The GNU Algol 68 Compiler

For GCC version 16.0.1 (pre-release)

(GCC)

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Short Contents

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1 Invoking ga68

The `ga68` command is the GNU compiler for the Algol 68 language and supports many of the same options as `gcc`. See Section "Option Summary" in *Using the GNU Compiler Collection (GCC)*. This manual only documents the options specific to `ga68`.

1.1 Dialect options

The following options control how the compiler handles certain dialect variations of the language.

`-std=`*`std`*
: Specify the standard to which the program is expected to conform, which may be one of '`algol68`' or '`gnu68`'. The default value for *std* is '`gnu68`', which specifies a strict super language of Algol 68 allowing GNU extensions. The '`algol68`' value specifies that the program strictly conform to the Revised Report.

`-fstropping=`*`stropping_regime`*
: Specify the stropping regime to expect in the input programs. The default value for *stropping_regime* is '`supper`', which specifies the modern SUPPER stropping which is a GNU extension. The '`upper`' value specifies the classic UPPER stropping of Algol 68 programs. See Section 4.4 [Stropping regimes], page 18.

`-fbrackets`
: This option controls whether `[ .. ]` is considered equivalent to `( .. )`. This syntactic variation is blessed by the Revised Report and is still strict Algol 68.

  This option is disabled by default.

1.2 Options for Directory Search

These options specify directories to search for files, libraries, and other parts of the compiler:

`-I`*`dir`*
: Add the directory *dir* to the list of directories to be searched for files when processing the Section 3.2.1 [pragmat include], page 15. Multiple `-I` options can be used, and the directories specified are scanned in left-to-right order, as with `gcc`. The directory will also be added to the list of directories to be searched for module interface-definitions Section 2.2.3 [Module activation], page 8.

`-L`*`dir`*
: Add the directory *dir* to the list of directories to be searched for module interface-definitions Section 2.2.3 [Module activation], page 8. Multiple `-L` options can be used, and the directories specified are scanned in left-to-right order, as with `gcc`. The directory will also be added to the list of library search directories, as with `gcc`.

1.3 Module search options

The following options can be used to tell the compiler where to look for certain modules.

`-fmodules-map=`*`string`*
: Use the mapping between module indicants and module base filenames specified in *string*, which must contain a sequence of entries with form

basename=*moduleindicant*[,*moduleindicant*]... separated by colon (:) characters.

When a module *moduleindicant* is accessed, the compiler will look for exports information for it in files *basename*.m68, lib*basename*.so, lib*basename*.a, *basename*.o, in that order.

This option is used to avoid the default behavior, in which the basename used to search for an accessed module is implicitly derived from its indicant, by transforming it to lower case.

The effect of this option is accumulative.

`-fmodules-map-file=`<*filename*>
: Like `-fmodules-map`, but read the mapping information from the file <*filename*>.

1.4 Warnings options

Warnings are diagnostic messages that report constructions that are not inherently erroneous but that are risky or suggest there is likely to be a bug in the program. Unless `-Werror` is specified, they do not prevent compilation of the program.

`-Wvoiding`
: Warn on non-void units being voided due to a strong context.

`-Wscope`
: Warn when a potential name scope violation is found.

`-Whidden-declarations=`*level*
: Warn when a declaration hides another declaration in a larger reach. This includes operators that hide firmly related operators defined in larger reach.

  `-Whidden-declarations=none`
  : At this level no warning is issued for any hidden declaration on an outer scope.

  `-Whidden-declarations=prelude`
  : At this level, warnings are issued for hidden declarations defined in the standard prelude. This is the default warning level of `-Whidden-declarations`.

  `-Whidden-declarations=all`
  : At this level, warnings are issued for any and all hidden declarations.

`-Wextensions`
: Warn when a non-portable Algol 68 construct is used, like GNU extensions to Algol 68.

1.5 Runtime options

These options affect the runtime behavior of programs compiled with `ga68`.

`-fno-assert`
: Turn off code generation for `ASSERT` contracts.

`-fcheck=<keyword>`
Enable the generation of run-time checks; the argument shall be a comma-delimited list of the following keywords. Prefixing a check with `no-` disables it if it was activated by a previous specification.

'`all`' Enable all run-time test of `-fcheck`.

'`none`' Disable all run-time test of `-fcheck`.

'`nil`' Check for nil while dereferencing.

'`bounds`' Enable generation of run-time checks when indexing and trimming multiple values.

1.6 Linking options

These options come into play when the compiler links object files into an executable output file. They are meaningless if the compiler is not doing a link step.

`-shared-libga68`
On systems that provide `libga68` as a shared and a static library, this option forces the use of the shared version. If no shared version was built when the compiler was configured, this option has no effect.

`-static-libga68`
On systems that provide `libga68` as a shared and a static library, this option forces the use of the static version. If no static version was built when the compiler was configured, this option has no effect. This is the default.

1.7 Developer options

This section describes command-line options that are primarily of interest to developers.

`-fa68-dump-modes`
Output a list of all the modes parsed by the front-end.

`-fa68-dump-ast`
Dump a textual representation of the parse tree.

`-fa68-dump-module-interfaces`
Dump the interfaces of module definitions in the compiled packet.

2 Composing programs

This chapter documents how to compose full Algol 68 programs using the modules and separated compilation support provided by this compiler.

2.1 Packets

Each Algol 68 source file, which are files using the file extension `.a68`, contains the definition of a so-called *packet*. Packets therefore play the role of *compilation units*, and each packet can be compiled separately to an object file. A set of compiled object files can then be linked in the usual fashion into an executable, archive or shared object by the system linker, without the need of any language-specific link editor or build system.

This compiler supports two different kind of packets:

- *Particular programs* constitute the entry point of a program. They roughly speaking correspond to the `main` function of other languages like C.

  See Section 2.3 [Particular programs], page 12.
- *Prelude packets* contain the definition of *modules*, which *publicize* definitions of modes, procedures, variables, operators and even the publicized definitions of other modules. Each prelude packet defines a single packet, defined at the top-level, which can be accessed by other packets (be them particular programs or other prelude packets) via an **access** construct. Prelude packets are so-called because their contents get conceptually stuffed in the *user-prelude* in the case of user-defined modules, or the *library-prelude* in the case of module packets provided by the compiler. They are usually used to compose libraries that can be used in a bottom-up fashion.

  See Section 2.2 [Modules], page 4.

Future versions of this compiler will eventually support a third kind of packet, oriented to top-down development:

- *Stuffing packets* contain the definition of an *actual hole*, an **egg** construct, that can be stuffed in a matching *formal hole* in another package via a **nest** construct. Formal holes are used in order to achieve separated compilation in a top-bottom fashion, and also to invoke procedures written in other languages, such as C functions or Fortran subroutines.

A *collection of packets*, all of which must be compatible with each other, constitutes either a *program* or a *library*. Exactly one of the packets constituting a program shall be a particular program. In libraries at least one packet must be a prelude packet.

2.2 Modules

Definition modules, often referred as just *modules* in the sequel, fulfill two different but related purposes. On one side, they provide some degree of *protection* by preventing accessing indicators defined within the module but not explicitly publicized. On the other, they allow to define *interfaces*, allow separated compilation based on these interfaces, and conform libraries.

Modules are usually associated with bottom-up development strategies, where several already written components are grouped and combined to conform bigger components.

2.2.1 Writing modules

A *definition module* is a construct that provides access to a set of publicized definitions. They appear in the outer reach of a prelude packet and constitute its only contents (see Section 2.1 [Packets], page 4). They are composed of a prelude and a postlude. The publicized definitions appear in the module's prelude.

Consider for example the following definition module, which implements a very simple logging facility:

```
module Logger =
def int fd = stderr;
    pub string originator;
    pub proc log = (string msg) void:
           fputs (fd, (originator /= "" | ": ") + msg + "'n");

    log ("beginning of log'n");
postlude
    log ("end of log'n");
fed
```

The *module text* delimited by **def** and **fed** gets ascribed to the module indicator **Logger**. Module indicators are bold tags.

The *prelude* of the module spans from **def** to either **postlude**, or to **fed** in case of modules not featuring a postlude. It consists on a restricted serial clause in a void strong context, which can contain units and declarations, but no labels or completers. The declarations in the prelude may be either publicized or no publicized. As we shall see, publicized indicators are accessible within the reach of the defining module publicizing them. Publicized declarations are marked by preceding them with **pub**.

In our example the module prelude consists on three declarations and one unit. The tag `fd` is not publicized and is to be used internally by the module. The indicators `originator` and `log`, on the other hand, are publicized and conform the interface of the module. Note how the range of the prelude also covers the postlude: the `log` procedure is reachable there, as it would be `fd` as well.

The *postlude* of the module is optional and spans from **postlude** to **fed**. It consists on a serial clause in a **void** strong context, where definitions, labels and module accesses are not allowed, just units.

2.2.2 Accessing modules

Once a module is defined (see Section 2.2.1 [Writing modules], page 5) it can be accessed from other packets using an *access clause*. The access clause identifies the modules to access and then makes the publicized definitions of these modules visible within a *control clause*.

For example, this is how we could use the logger definition module defined in a previous section to log the progress of some particular program that reads an input file and writes some output file:

```
access Logger
begin # Identify ourselves with the program name #
      originator := argv (1);
```

```
        # Read input file.  #
        if NOT parse_input (argv (2))
        then log ("error parsing input file"); stop fi;

        # Write output file.  #
        if NOT write_output (argv (3))
        then log ("error writing output file"); stop fi;

        log ("success")
end
```

In this case the controlled clause is the closed clause conforming the particular program, and the definitions publicized by the logger module, in this case `originator` and `log`, can be used within it.

2.2.2.1 Accessing several modules

An access clause is not restricted to just provide access to a single module: any number of module indicators can be specified in an access clause. Suppose that our example processing program has to read and write the data in JSON format, and that a suitable JSON library is available in the form of a reachable module. We could then make both logger and json modules accessible like this:

```
access Logger, JSON
begin { Identify ourselves with the program name }
        originator := argv (1);

        JSONVal data;

        { Read input file.  }
        if data := json_from_file (argv (2));
           data = json_no_val
        then log ("error parsing input file"); stop fi;

        { Write output file.  }
        if not json_to_file (argv (3), data)
        then log ("error writing output file"); stop fi;

        log ("success")
end
```

In this version of the program the access clause includes the module indicator **JSON**, and that makes the mode indicator **jsonval** and the tags `json_no_val`, `json_from_file` and `json_to_file` visible within the program's closed clause.

