The lstEventB package[*]

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March 28, 2021

Abstract

This package provides macros for listing Event-B code. It was developed at the University of Southampton.

Contents

1 Introduction

This package was developed in order to ease the listing of Event-B code in LaTeX.

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{lstEventB}`
to load the package.

[*]This document corresponds to lstEventB v1.1, dated 2020/03/28.

2.1 Package Options

Colouring Option. Loading package with the `colour` or `color` options will enable the various colouring of the Event-B code.

2.2 Typesetting Event-B Code

The current supported syntax are from CamilleX (cite XEvent-B paper). In particular, the Event-B mathematical symbols can be typeset using Unicode symbols. Alternatively, the mathematical symbols can be typeset using ASCII combinations (similar to the Event-B Summary (cite Ken Robinson)), with the exception that the *text* combinations must be prefixed by `!` (this is to prevent unintended translation of text in longer words). Some other symbols, e.g. `.` and `|` also need to be `!`-prefixed.

Table 1 shows the ASCII input for typesetting predicate-related symbols.

ASCII	Symbols	Explanation
`!false`	$\bot$	False
`!true`	$\top$	True
`&`	$\wedge$	Conjunction
`!or`	$\vee$	Disjunction
`=>`	$\Rightarrow$	Implication
`<=>`	$\Leftrightarrow$	Equivalence
`!not`	$\neg$	Negation
`!`	$\forall$	Universal quantification
`#`	$\exists$	Existential quantification
`!.`	$\cdot$	Quantification dot
`=`	$=$	Equality
`/=`	$\neq$	Inequality

Table 1: Predicates

Table 2 shows the ASCII inputs for typesetting set-related symbols.

ASCII	Symbols	Explanation
`{}`	$\varnothing$	Empty set
`|`	$\vert$	Vertical bar, e.g., in set comprehension
`\/`	$\cup$	Union
`/\`	$\cap$	Intersection
`\`	$\setminus$	Set difference
`|->`	$\mapsto$	Ordered pair
`**`	$\times$	Cartesian product
`!POW`	$\mathbb{P}$	Powerset
`!POW1`	$\mathbb{P}_1$	Non-empty subsets
`!card`	card	Cardinality
`!union`	union	Generalised union
`!inter`	inter	Generalised intersection
`!UNION`	$\bigcup$	Quantified union
`!INTER`	$\bigcap$	Quantified intersection

Table 2: Sets

3 Implementation

Our implementation is based on the listings package. Additionally, we also require xspace for spacing, xcolor for colouring, bsymb for typesetting Event-B mathematical symbols, and xargs for defining commands with argument lists.

```
\RequirePackage{listings}
\RequirePackage{xspace}
\RequirePackage{xcolor}
\RequirePackage{bsymb}
\RequirePackage{xargs}
\RequirePackage{mdframed}
\DeclareUnicodeCharacter{22A5}{$\bfalse$}
\DeclareUnicodeCharacter{22A4}{$\btrue$}
\DeclareUnicodeCharacter{2227}{$\land$}
\DeclareUnicodeCharacter{2228}{$\lor$}
\DeclareUnicodeCharacter{21D2}{$\limp$}
\DeclareUnicodeCharacter{21D4}{$\leqv$}
\DeclareUnicodeCharacter{2200}{$\forall$}
\DeclareUnicodeCharacter{2203}{$\exists$}
\DeclareUnicodeCharacter{2260}{$\neq$}
\DeclareUnicodeCharacter{2205}{$\emptyset$}
\DeclareUnicodeCharacter{2223}{$\mid$}
\DeclareUnicodeCharacter{222A}{$\bunion$}
\DeclareUnicodeCharacter{2229}{$\binter$}
\DeclareUnicodeCharacter{2216}{$\setminus$}
\DeclareUnicodeCharacter{21A6}{$\mapsto$}
\DeclareUnicodeCharacter{2119}{$\pow$}
\DeclareUnicodeCharacter{22C3}{$\Union$}
\DeclareUnicodeCharacter{22C2}{$\Inter$}
\DeclareUnicodeCharacter{2208}{$\in$}
\DeclareUnicodeCharacter{2209}{$\notin$}
\DeclareUnicodeCharacter{2286}{$\subseteq$}
\DeclareUnicodeCharacter{2288}{$\not\subseteq$}
\DeclareUnicodeCharacter{2282}{$\subset$}
\DeclareUnicodeCharacter{2284}{$\not\subset$}
\DeclareUnicodeCharacter{2124}{$\intg$}
\DeclareUnicodeCharacter{2115}{$\nat$}
\DeclareUnicodeCharacter{2212}{$-$}
\DeclareUnicodeCharacter{2217}{$*$}
\DeclareUnicodeCharacter{2025}{$\upto$}
\DeclareUnicodeCharacter{2265}{$\geq$}
\DeclareUnicodeCharacter{2264}{$\leq$}
\DeclareUnicodeCharacter{2194}{$\rel$}
\DeclareUnicodeCharacter{E100}{$\trel$}
\DeclareUnicodeCharacter{E101}{$\srel$}
\DeclareUnicodeCharacter{E102}{$\strel$}
\DeclareUnicodeCharacter{2218}{$\circ$}
\DeclareUnicodeCharacter{25C1}{$\domres$}
\DeclareUnicodeCharacter{2A64}{$\domsub$}
\DeclareUnicodeCharacter{25B7}{$\ranres$}
\DeclareUnicodeCharacter{2A65}{$\ransub$}
\DeclareUnicodeCharacter{223C}{$\mathtt{\sim}$}
\DeclareUnicodeCharacter{E103}{$\ovl$}
\DeclareUnicodeCharacter{2297}{$\dprod$}
```

```
\DeclareUnicodeCharacter{2225}{$\pprod$}
\DeclareUnicodeCharacter{21F8}{$\pfun$}
\DeclareUnicodeCharacter{2914}{$\pinj$}
\DeclareUnicodeCharacter{21A3}{$\tinj$}
\DeclareUnicodeCharacter{2900}{$\psur$}
\DeclareUnicodeCharacter{21A0}{$\tsur$}
\DeclareUnicodeCharacter{2916}{$\tbij$}
\DeclareUnicodeCharacter{03BB}{$\lambda$}
\DeclareUnicodeCharacter{2254}{$\bcmeq$}
```

