Redirection

Standard in, Standard out, Standard Error

\>   >>   Redirect standard out

echo Testing > file

echo More >> file   (append)

2>   2>>   Redirect standard error

cd notadir 2> ERR

<   Redirect standard in

sort < junk

< junk sort

grep george < file 2>> ERRS >OUT

- any order for operators, any number of operators
  - cmd > F1 > F2 2> F3 > F4 2> F5 joe

    F1, F2, F3 are empty but exist

    F4 has stdout output, F5 has stderr output

    command is "cmd joe"

Input redirection in a script file

cmd << WORD
data ...
data ...
WORD

Implementation:

- left to right scan, look for redirection characters
- find file name
- open file, remember information for child

- In Child:
  - for each of 0, 1, and 2 dup2 open file to fd

- bash also allows numbers higher than 2 and n< works to open for reading

  openfd 3> file 4< infile   /* see openfd.c */

```
x = fork();
if ( x < 0 ) error;
if ( x > 0 ) exit(0);
/* child continues */
```

daemon(nochdir, noclose)

Disassociate from controlling terminal
New process group and session
Typically closes 0, 1 and 2.

init, inetd, sendmail, cron, syslog
httpd, sshd, lpd, smbd, nmbd

Chapter 14, Advanced I/O

Locking, Record Locking

Non-blocking I/O, select(), poll()

readv(), writev()

Memory Mapped files

Ch 14 & 15: Interprocess Communication

Pipes -- half duplex and full duplex

named pipes (aka FIFOs)

Message queues & semaphores, Sys V shared Memory

Sockets -- networks and local (BSD)

Streams -- (SysV)

Passing File descriptors between unrelated processes! (BSD)

Other utility programs

bc
awk, perl
sed, tr
at, atq, atrm, cron, crontab
basename, dirname, true, false (shell programming)
chksum, md5, ...
diff, cmp, patch
leave, nice, renice
find, grep
head, tail
sort, uniq
od, hexdump
strings, objdump
printf
split, cat
strings
tar, shar, ar
gzip, gunzip, compress, others ... zip, ...
yes, vacation
file, which, type
cut, paste, join, comm, fold

Free and Open Source Software

GNU project, early 1980s, clone UNIX

- GNU’s Not Unix
- emacs & many userland programs
- Hurd (not used much)

Linux --

- Kernel written by Senior CS student
- Programs, Most of the GNU utilities, many others
- 1 Kernel, Many distributions

NetBSD

- Kernel & utilities
- Based in BSD (Graduate students & faculty at UC Berkeley)
- 3rd party software (pkgsrc)

Free and Open Source Software (page 2)

FreeBSD

OpenBSD

github.com -- many open source projects

FLTK

X

Many More!

How to help?

- Find a great project
- Find and fix bugs, submit bug fix reports
- May get asked to join development team