DEVELOPMENT OF AN ADMISSION RECOMMENDATION SYSTEM FOR PRE-TERTIARY INSTITUTIONS CANDIDATES IN NIGERIA

Submitted by:

ADERINTO, IBRAHIM BABATUNDE

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Department of Computer Science and Engineering,

Faculty of Technology,

Obafemi Awolowo University, Ile-Ife.

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CERTIFICATION

This is to certify that the project "Development of an Admission Recommendation System for Pre-Tertiary Institutions Candidates in Nigeria" was carried out by me ADERINTO IBRAHIM B. (CSC/2015/016) under the supervision of Dr. F.O. Asahiah of the Department of Computer Science and Engineering, Obafemi Awolowo University, Ile-Ife, in partial fulfillment of the requirement for the award of the Bachelor of Science degree.

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Dr. F.O. Asahiah	Dr. P.A. Idowu
SUPERVISOR	HEAD OF DEPARTMENT

DEDICATION

I dedicate this thesis to my amazing, loving, caring and wonderful mother, Mrs Taiwo Oriadetu who despite all the odds, stood her ground to make sure I become someone in life.

ACKNOWLEDGEMENT

I'd like to thank everyone who has assisted me to complete this task. To my supervisor, Dr. F.O. Asahiah, I would like to appreciate his extreme patience and guidance, he is the one I interacted with most of all the lecturers in the department and I never regretted it. I would like to acknowledge all lecturers & staff of the department of computer science and engineering, Obafemi Awolowo University and also all my classmates for being part of my undergraduate degree journey, and for their companionship. I would like to say a very big thank you.

ABSRTACT

Recommender systems are widely used in the world across various industries. First instances that comes to mind social media apps, video streaming apps among many others. These systems are also used widely in the educational sector to make relevant recommendations to admission seeking students, students studying in an institution or even self-learning students.

While these systems are widely used in the world, it's use in Nigeria's education sector isn't prominent yet. Students who graduated from secondary school and are seeking admission into tertiary institutions often face challenges in making a good choice of course and institution to study.

A recommender that takes students' credentials into account to find best fit institutions and course of study would, hence, be of great benefit to admission seeking students in serving as a guide to making the right choice.

CHAPTER 1

1.1 The History of Admission Seeking Process in Nigeria

The history of higher education in Nigeria dates to the 19th century. Higher education in Nigeria commenced in the form of a technical college with the establishment of the Yaba College by the colonial government in 1932, this was propelled by the paradigm of liberal education as introduced by the early missionaries, Nigerians sought opportunities to acquire this new and exciting vista of life which was then only available overseas. The college was established to provide "well-qualified assistants" in medical, engineering, and other vocations as well as teachers for secondary school then known as "higher middle schools". With time, the college offered sub-degree courses in engineering, medicine, agriculture, and teacher training to fill specific vacancies in the colonial administration (Adeleke 2018).

The restricted scope and vision of Yaba College generated greater pressures on the colonial administration to expand the opportunities for higher education. The British government responded by establishing the Elliot Commission in 1945. In its report, the commission suggested that "the need for educated Africans in West Africa in general far outruns the supply, present, and potential" and proceeded to recommend the establishment of a university college in Nigeria. Thus, the first Nigerian university (the University of Ibadan) started in 1948 as a college campus of the University of London. The University College, Ibadan, was established as a residential and tutorial college under the tutelage of the University of London. It attained an autonomous status as a degree-awarding institution in 1962, two years after Nigeria obtained its independence from Britain in 1960 (Adeleke 2018).

In 1959, another commission, the Ashby commission, was established to ascertain Nigeria's post-independence educational needs. In 1960, the University of Nigeria, Nsukka was established as the first indigenous university in Nigeria. The findings of the Ashby commission regarding balance in the structure and geographical distribution of university education led to the establishment of universities of Lagos and Ife in 1962. Most probably propelled by the increased income from oil and the increased demand for higher education in the country, in 1975 the federal government decided to take over the regional universities at Zaria, Ile-Ife, and Nsukka as well as establish new ones – the universities of Calabar, Jos, and Maiduguri, with University Colleges at Ilorin, Port-Harcourt and Kano, all of which became fully-fledged universities in 1977 (Adeleke 2018).

Up till 1977, every one of these existing universities conducted its concessional examination and admitted its students. However, this system of admission revealed serious limitations and quite often, waste of resources in the process of administering the concessional examination especially on the part of the candidates. The general untidiness in the uncoordinated system of admissions into universities and the attendant problems were sufficient causes for concern to the committee of vice-chancellors. These problems had assumed a new dimension when by 1976, the then federal military government, under the leadership of General Olusegun Obasanjo, established six (6) additional universities. Consequently, the government set up a national committee on university entrance under the chairmanship of Mr. M. S. Angulu (JAMB).

The Committee was specifically requested to consider the possibility of setting up a Joint Matriculation Board. The Committee recommended the setting up of two (2) bodies, the Central Admissions Board and the Joint Matriculation Board. The Federal military government

accepted some of the recommendations of the committee and set up the Joint Admissions and Matriculation Board (JAMB). At first, JAMB was to handle admission into universities, but this later expanded into polytechnics and college of educations. This means JAMB now becomes compulsory for any student seeking admission into any tertiary institution, be it a university, polytechnic, or college of education.

1.1.1 Jamb Mandate

The legal instrument establishing the Board was promulgated by the Act (No. 2 of 1978) of the Federal Military Government on 13th February 1978. By August 1988, the Federal Executive Council amended Decree No. 2 of 1978. The amendments have since been codified into Decree No. 33 of 1989, which took effect from 7th December 1989. Decree No. 2 of 1978 (amended by Decree No. 33 of 1989) empowered the Joint Admissions and Matriculation Board to:

(a) conduct Matriculation Examination for entry into all Universities, Polytechnics, and Colleges of Education (by whatever name is called) in Nigeria.

(b) appoint Examiners, Moderators, Invigilators, members of the Subject Panels and committees, and other persons with respect to matriculation examinations and any other matters incidental thereto or connected therewith.

(c) place suitably qualified candidates in the tertiary institutions after having taken into account:

(i) the vacancies available in each tertiary institution.
(ii) the guidelines approved for each tertiary institution by its proprietors or other competent authorities.
(iii) the preference expressed or otherwise indicated by the candidates for certain tertiary institutions and courses.
(iv) such other matters as the Board may be directed by the Honorable Minister to consider or the Board itself may consider appropriate in the circumstances.

(d) collate and disseminate information on all matters relating to admissions into tertiary institutions or any other matter relevant to the discharge of functions of the board.

(e) carry out other activities as are necessary or expedient for the full discharge of all or any of the functions conferred on it under or pursuant to this Decree.

1.1.2 How Jamb Affects Admission

After the establishment of JAMB, the Unified Tertiary Matriculation Examination (UTME) administered by JAMB was the only exam required for students to gain admission into a tertiary institution. Students seeking to write the exam must have sat for an O'level examination (WAEC, NECO, or GCE) and obtained its certificate with a minimum of five credits in subjects relevant to their course of choice or its equivalent like the National Technical Certificate (NTC) or Teacher's Grade II certificate. After the exam, JAMB is responsible for sending students into tertiary institutions of choice or refer them to other universities willing to admit them. However, by 2005, this changed when the federal government introduced the policy of Post-

UTME screening by universities. This policy made it mandatory for all tertiary institutions to screen candidates after their UTME results and before giving admission. Candidates with a score of 200 and above in the UTME exam would be shortlisted by JAMB and their names and scores sent to their universities of choice which would screen again using aptitude tests, oral interviews, or even another examination as per the university's admission policy. Generally, the stated 200 score (at least) for the UTME exam is required for admission into universities, and a score of 180 at least, is required for other tertiary institutions. The scoring rule is sometimes waived for students with some privileges like being the son/daughter of a lecturer, among other privileges.

By June 2016, the federal government ordered that the POST-UTME exam be scrapped, arguing that if there was absolute confidence in the Joint Admissions and Matriculation Board, there should be no need for Universities to conduct internal examinations to determine the fate of candidates seeking admissions. More emphasis was then placed on the WAEC results of candidates in the first year POST-UTME was scrapped. This, however, changed in the second year as POST-UTME was introduced again. Therefore, UTME, POST-UTME, and the WAEC result became factors considered for admission distribution.

1.2 Challenges in the Admission Seeking Process

The establishment of JAMB proved insufficient to solve the admission-seeking problems in Nigeria. Many unqualified candidates have been offered admissions into Nigerian Universities through JAMB thereby lowering standards in these institutions (Okoroma 2005).

The problems of admissions into Nigerian Universities and the maintenance of adequate standards have been associated with some unpopular policies adopted by the Federal Government of Nigeria to address the inadequacy in the number of admission places in the University system. Among the unpopular policies include:

(a) Catchment areas policy which provided that a certain percentage of admission places must be reserved for the indigenes of the areas in which universities are located.

(b) Backwardness factor policy ensured that a certain percentage of admission chances was reserved for the indigenes of States considered to be educationally disadvantaged or backward.

(c) Quota system policy provided the allocation of certain percentages of admission places into Nigerian Universities to students from neighbouring states in the region.

(d) Discriminatory fees policy provided for lower fees to be paid by the indigenes of the localities where Universities are established (Okoroma 2005).

