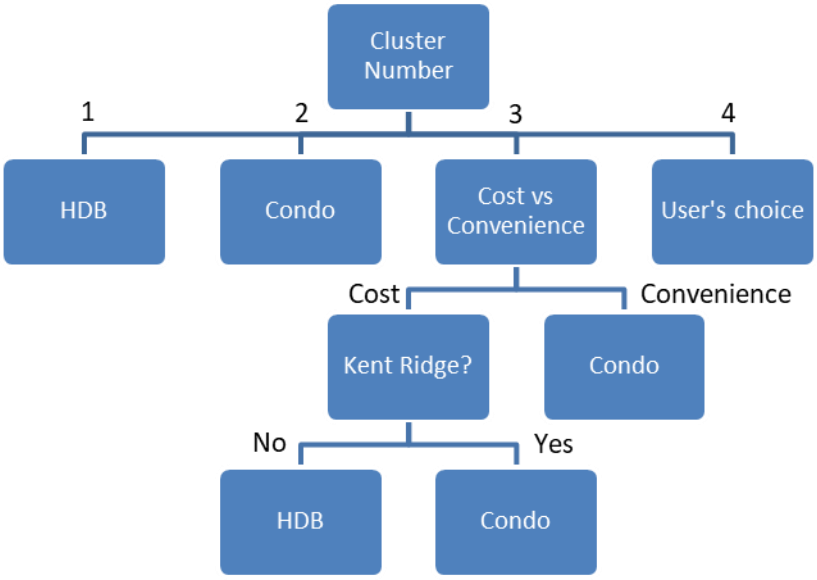
Cluster 3 – Clementi, West Coast, Dover, Kent Ridge



Cluster 4- PGPR Residences, UTown Residence

- Lively place, many student activities – UTown Residence
- Calm place, many in-house facilities – PGPR Residences

Stage 3 – Housing type selection → the housing type is selected based on the housing cluster and the area which has been recommended. The user's choice is also taken for whether the user wants to share the room and whether the user requires air conditioning. The rent is then estimated by matching the user's preferences with the knowledge base.



Stage 4 – Food cost calculation → the food cost is based on user's input. The dietary preference (veg/non-veg) and cooking frequency of the user is matched with estimated costs in the knowledge base to get the total food cost.

Stage 5 – Travel cost calculation → based on the housing cluster, the best travel mode is recommended to the user. The user has the option to change the travel mode if required. Finally, the travel mode selected and the housing area is matched with the knowledge base to retrieve the travel cost to NUS. The cost of travel to other areas is added as a constant number which has been estimated from survey and interview data.

4.1 SOLUTION UNIQUENESS

1. Our budget planning system is the first of its kind which specifically targets new NUS students. As new students ourselves, we have had difficulties in planning our budget without a system like this available. This makes the system better for any new student as they are expected to face the same problems as us

2. Apart from just calculating the budget, it also gives recommendations on the best housing area, housing type and travel mode for the student based on their preferences and constraints

3. Typically, budget planners only calculate the budget and have some static tips to save money and it also expects the user to know approximate expenditure. But, our system gives the best suited plan for every student only based on their preferences and also gives plans for food and travel expenses

4. Our system is built as a web app which, once hosted, can be used by anyone around the world without installing anything. The app also has a very user-friendly interface and gives a detailed budget plan in a nice format

4.2 SOLUTION ASSUMPTIONS

1. Most of our decisions are based on the trade-off between minimizing cost and maximizing convenience. We have assumed that the students' choice in this matter is binary rather than a scale of values

2. The cost given for travel to other places is a static value based on survey data and interviews. We assume that students usually tend to go out and spend money on weekends or evenings

3. To calculate the cost of phone bill, we have assumed a similar usage for all students

4.3 SOLUTION LIMITATIONS

1. We have considered only the areas where current NUS students are already staying. This mostly includes areas near the NUS campus

2. We have only considered the most basic essentials for students in the calculations. Extra spends like clothes, toiletries, etc. are not considered

3. For the calculation of convenience score, the housing areas are represented with a single landmark rather than the whole area

4. The current system is a static system which lacks dynamic loading of real time data

5.0 CONCLUSION & REFERENCES

From a knowledge base on housing and student budget, we built as rule based system which was able to create good budget plans for new NUS students.

