

# Foreword

This slides present a series of hobbit development topics. These topics include coding standard, compilation, test farm, software packaging, documentation, software distribution and auto update for hobbitmon supported OS platforms.

The latest version of this document can be retrieved from <http://hobbitmon.svn.sourceforge.net/viewvc/hobbitmon/branches/tjyang/docs/hobbitmon-slides/hobbit-slides-developer.pdf>

Please email the corrections and suggestions **about this document** hobbitmon mailman email list at [hobbit@hsw.n.dk](mailto:hobbit@hsw.n.dk).

# Hobbitmon Development

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# Part I

## Hobbitmon Development Models

# Manually created configure and Makefile

# Pros

The benefits of using homegrown configure and makefile ...

- No Need to learn GNU's autotools.

Learning GNU autotool is like learning driving. Take lots of efforts.

# Cons of manually created configure and Makefile

- Doesn't comply to GNU coding standard

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As long as it works, why not ?.

# Code Cluttered with #if/#else

## Excerpt of ffcall-1.10's alloc\_trampoline()

```
#if !defined(CODE_EXECUTABLE)
    static long pagesize = 0;
#endif
#if defined(EXECUTABLE_VIA_MMAP_DEVZERO)
    static int zero_fd;
#endif
    if (!pagesize) {
#if defined(HAVE_MACH_VM)
        pagesize = vm_page_size;
#else
        pagesize = getpagesize();
#endif
    }
#if defined(EXECUTABLE_VIA_MMAP_DEVZERO)
    zero_fd = open("/dev/zero", O_RDONLY, 0644);
    if (zero_fd < 0) {
        fprintf(stderr, "trampoline: _Cannot_open_/dev/zero!\n");
        abort();
    }
#endif
    }
```



# Substitution macros

## Excerpt of coreutils-5.2.1's *system.h*

```
#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

*strdup.c* (from the GNU C library)

```
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);  
}
```

# GNU development model

# 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.

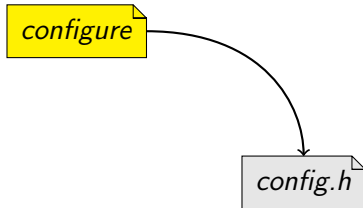
# *configure*'s Purpose



*configure*

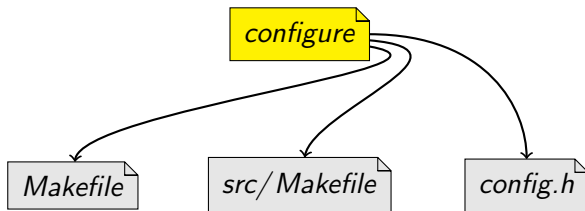
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- then it generates a *config.h* file with all `#defines`

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- *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/>

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- program behavior
  - how to report errors,
  - standard command line options,
  - etc.

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- **configuration**

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Practices that packages of the GNU project should follow:

- program behavior
  - how to report errors,
  - standard command line options,
  - etc.
- coding style
- configuration
- *Makefile* conventions
- etc.

# GNU Autotool model

# Standard Installation Procedure

```
~ % tar xzf amhello-1.0.tar.gz
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...
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...
~/amhello-1.0 % make
...
```

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...
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...
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...
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~/amhello-1.0 % make check
...
~/amhello-1.0 % su
Password:
```

# Standard Installation Procedure

```
~ % tar xzf 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

```
~ % tar xzf amhello-1.0.tar.gz
~ % cd amhello-1.0
~/amhello-1.0 % ./configure
...
~/amhello-1.0 % make
...
~/amhello-1.0 % make check
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~/amhello-1.0 % su
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/home/adl/amhello-1.0 # make install
...
/home/adl/amhello-1.0 # exit
```

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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

Directory variable	Default value
prefix	<i>/usr/local</i>
exec-prefix	prefix
bindir	exec-prefix/ <i>bin</i>
libdir	exec-prefix/ <i>lib</i>
...	
includedir	prefix/ <i>include</i>
datarootdir	prefix/ <i>share</i>
datadir	datarootdir
mandir	datarootdir/ <i>man</i>
infodir	datarootdir/ <i>info</i>
...	

```
~/amhello-1.0 %
```

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...	

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

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datadir	datarootdir
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```
~/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.

```
~/amhello-1.0 %
```

# Standard Configuration Variables

'./configure' automatically detects many settings.  
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**CC** C compiler command

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**LDFlags** linker flags

**CPPFLAGS** C/C++ preprocessor flags

... 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
```

# TWW's CPAM to complete GNU autotool

# Cross-Platform Application Management

Recall that old command

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



# Cross-Platform Application Management

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
```

# Cross-Platform Application Management

## 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 xzf ~/amhello-1.0.tar.gz  
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```

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

```
~ % tar xzf ~/amhello-1.0.tar.gz  
~ % cd amhello-1.0  
~/amhello-1.0 % mkdir build && cd build
```

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

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

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

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```
~ % tar xzf ~/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
...
```

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

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

```
~ % tar xzf ~/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/*.



# Parallel Build Trees for Multiple Architectures

Builds for multiple architectures can share the same source tree.

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

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

# Parallel Build Trees for Multiple Architectures

Builds for multiple architectures can share the same source tree.

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```
~ % cd /nfs/src  
/nfs/src % tar xzf ~/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
```

# Parallel Build Trees for Multiple Architectures

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~ % cd /nfs/src  
/nfs/src % tar xzf ~/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

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

# 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 xzf ~/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-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)



# Cross-Compilation

```
~/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...
...
```

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...
```

# 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 for suffix of executables... .exe  
checking for suffix of object files... o  
checking whether we are using the GNU C compiler... yes  
checking whether i586-mingw32msvc-gcc accepts -g... yes  
checking for i586-mingw32msvc-gcc option to accept ANSI C...  
...
```

# Cross-Compilation

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

# 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

```
~/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

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`--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.



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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

# Building Binary Packages Using DESTDIR

DESTDIR is used to relocate a package at install time.

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

# 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
...
```

# 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
...
~/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

# 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.

# 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.)

# Automatic Dependency Tracking

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~/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.

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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.

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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

# The (simplified) *configure* process



*Makefile.in*

*src/Makefile.in*

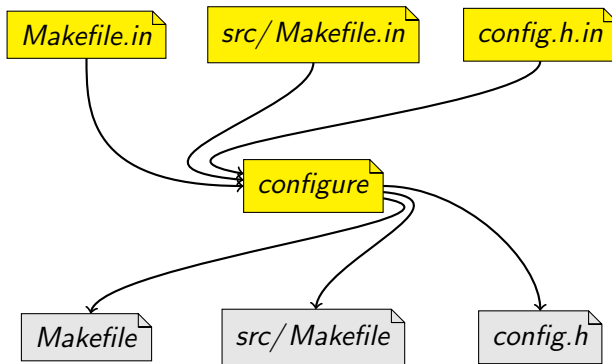
*config.h.in*

*configure*

*\*.in* files are configuration templates

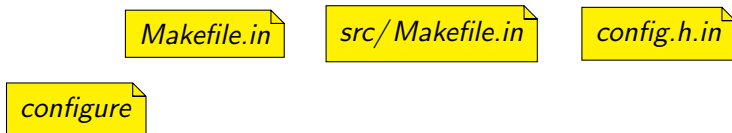


# The (simplified) *configure* process

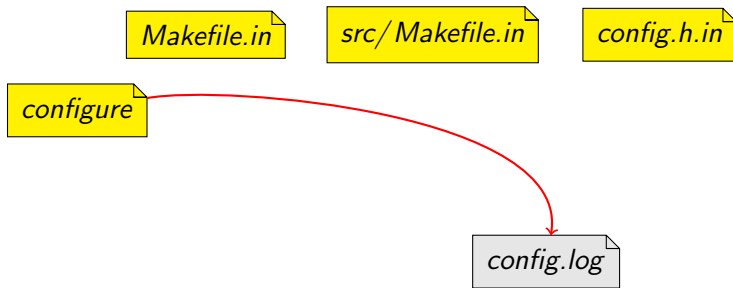


*\*.in* files are configuration templates  
from which *configure* generates the configuration files to use for building

# The (real) *configure* process

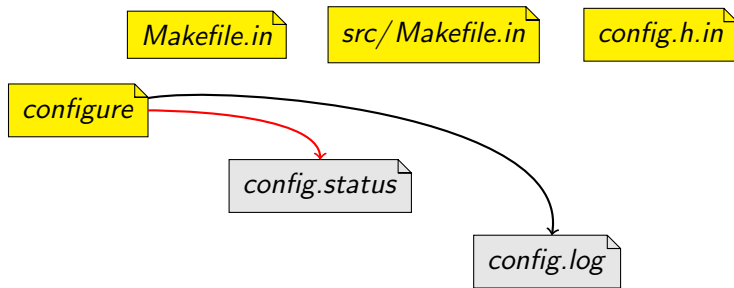


# The (real) *configure* process



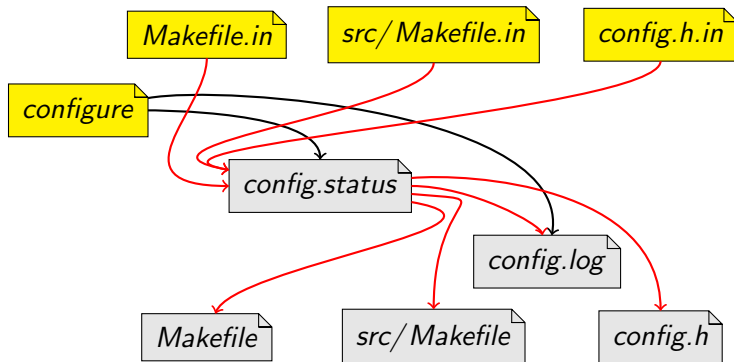
*config.log* contains a trace of the configuration

# The (real) *configure* process



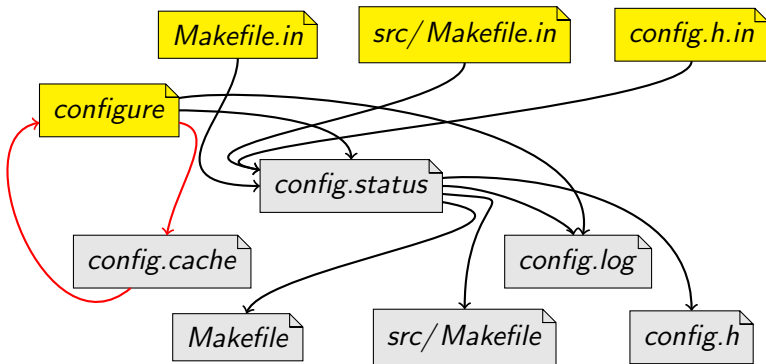
*config.status* will actually process the templates

# The (real) *configure* process



*config.status* will actually process the templates

# The (real) *configure* process



'`configure -C`' caches results in `config.cache` to speed up reconfigurations

# Why Hobbitmon developers Need autotools

# 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.



# Why We Need Tools

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(Think portable shell scripts, portable *Makefiles*, on systems you may not have handy.)

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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

# Hello World

# *src/main.c* for Hello World

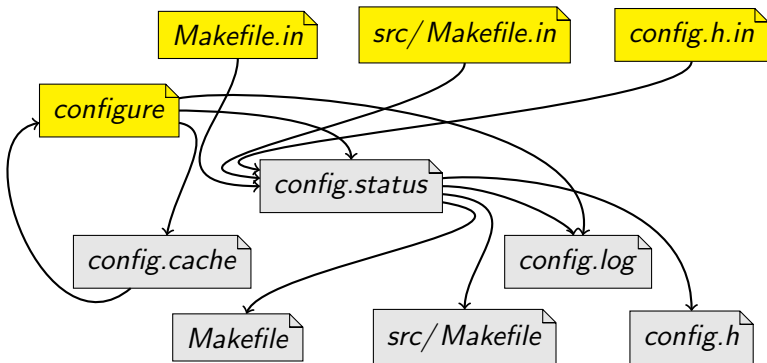
*src/main.c*

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

int
main (void)
{
    puts ("Hello _World!");
    puts ("This _is _" PACKAGE_STRING ".");
    return 0;
}
```



# Generating All Template Files



# Generating All Template Files



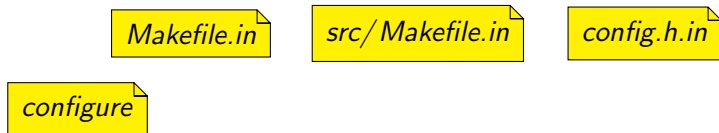
*Makefile.in*

*src/Makefile.in*

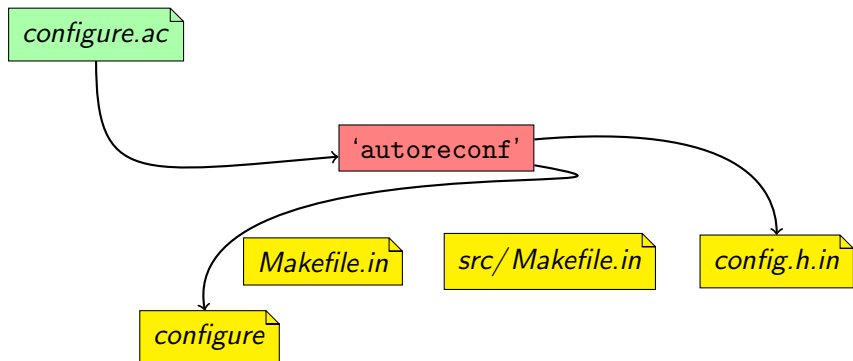
*config.h.in*

*configure*

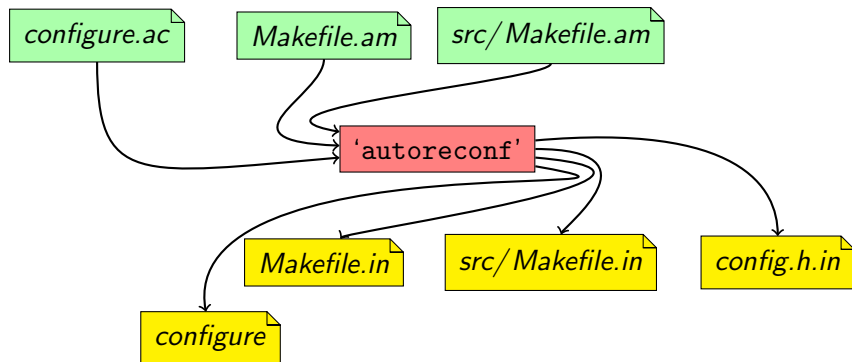
# Generating All Template Files



# Generating All Template Files



# Generating All Template Files



# Autotools Inputs

## *configure.ac*

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

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AC_CONFIG_FILES([  
    Makefile  
    src/Makefile  
])  
AC_OUTPUT
```