Some of these policies though, do not affect federal universities but do affect state ones. Policies (a) and (d) affect state universities, not federal ones. The backwardness policy of (b) seeks to ensure admission for students from states known as ELDS (Educationally Less Developed States). These states are majorly situated in the northern part of the country, and they include Adamawa, Bauchi, Borno, Jigawa, Benue, and others. In total, 20% of admission to each federal university is meant for students from ELDS states. Also, the quota system gets 35% of the total admission allocated to it. Hence, less than 45% (100% - 20% - 35%) of the

total admission quota is left out for free and fair selection. 'Less than' here is because of other unofficial policies adopted like grating preference to the Vice Chancellor's referrals, and other referrals from individuals in the university's system like the Dean of Student's affairs, the University Registrar, the University Bursar, Head of Departments, lecturers, and others, affect the admission process even further, shrinking the 45% meant for merit admission.

Akani (1996) believes that the above policies resulted in the reduction of admission standards, and this allowed poorly qualified candidates to be admitted into Nigerian Universities. This is because the policy conferred on the various categories of persons the rights of admission whether qualified or not. Furthermore, Akani (1996) believes that the quality of University education in Nigeria has consequently been lowered as a result of the Federal Government admission policies which apparently de-emphasize quality. Ndiomu (1989) also expressed disenchantment for the admission policies of the Federal Government which prompted him to state thus:

> *The quota system of admitting candidates into Federal Government institutions gives room for inequality which affects the much talked about standards in education. It seems there is no definite cut-off line for all candidates. A candidate from State Y may score 65% and may not be admitted because there are many others from the same State with higher scores; while another candidate from State X who scored 45% is admitted because only a few candidates from that State scored above 45%. The system seems to negate some of the major national objectives such as a free and democratic society, just and egalitarian society (Okoroma 2005).*

Also, other factors affect the admission-seeking process and thus, making more qualified candidates miss out on admission. One of these factors is the huge applications for a few 'hot courses' in a few 'hot universities'. A good number of students applying for these 'hot courses' have good JAMB result (over 250) and fail to get admitted because the competition is simply huge, and the available space is very limited. However, students with low JAMB scores (less than 250) who did not choose out of these 'hot courses', but perhaps, courses related to these 'hot courses' get admitted over students with much higher scores who would have been willing to take up courses like that.

If for instance, a student X is aware that though his state university charges a flat tuition rate of ₦100,000, as an indigen, he would only need to pay ₦30,000 or that a university in the same region as his state of origin usually have lower admission cut-off mark for students from his state of origin, or that he has greater chances of being admitted with course A than course B given the number of applications for course B and his credentials, his likeliness of not getting admitted would be at least, slimmer than before.

1.3 Problem Statement

Inadequate information about the factors that affect the admission process, majorly the admission policies of universities across Nigeria and the best course and university choice(s) considering these policies, as well as the ability, interest, passion, and competitiveness of the prospective student.

1.4 Aim and Objectives of Research

The aim is to build a recommendation system interfaced through a website that recommends the best choice of course(s) and/or universities(s), to admission seeking students throughout their admission seeking journey (before UTME after POST-UTME), given all the factors that affect this process. The objectives are as follows.

i. Determine universities and courses across south-west states in the country.
ii. Determine the most popular choice of courses and institutions among admission seeking students to identify hot courses and hot universities.
iii. Determine the base requirements (JAMB requirements), institution-specific requirements, for admission-seeking process.
iv. Design and implement a model to recommend the best choice of courses and universities for student seeking admission given data from the previous three objectives and students' credentials (WAEC result and if available, UTME score and if available, POST UTME score), interest, passion, competitiveness, university location of interest.
v. Design and implement a web interface for objective 4.

1.5 Research Methodology

The following are methodologies to be employed.

i. Obtain data on the universities and courses across south-west states through internet research.
ii. Obtain data about the top institutions (including universities, polytechnics and colleges of education) students are applying through internet research.
iii. Obtain data about JAMB admission requirements, universities specific requirements, through the JAMB portal.
iv. Define and implement a model with python for recommending the best choice(s) of courses and universities for admission-seeking students.
v. Build a web app using the following technologies.
    - Python – Main development language.
    - Streamlit – For web development.
    - Heroku – For web deployment.

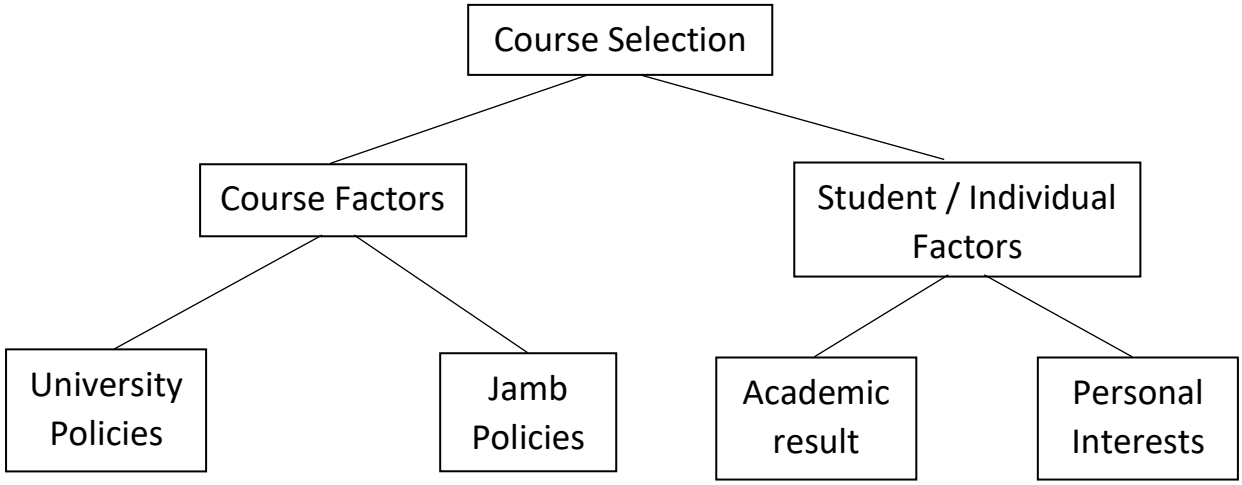
1.6 Justification

With this system, students will be guided into making the best choice of courses and universities, leading to less qualified students failing to get admitted into tertiary institutions across the country.

CHAPTER 2

2.1 Introduction

The issue of selecting the right choice when it comes to course of study and university can pose a major challenge for pre-tertiary students. Selecting course of study on its own can be difficult with all the influences around like peer influence (what friends are choosing as course of study), social influence (what the society perceive as good disciplines) among others, not to talk of all the major factors that affect admission in the country. A prospective tertiary student must be very careful with this so as not to waste some years studying what's not desired before later changing, or perhaps wasting the entire undergraduate years, only to finish and divert to another discipline, or losing interest completely in education when things become quite complicated.



A way of making the right choice is seeking out career guidance counselors but this has its own short comings. Many a times, these kinds of counselors aren't at students' disposal and if they are, they may be unqualified or prone to errors as they most likely, won't be totally aware of all available options for study in tertiary education. One way to fill this gap is to provide very intelligent recommendation systems that serves this function. There has been numerous research around the world on designing and implementing a recommendation system for course selection with similar and different approaches. The aim is to however, take factors affecting admission in Nigeria into consideration and build a recommendation system, interfaced with the web, to help students make the best choices throughout their admission seeking process from its inception to the very end.

2.2 Overview of tools available to JAMB students

The UTME (Unified Tertiary Matriculation Examination), administered by JAMB (Joint Admissions and Matriculations Board) is an exam written by millions of people across Nigeria and so, there are several tools available for students seeking to write the exam. These tools can be generally classified into two.

- Educational tools, and
- Informational tools.

Educational tools as the name implies are tools that educate prospective students on secondary school subjects like Mathematics, Biology, Chemistry, etc. These are e-learning tools in the form of websites or mobile applications where students can learn about their subjects of choice and/or practice UTME past questions to help them prepare well for the exam. Examples of such tools are uLesson, Gradely, Pass.ng, etc.

Informational tools are those that provide relevant information about UTME as released by JAMB to help students stay informed about the latest happenings, as well as UTME requirements for all available courses. They also provide very useful information like scholarship opportunities, vocational trainings, news concerning various universities in the country, news on critical deadlines, all for students to explore and stay informed. Popular examples include myschool.ng, and popular news platforms like guardian.ng, and others.

These classifications, however, do not include what's available to helping students generally in the world, they are pertaining to Nigeria only. The world has gone beyond just these kinds of tools to help pre-tertiary students in their academic journey. There are websites like topuniversities.com, timeshighereducation.com that help students all over the world to provide relevant information about universities, scholarships around the world, as well as useful learning materials like introductory courses to different disciplines. QS Universities for instance, has student matching tool which matches students with possible courses they can study and the universities that offer them in a desired country.

