This presentation targets developers familiar with Unix development tools (shell, make, compiler) that want to learn Autotools.

The latest version of this document can be retrieved from http://www.lrde.epita.fr/~adl/autotools.html

Please mail me corrections and suggestions about this document at adl@gnu.org.

Do not send me any general question about the Autotools. Use the appropriate mailing list instead (autoconf@gnu.org, or automake@gnu.org).
This document was updated for the following releases of the Autotools:

- GNU Autoconf 2.65 (November 2009)
- GNU Automake 1.11.1 (December 2009)
- GNU Libtool 2.2.6b (November 2009)
- GNU Gettext 0.17 (November 2007)

These were the last releases at the time of writing.

- The usage of these tools has improved a lot over the last years.
- Some syntaxes used here will not work with older tools.
- This a deliberate choice:
  - New users should learn today’s recommended usages.
  - Make sure you have up-to-date tools and do not bother with old releases.
Part I

The GNU Build System

1 Goals
   • Portable Packages
   • Uniform Builds

2 Package Use Cases
   • The User Point of View
   • The Power User Point of View
   • The Packager Point of View
   • The Maintainer Point of View

3 The configure Process

4 Why We Need Tools
1. **Goals**
   - Portable Packages
   - Uniform Builds

2. **Package Use Cases**
   - The User Point of View
   - The Power User Point of View
   - The Packager Point of View
   - The Maintainer Point of View

3. **The configure Process**

4. **Why We Need Tools**
Consider C functions...

- that do not exist everywhere (e.g., `strtod()`)
- that have different names (e.g., `strchr()` vs. `index()`)
- that have varying prototypes
  (e.g., `int setpgrp(void);` vs. `int setpgrp(int, int);`)
- that can behave differently (e.g., `malloc(0);`)
- that might require other libraries
  (is `pow()` in `libm.so` or in `libc.so`?)
- that can be defined in different headers
  (`string.h` vs. `strings.h` vs. `memory.h`)

How should a package deal with those?
Possible Solutions

- Slice the code with lots of `#if/#else`
- Create substitution macros
- Create substitution functions
Possible Solutions

- Slice the code with lots of `#if/#else`
- Create substitution macros
- Create substitution functions

The latter two are to be preferred.
Goals

Portable Packages

Code Cluttered with `#if/#else`

Excerpt of `ffcall-1.10's alloc_trampoline()`

```c
#if !defined(CODE_EXECUTABLE)
    static long pagesize = 0;
#elif defined(EXECUTABLE_VIA_MMAP_DEVZERO)
    static int zero_fd;
#endif
    if (!pagesize) {
#elif defined(HAVE_MACH_VM)
        pagesize = vm_page_size;
#else
        pagesize = getpagesize();
#endif
#elif defined(EXECUTABLE_VIA_MMAP_DEVZERO)
    zero_fd = open("/dev/zero", O_RDONLY, 0644);
    if (zero_fd < 0) {
        printf(stderr, "trampoline: Cannot open /dev/zero!\n");
        abort();
    }
#endif
}
#endif
```
Substitution macros

Excerpt of coreutils-5.2.1’s system.h

```c
#if ! HAVE_FSEEKO && ! defined fseeko
#define fseeko (s, o, w) ((o) == (long) (o) |
? fseek (s, o, w) |
: (errno = EOVERFLOW, -1))
#endif
```

Then use `fseeko()` whether it exists or not.
Substitution functions

If `strdup()` does not exist, link your program with a replacement definition such as

```c
char *
strdup (const char *s)
{
    size_t len = strlen (s) + 1;
    void *new = malloc (len);
    if (new == NULL)
        return NULL;
    return (char *) memcpy (new, s, len);
}
```
Uniform Builds

1. **Goals**
   - Portable Packages
   - **Uniform Builds**

2. **Package Use Cases**
   - The User Point of View
   - The Power User Point of View
   - The Packager Point of View
   - The Maintainer Point of View

3. **The configure Process**

4. **Why We Need Tools**
Need for Automatic Configuration

- Maintaining a collection of `#define` for each system by hand is cumbersome.
- Requiring users to add the necessary `-D`, `-I`, and `-l` compilation options to `Makefile` is burdensome.
- Complicated builds hinder the acceptance of free software.
Need for Automatic Configuration

- Maintaining a collection of `#define` for each system by hand is cumbersome.
- Requiring users to add the necessary `-D`, `-I`, and `-l` compilation options to `Makefile` is burdensome.
- Complicated builds hinder the acceptance of free software.

- In 1991 people started to write shell scripts to `guess` these settings for some GNU packages.
- Since then the `configure` script is mandatory in any package of the GNU project.
configure's Purpose

• configure probes the systems for required functions, libraries, and tools
configure's Purpose

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- then it generates a config.h file with all #defines
configure's Purpose

- configure probes the systems for required functions, libraries, and tools
- then it generates a config.h file with all #defines
- as well as Makefiles to build the package
GNU Coding Standards

http://www.gnu.org/prep/standards/

Practices that packages of the GNU project should follow:
GNU Coding Standards

http://www.gnu.org/prep/standards/

Practices that packages of the GNU project should follow:
- program behavior
  - how to report errors,
  - standard command line options,
  - etc.
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Practices that packages of the GNU project should follow:

- program behavior
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- coding style

- configuration

- Makefile conventions

- etc.
The User Point of View

1. Goals
   - Portable Packages
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4. Why We Need Tools
Standard Installation Procedure

~ % tar zxf amhello-1.0.tar.gz
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~ % tar zxf amhello-1.0.tar.gz
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~/amhello-1.0 % ./configure
...
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...
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Password:
Standard Installation Procedure

```bash
~ % tar zxf amhello-1.0.tar.gz
~ % cd amhello-1.0
~/amhello-1.0 % ./configure
...
~/amhello-1.0 % make
...
~/amhello-1.0 % make check
...
~/amhello-1.0 % su
Password:
/home/adl/amhello-1.0 # make install
...
```
Standard Installation Procedure

```bash
~ % tar zxf amhello-1.0.tar.gz
~ % cd amhello-1.0
~/amhello-1.0 % ./configure
...
~/amhello-1.0 % make
...
~/amhello-1.0 % make check
...
~/amhello-1.0 % su
Password:
/home/adl/amhello-1.0 # make install
...
/home/adl/amhello-1.0 # exit
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Standard Installation Procedure

~ % tar zxf amhello-1.0.tar.gz
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~/amhello-1.0 % ./configure
...
~/amhello-1.0 % make
...
~/amhello-1.0 % make check
...
~/amhello-1.0 % su
Password:
/home/adl/amhello-1.0 # make install
...
/home/adl/amhello-1.0 # exit
~/amhello-1.0 % make installcheck
...
Standard Makefile Targets

- `make all`  Build programs, libraries, documentation, etc. (Same as `make`).
- `make install`  Install what needs to be installed.
- `make install-strip`  Same as `make install`, then strip debugging symbols.
- `make uninstall`  The opposite of `make install`.
- `make clean`  Erase what has been built (the opposite of `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`  Create `PACKAGE-VERSION.tar.gz`. 
# Standard File System Hierarchy

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<thead>
<tr>
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</tr>
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<td>exec-prefix/bin</td>
</tr>
<tr>
<td>libdir</td>
<td>exec-prefix/lib</td>
</tr>
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<td>...</td>
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</tr>
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`~/amhello-1.0 % ...`
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```
~/amhello-1.0 % ./configure --prefix ~/usr
```

A. Duret-Lutz
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## Standard File System Hierarchy

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...  

| includedir         | prefix/include          |
| datarootdir        | prefix/share            |
| datadir            | datarootdir             |
| mandir             | datarootdir/man         |
| infodir            | datarootdir/info        |

...  

```bash
~/amhello-1.0 % ./configure --prefix ~/usr
~/amhello-1.0 % make
```
Standard File System Hierarchy

Directory variable | Default value
--- | ---
prefix | /usr/local
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bindir | exec-prefix/bin
libdir | exec-prefix/lib
	... | 
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datadir | datarootdir
mandir | datarootdir/man
infodir | datarootdir/info
	... | 

~/amhello-1.0 % ./configure --prefix ~/usr
~/amhello-1.0 % make
~/amhello-1.0 % make install
Standard Configuration Variables

`.configure` automatically detects many settings. You can force some of them using configuration variables.

- **CC** C compiler command
- **CFLAGS** C compiler flags
- **CXX** C++ compiler command
- **CXXFLAGS** C++ compiler flags
- **LDFLAGS** linker flags
- **CPPFLAGS** C/C++ preprocessor flags

... See `./configure --help` for a full list.
Standard Configuration Variables

`.configure' automatically detects many settings. You can force some of them using configuration variables.

- **CC** C compiler command
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- **CXXFLAGS** C++ compiler flags
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... See `.configure --help' for a full list.

~/.amhello-1.0 % ./configure --prefix ~/.usr CC=gcc-3 \ 
CPPFLAGS=-I$HOME/usr/include LDFLAGS=-L$HOME/usr/lib
The Power User Point of View

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4. Why We Need Tools
Overriding Default Configuration Settings with `config.site`

Recall that old command

```
~/amhello-1.0 % ./configure --prefix ~/usr CC=gcc-3 \ 
CPPFLAGS=-I$HOME/usr/include LDFLAGS=-L$HOME/usr/lib
```
Overriding Default Configuration Settings with `config.site`

Recall that old command

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

Common configuration settings can be put in prefix/share/config.site

```
~/amhello-1.0 % cat ~/usr/share/config.site
```
```
test -z "$CC" && CC=gcc-3
```
```
test -z "$CPPFLAGS" && CPPFLAGS=-I$HOME/usr/include
```
```
test -z "$LDFLAGS" && LDFLAGS=-L$HOME/usr/lib
```
Recall that old command

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

Common configuration settings can be put in prefix/share/config.site

```
~/amhello-1.0 % cat ~/usr/share/config.site

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

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

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

Reducing the command to...

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

configure: loading site script /home/adl/usr/share/config.site
...
Parallel Build Trees (a.k.a. VPATH Builds)

Objects files, programs, and libraries are built where `configure` was run.
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```
~ % tar zxf ~/amhello-1.0.tar.gz
~ % cd amhello-1.0
```
Objects files, programs, and libraries are built where `configure` was run.

```bash
~ % tar zxf ~/amhello-1.0.tar.gz
~ % cd amhello-1.0
~/amhello-1.0 % mkdir build && cd build
```
Parallel Build Trees (a.k.a. VPATH Builds)

Objects files, programs, and libraries are built where `configure` was run.

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

Sources files are in `~/amhello-1.0/`,
built files are all in `~/amhello-1.0/build/`. 
Parallel Build Trees for Multiple Architectures

Builds for multiple architectures can share the same source tree.
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Builds for multiple architectures can share the same source tree.

Have the source on a (possibly read-only) shared directory

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

Parallel Build Trees for Multiple Architectures

Builds for multiple architectures can share the same source tree.

Have the source on a (possibly read-only) shared directory

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

Compilation on first host

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

Compilation on second host, assuming shared data

```
~ % mkdir /tmp/amh && cd /tmp/amh
/tmp/amh % /nfs/src/amhello-1.0/configure
/tmp/amh % make && sudo make install
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~ % cd /nfs/src
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Compilation on first host

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

Compilation on second host, assuming shared data

```
~ % mkdir /tmp/amh && cd /tmp/amh
/tmp/amh % /nfs/src/amhello-1.0/configure
/tmp/amh % make && sudo make install-exec
```
Two Part Installation

'make install'
  =
'make install-exec'
  +
'make install-data'
Two Part Installation

‘make install’
  =
‘make install-exec’   install platform-dependent files
  +
‘make install-data’
Two Part Installation

‘make install’

= ‘make install-exec’ install platform-dependent files
   ‘make install-data’ install platform-independent files
   (can be shared among multiple machines)
~/amhello-1.0 % ./configure
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 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 ANSI C...
...
Cross-Compilation

```
~/amhello-1.0 % ./configure
checking for a BSD-compatible install... /usr/bin/install -c
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checking whether we are using the GNU C compiler... yes
checking whether gcc accepts -g... yes
checking for gcc option to accept ANSI C...
...
Cross-Compilation

~/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 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...
Cross-Compilation

```bash
~/amhello-1.0 % ./configure --build i686-pc-linux-gnu \       
   --host i586-mingw32msvc
...
~/amhello-1.0 % make
...
```

Of course you need a cross-compiler installed first.
Cross-Compilation

```bash
~/amhello-1.0 % ./configure --build i686-pc-linux-gnu \  
    --host i586-mingw32msvc
...
~/amhello-1.0 % make
```

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

Of course you need a cross-compiler installed first.
Cross-Compilation

```
~/amhello-1.0 % ./configure --build i686-pc-linux-gnu \
    --host i586-mingw32msvc
...
~/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
```

Of course you need a cross-compiler installed first.

Cross-compilation `configure` options:

- `--build=BUILD` The system on which the package is built.
- `--host=HOST` The system where built programs & libraries will run.
- `--target=TARGET` Only when building compiler tools: the system for which the tools will create output.

For simple cross-compilation, only `--host=HOST` is needed.
Renaming Programs at Install Time

Maybe *hello* is already a command on this host?
Renaming Programs at Install Time

Maybe `hello` is already a command on this host?

```
--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.
```
Renaming Programs at Install Time

Maybe *hello* is already a command on this host?

`--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.

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

Will install *hello* as `/usr/local/bin/test-hello`. 
The Packager Point of View

1. Goals
   - Portable Packages
   - Uniform Builds

2. Package Use Cases
   - The User Point of View
   - The Power User Point of View
   - The Packager Point of View
   - The Maintainer Point of View

3. The configure Process

4. Why We Need Tools
Building Binary Packages Using DESTDIR

DESTDIR is used to relocate a package at install time.

```bash
~/amhello-1.0 % ./configure --prefix /usr
...
```
Building Binary Packages Using DESTDIR

DESTDIR is used to relocate a package at install time.

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

~/amhello-1.0-i686.tar.gz is ready to be uncompressed in / on many hosts.
Building Binary Packages Using DESTDIR

DESTDIR is used to relocate a package at install time.

```
~/amhello-1.0 % ./configure --prefix /usr
...
~/amhello-1.0 % make
...
~/amhello-1.0 % make DESTDIR=$HOME/inst install
...
```
DESTDIR is used to relocate a package at install time.

```
~/amhello-1.0 % ./configure --prefix /usr
...
~/amhello-1.0 % make
...
~/amhello-1.0 % make DESTDIR=$HOME/inst install
...
~/amhello-1.0 % cd ~/inst
~/inst % tar zcvf ~/amhello-1.0-i686.tar.gz .
./
./usr/
./usr/bin/
./usr/bin/hello
```

... and ~/amhello-1.0-i686.tar.gz is ready to be uncompressed in / on many hosts.
The Maintainer Point of View

1 Goals
   - Portable Packages
   - Uniform Builds

2 Package Use Cases
   - The User Point of View
   - The Power User Point of View
   - The Packager Point of View
   - The Maintainer Point of View

3 The configure Process

4 Why We Need Tools
Preparing Distributions

`make dist` Create `PACKAGE-VERSION.tar.gz`.

`make distcheck` Likewise, with many sanity checks. Prefer this one!
Preparing Distributions

‘make dist’ Create $PACKAGE-VERSION.tar.gz$.

‘make distcheck’ Likewise, with many sanity checks. Prefer this one!

‘make distcheck’ ensures most of the use cases presented so far work.

- It tests VPATH builds (with read-only source tree)
- It ensures ‘make clean’, ‘make distclean’, and ‘make uninstall’ do not omit files,
- It checks that DESTDIR installations work,
- It runs the test suite (both ‘make check’ and ‘make installcheck’).

Releasing a package that fails ‘make distcheck’ means releasing a package that will disappoint many users.
Dependency tracking is performed as a side-effect of compilation. Several methods are supported, and checked for by `configure`. (The gcc3 method above is the fastest.)
Automatic Dependency Tracking

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

Dependency tracking is performed as a side-effect of compilation. Several methods are supported, and checked for by `configure`. (The gcc3 method above is the fastest.)

Dependency tracking is only needed when the source files change; it can be safely disabled for throw-away installation builds. Slow methods must be enabled explicitly.

```
'--disable-dependency-tracking'  speed up one-time builds
'--enable-dependency-tracking'  do not reject slow dependency extractors
```
Nested Packages

- *Autoconfiscated* packages can be nested to arbitrary depth.
  - A package can distribute a third-party library it uses in a subdirectory.
  - It’s possible to gather many packages this way to distribute a set of tools.
Nested Packages

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- For installers:
  - A single package to configure, build, and install.
  - ‘configure’ options are passed recursively to sub-packages.
  - ‘configure --help=recursive’ shows the help of all sub-packages.
Nested Packages

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- For installers:
  - A single package to configure, build, and install.
  - ‘configure’ options are passed recursively to sub-packages.
  - ‘configure --help=recursive’ shows the help of all sub-packages.

- For maintainers:
  - Easier integration.
  - The sub-package is autonomous.
The configure Process

1. Goals
   - Portable Packages
   - Uniform Builds

2. Package Use Cases
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   - The Power User Point of View
   - The Packager Point of View
   - The Maintainer Point of View

3. The configure Process

4. Why We Need Tools
The (simplified) `configure` process

`Makefile.in`  
`src/Makefile.in`  
`config.h.in`  

`configure`  

*.in files are configuration templates
The (simplified) *configure* process

*.in* files are configuration templates from which *configure* generates the configuration files to use for building.
The (real) `configure` process

- `Makefile.in`
- `src/Makefile.in`
- `config.h.in`
- `configure`
The (real) *configure* process

`configure` contains a trace of the configuration
The (real) `configure` process

`configure` will actually process the templates
The (real) `configure` process

`configure` will actually process the templates

`config.status` will actually process the templates
The (real) `configure` process

`configure -C` caches results in `config.cache` to speed up reconfigurations
Why We Need Tools

1. Goals
   - Portable Packages
   - Uniform Builds

2. Package Use Cases
   - The User Point of View
   - The Power User Point of View
   - The Packager Point of View
   - The Maintainer Point of View

3. The configure Process

4. Why We Need Tools
If you try to mimic this build system by hand, you’ll discover that

- The GNU Build System has a lot of features.
  Some users may expect features you do not use.
If you try to mimic this build system by hand, you’ll discover that

- The GNU Build System has a lot of features. Some users may expect features you do not use.
- Implementing them portably is difficult, and exhausting. (Think portable shell scripts, portable Makefiles, on systems you may not have handy.)
Why We Need Tools

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GNU Autotools provide:
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GNU Autotools provide:

- Tools to create the GNU Build System from simple instructions.
Why We Need Tools

If you try to mimic this build system by hand, you’ll discover that

- The GNU Build System has a lot of features. Some users may expect features you do not use.

- Implementing them portably is difficult, and exhausting. (Think portable shell scripts, portable Makefiles, on systems you may not have handy.)

- You will have to upgrade your setup to follow changes of the GNU Coding Standards.

GNU Autotools provide:

- Tools to create the GNU Build System from simple instructions.

