Laboratory of «Information technologies in learning and computer vision systems»

Program environment for learning and testing any discipline

Estimation of quality analysis of test items and definition of the item discrimination and ability parameters

Research director: Michail Bondarenko, Ph.D., Professor and Head of Kharkov National University Of Radio Electronics

Chief of the laboratory: Bilous Natalie, Ph.D., Professor of Software Department
Entrance of Ukraine into European (Bologna) educational space required development of complete sets of test items for initial, in-progress and final knowledge control.
The purpose of work

Development of technology for carrying out of testing, an estimation of test items quality and distributions of test items on complexity levels for the tests estimated on a continuous scale.
Knowledge marking scale

Scale

Dichotomizing

\{0,1\}

Polytomizing

\{0,1,\ldots,n\}

Continuous

[0,1]
• Necessity of qualitative tests and the knowledge marking systems which is taking into account individual abilities of each testee development;

• Independent training of examinees causes of an estimation of right answers guessing probability at testing.

• For increase of objectivity a knowledge level marking of testee it is necessary to take into account the test items difficulty
Abilities of programs

- Learning and testing of students for any disciplines
- Support of the any discipline for knowledge testing
- Support of all existing testing forms
- Author methodic for estimation of all forms of test items
- Objective estimation of students' knowledge by automatically
- Saving of learning and testing results for all students with different parameters in module of results
- Definition of item difficulty, item discrimination and ability parameters by automatically
- Definition of test items quality
Forms of test tasks

- closed test items
  - onealternative test items
  - multialternative test items.
- conformity test items
- right consequence test items
- open test items
  - items that have arithmetically calculated result
  - answers formed as a freestyle textual data
  - table filling.
- multistep items
Question №1
\[ F(x, y) = x \lor y \land \neg z \]
If \( x = 1 \) and \( y = 0 \) then \( F(x, y) \) is equal to:

- 1
- 0
- \( z \lor \neg z \)
- \( z \land \neg z \)
- \( z \lor z \)
- \( z \land z \)

Number of mistakes: 0
Cyrillic: Ivanin

Check
Multialternative test items

Question №5
Select formulas which correspond to the law of elimination

- $A \cap (A \cup B) = A$
- $A \cup (A \cap B) = A$
- $A \cap A = A$
- $A \cap U = A$
- $A \cup \emptyset = A$
Conformity test items

Question № 10
Set conformity between the laws of boolean algebra and their names

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<tr>
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<td>2. (x \cdot x = x)</td>
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<tr>
<td>C</td>
<td>3. (x \cdot (y \cdot z) = (x \cdot y) \cdot z)</td>
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<td>D</td>
<td>4. (x \cdot y = y \cdot x)</td>
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- A) associative law
- B) commutative law
- C) idempotent law
- D) identities with constants
Question №12
Place operations accounting their priority:
1) negation
2) equivalence
3) implication
4) conjunction
5) disjunction
Write numbers of operations through a comma
Select expression that corresponds to the given Venn diagram.
Table filling

Question №3
Prove the 1-st Distributive Law:
\[ x \lor (y \land z) = (x \lor y)(x \lor z) \]

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Number of mistakes: 0
Crymer: Ivan

Check
Multistep items

Question No1
Find the Jegalkin polynomial for the following function:
\((xy) \lor z\)

STEP 1: Change \(\lor\) into \(\Theta\)
The right formula is:

- \(xyz \Theta xy \Theta z\)
- \(xyz \Theta xyz\)
- \(xyz \Theta (xy)z\)
- \(xyz \Theta xy \Theta z\)
- \((xy)z \Theta (xy) \Theta z\)
Dear Vivir

Karnaugh maps

You have finished this work and showed the following results:

Stage:
Access questions:
Practical:
Test questions:

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Percent of doing work: 74%
Rating ball: 6
Your mark: 4

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Mathematical model of testing theory

\[ P_{ij} = f(\Theta_i - \beta_j) \]

Where
- \( P_{ij} \) – probability of that i-th person will execute j-th item;
- \( \Theta_i \) – the ability parameter of i-th testee (i = 1, 2,...,N);
- \( \beta_j \) – j-th item difficulty parameter (j = 1, 2,...,n).

