Quick Reference

Common lisp

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Contents

Typographic Conventions

name; $_{f}$**name**; $_{g}$**name**; $_{m}$**name**; $_{s}$**name**; $_{v}$***name***; $_{c}$**name**
▷ Symbol defined in Common Lisp; esp. function, generic function, macro, special operator, variable, constant.

them ▷ Placeholder for actual code.

`me` ▷ Literal text.

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

foo*; {*foo*}* ▷ Zero or more *foo*s.

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

foos ▷ English plural denotes a list argument.

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

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

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

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

$foo^{\mathsf{P}*}$ ▷ *foo** is evaluated as in $_{s}$**progn**; see page 21.

$\underline{foo}$; $\underline{bar}_{2}$; $\underline{baz}_{n}$ ▷ 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*$_0^*$)
($_f$* *a*$_1^*$)
▷ Return $\sum a$ or $\prod a$, respectively.

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

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

($_m$**incf** / $_m$**decf**) $\widetilde{place}$ [*delta*$_1$])
▷ Increment or decrement the value of *place* by *delta*. Return new value.

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

($_f$**log** *a* [*b*$_e$])
▷ Return $\log_b a$ or, without *b*, $\ln a$.

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

($_f$**lcm** *integer*$^*_1$)
($_f$**gcd** *integer**)
▷ Least common multiple or greatest common denominator, respectively, of *integer*s. (**gcd**) returns 0.

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

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

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

($_f$**atan** *a* [*b*$_1$])
▷ $\arctan \frac{a}{b}$ in radians.

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

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

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

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

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

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

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

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

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

*v**random-state* ▷ Current random state.

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

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

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

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

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

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

(*f*abs *n*) ▷ Return |*n*|.

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

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

1.3 Logic Functions

Negative integers are used in two's complement representation.

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

*c*__boole-1__	▷ *int-a*.
*c*__boole-2__	▷ *int-b*.
*c*__boole-c1__	▷ $\neg$*int-a*.
*c*__boole-c2__	▷ $\neg$*int-b*.
*c*__boole-set__	▷ All bits set.
*c*__boole-clr__	▷ All bits zero.
*c*__boole-eqv__	▷ *int-a* $\equiv$ *int-b*.
*c*__boole-and__	▷ *int-a* $\wedge$ *int-b*.
*c*__boole-andc1__	▷ $\neg$*int-a* $\wedge$ *int-b*.
*c*__boole-andc2__	▷ *int-a* $\wedge$ $\neg$*int-b*.
*c*__boole-nand__	▷ $\neg$(*int-a* $\wedge$ *int-b*).
*c*__boole-ior__	▷ *int-a* $\vee$ *int-b*.
*c*__boole-orc1__	▷ $\neg$*int-a* $\vee$ *int-b*.
*c*__boole-orc2__	▷ *int-a* $\vee$ $\neg$*int-b*.
*c*__boole-xor__	▷ $\neg$(*int-a* $\equiv$ *int-b*).
*c*__boole-nor__	▷ $\neg$(*int-a* $\vee$ *int-b*).

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

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

(*f*__logandc1__ *int-a int-b*) ▷ $\neg$*int-a* $\wedge$ *int-b*.

(*f*__logandc2__ *int-a int-b*) ▷ *int-a* $\wedge$ $\neg$*int-b*.

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

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

(*f*__logorc1__ *int-a int-b*) ▷ $\neg$*int-a* $\vee$ *int-b*.

(*f*__logorc2__ *int-a int-b*) ▷ *int-a* $\vee$ $\neg$*int-b*.

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

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

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

(*f*__logcount__ *int*)
▷ Number of 1 bits in *int* ≥ 0, number of 0 bits in *int* < 0.

1.4 Integer Functions

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

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

(ƒ**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.

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

(ƒ{**deposit-field**, **dpb**} *int-a byte-spec int-b*)
▷ Return *int-b* with bits denoted by *byte-spec* replaced by corresponding bits of *int-a*, or by the low (ƒ**byte-size** *byte-spec*) bits of *int-a*, respectively.

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

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

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

1.5 Implementation-Dependent

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

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

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

(ƒ**decode-float** *n*)
(ƒ**integer-decode-float** *n*)
▷ Return significand, exponent, and sign of **float** *n*.

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

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

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

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2 Characters

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(*f*__character__ *c*) ▷ Return #*c*.

3 Strings

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

(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$_2$ 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.

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

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

16 External Environment

(ƒ**get-internal-real-time**)
(ƒ**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.

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

(ƒ**decode-universal-time** *universal-time* [*time-zone*[current]])
(ƒ**get-decoded-time**)
▷ Return second, minute$_2$, hour$_3$, date$_4$, month$_5$, year$_6$, day$_7$, daylight-p$_8$, and zone$_9$.

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

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

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

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

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

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

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

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

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

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

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

($_f$**describe** *foo* [~~*stream*~~ $_v$***standard-output***])
▷ Send information about *foo* to *stream*.

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

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

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

15.4 Declarations

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

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

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

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

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

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

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

($_f$**atom** *foo*) ▷ Return `T` if *foo* is not a **cons**.

($_f$**tailp** *foo list*) ▷ Return `T` if *foo* is a tail of *list*.

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

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

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

4.2 Lists

($_f$**cons** *foo bar*) ▷ Return new cons (*foo* . *bar*).