3.1 Package Options

We define some options for customising the listing of Event-B code.

3.1.1 Colouring option

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

`EventB@SetKeywordColour` Command EventB@SetKeywordColour is used to set the colour of the Event-B keywords, by default, it is set to black.

```
\newcommand{\EventB@SetKeywordColour}[1]{%
  \colorlet{EventB@keywordcolour}{#1}%
}
\EventB@SetKeywordColour{black}
```

`EventB@SetNdKeywordColour` Command EventB@SetNdKeywordColour is used to set the colour of the secondary Event-B keywords, by default, it is set to black.

```
\newcommand{\EventB@SetNdKeywordColour}[1]{%
  \colorlet{EventB@ndkeywordcolour}{#1}%
}
\EventB@SetNdKeywordColour{black}
```

`EventB@SetIdentifierColour` Command EventB@SetIdentifierColour is used to set the colour of Event-B identifiers, by default, it is set to black.

```
\newcommand{\EventB@SetIdentifierColour}[1]{%
  \colorlet{EventB@identifiercolour}{#1}%
}
\EventB@SetIdentifierColour{black}
```

`EventB@SetCommentColour` Command EventB@SetCommentColour is used to set the colour of Event-B comments, by default, it is set to black.

```
\newcommand{\EventB@SetCommentColour}[1]{%
  \colorlet{EventB@commentcolour}{#1}%
}
\EventB@SetCommentColour{black}
```

`EventB@SetFormulaColour` Command EventB@SetFormulaColour is used to set the colour of Event-B formulae, by default, it is set to black.

```
\newcommand{\EventB@SetFormulaColour}[1]{%
  \colorlet{EventB@formulacolour}{#1}%
}
\EventB@SetFormulaColour{black}
```

We now define the colour option and set the different colours accordingly. The keywords colour (both first primary and secondary keywords) is red. The identifier colour is purple. The comment colour is green∀50∀black (dark green). The formula colour is blue.

```
\DeclareOption{colour}{
  \EventB@SetKeywordColour{red}
  \EventB@SetNdKeywordColour{red}
  \EventB@SetIdentifierColour{purple}
  \EventB@SetCommentColour{green!50!black}
  \EventB@SetFormulaColour{blue}
}
```

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

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

3.1.2 Execution of options

```
\ProcessOptions
```

3.2 Typesetting of the Event-B language

In this section, we define how to typesetting Event-B code.

