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

($_f$**asinh** *a*)
($_f$**acosh** *a*)
($_f$**atanh** *a*)
▷ $\underline{\operatorname{asinh} a}$, $\underline{\operatorname{acosh} a}$, or $\underline{\operatorname{atanh} a}$, respectively.

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

($_f$**conjugate** *a*) ▷ Return complex $\underline{\text{conjugate of } a}$.

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

($\left\{\begin{array}{l}\{_f\textbf{round} \mid {}_f\textbf{fround}\} \\ \{_f\textbf{floor} \mid {}_f\textbf{ffloor}\} \\ \{_f\textbf{ceiling} \mid {}_f\textbf{fceiling}\} \\ \{_f\textbf{truncate} \mid {}_f\textbf{ftruncate}\}\end{array}\right\}$ *n* [$d_{\boxed{1}}$])
▷ Return as **integer** or **float**, respectively, $\underline{n/d}$ rounded, or rounded towards $-\infty$, $+\infty$, or 0, respectively; and $\underset{2}{\underline{\text{remainder}}}$.

($\left\{\begin{array}{l}{}_f\textbf{mod} \\ {}_f\textbf{rem}\end{array}\right\}$ *n* *d*)
▷ Same as $_f$**floor** or $_f$**truncate**, respectively, but return remainder only.

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

($_f$**make-random-state** [{*state*|`NIL`|`T`}$_{\boxed{\texttt{NIL}}}$])
▷ 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*$_{\boxed{1}}$]) ▷ *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*$_{\boxed{0}}$]) ▷ Make a complex number.

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

($_f$**abs** *n*) ▷ Return $\underline{|n|}$.

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

($_f$**float** *real* [*prototype*$_{\boxed{\texttt{0.0F0}}}$])
▷ Convert *real* into float with type of *prototype*.

Quick Reference

cl

Common lisp

Bert Burgemeister

Contents

Typographic Conventions

name; ${}_f$**name**; ${}_g$**name**; ${}_m$**name**; ${}_s$**name**; ${}_v$***name***; ${}_c$**name**
▷ Symbol defined in Common Lisp; esp. function, generic function, macro, special operator, variable, constant.

them	▷ Placeholder for actual code.
`me`	▷ Literal text.
[*foo*$_{\boxed{\texttt{bar}}}$]	▷ Either one *foo* or nothing; defaults to `bar`.
foo*; {*foo*}*	▷ Zero or more *foo*s.
foo$^+$; {*foo*}$^+$	▷ One or more *foo*s.
foos	▷ English plural denotes a list argument.
{*foo*|*bar*|*baz*}; $\begin{cases}foo\\bar\\baz\end{cases}$	▷ Either *foo*, or *bar*, or *baz*.
$\left\{\begin{array}{\|l}foo\\bar\\baz\end{array}\right.$	▷ 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 21.
$\underline{foo}$; $\underline{bar}_2$; $\underline{baz}_n$	▷ Primary, secondary, and *n*th return value.
`T`; `NIL`	▷ **t**, or truth in general; and **nil** or **()**.

1 Numbers

1.1 Predicates

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

(${}_f$**>** *number*$^+$)
(${}_f$**>=** *number*$^+$)
(${}_f$**<** *number*$^+$)
(${}_f$**<=** *number*$^+$)
▷ Return $\underline{\texttt{T}}$ 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*)
▷ $\underline{\texttt{T}}$ if $a < 0$, $a = 0$, or $a > 0$, respectively.

(${}_f$**evenp** *int*)
(${}_f$**oddp** *int*)
▷ $\underline{\texttt{T}}$ 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*)
▷ $\underline{\texttt{T}}$ if *foo* is of indicated type.

1.2 Numeric Functions

(${}_f$**+** $a_{\boxed{0}}{}^*$)
(${}_f$***** $a_{\boxed{1}}{}^*$)
▷ Return $\underline{\sum a}$ or $\underline{\prod a}$, respectively.

(${}_f$**–** *a* b^*)
(${}_f$**/** *a* b^*)
▷ Return $\underline{a - \sum b}$ or $\underline{a/\prod b}$, respectively. Without any *b*s, return $\underline{-a}$ or $\underline{1/a}$, respectively.

(${}_f$**1+** *a*)
(${}_f$**1–** *a*)
▷ Return $\underline{a+1}$ or $\underline{a-1}$, respectively.

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

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

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

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

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

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

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

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

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

3 Strings

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

($_f$**stringp** *foo*)
($_f$**simple-string-p** *foo*)
▷ $\underline{\texttt{T}}$ if *foo* is of indicated type.

$\left(\left\{\begin{array}{l}{}_f\textbf{string=}\\ {}_f\textbf{string-equal}\end{array}\right\} \textit{foo bar} \left\{\left|\begin{array}{l}\textbf{:start1 } \textit{start-foo}_{\boxed{0}}\\ \textbf{:start2 } \textit{start-bar}_{\boxed{0}}\\ \textbf{:end1 } \textit{end-foo}_{\boxed{\texttt{NIL}}}\\ \textbf{:end2 } \textit{end-bar}_{\boxed{\texttt{NIL}}}\end{array}\right.\right\}\right)$

▷ Return $\underline{\texttt{T}}$ if subsequences of *foo* and *bar* are equal. Obey/ignore, respectively, case.

$\left(\left\{\begin{array}{l}{}_f\textbf{string}\{\textbf{/=} \mid \textbf{-not-equal}\}\\ {}_f\textbf{string}\{\textbf{>} \mid \textbf{-greaterp}\}\\ {}_f\textbf{string}\{\textbf{>=} \mid \textbf{-not-lessp}\}\\ {}_f\textbf{string}\{\textbf{<} \mid \textbf{-lessp}\}\\ {}_f\textbf{string}\{\textbf{<=} \mid \textbf{-not-greaterp}\}\end{array}\right\} \textit{foo bar} \left\{\left|\begin{array}{l}\textbf{:start1 } \textit{start-foo}_{\boxed{0}}\\ \textbf{:start2 } \textit{start-bar}_{\boxed{0}}\\ \textbf{:end1 } \textit{end-foo}_{\boxed{\texttt{NIL}}}\\ \textbf{:end2 } \textit{end-bar}_{\boxed{\texttt{NIL}}}\end{array}\right.\right\}\right)$

▷ If *foo* is lexicographically not equal, greater, not less, less, or not greater, respectively, then return $\underline{\text{position}}$ of first mismatching character in *foo*. Otherwise return $\underline{\texttt{NIL}}$. Obey/ignore, respectively, case.

$\left({}_f\textbf{make-string } \textit{size} \left\{\left|\begin{array}{l}\textbf{:initial-element } \textit{char}\\ \textbf{:element-type } \textit{type}_{\boxed{\textsf{character}}}\end{array}\right.\right\}\right)$

▷ Return $\underline{\text{string}}$ of length *size*.

($_f$**string** *x*)
$\left(\left\{\begin{array}{l}{}_f\textbf{string-capitalize}\\ {}_f\textbf{string-upcase}\\ {}_f\textbf{string-downcase}\end{array}\right\} x \left\{\left|\begin{array}{l}\textbf{:start } \textit{start}_{\boxed{0}}\\ \textbf{:end } \textit{end}_{\boxed{\texttt{NIL}}}\end{array}\right.\right\}\right)$

▷ Convert *x* (**symbol**, **string**, or **character**) into a $\underline{\text{string}}$, a $\underline{\text{string with capitalized words}}$, an $\underline{\text{all-uppercase string}}$, or an $\underline{\text{all-lowercase string}}$, respectively.

$\left(\left\{\begin{array}{l}{}_f\textbf{nstring-capitalize}\\ {}_f\textbf{nstring-upcase}\\ {}_f\textbf{nstring-downcase}\end{array}\right\} \widetilde{\textit{string}} \left\{\left|\begin{array}{l}\textbf{:start } \textit{start}_{\boxed{0}}\\ \textbf{:end } \textit{end}_{\boxed{\texttt{NIL}}}\end{array}\right.\right\}\right)$

▷ Convert *string* into a $\underline{\text{string with capitalized words}}$, an $\underline{\text{all-uppercase string}}$, or an $\underline{\text{all-lowercase string}}$, respectively.

$\left(\left\{\begin{array}{l}{}_f\textbf{string-trim}\\ {}_f\textbf{string-left-trim}\\ {}_f\textbf{string-right-trim}\end{array}\right\} \textit{char-bag string}\right)$

▷ Return $\underline{\textit{string}}$ 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 $\underline{i\text{th character}}$ of string ignoring/obeying, respectively, fill pointer. **setf**able.

$\left({}_f\textbf{parse-integer } \textit{string} \left\{\left|\begin{array}{l}\textbf{:start } \textit{start}_{\boxed{0}}\\ \textbf{:end } \textit{end}_{\boxed{\texttt{NIL}}}\\ \textbf{:radix } \textit{int}_{\boxed{10}}\\ \textbf{:junk-allowed } \textit{bool}_{\boxed{\texttt{NIL}}}\end{array}\right.\right\}\right)$

▷ Return $\underline{\text{integer}}$ parsed from *string* and $\underset{2}{\underline{\text{index}}}$ of parse end.

4 Conses

4.1 Predicates

($_f$**consp** *foo*)
($_f$**listp** *foo*)
▷ Return $\underline{\texttt{T}}$ if *foo* is of indicated type.

($_f$**endp** *list*)
($_f$**null** *foo*)
▷ Return $\underline{\texttt{T}}$ if *list*/*foo* is `NIL`.

1.3 Logic Functions

Negative integers are used in two's complement representation.

($_f$**boole** *operation int-a int-b*)
▷ Return $\underline{\text{value}}$ of bitwise logical *operation*. *operation*s are

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

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

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

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

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

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

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

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

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

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

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

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

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

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.

($\left\{\begin{array}{l}{}_f\textbf{deposit-field}\\ {}_f\textbf{dpb}\end{array}\right\}$ *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

$\left.\begin{array}{l}{}_c\textbf{short-float}\\ {}_c\textbf{single-float}\\ {}_c\textbf{double-float}\\ {}_c\textbf{long-float}\end{array}\right\}\text{-}\left\{\begin{array}{l}\textbf{epsilon}\\ \textbf{negative-epsilon}\end{array}\right.$
 ▷ Smallest possible number making a difference when added or subtracted, respectively.

$\left.\begin{array}{l}{}_c\textbf{least-negative}\\ {}_c\textbf{least-negative-normalized}\\ {}_c\textbf{least-positive}\\ {}_c\textbf{least-positive-normalized}\end{array}\right\}\text{-}\left\{\begin{array}{l}\textbf{short-float}\\ \textbf{single-float}\\ \textbf{double-float}\\ \textbf{long-float}\end{array}\right.$
 ▷ Available numbers closest to -0 or $+0$, respectively.

$\left.\begin{array}{l}{}_c\textbf{most-negative}\\ {}_c\textbf{most-positive}\end{array}\right\}\text{-}\left\{\begin{array}{l}\textbf{short-float}\\ \textbf{single-float}\\ \textbf{double-float}\\ \textbf{long-float}\\ \textbf{fixnum}\end{array}\right.$
 ▷ Available numbers closest to $-\infty$ or $+\infty$, respectively.

(${}_f$**decode-float** *n*)
(${}_f$**integer-decode-float** *n*)
 ▷ Return significand, $\underset{2}{\text{exponent}}$, and $\underset{3}{\text{sign}}$ 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*$_{\boxed{\texttt{NIL}}}$])
 ▷ 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*$_{\boxed{10}}$])
 ▷ Return its weight if *character* is a digit, or `NIL` otherwise.

(${}_f$**char=** *character*$^+$)
(${}_f$**char/=** *character*$^+$)
 ▷ Return `T` if all *character*s, or none, respectively, are equal.

(${}_f$**char-equal** *character*$^+$)
(${}_f$**char-not-equal** *character*$^+$)
 ▷ Return `T` if all *character*s, or none, respectively, are equal ignoring case.

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

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

(${}_f$**char-upcase** *character*)
(${}_f$**char-downcase** *character*)
 ▷ Return corresponding uppercase/lowercase character, respectively.

(${}_f$**digit-char** *i* [*radix*$_{\boxed{10}}$]) ▷ Character representing digit *i*.

(${}_f$**char-name** *char*) ▷ *char*'s name if any, or `NIL`.

(${}_f$**name-char** *foo*) ▷ Character named *foo* if any, or `NIL`.

(${}_f$**char-int** *character*)
(${}_f$**char-code** *character*)
 ▷ Code of *character*.

(${}_f$**code-char** *code*) ▷ Character with *code*.

${}_c$**char-code-limit** ▷ Upper bound of (${}_f$**char-code** *char*); ≥ 96.

(${}_f$**character** *c*) ▷ Return `#\`*c*.

($_f$**bit** *bit-array* [*subscripts*])
($_f$**sbit** *simple-bit-array* [*subscripts*])
▷ Return $\underline{\text{element}}$ of *bit-array* or of *simple-bit-array*. **setf**able.

($_f$**bit-not** $\widetilde{\textit{bit-array}}$ [$\widetilde{\textit{result-bit-array}}_{\boxed{\texttt{NIL}}}$])
▷ Return $\underline{\text{result}}$ 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.

($\left\{\begin{array}{l} _f\textbf{bit-eqv} \\ _f\textbf{bit-and} \\ _f\textbf{bit-andc1} \\ _f\textbf{bit-andc2} \\ _f\textbf{bit-nand} \\ _f\textbf{bit-ior} \\ _f\textbf{bit-orc1} \\ _f\textbf{bit-orc2} \\ _f\textbf{bit-xor} \\ _f\textbf{bit-nor} \end{array}\right\}$ $\widetilde{\textit{bit-array-a}}$ *bit-array-b* [$\widetilde{\textit{result-bit-array}}_{\boxed{\texttt{NIL}}}$])
▷ Return $\underline{\text{result}}$ of bitwise logical operations (cf. operations of $_f$**boole**, page 5) on *bit-array-a* and *bit-array-b*. If *result-bit-array* is `T`, put result in *bit-array-a*; if it is `NIL`, make a new array for result.

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

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

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

5.3 Vector Functions

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

($_f$**vector** *foo**) ▷ Return fresh $\underline{\text{simple vector of } \textit{foo}\text{s}}$.

($_f$**svref** *vector i*) ▷ $\underline{\text{Element } i}$ of simple *vector*. **setf**able.

