Lab2 - Shell Script

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February 26, 2024

Outline

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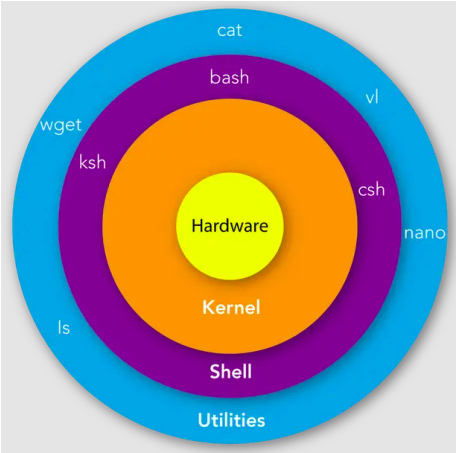
Shell

- Kernel: the core of OS
- Shell
  - the interface for user or program to access to the OS's services
  - often refer to the CLI (Command-Line Interface) shells
  - a sort of different shells: sh, bash, zsh, fish...



(Reference: https://mindmajix.com/shell-scripting-tutorial)

Bash

- Bash: Bourne-Again Shell
- Default login shell on most systems (ex: CSIE workstations)
- Will be used in this lab, HW, and semester
- Check your shell!

```
brianhsu:~$ echo $SHELL
/bin/bash
```

Shell Script

- If you want to type a lot of commands, then directly typing it in shell is inconvenience.
- Type the commands in a file, and execute it.

Outline

Who to Ask

- Ask the `man`:
  - `man cmd`: show the manual page of the command `cmd`
  - Ex: `man cd`, `man ls`, ...
  - `man man` for more details
- Ask for help:
  - `cmd -h`, `cmd --help`
  - Ex: `cd --help`, `ls --help`
- Ask Google or ChatGPT: will be very helpful in this class
- tldr may help

Editor

- How to edit/execute codes on workstations?
  - VSCode (or other local editors) + scp ?
  - Learn Vim instead.
  - VIM IS THE BEST EDITOR IN THE WORLD!
- Vim tutorial
  - `vimtutor`
  - Vim tutorial
- Edit `~/.vimrc` to make Vim more convenient:
  - `map <F9> :w<bar>!gcc "%"`
  - `map <F10> :w<bar>!./a.out`

Editor


I Am Devloper
@iamdevloper
Following
I've been using Vim for about 2 years now, mostly because I can't figure out how to exit it.
Vim
VIA 9GAG.COM
I wish I knew how to quit you.

SSH

- SSH: Secure SHell (secure for remote connection)
- Important:
  - Strong password
  - Give SSH key a try
- Keywords: `ssh-keygen`, `ssh-copy-id`, `ssh-agent`, `~/.ssh/config`, `keychain`
- Transfering file: `sftp`, `scp`

Outline

Hello World

- Open an editor and copy the following script:

```
#!/usr/bin/env bash
# The first line is shebang.
# Write comment after '#'.
echo 'Hello World!'
```

- Save it to a file (suppose it's `hello.sh`).

- Run it!
  - First way: `bash hello.sh`
  - Second way: `chmod +x hello.sh` (remember to give it the execution permission)

    `./hello.sh`
  - Result:

```
brianhsu:~$ bash hello.sh
Hello World!
brianhsu:~$ chmod +x hello.sh
brianhsu:~$ ./hello.sh
Hello World!
```

Shebang

- Shebang (=Hashbang): sharp + bang
- Specify the interpreter by adding shebang
- `#!/usr/bin/env bash` or `#!/bin/bash`
- Python is also an interpreter: `#!/usr/bin/env python`

Variables

- Assign value (no spaces in the syntax): `var=value`

```
brianhsu:~$ a=b
brianhsu:~$ echo $a
b
brianhsu:~$ a = b
a: command not found
brianhsu:~$ a= b
b: command not found
brianhsu:~$ a =b
a: command not found
```

- Take value: `$var`, `${var}`
- echo with:
  - Single quote: without replacement
  - Double quote: with replacement

- I just assigned a variable, but `echo $variable` shows something else
- Try this yourself:

```
#!/usr/bin/env bash
var="echo Hello World!"
$var
echo var
echo $var
echo '$var'
echo "$var"
```

What is the output?

