

Administration of Operating Systems

DO2003

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The Bourne Again Shell (bash)



Lecture Overview

- At the end of the lecture students are able to:
 - Use bash
 - Create and execute shell scripts
 - Control jobs
 - Create variables, functions, aliases

The Bourne Again Shell (Bash)

Bourne Again Shell (bash)

- Is both a
 - Command interpreter
 - Executes commands
 - Programming language
 - Executes commands from files called shell scripts
- Bash is the default shell in GNU/Linux
 - `/bin/bash`

What is a shell script?

- A shell script is a text file containing shell commands
 - Might contain also control structures
- The shell interprets and executes the commands in a shell script, one after another.
- Some scripts will run at the startup for self initialization
- Others will be started by the user for maintenance, administration, or repair work purposes
- Functionality
 - Read data
 - Process data
 - Produce results

```
#!/bin/bash
# ~/.profile: executed by the command interpreter for login shells.
# This file is not read by bash(1), if ~/.bash_profile or ~/.bash_login
# exists.
# see /usr/share/doc/bash/examples/startup-files for examples.
# the files are located in the bash-doc package.

# the default umask is set in /etc/profile; for setting the umask
# for ssh logins, install and configure the libpam-umask package.
#umask 022

# if running bash
if [ -n "$BASH_VERSION" ]; then
    # include .bashrc if it exists
    if [ -f "$HOME/.bashrc" ]; then
        . "$HOME/.bashrc"
    fi
fi

# set PATH so it includes user's private bin if it exists
if [ -d "$HOME/bin" ] ; then
    PATH="$HOME/bin:$PATH"
fi
```

Startup files

- When a shell starts, it runs startup files to initialize itself
 - Login Shells
 - `/etc/profile`: system-wide initialization
 - ➔ ● `~/.bash_profile`: override `/etc/profile`
 - `~/.bash_login`: substitute for `~/.bash_profile`
 - `~/.profile`: substitute for `~/.bash_profile`
 - `~/.bash_logout`: executed at logout
 - Interactive nonlogin Shell
 - `/etc/bashrc`: system-wide aliases and functions
 - ➔ ● `~/.bashrc`: personalization of the user's shell environment

Running a shell script

- Startup files

- Logout and login

```
$ . Filename [arguments]
```

- Otherwise

1.

```
$ Filename [arguments]
```

2.

```
$ ./Filename [arguments]
```

3.

```
$ bash Filename [arguments]
```

- 1 requires that the working directory be in the PATH variable
- 1 and 2 require that you have execute and read permission for the script file
- 3 requires that you have read permission for script file

Simple scripts

Script 1

```
$ cat > whoson
#Display date and users logged in
date
who
$ whoson
Whoson: command not found
$ ./whoson
-bash: ./whoson: Permission denied
$ chmod u+x whoson
$ ./whoson
Sun Nov 6 01:58:29 PST 2011
ide tty1 2011-11-05 23:43
$ dash whoson
Sun Nov 6 01:58:31 PST 2011
ide tty1 2011-11-05 23:43
$
```

Script 2

```
$ cat > whoson2
#!/bin/bash
echo "Today's date and users \
logged in"
(Date ; who)
$ dash whoson2
Today's date and users logged in
Sun Nov 6 01:59:23 PST 2011
ide tty1 2011-11-05 23:43
$ ./whoson2
-bash: ./whoson2: Permission denied
$ chmod u+x whoson
$ ./whoson2
Today's date and users logged in
Sun Nov 6 01:59:00 PST 2011
ide tty1 2011-11-05 23:43
```

Simple scripts II

```
$ cat > printArg.sh
#!/bin/bash
echo "The script has $# arguments."
echo $0
```

```
$ cat > srm
#!/bin/bash
# Safe Remove
backup_path=/tmp
cp $1 $backup_path
echo $1 is stored in $backup_path
rm $1
```

Job control

- One or more commands connected by pipes
- Suspend a job
 - Pressing the suspend key, typically CONTROL-Z
- Bring a job running in the background into the foreground
 - fg
- Put a foreground job into the background
 - bg
- To see which jobs are running or suspended
 - jobs

Job control II

```
$ cat > script2.sh
#!/bin/bash
sleep 15&
$ chmod 700 script2.sh
$ ./script2.sh& ls& ps& jobs&
```

- How many jobs have been created?
- How many child processes have been forked?

- What about

```
$ (./script2.sh ; ls)& ps& jobs&
```

Shell parameters

- A parameter stores values
- A variable is a parameter denoted by a name.
- Positional Parameters
 - Command-line arguments
\$#; \$1,\$2,..., \$9; \$?
- Special Parameters
 - Parameters denoted by special characters and are not modifiable
- Users can define *User-created variables*
VARIABLE=value
- The shell has *keyword variables*

User-created variables

- Must start with **letter** or **underscore** only
- You can change its value
- You can assign attributes to variables
 - Read-only (not removable), make it global, integer type
- You can remove a variable

```
$ declare myName='Wagner'
```

```
$echo myName
```

```
myName
```

```
$echo "$myName"
```

```
Wagner
```

```
$echo '$myName'
```

```
myName
```

```
$ declare -x myName="Wagner"
```

```
$ myAge=31
```

```
readonly age
```

```
$echo $myName
```

```
Wagner
```

```
$ unset myName
```

```
echo $myName
```

```
$
```

Keyword shell variables

- The shell creates and initialize keyword variables when it starts

```
$ echo $HOME
```

```
/home/ide
```

```
$ echo $PATH
```

```
/usr/local/sbin:/usr/local/bin:...
```

```
$ echo $LANG
```

```
en_US:UTF-8
```

```
$ echo $HISTFILE
```

```
/home/ide/.bash_history
```

