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

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

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

1 Numbers

1.1 Predicates

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

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

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

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

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

1.2 Numeric Functions

($_f$+ $a_{[0]}^*$)
($_f$* $a_{[1]}^*$)
▷ 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.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

({*f*round | *f*round}
{*f*floor | *f*ffloor}
{*f*ceiling | *f*fceiling}
{*f*truncate | *f*ftruncate} *n* [*d*1])
▷ Return as **integer** or **float**, respectively, *n*/*d* rounded, or rounded towards $-\infty$, $+\infty$, or 0, respectively; and remainder$_2$.

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

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

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

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

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

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

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

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

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

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

(*f*abs *n*) ▷ Return $|n|$.

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

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

1.3 Logic Functions

Negative integers are used in two's complement representation.

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

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

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$_c$**boole-eqv** ▷ $\underline{int\text{-}a \equiv int\text{-}b}$.

$_c$**boole-and** ▷ $\underline{int\text{-}a \wedge int\text{-}b}$.

$_c$**boole-andc1** ▷ $\underline{\neg int\text{-}a \wedge int\text{-}b}$.

$_c$**boole-andc2** ▷ $\underline{int\text{-}a \wedge \neg int\text{-}b}$.

$_c$**boole-nand** ▷ $\underline{\neg(int\text{-}a \wedge int\text{-}b)}$.

$_c$**boole-ior** ▷ $\underline{int\text{-}a \vee int\text{-}b}$.

$_c$**boole-orc1** ▷ $\underline{\neg int\text{-}a \vee int\text{-}b}$.

$_c$**boole-orc2** ▷ $\underline{int\text{-}a \vee \neg int\text{-}b}$.

$_c$**boole-xor** ▷ $\underline{\neg(int\text{-}a \equiv int\text{-}b)}$.

$_c$**boole-nor** ▷ $\underline{\neg(int\text{-}a \vee int\text{-}b)}$.

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

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

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

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

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

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

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

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

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

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

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

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

1.4 Integer Functions

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

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

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

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

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

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

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

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

1.5 Implementation-Dependent

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

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

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

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

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

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

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

2 Characters

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

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

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

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

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

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

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

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

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

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

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

16 External Environment

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

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

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

(f **decode-universal-time** *universal-time* [*time-zone*current])
(f **get-decoded-time**)
▷ Return second, minute, hour, date, month, year, day, daylight-p, and zone.

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

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

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

(ƒ**macroexpand-1** / ƒ**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.
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v***macroexpand-hook***
▷ Function of arguments expansion function, macro form, and environment called by ƒ**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*.

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

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

(ƒ**inspect** *foo*) ▷ Interactively give information about *foo*.

(ƒ**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 ƒ**describe**.

(ƒ**disassemble** *function*)
▷ Send disassembled representation of *function* to v***standard-output***. Return NIL.

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

15.4 Declarations

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(ƒ**character** *c*) ▷ Return #*c*.

3 Strings

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

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

({ƒ**string=** / ƒ**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**} / ƒ**string**{> |**-greaterp**} / ƒ**string**{>= |**-not-lessp**} / ƒ**string**{< |**-lessp**} / ƒ**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** / ƒ**string-upcase** / ƒ**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** / ƒ**nstring-upcase** / ƒ**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** / ƒ**string-left-trim** / ƒ**string-right-trim**} *char-bag string*)
▷ Return *string* with all characters in sequence *char-bag* removed from both ends, from the beginning, or from the end, respectively.

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

(*f*parse-integer *string* {:start *start*[0] | :end *end*[NIL] | :radix *int*[10] | :junk-allowed *bool*[NIL]})
▷ Return integer parsed from *string* and index$_2$ of parse end.

4 Conses

4.1 Predicates

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

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

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

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

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

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

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

4.2 Lists

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(*g*make-load-form *foo* [*environment*])
▷ Its methods are to return a creation form which on evaluation at *f*load time returns an object equivalent to *foo*, and an optional initialization form$_2$ which on evaluation performs some initialization of the object.

(*f*make-load-form-saving-slots *foo*
{:slot-names *slots*[all local slots] | :environment *environment*})
▷ Return a creation form and an initialization form$_2$ which on evaluation construct an object equivalent to *foo* with *slots* initialized with the corresponding values from *foo*.

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

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

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

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

14.4 Standard Packages

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

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

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

15 Compiler

15.1 Predicates

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

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

15.2 Compilation

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

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

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

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

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

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

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

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

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

(*f* **mapcar** | **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** | **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** | **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** | **rassoc** *foo alist* **:test** *test* = **#'eql** | **:test-not** *test* | **:key** *function*)
(*f* **assoc-if**[**-not**] | **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

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

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

({ƒ**subst** *new old tree* | ƒ**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*.

