The caa package*

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Abstract

This package provides macros for typesetting computer-aided assessments. It was developed at the University of Southampton.

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1 Introduction

This package was developed in order to ease the typesetting of computer-aided assessments in LaTeX.

*This document corresponds to caa v0.1, dated 2020/03/29.

2 Usage

Just like any other package, you need to request this package with a `\usepackage` command in the preamble. So in the simpler case (i.e., without any options), one just types

```
\usepackage{caa}
```

to load the package.

2.1 Package Options

Answers. Loading package with the `answers` option will enable the answer and explanation for the questions.

```
\usepackage[answers]{caa}
```

Colouring Option. Loading package with the `colour` or `color` options will enable the colour for indication of answers.

```
\usepackage[answers, colour]{caa}
```

2.2 Typesetting a Question Bank.

Using the `caa` package, ones can develop a question bank, and different exams can be drawn from the question bank. Typically, we use a style file for this purpose. For example, the following `sample-bank.sty` files contains some questions multiple choice questions.

```
\NeedsTeXFormat{LaTeX2e}\relax
\ProvidesPackage{sample-bank}
    [2020/03/29 v0.1 Package for sample question banks]

\RequirePackage{caa}

\num\newcommand{\SampleQuestion1}{%
  \newquestion{Question01}{1}{%
    This is an easy question.

    \begin{multiplechoice}
      \distractor{A distractor 1}

      \distractor{Another distractor 2}

      \keyed{A keyed answer}

      \distractor{Another distractor 3}
    \end{multiplechoice}
  }
}

\num\newcommand{\SampleQuestion2}{%
  \newquestion[Medium]{Question02}{2}{%
    This is a medium question.
```

```
    \begin{multiplechoice}
      \dropdown{Entry 1}{\correct{option1}, \incorrect{option2},
        \incorrect{option3}, \incorrect{option4}}

      \dropdown{Entry 2}{\incorrect{option1}, \incorrect{option2},
        \incorrect{option3}, \correct{option4}}

      \dropdown{Entry 3}{\incorrect{option1}, \correct{option2},
        \incorrect{option3}, \incorrect{option4}}

      \dropdown{Entry 4}{\incorrect{option1}, \incorrect{option2},
        \correct{option3}, \incorrect{option4}}
    \end{multiplechoice}
  }
}

\num\newcommand{\SampleQuestion3}{%
  \newquestion[Easy]{Question03}{1}{%
    This is a easy question.

    \begin{multiplechoice}
      \dropdown{Entry 1}{\correct{option1}, \incorrect{option2},
        \incorrect{option3}, \incorrect{option4}}

      \dropdown{Entry 2}{\incorrect{option1}, \incorrect{option2},
        \incorrect{option3}, \correct{option4}}

      \dropdown{Entry 3}{\incorrect{option1}, \correct{option2},
        \incorrect{option3}, \incorrect{option4}}

      \dropdown{Entry 4}{\incorrect{option1}, \incorrect{option2},
        \correct{option3}, \incorrect{option4}}
    \end{multiplechoice}
  }
}

\num\newcommand{\SampleQuestion4}{%
  \newquestion[Hard]{Question04}{4}{%
    This is a hard question.

    \begin{multiplechoice}
      \dropdown{Entry 1}{\correct{option1}, \incorrect{option2},
        \incorrect{option3}, \incorrect{option4}}

      \dropdown{Entry 2}{\incorrect{option1}, \incorrect{option2},
        \incorrect{option3}, \correct{option4}}

      \dropdown{Entry 3}{\incorrect{option1}, \correct{option2},
        \incorrect{option3}, \incorrect{option4}}

      \dropdown{Entry 4}{\incorrect{option1}, \incorrect{option2},
        \correct{option3}, \incorrect{option4}}
    \end{multiplechoice}
  }
```

```
}
```

2.3 Typesetting an Exam Using the Question Bank

An exam can be typeset by selecting the questions from the question bank by import the `sample-bank` package.

```
\usepackage{sample-bank}
```

To produce the list of questions, we use the `nomencl` package.

```
\usepackage{nomencl}
\renewcommand{\nomname}{List of Questions}
\makenomenclature
```

A summary for the set of question can by type set using `printcategory` to print the number of questions and the number of mark in each category. The following

```
\begin{table}[!htbp]
  \centering
  \begin{tabular}{|l|l|}
    \hline
    Category & Stats \\
    \hline
    \emph{Easy} & \printcategory{Easy} \\
    \emph{Medium} & \printcategory{Medium} \\
    \emph{Hard} & \printcategory{Hard} \\
    \hline
    \emph{\textbf{Total}} & \printcategory{Total} \\
    \hline
  \end{tabular}
  \caption{Summary}
  \label{tab:summary}
\end{table}
```

will produce something like this.

