Representing examination question knowledge into Genetic Algorithm

Conference Paper · April 2014

DOI: 10.1109/EDUCON.2014.6826203

CITATIONS
2

READS
173

3 authors, including:

Noor Hasimah Ibrahim Teo
Universiti Teknologi Mara (Melaka)
11 PUBLICATIONS **20** CITATIONS
SEE PROFILE

Nordin Abu-Bakar
Universiti Teknologi MARA
35 PUBLICATIONS **147** CITATIONS
SEE PROFILE

Representing Examination Question Knowledge into Genetic Algorithm

Noor Hasimah Ibrahim Teo, Nordin Abu Bakar, Mohamad Rezduan Abd Rashid
Faculty of Computer and Mathematical Sciences
University Technology MARA
Selangor, Malaysia
shimateo@tmsk.uitm.edu.my, nordin@tmsk.uitm.edu.my, naudzer90@gmail.com

Abstract— **Examination is a medium of knowing the IQ of a person and how far is the understanding of certain subjects. Normally, the questions are prepared by course instructor in sets and become a burden if the subject is new to them as they needs to prepare it in a given time. This paper describes a method of auto generating a new set of final exam questions. The objectives of this paper are: to optimize selection of final examination question based on the Cognitive Level of Blooms Taxonomy; to design and develop a prototype of auto-generator examination question using Genetic Algorithm and to evaluate performance of this tool. There are many types of questions in an examination; but this system chooses to analyze the structured question only. The newly populated examination questions are based on the fittest value of the fitness function calculated. This technique can be upgraded and be used by other type of question too.**

Keywords- examination question; knowledge extraction; Genetic Algorithm; cognitive knowledge ;

1. INTRODUCTION

Through examination, students' progression in their programmes can be determined and enables them to demonstrate that they have achieved the intended learning outcomes. It is also important to relate it with the examination questions.

It is time consuming in creating question and editing the format of the exam paper. Lecturers have to manually ensuring the level of the questions at least has the same level with the students. Traditional test paper generating algorithms have some shortcomings, such as slow generating speed, low success probability and low generating quality [1].

Existing system for selecting examination question used different technique such as utility based agent, genetic algorithm [2] [3] and shuffling algorithm [4]. Shuffling algorithm only focuses on selecting the paper randomly without repetition and duplication and does not include the difficulty and level of the question. The types of question selected also do not vary. Low quality of exam paper with fewer opportunities to success and expensive costs [5]. Whereas the utility based agent only focused on a single agent system [6].

In this study, questions are extracted from the final examination question bank. The tool will give benefits to instructor that has prepared the question. It will helps in reducing human error and time taken to prepare a particular set of question paper. The quality of the question paper generated will be based on the Bloom's Cognitive level [7] [8] [9]. The instructor can prepare proper questions based on Blooms Taxonomy as they don't have to be rushed because they can save the questions that they prepared at any time before the question is picked [10]. They also can generate a full set of exam questions in a very short time; through a button-click. The quality is also being controlled before being used in the examination.

This paper discussed the algorithm behind the development of this tool. The tool applies Genetic Algorithm (GA) technique for selecting the questions for the examination paper, to design the system requirement for auto-generator exam's question paper and to develop and test the tool.

Genetic Algorithms were invented to mimic some of the processes observed in natural evolution. The idea with GA is to use this power of evolution to solve optimization problems.

The general algorithms of GA [11]:

i. Randomly generate an initial population M(0)
ii. Compute and save the fitness u(m) for each individual m in the current population M(t)
iii. Define selection probabilities p(m) for each individual m in M(t) so that p(m) is proportional to u(m)
iv. Generate M(t+1) by probabilistically selecting individuals from M(t) to produce offspring via genetic operators
v. Repeat step 2 until satisfying solution is obtained.

Figure 1 show the flowchart on how the genetic algorithm works.

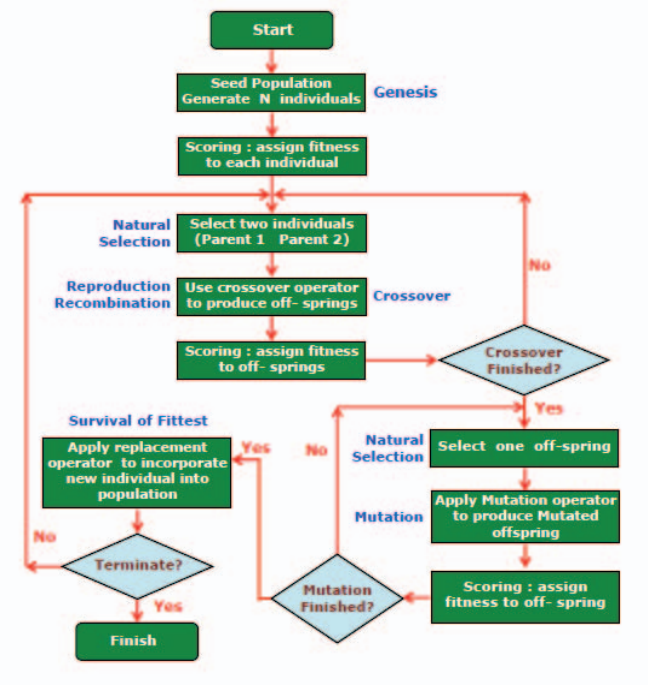

Figure 1: Flowchart on Genetic Algorithm Programming [3]