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

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

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

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

(ƒ**copy-tree** *tree*)

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

4.5 Sets

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

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

5 Arrays

5.1 Predicates

(ƒ**arrayp** *foo*)
(ƒ**vectorp** *foo*)
(ƒ**simple-vector-p** *foo*) ▷ T if *foo* is of indicated type.
(ƒ**bit-vector-p** *foo*)
(ƒ**simple-bit-vector-p** *foo*)

(ƒ**adjustable-array-p** *array*)
(ƒ**array-has-fill-pointer-p** *array*)

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

(ƒ**array-in-bounds-p** *array* [*subscripts*])

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

5.2 Array Functions

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

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

(ƒ**aref** *array* [*subscripts*])

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

(ƒ**row-major-aref** *array i*)

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

({ƒ**intern** | ƒ**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 ƒ**intern** has created a fresh symbol).

(ƒ**unintern** *symbol* [*package*v*package*])

▷ Remove *symbol* from *package*, return T on success.

({ƒ**import** | ƒ**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.

(ƒ**shadow** *symbols* [*package*v*package*])

▷ Make *symbols* of *package* shadow any otherwise accessible, equally named symbols from other packages. Return T.

(ƒ**package-shadowing-symbols** *package*)

▷ List of symbols of *package* that shadow any otherwise accessible, equally named symbols from other packages.

(ƒ**export** *symbols* [*package*v*package*])

▷ Make *symbols* external to *package*. Return T.

(ƒ**unexport** *symbols* [*package*v*package*])

▷ Revert *symbols* to internal status. Return T.

({m**do-symbols** | m**do-external-symbols** | m**do-all-symbols**} (~~*var*~~ [*package*v*package* [*result*NIL]]) (**declare** ~~*decl*~~*)* {| *tag* | *form*}*)

▷ Evaluate s**tagbody**-like body with *var* successively bound to every symbol from *package*, to every external symbol from *package*, or to every symbol from all registered packages, respectively. Return values of *result*. Implicitly, the whole form is a s**block** named NIL.

(m**with-package-iterator** (*foo packages* [**:internal**|**:external**|**:inherited**]) (**declare** ~~*decl*~~*)* *form*P*)

▷ Return values of *form*s. In *form*s, successive invocations of (*foo*) return: T if a symbol is returned; a symbol from *packages*; accessibility (**:internal**, **:external**, or **:inherited**); and the package the symbol belongs to.

(ƒ**require** *module* [*paths*NIL])

▷ If not in v***modules***, try *paths* to load *module* from. Signal **error** if unsuccessful. Deprecated.

(ƒ**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*).

(ƒ**make-symbol** *name*)

▷ Make fresh, uninterned symbol *name*.

(ƒ**gensym** [*s*G])

▷ Return fresh, uninterned symbol #:*sn* with *n* from v***gensym-counter***. Increment v***gensym-counter***.

(ƒ**gentemp** [*prefix*T [*package*v*package*]])

▷ Intern fresh symbol in package. Deprecated.

(ƒ**copy-symbol** *symbol* [*props*NIL])

▷ Return uninterned copy of *symbol*. If *props* is T, give copy the same value, function and property list.

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

14 Packages and Symbols

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

14.1 Predicates

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

14.2 Packages

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

5.3 Vector Functions

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

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

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

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

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

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

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

6 Sequences

6.1 Sequence Predicates

($\left\{\begin{array}{l}_f\textbf{every}\\ _f\textbf{notevery}\end{array}\right\}$ *test sequence*$^+$)
▷ Return NIL or T, respectively, as soon as *test* on any set of corresponding elements of *sequence*s returns NIL.

($\left\{\begin{array}{l}_f\textbf{some}\\ _f\textbf{notany}\end{array}\right\}$ *test sequence*$^+$)
▷ Return value of *test* or NIL, respectively, as soon as *test* on any set of corresponding elements of *sequence*s returns non-NIL.

(_f**mismatch** *sequence-a sequence-b* $\left\{\begin{array}{l}\textbf{:from-end}\ bool_{\texttt{NIL}}\\ \left\{\begin{array}{l}\textbf{:test}\ function_{\#\text{'}\textbf{eql}}\\ \textbf{:test-not}\ function\end{array}\right.\\ \textbf{:start1}\ start\text{-}a_{0}\\ \textbf{:start2}\ start\text{-}b_{0}\\ \textbf{:end1}\ end\text{-}a_{\texttt{NIL}}\\ \textbf{:end2}\ end\text{-}b_{\texttt{NIL}}\\ \textbf{:key}\ function\end{array}\right\}$)
▷ 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*$_{\texttt{NIL}}$])
▷ Return interleaved sequence of *type*. Merged sequence will be sorted if both *sequence-a* and *sequence-b* are sorted.