Note that the following two access clauses are not equivalent:

```
access Logger, JSON C ... C;
access Logger access JSON C ... C;
```

In the first case, a compilation time error is emitted if there is a conflict among the publicized definitions of both modules; for example, if both modules were to publicize a procedure called `log`. In the second case, the declaration of `log` publicized by **Logger** would hide the declaration of `log` publicized by **JSON**. This also has implications related to activation, that we will be discussing in a later section.

2.2.2.2 The controlled clause

The controlled clause in an access clause doesn't have to be a serial clause, like in the examples above. It can be any enclosed clause, like for example a loop clause:

```
proc frobnicate frobs = ([]Frob frobs) void:
   access Logger to UPB frobs
                 do log ("frobnicating " + name of frob);
                    frobnicate (frob)
                 od
```

2.2.2.3 The value yielded by an access clause

The elaboration of an access clause yields a value, which is the value yielded by the elaboration of the controlled clause. Since the later is an enclosed clause, coercions get passed into them whenever required, the usual fashion.

We can see an example of this in the following procedure, whose body is a controlled closed clause that yields a **real** value:

```
proc incr factor = (ref[]real factors, int idx) real:
   access logger (log ("factor increased"); factors[idx] +:= 1.0)
```

Note how the access clause above is in a strong context requiring a value of mode **real**. The value yielded by the access clause is the value yielded by the controlled enclosed clause, which in this case is a closed clause. The strong context and required mode gets passed to the last unit of the closed clause (the assignation) which in this case yields a value of mode **ref real**. The unit is coerced to **real** by dereferencing, and the resulting value becomes the value yielded by the access clause.

2.2.2.4 Modules accessing other modules

Up to this point we have seen particular programs accessing modules, but a definition module may itself access other modules. This is done by placing the module text as a controlled clause of an access clause. Suppose we rewrite our logger module so it uses JSON internally to log JSON objects rather than raw strings. We could do it this way:

```
module Logger =
   access JSON
   def int fd = stderr;
       pub string originator;
       pub proc log = (string msg) void:
              fputs (fd, json_array (json_string (originator),
                                     json_string (msg)));

       log (json_string ("beginning of log'n"));
   postlude
       log (json_string ("end of log'n"));
   fed
```

Note how this version of **Logger** uses a few definitions publicized by the **JSON** module.

A program accessing **Logger** will not see the definitions publicized by the **JSON** module. If that is what we intended, for example to allow the users of the logger to tweak their own JSON, we would need to specify it this way:

```
module Logger =
   access pub JSON
   def c ...as before... c fed
```

In this version the definitions publicized by **JSON** become visible to programs accessing **Logger**.

2.2.3 Module activation

In all the examples seen so far the modules were accessed just once. In these cases, accessing the module via an access-clause causes the *activation* of the module.

Activating a module involves elaborating all the declarations and units that conform its prelude. Depending on the particular module definition that gets activated, this may involve all sort of side effects, such as allocating space for values and initializing them, opening files, *etc*. Once the modules specified in the access clause are successfully activated, the controlled clause gets elaborated itself, within the reach of all the publicized definitions by the activated modules as we saw in the last section. Finally, once the controlled clause has been elaborated, the module gets *revoked* by elaborating the serial clause in its postlude.

However, nothing prevents some given definition module to be accessed more than once in the same program. The following program, that makes use of the **logger** module, exemplifies this:

```
access Logger
begin originator := argv (1);
      log ("executing program");
      c ... c
      access Logger (originator := argv (1) + ":subtask";
                     log ("doing subtask")
                     c ... c)
end
```

In this program the module **Logger** is accessed twice. The code is obviously written assuming that the inner access clause triggers a new activation of the **Logger** module, allocating new storage and executing its prelude. This would result in the following log contents:

```
a.out: beginning of log
a.out: executing program
a.out:subtask: beginning of log
a.out:subtask: doing subtask
a.out:subtask: end of log
a.out: end of log
```

However, this is not what happens. The module gets only activated once, as the result of the outer access clause. The inner access clause just makes the publicized indicators visible in its controlled clause. The actual resulting log output is:

```
a.out: beginning of log
```

```
a.out: executing program
a.out:subtask: doing subtask
a.out:subtask: end of log
```

Which is not what we intended. Modules are not classes. If we wanted the logger to support several originators that can be nested, we would need to add support for it in the definition module. Something like:

```
module Logger =
   def int fd = stderr, max_originators = 10;
       int orig := 0;
       [max_originators]string originators;

       pub proc push_originator = (string str) void:
              (assert (orig < max_originators);
               orig +:= 1;
               originators[orig] := str);
       pub proc pop_originator = void:
              (assert (max_originators > 0);
               orig -:= 1);
       pub proc log = (string msg) void:
              fputs (fd, (originator[orig] /= "" | ": ") + msg + "'n");

       log ("beginning of log'n");
   postlude
       log ("end of log'n");
   fed
```

Note how in this version of **Logger** `originators` acts as a stack of originator strings, and it is not publicized. The management of the stack is done via a pair of publicized procedures `push_originator` and `pop_originator`. Our program will now look like:

```
access Logger
begin push_originator (argv (1));
      log ("executing program");
      c ... c
      access logger (push_originator ("subtask");
                     log ("doing subtask")
                     c ... c;
                     pop_originator)
end
```

And the log output is:

```
a.out: beginning of log
a.out: executing program
a.out:subtask: doing subtask
a.out: end of log
```

2.2.4 Modules and exports

As we have seen, each Algol 68 source file contains either a particular program or a prelude packet. Prelude packets consist on the definition of a single top-level module, that is itself identified by a module indicant.

Consider for example a source file called `trilean.a68` that implements strong Kleene three-valued ("trilean") logic. It does so by the mean of a definition module called **Trilean**. A sketch of such a file may look like this:

```
module Trilean =
def
    pub mode Tril = int;

    pub Tril dontknow = 0, yes = 1, no = 2;

    pub prio AND3 = 3, OR3 = 3, XOR3 = 3;

    pub op NOT3 = (Tril a) Tril:
       (a + 1 | dontknow, no, yes);

    C ... other definitions ... C
fed
```

The module indicant **Trilean** identifies the module. If we now compile this file to an object file using GCC:

```
$ ga68 -c trilean.a68
```

The result of the compilation is an object file `trilean.o`, plus some *exports information* which is placed in a section in the object file, named `.a68_exports`. The exports information describes the interface provided by the **Trilean** module defined in the compilation unit. This includes all the modes, identifiers, priorities, operators, etc, that are publicized by the module. The particular encoding used to hold these exports is highly compact and not easy readable by persons; instead, it is designed to be read back by GCC when it builds another compilation unit that, in turn, needs to access the **Trilean** module.

Consider the following sketched particular program that resides in a source file `main.a68`, and that uses trilean logic:

```
access Trilean
begin
      C ... C
end
```

When this program gets compiled by GCC using `ga68 -c program.a68`, the compiler finds the access clause and needs to locate some exports for the module **Trilean**. To do so, it searches in the modules search path, composed by the current working directory, some system directories and all directories specified in `-I` and `-L` options, looking for files called `trilean.m68`, `trilean.so`, `trilean.a` and `trilean.o`, in that order, where:

`trilean.m68`
: Is a stand-alone file expected to contain export data for one or more modules.

`trilean.so`
: Is a DSO, or shared object, expected to contain a `.a68_exports` section with exports data for one or more modules.

`trilean.a`
: Is an archive, whose constituent object files may contain `.a68_exports` sections with exports data for one or more modules.

`trilean.o`
: Is an object file expected to contain export data for one or more modules in a `.a68_exports` section.

The files are tried in order, and if export data for the requested module **Trilean** is found, it is read in, decoded, and used to compile `main.a68` into `main.o`.

The last step in obtaining an executable for our program would be to use GCC to do a link like `ga68 trilean.o main.o -o main`.

Module indicants such as **Trilean** are bold words in the language. This means that, independently of the stropping regime used, they are constituted by a bold letter followed by a sequence of zero or more bold letters and digits. Using the modern stropping supported by the GNU Algol 68 compiler, this means that all of **Trilean**, **TRILEAN** and **Tri_lean** denote exactly the same module indicant, **trilean**.

The mapping from module indicant to the "base name" used to locate the module exports is quite straightforward: the bold letters are transformed to lower-case letters, and the bold digits are just normal digits. Therefore, the exports for the module **GRAMP_Grammar** would looked in files `grampgrammar.m68`, `libgrampgrammar.so`, etc.

But often this default, straightforward mapping, is not what we need.

Suppose for example that a shared object installed in the system, `liba68goodies.so`, provides many facilities in the form of several modules, including a **Trilean** module. We want to use the trilean implementation of liba68goodies in our program `main.a68`. If we just **access Trilean** GCC will look for `trilean.m68` etc, but wont even consider looking in `liba68goodies.so`. Accessing **A68Goodies** is obviously not a solution, as the module we want is **Trilean** and there may not even be a module called **A68Goodies** in `liba68goodies.so`.

The solution for this is to use the *modules map* of the compiler. This map is an association or map between module indicants and base-names. When it comes to access some module, the compiler looks in the map. If there is an entry for the module's indicant, then it fetches the base-name to use for looking for the module's export data. If there is not an entry for the module's indicant then the default, straightforward mapping described above is attempted.

By default the map is empty, but we can add entries by using the `-fmodules-map=` and `-fmodules-map-file=` command-line options. The first option expects entries to be added to the map in a string in the command-line, whereas the second option expects the name of a file containing the entries to add to the map. In both cases the format describing the entries is exactly the same (see Section 1.3 [Module search options], page 1).

In our case, we could compile our main program specifying an entry in the map telling the compiler where to find the trilean and logging modules:

```
$ ga68 -fmodules-map="a68goodies=Trilean,Logger" -c main.a68
```

2.2.5 Modules and libraries

XXX

As we have seen modules are accessed by referring to them in access-clauses, using the same sort of bold-word indicants that identify user-defined modes and operators, such as `JSON`, `Transput` or `LEB128_Arithmetic`.

