CS631 - Advanced Programming in the UNIX Environment

–

UNIX development tools

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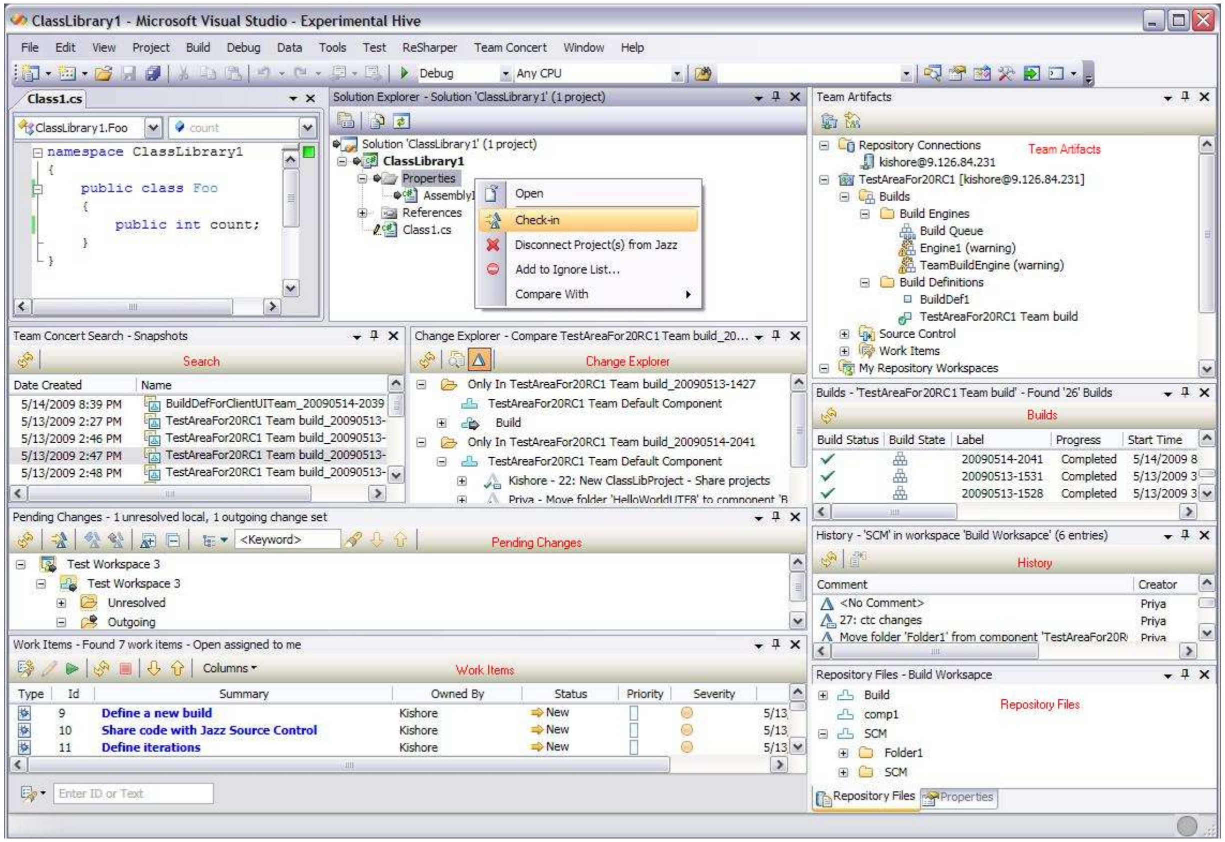
Software Development Tools


ClassLibrary1 - Microsoft Visual Studio - Experimental Hive
File
Edit
View
Project
Build
Debug
Data
Tools
Test
ReSharper
Team Concert
Window
Help
Debug
Any CPU
Class1.cs
ClassLibrary1.Foo
count
Solution Explorer - Solution 'ClassLibrary1' (1 project)
Open
Check-in
Disconnect Project(s) from Jazz
Add to Ignore List...
Compare With
Team Artifacts
Team Concert Search - Snapshots
Search
Change Explorer - Compare TestAreaFor20RC1 Team build_20...
Change Explorer
Builds - 'TestAreaFor20RC1 Team build' - Found '26' Builds
Builds
Pending Changes - 1 unresolved local, 1 outgoing change set
<Keyword>
Pending Changes
History - 'SCM' in workspace 'Build Worksapce' (6 entries)
History
Work Items - Found 7 work items - Open assigned to me
Columns
Work Items
Repository Files - Build Worksapce
Repository Files
Properties
Enter ID or Text

```
namespace ClassLibrary1
{
    public class Foo
    {
        public int count;
    }
}
```

Solution 'ClassLibrary1' (1 project)
ClassLibrary1
Properties
Assembly
References
Class1.cs

Repository Connections
kishore@9.126.84.231
TestAreaFor20RC1 [kishore@9.126.84.231]
Builds
Build Engines
Build Queue
Engine1 (warning)
TeamBuildEngine (warning)
Build Definitions
BuildDef1
TestAreaFor20RC1 Team build
Source Control
Work Items
My Repository Workspaces

Date Created	Name
5/14/2009 8:39 PM	BuildDefForClientUITeam_20090514-2039
5/13/2009 2:27 PM	TestAreaFor20RC1 Team build_20090513-
5/13/2009 2:46 PM	TestAreaFor20RC1 Team build_20090513-
5/13/2009 2:47 PM	TestAreaFor20RC1 Team build_20090513-
5/13/2009 2:48 PM	TestAreaFor20RC1 Team build_20090513-