(_f**fill** ~~*sequence*~~ *foo* $\left\{\begin{array}{l}\textbf{:start}\ start_{0}\\ \textbf{:end}\ end_{\texttt{NIL}}\end{array}\right\}$)
▷ 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* $\left\{\begin{array}{l}\textbf{:from-end}\ bool_{\texttt{NIL}}\\ \left\{\begin{array}{l}\textbf{:test}\ function_{\#\text{'}\textbf{eql}}\\ \textbf{:test-not}\ function\end{array}\right.\\ \textbf{:start}\ start_{0}\\ \textbf{:end}\ end_{\texttt{NIL}}\\ \textbf{:key}\ function\end{array}\right\}$)
▷ Return number of elements in *sequence* which match *foo*.

($\left\{\begin{array}{l}_f\textbf{count-if}\\ _f\textbf{count-if-not}\end{array}\right\}$ *test sequence* $\left\{\begin{array}{l}\textbf{:from-end}\ bool_{\texttt{NIL}}\\ \textbf{:start}\ start_{0}\\ \textbf{:end}\ end_{\texttt{NIL}}\\ \textbf{:key}\ function\end{array}\right\}$)
▷ Return 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*$_{\texttt{NIL}}$])
▷ Return subsequence of *sequence* between *start* and *end*. **setf**able.

($\left\{\begin{array}{l}_f\textbf{sort}\\ _f\textbf{stable-sort}\end{array}\right\}$ ~~*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**parse-namestring** *foo* [*host* [*default-pathname*$_{v\textbf{*default-pathname-defaults*}}$ $\left\{\begin{array}{l}\textbf{:start}\ start_{0}\\ \textbf{:end}\ end_{\texttt{NIL}}\\ \textbf{:junk-allowed}\ bool_{\texttt{NIL}}\end{array}\right\}$]])
▷ Return pathname converted from string, pathname, or stream *foo*; and position$_2$ where parsing stopped.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(*m* **with-open-stream** (*foo* $\widetilde{stream}$) (**declare** $\widehat{decl^*}$)* $form^{P*}$)
▷ Evaluate *form*s with *foo* locally bound to *stream*. Return values of *form*s.

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

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

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

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

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

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

13.7 Pathnames and Files

(*f* **make-pathname**
{ **:host** {*host* | NIL | **:unspecific**}
:device {*device* | NIL | **:unspecific**}
:directory { {*directory* | **:wild** | NIL | **:unspecific**} | ({ **:absolute** | **:relative** } { *directory* | **:wild** | **:wild-inferiors** | **:up** | **:back** }*) }
:name {*file-name* | **:wild** | NIL | **:unspecific**}
:type {*file-type* | **:wild** | NIL | **:unspecific**}
:version {**:newest** | *version* | **:wild** | NIL | **:unspecific**}
:defaults *path*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* **find** | *f* **position** } *foo sequence* { **:from-end** *bool*NIL | { **:test** *function*#'eql | **:test-not** *test* } | **:start** *start*0 | **:end** *end*NIL | **:key** *function* })
▷ Return first element in *sequence* which matches *foo*, or its position relative to the begin of *sequence*, respectively.

({ *f* **find-if** | *f* **find-if-not** | *f* **position-if** | *f* **position-if-not** } *test sequence* { **:from-end** *bool*NIL | **:start** *start*0 | **:end** *end*NIL | **:key** *function* })
▷ Return first element in *sequence* which satisfies *test*, or its position relative to the begin of *sequence*, respectively.

(*f* **search** *sequence-a sequence-b* { **:from-end** *bool*NIL | { **:test** *function*#'eql | **:test-not** *function* } | **:start1** *start-a*0 | **:start2** *start-b*0 | **:end1** *end-a*NIL | **:end2** *end-b*NIL | **:key** *function* })
▷ Search *sequence-b* for a subsequence matching *sequence-a*. Return position in *sequence-b*, or NIL.

({ *f* **remove** *foo* $\widetilde{sequence}$ | *f* **delete** *foo* $\widetilde{sequence}$ } { **:from-end** *bool*NIL | { **:test** *function*#'eql | **:test-not** *function* } | **:start** *start*0 | **:end** *end*NIL | **:key** *function* | **:count** *count*NIL })
▷ Make copy of *sequence* without elements matching *foo*.