- A central place where fixes and improvements are made. (A bug-fix for a portability issue benefits every package.)
Part II

GNU Autotools

5 Hello World

6 Introducing Core Autotools

7 Hello World Explained

8 Using Autoconf

9 Using Automake
Hello World

Introducing Core Autotools

Hello World Explained

Using Autoconf

Using Automake
```c
#include <config.h>
#include <stdio.h>

int main (void) {
    puts ("Hello World!");
    puts ("This is " PACKAGE_STRING ".");
    return 0;
}
```
Generating All Template Files

- Makefile.in
- src/Makefile.in
- config.h.in
- configure
- config.status
- config.cache
- config.log
- Makefile
- src/Makefile
- config.h
Generating All Template Files

- Makefile.in
- src/Makefile.in
- config.h.in
- configure
Generating All Template Files

- Makefile.in
- src/Makefile.in
- config.h.in
- configure
Generating All Template Files

configure.ac

'autoreconf'

Makefile.in
src/Makefile.in
config.h.in

configure
Generating All Template Files

- configure.ac
- Makefile.am
- src/Makefile.am

- 'autoreconf'
- Makefile.in
- src/Makefile.in
- config.h.in

- configure
Autotools Inputs

**configure.ac**

```plaintext
AC_INIT([amhello], [1.0], [bug-report@address])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile src/Makefile])
AC_OUTPUT
```

**Makefile.am**

```plaintext
SUBDIRS = src
```

**src/Makefile.am**

```plaintext
bin_PROGRAMS = hello
hello_SOURCES = main.c
```
Preparing the Package

~/amhello % ls -R
.
Makefile.am  configure.ac  src/

./src:
Makefile.am  main.c

~/amhello %
Preparing the Package

~/amhello % ls -R
.
Makefile.am configure.ac src/

./src:
Makefile.am main.c

~/amhello % autoreconf --install
configure.ac:2: installing `./install-sh'
configure.ac:2: installing `./missing'
src/Makefile.am: installing `./depcomp'
~/amhello %
Preparing the Package

```bash
~/amhello % ls -R
.
Makefile.am  configure.ac  src/

./src:
Makefile.am  main.c
```

```bash
~/amhello % autoreconf --install
configure.ac:2: installing './install-sh'
configure.ac:2: installing './missing'
src/Makefile.am: installing './depcomp'
```

```bash
~/amhello % ls -R
.
Makefile.am  configure.ac
Makefile.in  depcomp*
aclocal.m4  install-sh*
autom4te.cache/missing*
```
Preparing the Package

```bash
~/amhello % ls -R
.
Makefile.am configure.ac
Makefile.in depcomp*
aclocal.m4 install-sh*
autom4te.cache/ missing*
config.h.in src/
configure*

./autom4te.cache:
output.0 requests traces.1
output.1 traces.0

./src:
Makefile.am Makefile.in main.c
```
Preparing the Package

```bash
~/amhello % ls -R
.
Makefile.am  configure.ac
Makefile.in  depcomp*
aclocal.m4   install-sh*
autom4te.cache/missing*
config.h.in  src/
configure*

./autom4te.cache:
output.0  requests  traces.1
output.1  traces.0

./src:
Makefile.am  Makefile.in  main.c
```
Preparing the Package

```bash
~/amhello % ls -R
.
Makefile.am configure.ac
Makefile.in depcomp*
aclocal.m4 install-sh*
autom4te.cache/ missing*
cfg.in src/
configure*
```

definitions for third-party macros used in `configure.ac`

```bash
./autom4te.cache:
output.0 requests traces.1
output.1 traces.0
```

definitions for third-party macros used in `configure.ac`

```bash
./src:
Makefile.am Makefile.in main.c
```
Preparing the Package

```bash
~/amhello % ls -R
.
Makefile.am configure.ac
Makefile.in depcomp*  
aclocal.m4 install-sh*  
autom4te.cache/ missing*  
config.h.in src/ auxiliary tools
configure* used during the build

./autom4te.cache:
output.0 requests traces.1
output.1 traces.0

./src:
Makefile.am Makefile.in main.c
```
Preparing the Package

`~/amhello % ls -R`

```
.
Makefile.am  configure.ac
Makefile.in  depcomp*
aclocal.m4   install-sh*
autom4te.cache/ missing*
config.h.in   src/
configure*    Autotools cache files
```

`./autom4te.cache:`

```
output.0  requests  traces.1
output.1  traces.0
```

`./src:`

```
Makefile.am  Makefile.in  main.c
```
Preparing the Package

```bash
~/amhello % ./configure
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 gcc... gcc
...
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
~/amhello %
```
Preparing the Package

```
~/amhello % ./configure
checking for a BSD-compatible install... /usr/bin/install -c
cHECKING whether build environment is sane... yes
cHECKING whether gawk exists... gawk
cHECKING whether make sets $(MAKE)... yes
cHECKING whether gcc... gcc
... 
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
~/amhello %
```
Preparing the Package

```bash
~/amhello % ./configure
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 Gcc... gcc
...
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
~/amhello % make
...
```
Preparing the Package

```bash
~/amhello % src/hello
Hello World!
This is amhello 1.0.
~/amhello %
```
Preparing the Package

`~/amhello % src/hello`
Hello World!
This is amhello 1.0.
`~/amhello % make distcheck`
...

========================================
amhello archives ready for distribution:
amhello-1.0.tar.gz
========================================
`~/amhello %`
Preparing the Package

```bash
~/amhello % tar ztf amhello-1.0.tar.gz
amhello-1.0/
amhello-1.0/Makefile.am
amhello-1.0/Makefile.in
amhello-1.0/aclocal.m4
amhello-1.0/config.h.in
amhello-1.0/configure
amhello-1.0/configure.ac
amhello-1.0/depcomp
amhello-1.0/install-sh
amhello-1.0/missing
amhello-1.0/src/
amhello-1.0/src/Makefile.am
amhello-1.0/src/Makefile.in
amhello-1.0/src/main.c
~/amhello %
```
Introducing Core Autotools

5 Hello World

6 Introducing Core Autotools

7 Hello World Explained

8 Using Autoconf

9 Using Automake
Two Core Packages

GNU Autoconf

GNU Automake
Two Core Packages

GNU Autoconf

`autoconf` Create *configure* from *configure.ac*.

GNU Automake
Two Core Packages

GNU Autoconf

‘autoconf’ Create *configure* from *configure.ac*.

‘autoheader’ Create *config.h.in* from *configure.ac*.

GNU Automake
Introducing Core Autotools

Two Core Packages

GNU Autoconf

‘autoconf’  Create *configure* from *configure.ac*.
‘autoheader’ Create *config.h.in* from *configure.ac*.
‘autoreconf’ Run all tools in the right order.

GNU Automake

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Using GNU Autotools

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Two Core Packages

GNU Autoconf

‘autoconf’ Create configure from configure.ac.

‘autoheader’ Create config.h.in from configure.ac.

‘autoreconf’ Run all tools in the right order.

‘autoscan’ Scan sources for common portability problems, and related macros missing from configure.ac.

GNU Automake
Two Core Packages

GNU Autoconf

`autoconf` Create *configure* from *configure.ac*.
`autoheader` Create *config.h.in* from *configure.ac*.
`autoreconf` Run all tools in the right order.
`autoscan` Scan sources for common portability problems, and related macros missing from *configure.ac*.
`autoupdate` Update obsolete macros in *configure.ac*.

GNU Automake
Two Core Packages

GNU Autoconf

‘autoconf’ Create \textit{configure} from \textit{configure.ac}.
‘autoheader’ Create \textit{config.h.in} from \textit{configure.ac}.
‘autoreconf’ Run all tools in the right order.
‘autoscan’ Scan sources for common portability problems, and related macros missing from \textit{configure.ac}.
‘autoupdate’ Update obsolete macros in \textit{configure.ac}.
‘ifnames’ Gather identifiers from all \#if/\#ifdef/... directives.

GNU Automake
Two Core Packages

GNU Autoconf

- `autoconf` Create `configure` from `configure.ac`.
- `autoheader` Create `config.h.in` from `configure.ac`.
- `autoreconf` Run all tools in the right order.
- `autoscan` Scan sources for common portability problems, and related macros missing from `configure.ac`.
- `autoupdate` Update obsolete macros in `configure.ac`.
- `ifnames` Gather identifiers from all `#if/#ifdef/...` directives.
- `autom4te` The heart of Autoconf. It drives M4 and implements the features used by most of the above tools. Useful for creating more than just `configure` files.

GNU Automake
Two Core Packages

GNU Autoconf

`autoconf` Create *configure* from *configure.ac*.

`autoheader` Create *config.h.in* from *configure.ac*.

`autoreconf` Run all tools in the right order.

`autoscan` Scan sources for common portability problems, and related macros missing from *configure.ac*.

`autoupdate` Update obsolete macros in *configure.ac*.

`ifnames` Gather identifiers from all `#if/#ifdef/...` directives.

`autom4te` The heart of Autoconf. It drives M4 and implements the features used by most of the above tools. Useful for creating more than just *configure* files.

GNU Automake

`automake` Create *Makefile.ins* from *Makefile.am* and *configure.ac*.
Two Core Packages

GNU Autoconf

‘autoconf’ Create configure from configure.ac.
‘autoheader’ Create config.h.in from configure.ac.
‘autoreconf’ Run all tools in the right order.
‘autoscan’ Scan sources for common portability problems, and related macros missing from configure.ac.
‘autoupdate’ Update obsolete macros in configure.ac.
‘ifnames’ Gather identifiers from all #if/#ifdef/... directives.
‘autom4te’ The heart of Autoconf. It drives M4 and implements the features used by most of the above tools. Useful for creating more than just configure files.

GNU Automake

‘automake’ Create Makefile.ins from Makefile.ams and configure.ac.
‘aclocal’ Scan configure.ac for uses of third-party macros, and gather definitions in aclocal.m4.
Introducing Core Autotools

Two Core Packages

GNU Autoconf

‘autoconf’ Create configure from configure.ac.
‘autoheader’ Create config.h.in from configure.ac.
‘autoreconf’ Run all tools in the right order.
‘autoscan’ Scan sources for common portability problems, and related macros missing from configure.ac.
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‘autom4te’ The heart of Autoconf. It drives M4 and implements the features used by most of the above tools. Useful for creating more than just configure files.

GNU Automake

‘automake’ Create Makefile.ins from Makefile.ams and configure.ac.
‘aclocal’ Scan configure.ac for uses of third-party macros, and gather definitions in aclocal.m4.
Behind ‘autoreconf’

- `configure.ac`
- `Makefile.am`
- `src/Makefile.am`
- `configure`
- `config.h.in`
- `src/Makefile.in`
- `Makefile.in`
Behind ‘autoreconf’

- configure.ac
- Makefile.am
- src/Makefile.am
- configure
- config.h.in
- Makefile.in
- src/Makefile.in
Introducing Core Autotools

Behind ‘autoreconf’

- `configure.ac`
- `Makefile.am`
- `src/Makefile.am`
- ‘aclocal’
- `configure`
- `config.h.in`
- `Makefile.in`
- `src/Makefile.in`
Behind ‘autoreconf’

- `configure.ac`
- `aclocal.m4`
- `src/Makefile.am`
- `Makefile.am`
- ‘aclocal’
- `configure`
- `config.h.in`
- `Makefile.in`
- `src/Makefile.in`
Behind ‘autoreconf’

- configure.ac
- aclocal.m4
- ‘aclocal’
- src/Makefile.am
- ‘autoconf’
- configure
- config.h.in
- Makefile.in
- src/Makefile.in
Introducing Core Autotools

Behind ‘autoreconf’

configure.ac

aclocal.m4

‘aclocal’

‘autoconf’

configure

config.h.in

Makefile.in

src/Makefile.in

Makefile.am

src/Makefile.am
Introducing Core Autotools

Behind ‘autoreconf’

- configure.ac
- aclocal.m4
- Makefile.am
- src/Makefile.am
- ‘aclocal’
- ‘autoheader’
- ‘autoconf’
- configure
- config.h.in
- Makefile.in
- src/Makefile.in
Introducing Core Autotools

Behind ‘autoreconf’

- configure.ac
- aclocal.m4
- `aclocal`
- ‘autoheader’
- `autoconf`
- configure
- config.h.in
- Makefile.in
- src/Makefile.in
- Makefile.am
- src/Makefile.am
Behind ‘autoreconf’
Introducing Core Autotools

Behind ‘autoreconf’

- configure.ac
- aclocal.m4
- ‘aclocal’
- ‘autoconf’
- configure
- config.h.in
- ‘autoheader’
- Makefile.in
- src/Makefile.am
- ‘automake’
- src/Makefile.in
In practice,

- You do not have to remember the interaction of all tools.
- Use `autoreconf --install` to setup the package initially.
- Rely on the rebuild rules (output in *Makefiles*) to rerun the right autotool when you change some input file.
- You only need a rough idea of the purpose of each tool to understand errors. (What tool complains and about what?)
‘autoreconf’ is Your Friend

In practice,

- You do not have to remember the interaction of all tools.
- Use ‘autoreconf --install’ to setup the package initially.
- Rely on the rebuild rules (output in Makefiles) to rerun the right autotool when you change some input file.
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‘autoconf’ Creates configure from configure.ac.
‘autoheader’ Creates config.h.in from configure.ac.
‘automake’ Creates Makefile.ins from Makefile.ams and configure.ac.
‘aclocal’ Scans configure.ac for uses of third-party macros, and gather definitions in aclocal.m4.
‘autom4te’ Autoconf driver for M4. All tools that process configure.ac do so through ‘autom4te’.
amhello's `configure.ac` explained

`configure.ac`

AC_INIT([amhello], [1.0], [bug-report@address])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile src/Makefile])
AC_OUTPUT
amhello’s `configure.ac` explained

```bash
AC_INIT([amhello], [1.0], [bug-report@address])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile src/Makefile])
AC_OUTPUT
```

- Initialize Autoconf. Specify package’s name, version number, and bug-report address.
Initialize Autoconf. Specify package’s name, version number, and bug-report address.

Initialize Automake. Turn on all Automake warnings and report them as errors. This is a foreign package.
foreign Ignores some GNU Coding Standards

```
configure.ac

...  
AM_INIT_AUTOMAKE([foreign -Wall -Werror])  
...
```

```
~/amhello % autoreconf --install
configure.ac:2: installing `./install-sh'
configure.ac:2: installing `./missing'
src/Makefile.am: installing `./depcomp'
```

A. Duret-Lutz
foreign Ignores some GNU Coding Standards

configure.ac without the foreign option

...  
AM_INIT_AUTOMAKE([ -Wall -Werror])  
...

~/amhello % autoreconf --install  
configure.ac:2: installing ‘./install-sh’  
configure.ac:2: installing ‘./missing’  
src/Makefile.am: installing ‘./depcomp’  
Makefile.am: installing ‘./INSTALL’  
Makefile.am: required file ‘./NEWS’ not found  
Makefile.am: required file ‘./README’ not found  
Makefile.am: required file ‘./AUTHORS’ not found  
Makefile.am: required file ‘./ChangeLog’ not found  
Makefile.am: installing ‘./COPYING’  
autoreconf: automake failed with exit status: 1
amhello's `configure.ac` explained

`configure.ac`

- **AC_INIT**([amhello], [1.0], [bug-report@address])
- **AM_INIT_AUTOMAKE**([foreign -Wall -Werror])
- **AC_PROG_CC**
- **AC_CONFIG_HEADERS**([config.h])
- **AC_CONFIG_FILES**([Makefile src/Makefile])
- **AC_OUTPUT**

- Initialize Autoconf. Specify package’s name, version number, and bug-report address.
- Initialize Automake. Turn on all Automake warnings and report them as errors. This is a foreign package.
amhello’s `configure.ac` explained

**configure.ac**

AC_INIT([amhello], [1.0], [bug-report@address])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile src/Makefile])
AC_OUTPUT

- Initialize Autoconf. Specify package’s name, version number, and bug-report address.
- Initialize Automake. Turn on all Automake warnings and report them as errors. This is a foreign package.
- Check for a C compiler.
amhello's *configure.ac* explained

```c
AC_INIT([amhello], [1.0], [bug-report@address])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile src/Makefile])
AC_OUTPUT
```

- Initialize Autoconf. Specify package’s name, version number, and bug-report address.
- Initialize Automake. Turn on all Automake warnings and report them as errors. This is a foreign package.
- Check for a C compiler.
- Declare *config.h* as output header.
Initialize Autoconf. Specify package’s name, version number, and bug-report address.

Initialize Automake. Turn on all Automake warnings and report them as errors. This is a foreign package.

Check for a C compiler.

Declare `config.h` as output header.

Declare `Makefile` and `src/Makefile` as output files.
amhello’s `configure.ac` explained

`configure.ac`

AC_INIT([amhello], [1.0], [bug-report@address])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile src/Makefile])
AC_OUTPUT

- Initialize Autoconf. Specify package’s name, version number, and bug-report address.
- Initialize Automake. Turn on all Automake warnings and report them as errors. This is a foreign package.
- Check for a C compiler.
- Declare `config.h` as output header.
- Declare `Makefile` and `src/Makefile` as output files.
- Actually output all declared files.
amhello's *Makefile.am* explained

**Makefile.am**

```
SUBDIRS = src
```

- Build recursively in `src/`. 
amhello’s *Makefile.am* explained

**Makefile.am**

```
SUBDIRS = src
```

- Build recursively in `src/`.
- Nothing else is declared for the current directory. (The top-level *Makefile.am* is usually short.)
amhello's src/Makefile.am explained

```
src/Makefile.am

bin_PROGRAMS = hello
hello_SOURCES = main.c

We are building some programs.
```
We are building some programs.

These programs will be installed in `bindir`. 

```makefile
bin_PROGRAMS = hello
hello_SOURCES = main.c
```
### Standard File System Hierarchy

<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>
<tr>
<td>bindir</td>
<td>exec-prefix/bin</td>
</tr>
<tr>
<td>libdir</td>
<td>exec-prefix/lib</td>
</tr>
<tr>
<td>includedir</td>
<td>prefix/include</td>
</tr>
<tr>
<td>datarootdir</td>
<td>prefix/share</td>
</tr>
<tr>
<td>datadir</td>
<td>datarootdir</td>
</tr>
<tr>
<td>mandir</td>
<td>datarootdir/man</td>
</tr>
<tr>
<td>infodir</td>
<td>datarootdir/info</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
amhello’s *src/Makefile.am* explained

### *src/Makefile.am*

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

- We are building some programs.
- These programs will be installed in `bindir`. 
We are building some programs.

These programs will be installed in bindir.

