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

(*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|fround} / *f*{floor|ffloor} / *f*{ceiling|fceiling} / *f*{truncate|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|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	▷ $\neg$*int-a*.
*c*boole-c2	▷ $\neg$*int-b*.
*c*boole-set	▷ All bits set.
*c*boole-clr	▷ All bits zero.

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

($_f$**lognot** *integer*) ▷ $\underline{\neg integer}$.

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

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

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

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

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

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

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

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

($_f$**logbitp** *i int*) ▷ T if zero-indexed *i*th 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.

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

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

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

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

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

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

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

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

(ƒ**character** *c*) ▷ Return #*c*.

3 Strings

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

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

(ƒ{**string=** | **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.

(ƒ{**string**{/= | **-not-equal**} | **string**{> | **-greaterp**} | **string**{>= | **-not-lessp**} | **string**{< | **-lessp**} | **string**{<= | **-not-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.

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

(ƒ**string** *x*)
(ƒ{**string-capitalize** | **string-upcase** | **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.

(ƒ{**nstring-capitalize** | **nstring-upcase** | **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.

(ƒ{**string-trim** | **string-left-trim** | **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$_2$ of parse end.

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 *n*th 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*.

(**butlast** *list* [*num*1]) (**nbutlast** *list* [*num*1])
▷ *list* excluding last *num* conses.

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

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

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

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

(**push** *foo place*) ▷ Set *place* to (**cons** *foo place*).

(**pushnew** *foo place* [**:test** *function*#'eql | **:test-not** *function* | **:key** *function*])
▷ Set *place* to (**adjoin** *foo place*).

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

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

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

(**mapcan** *function list*+) (**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.

(**mapc** *function list*+) (**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.

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

4.3 Association Lists

(**pairlis** *keys values* [*alist*NIL])
▷ Prepend to *alist* an association list made from lists *keys* and *values*.

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

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

(**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*) ▷ T if *foo* is of indicated type.
($_f$**bit-vector-p** *foo*)
($_f$**simple-bit-vector-p** *foo*)

($_f$**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.

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

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

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

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

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

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

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

(ƒ**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.

(ƒ{**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 ƒ**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.

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

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

(ƒ**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.

(ƒ**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.

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

(ƒ**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*$_{\text{NIL}}$ | {**:test** *function*$_{\text{\#'eql}}$ | **:test-not** *function*} | **:start1** *start-a*$_0$ | **:start2** *start-b*$_0$ | **:end1** *end-a*$_{\text{NIL}}$ | **:end2** *end-b*$_{\text{NIL}}$ | **: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* $\widetilde{\textit{sequence}}$*-a* $\widetilde{\textit{sequence}}$*-b test* [**:key** *function*$_{\text{NIL}}$])

▷ Return interleaved sequence of *type*. Merged sequence will be sorted if both *sequence-a* and *sequence-b* are sorted.

($_f$**fill** $\widetilde{\textit{sequence}}$ *foo* {**:start** *start*$_0$ | **:end** *end*$_{\text{NIL}}$})

▷ 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*$_{\text{NIL}}$ | {**:test** *function*$_{\text{\#'eql}}$ | **:test-not** *function*} | **:start** *start*$_0$ | **:end** *end*$_{\text{NIL}}$ | **:key** *function*})

▷ Return number of elements in *sequence* which match *foo*.

($_f$**count-if** | **count-if-not** *test sequence* {**:from-end** *bool*$_{\text{NIL}}$ | **:start** *start*$_0$ | **:end** *end*$_{\text{NIL}}$ | **: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*$_{\text{NIL}}$])

▷ Return subsequence of *sequence* between *start* and *end*. **setf**able.

($_f$**sort** | **stable-sort** $\widetilde{\textit{sequence}}$ *test* [**:key** *function*])

▷ Return *sequence* sorted. Order of elements considered equal is not guaranteed/retained, respectively.

($_f$**reverse** *sequence*)
($_f$**nreverse** $\widetilde{\textit{sequence}}$)

▷ Return *sequence* in reverse order.

$$(\left\{\begin{matrix}_f\textbf{find}\\ _f\textbf{position}\end{matrix}\right\}\ foo\ sequence\ \left\{\begin{vmatrix}\textbf{:from-end}\ bool_{\texttt{NIL}}\\ \left\{\begin{matrix}\textbf{:test}\ function_{\#\text{'eql}}\\ \textbf{:test-not}\ test\end{matrix}\right.\\ \textbf{:start}\ start_{0}\\ \textbf{:end}\ end_{\texttt{NIL}}\\ \textbf{:key}\ function\end{vmatrix}\right\})$$

