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

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

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

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

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

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

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

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

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

(ƒ**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.

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

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

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

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

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

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

(ƒ**abs** *n*) ▷ Return $|n|$.

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

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

Quick Reference

cl

Common
lisp

Bert Burgemeister

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*$_{\boxed{\texttt{bar}}}$] ▷ Either one *foo* or nothing; defaults to `bar`.

foo*; {*foo*}* ▷ Zero or more *foo*s.

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

foos ▷ English plural denotes a list argument.

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

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

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

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

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

($\begin{Bmatrix} {}_m\textbf{incf} \\ {}_m\textbf{decf} \end{Bmatrix}$ $\widetilde{place}$ [$delta_{\boxed{1}}$])
▷ 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.

3 Strings

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

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

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

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

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

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

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

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

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

(ƒ**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.

4 Conses

4.1 Predicates

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

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

1.3 Logic Functions

Negative integers are used in two's complement representation.

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

c**boole-1**	▷ *int-a*.
c**boole-2**	▷ *int-b*.
c**boole-c1**	▷ ¬*int-a*.
c**boole-c2**	▷ ¬*int-b*.
c**boole-set**	▷ All bits set.
c**boole-clr**	▷ All bits zero.
c**boole-eqv**	▷ *int-a* ≡ *int-b*.
c**boole-and**	▷ *int-a* ∧ *int-b*.
c**boole-andc1**	▷ ¬*int-a* ∧ *int-b*.
c**boole-andc2**	▷ *int-a* ∧ ¬*int-b*.
c**boole-nand**	▷ ¬(*int-a* ∧ *int-b*).
c**boole-ior**	▷ *int-a* ∨ *int-b*.
c**boole-orc1**	▷ ¬*int-a* ∨ *int-b*.
c**boole-orc2**	▷ *int-a* ∨ ¬*int-b*.
c**boole-xor**	▷ ¬(*int-a* ≡ *int-b*).
c**boole-nor**	▷ ¬(*int-a* ∨ *int-b*).

(ƒ**lognot** *integer*) ▷ ¬*integer*.

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

(ƒ**logandc1** *int-a int-b*) ▷ ¬*int-a* ∧ *int-b*.

(ƒ**logandc2** *int-a int-b*) ▷ *int-a* ∧ ¬*int-b*.

(ƒ**lognand** *int-a int-b*) ▷ ¬(*int-a* ∧ *int-b*).

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

(ƒ**logorc1** *int-a int-b*) ▷ ¬*int-a* ∨ *int-b*.

(ƒ**logorc2** *int-a int-b*) ▷ *int-a* ∨ ¬*int-b*.

(ƒ**lognor** *int-a int-b*) ▷ ¬(*int-a* ∨ *int-b*).

(ƒ**logbitp** *i int*) ▷ T if zero-indexed *i*th bit of *int* is set.

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

(ƒ**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*. setfable.

({*f*deposit-field, *f*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*. setfable.

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

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

1.5 Implementation-Dependent

{*c*short-float, *c*single-float, *c*double-float, *c*long-float} - {epsilon, negative-epsilon}
▷ Smallest possible number making a difference when added or subtracted, respectively.

{*c*least-negative, *c*least-negative-normalized, *c*least-positive, *c*least-positive-normalized} - {short-float, single-float, double-float, long-float}
▷ Available numbers closest to −0 or +0, respectively.

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

(*f*decode-float *n*)
(*f*integer-decode-float *n*)
▷ Return significand, 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*.

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

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

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

(ƒ{**bit-eqv** | **bit-and** | **bit-andc1** | **bit-andc2** | **bit-nand** | **bit-ior** | **bit-orc1** | **bit-orc2** | **bit-xor** | **bit-nor**} *bit-array-a bit-array-b* [*result-bit-array*NIL])
▷ Return result of bitwise logical operations (cf. operations of ƒ**boole**, page 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.

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

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

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

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

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

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

6 Sequences

6.1 Sequence Predicates

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

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

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

(ƒ**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.

(ƒ{**member-if** | **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.

(ƒ**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

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

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

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

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

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

(ƒ**car** *list*) ▷ Car of *list* or NIL if *list* is NIL. **setf**able.

(ƒ**cdr** *list*)
(ƒ**rest** *list*) ▷ Cdr of *list* or NIL if *list* is NIL. **setf**able.

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

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

(ƒ**nth** *n list*) ▷ Zero-indexed *n*th element of *list*. **setf**able.

(ƒ**c***X***r** *list*)
▷ With *X* being one to four **a**s and **d**s representing ƒ**car**s and ƒ**cdr**s, e.g. (ƒ**cadr** *bar*) is equivalent to (ƒ**car** (ƒ**cdr** *bar*)). **setf**able.

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

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

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

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

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

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

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

(*m*pushnew *foo* *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 *list* *foo*)
▷ Return concatenated list after reversing order in *list*.

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

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

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

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

4.3 Association Lists

(*f*pairlis *keys* *values* [*alist*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* *tree*} { | :test *function*#'eql | :test-not *function* | :key *function* })
▷ Make copy of *tree* with each subtree or leaf matching *old* replaced by *new*.

({*f*subst-if[-not] *new* *test* *tree* | *f*nsubst-if[-not] *new* *test* *tree*} [:key *function*])
▷ Make copy of *tree* with each subtree or leaf satisfying *test* replaced by *new*.

