Sequential tests in selecting a trainee on a panel

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Summary

Selection a trainee on a panel uses the ISO-methodology, which may include usage of the sequential tests.

Sequential tests are a means to economize the number of evaluations (as much as 50%) required to draw a conclusion, for example, acceptance vs. rejection of a trainee on a panel. Tests are very practical and efficient as they take into consideration the possibility that the evidence derived from the first few evaluations may be quite sufficient to draw a conclusion.

Evaluations are conducted according to the procedure appropriate for the chosen method and the results of each completed test are entered into a graph in which three regions are identified: the acceptance region, the rejection region and the continue testing region. Testing continues until a point touches or crosses one of the lines bordering the region of indecision.

This work showed how in the simply way, with minimum number of the evaluations, may be reached a decision of acceptance or rejection of a trainee on a panel.

Key words: sensory analysis, sequential tests

Introduction

All food products, thus a milk and dairy products, are daily sensory examined. Sensory evaluation is an adequate measure of quality only if it is performed with trained panel and definite methods. The first step in the selection of assessors for future work is to eliminate candidates completely unsuitable for sensory analysis. Final selection is made only after training and their successful performance of set tasks.

Sequential analysis is a procedure, which leads to a statistical inference and in which the number of observations to be made is not determined before the experiment is begun. Sequential tests are means to economize the number of evaluations required to draw a conclusion about acceptance vs. rejection of a trainee on a panel. The procedure indicates when sufficient observations have been collected to make decisions with the risks α and β (the risks that we are willing to take of rejecting a true hypothesis or accepting a false hypothesis) we have chosen. Principle of the test can be characterized as follows: Observations are taken one at a time. After every observation we decide to do one of the

following three things: accept the hypothesis, reject the hypothesis or make an additional observation. In order to determine which one of these three possible actions to take we must determine the critical region for each sample size and compute p_0 and p_1 probabilities respectively. The characterization of the sequential test may be written:

1. if $p_{1m}/p_{0m} \leq \beta/1-\alpha$ accept H_0
2. if $p_{1m}/p_{0m} \geq 1-\beta/\alpha$ accept H_1
3. if $\beta/1-\alpha < p_{1m}/p_{0m} < 1-\beta/\alpha$ take another observation

This continues until either condition 1 or condition 2 is satisfied (Amerine, Pangborn, and Roessler, 1965; Dixon and Massey, 1957; Jellinek, 1985; Meilgaard, Civille, and Carr, 1991).

Materials and methods

In this work 20 candidates, from dairy industry, are tested by using the following four methods: test for identification of four basic tastes, odour identification test, test of threshold determination for basic tastes and difference threshold test (ISO, 1979; ISO, 1985; ISO, 1993; ISO,1994).

The success of all candidates is evaluated in terms of fractions of correct responses expressed by scoring and rank list is made. Out of 20 candidates 10 were selected for experimental panel.

Three candidates from list: the best one, the medium one and the worst one were chosen for another evaluation by using sequential analysis. The version of the used sequential test is that of the ISO (ISO, 1983). Evaluations are conducted according to the procedure for chosen method. The sample pairs are submitted one at a time in the form of Triangle tests. Intervals between tests are kept long enough to avoid fatigue. As each triangle is completed the result is entered into a graph such as Figure 1 in which with two parallel straight lines L_0 and L_1, three regions are identified: the acceptance region, the rejection region, and the continue-testing region. The number of trials is plotted on the horizontal (x) axis and the total number of correct responses is plotted on the vertical (y) axis. The results of the first test are entered, for correct ones as (x,y)=(1,1) and for incorrect, as (x,y)=(1,0). In each succeeding test, x and y are increased by 1, for a correct reply and by 0 for an incorrect reply. Testing is performed until a point touches or crosses one of the lines bordering the region of indecision.

Potential candidates are accepted or rejected on the basis of their performances as related to two parallel straight lines, L_0 and L_1 which are uniquely determined on the basis of the following parameters: $p_0 = 0{,}65$; $p_1 = 0{,}90$; $\alpha = 0{,}025$ and $\beta = 0{,}025$; where α is the probability of rejecting an acceptable candidate, β is the probability of selection of an unacceptable one, p_0 is the maximum unac-

Figure 1: Example of sequential approach for selection of panel trainees by Triangle tests
Slika 1: Primjer sekvencijalnog pristupa u odabiru senzorskog analitičara "triangl" testovima

