Quick Reference

Common lisp

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Contents

Typographic Conventions

name; $_f$**name**; $_g$**name**; $_m$**name**; $_s$**name**; $_v$***name***; $_c$**name**
▷ Symbol defined in Common Lisp; esp. function, generic function, macro, special operator, variable, constant.

them ▷ Placeholder for actual code.

`me` ▷ Literal text.

[*foo*`bar`] ▷ Either one *foo* or nothing; defaults to `bar`.

*foo**; {*foo*}* ▷ Zero or more *foo*s.

foo$^+$; {*foo*}$^+$ ▷ One or more *foo*s.

foos ▷ English plural denotes a list argument.

{*foo*|*bar*|*baz*}; $\begin{cases} foo \\ bar \\ baz \end{cases}$ ▷ Either *foo*, or *bar*, or *baz*.

$\left\{\begin{vmatrix} foo \\ bar \\ baz \end{vmatrix}\right.$ ▷ Anything from none to each of *foo*, *bar*, and *baz*.

$\widehat{foo}$ ▷ Argument *foo* is not evaluated.

$\widetilde{bar}$ ▷ Argument *bar* is possibly modified.

foo^{P_*} ▷ *foo** is evaluated as in $_s$**progn**; see page 20.

$\underline{foo}$; $\underline{\underline{bar}}$; $\underline{\underline{\underline{baz}}}$ ▷ Primary, secondary, and *n*th return value.

`T`; `NIL` ▷ **t**, or truth in general; and **nil** or **()**.

1 Numbers

1.1 Predicates

($_f$= *number*$^+$)
($_f$/= *number*$^+$)
▷ T if all *number*s, or none, respectively, are equal in value.

($_f$> *number*$^+$)
($_f$>= *number*$^+$)
($_f$< *number*$^+$)
($_f$<= *number*$^+$)
▷ Return T if *number*s are monotonically decreasing, monotonically non-increasing, monotonically increasing, or monotonically non-decreasing, respectively.

($_f$**minusp** *a*)
($_f$**zerop** *a*)
($_f$**plusp** *a*)
▷ T if $a < 0$, $a = 0$, or $a > 0$, respectively.

($_f$**evenp** *int*)
($_f$**oddp** *int*)
▷ T if *int* is even or odd, respectively.

($_f$**numberp** *foo*)
($_f$**realp** *foo*)
($_f$**rationalp** *foo*)
($_f$**floatp** *foo*)
($_f$**integerp** *foo*)
($_f$**complexp** *foo*)
($_f$**random-state-p** *foo*)
▷ T if *foo* is of indicated type.

1.2 Numeric Functions

($_f$+ a_{0}^*)
($_f$* a_{1}^*)
▷ Return $\sum a$ or $\prod a$, respectively.

($_f$− *a* *b**)
($_f$/ *a* *b**)
▷ Return $a - \sum b$ or $a / \prod b$, respectively. Without any *b*s, return $-a$ or $1/a$, respectively.

($_f$**1+** *a*)
($_f$**1−** *a*)
▷ Return $a + 1$ or $a - 1$, respectively.

($\left\{{}_m\textbf{incf}\atop{}_m\textbf{decf}\right\}$ $\widetilde{place}$ [$delta_{1}$])
▷ Increment or decrement the value of *place* by *delta*. Return new value.

($_f$**exp** *p*)
($_f$**expt** *b* *p*)
▷ Return e^p or b^p, respectively.

($_f$**log** *a* [b_{e}])
▷ Return $\log_b a$ or, without *b*, $\ln a$.

($_f$**sqrt** *n*)
($_f$**isqrt** *n*)
▷ $\sqrt{n}$ in complex numbers/natural numbers.

($_f$**lcm** *integer*$^*_{1}$)
($_f$**gcd** *integer**)
▷ Least common multiple or greatest common denominator, respectively, of *integer*s. (**gcd**) returns 0.

$_c$**pi**
▷ **long-float** approximation of π, Ludolph's number.

($_f$**sin** *a*)
($_f$**cos** *a*)
($_f$**tan** *a*)
▷ $\sin a$, $\cos a$, or $\tan a$, respectively. (*a* in radians.)

($_f$**asin** *a*)
($_f$**acos** *a*)
▷ $\arcsin a$ or $\arccos a$, respectively, in radians.

($_f$**atan** *a* [b_{1}])
▷ $\arctan \frac{a}{b}$ in radians.

($_f$**sinh** *a*)
($_f$**cosh** *a*)
($_f$**tanh** *a*)
▷ $\sinh a$, $\cosh a$, or $\tanh a$, respectively.

(*f*asinh *a*)
(*f*acosh *a*)
(*f*atanh *a*)
▷ asinh *a*, acosh *a*, or atanh *a*, respectively.

(*f*cis *a*) ▷ Return $e^{i\,a} = \cos a + i \sin a$.

(*f*conjugate *a*) ▷ Return complex conjugate of *a*.

(*f*max *num*+)
(*f*min *num*+)
▷ Greatest or least, respectively, of *num*s.

({ *f*round | *f*round } / { *f*floor | *f*ffloor } / { *f*ceiling | *f*fceiling } / { *f*truncate | *f*ftruncate } *n* [*d*1])
▷ Return as **integer** or **float**, respectively, *n*/*d* rounded, or rounded towards $-\infty$, $+\infty$, or 0, respectively; and remainder.

({ *f*mod / *f*rem } *n* *d*)
▷ Same as *f*floor or *f*truncate, respectively, but return remainder only.

(*f*random *limit* [*state*v*random-state*])
▷ Return non-negative random number less than *limit*, and of the same type.

(*f*make-random-state [{*state* | NIL | T}NIL])
▷ Copy of **random-state** object *state* or of the current random state; or a randomly initialized fresh random state.

v*random-state* ▷ Current random state.

(*f*float-sign *num-a* [*num-b*1]) ▷ *num-b* with *num-a*'s sign.

(*f*signum *n*)
▷ Number of magnitude 1 representing sign or phase of *n*.

(*f*numerator *rational*)
(*f*denominator *rational*)
▷ Numerator or denominator, respectively, of *rational*'s canonical form.

(*f*realpart *number*)
(*f*imagpart *number*)
▷ Real part or imaginary part, respectively, of *number*.

(*f*complex *real* [*imag*0]) ▷ Make a complex number.

(*f*phase *num*) ▷ Angle of *num*'s polar representation.

(*f*abs *n*) ▷ Return $|n|$.

(*f*rational *real*)
(*f*rationalize *real*)
▷ Convert *real* to rational. Assume complete/limited accuracy for *real*.

(*f*float *real* [*prototype*0.0F0])
▷ Convert *real* into float with type of *prototype*.

1.3 Logic Functions

Negative integers are used in two's complement representation.

(*f*boole *operation* *int-a* *int-b*)
▷ Return value of bitwise logical *operation*. *operation*s are

c**boole-1**	▷ *int-a*.
c**boole-2**	▷ *int-b*.
c**boole-c1**	▷ ¬*int-a*.
c**boole-c2**	▷ ¬*int-b*.
c**boole-set**	▷ All bits set.
c**boole-clr**	▷ All bits zero.

($_c$**boole-eqv** ▷ $int\text{-}a \equiv int\text{-}b$.
$_c$**boole-and** ▷ $int\text{-}a \wedge int\text{-}b$.
$_c$**boole-andc1** ▷ $\neg int\text{-}a \wedge int\text{-}b$.
$_c$**boole-andc2** ▷ $int\text{-}a \wedge \neg int\text{-}b$.
$_c$**boole-nand** ▷ $\neg(int\text{-}a \wedge int\text{-}b)$.
$_c$**boole-ior** ▷ $int\text{-}a \vee int\text{-}b$.
$_c$**boole-orc1** ▷ $\neg int\text{-}a \vee int\text{-}b$.
$_c$**boole-orc2** ▷ $int\text{-}a \vee \neg int\text{-}b$.
$_c$**boole-xor** ▷ $\neg(int\text{-}a \equiv int\text{-}b)$.
$_c$**boole-nor** ▷ $\neg(int\text{-}a \vee int\text{-}b)$.

($_f$**lognot** *integer*) ▷ $\neg integer$.

($_f$**logeqv** *integer**)
($_f$**logand** *integer**)
▷ Return value of exclusive-nored or anded *integer*s, respectively. Without any *integer*, return -1.

($_f$**logandc1** *int-a int-b*) ▷ $\neg int\text{-}a \wedge int\text{-}b$.

($_f$**logandc2** *int-a int-b*) ▷ $int\text{-}a \wedge \neg int\text{-}b$.

($_f$**lognand** *int-a int-b*) ▷ $\neg(int\text{-}a \wedge int\text{-}b)$.

($_f$**logxor** *integer**)
($_f$**logior** *integer**)
▷ Return value of exclusive-ored or ored *integer*s, respectively. Without any *integer*, return 0.

($_f$**logorc1** *int-a int-b*) ▷ $\neg int\text{-}a \vee int\text{-}b$.

($_f$**logorc2** *int-a int-b*) ▷ $int\text{-}a \vee \neg int\text{-}b$.

($_f$**lognor** *int-a int-b*) ▷ $\neg(int\text{-}a \vee int\text{-}b)$.

($_f$**logbitp** *i int*) ▷ T if zero-indexed ith bit of *int* is set.

($_f$**logtest** *int-a int-b*)
▷ Return T if there is any bit set in *int-a* which is set in *int-b* as well.

($_f$**logcount** *int*)
▷ Number of 1 bits in $int \geq 0$, number of 0 bits in $int < 0$.

1.4 Integer Functions

($_f$**integer-length** *integer*)
▷ Number of bits necessary to represent *integer*.

($_f$**ldb-test** *byte-spec integer*)
▷ Return T if any bit specified by *byte-spec* in *integer* is set.

($_f$**ash** *integer count*)
▷ Return copy of *integer* arithmetically shifted left by *count* adding zeros at the right, or, for $count < 0$, shifted right discarding bits.

($_f$**ldb** *byte-spec integer*)
▷ Extract byte denoted by *byte-spec* from *integer*. **setf**able.

($\left\{\begin{matrix}{}_f\textbf{deposit-field}\\ {}_f\textbf{dpb}\end{matrix}\right\}$ *int-a byte-spec int-b*)
▷ Return *int-b* with bits denoted by *byte-spec* replaced by corresponding bits of *int-a*, or by the low ($_f$**byte-size** *byte-spec*) bits of *int-a*, respectively.

($_f$**mask-field** *byte-spec integer*)
▷ Return copy of *integer* with all bits unset but those denoted by *byte-spec*. **setf**able.

($_f$**byte** *size position*)
▷ Byte specifier for a byte of *size* bits starting at a weight of $2^{position}$.

($_f$**byte-size** *byte-spec*)
($_f$**byte-position** *byte-spec*)
▷ Size or position, respectively, of *byte-spec*.

1.5 Implementation-Dependent

$_c$**short-float**, $_c$**single-float**, $_c$**double-float**, $_c$**long-float** – **epsilon**, **negative-epsilon**
▷ Smallest possible number making a difference when added or subtracted, respectively.

$_c$**least-negative**, $_c$**least-negative-normalized**, $_c$**least-positive**, $_c$**least-positive-normalized** – **short-float**, **single-float**, **double-float**, **long-float**
▷ Available numbers closest to -0 or $+0$, respectively.

$_c$**most-negative**, $_c$**most-positive** – **short-float**, **single-float**, **double-float**, **long-float**, **fixnum**
▷ Available numbers closest to $-\infty$ or $+\infty$, respectively.

($_f$**decode-float** *n*)
($_f$**integer-decode-float** *n*)
▷ Return significand$_2$, exponent, and sign$_3$ of **float** *n*.

($_f$**scale-float** *n* [*i*]) ▷ With *n*'s radix *b*, return nb^i.

($_f$**float-radix** *n*)
($_f$**float-digits** *n*)
($_f$**float-precision** *n*)
▷ Radix, number of digits in that radix, or precision in that radix, respectively, of float *n*.

($_f$**upgraded-complex-part-type** *foo* [*environment*`NIL`])
▷ Type of most specialized **complex** number able to hold parts of type *foo*.

2 Characters

The **standard-char** type comprises `a-z`, `A-Z`, `0-9`, `Newline`, `Space`, and `!?$"'‘.:,;*+-/|\~_^<=>#%@&()[]{}`.

($_f$**characterp** *foo*)
($_f$**standard-char-p** *char*)
▷ `T` if argument is of indicated type.

($_f$**graphic-char-p** *character*)
($_f$**alpha-char-p** *character*)
($_f$**alphanumericp** *character*)
▷ `T` if *character* is visible, alphabetic, or alphanumeric, respectively.

($_f$**upper-case-p** *character*)
($_f$**lower-case-p** *character*)
($_f$**both-case-p** *character*)
▷ Return `T` if *character* is uppercase, lowercase, or able to be in another case, respectively.

($_f$**digit-char-p** *character* [*radix*`10`])
▷ Return its weight if *character* is a digit, or `NIL` otherwise.

($_f$**char=** *character*$^+$)
($_f$**char/=** *character*$^+$)
▷ Return `T` if all *character*s, or none, respectively, are equal.

($_f$**char-equal** *character*$^+$)
($_f$**char-not-equal** *character*$^+$)
▷ Return `T` if all *character*s, or none, respectively, are equal ignoring case.

($_f$**char>** *character*$^+$)
($_f$**char>=** *character*$^+$)
($_f$**char<** *character*$^+$)
($_f$**char<=** *character*$^+$)
▷ Return `T` if *character*s are monotonically decreasing, monotonically non-increasing, monotonically increasing, or monotonically non-decreasing, respectively.

(*f* **char-greaterp** *character*$^+$)
(*f* **char-not-lessp** *character*$^+$)
(*f* **char-lessp** *character*$^+$)
(*f* **char-not-greaterp** *character*$^+$)
▷ Return `T` if *characters* are monotonically decreasing, monotonically non-increasing, monotonically increasing, or monotonically non-decreasing, respectively, ignoring case.

(*f* **char-upcase** *character*)
(*f* **char-downcase** *character*)
▷ Return corresponding uppercase/lowercase character, respectively.

(*f* **digit-char** *i* [*radix*10]) ▷ Character representing digit *i*.

(*f* **char-name** *char*) ▷ *char*'s name if any, or `NIL`.

(*f* **name-char** *foo*) ▷ Character named *foo* if any, or `NIL`.

(*f* **char-int** *character*)
(*f* **char-code** *character*) ▷ Code of *character*.

(*f* **code-char** *code*) ▷ Character with *code*.

c **char-code-limit** ▷ Upper bound of (*f* **char-code** *char*); ≥ 96.

(*f* **character** *c*) ▷ Return `#\`*c*.

3 Strings

Strings can as well be manipulated by array and sequence functions; see pages 10 and 12.

(*f* **stringp** *foo*)
(*f* **simple-string-p** *foo*) ▷ `T` if *foo* is of indicated type.

({*f* **string=** / *f* **string-equal**} *foo bar* { **:start1** *start-foo*0 / **:start2** *start-bar*0 / **:end1** *end-foo*NIL / **:end2** *end-bar*NIL })
▷ Return `T` if subsequences of *foo* and *bar* are equal. Obey/ignore, respectively, case.

({ *f* **string**{/= | **-not-equal**} / *f* **string**{> | **-greaterp**} / *f* **string**{>= | **-not-lessp**} / *f* **string**{< | **-lessp**} / *f* **string**{<= | **-greaterp**} } *foo bar* { **:start1** *start-foo*0 / **:start2** *start-bar*0 / **:end1** *end-foo*NIL / **:end2** *end-bar*NIL })
▷ If *foo* is lexicographically not equal, greater, not less, less, or not greater, respectively, then return position of first mismatching character in *foo*. Otherwise return `NIL`. Obey/ignore, respectively, case.

(*f* **make-string** *size* { **:initial-element** *char* / **:element-type** *type*character })
▷ Return string of length *size*.

(*f* **string** *x*)
({ *f* **string-capitalize** / *f* **string-upcase** / *f* **string-downcase** } *x* { **:start** *start*0 / **:end** *end*NIL })
▷ Convert *x* (**symbol**, **string**, or **character**) into a string, a string with capitalized words, an all-uppercase string, or an all-lowercase string, respectively.

({ *f* **nstring-capitalize** / *f* **nstring-upcase** / *f* **nstring-downcase** } $\widetilde{\textit{string}}$ { **:start** *start*0 / **:end** *end*NIL })
▷ Convert *string* into a string with capitalized words, an all-uppercase string, or an all-lowercase string, respectively.

({ *f* **string-trim** / *f* **string-left-trim** / *f* **string-right-trim** } *char-bag string*)
▷ Return *string* with all characters in sequence *char-bag* removed from both ends, from the beginning, or from the end, respectively.

(*f*char *string i*)
(*f*schar *string i*)
▷ Return zero-indexed *i*th character of string ignoring/obeying, respectively, fill pointer. setfable.

(*f*parse-integer *string* { :start *start*0 | :end *end*NIL | :radix *int*10 | :junk-allowed *bool*NIL })
▷ Return integer parsed from *string* and index of parse end.2

4 Conses

4.1 Predicates

(*f*consp *foo*)
(*f*listp *foo*) ▷ Return T if *foo* is of indicated type.

(*f*endp *list*)
(*f*null *foo*) ▷ Return T if *list*/*foo* is NIL.

(*f*atom *foo*) ▷ Return T if *foo* is not a cons.

(*f*tailp *foo list*) ▷ Return T if *foo* is a tail of *list*.

(*f*member *foo list* { :test *function*#'eql | :test-not *function* | :key *function* })
▷ Return tail of *list* starting with its first element matching *foo*. Return NIL if there is no such element.