2.3 A review of recommendation systems

Recommender systems are widely applicable in numerous fields such as medicine, movie, education, e-commerce, and tourism. These systems work by recommending a personalized list of items to users based on their interests, profile, history, or other personalized info, and thus helping users to overcome excessive information offered to them. They help users filter through large list to choose from by helping to recommend best options, as well as help them discover items of interest which they might not know of. Ecommerce companies like Amazon uses recommender systems to recommend products to users which might interest them. YouTube, Netflix also use recommender systems to recommend new videos/movies to users which they have not viewed and might interest them.

In education, recommender systems are used for a variety of purpose with the aim of supporting teaching and learning activities which include recommendation of academic choices, learning activities, learning resources, vocational and educational training, on e-learning platforms, among other uses. These systems can be web based, desktop based or mobile based. For users such as students, selecting the right courses is a very challenging task while joining a new academic level. Picking the wrong course may affect a student's academic life as well as their future career and this is where recommender systems come in. With recommender systems, students can get help navigating through a list of options that interests them buy finding the most suitable and possible option, as well as help them discover new options they might have not known of.

2.2.1 Classification of Recommender Systems

Generally, Recommender Systems are classified according to the methods they use. These methods are grouped into four major broad categories. The basic and most used models work with two types of data for their prediction process.

1) User-item interactions, e.g., ratings or user behaviour, and
2) Users-items attribute information like textual profiles or relevant keywords.

Besides, Techniques in Recommender Systems are also graded in two groups, that is, memory-based and model-based algorithms. In this manner, Memory-based algorithms work on the overall user-item rating matrix. In contrast, model-based techniques work by using the rating data to train a model which model is then used to produce recommendations (Lynn and Emanuel, 2021).

The different types of recommendation approaches or methods are briefly discussed below.

Content-Based Method

One of the most important and widely used types of recommender systems is the content-based filtering system. In this recommendation approach, the system uses data based on previously recorded facts about a particular user, or any other relevant data currently contained by the system about the user. The system attempts to find similarities between the available data to effectively recommend a certain object or item to the user (Adomavicius and Tuzhilin, 2005). In the context of course selection systems in universities worldwide, this approach may look at courses the student has taken in previous years, or courses students similar in character/interest

has taken be before and how successful they are in it to recommend course options for a new student. The system may also use keyword selection to look at course descriptions to find courses that are like those already selected. O'Mahony and Smyth (2007) demonstrated a similar approach in creating a "More Like This" recommender system, in which course descriptions were scanned and compared with descriptions of other courses within the course database, with the most similar courses being selected and ranked.

While the idea behind this approach seems simple and is one of the most widely used, it is not without limitations. Since the approach uses data previously recorded, it risks using data about unintended actions by the user, or other actions not representing the significant interest of the user. For instance, if Amazon were to recommend products based on the viewed products by a user, then it would be taking data on products the user just explored and was not really interested in. For course recommendation, the system risks recommending courses from a niche or faculty and may miss out on other courses that might be of interest to the user since it relies solely on previously recorded data.

Collaborative Filtering Method

While content-based approach employs data previously recorded on a particular user, collaborative filtering methods do not. Collaborative filtering approach instead uses data on preferences of similar users to recommend new items to another user. Preferences of a user are gotten through metrics like ratings (an item the user rated high, like a 5-star rating or 4-star rating), and in the case of an e-commerce store, items a user bought. This aims to capture not all previously recorded data but significant data about a particular user to recommend items to another user. Collaborative filtering method can be further divided into two:

- User-based recommendation
- Item-based recommendation

The user-based recommendation approach, recommendation is based on what "other users did". Users that give similar ratings to the same products or services are grouped together, and the system determines that other items that one of the users liked are also likely to be enjoyed by the second user. Using the data obtained from this, it is then possible for the system to make an informed prediction or recommendation that is likely to be in some way helpful to the current user (Adomavicius and Tuzhilin, 2005). For instance, if user A buys product X and Y, and rates them well, say 5 star each, then should a user B buys product X and rates it well, he gets recommendation of product Y.

In contrasts, item-based recommendation approach takes items themselves and not the users into consideration. The similarities in ratings between different items are examined and items that are rated similarly are grouped together. The system then compares these items to any items the user has already rated to find similarities, and if possible, recommend these items to the user. Here, metrics like user ratings does not matter. For instance, let's say user A watches a movie X, and movie X is categorized as an action movie, he can then get recommended to other action movies on the site since he watched one before.

Collaborative filtering approaches do have some drawbacks. Since collaborative filtering can be applied to a larger number of disciplines, certain disciplines with a very large number of users and/or items would require a large amount of processing power to scan through the available data and find effective recommendations (Vozalis and Margaritis, 2003). Also, the approach may potentially leave out a large number of items which would be relevant to the

user. The filtering method only considers objects that have been favoured or selected by other users in the past, and so any items that have not been selected before are not considered (Vozalis and Margaritis, 2003). Therefore, collaborative filtering approach may therefore not always be preferable over content-based approach since the specific problem in question must be analysed carefully before selecting a type of system to use.

Knowledge-based Method

These are recommender methods that are used to guide users to make the right decisions when choosing from items whose domains tend to be complex in terms of their various properties. The numerous properties of items here makes them unsuitable for either content-based method or collaborative-filtering. The user may only be interested in an object with specific features. For instance, when purchasing a car, a user may only be interested in the car model, engine type, and interior house design, among numerous characteristics of a car (Lynn and Emanuel, 2021).

The advantage of knowledge-based recommendation is that it does not have cold-start or data sparsity problem, but it relies heavily on the pre-defined knowledge structures such as ontology. Ontology is a formal knowledge representation that contains concepts, entities, and their relationships in a specific domain, which is also encoded by ontology language such as web ontology language (OWL) (Zhang and Lu, 2021). In some business situations where items are not bought at a high demand because of their high prices, it is challenging to find ratings to rely on for a recommendation. Therefore, these methods can be used since they work well in cold-start situations (Lynn and Emanuel, 2021).

Hybrid Method

As the name implies, these methods work by bringing together the strengths of different types of recommender systems. The objective is to create recommender systems with techniques that are more efficient and effective in performance. Content-based and collaborative systems have their advantages and disadvantages, some of which overlap with each other. A significant constraint with one filtering type, such as restriction to text-based information in content-based filtering, may be entirely negated by the other type of system, as in collaborative systems being able to process more diverse types of data. Some form of combination between these two types of systems may therefore have a positive influence on the outcome of the recommendation process. Systems that combine content-based and collaborative components are known as hybrid systems (Mike, 2017).

There are a number of methods used to implement hybrid systems (Adomavicius and Tuzhilin, 2005). The first and most obvious method is to simply transfer relevant features of one system into the other, creating a partially combined system and feature set. The system may compare similarity amongst all users for a set of items, but at the same time, can also consider the past decisions made by the user in order to arrive at a more well-rounded approach. In this way, common problems associated with collaborative systems can be eliminated, such as when items that have not been selected by other users before are being ignored. Another approach is to simply obtain the results of a content-based filter on the dataset and environment, and thereafter get results from a distinct collaborative approach as well. These two sets of results can be considered together to arrive at a final recommendation set (Adomavicius and Tuzhilin, 2005). An effective method when concatenating results would be to set different weights for each set of results based on the current environment of data (Vozalis and Margaritis, 2003). Depending

on the number of items in the database that have been selected by the user-base, the system can decide whether to place more or less weight on the results of the content-based or the collaborative filtering, as collaborative results would be more meaningful at a stage when the vast majority of items in the database could be accessed via their relation to users having previously selected them, for instance. It can thus be seen that there may be good reason to use hybrid systems in certain situations (Mike 2017).

2.3 A Review of Related Works

Recommender systems have been widely used in education throughout the world, though from the Nigerian perspective, little has been done. A systematic mapping study carried out by Mariela and Sergio, 2018 identified 1181 papers on recommendation systems around the world. Primary studies were carried out on 206 papers and 44 were finally selected for review. Recommendation systems were classified according to the approach used and the following results were obtained from the 44 papers finally selected for review.

Recommendation Approach	**Number of Papers**	**Percentage**
Collaborative filtering	13	29.55
Content based	1	2.27
Hybrid	20	45.45
Knowledge based	1	2.27
Others	9	20.45

The study also revealed the various academic fields in which recommender systems are being used and below are the results.

Field	**Number of Papers**	**Percentage**
Academic choices	21	47.78
Learning activities	8	18.18
Learning resources	13	29.55
Academic Performance	11	25.00
Educational training	4	9.09
E-learning	15	34.09

This clearly shows how wide recommender systems are used in Education. Unsurprisingly, the approach most used is the hybrid method.