($_f$**list** *foo**) ▷ Return list of *foo*s.

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

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

($_f$**list-length** *list*) ▷ Length of *list*; `NIL` for circular *list*.

($_f$**car** *list*) ▷ Car of *list* or `NIL` if *list* is `NIL`. **setf**able.

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

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

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

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

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

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

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

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

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

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

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

(*m*pushnew *foo* *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*.

(*s*eval-when ({ :compile-toplevel | compile | :load-toplevel | load | :execute | eval }) *form*P*)
▷ Return values of *forms* if *s*eval-when is in the top-level of a file being compiled, in the top-level of a compiled file being loaded, or anywhere, respectively. Return NIL if *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.[2]

(*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*.[2]

(*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. setfable.

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

15.3 REPL and Debugging

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

v− ▷ Form currently being evaluated by the REPL.

(*f*apropos *string* [*package*NIL])
▷ Print interned symbols containing *string*.

(*f*apropos-list *string* [*package*NIL])
▷ List of interned symbols containing *string*.

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

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

({*f*macroexpand-1 | *f*macroexpand} *form* [*environment*NIL])
▷ Return macro expansion, once or entirely, respectively, of *form* and T if *form* was a macro form. Return *form* and NIL otherwise.[2]

$_c$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*$_{\text{**$_v$*compile-verbose***}}$ | **:print** *bool*$_{\text{**$_v$*compile-print***}}$ | **:external-format** *file-format*$_{\text{**:default**}}$ })
▷ 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*$_{\text{**$_v$*load-verbose***}}$ | **:print** *bool*$_{\text{**$_v$*load-print***}}$ | **:if-does-not-exist** *bool*$_{\text{T}}$ | **:external-format** *file-format*$_{\text{**:default**}}$ })
▷ Load source file or compiled file into Lisp environment. Return T if successful.

$_v$*compile-file, **$_v$*load** { **pathname***$_{\text{NIL}}$ | **truename***$_{\text{NIL}}$ }
▷ 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**.

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

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

4.5 Sets

({ **$_f$intersection** | **$_f$set-difference** | **$_f$union** | **$_f$set-exclusive-or** } *a b* | { **$_f$nintersection** | **$_f$nset-difference** } $\widetilde{a}$ *b* | { **$_f$nunion** | **$_f$nset-exclusive-or** } $\widetilde{a}$ $\widetilde{b}$ { **:test** *function*$_{\text{**\#'eql**}}$ | **: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*$_{\text{NIL}}$] | **$_f$adjust-array** $\widetilde{array}$ *dimension-sizes* { **:element-type** *type*$_{\text{T}}$ | **:fill-pointer** {*num*|*bool*}$_{\text{NIL}}$ | **:initial-element** *obj* | **:initial-contents** *tree-or-array* | **:displaced-to** *array*$_{\text{NIL}}$ [**:displaced-index-offset** *i*$_{\text{0}}$] })
▷ Return fresh, or readjust, respectively, vector or array.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

5.3 Vector Functions

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

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

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

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

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

(*f*vector-pop $\widetilde{\textit{vector}}$)
▷ Return element of *vector* its fillpointer points to after decrementation.

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

6 Sequences

6.1 Sequence Predicates

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

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

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

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

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

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

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

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

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

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

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

({*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.

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_.

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

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

(_f_**intern** | _f_**find-symbol**) _foo_ [_package_[_v_***package***]])
▷ Intern or find, respectively, symbol _foo_ in _package_. Second return value is one of **:internal**, **:external**, or **:inherited** (or NIL if _f_**intern** has created a fresh symbol).

(_f_**unintern** _symbol_ [_package_[_v_***package***]])
▷ Remove _symbol_ from _package_, return T on success.

(_f_**import** | _f_**shadowing-import**) _symbols_ [_package_[_v_***package***]])
▷ Make _symbols_ internal to _package_. Return T. In case of a name conflict signal correctable **package-error** or shadow the old symbol, respectively.

(_f_**shadow** _symbols_ [_package_[_v_***package***]])
▷ Make _symbols_ of _package_ shadow any otherwise accessible, equally named symbols from other packages. Return T.

(_f_**mismatch** _sequence-a sequence-b_ { **:from-end** _bool_[NIL] | **:test** _function_[#'**eql**] | **:test-not** _function_ | **:start1** _start-a_[0] | **:start2** _start-b_[0] | **:end1** _end-a_[NIL] | **:end2** _end-b_[NIL] | **:key** _function_ })
▷ Return position in _sequence-a_ where _sequence-a_ and _sequence-b_ begin to mismatch. Return NIL if they match entirely.

6.2 Sequence Functions

(_f_**make-sequence** _sequence-type size_ [**:initial-element** _foo_])
▷ Make sequence of _sequence-type_ with _size_ elements.

(_f_**concatenate** _type sequence*_)
▷ Return concatenated sequence of _type_.

(_f_**merge** _type 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.

(_f_**fill** _sequence foo_ { **:start** _start_[0] | **:end** _end_[NIL] })
▷ Return _sequence_ after setting elements between _start_ and _end_ to _foo_.

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

(_f_**count** _foo sequence_ { **:from-end** _bool_[NIL] | **:test** _function_[#'**eql**] | **:test-not** _function_ | **:start** _start_[0] | **:end** _end_[NIL] | **:key** _function_ })
▷ Return number of elements in _sequence_ which match _foo_.

