Designing GA-based Auto-Generator of Examination Questions

Noor Hasimah Ibrahim Teo, Nordin Abu Bakar, Suraya Karim
Faculty of Computer and Mathematical Sciences
Universiti Teknologi MARA
Selangor, Malaysia
shimateo@tmsk.uitm.edu.my, nordin@tmsk.uitm.edu.my, surayabintikarim@gmail.com

Abstract— **Examinations are important tools for assessing student performance. They are commonly used as a metric to determine the quality of the students. However, preparation of quality examination questions is cumbersome and challenging especially for lecturers teaching new subjects. The problem becomes significant among novice lecturers. Usually, lecturers prepare complete sets of questions paper manually and store it in a Question bank. The glaring issue is how to auto-generate question papers that would conform to Outcome Based Education (OBE) specification. This project will investigate multi-constraints genetic algorithm approaches in designing Auto-Generator Of Examination Questions (AGEQ). The requirement model for AGEQ will be discussed in detail. The analysis shows impressive results in the difference between the desired and actual AGEQ output.**

Keywords- examination question; OBE; Genetic Algorithm; multiple constraint ;

I. INTRODUCTION

Assessment is a systematic and on-going process of collecting, interpreting, and acting on information relating to the goals and outcomes developed to support the institution's mission and purpose[1]. A typical examination question paper consists of a number of different type of questions such as single and multiple choices, short answer and essay. Preparing examination questions is challenging, cumbersome and time consuming for the lecturers. Maintaining the questions bank is another issue when it comes to huge institutions with hundreds of courses. It keeps the mixture of existing question and new created questions[2]. The advancement of technologies helps in reducing instructors' effort in preparing examination questions. Several methods have been designed to address the issue[2][3][4][6]. Different methods address to solve the same problem in different perspective.

A number of works have been done for generating examination questions that address different issues. Shuffling algorithm and randomized techniques[3][4] used to prevent duplication and repetitions on the sets of questions; auto-generator exam question using neural network[5]; Web-based question database using Functional-based Graph[2]; clustering techniques to store information on score and report[6]; design of Examination Paper Generating System using Genetic Algorithm[7]-[10]; electronic examination system using fuzzy logic[11]. This project proposed a novel approach to generate an examination paper based on OBE using multi-constraint genetic algorithm.

OBE is an educational process that focused at achieving certain specified outcomes in terms of individual student learning[12]. The Ministry of Higher Education has set eight learning outcomes which are important in providing wholesome quality education to students; namely, knowledge, practical skills, thinking and scientific skills, communication skills, social skills, teamwork and responsibility, values, ethics, moral and professionalism, information management and lifelong learning skills, managerial and entrepreneurial and leadership skills[13].

Each course in tertiary level of education needs to prepare OBE document. There are six documents to be prepared which documenting information on syllabus, student learning time, learning outcome and etc. The information specified in this document must be followed in order to conduct assessment for student. This is to prevent assessing student outside what they have been thought. Therefore, it is very important to generate questions that conform to OBE specification.

There are three evaluation criteria under OBE which are based on Bloom's taxonomy[14]. They are cognitive, psychomotor and affective. However, this paper will focus only on cognitive level for assessing student performance by using examination paper as a tool. Currently, there is no tool support the auto generation of examination question paper that based on OBE specification.

This research will benefit lecturers by supporting their effort in creating a set of complete examination paper and at the same time validating the questions according to OBE specifications.

II. PROPERTIES OF EXAMINATION PAPER

A typical examination question paper is divided into several sections which indicate different type of questions. Each question paper has multiple properties to define its attribute. These properties are required to achieve aformention objectives.