Variables

- Get the output of a command: `var=`cmd`` , `var=$(cmd)`
- Get the exit code of the last command: `var=$?`
- Exit with a specific exit code: `exit code`
- Calculation
  - String concatenation: `$a$b`
  - Integer Arithmetic: `$((a+b))` , `((a*=b))` , `((++a))` , `((a-=1))`
  - String length: `${#a}`

Variables - Array

- Declare an array (IFS-sep): `arr=("a" "b")` , `files=(`ls`)`
- Append to an array: `arr+=("c")`
- Assign: `arr[i]=value`
- Get the values of an array:
  - All items in `arr` : `${arr[@]}`
  - The size of `arr` : `${#arr[@]}`
  - The value of `arr[i]` : `${arr[i]}`

- Get the values of the arguments (can be seen as an array):
  - The argument of a script: `$1` , `$2` , ...
  - All arguments of a script: `$@`
  - The number of arguments: `$#`
- IFS (Internal Field Separator) (like `.split()` in python): `IFS=$' \t\n'` by default

Variables - Array

- Try the following code in a directory with more than 2 files.

```
#!/usr/bin/env bash
echo "$0 $1 $2"
echo $(($1+$2))
echo "$# $@"
arr=(`ls`)
echo ${arr[0]}
IFS=' '
arr=(`ls`)
echo ${arr[0]}
```

Save it to `script.sh` and run `./script.sh 12 34`.

Variables - Dictionary

- Declare with attributes: `declare [attribute-option] var=value`
- Delete a variable: `unset var`
- Declare a dictionary: `declare -A dict`, `dict=([abc]=def [123]='456')`
- Assign: `dict[key]=value`
- Get the values of an dictionary:
  - All items in `dict`: `${dict[@]}`
  - The size of `dict`: `${#dict[@]}`
  - The value of `dict[key]`: `${dict[key]}`
- What Are Bash Dictionaries on Linux, and How Do You Use Them?

Redirection

- Input into a variable: `read var`
- Redirection:
  - `<`: redirect STDIN to file
  - `>`: redirect STDOUT to file (cover)
  - `>>`: redirect STDOUT to file (append)
  - `2>`: redirect STDERR to file
  - `&>`: redirect STDOUT and STDERR to file
  - `>&`: redirect a stream to another

- What is the output and the content of each file after running the following code?

```
#!/usr/bin/env bash
echo 'Hello' > out
echo 'World' > out
echo 'Kitty' >> out
read a < out
echo $a
(read a && echo $a) < out > out1
cd -h > out2
cd -h 2> out3
(ls && cd -h) &> out4
cd -h 2>&1 > out5
cd -h > out6 2>&1
```

Redirection

- `cmd1 | cmd2`: pass the STDOUT of `cmd1` to the STDIN of `cmd2`
  The following do almost the same thing:
  - `cat messy.txt | sort | uniq > clean.txt`
  - `cat messy.txt > tmp1; sort < tmp1 > tmp2`
    `uniq < tmp2 > clean.txt; rm tmp1 tmp2`
- `cmd1; cmd2; ...`: use `;` to split the commands in a single line
- `cmd <<< str`: here-string, like redirecting STDIN to `str`
- `cmd &`: run `cmd` in background

If-Else

- If clause:

```
if cond; then
  cmd
fi
```

- If-else clause:

```
if cond1; then
  cmd1
elif cond2; then
  cmd2
else
  cmd3
fi
```

Condition

The spaces in the following syntaxes are important!

- Expression: `[[ expr ]]`
- Boolen operations:
  - `[[ ! expr ]]`: not
  - `[[ expr1 ]] && [[ expr2 ]]`: and
  - `[[ expr1 ]] || [[ expr2 ]]`: or
- Files:
  - `[[ -e FILE ]]`: exists
  - `[[ -f FILE ]]`: is file
  - `[[ -d FILE ]]`: is directory
  - `[[ -L FILE ]]`, `[[ -h FILE ]]`: is symbolic link

Condition

The spaces in the following syntaxes are important!

- Strings:
  - `[[ -z str ]]`: is empty string
  - `[[ -n str ]]`: is non-empty string
  - `[[ str1 == str2 ]]`: is equal
  - `[[ str1 != str2 ]]`: is unequal
  - `[[ str =~ regex ]]`: `str` satisfies `regex`
- Numerical comparison:
  - `[[ a -eq b ]]`: $a = b$
  - `[[ a -ne b ]]`: $a \neq b$
  - `[[ a -lt b ]]`: $a < b$
  - `[[ a -le b ]]`: $a \leq b$
  - `[[ a -gt b ]]`: $a > b$
  - `[[ a -ge b ]]`: $a \geq b$

Loops

- `for i in range(10)`

```
for i in {0..9}; do
  echo $i
done
```

- `for(i=0; i<10; ++i)`

```
for ((i=0; i<10; ++i)); do
  echo $i
done
```

- `for i in arr`

```
for i in `ls`; do
  echo $i
done
```

- `while`

```
while cond; do
  cmd
done
```

- Use `continue` to continue, and use `break` to break.

