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*.

$\left\{\middle|\begin{matrix} foo \\ bar \\ baz \end{matrix}\right.$ ▷ 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 21.

$\underline{foo}$; $\underline{\underset{2}{bar}}$; $\underline{\underset{n}{baz}}$ ▷ Primary, secondary, and nth 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

($_f$+ $a_{\boxed{0}}^*$)
($_f$* $a_{\boxed{1}}^*$)
▷ 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.

($\left\{\begin{matrix}{}_m\textbf{incf}\\ {}_m\textbf{decf}\end{matrix}\right\}$ $\widetilde{\textit{place}}$ [$\textit{delta}_{\boxed{1}}$])
▷ 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* [$b_{\boxed{e}}$])
▷ 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*$^*_{\boxed{1}}$)
($_f$**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* [$b_{\boxed{1}}$])
▷ $\arctan \frac{a}{b}$ in radians.

(*f*sinh *a*)
(*f*cosh *a*)
(*f*tanh *a*)
▷ sinh *a*, cosh *a*, or tanh *a*, respectively.

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

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

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

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

({*f*round | *f*fround}
{*f*floor | *f*ffloor}
{*f*ceiling | *f*fceiling}
{*f*truncate | *f*ftruncate} *n* [*d*1])
▷ Return as **integer** or **float**, respectively, *n*/*d* rounded, or rounded towards $-\infty$, $+\infty$, or 0, respectively; and remainder[2].

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

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

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

v*random-state* ▷ Current random state.

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

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

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

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

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

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

(*f*abs *n*) ▷ Return $|n|$.

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

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

1.3 Logic Functions

Negative integers are used in two's complement representation.

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

*c*boole-1 ▷ *int-a*.
*c*boole-2 ▷ *int-b*.
*c*boole-c1 ▷ $\neg$*int-a*.
*c*boole-c2 ▷ $\neg$*int-b*.
*c*boole-set ▷ All bits set.
*c*boole-clr ▷ All bits zero.
*c*boole-eqv ▷ *int-a* $\equiv$ *int-b*.
*c*boole-and ▷ *int-a* $\wedge$ *int-b*.
*c*boole-andc1 ▷ $\neg$*int-a* $\wedge$ *int-b*.
*c*boole-andc2 ▷ *int-a* $\wedge \neg$*int-b*.
*c*boole-nand ▷ $\neg$(*int-a* $\wedge$ *int-b*).
*c*boole-ior ▷ *int-a* $\vee$ *int-b*.
*c*boole-orc1 ▷ $\neg$*int-a* $\vee$ *int-b*.
*c*boole-orc2 ▷ *int-a* $\vee \neg$*int-b*.
*c*boole-xor ▷ $\neg$(*int-a* $\equiv$ *int-b*).
*c*boole-nor ▷ $\neg$(*int-a* $\vee$ *int-b*).

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

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

(*f*logandc1 *int-a int-b*) ▷ $\neg$*int-a* $\wedge$ *int-b*.

(*f*logandc2 *int-a int-b*) ▷ *int-a* $\wedge \neg$*int-b*.

(*f*lognand *int-a int-b*) ▷ $\neg$(*int-a* $\wedge$ *int-b*).

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

(*f*logorc1 *int-a int-b*) ▷ $\neg$*int-a* $\vee$ *int-b*.

(*f*logorc2 *int-a int-b*) ▷ *int-a* $\vee \neg$*int-b*.

(*f*lognor *int-a int-b*) ▷ $\neg$(*int-a* $\vee$ *int-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* ≥ 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.

(*f*{__deposit-field__, __dpb__} *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 −∞ or +∞, respectively.

(*f*__decode-float__ *n*)
(*f*__integer-decode-float__ *n*)
▷ Return significand, exponent, and sign of **float** *n*.

(*f*__scale-float__ *n* [*i*]) ▷ With *n*'s radix *b*, return nb^i.

(*f*__float-radix__ *n*)
(*f*__float-digits__ *n*)
(*f*__float-precision__ *n*)
▷ Radix, number of digits in that radix, or precision in that radix, respectively, of float *n*.

(*f*__upgraded-complex-part-type__ *foo* [*environment*NIL])
▷ Type of most specialized **complex** number able to hold parts of type *foo*.

2 Characters

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

(*f*__characterp__ *foo*)
(*f*__standard-char-p__ *char*) ▷ T if argument is of indicated type.

(*f*__graphic-char-p__ *character*)
(*f*__alpha-char-p__ *character*)
(*f*__alphanumericp__ *character*)
▷ T if *character* is visible, alphabetic, or alphanumeric, respectively.

(*f*__upper-case-p__ *character*)
(*f*__lower-case-p__ *character*)
(*f*__both-case-p__ *character*)
▷ Return T if *character* is uppercase, lowercase, or able to be in another case, respectively.

(*f*__digit-char-p__ *character* [$radix_{10}$])
▷ Return its weight if *character* is a digit, or NIL otherwise.

(*f*__char=__ $character^+$)
(*f*__char/=__ $character^+$)
▷ Return T if all *character*s, or none, respectively, are equal.

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

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

(*f*__char-greaterp__ $character^+$)
(*f*__char-not-lessp__ $character^+$)
(*f*__char-lessp__ $character^+$)
(*f*__char-not-greaterp__ $character^+$)
▷ Return T if *character*s are monotonically decreasing, monotonically non-increasing, monotonically increasing, or monotonically non-decreasing, respectively, ignoring case.

(*f*__char-upcase__ *character*)
(*f*__char-downcase__ *character*)
▷ Return corresponding uppercase/lowercase character, respectively.

(*f*__digit-char__ *i* [$radix_{10}$]) ▷ Character representing digit *i*.

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

(*f*__name-char__ *foo*) ▷ Character named *foo* if any, or NIL.