Special characters I

- ; Separates commands
- () Groups commands for execution by a subshell or identifies a function
- (()) Expands an arithmetic expression
- & Executes a command in the background
- | Sends stdout of the preceding command to stdin of the following command
- > Redirects standard output
- >> Appends standard output
- < Redirects standard input

Special characters II

- * Any string of zero or more characters in an ambiguous file reference
- ? Any single character in an ambiguous file reference (page 256)
- \ Quotes the following character
- ' Quotes a string, preventing all substitution
- " Quotes a string, allowing only variable and command substitution
- ‘...’ Performs command substitution
- [] Character class in an ambiguous file reference

Special characters III

- `$` References a variable
- `.` (dot builtin) Executes a command
- `#` Begins a comment
- `{ }` Surrounds the contents of a function
- `&&` (Boolean AND) Executes command on right only if command on left succeeds
- `||` (Boolean OR) Executes command on right only if command on left fails
- `!` (Boolean NOT) Reverses exit status of a command
- `$()` Performs command substitution
- `[]` Evaluates an arithmetic expression

Process

- A process is the execution of a command by the Linux kernel
 - If a command is not built in the shell (`cd`, `echo`, ...), the shell forks a new (child) process to execute the command
 - The shell waits, sleep state, for the child process to finish
- Each process has a PID number (`ps -f`)
- Processes can run in the background (`&`)
 - The shell does not wait the process to finish
- When a process terminates, it returns its exit status (`$?`) to its parent process
 - 0 = success
 - Otherwise, failure

History

- The shell provides access to a list of commands previously typed, i.e., the *command history*

- From `~/ .bashrc`

```
HISTCONTROL=ignoredups:ignorespace
```

```
HISTSIZE=1000
```

```
HISTFILESIZE=2000
```

- Bash assigns a event number to each issued command line

```
$ history | tail
```

```
...
```

```
416 vi ~/.bashrc
```

```
417 history|tail
```

Displaying and reexecuting commands

- Displaying the history list

`fc -l [first [last]]`

`fc -l 5 10`

`fc - echo vi`

- Reexecuting

- `fc -s 415`

- `!415`

- Event designators

Designator	Meaning
!	Starts a history event
!!	The previous command
!n	Command number n in the history list
!string	The most recent command line that started with string

Aliases

- Is a name that the shell translates into another name or (complex) command
- Aliases allow you to define new commands by substituting a string for the first token of a simple command

```
alias [name[=value]]
```

```
$ alias la='ls -a'
```

```
$ alias rm='rm -i'
```

- To list active aliases

```
$ alias
```

Functions

- The shell allow user to define shell functions
- It's a way to group commands using a single name for the group.
- Functions are executed in the same was as a command
- Unlike a shell script, a function is parsed prior to being stored in memory
 - Run faster than shell scripts
- A function can be defined on the command line or within a shell script

```
[function] name () { commands }
```
- **Functions may not be empty**

Function example I

```
$ function whoson()  
> {  
> date  
> echo "Users currently logged on"  
> who  
>}  
$ whoson  
Sun Nov    6 01:58:29 PST 2011  
Users currently logged on  
ide  tty1 2011-11-06 13:43  
$
```

Function example II

```
$ add()
```

```
> {
```

```
> echo $((($1+$2))
```

```
> }
```

```
$ add 3 5
```

```
8
```

```
$ add() { echo $((($1+$2)) };
```

```
$ add 3 5
```

```
8
```

```
$
```

Function example III

- Compacted into a single line
 - `$ myFunction () { echo "This is a function"; echo; }`
- Many functions in a script file

```
$ cat > script1.sh
```

```
f1 ()
```

```
{
```

```
    echo "Calling \"f2\" from within \"f1\"."
```

```
    f2
```

```
}
```

```
f2 () { echo "Function \"f2\"."; }
```

Controlling bash

- The `set` and `shopt` builtins allows shell customization by turning features on and off
 - `set -o [argument]`
 - Turns on the feature indicated by the argument
 - If the argument is not indicated, it lists all features controlled by `set`
 - `set +o [argument]`
 - Turns off the feature indicated by the argument
 - If the argument is not indicated, it lists how you can switch the state of all features controlled by `set`
- `set -o noclobber`

Command-line expansion

- After splitting the a command line into tokens, the bash may replace some words with expanded text

- Brace expansion

```
$ ls
```

```
script1.sh      script2.sh      script3.sh
```

```
script4.sh
```

```
$ chmod 700 script{1,2,3}.sh
```

- Tilde expansion

- `~` is equal to the value of `$HOME`
- `~/Docs` is equal to `$HOME/Docs`

Other Command-line expansions

- Parameter and variable expansion

```
$ myName='Wagner'
```

```
$ echo ${myName:= 'Unknown' }
```

```
Wagner
```

```
$ unset myname
```

```
$ echo ${myName:= 'Unknown' }
```

```
Unknown
```

- Quotation marks

- \$ echo "\$myName" vs. \$ echo '\$myName'

Other Command-line expansions

- Arithmetic expansion
 $\$((\$1+\$2))$

Operator	Meaning
VAR++, VAR--	variable post-increment and post-decrement
++VAR, --VAR	variable pre-increment and pre-decrement
! and ~	logical and bitwise negation
**	exponentiation
+, -, *, /, %	addition, subtraction, multiplication, division, remainder
<< and >>	left and right bitwise shifts
<=, >=, <, >	comparison operators
==, !=	equality and inequality
~, &, ^	bitwise AND, bitwise OR, bitwise exclusive OR
, &&	logical OR, logical AND
expr ? expr : expr	conditional evaluation
=, *=, /=, %=, +=, -=, <<=, >>=, &=, ^=, =	assignments
,	separator between expressions

