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A Theoretical Framework for an Intelligent Result Processing Expert System in Nigerian Universities

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Abstract: *Computation of GPA (Grade point average) and CGPA (Cumulative grade point average) in Nigerian universities is usually carried out by contracting the services of the ICT units of such institutions. The ICT approach uses portal management platform to manage and compute students' results. Unfortunately, the contracted ICT approach does not consider the departmental policies and regulations as well as that of the University governing body in graduating students. Moreover, the existing approach does not provide an avenue for the various departments to compare their computation results (if any) with that of the ICT units. This paper presents a framework for developing departmental expert system that uses Boolean logic to ascertain if a student has met with the requirements of the Nigeria's National University Commission (NUC), the respective individual universities and the various departments before graduation. The expert system framework is designed to first accept knowledge base and decision support data from hosting academic departments and secondly to accept registration data from students per level, and results from course lecturers. It uses the supplied knowledge base data to form inferential rules for the computation of students' GPA's and CGPA's respectively. An algorithm for the framework is presented using Java programming language.*

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I. Introduction

Universities usually award degrees at the completion of students' academic learning for a given discipline. These awards come in different classes depending on the GPA (Grade Point Average) and CGPA (Cumulative Grade Point Average) of the students. The Grade Point average is a reflection of the students' grade and accompanying point per course offered in the institution per semester. On the other hand, the Cumulative Grade Point Average reflects the grade and point obtained for each course for the students' whole duration of stay in the institution. Often times, the rigors of computation compel departments to shift their responsibilities to ICT units of such Institutions. Unfortunately, the ICT units do not incorporate individual departmental requirements, policies and regulations in their computation of GPA and CGPA. Besides this, the most common ICT approach of computing students GPA and CGPA's is by creating an academic database portal which allows students to register courses and view their results at the end of every semester or session. This approach works perfectly well for departments that run a fixed compulsory curriculum without elective options. Unfortunately, for other departments with more comprehensive and dynamic curriculum, where the students are allowed electives, it becomes difficult to predict whether a student has completely fulfilled the course requirement for the award of degree in such discipline.

Furthermore, the ICT departments solely do the computation of students GPA and CGPA without a check or means of comparing results with that computed by examination officers domiciled in the students' department. There have been cases of forgery, cheating, manipulation and deceitfulness associated with this approach in Nigerian Universities. The departments continue to depend on the output of the ICT units because they do not have an alternative automated system that could checkmate that of the ICT. Some other departments resort to manual computation of these GPA and CGPA's thereby introducing human errors and influence.

This paper presents a theoretical framework for the implementation of an expert system which is to be used in departments. The expert system incorporates the unique policies and requirements for a given academic department as well as that of the university and University governing body to form inferential rules for computing GPA and CGPA before awarding degrees. In addition, an algorithm is developed to provide a support guide for implementing the expert system using computer programming language. The significance of the work is that computation of students' GPA, CGPA, faculty presentation reports, and students' status reports could easily be made available not just at the ICT unit but also at the department level. This reduces errors and checkmates the activities of fraudulent ICT staff members.

II. Literature Review

Most universities in Nigeria run a semester result grading system as opposed to the annual grading system as seen in other countries. In India for instance, it is argued that the semester grading system discriminates between the students whose scores are at the extremes of the intervals that define a grade[1]. This means that if a student scores 70 and another scores 96 their grade will be A in both cases irrespective of the wide range disparity of 70 and 95 in the real number line. However, the semester GPA and CGPA number still remain the functional, viable and most effective means of reporting on students' performance in Nigerian universities. The importance of GPA number cannot be overemphasized. The GPA number has been used to ascertain students' credibility by comparing the student's entry point into the university[2]. In a similar research, it has been used to identify risk students that could be assisted within an institution[3]. The GPA number has also been used to study the impact of students' socioeconomic background on educational outcomes[4]. Other authors in their research had successfully predicted students CGPA from their scores in previous courses using Decision tree algorithm[5]. The prediction was done using students grades in mandatory courses. Furthermore, GPA number had successfully been used to measure the effect of extracurricular activities (ECA) on students' performance[6]. All these provide support on the importance of knowing students GPA and CGPA.