({*f*sublis *association-list* *tree* | *f*nsublis *association-list* *tree*} { | :test *function*#'eql | :test-not *function* | :key *function* })
▷ Make copy of *tree* with each subtree or leaf matching a key in *association-list* replaced by that key's value.

(*f*copy-tree *tree*) ▷ Copy of *tree* with same shape and leaves.

4.5 Sets

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

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

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

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

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

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

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

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

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

8 Structures

(м**defstruct**
foo
(*foo*
:conc-name
(**:conc-name** [*slot-prefix*`FOO-`])
:constructor
(**:constructor** [*maker*`MAKE-FOO` [(*ord-λ**)]])*
:copier
(**:copier** [*copier*`COPY-FOO`])
(**:include** *struct* *slot* (*slot* [*init* | **:type** *sl-type* | **:read-only** *b*])*)
(**:type** **list** | **vector** | (**vector** *type*)) [(**:initial-offset** *n*)]
(**:print-object** [*o-printer*])
(**:print-function** [*f-printer*])
:named
:predicate
(**:predicate** [*p-name*`FOO-P`])
)
[*doc*]
slot
(*slot* [*init* | **:type** *slot-type* | **:read-only** *bool*])*
)

▷ 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.

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

9 Control Structure

9.1 Predicates

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

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

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

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

(ƒ{**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`.

(ƒ**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

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

(ƒ**concatenate** *type sequence**)
▷ Return concatenated sequence of *type*.

(ƒ**merge** *type sequence-a 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.

(ƒ**fill** *sequence foo* {**:start** *start*`0` | **:end** *end*`NIL`})
▷ Return *sequence* after setting elements between *start* and *end* to *foo*.

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

(ƒ**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*.

(ƒ{**count-if** | **count-if-not**} *test sequence* {**:from-end** *bool*`NIL` | **:start** *start*`0` | **:end** *end*`NIL` | **:key** *function*})
▷ Return number of elements in *sequence* which satisfy *test*.

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

(ƒ**subseq** *sequence start* [*end*`NIL`])
▷ Return subsequence of *sequence* between *start* and *end*. **setf**able.

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

(ƒ**reverse** *sequence*)
(ƒ**nreverse** *sequence*) ▷ Return *sequence* in reverse order.

(ƒ**find** | ƒ**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.

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

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

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

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

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

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

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

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

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

▷ Make copy of *sequence* without duplicates.

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

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

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

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

(ƒ**replace** *sequence-a sequence-b* [**:start1** *start-a*0 | **:start2** *start-b*0 | **:end1** *end-a*NIL | **:end2** *end-b*NIL])

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

(ƒ**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 T if found, NIL 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**.

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

(*s*macrolet ((*foo* (*macro-λ**) { | (declare *local-decl**)* / *doc* } *macro-form*P*)*)
(declare *decl**)* *form*P*)
▷ Evaluate *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 *decl**)* *form*P*)
▷ Evaluate *forms* with locally defined symbol macros *foo*.

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

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

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

(*m*define-modify-macro *foo* ([&optional { *var* / (*var* [*init*NIL [*supplied-p*]]) }*]
[&rest *var*]) *function* [*doc*])
▷ Define macro *foo* able to modify a place. On invocation of (*foo place arg**), the value of *function* applied to *place* and *arg***s** will be stored into *place* and returned.

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

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

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

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

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

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

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

(*f*constantp *foo* [*environment*NIL])
▷ T if *foo* is a constant form.

(*f*functionp *foo*) ▷ T if *foo* is of type **function**.

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

9.2 Variables

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

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

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

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

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

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

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

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

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

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

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

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

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

($\{_s\textbf{let}, _s\textbf{let*}\}$ ($\{name, (name\ [value_{\texttt{NIL}}])\}^*$) (**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-form*s with *var*s lexically bound to the return values of *values-form*. Return values of *body-form*s.

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

9.3 Functions

Below, ordinary lambda list (*ord-λ**) has the form
(*var** [**&optional** $\{var, (var\ [init_{\texttt{NIL}}\ [supplied\text{-}p]])\}^*$] [**&rest** *var*]
[**&key** $\{var, (\{var, (:key\ var)\}\ [init_{\texttt{NIL}}\ [supplied\text{-}p]])\}^*$ [**&allow-other-keys**]]
[**&aux** $\{var, (var\ [init_{\texttt{NIL}}])\}^*$]).

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

($\{_m\textbf{defun}\ \{foo\ (ord\text{-}\lambda^*), (\textbf{setf}\ foo)\ (new\text{-}value\ ord\text{-}\lambda^*)\}, _m\textbf{lambda}\ (ord\text{-}\lambda^*)\}$ $\{\widehat{(\textbf{declare}\ decl^*)^*}, \widehat{doc}\}$ $form^{P*}$)
▷ Define a function named *foo* or (**setf** *foo*), or an anonymous function, respectively, which applies *form*s to *ord-λ*s. For $_m$**defun**, *form*s are enclosed in an implicit $_s$**block** named *foo*.

($\{_s\textbf{flet}, _s\textbf{labels}\}$ (($\{foo\ (ord\text{-}\lambda^*), (\textbf{setf}\ foo)\ (new\text{-}value\ ord\text{-}\lambda^*)\}$ $\{\widehat{(\textbf{declare}\ local\text{-}decl^*)^*}, \widehat{doc}\}$ *local-form*^{P*})*) (**declare** $\widehat{decl^*})^*$ $form^{P*}$)
▷ Evaluate *form*s with locally defined functions *foo*. Globally defined functions of the same name are shadowed. Each *foo* is also the name of an implicit $_s$**block** around its corresponding *local-form**. Only for $_s$**labels**, functions *foo* are visible inside *local-forms*. Return values of *form*s.