## *Makefile.am*

```
SUBDIRS = src
```

# Autotools Inputs

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```
AC_INIT([amhello], [1.0],  
        [bug-report@address])  
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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
```



# 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:4: installing './install-sh'
configure.ac:4: installing './missing'
src/Makefile.am: installing './depcomp'
~/amhello %
```

# Preparing the Package

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

./src:
Makefile.am  main.c
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configure.ac:4: installing './install-sh'
configure.ac:4: installing './missing'
src/Makefile.am: installing './depcomp'
~/amhello % ls -R
.:
Makefile.am      configure.ac
Makefile.in      depcomp*
aclocal.m4       install-sh*
autom4te.cache/  missing*
```

# 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*

./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/           expected configuration templates
configure*

./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*

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

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

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

# Preparing the Package

```
~/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/           Autotools cache files
configure*

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

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



# Preparing the Package

```
~/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

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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

```
~/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

```
~/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

# 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

# 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

# Two Core Packages

## GNU Autoconf

- 'autoconf' Create *configure* from *configure.ac*.
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- 'automake' Create *Makefile.ins* from *Makefile.am*s and *configure.ac*.



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## 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*.

# Two Core Packages

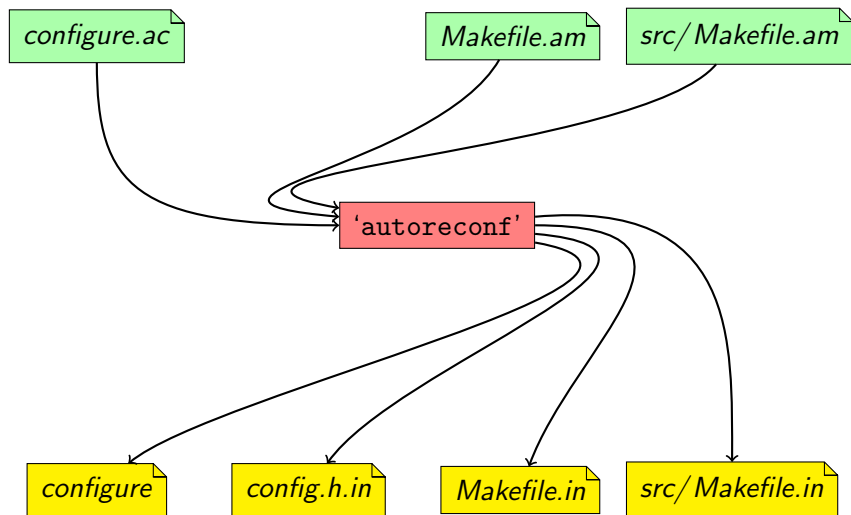
## GNU Autoconf

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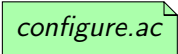
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## Behind 'autoreconf'



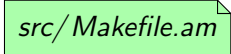
# Behind 'autoreconf'



*configure.ac*



*Makefile.am*



*src/Makefile.am*



*configure*



*config.h.in*

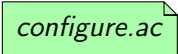


*Makefile.in*



*src/Makefile.in*

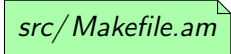
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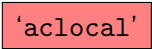
*configure.ac*



*Makefile.am*



*src/Makefile.am*



'aclocal'



*configure*



*config.h.in*

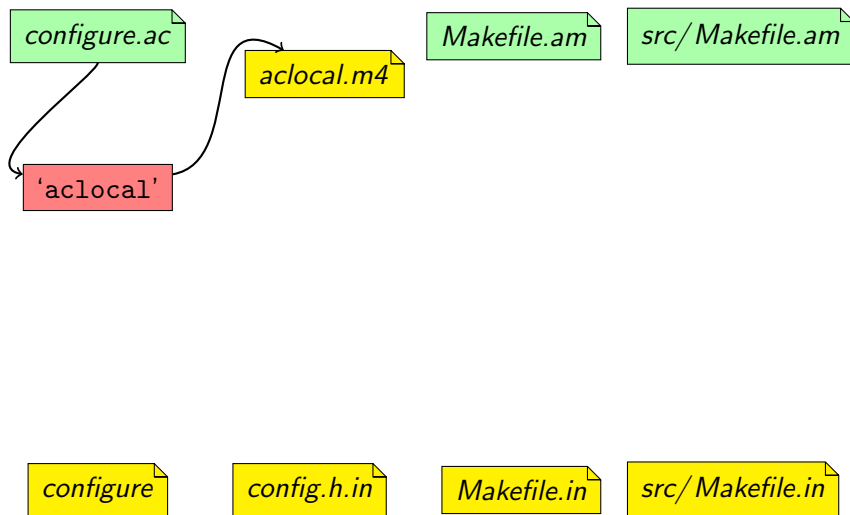


*Makefile.in*

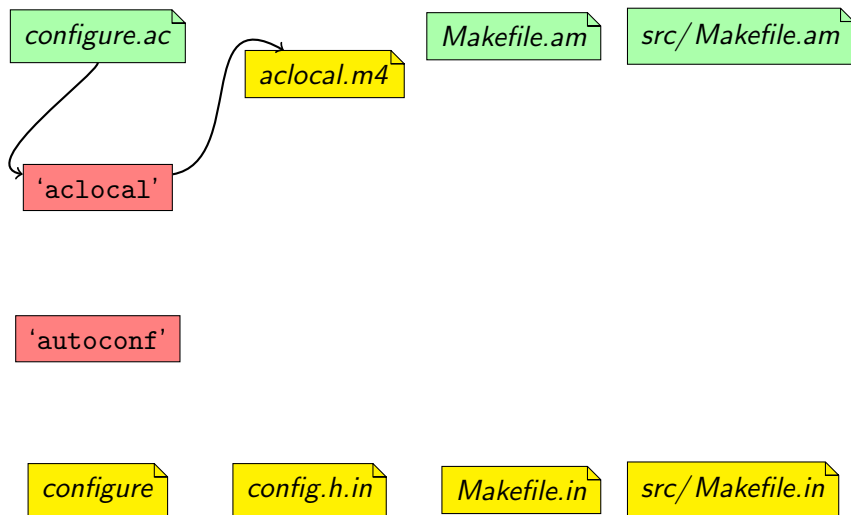


*src/Makefile.in*

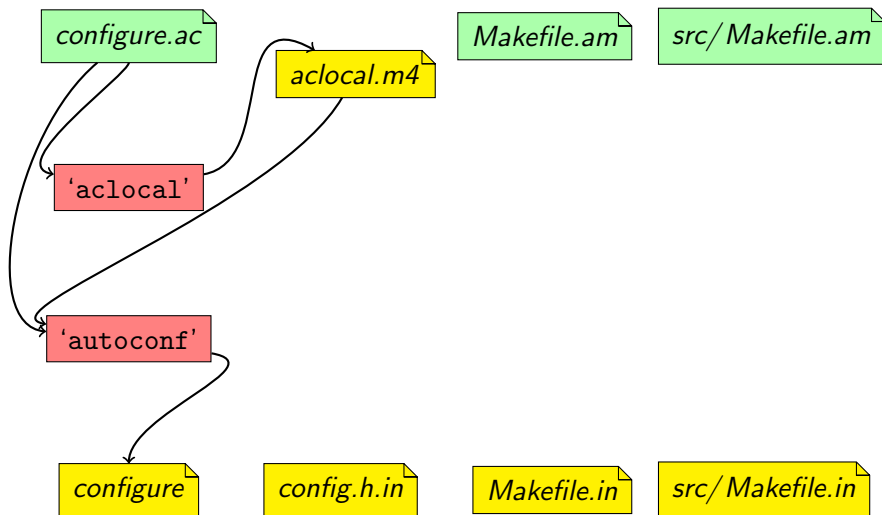
## Behind 'autoreconf'



## Behind 'autoreconf'

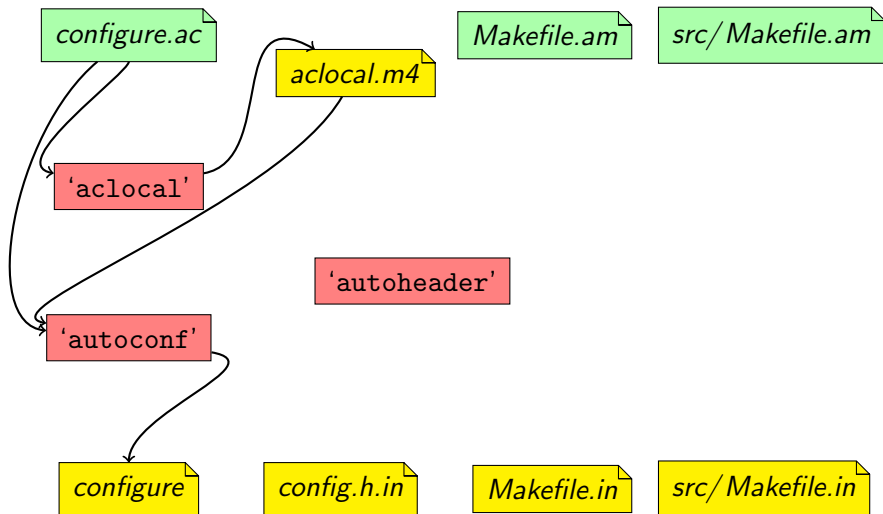


## Behind 'autoreconf'

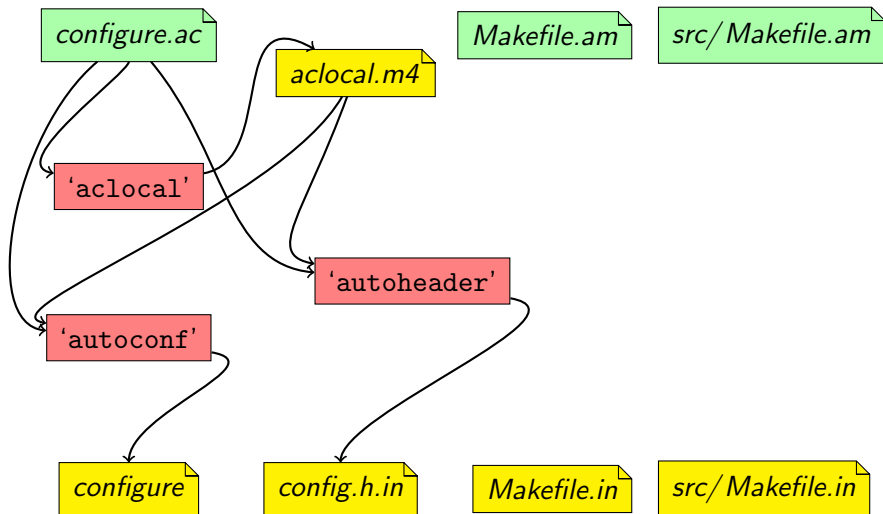




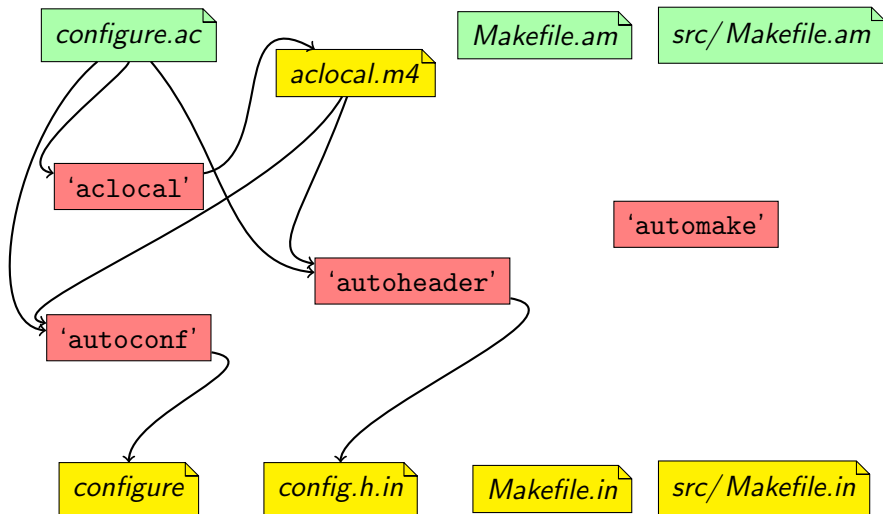
## Behind 'autoreconf'



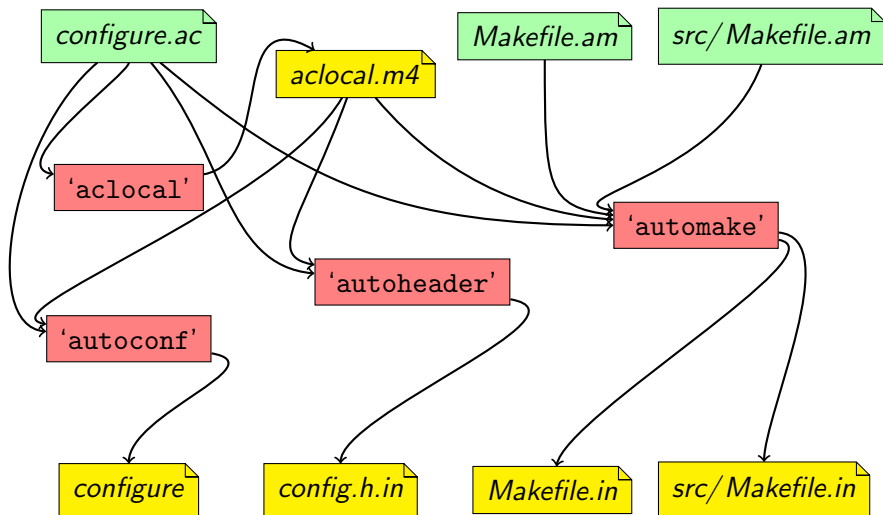
## Behind 'autoreconf'



## Behind 'autoreconf'



## Behind 'autoreconf'



# '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.
- You only need a rough idea of the purpose of each tool to understand errors. (What tool complains and about what?)

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'autoconf' Creates *configure* from *configure.ac*.

'autoheader' Creates *config.h.in* from *configure.ac*.

'automake' Creates *Makefile.in*s from *Makefile.am*s 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'.

# Hello World Explained

# amhello's *configure.ac* explained

## *configure.ac*

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



# amhello's *configure.ac* explained

## *configure.ac*

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

# amhello's *configure.ac* explained

## *configure.ac*

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

# foreign Ignores some GNU Coding Standards

*configure.ac*

...

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

...

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