There is only one program to build: hello.
amhello's `src/Makefile.am` explained

```makefile
bin_PROGRAMS = hello
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```

- We are building some programs.
- These programs will be installed in `bindir`.
- There is only one program to build: `hello`.
- To create `hello`, just compile `main.c`. 
Using Autoconf

5 Hello World

6 Introducing Core Autotools

7 Hello World Explained

8 Using Autoconf

9 Using Automake
‘autoconf’ is a macro processor.

It converts `configure.ac`, which is a shell script using macro instructions, into `configure`, a full-fledged shell script.
Using Autoconf

From *configure.ac* to *configure* and *config.h.in*

- ‘autoconf’ is a macro processor.
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- Autoconf offers many macros to perform common configuration checks.
- It is not uncommon to have a *configure.ac* without shell constructs, using only macros.
From `configure.ac` to `configure` and `config.h.in`

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‘autoconf’ is a macro processor.

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While processing `configure.ac` it is also possible to trace the occurrences of macros. This is how ‘autoheader’ creates `config.h.in`. It just looks for the macros that `#define` symbols.

The real macro processor actually is GNU M4. Autoconf offers some infrastructure on top of that, plus the pool of macros.
Discovering M4

_example.m4

m4_define(NAME1, Harry)
m4_define(NAME2, Sally)
m4_define(MET, $1 met $2)
MET(NAME1, NAME2)

~ %
Discovering M4

**example.m4**

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Discovering M4

**example.m4**

```
MET(Harry, Sally)
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```
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Harry met Sally
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Discovering M4

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M4(MET(Harry, Sally))

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A. Duret-Lutz
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Can you guess the output of the above?
M4 Quoting Rule of the Thumb

- Quote each macro argument once.
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- So it is processed only after it has been output.
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```
example.m4

m4_define('NAME1', 'Harry, Jr.')
m4_define('NAME2', 'Sally')
m4_define('MET', '$1 met $2')
MET('NAME1', 'NAME2')
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example.m4

NAME1 met NAME2
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- Quote each macro argument once.
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m4_define(NAME1, Harry, Jr.)
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NAME1 met NAME2
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example.m4
M4 Quoting Rule of the Thumb

- Quote each macro argument once.
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```
Harry, Jr. met NAME2
```
M4 Quoting Rule of the Thumb

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M4 Quoting Rule of the Thumb

- Quote each macro argument once.
- So it is processed only after it has been output.

```
example.m4

Harry, Jr. met NAME2
```

M4 Quoting Rule of the Thumb

- Quote each macro argument once.
- So it is processed only after it has been output.

**example.m4**

```m4
m4_define(NAME1, Harry, Jr.)
m4_define(NAME2, Sally)
m4_define(MET, $1 met $2)
```

Harry, Jr. met NAME2
M4 Quoting Rule of the Thumb

- Quote each macro argument once.
- So it is processed only after it has been output.

example.m4

Harry, Jr. met NAME2
M4 Quoting Rule of the Thumb

- Quote each macro argument once.
- So it is processed only after it has been output.

```bash
m4_define(NAME1, Harry, Jr.)
m4_define(NAME2, Sally)
m4_define(MET, $1 met $2)
```

```
Harry, Jr. met Sally
```
M4 Quoting Rule of the Thumb

- Quote each macro argument once.
- So it is processed only after it has been output.

example.m4

```
Harry, Jr. met Sally
```
M4 Quoting Rule of the Thumb

- Quote each macro argument once.
- So it is processed only after it has been output.

```m4
m4_define(NAME1, Harry, Jr.)
m4_define(NAME2, Sally)
m4_define(MET, $1 met $2)

Harry, Jr. met Sally
```

A. Duret-Lutz
Spacing Matters

```example.m4
m4_define('NAME1', 'Harry, Jr.')
m4_define('NAME2', 'Sally')
m4_define('MET', '$1 met $2')
MET('NAME1', 'NAME2')
```

```
~ % m4 -P example.m4
Harry, Jr. met Sally
```
Spacing Matters

- The parenthesis must stick to the macro name.

```m4
m4_define('NAME1', 'Harry, Jr.')
m4_define('NAME2', 'Sally')
m4_define('MET', '$1 met $2')
MET('NAME1', 'NAME2')

~ % m4 -P example.m4
met(NAME1, NAME2)
```
Spacing Matters

- The parenthesis must stick to the macro name.
- Spaces after or inside quotes are part of the arguments.

```
example.m4

m4_define('NAME1', 'Harry, Jr.')

m4_define('NAME2', 'Sally')

m4_define('MET', '$1 met $2')

MET('NAME1', 'NAME2')
```

~ % m4 -P example.m4

```
Harry, Jr. met Sally
```
Spacing Matters

- The parenthesis must stick to the macro name.
- Spaces after or inside quotes are part of the arguments.
- Spaces before quotes are ignored.

**example.m4**

```m4
m4_define('NAME1', 'Harry, Jr.')
m4_define('NAME2', 'Sally')
m4_define('MET', '$1 met $2')
MET('NAME1', 'NAME2')
```

~ % m4 -P example.m4

```
Harry, Jr. met Sally
```
Autoconf on Top of M4

- Autoconf = M4 with more machinery, and many predefined macros.
Autoconf on Top of M4

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- The quotes are [ and ] (instead of ‘ and ’).
Autoconf on Top of M4

- Autoconf = M4 with more machinery, and many predefined macros.
- The quotes are `[ and ]` (instead of `‘ and ’`).
- For this reason we use the `test` command instead of `[ in shell fragments:

```bash
if [ "$x" = "$y" ]; then ...
```
Autoconf on Top of M4

- Autoconf = M4 with more machinery, and many predefined macros.
- The quotes are [ and ] (instead of ‘ and ’).
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```bash
if test "$x" = "$y"; then ...
```
Autoconf on Top of M4

- Autoconf = M4 with more machinery, and many predefined macros.
- The quotes are [ and ] (instead of ‘ and ’).
- For this reason we use the test command instead of [ in shell fragments:

  ```
  if test "$x" = "$y"; then ...
  ```

- Macros are defined with AC_DEFUN.

```plaintext
AC_DEFUN([NAME1], [Harry, Jr.])
AC_DEFUN([NAME2], [Sally])
AC_DEFUN([MET], [$1 met $2])
MET([NAME1], [NAME2])
```
configure.ac

# Prelude.
AC_INIT([PACKAGE], [VERSION], [BUG-REPORT-ADDRESS])

# Checks for programs.

# Checks for libraries.
# Checks for header files.
# Checks for typedefs, structures, and compiler characteristics.
# Checks for library functions.
# Output files.

AC_CONFIG_HEADERS([config.h])

AC_CONFIG_FILES([FILES])

AC_OUTPUT
The Structure of a \textit{configure.ac}

\begin{verbatim}
# Prelude.
AC_INIT([amhello], [1.0], [bug-report@address])

# Checks for programs.

# Checks for libraries.
# Checks for header files.
# Checks for typedefs, structures, and compiler characteristics.
# Checks for library functions.
# Output files.

AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([FILES])
AC_OUTPUT
\end{verbatim}
The Structure of a configure.ac

**configure.ac**

# Prelude.
AC_INIT([amhello], [1.0], [bug-report@address])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])

# Checks for programs.

# Checks for libraries.
# Checks for header files.
# Checks for typedefs, structures, and compiler characteristics.
# Checks for library functions.
# Output files.

AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([FILES])
AC_OUTPUT
configure.ac

# Prelude.
AC_INIT([amhello], [1.0], [bug-report@address])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
# Checks for programs.
AC_PROG_CC
# Checks for libraries.
# Checks for header files.
# Checks for typedefs, structures, and compiler characteristics.
# Checks for library functions.
# Output files.

AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([FILES])
AC_OUTPUT
The Structure of a `configure.ac`

`configure.ac`

```plaintext
# Prelude.
AC_INIT([amhello], [1.0], [bug-report@address])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])

# Checks for programs.
AC_PROG_CC

# Checks for libraries.
# Checks for header files.
# Checks for typedefs, structures, and compiler characteristics.
# Checks for library functions.
# Output files.

AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile src/Makefile])
AC_OUTPUT
```

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Using GNU Autotools

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The Structure of a *configure.ac*

```plaintext
# Prelude.
AC_INIT([amhello], [1.0], [bug-report@address])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
# Checks for programs.
AC_PROG_CC
# Checks for libraries.
# Checks for header files.
# Checks for typedefs, structures, and compiler characteristics.
# Checks for library functions.
# Output files.
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile src/Makefile])
AC_OUTPUT
```
AC_INIT(PACKAGE, VERSION, BUG-REPORT-ADDRESS)

Mandatory Autoconf initialization.
Useful Autoconf Macros for Prelude

AC_INIT(PACKAGE, VERSION, BUG-REPORT-ADDRESS)
Mandatory Autoconf initialization.

AC_PREREQ(VERSION)
Require a minimum Autoconf version. E.g. AC_PREREQ([2.65])
Useful Autoconf Macros for Prelude

\textbf{AC\_INIT(PACKAGE, VERSION, BUG-REPORT-ADDRESS)}

Mandatory Autoconf initialization.

\textbf{AC\_PREREQ(VERSION)}

Require a minimum Autoconf version. E.g. \texttt{AC\_PREREQ([2.65])}

\textbf{AC\_CONFIG\_SRCDIR(FILE)}

A safety check. \texttt{FILE} should be a distributed source file, and this makes sure that ‘configure’ is not run from outer space. E.g. \texttt{AC\_CONFIG\_SRCDIR([src/main.c])}.
Useful Autoconf Macros for Prelude

**AC_INIT(PACKAGE, VERSION, BUG-REPORT-ADDRESS)**
Mandatory Autoconf initialization.

**AC_PREREQ(VERSION)**
Require a minimum Autoconf version. E.g. AC_PREREQ([2.65])

**AC_CONFIG_SRCDIR(FILE)**
A safety check. FILE should be a distributed source file, and this makes sure that ‘configure’ is not run from outer space. E.g.
AC_CONFIG_SRCDIR([src/main.c]).

**AC_CONFIG_AUX_DIR(DIRECTORY)**
Auxiliary scripts such as install-sh and depcomp should be in DIRECTORY. E.g. AC_CONFIG_AUX_DIR([build-aux]).
Preparing the Package

~/amhello % ls -R
.
Makefile.am configure.ac
Makefile.in depcomp*
adlocal.m4 install-sh*
autom4te.cache/ missing*
config.h.in src/ auxiliary tools
configure* used during the build

./autom4te.cache:
output.0 requests traces.1
output.1 traces.0
AC_CONFIG_AUX_DIR Example

```plaintext
configure.ac

AC_INIT([amhello], [1.1], [bug-report@address])

AM_INIT_AUTOMAKE([foreign -Wall -Werror])
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile src/Makefile])
AC_OUTPUT

% autoreconf --install
configure.ac:3: installing ‘missing’
configure.ac:3: installing ‘install-sh’
src/Makefile.am: installing ‘depcomp’
```
**AC_CONFIG_AUX_DIR Example**

```plaintext
configure.ac

AC_INIT([amhello], [1.1], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile src/Makefile])
AC_OUTPUT

% autoreconf --install

configure.ac:3: installing ‘build-aux/missing’
configure.ac:3: installing ‘build-aux/install-sh’
src/Makefile.am: installing ‘build-aux/depcomp’
```
Useful Program Checks

AC_PROG_CC, AC_PROG_CXX, AC_PROG_F77, ...

Compiler checks. (Handle search cross-compilers if needed.)
Useful Program Checks

AC_PROG_CC, AC_PROG_CXX, AC_PROG_F77, ...

Compiler checks. (Handle search cross-compilers if needed.)

AC_PROG_SED, AC_PROG_YACC, AC_PROG_LEX, ...

Find good implementations and set $SED, $YACC, $LEX, etc.
Useful Program Checks

AC_PROG_CC, AC_PROG_CXX, AC_PROG_F77, ...
  Compiler checks. (Handle search cross-compilers if needed.)

AC_PROG_SED, AC_PROG_YACC, AC_PROG_LEX, ...
  Find good implementations and set $SED, $YACC, $LEX, etc.

AC_CHECK_PROGS(VAR, PROGS, [VAL-IF-NOT-FOUND])
  Define VAR to the first PROGS found, or to VAL-IF-NOT-FOUND otherwise.

AC_CHECK_PROGS([TAR], [tar gtar], [:])
if test "$TAR" = :; then
   AC_MSG_ERROR([This package needs tar.])
fi

... and many more
Useful Program Checks

AC_PROG_CC, AC_PROG_CXX, AC_PROG_F77, ...
  Compiler checks. (Handle search cross-compilers if needed.)

AC_PROG_SED, AC_PROG_YACC, AC_PROG_LEX, ...
  Find good implementations and set $SED, $YACC, $LEX, etc.

AC_CHECK_PROGS(VAR, PROGS, [VAL-IF-NOT-FOUND])
  Define VAR to the first PROGS found, or to VAL-IF-NOT-FOUND otherwise.

AC_CHECK_PROGS([TAR], [tar gtar], [:])
if test "$TAR" = ::; then
  AC_MSG_ERROR([This package needs tar.])
fi

... and many more
Useful Autoconf Action Macros

AC_MSG_ERROR(ERROR-DESCRIPTION, [EXIT-STATUS])
Print ERROR-DESCRIPTION (also to config.log) and abort ‘configure’.

AC_MSG_WARN(ERROR-DESCRIPTION)
Likewise, but don’t abort.
Useful Autoconf Action Macros

\textbf{AC\_MSG\_ERROR(\texttt{ERROR-DESCRIPTION, [EXIT-STATUS]})}

Print \texttt{ERROR-DESCRIPTION} (also to \textit{config.log}) and abort ‘configure’.

\textbf{AC\_MSG\_WARN(\texttt{ERROR-DESCRIPTION})}

Likewise, but don’t abort.

\textbf{AC\_DEFINE(\texttt{VARIABLE, VALUE, DESCRIPTION})}

Output the following to \texttt{config.h}.

\begin{verbatim}
/* DESCRIPTION */
#define VARIABLE VALUE
\end{verbatim}
Useful Autoconf Action Macros

**AC_MSG_ERROR(ERROR-DESCRIPTION, [EXIT-STATUS])**
Print ERROR-DESCRIPTION (also to config.log) and abort ‘configure’.

**AC_MSG_WARN(ERROR-DESCRIPTION)**
Likewise, but don’t abort.

**AC_DEFINE(VARIABLE, VALUE, DESCRIPTION)**
Output the following to config.h.

```c
/* DESCRIPTION */
#define VARIABLE VALUE
```

**AC_SUBST(VARIABLE, [VALUE])**
Define $(VARIABLE) as VALUE in Makefile.

AC_SUBST([F00], [foo])
AC_SUBST([F00])
AC_SUBST([F00])

All equivalent.
AC_CHECK_LIB(LIBRARY, FUNCT, [ACT-IF-FOUND], [ACT-IF-NOT])

Check whether LIBRARY exists and contains FUNCT. Execute ACT-IF-FOUND if it does, ACT-IF-NOT otherwise.
Checking for Libraries

AC_CHECK_LIB(LIBRARY, FUNCT, [ACT-IF-FOUND], [ACT-IF-NOT])

Check whether LIBRARY exists and contains FUNCT. Execute ACT-IF-FOUND if it does, ACT-IF-NOT otherwise.

AC_CHECK_LIB([efence], [malloc], [EFENCELIB=-lefence])
AC_SUBST([EFENCELIB])

... we would later use $(EFENCELIB) in the link rule.
\begin{verbatim}
AC_CHECK_LIB(LIBRARY, FUNCT, [ACT-IF-FOUND], [ACT-IF-NOT])

Check whether \texttt{LIBRARY} exists and contains \texttt{FUNCT}.
Execute \texttt{ACT-IF-FOUND} if it does, \texttt{ACT-IF-NOT} otherwise.
\end{verbatim}

\begin{verbatim}
AC_CHECK_LIB([efence], [malloc], [EFENCELIB=-lefence])
AC_SUBST([EFENCELIB])
\end{verbatim}

\begin{verbatim}
... we would later use \$(EFENCELIB) in the link rule.
\end{verbatim}

If \texttt{ACT-IF-FOUND} is not set and the library is found, \texttt{AC_CHECK_LIB}
will do \texttt{LIBS="\-1LIBRARY $LIBS"} and \texttt{#define HAVE_LIBLIBRARY}.
(Automake uses \texttt{$LIBS} for linking everything.)
Checking for Headers

**AC_CHECK_HEADERS** *(HEADERS...)*

Check for **HEADERS** and `#define HAVE_HEADER_H` for each header found.

*Example:*

```plaintext
AC_CHECK_HEADERS([sys/param.h unistd.h])
AC_CHECK_HEADERS([wchar.h])
```

Might `#define HAVE_SYS_PARAM_H`, `HAVE_UNISTD_H`, and `HAVE_WCHAR_H`.

```plaintext
#ifndef HAVE_UNISTD_H
#include <unistd.h>
#endif
```

`AC_CHECK_HEADER(HEADER, [ACT-IF-FOUND], [ACT-IF-NOT])`

Check only one header.
Checking for Headers

**AC_CHECK_HEADERS(HEADERS...)**

Check for HEADERS and `#define HAVE_HEADER_H` for each header found.

AC_CHECK_HEADERS([sys/param.h unistd.h])
AC_CHECK_HEADERS([wchar.h])

Might `#define HAVE_SYS_PARAM_H`, `HAVE_UNISTD_H`, and `HAVE_WCHAR_H`. 
Checking for Headers

**AC_CHECK_HEADERS(HEADERS...)**

Check for HEADERS and #define HAVE_HEADER_H for each header found.

```
AC_CHECK_HEADERS([sys/param.h unistd.h])
AC_CHECK_HEADERS([wchar.h])
```

Might #define HAVE_SYS_PARAM_H, HAVE_UNISTD_H, and HAVE_WCHAR_H.

```
#if HAVE_UNISTD_H
#include <unistd.h>
#endif
```
AC_CHECK_HEADERS(HEADERS...)  
Check for HEADERS and define HAVE_HEADER_H for each header found.

AC_CHECK_HEADERS([sys/param.h unistd.h])  
AC_CHECK_HEADERS([wchar.h])

Might #define HAVE_SYS_PARAM_H, HAVE_UNISTD_H, and HAVE_WCHAR_H.

#if HAVE_UNISTD_H  
#include <unistd.h>  
#endif

AC_CHECK_HEADER(HEADER, [ACT-IF-FOUND], [ACT-IF-NOT])  
Check only one header.
Output Commands

**AC_CONFIG_HEADERS (HEADERS...)**
Create HEADER for all HEADER.in. Use only one such header unless you know what you are doing (‘autoheader’ creates HEADER.in only for the first HEADER).
HEADERS contain definitions made with AC_DEFINE.
Output Commands

**AC_CONFIG_HEADERS(HEADERS...)**
Create HEADER for all HEADER.in. Use only one such header unless you know what you are doing (‘autoheader’ creates HEADER.in only for the first HEADER).
HEADERS contain definitions made with AC_DEFINE.

**AC_CONFIG_HEADERS([config.h])**

Will create config.h from config.h.in
Output Commands

**AC_CONFIG_HEADERS(HEADERS...)**

Create **HEADER** for all **HEADER.in**. Use only one such header unless you know what you are doing (‘autoheader’ creates **HEADER.in** only for the first **HEADER**).

**HEADERS** contain definitions made with **AC_DEFINE**.

**AC_CONFIG_HEADERS([[config.h:config.hin]])**

Will create **config.h** from **config.hin** (DJGPP supports only 1 dot).
Output Commands

**AC_CONFIG_HEADERS(HEADERS...)**
Create HEADER for all HEADER.in. Use only one such header unless you know what you are doing (‘autoheader’ creates HEADER.in only for the first HEADER).
HEADERS contain definitions made with AC_DEFINE.

```
AC_CONFIG_HEADERS([config.h:config.hin])
```

Will create config.h from config.hin (DJGPP supports only 1 dot).