($_s$**function** $\{foo, (_m\textbf{lambda}\ form^*)\}$)
▷ Return lexically innermost function named *foo* or a lexical closure of the $_m$**lambda** expression.

($_f$**apply** $\{function, (\textbf{setf}\ function)\}$ arg^* *args*)
▷ Values of *function* called with *arg*s and the list elements of *args*. **setf**able if *function* is one of $_f$**aref**, $_f$**bit**, and $_f$**sbit**.

($_f$**funcall** *function* arg*) ▷ Values of *function* called with *arg*s.

($_s$**multiple-value-call** *function form**)
▷ Call *function* with all the values of each *form* as its arguments. Return values returned by *function*.

($_f$**values-list** *list*) ▷ Return elements of *list*.

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

($_f$**multiple-value-list** *form*) ▷ List of the values of *form*.

($_m$**nth-value** *n form*)
▷ Zero-indexed *n*th return value of *form*.

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

($_f$**constantly** *foo*)
▷ Function of any number of arguments returning *foo*.

($_f$**identity** *foo*) ▷ Return *foo*.

($_f$**function-lambda-expression** *function*)
▷ If available, return lambda expression of *function*, `NIL` if *function* was defined in an environment without bindings[2], and name of *function*.[3]

($_f$**fdefinition** $\{foo, (\textbf{setf}\ foo)\}$)
▷ 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*] $\{var, (macro\text{-}\lambda^*)\}^*$ [*E*]
[**&optional** $\{var, (\{var, (macro\text{-}\lambda^*)\}\ [init_{\texttt{NIL}}\ [supplied\text{-}p]])\}^*$] [*E*]
[$\{\textbf{&rest}, \textbf{&body}\}$ $\{rest\text{-}var, (macro\text{-}\lambda^*)\}$] [*E*]
[**&key** $\{var, (\{var, (:key\ \{var, (macro\text{-}\lambda^*)\})\}\ [init_{\texttt{NIL}}\ [supplied\text{-}p]])\}^*$ [*E*]
[**&allow-other-keys**]] [**&aux** $\{var, (var\ [init_{\texttt{NIL}}])\}^*$] [*E*])
or
([**&whole** *var*] [*E*] $\{var, (macro\text{-}\lambda^*)\}^*$ [*E*]
[**&optional** $\{var, (\{var, (macro\text{-}\lambda^*)\}\ [init_{\texttt{NIL}}\ [supplied\text{-}p]])\}^*$] [*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.

($\{_m\textbf{defmacro}, _m\textbf{define-compiler-macro}\}$ $\{foo, (\textbf{setf}\ foo)\}$ $(macro\text{-}\lambda^*)$ $\{\widehat{(\textbf{declare}\ decl^*)^*}, \widehat{doc}\}$ $form^{P*}$)
▷ Define macro *foo* which on evaluation as (*foo tree*) applies expanded *form*s to arguments from *tree*, which corresponds to *tree*-shaped *macro-λ*s. *form*s are enclosed in an implicit $_s$**block** named *foo*.

{**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.

= *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.

&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`.

($\left\{{}_m\textbf{when} \atop {}_m\textbf{unless}\right\}$ *test foo*^{P_*})
▷ Evaluate *foo*s and return their values if *test* returns `T` or `NIL`, respectively. Return `NIL` otherwise.

($_m$**case** *test* ($\left\{\widehat{(key^*)} \atop \widehat{key}\right\}$ *foo*^{P_*})* [($\left\{\textbf{otherwise} \atop \texttt{T}\right\}$ *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*.

($\left\{{}_m\textbf{ecase} \atop {}_m\textbf{ccase}\right\}$ *test* ($\left\{\widehat{(key^*)} \atop \widehat{key}\right\}$ *foo*^{P_*})*)
▷ Return the values of the first *foo** one of whose *key*s is **eql** *test*. Signal non-correctable/correctable **type-error** if there is no matching *key*.

($_m$**and** *form**[`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*.

($\left\{{}_m\textbf{prog} \atop {}_m\textbf{prog*}\right\}$ ($\left\{\left|\begin{array}{l}name\\(name\ [value_{\texttt{NIL}}])\end{array}\right.\right\}^*$) (**declare** $\widehat{decl^*}$)* $\left\{\widehat{tag} \atop form\right\}^*$)
▷ Evaluate $_s$**tagbody**-like body with *name*s lexically bound (in parallel or sequentially, respectively) to *value*s. Return `NIL` or explicitly $_m$**return**ed values. Implicitly, the whole form is a $_s$**block** named `NIL`.

($_s$**unwind-protect** *protected cleanup**)
▷ Evaluate *protected* and then, no matter how control leaves *protected*, *cleanup*s. Return values of *protected*.

($_s$**block** *name form*^{P_*})
▷ Evaluate *form*s in a lexical environment, and return their values unless interrupted by $_s$**return-from**.

($_s$**return-from** *foo* [*result*[`NIL`]])
($_m$**return** [*result*[`NIL`]])
▷ Have nearest enclosing $_s$**block** named *foo*/named `NIL`, respectively, return with values of *result*.