Functions

- Declare:

```
func(){
  cmd
}
```

- Call: `func`
- Arguments:
  - Passing: `func arg1 arg2 ...`
  - Get the value: `$1`, `$2`, ... in the function declaration are the arguments
- Local variable: `local var`

- Example of `min` function:

```
#!/usr/bin/env bash
min(){
  local res=$1
  for i in $@; do
    if [[ $i -lt $res ]]; then
      res=$i
    fi
  done
  echo $res
}
echo `min 3 1 4 1 5 9`
```

Outline

Frequently Used Commands

- Get file attributes: `ls`, `stat`, `file`
- Working directory: `cd`, `pwd`
- Create files/directories: `touch`, `mkdir`
- Move/copy/delete: `mv`, `cp`, `rm`
- Permission: `chmod`, `chown`, `chgrp`, ACL
- Search: `find`, `which`, `whereis`, `locate`
- I/O: `echo`, `printf`, `cat`, `less`, `head`, `tail`, `read`
- String: `grep`, `awk`, `sed`, `cut`, `wc`, `diff`, `tr`
- Order: `sort`, `uniq`
- Process: `ps`, `top`, `kill`
- Runtime: `time`, `/usr/bin/time`, `timeout`, `ulimit`, `strace`, `sleep`
- Network utilities: `ifconfig`, `ip`, `ping`, `dig`, `traceroute`, `host`
- Connection: `nc`, `telnet`, `ssh`, `sftp`, `scp`
- Web: `wget`, `curl`
- Other: `bc`, `openssl`, `xargs`, `tee`, `trap`, GlobPattern

Regular Expression

- Regular expression (regex) is a kind of expression method describing some forms of texts.
- BRE (Basic Regular Expressions) is used as default by many commands (e.g. `sed`, `grep`).
- BRE syntax

Basic Regular Expressions

Element	Description
`c`	Match any character
`^`	Anchor the pattern to the beginning of a line
`$`	Anchor the pattern to the end of a line
`.`	Match any single character
`[list]`	Match any single character in `list`
`[^list]`	Match any single character not in `list`
`a*`	Match zero or more occurrences of `a`
`a{n}`	Match exactly `n` occurrences of `a`
`a{n,}`	Match at least `n` occurrences of `a`
`a{n,m}`	Match at least `n` and at most `m` occurrences of `a`
`r|s`	Match either `r` or `s`
`(re)`	Grouping for precedence

Still A Lot to Learn

- Google
- Chatgpt
- Cheatsheet

Outline

Scenario - WA WA WA WA WA ...

224280181	Sep/21/2023 18:29 UTC+8	too_soft: Brian_Hsu, 2qbingxuan, casperwang #	E - Hilbert's Hedge Maze	GNU C++17 (64)	Wrong answer on test 2	0 ms	0 KB
224277342	Sep/21/2023 17:59 UTC+8	too_soft: Brian_Hsu, 2qbingxuan, casperwang #	H - Picking Up Steam	GNU C++17 (64)	Wrong answer on test 15	15 ms	0 KB
224276601	Sep/21/2023 17:51 UTC+8	too_soft: Brian_Hsu, 2qbingxuan, casperwang #	E - Hilbert's Hedge Maze	GNU C++17 (64)	Wrong answer on test 2	0 ms	0 KB
224276301	Sep/21/2023 17:48 UTC+8	too_soft: Brian_Hsu, 2qbingxuan, casperwang #	E - Hilbert's Hedge Maze	GNU C++17 (64)	Wrong answer on test 2	0 ms	0 KB
224275030	Sep/21/2023 17:34 UTC+8	too_soft: Brian_Hsu, 2qbingxuan, casperwang #	E - Hilbert's Hedge Maze	GNU C++17 (64)	Wrong answer on test 2	0 ms	0 KB
224274214	Sep/21/2023 17:26 UTC+8	too_soft: Brian_Hsu, 2qbingxuan, casperwang #	H - Picking Up Steam	GNU C++17 (64)	Wrong answer on test 13	0 ms	0 KB
224274072	Sep/21/2023 17:24 UTC+8	too_soft: Brian_Hsu, 2qbingxuan, casperwang #	E - Hilbert's Hedge Maze	GNU C++17 (64)	Wrong answer on test 2	0 ms	0 KB
224272774	Sep/21/2023 17:12 UTC+8	too_soft: Brian_Hsu, 2qbingxuan, casperwang #	H - Picking Up Steam	GNU C++17 (64)	Wrong answer on test 13	0 ms	0 KB

Scenario - WA WA WA WA WA ...