({*f*member-if | *f*member-if-not} *test list* [:key *function*])
▷ Return tail of *list* starting with its first element satisfying *test*. Return NIL if there is no such element.

(*f*subsetp *list-a list-b* { :test *function*#'eql | :test-not *function* | :key *function* })
▷ Return T if *list-a* is a subset of *list-b*.

4.2 Lists

(*f*cons *foo bar*) ▷ Return new cons (*foo* . *bar*).

(*f*list *foo**) ▷ Return list of *foo*s.

(*f*list* *foo*+)
▷ Return list of *foo*s with last *foo* becoming cdr of last cons. Return *foo* if only one *foo* given.

(*f*make-list *num* [:initial-element *foo*NIL])
▷ New list with *num* elements set to *foo*.

(*f*list-length *list*) ▷ Length of *list*; NIL for circular *list*.

(*f*car *list*) ▷ Car of *list* or NIL if *list* is NIL. setfable.

(*f*cdr *list*)
(*f*rest *list*) ▷ Cdr of *list* or NIL if *list* is NIL. setfable.

(*f*nthcdr *n list*) ▷ Return tail of *list* after calling *f*cdr *n* times.

({*f*first|*f*second|*f*third|*f*fourth|*f*fifth|*f*sixth|...|*f*ninth|*f*tenth} *list*)
▷ Return nth element of *list* if any, or NIL otherwise. setfable.

(*f*nth *n list*) ▷ Zero-indexed nth element of *list*. setfable.

(*f*c*X*r *list*)
▷ With *X* being one to four as and ds representing *f*cars and *f*cdrs, e.g. (*f*cadr *bar*) is equivalent to (*f*car (*f*cdr *bar*)). setfable.

(*f*last *list* [*num*1]) ▷ Return list of last *num* conses of *list*.

($_f$**butlast** *list* [*num*$_{1}$]) / ($_f$**nbutlast** *list* [*num*$_{1}$]) ▷ *list* excluding last *num* conses.

($_f$**rplaca** *cons object*) / ($_f$**rplacd** *cons object*)
▷ Replace car, or cdr, respectively, of *cons* with *object*.

($_f$**ldiff** *list foo*)
▷ If *foo* is a tail of *list*, return preceding part of *list*. Otherwise return *list*.

($_f$**adjoin** *foo list* [**:test** *function*$_{\#'\text{eql}}$ | **:test-not** *function* | **:key** *function*])
▷ Return *list* if *foo* is already member of *list*. If not, return ($_f$**cons** *foo list*).

($_m$**pop** *place*)
▷ Set *place* to ($_f$**cdr** *place*), return ($_f$**car** *place*).

($_m$**push** *foo place*) ▷ Set *place* to ($_f$**cons** *foo place*).

($_m$**pushnew** *foo place* [**:test** *function*$_{\#'\text{eql}}$ | **:test-not** *function* | **:key** *function*])
▷ Set *place* to ($_f$**adjoin** *foo place*).

($_f$**append** [*proper-list** *foo*$_{\text{NIL}}$])
($_f$**nconc** [*non-circular-list** *foo*$_{\text{NIL}}$])
▷ Return concatenated list or, with only one argument, *foo*. *foo* can be of any type.

($_f$**revappend** *list foo*)
($_f$**nreconc** *list foo*)
▷ Return concatenated list after reversing order in *list*.

($_f$**mapcar** | $_f$**maplist** *function list*$^+$)
▷ Return list of return values of *function* successively invoked with corresponding arguments, either cars or cdrs, respectively, from each *list*.

($_f$**mapcan** | $_f$**mapcon** *function list*$^+$)
▷ Return list of concatenated return values of *function* successively invoked with corresponding arguments, either cars or cdrs, respectively, from each *list*. *function* should return a list.

($_f$**mapc** | $_f$**mapl** *function list*$^+$)
▷ Return first *list* after successively applying *function* to corresponding arguments, either cars or cdrs, respectively, from each *list*. *function* should have some side effects.

($_f$**copy-list** *list*) ▷ Return copy of *list* with shared elements.

4.3 Association Lists

($_f$**pairlis** *keys values* [*alist*$_{\text{NIL}}$])
▷ Prepend to *alist* an association list made from lists *keys* and *values*.

($_f$**acons** *key value alist*)
▷ Return *alist* with a (*key* **.** *value*) pair added.

($_f$**assoc** | $_f$**rassoc** *foo alist* [**:test** *test*$_{\#'\text{eql}}$ | **:test-not** *test* | **:key** *function*])
($_f$**assoc-if**[**-not**] | $_f$**rassoc-if**[**-not**] *test alist* [**:key** *function*])
▷ First cons whose car, or cdr, respectively, satisfies *test*.

($_f$**copy-alist** *alist*) ▷ Return copy of *alist*.

4.4 Trees

($_f$**tree-equal** *foo bar* {**:test** *test*#'eql | **:test-not** *test*})

▷ Return T if trees *foo* and *bar* have same shape and leaves satisfying *test*.

({$_f$**subst** *new old tree* | $_f$**nsubst** *new old* ~~*tree*~~} {| **:test** *function*#'eql | **:test-not** *function* | **:key** *function*})

▷ Make copy of *tree* with each subtree or leaf matching *old* replaced by *new*.

({$_f$**subst-if**[**-not**] *new test tree* | $_f$**nsubst-if**[**-not**] *new test* ~~*tree*~~} [**:key** *function*])

▷ Make copy of *tree* with each subtree or leaf satisfying *test* replaced by *new*.

({$_f$**sublis** *association-list tree* | $_f$**nsublis** *association-list* ~~*tree*~~} {| **:test** *function*#'eql | **:test-not** *function* | **:key** *function*})

▷ Make copy of *tree* with each subtree or leaf matching a key in *association-list* replaced by that key's value.

($_f$**copy-tree** *tree*)

▷ Copy of *tree* with same shape and leaves.

4.5 Sets

({$_f$**intersection** | $_f$**set-difference** | $_f$**union** | $_f$**set-exclusive-or**} *a b* | {$_f$**nintersection** | $_f$**nset-difference**} $\widetilde{a}$ *b* | {$_f$**nunion** | $_f$**nset-exclusive-or**} $\widetilde{a}$ $\widetilde{b}$ {| **:test** *function*#'eql | **:test-not** *function* | **:key** *function*})

▷ Return $a \cap b$, $a \setminus b$, $a \cup b$, or $a \triangle b$, respectively, of lists a and b.

5 Arrays

5.1 Predicates

($_f$**arrayp** *foo*)
($_f$**vectorp** *foo*)
($_f$**simple-vector-p** *foo*)
($_f$**bit-vector-p** *foo*)
($_f$**simple-bit-vector-p** *foo*)

▷ T if *foo* is of indicated type.

($_f$**adjustable-array-p** *array*)
($_f$**array-has-fill-pointer-p** *array*)

▷ T if *array* is adjustable/has a fill pointer, respectively.

($_f$**array-in-bounds-p** *array* [*subscripts*])

▷ Return T if *subscripts* are in *array*'s bounds.

5.2 Array Functions

({$_f$**make-array** *dimension-sizes* [**:adjustable** *bool*NIL] | $_f$**adjust-array** ~~*array*~~ *dimension-sizes*} {| **:element-type** *type*T | **:fill-pointer** {*num* | *bool*}NIL | {**:initial-element** *obj* | **:initial-contents** *tree-or-array* | **:displaced-to** *array*NIL [**:displaced-index-offset** *i*0]}})

▷ Return fresh, or readjust, respectively, vector or array.

($_f$**aref** *array* [*subscripts*])

▷ Return array element pointed to by *subscripts*. **setf**able.

($_f$**row-major-aref** *array i*)

▷ Return *i*th element of *array* in row-major order. **setf**able.

(*f* **array-row-major-index** *array* [*subscripts*])
▷ Index in row-major order of the element denoted by *subscripts*.

(*f* **array-dimensions** *array*)
▷ List containing the lengths of *array*'s dimensions.

(*f* **array-dimension** *array i*)
▷ Length of *i*th dimension of *array*.

(*f* **array-total-size** *array*) ▷ Number of elements in *array*.

(*f* **array-rank** *array*) ▷ Number of dimensions of *array*.

(*f* **array-displacement** *array*) ▷ Target array and offset.

(*f* **bit** *bit-array* [*subscripts*])
(*f* **sbit** *simple-bit-array* [*subscripts*])
▷ Return element of *bit-array* or of *simple-bit-array*. **setf**able.

(*f* **bit-not** *bit-array* [*result-bit-array*NIL])
▷ Return result of bitwise negation of *bit-array*. If *result-bit-array* is `T`, put result in *bit-array*; if it is `NIL`, make a new array for result.

(*f* {**bit-eqv** | **bit-and** | **bit-andc1** | **bit-andc2** | **bit-nand** | **bit-ior** | **bit-orc1** | **bit-orc2** | **bit-xor** | **bit-nor**} *bit-array-a bit-array-b* [*result-bit-array*NIL])
▷ Return result of bitwise logical operations (cf. operations of *f* **boole**, page 4) on *bit-array-a* and *bit-array-b*. If *result-bit-array* is `T`, put result in *bit-array-a*; if it is `NIL`, make a new array for result.

c **array-rank-limit** ▷ Upper bound of array rank; ≥ 8.

c **array-dimension-limit**
▷ Upper bound of an array dimension; ≥ 1024.

c **array-total-size-limit** ▷ Upper bound of array size; ≥ 1024.

5.3 Vector Functions

Vectors can as well be manipulated by sequence functions; see section 6.

(*f* **vector** *foo**) ▷ Return fresh simple vector of *foo*s.

(*f* **svref** *vector i*) ▷ Element *i* of simple *vector*. **setf**able.

(*f* **vector-push** *foo vector*)
▷ Return `NIL` if *vector*'s fill pointer equals size of *vector*. Otherwise replace element of *vector* pointed to by fill pointer with *foo*; then increment fill pointer.

(*f* **vector-push-extend** *foo vector* [*num*])
▷ Replace element of *vector* pointed to by fill pointer with *foo*, then increment fill pointer. Extend *vector*'s size by $\geq$ *num* if necessary.

(*f* **vector-pop** *vector*)
▷ Return element of *vector* its fillpointer points to after decrementation.

(*f* **fill-pointer** *vector*) ▷ Fill pointer of *vector*. **setf**able.

6 Sequences

6.1 Sequence Predicates

($_f$ **every** / **notevery** *test sequence*$^+$)
▷ Return NIL or T, respectively, as soon as *test* on any set of corresponding elements of *sequence*s returns NIL.

($_f$ **some** / **notany** *test sequence*$^+$)
▷ Return value of *test* or NIL, respectively, as soon as *test* on any set of corresponding elements of *sequence*s returns non-NIL.

($_f$ **mismatch** *sequence-a sequence-b* { **:from-end** *bool*$_{NIL}$ | { **:test** *function*$_{\#'eql}$ | **:test-not** *function* } | **:start1** *start-a*$_0$ | **:start2** *start-b*$_0$ | **:end1** *end-a*$_{NIL}$ | **:end2** *end-b*$_{NIL}$ | **:key** *function* })
▷ Return position in *sequence-a* where *sequence-a* and *sequence-b* begin to mismatch. Return NIL if they match entirely.

6.2 Sequence Functions

($_f$ **make-sequence** *sequence-type size* [**:initial-element** *foo*])
▷ Make sequence of *sequence-type* with *size* elements.

($_f$ **concatenate** *type sequence**)
▷ Return concatenated sequence of *type*.

($_f$ **merge** *type* $\widetilde{sequence}$*-a* $\widetilde{sequence}$*-b test* [**:key** *function*$_{NIL}$])
▷ Return interleaved sequence of *type*. Merged sequence will be sorted if both *sequence-a* and *sequence-b* are sorted.

($_f$ **fill** $\widetilde{sequence}$ *foo* { **:start** *start*$_0$ | **:end** *end*$_{NIL}$ })
▷ Return *sequence* after setting elements between *start* and *end* to *foo*.

($_f$ **length** *sequence*)
▷ Return length of *sequence* (being value of fill pointer if applicable).

($_f$ **count** *foo sequence* { **:from-end** *bool*$_{NIL}$ | { **:test** *function*$_{\#'eql}$ | **:test-not** *function* } | **:start** *start*$_0$ | **:end** *end*$_{NIL}$ | **:key** *function* })
▷ Return number of elements in *sequence* which match *foo*.

($_f$ **count-if** / **count-if-not** *test sequence* { **:from-end** *bool*$_{NIL}$ | **:start** *start*$_0$ | **:end** *end*$_{NIL}$ | **:key** *function* })
▷ Return number of elements in *sequence* which satisfy *test*.

($_f$ **elt** *sequence index*)
▷ Return element of *sequence* pointed to by zero-indexed *index*. **setf**able.

($_f$ **subseq** *sequence start* [*end*$_{NIL}$])
▷ Return subsequence of *sequence* between *start* and *end*. **setf**able.

($_f$ **sort** / **stable-sort** $\widetilde{sequence}$ *test* [**:key** *function*])
▷ Return *sequence* sorted. Order of elements considered equal is not guaranteed/retained, respectively.

($_f$ **reverse** *sequence*)
($_f$ **nreverse** $\widetilde{sequence}$)
▷ Return *sequence* in reverse order.

(f**find** / f**position** *foo sequence* [**:from-end** *bool*NIL | [**:test** *function*#'eql | **:test-not** *test*] | **:start** *start*0 | **:end** *end*NIL | **:key** *function*])

▷ Return first element in *sequence* which matches *foo*, or its position relative to the begin of *sequence*, respectively.

(f**find-if** / f**find-if-not** / f**position-if** / f**position-if-not** *test sequence* [**:from-end** *bool*NIL | **:start** *start*0 | **:end** *end*NIL | **:key** *function*])

▷ Return first element in *sequence* which satisfies *test*, or its position relative to the begin of *sequence*, respectively.

(f**search** *sequence-a sequence-b* [**:from-end** *bool*NIL | [**:test** *function*#'eql | **:test-not** *function*] | **:start1** *start-a*0 | **:start2** *start-b*0 | **:end1** *end-a*NIL | **:end2** *end-b*NIL | **:key** *function*])

▷ Search *sequence-b* for a subsequence matching *sequence-a*. Return position in *sequence-b*, or NIL.

(f**remove** *foo sequence* / f**delete** *foo sequence* [**:from-end** *bool*NIL | [**:test** *function*#'eql | **:test-not** *function*] | **:start** *start*0 | **:end** *end*NIL | **:key** *function* | **:count** *count*NIL])

▷ Make copy of *sequence* without elements matching *foo*.

(f**remove-if** / f**remove-if-not** / f**delete-if** / f**delete-if-not** *test sequence* / *test sequence* [**:from-end** *bool*NIL | **:start** *start*0 | **:end** *end*NIL | **:key** *function* | **:count** *count*NIL])

▷ Make copy of *sequence* with all (or *count*) elements satisfying *test* removed.

(f**remove-duplicates** *sequence* / f**delete-duplicates** *sequence* [**:from-end** *bool*NIL | [**:test** *function*#'eql | **:test-not** *function*] | **:start** *start*0 | **:end** *end*NIL | **:key** *function*])

▷ Make copy of *sequence* without duplicates.

(f**substitute** *new old sequence* / f**nsubstitute** *new old sequence* [**:from-end** *bool*NIL | [**:test** *function*#'eql | **:test-not** *function*] | **:start** *start*0 | **:end** *end*NIL | **:key** *function* | **:count** *count*NIL])

▷ Make copy of *sequence* with all (or *count*) *old*s replaced by *new*.

(f**substitute-if** / f**substitute-if-not** / f**nsubstitute-if** / f**nsubstitute-if-not** *new test sequence* / *new test sequence* [**:from-end** *bool*NIL | **:start** *start*0 | **:end** *end*NIL | **:key** *function* | **:count** *count*NIL])

▷ Make copy of *sequence* with all (or *count*) elements satisfying *test* replaced by *new*.

(*f*replace *sequence-a sequence-b* { :start1 *start-a*0 | :start2 *start-b*0 | :end1 *end-a*NIL | :end2 *end-b*NIL })
▷ Replace elements of *sequence-a* with elements of *sequence-b*.

(*f*map *type function sequence*+)
▷ Apply *function* successively to corresponding elements of the *sequences*. Return values as a sequence of *type*. If *type* is NIL, return NIL.

(*f*map-into *result-sequence function sequence**)
▷ Store into *result-sequence* successively values of *function* applied to corresponding elements of the *sequences*.

(*f*reduce *function sequence* { :initial-value *foo*NIL | :from-end *bool*NIL | :start *start*0 | :end *end*NIL | :key *function* })
▷ Starting with the first two elements of *sequence*, apply *function* successively to its last return value together with the next element of *sequence*. Return last value of function.

(*f*copy-seq *sequence*)
▷ Copy of *sequence* with shared elements.

7 Hash Tables

The Loop Facility provides additional hash table-related functionality; see **loop**, page 21.

Key-value storage similar to hash tables can as well be achieved using association lists and property lists; see pages 9 and 16.

(*f*hash-table-p *foo*) ▷ Return T if *foo* is of type **hash-table**.

(*f*make-hash-table { :test {*f*eq | *f*eql | *f*equal | *f*equalp}#'eql | :size *int* | :rehash-size *num* | :rehash-threshold *num* })
▷ Make a hash table.

(*f*gethash *key hash-table* [*default*NIL])
▷ Return object with *key* if any or *default* otherwise; and T if found, NIL otherwise. **setf**able.
2

(*f*hash-table-count *hash-table*)
▷ Number of entries in *hash-table*.

(*f*remhash *key hash-table*)
▷ Remove from *hash-table* entry with *key* and return T if it existed. Return NIL otherwise.

(*f*clrhash *hash-table*) ▷ Empty *hash-table*.