Computation of the GPA and CGPA numbers has always been a challenge in many universities in Nigeria. In an effort aimed at solving this challenge, several programs and algorithms had been developed. The University of Jos Nigeria in particular faces a lot of challenges in computation of these numbers before they are presented for senate approval. In order to solve some of these challenges facing the university, an algorithm was developed and implemented for computing these numbers especially for large students using Excel templates[7]. Unfortunately, the algorithm is fixed and limited to serving the need of senate result approval at the University of Jos, Nigeria. Similarly, many other universities in Nigeria such as Obafemi Awolowo university, Ile Ife Nigeria, university of Nigeria, Nsukka, Nnamdi Azikiwe University Awka have resorted to using student's academic management portal systems to compute their student's GPA and CGPA. These portals are managed by ICT units of these institutions and have invariably taken away the responsibility of result processing from departments. The implication of this is that departments now depend on the ICT units to graduate their students for them. This can lead to cases of employee data sabotage and manipulation[8]. This situation can be avoided if there is less reliance on outside individuals in order to safeguard data[9].

There are other programs/packages that had been developed at departmental level to aid Departmental Examination officers (DEO) in the computation of GPA and CGPA. The SRAERCA (Student Record Analysis and Examination Result Computation Algorithm) for example makes use of three sub-programs GRADE, SORT and TGEN to compute GPA and CGPA respectively[10]. Unfortunately, the algorithm is not designed to be a database system capturing long term records of a department. Other programs such as Data Analysis and Result Computation(DARC) algorithm focuses on reporting on students' performance without details of computation[11].

A prominent common missing feature in the existing applications and algorithms is a dynamic platform requiring department in any institution to set up its own graduation requirements and policies which will invariably be used to formulate expert system rules that is used for computing the GPA and CGPA for graduating the students. In other words, the expert system component that dynamically accepts input data in the form of regulations as well as requirements and policies for a given department is seriously lacking. The expert system is supposed to exhibit the characteristics of DEO's and it will form its rules based on the data supplied. It will then make appropriate decisions just as the human DEO's would. Expert systems have been defined as computer programs exhibiting behavior characteristics of human experts[12]. An expert system is usually made up of knowledge base and the associated inference coming from it. This paper provides a theoretical framework on which such expert system could be developed.

III. Conceptual Definitions

Nigerian University Commission (NUC)

The NUC is the governing/regulatory body overseeing the activities and mode of operation of Nigerian Universities. The NUC stipulates the standards for awarding undergraduate degrees in Nigerian Universities. Such standards include duration of course, minimum graduation unit load, class of honours e.t.c. The standards differ according to disciplines and departments, for example the recent release of NUC on undergraduate yardstick for graduation in stipulates the disciplines classified under the Social sciences, the duration of each programme and others[13].

A typical NUC standard for a 4 year programme in Nigerian universities is summarized in table 1 as follows:

Table no 1: Shows NUC approved standard for Undergraduate grading system

Percentage	*Grade*	*Grade Point*	*Course*	*GPA*	*CGPA*	*Class of Honours*

Scores (I)	***(II)***	***(GP) (III)***	***Unit (IV)***	***(IV)***	***(V)***	***(VI)***
70-100	***A***	***5***	***Unit***	***Derived by multiplying III and IV and dividing by Total credit Units***	***4.50-5.00***	***First Class***
60-69	***B***	***4***	***Unit***		***3.50-4.49***	***2nd Class Upper***
50-59	***C***	***3***	***Unit***		***2.40-3.49***	***2nd Class Lower***
45-49	***D***	***2***	***Unit***		***1.50-2.39***	***3rd class***
0-44	***F***	***0***				

Grade Point (GP)

The Grade point is an NUC approved weight attached to a grade. The weight ranges from 0 to 5. Grade 'A' attracts the highest point of 5 while grade 'F' attracts zero (0) point. (See Table 1 for details). A grade in a particular course simply assesses the student's performance in that course and does not reflect a student's performance in other courses[14].