2.2.6 Modules and protection

XXX

2.3 Particular programs

An Algol 68 *particular program* consists on an enclosed clause in a strong context with target mode **void**, possibly preceded by a set of zero or more labels. For example:

```
hello:
begin puts ("Hello, world!'n")
end
```

Note that the enclosed clause conforming the particular program doesn't have to be a closed clause. Consider for example the following program, that prints out its command line arguments:

```
for i to argc
do puts (argv (i) + "'n") od
```

2.3.1 Exit status

Some operating systems have the notion of *exit status* of a process. In such systems, by default the execution of the particular program results in an exit status of success. It is possible for the program to specify an explicit exit status by using the standard procedure `posix exit`, like:

```
begin # ... program code ... #
      if error found;
      then posix exit (1) fi
end
```

In POSIX systems the status is an integer, and the system interprets a value other than zero as a run-time error. In other systems the status may be of some other type. To support this, the `posix exit` procedure accepts as an argument an united value that accommodates all the supported systems.

The following example shows a very simple program that prints "Hello world" on the standard output and then returns to the operating system with a success status:

```
begin puts ("Hello world'n")
end
```

2.3.2 The `stop` label

A predefined label named `stop` is defined in the standard postlude. This label can be jumped to at any time by a program and it will cause it to terminate and exit. For example:

```
begin if argc /= 2
```

```
        then puts ("Program requires exactly two arguments.");
       goto stop
        fi
        C ... C
   end
```

2.4 The standard environment

The environment in which particular programs run is expressed here in the form of pseudo code:

```
(c standard-prelude c;
 c library-prelude c;
 c system-prelude c;
 par begin c system-task-1 c,
           c system-task-2 c,
           c system-task-n c,
           c user-task-1 c,
           c user-task-2 c,
           c user-task-m c
     end)
```

Where each user task consists on:

```
(c particular-prelude c;
 c user-prelude c;
 c particular-program c;
 c particular-postlude c)
```

The only standard system task described in the report is expressed in pseudo-code as:

```
do down gremlins; undefined; up bfileprotect od
```

Which denotes that, once a book (file) is closed, anything may happen. Other system tasks may exist, depending on the operating system. In general these tasks in the parallel clause denote the fact that the operating system is running in parallel (intercalated) with the user's particular programs.

- The library-prelude contains, among other things, the prelude parts of the defining modules provided by library.
- The particular-prelude and particular-postlude are common to all the particular programs.
- The user-prelude is where the prelude parts of the defining modules involved in the compilation get stuffed. If no defining module is involved then the user-prelude is empty.

Subsequent sections in this manual include a detailed description of the contents of these preludes.

3 Comments and pragmats

Comments and pragmats, also known collectively as *pragments*, can appear almost anywhere in an Algol 68 program. Comments are usually used for documentation purposes, and pragmats contain annotations for the compiler. Both are handled at the lexical level.

3.1 Comments

In the default modern stropping regime supported by GCC comments are written between `{` and `}` delimiters, and can be nested to arbitrary depth. For example:

```
foo +:= 1; { Increment foo.  }
```

If UPPER stropping is selected, this compiler additionally supports three classical Algol 68 comment styles, in which the symbols marking the beginning of comments are the same than the symbols marking the end of comments and therefore can't be nested: **comment** ... **comment**, **co** ... **co** and `#` .. `#`. For example:

```
comment
  This is a comment.
comment

foo := 10; co this is also a comment co
foo +:= 1; # and so is this.  #
```

Unless `-std=algol68` is specified in the command line, two styles of nestable comments can be also used with UPPER stropping: the already explained `{ ... }` and a "bold" style that uses **code** ... **edoc**. For example:

```
foo := 10; { this is a nestable comment in brief style.  }
foo +:= 1; note this is a nestable comment in bold style.  eton.

note
   "Bold" nestable comments.
eton

{ "Brief" nestable comments. }
```

In UPPER stropping all comment styles are available, both classic and nestable. In modern SUPPER stropping, which is based on reserved words, only `{ ... }` is available.

3.2 Pragmats

Pragmats (also known as *pragmas* in other programming languages) are directives and annotations for the compiler, and their usage impacts the compilation process in several ways. A pragmat starts with either **pragmat** or **pr** and finished with either **pragmat** or **pr** respectively. Pragmats cannot be nested. For example:

```
pr include "foo.a68" pr
```

The interpretation of pragmats is compiler-specific. This chapter documents the pragmats supported by GCC.

3.2.1 pragmat include

An *include pragmat* has the form:

pr `include "PATH"` **pr**

Where `PATH` is the path of the file whose contents are to be included at the location of the pragmat. If the provided path is relative then it is interpreted as relative to the directory containing the source file that contains the pragmat.

The `-I` command line option can be used in order to add additional search paths for `include`.

4 Hardware representation

The *reference language* specified by the Revised Report describes Algol 68 particular programs as composed by *symbols*. However, the Report leaves the matter of the concrete representation of these symbols, the *representation language*, open to the several implementations. This was motivated by the very heterogeneous computer systems in existence at the time the Report was written, which made flexibility in terms of representation a crucial matter.

This flexibility was indeed exploited by the early implementations, and there was a price to pay for it. A few years after the publication of the Revised Report the different implementations had already given rise to a plethora of many related languages that, albeit being strict Algol 68, differed considerably in appearance. This, and the fact that people were already engrossed in writing programs other than compilers that needed to process Algol 68 programs, such as code formatters and macro processors, prompted the WG 2.1 to develop and publish a *Report on the Standard Hardware Representation for ALGOL 68*, which came out in 1975.

This compiler generally follows the Standard Hardware Representation, but deviates from it in a few aspects. This chapter provides an overview of the hardware representation and documents any deviation.

4.1 Representation languages

A program in the strict Algol 68 language is composed by a series of symbols. These symbols have names such as `letter-a-symbol` and `assigns-to-symbol` which are, well, purely symbolic. In fact, these are notions in the two-level grammar that defines the strict language.

A *representation language* provides a mapping between symbols in the strict language and the representation of these symbols. Each representation is a sequence of syntactic marks. For example, the `completion symbol` may be represented by **exit**, where the marks are the bold letters. The `tilde symbol` may be represented by `~`, which is a single mark. The representation of `assigns to symbol` is `:=`, which is composed by the two marks `:` and `=`. The representation of `letter-a` is, not surprising, the single mark `a`.

The section 9.4 of the Report describes the recommended representation for all the symbols of the language. The set of all recommendations constitutes the so-called *reference language*. Algol 68 implementations are strongly encouraged to use representation languages which are similar enough to the reference language, recognizable "without further elucidation", but this is not strictly required.

A representation language may specify more than one representation for a given symbol. For example, in the reference language the `is not symbol` is represented by **isnt**, `:/=:` and a variant of the later where the slash sign is superimposed on the equal sign. In this case, an implementation can choose to implement any number of the representations.

Spaces, tabs and newlines are *typographical display features* that, when they appear between symbols, are of no significance and do not alter the meaning of the program. However, when a space or a tab appear in string or character denotations, they represent the `space symbol` and the `tab symbol` respectively[1]. The different stropping regimes, however,

[1] The `tab symbol` is a GNU extension

may impose specific restrictions on where typographical display features may or may not appear. See Section 4.4 [Stropping regimes], page 18.

4.2 Worthy characters

The syntactic marks of a representation language, both symbols and typographical display features, are realized as a set of *worthy characters* and the newline. Effectively, an Algol 68 program is a sequence of *worthy characters* and newlines. The worthy characters are:

```
a b c d e f g h i j k l m n o p q r s t u v w x y z
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
0 1 2 3 4 5 6 7 8 9
space tab " # $ % & ' ( ) * + , - . / : ; < = >  @ [ \ ]
^ _ |  ! ? ~ { }
```

Some of the characters above were considered unworthy by the original Standard Hardware Representation:

`!` It was considered unworthy because many installations didn't have a vertical bar base character, and `!` was used as a base character for `|`. Today every computer system features a vertical bar character, so `!` can qualify as a worthy character.

`&` The Revised Report specifies that `&` is a monad, used as a symbol for the dyadic **and** operator. The Standard Hardware representation decided to turn it into an unworthy character, motivated by the fact that no nomads existed for the other logical operators **not** and **or**, and also with the goal of maintaining the set of worthy characters as small as possible to improve portability. Recognizing that the first motivation still holds, but not the second, this compiler re-instates `&` as a monad but doesn't use it as an alternative representation of the **and** operator.

`~` The Standard Hardware Representation vaguely cites some "severe difficulties" with the hardware representation of the tilde character. Whatever these difficulties were at the time, they surely don't exist anymore. This compiler therefore recognizes `~` as a worthy character, and is used as a monad.

`?` The question mark character was omitted as a worthy character to limit the size of the worthy set. This compiler recognizes `?` as a worthy character, and is used as a monad.

`\` Back-slash wasn't included as a worthy character because back in 1975 it wasn't supported in EBCDIC (it is now). This compiler recognizes `\` as a worthy character.

`tab` This compiler recognizes the tabulator character as a worthy character, and it is used as a typographical display feature.

4.3 Base characters

The worthy characters described in the previous section are to be interpreted symbolically rather than visually. The worthy character `|`, for example, is the vertical line character and generally looks the same in every system. The worthy character `space` is obviously referred by a symbolic name.

The actual visually distinguishable characters available in an installation are known as *base characters*. The Standard Hardware Representation allows implementations the possibility of using two or more base characters to represent a single worthy character. This was the case of the `|` character, which was represented in many implementations by either `|` or `!`.

This compiler uses the set of base characters corresponding to the subset of the Unicode character set that maps one to one to the set of worthy characters described in the previous section:

```
A-Z   65-90
a-z   97-122
space 32
tab   9
!     33
"     34
#     35
$     36
%     37
&     38
'     39
(     40
)     41
*     42
+     43
,     44
-     45
.     46
/     47
:     58
;     59
<     60
=     61
>     62
?     63
@     64
[     91
\     92
]     93
^     94
_     95
|     124
~     126
```

4.4 Stropping regimes

The Algol 68 reference language establishes that certain source constructs, namely mode indications and operator indications, consist in a sequence of *bold letters* and *bold digits*, known as a *bold word*. In contrast, other constructs like identifiers, field selectors and labels, collectively known as *tags*, are composed of regular, non-bold letters and digits.