Building a student budget recommendation system provided us knowledge of the housing domain, typical student spends, good budget plans and practical usage of rule based systems as recommenders. We also learnt that students mainly base most budget decisions on the trade-off between minimizing cost and maximizing comfort. Students also tend to have particular requirement in and near their housing areas.

Our student budget recommendation system can be further improved. The system takes into consideration only few areas and is specific to NUS students. This can be improved to include the whole of Singapore and other universities as well. The accuracy of our budget plan may also be further improved by considering supervised learning systems or other machine learning techniques.

5.1 REFERENCES

[1] https://www.sbstransit.com.sg/transport/trpt_fares_adults.aspx

[2] http://journey.smrt.com.sg/journey/bus_fare/

[3] http://www.hdb.gov.sg/cs/infoweb/residential/renting-a-flat/renting-from-the-open-market/rental-statistics

[4] https://www.propertyguru.com.sg/singapore-property-listing/property-for-rent?market=residential

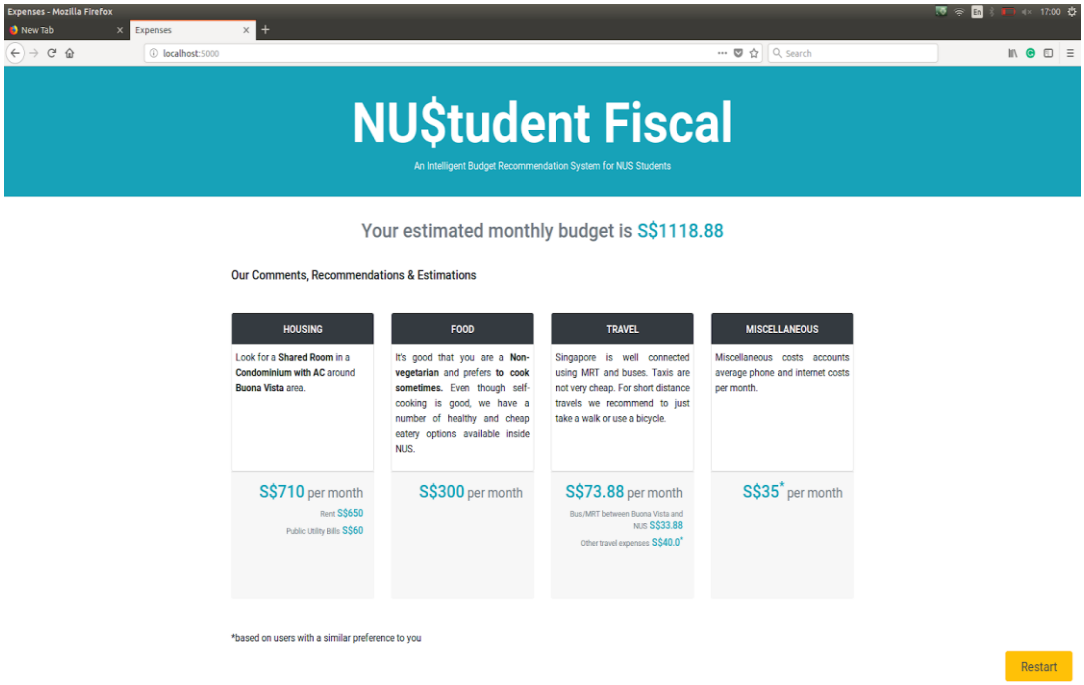
[5] https://www.singtel.com/personal/i/phones-plans/mobile/singtel-prepaid

