
k24: System Programming
Monday 18:00-20:00@Amf
Tuesday 18:00-20:00@Amf

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Course Logistics

- ▶ Four (4) Programming Assignments (60%)
 - ▶ Progr. Assignment I (15%): must attain at least 50% to continue with the class.
 - ▶ Progr. Assignments II, III, IV (15% each): must have at least 50% on the average.
- ▶ Final Examination (40%)
- ▶ Office Hour: Monday 17:00-18:00
- ▶ Page for Class: www.di.uoa.gr/~ad/k24/index.html
- ▶ *Acks*: slides are based on notes Takis Stamatopoulos (UoA) wrote when he taught k24; also, input and comments were provided by Maor Avidor (Bloomberg), Antonios Deligiannakis (TUC), Spyros Evangelatos (UoA), Vinay Kanitkar (Akamai) and Konstantinos Tsakalozos (UoA).

Course Material

- ▶ Introduction to Unix
- ▶ Shell Programming
- ▶ Using system calls in C:
 - ▶ Error Handling
 - ▶ Dispatch/receipt of Signals
 - ▶ Low level I/O Operations
 - ▶ Interprocess Communication: pipes, sockets, queues, semaphores, shared memory segments.
 - ▶ Creation and termination of processes and threads.

Operating System

- ◇: Software that goes-in-between user(s) + hardware
- ◇: Objective
 - ▶ Using a computing systems without much hassle
 - ▶ Efficient use of the hardware
- ◇: Continual Resource Management
 - ▶ Central Processor Units (CPUs)
 - ▶ Short-term, volatile, main memory
 - ▶ Secondary or long term memory including disks, flash memories.
 - ▶ I/O devices including Network Interface Cards - NICs

UNIX OS

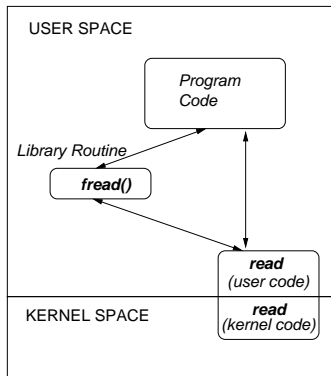
- ▶ Late sixties at Bell Laboratories (mostly written in assembly).
- ▶ Early seventies the system was re-written using C.
- ▶ Many changes since that time:
 1. Major revision by UC-Berkeley (in the 80s)
 2. Redevelopment for SPARC procs-SUN Microsystems (90s)
 3. Release of Linux and ongoing development (90s & 00s)
- ▶ Unix/Linux (in various versions and releases) are now used not only in servers but also in workstations, PCs and netbooks.
- ▶ If you do not have it in your own machine, get it.

Fundamental Characteristics of Unix

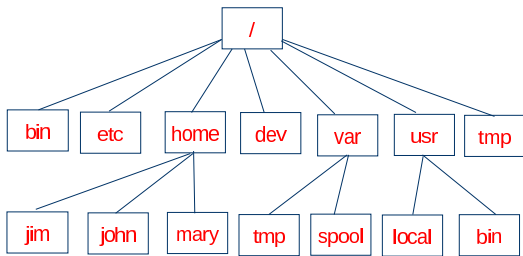
- ▶ Multiple Users Simultaneously
- ▶ Multi-tasking, concurrent processes, time-sharing
- ▶ Security mechanisms
- ▶ Networking support
- ▶ Monolithic structure:
 1. Kernel
 2. Shells (c, bash, bourne, korn, t, etc.)
 3. System Programs
- ▶ System Calls allow interaction with kernel services in terms of C functions.
- ▶ Scripting capabilities: one can "program" the shell.

System Calls and Library Routines

- ▶ library call:
`nread = fread(unputbuff, OBJSIZE, numberobjs, fileprt);`
- ▶ low-level system call:
`nread = read(filedes, inputbuf, BUFSIZE);`



Unix File System – Hierarchical Structure



- ▶ Root directory (/)
- ▶ Current directory (./)
- ▶ Parent directory (/..)
- ▶ Absolute and relative Paths
- ▶ Files and Links
- ▶ Devices

User Account

- ▶ User name (userid) and password (pass)
- ▶ Shell is available as soon as user gets authorized
- ▶ User groups (users, group, others)
- ▶ (Initial) Working directory

```
ad@melbourne's password:
Linux melbourne 2.6.24-23-generic #1 SMP Mon Jan 26 00:13:11 UTC 2009 i686

The programs included with the Ubuntu system are free software; the exact
distribution terms for each program are described in the individual files
in /usr/share/doc/*/copyright.
Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by applicable
law.

To access official Ubuntu documentation, please visit: http://help.ubuntu.com/
Last login: Mon Jan 7 01:25:54 2008
ad@melbourne:~$
```

Basic Commands in Unix

man	display manual page
ls	listing of the current dir
pwd	print working directory
cd	change current directory to
mkdir	create a new directory
rmdir	purge an existing directory
cp	copy a file/directory
mv	move a file/directory to
rm	remove a file/directory
cat	display content of a file
lpr	print out a file
vi	tty text editor

NAME

pwd - print name of current/working directory

SYNOPSIS

pwd [OPTION]...

DESCRIPTION

Print the full filename of the current working directory.

-L, --logical

use PWD from environment, even if it contains symlinks

-P, --physical

avoid all symlinks

--help display this help and exit

--version

output version information and exit

NOTE: your shell may have its own version of pwd, which usually super sedes the version described here. Please refer to your shell's documentation for details about the options it supports.

AUTHOR

Written by Jim Meyering.

The “man” command

REPORTING BUGS

Report pwd bugs to bug-coreutils@gnu.org
GNU coreutils home page: <http://www.gnu.org/software/coreutils/>
General help using GNU software: <http://www.gnu.org/gethelp/>

COPYRIGHT

Copyright 2009 Free Software Foundation, Inc. License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>.
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.

SEE ALSO

`getcwd(3)`
The full documentation for pwd is maintained as a Texinfo manual. If the `info` and `pwd` programs are properly installed at your site, the command `info coreutils 'pwd invocation'` should give you access to the complete manual.

GNU coreutils 7.4

October 2009

PWD(1)

The “man -k” command

```
ad@ad-desktop:~/SysProMaterial/Set001$ man -k mar
amarok (1) - The audio player for KDE
amarokcollectionscanner (1) - Collection Scanner for Amarok
amarokmp3tunesharmonydaemon (1) - Handles AutoSync for the MP3Tunes service i...
apt-mark (8) - mark/unmark a package as being automatically-installed
Glib::BookmarkFile (3pm) - Parser for bookmark files
Glib::Markup (3pm) - Wrapper for markup handling functions in GLib
ispell-wrapper (1) - smart wrapper for ispell
kbookmarkmerger (1) - A program for merging a given set of bookmarks into th...
mbadbblocks (1) - tests a floppy disk, and marks the bad blocks in the FAT
pbmtonokia (1) - convert a portable bitmap to Nokia Smart Messaging For...
pnmarith (1) - perform arithmetic on two portable anymaps
pnmmargin (1) - add a border to a portable anymap
sane-lexmark (5) - SANE backend for Lexmark X1100/X1200 Series scanners
sane-tamarack (5) - SANE backend for Tamarack flatbed scanners
sk98lin (4) - Marvell/SysKonnnect Gigabit Ethernet driver v6.21
socketmark (3) - determine whether socket is at out-of-band mark
time (1) - run programs and summarize system resource usage
Xmark (1) - summarize x11perf results
ad@ad-desktop:~/SysProMaterial/Set001$
ad@ad-desktop:~/SysProMaterial/Set001$ apropos amarok
amarok (1) - The audio player for KDE
amarokcollectionscanner (1) - Collection Scanner for Amarok
amarokmp3tunesharmonydaemon (1) - Handles AutoSync for the MP3Tunes service i...
ad@ad-desktop:~/SysProMaterial/Set001$
```

Command “ls” (-a -l -r)

```
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ ls
aaa bbbb Set-01.ppt zzz
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ ls -a
.  ..  aaa  bbbb  .getout  .myprofile  Set-01.ppt  zzz
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ ls -ls
total 10348
  4 -rw-r--r--  1 ad ad          15 2010-02-15  22:45 aaa
  4 -rw-r--r--  1 ad ad        1200 2010-02-15  22:48 bbbb
10336 -rw-----  1 ad ad    10583040 2010-02-15  22:49 Set-01.ppt
  4 -rw-r--r--  1 ad ad          72 2010-02-15  22:45 zzz
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ ls -lsr
total 10348
  4 -rw-r--r--  1 ad ad          72 2010-02-15  22:45 zzz
10336 -rw-----  1 ad ad    10583040 2010-02-15  22:49 Set-01.ppt
  4 -rw-r--r--  1 ad ad        1200 2010-02-15  22:48 bbbb
  4 -rw-r--r--  1 ad ad          15 2010-02-15  22:45 aaa
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
```

