

The ExSol package*

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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 0.91, dated 2014/08/31.

- 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
   $AB$  and  $BC$  adjacent to the right angle having lengths,  $3$  and
   $4$ , calculate the length of the hypotenuse, labeled  $AC$ .

```

```

\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 \LaTeX 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 a simple as including the file into a simple \LaTeX 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:

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

and

$$x_1 = \frac{3.1 + \sqrt{130.45}}{11.4} = 1.27 \quad (7)$$

$$x_2 = \frac{3.1 - \sqrt{130.45}}{11.4} = -0.73 \quad (8)$$

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:

$$\|A\|^2 + \|B\|^2 = \|C\|^2 \quad (9)$$

and therefore:

$$\|C\| = \sqrt{\|A\|^2 + \|B\|^2} \quad (10)$$

$$= \sqrt{3^2 + 4^2} \quad (11)$$

$$= \sqrt{25} = 5 \quad (12)$$

Therefore, the length of the hypotenuse equals 5.

3.2 Fiddling with the spacing

The default spacing provided by the ExSol package should be fine for most users. However, if you like to tweak, below you can find the controls.

3.2.1 Spacing before and after the exercises environment

The lengths below control the spacing of the `exercises` environment:

- `exsolexerciseaboveskip`: rubber length controlling the vertical space after the top marker line of the environment
- `exsolexercisebelowskip`: rubber length controlling the vertical space before the bottom marker line of the environment

You can simply specify them like:

```
\setlength{\exsolexercisesaboveskip}{1ex plus 1pt minus 1pt}
\setlength{\exsolexercisesbelowskip}{1ex plus 1pt minus 1pt}
```

The spacings specified here are the package defaults.

3.2.2 Spacing of the individual exercises

Caution: the spacing can only be tuned, when one invokes the `exercisearlist` package option!

Then lengths below control the spacing of the `exercise` environment:

- `exercisetopbottomsep`: rubber length controlling the vertical space before and after individual exercises
- `exerciseleftmargin`: length controlling the horizontal space between the surrounding environment's left margin (most often the page margin) and the left edge of the exercise environment
- `exerciserightmargin`: length controlling the horizontal space between the surrounding environment's right margin (most often the page margin) and the right edge of the exercise environment
- `exerciseitemindent`: length controlling the first-line indentation of the first paragraph in the exercise environment (actually, the label is set w.r.t. this position, that we will conveniently call position 'x')
- `exerciseparindent`: length controlling the first-line indentation of the other paragraphs in the exercise environment.
- `exerciselabelsep`: length controlling the distance between the label and position 'x'
- `exerciselabelwidth`: minimal width of the (internally right-aligned) box to use for the exercises label; if the box is not sufficiently big, position 'x' is shifted to the right
- `exerciseparsep`: internal paragraph separation (vertically)

You can simply specify them like:

```
\setlength{\exsolexercisetopbottomsep}{0pt plus 0pt minus 1pt}  
\setlength{\exsolexercisefleftmargin}{1em}  
\setlength{\exsolexerciserightmargin}{1em}  
\setlength{\exsolexerciseparindent}{0em}  
\setlength{\exsolexerciselabelsep}{0.5em}  
\setlength{\exsolexerciselabelwidth}{0pt}  
\setlength{\exsolexerciseitemindent}{0pt}  
\setlength{\exsolexerciseparsep}{\parskip}
```

The spacings specified here are the package defaults.

3.3 Tips and tricks

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}
```

If you want to avoid exercises being split by a page boundary, then provide the package option 'minipage'. This causes the exercises to be wrapped in a minipage environment.

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}
```

copyexercisesinsolutions 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]{copyexercisesinsolutions}
```

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 Customization of lengths

The commands below allow customizing many lengths that control the typesetting of the exercises.

First some lengths to control the spacing before and after `exercises`.

```
11 \newlength{\exsolexercisesaboveskip}  
12 \setlength{\exsolexercisesaboveskip}{1ex plus 1pt minus 1pt}  
13 \newlength{\exsolexercisesbelowskip}  
14 \setlength{\exsolexercisesbelowskip}{1ex plus 1pt minus 1pt}
```

Then some lengths to control the spacing for a single exercise. These lengths only work when the `exerciseaslist` package option has been specified. Sensible defaults have been set.

```
15 \newlength{\exsolexercisetopbottomsep}  
16 \setlength{\exsolexercisetopbottomsep}{0pt plus 0pt minus 1pt}  
17 \newlength{\exsolexerciseleftmargin}  
18 \setlength{\exsolexerciseleftmargin}{1em}  
19 \newlength{\exsolexerciserightmargin}  
20 \setlength{\exsolexerciserightmargin}{1em}  
21 \newlength{\exsolexerciseparindent}  
22 \setlength{\exsolexerciseparindent}{0em}  
23 \newlength{\exsolexerciselabelsep}  
24 \setlength{\exsolexerciselabelsep}{0.5em}  
25 \newlength{\exsolexerciselabelwidth}  
26 \setlength{\exsolexerciselabelwidth}{0pt}  
27 \newlength{\exsolexerciseitemindent}  
28 \setlength{\exsolexerciseitemindent}{0pt}  
29 \newlength{\exsolexerciseparsep}  
30 \setlength{\exsolexerciseparsep}{\parskip}
```

4.4 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.