[6] https://www.singtel.com/personal/products-services/mobile/postpaid-plans

APPENDIX A: SAMPLE INPUT & SYSTEM OUTPUT

SAMPLE 1 - Standard Case

~~~Welcome to NU$tudent Budget Recommendation System~~~

Are you ready to start? y

Question : Your Choice: What is your spending preference?

1. I can spend for the needs but wants to minimize the cost as possible

2. I can spend for comfort and convenience

(1/2) 2

Question : Your Choice: Do you want to stay at a calm residential area? (Yes/Nop) y

Question : Your Choice: Do you want a bus terminal nearby? (Yes/Nop) y

Question : Your Choice: Do you prefer to share the room? (Yes/No) y

Question : Your Choice: Do you prefer air conditioner in you room? (Yes/No) y

Question : Your Choice: What is your food preference?

1. Vegetarian 2. Non-Vegetarian

(1/2) 2

Question : Your Choice: How often do you cook?

1. Almost always 2. Sometimes 3. Never

(1/2/3) 2

Question : Your Choice: We recommend you to take a Bus/MRT to NUS.

Do you wish to change the preference? (Yes/No) n
~~~



SAMPLE 2 - Challenging Case

~~~Welcome to NU$tudent Budget Recommendation System~~~

Are you ready to start? y

Question : Your Choice: What is your spending preference?

1. I can spend for the needs but wants to minimize the cost as possible

2. I can spend for comfort and convenience

(1/2) 2

Question : Your Choice: Do you want to stay at a calm residential area? (Yes/Nop) n

Question : Your Choice: Do you prefer to stay at near but outside NUS campus? (Yes/No) y

Question : Your Choice: Do you want a bus terminal nearby? (Yes/Nop) n

Question : Your Choice: Do you want a mall nearby? (Yes/Nop) n

Question : Your Choice: Do you want a mosque near by? (Yes/Nop) n

Question : Your Choice: Do you want a chinese temple nearby? (Yes/Nop) n

Question : Your Choice: Do you prefer to share the room? (Yes/No) y

Question : Your Choice: Do you prefer air conditioner in you room? (Yes/No) y

Question : Your Choice: What is your food preference?

1. Vegetarian 2. Non-Vegetarian
~~~

(1/2) 1

Question : Your Choice: How often do you cook?

1. Almost always 2. Sometimes 3. Never

(1/2/3) 1

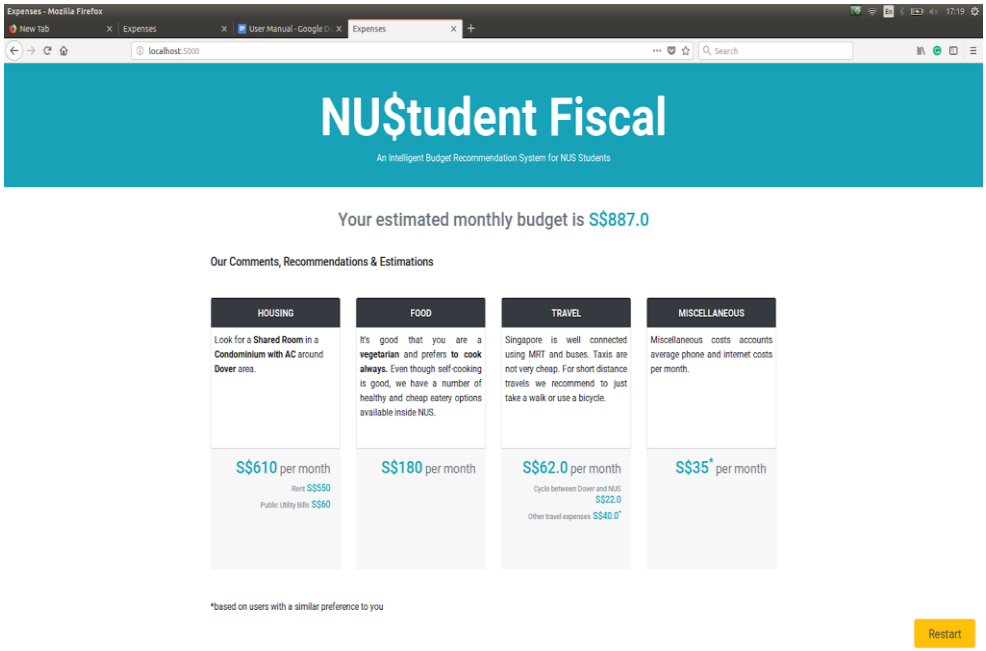
Question : Your Choice: We recommend you to take a Bus/MRT to NUS.