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

(ₛ**go** $\widehat{tag}$)
▷ Within the innermost possible enclosing ₛ**tagbody**, jump to a tag ₓ**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 ₓ**eq** *tag* return with the values of *form*.

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

9.6 Iteration

({ₘ**do**|ₘ**do***} ({*var*|(*var* [*start* [*step*]])}*) (*stop* *result*ᴾ*) (**declare** $\widehat{decl}$*)* {$\widehat{tag}$|*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** $\widehat{decl}$*)* {$\widehat{tag}$|*form*}*)
▷ Evaluate ₛ**tagbody**-like body with *var* successively bound to integers from 0 to $i-1$. Upon evaluation of *result*, *var* is i. Implicitly, the whole form is a ₛ**block** named NIL.

(ₘ**dolist** (*var* *list* [*result*NIL]) (**declare** $\widehat{decl}$*)* {$\widehat{tag}$|*form*}*)
▷ Evaluate ₛ**tagbody**-like body with *var* successively bound to the elements of *list*. Upon evaluation of *result*, *var* is NIL. Implicitly, the whole form is a ₛ**block** named NIL.

9.7 Loop Facility

(ₘ**loop** *form**)
▷ **Simple Loop.** If *form*s do not contain any atomic Loop Facility keywords, evaluate them forever in an implicit ₛ**block** named NIL.

(ₘ**loop** *clause**)
▷ **Loop Facility.** For Loop Facility keywords see below and Figure 1.

named *n*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**.

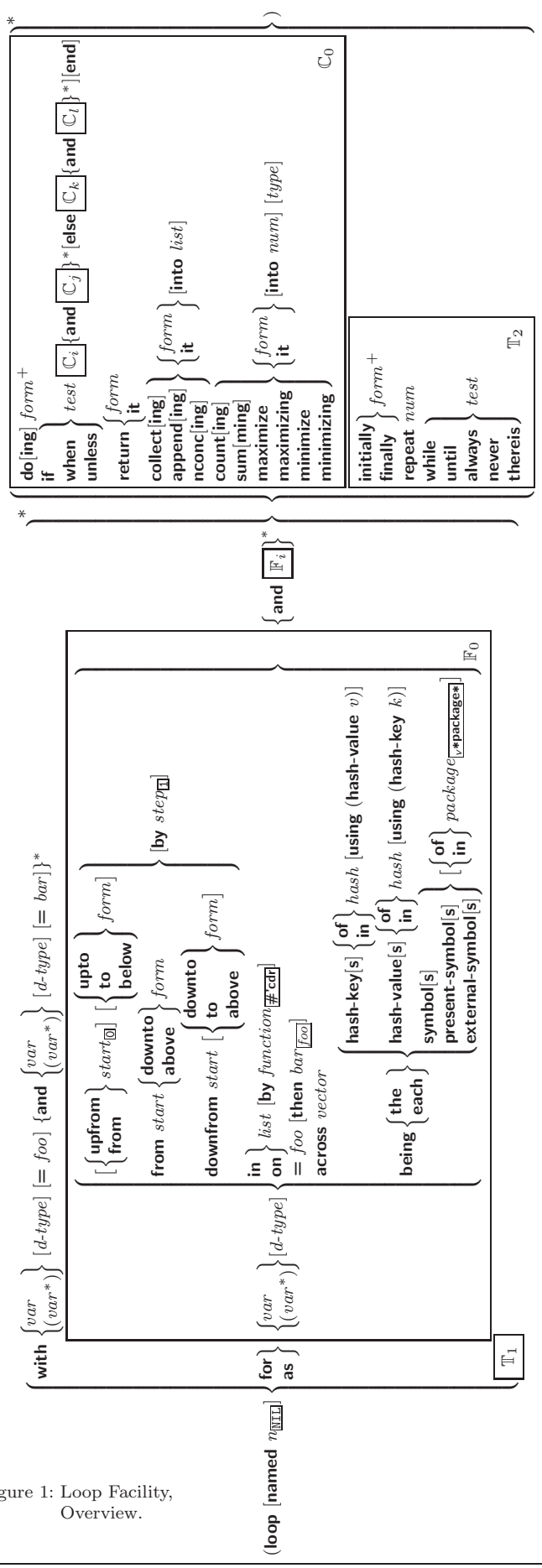

Figure 1: Loop Facility, Overview.

(*g*function-keywords *method*)
▷ Return list of keyword parameters of *method* and T if other keys are allowed.

(*g*method-qualifiers *method*) ▷ List of qualifiers of *method*.

10.3 Method Combination Types

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

and|**or**|**append**|**list**|**nconc**|**progn**|**max**|**min**|**+**
▷ Simple built-in **method-combination** types; have the same usage as the *c-type*s defined by the short form of *m*define-method-combination.

(*m*define-method-combination *c-type*
{ **: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*) }*)])

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

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

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

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

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

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

10 CLOS

10.1 Classes

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

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

(*m*defclass *foo* (*superclass**[standard-object])
(*slot* | (*slot* { {**:reader** *reader*}* | {**:writer** {*writer* | (**setf** *writer*)}}* | {**:accessor** *accessor*}* | **:allocation** {**:instance**|**:class**}[**:instance**] | {**:initarg** [**:**]*initarg-name*}* | **:initform** *form* | **:type** *type* | **:documentation** *slot-doc* }))*
{ (**:default-initargs** {*name value*}*) | (**:documentation** *class-doc*) | (**:metaclass** *name*[standard-class]) })
▷ Define or modify class *foo* as a subclass of *superclass*es. Transform existing instances, if any, by *g*make-instances-obsolete. In a new instance *i* of *foo*, a *slot*'s value defaults to *form* unless set via [**:**]*initarg-name*; it is readable via (*reader i*) or (*accessor i*), and writable via (*writer value i*) or (**setf** (*accessor i*) *value*). *slot*s with **:allocation :class** are shared by all instances of class *foo*.