```
configure.ac:2: installing './install-sh'
```

```
configure.ac:2: installing './missing'
```

```
src/Makefile.am: installing './depcomp'
```

# 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([-Wall -Werror foreign])
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([-Wall -Werror foreign])  
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.
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- 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.

# 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**.

# Standard File System Hierarchy

Directory variable	Default value
prefix	<i>/usr/local</i>
exec-prefix	prefix
bindir	exec-prefix/ <i>bin</i>
libdir	exec-prefix/ <i>lib</i>
...	
includedir	prefix/ <i>include</i>
datarootdir	prefix/ <i>share</i>
datadir	datarootdir
mandir	datarootdir/ <i>man</i>
infodir	datarootdir/ <i>info</i>
...	

# 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*.

# 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*.
- There is only one program to build: *hello*.



# 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*.
- There is only one program to build: *hello*.
- To create *hello*, just compile *main.c*.

# Using Autoconf

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

- 'autoconf' is a macro processor.
- It converts *configure.ac*, which is a shell script using macro instructions, into *configure*, a full-fledged shell script.

# 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.

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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.

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

- ‘autoconf’ is a macro processor.
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- It is not uncommon to have a *configure.ac* without shell constructs, using only macros.
- 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*

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

```
~ % m4 -P example.m4
```

```
↵  
↵  
↵
```

```
Harry met Sally↵
```



# Discovering M4

## *example.m4*

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

# Discovering M4

*example.m4*

```
↵  
m4_define(NAME2, Sally)↵  
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MET(NAME1, NAME2)↵
```

```
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↵  
↵  
↵  
Harry met Sally↵
```

# Discovering M4

*example.m4*

```
↵  
m4_define(NAME2, Sally)↵  
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```

```
~ % m4 -P example.m4  
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↵  
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# Discovering M4

*example.m4*

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↵  
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Harry met Sally↵
```

# Discovering M4

*example.m4*

```
↵  
↵  
m4_define(MET, $1 met $2)↵  
MET(NAME1, NAME2)↵
```

```
~ % m4 -P example.m4
```

```
↵  
↵  
↵  
Harry met Sally↵
```

# Discovering M4

*example.m4*

```
↵  
↵  
m4_define(MET, $1 met $2)↵  
MET(NAME1, NAME2)↵
```

```
~ % m4 -P example.m4
```

```
↵  
↵  
↵  
Harry met Sally↵
```



# Discovering M4

*example.m4*

```
↵  
↵  
m4_define(MET, $1 met $2)↵  
MET(NAME1, NAME2)↵
```

```
~ % m4 -P example.m4
```

```
↵  
↵  
↵  
Harry met Sally↵
```

# Discovering M4

*example.m4*

```
↵  
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MET(NAME1, NAME2)↵
```

```
~ % m4 -P example.m4
```

```
↵  
↵  
↵  
Harry met Sally↵
```

# Discovering M4

*example.m4*

```
↵  
↵  
m4_define(MET, $1 met $2)↵  
MET(NAME1, NAME2)↵
```

```
~ % m4 -P example.m4
```

```
↵  
↵  
↵  
Harry met Sally↵
```

# Discovering M4

*example.m4*

↵  
↵  
↵

MET(NAME1, NAME2)↵

~ % m4 -P example.m4

↵  
↵  
↵

Harry met Sally↵

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*example.m4*

↵  
↵  
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MET(Harry, NAME2)↵

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↵  
↵  
↵

Harry met Sally↵

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*example.m4*

↵  
↵  
↵

MET(Harry, NAME2)↵

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↵  
↵  
↵

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# Discovering M4

*example.m4*

↵  
↵  
↵

MET(Harry, NAME2)↵

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↵  
↵  
↵

Harry met Sally↵

# Discovering M4

*example.m4*

↵  
↵  
↵

MET(Harry, Sally)↵

~ % m4 -P example.m4

↵  
↵  
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# Discovering M4

*example.m4*

↵  
↵  
↵

MET(Harry, Sally)↵

~ % m4 -P example.m4

↵  
↵  
↵

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# Discovering M4

*example.m4*

↵  
↵  
↵

**MET**(Harry, Sally)↵

~ % m4 -P example.m4

↵  
↵  
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# Discovering M4

*example.m4*

↵  
↵  
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↵  
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- The macro's arguments are processed
- Then the macro is expanded
- Finally the output of the macro is processed too



# M4 Quoting

- The macro's arguments are processed
- Then the macro is expanded
- Finally the output of the macro is processed too
- A string can be protected from processing using **quotes**.

## *example.m4*

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

```
m4_define(NAME2, Sally)
```

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

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

# M4 Quoting

- The macro's arguments are processed
- Then the macro is expanded
- Finally the output of the macro is processed too
- A string can be protected from processing using quotes.

This is a source of many mistakes for the unwary.

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Can you guess the output of the above?

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↵

↵

m4\_define(MET, \$1 met \$2)↵

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```
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↵  
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MET(NAME1, NAME2)↵
```

Can you guess the output of the above?



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*example.m4*

↵  
↵  
↵

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*example.m4*

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↵  
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↵  
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*example.m4*

↵  
↵  
↵

MET(Harry, Jr., Sally)↵

Can you guess the output of the above?

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*example.m4*

↵  
↵  
↵

MET(Harry, Jr., Sally)↵

Can you guess the output of the above?

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*example.m4*

↵  
↵  
↵

**MET**(Harry, Jr., Sally)↵

Can you guess the output of the above?



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- The macro's arguments are processed
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*example.m4*

```
␣  
␣  
␣
```

```
Harry met Jr.␣
```

Can you guess the output of the above?

# M4 Quoting

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- Then the macro is expanded
- Finally the output of the macro is processed too
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*example.m4*

```
␣  
␣  
␣  
␣
```

```
Harry met Jr.␣
```

Can you guess the output of the above?

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*example.m4*

↵  
↵  
↵

Harry met Jr.↵

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*example.m4*

↵  
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*example.m4*

```
␣  
␣  
␣
```

```
Harry met Jr.␣
```

Can you guess the output of the above?

# M4 Quoting Rule of the Thumb

- Quote each macro argument once.

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

## *example.m4*

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

```
m4_define('NAME2', 'Sally')
```

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

```
MET('NAME1', '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_define('NAME1', 'Harry, Jr.')
```

```
m4_define('NAME2', 'Sally')
```

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

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

# M4 Quoting Rule of the Thumb

- Quote each macro argument once.
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## *example.m4*

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

```
m4_define('NAME2', 'Sally')
```

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

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

# M4 Quoting Rule of the Thumb

- Quote each macro argument once.
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*example.m4*

```
↵  
m4_define(NAME2, 'Sally')↵  
m4_define('MET', '$1 met $2')↵  
MET('NAME1', 'NAME2')↵
```

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- Quote each macro argument once.
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*example.m4*

```
↵  
m4_define(NAME2, Sally)↵  
m4_define('MET', '$1 met $2')↵  
MET('NAME1', 'NAME2')↵
```

# M4 Quoting Rule of the Thumb

- Quote each macro argument once.
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*example.m4*

```
↵  
↵  
m4_define('MET', '$1 met $2')↵  
MET('NAME1', 'NAME2')↵
```

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- Quote each macro argument once.
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*example.m4*

```
↵  
↵  
m4_define(MET, '$1 met $2')↵  
MET('NAME1', 'NAME2')↵
```



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- Quote each macro argument once.
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*example.m4*

```
↵  
↵  
m4_define(MET, $1 met $2)↵  
MET('NAME1', 'NAME2')↵
```

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↵  
↵

MET('NAME1', 'NAME2')↵

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↵  
↵

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↵  
↵

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*example.m4*

↵  
↵  
↵

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*example.m4*

↵  
↵  
↵

NAME1 met NAME2↵

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*example.m4*

↵  
↵  
↵

Harry, Jr. met NAME2↵

# M4 Quoting Rule of the Thumb

- Quote each macro argument once.
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*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*

↵  
↵  
↵

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.
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*example.m4*

↵  
↵  
↵

Harry, Jr. met NAME2↵

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*example.m4*

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↵  
↵

Harry, Jr. met Sally↵

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- Quote each macro argument once.
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*example.m4*

↵  
↵  
↵

Harry, Jr. met Sally↵

# 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.

## *example.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_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.

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```
if [ "$x" = "$y" ]; then ...
```

# Autoconf on Top of M4

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# 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.

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

# The Structure of a *configure.ac*

## *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\_FILES([**FILES**])

AC\_OUTPUT



# The Structure of a *configure.ac*

## *configure.ac*

# 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\_FILES([FILES])

AC\_OUTPUT

# The Structure of a *configure.ac*

## *configure.ac*

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

# The Structure of a *configure.ac*

## *configure.ac*

```
# Prelude.  
AC_INIT([amhello], [1.0], [bug-report@address])  
AM_INIT_AUTOMAKE([-Wall -Werror foreign])  
# 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_FILES([FILES])  
AC_OUTPUT
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# Checks for libraries.  
# Checks for header files.  
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# Output files.  
  
AC_CONFIG_FILES([Makefile src/Makefile])  
AC_OUTPUT
```

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```
# Prelude.  
AC_INIT([amhello], [1.0], [bug-report@address])  
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# 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
```

# Useful Autoconf Macros for Prelude

`AC_INIT(PACKAGE, VERSION, BUG-REPORT-ADDRESS)`

Mandatory Autoconf initialization.

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**AC\_INIT(PACKAGE, VERSION, BUG-REPORT-ADDRESS)**

Mandatory Autoconf initialization.

**AC\_PREREQ(VERSION)**

**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]).`



# Useful Autoconf Macros for Prelude

**AC\_INIT(PACKAGE, VERSION, BUG-REPORT-ADDRESS)**

Mandatory Autoconf initialization.

**AC\_PREREQ(VERSION)**

**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*
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
```

## AC\_CONFIG\_AUX\_DIR Example

### *configure.ac*

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

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

```
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

## *configure.ac*

```
AC_INIT([amhello], [1.1], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AM_INIT_AUTOMAKE([-Wall -Werror foreign])
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.)

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Find good implementations and set `$SED`, `$YACC`, `$LEX`, etc.

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`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`, ...

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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

`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*.

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

# 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*.

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

`AC_SUBST(VARIABLE, [VALUE])`

Define `$(VARIABLE)` as `VALUE` in *Makefile*.

```
AC_SUBST([FOO], [foo])
```

```
FOO=foo
```

```
AC_SUBST([FOO])
```

```
AC_SUBST([FOO])
```

```
FOO=foo
```

All equivalent.

# 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.

# 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=-leference])  
AC_SUBST([EFENCELIB])
```

... we would later use `$(EFENCELIB)` in the link rule.

# 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=-leference])  
AC_SUBST([EFENCELIB])
```

... we would later use `$(EFENCELIB)` in the link rule.