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

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

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

($_f$**fill-pointer** *vector*) ▷ $\underline{\text{Fill pointer}}$ 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 $\underline{\texttt{NIL}}$ or $\underline{\texttt{T}}$, 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 $\underline{\text{value of } \textit{test}}$ or $\underline{\texttt{NIL}}$, respectively, as soon as *test* on any set of corresponding elements of *sequence*s returns non-`NIL`.

($_f$**atom** *foo*) ▷ Return $\underline{\texttt{T}}$ if *foo* is not a **cons**.

($_f$**tailp** *foo list*) ▷ Return $\underline{\texttt{T}}$ if *foo* is a tail of *list*.

($_f$**member** *foo list* $\left\{\left|\begin{array}{l} \left\{\begin{array}{l} \textbf{:test } \textit{function}_{\boxed{\texttt{\#'eql}}} \\ \textbf{:test-not } \textit{function} \end{array}\right. \\ \textbf{:key } \textit{function} \end{array}\right.\right\}$)
▷ Return $\underline{\text{tail of } \textit{list}}$ starting with its first element matching *foo*. Return $\underline{\texttt{NIL}}$ if there is no such element.

($\left\{\begin{array}{l} _f\textbf{member-if} \\ _f\textbf{member-if-not} \end{array}\right\}$ *test list* [**:key** *function*])
▷ Return $\underline{\text{tail of } \textit{list}}$ starting with its first element satisfying *test*. Return $\underline{\texttt{NIL}}$ if there is no such element.

($_f$**subsetp** *list-a list-b* $\left\{\left|\begin{array}{l} \left\{\begin{array}{l} \textbf{:test } \textit{function}_{\boxed{\texttt{\#'eql}}} \\ \textbf{:test-not } \textit{function} \end{array}\right. \\ \textbf{:key } \textit{function} \end{array}\right.\right\}$)
▷ Return $\underline{\texttt{T}}$ if *list-a* is a subset of *list-b*.

4.2 Lists

($_f$**cons** *foo bar*) ▷ Return new cons $\underline{(\textit{foo} \texttt{ . } \textit{bar})}$.

($_f$**list** *foo**) ▷ Return $\underline{\text{list of } \textit{foo}\text{s}}$.

($_f$**list*** *foo*$^+$)
▷ Return $\underline{\text{list of } \textit{foo}\text{s}}$ with last *foo* becoming cdr of last cons. Return $\underline{\textit{foo}}$ if only one *foo* given.

($_f$**make-list** *num* [**:initial-element** *foo*$_{\boxed{\texttt{NIL}}}$])
▷ New $\underline{\text{list}}$ with *num* elements set to *foo*.

($_f$**list-length** *list*) ▷ $\underline{\text{Length}}$ of *list*; $\underline{\texttt{NIL}}$ for circular *list*.

($_f$**car** *list*) ▷ $\underline{\text{Car of } \textit{list}}$ or $\underline{\texttt{NIL}}$ if *list* is `NIL`. **setf**able.

($_f$**cdr** *list*)
($_f$**rest** *list*) ▷ $\underline{\text{Cdr of } \textit{list}}$ or $\underline{\texttt{NIL}}$ if *list* is `NIL`. **setf**able.

($_f$**nthcdr** *n list*) ▷ Return $\underline{\text{tail of } \textit{list}}$ after calling $_f$**cdr** *n* times.

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

($_f$**nth** *n list*) ▷ Zero-indexed $\underline{\text{nth element}}$ of *list*. **setf**able.

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

($_f$**last** *list* [*num*$_{\boxed{1}}$]) ▷ Return list of $\underline{\text{last } \textit{num} \text{ conses}}$ of *list*.

($\left\{\begin{array}{l} _f\textbf{butlast } \textit{list} \\ _f\textbf{nbutlast } \widetilde{\textit{list}} \end{array}\right\}$ [*num*$_{\boxed{1}}$]) ▷ $\underline{\textit{list}}$ excluding last *num* conses.

($\left\{\begin{array}{l} _f\textbf{rplaca} \\ _f\textbf{rplacd} \end{array}\right\}$ $\widetilde{\textit{cons}}$ *object*)
▷ Replace car, or cdr, respectively, of $\underline{\textit{cons}}$ with *object*.

($_f$**ldiff** *list foo*)
▷ If *foo* is a tail of *list*, return $\underline{\text{preceding part of } \textit{list}}$. Otherwise return $\underline{\textit{list}}$.

($_f$**adjoin** *foo list* $\left\{\left|\begin{array}{l} \left\{\begin{array}{l} \textbf{:test } \textit{function}_{\boxed{\texttt{\#'eql}}} \\ \textbf{:test-not } \textit{function} \end{array}\right. \\ \textbf{:key } \textit{function} \end{array}\right.\right\}$)
▷ Return $\underline{\textit{list}}$ if *foo* is already member of *list*. If not, return $\underline{(_f\textbf{cons } \textit{foo list})}$.

($_m$**pop** $\widetilde{\textit{place}}$)
▷ Set *place* to ($_f$**cdr** *place*), return $\underline{(_f\textbf{car } \textit{place})}$.

($_m$**push** *foo* $\widetilde{place}$) ▷ Set *place* to $\underline{(_f\textbf{cons}\ foo\ place)}$.

($_m$**pushnew** *foo* $\widetilde{place}$ $\left\{\left|\begin{array}{l}\left\{\begin{array}{l}\textbf{:test}\ function_{\boxed{\#'eql}}\\ \textbf{:test-not}\ function\end{array}\right.\\ \textbf{:key}\ function\end{array}\right.\right\}$)
▷ Set *place* to $\underline{(_f\textbf{adjoin}\ foo\ place)}$.

($_f$**append** [*proper-list** *foo*$_{\boxed{\texttt{NIL}}}$])
($_f$**nconc** [$\widetilde{non\text{-}circular\text{-}list}$* *foo*$_{\boxed{\texttt{NIL}}}$])
▷ Return $\underline{\text{concatenated list}}$ or, with only one argument, $\underline{foo}$. *foo* can be of any type.

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

($\left\{\begin{array}{l}_f\textbf{mapcar}\\ _f\textbf{maplist}\end{array}\right\}$ *function list*$^+$)
▷ Return $\underline{\text{list of return values}}$ of *function* successively invoked with corresponding arguments, either cars or cdrs, respectively, from each *list*.

($\left\{\begin{array}{l}_f\textbf{mapcan}\\ _f\textbf{mapcon}\end{array}\right\}$ *function* $\widetilde{list}^+$)
▷ Return list of $\underline{\text{concatenated return values}}$ of *function* successively invoked with corresponding arguments, either cars or cdrs, respectively, from each *list*. *function* should return a list.

($\left\{\begin{array}{l}_f\textbf{mapc}\\ _f\textbf{mapl}\end{array}\right\}$ *function list*$^+$)
▷ Return $\underline{\text{first }list}$ 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 $\underline{\text{copy}}$ of *list* with shared elements.

4.3 Association Lists

($_f$**pairlis** *keys values* [*alist*$_{\boxed{\texttt{NIL}}}$])
▷ Prepend to $\underline{alist}$ an association list made from lists *keys* and *values*.

($_f$**acons** *key value alist*)
▷ Return $\underline{alist}$ with a (*key* **.** *value*) pair added.

($\left\{\begin{array}{l}_f\textbf{assoc}\\ _f\textbf{rassoc}\end{array}\right\}$ *foo alist* $\left\{\left|\begin{array}{l}\left\{\begin{array}{l}\textbf{:test}\ test_{\boxed{\#'eql}}\\ \textbf{:test-not}\ test\end{array}\right.\\ \textbf{:key}\ function\end{array}\right.\right\}$)
($\left\{\begin{array}{l}_f\textbf{assoc-if}[\textbf{-not}]\\ _f\textbf{rassoc-if}[\textbf{-not}]\end{array}\right\}$ *test alist* [**:key** *function*])
▷ First $\underline{\text{cons}}$ whose car, or cdr, respectively, satisfies *test*.

($_f$**copy-alist** *alist*) ▷ Return $\underline{\text{copy}}$ of *alist*.

4.4 Trees

($_f$**tree-equal** *foo bar* $\left\{\begin{array}{l}\textbf{:test}\ test_{\boxed{\#'eql}}\\ \textbf{:test-not}\ test\end{array}\right\}$)
▷ Return $\underline{\texttt{T}}$ if trees *foo* and *bar* have same shape and leaves satisfying *test*.

($\left\{\begin{array}{l}_f\textbf{subst}\ new\ old\ tree\\ _f\textbf{nsubst}\ new\ old\ \widetilde{tree}\end{array}\right\}$ $\left\{\left|\begin{array}{l}\left\{\begin{array}{l}\textbf{:test}\ function_{\boxed{\#'eql}}\\ \textbf{:test-not}\ function\end{array}\right.\\ \textbf{:key}\ function\end{array}\right.\right\}$)
▷ Make $\underline{\text{copy of }tree}$ with each subtree or leaf matching *old* replaced by *new*.

($\left\{\begin{array}{l}_f\textbf{subst-if}[\textbf{-not}]\ new\ test\ tree\\ _f\textbf{nsubst-if}[\textbf{-not}]\ new\ test\ \widetilde{tree}\end{array}\right\}$ [**:key** *function*])
▷ Make $\underline{\text{copy of }tree}$ with each subtree or leaf satisfying *test* replaced by *new*.

($\left\{\begin{array}{l}_f\textbf{sublis}\ association\text{-}list\ tree\\ _f\textbf{nsublis}\ association\text{-}list\ \widetilde{tree}\end{array}\right\}$ $\left\{\left|\begin{array}{l}\left\{\begin{array}{l}\textbf{:test}\ function_{\boxed{\#'eql}}\\ \textbf{:test-not}\ function\end{array}\right.\\ \textbf{:key}\ function\end{array}\right.\right\}$)
▷ Make $\underline{\text{copy of }tree}$ with each subtree or leaf matching a key in *association-list* replaced by that key's value.

($_f$**copy-tree** *tree*) ▷ $\underline{\text{Copy of }tree}$ with same shape and leaves.

4.5 Sets

($\left\{\begin{array}{l}\left.\begin{array}{l}_f\textbf{intersection}\\ _f\textbf{set-difference}\\ _f\textbf{union}\\ _f\textbf{set-exclusive-or}\end{array}\right\}a\ b\\ \left.\begin{array}{l}_f\textbf{nintersection}\\ _f\textbf{nset-difference}\end{array}\right\}\widetilde{a}\ b\\ \left.\begin{array}{l}_f\textbf{nunion}\\ _f\textbf{nset-exclusive-or}\end{array}\right\}\widetilde{a}\ \widetilde{b}\end{array}\right\}$ $\left\{\left|\begin{array}{l}\left\{\begin{array}{l}\textbf{:test}\ function_{\boxed{\#'eql}}\\ \textbf{:test-not}\ function\end{array}\right.\\ \textbf{:key}\ function\end{array}\right.\right\}$)
▷ Return $\underline{a\cap b}$, $\underline{a\setminus b}$, $\underline{a\cup b}$, or $\underline{a\bigtriangleup b}$, respectively, of lists *a* and *b*.

5 Arrays

5.1 Predicates

($_f$**arrayp** *foo*)
($_f$**vectorp** *foo*)
($_f$**simple-vector-p** *foo*) ▷ $\underline{\texttt{T}}$ if *foo* is of indicated type.
($_f$**bit-vector-p** *foo*)
($_f$**simple-bit-vector-p** *foo*)

($_f$**adjustable-array-p** *array*)
($_f$**array-has-fill-pointer-p** *array*)
▷ $\underline{\texttt{T}}$ if *array* is adjustable/has a fill pointer, respectively.

($_f$**array-in-bounds-p** *array* [*subscripts*])
▷ Return $\underline{\texttt{T}}$ if *subscripts* are in *array*'s bounds.

5.2 Array Functions

($\left\{\begin{array}{l}_f\textbf{make-array}\ dimension\text{-}sizes\ \left[\textbf{:adjustable}\ bool_{\boxed{\texttt{NIL}}}\right]\\ _f\textbf{adjust-array}\ \widetilde{array}\ dimension\text{-}sizes\end{array}\right\}$
$\left\{\left|\begin{array}{l}\textbf{:element-type}\ type_{\boxed{\texttt{T}}}\\ \textbf{:fill-pointer}\ \{num|bool\}_{\boxed{\texttt{NIL}}}\\ \left\{\begin{array}{l}\textbf{:initial-element}\ obj\\ \textbf{:initial-contents}\ tree\text{-}or\text{-}array\\ \textbf{:displaced-to}\ array_{\boxed{\texttt{NIL}}}\ [\textbf{:displaced-index-offset}\ i_{\boxed{0}}]\end{array}\right.\end{array}\right.\right\}$)
▷ Return fresh, or readjust, respectively, $\underline{\text{vector}}$ or $\underline{\text{array}}$.

($_f$**aref** *array* [*subscripts*])
▷ Return $\underline{\text{array element}}$ pointed to by *subscripts*. **setf**able.

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

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

($_f$**array-dimensions** *array*)
▷ $\underline{\text{List}}$ containing the lengths of *array*'s dimensions.

($_f$**array-dimension** *array i*)
▷ $\underline{\text{Length of }i\text{th dimension}}$ of *array*.

($_f$**array-total-size** *array*) ▷ $\underline{\text{Number of elements}}$ in *array*.

($_f$**array-rank** *array*) ▷ $\underline{\text{Number of dimensions}}$ of *array*.

($_f$**array-displacement** *array*) ▷ $\underline{\text{Target array}}$ and $\underset{2}{\underline{\text{offset}}}$.

8 Structures

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

$[\widehat{\textit{doc}}] \left\{\begin{array}{l}\textit{slot} \\ (\textit{slot}\ [\textit{init} \left\{\begin{array}{|l}\textbf{:type } \widehat{\textit{slot-type}} \\ \textbf{:read-only } \widehat{\textit{bool}}\end{array}\right\}])\end{array}\right\}^*$)

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

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

9 Control Structure

9.1 Predicates

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

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

($_f$**equal** *foo bar*)
▷ <u>`T`</u> 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*)
▷ <u>`T`</u> 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*) ▷ <u>`T`</u> if *foo* is `NIL`; <u>`NIL`</u> otherwise.

