

The ExSol package*

Walter Daems (`walter.daems@uantwerpen.be`)

1 Introduction

The package ExSol provides macros to allow embedding exercises and solutions in the \LaTeX source of an instructional text (e.g., a book or a course text) while generating the following separate documents:

- your original text that only contains the exercises, and
- a solution book that only contains the solutions to the exercises (a package option exists to also copy the exercises themselves to the solution book).

The former is generated when running \LaTeX on your document. This run writes the solutions to a secondary file that can be included into a simple document harness, such that when running \LaTeX on the latter, you can generate a nice solution book.

Why use ExSol?

- It allows to keep the \LaTeX source of your exercises and their solutions in a single file. Away with the nightmare to keep your solutions in sync with the original text.
- It separates exercises and solutions, allowing you
 - to only release the solution book to the instructors of the course;

*This document corresponds to exsol 0.8, dated 2014/07/15.

- to encourage students that you provide with the solution book to first try solving the exercises without opening the book; this seems to be easier than not peeking into the solution of an exercise that is typeset just below the exercise itself.

The code of the ExSol package was taken almost literally from fancyvrb [1]. Therefore, all credits go to the authors/maintainers of fancyvrb.

Thanks to Pieter Pareit and Pekka Pere for signaling problems and making suggestions for the documentation.

2 Installation

Either you are a package manager and then you'll know how to prepare an installation package for ExSol.

Either you are a normal user and then you have two options. First, check if there is a package that your favorite L^AT_EX distributor has prepared for you. Second, grab the TDS package from CTAN [2] (`exsol.tds.zip`) and unzip it somewhere in your own TDS tree, regenerate your filename database and off you go. In any case, make sure that L^AT_EX finds the `exsol.sty` file.

The ExSol package uses some auxiliary packages: fancyvrb, ifthen, kvoptions and, optionally, babel. Fetch them from CTAN [2] if your T_EX distributor does not provide them.

3 Usage

3.1 Preparing your document source

The macro package exsol can be loaded with:

```
\usepackage{exsol}
```

Then, you are ready to add some exercises including their solution to your document source. To this end, embed them in a `exercise` and a corresponding `solution` environment. Optionally, you may embed several of

them in a `exercises` environment, to make them stand out in your text.

E.g.,

```
\begin{exercises}

\begin{exercise}
  Solve the following equation for  $x \in \mathbb{C}$ , with  $\mathbb{C}$  the set of
  complex numbers:
  \begin{equation}
    5x^2 - 3x = 5
  \end{equation}
\end{exercise}

\begin{solution}
  Let's start by rearranging the equation, a bit:
  \begin{equation}
    5.7x^2 - 3.1x = 5.3 \\
    5.7x^2 - 3.1x - 5.3 = 0
  \end{equation}
  The equation is now in the standard form:
  \begin{equation}
    ax^2 + bx + c = 0
  \end{equation}
  For quadratic equations in the standard form, we know that two
  solutions exist:
  \begin{equation}
    x_{1,2} = \frac{-b \pm \sqrt{d}}{2a}
  \end{equation}
  with
  \begin{equation}
    d = b^2 - 4ac
  \end{equation}
  If we apply this to our case, we obtain:
  \begin{equation}
    d = (-3.1)^2 - 4 \cdot 5.7 \cdot (-5.3) = 130.45
  \end{equation}
  and
  \begin{equation}
    x_1 = \frac{3.1 + \sqrt{130.45}}{11.4} = 1.27 \\
    x_2 = \frac{3.1 - \sqrt{130.45}}{11.4} = -0.73
  \end{equation}
  The proposed values  $x = x_1, x_2$  are solutions to the given equation.
\end{solution}

\begin{exercise}
  Consider a 2-dimensional vector space equipped with a Euclidean
  distance function. Given a right-angled triangle, with the sides
```

```

    $A$ and $B$ adjacent to the right angle having lengths, $3$ and
    $4$, calculate the length of the hypotenuse, labeled $C$.
\end{exercise}
\begin{solution}
    This calls for application of Pythagoras' theorem, which
    tells us:
    \begin{equation}
        \left|A\right|^2 + \left|B\right|^2 = \left|C\right|^2
    \end{equation}
    and therefore:
    \begin{eqnarray}
        \left|C\right| \\
        &= \sqrt{\left|A\right|^2 + \left|B\right|^2} \\
        &= \sqrt{3^2 + 4^2} \\
        &= \sqrt{25} = 5
    \end{eqnarray}
    Therefore, the length of the hypotenuse equals $5$.
\end{solution}

\end{exercises}

```

The result in the original document, can be seen below. As you can see, there's no trace of the solution.