File that is “interpreted” when the shell starts:

- ▶ bash \implies .bashrc
- ▶ csh \implies .cshrc
- ▶ tcsh \implies .tcshrc
- ▶

Access Rights

- ▶ Every file/catalog belongs to the user that created it.
- ▶ Every user belongs to at least one group (postgrads, undergrads, dep, users, etc)
- ▶ Every file is provided with 10 characters
 - ▶ - `rWX r-X r-X`
user group others
 - ▶ 1st character is either "d" (directory) or "-" (file)
 - ▶ Three groups of characters — read/write/execute options

Permission Rules for files/directories

	File	Directory
r	Read or Copy a file	Read content in directory
w	Change or delete a file	Add or delete entries (files) in directory using commands
x	Run executable file	Reference or move to directory (without seeing names of other files)

Command “ls” (-d -R -t)

```
pubsrv1:/tmp>ls
hsperfdata_reserv  junk                output26675        sh5720
hsperfdata_root   mysql.sock         output26935
pubsrv1:/tmp>ls -d junk
junk
pubsrv1:/tmp>ls -dl junk
drwx-----  2 ad          other          238 Feb 16 00:07 junk
pubsrv1:/tmp>ls -R junk/
junk/:
aaa  bbbb
pubsrv1:/tmp>ls -lsRa junk/
junk/:
total 64
 16 drwx-----  2 ad          other          238 Feb 16 00:07 .
 16 drwxrwxrwt  5 root        sys            590 Feb 16 00:45 ..
 16 -rw-----  1 ad          other           16 Feb 16 00:07 aaa
 16 -rw-----  1 ad          other           59 Feb 16 00:07 bbbb
```

- ▶ Sticky bit: When the sticky bit is set, only the file's owner, the directory's owner, or the superuser can rename or delete items in question.

Command “ls” (-d -R -t)

```
pubsrv1:/tmp>ls -ltR
.:
total 64
drwx-----  2 ad      other      238 Feb 16 00:07 junk
drwxr-xr-x   2 root    root       117 Feb 15 02:24 hsperfdata_root
-rw-r--r--   1 vfisikop doctoral    0 Jan 27 14:29 output26935
-rw-r--r--   1 vfisikop doctoral    0 Jan 27 14:27 output26675
drwxr-xr-x   2 reserv  other     177 Jan 24 16:22 hsperfdata_reserv
srwxrwxrwx   1 mysql   mysql     0 Jan 24 16:22 mysql.sock
-rw-----   1 root    root     849 Jan 24 16:22 sh5720

./junk:
total 32
-rw-----   1 ad      other     59 Feb 16 00:07 bbbb
-rw-----   1 ad      other     16 Feb 16 00:07 aaa

./hsperfdata_root:
total 0

./hsperfdata_reserv:
total 64
-rw-----   1 reserv  other    32768 Feb 14 16:58 611
pubsrv1:/tmp>
```

Commands: pwd, cd, mkdir, rmdir

```
pubsrv1:/tmp>pwd
/tmp
pubsrv1:/tmp>ls -as
total 82
 16 .                16 junk                16 sh5720
  2 ..              0 mysql.sock
 16 hspferdata_reserv 0 output26675
 16 hspferdata_root   0 output26935
pubsrv1:/tmp>ls -lF
total 64
drwxr-xr-x  2 reserv  other          177 Jan 24 16:22 hspferdata_reserv /
drwxr-xr-x  2 root   root           117 Feb 15 02:24 hspferdata_root /
drwx----- 2 ad     other          238 Feb 16 00:07 junk/
srwxrwxrwx  1 mysql  mysql          0 Jan 24 16:22 mysql.sock=
-rw-r--r--  1 vfisikop doctoral          0 Jan 27 14:27 output26675
-rw-r--r--  1 vfisikop doctoral          0 Jan 27 14:29 output26935
-rw-----  1 root   root           849 Jan 24 16:22 sh5720

pubsrv1:/tmp>mkdir subdir
pubsrv1:/tmp>ls -lF
total 80
drwxr-xr-x  2 reserv  other          177 Jan 24 16:22 hspferdata_reserv /
drwxr-xr-x  2 root   root           117 Feb 15 02:24 hspferdata_root /
drwx----- 2 ad     other          238 Feb 16 00:07 junk/
srwxrwxrwx  1 mysql  mysql          0 Jan 24 16:22 mysql.sock=
-rw-r--r--  1 vfisikop doctoral          0 Jan 27 14:27 output26675
-rw-r--r--  1 vfisikop doctoral          0 Jan 27 14:29 output26935
-rw-----  1 root   root           849 Jan 24 16:22 sh5720
drwx----- 2 ad     other          117 Feb 16 01:04 subdir/
```

Commands: pwd, cd, mkdir, rmdir

```
pubsrv1:/tmp>pwd
pubsrv1:/tmp>cd subdir/
pubsrv1:/tmp/subdir>ls -las
total 32
 16 drwx-----  2 ad      other      117 Feb 16 01:04 .
 16 drwxrwxrwt  6 root    sys        653 Feb 16 01:05 ..
pubsrv1:/tmp/subdir>pwd
/tmp/subdir
pubsrv1:/tmp/subdir>cd ..
pubsrv1:/tmp>rmdir subdir/
pubsrv1:/tmp>ls subdir
subdir: No such file or directory
pubsrv1:
```

Commands: cp (-i, -r), mv (-i), rm (-i, -r, -f)

- ▶ “-i”: interactive mode (asks before an action can be taken).
- ▶ “-r”: option about directories in cp and rm commands
- ▶ “-f”: force option (in removing files/directories).
- ▶ “rm -f” is less powerful than “rm -i”

Command: rm

```
pubsrv1:/tmp>cd junk/  
pubsrv1:/tmp/junk>ls  
aaa  bbbb  
pubsrv1:/tmp/junk>rm -fi bbbb  
rm: remove bbbb (yes/no)? y  
pubsrv1:/tmp/junk>ls  
aaa  
pubsrv1:/tmp/junk>rm -f aaa  
rm: remove aaa (yes/no)? n  
pubsrv1:/tmp/junk>alias rm  
rm -i  
pubsrv1:/tmp/junk>unalias rm  
pubsrv1:/tmp/junk>rm -fi aaa  
rm: remove aaa (yes/no)? n  
pubsrv1:/tmp/junk>rm -f aaa  
pubsrv1:/tmp/junk>ls  
pubsrv1:/tmp/junk>
```

Commands: more, cat

```
ad@ad-desktop:/tmp$ more .bashrc
# .bashrc file
# User specific aliases and functions

# Source definitions
if [ -f /etc/bashrc ]; then
    . /etc/bashrc
fi

alias ll='ls -l'
alias la='ls -A'
alias l='ls -CF'

PS1='$ '
ad@ad-desktop:/tmp$ cat -n .bashrc
 1 # .bashrc file
 2 # User specific aliases and functions
 3
 4 # Source definitions
 5 if [ -f /etc/bashrc ]; then
 6     . /etc/bashrc
 7 fi
 8
 9 alias ll='ls -l'
10 alias la='ls -A'
11 alias l='ls -CF'
12
13 PS1='$ '
ad@ad-desktop:/tmp$
```

Command: lpr, lpstat -t

```
ad@ad-desktop:/tmp$ lpstat -t
scheduler is running
system default destination: hp-LaserJet-1320-series
device for hp-LaserJet-1320-series: usb://HP/LaserJet%201320%20series
hp-LaserJet-1320-series accepting requests since Tue 12 Jan 2010 11:37:50 AM EET
printer hp-LaserJet-1320-series is idle.  enabled since Tue 12 Jan 2010 11:37:50
AM EET
ad@ad-desktop:/tmp$
ad@ad-desktop:/tmp$ lpr -Php-LaserJet-1320-series .bashrc
ad@ad-desktop:/tmp$
ad@ad-desktop:/tmp$ lpstat -t
scheduler is running
system default destination: hp-LaserJet-1320-series
device for hp-LaserJet-1320-series: usb://HP/LaserJet%201320%20series
hp-LaserJet-1320-series accepting requests since Tue 16 Feb 2010 01:50:49 AM EET
printer hp-LaserJet-1320-series is idle.  enabled since Tue 16 Feb 2010 01:50:49
AM EET
Printer is now online.
ad@ad-desktop:/tmp$
```


Text Editors

- ▶ `vi/vim <filename>`: edit the content of the file with name `<filename>`
 - ◇ Two modes of operations: input and edit
 - ◇ Move from input to edit with ESC
 - ◇ Move from edit to input mode by pressing "i"
- ▶ www.yolinux.com/TUTORIALS/LinuxTutorialAdvanced_vi.html
- ▶ emacs
- ▶ pico
- ▶ ed
- ▶ gedit, xemacs, etc.