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

$$(\left\{\begin{matrix}_f\textbf{find-if}\\ _f\textbf{find-if-not}\\ _f\textbf{position-if}\\ _f\textbf{position-if-not}\end{matrix}\right\}\ test\ sequence\ \left\{\begin{vmatrix}\textbf{:from-end}\ bool_{\texttt{NIL}}\\ \textbf{:start}\ start_{0}\\ \textbf{:end}\ end_{\texttt{NIL}}\\ \textbf{:key}\ function\end{vmatrix}\right\})$$

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

$$(_f\textbf{search}\ sequence\text{-}a\ sequence\text{-}b\ \left\{\begin{vmatrix}\textbf{:from-end}\ bool_{\texttt{NIL}}\\ \left\{\begin{matrix}\textbf{:test}\ function_{\#\text{'eql}}\\ \textbf{:test-not}\ function\end{matrix}\right.\\ \textbf{:start1}\ start\text{-}a_{0}\\ \textbf{:start2}\ start\text{-}b_{0}\\ \textbf{:end1}\ end\text{-}a_{\texttt{NIL}}\\ \textbf{:end2}\ end\text{-}b_{\texttt{NIL}}\\ \textbf{:key}\ function\end{vmatrix}\right\})$$

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

$$(\left\{\begin{matrix}_f\textbf{remove}\ foo\ sequence\\ _f\textbf{delete}\ foo\ \widetilde{sequence}\end{matrix}\right\}\ \left\{\begin{vmatrix}\textbf{:from-end}\ bool_{\texttt{NIL}}\\ \left\{\begin{matrix}\textbf{:test}\ function_{\#\text{'eql}}\\ \textbf{:test-not}\ function\end{matrix}\right.\\ \textbf{:start}\ start_{0}\\ \textbf{:end}\ end_{\texttt{NIL}}\\ \textbf{:key}\ function\\ \textbf{:count}\ count_{\texttt{NIL}}\end{vmatrix}\right\})$$

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

$$(\left\{\begin{matrix}_f\textbf{remove-if}\\ _f\textbf{remove-if-not}\\ _f\textbf{delete-if}\\ _f\textbf{delete-if-not}\end{matrix}\right\}\ \begin{matrix}test\ sequence\\ test\ \widetilde{sequence}\end{matrix}\ \left\}\begin{vmatrix}\textbf{:from-end}\ bool_{\texttt{NIL}}\\ \textbf{:start}\ start_{0}\\ \textbf{:end}\ end_{\texttt{NIL}}\\ \textbf{:key}\ function\\ \textbf{:count}\ count_{\texttt{NIL}}\end{vmatrix}\right\})$$

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

$$(\left\{\begin{matrix}_f\textbf{remove-duplicates}\ sequence\\ _f\textbf{delete-duplicates}\ \widetilde{sequence}\end{matrix}\right\}\ \left\{\begin{vmatrix}\textbf{:from-end}\ bool_{\texttt{NIL}}\\ \left\{\begin{matrix}\textbf{:test}\ function_{\#\text{'eql}}\\ \textbf{:test-not}\ function\end{matrix}\right.\\ \textbf{:start}\ start_{0}\\ \textbf{:end}\ end_{\texttt{NIL}}\\ \textbf{:key}\ function\end{vmatrix}\right\})$$

▷ Make copy of *sequence* without duplicates.

$$(\left\{\begin{matrix}_f\textbf{substitute}\ new\ old\ sequence\\ _f\textbf{nsubstitute}\ new\ old\ \widetilde{sequence}\end{matrix}\right\}\ \left\{\begin{vmatrix}\textbf{:from-end}\ bool_{\texttt{NIL}}\\ \left\{\begin{matrix}\textbf{:test}\ function_{\#\text{'eql}}\\ \textbf{:test-not}\ function\end{matrix}\right.\\ \textbf{:start}\ start_{0}\\ \textbf{:end}\ end_{\texttt{NIL}}\\ \textbf{:key}\ function\\ \textbf{:count}\ count_{\texttt{NIL}}\end{vmatrix}\right\})$$

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

$$(\left\{\begin{matrix}_f\textbf{substitute-if}\\ _f\textbf{substitute-if-not}\\ _f\textbf{nsubstitute-if}\\ _f\textbf{nsubstitute-if-not}\end{matrix}\right\}\ \begin{matrix}new\ test\ sequence\\ new\ test\ \widetilde{sequence}\end{matrix}\ \left\}\begin{vmatrix}\textbf{:from-end}\ bool_{\texttt{NIL}}\\ \textbf{:start}\ start_{0}\\ \textbf{:end}\ end_{\texttt{NIL}}\\ \textbf{:key}\ function\\ \textbf{:count}\ count_{\texttt{NIL}}\end{vmatrix}\right\})$$

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

$$(_f\textbf{replace}\ \widetilde{sequence\text{-}a}\ sequence\text{-}b\ \left\{\begin{vmatrix}\textbf{:start1}\ start\text{-}a_{0}\\ \textbf{:start2}\ start\text{-}b_{0}\\ \textbf{:end1}\ end\text{-}a_{\texttt{NIL}}\\ \textbf{:end2}\ end\text{-}b_{\texttt{NIL}}\end{vmatrix}\right\})$$

▷ Replace elements of *sequence-a* with elements of *sequence-b*.