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

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

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

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

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

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

(f**ensure-generic-function** {*foo* / (**setf** *foo*)}
({**:argument-precedence-order** *required-var*+ / **:declare** (**optimize** *method-selection-optimization*) / **:documentation** *string* / **:generic-function-class** *gf-class* / **:method-class** *method-class* / **:method-combination** *c-type c-arg** / **:lambda-list** *lambda-list* / **:environment** *environment*})
▷ Define or modify generic function *foo*. *gf-class* and *lambda-list* must be compatible with a pre-existing generic function or with existing methods, respectively. Changes to *method-class* do not propagate to existing methods. For *c-type* see section 10.3.

(m**defmethod** {*foo* / (**setf** *foo*)} [{**:before** / **:after** / **:around** / *qualifier**} primary method]
({*var* / (*spec-var* {*class* / (**eql** *bar*)})}* [**&optional** {*var* / (*var* [*init* [*supplied-p*]])}*] [**&rest** *var*] [**&key** {*var* / ({*var* / (**:***key var*)} [*init* [*supplied-p*]])}* [**&allow-other-keys**]]
[**&aux** {*var* / (*var* [*init*])}*]) {(**declare** decl*)* / *doc*} *form*P*)
▷ Define new method for generic function *foo*. *spec-var*s specialize to either being of *class* or being **eql** *bar*, respectively. On invocation, *var*s and *spec-var*s of the new method act like parameters of a function with body *form**. *form*s are enclosed in an implicit s**block** *foo*. Applicable *qualifier*s depend on the **method-combination** type; see section 10.3.

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

(g**find-method** *generic-function qualifiers specializers* [*error*T])
▷ Return suitable method, or signal **error**.

(g**compute-applicable-methods** *generic-function args*)
▷ List of methods suitable for *args*, most specific first.

(f**call-next-method** *arg** current args)
▷ From within a method, call next method with *args*; return its values.

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

({f**invalid-method-error** *method* / f**method-combination-error**} *control arg**)
▷ Signal **error** on applicable method with invalid qualifiers, or on method combination. For *control* and *args* 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.

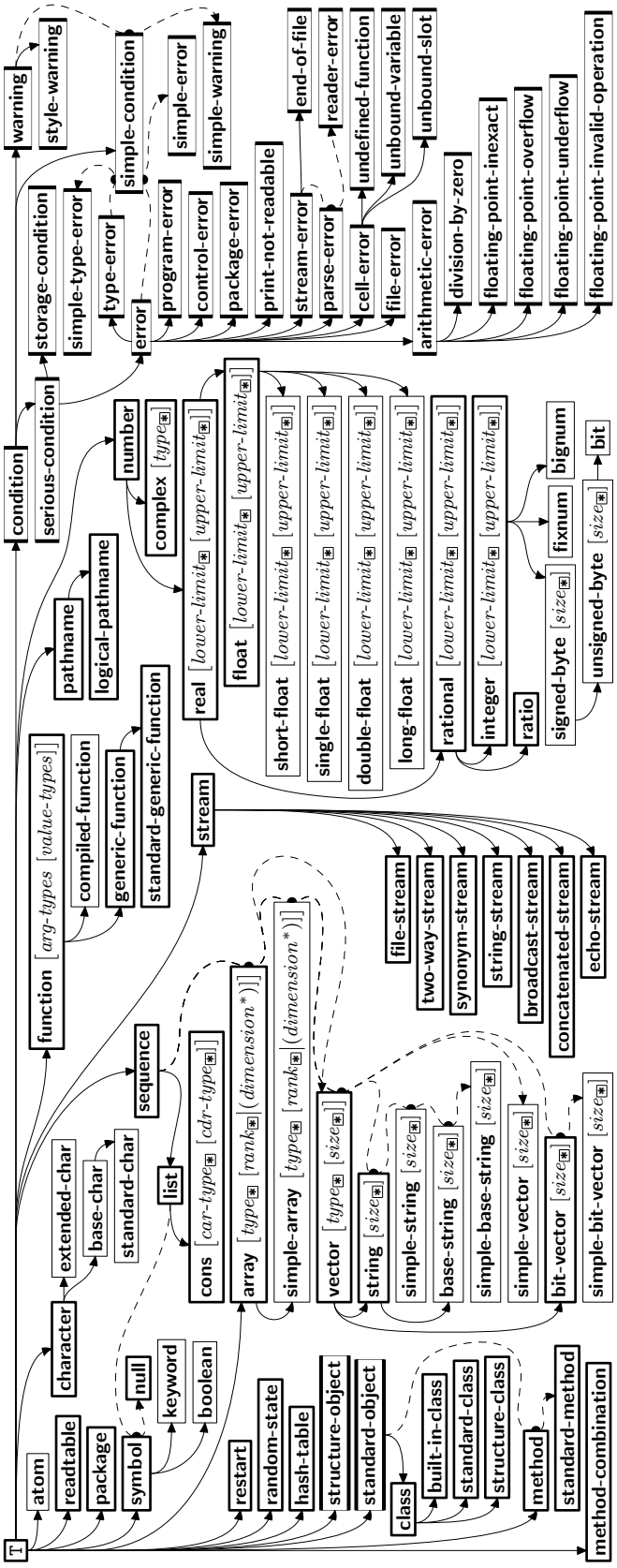

Figure 2: Precedence Order of System Classes (▭), Classes (▬), Types (▭), and Condition Types (▭).
Every type is also a supertype of NIL, the empty type.