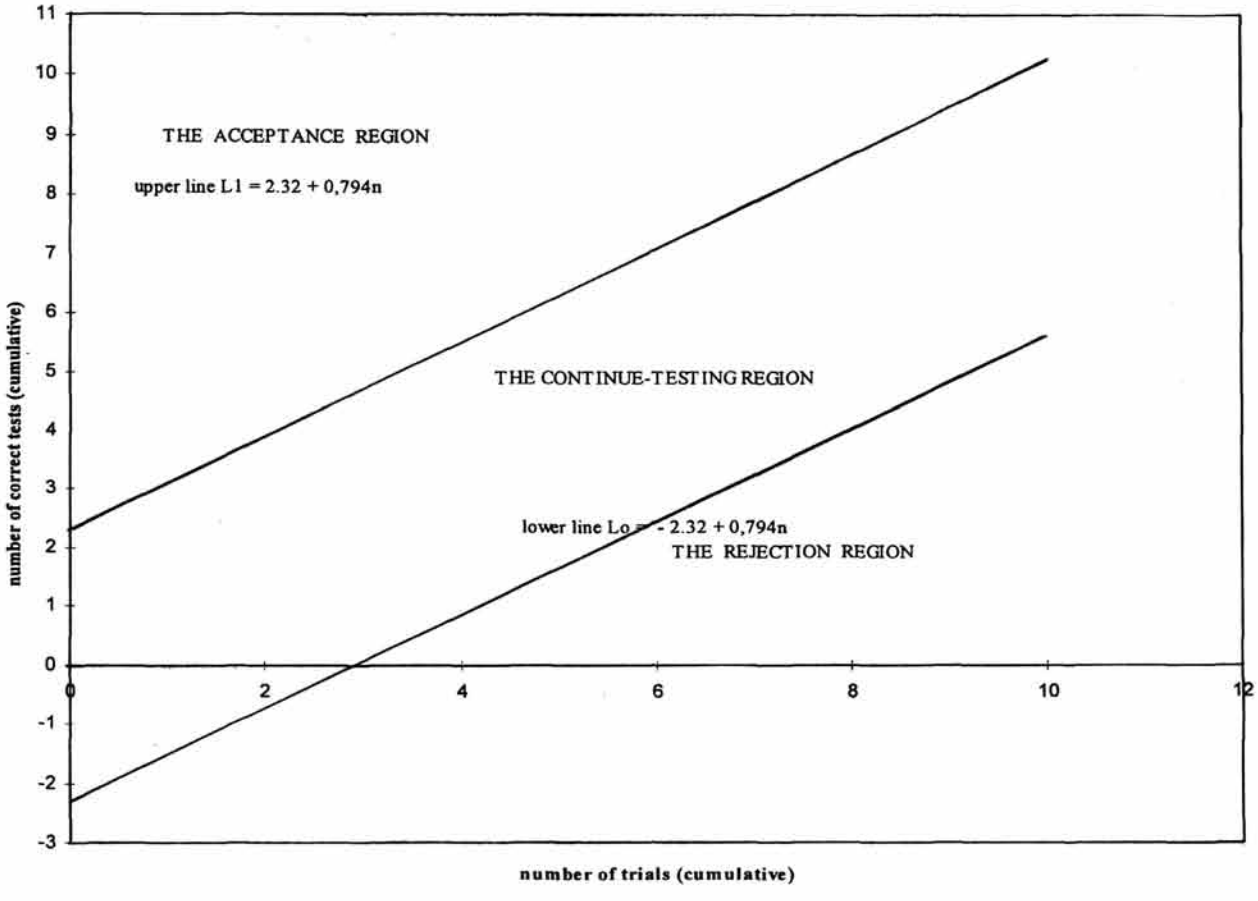

Table 1: Summary of the results of triangle tests for three candidates in taste identification.
Tablica 1: Sažetak rezultata ocjenjivanja okusa za tri ispitanika triangl testovima

