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tab/2	Output number of spaces on a stream
tan/1	Arithmetic: tangent
tell/1	Change current output stream
telling/1	Query current output stream
term_expansion/2	Convert term before compilation
term_to_atom/2	Convert between term and atom
time/1	Determine time needed to execute goal
time_file/2	Get last modification time of file
told/0	Close current output
trace/0	Start the tracer
tracing/0	Query status of the tracer
trim_stacks/0	Release unused memory resources
true/0	Succeed
tty_fold/2	Make terminal fold long lines in output
tty_get_capability/3	Get terminal parameter
tty_goto/2	Goto position on screen
tty_put/2	Write control string to terminal
ttyflush/0	Flush output on terminal
union/3	Union of two sets
unknown/2	Trap undefined predicates
unsetenv/1	Delete Unix environment variable
use_module/1	Import a module
use_module/2	Import predicates from a module
var/1	Type check for unbound variable
visible/1	Set ports that are visible in the tracer
wait_for_input/3	Wait for input with optional timeout
wildcard_match/2	Csh(1) style wildcard match
write/1	Write term
write/2	Write term to stream
write_ln/1	Write term, followed by a newline
writeln/1	Formatted write
writeln/2	Formatted write
writelnq/1	Write term, insert quotes
writelnq/2	Write term, insert quotes on stream
xor/2	Arithmetic: exclusive or
/2	Disjunction of goals

recorded/3	Obtain term from the database
recordz/2	Record term in the database (last)
recordz/3	Record term in the database (last)
rename_file/2	Change name of Unix file
repeat/0	Succeed, leaving infinite backtrackpoints
reset_profiler/0	Clear statistics obtained by the profiler
retract/1	Remove clause from the database
retractall/1	Remove unifying clauses from the database
reverse/2	Inverse the order of the elements in a list
same_file/2	Succeeds if arguments refer to same file
save_program/1	Save the current program on a file
save_program/2	Save the current program on a file
see/1	Change the current input stream
seeing/1	Query the current input stream
seen/0	Close the current input stream
select/3	Select element of a list
set_input/1	Set current input stream from a stream
set_output/1	Set current output stream from a stream
set_tty/2	Set 'tty' stream
setenv/2	Set Unix environment variable
setof/3	Find all unique solutions to a goal
sformat/2	Format on a string
sformat/3	Format on a string
shell/0	Execute interactive Unix subshell
shell/1	Execute Unix command
shell/2	Execute Unix command
show_profile/1	Show results of the profiler
sin/1	Arithmetic: sine
size_file/2	Get size of a file in characters
sleep/1	Suspend execution for specified time
sort/2	Sort elements in a list
source_file/1	Examine currently loaded source files
source_file/2	Obtain source file of predicate
spy/1	Force tracer on specified predicate
sqrt/1	Arithmetic: square root
statistics/0	Show execution statistics
statistics/2	Obtain collected statistics
stream_position/3	Get/seek to position in file
string/1	Type check for string
string_length/2	Determine length of a string
string_to_atom/2	Conversion between string and atom
string_to_list/2	Conversion between string and list of ASCII
style_check/1	Change level of warnings
sublist/3	Determine elements that meet condition
subset/2	Generate/check subset relation
substring/4	Get part of a string
subtract/3	Delete elements that do not meet condition
succ/2	Logical integer successor relation
writef/2	Formatted write on a string
writef/3	Formatted write on a string
tab/1	Output number of spaces