({ *f* **remove-if** | *f* **remove-if-not** } *test sequence* | { *f* **delete-if** | *f* **delete-if-not** } *test* $\widetilde{sequence}$ } { **:from-end** *bool*NIL | **:start** *start*0 | **:end** *end*NIL | **:key** *function* | **:count** *count*NIL })
▷ Make copy of *sequence* with all (or *count*) elements satisfying *test* removed.

({ *f* **remove-duplicates** *sequence* | *f* **delete-duplicates** $\widetilde{sequence}$ } { **:from-end** *bool*NIL | { **:test** *function*#'eql | **:test-not** *function* } | **:start** *start*0 | **:end** *end*NIL | **:key** *function* })
▷ Make copy of *sequence* without duplicates.

({ *f* **substitute** *new old sequence* | *f* **nsubstitute** *new old* $\widetilde{sequence}$ } { **:from-end** *bool*NIL | { **:test** *function*#'eql | **:test-not** *function* } | **:start** *start*0 | **:end** *end*NIL | **:key** *function* | **:count** *count*NIL })
▷ Make copy of *sequence* with all (or *count*) *old*s replaced by *new*.

({ *f* **substitute-if** | *f* **substitute-if-not** } *new test sequence* | { *f* **nsubstitute-if** | *f* **nsubstitute-if-not** } *new test* $\widetilde{sequence}$ } { **:from-end** *bool*NIL | **:start** *start*0 | **:end** *end*NIL | **:key** *function* | **:count** *count*NIL })
▷ Make copy of *sequence* with all (or *count*) elements satisfying *test* replaced by *new*.

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

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

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

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

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

7 Hash Tables

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

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

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

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

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

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

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

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

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

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

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

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

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

13.6 Streams

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

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

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

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

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

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

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

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

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

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

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

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

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

~>
▷ **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.

{~ [n_0] **i**|~ [n_0] **:i**}
▷ **Indent.** Set indentation to n relative to leftmost/to current position.

~ [c_1] [,i_1] [:] [@] **T**
▷ **Tabulate.** Move cursor forward to column number $c+ki$, $k \geq 0$ being as small as possible. With **:**, calculate column numbers relative to the immediately enclosing section. With **@**, move to column number $c_0 + c + ki$ where c_0 is the current position.

{~ [m_1] *****|~ [m_1] **:***|~ [n_0] **@***}
▷ **Go-To.** Jump m arguments forward, or backward, or to argument n.

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

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

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

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

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

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

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

8 Structures

($_m$**defstruct**
$$\left(\begin{array}{l} foo \\ \left[\widehat{doc}\right] \end{array}\right.\left\{\begin{array}{l} foo \\ (slot\ [init\ \{\,|\,:\textbf{type}\ \widehat{slot\text{-}type}\ |\ :\textbf{read-only}\ \widehat{bool}\,|\,\}])\end{array}\right\}^*\left.\begin{array}{l})\\)\end{array}\right)$$
▷ Define structure *foo* together with functions MAKE-*foo*, COPY-*foo* and *foo*-P; and **setf**able accessors *foo*-*slot*. Instances are of class *foo* or, if **defstruct** option **:type** is given, of the specified type. They can be created by (MAKE-*foo* {**:***slot value*}*) or, if *ord*-λ (see page 17) is given, by (*maker arg** {**:***key value*}*). In the latter case, *arg*s and **:***key*s correspond to the positional and keyword parameters defined in *ord*-λ whose *var*s in turn correspond to *slot*s. **:print-object**/**:print-function** generate a $_g$**print-object** method for an instance *bar* of *foo* calling (*o-printer bar stream*) or (*f-printer bar stream print-level*), respectively. If **:type** without **:named** is given, no *foo*-P is created.

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

9 Control Structure

9.1 Predicates

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

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

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

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

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

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

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

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

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

9.2 Variables

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

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

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

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

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

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

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

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

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

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

(*f* **get-properties** *property-list keys*)
▷ Return key and value$_2$ of first entry from *property-list* matching a key from *keys*, and tail of *property-list*$_3$ starting with that key. Return NIL, NIL$_2$, and NIL$_3$ if there was no matching key in *property-list*.

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

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

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

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

~ [*min-col*$_0$] [,[*col-inc*$_1$] [,[*min-pad*$_0$] [,'*pad-char*$_{\text{␣}}$]]]
[:] [@] {**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*$_{\text{␣}}$] [,['*comma-char*$_{,}$]
[,*comma-interval*$_3$]]]] [:] [@] **R**
▷ **Radix.** (With one or more prefix arguments.) Print argument as number; with :, group digits *comma-interval* each; with @, always prepend a sign.