Ikono *et al* 2017, carried out a study on An Enhanced System for Allocation of Resources in Nigerian Universities. This study focused only on pre-degree students and was designed to find an efficient way of automatically allocates courses to students seeking admission into Nigerian Universities through the pre-degree program. The system uses artificial neural network for its decision-making capabilities to eliminate bias that unaided human judgment is prone to during admission process. The proposed system consists of three modules - the input module, the process module, and the output module. The input module contains data for all pre-degree students, the process module would then process the data, comparing the input score with the general cut-off loaded from the database of the system. If the score is lower than the general cut-off, the applicants is denied admission otherwise the processing continued to the next stage. At the next stage, data is processed using artificial neural networks and then outputted through

the output module. The output not only displays recommendations on admission, but also data on the accuracy of the model, as well as the imputed data.
Mabu and Muhammed 2016, developed a system that helps Nigerian universities in screening students during admission process. The system was developed using ID3 algorithm. The system was implemented using C++ programming language. The study concluded that the use of a decision support system for student enrolment will increase the accuracy and speed of the admission system. The system is mainly interested in identifying the best applicants for admission purpose and gives little or no consideration to others (Ikono *et al*, 2017).
Ajayi *et al* 2014, developed a rule-based support system for admission into higher institution of learning. The support system was designed with Unified modelling language tools and the implemented database was designed using MySQL. The study concluded that a support system seems to be the needed shift away from the awkward manual process for admission and recommends its use for a proper, efficient, and effective admission process management. This system generates the cut-off mark itself based on some defined rules in the system and values supplied which causes continuous change in the requirement without a certain standard (Ikono *et al*, 2017).
Waters and Miikkulaine 2013, developed GRADE, a statistical machine learning system to provide support for the work of the graduate admissions committee at the University of Texas. GRADE uses historical admissions data to predict the probability that the committee will admit a particular applicant. The system makes the review process more efficient by enabling reviewers to spend most of their time on applicants near the decision boundary and by focusing their attention on parts of each applicant's file that matters the most. An evaluation of the system over two sessions of PhD admissions shows that the system leads to dramatic time savings, reducing the total time spent on reviews by at least 74% but it is designed only for graduate admissions and undergraduate admission was not considered (Ikono *et al*, 2017).

Habila and Wajiga developed a system for students' admission placement in Nigerian universities using artificial neural networks with the sole objective of automating the university screening and placement process. The system employed back propagation algorithm technique to minimize error and maximize accuracy. Placement of candidates into Departments is based on candidate's choice when requirements are met; otherwise, the system assigns an alternative course for the candidate. Each candidate must have at least five relevant O' level credits including Mathematics and English language, to qualify for the chosen course. Candidates' O' level grades are strictly used for the placement process, having met the UTME and other entry requirements. The system was implemented using visual C# compiler. It generates an output of all accepted and rejected candidates. This system is clearly for the client side (universities) and not for students.

Kazeem *et al* developed a web-based intelligent career guidance system that assists pre-tertiary science students in Nigeria to independently choose a career path at anytime and anywhere with the use of computer system or mobile/smart phones as applicants seek admission into various fields of study in Nigerian Higher Institutions (Universities or Polytechnics). The intelligent system uses student-driven parameters such as favourite science subjects' combination, career interest inventory analysis result, and intelligent quotient test result for career recommendation. The web-based intelligent system was designed and implemented with principle of a rule-based expert system using forward chaining algorithm, the client-

side/interface pages (front-end) were designed using Bootstrap3, HTML5, CSS3 and JavaScript. For the back-end, XAMPP was used. Focusing on science students only means it not useful to all categories of students. Also, parameters like intelligent quotient might not be great parameters for determining best fit course(s) for a student.

2.4 Conclusion

The advantages of recommender systems if far reaching in numerous fields, including education. Different models of recommender systems have been adopted throughout the world to help guide pre-tertiary students and other kinds of students make the best decision in their academic journey. Considering the situation of Nigeria where lots of factors affect admission into tertiary institution, with most of these factors being unknown to many students, an intelligent system that will consider all these factors and recommend the best choices to a student is needed.

While there have been many works on recommender systems, there seems to be none taking all the factors affecting admission into tertiary institutions in Nigeria into account, as well as the students' academic capability and interests. The introduction of a recommender system is meant to complement the work of an academic advisor for pre-tertiary students or serve as one when there is non accessible to a student. It is intended to help UTME students throughout their admission seeking process, from the point of just having O'level result by recommending courses based on the result and their interests, to the point of writing UTME exam by recommending the best universities for their score, O'level result, and interests, then finally to the point of writing Post-UTME by recommending other suitable courses they can switch to should they not meet the requirement of chosen course, or recommending them to other suitable universities.

CHAPTER 3

3.1 Introduction

There are various approaches to building a recommender system. To build an effective one, the domain must be carefully examined. Part of this is carefully examining the available data, and the users it's intended for. A model in the case of this research must make use of from a couple of sources and make predictions based on it. Considering these sources, an appropriate recommender system approach was selected with a view of being improved on in later research studies.

3.2 Proposed Approach for Building the Recommendation System

The heart of recommender systems is the data being used for recommendation.
Various recommendation approaches have their strength and weakness. Before picking an approach, the entire domain of interaction needs to be examined. Collaborative filtering method, and Content based method both relies on data previously recorded on a user, which means there must have been a previous interaction of the user with the system. Yet, users still get recommendation as a new user of a platform. This sort of recommendation is based on a weighted approach to make some likely useful recommendation, after which the interaction of the user with these recommendations will begin to form the data behind a more robust collaborative filtering or content-based approach.

Hence, a weighted approach is deemed most befitting for the purpose of this research. There are no previously recorded data on students seeking admission that can serve the purpose of a collaborative filtering approach or a content based one. Also, since a weighted approach is the start of recommendation, and the purpose of this research is to build a new system a weighted approach is deemed most fit.

3.3 Data Gathering

For a recommendation system, data is the engine, and this is no different for the case of this research. The scope of the research is limited to south western universities and further limited to 5 institutions each for:

1. Federal universities: Obafemi Awolowo University (OAU), University of Ibadan (UI), Federal University of Agriculture, Abeokuta (FUNAAB), Federal University of Technology, Akure (FUTA), University of Lagos (UNILAG).

2. State universities: Adeleke Ajasin University, Akungba (AAUA), Ekiti State University (EKSU), Lagos State University (LASU), Ladoke Akintola University of Technology (LAUTECH), Olabisi Onabanjo University (OOU).

3. Private Universities: Afe Babalola University (ABUAD), Adeleke University (AUE), Babcock University (BABCOCK), 'Bowen University (BOWEN), Covenant University (COVENANT).

4. Polytechnics: Federal Polytechnic, Ede, The Polytechnic Ibadan, Federal Polytechnic, Ilaro, Lagos State Polytechnic, Ikorodu, Yaba College of Technology.

5. Colleges of Education: Adeyemi College of Education, Ondo, Emmanuel Ayanlade College of Education, Federal College of Education, Abeokuta, Federal College of Education, Oyo, Federal College of Education, Akoka.

Also, a total of 17 popular course among admission seeking students were selected for all institutions except colleges namely:

1. Accountancy
2. Architecture
3. Biochemistry
4. Business Administration
5. Estate Management
6. Civil Engineering
7. Chemical Engineering
8. Computer Engineering
9. Computer Science
10. Electrical engineering
11. Law
12. Marketing
13. Medicine and Surgery
14. Mass Communication
15. Nursing
16. Pharmacy
17. Theatre Arts

And for colleges the following corresponding courses were selected.

1. Biology
2. Business Education
3. Computer Science Education
4. Fine and Applied Arts

For each course in each institution that offer it, data on the WAEC subject requirements and the JAMB subject requirements were gathered in the tabular format as in the example below, through manual web scraping of JAMB's official website https://jamb.gov.ng/ibass.

Course	WAEC	UTME
course1	eng math econs any2(geo-bio/agric-accnt-govt)	eng math econs geo/bio/agric/accnt/govt
course2	eng math phy any2(econs-chem-td-fn-geo)	eng math phy chem/geo/td

The abbreviation of subjects is based on popularly known standards as listed below.

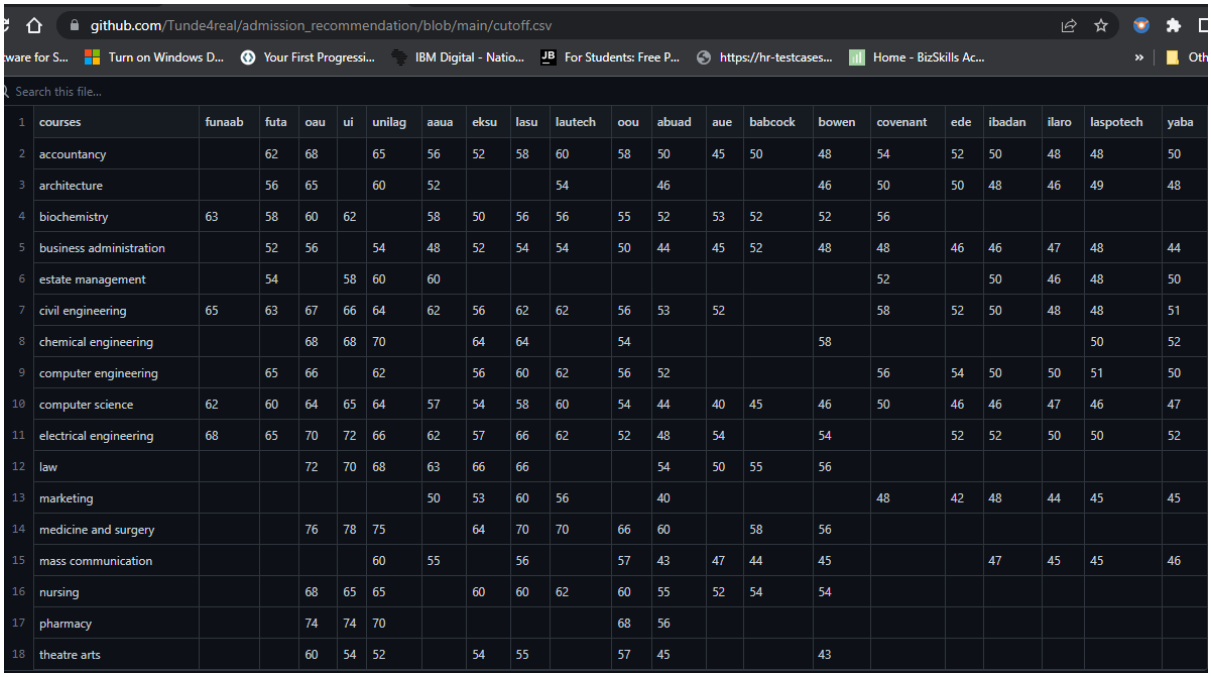
Subjects	Abbreviation
Commerce	Comm
Financial Accounting	Accnt
Christian Religious Studies	CRS
Economics	Econs
Geography	Geo
History	His
Islamic Studies	IRS
Literature in English	Lit_in_eng
Civic education	Civic
English	Eng
Hausa	Hausa
Igbo	Igbo
Yoruba	Yor
Further Mathematics	Fur_math
Mathematics	Math
Agricultural Science	Agric
Biology	Bio
Chemistry	Chem
Physics	Phy
Health Education	He
Building Construction	Bc
Technical Drawing	Td
Basic Electricity	Be
Basic Electronics	Ben
Food and Nutrotuin	F&n
Fine Arts	Fn
Basic Science	Bs
Computer Studies	Comp
Statistics	Stat
Business Studies	Bus
Government	Govt