224272623	Sep/21/2023 17:11 UTC+8	too_soft: Brian_Hsu, 2qbingxuan, casperwang #	H - Picking Up Steam	GNU C++17 (64)	Wrong answer on test 13	0 ms	0 KB
224271140	Sep/21/2023 16:57 UTC+8	too_soft: Brian_Hsu, 2qbingxuan, casperwang #	H - Picking Up Steam	GNU C++17 (64)	Wrong answer on test 9	0 ms	0 KB
224268953	Sep/21/2023 16:38 UTC+8	too_soft: Brian_Hsu, 2qbingxuan, casperwang #	H - Picking Up Steam	GNU C++17 (64)	Wrong answer on test 13	0 ms	0 KB
224267197	Sep/21/2023 16:20 UTC+8	too_soft: Brian_Hsu, 2qbingxuan, casperwang #	H - Picking Up Steam	GNU C++17 (64)	Wrong answer on test 3	0 ms	0 KB
224266697	Sep/21/2023 16:15 UTC+8	too_soft: Brian_Hsu, 2qbingxuan, casperwang #	H - Picking Up Steam	GNU C++17 (64)	Wrong answer on test 3	0 ms	0 KB

Scenario

- The code with correct time complexity is complicated.
- However, it is easy to write the code using brute force.

How to Debug

- The WA test case might help.
- The judge does not show the WA test case.
- Generate it yourself.
- Compare with the output of your brute force code.

Generator

- Randomly generate some tests in the given range.
- Example generator `gen.c` of Print Two Numbers.

```c
#include <stdio.h>
#include <stdlib.h>

int main(int argc, char **argv){
  srand(atoi(argv[1]));
  printf("%d\n%d\n", rand(), rand());
  return 0;
}
```

- Compile `gen.c` to `gen`, and run `./gen arg`.
- The output is determined by the argument `arg`.

Brute Force Solution

- A code that generates the correct output.
- Example brute force solution `sol.c` of Print Two Numbers.

```c
#include <stdio.h>

int main(){
  int a, b;
  scanf("%d%d", &a, &b);
  printf("%d\n%d\n", b, a);
  return 0;
}
```

The WA Code

- The code that got WA on the judge.
- Example WA code `wa.c` of Print Two Numbers.

```c
#include <stdio.h>

int main(){
  int a, b;
  scanf("%d%d", &a, &b);
  if(a+b&1)printf("%d\n%d\n", b, a);
  else printf("%d\n%d\n", a, b);
  return 0;
}
```

Debugger

- Write a shell script (called `debugger.sh`).
- Usage: `./debugger.sh <Generator> <Code 1> <Code 2> <time>`
- The shell script should do the following things:
  - Compile `<Generator>`, `<Code 1>`, `<Code 2>` into `gen`, `a`, `b`, respectively.
  - For `i=1` to `<time>`, use the output generated by `./gen i` as the input `in.txt` of `a` and `b`.
  - If the outputs of running `a` and `b` are different, then output the debug message (the format is in the next page), and then `debugger.sh` should exit.

Debugger

- Output format:
  - First line: `Test $i:`
  - Second line: `Input:`
  - Print the content of `in.txt` with 20 '-' each above and below.
  - Next line: `Output of <Code 1>:`
  - Print the output of running `a` with 20 '-' each above and below.
  - Next line: `Output of <Code 2>:`
  - Print the output of running `b` with 20 '-' each above and below.

Debugger

- Example output of `./debugger.sh gen.c sol.c wa.c 10`:

```
Test 4:
Input:
--------------------
287724083
1968078301
--------------------
Output of sol.c:
--------------------
1968078301
287724083
--------------------
Output of wa.c:
--------------------
287724083
1968078301
--------------------
```

Time Limit

- Time limit: 1 minute.
- `<time>` ≤ 1000.
- If `<Code A>`, `<Code B>` are guaranteed to finish running in s seconds, then $s\times$ `<time>` ≤ 50 is guaranteed.

Submission

- Deadline: 2024/2/29 23:59
- Submit your code here.
- Check your result here.
- Use base64 to encode a file: `base64 FILE`
- Calculate the sha1sum of a file: `sha1sum FILE`
- 0 point for plagiarism.
- 0 point for any malicious behavior in your script.
- Your script should NOT create nor remove things that are not in the current working directory.
- Your script will be run on the workstation.

Acknowledgement

- Hsin-Mu
- HY, Lin (2023 TA)
- Brian Tsai (2022 TA)
- Giver (2021 TA)
- Wu-Jun Pei (2020 TA)
- Tsung-Han Wu (2019 TA)
- Kai-Ling Lo (2018 TA)
- The entire NASA team