Category	Stats
Easy	2 questions (2 marks)
Medium	1 question (2 marks)
Hard	1 question (4 marks)
Total	4 questions (8 marks)

Table 1: Summary

The question can be typeset by using the question macros defined earlier in the question bank. For example, the following

```
\SampleQuestion1
```

will produce (with `answers` and `colour` options enabled)
Question01 (Easy) [1 mark]
This is an easy question.

✗ A distractor 1

✗ Another distractor 2

✓ A keyed answer

✗ Another distractor 3

Similarly, the following

```
\SampleQuestion2
```

will produce (with `answers` and `colour` options enabled)
Question02 (Medium) [2 marks]
This is a medium question.

- *Entry 1*: ✓option1, ✗option2, ✗option3, ✗option4
- *Entry 2*: ✗option1, ✗option2, ✗option3, ✓option4
- *Entry 3*: ✗option1, ✓option2, ✗option3, ✗option4
- *Entry 4*: ✗option1, ✗option2, ✓option3, ✗option4

Furthermore,

```
\SampleQuestion3
```

will produce (with `answers` and `colour` options enabled)
Question03 (Easy) [1 mark]
This is a easy question.

- *Entry 1*: ✓option1, ✗option2, ✗option3, ✗option4
- *Entry 2*: ✗option1, ✗option2, ✗option3, ✓option4
- *Entry 3*: ✗option1, ✓option2, ✗option3, ✗option4
- *Entry 4*: ✗option1, ✗option2, ✓option3, ✗option4

and, finally

```
\SampleQuestion4
```

will produce (with `answers` and `colour` options enabled)
Question04 (Hard) [4 marks]
This is a hard question.

- *Entry 1*: ✓option1, ✗option2, ✗option3, ✗option4
- *Entry 2*: ✗option1, ✗option2, ✗option3, ✓option4
- *Entry 3*: ✗option1, ✓option2, ✗option3, ✗option4
- *Entry 4*: ✗option1, ✗option2, ✓option3, ✗option4

The list of questions can be produced using the following command from the `nomencl` package. The following

```
\printnomenclature
```

will produce

List of Questions

Question01 (Easy) 1 mark

Question02 (Medium) 2 marks

Question03 (Easy) 1 mark

Question04 (Hard) 4 marks

2.4 Compilation

The statistics for the each category require two compilation passes. The list of questions requires a run of `makeindex`. So the following steps requires to compile an exam (assuming that we use `pdflatex`).

1. `pdflatex <exam>`
2. `makeindex <exam>.nlo -s nomecl.ist -o <exam>.nls`
3. `pdflatex <exam>`
4. `pdflatex <exam>`

3 Implementation

3.1 Package Dependencies

Our implementation uses `numdef` package for macros with numbering suffix.

```
\RequirePackage{numdef}
```

We use `nomencl` package to produce the list of the questions.

```
\RequirePackage{nomencl}
```

For colours, we use `xcolor` package.

```
\RequirePackage{xcolor}
```

We use `pifont` for checked mark and crossed mark.

```
\RequirePackage{pifont}
```

To store the total number of questions, we use `crossreftools` package.

```
\RequirePackage{crossreftools}
```

We use `ifthen` package for conditional statements.

```
\RequirePackage{ifthen}
```

Finally, we use `etoolbox` to get access to LaTeX front-end to e-TeX primitives.

```
\RequirePackage{etoolbox}
```

3.2 Package Options

We define some options for typesetting the questions.

3.2.1 Answers option

We first declare some internal macros that can be updated when the `answers` package option is enabled.