(_f_**count-if** | _f_**count-if-not**) _test sequence_ { **:from-end** _bool_[NIL] | **:start** _start_[0] | **:end** _end_[NIL] | **:key** _function_ })
▷ Return number of elements in _sequence_ which satisfy _test_.

(_f_**elt** _sequence index_)
▷ Return element of _sequence_ pointed to by zero-indexed _index_. **setf**able.

(_f_**subseq** _sequence start_ [_end_[NIL]])
▷ Return subsequence of _sequence_ between _start_ and _end_. **setf**able.

(_f_**sort** | _f_**stable-sort**) _sequence test_ [**:key** _function_])
▷ Return _sequence_ sorted. Order of elements considered equal is not guaranteed/retained, respectively.

(_f_**reverse** _sequence_)
(_f_**nreverse** _sequence_) ▷ Return _sequence_ in reverse order.

(_f_**find** | _f_**position**) _foo sequence_ { **:from-end** _bool_[NIL] | **:test** _function_[#'**eql**] | **:test-not** _test_ | **:start** _start_[0] | **:end** _end_[NIL] | **:key** _function_ })
▷ Return first element in _sequence_ which matches _foo_, or its position relative to the begin of _sequence_, respectively.

($_f$ {**find-if** | **find-if-not** | **position-if** | **position-if-not**} *test sequence* {**:from-end** *bool*$_{\texttt{NIL}}$ | **:start** *start*$_{\texttt{0}}$ | **:end** *end*$_{\texttt{NIL}}$ | **:key** *function*})

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

($_f$ **search** *sequence-a sequence-b* {**:from-end** *bool*$_{\texttt{NIL}}$ | {**:test** *function*$_{\texttt{\#'eql}}$ | **:test-not** *function*} | **:start1** *start-a*$_{\texttt{0}}$ | **:start2** *start-b*$_{\texttt{0}}$ | **:end1** *end-a*$_{\texttt{NIL}}$ | **:end2** *end-b*$_{\texttt{NIL}}$ | **:key** *function*})

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

($_f$ {**remove** *foo sequence* | **delete** *foo sequence*} {**:from-end** *bool*$_{\texttt{NIL}}$ | {**:test** *function*$_{\texttt{\#'eql}}$ | **:test-not** *function*} | **:start** *start*$_{\texttt{0}}$ | **:end** *end*$_{\texttt{NIL}}$ | **:key** *function* | **:count** *count*$_{\texttt{NIL}}$})

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

($_f$ {**remove-if** | **remove-if-not** | **delete-if** | **delete-if-not**} *test sequence* {**:from-end** *bool*$_{\texttt{NIL}}$ | **:start** *start*$_{\texttt{0}}$ | **:end** *end*$_{\texttt{NIL}}$ | **:key** *function* | **:count** *count*$_{\texttt{NIL}}$})

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

($_f$ {**remove-duplicates** *sequence* | **delete-duplicates** *sequence*} {**:from-end** *bool*$_{\texttt{NIL}}$ | {**:test** *function*$_{\texttt{\#'eql}}$ | **:test-not** *function*} | **:start** *start*$_{\texttt{0}}$ | **:end** *end*$_{\texttt{NIL}}$ | **:key** *function*})

▷ Make copy of *sequence* without duplicates.

($_f$ {**substitute** *new old sequence* | **nsubstitute** *new old sequence*} {**:from-end** *bool*$_{\texttt{NIL}}$ | {**:test** *function*$_{\texttt{\#'eql}}$ | **:test-not** *function*} | **:start** *start*$_{\texttt{0}}$ | **:end** *end*$_{\texttt{NIL}}$ | **:key** *function* | **:count** *count*$_{\texttt{NIL}}$})

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

($_f$ {**substitute-if** | **substitute-if-not** | **nsubstitute-if** | **nsubstitute-if-not**} *new test sequence* {**:from-end** *bool*$_{\texttt{NIL}}$ | **:start** *start*$_{\texttt{0}}$ | **:end** *end*$_{\texttt{NIL}}$ | **:key** *function* | **:count** *count*$_{\texttt{NIL}}$})

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

($_f$ **replace** *sequence-a sequence-b* {**:start1** *start-a*$_{\texttt{0}}$ | **:start2** *start-b*$_{\texttt{0}}$ | **:end1** *end-a*$_{\texttt{NIL}}$ | **:end2** *end-b*$_{\texttt{NIL}}$})

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

($_f$ **map** *type function sequence*$^+$)

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

($_f$ **enough-namestring** *path-or-stream* [*root-path*$_{v\texttt{*default-pathname-defaults*}}$])

▷ Return minimal path string that sufficiently describes the path of *path-or-stream* relative to *root-path*.

($_f$ **namestring** *path-or-stream*)
($_f$ **file-namestring** *path-or-stream*)
($_f$ **directory-namestring** *path-or-stream*)
($_f$ **host-namestring** *path-or-stream*)

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

($_f$ **translate-pathname** *path-or-stream wildcard-path-a wildcard-path-b*)

▷ Translate the path of *path-or-stream* from *wildcard-path-a* into *wildcard-path-b*. Return new path.