Only In TestAreaFor20RC1 Team build_20090513-1427
TestAreaFor20RC1 Team Default Component
Build
Only In TestAreaFor20RC1 Team build_20090514-2041
TestAreaFor20RC1 Team Default Component
Kishore - 22: New ClassLibProject - Share projects
Priya - Move folder 'HelloWorldUTF8' to component 'B

Build Status	Build State	Label	Progress	Start Time
✓		20090514-2041	Completed	5/14/2009 8
✓		20090513-1531	Completed	5/13/2009 3
✓		20090513-1528	Completed	5/13/2009 3

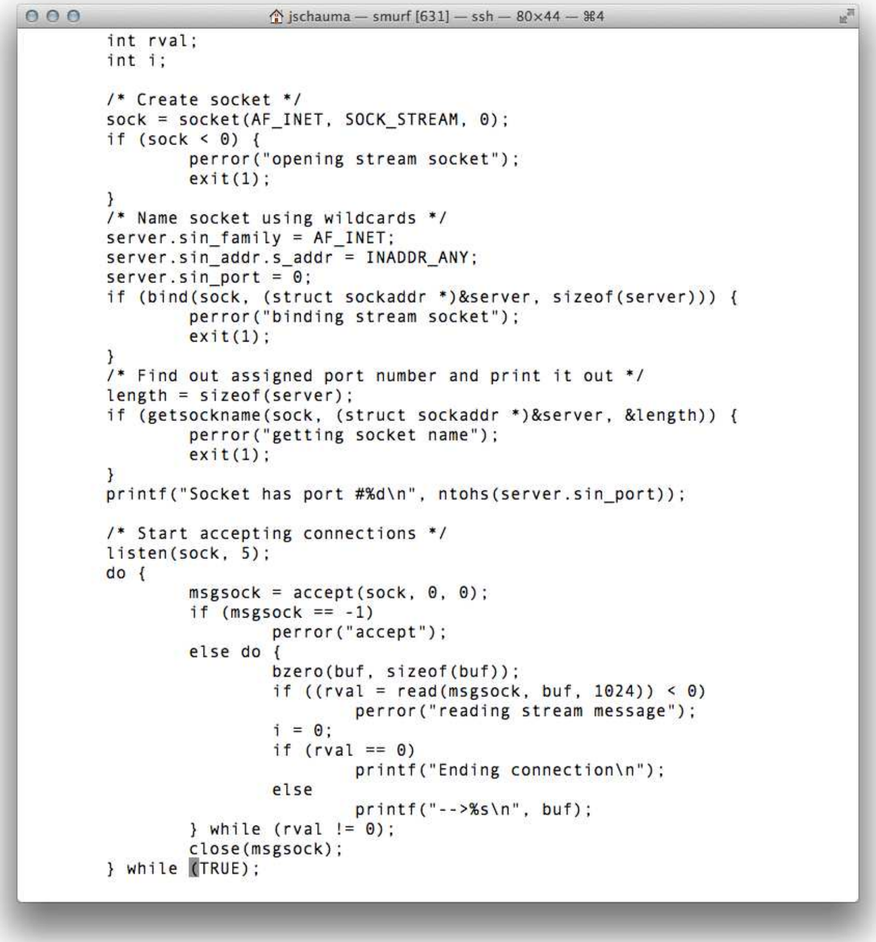
Test Workspace 3
Test Workspace 3
Unresolved
Outgoing

Comment	Creator
<No Comment>	Priya
27: ctc changes	Priya
Move folder 'Folder1' from component 'TestAreaFor20R	Priya

Type	Id	Summary	Owned By	Status	Priority	Severity	
	9	**Define a new build**	Kishore	New	□	●	5/13
	10	**Share code with Jazz Source Control**	Kishore	New	□	●	5/13
	11	**Define iterations**	Kishore	New	□	●	5/13

Build
comp1
SCM
Folder1
SCM

Software Development Tools



```
        int rval;
        int i;

        /* Create socket */
        sock = socket(AF_INET, SOCK_STREAM, 0);
        if (sock < 0) {
                perror("opening stream socket");
                exit(1);
        }
        /* Name socket using wildcards */
        server.sin_family = AF_INET;
        server.sin_addr.s_addr = INADDR_ANY;
        server.sin_port = 0;
        if (bind(sock, (struct sockaddr *)&server, sizeof(server))) {
                perror("binding stream socket");
                exit(1);
        }
        /* Find out assigned port number and print it out */
        length = sizeof(server);
        if (getsockname(sock, (struct sockaddr *)&server, &length)) {
                perror("getting socket name");
                exit(1);
        }
        printf("Socket has port #%d\n", ntohs(server.sin_port));

        /* Start accepting connections */
        listen(sock, 5);
        do {
                msgsock = accept(sock, 0, 0);
                if (msgsock == -1)
                        perror("accept");
                else do {
                        bzero(buf, sizeof(buf));
                        if ((rval = read(msgsock, buf, 1024)) < 0)
                                perror("reading stream message");
                        i = 0;
                        if (rval == 0)
                                printf("Ending connection\n");
                        else
                                printf("-->%s\n", buf);
                } while (rval != 0);
                close(msgsock);
        } while (TRUE);
```

Software Development Tools

UNIX Userland is an IDE – essential tools that follow the paradigm of “Do one thing, and do it right” can be combined.