**AC_CONFIG_FILES.FILES...)**
Create FILE for all FILE.in.
FILES contain definitions made with AC_SUBST.

```
AC_CONFIG_FILES([Makefile sub/Makefile script.sh:script.in])
```
Output Commands

**AC_CONFIG_HEADERS(HEADERS...)**

Create **HEADER** for all **HEADER.in**. Use only one such header unless you know what you are doing (‘autoheader’ creates **HEADER.in** only for the first **HEADER**). **HEADERS** contain definitions made with **AC_DEFINE**.

```plaintext
AC_CONFIG_HEADERS([config.h:config.h.in])
```

Will create **config.h** from **config.h.in** (DJGPP supports only 1 dot).

**AC_CONFIG_FILES(FILES...)**

Create **FILE** for all **FILE.in**. **FILES** contain definitions made with **AC_SUBST**.

```plaintext
AC_CONFIG_FILES([Makefile sub/Makfile script.sh:script.in])
```
Output Commands

**AC_CONFIG_HEADERS(HEADERS...)**
Create HEADER for all HEADER.in. Use only one such header unless you know what you are doing (‘autoheader’ creates HEADER.in only for the first HEADER).
HEADERS contain definitions made with AC_DEFINE.

```bash
AC_CONFIG_HEADERS([config.h:config.hin])
```
Will create config.h from config.hin (DJGPP supports only 1 dot).

**AC_CONFIG_FILES(FILES...)**
Create FILE for all FILE.in.
FILES contain definitions made with AC_SUBST.

```bash
AC_CONFIG_FILES([Makefile sub/Makefile script.sh:script.in])
```
Automake creates FILE.in for each FILE that has a FILE.am.
Output Commands

**AC_CONFIG_HEADERS(HEADERS...)**
Create **HEADER** for all **HEADER.in**. Use only one such header unless you know what you are doing (‘autoheader’ creates **HEADER.in** only for the first **HEADER**).
**HEADERS** contain definitions made with **AC_DEFINE**.

**AC_CONFIG_HEADERS([[config.h:config.hin]])**

Will create **config.h** from **config.hin** (DJGPP supports only 1 dot).

**AC_CONFIG_FILES.FILES(FILES...)**
Create **FILE** for all **FILE.in**.
**FILES** contain definitions made with **AC_SUBST**.

**AC_CONFIG_FILES([[Makefile sub/Makefile script.sh:script.in]])**

Automake creates **FILE.in** for each **FILE** that has a **FILE.am**.
It’s legitimate to process non-**Makefiles** too.
AC_CONFIG_FILES([script.sh:script.in]) Example

**script.in**

```bash
#!/bin/sh
SED='@SED@'
TAR='@TAR@
d=$1; shift; mkdir "$d"
for f; do
  "$SED" 's/#.*//' "$f" \
    >"$d/$f"
done
"$TAR" cf "$d.tar" "$d"
```

.in files are templates
AC_CONFIG_FILES([script.sh:script.in]) Example

### script.in

```bash
#!/bin/sh
SED='@SED@'
TAR='@TAR@'
d=$1; shift; mkdir "$d"
for f; do
  "$SED" 's/#.*//' "$f" >"$d/$f"
done
"$TAR" cf "$d.tar" "$d"
```

.in files are templates where @XYZ@ are placeholders for AC_SUBST([XYZ]) definitions.
AC_CONFIG_FILES([script.sh:script.in]) Example

**script.in**

```sh
#!/bin/sh
SED='@SED@'
TAR='@TAR@'
d=$1; shift; mkdir "$d"
for f; do
  "$SED" 's/#.*//' "$f" 
  >"$d/$f"
done
"$TAR" cf "$d.tar" "$d"
```

**script.sh**

```sh
#!/bin/sh
SED='/usr/xpg4/bin/sed'
TAR='/usr/bin/tar'
d=$1; shift; mkdir "$d"
for f; do
  "$SED" 's/#.*//' "$f" 
  >"$d/$f"
done
"$TAR" cf "$d.tar" "$d"
```

.in files are templates where @XYZ@ are placeholders for AC_SUBST([XYZ]) definitions. ‘config.status’ substitutes them.
AC_CONFIG_FILES([script.sh:script.in]) Example

**script.in**

```sh
#!/bin/sh
SED='@SED@'
TAR='@TAR@
d=$1; shift; mkdir "$d"
for f; do
   "$SED" 's/#.*//' "$f" >"$d/$f"
done
"$TAR" cf "$d.tar" "$d"
```

**script.sh**

```sh
#!/bin/sh
SED='@SED@'
TAR='@TAR@'
d=$1; shift; mkdir "$d"
for f; do
   "$SED" 's/#.*//' "$f" >"$d/$f"
done
"$TAR" cf "$d.tar" "$d"
```

.in files are templates where @XYZ@ are placeholders for AC_SUBST([XYZ]) definitions. ‘config.status’ substitutes them.

Makefile.ins also use @XYZ@ as placeholders but Automake makes all XYZ=@XYZ@ definitions and you may simply use $(XYZ) as needed.
Using Automake

5 Hello World

6 Introducing Core Autotools

7 Hello World Explained

8 Using Autoconf

9 Using Automake
Automake Principles

Automake helps creating portable and GNU-standard compliant Makefiles.
Automake Principles

- Automake helps creating portable and **GNU-standard compliant Makefiles**.
  - You may be used to other kinds of build systems.
    (E.g., no VPATH builds, but all objects go into `obj/`.)
Automake Principles

- Automake helps creating portable and GNU-standard compliant `Makefiles`.
  - You may be used to other kinds of build systems. (E.g., no VPATH builds, but all objects go into `obj/`.)
  - Do not use Automake if you do not like the GNU Build System: Automake will get in your way if you don’t fit the mold.
Automake Principles

- Automake helps creating portable and GNU-standard compliant Makefiles.
  - You may be used to other kinds of build systems. (E.g., no VPATH builds, but all objects go into obj/.)
  - Do not use Automake if you do not like the GNU Build System: Automake will get in your way if you don’t fit the mold.
- ‘automake’ creates complex Makefile.ins from simple Makefile.ams.
Automake helps creating portable and GNU-standard compliant *Makefiles*.

- You may be used to other kinds of build systems. (E.g., no VPATH builds, but all objects go into *obj/*.)
- Do not use Automake if you do not like the GNU Build System: Automake will get in your way if you don’t fit the mold.

- ‘automake’ creates complex *Makefile.ins* from simple *Makefile.ams*.
- Consider *Makefile.ins* as internal details.
Automake Principles

- Automake helps creating portable and GNU-standard compliant `Makefile`
- You may be used to other kinds of build systems.
  - (E.g., no VPATH builds, but all objects go into `obj/`.)
  - Do not use Automake if you do not like the GNU Build System: Automake will get in your way if you don’t fit the mold.
- ‘automake’ creates complex `Makefile.ins` from simple `Makefile.ams`.
  - Consider `Makefile.ins` as internal details.
- `Makefile.ams` follow roughly the same syntax as `Makefile` however they usually contains only variable definitions.
Automake Principles

- Automake helps creating portable and GNU-standard compliant *Makefiles*.
  - You may be used to other kinds of build systems.
    (E.g., no VPATH builds, but all objects go into *obj/.*).
  - Do not use Automake if you do not like the GNU Build System:
    Automake will get in your way if you don’t fit the mold.

- ‘automake’ creates complex *Makefile.ins* from simple *Makefile.ams*.
  - Consider *Makefile.ins* as internal details.

- *Makefile.ams* follow roughly the same syntax as *Makefiles* however
  they usually contains only variable definitions.
  - ‘automake’ creates build rules from these definitions.
Automake Principles

- Automake helps creating portable and GNU-standard compliant Makefiles.
  - You may be used to other kinds of build systems. (E.g., no VPATH builds, but all objects go into `obj/`.)
  - Do not use Automake if you do not like the GNU Build System: Automake will get in your way if you don’t fit the mold.

- ‘automake’ creates complex `Makefile.ins` from simple `Makefile.ams`.
  - Consider `Makefile.ins` as internal details.

- `Makefile.ams` follow roughly the same syntax as `Makefiles` however they usually contains only variable definitions.
  - ‘automake’ creates build rules from these definitions.
  - It’s OK to add extra `Makefile` rules in `Makefile.am`: ‘automake’ will preserve them in the output.
Declaring Automake in *configure.ac*

```plaintext
AM_INIT_AUTOMAKE([OPTIONS...])
```

Check for tools needed by ‘automake’-generated *Makefiles.*
The Structure of a configure.ac

configure.ac

# Prelude.
AC_INIT([amhello], [1.0], [bug-report@address])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
# Checks for programs.

# Checks for libraries.
# Checks for header files.
# Checks for typedefs, structures, and compiler characteristics.
# Checks for library functions.
# Output files.

AC_CONFIG_FILES([FILES])
AC_OUTPUT
AM_INIT_AUTOMAKE([OPTIONS...])

Check for tools needed by ‘automake’-generated Makefiles.
Useful options:

-Wall Turn all warnings on.
-Werror Report warnings as errors.
foreign Relax some GNU standard requirements.
  1.11.1 Require a minimum version of ‘automake’.
  dist-bzip2 Also create tar.bz2 archives during ‘make dist’ and ‘make distcheck’.
  tar-ustar Create tar archives using the ustar format.
Declaring Automake in *configure.ac*

**AM_INIT_AUTOMAKE([OPTIONS...])**

Check for tools needed by ‘automake’-generated Makefiles.

Useful options:

- `-Wall` Turn all warnings on.
- `-Werror` Report warnings as errors.
- `foreign` Relax some GNU standard requirements.
- `1.11.1` Require a minimum version of ‘automake’.
- `dist-bzip2` Also create tar.bz2 archives during ‘make dist’ and ‘make distcheck’.
- `tar-ustar` Create tar archives using the ustar format.

**AC_CONFIG_FILES(FILES...)**

Automake creates FILE.in for each FILE that has a FILE.am.

**AC_CONFIG_FILES([Makefile sub/Makefile])**

... and write Makefile.am and sub/Makefile.am.
where_PRIMARY Convention for Declaring Targets

*Makefile.am*

```
where_PRIMARY = targets ...
```
where_PRIMARY Convention for Declaring Targets

Makefile.am

where_PRIMARY = targets ...

targets should be built as...

_PROGRAMS
_LIBRARIES
_LTLIBRARIES (Libtool libraries)
_HEADERS
_SCRIPTS
_DATA
where_PRIMARY Convention for Declaring Targets

**Makefile.am**

```
where_PRIMARY = targets ...
```

targets should be installed in...

- `bin_ $(bindir)`
- `lib_ $(libdir)`
- ...

targets should be built as...

- `_PROGRAMS`
- `_LIBRARIES`
- `_LTLIBRARIES` (Libtool libraries)
- `_HEADERS`
- `_SCRIPTS`
- `_DATA`
<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>
<tr>
<td>bindir</td>
<td>exec-prefix/bin</td>
</tr>
<tr>
<td>libdir</td>
<td>exec-prefix/lib</td>
</tr>
<tr>
<td>...</td>
<td></td>
</tr>
<tr>
<td>includedir</td>
<td>prefix/include</td>
</tr>
<tr>
<td>datarootdir</td>
<td>prefix/share</td>
</tr>
<tr>
<td>datadir</td>
<td>datarootdir</td>
</tr>
<tr>
<td>mandir</td>
<td>datarootdir/man</td>
</tr>
<tr>
<td>infodir</td>
<td>datarootdir/info</td>
</tr>
<tr>
<td>...</td>
<td></td>
</tr>
</tbody>
</table>
where_PRIMARY Convention for Declaring Targets

**Makefile.am**

```
where_PRIMARY = targets ...
```

targets should be installed in...

```
bin_ $(bindir)
lib_ $(libdir)
...
```

targets should be built as...

```
PROGRAMS
_LIBRARIES
_LTLIBRARIES (Libtool libraries)
_HEADERS
_SCRIPTS
_DATA
```
where_Primary Convention for Declaring Targets

```
Makefile.am
where_Primary = targets ...
```

targets should be installed in...
- bin_ $(bindir)
- lib_ $(libdir)
- ...
- custom_ $(customdir)
  You define customdir.

targets should be built as...
  _PROGRAMS
  _LIBRARIES
  _LTLIBRARIES  (Libtool libraries)
  _HEADERS
  _SCRIPTS
  _DATA
where_PRIMARY Convention for Declaring Targets

**Makefile.am**

```makefile
where_PRIMARY = targets ...
```

targets should be installed in...

```makefile
bin_ $(bindir)
lib_ $(libdir)
... 
custom_ $(customdir)
```

You define customdir.

noinst_ Not installed.

targets should be built as...

```makefile
_PROGRAMS
_LIBRARIES
_LTLIBRARIES (Libtool libraries)
_HEADERS
_SCRIPTS
_DATA
```
Using Automake

where_PRIMARY Convention for Declaring Targets

\textit{Makefile.am}

\begin{verbatim}
where_PRIMARY = targets ...
\end{verbatim}

targets should be installed in...
  \begin{itemize}
  \item bin_ \$(bindir)
  \item lib_ \$(libdir)
  \item custom_ \$(customdir)
  \end{itemize}

You define customdir.

noinst_ Not installed.

check_ Built by ‘make check’.

targets should be built as...
  \begin{itemize}
  \item \_PROGRAMS
  \item \_LIBRARIES
  \item \_LTLIBRARIES (Libtool libraries)
  \item \_HEADERS
  \item \_SCRIPTS
  \item \_DATA
  \end{itemize}
where_PRIMARY Convention for Declaring Targets

Makefile.am

\texttt{option\_where\_PRIMARY = targets ...}

targets should be installed in...

\begin{itemize}
  \item \texttt{bin\_ $(bindir)}$
  \item \texttt{lib\_ $(libdir)}$
  \item \texttt{ custom\_ $(customdir)}$
    \begin{itemize}
    \item You define customdir.
    \end{itemize}
  \item \texttt{noinst\_ Not installed.}$
  \item \texttt{check\_ Built by ‘make check’}$
\end{itemize}

targets should be built as...

\begin{itemize}
  \item \texttt{ _PROGRAMS}$
  \item \texttt{ _LIBRARIES}$
  \item \texttt{ _LTLIBRARIES (Libtool libraries)}$
  \item \texttt{ _HEADERS}$
  \item \texttt{ _SCRIPTS}$
  \item \texttt{ _DATA}$
\end{itemize}

Optionally:

\begin{itemize}
  \item \texttt{ dist\_ Distribute targets (if not the default)}$
  \item \texttt{ nodist\_ Don’t.}$
\end{itemize}
Declaring Sources

**Makefile.am**

```
bin_PROGRAMS = foo run-me
foo_SOURCES = foo.c foo.h print.c print.h
run_me_SOURCES = run.c run.h print.c
```

- These programs will be installed in `$(bindir)`. 
Declaring Sources

**Makefile.am**

```makefile
bin_PROGRAMS = foo run-me
foo_SOURCES = foo.c foo.h print.c print.h
run_me_SOURCES = run.c run.h print.c
```

- These programs will be installed in `${bindir}`.
- The sources of each `program` go into `program_SOURCES`. 
Declaring Sources

**Makefile.am**

```makefile
bin_PROGRAMS = foo run-me
foo_SOURCES = foo.c foo.h print.c print.h
run_me_SOURCES = run.c run.h print.c
```

- These programs will be installed in `$(bindir)`.
- The sources of each program go into `program_SOURCES`.
- Non-alphanumerics are mapped to `_'.
Declaring Sources

**Makefile.am**

```plaintext
bin_PROGRAMS = foo run-me
foo_SOURCES = foo.c foo.h print.c print.h
run_me_SOURCES = run.c run.h print.c
```

- These programs will be installed in `$(bindir)`.  
- The sources of each program go into `program_SOURCES`. 
- Non-alphanumeric characters are mapped to `.`. 
- Automake automatically computes the list of objects to build and link from these files.
Declaring Sources

**Makefile.am**

```plaintext
bin_PROGRAMS = foo run-me
foo_SOURCES = foo.c foo.h print.c print.h
run_me_SOURCES = run.c run.h print.c
```

- These programs will be installed in `$\{bindir\}`.
- The sources of each `program` go into `program_SOURCES`.
- Non-alphanumeric characters are mapped to `\_`.
- Automake automatically computes the list of objects to build and link from these files.
- Header files are not compiled. We list them only so they get distributed (Automake does not distribute files it does not know about).
Declaring Sources

**Makefile.am**

```makefile
bin_PROGRAMS = foo run-me
foo_SOURCES = foo.c foo.h print.c print.h
run_me_SOURCES = run.c run.h print.c
```

- These programs will be installed in `$(bindir)`.  
- The sources of each program go into `program_SOURCES`.  
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- Header files are not compiled. We list them only so they get distributed (Automake does not distribute files it does not know about).
- It's OK to use the same source for two programs.
Declaring Sources

**Makefile.am**

```makefile
bin_PROGRAMS = foo run-me
foo_SOURCES = foo.c foo.h print.c print.h
run_me_SOURCES = run.c run.h print.c
```

- These programs will be installed in `$(bindir)`.  
- The sources of each program go into `program SOURCES`.  
- Non-alphanumeric characters are mapped to `_' .  
- Automake automatically computes the list of objects to build and link from these files.  
- Header files are not compiled. We list them only so they get distributed (Automake does not distribute files it does not know about).  
- It’s OK to use the same source for two programs.  
- Compiler and linker are inferred from the extensions.
(Static) Libraries

- Add `AC_PROG_RANLIB` to `configure.ac`.

```makefile.am
lib_LIBRARIES = libfoo.a libbar.a
libfoo_a_SOURCES = foo.c privfoo.h
libbar_a_SOURCES = bar.c privbar.h
include_HEADERS = foo.h bar.h
```

These libraries will be installed in `$(libdir)`. Library names must match `lib*.a`.

Public headers will be installed in `$(includedir)`. Private headers are not installed, like ordinary source files.
(Static) Libraries

- Add AC_PROG_RANLIB to `configure.ac`.

**Makefile.am**

```plaintext
lib_LIBRARIES = libfoo.a libbar.a
libfoo_a_SOURCES = foo.c privfoo.h
libbar_a_SOURCES = bar.c privbar.h
include_HEADERS = foo.h bar.h
```
(Static) Libraries

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**Makefile.am**

```plaintext
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libfoo_a_SOURCES = foo.c privfoo.h
libbar_a_SOURCES = bar.c privbar.h
include_HEADERS = foo.h bar.h
```

- These libraries will be installed in `$(libdir)`.
(Static) Libraries

- Add AC_PROG_RANLIB to configure.ac.

**Makefile.am**

```plaintext
lib_LIBRARIES = libfoo.a libbar.a
libfoo_a_SOURCES = foo.c privfoo.h
libbar_a_SOURCES = bar.c privbar.h
include_HEADERS = foo.h bar.h
```

- These libraries will be installed in $(libdir).
- Library names must match lib*.a.
(Static) Libraries

- Add AC_PROG_RANLIB to configure.ac.

```makefile
lib_LIBRARIES = libfoo.a libbar.a
libfoo_a_SOURCES = foo.c privfoo.h
libbar_a_SOURCES = bar.c privbar.h
include_HEADERS = foo.h bar.h
```

- These libraries will be installed in $(libdir).
- Library names must match lib*.a.
- Public headers will be installed in $(includedir).
(Static) Libraries

- Add `AC_PROG_RANLIB` to `configure.ac`.