(*f*__char-int__ *character*)
(*f*__char-code__ *character*) ▷ Code of *character*.

(*f*__code-char__ *code*) ▷ Character with *code*.

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

(*f*__character__ *c*) ▷ Return #*c*.

3 Strings

Strings can as well be manipulated by array and sequence functions; see pages 11 and 12.

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

(*f* {**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.

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

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

(*f* **string** *x*)
(*f* {**string-capitalize** | **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.

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

(*f* {**string-trim** | **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. **setf**able.

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

4 Conses

4.1 Predicates

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

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

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

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

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

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

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

4.2 Lists

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

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

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

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

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

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

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

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

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

(*f*nth *n list*) ▷ Zero-indexed *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*.

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

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

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

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

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

(*m*pushnew *foo* $\widetilde{place}$ { [:test *function* #'eql | :test-not *function*] | :key *function* })
▷ Set *place* to (*f*adjoin *foo place*).

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

(*f*revappend *list foo*)
(*f*nreconc $\widetilde{list}$ *foo*)
▷ Return concatenated list after reversing order in *list*.

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

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

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

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

4.3 Association Lists

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

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

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

(*f*copy-alist *alist*) ▷ Return copy of *alist*.

4.4 Trees

(*f*tree-equal *foo bar* [:test *test* #'eql | :test-not *test*])
▷ Return T if trees *foo* and *bar* have same shape and leaves satisfying *test*.

({*f*subst *new old tree* | *f*nsubst *new old* $\widetilde{tree}$} { [: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* $\widetilde{tree}$} [:key *function*])
▷ Make copy of *tree* with each subtree or leaf satisfying *test* replaced by *new*.

($_f$ {**sublis** | **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** | **set-difference** | **union** | **set-exclusive-or** | **nintersection** | **nset-difference** | **nunion** | **nset-exclusive-or**} *a 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] | **adjust-array** *array dimension-sizes*
[**:element-type** *type*T | **:fill-pointer** {*num* | *bool*}NIL | **:initial-element** *obj* | **:initial-contents** *tree-or-array* | **:displaced-to** *array*NIL [**:displaced-index-offset** *i*0]])
▷ Return fresh, or readjust, respectively, vector or array.

($_f$ **aref** *array* [*subscripts*])
▷ Return array element pointed to by *subscripts*. **setf**able.

($_f$ **row-major-aref** *array i*)
▷ Return *i*th element of *array* in row-major order. **setf**able.

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

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

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

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

($_f$ **array-rank** *array*) ▷ Number of dimensions of *array*.

($_f$ **array-displacement** *array*) ▷ Target array and offset.
2

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

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

(*f* {**bit-eqv** | **bit-and** | **bit-andc1** | **bit-andc2** | **bit-nand** | **bit-ior** | **bit-orc1** | **bit-orc2** | **bit-xor** | **bit-nor**} *bit-array-a bit-array-b* [*result-bit-array*$_{\texttt{NIL}}$])
▷ Return result of bitwise logical operations (cf. operations of *f* **boole**, page 5) on *bit-array-a* and *bit-array-b*. If *result-bit-array* is `T`, put result in *bit-array-a*; if it is `NIL`, make a new array for result.

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

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

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

5.3 Vector Functions

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

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

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

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

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

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

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

6 Sequences

6.1 Sequence Predicates

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

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

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

▷ Return position in *sequence-a* where *sequence-a* and *sequence-b* begin to mismatch. Return NIL if they match entirely.

6.2 Sequence Functions

(*f* **make-sequence** *sequence-type size* [**:initial-element** *foo*])

▷ Make sequence of *sequence-type* with *size* elements.

(*f* **concatenate** *type sequence**)

▷ Return concatenated sequence of *type*.

(*f* **merge** *type* $\widetilde{sequence}$*-a* $\widetilde{sequence}$*-b test* [**:key** *function*[NIL]])

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

(*f* **fill** $\widetilde{sequence}$ *foo* { **:start** *start*[0] | **:end** *end*[NIL] })

▷ Return *sequence* after setting elements between *start* and *end* to *foo*.

(*f* **length** *sequence*)

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

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

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

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

▷ Return number of elements in *sequence* which satisfy *test*.

(*f* **elt** *sequence index*)

▷ Return element of *sequence* pointed to by zero-indexed *index*. **setf**able.

(*f* **subseq** *sequence start* [*end*[NIL]])

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

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

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

(*f* **reverse** *sequence*)
(*f* **nreverse** $\widetilde{sequence}$)

▷ Return *sequence* in reverse order.

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

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

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

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

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

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

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

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

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

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

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

▷ Make copy of *sequence* without duplicates.

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

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

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

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

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

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

$(_f\textbf{map}\ type\ function\ sequence^{+})$

▷ Apply *function* successively to corresponding elements of the *sequence*s. Return values as a sequence of *type*. If *type* is NIL, return NIL.

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

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

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

7 Hash Tables

The Loop Facility provides additional hash table-related functionality; see **loop**, page 22.

Key-value storage similar to hash tables can as well be achieved using association lists and property lists; see pages 10 and 17.

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

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

(ƒ**gethash** *key hash-table* [*default*NIL])
▷ Return object with *key* if any or *default* otherwise; and T2 if found, NIL2 otherwise. **setf**able.

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

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

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

(ƒ**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.

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

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

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

8 Structures

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

▷ Define structure *foo* together with functions `MAKE-`*foo*, `COPY-`*foo* and *foo*`-P`; and **setf**able accessors *foo*`-`*slot*. Instances are of class *foo* or, if **defstruct** option **:type** is given, of the specified type. They can be created by (`MAKE-`*foo* {**:**_slot_ _value_}*) or, if *ord*-λ (see page 18) is given, by (*maker* *arg** {**:**_key_ _value_}*). In the latter case, *arg*s and **:***key*s correspond to the positional and keyword parameters defined in *ord*-λ whose *var*s in turn correspond to *slot*s. **:print-object**/**:print-function** generate a $_g$**print-object** method for an instance *bar* of *foo* calling (*o-printer bar stream*) or (*f-printer bar stream print-level*), respectively. If **:type** without **:named** is given, no *foo*`-P` is created.