Commands for the processing of files

chmod	change access rights for files and catalogs
more	page-by-page display of file content
less	forward/backward display of a file content
grep	search for a specific symbol patterns in a file
wc	lexical statistics for files
sort	sort the lines of a text file
ln	created links
cut	display portion of lines from a file
cmp	compare two files
diff	display differences between two files
head	display top-k lines of a file
tail	display bottom-k lines of a file
touch	change the timestamp or create a file

Command: chmod

```
ad@ad-desktop:/tmp/junk$ ls -las
total 48
 4 drwxr-xr-x  2 ad  ad   4096 2010-02-16 02:44 .
40 drwxrwxrwt 18 root root 36864 2010-02-16 02:43 ..
 4 -rw-r--r--  1 ad  ad   184 2010-02-16 02:44 .bashrc
ad@ad-desktop:/tmp/junk$ cp .bashrc tmp1
ad@ad-desktop:/tmp/junk$ ls -l
total 4
-rw-r--r-- 1 ad ad 184 2010-02-16 02:44 tmp1
ad@ad-desktop:/tmp/junk$ mkdir bin
ad@ad-desktop:/tmp/junk$ ls -l
total 8
drwxr-xr-x 2 ad ad 4096 2010-02-16 02:44 bin
-rw-r--r-- 1 ad ad 184 2010-02-16 02:44 tmp1
ad@ad-desktop:/tmp/junk$ chmod g-r tmp1
ad@ad-desktop:/tmp/junk$ chmod g+wx tmp1
ad@ad-desktop:/tmp/junk$ ls -l
total 8
drwxr-xr-x 2 ad ad 4096 2010-02-16 02:44 bin
-rw--wxr-- 1 ad ad 184 2010-02-16 02:44 tmp1
ad@ad-desktop:/tmp/junk$ chmod u-wx,g=rx,o+x tmp1
ad@ad-desktop:/tmp/junk$ ls -l
total 8
drwxr-xr-x 2 ad ad 4096 2010-02-16 02:44 bin
-r--r-xr-x 1 ad ad 184 2010-02-16 02:44 tmp1
ad@ad-desktop:/tmp/junk$ rm tmp1
rm: remove write-protected regular file 'tmp1'? y
```

```

ad@ad-desktop:/tmp/junk$ ls -las
total 52
 4 drwxr-xr-x  3 ad  ad    4096 2010-02-16 02:46 .
40 drwxrwxrwt 18 root root 36864 2010-02-16 02:43 ..
 4 -rw-r--r--  1 ad  ad     184 2010-02-16 02:44 .bashrc
 4 drwxr-xr-x  2 ad  ad    4096 2010-02-16 02:44 bin
ad@ad-desktop:/tmp/junk$ cp -r /tmp/mydir .
ad@ad-desktop:/tmp/junk$ ls -Rl
.:
total 8
drwxr-xr-x 2 ad ad 4096 2010-02-16 02:44 bin
drwxr-xr-x 2 ad ad 4096 2010-02-16 02:48 mydir
./bin:
total 0
./mydir:
total 8
-rwxr-xr-x 1 ad ad 14 2010-02-16 02:48 A1
-rwxr-xr-x 1 ad ad 20 2010-02-16 02:48 A2
ad@ad-desktop:/tmp/junk$ chmod -R 700 mydir/
ad@ad-desktop:/tmp/junk$ ls -lR mydir/
mydir/:
total 8
-rwx----- 1 ad ad 14 2010-02-16 02:48 A1
-rwx----- 1 ad ad 20 2010-02-16 02:48 A2
ad@ad-desktop:/tmp/junk$ ls -lasR mydir/
mydir/:
total 16
4 drwx----- 2 ad ad 4096 2010-02-16 02:48 .
4 drwxr-xr-x 4 ad ad 4096 2010-02-16 02:48 ..
4 -rwx----- 1 ad ad 14 2010-02-16 02:48 A1
4 -rwx----- 1 ad ad 20 2010-02-16 02:48 A2
ad@ad-desktop:/tmp/junk$

```

Command: less

```
ad@ad-desktop:~/SysProMaterial/Set001$ less set001.tex
\documentclass []{beamer}
% Theme for beamer presentation.
\usepackage{beamerthemelined}
% \usepackage{beamerthemesplit}
% Other themes include: beamerthemebars , beamerthemelined ,
%                          beamerthemetree , beamerthemetreebars

\usepackage{algorithmic}
\usepackage{listings}
\usepackage{pifont}
\usepackage{color}
\usepackage{hyperref}
\newcommand{\crossout} {\ding{55}}

\newenvironment{pkl}{%
  \begin{itemize}%
  \vspace{-\topsep}%
  \setlength\itemsep{-\parskip}%
set001.tex
```

- ◇ [return] - skip a line; [space] - get next page; b: display previous page; /<s>: search for pattern s; !<c>[return]: execute command c; h: help; q: exit from less

Command: grep

```
ad@ad-desktop:/var/log$
ad@ad-desktop:/var/log$ grep x86 dmesg
[ 0.000000] Transmeta GenuineTMx86
[ 0.000000] x86 PAT enabled: cpu 0, old 0x7040600070406, new 0x7010600070106
[ 0.000000] Using x86 segment limits to approximate NX protection
[ 0.004000] x86 PAT enabled: cpu 1, old 0x7040600070406, new 0x7010600070106
[ 10.148624] NVRM: loading NVIDIA UNIX x86 Kernel Module 185.18.36 Fri Aug
14 17:18:04 PDT 2009
ad@ad-desktop:/var/log$
ad@ad-desktop:/var/log$ grep -n x86 dmesg
10:[ 0.000000] Transmeta GenuineTMx86
41:[ 0.000000] x86 PAT enabled: cpu 0, old 0x7040600070406, new 0
x7010600070106
58:[ 0.000000] Using x86 segment limits to approximate NX protection
212:[ 0.004000] x86 PAT enabled: cpu 1, old 0x7040600070406, new 0
x7010600070106
737:[ 10.148624] NVRM: loading NVIDIA UNIX x86 Kernel Module 185.18.36 Fri
Aug 14 17:18:04 PDT 2009
ad@ad-desktop:/var/log$
ad@ad-desktop:/var/log$ grep -i CoLLing dmesg
[ 0.414599] processor LNXCPU:00: registered as cooling_device0
[ 0.414803] processor LNXCPU:01: registered as cooling_device1
ad@ad-desktop:/var/log$
```

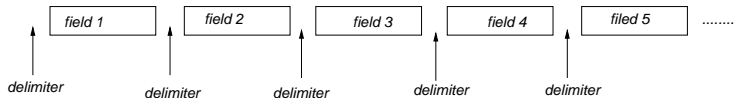
Command wc

```
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ ls
aaa  bbbb  lista  Set-01.ppt  zzz
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ wc lista
 10  30 183 lista
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ wc -w lista
30 lista
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ wc -l lista
10 lista
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ wc -c lista
183 lista
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ wc -lc lista
 10 183 lista
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ wc -lw lista
 10 30 lista
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
```