Also, for each course, a corresponding list of attributes deemed necessary for a student who wish to study the course were determined through internet research, as in the example below.

course	characteristics
Accountancy	service-oriented innovativeness reliability trustworthiness vigilance organizational

Architecture	passion easy-going confidence creativity adaptability love-of-nature

Lastly, for the purpose of the model, a mock-up cut-off mark weighted in percentage was generated for all course and the respective institutions (other than colleges) that offer them
.



	courses	funaab	futa	oau	ui	unilag	aaua	eksu	lasu	lautech	oou	abuad	aue	babcock	bowen	covenant	ede	ibadan	ilaro	laspotech	yaba
2	accountancy		62	68		65	56	52	58	60	58	50	45	50	48	54	52	50	48	48	50
3	architecture		56	65		60	52			54		46			46	50	50	48	46	49	48
4	biochemistry	63	58	60	62		58	50	56	56	55	52	53	52	52	56					
5	business administration		52	56		54	48	52	54	54	50	44	45	52	48	48	46	46	47	48	44
6	estate management		54		58	60	60									52		50	46	48	50
7	civil engineering	65	63	67	66	64	62	56	62	62	56	53	52			58	52	50	48	48	51
8	chemical engineering			68	68	70		64	64		54				58					50	52
9	computer engineering		65	66		62		56	60	62	56	52				56	54	50	50	51	50
10	computer science	62	60	64	65	64	57	54	58	60	54	44	40	45	46	50	46	46	47	46	47
11	electrical engineering	68	65	70	72	66	62	57	66	62	52	48	54		54		52	52	50	50	52
12	law			72	70	68	63	66	66			54	50	55	56						
13	marketing						50	53	60	56		40				48	42	48	44	45	45
14	medicine and surgery			76	78	75		64	70	70	66	60		58	56						
15	mass communication					60	55		56		57	43	47	44	45			47	45	45	46
16	nursing			68	65	65		60	60	62	60	55	52	54	54						
17	pharmacy			74	74	70					68	56									
18	theatre arts			60	54	52		54	55		57	45			43						

Figure 1: Cut-Off Mark csv file

3.4 The Model

The model can be expressed with the formula below.
Weight = UTME weight + Post-UTME weight + Stats of Origin weight +WAEC weight

$$\text{UTME weight} = \frac{\text{UTME score}}{400} \times 20 \quad (20\% \text{ of total})$$

$$\text{Post-UTME weight} = \frac{\text{P-UTME score} - \text{P-UTME cutoff}}{100 - \text{P-UTME cutoff}} \times 10 \quad (10\% \text{ of total})$$

State of origin factor = 10% (added if the student comes from the same state as the institution in case of federal or state institutions)

WAEC weight = cumulative weight of all WAEC subject pertaining to a course. There are 8 possible grades for a WAEC subject, and for each of these grades, the following score in assigned.
A1 – 8, B2 – 7, B3 – 6, C4 – 5, C5 - 4, C6 – 3, D7 – 2, D8 – 1, F9 – 0.
Since the highest possible grade is A1, and WAEC subjects' requirements is always 5, a total score of 40 (8 for highest grade A1 multiplied by 5) is possible. This score is then calculated in percentage of 50.

The model, however, can work without assigning a UTME weight or a Post-UTME weight since a student might have just his WAEC result, yet to take UTME exam and/or Post-UTME exam.

3.4 Conclusion

Recommender systems use weighted approach to generate recommendations to first time users who they have little to no data about and this is what this model seeks to achieve. The aim is to generate recommendation for admission seeking students at any stage in their admission seeking process, that is when the student just finished the WAEC exam, after UTME exam and after Post-UTME exam and this aim has been well achieved. The model employs a simplistic approach, and it is often said that the simplest solutions are the most effective.

CHAPTER 4

4.1 Introduction

Part of the objectives of this research is to develop a model and a web interface on top of the model. To realize these objectives, python programming language and the streamlit package together with it, were majorly used. Python is one of the most popular programming languages in the world and is the most preferred choice for building recommender systems. Streamlit is a web package built on top of web technologies (HTML, CSS, and JavaScript included), and wrapped with python APIs to make it easier for python developers to develop web applications while still using python with just API calls.

4.2 Web Interface

A web interface is simply a web application or website through which a user can interact with the model built by filling in some data and getting results. The interface built with python and streamlit is hosted primarily on Heroku and can be accessed via http://admission-recommendation.herokuapp.com/. However, the website is hosted on Heroku free tier, a service which Heroku plans to discontinue by 28th of November 2022. Hence, the website is also hosted on https://tunde4real-admission-recommendation-streamlit-app-4j346o.streamlitapp.com/.

4.2.0 A Walkthrough of the Website

The website is a single page site which contains:

1. A brief introduction of the project.

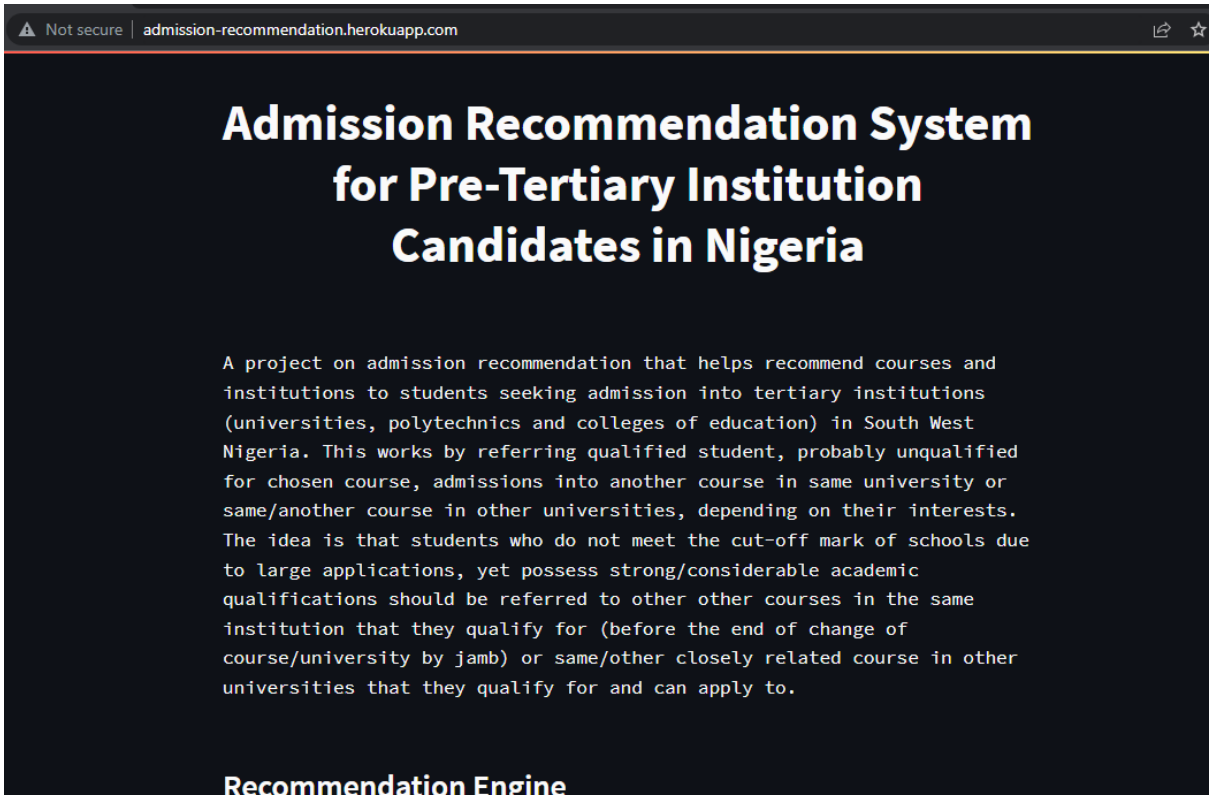


Figure 2: Part 1 Of the website

2. Input fields to collect user data on WAEC subjects and their grades, UTME subjects (if available), UTME score (if available), state of origin, POST-UTME score (if available), interests, intended/chosen course, intended/chosen university.