Scope is narrowed to the text-based question or the structured questions and followed the cognitive level of Blooms Taxonomy. There are lots of people who will have benefit from the tool. Among them is an instructor. They will get benefit from the system since they can provide the question based on learning outcome. Next, student will know their ability and performance in certain subjects. This research will also bring its own benefit to any institutions or organization that want to evaluate the quality of examination question paper.

In this paper, the GA technique will be used to select the questions to generate the exam paper. It is an adaptive heuristic search based on evolutionary ideas of natural selection and genetics. GA's exploit random search in optimizing the selection, it is random but have objective/lead to the result of the search.

2. PROPERTIES FOR EXAMINATION QUESTION GENERATOR

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 [12]. These properties are required to achieve aforementioned objectives. Following are the properties considered for this exam generator.

- Type [13]: Indicate type of question that needs to be created for examination paper. Type of question considered for analysis is short answer.
- Score: Indicate score for each question.
- Total Score: Indicate the overall score for the examination paper. This total score is indicated by user.
- Level: Indicate the difficulty level for each question. Difficulty level is determined using Bloom taxonomy cognitive level. Each course has it predefine cognitive level.
- Number of Question: Indicate number of question to be generated for the examination question paper.

3. THE SYSTEM DESIGN

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

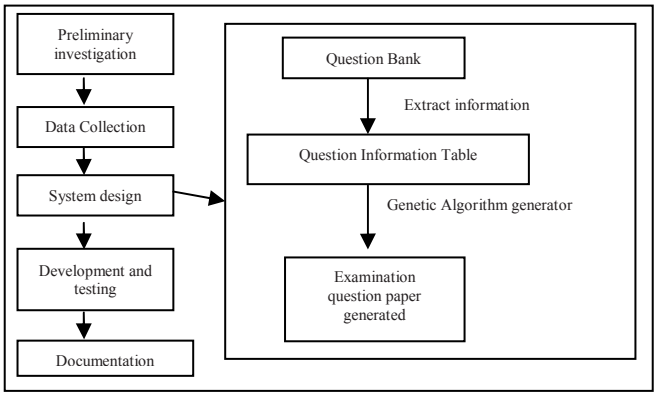

Figure 2: System design

Question Bank will store all questions that have been created by the instructors. Questions are organized according to the set of paper for each semester and by subject. Properties of these question will be extracted and keep in information table. The information from this table will be the input for the GA generator. The GA generator will process the input to obtain new population with fittest. New set of examination question paper will be produced from this step.

1. Database Structure

The examination question collected in .pdf format will be converted to .txt format. Database contains information of the examination question that is extracted from the .txt format of exam question and will be written into information table. Fig. 2 shows the extraction from question bank into information table. Information table contain information such as question number, question, score and keywords from each question respectively.

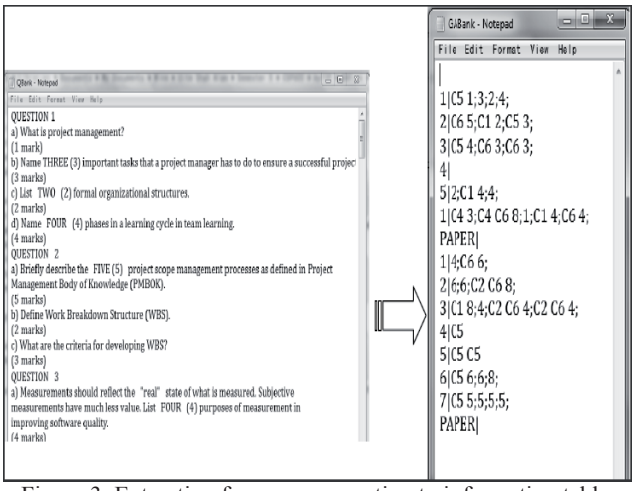

Figure 3: Extraction from exam question to information table

2. Populating Questions using GA

Two initial populations created from the questions that are selected randomly according to the number of question input by user. Each population represented by a chromosome in genetic algorithm. Fig. 3 shows the representation of examination question inside chromosome. Each cell in the chromosome will represent each question in the selected question paper.