(*f*map *type function sequence*$^+$)
▷ Apply *function* successively to corresponding elements of the *sequence*s. 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 *sequence*s.

(*f*reduce *function sequence* { :initial-value *foo*$_{\text{NIL}}$ | :from-end *bool*$_{\text{NIL}}$ | :start *start*$_{0}$ | :end *end*$_{\text{NIL}}$ | :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}$_{\text{\#'eql}}$ | :size *int* | :rehash-size *num* | :rehash-threshold *num* })
▷ Make a hash table.

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

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

▷ 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.

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

9 Control Structure

9.1 Predicates

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

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

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

(ₓ**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 ₓ**equalp** elements; or are structures of the same type with ₓ**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 ₓ**equalp** elements.

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

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

(ₓ**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, and NIL if there was no matching key in *property-list*.
(2) (3) (3)

(*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__ {*foo* (*ord-λ**) | (__setf__ *foo*) (*new-value ord-λ**)} | *m*__lambda__ (*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** {*foo* | (**setf** *foo*)})
▷ 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*] {*var* | (*macro*-λ*)}* [*E*]
[**&optional** {*var* | ({*var* | (*macro*-λ*)} [*init*NIL [*supplied-p*]])}*] [*E*]
[{**&rest** | **&body**} {*rest-var* | (*macro*-λ*)}] [*E*]
[**&key** {*var* | ({*var* | (**:***key* {*var* | (*macro*-λ*)})} [*init*NIL [*supplied-p*]])}* [*E*]
[**&allow-other-keys**] [**&aux** {*var* | (*var* [*init*NIL])}*] [*E*])
or
([**&whole** *var*] [*E*] {*var* | (*macro*-λ*)}* [*E*] [**&optional**
{*var* | ({*var* | (*macro*-λ*)} [*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.

({*m* **defmacro** | *m* **define-compiler-macro**} {*foo* | (**setf** *foo*)} (*macro*-λ*)
{(**declare** *decl**)* | *doc*} *form*P*)
▷ Define macro *foo* which on evaluation as (*foo tree*) applies expanded *form*s to arguments from *tree*, which corresponds to *tree*-shaped *macro*-λs. *form*s 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** *local-decl**)* | *doc*}
*macro-form*P*)*) (**declare** *decl**)* *form*P*)
▷ Evaluate *form*s 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** *decl**)* *form*P*)
▷ Evaluate *form*s with locally defined symbol macros *foo*.

(*m* **defsetf** *function* {*updater* [*doc*] | (*setf*-λ*) (*s-var**) {(**declare** *decl**)* | *doc*} *form*P*})
where defsetf lambda list (*setf*-λ*) has the form

(*var** [**&optional** {*var* | (*var* [*init*NIL [*supplied-p*]])}*] [**&rest** *var*] [**&key** {*var* | ({*var* | (:*key var*)} [*init*NIL [*supplied-p*]])}* [**&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** *decl**)* | *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*.

(f**get-setf-expansion** *place* [*environment*NIL])

▷ Return lists of temporary variables *arg-vars* and of corresponding *args* as given with *place*, list *newval-vars* with temporary variables corresponding to the new values, and *set-form* and *get-form* specifying in terms of *arg-vars* and *newval-vars* how to **setf** and how to read *place*.

(m**define-modify-macro** *foo* ([**&optional** {*var* | (*var* [*init*NIL [*supplied-p*]])}*] [**&rest** *var*]) *function* [*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*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`.

({m**when** | m**unless**} *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 *bars* 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

($_m$**do** | $_m$**do***) ({*var* | (*var* [*start* [*step*]])}*) (*stop* *result*P*) (**declare** *decl*^*)* {*tag* | *form*}*)

▷ 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** *decl*^*)* {*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** *decl*^*)* {*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** {*var-s* | (*var-s**)} [*d-type*] [= *foo*]}+

{**and** {*var-p* | (*var-p**)} [*d-type*] [= *bar*]}*

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

{**fixnum** | **float** | `T` | `NIL` | {**of-type** {*type* | (*type**)}}}

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

{{**for** | **as**} {*var-s* | (*var-s**)} [*d-type*]}+ {**and** {*var-p* | (*var-p**)} [*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*$_{\texttt{1}}$ | *function*$_{\texttt{\#'cdr}}$}