The most important tools are:

- `$EDITOR`
- the compiler toolchain
- `gdb(1)` – debugging your code
- `make(1)` – project build management, maintain program dependencies
- `diff(1)` and `patch(1)` – report and apply differences between files
- `cvs(1)`, `svn(1)`, `git(1)` etc. – distributed project management, version control

EDITOR

Know your `$EDITOR`. Core functionality:

- syntax highlighting
- efficient keyboard maneuvering
- setting markers, using buffers
- copy, yank, fold e.g. blocks
- search and replace
- window splitting
- autocompletion
- jump to definition / manual page
- applying external commands and filters

EDITOR

Examples given using `vim(1)`.

Efficient keyboard maneuvering:

- up, down, left, right (h, j, k, l)
- move by word, go to end (w, b, e)
- search forward, backward, move to beginning or end of line (, /, ?, `^`, `$`)
- page up or down (`^`D, `^`B)
- center page, top or bottom (zz, zt, zb)
- move to matching brace, move to beginning/end of code block (%, `]}`, `[{`)
- move through multiple files (:n, :prev, :rew)

EDITOR

Examples given using `vim(1)`.

Copy, yank, fold, markers, buffers etc.:

- set and display markers (m `[`a-zA-Z`]`, :marks)
- select visual blocks (v, V)
- format / indent selected block (=)
- delete, yank, use of buffers (d, y, ”xy, ”xp)
- fold sections (zf, zA)

EDITOR

Examples given using `vim(1)`.

Look-ups:

-
  ```
  find /usr/src -name ’*[ch]’ -print | xargs ctags -f ~/.ctags
  ```
- `echo "set tags+=~/.ctags" >> ~/.vimrc`
- Ctrl+], Ctrl+t – jump to definition and back
- K – jump to manual page
- Ctrl+N – autocomplete

EDITOR

Examples given using `vim(1)`.

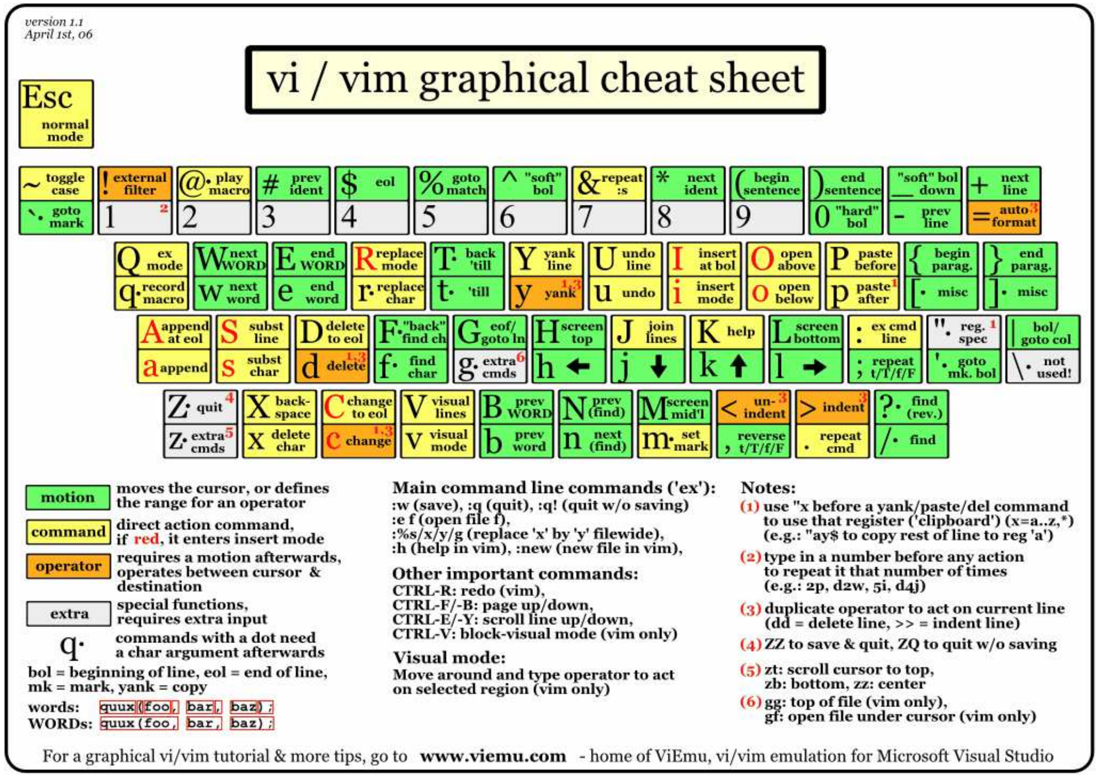
Integration with compiler, debugger, `make(1)` etc.

```
vim welcome.c
:make
Ctrl+]
:cnext
...
```

Finally, two of your most powerful Unix IDE integrations are a terminal multiplexer (e.g. `screen(1)` or `tmux(1)`) and copious use of Ctrl+Z (i.e., the shell's job control mechanisms).

