AN AUTOMATED ALGORITHM FOR HIGH SCHOOL ADMISSIONS IN UGANDA

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Abstract- The High School admission process in Uganda is intricate with varying parameters from school to school. Government affirmative action policies implementedthrough programs such as Universal Primary Education and Universal Secondary Education have resulted into unprecedented growth in High School enrollment. The high number of applicants necessitates a robust approach to selection. This paper presentsan algorithm for generating admission lists and assigning subject combinations for a typical High School in Uganda.

Index Terms- High School Admissions, Algorithm, Education in Uganda, Requirements Analysis.

I. INTRODUCTION

Uganda's population has increased from 9.5 million in 1969 to 34.8 million in 2014 [1]. The Uganda population pyramid for 2014 is presented in Figure 1. The notable statistics here are that 48.47% of Uganda's population is in the age range 0-14 years (male 8,966,494/female 9,015,302) and 21.16% in the age range 15-25 years in 2014 [2]. This represents 69.63% of the nation's population.

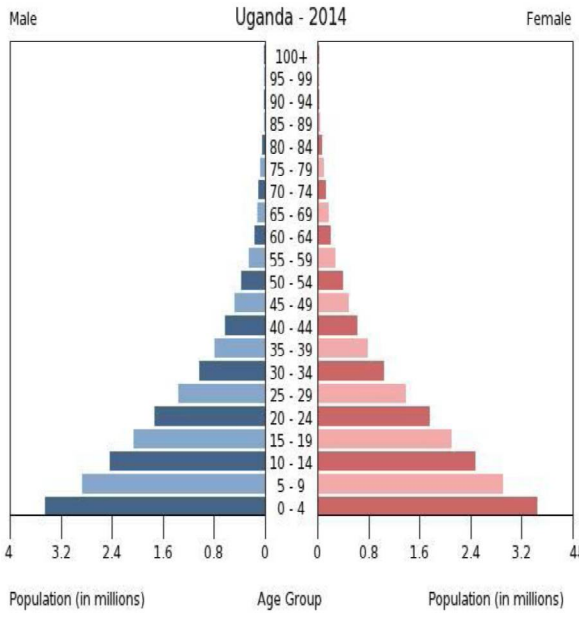


Figure 1: Uganda Population Pyramid [2]

The government of Uganda instituted affirmative action programs, Universal Primary Education and the Universal Secondary Education (2010) as part of the intervention to meet the Millennium Development Goal 2: Achieve Universal Primary Education. This intervention has resulted into unprecedented growth in High School enrollment and the sector at large.

Table 1: Secondary School Enrollment by Class 2009-2013

Class/ Year	Sex	Student Enrollment (Thousands)				
		2009	2010	2011	2012	2013
S1	Male	156	168	167	165	179
	Female	141	157	153	152	168
	Total	**297**	**325**	**320**	**317**	**347**
S2	Male	150	146	145	155	159
	Female	130	132	134	141	147
	Total	**280**	**278**	**279**	**296**	**306**
S3	Male	140	137	122	136	150
	Female	118	120	109	123	135
	Total	**258**	**257**	**231**	**259**	**285**
S4	Male	104	120	121	117	133
	Female	89	101	101	100	117
	Total	**193**	**221**	**222**	**217**	**250**
S5	Male	51	45	50	53	52
	Female	36	34	34	34	34
	Total	**87**	**79**	**84**	**87**	**86**
S6	Male	47	40	44	46	55
	Female	33	28	30	29	35
	Total	**80**	**68**	**74**	**75**	**90**
Total	Male	648	656	649	672	728
	Female	547	572	561	579	636
	Total	**1,195**	**1,228**	**1,210**	**1,251**	**1,364**