(*f*maphash *function hash-table*)
▷ Iterate over *hash-table* calling *function* on key and value. Return NIL.

(*m*with-hash-table-iterator (*foo hash-table*) (**declare** *decl**)* *form*P*)
▷ Return values of *forms*. In *forms*, invocations of (*foo*) return: T if an entry is returned; its key; its value.

(*f*hash-table-test *hash-table*)
▷ Test function used in *hash-table*.

(*f*hash-table-size *hash-table*)
(*f*hash-table-rehash-size *hash-table*)
(*f*hash-table-rehash-threshold *hash-table*)
▷ Current size, rehash-size, or rehash-threshold, respectively, as used in *f*make-hash-table.

(*f*sxhash *foo*)
▷ Hash code unique for any argument *f*equal *foo*.

8 Structures

($_m$**defstruct**
$$\left\{\begin{array}{l} foo \\ \left\{\left|\begin{array}{l} \left\{\begin{array}{l}\textbf{:conc-name}\\(\textbf{:conc-name}\ [\widehat{slot\text{-}prefix}_{\boxed{foo\text{-}}}])\end{array}\right. \\ \left\{\begin{array}{l}\textbf{:constructor}\\(\textbf{:constructor}\ [\widehat{maker}_{\boxed{\texttt{MAKE-}foo}}\ [(\widehat{ord\text{-}\lambda}^*)]])\end{array}\right\}^* \\ \left\{\begin{array}{l}\textbf{:copier}\\(\textbf{:copier}\ [\widehat{copier}_{\boxed{\texttt{COPY-}foo}}])\end{array}\right. \\ (\textbf{:include}\ \widehat{struct}\ \left\{\begin{array}{l}\widehat{slot}\\(\widehat{slot}\ [init\ \left\{\begin{array}{l}\textbf{:type}\ \widehat{sl\text{-}type}\\\textbf{:read-only}\ \widehat{b}\end{array}\right\}])\end{array}\right\}^*) \\ \left\{\begin{array}{l}(\textbf{:type}\ \left\{\begin{array}{l}\textbf{list}\\\textbf{vector}\\(\textbf{vector}\ \widehat{type})\end{array}\right\})\ \left\{\begin{array}{l}\textbf{:named}\\(\textbf{:initial-offset}\ \widehat{n})\end{array}\right.\end{array}\right. \\ \left\{\begin{array}{l}(\textbf{:print-object}\ [\widehat{o\text{-}printer}])\\(\textbf{:print-function}\ [\widehat{f\text{-}printer}])\end{array}\right. \\ \left\{\begin{array}{l}\textbf{:predicate}\\(\textbf{:predicate}\ [\widehat{p\text{-}name}_{\boxed{foo\text{-}P}}])\end{array}\right.\end{array}\right.\right\}\end{array}\right\}$$
$$[\widehat{doc}]\ \left\{\begin{array}{l}slot\\(slot\ [init\ \left\{\left|\begin{array}{l}\textbf{:type}\ \widehat{slot\text{-}type}\\\textbf{:read-only}\ \widehat{bool}\end{array}\right.\right\}])\end{array}\right\}^*)$$

▷ Define structure *foo* together with functions `MAKE-`*foo*, `COPY-`*foo* and *foo*`-P`; and **setf**able accessors *foo*`-`*slot*. Instances are of class *foo* or, if **defstruct** option **:type** is given, of the specified type. They can be created by (`MAKE-`*foo* {**:**_slot_ _value_}*) or, if *ord*-λ (see page 17) is given, by (*maker arg** {**:**_key_ _value_}*). In the latter case, *arg*s and **:***key*s correspond to the positional and keyword parameters defined in *ord*-λ whose *var*s in turn correspond to *slot*s. **:print-object**/**:print-function** generate a $_g$**print-object** method for an instance *bar* of *foo* calling (*o-printer bar stream*) or (*f-printer bar stream print-level*), respectively. If **:type** without **:named** is given, no *foo*`-P` is created.

($_f$**copy-structure** *structure*)
▷ Return copy of *structure* with shared slot values.

9 Control Structure

9.1 Predicates

($_f$**eq** *foo bar*) ▷ `T` if *foo* and *bar* are identical.

($_f$**eql** *foo bar*)
▷ `T` if *foo* and *bar* are identical, or the same **character**, or **number**s of the same type and value.

($_f$**equal** *foo bar*)
▷ `T` if *foo* and *bar* are $_f$**eql**, or are equivalent **pathname**s, or are **cons**es with $_f$**equal** cars and cdrs, or are **string**s or **bit-vector**s with $_f$**eql** elements below their fill pointers.

($_f$**equalp** *foo bar*)
▷ `T` if *foo* and *bar* are identical; or are the same **character** ignoring case; or are **number**s of the same value ignoring type; or are equivalent **pathname**s; or are **cons**es or **array**s of the same shape with $_f$**equalp** elements; or are structures of the same type with $_f$**equalp** elements; or are **hash-table**s of the same size with the same **:test** function, the same keys in terms of **:test** function, and $_f$**equalp** elements.

($_f$**not** *foo*) ▷ `T` if *foo* is `NIL`; `NIL` otherwise.

($_f$**boundp** *symbol*) ▷ `T` if *symbol* is a special variable.

($_f$**constantp** *foo* [*environment*$_{\boxed{\texttt{NIL}}}$])
▷ `T` if *foo* is a constant form.

($_f$**functionp** *foo*) ▷ `T` if *foo* is of type **function**.

(*f* **fboundp** {*foo* | (**setf** *foo*)})
▷ T if *foo* is a global function or macro.

9.2 Variables

({*m* **defconstant** | *m* **defparameter**} *foo* *form* [*doc*])
▷ Assign value of *form* to global constant/dynamic variable *foo*.

(*m* **defvar** *foo* [*form* [*doc*]])
▷ Unless bound already, assign value of *form* to dynamic variable *foo*.

({*m* **setf** | *m* **psetf**} {*place* *form*}*)
▷ Set *place*s to primary values of *form*s. Return values of last *form*/NIL; work sequentially/in parallel, respectively.

({*s* **setq** | *m* **psetq**} {*symbol* *form*}*)
▷ Set *symbol*s to primary values of *form*s. Return value of last *form*/NIL; work sequentially/in parallel, respectively.

(*f* **set** *symbol* *foo*)
▷ Set *symbol*'s value cell to *foo*. Deprecated.

(*m* **multiple-value-setq** *vars* *form*)
▷ Set elements of *vars* to the values of *form*. Return *form*'s primary value.

(*m* **shiftf** *place*+ *foo*)
▷ Store value of *foo* in rightmost *place* shifting values of *place*s left, returning first *place*.

(*m* **rotatef** *place**)
▷ Rotate values of *place*s left, old first becoming new last *place*'s value. Return NIL.

(*f* **makunbound** *foo*) ▷ Delete special variable *foo* if any.

(*f* **get** *symbol* *key* [*default*NIL])
(*f* **getf** *place* *key* [*default*NIL])
▷ First entry *key* from property list stored in *symbol*/in *place*, respectively, or *default* if there is no *key*. **setf**able.

(*f* **get-properties** *property-list* *keys*)
▷ Return key and value of first entry from *property-list* matching a key from *keys*, and tail of *property-list* starting with that key. Return NIL, NIL (2), and NIL (3) if there was no matching key in *property-list*.

(*f* **remprop** *symbol* *key*)
(*m* **remf** *place* *key*)
▷ Remove first entry *key* from property list stored in *symbol*/in *place*, respectively. Return T if *key* was there, or NIL otherwise.

(*s* **progv** *symbols* *values* *form*P*)
▷ Evaluate *form*s with locally established dynamic bindings of *symbols* to *values* or NIL. Return values of *form*s.

({*s* **let** | *s* **let***} ({*name* | (*name* [*value*NIL])}*) (**declare** *decl**)* *form*P*)
▷ Evaluate *form*s with *name*s lexically bound (in parallel or sequentially, respectively) to *value*s. Return values of *form*s.

(*m* **multiple-value-bind** (*var**) *values-form* (**declare** *decl**)* *body-form*P*)
▷ Evaluate *body-form*s with *var*s lexically bound to the return values of *values-form*. Return values of *body-form*s.

(*m*__destructuring-bind__ *destruct-λ bar* (__declare__ $\widehat{decl^*}$)* *form*^{P*})
▷ Evaluate *form*s with variables from tree *destruct-λ* bound to corresponding elements of tree *bar*, and return their values. *destruct-λ* resembles *macro-λ* (section 9.4), but without any **&environment** clause.

9.3 Functions

Below, ordinary lambda list (*ord-λ**) has the form
(*var** [__&optional__ {*var* | (*var* [*init*$_{\texttt{NIL}}$ [*supplied-p*]])}*] [__&rest__ *var*]
[__&key__ {*var* | ({*var* | (__:__*key var*)} [*init*$_{\texttt{NIL}}$ [*supplied-p*]])}*]
[__&allow-other-keys__] [__&aux__ {*var* | (*var* [*init*$_{\texttt{NIL}}$])}*]).

supplied-p is **T** if there is a corresponding argument. *init* forms can refer to any *init* and *supplied-p* to their left.

({*m*__defun__ | *m*__lambda__} {*foo* (*ord-λ**) | (__setf__ *foo*)} (*new-value ord-λ**) (__declare__ $\widehat{decl^*}$)* [$\widehat{doc}$] *form*^{P*})
▷ Define a function named *foo* or (__setf__ *foo*), or an anonymous function, respectively, which applies *form*s to *ord-λ*s. For *m*__defun__, *form*s are enclosed in an implicit *s*__block__ named *foo*.

({*s*__flet__ | *s*__labels__} (({*foo* (*ord-λ**) | (__setf__ *foo*) (*new-value ord-λ**)} (__declare__ $\widehat{local\text{-}decl^*}$)* [$\widehat{doc}$] *local-form*^{P*})*) (__declare__ $\widehat{decl^*}$)* *form*^{P*})
▷ Evaluate *form*s with locally defined functions *foo*. Globally defined functions of the same name are shadowed. Each *foo* is also the name of an implicit *s*__block__ around its corresponding *local-form**. Only for *s*__labels__, functions *foo* are visible inside *local-forms*. Return values of *form*s.

(*s*__function__ {*foo* | (*m*__lambda__ *form**)})
▷ Return lexically innermost function named *foo* or a lexical closure of the *m*__lambda__ expression.

(*f*__apply__ {*function* | (__setf__ *function*)} *arg** *args*)
▷ Values of *function* called with *arg*s and the list elements of *args*. **setf**able if *function* is one of *f*__aref__, *f*__bit__, and *f*__sbit__.

(*f*__funcall__ *function* arg*)
▷ Values of *function* called with *arg*s.

(*s*__multiple-value-call__ *function form**)
▷ Call *function* with all the values of each *form* as its arguments. Return values returned by *function*.

(*f*__values-list__ *list*) ▷ Return elements of *list*.

(*f*__values__ *foo**)
▷ Return as multiple values the primary values of the *foo*s. **setf**able.

(*f*__multiple-value-list__ *form*) ▷ List of the values of *form*.

(*m*__nth-value__ *n form*)
▷ Zero-indexed *n*th return value of *form*.

(*f*__complement__ *function*)
▷ Return new function with same arguments and same side effects as *function*, but with complementary truth value.

(*f*__constantly__ *foo*)
▷ Function of any number of arguments returning *foo*.

(*f*__identity__ *foo*) ▷ Return *foo*.

(*f* **function-lambda-expression** *function*)
▷ If available, return lambda expression of *function*, NIL if *function* was defined in an environment without bindings, and name of *function*.

(*f* **fdefinition** $\begin{Bmatrix} foo \\ (\textbf{setf}\ foo) \end{Bmatrix}$)
▷ Definition of global function *foo*. **setf**able.

(*f* **fmakunbound** *foo*)
▷ Remove global function or macro definition *foo*.

c **call-arguments-limit**
c **lambda-parameters-limit**
▷ Upper bound of the number of function arguments or lambda list parameters, respectively; ≥ 50.

c **multiple-values-limit**
▷ Upper bound of the number of values a multiple value can have; ≥ 20.

9.4 Macros

Below, macro lambda list (*macro-λ**) has the form of either

([**&whole** *var*] [*E*] $\begin{Bmatrix} var \\ (macro\text{-}\lambda^*) \end{Bmatrix}^*$ [*E*]
[**&optional** $\begin{Bmatrix} var \\ (\begin{Bmatrix} var \\ (macro\text{-}\lambda^*) \end{Bmatrix}) \end{Bmatrix}$ [*init*NIL [*supplied-p*]])]* [*E*]
[$\begin{Bmatrix} \textbf{\&rest} \\ \textbf{\&body} \end{Bmatrix}$ $\begin{Bmatrix} rest\text{-}var \\ (macro\text{-}\lambda^*) \end{Bmatrix}$] [*E*]
[**&key** $\begin{Bmatrix} var \\ (\begin{Bmatrix} var \\ (\textbf{:}key\ \begin{Bmatrix} var \\ (macro\text{-}\lambda^*) \end{Bmatrix}) \end{Bmatrix}$ [*init*NIL [*supplied-p*]])]* [*E*]
[**&allow-other-keys**]] [**&aux** $\begin{Bmatrix} var \\ (var\ [init_{\texttt{NIL}}]) \end{Bmatrix}^*$] [*E*])
or
([**&whole** *var*] [*E*] $\begin{Bmatrix} var \\ (macro\text{-}\lambda^*) \end{Bmatrix}^*$ [*E*] [**&optional**
$\begin{Bmatrix} var \\ (\begin{Bmatrix} var \\ (macro\text{-}\lambda^*) \end{Bmatrix}) \end{Bmatrix}$ [*init*NIL [*supplied-p*]])]* [*E*] **.** *rest-var*).

One toplevel [*E*] may be replaced by **&environment** *var*. *supplied-p* is T if there is a corresponding argument. *init* forms can refer to any *init* and *supplied-p* to their left.

($\begin{Bmatrix} m\textbf{defmacro} \\ f\textbf{define-compiler-macro} \end{Bmatrix}$ $\begin{Bmatrix} foo \\ (\textbf{setf}\ foo) \end{Bmatrix}$ (*macro-λ**) (**declare** $\widehat{decl^*}$)* [$\widehat{doc}$] $form^{P*}$)
▷ Define macro *foo* which on evaluation as (*foo tree*) applies expanded *forms* to arguments from *tree*, which corresponds to *tree*-shaped *macro-λ*s. *forms* are enclosed in an implicit *s* **block** named *foo*.

(*m* **define-symbol-macro** *foo form*)
▷ Define symbol macro *foo* which on evaluation evaluates expanded *form*.

(*s* **macrolet** ((*foo* (*macro-λ**) (**declare** $\widehat{local\text{-}decl^*}$)* [$\widehat{doc}$] $macro\text{-}form^{P*}$)*) (**declare** $\widehat{decl^*}$)* $form^{P*}$)
▷ Evaluate *forms* with locally defined mutually invisible macros *foo* which are enclosed in implicit *s* **block**s of the same name.

(*s* **symbol-macrolet** ((*foo expansion-form*)*) (**declare** $\widehat{decl^*}$)* $form^{P*}$)
▷ Evaluate *forms* with locally defined symbol macros *foo*.

(*m* **defsetf** $\widehat{function}$
$\begin{Bmatrix} \widehat{updater}\ [\widehat{doc}] \\ (setf\text{-}\lambda^*)\ (s\text{-}var^*)\ (\textbf{declare}\ \widehat{decl^*})^*\ [\widehat{doc}]\ form^{P*} \end{Bmatrix}$)
where defsetf lambda list (*setf-λ**) has the form (*var**

[**&optional** $\left\{\begin{array}{l} var \\ (var\ [init_{\texttt{NIL}}\ [supplied\text{-}p]]) \end{array}\right\}^{*}$] [**&rest** *var*]
[**&key** $\left\{\begin{array}{l} var \\ (\left\{\begin{array}{l} var \\ (\texttt{:}key\ var) \end{array}\right\}\ [init_{\texttt{NIL}}\ [supplied\text{-}p]]) \end{array}\right\}^{*}$
[**&allow-other-keys**]] [**&environment** *var*])
▷ Specify how to **setf** a place accessed by *function*. **Short form:** (**setf** (*function arg**) *value-form*) is replaced by (*updater arg* value-form*); the latter must return *value-form*. **Long form:** on invocation of (**setf** (*function arg**) *value-form*), *form*s must expand into code that sets the place accessed where *setf-λ* and *s-var** describe the arguments of *function* and the value(s) to be stored, respectively; and that returns the value(s) of *s-var**. *form*s are enclosed in an implicit ₛ**block** named *function*.

(ₘ**define-setf-expander** *function* (*macro-λ**) (**declare** $\widehat{decl^*}$)* [$\widehat{doc}$] $form^{P*}$)
▷ Specify how to **setf** a place accessed by *function*. On invocation of (**setf** (*function arg**) *value-form*), *form** must expand into code returning *arg-vars*, *args*, *newval-vars*, *set-form*, and *get-form* as described with ₍f₎**get-setf-expansion** where the elements of macro lambda list *macro-λ** are bound to corresponding *arg*s. *form*s are enclosed in an implicit ₛ**block** named *function*.

(ₓ**get-setf-expansion** *place* [*environment*$_{\texttt{NIL}}$])
▷ Return lists of temporary variables *arg-vars* and of corresponding *args* as given with *place*, list ^{2}*newval-vars* with temporary variables corresponding to the ^{3}new values, and *set-form* and ^{4}*get-form* specifying in terms of *arg-vars* and *newval-vars* ^{5}how to **setf** and how to read *place*.