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

($_f$**mismatch** *sequence-a sequence-b* $\left\{\begin{array}{|l}\textbf{:from-end } \textit{bool}_{\boxed{\texttt{NIL}}} \\ \left\{\begin{array}{l}\textbf{:test } \textit{function}_{\boxed{\texttt{\#'eql}}} \\ \textbf{:test-not } \textit{function}\end{array}\right. \\ \textbf{:start1 } \textit{start-a}_{\boxed{0}} \\ \textbf{:start2 } \textit{start-b}_{\boxed{0}} \\ \textbf{:end1 } \textit{end-a}_{\boxed{\texttt{NIL}}} \\ \textbf{:end2 } \textit{end-b}_{\boxed{\texttt{NIL}}} \\ \textbf{:key } \textit{function}\end{array}\right\}$)
▷ Return <u>position in *sequence-a*</u> where *sequence-a* and *sequence-b* begin to mismatch. Return <u>`NIL`</u> if they match entirely.

6.2 Sequence Functions

($_f$**make-sequence** *sequence-type size* [**:initial-element** *foo*])
▷ Make <u>sequence</u> of *sequence-type* with *size* elements.

($_f$**concatenate** *type sequence**)
▷ Return <u>concatenated sequence</u> of *type*.

($_f$**merge** *type* $\widetilde{\textit{sequence-a}}$ $\widetilde{\textit{sequence-b}}$ *test* [**:key** $\textit{function}_{\boxed{\texttt{NIL}}}$])
▷ Return <u>interleaved sequence</u> of *type*. Merged sequence will be sorted if both *sequence-a* and *sequence-b* are sorted.

($_f$**fill** $\widetilde{\textit{sequence}}$ *foo* $\left\{\begin{array}{|l}\textbf{:start } \textit{start}_{\boxed{0}} \\ \textbf{:end } \textit{end}_{\boxed{\texttt{NIL}}}\end{array}\right\}$)
▷ Return <u>*sequence*</u> after setting elements between *start* and *end* to *foo*.

($_f$**length** *sequence*)
▷ Return <u>length of *sequence*</u> (being value of fill pointer if applicable).

($_f$**count** *foo sequence* $\left\{\begin{array}{|l}\textbf{:from-end } \textit{bool}_{\boxed{\texttt{NIL}}} \\ \left\{\begin{array}{l}\textbf{:test } \textit{function}_{\boxed{\texttt{\#'eql}}} \\ \textbf{:test-not } \textit{function}\end{array}\right. \\ \textbf{:start } \textit{start}_{\boxed{0}} \\ \textbf{:end } \textit{end}_{\boxed{\texttt{NIL}}} \\ \textbf{:key } \textit{function}\end{array}\right\}$)
▷ Return <u>number of elements</u> in *sequence* which match *foo*.

($\left\{\begin{array}{l}_f\textbf{count-if} \\ _f\textbf{count-if-not}\end{array}\right\}$ *test sequence* $\left\{\begin{array}{|l}\textbf{:from-end } \textit{bool}_{\boxed{\texttt{NIL}}} \\ \textbf{:start } \textit{start}_{\boxed{0}} \\ \textbf{:end } \textit{end}_{\boxed{\texttt{NIL}}} \\ \textbf{:key } \textit{function}\end{array}\right\}$)
▷ Return <u>number of elements</u> in *sequence* which satisfy *test*.

($_f$**elt** *sequence index*)
▷ Return <u>element of *sequence*</u> pointed to by zero-indexed *index*. **setf**able.

($_f$**subseq** *sequence start* [$\textit{end}_{\boxed{\texttt{NIL}}}$])
▷ Return <u>subsequence of *sequence*</u> between *start* and *end*. **setf**able.

($\left\{\begin{array}{l}_f\textbf{sort} \\ _f\textbf{stable-sort}\end{array}\right\}$ $\widetilde{\textit{sequence}}$ *test* [**:key** *function*])
▷ Return <u>*sequence* sorted</u>. Order of elements considered equal is not guaranteed/retained, respectively.

($_f$**reverse** *sequence*)
($_f$**nreverse** $\widetilde{\textit{sequence}}$) ▷ Return <u>*sequence* in reverse order</u>.

($\left\{\begin{array}{l}_f\textbf{find} \\ _f\textbf{position}\end{array}\right\}$ *foo sequence* $\left\{\begin{array}{|l}\textbf{:from-end } \textit{bool}_{\boxed{\texttt{NIL}}} \\ \left\{\begin{array}{l}\textbf{:test } \textit{function}_{\boxed{\texttt{\#'eql}}} \\ \textbf{:test-not } \textit{test}\end{array}\right. \\ \textbf{:start } \textit{start}_{\boxed{0}} \\ \textbf{:end } \textit{end}_{\boxed{\texttt{NIL}}} \\ \textbf{:key } \textit{function}\end{array}\right\}$)
▷ Return <u>first element</u> in *sequence* which matches *foo*, or its <u>position</u> relative to the begin of *sequence*, respectively.

$(\left\{\begin{array}{l}{}_f\textbf{find-if}\\{}_f\textbf{find-if-not}\\{}_f\textbf{position-if}\\{}_f\textbf{position-if-not}\end{array}\right\}\ \mathit{test}\ \mathit{sequence}\ \left\{\begin{array}{|l}\textbf{:from-end}\ \mathit{bool}_{\boxed{\texttt{NIL}}}\\\textbf{:start}\ \mathit{start}_{\boxed{0}}\\\textbf{:end}\ \mathit{end}_{\boxed{\texttt{NIL}}}\\\textbf{:key}\ \mathit{function}\end{array}\right\})$

▷ Return $\underline{\text{first element}}$ in *sequence* which satisfies *test*, or its $\underline{\text{position}}$ relative to the begin of *sequence*, respectively.

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

▷ Search *sequence-b* for a subsequence matching *sequence-a*. Return $\underline{\text{position}}$ in *sequence-b*, or $\underline{\texttt{NIL}}$.

$(\left\{\begin{array}{l}{}_f\textbf{remove}\ \mathit{foo}\ \mathit{sequence}\\{}_f\textbf{delete}\ \mathit{foo}\ \widetilde{\mathit{sequence}}\end{array}\right\}\ \left\{\begin{array}{|l}\textbf{:from-end}\ \mathit{bool}_{\boxed{\texttt{NIL}}}\\\left\{\begin{array}{l}\textbf{:test}\ \mathit{function}_{\boxed{\texttt{\#'eql}}}\\\textbf{:test-not}\ \mathit{function}\end{array}\right.\\\textbf{:start}\ \mathit{start}_{\boxed{0}}\\\textbf{:end}\ \mathit{end}_{\boxed{\texttt{NIL}}}\\\textbf{:key}\ \mathit{function}\\\textbf{:count}\ \mathit{count}_{\boxed{\texttt{NIL}}}\end{array}\right\})$

▷ Make $\underline{\text{copy of } \mathit{sequence}}$ without elements matching *foo*.

$(\left\{\begin{array}{l}\left.\begin{array}{l}{}_f\textbf{remove-if}\\{}_f\textbf{remove-if-not}\end{array}\right\}\ \mathit{test}\ \mathit{sequence}\\\left.\begin{array}{l}{}_f\textbf{delete-if}\\{}_f\textbf{delete-if-not}\end{array}\right\}\ \mathit{test}\ \widetilde{\mathit{sequence}}\end{array}\right\}\ \left\{\begin{array}{|l}\textbf{:from-end}\ \mathit{bool}_{\boxed{\texttt{NIL}}}\\\textbf{:start}\ \mathit{start}_{\boxed{0}}\\\textbf{:end}\ \mathit{end}_{\boxed{\texttt{NIL}}}\\\textbf{:key}\ \mathit{function}\\\textbf{:count}\ \mathit{count}_{\boxed{\texttt{NIL}}}\end{array}\right\})$

▷ Make $\underline{\text{copy of } \mathit{sequence}}$ with all (or *count*) elements satisfying *test* removed.

$(\left\{\begin{array}{l}{}_f\textbf{remove-duplicates}\ \mathit{sequence}\\{}_f\textbf{delete-duplicates}\ \widetilde{\mathit{sequence}}\end{array}\right\}\ \left\{\begin{array}{|l}\textbf{:from-end}\ \mathit{bool}_{\boxed{\texttt{NIL}}}\\\left\{\begin{array}{l}\textbf{:test}\ \mathit{function}_{\boxed{\texttt{\#'eql}}}\\\textbf{:test-not}\ \mathit{function}\end{array}\right.\\\textbf{:start}\ \mathit{start}_{\boxed{0}}\\\textbf{:end}\ \mathit{end}_{\boxed{\texttt{NIL}}}\\\textbf{:key}\ \mathit{function}\end{array}\right\})$

▷ Make $\underline{\text{copy of } \mathit{sequence}}$ without duplicates.

$(\left\{\begin{array}{l}{}_f\textbf{substitute}\ \mathit{new}\ \mathit{old}\ \mathit{sequence}\\{}_f\textbf{nsubstitute}\ \mathit{new}\ \mathit{old}\ \widetilde{\mathit{sequence}}\end{array}\right\}\ \left\{\begin{array}{|l}\textbf{:from-end}\ \mathit{bool}_{\boxed{\texttt{NIL}}}\\\left\{\begin{array}{l}\textbf{:test}\ \mathit{function}_{\boxed{\texttt{\#'eql}}}\\\textbf{:test-not}\ \mathit{function}\end{array}\right.\\\textbf{:start}\ \mathit{start}_{\boxed{0}}\\\textbf{:end}\ \mathit{end}_{\boxed{\texttt{NIL}}}\\\textbf{:key}\ \mathit{function}\\\textbf{:count}\ \mathit{count}_{\boxed{\texttt{NIL}}}\end{array}\right\})$

▷ Make $\underline{\text{copy of } \mathit{sequence}}$ with all (or *count*) *old*s replaced by *new*.

$(\left\{\begin{array}{l}\left.\begin{array}{l}{}_f\textbf{substitute-if}\\{}_f\textbf{substitute-if-not}\end{array}\right\}\ \mathit{new}\ \mathit{test}\ \mathit{sequence}\\\left.\begin{array}{l}{}_f\textbf{nsubstitute-if}\\{}_f\textbf{nsubstitute-if-not}\end{array}\right\}\ \mathit{new}\ \mathit{test}\ \widetilde{\mathit{sequence}}\end{array}\right\}\ \left\{\begin{array}{|l}\textbf{:from-end}\ \mathit{bool}_{\boxed{\texttt{NIL}}}\\\textbf{:start}\ \mathit{start}_{\boxed{0}}\\\textbf{:end}\ \mathit{end}_{\boxed{\texttt{NIL}}}\\\textbf{:key}\ \mathit{function}\\\textbf{:count}\ \mathit{count}_{\boxed{\texttt{NIL}}}\end{array}\right\})$

▷ Make $\underline{\text{copy of } \mathit{sequence}}$ with all (or *count*) elements satisfying *test* replaced by *new*.

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

▷ Replace elements of $\underline{\mathit{sequence\text{-}a}}$ with elements of *sequence-b*.

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

▷ Apply *function* successively to corresponding elements of the *sequence*s. Return values as a $\underline{\text{sequence}}$ of *type*. If *type* is `NIL`, return $\underline{\texttt{NIL}}$.

$({}_f\textbf{map-into}\ \widetilde{\mathit{result\text{-}sequence}}\ \mathit{function}\ \mathit{sequence}^{*})$

▷ Store into $\underline{\mathit{result\text{-}sequence}}$ successively values of *function* applied to corresponding elements of the *sequence*s.

$({}_f\textbf{reduce}\ \mathit{function}\ \mathit{sequence}\ \left\{\begin{array}{|l}\textbf{:initial-value}\ \mathit{foo}_{\boxed{\texttt{NIL}}}\\\textbf{:from-end}\ \mathit{bool}_{\boxed{\texttt{NIL}}}\\\textbf{:start}\ \mathit{start}_{\boxed{0}}\\\textbf{:end}\ \mathit{end}_{\boxed{\texttt{NIL}}}\\\textbf{:key}\ \mathit{function}\end{array}\right\})$

▷ Starting with the first two elements of *sequence*, apply *function* successively to its last return value together with the next element of *sequence*. Return $\underline{\text{last value}}$ of function.

$({}_f\textbf{copy-seq}\ \mathit{sequence})$

▷ $\underline{\text{Copy of } \mathit{sequence}}$ with shared elements.

7 Hash Tables

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

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

$({}_f\textbf{hash-table-p}\ \mathit{foo})$ ▷ Return $\underline{\texttt{T}}$ if *foo* is of type **hash-table**.

$({}_f\textbf{make-hash-table}\ \left\{\begin{array}{|l}\textbf{:test}\ \{{}_f\textbf{eq}|{}_f\textbf{eql}|{}_f\textbf{equal}|{}_f\textbf{equalp}\}_{\boxed{\texttt{\#'eql}}}\\\textbf{:size}\ \mathit{int}\\\textbf{:rehash-size}\ \mathit{num}\\\textbf{:rehash-threshold}\ \mathit{num}\end{array}\right\})$

▷ Make a $\underline{\text{hash table}}$.

$({}_f\textbf{gethash}\ \mathit{key}\ \mathit{hash\text{-}table}\ [\mathit{default}_{\boxed{\texttt{NIL}}}])$

▷ Return $\underline{\text{object}}$ with *key* if any or $\underline{\mathit{default}}$ otherwise; and $\underline{\texttt{T}}_2$ if found, $\underline{\texttt{NIL}}_2$ otherwise. **setf**able.

$({}_f\textbf{hash-table-count}\ \mathit{hash\text{-}table})$

▷ $\underline{\text{Number of entries}}$ in *hash-table*.

$({}_f\textbf{remhash}\ \mathit{key}\ \widetilde{\mathit{hash\text{-}table}})$

▷ Remove from *hash-table* entry with *key* and return $\underline{\texttt{T}}$ if it existed. Return $\underline{\texttt{NIL}}$ otherwise.

$({}_f\textbf{clrhash}\ \widetilde{\mathit{hash\text{-}table}})$ ▷ Empty $\underline{\mathit{hash\text{-}table}}$.

$({}_f\textbf{maphash}\ \mathit{function}\ \mathit{hash\text{-}table})$

▷ Iterate over *hash-table* calling *function* on key and value. Return $\underline{\texttt{NIL}}$.