<code>nl/1</code>	Generate a newline on a stream
<code>nodebug/0</code>	Disable debugging
<code>nonvar/1</code>	Type check for bound term
<code>noprotocol/0</code>	Disable logging of user interaction
<code>nospy/1</code>	Remove spy point
<code>nospyall/0</code>	Remove all spy points
<code>not/1</code>	Negation by failure (not provable)
<code>notrace/0</code>	Stop tracing
<code>nth0/3</code>	N-th element of a list (0-based)
<code>nth1/3</code>	N-th element of a list (1-based)
<code>number/1</code>	Type check for integer or float
<code>numbervars/4</code>	Enumerate unbound variables of a term
<code>once/1</code>	Call a goal deterministically
<code>op/3</code>	Declare an operator
<code>open/3</code>	Open a file (creating a stream)
<code>open_null_stream/1</code>	Open a stream to discard output
<code>pi/0</code>	Arithmetic: mathematical constant
<code>please/3</code>	Query/change environment parameters
<code>plus/3</code>	Logical integer addition
<code>portray/1</code>	Modify behaviour of <code>print/1</code>
<code>portray_clause/1</code>	Pretty print a clause
<code>predicate_property/2</code>	Query predicate attributes
<code>predsort/3</code>	Sort, using a predicate to determine the order
<code>preprocessor/2</code>	Install a preprocessor before the compiler
<code>print/1</code>	Print a term
<code>print/2</code>	Print a term on a stream
<code>profile/3</code>	Obtain execution statistics
<code>profile_count/3</code>	Obtain profile results on a predicate
<code>profiler/2</code>	Obtain/change status of the profiler
<code>prolog/0</code>	Run interactive toplevel
<code>prolog_current_frame/1</code>	Reference to goal's environment stack
<code>prolog_frame_attribute/3</code>	Obtain information on a goal environment
<code>prolog_skip_level/2</code>	Indicate deepest recursion to trace
<code>prolog_trace_interception/3</code>	Intercept the Prolog tracer
<code>prompt/2</code>	Change the prompt used by <code>read/1</code>
<code>proper_list/1</code>	Type check for list
<code>protocol/1</code>	Make a log of the user interaction
<code>protocola/1</code>	Append log of the user interaction to file
<code>protocolling/1</code>	On what file is user interaction logged
<code>put/1</code>	Write a character
<code>put/2</code>	Write a character on a stream
<code>random/1</code>	Arithmetic: generate random number
<code>read/1</code>	Read Prolog term
<code>read/2</code>	Read Prolog term from stream
<code>read_clause/1</code>	Read clause
<code>read_clause/2</code>	Read clause from stream
<code>read_variables/2</code>	Read clause including variable names
<code>read_variables/3</code>	Read clause including variable names from stream
<code>recorda/2</code>	Record term in the database (first)
<code>recorda/3</code>	Record term in the database (first)
<code>recorded/2</code>	Obtain term from the database

get0/2	Read next character from a stream
get_single_char/1	Read next character from the terminal
get_time/1	Get current time
getenv/2	Get Unix environment variable
ground/1	Verify term holds no unbound variables
halt/0	Exit from Prolog
help/0	Give help on help
help/1	Give help on predicates and show parts of manual
history_depth/1	Number of remembered queries
read_history/6	Read using history substitution
ignore/1	Call the argument, but always succeed
import/1	Import a predicate from a module
index/1	Change clause indexing
int_to_atom/2	Convert from integer to atom
int_to_atom/3	Convert from integer to atom (non-decimal)
integer/1	Arithmetic: round to nearest integer
integer/1	Type check for integer
intersection/3	Set intersection
is/2	Evaluate arithmetic expression
is_list/1	Type check for a list
is_set/1	Type check for a set
keysort/2	Sort, using a key
last/2	Last element of a list
leash/1	Change ports visited by the tracer
length/2	Length of a list
library_directory/1	Directories holding Prolog libraries
limit_stack/2	Limit stack expansion
line_count/2	Line number on stream
line_position/2	Character position in line on stream
list_to_set/2	Remove duplicates
listing/0	List program in current module
listing/1	List predicate
load_foreign/2	Load foreign (C) module
load_foreign/5	Load foreign (C) module
log/1	Arithmetic: natural logarithm
log10/1	Arithmetic: 10 base logarithm
make/0	Reconsult all changed source files
maplist/3	Transform all elements of a list
max/2	Arithmetic: Maximum of two numbers
member/2	Element is member of a list
memberchk/2	Deterministic member/2
merge/3	Merge two sorted lists
merge_set/3	Merge two sorted sets
min/2	Arithmetic: Minimum of two numbers
mod/2	Arithmetic: remainder of division
module/2	Declare a module
module_transparent/1	Indicate module based meta predicate
msort/2	Sort, do not remove duplicates
multifile/1	Indicate distributed definition of predicate
name/2	Convert between atom and list of ASCII characters
nl/0	Generate a newline