Total Grade Point (TGP)

The total grade point is the summation of the respective Grade point and course unit earned by a student in a semester. It is mathematically given as:

TGP = $\sum_i^n (GP_i * Unit_i)$..... (equation 3.3)

Where GP_i and $Unit_i$ are Grade Point and Units associated to course i respectively.

Total Credit Earned (TCE)

The Total Credit Earned is the summation of the individual course units registered by a student in a semester. It is given as:

TCE = $\sum_i^n (Unit_i)$..... (equation 3.4)

Grade point average (GPA)

The grade point average is a number that indicates the performance score of a student in his/her courses on the average. It is seen as a yardstick measure to assess whether a student has met the standards and expectations set by the degree programme or university for a given semester. The computation of GPA in Nigerian institutions takes into cognizance the NUC (Nigerian University commission) grading system and the associated weight per grade. The GPA is computed as a quotient of TGP and TCE. Mathematically given as:

GPA = $\frac{TGP}{TCE}$……..(equation 3.5)

The GPA number is a requirement for:

a. scholarship application
b. graduate or post-graduate programme application
c. joining an organization or club

Cumulative Total Credit Earned (CTCE)

This is the sum of all the course credit units earned by a student for all the semesters registered for. It can also represent the sum of TCE for each semester. It is given as:

CTCE= $\sum_i^n TCE_i$..... (equation 3.6)

3.6 Cumulative Total Grade Point (CTGP)

The Cumulative total grade point represents the summation of the product of the Grade point and Course unit for all the courses registered by a student in all the semesters. It can also represent the sum of the TGP for all the semesters. It is usually computed at the end of a programme and represented mathematically thus:

CTGP = $\sum_i^n (TGP_i)$..... (equation 3.6)

Cumulative Grade Point Average (CGPA)

The Cumulative grade point average is the final determining performance measure that awards a degree. The CGPA is an NUC approved scale (see Table 1) which determines the class of degree to be awarded. It is a quotient involving the CTGP and the CTCE iven as:

CGPA= $\left(\frac{CTGP}{CTCE}\right)$..... (equation 3.7)

IV. Theoretical background

The background of this paper is based on the theory of expert systems. According to [15], the paradigm of expert system design is given as:
Expert system = Knowledge + inference. Hence, an expert system consists of:

- A knowledge base which captures the domain-specific knowledge for the task at hand. In this case, the knowledge base includes the department regulations data, students' registration data and results.
- An inference engine which is made up of algorithms that manipulate the knowledge

represented in the knowledge base. The inference engine employed in our case includes the Boolean logic and rules emanating from the NUC, department and University regulations. The expert system architecture is shown in figure no 1.

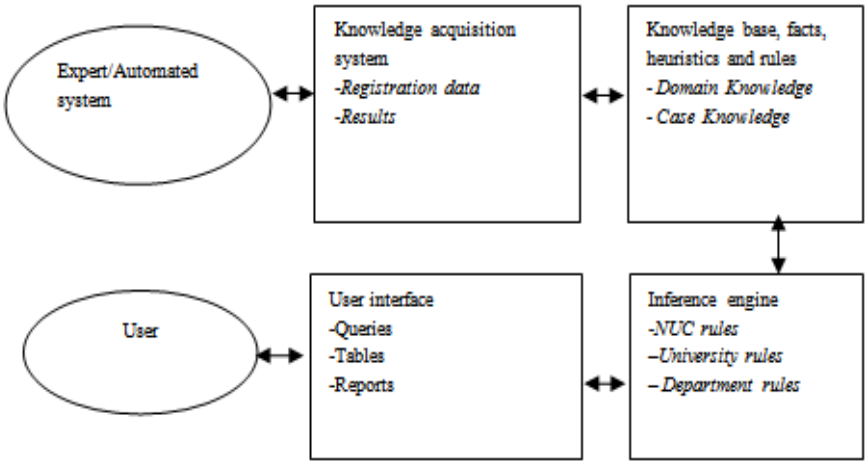

Figure no 1: Architecture of the expert System

The result processing expert system makes use of the following sub-systems:

Knowledge acquisition sub-system

This is an interactive process which involves eliciting information from the departmental examination officers who are regarded as the human experts. This sub-system was developed from interviews and interactions between examination officers from various departments in the University of Nigeria, Nsukka. The aim of the interaction was to ascertain the challenges involved in processing results within departments. Information was gathered at several occasions during their meeting forum with the university administration. Information gathered focused on finding solutions on the existing challenges. The elicited information was conceptualized to form simple reasoning that solves the problem. Table 2 summarizes the information elicited (challenges) and the possible conceptualized reasoning arising from them.

Table no 2: Shoes elicited information and conceptualized reasoning

Information (Challenge)	Reasoning (Solution)
Students' registration	Data acquisition from students through offline broadsheet templates per semester and per level, data porting of registration data from ICT students' portal. Creating of course registration output per student.
Lecturers'single results	Automated offline template interfacing with expert system
Detecting\failed courses	Use of acquired registration data in checking failed courses
Detectingunreleased results	Use of acquired registration data in checking unreleased results
Students'semester transcript result	Semester result output for each registered student
Broadsheet results for levels	Semester result output for each level in a broadsheet form
Faculty board result presentation format	Summary of departmental results in an approved format
Possible graduands list	List of students expected to graduate based on registered courses, available results, un-failed courses e.t.c.
CGPA computation	Full transcript of each students' result

Knowledge base facts, heuristics and rules sub-system

The knowledge base of facts is classified into:

- Domain Knowledge:- This includes general core knowledge of course registration procedure, minimum and maximum unit load per semester, result processing procedure, single lecturers' result, C.A and Examination score limit e.t.c
- Case Knowledge:- These are specific facts/knowledge about particular departments, students, results or registration. These includes department names, name of course lecturers, names and Reg.no of students, names of the head of department e.t.c..

Inference Engine sub-system

The proposed expert system for result processing will derive its inference engine for logical comparisons from the NUC, University (University of Nigeria, Nsukka) and departmental rules.

NUC (Nigerian University Commission) rules and policies on award of degrees:- The NUC rules and policies considered are:

a. NUC rule for grade:- Table no 3 represents the NUC score range and the associated grade point.

Table no 3: Shows NUC rule for grade and point

Rule	Grade	Point
If (70≤score≤100) then	A	5
If (60≤score≤69) then	B	4
If(50≤score≤59) then	C	3
If (45≤score≤49) then	D	2
If (0≤score≤44) then	F	0

b. NUC rule for Class of Honours: Table 4 represents the NUC rule for class of honours.

Table no 4: Shows NUC rule for class of honours

Rule	Class
If (4.50≤cgpa≤5.00) then	1st Class
If (3.5≤cgpa≤4.49) then	2nd Class (Upper)
If(2.40≤cgpa≤3.49) then	2nd Class (Lower)
If (1.50≤cgpa≤2.39) then	3rd Class
If (0≤cgpa≤1.49) then	Pass

University rules and policies on award of degrees:

The university rules considered are as follows:

a. University rule for course registration: The University rule for course registration is a Boolean expression given as:

$$\text{Course Registration}_{\text{rule}} = \begin{cases} 1 & \text{if (course is registered} \\ 0 & otherwise \end{cases} \quad \text{..... (equation 4.3.2a)}$$

b. University rule for Minimum/Maximum credit unit registration: The University rule for semester registration is a Boolean expression given as:

$$\text{Min/Max Registration}_{\text{rule}} = \begin{cases} 1 & \text{if } (15 \leq tce \leq 24) \\ 0 & otherwise \end{cases} \quad \text{..... (equation 4.3.2b)}$$