**Makefile.am**

```makefile
lib_LIBRARIES = libfoo.a libbar.a
libfoo_a_SOURCES = foo.c privfoo.h
libbar_a_SOURCES = bar.c privbar.h
include_HEADERS = foo.h bar.h
```

- These libraries will be installed in `$\text{libdir}$`.
- Library names must match `lib*.a`.
- Public headers will be installed in `$\text{includedir}$`.
- Private headers are not installed, like ordinary source files.
Directory Layout

- You may have one *Makefile* (hence one *Makefile.am*) per directory.
You may have one Makefile (hence one Makefile.am) per directory.

They must all be declared in configure.ac.

configure.ac

AC_CONFIG_FILES([Makefile lib/Makefile src/Makefile src/dira/Makefile src/dirb/Makefile])
Directory Layout

- You may have one **Makefile** (hence one **Makefile.am**) per directory.
- They must all be declared in **configure.ac**.

```
configure.ac

AC_CONFIG_FILES([Makefile lib/Makefile src/Makefile
                 src/dira/Makefile src/dirb/Makefile])
```

- ‘make’ is run at the top-level.
- **Makefile.am**s should fix the order in which to recurse directories using the **SUBDIRS** variable.
Directory Layout

- You may have one *Makefile* (hence one *Makefile.am*) per directory.
- They must all be declared in *configure.ac*.

**configure.ac**

```bash
AC_CONFIG_FILES([Makefile lib/Makefile src/Makefile
                 src/dira/Makefile src/dirb/Makefile])
```

- ‘make’ is run at the top-level.
- *Makefile.am*s should fix the order in which to recurse directories using the `SUBDIRS` variable.

**Makefile.am**

```bash
SUBDIRS = lib src
```

**src/Makefile.am**

```bash
SUBDIRS = dira dirb
```
Directory Layout

- You may have one Makefile (hence one Makefile.am) per directory.
- They must all be declared in configure.ac.

```
configure.ac

AC_CONFIG_FILES(['Makefile lib/Makefile src/Makefile
src/dira/Makefile src/dirb/Makefile'])
```

- ‘make’ is run at the top-level.
- Makefile.am should fix the order in which to recurse directories using the SUBDIRS variable.

```
Makefile.am

SUBDIRS = lib src
```

```
src/Makefile.am

SUBDIRS = dira dirb
```

- The current directory is implicitly built after subdirectories.
Directory Layout

- You may have one `Makefile` (hence one `Makefile.am`) per directory.
- They must all be declared in `configure.ac`.

**configure.ac**

```
AC_CONFIG_FILES([Makefile lib/Makefile src/Makefile
                  src/dira/Makefile src/dirb/Makefile])
```

- `make` is run at the top-level.
- `Makefile.am`s should fix the order in which to recurse directories using the `SUBDIRS` variable.

**Makefile.am**

```
SUBDIRS = lib src
```

**src/Makefile.am**

```
SUBDIRS = dira dirb .
```

- The current directory is implicitly built after subdirectories.
- You can put `.` where you want to override this.
Directory Layout

- You may have one *Makefile* (hence one *Makefile.am*) per directory.
- They must all be declared in *configure.ac*.

```
configure.ac

AC_CONFIG_FILES([Makefile lib/Makefile src/Makefile
src/dira/Makefile src/dirb/Makefile])
```

- ‘make’ is run at the top-level.
- *Makefile.am* should fix the order in which to recurse directories using the `SUBDIRS` variable.

```
Makefile.am

SUBDIRS = lib src
```

```
src/Makefile.am

SUBDIRS = dira . dirb
```

- The current directory is implicitly built after subdirectories.
- You can put ‘.’ where you want to override this.
You may have one `Makefile` (hence one `Makefile.am`) per directory.

They must all be declared in `configure.ac`.

```
configure.ac

AC_CONFIG_FILES([Makefile lib/Makefile src/Makefile
                src/dira/Makefile src/dirb/Makefile])
```

- ‘make’ is run at the top-level.
- `Makefile.am`s should fix the order in which to recurse directories using the `SUBDIRS` variable.

```
Makefile.am

SUBDIRS = lib src
```

```
src/Makefile.am

SUBDIRS = . dira dirb
```

- The current directory is implicitly built after subdirectories.
- You can put ‘.’ where you want to override this.
$(srcdir) and VPATH Builds

- Remember VPATH builds: a source file is not necessary in the current directory.
Parallel Build Trees (a.k.a. VPATH Builds)

Objects files, programs, and libraries are built where `configure` was run.

```
~ % 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
...
```

Sources files are in `~/amhello-1.0/`, built files are all in `~/amhello-1.0/build/`.
$(srcdir) and VPATH Builds

- Remember VPATH builds: a source file is not necessary in the current directory.
- There are two twin trees: the **build tree**, and the **source tree**.
  - Makefile and objects files are in the build tree.
  - Makefile.in, Makefile.am, and source files are in the source tree.
  - If `./configure` is run in the current directory, the two trees are one.
Remember VPATH builds: a source file is not necessary in the current directory.

There are two twin trees: the build tree, and the source tree.

- Makefile and objects files are in the build tree.
- Makefile.in, Makefile.am, and source files are in the source tree.
- If ‘./configure’ is run in the current directory, the two trees are one.

In each Makefile, ‘config.status’ will define $(srcdir): the path to the matching source directory.
$(srcdir) and VPATH Builds

- Remember VPATH builds: a source file is not necessary in the current directory.
- There are two twin trees: the **build tree**, and the **source tree**.
  - *Makefile* and objects files are in the build tree.
  - *Makefile.in, Makefile.am*, and source files are in the source tree.
  - If `./configure` is run in the current directory, the two trees are one.
- In each *Makefile*, `config.status` will define $(srcdir): the path to the matching source directory.
- When referring to sources files or targets in Automake variables, you do not have to worry about *source vs. build*, because `make` will check both directories.
Remember VPATH builds: a source file is not necessary in the current directory.

There are two twin trees: the **build tree**, and the **source tree**.
- *Makefile* and objects files are in the build tree.
- *Makefile.in*, *Makefile.am*, and source files are in the source tree.
- If `./configure` is run in the current directory, the two trees are one.

In each *Makefile*, `config.status` will define `${srcdir}`: the path to the matching source directory.

When referring to sources files or targets in Automake variables, you do not have to worry about *source* vs. *build*, because `make` will check both directories.

You may need `${srcdir}` when specifying flags for tools, or writing custom commands. E.g., to tell the compiler to include headers from *dir/*, you should write `-I${srcdir}/dir`, not `-Idir`. (`-Idir` would fetch headers from the build tree.)
Convenience Libraries

**lib/Makefile.am**

```plaintext
noinst_LIBRARIES = libcompat.a
libcompat_a_SOURCES = xalloc.c xalloc.h
```

This is a convenience library, used only when building the package.

LDADD is added when linking all programs.

AM_CPPFLAGS contains additional preprocessor flags.

You can use per-target variables: they apply to a single program.
Convenience Libraries

**lib/Makefile.am**

- `noinst_LIBRARIES = libcompat.a`
- `libcompat_a_SOURCES = xalloc.c xalloc.h`

- This is a convenience library, used only when building the package.
Convenience Libraries

`lib/Makefile.am`

noinst_LIBRARIES = libcompat.a
libcompat_a_SOURCES = xalloc.c xalloc.h

- This is a convenience library, used only when building the package.

`src/Makefile.am`

LDADD = ../lib/libcompat.a
AM_CPPFLAGS = -I$(srcdir)/../lib
bin_PROGRAMS = foo run-me
foo_SOURCES = foo.c foo.h print.c print.h
run_me_SOURCES = run.c run.h print.c
Convenience Libraries

```
lib/Makefile.am
```

- `noinst_LIBRARIES = libcompat.a`
- `libcompat_a_SOURCES = xalloc.c xalloc.h`

- This is a convenience library, used only when building the package.

```
src/Makefile.am
```

- `LDADD = ../lib/libcompat.a`
- `AM_CPPFLAGS = -I$(srcdir)/../lib`
- `bin_PROGRAMS = foo run-me`
- `foo_SOURCES = foo.c foo.h print.c print.h`
- `run_me_SOURCES = run.c run.h print.c`

- `LDADD` is added when linking all programs.
Convenience Libraries

lib/Makefile.am

noinst_LIBRARIES = libcompat.a
libcompat_a_SOURCES = xalloc.c xalloc.h

- This is a convenience library, used only when building the package.

src/Makefile.am

LDADD = ../lib/libcompat.a
AM_CPPFLAGS = -I$(srcdir)/../lib
bin_PROGRAMS = foo run-me
foo_SOURCES = foo.c foo.h print.c print.h
run_me_SOURCES = run.c run.h print.c

- LDADD is added when linking all programs.
- AM_CPPFLAGS contains additional preprocessor flags.
Convenience Libraries

**lib/Makefile.am**

- `noinst_LIBRARIES = libcompat.a`
- `libcompat_a_SOURCES = xalloc.c xalloc.h`

- This is a convenience library, used only when building the package.

**src/Makefile.am**

- `bin_PROGRAMS = foo run-me`
- `foo_SOURCES = foo.c foo.h print.c print.h`
- `run_me_SOURCES = run.c run.h print.c`
- `run_me_LDADD = ../lib/libcompat.a`
- `run_me_CPPFLAGS = -I$(srcdir)/../lib`

- **LDADD** is added when linking all programs.
- **AM_CPPFLAGS** contains additional preprocessor flags.
- You can use per-target variables: they apply to a single program.
Per-Target Flags

Assuming foo is a program or library:

- **foo_CFLAGS** Additional C compiler flags
- **foo_CPPFLAGS** Additional preprocessor flags (\(-I\)s and \(-D\)s)

The default value for foo_XXXFLAGS is $(AM_XXXFLAGS).
Per-Target Flags

Assuming **foo** is a program or library:

- **foo_CFLAGS** Additional C compiler flags
- **foo_CPPFLAGS** Additional preprocessor flags (`-Is` and `-Ds`)
- **foo_LDADD** Additional link objects, `-ls` and `-Ls` (if **foo** is a program)
- **foo_LIBADD** Additional link objects, `-ls` and `-Ls` (if **foo** is a library)
- **foo_LDFLAGS** Additional linker flags

The default value for **foo_XXXFLAGS** is `$\text{AM}_{XXX}\text{FLAGS}$`. 
Per-Target Flags

Assuming foo is a program or library:

- `foo_CFLAGS` Additional C compiler flags
- `foo_CPPFLAGS` Additional preprocessor flags (`-I` and `-D`)
- `foo_LDADD` Additional link objects, `-l` and `-L` (if foo is a program)
- `foo_LIBADD` Additional link objects, `-l` and `-L` (if foo is a library)
- `foo_LDFLAGS` Additional linker flags

The default value for `foo_XXXFLAGS` is `$(AM_XXXFLAGS)`. Use plain file names to refer to libraries inside your package (keep `-l` and `-L` for external libraries only).

```
src/Makefile.am
```

```makefile
bin_PROGRAMS = foo run-me
tmp_SOURCES = foo.c foo.h print.c print.h
run_me_SOURCES = run.c run.h print.c
run_me_CPPFLAGS = -I$(srcdir)/../lib
run_me_LDADD = ../lib/libcompat.a
```
AC_CHECK_LIB(LIBRARY, FUNCT, [ACT-IF-FOUND], [ACT-IF-NOT])

Check whether LIBRARY exists and contains FUNCT. Execute ACT-IF-FOUND if it does, ACT-IF-NOT otherwise.

AC_CHECK_LIB([efence], [malloc], [EFENCELIB=-leffence])
AC_SUBST([EFENCELIB])

... we would later use $(EFENCELIB) in the link rule.
Per-Target Flags

Assuming foo is a program or library:

- **foo_CFLAGS** Additional C compiler flags
- **foo_CPPFLAGS** Additional preprocessor flags (-Is and -Ds)
- **foo_LDADD** Additional link objects, -ls and -Ls (if foo is a program)
- **foo_LIBADD** Additional link objects, -ls and -Ls (if foo is a library)
- **foo_LDFLAGS** Additional linker flags

The default value for foo_XXXFLAGS is $(AM_XXXFLAGS).

Use plain file names to refer to libraries inside your package (keep -ls and -Ls for external libraries only).

```
src/Makefile.am
```

```
bin_PROGRAMS = foo run-me
foo_SOURCES = foo.c foo.h print.c print.h
run_me_SOURCES = run.c run.h print.c
run_me_CPPFLAGS = -I$(srcdir)/../lib
run_me_LDADD = ../lib/libcompat.a $(EFENCELIB)
```
What Gets Distributed

‘make dist’ and ‘make distcheck’ create a tarball containing:

- All sources declared using ....SOURCES
- All headers declared using ....HEADERS

Common files such as ChangeLog, NEWS, etc.
See ‘automake --help’ for a list of those files.

Extra files or directories listed into EXTRA_DIST.

Makefile.am

SUBDIRS = lib src

... will additionally distribute HACKING.
What Gets Distributed

‘make dist’ and ‘make distcheck’ create a tarball containing:

- All sources declared using ..._SOURCES
- All headers declared using ..._HEADERS
- All scripts declared with dist....._SCRIPTS
- All data files declared with dist....._DATA
- ...

Common files such as ChangeLog, NEWS, etc.

See ‘automake --help’ for a list of those files.

Extra files or directories listed into EXTRA_DIST.

Makefile.am

SUBDIRS = lib src
EXTRA_DIST = HACKING

... will additionally distribute HACKING.
What Gets Distributed

`make dist` and `make distcheck` create a tarball containing:

- All sources declared using `..._SOURCES`
- All headers declared using `..._HEADERS`
- All scripts declared with `dist.....SCRIPTS`
- All data files declared with `dist.....DATA`
- ...
- Common files such as `ChangeLog`, `NEWS`, etc.
  
See `automake --help` for a list of those files.
'make dist' and 'make distcheck' create a tarball containing:

- All sources declared using ..._SOURCES
- All headers declared using ..._HEADERS
- All scripts declared with dist...._SCRIPTS
- All data files declared with dist...._DATA
- ...
- Common files such as ChangeLog, NEWS, etc.
  See 'automake --help' for a list of those files.
- Extra files or directories listed into EXTRA_DIST.
What Gets Distributed

‘make dist’ and ‘make distcheck’ create a tarball containing:

- All sources declared using ..._SOURCES
- All headers declared using ..._HEADERS
- All scripts declared with dist....._SCRIPTS
- All data files declared with dist....._DATA
- ...
- Common files such as ChangeLog, NEWS, etc. See ‘automake --help’ for a list of those files.
- Extra files or directories listed into EXTRA_DIST.

---

Makefile.am

| SUBDIRS = lib src |
| EXTRA_DIST = HACKING |

... will additionally distribute HACKING.
Conditionals: Usage

- *Conditionals* allow for conditional builds and unconditional distribution.
Conditionals: Usage

- *Conditionals* allow for conditional builds and unconditional distribution.

### Conditional Programs

```makefile
bin_PROGRAMS = foo
if WANT_BAR
    bin_PROGRAMS += bar
endif
foo_SOURCES = foo.c
bar_SOURCES = bar.c
```

*bar* is built iff WANT BAR is true.

*bar.o* is linked in *foo* iff WANT BAR is true.

In all cases *foo.c* and *bar.c* are distributed regardless of WANT BAR.

This is portable. 'config.status' will comment rules of Makefile.in that must be disabled.

WANT BAR must be declared and valued in configure.ac.
Conditionals: Usage

- *Conditionals* allow for conditional builds and unconditional distribution.

### Conditional Programs

```
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```

### Conditional Sources

```
bin_PROGRAMS = foo
foo_SOURCES = foo.c
if WANT_BAR
    foo_SOURCES += bar.c
endif
```

*bar* is built iff *WANT_BAR* is true. *bar.o* is linked in *foo* iff *WANT_BAR* is true. In all cases *foo.c* and *bar.c* are distributed regardless of *WANT_BAR*. This is portable. 'config.status' will comment rules of *Makefile.in* that must be disabled. *WANT_BAR* must be declared and valued in *configure.ac*. 
### Conditionals: Usage

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**Conditional Sources**

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bin_PROGRAMS = foo
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```
AM_CONDITIONAL(NAME, CONDITION)

Declare conditional NAME. CONDITION should be a shell instruction that succeeds iff NAME should be enabled.
**Conditionals: Declaration**

**AM_CONDITIONAL**(NAME, CONDITION)
Declare conditional NAME. CONDITION should be a shell instruction that succeeds iff NAME should be enabled.

**configure.ac**

AC_CHECK_HEADER([bar.h], [use_bar=yes])
AM_CONDITIONAL([WANT_BAR], [test "$use_bar" = yes])

Will enable WANT_BAR only if bar.h is present on the system.
Extending Automake Rules

- The contents of `Makefile.am` are copied almost verbatim to `Makefile.in`.
- ‘automake’ adds new rules and variables in `Makefile.in`, to achieve the semantics of the special variables you have defined.
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  - Build idiosyncratic files (generate a FAQ from some random source)
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Helpful maintenance targets (‘make style-check’):
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It’s OK to define variables that are meaningless to Automake.
- For use in custom rules.
Extending Automake Rules

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  - ...

- It’s OK to define variables that are meaningless to Automake.
  - For use in custom rules.

- Beware of conflicts: your definitions (of variables or rules) will override those of Automake.
  - `-Wall` will diagnose these.
Recommendations

- Use `-Wall -Werror`.

Keep Your Setup Simple (KYSS!). You will spend a large part of time debugging your cunning tricks if you try to automatize too much.

Do not lie to Automake. Automake can be annoying, but when you lie it gets worse!
Recommendations

- Use \texttt{-Wall -Werror}.
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- Do not lie to Automake.
  - Automake can be annoying, but when you lie it gets worse!
Lost? ‘autoreconf’ is Still Your Friend

If ‘make’ fails to rebuild configuration files, run ‘autoreconf’ manually.

~/amhello % autoreconf --install

~/amhello % autoreconf --install --force

~/amhello % make -k maintainer-clean

~/amhello % autoreconf --install --force

Do this only when necessary. Each of these commands will cause your package to take longer to reconfigure and recompile.
Lost? ‘autoreconf’ is Still Your Friend

If ‘make’ fails to rebuild configuration files, run ‘autoreconf’ manually.

```
~/amhello % autoreconf --install
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If this does not help, try harder.

```
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```
Lost? ‘autoreconf’ is Still Your Friend

If ‘make’ fails to rebuild configuration files, run ‘autoreconf’ manually.

```bash
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If this does not help, try harder.

```bash
~/amhello % autoreconf --install --force
```

If this still does not help, try even harder.

```bash
~/amhello % make -k maintainer-clean
~/amhello % autoreconf --install --force
```

Do this only when necessary. Each of these commands will cause your package to take longer to reconfigure and recompile.
Part III

More Autotools

10 Writing and Managing Custom Macros
   • Writing Autoconf Macros
   • Managing Custom Macros with ‘aclocal’

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Writing Autoconf Macros

Writing and Managing Custom Macros
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Writing an Autoconf Macro? Why? How?

Two fundamentally different types of new macros:

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- Macros that implement new tests.
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  - Combination of existing lower-level macros.
  - May not use shell code at all.