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

~ [*width*] [,['*pad-char*$_{\text{␣}}$] [,['*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*$_{\text{␣}}$]]]] [@] **F**
▷ **Fixed-Format Floating-Point.** With @, always prepend a sign.

~ [*width*] [,[*dec-digits*] [,[*exp-digits*] [,[*scale-factor*$_1$]
[,['*overflow-char*] [,['*pad-char*$_{\text{␣}}$] [,'*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*$_{\text{␣}}$]]] [:]
[@] **$**
▷ **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*$_{\text{␣}}$]]]
[:] [@] < [*nl-text* ~[*spare*$_0$ [,*width*]]:;] {*text* ~;}* *text*

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

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

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

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

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

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

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

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

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

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

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

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

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

(*f*set-pprint-dispatch *type function* [*priority*$_0$ [*table*$_{v*print-pprint-dispatch*}$]])
▷ Install entry comprising *function* of arguments stream and object to print; and *priority* as *type* into *table*. If *function* is NIL, remove *type* from *table*. Return NIL.

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

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

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

13.5 Format

(*m*formatter $\widehat{control}$)
▷ 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.

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

9.3 Functions

Below, ordinary lambda list (*ord-λ**) has the form
(*var** [&optional {*var* | (*var* [*init*$_{NIL}$ [*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**) | (setf *foo*) (*new-value ord-λ**) | *m*lambda (*ord-λ**)} (declare $\widehat{decl*}$)* [$\widehat{doc}$] *form*^{P}*)
▷ Define a function named *foo* or (setf *foo*), or an anonymous function, respectively, which applies *form*s to *ord-λ*s. For *m*defun, *form*s are enclosed in an implicit *s*block named *foo*.

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

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

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

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

(*f*identity *foo*) ▷ Return *foo*.

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

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

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

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

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

9.4 Macros

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

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

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

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

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

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

(*s* **symbol-macrolet** ((*foo expansion-form*)*) (**declare** *decl**)* *form*P*)
▷ Evaluate *forms* with locally defined symbol macros *foo*.

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

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

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

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

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

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

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

(*m* **pprint-logical-block** (*stream list* {{**:prefix** *string* | **:per-line-prefix** *string*} | **:suffix** *string*""})
(**declare** *decl**)* *form*P*)
▷ Evaluate *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** {**:line** | **:line-relative** | **:section** | **:section-relative**} *c i* [*stream*∗standard-output∗])
▷ Move cursor forward to column number $c + ki$, $k \geq 0$ being as small as possible.

(*f* **pprint-indent** {**:block** | **:current**} *n* [*stream*∗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.

n/*d* ▷ The **ratio** $\frac{n}{d}$.

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

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

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

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

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

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

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

#P*string* ▷ A pathname.

#:*foo* ▷ Uninterned symbol *foo*.

#.*form* ▷ Read-time value of *form*.

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

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

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

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

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

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

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

13.4 Printer

$\left(\begin{Bmatrix}{}_f\textbf{prin1}\\ {}_f\textbf{print}\\ {}_f\textbf{pprint}\\ {}_f\textbf{princ}\end{Bmatrix}\right.$ *foo* [$\widetilde{stream}_{\boxed{{}_v\textbf{*standard-output*}}}$]$)$
▷ 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* $\widetilde{stream}$)
▷ Print *object* to *stream*. Called by the Lisp printer.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

9.5 Control Flow

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

($_m$**cond** (*test then*$^{P_*}_{\boxed{test}}$)∗)
▷ Return the values of the first *then*∗ whose *test* returns T; return NIL if all *test*s return NIL.

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

(*m*case *test* ({(*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*returned values. Implicitly, the whole form is a *s*block named NIL.

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

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

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

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

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

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

(*s*throw *tag form*)
▷ Have the nearest dynamically enclosing *s*catch with a tag *f*eq *tag* return with the values of *form*.

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

(*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*. setfable.

(*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 integers and ratios.

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

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

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

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

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

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

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

13.3 Character Syntax

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

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

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

" ▷ Begin and end of a string.

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

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

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

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

13 Input/Output

13.1 Predicates

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

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

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

(ƒ**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

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

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

(ƒ**read-from-string** *string* [*eof-error*T [*eof-val*NIL [{**:start** *start*0|**:end** *end*NIL|**:preserve-whitespace** *bool*NIL}]]])
▷ Return object read from string and zero-indexed position$_2$ of next character.

(ƒ**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.

(ƒ**read-char** [*stream*~ v***standard-input***] [*eof-err*T [*eof-val*NIL [*recursive*NIL]]])
▷ Return next character from *stream*.