Command sort

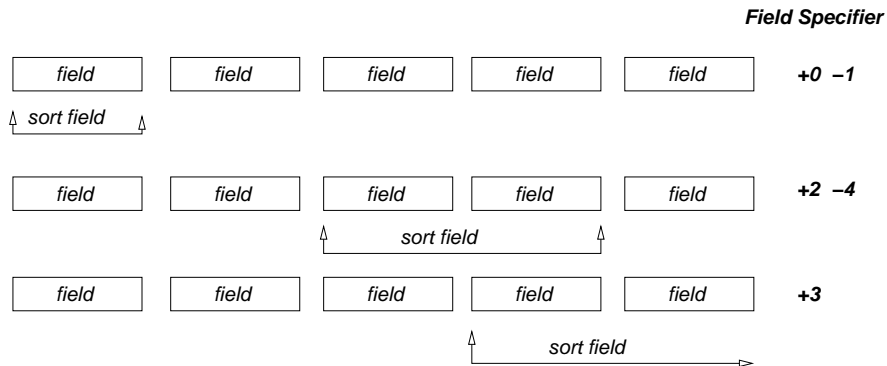
```
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ cat lista
john    32    london
eduardo 19    brazilia
jean    21    athens
marco   7     buenosaires
filip   23    telaviv
dennis  15    brisbane
louis   31    heraclion
dimi    34    heraclion
ji      27    washington
hyseyin 33    izmir
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ sort lista
dennis  15    brisbane
dimi    34    heraclion
eduardo 19    brazilia
filip   23    telaviv
hyseyin 33    izmir
jean    21    athens
ji      27    washington
john    32    london
louis   31    heraclion
marco   7     buenosaires
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
```


Using the Delimiters in sort()



- ▶ When a field for sorting is needed: $+number_1 - number_2$
- ▶ $number_1$: specifies the number of fields to be skipped to get to the beginning of the sort field.
- ▶ $number_2$: specifies the number of fields to be skipped, relative to the beginning of the line, to get to the end of the sort key.

Delimiter Examples



```
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ sort +0 -1 lista
dennis 15 brisbane
dimi 34 heraclion
eduardo 19 brazilia
filip 23 telaviv
hyseyin 33 izmir
jean 21 athens
ji 27 washington
john 32 london
louis 31 heraclion
marco 7 buenosaires
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ sort -r -u +2 -3 lista
ji 27 washington
filip 23 telaviv
john 32 london
hyseyin 33 izmir
louis 31 heraclion
marco 7 buenosaires
dennis 15 brisbane
eduardo 19 brazilia
jean 21 athens
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ sort -r +2 -3 lista
ji 27 washington
filip 23 telaviv
john 32 london
hyseyin 33 izmir
louis 31 heraclion
dimi 34 heraclion
marco 7 buenosaires
dennis 15 brisbane
eduardo 19 brazilia
jean 21 athens
```

```
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ sort -r -n +1 -2 lista
dimi      34  heraclion
hyseyin   33  izmir
john      32  london
louis     31  heraclion
ji        27  washington
filip     23  telaviv
jean      21  athens
eduardo   19  brazilia
dennis    15  brisbane
marco     7   buenosaires
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ sort -u +1 -4 lista
dennis    15  brisbane
eduardo   19  brazilia
jean      21  athens
filip     23  telaviv
ji        27  washington
louis     31  heraclion
john      32  london
hyseyin   33  izmir
dimi      34  heraclion
marco     7   buenosaires
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
```

Command touch (change timestamp or create an empty file)

```
ad@sydney :/media/2CD3-FD08/Set001/Samples$ ls
aaa  bbbb  lista  Set-01.ppt  zzz
ad@sydney :/media/2CD3-FD08/Set001/Samples$ touch delis
ad@sydney :/media/2CD3-FD08/Set001/Samples$ ls -l
total 10464
-rwxr-xr-x 1 ad ad          15 2010-02-18 08:42 aaa
-rwxr-xr-x 1 ad ad       1200 2010-02-18 08:42 bbbb
-rwxr-xr-x 1 ad ad          0 2010-02-18 12:16 delis
-rwxr-xr-x 1 ad ad        183 2010-02-18 08:42 lista
-rwxr-xr-x 1 ad ad 10583040 2010-02-18 08:42 Set-01.ppt
-rwxr-xr-x 1 ad ad         72 2010-02-18 08:42 zzz
ad@sydney :/media/2CD3-FD08/Set001/Samples$ touch aaa
ad@sydney :/media/2CD3-FD08/Set001/Samples$ ls -l
total 10464
-rwxr-xr-x 1 ad ad          15 2010-02-18 12:16 aaa
-rwxr-xr-x 1 ad ad       1200 2010-02-18 08:42 bbbb
-rwxr-xr-x 1 ad ad          0 2010-02-18 12:16 delis
-rwxr-xr-x 1 ad ad        183 2010-02-18 08:42 lista
-rwxr-xr-x 1 ad ad 10583040 2010-02-18 08:42 Set-01.ppt
-rwxr-xr-x 1 ad ad         72 2010-02-18 08:42 zzz
ad@sydney :/media/2CD3-FD08/Set001/Samples$
```

Hard Links with ln

```
ad@sydney:~/Set001/Samples$ ln bbbb myhardlink
ad@sydney:~/Set001/Samples$ ls -l
total 10356
-rwxr-xr-x 1 ad ad      15 2010-02-18 12:25 aaa
-rwxr-xr-x 2 ad ad    1200 2010-02-18 12:27 bbbb
-rwxr-xr-x 1 ad ad      0 2010-02-18 12:25 delis
-rwxr-xr-x 1 ad ad    183 2010-02-18 12:25 lista
-rwxr-xr-x 2 ad ad    1200 2010-02-18 12:27 myhardlink
-rwxr-xr-x 1 ad ad 10583040 2010-02-18 12:25 Set-01.ppt
-rwxr-xr-x 1 ad ad     72 2010-02-18 12:25 zzz
ad@sydney:~/Set001/Samples$ ls -i bbbb myhardlink
691247 bbbb 691247 myhardlink
ad@sydney:~/Set001/Samples$ cp bbbb eeee
ad@sydney:~/Set001/Samples$ ls -li bbbb myhardlink eeee
691247 -rwxr-xr-x 2 ad ad 1200 2010-02-18 12:27 bbbb
691204 -rwxr-xr-x 1 ad ad 1200 2010-02-18 12:34 eeee
691247 -rwxr-xr-x 2 ad ad 1200 2010-02-18 12:27 myhardlink
ad@sydney:~/Set001/Samples$ diff bbbb myhardlink
ad@sydney:~/Set001/Samples$ rm bbbb
ad@sydney:~/Set001/Samples$ ls -l myhardlink
-rwxr-xr-x 1 ad ad 1200 2010-02-18 12:27 myhardlink
ad@sydney:~/Set001/Samples$ cp myhardlink bbbb
ad@sydney:~/Set001/Samples$ ls -l
total 10360
-rwxr-xr-x 1 ad ad      15 2010-02-18 12:25 aaa
-rwxr-xr-x 1 ad ad    1200 2010-02-18 12:35 bbbb
-rwxr-xr-x 1 ad ad      0 2010-02-18 12:25 delis
-rwxr-xr-x 1 ad ad    1200 2010-02-18 12:34 eeee
-rwxr-xr-x 1 ad ad    183 2010-02-18 12:25 lista
-rwxr-xr-x 1 ad ad    1200 2010-02-18 12:27 myhardlink
-rwxr-xr-x 1 ad ad 10583040 2010-02-18 12:25 Set-01.ppt
```

Soft links with ln

```
ad@sydney:~/Set001/Samples$ ls
aaa  bbbb  delis  eeee  lista  myhardlink  Set-01.ppt  zzz
ad@sydney:~/Set001/Samples$ ln -s bbbb mysoftlink
ad@sydney:~/Set001/Samples$ ls -l mysoftlink
lrwxrwxrwx 1 ad ad 4 2010-02-18 12:43 mysoftlink -> bbbb
ad@sydney:~/Set001/Samples$ file *
aaa:          ASCII text
bbbb:         ASCII text
delis:        empty
eeee:        ASCII text
lista:        ASCII text
myhardlink:   ASCII text
mysoftlink:   symbolic link to 'bbbb'
Set-01.ppt:   CDF V2 Document, corrupt: Can't expand
              summary_info
zzz:          ASCII text
ad@sydney:~/Set001/Samples$ rm bbbb
ad@sydney:~/Set001/Samples$ ls
aaa  delis  eeee  lista  myhardlink  mysoftlink  Set-01.ppt
zzz
ad@sydney:~/Set001/Samples$ more mysoftlink
mysoftlink: No such file or directory
ad@sydney:~/Set001/Samples$
```

Comparison between soft/hard links

Hard Links	Soft Links
"Pointer" to the initial file	Copy of the path to the initial file
Does not apply to directories	Applies to directories
Name change of the initial file does not create any problems	Name change in the initial file creates problems
Content changes in initial file are reflected in the link as well	Content changes in initial file are reflected in the link as well
File gets purged when <i>all</i> links are deleted	Deletion of initial file affects the link (point to non-existing file)