```
31 \AtBeginDocument{
32   \newwrite\solutionstream
33   \immediate\openout\solutionstream=\jobname.sol.tex
34   \newwrite\exercisestream
35 }
36 \AtEndDocument{
37   \immediate\closeout\solutionstream
38 }
```

4.5 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.

```
39 \newcounter{exercise}[subsection]
40 \setcounter{exercise}{0}
41 \renewcommand{\theexercise}{%
42   \@ifundefined{c@chapter}{\if0\arabic{chapter}\else\arabic{chapter}.\fi}%
43   \if0\arabic{section}\else\arabic{section}\fi%
44   \if0\arabic{subsection}\else.\arabic{subsection}\fi%
45   \if0\arabic{subsubsection}\else.\arabic{subsubsection}\fi%
46   \if0\arabic{exercise}\else%
47     \@ifundefined{c@chapter}%
48       {\if0\arabic{section}\else-\fi}%
49     {-}%
50   \arabic{exercise}%
51 \fi
52 }
```

4.6 Detokenization in order to cope with utf8

Combining old-school L^AT_EX (before X_ƒL^AT_EX and Lua_TE_X) 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.

```

53 \newcommand{\GPES@write@detok}[1]{%
54   \immediate\write\exercisestream{\detokenize{#1}}}%
55 \newcommand{\GPSS@write@detok}[1]{%
56   \immediate\write\solutionstream{\detokenize{#1}}}%
57 \newcommand{\GPSS@write@detok}[1]{%
58   \GPES@write@detok{#1}%
59   \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.

```

60 \def\exercise{\FV@Environment}{exercise}}
61 \def\FVB@exercise{%
62   \refstepcounter{exercise}%
63   \immediate\openout\exercisestream=\jobname.exc.tex
64   \ifxsol@copyexercisessolutions
65     \typeout{Writing exercise to \jobname.sol.tex}
66     \immediate\write\solutionstream{\string\par---\string\newline
67       \string\textbf\string{exercisename} \theexercise \string}}
68   \else
69     \immediate\write\solutionstream{\string\par---\string\newline}
70   \fi
71   \immediate\write\exercisestream{\string\begin{exsol@exercise}}
72   \@bsphack
73   \begingroup
74     \FV@UseKeyValues
75     \FV@DefineWhiteSpace
76     \def\FV@Space{\space}%
77     \FV@DefineTabOut
78     \ifxsol@copyexercisessolutions
79       \let\FV@ProcessLine\GPSS@write@detok %
80     \else
81       \let\FV@ProcessLine\GPES@write@detok %
82     \fi
83     \relax
84     \let\FV@FontScanPrep\relax
85     \let\@noligs\relax

```

```

86     \FV@Scan
87   }
88 \def\FVE@exercise{
89   \endgroup\@esphack
90   \immediate\write\exercisestream{\string\end{exsol@exercise}}
91   \ifexsol@copyexercisesinsolutions
92     \immediate\write\solutionstream{\string~\string\newline}
93   \fi
94   \immediate\closeout\exercisestream
95   \input{\jobname.exc.tex}
96 }
97 \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.

```

98 \newenvironment{exsol@exercise}[0]
99 {%
100  \ifthenelse{\boolean{exsol@minipage}}{\begin{minipage}[t]{\textwidth}}{%
101    \ifthenelse{\boolean{exsol@exerciseaslist}}
102      {\begin{list}%
103        {%
104          }%
105          {%
106            \setlength{\topsep}{\exsolexercisetopbottomsep}%
107            \setlength{\leftmargin}{\exsolexerciseleftmargin}%
108            \setlength{\rightmargin}{\exsolexerciserightmargin}%
109            \setlength{\listparindent}{\exsolexerciseparindent}%
110            \setlength{\itemindent}{\exsolexerciseitemindent}%
111            \setlength{\parsep}{\exsolexerciseparsep}
112            \setlength{\labelsep}{\exsolexerciselabelsep}
113            \setlength{\labelwidth}{\exsolexerciselabelwidth}}
114          \item[\textit{~\exercisename{}} \theexercise:~]}
115        }%
116        {\textit{\exercisename{}} \theexercise:}}
117  }
118  {%
119    \ifthenelse{\boolean{exsol@exerciseaslist}}%
120      {\end{list}}{%
121        \ifthenelse{\boolean{exsol@minipage}}{\end{minipage}}{\par}%
122      }

```

solution The `solution` environment is used to typeset your solutions and pro-

vide 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.