If **ACT-IF-FOUND** is not set and the library is found, `AC_CHECK_LIB` will do `LIBS="-lLIBRARY $LIBS"` and `#define HAVE_LIBLIBRARY`.  
(Automake uses `$LIBS` for linking everything.)

# Checking for Headers

`AC_CHECK_HEADERS(HEADERS...)`

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

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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
```

# 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_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.

# 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.

```
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])
```

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...)

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-*Makefile* too.

## AC\_CONFIG\_FILES([script.sh:script.in]) Example

*script.in*

```
#!/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*

```
#!/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*

```
#!/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*

```
#!/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*

```
#!/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*

```
#!/bin/sh
SED='/usr/xpg4/bin/sed'
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```

*.in* files are templates where @XYZ@ are placeholders for AC\_SUBST([XYZ]) definitions. 'config.status' substitutes them.

*Makefile.in*s also use @XYZ@ as placeholders but Automake makes all XYZ=@XYZ@ definitions and you may simply use \$(XYZ) as needed.

# Using Automake

# Automake Principles

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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*

```
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([-Wall -Werror foreign])  
  
# 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
```



# 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.

`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*

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`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 ...
```

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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
```

# Standard File System Hierarchy

Directory variable	Default value
prefix	<i>/usr/local</i>
exec-prefix	prefix
bindir	exec-prefix/ <i>bin</i>
libdir	exec-prefix/ <i>lib</i>
...	
includedir	prefix/ <i>include</i>
datarootdir	prefix/ <i>share</i>
datadir	datarootdir
mandir	datarootdir/ <i>man</i>
infodir	datarootdir/ <i>info</i>
...	

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where_PRIMARY = targets ...
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targets should be installed in...

```
bin_ $(bindir)
```

```
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```

```
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targets should be built as...

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```

```
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```

```
_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**

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# where\_PRIMARY Convention for Declaring Targets

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

targets should be installed in...

bin\_ \$(bindir)

lib\_ \$(libdir)

...

custom\_ \$(customdir)

You define customdir.

noinst\_ Not installed.

targets should be built as...

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# where\_PRIMARY Convention for Declaring Targets

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```
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```

**targets** should be installed in...

`bin_ $(bindir)`

`lib_ $(libdir)`

...

`custom_ $(customdir)`

You define customdir.

`noinst_` Not installed.

`check_` Built by 'make check'.

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# where\_PRIMARY Convention for Declaring Targets

*Makefile.am*

`option_where_PRIMARY = targets ...`

`targets` should be installed in...

`bin_ $(bindir)`

`lib_ $(libdir)`

...

`custom_ $(customdir)`

You define `customdir`.

`noinst_` Not installed.

`check_` Built by 'make check'.

`targets` should be built as...

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`_LTLIBRARIES` (Libtool libraries)

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`_DATA`

Optionally: `dist_` Distribute `targets` (if not the default)

`nodist_` Don't.

# 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

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- These programs will be installed in `$(bindir)`.
- The sources of each `program` go into `programs_SOURCES`.

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- Non-alphanumeric characters are mapped to `'_'`.

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- Automake automatically computes the list of objects to build and link from these files.

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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).



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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.
- Compiler and linker are inferred from the extensions.

# (Static) Libraries

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

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## *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
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```

- 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 sources files.



# Directory Layout

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

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*configure.ac*

```
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                 src/dira/Makefile src/dirb/Makefile])
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- 'make' is run at the top-level.
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## *src/Makefile.am*

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- The current directory is implicitly built after subdirectories.

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- You can put '.' where you want to override this.

## *src/Makefile.am*

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```
SUBDIRS = . dira dirb
```



## `$(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 xzf ~/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.

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  - *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.

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  - 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.
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  - *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*

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

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# 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  
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```

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## *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  
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```

- 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.

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## *lib/Makefile.am*

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noinst_LIBRARIES = libcompat.a  
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```

- 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:

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The default value for `foo_XXXFLAGS` is `$(AM_XXXFLAGS)`.

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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
```

# 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=-leference])  
AC_SUBST([EFENCELIB])
```

... we would later use `$(EFENCELIB)` in the link rule.



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

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See 'automake --help' for a list of those files.

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See 'automake --help' for a list of those files.
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## *Makefile.am*

```
SUBDIRS = lib src  
EXTRA_DIST = HACKING
```

... will additionally distribute *HACKING*.

# Conditionals: Usage

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

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bin_PROGRAMS = foo
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  bin_PROGRAMS += bar
endif
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- 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*.

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`AM_CONDITIONAL(NAME, CONDITION)`

Declare conditional `NAME`. `CONDITION` should be a shell instruction that succeeds iff `NAME` should be enabled.

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*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* is copied almost verbatim to *Makefile.in*.
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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.

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- 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!



# Lost? 'autoreconf' is Still Your Friend

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

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

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

If this still does not help, try even harder.

```
~/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

# Writing Autoconf Macros

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Two fundamentally different types of new macros:

- Macros that factor related tests in a single reusable entity.
- Macros that implements new tests.

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  - 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.



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AC_DEFUN(MACRO-NAME, MACRO-BODY)
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Define MACRO-NAME as MACRO-BODY.

Avoid names that may conflict.

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`AS_` M4sh macros (macroized shell constructs)

`AH_` Autoheader macros

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`AM_` Automake macros

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**AH\_** **Autoheader** macros

**AC\_** **Autoconf** macros (written on top of the above layers)

**AC\_CHECK\_** Generic checks.

**AC\_FUNC\_** Specific function checks.

**AC\_HEADER\_** Specific header checks.

**AC\_PROG\_** Specific program checks.

    ...

**AM\_** **Automake** macros

**AT\_** **Autotest** macros

## `mkdir()` Example

- POSIX systems define `mkdir()` with two arguments.
- On Mingw32 (at least), `mkdir()` takes only one argument.
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```
#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
```

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# else
#   error "Don't know how to create a directory."
# endif
#endif
```

Let's write an Autoconf macro to define **these C macros**

# Writing a High-Level Macro: AX\_FUNC\_MKDIR

```
AC_DEFUN([AX_FUNC_MKDIR],  
[AC_CHECK_FUNCS([mkdir _mkdir])  
AC_CHECK_HEADERS([io.h])  
AX_FUNC_MKDIR_ONE_ARG  
)
```

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- Suggested name space for extension macros.



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- Suggested name space for extension macros.
- Use same convention as Autoconf for categorizing macros.
- Defines HAVE\_MKDIR and HAVE\_\_MKDIR.

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AC_DEFUN([AX_FUNC_MKDIR],  
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```

- 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`)

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- 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

```
# _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_TRY_COMPILE([
#include <sys/stat.h>
#if HAVE_UNISTD_H
# include <unistd.h>
#endif
#if HAVE_IO_H
# include <io.h>
#endif
], [mkdir (".", 0700);], [$2], [$1]))]
```

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```

## Comments

Showcase of the traditional style used to document autoconf macros.

# Checking mkdir()'s number of arguments

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#endif
#include HAVE_IO_H
#include <io.h>
#endif
], [mkdir (".", 0700);], [$2], [$1]))
```

## AC\_TRY\_COMPILE

Creates a small program and attempt to compile it. In our case it will execute one of the `_AX_FUNC_MKDIR_ONE_ARG` arguments depending on whether the program compiled or not.

# Checking mkdir()'s number of arguments

```
# _AX_FUNC_MKDIR_ONE_ARG(IF-ONE-ARG, IF-TWO-ARGS)
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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

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```

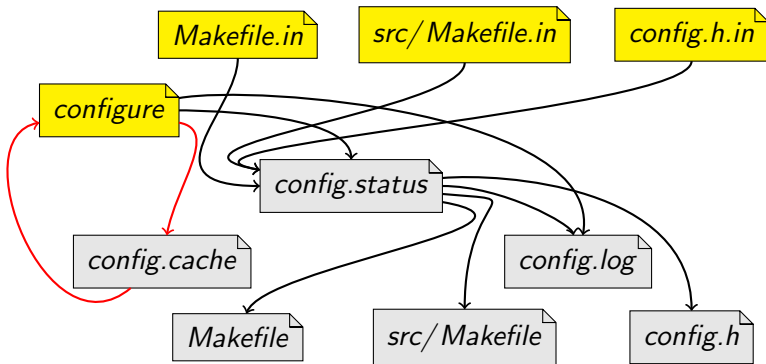
- Wait! That's not enough for an Autoconf check: we should also add some *checking whether...* message on top of this.
- We use the `_AX` prefix for helper macros not meant to be used directly.

# 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

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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,  
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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],  
                [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`

# 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.
- 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:  
<http://www.testdrive.hp.com/>  
<http://sourceforge.net/docs/E02/>

# Managing Custom Macros with 'aclocal'



## *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).

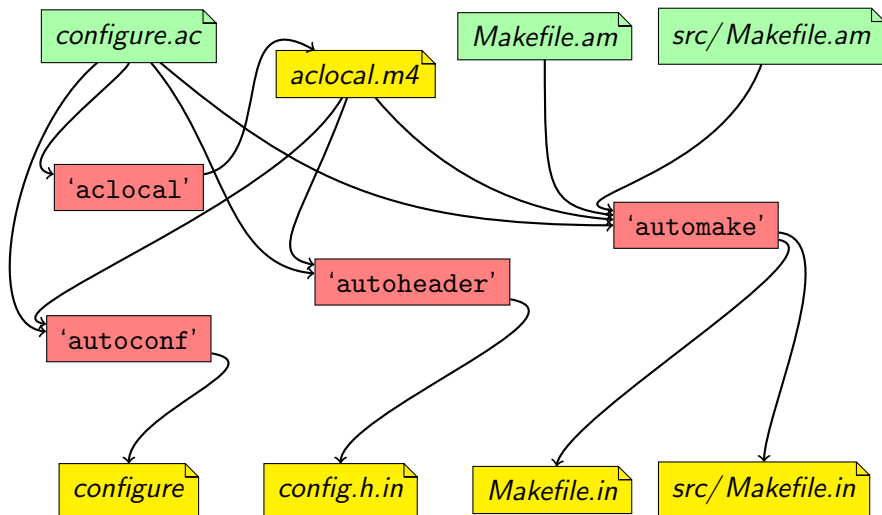
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# Behind 'autoreconf'



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- '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

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E.g., define `AX_FUNC_MKDIR` and `AX_FUNC_MKDIR_ONE_ARG` in *m4/mkdir.m4*.  
(The extension *must* be *\*.m4*)
- Add `ACLOCAL_AMFLAGS = -I m4` to the top-level *Makefile.am*.
- Add `AC_CONFIG_MACRO_DIR([m4])` to *configure.ac*. (This is not strictly needed yet, but let's be future-proof.)

The `ACLOCAL_AMFLAGS` are used by 'autoreconf' and by the *Makefile* rebuild rule when they need to run 'aclocal'.

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You need such a setup to use Gettext, and the upcoming Libtool 2.0.

# Libtool

# Shared Libraries: A Portability Hell

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  - *libhello.so*
  - *libhello.dll*
  - *libhello.sl*
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  - ...

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- There is no way for a developer to keep track of all these details.
  - Quiz: match each of the above example with its OS.
- Not all systems support shared libraries.

# Shared Libraries: Libtool's Solution

- A new library format that abstracts all the others
  - [libhello.la](http://libhello.la) (libtool archive)



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- 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.

# Setting Up Libtool: Roadmap

- Call `AC_PROG_LIBTOOL` in *configure.ac*.

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- Use \_LTLIBRARIES to declare libtool archives in *Makefile.am*

## *Makefile.am*

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

# Setting Up Libtool: Roadmap

- Call AC\_PROG\_LIBTOOL in *configure.ac*.
- Use \_LTLIBRARIES to declare libtool archives in *Makefile.am*
- Use \_LDADD to link against local libtool archives.

## *Makefile.am*

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

bin_PROGRAMS = runme
runme_SOURCES = main.c
runme_LDADD = libfoo.la
```

# Hello World Using Libtool: C Files

## *lib/say.c*

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

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

## *lib/say.h*

```
void say_hello (void);
```

## *src/main.c*

```
#include "say.h"

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

# Hello World Using Libtool: *Makefile.am*

## *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
```

# Hello World Using Libtool: *configure.ac*

## *configure.ac*

```
AC_INIT([amhello], [2.0], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AM_INIT_AUTOMAKE([-Wall -Werror foreign])
AC_PROG_LIBTOOL
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'

```
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.:
Makefile.am  configure.ac  lib/  src/

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

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

# Hello World Using Libtool: 'autoreconf'

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

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

```
Putting files in AC_CONFIG_AUX_DIR, 'build-aux'.
```

```
configure.ac: installing 'build-aux/install-sh'
```

```
configure.ac: installing 'build-aux/missing'
```

```
lib/Makefile.am: installing 'build-aux/depcomp'
```

```
~/amhello %
```

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

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

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configure.ac: installing 'build-aux/missing'
lib/Makefile.am: installing 'build-aux/depcomp'
~/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 % 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 %
```



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~/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)
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~/amhello % ldd src/hello
not a dynamic executable
~/amhello % file src/hello
src/hello: Bourne shell script text executable
```

# Building Shared or Static Libraries

- By default, both static and shared libraries are built.
- This default can be changed in a package using two macros:  
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  - `--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.

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"src/hello": not in executable format: File format not recognized  
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"src/hello": not in executable format: File format not recognized  
(gdb)
```

## Prefix such commands with `libtool --mode=execute`

```
~/amhello % libtool --mode=execute gdb -q src/hello
```

# Versioning Libtool Libraries: Interfaces

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- A library can implement several interfaces.
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- 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**.