Command cut: -f: designates column selection, -d designates delimiter

```
ad@sydney:~/Set001/Samples$ cat lista1
123:jim:morrison:2103456789:reading
345:peter:gabriel:4567891234:london
673:pete:garret:9602345612:sydney
133:time:machine:3452678967:moscow
231:kitrina:podilata:2138905674:athens
ad@sydney:~/Set001/Samples$
ad@sydney:~/Set001/Samples$ cut -f3,2 -d':' lista1
jim:morrison
peter:gabriel
pete:garret
time:machine
kitrina:podilata
ad@sydney:~/Set001/Samples$
ad@sydney:~/Set001/Samples$ cut -f1-3 -d':' lista1
123:jim:morrison
345:peter:gabriel
673:pete:garret
133:time:machine
231:kitrina:podilata
ad@sydney:~/Set001/Samples$
```

Commands: cmp, diff, head, tail

```
ad@sydney:/media/2CD3-FD08/Set001/Samples$ ls lista*
lista lista1 lista2 lista3
ad@sydney:/media/2CD3-FD08/Set001/Samples$ cmp lista lista3
ad@sydney:/media/2CD3-FD08/Set001/Samples$ diff lista lista2
4c4
< marco 7    buenosaires
---
> marco 97   buenosaires
ad@sydney:/media/2CD3-FD08/Set001/Samples$ head lista2
john    32    london
eduardo 19    brazilia
jean    21    athens
marco   97    buenosaires
filip   23    telaviv
dennis  15    brisbane
louis   31    heraclion
dimi    34    heraclion
ji      27    washington
hyseyin 33    izmir
ad@sydney:/media/2CD3-FD08/Set001/Samples$ head -3 lista2
john    32    london
eduardo 19    brazilia
jean    21    athens
ad@sydney:/media/2CD3-FD08/Set001/Samples$ tail -3 lista2
dimi    34    heraclion
ji      27    washington
hyseyin 33    izmir
ad@sydney:/media/2CD3-FD08/Set001/Samples$
```

Commands echo, whoami, hostname, lpq/lpstat -t, lprm

```
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ echo this is a test for k24
this is a test for k24
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ echo -n this is a test for k24
this is a test for k24ad@ad-desktop:~/SysProMaterial/Set001/Samples$
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ whoami
ad
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ hostname
ad-desktop
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ lpr Set-01.ps
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ lpq
hp-LaserJet-1320-series is ready and printing
Rank   Owner   Job     File(s)                Total Size
1st    ad      143     Set-01                  12930048 bytes
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ lprm -Php-LaserJet-1320-series
143
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ lpq
hp-LaserJet-1320-series is ready and printing
Rank   Owner   Job     File(s)                Total Size
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ lpstat -t
scheduler is running
system default destination: hp-LaserJet-1320-series
device for hp-LaserJet-1320-series: usb://HP/LaserJet%201320%20series
hp-LaserJet-1320-series accepting requests since Fri 19 Feb 2010 01:03:52 PM EET
printer hp-LaserJet-1320-series is idle. enabled since Fri 19 Feb 2010 01:03:52
PM EET
Printer is now online.
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
```

Shells (csh, tcsh, bash, kornsh, etc.)

- ▶ Once “connected” to a tty in Linux, you are provided with a default *bash* shell.
- ▶ *logout* severs the authenticated session the user maintains.
- ▶ *exit* or *control-d* disconnect terminates the shell session.
- ▶ You can go to csh or tcsh by simply typing *tcsh* or *csh*.
- ▶ Once a shell is initiated, the file *~/.cshrc* is executed.
- ▶ As soon as a user logs into a system, the commands in file *.login* are executed.
- ▶ Once a user logouts from the system the shell commands in file *.logout* are executed.

Shell (input/output)

Every shell has three predefined I/O means of communicating with the user:

- ▶ *stdin*: standard input (often the keyboard)
- ▶ *stdout*: standard output (often the screen)
- ▶ *stderr*: standard error (often the screen)
- ▶ file descriptors for the above files are 0, 1, 2 respectively.

For a number of system programs including `cat`, `lpr`, `grep`, `wc`, `sort`, `head`, `tail` etc. the file parameters are optional:

```
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ wc
this is a test - this is only
a test, this is a test
this is only a test
this is a
test
only
bye
{control -d}
      7      25      100
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
```

csh redirection

- Redirection of the *stdin*:

```
ad@ad-desktop:~/SysProMaterial/Set001$  
ad@ad-desktop:~/SysProMaterial/Set001$ csh  
%  
%  
% grep clio lista  
louis 31 heraclion  
dimi 34 heraclion  
% grep clio < lista  
louis 31 heraclion  
dimi 34 heraclion  
% grep bra < lista > out1  
% cat out1  
eduardo 19 brazilia
```

csh redirection

- Redirection of the *stdout* and *stderr* (>, >!, >&)

```
% date > filea
% cat < filea
Fri Feb 19 17:59:46 EET 2010
% ls -la > filea
filea: File exists.
% echo A test line > filea
filea: File exists.
% echo This is a test >! filea
% more filea
This is a test
% cp
cp: missing file operand
Try 'cp --help' for more information.
% cp >& fileb
% cat < fileb
cp: missing file operand
Try 'cp --help' for more information.
% cat filec >& fileb
% cat fileb
cat: filec: No such file or directory
% ls AA* > mylist 2>&1
% cat mylist
ls: cannot access AA*: No such file or directory
%
```

- You get the above results when the *noclobber* variable is set
- in *csh* "set noclobber=on" and in *bash* "set -o noclobber on"

Append type redirection

```
% cat a_file
Fri Feb 19 17:38:24 EET 2010
% cat b_file
cat: b_file: No such file or directory
% date >> c_file
% cat c_file
Fri Feb 19 20:54:59 EET 2010
% cat c_file >> a_file
% cat a_file
Fri Feb 19 17:38:24 EET 2010
Fri Feb 19 20:54:59 EET 2010
% wc < a_file >>! c_file
% cat c_file
Fri Feb 19 20:54:59 EET 2010
 2 12 58
% lls >>& b_file
% cat b_file
lls: Command not found.
% cat a_file b_file c_file >>& d_file
% cat d_file
Fri Feb 19 17:38:24 EET 2010
Fri Feb 19 20:54:59 EET 2010
lls: Command not found.
Fri Feb 19 20:54:59 EET 2010
 2 12 58
%
```


Filters and Pipes

```
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ !! | grep 6
ls -las | grep 6
total 10436
  4 drwxr-xr-x  3 ad ad      4096 2010-02-19  20:58 .
  4 drwxr-xr-x  6 ad ad      4096 2010-02-19  21:09 ..
  4 drwx-----  2 ad ad      4096 2010-02-19  12:41 Alexdir
  4 -rw-r--r--  1 ad ad         38 2010-02-19  20:56 c_file
  4 -rw-r--r--  1 ad ad         21 2010-02-19  16:45 mytest
10336 -rw-----  1 ad ad 10583040 2010-02-19  12:41 Set-01.ppt
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ grep 3 lista
john    32    london
filip   23    telaviv
louis   31    heraclion
dimi    34    heraclion
hyseyin 33    izmir
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ grep 3 lista | tail -4 | sort -n
+1 -2
filip   23    telaviv
louis   31    heraclion
hyseyin 33    izmir
dimi    34    heraclion
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ grep 3 lista | tail -4 | sort -n
+1 -2 | lpr -Pmypr
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
```

Sequences and Groups of Commands

```
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ mkdir konnos; cd konnos; ls -las
total 8
4 drwxr-xr-x 2 ad ad 4096 2010-02-19 21:27 .
4 drwxr-xr-x 4 ad ad 4096 2010-02-19 21:27 ..
ad@ad-desktop:~/SysProMaterial/Set001/Samples/konnos$ pwd
/home/ad/SysProMaterial/Set001/Samples/konnos
ad@ad-desktop:~/SysProMaterial/Set001/Samples/konnos$
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ mkdir mydir; cd mydir; ls -al;
mkdir: cannot create directory 'mydir': File exists
total 8
drwxr-xr-x 2 ad ad 4096 2010-02-19 21:29 .
drwxr-xr-x 4 ad ad 4096 2010-02-19 21:32 ..
ad@ad-desktop:~/SysProMaterial/Set001/Samples/mydir$ cd ..; rm -rf mydir
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ (mkdir mydir; cd mydir; ls -al;)
total 8
drwxr-xr-x 2 ad ad 4096 2010-02-19 21:34 .
drwxr-xr-x 4 ad ad 4096 2010-02-19 21:34 ..
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
```

