This manual is for GNU Automake (version 1.12.3, 13 August 2012), a program that creates GNU standards-compliant Makefiles from template files.

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1 Introduction

Automake is a tool for automatically generating `Makefile.ins` from files called `Makefile.am`. Each `Makefile.am` is basically a series of `make` variable definitions\(^1\), with rules being thrown in occasionally. The generated `Makefile.ins` are compliant with the GNU Makefile standards.

The GNU Makefile Standards Document (see Section “Makefile Conventions” in *The GNU Coding Standards*) is long, complicated, and subject to change. The goal of Automake is to remove the burden of Makefile maintenance from the back of the individual GNU maintainer (and put it on the back of the Automake maintainers).

The typical Automake input file is simply a series of variable definitions. Each such file is processed to create a `Makefile.in`. There should generally be one `Makefile.am` per directory of a project.

Automake does constrain a project in certain ways; for instance, it assumes that the project uses Autoconf (see Section “Introduction” in *The Autoconf Manual*), and enforces certain restrictions on the `configure.ac` contents.

Automake requires *perl* in order to generate the `Makefile.ins`. However, the distributions created by Automake are fully GNU standards-compliant, and do not require *perl* in order to be built.

For more information on bug reports, See Section 28.12 [Reporting Bugs], page 156.

2 An Introduction to the Autotools

If you are new to Automake, maybe you know that it is part of a set of tools called *The Autotools*. Maybe you’ve already delved into a package full of files named `configure`, `configure.ac`, `Makefile.in`, `Makefile.am`, `aclocal.m4`, ..., some of them claiming to be *generated by* Autoconf or Automake. But the exact purpose of these files and their relations is probably fuzzy. The goal of this chapter is to introduce you to this machinery, to show you how it works and how powerful it is. If you’ve never installed or seen such a package, do not worry: this chapter will walk you through it.

If you need some teaching material, more illustrations, or a less *automake*-centered continuation, some slides for this introduction are available in Alexandre Duret-Lutz’s Autotools Tutorial ([http://www.lrde.epita.fr/~adl/autotools.html](http://www.lrde.epita.fr/~adl/autotools.html)). This chapter is the written version of the first part of his tutorial.

2.1 Introducing the GNU Build System

It is a truth universally acknowledged, that as a developer in possession of a new package, you must be in want of a build system.

In the Unix world, such a build system is traditionally achieved using the command `make` (see Section “Overview” in *The GNU Make Manual*). You express the recipe to build your package in a `Makefile`. This file is a set of rules to build the files in the package.

---

\(^1\) These variables are also called *make macros* in Make terminology, however in this manual we reserve the term *macro* for Autoconf’s macros.
Chapter 2: An Introduction to the Autotools

For instance the program `prog` may be built by running the linker on the files `main.o`, `foo.o`, and `bar.o`; the file `main.o` may be built by running the compiler on `main.c`; etc. Each time `make` is run, it reads `Makefile`, checks the existence and modification time of the files mentioned, decides what files need to be built (or rebuilt), and runs the associated commands.

When a package needs to be built on a different platform than the one it was developed on, its `Makefile` usually needs to be adjusted. For instance the compiler may have another name or require more options. In 1991, David J. MacKenzie got tired of customizing `Makefile` for the 20 platforms he had to deal with. Instead, he handcrafted a little shell script called `configure` to automatically adjust the `Makefile` (see Section “Genesis” in *The Autoconf Manual*). Compiling his package was now as simple as running `./configure && make`.

Today this process has been standardized in the GNU project. The GNU Coding Standards (see Section “Managing Releases” in *The GNU Coding Standards*) explains how each package of the GNU project should have a `configure` script, and the minimal interface it should have. The `Makefile` too should follow some established conventions. The result? A unified build system that makes all packages almost indistinguishable by the installer. In its simplest scenario, all the installer has to do is to unpack the package, run `./configure && make && make install`, and repeat with the next package to install.

We call this build system the *GNU Build System*, since it was grown out of the GNU project. However it is used by a vast number of other packages: following any existing convention has its advantages.

The Autotools are tools that will create a GNU Build System for your package. Autoconf mostly focuses on `configure` and Automake on `Makefiles`. It is entirely possible to create a GNU Build System without the help of these tools. However it is rather burdensome and error-prone. We will discuss this again after some illustration of the GNU Build System in action.

### 2.2 Use Cases for the GNU Build System

In this section we explore several use cases for the GNU Build System. You can replay all of these examples on the `amhello-1.0.tar.gz` package distributed with Automake. If Automake is installed on your system, you should find a copy of this file in `prefix/share/doc/automake/amhello-1.0.tar.gz`, where `prefix` is the installation prefix specified during configuration (`prefix` defaults to `/usr/local`, however if Automake was installed by some GNU/Linux distribution it most likely has been set to `/usr`). If you do not have a copy of Automake installed, you can find a copy of this file inside the `doc` directory of the Automake package.

Some of the following use cases present features that are in fact extensions to the GNU Build System. Read: they are not specified by the GNU Coding Standards, but they are nonetheless part of the build system created by the Autotools. To keep things simple, we do not point out the difference. Our objective is to show you many of the features that the build system created by the Autotools will offer to you.

#### 2.2.1 Basic Installation

The most common installation procedure looks as follows.
The user first unpacks the package. Here, and in the following examples, we will use the non-portable tar zxf command for simplicity. On a system without GNU tar installed, this command should read gunzip -c amhello-1.0.tar.gz | tar xf -.

The user then enters the newly created directory to run the configure script. This script probes the system for various features, and finally creates the Makefiles. In this toy example there are only two Makefiles, but in real-world projects, there may be many more, usually one Makefile per directory.

It is now possible to run make. This will construct all the programs, libraries, and scripts that need to be constructed for the package. In our example, this compiles the hello program. All files are constructed in place, in the source tree; we will see later how this can be changed.

make check causes the package’s tests to be run. This step is not mandatory, but it is often good to make sure the programs that have been built behave as they should, before you decide to install them. Our example does not contain any tests, so running make check is a no-op.

After everything has been built, and maybe tested, it is time to install it on the system. That means copying the programs, libraries, header files, scripts, and other data files from the source directory to their final destination on the system. The command make install will do that. However, by default everything will be installed in subdirectories of /usr/local: binaries will go into /usr/local/bin, libraries will end up in /usr/local/lib, etc. This destination is usually not writable by any user, so we assume that we have to become root before we can run make install. In our example, running make install will copy the program hello into /usr/local/bin and README into /usr/local/share/doc/amhello.

A last and optional step is to run make installcheck. This command may run tests on the installed files. make check tests the files in the source tree, while make installcheck tests their installed copies. The tests run by the latter can be different from those run by the
former. For instance, there are tests that cannot be run in the source tree. Conversely, some packages are set up so that `make installcheck` will run the very same tests as `make check`, only on different files (non-installed vs. installed). It can make a difference, for instance when the source tree’s layout is different from that of the installation. Furthermore it may help to diagnose an incomplete installation.

Presently most packages do not have any `installcheck` tests because the existence of `installcheck` is little known, and its usefulness is neglected. Our little toy package is no better: `make installcheck` does nothing.

### 2.2.2 Standard Makefile Targets

So far we have come across four ways to run `make` in the GNU Build System: `make`, `make check`, `make install`, and `make installcheck`. The words `check`, `install`, and `installcheck`, passed as arguments to `make`, are called targets. `make` is a shorthand for `make all`, `all` being the default target in the GNU Build System.

Here is a list of the most useful targets that the GNU Coding Standards specify.

- **make all** Build programs, libraries, documentation, etc. (same as `make`).
- **make install** Install what needs to be installed, copying the files from the package’s tree to system-wide directories.
- **make install-strip** Same as `make install`, then strip debugging symbols. Some users like to trade space for useful bug reports...
- **make uninstall** The opposite of `make install`: erase the installed files. (This needs to be run from the same build tree that was installed.)
- **make clean** Erase from the build tree the files built by `make all`.
- **make distclean** Additionally erase anything `./configure` created.
- **make check** Run the test suite, if any.
- **make installcheck** Check the installed programs or libraries, if supported.
- **make dist** Recreate `package-version.tar.gz` from all the source files.

### 2.2.3 Standard Directory Variables

The GNU Coding Standards also specify a hierarchy of variables to denote installation directories. Some of these are:

<table>
<thead>
<tr>
<th>Directory variable</th>
<th>Default value</th>
</tr>
</thead>
<tbody>
<tr>
<td>prefix</td>
<td>/usr/local</td>
</tr>
<tr>
<td>exec_prefix</td>
<td>${prefix}</td>
</tr>
</tbody>
</table>
bindir \quad ${\text{exec_prefix}}/\text{bin} \\
libdir \quad ${\text{exec_prefix}}/\text{lib} \\
... \\
includedir \quad ${\text{prefix}}/\text{include} \\
datarootdir \quad ${\text{prefix}}/\text{share} \\
datadir \quad ${\text{datarootdir}} \\
mandir \quad ${\text{datarootdir}}/\text{man} \\
infodir \quad ${\text{datarootdir}}/\text{info} \\
docdir \quad ${\text{datarootdir}}/\text{doc}/${\text{PACKAGE}} \\
... \\

Each of these directories has a role which is often obvious from its name. In a package, any installable file will be installed in one of these directories. For instance in amhello-1.0, the program hello is to be installed in \text{bindir}, the directory for binaries. The default value for this directory is /usr/local/bin, but the user can supply a different value when calling configure. Also the file README will be installed into \text{docdir}, which defaults to /usr/local/share/doc/amhello.

As a user, if you wish to install a package on your own account, you could proceed as follows:

```
~/amhello-1.0 % ./configure --prefix ~/usr 
... 
~/amhello-1.0 % make 
... 
~/amhello-1.0 % make install 
... 
```

This would install ~/usr/bin/hello and ~/usr/share/doc/amhello/README.

The list of all such directory options is shown by ./configure --help.

### 2.2.4 Standard Configuration Variables

The GNU Coding Standards also define a set of standard configuration variables used during the build. Here are some:

\text{CC} \quad \text{C compiler command} \\
\text{CFLAGS} \quad \text{C compiler flags} \\
\text{CXX} \quad \text{C++ compiler command} \\
\text{CXXFLAGS} \quad \text{C++ compiler flags} \\
\text{LDFLAGS} \quad \text{linker flags} \\
\text{CPPFLAGS} \quad \text{C/C++ preprocessor flags} \\
...

configure usually does a good job at setting appropriate values for these variables, but there are cases where you may want to override them. For instance you may have several versions of a compiler installed and would like to use another one, you may have header files installed outside the default search path of the compiler, or even libraries out of the way of the linker.
Here is how one would call `configure` to force it to use `gcc-3` as C compiler, use header files from `~/usr/include` when compiling, and libraries from `~/usr/lib` when linking.

```
~/amhello-1.0 % ./configure --prefix ~/usr CC=gcc-3 \ 
CPPFLAGS=-I$HOME/usr/include LDFLAGS=-L$HOME/usr/lib
```

Again, a full list of these variables appears in the output of `./configure --help`.

### 2.2.5 Overriding Default Configuration Setting with `config.site`

When installing several packages using the same setup, it can be convenient to create a file to capture common settings. If a file named `prefix/share/config.site` exists, `configure` will source it at the beginning of its execution.

Recall the command from the previous section:

```
~/amhello-1.0 % ./configure --prefix ~/usr CC=gcc-3 \ 
CPPFLAGS=-I$HOME/usr/include LDFLAGS=-L$HOME/usr/lib
```

Assuming we are installing many package in `~/usr`, and will always want to use these definitions of `CC`, `CPPFLAGS`, and `LDFLAGS`, we can automate this by creating the following `~/usr/share/config.site` file:

```
test -z "$CC" && CC=gcc-3

test -z "$CPPFLAGS" && CPPFLAGS=-I$HOME/usr/include

test -z "$LDFLAGS" && LDFLAGS=-L$HOME/usr/lib
```

Now, any time a `configure` script is using the `~/usr` prefix, it will execute the above `config.site` and define these three variables.

```
~/amhello-1.0 % ./configure --prefix ~/usr
configure: loading site script /home/adl/usr/share/config.site
...
```

See Section “Setting Site Defaults” in *The Autoconf Manual*, for more information about this feature.

### 2.2.6 Parallel Build Trees (a.k.a. VPATH Builds)

The GNU Build System distinguishes two trees: the source tree, and the build tree.

The source tree is rooted in the directory containing `configure`. It contains all the sources files (those that are distributed), and may be arranged using several subdirectories.

The build tree is rooted in the directory in which `configure` was run, and is populated with all object files, programs, libraries, and other derived files built from the sources (and hence not distributed). The build tree usually has the same subdirectory layout as the source tree; its subdirectories are created automatically by the build system.

If `configure` is executed in its own directory, the source and build trees are combined: derived files are constructed in the same directories as their sources. This was the case in our first installation example (see Section 2.2.1 [Basic Installation], page 2).

A common request from users is that they want to confine all derived files to a single directory, to keep their source directories uncluttered. Here is how we could run `configure` to build everything in a subdirectory called `build/`.

```
~ % tar zxf ~/amhello-1.0.tar.gz
~ % cd amhello-1.0
```
~/amhello-1.0 % mkdir build && cd build
~/amhello-1.0/build % ../configure
...
~/amhello-1.0/build % make
...

These setups, where source and build trees are different, are often called parallel builds or VPATH builds. The expression parallel build is misleading: the word parallel is a reference to the way the build tree shadows the source tree, it is not about some concurrency in the way build commands are run. For this reason we refer to such setups using the name VPATH builds in the following. VPATH is the name of the make feature used by the Makefiles to allow these builds (see Section “VPATH Search Path for All Prerequisites” in The GNU Make Manual).

VPATH builds have other interesting uses. One is to build the same sources with multiple configurations. For instance:

```
~/ % tar zxf ~/amhello-1.0.tar.gz
~/ % cd amhello-1.0
~/amhello-1.0 % mkdir debug optim && cd debug
~/amhello-1.0/debug % ../configure CFLAGS=-g -O0
...
~/amhello-1.0/debug % make
...
~/amhello-1.0/debug % cd ../optim
~/amhello-1.0/optim % ../configure CFLAGS=-O3 -fomit-frame-pointer
...
~/amhello-1.0/optim % make
...
```

With network file systems, a similar approach can be used to build the same sources on different machines. For instance, suppose that the sources are installed on a directory shared by two hosts: HOST1 and HOST2, which may be different platforms.

```
~/ % cd /nfs/src
/nfs/src % tar zxf ~/amhello-1.0.tar.gz
```

On the first host, you could create a local build directory:

```
[HOST1] ~/ % mkdir /tmp/amh && cd /tmp/amh
[HOST1] /tmp/amh % /nfs/src/amhello-1.0/configure
...
[HOST1] /tmp/amh % make && sudo make install
```

(Here we assume that the installer has configured sudo so it can execute make install with root privileges; it is more convenient than using su like in Section 2.2.1 [Basic Installation], page 2).

On the second host, you would do exactly the same, possibly at the same time:

```
[HOST2] ~/ % mkdir /tmp/amh && cd /tmp/amh
[HOST2] /tmp/amh % /nfs/src/amhello-1.0/configure
...
[HOST2] /tmp/amh % make && sudo make install
```
In this scenario, nothing forbids the /nfs/src/amhello-1.0 directory from being read-only. In fact VPATH builds are also a means of building packages from a read-only medium such as a CD-ROM. (The FSF used to sell CD-ROM with unpacked source code, before the GNU project grew so big.)

### 2.2.7 Two-Part Installation

In our last example (see Section 2.2.6 [VPATH Builds], page 6), a source tree was shared by two hosts, but compilation and installation were done separately on each host.

The GNU Build System also supports networked setups where part of the installed files should be shared amongst multiple hosts. It does so by distinguishing architecture-dependent files from architecture-independent files, and providing two Makefile targets to install each of these classes of files.

These targets are `install-exec` for architecture-dependent files and `install-data` for architecture-independent files. The command we used up to now, `make install`, can be thought of as a shorthand for `make install-exec install-data`.

From the GNU Build System point of view, the distinction between architecture-dependent files and architecture-independent files is based exclusively on the directory variable used to specify their installation destination. In the list of directory variables we provided earlier (see Section 2.2.3 [Standard Directory Variables], page 4), all the variables based on `exec-prefix` designate architecture-dependent directories whose files will be installed by `make install-exec`. The others designate architecture-independent directories and will serve files installed by `make install-data`. See Section 12.2 [The Two Parts of Install], page 95, for more details.

Here is how we could revisit our two-host installation example, assuming that (1) we want to install the package directly in `/usr`, and (2) the directory `/usr/share` is shared by the two hosts.

On the first host we would run

```bash
[HOST1] ~ % mkdir /tmp/amh && cd /tmp/amh
[HOST1] /tmp/amh % /nfs/src/amhello-1.0/configure --prefix /usr
... 
[HOST1] /tmp/amh % make && sudo make install
... 
```

On the second host, however, we need only install the architecture-specific files.

```bash
[HOST2] ~ % mkdir /tmp/amh && cd /tmp/amh
[HOST2] /tmp/amh % /nfs/src/amhello-1.0/configure --prefix /usr
... 
[HOST2] /tmp/amh % make && sudo make install-exec
... 
```

In packages that have installation checks, it would make sense to run `make installcheck` (see Section 2.2.1 [Basic Installation], page 2) to verify that the package works correctly despite the apparent partial installation.
2.2.8 Cross-Compilation

To cross-compile is to build on one platform a binary that will run on another platform. When speaking of cross-compilation, it is important to distinguish between the build platform on which the compilation is performed, and the host platform on which the resulting executable is expected to run. The following configure options are used to specify each of them:

--build=build
The system on which the package is built.

--host=host
The system where built programs and libraries will run.

When the --host is used, configure will search for the cross-compiling suite for this platform. Cross-compilation tools commonly have their target architecture as prefix of their name. For instance my cross-compiler for MinGW32 has its binaries called `i586-mingw32msvc-gcc`, `i586-mingw32msvc-ld`, `i586-mingw32msvc-as`, etc.

Here is how we could build `amhello-1.0` for `i586-mingw32msvc` on a GNU/Linux PC.

```
~/amhello-1.0 % ./configure --build i686-pc-linux-gnu --host i586-mingw32msvc
checking for a BSD-compatible install... /usr/bin/install -c
checking whether build environment is sane... yes
checking for gawk... gawk
checking whether make sets $(MAKE)... yes
checking for i586-mingw32msvc-strip... i586-mingw32msvc-strip
checking for i586-mingw32msvc-gcc... i586-mingw32msvc-gcc
checking for C compiler default output file name... a.exe
checking whether the C compiler works... yes
checking whether we are cross compiling... yes
checking for suffix of executables... .exe
checking for suffix of object files... o
checking whether we are using the GNU C compiler... yes
checking whether i586-mingw32msvc-gcc accepts -g... yes
checking for i586-mingw32msvc-gcc option to accept ANSI C...

~/amhello-1.0 % make

~/amhello-1.0 % cd src; file hello.exe
hello.exe: MS Windows PE 32-bit Intel 80386 console executable not relocatable
```

The --host and --build options are usually all we need for cross-compiling. The only exception is if the package being built is itself a cross-compiler: we need a third option to specify its target architecture.

--target=target
When building compiler tools: the system for which the tools will create output.

For instance when installing GCC, the GNU Compiler Collection, we can use --target=target to specify that we want to build GCC as a cross-compiler for target. Mixing --build and --target, we can actually cross-compile a cross-compiler; such a three-way cross-compilation is known as a Canadian cross.

See Section “Specifying the System Type” in The Autoconf Manual, for more information about these configure options.
2.2.9 Renaming Programs at Install Time

The GNU Build System provides means to automatically rename executables and man-pages before they are installed (see Section 11.2 [Man Pages], page 93). This is especially convenient when installing a GNU package on a system that already has a proprietary implementation you do not want to overwrite. For instance, you may want to install GNU `tar` as `gtar` so you can distinguish it from your vendor’s `tar`.

This can be done using one of these three `configure` options.

---

**--program-prefix=prefix**
Prepend `prefix` to installed program names.

**--program-suffix=suffix**
Append `suffix` to installed program names.

**--program-transform-name=program**
Run `sed program` on installed program names.

---

The following commands would install `hello` as `/usr/local/bin/test-hello`, for instance.

```
~/amhello-1.0 % ./configure --program-prefix test-
... 
~/amhello-1.0 % make
... 
~/amhello-1.0 % sudo make install
... 
```

2.2.10 Building Binary Packages Using DESTDIR

The GNU Build System’s `make install` and `make uninstall` interface does not exactly fit the needs of a system administrator who has to deploy and upgrade packages on lots of hosts. In other words, the GNU Build System does not replace a package manager.

Such package managers usually need to know which files have been installed by a package, so a mere `make install` is inappropriate.

The `DESTDIR` variable can be used to perform a staged installation. The package should be configured as if it was going to be installed in its final location (e.g., `--prefix /usr`), but when running `make install`, the `DESTDIR` should be set to the absolute name of a directory into which the installation will be diverted. From this directory it is easy to review which files are being installed where, and finally copy them to their final location by some means.

For instance here is how we could create a binary package containing a snapshot of all the files to be installed.

```
~/amhello-1.0 % ./configure --prefix /usr
...
~/amhello-1.0 % make
...
~/amhello-1.0 % make DESTDIR=$HOME/inst install
...
~/amhello-1.0 % cd ~/inst
~/inst % find . -type f -print > ../files.lst
```
~/inst % tar zcvf ~/amhello-1.0-i686.tar.gz `cat ../files.lst`
./usr/bin/hello
./usr/share/doc/amhello/README

After this example, amhello-1.0-i686.tar.gz is ready to be uncompressed in / on many hosts. (Using `cat ../files.lst` instead of `.` as argument for `tar` avoids entries for each subdirectory in the archive: we would not like `tar` to restore the modification time of /, /usr/, etc.)

Note that when building packages for several architectures, it might be convenient to use `make install-data` and `make install-exec` (see Section 2.2.7 [Two-Part Install], page 8) to gather architecture-independent files in a single package.

See Chapter 12 [Install], page 94, for more information.

2.2.11 Preparing Distributions

We have already mentioned `make dist`. This target collects all your source files and the necessary parts of the build system to create a tarball named `package-version.tar.gz`.

Another, more useful command is `make distcheck`. The `distcheck` target constructs `package-version.tar.gz` just as well as `dist`, but it additionally ensures most of the use cases presented so far work:

- It attempts a full compilation of the package (see Section 2.2.1 [Basic Installation], page 2), unpacking the newly constructed tarball, running `make`, `make check`, `make install`, as well as `make installcheck`, and even `make dist`,
- it tests VPATH builds with read-only source tree (see Section 2.2.6 [VPATH Builds], page 6),
- it makes sure `make clean`, `make distclean`, and `make uninstall` do not omit any file (see Section 2.2.2 [Standard Targets], page 4),
- and it checks that DESTDIR installations work (see Section 2.2.10 [DESTDIR], page 10).

All of these actions are performed in a temporary subdirectory, so that no root privileges are required.

Releasing a package that fails `make distcheck` means that one of the scenarios we presented will not work and some users will be disappointed. Therefore it is a good practice to release a package only after a successful `make distcheck`. This of course does not imply that the package will be flawless, but at least it will prevent some of the embarrassing errors you may find in packages released by people who have never heard about `distcheck` (like DESTDIR not working because of a typo, or a distributed file being erased by `make clean`, or even VPATH builds not working).

See Section 2.4.1 [Creating amhello], page 13, to recreate `amhello-1.0.tar.gz` using `make distcheck`. See Section 14.4 [Checking the Distribution], page 99, for more information about `distcheck`.

2.2.12 Automatic Dependency Tracking

Dependency tracking is performed as a side-effect of compilation. Each time the build system compiles a source file, it computes its list of dependencies (in C these are the header files included by the source being compiled). Later, any time `make` is run and a dependency appears to have changed, the dependent files will be rebuilt.
Automake generates code for automatic dependency tracking by default, unless the developer chooses to override it; for more information, see Section 8.19 [Dependencies], page 80.

When configure is executed, you can see it probing each compiler for the dependency mechanism it supports (several mechanisms can be used):

```
~/amhello-1.0 % ./configure --prefix /usr
...
checking dependency style of gcc... gcc3
...
```

Because dependencies are only computed as a side-effect of the compilation, no dependency information exists the first time a package is built. This is OK because all the files need to be built anyway: make does not have to decide which files need to be rebuilt. In fact, dependency tracking is completely useless for one-time builds and there is a configure option to disable this:

```
--disable-dependency-tracking
```

Speed up one-time builds.

Some compilers do not offer any practical way to derive the list of dependencies as a side-effect of the compilation, requiring a separate run (maybe of another tool) to compute these dependencies. The performance penalty implied by these methods is important enough to disable them by default. The option `--enable-dependency-tracking` must be passed to configure to activate them.

```
--enable-dependency-tracking
```

Do not reject slow dependency extractors.

See Section “Dependency Tracking Evolution” in Brief History of Automake, for some discussion about the different dependency tracking schemes used by Automake over the years.

2.2.13 Nested Packages

Although nesting packages isn’t something we would recommend to someone who is discovering the Autotools, it is a nice feature worthy of mention in this small advertising tour.

Autoconfiscated packages (that means packages whose build system have been created by Autoconf and friends) can be nested to arbitrary depth.

A typical setup is that package A will distribute one of the libraries it needs in a subdirectory. This library B is a complete package with its own GNU Build System. The configure script of A will run the configure script of B as part of its execution, building and installing A will also build and install B. Generating a distribution for A will also include B.

It is possible to gather several packages like this. GCC is a heavy user of this feature. This gives installers a single package to configure, build and install, while it allows developers to work on subpackages independently.

When configuring nested packages, the configure options given to the top-level configure are passed recursively to nested configure. A package that does not understand an option will ignore it, assuming it is meaningful to some other package.
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The command `configure --help=recursive` can be used to display the options supported by all the included packages.

See Section 7.4 [Subpackages], page 52, for an example setup.

2.3 How Autotools Help

There are several reasons why you may not want to implement the GNU Build System yourself (read: write a `configure` script and `Makefile`s yourself).

- As we have seen, the GNU Build System has a lot of features (see Section 2.2 [Use Cases], page 2). Some users may expect features you have not implemented because you did not need them.
- Implementing these features portably is difficult and exhausting. Think of writing portable shell scripts, and portable `Makefile`s, for systems you may not have handy. See Section “Portable Shell Programming” in *The Autoconf Manual*, to convince yourself.
- You will have to upgrade your setup to follow changes to the GNU Coding Standards.

The GNU Autotools take all this burden off your back and provide:

- Tools to create a portable, complete, and self-contained GNU Build System, from simple instructions. *Self-contained* meaning the resulting build system does not require the GNU Autotools.
- A central place where fixes and improvements are made: a bug-fix for a portability issue will benefit every package.

Yet there also exist reasons why you may want NOT to use the Autotools... For instance you may be already using (or used to) another incompatible build system. Autotools will only be useful if you do accept the concepts of the GNU Build System. People who have their own idea of how a build system should work will feel frustrated by the Autotools.

2.4 A Small Hello World

In this section we recreate the `amhello-1.0` package from scratch. The first subsection shows how to call the Autotools to instantiate the GNU Build System, while the second explains the meaning of the `configure.ac` and `Makefile.am` files read by the Autotools.

2.4.1 Creating `amhello-1.0.tar.gz`

Here is how we can recreate `amhello-1.0.tar.gz` from scratch. The package is simple enough so that we will only need to write 5 files. (You may copy them from the final `amhello-1.0.tar.gz` that is distributed with Automake if you do not want to write them.)

Create the following files in an empty directory.

- `src/main.c` is the source file for the `hello` program. We store it in the `src/` subdirectory, because later, when the package evolves, it will ease the addition of a `man/` directory for man pages, a `data/` directory for data files, etc.

```bash
~/amhello % cat src/main.c
#include <config.h>
#include <stdio.h>
```
int
main (void)
{
    puts ("Hello World!");
    puts ("This is " PACKAGE_STRING ");
    return 0;
}

- README contains some very limited documentation for our little package.

```
~/amhello % cat README
This is a demonstration package for GNU Automake.
Type 'info Automake' to read the Automake manual.
```

- Makefile.am and src/Makefile.am contain Automake instructions for these two directories.

```
~/amhello % cat src/Makefile.am
bin_PROGRAMS = hello
hello_SOURCES = main.c
~/amhello % cat Makefile.am
SUBDIRS = src
dist_doc_DATA = README
```

- Finally, configure.ac contains Autoconf instructions to create the configure script.

```
~/amhello % cat configure.ac
AC_INIT([amhello], [1.0], [bug-automake@gnu.org])
AM_INIT_AUTOMAKE([-Wall -Werror foreign])
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([
    Makefile
    src/Makefile
])
AC_OUTPUT
```

Once you have these five files, it is time to run the Autotools to instantiate the build system. Do this using the autoreconf command as follows:

```
~/amhello % autoreconf --install
configure.ac: installing './install-sh'
configure.ac: installing './missing'
src/Makefile.am: installing './depcomp'
```

At this point the build system is complete.

In addition to the three scripts mentioned in its output, you can see that autoreconf created four other files: configure, config.h.in, Makefile.in, and src/Makefile.in. The latter three files are templates that will be adapted to the system by configure under the names config.h, Makefile, and src/Makefile. Let’s do this:

```
~/amhello % ./configure
checking for a BSD-compatible install... /usr/bin/install -c
checking whether build environment is sane... yes
checking for gawk... no
checking for mawk... mawk
checking whether make sets $(MAKE)... yes
checking for gcc... gcc
checking for C compiler default output file name... a.out
checking whether the C compiler works... yes
checking whether we are cross compiling... no
checking for suffix of executables...
checking for suffix of object files... o
checking whether we are using the GNU C compiler... yes
checking whether gcc accepts -g... yes
checking for gcc option to accept ISO C89... none needed
checking for style of include used by make... GNU
checking dependency style of gcc... gcc3
configure: creating ./config.status
config.status: creating Makefile
config.status: creating src/Makefile
config.status: creating config.h
config.status: executing depfiles commands

You can see Makefile, src/Makefile, and config.h being created at the end after configure has probed the system. It is now possible to run all the targets we wish (see Section 2.2.2 [Standard Targets], page 4). For instance:

```
~/amhello % make
...
~/amhello % src/hello
Hello World!
This is amhello 1.0.
~/amhello % make distcheck
...
=====================================================================
amhhello-1.0 archives ready for distribution:
amhhello-1.0.tar.gz
=====================================================================
```

Note that running autoreconf is only needed initially when the GNU Build System does not exist. When you later change some instructions in a Makefile.am or configure.ac, the relevant part of the build system will be regenerated automatically when you execute make.

autoreconf is a script that calls autoconf, automake, and a bunch of other commands in the right order. If you are beginning with these tools, it is not important to figure out in which order all of these tools should be invoked and why. However, because Autoconf and Automake have separate manuals, the important point to understand is that autoconf is in charge of creating configure from configure.ac, while automake is in charge of creating Makefile.ins from Makefile.ams and configure.ac. This should at least direct you to the right manual when seeking answers.
2.4.2 amhello’s configure.ac Setup Explained

Let us begin with the contents of configure.ac.

```makefile
AC_INIT([amhello], [1.0], [bug-automake@gnu.org])
AM_INIT_AUTOMAKE([-Wall -Werror foreign])
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([
    Makefile
    src/Makefile
])
AC_OUTPUT
```

This file is read by both autoconf (to create configure) and automake (to create the various Makefile.ins). It contains a series of M4 macros that will be expanded as shell code to finally form the configure script. We will not elaborate on the syntax of this file, because the Autoconf manual has a whole section about it (see Section “Writing configure.ac” in The Autoconf Manual).

The macros prefixed with AC_ are Autoconf macros, documented in the Autoconf manual (see Section “Autoconf Macro Index” in The Autoconf Manual). The macros that start with AM_ are Automake macros, documented later in this manual (see Section B.1 [Macro Index], page 166).

The first two lines of configure.ac initialize Autoconf and Automake. AC_INIT takes in as parameters the name of the package, its version number, and a contact address for bug-reports about the package (this address is output at the end of ./configure --help, for instance). When adapting this setup to your own package, by all means please do not blindly copy Automake’s address: use the mailing list of your package, or your own mail address.

The argument to AM_INIT_AUTOMAKE is a list of options for automake (see Chapter 17 [Options], page 117). -Wall and -Werror ask automake to turn on all warnings and report them as errors. We are speaking of Automake warnings here, such as dubious instructions in Makefile.am. This has absolutely nothing to do with how the compiler will be called, even though it may support options with similar names. Using -Wall -Werror is a safe setting when starting to work on a package: you do not want to miss any issues. Later you may decide to relax things a bit. The foreign option tells Automake that this package will not follow the GNU Standards. GNU packages should always distribute additional files such as ChangeLog, AUTHORS, etc. We do not want automake to complain about these missing files in our small example.

The AC_PROG_CC line causes the configure script to search for a C compiler and define the variable CC with its name. The src/Makefile.in file generated by Automake uses the variable CC to build hello, so when configure creates src/Makefile from src/Makefile.in, it will define CC with the value it has found. If Automake is asked to create a Makefile.in that uses CC but configure.ac does not define it, it will suggest you add a call to AC_PROG_CC.

The AC_CONFIG_HEADERS([config.h]) invocation causes the configure script to create a config.h file gathering ‘#define’s defined by other macros in configure.ac. In our case,
the AC_INIT macro already defined a few of them. Here is an excerpt of config.h after configure has run:

```plaintext
...  
/* Define to the address where bug reports for this package should be sent. */
#define PACKAGE_BUGREPORT "bug-automake@gnu.org"

/* Define to the full name and version of this package. */
#define PACKAGE_STRING "amhello 1.0"
... 
```

As you probably noticed, src/main.c includes config.h so it can use PACKAGE_STRING. In a real-world project, config.h can grow really big, with one ‘#define’ per feature probed on the system.

The AC_CONFIG_FILES macro declares the list of files that configure should create from their *.in templates. Automake also scans this list to find the Makefile.am files it must process. (This is important to remember: when adding a new directory to your project, you should add its Makefile to this list, otherwise Automake will never process the new Makefile.am you wrote in that directory.)

Finally, the AC_OUTPUT line is a closing command that actually produces the part of the script in charge of creating the files registered with AC_CONFIG_HEADERS and AC_CONFIG_FILES.

When starting a new project, we suggest you start with such a simple configure.ac, and gradually add the other tests it requires. The command autoscan can also suggest a few of the tests your package may need (see Section “Using autoscan to Create configure.ac” in The Autoconf Manual).

### 2.4.3 amhello’s Makefile.am Setup Explained

We now turn to src/Makefile.am. This file contains Automake instructions to build and install hello.

```plaintext
bin_PROGRAMS = hello
hello_SOURCES = main.c
```

A Makefile.am has the same syntax as an ordinary Makefile. When automake processes a Makefile.am it copies the entire file into the output Makefile.in (that will be later turned into Makefile by configure) but will react to certain variable definitions by generating some build rules and other variables. Often Makefile.ams contain only a list of variable definitions as above, but they can also contain other variable and rule definitions that automake will pass along without interpretation.

Variables that end with _PROGRAMS are special variables that list programs that the resulting Makefile should build. In Automake speak, this _PROGRAMS suffix is called a primary; Automake recognizes other primaries such as _SCRIPTS, _DATA, _LIBRARIES, etc. corresponding to different types of files.

The ‘bin’ part of the bin_PROGRAMS tells automake that the resulting programs should be installed in bindir. Recall that the GNU Build System uses a set of variables to denote destination directories and allow users to customize these locations (see Section 2.2.3 [Standard Directory Variables], page 4). Any such directory variable can be put in front of a primary (omitting the dir suffix) to tell automake where to install the listed files.
Programs need to be built from source files, so for each program prog listed in a _PROGRAMS variable, automake will look for another variable named prog_SOURCES listing its source files. There may be more than one source file: they will all be compiled and linked together.

Automake also knows that source files need to be distributed when creating a tarball (unlike built programs). So a side-effect of this hello_SOURCES declaration is that main.c will be part of the tarball created by make dist.

Finally here are some explanations regarding the top-level Makefile.am.

    SUBDIRS = src
dist_doc_DATA = README

SUBDIRS is a special variable listing all directories that make should recurse into before processing the current directory. So this line is responsible for make building src/hello even though we run it from the top-level. This line also causes make install to install src/hello before installing README (not that this order matters).

The line dist_doc_DATA = README causes README to be distributed and installed in docdir. Files listed with the _DATA primary are not automatically part of the tarball built with make dist, so we add the dist_ prefix so they get distributed. However, for README it would not have been necessary: automake automatically distributes any README file it encounters (the list of other files automatically distributed is presented by automake --help). The only important effect of this second line is therefore to install README during make install.

One thing not covered in this example is accessing the installation directory values (see Section 2.2.3 [Standard Directory Variables], page 4) from your program code, that is, converting them into defined macros. For this, see Section “Defining Directories” in The Autoconf Manual.

## 3 General ideas

The following sections cover a few basic ideas that will help you understand how Automake works.

### 3.1 General Operation

Automake works by reading a Makefile.am and generating a Makefile.in. Certain variables and rules defined in the Makefile.am instruct Automake to generate more specialized code; for instance, a bin_PROGRAMS variable definition will cause rules for compiling and linking programs to be generated.

The variable definitions and rules in the Makefile.am are copied mostly verbatim into the generated file, with all variable definitions preceding all rules. This allows you to add almost arbitrary code into the generated Makefile.in. For instance, the Automake distribution includes a non-standard rule for the git-dist target, which the Automake maintainer uses to make distributions from the source control system.

Note that most GNU make extensions are not recognized by Automake. Using such extensions in a Makefile.am will lead to errors or confusing behavior.
A special exception is that the GNU make append operator, `+=`, is supported. This operator appends its right hand argument to the variable specified on the left. Automake will translate the operator into an ordinary `=` operator; `+=` will thus work with any make program.

Automake tries to keep comments grouped with any adjoining rules or variable definitions.

Generally, Automake is not particularly smart in the parsing of unusual Makefile constructs, so you’re advised to avoid fancy constructs or “creative” use of whitespaces. For example, TAB characters cannot be used between a target name and the following `:` character, and variable assignments shouldn’t be indented with TAB characters. Also, using more complex macro in target names can cause trouble:

```plaintext
% cat Makefile.am
$(FOO:=x): bar
% automake
Makefile.am:1: bad characters in variable name '$(FOO'
Makefile.am:1: ':=','-style assignments are not portable
```

A rule defined in `Makefile.am` generally overrides any such rule of a similar name that would be automatically generated by `automake`. Although this is a supported feature, it is generally best to avoid making use of it, as sometimes the generated rules are very particular.

Similarly, a variable defined in `Makefile.am` or AC_SUBSTed from `configure.ac` will override any definition of the variable that `automake` would ordinarily create. This feature is more often useful than the ability to override a rule. Be warned that many of the variables generated by `automake` are considered to be for internal use only, and their names might change in future releases.

When examining a variable definition, Automake will recursively examine variables referenced in the definition. For example, if Automake is looking at the content of `foo_SOURCES` in this snippet

```plaintext
xs = a.c b.c
foo_SOURCES = c.c $(xs)
```

it would use the files `a.c`, `b.c`, and `c.c` as the contents of `foo_SOURCES`.

Automake also allows a form of comment that is not copied into the output; all lines beginning with `##` (leading spaces allowed) are completely ignored by Automake.

It is customary to make the first line of `Makefile.am` read:

```plaintext
## Process this file with automake to produce Makefile.in
```

### 3.2 Strictness

While Automake is intended to be used by maintainers of GNU packages, it does make some effort to accommodate those who wish to use it, but do not want to use all the GNU conventions.

To this end, Automake supports three levels of strictness—the strictness indicating how stringently Automake should check standards conformance.
The valid strictness levels are:

- **foreign** Automake will check for only those things that are absolutely required for proper operations. For instance, whereas GNU standards dictate the existence of a NEWS file, it will not be required in this mode. This strictness will also turn off some warnings by default (among them, portability warnings). The name comes from the fact that Automake is intended to be used for GNU programs; these relaxed rules are not the standard mode of operation.

- **gnu** Automake will check—as much as possible—for compliance to the GNU standards for packages. This is the default.

- **gnits** Automake will check for compliance to the as-yet-unwritten Gnits standards. These are based on the GNU standards, but are even more detailed. Unless you are a Gnits standards contributor, it is recommended that you avoid this option until such time as the Gnits standard is actually published (which may never happen).

See Chapter 22 [Gnits], page 130, for more information on the precise implications of the strictness level.

Automake also has a special (and today deprecated) “cygnus” mode that is similar to strictness but handled differently. This mode is useful for packages that are put into a “Cygnus” style tree (e.g., older versions of the GCC and gdb trees). See Chapter 23 [Cygnus], page 131, for more information on this mode. Please note that this mode is deprecated and will be removed in the next major Automake release (1.13); you must avoid its use in new packages, and should stop using it in existing packages as well.

### 3.3 The Uniform Naming Scheme

Automake variables generally follow a uniform naming scheme that makes it easy to decide how programs (and other derived objects) are built, and how they are installed. This scheme also supports configure time determination of what should be built.

At make time, certain variables are used to determine which objects are to be built. The variable names are made of several pieces that are concatenated together.

The piece that tells automake what is being built is commonly called the **primary**. For instance, the primary PROGRAMS holds a list of programs that are to be compiled and linked.

A different set of names is used to decide where the built objects should be installed. These names are prefixes to the primary, and they indicate which standard directory should be used as the installation directory. The standard directory names are given in the GNU standards (see Section “Directory Variables” in The GNU Coding Standards). Automake extends this list with pkgdatadir, pkgincludedir, pkglibdir, and pkglibexecdir; these are the same as the non-'pkg' versions, but with ‘$(PACKAGE)’ appended. For instance, pkglibdir is defined as ‘$(libdir)/$(PACKAGE)’.

For each primary, there is one additional variable named by prepending ‘EXTRA_’ to the primary name. This variable is used to list objects that may or may not be built, depending on what configure decides. This variable is required because Automake must statically know the entire list of objects that may be built in order to generate a Makefile.in that will work in all cases.
For instance, `cpio` decides at configure time which programs should be built. Some of the programs are installed in `bindir`, and some are installed in `sbin`: 

```bash
EXTRA_PROGRAMS = mt rmt
bin_PROGRAMS = cpio pax
sbin_PROGRAMS = $(MORE_PROGRAMS)
```

Defining a primary without a prefix as a variable, e.g., `PROGRAMS`, is an error.

Note that the common `dir` suffix is left off when constructing the variable names; thus one writes `bin_PROGRAMS` and not `bindir_PROGRAMS`.

Not every sort of object can be installed in every directory. Automake will flag those attempts it finds in error (but see below how to override the check if you really need to). Automake will also diagnose obvious misspellings in directory names.

Sometimes the standard directories—even as augmented by Automake—are not enough. In particular it is sometimes useful, for clarity, to install objects in a subdirectory of some predefined directory. To this end, Automake allows you to extend the list of possible installation directories. A given prefix (e.g., `zar`) is valid if a variable of the same name with `dir` appended is defined (e.g., `zardir`).

For instance, the following snippet will install `file.xml` into `(datadir)/xml`.