3.2.1 Defining the Event-B language

We first define the Event-B language using lstdefinelanguage.

```
\def\lst@visiblespace{\hspace{0.2em}}
\lstdefinelanguage{Event-B}{%
  basicstyle=\rmfamily\footnotesize,
```

Subsequently, we define the keywords of Event-B and how to typeset them. Note that the keywords are insensitive.

```
    keywords={%
      % Keywords for contexts
      context,extends,sets,constants,axioms,theorem,end,%
      % Keywords for machines
      machine,sees,refines,variables,invariants,variant,events,%
    },%
    keywordstyle=\color{EventB@keywordcolour}\bfseries\sffamily,%
    sensitive=false,
```

We also define the secondary keywords of Event-B and how to typeset them.

```
    ndkeywords={%
      % Keywords for events
      extended,theorem,any,where,when,with,begin,then%
    },%
    ndkeywordstyle=\color{EventB@ndkeywordcolour}\bfseries\sffamily,%
```

Next, we define how to typeset Event-B identifiers.

```
    identifierstyle=\color{EventB@identifiercolour}\sffamily,
```

We define how comments are typeset.

```
    comment=[l]{//},%
    morecomment=[s]{/*}{*/},%
    commentstyle=\color{EventB@commentcolour}\rmfamily,%
```

Furthermore, we define the appearance of formulae (which are typeset strings).

```
stringstyle=\color{EventB@formulacolour}\sffamily,
string=[b]",
showstringspaces=true, % Do not show the space in formulae
```