EDITOR

Examples given using `vim(1)`.



motion — moves the cursor, or defines the range for an operator

command — direct action command, if red, it enters insert mode

operator — requires a motion afterwards, operates between cursor & destination

extra — special functions, requires extra input

q· — commands with a dot need a char argument afterwards

bol = beginning of line, eol = end of line, mk = mark, yank = copy

words: `quux(foo, bar, baz);`
WORDs: `quux(foo, bar, baz);`

Main command line commands ('ex'):
:w (save), :q (quit), :q! (quit w/o saving)
:e f (open file f),
:%s/x/y/g (replace 'x' by 'y' filewide),
:h (help in vim), :new (new file in vim),

Other important commands:
CTRL-R: redo (vim),
CTRL-F/-B: page up/down,
CTRL-E/-Y: scroll line up/down,
CTRL-V: block-visual mode (vim only)

Visual mode:
Move around and type operator to act on selected region (vim only)

Notes:

(1) use "x before a yank/paste/del command to use that register ('clipboard') (x=a..z,*) (e.g.: "ay$ to copy rest of line to reg 'a')

(2) type in a number before any action to repeat it that number of times (e.g.: 2p, d2w, 5i, d4j)

(3) duplicate operator to act on current line (dd = delete line, >> = indent line)

(4) ZZ to save & quit, ZQ to quit w/o saving

(5) zt: scroll cursor to top, zb: bottom, zz: center

(6) gg: top of file (vim only), gf: open file under cursor (vim only)

For a graphical vi/vim tutorial & more tips, go to **www.viemu.com** - home of ViEmu, vi/vim emulation for Microsoft Visual Studio

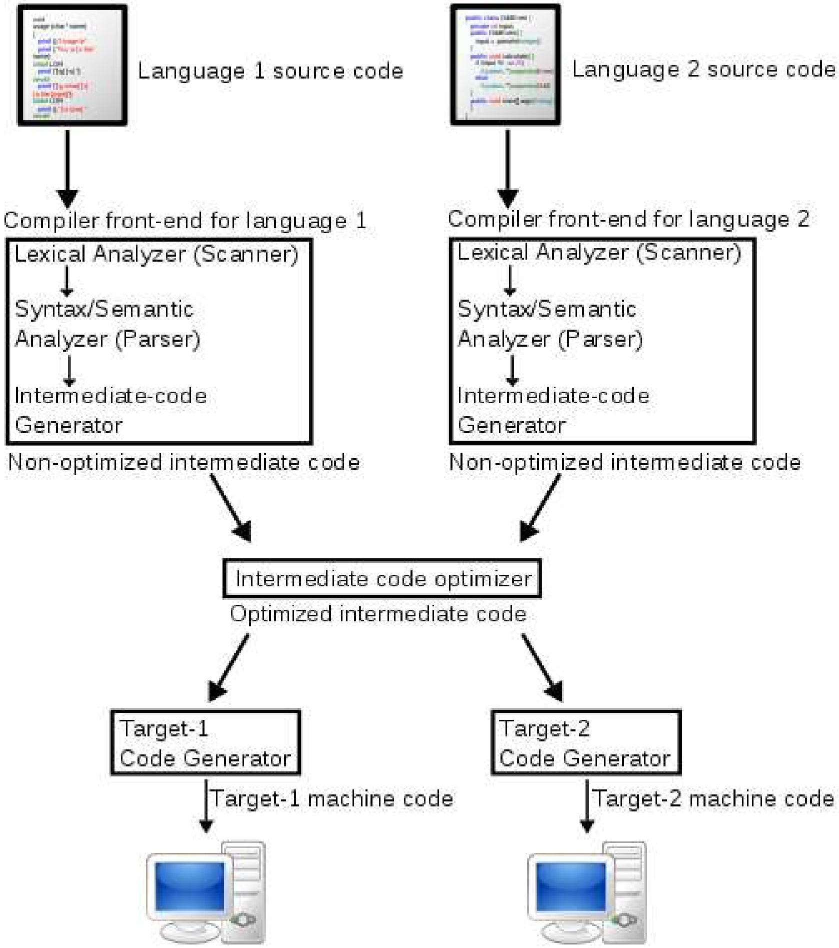
`https://duckduckgo.com/?q=vim+tutorial`

Compilers

A compiler translates *source code* from a high-level programming language into *machine code* for a given architecture by performing a number of steps:

- lexical analysis
- preprocessing
- parsing
- semantic analysis
- code optimization
- code generation
- assembly
- linking

Compilers



Language 1 source code

Language 2 source code

Compiler front-end for language 1

Lexical Analyzer (Scanner)

Syntax/Semantic Analyzer (Parser)

Intermediate-code Generator

Non-optimized intermediate code

Compiler front-end for language 2

Lexical Analyzer (Scanner)

Syntax/Semantic Analyzer (Parser)

Intermediate-code Generator

Non-optimized intermediate code

Intermediate code optimizer

Optimized intermediate code

Target-1 Code Generator

Target-1 machine code

Target-2 Code Generator

Target-2 machine code

Compilers

There are many different closed- and open-source compiler chains:

- Intel C/C++ Compiler (or `icc`)
- Turbo C / Turbo C++ / C++Builder (Borland)
- Microsoft Visual C++
- ...

- Clang (a frontend to LLVM)
- GNU Compiler Collection (or `gcc`)
- Portable C Compiler (or `pcc`)
- ...

The compiler toolchain

The compiler chain or driver usually performs preprocessing (e.g. via `cpp(1)`), compilation (`cc(1)`), assembly (`as(1)`) and linking (`ld(1)`).

Preprocessing

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```
$ cd compilechain
$ cat hello.c
$ man cpp
$ cpp hello.c hello.i
$ file hello.i
$ man cc
$ cc -v -E hello.c > hello.i
$ more hello.i
$ cc -v -DFOOD=\"Avocado\" -E hello.c > hello.i.2
$ diff -bu hello.i hello.i.2
```

Compilation

The compiler chain or driver usually performs preprocessing (e.g. via `cpp(1)`), compilation (`cc(1)`), assembly (`as(1)`) and linking (`ld(1)`).