Do you wish to change the preference? (Yes/No) y

Question : Your Choice: What is your prefered mode of transportation to NUS?

1. Bus/MRT 2. Taxi 3. Cycle

(1/2/3) 3



SAMPLE 3 - Random Case

~~~Welcome to NU$tudent Budget Recommendation System~~~

Are you ready to start? y

Question : Your Choice: What is your spending preference?

1. I can spend for the needs but wants to minimize the cost as possible

2. I can spend for comfort and convenience

(1/2) 2
~~~

Question : Your Choice: Do you want to stay at a calm residential area? (Yes/Nop) n

Question : Your Choice: Do you prefer to stay at near but outside NUS campus? (Yes/No) n

Question : Your Choice: Which one of the following do you prefer in case of staying inside the campus?

1.A live and active place

2. A calm and more residential place

(1/2) 2

Question : Your Choice: Are you looking for an apartment for married couples? (Yes/No) n

Question : Your Choice: Do you prefer air conditioner in you room? (Yes/No) y

Question : Your Choice: What is your food preference?

1. Vegetarian

2. Non-Vegetarian

(1/2) 1

Your estimated monthly budget is S$1227.0

Our Comments, Recommendations & Estimations

HOUSING	FOOD	TRAVEL	MISCELLANEOUS
Look for a **Single Room** in a **Single Room with AC** around **NUS PGP** area.	It's good that you are a **vegetarian** and prefers **not to cook.** Even though self-cooking is good, we have a number of healthy and cheap eatery options available inside NUS.	Singapore is well connected using MRT and buses. Taxis are not very cheap. For short distance travels we recommend to just take a walk or use a bicycle.	Miscellaneous costs accounts average phone and internet costs per month.
S$852 per month Rent S$852 Public Utility Bills S$0	S$300 per month	S$40.0 per month Walk between NUS PGP and NUS S$0.0 Other travel expenses S$40.0*	S$35* per month

*based on users with a similar preference to you

APPENDIX B: USERS MANUAL

INSTALLATION GUIDE

INSTALLING DEPENDENCIES

The web app is built to be hosted on a Linux server. It can be run on any Linux system during production and testing. However, it does not run on a Windows system.

The dependencies for the program are CLIPS - 'C' Language Integrated Production System which is a rule based programming language to create and run rule based systems

To install CLIPS on the system:

1. Open the terminal

   CTRL + ALT +T

2. Update the system

   sudo apt-get update

3. Install clips using apt-get

   sudo apt-get install clips

INSTALLING THE PROGRAM

1. You can copy the zip file provided to a folder and run readily once the dependencies are set.

2. You may also choose to clone this repo to get the latest version of the program

   https://github.com/theidentity/WebApp.git

HOW TO RUN THE PROGRAM

RUN ON DEFAULT SETTINGS

To run the program at default settings

1. Open the terminal

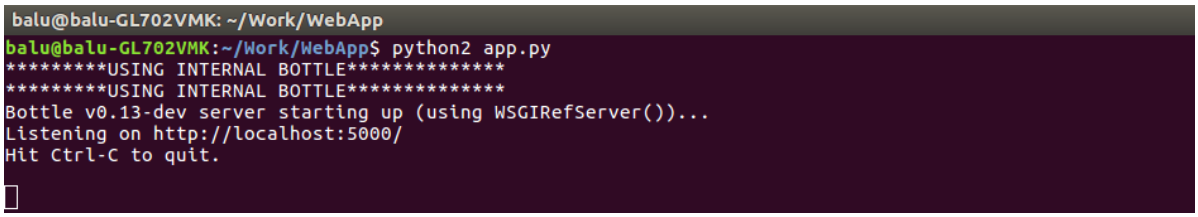
   CTRL + ALT +T

2. Navigate to the folder WebApp

   cd your_dir/WebApp

3. Start the program at the default port 5000

   python2 app.py



4. Go to the address in your browser to see the program up and running

   http://localhost:5000/

RUN ON CUSTOM PORT

To run the program on a custom port, provide the port number as a command line argument