No. of trial	Candidate A								Candidate B								Candidate C							
	correct decisions				cumulative correct decisions				correct decisions				cumulative correct decisions				correct decisions				cumulative correct decisions			
	Sal	Sw	So	B	Sal	Sw	So	B	Sal	Sw	So	B	Sal	Sw	So	B	Sal	Sw	So	B	Sal	Sw	So	B
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	0	1
2	1	1	1	1	2	2	2	2	1	1	1	1	2	2	2	2	0	1	1	0	1	0	1	1
3	1	1	1	1	3	3	3	3	1	1	0	1	3	3	2	3	1	1	0	0	2	1	1	1
4	1	1	0	1	4	4	3	4	1	0	1	1	4	3	3	4	1	0	0	1	3	1	1	2
5	1	1	1	1	5	5	4	5	0	1	1	0	4	4	4	4	0	0	0	1	3	1	1	3
6	1	1	1	1	6	6	5	6	1	1	0	1	5	5	4	5	1	1	0	0	4	2	1	3
7	1	1	1	1	7	7	6	7	1	0	1	1	6	5	5	6	0	0	1	1	4	2	2	4
8	1	1	1	1	8	8	7	8	1	1	1	1	7	6	6	7	1	1	1	0	5	3	3	4
9	1	1	1	1	9	9	8	9	1	1	1	1	8	7	7	8	0	0	0	0	5	3	3	4
10	1	1	1	1	10	10	9	10	1	1	1	1	9	8	8	9	0	0	1	0	5	3	4	4
11	1	1	1	1	11	11	10	11	1	1	1	0	10	9	9	9	0	1	0	0	5	4	4	4
12	1	1	1	1	12	12	11	12	0	1	1	1	10	10	10	10	0	1	0	1	5	5	4	5

Sal = saltiness (slanost)
Sw = sweetness (slatkoća)
So = sourness (kiselost)
B = bitterness (gorčina)