```
$ more hello.i
$ cc -v -S hello.i
$ file hello.s
$ more hello.s
```

Assembly

The compiler chain or driver usually performs preprocessing (e.g. via `cpp(1)`), compilation (`cc(1)`), assembly (`as(1)`) and linking (`ld(1)`).

```
$ as -o hello.o hello.s
$ file hello.o
$ cc -v -c hello.s
$ objdump -d hello.o
[...]
```

Linking

The compiler chain or driver usually performs preprocessing (e.g. via `cpp(1)`), compilation (`cc(1)`), assembly (`as(1)`) and linking (`ld(1)`).

```
$ ld hello.o
[...]
$ ld hello.o -lc
[...]
$ cc -v hello.o
[...]
$ ld -dynamic-linker /usr/libexec/ld.elf_so                 \
        /usr/lib/crt0.o /usr/lib/crti.o /usr/lib/crtbegin.o \
        hello.o -lc /usr/lib/crtend.o /usr/lib/crtn.o
$ file a.out
$ ./a.out
```

Linking

The compiler chain or driver usually performs preprocessing (e.g. via `cpp(1)`), compilation (`cc(1)`), assembly (`as(1)`) and linking (`ld(1)`).

```
$ cc -v -DFOOD=\"Avocado\" hello.c 2>&1 | more
```

cc(1) and ld(1)

The compiler chain or driver usually performs preprocessing (e.g. via cpp(1)), compilation (cc(1)), assembly (as(1)) and linking (ld(1)).

Different flags can be passed to cc(1) to be passed through to each tool as well as to affect all tools.

```
$ cc -v -O2 -g hello.c 2>&1 | more
```

cc(1) and ld(1)

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The order of the command line flags *may* play a role! Directories searched for libraries via -L and the resolving of undefined symbols via -l are examples of position sensitive flags.

```
$ cc -v main.c -L./lib2 -L./lib -lldtest 2>&1 | more
```

```
$ cc -v main.c -L./lib -L./lib2 -lldtest 2>&1 | more
```

`cc(1)` and `ld(1)`

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The behavior of the compiler toolchain may be influenced by environment variables (eg `TMPDIR`, `SGI_ABI`) and/or the compilers default configuration file (MIPSPro's `/etc/compiler.defaults` or gcc's `specs`).

```
$ cc -v hello.c
$ TMPDIR=/var/tmp cc -v hello.c
$ cc -dumpspec
```

A Debugger

`gdb(1)`

The purpose of a debugger such as `gdb(1)` is to allow you to see what is going on “inside” another program while it executes – or what another program was doing at the moment it crashed. `gdb` allows you to

- make your program stop on specified conditions (for example by setting *breakpoints*)
- examine what has happened, when your program has stopped (by looking at the *backtrace*, inspecting the value of certain variables)
- inspect control flow (for example by *stepping* through the program)

Other interesting things you can do:

- examine stack frames: *info frame*, *info locals*, *info args*
- examine memory: *x*
- examine assembly: *disassemble func*

gdb(1)

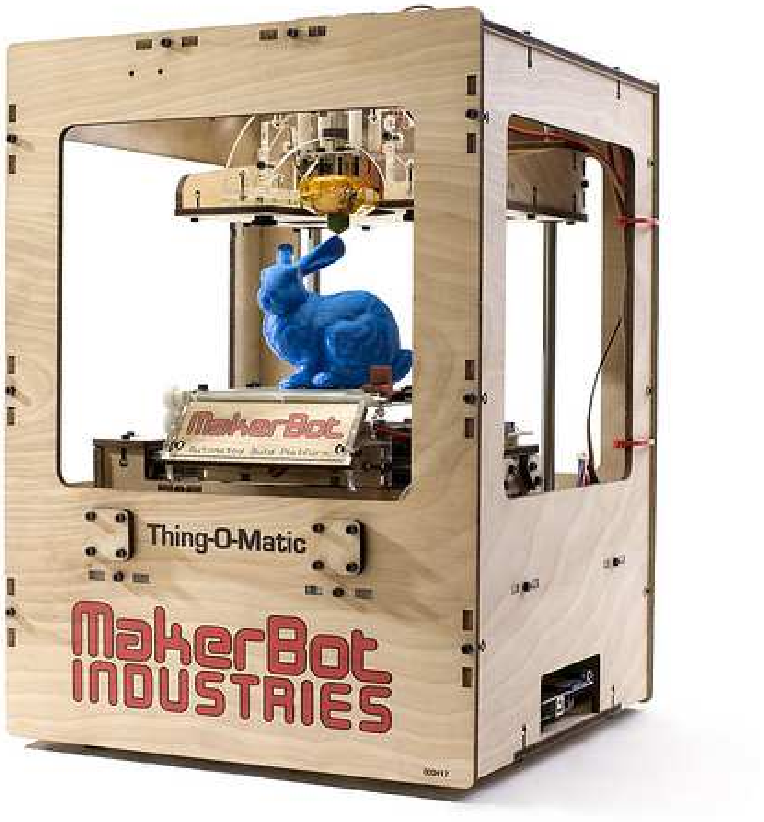
```
$ cc simple-ls.c
$ ./a.out ~/testdir
Memory fault (core dumped)
$ gdb ./a.out
(gdb) run ~/testdir

