CL-Yacc is a LALR(1) parser generator for Common Lisp, somewhat like Yacc, GNU Bison, Zebu, lalr.cl or lalr.scm.

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# Table of Contents

1 A complete example .............................................. 1

2 Reference ............................................................. 3
   2.1 Running the parser ........................................... 3
   2.2 Macro interface ............................................... 3
   2.3 Functional interface ......................................... 4
   2.4 Conditions .................................................... 4
      2.4.1 Compile-time conditions ................................ 4
      2.4.2 Runtime conditions ..................................... 5

Acknowledgements .................................................. 6

Copying ............................................................... 7

Index ................................................................. 8
1 A complete example

CL-Yacc exports its symbols from the package yacc:

```
(use-package #:yacc)
```

A parser consumes the output of a lexer, that produces a stream of terminals. CL-Yacc
expects the lexer to be a function of no arguments (a thunk) that returns two values: the next
terminal symbol, and the value of the symbol, which will be passed to the action associated with
a production. At the end of the input, the lexer should return nil.

A very simple lexer that grabs tokens from a list:

```
defun list-lexer (list)
  #'(lambda ()
    (let ((value (pop list)))
      (if (null value)
        (values nil nil)
        (let ((terminal
          (cond ((member value '(+ - * / |(| |)|)) value)
              ((integerp value) 'int)
              ((symbolp value) 'id)
              (t (error "Unexpected value ~S" value))))
          (values terminal value)))))
```

We will implement the following grammar:

- expression ::= expression + expression
- expression ::= expression - expression
- expression ::= expression * expression
- expression ::= expression / expression
- expression ::= term

- term ::= id
- term ::= int
- term ::= - term
- term ::= ( expression )

As this grammar is ambiguous, we need to specify the precedence and associativity of the
operators. The operators * and / will have the highest precedence, + and - will have a lower
one. All operators will be left-associative.

If no semantic action is specified, CL-Yacc provides default actions which are either #'list
or #'identity, depending on how a production is written. For building a Lisp-like parse tree
with this grammar, we will need two additional actions:

```
(eval-when (:compile-toplevel :load-toplevel :execute)
  (defun i2p (a b c)
    "Infix to prefix"
    (list b a c))

  (defun k-2-3 (a b c)
    "Second out of three"
    (declare (ignore a c))
    b)
)
```