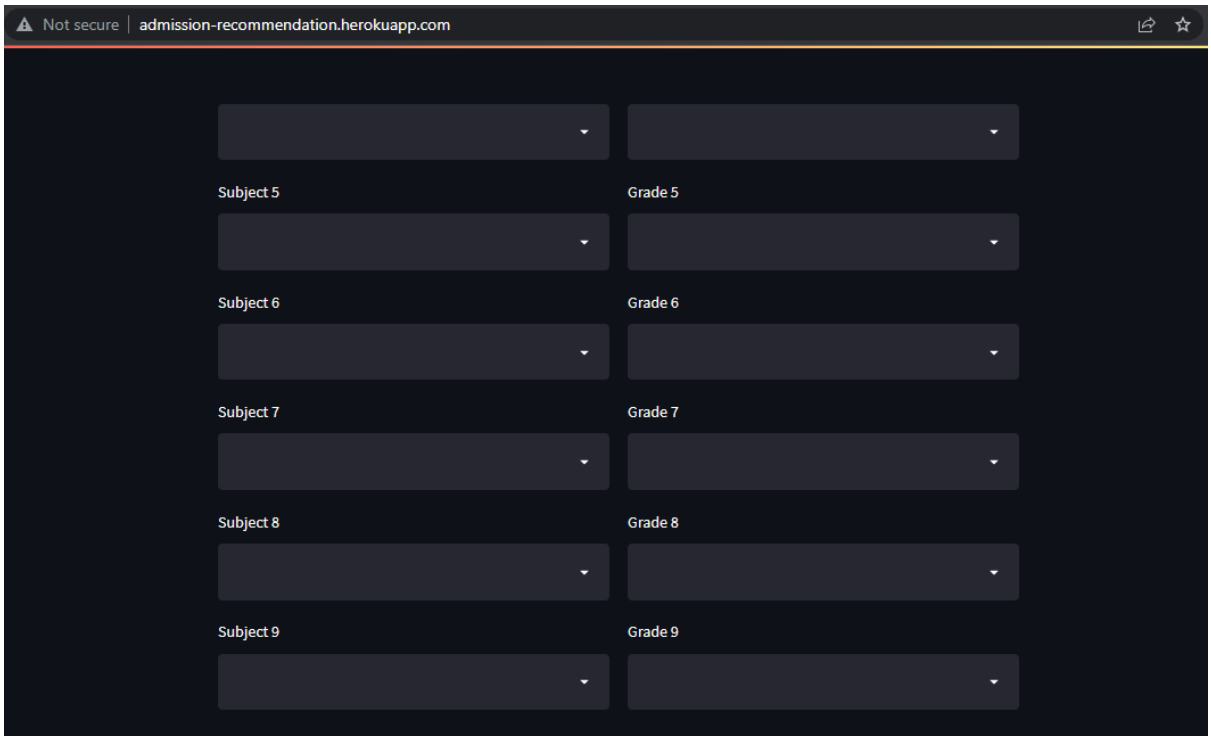


Figure 3: Part 2 of the website

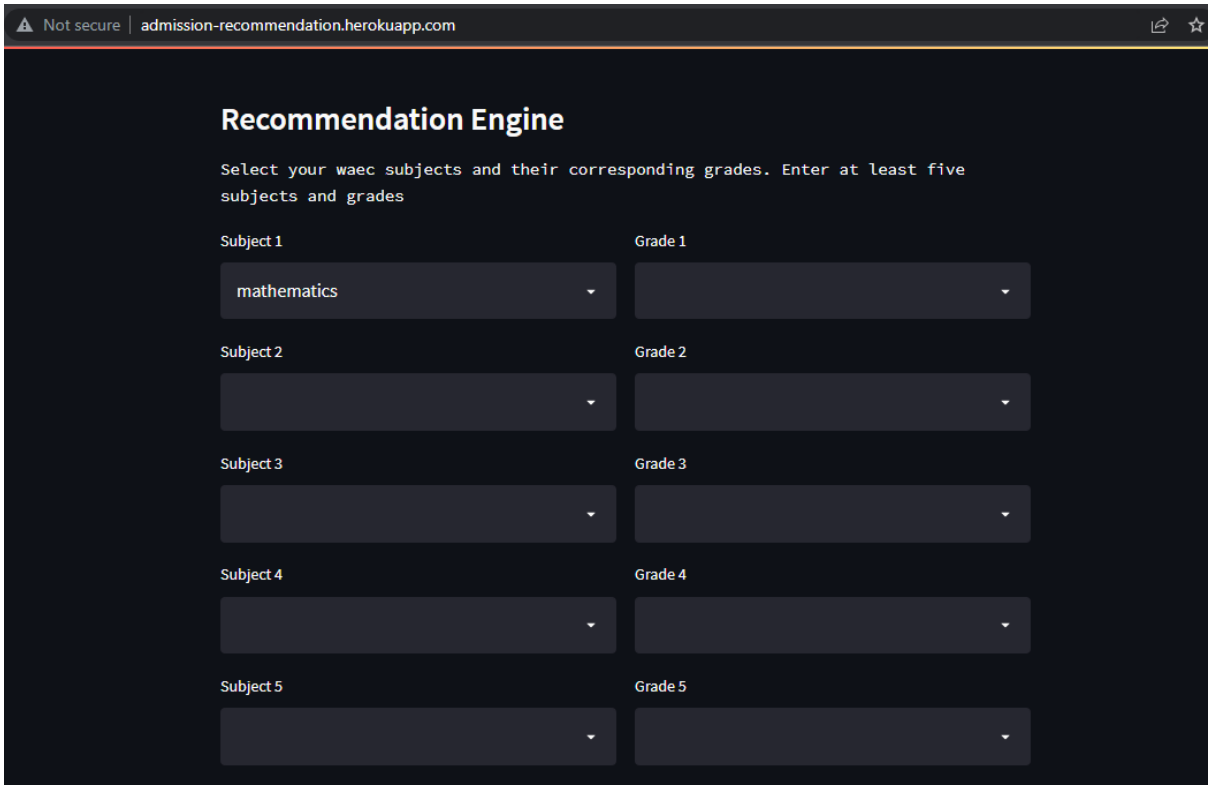


Figure 4: Part 3 of the website

3. A button to get recommendation after which results are displayed.

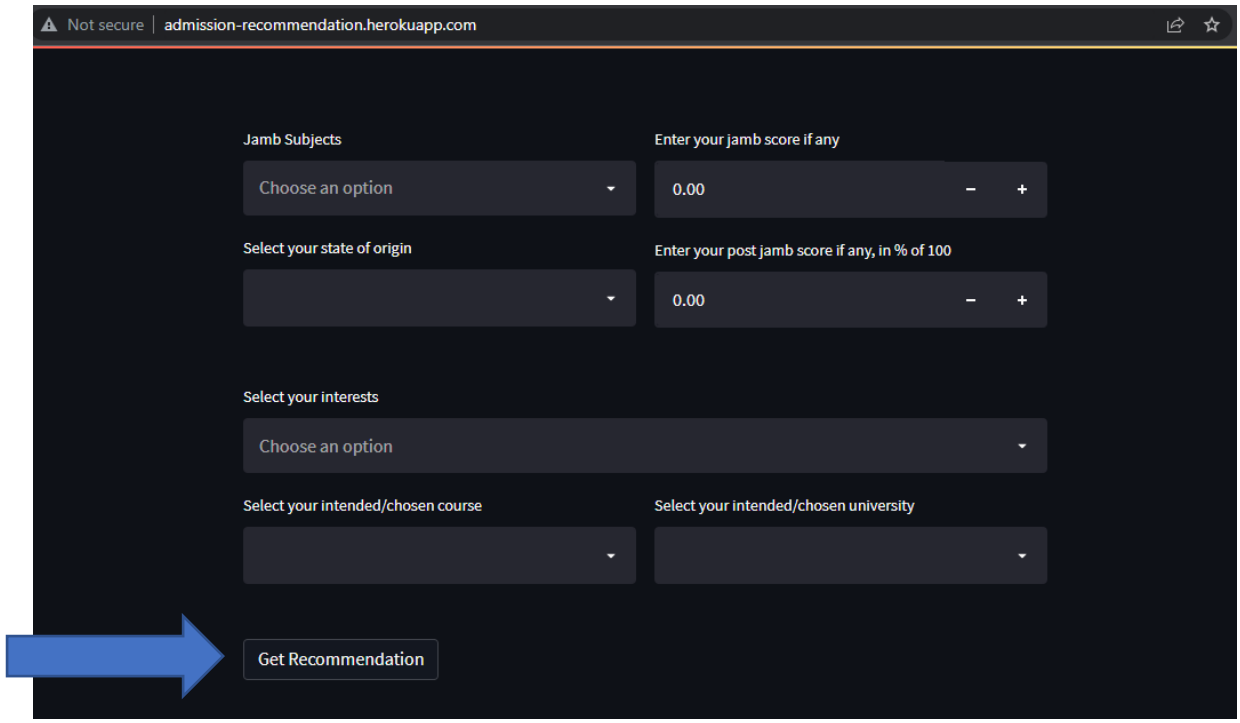


Figure 5: Part 4 of the website

4.2.1 Example test case

1. A user inputs WAEC and JAMB details as shown in the pictures below.

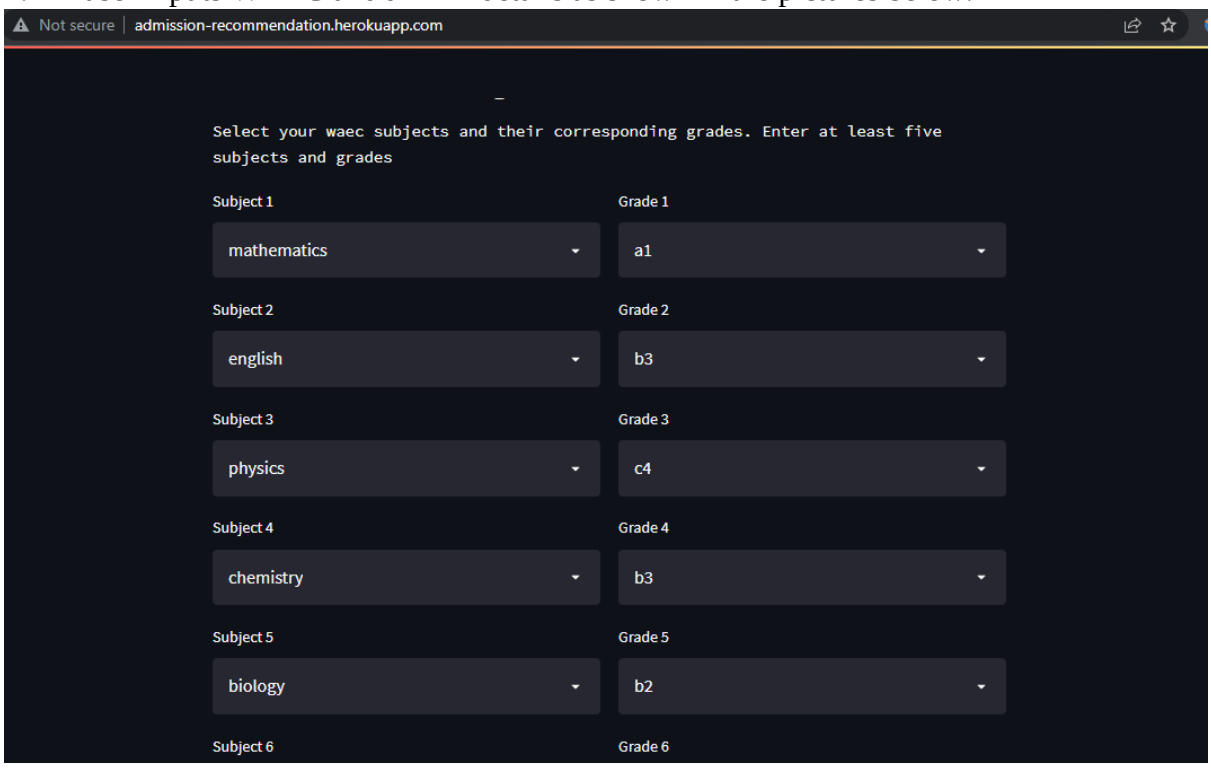


Figure 6: Example test case, part 1

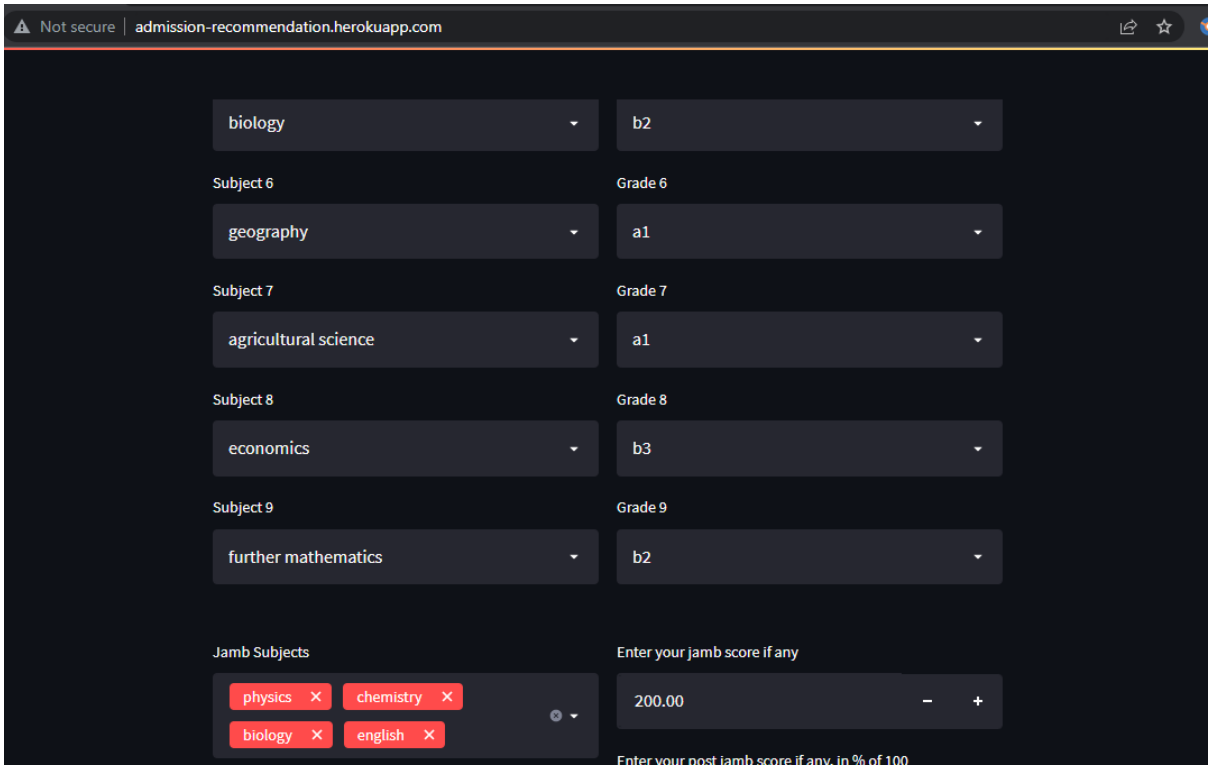


Figure 7: Example test case, part 2

2. A user inputs state of origin, interests, intended/chosen course and intended/chosen university as shown below.

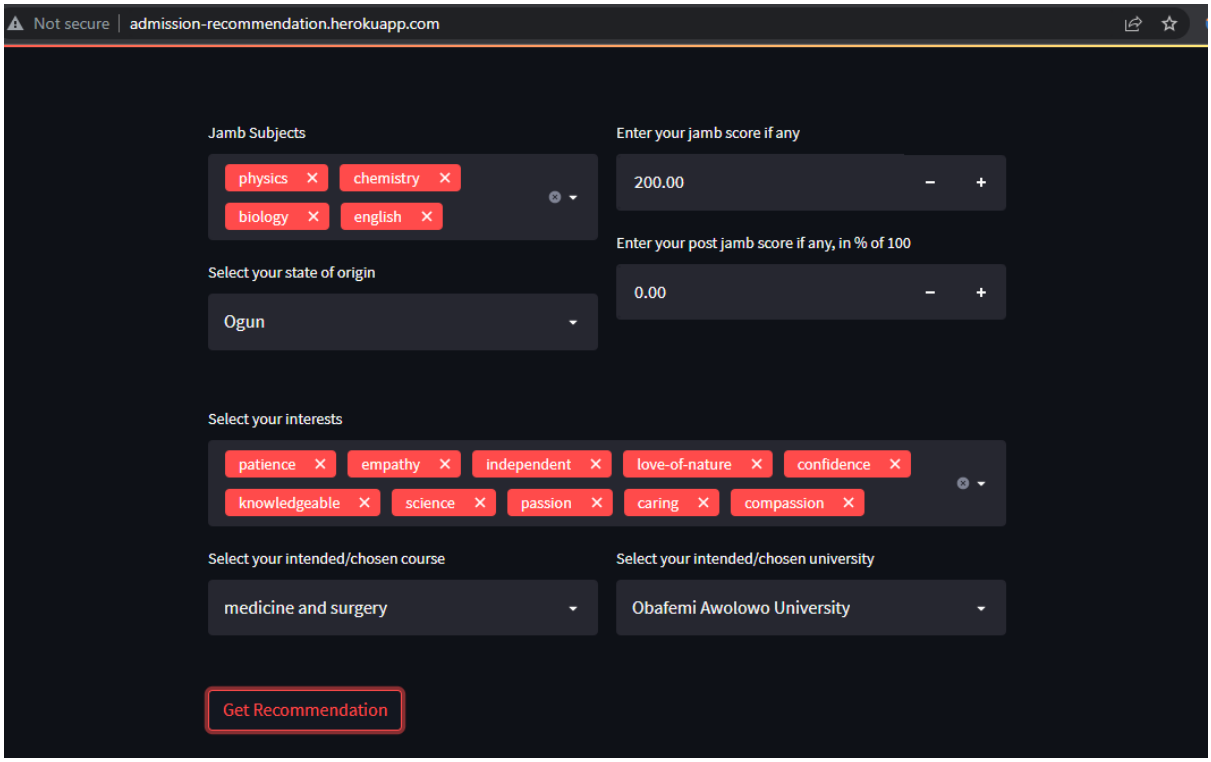


Figure 8: Example test case, part 3

3. The user gets recommendation.

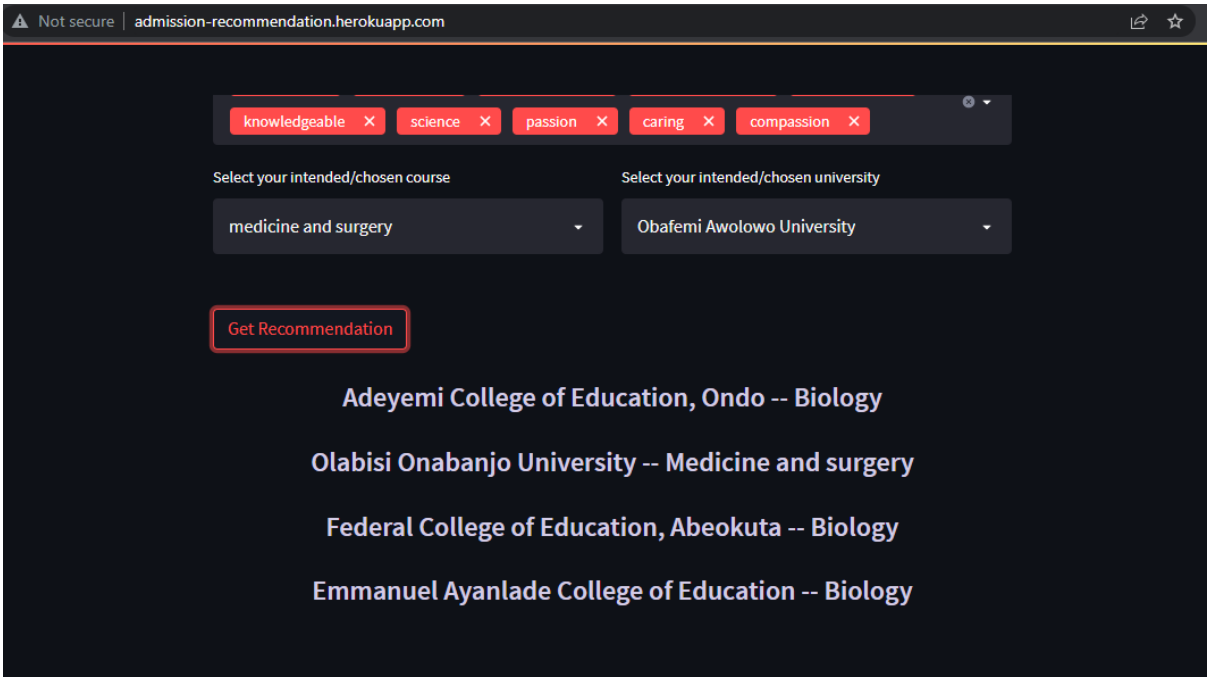


Figure 9: Example test case, part 4

4.4 System Documentation

All the project files are permanently situated at this github repository https://github.com/Tunde4real/admission_recommendation.

4.3.1 File Structure

The files on the GitHub page are as seen in the image below.

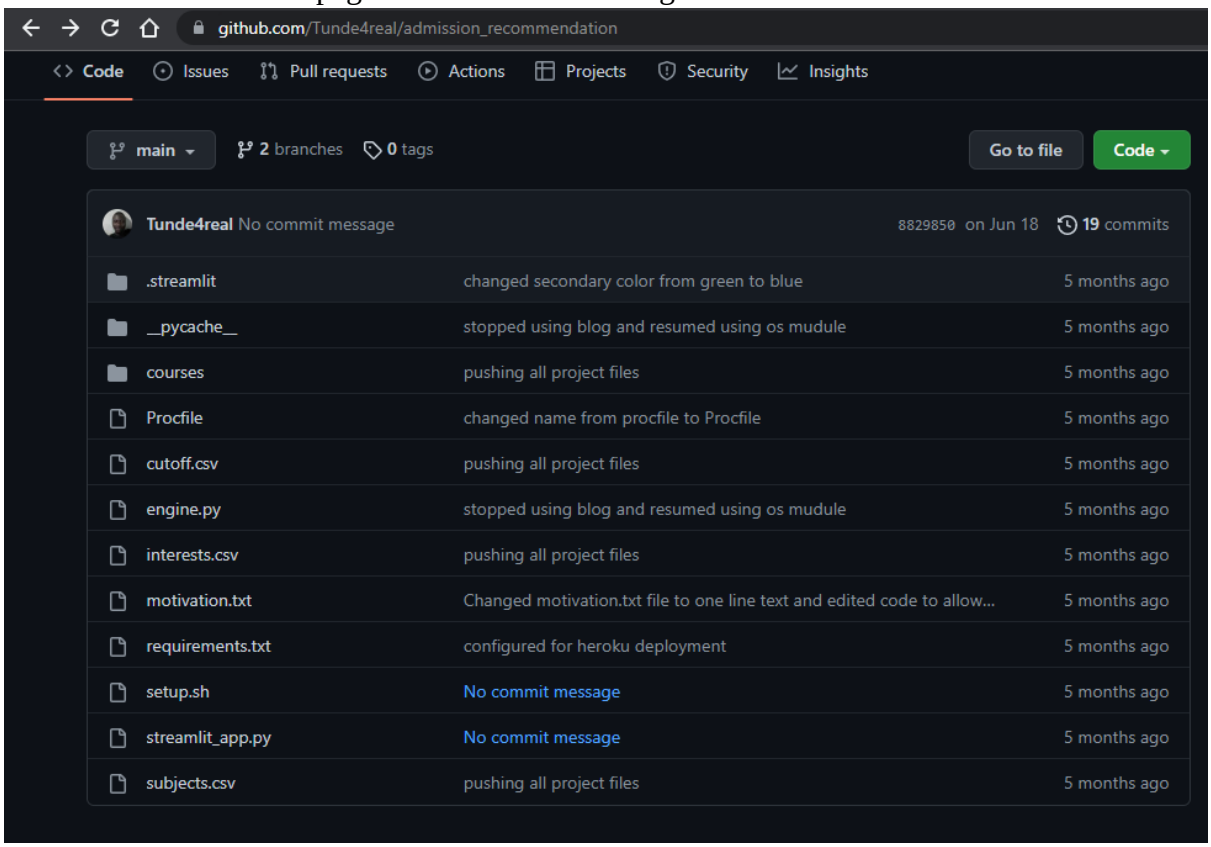


Figure 10: Project File Structure

- Streamlit: This is a folder that contains a configuration file for the streamlit app (streamlit_app.py) built for this project.
- __pycache__: Simply a cache folder.