```bash
xmldir = $(datadir)/xml
xml_DATA = file.xml
```

This feature can also be used to override the sanity checks Automake performs to diagnose suspicious directory/primary couples (in the unlikely case these checks are undesirable, and you really know what you’re doing). For example, Automake would error out on this input:

```bash
# Forbidden directory combinations, automake will error out on this.
pkglib_PROGRAMS = foo
doc_LIBRARIES = libquux.a
```

but it will succeed with this:

```bash
# Work around forbidden directory combinations. Do not use this
# without a very good reason!
my_execbindir = $(pkglibdir)
my_doclibdir = $(docdir)
my_execbin_PROGRAMS = foo
my_doclib_LIBRARIES = libquux.a
```

The `exec` substring of the `my_execbindir` variable lets the files be installed at the right time (see Section 12.2 [The Two Parts of Install], page 95).

The special prefix `noinst_` indicates that the objects in question should be built but not installed at all. This is usually used for objects required to build the rest of your package, for instance static libraries (see Section 8.2 [A Library], page 57), or helper scripts.

The special prefix `check_` indicates that the objects in question should not be built until the `make check` command is run. Those objects are not installed either.

The current primary names are `PROGRAMS`, `LIBRARIES`, `LTLIBRARIES`, `LISP`, `PYTHON`, `JAVA`, `SCRIPTS`, `DATA`, `HEADERS`, `MANS`, and `TEXINFOS`.

Some primaries also allow additional prefixes that control other aspects of automake’s behavior. The currently defined prefixes are `dist_`, `nodist_`, `nobase_`, and `notrans_`. 
These prefixes are explained later (see Section 8.4 [Program and Library Variables], page 64) (see Section 11.2 [Man Pages], page 93).

### 3.4 Staying below the command line length limit

Traditionally, most unix-like systems have a length limitation for the command line arguments and environment contents when creating new processes (see for example http://www.in-ulm.de/~mascheck/various/argmax/ for an overview on this issue), which of course also applies to commands spawned by `make`. POSIX requires this limit to be at least 4096 bytes, and most modern systems have quite high limits (or are unlimited).

In order to create portable Makefiles that do not trip over these limits, it is necessary to keep the length of file lists bounded. Unfortunately, it is not possible to do so fully transparently within Automake, so your help may be needed. Typically, you can split long file lists manually and use different installation directory names for each list. For example,

```bash
data_DATA = file1 ... fileN fileN+1 ... file2N
```

may also be written as

```bash
data_DATA = file1 ... fileN
data2dir = $(datadir)
data2_DATA = fileN+1 ... file2N
```

and will cause Automake to treat the two lists separately during `make install`. See Section 12.2 [The Two Parts of Install], page 95, for choosing directory names that will keep the ordering of the two parts of installation. Note that `make dist` may still only work on a host with a higher length limit in this example.

Automake itself employs a couple of strategies to avoid long command lines. For example, when `$\{srcdir\}/` is prepended to file names, as can happen with above `$\{data_DATA\}` lists, it limits the amount of arguments passed to external commands.

Unfortunately, some system’s `make` commands may prepend `VPATH` prefixes like `$\{srcdir\}/` to file names from the source tree automatically (see Section “Automatic Rule Rewriting” in The Autoconf Manual). In this case, the user may have to switch to use GNU Make, or refrain from using VPATH builds, in order to stay below the length limit.

For libraries and programs built from many sources, convenience archives may be used as intermediates in order to limit the object list length (see Section 8.3.5 [Libtool Convenience Libraries], page 61).

### 3.5 How derived variables are named

Sometimes a Makefile variable name is derived from some text the maintainer supplies. For instance, a program name listed in `\_PROGRAMS` is rewritten into the name of a `\_SOURCES` variable. In cases like this, Automake canonicalizes the text, so that program names and the like do not have to follow Makefile variable naming rules. All characters in the name except for letters, numbers, the strudel (@), and the underscore are turned into underscores when making variable references.

For example, if your program is named `sniff-glue`, the derived variable name would be `\_sniff\_glue\_SOURCES`, not `\_sniff\_glue\_SOURCES`. Similarly the sources for a library named `libmumble++.a` should be listed in the `\_libmumble+++\_SOURCES` variable.
The strudel is an addition, to make the use of Autoconf substitutions in variable names less obfuscating.

### 3.6 Variables reserved for the user

Some Makefile variables are reserved by the GNU Coding Standards for the use of the “user”—the person building the package. For instance, CFLAGS is one such variable.

Sometimes package developers are tempted to set user variables such as CFLAGS because it appears to make their job easier. However, the package itself should never set a user variable, particularly not to include switches that are required for proper compilation of the package. Since these variables are documented as being for the package builder, that person rightfully expects to be able to override any of these variables at build time.

To get around this problem, Automake introduces an automake-specific shadow variable for each user flag variable. (Shadow variables are not introduced for variables like CC, where they would make no sense.) The shadow variable is named by prepending ‘AM_’ to the user variable’s name. For instance, the shadow variable for YFLAGS is AM_YFLAGS. The package maintainer—that is, the author(s) of the Makefile.am and configure.ac files—may adjust these shadow variables however necessary.

See Section 28.6 [Flag Variables Ordering], page 145, for more discussion about these variables and how they interact with per-target variables.

### 3.7 Programs automake might require

Automake sometimes requires helper programs so that the generated Makefile can do its work properly. There are a fairly large number of them, and we list them here.

Although all of these files are distributed and installed with Automake, a couple of them are maintained separately. The Automake copies are updated before each release, but we mention the original source in case you need more recent versions.

**ar-lib**
This is a wrapper primarily for the Microsoft lib archiver, to make it more POSIX-like.

**compile**
This is a wrapper for compilers that do not accept options -c and -o at the same time. It is only used when absolutely required. Such compilers are rare, with the Microsoft C/C++ Compiler as the most notable exception. This wrapper also makes the following common options available for that compiler, while performing file name translation where needed: -I, -L, -l, -Wl, and -Xlinker.

**config.guess**
**config.sub**
These two programs compute the canonical triplets for the given build, host, or target architecture. These programs are updated regularly to support new architectures and fix probes broken by changes in new kernel versions. Each new release of Automake comes with up-to-date copies of these programs. If your copy of Automake is getting old, you are encouraged to fetch the latest versions of these files from http://savannah.gnu.org/git/?group=config before making a release.
depcomp  This program understands how to run a compiler so that it will generate not only the desired output but also dependency information that is then used by the automatic dependency tracking feature (see Section 8.19 [Dependencies], page 80).

elisp-comp  This program is used to byte-compile Emacs Lisp code.

install-sh  This is a replacement for the install program that works on platforms where install is unavailable or unusable.

mdate-sh  This script is used to generate a version.texi file. It examines a file and prints some date information about it.

missing  This wraps a number of programs that are typically only required by maintainers. If the program in question doesn’t exist, missing prints an informative warning and attempts to fix things so that the build can continue.

mkinstalldirs  This script used to be a wrapper around ‘mkdir -p’, which is not portable. Now we prefer to use ‘install-sh -d’ when configure finds that ‘mkdir -p’ does not work, this makes one less script to distribute.

For backward compatibility mkinstalldirs is still used and distributed when automake finds it in a package. But it is no longer installed automatically, and it should be safe to remove it.

py-compile  This is used to byte-compile Python scripts.

test-driver  This implements the default test driver offered by the parallel testsuite harness.

texinfo.tex  Not a program, this file is required for ‘make dvi’, ‘make ps’ and ‘make pdf’ to work when Texinfo sources are in the package. The latest version can be downloaded from http://www.gnu.org/software/texinfo/.

ylwrap  This program wraps lex and yacc to rename their output files. It also ensures that, for instance, multiple yacc instances can be invoked in a single directory in parallel.

4 Some example packages

This section contains two small examples.

The first example (see Section 4.1 [Complete], page 25) assumes you have an existing project already using Autoconf, with handcrafted Makefiles, and that you want to convert it to using Automake. If you are discovering both tools, it is probably better that you look at the Hello World example presented earlier (see Section 2.4 [Hello World], page 13).

The second example (see Section 4.2 [true], page 25) shows how two programs can be built from the same file, using different compilation parameters. It contains some technical digressions that are probably best skipped on first read.
4.1 A simple example, start to finish

Let’s suppose you just finished writing zardoz, a program to make your head float from vortex to vortex. You’ve been using Autoconf to provide a portability framework, but your Makefile.ins have been ad-hoc. You want to make them bulletproof, so you turn to Automake.

The first step is to update your configure.ac to include the commands that automake needs. The way to do this is to add an AM_INIT_AUTOMAKE call just after AC_INIT:

```am_init([zardoz], [1.0])
AM_INIT_AUTOMAKE```

Since your program doesn’t have any complicating factors (e.g., it doesn’t use gettext, it doesn’t want to build a shared library), you’re done with this part. That was easy!

Now you must regenerate configure. But to do that, you’ll need to tell autoconf how to find the new macro you’ve used. The easiest way to do this is to use the aclocal program to generate your aclocal.m4 for you. But wait... maybe you already have an aclocal.m4, because you had to write some hairy macros for your program. The aclocal program lets you put your own macros into acinclude.m4, so simply rename and then run:

```mv aclocal.m4 acinclude.m4
aclocal
autoconf```

Now it is time to write your Makefile.am for zardoz. Since zardoz is a user program, you want to install it where the rest of the user programs go: bindir. Additionally, zardoz has some Texinfo documentation. Your configure.ac script uses AC_REPLACE_FUNCS, so you need to link against ‘$(LIBOBJS)’. So here’s what you’d write:

```bin_PROGRAMS = zardoz
zardoz_SOURCES = main.c head.c float.c vortex9.c gun.c
zardoz_LDADD = $(LIBOBJS)

info_TEXINFOS = zardoz.texi```

Now you can run ‘automake --add-missing’ to generate your Makefile.in and grab any auxiliary files you might need, and you’re done!

4.2 Building true and false

Here is another, trickier example. It shows how to generate two programs (true and false) from the same source file (true.c). The difficult part is that each compilation of true.c requires different cpp flags.

```bin_PROGRAMS = true false
default_SOURCES =
default_LDADD = false.o

true.o: true.c
    $(COMPILE) -DEXIT_CODE=0 -c true.c

false.o: true.c```
$(COMPILE) -DEXIT_CODE=1 -o false.o -c true.c

Note that there is no true_SOURCES definition. Automake will implicitly assume that there is a source file named true.c (see Section 8.5 [Default SOURCES], page 68), and define rules to compile true.o and link true. The ‘true.o: true.c’ rule supplied by the above Makefile.am, will override the Automake generated rule to build true.o.

false_SOURCES is defined to be empty—that way no implicit value is substituted. Because we have not listed the source of false, we have to tell Automake how to link the program. This is the purpose of the false_LDADD line. A false_DEPENDENCIES variable, holding the dependencies of the false target will be automatically generated by Automake from the content of false_LDADD.

The above rules won’t work if your compiler doesn’t accept both -c and -o. The simplest fix for this is to introduce a bogus dependency (to avoid problems with a parallel make):

true.o: true.c false.o
  $(COMPILE) -DEXIT_CODE=0 -c true.c

false.o: true.c
  $(COMPILE) -DEXIT_CODE=1 -c true.c && mv true.o false.o

As it turns out, there is also a much easier way to do this same task. Some of the above technique is useful enough that we’ve kept the example in the manual. However if you were to build true and false in real life, you would probably use per-program compilation flags, like so:

bin_PROGRAMS = false true

false_SOURCES = true.c
false_CPPFLAGS = -DEXIT_CODE=1

true_SOURCES = true.c
true_CPPFLAGS = -DEXIT_CODE=0

In this case Automake will cause true.c to be compiled twice, with different flags. In this instance, the names of the object files would be chosen by automake; they would be false-true.o and true-true.o. (The name of the object files rarely matters.)

5 Creating a Makefile.in

To create all the Makefile.in.s for a package, run the automake program in the top level directory, with no arguments. automake will automatically find each appropriate Makefile.am (by scanning configure.ac; see Chapter 6 [configure], page 29) and generate the corresponding Makefile.in. Note that automake has a rather simplistic view of what constitutes a package; it assumes that a package has only one configure.ac, at the top. If your package has multiple configure.acs, then you must run automake in each directory holding a configure.ac. (Alternatively, you may rely on Autoconf’s autoreconf, which is able to recurse your package tree and run automake where appropriate.)

You can optionally give automake an argument; .am is appended to the argument and the result is used as the name of the input file. This feature is generally only used to
automatically rebuild an out-of-date `Makefile.in`. Note that `automake` must always be run from the topmost directory of a project, even if being used to regenerate the `Makefile.in` in some subdirectory. This is necessary because `automake` must scan `configure.ac`, and because `automake` uses the knowledge that a `Makefile.in` is in a subdirectory to change its behavior in some cases.

Automake will run `autoconf` to scan `configure.ac` and its dependencies (i.e., `aclocal.m4` and any included file), therefore `autoconf` must be in your `PATH`. If there is an AUTOCONF variable in your environment it will be used instead of `autoconf`, this allows you to select a particular version of Autoconf. By the way, don’t misunderstand this paragraph: `automake` runs `autoconf` to scan your `configure.ac`, this won’t build `configure` and you still have to run `autoconf` yourself for this purpose.

`automake` accepts the following options:

- `-a`
  **--add-missing**
  Automake requires certain common files to exist in certain situations; for instance, `config.guess` is required if `configure.ac` invokes AC_CANONICAL_HOST. Automake is distributed with several of these files (see Section 3.7 [Auxiliary Programs], page 23); this option will cause the missing ones to be automatically added to the package, whenever possible. In general if Automake tells you a file is missing, try using this option. By default Automake tries to make a symbolic link pointing to its own copy of the missing file; this can be changed with **--copy**.

  Many of the potentially-missing files are common scripts whose location may be specified via the AC_CONFIG_AUX_DIR macro. Therefore, AC_CONFIG_AUX_DIR’s setting affects whether a file is considered missing, and where the missing file is added (see Section 6.2 [Optional], page 31).

  In some strictness modes, additional files are installed, see Chapter 22 [Gnits], page 130, for more information.

- `--libdir=dir`
  Look for Automake data files in directory `dir` instead of in the installation directory. This is typically used for debugging.

- `--print-libdir`
  Print the path of the installation directory containing Automake-provided scripts and data files (like e.g., `texinfo.texi` and `install-sh`).

- `-c`
  **--copy**
  When used with **--add-missing**, causes installed files to be copied. The default is to make a symbolic link.

- `--cygnus`
  Causes the generated `Makefile.ins` to follow Cygnum rules, instead of GNU or Gnits rules. For more information, see Chapter 23 [Cygnum], page 131. Note that this mode of operation is deprecated, and will be removed in the next major Automake release (1.13).
When used with --add-missing, causes standard files to be reinstalled even if they already exist in the source tree. This involves removing the file from the source tree before creating the new symlink (or, with --copy, copying the new file).

--foreign
Set the global strictness to foreign. For more information, see Section 3.2 [Strictness], page 19.

--gnits
Set the global strictness to gnits. For more information, see Chapter 22 [Gnits], page 130.

--gnu
Set the global strictness to gnu. For more information, see Chapter 22 [Gnits], page 130. This is the default strictness.

--help
Print a summary of the command line options and exit.

-i
--ignore-deps
This disables the dependency tracking feature in generated Makefile; see Section 8.19 [Dependencies], page 80.

--include-deps
This enables the dependency tracking feature. This feature is enabled by default. This option is provided for historical reasons only and probably should not be used.

--no-force
Ordinarily automake creates all Makefile.ins mentioned in configure.ac. This option causes it to only update those Makefile.ins that are out of date with respect to one of their dependents.

-o dir
--output-dir=dir
Put the generated Makefile.in in the directory dir. Ordinarily each Makefile.in is created in the directory of the corresponding Makefile.am. This option is deprecated and will be removed in a future release.

-v
--verbose
Cause Automake to print information about which files are being read or created.

--version
Print the version number of Automake and exit.

-W CATEGORY
--warnings=category
Output warnings falling in category. category can be one of:

gnu warnings related to the GNU Coding Standards (see The GNU Coding Standards).
obsolete obsolete features or constructions
override user redefinitions of Automake rules or variables
portability portability issues (e.g., use of make features that are known to be not portable)
extra-portability extra portability issues related to obscure tools. One example of such a tool is the Microsoft lib archiver.
syntax weird syntax, unused variables, typos
unsupported unsupported or incomplete features
all all the warnings
none turn off all the warnings
error treat warnings as errors

A category can be turned off by prefixing its name with 'no-'. For instance, 
-Wno-syntax will hide the warnings about unused variables.

The categories output by default are 'syntax' and 'unsupported'. Additionally, 'gnu' and 'portability' are enabled in --gnu and --gnits strictness. On the other hand, the silent-rules options (see Chapter 17 [Options], page 117) turns off portability warnings about recursive variable expansions.

Turning off 'portability' will also turn off 'extra-portability', and similarly turning on 'extra-portability' will also turn on 'portability'. However, turning on 'portability' or turning off 'extra-portability' will not affect the other category.

The environment variable WARNINGS can contain a comma separated list of categories to enable. It will be taken into account before the command-line switches, this way -Wnone will also ignore any warning category enabled by WARNINGS. This variable is also used by other tools like autoconf; unknown categories are ignored for this reason.

If the environment variable AUTOMAKE_JOBS contains a positive number, it is taken as the maximum number of Perl threads to use in automake for generating multiple Makefile.in files concurrently. This is an experimental feature.

6 Scanning configure.ac, using aclocal

Automake scans the package's configure.ac to determine certain information about the package. Some autoconf macros are required and some variables must be defined in configure.ac. Automake will also use information from configure.ac to further tailor its output.

Automake also supplies some Autoconf macros to make the maintenance easier. These macros can automatically be put into your aclocal.m4 using the aclocal program.
6.1 Configuration requirements

The one real requirement of Automake is that your configure.ac call `AM_INIT_AUTOMAKE`. This macro does several things that are required for proper Automake operation (see Section 6.4 [Macros], page 44).

Here are the other macros that Automake requires but which are not run by `AM_INIT_AUTOMAKE`:

**AC_CONFIG_FILES**
**AC_OUTPUT**

These two macros are usually invoked as follows near the end of configure.ac.

```
...  
AC_CONFIG_FILES([  
    Makefile  
    doc/Makefile  
    src/Makefile  
    src/lib/Makefile  
    ...  
])  
AC_OUTPUT
```

Automake uses these to determine which files to create (see Section “Creating Output Files” in The Autoconf Manual). A listed file is considered to be an Automake generated Makefile if there exists a file with the same name and the .am extension appended. Typically, ‘AC_CONFIG_FILES([foo/Makefile])’ will cause Automake to generate foo/Makefile.in if foo/Makefile.am exists.

When using AC_CONFIG_FILES with multiple input files, as in

```
AC_CONFIG_FILES([Makefile:top.in:Makefile.in:bot.in])
```

automake will generate the first .in input file for which a .am file exists. If no such file exists the output file is not considered to be generated by Automake. Files created by AC_CONFIG_FILES, be they Automake Makefiles or not, are all removed by `make distclean`. Their inputs are automatically distributed, unless they are the output of prior AC_CONFIG_FILES commands. Finally, rebuild rules are generated in the Automake Makefile existing in the subdirectory of the output file, if there is one, or in the top-level Makefile otherwise.

The above machinery (cleaning, distributing, and rebuilding) works fine if the AC_CONFIG_FILES specifications contain only literals. If part of the specification uses shell variables, automake will not be able to fulfill this setup, and you will have to complete the missing bits by hand. For instance, on

```
file=input  
...  
AC_CONFIG_FILES([output:$file],, [file=$file])
```

automake will output rules to clean output, and rebuild it. However the rebuild rule will not depend on input, and this file will not be distributed either. (You must add ‘EXTRA_DIST = input’ to your Makefile.am if input is a source file.) Similarly

```
file=output
```
file2= outf:in
...
AC_CONFIG_FILES([file:input], [file=$file])
AC_CONFIG_FILES([file2], [file2=$file2])

will only cause input to be distributed. No file will be cleaned automatically
(add ‘DISTCLEANFILES = output out’ yourself), and no rebuild rule will be out-
put.

Obviously automake cannot guess what value ‘$file’ is going to hold later when
configure is run, and it cannot use the shell variable ‘$file’ in a Makefile.
However, if you make reference to ‘$file’ as ‘${file}’ (i.e., in a way that
is compatible with make’s syntax) and furthermore use AC_SUBST to ensure
that ‘${file}’ is meaningful in a Makefile, then automake will be able to use
‘${file}’ to generate all of these rules. For instance, here is how the Automake
package itself generates versioned scripts for its test suite:

   AC_SUBST([APIVERSION], ...)
...
AC_CONFIG_FILES(
   [tests/aclocal-${APIVERSION}:tests/aclocal.in],
   [chmod +x tests/aclocal-${APIVERSION}],
   [APIVERSION=${APIVERSION}])
AC_CONFIG_FILES(
   [tests/automake-${APIVERSION}:tests/automake.in],
   [chmod +x tests/automake-${APIVERSION}]))

Here cleaning, distributing, and rebuilding are done automatically, because
‘${APIVERSION}’ is known at make-time.

Note that you should not use shell variables to declare Makefile files for which
automake must create Makefile.in. Even AC_SUBST does not help here, be-
cause automake needs to know the file name when it runs in order to check
whether Makefile.am exists. (In the very hairy case that your setup requires
such use of variables, you will have to tell Automake which Makefile.ins to
generate on the command-line.)

It is possible to let automake emit conditional rules for AC_CONFIG_FILES with
the help of AM_COND_IF (see Section 6.2 [Optional], page 31).

To summarize:

- Use literals for Makefiles, and for other files whenever possible.
- Use ‘$file’ (or ‘${file}’) without ‘AC_SUBST([file])’ for files that
  automake should ignore.
- Use ‘${file}’ and ‘AC_SUBST([file])’ for files that automake should not
  ignore.

6.2 Other things Automake recognizes

Every time Automake is run it calls Autoconf to trace configure.ac. This way it can
recognize the use of certain macros and tailor the generated Makefile.in appropriately.
Currently recognized macros and their effects are:
AC_CANONICAL_BUILD
AC_CANONICAL_HOST
AC_CANONICAL_TARGET
Automake will ensure that `config.guess` and `config.sub` exist. Also, the
`Makefile` variables `build_triplet`, `host_triplet` and `target_triplet` are
introduced. See Section “Getting the Canonical System Type” in `The Autoconf
Manual`.

AC_CONFIG_AUX_DIR
Automake will look for various helper scripts, such as `install-sh`, in the
directory named in this macro invocation. (The full list of scripts is: `ar-lib`,
`config.guess`, `config.sub`, `depcomp`, `elisp-comp`, `compile`, `install-sh`,
`ltmain.sh`, `mdate-sh`, `missing`, `mkinstalldirs`, `py-compile`, `test-driver`,
texinfo.tex, `ylwrap`.) Not all scripts are always searched for; some scripts
will only be sought if the generated `Makefile.in` requires them.

If `AC_CONFIG_AUX_DIR` is not given, the scripts are looked for in their standard
locations. For `mdate-sh`, `texinfo.tex`, and `ylwrap`, the standard location
is the source directory corresponding to the current `Makefile.am`. For the
rest, the standard location is the first one of `..`, `..`, or `../..` (relative to the
top source directory) that provides any one of the helper scripts. See Section

Required files from `AC_CONFIG_AUX_DIR` are automatically distributed, even if
there is no `Makefile.am` in this directory.

AC_CONFIG_LIBOBJ_DIR
Automake will require the sources file declared with `AC_LIBSOURCE` (see below)
in the directory specified by this macro.

AC_CONFIG_HEADERS
Automake will generate rules to rebuild these headers. Older versions of
Automake required the use of `AM_CONFIG_HEADER` (see Section 6.4 [Macros],
page 44); this is no longer the case.

As with `AC_CONFIG_FILES` (see Section 6.1 [Requirements], page 30), parts of
the specification using shell variables will be ignored as far as cleaning, dis-
tributing, and rebuilding is concerned.

AC_CONFIG_LINKS
Automate will generate rules to remove `configure` generated links on `make
distclean` and to distribute named source files as part of `make dist`.

As for `AC_CONFIG_FILES` (see Section 6.1 [Requirements], page 30), parts of
the specification using shell variables will be ignored as far as cleaning and
distributing is concerned. (There are no rebuild rules for links.)

AC_LIBOBJ
AC_LIBSOURCE
AC_LIBSOURCES
Automake will automatically distribute any file listed in `AC_LIBSOURCE` or `AC_
LIBSOURCES`. 
Note that the `AC_LIBOBJ` macro calls `AC_LIBSOURCE`. So if an Autoconf macro is documented to call `AC_LIBOBJ([file])`, then `file.c` will be distributed automatically by Automake. This encompasses many macros like `AC_FUNC_ALLOC`, `AC_FUNC_MEMCMP`, `AC_REPLACE_FUNCS`, and others.

By the way, direct assignments to `LIBOBJS` are no longer supported. You should always use `AC_LIBOBJ` for this purpose. See Section “AC_LIBOBJ vs. LIBOBJS” in The Autoconf Manual.

**AC_PROG_RANLIB**
This is required if any libraries are built in the package. See Section “Particular Program Checks” in The Autoconf Manual.

**AC_PROG_CXX**
This is required if any C++ source is included. See Section “Particular Program Checks” in The Autoconf Manual.

**AC_PROG_OBJC**
This is required if any Objective C source is included. See Section “Particular Program Checks” in The Autoconf Manual.

**AC_PROG_OBJCXX**
This is required if any Objective C++ source is included. See Section “Particular Program Checks” in The Autoconf Manual.

**AC_PROG_F77**
This is required if any Fortran 77 source is included. See Section “Particular Program Checks” in The Autoconf Manual.

**AC_F77_LIBRARY_LDFLAGS**
This is required for programs and shared libraries that are a mixture of languages that include Fortran 77 (see Section 8.14.3 [Mixing Fortran 77 With C and C++], page 77). See Section 6.4 [Autoconf macros supplied with Automake], page 44.

**AC_FC_SRCEXT**
Automake will add the flags computed by `AC_FC_SRCEXT` to compilation of files with the respective source extension (see Section “Fortran Compiler Characteristics” in The Autoconf Manual).

**AC_PROG_FC**
This is required if any Fortran 90/95 source is included. This macro is distributed with Autoconf version 2.58 and later. See Section “Particular Program Checks” in The Autoconf Manual.

**AC_PROG_LIBTOOL**
Automake will turn on processing for `libtool` (see Section “Introduction” in The Libtool Manual).

**AC_PROG_YACC**
If a Yacc source file is seen, then you must either use this macro or define the variable `YACC` in `configure.ac`. The former is preferred (see Section “Particular Program Checks” in The Autoconf Manual).
AC_PROG_LEX
   If a Lex source file is seen, then this macro must be used. See Section “Particular Program Checks” in The Autoconf Manual.

AC_REQUIRE_AUX_FILE
   For each AC_REQUIRE_AUX_FILE([file]), automake will ensure that file exists in the aux directory, and will complain otherwise. It will also automatically distribute the file. This macro should be used by third-party Autoconf macros that require some supporting files in the aux directory specified with AC_CONFIG_AUX_DIR above. See Section “Finding configure Input” in The Autoconf Manual.

AC_SUBST
   The first argument is automatically defined as a variable in each generated Makefile.in, unless AM_SUBST_NOTMAKE is also used for this variable. See Section “Setting Output Variables” in The Autoconf Manual.

   For every substituted variable var, automake will add a line var = value to each Makefile.in file. Many Autoconf macros invoke AC_SUBST to set output variables this way, e.g., AC_PATH_XTRA defines X_CFLAGS and X_LIBS. Thus, you can access these variables as $(X_CFLAGS) and $(X_LIBS) in any Makefile.am if AC_PATH_XTRA is called.

AM_CONDITIONAL
   This introduces an Automake conditional (see Chapter 20 [Conditionals], page 124).

AM_COND_IF
   This macro allows automake to detect subsequent access within configure.ac to a conditional previously introduced with AM_CONDITIONAL, thus enabling conditional AC_CONFIG_FILES (see Section 20.1 [Usage of Conditionals], page 124).

AM_GNU_GETTEXT
   This macro is required for packages that use GNU gettext (see Section 10.2 [gettext], page 88). It is distributed with gettext. If Automake sees this macro it ensures that the package meets some of gettext’s requirements.

AM_GNU_GETTEXT_INTL_SUBDIR
   This macro specifies that the intl/ subdirectory is to be built, even if the AM_GNU_GETTEXT macro was invoked with a first argument of ‘external’.

AM_MAINTAINER_MODE([default-mode])
   This macro adds an --enable-maintainer-mode option to configure. If this is used, automake will cause “maintainer-only” rules to be turned off by default in the generated Makefile.ins, unless default-mode is ‘enable’. This macro defines the MAINTAINER_MODE conditional, which you can use in your own Makefile.am. See Section 28.2 [maintainer-mode], page 140.

AM_SUBST_NOTMAKE(var)
   Prevent Automake from defining a variable var, even if it is substituted by config.status. Normally, Automake defines a make variable for each configure substitution, i.e., for each AC_SUBST([var]). This macro prevents that definition from Automake. If AC_SUBST has not been called
for this variable, then `AM_SUBST_NOTMAKE` has no effects. Preventing variable definitions may be useful for substitution of multi-line values, where `var = @value@` might yield unintended results.

**m4_include**

Files included by `configure.ac` using this macro will be detected by Auto
tomake and automatically distributed. They will also appear as dependencies in `Makefile` rules.

`m4_include` is seldom used by `configure.ac` authors, but can appear in `aclocal.m4` when `aclocal` detects that some required macros come from files local to your package (as opposed to macros installed in a system-wide directory, see Section 6.3 [aclocal Invocation], page 35).

### 6.3 Auto-generating `aclocal.m4`

Automake includes a number of Autoconf macros that can be used in your package (see Section 6.4 [Macros], page 44); some of them are actually required by Automake in certain situations. These macros must be defined in your `aclocal.m4`; otherwise they will not be seen by `autoconf`.

The `aclocal` program will automatically generate `aclocal.m4` files based on the contents of `configure.ac`. This provides a convenient way to get Automake-provided macros, without having to search around. The `aclocal` mechanism allows other packages to supply their own macros (see Section 6.3.3 [Extending aclocal], page 39). You can also use it to maintain your own set of custom macros (see Section 6.3.4 [Local Macros], page 41).

At startup, `aclocal` scans all the `.m4` files it can find, looking for macro definitions (see Section 6.3.2 [Macro Search Path], page 37). Then it scans `configure.ac`. Any mention of one of the macros found in the first step causes that macro, and any macros it in turn requires, to be put into `aclocal.m4`.

**Putting** the file that contains the macro definition into `aclocal.m4` is usually done by copying the entire text of this file, including unused macro definitions as well as both `#` and `dnl` comments. If you want to make a comment that will be completely ignored by `aclocal`, use `##` as the comment leader.

When a file selected by `aclocal` is located in a subdirectory specified as a relative search path with `aclocal`’s `-I` argument, `aclocal` assumes the file belongs to the package and uses `m4_include` instead of copying it into `aclocal.m4`. This makes the package smaller, eases dependency tracking, and cause the file to be distributed automatically. (See Section 6.3.4 [Local Macros], page 41, for an example.) Any macro that is found in a system-wide directory, or via an absolute search path will be copied. So use `-I `pwd`/reldir` instead of `-I reldir` whenever some relative directory should be considered outside the package.

The contents of `acinclude.m4`, if this file exists, are also automatically included in `aclocal.m4`. We recommend against using `acinclude.m4` in new packages (see Section 6.3.4 [Local Macros], page 41).

While computing `aclocal.m4`, `aclocal` runs `autom4te` (see Section “Using Autom4te” in *The Autoconf Manual*) in order to trace the macros that are really used, and omit from `aclocal.m4` all macros that are mentioned but otherwise unexpanded (this can happen when a macro is called conditionally). `autom4te` is expected to be in the `PATH`, just as `autoconf`. Its location can be overridden using the `AUTOM4TE` environment variable.
6.3.1 `aclocal` Options

`aclocal` accepts the following options:

- **--automake-acdir=dir**  
  Look for the automake-provided macro files in `dir` instead of in the installation directory. This is typically used for debugging.

- **--system-acdir=dir**  
  Look for the system-wide third-party macro files (and the special `dirlist` file) in `dir` instead of in the installation directory. This is typically used for debugging.

- **--diff [=command]**  
  Run `command` on M4 file that would be installed or overwritten by `--install`. The default `command` is `diff -u`. This option implies `--install` and `--dry-run`.

- **--dry-run**  
  Do not actually overwrite (or create) `aclocal.m4` and M4 files installed by `--install`.

- **--help**  
  Print a summary of the command line options and exit.

- **-I dir**  
  Add the directory `dir` to the list of directories searched for `.m4` files.

- **--install**  
  Install system-wide third-party macros into the first directory specified with `-I dir` instead of copying them in the output file. Note that this will happen also if `dir` is an absolute path.

  When this option is used, and only when this option is used, `aclocal` will also honor `#serial number` lines that appear in macros: an M4 file is ignored if there exists another M4 file with the same basename and a greater serial number in the search path (see Section 6.3.5 [Serials], page 42).

- **--force**  
  Always overwrite the output file. The default is to overwrite the output file only when really needed, i.e., when its contents changes or if one of its dependencies is younger.

  This option forces the update of `aclocal.m4` (or the file specified with `--output` below) and only this file, it has absolutely no influence on files that may need to be installed by `--install`.

- **--output=file**  
  Cause the output to be put into `file` instead of `aclocal.m4`.

- **--print-ac-dir**  
  Prints the name of the directory that `aclocal` will search to find third-party `.m4` files. When this option is given, normal processing is suppressed. This option was used in the past by third-party packages to determine where to install `.m4` macro files, but this usage is today discouraged, since it causes `$(prefix)` not to be thoroughly honoured (which violates the GNU Coding Standards), and a similar semantics can be better obtained with the `ACLOCAL_PATH` environment variable; see Section 6.3.3 [Extending aclocal], page 39.
--verbose
Print the names of the files it examines.

--version
Print the version number of Automake and exit.

-W CATEGORY
--warnings=category
Output warnings falling in category. category can be one of:

  syntax    dubious syntactic constructs, underquoted macros, unused macros, etc.

  unsupported  unknown macros

  all        all the warnings, this is the default

  none       turn off all the warnings

  error      treat warnings as errors

All warnings are output by default.
The environment variable WARNINGS is honored in the same way as it is for automake (see Chapter 5 [automake Invocation], page 26).

6.3.2 Macro Search Path
By default, aclocal searches for .m4 files in the following directories, in this order:

  acdir-APIVERSION
This is where the .m4 macros distributed with Automake itself are stored.
APIVERSION depends on the Automake release used; for example, for Automake 1.11.x, APIVERSION = 1.11.

  acdir
This directory is intended for third party .m4 files, and is configured when automake itself is built. This is @datadir@/aclocal/, which typically expands to ${prefix}/share/aclocal/. To find the compiled-in value of acdir, use the --print-ac-dir option (see Section 6.3.1 [aclocal Options], page 36).

As an example, suppose that automake-1.11.2 was configured with --prefix=/usr/local. Then, the search path would be:
1. /usr/local/share/aclocal-1.11.2/
2. /usr/local/share/aclocal/

The paths for the acdir and acdir-APIVERSION directories can be changed respectively through aclocal options --system-acdir and --automake-acdir (see Section 6.3.1 [aclocal Options], page 36). Note however that these options are only intended for use by the internal Automake test suite, or for debugging under highly unusual situations; they are not ordinarily needed by end-users.

As explained in (see Section 6.3.1 [aclocal Options], page 36), there are several options that can be used to change or extend this search path.
Modifying the Macro Search Path: ‘-I dir’

Any extra directories specified using -I options (see Section 6.3.1 [aclocal Options], page 36) are prepended to this search list. Thus, `aclocal -I /foo -I /bar’ results in the following search path:

1. /foo
2. /bar
3. acdir-APIVERSION
4. acdir

Modifying the Macro Search Path: dirlist

There is a third mechanism for customizing the search path. If a dirlist file exists in acdir, then that file is assumed to contain a list of directory patterns, one per line. aclocal expands these patterns to directory names, and adds them to the search list after all other directories. dirlist entries may use shell wildcards such as ‘*’, ‘?’, or [...].

For example, suppose acdir/dirlist contains the following:

```
/test1
/test2
/test3*
```

and that aclocal was called with the ‘-I /foo -I /bar’ options. Then, the search path would be

1. /foo
2. /bar
3. acdir-APIVERSION
4. acdir
5. /test1
6. /test2

and all directories with path names starting with /test3.

If the --system-acdir=dir option is used, then aclocal will search for the dirlist file in dir; but remember the warnings above against the use of --system-acdir.

dirlist is useful in the following situation: suppose that automake version 1.11.2 is installed with ‘--prefix=/usr’ by the system vendor. Thus, the default search directories are

1. /usr/share/aclocal-1.11/
2. /usr/share/aclocal/

However, suppose further that many packages have been manually installed on the system, with $prefix=/usr/local, as is typical. In that case, many of these “extra” .m4 files are in /usr/local/share/aclocal. The only way to force /usr/bin/aclocal to find these “extra” .m4 files is to always call ‘aclocal -I /usr/local/share/aclocal’. This is inconvenient. With dirlist, one may create a file /usr/share/aclocal/dirlist containing only the single line

```
/usr/local/share/aclocal
```
Now, the “default” search path on the affected system is
1. /usr/share/aclocal-1.11/
2. /usr/share/aclocal/
3. /usr/local/share/aclocal/

without the need for -I options; -I options can be reserved for project-specific needs (my-source-dir/m4/), rather than using it to work around local system-dependent tool installation directories.

Similarly, dirlist can be handy if you have installed a local copy of Automake in your account and want aclocal to look for macros installed at other places on the system.

**Modifying the Macro Search Path: ACLOCAL_PATH**

The fourth and last mechanism to customize the macro search path is also the simplest. Any directory included in the colon-separated environment variable ACLOCAL_PATH is added to the search path and takes precedence over system directories (including those found via dirlist), with the exception of the versioned directory acdir-APIVERSION (see Section 6.3.2 [Macro Search Path], page 37). However, directories passed via -I will take precedence over directories in ACLOCAL_PATH.

Also note that, if the --install option is used, any .m4 file containing a required macro that is found in a directory listed in ACLOCAL_PATH will be installed locally. In this case, serial numbers in .m4 are honoured too, see Section 6.3.5 [Serials], page 42.

Conversely to dirlist, ACLOCAL_PATH is useful if you are using a global copy of Automake and want aclocal to look for macros somewhere under your home directory.

**Planned future incompatibilities**

The order in which the directories in the macro search path are currently looked up is confusing and/or suboptimal in various aspects, and is probably going to be changed in the future Automake release. In particular, directories in ACLOCAL_PATH and acdir might end up taking precedence over acdir-APIVERSION, and directories in acdir/dirlst might end up taking precedence over acdir. This is a possible future incompatibility!

**6.3.3 Writing your own aclocal macros**

The aclocal program doesn’t have any built-in knowledge of any macros, so it is easy to extend it with your own macros.

This can be used by libraries that want to supply their own Autoconf macros for use by other programs. For instance, the gettext library supplies a macro AM_GNU_GETTEXT that should be used by any package using gettext. When the library is installed, it installs this macro so that aclocal will find it.

A macro file’s name should end in .m4. Such files should be installed in $(datadir)/aclocal. This is as simple as writing:

```bash
aclocaldir = $(datadir)/aclocal
aclocal_DATA = mymacro.m4 myothermacro.m4
```

Please do use $(datadir)/aclocal, and not something based on the result of ‘aclocal --print-ac-dir’ (see Section 28.10 [Hard-Coded Install Paths], page 154, for arguments). It might also be helpful to suggest to the user to add the $(datadir)/aclocal directory
to his `ACLOCAL_PATH` variable (see `ACLOCAL_PATH`, page 39) so that `aclocal` will find the `.m4` files installed by your package automatically.

A file of macros should be a series of properly quoted `AC_DEFUN`’s (see Section “Macro Definitions” in *The Autoconf Manual*). The `aclocal` programs also understands `ACQUIRE` (see Section “Prerequisite Macros” in *The Autoconf Manual*), so it is safe to put each macro in a separate file. Each file should have no side effects but macro definitions. Especially, any call to `AC_PREREQ` should be done inside the defined macro, not at the beginning of the file.

Starting with Automake 1.8, `aclocal` will warn about all underquoted calls to `AC_DEFUN`. We realize this will annoy a lot of people, because `aclocal` was not so strict in the past and many third party macros are underquoted; and we have to apologize for this temporary inconvenience. The reason we have to be stricter is that a future implementation of `aclocal` (see Section 6.3.6 [Future of aclocal], page 44) will have to temporarily include all of these third party `.m4` files, maybe several times, including even files that are not actually needed. Doing so should alleviate many problems of the current implementation, however it requires a stricter style from the macro authors. Hopefully it is easy to revise the existing macros. For instance,

```
# bad style
AC_PREREQ(2.68)
AC_DEFUN(AX_FOOBAR,
    [AC_REQUIRE([AX_SOMETHING])dnl
    AX_FOO
    AX_BAR
  ])
```

should be rewritten as