▷ 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)
({ *slot* | (*slot* { {:reader *reader*}* | {:writer *writer*}* | (setf *writer*)* | {:accessor *accessor*}* | :allocation {:instance | :class} :instance | {:initarg [:]*initarg-name*}* | :initform *form* | :type *type* | :documentation *slot-doc* }) }*
{ (:default-initargs {*name value*}*) | (:documentation *condition-doc*) | (:report {*string* | *report-function*}) }*)

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

(*f*make-condition *condition-type* {[:]*initarg-name value*}*)

▷ Return new instance of *condition-type*.

({*f*signal | *f*warn | *f*error} { *condition* | *condition-type* {[:]*initarg-name value*}* | *control arg** })

▷ Unless handled, signal as **condition**, **warning** or **error**, respectively, *condition* or a new instance of *condition-type* or, with *f***format** *control* and *arg*s (see page 38), **simple-condition**, **simple-warning**, or **simple-error**, respectively. From *f***signal** and *f***warn**, return NIL.

(*f*cerror *continue-control* { *condition continue-arg** | *condition-type* {[:]*initarg-name value*}* | *control arg** })

▷ Unless handled, signal as correctable **error** *condition* or a new instance of *condition-type* or, with *f***format** *control* and *arg*s (see page 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**) [{ *condition continue-arg** | *condition-type* {[:]*initarg-name value*}* | *control arg** }]])

▷ If *test*, which may depend on *place*s, returns NIL, signal as correctable **error** *condition* or a new instance of *condition-type* or, with *f***format** *control* and *arg*s (see page 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-form*^{P_*})*
[(:no-error (*ord-λ**) (declare $\widehat{decl^*}$)* *form*^{P_*})])
▷ If, on evaluation of *foo*, a condition of *type* is signalled, evaluate matching *condition-form*s with *var* bound to the condition, and return their values. Without a condition, bind *ord-λ*s to values of *foo* and return values of *form*s or, without a :no-error clause, return values of *foo*. See page 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 ({*restart* | NIL} *control arg**) *form*^{P_*})
▷ Return values of *form*s unless *restart* is called during their evaluation. In this case, describe *restart* using *f*format *control* and *arg*s (see page 38) and return NIL and T.

(*m*restart-case *form* (*restart* (*ord-λ**) {:interactive *arg-function* | :report {*report-function* | *string* "restart"} | :test *test-function* T}
(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 (({$\widehat{restart}$ | NIL} *restart-function*
{:interactive-function *arg-function* | :report-function *report-function* | :test-function *test-function*})*) *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 are described by *restart-function* (of a stream). A *restart* can be called by (invoke-restart *restart arg**), where *arg*s must be suitable for the corresponding *restart-function*, or by (invoke-restart-interactively *restart*) where a list of the respective *arg*s is supplied by *arg-function*.

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

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

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

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

(*m*with-condition-restarts *condition restarts form*^{P_*})
▷ Evaluate *form*s with *restarts* dynamically associated with *condition*. Return values of *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.

(*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*NIL^{P_*})])
▷ Return values of the first *a-form** whose *type* is *foo* of. Return values of *b-form*s if no *type* matches.

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

#[n]*b**
▷ Bit vector of some (or n) bs 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*$_{v\text{*standard-output*}}$])
▷ 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*$_{\text{NIL}}$|**:identity** *bool*$_{\text{NIL}}$}) *form*^{P*})
▷ Enclosed in **#<** and **>**, print *foo* by means of *form*s to *stream*. Return NIL.

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

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

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

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

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

($_f$**type-of** *foo*) ▷ Type of *foo*.

($_m$**check-type** *place type* [*string*$_{\text{[a|an] }type}$])
▷ 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*$_{\text{NIL}}$])
▷ Element type of most specialized array capable of holding elements of *type*.

($_m$**deftype** *foo* (*macro-λ**) {(**declare** *decl**)*|*doc*} *form*^{P*})
▷ Define type *foo* which when referenced as (*foo 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**$_{\text{T}}$) ▷ Type specifier for intersection of *type*s.

(**or** *type**$_{\text{NIL}}$) ▷ 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

($\left\{\begin{matrix}_f\textbf{y-or-n-p}\\ _f\textbf{yes-or-no-p}\end{matrix}\right\}$ [*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.

($\left\{\begin{matrix}_f\textbf{read}\\ _f\textbf{read-preserving-whitespace}\end{matrix}\right\}$ [*stream*$_{\text{v*standard-input*}}$ [*eof-err*$_{\text{T}}$ [*eof-val*$_{\text{NIL}}$ [*recursive*$_{\text{NIL}}$]]]])
▷ Read printed representation of object.

($_f$**read-from-string** *string* [*eof-error*$_{\text{T}}$ [*eof-val*$_{\text{NIL}}$ [$\left\{\begin{matrix}\textbf{:start}\ start_{0}\\ \textbf{:end}\ end_{\text{NIL}}\\ \textbf{:preserve-whitespace}\ bool_{\text{NIL}}\end{matrix}\right\}$]]])
▷ Return object read from string and zero-indexed position of next character.