What is precisely a bold letter or digit, and how they differ from non-bold letters and digits, is not specified by the Report. This is no negligence, but a conscious effort at abstracting the definition of the so-called *strict language* from its representation. This allows different representations of the same language.

Some representations of Algol 68 are intended to be published in books, be it paper or electronic devices, and be consumed by persons. These are called *publication languages*. In publication languages bold letters and digits are typically represented by actual bold alphanumeric typographic marks. An Algol 68 program hand written on a napkin or a sheet of paper would typically represent bold letters and digits underlined, or stroked using a different color ink.

Other representations of Algol 68 are intended to be automatically processed by a computer. These representations are called *hardware languages*. Sometimes the hardware languages are also intended to be written and read by programmers; these are called *programming languages*.

Unfortunately, computer systems today usually do not yet provide readily usable and ergonomic bold or underline alphanumeric marks, despite the existence of Unicode and modern and sophisticated editing environments. The lack of appropriate input methods surely plays a role to explain this. Thus, the programming representation languages of Algol 68 should resort to a technique known as *stropping* in order to differentiate bold letters and digits from non-bold letters and digits. The set of rules specifying the representation of these characters is called a *stropping regime*.

There are three classical stropping regimes for Algol 68, which are standardized and specified in the Standard Hardware Representation normative document. These are *POINT stropping*, *RES stropping* and *UPPER stropping*. The following sections do a cursory tour over them; for more details the reader is referred to the Standard Hardware Representation.

This compiler implements UPPER stropping and SUPPER stropping.

4.4.1 POINT stropping

POINT stropping is in a way the most fundamental of the three standard regimes. It was designed to work in installations with limited character sets that provide only one alphabet, one set of digits, and a very restricted set of other symbols.

In POINT stropping a bold word is represented by its constituent letters and digits preceded by a point character. For example, the symbol `bold begin symbol` in the strict language, which is represented as **begin** in bold face in the reference language, would be represented as `.BEGIN` in POINT stropping.

More examples are summarized in the following table.

Strict language	**Reference language**	**POINT stropping**
`true symbol`	**true**	`.TRUE`
`false symbol`	**false**	`.FALSE`
`integral symbol`	**int**	`.INT`
`completion symbol`	**exit**	`.EXIT`
`bold-letter-c-...`	**crc32**	`.CRC32`

In POINT stropping a tag is represented by writing its constituent non-bold letters and digits in order. But they are organized in several *taggles*.

Each taggle is a sequence of one or more letters and digits, optionally followed by an underscore character. For example, the tag `PRINT` is composed of a single taggle, but the tag `PRINT_TABLE` is composed of a first taggle `PRINT_` followed by a second taggle `TABLE`.

To improve readability it is possible to insert zero or more white space characters between the taggles in a tag. Therefore, the tag `PRINT_TABLE` could have been written `PRINT TABLE`, or even `PRINT_ TABLE`. This is the reason why Algol 68 identifiers, labels and field selectors can and do usually feature white spaces in them.

It is important to note that both the trailing underscore characters in taggles and the white spaces in a tag do not contribute anything to the denoted tag: these are just stropping artifacts aimed to improve readability. Therefore `FOOBAR` `FOO BAR`, `FOO_BAR` and `FOO_BAR_` are all representations of the same tag, that represents the `letter-f-letter-o-letter-o-letter-b-letter-a-letter-r` language construct.

Below is the text of an example Algol 68 procedure encoded in POINT stropping.

```
.PROC RECSEL OUTPUT RECORDS = .VOID:
.BEGIN .BITS FLAGS
          := (INCLUDE DESCRIPTORS | REC F DESCRIPTOR | REC F NONE);
       .RECRSET RES = REC DB QUERY (DB, RECUTL TYPE,
                                    RECUTL QUICK, FLAGS);
       .RECWRITER WRITER := REC WRITER FILE NEW (STDOUT);

       SKIP COMMENTS .OF WRITER := .TRUE;
       .IF RECUTL PRINT SEXPS
       .THEN MODE .OF WRITER := REC WRITER SEXP .FI;
       REC WRITE (WRITER, RES)
.END
```

4.4.2 RES stropping

The early installations where Algol 68 ran not only featured a very restricted character set, but also suffered from limited storage and complex to use and time consuming input methods such as card punchers and readers. It was important for the representation of programs to be as compact as possible.

It is likely that is what motivated the introduction of the RES stropping regime. As its name implies, it removes the need of stropping many bold words by introducing *reserved words*.

A *reserved word* is one of the bold words specified in the section 9.4.1 of the Report as a representation of some symbol. Examples are **at**, **begin**, **if**, **int** and **real**.

RES stropping encodes bold words and tags like POINT stropping, but if a bold word is a reserved word then it can then be written without a preceding point, achieving this way a more compact, and easier to read, representation for programs.

Introducing reserved words has the obvious disadvantage that some tags cannot be written the obvious way due to the possibility of conflicts. For example, to represent a tag `if` it is not possible to just write `IF`, because it conflicts with a reserved word, but this can be overcome easily (if not elegantly) by writing `IF_` instead.

Below is the `recsel output records` procedure again, this time encoded in RES stropping.

```
PROC RECSEL OUTPUT RECORDS = VOID:
BEGIN BITS FLAGS
         := (INCLUDE DESCRIPTORS | REC F DESCRIPTOR | REC F NONE);
      .RECRSET RES = REC DB QUERY (DB, RECUTL TYPE,
                                   RECUTL QUICK, FLAGS);
      .RECWRITER WRITER := REC WRITER FILE NEW (STDOUT);

      SKIP COMMENTS OF WRITER := TRUE;
      IF RECUTL PRINT SEXPS
      THEN MODE .OF WRITER := REC WRITER SEXP FI;
      REC WRITE (WRITER, RES)
END
```

Note how user-defined mode an operator indications still require explicit stropping.

4.4.3 UPPER stropping

In time computers added support for more than one alphabet by introducing character sets with both upper and lower case letters, along with convenient ways to both input and display these.

In UPPER stropping the bold letters in bold word are represented by upper-case letters, whereas the letters in tags are represented by lower-case letters.

The notions of upper- and lower-case are not applicable to digits, but since the language syntax assures that it is not possible to have a bold word that starts with a digit, digits are considered to be bold if they follow a bold letter or another bold digit.

Below is the `recsel output records` procedure again, this time encoded in UPPER stropping.

```
PROC recsel output records = VOID:
BEGIN BITS flags
         := (include descriptors | rec f descriptor | rec f none);
      RECRSET res = rec db query (db, recutl type,
                                  recutl quick, flags);
      RECWRITER writer := rec writer file new (stdout);

      skip comments of writer := TRUE;
      IF recutl print sexps
      THEN mode OF writer := rec writer sexp FI;
      rec write (writer, res)
END
```

Note how in this regime it is almost never necessary to introduce bold tags with points. All in all, it looks much more natural to contemporary readers. UPPER stropping is in fact the stropping regime of choice today. It is difficult to think of any reason why anyone would resort to use POINT or RES stropping.

4.4.4 SUPPER stropping

In the SUPPER stropping regime bold words are written by writing a sequence of one or more *taggles*. Each taggle is written by writing a letter followed by zero or more other letters and digits and is optionally followed by a trailing underscore character. The first letter in a bold word shall be an upper-case letter. The rest of the letters in the bold word may be either upper- or lower-case.

For example, `RecRset`, `Rec_Rset` and `RECRset` are all different ways to represent the same mode indication. This allows to recreate popular naming conventions such as `CamelCase`.

As in the other stropping regimes, the casing of the letters and the underscore characters are not really part of the mode or operator indication.

Operator indications are also bold words and are written in exactly the same way than mode indications, but it is usually better to always use upper-case letters in operator indications. On one side, it looks better, especially in the case of dyadic operators where the asymmetry of, for example `Equal` would look odd, consider `m1 Equal m2` as opposed to `m1 EQUAL m2`. On the other side, tools like editors can make use of this convention in order to highlight operator indications differently than mode indications.

In the SUPPER stropping regime tags are written by writing a sequence of one or more *taggles*. Each taggle is written by writing a letter followed by zero or more other letters and digits and is optionally followed by a trailing underscore character. All letters in a tag shall be lower-case letters.

For example, the identifier `list` is represented by a single taggle, and it is composed by the letters `l`, `i`, `s` and `t`, in order. In the jargon of the strict language we would spell the tag as `letter-l-letter-i-letter-s-letter-t`.

The label `found_zero` is represented by two taggles, `found_` and `zero`, and it is composed by the letters `f`, `o`, `u`, `n`, `d`, `z`, `e`, `r` and `o`, in order. In the jargon of the strict language we would spell the tag as `letter-f-letter-o-letter-u-letter-n -letter-d-letter-z-letter-e-letter-r-letter-o`.

The identifier `crc_32` is likewise represented by two taggles, `crc_` and `32`. Note how the second taggle contains only digits. In the jargon of the strict language we would spell the tag as `letter-c-letter-r-letter-c-digit-three-digit-two`.

The underscore characters are not really part of the tag, but part of the stropping. For example, both `goto found_zero` and `goto foundzero` jump to the same label.

In general, typographical display features are allowed between any symbol in the written program. In SUPPER stropping, however, it is not allowed to place spaces or tab characters between the constituent digits of bits denotations when the radix is 16. This is to avoid confusing situations like the following invalid program:

while `bitmask /= 16r0` **do** `~` **od**

Where the bits denotation would be interpreted as `16r0d` rather than `16r0`, leading to a syntax error. Note however that typographical display features are still allowed between the radix part and the digits, so `16r aabb` is valid also in SUPPER stropping.

The `recsel output records` procedure, encoded in SUPPER stropping, looks like below.

```
proc recsel_output_records = void:
begin bits flags
```

```
      := (include_descriptors | rec_f_descriptor | rec_f_none);
    RecRset res = rec_db_query (db, recutl_type,
                                recutl_uick, flags);
    RecWriter writer := rec_writer_file_new (stdout);

    skip_comments of writer := true;
    if recutl_print_sexps
    then mode_ of writer := rec_writer_sexp fi;
    rec_write (writer, res)
end
```

4.5 Monads and Nomads

Algol68 operators, be them predefined or defined by the programmer, can be referred via either bold tags or sequences of certain non-alphabetic symbols. For example, the dyadic operator `+` is defined for many modes to perform addition, the monadic operator **entier** gets a real value and rounds it to an integral value, and the operator `:=:` is the identity relation. Many operators provide both bold tag names and symbols names, like in the case of `:/=:` that can also be written as **isnt**.