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

9 Control Structure

9.1 Predicates

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

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

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

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

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

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

(*f* **constantp** *foo* [*environment*$_{\texttt{NIL}}$])
▷ 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**} $\widehat{foo}$ *form* [$\widehat{doc}$])
▷ Assign value of *form* to global constant/dynamic variable *foo*.

(*m* **defvar** $\widehat{foo}$ [*form* [$\widehat{doc}$]])
▷ 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** $\widetilde{symbol}$ *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** $\widetilde{place}^{+}$ *foo*)
▷ Store value of *foo* in rightmost *place* shifting values of *place*s left, returning first *place*.

(*m* **rotatef** $\widetilde{place}^{*}$)
▷ Rotate values of *place*s left, old first becoming new last *place*'s value. Return NIL.

(*f* **makunbound** $\widetilde{foo}$) ▷ Delete special variable *foo* if any.

(*f* **get** *symbol key* [*default*$_{\texttt{NIL}}$])
(*f* **getf** *place key* [*default*$_{\texttt{NIL}}$])
▷ 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$_2$ of first entry from *property-list* matching a key from *keys*, and tail of *property-list*$_3$ starting with that key. Return NIL, NIL$_2$, and NIL$_3$ if there was no matching key in *property-list*.

(*f* **remprop** $\widetilde{symbol}$ *key*)
(*m* **remf** $\widetilde{place}$ *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*$_{\texttt{NIL}}$])}*) (**declare** $\widehat{decl}^{*}$)* $form^{P}_{*}$)
▷ 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 ($\widehat{var}^*$) *values-form* (declare $\widehat{decl}^*$)* *body-form*^{P*})
▷ Evaluate *body-forms* with *vars* lexically bound to the return values of *values-form*. Return values of *body-forms*.

(*m*destructuring-bind *destruct-λ bar* (declare $\widehat{decl}^*$)* *form*^{P*})
▷ Evaluate *forms* 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

$$(var^* \ [\text{\&optional } \{var \mid (var \ [init_{\boxed{\text{NIL}}} \ [supplied\text{-}p]])\}^*] \ [\text{\&rest } var]$$
$$[\text{\&key } \{var \mid (\{var \mid (\text{:}key \ var)\} \ [init_{\boxed{\text{NIL}}} \ [supplied\text{-}p]])\}^* \ [\text{\&allow-other-keys}]]$$
$$[\text{\&aux } \{var \mid (var \ [init_{\boxed{\text{NIL}}}])\}^*]).$$

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

({*m*defun | *m*lambda} {*foo* (*ord-λ**) | (setf *foo*) (*new-value ord-λ**)} (declare $\widehat{decl}^*$)* [$\widehat{doc}$] *form*^{P*})
▷ Define a function named *foo* or (setf *foo*), or an anonymous function, respectively, which applies *forms* to *ord-λ*s. For *m*defun, *forms* 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 *forms* 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 *forms*.

(*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 *args* and the list elements of *args*. setfable if *function* is one of *f*aref, *f*bit, and *f*sbit.

(*f*funcall *function* arg*) ▷ Values of *function* called with *args*.

(*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 *foos*. setfable.

(*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*.
2 3

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

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

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

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

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

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

(*f*get-setf-expansion *place* [*environment*$_{\texttt{NIL}}$])
▷ Return lists of temporary variables *arg-vars*^{1} and of corresponding *args*^{2} as given with *place*, list *newval-vars*^{3} with temporary variables corresponding to the new values, and *set-form*^{4} and *get-form*^{5} specifying in terms of *arg-vars* and *newval-vars* how to **setf** and how to read *place*.

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

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

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

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

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

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

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

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

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

9.5 Control Flow

(*s*__if__ *test then* [*else*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* ({(*key**) / *key*} *foo*P*)* [({__otherwise__ / T} *bar*P*)NIL])
▷ Return the values of the first *foo** one of whose *key*s is __eql__ *test*. Return values of *bar*s if there is no matching *key*.

({*m*__ecase__ / *m*__ccase__} *test* ({(*key**) / *key*} *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**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**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**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*.

({*m*__prog__ / *m*__prog*__} ({*name* | (*name* [*value*NIL])}*) (__declare__ (*decl**)* {*tag* / *form*}*)
▷ 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*NIL])
(*m*__return__ [*result*NIL])
▷ Have nearest enclosing *s*__block__ named *foo*/named NIL, respectively, return with values of *result*.

(*s*__tagbody__ {*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__ *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*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*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*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*1 | *function*#'cdr}
▷ Specify the (positive) decrement or increment or the *function* of one argument returning the next part of the list.