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

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

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

($_f$**peek-char** [*mode*$_{\text{NIL}}$ [*stream*$_{\text{v*standard-input*}}$ [*eof-error*$_{\text{T}}$ [*eof-val*$_{\text{NIL}}$ [*recursive*$_{\text{NIL}}$]]]])
▷ 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*$_{\text{v*standard-input*}}$])
▷ Put last $_f$**read-char**ed *character* back into *stream*; return `NIL`.

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

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

($_f$**read-sequence** *sequence* *stream* [**:start** *start*$_0$][**:end** *end*$_{\text{NIL}}$])
▷ 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*)$_{\text{:upcase}}$
▷ Case sensitivity attribute (one of **:upcase**, **:downcase**, **:preserve**, **:invert**) of *readtable*. **setf**able.

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

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

$_v$***readtable*** ▷ Current readtable.

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

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

$_v$***read-suppress***$_{\text{NIL}}$ ▷ If `T`, reader is syntactically more tolerant.

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

($_f$**get-macro-character** *char* [*rt*$_{\text{v*readtable*}}$])
▷ Reader macro function associated with *char*, and $\frac{\text{T}}{2}$ if *char* is a non-terminating macro character.

($_f$**make-dispatch-macro-character** *char* [*non-term-p*$_{\text{NIL}}$ [*rt*$_{\text{v*readtable*}}$]])
▷ Make *char* a dispatching macro character. Return `T`.

($_f$**set-dispatch-macro-character** *char sub-char function* [*rt*$_{\text{v*readtable*}}$])
▷ 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*$_{\text{v*readtable*}}$])
▷ 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*$_{\text{NIL}}$]) ▷ List of *foo*s with the terminating cdr *bar*.

" ▷ Begin and end of a string.

'*foo* ▷ ($_s$**quote** *foo*); *foo* unevaluated.

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

#*c* ▷ ($_f$**character** "*c*"), the character *c*.

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

*n***/***d* ▷ The **ratio** $\frac{n}{d}$.

$\left\{[m].n[\{\textbf{S}|\textbf{F}|\textbf{D}|\textbf{L}|\textbf{E}\}x_{\text{E0}}]\,\middle|\,m[.[n]]\{\textbf{S}|\textbf{F}|\textbf{D}|\textbf{L}|\textbf{E}\}x\right\}$
▷ $m.n \cdot 10^x$ 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 $a + b\mathrm{i}$.

#'*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.

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

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

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

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

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

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

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

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

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

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

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

(*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*1 [*noop*]])
(*f*pprint-tabular ~*stream* *foo* [*parenthesis*1 [*noop* [*n*16]]])
(*f*pprint-linear ~*stream* *foo* [*parenthesis*1 [*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** $\widehat{\textit{control}}$)
▷ Return function of *stream* and *arg** applying *f* **format** to *stream*, *control*, and *arg** returning NIL or any excess *arg*s.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

~ [*n* [1]] ~ ▷ **Tilde.** Print *n* tildes.

~ [*min-col* [0] [,[*col-inc* [1]] [,[*min-pad* [0]] [,'*pad-char* [ ]]]] [:] [@] **<**
[*nl-text* ~[*spare* [0] [,*width*]]**:**;] {*text* ~**;**}* *text* ~**>**
▷ **Justification.** Justify text produced by *text*s in a field of at least *min-col* columns. With **:**, right justify; with **@**, left justify. If this would leave less than *spare* characters on the current line, output *nl-text* first.

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

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

14 Packages and Symbols

The Loop Facility provides additional means of symbol handling; see **loop**, page 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* [*v**package*]])
▷ Make exported symbols of *other-packages* available in *package*, or remove them from *package*, respectively. Return T.

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

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

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

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

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

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

13.6 Streams

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

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

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

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

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

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

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

(*f*get-output-stream-string *string-stream*)
▷ Clear and return as a string characters on *string-stream*.

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

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

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

(*f*clear-input [*stream* [*v**standard-input*]])
▷ Clear input from *stream*, return NIL.

({*f*clear-output | *f*force-output | *f*finish-output} [*stream* [*v**standard-output*]])
▷ End output to *stream* and return NIL immediately, after initiating flushing of buffers, or after flushing of buffers, respectively.

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

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

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

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

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

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

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

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

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

13.7 Pathnames and Files

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

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

(*f*parse-namestring *foo* [*host* [*default-pathname**v**default-pathname-defaults**
{ :start *start*0 | :end *end*NIL | :junk-allowed *bool*NIL }]])
▷ Return pathname converted from string, pathname, or stream *foo*; and position$_2$ where parsing stopped.

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

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

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

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

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

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

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

(*f*logical-pathname *logical-path-or-stream*)
▷ Logical pathname of *logical-path-or-stream*. Logical pathnames are represented as all-uppercase "[*host*:][;]{{*dir*|*}+|**};}*{*name*|*}*[.{{*type*|*}+|LISP}[.{*version*|*|newest|NEWEST}]]".

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

(*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.

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*$_{\boxed{\texttt{NIL}}}$])
▷ Print interned symbols containing *string*.

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

($\left\{\begin{matrix}{}_f\textbf{macroexpand-1}\\ {}_f\textbf{macroexpand}\end{matrix}\right\}$ *form* [*environment*$_{\boxed{\texttt{NIL}}}$])
▷ Return macro expansion, once or entirely, respectively, of *form* and T (2) if *form* was a macro form. Return *form* and NIL (2) otherwise.

