Item Registration for the Adaptive Online Testing System

1 Introduction

To evaluate the examinees' abilities accurately and fairly, the use of the item response theory (IRT) is considered to be one of the fundamental methods because it provides us the difficulties of the test items (problems) and the examinees' abilities together. Adaptive testing using the IRT selects the most appropriate items to examinees automatically, resulting more accurate ability estimation and more efficient test procedures. In such systems, the item difficulties should be obtained somehow, e.g., by using the monitor test, in advance.

However, as the number of examinees is growing, the difficulty values measured by the monitor test will possibly be different from those assessed by the new examinees. In addition, when we want to add new items to the item bank, the difficulty values for them have to be adjusted appropriately. In both cases, calibrating the difficulty values may be required. Here, we propose to use matrix completion methods which can estimate the item difficulties and examinees' abilities altogether from incomplete item response matrices.

We call this system the dually adaptive online IRT testing system, where "dually adaptive" means that one is targeted to the adequate item selection and the other is targeted to the adjustment of the difficulty values for items. Obviously, the monitor tests are not necessarily required for the newly added items in the proposed system.

2 Item Registration Function

The dually adaptive online IRT testing system is automatically growing by allowing item contributors to submit new items anytime. The IRT item bank usually has the non-variant item difficulty values in providing appropriate questions to examinees in the adaptive testing. However, as the number of examinees grows and the new items are added to the system, item difficulty values should be updated (calibrated). This database allows this. Anyone who wants to contribute the new items can submit items to item bank, and the item bank is growing as the new item is registered to the system.

3 Typical Examples for the Item Registration

We introduce here a typical example for the item registration. Figure 1 shows the welcome page, where applicants can select their roles as clicking the button.

From the welcome page, the item contributor can go into the item registration page as shown in Figure 2. He provides the pdf file which includes the problem and the answer in separate pages. He can select the question style either 1) selecting the button or 2) choosing the number, character, or sign. In the illustrative case in the figure, he chose two numbers (one is the ten's place, and the other is the one's place). On the bottom of the page, an explanation to the answer is shown.
The registration system has functions of 1) initial registration, 2) modification, 3) adding, 4) deleting, and confirming. In Figure 3, we show the confirmation page.

4 Concluding Remarks

Online adaptive testing method selects the most appropriate items to examinees automatically, resulting more accurate ability estimation and more efficient test procedures, where the item difficulty values remain the same. However, such a system is static. It cannot overcome the possible two dynamic issues: 1) the item difficulty values could be different from those assessed by the new examinees as the number of examinees is growing in online testing, 2) we may want to add new items to the system during the operation. Calibration of the difficulty values could solve the problems, and the dually adaptive online IRT testing system may work, where “dually adaptive” means that one is targeted to the adequate item selection and the other is targeted to the adjustment of the item difficulty values. Using the dually adaptive online IRT testing method, the database in the system will automatically be growing and be updated. In this paper, we have introduced such a novel aspect of allowing the item registration to the item bank.
The system works successfully, and we believe this system will be promising.

5 Appendix

5.1 Adaptive Online Ability Evaluation Procedure

When we assume that the monitor test was already done, then the difficulty parameters were obtained in advance by using the common IRT method. In that situation, we can estimate the ability parameters by using these estimated difficulty parameters, and this is not a difficult task. The conventional adaptive online systems use this kind of procedure. In a typical adaptive online testing, the most appropriate items are automatically chosen from the item bank at each item selection time according to the responses of the examinee. Usually, optimal selection of the items is done by using the information amount to each new item. When the very first problem is successfully solved, then the system provides the more difficult problem to the examinee. The level of the difficulty is set to around the estimated examinee's ability. We continue this procedure until the appropriate number of iterations.

Note that we need not care about the completeness of the response matrix; there are only 0/1 sequences of response value. However, we cannot make update the difficulty values even if the group of examinees is changed because the matrix is incomplete. To compensate for this defect, we have developed the EM-type IRT method which can deal with the incomplete matrix.

5.2 Dually Adaptive Online IRT Testing

As explained before, as the number of examinees is growing, the difficulty values measured by the monitor test will possibly be different from those assessed by the new examinees. Then, calibrating the difficulty values may be required. In addition, when we add new items to the item bank, the difficulty values for them have to be adjusted appropriately. For such conditions, we propose to use the dually adaptive online IRT testing system, where “dually adaptive” means that one is targeted to the adequate item selection and the other is targeted to the adjustment of the difficulty values for items. That is, the difficulty values are dynamically changed using the expanded incomplete matrix. Because of the acceptance of the new users and new items, the user-item matrix will be expanded as shown in Figure 5.

図4: Typical conventional adaptive testing.

図5: Matrix expansion dually to user and item.

参考文献