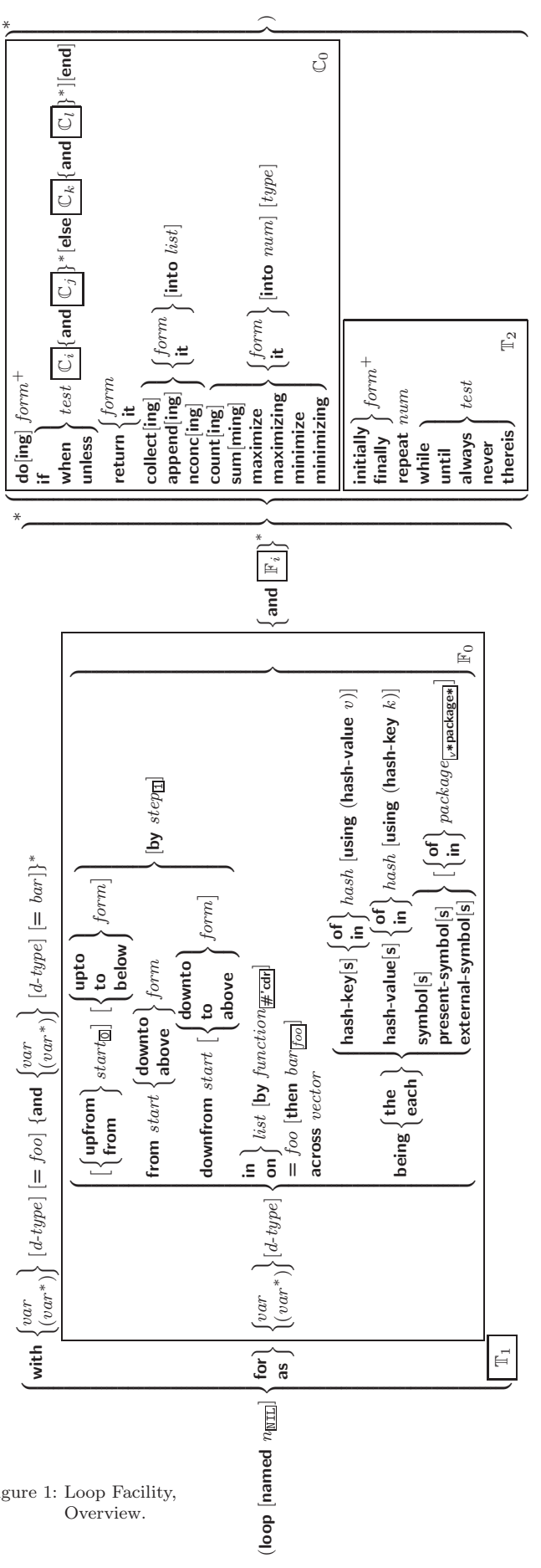

Figure 1: Loop Facility, Overview.

= *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.

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

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

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

(*g*update-instance-for-redefined-class *new-instance added-slots discarded-slots discarded-slots-property-list* {:*initarg value*}* *other-keyarg**)
▷ On behalf of *g*make-instances-obsolete and by means of *g*shared-initialize, set any *initarg* slots to their corresponding *value*s; set any remaining *added-slots* to the values of their **:initform** forms. Not to be called by user.

(*g*allocate-instance *class* {:*initarg value*}* *other-keyarg**)
▷ Return uninitialized instance of *class*. Called by *g*make-instance.

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

(*g*slot-missing *class instance slot* { **setf** / **slot-boundp** / **slot-makunbound** / **slot-value** } [*value*])
(*g*slot-unbound *class instance slot*)
▷ Called on attempted access to non-existing or unbound *slot*. Default methods signal **error**/**unbound-slot**, respectively. Not to be called by user.

10.2 Generic Functions

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

(*m*defgeneric { *foo* / (**setf** *foo*) } (*required-var** [**&optional** { *var* / (*var*) }*] [**&rest** *var*] [**&key** { *var* / (*var* | (:*key var*)) }* [**&allow-other-keys**]])
{ (**:argument-precedence-order** *required-var*+) / (**declare** (**optimize** *method-selection-optimization*)+) / (**:documentation** $\widehat{\textit{string}}$) / (**:generic-function-class** *gf-class* standard-generic-function) / (**:method-class** *method-class* standard-method) / (**:method-combination** *c-type* standard *c-arg**) / (**:method** *defmethod-args*)* }
▷ Define or modify generic function *foo*. Remove any methods previously defined by defgeneric. *gf-class* and the lambda paramters *required-var** and *var** must be compatible with existing methods. *defmethod-args* resemble those of *m*defmethod. For *c-type* see section 10.3.

(*f*ensure-generic-function { *foo* / (**setf** *foo*) }

$$\left\{\begin{array}{l}\textbf{:argument-precedence-order}\ \textit{required-var}^{+}\\ \textbf{:declare}\ (\textbf{optimize}\ \textit{method-selection-optimization})\\ \textbf{:documentation}\ \textit{string}\\ \textbf{:generic-function-class}\ \textit{gf-class}\\ \textbf{:method-class}\ \textit{method-class}\\ \textbf{:method-combination}\ \textit{c-type}\ \textit{c-arg}^{*}\\ \textbf{:lambda-list}\ \textit{lambda-list}\\ \textbf{:environment}\ \textit{environment}\end{array}\right\})$$

▷ 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** $\left\{\begin{array}{l}\textit{foo}\\ (\textbf{setf}\ \textit{foo})\end{array}\right\}$ $[\left\{\begin{array}{l}\textbf{:before}\\ \textbf{:after}\\ \textbf{:around}\\ \textit{qualifier}^{*}\end{array}\right\}$ primary method$]$
$(\left\{\begin{array}{l}\textit{var}\\ (\textit{spec-var}\ \left\{\begin{array}{l}\textit{class}\\ (\textbf{eql}\ \textit{bar})\end{array}\right\})\end{array}\right\}^{*}$ $[\textbf{\&optional}$
$\left\{\begin{array}{l}\textit{var}\\ (\textit{var}\ [\textit{init}\ [\textit{supplied-p}]])\end{array}\right\}^{*}]$ $[\textbf{\&rest}\ \textit{var}]$ $[\textbf{\&key}$
$\left\{\begin{array}{l}\textit{var}\\ (\left\{\begin{array}{l}\textit{var}\\ (\textbf{:}\textit{key}\ \textit{var})\end{array}\right\}[\textit{init}\ [\textit{supplied-p}]])\end{array}\right\}^{*}$ $[\textbf{\&allow-other-keys}]]$
$[\textbf{\&aux}\ \left\{\begin{array}{l}\textit{var}\\ (\textit{var}\ [\textit{init}])\end{array}\right\}^{*}])$ $\left\{\begin{array}{l}\widehat{(\textbf{declare}\ \textit{decl}^{*})^{*}}\\ \widehat{\textit{doc}}\end{array}\right\}$ $\textit{form}^{P,*}$)

▷ 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 $\textit{form}^{*}$. *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*$_{\boxed{\mathrm{T}}}$])

▷ 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** $\textit{arg}^{*}$ 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 38.