Bold tags are lexically well delimited, and if the same tag is used to refer to a monadic operator and to a dyadic operator, no ambiguity can arise. For example, in the following program it is clear that the second instance of **plus** refers to the monadic operator, and the first instance refers to the dyadic operator[2].

```
op PLUS = (int a, b) int: a + b,
   PLUS = (int a): a;
int val = 2 PLUS PLUS 3;
```

On the other hand, symbols are not lexically delimited as words, and one symbol can appear immediately following another symbol. This can lead to ambiguities. For example, if we were to define a C-like monadic operator `++` like:

```
op ++ = (ref int a) int: (int t = a; a +:=1; t);
```

Then the expression `++a` would be ambiguous: is it `++a` or `+(+a)`?. In a similar way, if we would use `++` as the name of a dyadic operator, an expression like `a++b` could be also interpreted as both `a++b` and `a+(+b)`.

To avoid these problems Algol 68 divides the symbols which are suitable to appear in the name of an operator into two classes: monads and nomads. *Monads* are symbols that can be used as monadic operators. *Nomads* are symbols which can be used as both monadic or dyadic operators. Given these two sets, the rules to conform a valid operator are:

– A bold tag.
– Any monad.
– A monad followed by a nomad.
– A monad optionally followed by a nomad followed by either `:=` or `=:`, but not by both.

In the GNU Algol 68 compiler:

– The set of monads is `%^&+-~!?`.

[2] If one would write **plusplus**, it would be a third different bold tag.

– The set of nomads is `></=*`.

4.6 String breaks

The intrinsic value of each worthy character that appears inside a string denotation is itself. The string `"/abc"`, therefore, contains a slash character followed by the three letters `a`, `b` and `c`.

Sometimes, however, it becomes necessary to represent some non-worthy character in a string denotation. In these cases, an escape convention has to be used to represent these extra string-items. It is up to the implementation to decide this convention, and the only requirement imposed by the Standard Hardware Representation on this regard is that the character used to introduce escapes, the *escape character*, shall be the apostrophe. This section documents the escape conventions implemented by the GNU compiler.

Two characters have special meaning inside string denotations: double quote (`"`) and apostrophe (`'`). The first finishes the string denotation, and the second starts a *string break*, which is the Algol 68 term for what is known as an "escape sequence" in other programming languages. Two consecutive double-quote characters specify a single double-quote character.

The following string breaks are recognized by this compiler:

`''` Apostrophe character `'`.

`'n` Newline character.

`'f` Form feed character.

`'r` Carriage return (no line feed).

`'t` Tab.

`'(list of character codes separated by commas)`
The indicated characters, where each code has the form `uhhhh` or `Uhhhhhhhh`, where `hhhh` and `hhhhhhhh` are integers expressing the character code in hexadecimal. The list must contain at least one entry.

A string break can appear as the single string-item in a character denotation, subject to the following restrictions:

- List of characters string breaks `'(...)` that contain more than one character code are not allowed in character denotations. If the specified code point is not a valid Unicode character then a compilation error shall be raised.

5 Standard prelude

The Algol 68 Revised Report defines an extensive set of standard modes, operators, procedures and values, collectively known as the *standard prelude*.

The standard prelude is available to Algol 68 programs without needing to import any module.

For brevity, in this section the pseudo-mode **L** represents a *shortsety*, i.e. a sequence of either zero or more **LONG** or zero or more **SHORT**.

5.1 Environment enquiries

An *environment enquiry* is a constant or a procedure, whose elaboration yields a value that may be useful to the programmer, that reflects some characteristic of the particular implementation. The values of these enquiries are also determined by the architecture and operating system targeted by the compiler.

int `int lengths` [Constant]
: 1 plus the number of extra lenghts of integers which are meaningful.

int `int shorths` [Constant]
: 1 plus the number of extra shorths of integers which are meaningful.

l int `L max int` [Constant]
: The largest integral value.

int `real lengths` [Constant]
: 1 plus the number of extra lenghts of real numbers which are meaningful.

int `real shorths` [Constant]
: 1 plus the number of extra shorths of real numbers which are meaningful.

l real `L max real` [Constant]
: The largest real value.

l real `L small real` [Constant]
: The smallest real value such that both `1 + small real > 1` and `1 - small real < 1`.

int `bits lengths` [Constant]
: 1 plus the number of extra widths of bits which are meaningful.

int `bits shorths` [Constant]
: 1 plus the number of extra shorths of bits which are meaningful.

int `bits width` [Constant]
int `long bits width` [Constant]
int `long long bits width` [Constant]
: The number of bits in a **bits** value.

int `bytes lengths` [Constant]
: 1 plus the number of extra widths of bytes which are meaningful.

int `bytes shorths` [Constant]
1 plus the number of extra shorths of bytes which are meaningful.

int `bytes width` [Constant]
int `long bytes width` [Constant]
int `long long bytes width` [Constant]
The number of chars in a **bytes** value.

int `max abs char` [Constant]
The largest value which **abs** of a **char** can yield.

char `null character` [Constant]
Some character.

char `flip` [Constant]
char `flop` [Constant]
Characters used to represent **true** and **false** boolean values in textual transput.

char `error char` [Constant]
Character used to represent the digit of a value resulting from a conversion error in textual transput.

char `blank` [Constant]
The space character.

l real `L pi` [Constant]
The number pi.

5.2 Standard modes

void [Mode]
The only value of this mode is **empty**.

bool [Mode]
Mode for the boolean truth values **true** and **false**.

l int [Mode]
Modes for signed integral values. Each **long** or **short** may increase or decrease the range of the domain, depending on the characteristics of the current target. Further **long**s and **short**s may be specified with no effect.

l real [Mode]
Modes for signed real values. Each **long** may increase the upper range of the domain, depending on the characteristics of the current target. Further **long**s may be specified but with no effect.

char [Mode]
Mode for character values. The character values are mapped one-to-one to code points in the 21-bit space of Unicode.

string = **flex**[*1:0*]**char** [Mode]

Mode for sequences of characters. This is implemented as a flexible row of **char** values.

l compl = **struct** (**real** *re,im*) [Mode]

Modes for complex values. Each **long** may increase the precision of both the real and imaginary parts of the numbers, depending on the characteristics of the current target. Further **long**s may be specified with no effect.

l bits [Mode]

Compact and efficient representation of a row of boolean values. Each **long** may increase the number of booleans that can be packed in a bits, depending on the characteristics of the current target.

l bytes [Mode]

Compact and efficient representation of a row of character values. Each **long** may increase the number of characters that can be packed in a bytes, depending on the characteristics of the current target.

5.3 Standard priorities

`1`

- `plusab`, `+:=`
- `minusab`, `-:=`
- `timesab`, `*:=`
- `divab`, `/:=`
- `overab`, `%:=`
- `modab`, `%*:=`
- `plusto`, `+=:`

`2`

- `or`

`3`

- `and`
- `xor`

`4`

- **eq**, `=`
- **ne**, `/=`

`5`

- **lt**, `<`,
- **le**, `<=`
- **gt**, `>`
- **ge**, `>=`

`6`

- `+`

- -

7

- *
- /
- **over**, %
- **mod**, %*
- **elem**

8

- **
- **shl**, **up**
- **shr**, **down**
- **up**, **down**
- ^
- **lwb**
- **upb**

9

- **i**
- +*

5.4 Rows operators

The following operators work on any row mode, denoted below using the pseudo-mode **rows**.

lwb = (**rows** a) **int** [Operator]

Monadic operator that yields the lower bound of the first bound pair of the descriptor of the value of a.

upb = (**rows** a) **int** [Operator]

Monadic operator that yields the upper bound of the first bound pair of the descriptor of the value of a.

lwb = (**int** n, **rows** a) **int** [Operator]

Dyadic operator that yields the lower bound in the n-th bound pair of the descriptor of the value of a, if that bound pair exists. Attempting to access a non-existing bound pair results in a run-time error.

upb = (**int** n, **rows** a) **int** [Operator]

Dyadic operator that yields the upper bound in the n-th bound pair of the descriptor of the value of a, if that bound pair exists. Attempting to access a non-existing bound pair results in a run-time error.

5.5 Boolean operators

not = (**bool** a) **bool** [Operator]
˜ = (**bool** a) **bool** [Operator]

Monadic operator that yields the logical negation of its operand.

or = (**bool** a, b) **bool** [Operator]

Dyadic operator that yields the logical "or" of its operands.

and = (**bool** a, b) **bool** [Operator]
& = (**bool** a, b) **bool** [Operator]

Dyadic operator that yields the logical "and" of its operands.

eq = (**bool** a, b) **bool** [Operator]
= = (**bool** a, b) **bool** [Operator]

Dyadic operator that yields **true** if its operands are the same truth value, **false** otherwise.

ne = (**bool** a, b) **bool** [Operator]
/= = (**bool** a, b) **bool** [Operator]

Dyadic operator that yields **false** if its operands are the same truth value, **true** otherwise.

abs = (**bool** a) **int** [Operator]

Monadic operator that yields 1 if its operand is **true**, and 0 if its operand is **false**.

5.6 Integral operators

5.6.1 Arithmetic

+ = (**l int** a) **l int** [Operator]

Monadic operator that yields the affirmation of its operand.

- = (**l int** a) **l int** [Operator]

Monadic operator that yields the negative of its operand.

abs = (**l int** a) **l int** [Operator]

Monadic operator that yields the absolute value of its operand.

sign = (**l int** a) **int** [Operator]

Monadic operator that yields -1 if a if negative, 0 if a is zero and 1 if a is positive.

odd = (**l int** a) **bool** [Operator]

Monadic operator that yields **true** if its operand is odd, **false** otherwise.

+ = (**l int** a, b) **l int** [Operator]

Dyadic operator that yields the addition of its operands.