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

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

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

across *vector*

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

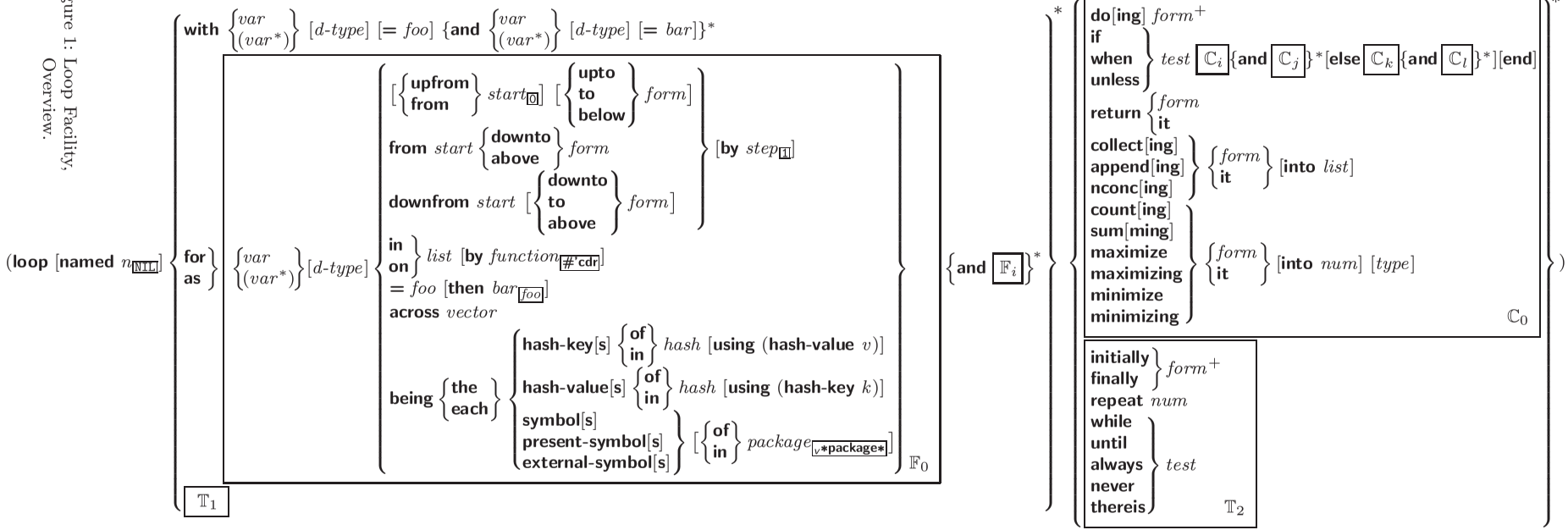
being {**the** | **each**}

▷ 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*$_{v}$***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** ({$\widehat{slot}$ | ($\widehat{var}$ $\widehat{slot}$)}*)
| $_m$**with-accessors** (($\widehat{var}$ $\widehat{accessor}$)*)) *instance* (**declare** $\widehat{decl}^*$)*
form^{P,*})
▷ Return values of *forms* 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** $\widetilde{instance}$ *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* $\left\{\begin{matrix}\textit{initform-slots}\\ \texttt{T}\end{matrix}\right\}$ {[__:__]*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* $\left\{\begin{matrix}\textbf{setf}\\ \textbf{slot-boundp}\\ \textbf{slot-makunbound}\\ \textbf{slot-value}\end{matrix}\right\}$ [*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__ $\left\{\begin{matrix}\textit{foo}\\ (\textbf{setf}\ \textit{foo})\end{matrix}\right\}$ (*required-var**
[__&optional__ $\left\{\begin{matrix}\textit{var}\\ (\textit{var})\end{matrix}\right\}^{*}$]
[__&rest__ *var*] [__&key__ $\left\{\begin{matrix}\textit{var}\\ (\textit{var}\,|\,(\textbf{:}\textit{key}\ \textit{var}))\end{matrix}\right\}^{*}$ [__&allow-other-keys__]])
$\left\{\begin{matrix}(\textbf{:argument-precedence-order}\ \textit{required-var}^{+})\\ (\textbf{declare}\ (\textbf{optimize}\ \textit{method-selection-optimization})^{+})\\ (\textbf{:documentation}\ \widehat{\textit{string}})\\ (\textbf{:generic-function-class}\ \textit{gf-class}\ \boxed{\textbf{standard-generic-function}})\\ (\textbf{:method-class}\ \textit{method-class}\ \boxed{\textbf{standard-method}})\\ (\textbf{:method-combination}\ \textit{c-type}\ \boxed{\textbf{standard}}\ \textit{c-arg}^{*})\\ (\textbf{:method}\ \textit{defmethod-args})^{*}\end{matrix}\right\}$)
▷ 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__ $\left\{\begin{matrix}\textit{foo}\\ (\textbf{setf}\ \textit{foo})\end{matrix}\right\}$
$\left\{\begin{matrix}\textbf{:argument-precedence-order}\ \textit{required-var}^{+}\\ \textbf{:declare}\ (\textbf{optimize}\ \textit{method-selection-optimization})\\ \textbf{:documentation}\ \textit{string}\\ \textbf{:generic-function-class}\ \textit{gf-class}\\ \textbf{:method-class}\ \textit{method-class}\\ \textbf{:method-combination}\ \textit{c-type}\ \textit{c-arg}^{*}\\ \textbf{:lambda-list}\ \textit{lambda-list}\\ \textbf{:environment}\ \textit{environment}\end{matrix}\right\}$)
▷ 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__ $\left\{\begin{matrix}\textit{foo}\\ (\textbf{setf}\ \textit{foo})\end{matrix}\right\}$ [$\left\{\begin{matrix}\textbf{:before}\\ \textbf{:after}\\ \textbf{:around}\\ \textit{qualifier}^{*}\end{matrix}\right\}$ $\boxed{\text{primary method}}$]
($\left\{\begin{matrix}\textit{var}\\ (\textit{spec-var}\ \left\{\begin{matrix}\textit{class}\\ (\textbf{eql}\ \textit{bar})\end{matrix}\right\})\end{matrix}\right\}^{*}$ [__&optional__
$\left\{\begin{matrix}\textit{var}\\ (\textit{var}\ [\textit{init}\ [\textit{supplied-p}]])\end{matrix}\right\}^{*}$] [__&rest__ *var*] [__&key__
$\left\{\begin{matrix}\textit{var}\\ (\left\{\begin{matrix}\textit{var}\\ (\textbf{:}\textit{key}\ \textit{var})\end{matrix}\right\}[\textit{init}\ [\textit{supplied-p}]])\end{matrix}\right\}^{*}$ [__&allow-other-keys__]]
[__&aux__ $\left\{\begin{matrix}\textit{var}\\ (\textit{var}\ [\textit{init}])\end{matrix}\right\}^{*}$]) $\left\{\begin{matrix}(\textbf{declare}\ \widehat{\textit{decl}^{*}})^{*}\\ \widehat{\textit{doc}}\end{matrix}\right\}$ $\textit{form}^{P*}$)