($_{g}$**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 $\frac{\mathrm{T}}{2}$ 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*
{ | **:documentation** *string*^
  | **:identity-with-one-argument** *bool*[NIL]
  | **:operator** *operator*[*c-type*] }^)
▷ **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 18, 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 32.

($_m$**define-condition** *foo* (*parent-type** **condition**)
$$\left(\left\{\begin{array}{l} \textit{slot} \\ \left(\textit{slot}\ \left\{\begin{array}{l} \{\textbf{:reader}\ \textit{reader}\}^* \\ \{\textbf{:writer}\ \left\{\begin{array}{l}\textit{writer}\\(\textbf{setf}\ \textit{writer})\end{array}\right\}\}^* \\ \{\textbf{:accessor}\ \textit{accessor}\}^* \\ \textbf{:allocation}\ \left\{\begin{array}{l}\textbf{:instance}\\\textbf{:class}\end{array}\right\}_{\textbf{:instance}} \\ \{\textbf{:initarg}\ \textit{:initarg-name}\}^* \\ \textbf{:initform}\ \textit{form} \\ \textbf{:type}\ \textit{type} \\ \textbf{:documentation}\ \textit{slot-doc}\end{array}\right\}\right) \end{array}\right\}^*\right)$$
$$\left\{\begin{array}{l}(\textbf{:default-initargs}\ \{\textit{name}\ \textit{value}\}^*) \\ (\textbf{:documentation}\ \textit{condition-doc}) \\ (\textbf{:report}\ \left\{\begin{array}{l}\textit{string}\\\textit{report-function}\end{array}\right\})\end{array}\right\})$$
▷ Define, as a subtype of *parent-type*s, condition type *foo*. In a new condition, a *slot*'s value defaults to *form* unless set via **:***initarg-name*; it is readable via (*reader i*) or (*accessor i*), and writable via (*writer value i*) or (**setf** (*accessor i*) *value*). With **:allocation :class**, *slot* is shared by all conditions of type *foo*. A condition is reported by *string* or by *report-function* of arguments condition and stream.

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

$$(\left\{\begin{array}{l}{}_f\textbf{signal}\\{}_f\textbf{warn}\\{}_f\textbf{error}\end{array}\right\}\ \left\{\begin{array}{l}\textit{condition}\\\textit{condition-type}\ \{\textbf{:}\textit{initarg-name}\ \textit{value}\}^*\\\textit{control}\ \textit{arg}^*\end{array}\right\})$$
▷ Unless handled, signal as **condition**, **warning** or **error**, respectively, *condition* or a new instance of *condition-type* or, with $_f$**format** *control* and *arg*s (see page 38), **simple-condition**, **simple-warning**, or **simple-error**, respectively. From $_f$**signal** and $_f$**warn**, return `NIL`.

($_f$**cerror** *continue-control* $\left\{\begin{array}{l}\textit{condition}\ \textit{continue-arg}^*\\\textit{condition-type}\ \{\textbf{:}\textit{initarg-name}\ \textit{value}\}^*\\\textit{control}\ \textit{arg}^*\end{array}\right\}$)
▷ Unless handled, signal as correctable **error** *condition* or a new instance of *condition-type* or, with $_f$**format** *control* and *arg*s (see page 38), **simple-error**. In the debugger, use $_f$**format** arguments *continue-control* and *continue-arg*s to tag the continue option. Return `NIL`.

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

($_f$**invoke-debugger** *condition*)
▷ Invoke debugger with *condition*.

($_m$**assert** *test* [(*place**) [$\left\{\begin{array}{l}\textit{condition}\ \textit{continue-arg}^*\\\textit{condition-type}\ \{\textbf{:}\textit{initarg-name}\ \textit{value}\}^*\\\textit{control}\ \textit{arg}^*\end{array}\right\}$]])
▷ If *test*, which may depend on *place*s, returns `NIL`, signal as correctable **error** *condition* or a new instance of *condition-type* or, with $_f$**format** *control* and *arg*s (see page 38), **error**. When using the debugger's continue option, *place*s can be altered before re-evaluation of *test*. Return `NIL`.

($_m$**handler-case** *foo* (*type* ([*var*]) (**declare** $\widehat{decl}^*$)* $condition\text{-}form^{P*}$)*
[(**:no-error** (*ord-*λ^*) (**declare** $\widehat{decl}^*$)* $form^{P*}$)])
▷ If, on evaluation of *foo*, a condition of *type* is signalled, evaluate matching *condition-form*s with *var* bound to the condition, and return their values. Without a condition, bind *ord-*λs to values of *foo* and return values of *form*s or, without a **:no-error** clause, return values of *foo*. See page 18 for (*ord-*λ^*).

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

($_m$**with-simple-restart** ($\left\{\begin{matrix}restart\\ \texttt{NIL}\end{matrix}\right\}$ *control* *arg**) *form*^{P*})

▷ Return values of *forms* unless *restart* is called during their evaluation. In this case, describe *restart* using $_f$**format** *control* and *arg*s (see page 38) and return `NIL` and `T`.