$({}_m\textbf{with-hash-table-iterator}\ (\mathit{foo}\ \mathit{hash\text{-}table})\ (\textbf{declare}\ \widehat{\mathit{decl}}^{*})^{*}\ \mathit{form}^{P_*})$

▷ Return $\underline{\text{values of } \mathit{forms}}$. In *forms*, invocations of (*foo*) return: `T` if an entry is returned; its key; its value.

$({}_f\textbf{hash-table-test}\ \mathit{hash\text{-}table})$

▷ $\underline{\text{Test function}}$ used in *hash-table*.

$({}_f\textbf{hash-table-size}\ \mathit{hash\text{-}table})$
$({}_f\textbf{hash-table-rehash-size}\ \mathit{hash\text{-}table})$
$({}_f\textbf{hash-table-rehash-threshold}\ \mathit{hash\text{-}table})$

▷ Current $\underline{\text{size}}$, $\underline{\text{rehash-size}}$, or $\underline{\text{rehash-threshold}}$, respectively, as used in ${}_f$**make-hash-table**.

$({}_f\textbf{sxhash}\ \mathit{foo})$

▷ $\underline{\text{Hash code}}$ unique for any argument ${}_f$**equal** *foo*.

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

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

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

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

(${}_m$**define-modify-macro** foo ($\left[\textbf{\&optional} \begin{Bmatrix} var \\ (var\ [init_{\boxed{NIL}}\ [supplied\text{-}p]]) \end{Bmatrix}^*\right]$ $[\textbf{\&rest}\ var]$) $function$ $[\widehat{doc}]$)
  ▷ Define macro $\underline{foo}$ able to modify a place. On invocation of (foo $place$ arg^*), the value of $function$ applied to $place$ and $args$ 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 $vars$ to corresponding arguments if any.

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

&key var^*
  ▷ Bind $vars$ 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 $vars$ as in ${}_s$**let***.

(${}_f$**constantp** foo $[environment_{\boxed{NIL}}]$)
  ▷ $\underline{\texttt{T}}$ if foo is a constant form.

(${}_f$**functionp** foo) ▷ $\underline{\texttt{T}}$ if foo is of type **function**.

(${}_f$**fboundp** $\begin{Bmatrix} foo \\ (\textbf{setf}\ foo) \end{Bmatrix}$) ▷ $\underline{\texttt{T}}$ if foo is a global function or macro.

9.2 Variables

($\begin{Bmatrix} {}_m\textbf{defconstant} \\ {}_m\textbf{defparameter} \end{Bmatrix}$ $\widehat{foo}$ $form$ $[\widehat{doc}]$)
  ▷ Assign value of $form$ to global constant/dynamic variable $\underline{foo}$.

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

($\begin{Bmatrix} {}_m\textbf{setf} \\ {}_m\textbf{psetf} \end{Bmatrix}$ {$place$ $form$}*)
  ▷ Set $places$ to primary values of $forms$. Return $\underline{\text{values of last } form}$/$\underline{\texttt{NIL}}$; work sequentially/in parallel, respectively.

($\begin{Bmatrix} {}_s\textbf{setq} \\ {}_m\textbf{psetq} \end{Bmatrix}$ {$symbol$ $form$}*)
  ▷ Set $symbols$ to primary values of $forms$. Return $\underline{\text{value of last } form}$/$\underline{\texttt{NIL}}$; work sequentially/in parallel, respectively.

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

(${}_m$**multiple-value-setq** $vars$ $form$)
  ▷ Set elements of $vars$ to the values of $form$. Return $\underline{form\text{'s primary value}}$.

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

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

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

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

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

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

(${}_s$**progv** $symbols$ $values$ $form^{\overset{P}{*}}$)
  ▷ Evaluate $forms$ with locally established dynamic bindings of $symbols$ to $values$ or `NIL`. Return $\underline{\text{values of } forms}$.

($\begin{Bmatrix} {}_s\textbf{let} \\ {}_s\textbf{let*} \end{Bmatrix}$ ($\begin{Bmatrix} \left| \begin{matrix} name \\ (name\ [value_{\boxed{NIL}}]) \end{matrix} \right. \end{Bmatrix}^*$) (**declare** $\widehat{decl}^*$)* $form^{\overset{P}{*}}$)
  ▷ Evaluate $forms$ with $names$ lexically bound (in parallel or sequentially, respectively) to $values$. Return $\underline{\text{values of } forms}$.

($_m$**multiple-value-bind** ($\widehat{var^*}$) *values-form* (**declare** $\widehat{decl^*}$)* *body-form*$^{\mathrm{P}*}$)
▷ Evaluate *body-forms* with *vars* lexically bound to the return values of *values-form*. Return values of *body-forms*.

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

9.3 Functions

Below, ordinary lambda list (*ord-λ**) has the form

$$(var^*\ [\textbf{\&optional} \left\{\begin{array}{l} var \\ (var\ [init_{\boxed{\texttt{NIL}}}\ [supplied\text{-}p]]) \end{array}\right\}^*]\ [\textbf{\&rest}\ var]$$

$$[\textbf{\&key} \left\{\begin{array}{l} var \\ (\left\{\begin{array}{l} var \\ (\text{:}key\ var) \end{array}\right\}\ [init_{\boxed{\texttt{NIL}}}\ [supplied\text{-}p]]) \end{array}\right\}^*\ [\textbf{\&allow-other-keys}]]$$

$$[\textbf{\&aux} \left\{\begin{array}{l} var \\ (var\ [init_{\boxed{\texttt{NIL}}}]) \end{array}\right\}^*]).$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

($_f$**function-lambda-expression** *function*)
▷ If available, return lambda expression of *function*, $\underset{2}{\texttt{NIL}}$ if *function* was defined in an environment without bindings, and $\underset{3}{\text{name}}$ of *function*.

$$({}_f\textbf{fdefinition} \left\{\begin{array}{l} foo \\ (\textbf{setf}\ foo) \end{array}\right\})$$
▷ 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

$$([\textbf{\&whole}\ var]\ [E] \left\{\begin{array}{l} var \\ (macro\text{-}\lambda^*) \end{array}\right\}^*\ [E]$$

$$[\textbf{\&optional} \left\{\begin{array}{l} var \\ (\left\{\begin{array}{l} var \\ (macro\text{-}\lambda^*) \end{array}\right\}\ [init_{\boxed{\texttt{NIL}}}\ [supplied\text{-}p]]) \end{array}\right\}^*]\ [E]$$

$$[\left\{\begin{array}{l} \textbf{\&rest} \\ \textbf{\&body} \end{array}\right\} \left\{\begin{array}{l} rest\text{-}var \\ (macro\text{-}\lambda^*) \end{array}\right\}]\ [E]$$

$$[\textbf{\&key} \left\{\begin{array}{l} var \\ (\left\{\begin{array}{l} var \\ (\text{:}key \left\{\begin{array}{l} var \\ (macro\text{-}\lambda^*) \end{array}\right\}) \end{array}\right\}\ [init_{\boxed{\texttt{NIL}}}\ [supplied\text{-}p]]) \end{array}\right\}^*\ [E]$$

$$[\textbf{\&allow-other-keys}]]\ [\textbf{\&aux} \left\{\begin{array}{l} var \\ (var\ [init_{\boxed{\texttt{NIL}}}]) \end{array}\right\}^*]\ [E])$$

or

$$([\textbf{\&whole}\ var]\ [E] \left\{\begin{array}{l} var \\ (macro\text{-}\lambda^*) \end{array}\right\}^*\ [E]\ [\textbf{\&optional}$$

$$\left\{\begin{array}{l} var \\ (\left\{\begin{array}{l} var \\ (macro\text{-}\lambda^*) \end{array}\right\}\ [init_{\boxed{\texttt{NIL}}}\ [supplied\text{-}p]]) \end{array}\right\}^*]\ [E]\ \textbf{.}\ rest\text{-}var).$$

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.

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

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

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

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

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

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

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

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

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

{**do**|**doing**} *form*$^+$
▷ Evaluate *forms* 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-clauses*; otherwise, evaluate *k-clause* and *l-clauses*.

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 *forms* 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.

9.5 Control Flow

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

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

({${}_m$**when**|${}_m$**unless**} *test foo*$^{\text{P}*}$)
▷ Evaluate *foos* and return their values if *test* returns T or NIL, respectively. Return NIL otherwise.

(${}_m$**case** *test* ({($\widehat{key}$*)|$\widehat{key}$} *foo*$^{\text{P}*}$)* [({**otherwise**|T} *bar*$^{\text{P}*}$)$_{\boxed{\text{NIL}}}$])
▷ Return the values of the first *foo** one of whose *keys* is **eql** *test*. Return values of *bars* if there is no matching *key*.

({${}_m$**ecase**|${}_m$**ccase**} *test* ({($\widehat{key}$*)|$\widehat{key}$} *foo*$^{\text{P}*}$)*)
▷ Return the values of the first *foo** one of whose *keys* is **eql** *test*. Signal non-correctable/correctable **type-error** if there is no matching *key*.

(${}_m$**and** *form**$_{\boxed{\text{T}}}$)
▷ Evaluate *forms* from left to right. Immediately return NIL if one *form*'s value is NIL. Return values of last *form* otherwise.

(${}_m$**or** *form**$_{\boxed{\text{NIL}}}$)
▷ Evaluate *forms* from left to right. Immediately return primary value of first non-NIL-evaluating form, or all values if last *form* is reached. Return NIL if no *form* returns T.

(${}_s$**progn** *form**$_{\boxed{\text{NIL}}}$)
▷ Evaluate *forms* 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*$_{\boxed{\text{NIL}}}$])}*) (**declare** $\widehat{decl}$*)* {$\widehat{tag}$|*form*}*)
▷ Evaluate ${}_s$**tagbody**-like body with *names* lexically bound (in parallel or sequentially, respectively) to *values*. Return NIL or explicitly ${}_m$**return**ed values. Implicitly, the whole form is a ${}_s$**block** named NIL.

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

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

(${}_s$**return-from** *foo* [*result*$_{\boxed{\text{NIL}}}$])
(${}_m$**return** [*result*$_{\boxed{\text{NIL}}}$])
▷ Have nearest enclosing ${}_s$**block** named *foo*/named NIL, respectively, return with values of *result*.

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

(${}_s$**go** $\widehat{tag}$)
▷ Within the innermost possible enclosing ${}_s$**tagbody**, jump to a tag ${}_f$**eql** *tag*.

(${}_s$**catch** *tag form*^{P*})
 ▷ Evaluate *forms* and return $\underline{\text{their values}}$ 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 $\underline{\texttt{NIL}}$.

9.6 Iteration

($\begin{Bmatrix}{}_m\textbf{do}\\ {}_m\textbf{do*}\end{Bmatrix}$ ($\begin{Bmatrix}var\\ (var\ [start\ [step]])\end{Bmatrix}^*$) (*stop result*^{P*}) (**declare** $\widehat{decl}^*$)* $\begin{Bmatrix}\widehat{tag}\\ form\end{Bmatrix}^*$)
 ▷ Evaluate ${}_s$**tagbody**-like body with *vars* successively bound according to the values of the corresponding *start* and *step* forms. *vars* are bound in parallel/sequentially, respectively. Stop iteration when *stop* is `T`. Return $\underline{\text{values of } result^*}$. Implicitly, the whole form is a ${}_s$**block** named `NIL`.

(${}_m$**dotimes** (*var i* [$result_{\boxed{\texttt{NIL}}}$]) (**declare** $\widehat{decl}^*$)* {$\widehat{tag}$|*form*}*)
 ▷ Evaluate ${}_s$**tagbody**-like body with *var* successively bound to integers from 0 to $i-1$. Upon evaluation of $\underline{result}$, *var* is *i*. Implicitly, the whole form is a ${}_s$**block** named `NIL`.

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

9.7 Loop Facility

(${}_m$**loop** *form**)
 ▷ **Simple Loop.** If *forms* 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 $n_{\boxed{\texttt{NIL}}}$ ▷ Give ${}_m$**loop**'s implicit ${}_s$**block** a name.

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

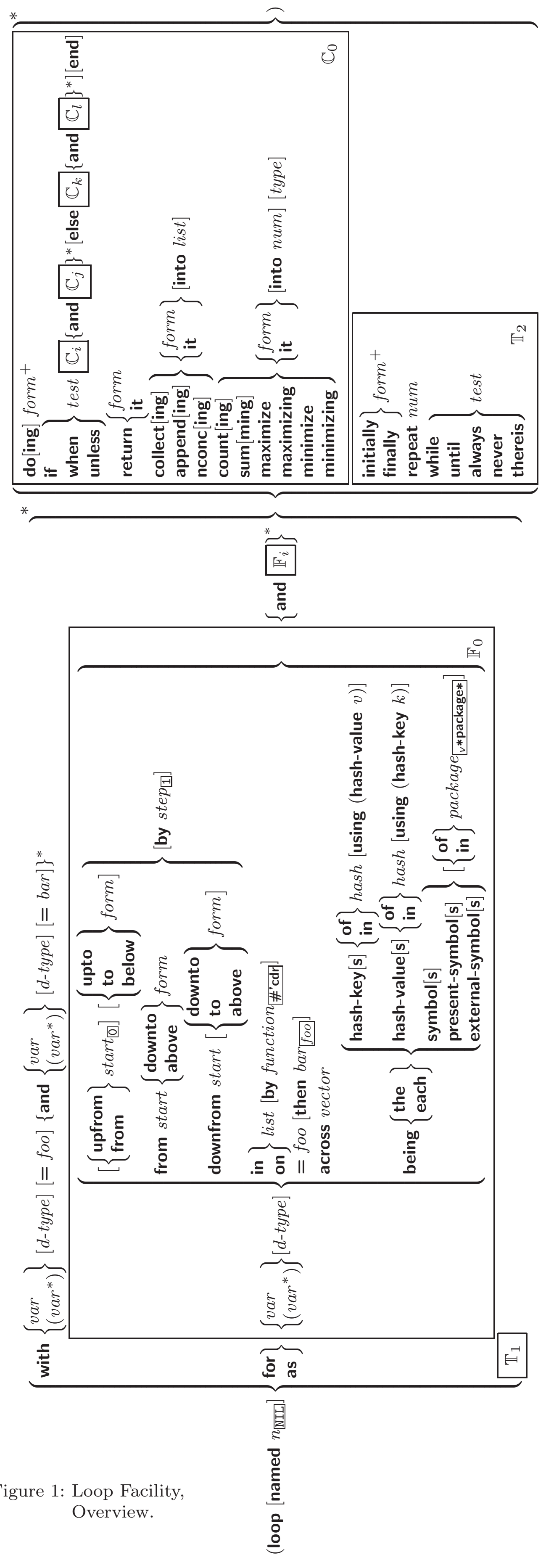
{{**for**|**as**} $\begin{Bmatrix}var\text{-}s\\ (var\text{-}s^*)\end{Bmatrix}$ [*d-type*]}$^+$ {**and** $\begin{Bmatrix}var\text{-}p\\ (var\text{-}p^*)\end{Bmatrix}$ [*d-type*]}*
 ▷ Begin of iteration control clauses. Initialize and step (possibly trees of) local variables *var-s* sequentially and *var-p* 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 {$step_{\boxed{1}}$|$function_{\boxed{\texttt{\#'cdr}}}$}
  ▷ Specify the (positive) decrement or increment or the *function* of one argument returning the next part of the list.