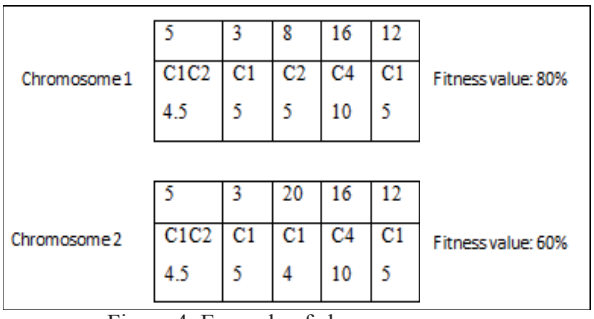

Figure 4: Example of chromosomes

Fitness value for each chromosome will be calculated according to the formula in (1).

$$\frac{UI-PI}{UI}\text{x}100. \quad (1)$$

UI is the value of user input and PI is the value within the population. The smaller value of fitness function indicates smaller error in the population. Error is defined as the difference between user input and generated population requirement.

Selection: The best population is indicated by the lowest value of fitness function between two initial populations. The Roulette wheel selection [13] is used to select the best population. Each of the questions also has corresponding score and level information.

Single crossover technique is used with crossover point is chosen randomly. The process is to enhance the fitness value of generated chromosome.

The mutation process will take out one question from the chromosome and replace it with one new question from question bank randomly.

At the mutation point, the bit is mutated and number of the question is changed with their respective score and level.

Step selection to mutation will be repeated until the optimal objective function or maximum loop is obtained. All fitness value will be compared and the lowest will be chosen. Optimal fitness is evaluated based on user input and the maximum loop is set to 1000 times.

4. RESULT

Fig. 4 shows the input interface for the tool support. The input indicates the instructor requirement in order to construct a question paper. The input consists of number of question needed, percentage of each level and total score.

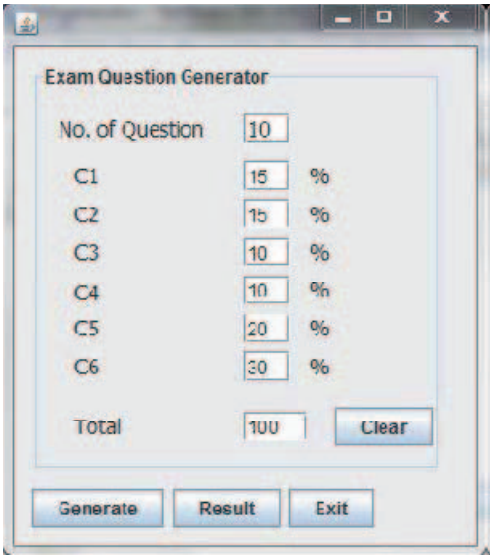

Figure 5: User input

User has to input the number of questions and the percentage of each level of Blooms Cognitive Level. The values will be the reference of all calculations. For example, if user inserts 10 for the number of questions, 15% of it is from cognitive level 1, 15% of it from cognitive level 2, 10% of it from cognitive level 3, 10% of it from cognitive level 4, 20% of it from cognitive level 5, and 30% of it from cognitive level 6. The percentage will determine how many questions from the 10 questions intended for each cognitive level. Result button will show the questions generated to the user.

The fitness value is calculated based on user input. In this case, the number of questions, and the percentage of questions for each level of cognitive level from level one until level six is the boundary in calculating the fitness of the population of questions sets. The sums of the percentage of each level must be 100. The questions had been extracted from pdf files to text files using software. After that, the questions are divided according to Blooms cognitive levels using keyword matching. Fig. 5 shows the new generated question paper.

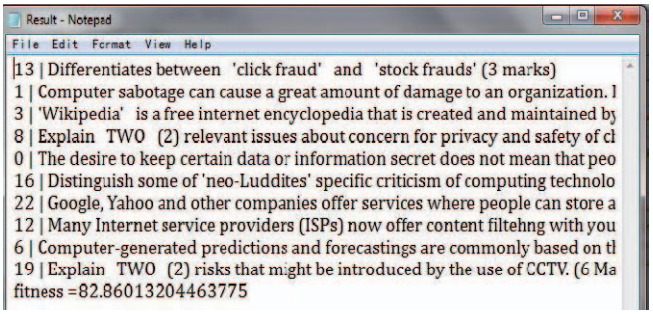

Figure 6: New question generated

The .txt file show the list of question generated according to the input user requested. The prototype has been run 100 times. In order to do the analysis, the fitness value of each run was captured. Each run consist of different number of question and percentage of each cognitive level.

Fig. 6 shows the graph analysis showing the fitness value of each trial. As shown below the fitness can reach as high as 97%.