($_m$**restart-case** *form* (*restart* (*ord-λ**) $\left\{\begin{matrix}\textbf{:interactive}\ arg\text{-}function\\ \textbf{:report}\ \left\{\begin{matrix}report\text{-}function\\ string_{\text{"}restart\text{"}}\end{matrix}\right.\\ \textbf{:test}\ test\text{-}function_{\texttt{T}}\end{matrix}\right\}$
(**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 18 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 *form*s evaluated with dynamically established *restart*s whose *restart-function*s should perform a non-local transfer of control. A restart is visible under *condition* if (*test-function condition*) returns `T`. If presented in the debugger, *restart*s ar described by *restart-function* (of a stream). A *restart* can be called by (**invoke-restart** *restart arg**), where *arg*s must be suitable for the corresponding *restart-function*, or by (**invoke-restart-interactively** *restart*) where a list of the respective *arg*s is supplied by *arg-function*.

($_f$**invoke-restart** *restart arg**)
($_f$**invoke-restart-interactively** *restart*)

▷ Call function associated with *restart* with arguments given or prompted for, respectively. If *restart* function returns, return its values.

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

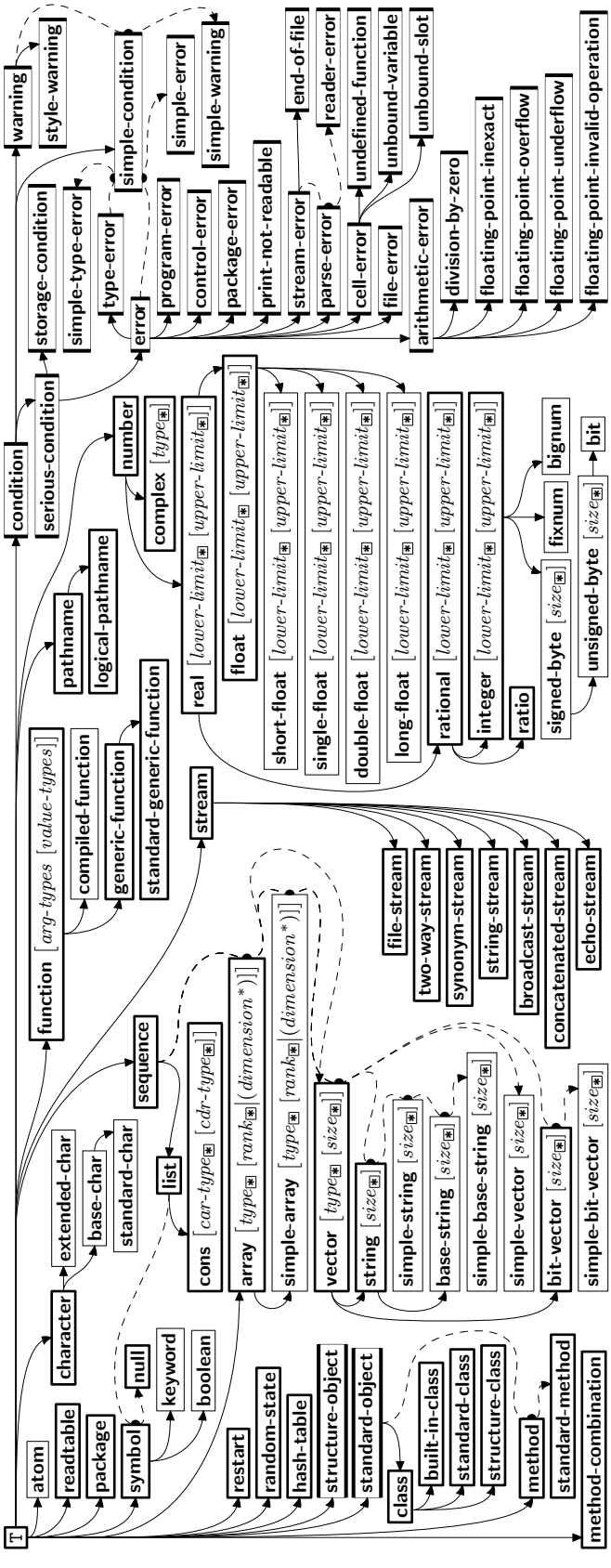

Figure 2: Precedence Order of System Classes (▭), Classes (▬), Types (▭), and Condition Types (▭).
Every type is also a supertype of NIL, the empty type.

(*m*__deftype__ *foo* (*macro-λ**) (__declare__ $\widehat{decl^*}$)* [$\widehat{doc}$] *form*^{P*})
▷ Define type *foo* which when referenced as (*foo* $\widehat{arg^*}$) (or as *foo* if *macro-λ* doesn't contain any required parameters) applies expanded *form*s to *arg*s returning the new type. For (*macro-λ**) see page 19 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.

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 38, *f*__format__, for *control* and *arg*s.

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

({*f*__read__ / *f*__read-preserving-whitespace__} [$\widetilde{stream}$[*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-char**ed *character* back into *stream*; return NIL.

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

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

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

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

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

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

v ***readtable*** ▷ Current readtable.

v ***read-base***$_{10}$ ▷ Radix for reading **integer**s and **ratio**s.

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

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

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

(*f* **get-macro-character** *char* [*rt*$_{v*readtable*}$])
▷ Reader macro function associated with *char*, and $\frac{T}{2}$ 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*] [,.$\widetilde{quux}$] [*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*; $2 \le r \le 36$.

n/*d* ▷ The ratio $\frac{n}{d}$.

$\left\{[m].n[\{\mathbf{S}|\mathbf{F}|\mathbf{D}|\mathbf{L}|\mathbf{E}\}x_{E0}]\,|\,m[.[n]]\{\mathbf{S}|\mathbf{F}|\mathbf{D}|\mathbf{L}|\mathbf{E}\}x\right\}$
▷ $m.n \cdot 10^x$ 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*$_{T}$ ▷ 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

({$_f$**prin1** | $_f$**print** | $_f$**pprint** | $_f$**princ**} *foo* [*stream*$_{v*standard-output*}$])
▷ 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 stream*)
▷ Print *object* to *stream*. Called by the Lisp printer.