(ₘ**define-modify-macro** *foo* ([**&optional** $\left\{\begin{array}{l} var \\ (var\ [init_{\texttt{NIL}}\ [supplied\text{-}p]]) \end{array}\right\}^{*}$] [**&rest** *var*]) *function* [$\widehat{doc}$])
▷ Define macro *foo* able to modify a place. On invocation of (*foo place arg**), the value of *function* applied to *place* and *arg*s will be stored into *place* and returned.

₍c₎**lambda-list-keywords**
▷ List of macro lambda list keywords. These are at least:

&whole *var*
▷ Bind *var* to the entire macro call form.

&optional *var**
▷ Bind *var*s to corresponding arguments if any.

{**&rest**|**&body**} *var*
▷ Bind *var* to a list of remaining arguments.

&key *var**
▷ Bind *var*s to corresponding keyword arguments.

&allow-other-keys
▷ Suppress keyword argument checking. Callers can do so using **:allow-other-keys** `T`.

&environment *var*
▷ Bind *var* to the lexical compilation environment.

&aux *var** ▷ Bind *var*s as in ₛ**let∗**.

9.5 Control Flow

(ₛ**if** *test then* [*else*$_{\texttt{NIL}}$])
▷ Return values of *then* if *test* returns `T`; return values of *else* otherwise.

(ₘ**cond** (*test* $then^{P*}_{[test]}$)*)
▷ Return the values of the first *then** whose *test* returns `T`; return `NIL` if all *test*s return `NIL`.

($\left\{\begin{array}{l} {}_{m}\textbf{when} \\ {}_{m}\textbf{unless} \end{array}\right\}$ *test* foo^{P*})
▷ Evaluate *foo*s and return their values if *test* returns `T` or `NIL`, respectively. Return `NIL` otherwise.

($_m$**case** *test* ($\left\{\begin{matrix}(\widehat{key}^*)\\ \widehat{key}\end{matrix}\right\}$ foo^{P*})* [($\left\{\begin{matrix}\textbf{otherwise}\\ \texttt{T}\end{matrix}\right\}$ bar^{P*})$_{\boxed{\texttt{NIL}}}$])

▷ Return the values of the first *foo** one of whose *key*s is **eql** *test*. Return values of *bar*s if there is no matching *key*.

($\left\{\begin{matrix}{}_m\textbf{ecase}\\ {}_m\textbf{ccase}\end{matrix}\right\}$ *test* ($\left\{\begin{matrix}(\widehat{key}^*)\\ \widehat{key}\end{matrix}\right\}$ foo^{P*})*)

▷ Return the values of the first *foo** one of whose *key*s is **eql** *test*. Signal non-correctable/correctable **type-error** if there is no matching *key*.

($_m$**and** $form^*_{\boxed{\texttt{T}}}$)

▷ Evaluate *form*s from left to right. Immediately return NIL if one *form*'s value is NIL. Return values of last *form* otherwise.

($_m$**or** $form^*_{\boxed{\texttt{NIL}}}$)

▷ Evaluate *form*s from left to right. Immediately return primary value of first non-NIL-evaluating form, or all values if last *form* is reached. Return NIL if no *form* returns T.

($_s$**progn** $form^*_{\boxed{\texttt{NIL}}}$)

▷ Evaluate *form*s sequentially. Return values of last *form*.

($_s$**multiple-value-prog1** *form-r* *form**)
($_m$**prog1** *form-r* *form**)
($_m$**prog2** *form-a* *form-r* *form**)

▷ Evaluate forms in order. Return values/primary value, respectively, of *form-r*.

($\left\{\begin{matrix}{}_m\textbf{prog}\\ {}_m\textbf{prog*}\end{matrix}\right\}$ ($\left\{\begin{matrix}name\\ (name\ [value_{\boxed{\texttt{NIL}}}])\end{matrix}\right\}^*$) (**declare** $\widehat{decl}^*$)* $\left\{\begin{matrix}\widehat{tag}\\ form\end{matrix}\right\}^*$)

▷ Evaluate $_s$**tagbody**-like body with *name*s lexically bound (in parallel or sequentially, respectively) to *value*s. Return NIL or explicitly $_m$**return**ed values. Implicitly, the whole form is a $_s$**block** named NIL.

($_s$**unwind-protect** *protected* *cleanup**)

▷ Evaluate *protected* and then, no matter how control leaves *protected*, *cleanup*s. Return values of *protected*.

($_s$**block** *name* $form^{P*}$)

▷ Evaluate *form*s in a lexical environment, and return their values unless interrupted by $_s$**return-from**.

($_s$**return-from** *foo* [$result_{\boxed{\texttt{NIL}}}$])
($_m$**return** [$result_{\boxed{\texttt{NIL}}}$])

▷ Have nearest enclosing $_s$**block** named *foo*/named NIL, respectively, return with values of *result*.

($_s$**tagbody** {$\widehat{tag}$|*form*}*)

▷ Evaluate *form*s in a lexical environment. *tag*s (symbols or integers) have lexical scope and dynamic extent, and are targets for $_s$**go**. Return NIL.

($_s$**go** $\widehat{tag}$)

▷ Within the innermost possible enclosing $_s$**tagbody**, jump to a tag $_f$**eql** *tag*.

($_s$**catch** *tag* $form^{P*}$)

▷ Evaluate *form*s and return their values unless interrupted by $_s$**throw**.

($_s$**throw** *tag* *form*)

▷ Have the nearest dynamically enclosing $_s$**catch** with a tag $_f$**eq** *tag* return with the values of *form*.

($_f$**sleep** *n*) ▷ Wait *n* seconds; return NIL.

9.6 Iteration

($\left\{\begin{matrix}_m\textbf{do}\\ _m\textbf{do*}\end{matrix}\right\}$ ($\left\{\begin{matrix}var\\ (var\ [start\ [step]])\end{matrix}\right\}^*$) (*stop result*^{P*}) (**declare** $\widehat{decl}^*$)* $\left\{\begin{matrix}\widehat{tag}\\ form\end{matrix}\right\}^*$)

▷ Evaluate $_s$**tagbody**-like body with *var*s successively bound according to the values of the corresponding *start* and *step* forms. *var*s are bound in parallel/sequentially, respectively. Stop iteration when *stop* is `T`. Return values of *result**. Implicitly, the whole form is a $_s$**block** named `NIL`.

($_m$**dotimes** (*var i* [*result*$_{\texttt{NIL}}$]) (**declare** $\widehat{decl}^*$)* {$\widehat{tag}$|*form*}*)

▷ Evaluate $_s$**tagbody**-like body with *var* successively bound to integers from 0 to $i-1$. Upon evaluation of *result*, *var* is i. Implicitly, the whole form is a $_s$**block** named `NIL`.

($_m$**dolist** (*var list* [*result*$_{\texttt{NIL}}$]) (**declare** $\widehat{decl}^*$)* {$\widehat{tag}$|*form*}*)

▷ Evaluate $_s$**tagbody**-like body with *var* successively bound to the elements of *list*. Upon evaluation of *result*, *var* is `NIL`. Implicitly, the whole form is a $_s$**block** named `NIL`.

9.7 Loop Facility

($_m$**loop** *form**)

▷ **Simple Loop.** If *form*s do not contain any atomic Loop Facility keywords, evaluate them forever in an implicit $_s$**block** named `NIL`.

($_m$**loop** *clause**)

▷ **Loop Facility.** For Loop Facility keywords see below and Figure 1.

named $n_{\texttt{NIL}}$ ▷ Give $_m$**loop**'s implicit $_s$**block** a name.

{**with** $\left\{\begin{matrix}var\text{-}s\\ (var\text{-}s^*)\end{matrix}\right\}$ [*d-type*] [**=** *foo*]}$^+$

{**and** $\left\{\begin{matrix}var\text{-}p\\ (var\text{-}p^*)\end{matrix}\right\}$ [*d-type*] [**=** *bar*]}*

where destructuring type specifier *d-type* has the form

$\left\{\textbf{fixnum}\left|\textbf{float}\right|\texttt{T}\left|\texttt{NIL}\right|\{\textbf{of-type}\ \left\{\begin{matrix}type\\ (type^*)\end{matrix}\right\}\}\right\}$

▷ Initialize (possibly trees of) local variables *var-s* sequentially and *var-p* in parallel.

{{**for**|**as**} $\left\{\begin{matrix}var\text{-}s\\ (var\text{-}s^*)\end{matrix}\right\}$ [*d-type*]}$^+$ {**and** $\left\{\begin{matrix}var\text{-}p\\ (var\text{-}p^*)\end{matrix}\right\}$ [*d-type*]}*

▷ Begin of iteration control clauses. Initialize and step (possibly trees of) local variables *var-s* sequentially and *var-p* in parallel. Destructuring type specifier *d-type* as with **with**.

{**upfrom**|**from**|**downfrom**} *start*

▷ Start stepping with *start*

{**upto**|**downto**|**to**|**below**|**above**} *form*

▷ Specify *form* as the end value for stepping.

{**in**|**on**} *list*

▷ Bind *var* to successive elements/tails, respectively, of *list*.

by {*step*$_{\boxed{1}}$|*function*$_{\boxed{\#'\texttt{cdr}}}$}

▷ Specify the (positive) decrement or increment or the *function* of one argument returning the next part of the list.

= *foo* [**then** *bar*$_{\boxed{foo}}$]

▷ Bind *var* initially to *foo* and later to *bar*.

across *vector*

▷ Bind *var* to successive elements of *vector*.

being {**the**|**each**}

▷ Iterate over a hash table or a package.

{**hash-key**|**hash-keys**} {**of**|**in**} *hash-table* [**using** (**hash-value** *value*)]

▷ Bind *var* successively to the keys of *hash-table*; bind *value* to corresponding values.

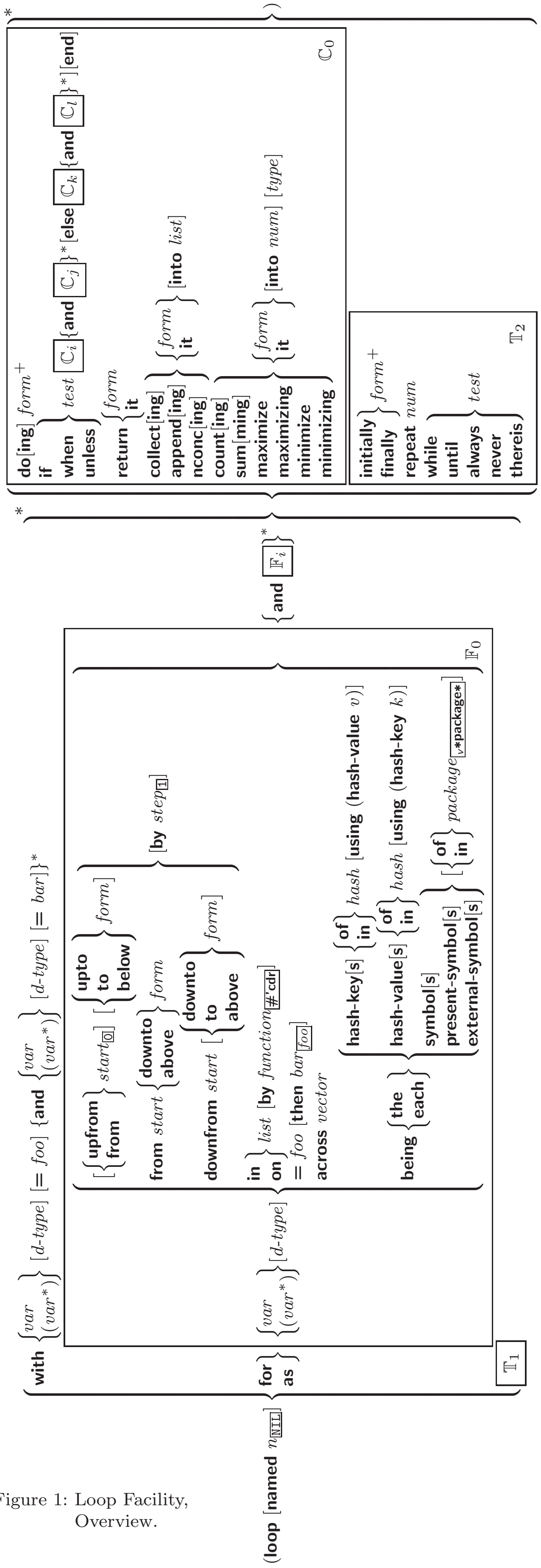

Figure 1: Loop Facility, Overview.

{**hash-value**|**hash-values**} {**of**|**in**} *hash-table* [**using** (**hash-key** *key*)]
▷ Bind *var* successively to the values of *hash-table*; bind *key* to corresponding keys.

{**symbol**|**symbols**|**present-symbol**|**present-symbols**|**external-symbol**|**external-symbols**} [{**of**|**in**} *package*$_{\boxed{v\,*package*}}$]
▷ Bind *var* successively to the accessible symbols, or the present symbols, or the external symbols respectively, of *package*.

{**do**|**doing**} *form*$^+$
▷ Evaluate *form*s in every iteration.

{**if**|**when**|**unless**} *test i-clause* {**and** *j-clause*}* [**else** *k-clause* {**and** *l-clause*}*] [**end**]
▷ If *test* returns `T`, `T`, or `NIL`, respectively, evaluate *i-clause* and *j-clause*s; otherwise, evaluate *k-clause* and *l-clause*s.

it ▷ Inside *i-clause* or *k-clause*: value of *test*.

return {*form*|**it**}
▷ Return immediately, skipping any **finally** parts, with values of *form* or **it**.

{**collect**|**collecting**} {*form*|**it**} [**into** *list*]
▷ Collect values of *form* or **it** into *list*. If no *list* is given, collect into an anonymous list which is returned after termination.

{**append**|**appending**|**nconc**|**nconcing**} {*form*|**it**} [**into** *list*]
▷ Concatenate values of *form* or **it**, which should be lists, into *list* by the means of $_f$**append** or $_f$**nconc**, respectively. If no *list* is given, collect into an anonymous list which is returned after termination.

{**count**|**counting**} {*form*|**it**} [**into** *n*] [*type*]
▷ Count the number of times the value of *form* or of **it** is `T`. If no *n* is given, count into an anonymous variable which is returned after termination.

{**sum**|**summing**} {*form*|**it**} [**into** *sum*] [*type*]
▷ Calculate the sum of the primary values of *form* or of **it**. If no *sum* is given, sum into an anonymous variable which is returned after termination.

{**maximize**|**maximizing**|**minimize**|**minimizing**} {*form*|**it**} [**into** *max-min*] [*type*]
▷ Determine the maximum or minimum, respectively, of the primary values of *form* or of **it**. If no *max-min* is given, use an anonymous variable which is returned after termination.

{**initially**|**finally**} *form*$^+$
▷ Evaluate *form*s before begin, or after end, respectively, of iterations.

repeat *num*
▷ Terminate $_m$**loop** after *num* iterations; *num* is evaluated once.

{**while**|**until**} *test*
▷ Continue iteration until *test* returns `NIL` or `T`, respectively.

{**always**|**never**} *test*
▷ Terminate $_m$**loop** returning `NIL` and skipping any **finally** parts as soon as *test* is `NIL` or `T`, respectively. Otherwise continue $_m$**loop** with its default return value set to `T`.

thereis *test*
▷ Terminate $_m$**loop** when *test* is `T` and return value of *test*, skipping any **finally** parts. Otherwise continue $_m$**loop** with its default return value set to `NIL`.

($_m$**loop-finish**)
▷ Terminate $_m$**loop** immediately executing any **finally** clauses and returning any accumulated results.

10 CLOS

10.1 Classes

(*f* **slot-exists-p** *foo bar*) ▷ T if *foo* has a slot *bar*.

(*f* **slot-boundp** *instance slot*) ▷ T if *slot* in *instance* is bound.

(*m* **defclass** *foo* (*superclass** **standard-object**)
(
{ *slot*
| (*slot* { | {**:reader** *reader*}*
| {**:writer** { *writer* | (**setf** *writer*) }}*
| {**:accessor** *accessor*}*
| **:allocation** { **:instance** | **:class** } **:instance**
| {**:initarg** *:initarg-name*}*
| **:initform** *form*
| **:type** *type*
| **:documentation** *slot-doc* }*
)
{ | (**:default-initargs** {*name value*}*)
| (**:documentation** *class-doc*)
| (**:metaclass** *name* **standard-class**) }
)

▷ Define or modify class *foo* as a subclass of *superclass*es. Transform existing instances, if any, by *g* **make-instances-obsolete**. In a new instance *i* of *foo*, a *slot*'s value defaults to *form* unless set via **:***initarg-name*; it is readable via (*reader i*) or (*accessor i*), and writable via (*writer value i*) or (**setf** (*accessor i*) *value*). *slot*s with **:allocation :class** are shared by all instances of class *foo*.

(*f* **find-class** *symbol* [*errorp* T [*environment*]])
▷ Return class named *symbol*. **setf**able.

(*g* **make-instance** *class* {**:***initarg value*}* *other-keyarg**)
▷ Make new instance of *class*.

(*g* **reinitialize-instance** *instance* {**:***initarg value*}* *other-keyarg**)
▷ Change local slots of *instance* according to *initarg*s by means of *g* **shared-initialize**.

(*f* **slot-value** *foo slot*) ▷ Return value of *slot* in *foo*. **setf**able.

(*f* **slot-makunbound** *instance slot*)
▷ Make *slot* in *instance* unbound.

({ *m* **with-slots** ({*slot* | (*var slot*)}*)
m **with-accessors** ((*var accessor*)*) } *instance* (**declare** *decl**)* *form*P*)
▷ Return values of *form*s after evaluating them in a lexical environment with slots of *instance* visible as **setf**able *slot*s or *var*s/with *accessor*s of *instance* visible as **setf**able *var*s.