978-0-7695-4926-2/12 $26.00 © 2012 IEEE
DOI 10.1109/EMS.2012.69

- Type: Indicate type of question that needs to be created for examination paper. Type of question includes multiple choice, true and false, short answer and essay.
- Type score: The score for each type of question. The score is set by the user.
- Score: Indicate score for each question.
- Total Score: Indicate the overall score for the examination paper.
- Level: Indicate the difficulty level for each question. Difficulty level is determined using Bloom taxonomy cognitive level. Each course have it's predefine cognitive level in its OBE documents.
- Knowledge: indicate knowledge point to be covered within the test. This paper represents knowledge by subtopic of each course.
- Total Time: Indicate total time required to complete the examination.
- Number of Question: Indicate number of question to be generated for each type of question.

III. THE REQUIREMENT MODELING FOR AGED USING GENETIC ALGORITHM (GA)

This section is divided into three sections which are research framework, database structure and populating question set using GA.

A. System Development

Fig. 1 shows the activities undertaken to complete this project. It applies a standard System Development Lifecycle (SDLC).

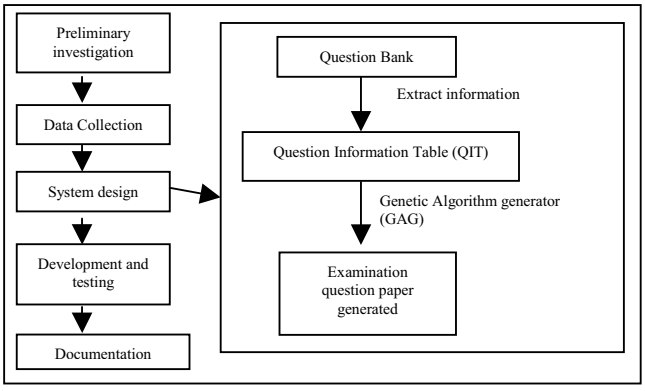


Figure 1: The Framework

Question Bank will store all questions posted by user. Questions are organized according to the type of questions. Properties of these question will be extracted and keep in QIT. This table is important as a source of information for GAG.

B. Database Structure

Database will be used to store two kinds of information which are the questions and QIT.

1) Questions: Store questions according to courses and it is organized according to subtopic and type of questions.

2) QIT: Store information about each of the questions as shown in TABLE I.

TABLE I. QIT EXAMPLE

Question Number	Type	Score	Difficulty Level	Knowledge	Time
1	Short Answer	20	C3	2.1	35
2	Short Answer	15	C2	3.1	25
•	Multiple choice	2	C1	1.1	2
•	Multiple Choice	2	C2	4.2	2
•	True/False	1	C1	5.2	1
n	True/False	1	C2	3.1	1

Information in QIT is based on the properties of the examination paper. This information is important as a constraint for executing GA in the next stage. Other properties such as total time,type score,total score and number of questions are also constraints to generate examination paper but are not used by GAG process. These properties will be set by the user.

Information in QIT can be extracted directly or indirectly. Type can be extracted from the section in the database; score normally defined together with a question; difficulty level is extracted from the Bloom's cognitive keyword; knowledge can be retrieved from the database directly as the question is organized in subtopic; time to answer each question is determined by the expert.

C. Populating Questions using GA

GA is chosen to populate examination paper randomly with a particular objective function and a group of constraints.

1) Constraint: There are five constraints identified from the examination paper' s properties for generating examination paper which are type, score, level, knowledge and time to answer each question. The Information is taken from QIT.

2) Chromosome Representation: Information for chromosome representation is taken from QIT. The representation is shown in Fig. 2.

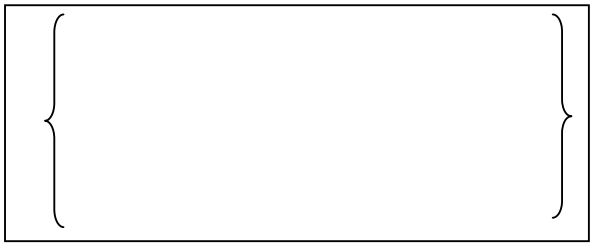


Figure 2:Chromosome representation of QIT

Row of the matrix represents each question in the set of examination paper. Each of the questions having it corresponding properties (t = type, s = score, d = difficulty level, k = knowledge, m = time). The detailed information for each of the question is further represented in binary and actual value representation format as shown in Fig. 3.