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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
```

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## 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.

# Versioning Libtool Libraries: Bumping Versions

Remember to bump library versions before a release.

Suppose the old version was **CURRENT** **REVISION** **AGE**.

If you have	bump the version to
not changed the interface (bug fixes)	<b>CURRENT</b> : <b>REVISION</b> +1 : <b>AGE</b>
augmented the interface (new functions)	<b>CURRENT</b> +1 : 0 : <b>AGE</b> +1
broken old interface (e.g. removed functions)	<b>CURRENT</b> +1 : 0 : 0

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Providing an internationalized package the necessary bits to support one's native language and cultural habits.

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- Character handling (unicode...)
- Locale awareness (date formats, currencies, numbers, time zones, etc.)
- Localizability
  - Isolate localizable items (messages, pictures, etc.)
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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.

# 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.

The programmer's work.

- Localization = L10n

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- **Localizability**
  - **Isolate localizable items** (messages, pictures, etc.)
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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

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

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

- The program is written in English.

# Translating Messages Made Easy

```
#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.

# Translating Messages Made Easy

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

- 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



# Internationalizing a Package, Start to Finish

## 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;  
}
```

## *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([-Wall -Werror foreign])
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

## *configure.ac*

```
AC_INIT([amhello], [3.0], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AM_INIT_AUTOMAKE([-Wall -Werror foreign])
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*

```
AC_INIT([amhello], [3.0], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AM_INIT_AUTOMAKE([-Wall -Werror foreign])
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

## *configure.ac*

```
AC_INIT([amhello], [3.0], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AM_INIT_AUTOMAKE([-Wall -Werror foreign])
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 %
```

# 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*

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

## *Makefile.am*

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

## *src/Makefile.am*

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

## *po/Makevars* and *po/POTFILES.in*

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 =
```

# *po/Makevars* and *po/POTFILES.in*

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 =
```

**\$(PACKAGE\_BUGREPORT)** is the third argument of AC\_INIT. Some packages use a mailing list dedicated to translation issues instead.

## *po/Makevars* and *po/POTFILES.in*

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*

## src/Makefile.am

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



# Updating *src/Makefile.am*

## src/Makefile.am

```
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.

# Updating *src/Makefile.am*

## 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*

## 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*

## 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;
}
```

# Initializing Gettext

*src/main.c*

```
#include <locale.h>

#include "say.h"
int
main (void)
{
    setlocale (LC_ALL, "");

    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.)

# Initializing Gettext

*src/main.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

*src/say.c*

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

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



# Marking Strings for Translation

*src/say.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

*src/say.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 `_(...)`.
- 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.

# Building the Whole Shebang

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

# *po/amhello.pot*: The PO Template File

```
# ... 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 ""
```

# *po/amhello.pot*: The PO Template File

```
# ... 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 ""
```

## *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 ""
```



## *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

## *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

## *po/amhello.pot*: List of Messages

```
#: src/say.c:9
msgid "Hello World!"
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#: 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

## *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

# *po/amhello.pot*: The PO Template File

```
# ... 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 ""
```

# *po/amhello.pot*: The PO Template File

```
# ... 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 ""
```

## *po/amhello.pot*: The Header Entry

```
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"
```

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*

```
~/amhello % cd po  
~/amhello/po % msginit -l fr  
...  
~/amhello/po % emacs fr.po &
```

# Preparing *po/fr.po*

```
~/amhello % cd po  
~/amhello/po % msginit -l fr  
...  
~/amhello/po % emacs fr.po &
```

The PO mode of 'emacs' ( po-mode):

- The buffer is modified only indirectly.
-  on a message will open a buffer to edit the translation.
- Use   after you have completed the translation, to get back to the updated *amhello.pot* buffer.
- Once all strings are translated, use  to save and check the file.
- Use  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 ""
```

# *po/fr.po*: Message Translations

```
#: 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"
```

## *po/fr.po*: Header

```
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: Hobbitmon Community <hobbit@hsw.n.dk>\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.

## *po/fr.po*: Header

```
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: Hobbitmon Community <hobbit@hsw.n.dk>\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.

## *po/fr.po*: Header

```
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: Hobbitmon Community <hobbit@hsw.n.dk>\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.



## *po/fr.po*: Header

```
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: Hobbitmon Community <hobbit@hsw.n.dk>\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.
- The revision date will also be updated on save.

## *po/fr.po*: Validation and Addition

Once *po/fr.po* is completed, hit . This will:

- 1 Update the revision date
- 2 Save the file
- 3 Run `'msgfmt --statistics --check'` on *po/fr.po*, to validate it.

## *po/fr.po*: Validation and Addition

Once *po/fr.po* is completed, hit . 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 %
```

# hello now Speaks French!

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

# hello now Speaks French!

```
~/amhello % ./configure --prefix ~/test  
~/amhello % make  
~/amhello % cd po  
~/amhello/po %
```

# hello now Speaks French!

```
~/amhello % ./configure --prefix ~/test
~/amhello % make
~/amhello % cd po
~/amhello/po % make update-po
~/amhello/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!

```
~/amhello % ./configure --prefix ~/test  
~/amhello % make  
~/amhello % cd po  
~/amhello/po % make update-po  
~/amhello/po % cd ..  
~/amhello % make install  
~/amhello %
```

# 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 %
```

# 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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Translators remove fuzzy attributes (`~`) after verification.

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Not up-to-date. `gettext` copes with incomplete translations as follows.

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Not up-to-date. `gettext` copes with incomplete translations as follows.

- Untranslated messages are output untranslated.
- 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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- Pages in The Translation Project will show where work is needed (consider adopting an orphan *\*.po* file.)

# Language Teams & The Translation Project

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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

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- *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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- A sub-package should appear as an ordinary directory.
- In *Makefile.am*, this directory must appear in **SUBDIRS** so 'make' recurses into it.
- *configure.ac* should also declare this directory

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



# 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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  - 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.
- Subscribe to these tools' mailing lists, to see other people's uses of the tools.
- 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*.

## Part IV

# GNU Autotools

# Hello World

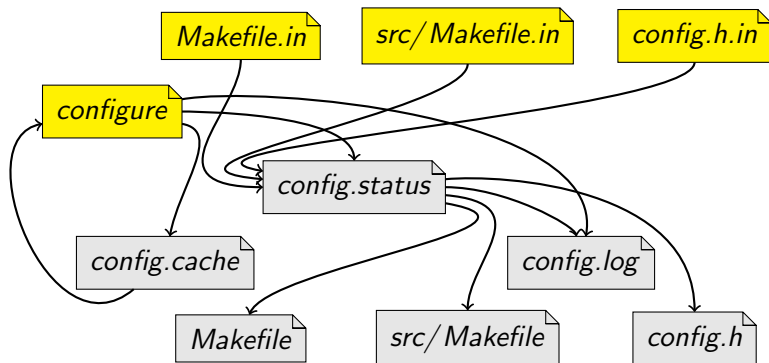
# *src/main.c* for Hello World

*src/main.c*

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

int
main (void)
{
    puts ("Hello _World!");
    puts ("This _is _" PACKAGE_STRING ".");
    return 0;
}
```

# Generating All Template Files





# Generating All Template Files



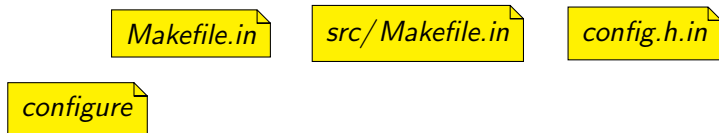
*Makefile.in*

*src/Makefile.in*

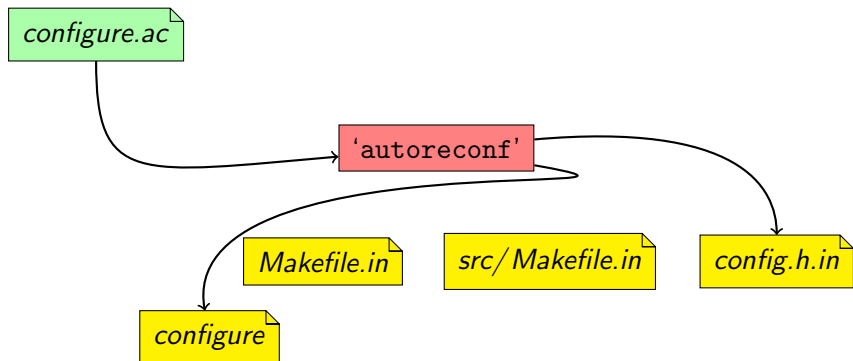
*config.h.in*

*configure*

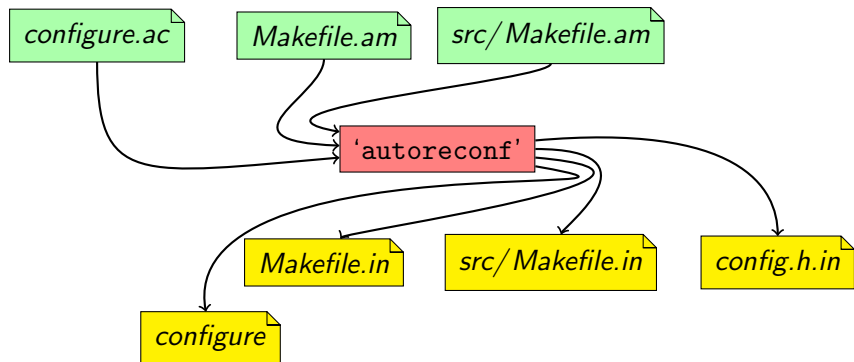
# Generating All Template Files



# Generating All Template Files



# Generating All Template Files



# Autotools Inputs

## *configure.ac*

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

# Autotools Inputs

## *configure.ac*

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

## *Makefile.am*

```
SUBDIRS = src
```

# Autotools Inputs

## *configure.ac*

```
AC_INIT([amhello], [1.0],  
        [bug-report@address])  
AM_INIT_AUTOMAKE([  
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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
```

# 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:4: installing './install-sh'
configure.ac:4: installing './missing'
src/Makefile.am: installing './depcomp'
~/amhello %
```

# Preparing the Package

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

./src:
Makefile.am  main.c
~/amhello % autoreconf --install
configure.ac:4: installing './install-sh'
configure.ac:4: installing './missing'
src/Makefile.am: installing './depcomp'
~/amhello % ls -R
.:
Makefile.am      configure.ac
Makefile.in      depcomp*
aclocal.m4       install-sh*
autom4te.cache/  missing*
```

# 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*

./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/           expected configuration templates
configure*

./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*

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

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

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

# Preparing the Package

```
~/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/           Autotools cache files
configure*

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

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

# Preparing the Package

```
~/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

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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

