

Computer Adaptive Testing Using Rule Based

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Abstract—Computer Adaptive Testing Using Rule Based Approach is an approach for delivering on line tests. It is based on complex computer algorithms rendered to achieve proper content distribution, item exposure and test length. In the Computer Adaptive Testing environment, test assessment and evaluation of each user helps the examiner to process a thorough assessment of the user's performance level based on the knowledge and learning ability. The other benefit of this system is that each user gets different sets of questions and the probability of the questions also differs depending upon the answer that the user chooses. The Adaptive testing using rule based approach will ensure that the next question given to the user will be dependent on the previous set of questions answered by them. The intention of this work is to design and test Computer Adaptive Testing Using Rule Based Approach technique for web based applications.

Keywords—*Computer Adaptive Testing, Rule based approach, Performance assessment, Polymer, web based application, mobile devices.*

I. INTRODUCTION

Testing centers conducting tests like GRE, TOEFL, CAT and GMAT have taken the initiative to make exams more cost effective and to lower the risk pertaining towards workload and delay of scoring. Presently, various institutions and organizations are using Common Admission Test (CAT) as a procedure for accomplishing large scale testing[3]. Using the rule based approach we are able to take CAT to a higher level in providing maximal balance of accuracy and efficiency. The basic idea is to test each user so as to obtain precise results when there are users with diverse educational background and performance levels. This testing can be accomplished through computer based systems such as laptops, desktops, smart phones or tablets. This paper is planned as follows –

- Section II describes the theoretical basis for CAT.
- Section III gives a brief idea of the literature review.
- Section IV gives detailed explanation about the rule based approach used in this work.

This is followed by the results and discussion in section V and conclusion in section VI.

II. THEORITICAL BASIS OF COMPUTER ADAPTIVE TEST

A. Design

CAT (Computerized Adaptive Testing) is designed in such a way that it becomes possible to improve the adeptness of judging the user's knowledge. This can be obtained by altering the questions on basis of the user's previous answers during the exam duration. The next question is chosen in such a way that it is neither too easy, nor too hard. The question is selected such that there is a probability of 50% that user would choose the right answer. But, the first question cannot be chosen in the above way because there is no clearness about the user's aptitudes. A question of moderate difficulty is chosen such that it is in a good position to adjust to each user answer to the previous question. Along with every answered question, our system is increasingly better into evaluating user's knowledge [4].

B. Drawbacks

Computer Adaptive Tests have some drawbacks which raise certain procedural and technical issues:

- CAT exams are devised on an item-response theory model which is not appropriate for all attributes.
- This testing requires large number of computers. The users have to be computer literate.
- Since each user is given a dissimilar set of questions, there may be seeming inequities.

User's have to answer the questions in a sequential manner, they cannot go back to answer the previous answer. This is because the strength of the next question depends upon the answer to the previous question. [4].

C. Algorithm

The steps of the CAT algorithm are:

- Depending upon the answer chosen by the user, the question repository is checked, and a suitable question is selected such that it was not there earlier. This question is of the appropriate difficulty level.
- A new ability estimate would then be calculated based on the answers to all of the given questions.

- Steps 1 through 3 are repeated until the closure condition is encountered. [4].

III. LITERATURE REVIEW

Chi-Keung Leung, Hua-Hua Chang, Kit-Tai Hau, "Computerized Adaptive Testing : A Comparison of three Content Balancing Methods" elaborates on the pros and cons of the three content balancing methods (CCAT, MCCAT and MMM). The main concern in all of these three methods which was specified was the "Over Exposure" problem faced by CCAT. The problem was dealt with by MCCAT (Modified Constrained CAT). We get know and learn about Exposure control and item selection procedures and precautionary measure from the study. The comparison between Over exposed and under used items leads us to understand how to deal with such scenarios in our project[1].

Nathan A. Thompson, David J. Weiss, "A Framework for the Development of Computerized Adaptive Tests", have provided a broad framework for the development of a CAT, applicable to most situations. The development of a CAT is often left completely to the judgment of the professionals working on the CAT. We also learn that many testing programs will have various issues that must not only be identified, but also isolated so that they can be investigated as empirically as possible And through the use of simulation research, remains applicable to all programs the process of

CAT can
be better
understood[2].