▷ 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.

($\left\{\begin{array}{l}{}_f\textbf{invalid-method-error}\ \textit{method}\\ {}_f\textbf{method-combination-error}\end{array}\right\}$ *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 $\frac{\mathtt{T}}{2}$ 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*
$\left\{\begin{array}{l}\textbf{:documentation}\ \widehat{\textit{string}}\\ \textbf{:identity-with-one-argument}\ \textit{bool}_{\boxed{\text{NIL}}}\\ \textbf{:operator}\ \textit{operator}_{\boxed{\textit{c-type}}}\end{array}\right\}$)

▷ **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*.

(*f* {**signal** / **warn** / **error**} {*condition* / *condition-type* {[**:**]*initarg-name value*}* / *control arg**})
▷ 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* {*condition continue-arg** / *condition-type* {[**:**]*initarg-name value*}* / *control arg**})
▷ 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 *forms* or, in case of **error**s, NIL and the condition.
2

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

(*m* **assert** *test* [(*place**) [{*condition continue-arg** / *condition-type* {[**:**]*initarg-name value*}* / *control arg**}]])
▷ 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-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 *forms* 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 *forms* after evaluating them with *condition-type*s dynamically bound to their respective *handler-function*s of argument condition.

(*m* **with-simple-restart** ({*restart* / NIL} *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**) {**:interactive** *arg-function* / **:report** {*report-function* / *string*"*restart*"} / **:test** *test-function*1} (**declare** $\widehat{decl}$*)* *restart-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__ (($\left\{\begin{matrix}\widehat{restart}\\ \texttt{NIL}\end{matrix}\right\}$ *restart-function*
$\left\{\begin{matrix}\textbf{:interactive-function}\ arg\text{-}function\\ \textbf{:report-function}\ report\text{-}function\\ \textbf{:test-function}\ test\text{-}function\end{matrix}\right\})^*$) $form^{P*}$)
▷ 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 are 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.

($\left\{\begin{matrix}f\textbf{find-restart}\\ f\textbf{compute-restarts}\ name\end{matrix}\right\}$ [*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*.

($\left\{\begin{matrix}f\textbf{abort}\\ f\textbf{muffle-warning}\\ f\textbf{continue}\\ f\textbf{store-value}\ value\\ f\textbf{use-value}\ value\end{matrix}\right\}$ [$condition_{\texttt{NIL}}$])
▷ 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 *form*s.

(*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*__$_{\texttt{NIL}}$
▷ 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 first *a-form** whose *type* is *foo* of. Return values of *b-forms* 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**) {($\widehat{\textbf{declare}\ decl*}$)* | $\widehat{doc}$} *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.