```
~/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

```
~/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

# 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

# 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

# Two Core Packages

## GNU Autoconf

- 'autoconf' Create *configure* from *configure.ac*.
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## GNU Automake

- 'automake' Create *Makefile.ins* from *Makefile.ams* and *configure.ac*.

# Two Core Packages

## GNU Autoconf

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## 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*.



# Two Core Packages

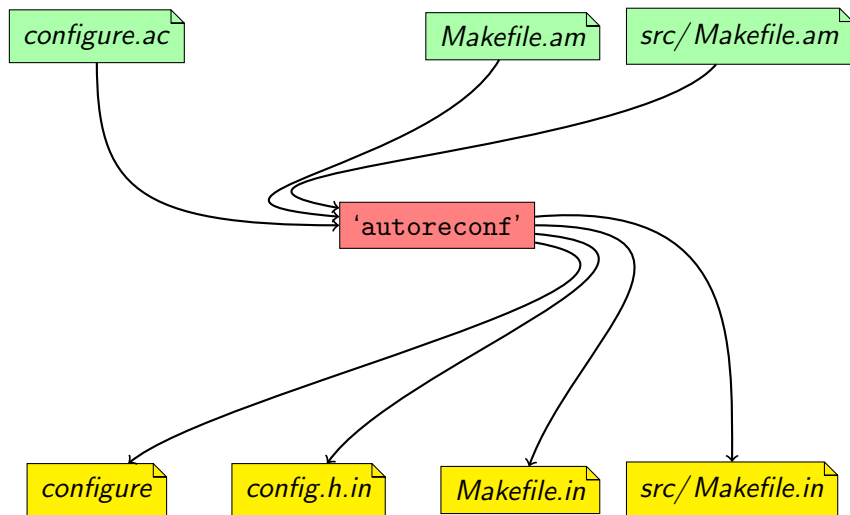
## GNU Autoconf

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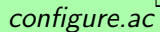
## GNU Automake

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- 'aclocal' Scan *configure.ac* for uses of third-party macros, and gather definitions in *aclocal.m4*.

## Behind 'autoreconf'



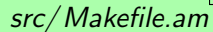
# Behind 'autoreconf'



*configure.ac*



*Makefile.am*



*src/Makefile.am*



*configure*



*config.h.in*

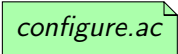


*Makefile.in*



*src/Makefile.in*

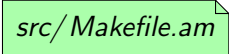
# Behind 'autoreconf'



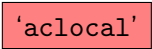
*configure.ac*



*Makefile.am*



*src/Makefile.am*



'aclocal'



*configure*



*config.h.in*

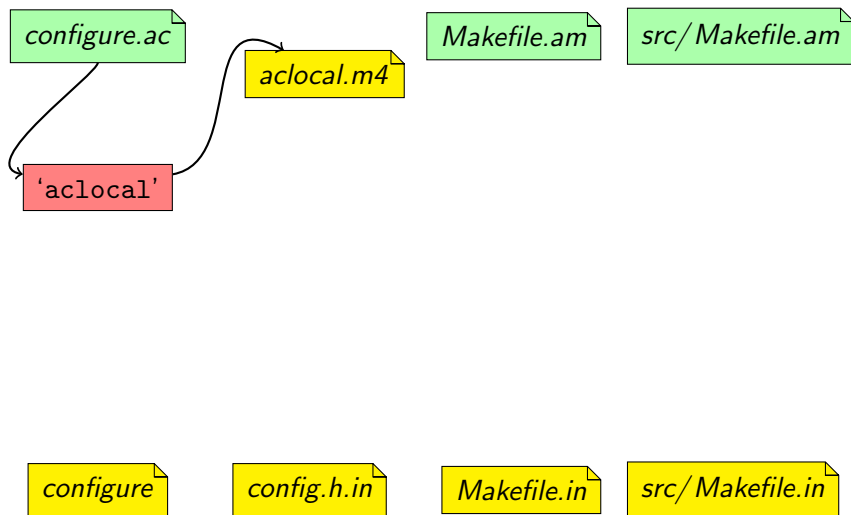


*Makefile.in*

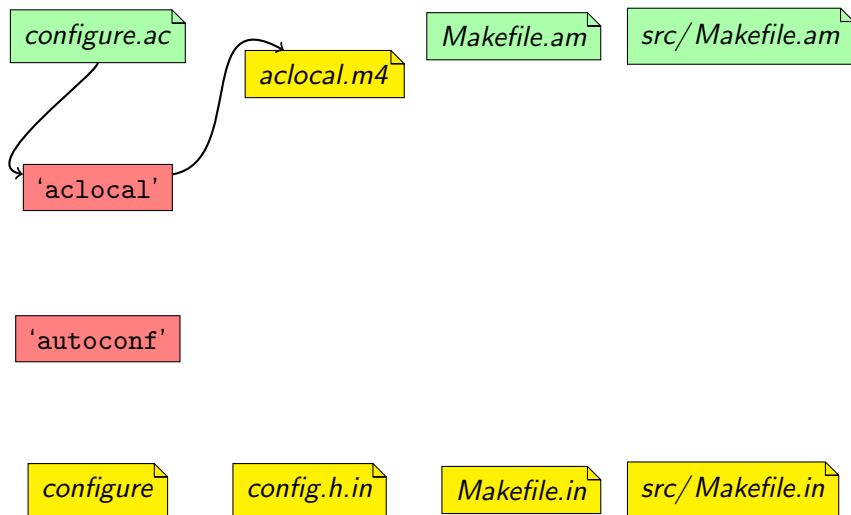


*src/Makefile.in*

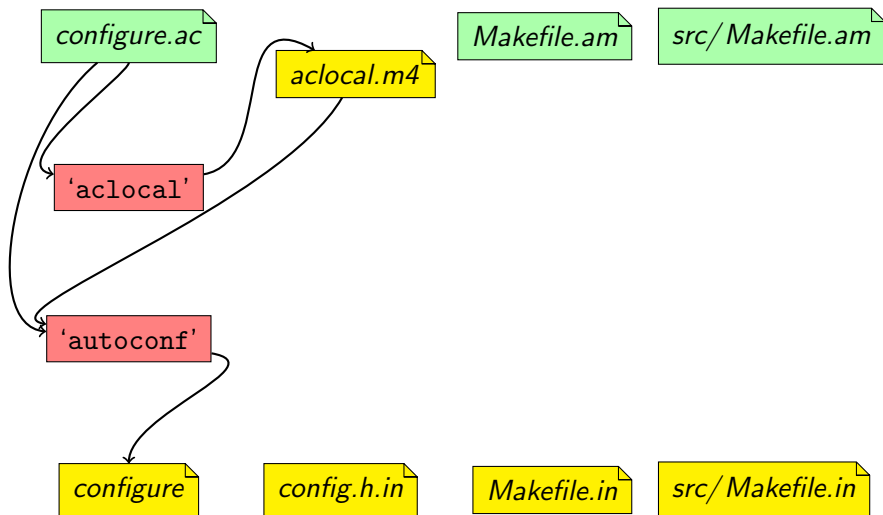
## Behind 'autoreconf'



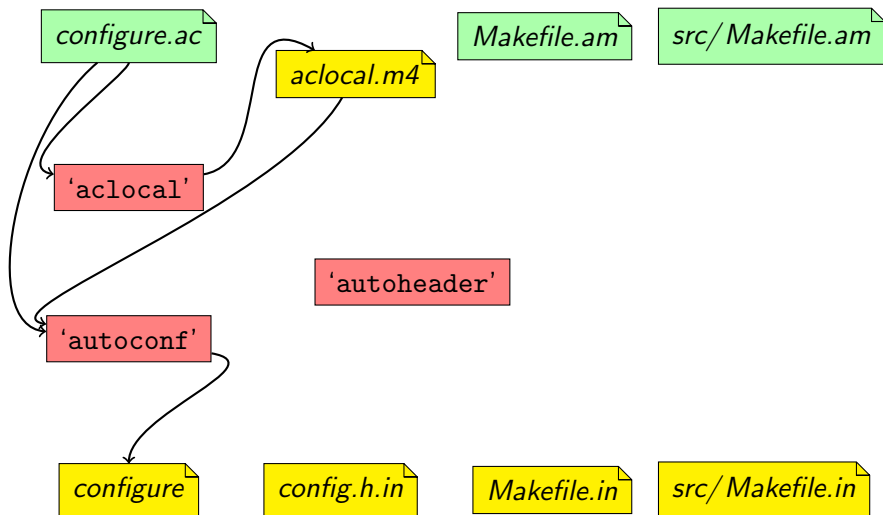
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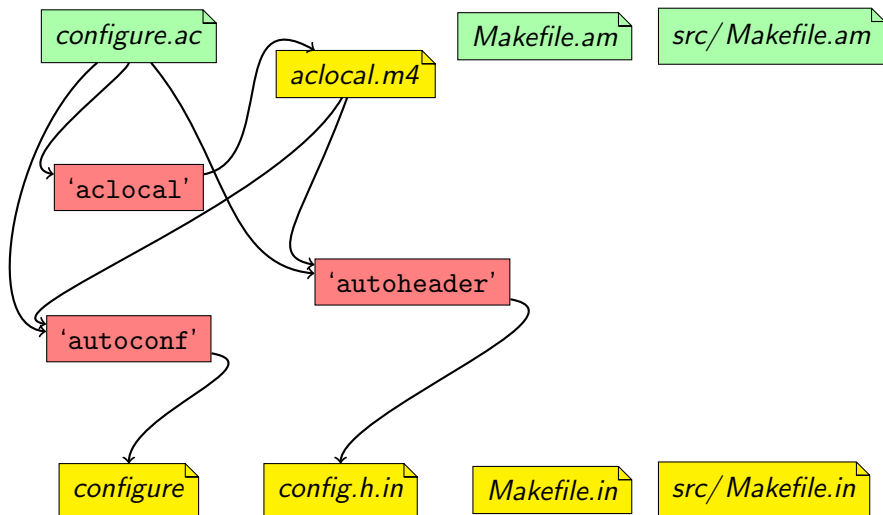


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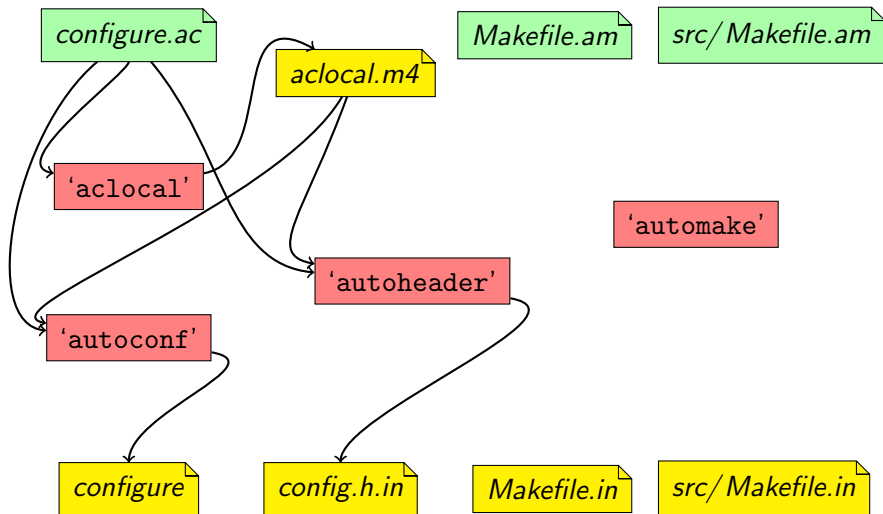




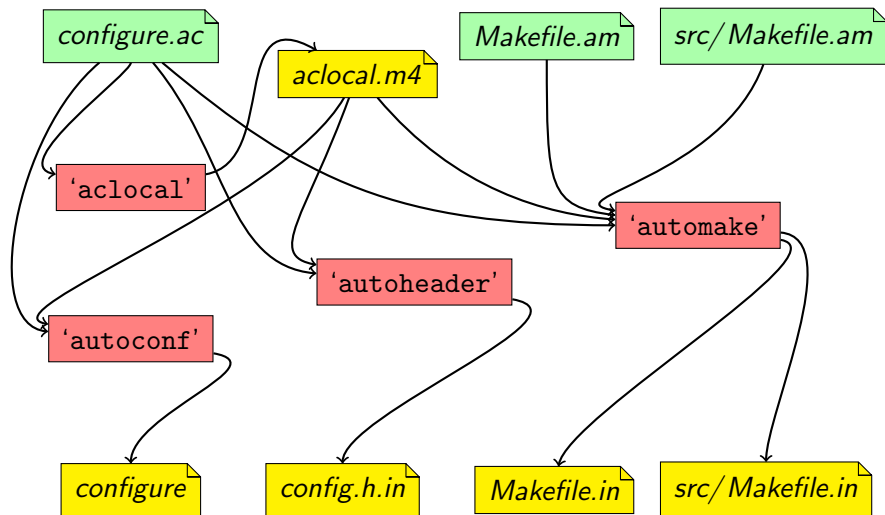
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# 'autoreconf' is Your Friend

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.
- 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

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'autoconf' Creates *configure* from *configure.ac*.

'autoheader' Creates *config.h.in* from *configure.ac*.

'automake' Creates *Makefile.in*s from *Makefile.am*s 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'.

# Hello World Explained

# amhello's *configure.ac* explained

## *configure.ac*

```
AC_INIT([amhello], [1.0], [bug-report@address])
AM_INIT_AUTOMAKE([-Wall -Werror foreign])
AC_PROG_CC
AC_CONFIG_HEADERS([config.h])
AC_CONFIG_FILES([Makefile src/Makefile])
AC_OUTPUT
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- Initialize Autoconf. Specify package's name, version number, and bug-report address.



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

...

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

```
configure.ac:2: installing './install-sh'
```

```
configure.ac:2: installing './missing'
```

```
src/Makefile.am: installing './depcomp'
```

# 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*

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- 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.

# amhello's *src/Makefile.am* explained

## *src/Makefile.am*

```
bin_PROGRAMS = hello  
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```

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

# Standard File System Hierarchy

Directory variable	Default value
prefix	<i>/usr/local</i>
exec-prefix	prefix
bindir	exec-prefix/ <i>bin</i>
libdir	exec-prefix/ <i>lib</i>
...	
includedir	prefix/ <i>include</i>
datarootdir	prefix/ <i>share</i>
datadir	datarootdir
mandir	datarootdir/ <i>man</i>
infodir	datarootdir/ <i>info</i>
...	

# amhello's *src/Makefile.am* explained

## *src/Makefile.am*

```
bin_PROGRAMS = hello  
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- We are building some programs.
- These programs will be installed in **bindir**.

# amhello's *src/Makefile.am* explained

## *src/Makefile.am*

```
bin_PROGRAMS = hello
hello_SOURCES = main.c
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- We are building some programs.
- These programs will be installed in *bindir*.
- There is only one program to build: *hello*.

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## *src/Makefile.am*

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bin_PROGRAMS = hello  
hello_SOURCES = main.c
```

- 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

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

- 'autoconf' is a macro processor.
- It converts *configure.ac*, which is a shell script using macro instructions, into *configure*, a full-fledged shell script.

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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)↵
```

~ %

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↵  
↵  
↵  
Harry met Sally↵
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```

Can you guess the output of the above?

# M4 Quoting

- The macro's arguments are processed
- Then the macro is expanded
- Finally the output of the macro is processed too
- A string can be protected from processing using quotes.

This is a source of many mistakes for the unwary.

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↵

MET(NAME1, NAME2)↵

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↵  
↵  
↵  
↵

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*example.m4*

```
␣  
␣  
␣  
␣
```

```
Harry met Jr.␣
```

Can you guess the output of the above?



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```
↵  
↵  
↵  
↵  
Harry met Jr.↵
```

Can you guess the output of the above?