c. University rule for Overstay Condition: The University rule for students on a 4 year and 6 year programme to enter overstay is given in equations 4.3.2c and 4.3.2d respectively:

$$\text{Overstay}_{6\text{yrs}} = \begin{cases} 0 & \text{if } (1 \leq \text{yrofstudy} \leq 6) \\ 1 & otherwise \end{cases} \quad \text{..... (equation 4.3.2c)}$$

$$\text{Overstay}_{8\text{yrs}} = \begin{cases} 0 & \text{if } (1 \leq \text{yrofstudy} \leq 8) \\ 1 & otherwise \end{cases} \quad \text{..... (equation 4.3.2d)}$$

Departmental requirements, regulations and rules

a. Department rule on Minimum credit unit per student: Each department have their minimum required credit load per student which must be attained at the end of the programme duration before graduation. The minimum credit load per student is computed by summing all the required minimum credit load per semester for the course duration. This is given as:

$\text{CreditLoad}_{\text{min}} = \sum_i^n (TCE_{min})_i$ ..... (equation 4.3.3a)

Where n = course duration, TCE_{min} = semester minimum credit load

b. Department rule on Major Courses:- Every student must have registered and passed all the major courses stipulated in the departmental hand book for course registration. If *n* represents the number of major courses required for graduation and *m* represents the number of major courses registered and passed by the student, then the Boolean expression:

$$Courses_{major} = \begin{cases} 1 & \text{if (n=m)} \\ 0 & otherwise \end{cases}$$ ..... (equation 4.3.3b)

4.4 Graduation Decision Support Sub-System

The decision support module performs two functions:

a. It computes the GP, TGP, TCE, GPA, CTCE, CTGP and CGPA using the equations in section 3.
b. It makes a decision on whether a student graduates or not by considering all the inference rules for NUC, university and the department respectively. The decision support structure is given in figure no2.

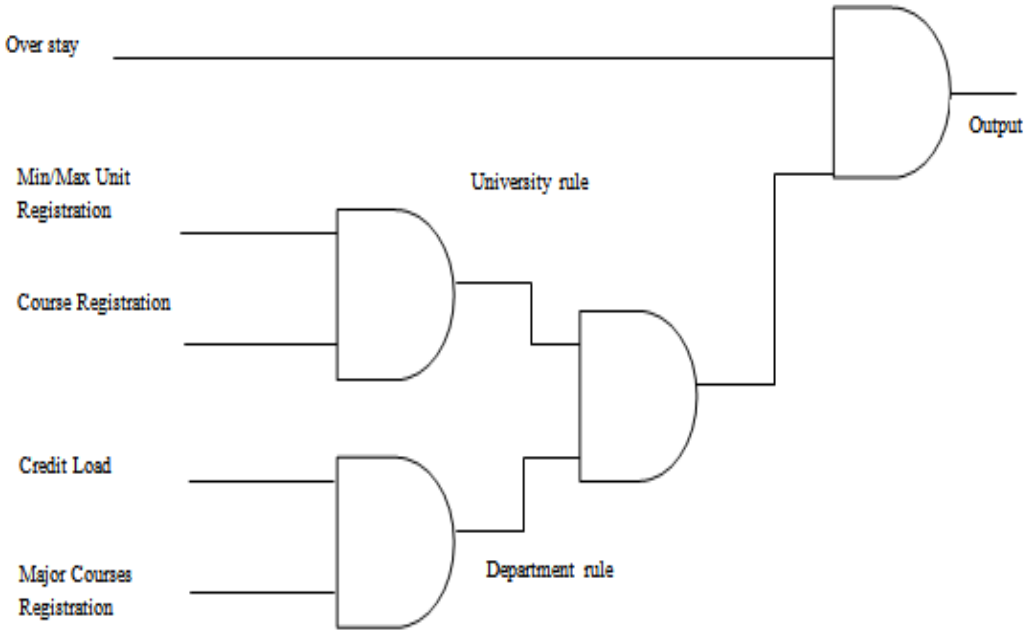

Figure no2: Graduation Decision Support Structure

The binary truth table arising from the decision support system is a 2^5-1 = 31 possible negative outcomes which indicates unsuccessful graduation and just one positive outcome for a successful graduation condition. The truth table is shown in table no 5.