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

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

($_m$**untrace** $\left\{\begin{matrix}\textit{function}\\ (\textbf{setf}\ \textit{function})\end{matrix}\right\}^*$)
▷ Stop *function*s, or each currently traced function, from being traced.

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

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

($_f$**break** [*control arg**])
▷ Jump directly into debugger; return NIL. See page 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* [$\widetilde{\textit{stream}}_{\boxed{{}_v\textbf{*standard-output*}}}$])
▷ Send information about *foo* to *stream*.

($_g$**describe-object** *foo* [$\widetilde{\textit{stream}}$])
▷ 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}$_{\boxed{\textbf{:default}}}$])
▷ Print information about internal storage management to ***standard-output***.

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

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

($\left\{\begin{matrix}{}_f\textbf{intern}\\ {}_f\textbf{find-symbol}\end{matrix}\right\}$ *foo* [*package*$_{\boxed{{}_v\textbf{*package*}}}$])
▷ Intern or find, respectively, symbol *foo* in *package*. Second return value is one of **:internal** (2), **:external** (2), or **:inherited** (2) (or NIL (2) if $_f$**intern** has created a fresh symbol).

($_f$**unintern** *symbol* [*package*$_{\boxed{{}_v\textbf{*package*}}}$])
▷ Remove *symbol* from *package*, return T on success.

($\left\{\begin{matrix}{}_f\textbf{import}\\ {}_f\textbf{shadowing-import}\end{matrix}\right\}$ *symbols* [*package*$_{\boxed{{}_v\textbf{*package*}}}$])
▷ Make *symbols* internal to *package*. Return T. In case of a name conflict signal correctable **package-error** or shadow the old symbol, respectively.

($_f$**shadow** *symbols* [*package*$_{\boxed{{}_v\textbf{*package*}}}$])
▷ Make *symbols* of *package* shadow any otherwise accessible, equally named symbols from other packages. Return T.

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

($_f$**export** *symbols* [*package*$_{\boxed{{}_v\textbf{*package*}}}$])
▷ Make *symbols* external to *package*. Return T.

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

($\left\{\begin{matrix}{}_m\textbf{do-symbols}\\ {}_m\textbf{do-external-symbols}\\ {}_m\textbf{do-all-symbols}\ (\textit{var}\ [\textit{result}_{\boxed{\texttt{NIL}}}])\end{matrix}\right\}$ ($\widehat{\textit{var}}$ [*package*$_{\boxed{{}_v\textbf{*package*}}}$ [*result*$_{\boxed{\texttt{NIL}}}$]])
(**declare** $\widehat{\textit{decl}^*})^*$ $\left\{\begin{matrix}\widehat{\textit{tag}}\\ \textit{form}\end{matrix}\right\}^*$)
▷ Evaluate $_s$**tagbody**-like body with *var* successively bound to every symbol from *package*, to every external symbol from *package*, or to every symbol from all registered packages, respectively. Return values of *result*. Implicitly, the whole form is a $_s$**block** named NIL.

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

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

($_f$**provide** *module*)
▷ If not already there, add *module* to $_v$***modules***. Deprecated.

$_v$***modules*** ▷ List of names of loaded modules.

14.3 Symbols

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

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

(*f*gensym [*s*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*) ▷ Name or package, respectively, of *symbol*.

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

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

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

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

14.4 Standard Packages

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

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

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

15 Compiler

15.1 Predicates

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

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

15.2 Compilation

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

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

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

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

*v**compile-file* / *v**load* { pathname*NIL | truename*NIL } ▷ Input file used by *f*compile-file/by *f*load.

*v**compile* / *v**load* { print* | verbose* } ▷ Defaults used by *f*compile-file/by *f*load.

(*s*eval-when ({ {:compile-toplevel | compile} | {:load-toplevel | load} | {:execute | eval} }) *form*P*) ▷ Return values of *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** *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*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* [*read-only*NIL]) ▷ Evaluate *form* at compile time and treat its value as literal at run time.

(*s*quote *foo*) ▷ Return unevaluated *foo*.

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

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

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

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

15.4 Declarations

(*f* **proclaim** *decl*)
(*m* **declaim** $\widehat{decl^*}$)
▷ Globally make declaration(s) *decl*. *decl* can be: **declaration**, **type**, **ftype**, **inline**, **notinline**, **optimize**, or **special**. See below.

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

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

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

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

$$(\begin{Bmatrix}\textbf{ignorable}\\ \textbf{ignore}\end{Bmatrix}\ \begin{Bmatrix}var\\ (\textbf{function}\ function)\end{Bmatrix}^*)$$
▷ 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.

$$(\textbf{optimize}\ \begin{Bmatrix}\textbf{compilation-speed} & (\textbf{compilation-speed}\ n_{\boxed{3}})\\ \textbf{debug} & (\textbf{debug}\ n_{\boxed{3}})\\ \textbf{safety} & (\textbf{safety}\ n_{\boxed{3}})\\ \textbf{space} & (\textbf{space}\ n_{\boxed{3}})\\ \textbf{speed} & (\textbf{speed}\ n_{\boxed{3}})\end{Bmatrix})$$
▷ 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*$_{\boxed{\text{curr}}}$])
(*f* **get-universal-time**)
▷ Seconds from 1900-01-01, 00:00, ignoring leap seconds.

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

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

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

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

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