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↵  
↵  
↵  
↵

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↵  
↵  
↵  
↵

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*example.m4*

```
␣  
␣  
␣  
␣
```

```
Harry met Jr.␣
```

Can you guess the output of the above?

# M4 Quoting Rule of the Thumb

- Quote each macro argument once.

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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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- Quote each macro argument once.
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### *example.m4*

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

```
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```

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




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## *example.m4*


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


```
m4_define('NAME2', 'Sally')
```

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

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

# M4 Quoting Rule of the Thumb

- Quote each macro argument once.
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## *example.m4*

```
↵  
m4_define(NAME2, 'Sally')↵  
m4_define('MET', '$1 met $2')↵  
MET('NAME1', 'NAME2')↵
```

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*example.m4*

```
↵  
m4_define(NAME2, Sally)↵  
m4_define('MET', '$1 met $2')↵  
MET('NAME1', 'NAME2')↵
```

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```
↵  
↵  
m4_define('MET', '$1 met $2')↵  
MET('NAME1', 'NAME2')↵
```

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- Quote each macro argument once.
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*example.m4*

```
↵  
↵  
m4_define(MET, '$1 met $2')↵  
MET('NAME1', 'NAME2')↵
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*example.m4*

```
↵  
↵  
m4_define(MET, $1 met $2)↵  
MET('NAME1', 'NAME2')↵
```



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- Quote each macro argument once.
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*example.m4*

↵  
↵  
↵

MET('NAME1', 'NAME2')↵

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- Quote each macro argument once.
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*example.m4*

↵  
↵  
↵

MET(NAME1, 'NAME2')↵

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*example.m4*

↵  
↵  
↵

**MET**(NAME1 , NAME2)↵

# M4 Quoting Rule of the Thumb

- Quote each macro argument once.
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*example.m4*

↵  
↵  
↵

NAME1 met NAME2↵

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- Quote each macro argument once.
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*example.m4*

↵  
↵  
↵

NAME1 met NAME2↵

# M4 Quoting Rule of the Thumb

- Quote each macro argument once.
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*example.m4*

↵  
↵  
↵

Harry, Jr. met NAME2↵

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- Quote each macro argument once.
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*example.m4*

↵  
↵  
↵

Harry, Jr. met NAME2↵

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- 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*

↵  
↵  
↵

Harry, Jr. **met** NAME2↵

# M4 Quoting Rule of the Thumb

- Quote each macro argument once.
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*example.m4*

↵  
↵  
↵

Harry, Jr. met NAME2↵

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*example.m4*

↵  
↵  
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*example.m4*

↵  
↵  
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*example.m4*

↵  
↵  
↵

Harry, Jr. met Sally↵

# 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.

## *example.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_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.

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if [ "$x" = "$y" ]; then ...
```

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- 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.

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

# The Structure of a *configure.ac*

## *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\_FILES([**FILES**])

AC\_OUTPUT

# The Structure of a *configure.ac*

## *configure.ac*

```
# 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_FILES([FILES])  
AC_OUTPUT
```



# The Structure of a *configure.ac*

## *configure.ac*

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

# The Structure of a *configure.ac*

## *configure.ac*

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

# The Structure of a *configure.ac*

## *configure.ac*

```
# Prelude.  
AC_INIT([amhello], [1.0], [bug-report@address])  
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# 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_FILES([Makefile src/Makefile])  
AC_OUTPUT
```

# The Structure of a *configure.ac*

## *configure.ac*

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

# Useful Autoconf Macros for Prelude

`AC_INIT(PACKAGE, VERSION, BUG-REPORT-ADDRESS)`

Mandatory Autoconf initialization.

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Mandatory Autoconf initialization.

**AC\_PREREQ(VERSION)**

**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]).`

# Useful Autoconf Macros for Prelude

**AC\_INIT(PACKAGE, VERSION, BUG-REPORT-ADDRESS)**

Mandatory Autoconf initialization.

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**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*
aclocal.m4       install-sh*
autom4te.cache/  missing*
config.h.in      src/
configure*       auxiliary tools
                  used during the build

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

## AC\_CONFIG\_AUX\_DIR Example

### *configure.ac*

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

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

```
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

## *configure.ac*

```
AC_INIT([amhello], [1.1], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AM_INIT_AUTOMAKE([-Wall -Werror foreign])
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.)

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`AC_PROG_SED`, `AC_PROG_YACC`, `AC_PROG_LEX`, ...

Find good implementations and set `$SED`, `$YACC`, `$LEX`, etc.

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`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.)

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Find good implementations and set `$SED`, `$YACC`, `$LEX`, etc.

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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

`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*.

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

# 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*.

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

`AC_SUBST(VARIABLE, [VALUE])`

Define `$(VARIABLE)` as `VALUE` in *Makefile*.

```
AC_SUBST([FOO], [foo])
```

```
FOO=foo
```

```
AC_SUBST([FOO])
```

```
AC_SUBST([FOO])
```

```
FOO=foo
```

All equivalent.

# 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.

# 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=-leference])  
AC_SUBST([EFENCELIB])
```

... we would later use `$(EFENCELIB)` in the link rule.

# 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=-leference])
AC_SUBST([EFENCELIB])
```

... we would later use `$(EFENCELIB)` in the link rule.

If **ACT-IF-FOUND** is not set and the library is found, `AC_CHECK_LIB` will do `LIBS="-lLIBRARY $LIBS"` and `#define HAVE_LIBLIBRARY`. (Automake uses `$LIBS` for linking everything.)

# Checking for Headers

`AC_CHECK_HEADERS(HEADERS...)`

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

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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
```



# 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_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.

# 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.

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

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...)

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-*Makefile* too.



## AC\_CONFIG\_FILES([script.sh:script.in]) Example

*script.in*

```
#!/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*

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

*.in* files are templates where @XYZ@ are placeholders for AC\_SUBST([XYZ]) definitions.

## AC\_CONFIG\_FILES([script.sh:script.in]) Example

*script.in*

```
#!/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*

```
#!/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*

```
#!/bin/sh
SED='@SED@'
TAR='@TAR@'
d=$1; shift; mkdir "$d"
for f; do
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        >"$d/$f"
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```

*script.sh*

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#!/bin/sh
SED='/usr/xpg4/bin/sed'
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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.in*s also use **@XYZ@** as placeholders but Automake makes all `XYZ=@XYZ@` definitions and you may simply use `$(XYZ)` as needed.

# Using Automake

# Automake Principles

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

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- Automake helps creating portable and GNU-standard compliant *Makefiles*.
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(E.g., no VPATH builds, but all objects go into *obj/*.)
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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*

```
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([-Wall -Werror foreign])  
  
# 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
```

# 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.

`dist-bzip2` Also create tar.bz2 archives during 'make dist' and 'make distcheck'.

`tar-ustar` Create tar archives using the ustar format.



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`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 ...
```

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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
```

# Standard File System Hierarchy

Directory variable	Default value
prefix	<i>/usr/local</i>
exec-prefix	prefix
bindir	exec-prefix/ <i>bin</i>
libdir	exec-prefix/ <i>lib</i>
...	
includedir	prefix/ <i>include</i>
datarootdir	prefix/ <i>share</i>
datadir	datarootdir
mandir	datarootdir/ <i>man</i>
infodir	datarootdir/ <i>info</i>
...	

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*Makefile.am*

```
where_PRIMARY = targets ...
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targets should be installed in...

```
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```
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```

```
...
```

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```
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```
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```

```
_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**

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

targets should be installed in...

`bin_ $(bindir)`

`lib_ $(libdir)`

...

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You define customdir.

`noinst_` Not installed.

targets should be built as...

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# 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.

`noinst_` Not installed.

`check_` Built by 'make check'.

**targets** should be built as...

`_PROGRAMS`

`_LIBRARIES`

`_LTLIBRARIES` (Libtool libraries)

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`_SCRIPTS`

`_DATA`

# where\_PRIMARY Convention for Declaring Targets

*Makefile.am*

**option\_**where\_PRIMARY = **targets** ...

**targets** should be installed in...

`bin_ $(bindir)`

`lib_ $(libdir)`

...

`custom_ $(customdir)`

You define customdir.

`noinst_` Not installed.

`check_` Built by 'make check'.

**targets** should be built as...

`_PROGRAMS`

`_LIBRARIES`

`_LTLIBRARIES` (Libtool libraries)

`_HEADERS`

`_SCRIPTS`

`_DATA`

Optionally: `dist_` Distribute **targets** (if not the default)

`nodist_` Don't.

# 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*

```
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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 `programs_SOURCES`.

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## *Makefile.am*

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- Non-alphanumeric characters are mapped to `'_'`.

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- These programs will be installed in `$(bindir)`.
- The sources of each **program** go into `programs_SOURCES`.
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- Automake automatically computes the list of objects to build and link from these files.

# Declaring Sources

## *Makefile.am*

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- These programs will be installed in `$(bindir)`.
- The sources of each `program` go into `programs_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).

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## *Makefile.am*

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bin_PROGRAMS = foo run-me  
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- It's OK to use the same source for two programs.



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- These programs will be installed in `$(bindir)`.
- The sources of each **program** go into `programs_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*.

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## *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
```

# (Static) Libraries

- Add AC\_PROG\_RANLIB to *configure.ac*.

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- Add AC\_PROG\_RANLIB to *configure.ac*.

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```

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

# (Static) Libraries

- Add AC\_PROG\_RANLIB to *configure.ac*.

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lib_LIBRARIES = libfoo.a libbar.a
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- 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*

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lib_LIBRARIES = libfoo.a libbar.a
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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 sources files.

# Directory Layout

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



# 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])
```

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- They must all be declared in *configure.ac*.

## *configure.ac*

```
AC_CONFIG_FILES([Makefile lib/Makefile src/Makefile  
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```

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

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## *Makefile.am*

```
SUBDIRS = lib src
```

## *src/Makefile.am*

```
SUBDIRS = dira dirb
```

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- The current directory is implicitly built after subdirectories.

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```

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

## *src/Makefile.am*

```
SUBDIRS = dira dirb .
```

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```
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```
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```

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```

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

## *src/Makefile.am*

```
SUBDIRS = . dira dirb
```

## `$(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 xzf ~/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.
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## `$(srcdir)` and `VPATH` Builds

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- 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*

```
noinst_LIBRARIES = libcompat.a  
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## *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
```



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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 (`-Is` and `-Ds`)

The default value for `foo_XXXFLAGS` is `$(AM_XXXFLAGS)`.

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

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

# 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=-leference])  
AC_SUBST([EFENCELIB])
```

... we would later use `$(EFENCELIB)` in the link rule.

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

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See 'automake --help' for a list of those files.
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## *Makefile.am*

```
SUBDIRS = lib src  
EXTRA_DIST = HACKING
```

... will additionally distribute *HACKING*.

# Conditionals: Usage

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

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- 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*.

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Declare conditional `NAME`. `CONDITION` should be a shell instruction that succeeds iff `NAME` should be enabled.

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*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* is 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)
  - ...
- 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

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- 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!

# Lost? 'autoreconf' is Still Your Friend

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

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

```
~/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 V

### More Autotools

# Writing Autoconf Macros

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Two fundamentally different types of new macros:

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- 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

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AC_DEFUN(MACRO-NAME, MACRO-BODY)
```

Define MACRO-NAME as MACRO-BODY.

Avoid names that may conflict.



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`m4_` Original M4 macros, plus M4sugar macros.

`AS_` M4sh macros (macroized shell constructs)

`AH_` Autoheader macros

`AC_` Autoconf macros (written on top of the above layers)

`AM_` Automake macros

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**AH\_** **Auto**header macros

**AC\_** **Auto**conf macros (written on top of the above layers)

**AC\_CHECK\_** Generic checks.

**AC\_FUNC\_** Specific function checks.

**AC\_HEADER\_** Specific header checks.

**AC\_PROG\_** Specific program checks.

    ...

**AM\_** **Auto**make macros

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## `mkdir()` Example

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

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```
#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
```

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#endif
```

Let's write an Autoconf macro to define **these C macros**

# Writing a High-Level Macro: AX\_FUNC\_MKDIR

```
AC_DEFUN([AX_FUNC_MKDIR],  
[AC_CHECK_FUNCS([mkdir _mkdir])  
AC_CHECK_HEADERS([io.h])  
AX_FUNC_MKDIR_ONE_ARG  
)
```

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- Suggested name space for extension macros.

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- 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)

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- 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

```
# _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_TRY_COMPILE([
#include <sys/stat.h>
#if HAVE_UNISTD_H
# include <unistd.h>
#endif
#if HAVE_IO_H
# include <io.h>
#endif
], [mkdir (".", 0700);], [$2], [$1]))]
```

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```

## Comments

Showcase of the traditional style used to document autoconf macros.

# Checking mkdir()'s number of arguments

```
# _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_TRY_COMPILE([
#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\_TRY\_COMPILE

Creates a small program and attempt to compile it. In our case it will execute one of the `_AX_FUNC_MKDIR_ONE_ARG` arguments depending on whether the program compiled or not.

# Checking `mkdir()`'s number of arguments

```
# _AX_FUNC_MKDIR_ONE_ARG(IF-ONE-ARG, IF-TWO-ARGS)
# -----
# Execute IF-TWO-ARGS if mkdir() accepts two
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[AC_TRY_COMPILE([
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# include <unistd.h>
#endif
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#endif
], [mkdir (".", 0700);], [$2], [$1]))]
```

- Wait! That's not enough for an Autoconf check: we should also add some *checking whether...* message on top of this.