Source: 2014 Statistical Abstract, Uganda Bureau of Statistics, pp.134

II. SECONDARY SCHOOL EDUCATION IN UGANDA

The education system in Uganda is made up of 4 distinct levels, with the first being 1 to 4 years of pre-primary education followed by 7 years of primary education to 6 years of secondary education and finally university or tertiary education whose duration is dependent on the program selected by the student [3][4]. The Uganda secondary school education has two stages. The first stage referred to as Ordinary Level (O-Level) takes 4 years in which a student does 16 subjects in Senior 1 and 2, and registers for a

minimum of 8 and a maximum of 10 subjects in Senior 3 and 4. Upon completion of O-Level, the student is awarded the Uganda Certificate of Education (UCE) by the Uganda National Examination Board (UNEB). The second stage referred to as Advanced Level (A-Level) lasts for 2 years with the student taking 3 principal subjects and 1 subsidiary subject called General Paper. For the purposes of this paper, the Advanced Level is referred to as high school.Upon completion of A-Level, the student is awarded the Uganda Advanced Certificate of Education (UACE), a prerequisite for most of the university and tertiary institution programs [5].

The process of selection of students who join Senior 5 for any given school is an intricate one with the involvement of the different stakeholders in the process that include the Ministry of Education and Sports, various secondary schools and students. The process begins with the first selection exercise carried out by the Ministry of Education and Sports together with various secondary schools around the country after UCE results have been published. In this exercise, forms that each student filled while in senior 4 indicating the list of secondary schools of interest for A-Level studies are reviewed and allocations are done to the various secondary schools based on criteria like student's performance and capacity of the school. The ministry then publishes admission lists for each school. It's to the discretion of each student, however, to accept admission to a given school. Students that are not in assent to their allocation to a school or those not on any admission list can apply to any school of their choice for private consideration by the school. This process entails the second and final phase of the admission process of a typical secondary school in Uganda.

Before the school carries out private admission of students, all students on the ministry list have to be assigned subject combinations and streams to ascertain available slots in each stream that in turn informs the number of students to admit privately.

III. REQUIREMENTS ANALYSIS

An elaborate requirements analysis was carried out based on current high schools best practices in the process of admission of prospective students. This process gave the foundational understanding that greatly informed the development of the algorithm. The sections below highlight the requirements that were identified.

A. School's Maximum Intake

No school has access to an unlimited well of resources and facilities and as a result, there is a limitation to the number of students it can admit into a class. This figure is to the school's discretion. Furthermore, every high school class is split up into streams with each stream housing specific subject combinations. With limitations in classroom capacity, the number of students each school can admit for a specific subject combination is directly restricted.

B. Number of Students on the Ministry List

The Uganda Ministry of Education and Sports carries out preliminary allocation of applicants to public high schools based on the choices they make before sitting their Uganda Certificate of Education exams and their performance in reference to other applicants to the same schools. A list of chosen applicants is prepared for each school. The length of this list is greatly informed by the number of students the school specifies to admit under this arrangement.

C. Subject Combinations Available at the School

It is not mandatory for every high school to offer all valid subject combinations. The school decides subject combination options its students can undertake. This is partially due to the fact that schools vary in competence and capacity to offer specific subjects like languages and technical subjects that require a lot of resource.

D. Cutoff Points Difference between Boys and Girls

Mixed gender schools always have cut off points for girls placed higher than those for boys with an aim of attaining an acceptable gender balance in the school. This is because there are fewer girls in school than there are boys.

IV. ALGORITHM

The admission algorithm begins with the allocation of subject combinations and streams to the ministry list as shown by the flowchart in Figure 1 and is then followed by processes on admitting private applicants as shown by the flowchart in Figure 2.

A. Subject Combination Allocation of Ministry List Students Algorithm

The pseudo code below describes the algorithm used for allocation of subject combinations to the students on the Ministry of Education and Sports list.

*Definitions: QCList*is a list of all combinations a student qualifies for, *ComList* is a list of all school's available combinations, *students* is a list of all ministry students, SubList is an empty list.