```
AC_DEFUN([AX_FOOBAR],
    [AC_PREREQ([2.68])dnl
    AC_REQUIRE([AX_SOMETHING])dnl
    AX_FOO
    AX_BAR
  ])
```

Wrapping the `AC_PREREQ` call inside the macro ensures that Autoconf 2.68 will not be required if `AX_FOOBAR` is not actually used. Most importantly, quoting the first argument of `AC_DEFUN` allows the macro to be redefined or included twice (otherwise this first argument would be expanded during the second definition). For consistency we like to quote even arguments such as 2.68 that do not require it.

If you have been directed here by the `aclocal` diagnostic but are not the maintainer of the implicated macro, you will want to contact the maintainer of that macro. Please make sure you have the latest version of the macro and that the problem hasn’t already been reported before doing so: people tend to work faster when they aren’t flooded by mails.

Another situation where `aclocal` is commonly used is to manage macros that are used locally by the package, Section 6.3.4 [Local Macros], page 41.
6.3.4 Handling Local Macros

Feature tests offered by Autoconf do not cover all needs. People often have to supplement existing tests with their own macros, or with third-party macros.

There are two ways to organize custom macros in a package.

The first possibility (the historical practice) is to list all your macros in `acinclude.m4`. This file will be included in `aclocal.m4` when you run `aclocal`, and its macro(s) will henceforth be visible to `autoconf`. However if it contains numerous macros, it will rapidly become difficult to maintain, and it will be almost impossible to share macros between packages.

The second possibility, which we do recommend, is to write each macro in its own file and gather all of these files in a directory. This directory is usually called `m4/`. To build `aclocal.m4`, one should therefore instruct `aclocal` to scan `m4/`. From the command line, this is done with `aclocal -I m4`. The top-level `Makefile.am` should also be updated to define

    ACLOCAL_AMFLAGS = -I m4

`ACLOCAL_AMFLAGS` contains options to pass to `aclocal` when `aclocal.m4` is to be rebuilt by `make`. This line is also used by `autoreconf` (see Section “Using autoreconf to Update configure Scripts” in *The Autoconf Manual*) to run `aclocal` with suitable options, or by `autopoint` (see Section “Invoking the autopoint Program” in *GNU gettext tools*) and `gettextize` (see Section “Invoking the gettextize Program” in *GNU gettext tools*) to locate the place where Gettext’s macros should be installed. So even if you do not really care about the rebuild rules, you should define `ACLOCAL_AMFLAGS`.

When `aclocal -I m4` is run, it will build an `aclocal.m4` that `m4_include`s any file from `m4/` that defines a required macro. Macros not found locally will still be searched in system-wide directories, as explained in Section 6.3.2 [Macro Search Path], page 37.

Custom macros should be distributed for the same reason that `configure.ac` is: so that other people have all the sources of your package if they want to work on it. Actually, this distribution happens automatically because all `m4_include`d files are distributed.

However there is no consensus on the distribution of third-party macros that your package may use. Many libraries install their own macro in the system-wide `aclocal` directory (see Section 6.3.3 [Extending aclocal], page 39). For instance, Guile ships with a file called `guile.m4` that contains the macro `GUILE_FLAGS` that can be used to define setup compiler and linker flags appropriate for using Guile. Using `GUILE_FLAGS` in `configure.ac` will cause `aclocal` to copy `guile.m4` into `aclocal.m4`, but as `guile.m4` is not part of the project, it will not be distributed. Technically, that means a user who needs to rebuild `aclocal.m4` will have to install Guile first. This is probably OK, if Guile already is a requirement to build the package. However, if Guile is only an optional feature, or if your package might run on architectures where Guile cannot be installed, this requirement will hinder development. An easy solution is to copy such third-party macros in your local `m4/` directory so they get distributed.

Since Automake 1.10, `aclocal` offers an option to copy these system-wide third-party macros in your local macro directory, solving the above problem. Simply use:

    ACLOCAL_AMFLAGS = -I m4 --install
With this setup, system-wide macros will be copied to \texttt{m4/} the first time you run \texttt{autoreconf}. Then the locally installed macros will have precedence over the system-wide installed macros each time \texttt{aclocal} is run again.

One reason why you should keep \texttt{--install} in the flags even after the first run is that when you later edit \texttt{configure.ac} and depend on a new macro, this macro will be installed in your \texttt{m4/} automatically. Another one is that serial numbers (see Section 6.3.5 [Serials], page 42) can be used to update the macros in your source tree automatically when new system-wide versions are installed. A serial number should be a single line of the form

\begin{verbatim}
#serial nnn
\end{verbatim}

where \texttt{nnn} contains only digits and dots. It should appear in the M4 file before any macro definition. It is a good practice to maintain a serial number for each macro you distribute, even if you do not use the \texttt{--install} option of \texttt{aclocal}: this allows other people to use it.

### 6.3.5 Serial Numbers

Because third-party macros defined in \texttt{*.m4} files are naturally shared between multiple projects, some people like to version them. This makes it easier to tell which of two M4 files is newer. Since at least 1996, the tradition is to use a \texttt{#serial} line for this.

A serial number should be a single line of the form

\begin{verbatim}
# serial version
\end{verbatim}

where \texttt{version} is a version number containing only digits and dots. Usually people use a single integer, and they increment it each time they change the macro (hence the name of “serial”). Such a line should appear in the M4 file before any macro definition.

The \texttt{#} must be the first character on the line, and it is OK to have extra words after the version, as in

\begin{verbatim}
#serial version garbage
\end{verbatim}

Normally these serial numbers are completely ignored by \texttt{aclocal} and \texttt{autoconf}, like any genuine comment. However when using \texttt{aclocal}’s \texttt{--install} feature, these serial numbers will modify the way \texttt{aclocal} selects the macros to install in the package: if two files with the same basename exist in your search path, and if at least one of them uses a \texttt{#serial} line, \texttt{aclocal} will ignore the file that has the older \texttt{#serial} line (or the file that has none).

Note that a serial number applies to a whole M4 file, not to any macro it contains. A file can contains multiple macros, but only one serial.

Here is a use case that illustrates the use of \texttt{--install} and its interaction with serial numbers. Let’s assume we maintain a package called MyPackage, the \texttt{configure.ac} of which requires a third-party macro \texttt{AX_THIRD_PARTY} defined in \texttt{/usr/share/aclocal/thirdparty.m4} as follows:

\begin{verbatim}
# serial 1
AC_DEFUN([AX_THIRD_PARTY], [...] )
\end{verbatim}

MyPackage uses an \texttt{m4/} directory to store local macros as explained in Section 6.3.4 [Local Macros], page 41, and has

\begin{verbatim}
ACLOCAL_AMFLAGS = -I m4 --install
\end{verbatim}
in its top-level \texttt{Makefile.am}.\[90x684]
Initially the `m4/` directory is empty. The first time we run `autoreconf`, it will fetch the options to pass to `aclocal` in `Makefile.am`, and run `aclocal -I m4 --install`. `aclocal` will notice that

- `configure.ac` uses `AX_THIRD_PARTY`
- No local macros define `AX_THIRD_PARTY`
- `/usr/share/aclocal/thirdparty.m4` defines `AX_THIRD_PARTY` with serial 1.

Because `/usr/share/aclocal/thirdparty.m4` is a system-wide macro and `aclocal` was given the `--install` option, it will copy this file in `m4/thirdparty.m4`, and output an `aclocal.m4` that contains `m4_include([m4/thirdparty.m4])`.

The next time `aclocal -I m4 --install` is run (either via `autoreconf`, by hand, or from the `Makefile` rebuild rules) something different happens. `aclocal` notices that

- `configure.ac` uses `AX_THIRD_PARTY`
- `m4/thirdparty.m4` defines `AX_THIRD_PARTY` with serial 1.
- `/usr/share/aclocal/thirdparty.m4` defines `AX_THIRD_PARTY` with serial 1.

Because both files have the same serial number, `aclocal` uses the first it found in its search path order (see Section 6.3.2 [Macro Search Path], page 37). `aclocal` therefore ignores `/usr/share/aclocal/thirdparty.m4` and outputs an `aclocal.m4` that contains `m4_include([m4/thirdparty.m4])`.

Local directories specified with `-I` are always searched before system-wide directories, so a local file will always be preferred to the system-wide file in case of equal serial numbers.

Now suppose the system-wide third-party macro is changed. This can happen if the package installing this macro is updated. Let’s suppose the new macro has serial number 2. The next time `aclocal -I m4 --install` is run the situation is the following:

- `configure.ac` uses `AX_THIRD_PARTY`
- `m4/thirdparty.m4` defines `AX_THIRD_PARTY` with serial 1.
- `/usr/share/aclocal/thirdparty.m4` defines `AX_THIRD_PARTY` with serial 2.

When `aclocal` sees a greater serial number, it immediately forgets anything it knows from files that have the same basename and a smaller serial number. So after it has found `/usr/share/aclocal/thirdparty.m4` with serial 2, `aclocal` will proceed as if it had never seen `m4/thirdparty.m4`. This brings us back to a situation similar to that at the beginning of our example, where no local file defined the macro. `aclocal` will install the new version of the macro in `m4/thirdparty.m4`, in this case overriding the old version. MyPackage just had its macro updated as a side effect of running `aclocal`.

If you are leery of letting `aclocal` update your local macro, you can run `aclocal -I m4 --diff` to review the changes `aclocal -I m4 --install` would perform on these macros.

Finally, note that the `--force` option of `aclocal` has absolutely no effect on the files installed by `--install`. For instance, if you have modified your local macros, do not expect `--install --force` to replace the local macros by their system-wide versions. If you want to do so, simply erase the local macros you want to revert, and run `aclocal -I m4 --install`.
6.3.6 The Future of aclocal

aclocal is expected to disappear. This feature really should not be offered by Automake. Automake should focus on generating Makefiles; dealing with M4 macros really is Autoconf’s job. The fact that some people install Automake just to use aclocal, but do not use automake otherwise is an indication of how that feature is misplaced.

The new implementation will probably be done slightly differently. For instance, it could enforce the m4/-style layout discussed in Section 6.3.4 [Local Macros], page 41.

We have no idea when and how this will happen. This has been discussed several times in the past, but someone still has to commit to that non-trivial task.

From the user point of view, aclocal’s removal might turn out to be painful. There is a simple precaution that you may take to make that switch more seamless: never call aclocal yourself. Keep this guy under the exclusive control of autoreconf and Automake’s rebuild rules. Hopefully you won’t need to worry about things breaking, when aclocal disappears, because everything will have been taken care of. If otherwise you used to call aclocal directly yourself or from some script, you will quickly notice the change.

Many packages come with a script called bootstrap.sh or autogen.sh, that will just call aclocal, libtoolize, gettextize or autopoint, autoconf, autoheader, and automake in the right order. Actually this is precisely what autoreconf can do for you. If your package has such a bootstrap.sh or autogen.sh script, consider using autoreconf. That should simplify its logic a lot (less things to maintain, yum!), it’s even likely you will not need the script anymore, and more to the point you will not call aclocal directly anymore.

For the time being, third-party packages should continue to install public macros into /usr/share/aclocal/. If aclocal is replaced by another tool it might make sense to rename the directory, but supporting /usr/share/aclocal/ for backward compatibility should be really easy provided all macros are properly written (see Section 6.3.3 [Extending aclocal], page 39).

6.4 Autoconf macros supplied with Automake

Automake ships with several Autoconf macros that you can use from your configure.ac. When you use one of them it will be included by aclocal in aclocal.m4.

6.4.1 Public Macros

AM_INIT_AUTOMAKE([OPTIONS])

Runs many macros required for proper operation of the generated Makefiles.

Today, AM_INIT_AUTOMAKE is called with a single argument: a space-separated list of Automake options that should be applied to every Makefile.am in the tree. The effect is as if each option were listed in AUTOMAKE_OPTIONS (see Chapter 17 [Options], page 117).

This macro can also be called in another, deprecated form (support for which will be removed in the next major Automake release (1.13)): AM_INIT_AUTOMAKE(PACKAGE, VERSION, [NO-DEFINE]). In this form, there are two required arguments: the package and the version number. This form is obsolete because the package and version can be obtained from Autoconf’s AC_INIT macro (which itself has an old and a new form).
If your `configure.ac` has:

```plaintext
AC_INIT([src/foo.c])
AM_INIT_AUTOMAKE([mumble], [1.5])
```

you should modernize it as follows:

```plaintext
AC_INIT([mumble], [1.5])
AC_CONFIG_SRCDIR([src/foo.c])
AM_INIT_AUTOMAKE
```

Note that if you're upgrading your `configure.ac` from an earlier version of Automake, it is not always correct to simply move the package and version arguments from `AM_INIT_AUTOMAKE` directly to `AC_INIT`, as in the example above. The first argument to `AC_INIT` should be the name of your package (e.g., `'GNU Automake'`), not the tarball name (e.g., `'automake'`) that you used to pass to `AM_INIT_AUTOMAKE`. Autoconf tries to derive a tarball name from the package name, which should work for most but not all package names. (If it doesn't work for yours, you can use the four-argument form of `AC_INIT` to provide the tarball name explicitly).

By default this macro `AC_DEFINE`'s `PACKAGE` and `VERSION`. This can be avoided by passing the `no-define` option:

```plaintext
AM_INIT_AUTOMAKE([gnits 1.5 no-define dist-bzip2])
```

**AM_PATH_LISPDIR**

Searches for the program `emacs`, and, if found, sets the output variable `lispdir` to the full path to Emacs' site-lisp directory.

Note that this test assumes the `emacs` found to be a version that supports Emacs Lisp (such as GNU Emacs or XEmacs). Other emacs can cause this test to hang (some, like old versions of MicroEmacs, start up in interactive mode, requiring `C-x C-c` to exit, which is hardly obvious for a non-emacs user). In most cases, however, you should be able to use `C-c` to kill the test. In order to avoid problems, you can set `EMACS` to “no” in the environment, or use the `--with-lispdir` option to `configure` to explicitly set the correct path (if you're sure you have an `emacs` that supports Emacs Lisp).

**AM_PROG_AR**

You must use this macro when you use the archiver in your project, if you want support for unusual archivers such as Microsoft `lib`. The content of the optional argument is executed if the archiver interface is not recognized; the default action is to abort configure with an error message.

**AM_PROG_AS**

Use this macro when you have assembly code in your project. This will choose the assembler for you (by default the C compiler) and set `CCAS`, and will also set `CCASFLAGS` if required.

**AM_PROG_CC_C_O**

This is like `AC_PROG_CC_C_O`, but it generates its results in the manner required by Automake. You must use this instead of `AC_PROG_CC_C_O` when you need this functionality, that is, when using per-target flags or subdir-objects with C sources.
AM_PROG_LEX
Like AC_PROG_LEX (see Section “Particular Program Checks” in The Autoconf Manual), but uses the missing script on systems that do not have lex. HP-UX 10 is one such system.

AM_PROG_GCJ
This macro finds the gcj program or causes an error. It sets GCJ and GCJFLAGS. gcj is the Java front-end to the GNU Compiler Collection.

AM_PROG_UPC([compiler-search-list])
Find a compiler for Unified Parallel C and define the UPC variable. The default compiler-search-list is ‘upcc upc’. This macro will abort configure if no Unified Parallel C compiler is found.

AM_MISSING_PROG(name, program)
Find a maintainer tool program and define the name environment variable with its location. If program is not detected, then name will instead invoke the missing script, in order to give useful advice to the user about the missing maintainer tool. See Section 28.2 [maintainer-mode], page 140, for more information on when the missing script is appropriate.

AM_SILENT_RULES
Enable the machinery for less verbose build output (see Chapter 17 [Options], page 117).

AM_WITH_DMALLOC
Add support for the Dmalloc package (http://dmalloc.com/). If the user runs configure with --with-dmalloc, then define WITH_DMALLOC and add -ldmalloc to LIBS.

6.4.2 Obsolete Macros
Although using some of the following macros was required in past releases, you should not use any of them in new code. All these macros will be removed in the next major Automake version; if you are still using them, running autoupdate should adjust your configure.ac automatically (see Section “Using autoupdate to Modernize configure.ac” in The Autoconf Manual). Do it NOW!

AM_CONFIG_HEADER
Automake will generate rules to automatically regenerate the config header. This obsolete macro is a synonym of AC_CONFIG_HEADERS today (see Section 6.2 [Optional], page 31).

AM_HEADER_TIOCGWINSZ_NEEDS_SYS_IOCTL
If the use of TIOCGWINSZ requires <sys/ioctl.h>, then define GWINSZ_IN_SYS_IOCTL. Otherwise TIOCGWINSZ can be found in <termios.h>. This macro is obsolete, you should use Autoconf’s AC_HEADER_TIOCGWINSZ instead.

AM_PROG_MKDIR_P
From Automake 1.8 to 1.9.6 this macro used to define the output variable mkdir_p to one of mkdir -p, install-sh -d, or mkinstalldirs. Nowadays Autoconf provides a similar functionality with AC_PROG_MKDIR_P (see Section “Particular Program Checks” in The Autoconf Manual), however this
defines the output variable `MKDIR_P` instead. In case you are still using the `AM_PROG_MKDIR_P` macro in your `configure.ac`, or its provided variable `$ (mkdir_p)` in your `Makefile.am`, you are advised to switch ASAP to the more modern Autoconf-provided interface instead; both the macro and the variable will be removed in the next major Automake release.

`AM_SYS_POSIX_TERMIOS`
Check to see if POSIX termios headers and functions are available on the system. If so, set the shell variable `am_cv_sys_posix_termios` to ‘yes’. If not, set the variable to ‘no’. This macro is obsolete, you should use Autoconf’s `AC_SYS_POSIX_TERMIOS` instead.

6.4.3 Private Macros
The following macros are private macros you should not call directly. They are called by the other public macros when appropriate. Do not rely on them, as they might be changed in a future version. Consider them as implementation details; or better, do not consider them at all: skip this section!

`_AM_DEPENDENCIES`
`AM_SET_DEPDIR`
`AM_DEP_TRACK`
`AM_OUTPUT_DEPENDENCY_COMMANDS`
These macros are used to implement Automake’s automatic dependency tracking scheme. They are called automatically by Automake when required, and there should be no need to invoke them manually.

`AM_MAKE_INCLUDE`
This macro is used to discover how the user’s `make` handles `include` statements. This macro is automatically invoked when needed; there should be no need to invoke it manually.

`AM_PROG_INSTALL_STRIP`
This is used to find a version of `install` that can be used to strip a program at installation time. This macro is automatically included when required.

`AM_SANITY_CHECK`
This checks to make sure that a file created in the build directory is newer than a file in the source directory. This can fail on systems where the clock is set incorrectly. This macro is automatically run from `AM_INIT_AUTOMAKE`.

7 Directories
For simple projects that distribute all files in the same directory it is enough to have a single `Makefile.am` that builds everything in place.

In larger projects, it is common to organize files in different directories, in a tree. For example, there could be a directory for the program’s source, one for the testsuite, and one for the documentation; or, for very large projects, there could be one directory per program, per library or per module.
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The traditional approach is to build these subdirectories recursively, employing *make recursion*: each directory contains its own *Makefile*, and when *make* is run from the top-level directory, it enters each subdirectory in turn, and invokes there a new *make* instance to build the directory’s contents.

Because this approach is very widespread, Automake offers built-in support for it. However, it is worth nothing that the use of make recursion has its own serious issues and drawbacks, and that it’s well possible to have packages with a multi directory layout that make little or no use of such recursion (examples of such packages are GNU Bison and GNU Automake itself); see also the Section 7.3 [Alternative], page 51, section below.

### 7.1 Recursing subdirectories

In packages using make recursion, the top level *Makefile.am* must tell Automake which subdirectories are to be built. This is done via the *SUBDIRS* variable.

The *SUBDIRS* variable holds a list of subdirectories in which building of various sorts can occur. The rules for many targets (e.g., *all*) in the generated *Makefile* will run commands both locally and in all specified subdirectories. Note that the directories listed in *SUBDIRS* are not required to contain *Makefile.am*s; only *Makefiles* (after configuration). This allows inclusion of libraries from packages that do not use Automake (such as *gettext*; see also Section 24.2 [Third-Party Makefiles], page 133).

In packages that use subdirectories, the top-level *Makefile.am* is often very short. For instance, here is the *Makefile.am* from the GNU Hello distribution:

```make
EXTRA_DIST = BUGS ChangeLog.O README-alpha
SUBDIRS = doc intl po src tests
```

When Automake invokes *make* in a subdirectory, it uses the value of the *MAKE* variable. It passes the value of the variable *AM_MAKEFLAGS* to the *make* invocation; this can be set in *Makefile.am* if there are flags you must always pass to *make*.

The directories mentioned in *SUBDIRS* are usually direct children of the current directory, each subdirectory containing its own *Makefile.am* with a *SUBDIRS* pointing to deeper subdirectories. Automake can be used to construct packages of arbitrary depth this way.

By default, Automake generates *Makefiles* that work depth-first in postfix order: the subdirectories are built before the current directory. However, it is possible to change this ordering. You can do this by putting ‘.’ into *SUBDIRS*. For instance, putting ‘.’ first will cause a prefix ordering of directories.

Using

```
SUBDIRS = lib src . test
```

will cause *lib/* to be built before *src/*, then the current directory will be built, finally the *test/* directory will be built. It is customary to arrange test directories to be built after everything else since they are meant to test what has been constructed.

### 7.2 Conditional Subdirectories

It is possible to define the *SUBDIRS* variable conditionally if, like in the case of GNU Inetutils, you want to only build a subset of the entire package.

To illustrate how this works, let’s assume we have two directories *src/* and *opt/*. *src/* should always be built, but we want to decide in *configure* whether *opt/* will be built...
or not. (For this example we will assume that opt/ should be built when the variable ‘$want_opt’ was set to ‘yes’.)

Running make should thus recurse into src/ always, and then maybe in opt/.

However ‘make dist’ should always recurse into both src/ and opt/. Because opt/ should be distributed even if it is not needed in the current configuration. This means opt/Makefile should be created unconditionally.

There are two ways to setup a project like this. You can use Automake conditionals (see Chapter 20 [Conditionals], page 124) or use Autoconf AC_SUBST variables (see Section “Setting Output Variables” in The Autoconf Manual). Using Automake conditionals is the preferred solution. Before we illustrate these two possibilities, let’s introduce DIST_SUBDIRS.

7.2.1 SUBDIRS vs. DIST_SUBDIRS

Automake considers two sets of directories, defined by the variables SUBDIRS and DIST_SUBDIRS.

SUBDIRS contains the subdirectories of the current directory that must be built (see Section 7.1 [Subdirectories], page 48). It must be defined manually; Automake will never guess a directory is to be built. As we will see in the next two sections, it is possible to define it conditionally so that some directory will be omitted from the build.

DIST_SUBDIRS is used in rules that need to recurse in all directories, even those that have been conditionally left out of the build. Recall our example where we may not want to build subdirectory opt/; but yet we want to distribute it? This is where DIST_SUBDIRS comes into play: ‘opt’ may not appear in SUBDIRS, but it must appear in DIST_SUBDIRS.

Precisely, DIST_SUBDIRS is used by ‘make maintainer-clean’, ‘make distclean’ and ‘make dist’. All other recursive rules use SUBDIRS.

If SUBDIRS is defined conditionally using Automake conditionals, Automake will define DIST_SUBDIRS automatically from the possible values of SUBDIRS in all conditions.

If SUBDIRS contains AC_SUBST variables, DIST_SUBDIRS will not be defined correctly because Automake does not know the possible values of these variables. In this case DIST_SUBDIRS needs to be defined manually.

7.2.2 Subdirectories with AM_CONDITIONAL

configure should output the Makefile for each directory and define a condition into which opt/ should be built.

...  
AM_CONDITIONAL([COND_OPT], [test "$want_opt" = yes])  
AC_CONFIG_FILES([Makefile src/Makefile opt/Makefile])  
...

Then SUBDIRS can be defined in the top-level Makefile.am as follows.

if COND_OPT  
    MAYBE_OPT = opt  
endif  
SUBDIRS = src $(MAYBE_OPT)

As you can see, running make will rightly recurse into src/ and maybe opt/.
As you can’t see, running `make dist` will recurse into both src/ and opt/ directories because `make dist`, unlike `make all`, doesn’t use the SUBDIRS variable. It uses the DIST_SUBDIRS variable.

In this case Automake will define `DIST_SUBDIRS = src opt` automatically because it knows that MAYBE_OPT can contain ‘opt’ in some condition.

### 7.2.3 Subdirectories with AC_SUBST

Another possibility is to define MAYBE_OPT from ./configure using AC_SUBST:

```bash
...
if test "\$want_opt" = yes; then
    MAYBE_OPT=opt
else
    MAYBE_OPT=
fi
AC_SUBST([MAYBE_OPT])
AC_CONFIG_FILES([Makefile src/Makefile opt/Makefile])
...
```

In this case the top-level `Makefile.am` should look as follows.

```bash
SUBDIRS = src $(MAYBE_OPT)
DIST_SUBDIRS = src opt
```

The drawback is that since Automake cannot guess what the possible values of MAYBE_OPT are, it is necessary to define DIST_SUBDIRS.

### 7.2.4 Unconfigured Subdirectories

The semantics of DIST_SUBDIRS are often misunderstood by some users that try to configure and build subdirectories conditionally. Here by configuring we mean creating the `Makefile` (it might also involve running a nested configure script: this is a costly operation that explains why people want to do it conditionally, but only the `Makefile` is relevant to the discussion).

The above examples all assume that every `Makefile` is created, even in directories that are not going to be built. The simple reason is that we want `make dist` to distribute even the directories that are not being built (e.g., platform-dependent code), hence `make dist` must recurse into the subdirectory, hence this directory must be configured and appear in DIST_SUBDIRS.

Building packages that do not configure every subdirectory is a tricky business, and we do not recommend it to the novice as it is easy to produce an incomplete tarball by mistake. We will not discuss this topic in depth here, yet for the adventurous here are a few rules to remember.
• **SUBDIRS** should always be a subset of **DIST_SUBDIRS**.
  It makes little sense to have a directory in **SUBDIRS** that is not in **DIST_SUBDIRS**. Think of the former as a way to tell which directories listed in the latter should be built.

• Any directory listed in **DIST_SUBDIRS** and **SUBDIRS** must be configured.
  I.e., the **Makefile** must exists or the recursive **make** rules will not be able to process the directory.

• Any configured directory must be listed in **DIST_SUBDIRS**.
  So that the cleaning rules remove the generated **Makefiles**. It would be correct to see **DIST_SUBDIRS** as a variable that lists all the directories that have been configured.

In order to prevent recursion in some unconfigured directory you must therefore ensure that this directory does not appear in **DIST_SUBDIRS** (and **SUBDIRS**). For instance, if you define **SUBDIRS** conditionally using **AC_SUBST** and do not define **DIST_SUBDIRS** explicitly, it will be default to ‘$(SUBDIRS)’; another possibility is to force **DIST_SUBDIRS = $(SUBDIRS)**.

Of course, directories that are omitted from **DIST_SUBDIRS** will not be distributed unless you make other arrangements for this to happen (for instance, always running ‘**make dist**’ in a configuration where all directories are known to appear in **DIST_SUBDIRS**; or writing a **dist-hook** target to distribute these directories).

In few packages, unconfigured directories are not even expected to be distributed. Although these packages do not require the aforementioned extra arrangements, there is another pitfall. If the name of a directory appears in **SUBDIRS** or **DIST_SUBDIRS**, **automake** will make sure the directory exists. Consequently **automake** cannot be run on such a distribution when one directory has been omitted. One way to avoid this check is to use the **AC_SUBST** method to declare conditional directories; since **automake** does not know the values of **AC_SUBST** variables it cannot ensure the corresponding directory exists.

### 7.3 An Alternative Approach to Subdirectories

If you’ve ever read Peter Miller’s excellent paper, Recursive Make Considered Harmful ([http://miller.emu.id.au/pmiller/books/rmch/](http://miller.emu.id.au/pmiller/books/rmch/)), the preceding sections on the use of make recursion will probably come as unwelcome advice. For those who haven’t read the paper, Miller’s main thesis is that recursive **make** invocations are both slow and error-prone.

Automake provides sufficient cross-directory support\(^2\) to enable you to write a single **Makefile.am** for a complex multi-directory package.

By default an installable file specified in a subdirectory will have its directory name stripped before installation. For instance, in this example, the header file will be installed as **$(includedir)/stdio.h**:

```make
include_HEADERS = inc/stdio.h
```

However, the ‘**nobase_**’ prefix can be used to circumvent this path stripping. In this example, the header file will be installed as **$(includedir)/sys/types.h**:

```make
nobase_include_HEADERS = sys/types.h
```

\(^2\) We believe. This work is new and there are probably warts. See Chapter 1 [Introduction], page 1, for information on reporting bugs.
‘nobase_’ should be specified first when used in conjunction with either ‘dist_’ or ‘nodist_’ (see Section 14.2 [Fine-grained Distribution Control], page 98). For instance:

```
nobase_dist_pkgdata_DATA = images/vortex.pgm sounds/whirl.ogg
```

Finally, note that a variable using the ‘nobase_’ prefix can often be replaced by several variables, one for each destination directory (see Section 3.3 [Uniform], page 20). For instance, the last example could be rewritten as follows:

```
imagesdir = $(pkgdatadir)/images
soundsdir = $(pkgdatadir)/sounds
dist_images_DATA = images/vortex.pgm
dist_sounds_DATA = sounds/whirl.ogg
```

This latter syntax makes it possible to change one destination directory without changing the layout of the source tree.

Currently, ‘nobase_*_LTLIBRARIES’ are the only exception to this rule, in that there is no particular installation order guarantee for an otherwise equivalent set of variables without ‘nobase_’ prefix.

### 7.4 Nesting Packages

In the GNU Build System, packages can be nested to arbitrary depth. This means that a package can embed other packages with their own `configure`, `Makefile`, etc.

These other packages should just appear as subdirectories of their parent package. They must be listed in `SUBDIRS` like other ordinary directories. However the subpackage’s `Makefile` should be output by its own `configure` script, not by the parent’s `configure`. This is achieved using the `AC_CONFIG_SUBDIRS` Autoconf macro (see Section “Configuring Other Packages in Subdirectories” in *The Autoconf Manual*).

Here is an example package for an `arm` program that links with a `hand` library that is a nested package in subdirectory `hand`.

**arm**’s `configure.ac`:

```
AC_INIT([arm], [1.0])
AC_CONFIG_AUX_DIR([.])
AM_INIT_AUTOMAKE
AC_PROG_CC
AC_CONFIG_FILES([Makefile])
# Call hand’s ./configure script recursively.
AC_CONFIG_SUBDIRS([hand])
AC_OUTPUT
```

**arm**’s `Makefile.am`:

```
# Build the library in the hand subdirectory first.
SUBDIRS = hand

# Include hand’s header when compiling this directory.
AM_CPPFLAGS = -I$(srcdir)/hand

bin_PROGRAMS = arm
arm_SOURCES = arm.c
```
# link with the hand library.
arm_LDADD = hand/libhand.a

Now here is hand's hand/configure.ac:

```
AC_INIT([hand], [1.2])
AC_CONFIG_AUX_DIR([.])
AM_INIT_AUTOMAKE
AC_PROG_CC
AM_PROG_AR
AC_PROG_RANLIB
AC_CONFIG_FILES([Makefile])
AC_OUTPUT
```

and its hand/Makefile.am:

```c
lib_LIBRARIES = libhand.a
libhand_a_SOURCES = hand.c
```

When 'make dist' is run from the top-level directory it will create an archive arm-1.0.tar.gz that contains the arm code as well as the hand subdirectory. This package can be built and installed like any ordinary package, with the usual `./configure &amp; make &amp; make install` sequence (the hand subpackage will be built and installed by the process).

When 'make dist' is run from the hand directory, it will create a self-contained hand-1.2.tar.gz archive. So although it appears to be embedded in another package, it can still be used separately.

The purpose of the 'AC_CONFIG_AUX_DIR([.])' instruction is to force Automake and Autoconf to search for auxiliary scripts in the current directory. For instance, this means that there will be two copies of install-sh: one in the top-level of the arm package, and another one in the hand/ subdirectory for the hand package.

The historical default is to search for these auxiliary scripts in the parent directory and the grandparent directory. So if the 'AC_CONFIG_AUX_DIR([.])' line was removed from hand/configure.ac, that subpackage would share the auxiliary script of the arm package. This may looks like a gain in size (a few kilobytes), but it is actually a loss of modularity as the hand subpackage is no longer self-contained ('make dist' in the subdirectory will not work anymore).

Packages that do not use Automake need more work to be integrated this way. See Section 24.2 [Third-Party Makefiles], page 133.

## 8 Building Programs and Libraries

A large part of Automake's functionality is dedicated to making it easy to build programs and libraries.

### 8.1 Building a program

In order to build a program, you need to tell Automake which sources are part of it, and which libraries it should be linked with.
This section also covers conditional compilation of sources or programs. Most of the comments about these also apply to libraries (see Section 8.2 [A Library], page 57) and libtool libraries (see Section 8.3 [A Shared Library], page 58).

### 8.1.1 Defining program sources

In a directory containing source that gets built into a program (as opposed to a library or a script), the `PROGRAMS` primary is used. Programs can be installed in `bindir`, `sbindir`, `libexecdir`, `pkglibexecdir`, or not at all (`noinst_`). They can also be built only for `make check`, in which case the prefix is `check_`.

For instance:

```
bin_PROGRAMS = hello
```

In this simple case, the resulting `Makefile.in` will contain code to generate a program named `hello`.

Associated with each program are several assisting variables that are named after the program. These variables are all optional, and have reasonable defaults. Each variable, its use, and default is spelled out below; we use the “hello” example throughout.

The variable `hello_SOURCES` is used to specify which source files get built into an executable:

```
hello_SOURCES = hello.c version.c getopt.c getopt1.c getopt.h system.h
```

This causes each mentioned `.c` file to be compiled into the corresponding `.o`. Then all are linked to produce `hello`.

If `hello_SOURCES` is not specified, then it defaults to the single file `hello.c` (see Section 8.5 [Default _SOURCES], page 68).

Multiple programs can be built in a single directory. Multiple programs can share a single source file, which must be listed in each _SOURCES definition.

Header files listed in a _SOURCES definition will be included in the distribution but otherwise ignored. In case it isn’t obvious, you should not include the header file generated by `configure` in a _SOURCES variable; this file should not be distributed. Lex (.l) and Yacc (.y) files can also be listed; see Section 8.8 [Yacc and Lex], page 72.

### 8.1.2 Linking the program

If you need to link against libraries that are not found by `configure`, you can use `LDADD` to do so. This variable is used to specify additional objects or libraries to link with; it is inappropriate for specifying specific linker flags, you should use `AM_LDFLAGS` for this purpose.

Sometimes, multiple programs are built in one directory but do not share the same link-time requirements. In this case, you can use the `prog_LDADD` variable (where `prog` is the name of the program as it appears in some _PROGRAMS variable, and usually written in lowercase) to override `LDADD`. If this variable exists for a given program, then that program is not linked using `LDADD`.

For instance, in GNU `cpio`, `pax`, `cpio` and `mt` are linked against the library `libcpio.a`. However, `rmt` is built in the same directory, and has no such link requirement. Also, `mt` and
rmt are only built on certain architectures. Here is what cpio’s src/Makefile.am looks like (abridged):

```
bin_PROGRAMS = cpio pax $(MT)
libexec_PROGRAMS = $(RMT)
EXTRA_PROGRAMS = mt rmt

LDADD = ../lib/libcpio.a $(INTLLIBS)
rmt_LDADD =

cpio_SOURCES = ...
pax_SOURCES = ...
mt_SOURCES = ...
rmt_SOURCES = ...
```

`prog_LDADD` is inappropriate for passing program-specific linker flags (except for `-l`, `-L`, `-dlopen` and `-dlpreopen`). So, use the `prog_LDFLAGS` variable for this purpose.

It is also occasionally useful to have a program depend on some other target that is not actually part of that program. This can be done using either the `prog_DEPENDENCIES` or the `EXTRA_prog_DEPENDENCIES` variable. Each program depends on the contents both variables, but no further interpretation is done.

Since these dependencies are associated to the link rule used to create the programs they should normally list files used by the link command. That is `*.$(OBJEXT)`, `*.a`, or `*.la` files. In rare cases you may need to add other kinds of files such as linker scripts, but *listing a source file in _DEPENDENCIES is wrong.* If some source file needs to be built before all the components of a program are built, consider using the `BUILT_SOURCES` variable instead (see Section 9.4 [Sources], page 84).

If `prog_DEPENDENCIES` is not supplied, it is computed by Automake. The automatically-assigned value is the contents of `prog_LDADD`, with most configure substitutions, `-l`, `-L`, `-dlopen` and `-dlpreopen` options removed. The configure substitutions that are left in are only `$(LIBOBJS)` and `$(ALLOCA)`; these are left because it is known that they will not cause an invalid value for `prog_DEPENDENCIES` to be generated.

Section 8.1.3 [Conditional Sources], page 55, shows a situation where _DEPENDENCIES may be used.

The `EXTRA_prog_DEPENDENCIES` may be useful for cases where you merely want to augment the `automake`-generated `prog_DEPENDENCIES` rather than replacing it.

We recommend that you avoid using `-l` options in `LDADD` or `prog_LDADD` when referring to libraries built by your package. Instead, write the file name of the library explicitly as in the above `cpio` example. Use `-l` only to list third-party libraries. If you follow this rule, the default value of `prog_DEPENDENCIES` will list all your local libraries and omit the other ones.

### 8.1.3 Conditional compilation of sources

You can’t put a configure substitution (e.g., `@FOO@` or `$(FOO)` where `FOO` is defined via `AC_SUBST`) into a _SOURCES variable. The reason for this is a bit hard to explain, but suffice to say that it simply won’t work. Automake will give an error if you try to do this.
Fortunately there are two other ways to achieve the same result. One is to use configure substitutions in `LDADD` variables, the other is to use an Automake conditional.

**Conditional Compilation using _LDADD Substitutions**

Automake must know all the source files that could possibly go into a program, even if not all the files are built in every circumstance. Any files that are only conditionally built should be listed in the appropriate `EXTRA_` variable. For instance, if `hello-linux.c` or `hello-generic.c` were conditionally included in `hello`, the `Makefile.am` would contain:

```text
bin_PROGRAMS = hello
hello_SOURCES = hello-common.c
EXTRA_hello_SOURCES = hello-linux.c hello-generic.c
hello_LDADD = $(HELLO_SYSTEM)
hello_DEPENDENCIES = $(HELLO_SYSTEM)
```

You can then setup the `$(HELLO_SYSTEM)` substitution from `configure.ac`:

```text
... 
  case $host in  
    *linux*) HELLO_SYSTEM='hello-linux.$(OBJEXT)';; 
    * ) HELLO_SYSTEM='hello-generic.$(OBJEXT)';; 
  esac
  AC_SUBST([HELLO_SYSTEM])
... 
```

In this case, the variable `HELLO_SYSTEM` should be replaced by either `hello-linux.o` or `hello-generic.o`, and added to both `hello_DEPENDENCIES` and `hello_LDADD` in order to be built and linked in.

**Conditional Compilation using Automake Conditionals**

An often simpler way to compile source files conditionally is to use Automake conditionals. For instance, you could use this `Makefile.am` construct to build the same `hello` example:

```text
bin_PROGRAMS = hello
if LINUX
  hello_SOURCES = hello-linux.c hello-common.c
else
  hello_SOURCES = hello-generic.c hello-common.c
endif
```

In this case, `configure.ac` should setup the `LINUX` conditional using `AM_CONDITIONAL` (see Chapter 20 [Conditionals], page 124).

When using conditionals like this you don’t need to use the `EXTRA_` variable, because Automake will examine the contents of each variable to construct the complete list of source files.

If your program uses a lot of files, you will probably prefer a conditional `+=`:

```text
bin_PROGRAMS = hello
hello_SOURCES = hello-common.c
if LINUX
  hello_SOURCES += hello-linux.c
else
```
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8.1.4 Conditional compilation of programs

Sometimes it is useful to determine the programs that are to be built at configure time. For instance, GNU cpio only builds mt and rmt under special circumstances. The means to achieve conditional compilation of programs are the same you can use to compile source files conditionally: substitutions or conditionals.

Conditional Programs using configure Substitutions

In this case, you must notify Automake of all the programs that can possibly be built, but at the same time cause the generated Makefile.in to use the programs specified by configure. This is done by having configure substitute values into each _PROGRAMS definition, while listing all optionally built programs in EXTRA_PROGRAMS.

```plaintext
bin_PROGRAMS = cpio pax $(MT)
libexec_PROGRAMS = $(RMT)
EXTRA_PROGRAMS = mt rmt
```

As explained in Section 8.20 [EXEEXT], page 81, Automake will rewrite bin_PROGRAMS, libexec_PROGRAMS, and EXTRA_PROGRAMS, appending `$EXEEXT` to each binary. Obviously it cannot rewrite values obtained at run-time through configure substitutions, therefore you should take care of appending `$EXEEXT` yourself, as in `AC_SUBST([MT], ['mt${EXEEXT}'])`.

Conditional Programs using Automake Conditionals

You can also use Automake conditionals (see Chapter 20 [Conditionals], page 124) to select programs to be built. In this case you don’t have to worry about `$EXEEXT` or EXTRA_PROGRAMS.

```plaintext
bin_PROGRAMS = cpio pax
if WANT_MT
    bin_PROGRAMS += mt
endif
if WANT_RMT
    libexec_PROGRAMS = rmt
endif
```

8.2 Building a library

Building a library is much like building a program. In this case, the name of the primary is LIBRARIES. Libraries can be installed in libdir or pkglibdir.

See Section 8.3 [A Shared Library], page 58, for information on how to build shared libraries using libtool and the LTLIBRARIES primary.

Each _LIBRARIES variable is a list of the libraries to be built. For instance, to create a library named libcpio.a, but not install it, you would write:

```plaintext
noinst_LIBRARIES = libcpio.a
libcpio_a_SOURCES = ...
```
The sources that go into a library are determined exactly as they are for programs, via the _SOURCES variables. Note that the library name is canonicalized (see Section 3.5 [Canonicalization], page 22), so the _SOURCES variable corresponding to libcpio.a is 'libcpio_a_SOURCES', not 'libcpio.a_SOURCES'.

Extra objects can be added to a library using the library_LIBADD variable. This should be used for objects determined by configure. Again from cpio:

\[
\text{libcpio_a_LIBADD = $(LIBOBJS) $(ALLOCA)}
\]

In addition, sources for extra objects that will not exist until configure-time must be added to the BUILT_SOURCES variable (see Section 9.4 [Sources], page 84).

Building a static library is done by compiling all object files, then by invoking '$(AR) $(ARFLAGS)' followed by the name of the library and the list of objects, and finally by calling '$(RANLIB)' on that library. You should call AC_PROG_RANLIB from your configure.ac to define RANLIB (Automake will complain otherwise). You should also call AM_PROG_AR to define AR, in order to support unusual archivers such as Microsoft lib. ARFLAGS will default to cru; you can override this variable by setting it in your Makefile.am or by AC_SUBSTing it from your configure.ac. You can override the AR variable by defining a per-library maude_AR variable (see Section 8.4 [Program and Library Variables], page 64).

Be careful when selecting library components conditionally. Because building an empty library is not portable, you should ensure that any library always contains at least one object.

To use a static library when building a program, add it to LDADD for this program. In the following example, the program cpio is statically linked with the library libcpio.a.

\[
\begin{align*}
\text{noinst_LIBRARIES} & = \text{libcpio.a} \\
\text{libcpio_a_SOURCES} & = \ldots \\
\text{bin_PROGRAMS} & = \text{cpio} \\
\text{cpio_SOURCES} & = \text{cpio.c} \ldots \\
\text{cpio_LDADD} & = \text{libcpio.a}
\end{align*}
\]

### 8.3 Building a Shared Library

Building shared libraries portably is a relatively complex matter. For this reason, GNU Libtool (see Section “Introduction” in The Libtool Manual) was created to help build shared libraries in a platform-independent way.

#### 8.3.1 The Libtool Concept

Libtool abstracts shared and static libraries into a unified concept henceforth called *libtool libraries*. Libtool libraries are files using the .la suffix, and can designate a static library, a shared library, or maybe both. Their exact nature cannot be determined until ./configure is run: not all platforms support all kinds of libraries, and users can explicitly select which libraries should be built. (However the package’s maintainers can tune the default, see Section “The AC_PROG_LIBTOOL macro” in The Libtool Manual.)

Because object files for shared and static libraries must be compiled differently, libtool is also used during compilation. Object files built by libtool are called *libtool objects*: these are files using the .lo suffix. Libtool libraries are built from these libtool objects.
You should not assume anything about the structure of .la or .lo files and how libtool constructs them: this is libtool’s concern, and the last thing one wants is to learn about libtool’s guts. However the existence of these files matters, because they are used as targets and dependencies in Makefiles rules when building libtool libraries. There are situations where you may have to refer to these, for instance when expressing dependencies for building source files conditionally (see Section 8.3.4 [Conditional Libtool Sources], page 60).

People considering writing a plug-in system, with dynamically loaded modules, should look into libltdl: libtool’s dlopening library (see Section “Using libltdl” in The Libtool Manual). This offers a portable dlopening facility to load libtool libraries dynamically, and can also achieve static linking where unavoidable.

Before we discuss how to use libtool with Automake in details, it should be noted that the libtool manual also has a section about how to use Automake with libtool (see Section “Using Automake with Libtool” in The Libtool Manual).

8.3.2 Building Libtool Libraries
Automake uses libtool to build libraries declared with the LTLIBRARIES primary. Each _LTLIBRARIES variable is a list of libtool libraries to build. For instance, to create a libtool library named libgettext.la, and install it in libdir, write:

lib_LTLIBRARIES = libgettext.la
libgettext_la_SOURCES = gettext.c gettext.h ...

Automake predefines the variable pkglibdir, so you can use pkglib_LTLIBRARIES to install libraries in ‘$(libdir)/@PACKAGE@/’.

If gettext.h is a public header file that needs to be installed in order for people to use the library, it should be declared using a _HEADERS variable, not in libgettext_la_SOURCES. Headers listed in the latter should be internal headers that are not part of the public interface.

lib_LTLIBRARIES = libgettext.la
libgettext_la_SOURCES = gettext.c ...
include_HEADERS = gettext.h ...

A package can build and install such a library along with other programs that use it. This dependency should be specified using LDADD. The following example builds a program named hello that is linked with libgettext.la.

lib_LTLIBRARIES = libgettext.la
libgettext_la_SOURCES = gettext.c ...

bin_PROGRAMS = hello
hello_SOURCES = hello.c ...
hello_LDADD = libgettext.la

Whether hello is statically or dynamically linked with libgettext.la is not yet known: this will depend on the configuration of libtool and the capabilities of the host.

8.3.3 Building Libtool Libraries Conditionally
Like conditional programs (see Section 8.1.4 [Conditional Programs], page 57), there are two main ways to build conditional libraries: using Automake conditionals or using Autoconf AC_SUBSTitutions.
The important implementation detail you have to be aware of is that the place where a library will be installed matters to libtool: it needs to be indicated at link-time using the \texttt{-rpath} option.

For libraries whose destination directory is known when Automake runs, Automake will automatically supply the appropriate \texttt{-rpath} option to libtool. This is the case for libraries listed explicitly in some installable \texttt{_LTLIBRARIES} variables such as \texttt{lib_LTLIBRARIES}.

However, for libraries determined at configure time (and thus mentioned in \texttt{EXTRA_LTLIBRARIES}), Automake does not know the final installation directory. For such libraries you must add the \texttt{-rpath} option to the appropriate \texttt{_LDFLAGS} variable by hand.

The examples below illustrate the differences between these two methods.

Here is an example where \texttt{WANTEDLIBS} is an \texttt{AC_SUBST}ed variable set at \texttt{./configure}-time to either \texttt{libfoo.la}, \texttt{libbar.la}, both, or none. Although \texttt{\$(WANTEDLIBS)} appears in the \texttt{lib_LTLIBRARIES}, Automake cannot guess it relates to \texttt{libfoo.la} or \texttt{libbar.la} at the time it creates the link rule for these two libraries. Therefore the \texttt{-rpath} argument must be explicitly supplied.

\begin{verbatim}
EXTRA_LTLIBRARIES = libfoo.la libbar.la
lib_LTLIBRARIES = \$(WANTEDLIBS)
libfoo_la_SOURCES = foo.c ...
libfoo_la_LDFLAGS = -rpath \'$\(libdir)\'
libbar_la_SOURCES = bar.c ...
libbar_la_LDFLAGS = -rpath \'$\(libdir)\'
\end{verbatim}

Here is how the same Makefile.am would look using Automake conditionals named \texttt{WANT_LIBFOO} and \texttt{WANT_LIBBAR}. Now Automake is able to compute the \texttt{-rpath} setting itself, because it's clear that both libraries will end up in \texttt{\$(libdir)} if they are installed.

\begin{verbatim}
lib_LTLIBRARIES =
if WANT_LIBFOO
  lib_LTLIBRARIES += libfoo.la
endif
if WANT_LIBBAR
  lib_LTLIBRARIES += libbar.la
endif
libfoo_la_SOURCES = foo.c ...
libbar_la_SOURCES = bar.c ...
\end{verbatim}

### 8.3.4 Libtool Libraries with Conditional Sources

Conditional compilation of sources in a library can be achieved in the same way as conditional compilation of sources in a program (see Section 8.1.3 [Conditional Sources], page 55). The only difference is that \texttt{_LIBADD} should be used instead of \texttt{_LDADD} and that it should mention libtool objects (.lo files).

So, to mimic the \texttt{hello} example from Section 8.1.3 [Conditional Sources], page 55, we could build a \texttt{libhello.la} library using either \texttt{hello-linux.c} or \texttt{hello-generic.c} with the following Makefile.am.

\begin{verbatim}
lib_LTLIBRARIES = libhello.la
libhello_la_SOURCES = hello-common.c
EXTRA_libhello_la_SOURCES = hello-linux.c hello-generic.c
\end{verbatim}
libhello_la_LIBADD = $(HELLO_SYSTEM)
libhello_la_DEPENDENCIES = $(HELLO_SYSTEM)

And make sure configure defines HELLO_SYSTEM as either hello-linux.lo or hello-generic.lo.

Or we could simply use an Automake conditional as follows.

lib_LTLIBRARIES = libhello.la
libhello_la_SOURCES = hello-common.c
if LINUX
libhello_la_SOURCES += hello-linux.c
else
libhello_la_SOURCES += hello-generic.c
endif

### 8.3.5 Libtool Convenience Libraries

Sometimes you want to build libtool libraries that should not be installed. These are called **libtool convenience libraries** and are typically used to encapsulate many sublibraries, later gathered into one big installed library.

Libtool convenience libraries are declared by directory-less variables such as `noinst_LTLIBRARIES`, `check_LTLIBRARIES`, or even `EXTRA_LTLIBRARIES`. Unlike installed libtool libraries they do not need an `-rpath` flag at link time (actually this is the only difference).

Convenience libraries listed in `noinst_LTLIBRARIES` are always built. Those listed in `check_LTLIBRARIES` are built only upon `make check`. Finally, libraries listed in `EXTRA_LTLIBRARIES` are never built explicitly: Automake outputs rules to build them, but if the library does not appear as a Makefile dependency anywhere it won’t be built (this is why `EXTRA_LTLIBRARIES` is used for conditional compilation).

Here is a sample setup merging libtool convenience libraries from subdirectories into one main `libtop.la` library.