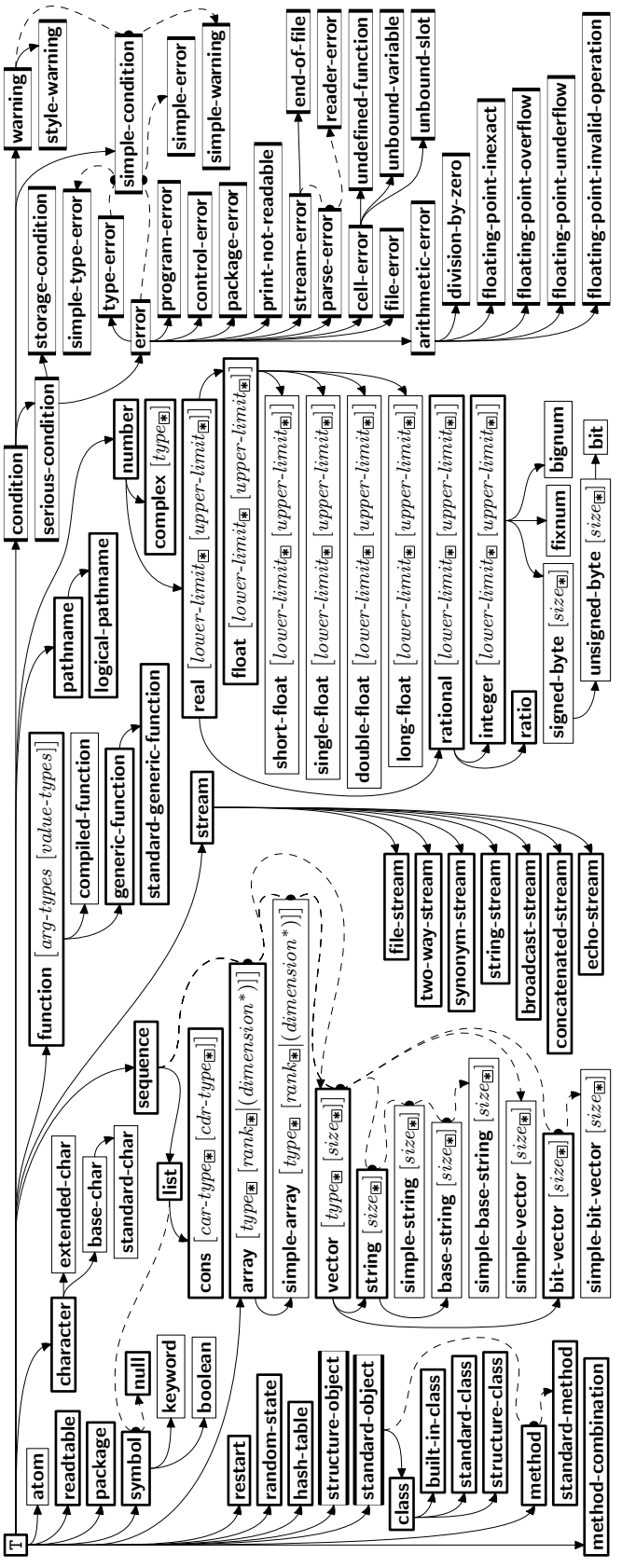


Figure 2: Precedence Order of System Classes (▭), Classes (▬), Types (▭), and Condition Types (▭).
Every type is also a supertype of NIL, the empty type.

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 *args*.

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

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

(*f*peek-char [*mode*$_{NIL}$ [*stream*$_{v*standard-input*}$ [*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*$_{v*standard-input*}$])
▷ Put last *f*read-chared *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*$_{v*standard-input*}$ [*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*$_{single\text{-}float}$
▷ 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

$\left(\begin{Bmatrix}{}_f\mathbf{prin1}\\ {}_f\mathbf{print}\\ {}_f\mathbf{pprint}\\ {}_f\mathbf{princ}\end{Bmatrix}\ foo\ [\widetilde{stream}_{\boxed{{}_v\ast\mathbf{standard\text{-}output}\ast}}]\right)$
▷ 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* $\widetilde{stream}$ $\left\{\begin{array}{l}\mathbf{:type}\ bool_{\boxed{\mathtt{NIL}}}\\ \mathbf{:identity}\ bool_{\boxed{\mathtt{NIL}}}\end{array}\right\}$) $form^{P}_{*}$)
▷ Enclosed in **#<** and **>**, print *foo* by means of *form*s to *stream*. Return NIL.

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

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

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

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

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

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

(ƒ{**write** | **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 ƒ**write** only.)

(ƒ**pprint-fill** *stream foo* [*parenthesis*$_T$ [*noop*]])
(ƒ**pprint-tabular** *stream foo* [*parenthesis*$_T$ [*noop* [*n*$_{16}$]]])
(ƒ**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 ƒ**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 ƒ**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*.

(ƒ**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.