0. Initialize *q* = true
    1. **foreach***student* in *students*
    2. **foreach** combination *C* in *ComList*:
    3. *SubList*= all subjectsin C
    4. **for each***subject* in SubList:
    5. **if***student* does not have the required grade qualification to do the subject:
    6. *q* = false
    7. **end if**
    8. **endfor**

9. **if** *q* = true:
10. add*C* to *QCList,*
11. **end if**
12. *q = true*
13. **end for**
14. Sort *QCList* by sum of grades obtained in each subject in ascending order, allocate student's combination as the first item in *QCList* and allocate stream to student
15. Reduce available number of slots for private admission by 1
16. **end for**

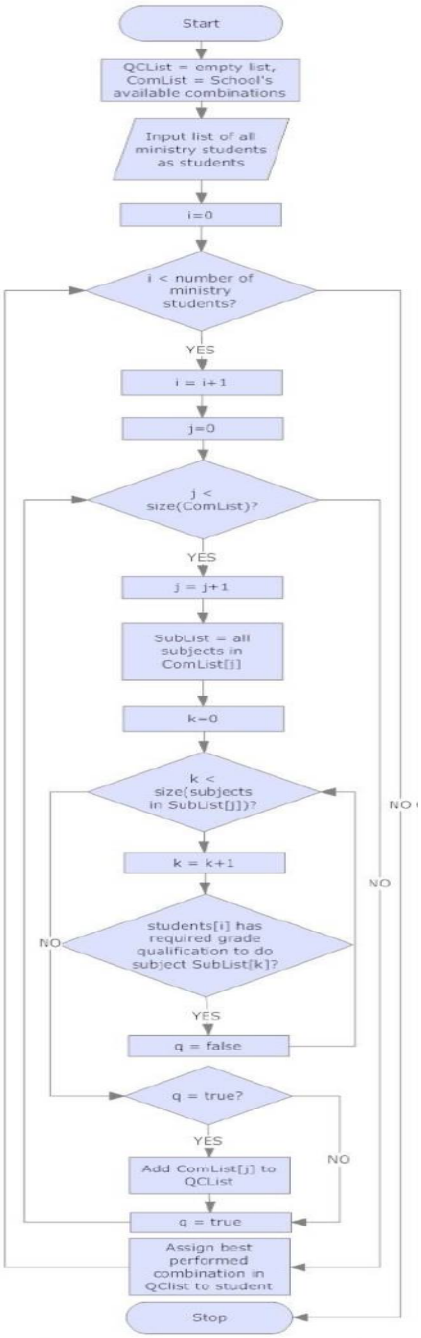


Figure 2: Subject Combination Allocation of Ministry List Students Work Flow Diagram

B. Algorithm for Admission of Private Students

The pseudo code below describes the algorithm used for admission of private students.

*Definitions:MAX*is the maximum difference between girl's cutoff and boy's cutoff points, *slots* is the number of available slots for private admission, *bAdmit* is list of admitted boys, *gAdmit* is list of admitted girls

0. Initialize *b*= number of available slots for boys, *g*= number of available slots for girls, *lb* = all male applicants in ascending order of points attained, *lg* = all female applicants in ascending order of points attained
1. **if***lb*.size<= ceil(*slots*/2) and *lg*.size<= *slots* – *b*:
2. *bAdmit* = *lb*, *lb* = 0, *gAdmit* = *lg*, *lg* = 0
3. GO TO line 21
4. **end if**
5. **else if***lb*.size<= ceil(*slots*/2) and *lg*.size>*slots* – *b*:
6. *bAdmit* = *lb*, *lb* = 0
7. *gAdmit* = first (*slots* – *lb*.size) items in *lg*
8. Remove first (*slots* – *lb*.size) items from *lg*
9. **end else if**
10. **else if***lb*.size>ceil(*slots*/2) and *lg*.size<= *slots* – *b*:
11. *gAdmit* = *lg*, *lg*= 0
12. *bAdmit* = first (*slots* – *lg*.size) items in *lb*
13. Remove first (*slots* – *lg*.size) items from *lb*
14. **end else if**
15. **else if***lb*.size>ceil(*slots*/2) and *lg*.size>*slots* – *b*:
16. *gAdmit* = first (*slots* – *b*) items in *lg*
17. Remove first (*slots* – *b*) items from *lg*
18. *bAdmit* = first (ceil(*slots*/2)) items in *lb*
19. Remove first (ceil(*slots*/2)) items from *lb*
20. **end else if**
21. *DIFF*= difference between points of the girl at the bottom of list *gAdmit* and points of boy at the bottom list *bAdmit*
22. **if***DIFF>MAX*:
23. *COUNT* = number of all girls in *gAdmit* with similar points as girl at the bottom of gAdmit
24. Remove all girls with points of girl at the bottom of *gAdmit* from *gAdmit*
25. Move the first *COUNT* boys from *lb* to *bAdmit*
26. GO TO line 21
27. **end if**
28. Publish *bAdmit* as the list of admitted boys and *gAdmit* as the list of admitted girls
29. Allocate combinations to admitted students