```make
# -- Top-level Makefile.am --
SUBDIRS = sub1 sub2 ...
lib_LTLIBRARIES = libtop.la
libtop_la_SOURCEs = 
libtop_la_LIBADD = \
    sub1/libsub1.la \n    sub2/libsub2.la \n    ...

# -- sub1/Makefile.am --
noinst_LTLIBRARIES = libsub1.la
libsub1_la_SOURCEs = ...

# -- sub2/Makefile.am --
# showing nested convenience libraries
SUBDIRS = sub2.1 sub2.2 ...
noinst_LTLIBRARIES = libsub2.la
libsub2_la_SOURCEs =
```
libsub2_la_LIBADD = \
  sub21/libsub21.la \
  sub22/libsub22.la \
  ...

When using such setup, beware that `automake` will assume `libtop.la` is to be linked with the C linker. This is because `libtop_la_SOURCES` is empty, so `automake` picks C as default language. If `libtop_la_SOURCES` was not empty, `automake` would select the linker as explained in Section 8.14.3.1 [How the Linker is Chosen], page 78.

If one of the sublibraries contains non-C source, it is important that the appropriate linker be chosen. One way to achieve this is to pretend that there is such a non-C file among the sources of the library, thus forcing `automake` to select the appropriate linker. Here is the top-level `Makefile` of our example updated to force C++ linking.

```makefile
SUBDIRS = sub1 sub2 ...
lib_LTLIBRARIES = libtop.la
libtop_la_SOURCES =
  # Dummy C++ source to cause C++ linking.
  nodist_EXTRA_libtop_la_SOURCES = dummy.cxx
libtop_la_LIBADD = \
  sub1/libsub1.la \
  sub2/libsub2.la \
  ...

'EXTRA_*_SOURCES' variables are used to keep track of source files that might be compiled (this is mostly useful when doing conditional compilation using `AC_SUBST`, see Section 8.3.4 [Conditional Libtool Sources], page 60), and the `nodist_` prefix means the listed sources are not to be distributed (see Section 8.4 [Program and Library Variables], page 64). In effect the file `dummy.cxx` does not need to exist in the source tree. Of course if you have some real source file to list in `libtop_la_SOURCES` there is no point in cheating with `nodist_EXTRA_libtop_la_SOURCES`.

8.3.6 Libtool Modules

These are libtool libraries meant to be dlopened. They are indicated to libtool by passing `-module` at link-time.

```makefile
pkglib_LTLIBRARIES = mymodule.la
mymodule_la_SOURCES = doit.c
mymodule_la_LDFLAGS = -module
```

Ordinarily, Automake requires that a library’s name start with `lib`. However, when building a dynamically loadable module you might wish to use a "nonstandard" name. Automake will not complain about such nonstandard names if it knows the library being built is a libtool module, i.e., if `-module` explicitly appears in the library’s `_LDFLAGS` variable (or in the common `AM_LDFLAGS` variable when no per-library `_LDFLAGS` variable is defined).

As always, `AC_SUBST` variables are black boxes to Automake since their values are not yet known when `automake` is run. Therefore if `-module` is set via such a variable, Automake cannot notice it and will proceed as if the library was an ordinary libtool library, with strict naming.
If `mymodule_la_SOURCES` is not specified, then it defaults to the single file `mymodule.c` (see Section 8.5 [Default _SOURCES], page 68).

8.3.7 _LIBADD, _LDFLAGS, and _LIBTOOLFLAGS

As shown in previous sections, the ‘library_LIBADD’ variable should be used to list extra libtool objects (.lo files) or libtool libraries (.la) to add to library.

The ‘library_LDFLAGS’ variable is the place to list additional libtool linking flags, such as `-version-info`, `-static`, and a lot more. See Section “Link mode” in *The Libtool Manual*.

The libtool command has two kinds of options: mode-specific options and generic options. Mode-specific options such as the aforementioned linking flags should be lumped with the other flags passed to the tool invoked by libtool (hence the use of ‘library_LDFLAGS’ for libtool linking flags). Generic options include `--tag=tag` and `--silent` (see Section “Invoking libtool” in *The Libtool Manual* for more options) should appear before the mode selection on the command line; in Makefile.am they should be listed in the ‘library_LIBTOOLFLAGS’ variable.

If ‘library_LIBTOOLFLAGS’ is not defined, then the variable AM_LIBTOOLFLAGS is used instead.

These flags are passed to libtool after the `--tag=tag` option computed by Automake (if any), so ‘library_LIBTOOLFLAGS’ (or AM_LIBTOOLFLAGS) is a good place to override or supplement the `--tag=tag` setting.

The libtool rules also use a LIBTOOLFLAGS variable that should not be set in Makefile.am: this is a user variable (see Section 28.6 [Flag Variables Ordering], page 145. It allows users to run `make LIBTOOLFLAGS=--silent`, for instance. Note that the verbosity of libtool can also be influenced with the Automake silent-rules option (see Chapter 17 [Options], page 117).

8.3.8 LTLIBOBJS and LTALLOCA

Where an ordinary library might include `$(LIBOBJS)` or `$(ALLOCA)` (see Section 8.6 [LIBOBJS], page 69), a libtool library must use `$(LTLIBOBJS)` or `$(LTALLOCA)`]. This is required because the object files that libtool operates on do not necessarily end in .o.

Nowadays, the computation of LTLIBOBJS from LIBOBJS is performed automatically by Autoconf (see Section “AC_LIBOBJ vs. LIBOBJS” in *The Autoconf Manual*).

8.3.9 Common Issues Related to Libtool’s Use

8.3.9.1 Error: ‘required file ‘./ltmain.sh’ not found’

Libtool comes with a tool called libtoolize that will install libtool’s supporting files into a package. Running this command will install ltmain.sh. You should execute it before aclocal and automake.

People upgrading old packages to newer autotools are likely to face this issue because older Automake versions used to call libtoolize. Therefore old build scripts do not call libtoolize.

Since Automake 1.6, it has been decided that running libtoolize was none of Automake’s business. Instead, that functionality has been moved into the autoreconf com-
mand (see Section “Using autoreconf” in The Autoconf Manual). If you do not want to remember what to run and when, just learn the autoreconf command. Hopefully, replacing existing bootstrap.sh or autogen.sh scripts by a call to autoreconf should also free you from any similar incompatible change in the future.

8.3.9.2 Objects ‘created with both libtool and without’

Sometimes, the same source file is used both to build a libtool library and to build another non-libtool target (be it a program or another library).

Let’s consider the following Makefile.am.

```
bin_PROGRAMS = prog
prog_SOURCES = prog.c foo.c ...

lib_LTLIBRARIES = libfoo.la
libfoo_la_SOURCES = foo.c ...
```

(In this trivial case the issue could be avoided by linking libfoo.la with prog instead of listing foo.c in prog_SOURCES. But let’s assume we really want to keep prog and libfoo.la separate.)

Technically, it means that we should build foo.$(OBJEXT) for prog, and foo.lo for libfoo.la. The problem is that in the course of creating foo.lo, libtool may erase (or replace) foo.$(OBJEXT), and this cannot be avoided.

Therefore, when Automake detects this situation it will complain with a message such as

```
object 'foo.$(OBJEXT)' created both with libtool and without
```

A workaround for this issue is to ensure that these two objects get different basenames. As explained in Section 28.7 [Renamed Objects], page 147, this happens automatically when per-targets flags are used.

```
bin_PROGRAMS = prog
prog_SOURCES = prog.c foo.c ...
prog_CFLAGS = $(AM_CFLAGS)

lib_LTLIBRARIES = libfoo.la
libfoo_la_SOURCES = foo.c ...
```

Adding ‘prog_CFLAGS = $(AM_CFLAGS)’ is almost a no-op, because when the prog_CFLAGS is defined, it is used instead of AM_CFLAGS. However as a side effect it will cause prog.c and foo.c to be compiled as prog-prog.$(OBJEXT) and prog-foo.$(OBJEXT), which solves the issue.

8.4 Program and Library Variables

Associated with each program is a collection of variables that can be used to modify how that program is built. There is a similar list of such variables for each library. The canonical name of the program (or library) is used as a base for naming these variables.

In the list below, we use the name “maude” to refer to the program or library. In your Makefile.am you would replace this with the canonical name of your program. This list also refers to “maude” as a program, but in general the same rules apply for both static and
dynamic libraries; the documentation below notes situations where programs and libraries differ.

**maude\_SOURCES**

This variable, if it exists, lists all the source files that are compiled to build the program. These files are added to the distribution by default. When building the program, Automake will cause each source file to be compiled to a single `.o` file (or `.lo` when using libtool). Normally these object files are named after the source file, but other factors can change this. If a file in the \_SOURCES variable has an unrecognized extension, Automake will do one of two things with it. If a suffix rule exists for turning files with the unrecognized extension into `.o` files, then `automake` will treat this file as it will any other source file (see Section 8.18 [Support for Other Languages], page 80). Otherwise, the file will be ignored as though it were a header file.

The prefixes `dist_` and `nodist_` can be used to control whether files listed in a \_SOURCES variable are distributed. `dist_` is redundant, as sources are distributed by default, but it can be specified for clarity if desired.

It is possible to have both `dist_` and `nodist_` variants of a given \_SOURCES variable at once; this lets you easily distribute some files and not others, for instance:

```make
nodist_maude\_SOURCES = nodist.c
dist_maude\_SOURCES = dist-me.c
```

By default the output file (on Unix systems, the `.o` file) will be put into the current build directory. However, if the option `subdir-objects` is in effect in the current directory then the `.o` file will be put into the subdirectory named after the source file. For instance, with `subdir-objects` enabled, `sub/dir/file.c` will be compiled to `sub/dir/file.o`. Some people prefer this mode of operation. You can specify `subdir-objects` in `AUTOMAKE_OPTIONS` (see Chapter 17 [Options], page 117).

**EXTRA\_maude\_SOURCES**

Automake needs to know the list of files you intend to compile *statically*. For one thing, this is the only way Automake has of knowing what sort of language support a given `Makefile.in` requires.\(^3\) This means that, for example, you can’t put a configure substitution like `@my\_sources@` into a \_SOURCES variable. If you intend to conditionally compile source files and use `configure` to substitute the appropriate object names into, e.g., \_LDADD (see below), then you should list the corresponding source files in the EXTRA\_ variable.

This variable also supports `dist_` and `nodist_` prefixes. For instance, `nodist_ EXTRA\_maude\_SOURCES` would list extra sources that may need to be built, but should not be distributed.

**maude\_AR**

A static library is created by default by invoking `$(AR) $(ARFLAGS)` followed by the name of the library and then the objects being put into the library. You can override this by setting the \_AR variable. This is usually used with C++; some C++ compilers require a special invocation in order to instantiate all the

---

\(^3\) There are other, more obscure reasons for this limitation as well.
templates that should go into a library. For instance, the SGI C++ compiler
likes this variable set like so:

\[
\text{libmaude\_a\_AR} = \$(CXX) -ar -o
\]

**maude\_LIBADD**

Extra objects can be added to a library using the _LIBADD variable. For instance, this should be used for objects determined by configure (see Section 8.2 [A Library], page 57).

In the case of libtool libraries, maude\_LIBADD can also refer to other libtool libraries.

**maude\_LDADD**

Extra objects (*.\$(OBJEXT)) and libraries (*.a, *.la) can be added to a program by listing them in the _LDADD variable. For instance, this should be used for objects determined by configure (see Section 8.1.2 [Linking], page 54).

_LDADD and _LIBADD are inappropriate for passing program-specific linker flags (except for -l, -L, -dlopen and -dlpreopen). Use the _LDFLAGS variable for this purpose.

For instance, if your configure.ac uses AC_PATH_XTRA, you could link your program against the X libraries like so:

\[
\text{maude\_LDADD} = \$(X\_PRE\_LIBS) \$(X\_LIBS) \$(X\_EXTRA\_LIBS)
\]

We recommend that you use -l and -L only when referring to third-party libraries, and give the explicit file names of any library built by your package. Doing so will ensure that maude\_DEPENDENCIES (see below) is correctly defined by default.

**maude\_LDFLAGS**

This variable is used to pass extra flags to the link step of a program or a shared library. It overrides the AM\_LDFLAGS variable.

**maude\_LIBTOOLFLAGS**

This variable is used to pass extra options to libtool. It overrides the AM\_LIBTOOLFLAGS variable. These options are output before libtool’s --mode=mode option, so they should not be mode-specific options (those belong to the compiler or linker flags). See Section 8.3.7 [Libtool Flags], page 63.

**maude\_DEPENDENCIES**

It is also occasionally useful to have a target (program or library) depend on some other file that is not actually part of that target. This can be done using the _DEPENDENCIES variable. Each target depends on the contents of such a variable, but no further interpretation is done.

Since these dependencies are associated to the link rule used to create the programs they should normally list files used by the link command. That is *.\$(OBJEXT), *.a, or *.la files for programs; *.lo and *.la files for Libtool libraries; and *.\$(OBJEXT) files for static libraries. In rare cases you may need to add other kinds of files such as linker scripts, but listing a source file in _DEPENDENCIES is wrong. If some source file needs to be built before all the
components of a program are built, consider using the BUILT_SOURCES variable (see Section 9.4 [Sources], page 84).

If _DEPENDENCIES is not supplied, it is computed by Automake. The automatically-assigned value is the contents of _LDADD or _LIBADD, with most configure substitutions, -l, -L, -dlopen and -dlpreopen options removed. The configure substitutions that are left in are only ‘$(LIBOBS)’ and ‘$(ALLOC)’; these are left because it is known that they will not cause an invalid value for _DEPENDENCIES to be generated.

DEPENDENCIES is more likely used to perform conditional compilation using an AC_SUBST variable that contains a list of objects. See Section 8.1.3 [Conditional Sources], page 55, and Section 8.3.4 [Conditional Libtool Sources], page 60.

The EXTRA_*_DEPENDENCIES variable may be useful for cases where you merely want to augment the automake-generated _DEPENDENCIES variable rather than replacing it.

maude_LINK

You can override the linker on a per-program basis. By default the linker is chosen according to the languages used by the program. For instance, a program that includes C++ source code would use the C++ compiler to link. The _LINK variable must hold the name of a command that can be passed all the .o file names and libraries to link against as arguments. Note that the name of the underlying program is not passed to _LINK; typically one uses ‘$@’:

maude_LINK = $(CCLD) -magic -o $@

If a _LINK variable is not supplied, it may still be generated and used by Automake due to the use of per-target link flags such as _CFLAGS, _LDFLAGS or _LIBTOOLFLAGS, in cases where they apply.

maude_CCASFLAGS
maude_CFLAGS
maude_CPPFLAGS
maude_CXXFLAGS
maude_FFLAGS
maude_GCJFLAGS
maude_LFLAGS
maude_OBJCFLAGS
maude_OBJCXXFLAGS
maude_RFLAGS
maude_UPCFLAGS
maude_YFLAGS

Automake allows you to set compilation flags on a per-program (or per-library) basis. A single source file can be included in several programs, and it will potentially be compiled with different flags for each program. This works for any language directly supported by Automake. These per-target compilation flags are '_CCASFLAGS', '_CFLAGS', '_CPPFLAGS', '_CXXFLAGS', '_FFLAGS', '_GCJFLAGS', '_LFLAGS', '_OBJCFLAGS', '_OBJCXXFLAGS', '_RFLAGS', '_UPCFLAGS', and '_YFLAGS'.

When using a per-target compilation flag, Automake will choose a different name for the intermediate object files. Ordinarily a file like `sample.c` will be compiled to produce `sample.o`. However, if the program’s `_CFLAGS` variable is set, then the object file will be named, for instance, `maude-sample.o`. (See also Section 28.7 [Renamed Objects], page 147.) The use of per-target compilation flags with C sources requires that the macro `AM_PROG_CC_C_O` be called from `configure.ac`.

In compilations with per-target flags, the ordinary `AM_` form of the flags variable is not automatically included in the compilation (however, the user form of the variable is included). So for instance, if you want the hypothetical `maude` compilations to also use the value of `AM_CFLAGS`, you would need to write:

```
maude_CFLAGS = ... your flags ... $(AM_CFLAGS)
```

See Section 28.6 [Flag Variables Ordering], page 145, for more discussion about the interaction between user variables, ‘AM_’ shadow variables, and per-target variables.

**maude_SHORTNAME**

On some platforms the allowable file names are very short. In order to support these systems and per-target compilation flags at the same time, Automake allows you to set a “short name” that will influence how intermediate object files are named. For instance, in the following example,

```
bin_PROGRAMS = maude
maude_CPPFLAGS = -DSOMEFLAG
maude_SHORTNAME = m
maude_SOURCES = sample.c ...
```

the object file would be named `m-sample.o` rather than `maude-sample.o`.

This facility is rarely needed in practice, and we recommend avoiding it until you find it is required.

### 8.5 Default _SOURCES

_SOURCES_ variables are used to specify source files of programs (see Section 8.1 [A Program], page 53), libraries (see Section 8.2 [A Library], page 57), and Libtool libraries (see Section 8.3 [A Shared Library], page 58).

When no such variable is specified for a target, Automake will define one itself. The default is to compile a single C file whose base name is the name of the target itself, with any extension replaced by `AM_DEFAULT_SOURCE_EXT`, which defaults to `.c`.

For example if you have the following somewhere in your `Makefile.am` with no corresponding `libfoo_a_SOURCES`:

```
lib_LIBRARIES = libfoo.a sub/libc++.a
```

`libfoo.a` will be built using a default source file named `libfoo.c`, and `sub/libc++.a` will be built from `sub/libc++.c`. (In older versions `sub/libc++.a` would be built from `sub/libc___.a.c`, i.e., the default source was the canonized name of the target, with `.c` appended. We believe the new behavior is more sensible, but for backward compatibility _automake_ will use the old name if a file or a rule with that name exists and `AM_DEFAULT_SOURCE_EXT` is not used.)
Default sources are mainly useful in test suites, when building many test programs each from a single source. For instance, in

```
check_PROGRAMS = test1 test2 test3
AM_DEFAULT_SOURCE_EXT = .cpp
```
test1, test2, and test3 will be built from test1.cpp, test2.cpp, and test3.cpp. Without the last line, they will be built from test1.c, test2.c, and test3.c.

Another case where this is convenient is building many Libtool modules (modulen.la), each defined in its own file (modulen.c).

```
AM_LDFLAGS = -module
lib_LTLIBRARIES = module1.la module2.la module3.la
```

Finally, there is one situation where this default source computation needs to be avoided: when a target should not be built from sources. We already saw such an example in Section 4.2 [true], page 25; this happens when all the constituents of a target have already been compiled and just need to be combined using a _LDADD variable. Then it is necessary to define an empty _SOURCES variable, so that automake does not compute a default.

```
bin_PROGRAMS = target
target_SOURCES =
target_LDADD = libmain.a libmisc.a
```

8.6 Special handling for LIBOBS and ALLOCA

The ‘$(LIBOBS)’ and ‘$(ALLOCA)’ variables list object files that should be compiled into the project to provide an implementation for functions that are missing or broken on the host system. They are substituted by configure.

These variables are defined by Autoconf macros such as AC_LIBOBJ, AC_REPLACE_FUNCS (see Section “Generic Function Checks” in The Autoconf Manual), or AC_FUNC_ALLOCA (see Section “Particular Function Checks” in The Autoconf Manual). Many other Autoconf macros call AC_LIBOBJ or AC_REPLACE_FUNCS to populate ‘$(LIBOBS)’.

Using these variables is very similar to doing conditional compilation using AC_SUBST variables, as described in Section 8.1.3 [Conditional Sources], page 55. That is, when building a program, ‘$(LIBOBS)’ and ‘$(ALLOCA)’ should be added to the associated ‘*LDADD’ variable, or to the ‘*_LIBADD’ variable when building a library. However there is no need to list the corresponding sources in ‘EXTRA_*_SOURCES’ nor to define ‘*_DEPENDENCIES’. Automake automatically adds ‘$(LIBOBS)’ and ‘$(ALLOCA)’ to the dependencies, and it will discover the list of corresponding source files automatically (by tracing the invocations of the AC_LIBSOURCE Autoconf macros). If you have already defined ‘*_DEPENDENCIES’ explicitly for an unrelated reason, then you either need to add these variables manually, or use ‘EXTRA_*_DEPENDENCIES’ instead of ‘*_DEPENDENCIES’.

These variables are usually used to build a portability library that is linked with all the programs of the project. We now review a sample setup. First, configure.ac contains some checks that affect either LIBOBS or ALLOCA.

```
# configure.ac
...
AC_CONFIG_LIBOBJ_DIR([lib])
...
```
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AC_FUNC_MALLOC  
dnl May add malloc.$(OBJEXT) to LIBOBJS
AC_FUNC_MEMCMP  
dnl May add memcmp.$(OBJEXT) to LIBOBJS
AC_REPLACE_FUNCS([strdup])  
dnl May add strdup.$(OBJEXT) to LIBOBJS
AC_FUNC_ALLOCA  
dnl May add alloca.$(OBJEXT) to ALLOCA

AC_CONFIG_FILES([
    lib/Makefile
    src/Makefile
])

AC_OUTPUT

The AC_CONFIG_LIBOBJ_DIR tells Autoconf that the source files of these object files are to be found in the lib/ directory. Automake can also use this information, otherwise it expects the source files are to be in the directory where the ‘$(LIBOBJS)’ and ‘$(ALLOCA)’ variables are used.

The lib/ directory should therefore contain malloc.c, memcmp.c, strdup.c, alloca.c. Here is its Makefile.am:

# lib/Makefile.am

noinst_LIBRARIES = libcompat.a
libcompat_a_SOURCES =
libcompat_a_LIBADD = $(LIBOBJS) $(ALLOCA)

The library can have any name, of course, and anyway it is not going to be installed: it just holds the replacement versions of the missing or broken functions so we can later link them in. Many projects also include extra functions, specific to the project, in that library: they are simply added on the _SOURCES line.

There is a small trap here, though: ‘$(LIBOBJS)’ and ‘$(ALLOCA)’ might be empty, and building an empty library is not portable. You should ensure that there is always something to put in libcompat.a. Most projects will also add some utility functions in that directory, and list them in libcompat_a_SOURCES, so in practice libcompat.a cannot be empty.

Finally here is how this library could be used from the src/ directory.

# src/Makefile.am

# Link all programs in this directory with libcompat.a
LDADD = ../lib/libcompat.a

bin_PROGRAMS = tool1 tool2 ...
tool1_SOURCES = ...
tool2_SOURCES = ...

When option subdir-objects is not used, as in the above example, the variables ‘$(LIBOBJS)’ or ‘$(ALLOCA)’ can only be used in the directory where their sources lie. E.g., here it would be wrong to use ‘$(LIBOBJS)’ or ‘$(ALLOCA)’ in src/Makefile.am. However if both subdir-objects and AC_CONFIG_LIBOBJ_DIR are used, it is OK to use these variables in other directories. For instance src/Makefile.am could be changed as follows.

# src/Makefile.am
AUTOMAKE_OPTIONS = subdir-objects
LDADD = $(LIBOBJS) $(ALLOCA)

bin_PROGRAMS = tool1 tool2 ...
tool1_SOURCES = ...
tool2_SOURCES = ...

Because `$LIBOBJS` and `$ALLOCA` contain object file names that end with 
`.$(OBJEXT)`, they are not suitable for Libtool libraries (where the expected object extension is .lo): 
`LTLIBOBJS` and `LTALLOCA` should be used instead.

`LTLIBOBJS` is defined automatically by Autoconf and should not be defined by hand (as 
in the past), however at the time of writing `LTALLOCA` still needs to be defined from 

### 8.7 Variables used when building a program

Occasionally it is useful to know which `Makefile` variables Automake uses for compilations, 
and in which order (see Section 28.6 [Flag Variables Ordering], page 145); for instance, you 
might need to do your own compilation in some special cases.

Some variables are inherited from Autoconf; these are `CC`, `CFLAGS`, `CPPFLAGS`, `DEFS`, 
`LDFLAGS`, and `LIBS`.

There are some additional variables that Automake defines on its own:

**AM_CPPFLAGS**

The contents of this variable are passed to every compilation that invokes the 
C preprocessor; it is a list of arguments to the preprocessor. For instance, `-I` 
and `-D` options should be listed here.

Automake already provides some `-I` options automatically, in a separate vari-
able that is also passed to every compilation that invokes the C preprocessor. In 
particular it generates ‘-I.’, ‘-I$(srcdir)’, and a `-I` pointing to the directory 
holding `config.h` (if you’ve used `AC_CONFIG_HEADERS` or `AM_CONFIG_HEADER`). 
You can disable the default `-I` options using the `nostdinc` option.

When a file to be included is generated during the build and not part 
of a distribution tarball, its location is under `$(builddir)`, not under 
`$(srcdir)`. This matters especially for packages that use header files placed 
in sub-directories and want to allow builds outside the source tree (see 
Section 2.2.6 [VPath Builds], page 6). In that case we recommend to use a 
pair of `-I` options, such as, e.g., ‘-Isome/subdir -I$(srcdir)/some/subdir’ 
or ‘-I$(top_builddir)/some/subdir -I$(top_srcdir)/some/subdir’. Note 
that the reference to the build tree should come before the reference to the 
source tree, so that accidentally leftover generated files in the source directory 
are ignored.

`AM_CPPFLAGS` is ignored in preference to a per-executable (or per-library) 
CPPFLAGS variable if it is defined.
**INCLUDES**

This does the same job as `AM_CPPFLAGS` (or any per-target `_CPPFLAGS` variable if it is used). It is an older name for the same functionality. This variable is deprecated; we suggest using `AM_CPPFLAGS` and per-target `_CPPFLAGS` instead.

**AM_CFLAGS**

This is the variable the `Makefile.am` author can use to pass in additional C compiler flags. It is more fully documented elsewhere. In some situations, this is not used, in preference to the per-executable (or per-library) `_CFLAGS`.

**COMPILCE**

This is the command used to actually compile a C source file. The file name is appended to form the complete command line.

**AM_LDFLAGS**

This is the variable the `Makefile.am` author can use to pass in additional linker flags. In some situations, this is not used, in preference to the per-executable (or per-library) `_LDFLAGS`.

**LINK**

This is the command used to actually link a C program. It already includes `-o $@` and the usual variable references (for instance, `CFLAGS`); it takes as "arguments" the names of the object files and libraries to link in. This variable is not used when the linker is overridden with a per-target `_LINK` variable or per-target flags cause Automake to define such a `_LINK` variable.

### 8.8 Yacc and Lex support

Automake has somewhat idiosyncratic support for Yacc and Lex.

Automake assumes that the `.c` file generated by `yacc` (or `lex`) should be named using the basename of the input file. That is, for a `yacc` source file `foo.y`, Automake will cause the intermediate file to be named `foo.c` (as opposed to `y.tab.c`, which is more traditional).

The extension of a `yacc` source file is used to determine the extension of the resulting C or C++ source and header files. Note that header files are generated only when the `-d` `Yacc` option is used; see below for more information about this flag, and how to specify it. Files with the extension `.y` will thus be turned into `.c` sources and `.h` headers; likewise, `.yy` will become `.cc` and `.hh`, `.y++` will become `.cpp` and `.hpp`, `.yxx` will become `.cxx` and `.hxx`, and `.ypp` will become `.cpp` and `.hpp`.

Similarly, `lex` source files can be used to generate C or C++; the extensions `.l`, `.ll`, `.l++`, `.hxx`, and `.lpp` are recognized.

You should never explicitly mention the intermediate (C or C++) file in any SOURCES variable; only list the source file.

The intermediate files generated by `yacc` (or `lex`) will be included in any distribution that is made. That way the user doesn’t need to have `yacc` or `lex`.

If a `yacc` source file is seen, then your `configure.ac` must define the variable `YACC`. This is most easily done by invoking the macro `AC_PROG_YACC` (see Section “Particular Program Checks” in *The Autoconf Manual*).

When `yacc` is invoked, it is passed `AM_YFLAGS` and `YFLAGS`. The latter is a user variable and the former is intended for the `Makefile.am` author.

`AM_YFLAGS` is usually used to pass the `-d` option to `yacc`. Automake knows what this means and will automatically adjust its rules to update and distribute the header file built
by `yacc -d`\(^4\). What Automake cannot guess, though, is where this header will be used: it is up to you to ensure the header gets built before it is first used. Typically this is necessary in order for dependency tracking to work when the header is included by another file. The common solution is listing the header file in `BUILT_SOURCES` (see Section 9.4 [Sources], page 84) as follows:

```
BUILT_SOURCES = parser.h
AM_YFLAGS = -d
bin_PROGRAMS = foo
foo_SOURCES = ... parser.y ...
```

If a `lex` source file is seen, then your `configure.ac` must define the variable `LEX`. You can use `AC_PROG_LEX` to do this (see Section “Particular Program Checks” in *The Autoconf Manual*), but using `AM_PROG_LEX` macro (see Section 6.4 [Macros], page 44) is recommended.

When `lex` is invoked, it is passed `AM_LFLAGS` and `LFLAGS`. The latter is a user variable and the former is intended for the `Makefile.am` author.

When `AM_MAINTAINER_MODE` (see Section 28.2 [maintainer-mode], page 140) is used, the rebuild rule for distributed Yacc and Lex sources are only used when `maintainer-mode` is enabled, or when the files have been erased.

When `lex` or `yacc` sources are used, `automake -i` automatically installs an auxiliary program called `ylwrap` in your package (see Section 3.7 [Auxiliary Programs], page 23). This program is used by the build rules to rename the output of these tools, and makes it possible to include multiple `yacc` (or `lex`) source files in a single directory. (This is necessary because yacc’s output file name is fixed, and a parallel make could conceivably invoke more than one instance of yacc simultaneously.)

For `yacc`, simply managing locking is insufficient. The output of `yacc` always uses the same symbol names internally, so it isn’t possible to link two `yacc` parsers into the same executable.

We recommend using the following renaming hack used in `gdb`:

```
#define yymaxdepth c_maxdepth
#define yyparse c_parse
#define yylex  c_lex
#define yyerror c_error
#define yylval c_lval
#define yychar c_char
#define yydebug c_debug
#define yypact c_pact
#define yyr1  c_r1
#define yyr2  c_r2
#define yydef c_def
#define yychk c_chk
#define yypgo c_pgo
#define yyact c_act
#define yyexca c_exca
```

\(^4\) Please note that `automake` recognizes `-d` in `AM_YFLAGS` only if it is not clustered with other options; for example, it won’t be recognized if `AM_YFLAGS` is `-dt`, but it will be if `AM_YFLAGS` is `-d` `-t` or `-t -d`. 
#define yyerrflag c_errflag
#define yynerrs c_nerrs
#define yyps c_ps
#define yyvp c_pv
#define yys c_s
#define yy_yys c_yys
#define yystate c_state
#define yytmp c_tmp
#define yyv c_v
#define yy_yyv c_yyv
#define yyval c_val
#define yyloc c_lloc
#define yyreds c_reds
#define yytoks c_toks
#define yylhs c_yylhs
#define yylen c_yylen
#define yydefred c_yydefred
#define yydgoto c_yydgoto
#define yysindex c_yysindex
#define yyrindex c_yyrindex
#define yygindex c_yygindex
#define yytable c_yytable
#define yycheck c_yycheck
#define yyname c_yyname
#define yyrule c_yyrule

For each define, replace the ‘c_’ prefix with whatever you like. These defines work for 
bison, byacc, and traditional yaccs. If you find a parser generator that uses a symbol not 
covered here, please report the new name so it can be added to the list.

8.9 C++ Support

Automake includes full support for C++.

Any package including C++ code must define the output variable CXX in configure.ac; 
the simplest way to do this is to use the AC_PROG_CXX macro (see Section “Particular 

A few additional variables are defined when a C++ source file is seen:

CXX The name of the C++ compiler.

CXXFLAGS Any flags to pass to the C++ compiler.

AM_CXXFLAGS The maintainer’s variant of CXXFLAGS.

CXXCOMPILE The command used to actually compile a C++ source file. The file name is 
appended to form the complete command line.

CXXLINK The command used to actually link a C++ program.
8.10 Objective C Support

Automake includes some support for Objective C.

Any package including Objective C code must define the output variable OBJC in configure.ac; the simplest way to do this is to use the AC_PROG_OBJC macro (see Section “Particular Program Checks” in The Autoconf Manual).

A few additional variables are defined when an Objective C source file is seen:

- **OBJC** The name of the Objective C compiler.
- **OBJCFLAGS** Any flags to pass to the Objective C compiler.
- **AM_OBJCFLAGS** The maintainer’s variant of OBJCFLAGS.
- **OBJCCOMPILE** The command used to actually compile an Objective C source file. The file name is appended to form the complete command line.
- **OBJCLINK** The command used to actually link an Objective C program.

8.11 Objective C++ Support

Automake includes some support for Objective C++.

Any package including Objective C++ code must define the output variable OBJCXX in configure.ac; the simplest way to do this is to use the AC_PROG_OBJCXX macro (see Section “Particular Program Checks” in The Autoconf Manual).

A few additional variables are defined when an Objective C++ source file is seen:

- **OBJCXX** The name of the Objective C++ compiler.
- **OBJCXXFLAGS** Any flags to pass to the Objective C++ compiler.
- **AM_OBJCXXFLAGS** The maintainer’s variant of OBJCXXFLAGS.
- **OBJCXXCOMPILE** The command used to actually compile an Objective C++ source file. The file name is appended to form the complete command line.
- **OBJCXXLINK** The command used to actually link an Objective C++ program.

8.12 Unified Parallel C Support

Automake includes some support for Unified Parallel C.

Any package including Unified Parallel C code must define the output variable UPC in configure.ac; the simplest way to do this is to use the AM_PROG_UPC macro (see Section 6.4.1 [Public Macros], page 44).

A few additional variables are defined when a Unified Parallel C source file is seen:

- **UPC** The name of the Unified Parallel C compiler.
UPCFLAGS Any flags to pass to the Unified Parallel C compiler.

AM_UPCFLAGS The maintainer’s variant of UPCFLAGS.

UPCCOMPILE The command used to actually compile a Unified Parallel C source file. The file name is appended to form the complete command line.

UPCLINK The command used to actually link a Unified Parallel C program.

### 8.13 Assembly Support

Automake includes some support for assembly code. There are two forms of assembler files: normal (*.s) and preprocessed by CPP (*.S or *.sx).

The variable CCAS holds the name of the compiler used to build assembly code. This compiler must work a bit like a C compiler; in particular it must accept `-c` and `-o`. The values of CCASFLAGS and AM_CCASFLAGS (or its per-target definition) is passed to the compilation. For preprocessed files, DEFS, DEFAULT_INCLUDES, INCLUDES, CPPFLAGS and AM_CPPFLAGS are also used.

The autoconf macro AM_PROG_AS will define CCAS and CCASFLAGS for you (unless they are already set, it simply sets CCAS to the C compiler and CCASFLAGS to the C compiler flags), but you are free to define these variables by other means.

Only the suffixes .s, .S, and .sx are recognized by automake as being files containing assembly code.

### 8.14 Fortran 77 Support

Automake includes full support for Fortran 77.

Any package including Fortran 77 code must define the output variable F77 in configure.ac; the simplest way to do this is to use the AC_PROG_F77 macro (see Section “Particular Program Checks” in The Autoconf Manual).

A few additional variables are defined when a Fortran 77 source file is seen:

F77 The name of the Fortran 77 compiler.

FFLAGS Any flags to pass to the Fortran 77 compiler.

AM_FFLAGS The maintainer’s variant of FFLAGS.

RFLAGS Any flags to pass to the Ratfor compiler.

AM_RFLAGS The maintainer’s variant of RFLAGS.

F77COMPILE The command used to actually compile a Fortran 77 source file. The file name is appended to form the complete command line.

FLINK The command used to actually link a pure Fortran 77 program or shared library.
Automake can handle preprocessing Fortran 77 and Ratfor source files in addition to compiling them\(^5\). Automake also contains some support for creating programs and shared libraries that are a mixture of Fortran 77 and other languages (see Section 8.14.3 [Mixing Fortran 77 With C and C++], page 77).

These issues are covered in the following sections.

### 8.14.1 Preprocessing Fortran 77

N.f is made automatically from N.F or N.r. This rule runs just the preprocessor to convert a preprocessable Fortran 77 or Ratfor source file into a strict Fortran 77 source file. The precise command used is as follows:

\[
\begin{align*}
\&.F \quad $(F77) -F $(DEFS) $(INCLUDES) $(AM_CPPFLAGS) $(CPPFLAGS) \\
&\quad $(AM_FFLAGS) $(FFLAGS) \\
\&.r \quad $(F77) -F $(AM_FFLAGS) $(FFLAGS) $(AM_RFLAGS) $(RFLAGS)
\end{align*}
\]

### 8.14.2 Compiling Fortran 77 Files

N.o is made automatically from N.f, N.F or N.r by running the Fortran 77 compiler. The precise command used is as follows:

\[
\begin{align*}
\&.f \quad $(F77) -c $(AM_FFLAGS) $(FFLAGS) \\
\&.F \quad $(F77) -c $(DEFS) $(INCLUDES) $(AM_CPPFLAGS) $(CPPFLAGS) \\
&\quad $(AM_FFLAGS) $(FFLAGS) \\
\&.r \quad $(F77) -c $(AM_FFLAGS) $(FFLAGS) $(AM_RFLAGS) $(RFLAGS)
\end{align*}
\]

### 8.14.3 Mixing Fortran 77 With C and C++

Automake currently provides limited support for creating programs and shared libraries that are a mixture of Fortran 77 and C and/or C++. However, there are many other issues related to mixing Fortran 77 with other languages that are not (currently) handled by Automake, but that are handled by other packages\(^6\).

Automake can help in two ways:

1. Automatic selection of the linker depending on which combinations of source code.
2. Automatic selection of the appropriate linker flags (e.g., -L and -l) to pass to the automatically selected linker in order to link in the appropriate Fortran 77 intrinsic and run-time libraries.

These extra Fortran 77 linker flags are supplied in the output variable FLIBS by the `AC_F77_LIBRARY_LDFLAGS` Autoconf macro. See Section “Fortran Compiler Characteristics” in The Autoconf Manual.

If Automake detects that a program or shared library (as mentioned in some `_PROGRAMS` or `_LTLIBRARIES` primary) contains source code that is a mixture of Fortran 77 and C and/or

\(^5\) Much, if not most, of the information in the following sections pertaining to preprocessing Fortran 77 programs was taken almost verbatim from Section “Catalogue of Rules” in The GNU Make Manual.

\(^6\) For example, the cfortran package (http://www-zeus.desy.de/~burow/cfortran/) addresses all of these inter-language issues, and runs under nearly all Fortran 77, C and C++ compilers on nearly all platforms. However, cfortran is not yet Free Software, but it will be in the next major release.
C++, then it requires that the macro `AC_F77_LIBRARY_LDFLAGS` be called in `configure.ac`, and that either `$FLIBS` appear in the appropriate `_LDADD` (for programs) or `_LIBADD` (for shared libraries) variables. It is the responsibility of the person writing the `Makefile.am` to make sure that `$FLIBS` appears in the appropriate `_LDADD` or `_LIBADD` variable.

For example, consider the following `Makefile.am`:

```makefile
bin_PROGRAMS = foo
foo_SOURCES = main.cc foo.f
foo_LDADD = libfoo.la $(FLIBS)

pkglib_LTLIBRARIES = libfoo.la
libfoo_la_SOURCES = bar.f baz.c zardoz.cc
libfoo_la_LIBADD = $(FLIBS)
```

In this case, Automake will insist that `AC_F77_LIBRARY_LDFLAGS` is mentioned in `configure.ac`. Also, if `$FLIBS` hadn’t been mentioned in `foo_LDADD` and `libfoo_la_LIBADD`, then Automake would have issued a warning.

### 8.14.3.1 How the Linker is Chosen

When a program or library mixes several languages, Automake choose the linker according to the following priorities. (The names in parentheses are the variables containing the link command.)

1. Native Java (`GCJLINK`)
2. Objective C++ (`OBJCXXLINK`)
3. C++ (`CXXLINK`)
4. Fortran 77 (`F77LINK`)
5. Fortran (`FCLINK`)
6. Objective C (`OBJCLINK`)
7. Unified Parallel C (`UPCLINK`)
8. C (`LINK`)

For example, if Fortran 77, C and C++ source code is compiled into a program, then the C++ linker will be used. In this case, if the C or Fortran 77 linkers required any special libraries that weren’t included by the C++ linker, then they must be manually added to an `_LDADD` or `_LIBADD` variable by the user writing the `Makefile.am`.

Automake only looks at the file names listed in `_SOURCES` variables to choose the linker, and defaults to the C linker. Sometimes this is inconvenient because you are linking against a library written in another language and would like to set the linker more appropriately. See Section 8.3.5 [Libtool Convenience Libraries], page 61, for a trick with `nodist_EXTRA_..._SOURCES`.

A per-target `_LINK` variable will override the above selection. Per-target link flags will cause Automake to write a per-target `_LINK` variable according to the language chosen as above.
8.15 Fortran 9x Support

Automake includes support for Fortran 9x.

Any package including Fortran 9x code must define the output variable FC in configure.ac; the simplest way to do this is to use the AC_PROG_FC macro (see Section “Particular Program Checks” in The Autoconf Manual).

A few additional variables are defined when a Fortran 9x source file is seen:

- **FC** The name of the Fortran 9x compiler.
- **FCFLAGS** Any flags to pass to the Fortran 9x compiler.
- **AM_FCFLAGS** The maintainer’s variant of FCFLAGS.
- **FCCOMPILE** The command used to actually compile a Fortran 9x source file. The file name is appended to form the complete command line.
- **FCLINK** The command used to actually link a pure Fortran 9x program or shared library.

8.15.1 Compiling Fortran 9x Files

file.o is made automatically from file.f90, file.f95, file.f03, or file.f08 by running the Fortran 9x compiler. The precise command used is as follows:

- .f90 $(FC) $(AM_FCFLAGS) $(FCFLAGS) -c $(FCFLAGS_f90) $<
- .f95 $(FC) $(AM_FCFLAGS) $(FCFLAGS) -c $(FCFLAGS_f95) $<
- .f03 $(FC) $(AM_FCFLAGS) $(FCFLAGS) -c $(FCFLAGS_f03) $<
- .f08 $(FC) $(AM_FCFLAGS) $(FCFLAGS) -c $(FCFLAGS_f08) $<

8.16 Compiling Java sources using gcj

Automake includes support for natively compiled Java, using gcj, the Java front end to the GNU Compiler Collection (rudimentary support for compiling Java to bytecode using the javac compiler is also present, albeit deprecated; see Section 10.4 [Java], page 88).

Any package including Java code to be compiled must define the output variable GCJ in configure.ac; the variable GCJFLAGS must also be defined somehow (either in configure.ac or Makefile.am). The simplest way to do this is to use the AM_PROG_GCJ macro.

By default, programs including Java source files are linked with gcj.

As always, the contents of AM_GCJFLAGS are passed to every compilation invoking gcj (in its role as an ahead-of-time compiler, when invoking it to create .class files, AM_JAVACFLAGS is used instead). If it is necessary to pass options to gcj from Makefile.am, this variable, and not the user variable GCJFLAGS, should be used.

 gcj can be used to compile .java, .class, .zip, or .jar files.

When linking, gcj requires that the main class be specified using the --main= option. The easiest way to do this is to use the _LDFLAGS variable for the program.
8.17 Vala Support

Automake provides initial support for Vala (http://www.vala-project.org/). This requires valac version 0.7.0 or later, and currently requires the user to use GNU make.

```
foo_SOURCES = foo.vala bar.vala zardoc.c
```

Any .vala file listed in a _SOURCES variable will be compiled into C code by the Vala compiler. The generated .c files are distributed. The end user does not need to have a Vala compiler installed.