($_m$**print-unreadable-object** (*foo stream* {**:type** *bool*$_{NIL}$ | **:identity** *bool*$_{NIL}$}) *form*^{P*})
▷ Enclosed in #< and >, print *foo* by means of *form*s to *stream*. Return `NIL`.

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

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

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

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

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

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

(f**write** / f**write-to-string** *foo* { **:array** *bool* | **:base** *radix* | **:case** { **:upcase** / **:downcase** / **:capitalize** } | **:circle** *bool* | **:escape** *bool* | **:gensym** *bool* | **:length** {*int* | NIL} | **:level** {*int* | NIL} | **:lines** {*int* | NIL} | **:miser-width** {*int* | NIL} | **:pprint-dispatch** *dispatch-table* | **:pretty** *bool* | **:radix** *bool* | **:readably** *bool* | **:right-margin** {*int* | NIL} | **:stream** *stream*v**standard-output** })

▷ Print *foo* to *stream* and return *foo*, or print *foo* into string, respectively, after dynamically setting printer variables corresponding to keyword parameters (***print-***bar****** becoming **:***bar*). (**:stream** keyword with f**write** only.)

(f**pprint-fill** *stream* *foo* [*parenthesis*T [*noop*]])
(f**pprint-tabular** *stream* *foo* [*parenthesis*T [*noop* [*n*16]]])
(f**pprint-linear** *stream* *foo* [*parenthesis*T [*noop*]])

▷ Print *foo* to *stream*. If *foo* is a list, print as many elements per line as possible; do the same in a table with a column width of *n* ems; or print either all elements on one line or each on its own line, respectively. Return NIL. Usable with f**format** directive **~//**.

(m**pprint-logical-block** (*stream* *list* { { **:prefix** *string* / **:per-line-prefix** *string* } | **:suffix** *string*"") })
(**declare** *decl**)* *form*P*)

▷ Evaluate *form*s, which should print *list*, with *stream* locally bound to a pretty printing stream which outputs to the original *stream*. If *list* is in fact not a list, it is printed by f**write**. Return NIL.

(m**pprint-pop**)

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

(f**pprint-tab** { **:line** / **:line-relative** / **:section** / **:section-relative** } *c* *i* [*stream*v**standard-output**])

▷ Move cursor forward to column number $c + ki$, $k \geq 0$ being as small as possible.

(f**pprint-indent** { **:block** / **:current** } *n* [*stream*v**standard-output**])

▷ Specify indentation for innermost logical block relative to leftmost position/to current position. Return NIL.

(m**pprint-exit-if-list-exhausted**)

▷ If *list* is empty, terminate logical block. Return NIL otherwise.

(f**pprint-newline** { **:linear** / **:fill** / **:miser** / **:mandatory** } [*stream*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*$_{\square}$] [**,**['*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*$_{\square}$]]]] [**@**] **F**
▷ **Fixed-Format Floating-Point.** With **@**, always prepend a sign.

~ [*width*] [**,**[*dec-digits*] [**,**[*exp-digits*] [**,**[*scale-factor*$_{1}$] [**,**['*overflow-char*] [**,**['*pad-char*$_{\square}$] [**,**'*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*$_{\square}$]]] [**:**] [**@**] **$**
▷ **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*$_{\square}$]]]
[**:**] [**@**] **<** [*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*$_{\square\square}$ **~;**]|[*per-line-prefix* **~@;**]} *body* [**~;** *suffix*$_{\square\square}$] **~:** [**@**] **>**
▷ **Logical Block.** Act like **pprint-logical-block** using *body* as *f***format** control string on the elements of the list argument or, with **@**, on the remaining arguments, which are extracted by **pprint-pop**. With **:**, *prefix* and *suffix* default to **(** and **)**. When closed by **~@:>**, spaces in *body* are replaced with conditional newlines.

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

~ [c#] [,i#] [**:**] [**@**] **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#] *****|~ [m#] **:***|~ [n@] **@***}
▷ **Go-To.** Jump m arguments forward, or backward, or to argument n.

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

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

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

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

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

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

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

13.6 Streams

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

)

▷ Open **file-stream** to *path*.

(*f*make-concatenated-stream *input-stream**)
(*f*make-broadcast-stream *output-stream**)
(*f*make-two-way-stream *input-stream-part output-stream-part*)
(*f*make-echo-stream *from-input-stream to-output-stream*)
(*f*make-synonym-stream *variable-bound-to-stream*)
▷ Return stream of indicated type.

(*f*make-string-input-stream *string* [*start*0 [*end*NIL]])
▷ Return a string-stream supplying the characters from *string*.

(*f*make-string-output-stream [:element-type *type*character])
▷ Return a string-stream accepting characters (available via *f*get-output-stream-string).

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

(*f*two-way-stream-input-stream *two-way-stream*)
(*f*two-way-stream-output-stream *two-way-stream*)
(*f*echo-stream-input-stream *echo-stream*)
(*f*echo-stream-output-stream *echo-stream*)
▷ Return source stream or sink stream of *two-way-stream*/*echo-stream*, respectively.

(*f*synonym-stream-symbol *synonym-stream*)
▷ Return symbol of *synonym-stream*.

(*f*get-output-stream-string $\widetilde{string\text{-}stream}$)
▷ Clear and return as a string characters on *string-stream*.

(*f*file-position *stream* [{:start | :end | *position*}])
▷ Return position within stream, or set it to *position* and return T on success.

(*f*file-string-length *stream foo*)
▷ Length *foo* would have in *stream*.

(*f*listen [*stream**v**standard-input*])
▷ T if there is a character in input *stream*.

(*f*clear-input [$\widetilde{stream}$*v**standard-input*])
▷ Clear input from *stream*, return NIL.