(ƒ**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.

(ƒ**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.

(ƒ**unread-char** *character* [*stream*~ v***standard-input***])
▷ Put last ƒ**read-char**ed *character* back into *stream*; return NIL.

(ƒ**read-byte** *stream*~ [*eof-err*T [*eof-val*NIL]])
▷ Read next byte from binary *stream*.

(ƒ**read-line** [*stream*~ v***standard-input***] [*eof-err*T [*eof-val*NIL [*recursive*NIL]]])
▷ Return a line of text from *stream* and T$_2$ if line has been ended by end of file.

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.

= *foo* [**then** *bar*foo]
▷ Bind *var* initially to *foo* and later to *bar*.

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

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

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

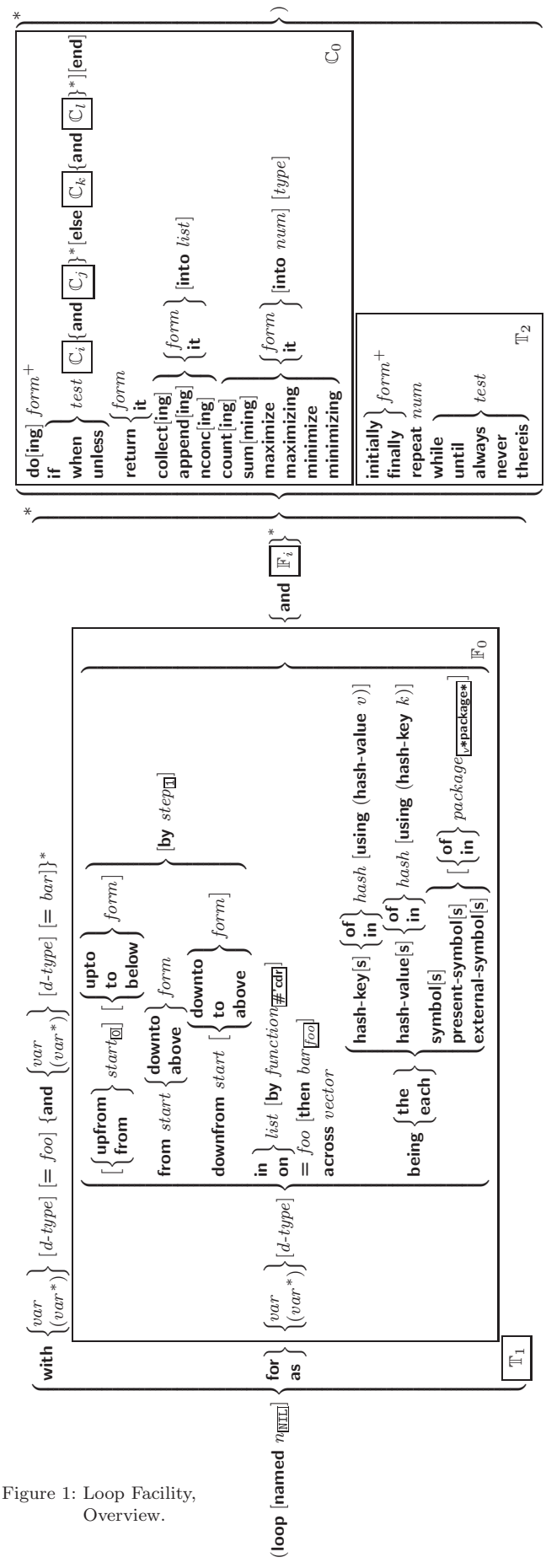

Figure 1: Loop Facility, Overview.