(*g* **class-name** *class*)
((**setf** *g* **class-name**) *new-name class*) ▷ Get/set name of *class*.

(*f* **class-of** *foo*) ▷ Class *foo* is a direct instance of.

(*g* **change-class** *instance new-class* {**:***initarg value*}* *other-keyarg**)
▷ Change class of *instance* to *new-class*. Retain the status of any slots that are common between *instance*'s original class and *new-class*. Initialize any newly added slots with the *value*s of the corresponding *initarg*s if any, or with the values of their **:initform** forms if not.

(*g* **make-instances-obsolete** *class*)
▷ Update all existing instances of *class* using *g* **update-instance-for-redefined-class**.

({ *g* **initialize-instance** *instance*
g **update-instance-for-different-class** *previous current* }
{**:***initarg value*}* *other-keyarg**)
▷ Set slots on behalf of *g* **make-instance**/of *g* **change-class** by means of *g* **shared-initialize**.

(*g*__update-instance-for-redefined-class__ *new-instance added-slots discarded-slots discarded-slots-property-list* {__:__*initarg value*}* *other-keyarg**)
▷ On behalf of *g*__make-instances-obsolete__ and by means of *g*__shared-initialize__, set any *initarg* slots to their corresponding *value*s; set any remaining *added-slots* to the values of their __:initform__ forms. Not to be called by user.

(*g*__allocate-instance__ *class* {__:__*initarg value*}* *other-keyarg**)
▷ Return uninitialized instance of *class*. Called by *g*__make-instance__.

(*g*__shared-initialize__ *instance* { *initform-slots* | T } {__:__*initarg-slot value*}* *other-keyarg**)
▷ Fill the *initarg-slot*s of *instance* with the corresponding *value*s, and fill those *initform-slots* that are not *initarg-slot*s with the values of their __:initform__ forms.

(*g*__slot-missing__ *class instance slot* { __setf__ | __slot-boundp__ | __slot-makunbound__ | __slot-value__ } [*value*])
(*g*__slot-unbound__ *class instance slot*)
▷ Called on attempted access to non-existing or unbound *slot*. Default methods signal __error__/__unbound-slot__, respectively. Not to be called by user.

10.2 Generic Functions

(*f*__next-method-p__)
▷ T if enclosing method has a next method.

(*m*__defgeneric__ { *foo* | (__setf__ *foo*) } (*required-var** [__&optional__ { *var* | (*var*) }*] [__&rest__ *var*] [__&key__ { *var* | (*var* | (__:__*key var*)) }* [__&allow-other-keys__]]) ({ (__:argument-precedence-order__ *required-var*+) | (__declare__ (__optimize__ *method-selection-optimization*)+) | (__:documentation__ *string*) | (__:generic-function-class__ *gf-class* standard-generic-function) | (__:method-class__ *method-class* standard-method) | (__:method-combination__ *c-type* standard *c-arg**) | (__:method__ *defmethod-args*)* })
▷ Define or modify generic function *foo*. Remove any methods previously defined by defgeneric. *gf-class* and the lambda paramters *required-var** and *var** must be compatible with existing methods. *defmethod-args* resemble those of *m*__defmethod__. For *c-type* see section 10.3.

(*f*__ensure-generic-function__ { *foo* | (__setf__ *foo*) } ({ __:argument-precedence-order__ *required-var*+ | __:declare__ (__optimize__ *method-selection-optimization*) | __:documentation__ *string* | __:generic-function-class__ *gf-class* | __:method-class__ *method-class* | __:method-combination__ *c-type c-arg** | __:lambda-list__ *lambda-list* | __:environment__ *environment* })
▷ Define or modify generic function *foo*. *gf-class* and *lambda-list* must be compatible with a pre-existing generic function or with existing methods, respectively. Changes to *method-class* do not propagate to existing methods. For *c-type* see section 10.3.

(*m*__defmethod__ { *foo* | (__setf__ *foo*) } [{ __:before__ | __:after__ | __:around__ | *qualifier** }] primary method ({ *var* | (*spec-var* { *class* | (__eql__ *bar*) }) }* [__&optional__

$\left\{\begin{array}{l} var \\ (var\ [init\ [supplied\text{-}p]]) \end{array}\right\}^*$] [**&rest** *var*] [**&key** $\left\{\begin{array}{l} var \\ (\left\{\begin{array}{l} var \\ (\textbf{:}key\ var) \end{array}\right\}\ [init\ [supplied\text{-}p]]) \end{array}\right\}^*$ [**&allow-other-keys**]] [**&aux** $\left\{\begin{array}{l} var \\ (var\ [init]) \end{array}\right\}^*$]) $\left\{\begin{array}{l} \widehat{(\textbf{declare}\ decl^*)^*} \\ \widehat{doc} \end{array}\right\}$ $form^{P*}$)

▷ Define new method for generic function *foo*. *spec-var*s specialize to either being of *class* or being **eql** *bar*, respectively. On invocation, *var*s and *spec-var*s of the new method act like parameters of a function with body $form^*$. *form*s are enclosed in an implicit $_s$**block** *foo*. Applicable *qualifier*s depend on the **method-combination** type; see section 10.3.

($\left\{\begin{array}{l} {}_g\textbf{add-method} \\ {}_g\textbf{remove-method} \end{array}\right\}$ *generic-function method*)

▷ Add (if necessary) or remove (if any) *method* to/from *generic-function*.

($_g$**find-method** *generic-function qualifiers specializers* [*error*$_{\boxed{\mathtt{T}}}$])

▷ Return suitable method, or signal **error**.

($_g$**compute-applicable-methods** *generic-function args*)

▷ List of methods suitable for *args*, most specific first.

($_f$**call-next-method** $arg^*_{\boxed{\text{current args}}}$)

▷ From within a method, call next method with *arg*s; return its values.

($_g$**no-applicable-method** *generic-function* arg^*)

▷ Called on invocation of *generic-function* on *arg*s if there is no applicable method. Default method signals **error**. Not to be called by user.

($\left\{\begin{array}{l} {}_f\textbf{invalid-method-error}\ method \\ {}_f\textbf{method-combination-error} \end{array}\right\}$ *control* arg^*)

▷ Signal **error** on applicable method with invalid qualifiers, or on method combination. For *control* and *arg*s see **format**, page 36.

($_g$**no-next-method** *generic-function method* arg^*)

▷ Called on invocation of **call-next-method** when there is no next method. Default method signals **error**. Not to be called by user.

($_g$**function-keywords** *method*)

▷ Return list of keyword parameters of *method* and $\underline{\underline{\mathtt{T}}}$ if other keys are allowed.

($_g$**method-qualifiers** *method*) ▷ List of qualifiers of *method*.

10.3 Method Combination Types

standard

▷ Evaluate most specific **:around** method supplying the values of the generic function. From within this method, $_f$**call-next-method** can call less specific **:around** methods if there are any. If not, or if there are no **:around** methods at all, call all **:before** methods, most specific first, and the most specific primary method which supplies the values of the calling $_f$**call-next-method** if any, or of the generic function; and which can call less specific primary methods via $_f$**call-next-method**. After its return, call all **:after** methods, least specific first.

and|**or**|**append**|**list**|**nconc**|**progn**|**max**|**min**|**+**

▷ Simple built-in **method-combination** types; have the same usage as the *c-type*s defined by the short form of $_m$**define-method-combination**.

($_m$**define-method-combination** *c-type*

$\left\{\begin{array}{l} \widehat{\textbf{:documentation}\ string} \\ \textbf{:identity-with-one-argument}\ bool_{\boxed{\mathtt{NIL}}} \\ \textbf{:operator}\ operator_{\boxed{c\text{-}type}} \end{array}\right\}$)

▷ **Short Form.** Define new **method-combination** *c-type*. In a generic function using *c-type*, evaluate most specific **:around** method supplying the values of the generic function. From within this method, $_f$**call-next-method** can call less specific **:around** methods if there are any. If not, or if there are no **:around** methods at all, return from the calling **call-next-method** or from the generic function, respectively, the values of (*operator* (*primary-method gen-arg**)*), *gen-arg** being the arguments of the generic function. The *primary-method*s are ordered [{**:most-specific-first** | **:most-specific-last**} **:most-specific-first**] (specified as *c-arg* in $_m$**defgeneric**). Using *c-type* as the *qualifier* in $_m$**defmethod** makes the method primary.

($_m$**define-method-combination** *c-type* (*ord-λ**) ((*group* {***** | (*qualifier** [*****]) | *predicate*} {| **:description** *control* | **:order** {**:most-specific-first** | **:most-specific-last**} **:most-specific-first** | **:required** *bool*}*)* {| (**:arguments** *method-combination-λ**) | (**:generic-function** *symbol*) | (**declare** *decl**)* | *doc*} *body*^{P}*)

▷ **Long Form.** Define new **method-combination** *c-type*. A call to a generic function using *c-type* will be equivalent to a call to the forms returned by *body** with *ord-λ** bound to *c-arg** (cf. $_m$**defgeneric**), with *symbol* bound to the generic function, with *method-combination-λ** bound to the arguments of the generic function, and with *group*s bound to lists of methods. An applicable method becomes a member of the leftmost *group* whose *predicate* or *qualifier*s match. Methods can be called via $_m$**call-method**. Lambda lists (*ord-λ**) and (*method-combination-λ**) according to *ord-λ* on page 17, the latter enhanced by an optional **&whole** argument.

($_m$**call-method** {*method* | ($_m$**make-method** *form*)} [({*next-method* | ($_m$**make-method** *form*)}*)])

▷ From within an effective method form, call *method* with the arguments of the generic function and with information about its *next-method*s; return its values.

11 Conditions and Errors

For standardized condition types cf. Figure 2 on page 31.

($_m$**define-condition** *foo* (*parent-type** **condition**) ({*slot* | (*slot* {{**:reader** *reader*}* | {**:writer** {*writer* | (**setf** *writer*)}}* | {**:accessor** *accessor*}* | **:allocation** {**:instance** | **:class**} **:instance** | {**:initarg** *:initarg-name*}* | **:initform** *form* | **:type** *type* | **:documentation** *slot-doc*})}*) ({| (**:default-initargs** {*name value*}*) | (**:documentation** *condition-doc*) | (**:report** {*string* | *report-function*})})

▷ Define, as a subtype of *parent-type*s, condition type *foo*. In a new condition, a *slot*'s value defaults to *form* unless set via **:***initarg-name*; it is readable via (*reader i*) or (*accessor i*), and writable via (*writer value i*) or (**setf** (*accessor i*) *value*). With **:allocation :class**, *slot* is shared by all conditions of type *foo*. A condition is reported by *string* or by *report-function* of arguments condition and stream.

(*f*make-condition *condition-type* {:*initarg-name value*}*)
▷ Return new instance of *condition-type*.

$$(\left\{\begin{array}{l}{}_f\textbf{signal}\\ {}_f\textbf{warn}\\ {}_f\textbf{error}\end{array}\right\}\ \left\{\begin{array}{l}\textit{condition}\\ \textit{condition-type}\ \{\textbf{:}\textit{initarg-name value}\}^*\\ \textit{control}\ \textit{arg}^*\end{array}\right\})$$
▷ Unless handled, signal as **condition**, **warning** or **error**, respectively, *condition* or a new instance of *condition-type* or, with *f***format** *control* and *arg*s (see page 36), **simple-condition**, **simple-warning**, or **simple-error**, respectively. From *f***signal** and *f***warn**, return NIL.

(*f*cerror *continue-control*
$$\left\{\begin{array}{l}\textit{condition}\ \textit{continue-arg}^*\\ \textit{condition-type}\ \{\textbf{:}\textit{initarg-name value}\}^*\\ \textit{control}\ \textit{arg}^*\end{array}\right\})$$
▷ Unless handled, signal as correctable **error** *condition* or a new instance of *condition-type* or, with *f***format** *control* and *arg*s (see page 36), **simple-error**. In the debugger, use *f***format** arguments *continue-control* and *continue-arg*s to tag the continue option. Return NIL.

(*m*ignore-errors $form^{P_*}$)
▷ Return values of *form*s or, in case of **error**s, NIL and the condition.
2

(*f*invoke-debugger *condition*)
▷ Invoke debugger with *condition*.

(*m*assert *test* [(*place**)
$$[\left\{\begin{array}{l}\textit{condition}\ \textit{continue-arg}^*\\ \textit{condition-type}\ \{\textbf{:}\textit{initarg-name value}\}^*\\ \textit{control}\ \textit{arg}^*\end{array}\right\}]])$$
▷ If *test*, which may depend on *place*s, returns NIL, signal as correctable **error** *condition* or a new instance of *condition-type* or, with *f***format** *control* and *arg*s (see page 36), **error**. When using the debugger's continue option, *place*s can be altered before re-evaluation of *test*. Return NIL.

(*m*handler-case *foo*
(*type* ([*var*]) (**declare** $\widehat{decl^*})^*$ $condition\text{-}form^{P_*}$)*
[(**:no-error** (*ord-λ**) (**declare** $\widehat{decl^*})^*$ $form^{P_*}$)])
▷ If, on evaluation of *foo*, a condition of *type* is signalled, evaluate matching *condition-form*s with *var* bound to the condition, and return their values. Without a condition, bind *ord-λ*s to values of *foo* and return values of *form*s or, without a **:no-error** clause, return values of *foo*. See page 17 for (*ord-λ**).

(*m*handler-bind ((*condition-type handler-function*)*) $form^{P_*}$)
▷ Return values of *form*s after evaluating them with *condition-type*s dynamically bound to their respective *handler-function*s of argument condition.

(*m*with-simple-restart ($\left\{\begin{array}{l}\textit{restart}\\ \texttt{NIL}\end{array}\right\}$ *control arg**) $form^{P_*}$)
▷ Return values of *form*s unless *restart* is called during their evaluation. In this case, describe *restart* using *f***format** *control* and *arg*s (see page 36) and return NIL and T.
2

(*m*restart-case *form* (*restart* (*ord-λ**) $\left\{\begin{array}{l}\textbf{:interactive}\ \textit{arg-function}\\ \textbf{:report}\ \left\{\begin{array}{l}\textit{report-function}\\ \textit{string}_{\boxed{\text{"}restart\text{"}}}\end{array}\right.\\ \textbf{:test}\ \textit{test-function}_{\boxed{1}}\end{array}\right\}$
(**declare** $\widehat{decl^*})^*$ $restart\text{-}form^{P_*}$)*)
▷ Return values of *form* or, if during evaluation of *form* one of the dynamically established *restart*s is called, the values of its *restart-form*s. A *restart* is visible under *condition* if (**funcall #'***test-function condition*) returns T. If presented in the debugger, *restart*s are described by *string* or by **#'***report-function* (of a stream). A *restart* can be called by (**invoke-restart** *restart arg**), where *arg*s match *ord-λ**, or by (**invoke-restart-interactively** *restart*) where a list of the respective *arg*s is supplied by **#'***arg-function*. See page 17 for *ord-λ**.

(*m*restart-bind ((restart | NIL) *restart-function*
{:interactive-function *arg-function* | :report-function *report-function* | :test-function *test-function*}*) *form*P*)
▷ Return values of *forms* evaluated with dynamically established *restart*s whose *restart-function*s should perform a non-local transfer of control. A restart is visible under *condition* if (*test-function condition*) returns T. If presented in the debugger, *restart*s ar described by *restart-function* (of a stream). A *restart* can be called by (**invoke-restart** *restart arg**), where *arg*s must be suitable for the corresponding *restart-function*, or by (**invoke-restart-interactively** *restart*) where a list of the respective *arg*s is supplied by *arg-function*.

(*f*invoke-restart *restart arg**)
(*f*invoke-restart-interactively *restart*)
▷ Call function associated with *restart* with arguments given or prompted for, respectively. If *restart* function returns, return its values.

({*f*find-restart | *f*compute-restarts} *name* [*condition*])
▷ Return innermost restart *name*, or a list of all restarts, respectively, out of those either associated with *condition* or un-associated at all; or, without *condition*, out of all restarts. Return NIL if search is unsuccessful.

(*f*restart-name *restart*) ▷ Name of *restart*.

({*f*abort | *f*muffle-warning | *f*continue | *f*store-value *value* | *f*use-value *value*} [*condition*NIL])
▷ Transfer control to innermost applicable restart with same name (i.e. **abort**, ..., **continue** ...) out of those either associated with *condition* or un-associated at all; or, without *condition*, out of all restarts. If no restart is found, signal **control-error** for *f*abort and *f*muffle-warning, or return NIL for the rest.

(*m*with-condition-restarts *condition restarts form*P*)
▷ Evaluate *form*s with *restarts* dynamically associated with *condition*. Return values of *forms*.

(*f*arithmetic-error-operation *condition*)
(*f*arithmetic-error-operands *condition*)
▷ List of function or of its operands respectively, used in the operation which caused *condition*.

(*f*cell-error-name *condition*)
▷ Name of cell which caused *condition*.

(*f*unbound-slot-instance *condition*)
▷ Instance with unbound slot which caused *condition*.

(*f*print-not-readable-object *condition*)
▷ The object not readably printable under *condition*.

(*f*package-error-package *condition*)
(*f*file-error-pathname *condition*)
(*f*stream-error-stream *condition*)
▷ Package, path, or stream, respectively, which caused the *condition* of indicated type.

(*f*type-error-datum *condition*)
(*f*type-error-expected-type *condition*)
▷ Object which caused *condition* of type **type-error**, or its expected type, respectively.

(*f*simple-condition-format-control *condition*)
(*f*simple-condition-format-arguments *condition*)
▷ Return *f*format control or list of *f*format arguments, respectively, of *condition*.

*v**break-on-signals*NIL
▷ Condition type debugger is to be invoked on.

v ***debugger-hook*** NIL
▷ Function of condition and function itself. Called before debugger.