- = (**l int** a, b) **l int** [Operator]

Dyadic operator that yields b subtracted from a.

***** = (**l int** a, b) **l int** [Operator]

Dyadic operator that yields the multiplication of its operands.

over = (**l int** a, b) **l int** [Operator]
% = (**l int** a, b) **l int** [Operator]

Dyadic operator that yields the integer division of a by b, rounding the quotient toward zero.

mod = (**l int** a, b) **l int** [Operator]
%* = (**l int** a, b) **l int** [Operator]

Dyadic operator that yields the remainder of the division of a by b.

/ = (**l int** a, b) **l real** [Operator]

Dyadic operator that yields the integer division with real result of a by b.

****** = (**l int** a, b) **l int** [Operator]
^ = (**l int** a, b) **l int** [Operator]

Dyadic operator that yields a raised to the exponent b.

5.6.2 Arithmetic combined with assignation

plusab = (**ref l int** a, **l int** b) **ref l int** [Operator]
+:= = (**ref l int** a, **l int** b) **ref l int** [Operator]

Plus and become. Dyadic operator that calculates a + b, assigns the result of the operation to the name a and then yields a.

minusab = (**ref l int** a, **l int** b) **ref l int** [Operator]
-:= = (**ref l int** a, **l int** b) **ref l int** [Operator]

Dyadic operator that calculates a - b, assigns the result of the operation to the name a and then yields a.

timesab = (**ref l int** a, **l int** b) **ref l int** [Operator]
***:=** = (**ref l int** a, **l int** b) **ref l int** [Operator]

Dyadic operator that calculates a * b, assigns the result of the operation to the name a and then yields a.

overab = (**ref l int** a, **l int** b) **ref l int** [Operator]
%:= = (**ref l int** a, **l int** b) **ref l int** [Operator]

Dyadic operator that calculates a % b, assigns the result of the operation to the name a and then yields a.

modab = (**ref l int** a, **l int** b) **ref l int** [Operator]
%*:= = (**ref l int** a, **l int** b) **ref l int** [Operator]

Dyadic operator that calculates a %* b, assigns the result of the operation to the name a and then yields a.

5.6.3 Relational

eq = (**l int** a, b) **bool** [Operator]
= = (**l int** a, b) **bool** [Operator]

Dyadic operator that yields whether its operands are equal.

ne = (**l int** a, b) **bool** [Operator]
/= = (**l int** a, b) **bool** [Operator]
Dyadic operator that yields whether its operands are not equal.

lt = (**l int** a, b) **bool** [Operator]
< = (**l int** a, b) **bool** [Operator]
Dyadic operator that yields whether a is less than b.

le = (**l int** a, b) **bool** [Operator]
<= = (**l int** a, b) **bool** [Operator]
Dyadic operator that yields whether a is less than, or equal to b.

gt = (**l int** a, b) **bool** [Operator]
> = (**l int** a, b) **bool** [Operator]
Dyadic operator that yields whether a is greater than b.

ge = (**l int** a, b) **bool** [Operator]
>= = (**l int** a, b) **bool** [Operator]
Dyadic operator that yields whether a is greater than, or equal to b.

5.6.4 Conversion

shorten = (**short int** a) **short short int** [Operator]
shorten = (**int** a) **short int** [Operator]
shorten = (**long int** a) **int** [Operator]
shorten = (**long long int** a) **long int** [Operator]
Monadic operator that yields, if it exists, the integral value that can be lengthened to the value of a. If the value doesn't exist then the operator yields either the most positive integral value in the destination mode, if a is bigger than that value, or the most negative integral value in the destination mode, if a is smaller than that value.

leng = (**short short int** a) **short int** [Operator]
leng = (**short int** a) **int** [Operator]
leng = (**int** a) **long int** [Operator]
leng = (**long int** a) **long long int** [Operator]
Monadic operator that yields the integral value lengthened from the value of a.

5.7 Real operators

5.7.1 Arithmetic

+ = (**l real** a) **l real** [Operator]
Monadic operator that yields the affirmation of its operand.

- = (**l real** a) **l real** [Operator]
Monadic operator that yields the negative of its operand.

abs = (**l real** a) **l real** [Operator]
Monadic operator that yields the absolute value of its operand.

sign = (**l real** a) **int** [Operator]

Monadic operator that yields -1 if a if negative, 0 if a is zero and 1 if a is positive.

+ = (**l real** a, b) **l real** [Operator]

Dyadic operator that yields the addition of its operands.

- = (**l real** a, b) **l real** [Operator]

Dyadic operator that yields b subtracted from a.

* = (**l real** a, b) **l real** [Operator]

Dyadic operator that yields the multiplication of its operands.

/ = (**l real** a, b) **l real** [Operator]

Dyadic operator that yields the realeger division with real result of a by b.

** = (**l real** a, b) **l real** [Operator]
^ = (**l real** a, b) **l real** [Operator]

Dyadic operator that yields a raised to the real exponent b.

** = (**l real** a, **int** b) **l real** [Operator]
^ = (**l real** a, **int** b) **l real** [Operator]

Dyadic operator that yields a raised to the integral exponent b.

5.7.2 Arithmetic combined with assignation

plusab = (**ref l real** a, **l real** b) **ref l real** [Operator]
+:= = (**ref l real** a, **l real** b) **ref l real** [Operator]

Plus and become. Dyadic operator that calculates a + b, assigns the result of the operation to the name a and then yields a.

minusab = (**ref l real** a, **l real** b) **ref l real** [Operator]
-:= = (**ref l real** a, **l real** b) **ref l real** [Operator]

Dyadic operator that calculates a - b, assigns the result of the operation to the name a and then yields a.

timesab = (**ref l real** a, **l real** b) **ref l real** [Operator]
*:= = (**ref l real** a, **l real** b) **ref l real** [Operator]

Dyadic operator that calculates a * b, assigns the result of the operation to the name a and then yields a.

divab = (**ref l real** a, **l real** b) **ref l real** [Operator]
/:= = (**ref l real** a, **l real** b) **ref l real** [Operator]

Dyadic operator that calculates a / b, assigns the result of the operation to the name a and then yields a.

5.7.3 Relational

eq = (**l real** a, b) **bool** [Operator]
= = (**l real** a, b) **bool** [Operator]

Dyadic operator that yields whether its operands are equal.

ne = (**l real** a, b) **bool** [Operator]
/= = (**l real** a, b) **bool** [Operator]
Dyadic operator that yields whether its operands are not equal.

lt = (**l real** a, b) **bool** [Operator]
< = (**l real** a, b) **bool** [Operator]
Dyadic operator that yields whether a is less than b.

le = (**l real** a, b) **bool** [Operator]
<= = (**l real** a, b) **bool** [Operator]
Dyadic operator that yields whether a is less than, or equal to b.

gt = (**l real** a, b) **bool** [Operator]
> = (**l real** a, b) **bool** [Operator]
Dyadic operator that yields whether a is greater than b.

ge = (**l real** a, b) **bool** [Operator]
>= = (**l real** a, b) **bool** [Operator]
Dyadic operator that yields whether a is greater than, or equal to b.

5.7.4 Conversions

round = (**l real** a) **int** [Operator]
Monadic operator that yields the nearest integer to its operand.

entier = (**l real** a) **int** [Operator]
Monadic operator that yields the integer equal to a, or the next integer below (more negative than) a.

shorten = (**long real** a) **real** [Operator]
shorten = (**long long real** a) **long real** [Operator]
Monadic operator that yields, if it exists, the real value that can be lengthened to the value of a. If the value doesn't exist then the operator yields either the most positive real value in the destination mode, if a is bigger than that value, or the most negative real value in the destination mode, if a is smaller than that value.

leng = (**real** a) **long real** [Operator]
leng = (**long real** a) **long long real** [Operator]
Monadic operator that yields the real value lengthened from the value of a.

5.8 Character operators

5.8.1 Relational

eq = (**char** a, b) **bool** [Operator]
= = (**char** a, b) **bool** [Operator]
Dyadic operator that yields whether its operands are equal.

ne = (**char** a, b) **bool** [Operator]
/= = (**char** a, b) **bool** [Operator]
Dyadic operator that yields whether its operands are not equal.

lt = (**char** `a`, `b`) **bool** [Operator]
< = (**char** `a`, `b`) **bool** [Operator]

Dyadic operator that yields whether `a` is less than `b`.

le = (**char** `a`, `b`) **bool** [Operator]
<= = (**char** `a`, `b`) **bool** [Operator]

Dyadic operator that yields whether `a` is less than, or equal to `b`.

gt = (**char** `a`, `b`) **bool** [Operator]
> = (**char** `a`, `b`) **bool** [Operator]

Dyadic operator that yields whether `a` is greater than `b`.

ge = (**char** `a`, `b`) **bool** [Operator]
>= = (**char** `a`, `b`) **bool** [Operator]

Dyadic operator that yields whether `a` is greater than, or equal to `b`.

5.8.2 Conversions

ABS = (**char** `a`) **int** [Operator]

Monadic operator that yields an unique integer for each permissable value of **char**.

REPR = (**int** `a`) **char** [Operator]

The opposite of **abs** of a character.

5.9 String operators

5.9.1 Relational

eq = (**string** `a`, `b`) **bool** [Operator]
= = (**string** `a`, `b`) **bool** [Operator]

Dyadic operator that yields whether its operands are equal. Two strings are equal if they contain the same sequence of characters.

ne = (**string** `a`, `b`) **bool** [Operator]
/= = (**string** `a`, `b`) **bool** [Operator]

Dyadic operator that yields whether its operands are not equal.

lt = (**string** `a`, `b`) **bool** [Operator]
< = (**string** `a`, `b`) **bool** [Operator]

Dyadic operator that yields whether the string `a` is less than the string `b`.

le = (**string** `a`, `b`) **bool** [Operator]
<= = (**string** `a`, `b`) **bool** [Operator]

Dyadic operator that yields whether the string `a` is less than, or equal to string `b`.

gt = (**string** `a`, `b`) **bool** [Operator]
> = (**string** `a`, `b`) **bool** [Operator]

Dyadic operator that yields whether the string `a` is greater than the string `b`.

ge = (**string** a, b) **bool** [Operator]
>= = (**string** a, b) **bool** [Operator]

Dyadic operator that yields whether the string a is greater than, or equal to the string b.