- Courses: A folder that contains folders for selected colleges, polytechnic, federal universities, state universities and private universities. Each of these folders contain a single file for each institution, and each of these files contain the WAEC subject requirements and JAMB subject requirements for the courses they offer.
- Procfile: A configuration file required for deployment on Heroku.
- Cutoff.csv: a file that contains mock-up cut off marks, graded as percentages for all courses.
- Engine.py: A python script that contains implementation of the model.
- Interests.csv: A csv file containing course and corresponding attributes/interests of associated with it.
- Motivation.txt: A text file containing the paragraphed text written on the website.
- Requirements.txt: A text file containing all the projects' dependencies.
- Setup.sh: A setup file required for deployment on Heroku. This file instructs the Heroku server on how to set up the web application.
- Streanlitapp.py: A python script containing the implementation of the website using streamlit.

- Subjects.csv: A csv file that contains WAEC subjects and their corresponding abbreviation.

4.4 Conclusion

Python is the most popular choice for building recommender system and its capabilities were greatly used in this project. The ability to build web apps with native python code, though with very little HTML is most interesting, saving the stress of writing pure HTML, CSS JavaScript, Flask/Django, and other possible technologies.

CHAPTER 5

5.1 Conclusion

As a secondary school graduate, I didn't have the opportunity to get recommendations of just what course could I study given my strengths and my results, I eventually decided to choose Computer Science simply because I thought it has a bright future. The idea of this project is for students to have a system that can provide a bit of guidance, if not excellent guidance to choosing a good discipline. Students who know little to nothing about tertiary education need guidance in choosing a course of studying or if a course of study is a good fit for them, plus which university to go to.

Course recommendation systems are widely used around the world and forms a good element of the education system in the developed world. They are used to recommend disciplines and even course works to students around the globe. Nigeria definitely needs to incorporate such systems into her education system to make the system better and more robust.

5.2 Recommendation

The start of recommendation is often a weighted approach, and this project has solved that problem. Furthermore, more work is recommended on expanding the system built into a full-blown solution used by Nigerian students and hence, adequate data should be collected for more robust recommendation engines.

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