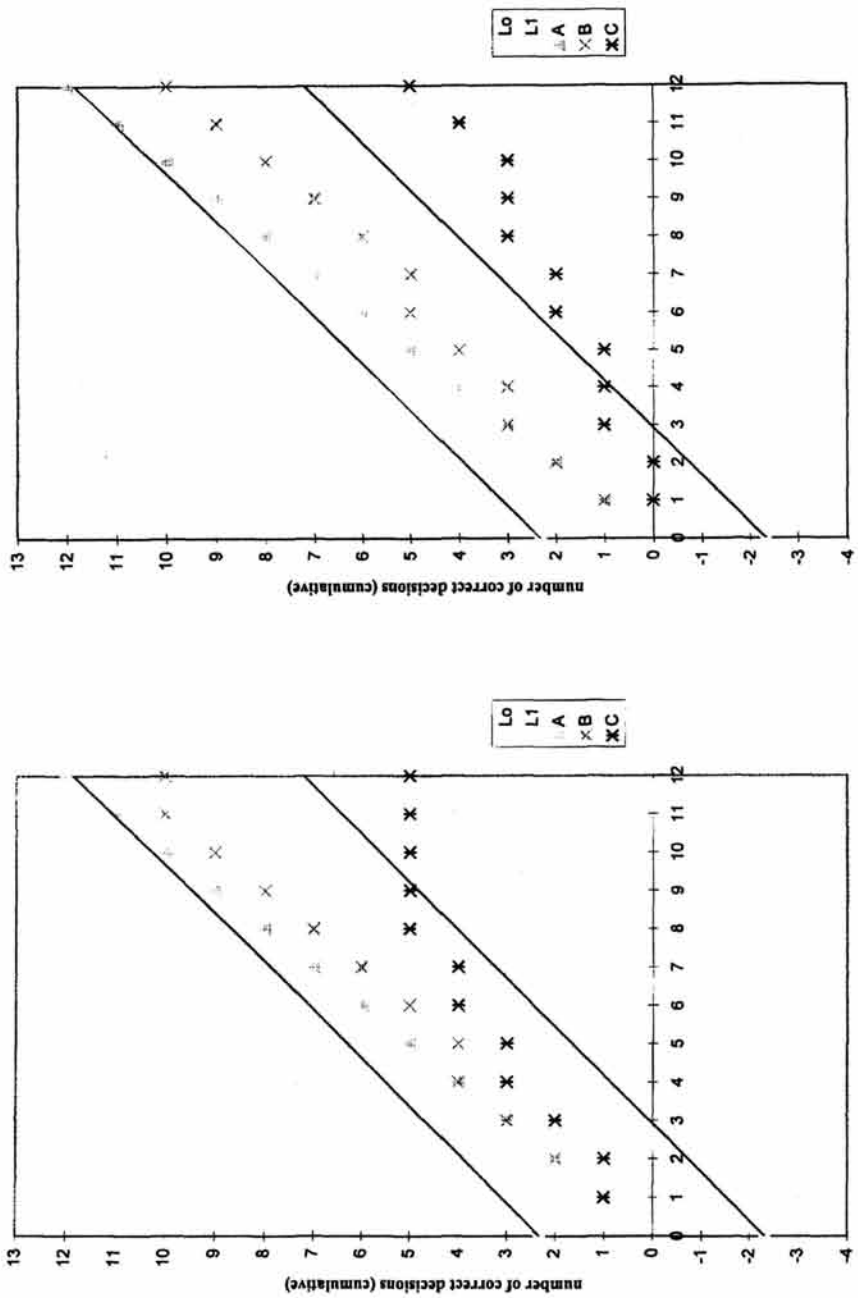

Figure 2: Sequential test charts on obtained results for three candidates in taste identification: a) saltiness b) sweetness
Slika 2: Karta dobivenih rezultata sekvencijalnog testa za tri kandidata pri ocjenjivanju: a) slanoće b) slatkoće

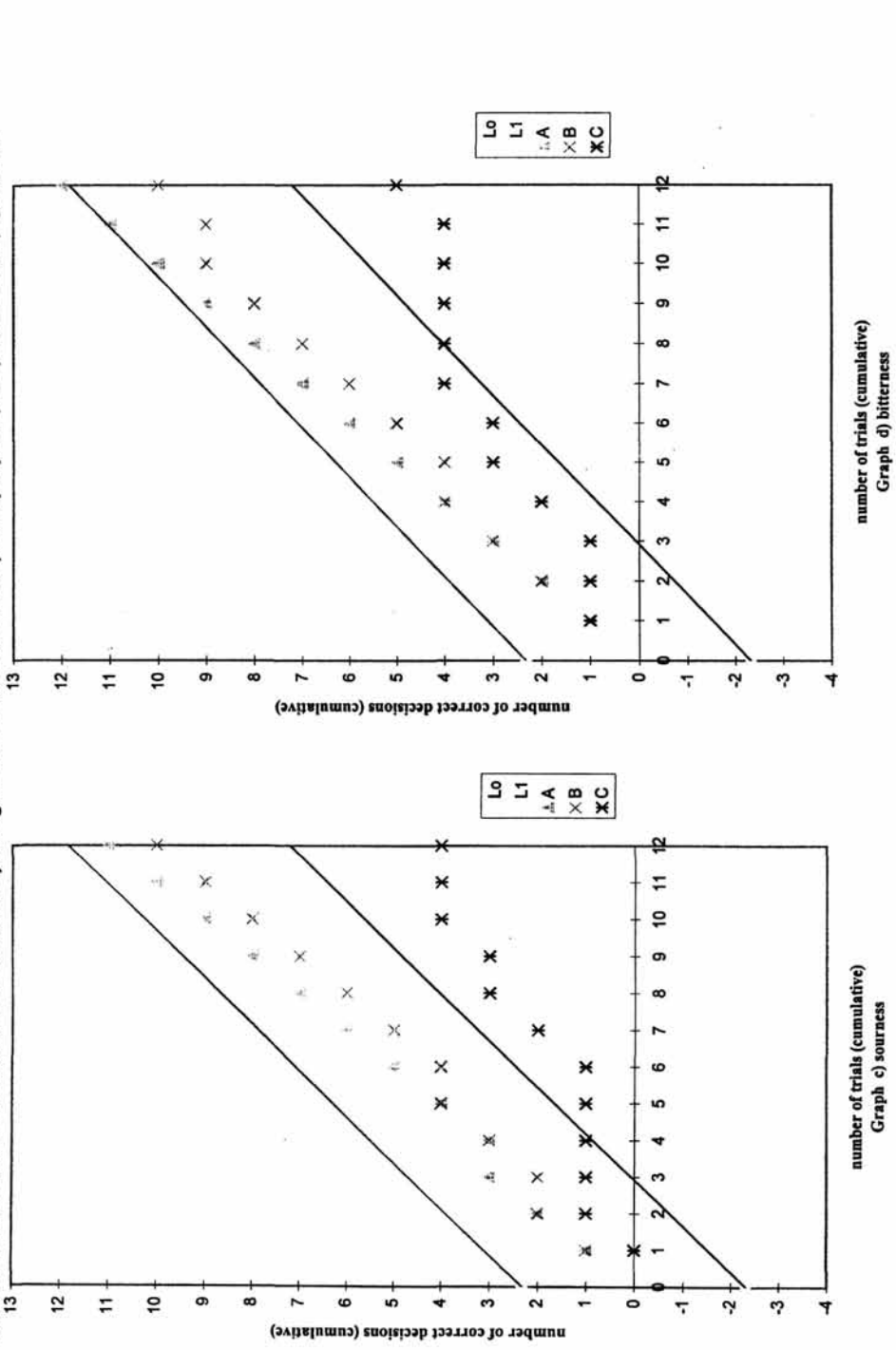

Figure 3: Sequential test charts on obtained results for three candidates in taste identification: a) sourness b) bitterness
Slika 3: Karta dobivenih rezultata sekvencijalnog testa za tri kandidata pri ocjenjivanju: a) kiselosti b) gorčine

ceptable ability and p_1 is the minimum acceptable ability (both measured as the proportion of correct answers). The panel leader assigned values for these four parameters.