Exercises

Exercise 3.1-1: Solve the following equation for $x \in C$, with C the set of complex numbers:

$$5x^2 - 3x = 5 \tag{1}$$

Exercise 3.1-2: Consider a 2-dimensional vector space equipped with a Euclidean distance function. Given a right-angled triangle, with the sides A and B adjacent to the right angle having lengths, 3 and 4, calculate the length of the hypotenuse, labeled C .

When running L^AT_EX on your document (in our case on the `exsol.dtx` file, as a side effect a file with extension `.sol.tex` has been written to disk (in our case, the file `exsol.sol.tex`), containing all solutions in sequence.

Generating a solution book is as simple as including the file into a simple harness, that allows you giving it a proper title page and to add other bells and whistles.

E.g.,

```
\documentclass{article}
\usepackage[english]{babel}
\title{Solutions to the exercises, specified in the \textsf{ExSol} package}
\author{Walter Daems}
\date{2013/05/12}

\begin{document}

\maketitle

\input{exsol.sol}

\end{document}
```

You may generate this solution book, by running \LaTeX on the file named `exsol-solutionbook.tex` that is generated when running \LaTeX on the `exsol.dtx` file.

The result approximately looks like this:

Solutions to the exercises, specified in the `ExSol` package
Walter Daems
2013/05/12

Solution 3.1-1 Let's start by rearranging the equation, a bit:

$$5.7x^2 - 3.1x = 5.3 \tag{1}$$

$$5.7x^2 - 3.1x - 5.3 = 0 \tag{2}$$

The equation is now in the standard form:

$$ax^2 + bx + c = 0 \tag{3}$$

For quadratic equations in the standard form, we know that two solutions exist:

$$x_{1,2} = \frac{-b \pm \sqrt{d}}{2a} \tag{4}$$

with

$$d = b^2 - 4ac \tag{5}$$

If we apply this to our case, we obtain:

$$d = (-3.1)^2 - 4 \cdot 5.7 \cdot (-5.3) = 130.45 \tag{6}$$

and

$$x_1 = \frac{3.1 + \sqrt{130.45}}{11.4} = 1.27 \tag{7}$$

$$x_2 = \frac{3.1 - \sqrt{130.45}}{11.4} = -0.73 \tag{8}$$

The proposed values $x = x_1, x_2$ are solutions to the given equation.

Solution 3.1-2 This calls for application of Pythagoras' theorem, which tells us:

$$\|A\|^2 + \|B\|^2 = \|C\|^2 \tag{9}$$

and therefore:

$$\|C\| = \sqrt{\|A\|^2 + \|B\|^2} \tag{10}$$

$$= \sqrt{3^2 + 4^2} \tag{11}$$

$$= \sqrt{25} = 5 \tag{12}$$

Therefore, the length of the hypotenuse equals 5.

3.2 Tips and tricks

Just one for now: if you want to include the solutions all at the end of the current document, you need to explicitly close the solution stream before including it:

```
\closeout\solutionstream\input{\jobname.sol.tex}
```

4 Implementation

```
1 <*package>
```

4.1 Auxiliary packages

The package uses some auxiliary packages:

```
2 \RequirePackage{fancyvrb}
3 \RequirePackage{ifthen}
4 \RequirePackage{kvoptions}
```

4.2 Package options

The package offers some options:

exercisefontsize This option allows setting the font of the `exercises` environment. You may choose one of `tiny`, `scriptsize`, `footnotesize`, `small`, `normalsize`, `large`, etc.