(ƒ**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*~ *v* ***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* *v* ***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* *v* ***print-pprint-dispatch****])
▷ Return highest priority *function* associated with type of *foo* and T if there was a matching type specifier in *table*.

(*f* **copy-pprint-dispatch** [*table* *v* ***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*␣]]]
[:] [@] {**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*␣] [,'*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*␣] [,'*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*␣]]] [@] **F**
▷ **Fixed-Format Floating-Point.** With **@**, always prepend a sign.

~ [*width*] [,[*dec-digits*] [,[*exp-digits*] [,[*scale-factor*[1]]
[,'*overflow-char*] [,'*pad-char*␣] [,'*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*␣]]] [:]
[@] **$**
▷ **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*␣]]]
[:] [@] **<** [*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*"" ~;]|[*per-line-prefix* ~@;]} *body* [~; *suffix*"" ~: [@] >
▷ **Logical Block.** Act like **pprint-logical-block** using *body* as ƒ**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 ƒ**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 ƒ**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

(ƒ**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*.

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

▷ Return stream of indicated type.

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

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

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

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

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

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

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

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

(ƒ**synonym-stream-symbol** *synonym-stream*)

▷ Return symbol of *synonym-stream*.

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

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

(ƒ**file-position** *stream* [{ **:start** | **:end** | *position* }])

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

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

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

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

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

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

▷ Clear input from *stream*, return `NIL`.

({ ƒ**clear-output** | ƒ**force-output** | ƒ**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** $\widetilde{stream}$ [**:abort** *bool*$_{\texttt{NIL}}$])
▷ 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** $\widehat{decl}^*$)* *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* $\widetilde{stream}$) (**declare** $\widehat{decl}^*$)* *form*^{P*})
▷ Evaluate *form*s with *foo* locally bound to *stream*. Return values of *form*s.

(*m* **with-input-from-string** (*foo string* { **:index** $\widetilde{index}$ | **:start** *start*$_0$ | **:end** *end*$_{\texttt{NIL}}$ }) (**declare** $\widehat{decl}^*$)* *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* [$\widetilde{string}_{\texttt{NIL}}$ [**:element-type** *type*$_{\texttt{character}}$]])
(**declare** $\widehat{decl}^*$)* *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*$_{\text{host from }v\text{*default-pathname-defaults*}}$
| **:case** {**:local**|**:common**}$_{\texttt{:local}}$ }
▷ 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** }$_{\texttt{:local}}$])
(*f* **pathname-version** *path-or-stream*)
▷ Return pathname component.

(*f*parse-namestring *foo* [*host*
[*default-pathname*$_{v}$*default-pathname-defaults**
{:start *start*$_{0}$ | :end *end*$_{NIL}$ | :junk-allowed *bool*$_{NIL}$}]])
▷ 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*$_{:newest}$]])
▷ 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*:][;]{{*dir*|*}$^{+}$|**};}*{*name*|*}*[.{{*type*|*}$^{+}$|LISP}[.{*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$_{2}$ 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** | **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.

($\left\{\begin{matrix}_f\textbf{import}\\ _f\textbf{shadowing-import}\end{matrix}\right\}$ *symbols* [*package*$_{\boxed{_v\textbf{*package*}}}$])
▷ 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*$_{\boxed{_v\textbf{*package*}}}$])
▷ 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*$_{\boxed{_v\textbf{*package*}}}$])
▷ Make *symbols* external to *package*. Return T.

($_f$**unexport** *symbols* [*package*$_{\boxed{_v\textbf{*package*}}}$])
▷ Revert *symbols* to internal status. Return T.

($\left\{\begin{matrix}_m\textbf{do-symbols}\\ _m\textbf{do-external-symbols}\\ _m\textbf{do-all-symbols}\end{matrix}\right\}$ ($\widehat{var}$ [*package*$_{\boxed{_v\textbf{*package*}}}$ [*result*$_{\boxed{\texttt{NIL}}}$]])
($\textbf{declare}\ \widehat{decl^*})^*\ \left\{\begin{matrix}\widehat{tag}\\ form\end{matrix}\right\}^*$)
▷ 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**])
($\textbf{declare}\ \widehat{decl^*})^*\ form^{P_*}$)
▷ 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*$_{\boxed{\texttt{NIL}}}$])
▷ 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** [$s_{\boxed{\texttt{G}}}$])
▷ Return fresh, uninterned symbol #:*sn* with *n* from $_v$***gensym-counter***. Increment $_v$***gensym-counter***.

($_f$**gentemp** [*prefix*$_{\boxed{\texttt{T}}}$ [*package*$_{\boxed{_v\textbf{*package*}}}$]])
▷ Intern fresh symbol in package. Deprecated.

($_f$**copy-symbol** *symbol* [*props*$_{\boxed{\texttt{NIL}}}$])
▷ 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*)
▷ Name or package, respectively, of *symbol*.