5.9.2 Composition

+ = (**string** a, b) **string** [Operator]

Dyadic operator that yields the concatenation of the two given strings as a new string.

+ = (**string** a, **char** b) **string** [Operator]

Dyadic operator that yields the concatenation of the given string a and a string whose contents are the character b.

* (= (**int** a, **string** b) **string**) [Operator]
* (= (**string** b, **int** a) **string**) [Operator]

Dyadic operator that yields the string a concatenated a times to itself. If a is less than zero then it is interpreted to be zero.

5.9.3 Composition combined with assignation

plusab = (**ref string** a, **string** b) **ref string** [Operator]
+:= = (**ref string** a, **string** b) **ref string** [Operator]

Plus and become. Dyadic operator that calculates a + b, assigns the result of the operation to the name a and then yields a.

plusto = (**string** b, **ref string** a) **ref string** [Operator]
+=: = (**string** b, **ref string** b) **ref string** [Operator]

Dyadic operator that calculates a + b, assigns the result of the operation to the name a and then yields a.

timesab = (**ref string** a, **string** b) **ref string** [Operator]
*:= = (**ref string** a, **string** b) **ref stringl** [Operator]

Plus and become. Dyadic operator that calculates a * b, assigns the result of the operation to the name a and then yields a.

5.10 Complex operators

5.11 Bits operators

5.11.1 Logical

NOT = (**l bits** a, b) **l bits** [Operator]
~ = (**l bits** a, b) **l bits** [Operator]

Monadic operator that yields the element-wise not logical operation in the elements of the given bits operand.

AND = (**l bits** a, b) **l bits** [Operator]
& = (**l bits** a, b) **l bits** [Operator]

Dyadic operator that yields the element-wise and logical operation in the elements of the given bits operands.

OR = (**l bits** `a, b`) **l bits** [Operator]

Dyadic operator that yields the element-wise "or" logical operation in the elements of the given bits operands.

5.11.2 Shifting

SHL = (**l bits** `a`, **int** `n`) **l bits** [Operator]
UP = (**l bits** `a`, **int** `n`) **l bits** [Operator]

Dyadic operator that yields the given bits operand shifted `n` positions to the left. Extra elements introduced on the right are initialized to **false**.

SHR = (**l bits** `a`, **int** `n`) **l bits** [Operator]
DOWN = (**l bits** `a`, **int** `n`) **l bits** [Operator]

Dyadic operator that yields the given bits operand shifted `n` positions to the right. Extra elements introduced on the left are initialized to **false**.

5.11.3 Relational

eq = (**l bits** `a, b`) **bool** [Operator]
= = (**l bits** `a, b`) **bool** [Operator]

Dyadic operator that yields whether its operands are equal. Two bits are equal if they contain the same sequence of booleans.

ne = (**l bits** `a, b`) **bool** [Operator]
/= = (**l bits** `a, b`) **bool** [Operator]

Dyadic operator that yields whether its operands are not equal.

lt = (**l bits** `a, b`) **bool** [Operator]
< = (**l bits** `a, b`) **bool** [Operator]

Dyadic operator that yields whether the bits `a` is less than the bits `b`.

le = (**l bits** `a, b`) **bool** [Operator]
<= = (**l bits** `a, b`) **bool** [Operator]

Dyadic operator that yields whether the bits `a` is less than, or equal to bits `b`.

gt = (**l bits** `a, b`) **bool** [Operator]
> = (**l bits** `a, b`) **bool** [Operator]

Dyadic operator that yields whether the bits `a` is greater than the bits `b`.

ge = (**l bits** `a, b`) **bool** [Operator]
>= = (**l bits** `a, b`) **bool** [Operator]

Dyadic operator that yields whether the bits `a` is greater than, or equal to the bits `b`.

5.11.4 Conversions

abs = (**l bits** `a`) **l int** [Operator]

Monadic operator that yields the integral value whose constituent bits correspond to the booleans stored in `a`. See Section 8.1 [**bin** and **abs** of negative integral values], page 46.

bin = (**l int** a) **l bits** [Operator]
Monadic operator that yields the bits value whose boolean elements map the bits in the given integral operand. See Section 8.1 [**bin** and **abs** of negative integral values], page 46.

shorten = (**long bits** a) **bits** [Operator]
shorten = (**long long bits** a) **long bits** [Operator]
Monadic operator that yields the bits value that can be lengthened to the value of `a`.

leng = (**bits** a) **long bits** [Operator]
leng = (**long bits** a) **long long bits** [Operator]
Monadic operator that yields the bits value lengthened from the value of `a`. The lengthened value features **false** in the extra left positions added to match the lengthened size.

5.12 Bytes operators

5.13 Semaphore operators

5.14 Math procedures

5.14.1 Arithmetic

sqrt = (**l real** a) **l real** [Procedure]
Procedure that yields the square root of the given real argument.

5.14.2 Logarithms

ln = (**l real** a) **l real** [Procedure]
Procedure that yields the base `e` logarithm of the given real argument.

exp = (**l real** a) **l real** [Procedure]
Procedure that yields the exponential function of the given real argument. This is the inverse of **ln**.

5.14.3 Trigonometric

sin = (**l real** a) **l real** [Procedure]
Procedure that yields the sin trigonometric function of the given real argument.

arcsin = (**l real** a) **l real** [Procedure]
Procedure that yields the arc-sin trigonometric function of the given real argument.

cos = (**l real** a) **l real** [Procedure]
Procedure that yields the cos trigonometric function of the given real argument.

arccos = (**l real** a) **l real** [Procedure]
Procedure that yields the arc-cos trigonometric function of the given real argument.

tan = (**l real** a) **l real** [Procedure]

Procedure that yields the tan trigonometric function of the given real argument.

arctan = (**l real** a) **l real** [Procedure]

Procedure that yields the arc-tan trigonometric function of the given real argument.

6 Extended prelude

This chapter documents the GNU extensions to the standard prelude. The facilities documented below are available to Algol 68 programs only if the `gnu68` language dialect is selected, which is the default.

The extended prelude is available to Algol 68 programs without needing to import any module, provided they are compiled as `gnu68` code, which is the default.

6.1 Extended priorities

`3`

- **xor**

`8`

- **elems**

6.2 Extended environment enquiries

An *environment enquiry* is a constant, whose value may be useful to the programmer, that reflects some characteristic of the particular implementation. The values of these enquiries are also determined by the architecture and operating system targeted by the compiler.

l int `L min int` [Constant]
: The most negative integral value.

l real `L min real` [Constant]
: The most negative real value.

l real `L infinity` [Constant]
: Positive infinity expressed in a real value.

l real `L minus infinity` [Constant]
: Negative infinity expressed in a real value.

char `replacement char` [Constant]
: A character that is unknown, unrecognizable or unrepresentable in Unicode.

char `eof char` [Constant]
: **char** value that doesn't denote an actual char, but an end-of-file situation.

6.3 Extended rows operators

The following operators work on any row mode, denoted below using the pseudo-mode **rows**.

elems `=` (**rows** `a`) **int** [Operator]
: Monadic operator that yields the number of elements implied by the first bound pair of the descriptor of the value of `a`.

elems `=` (**int** `n`, **rows** `a`) **int** [Operator]
: Dyadic operator that yields the number of elements implied by the n-th bound pair of the descriptor of the value of `a`.

6.4 Extended boolean operators

xor = (**bool** `a, b`) **bool** [Operator]

Dyadic operator that yields the exclusive-or operation of the given boolean arguments.

6.5 Extended bits operators

xor = (**l bits** `a, b`) **l bits** [Operator]

Dyadic operator that yields the bit exclusive-or operation of the given bits arguments.

6.6 Extended math procedures

6.6.1 Logarithms

log = (**l real** `a, b`) **l real** [Procedure]

Procedure that calculates the base ten logarithm of the given arguments.

7 POSIX prelude

The POSIX prelude provides facilities to perform simple transput (I/O) based on POSIX file descriptors, accessing the file system, command-line arguments, environment variables, etc.

This prelude is available to Algol 68 programs without needing to import any module, provided they are compiled as `gnu68` code, which is the default.

7.1 POSIX process

The Algol 68 program reports an exit status to the operating system once it stops running. The exit status reported by default is zero, which corresponds to success.

`posix exit = (`**int** `status)` [Procedure]

Procedure that sets the exit status to report to the operating system and immediately stops executing the program. The default exit status is 0 which, by convention, is interpreted by POSIX systems as success. A value different to zero is interpreted as an error status.

7.2 POSIX command line

Algol 68 programs can access the command-line arguments passed to them by using the following procedures.

`argc =` **int** [Procedure]

Procedure that yields the number of arguments passed in the command line, including the name of the program.

`argv = (`**int** `n)` **string** [Procedure]

Procedure that yields the `n`th argument passed in the command line. The first argument is always the name used to invoke the program. If `n` is out of range then this procedure returns the empty string.

7.3 POSIX environment

`getenv = (`**string** `varname)` **string** [Procedure]

Procedure that yields the value of the environment variable `varname` as a string. If the specified environmental variable is not defined the this procedure returns an empty string.

7.4 POSIX errors

When a call to a procedure in this prelude results in an error, the called procedure signals the error in some particular way and also sets a global `errno` to a code describing the error. For example, trying to opening a file that doesn't exist will result in `fopen` returning `-1`, which signals an error. The caller can then inspect the global `errno` to see what particular error prevented the operation to be completed: in this case, `errno` will contain the error code corresponding to "file doesn't exist".

`errno` = **int** [Procedure]
This procedure yields the current value of the global `errno`. The yielded value reflects the error status of the last executed POSIX prelude operation.

`strerror` = (**int** `ecode`) **string** [Procedure]
This procedure gets an error code and yields a string containing an explanatory short description of the error. It is typical to pass the output of `errno` to this procedure.

`perror` = (**string** `msg`) **void** [Procedure]
This procedure prints the given string `msg` in the standard error output, followed by a colon character, a space character and finally the string error of the current value of `errno`.

7.5 POSIX files

File descriptors are **int** values that identify open files that can be accessed by the program. The `fopen` procedure allocates file descriptors as it opens files, and the descriptor is used in subsequent transput calls to perform operations on the files.