Finally, we define the Event-B mathematical symbols using the bsymb package as follows.

```
inputencoding=utf8, % Allow UTF-8 input encoding
extendedchars=true, % Use extended characters
literate= % Event-B mathematical symbols
% Short sequences should appear before long sequences containing them
% Predicates
{⊥}{{$\bfalse$}}1% False
{⊤}{{$\btrue$}}1% True
{∧}{{$\land$}}1% Conjunction
{∨}{{$\lor$}}1% Disjunction
{⇒}{{$\limp$}}1% Implication
{⇔}{{$\leqv$}}1% Equivalence
{¬}{{$\lnot$}}1% Negation
{∀}{{$\forall$}}1% Universal quantification
{∃}{{$\exists$}}1% Existential quantification
{·}{{$\qdot$}}1% Quantification dot
{=}{{$=$}}1% Equality
{≠}{{$\neq$}}1% Inequality
% Sets
{!}{{$\forall$}}1% Universal quantification (This is moved here from ASCII perdicates)
{∅}{{$\emptyset$}}1% Empty set
{∣}{{$\mid$}}1% Vertical bar, e.g., in set comprehension
{∪}{{$\bunion$}}1% Union
{∩}{{$\binter$}}1% Intersection
{∖}{{$\setminus$}}1% Set difference
{↦}{{$\mapsto$}}1% Ordered pair
{×}{{$\cprod$}}1% Cartesian product
{ℙ}{{$\pow$}}1% Powerset
{ℙ1}{{$\pown$}}1% Non-empty subsets
{!card}{{$\card$}}1% Cardinality
{!union}{{$\union$}}1% Generalised union
{!inter}{{$\inter$}}1% Generalised intersection
{⋃}{{$\Union$}}1% Quantified union
{⋂}{{$\Inter$}}1% Quantified intersection
% Set predicates
{∈}{{$\in$}}1% Set membership
{∉}{{$\notin$}}1% Set non-membership
{⊆}{{$\subseteq$}}1% Subset
{⊈}{{$\not\subseteq$}}1% Not a subset
{⊂}{{$\subset$}}1% Proper subset
{⊄}{{$\not\subset$}}1% Not a proper subset
{!finite}{{$\finite$}}1% Finite set
{!partition}{{$\partition$}}1% Partition
% Bool and bool
{!BOOL}{{$\Bool$}}1% BOOL set
{!TRUE}{{$\True$}}1% TRUE
{!FALSE}{{$\False$}}1% FALSE
{!bool}{{$\bool$}}1% bool predicate set
```

```
% Numbers
{ℤ}{{$\intg$}}1% Set of integer numbers
{ℕ}{{$\nat$}}1% Set of natural numbers
{ℕ1}{{$\natn$}}1% Set of positive natural numbers
{!min}{{$\min$}}1% Minimum
{!max}{{$\max$}}1% Maximum
{+}{{$+$}}1% Sum
{−}{{$-$}}1% Difference
{∗}{{$*$}}1% Product
{÷}{{$\div$}}1% Quotient
{!mod}{{$\textrm{mod}$}}1% Remainder
{‥}{{$\upto$}}1% Interval
% Number predicates
{≥}{{$\geq$}}1% Greater or equal
{≤}{{$\leq$}}1% Less or equal
% Relations
{↔}{{$\rel$}}1% Relations
{!dom}{{$\dom$}}1% Domain
{!ran}{{$\ran$}}1% Range
{}{{$\trel$}}1% Total relations
{}{{$\srel$}}1% Surjective relations
{}{{$\strel$}}1% Total surjective relations
{∘}{{$\circ$}}1% Backward composition
{!id}{{$\id$}}1% Identity
{◁}{{$\domres$}}1% Domain restriction
{⩤}{{$\domsub$}}1% Domain subtraction
{▷}{{$\ranres$}}1% Range restriction
{⩥}{{$\ransub$}}1% Range subtraction
{∼}{{$\mathtt{\sim}$}}1% Inverse
{}{{$\ovl$}}1% Overriding
{⊗}{{$\dprod$}}1% Direct product
{∥}{{$\pprod$}}1% Parallel product
{!prj1}{{$\prjone$}}1% First projection
{!prj2}{{$\prjtwo$}}1% Second projection
% Functions
{⇸}{{$\pfun$}}1% Partial functions
{→}{{$\tfun$}}1% Total functions
{⤔}{{$\pinj$}}1% Partial injections
{↣}{{$\tinj$}}1% Total injections
{⤀}{{$\psur$}}1% Partial surjections
{↠}{{$\tsur$}}1% Total surjections
{⤖}{{$\tbij$}}1% Bijections
{λ}{{$\lambda$}}1% Lambda abstraction
% Assignment
{≔}{{$\bcmeq$}}1% Becomes equal to
{:∈}{{$\bcmin$}}1% Choice from a set
{:∣}{{$\bcmsuch$}}1% Choice by predicate
% ASCII Number predicates (This has to be before ASCII Predicates)
{>}{{$>$}}1% Greater
{<}{{$<$}}1% Less
{>=}{{$\geq$}}1% Greater or equal
{<=}{{$\leq$}}1% Less or equal
% ASCII Predicates
{!false}{{$\bfalse$}}1% False
```

```
{!true}{{$\btrue$}}1% True
{\&}{{$\land$}}1% Conjunction (note the backslash)
{!or}{{$\lor$}}1% Disjunction
{=>}{{$\limp$}}1% Implication
{<=>}{{$\leqv$}}1% Equivalence
{!not}{{$\lnot$}}1% Negation
{\#}{{$\exists$}}1% Existential quantification (note the backslash)
{!.}{{$\qdot$}}1% Quantification dot
{/=}{{$\neq$}}1% Inequality
% ASCII Sets
{\{\}}{{$\emptyset$}}1% Empty set (note the backslashes)
{\|}{{$\mid$}}1% Vertical bar, e.g., in set comprehension (not the backslash)
{\\}{{$\setminus$}}1% Difference
{\\/}{{$\bunion$}}1% Union
{/\\}{{$\binter$}}1% Intersection
{|->}{{$\mapsto$}}1% Ordered pair
{**}{{$\cprod$}}1% Cartesian product
{!POW}{{$\pow$}}1% Powerset
{!POW1}{{$\pown$}}1% Non-empty subsets
{!UNION}{{$\Union$}}1% Quantified union
% ASCII Set predicates
{/:}{{$\notin$}}1% Set non-membership
{/<:}{{$\not\subseteq$}}1% Not a subset
{/<<:}{{$\not\subset$}}1% Not a proper subset
{<<:}{{$\subset$}}1% Proper subset
{<:}{{$\subseteq$}}1% Subset
{!:}{{$\in$}}1% Set membership
% ASCII Numbers
{!INT}{{$\intg$}}1% Set of integer numbers
{!INTER}{{$\Inter$}}1% Quantified intersection (This is moved here from ASCII Sets)
{!NAT}{{$\nat$}}1% Set of natural numbers
{!NAT1}{{$\natn$}}1% Set of positive natural numbers
{-}{{$-$}}1% Difference
{!*}{{$*$}}1% Product (Note the !)
{!/}{{$\div$}}1% Quotient (Note the !)
{..}{{$\upto$}}1% Interval
% ASCII Relations
{<->}{{$\rel$}}1% Relations
{<<->}{{$\trel$}}1% Total relations
{<->>}{{$\srel$}}1% Surjective relations
{<<->>}{{$\strel$}}1% Total surjective relations
{!circ}{{$\circ$}}1% Backward composition
{<|}{{$\domres$}}1% Domain restriction
{<<|}{{$\domsub$}}1% Domain subtraction
{|>}{{$\ranres$}}1% Range restriction
{|>>}{{$\ransub$}}1% Range subtraction
{~}{{$\mathtt{\sim}$}}1% Inverse
{<+}{{$\ovl$}}1% Overriding
{><}{{$\dprod$}}1% Direct product
{||}{{$\pprod$}}1% Parallel product
% ASCII Functions
{+->}{{$\pfun$}}1% Partial functions
{-->}{{$\tfun$}}1% Total functions
{>+>}{{$\pinj$}}1% Partial injections
```

```
    {>->}{{$\tinj$}}1% Total injections
    {+>>}{{$\psur$}}1% Partial surjections
    {->>}{{$\tsur$}}1% Total surjections
    {>->>}{{$\tbij$}}1% Bijections
    {\%}{{$\lambda$}}1% Lambda abstraction
    % ASCII Assignment
    {:=}{{$\bcmeq$}}1% Becomes equal to
    {::}{{$\bcmin$}}1% Choice from a set
    {:|}{{$\bcmsuch$}}1% Choice by predicate
    , % End of Event-B mathematical symbols
  }
```