current_op/3	Examine current operator declarations
current_output/1	Get the current output stream
current_predicate/2	Examine existing predicates
current_stream/3	Examine open streams
debug/0	Test for debugging mode
debugging/0	Show debugger status
delete/3	Delete all matching members from a list
delete_file/1	Unlink a file from the Unix file system
discontiguous/1	Indicate distributed definition of a predicate
display/1	Write a term, ignore operators
display/2	Write a term, ignore operators on a stream
displayq/1	Write a term with quotes, ignore operators
displayq/2	Write a term with quotes, ignore operators on a stream
dwim_match/2	Atoms match in “Do What I Mean” sense
dwim_match/3	Atoms match in “Do What I Mean” sense
dwim_predicate/2	Find predicate in “Do What I Mean” sense
dynamic/1	Indicate predicate definition may change
e/0	Arithmetic: mathematical constant
ed/0	Edit last edited predicate
ed/1	Edit a predicate
edit/0	Edit last edited file
edit/1	Edit a file
ensure_loaded/1	Consult a file if that has not yet been done
erase/1	Erase a database record or clause
exception/3	Handle runtime exceptions
exists_directory/1	Check existence of Unix directory
exists_file/1	Check existence of Unix file
exp/1	Arithmetic: exponent (base e)
expand_file_name/2	Wildcard expansion of file names
export/1	Export a predicate from a module
fail/0	Always false
fileerrors/2	Do/Don't warn on file errors
findall/3	Find all solutions to a goal
flag/3	Simple global variable system
flatten/2	Transform nested list into flat list
float/1	Type check for a floating point number
floor/1	Arithmetic: largest integer below argument
flush/0	Output pending characters on current stream
flush_output/1	Output pending characters on specified stream
forall/2	Prove goal for all solutions of another goal
foreign_file/1	Examine loaded foreign files
format/1	Produce formatted output
format/2	Produce formatted output on a stream
format_predicate/2	Program format/[1,2]
free_variables/2	Find unbound variables in a term
functor/3	Get name and arity of a term or construct a term
garbage_collect/0	Invoke the garbage collector
gensym/2	Generate unique atoms from a base
get/1	Read first non-blank character
get/2	Read first non-blank character from a stream
get0/1	Read next character

abolish/2	Remove predicate definition from the database
abort/0	Abort execution, return to top level
abs/1	Arithmetic: absolute value
absolute_file_name/2	Get absolute Unix path name
access_file/2	Check access permissions of a file
acos/1	Arithmetic: inverse (arc) cosine
append/1	Append to a file
append/3	Concatenate lists
apply/2	Call goal with additional arguments
apropos/1	Show related predicates and manual sections
arithmetic_function/1	Register an evaluable function
arg/3	Access argument of a term
asin/1	Arithmetic: inverse (arc) sine
assert/1	Add a clause to the database
assert/2	Add a clause to the database, give reference
asserta/1	Add a clause to the database (first)
asserta/2	Add a clause to the database (first)
assertz/1	Add a clause to the database (last)
assertz/2	Add a clause to the database (last)
atan/1	Arithmetic: inverse (arc) tangent
atan/2	Arithmetic: rectangular to polar conversion
atom/1	Type check for an atom
atom_length/2	Determine length of an atom
atom_to_term/3	Convert between atom and term
atomic/1	Type check for primitive
bagof/3	Find all solutions to a goal
between/3	Integer range checking/generating
break/0	Start interactive toplevel
call/1	Call a goal
ceil/1	Arithmetic: smallest integer larger than argument
character_count/2	Get character index on a stream
chdir/1	Change working directory
checklist/2	Invoke goal on all members of a list
clause/2	Get clauses of a predicate
clause/3	Get clauses of a predicate
close/1	Close stream
compiling/0	Is this a compilation run?
concat/3	Append two atoms
concat_atom/2	Append a list of atoms
consult/1	Read (compile) a Prolog source file
context_module/1	Get context module of current goal
convert_time/8	Convert time stamp
copy_term/2	Make a copy of a term
cos/1	Arithmetic: cosine
cputime/0	Arithmetic: get CPU time
current_atom/1	Examine existing atoms
current_arithmetic_function/1	Examine evaluable functions
current_flag/1	Examine existing flags
current_functor/2	Examine existing name/arity pairs
current_input/1	Get current input stream
current_key/1	Examine existing database keys