The equations for the lines dividing the graph into regions depend on α, β, p_0 and p_1.

The slopes and intercepts of straight lines were computed from relations:

$b = k_2/k_1\text{-}k_2$; $a_0 = e_1/ k_1\text{-}k_2$; $a_1 = e_2/ k_1\text{-}k_2$

where:

$k_1 = \log p_1 - \log p_0$

$k_2 = \log (1\text{-}p_1) - \log (1\text{-}p_0) = \log q_1 - \log q_0$

$e_1 = \log \beta - \log (1\text{-} \alpha)$

$e_2 = \log (1\text{-}\beta) - \log \alpha$

Results and disscusion

The slopes and intercepts of straight lines computed from above equations are as follows: $b = 0{,}794$ $a_0 = -2{,}32$ $a_1 = 2{,}32$.

Thus, equations of lower and upper line, respectively are:

$L_0 = -2{,}32 + 0{,}794n$ $L_1 = 2{,}32 + 0{,}794n$

The results of three candidates are given in table 1, where 1 indicates a correct judgment and 0 denotes a wrong one.

Figures 2 and 3 show the number of trials and the cumulative number of correct decisions, separately for each taste.

As it is shown in Figs. 2 and 3 after 11 trials for saltiness, sweetness and bitterness, candidate A crossed the upper line and may be accepted as panel member. For sourness he/she is still in the region of indecision and will have to continue tasting to qualify as a panel member.

All the points representing candidate B for all four tastes, up to this number of trials are still in the region of indecision.

Candidate C surpassed the lower line after 10 tests for saltiness, after 5 tests for sweetness, and after 5 and 8 tests for sourness and bitterness, respectively. He/she had achieved 5, 5, 4 and 5 correct results and is rejected as a panel member.

In such a manner may be presented summary of the results of triangle and success evaluation in taste identification of other 17 candidates.

Various values of the p_0, p_1, α and β may be used too, in selecting a trainee on a panel. As p_0 approaches p_1, the number of required trial increases. For reducing the number of required trials, the minimum acceptable probability can be set higher or α and β could be assigned larger values.

Conclusions

This work is an example how to use a sequential analysis in procedure of choosing and training of a candidates for panel members.

Using sequential analysis, in this case, only 12 trials were necessary to make a decision about acceptance vs. rejection of a trainee on a panel. The decision for three candidates was the same for both chosen methods (sequential tests and in terms of fractions of correct responses expressed by scoring). Two of them were accepted and one was rejected of a trainee on a panel.

SEKVENCIJALNI TESTOVI U ODABIRU ČLANOVA PANEL GRUPE

Sažetak

Odabir kandidata za senzorskog analitičara vrši se prema ISO-metodologiji pri čemu se mogu koristiti i sekvencijalni testovi.

Sekvencijalnim testovima se smanjuje broj potrebnih mjerenja (čak i za 50%) pri donošenju zaključka o prihvaćanju ili odbacivanju kandidata za senzorskog analitičara. Testovi su vrlo praktični i efikasni jer uzimaju u obzir vjerojatnost da rezultati dobiveni iz prvih nekoliko mjerenja mogu biti sasvim dovoljni za donošenje valjanog zaključka.

Izvođenje testa vrši se po odgovarajućem postupku za izabranu metodu, a rezultati svakog završenog testa se unose u odgovarajući graf u kojemu su već unaprijed definirana tri područja: područje prihvaćanja, područje odbacivanja te područje nastavljanja testiranja. Test traje do trenutka kada odgovor kandidata prijeđe ili dodirne jednu od graničnih linija područja. Ovim radom je pokazano kako se sekvencionalnom analizom na jednostavan način i s malim brojem mjerenja može postići odluka o prihvaćanju ili odbacivanju kandidata za panel grupu.

Ključne riječi: senzorske analize, sekvencijalni testovi

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