- ▶ With “grouping” of commands, the shell remains in the original directory.
- ▶ (command > stdout_file) >& stderr_file
- ▶ sh -c 'command 2> stderr_file'

Command `umask`

- ▶ The number of `umask` indicates which access rights should NOT be given to files to be created.
- ▶ `chmod` starts off where `umask` left at.

```
d@ad-desktop:~/SysProMaterial/Set001/Samples/UMASK$ umask
0022
ad@ad-desktop:~/SysProMaterial/Set001/Samples/UMASK$ touch file1
ad@ad-desktop:~/SysProMaterial/Set001/Samples/UMASK$ mkdir alex
ad@ad-desktop:~/SysProMaterial/Set001/Samples/UMASK$ ls -l -sa
total 12
4 drwxr-xr-x 3 ad ad 4096 2010-02-19 22:53 .
4 drwxr-xr-x 5 ad ad 4096 2010-02-19 22:53 ..
4 drwxr-xr-x 2 ad ad 4096 2010-02-19 22:53 alex
0 -rw-r--r-- 1 ad ad 0 2010-02-19 22:53 file1
ad@ad-desktop:~/SysProMaterial/Set001/Samples/UMASK$ umask 077
ad@ad-desktop:~/SysProMaterial/Set001/Samples/UMASK$ touch file2
ad@ad-desktop:~/SysProMaterial/Set001/Samples/UMASK$ mkdir alex2
ad@ad-desktop:~/SysProMaterial/Set001/Samples/UMASK$ ls -las
total 16
4 drwxr-xr-x 4 ad ad 4096 2010-02-19 22:54 .
4 drwxr-xr-x 5 ad ad 4096 2010-02-19 22:53 ..
4 drwxr-xr-x 2 ad ad 4096 2010-02-19 22:53 alex
4 drwx----- 2 ad ad 4096 2010-02-19 22:54 alex2
0 -rw-r--r-- 1 ad ad 0 2010-02-19 22:53 file1
0 -rw----- 1 ad ad 0 2010-02-19 22:54 file2
ad@ad-desktop:~/SysProMaterial/Set001/Samples/UMASK$ umask 022
ad@ad-desktop:~/SysProMaterial/Set001/Samples/UMASK$ rm file1 file2 ; rmdir alex
alex2
ad@ad-desktop:~/SysProMaterial/Set001/Samples/UMASK$
```

Metacharacters

- * : matches any number (zero or more) of characters
- ? : matches one exactly character
- $[c_1 c_2 c_3 \dots c_n]$: matches exactly one character from set:
 $\{c_1 c_2 c_3 \dots c_n\}$
- $[c_1 - c_n]$: matches exactly one character from those in the range $c_1 - c_n$

Metacharacter-Examples with `ls`

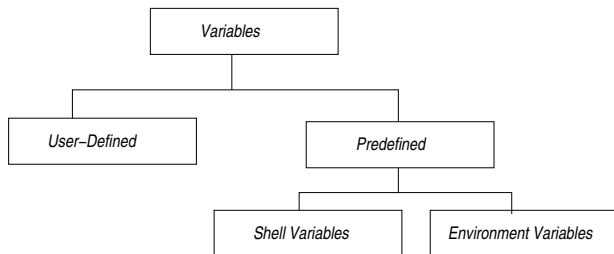
```
ad@sydney:~/fcairns/Courses/Sys.Pro10/Transparencies/Set001/Samples$ ls -dF ???
aaa sss/ sts/ usr/ uuu/ zzz
ad@sydney:~/fcairns/Courses/Sys.Pro10/Transparencies/Set001/Samples$ ls *z*
all-lists.zip mylists.zip mylist.tar.gz mylist.zip zzz
ad@sydney:~/fcairns/Courses/Sys.Pro10/Transparencies/Set001/Samples$ ls -l *[uz
]*
-rw-r--r-- 1 ad ad 1123 2010-03-02 00:56 all-lists.zip
-rw-r--r-- 1 ad ad 0 2010-03-02 00:56 mylout
-rw-r--r-- 1 ad ad 1123 2010-03-02 00:56 mylists.zip
-rw-r--r-- 1 ad ad 443 2010-03-02 00:56 mylist.tar.gz
-rw-r--r-- 1 ad ad 1123 2010-03-02 00:56 mylist.zip
-rw-r--r-- 1 ad ad 20 2010-03-02 00:56 out1
-rw-r--r-- 1 ad ad 72 2010-03-02 00:56 zzz

usr:
total 0

uuu:
total 0
ad@sydney:~/fcairns/Courses/Sys.Pro10/Transparencies/Set001/Samples$ ls *[a-z][
uz][b-z]*
mylout out1 zzz

uuu:
ad@sydney:~/fcairns/Courses/Sys.Pro10/Transparencies/Set001/Samples$ ls [Mm]
ylists*
mylists.tar mylists.zip
ad@sydney:~/fcairns/Courses/Sys.Pro10/Transparencies/Set001/Samples$
```

Variables



- ▶ **Predefined Variables:**
 - ▶ **Shell Variables:** used to configure shell (ie, setting the internal field separator which is often a space or tab).
 - ▶ **Environment Variables:** used to configure the environment (ie, a system variable determines which editor to edit the history file).
- ▶ **User defined Variables:** created by the users for storing values; may start with an alphabetic or `_` character.

setting & unsetting environment variables with *cs*

```
perth:/home/users/ad>printenv | head -6
USER=ad
HOME=/home/users/ad
PATH=/usr/bin/X11:/bin:/usr/bin:/usr/ucb:/usr/etc:/usr/local
/bin
SHELL=/usr/local/bin/csh
TZ=EET
SSH_TTY=/dev/pts/2
perth:/home/users/ad>setenv ALEX delis
perth:/home/users/ad>printenv | tail -3
TEXINPUTS=:/home/users/ad/tex
ICAROOT=/home/appl/ICAClient
ALEX=delis
perth:/home/users/ad>echo $ALEX
delis
perth:/home/users/ad>unsetenv ALEX
perth:/home/users/ad>printenv | tail -2
TEXINPUTS=:/home/users/ad/tex
ICAROOT=/home/appl/ICAClient
perth:/home/users/ad>
```

setting/unsetting local & shell variables (bash)

```
ad@ad-desktop:~$ set | head -4
BASH=/bin/bash
BASH_ALIASES=()
BASH_ARGC=()
BASH_ARGV=()
ad@ad-desktop:~$ MYVAR="alexis"
ad@ad-desktop:~$ echo MYVAR
MYVAR
ad@ad-desktop:~$ echo $MYVAR
alexis
ad@ad-desktop:~$ set | grep MYVAR
MYVAR=alexis
ad@ad-desktop:~$ unset MYVAR
ad@ad-desktop:~$ echo $MYVAR

ad@ad-desktop:~$
ad@ad-desktop:~$ set | grep MYVAR
ad@ad-desktop:~$
```