($_f$**symbol-plist** *symbol*)
($_f$**symbol-value** *symbol*)
($_f$**symbol-function** *symbol*)
▷ Property list, value, or function, respectively, of *symbol*. **setf**able.

(⎧g**documentation**⎫ ⎧**'variable**|**'function**⎫)
(⎩(**setf** g**documentation**) *new-doc*⎭ *foo* ⎨**'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*⎫ [*definition*])
⎨*name*⎬
⎩(**setf** *name*)⎭

▷ 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. (2) (3)

(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. (2) (3)

(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***⎫ ⎧**pathname*** NIL
v***load***⎭ ⎩**truename*** NIL

▷ Input file used by f**compile-file**/by f**load**.

v***compile***⎫ ⎧**print***
v***load***⎭ ⎩**verbose***

▷ Defaults used by f**compile-file**/by f**load**.

(*s*eval-when ($\left\{\begin{array}{l}\{\text{:compile-toplevel}\,|\,\text{compile}\}\\ \{\text{:load-toplevel}\,|\,\text{load}\}\\ \{\text{:execute}\,|\,\text{eval}\}\end{array}\right\}$) $form^{P*}$)

▷ Return values of *forms* if **seval-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 $bool_{\text{NIL}}$]) $form^{P*}$)

▷ 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* [$\widehat{read\text{-}only}_{\text{NIL}}$])

▷ 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.[2]

(*f*make-load-form-saving-slots *foo* $\left\{\begin{array}{l}\text{:slot-names } slots_{\text{all local slots}}\\ \text{:environment } environment\end{array}\right\}$)

▷ 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*.[2]

(*f*macro-function *symbol* [*environment*])

(*f*compiler-macro-function $\left\{\begin{array}{l}name\\ (\text{setf } name)\end{array}\right\}$ [*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* [$package_{\text{NIL}}$])

▷ Print interned symbols containing *string*.

(*f*apropos-list *string* [$package_{\text{NIL}}$])

▷ 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*$_{\text{NIL}}$]) ▷ Invoke editor if possible.

($\left\{\begin{array}{l}f\text{macroexpand-1}\\ f\text{macroexpand}\end{array}\right\}$ *form* [$environment_{\text{NIL}}$])

▷ Return macro expansion, once or entirely, respectively, of *form* and T if *form* was a macro form. Return *form* and NIL otherwise.[2]

*v**macroexpand-hook*

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

($_m$**trace** $\left\{\begin{array}{l}function\\(\textbf{setf}\ function)\end{array}\right\}^*$)
▷ Cause *function*s to be traced. With no arguments, return list of traced functions.

($_m$**untrace** $\left\{\begin{array}{l}function\\(\textbf{setf}\ function)\end{array}\right\}^*$)
▷ 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* [$\widetilde{stream}$ $_v$***standard-output***])
▷ Send information about *foo* to *stream*.

($_g$**describe-object** *foo* [$\widetilde{stream}$])
▷ 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** $\widehat{decl^*}$)
▷ Globally make declaration(s) *decl*. *decl* can be: **declaration**, **type**, **ftype**, **inline**, **notinline**, **optimize**, or **special**. See below.

(**declare** $\widehat{decl^*}$)
▷ 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*.

($\left\{\begin{array}{l}\textbf{ignorable}\\\textbf{ignore}\end{array}\right\}$ $\left\{\begin{array}{l}var\\(\textbf{function}\ function)\end{array}\right\}^*$)
▷ 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** $\left\{\begin{array}{l}\textbf{compilation-speed}\,|\,(\textbf{compilation-speed}\ n_{\boxed{3}})\\\textbf{debug}\,|\,(\textbf{debug}\ n_{\boxed{3}})\\\textbf{safety}\,|\,(\textbf{safety}\ n_{\boxed{3}})\\\textbf{space}\,|\,(\textbf{space}\ n_{\boxed{3}})\\\textbf{speed}\,|\,(\textbf{speed}\ n_{\boxed{3}})\end{array}\right\}$)
▷ 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*$_{\text{curr}}$])
(*f* **get-universal-time**)
▷ Seconds from 1900-01-01, 00:00, ignoring leap seconds.

(*f* **decode-universal-time** *universal-time* [*time-zone*$_{\text{current}}$])
(*f* **get-decoded-time**)
▷ Return second$_{1}$, minute$_{2}$, hour$_{3}$, date$_{4}$, month$_{5}$, year$_{6}$, day$_{7}$, daylight-p$_{8}$, and zone$_{9}$.

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

$$\left(\left\{\begin{array}{l}f\,\textbf{lisp-implementation}\\ f\,\textbf{software}\\ f\,\textbf{machine}\end{array}\right\}\text{-}\left\{\begin{array}{l}\textbf{type}\\ \textbf{version}\end{array}\right\}\right)$$
▷ Name or version of implementation, operating system, or hardware, respectively.

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

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