E.g., `[exercisefontsize=small]`.

```
5 \DeclareStringOption[normalsize]{exercisefontsize}
```

exerciseaslist This boolean option (`true`, `false`) allows setting the typesetting of the `exercises` in a list environment. This causes the exercises to be typeset in a more compact fashion, with indented left and right margin.

```
6 \DeclareBoolOption[false]{exerciseaslist}
```

copyexercisessolutions This boolean option (`true`, `false`) allows copying the exercises in the solutions file, to allow for making a complete stand-alone exercises bundle.

```
7 \DeclareBoolOption[false]{copyexercisessolutions}
```

minipage This boolean option (`true`, `false`) causes the exercises to be wrapped in minipages. This avoids them getting split by a page boundary.

```
8 \DeclareBoolOption[false]{minipage}
```

The options are processed using:

```
9 \ProcessKeyvalOptions*
```

The options are subsequently handled

```
10 \newcommand{\exercisefontsize}{\csname \exsol@exercisefontsize\endcsname}
```

4.3 Con- and destruction of the auxiliary streams

At the beginning of your document, we start by opening a stream to a file that will be used to write the solutions to. At the end of your document, the package closes the stream.

```
11 \AtBeginDocument{
12   \newwrite\solutionstream
13   \immediate\openout\solutionstream=\jobname.sol.tex
14   \newwrite\exercisestream
15 }
16 \AtEndDocument{
17   \immediate\closeout\solutionstream
18 }
```

4.4 Exercises counter

By providing an exercise counter, proper numbering of the exercises is provided to allow for good cross referencing of the solutions to the exercises.

```
19 \newcounter{exercise}[subsection]
20 \setcounter{exercise}{0}
21 \renewcommand{\theexercise}{%
22   \@ifundefined{c@chapter}{\if0\arabic{chapter}\else\arabic{chapter}.\fi}%
23   \if0\arabic{section}\else\arabic{section}\fi%
24   \if0\arabic{subsection}\else.\arabic{subsection}\fi%
25   \if0\arabic{subsubsection}\else.\arabic{subsubsection}\fi%
26   \if0\arabic{exercise}\else%
27     \@ifundefined{c@chapter}%
28       {\if0\arabic{section}\else-\fi}%
29     {-}%
30   \arabic{exercise}%
31 \fi
32 }
```

4.5 Detokenization in order to cope with utf8

Combining old-school L^AT_EX (before X_YL^AT_EX and Lua_T_EX) and UTF-8 is a pain. Detokenization has been suggested by Geoffrey Poore to solve issues with UTF-8 characters messing up the fancyvrb internals.

```
33 \newcommand{\GPES@write@detok}[1]{%
34   \immediate\write\exercisestream{\detokenize{#1}}}%
35 \newcommand{\GPSS@write@detok}[1]{%
36   \immediate\write\solutionstream{\detokenize{#1}}}%
37 \newcommand{\GPSS@write@detok}[1]{%
38   \GPES@write@detok{#1}%
39   \GPSS@write@detok{#1}}%
```

5 The user environments

exercise The `exercise` environment is used to typeset your exercises, provide them with a nice label and allow for copying the exercise to the solutions file (if the package option `copyexercisessolutions`) is set. The label can be set by redefining the `\exercisename` macro, or by relying on the Babel provisions. The code is almost literally taken from the `fancyvrb` package.

```
40 \def\exercise{\FV@Environment{}{exercise}}
41 \def\FVB@exercise{%
42   \refstepcounter{exercise}%
43   \immediate\openout\exercisestream=\jobname.exc.tex
44   \ifexsol@copyexercisessolutions
45     \typeout{Writing exercise to \jobname.sol.tex}
46     \immediate\write\solutionstream{\string\par---\string\newline
47       \string\textbf\string{\exercisename{} \theexercise \string}}
48   \else
49     \immediate\write\solutionstream{\string\par---\string\newline}
50   \fi
51   \immediate\write\exercisestream{\string\begin{exsol@exercise}}
52   \@bsphack
53   \begingroup
54     \FV@UseKeyValues
55     \FV@DefineWhiteSpace
56     \def\FV@Space{\space}%
57     \FV@DefineTabOut
58     \ifexsol@copyexercisessolutions
59       \let\FV@ProcessLine\GPSS@write@detok %
```

```

60   \else
61     \let\FV@ProcessLine\GPES@write@detok %
62   \fi
63   \relax
64   \let\FV@FontScanPrep\relax
65   \let\@noligs\relax
66   \FV@Scan
67 }
68 \def\FVE@exercise{
69   \endgroup\@esphack
70   \immediate\write\exercisestream{\string\end{exsol@exercise}}
71   \ifexsol@copyexercisesinsolutions
72     \immediate\write\solutionstream{\string~\string\newline}
73   \fi
74   \immediate\closeout\exercisestream
75   \input{\jobname.exc.tex}
76 }
77 \DefineVerbatimEnvironment{exercise}{exercise}{}

