

Interactive learning in mathematics: coding theory and discrete algebra

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Learning style: Classic vs. Modern





Learning style: Classic vs. Modern

New technology

- Internet
- Web 2.0
- Cloud computing
- Semantic web



Learning style: Classic vs. Modern

Modern era

- Less effort
- Easier in finding references



Online exercises

Purposes

- Reduce tedious work of grading simple exercises
- Student can get immediate feedback
- Help student study individually

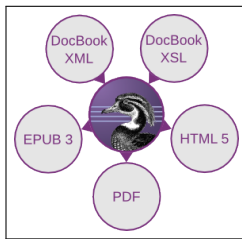
Introduction to MathDox

MathDox

- 1 An interactive mathematical system
- 2 Developed in Eindhoven University of Technology

Developing MathDox

- DocBook
- OpenMath
- XForm
- Jelly
- XInclude



Features

Open Source

MathDox Format Compability

LaTeX document \leftrightarrow MathDox document \leftrightarrow XHTML document

Features

Easily extendable via web service calls

MathDox \leftrightarrow Computer Algebra System

Wolfram *Mathematica*[®]



Multiple choice question

<

The ISBN-10 is the acronym for International Standard Book Number. This code was used by book publishers to identify a specific book, an edition of a book or any book-like product. It is a 11-ary code of length 10 defined as follows:

$$\mathcal{C} = \{(c_1, c_2, \dots, c_{10}) \in \mathbb{F}_{11}^{10} \text{ such that } \sum_{i=1}^{10} ic_i = 0 \pmod{11}\}.$$

Which of the following are valid ISBNs?

- a. 0702876143
- b. 0257973213
- c. 0966621123
- d. a and b
- e. a and c
- f. b and c

a b c d e f

Figure: An example of a multiple choice question.

Open answer question



The parity check matrix of the binary code C is given by

$$H = \begin{pmatrix} 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{pmatrix}$$

Let $P = \{5\}$.

A parity check matrix of the punctured code C_P is of the form $(I_2|A)$ where A is a 2×3 matrix.

Give A



Submit

Mathematical symbols and functions available for input:

$+$ $-$ \cdot \wedge \vee $\cos()$ $\sin()$ $\tan()$
 $<$ \leq $=$ \geq $>$ e $\log()$ $\ln()$
 π e i ∞ $\sqrt{\quad}$ $()$ (\quad) $(\quad\quad)$
 $\frac{\quad}{\quad}$ $\|$ $!$ $\sqrt{\quad}$ $()$ (\quad) $(\quad\quad)$

Source code example

```
1 \begin{exercise-graph}
2   \score{100}
3   \begin{first}
4     \setrandom{r}{1}{5}
5     \setargument[evalpos]{choice_a}{[9608460476, 0198538030,
6       0702876143, 0077354761]}{\#r}
7     ...
8     \setargument[evalpos]{correct}{[{\$e, \$a, \$c, \$b]}{\#r}
9   \end{first}
10  \begin{interaction}{question}
11    ...
12    Which of the following are valid ISBNs?
13    \begin{scgroup}
14      ...
15    \end{scgroup}
16  \end{interaction}{question}
17  \begin{interaction}{wrong} \pen{50}
18    This is not correct.
19    \button{Try Again}{question}
20    ...
21 \end{exercise-graph}
```

Figure: An example of source code for multiple choice question .

Source code example

```
1 \begin{exercise-graph}
2   \score{100}
3   \begin{first}
4     \setrandom{r}{1}{6}
5     \setpc{parity}{matrix(matrixrow(1,0,0,0,1,1),
6       matrixrow(0,1,0,1,0,1), matrixrow(0,0,1,1,1,0))}
7     ...
8     \setpc{answer}{matrix(matrixrow(box,box,box), matrixrow(box,box,box))}
9   \end{first}
10  \begin{interaction}{question}
11    The parity check matrix of the binary code  $CC$  is given by
12     $H = \text{\out{parity}}$ . Let  $P = \{ \text{\out{r}} \}$ .
13    ...
14    \begin{test-graph}{correct}
15      \#answer = \#ans
16    \end{test-graph}
17  \end{interaction}
18  \begin{interaction}{correct} \correct
19    That is indeed correct! Your score is: \out{score}.
20  \end{interaction}
21    ...
22 \end{exercise-graph}
```

Figure: An example of source code for open answer question.

Source code example

```
1      ...
2      \begin{first}
3          \setrandom{r}{1}{7}
4          \setargument{evalpos}{n}{[5,6,8,9,10,14]}{\#r}
5          \setargument{evalpos}{d}{[5,3,4,3,5,7]}{\#r}
6          \setpc{eval}{ans}{\#n - integer2.euler(\#d)}
7      \end{first}
8      \begin{interaction}{question}
9          Let  $\mathbb{C}^n$  be the  $\mathbb{F}_q$ -linear cyclic code of length  $n$ 
10         with generator polynomial the cyclotomic polynomial  $\Phi_{-d}(X)$ .
11         Give the dimension of  $\mathbb{C}^n$ 
12         \begin{answer-open}[pc]
13             \begin{test-graph}{correct}
14                 \#answer=\#ans
15             \end{test-graph}
16             \default{wrong}
17         \end{answer-open}
18     \end{interaction}
19     \begin{interaction}{correct} \correct
20         That is indeed correct! Your score is:  $s$ .
21     \end{interaction}
22     ...
```

Figure: The source code of question with CAS computation.

Concluding remarks

To conclude,

- It could increase productivity of the teacher
- Many students have given positive responses

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The End