The parser definition itself:

```
(define-parser *expression-parser*
  ...)
Chapter 1: A complete example

(:start-symbol expression)
(:terminals (int id + - * / |(| )))
(:precedence ((:left * /) (:left + -)))

(expression
(expression + expression #'i2p)
(expression - expression #'i2p)
(expression * expression #'i2p)
(expression / expression #'i2p)
(term)

(term
id
int
(- term)
(|(| expression |)| #'k-2-3)))

After loading this code, the parser is the value of the special variable *expression-parser*, which can be passed to parse-with-lexer:

(parse-with-lexer (list-lexer '(x * - - 2 + 3 * y)) *expression-parser*)
⇒ (+ (* X (- (- 2))) (* 3 Y))
2 Reference

2.1 Running the parser

The main entry point to the parser is `parse-with-lexer`.

`parse-with-lexer` `lexer` `parser`  
Function

Parse the input provided by the lexer `lexer` using the parser `parser`.

The value of `lexer` should be a function of no arguments that returns two values: the terminal symbol corresponding to the next token (a non-null symbol), and its value (anything that the associated actions can take as argument). It should return `(values nil nil)` when the end of the input is reached.

The value of `parser` should be a `parser` structure, as computed by `make-parser` and `define-parser`.

2.2 Macro interface

`define-grammar` `name` `option...` `production...`  
Macro

Generates a grammar and binds it to the special variable `name`. This has the side effect of globally proclaiming `name` special.

Every production is a list of a non-terminal symbol and one or more right hand sides. Every right hand side is either a symbol, or a list of symbols optionally followed with an action.

The action should be a non-atomic form that evaluates to a function in a null lexical environment. If omitted, it defaults to `#'identity` in the first form of `rhs`, and to `#'list` in the second form.

The legal options are:

`:start-symbol`  
Defines the starting symbol of the grammar. This is required.

`:terminals`  
Defines the list of terminals of the grammar. This is required.

`:precedence`  
The value of this option should be a list of items of the form `(associativity . terminals)`, where `associativity` is one of :left, :right or :nonassoc, and `terminals` is a list of terminal symbols. `Associativity` specifies the associativity of the terminals, and earlier items will give their elements a precedence higher than that of later ones.

`define-parser` `name` `option...` `production...`  
Macro

Generates a parser and binds it to the special variable `name`. This has the side effect of globally proclaiming `name` special.

The syntax is the same as that of `define-grammar`, except that the following additional options are allowed:

`:muffle-conflicts`  
If `nil` (the default), a warning is signalled for every conflict. If the symbol `:some`, then only a summary of the number of conflicts is signalled. If `T`, then no
Chapter 2: Reference

warnings at all are signalled for conflicts. Otherwise, its value should be a list of two integers \((sr \ rr)\), in which case a summary warning will be signalled unless exactly \(sr\) shift-reduce and \(rr\) reduce-reduce conflicts were found.

:print-derives-epsilon
    If true, print the list of nonterminal symbols that derive the empty string.

:print-first-terminals
    If true, print, for every nonterminal symbol, the list of terminals that it may start with.

:print-states
    If true, print the computed kernels of LR(0) items.

:print-goto-graph
    If true, print the computed goto graph.

:print-lookaheads
    If true, print the computed kernels of LR(0) items together with their lookaheads.

2.3 Functional interface

The macros \texttt{define-parser} and \texttt{define-grammar} expand into calls to \texttt{defparameter}, \texttt{make-parser}, \texttt{make-grammar} and \texttt{make-production} with suitable \texttt{make-load-form} magic to ensure that the time consuming parser generation happens at compile time rather than at load time. The underlying functions are exported in case you want to design a different syntax for grammars, or generate grammars automatically.

\begin{verbatim}
make-production symbol derives &key action action-form
    Returns a production for non-terminal \texttt{symbol} with right-hand-side \texttt{derives} (a list of symbols). \texttt{Action} is the associated action, and should be a function; it defaults to \texttt{#'list}. \texttt{Action-form} should be a form that evaluates to \texttt{action} in a null lexical environment; if null (the default), the production (and hence any grammar or parser that uses it) will not be fasdumpable.

make-grammar &key name start-symbol terminals precedence productions
    Returns a grammar. \texttt{Name} is the name of the grammar (gratuitious documentation). \texttt{Start-symbol}, \texttt{terminals} and \texttt{precedence} are as in \texttt{define-grammar}. \texttt{Productions} is a list of productions.

make-parser grammar &key discard-memos muffle-conflicts
    \texttt{print-derives-epsilon print-first-terminals print-states print-goto-graph print-lookaheads}
    Computes and returns a parser for grammar \texttt{grammar}. \texttt{discard-memos} specifies whether temporary data associated with the grammar should be discarded. \texttt{Muffle-conflicts}, \texttt{print-derives-epsilon}, \texttt{print-first-terminals}, \texttt{print-states}, \texttt{print-goto-graph} and \texttt{print-lookaheads} are as in \texttt{define-parser}.
\end{verbatim}

2.4 Conditions

CL-Yacc may signal warnings at compile time when it finds conflicts. It may also signal an error at parse time when it finds that the input is incorrect.

2.4.1 Compile-time conditions

If the grammar given to CL-Yacc is ambiguous, a warning of type \texttt{conflict-warning} will be signalled for every conflict as it is found, and a warning of type \texttt{conflict-summary-warning} will be signalled at the end of parser generation.
**conflict-warning** kind state terminal

Signalled whenever a conflict is found. *Kind* is one of :shift-reduce or :reduce-reduce. *State* (an integer) and *terminal* (a symbol) are the state and terminal for which the conflict arises.

**conflict-summary-warning** shift-reduce reduce-reduce

Signalled at the end of parser generation if there were any conflicts. *Shift-reduce* and *reduce-reduce* are integers that indicate how many conflicts were found.

**yacc-compile-warning**

A superclass of *conflict-warning* and *conflict-summary-warning*, and a convenient place to hook your own condition types.

### 2.4.2 Runtime conditions

If the output cannot be parsed, the parser will signal a condition of type **yacc-parse-error**. It should be possible to invoke a restart from a handler for **yacc-parse-error** in order to trigger error recovery, but this hasn’t been implemented yet.

**yacc-parse-error** terminal value expected-terminals

Signalled whenever the input cannot be parsed. The symbol *terminal* is the terminal that couldn’t be accepted; *value* is its value. *Expected-terminals* is the list of terminals that could have been accepted in that state.

**yacc-runtime-error**

A superclass of **yacc-parse-error**, and a convenient place to hook your own condition types.
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Index

C
conflict-summary-warning ..................... 5
conflict-warning .............................. 5

D
define-grammar ............................... 3
define-parser ................................. 3

M
make-grammar ................................. 4

make-parsers .................................. 4
make-production .............................. 4

P
parse-with-lexer .............................. 3

Y
yacc-compile-warning ....................... 5
yacc-parse-error .............................. 5
yacc-runtime-error ......................... 5