12 Types and Classes

For any class, there is always a corresponding type of the same name.

(*f* **typep** *foo type* [*environment* NIL]) ▷ T if *foo* is of *type*.

(*f* **subtypep** *type-a type-b* [*environment*])
▷ Return T if *type-a* is a recognizable subtype of *type-b*, and NIL if the relationship could not be determined.
2

(*s* **the** $\widehat{type}$ *form*) ▷ Declare values of *form* to be of *type*.

(*f* **coerce** *object type*) ▷ Coerce *object* into *type*.

(*m* **typecase** *foo* ($\widehat{type}$ *a-form*P*)* [({**otherwise** | T} *b-form*P* NIL)])
▷ Return values of the *a-form*s whose *type* is *foo* of. Return values of *b-form*s if no *type* matches.

({*m* **etypecase** | *m* **ctypecase**} *foo* ($\widehat{type}$ *form*P*)*)
▷ Return values of the first *form** whose *type* is *foo* of. Signal non-correctable/correctable **type-error** if no *type* matches.

(*f* **type-of** *foo*) ▷ Type of *foo*.

(*m* **check-type** *place type* [*string* [{a | an} *type*]])
▷ Signal correctable **type-error** if *place* is not of *type*. Return NIL.

(*f* **stream-element-type** *stream*) ▷ Type of *stream* objects.

(*f* **array-element-type** *array*) ▷ Element type *array* can hold.

(*f* **upgraded-array-element-type** *type* [*environment* NIL])
▷ Element type of most specialized array capable of holding elements of *type*.

(*m* **deftype** *foo* (*macro-λ**) (**declare** $\widehat{decl}$*)* [$\widehat{doc}$] *form*P*)
▷ Define type *foo* which when referenced as (*foo* $\widehat{arg}$*) (or as *foo* if *macro-λ* doesn't contain any required parameters) applies expanded *form*s to *arg*s returning the new type. For (*macro-λ**) see page 18 but with default value of * instead of NIL. *form*s are enclosed in an implicit *s* **block** named *foo*.

(**eql** *foo*)
(**member** *foo**) ▷ Specifier for a type comprising *foo* or *foo*s.

(**satisfies** *predicate*)
▷ Type specifier for all objects satisfying *predicate*.

(**mod** *n*) ▷ Type specifier for all non-negative integers $< n$.

(**not** *type*) ▷ Complement of type.

(**and** *type** T) ▷ Type specifier for intersection of *type*s.

(**or** *type** NIL) ▷ Type specifier for union of *type*s.

(**values** *type** [**&optional** *type** [**&rest** *other-args*]])
▷ Type specifier for multiple values.

* ▷ As a type argument (cf. Figure 2): no restriction.

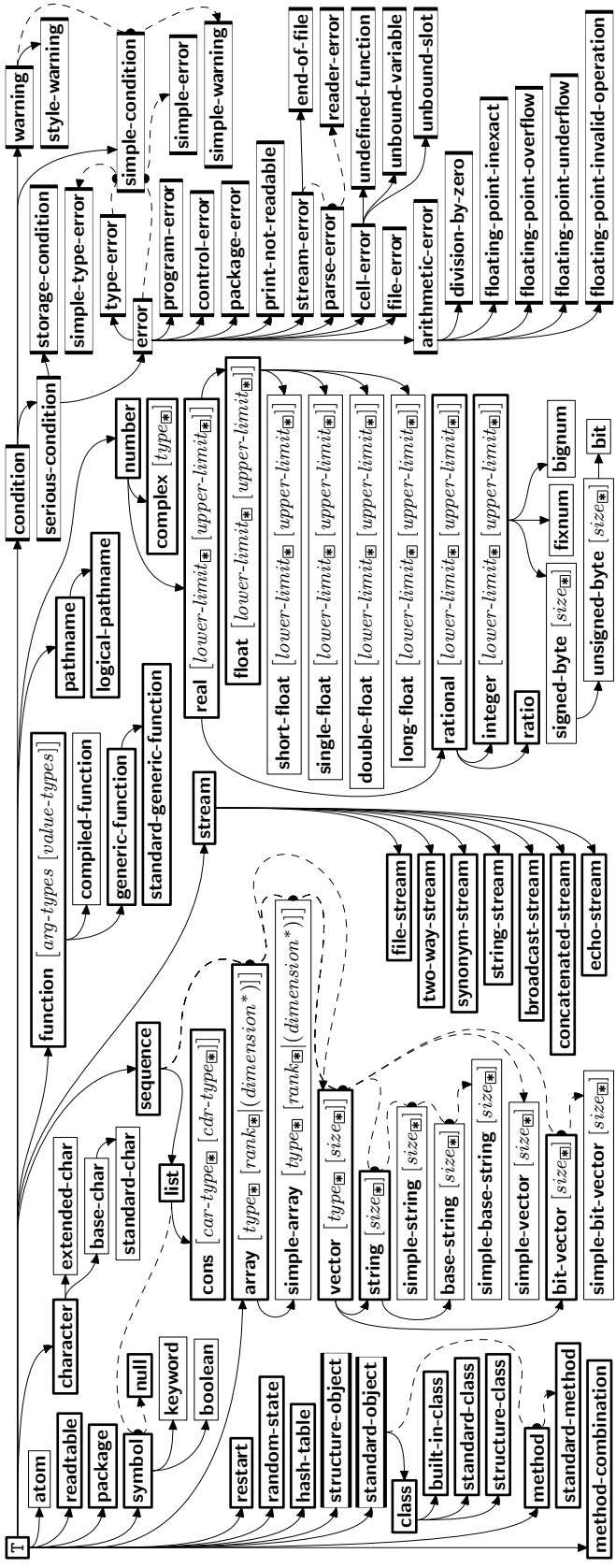

Figure 2: Precedence Order of System Classes (▭), Classes (▬), Types (▭), and Condition Types (▭).
Every type is also a supertype of NIL, the empty type.

13 Input/Output

13.1 Predicates

(*f* **streamp** *foo*)
(*f* **pathnamep** *foo*) ▷ T if *foo* is of indicated type.
(*f* **readtablep** *foo*)

(*f* **input-stream-p** *stream*)
(*f* **output-stream-p** *stream*)
(*f* **interactive-stream-p** *stream*)
(*f* **open-stream-p** *stream*)
▷ Return T if *stream* is for input, for output, interactive, or open, respectively.

(*f* **pathname-match-p** *path wildcard*)
▷ T if *path* matches *wildcard*.

(*f* **wild-pathname-p** *path* [{**:host**|**:device**|**:directory**|**:name**|**:type**|**:version**|NIL}])
▷ Return T if indicated component in *path* is wildcard. (NIL indicates any component.)

13.2 Reader

({*f* **y-or-n-p** | *f* **yes-or-no-p**} [*control arg**])
▷ Ask user a question and return T or NIL depending on their answer. See page 36, *f* **format**, for *control* and *arg*s.

(*m* **with-standard-io-syntax** *form*^{P*})
▷ Evaluate *form*s with standard behaviour of reader and printer. Return values of *form*s.

({*f* **read** | *f* **read-preserving-whitespace**} [*stream*$_{v*\textbf{standard-input}*}$ [*eof-err*$_{T}$ [*eof-val*$_{NIL}$ [*recursive*$_{NIL}$]]]])
▷ Read printed representation of object.

(*f* **read-from-string** *string* [*eof-error*$_{T}$ [*eof-val*$_{NIL}$ [{**:start** *start*$_{0}$ | **:end** *end*$_{NIL}$ | **:preserve-whitespace** *bool*$_{NIL}$}]]])
▷ Return object read from string and zero-indexed position$_{2}$ of next character.

(*f* **read-delimited-list** *char* [*stream*$_{v*\textbf{standard-input}*}$ [*recursive*$_{NIL}$]])
▷ Continue reading until encountering *char*. Return list of objects read. Signal error if no *char* is found in stream.

(*f* **read-char** [*stream*$_{v*\textbf{standard-input}*}$ [*eof-err*$_{T}$ [*eof-val*$_{NIL}$ [*recursive*$_{NIL}$]]]])
▷ Return next character from *stream*.

(*f* **read-char-no-hang** [*stream*$_{v*\textbf{standard-input}*}$ [*eof-error*$_{T}$ [*eof-val*$_{NIL}$ [*recursive*$_{NIL}$]]]])
▷ Next character from *stream* or NIL if none is available.

(*f* **peek-char** [*mode*$_{NIL}$ [*stream*$_{v*\textbf{standard-input}*}$ [*eof-error*$_{T}$ [*eof-val*$_{NIL}$ [*recursive*$_{NIL}$]]]]])
▷ Next, or if *mode* is T, next non-whitespace character, or if *mode* is a character, next instance of it, from *stream* without removing it there.

(*f* **unread-char** *character* [*stream*$_{v*\textbf{standard-input}*}$])
▷ Put last *f* **read-char**ed *character* back into *stream*; return NIL.

(*f* **read-byte** *stream* [*eof-err*$_{T}$ [*eof-val*$_{NIL}$]])
▷ Read next byte from binary *stream*.

(*f* **read-line** [*stream*$_{v*\textbf{standard-input}*}$ [*eof-err*$_{T}$ [*eof-val*$_{NIL}$ [*recursive*$_{NIL}$]]]])
▷ Return a line of text from *stream* and T$_{2}$ if line has been ended by end of file.

(*f* **read-sequence** *sequence stream* [**:start** *start*0][**:end** *end*NIL])
▷ Replace elements of *sequence* between *start* and *end* with elements from binary or character *stream*. Return index of *sequence*'s first unmodified element.

(*f* **readtable-case** *readtable*)**:upcase**
▷ Case sensitivity attribute (one of **:upcase**, **:downcase**, **:preserve**, **:invert**) of *readtable*. **setf**able.

(*f* **copy-readtable** [*from-readtable**v**readtable*] [*to-readtable*NIL]])
▷ Return copy of *from-readtable*.

(*f* **set-syntax-from-char** *to-char from-char* [*to-readtable**v**readtable*
[*from-readtable*standard readtable]])
▷ Copy syntax of *from-char* to *to-readtable*. Return T.

*v**readtable* ▷ Current readtable.

*v**read-base*10 ▷ Radix for reading **integer**s and **ratio**s.

*v**read-default-float-format*single-float
▷ Floating point format to use when not indicated in the number read.

*v**read-suppress*NIL
▷ If T, reader is syntactically more tolerant.

(*f* **set-macro-character** *char function* [*non-term-p*NIL
[*rt**v**readtable*]])
▷ Make *char* a macro character associated with *function* of stream and *char*. Return T.

(*f* **get-macro-character** *char* [*rt**v**readtable*])
▷ Reader macro function associated with *char*, and T if *char* is a non-terminating macro character.

(*f* **make-dispatch-macro-character** *char* [*non-term-p*NIL
[*rt**v**readtable*]])
▷ Make *char* a dispatching macro character. Return T.

(*f* **set-dispatch-macro-character** *char sub-char function*
[*rt**v**readtable*])
▷ Make *function* of stream, *n*, *sub-char* a dispatch function of *char* followed by *n*, followed by *sub-char*. Return T.

(*f* **get-dispatch-macro-character** *char sub-char* [*rt**v**readtable*])
▷ Dispatch function associated with *char* followed by *sub-char*.

13.3 Character Syntax

#| *multi-line-comment** **|#**
; *one-line-comment**
▷ Comments. There are stylistic conventions:

;;;; *title*	▷ Short title for a block of code.
;;; *intro*	▷ Description before a block of code.
;; *state*	▷ State of program or of following code.
;*explanation* **;** *continuation*	▷ Regarding line on which it appears.

(*foo**[**.** *bar*NIL]**)** ▷ List of *foo*s with the terminating cdr *bar*.

" ▷ Begin and end of a string.

'*foo* ▷ (*s***quote** *foo*); *foo* unevaluated.

`([*foo*] [**,***bar*] [**,@***baz*] [**,.***quux*] [*bing*])
▷ Backquote. *s***quote** *foo* and *bing*; evaluate *bar* and splice the lists *baz* and *quux* into their elements. When nested, outermost commas inside the innermost backquote expression belong to this backquote.

#*c* ▷ (*f***character "***c***"**), the character *c*.

#B*n*; **#O***n*; *n***.**; **#X***n*; **#***r***R***n*
▷ Integer of radix 2, 8, 10, 16, or *r*; $2 \leq r \leq 36$.

n/d ▷ The **ratio** $\frac{n}{d}$.

$\left\{[m].n[\{\mathbf{S}|\mathbf{F}|\mathbf{D}|\mathbf{L}|\mathbf{E}\}x_{\boxed{\mathtt{E0}}}]\,|\,m[.[n]]\{\mathbf{S}|\mathbf{F}|\mathbf{D}|\mathbf{L}|\mathbf{E}\}x\right\}$
▷ $m.n \cdot 10^x$ as **short-float**, **single-float**, **double-float**, **long-float**, or the type from ∗**read-default-float-format**∗.

#C(*a b***)** ▷ ($_f$**complex** *a b*), the complex number $a + b$i.

#'*foo* ▷ ($_s$**function** *foo*); the function named *foo*.

#*n***A***sequence* ▷ n-dimensional array.

#[*n*]**(***foo*∗**)**
▷ Vector of some (or n) *foo*s filled with last *foo* if necessary.

#[*n*]∗*b*∗
▷ Bit vector of some (or n) *b*s filled with last *b* if necessary.

#S(*type* {*slot value*}∗**)** ▷ Structure of *type*.

#P*string* ▷ A pathname.

#:*foo* ▷ Uninterned symbol *foo*.

#.*form* ▷ Read-time value of *form*.

$_v$∗**read-eval**∗$_{\boxed{\mathtt{T}}}$ ▷ If NIL, a **reader-error** is signalled at **#.**.

#*integer***=** *foo* ▷ Give *foo* the label *integer*.

#*integer***#** ▷ Object labelled *integer*.

#< ▷ Have the reader signal **reader-error**.

#+*feature when-feature*
#−*feature unless-feature*
▷ Means *when-feature* if *feature* is T; means *unless-feature* if *feature* is NIL. *feature* is a symbol from $_v$∗**features**∗, or ({**and**|**or**} *feature*∗), or (**not** *feature*).

$_v$∗**features**∗
▷ List of symbols denoting implementation-dependent features.

|*c*∗|; *c*
▷ Treat arbitrary character(s) *c* as alphabetic preserving case.

13.4 Printer

$\left(\begin{Bmatrix}_f\mathbf{prin1}\\ _f\mathbf{print}\\ _f\mathbf{pprint}\\ _f\mathbf{princ}\end{Bmatrix}\ foo\ [\widetilde{stream}_{\boxed{v*\mathbf{standard\text{-}output}*}}]\right)$
▷ Print *foo* to *stream* $_f$**read**ably, $_f$**read**ably between a newline and a space, $_f$**read**ably after a newline, or human-readably without any extra characters, respectively. $_f$**prin1**, $_f$**print** and $_f$**princ** return *foo*.

($_f$**prin1-to-string** *foo*)
($_f$**princ-to-string** *foo*)
▷ Print *foo* to *string* $_f$**read**ably or human-readably, respectively.

($_g$**print-object** *object* $\widetilde{stream}$)
▷ Print *object* to *stream*. Called by the Lisp printer.

($_m$**print-unreadable-object** (*foo* $\widetilde{stream}$ $\left\{\begin{matrix}\mathbf{:type}\ bool_{\boxed{\mathtt{NIL}}}\\ \mathbf{:identity}\ bool_{\boxed{\mathtt{NIL}}}\end{matrix}\right\}$) $form^{P*}$)
▷ Enclosed in **#<** and **>**, print *foo* by means of *form*s to *stream*. Return NIL.

($_f$**terpri** [$\widetilde{stream}_{\boxed{v*\mathbf{standard\text{-}output}*}}$])
▷ Output a newline to *stream*. Return NIL.

($_f$**fresh-line**) [$\widetilde{stream}_{\boxed{v*\mathbf{standard\text{-}output}*}}$]
▷ Output a newline to *stream* and return T unless *stream* is already at the start of a line.

(*f* **write-char** *char* [*stream*$_{v*standard-output*}$])
▷ Output *char* to *stream*.

({*f* **write-string** | *f* **write-line**} *string* [*stream*$_{v*standard-output*}$ [{**:start** *start*$_0$ | **:end** *end*$_{NIL}$}]])
▷ Write *string* to *stream* without/with a trailing newline.

(*f* **write-byte** *byte stream*) ▷ Write *byte* to binary *stream*.

(*f* **write-sequence** *sequence stream* {**:start** *start*$_0$ | **:end** *end*$_{NIL}$})
▷ Write elements of *sequence* to binary or character *stream*.

({*f* **write** | *f* **write-to-string**} *foo* {**:array** *bool* | **:base** *radix* | **:case** {**:upcase** | **:downcase** | **:capitalize**} | **:circle** *bool* | **:escape** *bool* | **:gensym** *bool* | **:length** {*int* | NIL} | **:level** {*int* | NIL} | **:lines** {*int* | NIL} | **:miser-width** {*int* | NIL} | **:pprint-dispatch** *dispatch-table* | **:pretty** *bool* | **:radix** *bool* | **:readably** *bool* | **:right-margin** {*int* | NIL} | **:stream** *stream*$_{v*standard-output*}$})
▷ Print *foo* to *stream* and return *foo*, or print *foo* into string, respectively, after dynamically setting printer variables corresponding to keyword parameters (***print-***bar****** becoming **:***bar*). (**:stream** keyword with *f* **write** only.)