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

($_f$ **logical-pathname** *logical-path-or-stream*)

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

($_f$ **logical-pathname-translations** *logical-host*)

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

($_f$ **load-logical-pathname-translations** *logical-host*)

▷ Load *logical-host*'s translations. Return `NIL` if already loaded; return `T` if successful.

($_f$ **translate-logical-pathname** *path-or-stream*)

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

($_f$ **probe-file** *file*)
($_f$ **truename** *file*)

▷ Canonical name of *file*. If *file* does not exist, return `NIL`/signal **file-error**, respectively.

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

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

($_f$ **file-length** *stream*) ▷ Return length of *stream*.

($_f$ **rename-file** *foo bar*)

▷ Rename file *foo* to *bar*. Unspecified components of path *bar* default to those of *foo*. Return new pathname, old physical file name$_2$, and new physical file name$_3$.

($_f$ **delete-file** *file*) ▷ Delete *file*. Return `T`.

($_f$ **directory** *path*) ▷ List of pathnames matching *path*.

($_f$ **ensure-directories-exist** *path* [**:verbose** *bool*])

▷ Create parts of *path* if necessary. Second return value is `T`$_2$ if something has been created.

14 Packages and Symbols

The Loop Facility provides additional means of symbol handling; see **loop**, page 22.

14.1 Predicates

($_f$ **symbolp** *foo*)
($_f$ **packagep** *foo*) ▷ `T` if *foo* is of indicated type.
($_f$ **keywordp** *foo*)

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

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

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

7 Hash Tables

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

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

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

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

(*f*gethash *key hash-table* [*default*NIL])
▷ Return object with *key* if any or *default* otherwise; and T$_2$ if found, NIL$_2$ otherwise. setfable.

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

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

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

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

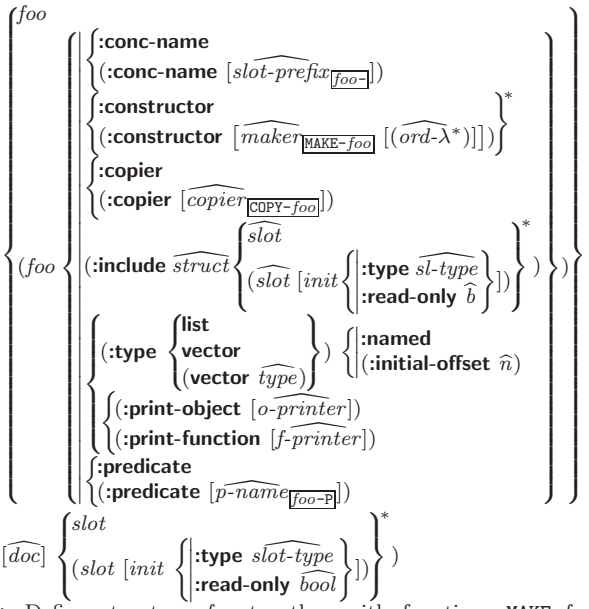
(*m*with-hash-table-iterator (*foo hash-table*) (declare *decl**)* *form*P*)
▷ Return values of *form*s. In *form*s, invocations of (*foo*) return: T if an entry is returned; its key; its value.

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

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

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

8 Structures

(*m*defstruct


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

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

9 Control Structure

9.1 Predicates

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

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

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

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

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

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

(*f***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*.

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

~ [$c_{\boxed{1}}$] [,$i_{\boxed{1}}$] [**:**] [**@**] **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.

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

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

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

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

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

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

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

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

13.6 Streams

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

)
▷ Open **file-stream** to *path*.

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

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

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

9.2 Variables

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

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

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

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

(*f***set** $\widetilde{symbol}$ *foo*) ▷ Set *symbol*'s value cell to *foo*. Deprecated.

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

(*m***shiftf** $\widetilde{place}^{+}$ *foo*)
▷ Store value of *foo* in rightmost *place* shifting values of *place*s left, returning first *place*.

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

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

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

(*f***get-properties** *property-list keys*)
▷ Return $\underset{1}{\text{key}}$ and $\underset{2}{\text{value}}$ of first entry from *property-list* matching a key from *keys*, and $\underset{3}{\text{tail of } property\text{-}list}$ starting with that key. Return `NIL`, $\underset{2}{\texttt{NIL}}$, and $\underset{3}{\texttt{NIL}}$ if there was no matching key in *property-list*.

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

(*s***progv** *symbols values* $form^{P_*}$)
▷ Evaluate *form*s with locally established dynamic bindings of *symbols* to *values* or `NIL`. Return values of *form*s.

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

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

(*m*destructuring-bind *destruct-λ bar* (declare *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*NIL [*supplied-p*]])}*] [&rest *var*]
[&key {*var* | ({*var* | (:*key var*)} [*init*NIL [*supplied-p*]])}* [&allow-other-keys]]
[&aux {*var* | (*var* [*init*NIL])}*]).

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

({*m*defun *foo* (*ord-λ**) | *m*defun (setf *foo*) (*new-value ord-λ**) | *m*lambda (*ord-λ**)} (declare *decl**)* [*doc*]
*form*P*)
▷ Define a function named *foo* or (setf *foo*), or an anonymous function, respectively, which applies *form*s to *ord-λ*s. For *m*defun, *form*s are enclosed in an implicit *s*block named *foo*.