`\explanation` Command `\explanation` is used to typeset the explanation to the answer. By default, this is disabled, i.e., it gobbles the argument. It is enabled when the package option `answers` is set.

```
\newcommand{\explanation}[1]{}
```

`multiplechoice` We create a new environment for multiple choice question. It is the same as `itemize`.

```
\newenvironment{multiplechoice}{\begin{itemize}}{\end{itemize}}
```

`\keyed` Command `\keyed` is used to typeset keyed answers in multiple choice question. By default, it shows the the input argument. When the `answers` package option is enabled, a checked mark is used to indicate it is the keyed answer.

```
\newcommand{\keyed}[1]{\item #1}
```

`\distractor` Command `\distractor` is used to typeset distractor answers in multiple choice question. By default, it shows the the input argument. When the `answers` package option is enabled, a crossed mark is used to indicate it is the distractor answer.

```
\newcommand{\distractor}[1]{\item #1}
```

`\dropdown` Command `\dropdown` can be used to typeset dropdown answers in multiple choice question.

```
\newcommand{\dropdown}[2]{%
  \item \emph{#1}: #2
}
```

`\correct` Command `\correct` is used to typeset correct options in dropdown answers. By default, it shows the the input argument. When the `answers` package option is enabled, a checked mark is used to indicate it is the correct option.

```
\newcommand{\correct}[1]{#1}
```

`\incorrect` Command `\incorrect` is used to typeset incorrect options in dropdown answers. By default, it shows the the input argument. When the `answers` package option is enabled, a crossed mark is used to indicate it is the incorrect answer.

```
\newcommand{\incorrect}[1]{#1}
```

We now redefine the above macros when the `answers` package option is enabled.

```
\DeclareOption{answers}{
  \renewcommand{\explanation}[1]{\textbf{Explanation:}\\#1}
  \renewcommand{\keyed}[1]{\item[\cmark] #1}
  \renewcommand{\distractor}[1]{\item[\xmark] #1}
  \renewcommand{\correct}[1]{\cmark #1}
  \renewcommand{\incorrect}[1]{\xmark #1}
}
```

3.2.2 Colouring option

We first declare some internal macros that can be updated when accordingly to the option for colouring.

`\cmark` Command `\cmark` is used to indicate the keyed answer or correct option in multiple choice question. When the package options `colour` or `color` is enabled, it is also coloured accordingly.

```
\newcommand{\cmark}{\textcolor{\CAA@cmarkcolour}{\ding{51}}}%
```

`\xmark` Command `\xmark` is used to indicate the distractor answer or incorrect option in multiple choice question. When the package options `colour` or `color` is enabled, it is also coloured accordingly.

```
\newcommand{\xmark}{\textcolor{\CAA@xmarkcolour}{\ding{55}}}%
```

`\CAA@cmarkcolour` Command `\CAA@cmarkcolour` is used as the colour for the checked mark. By default, it is `black`. When the `colour` option is enabled, the colour is set to `green`.

```
\newcommand{\CAA@cmarkcolour}{black}
```

`\CAA@xmarkcolour` Command `\CAA@xmarkcolour` is used as the colour for the crossed mark. By default, it is `black`. When the `colour` option is enabled, the colour is set to `red`.

```
\newcommand{\CAA@xmarkcolour}{black}
```

`\setcmarkcolour` Command `\setcmarkcolour` is used to redefine the colour for the checked mark.

```
\newcommand{\setcmarkcolour}[1]{%
  \renewcommand{\CAA@cmarkcolour}{#1}%
}%
```

`\setxmarkcolour` Command `\setxmarkcolour` is used to redefine the colour for the crossed mark.

```
\newcommand{\setxmarkcolour}[1]{%
  \renewcommand{\CAA@xmarkcolour}{#1}%
}%
```

We now define the `colour` option and set the different colours accordingly.

```
\DeclareOption{colour}{
  \setcmarkcolour{green}%
  \setxmarkcolour{red}%
}
```

Additionally, we define the `color` package option as an alias of `colour`.

```
\DeclareOption{color}{
  \ExecuteOptions{colour}
}
```

3.2.3 Execution of options

We are now execute the options by executing `\ProcessOptions` command.

```
\ProcessOptions
```

3.3 Typesetting Questions

We define macros for typesetting questions for computer-aided assessments.