(loop [named n NIL]
with {var | (var*)} [d-type] [= foo] {and {var | (var*)} [d-type] [= bar]}*
for | as {var | (var*)} [d-type]
upfrom | from start, downto | above form, upto | to | below form, by step 1
from start, downfrom start
in | on list [by function #'cdr]
= foo [then bar foo]
across vector
being the | each hash-key[s] | hash-value[s] | symbol[s] | present-symbol[s] | external-symbol[s]
of | in hash [using (hash-value v)] [using (hash-key k)] package *package*
{and F_i}*
F_0
T_1
do[ing] form+
if | when | unless test C_i {and C_j}* [else C_k {and C_l}*] [end]
return form | it
collect[ing] | append[ing] | nconc[ing] form | it [into list]
count[ing] | sum[ming] | maximize | maximizing | minimize | minimizing form | it [into num] [type]
C_0
initially | finally form+
repeat num
while | until | always | never | thereis test
T_2

Figure 1: Loop Facility, Overview.

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-types* defined by the short form of $_m$**define-method-combination**.

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

▷ **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-methods* are ordered $\left[\left\{\begin{array}{l}\textbf{:most-specific-first}\\ \textbf{:most-specific-last}\end{array}\right\}_{\boxed{\textbf{:most-specific-first}}}\right]$ (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*
$\left\{\begin{array}{l}\textbf{*}\\ (qualifier^* \;[\textbf{*}])\\ predicate\end{array}\right\}$
$\left\{\begin{array}{l}\textbf{:description } control\\ \textbf{:order } \left\{\begin{array}{l}\textbf{:most-specific-first}\\ \textbf{:most-specific-last}\end{array}\right\}_{\boxed{\textbf{:most-specific-first}}}\\ \textbf{:required } bool\end{array}\right\}$)*)
$\left\{\begin{array}{l}(\textbf{:arguments } method\text{-}combination\text{-}\lambda^*)\\ (\textbf{:generic-function } symbol)\\ (\textbf{declare } \widehat{decl}^*)^*\\ \widehat{doc}\end{array}\right\} body^{\overset{P}{*}}$)

▷ **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 *groups* bound to lists of methods. An applicable method becomes a member of the leftmost *group* whose *predicate* or *qualifiers* match. Methods can be called via $_m$**call-method**. Lambda lists (*ord-λ**) and (*method-combination-λ**) according to *ord-λ* on page 18, the latter enhanced by an optional **&whole** argument.

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

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

11 Conditions and Errors

For standardized condition types cf. Figure 2 on page 32.

{**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**$_{\boxed{\textbf{standard-object}}}$)
$\left(\left\{\begin{array}{l} slot\\ (slot \left\{\begin{array}{l}\{\textbf{:reader } reader\}^*\\ \{\textbf{:writer } \left\{\begin{array}{l}writer\\(\textbf{setf } writer)\end{array}\right\}\}^*\\ \{\textbf{:accessor } accessor\}^*\\ \textbf{:allocation } \left\{\begin{array}{l}\textbf{:instance}\\ \textbf{:class}\end{array}\right\}_{\boxed{\textbf{:instance}}}\\ \{\textbf{:initarg :}initarg\text{-}name\}^*\\ \textbf{:initform } form\\ \textbf{:type } type\\ \textbf{:documentation } slot\text{-}doc\end{array}\right\})\end{array}\right\}^*\right)$
$\left\{\begin{array}{l}(\textbf{:default-initargs } \{name\ value\}^*)\\ (\textbf{:documentation } class\text{-}doc)\\ (\textbf{:metaclass } name_{\boxed{\textbf{standard-class}}})\end{array}\right\}$)

▷ Define or modify class *foo* as a subclass of *superclasses*. 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*). *slots* with **:allocation :class** are shared by all instances of class *foo*.

($_f$**find-class** *symbol* [*errorp*$_{\boxed{\texttt{T}}}$ [*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 *initargs* 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.

$\left(\left\{\begin{array}{l}{}_m\textbf{with-slots } (\{\widehat{slot}|(\widehat{var}\ \widehat{slot})\}^*)\\ {}_m\textbf{with-accessors } ((\widehat{var}\ \widehat{accessor})^*)\end{array}\right\}\right.$ *instance* (**declare** $\widehat{decl}$*)*
$form^{\overset{P}{*}}$)

▷ Return values of *forms* after evaluating them in a lexical environment with slots of *instance* visible as **setf**able *slots* or *vars*/with *accessors* of *instance* visible as **setf**able *vars*.

($_g$**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** $\widehat{instance}$ *new-class* {**:***initarg value*}* *other-keyarg**)
▷ Change class of <u>*instance*</u> 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**.

($\left\{\begin{array}{l}{}_g\textbf{initialize-instance}\ \textit{instance}\\ {}_g\textbf{update-instance-for-different-class}\ \textit{previous current}\end{array}\right\}$
{**:***initarg value*}* *other-keyarg**)
▷ Set slots on behalf of $_g$**make-instance**/of $_g$**change-class** by means of $_g$**shared-initialize**.

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

($_g$**allocate-instance** *class* {**:***initarg value*}* *other-keyarg**)
▷ Return uninitialized <u>instance</u> of *class*. Called by $_g$**make-instance**.

($_g$**shared-initialize** *instance* $\left\{\begin{array}{l}\textit{initform-slots}\\ \texttt{T}\end{array}\right\}$ {**:***initarg-slot value*}* *other-keyarg**)
▷ Fill the *initarg-slots* of *instance* with the corresponding *value*s, and fill those *initform-slots* that are not *initarg-slots* with the values of their **:initform** forms.

($_g$**slot-missing** *class instance slot* $\left\{\begin{array}{l}\textbf{setf}\\ \textbf{slot-boundp}\\ \textbf{slot-makunbound}\\ \textbf{slot-value}\end{array}\right\}$ [*value*])
($_g$**slot-unbound** *class instance slot*)
▷ Called on attempted access to non-existing or unbound *slot*. Default methods signal **error**/**unbound-slot**, respectively. Not to be called by user.

10.2 Generic Functions

($_f$**next-method-p**) ▷ <u>T</u> if enclosing method has a next method.

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

($_f$**ensure-generic-function** $\left\{\begin{array}{l}\textit{foo}\\ (\textbf{setf}\ \textit{foo})\end{array}\right\}$
$\left\{\begin{array}{|l}\textbf{:argument-precedence-order}\ \textit{required-var}^+\\ \textbf{:declare}\ (\textbf{optimize}\ \textit{method-selection-optimization})\\ \textbf{:documentation}\ \textit{string}\\ \textbf{:generic-function-class}\ \textit{gf-class}\\ \textbf{:method-class}\ \textit{method-class}\\ \textbf{:method-combination}\ \textit{c-type c-arg}^*\\ \textbf{:lambda-list}\ \textit{lambda-list}\\ \textbf{:environment}\ \textit{environment}\end{array}\right\}$)
▷ Define or modify <u>generic function</u> *foo*. *gf-class* and *lambda-list* must be compatible with a pre-existing generic function or with existing methods, respectively. Changes to *method-class* do not propagate to existing methods. For *c-type* see section 10.3.

($_m$**defmethod** $\left\{\begin{array}{l}\textit{foo}\\ (\textbf{setf}\ \textit{foo})\end{array}\right\}$ [$\left\{\begin{array}{l}\textbf{:before}\\ \textbf{:after}\\ \textbf{:around}\\ \textit{qualifier}^*\end{array}\right\}_{\boxed{\text{primary method}}}$]
($\left\{\begin{array}{l}\textit{var}\\ (\textit{spec-var}\ \left\{\begin{array}{l}\textit{class}\\ (\textbf{eql}\ \textit{bar})\end{array}\right\})\end{array}\right\}^*$ [**&optional**
$\left\{\begin{array}{l}\textit{var}\\ (\textit{var}\ [\textit{init}\ [\textit{supplied-p}]])\end{array}\right\}^*$] [**&rest** *var*] [**&key**
$\left\{\begin{array}{l}\textit{var}\\ (\left\{\begin{array}{l}\textit{var}\\ (\textbf{:}\textit{key var})\end{array}\right\}[\textit{init}\ [\textit{supplied-p}]])\end{array}\right\}^*$ [**&allow-other-keys**]]
[**&aux** $\left\{\begin{array}{l}\textit{var}\\ (\textit{var}\ [\textit{init}])\end{array}\right\}^*$]) $\left\{\begin{array}{|l}(\textbf{declare}\ \widehat{\textit{decl}}^*)^*\\ \widehat{\textit{doc}}\end{array}\right\}$ *form*^{P*})
▷ Define <u>new method</u> 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 <u>new method</u> 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 <u>*generic-function*</u>.

($_g$**find-method** *generic-function qualifiers specializers* [*error*$_{\boxed{\texttt{T}}}$])
▷ Return suitable <u>method</u>, or signal **error**.

($_g$**compute-applicable-methods** *generic-function args*)
▷ <u>List of methods</u> 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 <u>its values</u>.

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

($\left\{\begin{array}{l}{}_f\textbf{invalid-method-error}\ \textit{method}\\ {}_f\textbf{method-combination-error}\end{array}\right\}$ *control arg**)
▷ Signal **error** on applicable method with invalid qualifiers, or on method combination. For *control* and *arg*s see **format**, page 38.

($_g$**no-next-method** *generic-function method arg**)
▷ Called on invocation of **call-next-method** when there is no next method. Default method signals **error**. Not to be called by user.

($_g$**function-keywords** *method*)
▷ Return list of <u>keyword parameters</u> of *method* and $\underline{\texttt{T}}_2$ if other keys are allowed.

($_g$**method-qualifiers** *method*) ▷ <u>List of qualifiers</u> of *method*.

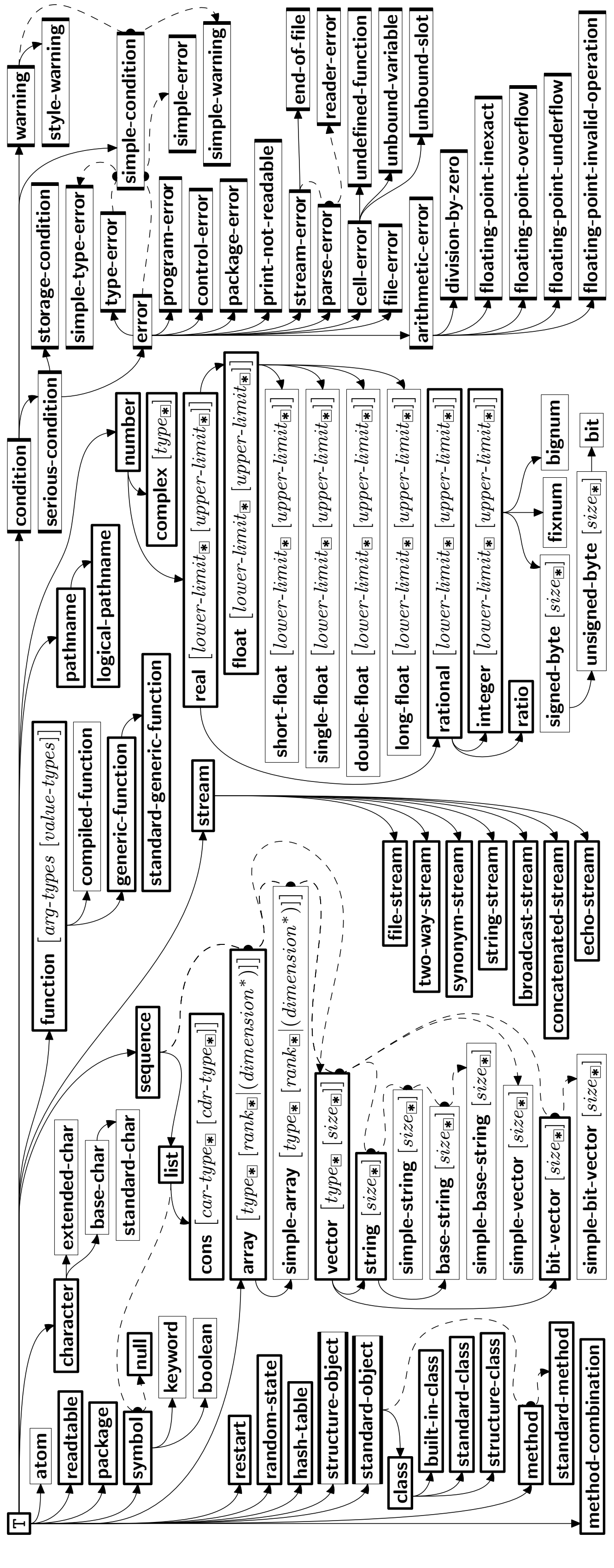


Figure 2: Precedence Order of System Classes (▭), Classes (▬), Types (▭), and Condition Types (▭).
Every type is also a supertype of `NIL`, the empty type.