Appendix B

Predicate Summary

!/0	Cut. Discard choicepoints
*/2	Arithmetic: multiplication
+/2	Arithmetic: addition
,/2	Conjunction of goals
-/1	Arithmetic: unary minus
-/2	Arithmetic: subtraction
->/2	If-then-else
./2	List operator. Also consult
///2	Arithmetic: Integer division
//2	Arithmetic: division
/\2	Arithmetic: bitwise and
;/2	Disjunction of goals
</2	Arithmetic smaller
<</2	Arithmetic: bitwise left shift
=./2	Univ. Term to list conversion
=/2	Unification
:=/2	Arithmetic equal
=</2	Arithmetic smaller or equal
==/2	Identical
=@=/2	Structural identical
=\=/2	Arithmetic not equal
>/2	Arithmetic larger
>=/2	Arithmetic larger or equal
>>/2	Arithmetic: bitwise right shift
@</2	Standard order smaller
@=</2	Standard order smaller or equal
@>/2	Standard order larger
@>=/2	Standard order larger or equal
\1	Bitwise negation
\//2	Arithmetic: bitwise or
\+/1	Negation by failure (not provable)
\=/2	Not unifyable
\==/2	Not identical
\=@=/2	Not structural identical
~/2	Existential quantification (bagof/3, setof/3)

A.3 Exception Handling

A start has been made to make exception handling available to the Prolog user. On exceptions a dynamic and multifile defined predicate `exception/3` is called. If this user defined predicate succeeds Prolog assumes the exception has been taken care of. Otherwise the system default exception handler is called.

exception(*+Exception, +Context, -Action*)

Dynamic predicate, normally not defined. Called by the Prolog system on run-time exceptions. Currently `exception/3` is only used for trapping undefined predicates. Future versions might handle signal handling, floating exceptions and other runtime errors via this mechanism. The values for *Exception* are described below.

undefined_predicate

If *Exception* is `undefined_predicate` *Context* is instantiated to a term *Name/Arity*. *Name* refers to the name and *Arity* to the arity of the undefined predicate. If the definition module of the predicate is not *user* *Context* will be of the form *Module:Name/Arity*. If the predicate fails Prolog will print the default error warning and start the tracer. If the predicate succeeds it should instantiate the last argument either to the atom `fail` to tell Prolog to fail the predicate or the atom `retry` to tell Prolog to retry the predicate. This only makes sense if the exception handler has defined the predicate. Otherwise it will lead to a loop.

warning

If prolog wants to give a warning while reading a file, it will first raise the exception *warning*. The context argument is a term of the form *warning(Path, LineNo, Message)*, where *Path* is the absolute filename of the file prolog is reading; *LineNo* is an estimate of the line number where the error occurred and *Message* is a Prolog string indicating the message. The *Action* argument is ignored. The error is supposed to be presented to the user if the exception handler succeeds. Otherwise the standard Prolog warning message is printed.

This exception is used by the library `emacs_interface`, that integrates error handling with GNU-Emacs.

Key	Value
alternative	<i>Value</i> is unified with an integer reference to the local stack frame in which execution is resumed if the goal associated with <i>Frame</i> fails. Fails if the frame has no alternative frame.
has_alternatives	<i>Value</i> is unified with '1' if <i>Frame</i> still is a candidate for backtracking. '0' otherwise.
goal	<i>Value</i> is unified with the goal associated with <i>Frame</i> . If the definition module of the active predicate is not <i>user</i> the goal is represented as <i>module:goal</i> . Do not instantiate variables in this goal unless you <i>know</i> what you are doing!
level	<i>Value</i> is unified with the recursion level of <i>Frame</i> . The top level frame is at level '0'.
parent	<i>Value</i> is unified with an integer reference to the parent local stack frame of <i>Frame</i> . Fails if <i>Frame</i> is the top frame.
context_module	<i>Value</i> is unified with the name of the context module of the environment.
top	<i>Value</i> is unified with '1' if <i>Frame</i> is the top Prolog goal from a recursive call back from the foreign language. '0' otherwise.