Table no 5: Binary Truth Table for the decision support system

Major Courses	Credit load	Course Registration	Min/Max Registration	Overstay	Output
0	0	0	0	0	0
0	0	0	0	1	0
0	0	0	1	0	0
0	0	0	1	1	0
0	0	1	0	0	0
0	0	1	0	1	0
.	.	.	.	.	.
.	.	.	.	.	.
1	1	1	1	1	1

User Interface Sub-system

The user interface unit comprises of all the input and output interactions between the user and the expert system. These interactions are categorized into

a. Expert system Interviewer Component:- Interactions in form of dialogs and reading of measured data into the system are done through excel templates designed in form of queries and tables which elicits information from students and course lecturers.

b. The Explanation component:- This components provides the system solution in to user's input. These solutions come in form of reports. Such reports include broadsheet reports for GPA, broadsheet reports for class courses registration, faculty board presentation report, problem candidates' reports, possible gradaunds report, CGPA report and other related summary sheets reports.

V. Implementation Algorithm

This section presents a summary of the logical sequential steps for the result processing expert system using Java programming syntax. The algorithm is divided into six (6) sections which are:

I. Setup section:- sets up all the required parameters such as department names, faculty names, major courses, department minimum TCE load e.t.c.
II. Registration section :- Initiates registration uploads and invokes the registration sub-function (fn_register_rules) to verify the registration upload data in real time.
III. Result section:- Initiates result uploads and invokes the result sub-function (fn_result_rules) to verify the result upload data in real time.
IV. Computation section:- Initiates and invokes the computation sub-function (fn_compute_rules) for the computation and verification of GP, TGP, TCE, GPA e.t.c.
V. Report section:- Activates the report sub-function (fn_report) to extract required data from the database through the database sub-function (fn_database) and generate reports.
VI. Update/Edit section:- Initiates record editing and updates using the edit sub-function (fn_edit).

The system therefore makes use of eight (8) sub-function_calls namely; fn_setup(), fn_upload(), fn_database(), fn_register_rules(), fn_result_rules(), fn_compute_rules(), fn_report() and fn_edit().

The Algorithm steps

1. Setup section

1.1 *Initiate environment setup: fn_setup(data_set); /* sets up the department name, faculty, TCE minimum load, major courses e.t.c. */*

2. Registration section

2.1 *Initiate registration:*
2.1.1 Initialize int n = 4; / n = number of class levels in the department */*
2.1.2 for (int level=1; level<=n; level++){ fn_upload(level_registration_dataset); }
2.1.3 Invoke fn_register_rules(registration_dataset); / NUC, Department and university rules */*

3. Result section

3.1 Initiate result processing:
3.1.2 int registered_courses = fn_database(registration_dataset);
3.1.3 for (int courseno=1; courseno<=registered_courses; courseno++){
fn_upload (courseno_result_dataset);
fn_database(courseno_result_dataset; }
3.1.4 Invoke fn_result_rules (result_dataset);

4. Computation Section

4.1 Invoke fn_compute_rules (registration_dataset, result_dataset);

5. Report Section

5.1 Invoke fn_report (registration_dataset, result_dataset);

6. Edit/Update Section

6.1 *Invoke fn_edit (registration_dataset, result_dataset);*
stop;

VI. Conclusion

The proposed system framework could be implemented using any scripting programming language such as java script or Php. The framework will necessary develop into a portal for departmental exam officers to manage the results of their students. The portal excludes any direct input from students and will simply serve as an administrative medium for result management within a department. The significance of the system is that all existing NUC, University and department rules are put into consideration before a student is supposed to graduate. This intelligent attribute could be appreciated especially on departments with considerable numerical strength.

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