```

`exsol@exercise` The `exsol@exercise` environment is an internal macro used to typeset your exercises and provide them with a nice label and number. Do not use it directly. Use the proper environment `exercise` instead.

```

78 \newenvironment{exsol@exercise}[0]
79 {%
80   \ifthenelse{\boolean{exsol@minipage}}{\begin{minipage}[t]{\textwidth}}{%
81     \ifthenelse{\boolean{exsol@exerciseaslist}}
82       {\begin{list}%
83         {%
84           }%
85         {%
86           \setlength{\topsep}{0pt}%
87           \setlength{\leftmargin}{1em}%
88           \setlength{\rightmargin}{1em}%
89           \setlength{\listparindent}{0em}%
90           \setlength{\itemindent}{0em}%
91           \setlength{\parsep}{\parskip}}%
92         \item[\hspace*{\leftmargin}\textit{\exercisename{}
93           \theexercise:}]
94       }%
95     {
96       \textit{\exercisename{} \theexercise:}~
97     }
98 }

```

```

99 {%
100 \ifthenelse{\boolean{exsol@exerciseaslist}}
101         {\end{list}}{}
102 \ifthenelse{\boolean{exsol@minipage}}{\end{minipage}}{}
103 \vspace{1ex}\par
104 }

```

solution The `solution` environment is used to typeset your solutions and provide them with a nice label and number that corresponds to the exercise that preceded this solution. The label can be set by redefining the `\solutionname` macro, or by relying on the Babel provisions. The code is almost literally taken from the `fancyvrb` package.

```

105 \def\solution{\FV@Environment{}{solution}}
106 \def\FVB@solution{%
107   \typeout{Writing solution to \jobname.sol.tex}
108   \immediate\write\solutionstream{\string\textbf\string{\solutionname}\string}}
109   \ifexsol@copyexercisesinsolutions
110     \immediate\write\solutionstream{\string\newline}
111   \else
112     \immediate\write\solutionstream{\string\textbf\string{theexercise}\string}%
113                                   \string\newline}
114   \fi
115   \@bsphack
116   \begingroup
117     \FV@UseKeyValues
118     \FV@DefineWhiteSpace
119     \def\FV@Space{\space}%
120     \FV@DefineTabOut
121     \let\FV@ProcessLine\GPSS@write@detok %
122     \relax
123     \let\FV@FontScanPrep\relax
124     \let\@noligs\relax
125     \FV@Scan
126   }
127 \def\FVE@solution{\endgroup\@esphack}
128 \DefineVerbatimEnvironment{solution}{solution}{}

```

exercises The `exercises` environment helps typesetting your exercises to stand out from the rest of the text. You may use it at the end of a chapter, or just to group some exercises in the text.

```

129 \newenvironment{exercises}
130 {\par\exercisesfontsize\rule{.25\linewidth}{0.15mm}\*~\*%

```

```

131 \textbf{\normalsize \exercisename}\vspace*{1ex}\}
132 {\~\*\rule{.25\linewidth}{0.15mm}\par}

```

5.1 Some Babel provisions

`\exercisename` The exercise environment makes use of a label `Exercise` macro.

```
133 \newcommand{\exercisename}{Exercise}
```

`\exercisename` The exercises environment makes use of a label `Exercises` macro.

```
134 \newcommand{\exercisename}{Exercises}
```

`\solutionname` The solution environment makes use of a label `Solution` macro.

```
135 \newcommand{\solutionname}{Solution}
```

`\solutionname` The solution environment makes use of a label `Solutions` macro.

```
136 \newcommand{\solutionsname}{Solutions}
```

You may redefine these macros, but to help you out a little bit, we provide with some basic Babel auxiliaries. If you're a true polyglot and are willing to help me out by providing translations for other languages, I'm very willing to incorporate them into the code.

```

137 \addto\captionsdutch{%
138   \renewcommand{\exercisename}{Oefening}%
139   \renewcommand{\exercisename}{Oefeningen}%
140   \renewcommand{\solutionname}{Oplossing}%
141   \renewcommand{\solutionsname}{Oplossingen}%
142 }
143 \addto\captionsgerman{%
144   \renewcommand{\exercisename}{Aufgabe}%
145   \renewcommand{\exercisename}{Aufgaben}%
146   \renewcommand{\solutionname}{L"osung}%
147   \renewcommand{\solutionsname}{L"osungen}%
148 }
149 \addto\captionsfrench{%
150   \renewcommand{\exercisename}{Exercice}%
151   \renewcommand{\exercisename}{Exercices}%
152   \renewcommand{\solutionname}{Solution}%