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Writing an Autoconf Macro? Why? How?

Two fundamentally different types of new macros:

- Macros that factor related tests in a single reusable entity.
  - High-level.
  - Combination of existing lower-level macros.
  - May not use shell code at all.
- Macros that implements new tests.
  - Low-level.
  - Actually code the check.
  - Need to bother with caching values.
Defining Macros

\texttt{AC\_DEFUN(MACRO-NAME, MACRO-BODY)}

Define \texttt{MACRO-NAME} as \texttt{MACRO-BODY}.

Avoid names that may conflict.
Defining Macros

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Avoid names that may conflict. Macro name spaces:

\texttt{m4}  Original M4 macros, plus M4sugar macros.
\texttt{AS}  M4sh macros (macroized shell constructs)
\texttt{AH}  Autoheader macros
\texttt{AC}  Autoconf macros (written on top of the above layers)

\texttt{AM}  Automake macros
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Defining Macros

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- \texttt{m4} Original M4 macros, plus M4sugar macros.
- \texttt{AS} M4sh macros (macroized shell constructs)
- \texttt{AH} Autoheader macros
- \texttt{AC} Autoconf macros (written on top of the above layers)
  - \texttt{AC\_CHECK} Generic checks.
  - \texttt{AC\_FUNC} Specific function checks.
  - \texttt{AC\_HEADER} Specific header checks.
  - \texttt{AC\_PROG} Specific program checks.
  
  ...

- \texttt{AM} Automake macros
- \texttt{AT} Autotest macros
mkdir() Example

- POSIX systems define `mkdir()` with two arguments.
- On Mingw32 (at least), `mkdir()` takes only one argument.
- On Win32 (at least), the name is `mkdir()` with one argument.
mkdir() Example

- POSIX systems define `mkdir()` with two arguments.
- On Mingw32 (at least), `mkdir()` takes only one argument.
- On Win32 (at least), the name is `_mkdir()` with one argument.

```
#if HAVE_MKDIR
  # if MKDIR_ONE_ARG
  # define mkdir(a,b) mkdir(a)
  # endif
#else
  # if HAVE__MKDIR
  # define mkdir(a,b) _mkdir(a)
  # else
  # error "Don’t know how to create a directory."
  # endif
#endif
```
mkdir() Example

- POSIX systems define `mkdir()` with two arguments.
- On Mingw32 (at least), `mkdir()` takes only one argument.
- On Win32 (at least), the name is `_mkdir()` with one argument.

```
#if HAVE_MKDIR
#if MKDIR_ONE_ARG
#define mkdir(a,b) mkdir(a)
#else
#define mkdir(a,b) _mkdir(a)
#endif
#else
#error "Don’t know how to create a directory."
#endif
```

Let’s write an Autoconf macro to define these C macros.
AC_DEFUN([AX_FUNC_MKDIR],
[AC_CHECK_FUNCS([mkdir _mkdir])
AC_CHECK_HEADERS([io.h])
AX_FUNC_MKDIR_ONE_ARG])

...
Writing and Managing Custom Macros

Writing Autoconf Macros

Writing a High-Level Macro: AX_FUNC_MKDIR

AC_DEFUN([AX_FUNC_MKDIR],
[AC_CHECK_FUNCS([mkdir _mkdir])
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)

- Suggested name space for extension macros.
Writing a High-Level Macro: AX_FUNC_MKDIR

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Writing a High-Level Macro: AX_FUNC_MKDIFR

AC_DEFUN([AX_FUNC_MKDIF],
[AC_CHECK_FUNCS([mkdir _mkdir])
AC_CHECK_HEADERS([io.h])
AX_FUNC_MKDIF_ONE_ARG
])

- Suggested name space for extension macros.
- Use same convention as Autoconf for categorizing macros.
- Defines HAVE_MKDIF and HAVE_MKDIF.
- Defines HAVE_IO_H if io.h exists.
  (mkdir() may also be defined there, and sys/stat.h and unistd.h are always tested by AC_PROG_CC)
Writing and Managing Custom Macros

Writing Autoconf Macros

Writing a High-Level Macro: AXFUNC_MKDIR

AC_DEFUN([AX_FUNC_MKDIR],
[AC_CHECK_FUNCS([mkdir _mkdir])
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AX_FUNC_MKDIR_ONE_ARG
])

- Suggested name space for extension macros.
- Use same convention as Autoconf for categorizing macros.
- Defines HAVE_MKDIR and HAVE__MKDIR.
- Defines HAVE_IO_H if io.h exists.
  (mkdir() may also be defined there, and sys/stat.h and unistd.h are always tested by AC_PROG_CC)
- Will define MKDIR_ONE_ARG... once written.
Checking `mkdir()`’s number of arguments

```plaintext
# _AX_FUNC_MKDIR_ONE_ARG(IF-ONE-ARG, IF-TWO-ARGS)
# -----------------------------------------------
# Execute IF-TWO-ARGS if mkdir() accepts two
# arguments; execute IF-ONE-ARG otherwise.
AC_DEFUN([_AX_FUNC_MKDIR_ONE_ARG],
[AC_COMPILE_IFELSE([AC_LANG_PROGRAM([[
#include <sys/stat.h>
#if HAVE_UNISTD_H
# include <unistd.h>
#endif
#if HAVE_IO_H
# include <io.h>
#endif
]], [[mkdir (".", 0700);]]], [$2], [$1]))
```

Wait! That’s not enough for an Autoconf check: we should also add some checking whether...
Checking `mkdir()`’s number of arguments

```plaintext
# _AX_FUNC_MKDIR_ONE_ARG(IF-ONE-ARG, IF-TWO-ARGS)
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# Execute IF-TWO-ARGS if mkdir() accepts two
# arguments; execute IF-ONE-ARG otherwise.
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#endif
#if HAVE_IO_H
#include <io.h>
#endif
]], [[mkdir (".", 0700);]]), [$2], [$1]])
```

Comments

Showcase of the traditional style used to document autoconf macros.
Checking `mkdir()`'s number of arguments

```plaintext
# _AX_FUNC_MKDIR_ONE_ARG(IF-ONE-ARG, IF-TWO-ARGS)
# -----------------------------------------------
# Execute IF-TWO-ARGS if mkdir() accepts two
# arguments; execute IF-ONE-ARG otherwise.
AC_DEFUN([_AX_FUNC_MKDIR_ONE_ARG],
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#include <sys/stat.h>
#if HAVE_UNISTD_H
#include <unistd.h>
#endif
#if HAVE_IO_H
#include <io.h>
#endif
]], [[mkdir (".", 0700);]]), [$2], [$1]])
```

**AC_COMPILE_IFELSE**
Creates a small program and attempt to compile it. In our case it will execute one of
_AX_FUNC_MKDIR_ONE_ARG’s arguments depending on whether compilation succeeded.
Checking \texttt{mkdir()}’s number of arguments

```c
#pragma GCC diagnostic push
#pragma GCC diagnostic ignore "-Wvariadic-macros"

#define _AX_FUNC_MKDIR_ONE_ARG(IF-ONE-ARG, IF-TWO-ARGS)
#define _AX_DEF_MKDIR_ONE_ARG(IF-ONE-ARG, IF-TWO-ARGS)
#define _AX_COMP_MKDIR_ONE_ARG(IF-ONE-ARG, IF-TWO-ARGS)

#define _AX_FUNC_MKDIR_ONE_ARG(IF-ONE-ARG, IF-TWO-ARGS)
#define _AX_DEF_MKDIR_ONE_ARG(IF-ONE-ARG, IF-TWO-ARGS)
#define _AX_COMP_MKDIR_ONE_ARG(IF-ONE-ARG, IF-TWO-ARGS)

#include <sys/stat.h>
#include <unistd.h>
#include <io.h>

AC_DEFUN([_AX_FUNC_MKDIR_ONE_ARG],
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- Wait! That’s not enough for an Autoconf check: we should also add some checking whether… message on top of this.
Checking `mkdir()`’s number of arguments

```c
# _AX_FUNC_MKDIR_ONE_ARG(IF-ONE-ARG, IF-TWO-ARGS)
# -----------------------------------------------
# Execute IF-TWO-ARGS if mkdir() accepts two
# arguments; execute IF-ONE-ARG otherwise.
AC_DEFUN([_AX_FUNC_MKDIR_ONE_ARG],
[AC_COMPILE_IFELSE([AC_LANG_PROGRAM([[
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#if HAVE_UNISTD_H
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#endif
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```

- Wait! That’s not enough for an Autoconf check: we should also add some checking whether...
- We use the _AX prefix for helper macros not meant to be used directly.
Writing a Low-Level Macro

Low-level macros need to

- print a *checking whether...* message
- do the actual check
- cache the result of the check
The (real) *configure* process

`configure -C` caches results in `config.cache` to speed up reconfigurations.
Writing a Low-Level Macro

Low-level macros need to

- print a *checking whether*... message
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- cache the result of the check

Most of this is achieved via the `AC_CACHE_CHECK` macro.

```
AC_DEFUN(MACRO-NAME, 
[AC_CACHE_CHECK(WHETHER-MESSAGE, 
    CACHE-VARIABLE, 
    CODE-TO-SET-CACHE-VARIABLE) 
    CODE-USING-CACHE-VARIABLE])
```
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- The CACHE-VARIABLE should match *_cv_*.
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[AC_CACHE_CHECK(WHETHER-MESSAGE,
    CACHE-VARIABLE,
    CODE-TO-SET-CACHE-VARIABLE)
CODE-USING-CACHE-VARIABLE]]
)
```

- The `CACHE-VARIABLE` should match `*_cv_*`.
- `CODE-TO-SET-CACHE-VARIABLE` should contain the check. It will be skipped when the cache is used.
- `CODE-USING-CACHE-VARIABLE` is always executed, use `AC_SUBST` and `AC_DEFINE` here.
A Low-Level Macro: AX_FUNC_MKDIR_ONE_ARG

AC_DEFUN([AX_FUNC_MKDIR_ONE_ARG],
[AC_CACHE_CHECK([whether mkdir takes one argument],
    [ax_cv_mkdir_one_arg],
    [_AX_FUNC_MKDIR_ONE_ARG([ax_cv_mkdir_one_arg=yes],
        [ax_cv_mkdir_one_arg=no])])
if test x"$ax_cv_mkdir_one_arg" = xyes; then
    AC_DEFINE([MKDIR_ONE_ARG], 1,
        [Define if mkdir takes only one argument.])
fi] ) # AX_FUNC_MKDIR_ONE_ARG
A Low-Level Macro: AX_FUNC_MKDIR_ONE_ARG

AC_DEFUN([AX_FUNC_MKDIR_ONE_ARG],
[AC_CACHE_CHECK([whether mkdir takes one argument],
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- AC_CACHE_CHECK
  - prints checking whether mkdir...
  - does the check (unless already done)
  - cache the result in ax_cv_mkdir_one_arg
A Low-Level Macro: **AX_FUNC_MKDIR_ONE_ARG**

**AC_DEFUN([AX_FUNC_MKDIR_ONE_ARG],**

**[AC_CACHE_CHECK([whether mkdir takes one argument],**

**[ax_cv_mkdir_one_arg],**

**[_AX_FUNC_MKDIR_ONE_ARG([ax_cv_mkdir_one_arg=yes],**

**[ax_cv_mkdir_one_arg=no])])**

**if test x"$ax_cv_mkdir_one_arg" = xyes; then**

**AC_DEFINE([MKDIR_ONE_ARG], 1,**

**[Define if mkdir takes only one argument.])**

**fi]**) # AX_FUNC_MKDIR_ONE_ARG

- **AC_CACHE_CHECK**
  - prints *checking whether mkdir...*
  - does the check (unless already done)
  - cache the result in ax_cv_mkdir_one_arg

- Keep configuration actions outside **AC_CACHE_CHECK**: they have to be executed whether the check is run or cached.
Recommendations for Writing Autoconf Macros

- Test for features, not for systems.
  - E.g., check whether `mkdir()` takes one argument, not whether you are compiling for Win32.
  - Your package will be more likely to adapt to untested systems.
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- Do not reinvent the wheel.
  - Autoconf comes with a lot of well-tested macros. Use them.
Recommendations for Writing Autoconf Macros

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  - E.g., check for mkdir() even if mkdir() exists.

- Do not reinvent the wheel.
  - Autoconf comes with a lot of well-tested macros. Use them.

- Remember to [quote].

- Read the *Portable Shell* section of the Autoconf manual, before writing shell code.
Recommendations for Writing Autoconf Macros

- Test for features, not for systems.
  - E.g., check whether mkdir() takes one argument, not whether you are compiling for Win32.
  - Your package will be more likely to adapt to untested systems.

- Avoid writing tests that are conditional on previous tests.
  - Have unconditional tests, with conditional actions.
  - E.g., check for mkdir() even if mkdir() exists.

- Do not reinvent the wheel.
  - Autoconf comes with a lot of well-tested macros. Use them.

- Remember to [quote].

- Read the Portable Shell section of the Autoconf manual, before writing shell code.

- Test your macros on different systems.
  - Check test results in config.log.
  - Get accounts on foreign systems (Google for “free shell account”).
Managing Custom Macros with `aclocal`

10 Writing and Managing Custom Macros
   - Writing Autoconf Macros
   - Managing Custom Macros with `aclocal`

11 Libtool

12 Gettext
   - Introducing Gettext
   - Internationalizing a Package, Start to Finish
   - Localizing a Package

13 Nested Packages

14 The End
aclocal.m4 and Third-Party Macros

- ‘autoconf’ knows only the macros it provides. (m4_*, AS_*, AH_*, AC_*, AT_*).
- ‘autoconf’ knows nothing about macro supplied by third-party tools (e.g., Automake’s AM_* macros).
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- aclocal.m4 should define the extra macros required by configure.ac.
- ‘aclocal’ automates the construction of aclocal.m4 from various sources.
Behind ‘autoreconf’

configure.ac

aclocal.m4

configure

config.h.in

Makefile.in

src/Makefile.in

Makefile.am

src/Makefile.am
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- aclocal.m4 should define the extra macros required by configure.ac.
- ‘aclocal’ automates the construction of aclocal.m4 from various sources.

‘aclocal’ searches macros in
- directories specified with -I options
- a system-wide directory (usually /usr/share/aclocal/) where third-party packages may install their macros
- Automake’s own private macro directory
Managing Custom Macros in Your Package

- Create a *m4/* subdirectory.
- Put your macros there.
  E.g., define `AX_FUNC_MKDIR` and `AX_FUNC_MKDIR_ONE_ARG` in `m4/mkdir.m4`.
  (The extension *must* be *.*m4*)
Managing Custom Macros in Your Package

- Create a *m4/* subdirectory.
- Put your macros there.
  E.g., define `AX_FUNC_MKDIR` and `AX_FUNC_MKDIR_ONE_ARG` in `m4/mkdir.m4`.
  (The extension *must* be `*.m4`)
- Add `ACLOCAL_AMFLGS = -I m4` to the top-level `Makefile.am`.
- Add `AC_CONFIG_MACRO_DIR([m4])` to `configure.ac`.

The `ACLOCAL_AMFLGS` are used by ‘autoreconf’ and by the `Makefile` rebuild rule when they need to run ‘aclocal’.
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The `ACLOCAL_AMFLAGS` are used by ‘autoreconf’ and by the `Makefile` rebuild rule when they need to run ‘aclocal’.
Local macros that are used are automatically distributed. (Those that are not used are simply ignored.)
You need such a setup to use Gettext, and Libtool.
10 Writing and Managing Custom Macros
  • Writing Autoconf Macros
  • Managing Custom Macros with ‘aclocal’

11 Libtool

12 Gettext
  • Introducing Gettext
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  • Localizing a Package

13 Nested Packages

14 The End
Almost each system has its own format of shared library

- `libhello.so`
- `libhello.dll`
- `libhello.sl`
- `libhello.dylib`
- `libhello.dylib`
- ...

Building will require different flags

- `-fPIC`
- `-shared`
- `-KPIC`
- `-bM:SRE`

Linking against the library may also require specific flags.

Not all systems support shared libraries.
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Quiz: match each of the above example with its OS.
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- `libhello.dll`
- `libhello.sl`
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- ...

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Not all systems support shared libraries.
Shared Libraries: Libtool’s Solution

- A new library format that abstracts all the others
  - *libhello.la* (libtool archive)
Shared Libraries: Libtool’s Solution

- A new library format that abstracts all the others
  - *libhello.la* (libtool archive)
- A wrapper script for the compiler and linker
  - translates operations involving *libhello.la* into the correct operation for the current system using the real library
Shared Libraries: Libtool’s Solution

- A new library format that abstracts all the others
  - `libhello.la` (libtool archive)
- A wrapper script for the compiler and linker
  - translates operations involving `libhello.la` into the correct operation for the current system using the real library

- In a *Makefile.am*, you simply create and link against `.la` files.
- These operations are translated appropriately.
Libtool will require some local Autoconf macros for all the checks it has to perform. Use an \texttt{m4/} subdirectory as explained earlier.
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- Call \texttt{LT_INIT} in \texttt{configure.ac}.
Setting Up Libtool: Roadmap

- Libtool will require some local Autoconf macros for all the checks it has to perform. Use an `m4/` subdirectory as explained earlier.
- Call `LT_INIT` in `configure.ac`.
- Use `_LTLIBRARIES` to declare libtool archives in `Makefile.am`

```
Makefile.am
lib_LTLIBRARIES = libfoo.la
libfoo_la_SOURCES = foo.c foo.h etc.c
```
Libtool will require some local Autoconf macros for all the checks it has to perform. Use an \texttt{m4/} subdirectory as explained earlier.

Call \texttt{LT\_INIT} in \texttt{configure.ac}.

Use \texttt{_LTLIBRARIES} to declare libtool archives in \texttt{Makefile.am}.

Use \texttt{LDADD} to link against local libtool archives.

\textbf{Makefile.am}

\begin{verbatim}
lib_LTLIBRARIES = libfoo.la
libfoo_la_SOURCES = foo.c foo.h etc.c

bin_PROGRAMS = runme
runme_SOURCES = main.c
runme_LDADD = libfoo.la
\end{verbatim}
Hello World Using Libtool: C Files

### lib/say.c
```c
#include <config.h>
#include <stdio.h>

void say_hello (void)
{
    puts ("Hello World!");
    puts ("This is " PACKAGE_STRING ".");
}
```

### lib/say.h
```c
void say_hello (void);
```

### src/main.c
```c
#include "say.h"

int main (void)
{
    say_hello ();
    return 0;
}
```
Hello World Using Libtool: **Makefile.ams**

### lib/Makefile.am

lib_LTLIBRARIES = libhello.la
libhello_la_SOURCES = say.c say.h

### src/Makefile.am

AM_CPPFLAGS = -I$(srcdir)/../lib
bin_PROGRAMS = hello
hello_SOURCES = main.c
hello_LDADD = ../lib/libhello.la

### Makefile.am

SUBDIRS = lib src
ACLOCAL_AMFLAGS = -I m4
Hello World Using Libtool: `configure.ac`