History in bash

```
ad@ad-desktop:~/SysProMaterial/Set001$ ls -la *tex
-rw-r--r-- 1 ad ad 48821 2010-02-20 11:17 set001.tex
ad@ad-desktop:~/SysProMaterial/Set001$ pwd
/home/ad/SysProMaterial/Set001
ad@ad-desktop:~/SysProMaterial/Set001$ ls *set*
set001.aux set001.log set001.out set001.snm set001.tex.bak
set001.dvi set001.nav set001.ps set001.tex set001.toc
ad@ad-desktop:~/SysProMaterial/Set001$ echo this is work in progress
this is work in progress
ad@ad-desktop:~/SysProMaterial/Set001$ history | tail -5
 511 ls -la *tex
 512 pwd
 513 ls *set*
 514 echo this is work in progress
 515 history | tail -5
ad@ad-desktop:~/SysProMaterial/Set001$ !511
ls -la *tex
-rw-r--r-- 1 ad ad 48821 2010-02-20 11:17 set001.tex
ad@ad-desktop:~/SysProMaterial/Set001$ !pw
pwd
/home/ad/SysProMaterial/Set001
ad@ad-desktop:~/SysProMaterial/Set001$ date
Sat Feb 20 11:35:08 EET 2010
ad@ad-desktop:~/SysProMaterial/Set001$ history | tail -3
 517 pwd
 518 date
 519 history | tail -3
ad@ad-desktop:~/SysProMaterial/Set001$ !da
date
Sat Feb 20 11:35:24 EET 2010
ad@ad-desktop:~/SysProMaterial/Set001$
```

history in *cs*h

```
perth:/home/users/ad>set history=5
perth:/home/users/ad>history
 39 11:48 history
 40 11:48 ls x2del.*
 41 11:48 ls x2del.* TP
 42 11:48 set history=5
 43 11:48 history
perth:/home/users/ad>!ls
ls x2del.* TP
TP: No such file or directory
x2del.pdf      x2del.qxp.pdf
perth:/home/users/ad>ls TPD*
TPDS-0026-0206.pdf  TPDS-0026-0206.ps
perth:/home/users/ad>!!
ls TPD*
TPDS-0026-0206.pdf  TPDS-0026-0206.ps
perth:/home/users/ad>!41
ls x2del.* TP
TP: No such file or directory
x2del.pdf      x2del.qxp.pdf
perth:/home/users/ad>
```

alias-ing within the shell

```
ad@ad-desktop:~/SysProMaterial/Set001$ alias
alias egrep='egrep --color=auto'
alias grep='grep --color=auto'
alias ls='ls --color=auto'
ad@ad-desktop:~/SysProMaterial/Set001$ cd Samples/
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ ls
!      Alexdir  b_file  delis   lista  lista3  out1      UMASK
aaa    bb        c_file  d_file  lista1 mydir   Set-01.ppt zzz
a_file bbbb     dddd    eeee    lista2 mytest  sfile
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ alias
alias egrep='egrep --color=auto'
alias grep='grep --color=auto'
alias ls='ls --color=auto'
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ alias dir='ls -sa'
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ dir *bb
4 bb 4 bbbb
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ alias lls='ls -las'
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ alias mydir='ls;pwd'
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ mydir
!      Alexdir  b_file  delis   lista  lista3  out1      UMASK
aaa    bb        c_file  d_file  lista1 mydir   Set-01.ppt zzz
a_file bbbb     dddd    eeee    lista2 mytest  sfile
/home/ad/SysProMaterial/Set001/Samples
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ unalias lls mydir
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ alias
alias dir='ls -sa'
alias egrep='egrep --color=auto'
alias grep='grep --color=auto'
alias ls='ls --color=auto'
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
```

Process Management

ps	display status of the processes
jobs	display interrupted processes
kill	kill a specific process
bg	set a process in “background” processing
fg	set a process in “foreground” processing
top	show status of processor(s), memory, running programs

Working with *bg*, and *fg*

```
ad@ad-desktop:~/SysProMaterial/Set001$ ./a.out
^Z
[3]+  Stopped                  ./a.out
ad@ad-desktop:~/SysProMaterial/Set001$ jobs
[1]  Running                    make &
[2]-  Running                    gv set001.ps &
[3]+  Stopped                  ./a.out
ad@ad-desktop:~/SysProMaterial/Set001$ bg
[3]+  ./a.out &
ad@ad-desktop:~/SysProMaterial/Set001$ jobs
[1]  Running                    make &
[2]-  Running                    gv set001.ps &
[3]+  Running                    ./a.out &
ad@ad-desktop:~/SysProMaterial/Set001$ fg %3
./a.out
^Z
[3]+  Stopped                  ./a.out
ad@ad-desktop:~/SysProMaterial/Set001$ kill %3
[3]+  Terminated              ./a.out
ad@ad-desktop:~/SysProMaterial/Set001$ ps
  PID TTY          TIME CMD
 2659 pts/0        00:00:00 bash
 2695 pts/0        00:00:00 gv
 2739 pts/0        00:03:17 soffice.bin
 3406 pts/0        00:00:00 gs
 3448 pts/0        00:00:00 ps
ad@ad-desktop:~/SysProMaterial/Set001$
```

Command `top`

```
top - 13:18:11 up 3:20, 5 users, load average: 0.00, 0.00, 0.00
Tasks: 181 total, 3 running, 178 sleeping, 0 stopped, 0 zombie
Cpu(s): 1.2%us, 1.0%sy, 0.0%ni, 97.9%id, 0.0%wa, 0.0%hi, 0.0%si, 0.0%st
Mem: 2061416k total, 1311888k used, 749528k free, 157420k buffers
Swap: 4883720k total, 0k used, 4883720k free, 642324k cached
```

PID	USER	PR	NI	VIRT	RES	SHR	S	%CPU	%MEM	TIME+	COMMAND
1807	ad	20	0	156m	4896	3672	R	2	0.2	1:48.90	pulseaudio
1946	ad	20	0	422m	117m	33m	S	1	5.8	7:41.66	firefox
1248	root	20	0	305m	38m	11m	S	1	1.9	4:32.62	Xorg
3515	ad	20	0	2472	1204	884	R	1	0.1	0:00.18	top
1851	ad	20	0	104m	14m	10m	S	0	0.7	0:07.31	metacity
2933	ad	20	0	149m	80m	25m	S	0	4.0	0:24.08	acoread
1	root	20	0	2664	1552	1128	S	0	0.1	0:00.85	init
2	root	15	-5	0	0	0	S	0	0.0	0:00.00	kthreadd
3	root	RT	-5	0	0	0	S	0	0.0	0:00.00	migration/0
4	root	15	-5	0	0	0	S	0	0.0	0:00.36	ksoftirqd/0
5	root	RT	-5	0	0	0	S	0	0.0	0:00.00	watchdog/0
6	root	RT	-5	0	0	0	S	0	0.0	0:00.00	migration/1
7	root	15	-5	0	0	0	S	0	0.0	0:00.60	ksoftirqd/1
8	root	RT	-5	0	0	0	S	0	0.0	0:00.00	watchdog/1

.....

Compression of files

- ▶ create flat version of files and directories with *tar* or *zip*
- ▶ compress their size with *gzip*

```
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ tar cvf mylist.tar lista*
lista
lista1
lista2
lista3
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ zip mylist.zip lista*
  adding: lista (deflated 26%)
  adding: lista1 (deflated 26%)
  adding: lista2 (deflated 26%)
  adding: lista3 (deflated 26%)
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ ls -l mylist.*
-rw-r--r-- 1 ad ad 10240 2010-02-20 16:54 mylist.tar
-rw-r--r-- 1 ad ad 1123 2010-02-20 16:54 mylist.zip
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ gzip mylist.tar
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ !ls
ls -l mylist.*
-rw-r--r-- 1 ad ad 443 2010-02-20 16:54 mylist.tar.gz
-rw-r--r-- 1 ad ad 1123 2010-02-20 16:54 mylist.zip
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
```

Decompression of .gz .zip files

- ▶ *zcat*: does not alter the structure of the compressed file.
- ▶ decompression: *gunzip* or *unzip*

```
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ zcat mylists.tar.gz | tar xv
lista
lista1
lista2
lista3
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ gunzip mylists.tar.gz
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ ls -l mylists.*
-rw-r--r-- 1 ad ad 10240 2010-02-20 16:42 mylists.tar
-rw-r--r-- 1 ad ad 1123 2010-02-20 16:42 mylists.zip
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ unzip mylists.zip
Archive:  mylists.zip
replace lista? [y]es, [n]o, [A]ll, [N]one, [r]ename: A
  inflating: lista
  inflating: lista1
  inflating: lista2
  inflating: lista3
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
```


Other commands

<i>tr</i>	translate or delete characters in files
<i>colrm</i>	delete columns from file
<i>find</i>	locate file/catalogs in an FS
<i>script</i>	record the interaction with the shell
<i>sleep</i>	wait for a number of seconds
<i>last</i>	last appearances of user(s)
<i>clear</i>	clear tty

tr usage

```
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ cat test1
This is a test - test FILE
of manuscript that is to be
served as a subpoena
to the jurors of the court
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ tr acbdef ijklm < test1
This is i tmst - tmst FILE
om minusjript thit is to km
smrvml is i sukpomni
to thm jurors om thm jourt
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ tr -d '[i-l]s' <test1
Th a tet - tet FILE
of manucrpt that to be
erved a a ubpoena
to the uror of the court
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
```

colrm usage

```
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ colrm 8 15 < lista1
123: jimn:2103456789: reading
345: petel:4567891234: london
673: pet:9602345612: sydney
133: time:3452678967: moscow
231: kitilata:2138905674: athens
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ colrm 10 < lista1
123: jim:m
345: peter
673: pete:
133: time:
231: kitri
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ ls -ald mydir
drwxr-xr-x 2 ad ad 4096 2010-02-19 21:34 mydir
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ ls -ald mydir | colrm 11 55
drwxr-xr-x
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ ls -ald mydir | colrm 11 44
drwxr-xr-x mydir
ad@ad-desktop:~/SysProMaterial/Set001/Samples$ ls -ald * | colrm 11 44 | grep
zip
-rw-r--r-- all-lists.zip
-rw-r--r-- mylists.zip
-rw-r--r-- mylist.zip
ad@ad-desktop:~/SysProMaterial/Set001/Samples$
```