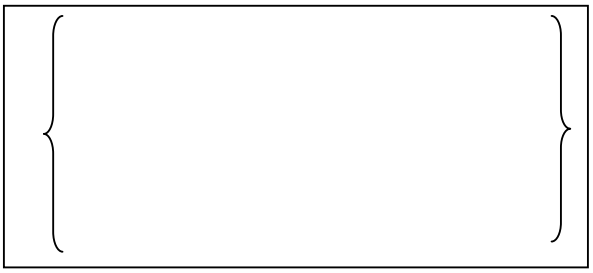


Figure 3: Example of QIT Detail Representation

3) Initial population: Initial population is generated randomly from the database. Each matrix represents one population. Two initial populations need to be generated randomly at the beginning. Both of the populations will be processed to reproduce another new population.

4) Objective function: The objective function indicates the user specification for examination paper they intent to set. Therefore, objective function is determined by the user based on the properties of the examination paper. User will be asked to fill up the information of the properties mention in the earlier section. The chromosome with the smallest error will be selected for reproduction. Error are calculated based on the difference between objective function defined by the user and the actual value produced by the chromosome. The smaller the value of error indicates a better objective function.

5) Reproduction: There are three steps involved in reproduction which are selection, crossover and mutation. The best population will be selected for reproduction. The smallest error in objective function is the best population to be selected. This fittest population will undergo crossover process with the other population within certain crossover rate. The rate normally around 60 percent of the chromosome length. Crossover will result in selection of several question from first population and selection of another several question from another population. This would generate a new set of examination question paper population. Next, is to run mutation on the chromosome. Mutation rate used is around 1 percent. Mutation will result in replacing a question in the new population with a new question from the database. This is done by replacing information in a row of matrix.

6) Iteration and Termination: The termination will occur when the objective function is achieved or the predefined maximum generation of population is reached. Otherwise, the process will be iterate from step 3. The objective function is determine by the user. The maximum generation of population is set to 1000 generations.

IV. RESULT

Table II shows the analysis of the experiment to test level of knowledge properties(prop). The test has been executed five times with predefined value for total score of 100 for each execution. Information for desired and actual output is recorded for each execution. Desired output indicates the instructor's requirement, whereas actual output indicates output generated by AGEQ tool.

TABLE II. ANALYSIS BASED ON LEVEL OF KNOWLEDGE PROPERTIES

Prop	1st		2nd		3rd		4th		5th	
	Desired	Actual	Desired	Actual	Desired	Actual	Desired	Actual	Desired	Actual
No. Que	10	10	15	15	15	15	12	12	10	10
C1	20	10	25	13.3	20	13.3	30	33.3	30	30
C2	20	20	25	13.3	20	13.3	30	8.33	20	10
C3	20	20	15	6.67	20	20	20	25	20	20
C4	20	20	15	26.6	15	20	10	8.33	10	20
C5	10	30	10	26.6	15	26.6	5	8.33	10	20
C6	10	0	10	13.3	10	6.67	5	16.6	10	0
TS	100	100	100	100	100	100	100	99.9	100	100

As shown in Figure 4, Run 3 (r3) and Run 5 (r5) produced better results than the others. Data are the raw score of differences between desired and the actual output.