({*f*clear-output | *f*force-output | *f*finish-output} [$\widetilde{stream}$*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*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*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* [*string*$_{\text{NIL}}$ [**:element-type** *type*$_{\text{character}}$]])
(**declare** *decl**)* *form*^{P}*)
▷ Evaluate *forms* with *foo* locally bound to an output **string-stream**. Append output to *string* and return values of *forms* 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**}$_{\text{:local}}$})
▷ 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**}$_{\text{:local}}$])
(*f* **pathname-version** *path-or-stream*)
▷ Return pathname component.

(*f* **parse-namestring** *foo* [*host*
[*default-pathname*$_{v\text{*default-pathname-defaults*}}$
{**:start** *start*$_{0}$|**:end** *end*$_{\text{NIL}}$|**:junk-allowed** *bool*$_{\text{NIL}}$}]])
▷ 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*$_{v\text{*default-pathname-defaults*}}$
[*default-version*$_{\text{:newest}}$]])
▷ 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 22.

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** | _f_**unuse-package**} _other-packages_ [_package_*package*])
▷ Make exported symbols of _other-packages_ available in _package_, or remove them from _package_, respectively. Return T.

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

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

_v_***package***common-lisp-user ▷ The current package.

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

(_f_**package-name** _package_) ▷ Name of _package_.

(_f_**package-nicknames** _package_) ▷ Nicknames of _package_.

(_f_**find-package** _name_) ▷ Package with _name_ (case-sensitive).

(_f_**find-all-symbols** _foo_)
▷ List of symbols _foo_ from all registered packages.

({_f_**intern** | _f_**find-symbol**} _foo_ [_package_*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_*package*])
▷ Remove _symbol_ from _package_, return T on success.

({_f_**import** | _f_**shadowing-import**} _symbols_ [_package_*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_*package*])
▷ Make _symbols_ of _package_ shadow any otherwise accessible, equally named symbols from other packages. Return T.

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

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

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

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

(*m* **with-package-iterator** (*foo packages* [**:internal**|**:external**|**:inherited**])
(**declare** $\widehat{decl}$*)** *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*$_{NIL}$])
▷ If not in *v* ***modules***, try *paths* to load *module* from. Signal **error** if unsuccessful. Deprecated.

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

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

14.3 Symbols

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

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

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

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

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

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

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

$_c$**t**
▷ Truth; the supertype of every type including **t**; the superclass of every class except **t**; $_v$***terminal-io***.

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

14.4 Standard Packages

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

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

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

15 Compiler

15.1 Predicates

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

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

15.2 Compilation

(*f*__compile__ { NIL *definition* | { *name* | (__setf__ *name*) } [*definition*] })
▷ Return compiled function or replace *name*'s function definition with the compiled function. Return T[2] in case of **warning**s or **error**s, and T[3] in case of **warning**s or **error**s excluding **style-warning**s.

(*f*__compile-file__ *file* { __:output-file__ *out-path* | __:verbose__ *bool*$_{v*compile-verbose*}$ | __:print__ *bool*$_{v*compile-print*}$ | __:external-format__ *file-format*$_{:default}$ })
▷ Write compiled contents of *file* to *out-path*. Return true output path or NIL, T[2] in case of **warning**s or **error**s, T[3] in case of **warning**s or **error**s excluding **style-warning**s.

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

(*f*__load__ *path* { __:verbose__ *bool*$_{v*load-verbose*}$ | __:print__ *bool*$_{v*load-print*}$ | __:if-does-not-exist__ *bool*$_{T}$ | __:external-format__ *file-format*$_{:default}$ })
▷ Load source file or compiled file into Lisp environment. Return T if successful.

$_v$***compile-file***, $_v$***load*** { __pathname*__$_{NIL}$ | __truename*__$_{NIL}$ }
▷ Input file used by *f*__compile-file__/by *f*__load__.

$_v$***compile***, $_v$***load*** { __print*__ | __verbose*__ }
▷ Defaults used by *f*__compile-file__/by *f*__load__.

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

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

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

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

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

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

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

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

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

15.3 REPL and Debugging

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

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

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

($_f$**apropos-list** *string* [$package_{\texttt{NIL}}$])
▷ 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*$_{\texttt{NIL}}$]) ▷ Invoke editor if possible.

({$_f$**macroexpand-1** | $_f$**macroexpand**} *form* [$environment_{\texttt{NIL}}$])
▷ Return macro expansion, once or entirely, respectively, of *form* and `T` if *form* was a macro form. Return *form* and `NIL` otherwise.^{2}

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

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

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

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

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

($_f$**break** [*control arg**])
▷ Jump directly into debugger; return `NIL`. See page 38, $_f$**format**, for *control* and *arg*s.

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

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

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

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

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

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

15.4 Declarations

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

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

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

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

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

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

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

(**optimize** { **compilation-speed** | (**compilation-speed** $n_{[3]}$) / **debug** | (**debug** $n_{[3]}$) / **safety** | (**safety** $n_{[3]}$) / **space** | (**space** $n_{[3]}$) / **speed** | (**speed** $n_{[3]}$) })

▷ Tell compiler how to optimize. $n = 0$ means unimportant, $n = 1$ is neutral, $n = 3$ means important.

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

16 External Environment

(*f* **get-internal-real-time**)
(*f* **get-internal-run-time**)

▷ Current time, or computing time, respectively, in clock ticks.

c **internal-time-units-per-second**

▷ Number of clock ticks per second.

(*f* **encode-universal-time** *sec min hour date month year* [*zone*$_{\text{curr}}$])
(*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$_0$, minute$_1$, hour$_2$, date$_3$, month$_4$, year$_5$, day$_6$, daylight-p$_7$, and zone$_8$.

(*f* **short-site-name**)
(*f* **long-site-name**)

▷ String representing physical location of computer.

({ *f* **lisp-implementation** / *f* **software** / *f* **machine** } - { **type** / **version** })

▷ Name or version of implementation, operating system, or hardware, respectively.

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

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