Automake ships with an Autoconf macro called AM_PROG_VALAC that will locate the Vala compiler and optionally check its version number.

```
AM_PROG_VALAC ([minimum-version]) [Macro]
```

Try to find a Vala compiler in PATH. If it is found, the variable VALAC is set. Optionally a minimum release number of the compiler can be requested:

```
AM_PROG_VALAC([0.7.0])
```

There are a few variables that are used when compiling Vala sources:

```
VALAC        Path to the Vala compiler.
VALAFLAGS    Additional arguments for the Vala compiler.
AM_VALAFLAGS The maintainer's variant of VALAFLAGS.
```

```
lib_LTLIBRARIES = libfoo.la
libfoo_la_SOURCES = foo.vala
```

Note that currently, you cannot use per-target *_VALAFLAGS (see Section 28.7 [Renamed Objects], page 147) to produce different C files from one Vala source file.

8.18 Support for Other Languages

Automake currently only includes full support for C, C++ (see Section 8.9 [C++ Support], page 74), Objective C (see Section 8.10 [Objective C Support], page 75), Objective C++ (see Section 8.11 [Objective C++ Support], page 75), Fortran 77 (see Section 8.14 [Fortran 77 Support], page 76), Fortran 9x (see Section 8.15 [Fortran 9x Support], page 79), and Java (see Section 8.16 [Java Support with gcj], page 79). There is only rudimentary support for other languages, support for which will be improved based on user demand.

Some limited support for adding your own languages is available via the suffix rule handling (see Section 18.2 [Suffixes], page 123).

8.19 Automatic dependency tracking

As a developer it is often painful to continually update the Makefile.am whenever the include-file dependencies change in a project. Automake supplies a way to automatically track dependency changes (see Section 2.2.12 [Dependency Tracking], page 11).

Automake always uses complete dependencies for a compilation, including system headers. Automake’s model is that dependency computation should be a side effect of the build.
To this end, dependencies are computed by running all compilations through a special wrapper program called `depcomp`. `depcomp` understands how to coax many different C and C++ compilers into generating dependency information in the format it requires. `automake -a` will install `depcomp` into your source tree for you. If `depcomp` can’t figure out how to properly invoke your compiler, dependency tracking will simply be disabled for your build.

Experience with earlier versions of Automake (see Section “Dependency Tracking Evolution” in Brief History of Automake) taught us that it is not reliable to generate dependencies only on the maintainer’s system, as configurations vary too much. So instead Automake implements dependency tracking at build time.

Automatic dependency tracking can be suppressed by putting `no-dependencies` in the variable `AUTOMAKE_OPTIONS`, or passing `no-dependencies` as an argument to `AM_INIT_AUTOMAKE` (this should be the preferred way). Or, you can invoke `automake` with the `-i` option. Dependency tracking is enabled by default.

The person building your package also can choose to disable dependency tracking by configuring with `--disable-dependency-tracking`.

### 8.20 Support for executable extensions

On some platforms, such as Windows, executables are expected to have an extension such as `.exe`. On these platforms, some compilers (GCC among them) will automatically generate `foo.exe` when asked to generate `foo`.

Automake provides mostly-transparent support for this. Unfortunately mostly doesn’t yet mean fully. Until the English dictionary is revised, you will have to assist Automake if your package must support those platforms.

One thing you must be aware of is that, internally, Automake rewrites something like this:

```
bin_PROGRAMS = liver
```

to this:

```
bin_PROGRAMS = liver$(EXEEXT)
```

The targets Automake generates are likewise given the ‘$(EXEEXT)’ extension.

The variables `TESTS` and `XFAIL_TESTS` (see Section 15.2 [Simple Tests], page 102) are also rewritten if they contain filenames that have been declared as programs in the same `Makefile`. (This is mostly useful when some programs from `check_PROGRAMS` are listed in `TESTS`.)

However, Automake cannot apply this rewriting to `configure` substitutions. This means that if you are conditionally building a program using such a substitution, then your `configure.ac` must take care to add ‘$(EXEEXT)’ when constructing the output variable.

Sometimes maintainers like to write an explicit link rule for their program. Without executable extension support, this is easy—you simply write a rule whose target is the name of the program. However, when executable extension support is enabled, you must instead add the ‘$(EXEEXT)’ suffix.

This might be a nuisance for maintainers who know their package will never run on a platform that has executable extensions. For those maintainers, the `no-exeext` option (see Chapter 17 [Options], page 117) will disable this feature. This works in a fairly ugly way; if
no-execext is seen, then the presence of a rule for a target named foo in Makefile.am will override an automake-generated rule for ‘foo$(EXEEXT)’. Without the no-execext option, this use will give a diagnostic.

9 Other Derived Objects

Automake can handle derived objects that are not C programs. Sometimes the support for actually building such objects must be explicitly supplied, but Automake will still automatically handle installation and distribution.

9.1 Executable Scripts

It is possible to define and install programs that are scripts. Such programs are listed using the SCRIPTS primary name. When the script is distributed in its final, installable form, the Makefile usually looks as follows:

```
# Install my_script in $(bindir) and distribute it.
dist_bin_SCRIPTS = my_script
```

Scripts are not distributed by default; as we have just seen, those that should be distributed can be specified using a dist_ prefix as with other primaries.

Scripts can be installed in bindir, sbindir, libexecdir, pkglibexecdir, or pkgdatadir.

Scripts that need not be installed can be listed in noinst_SCRIPTS, and among them, those which are needed only by `make check` should go in check_SCRIPTS.

When a script needs to be built, the Makefile.am should include the appropriate rules. For instance the automake program itself is a Perl script that is generated from automake.in. Here is how this is handled:

```
bin_SCRIPTS = automake
CLEANFILES = $(bin_SCRIPTS)
EXTRA_DIST = automake.in

do_subst = sed -e 's,[@]datadir[@],$(datadir),g' \
         -e 's,[@]PERL[@],$(PERL),g' \
         -e 's,[@]PACKAGE[@],$(PACKAGE),g' \
         -e 's,[@]VERSION[@],$(VERSION),g' \
         ...

automake: automake.in Makefile
    $(do_subst) < $(srcdir)/automake.in > automake
    chmod +x automake
```

Such scripts for which a build rule has been supplied need to be deleted explicitly using CLEANFILES (see Chapter 13 [Clean], page 96), and their sources have to be distributed, usually with EXTRA_DIST (see Section 14.1 [Basics of Distribution], page 97).

Another common way to build scripts is to process them from configure with AC_CONFIG_FILES. In this situation Automake knows which files should be cleaned and distributed, and what the rebuild rules should look like.
For instance if configure.ac contains

```plaintext
AC_CONFIG_FILES([src/my_script], [chmod +x src/my_script])
```
to build src/my_script from src/my_script.in, then a src/Makefile.am to install this
script in $(bindir) can be as simple as

```plaintext
bin_SCRIPTS = my_script
CLEANFILES = $(bin_SCRIPTS)
```

There is no need for EXTRA_DIST or any build rule: Automake infers them from AC_CONFIG_ FILES (see Section 6.1 [Requirements], page 30). CLEANFILES is still useful, because by
default Automake will clean targets of AC_CONFIG_FILES in distclean, not clean.

Although this looks simpler, building scripts this way has one drawback: directory variables such as $(datadir) are not fully expanded and may refer to other directory variables.

### 9.2 Header files

Header files that must be installed are specified by the HEADERS family of variables. Headers
can be installed in includedir, oldincludedir, pkgincludedir or any other directory you
may have defined (see Section 3.3 [Uniform], page 20). For instance,

```plaintext
include_HEADERS = foo.h bar/bar.h
```

will install the two files as $(includedir)/foo.h and $(includedir)/bar.h.

The nobase_ prefix is also supported,

```plaintext
nobase_include_HEADERS = foo.h bar/bar.h
```

will install the two files as $(includedir)/foo.h and $(includedir)/bar/bar.h (see
Section 7.3 [Alternative], page 51).

Usually, only header files that accompany installed libraries need to be installed. Headers
used by programs or convenience libraries are not installed. The noinst_HEADERS variable
can be used for such headers. However when the header actually belongs to a single conven-
ience library or program, we recommend listing it in the program’s or library’s _SOURCES
variable (see Section 8.1.1 [Program Sources], page 54) instead of in noinst_HEADERS. This
is clearer for the Makefile.am reader. noinst_HEADERS would be the right variable to use
in a directory containing only headers and no associated library or program.

All header files must be listed somewhere; in a _SOURCES variable or in a _HEADERS
variable. Missing ones will not appear in the distribution.

For header files that are built and must not be distributed, use the nodist_ prefix as in
nodist_include_HEADERS or nodist_prog_SOURCES. If these generated headers are
needed during the build, you must also ensure they exist before they are used (see Section 9.4
[Sources], page 84).

### 9.3 Architecture-independent data files

Automake supports the installation of miscellaneous data files using the DATA family of
variables.

Such data can be installed in the directories datadir, sysconfdir, sharedstatedir, localstatedir, or pkgdatadir.

By default, data files are not included in a distribution. Of course, you can use the dist_ prefix to change this on a per-variable basis.
Here is how Automake declares its auxiliary data files:

\texttt{dist\_pkgdata\_DATA = clean-kr.am clean.am ...}

## 9.4 Built Sources

Because Automake’s automatic dependency tracking works as a side-effect of compilation (see Section 8.19 [Dependencies], page 80) there is a bootstrap issue: a target should not be compiled before its dependencies are made, but these dependencies are unknown until the target is first compiled.

Ordinarily this is not a problem, because dependencies are distributed sources: they preexist and do not need to be built. Suppose that \texttt{foo.c} includes \texttt{foo.h}. When it first compiles \texttt{foo.o}, \texttt{make} only knows that \texttt{foo.o} depends on \texttt{foo.c}. As a side-effect of this compilation \texttt{depcomp} records the \texttt{foo.h} dependency so that following invocations of \texttt{make} will honor it. In these conditions, it’s clear there is no problem: either \texttt{foo.o} doesn’t exist and has to be built (regardless of the dependencies), or accurate dependencies exist and they can be used to decide whether \texttt{foo.o} should be rebuilt.

It’s a different story if \texttt{foo.h} doesn’t exist by the first \texttt{make} run. For instance, there might be a rule to build \texttt{foo.h}. This time \texttt{file.o}'s build will fail because the compiler can’t find \texttt{foo.h}. \texttt{make} failed to trigger the rule to build \texttt{foo.h} first by lack of dependency information.

The \texttt{BUILT\_SOURCES} variable is a workaround for this problem. A source file listed in \texttt{BUILT\_SOURCES} is made on \texttt{'make all} or \texttt{'make check} (or even \texttt{'make install'}) before other targets are processed. However, such a source file is not \texttt{compiled} unless explicitly requested by mentioning it in some other \texttt{\_SOURCES} variable.

So, to conclude our introductory example, we could use \texttt{'BUILT\_SOURCES = foo.h'} to ensure \texttt{foo.h} gets built before any other target (including \texttt{foo.o}) during \texttt{'make all} or \texttt{'make check}.

\texttt{BUILT\_SOURCES} is actually a bit of a misnomer, as any file which must be created early in the build process can be listed in this variable. Moreover, all built sources do not necessarily have to be listed in \texttt{BUILT\_SOURCES}. For instance, a generated \texttt{.c} file doesn’t need to appear in \texttt{BUILT\_SOURCES} (unless it is included by another source), because it’s a known dependency of the associated object.

It might be important to emphasize that \texttt{BUILT\_SOURCES} is honored only by \texttt{'make all'}, \texttt{'make check'} and \texttt{'make install'}. This means you cannot build a specific target (e.g., \texttt{'make foo'}) in a clean tree if it depends on a built source. However it will succeed if you have run \texttt{'make all'} earlier, because accurate dependencies are already available.

The next section illustrates and discusses the handling of built sources on a toy example.

### 9.4.1 Built Sources Example

Suppose that \texttt{foo.c} includes \texttt{bindir.h}, which is installation-dependent and not distributed: it needs to be built. Here \texttt{bindir.h} defines the preprocessor macro \texttt{bindir} to the value of the \texttt{make} variable \texttt{bindir} (inherited from \texttt{configure}).

We suggest several implementations below. It’s not meant to be an exhaustive listing of all ways to handle built sources, but it will give you a few ideas if you encounter this issue.
First Try

This first implementation will illustrate the bootstrap issue mentioned in the previous section (see Section 9.4 [Sources], page 84).

Here is a tentative Makefile.am.

```
# This won’t work.
bin_PROGRAMS = foo
foo_SOURCES = foo.c
nodist_foo_SOURCES = bindir.h
CLEANFILES = bindir.h
bindir.h: Makefile
    echo '#define bindir "$(bindir)"' >$@
```

This setup doesn’t work, because Automake doesn’t know that foo.c includes bindir.h. Remember, automatic dependency tracking works as a side-effect of compilation, so the dependencies of foo.o will be known only after foo.o has been compiled (see Section 8.19 [Dependencies], page 80). The symptom is as follows.

```
% make
source='foo.c' object='foo.o' libtool=no \  
deepfile='.deps/foo.Po' tmpdepfile='.deps/foo.TPo' \  
depmode=gcc /bin/sh ./depcomp \  
gcc -I. -I. -g -O2 -c 'test -f 'foo.c' || echo './''foo.c  
foo.c:2: bindir.h: No such file or directory  
make: *** [foo.o] Error 1
```

In this example bindir.h is not distributed nor installed, and it is not even being built on-time. One may wonder if the ‘nodist_foo_SOURCES = bindir.h’ line has any use at all. This line simply states that bindir.h is a source of foo, so for instance, it should be inspected while generating tags (see Section 18.1 [Tags], page 122). In other words, it does not help our present problem, and the build would fail identically without it.

Using BUILT_SOURCES

A solution is to require bindir.h to be built before anything else. This is what BUILT_SOURCES is meant for (see Section 9.4 [Sources], page 84).

```
bin_PROGRAMS = foo
foo_SOURCES = foo.c
nodist_foo_SOURCES = bindir.h
BUILT_SOURCES = bindir.h
CLEANFILES = bindir.h
bindir.h: Makefile
    echo '#define bindir "$(bindir)"' >$@
```

See how bindir.h gets built first:

```
% make
    echo '#define bindir "/usr/local/bin"' >bindir.h
make all-am
make[1]: Entering directory '/home/adl/tmp'
source='foo.c' object='foo.o' libtool=no \  
deepfile='.deps/foo.Po' tmpdepfile='.deps/foo.TPo' \
```
depmode=gcc /bin/sh ./depcomp \
gcc -I. -I. -g -O2 -c 'test -f 'foo.c' || echo './''foo.c  
gcc -g -O2 -o foo foo.o  
make[1]: Leaving directory `/home/adl/tmp'  

However, as said earlier, BUILT_SOURCES applies only to the all, check, and install targets. It still fails if you try to run `make foo` explicitly:

```bash
% make clean
test -z "bindir.h" || rm -f bindir.h
test -z "foo" || rm -f foo  
rm -f *
% : > .deps/foo.Po # Suppress previously recorded dependencies
% make foo  
source='foo.c' object='foo.o' libtool=no 
depfile='.' .deps/foo.Po' tmpdepfile='.' .deps/foo.TPo' 
depmode=gcc /bin/sh ./depcomp \
gcc -I. -I. -g -O2 -c 'test -f 'foo.c' || echo './''foo.c  
foo.c:2: bindir.h: No such file or directory  
make: *** [foo.o] Error 1
```

### Recording Dependencies manually

Usually people are happy enough with BUILT_SOURCES because they never build targets such as `make foo` before `make all`, as in the previous example. However if this matters to you, you can avoid BUILT_SOURCES and record such dependencies explicitly in the Makefile.am.

```make
bin_PROGRAMS = foo  
foo_SOURCES = foo.c  
nodist_foo_SOURCES = bindir.h  
foo.$(OBJEXT): bindir.h  
CLEANFILES = bindir.h  
bindir.h: Makefile  
  echo '#define bindir "$(bindir)"' >@  
```

You don't have to list all the dependencies of foo.o explicitly, only those that might need to be built. If a dependency already exists, it will not hinder the first compilation and will be recorded by the normal dependency tracking code. (Note that after this first compilation the dependency tracking code will also have recorded the dependency between foo.o and bindir.h; so our explicit dependency is really useful to the first build only.)

Adding explicit dependencies like this can be a bit dangerous if you are not careful enough. This is due to the way Automake tries not to overwrite your rules (it assumes you know better than it). `foo.$(OBJEXT): bindir.h` supersedes any rule Automake may want to output to build `foo.$(OBJEXT)`'. It happens to work in this case because Automake doesn't have to output any `foo.$(OBJEXT):` target: it relies on a suffix rule instead (i.e., `c.$(OBJEXT):`). Always check the generated Makefile.in if you do this.

### Build bindir.h from configure

It's possible to define this preprocessor macro from configure, either in config.h (see Section “Defining Directories” in The Autoconf Manual), or by processing a bindir.h.in file using AC_CONFIG_FILES (see Section “Configuration Actions” in The Autoconf Manual).
At this point it should be clear that building bindir.h from configure works well for this example. bindir.h will exist before you build any target, hence will not cause any dependency issue.

The Makefile can be shrunk as follows. We do not even have to mention bindir.h.

```makefile
bin_PROGRAMS = foo
foo_SOURCES = foo.c

However, it’s not always possible to build sources from configure, especially when these sources are generated by a tool that needs to be built first.

Build bindir.c, not bindir.h.

Another attractive idea is to define bindir as a variable or function exported from bindir.o, and build bindir.c instead of bindir.h.

```makefile
noinst_PROGRAMS = foo
foo_SOURCES = foo.c bindir.h
nodist_foo_SOURCES = bindir.c
CLEANFILES = bindir.c
bindir.c: Makefile
    echo 'const char bindir[] = "$(bindir)";'; >@@

bindir.h contains just the variable’s declaration and doesn’t need to be built, so it won’t cause any trouble. bindir.o is always dependent on bindir.c, so bindir.c will get built first.

Which is best?

There is no panacea, of course. Each solution has its merits and drawbacks.

You cannot use BUILT_SOURCES if the ability to run ‘make foo’ on a clean tree is important to you.

You won’t add explicit dependencies if you are leery of overriding an Automake rule by mistake.

Building files from ./configure is not always possible, neither is converting .h files into .c files.

10 Other GNU Tools

Since Automake is primarily intended to generate Makefile.ins for use in GNU programs, it tries hard to interoperate with other GNU tools.

10.1 Emacs Lisp

Automake provides some support for Emacs Lisp. The LISP primary is used to hold a list of .el files. Possible prefixes for this primary are lisp_ and noinst_. Note that if lisp_LISP is defined, then configure.ac must run AM_PATH_LISPDIR (see Section 6.4 [Macros], page 44).

Lisp sources are not distributed by default. You can prefix the LISP primary with dist_, as in dist_lisp_LISP or dist_noinst_LISP, to indicate that these files should be distributed.
Automake will byte-compile all Emacs Lisp source files using the Emacs found by AM_PATH_LISPDIR, if any was found.

Byte-compiled Emacs Lisp files are not portable among all versions of Emacs, so it makes sense to turn this off if you expect sites to have more than one version of Emacs installed. Furthermore, many packages don’t actually benefit from byte-compilation. Still, we recommend that you byte-compile your Emacs Lisp sources. It is probably better for sites with strange setups to cope for themselves than to make the installation less nice for everybody else.

There are two ways to avoid byte-compiling. Historically, we have recommended the following construct.

```
  lisp_LISP = file1.el file2.el
  ELCFILES =
```

ELCFILES is an internal Automake variable that normally lists all .elc files that must be byte-compiled. Automake defines ELCFILES automatically from lisp_LISP. Emptying this variable explicitly prevents byte-compilation.

Since Automake 1.8, we now recommend using lisp_DATA instead:

```
  lisp_DATA = file1.el file2.el
```

Note that these two constructs are not equivalent. _LISP will not install a file if Emacs is not installed, while _DATA will always install its files.

10.2 Gettext

If AM_GNU_GETTEXT is seen in configure.ac, then Automake turns on support for GNU gettext, a message catalog system for internationalization (see Section “Introduction” in GNU gettext utilities).

The gettext support in Automake requires the addition of one or two subdirectories to the package: po and possibly also intl. The latter is needed if AM_GNU_GETTEXT is not invoked with the ’external’ argument, or if AM_GNU_GETTEXT_INTL_SUBDIR is used. Automake ensures that these directories exist and are mentioned in SUBDIRS.

10.3 Libtool

Automake provides support for GNU Libtool (see Section “Introduction” in The Libtool Manual) with the LTLIBRARIES primary. See Section 8.3 [A Shared Library], page 58.

10.4 Java bytecode compilation (deprecated)

Automake provides some minimal support for Java bytecode compilation with the JAVA primary (in addition to the support for compiling Java to native machine code; see Section 8.16 [Java Support with gcj], page 79). Note however that the interface and most features described here are deprecated; the next automake release will strive to provide a better and cleaner interface, which however won’t be backward-compatible; the present interface will probably be removed altogether in future automake releases (1.13 or later), so don’t use it in new code.

Any .java files listed in a _JAVA variable will be compiled with JAVAC at build time. By default, .java files are not included in the distribution, you should use the dist_ prefix to distribute them.
Here is a typical setup for distributing `.java` files and installing the `.class` files resulting from their compilation.

```
javadir = $(datadir)/java
dist_java_JAVA = a.java b.java ...
```

Currently Automake enforces the restriction that only one `_JAVA` primary can be used in a given `Makefile.am`. The reason for this restriction is that, in general, it isn’t possible to know which `.class` files were generated from which `.java` files, so it would be impossible to know which files to install where. For instance, a `.java` file can define multiple classes; the resulting `.class` file names cannot be predicted without parsing the `.java` file.

There are a few variables that are used when compiling Java sources:

- **JAVAC**: The name of the Java compiler. This defaults to `javac`.
- **JAVACFLAGS**: The flags to pass to the compiler. This is considered to be a user variable (see Section 3.6 [User Variables], page 23).
- **AM_JAVACFLAGS**: More flags to pass to the Java compiler. This, and not `JAVACFLAGS`, should be used when it is necessary to put Java compiler flags into `Makefile.am`.
- **JAVAROOT**: The value of this variable is passed to the `-d` option to `javac`. It defaults to `$(top_builddir)`.
- **CLASSPATH_ENV**: This variable is a shell expression that is used to set the CLASSPATH environment variable on the `javac` command line. (In the future we will probably handle class path setting differently.)

### 10.5 Python

Automake provides support for Python compilation with the `PYTHON` primary. A typical setup is to call `AM_PATH_PYTHON` in `configure.ac` and use a line like the following in `Makefile.am`:

```
python_PYTHON = tree.py leave.py
```

Any files listed in a `_PYTHON` variable will be byte-compiled with `py-compile` at install time. `py-compile` actually creates both standard (`.pyc`) and optimized (`.pyo`) byte-compiled versions of the source files. Note that because byte-compilation occurs at install time, any files listed in `noinst_PYTHON` will not be compiled. Python source files are included in the distribution by default, prepend `nodist_` (as in `nodist_python_PYTHON`) to omit them.

Automake ships with an Autoconf macro called `AM_PATH_PYTHON` that will determine some Python-related directory variables (see below). If you have called `AM_PATH_PYTHON` from `configure.ac`, then you may use the variables `python_PYTHON` or `pkgpython_PYTHON` to list Python source files in your `Makefile.am`, depending on where you want your files installed (see the definitions of `pythondir` and `pkgpythondir` below).

```
AM_PATH_PYTHON (version, [action-if-found], [action-if-not-found])
```

[Macro]
Search for a Python interpreter on the system. This macro takes three optional arguments. The first argument, if present, is the minimum version of Python required for this package: `AM_PATH_PYTHON` will skip any Python interpreter that is older than `version`. If an interpreter is found and satisfies `version`, then `action-if-found` is run. Otherwise, `action-if-not-found` is run.

If `action-if-not-found` is not specified, as in the following example, the default is to abort `configure`.

```
AM_PATH_PYTHON([2.2])
```

This is fine when Python is an absolute requirement for the package. If Python $\geq 2.5$ was only optional to the package, `AM_PATH_PYTHON` could be called as follows.

```
AM_PATH_PYTHON([2.5],, [:])
```

If the `PYTHON` variable is set when `AM_PATH_PYTHON` is called, then that will be the only Python interpreter that is tried.

`AM_PATH_PYTHON` creates the following output variables based on the Python installation found during configuration.

- **PYTHON**: The name of the Python executable, or `:` if no suitable interpreter could be found.

  Assuming `action-if-not-found` is used (otherwise `./configure` will abort if Python is absent), the value of `PYTHON` can be used to setup a conditional in order to disable the relevant part of a build as follows.

  ```
  AM_PATH_PYTHON(,, [:])
  AM_CONDITIONAL([HAVE_PYTHON], [test "$PYTHON" != :])
  ```

- **PYTHON_VERSION**: The Python version number, in the form `major.minor` (e.g., `2.5`). This is currently the value of `sys.version[:3]`.

- **PYTHON_PREFIX**: The string `$\{prefix\}`. This term may be used in future work that needs the contents of Python's `sys.prefix`, but general consensus is to always use the value from `configure`.

- **PYTHON_EXEC_PREFIX**: The string `$\{exec_prefix\}`. This term may be used in future work that needs the contents of Python's `sys.exec_prefix`, but general consensus is to always use the value from `configure`.

- **PYTHON_PLATFORM**: The canonical name used by Python to describe the operating system, as given by `sys.platform`. This value is sometimes needed when building Python extensions.

- **pythondir**: The directory name for the `site-packages` subdirectory of the standard Python install tree.

- **pkgpythondir**: This is the directory under `pythondir` that is named after the package. That is, it is `$\{pythondir\}/\$(PACKAGE)$`. It is provided as a convenience.
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pyexecdir

This is the directory where Python extension modules (shared libraries) should be installed. An extension module written in C could be declared as follows to Automake:

```
pyexec_LTLIBRARIES = quaternion.la
quaternion_la_SOURCES = quaternion.c support.c support.h
quaternion_la_LDFLAGS = -avoid-version -module
```

pkgpyexecdir

This is a convenience variable that is defined as `$(pyexecdir)/$(PACKAGE)`.

All of these directory variables have values that start with either `$(prefix)` or `$(exec_prefix)` unexpanded. This works fine in Makefiles, but it makes these variables hard to use in configure. This is mandated by the GNU coding standards, so that the user can run `make prefix=/foo install`. The Autoconf manual has a section with more details on this topic (see Section “Installation Directory Variables” in The Autoconf Manual). See also Section 28.10 [Hard-Coded Install Paths], page 154.

11 Building documentation

Currently Automake provides support for Texinfo and man pages.

11.1 Texinfo

If the current directory contains Texinfo source, you must declare it with the TEXINFOS primary. Generally Texinfo files are converted into info, and thus the info_TEXINFOS variable is most commonly used here. Any Texinfo source file must end in the .texi, .txi, or .texinfo extension. We recommend .texi for new manuals.

Automake generates rules to build .info, .dvi, .ps, .pdf and .html files from your Texinfo sources. Following the GNU Coding Standards, only the .info files are built by `make all` and installed by `make install` (unless you use no-installinfo, see below). Furthermore, .info files are automatically distributed so that Texinfo is not a prerequisite for installing your package.

Other documentation formats can be built on request by `make dvi`, `make ps`, `make pdf` and `make html`, and they can be installed with `make install-dvi`, `make install-ps`, `make install-pdf` and `make install-html` explicitly. `make uninstall` will remove everything: the Texinfo documentation installed by default as well as all the above optional formats.

All of these targets can be extended using ‘-local’ rules (see Section 24.1 [Extending], page 132).

If the .texi file @includes version.texi, then that file will be automatically generated. The file version.texi defines four Texinfo flag you can reference using @value{EDITION}, @value{VERSION}, @value{UPDATED}, and @value{UPDATED-MONTH}.

EDITION
VERSION

Both of these flags hold the version number of your program. They are kept separate for clarity.
This holds the date the primary .texi file was last modified.

This holds the name of the month in which the primary .texi file was last modified.

The version.texi support requires the mdate-sh script; this script is supplied with Automake and automatically included when automake is invoked with the --add-missing option.

If you have multiple Texinfo files, and you want to use the version.texi feature, then you have to have a separate version file for each Texinfo file. Automake will treat any include in a Texinfo file that matches vers*.texi just as an automatically generated version file.

Sometimes an info file actually depends on more than one .texi file. For instance, in GNU Hello, hello.texi includes the file fdl.texi. You can tell Automake about these dependencies using the texi_TEXINFOS variable. Here is how GNU Hello does it:

```plaintext
info_TEXINFOS = hello.texi
hello_TEXINFOS = fdl.texi
```

By default, Automake requires the file texinfo.tex to appear in the same directory as the Makefile.am file that lists the .texi files. If you used AC_CONFIG_AUX_DIR in configure.ac (see Section “Finding ‘configure’ Input” in The Autoconf Manual), then texinfo.tex is looked for there. In both cases, automake then supplies texinfo.tex if --add-missing is given, and takes care of its distribution. However, if you set the TEXINFO_TEX variable (see below), it overrides the location of the file and turns off its installation into the source as well as its distribution.

The option no-texinfo.tex can be used to eliminate the requirement for the file texinfo.tex. Use of the variable TEXINFO_TEX is preferable, however, because that allows the dvi, ps, and pdf targets to still work.

Automake generates an install-info rule; some people apparently use this. By default, info pages are installed by ‘make install’, so running make install-info is pointless. This can be prevented via the no-installinfo option. In this case, .info files are not installed by default, and user must request this explicitly using ‘make install-info’.

By default, make install-info and make uninstall-info will try to run the install-info program (if available) to update (or create/remove) the ${infodir}/dir index. If this is undesired, it can be prevented by exporting the AM_UPDATE_INFO_DIR variable to "no".

The following variables are used by the Texinfo build rules.

MAKEINFO The name of the program invoked to build .info files. This variable is defined by Automake. If the makeinfo program is found on the system then it will be used by default; otherwise missing will be used instead.

MAKEINFOHTML The command invoked to build .html files. Automake defines this to ‘$(MAKEINFO) --html’.

MAKEINFOFLAGS User flags passed to each invocation of ‘$(MAKEINFO)’ and ‘$(MAKEINFOHTML)’. This user variable (see Section 3.6 [User Variables], page 23) is not expected to
be defined in any Makefile; it can be used by users to pass extra flags to suit their needs.

AM_MAKEINFOFLAGS
AM_MAKEINFOHTMLFLAGS
Maintainer flags passed to each makeinfo invocation. Unlike MAKEINFOFLAGS, these variables are meant to be defined by maintainers in Makefile.am. ‘$(AM_MAKEINFOFLAGS)’ is passed to makeinfo when building .info files; and ‘$(AM_MAKEINFOHTMLFLAGS)’ is used when building .html files.

For instance, the following setting can be used to obtain one single .html file per manual, without node separators.

    AM_MAKEINFOHTMLFLAGS = --no-headers --no-split

AM_MAKEINFOHTMLFLAGS defaults to ‘$(AM_MAKEINFOFLAGS)’. This means that defining AM_MAKEINFOFLAGS without defining AM_MAKEINFOHTMLFLAGS will impact builds of both .info and .html files.

TEXI2DVI
The name of the command that converts a .texi file into a .dvi file. This defaults to ‘texi2dvi’, a script that ships with the Texinfo package.

TEXI2PDF
The name of the command that translates a .texi file into a .pdf file. This defaults to ‘$(TEXI2DVI) --pdf --batch’.

DVIPS
The name of the command that builds a .ps file out of a .dvi file. This defaults to ‘dvips’.

TEXINFO_TEX
If your package has Texinfo files in many directories, you can use the variable TEXINFO_TEX to tell Automake where to find the canonical texinfo.tex for your package. The value of this variable should be the relative path from the current Makefile.am to texinfo.tex:

    TEXINFO_TEX = ../doc/texinfo.tex

11.2 Man Pages

A package can also include man pages (but see the GNU standards on this matter, Section “Man Pages” in The GNU Coding Standards.) Man pages are declared using the MANS primary. Generally the man_MANS variable is used. Man pages are automatically installed in the correct subdirectory of mandir, based on the file extension.

File extensions such as .1c are handled by looking for the valid part of the extension and using that to determine the correct subdirectory of mandir. Valid section names are the digits ‘0’ through ‘9’, and the letters ‘1’ and ‘n’.

Sometimes developers prefer to name a man page something like foo.man in the source, and then rename it to have the correct suffix, for example foo.1, when installing the file. Automake also supports this mode. For a valid section named section, there is a corresponding directory named ‘mansectiondir’, and a corresponding _MANS variable. Files listed in such a variable are installed in the indicated section. If the file already has a valid suffix, then it is installed as-is; otherwise the file suffix is changed to match the section.

For instance, consider this example:

    man1_MANS = rename.man thesame.1 alsothesame.1c
In this case, `rename.man` will be renamed to `rename.1` when installed, but the other files will keep their names.

By default, man pages are installed by `make install`. However, since the GNU project does not require man pages, many maintainers do not expend effort to keep the man pages up to date. In these cases, the `no-installman` option will prevent the man pages from being installed by default. The user can still explicitly install them via `make install-man`.

For fast installation, with many files it is preferable to use `mansection_MANS` over `man_MANS` as well as files that do not need to be renamed.

Man pages are not currently considered to be source, because it is not uncommon for man pages to be automatically generated. Therefore they are not automatically included in the distribution. However, this can be changed by use of the `dist_` prefix. For instance here is how to distribute and install the two man pages of GNU cpio (which includes both Texinfo documentation and man pages):

```
  dist_man_MANS = cpio.1 mt.1
```

The `nobase_` prefix is meaningless for man pages and is disallowed.

Executables and manpages may be renamed upon installation (see Section 2.2.9 [Renaming], page 10). For manpages this can be avoided by use of the `notrans_` prefix. For instance, suppose an executable `foo` allowing to access a library function `foo` from the command line. The way to avoid renaming of the `foo.3` manpage is:

```
  man_MANS = foo.1
  notrans_man_MANS = foo.3
```

`notrans_` must be specified first when used in conjunction with either `dist_` or `nodist_` (see Section 14.2 [Fine-grained Distribution Control], page 98). For instance:

```
  notrans_dist_man3_MANS = bar.3
```

## 12 What Gets Installed

Naturally, Automake handles the details of actually installing your program once it has been built. All files named by the various primaries are automatically installed in the appropriate places when the user runs `make install`.

### 12.1 Basics of Installation

A file named in a primary is installed by copying the built file into the appropriate directory. The base name of the file is used when installing.

```
  bin_PROGRAMS = hello subdir/goodbye
```

In this example, both `hello` and `goodbye` will be installed in `${bindir}`.

Sometimes it is useful to avoid the basename step at install time. For instance, you might have a number of header files in subdirectories of the source tree that are laid out precisely how you want to install them. In this situation you can use the `nobase_` prefix to suppress the base name step. For example:

```
  nobase_include_HEADERS = stdio.h sys/types.h
```

will install `stdio.h` in `${includedir}` and `types.h` in `${includedir}/sys`.
For most file types, Automake will install multiple files at once, while avoiding command line length issues (see Section 3.4 [Length Limitations], page 22). Since some install programs will not install the same file twice in one invocation, you may need to ensure that file lists are unique within one variable such as `nobase_include_HEADERS` above.

You should not rely on the order in which files listed in one variable are installed. Likewise, to cater for parallel make, you should not rely on any particular file installation order even among different file types (library dependencies are an exception here).

### 12.2 The Two Parts of Install

Automake generates separate `install-data` and `install-exec` rules, in case the installer is installing on multiple machines that share directory structure—these targets allow the machine-independent parts to be installed only once. `install-exec` installs platform-dependent files, and `install-data` installs platform-independent files. The `install` target depends on both of these targets. While Automake tries to automatically segregate objects into the correct category, the `Makefile.am` author is, in the end, responsible for making sure this is done correctly.

Variables using the standard directory prefixes `data`, `info`, `man`, `include`, `oldinclude`, `pkgdata`, or `pkginclude` are installed by `install-data`.

Variables using the standard directory prefixes `bin`, `sbin`, `libexec`, `sysconf`, `localstate`, `lib`, or `pkglib` are installed by `install-exec`.

For instance, `data_DATA` files are installed by `install-data`, while `bin_PROGRAMS` files are installed by `install-exec`.

Any variable using a user-defined directory prefix with `exec` in the name (e.g., `myexecbin_PROGRAMS`) is installed by `install-exec`. All other user-defined prefixes are installed by `install-data`.

### 12.3 Extending Installation

It is possible to extend this mechanism by defining an `install-exec-local` or `install-data-local` rule. If these rules exist, they will be run at `make install` time. These rules can do almost anything; care is required.

Automake also supports two install hooks, `install-exec-hook` and `install-data-hook`. These hooks are run after all other install rules of the appropriate type, exec or data, have completed. So, for instance, it is possible to perform post-installation modifications using an install hook. See Section 24.1 [Extending], page 132, for some examples.

### 12.4 Staged Installs

Automake generates support for the `DESTDIR` variable in all install rules. `DESTDIR` is used during the `make install` step to relocate install objects into a staging area. Each object and path is prefixed with the value of `DESTDIR` before being copied into the install area.

Here is an example of typical DESTDIR usage:

```
mkdir /tmp/staging &&
make DESTDIR=/tmp/staging install
```

The `mkdir` command avoids a security problem if the attacker creates a symbolic link from `/tmp/staging` to a victim area; then `make` places install objects in a directory
tree built under /tmp/staging. If /gnu/bin/foo and /gnu/share/aclocal/foo.m4 are to be installed, the above command would install /tmp/staging/gnu/bin/foo and /tmp/staging/gnu/share/aclocal/foo.m4.

This feature is commonly used to build install images and packages (see Section 2.2.10 [DESTDIR], page 10).

Support for DESTDIR is implemented by coding it directly into the install rules. If your Makefile.am uses a local install rule (e.g., install-exec-local) or an install hook, then you must write that code to respect DESTDIR.

See Section “Makefile Conventions” in The GNU Coding Standards, for another usage example.

12.5 Install Rules for the User

Automake also generates rules for targets uninstall, installdirs, and install-strip.

Automake supports uninstall-local and uninstall-hook. There is no notion of separate uninstalls for “exec” and “data”, as these features would not provide additional functionality.

Note that uninstall is not meant as a replacement for a real packaging tool.

13 What Gets Cleaned

The GNU Makefile Standards specify a number of different clean rules. See Section “Standard Targets for Users” in The GNU Coding Standards.

Generally the files that can be cleaned are determined automatically by Automake. Of course, Automake also recognizes some variables that can be defined to specify additional files to clean. These variables are MOSTLYCLEANFILES, CLEANFILES, DISTCLEANFILES, and MAINTAINERCLEANFILES.

When cleaning involves more than deleting some hard-coded list of files, it is also possible to supplement the cleaning rules with your own commands. Simply define a rule for any of the mostlyclean-local, clean-local, distclean-local, or maintainer-clean-local targets (see Section 24.1 [Extending], page 132). A common case is deleting a directory, for instance, a directory created by the test suite:

    clean-local:
    -rm -rf testSubDir

Since make allows only one set of rules for a given target, a more extensible way of writing this is to use a separate target listed as a dependency:

    clean-local: clean-local-check
    .PHONY: clean-local-check
    clean-local-check:
    -rm -rf testSubDir

As the GNU Standards aren’t always explicit as to which files should be removed by which rule, we’ve adopted a heuristic that we believe was first formulated by François Pinard:

- If make built it, and it is commonly something that one would want to rebuild (for instance, a .o file), then mostlyclean should delete it.
• Otherwise, if `make` built it, then `clean` should delete it.
• If `configure` built it, then `distclean` should delete it.
• If the maintainer built it (for instance, a `.info` file), then `maintainer-clean` should delete it. However `maintainer-clean` should not delete anything that needs to exist in order to run `./configure & make`.

We recommend that you follow this same set of heuristics in your `Makefile.am`.

14 What Goes in a Distribution

14.1 Basics of Distribution

The `dist` rule in the generated `Makefile.in` can be used to generate a gzipped `tar` file and other flavors of archive for distribution. The file is named based on the `PACKAGE` and `VERSION` variables defined by `AM_INIT_AUTOMAKE` (see Section 6.4 [Macros], page 44); more precisely the gzipped `tar` file is named `package-version.tar.gz`. You can use the `make` variable `GZIP_ENV` to control how gzip is run. The default setting is `--best`.

For the most part, the files to distribute are automatically found by Automake: all source files are automatically included in a distribution, as are all `Makefile.am` and `Makefile.in` files. Automake also has a built-in list of commonly used files that are automatically included if they are found in the current directory (either physically, or as the target of a `Makefile.am` rule); this list is printed by `automake --help`. Note that some files in this list are actually distributed only if other certain conditions hold (for example, the `config.h.top` and `config.h.bot` files are automatically distributed only if, e.g., `AC_CONFIG_HEADERS([config.h])` is used in `configure.ac`). Also, files that are read by `configure` (i.e. the source files corresponding to the files specified in various Autoconf macros such as `AC_CONFIG_FILES` and siblings) are automatically distributed. Files included in a `Makefile.am` (using `include`) or in `configure.ac` (using `m4_include`), and helper scripts installed with `automake --add-missing` are also distributed.

Still, sometimes there are files that must be distributed, but which are not covered in the automatic rules. These files should be listed in the `EXTRA_DIST` variable. You can mention files from subdirectories in `EXTRA_DIST`.

You can also mention a directory in `EXTRA_DIST`; in this case the entire directory will be recursively copied into the distribution. Please note that this will also copy *everything* in the directory, including, e.g., Subversion’s `.svn` private directories or CVS/RCS version control files. We recommend against using this feature.

If you define `SUBDIRS`, Automake will recursively include the subdirectories in the distribution. If `SUBDIRS` is defined conditionally (see Chapter 20 [Conditionals], page 124), Automake will normally include all directories that could possibly appear in `SUBDIRS` in the distribution. If you need to specify the set of directories conditionally, you can set the variable `DIST_SUBDIRS` to the exact list of subdirectories to include in the distribution (see Section 7.2 [Conditional Subdirectories], page 48).
**14.2 Fine-grained Distribution Control**

Sometimes you need tighter control over what does not go into the distribution; for instance, you might have source files that are generated and that you do not want to distribute. In this case Automake gives fine-grained control using the `dist` and `nodist` prefixes. Any primary or `_SOURCES` variable can be prefixed with `dist_` to add the listed files to the distribution. Similarly, `nodist_` can be used to omit the files from the distribution.

As an example, here is how you would cause some data to be distributed while leaving some source code out of the distribution:

```plaintext
   dist_data_DATA = distribute-this
   bin_PROGRAMS = foo
   nodist_foo_SOURCES = do-not-distribute.c
```

**14.3 The dist Hook**

Occasionally it is useful to be able to change the distribution before it is packaged up. If the `dist-hook` rule exists, it is run after the distribution directory is filled, but before the actual distribution archives are created. One way to use this is for removing unnecessary files that get recursively included by specifying a directory in `EXTRA_DIST`:

```plaintext
EXTRA_DIST = doc
dist-hook:
   rm -rf "find $(distdir)/doc -type d -name .svn"
```

Note that the `dist-hook` recipe shouldn’t assume that the regular files in the distribution directory are writable; this might not be the case if one is packaging from a read-only source tree, or when a `make distcheck` is being done. For similar reasons, the recipe shouldn’t assume that the subdirectories put into the distribution directory as effect of having them listed in `EXTRA_DIST` are writable. So, if the `dist-hook` recipe wants to modify the content of an existing file (or `EXTRA_DIST` subdirectory) in the distribution directory, it should explicitly to make it writable first:

```plaintext
EXTRA_DIST = README doc
dist-hook:
   chmod u+w $(distdir)/README $(distdir)/doc
   echo "Distribution date: 'date'" >> README
   rm -f $(distdir)/doc/HACKING
```

Two variables that come handy when writing `dist-hook` rules are `$(distdir)` and `$(top_distdir)`.

`$(distdir)` points to the directory where the `dist` rule will copy files from the current directory before creating the tarball. If you are at the top-level directory, then `distdir = $(PACKAGE)-$(VERSION)`. When used from subdirectory named `foo/`, then `distdir = ../$PACKAGE-$VERSION/foo`. `$(distdir)` can be a relative or absolute path, do not assume any form.

`$(top_distdir)` always points to the root directory of the distributed tree. At the top-level it’s equal to `$(distdir)`. In the `foo/` subdirectory `top_distdir = ../$PACKAGE-$VERSION`. `$(top_distdir)` too can be a relative or absolute path.
Note that when packages are nested using AC_CONFIG_SUBDIRS (see Section 7.4 [Sub-packages], page 52), then \$\{distdir\} and \$\{top_distdir\} are relative to the package where \texttt{make dist} was run, not to any sub-packages involved.