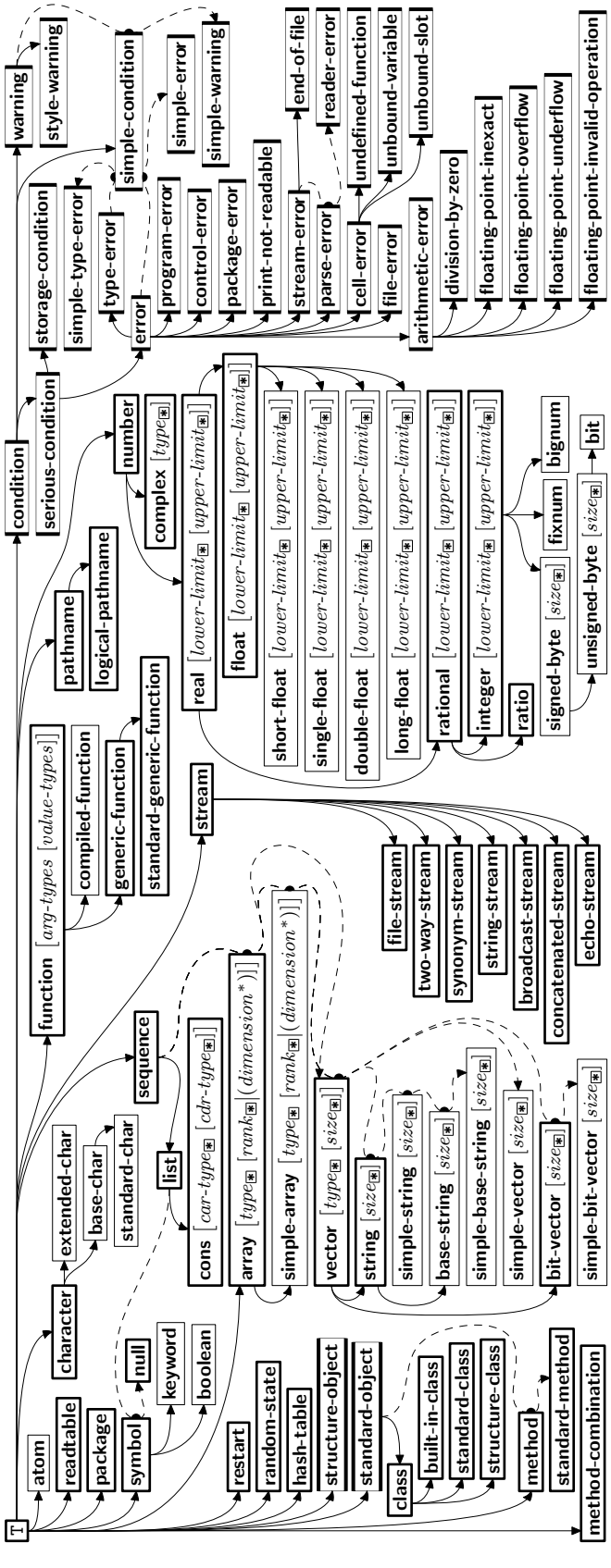

Figure 2: Precedence Order of System Classes (▭), Classes (▬), Types (▭), and Condition Types (▭).
Every type is also a supertype of NIL, the empty type.

$_v$***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*$_{\text{NIL}}$]) ▷ 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** $\widehat{\textit{type}}$ *form*) ▷ Declare values of *form* to be of *type*.

($_f$**coerce** *object type*) ▷ Coerce *object* into *type*.

($_m$**typecase** *foo* ($\widehat{\textit{type}}$ *a-form*^{P*})* [({**otherwise**|T} *b-form*$_{\text{NIL}}^{P*}$)])
▷ 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* ($\widehat{\textit{type}}$ *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*$_{\text{[\{a|an\} type]}}$])
▷ Signal correctable **type-error** if *place* is not of *type*. Return NIL.

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

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

($_f$**upgraded-array-element-type** *type* [*environment*$_{\text{NIL}}$])
▷ Element type of most specialized array capable of holding elements of *type*.

($_m$**deftype** *foo* (*macro-λ**) (**declare** $\widehat{\textit{decl}}^*$)* [$\widehat{\textit{doc}}$] *form*^{P*})
▷ Define type *foo* which when referenced as (*foo* $\widehat{\textit{arg}}^*$) (or as *foo* if *macro-λ* doesn't contain any required parameters) applies expanded *forms* to *args* returning the new type. For (*macro-λ**) see page 18 but with default value of ∗ instead of NIL. *forms* 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.

{**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*$_{\text{[}_v\text{*package**]}}$]
▷ Bind *var* successively to the accessible symbols, or the present symbols, or the external symbols respectively, of *package*.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

10 CLOS

10.1 Classes

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(*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*.

(*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.

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

(*f* {**signal** / **warn** / **error**} {*condition* / *condition-type* {**:***initarg-name value*}* / *control arg**})
▷ Unless handled, signal as **condition**, **warning** or **error**, respectively, *condition* or a new instance of *condition-type* or, with *f* **format** *control* and *args* (see page 36), **simple-condition**, **simple-warning**, or **simple-error**, respectively. From *f* **signal** and *f* **warn**, return NIL.

(*f* **cerror** *continue-control* {*condition continue-arg** / *condition-type* {**:***initarg-name value*}* / *control arg**})
▷ Unless handled, signal as correctable **error** *condition* or a new instance of *condition-type* or, with *f* **format** *control* and *args* (see page 36), **simple-error**. In the debugger, use *f* **format** arguments *continue-control* and *continue-args* to tag the continue option. Return NIL.