Table A.1: Key values of `prolog_current_frame/1`

in figure A.1 records all goals trapped by the tracer in the database. To trace the execution of 'go' this way the following query should be given:

```
?- trace, go, notrace.
```

```
prolog_trace_interception(Port, Frame, continue) :-
    prolog_frame_attribute(Frame, goal, Goal),
    prolog_frame_attribute(Frame, level, Level),
    recordz(trace, trace(Port, Level, Goal)).
```

Figure A.1: Record a trace in the database

prolog_skip_level(-Old, +New)

Unify *Old* with the old value of 'skip level' and then set this level according to *New*. *New* is an integer, or the special atom **very_deep** (meaning don't skip). The 'skip level' is a global variable of the Prolog system that disables the debugger on all recursion levels deeper than the level of the variable. Used to implement the trace options 'skip' (sets skip level to the level of the frame) and 'up' (sets skip level to the level of the parent frame (i.e. the level of this frame minus 1)).

Appendix A

Hackers corner

This appendix describes a number of predicates which enable the Prolog user to inspect the Prolog environment and manipulate (or even redefine) the debugger. They can be used as entry points for experiments with debugging tools for Prolog. The predicates described here should be handled with some care as it is easy to corrupt the consistency of the Prolog system by misusing them.

A.1 Examining the Environment Stack

prolog_current_frame(-*Frame*)

Unify *Frame* with an integer providing a reference to the parent of the current local stack frame. A pointer to the current local frame cannot be provided as the predicate succeeds deterministically and therefore its frame is destroyed immediately after succeeding.

prolog_frame_attribute(+*Frame*, +*Key*, -*Value*)

Obtain information about the local stack frame *Frame*. *Frame* is a frame reference as obtained through `prolog_current_frame/1`, `prolog_trace_interception/3` or this predicate. The key values are described in table A.1.

A.2 Intercepting the Tracer

prolog_trace_interception(+*Port*, +*Frame*, -*Action*)

Dynamic predicate, normally not defined. This predicate is called from the SWI-Prolog debugger just before it would show a port. If this predicate succeeds the debugger assumes the trace action has been taken care of and continues execution as described by *Action*. Otherwise the normal Prolog debugger actions are performed.

Port is one of `call`, `redo`, `exit`, `fail` or `unify`. *Frame* is an integer reference to the current local stack frame. *Action* should be unified with one of the atoms `continue` (just continue execution), `retry` (retry the current goal) or `fail` (force the current goal to fail). Leaving it a variable is identical to `continue`.

Together with the predicates described in section 3.34 and the other predicates of this chapter this predicate enables the Prolog user to define a complete new debugger in Prolog. Besides this it enables the Prolog programmer monitor the execution of a program. The example shown

option to include dbx debugging information. Then load them into SWI-Prolog. Now obtain the name of the current symbol table and the process id of Prolog. Then start dbx (or dbxtool) using

```
sun% dbx[tool] <symbol file> <pid>
```

Should this be done often then the following foreign predicate definition might help:

```
pl_dbx()
{ char *symbolfile = PL_query(PL_QUERY_SYMBOLFILE);
  char cmd[256];

  sprintf(cmd, "dbxtool %s %d &", symbolfile, getpid());
  if ( system(cmd) == 0 )
    PL_succeed;
  else
    PL_fail;
}
```

Register this predicate as `dbx/0` using the following call in your initialisation function:

```
PL_register_foreign("dbx", 0, pl_dbx, 0);
```

5.7.4 Name Conflicts in C modules

In the current version of the system all public C functions of SWI-Prolog are in the symbol table. This can lead to name clashes with foreign code. Someday I should write a program to strip all these symbols from the symbol table (why does Unix not have that?). For now I can only suggest to give your function another name. You can do this using the C preprocessor. If `-for example-` your foreign package uses a function `warning()`, which happens to exist in SWI-Prolog as well, the following macro should fix the problem.

```
#define warning warning_
```

5.7.5 Compatibility of the Foreign Interface

As far as I am aware of, there is no standard for foreign language interfaces in Prolog. The SWI-Prolog interface is no attempt to propose such a standard. It is (in part) tailored to the possibilities of the SWI-Prolog machinery. BIM-Prolog has a similar interface to analyse and construct terms. The major difference is that they have garbage collection and calls are made available to lock and unlock terms for garbage collection. I built a similar interface to Edinburgh C-Prolog (although less clean). This at least tells us that the interface can work for various forms of the WAM as well as a structure sharing Prolog.