3.2.2 Typesetting Event-B Code

We first create a short inline Event-B code with `|` using lstMakeShortInline command.

```
  \lstMakeShortInline%
  [language=Event-B, breaklines=f, basicstyle=\rmfamily\normalsize]|%
```

We then create a dedicated `EventBcode` environment using `lstnewenvironment`.

```
  \lstnewenvironment{EventBcode}{\lstset{language=Event-B}}{}
```

We then create a dedicated `EventBNoInline` environment using `newenvironment`.

```
  \newenvironment{EventBNoShortInline}
  {
    % Remove the short-inline
    \lstDeleteShortInline|
    % Set the language to be Event-B
    \lstset{language=Event-B, breaklines=f, basicstyle=\rmfamily\normalsize}
  }
  {
    % Restore the short inline
    \lstMakeShortInline[language=Event-B,breaklines=f,basicstyle=\rmfamily\normalsize]|
  }
  \newcommand{\EventBInline}[1]{%
    \lstinline[language=Event-B, breaklines=f,basicstyle=\rmfamily\normalsize]$#1$
  }
```

Finally, we set some appearance parameters for display the code.

```
  \lstset{%
    columns=fullflexible, % The columns are fully flexible.
    numberbychapter=false,
    frame=top,frame=bottom, % There are line (frame at top and bottom).
    stepnumber=1, % the step between two line-numbers. If it is 1 each line will be numbered
    numberstyle=\tiny,
    numbersep=5pt, % how far the line-numbers are from the code
    tabsize=2, % tab size in blank spaces
    breaklines=true, % sets automatic line breaking
    captionpos=b, % sets the caption-position to top
    mathescape=false,
    showspaces=true, % Do not show spaces
    showtabs=false, % Do not show tabs
    xleftmargin=10pt,
    framexleftmargin=10pt,
    framexrightmargin=0pt,
  framexbottommargin=5pt,
  framextopmargin=5pt,
  escapechar=\%,
  numbers=left, % where to put the line-numbers; possible values are (none, left, right)
  numbersep=5pt,
}
```

```
\newcommandx{\EventBinputlisting}[2][1=]{%
  \begin{mdframed}[backgroundcolor=yellow!10, rightline=false,leftline=false]
    \lstinputlisting[language=Event-B,mathescape,frame={},#1]{#2}
  \end{mdframed}
}
```

`Event@SetKeywordColour`

```
\let\EventBSetKeywordColour\EventB@SetKeywordColour
```

```
\newcommand{\EventB}{Event-B\xspace}
```

Change History

v0.1
  General: Initial version 1
v0.2
  General: Added support for ASCII combinations (Issue #3) 1
v1.0
  `Event@SetKeywordColour`: Added 10
v1.1
  General: Declare Unicode symbols 1
  Fixed symbols for inverse relation, multiplication, not subset and not strict subset . . . 1