Program received signal SIGSEGV, Segmentation fault.
0x0000000000400cc7 in main (argc=2, argv=0x7f7fffa71978) at simple-ls-stat.c:48
warning: Source file is more recent than executable.
48                      printf("%s (%s)\n", dirp->d_name, pwd->pw_name);

(gdb) bt
(gdb) frame 0
(gdb) li
(gdb) print pwd
```

gdb(1)

```
$ cc gdb2.c
$ ./a.out
$ gdb ./a.out a.out.core
(gdb) from 2
(gdb) p argv[1]

$ ./a.out -1
$ ./a.out 123456789012345

$ ./a.out 1
123456789

$ gdb ./a.out
(gdb) break main
(gdb) run 1
(gdb) p buf
(gdb) p buf2
```

```
(gdb) call sizeof buf
(gdb) p buf
(gdb) p (buf+8)
```

make(1)


MakerBot
Automated Build Platform
Thing-O-Matic
MakerBot
INDUSTRIES

make(1)

make(1) is a command generator and build utility. Using a description file (usually *Makefile*) it creates a sequence of commands for execution by the shell.

- used to sort out dependency relations among files

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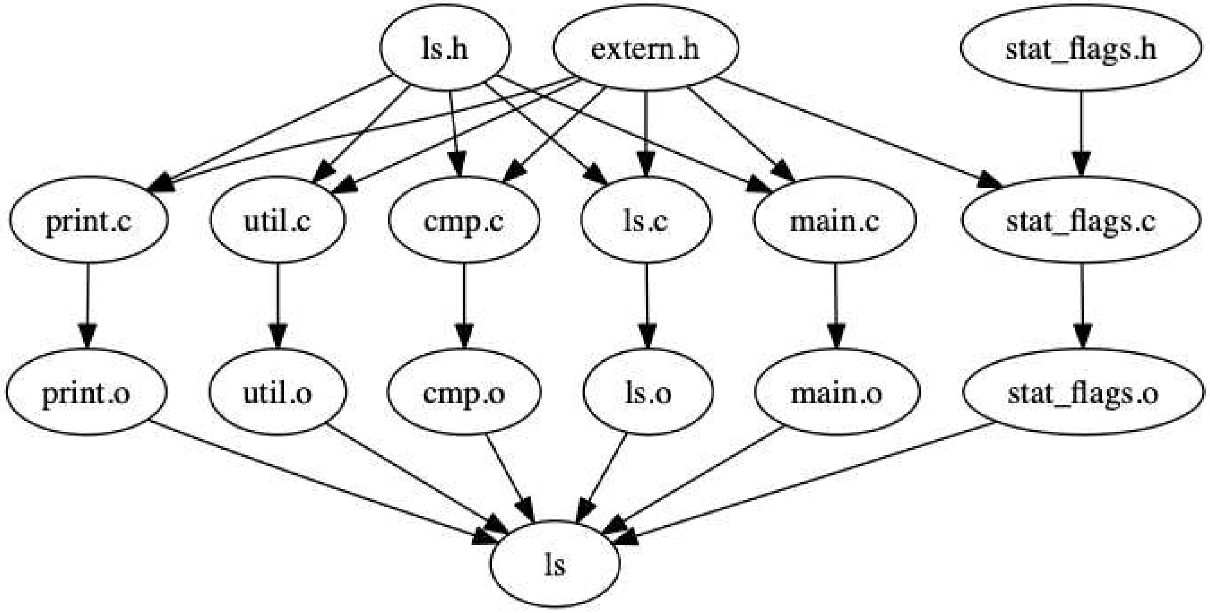
- performs *selective* rebuilds following a *dependency graph*
- allows simplification of rules through use of *macros* and *suffixes*, some of which are internally defined
- different versions of `make(1)` (BSD make, GNU make, Sys V make, ...) may differ (among other things) in
  - variable assignment and expansion/substitution
  - including other files
  - flow control (for-loops, conditionals etc.)

make(1)