({*s*flet | *s*labels} (({*foo* (*ord-λ**) | (setf *foo*) (*new-value ord-λ**)} (declare *local-decl**)*
[*doc*] *local-form*P*)*) (declare *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-form*s. Return values of *form*s.

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

(*f*apply {*function* | (setf *function*)} *arg** *args*)
▷ Values of *function* called with *arg*s and the list elements of *args*. setfable 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. setfable.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

~ [:] [@] < {[*prefix*␣␣ ~;]|[*per-line-prefix* ~@;]} *body* [~; *suffix*␣␣] ~: [@] >
▷ **Logical Block.** Act like pprint-logical-block using *body* as *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.

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 [2] 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** $\widehat{control}$)
▷ 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.

(*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 [2] if *function* was defined in an environment without bindings, and name [3] of *function*.

(*f* **fdefinition** {*foo* | (**setf** *foo*)})
▷ Definition of global function *foo*. **setf**able.

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

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

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

9.4 Macros

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

([**&whole** *var*] [*E*] {*var* | (*macro-λ**)}* [*E*]
[**&optional** {*var* | ({*var* | (*macro-λ**)} [*init* NIL [*supplied-p*]])}*] [*E*]
[{**&rest** | **&body**} {*rest-var* | (*macro-λ**)}] [*E*]
[**&key** {*var* | ({*var* | (:*key* {*var* | (*macro-λ**)})} [*init* NIL [*supplied-p*]])}* [*E*]
[**&allow-other-keys**]] [**&aux** {*var* | (*var* [*init* NIL])}*] [*E*])
or
([**&whole** *var*] [*E*] {*var* | (*macro-λ**)}* [*E*] [**&optional** {*var* | ({*var* | (*macro-λ**)} [*init* NIL [*supplied-p*]])}*] [*E*] **.** *rest-var*).

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

({*m* **defmacro** | *f* **define-compiler-macro**} {*foo* | (**setf** *foo*)} (*macro-λ**) (**declare** $\widehat{decl^*}$)* [$\widehat{doc}$] *form*P*)
▷ Define macro *foo* which on evaluation as (*foo tree*) applies expanded *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*.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

($\left\{\begin{array}{l}f\textbf{write}\\ f\textbf{write-to-string}\end{array}\right\}$ *foo* $\left\{\begin{array}{l}\textbf{:array}\ bool\\ \textbf{:base}\ radix\\ \textbf{:case}\ \left\{\begin{array}{l}\textbf{:upcase}\\ \textbf{:downcase}\\ \textbf{:capitalize}\end{array}\right.\\ \textbf{:circle}\ bool\\ \textbf{:escape}\ bool\\ \textbf{:gensym}\ bool\\ \textbf{:length}\ \{int|\texttt{NIL}\}\\ \textbf{:level}\ \{int|\texttt{NIL}\}\\ \textbf{:lines}\ \{int|\texttt{NIL}\}\\ \textbf{:miser-width}\ \{int|\texttt{NIL}\}\\ \textbf{:pprint-dispatch}\ dispatch\text{-}table\\ \textbf{:pretty}\ bool\\ \textbf{:radix}\ bool\\ \textbf{:readably}\ bool\\ \textbf{:right-margin}\ \{int|\texttt{NIL}\}\\ \textbf{:stream}\ \widetilde{stream}_{v*\textbf{standard-output}*}\end{array}\right.$)
▷ 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 $\widetilde{stream}$ *foo* [*parenthesis*$_{\texttt{T}}$ [*noop*]])
(*f*pprint-tabular $\widetilde{stream}$ *foo* [*parenthesis*$_{\texttt{T}}$ [*noop* [n_{16}]]])
(*f*pprint-linear $\widetilde{stream}$ *foo* [*parenthesis*$_{\texttt{T}}$ [*noop*]])
▷ Print *foo* to *stream*. If *foo* is a list, print as many elements per line as possible; do the same in a table with a column width of n ems; or print either all elements on one line or each on its own line, respectively. Return NIL. Usable with *f***format** directive ~//.

(*m*pprint-logical-block ($\widetilde{stream}$ *list* $\left\{\left|\begin{array}{l}\textbf{:prefix}\ string\\ \textbf{:per-line-prefix}\ string\end{array}\right.\right\}$
$\textbf{:suffix}\ string_{\texttt{""}}$)
(**declare** $\widehat{decl^*}$)* $form^{P*}$)
▷ Evaluate *forms*, 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 $\left\{\begin{array}{l}\textbf{:line}\\ \textbf{:line-relative}\\ \textbf{:section}\\ \textbf{:section-relative}\end{array}\right\}$ $c\ i$ [$\widetilde{stream}_{v*\textbf{standard-output}*}$])
▷ Move cursor forward to column number $c + ki$, $k \geq 0$ being as small as possible.

(*f*pprint-indent $\left\{\begin{array}{l}\textbf{:block}\\ \textbf{:current}\end{array}\right\}$ n [$\widetilde{stream}_{v*\textbf{standard-output}*}$])
▷ 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 $\left\{\begin{array}{l}\textbf{:linear}\\ \textbf{:fill}\\ \textbf{:miser}\\ \textbf{:mandatory}\end{array}\right\}$ [$\widetilde{stream}_{v*\textbf{standard-output}*}$])
▷ 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.