1. Open the terminal

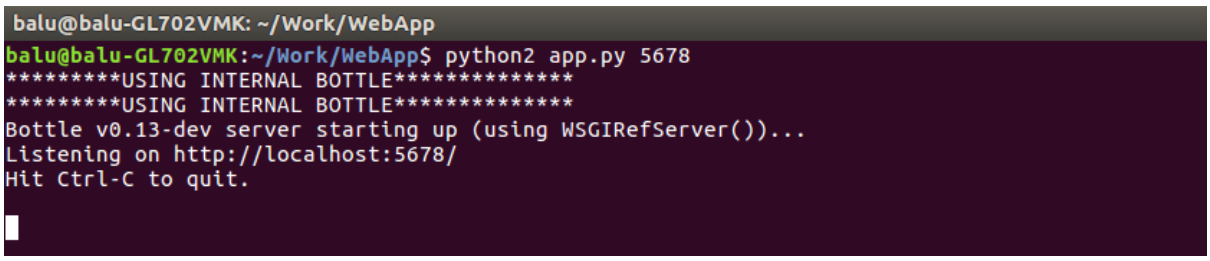
   CTRL + ALT +T

2. Navigate to the folder WebApp

   cd your_dir/WebApp

3. Start the program and specify the port number you want to start the program on

   python2 app.py 5678



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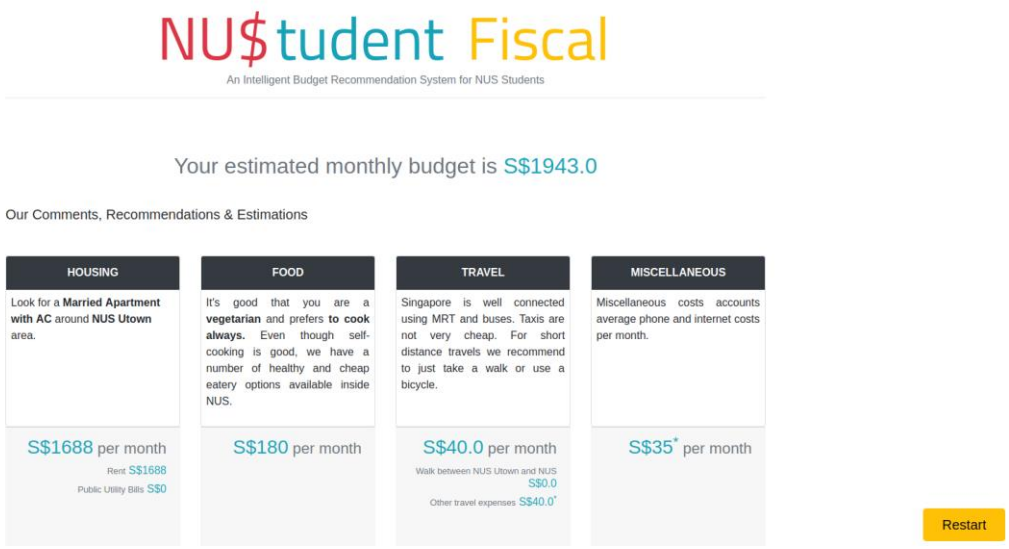
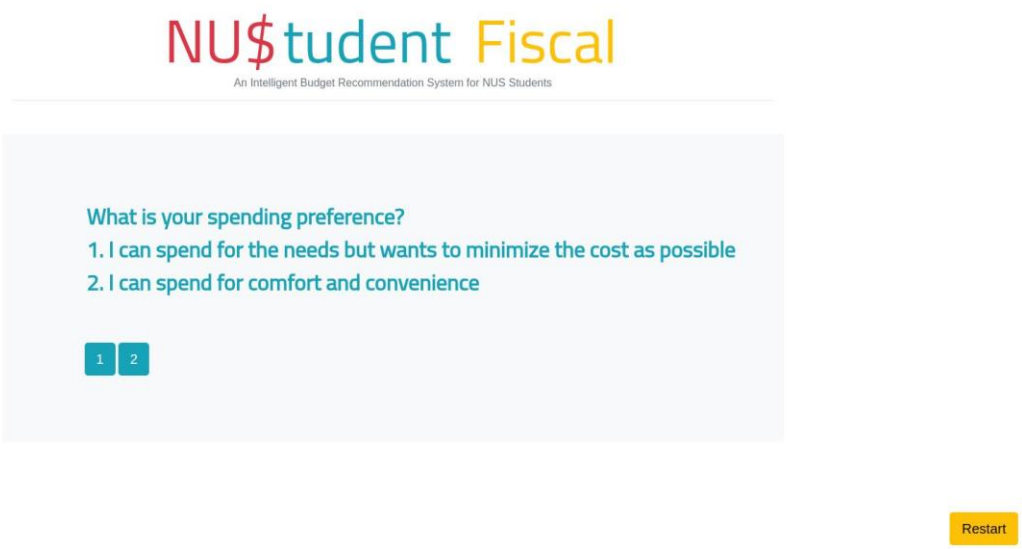
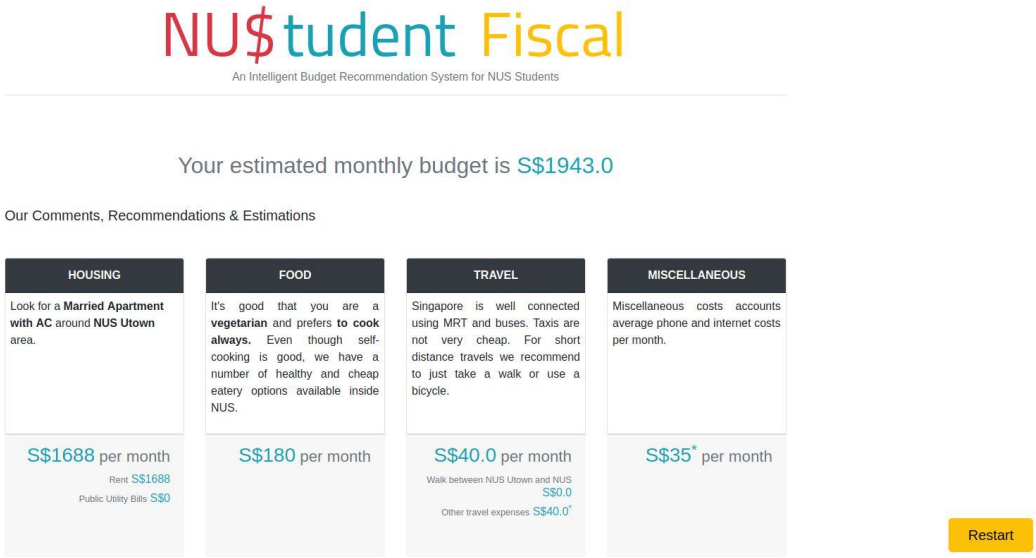
   http://localhost:5678/