### 14.4 Checking the Distribution

Automake also generates a \texttt{distcheck} rule that can be of help to ensure that a given distribution will actually work. Simplifying a bit, we can say this rule first makes a distribution, and then, \textit{operating from it}, takes the following steps:

- tries to do a VPATH build (see Section 2.2.6 [VPATH Builds], page 6), with the \texttt{srcdir} and all its content made \texttt{read-only};
- runs the test suite (with \texttt{make check}) on this fresh build;
- installs the package in a temporary directory (with \texttt{make install}), and tries runs the test suite on the resulting installation (with \texttt{make installcheck});
- checks that the package can be correctly uninstalled (by \texttt{make uninstall}) and cleaned (by \texttt{make distclean});
- finally, makes another tarball to ensure the distribution is self-contained.

#### DISTCHECK\_CONFIGURE\_FLAGS

Building the package involves running `./configure`. If you need to supply additional flags to \texttt{configure}, define them in the \texttt{AM_DISTCHECK_CONFIGURE_FLAGS} variable in your top-level \texttt{Makefile.am}. The user can still extend or override the flags provided there by defining the \texttt{DISTCHECK_CONFIGURE_FLAGS} variable, on the command line when invoking \texttt{make}.

Still, developers are encouraged to strive to make their code buildable without requiring any special configure option; thus, in general, you shouldn’t define \texttt{AM_DISTCHECK_CONFIGURE_FLAGS}. However, there might be few scenarios in which the use of this variable is justified. GNU \texttt{m4} offers an example. GNU \texttt{m4} configures by default with its experimental and seldom used "changeword" feature disabled; so in its case it is useful to have \texttt{make distcheck} run configure with the \texttt{--with-changeword} option, to ensure that the code for changeword support still compiles correctly. GNU \texttt{m4} also employs the \texttt{AM_DISTCHECK_CONFIGURE_FLAGS} variable to stress-test the use of \texttt{--program-prefix=g}, since at one point the \texttt{m4} build system had a bug where \texttt{make installcheck} was wrongly assuming it could blindly test \texttt{"m4"}, rather than the just-installed \texttt{"gm4"}.

#### distcheck-hook

If the \texttt{distcheck-hook} rule is defined in your top-level \texttt{Makefile.am}, then it will be invoked by \texttt{distcheck} after the new distribution has been unpacked, but before the unpacked copy is configured and built. Your \texttt{distcheck-hook} can do almost anything, though as always caution is advised. Generally this hook is used to check for potential distribution errors not caught by the standard mechanism. Note that \texttt{distcheck-hook} as well as \texttt{AM_DISTCHECK_CONFIGURE_FLAGS} and \texttt{DISTCHECK_CONFIGURE_FLAGS} are not honored in a subpackage \texttt{Makefile.am}, but the flags from \texttt{AM_DISTCHECK_CONFIGURE_FLAGS} and \texttt{DISTCHECK_CONFIGURE_FLAGS} are passed down to the \texttt{configure} script of the subpackage.
distcleancheck

Speaking of potential distribution errors, distcheck also ensures that the distclean rule actually removes all built files. This is done by running `make distcleancheck` at the end of the VPATH build. By default, distcleancheck will run distclean and then make sure the build tree has been emptied by running `$(distcleancheck_listfiles)`. Usually this check will find generated files that you forgot to add to the DISTCLEANFILES variable (see Chapter 13 [Clean], page 96).

The distcleancheck behavior should be OK for most packages, otherwise you have the possibility to override the definition of either the distcleancheck rule, or the `$(distcleancheck_listfiles)` variable. For instance, to disable distcleancheck completely, add the following rule to your top-level Makefile.am:

```
distcleancheck:
@:
```

If you want distcleancheck to ignore built files that have not been cleaned because they are also part of the distribution, add the following definition instead:

```
distcleancheck_listfiles = \n    find . -type f -exec sh -c 'test -f $(srcdir)/$$1 || echo $$1' \n    sh '{}' ';'
```

The above definition is not the default because it’s usually an error if your Makefiles cause some distributed files to be rebuilt when the user build the package. (Think about the user missing the tool required to build the file; or if the required tool is built by your package, consider the cross-compilation case where it can’t be run.) There is an entry in the FAQ about this (see Section 28.5 [Errors with distclean], page 143), make sure you read it before playing with distcleancheck_listfiles.

distuninstallcheck

distcheck also checks that the uninstall rule works properly, both for ordinary and DESTDIR builds. It does this by invoking `make uninstall`, and then it checks the install tree to see if any files are left over. This check will make sure that you correctly coded your uninstall-related rules.

By default, the checking is done by the distuninstallcheck rule, and the list of files in the install tree is generated by `$(distuninstallcheck_listfiles)` (this is a variable whose value is a shell command to run that prints the list of files to stdout).

Either of these can be overridden to modify the behavior of distcheck. For instance, to disable this check completely, you would write:

```
distuninstallcheck:
@:
```

14.5 The Types of Distributions

Automake generates rules to provide archives of the project for distributions in various formats. Their targets are:

dist-bzip2

Generate a bzip2 tar archive of the distribution. bzip2 archives are frequently smaller than gzipped archives. By default, this rule makes `bzip2` use a com-
expression option of \texttt{-9}. To make it use a different one, set the \texttt{BZIP2} environment variable. For example, \texttt{'make dist-bzip2 BZIP2=-7'}.

dist-gzip
Generate a gzip tar archive of the distribution.

dist-lzip
Generate an \texttt{'lzip'} tar archive of the distribution. \texttt{lzip} archives are frequently smaller than \texttt{bzip2}-compressed archives.

dist-shar
Generate a shar archive of the distribution.

dist-xz
Generate an \texttt{'xz'} tar archive of the distribution. \texttt{xz} archives are frequently smaller than \texttt{bzip2}-compressed archives. By default, this rule makes \texttt{'xz'} use a compression option of \texttt{-e}. To make it use a different one, set the \texttt{XZ_OPT} environment variable. For example, run this command to use the default compression ratio, but with a progress indicator: \texttt{'make dist-xz XZ_OPT=-7e'}.

dist-zip
Generate a zip archive of the distribution.

dist-tarZ
Generate a compressed tar archive of the distribution.

The rule \texttt{dist} (and its historical synonym \texttt{dist-all}) will create archives in all the enabled formats, Chapter 17 [Options], page 117. By default, only the \texttt{dist-gzip} target is hooked to \texttt{dist}.

15 Support for test suites

Automake can generate code to handle two kinds of test suites. One is based on integration with the \texttt{dejagnu} framework. The other (and most used) form is based on the use of generic test scripts, and its activation is triggered by the definition of the special \texttt{TESTS} variable. This second form allows for various degrees of sophistication and customization; in particular, it allows for concurrent execution of test scripts, use of established test protocols such as TAP, and definition of custom test drivers and test runners.

In either case, the testsuite is invoked via \texttt{'make check'}.

15.1 Generalities about Testing

The purpose of testing is to determine whether a program or system behaves as expected (e.g., known inputs produce the expected outputs, error conditions are correctly handled or reported, and older bugs do not resurface).

The minimal unit of testing is usually called \textit{test case}, or simply \textit{test}. How a test case is defined or delimited, and even what exactly \textit{constitutes} a test case, depends heavily on the testing paradigm and/or framework in use, so we won’t attempt any more precise definition. The set of the test cases for a given program or system constitutes its \textit{testsuite}.

A \textit{test harness} (also \textit{testsuite harness}) is a program or software component that executes all (or part of) the defined test cases, analyzes their outcomes, and report or register these outcomes appropriately. Again, the details of how this is accomplished (and how the
developer and user can influence it or interface with it) varies wildly, and we’ll attempt no precise definition.

A test is said to pass when it can determine that the condition or behaviour it means to verify holds, and is said to fail when it can determine that such condition of behaviour does not hold.

Sometimes, tests can rely on non-portable tools or prerequisites, or simply make no sense on a given system (for example, a test checking a Windows-specific feature makes no sense on a GNU/Linux system). In this case, accordingly to the definition above, the tests can neither be considered passed nor failed; instead, they are skipped – i.e., they are not run, or their result is anyway ignored for what concerns the count of failures an successes. Skips are usually explicitly reported though, so that the user will be aware that not all of the testsuite has really run.

It’s not uncommon, especially during early development stages, that some tests fail for known reasons, and that the developer doesn’t want to tackle these failures immediately (this is especially true when the failing tests deal with corner cases). In this situation, the better policy is to declare that each of those failures is an expected failure (or xfail). In case a test that is expected to fail ends up passing instead, many testing environments will flag the result as a special kind of failure called unexpected pass (or xpass).

Many testing environments and frameworks distinguish between test failures and hard errors. As we’ve seen, a test failure happens when some invariant or expected behaviour of the software under test is not met. An hard error happens when e.g., the set-up of a test case scenario fails, or when some other unexpected or highly undesirable condition is encountered (for example, the program under test experiences a segmentation fault).

TODO: Links to other test harnesses (esp. those sharing our terminology)?

15.2 Simple Tests

15.2.1 Scripts-based Testsuites

If the special variable TESTS is defined, its value is taken to be a list of programs or scripts to run in order to do the testing. Under the appropriate circumstances, it’s possible for TESTS to list also data files to be passed to one or more test scripts defined by different means (the so-called “log compilers”, see Section 15.2.3 [Parallel Test Harness], page 105).

Test scripts can be executed serially or concurrently. Automake supports both these kinds of test execution, with the serial test harness being the default (for backward-compatibility reasons only, as its use is nowadays discouraged). The concurrent test harness relies on the concurrence capabilities (if any) offered by the underlying make implementation, and can thus only be as good as those are.

By default, only the exit statuses of the test scripts are considered when determining the testsuite outcome. But Automake allows also the use of more complex test protocols, either standard (see Section 15.4 [Using the TAP test protocol], page 112) or custom (see Section 15.3 [Custom Test Drivers], page 108). Note that you can enable such protocols only when the parallel harness is used: they won’t work with the serial test harness. In the rest of this section we are going to concentrate mostly on protocol-less tests, since we cover test protocols in a later section (again, see Section 15.3 [Custom Test Drivers], page 108).
When no test protocol is in use, an exit status of 0 from a test script will denote a success, an exit status of 77 a skipped test, an exit status of 99 an hard error, and any other exit status will denote a failure.

You may define the variable `XFAIL_TESTS` to a list of tests (usually a subset of `TESTS`) that are expected to fail; this will effectively reverse the result of those tests (with the provision that skips and hard errors remain untouched). You may also instruct the testsuite harness to treat hard errors like simple failures, by defining the `DISABLE_HARD_ERRORS` make variable to a nonempty value.

Note however that, for tests based on more complex test protocols, the exact effects of `XFAIL_TESTS` and `DISABLE_HARD_ERRORS` might change, or they might even have no effect at all (for example, in tests using TAP, there is not way to disable hard errors, and the `DISABLE_HARD_ERRORS` variable has no effect on them).

The result of each test case run by the scripts in `TESTS` will be printed on standard output, along with the test name. For test protocols that allow more test cases per test script (such as TAP), a number, identifier and/or brief description specific for the single test case is expected to be printed in addition to the name of the test script. The possible results (whose meanings should be clear from the previous Section 15.1 [Generalities about Testing], page 101) are `PASS`, `FAIL`, `SKIP`, `XFAIL`, `XPASS` and `ERROR`. Here is an example of output from an hypothetical testsuite that uses both plain and TAP tests:

```
PASS: foo.sh
PASS: zardoz.tap 1 - Daemon started
PASS: zardoz.tap 2 - Daemon responding
SKIP: zardoz.tap 3 - Daemon uses /proc # SKIP /proc is not mounted
PASS: zardoz.tap 4 - Daemon stopped
SKIP: bar.sh
PASS: mu.tap 1
XFAIL: mu.tap 2 # TODO frobnication not yet implemented
```

A testsuite summary (expected to report at least the number of run, skipped and failed tests) will be printed at the end of the testsuite run.

If the Automake option `color-tests` is used (see Chapter 17 [Options], page 117) and standard output is connected to a capable terminal, then the test results and the summary are colored appropriately. The user can disable colored output by setting the `make` variable `AM_COLOR_TESTS=no`, or force colored output even without a connecting terminal with `AM_COLOR_TESTS=always`. It’s also worth noting that some `make` implementations, when used in parallel mode, have slightly different semantics (see Section “Parallel make” in The Autoconf Manual), which can break the automatic detection of a connection to a capable terminal. If this is the case, you’ll have to resort to the use of `AM_COLOR_TESTS=always` in order to have the testsuite output colorized.

Test programs that need data files should look for them in `srcdir` (which is both a make variable and an environment variable made available to the tests), so that they work when building in a separate directory (see Section “Build Directories” in The Autoconf Manual), and in particular for the `distcheck` rule (see Section 14.4 [Checking the Distribution], page 99).

The `AM_TESTS_ENVIRONMENT` and `TESTS_ENVIRONMENT` variables can be used to run initialization code and set environment variables for the test scripts. The former variable is
developer-reserved, and can be defined in the Makefile.am, while the latter is reserved for
the user, which can employ it to extend or override the settings in the former; for this
to work portably, however, the contents of a non-empty AM_TESTS_ENVIRONMENT must be
terminated by a semicolon.

The AM_TESTS_FD_REDIRECT variable can be used to define file descriptor redirections
for the test scripts. One might think that AM_TESTS_ENVIRONMENT could be used for this
purpose, but experience has shown that doing so portably is practically impossible. The
main hurdle is constituted by Korn shells, which usually set the close-on-exec flag on file de-
scriptors opened with the exec builtin, thus rendering an idiom like AM_TESTS_ENVIRONMENT = exec 9>&2; ineffectual. This issue also affects some Bourne shells, such as the HP-UX’s
/bin/sh,

```
AM_TESTS_ENVIRONMENT = \ 
## Some environment initializations are kept in a separate shell
## file 'tests-env.sh', which can make it easier to also run tests
## from the command line.
. $(srcdir)/tests-env.sh; \ 
## On Solaris, prefer more POSIX-compliant versions of the standard
## tools by default.
  if test -d /usr/xpg4/bin; then \ 
    PATH=/usr/xpg4/bin:$PATH; export PATH; \ 
   fi;
## With this, the test scripts will be able to print diagnostic
## messages to the original standard error stream, even if the test
## driver redirects the stderr of the test scripts to a log file
## before executing them.
AM_TESTS_FD_REDIRECT = 9>&2
```

Note however that AM_TESTS_ENVIRONMENT is, for historical and implementation reasons, not supported by the serial harness (see Section 15.2.2 [Serial Test Harness], page 104).

Automake ensures that each file listed in TESTS is built before it is run; you can list
both source and derived programs (or scripts) in TESTS; the generated rule will look both
in srcdir and .. For instance, you might want to run a C program as a test. To do this
you would list its name in TESTS and also in check_PROGRAMS, and then specify it as you
would any other program.

Programs listed in check_PROGRAMS (and check_LIBRARIES, check_LTLIBRARIES...) are
only built during make check, not during make all. You should list there any program
needed by your tests that does not need to be built by make all. Note that check_PROGRAMS
are not automatically added to TESTS because check_PROGRAMS usually lists programs used
by the tests, not the tests themselves. Of course you can set TESTS = $(check_PROGRAMS)
if all your programs are test cases.

15.2.2 Serial Test Harness

NOTE: This harness, while still being the default one, is obsolescent, and kept mostly for
backward-compatibility reasons. The user is advised to use the parallel test harness instead
(see Section 15.2.3 [Parallel Test Harness], page 105). Be warned that future Automake
versions might switch to use that more modern and feature-rich harness by default.
The serial test harness is enabled by the Automake option `serial-tests`. It operates by simply running the tests serially, one at the time, without any I/O redirection. It’s up to the user to implement logging of tests’ output, if that’s required or desired.

For historical and implementation reasons, the `AM_TESTS_ENVIRONMENT` variable is not supported by this harness (it will be silently ignored if defined); only `TESTS_ENVIRONMENT` is, and it is to be considered a developer-reserved variable. This is done so that, when using the serial harness, `TESTS_ENVIRONMENT` can be defined to an invocation of an interpreter through which the tests are to be run. For instance, the following setup may be used to run tests with Perl:

```
TESTS_ENVIRONMENT = $(PERL) -Mstrict -w
TESTS = foo.pl bar.pl baz.pl
```

It’s important to note that the use of `TESTS_ENVIRONMENT` endorsed here would be **invalid** with the parallel harness. That harness provides a more elegant way to achieve the same effect, with the further benefit of freeing the `TESTS_ENVIRONMENT` variable for the user (see Section 15.2.3 [Parallel Test Harness], page 105).

Another, less serious limit of the serial harness is that it doesn’t really distinguish between simple failures and hard errors; this is due to historical reasons only, and might be fixed in future Automake versions.

### 15.2.3 Parallel Test Harness

The parallel (or concurrent) test harness is enabled by the Automake option `parallel-tests`. It features automatic collection of the test scripts output in `.log` files, concurrent execution of tests with `make -j`, specification of inter-test dependencies, lazy reruns of tests that have not completed in a prior run, and hard errors for exceptional failures.

This harness is still somewhat experimental and may undergo changes in order to satisfy additional portability requirements.

The parallel test harness operates by defining a set of `make` rules that run the test scripts listed in `TESTS`, and, for each such script, save its output in a corresponding `.log` file and its results (and other “metadata”, see Section 15.3.3 [API for Custom Test Drivers], page 109) in a corresponding `.trs` (as in Test ReSults) file. The `.log` file will contain all the output emitted by the test on its standard output and its standard error. The `.trs` file will contain, among the other things, the results of the test cases run by the script.

The parallel test harness will also create a summary log file, `TEST_SUITE_LOG`, which defaults to `test-suite.log` and requires a `.log` suffix. This file depends upon all the `.log` and `.trs` files created for the test scripts listed in `TESTS`.

As with the serial harness above, by default one status line is printed per completed test, and a short summary after the suite has completed. However, standard output and standard error of the test are redirected to a per-test log file, so that parallel execution does not produce intermingled output. The output from failed tests is collected in the `test-suite.log` file. If the variable ‘`VERBOSE`’ is set, this file is output after the summary. For best results, the tests should be verbose by default now.

Each couple of `.log` and `.trs` files is created when the corresponding test has completed. The set of log files is listed in the read-only variable `TEST_LOGS`, and defaults to `TESTS`, with the executable extension if any (see Section 8.20 [EXEEXT], page 81), as well as any suffix
listed in \texttt{TEST_EXTENSIONS} removed, and \texttt{.log} appended. Results are undefined if a test file name ends in several concatenated suffixes. \texttt{TEST_EXTENSIONS} defaults to \texttt{.test}; it can be overridden by the user, in which case any extension listed in it must be constituted by a dot, followed by a non-digit alphabetic character, followed by any number of alphabetic characters. For example, \texttt{.sh}, \texttt{.T} and \texttt{.t1} are valid extensions, while \texttt{.x-y}, \texttt{.6c} and \texttt{.t.1} are not.

For tests that match an extension \texttt{.ext} listed in \texttt{TEST_EXTENSIONS}, you can provide a custom “test runner” using the variable \texttt{ext\_LOG\_COMPILER} (note the upper-case extension) and pass options in \texttt{AM\_ext\_LOG\_FLAGS} and allow the user to pass options in \texttt{ext\_LOG\_FLAGS}. It will cause all tests with this extension to be called with this runner. For all tests without a registered extension, the variables \texttt{LOG\_COMPILER}, \texttt{AM\_LOG\_FLAGS}, and \texttt{LOG\_FLAGS} may be used. For example,

\begin{verbatim}
TESTS = foo.pl bar.py baz
TEST_EXTENSIONS = .pl .py
PL_LOG_COMPILER = $(PERL)
AM_PL_LOG_FLAGS = -w
PY_LOG_COMPILER = $(PYTHON)
AM_PY_LOG_FLAGS = -v
LOG_COMPILER = ./wrapper-script
AM_LOG_FLAGS = -d
\end{verbatim}

will invoke \texttt{$(PERL) -w foo.pl}, \texttt{$(PYTHON) -v bar.py}, and \texttt{./wrapper-script -d baz} to produce \texttt{foo.log}, \texttt{bar.log}, and \texttt{baz.log}, respectively. The \texttt{foo.trs}, \texttt{bar.trs} and \texttt{baz.trs} files will be automatically produced as a side-effect.

It’s important to note that, differently from what we’ve seen for the serial test harness (see Section 15.2.3 [Parallel Test Harness], page 105), the \texttt{AM_TESTS\_ENVIRONMENT} and \texttt{TESTS\_ENVIRONMENT} variables cannot be use to define a custom test runner; the \texttt{LOG\_COMPILER} and \texttt{LOG\_FLAGS} (or their extension-specific counterparts) should be used instead:

\begin{verbatim}
## This is WRONG!
AM_TESTS\_ENVIRONMENT = PERL5LIB='$(srcdir)/lib' $(PERL) -Mstrict -w
## Do this instead.
AM_TESTS\_ENVIRONMENT = PERL5LIB='$(srcdir)/lib'; export PERL5LIB;
LOG\_COMPILER = $(PERL)
AM_LOG\_FLAGS = -Mstrict -w
\end{verbatim}

By default, the test suite harness will run all tests, but there are several ways to limit the set of tests that are run:

- You can set the \texttt{TESTS} variable. For example, you can use a command like this to run only a subset of the tests:

\begin{verbatim}
env TESTS="foo.test bar.test" make -e check
\end{verbatim}

Note however that the command above will unconditionally overwrite the \texttt{test-suite.log} file, thus clobbering the recorded results of any previous testsuite run. This might be undesirable for packages whose testsuite takes long time to execute. Luckily, this problem can easily be avoided by overriding also \texttt{TEST\_SUITE\_LOG} at runtime; for example,

\begin{verbatim}
env TEST\_SUITE\_LOG=partial.log TESTS="..." make -e check
\end{verbatim}
will write the result of the partial testsuite runs to the `partial.log`, without touching `test-suite.log`.

- You can set the `TEST_LOGS` variable. By default, this variable is computed at `make` run time from the value of `TESTS` as described above. For example, you can use the following:
  
  ```
  set x subset*.log; shift
  env TEST_LOGS="foo.log $*" make -e check
  ```

  The comments made above about `TEST_SUITE_LOG` overriding applies here too.

- By default, the test harness removes all old per-test `.log` and `.trs` files before it starts running tests to regenerate them. The variable `RECHECK_LOGS` contains the set of `.log` (and, by implication, `.trs`) files which are removed. `RECHECK_LOGS` defaults to `TEST_LOGS`, which means all tests need to be rechecked. By overriding this variable, you can choose which tests need to be reconsidered. For example, you can lazily rerun only those tests which are outdated, i.e., older than their prerequisite test files, by setting this variable to the empty value:
  
  ```
  env RECHECK_LOGS= make -e check
  ```

- You can ensure that all tests are rerun which have failed or passed unexpectedly, by running `make recheck` in the test directory. This convenience target will set `RECHECK_LOGS` appropriately before invoking the main test harness.

In order to guarantee an ordering between tests even with `make -jN`, dependencies between the corresponding `.log` files may be specified through usual `make` dependencies. For example, the following snippet lets the test named `foo-execute.test` depend upon completion of the test `foo-compile.test`:

```
TESTS = foo-compile.test foo-execute.test
foo-execute.log: foo-compile.log
```

Please note that this ordering ignores the results of required tests, thus the test `foo-execute.test` is run even if the test `foo-compile.test` failed or was skipped beforehand. Further, please note that specifying such dependencies currently works only for tests that end in one of the suffixes listed in `TEST_EXTENSIONS`.

Tests without such specified dependencies may be run concurrently with parallel `make -jN`, so be sure they are prepared for concurrent execution.

The combination of lazy test execution and correct dependencies between tests and their sources may be exploited for efficient unit testing during development. To further speed up the edit-compile-test cycle, it may even be useful to specify compiled programs in `EXTRA_PROGRAMS` instead of with `check_PROGRAMS`, as the former allows intertwined compilation and test execution (but note that `EXTRA_PROGRAMS` are not cleaned automatically, see Section 3.3 [Uniform], page 20).

The variables `TESTS` and `XFAIL_TESTS` may contain conditional parts as well as configure substitutions. In the latter case, however, certain restrictions apply: substituted test names must end with a nonempty test suffix like `.test`, so that one of the inference rules generated by `automake` can apply. For literal test names, `automake` can generate per-target rules to avoid this limitation.

Please note that it is currently not possible to use `$(srcdir)` or `$(top_srcdir)` in the `TESTS` variable. This technical limitation is necessary to avoid generating test logs in the
source tree and has the unfortunate consequence that it is not possible to specify distributed
tests that are themselves generated by means of explicit rules, in a way that is portable to
all make implementations (see Section “Make Target Lookup” in The Autoconf Manual, the
semantics of FreeBSD and OpenBSD make conflict with this). In case of doubt you may
want to require to use GNU make, or work around the issue with inference rules to generate
the tests.

15.3 Custom Test Drivers

15.3.1 Overview of Custom Test Drivers Support

Starting from Automake version 1.12, the parallel test harness allows the package authors
to use third-party custom test drivers, in case the default ones are inadequate for their
purposes, or do not support their testing protocol of choice.

A custom test driver is expected to properly run the test programs passed to it (including
the command-line arguments passed to those programs, if any), to analyze their execution
and outcome, to create the .log and .trs files associated to these test runs, and to display
the test results on the console. It is responsibility of the author of the test driver to ensure
that it implements all the above steps meaningfully and correctly; Automake isn’t and can’t
be of any help here. On the other hand, the Automake-provided code for testsuite summary
generation offers support for test drivers allowing several test results per test script, if they
take care to register such results properly (see Section 15.3.3.2 [Log files generation and test
results recording], page 110).

The exact details of how test scripts’ results are to be determined and analyzed is left
to the individual drivers. Some drivers might only consider the test script exit status (this
is done for example by the default test driver used by the parallel test harness, described
in the previous section). Other drivers might implement more complex and advanced test
protocols, which might require them to parse and interpreter the output emitted by the test
script they’re running (examples of such protocols are TAP and SubUnit).

It’s very important to note that, even when using custom test drivers, most of the
infrastructure described in the previous section about the parallel harness remains in place;
this includes:

- list of test scripts defined in TESTS, and overridable at runtime through the redefinition
  of TESTS or TEST_LOGS;
- concurrency through the use of make’s option -j;
- per-test .log and .trs files, and generation of a summary .log file from them;
- recheck target, RECHECK_LOGS variable, and lazy reruns of tests;
- inter-test dependencies;
- support for check_* variables (check_PROGRAMS, check_LIBRARIES, ...);
- use of VERBOSE environment variable to get verbose output on testsuite failures;
- definition and honoring of TESTS_ENVIRONMENT, AM_TESTS_ENVIRONMENT and
  AM_TESTS_FD_REDIRECT variables;
- definition of generic and extension-specific LOG_COMPILER and LOG_FLAGS variables.

On the other hand, the exact semantics of how (and if) color-tests, XFAIL_TESTS, and
hard errors are supported and handled is left to the individual test drivers.
15.3.2 Declaring Custom Test Drivers

Custom testsuite drivers are declared by defining the make variables LOG_DRIVER or ext_LOG_DRIVER (where ext must be declared in TEST_EXTENSIONS). They must be defined to programs or scripts that will be used to drive the execution, logging, and outcome report of the tests with corresponding extensions (or of those with no registered extension in the case of LOG_DRIVER). Clearly, multiple distinct test drivers can be declared in the same Makefile.am. Note moreover that the LOG_DRIVER variables are not a substitute for the LOG_COMPILER variables: the two sets of variables can, and often do, usefully and legitimately coexist.

The developer-reserved variable AM_LOG_DRIVER_FLAGS and the user-reserved variable LOG_DRIVER_FLAGS can be used to define flags that will be passed to each invocation of LOG_DRIVER, with the user-defined flags obviously taking precedence over the developer-reserved ones. Similarly, for each extension ext declared in TEST_EXTENSIONS, flags listed in AM_ext_LOG_DRIVER_FLAGS and ext_LOG_DRIVER_FLAGS will be passed to invocations of ext_LOG_DRIVER.

15.3.3 API for Custom Test Drivers

Note that the APIs described here are still highly experimental, and will very likely undergo tightenings and likely also extensive changes in the future, to accommodate for new features or to satisfy additional portability requirements.

The main characteristic of these APIs is that they are designed to share as much infrastructure, semantics, and implementation details as possible with the parallel test harness and its default driver.

15.3.3.1 Command-line arguments for test drivers

A custom driver can rely on various command-line options and arguments being passed to it automatically by the Automake’s parallel-tests harness. It is mandatory that it understands all of them (even if the exact interpretation of the associated semantics can legitimately change between a test driver and another, and even be a no-op in some drivers).

Here is the list of options:

--test-name=NAME
The name of the test, with VPATH prefix (if any) removed. This can have a suffix and a directory component (as in e.g., sub/foo.test), and is mostly meant to be used in console reports about testsuite advancements and results (see Section 15.3.3.3 [Testsuite progress output], page 111).

--log-file=PATH.log
The .log file the test driver must create (see [Basics of test metadata], page 105). If it has a directory component (as in e.g., sub/foo.log), the test harness will ensure that such directory exists before the test driver is called.

--trs-file=PATH.trs
The .trs file the test driver must create (see [Basics of test metadata], page 105). If it has a directory component (as in e.g., sub/foo.trs), the test harness will ensure that such directory exists before the test driver is called.
**--color-tests={yes|no}**
Whether the console output should be colorized or not (see [Simple tests and color-tests], page 103, to learn when this option gets activated and when it doesn’t).

**--expect-failure={yes|no}**
Whether the tested program is expected to fail.

**--enable-hard-errors={yes|no}**
Whether “hard errors” in the tested program should be treated differently from normal failures or not (the default should be yes). The exact meaning of “hard error” is highly dependent from the test protocols or conventions in use.

**--**
Explicitly terminate the list of options.

The first non-option argument passed to the test driver is the program to be run, and all the following ones are command-line options and arguments for this program.

Note that the exact semantics attached to the **--color-tests**, **--expect-failure** and **--enable-hard-errors** options are left up to the individual test drivers. Still, having a behaviour compatible or at least similar to that provided by the default **parallel-tests** driver is advised, as that would offer a better consistency and a more pleasant user experience.

### 15.3.3.2 Log files generation and test results recording

The test driver must correctly generate the files specified by the **--log-file** and **--trs-file** option (even when the tested program fails or crashes).

The `.log` file should ideally contain all the output produced by the tested program, plus optionally other information that might facilitate debugging or analysis of bug reports. Apart from that, its format is basically free.

The `.trs` file is used to register some metadata through the use of custom reStructured-Text fields. This metadata is expected to be employed in various ways by the parallel test harness; for example, to count the test results when printing the testsuite summary, or to decide which tests to re-run upon `make reheck`. Unrecognized metadata in a `.trs` file is currently ignored by the harness, but this might change in the future. The list of currently recognized metadata follows.

**:test-result:**
The test driver must use this field to register the results of each test case run by a test script file. Several **:test-result:** fields can be present in the same `.trs` file; this is done in order to support test protocols that allow a single test script to run more test cases.

The only recognized test results are currently **PASS**, **XFAIL**, **SKIP**, **FAIL**, **XPASS** and **ERROR**. These results, when declared with **:test-result:**, can be optionally followed by text holding the name and/or a brief description of the corresponding test; the **parallel-tests** harness will ignore such extra text when generating **test-suite.log** and preparing the testsuite summary.
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:recheck:
If this field is present and defined to no, then the corresponding test script will not be run upon a make recheck. What happens when two or more :recheck: fields are present in the same .trs file is undefined behaviour.

:copy-in-global-log:
If this field is present and defined to no, then the content of the .log file will not be copied into the global test-suite.log. We allow to forsake such copying because, while it can be useful in debugging and analysis of bug report, it can also be just a waste of space in normal situations, e.g., when a test script is successful. What happens when two or more :copy-in-global-log: fields are present in the same .trs file is undefined behaviour.

:test-global-result:
This is used to declare the "global result" of the script. Currently, the value of this field is needed only to be reported (more or less verbatim) in the generated global log file $(TEST_SUITE_LOG), so it’s quite free-form. For example, a test script which run 10 test cases, 6 of which pass and 4 of which are skipped, could reasonably have a PASS/SKIP value for this field, while a test script which run 19 successful tests and one failed test could have an ALMOST PASSED value. What happens when two or more :test-global-result: fields are present in the same .trs file is undefined behaviour.

Let’s see a small example. Assume a .trs file contains the following lines:

: test-result: PASS server starts
: global-log-copy: no
: test-result: PASS HTTP/1.1 request
: test-result: FAIL HTTP/1.0 request
: recheck: yes
: test-result: SKIP HTTPS request (TLS library wasn’t available)
: test-result: PASS server stops

Then the corresponding test script will be re-run by make check, will contribute with five test results to the testsuite summary (three of these tests being successful, one failed, and one skipped), and the content of the corresponding .log file will not be copied in the global log file test-suite.log.

15.3.3.3 Testsuite progress output
A custom test driver also has the task of displaying, on the standard output, the test results as soon as they become available. Depending on the protocol in use, it can also display the reasons for failures and skips, and, more generally, any useful diagnostic output (but remember that each line on the screen is precious, so that cluttering the screen with overly verbose information is bad idea). The exact format of this progress output is left up to the test driver; in fact, a custom test driver might theoretically even decide not to do any such report, leaving it all to the testsuite summary (that would be a very lousy idea, of course, and serves only to illustrate the flexibility that is granted here).

Remember that consistency is good; so, if possible, try to be consistent with the output of the built-in Automake test drivers, providing a similar “look & feel”. In particular, the testsuite progress output should be colorized when the --color-tests is passed to the
driver. On the other end, if you are using a known and widespread test protocol with well-established implementations, being consistent with those implementations’ output might be a good idea too.

15.4 Using the TAP test protocol

15.4.1 Introduction to TAP

TAP, the Test Anything Protocol, is a simple text-based interface between testing modules or programs and a test harness. The tests (also called “TAP producers” in this context) write test results in a simple format on standard output; a test harness (also called “TAP consumer”) will parse and interpret these results, and properly present them to the user, and/or register them for later analysis. The exact details of how this is accomplished can vary among different test harnesses. The Automake parallel harness will present the results on the console in the usual fashion (see [Testsuite progress on console], page 103), and will use the .trs files (see [Basics of test metadata], page 105) to store the test results and related metadata. Apart from that, it will try to remain as much compatible as possible with pre-existing and widespread utilities, such as the prove utility (http://search.cpan.org/~andya/Test-Harness/bin/prove), at least for the simpler usages.

TAP started its life as part of the test harness for Perl, but today it has been (mostly) standardized, and has various independent implementations in different languages; among them, C, C++, Perl, Python, PHP, and Java. For a semi-official specification of the TAP protocol, please refer to the documentation of ‘Test::Harness::TAP’ (http://search.cpan.org/~petdance/Test-Harness/lib/Test/Harness/TAP.pod).

The most relevant real-world usages of TAP are obviously in the testsuites of perl and of many perl modules. Still, also other important third-party packages, such as git (http://git-scm.com/), use TAP in their testsuite.

15.4.2 Use TAP with the Automake test harness

Currently, the TAP driver that comes with Automake requires some by-hand steps on the developer’s part (this situation should hopefully be improved in future Automake versions). You’ll have to grab the tap-driver.sh script from the Automake distribution by hand, copy it in your source tree, add a call to AC_PROG_AWK in configure.ac to search for a proper awk program, and use the Automake support for third-party test drivers to instruct the harness to use the tap-driver.sh script and that awk program to run your TAP-producing tests. See the example below for clarification.

Apart from the options common to all the Automake test drivers (see Section 15.3.3.1 [Command-line arguments for test drivers], page 109), the tap-driver.sh supports the following options, whose names are chosen for enhanced compatibility with the prove utility.

```
--ignore-exit
```

Causes the test driver to ignore the exit status of the test scripts; by default, the driver will report an error if the script exits with a non-zero status. This option has effect also on non-zero exit statuses due to termination by a signal.
--comments
Instruct the test driver to display TAP diagnostic (i.e., lines beginning with the
`#` character) in the testsuite progress output too; by default, TAP diagnostic
is only copied to the `.log` file.

--no-comments
Revert the effects of --comments.

--merge
Instruct the test driver to merge the test scripts' standard error into their
standard output. This is necessary if you want to ensure that diagnostics from
the test scripts are displayed in the correct order relative to test results; this
can be of great help in debugging (especially if your test scripts are shell scripts
run with shell tracing active). As a downside, this option might cause the test
harness to get confused if anything that appears on standard error looks like a
test result.

--no-merge
Revert the effects of --merge.

--diagnostic-string=STRING
Change the string that introduces TAP diagnostic from the default value of “#”
to STRING. This can be useful if your TAP-based test scripts produce verbose
output on which they have limited control (because, say, the output comes from
other tools invoked in the scripts), and it might contain text that gets spuriously
interpreted as TAP diagnostic: such an issue can be solved by redefining the
string that activates TAP diagnostic to a value you know won't appear by
chance in the tests' output. Note however that this feature is non-standard, as
the “official” TAP protocol does not allow for such a customization; so don’t
use it if you can avoid it.

Here is an example of how the TAP driver can be set up and used.

```
% cat configure.ac
AC_INIT([GNU Try Tap], [1.0], [bug-automake@gnu.org])
AC_CONFIG_AUX_DIR([build-aux])
AM_INIT_AUTOMAKE([foreign parallel-tests -Wall -Werror])
AC_CONFIG_FILES([Makefile])
AC_REQUIRE_AUX_FILE([tap-driver.sh])
AC_PROG_AWK
AC_OUTPUT

% cat Makefile.am
TEST_LOG_DRIVER = env AM_TAP_AWK='$(AWK)' $(SHELL) \$(top_srcdir)/build-aux/tap-driver.sh
TESTS = foo.test bar.test baz.test
EXTRA_DIST = $(TESTS)

% cat foo.test
#!/bin/sh
echo 1..4 # Number of tests to be executed.
```
echo 'ok 1 - Swallows fly'
echo 'not ok 2 - Caterpillars fly # TODO metamorphosis in progress'
echo 'ok 3 - Pigs fly # SKIP not enough acid'
echo '# I just love word plays ...'
echo 'ok 4 - Flies fly too :-)' 

% cat bar.test
#!/bin/sh
echo 1..3
echo 'not ok 1 - Bummer, this test has failed.'
echo 'ok 2 - This passed though.'
echo 'Bail out! Ennui kicking in, sorry...'
echo 'ok 3 - This will not be seen.' 

% cat baz.test
#!/bin/sh
echo 1..1
echo ok 1
# Exit with error, even if all the tests have been successful. 
exit 7

% cp PREFIX/share/automake-APIVERSION/tap-driver.pl .
% autoreconf --vi ./configure && make check
... 
PASS: foo.test 1 - Swallows fly 
XFAIL: foo.test 2 - Caterpillars fly # TODO metamorphosis in progress
SKIP: foo.test 3 - Pigs fly # SKIP not enough acid
PASS: foo.test 4 - Flies fly too :-) 
FAIL: bar.test 1 - Bummer, this test has failed.
PASS: bar.test 2 - This passed though.
ERROR: bar.test - Bail out! Ennui kicking in, sorry...
PASS: baz.test 1
ERROR: baz.test - exited with status 7
...
Please report to bug-automake@gnu.org
...
% echo exit status: $?
exit status: 1

% env TEST_LOG_DRIVER_FLAGS='--comments --ignore-exit' \ 
   TESTS='foo.test baz.test' make -e check
... 
PASS: foo.test 1 - Swallows fly 
XFAIL: foo.test 2 - Caterpillars fly # TODO metamorphosis in progress
SKIP: foo.test 3 - Pigs fly # SKIP not enough acid 
# foo.test: I just love word plays...
PASS: foo.test 4 - Flies fly too :-)

15.4.3 Incompatibilities with other TAP parsers and drivers

For implementation or historical reasons, the TAP driver and harness as implemented by Automake have some minors incompatibilities with the mainstream versions, which you should be aware of.

- A **Bail out!** directive doesn’t stop the whole testsuite, but only the test script it occurs in. This doesn’t follow TAP specifications, but on the other hand it maximizes compatibility (and code sharing) with the “hard error” concept of the default parallel-tests driver.

- The **version** and **pragma** directives are not supported.

- The **--diagnostic-string** option of our driver allows to modify the string that introduces TAP diagnostic from the default value of “#”. The standard TAP protocol has currently no way to allow this, so if you use it your diagnostic will be lost to more compliant tools like prove and Test::Harness

- And there are probably some other small and yet undiscovered incompatibilities, especially in corner cases or with rare usages.

15.4.4 Links and external resources on TAP

Here are some links to more extensive official or third-party documentation and resources about the TAP protocol and related tools and libraries.

- [‘Test::Harness::TAP’](http://search.cpan.org/~petdance/Test-Harness/lib/Test/Harness/TAP.pod), the (mostly) official documentation about the TAP format and protocol.

- [prove](http://search.cpan.org/~andya/Test-Harness/bin/prove), the most famous command-line TAP test driver, included in the distribution of perl and ‘Test::Harness’ ([http://search.cpan.org/~andya/Test-Harness/lib/Test/Harness.pm](http://search.cpan.org/~andya/Test-Harness/lib/Test/Harness.pm)).

- The TAP wiki ([http://testanything.org/wiki/index.php/Main_Page](http://testanything.org/wiki/index.php/Main_Page)).


- [‘Test::Simple’](http://search.cpan.org/~mschwern/Test-Simple/lib/Test/Simple.pm) and [‘Test::More’](http://search.cpan.org/~mschwern/Test-Simple/lib/Test/More.pm), the standard perl testing libraries, which are based on TAP.

- C TAP Harness ([http://www.eyrie.org/~eagle/software/c-tap-harness/](http://www.eyrie.org/~eagle/software/c-tap-harness/)), a C-based project implementing both a TAP producer and a TAP consumer.

- tap4j ([http://www.tap4j.org/](http://www.tap4j.org/)), a Java-based project implementing both a TAP producer and a TAP consumer.
15.5 DejaGnu Tests

If dejagnu (ftp://ftp.gnu.org/gnu/dejagnu/) appears in AUTOMAKE_OPTIONS, then a dejagnu-based test suite is assumed. The variable DEJATOOL is a list of names that are passed, one at a time, as the --tool argument to runtest invocations; it defaults to the name of the package.

The variable RUNTESTDEFAULTFLAGS holds the --tool and --sdir flags that are passed to dejagnu by default; this can be overridden if necessary.

The variables EXPECT and RUNTEST can also be overridden to provide project-specific values. For instance, you will need to do this if you are testing a compiler toolchain, because the default values do not take into account host and target names.

The contents of the variable RUNTESTFLAGS are passed to the runtest invocation. This is considered a “user variable” (see Section 3.6 [User Variables], page 23). If you need to set runtest flags in Makefile.am, you can use AM_RUNTESTFLAGS instead.

Automake will generate rules to create a local site.exp file, defining various variables detected by configure. This file is automatically read by DejaGnu. It is OK for the user of a package to edit this file in order to tune the test suite. However this is not the place where the test suite author should define new variables: this should be done elsewhere in the real test suite code. Especially, site.exp should not be distributed.

Still, if the package author has legitimate reasons to extend site.exp at make time, he can do so by defining the variable EXTRA_DEJAGNU_SITE_CONFIG; the files listed there will be considered site.exp prerequisites, and their content will be appended to it (in the same order in which they appear in EXTRA_DEJAGNU_SITE_CONFIG). Note that files are not distributed by default.

For more information regarding DejaGnu test suites, see The DejaGnu Manual.

15.6 Install Tests

The installcheck target is available to the user as a way to run any tests after the package has been installed. You can add tests to this by writing an installcheck-local rule.

16 Rebuilding Makefiles

Automake generates rules to automatically rebuild Makefiles, configure, and other derived files like Makefile.in.

If you are using AM_MAINTAINER_MODE in configure.ac, then these automatic rebuilding rules are only enabled in maintainer mode.

Sometimes you need to run aclocal with an argument like -I to tell it where to find .m4 files. Since sometimes make will automatically run aclocal, you need a way to specify these arguments. You can do this by defining ACLOCAL_AMFLAGS; this holds arguments that are passed verbatim to aclocal. This variable is only useful in the top-level Makefile.am.

Sometimes it is convenient to supplement the rebuild rules for configure or config.status with additional dependencies. The variables CONFIGURE_DEPENDENCIES and CONFIG_STATUS_DEPENDENCIES can be used to list these extra dependencies. These variables should be defined in all Makefiles of the tree (because these two rebuild rules are
output in all them), so it is safer and easier to AC_SUBST them from configure.ac. For instance, the following statement will cause configure to be rerun each time version.sh is changed.

\[\text{AC_SUBST}([\text{CONFIG_STATUS_DEPENDENCIES}], ['$(top_srcdir)/version.sh'])\]

Note the ‘$(top_srcdir)/’ in the file name. Since this variable is to be used in all Makefiles, its value must be sensible at any level in the build hierarchy.

Beware not to mistake \texttt{CONFIGURE_DEPENDENCIES} for \texttt{CONFIG_STATUS_DEPENDENCIES}.