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

ᵥ***features***
▷ List of symbols denoting implementation-dependent features.

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

13.4 Printer

({ᶠ**prin1** | ᶠ**print** | ᶠ**pprint** | ᶠ**princ**} *foo* [*stream*ᵥ***standard-output***])
▷ Print *foo* to *stream* ᶠ**read**ably, ᶠ**read**ably between a newline and a space, ᶠ**read**ably after a newline, or human-readably without any extra characters, respectively. ᶠ**prin1**, ᶠ**print** and ᶠ**princ** return *foo*.

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

(ᵍ**print-object** *object stream*)
▷ Print *object* to *stream*. Called by the Lisp printer.

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

(ᶠ**terpri** [*stream*ᵥ***standard-output***])
▷ Output a newline to *stream*. Return `NIL`.

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

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

({ᶠ**write-string** | ᶠ**write-line**} *string* [*stream*ᵥ***standard-output*** [{**:start** *start*0 | **:end** *end*NIL}]])
▷ Write *string* to *stream* without/with a trailing newline.

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

(ᶠ**write-sequence** *sequence stream* {**:start** *start*0 | **:end** *end*NIL})
▷ Write elements of *sequence* to binary or character *stream*.

9.5 Control Flow

(ₛ**if** *test then* [*else*NIL])
▷ Return values of *then* if *test* returns `T`; return values of *else* otherwise.

(ₘ**cond** (*test then*P*(*test*))*)
▷ Return the values of the first *then** whose *test* returns `T`; return `NIL` if all *test*s return `NIL`.

({ₘ**when** | ₘ**unless**} *test foo*P*)
▷ Evaluate *foo*s and return their values if *test* returns `T` or `NIL`, respectively. Return `NIL` otherwise.

(ₘ**case** *test* ({(*key**) | *key*} *foo*P*)* [({**otherwise** | T} *bar*P*)NIL])
▷ Return the values of the first *foo** one of whose *key*s is **eql** *test*. Return values of *bar*s if there is no matching *key*.

({ₘ**ecase** | ₘ**ccase**} *test* ({(*key**) | *key*} *foo*P*)*)
▷ Return the values of the first *foo** one of whose *key*s is **eql** *test*. Signal non-correctable/correctable **type-error** if there is no matching *key*.

(ₘ**and** *form**T)
▷ Evaluate *form*s from left to right. Immediately return `NIL` if one *form*'s value is `NIL`. Return values of last *form* otherwise.

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

(ₛ**progn** *form**NIL)
▷ Evaluate *form*s sequentially. Return values of last *form*.

(ₛ**multiple-value-prog1** *form-r form**)
(ₘ**prog1** *form-r form**)
(ₘ**prog2** *form-a form-r form**)
▷ Evaluate forms in order. Return values/primary value, respectively, of *form-r*.

({ₘ**prog** | ₘ**prog***} ({*name* | (*name* [*value*NIL])}*) (**declare** *decl**)* {*tag* | *form*}*)
▷ Evaluate ₛ**tagbody**-like body with *name*s lexically bound (in parallel or sequentially, respectively) to *value*s. Return `NIL` or explicitly ₘ**return**ed values. Implicitly, the whole form is a ₛ**block** named `NIL`.

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

(ₛ**block** *name form*P*)
▷ Evaluate *form*s in a lexical environment, and return their values unless interrupted by ₛ**return-from**.

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

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

(ₛ**go** *tag*)
▷ Within the innermost possible enclosing ₛ**tagbody**, jump to a tag ᶠ**eql** *tag*.

(ₛ**catch** *tag form*ᴾ*)
▷ Evaluate *form*s and return their values unless interrupted by ₛ**throw**.

(ₛ**throw** *tag form*)
▷ Have the nearest dynamically enclosing ₛ**catch** with a tag 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** *decl**)* {*tag* / *form*}*)
▷ Evaluate ₛ**tagbody**-like body with *var*s successively bound according to the values of the corresponding *start* and *step* forms. *var*s are bound in parallel/sequentially, respectively. Stop iteration when *stop* is `T`. Return values of *result**. Implicitly, the whole form is a ₛ**block** named `NIL`.

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

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

9.7 Loop Facility

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

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

named *n*ₙᵢₗ ▷ Give ₘ**loop**'s implicit ₛ**block** a name.

{**with** {*var-s* / (*var-s**)} [*d-type*] [= *foo*]}⁺
{**and** {*var-p* / (*var-p**)} [*d-type*] [= *bar*]}*
where destructuring type specifier *d-type* has the form
{**fixnum**|**float**|`T`|`NIL`|{**of-type** {*type* / (*type**)}}}
▷ Initialize (possibly trees of) local variables *var-s* sequentially and *var-p* in parallel.

{{**for**|**as**} {*var-s* / (*var-s**)} [*d-type*]}⁺ {**and** {*var-p* / (*var-p**)} [*d-type*]}*
▷ Begin of iteration control clauses. Initialize and step (possibly trees of) local variables *var-s* sequentially and *var-p* in parallel. Destructuring type specifier *d-type* as with **with**.

{**upfrom**|**from**|**downfrom**} *start*
▷ Start stepping with *start*

{**upto**|**downto**|**to**|**below**|**above**} *form*
▷ Specify *form* as the end value for stepping.