($_m$**define-condition** *foo* (*parent-type** $\boxed{\text{condition}}$)
({*slot* | (*slot* {{**:reader** *reader*}* | {**:writer** {*writer* | (**setf** *writer*)}}* | {**:accessor** *accessor*}* | **:allocation** {**:instance** | **:class**} $\boxed{\text{:instance}}$ | {**:initarg** **:***initarg-name*}* | **:initform** *form* | **:type** *type* | **:documentation** *slot-doc*})}*)
{|(**:default-initargs** {*name value*}*) | (**:documentation** *condition-doc*) | (**:report** {*string* | *report-function*})})

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

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

({$_f$**signal** | $_f$**warn** | $_f$**error**} {*condition* | *condition-type* {**:***initarg-name value*}* | *control arg**})
▷ Unless handled, signal as **condition**, **warning** or **error**, respectively, *condition* or a new instance of *condition-type* or, with $_f$**format** *control* and *args* (see page 38), **simple-condition**, **simple-warning**, or **simple-error**, respectively. From $_f$**signal** and $_f$**warn**, return <u>`NIL`</u>.

($_f$**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 38), **simple-error**. In the debugger, use $_f$**format** arguments *continue-control* and *continue-arg*s to tag the continue option. Return <u>`NIL`</u>.

($_m$**ignore-errors** *form*^{P}*)
▷ Return <u>values of *form*s</u> or, in case of **error**s, <u>`NIL`</u> and the $\underset{2}{\underline{\text{condition}}}$.

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

($_m$**assert** *test* [(*place**) [{*condition continue-arg** | *condition-type* {**:***initarg-name value*}* | *control arg**}]])
▷ If *test*, which may depend on *place*s, returns `NIL`, signal as correctable **error** *condition* or a new instance of *condition-type* or, with $_f$**format** *control* and *args* (see page 38), **error**. When using the debugger's continue option, *place*s can be altered before re-evaluation of *test*. Return <u>`NIL`</u>.

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

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

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

▷ Return values of *form*s unless *restart* is called during their evaluation. In this case, describe *restart* using $_f$**format** *control* and *arg*s (see page 38) and return `NIL` and `T`$_{\overline{2}}$.

($_m$**restart-case** *form* (*restart* (*ord-λ**) $\left\{\begin{array}{l}|\textbf{:interactive}\ \textit{arg-function}\\ |\textbf{:report}\ \left\{\begin{array}{l}\textit{report-function}\\ \textit{string}_{\boxed{\texttt{"}\textit{restart}\texttt{"}}}\end{array}\right.\\ |\textbf{:test}\ \textit{test-function}_{\boxed{T}}\end{array}\right\}$

(**declare** $\widehat{decl^*}$)* *restart-form*^{P*})*)

▷ Return values of *form* or, if during evaluation of *form* one of the dynamically established *restart*s is called, the values of its *restart-form*s. A *restart* is visible under *condition* if (**funcall** **#'***test-function condition*) returns `T`. If presented in the debugger, *restart*s are described by *string* or by **#'***report-function* (of a stream). A *restart* can be called by (**invoke-restart** *restart arg**), where *arg*s match *ord-λ**, or by (**invoke-restart-interactively** *restart*) where a list of the respective *arg*s is supplied by **#'***arg-function*. See page 18 for *ord-λ**.

($_m$**restart-bind** (($\left\{\begin{array}{l}\widehat{\textit{restart}}\\ \texttt{NIL}\end{array}\right\}$ *restart-function*

$\left\{\begin{array}{l}|\textbf{:interactive-function}\ \textit{arg-function}\\ |\textbf{:report-function}\ \textit{report-function}\\ |\textbf{:test-function}\ \textit{test-function}\end{array}\right\}$)*) *form*^{P*})

▷ Return values of *forms* evaluated with dynamically established *restarts* whose *restart-function*s should perform a non-local transfer of control. A restart is visible under *condition* if (*test-function condition*) returns `T`. If presented in the debugger, *restart*s are described by *restart-function* (of a stream). A *restart* can be called by (**invoke-restart** *restart arg**), where *arg*s must be suitable for the corresponding *restart-function*, or by (**invoke-restart-interactively** *restart*) where a list of the respective *arg*s is supplied by *arg-function*.

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

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

($\left\{\begin{array}{l}_f\textbf{find-restart}\\ _f\textbf{compute-restarts}\ \textit{name}\end{array}\right\}$ [*condition*])

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

($_f$**restart-name** *restart*) ▷ Name of *restart*.

($\left\{\begin{array}{l}_f\textbf{abort}\\ _f\textbf{muffle-warning}\\ _f\textbf{continue}\\ _f\textbf{store-value}\ \textit{value}\\ _f\textbf{use-value}\ \textit{value}\end{array}\right\}$ [*condition*$_{\boxed{\texttt{NIL}}}$])

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

($_m$**with-condition-restarts** *condition restarts form*^{P*})

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

($_f$**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***$_{\boxed{\texttt{NIL}}}$

▷ Condition type debugger is to be invoked on.

$_v$***debugger-hook***$_{\boxed{\texttt{NIL}}}$

▷ 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*$_{\boxed{\texttt{NIL}}}$]) ▷ `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`$_{\overline{2}}$ if the relationship could not be determined.

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

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

($_m$**typecase** *foo* ($\widehat{type}$ *a-form*^{P*})* [($\left\{\begin{array}{l}\textbf{otherwise}\\ \texttt{T}\end{array}\right\}$ *b-form*$_{\boxed{\texttt{NIL}}}$^{P*})])

▷ Return values of the first *a-form** whose *type* is *foo* of. Return values of *b-forms* if no *type* matches.

($\left\{\begin{array}{l}_m\textbf{etypecase}\\ _m\textbf{ctypecase}\end{array}\right\}$ *foo* ($\widehat{type}$ *form*^{P*})*)

▷ Return values of the first *form** whose *type* is *foo* of. Signal non-correctable/correctable **type-error** if no *type* matches.

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

($_m$**check-type** *place type* [*string*$_{\boxed{\{\texttt{a}|\texttt{an}\}\ \textit{type}}}$])

▷ 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*$_{\boxed{\texttt{NIL}}}$])

▷ Element type of most specialized array capable of holding elements of *type*.

#+*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

($\left\{\begin{array}{l}{}_f\textbf{prin1}\\ {}_f\textbf{print}\\ {}_f\textbf{pprint}\\ {}_f\textbf{princ}\end{array}\right\}$ *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 $\underline{foo}$.

($_f$**prin1-to-string** *foo*)
($_f$**princ-to-string** *foo*)
▷ Print *foo* to $\underline{string}$ $_f$**read**ably or human-readably, respectively.

($_g$**print-object** *object* $\widetilde{stream}$)
▷ Print $\underline{object}$ 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 *forms* to *stream*. Return $\underline{\texttt{NIL}}$.

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

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

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

($\left\{\begin{array}{l}{}_f\textbf{write-string}\\ {}_f\textbf{write-line}\end{array}\right\}$ *string* [$\widetilde{stream}_{\boxed{v\textbf{*standard-output*}}}$ [$\left\{\begin{array}{l}\textbf{:start}\ start_{\boxed{0}}\\ \textbf{:end}\ end_{\boxed{\texttt{NIL}}}\end{array}\right\}$]])
▷ Write $\underline{string}$ to *stream* without/with a trailing newline.

($_f$**write-byte** *byte* $\widetilde{stream}$) ▷ Write $\underline{byte}$ to binary *stream*.

($_f$**write-sequence** *sequence* $\widetilde{stream}$ $\left\{\begin{array}{l}\textbf{:start}\ start_{\boxed{0}}\\ \textbf{:end}\ end_{\boxed{\texttt{NIL}}}\end{array}\right\}$)
▷ Write elements of $\underline{sequence}$ to binary or character *stream*.

($_m$**deftype** *foo* (*macro-λ**) (**declare** $\widehat{decl}$*)* [$\widehat{doc}$] *form*^{P_*})
▷ Define type $\underline{foo}$ which when referenced as (*foo* $\widehat{arg}$*) (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 19 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**$_{\boxed{\texttt{T}}}$) ▷ Type specifier for intersection of *type*s.

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

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

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

13 Input/Output

13.1 Predicates

($_f$**streamp** *foo*)
($_f$**pathnamep** *foo*) ▷ $\underline{\texttt{T}}$ if *foo* is of indicated type.
($_f$**readtablep** *foo*)

($_f$**input-stream-p** *stream*)
($_f$**output-stream-p** *stream*)
($_f$**interactive-stream-p** *stream*)
($_f$**open-stream-p** *stream*)
▷ Return $\underline{\texttt{T}}$ if *stream* is for input, for output, interactive, or open, respectively.

($_f$**pathname-match-p** *path wildcard*)
▷ $\underline{\texttt{T}}$ if *path* matches *wildcard*.

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

13.2 Reader

($\left\{\begin{array}{l}{}_f\textbf{y-or-n-p}\\ {}_f\textbf{yes-or-no-p}\end{array}\right\}$ [*control arg**])
▷ Ask user a question and return $\underline{\texttt{T}}$ or $\underline{\texttt{NIL}}$ depending on their answer. See page 38, $_f$**format**, for *control* and *args*.

($_m$**with-standard-io-syntax** *form*^{P_*})
▷ Evaluate *forms* with standard behaviour of reader and printer. Return $\underline{\text{values of } forms}$.

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

($_f$**read-from-string** *string* [*eof-error*$_{\boxed{\texttt{T}}}$ [*eof-val*$_{\boxed{\texttt{NIL}}}$ [$\left\{\begin{array}{l}\textbf{:start}\ start_{\boxed{0}}\\ \textbf{:end}\ end_{\boxed{\texttt{NIL}}}\\ \textbf{:preserve-whitespace}\ bool_{\boxed{\texttt{NIL}}}\end{array}\right\}$]]])
▷ Return $\underline{object}$ read from string and zero-indexed $\underset{2}{\underline{position}}$ of next character.

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

($_f$**read-char** [$\widetilde{\mathit{stream}}_{\boxed{_v\textbf{*standard-input*}}}$ [*eof-err*$_{\boxed{\texttt{T}}}$ [*eof-val*$_{\boxed{\texttt{NIL}}}$ [*recursive*$_{\boxed{\texttt{NIL}}}$]]]])
▷ Return $\underline{\text{next character}}$ from *stream*.

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

($_f$**peek-char** [*mode*$_{\boxed{\texttt{NIL}}}$ [$\widetilde{\mathit{stream}}_{\boxed{_v\textbf{*standard-input*}}}$ [*eof-error*$_{\boxed{\texttt{T}}}$ [*eof-val*$_{\boxed{\texttt{NIL}}}$ [*recursive*$_{\boxed{\texttt{NIL}}}$]]]]])
▷ Next, or if *mode* is `T`, next non-whitespace $\underline{\text{character}}$, or if *mode* is a character, $\underline{\text{next instance}}$ of it, from *stream* without removing it there.

($_f$**unread-char** *character* [$\widetilde{\mathit{stream}}_{\boxed{_v\textbf{*standard-input*}}}$])
▷ Put last $_f$**read-char**ed *character* back into *stream*; return $\underline{\texttt{NIL}}$.

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

($_f$**read-line** [$\widetilde{\mathit{stream}}_{\boxed{_v\textbf{*standard-input*}}}$ [*eof-err*$_{\boxed{\texttt{T}}}$ [*eof-val*$_{\boxed{\texttt{NIL}}}$ [*recursive*$_{\boxed{\texttt{NIL}}}$]]]])
▷ Return a $\underline{\text{line of text}}$ from *stream* and $\underset{2}{\underline{\texttt{T}}}$ if line has been ended by end of file.

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

($_f$**readtable-case** *readtable*)$_{\boxed{\textbf{:upcase}}}$
▷ $\underline{\text{Case sensitivity attribute}}$ (one of **:upcase**, **:downcase**, **:preserve**, **:invert**) of *readtable*. **setf**able.

($_f$**copy-readtable** [*from-readtable*$_{\boxed{_v\textbf{*readtable*}}}$ [$\widetilde{\mathit{to\text{-}readtable}}_{\boxed{\texttt{NIL}}}$]])
▷ Return $\underline{\text{copy of } \mathit{from\text{-}readtable}}$.

($_f$**set-syntax-from-char** *to-char from-char* [$\widetilde{\mathit{to\text{-}readtable}}_{\boxed{_v\textbf{*readtable*}}}$ [*from-readtable*$_{\boxed{\text{standard readtable}}}$]])
▷ Copy syntax of *from-char* to *to-readtable*. Return $\underline{\texttt{T}}$.

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

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

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

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

($_f$**set-macro-character** *char function* [*non-term-p*$_{\boxed{\texttt{NIL}}}$ [$\widetilde{\mathit{rt}}_{\boxed{_v\textbf{*readtable*}}}$]])
▷ Make *char* a macro character associated with *function* of stream and *char*. Return $\underline{\texttt{T}}$.

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

($_f$**make-dispatch-macro-character** *char* [*non-term-p*$_{\boxed{\texttt{NIL}}}$ [*rt*$_{\boxed{_v\textbf{*readtable*}}}$]])
▷ Make *char* a dispatching macro character. Return $\underline{\texttt{T}}$.

($_f$**set-dispatch-macro-character** *char sub-char function* [$\widetilde{\mathit{rt}}_{\boxed{_v\textbf{*readtable*}}}$])
▷ Make *function* of stream, *n*, *sub-char* a dispatch function of *char* followed by *n*, followed by *sub-char*. Return $\underline{\texttt{T}}$.

($_f$**get-dispatch-macro-character** *char sub-char* [*rt*$_{\boxed{_v\textbf{*readtable*}}}$])
▷ $\underline{\text{Dispatch function}}$ 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*$_{\boxed{\texttt{NIL}}}$]**)** ▷ List of *foo*s with the terminating cdr *bar*.

" ▷ Begin and end of a string.

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

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

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

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

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

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

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

#'*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**.