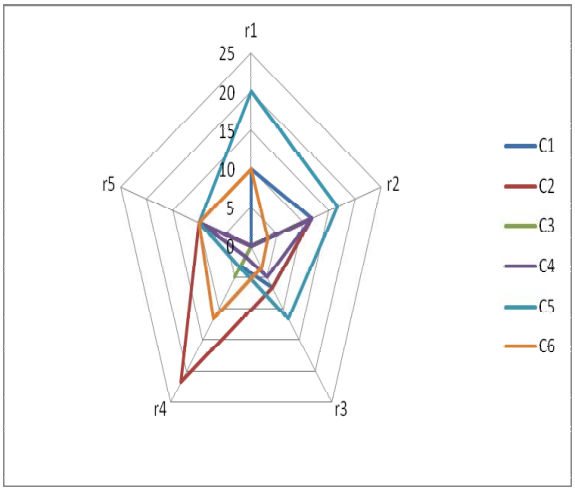
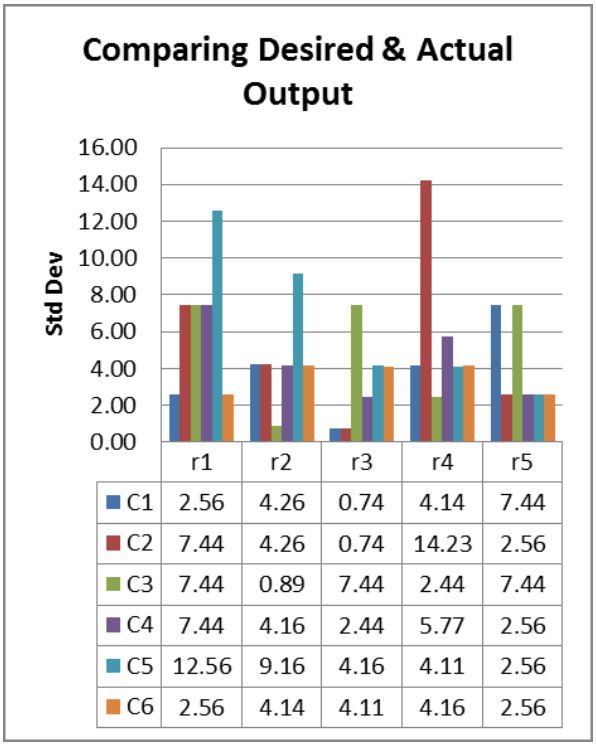


Figure 4: Raw Score of Desired & Actual Output

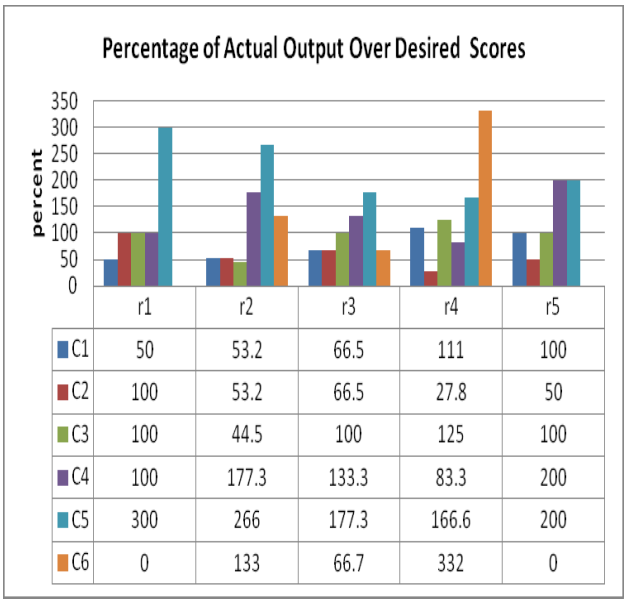
Figure 5 shows the standard deviations of desired and actual output produced by AGEQ. Run 5 produced relatively low deviation values across categories (C4,C5,C6).



	r1	r2	r3	r4	r5
C1	2.56	4.26	0.74	4.14	7.44
C2	7.44	4.26	0.74	14.23	2.56
C3	7.44	0.89	7.44	2.44	7.44
C4	7.44	4.16	2.44	5.77	2.56
C5	12.56	9.16	4.16	4.11	2.56
C6	2.56	4.14	4.11	4.16	2.56

Figure 4: Standard Deviations of the Desired & Actual Output

Figure 6 shows the percentage of actual output over the desired score. Run 1 has produced more 100% matches compared to other Runs.