{**in**|**on**} *list*
▷ Bind *var* to successive elements/tails, respectively, of *list*.

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

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

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

13.3 Character Syntax

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

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

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

" ▷ Begin and end of a string.

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

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

#*c* ▷ (ₓ**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** $\frac{n}{d}$.

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

#C(*a b***)** ▷ (ₓ**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.

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

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

#P*string* ▷ A pathname.

#:*foo* ▷ Uninterned symbol *foo*.

#.*form* ▷ Read-time value of *form*.

ᵥ**∗read-eval∗**ₜ ▷ If `NIL`, a **reader-error** is signalled at **#.**.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$_{v}$***readtable*** ▷ Current readtable.

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

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

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

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

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

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

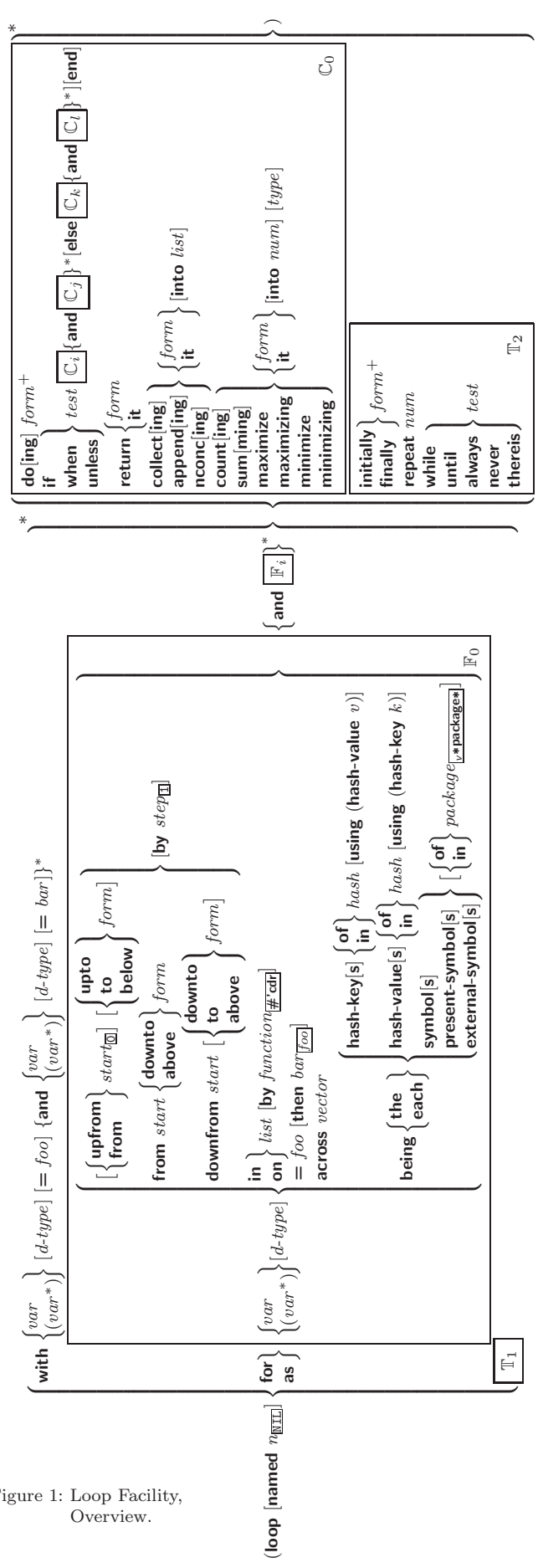


Figure 1: Loop Facility, Overview.

= *foo* [**then** *bar*$_{foo}$]
▷ Bind *var* initially to *foo* and later to *bar*.

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

being {**the**|**each**}
▷ Iterate over a hash table or a package.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

($_m$**deftype** *foo* (*macro-λ**) (**declare** $\widehat{decl}$*)* [$\widehat{doc}$] *form*^{P}*)
▷ Define type *foo* which when referenced as (*foo* $\widehat{arg}$*) (or as *foo* if *macro-λ* doesn't contain any required parameters) applies expanded *form*s to *arg*s returning the new type. For (*macro-λ**) see page 19 but with default value of ∗ instead of `NIL`. *form*s are enclosed in an implicit $_s$**block** named *foo*.

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

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

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

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

(**and** *type**$_{T}$) ▷ Type specifier for intersection of *type*s.

(**or** *type**$_{NIL}$) ▷ Type specifier for union of *type*s.

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

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

13 Input/Output

13.1 Predicates

($_f$**streamp** *foo*)
($_f$**pathnamep** *foo*) ▷ `T` if *foo* is of indicated type.
($_f$**readtablep** *foo*)

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

($_f$**pathname-match-p** *path wildcard*)
▷ `T` if *path* matches *wildcard*.

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

13.2 Reader

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

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

($_f$**read-from-string** *string* [*eof-error*$_T$ [*eof-val*$_{NIL}$ [$\left\{\begin{array}{l}\textbf{:start } start_0\\ \textbf{:end } end_{NIL}\\ \textbf{:preserve-whitespace } bool_{NIL}\end{array}\right\}$]]])
▷ Return object read from string and zero-indexed position^2 of next character.