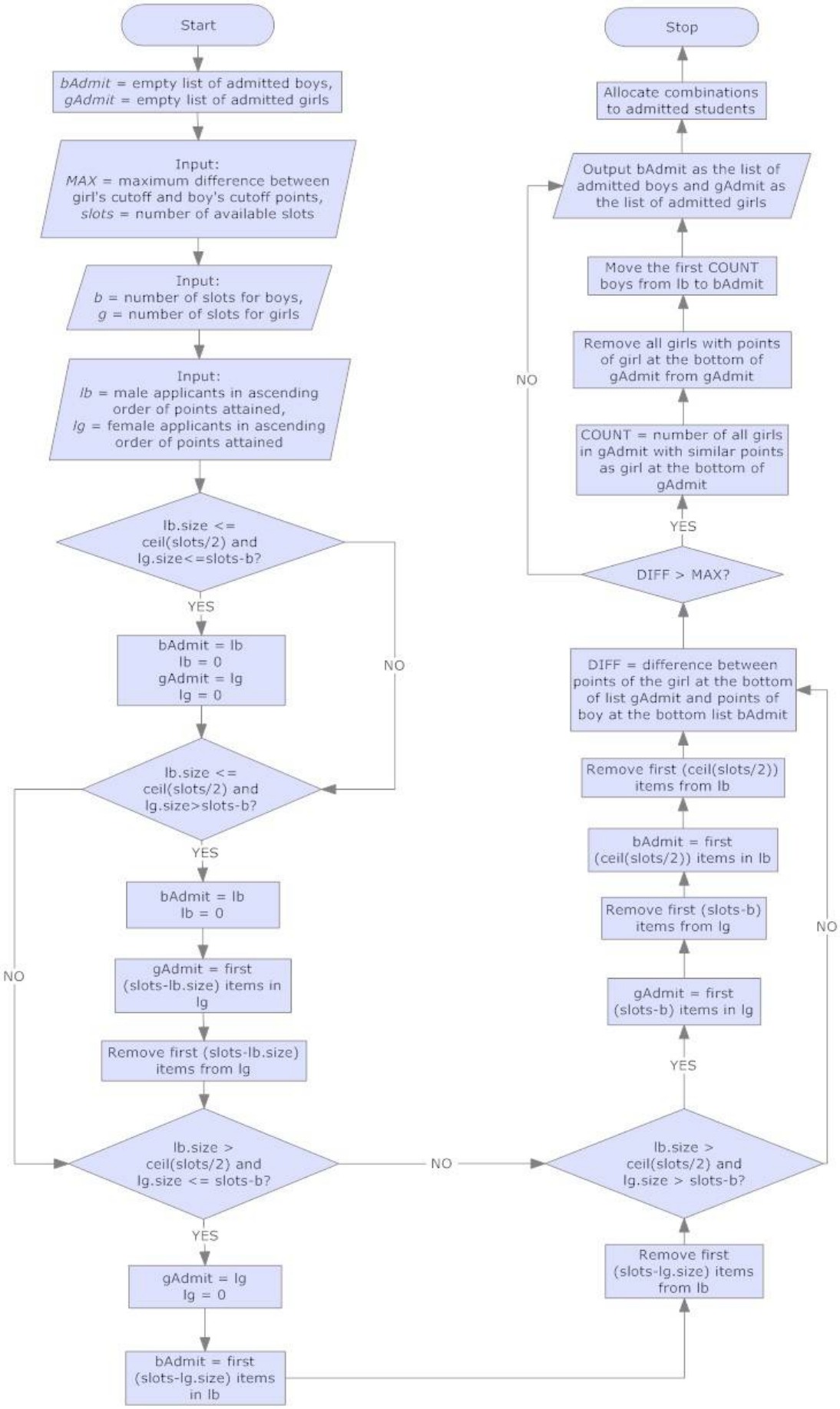
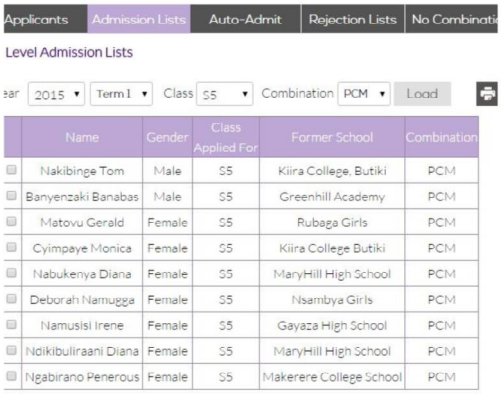