3.3.1 Question Categories

`\newcategory` We group questions into categories and we track the number of questions and the marks allocated in each category. As a result, we create two counters for each newly created category.

```
\newcommand{\newcategory}[1]{%
  \newcounter{#1}
  \setcounter{#1}{0}
  \newcounter{#1mark}
  \setcounter{#1mark}{0}
}
```

We create some default categories `Easy` for easy difficulty questions, `Medium` for medium difficulty questions, `Hard` for hard difficulty questions, and `Total` for the all questions.

`Easy category` A category for easy questions.

```
\newcategory{Easy}
```

`Medium category` A category for medium questions.

```
\newcategory{Medium}
```

`Hard category` A category for hard questions.

```
\newcategory{Hard}
```

`Total category` A category for all questions.

```
\newcategory{Total}
```

`\addtocategory` An utiltiy macro is created to add a question and its marks to the category.

```
\newcommand{\addtocategory}[2]{%
  \refstepcounter{#1}
  \CAA@save{#1}{\arabic{#1}}
  \addtocounter{#1mark}{#2}
  \CAA@save{#1mark}{\arabic{#1mark}}
}
```

3.3.2 Create Questions

`\newquestion` This macro is to create a question. Each question has a label, marks, category, and content. The question and its marks are added to the given category. The total number of questions and marks are increased accordingly. The nomenclature is updated with the question and its marks.

```
\newcommand{\newquestion}[4][Easy]{%
  \listadd{\CAA@list}{#2}%
  \addtocategory{#1}{#3}
  \addtocategory{Total}{#3}
  \ifthenelse{#3 = 1}{%
    \nomenclature{#2 (#1)~~~~~}{#3 mark}%
  }{%
    \nomenclature{#2 (#1)~~~~~}{#3 marks}%
  }%

  \noindent\textbf{#2 (#1)} [\CAA@plural{#3}{mark}]\\%
  #4%
}%
```

3.3.3 Question Summary

We first create some utility macros for produce the question summary, e.g., the number of questions or marks in a certain category.

`\CAA@save` This macro save the value of a counter to a reference. The value can be loaded using `CAA@load` in the next compilation.

```
\newcommand{\CAA@save}[2]{%
  \crtcrossreflabel*{#2}[#1]%
}
```

`\CAA@load` This macro load the value of a counter from a reference.

```
\newcommand{\CAA@load}[2]{%
  \setcounter{#1}{\crtrefnumber{#2}}
}
```

In the case where the reference is not found when loading, e.g., in the first compilation, the value which is set to the counter is 0 as specified by the following command.

```
\crtrefundefinedtext{0}% Returns 0 for undefined references!
```

`\CAA@ifstrequal` This macro provides a wrapper for `\ifstrequal` to ensure that the first argument is properly expanded.

```
\newcommand{\CAA@ifstrequal}{\expandafter\ifstrequal\expandafter}
```

`\CAA@plural` This macro is to print the number with singular/plural noun.

```
\newcommand{\CAA@plural}[3][]{%
  \CAA@ifstrequal{#1}{}{%
    \ifthenelse{#2 = 1}{#2 #3}{#2 #3s}%
  }{%
    \ifthenelse{#2 = 1}{#2 #3}{#2 #1}%
  }%
}%
```

`\CAA@pluralref` This macro is to print the number with singular/plural noun.

```
\newcounter{CAA@temp}
\newcommand{\CAA@pluralref}[3][]{%
  \CAA@load{CAA@temp}{#2}
  \CAA@ifstrequal{#1}{}{%
    \ifthenelse{\value{CAA@temp} = 1}{\arabic{CAA@temp} #3}{\arabic{CAA@temp} #3s}%
  }{%
    \ifthenelse{\value{CAA@temp} = 1}{\arabic{CAA@temp} #3}{\arabic{CAA@temp} #1}%
  }%
}%
```

`\printcategory` This macro print the information about a category (i.e., the number of questions and the number of marks.

```
\newcommand{\printcategory}[1]{%
  \CAA@pluralref{#1}{question} (\CAA@pluralref{#1mark}{mark})
}%
```

Change History

v0.1

\addtocategory: Initial version . . 9
\cmark: Initial version 7
\correct: Initial version 7
\distractor: Initial version 6
\dropdown: Initial version 7
\explanation: Initial version 6
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