As no standard exists nor emerges, users of the foreign language interface should carefully design the interface if the C-code should be portable to other Prolog implementation. The best advice to give is to define a small interface layer around the C-application and interface this to Prolog.

Compiling and Loading Foreign Code

```

sun% cc -O -c lowercase.c
sun% pl
/staff/jan/.plrc consulted, 0.166667 seconds, 2256 bytes.
Welcome to SWI-Prolog (version 1.6.0, May 1992)
Copyright (c) 1990, University of Amsterdam

1 ?- load_foreign(lowercase, init_lowercase).
foreign file(s) lowercase loaded, 0.016667 seconds, 464 bytes.

Yes
2 ?- lowercase('Hello World!', L).

L = 'hello world!'

Yes

```

5.7 Notes on Using Foreign Code

5.7.1 Garbage Collection and Foreign Code

Currently no interface between foreign code and the garbage collector has been defined. The garbage collector is disabled during execution of foreign code. Future versions might define such an interface. This probably will introduce incompatible changes to the current interface definition.

5.7.2 Memory Allocation

SWI-Prolog's memory allocation is based on the `malloc()` library routines. Foreign applications can safely use `malloc()`, `realloc()` and `free()`. Memory allocation using `brk()` or `sbrk()` is not allowed as these calls conflict with `malloc()`.

5.7.3 Debugging Foreign Code

NOTE: this section is highly machine dependent. The tricks described here are tested on SUN-3 and SUN-4. They might work on other BSD variants of Unix.

Debugging incrementally loaded executables is a bit more difficult than debugging normal executables. The oldest way of debugging (putting print statements in your code at critical points) of course still works. 'Post-crash' debugging however is not possible. For `adb/dbx` to work they need (besides the core) the text segment and the symbol table. The symbol table lives somewhere on `/tmp` (called `'/tmp/pl_ld_...'`, where `'...'` is the process id and `'.'` is an additional number to make sure the temporary file is unique. The text segment lives partly in the core (the incremental loaded bit) and partly in the SWI-Prolog executable.

The only way to debug foreign language code using a debugger is by starting the debugger on the running core image. `Dbx(1)` can do this. First compile the source files to be debugged with the `'-g'`

5.6 Example of Using the Foreign Interface

Below is an example showing all stages of the declaration of a foreign predicate that transforms atoms possibly holding uppercase letters into an atom only holding lower case letters. Figure 5.4 shows the C-source file.

C-Source file (lowercase.c)

```
/* Include file depends on local installation */
#include "/usr/local/lib/pl/library/SWI-prolog.h"
#include <ctype.h>

long
pl_lowercase(u, l)
term u, l;
{ char *copy;
  char *s, *q;
  atomic la;

  if ( PL_type(u) != PL_ATOM )
    return PL_warning("lowercase/2: instantiation fault");
  s = PL_atom_value(PL_atomic(u));
  copy = (char *) malloc(strlen(s)+1);

  for( q=copy; *s; q++, s++)
    *q = (isupper(*s) ? tolower(*s) : *s);
  *q = '\0';

  la = PL_new_atom(copy);
  free(copy);

  return PL_unify_atomic(l, la);
}

init_lowercase()
{ PL_register_foreign("lowercase", 2, pl_lowercase, 0);
}
```

Figure 5.4: Lowercase source file

Registering Foreign Predicates

bool **PL_register_foreign**(*name*, *arity*, *function*, [...*option...*] 0)

Register a C-function to implement a Prolog predicate. After this call returns successfully a predicate with name *name* (a char *) and arity *arity* (a C int) is created. When called in Prolog, Prolog will call *function*. [...*option...*] forms a 0-terminated list of options for the installation. These are:

PL_FA_NOTRACE	Predicate cannot be seen in the tracer
PL_FA_TRANSPARENT	Predicate is module transparent
PL_FA_NONDETERMINISTIC	Predicate is non-deterministic. This attribute is currently ignored, but will probably be used in future versions.

void **PL_fatal_error**(*format, a1, ...*)

Print a message like `PL_warning()`, but starting with `'FATAL ERROR: '` and then exits Prolog.