Figure 3: Algorithm for Admission of Private Students

V. RESULTS

The algorithm was integrated into an information system with intrinsic functionality of data input, data storageand an interactive graphical user interface. The processed data was displayed in tables in the different categories of Applicants, Admission Lists and Rejection Lists. The admission lists could further be categorized under the different assigned subject combinations. Figure 4shows the generated A-Level admission list of applicants assignedthe PCM subject combination while Figure 5 shows the list of rejected applicants from a test run on input data.


Applicants | Admission Lists | Auto-Admit | Rejection Lists | No Combinati

Level Admission Lists

ear 2015 Term 1 Class S5 Combination PCM Load

	Name	Gender	Class Applied For	Former School	Combination
	Nakibinge Tom	Male	S5	Kiira College, Butiki	PCM
	Banyenzaki Banabas	Male	S5	Greenhill Academy	PCM
	Matovu Gerald	Female	S5	Rubaga Girls	PCM
	Cyimpaye Monica	Female	S5	Kiira College Butiki	PCM
	Nabukenya Diana	Female	S5	MaryHill High School	PCM
	Deborah Namugga	Female	S5	Nsambya Girls	PCM
	Namusisi Irene	Female	S5	Gayaza High School	PCM
	Ndikibuliraani Diana	Female	S5	MaryHill High School	PCM
	Ngabirano Penerous	Female	S5	Makerere College School	PCM

Figure 4: Generated A-Level Admission List for PCM Combination


Applicant | Admission Lists | Auto-Admit | Rejection Lists | No Combination

A Level Rejection List

Year 2015 Term Term 1 Class S5 Load

Name	Gender	Class Applied For	Former School
Ahereza Phillip	Male	S5	Ntare School
Kasiri Joseph	Male	S5	BP CYPRIAN KIHANGIRE SECONDARY LUZIRA
Nakayemba Lydia	Male	S5	BP CYPRIAN KIHANGIRE SECONDARY LUZIRA
Nakiwolo Margret	Male	S5	BP CYPRIAN KIHANGIRE SS LUZIRA
Nambooze Harriet	Male	S5	BP CYPRIAN KIHANGIRE SS LUZIRA
Ntegyeza Arthur	Male	S5	BP CYPRIAN KIHANGIRE SS LUZIRA
Wandobire Brian Joram	Male	S5	Mengo Senior School

Figure 5: Generated A-Level Rejection List

CONCLUSION

In this paper, the premise for a customized automated algorithm for high school admission in Uganda has been presented. Pseudo code and associated flowcharts for subject combination selection and admission have been presented. Results from the implementation for the algorithm indicate that the realization of the automation provides a good tool for enhancing operation efficiency and effectiveness in the high school admission functions for a typical school in Uganda. Production tests are needed to validate and fine tune this algorithm.

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