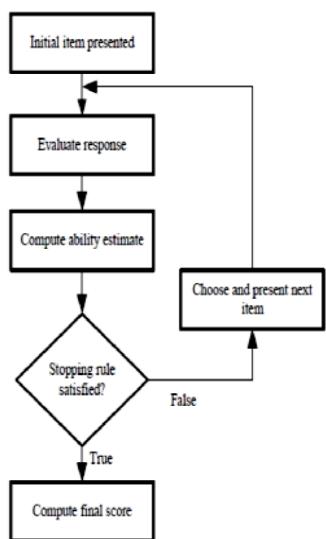


Fig. 1. Flowchart of the CAT algorithm

IV. RULE BASED ANALYSIS – ASSESSMENT ENVIRONMENT FACTORS

The system is designed to suite the requirements of CAT making it easily accessible and readily available to larger audiences. Our goal is to train users and help them improve their technical skills and answering abilities by keeping track of their performance history. The complexity of the next question is currently determined by a window of 4 questions answered by the user which iterates further until completion of the test. This window attribute is known as dynamic average whose size can be variable i.e. currently the algorithm is implemented with a window of 4 questions but it can be increased to 8 and beyond.

Algorithm Proposed

```

if (Question1 is Right) then Value=1;
else
Value=0;
if (Question2 is Right) then Value=1;
else
Value=0;
if (Question3 is Right) then Value=1;
else
Value=0;
if (Question4 is Right) then Value=1;
else
Value=0;
For(int i=5;i<=20;i++)
{
Question i = 
$$\frac{(Q(i-1) + Q(i-2) + Q(i-3) + Q(i-4))}{4}$$

Switch(Question i)
  
```

```
{
Case 0: Level= Simple;
Case 0.25: Level= Simple;
Case 0.50: Level= Medium;
Case 0.75: Level= Hard;
Case 1: Level= Very Hard;
}
}
```

A. Question Selection

At the start of the quiz a set of 4 questions are selected from the database as per levels simple, medium, hard and very hard respectively. Once the user has attempted these questions, the next question will be dependent on the dynamic average value. This dynamic average value is calculated depending on the previous set of question answered by the user. The complexity levels is been assigned with a range of value for the dynamic average calculation. The dynamic average will be calculating a value which will be in range of the complexity questions. This dynamic average value will be calculated till the test ends.

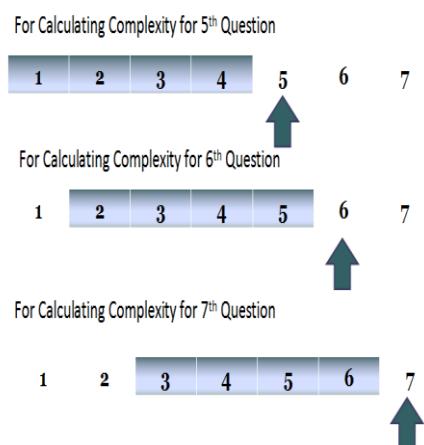


Fig. 2. Illustration of the CAT algorithm

B. Score Calculation

Initially each question answered correct is provided with a score of 1. Once the test ends it checks for the number of questions answered from each complexity levels and depending on the complexity a bonus score is been given to the user so that that the capability of each user is well defined. After the score calculation, the score will be displayed to the user showing the number of question attempted right as well as attempted wrong and the bonus marks depending on the complexity of level Hard and Very Hard questions.

C. Adaptive Test Question Sequencing

Sequencing refers to the arrangement of the questions shown to the users. In CAT, the sequence of the questions mainly rest on the users' choice of the answers. The duration and the number of questions are sufficiently accurate to produce useable marks. It supports an assortment of types, scoring and sequencing methods. It supports a large number of simultaneous tests. The scores are unchanging, consistent and reproducible [3].

D. Test Performance Feedback

Feedback indicates the response by the CAT system to the users' answers. It tries to direct and improve the users' performance. The feedback to the questions is personalized and accurate[3].

E. Technical Environment

The technical environment for Computer Adaptive Test consists of the following factors: 1) Rich User Interface, 2) Reliability and Maintainability, 3) Connectivity, and 4) Security [3].