\texttt{CONFIGURE_DEPENDENCIES} adds dependencies to the configure rule, whose effect is to run autoconf. This variable should be seldom used, because automake already tracks m4_-included files. However it can be useful when playing tricky games with m4_esyscmd or similar non-recommendable macros with side effects.

\texttt{CONFIG_STATUS_DEPENDENCIES} adds dependencies to the config.status rule, whose effect is to run configure. This variable should therefore carry any non-standard source that may be read as a side effect of running configure, like version.sh in the example above.

Speaking of version.sh scripts, we recommend against them today. They are mainly used when the version of a package is updated automatically by a script (e.g., in daily builds). Here is what some old-style configure.acs may look like:

\begin{verbatim}
AC_INIT
  . $srcdir/version.sh
AM_INIT_AUTOMAKE([name], $VERSION_NUMBER)
...
\end{verbatim}

Here, version.sh is a shell fragment that sets VERSION_NUMBER. The problem with this example is that automake cannot track dependencies (listing version.sh in CONFIG_STATUS_DEPENDENCIES, and distributing this file is up to the user), and that it uses the obsolete form of AC_INIT and AM_INIT_AUTOMAKE. Upgrading to the new syntax is not straightforward, because shell variables are not allowed in AC_INIT’s arguments. We recommend that version.sh be replaced by an M4 file that is included by configure.ac:

\begin{verbatim}
m4_include([version.m4])
AC_INIT([name], VERSION_NUMBER)
AM_INIT_AUTOMAKE
...
\end{verbatim}

Here version.m4 could contain something like ‘m4_define([VERSION_NUMBER], [1.2])’. The advantage of this second form is that automake will take care of the dependencies when defining the rebuild rule, and will also distribute the file automatically. An inconvenience is that autoconf will now be rerun each time the version number is bumped, when only configure had to be rerun in the previous setup.

\section*{17 Changing Automake’s Behavior}
17.1 Options generalities

Various features of Automake can be controlled by options. Except where noted otherwise, options can be specified in one of several ways. Most options can be applied on a per-`Makefile` basis when listed in a special `Makefile` variable named `AUTOMAKE_OPTIONS`. Some of these options only make sense when specified in the toplevel `Makefile.am` file. Options are applied globally to all processed `Makefile` files when listed in the first argument of `AM_INIT_AUTOMAKE` in `configure.ac`, and some options which require changes to the `configure` script can only be specified there. These are annotated below.

As a general rule, options specified in `AUTOMAKE_OPTIONS` take precedence over those specified in `AM_INIT_AUTOMAKE`, which in turn take precedence over those specified on the command line.

Also, some care must be taken about the interactions among strictness level and warning categories. As a general rule, strictness-implied warnings are overridden by those specified by explicit options. For example, even if `portability` warnings are disabled by default in `foreign` strictness, an usage like this will end up enabling them:

```
AUTOMAKE_OPTIONS = -Wportability foreign
```

However, a strictness level specified in a higher-priority context will override all the explicit warnings specified in a lower-priority context. For example, if `configure.ac` contains:

```
AM_INIT_AUTOMAKE([-Wportability])
```

and `Makefile.am` contains:

```
AUTOMAKE_OPTIONS = foreign
```

then `portability` warnings will be disabled in `Makefile.am`.

17.2 List of Automake options

- **gnits**
- **gnu**
- **foreign**
- **cygnus**

Set the strictness as appropriate. The `gnits` option also implies options `readme-alpha` and `check-news`.

- **check-news**

  Cause `make dist` to fail unless the current version number appears in the first few lines of the `NEWS` file.

- **color-tests**

  Cause output of the serial and parallel test harnesses (see Section 15.2 [Simple Tests], page 102) and of properly-written custom test drivers (see Section 15.3 [Custom Test Drivers], page 108) to be colorized on capable terminals.

- **dejagnu**

  Cause `dejagnu`-specific rules to be generated. See Section 15.5 [DejaGnu Tests], page 116.

- **dist-bzip2**

  Hook `dist-bzip2` to `dist`. 
Chapter 17: Changing Automake’s Behavior

dist-lzip
Hook dist-lzip to dist.

dist-shar
Hook dist-shar to dist.

dist-zip
Hook dist-zip to dist.

dist-tarZ
Hook dist-tarZ to dist.

filename-length-max=99
Abort if file names longer than 99 characters are found during ‘make dist’. Such long file names are generally considered not to be portable in tarballs. See the tar-v7 and tar-ustar options below. This option should be used in the top-level Makefile.am or as an argument of AM_INIT_AUTOMAKE in configure.ac, it will be ignored otherwise. It will also be ignored in sub-packages of nested packages (see Section 7.4 [Subpackages], page 52).

no-define
This option is meaningful only when passed as an argument to AM_INIT_AUTOMAKE. It will prevent the PACKAGE and VERSION variables from being AC_DEFINED.

no-dependencies
This is similar to using --ignore-deps on the command line, but is useful for those situations where you don’t have the necessary bits to make automatic dependency tracking work (see Section 8.19 [Dependencies], page 80). In this case the effect is to effectively disable automatic dependency tracking.

no-dist
Don’t emit any code related to dist target. This is useful when a package has its own method for making distributions.

no-dist-gzip
Do not hook dist-gzip to dist.

no-exeext
If your Makefile.am defines a rule for target foo, it will override a rule for a target named ‘foo$(EXEEXT)’. This is necessary when EXEEXT is found to be empty. However, by default automake will generate an error for this use. The no-exeext option will disable this error. This is intended for use only where it is known in advance that the package will not be ported to Windows, or any other operating system using extensions on executables.

no-installinfo
The generated Makefile.in will not cause info pages to be built or installed by default. However, info and install-info targets will still be available. This option is disallowed at gnu strictness and above.

no-installman
The generated Makefile.in will not cause man pages to be installed by default. However, an install-man target will still be available for optional installation. This option is disallowed at gnu strictness and above.
nostdinc  This option can be used to disable the standard -I options that are ordinarily automatically provided by Automake.

no-texinfo.tex  Don’t require texinfo.tex, even if there are texinfo files in this directory.

parallel-tests  Enable test suite harness for TESTS that can run tests in parallel (see Section 15.2.3 [Parallel Test Harness], page 105, for more information).

serial-tests  Enable the older serial test suite harness for TESTS (see Section 15.2.2 [Serial Test Harness], page 104, for more information). This is still the default for the moment.

readme-alpha  If this release is an alpha release, and the file README-alpha exists, then it will be added to the distribution. If this option is given, version numbers are expected to follow one of two forms. The first form is ‘major.minor.alpha’, where each element is a number; the final period and number should be left off for non-alpha releases. The second form is ‘major.minoralpha’, where alpha is a letter; it should be omitted for non-alpha releases.

silent-rules  Enable less verbose build rules. This can be used to let build rules output status lines of the form:

```
    GEN output-file
    CC object-file
```

instead of printing the command that will be executed to update output-file or to compile object-file. It can also silence libtool output.

For more information about how to use, enable, or disable silent rules, see Section 21.3 [Automake silent-rules Option], page 127.

std-options  Make the installcheck rule check that installed scripts and programs support the --help and --version options. This also provides a basic check that the program’s run-time dependencies are satisfied after installation.

In a few situations, programs (or scripts) have to be exempted from this test. For instance, false (from GNU coreutils) is never successful, even for --help or --version. You can list such programs in the variable AM_INSTALLCHECK_STD_OPTIONS_EXEMPT. Programs (not scripts) listed in this variable should be suffixed by ‘$(EXEEXT)’ for the sake of Windows or OS/2. For instance, suppose we build false as a program but true.sh as a script, and that neither of them support --help or --version:

```
AUTOMAKE_OPTIONS = std-options
bin_PROGRAMS = false ...
bin_SCRIPTS = true.sh ...
AM_INSTALLCHECK_STD_OPTIONS_EXEMPT = false$(EXEEXT) true.sh
```
subdir-objects

If this option is specified, then objects are placed into the subdirectory of the build directory corresponding to the subdirectory of the source file. For instance, if the source file is subdir/file.cxx, then the output file would be subdir/file.o.

In order to use this option with C sources, you should add AM_PROG_CC_C_0 to configure.ac.

tar-v7
tar-ustar
tar-pax

These three mutually exclusive options select the tar format to use when generating tarballs with `make dist`. (The tar file created is then compressed according to the set of no-dist-gzip, dist-bzip2, dist-lzip, dist-xx and dist-tarZ options in use.)

These options must be passed as arguments to AM_INIT_AUTOMAKE (see Section 6.4 [Macros], page 44) because they can require additional configure checks. Automake will complain if it sees such options in an AUTOMAKE_OPTIONS variable.

tar-v7 selects the old V7 tar format. This is the historical default. This antiquated format is understood by all tar implementations and supports file names with up to 99 characters. When given longer file names some tar implementations will diagnose the problem while other will generate broken tarballs or use non-portable extensions. Furthermore, the V7 format cannot store empty directories. When using this format, consider using the filename-length-max=99 option to catch file names too long.

tar-ustar selects the ustar format defined by POSIX 1003.1-1988. This format is believed to be old enough to be portable. It fully supports empty directories. It can store file names with up to 256 characters, provided that the file name can be split at directory separator in two parts, first of them being at most 155 bytes long. So, in most cases the maximum file name length will be shorter than 256 characters. However you may run against broken tar implementations that incorrectly handle file names longer than 99 characters (please report them to bug-automake@gnu.org so we can document this accurately).

tar-pax selects the new pax interchange format defined by POSIX 1003.1-2001. It does not limit the length of file names. However, this format is very young and should probably be restricted to packages that target only very modern platforms. There are moves to change the pax format in an upward-compatible way, so this option may refer to a more recent version in the future.

See Section “Controlling the Archive Format” in GNU Tar, for further discussion about tar formats.

configure knows several ways to construct these formats. It will not abort if it cannot find a tool up to the task (so that the package can still be built), but ‘make dist’ will fail.

version

A version number (e.g., ‘0.30’) can be specified. If Automake is not newer than the version specified, creation of the Makefile.in will be suppressed.
-Wcategory or --warnings=category

These options behave exactly like their command-line counterpart (see Chapter 5 [automake Invocation], page 26). This allows you to enable or disable some warning categories on a per-file basis. You can also setup some warnings for your entire project; for instance, try ‘AM_INIT_AUTOMAKE([-Wall])’ in your configure.ac.

Unrecognized options are diagnosed by automake.

If you want an option to apply to all the files in the tree, you can use the AM_INIT_AUTOMAKE macro in configure.ac. See Section 6.4 [Macros], page 44.

18 Miscellaneous Rules

There are a few rules and variables that didn’t fit anywhere else.

18.1 Interfacing to etags

Automake will generate rules to generate TAGS files for use with GNU Emacs under some circumstances.

If any C, C++ or Fortran 77 source code or headers are present, then tags and TAGS rules will be generated for the directory. All files listed using the _SOURCES, _HEADERS, and _LISP primaries will be used to generate tags. Note that generated source files that are not distributed must be declared in variables like nodist_noinst_HEADERS or nodistProg_SOURCES or they will be ignored.

A tags rule will be output at the topmost directory of a multi-directory package. When run from this topmost directory, ‘make tags’ will generate a TAGS file that includes by reference all TAGS files from subdirectories.

The tags rule will also be generated if the variable ETAGS_ARGS is defined. This variable is intended for use in directories that contain taggable source that etags does not understand. The user can use the ETAGSFLAGS to pass additional flags to etags; AM_ETAGSFLAGS is also available for use in Makefile.am.

Here is how Automake generates tags for its source, and for nodes in its Texinfo file:

    ETAGS_ARGS = automake.in --lang=none \
      --regex='/^@node[ \t]+\([^,]+\)/\1/ automake.texi

If you add file names to ETAGS_ARGS, you will probably also want to define TAGS_DEPENDENCIES. The contents of this variable are added directly to the dependencies for the tags rule.

Automake also generates a ctags rule that can be used to build vi-style tags files. The variable CTAGS is the name of the program to invoke (by default ctags); CTAGSFLAGS can be used by the user to pass additional flags, and AM_CTAGSFLAGS can be used by the Makefile.am.

Automake will also generate an ID rule that will run mkid on the source. This is only supported on a directory-by-directory basis.

Similarly, the cscope rule will create a list of all the source files in the tree and run cscope to build an inverted index database. The variable CSCOPE is the name of the program to
invoke (by default cscope); CSOPEFLAGS and CSOPE_ARGS can be used by the user to pass additional flags and file names respectively, while AM_CSCOPEFLAGS can be used by the Makefile.am. Note that, currently, the Automake-provided cscope support, when used in a VPATH build, might not work well with non-GNU make implementations (especially with make implementations performing Section “VPATH rewrites” in The Autoconf Manual).

Finally, Automake also emits rules to support the GNU Global Tags program (http://www.gnu.org/software/global/). The GTAGS rule runs Global Tags and puts the result in the top build directory. The variable GTAGS_ARGS holds arguments that are passed to gtags.

18.2 Handling new file extensions

It is sometimes useful to introduce a new implicit rule to handle a file type that Automake does not know about.

For instance, suppose you had a compiler that could compile .foo files to .o files. You would simply define a suffix rule for your language:

```
/foo.o:
  foocc -c -o $@ $<
```

Then you could directly use a .foo file in a _SOURCES variable and expect the correct results:

```
bin_PROGRAMS = doit
doit_SOURCES = doit.foo
```

This was the simpler and more common case. In other cases, you will have to help Automake to figure out which extensions you are defining your suffix rule for. This usually happens when your extension does not start with a dot. Then, all you have to do is to put a list of new suffixes in the SUFFIXES variable before you define your implicit rule.

For instance, the following definition prevents Automake from misinterpreting the ‘.idlC.cpp’ rule as an attempt to transform .idlC files into .cpp files.

```
SUFFIXES = .idl C.cpp
.idlC.cpp:
  # whatever
```

As you may have noted, the SUFFIXES variable behaves like the .SUFFIXES special target of make. You should not touch .SUFFIXES yourself, but use SUFFIXES instead and let Automake generate the suffix list for .SUFFIXES. Any given SUFFIXES go at the start of the generated suffixes list, followed by Automake generated suffixes not already in the list.

19 Include

Automake supports an include directive that can be used to include other Makefile fragments when automake is run. Note that these fragments are read and interpreted by automake, not by make. As with conditionals, make has no idea that include is in use.

There are two forms of include:

```
include $(srcdir)/file
```

Include a fragment that is found relative to the current source directory.
include $(top_srcdir)/file

   Include a fragment that is found relative to the top source directory.

Note that if a fragment is included inside a conditional, then the condition applies to
the entire contents of that fragment.

Makefile fragments included this way are always distributed because they are needed to
rebuild Makefile.in.

20  Conditionals

Automake supports a simple type of conditionals.

These conditionals are not the same as conditionals in GNU Make. Automake conditionals are checked at configure time by the configure script, and affect the translation from Makefile.in to Makefile. They are based on options passed to configure and on results that configure has discovered about the host system. GNU Make conditionals are checked at make time, and are based on variables passed to the make program or defined in the Makefile.

Automake conditionals will work with any make program.

20.1 Usage of Conditionals

Before using a conditional, you must define it by using AM_CONDITIONAL in the
configure.ac file (see Section 6.4 [Macros], page 44).

AM_CONDITIONAL (conditional, condition)  [Macro]

   The conditional name, conditional, should be a simple string starting with a letter
   and containing only letters, digits, and underscores. It must be different from 'TRUE'
   and 'FALSE' that are reserved by Automake.

   The shell condition (suitable for use in a shell if statement) is evaluated when
   configure is run. Note that you must arrange for every AM_CONDITIONAL to be
   invoked every time configure is run. If AM_CONDITIONAL is run conditionally (e.g.,
   in a shell if statement), then the result will confuse automake.

Conditionals typically depend upon options that the user provides to the configure
script. Here is an example of how to write a conditional that is true if the user uses the
--enable-debug option.

   AC_ARG_ENABLE([debug],
     [ --enable-debug  Turn on debugging],
     [case "${enableval}" in
       yes) debug=true ;;
       no) debug=false ;;
       *) AC_MSG_ERROR([bad value ${enableval} for --enable-debug]) ;;
       esac],[debug=false])

AM_CONDITIONAL([DEBUG], [test x$debug = xtrue])

Here is an example of how to use that conditional in Makefile.am:

     if DEBUG
DBG = debug
else
DBG =
endif
noinst_PROGRAMS = $(DBG)

This trivial example could also be handled using EXTRA_PROGRAMS (see Section 8.1.4 [Conditional Programs], page 57).

You may only test a single variable in an if statement, possibly negated using ‘!’ . The else statement may be omitted. Conditionals may be nested to any depth. You may specify an argument to else in which case it must be the negation of the condition used for the current if. Similarly you may specify the condition that is closed on the endif line:

if DEBUG
DBG = debug
else !DEBUG
DBG =
endif !DEBUG

Unbalanced conditions are errors. The if, else, and endif statements should not be indented, i.e., start on column one.

The else branch of the above two examples could be omitted, since assigning the empty string to an otherwise undefined variable makes no difference.

In order to allow access to the condition registered by AM_CONDITIONAL inside configure.ac, and to allow conditional AC_CONFIG_FILES, AM_COND_IF may be used:

AM_COND_IF (conditional, [if-true], [if-false]) [Macro]
If conditional is fulfilled, execute if-true, otherwise execute if-false. If either branch contains AC_CONFIG_FILES, it will cause automake to output the rules for the respective files only for the given condition.

AM_COND_IF macros may be nested when m4 quotation is used properly (see Section “M4 Quotation” in The Autoconf Manual).

Here is an example of how to define a conditional config file:

AM_CONDITIONAL([SHELL_WRAPPER], [test "x$with_wrapper" = xtrue])
AM_COND_IF([SHELL_WRAPPER],
[AC_CONFIG_FILES([wrapper:wrapper.in])])

20.2 Limits of Conditionals
Conditionals should enclose complete statements like variables or rules definitions. Automake cannot deal with conditionals used inside a variable definition, for instance, and is not even able to diagnose this situation. The following example would not work:

# This syntax is not understood by Automake
AM_CPPFLAGS = \
-DFEATURE_A \
if WANT_DEBUG
-DDEBUG \
endif
Chapter 21: Silencing `make`

21 Silencing `make`

21.1 Make is verbose by default

Normally, when executing the set of rules associated with a target, `make` prints each rule before it is executed. This behaviour, while having been in place for a long time, and being even mandated by the POSIX standard, starkly violates the “silence is golden” UNIX principle:

> When a program has nothing interesting or surprising to say, it should say nothing. Well-behaved Unix programs do their jobs unobtrusively, with a minimum of fuss and bother. Silence is golden.

In fact, while such verbosity of `make` can theoretically be useful to track bugs and understand reasons of failures right away, it can also hide warning and error messages from `make`-invoked tools, drowning them in a flood of uninteresting and seldom useful messages, and thus allowing them to go easily undetected.

This problem can be very annoying, especially for developers, who usually know quite well what’s going on behind the scenes, and for whom the verbose output from `make` ends up being mostly noise that hampers the easy detection of potentially important warning messages.

---

Chapter 21: Silencing make

21.2 Standard and generic ways to silence make

Here we describe some common idioms/tricks to obtain a quieter make output, with their relative advantages and drawbacks. In the next section (Section 21.3 [Automake silent-rules Option], page 127) we’ll see how Automake can help in this respect.

- **make** -s
  This simply causes `make` not to print any rule before executing it.
  The -s flag is mandated by POSIX, universally supported, and its purpose and function are easy to understand.
  But it also has its serious limitations too. First of all, it embodies an “all or nothing” strategy, i.e., either everything is silenced, or nothing is; this lack of granularity can sometimes be a fatal flaw. Moreover, when the -s flag is used, the `make` output might turn out to be too much terse; in case of errors, the user won’t be able to easily see what rule or command have caused them, or even, in case of tools with poor error reporting, what the errors were!

- **make >/dev/null || make**
  Apparently, this perfectly obeys the “silence is golden” rule: warnings from stderr are passed through, output reporting is done only in case of error, and in that case it should provide a verbose-enough report to allow an easy determination of the error location and causes.
  However, calling `make` two times in a row might hide errors (especially intermittent ones), or subtly change the expected semantic of the `make` calls — things which can clearly make debugging and error assessment very difficult.

- **make** --no-print-directory
  This is GNU `make` specific. When called with the --no-print-directory option, GNU `make` will disable printing of the working directory by invoked sub-makes (the well-known “Entering/Leaving directory ...” messages). This helps to decrease the verbosity of the output, but experience has shown that it can also often render debugging considerably harder in projects using deeply-nested `make` recursion.
  As an aside, notice that the --no-print-directory option is automatically activated if the -s flag is used.

21.3 How Automake can help in silencing make

The tricks and idioms for silencing `make` described in the previous section can be useful from time to time, but we’ve seen that they all have their serious drawbacks and limitations. That’s why automake provides support for a more advanced and flexible way of obtaining quieter output from make: the silent-rules mode.

To give the gist of what silent-rules can do, here is a simple comparison between a typical `make` output (where silent rules are disabled) and one with silent rules enabled:

```
% cat Makefile.am
bin_PROGRAMS = foo
foo SOURCES = main.c func.c
% cat main.c
int main (void) { return func (); } /* func used undeclared */
```
% cat func.c
int func (void) { int i; return i; } /* i used uninitialized */

The make output is by default very verbose. This causes warnings from the compiler to be somewhat hidden, and not immediate to spot.
% make CFLAGS=-Wall
gcc -DPACKAGE_NAME="foo" -DPACKAGE_TARNAME="foo" ... -DPACKAGE_STRING="foo 1.0" -DPACKAGE_BUGREPORT="" ... -DPACKAGE="foo" -DVERSION="1.0" -I. -Wall -MT main.o -MD -MP -MF .deps/main.Tpo -c -o main.o main.c
main.c: In function 'main':
main.c:3:3: warning: implicit declaration of function 'func'
mv -f .deps/main.Tpo .deps/main.Po
gcc -DPACKAGE_NAME="foo" -DPACKAGE_TARNAME="foo" ... -DPACKAGE_STRING="foo 1.0" -DPACKAGE_BUGREPORT="" ... -DPACKAGE="foo" -DVERSION="1.0" -I. -Wall -MT func.o -MD -MP -MF .deps/func.Tpo -c -o func.o func.c
func.c: In function 'func':
func.c:4:3: warning: 'i' used uninitialized in this function
mv -f .deps/func.Tpo .deps/func.Po
gcc -Wall -o foo main.o func.o

Clean up, so that we we can rebuild everything from scratch.
% make clean
test -z "foo" || rm -f foo
rm -f *.o

Silent rules enabled: the output is minimal but informative. In particular, the warnings from the compiler stick out very clearly.
% make V=0 CFLAGS=-Wall
CC main.o
main.c: In function 'main':
main.c:3:3: warning: implicit declaration of function 'func'
CC func.o
func.c: In function 'func':
func.c:4:3: warning: 'i' used uninitialized in this function
CCLD foo

Also, in projects using libtool, the use of silent rules can automatically enable the libtool's --silent option:
% cat Makefile.am
lib_LTLIBRARIES = libx.la

% make # Both make and libtool are verbose by default.
...
libtool: compile: gcc -DPACKAGE_NAME="foo" ... -DLT_OBJDIR=".libs/" -I. -g -O2 -MT libx.lo -MD -MP -MF .deps/libx.Tpo -c libx.c -fPIC
Let's now see how the silent-rules mode interfaces with the package developer and the package user.

To enable the use of silent-rules in his package, a developer needs to do either of the following:

- Add the silent-rules option as argument to AM_INIT_AUTOMAKE.
- Call the AM_SILENT_RULES macro from within the configure.ac file.

It is not possible to instead specify silent-rules in a Makefile.am file.

If the developer has done either of the above, then the user of the package may influence the verbosity at configure run time as well as at make run time:

- Passing --enable-silent-rules to configure will cause build rules to be less verbose; the option --disable-silent-rules will cause normal verbose output.
- At make run time, the default chosen at configure time may be overridden: make V=1 will produce verbose output, make V=0 less verbose output.

Note that silent rules are disabled by default; the user must enable them explicitly at either configure run time or at make run time. We think that this is a good policy, since it provides the casual user with enough information to prepare a good bug report in case anything breaks.

Still, notwithstanding the rationales above, a developer who wants to make silent rules enabled by default in his own package can do so by adding a 'yes' argument to the AM_SILENT_RULES call in configure.ac. We advise against this approach, though.

Users who prefer to have silent rules enabled by default can edit their config.site file to make the variable enable_silent_rules default to 'yes'. This should still allow disabling silent rules at configure time and at make time.

For portability to different make implementations, package authors are advised to not set the variable V inside the Makefile.am file, to allow the user to override the value for subdirectories as well.

The current implementation of this feature normally uses nested variable expansion '$(var1$(V))', a Makefile feature that is not required by POSIX 2008 but is widely supported in practice. The silent-rules option thus turns off warnings about recursive variable expansion, which are in turn enabled by -Wportability (see Chapter 5 [automake Invocation], page 26). On the rare make implementations that do not support nested variable expansion, whether rules are silent is always determined at configure time, and cannot
be overridden at make time. Future versions of POSIX are likely to require nested variable expansion, so this minor limitation should go away with time.

To extend the silent mode to your own rules, you have few choices:

- You can use the predefined variable \texttt{AM\_V\_GEN} as a prefix to commands that should output a status line in silent mode, and \texttt{AM\_V\_at} as a prefix to commands that should not output anything in silent mode. When output is to be verbose, both of these variables will expand to the empty string.

- You can silence a recipe unconditionally with \texttt{@}, and then use the predefined variable \texttt{AM\_V\_P} to know whether make is being run in silent or verbose mode, adjust the verbose information your recipe displays accordingly:

  ```
  generate-headers:
  ... [commands defining a shell variable '[$headers']] ...;
  if $(AM\_V\_P); then set -x; else echo " GEN [headers]"; fi;
  rm -f $$headers & & \texttt{generate-header flags $$headers}
  ```

- You can add your own variables, so strings of your own choice are shown. The following snippet shows how you would define your own equivalent of \texttt{AM\_V\_GEN}:

  ```
  pkg\_verbose = $(pkg\_verbose_@AM\_V@)
  pkg\_verbose_ = $(pkg\_verbose_@AM\_DEFAULT\_V@)
  pkg\_verbose_0 = @echo PKG-GEN $@

  foo: foo.in
  $(pkg\_verbose)cp $(srcdir)/foo.in $@
  ```

  As a final note, observe that, even when silent rules are enabled, the \texttt{--no-print-directory} option is still required with GNU \texttt{make} if the “Entering/Leaving directory ...” messages are to be disabled.

22 The effect of \texttt{--gnu} and \texttt{--gnits}

The \texttt{--gnu} option (or \texttt{gnu} in the \texttt{AUTOMAKE\_OPTIONS} variable) causes \texttt{automake} to check the following:

- The files \texttt{INSTALL}, \texttt{NEWS}, \texttt{README}, \texttt{AUTHORS}, and \texttt{ChangeLog}, plus one of \texttt{COPYING\_LIB}, \texttt{COPYING\_LESSER} or \texttt{COPYING}, are required at the topmost directory of the package.

  If the \texttt{--add-missing} option is given, \texttt{automake} will add a generic version of the \texttt{INSTALL} file as well as the \texttt{COPYING} file containing the text of the current version of the GNU General Public License existing at the time of this Automake release (version 3 as this is written, \url{http://www.gnu.org/copyleft/gpl.html}). However, an existing \texttt{COPYING} file will never be overwritten by \texttt{automake}.

- The options \texttt{no-installman} and \texttt{no-installinfo} are prohibited.

  Note that this option will be extended in the future to do even more checking; it is advisable to be familiar with the precise requirements of the GNU standards. Also, \texttt{--gnu} can require certain non-standard GNU programs to exist for use by various maintainer-only rules; for instance, in the future \texttt{pathchk} might be required for `\texttt{make dist}`.
The --gnits option does everything that --gnu does, and checks the following as well:

- 'make installcheck' will check to make sure that the --help and --version really print a usage message and a version string, respectively. This is the std-options option (see Chapter 17 [Options], page 117).
- 'make dist' will check to make sure the NEWS file has been updated to the current version.
- VERSION is checked to make sure its format complies with Gnits standards.
- If VERSION indicates that this is an alpha release, and the file README-alpha appears in the topmost directory of a package, then it is included in the distribution. This is done in --gnits mode, and no other, because this mode is the only one where version number formats are constrained, and hence the only mode where Automake can automatically determine whether README-alpha should be included.
- The file THANKS is required.

## 23 The effect of --cygnus

The features described in this section are deprecated; you must not use any of them in new code, and should remove their use from older but still maintained code: they will be withdrawn the next major Automake release (1.13).

Some packages, notably GNU GCC and GNU gdb, used to have a build environment originally written at Cygnus Support (subsequently renamed Cygnus Solutions, and then later purchased by Red Hat). Packages with this ancestry are sometimes referred to as “Cygnus” trees.

A Cygnus tree has slightly different rules for how a Makefile.in is to be constructed. Passing --cygnus to automake will cause any generated Makefile.in to comply with Cygnus rules.

Here are the precise effects of --cygnus:

- The foreign strictness is implied.
- The options no-installinfo, no-dependencies and no-dist are implied (see Chapter 17 [Options], page 117).
- The macro AM_MAINTAINER_MODE is required.
- Info files are always created in the build directory, and not in the source directory. Packages that don’t use the cygnus option can emulate this effect by using the no-installinfo option and listing the generated info files in the CLEANFILES variable.
- texinfo.tex is not required if a Texinfo source file is specified. The assumption is that the file will be supplied, but in a place that Automake cannot find – it is an artifact of how Cygnus packages are typically bundled. This effect can be emulated in packages not using the cygnus option with a proper definition of the TEXPINFO_TEX variable (see Section 11.1 [Texinfo], page 91).
- Certain tools will be searched for in the build tree as well as in the user’s PATH. These tools are runtest, expect, makeinfo and texi2dvi.
- The check target doesn’t depend on all.
24 When Automake Isn’t Enough

In some situations, where Automake is not up to one task, one has to resort to handwritten rules or even handwritten Makefiles.

24.1 Extending Automake Rules

With some minor exceptions (for example _PROGRAMS variables, TESTS, or XFAIL_TESTS) being rewritten to append ‘$(EXEEXT)’), the contents of a Makefile.am is copied to Makefile.in verbatim.

These copying semantics mean that many problems can be worked around by simply adding some make variables and rules to Makefile.am. Automake will ignore these additions.

Since a Makefile.in is built from data gathered from three different places (Makefile.am, configure.ac, and automake itself), it is possible to have conflicting definitions of rules or variables. When building Makefile.in the following priorities are respected by automake to ensure the user always has the last word:

- User defined variables in Makefile.am have priority over variables AC_SUBSTed from configure.ac, and AC_SUBSTed variables have priority over automake-defined variables.

- As far as rules are concerned, a user-defined rule overrides any automake-defined rule for the same target.

These overriding semantics make it possible to fine tune some default settings of Automake, or replace some of its rules. Overriding Automake rules is often inadvisable, particularly in the topmost directory of a package with subdirectories. The -Woverride option (see Chapter 5 [automake Invocation], page 26) comes in handy to catch overridden definitions.

Note that Automake does not make any distinction between rules with commands and rules that only specify dependencies. So it is not possible to append new dependencies to an automake-defined target without redefining the entire rule.

However, various useful targets have a ‘-local’ version you can specify in your Makefile.am. Automake will supplement the standard target with these user-supplied targets.

The targets that support a local version are all, info, dvi, ps, pdf, html, check, install-data, install-dvi, install-exec, install-html, install-info, install-pdf, install-ps, uninstall, installdirs, installcheck and the various clean targets (mostlyclean, clean, distclean, and maintainer-clean).

Note that there are no uninstall-exec-local or uninstall-data-local targets; just use uninstall-local. It doesn’t make sense to uninstall just data or just executables.

For instance, here is one way to erase a subdirectory during ‘make clean’ (see Chapter 13 [Clean], page 96).

    clean-local:
      -rm -rf testSubDir

You may be tempted to use install-data-local to install a file to some hard-coded location, but you should avoid this (see Section 28.10 [Hard-Coded Install Paths], page 154).
With the `-local` targets, there is no particular guarantee of execution order; typically, they are run early, but with parallel make, there is no way to be sure of that.

In contrast, some rules also have a way to run another rule, called a `hook`; hooks are always executed after the main rule's work is done. The hook is named after the principal target, with `-'hook' appended. The targets allowing hooks are `install-data`, `install-exec`, `uninstall`, `dist`, and `distcheck`.

For instance, here is how to create a hard link to an installed program:

```bash
install-exec-hook:
    ln $(DESTDIR)$(bindir)/program$(EXEEXT) \
         $(DESTDIR)$(bindir)/proglink$(EXEEXT)
```

Although cheaper and more portable than symbolic links, hard links will not work everywhere (for instance, OS/2 does not have `ln`). Ideally you should fall back to `cp -p` when `ln` does not work. An easy way, if symbolic links are acceptable to you, is to add `AC_PROG_LN_S` to `configure.ac` (see Section “Particular Program Checks” in *The Autoconf Manual*) and use `$(LN_S)` in `Makefile.am`.

For instance, here is how you could install a versioned copy of a program using `$(LN_S)`:

```bash
install-exec-hook:
    cd $(DESTDIR)$(bindir) && \
    mv -f prog$(EXEEXT) prog-$(VERSION)$(EXEEXT) && \
    $(LN_S) prog-$(VERSION)$(EXEEXT) prog$(EXEEXT)
```

Note that we rename the program so that a new version will erase the symbolic link, not the real binary. Also we `cd` into the destination directory in order to create relative links.

When writing `install-exec-hook` or `install-data-hook`, please bear in mind that the exec/data distinction is based on the installation directory, not on the primary used (see Section 12.2 [The Two Parts of Install], page 95). So a `foo_SCRIPTS` will be installed by `install-data`, and a `barexec_SCRIPTS` will be installed by `install-exec`. You should define your hooks consequently.

### 24.2 Third-Party Makefiles

In most projects all `Makefiles` are generated by Automake. In some cases, however, projects need to embed subdirectories with handwritten `Makefiles`. For instance, one subdirectory could be a third-party project with its own build system, not using Automake.

It is possible to list arbitrary directories in `SUBDIRS` or `DIST_SUBDIRS` provided each of these directories has a `Makefile` that recognizes all the following recursive targets.

When a user runs one of these targets, that target is run recursively in all subdirectories. This is why it is important that even third-party `Makefiles` support them.

```bash
all          Compile the entire package. This is the default target in Automake-generated `Makefiles`, but it does not need to be the default in third-party `Makefiles`.

distdir     Copy files to distribute into `$(distdir)`, before a tarball is constructed. Of course this target is not required if the `no-dist` option (see Chapter 17 [Options], page 117) is used.

The variables `$(top_distdir)` and `$(distdir)` (see Section 14.3 [The dist Hook], page 98) will be passed from the outer package to the subpackage when
the distdir target is invoked. These two variables have been adjusted for the
directory that is being recursed into, so they are ready to use.

install
install-data
install-exec
uninstall
    Install or uninstall files (see Chapter 12 [Install], page 94).

install-dvi
install-html
install-info
install-ps
install-pdf
    Install only some specific documentation format (see Section 11.1 [Texinfo],
    page 91).

installdirs
    Create install directories, but do not install any files.

check
installcheck
    Check the package (see Chapter 15 [Tests], page 101).

mostlyclean
clean
distclean
maintainer-clean
    Cleaning rules (see Chapter 13 [Clean], page 96).

dvi
pdf
ps
info
html
    Build the documentation in various formats (see Section 11.1 [Texinfo],
    page 91).
tags
ctags
    Build TAGS and CTAGS (see Section 18.1 [Tags], page 122).

If you have ever used Gettext in a project, this is a good example of how third-party
Makefiles can be used with Automake. The Makefiles gettextize puts in the po/ and
intl/ directories are handwritten Makefiles that implement all of these targets. That way
they can be added to SUBDIRS in Automake packages.

Directories that are only listed in DIST_SUBDIRS but not in SUBDIRS need only the
distclean, maintainer-clean, and distdir rules (see Section 7.2 [Conditional Subdi-
rectories], page 48).

Usually, many of these rules are irrelevant to the third-party subproject, but they are
required for the whole package to work. It’s OK to have a rule that does nothing, so if
you are integrating a third-party project with no documentation or tag support, you could
simply augment its Makefile as follows:

    EMPTY_AUTOMAKE_TARGETS = dvi pdf ps info html tags ctags
Another aspect of integrating third-party build systems is whether they support VPATH builds (see Section 2.2.6 [VPATH Builds], page 6). Obviously if the subpackage does not support VPATH builds the whole package will not support VPATH builds. This in turns means that `make distcheck` will not work, because it relies on VPATH builds. Some people can live without this (actually, many Automake users have never heard of `make distcheck`). Other people may prefer to revamp the existing Makefiles to support VPATH. Doing so does not necessarily require Automake, only Autoconf is needed (see Section “Build Directories” in The Autoconf Manual). The necessary substitutions: `@srcdir@`, `@top_srcdir@`, and `@top_builddir@` are defined by configure when it processes a Makefile (see Section “Preset Output Variables” in The Autoconf Manual), they are not computed by the Makefile like the aforementioned `$(_distdir)` and `$(top_distdir)` variables.

It is sometimes inconvenient to modify a third-party Makefile to introduce the above required targets. For instance, one may want to keep the third-party sources untouched to ease upgrades to new versions.

Here are two other ideas. If GNU make is assumed, one possibility is to add to that subdirectory a GNUmakefile that defines the required targets and includes the third-party Makefile. For this to work in VPATH builds, GNUmakefile must lie in the build directory; the easiest way to do this is to write a GNUmakefile.in instead, and have it processed with `AC_CONFIG_FILES` from the outer package. For example if we assume Makefile defines all targets except the documentation targets, and that the check target is actually called test, we could write GNUmakefile (or GNUmakefile.in) like this:

```makefile
# First, include the real Makefile
include Makefile

# Then, define the other targets needed by Automake Makefiles.
.PHONY: dvi pdf ps info html check
dvi pdf ps info html:
check: test
```

A similar idea that does not use include is to write a proxy Makefile that dispatches rules to the real Makefile, either with `$(MAKE) -f Makefile.real $(AM_MAKEFLAGS) target` (if it’s OK to rename the original Makefile) or with `cd subdir && $(MAKE) $(AM_MAKEFLAGS) target` (if it’s OK to store the subdirectory project one directory deeper). The good news is that this proxy Makefile can be generated with Automake. All we need are -local targets (see Section 24.1 [Extending], page 132) that perform the dispatch. Of course the other Automake features are available, so you could decide to let Automake perform distribution or installation. Here is a possible Makefile.am:

```makefile
all-local:
    cd subdir && $(MAKE) $(AM_MAKEFLAGS) all
check-local:
    cd subdir && $(MAKE) $(AM_MAKEFLAGS) test
clean-local:
    cd subdir && $(MAKE) $(AM_MAKEFLAGS) clean
```

# Assuming the package knows how to install itself
install-data-local:
  cd subdir && $(MAKE) $(AM_MAKEFLAGS) install-data
install-exec-local:
  cd subdir && $(MAKE) $(AM_MAKEFLAGS) install-exec
uninstall-local:
  cd subdir && $(MAKE) $(AM_MAKEFLAGS) uninstall

# Distribute files from here.
EXTRA_DIST = subdir/Makefile subdir/program.c ...

Pushing this idea to the extreme, it is also possible to ignore the subproject build system and build everything from this proxy Makefile.am. This might sound very sensible if you need VPATH builds but the subproject does not support them.

25 Distributing Makefile.ins

Automake places no restrictions on the distribution of the resulting Makefile.ins. We still encourage software authors to distribute their work under terms like those of the GPL, but doing so is not required to use Automake.

Some of the files that can be automatically installed via the --add-missing switch do fall under the GPL. However, these also have a special exception allowing you to distribute them with your package, regardless of the licensing you choose.

26 Automake API Versioning

New Automake releases usually include bug fixes and new features. Unfortunately they may also introduce new bugs and incompatibilities. This makes four reasons why a package may require a particular Automake version.

Things get worse when maintaining a large tree of packages, each one requiring a different version of Automake. In the past, this meant that any developer (and sometimes users) had to install several versions of Automake in different places, and switch `$PATH' appropriately for each package.

Starting with version 1.6, Automake installs versioned binaries. This means you can install several versions of Automake in the same `$prefix', and can select an arbitrary Automake version by running automake-1.6 or automake-1.7 without juggling with `$PATH'. Furthermore, Makefile's generated by Automake 1.6 will use automake-1.6 explicitly in their rebuild rules.

The number '1.6' in automake-1.6 is Automake's API version, not Automake's version. If a bug fix release is made, for instance Automake 1.6.1, the API version will remain 1.6. This means that a package that works with Automake 1.6 should also work with 1.6.1; after all, this is what people expect from bug fix releases.

If your package relies on a feature or a bug fix introduced in a release, you can pass this version as an option to Automake to ensure older releases will not be used. For instance, use this in your configure.ac:

```
AM_INIT_AUTOMAKE([1.6.1])  dnl Require Automake 1.6.1 or better.
```
or, in a particular Makefile.am:

```
AUTOMAKE_OPTIONS = 1.6.1  # Require Automake 1.6.1 or better.
```

Automake will print an error message if its version is older than the requested version.

### What is in the API

Automake’s programming interface is not easy to define. Basically it should include at least all documented variables and targets that a Makefile.am author can use, any behavior associated with them (e.g., the places where ‘-hook’‘s are run), the command line interface of automake and aclocal, ...

### What is not in the API

Every undocumented variable, target, or command line option, is not part of the API. You should avoid using them, as they could change from one version to the other (even in bug fix releases, if this helps to fix a bug).

If it turns out you need to use such an undocumented feature, contact automake@gnu.org and try to get it documented and exercised by the test-suite.

## 27 Upgrading a Package to a Newer Automake Version

Automake maintains three kind of files in a package.

- `aclocal.m4`
- `Makefile.in`
- auxiliary tools like `install-sh` or `py-compile`

`aclocal.m4` is generated by `aclocal` and contains some Automake-supplied M4 macros. Auxiliary tools are installed by `automake --add-missing` when needed. `Makefile.ins` are built from `Makefile.am` by `automake`, and rely on the definitions of the M4 macros put in `aclocal.m4` as well as the behavior of the auxiliary tools installed.

Because all of these files are closely related, it is important to regenerate all of them when upgrading to a newer Automake release. The usual way to do that is

```
aclocal # with any option needed (such a -I m4)
autoconf
automake --add-missing --force-missing
```

or more conveniently:

```
autoreconf --vfi
```

The use of `--force-missing` ensures that auxiliary tools will be overridden by new versions (see Chapter 5 [automake Invocation], page 26).

It is important to regenerate all of these files each time Automake is upgraded, even between bug fixes releases. For instance, it is not unusual for a bug fix to involve changes to both the rules generated in `Makefile.in` and the supporting M4 macros copied to `aclocal.m4`. 
Presently `automake` is able to diagnose situations where `aclocal.m4` has been generated with another version of `aclocal`. However it never checks whether auxiliary scripts are up-to-date. In other words, `automake` will tell you when `aclocal` needs to be rerun, but it will never diagnose a missing `--force-missing`.

Before upgrading to a new major release, it is a good idea to read the file `NEWS`. This file lists all changes between releases: new features, obsolete constructs, known incompatibilities, and workarounds.

### 28 Frequently Asked Questions about Automake

This chapter covers some questions that often come up on the mailing lists.

#### 28.1 CVS and generated files

**Background: distributed generated Files**

Packages made with Autoconf and Automake ship with some generated files like `configure` or `Makefile.in`. These files were generated on the developer's host and are distributed so that end-users do not have to install the maintainer tools required to rebuild them. Other generated files like Lex scanners, Yacc parsers, or Info documentation, are usually distributed on similar grounds.

Automake outputs rules in `Makefiles` to rebuild these files. For instance, `make` will run `autoconf` to rebuild `configure` whenever `configure.ac` is changed. This makes development safer by ensuring a `configure` is never out-of-date with respect to `configure.ac`.

As generated files shipped in packages are up-to-date, and because `tar` preserves timestamps, these rebuild rules are not triggered when a user unpacks and builds a package.

**Background: CVS and Timestamps**

Unless you use CVS keywords (in which case files must be updated at commit time), CVS preserves timestamp during `cvs commit` and `cvs import -d` operations.

When you check out a file using `cvs checkout` its timestamp is set to that of the revision that is being checked out.

However, during `cvs update`, files will have the date of the update, not the original timestamp of this revision. This is meant to make sure that `make` notices sources files have been updated.

This timestamp shift is troublesome when both sources and generated files are kept under CVS. Because CVS processes files in lexical order, `configure.ac` will appear newer than `configure` after a `cvs update` that updates both files, even if `configure` was newer than `configure.ac` when it was checked in. Calling `make` will then trigger a spurious rebuild of `configure`.

**Living with CVS in Autoconfiscated Projects**

There are basically two clans amongst maintainers: those who keep all distributed files under CVS, including generated files, and those who keep generated files `out` of CVS.
All Files in CVS

- The CVS repository contains all distributed files so you know exactly what is distributed, and you can checkout any prior version entirely.
- Maintainers can see how generated files evolve (for instance, you can see what happens to your `Makefile.in` when you upgrade Automake and make sure they look OK).
- Users do not need the autotools to build a checkout of the project, it works just like a released tarball.
- If users use `cvs update` to update their copy, instead of `cvs checkout` to fetch a fresh one, timestamps will be inaccurate. Some rebuild rules will be triggered and attempt to run developer tools such as `autoconf` or `automake`.

Actually, calls to such tools are all wrapped into a call to the `missing` script discussed later (see Section 28.2 [maintainer-mode], page 140). `missing` will take care of fixing the timestamps when these tools are not installed, so that the build can continue.

- In distributed development, developers are likely to have different version of the maintainer tools installed. In this case rebuilds triggered by timestamp lossage will lead to spurious changes to generated files. There are several solutions to this:
  - All developers should use the same versions, so that the rebuilt files are identical to files in CVS. (This starts to be difficult when each project you work on uses different versions.)
  - Or people use a script to fix the timestamp after a checkout (the GCC folks have such a script).
  - Or `configure.ac` uses `AM_MAINTAINER_MODE`, which will disable all of these rebuild rules by default. This is further discussed in Section 28.2 [maintainer-mode], page 140.
- Although we focused on spurious rebuilds, the converse can also happen. CVS’s timestamp handling can also let you think an out-of-date file is up-to-date.

For instance, suppose a developer has modified `Makefile.am` and has rebuilt `Makefile.in`, and then decides to do a last-minute change to `Makefile.am` right before checking in both files (without rebuilding `Makefile.in` to account for the change).

This last change to `Makefile.am` makes the copy of `Makefile.in` out-of-date. Since CVS processes files alphabetically, when another developer `cvs update`s his or her tree, `Makefile.in` will happen to be newer than `Makefile.am`. This other developer will not see that `Makefile.in` is out-of-date.

Generated Files out of CVS

One way to get CVS and `make` working peacefully is to never store generated files in CVS, i.e., do not CVS-control files that are `Makefile` targets (also called derived files).

This way developers are not annoyed by changes to generated files. It does not matter if they all have different versions (assuming they are compatible, of course). And finally, timestamps are not lost, changes to sources files can’t be missed as in the `Makefile.am/Makefile.in` example discussed earlier.
The drawback is that the CVS repository is not an exact copy of what is distributed and that users now need to install various development tools (maybe even specific versions) before they can build a checkout. But, after all, CVS's job is versioning, not distribution.

Allowing developers to use different versions of their tools can also hide bugs during distributed development. Indeed, developers will be using (hence testing) their own generated files, instead of the generated files that will be released actually. The developer who prepares the tarball might be using a version of the tool that produces bogus output (for instance a non-portable C file), something other developers could have noticed if they weren’t using their own versions of this tool.

Third-party Files

Another class of files not discussed here (because they do not cause timestamp issues) are files that are shipped with a package, but maintained elsewhere. For instance, tools like gettextize and autopoint (from Gettext) or libtoolize (from Libtool), will install or update files in your package.

These files, whether they are kept under CVS or not, raise similar concerns about version mismatch between developers’ tools. The Gettext manual has a section about this, see Section “Integrating with CVS” in GNU gettext tools.

28.2 missing and AM_MAINTAINER_MODE

missing

The missing script is a wrapper around several maintainer tools, designed to warn users if a maintainer tool is required but missing. Typical maintainer tools are autoconf, automake, bison, etc. Because file generated by these tools are shipped with the other sources of a package, these tools shouldn’t be required during a user build and they are not checked for in configure.

However, if for some reason a rebuild rule is triggered and involves a missing tool, missing will notice it and warn the user. Besides the warning, when a tool is missing, missing will attempt to fix timestamps in a way that allows the build to continue. For instance, missing will touch configure if autoconf is not installed. When all distributed files are kept under version control, this feature of missing allows a user with no maintainer tools to build a package off its version control repository, bypassing any timestamp inconsistency (implied by e.g. ‘cvs update’ or ‘git clone’).

If the required tool is installed, missing will run it and won’t attempt to continue after failures. This is correct during development: developers love fixing failures. However, users with wrong versions of maintainer tools may get an error when the rebuild rule is spuriously triggered, halting the build. This failure to let the build continue is one of the arguments of the AM_MAINTAINER_MODE advocates.

AM_MAINTAINER_MODE

AM_MAINTAINER_MODE allows you to choose whether the so called "rebuild rules" should be enabled or disabled. With AM_MAINTAINER_MODE([enable]), they are enabled by default, otherwise they are disabled by default. In the latter case, if you have AM_MAINTAINER_MODE in configure.ac, and run './configure && make', then make will *never* attempt to
rebuild configure, Makefile.in, Lex or Yacc outputs, etc. I.e., this disables build rules
for files that are usually distributed and that users should normally not have to update.

The user can override the default setting by passing either ‘--enable-maintainer-mode’
or ‘--disable-maintainer-mode’ to configure.

People use AM_MAINTAINER_MODE either because they do not want their users (or them-
selves) annoyed by timestamps lossage (see Section 28.1 [CVS], page 138), or because they
simply can’t stand the rebuild rules and prefer running maintainer tools explicitly.

AM_MAINTAINER_MODE also allows you to disable some custom build rules conditionally.
Some developers use this feature to disable rules that need exotic tools that users may not
have available.

Several years ago François Pinard pointed out several arguments against this
AM_MAINTAINER_MODE macro. Most of them relate to insecurity. By removing dependencies
you get non-dependable builds: changes to sources files can have no effect on generated
files and this can be very confusing when unnoticed. He adds that security shouldn’t be
reserved to maintainers (what --enable-maintainer-mode suggests), on the contrary. If
one user has to modify a Makefile.am, then either Makefile.in should be updated or a
warning should be output (this is what Automake uses missing for) but the last thing you
want is that nothing happens and the user doesn’t notice it (this is what happens when
rebuild rules are disabled by AM_MAINTAINER_MODE).

Jim Meyering, the inventor of the AM_MAINTAINER_MODE macro was swayed by François’s
arguments, and got rid of AM_MAINTAINER_MODE in all of his packages.

Still many people continue to use AM_MAINTAINER_MODE, because it helps them working
on projects where all files are kept under version control, and because missing isn’t enough
if you have the wrong version of the tools.

28.3 Why doesn’t Automake support wildcards?

Developers are lazy. They would often like to use wildcards in Makefile.ams, so that
they would not need to remember to update Makefile.ams every time they add, delete, or
rename a file.

There are several objections to this:

• When using CVS (or similar) developers need to remember they have to run ‘cvs add’
or ‘cvs rm’ anyway. Updating Makefile.am accordingly quickly becomes a reflex.
Conversely, if your application doesn’t compile because you forgot to add a file in
Makefile.am, it will help you remember to ‘cvs add’ it.

• Using wildcards makes it easy to distribute files by mistake. For instance, some code
a developer is experimenting with (a test case, say) that should not be part of the
distribution.

• Using wildcards it’s easy to omit some files by mistake. For instance, one developer
creates a new file, uses it in many places, but forgets to commit it. Another developer
then checks out the incomplete project and is able to run ‘make dist’ successfully, even
though a file is missing. By listing files, ‘make dist’ will complain.

• Wildcards are not portable to some non-GNU make implementations, e.g., NetBSD
make will not expand globs such as ‘*’ in prerequisites of a target.
Finally, it’s really hard to forget to add a file to `Makefile.am`: files that are not listed in `Makefile.am` are not compiled or installed, so you can’t even test them.

Still, these are philosophical objections, and as such you may disagree, or find enough value in wildcards to dismiss all of them. Before you start writing a patch against Automake to teach it about wildcards, let’s see the main technical issue: portability.

Although `$(wildcard ...)’ works with GNU `make`, it is not portable to other `make` implementations.

The only way Automake could support `$(wildcard ...)’ is by expending `$(wildcard ...)’ when `automake` is run. The resulting `Makefile.ins` would be portable since they would list all files and not use `$(wildcard ...)’.

Compared to editing `Makefile.am`, this is a very small gain. Sure, it’s easier and faster to type `automake; make` than to type `emacs Makefile.am; make`. But nobody bothered enough to write a patch to add support for this syntax. Some people use scripts to generate file lists in `Makefile.am` or in separate `Makefile` fragments.

Even if you don’t care about portability, and are tempted to use `$(wildcard ...)’ anyway because you target only GNU Make, you should know there are many places where Automake needs to know exactly which files should be processed. As Automake doesn’t know how to expand `$(wildcard ...)’, you cannot use it in these places. `$(wildcard ...)’ is a black box comparable to `AC_SUBST`ed variables as far Automake is concerned.

You can get warnings about `$(wildcard ...)’ constructs using the `-Wportability` flag.

### 28.4 Limitations on File Names

Automake attempts to support all kinds of file names, even those that contain unusual characters or are unusually long. However, some limitations are imposed by the underlying operating system and tools.

Most operating systems prohibit the use of the null byte in file names, and reserve ‘/’ as a directory separator. Also, they require that file names are properly encoded for the user’s locale. Automake is subject to these limits.

Portable packages should limit themselves to POSIX file names. These can contain ASCII letters and digits, ‘_’, ‘.’, and ‘-’. File names consist of components separated by ‘/’. File name components cannot begin with ‘-’.

Portable POSIX file names cannot contain components that exceed a 14-byte limit, but nowadays it’s normally safe to assume the more-generous XOPEN limit of 255 bytes. POSIX limits file names to 255 bytes (XOPEN allows 1023 bytes), but you may want to limit a source tarball to file names of 99 bytes to avoid interoperability problems with old versions of `tar`.

If you depart from these rules (e.g., by using non-ASCII characters in file names, or by using lengthy file names), your installers may have problems for reasons unrelated to Automake. However, if this does not concern you, you should know about the limitations imposed by Automake itself. These limitations are undesirable, but some of them seem to be inherent to underlying tools like Autoconf, Make, M4, and the shell. They fall into three categories: install directories, build directories, and file names.
The following characters:

newline " # $ ' '\n
should not appear in the names of install directories. For example, the operand of configure's --prefix option should not contain these characters.

Build directories suffer the same limitations as install directories, and in addition should not contain the following characters:

& @ \n
For example, the full name of the directory containing the source files should not contain these characters.

Source and installation file names like main.c are limited even further: they should conform to the POSIX/XOPEN rules described above. In addition, if you plan to port to non-POSIX environments, you should avoid file names that differ only in case (e.g., makefile and Makefile). Nowadays it is no longer worth worrying about the 8.3 limits of DOS file systems.

### 28.5 Errors with distclean

This is a diagnostic you might encounter while running `make distcheck`.

As explained in Section 14.4 [Checking the Distribution], page 99, `make distcheck` attempts to build and check your package for errors like this one.

`make distcheck` will perform a VPATH build of your package (see Section 2.2.6 [VPATH Builds], page 6), and then call `make distclean`. Files left in the build directory after `make distclean` has run are listed after this error.

This diagnostic really covers two kinds of errors:

- files that are forgotten by distclean;
- distributed files that are erroneously rebuilt.

The former left-over files are not distributed, so the fix is to mark them for cleaning (see Chapter 13 [Clean], page 96), this is obvious and doesn’t deserve more explanations.

The latter bug is not always easy to understand and fix, so let’s proceed with an example. Suppose our package contains a program for which we want to build a man page using help2man. GNU help2man produces simple manual pages from the --help and --version output of other commands (see Section “Overview” in The Help2man Manual). Because we don’t want to force our users to install help2man, we decide to distribute the generated man page using the following setup.

```
# This Makefile.am is bogus.
bin_PROGRAMS = foo
foo_SOURCES = foo.c
dist_man_MANS = foo.1

foo.1: foo$(EXEEXT)
    help2man --output=foo.1 ./foo$(EXEEXT)
```

This will effectively distribute the man page. However, `make distcheck` will fail with:

ERROR: files left in build directory after distclean:
Why was \texttt{foo.1} rebuilt? Because although distributed, \texttt{foo.1} depends on a non-distributed built file: \texttt{foo$(EXEEXT)$}. \texttt{foo$(EXEEXT)$} is built by the user, so it will always appear to be newer than the distributed \texttt{foo.1}.

\texttt{make distcheck}' caught an inconsistency in our package. Our intent was to distribute \texttt{foo.1} so users do not need to install \texttt{help2man}, however since this rule causes this file to be always rebuilt, users \textit{do} need \texttt{help2man}. Either we should ensure that \texttt{foo.1} is not rebuilt by users, or there is no point in distributing \texttt{foo.1}.

More generally, the rule is that distributed files should never depend on non-distributed built files. If you distribute something generated, distribute its sources.

One way to fix the above example, while still distributing \texttt{foo.1} is to not depend on \texttt{foo$(EXEEXT)$}. For instance, assuming \texttt{foo --version} and \texttt{foo --help} do not change unless \texttt{foo.c} or \texttt{configure.ac} change, we could write the following \texttt{Makefile.am}:

\begin{verbatim}
bin_PROGRAMS = foo
foo_SOURCES = foo.c
dist_man_MANS = foo.1

foo.1: foo.c $(top_srcdir)/configure.ac
    $(MAKE) $(AM_MAKEFLAGS) foo$(EXEEXT)
    $(MAKE) $(AM_MAKEFLAGS) help2man --output=foo.1 ./foo$(EXEEXT)
\end{verbatim}

This way, \texttt{foo.1} will not get rebuilt every time \texttt{foo$(EXEEXT)$} changes. The \texttt{make} call makes sure \texttt{foo$(EXEEXT)$} is up-to-date before \texttt{help2man}. Another way to ensure this would be to use separate directories for binaries and man pages, and set \texttt{SUBDIRS} so that binaries are built before man pages.

We could also decide not to distribute \texttt{foo.1}. In this case it’s fine to have \texttt{foo.1} dependent upon \texttt{foo$(EXEEXT)$}, since both will have to be rebuilt. However it would be impossible to build the package in a cross-compilation, because building \texttt{foo.1} involves an \texttt{execution} of \texttt{foo$(EXEEXT)$}.

Another context where such errors are common is when distributed files are built by tools that are built by the package. The pattern is similar:

\begin{verbatim}
distributed-file: built-tools distributed-sources
    build-command
\end{verbatim}

should be changed to

\begin{verbatim}
distributed-file: distributed-sources
    $(MAKE) $(AM_MAKEFLAGS) built-tools
    build-command
\end{verbatim}

or you could choose not to distribute \texttt{distributed-file}, if cross-compilation does not matter.

The points made through these examples are worth a summary:

- Distributed files should never depend upon non-distributed built files.
- Distributed files should be distributed with all their dependencies.
- If a file is \textit{intended} to be rebuilt by users, then there is no point in distributing it.
For desperate cases, it’s always possible to disable this check by setting \texttt{distcleancheck\_listfiles} as documented in Section 14.4 [Checking the Distribution], page 99. Make sure you do understand the reason why ‘\texttt{make distcheck}’ complains before you do this. \texttt{distcleancheck\_listfiles} is a way to hide errors, not to fix them. You can always do better.

\section*{28.6 Flag Variables Ordering}

What is the difference between \texttt{AM\_CFLAGS}, \texttt{CFLAGS}, and \texttt{mumble\_CFLAGS}?

Why does \texttt{automake} output \texttt{CPPFLAGS} after \texttt{AM\_CPPFLAGS} on compile lines? Shouldn’t it be the converse?

My \texttt{configure} adds some warning flags into \texttt{CXXFLAGS}. In one \texttt{Makefile.am} I would like to append a new flag, however if I put the flag into \texttt{AM\_CXXFLAGS} it is prepended to the other flags, not appended.

\section*{Compile Flag Variables}

This section attempts to answer all the above questions. We will mostly discuss \texttt{CPPFLAGS} in our examples, but actually the answer holds for all the compile flags used in Automake: \texttt{CCASFLAGS}, \texttt{CFLAGS}, \texttt{CPPFLAGS}, \texttt{CXXFLAGS}, \texttt{FCFLAGS}, \texttt{FFLAGS}, \texttt{GCJFLAGS}, \texttt{LDFLAGS}, \texttt{LFLAGS}, \texttt{LIBTOOLFLAGS}, \texttt{OBJCFLAGS}, \texttt{OBJCXXFLAGS}, \texttt{RFLAGS}, \texttt{UPCFLAGS}, and \texttt{YFLAGS}.

\texttt{CPPFLAGS}, \texttt{AM\_CPPFLAGS}, and \texttt{mumble\_CPPFLAGS} are three variables that can be used to pass flags to the \texttt{C} preprocessor (actually these variables are also used for other languages like C++ or preprocessed Fortran). \texttt{CPPFLAGS} is the user variable (see Section 3.6 [User Variables], page 23), \texttt{AM\_CPPFLAGS} is the Automake variable, and \texttt{mumble\_CPPFLAGS} is the variable specific to the \texttt{mumble} target (we call this a per-target variable, see Section 8.4 [Program and Library Variables], page 64).

Automake always uses two of these variables when compiling \texttt{C} sources files. When compiling an object file for the \texttt{mumble} target, the first variable will be \texttt{mumble\_CPPFLAGS} if it is defined, or \texttt{AM\_CPPFLAGS} otherwise. The second variable is always \texttt{CPPFLAGS}.

In the following example,

\begin{verbatim}
bin_PROGRAMS = foo bar
foo_SOURCES = xyz.c
bar_SOURCES = main.c
foo_CPPFLAGS = -DFOO
AM_CPPFLAGS = -DBAZ
\end{verbatim}

\texttt{xyz.o} will be compiled with ‘$(foo\_CPPFLAGS) $(CPPFLAGS)’, (because \texttt{xyz.o} is part of the \texttt{foo} target), while \texttt{main.o} will be compiled with ‘$(AM\_CPPFLAGS) $(CPPFLAGS)’ (because there is no per-target variable for target \texttt{bar}).

The difference between \texttt{mumble\_CPPFLAGS} and \texttt{AM\_CPPFLAGS} being clear enough, let’s focus on \texttt{CPPFLAGS}. \texttt{CPPFLAGS} is a user variable, i.e., a variable that users are entitled to modify in order to compile the package. This variable, like many others, is documented at the end of the output of ‘\texttt{configure --help}’. 
For instance, someone who needs to add `/home/my/usr/include` to the C compiler’s search path would configure a package with
```
./configure CPPFLAGS='-I /home/my/usr/include'
```
and this flag would be propagated to the compile rules of all Makefiles.

It is also not uncommon to override a user variable at make-time. Many installers do this with `prefix`, but this can be useful with compiler flags too. For instance, if, while debugging a C++ project, you need to disable optimization in one specific object file, you can run something like
```
rm file.o
make CXXFLAGS=-O0 file.o
make
```

The reason `$(CPPFLAGS)` appears after `$(AM_CPPFLAGS)` or `$(mumble_CPPFLAGS)` in the compile command is that users should always have the last say. It probably makes more sense if you think about it while looking at the `CXXFLAGS=-O0` above, which should supersede any other switch from `AM_CXXFLAGS` or `mumble_CXXFLAGS` (and this of course replaces the previous value of `CXXFLAGS`).

You should never redefine a user variable such as `CPPFLAGS` in `Makefile.am`. Use `automake --override` to diagnose such mistakes. Even something like
```
CPPFLAGS = -DDATADIR="$(datadir)" @CPPFLAGS@
```
is erroneous. Although this preserves `configure`’s value of `CPPFLAGS`, the definition of `DATADIR` will disappear if a user attempts to override `CPPFLAGS` from the `make` command line.

```
AM_CPPFLAGS = -DDATADIR="$(datadir)"
```
is all that is needed here if no per-target flags are used.

You should not add options to these user variables within `configure` either, for the same reason. Occasionally you need to modify these variables to perform a test, but you should reset their values afterwards. In contrast, it is OK to modify the `AM_` variables within `configure` if you `AC_SUBST` them, but it is rather rare that you need to do this, unless you really want to change the default definitions of the `AM_` variables in all `Makefiles`.

What we recommend is that you define extra flags in separate variables. For instance, you may write an Autoconf macro that computes a set of warning options for the C compiler, and `AC_SUBST` them in `WARNINGCFLAGS`; you may also have an Autoconf macro that determines which compiler and which linker flags should be used to link with library `libfoo`, and `AC_SUBST` these in `LIBFOOCFLAGS` and `LIBFOOLDFLAGS`. Then, a `Makefile.am` could use these variables as follows:

```
AM_CFLAGS = $(WARNINGCFLAGS)
bin_PROGRAMS = prog1 prog2
prog1_SOURCES = ...
prog2_SOURCES = ...
prog2_CFLAGS = $(LIBFOOCFLAGS) $(AM_CFLAGS)
prog2_LDFLAGS = $(LIBFOOLDFLAGS)
```

In this example both programs will be compiled with the flags substituted into `$(WARNINGCFLAGS)`, and `prog2` will additionally be compiled with the flags required to link with `libfoo`.

Note that listing `AM_CFLAGS` in a per-target `CFLAGS` variable is a common idiom to ensure that `AM_CFLAGS` applies to every target in a `Makefile.in`.

Using variables like this gives you full control over the ordering of the flags. For instance, if there is a flag in `$(WARNINGCFLAGS)` that you want to negate for a particular target, you can use something like `prog1_CFLAGS = $(AM_CFLAGS) -no-flag`. If all of these flags had been forcefully appended to `CFLAGS`, there would be no way to disable one flag. Yet another reason to leave user variables to users.

Finally, we have avoided naming the variable of the example `LIBFOO_LDFLAGS` (with an underscore) because that would cause Automake to think that this is actually a per-target variable (like `mumble_LDFLAGS`) for some non-declared `LIBFOO` target.

**Other Variables**

There are other variables in Automake that follow similar principles to allow user options. For instance, Texinfo rules (see Section 11.1 [Texinfo], page 91) use `MAKEINFOFLAGS` and `AM_MAKEINFOFLAGS`. Similarly, DejaGnu tests (see Section 15.5 [DejaGnu Tests], page 116) use `RUNTESTDEFAULTFLAGS` and `AM_RUNTESTDEFAULTFLAGS`. The tags and ctags rules (see Section 18.1 [Tags], page 122) use `ETAGSFLAGS`, `AM_ETAGSFLAGS`, `CTAGSFLAGS`, and `AM_CTAGSFLAGS`. Java rules (see Section 10.4 [Java], page 88) use `JAVACFLAGS` and `AM_JAVACFLAGS`. None of these rules support per-target flags (yet).

To some extent, even `AM_MAKEFLAGS` (see Section 7.1 [Subdirectories], page 48) obeys this naming scheme. The slight difference is that `MAKEFLAGS` is passed to sub-makes implicitly by `make` itself.

However you should not think that all variables ending with `FLAGS` follow this convention. For instance, `DISTCHECK_CONFIGURE_FLAGS` (see Section 14.4 [Checking the Distribution], page 99) and `ACLOCAL_AMFLAGS` (see Chapter 16 [Rebuilding], page 116, and Section 6.3.4 [Local Macros], page 41), are two variables that are only useful to the maintainer and have no user counterpart.

`ARFLAGS` (see Section 8.2 [A Library], page 57) is usually defined by Automake and has neither `AM_` nor per-target cousin.

Finally you should not think that the existence of a per-target variable implies the existence of an `AM_` variable or of a user variable. For instance, the `mumble_LDADD` per-target variable overrides the makefile-wide `LDADD` variable (which is not a user variable), and `mumble_LIBADD` exists only as a per-target variable. See Section 8.4 [Program and Library Variables], page 64.

**28.7 Why are object files sometimes renamed?**

This happens when per-target compilation flags are used. Object files need to be renamed just in case they would clash with object files compiled from the same sources, but with different flags. Consider the following example.

```sh
bin_PROGRAMS = true false
ture_SOURCES = generic.c
ture_CPPFLAGS = -DEXIT_CODE=0
false_SOURCES = generic.c
false_CPPFLAGS = -DEXIT_CODE=1
```
Obviously the two programs are built from the same source, but it would be bad if they shared the same object, because `generic.o` cannot be built with both `-DEXIT_CODE=0` and `-DEXIT_CODE=1`. Therefore `automake` outputs rules to build two different objects: `true-generic.o` and `false-generic.o`.

`automake` doesn’t actually look whether source files are shared to decide if it must rename objects. It will just rename all objects of a target as soon as it sees per-target compilation flags used.

It’s OK to share object files when per-target compilation flags are not used. For instance, `true` and `false` will both use `version.o` in the following example.

```makefile
AM_CPPFLAGS = -DVERSION=1.0
bin_PROGRAMS = true false
true_SOURCES = true.c version.c
false_SOURCES = false.c version.c
```

Note that the renaming of objects is also affected by the `_SHORTNAME` variable (see Section 8.4 [Program and Library Variables], page 64).

### 28.8 Per-Object Flags Emulation

One of my source files needs to be compiled with different flags. How do I do?

Automake supports per-program and per-library compilation flags (see Section 8.4 [Program and Library Variables], page 64, and Section 28.6 [Flag Variables Ordering], page 145). With this you can define compilation flags that apply to all files compiled for a target. For instance, in

```makefile
bin_PROGRAMS = foo
foo_SOURCES = foo.c foo.h bar.c bar.h main.c
foo_CFLAGS = -some -flags
```

`foo-foo.o`, `foo-bar.o`, and `foo-main.o` will all be compiled with ‘-some -flags’. (If you wonder about the names of these object files, see Section 28.7 [Renamed Objects], page 147.) Note that `foo_CFLAGS` gives the flags to use when compiling all the C sources of the _program_ `foo`, it has nothing to do with `foo.c` or `foo-foo.o` specifically.

What if `foo.c` needs to be compiled into `foo.o` using some specific flags, that none of the other files requires? Obviously per-program flags are not directly applicable here. Something like per-object flags are expected, i.e., flags that would be used only when creating `foo-foo.o`. Automake does not support that, however this is easy to simulate using a library that contains only that object, and compiling this library with per-library flags.

```makefile
bin_PROGRAMS = foo
foo_SOURCES = bar.c bar.h main.c
foo_CFLAGS = -some -flags
foo_LDADD = libfoo.a
noinst_LIBRARIES = libfoo.a
libfoo_a_SOURCES = foo.c foo.h
libfoo_a_CFLAGS = -some -other -flags
```
Here `foo-bar.o` and `foo-main.o` will all be compiled with `'-some -flags'`, while `libfoo_a-foo.o` will be compiled using `'-some-other -flags'`. Eventually, all three objects will be linked to form `foo`.

This trick can also be achieved using Libtool convenience libraries, for instance `noinst_LTLIBRARIES = libfoo.la` (see Section 8.3.5 [Libtool Convenience Libraries], page 61).

Another tempting idea to implement per-object flags is to override the compile rules `automake` would output for these files. Automake will not define a rule for a target you have defined, so you could think about defining the `foo-foo.o: foo.c` rule yourself. We recommend against this, because this is error prone. For instance, if you add such a rule to the first example, it will break the day you decide to remove `foo_CFLAGS` (because `foo.c` will then be compiled as `foo.o` instead of `foo-foo.o`, see Section 28.7 [Renamed Objects], page 147). Also in order to support dependency tracking, the two `.o/.obj` extensions, and all the other flags variables involved in a compilation, you will end up modifying a copy of the rule previously output by `automake` for this file. If a new release of Automake generates a different rule, your copy will need to be updated by hand.

### 28.9 Handling Tools that Produce Many Outputs

This section describes a `make` idiom that can be used when a tool produces multiple output files. It is not specific to Automake and can be used in ordinary `Makefiles`.

Suppose we have a program called `foo` that will read one file called `data.foo` and produce two files named `data.c` and `data.h`. We want to write a `Makefile` rule that captures this one-to-two dependency.

The naive rule is incorrect:

```make
# This is incorrect.
data.c data.h: data.foo
  foo data.foo
```

What the above rule really says is that `data.c` and `data.h` each depend on `data.foo`, and can each be built by running `foo data.foo`. In other words it is equivalent to:

```make
# We do not want this.
data.c: data.foo
  foo data.foo
data.h: data.foo
  foo data.foo
```

which means that `foo` can be run twice. Usually it will not be run twice, because `make` implementations are smart enough to check for the existence of the second file after the first one has been built; they will therefore detect that it already exists. However there are a few situations where it can run twice anyway:

- The most worrying case is when running a parallel `make`. If `data.c` and `data.h` are built in parallel, two `foo data.foo` commands will run concurrently. This is harmful.
- Another case is when the dependency (here `data.foo`) is (or depends upon) a phony target.

A solution that works with parallel `make` but not with phony dependencies is the following:
data.c data.h: data.foo
   foo data.foo

data.h: data.c

The above rules are equivalent to

data.c: data.foo
   foo data.foo

data.h: data.foo data.c
   foo data.foo

therefore a parallel `make` will have to serialize the builds of `data.c` and `data.h`, and will detect that the second is no longer needed once the first is over.

Using this pattern is probably enough for most cases. However it does not scale easily to more output files (in this scheme all output files must be totally ordered by the dependency relation), so we will explore a more complicated solution.

Another idea is to write the following:

```
# There is still a problem with this one.
data.c: data.foo
   foo data.foo

data.h: data.c

```

The idea is that ‘foo data.foo’ is run only when `data.c` needs to be updated, but we further state that `data.h` depends upon `data.c`. That way, if `data.h` is required and `data.foo` is out of date, the dependency on `data.c` will trigger the build.

This is almost perfect, but suppose we have built `data.h` and `data.c`, and then we erase `data.h`. Then, running `make data.h` will not rebuild `data.h`. The above rules just state that `data.c` must be up-to-date with respect to `data.foo`, and this is already the case.

What we need is a rule that forces a rebuild when `data.h` is missing. Here it is:

```
data.c: data.foo
   foo data.foo

data.h: data.c

## Recover from the removal of $@
@if test -f $@; then :; else \
   rm -f data.c; \n   $(MAKE) $(AM_MAKEFLAGS) data.c; \
fi
```

The above scheme can be extended to handle more outputs and more inputs. One of the outputs is selected to serve as a witness to the successful completion of the command, it depends upon all inputs, and all other outputs depend upon it. For instance, if `foo` should additionally read `data.bar` and also produce `data.w` and `data.x`, we would write:

```
data.c: data.foo data.bar
   foo data.foo data.bar

data.h data.w data.x: data.c

## Recover from the removal of $@
@if test -f $@; then :; else \
   rm -f data.c; \n   $(MAKE) $(AM_MAKEFLAGS) data.c; \
```
fi

However there are now three minor problems in this setup. One is related to the time-stamp ordering of `data.h`, `data.w`, `data.x`, and `data.c`. Another one is a race condition if a parallel `make` attempts to run multiple instances of the recover block at once. Finally, the recursive rule breaks `make -n` when run with GNU `make` (as well as some other `make` implementations), as it may remove `data.h` even when it should not (see Section “How the `MAKE` Variable Works” in *The GNU Make Manual*).

Let us deal with the first problem. `foo` outputs four files, but we do not know in which order these files are created. Suppose that `data.h` is created before `data.c`. Then we have a weird situation. The next time `make` is run, `data.h` will appear older than `data.c`, the second rule will be triggered, a shell will be started to execute the `if...fi` command, but actually it will just execute the `then` branch, that is: nothing. In other words, because the witness we selected is not the first file created by `foo`, `make` will start a shell to do nothing each time it is run.

A simple riposte is to fix the timestamps when this happens.

```bash
data.c: data.foo data.bar
  foo data.foo data.bar
data.h data.w data.x: data.c
  @if test -f $@; then \n    touch $@; \n  else \n    ## Recover from the removal of $@
    rm -f data.c; \n    $(MAKE) $(AM_MAKEFLAGS) data.c; \n  fi
```

Another solution is to use a different and dedicated file as witness, rather than using any of `foo`’s outputs.

```bash
data.stamp: data.foo data.bar
  @rm -f data.tmp
  @touch data.tmp
  foo data.foo data.bar
  @mv -f data.tmp $@
data.c data.h data.w data.x: data.stamp
  ## Recover from the removal of $@
  @if test -f $@; then ;; else \n    rm -f data.stamp; \n    $(MAKE) $(AM_MAKEFLAGS) data.stamp; \n  fi
```

`data.tmp` is created before `foo` is run, so it has a timestamp older than output files output by `foo`. It is then renamed to `data.stamp` after `foo` has run, because we do not want to update `data.stamp` if `foo` fails.

This solution still suffers from the second problem: the race condition in the recover rule. If, after a successful build, a user erases `data.c` and `data.h`, and runs ‘`make -j`’, then `make` may start both recover rules in parallel. If the two instances of the rule execute ‘$(MAKE)’
$(AM_MAKEFLAGS) data.stamp' concurrently the build is likely to fail (for instance, the two rules will create data.tmp, but only one can rename it).

Admittedly, such a weird situation does not arise during ordinary builds. It occurs only when the build tree is mutilated. Here data.c and data.h have been explicitly removed without also removing data.stamp and the other output files. make clean; make will always recover from these situations even with parallel makes, so you may decide that the recover rule is solely to help non-parallel make users and leave things as-is. Fixing this requires some locking mechanism to ensure only one instance of the recover rule rebuilds data.stamp. One could imagine something along the following lines.

```
data.c data.h data.w data.x: data.stamp
  ## Recover from the removal of @
  @if test -f $@; then ;; else \n    trap 'rm -rf data.lock data.stamp' 1 2 13 15; \n    ## mkdir is a portable test-and-set
    if mkdir data.lock 2>/dev/null; then \n    ## This code is being executed by the first process.
      rm -f data.stamp; \n      $(MAKE) $(AM_MAKEFLAGS) data.stamp; \n      result=$$?; rm -rf data.lock; exit $$result; \n      else \n    ## This code is being executed by the follower processes.
    ## Wait until the first process is done.
      while test -d data.lock; do sleep 1; done; \n    ## Succeed if and only if the first process succeeded.
      test -f data.stamp; \n      fi; \n  fi
```

Using a dedicated witness, like data.stamp, is very handy when the list of output files is not known beforehand. As an illustration, consider the following rules to compile many *.el files into *.elc files in a single command. It does not matter how ELFFILES is defined (as long as it is not empty: empty targets are not accepted by POSIX).

```
ELFILES = one.el two.el three.el ...
ELCFILES = $(ELFILES:=c)

elc-stamp: $(ELFILES)
  @rm -f elc-temp
  @touch elc-temp
  $(elisp_comp) $(ELFILES)
  @mv -f elc-temp @

$(ELCFILES): elc-stamp
  @if test -f $@; then ;; else \n    ## Recover from the removal of @
    trap 'rm -rf elc-lock elc-stamp' 1 2 13 15; \n    if mkdir elc-lock 2>/dev/null; then \n    ## This code is being executed by the first process.
```

These solutions all still suffer from the third problem, namely that they break the promise that `make -n` should not cause any actual changes to the tree. For those solutions that do not create lock files, it is possible to split the recover rules into two separate recipe commands, one of which does all work but the recursion, and the other invokes the recursive `${MAKE}`. The solutions involving locking could act upon the contents of the `${MAKEFLAGS}` variable, but parsing that portably is not easy (see Section “The Make Macro MAKEFLAGS” in The Autoconf Manual). Here is an example:

```
ELFILES = one.el two.el three.el ...
ELCFILES = $(ELFILES:=c)

elc-stamp: $(ELFILES)
  @rm -f elc-temp
  @touch elc-temp
  $(elisp_comp) $(ELFILES)
  @mv -f elc-temp $@

$(ELCFILES): elc-stamp
  ## Recover from the removal of $@
  @dry=; for f in x $$MAKEFLAGS; do \n    case $$f in \n      *=*|--*);; \n      *n*) dry=; ;; 
      esac; \n  done; \n  if test -f $@; then ;; else \n    $$dry trap 'rm -rf elc-lock elc-stamp' 1 2 13 15; \n    if $$dry mkdir elc-lock 2>/dev/null; then \n      ## This code is being executed by the first process.
      $$dry rm -f elc-stamp; \n      $(MAKE) $(AM_MAKEFLAGS) elc-stamp; \n      $$dry rmdir elc-lock; \n    else \n      ## This code is being executed by the follower processes.
      ## Wait until the first process is done.
      while test -d elc-lock & test -z "$$dry"; do \n```
sleep 1; \
    done; \ 
## Succeed if and only if the first process succeeded.
    $$\text{dry test } -f \text{ elc-stamp; exit } $$ $?; \\
    fi; \\
fi

For completeness it should be noted that GNU \texttt{make} is able to express rules with multiple output files using pattern rules (see Section “Pattern Rule Examples” in \textit{The GNU Make Manual}). We do not discuss pattern rules here because they are not portable, but they can be convenient in packages that assume GNU \texttt{make}.

28.10 Installing to Hard-Coded Locations

My package needs to install some configuration file. I tried to use the following rule, but \texttt{make distcheck} fails. Why?

# Do not do this.
install-data-local:
    \$(INSTALL_DATA) \$(srcdir)/afile \$(DESTDIR)/etc/afile

My package needs to populate the installation directory of another package at install-time. I can easily compute that installation directory in \texttt{configure}, but if I install files therein, \texttt{make distcheck} fails. How else should I do?

These two setups share their symptoms: \texttt{make distcheck} fails because they are installing files to hard-coded paths. In the later case the path is not really hard-coded in the package, but we can consider it to be hard-coded in the system (or in whichever tool that supplies the path). As long as the path does not use any of the standard directory variables (\texttt{\$(prefix)}, \texttt{\$(bindir)}, \texttt{\$(datadir)}, etc.), the effect will be the same: user-installations are impossible.

As a (non-root) user who wants to install a package, you usually have no right to install anything in \texttt{/usr} or \texttt{/usr/local}. So you do something like ‘\texttt{./configure --prefix ~/usr}’ to install a package in your own \texttt{~/usr} tree.

If a package attempts to install something to some hard-coded path (e.g., \texttt{/etc/afile}), regardless of this \texttt{--prefix} setting, then the installation will fail. \texttt{make distcheck} performs such a \texttt{--prefix} installation, hence it will fail too.

Now, there are some easy solutions.

The above \texttt{install-data-local} example for installing \texttt{/etc/afile} would be better replaced by

\texttt{sysconf_DATA = afile}

by default \texttt{sysconfdir} will be \texttt{\$(prefix)/etc}, because this is what the GNU Standards require. When such a package is installed on an FHS compliant system, the installer will have to set \texttt{--sysconfdir=/etc}. As the maintainer of the package you should not be concerned by such site policies: use the appropriate standard directory variable to install your files so that the installer can easily redefine these variables to match their site conventions.
Installing files that should be used by another package is slightly more involved. Let’s take an example and assume you want to install a shared library that is a Python extension module. If you ask Python where to install the library, it will answer something like this:

\[
% \texttt{python -c 'from distutils import sysconfig;}
\]
\[\texttt{print sysconfig.get_python_lib(1,0)'}
\]
\[\texttt{/usr/lib/python2.5/site-packages}
\]

If you indeed use this absolute path to install your shared library, non-root users will not be able to install the package, hence distcheck fails.

Let’s do better. The `sysconfig.get_python_lib()` function actually accepts a third argument that will replace Python’s installation prefix.

\[
% \texttt{python -c 'from distutils import sysconfig;}
\]
\[\texttt{print sysconfig.get_python_lib(1,0, '$\{exec_prefix\}'\})}
\]
\[\texttt{${exec_prefix}/lib/python2.5/site-packages}
\]

You can also use this new path. If you do

- root users can install your package with the same `--prefix` as Python (you get the behavior of the previous attempt)
- non-root users can install your package too, they will have the extension module in a place that is not searched by Python but they can work around this using environment variables (and if you installed scripts that use this shared library, it’s easy to tell Python were to look in the beginning of your script, so the script works in both cases).

The `AM_PATH_PYTHON` macro uses similar commands to define `$(pythondir)` and `$(pyexecdir)` (see Section 10.5 [Python], page 89).

Of course not all tools are as advanced as Python regarding that substitution of prefix. So another strategy is to figure the part of the installation directory that must be preserved. For instance, here is how `AM_PATH_LISPDIR` (see Section 10.1 [Emacs Lisp], page 87) computes `$(lispdir)`:

\[
\texttt{$EMACS -batch -q -eval '&(while load-path}
\]
\[\texttt{(princ (concat (car load-path) "\n\")}
\]
\[\texttt{(setq load-path (cdr load-path)))'}} >\texttt{conftest.out}
\]
\[\texttt{lispdir='sed -n}
\]
\[\texttt{-e 's,,,'}
\]
\[\texttt{-e '/.*\slash/x*emacs/\site-lisp$/{}
\]
\[\texttt{s,,/\slash/x*emacs/\site-lisp\slash,$\{libdir\}/\1,;p;q;}
\]
\[\texttt{}}
\]
\[\texttt{-e '/.*\slash/x*emacs/\site-lisp$/{}
\]
\[\texttt{s,,/\slash/x*emacs/\site-lisp\slash,$\{datarootdir\}/\1,;p;q;}
\]
\[\texttt{}}
\]
\[\texttt{conftest.out'}
\]

I.e., it just picks the first directory that looks like */lib/*emacs/site-lisp or */share/*emacs/site-lisp in the search path of emacs, and then substitutes `$(libdir)` or `$(datadir)` appropriately.

The emacs case looks complicated because it processes a list and expects two possible layouts, otherwise it’s easy, and the benefits for non-root users are really worth the extra `sed` invocation.
28.11 Debugging Make Rules

The rules and dependency trees generated by `automake` can get rather complex, and leave the developer head-scratching when things don’t work as expected. Besides the debug options provided by the `make` command (see Section “Options Summary” in *The GNU Make Manual*), here’s a couple of further hints for debugging makefiles generated by `automake` effectively:

- If less verbose output has been enabled in the package with the ‘silent-rules’ option (see Chapter 17 [Options], page 117), you can use `make V=1` to see the commands being executed.
- `make -n` can help show what would be done without actually doing it. Note however, that this will still execute commands prefixed with ‘+’, and, when using GNU `make`, commands that contain the strings `$(MAKE)` or `${MAKE}` (see Section “Instead of Execution” in *The GNU Make Manual*). Typically, this is helpful to show what recursive rules would do, but it means that, in your own rules, you should not mix such recursion with actions that change any files. Furthermore, note that GNU `make` will update prerequisites for the Makefile file itself even with `-n` (see Section “Remaking Makefiles” in *The GNU Make Manual*).
- `echo 'print: ; @echo "$\{VAR\}"' | make -f Makefile -f - print` can be handy to examine the expanded value of variables. You may need to use a target other than ‘print’ if that is already used or a file with that name exists.
- [http://bashdb.sourceforge.net/remake/](http://bashdb.sourceforge.net/remake/) provides a modified GNU `make` command called `remake` that copes with complex GNU `make`-specific Makefiles and allows to trace execution, examine variables, and call rules interactively, much like a debugger.

28.12 Reporting Bugs

Most nontrivial software has bugs. Automake is no exception. Although we cannot promise we can or will fix a bug, and we might not even agree that it is a bug, we want to hear about problems you encounter. Often we agree they are bugs and want to fix them.

To make it possible for us to fix a bug, please report it. In order to do so effectively, it helps to know when and how to do it.

Before reporting a bug, it is a good idea to see if it is already known. You can look at the GNU Bug Tracker ([http://debbugs.gnu.org/](http://debbugs.gnu.org/)) and the bug-automake mailing list archives ([http://lists.gnu.org/archive/html/bug-automake/](http://lists.gnu.org/archive/html/bug-automake/)) for previous bug reports. We previously used a Gnat database ([http://sourceware.org/cgi-bin/gnatsweb.pl?database=automake](http://sourceware.org/cgi-bin/gnatsweb.pl?database=automake)) for bug tracking, so some bugs might have been reported there already. Please do not use it for new bug reports, however.

If the bug is not already known, it should be reported. It is very important to report bugs in a way that is useful and efficient. For this, please familiarize yourself with

---

8 Automake’s ‘dist’ and ‘distcheck’ rules had a bug in this regard in that they created directories even with `-n`, but this has been fixed in Automake 1.11.
How to Report Bugs Effectively (http://www.chiark.greenend.org.uk/~sgtatham/bugs.html) and How to Ask Questions the Smart Way (http://catb.org/~esr/faqs/smart-questions.html). This helps you and developers to save time which can then be spent on fixing more bugs and implementing more features.

For a bug report, a feature request or other suggestions, please send email to bug-automake@gnu.org. This will then open a new bug in the bug tracker (http://debbugs.gnu.org/automake). Be sure to include the versions of Autoconf and Automake that you use. Ideally, post a minimal Makefile.am and configure.ac that reproduces the problem you encounter. If you have encountered test suite failures, please attach the test-suite.log file.
Appendix A  Copying This Manual

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