```plaintext
configure.ac

AC_INIT([amhello], [2.0], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AC_CONFIG_MACRO_DIR([m4])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
LT_INIT
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile lib/Makefile src/Makefile])
AC_OUTPUT
```
Hello World Using Libtool: ‘autoreconf’

~/amhello % ls -R
Hello World Using Libtool: ‘autoreconf’

~/amhello % ls -R
.
Makefile.am  configure.ac  lib/  src/

./lib:
Makefile.am  say.c  say.h

./src:
Makefile.am  main.c
Hello World Using Libtool: ‘autoreconf’

`~/amhello % mkdir m4`
`~/amhello % autoreconf --install`

`~/amhello % ./configure --prefix ~/test`

`~/amhello % make && make install`

`~/amhello % ~/test/bin/hello`

Hello World!

This is amhello 2.0.
Hello World Using Libtool: ‘autoreconf’

~/amhello % mkdir m4
~/amhello % autoreconf --install
libtoolize: putting auxiliary files in AC_CONFIG_AUX_DIR, ‘build-aux’.
libtoolize: copying file ‘build-aux/ltmain.sh’
libtoolize: putting macros in AC_CONFIG_MACRO_DIR, ‘m4’.
libtoolize: copying file ‘m4/libtool.m4’
libtoolize: copying file ‘m4/ltoptions.m4’
libtoolize: copying file ‘m4/ltsugar.m4’
libtoolize: copying file ‘m4/ltversion.m4’
libtoolize: copying file ‘m4/lt~obsolete.m4’
configure.ac:5: installing ‘build-aux/config.guess’
configure.ac:5: installing ‘build-aux/config.sub’
configure.ac:4: installing ‘build-aux/install-sh’
configure.ac:4: installing ‘build-aux/missing’
lib/Makefile.am: installing ‘build-aux/depcomp’
~/amhello %
Hello World Using Libtool: ‘autoreconf’

```bash
~/amhello % mkdir m4
~/amhello % autoreconf --install
...
~/amhello % ./configure --prefix ~/test
...
~/amhello %
```
Hello World Using Libtool: ‘autoreconf’

```bash
~/amhello % mkdir m4
~/amhello % autoreconf --install
...
~/amhello % ./configure --prefix ~/test
...
~/amhello % make & make install
...
~/amhello %
```
Hello World Using Libtool: ‘autoreconf’

~/$amhello % mkdir m4
~/$amhello % autoreconf --install
...
~/$amhello % ./configure --prefix ~/test
...
~/$amhello % make & & make install
...
~/$amhello % ~/test/bin/hello
Hello World!
This is amhello 2.0.
~/$amhello %
What Was Built and Installed

~/amhello % \texttt{ls -R ~/test}

/home/adl/test:
bin/ lib/

/home/adl/test/bin:
hello*

/home/adl/test/lib:
libhello.a libhello.so@ libhello.so.0.0.0*
libhello.la* libhello.so.0@

~/amhello %
What Was Built and Installed

~/amhello % ls -R ~/test
/home/adl/test:
bin/  lib/
/home/adl/test/bin:
hello*
/home/adl/test/lib:
libhello.a  libhello.so@  libhello.so.0.0.0*
libhello.la*  libhello.so.0@
~/amhello % ldd ~/test/bin/hello
libhello.so.0 => /home/adl/test/lib/libhello.so.0 (0xb7fe7000)
libc.so.6 => /lib/tls/libc.so.6 (0xb7e9c000)
lib/ld-linux.so.2 => /lib/ld-linux.so.2 (0xb7fe9b000)
~/amhello %
What Was Built and Installed

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~/amhello % ls -R ~/test
/home/adl/test:
  bin/  lib/
/home/adl/test/bin:
  hello*
/home/adl/test/lib:
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  libhello.la*  libhello.so.0@
~/amhello % ldd ~/test/bin/hello
  libhello.so.0 => /home/adl/test/lib/libhello.so.0 (0xb7fe7000)
  libc.so.6 => /lib/tls/libc.so.6 (0xb7e9c000)
  lib/ld-linux.so.2 => /lib/ld-linux.so.2 (0xb7fea000)
~/amhello % ldd src/hello
  not a dynamic executable
~/amhello %
```
What Was Built and Installed

```bash
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/home/adl/test:
bin/  lib/
/home/adl/test/bin:
hello*
/home/adl/test/lib:
libhello.a  libhello.so@  libhello.so.0.0.0*
libhello.la*  libhello.so.0.0@
~/amhello % ldd ~/test/bin/hello
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libc.so.6 => /lib/tls/libc.so.6 (0xb7e9c000)
lib/ld-linux.so.2 => /lib/ld-linux.so.2 (0xb7fea000)
~/amhello % ldd src/hello
not a dynamic executable
~/amhello % file src/hello
src/hello: Bourne shell script text executable
```
By default, both static and shared libraries are built.

This default can be changed in a package using options passed to `LT_INIT(options...)`

- `disable-shared` do not build shared libraries by default
- `disable-static` do not build static libraries by default

At least one flavor is built, always.

Some systems don't leave any choice.
By default, both static and shared libraries are built.

This default can be changed in a package using options passed to `LT_INIT(options...)`:

- `disable-shared` do not build shared libraries by default
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The installer can override these settings using `configure` options.

- `--enable-shared` build shared libraries
- `--disable-shared` don’t
- `--enable-static` build static libraries
- `--disable-static` don’t
Building Shared or Static Libraries

- By default, both static and shared libraries are built.
- This default can be changed in a package using options passed to `LT_INIT(options...)`:
  - `disable-shared` do not build shared libraries by default
  - `disable-static` do not build static libraries by default
- The installer can override these settings using `configure` options.
  - `--enable-shared` build shared libraries
  - `--disable-shared` don’t
  - `--enable-static` build static libraries
  - `--disable-static` don’t
- At least one flavor is built, always.
- Some systems don’t leave any choice.
The *src/hello* Wrapper Script

- *src/hello* can be a wrapper script
  - Depending on Libtool’s configuration.

```bash
~/amhello %
gdb -q src/hello
```

“*src/hello*”: not in executable format: File format not recognized

(gdb)

Prefix such commands with

```bash
~/amhello %
libtool --mode=execute
gdb -q src/hello
```
The *src/hello* Wrapper Script

- *src/hello* can be a wrapper script
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- The real binary has been built elsewhere
  - Libtool hides it in the build tree (don’t bother about it)

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~/amhello % libtool --mode=execute gdb -q src/hello
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- This wrapper script runs the real binary, and arranges so it finds the not-yet-installed libraries
  - This way *src/hello* can be run, for instance in a test suite

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Do not debug the shell script!

```
~/amhello % gdb -q src/hello
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The *src/hello* Wrapper Script

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```
Versioning libraries allow several versions to coexist.

It ensures programs use the library that implements the interface they require.

Interface = public variables and functions, I/O, formats, protocols, ...

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- Interfaces are identified using integers.
- A program remembers the interface numbers of the libraries it was linked against.
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- A library can implement several interfaces.
  - E.g., adding new functions changes the interface, but does not break old interfaces.
- Hence libtool’s versioning format encodes a range of supported interfaces.
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- A library can implement several interfaces.
  - E.g., adding new functions changes the interface, but does not break old interfaces.
  - Hence libtool’s versioning format encodes a range of supported interfaces.

Interface numbers are not release numbers.
Versioning Libtool Libraries: Version Triplets

**CURRENT**  The latest interface implemented.

**REVISION** The implementation number of CURRENT (read: number of bugs fixed...)

**AGE** The number of interfaces implemented, minus one. The library supports all interfaces between CURRENT — AGE and CURRENT.
Versioning Libtool Libraries: Version Triplets

**CURRENT** The latest interface implemented.

**REVISION** The implementation number of **CURRENT** (read: number of bugs fixed...)

**AGE** The number of interfaces implemented, minus one.

The library supports all interfaces between **CURRENT** − **AGE** and **CURRENT**.

These numbers should be specified using `-version-info`.

```
lib/Makefile.am
```

```
lib_LTLIBRARIES = libhello.la
libhello_la_SOURCES = say.c say.h
libhello_la_LDFLAGS = -version-info CURRENT:REVISION:AGE
```
Versioning Libtool Libraries: Version Triplets

CURRENT  The latest interface implemented.

REVISION  The implementation number of CURRENT (read: number of bugs fixed...)

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These numbers should be specified using --version-info.

```
lib/Makefile.am
```

```
lib_LTLIBRARIES = libhello.la
libhello_la_SOURCES = say.c say.h
libhello_la_LDFLAGS = --version-info 0:0:0
```

The default version is 0:0:0. It’s also a good initial version.
Remember to bump library versions before a release. Suppose the old version was `CURRENT:REVISION:AGE`.

<table>
<thead>
<tr>
<th>If you have</th>
<th>bump the version to</th>
</tr>
</thead>
<tbody>
<tr>
<td>not changed the interface</td>
<td><code>CURRENT : REVISION+1 : AGE</code></td>
</tr>
<tr>
<td>(bug fixes)</td>
<td></td>
</tr>
<tr>
<td>augmented the interface</td>
<td><code>CURRENT +1 : 0 : AGE +1</code></td>
</tr>
<tr>
<td>(new functions)</td>
<td></td>
</tr>
<tr>
<td>broken old interface (e.g. removed functions)</td>
<td><code>CURRENT +1 : 0 : 0</code></td>
</tr>
</tbody>
</table>
Introducing Gettext

10 Writing and Managing Custom Macros
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- Internationalization

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- Internationalization
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- Localization
Introducing Gettext

- **Internationalization**
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  Providing an internationalized package the necessary bits to support one’s native language and cultural habits.
Introducing Gettext

- **Internationalization** = **l18n**
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Introducing Gettext

- Internationalization = I18n
  Changing a program to support for multiple languages and cultural habits.
  - Character handling (unicode...)
  - Locale awareness (date formats, currencies, numbers, time zones, etc.)
  - Localizability
    - Isolate localizable items (messages, pictures, etc.)
    - Implement infrastructure necessary for localizing above items.

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Introducing Gettext

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Introducing Gettext

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The programmer’s work.

Localization = L10n
Providing an internationalized package the necessary bits to support one’s native language and cultural habits.
- Translate localizable items (messages, pictures, etc.) for one language.

The translator’s work.

Gettext = complete toolset for translating messages output by programs.
Translating Messages Made Easy

```c
#include <config.h>
#include <stdio.h>

void say_hello (void)
{
    puts ("Hello World!");
    puts ("This is " PACKAGE_STRING ".");
}
```

- The program is written in English.
#include <config.h>
#include <stdio.h>
#include "gettext.h"
#define _(string) gettext (string)

void say_hello (void)
{
    puts (_("Hello World!"));
    printf (_("This is %s.\n"), PACKAGE_STRING);
}

- The program is written in English.
- Messages that must be translated are marked with `_(...)`.
  - `xgettext` builds catalogs of translatable messages from such strings.
  - Translators will provide translated catalogs for their locale.
The program is written in English.
Messages that must be translated are marked with `_(...).`
  * ‘xgettext’ builds catalogs of translatable messages from such strings.
  * Translators will provide translated catalogs for their locale.

`gettext` looks up the translation of the English message in the current locale’s catalog.
Internationalizing a Package, Start to Finish

10 Writing and Managing Custom Macros
   - Writing Autoconf Macros
   - Managing Custom Macros with ‘aclocal’

11 Libtool

12 Gettext
   - Introducing Gettext
   - Internationalizing a Package, Start to Finish
   - Localizing a Package

13 Nested Packages

14 The End
Roadmap:

1. Start with a non-internationalized Hello World.
2. Invoke AM_GNU_GETTEXT from configure.ac
3. Run ‘gettextize’ to provide the basic infrastructure.
4. Fill in the configuration files left by ‘gettextize’.
5. Update src/Makefile.am to link hello with the necessary library.
6. Update the code:
   - Initialize Gettext in main()
   - Mark translatable strings.
7. Generate messages catalogs automatically.

We’ll talk about localization once this is done.
Non Internationalized Hello World (1/2)

```
src/main.c
#include "say.h"

int main (void) {  
    say_hello ();   
    return 0; 
}

text

src/say.h
#ifndef AMHELLO_SAY_H
#define AMHELLO_SAY_H

void say_hello (void);

#endif

src/say.c
#include <config.h>
#include <stdio.h>

void say_hello (void) {
    puts ("Hello World!");
    puts ("This is " PACKAGE_STRING ".");
}
Non Internationalized Hello World (2/2)

configure.ac

AC_INIT([amhello], [3.0], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile src/Makefile])
AC_OUTPUT

Makefile.am

SUBDIRS = src

src/Makefile.am

bin_PROGRAMS = hello
hello_SOURCES = main.c say.c say.h
Update *configure.ac* for Gettext

```plaintext
configure.ac

AC_INIT([amhello], [3.0], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
AM_GNU_GETTEXT_VERSION([0.17])
AM_GNU_GETTEXT([external])
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile src/Makefile])
AC_OUTPUT
```
Update `configure.ac` for Gettext

`configure.ac`

```plaintext
AC_INIT([amhello], [3.0], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
AM_GNU_GETTEXT_VERSION([0.17])
AM_GNU_GETTEXT([external])
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile src/Makefile])
AC_OUTPUT
```

- `AM_GNU_GETTEXT_VERSION` = *exactly* which Gettext version to use.
Update `configure.ac` for Gettext

```
AC_INIT([amhello], [3.0], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
AM_GNU_GETTEXT_VERSION([0.17])
AM_GNU_GETTEXT([external])
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile src/Makefile])
AC_OUTPUT
```

- `AM_GNU_GETTEXT_VERSION` = *exactly* which Gettext version to use.
- `AM_GNU_GETTEXT([external])`
  - the GNU libc or an external (= not distributed) Gettext library will be used if found
  - NLS (Native Language System) will be disabled otherwise
Running ‘gettextize’

You should run ‘gettextize’:

- A first time, to install the Gettext infrastructure in your package.
- Each time you upgrade Gettext to a new version.

```
~/amhello %
```

```bash
gettextize --copy --no-changelog
```

Install most of the Gettext infrastructure.
Copy `gettext.h` in the source tree, it will be distributed.

Running ‘gettextize’

You should run ‘gettextize’:

- A first time, to install the Gettext infrastructure in your package.
- Each time you upgrade Gettext to a new version.

```
~/amhello % gettextize --copy --no-changelog
[...]
~/amhello %
```

- Install most of the Gettext infrastructure.
Running ‘gettextize’

You should run ‘gettextize’:

- A first time, to install the Gettext infrastructure in your package.
- Each time you upgrade Gettext to a new version.

```
~/amhello % gettextize --copy --no-changelog
[...]
~/amhello % cp /usr/share/gettext/gettext.h src
```

- Install most of the Gettext infrastructure.
- Copy `gettext.h` in the source tree, it will be distributed.
**Gettextize Updated Some Files**

### configure.ac

```plaintext
AC_INIT([amhello], [3.0], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AM_GNU_GETTEXT_VERSION([0.17])
AM_GNU_GETTEXT([external])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile src/Makefile po/Makefile.in])
AC_OUTPUT
```

### Makefile.am

```plaintext
SUBDIRS = po src
ACLOCAL_AMFLAGS = -I m4
EXTRA_DIST = ...
```

### src/Makefile.am

```plaintext
bin_PROGRAMS = hello
hello SOURCES = main.c say.c say.h
```
Fill `po/Makevars.template` and rename it as `po/Makevars`:

```plaintext
po/Makevars

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOMAIN</td>
<td>$(PACKAGE)</td>
</tr>
<tr>
<td>subdir</td>
<td>po</td>
</tr>
<tr>
<td>top_builddir</td>
<td>..</td>
</tr>
<tr>
<td>XGETTEXT_OPTIONS</td>
<td>--keyword=_ --keyword=N_</td>
</tr>
<tr>
<td>COPYRIGHT HOLDER</td>
<td>Your Name or Your Employer</td>
</tr>
<tr>
<td>MSGID_BUGS_ADDRESS</td>
<td>$(PACKAGE_BUGREPORT)</td>
</tr>
<tr>
<td>EXTRA_LOCALE_CATEGORIES</td>
<td></td>
</tr>
</tbody>
</table>
```
Fill `po/Makevars.template` and rename it as `po/Makevars`:

```bash
po/Makevars

DOMAIN = $(PACKAGE)
subdir = po
top_builddir = ..
XGETTEXT_OPTIONS = --keyword=_ --keyword=N_
COPYRIGHT_HOLDER = Your Name or Your Employer
MSGID_BUGS_ADDRESS = $(PACKAGE_BUGREPORT)
EXTRA_LOCALE_CATEGORIES =

$(PACKAGE_BUGREPORT) is the third argument of AC_INIT. Some packages use a mailing list dedicated to translation issues instead.
```
Fill `po/Makevars.template` and rename it as `po/Makevars`:

```
po/Makevars

DOMAIN = $(PACKAGE)
subdir = po
top_builddir = ..
XGETTEXT_OPTIONS = --keyword=_ --keyword=N_
COPYRIGHT_HOLDER = Your Name or Your Employer
MSGID_BUGS_ADDRESS = $(PACKAGE	BUGREPORT)
EXTRA_LOCALE_CATEGORIES =
```

List sources files that (may) contain translatable strings in `POTFILES.in`.

```
po/POTFILES.in

src/main.c
src/say.c
```
What’s Next?

Done:

1. Start with a non-internationalized Hello World.
2. Invoke AM_GNU_GETTEXT from `configure.ac`
3. Run ‘gettextize’ to provide the basic infrastructure.
4. Fill in the configuration files left by ‘gettextize’.

Now, ‘autoreconf --install; ./configure; make’ should work.
What’s Next?

Done:

1. Start with a non-internationalized Hello World.
2. Invoke AM_GNU_GETTEXT from configure.ac
3. Run ‘gettextize’ to provide the basic infrastructure.
4. Fill in the configuration files left by ‘gettextize’.

Now, ‘autoreconf --install; ./configure; make’ should work.

To do:

5. Update src/Makefile.am to link hello with the necessary library.
6. Update the code:
   - Initialize Gettext in main()
   - Mark translatable strings.
7. Generate messages catalogs automatically.
Updating `src/Makefile.am`

```
bin_PROGRAMS = hello
hello_SOURCES = main.c say.c say.h
```

$(LOCALEDIR) lists the libraries any internationalized program should be linked against. We can strip the leading `hello` and use the global `LDADD` instead. Mention `gettext.h` (we will use it shortly) so it is distributed. $(LOCALEDIR) is the place where message catalogs are installed. This is needed during initialization.
Updating `src/Makefile.am`

```plaintext
bin_PROGRAMS = hello
hello_SOURCES = main.c say.c say.h
hello_LDADD = $(LIBINTL)
```

- `$(LIBINTL)` lists the libraries any internationalized program should be linked against.
src/Makefile.am

bin_PROGRAMS = hello
hello_SOURCES = main.c say.c say.h
LDADD = $(LIBINTL)

- $(LIBINTL) lists the libraries any internationalized program should be linked against.
- We can strip the leading hello and use the global LDADD instead.
Updating `src/Makefile.am`

```
bin_PROGRAMS = hello
hello_SOURCES = main.c say.c say.h gettext.h
LDADD = $(LIBINTL)
```

- `$(LIBINTL)` lists the libraries any internationalized program should be linked against.
- We can strip the leading `hello_` and use the global `LDADD` instead.
- Mention `gettext.h` (we will use it shortly) so it is distributed.
Updating `src/Makefile.am`

```
AM_CPPFLAGS = -DLOCALEDIR="$(localedir)"
bin_PROGRAMS = hello
hello_SOURCES = main.c say.c say.h gettext.h
LDADD = $(LIBINTL)
```

- `$(LIBINTL)` lists the libraries any internationalized program should be linked against.
- We can strip the leading `hello_` and use the global `LDADD` instead.
- Mention `gettext.h` (we will use it shortly) so it is distributed.
- `$(LOCALEDIR)` is the place where message catalogs are installed. This is needed during initialization.
Initializing gettext

```
src/main.c

#include "say.h"
int
main (void)
{
  say_hello();
  return 0;
}
```

Initialize the locale as specified in the environment.
(E.g., the user sets LANG=fr in the environment to get French messages.)