- Rich User Interface is based on the amalgamation of contribution and outcome by which each user can interact with the CAT system. The API (front-end) or framework applied on this quiz system is Polymer. “Polymer” - A new web framework by Google designed to leverage the evolving web platform helps in solving tedious task of coding and provides with richer user interface. This framework by Google does possess power to make beautiful interactive designs and user interfaces. Most of the design aspects in Polymer follow the design philosophy of Google’s Android ‘Material Design’. Polymer inculcates the feature of being responsive in nature. Smooth and better quality transitions are provided which can be used effectively. Polymer requires dependencies for its working and those are installed and managed by ‘bower’ package management software. Polymer does also comes with support for custom element wherein developers can create their own web component with its own specific attributes and features. The User Interface has also an important role while the user is attempting the quiz. The User interface should be kept simple in order that it doesn’t take much time for the user to understand the user interface and attempts the set of questions making the system effective and satisfying. As said earlier Polymer is a web component and would support any browser hence would work on any device with any size and any operating system irrespective of the device’s display dimensions. Polymer will adapt to the device dimensions and scale accordingly, which provides facility of cross platform compatibility.

- Reliability indicates the potential of the CAT system to support a justified level of working while doing the assessment. The CAT system achieves the following capabilities with less effort and in less time: i) avoids failures and errors, ii) maintains consistent operation even in the case of failures
- Maintainability indicates the time and effort needed for updates, installation, expansion, upgrade, error removal and other such modifications to the system. Also, it relates to the risk undertaken from unanticipated effects of modifications[3].
- Connectivity indicates the capability of the CAT system to interact with server through wired or wireless environment[3].
- Security indicates the safety of the CAT system against unapproved login to the system and trying to alter the information that is present in the system which will cause the system to behave inaccurately hence producing unpredicted results. It prevents unauthorized personnel from getting access to confidential information. [3]. The other important factor assessed in this quiz system is the avoidance of any kind of unethical behavior induced by the user. Most on line assessments have a higher risk towards cheating because examiners are physically separated from users making it difficult to actively monitor them. This system can help eliminate or reduce the chances of cheating in the following ways (with respect to web browsers): 1) Cheating is not allowed, on minimize window. 2) Cheating is not allowed, on window close. 3) Disabling 'Ctrl + C'. 4) Disabling 'F5' or Reload. 5) Disabling Context Menu. 6) Disabling 'F12' or View Source.

V. RESULTS

While the administrator is typing the question to be added to the database, it filters out whether or not the current question is present in the database. If yes then the appropriate questions will be displayed to the administrator as shown in figure shown below.

Page Load : 0.016 seconds

Window : 1 1 0 1

Complexity : 0.75

Qid.5) Find the synonym : EMBEZZLE

Balance
 Remunerate
 Clear
 Misappropriate

Fig. 3. Filtering Questions

After implementing the algorithm on the quiz system, it was seen that the complexity for the 5 th Question was calculated by the dynamic average of the previous set of questions answered by the user as shown in the figure shown



below.

Fig. 4. Complexity for the 5th question

| id | username | percentage | bonus | pageload | date_time |
|----|----------|------------|-------|----------|---------------------|
| 1 | poplya | 30 | 0 | 0.011 | 2015-03-19 10:32:11 |
| 2 | savi | 30 | 0 | 0.015 | 2015-03-19 10:32:18 |
| 3 | amogh | 90 | 26 | 0.004 | 2015-03-19 10:33:05 |
| 4 | Sinister | 40 | 0 | 0.017 | 2015-03-19 10:33:25 |
| 5 | daniel | 80 | 20 | 0.014 | 2015-03-19 10:33:28 |

Fig. 5. User Database record

When a set of users attempted the quiz simultaneously through remote access, their respective score along with the average page load time was recorded in the database under the column name 'page-load' as shown in the figure above

VI. Conclusion

Computer Adaptive Testing Using Rule Based Approach can improve the on line assessment system in a manner such that emphasis on the user's knowledge acquirement through the assessment methods. From the output obtained from this system it can be concluded that the algorithm applied on this CAT system was successfully implemented and the performance measures suggest that the load of each question retrieved onto the web-page was comparatively less.

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