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

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

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

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

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

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

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

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

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

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

13.6 Streams

$$(_f\textbf{open}\ \textit{path} \left\{\left|\begin{array}{l} \textbf{:direction} \left\{\begin{array}{l}\textbf{:input}\\ \textbf{:output}\\ \textbf{:io}\\ \textbf{:probe}\end{array}\right\}_{\boxed{\textbf{:input}}} \\ \textbf{:element-type} \left\{\begin{array}{l}\textit{type}\\ \textbf{:default}\end{array}\right\}_{\boxed{\textbf{character}}} \\ \textbf{:if-exists} \left\{\begin{array}{l}\textbf{:new-version}\\ \textbf{:error}\\ \textbf{:rename}\\ \textbf{:rename-and-delete}\\ \textbf{:overwrite}\\ \textbf{:append}\\ \textbf{:supersede}\\ \texttt{NIL}\end{array}\right\}_{\boxed{\textbf{:new-version}\text{ if } \textit{path} \text{ specifies } \textbf{:newest}\text{; } \texttt{NIL} \text{ otherwise}}} \\ \textbf{:if-does-not-exist} \left\{\begin{array}{l}\textbf{:error}\\ \textbf{:create}\\ \texttt{NIL}\end{array}\right\}_{\boxed{\texttt{NIL}\text{ for } \textbf{:direction :probe}\text{; } \{\textbf{:create}|\textbf{:error}\}\text{ otherwise}}} \\ \textbf{:external-format}\ \textit{format}_{\boxed{\textbf{:default}}} \end{array}\right.\right\})$$

▷ Open <u>**file-stream** to *path*</u>.

$$(\left\{\begin{array}{l}_f\textbf{write}\\ _f\textbf{write-to-string}\end{array}\right\} \textit{foo} \left\{\left|\begin{array}{l} \textbf{:array}\ \textit{bool}\\ \textbf{:base}\ \textit{radix}\\ \textbf{:case} \left\{\begin{array}{l}\textbf{:upcase}\\ \textbf{:downcase}\\ \textbf{:capitalize}\end{array}\right.\\ \textbf{:circle}\ \textit{bool}\\ \textbf{:escape}\ \textit{bool}\\ \textbf{:gensym}\ \textit{bool}\\ \textbf{:length}\ \{\textit{int}|\texttt{NIL}\}\\ \textbf{:level}\ \{\textit{int}|\texttt{NIL}\}\\ \textbf{:lines}\ \{\textit{int}|\texttt{NIL}\}\\ \textbf{:miser-width}\ \{\textit{int}|\texttt{NIL}\}\\ \textbf{:pprint-dispatch}\ \textit{dispatch-table}\\ \textbf{:pretty}\ \textit{bool}\\ \textbf{:radix}\ \textit{bool}\\ \textbf{:readably}\ \textit{bool}\\ \textbf{:right-margin}\ \{\textit{int}|\texttt{NIL}\}\\ \textbf{:stream}\ \widetilde{\textit{stream}}_{\boxed{_v\textbf{*standard-output*}}} \end{array}\right.\right\})$$

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

($_f$**pprint-fill** $\widetilde{\textit{stream}}$ *foo* [*parenthesis*$_{\boxed{\text{T}}}$ [*noop*]])
($_f$**pprint-tabular** $\widetilde{\textit{stream}}$ *foo* [*parenthesis*$_{\boxed{\text{T}}}$ [*noop* [$n_{\boxed{16}}$]]])
($_f$**pprint-linear** $\widetilde{\textit{stream}}$ *foo* [*parenthesis*$_{\boxed{\text{T}}}$ [*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 <u>NIL</u>. Usable with $_f$**format** directive **~//**.

$$(_m\textbf{pprint-logical-block}\ (\widetilde{\textit{stream}}\ \textit{list} \left\{\left|\begin{array}{l} \left\{\begin{array}{l}\textbf{:prefix}\ \textit{string}\\ \textbf{:per-line-prefix}\ \textit{string}\end{array}\right\}\\ \textbf{:suffix}\ \textit{string}_{\boxed{""}}\end{array}\right.\right\})$$

(**declare** $\widetilde{\textit{decl}}$*)* *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 <u>NIL</u>.

($_m$**pprint-pop**)
▷ Take <u>next element</u> 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*.

$$(_f\textbf{pprint-tab} \left\{\begin{array}{l}\textbf{:line}\\ \textbf{:line-relative}\\ \textbf{:section}\\ \textbf{:section-relative}\end{array}\right\} c\ i\ [\widetilde{\textit{stream}}_{\boxed{_v\textbf{*standard-output*}}}])$$

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

$$(_f\textbf{pprint-indent} \left\{\begin{array}{l}\textbf{:block}\\ \textbf{:current}\end{array}\right\} n\ [\widetilde{\textit{stream}}_{\boxed{_v\textbf{*standard-output*}}}])$$

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

($_m$**pprint-exit-if-list-exhausted**)
▷ If *list* is empty, terminate logical block. Return <u>NIL</u> otherwise.

$$(_f\textbf{pprint-newline} \left\{\begin{array}{l}\textbf{:linear}\\ \textbf{:fill}\\ \textbf{:miser}\\ \textbf{:mandatory}\end{array}\right\} [\widetilde{\textit{stream}}_{\boxed{_v\textbf{*standard-output*}}}])$$

▷ Print a conditional newline if *stream* is a pretty printing stream. Return <u>NIL</u>.

$_v$***print-array***	▷ If T, print arrays $_f$**read**ably.
$_v$***print-base***$_{\boxed{10}}$	▷ Radix for printing rationals, from 2 to 36.

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

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

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

$_v$*print-gensym*$_{\boxed{\text{T}}}$ ▷ If T, print #: before uninterned symbols.

$_v$*print-length*$_{\boxed{\text{NIL}}}$
$_v$*print-level*$_{\boxed{\text{NIL}}}$
$_v$*print-lines*$_{\boxed{\text{NIL}}}$
▷ 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*$_{\boxed{\text{NIL}}}$ ▷ If T, print rationals with a radix indicator.

$_v$*print-readably*$_{\boxed{\text{NIL}}}$
▷ If T, print $_f$**read**ably or signal error **print-not-readable**.

$_v$*print-right-margin*$_{\boxed{\text{NIL}}}$
▷ Right margin width in ems while pretty-printing.

($_f$**set-pprint-dispatch** *type function* [*priority*$_{\boxed{0}}$ [*table*$_{\boxed{v\text{*print-pprint-dispatch*}}}$]])
▷ 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 $\underline{\text{NIL}}$.

($_f$**pprint-dispatch** *foo* [*table*$_{\boxed{v\text{*print-pprint-dispatch*}}}$])
▷ Return highest priority $\underline{\textit{function}}$ associated with type of *foo* and $\underset{2}{\underline{\text{T}}}$ if there was a matching type specifier in *table*.

($_f$**copy-pprint-dispatch** [*table*$_{\boxed{v\text{*print-pprint-dispatch*}}}$])
▷ Return $\underline{\text{copy of } \textit{table}}$ or, if *table* is NIL, initial value of $_v$*print-pprint-dispatch*.

$_v$*print-pprint-dispatch* ▷ Current pretty print dispatch table.

13.5 Format

($_m$**formatter** $\widehat{\textit{control}}$)
▷ Return $\underline{\text{function}}$ of *stream* and *arg** applying $_f$**format** to *stream*, *control*, and *arg** returning NIL or any excess *args*.

($_f$**format** {T|NIL|*out-string*|*out-stream*} *control arg**)
▷ Output string *control* which may contain ~ directives possibly taking some *args*. 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 $\underline{\text{NIL}}$. If first argument is NIL, return $\underline{\text{formatted output}}$.

~ [*min-col*$_{\boxed{0}}$] [,[*col-inc*$_{\boxed{1}}$] [,[*min-pad*$_{\boxed{0}}$] [,'*pad-char*$_{\boxed{␣}}$]]] [:] [@] {**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*$_{\boxed{10}}$] [,[*width*] [,['*pad-char*$_{\boxed{␣}}$] [,['*comma-char*$_{\boxed{,}}$] [,*comma-interval*$_{\boxed{3}}$]]]] [:] [@] **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*$_{\boxed{␣}}$] [,['*comma-char*$_{\boxed{,}}$] [,*comma-interval*$_{\boxed{3}}$]]] [:] [@] {**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*$_{\boxed{0}}$] [,['*overflow-char*] [,'*pad-char*$_{\boxed{␣}}$]]]] [@] **F**
▷ **Fixed-Format Floating-Point.** With **@**, always prepend a sign.

~ [*width*] [,[*dec-digits*] [,[*exp-digits*] [,[*scale-factor*$_{\boxed{1}}$] [,['*overflow-char*] [,['*pad-char*$_{\boxed{␣}}$] [,'*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*$_{\boxed{2}}$] [,[*int-digits*$_{\boxed{1}}$] [,[*width*$_{\boxed{0}}$] [,'*pad-char*$_{\boxed{␣}}$]]] [:] [@] **$**
▷ **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*$_{\boxed{1}}$] **%** ▷ **Newline.** Print *n* newlines.

~ [*n*$_{\boxed{1}}$] **&**
▷ **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*$_{\boxed{1}}$] **|** ▷ **Page.** Print *n* page separators.

~ [*n*$_{\boxed{1}}$] **~** ▷ **Tilde.** Print *n* tildes.

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

~ [:] [@] **<** {[*prefix*$_{\boxed{""}}$ **~;**]|[*per-line-prefix* **~@;**]} *body* [**~;** *suffix*$_{\boxed{""}}$] **~:** [@] **>**
▷ **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.

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* $\left\{\begin{array}{l|}\text{(:nicknames } nick^*)^* \\ \text{(:documentation } string) \\ \text{(:intern } interned\text{-}symbol^*)^* \\ \text{(:use } used\text{-}package^*)^* \\ \text{(:import-from } pkg\ imported\text{-}symbol^*)^* \\ \text{(:shadowing-import-from } pkg\ shd\text{-}symbol^*)^* \\ \text{(:shadow } shd\text{-}symbol^*)^* \\ \text{(:export } exported\text{-}symbol^*)^* \\ \text{(:size } int)\end{array}\right\}$)

▷ 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* $\left\{\begin{array}{|l}\text{:nicknames } (nick^*)_{\boxed{\texttt{NIL}}} \\ \text{:use } (used\text{-}package^*)\end{array}\right\}$)

▷ Create package *foo*.

($_f$**rename-package** *package new-name* [*new-nicknames*$_{\boxed{\texttt{NIL}}}$])

▷ Rename *package*. Return renamed package.

($_m$**in-package** $\widehat{foo}$) ▷ Make package *foo* current.

($\left\{\begin{array}{l}{}_f\text{use-package} \\ {}_f\text{unuse-package}\end{array}\right\}$ *other-packages* [*package*$_{\boxed{_v\text{*package*}}}$])

▷ 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** $\widetilde{package}$)

▷ Delete *package*. Return `T` if successful.

$_v$***package***$_{\boxed{\text{common-lisp-user}}}$ ▷ 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.

($\left\{\begin{array}{l}{}_f\text{intern} \\ {}_f\text{find-symbol}\end{array}\right\}$ *foo* [*package*$_{\boxed{_v\text{*package*}}}$])

▷ Intern or find, respectively, symbol *foo* in *package*. Second return value is one of $\underset{2}{\textbf{:internal}}$, $\underset{2}{\textbf{:external}}$, or $\underset{2}{\textbf{:inherited}}$ (or $\underset{2}{\texttt{NIL}}$ if $_f$**intern** has created a fresh symbol).

($_f$**unintern** *symbol* [*package*$_{\boxed{_v\text{*package*}}}$])

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

($\left\{\begin{array}{l}{}_f\text{import} \\ {}_f\text{shadowing-import}\end{array}\right\}$ *symbols* [*package*$_{\boxed{_v\text{*package*}}}$])

▷ Make *symbols* internal to *package*. Return `T`. In case of a name conflict signal correctable **package-error** or shadow the old symbol, respectively.

($_f$**shadow** *symbols* [*package*$_{\boxed{_v\text{*package*}}}$])

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

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

▷ Return stream of indicated type.

($_f$**make-string-input-stream** *string* [*start*$_{\boxed{0}}$ [*end*$_{\boxed{\texttt{NIL}}}$]])

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

($_f$**make-string-output-stream** [**:element-type** *type*$_{\boxed{\text{character}}}$])

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

($_f$**concatenated-stream-streams** *concatenated-stream*)
($_f$**broadcast-stream-streams** *broadcast-stream*)

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

($_f$**two-way-stream-input-stream** *two-way-stream*)
($_f$**two-way-stream-output-stream** *two-way-stream*)
($_f$**echo-stream-input-stream** *echo-stream*)
($_f$**echo-stream-output-stream** *echo-stream*)

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

($_f$**synonym-stream-symbol** *synonym-stream*)

▷ Return symbol of *synonym-stream*.

($_f$**get-output-stream-string** $\widetilde{string\text{-}stream}$)

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

($_f$**file-position** *stream* [$\left\{\begin{array}{l}\text{:start} \\ \text{:end} \\ position\end{array}\right\}$])

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

($_f$**file-string-length** *stream foo*)

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

($_f$**listen** [*stream*$_{\boxed{_v\text{*standard-input*}}}$])

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

($_f$**clear-input** [$\widetilde{stream}$$_{\boxed{_v\text{*standard-input*}}}$])

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

($\left\{\begin{array}{l}{}_f\text{clear-output} \\ {}_f\text{force-output} \\ {}_f\text{finish-output}\end{array}\right\}$ [$\widetilde{stream}$$_{\boxed{_v\text{*standard-output*}}}$])

▷ End output to *stream* and return `NIL` immediately, after initiating flushing of buffers, or after flushing of buffers, respectively.

($_f$**close** $\widetilde{stream}$ [**:abort** *bool*$_{\boxed{\texttt{NIL}}}$])

▷ Close *stream*. Return `T` if *stream* had been open. If **:abort** is `T`, delete associated file.

($_m$**with-open-file** (*stream path open-arg**) (**declare** $\widehat{decl}$*)* *form*^{P_*})

▷ Use $_f$**open** with *open-arg*s to temporarily create *stream* to *path*; return values of *forms*.

($_m$**with-open-stream** (*foo* $\widetilde{stream}$) (**declare** $\widehat{decl}$*)* *form*^{P_*})

▷ Evaluate *forms* with *foo* locally bound to *stream*. Return values of *forms*.

($_m$**with-input-from-string** (*foo string* $\left\{\begin{array}{|l}\text{:index } \widetilde{index} \\ \text{:start } start_{\boxed{0}} \\ \text{:end } end_{\boxed{\texttt{NIL}}}\end{array}\right\}$) (**declare** $\widehat{decl}$*)* *form*^{P_*})

▷ Evaluate *forms* with *foo* locally bound to input **string-stream** from *string*. Return values of *forms*; store next reading position into *index*.

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

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

$_v$***terminal-io*** ▷ Bidirectional stream to user terminal.