Command *find*

```
ad@ad-desktop:~$ find SysProMaterial -name '*dvi*' -print
SysProMaterial/syspro_sockets_presentation/syspro_sockets_presentation/sockIPC.dvi
SysProMaterial/syspro_sockets_presentation/sockIPC.dvi
SysProMaterial/Set001/set001.dvi
SysProMaterial/PERNASVIP-kickoff/myprese.dvi
ad@ad-desktop:~$ find . -name set001.ps -print
./SysProMaterial/Set001/set001.ps
ad@ad-desktop:~/SysProMaterial$ find .. -type d -name '*Set*' -exec file '{}' \;
../SysProMaterial/Set001: directory
../K24/Set-3-Code: directory
../K24/Set-4-Code: directory
ad@ad-desktop:~/SysProMaterial$
ad@ad-desktop:~/SysProMaterial$ find . -type f -name '*tex' -exec ls -l '{}' \;
-rw-r--r-- 1 ad ad 6317 2010-02-15 21:22 ./Admin/k24-syllabus10.tex
-rwx----- 1 ad ad 1103 2010-02-15 21:22 ./Admin/Bebaiwsi.tex
-rwxr-xr-x 1 ad ad 25200 2010-02-15 21:22 ./syspro_sockets_presentation/sockIPC.tex
-rwxr-xr-x 1 ad ad 25200 2010-02-15 21:22 ./syspro_sockets_presentation/syspro_sockets_presentation/sockIPC.tex
-rw-r--r-- 1 ad ad 59746 2010-02-20 18:10 ./Set001/set001.tex
-rw-r--r-- 1 ad ad 58694 2010-02-19 12:41 ./Set001/._sockIPC.tex
-rwxr-xr-x 1 ad ad 26056 2010-02-15 21:22 ./PERNASVIP-kickoff/myprese.tex
ad@ad-desktop:~/SysProMaterial$
ad@ad-desktop:~/SysProMaterial$ find /usr/ -perm 664 -print
/usr/local/share/texmf/ls-R
ad@ad-desktop:~/SysProMaterial$ find /usr/ -perm 664
/usr/local/share/texmf/ls-R
ad@ad-desktop:~/SysProMaterial$
```

Commands: *last*, *script*, *sleep*, *clear*

```
ad@ad-desktop:~/SysProMaterial/Set001$ last -n 5
ad      pts/4      :0.0      Sat Feb 20 20:11   still logged in
ad      pts/3      :0.0      Sat Feb 20 18:19   still logged in
ad      pts/3      :0.0      Sat Feb 20 11:31 - 18:19   (06:47)
ad      pts/3      :0.0      Sat Feb 20 11:28 - 11:31   (00:02)
ad      pts/2      :0.0      Sat Feb 20 11:00   still logged in

wtmp begins Wed Feb  3 20:05:09 2010
ad@ad-desktop:~/SysProMaterial/Set001$ script mysession
Script started, file is mysession
ad@ad-desktop:~/SysProMaterial/Set001$ ls *tex
set001.tex
ad@ad-desktop:~/SysProMaterial/Set001$ pwd
/home/ad/SysProMaterial/Set001
ad@ad-desktop:~/SysProMaterial/Set001$ exit
Script done, file is mysession
ad@ad-desktop:~/SysProMaterial/Set001$ cat mysession
Script started on Sat 20 Feb 2010 08:29:09 PM EET
ad@ad-desktop:~/SysProMaterial/Set001$ ls *tex
set001.tex
ad@ad-desktop:~/SysProMaterial/Set001$ pwd
/home/ad/SysProMaterial/Set001
ad@ad-desktop:~/SysProMaterial/Set001$ exit

Script done on Sat 20 Feb 2010 08:29:17 PM EET
ad@ad-desktop:~/SysProMaterial/Set001$ rm mysession
ad@ad-desktop:~/SysProMaterial/Set001$ date; sleep 10; date
Sat Feb 20 20:31:25 EET 2010
Sat Feb 20 20:31:35 EET 2010
ad@ad-desktop:~/SysProMaterial/Set001$ clear;
```

mutt, pine, gcc

- ▶ electronic mail: *mail, mutt, pine, xmail*
- ▶ compiling programs in C/C++: *gcc/g++*

```
ad@ad-desktop:~/SysProMaterial/Set001/Sample-C/SampleGCC$ ls
InputFile      LinkedList.c  main.c      MyHeader.h      OrderedLinkedList.h
InputFile.out  LinkedList.h  Makefile    OrderedLinkedList.c
ad@ad-desktop:~/SysProMaterial/Set001/Sample-C/SampleGCC$
ad@ad-desktop:~/SysProMaterial/Set001/Sample-C/SampleGCC$ gcc -c main.c
ad@ad-desktop:~/SysProMaterial/Set001/Sample-C/SampleGCC$ gcc -c LinkedList.c
ad@ad-desktop:~/SysProMaterial/Set001/Sample-C/SampleGCC$ gcc -c
OrderedLinkedList.c
ad@ad-desktop:~/SysProMaterial/Set001/Sample-C/SampleGCC$ gcc main.o LinkedList.o
OrderedLinkedList.o -o myexe
ad@ad-desktop:~/SysProMaterial/Set001/Sample-C/SampleGCC$ ./myexe
expected syntax: myexe inputfile
```

The use of *Makefile*

- ▶ An easy way to organize separate compilation of programs and activities
- ▶ The basic format of *Makefile* command is:
target: required-files
TAB → *command*
- ▶ The existence of TAB before the command above is **imperative**; otherwise, makefile does not work! (strange but that is the way it goes).
- ▶ The *required-files* have to be “done” before the *target* is realized.
- ▶ If *required-files* have not “changed” then the command of the Makefile does not get executed (things are up to date).
- ▶ Often, the final target of a Makefile is termed *all*.
- ▶ There is also a target named *clean* that purges all *.o and executable files.

Makefile

```
# In order to execute this "Makefile" just type "make"
#   A. Delis (ad@di.uoa.gr)
#
OBJS    = main.o LinkedList.o OrderedLinkedList.o
SOURCE  = main.c LinkedList.c OrderedLinkedList.c
HEADER  = MyHeader.h LinkedList.h OrderedLinkedList.h
OUT     = myexe
CC      = gcc
FLAGS   = -g -c
# -g option enables debugging mode
# -c flag generates object code for separate files

all: $(OBJS)
    $(CC) -g $(OBJS) -o $(OUT)

# create/compile the individual files >>separately<<
main.o: main.c
    $(CC) $(FLAGS) main.c

LinkedList.o: LinkedList.c
    $(CC) $(FLAGS) LinkedList.c
OrderedLinkedList.o: OrderedLinkedList.c
    $(CC) $(FLAGS) OrderedLinkedList.c

# clean house
clean:
    rm -f $(OBJS) $(OUT)

# do a bit of accounting
count:
    wc $(SOURCE) $(HEADER)
```



```
OBJS = main.o iodat.o dorun.o
LIB = /usr/lib/crtn.o
CC = /usr/bin/gcc

program: ${OBJ} ${LIB} mylibops.a
        ${CC} -o $@ ${OBJ} ${LIB} mylibops.a

main.o: main.c
        ${CC} -c $?

iodat.o: iodat.c
        ${CC} -c $?

dorun.o: dorun.c
        ${CC} -c $?

mylibops.a: interact.o sched.o gen.o
        ar r $@ $?

interact.o: interact.c
        ${CC} -c $?

gen.o: gen.c
        ${CC} -c $?

sched.o: sched.c
        ${CC} -c ??
```

- ▶ `$?` : current list of prerequisites
- ▶ `$@` : current target