```

123 \def\solution{\FV@Environment{}{solution}}
124 \def\FVB@solution{%
125   \typeout{Writing solution to \jobname.sol.tex}
126   \immediate\write\solutionstream{\string\textbf\string{\solutionname}\string}}
127   \ifexsol@copyexercisessolutions
128     \immediate\write\solutionstream{\string\newline}
129   \else
130     \immediate\write\solutionstream{\string\textbf\string{\theexercise}\string}%
131                                   \string\newline}
132   \fi
133   \@bsphack
134   \begingroup
135     \FV@UseKeyValues
136     \FV@DefineWhiteSpace
137     \def\FV@Space{\space}%
138     \FV@DefineTabOut
139     \let\FV@ProcessLine\GPSS@write@detok %
140     \relax
141     \let\FV@FontScanPrep\relax
142     \let\@noligs\relax
143     \FV@Scan
144   }
145 \def\FVE@solution{\endgroup\@esphack}
146 \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.

```

147 \newenvironment{exercises}
148 {\par\exercisesfontsize\rule{.25\linewidth}{0.15mm}\vspace*{\exsolexercisesskip}}
149 \textbf{\normalsize \exercisename}}
150 {\vspace*{-\baselineskip}\vspace*{\exsolexercisesskip}\rule{.25\linewidth}{0.15mm}}

```

5.1 Some Babel provisions

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

```
151 \newcommand{\exercisename}{Exercise}
```

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

```
152 \newcommand{\exercisename}{Exercises}
```

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

```
153 \newcommand{\solutionname}{Solution}
```

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

```
154 \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.

```
155 \addto\captionsdutch{%
156   \renewcommand{\exercisename}{Oefening}%
157   \renewcommand{\exercisename}{Oefeningen}%
158   \renewcommand{\solutionname}{Oplossing}%
159   \renewcommand{\solutionsname}{Oplossingen}%
160 }
161 \addto\captionsgerman{%
162   \renewcommand{\exercisename}{Aufgabe}%
163   \renewcommand{\exercisename}{Aufgaben}%
164   \renewcommand{\solutionname}{L"osung}%
165   \renewcommand{\solutionsname}{L"osungen}%
166 }
167 \addto\captionsfrench{%
168   \renewcommand{\exercisename}{Exercice}%
169   \renewcommand{\exercisename}{Exercices}%
170   \renewcommand{\solutionname}{Solution}%
171   \renewcommand{\solutionsname}{Solutions}%
172 }
173 \addto\captionsofinnish{
174   \renewcommand{\exercisename}{Teht"av"a}%
175   \renewcommand{\exercisename}{Teht"avi"a}%
176   \renewcommand{\solutionname}{Ratkaisu}%
177   \renewcommand{\solutionsname}{Ratkaisut}%
178 }
```

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

```

179 \let\exsol@@makechapterhead\@makechapterhead
180 \def\@makechapterhead#1{%
181   \immediate\write\solutionstream{\string\chapter{#1}}%
182   \exsol@@makechapterhead{#1}
183 }
184 \ifdefined\frontmatter
185   \let\exsol@@frontmatter\frontmatter
186   \def\frontmatter{%
187     \immediate\write\solutionstream{\string\frontmatter}%
188     \exsol@@frontmatter
189   }
190 \fi
191 \ifdefined\frontmatter
192   \let\exsol@@mainmatter\mainmatter
193   \def\mainmatter{%
194     \immediate\write\solutionstream{\string\mainmatter}%
195     \exsol@@mainmatter
196   }
197 \fi
198 \ifdefined\backmatter
199   \let\exsol@@backmatter\backmatter
200   \def\backmatter{%
201     \immediate\write\solutionstream{\string\backmatter}%
202     \exsol@@backmatter
203   }
204 \fi

```

`\noexerciseshapter` 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.

```

205 \newcommand{\noexerciseshapter}
206 {
207   \immediate\write\solutionstream{No exercises in this chapter}
208 }

209 </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	Changed name of option to <code>exercisefontsize</code> 9
v0.2	General: . Minor bug fixes based on first use by Paul Levrie . . 1	<code>exsol@exercise</code> : Added option <code>exerciselinlist</code> such that default results in non list formatting of exercise 13
	Added option <code>exercisefont</code> . . 9	
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	<code>exercisefont</code> : Attempted to fix MiKTeX formatting problems 14	
	<code>exsol@exercise</code> : Attempted to fix MiKTeX formatting problems 13	
v0.3	General: . Minor bug fixes based on second use by Paul 1	v0.5
	<code>exercisefont</code> : Added some extra whitespace below <code>exercisefontname</code> 14	General: . Added option to also send exercises to solutions file 1
	<code>exsol@exercise</code> : Fixed <code>labelsep</code> to avoid cluttered <code>itemize</code> environments 13	Added option <code>copyexerciselinlist</code> 9
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		<code>exsol@exercise</code> : Changed implementation to allow for copying the exercises to the solutions file. 13
v0.4	General: . Allowed for non-list formatting of exercises (as default) 1	v0.6
	Added option <code>exerciselinlist</code> . 9	General: . Prepared for CTAN publication 1
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		General: . Fixed UTF8 compatibility issues 1
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