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], [mkdir (".", 0700);], [$2], [$1]))]
```

- Wait! That's not enough for an Autoconf check: we should also add some *checking whether...* message on top of this.
- We use the `_AX` prefix for helper macros not meant to be used directly.

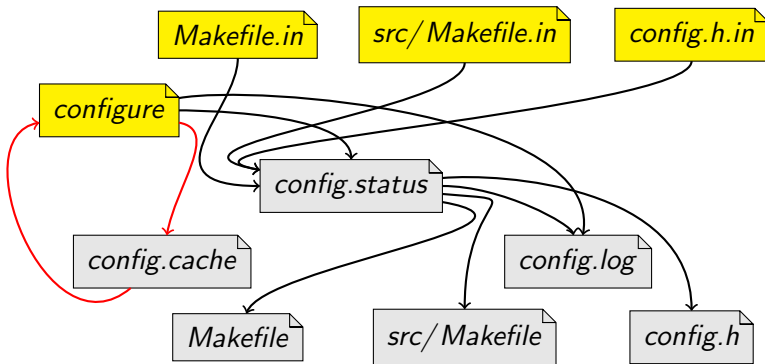


# Writing a Low-Level Macro

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

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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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```

- 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

```
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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

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

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- 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:  
<http://www.testdrive.hp.com/>  
<http://sourceforge.net/docs/E02/>

# Managing Custom Macros with 'aclocal'

## *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).



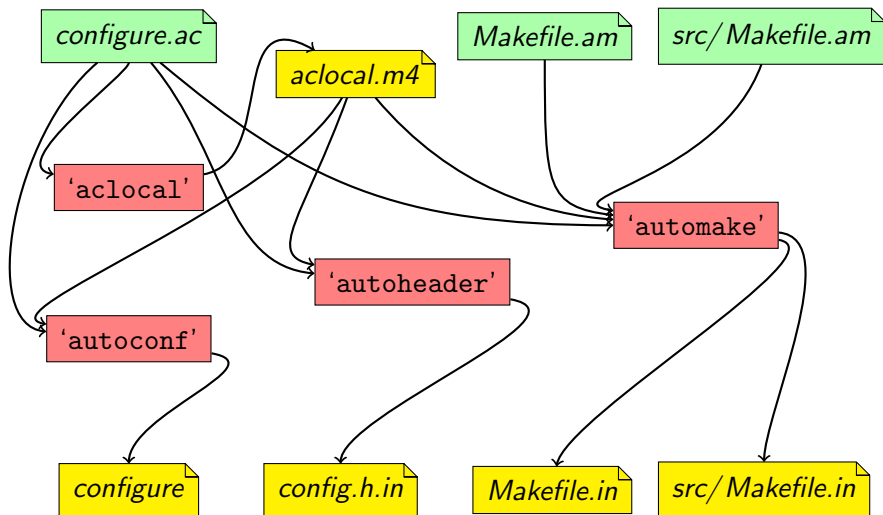
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# Behind 'autoreconf'



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'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`)

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- Add `ACLOCAL_AMFLAGS = -I m4` to the top-level `Makefile.am`.
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The `ACLOCAL_AMFLAGS` are used by 'autoreconf' and by the `Makefile` rebuild rule when they need to run 'aclocal'.

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You need such a setup to use Gettext, and the upcoming Libtool 2.0.



# Libtool

# Shared Libraries: A Portability Hell

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  - *libhello.so*
  - *libhello.dll*
  - *libhello.sl*
  - *libhello.dylib*
  - ...

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- There is no way for a developer to keep track of all these details.
  - Quiz: match each of the above example with its OS.
- Not all systems support shared libraries.

# Shared Libraries: Libtool's Solution

- A new library format that abstracts all the others
  - [libhello.la](http://libhello.la) (libtool archive)

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- 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.

# Setting Up Libtool: Roadmap

- Call `AC_PROG_LIBTOOL` in *configure.ac*.

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- Use \_LTLIBRARIES to declare libtool archives in *Makefile.am*

## *Makefile.am*

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

# Setting Up Libtool: Roadmap

- Call AC\_PROG\_LIBTOOL in *configure.ac*.
- Use \_LTLIBRARIES to declare libtool archives in *Makefile.am*
- Use \_LDADD to link against local libtool archives.

## *Makefile.am*

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

bin_PROGRAMS = runme
runme_SOURCES = main.c
runme_LDADD = libfoo.la
```

# Hello World Using Libtool: C Files

## *lib/say.c*

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

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

## *lib/say.h*

```
void say_hello (void);
```

## *src/main.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
```

# Hello World Using Libtool: *configure.ac*

## *configure.ac*

```
AC_INIT([amhello], [2.0], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AM_INIT_AUTOMAKE([-Wall -Werror foreign])
AC_PROG_LIBTOOL
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
```



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```
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.:
Makefile.am  configure.ac  lib/  src/

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

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

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

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~/amhello % autoreconf --install
```

```
Putting files in AC_CONFIG_AUX_DIR, 'build-aux'.
```

```
configure.ac: installing 'build-aux/install-sh'
```

```
configure.ac: installing 'build-aux/missing'
```

```
lib/Makefile.am: installing 'build-aux/depcomp'
```

```
~/amhello %
```

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

# Hello World Using Libtool: 'autoreconf'

```
~/amhello % autoreconf --install
Putting files in AC_CONFIG_AUX_DIR, 'build-aux'.
configure.ac: installing 'build-aux/install-sh'
configure.ac: installing 'build-aux/missing'
lib/Makefile.am: installing 'build-aux/depcomp'
~/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 % 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 %
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~/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)
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not a dynamic executable
~/amhello %
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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
```

# Building Shared or Static Libraries

- By default, both static and shared libraries are built.
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  - `--enable-static` build static libraries
  - `--disable-static` don't
- At least one flavor is built, always.
- Some systems don't leave any choice.

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  - Libtool hides it in the build tree (don't bother about it)
- 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



# The *src/hello* Wrapper Script

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

Do not debug the shell script!

```
~/amhello % gdb -q src/hello  
"src/hello": not in executable format: File format not recognized  
(gdb)
```

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## Do not debug the shell script!

```
~/amhello % gdb -q src/hello  
"src/hello": not in executable format: File format not recognized  
(gdb)
```

## Prefix such commands with *libtool --mode=execute*

```
~/amhello % libtool --mode=execute gdb -q src/hello
```

# Versioning Libtool Libraries: Interfaces

- 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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- A program remembers the interface numbers of the libraries it was linked against.
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  - E.g., adding new functions changes the interface, but does not break old interfaces.
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- A program remembers the interface numbers of the libraries it was linked against.
- 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**.

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(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

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(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 0:0:0
```

The default version is 0:0:0. It's also a good initial version.

# Versioning Libtool Libraries: Bumping Versions

Remember to bump library versions before a release.

Suppose the old version was **CURRENT** **REVISION** **AGE**.

If you have	bump the version to
not changed the interface (bug fixes)	<b>CURRENT</b> : <b>REVISION</b> + 1 : <b>AGE</b>
augmented the interface (new functions)	<b>CURRENT</b> + 1 : 0 : <b>AGE</b> + 1
broken old interface (e.g. removed functions)	<b>CURRENT</b> + 1 : 0 : 0

# Introducing Gettext

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- Internationalization

- Localization

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Changing a program to support for multiple languages and cultural habits.

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Providing an internationalized package the necessary bits to support one's native language and cultural habits.

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- **Internationalization** = I18n

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- **Localization** = L10n

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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.

- Localization = L10n

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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.

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## The translator's work.

# Introducing Gettext

- Internationalization = I18n

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- Character handling (unicode...)
- Locale awareness (date formats, currencies, numbers, time zones, etc.)
- **Localizability**
  - **Isolate localizable items** (messages, pictures, etc.)
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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

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

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

- The program is written in English.

# Translating Messages Made Easy

```
#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.

# Translating Messages Made Easy

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#include <config.h>
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```

- 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

# Internationalizing a Package, Start to Finish

## 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;
}
```

## *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([-Wall -Werror foreign])
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

## *configure.ac*

```
AC_INIT([amhello], [3.0], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AM_INIT_AUTOMAKE([-Wall -Werror foreign])
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*

```
AC_INIT([amhello], [3.0], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AM_INIT_AUTOMAKE([-Wall -Werror foreign])
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

## *configure.ac*

```
AC_INIT([amhello], [3.0], [bug-report@address])
AC_CONFIG_AUX_DIR([build-aux])
AM_INIT_AUTOMAKE([-Wall -Werror foreign])
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 %
```

# Running 'gettextize'

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- 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*

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

## *Makefile.am*

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

## *src/Makefile.am*

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

## *po/Makevars* and *po/POTFILES.in*

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 =
```

## *po/Makevars* and *po/POTFILES.in*

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 =
```

**\$(PACKAGE\_BUGREPORT)** is the third argument of AC\_INIT. Some packages use a mailing list dedicated to translation issues instead.

## *po/Makevars* and *po/POTFILES.in*

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*

## src/Makefile.am

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

# Updating *src/Makefile.am*

## src/Makefile.am

```
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.



# Updating *src/Makefile.am*

## 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*

## 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*

## 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;
}
```

# Initializing Gettext

*src/main.c*

```
#include <locale.h>

#include "say.h"
int
main (void)
{
    setlocale (LC_ALL, "");

    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.)

# Initializing Gettext

*src/main.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

*src/say.c*

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

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

# Marking Strings for Translation

*src/say.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

*src/say.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 `_(...)`.
- 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.

# Building the Whole Shebang

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

# *po/amhello.pot*: The PO Template File

```
# ... 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 ""
```

# *po/amhello.pot*: The PO Template File

```
# ... COMMENTS ...
#, fuzzy
msgid ""
msgstr ""
"Project-Id-Version: PACKAGE VERSION\n"
"Report-Msgid-Bugs-To: bug-report@address\n"
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```

```
#: src/say.c:9
msgid "Hello World!"
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#: src/say.c:10
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msgid "This is %s.\n"
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 ""
```

## *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



## *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

## *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 ""
```

- `msgid`s identify all strings in the package
- empty `msgstr`s are placeholders for translations
- the location of each string is shown, so the translator can check the context if needed

## *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

# *po/amhello.pot*: The PO Template File

```
# ... 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"
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```

```
#: src/say.c:9
msgid "Hello World!"
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```

```
#: src/say.c:10
#, c-format
msgid "This is %s.\n"
msgstr ""
```

# *po/amhello.pot*: The PO Template File

```
# ... COMMENTS ...  
#, fuzzy  
msgid ""  
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"Project-Id-Version: PACKAGE VERSION\n"  
"Report-Msgid-Bugs-To: bug-report@address\n"  
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"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 ""
```

## *po/amhello.pot*: The Header Entry

```
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"
```

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*

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(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*

```
~/amhello % cd po  
~/amhello/po % msginit -l fr  
...  
~/amhello/po % emacs fr.po &
```

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```
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```

The PO mode of 'emacs' ( po-mode):

- The buffer is modified only indirectly.
-  on a message will open a buffer to edit the translation.
- Use   after you have completed the translation, to get back to the updated *amhello.pot* buffer.
- Once all strings are translated, use  to save and check the file.
- Use  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 ""
```

# *po/fr.po*: Message Translations

```
#: 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"
```

## *po/fr.po*: Header

```
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: Hobbitmon Community <hobbit@hsw.n.dk>\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.

## *po/fr.po*: Header

```
msgid ""
msgstr ""
"Project-Id-Version: amhello 3.0\n"
"Report-Msgid-Bugs-To: bug-report@address\n"
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msgstr ""
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"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: Hobbitmon Community <hobbit@hsw.n.dk>\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.

## *po/fr.po*: Header

```
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"
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"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.
- The revision date will also be updated on save.



## *po/fr.po*: Validation and Addition

Once *po/fr.po* is completed, hit . This will:

- 1 Update the revision date
- 2 Save the file
- 3 Run `'msgfmt --statistics --check'` on *po/fr.po*, to validate it.

## *po/fr.po*: Validation and Addition

Once *po/fr.po* is completed, hit . 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 %
```

# hello now Speaks French!

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

# hello now Speaks French!

```
~/amhello % ./configure --prefix ~/test  
~/amhello % make  
~/amhello % cd po  
~/amhello/po %
```

# hello now Speaks French!

```
~/amhello % ./configure --prefix ~/test  
~/amhello % make  
~/amhello % cd po  
~/amhello/po % make update-po  
~/amhello/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!

```
~/amhello % ./configure --prefix ~/test  
~/amhello % make  
~/amhello % cd po  
~/amhello/po % make update-po  
~/amhello/po % cd ..  
~/amhello % make install  
~/amhello %
```



# 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 %
```

# 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:

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Translators remove fuzzy attributes (`<Tab>`) after verification.

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Not up-to-date. `gettext` copes with incomplete translations as follows.

- Untranslated messages are output untranslated.
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**Not up-to-date.** `gettext` copes with incomplete translations as follows.

- Untranslated messages are output untranslated.
- 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

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- *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

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

# 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.
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- Subscribe to these tools' mailing lists, to see other people's uses of the tools.
- 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*.