(*m* **ignore-errors** *form*P*)
▷ Return values of *forms* or, in case of **error**s, NIL and the condition.
2

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

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

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

(*m* **handler-bind** ((*condition-type handler-function*)*) *form*P*)
▷ Return values of *forms* after evaluating them with *condition-types* dynamically bound to their respective *handler-functions* of argument condition.

(*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 *args* (see page 36) and return NIL and T.
2

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

(*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 *values*; 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-slots* of *instance* with the corresponding *values*, and fill those *initform-slots* that are not *initarg-slots* 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*)} {**:argument-precedence-order** *required-var*+ / **:declare** (**optimize** *method-selection-optimization*) / **:documentation** *string* / **:generic-function-class** *gf-class* / **:method-class** *method-class* / **:method-combination** *c-type c-arg** / **:lambda-list** *lambda-list* / **:environment** *environment*})
▷ Define or modify generic function *foo*. *gf-class* and *lambda-list* must be compatible with a pre-existing generic function or with existing methods, respectively. Changes to *method-class* do not propagate to existing methods. For *c-type* see section 10.3.

(*m* **defmethod** {*foo* / (**setf** *foo*)} [{**:before** / **:after** / **:around** / *qualifier**}] primary method [({*var* / (*spec-var* {*class* / (**eql** *bar*)})}* [**&optional**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

▷ Return list of keyword parameters of *method* and $\underset{2}{\mathtt{T}}$ if other keys are allowed.

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

10.3 Method Combination Types

standard

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

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

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

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

▷ **Short Form.** Define new **method-combination** *c-type*. In a generic function using *c-type*, evaluate most specific **:around** method supplying the values of the generic function. From within this method, $_f$**call-next-method** can call less specific **:around** methods if there are any. If not, or if there are no **:around** methods at all, return from the calling **call-next-method** or from the generic function, respectively, the values of (*operator* (*primary-method gen-arg**)*), *gen-arg** being the arguments of the generic function. The *primary-method*s are ordered [$\left\{\begin{array}{l} \textbf{:most-specific-first} \\ \textbf{:most-specific-last} \end{array}\right\}_{\boxed{\textbf{:most-specific-first}}}$] (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*
$\left\{\begin{array}{l} \textbf{*} \\ (qualifier^*\ [\textbf{*}]) \\ predicate \end{array}\right\}$
$\left\{\begin{array}{l} \textbf{:description}\ control \\ \textbf{:order}\ \left\{\begin{array}{l} \textbf{:most-specific-first} \\ \textbf{:most-specific-last} \end{array}\right\}_{\boxed{\textbf{:most-specific-first}}} \\ \textbf{:required}\ bool \end{array}\right\}^*$)
$\left\{\begin{array}{l} (\textbf{:arguments}\ method\text{-}combination\text{-}\lambda^*) \\ (\textbf{:generic-function}\ symbol) \\ (\textbf{declare}\ \widehat{decl^*})^* \\ \widehat{doc} \end{array}\right\}$ $body^{P*}$)

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

($_m$**call-method**
$\left\{\begin{array}{l} \widehat{method} \\ (_m\textbf{make-method}\ \widehat{form}) \end{array}\right\}$ [($\left\{\begin{array}{l} \widehat{next\text{-}method} \\ (_m\textbf{make-method}\ \widehat{form}) \end{array}\right\}^*$)])

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

11 Conditions and Errors

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

($_m$**define-condition** *foo* (*parent-type*$^*_{\boxed{\textbf{condition}}}$)
$\left\{\begin{array}{l} slot \\ (slot\ \left\{\begin{array}{l} \{\textbf{:reader}\ reader\}^* \\ \{\textbf{:writer}\ \left\{\begin{array}{l} writer \\ (\textbf{setf}\ writer) \end{array}\right\}\}^* \\ \{\textbf{:accessor}\ accessor\}^* \\ \textbf{:allocation}\ \left\{\begin{array}{l} \textbf{:instance} \\ \textbf{:class} \end{array}\right\}_{\boxed{\textbf{:instance}}} \\ \{\textbf{:initarg}\ \textbf{:}initarg\text{-}name\}^* \\ \textbf{:initform}\ form \\ \textbf{:type}\ type \\ \textbf{:documentation}\ slot\text{-}doc \end{array}\right\}) \end{array}\right\}^*$)
$\left\{\begin{array}{l} (\textbf{:default-initargs}\ \{name\ value\}^*) \\ (\textbf{:documentation}\ condition\text{-}doc) \\ (\textbf{:report}\ \left\{\begin{array}{l} string \\ report\text{-}function \end{array}\right\}) \end{array}\right\}$)

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