```
$ cd make-examples
$ ls *.[ch]
cmp.c       ls.c        main.c       stat_flags.c      util.c
extern.h    ls.h        print.c      stat_flags.h
```



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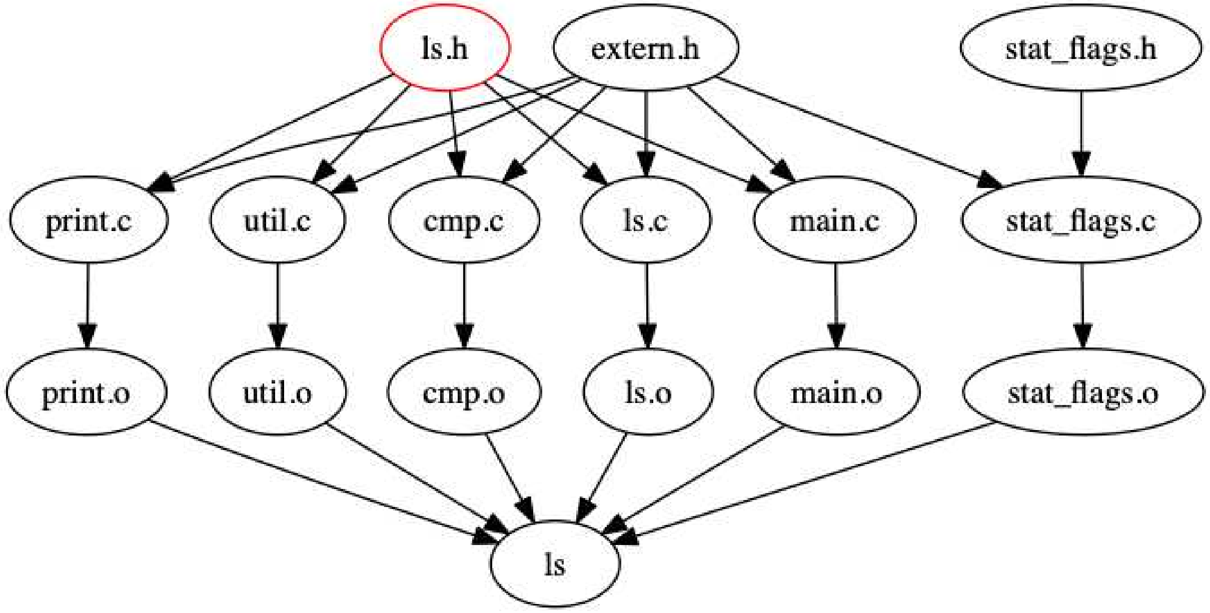

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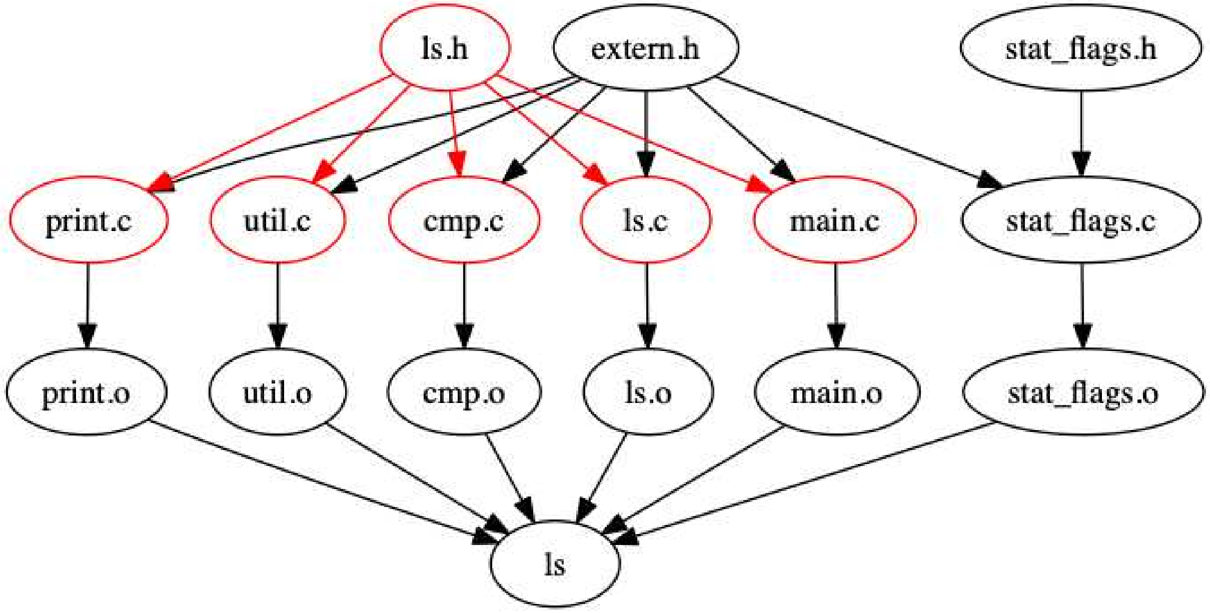

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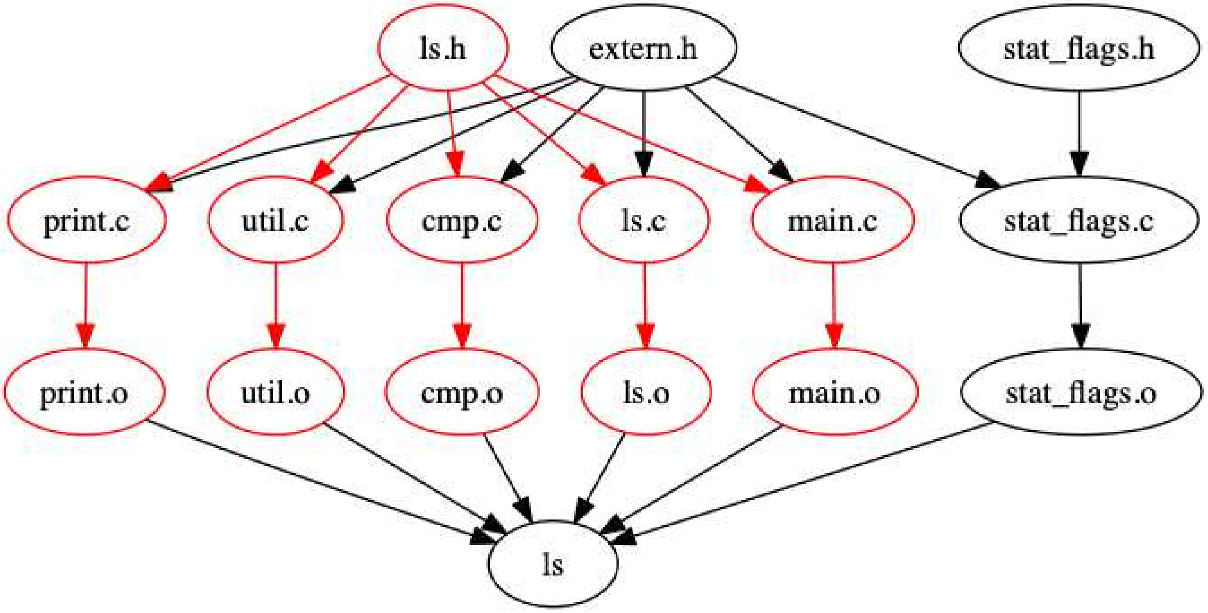

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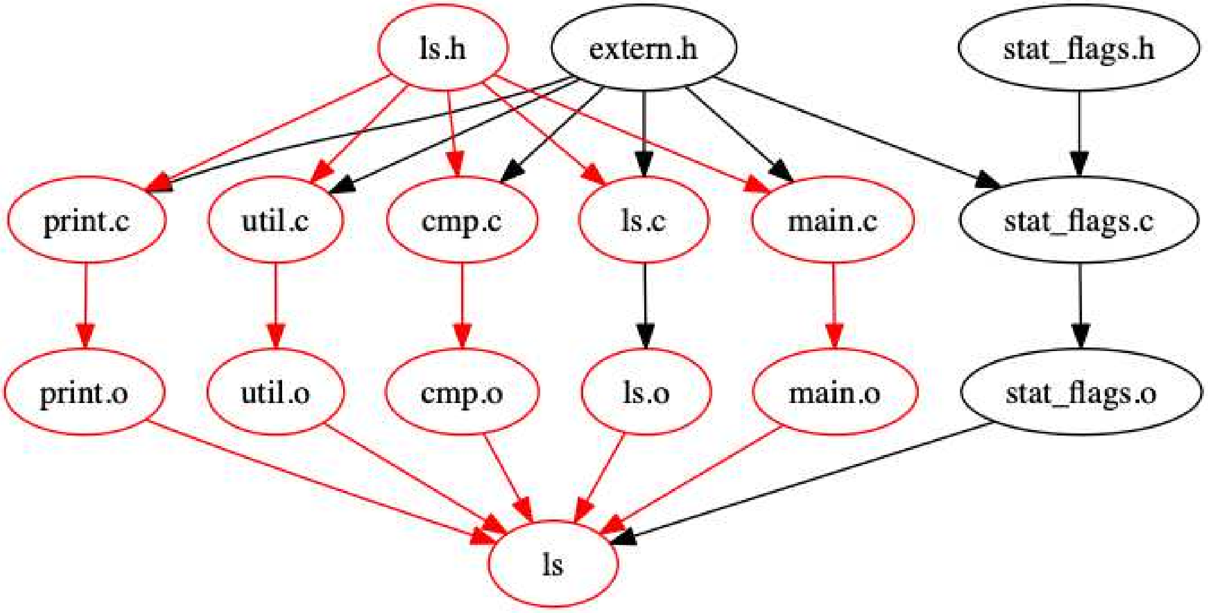

make(1)