UI ELEMENTS


NU$tudent Fiscal
An Intelligent Budget Recommendation System for NUS Students
Your estimated monthly budget is S$1943.0
Our Comments, Recommendations & Estimations
HOUSING
Look for a Married Apartment with AC around NUS Utown area.
S$1688 per month
Rent S$1688
Public Utility Bills S$0
FOOD
It's good that you are a vegetarian and prefers to cook always. Even though self-cooking is good, we have a number of healthy and cheap eatery options available inside NUS.
S$180 per month
TRAVEL
Singapore is well connected using MRT and buses. Taxis are not very cheap. For short distance travels we recommend to just take a walk or use a bicycle.
S$40.0 per month
Walk between NUS Utown and NUS S$0.0
Other travel expenses S$40.0*
MISCELLANEOUS
Miscellaneous costs accounts average phone and internet costs per month.
S$35* per month
Restart


NU$tudent Fiscal
An Intelligent Budget Recommendation System for NUS Students
What is your spending preference?
1. I can spend for the needs but wants to minimize the cost as possible
2. I can spend for comfort and convenience
1
2
Restart


NU$tudent Fiscal
An Intelligent Budget Recommendation System for NUS Students
Your estimated monthly budget is S$1943.0
Our Comments, Recommendations & Estimations
HOUSING
Look for a Married Apartment with AC around NUS Utown area.
S$1688 per month
Rent S$1688
Public Utility Bills S$0
FOOD
It's good that you are a vegetarian and prefers to cook always. Even though self-cooking is good, we have a number of healthy and cheap eatery options available inside NUS.
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Singapore is well connected using MRT and buses. Taxis are not very cheap. For short distance travels we recommend to just take a walk or use a bicycle.
S$40.0 per month
Walk between NUS Utown and NUS S$0.0
Other travel expenses S$40.0*
MISCELLANEOUS
Miscellaneous costs accounts average phone and internet costs per month.
S$35* per month
Restart

TROUBLESHOOTING

PORT ALREADY TAKEN

```
balu@balu-GL702VMK: ~/Work/WebApp
balu@balu-GL702VMK:~$ cd Work/WebApp/
balu@balu-GL702VMK:~/Work/WebApp$ python2 app.py
*********USING INTERNAL BOTTLE**************
*********USING INTERNAL BOTTLE**************
Bottle v0.13-dev server starting up (using WSGIRefServer())...
Listening on http://localhost:5000/
Hit Ctrl-C to quit.

Traceback (most recent call last):
  File "/home/balu/Work/WebApp/bottle.py", line 3715, in run
    server.run(app)
  File "/home/balu/Work/WebApp/bottle.py", line 3257, in run
    handler_cls)
  File "/usr/lib/python2.7/wsgiref/simple_server.py", line 151, in make_server
    server = server_class((host, port), handler_class)
  File "/usr/lib/python2.7/SocketServer.py", line 417, in __init__
    self.server_bind()
  File "/usr/lib/python2.7/wsgiref/simple_server.py", line 48, in server_bind
    HTTPServer.server_bind(self)
  File "/usr/lib/python2.7/BaseHTTPServer.py", line 108, in server_bind
    SocketServer.TCPServer.server_bind(self)
  File "/usr/lib/python2.7/SocketServer.py", line 431, in server_bind
    self.socket.bind(self.server_address)
  File "/usr/lib/python2.7/socket.py", line 228, in meth
    return getattr(self._sock,name)(*args)
error: [Errno 98] Address already in use
*********USING INTERNAL BOTTLE**************
Bottle v0.13-dev server starting up (using WSGIRefServer())...
Listening on http://localhost:5000/
Hit Ctrl-C to quit.
```