(*f* **pprint-fill** *stream foo* [*parenthesis*$_T$ [*noop*]])
(*f* **pprint-tabular** *stream foo* [*parenthesis*$_T$ [*noop* [n_{16}]]])
(*f* **pprint-linear** *stream foo* [*parenthesis*$_T$ [*noop*]])
▷ Print *foo* to *stream*. If *foo* is a list, print as many elements per line as possible; do the same in a table with a column width of n ems; or print either all elements on one line or each on its own line, respectively. Return NIL. Usable with *f* **format** directive **~//**.

(*m* **pprint-logical-block** (*stream list* {{**:prefix** *string* | **:per-line-prefix** *string*} | **:suffix** *string*$_{""}$})
(**declare** *decl**)* *form*^{P*})
▷ Evaluate *form*s, which should print *list*, with *stream* locally bound to a pretty printing stream which outputs to the original *stream*. If *list* is in fact not a list, it is printed by *f* **write**. Return NIL.

(*m* **pprint-pop**)
▷ Take next element off *list*. If there is no remaining tail of *list*, or *v* ***print-length*** or *v* ***print-circle*** indicate printing should end, send element together with an appropriate indicator to *stream*.

(*f* **pprint-tab** {**:line** | **:line-relative** | **:section** | **:section-relative**} *c i* [*stream*$_{v*standard-output*}$])
▷ Move cursor forward to column number $c + ki$, $k \geq 0$ being as small as possible.

(*f* **pprint-indent** {**:block** | **:current**} *n* [*stream*$_{v*standard-output*}$])
▷ Specify indentation for innermost logical block relative to leftmost position/to current position. Return NIL.

(*m* **pprint-exit-if-list-exhausted**)
▷ If *list* is empty, terminate logical block. Return NIL otherwise.

(*f*pprint-newline {:linear | :fill | :miser | :mandatory} [*stream*$_{*standard-output*}$])
▷ Print a conditional newline if *stream* is a pretty printing stream. Return NIL.

*v**print-array* ▷ If T, print arrays *f*read ably.

*v**print-base*$_{10}$ ▷ Radix for printing rationals, from 2 to 36.

*v**print-case*$_{:upcase}$
▷ Print symbol names all uppercase (:upcase), all lowercase (:downcase), capitalized (:capitalize).

*v**print-circle*$_{NIL}$
▷ If T, avoid indefinite recursion while printing circular structure.

*v**print-escape*$_{T}$
▷ If NIL, do not print escape characters and package prefixes.

*v**print-gensym*$_{T}$
▷ If T, print #: before uninterned symbols.

*v**print-length*$_{NIL}$
*v**print-level*$_{NIL}$
*v**print-lines*$_{NIL}$
▷ If integer, restrict printing of objects to that number of elements per level/to that depth/to that number of lines.

*v**print-miser-width*
▷ If integer and greater than the width available for printing a substructure, switch to the more compact miser style.

*v**print-pretty* ▷ If T, print prettily.

*v**print-radix*$_{NIL}$
▷ If T, print rationals with a radix indicator.

*v**print-readably*$_{NIL}$
▷ If T, print *f*read ably or signal error print-not-readable.

*v**print-right-margin*$_{NIL}$
▷ Right margin width in ems while pretty-printing.

(*f*set-pprint-dispatch *type function* [*priority*$_{0}$ [*table*$_{*print-pprint-dispatch*}$]])
▷ Install entry comprising *function* of arguments stream and object to print; and *priority* as *type* into *table*. If *function* is NIL, remove *type* from *table*. Return NIL.

(*f*pprint-dispatch *foo* [*table*$_{*print-pprint-dispatch*}$])
▷ Return highest priority *function* associated with type of *foo* and $\frac{T}{2}$ if there was a matching type specifier in *table*.

(*f*copy-pprint-dispatch [*table*$_{*print-pprint-dispatch*}$])
▷ Return copy of *table* or, if *table* is NIL, initial value of *v**print-pprint-dispatch*.

*v**print-pprint-dispatch*
▷ Current pretty print dispatch table.

13.5 Format

(*m*formatter *control*)
▷ Return function of *stream* and *arg** applying *f*format to *stream*, *control*, and *arg** returning NIL or any excess *arg*s.

(*f*format {T | NIL | *out-string* | *out-stream*} *control arg**)
▷ Output string *control* which may contain ~ directives possibly taking some *arg*s. Alternatively, *control* can be a function returned by *m*formatter which is then applied to *out-stream* and *arg**. Output to *out-string*, *out-stream* or, if first argument is T, to *v**standard-output*. Return NIL. If first argument is NIL, return formatted output.

~ [*min-col*$_{0}$] [,[*col-inc*$_{1}$] [,[*min-pad*$_{0}$] [,'*pad-char*$_{\sqcup}$]]]
[:] [@] {**A**|**S**}
▷ **Aesthetic/Standard.** Print argument of any type for consumption by humans/by the reader, respectively. With **:**, print `NIL` as `()` rather than `nil`; with **@**, add *pad-char*s on the left rather than on the right.

~ [*radix*$_{10}$] [,[*width*] [,['*pad-char*$_{\sqcup}$] [,['*comma-char*$_{,}$]
[,*comma-interval*$_{3}$]]]] [:] [@] **R**
▷ **Radix.** (With one or more prefix arguments.) Print argument as number; with **:**, group digits *comma-interval* each; with **@**, always prepend a sign.

{~**R**|~**:R**|~**@R**|~**@:R**}
▷ **Roman.** Take argument as number and print it as English cardinal number, as English ordinal number, as Roman numeral, or as old Roman numeral, respectively.

~ [*width*] [,['*pad-char*$_{\sqcup}$] [,['*comma-char*$_{,}$]
[,*comma-interval*$_{3}$]]] [:] [@] {**D**|**B**|**O**|**X**}
▷ **Decimal/Binary/Octal/Hexadecimal.** Print integer argument as number. With **:**, group digits *comma-interval* each; with **@**, always prepend a sign.

~ [*width*] [,[*dec-digits*] [,[*shift*$_{0}$] [,['*overflow-char*]
[,'*pad-char*$_{\sqcup}$]]]] [@] **F**
▷ **Fixed-Format Floating-Point.** With **@**, always prepend a sign.

~ [*width*] [,[*dec-digits*] [,[*exp-digits*] [,[*scale-factor*$_{1}$]
[,['*overflow-char*] [,['*pad-char*$_{\sqcup}$] [,'*exp-char*]]]]]]
[@] {**E**|**G**}
▷ **Exponential/General Floating-Point.** Print argument as floating-point number with *dec-digits* after decimal point and *exp-digits* in the signed exponent. With **~G**, choose either **~E** or **~F**. With **@**, always prepend a sign.

~ [*dec-digits*$_{2}$] [,[*int-digits*$_{1}$] [,[*width*$_{0}$] [,'*pad-char*$_{\sqcup}$]]] [:]
[@] **$**
▷ **Monetary Floating-Point.** Print argument as fixed-format floating-point number. With **:**, put sign before any padding; with **@**, always prepend a sign.

{~**C**|~**:C**|~**@C**|~**@:C**}
▷ **Character.** Print, spell out, print in **#** syntax, or tell how to type, respectively, argument as (possibly non-printing) character.

{~**(** *text* ~**)**|~**:(** *text* ~**)**|~**@(** *text* ~**)**|~**@:(** *text* ~**)**}
▷ **Case-Conversion.** Convert *text* to lowercase, convert first letter of each word to uppercase, capitalize first word and convert the rest to lowercase, or convert to uppercase, respectively.

{~**P**|~**:P** |~**@P**|~**@:P**}
▷ **Plural.** If argument **eql** `1` print nothing, otherwise print **s**; do the same for the previous argument; if argument **eql** `1` print `y`, otherwise print `ies`; do the same for the previous argument, respectively.

~ [n_{1}] **%** ▷ **Newline.** Print n newlines.

~ [n_{1}] **&**
▷ **Fresh-Line.** Print $n-1$ newlines if output stream is at the beginning of a line, or n newlines otherwise.

{~**_**|~**:_**|~**@_**|~**@:_**}
▷ **Conditional Newline.** Print a newline like **pprint-newline** with argument **:linear**, **:fill**, **:miser**, or **:mandatory**, respectively.

{~**:↩**|~**@↩**|~**↩**}
▷ **Ignored Newline.** Ignore newline, or whitespace following newline, or both, respectively.

~ [n_{1}] **|** ▷ **Page.** Print n page separators.

~ [n_{1}] **~** ▷ **Tilde.** Print n tildes.

~ [*min-col*$_{0}$] [,[*col-inc*$_{1}$] [,[*min-pad*$_{0}$] [,'*pad-char*$_{\sqcup}$]]]
[:] [@] **<** [*nl-text* ~[*spare*$_{0}$ [,*width*]]**:**;] {*text* ~**;**}* *text*

~>
▷ **Justification.** Justify text produced by *text*s in a field of at least *min-col* columns. With **:**, right justify; with **@**, left justify. If this would leave less than *spare* characters on the current line, output *nl-text* first.

~ [**:**] [**@**] **<** {[*prefix*`nil` **~;**]|[*per-line-prefix* **~@;**]} *body* [**~;** *suffix*`nil`] **~:** [**@**] **>**
▷ **Logical Block.** Act like **pprint-logical-block** using *body* as *f***format** control string on the elements of the list argument or, with **@**, on the remaining arguments, which are extracted by **pprint-pop**. With **:**, *prefix* and *suffix* default to (and). When closed by **~@:>**, spaces in *body* are replaced with conditional newlines.

{**~** [*n*`0`] **i**|**~** [*n*`0`] **:i**}
▷ **Indent.** Set indentation to *n* relative to leftmost/to current position.

~ [*c*`1`] [**,***i*`1`] [**:**] [**@**] **T**
▷ **Tabulate.** Move cursor forward to column number $c+ki$, $k \geq 0$ being as small as possible. With **:**, calculate column numbers relative to the immediately enclosing section. With **@**, move to column number $c_0 + c + ki$ where c_0 is the current position.

{**~** [*m*`1`] *****|**~** [*m*`1`] **:***|**~** [*n*`0`] **@***}
▷ **Go-To.** Jump *m* arguments forward, or backward, or to argument *n*.

~ [*limit*] [**:**] [**@**] **{** *text* **~}**
▷ **Iteration.** Use *text* repeatedly, up to *limit*, as control string for the elements of the list argument or (with **@**) for the remaining arguments. With **:** or **@:**, list elements or remaining arguments should be lists of which a new one is used at each iteration step.

~ [*x* [**,***y* [**,***z*]]] **^**
▷ **Escape Upward.** Leave immediately **~<** **~>**, **~<** **~:>**, **~{** **~}**, **~?**, or the entire *f***format** operation. With one to three prefixes, act only if $x = 0$, $x = y$, or $x \leq y \leq z$, respectively.

~ [*i*] [**:**] [**@**] **[** [{*text* **~;**}* *text*] [**~:;** *default*] **~]**
▷ **Conditional Expression.** Use the zero-indexed argumenth (or *i*th if given) *text* as a *f***format** control subclause. With **:**, use the first *text* if the argument value is `NIL`, or the second *text* if it is `T`. With **@**, do nothing for an argument value of `NIL`. Use the only *text* and leave the argument to be read again if it is `T`.

{**~?**|**~@?**}
▷ **Recursive Processing.** Process two arguments as control string and argument list, or take one argument as control string and use then the rest of the original arguments.

~ [*prefix* {**,***prefix*}*] [**:**] [**@**] **/**[*package* [**:**]:`cl-user:`]*function***/**
▷ **Call Function.** Call all-uppercase *package***::***function* with the arguments stream, format-argument, colon-p, at-sign-p and *prefix*es for printing format-argument.

~ [**:**] [**@**] **W**
▷ **Write.** Print argument of any type obeying every printer control variable. With **:**, pretty-print. With **@**, print without limits on length or depth.

{**V**|**#**}
▷ In place of the comma-separated prefix parameters: use next argument or number of remaining unprocessed arguments, respectively.

13.6 Streams

(*f*open *path* { :direction { :input / :output / :io / :probe } [:input]
:element-type { *type* / :default } [character]
:if-exists { :new-version / :error / :rename / :rename-and-delete / :overwrite / :append / :supersede / NIL } [:new-version if *path* specifies :newest; NIL otherwise]
:if-does-not-exist { :error / :create / NIL } [NIL for :direction :probe; {:create | :error} otherwise]
:external-format *format* [:default] })

▷ Open file-stream to *path*.

(*f*make-concatenated-stream *input-stream**)
(*f*make-broadcast-stream *output-stream**)
(*f*make-two-way-stream *input-stream-part output-stream-part*)
(*f*make-echo-stream *from-input-stream to-output-stream*)
(*f*make-synonym-stream *variable-bound-to-stream*)

▷ Return stream of indicated type.

(*f*make-string-input-stream *string* [*start*[0] [*end*[NIL]]])

▷ Return a string-stream supplying the characters from *string*.

(*f*make-string-output-stream [:element-type *type*[character]])

▷ Return a string-stream accepting characters (available via *f*get-output-stream-string).

(*f*concatenated-stream-streams *concatenated-stream*)
(*f*broadcast-stream-streams *broadcast-stream*)

▷ Return list of streams *concatenated-stream* still has to read from/*broadcast-stream* is broadcasting to.

(*f*two-way-stream-input-stream *two-way-stream*)
(*f*two-way-stream-output-stream *two-way-stream*)
(*f*echo-stream-input-stream *echo-stream*)
(*f*echo-stream-output-stream *echo-stream*)

▷ Return source stream or sink stream of *two-way-stream*/*echo-stream*, respectively.

(*f*synonym-stream-symbol *synonym-stream*)

▷ Return symbol of *synonym-stream*.

(*f*get-output-stream-string *string-stream*)

▷ Clear and return as a string characters on *string-stream*.

(*f*file-position *stream* [{ :start / :end / *position* }])

▷ Return position within stream, or set it to *position* and return T on success.

(*f*file-string-length *stream foo*)

▷ Length *foo* would have in *stream*.

(*f*listen [*stream*[*v**standard-input*]])

▷ T if there is a character in input *stream*.

(*f*clear-input [*stream*[*v**standard-input*]])

▷ Clear input from *stream*, return NIL.

({ *f*clear-output / *f*force-output / *f*finish-output } [*stream*[*v**standard-output*]])

▷ End output to *stream* and return NIL immediately, after initiating flushing of buffers, or after flushing of buffers, respectively.

(*f* **close** *stream* [**:abort** *bool*NIL])
▷ Close *stream*. Return T if *stream* had been open. If **:abort** is T, delete associated file.

(*m* **with-open-file** (*stream path open-arg**) (**declare** *decl**)* *form*P*)
▷ Use *f* **open** with *open-arg*s to temporarily create *stream* to *path*; return values of *form*s.

(*m* **with-open-stream** (*foo stream*) (**declare** *decl**)* *form*P*)
▷ Evaluate *form*s with *foo* locally bound to *stream*. Return values of *form*s.

(*m* **with-input-from-string** (*foo string* { **:index** *index* | **:start** *start*0 | **:end** *end*NIL }) (**declare** *decl**)* *form*P*)
▷ Evaluate *form*s with *foo* locally bound to input **string-stream** from *string*. Return values of *form*s; store next reading position into *index*.

(*m* **with-output-to-string** (*foo* [*string*NIL [**:element-type** *type*character]]) (**declare** *decl**)* *form*P*)
▷ Evaluate *form*s with *foo* locally bound to an output **string-stream**. Append output to *string* and return values of *form*s if *string* is given. Return string containing output otherwise.

(*f* **stream-external-format** *stream*)
▷ External file format designator.

v ***terminal-io*** ▷ Bidirectional stream to user terminal.

v ***standard-input***
v ***standard-output***
v ***error-output***
▷ Standard input stream, standard output stream, or standard error output stream, respectively.

v ***debug-io***
v ***query-io***
▷ Bidirectional streams for debugging and user interaction.

13.7 Pathnames and Files

(*f* **make-pathname**
{ **:host** {*host* | NIL | **:unspecific**}
:device {*device* | NIL | **:unspecific**}
:directory { {*directory* | **:wild** | NIL | **:unspecific**} | ({ **:absolute** | **:relative** } { *directory* | **:wild** | **:wild-inferiors** | **:up** | **:back** }*) }
:name {*file-name* | **:wild** | NIL | **:unspecific**}
:type {*file-type* | **:wild** | NIL | **:unspecific**}
:version {**:newest** | *version* | **:wild** | NIL | **:unspecific**}
:defaults *path*host from *v* ***default-pathname-defaults***
:case {**:local** | **:common**}**:local** }
▷ Construct a logical pathname if there is a logical pathname translation for *host*, otherwise construct a physical pathname. For **:case :local**, leave case of components unchanged. For **:case :common**, leave mixed-case components unchanged; convert all-uppercase components into local customary case; do the opposite with all-lowercase components.

({ *f* **pathname-host** | *f* **pathname-device** | *f* **pathname-directory** | *f* **pathname-name** | *f* **pathname-type** } *path-or-stream* [**:case** { **:local** | **:common** }**:local**])

(*f* **pathname-version** *path-or-stream*)
▷ Return pathname component.

(*f* **parse-namestring** *foo* [*host*
[*default-pathname*$_{v}$ ***default-pathname-defaults***
$\left\{\begin{array}{l}\textbf{:start}\ start_{\boxed{0}}\\ \textbf{:end}\ end_{\boxed{\texttt{NIL}}}\\ \textbf{:junk-allowed}\ bool_{\boxed{\texttt{NIL}}}\end{array}\right\}$]])
▷ Return pathname converted from string, pathname, or stream *foo*; and position$_{2}$ where parsing stopped.

(*f* **merge-pathnames** *path-or-stream*
[*default-path-or-stream*$_{v}$ ***default-pathname-defaults***
[*default-version*$_{\boxed{\textbf{:newest}}}$]])
▷ Return pathname made by filling in components missing in *path-or-stream* from *default-path-or-stream*.