7.5.1 Standard file descriptors

There are three descriptors, however, which are automatically opened when the program starts executing and automatically closed when the program finishes. These are:

int `stdin` [Constant]
File descriptor associated with the standard input. Its value is `0`.

int `stdout` [Constant]
File descriptor associated with the standard output. Its value is `1`.

int `stderr` [Constant]
File descriptor associated with the standard error. Its value is `2`.

7.5.2 Opening and closing files

`fopen` = (**string** `pathname`, **bits** `flags`) **int** [Procedure]
Open the file specified by `pathname`. The argument `flags` is a combination of `file o` flags as defined below. If the specified file is successfully opened while satisfying the constraints implied by `flags` then this procedure yields a file descriptor that is used in subsequent I/O calls to refer to the open file. Otherwise, this procedure yields -1. The particular error can be inspected by calling the `errno` procedure.

`fclose` = (**int** `fd`) **int** [Procedure]
Close the given file descriptor, which no longer refers to any file. This procedure yields zero on success, and -1 on error. In the later case, the program can look at the particular error by calling the `errno` procedure.

7.5.3 Creating files

`fcreate` = (**string** `pathname`, **bits** `mode`) **int** [Procedure]
Create a file with name `pathname`. The argument `mode` is a **bits** value containing a bit pattern that determines the permissions on the created file. The bit pattern has

the form `8rUGO`, where `U` reflects the permissions of the user who owns the file, `U` reflects the permissions of the users pertaining to the file's group, and `O` reflects the permissions of all other users. The permission bits are 1 for execute, 2 for write and 4 for read. If the file is successfully created then this procedure yields a file descriptor that is used in subsequent I/O calls to refer to the newly created file. Otherwise, this procedure yields -1. The particular error can be inspected by calling the `errno` procedure.

7.5.4 Flags for `fopen`

The following flags can be combined using bit-wise operators. Note that in POSIX systems the effective mode of the created file is the mode specified by the programmer masked with the process's *umask*.

bits `file o default` [Constant]

Flag for `fopen` indicating that the file shall be opened with whatever capabilities allowed by its permissions.

bits `file o rdwr` [Constant]

Flag for `fopen` indicating that the file shall be opened for both reading and writing.

bits `file o rdonly` [Constant]

Flag for `fopen` indicating that the file shall be opened for reading only. This flag is not compatible with `file o rdwr` nor with `file o wronly`.

bits `file o wronly` [Constant]

Flag for `fopen` indicating that the file shall be opened for write only. This flag is not compatible with `file o rdwr` nor with `file o rdonly`.

bits `file o trunc` [Constant]

Flag for `fopen` indicating that the opened file shall be truncated upon opening it. The file must allow writing for this flag to take effect. The effect of combining `file o trunc` and `file o rdonly` is undefined and varies among implementations.

7.5.5 Getting file properties

`fsize =` (**int** `fd`) **long long int** [Procedure]

Return the size in bytes of the file characterized by the file descriptor `fd`. If the system entity characterized by the given file descriptor doesn't have a size, if the size of the file cannot be stored in a **long long int**, or if there is any other error condition, this procedure yields -1 and `errno` is set appropriately.

`lseek =` (**int** `fd,` **long long int** `offset,` **int** `whence`) **long long int** [Procedure]

Set the file offset of the file characterized by the file descriptor `fd` depending on the values of `offset` and `whence`. On success, the resulting offset, as measured in bytes from the beginning of the file, is returned. Otherwise, -1 is returned, `errno` is set to indicate the error, and the file offset remains unchanged. The effects of `offset` and `whence` are:

- If `whence` is `seek set`, the file offset is set to `offset` bytes.
- If `whence` is `seek cur`, the file offset is set to its current location plus `offset`.
- If `whence` is `seek end`, the file offset is set to the size of the file plus `offset`.

7.6 POSIX sockets

A program can communicate with other computers, or with other processes running in the same computer, via sockets. The sockets are identified by file descriptors.

`fconnect` = (**string** `host`, **int** `port`) **int** [Procedure]

This procedure creates a stream socket and connects it to the given `host` using port `port`. The established communication is full-duplex, and allows sending and receiving data using transput until it gets closed. On success this procedure yields a file descriptor. On error this procedure yields -1 and `errno` is set appropriately.

7.7 POSIX string transput

The following procedures read or write characters and strings from and to open files. The external encoding of the files is assumed to be UTF-8. Since Algol 68 **char**s are UCS-4, this means that reading or writing a character may involve reading or writing more than one byte, depending on the particular Unicode code points involved.

7.7.1 Output of strings and chars

`putchar` = (**char** `c`) **char** [Procedure]

Write the given character to the standard output. This procedure yields `c` in case the character got successfully written, or `eof char` otherwise.

`puts` = (**string** `str`) **void** [Procedure]

Write the given string to the standard output.

`fputc` = (**int** `fd`, **char** `c`) **int** [Procedure]

Write given character `c` to the file with descriptor `fd`. This procedure yields `c` on success, or `eof char` on error.

`fputs` = (**int** `fd`, **string** `str`) **int** [Procedure]

Write the given string `str` to the file with descriptor `fd`. This procedure yields the number of bytes written on success, or 0 on error.

7.7.2 Input of strings and chars

`getchar` = **char** [Procedure]

Read a character from the standard input. This procedure yields the read character in case the character got successfully read, or `eof char` otherwise.

`gets` = (**int** `n`) **ref string** [Procedure]

Read a string composed of `n` characters from the standard input and yield a reference to it. If `n` is bigger than zero then characters get read until either `n` characters have been read or the end of line is reached. If `n` is zero or negative then characters get read until either a new line character is read or the end of line is reached.

`fgetc` = (**int** `fd`) **int** [Procedure]

Read a character from the file with descriptor `fd`. This procedure yields the read character in case a valid Unicode character got successfully read. If an unrecognizable or unknown character is found then this procedure yields `replacement char`. In case of end of file this procedure yields `eof char`.

`fgets = (`**int** `fd,` **int** `n)` **ref string** [Procedure]

Read a string from the file with descriptor `fd` and yield a reference to it. If `n` is bigger than zero then characters get read until either `n` characters have been read or the end of line is reached. If `n` is zero or negative then characters get read until either a new line character is read or the end of line is reached.

8 Language extensions

This chapter documents the GNU extensions implemented by this compiler on top of the Algol 68 programming language. These extensions collectively conform a strict *superlanguage* of Algol 68, and are enabled by default. To disable them the user can select the strict Algol 68 standard by passing the option `-std=algol68` when invoking the compiler.

8.1 bin and abs of negative integral values

The **bin** operator gets an integral value and yields a **bits** value that reflects the internal bits of the integral value. The semantics of this operator, as defined in the Algol 68 standard prelude, are:

```
op bin = (L int a) L bits:
  if a >= L 0
  then L int b := a; L bits;
       for i from L bits width by -1 to 1
       do (L F of c)[i] := odd b; b := b % L 2 od;
       c
  fi;
```

The **abs** operator performs the inverse operation of **bits**. Given a `L` **bits** value, it yields the `L` **int** value whose bits representation is the bits value. The semantics of this operator, as defined in the Algol 68 prelude, are:

```
op abs = (L bits a) L int:
begin L int c := L 0;
      for i to L bits width
      do c := L 2 * c + K abs (L F of a)[i] od;
      c
end
```

Note how the **bin** of a negative integral value is not defined: the implicit else-part of the conditional yields **skip**, which is defined as any bits value in that context. Note also how **abs** doesn't make any provision to check whether the resulting value is positive: it assumes it is so.

The GNU Algol 68 compiler, when working in strict Algol 68 mode (`-std=algol68`), makes **bin** to always yield `L` **bits (skip)** when given a negative value, as mandated by the report. But the skip value is always the bits representation of zero, *i.e.* 2r0. Strict Algol 68 programs, however, must not rely on this.

When GNU extensions are enabled (`-std=gnu68`) the **bin** of a negative value yields the two's complement bit pattern of the value rather than zero. Therefore, **bin - short short** `2` yields `2r11111110`. And **abs short short** `2r11111110` yields -2.

8.2 Bold taggles

This compiler supports the stropping regimes known as UPPER and SUPPER. In both regimes bold words are written by writing their constituent bold letters and digits, in order. In UPPER regime all the letters of a bold word are to be written using upper-case. In

SUPPER regime, only the first bold letter is required to be written using upper-case, and this only when the bold word is not a reserved word.

When a bold word comprises several natural words, it may be a little difficult to distinguish them at first sight. Consider for example the following code, written fist in UPPER stropping:

```
MODE TREENODE = STRUCT (TREENODEPAYLOAD data, REF TREENODE next),
     TREENODEPAYLOAD = STRUCT (INT code, REAL average, mean);
```

Then written in SUPPER stropping:

```
mode TreeNode = struct (TreeNodePayload data, REF TreeNode next),
     TreeNodePayload = struct (int code, real average, mean);
```

Particularly in UPPER stropping, it may be difficult to distinguish the constituent natural words at first sight.

In order to improve this, this compiler implements a GNU extension called *bold taggles* that allows to use underscore characters (`_`) within mode and operator indications as a visual aid to improve readability. When this extension is enabled, mode indications and operator indications consist in a sequence of the so-called *bold taggles*, which are themselves sequences of one or more bold letters or digits optionally terminated by an underscore character.

With bold taggles enabled the program above could have been written using UPPER stropping as:

```
MODE TREE_NODE = STRUCT (TREE_NODE_PAYLOAD data, REF TREE_NODE next),
     TREE_NODE_PAYLOAD = STRUCT (INT code, REAL average, mean);
```

And using SUPPER stropping as:

```
mode Tree_Node = struct (Tree_Node_Payload data, ref Tree_Node next),
     Tree_Node_Payload = struct (int code, real average, mean);
```

Which is perhaps more readable for most people. Note that the underscore characters are not really part of the mode or operator indication. Both `TREE_NODE` and `TREENODE` denote the same mode indication. Note also that, following the definition, constructs like `Foo__bar` and `_Baz` are not valid indications.

Bold taggles are available when the gnu68 dialect of the language is selected. See Section 1.1 [Dialect options], page 1.

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```
program Copyright (C) year name of author
This program comes with ABSOLUTELY NO WARRANTY; for details type 'show w'.
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```

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