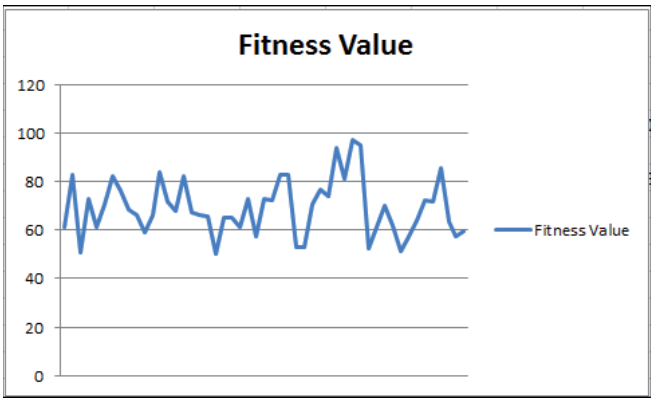

Figure 7: Graph analysis of fitness value

5. Conclusion

From creating examination paper manually that can make the panels become stressed, this paper proposed tool support for populating examination question paper based on Cognitive Levels of Blooms Taxonomy and to develop an auto-generation of examination question prototype.

There are two main techniques used; text matching, to match the keywords of cognitive domain in Blooms Taxonomy with the question so that the questions can be sorted accordingly and genetic algorithm, to process the sorted questions to become a new set of better combination of questions.

This project only focused on the structured question on the examination question. The number of question for each trial also affects this project end result because now there are fewer questions for each cognitive level. The question should be retrieved from a text file of bank question so that there are more options to be selected; thus increase the fitness values. The marks of the question also should be used to calculate the fitness value.

For future research, the scope can be opened to other Computer Science and Mathematics papers too. Furthermore, the question types in examination papers are not only the short answer question. The other types are multiple choice questions, true or false, fill in the blanks and essay. This tool support can be enhanced to include the other question types so that a perfect set of examination questions can be made.

Acknowledgment

This research is funded by Ministry of Higher Education (Malaysia) and Universiti Teknologi MARA (UiTM) under Research Acculturation Grants Scheme (RAGS) (RAGS/2012/UITM/SG05/2).

References

[1] Xiong, L., & Shi, J. (2010). Automatic Generating Test Paper System Based On Genetic Algorithm. *Second International Workshop on Education Technology and Computer Science*

[2] NHI Teo, NA Bakar, S Karim (2012). Designing GA-Based Auto-Generator of Examination Questions. Computer Modeling and Simulation (EMS), 2012 Sixth UKSim/AMSS European Symposium.

[3] Genetic Algorithm. (2010). *Genetic Algorithm*. Retrieved October 4, 2012, from http://www.myreaders.info/09-Genetic_Algorithms.pdf

[4] Sutan, N. S. (2010). Shuffling Algorithms for Automatic Generator Question Paper System. *Computer and Information Science (CCSECIS)* , (pp. 3(2):244-251.).

[5] Huang, W., & Wang, Z.-h. (2008). Design of Examination Paper Generating System from Item Bank by Using Genetic Algorithm. *International Conference on Computer Science and Software Engineering*.

[6] Memoona Naz, M. A.-u.-h. (2010). Utility Based Agent for Test Paper Generation. *International Journal of Multidisciplinary Sciences and Engineering*, (pp. Vol. 1, No. 1, September 2010.).

[7] Bjorn, S. (2012). *Bloom's Taxonomy*. Retrieved October 20, 2012, from http://www.coun.uvic.ca/learning/exams/blooms-taxonomy.html.

[8] Bloom, B. (. (1956). *Taxonomy of educational objectives: The classification of educational goals: Handbook I, cognitive domain.* New York.

[9] Clark, D. (2010). *Bloom's Taxonomy of Learning Domains*. Retrieved October 20, 2012, from http://www.nwlink.com/~donclark/hrd/bloom.html

[10] Huitt, W. (2011). *Bloom et al.'s taxonomy of the cognitive domain*. Retrieved October 20, 2012, from Educational Psychology Interactive. Valdosta, GA: Valdosta State University: http://www.edpsycinteractive.org/topics/cognition/bloom.html

[11] Kumara Sastry, D. G. (2004). Genetic Algorithms. University of Illionis, USA, University of Nottingham, UK.Karl O.

[13] NeuroDimension, Inc. (2012). *Optigen Library – Selection Operators.* Retrieved October 20, 2012 ,from http://www.nd.com/genetic/selection.html

Jones, J. H. (2009). Relationship Between Examination Questions and Bloom's Taxonomy. *ASEE/IEEE Frontiers in Education Conference W1G-6.* San Antonio, Texas

[12] University of Waterloo. (2012). *Centre for Teaching Excellence*. Retrieved October 20, 2012, from Exam Questions : Types, Characteristics and Suggestions: http://cte.uwaterloo.ca/teaching_resources/tips/exam_questions.html