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

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

13.7 Pathnames and Files

($_f$**make-pathname**
$$\left\{\begin{array}{l}
\textbf{:host}\ \{host|\texttt{NIL}|\textbf{:unspecific}\}\\
\textbf{:device}\ \{device|\texttt{NIL}|\textbf{:unspecific}\}\\
\textbf{:directory}\ \left\{\begin{array}{l}\{directory|\textbf{:wild}|\texttt{NIL}|\textbf{:unspecific}\}\\ (\left\{\begin{array}{l}\textbf{:absolute}\\ \textbf{:relative}\end{array}\right\}\left\{\begin{array}{l}directory\\ \textbf{:wild}\\ \textbf{:wild-inferiors}\\ \textbf{:up}\\ \textbf{:back}\end{array}\right\}^{*})\end{array}\right.\\
\textbf{:name}\ \{file\text{-}name|\textbf{:wild}|\texttt{NIL}|\textbf{:unspecific}\}\\
\textbf{:type}\ \{file\text{-}type|\textbf{:wild}|\texttt{NIL}|\textbf{:unspecific}\}\\
\textbf{:version}\ \{\textbf{:newest}|version|\textbf{:wild}|\texttt{NIL}|\textbf{:unspecific}\}\\
\textbf{:defaults}\ path_{\boxed{\text{host from }_v\textbf{*default-pathname-defaults*}}}\\
\textbf{:case}\ \{\textbf{:local}|\textbf{:common}\}_{\boxed{\textbf{:local}}}
\end{array}\right\})$$
 ▷ 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.

$$(\left\{\begin{array}{l}{}_f\textbf{pathname-host}\\ {}_f\textbf{pathname-device}\\ {}_f\textbf{pathname-directory}\\ {}_f\textbf{pathname-name}\\ {}_f\textbf{pathname-type}\end{array}\right\}\ path\text{-}or\text{-}stream\ [\textbf{:case}\ \left\{\begin{array}{l}\textbf{:local}\\ \textbf{:common}\end{array}\right\}_{\boxed{\textbf{:local}}}])$$
($_f$**pathname-version** *path-or-stream*)
 ▷ Return pathname component.

($_f$**parse-namestring** *foo* [*host*
 [*default-pathname*$_{\boxed{_v\textbf{*default-pathname-defaults*}}}$
$$\left\{\begin{array}{l}\textbf{:start}\ start_{\boxed{0}}\\ \textbf{:end}\ end_{\boxed{\text{NIL}}}\\ \textbf{:junk-allowed}\ bool_{\boxed{\text{NIL}}}\end{array}\right\}]])$$
 ▷ 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*$_{\boxed{_v\textbf{*default-pathname-defaults*}}}$
 [*default-version*$_{\boxed{\textbf{:newest}}}$]])
 ▷ 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*$_{\boxed{_v\textbf{*default-pathname-defaults*}}}$])
 ▷ 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
$$\texttt{"}[host\texttt{:}][\texttt{;}]\{\left\{\begin{array}{l}\{dir|\texttt{*}\}^{+}\\ \texttt{**}\end{array}\right\}\texttt{;}\}^{*}\{name|\texttt{*}\}^{*}[\texttt{.}\left\{\begin{array}{l}\{type|\texttt{*}\}^{+}\\ \texttt{LISP}\end{array}\right\}$$
$$[\texttt{.}\{version|\texttt{*}|\texttt{newest}|\texttt{NEWEST}\}]]\texttt{"}.$$

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

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

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

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

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

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

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

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

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

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

($_f$**ensure-directories-exist** *path* [**:verbose** *bool*])
 ▷ Create parts of *path* if necessary. Second return value is `T`$_2$ if something has been created.

14 Packages and Symbols

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

14.1 Predicates

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

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

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

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

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

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

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

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

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

($_f$**describe** *foo* [$\widetilde{\textit{stream}}_{\boxed{v\ast\text{standard-output}\ast}}$])
▷ Send information about *foo* to *stream*.

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

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

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

15.4 Declarations

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

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

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

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

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

($\left\{\begin{array}{l}\textbf{ignorable}\\ \textbf{ignore}\end{array}\right\}$ $\left\{\begin{array}{l}\textit{var}\\ (\textbf{function}\ \textit{function})\end{array}\right\}^*$)
▷ Suppress warnings about used/unused bindings.

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

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

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

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

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

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

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

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

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

14.3 Symbols

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

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

($_f$**gensym** [$s_{\boxed{\text{G}}}$])
▷ Return fresh, uninterned symbol **#:***sn* with *n* from $_v$**∗gensym-counter∗**. Increment $_v$**∗gensym-counter∗**.

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

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

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

($\left\{\begin{array}{l}{}_g\textbf{documentation}\\ (\textbf{setf}\ {}_g\textbf{documentation})\ \textit{new-doc}\end{array}\right\}$ *foo* $\left\{\begin{array}{l}\textbf{'variable}|\textbf{'function}\\ \textbf{'compiler-macro}\\ \textbf{'method-combination}\\ \textbf{'structure}|\textbf{'type}|\textbf{'setf}|\text{T}\end{array}\right\}$)
▷ 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*) ▷ $\underline{\texttt{T}}$ if *foo* is a special operator.

($_f$**compiled-function-p** *foo*)

▷ $\underline{\texttt{T}}$ if *foo* is of type **compiled-function**.

15.2 Compilation

($_f$**compile** $\left\{\begin{array}{l}\texttt{NIL}\ \textit{definition}\\ \left\{\begin{array}{l}\textit{name}\\ (\textbf{setf}\ \textit{name})\end{array}\right\}\ [\textit{definition}]\end{array}\right\}$)

▷ Return $\underline{\text{compiled function}}$ or replace $\underline{\textit{name}}$'s function definition with the compiled function. Return $\underline{\texttt{T}}_2$ in case of **warning**s or **error**s, and $\underline{\texttt{T}}_3$ in case of **warning**s or **error**s excluding **style-warning**s.

($_f$**compile-file** *file* $\left\{\begin{array}{l}|\ \textbf{:output-file}\ \textit{out-path}\\ |\ \textbf{:verbose}\ \textit{bool}_{\boxed{_v\textbf{*compile-verbose*}}}\\ |\ \textbf{:print}\ \textit{bool}_{\boxed{_v\textbf{*compile-print*}}}\\ |\ \textbf{:external-format}\ \textit{file-format}_{\boxed{\textbf{:default}}}\end{array}\right\}$)

▷ Write compiled contents of *file* to *out-path*. Return $\underline{\text{true output path}}$ or $\underline{\texttt{NIL}}$, $\underline{\texttt{T}}_2$ in case of **warning**s or **error**s, $\underline{\texttt{T}}_3$ in case of **warning**s or **error**s excluding **style-warning**s.

($_f$**compile-file-pathname** *file* [**:output-file** *path*] [*other-keyargs*])

▷ $\underline{\text{Pathname}}$ $_f$**compile-file** writes to if invoked with the same arguments.

($_f$**load** *path* $\left\{\begin{array}{l}|\ \textbf{:verbose}\ \textit{bool}_{\boxed{_v\textbf{*load-verbose*}}}\\ |\ \textbf{:print}\ \textit{bool}_{\boxed{_v\textbf{*load-print*}}}\\ |\ \textbf{:if-does-not-exist}\ \textit{bool}_{\boxed{\texttt{T}}}\\ |\ \textbf{:external-format}\ \textit{file-format}_{\boxed{\textbf{:default}}}\end{array}\right\}$)

▷ Load source file or compiled file into Lisp environment. Return $\underline{\texttt{T}}$ if successful.

$\left.\begin{array}{l}_v\textbf{*compile-file}\\ _v\textbf{*load}\end{array}\right\}$-$\left\{\begin{array}{l}\textbf{pathname*}_{\boxed{\texttt{NIL}}}\\ \textbf{truename*}_{\boxed{\texttt{NIL}}}\end{array}\right.$

▷ Input file used by $_f$**compile-file**/by $_f$**load**.

$\left.\begin{array}{l}_v\textbf{*compile}\\ _v\textbf{*load}\end{array}\right\}$-$\left\{\begin{array}{l}\textbf{print*}\\ \textbf{verbose*}\end{array}\right.$

▷ Defaults used by $_f$**compile-file**/by $_f$**load**.

($_s$**eval-when** ($\left\{\begin{array}{l}|\ \{\textbf{:compile-toplevel}|\textbf{compile}\}\\ |\ \{\textbf{:load-toplevel}|\textbf{load}\}\\ |\ \{\textbf{:execute}|\textbf{eval}\}\end{array}\right\}$) *form*^{P_*})

▷ Return $\underline{\text{values of }\textit{forms}}$ if $_s$**eval-when** is in the top-level of a file being compiled, in the top-level of a compiled file being loaded, or anywhere, respectively. Return $\underline{\texttt{NIL}}$ if *forms* are not evaluated. (**compile**, **load** and **eval** deprecated.)

($_s$**locally** (**declare** $\widehat{\textit{decl}^*}$)* *form*^{P_*})

▷ Evaluate *forms* in a lexical environment with declarations *decl* in effect. Return $\underline{\text{values of }\textit{forms}}$.

($_m$**with-compilation-unit** ([**:override** *bool*$_{\boxed{\texttt{NIL}}}$]) *form*^{P_*})

▷ Return $\underline{\text{values of }\textit{forms}}$. Warnings deferred by the compiler until end of compilation are deferred until the end of evaluation of *forms*.

($_s$**load-time-value** *form* [$\widehat{\textit{read-only}_{\boxed{\texttt{NIL}}}}$])

▷ Evaluate *form* at compile time and treat $\underline{\text{its value}}$ as literal at run time.

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

($_g$**make-load-form** *foo* [*environment*])

▷ Its methods are to return a $\underline{\text{creation form}}$ which on evaluation at $_f$**load** time returns an object equivalent to *foo*, and an optional $\underline{\text{initialization form}}_2$ which on evaluation performs some initialization of the object.

($_f$**make-load-form-saving-slots** *foo* $\left\{\begin{array}{l}|\ \textbf{:slot-names}\ \textit{slots}_{\boxed{\text{all local slots}}}\\ |\ \textbf{:environment}\ \textit{environment}\end{array}\right\}$)

▷ Return a $\underline{\text{creation form}}$ and an $\underline{\text{initialization form}}_2$ 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** $\left\{\begin{array}{l}\textit{name}\\ (\textbf{setf}\ \textit{name})\end{array}\right\}$ [*environment*])

▷ Return specified $\underline{\text{macro function}}$, or $\underline{\text{compiler macro function}}$, respectively, if any. Return $\underline{\texttt{NIL}}$ otherwise. **setf**able.

($_f$**eval** *arg*)

▷ Return $\underline{\text{values of value of }\textit{arg}}$ evaluated in global environment.

15.3 REPL and Debugging

$_v$**+**|$_v$**++**|$_v$**+++**

$_v$***** | $_v$****** | $_v$*******

$_v$**/** | $_v$**//** | $_v$**///**

▷ Last, penultimate, or antepenultimate $\underline{\text{form}}$ evaluated in the REPL, or their respective $\underline{\text{primary value}}$, or a $\underline{\text{list}}$ of their respective values.

$_v$**–** ▷ $\underline{\text{Form}}$ currently being evaluated by the REPL.

($_f$**apropos** *string* [*package*$_{\boxed{\texttt{NIL}}}$])

▷ Print interned symbols containing *string*.

($_f$**apropos-list** *string* [*package*$_{\boxed{\texttt{NIL}}}$])

▷ $\underline{\text{List of interned symbols}}$ containing *string*.

($_f$**dribble** [*path*])

▷ Save a record of interactive session to file at *path*. Without *path*, close that file.

($_f$**ed** [*file-or-function*$_{\boxed{\texttt{NIL}}}$]) ▷ Invoke editor if possible.

($\left\{\begin{array}{l}_f\textbf{macroexpand-1}\\ _f\textbf{macroexpand}\end{array}\right\}$ *form* [*environment*$_{\boxed{\texttt{NIL}}}$])

▷ Return $\underline{\text{macro expansion}}$, once or entirely, respectively, of *form* and $\underline{\texttt{T}}_2$ if *form* was a macro form. Return $\underline{\textit{form}}$ and $\underline{\texttt{NIL}}_2$ otherwise.

$$(\textbf{optimize} \left\{\begin{array}{l} \textbf{compilation-speed} \,|\, (\textbf{compilation-speed}\ n_{\boxed{3}}) \\ \textbf{debug} \,|\, (\textbf{debug}\ n_{\boxed{3}}) \\ \textbf{safety} \,|\, (\textbf{safety}\ n_{\boxed{3}}) \\ \textbf{space} \,|\, (\textbf{space}\ n_{\boxed{3}}) \\ \textbf{speed} \,|\, (\textbf{speed}\ n_{\boxed{3}}) \end{array}\right\})$$

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

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

16 External Environment

($_f$**get-internal-real-time**)
($_f$**get-internal-run-time**)

▷ $\underline{\text{Current time}}$, or $\underline{\text{computing time}}$, respectively, in clock ticks.

$_c$**internal-time-units-per-second**

▷ Number of clock ticks per second.

($_f$**encode-universal-time** *sec min hour date month year* [*zone*$_{\boxed{\text{curr}}}$])
($_f$**get-universal-time**)

▷ $\underline{\text{Seconds from 1900-01-01, 00:00}}$, ignoring leap seconds.

($_f$**decode-universal-time** *universal-time* [*time-zone*$_{\boxed{\text{current}}}$])
($_f$**get-decoded-time**)

▷ Return $\underline{\text{second}}$, $\underset{2}{\underline{\text{minute}}}$, $\underset{3}{\underline{\text{hour}}}$, $\underset{4}{\underline{\text{date}}}$, $\underset{5}{\underline{\text{month}}}$, $\underset{6}{\underline{\text{year}}}$, $\underset{7}{\underline{\text{day}}}$, $\underset{8}{\underline{\text{daylight-p}}}$, and $\underset{9}{\underline{\text{zone}}}$.

($_f$**short-site-name**)
($_f$**long-site-name**)

▷ $\underline{\text{String}}$ representing physical location of computer.

$$(\left\{\begin{array}{l} {}_f\textbf{lisp-implementation} \\ {}_f\textbf{software} \\ {}_f\textbf{machine} \end{array}\right\}\text{-}\left\{\begin{array}{l} \textbf{type} \\ \textbf{version} \end{array}\right\})$$

▷ $\underline{\text{Name}}$ or $\underline{\text{version}}$ of implementation, operating system, or hardware, respectively.

($_f$**machine-instance**) ▷ $\underline{\text{Computer name}}$.

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