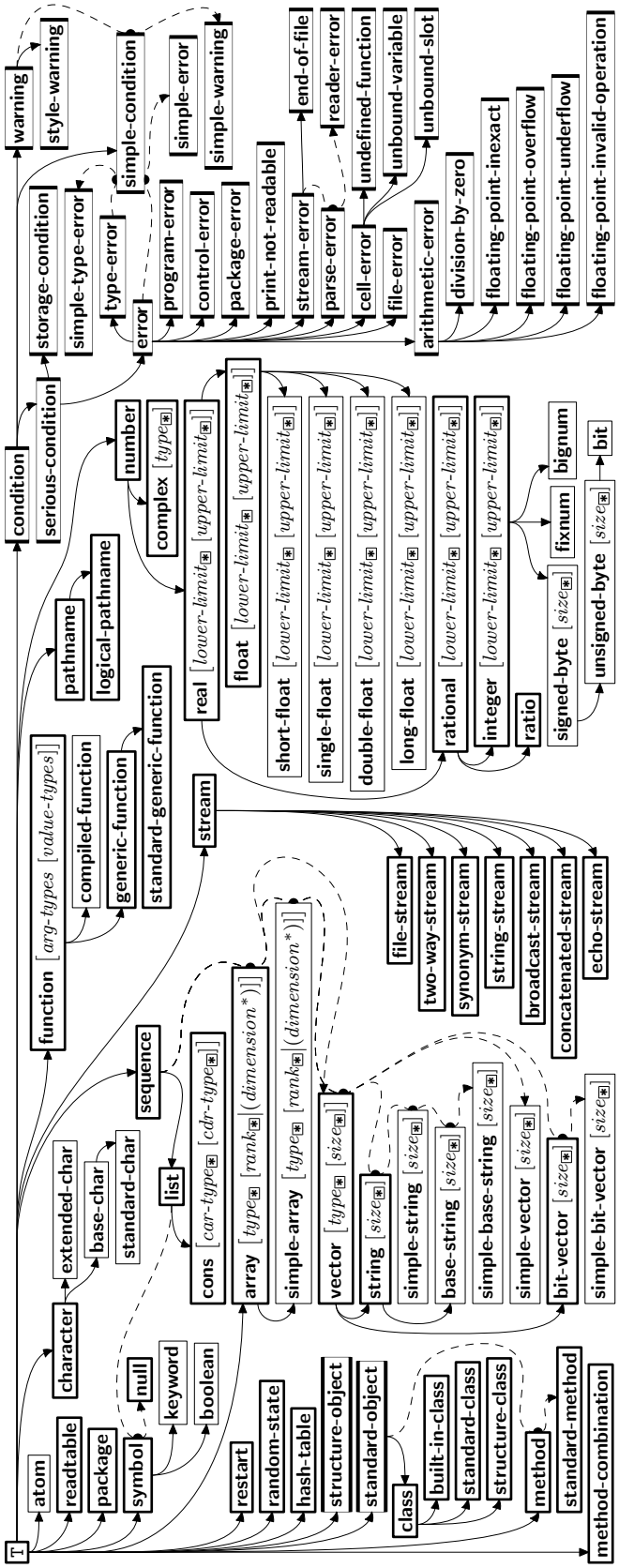


Figure 2: Precedence Order of System Classes (▭), Classes (▬), Types (▭), and Condition Types (▭).
Every type is also a supertype of NIL, the empty type.

{**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

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

(ₓ**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 ₘ**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*.

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

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

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

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

(ₓ**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.

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

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

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

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

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

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

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

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

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

10.2 Generic Functions

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

(*m*defgeneric {*foo* | (**setf** *foo*)} (*required-var** [**&optional** {*var* | (*var*)}*] [**&rest** *var*] [**&key** {*var* | (*var* | (:*key var*))}* [**&allow-other-keys**]])
{(:**argument-precedence-order** *required-var*+)
(**declare** (**optimize** *method-selection-optimization*)+)
(:**documentation** $\widehat{string}$)
(:**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*)}

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

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

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

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

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

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

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

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

12 Types and Classes

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

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

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

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

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

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

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

(*f*type-of *foo*) ▷ Type of *foo*.

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

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

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

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

(*m*with-simple-restart ({*restart* | NIL} *control arg**) *form*P*)

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

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

(*f*invoke-restart *restart arg**)
(*f*invoke-restart-interactively *restart*)

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

({*f*find-restart | *f*compute-restarts *name*} [*condition*])

▷ Return innermost restart *name*, or a list of all restarts, respectively, out of those either associated with *condition* or un-associated at all; or, without *condition*, out of all restarts. Return NIL if search is unsuccessful.

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

({*f*abort | *f*muffle-warning | *f*continue | *f*store-value *value* | *f*use-value *value*} [*condition*NIL])

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

(*m*with-condition-restarts *condition restarts form*P*)

▷ Evaluate *form*s with *restarts* dynamically associated with *condition*. Return values of *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*.

{: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 *arg*s; return its values.

(*g*no-applicable-method *generic-function arg**)

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

({*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 *arg*s see format, page 38.

(*g*no-next-method *generic-function method arg**)

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

(*g*function-keywords *method*)

▷ Return list of keyword parameters of *method* and 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*^)}*)])
▷ 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** *decl*^*)* *condition-form*P*)*
[(**:no-error** (*ord-λ**) (**declare** *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.