```
$ ln -s Makefile.1 Makefile
$ make # or: make -f Makefile.1
[...]
$ make
[...]
$ make clean
$ export CFLAGS="-Wall -Werror"
$ make
[...]
$ make clean
[...]
$ make showvars
[...]
$ make CFLAGS="${CFLAGS}" showvars
[...]
```

Repeat with other Makefiles.

Priority of Macro Assignments for `make(1)`

1. Internal (default) definitions of `make(1)`
2. Current shell environment variables. This includes macros that you enter on the *make* command line itself.
3. Macro definitions in *Makefile*.
4. Macros entered on the `make(1)` command line, if they follow the *make* command itself.

Ed is the standard text editor.

```
$ ed
?
help
?
quit
?
exit
?
bye
?
eat flaming death
?
^C
?
^D
?
```

Ed is the standard text editor.

```
$ ed
a
ed is the standard Unix text editor.
This is line number two.
.
2i

.
%l
3s/two/three/
w foo
q
$ cat foo
```

diff(1) and patch(1)

diff(1):

- compares files line by line
- output may be used to automatically edit a file
- can produce human “readable” output as well as diff entire directory structures
- output called a *patch*

`diff(1)` and `patch(1)`

`patch(1)`:

- applies a `diff(1)` file (aka *patch*) to an original
- may back up original file
- may guess correct format
- ignores leading or trailing “garbage”
- allows for reversing the patch
- may even correct context line numbers

diff(1) and patch(1)

```
$ diff Makefile.2 Makefile.5
[...]
$ cp Makefile.2 /tmp
$ ( diff -e Makefile.2 Makefile.5; echo w; ) | ed Makefile.2
$ diff Makefile.[25]
$ mv /tmp/Makefile.2 .
$ diff -c Makefile.[25]
$ diff -u Makefile.[25] > /tmp/patch
$ patch </tmp/patch
$ diff Makefile.[25]
```

diff(1) and patch(1)

Difference in ls(1) between NetBSD and OpenBSD:

```
$ diff -bur netbsd/src/bin/ls openbsd/src/bin/ls
```

Difference in ls(1) between NetBSD and FreeBSD:

```
$ diff -bur netbsd/src/bin/ls freebsd-ls/ls
```

Revision Control

To be continued...

Links

GDB:

https://sourceware.org/gdb/current/onlinedocs/gdb/
http://heather.cs.ucdavis.edu/~matloff/UnixAndC/CLanguage/Debug.html

http://www.unknownroad.com/rtfm/gdbtut/gdbtoc.html