Tell Gettext where to find message catalogs for this program.
(All programs in the same package usually share the same message catalog.)
Initialize the locale as specified in the environment. (E.g., the user sets LANG=fr_FR in the environment to get French messages.)
Initializing Gettext

**src/main.c**

```c
#include <config.h>
#include <locale.h>
#include "gettext.h"
#include "say.h"

int main (void)
{
    setlocale (LC_ALL, "");
    bindtextdomain (PACKAGE, LOCALEDIR);
    textdomain (PACKAGE);
    say_hello();
    return 0;
}
```

- Initialize the locale as specified in the environment. (E.g., the user sets LANG=fr_FR in the environment to get French messages.)

- Tell Gettext where to find message catalogs for this program. (All programs in the same package usually share the same message catalog.)
Marking Strings for Translation

Include `gettext.h` in your source files to define the `gettext()` function, which is used for translation. Messages that must be translated are marked with `(message string)`.

NLS (Native Language System) can be disabled explicitly with `./configure --disable-nls` or implicitly if no `gettext` implementation is installed.

Then, `gettext.h` defines `gettext()`, `textdomain()`, etc., as no-ops.

```c
#include <config.h>
#include <stdio.h>
#define _(string) gettext (string)

void say_hello (void)
{
    puts ("Hello World!");
    puts ("This is " PACKAGE_STRING ".");
}
```
Marking Strings for Translation

```c
#include <config.h>
#include <stdio.h>
#include "gettext.h"
#define _(string) gettext (string)
void say_hello (void)
{
    puts (_("Hello World!"));
    printf (_("This is %s.\n"), PACKAGE_STRING);
}
```

- Messages that must be translated are marked with `_(...)`.
Marking Strings for Translation

Messages that must be translated are marked with `_(...)`. NLS (Native Language System) can be disabled.

- Explicitly with `./configure --disable-nls`
- Implicitly if no gettext implementation is installed.

Then `gettext.h` defines gettext(), textdomain(), ..., as no-ops.

```c
#include <config.h>
#include <stdio.h>
#include "gettext.h"
#define _(string) gettext (string)

void say_hello (void)
{
    puts (_("Hello World!"));
    printf (_("This is %s.\n"), PACKAGE_STRING);
}
```
Our Hello World is now internationalized.

```
~/amhello % autoreconf --install
...
~/amhello % ./configure
...
~/amhello % make
...```
Building the Whole Shebang

Our Hello World is now internationalized.

```
~/amhello % autoreconf --install
...
~/amhello % ./configure
...
~/amhello % make
...
Making all in po
make amhello.pot-update
...
```

The `po/` directory contains messages catalogs. `po/amhello.pot` is the template message catalog.

Updating `po/amhello.pot` is costly and occurs only before releases (e.g., during `make distcheck`) or if the file did not exist (our case above). It can be updated explicitly with `cd po; make update-po`.
Localizing a Package

10 Writing and Managing Custom Macros
   • Writing Autoconf Macros
   • Managing Custom Macros with ‘aclocal’

11 Libtool

12 Gettext
   • Introducing Gettext
   • Internationalizing a Package, Start to Finish
   • Localizing a Package

13 Nested Packages

14 The End
# ... COMMENTS ...
#, fuzzy
msgid ""
msgstr ""
"Project-Id-Version: PACKAGE VERSION\n"
"Report-Msgid-Bugs-To: bug-report@address\n"
"POT-Creation-Date: 2005-03-05 00:27+0100\n"
"PO-Revision-Date: YEAR-MO-DA HO:MI+ZONE\n"
"Last-Translator: FULL NAME <EMAIL@ADDRESS>\n"
"Language-Team: LANGUAGE <LL@li.org>\n"
"MIME-Version: 1.0\n"
"Content-Type: text/plain; charset=CHARSET\n"
"Content-Transfer-Encoding: 8bit\n"

#: src/say.c:9
msgid "Hello World!"
msgstr ""

#: src/say.c:10
#, c-format
msgid "This is %s.\n"
msgstr ""
Gettext
Localizing a Package

po/amhello.pot: The PO Template File

# ... COMMENTS ...
#, fuzzy
msgid ""
msgstr ""
"Project-Id-Version: PACKAGE VERSION
"Report-Msgid-Bugs-To: bug-report@address
"POT-Creation-Date: 2005-03-05 00:27+0100
"PO-Revision-Date: YEAR-MO-DA HO:MI+ZONE
"Last-Translator: FULL NAME <EMAIL@ADDRESS>
"Language-Team: LANGUAGE <LL@li.org>
"MIME-Version: 1.0
"Content-Type: text/plain; charset=CHARSET
"Content-Transfer-Encoding: 8bit

#: src/say.c:9
msgid "Hello World!"
msgstr ""

#: src/say.c:10
#, c-format
msgid "This is %s."
msgstr ""
po/amhello.pot: List of Messages

#: src/say.c:9
msgid "Hello World!"
msgstr ""

#: src/say.c:10
#, c-format
msgid "This is %s.\n"
msgstr ""
### Gettext

**Localizing a Package**

**po/amhello.pot: List of Messages**

```plaintext
#: src/say.c:9
msgid "Hello World!"
msgstr ""

#: src/say.c:10
#, c-format
msgid "This is %s.\n"
msgstr ""
```

- **msgid**s identify all strings in the package
### `po/amhello.pot`: List of Messages

```plaintext
#: src/say.c:9
msgid "Hello World!"
msgstr ""

#: src/say.c:10
#, c-format
msgid "This is %s.\n"
msgstr ""
```

- **msgids** identify all strings in the package
- **empty msgstrs** are placeholders for translations
### po/amhello.pot: List of Messages

#### #: src/say.c:9
msgid "Hello World!"
msgstr ""

#### #: src/say.c:10
#, c-format
msgid "This is %s.\n"
msgstr ""

- msgids identify all strings in the package
- empty msgstrs are placeholders for translations
- the location of each string is shown, so the translator can check the context if needed
Gettext

Localizing a Package

po/amhello.pot: List of Messages

#: src/say.c:9
msgid "Hello World!"
msgstr ""

#: src/say.c:10
#, c-format
msgid "This is %s.\n"
msgstr ""

- msgids identify all strings in the package
- empty msgstrs are placeholders for translations
- the location of each string is shown, so the translator can check the context if needed
- additional flags can be used
# ... COMMENTS ...
#, fuzzy
msgid ""
msgstr ""
"Project-Id-Version: PACKAGE VERSION"
"Report-Msgid-Bugs-To: bug-report@address"
"POT-Creation-Date: 2005-03-05 00:27+0100"
"PO-Revision-Date: YEAR-MO-DA HO:MI+ZONE"
"Last-Translator: FULL NAME <EMAIL@ADDRESS>"
"Language-Team: LANGUAGE <LL@li.org>"
"MIME-Version: 1.0"
"Content-Type: text/plain; charset=CHARSET"
"Content-Transfer-Encoding: 8bit"

#: src/say.c:9
msgid "Hello World!"
msgstr ""

#: src/say.c:10
#, c-format
msgid "This is %s."
msgstr ""
Gettext

Localizing a Package

**po/amhello.pot:** The PO Template File

```
# ... COMMENTS ...
#, fuzzy
msgid ""
msgstr ""
"Project-Id-Version: PACKAGE VERSION
"Report-Msgid-Bugs-To: bug-report@address
"POT-Creation-Date: 2005-03-05 00:27+0100
"PO-Revision-Date: YEAR-MO-DA HO:MI+ZONE
"Last-Translator: FULL NAME <EMAIL@ADDRESS>
"Language-Team: LANGUAGE <LL@li.org>
"MIME-Version: 1.0
"Content-Type: text/plain; charset=CHARSET
"Content-Transfer-Encoding: 8bit

#: src/say.c:9
msgid "Hello World!"
msgstr ""

#: src/say.c:10
#, c-format
msgid "This is %s."
msgstr ""
```
The translation of the empty string is a special entry that will be filled with administrative information.
How to Add a New Language?

1. Initialize `po/LL.po` or `po/LL_CC.po` from `po/amhello.pot`, using `msginit`.
   LL is your language code, and CC is your country code
   pt is Portuguese
   pt_BR is Brazilian Portuguese
   (The annexes of the Gettext manual show lists of LLs and CCs.)

2. Fill in `po/LL.po` (or `po/LL_CC.po`)

3. List the new translation in `po/LINGUAS`
How to Add a New Language?

1. Initialize `po/LL.po` or `po/LL_CC.po` from `po/amhello.pot`, using `msginit`.
   LL is your language code, and CC is your country code
   - pt is Portuguese
   - pt_BR is Brazilian Portuguese
   (The annexes of the Gettext manual show lists of LLs and CCs.)
2. Fill in `po/LL.po` (or `po/LL_CC.po`)
3. List the new translation in `po/LINGUAS`

Let’s add a French translation for amhello.
Preparing `po/fr.po`

```bash
~/amhello % cd po
~/amhello/po % msginit -l fr
...
~/amhello/po % emacs fr.po &
```
Preparing *po/*fr.po

```bash
~/amhello % cd po
~/amhello/po % msginit -l fr
...
~/amhello/po % emacs fr.po &
```

The PO mode of ‘emacs’ (`M-x po-mode`):

- The buffer is modified only indirectly.
- `Enter` on a message will open a buffer to edit the translation.
- Use `C-c C-c` after you have completed the translation, to get back to the updated *amhello.pot* buffer.
- Once all strings are translated, use `V` to save and check the file.
- Use `Tab` to remove fuzzy attributes.
**po/fr.po: Message Translations**

#: src/say.c:9
msgid "Hello World!"
msgstr ""

#: src/say.c:10
#, c-format
msgid "This is %s.\n"
msgstr ""
Gettext

Localizing a Package

**po/fr.po: Message Translations**

```plaintext
#: src/say.c:9
msgid "Hello World!"
msgstr "Bonjour Monde !"

#: src/say.c:10
#, c-format
msgid "This is %s.\n"
msgstr "Ceci est %s.\n"
```


Gettext

Localizing a Package

**po/fr.po: Header**

```plaintext
msgid ""
msgid ""
"Project-Id-Version: amhello 3.0\n"
"Report-Msgid-Bugs-To: bug-report@address\n"
"POT-Creation-Date: 2005-03-05 00:27+0100\n"
"PO-Revision-Date: 2005-03-15 20:54+0100\n"
"Last-Translator: Alexandre Duret-Lutz <adl@gnu.org>\n"
"Language-Team: French\n"
"MIME-Version: 1.0\n"
"Content-Type: text/plain; charset=ASCII\n"
"Content-Transfer-Encoding: 8bit\n"
"Plural-Forms: nplurals=2; plural=(n > 1);\n"
```

- ‘msginit’ filled these fields.

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**po/fr.po: Header**

```plaintext
msgid ""
msgstr ""
"Project-Id-Version: amhello 3.0\n"
"Report-Msgid-Bugs-To: bug-report@address\n"
"POT-Creation-Date: 2005-03-05 00:27+0100\n"
"PO-Revision-Date: 2005-03-15 20:54+0100\n"
"Last-Translator: Alexandre Duret-Lutz <adl@gnu.org>\n"
"Language-Team: French\n"
"MIME-Version: 1.0\n"
"Content-Type: text/plain; charset=ASCII\n"
"Content-Transfer-Encoding: 8bit\n"
"Plural-Forms: nplurals=2; plural=(n > 1);\n"
```

- `msginit` filled these fields.
Gettext

Localizing a Package

**po/fr.po: Header**

```plaintext
msgid ""
msgstr ""
"Project-Id-Version: amhello 3.0\n"
"Report-Msgid-Bugs-To: bug-report@address\n"
"POT-Creation-Date: 2005-03-05 00:27+0100\n"
"PO-Revision-Date: 2005-03-15 20:54+0100\n"
"Last-Translator: Alexandre Duret-Lutz <adl@gnu.org>\n"
"Language-Team: French\n"
"MIME-Version: 1.0\n"
"Content-Type: text/plain; charset=iso-8859-1\n"
"Content-Transfer-Encoding: 8bit\n"
"Plural-Forms: nplurals=2; plural=(n > 1);\n"
```

- ‘msginit’ filled these fields.
- You may have to customize it a bit.
‘msginit’ filled these fields.

You may have to customize it a bit.

The revision date will also be updated on save.
Once \texttt{po/fr.po} is completed, hit \texttt{V}. This will:

1. Update the revision date
2. Save the file
3. Run `msgfmt --statistics --check` on \texttt{po/fr.po}, to validate it.
Once `po/fr.po` is completed, hit \( \vec{v} \). This will:

1. Update the revision date
2. Save the file
3. Run `msgfmt --statistics --check` on `po/fr.po`, to validate it.

We can now register the language.

```
~/amhello/po % echo fr >> LINGUAS
```
hello now Speaks French!

~/amhello % ./configure --prefix ~/test
~/amhello %

This step is needed because we just created fr.po, and it has to be compiled. This happens automatically during `make dist`.

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hello now Speaks French!

```Shell
~/amhello % ./configure --prefix ~/test
~/amhello % make
~/amhello %
```
hello now Speaks French!

```bash
~/amhello % ./configure --prefix ~/test
~/amhello % make
~/amhello % cd po
~/amhello/po % make update-po
```

This step is needed because we just created `fr.po`, and it has to be compiled. This happens automatically during 'make dist'.
hello now Speaks French!

```bash
~/amhello % ./configure --prefix ~/test
~/amhello % make
~/amhello % cd po
~/amhello/po % make update-po
```

update-po

This step is needed because we just created `fr.po`, and it has to be compiled. This happens automatically during ‘make dist’.
hello now Speaks French!

```
~/amhello % ./configure --prefix ~/test
~/amhello % make
~/amhello % cd po
~/amhello/po % make update-po
~/amhello/po % cd ..
~/amhello %
```
hello now Speaks French!

```bash
~/amhello % ./configure --prefix ~/test
~/amhello % make
~/amhello % cd po
~/amhello/po % make update-po
~/amhello/po % cd ..
~/amhello % make install
~/amhello %
```

```
LANG=fr_FR ~/test/bin/hello
Bonjour Monde !
Ceci est amhello 3.0.
```

This step is needed because we just created fr.po, and it has to be compiled. This happens automatically during `make dist`.
hello now Speaks French!

```bash
~/amhello % ./configure --prefix ~/test
~/amhello % make
~/amhello % cd po
~/amhello/po % make update-po
~/amhello/po % cd..
~/amhello % make install
~/amhello % ~/test/bin/hello
Hello World!
This is amhello 3.0.
~/amhello %
```

This step is needed because we just created fr.po, and it has to be compiled. This happens automatically during `make dist`.

A. Duret-Lutz
Using GNU Autotools
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hello now Speaks French!

```
~/amhello % ./configure --prefix ~/test
~/amhello % make
~/amhello % cd po
~/amhello/po % make update-po
~/amhello/po % cd ..
~/amhello % make install
~/amhello % ~/test/bin/hello
Hello World!
This is amhello 3.0.
~/amhello % LANG=fr_FR ~/test/bin/hello
Bonjour Monde !
Ceci est amhello 3.0.
```
Updating Message Catalogs

Because maintainers can change the strings marked for translation, the messages catalogs are varying, and are not always up-to-date.
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Varying messages. `update-po modify` `*.po` file:
- New messages are added with a blank translation.
- Obsolete translations, not used anymore, are commented.
- Messages with tiny changes keep their translation, but are marked fuzzy.
  Translators remove fuzzy attributes (`Tab`) after verification.
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- Fuzzy messages are also output untranslated. (Better output the original sentence, rather than an inappropriate translation.)
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- Fuzzy messages are also output untranslated. (Better output the original sentence, rather than an inappropriate translation.)

**Good practice: the string freeze.** Two weeks before a release, run `'make update-po'` and send the `*.pot` file to translators. Don’t change or add strings from this point on. Let translators send you updated `*.po` files.
Language Teams & The Translation Project

http://www.iro.umontreal.ca/translation/

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- Translators gather in *Language Teams* (consider joining the team of your own language) to discuss issues.
- Maintainer submit *.pot* files and are notified when *.po* files are updated.
- Pages in The Translation Project will show where work is needed (consider adopting an orphan *.po* file.)
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This is only one way of getting a project translated. A lot of packages have dedicated translators and deal with them directly.
Nested Packages

10 Writing and Managing Custom Macros
   • Writing Autoconf Macros
   • Managing Custom Macros with ‘aclocal’

11 Libtool

12 Gettext
   • Introducing Gettext
   • Internationalizing a Package, Start to Finish
   • Localizing a Package

13 Nested Packages

14 The End
**Nested Packages**

- *Autoconfiscated* packages can be nested to arbitrary depth.
  - A package can distribute a third-party library it uses in a subdirectory.
  - It’s possible to gather many packages this way to distribute a set of tools.

- For installers:
  - A single package to configure, build, and install.
  - ‘configure’ options are passed recursively to sub-packages.
  - ‘configure --help=recursive’ shows the help of all sub-packages.

- For maintainers:
  - Easier integration.
  - The sub-package is autonomous.
Setting Up Nested Packages

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- In `Makefile.am`, this directory must appear in `SUBDIRS` so `make` recurses into it.
- `configure.ac` should also declare this directory

```plaintext
AC_CONFIG_SUBDIRS([subdir])
```

so `configure` calls `subdir/configure` recursively.
Nested Packages Example

The *arm* program links with an *hand* library, a nested package in *hand/*/.

### arm’s configure.ac

AC_INIT([arm], [1.0])
AM_INIT_AUTOMAKE([foreign -Wall -Werror])
AC_PROG_CC
AC_CONFIG_FILES([Makefile src/Makefile])
AC_CONFIG_SUBDIRS([hand])
AC_OUTPUT

### arm’s Makefile.am

SUBDIRS = *hand* src

### arm’s src/Makefile.am

AM_CPPFLAGS = -I$(top_srcdir)/hand
bin_PROGRAMS = arm
arm_SOURCES = arm.c
arm_LDADD = ..:/hand/libhand.a
Writing and Managing Custom Macros

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Nested Packages

The End
Where to go Now?

- Locate the reference manuals in your preferred format.
  - Autoconf, Automake, Libtool, and Gettext all install reference manuals in the Info format. (Try ‘info Autoconf’, ‘info Automake’, etc.)
  - The web pages of these tools also have .html or .pdf versions.
  - These manuals may not be easy introductions to the tools, but they make good and up-to-date references.
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- Pick a package that uses these tools and dissect its setup.
  - Try picking something written by somebody who isn’t just another neophyte!
  - I recommend looking at GNU Coreutils.