

# Who Has the Final Say in Computerized Classification Test: Three

## Types of Termination Rules

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**Abstract:** As a subset of computerized adaptive testing, computerized classification testing (CCT) aims to classify participants into two or more different categories adaptively and has been widely used in eligibility testing and clinical psychology or medical diagnosis. As a crucial part of CCT, the termination rule determines when the test is to be stopped and what category the participants are ultimately classified into, which directly affects the efficiency and accuracy of the test. According to the theory on which the termination rules are based, the existing termination rules can be divided into three types: likelihood ratio rules, Bayesian decision theory rules, and ability confidence intervals rules (ACI). Specifically, their core ideas are: (1) by pre-setting the upper and lower bound of different categories, constructing hypothesis tests and calculating likelihood ratio statistics; (2) obtaining the posterior distribution of the participant's ability by responses, and calculating the loss function value; (3) determining if the confidence interval of the participant's ability estimate includes, above, or below the cut-point, the classification of the participant is decided. At the same time, in different test situations (mainly including the number of categories and the number of items' dimensions), CCT termination rules have various specific forms. In general, the likelihood ratio rule is based on the likelihood ratio test, which has good theoretical properties, and there are many related studies. However, this method is more difficult to be extended to complex test situations such as multi-dimension and multi-category. The Bayesian decision theory rules complete the classification decision by calculating posterior probability and loss function. The diversity of the loss function makes the method very flexible and makes it easy to be applied to different test situations. However, the flexibility of the form may inevitably cause users to have questions about the choice of the loss function and may also cause an extra error due to improper loss function in practice. The ACI method directly compares the cut-off score with the ability confidence interval, so it is the simplest and most direct rule among the three methods. However, this method has poor robustness and relatively low efficiency. Future research can continue to develop Bayesian rules, consider multi-dimensional and multi-category situations, or combine response time and machine learning algorithms to construct new termination rules. In view of the actual needs of different practical situations of the CCT test, all of the three rules have application potential in the eligibility test, and the Bayesian rule is more applicable in clinical medical questionnaires.

**Keywords:** computerized classification test, termination rule, likelihood ratio, Bayesian decision theory

# 谁掌握着计算机化分类测验的最终话语权？——三大类终止规则

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**摘要** 作为一种特殊的计算机化自适应测验，计算机化分类测验（Computerized Classification Testing, CCT）能够自适应地将被试划分到两个或多个不同的类别，已被广泛应用于合格性测验及临床心理学或医学诊断中。作为 CCT 的重要组成部分，终止规则决定测验何时停止以及将被试最终划分到何种类别，因此直接影响测验效率及分类准确率。根据终止规则所基于的理论基础，已有终止规则可以划分为三大类：似然比规则、贝叶斯决策理论规则及置信区间规则。具体地说，它们的核心思路分别是：（1）通过事先设定不同类别被试的能力的上下界，构造假设检验以及似然比统计量；（2）通过作答反应获得被试能力的后验分布，并由此计算损失函数值；（3）通过判断被试能力估计值的置信区间是否高于/低于分界分数，从而完成对被试的分类。同时，在构造具体的终止规则时，还要考虑不同测验情境（主要包括划分的类别数以及测验的维度数）的特点。总体而言，似然比规则基于似然比检验，具有较好的理论性质，相关研究也较多。但是，该方法在多维、多分类等复杂测验情境下的拓展难度较大。贝叶斯决策理论规则通过后验概率与损失函数，完成对被试的分类判断。损失函数的多样性使得该方法的形式非常灵活，也使得该方法很容易就可以被应用于不同的测验情境中。但是，形式的灵活会不可避免地导致使用者在损失函数的选择上产生疑问，也可能会在实际应用中产生由于损失函数选取不恰当而导致的误差。置信区间方法直接将分界分数与能力估计值的置信区间进行比较，是三种方法中最简单直接的一类方法。但是，这种方法的稳健性较差，测验效率也相对较低。未来研究可以继续开发贝叶斯规则、考虑多维多类别情境或者结合反应时和机器学习算法。针对 CCT 测验的不同应用场景的实际需求，三类终止规则在合格性测验上均有应用潜力，而贝叶斯规则在临床医学问卷中更为适用。

**关键词** 计算机化分类测验，终止规则，似然比，贝叶斯决策理论