Kind of the model:
- one-parametrical;
- two-parametrical;
- three-parametrical.
One-parametrical model

\[ P_j(\Theta) = \frac{1}{1 + e^{-1.7(\Theta - \beta_j)}} \]

\[ P_i(\beta) = \frac{1}{1 + e^{-1.7(\Theta_i - \beta)}} \]

\( P_j(\Theta) \) Probability of correct execution of the j-th test item by the testee with various knowledge level. \textit{The above a level of testee knowledge, the above probability of a right answer on j-th test item.}

\( P_i(\beta) \) – Probability of correct execution by the i-th testee of various difficulty test items. \textit{Is decreasing function of variable } \beta.\textit{.}
One-parametrical model

The graph of a characteristic curve for j-th test item
One-parametrical model

The graph of an individual curve for i-th testee
Two-parametrical model

\[ P_{ij} (\Theta) = \frac{1}{1 + e^{-1.7a_j (\Theta_i - \beta_j)}} \]

where \( a_j \) – the item discrimination parameter.
Two-parametrical model

The graph of a characteristic curve for j-th test item
Two-parametrical model

Characteristic curves of three test items of equal difficulty
Three-parametrical model

\[ P_{ij}(\Theta) = c_j + \frac{(1 - c_j)}{1 + e^{-1.7a_j(\Theta_i - \beta_j)}} \]

где \( P_{ij} \) – probability of that \( i \)-th person will execute \( j \)-th item;

\( \Theta_i \) – the ability parameter of \( i \)-th testee \((i = 1, 2, \ldots, N)\);

\( \beta_j \) – the \( j \)-th item difficulty parameter \((j = 1, 2, \ldots, n)\);

\( a_j \) – the item discrimination parameter;

\( c_j \) – the guessing parameter \((\Theta \rightarrow - \infty)\).
Three-parametrical model

The graph of a characteristic curve for j-th test item
The integrated functional model of a complexity level definition of test items

\[ \beta_j = f(P_{1j}(\Theta_i, \text{res}_{ij}), P_{2j}(\Theta_i, a_j, \text{res}_{ij}), P_{3j}(\Theta_i, a_j, c_j, \text{res}_{ij})) \]

where \( \beta_j \) – j-th item difficulty parameter;

\( P_{1j}(\Theta_i, \text{res}_{ij}), P_{2j}(\Theta_i, a_j, \text{res}_{ij}), P_{3j}(\Theta_i, a_j, c_j, \text{res}_{ij}) \) – modified one-, two- and three-parametrical models constructed on continuous scale;

\( \Theta_i \) – the ability parameter of i-th testee;

\( r_{ij} \) – result of executing of the j-th test item the i-th testee;

\( a_j \) – the item discrimination parameter;

\( c_j \) – the guessing parameter.
The integrated functional model of a complexity level definition of test items

Determinant of the test performance results
- closed test items
- conformity test items
- right consequence test items
- open test items
- multistep items

The calculator of steady values
- 1-parametrical model ($P_1$)
- 2-parametrical model ($P_2$)
- 3-parametrical model ($P_3$)

Skaling of the results

Ph. D. Bilous Nataliya e-mail: belous@kture.kharkov.ua
## Program system for quality analysis of test items

### Testing results

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**Program system for quality analysis of test items**

**Ordered matrix**

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**Program system for quality analysis of test items**

**Correlation matrix**

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</tr>
</tbody>
</table>
```
Program system for quality analysis of test items

Estimation of questions

Easy questions:  

Complicated questions:  

Insolvent questions:  

R: <0.3
R: <0.3
Program system for quality analysis of test items

Finding of steady parameters: the ability parameter - (teta), item difficulty parameter (beta) and item discrimination parameter of items (A)
Program system for definition of the item discrimination and ability parameters
Application of psychological testing

Cattell's 16 Factor Test

Question:
Если предположить, что небо находится «снизу» и что зимой «жарко», я должен был бы назвать преступника

Answers:
- бандитом
- святым
- тучей

Luscher Color Test (Short)

Choose the color you love the most:

Step 2 from 2

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Conclusions

The developed technology of marking of the tests depending on type and a difficulty level of test items:

✓ It is simple in use;
✓ Make easy process of the knowledge control of testee;
✓ Takes into account performance of all test items forms on a continuous scale;
✓ Allows to estimate a difficulty level of test items;
✓ Allows to carry out the qualitative analysis of test items
✓ allows to use of different scales.
• Introduction of this system in higher educational establishments will allow to conduct objective testing of knowledge trained.

• The system can be used both in educational institutions of any level of accreditation, and in organizations and establishments where professional selection with the help of testing is conducted, and also on courses of improvement of qualification where there are computer classes.
Introduction of the system
Україна
Міністерство освіти і науки України
Державний департамент інтелектуальної власності

Свідоцтво
про реєстрацію авторського права на твір
№ 14030

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