```

```

153 \renewcommand{\solutionsname}{Solutions}%
154 }
155 \addto\captionsfinnish{
156 \renewcommand{\exercisename}{Teht "av" a}%
157 \renewcommand{\exercisesname}{Teht "avi" a}%
158 \renewcommand{\solutionname}{Ratkaisu}%
159 \renewcommand{\solutionsname}{Ratkaisut}%
160 }

```

Now the final hack overloads the basic sectioning commands to make sure that they are copied into your solution book.

```

161 \let\exsol@@makechapterhead\@makechapterhead
162 \def\@makechapterhead#1{%
163 \immediate\write\solutionstream{\string\chapter{#1}}%
164 \exsol@@makechapterhead{#1}
165 }
166 \ifdefined\frontmatter
167 \let\exsol@@frontmatter\frontmatter
168 \def\frontmatter{%
169 \immediate\write\solutionstream{\string\frontmatter}%
170 \exsol@@frontmatter
171 }
172 \fi
173 \ifdefined\mainmatter
174 \let\exsol@@mainmatter\mainmatter
175 \def\mainmatter{%
176 \immediate\write\solutionstream{\string\mainmatter}%
177 \exsol@@mainmatter
178 }
179 \fi
180 \ifdefined\backmatter
181 \let\exsol@@backmatter\backmatter
182 \def\backmatter{%
183 \immediate\write\solutionstream{\string\backmatter}%
184 \exsol@@backmatter
185 }
186 \fi

```

`\noexerciseseinchapter` If you have chapters without exercises, you may want to indicate this clearly into your source. Otherwise empty chapters may appear in your solution book.

```

187 \newcommand{\noexerciseseinchapter}

```

```

188 {
189   \immediate\write\solutionstream{No exercises in this chapter}
190 }

191 </package>

```

References

- [1] Timothy Van Zandt, Herbert Voß, Denis Girou, Sebastian Rahtz, Niall Mansfield The `fancyvrb` package. <http://ctan.org/pkg/fancyvrb>. online, accessed in January 2012.
- [2] The Comprehensive TeX Archive Network. <http://www.ctan.org>. online, accessed in January 2012.

Change History

v0.1 General: . Initial version 1	to avoid cluttered itemize environments 10
v0.2 General: . Minor bug fixes based on first use by Paul Levrie . . 1 Added option <code>exercisefont</code> . . 7 Fixed babel errors 12 Removed dash in counter when in document without sectioning commands 8 <code>exercises</code> : Attempted to fix MiKTeX formatting problems 11 <code>exsol@exercise</code> : Attempted to fix MiKTeX formatting problems 10	v0.4 General: . Allowed for non-list formatting of exercises (as default) 1 Added option <code>exerciselinlist</code> . 7 Changed name of option to <code>exercisefontsize</code> 7 <code>exsol@exercise</code> : Added option <code>exerciselinlist</code> such that default results in non list formatting of exercise 10
v0.3 General: . Minor bug fixes based on second use by Paul 1 <code>exercises</code> : Added some extra whitespace below exercises-name 11 <code>exsol@exercise</code> : Fixed <code>labelsep</code>	v0.5 General: . Added option to also send exercises to solutions file 1 Added option <code>copyexerciselinlist</code> 7 Changed option <code>exerciselinlist</code> to <code>exerciseaslist</code> 7 <code>exsol@exercise</code> : Changed implementation to allow for

	copying the exercises to the solutions file.	10		tag and running out of write handles	1
v0.6	General: . Prepared for CTAN publication	1		moved newwrite of exercise stream to this spot to avoid consuming all handles	8
v0.7	General: . Fixed UTF8 compatibility issues	1		\solutionname: Added missing babel tag	12
	Added detokenized writing	9	v0.9	General: . Changed default behavior w.r.t. minipage-wrapping of exercises	1, 7
	Added Finnish language support	12			
v0.8	General: . Fixed missing babel				

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Numbers written in *italic* refer to the page where the corresponding entry is described; numbers underlined refer to the code line of the definition; numbers in *roman* refer to the code lines where the entry is used.

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