	r1	r2	r3	r4	r5
C1	50	53.2	66.5	111	100
C2	100	53.2	66.5	27.8	50
C3	100	44.5	100	125	100
C4	100	177.3	133.3	83.3	200
C5	300	266	177.3	166.6	200
C6	0	133	66.7	332	0

Figure 5: Percentage of differences between actual output and desired scores

V. CONCLUSION

This paper has introduced the requirement model for OBE-Oriented Auto-Generator Of Examination Question (AGEQ). AGEQ applied a genetic algorithm to resolve issues around generating examination questions based on OBE specification. The tool helps to support lecturer's effort in the construction of examination paper and at the same time validating the process with OBE specification. Future works on this subject include looking into an optimization of objective function and fine tuning GA parameter values to improve performance.

ACKNOWLEDGMENT

This research is financed by an internal fund under Research Intensive Faculty Scheme, UiTM, Malaysia.

REFERENCES

[1] S. Osters and F. Simone Tiu, "Writing Measurable Learning Outcomes", Texas A&M 3rd Annual 2003 Assessment Conference. Retrieved April 10, 2011, from http://www.gavilan.edu/research/spd/Writing-Measurable-Learning-Outcomes.pdf

[2] Ang Tan Fong, Hu Heng Siew, Por Lip Yee and Lew Chee Sun, "Intelligent Question Bank and Examination System," In proceedings of the 5th WSEAS International Conference on E-ACTIVITIES, Venice, Italy, November 20 – 22, 2006

[3] N.S. Mohd Jamil and A.B. Md Sutan, "Shuffling Algorithms for Automatic Generator Question Paper System," Computer and Information Science, Vol 3, No. 2, 2010. ISSN 1913-8997

[4] Astech, "Atlantic Simulation and Training Technologies", [online] Available: http://www.astech.ie/ retrieved on 4th April 2011.

[5] S.T. Chakradhar, M.L.Busnell and V.D. Agrawal,"Automatic Test Generation using Neural Networks," IEEE International Conference on Computer-Aided Design, 1998. ICCAD-88. Digest of Technical Papers. pp. 416-419. DOI 10.1109/ICCAD.1988.122540

[6] DataDirector,"How to Create an Exam to Store, Score and Report Test Data," Retrieved from www.datadirector.com on 14 April 2011

[7] Wei Huang and Zhao-hui Wang, "Design of Examination Paper Generating System from Item Bank by using Genetic Algorithm", In proceeding of International Conference on Computer Science and Software Engineering, 2008 DOI 10.1109/CSSE.2008.47

[8] Wu Xiaoqin, "Research of Intelligent Generating Test Paper System," In proceeding of The International Conference on Computational Intelligence and Software engineering, 2009. CiSE, 2009, pp.1-4. DOI 10.1109/ISE.2009.5365944

[9] W. Shupei, Yi Yeqing, "Investigating of test Paper Auto-generation Based on Improved Adaptived Genetic Algorithm". Science Technology and Engineering, 2006, (2) pp: 468 – 473

[10] Mao. Bingying, "Research on Database Structure composing test paper intelligently Base on GA," Journal of Computer Engineering and Aplication. 2002; 28 (6) pp:280 - 281.

[11] Xien Cheng, Jinghua Zheng. Novel Approach of Auto-generating Examination Papers Based on Fuzzy Logic. In proceeding of 2010 International Conference on e-education, e-Business, e-Management and e-Learning. 2010 DOI 10.1109/IC4E.2010.11.

[12] A.M. Faizah,"The Use of Reflective Journals in Outcome-Based Education During the Teaching Practicum," Malaysian Journal of ELT Research. Vol. 4, pp. 32-42, ISSN 1511-8002.

[13] M. G. Mohayyidin, T. Suandi, G. Mustapha, M. M. Konting, N. Kamaruddin, N.A. Man, A. Adam, S.N. Abdullah, "Implementation of Outcomes-Based Education in Universiti Putra Malaysia: A Focus on Students' Learning Outcomes", International education Studies, Vol 1, No. 4, 2008. ISSN 1913-9039