Environment Control from Foreign Code

bool **PL_action**(*int, C_type*)

Perform some action on the Prolog system. *int* describes the action, *C_type* provides the argument if necessary. The actions are listed in table 5.1.

<code>PL_ACTION_TRACE</code>	Start Prolog tracer
<code>PL_ACTION_DEBUG</code>	Switch on Prolog debug mode
<code>PL_ACTION_BACKTRACE</code>	Print backtrace on current output stream
<code>PL_ACTION_HALT</code>	Halt Prolog execution. This action should be called rather than <code>Unix exit()</code> to give Prolog the opportunity to clean up. This call does not return.
<code>PL_ACTION_ABORT</code>	Generate a Prolog abort. This call does not return.
<code>PL_ACTION_BREAK</code>	Create a standard Prolog break environment. Returns after the user types control-D.
<code>PL_ACTION_SYMBOLFILE</code>	The argument (a <code>char *</code>) is considered to be hold the symbolfile for further incremental loading. Should be called by user applications that perform incremental loading as well and want to inform Prolog of the new symbol table.

Table 5.1: `PL_action()` options

Querying Prolog

C_type **PL_query**(*int*)

Obtain status information on the Prolog system. The actual argument type depends on the information required. *int* describes what information is wanted. The options are given in table 5.2.

<code>PL_QUERY_ARGC</code>	Return an integer holding the number of arguments given to Prolog from Unix.
<code>PL_QUERY_ARGV</code>	Return a <code>char **</code> holding the argument vector given to Prolog from Unix.
<code>PL_QUERY_SYMBOLFILE</code>	Return a <code>char *</code> holding the current symbol file of the running process.
<code>PL_QUERY_ORGSYMBOLFILE</code>	Return the initial symbol file (before loading) of Prolog. By setting the symbol file to this value no name clashes can occur with previously loaded foreign files (but no symbols can be shared with earlier loaded modules as well).

Table 5.2: `PL_query()` options

Foreign Code and Modules

Modules are identified via a unique handle. The following functions are available to query and manipulate modules.

module **PL_context()**

Return the module identifier of the context module of the currently active foreign predicate.

term **PL_strip_module(*term*, *module* *)**

Utility function. If *term* is a term, possibly holding the module construct *module:rest* this function will return *rest* and fill *module* * with *module*. For further nested module constructs the inner most module is returned via *module* *. If *term* is not a module construct *term* will simply be returned. If *module* * is **NULL** it will be set to the context module. Otherwise it will be left untouched. The following example shows how to obtain the plain term and module if the default module is the user module:

```
{ module m = PL_new_module(PL_new_atom("user"));

  if ( (term = PL_strip_module(term, &m)) == NULL )
    return PL_warning("Illegal module specification");

  ...
```

atomic **PL_module_name(*module*)**

Return the name of *module* as an atom.

module **PL_new_module(*atomic*)**

Find an existing or create a new module with name specified by the atom *atomic*.

Catching Unix Signals

SWI-Prolog catches the Unix signals SIGINT, SIGFPE and SIGSEGV. To avoid problems with foreign code attempting to catch these signals foreign code should call PL_signal() to install signal handlers rather than the Unix library function signal(). SWI-Prolog will always handle SIGINT itself. SIGFPE and SIGSEGV are passed to the foreign code handlers if Prolog did not expect that signal.

void **(*PL_signal(*sig*, *func*))()**

This function should be used to install signal handlers rather than the Unix library function signal(). It ensures consistent signal handling between SWI-Prolog and the foreign code and reinstalls signal handlers if a state created with **save_program/1** is restarted.

Errors and warnings

Two standard functions are available to print standard Prolog errors to the standard error stream.

bool **PL_warning(*format*, *a1*, ...)**

Print an error message starting with '[WARNING: ', followed by the output from *format*, followed by a ']' and a newline. Then start the tracer. *format* and the arguments are the same as for printf(2). No more than 10 arguments can be provided.