$_{v}$***default-pathname-defaults***
▷ Pathname to use if one is needed and none supplied.

(*f* **user-homedir-pathname** [*host*]) ▷ User's home directory.

(*f* **enough-namestring** *path-or-stream*
[*root-path*$_{v}$ ***default-pathname-defaults***])
▷ Return minimal path string that sufficiently describes the path of *path-or-stream* relative to *root-path.*

(*f* **namestring** *path-or-stream*)
(*f* **file-namestring** *path-or-stream*)
(*f* **directory-namestring** *path-or-stream*)
(*f* **host-namestring** *path-or-stream*)
▷ Return string representing full pathname; name, type, and version; directory name; or host name, respectively, of *path-or-stream*.

(*f* **translate-pathname** *path-or-stream wildcard-path-a*
wildcard-path-b)
▷ Translate the path of *path-or-stream* from *wildcard-path-a* into *wildcard-path-b*. Return new path.

(*f* **pathname** *path-or-stream*) ▷ Pathname of *path-or-stream*.

(*f* **logical-pathname** *logical-path-or-stream*)
▷ Logical pathname of *logical-path-or-stream*. Logical pathnames are represented as all-uppercase "[*host*:][;]{$\left\{\begin{array}{l}\{dir\mid\texttt{*}\}^{+}\\ \texttt{**}\end{array}\right\}$;}*{*name*|*}*[.$\left\{\begin{array}{l}\{type\mid\texttt{*}\}^{+}\\ \texttt{LISP}\end{array}\right\}$
[.{*version*|*|**newest**|**NEWEST**}]]".

(*f* **logical-pathname-translations** *logical-host*)
▷ List of (*from-wildcard to-wildcard*) translations for *logical-host*. **setf**able.

(*f* **load-logical-pathname-translations** *logical-host*)
▷ Load *logical-host*'s translations. Return NIL if already loaded; return T if successful.

(*f* **translate-logical-pathname** *path-or-stream*)
▷ Physical pathname corresponding to (possibly logical) pathname of *path-or-stream*.

(*f* **probe-file** *file*)
(*f* **truename** *file*)
▷ Canonical name of *file*. If *file* does not exist, return NIL/signal **file-error**, respectively.

(*f* **file-write-date** *file*) ▷ Time at which *file* was last written.

(*f* **file-author** *file*) ▷ Return name of *file* owner.

(*f* **file-length** *stream*) ▷ Return length of *stream*.

(*f* **rename-file** *foo bar*)
▷ Rename file *foo* to *bar*. Unspecified components of path *bar* default to those of *foo*. Return new pathname, old physical file name$_{2}$, and new physical file name$_{3}$.

(*f* **delete-file** *file*) ▷ Delete *file*. Return T.

(*f* **directory** *path*) ▷ List of pathnames matching *path*.

(*f* **ensure-directories-exist** *path* [**:verbose** *bool*])
▷ Create parts of *path* if necessary. Second return value is T if something has been created.

14 Packages and Symbols

The Loop Facility provides additional means of symbol handling; see **loop**, page 21.

14.1 Predicates

(*f* **symbolp** *foo*)
(*f* **packagep** *foo*) ▷ T if *foo* is of indicated type.
(*f* **keywordp** *foo*)

14.2 Packages

:*bar* | **keyword:***bar* ▷ Keyword, evaluates to :*bar*.

package:*symbol* ▷ Exported *symbol* of *package*.

package::*symbol* ▷ Possibly unexported *symbol* of *package*.

(*m* **defpackage** *foo*
{ (**:nicknames** *nick**)* | (**:documentation** *string*) | (**:intern** *interned-symbol**)* | (**:use** *used-package**)* | (**:import-from** *pkg imported-symbol**)* | (**:shadowing-import-from** *pkg shd-symbol**)* | (**:shadow** *shd-symbol**)* | (**:export** *exported-symbol**)* | (**:size** *int*) }*)
▷ Create or modify package *foo* with *interned-symbol*s, symbols from *used-package*s, *imported-symbol*s, and *shd-symbol*s. Add *shd-symbol*s to *foo*'s shadowing list.

(*f* **make-package** *foo* { **:nicknames** (*nick**)[NIL] | **:use** (*used-package**) }*)*
▷ Create package *foo*.

(*f* **rename-package** *package new-name* [*new-nicknames*[NIL]])
▷ Rename *package*. Return renamed package.

(*m* **in-package** *foo*) ▷ Make package *foo* current.

(*f* { **use-package** | **unuse-package** } *other-packages* [*package*[*v* ***package***]])
▷ Make exported symbols of *other-packages* available in *package*, or remove them from *package*, respectively. Return T.

(*f* **package-use-list** *package*)
(*f* **package-used-by-list** *package*)
▷ List of other packages used by/using *package*.

(*f* **delete-package** *package*)
▷ Delete *package*. Return T if successful.

v ***package***[common-lisp-user] ▷ The current package.

(*f* **list-all-packages**) ▷ List of registered packages.

(*f* **package-name** *package*) ▷ Name of *package*.

(*f* **package-nicknames** *package*) ▷ Nicknames of *package*.

(*f* **find-package** *name*) ▷ Package with *name* (case-sensitive).

(*f* **find-all-symbols** *foo*)
▷ List of symbols *foo* from all registered packages.

(f**intern** / f**find-symbol** *foo* [*package*$_{v*package*}$])
▷ Intern or find, respectively, symbol *foo* in *package*. Second return value is one of **:internal**, **:external**, or **:inherited** (or NIL if f**intern** has created a fresh symbol).

(f**unintern** *symbol* [*package*$_{v*package*}$])
▷ Remove *symbol* from *package*, return T on success.

(f**import** / f**shadowing-import** *symbols* [*package*$_{v*package*}$])
▷ Make *symbols* internal to *package*. Return T. In case of a name conflict signal correctable **package-error** or shadow the old symbol, respectively.

(f**shadow** *symbols* [*package*$_{v*package*}$])
▷ Make *symbols* of *package* shadow any otherwise accessible, equally named symbols from other packages. Return T.

(f**package-shadowing-symbols** *package*)
▷ List of symbols of *package* that shadow any otherwise accessible, equally named symbols from other packages.

(f**export** *symbols* [*package*$_{v*package*}$])
▷ Make *symbols* external to *package*. Return T.

(f**unexport** *symbols* [*package*$_{v*package*}$])
▷ Revert *symbols* to internal status. Return T.

(m**do-symbols** / m**do-external-symbols** / m**do-all-symbols** (*var* [*result*$_{NIL}$])
(**declare** *decl**)* { *tag* | *form* }*)
▷ Evaluate s**tagbody**-like body with *var* successively bound to every symbol from *package*, to every external symbol from *package*, or to every symbol from all registered packages, respectively. Return values of *result*. Implicitly, the whole form is a s**block** named NIL.

(m**with-package-iterator** (*foo packages* [**:internal**|**:external**|**:inherited**]) (**declare** *decl**)* *form*^{P*})
▷ Return values of *form*s. In *form*s, successive invocations of (*foo*) return: T if a symbol is returned; a symbol from *packages*; accessibility (**:internal**, **:external**, or **:inherited**); and the package the symbol belongs to.

(f**require** *module* [*paths*$_{NIL}$])
▷ If not in v***modules***, try *paths* to load *module* from. Signal **error** if unsuccessful. Deprecated.

(f**provide** *module*)
▷ If not already there, add *module* to v***modules***. Deprecated.

v***modules*** ▷ List of names of loaded modules.

14.3 Symbols

A **symbol** has the attributes *name*, home **package**, property list, and optionally value (of global constant or variable *name*) and function (**function**, macro, or special operator *name*).

(f**make-symbol** *name*)
▷ Make fresh, uninterned symbol *name*.

(f**gensym** [*s*$_{G}$])
▷ Return fresh, uninterned symbol #:*sn* with *n* from v***gensym-counter***. Increment v***gensym-counter***.

(f**gentemp** [*prefix*$_{T}$ [*package*$_{v*package*}$]])
▷ Intern fresh symbol in package. Deprecated.

(f**copy-symbol** *symbol* [*props*$_{NIL}$])
▷ Return uninterned copy of *symbol*. If *props* is T, give copy the same value, function and property list.

(*f* **symbol-name** *symbol*)
(*f* **symbol-package** *symbol*)
(*f* **symbol-plist** *symbol*)
(*f* **symbol-value** *symbol*)
(*f* **symbol-function** *symbol*)
▷ Name, package, property list, value, or function, respectively, of *symbol*. **setf**able.

(*g* **documentation** | (**setf** *g* **documentation**) *new-doc* *foo* **'variable** | **'function** | **'compiler-macro** | **'method-combination** | **'structure** | **'type** | **'setf** | **T**)
▷ Get/set documentation string of *foo* of given type.

c **t**
▷ Truth; the supertype of every type including **t**; the superclass of every class except **t**; *v* ***terminal-io***.

c **nil** | *c* **()**
▷ Falsity; the empty list; the empty type, subtype of every type; *v* ***standard-input***; *v* ***standard-output***; the global environment.

14.4 Standard Packages

common-lisp | **cl**
▷ Exports the defined names of Common Lisp except for those in the **keyword** package.

common-lisp-user | **cl-user**
▷ Current package after startup; uses package **common-lisp**.

keyword
▷ Contains symbols which are defined to be of type **keyword**.

15 Compiler

15.1 Predicates

(*f* **special-operator-p** *foo*) ▷ T if *foo* is a special operator.

(*f* **compiled-function-p** *foo*)
▷ T if *foo* is of type **compiled-function**.

15.2 Compilation

(*f* **compile** NIL *definition* | *name* | (**setf** *name*) [*definition*])
▷ Return compiled function or replace *name*'s function definition with the compiled function. Return T in case of **warning**s or **error**s, and T in case of **warning**s or **error**s excluding **style-warning**s.

(*f* **compile-file** *file* **:output-file** *out-path* | **:verbose** *bool* *v* ***compile-verbose*** | **:print** *bool* *v* ***compile-print*** | **:external-format** *file-format* **:default**)
▷ Write compiled contents of *file* to *out-path*. Return true output path or NIL, T in case of **warning**s or **error**s, T in case of **warning**s or **error**s excluding **style-warning**s.

(*f* **compile-file-pathname** *file* [**:output-file** *path*] [*other-keyargs*])
▷ Pathname *f* **compile-file** writes to if invoked with the same arguments.

(*f* **load** *path* **:verbose** *bool* *v* ***load-verbose*** | **:print** *bool* *v* ***load-print*** | **:if-does-not-exist** *bool* **T** | **:external-format** *file-format* **:default**)
▷ Load source file or compiled file into Lisp environment. Return T if successful.

$_v$***compile-file**, $_v$***load** – {**pathname***NIL, **truename***NIL}
▷ Input file used by $_f$**compile-file**/by $_f$**load**.

$_v$***compile**, $_v$***load** – {**print***, **verbose***}
▷ Defaults used by $_f$**compile-file**/by $_f$**load**.

($_s$**eval-when** ({{**:compile-toplevel**|**compile**}, {**:load-toplevel**|**load**}, {**:execute**|**eval**}}) $form^{P,*}$)
▷ Return values of *forms* if $_s$**eval-when** is in the top-level of a file being compiled, in the top-level of a compiled file being loaded, or anywhere, respectively. Return NIL if *forms* are not evaluated. (**compile**, **load** and **eval** deprecated.)

($_s$**locally** (**declare** $\widehat{decl^*}$)* $form^{P,*}$)
▷ Evaluate *forms* in a lexical environment with declarations *decl* in effect. Return values of *forms*.

($_m$**with-compilation-unit** ([**:override** $bool_{NIL}$]) $form^{P,*}$)
▷ Return values of *forms*. Warnings deferred by the compiler until end of compilation are deferred until the end of evaluation of *forms*.

($_s$**load-time-value** *form* [$\widehat{read\text{-}only}_{NIL}$])
▷ Evaluate *form* at compile time and treat its value as literal at run time.

($_s$**quote** $\widehat{foo}$) ▷ Return unevaluated *foo*.

($_g$**make-load-form** *foo* [*environment*])
▷ Its methods are to return a creation form which on evaluation at $_f$**load** time returns an object equivalent to *foo*, and an optional initialization form which on evaluation performs some initialization of the object.

($_f$**make-load-form-saving-slots** *foo* {{**:slot-names** *slots*all local slots}, {**:environment** *environment*}})
▷ Return a creation form and an initialization form which on evaluation construct an object equivalent to *foo* with *slots* initialized with the corresponding values from *foo*.

($_f$**macro-function** *symbol* [*environment*])
($_f$**compiler-macro-function** {*name*, (**setf** *name*)} [*environment*])
▷ Return specified macro function, or compiler macro function, respectively, if any. Return NIL otherwise. **setf**able.

($_f$**eval** *arg*)
▷ Return values of value of *arg* evaluated in global environment.

15.3 REPL and Debugging

$_v$+ | $_v$++ | $_v$+++
$_v$* | $_v$** | $_v$***
$_v$/ | $_v$// | $_v$///
▷ Last, penultimate, or antepenultimate form evaluated in the REPL, or their respective primary value, or a list of their respective values.

$_v$− ▷ Form currently being evaluated by the REPL.

($_f$**apropos** *string* [$package_{NIL}$])
▷ Print interned symbols containing *string*.

($_f$**apropos-list** *string* [$package_{NIL}$])
▷ List of interned symbols containing *string*.

($_f$**dribble** [*path*])
▷ Save a record of interactive session to file at *path*. Without *path*, close that file.

($_f$**ed** [*file-or-function*NIL]) ▷ Invoke editor if possible.

($_f$**macroexpand-1** / $_f$**macroexpand**) *form* [*environment*$_{\texttt{NIL}}$])
▷ Return macro expansion, once or entirely, respectively, of *form* and T if *form* was a macro form. Return *form* and NIL otherwise.

$_v$***macroexpand-hook***
▷ Function of arguments expansion function, macro form, and environment called by $_f$**macroexpand-1** to generate macro expansions.

($_m$**trace** {*function* / (**setf** *function*)}*)
▷ Cause *function*s to be traced. With no arguments, return list of traced functions.

($_m$**untrace** {*function* / (**setf** *function*)}*)
▷ Stop *function*s, or each currently traced function, from being traced.

$_v$***trace-output***
▷ Output stream $_m$**trace** and $_m$**time** send their output to.

($_m$**step** *form*)
▷ Step through evaluation of *form*. Return values of *form*.

($_f$**break** [*control arg**])
▷ Jump directly into debugger; return NIL. See page 36, $_f$**format**, for *control* and *arg*s.

($_m$**time** *form*)
▷ Evaluate *form*s and print timing information to $_v$***trace-output***. Return values of *form*.

($_f$**inspect** *foo*) ▷ Interactively give information about *foo*.

($_f$**describe** *foo* [*stream*$_{v*standard-output*}$])
▷ Send information about *foo* to *stream*.

($_g$**describe-object** *foo* [*stream*])
▷ Send information about *foo* to *stream*. Called by $_f$**describe**.

($_f$**disassemble** *function*)
▷ Send disassembled representation of *function* to $_v$***standard-output***. Return NIL.

($_f$**room** [{NIL|**:default**|T}$_{:default}$])
▷ Print information about internal storage management to ***standard-output***.

15.4 Declarations

($_f$**proclaim** *decl*)
($_m$**declaim** *decl**)
▷ Globally make declaration(s) *decl*. *decl* can be: **declaration**, **type**, **ftype**, **inline**, **notinline**, **optimize**, or **special**. See below.

(**declare** *decl**)
▷ Inside certain forms, locally make declarations *decl**. *decl* can be: **dynamic-extent**, **type**, **ftype**, **ignorable**, **ignore**, **inline**, **notinline**, **optimize**, or **special**. See below.

(**declaration** foo*)
▷ Make *foo*s names of declarations.

(**dynamic-extent** *variable** (**function** *function*)*)
▷ Declare lifetime of *variable*s and/or *function*s to end when control leaves enclosing block.

([**type**] *type variable**)
(**ftype** *type function**)
▷ Declare *variable*s or *function*s to be of *type*.

({**ignorable** / **ignore**} {*var* / (**function** *function*)}*)
▷ Suppress warnings about used/unused bindings.

(**inline** *function**)
(**notinline** *function**)
▷ Tell compiler to integrate/not to integrate, respectively, called *function*s into the calling routine.

(**optimize** { **compilation-speed** | (**compilation-speed** *n*[3]) | **debug** | (**debug** *n*[3]) | **safety** | (**safety** *n*[3]) | **space** | (**space** *n*[3]) | **speed** | (**speed** *n*[3]) })
▷ Tell compiler how to optimize. $n = 0$ means unimportant, $n = 1$ is neutral, $n = 3$ means important.

(**special** *var**) ▷ Declare *var*s to be dynamic.

16 External Environment

(*f* **get-internal-real-time**)
(*f* **get-internal-run-time**)
▷ Current time, or computing time, respectively, in clock ticks.

c **internal-time-units-per-second**
▷ Number of clock ticks per second.

(*f* **encode-universal-time** *sec min hour date month year* [*zone*[curr]])
(*f* **get-universal-time**)
▷ Seconds from 1900-01-01, 00:00, ignoring leap seconds.

(*f* **decode-universal-time** *universal-time* [*time-zone*[current]])
(*f* **get-decoded-time**)
▷ Return second[0], minute[1], hour[2], date[3], month[4], year[5], day[6], daylight-p[7], and zone[8].

(*f* **short-site-name**)
(*f* **long-site-name**)
▷ String representing physical location of computer.

({ *f* **lisp-implementation** / *f* **software** / *f* **machine** } - { **type** / **version** })
▷ Name or version of implementation, operating system, or hardware, respectively.

(*f* **machine-instance**) ▷ Computer name.

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