

Shell Programming

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Why Shell Programming

- Just like coding in C/C++
 - Variables
 - If-else
 - Loop
 - Read from keyboard
 - Output to screen
 - Execute other commands
 - In C/C++: `system()`
- Using shell syntax

Outline

- Variable pre-operations
- args, argc in Shell Scripts
- Arithmetic and Logics
 - Test commands
- Control Structures: if-else, switch-case, for/while loops
- Input/output: Read from keyboard
- Defining Functions & Parsing Arguments
- Error Handling and Debug tool (sh -x)
- Regular Expression
- Advanced scripting: sed and awk
- A Shell Script Sample: Failure Detection on Servers

Bourne Shell

- We use Bourne Shell in this slide
- Check your login shell

```
$ echo $SHELL  
/bin/tcsh
```

- Print the current shell

```
$ ps -p $$  
3463  0  S      0:00.01  tcsh  
$ sh  
$ ps -p $$  
3474  0  S      0:00.00  sh
```

Sample script

- Print "Hello World" 3 times

```
#!/bin/sh
# ^ shebang: tell the system which interpreter to use

for i in `seq 1 3` ; do
    echo "Hello world $i" # the body of the script
done
```

- Output

```
$ chmod +x test.sh # grant execution permission
$ ./test.sh        # execute the script. Must specify the directory(./)
```

Executable script

- Shebang (#!), or called Shabang
 - Sharp (#) + Bang (!)
 - or Hash Bang
 - Specify which interpreter is going to execute this script
 - Many interpreted language uses # as comment indicators
 - The first widely known appearance of this feature was on BSD

Executable script

- Shebang examples
 - `#!/bin/sh`
 - `#!/bin/sh -x`
 - `#!/bin/bash`
 - `#!/usr/local/bin/bash`
 - `#!/usr/bin/env bash`
 - `#!/usr/bin/env python`
- Execution
 - `$ sh test.sh`
 - Can execute without shebang
 - `$ chmod a+x test.sh`
 - `$./test.sh`

Shell variables (1)

- Assignment

	Syntax	Scope
Variable	<code>my=test</code>	Process
Local variable	<code>local my=test</code>	Function
Environment variable	<code>export my</code>	Process and sub-process

- Example

```
$ export PAGER=/usr/bin/less
$ current_month=`date +%m`
$ myFun() { local arg1="$1" }
```


Shell variables (2)

- There are two ways to call variable
 - `$ echo "$PAGER"`
 - `$ echo "${PAGER}"` **<= Why?**
 - Use `{ }` to avoid ambiguity
- Example

```
$ temp_name="haha" && temp="hehe" # No Space Beside "="  
$ echo $temp  
hehe  
$ echo $temp_name  
haha  
$ echo ${temp}_name  
hehe_name  
$ echo ${temp_name}  
haha
```

Quotation marks

Quotes	Description	Example
' '	Single quote, Preserves the literal value of each character within the quotes	\$ echo 'echo \$USER' echo \$USER
" "	Double quote, Parse special character, like: \$ ` \	\$ echo "echo \$USER" echo tsaimh
` `	Back quotes, The stdout of the command	\$ echo `echo \$USER` tsaimh \$ echo now is `date` now is Sat Aug 15 03:56:54 CST 2022

Shell variable operator (1)

- sh(1): Parameter Expansion

Operator	Description
<code>\${var:=value}</code>	If "Bad", use the given value and assign to var.
<code>\${var:+value}</code>	If "Good", use the given value . Otherwise, null is used but not assign to var . => Replace if "Good", not assign to var.
<code>\${var:-value}</code>	If "Good", use the value of var . Otherwise, use the given value but not assign to var . => Replace if "Bad", not assign to var.
<code>\${var:?value}</code>	If "Bad", print given value (stderr) and shell exits (The command stops immediately).

- Good: var is set and is not null.
- Bad: var is not set or the value is null.
 - Bad == not Good

Shell variable operator (2)

- Script

```
#!/bin/sh
var1="haha"
echo "01" ${var1:+ "hehe"}
echo "02" ${var1}
echo "03" ${var2:+ "hehe"}
echo "04" ${var2}
echo "05" ${var1:="hehehe"}
echo "06" ${var1}
echo "07" ${var2:="hehehe"}
echo "08" ${var2}
echo "09" ${var1:- "he"}
echo "10" ${var1}
echo "11" ${var3:- "he"}
echo "12" ${var3}
echo "13" ${var1:? "hoho"}
echo "14" ${var1}
echo "15" ${var3:? "hoho"}
echo "16" ${var3}
```

- Result

```
01 hehe
02 haha
03
04
05 haha
06 haha
07 hehehe
08 hehehe
09 haha
10 haha
11 he
12
13 haha
14 haha
hoho
(program exited)
```

Shell variable operator (3)

Operator	Description	
\${#var}	String <u>length</u>	These operators do not change the value of var
\${var#pattern}	Remove the <u>smallest prefix</u>	
\${var##pattern}	Remove the <u>largest prefix</u>	
\${var%pattern}	Remove the <u>smallest suffix</u>	
\${var%%pattern}	Remove the <u>largest suffix</u>	

● Script

```
#!/bin/sh
var="Nothing happened end closing end"
echo ${#var}
echo ${var#*ing}
echo ${var##*ing}
echo ${var%end*}
echo ${var%%end*}
```

● Result

```
32
happened end closing end
end
Nothing happened end closing
Nothing happened
```

Predefined shell variables

- Environment Variables
- Other useful variables
 - Similar to C program's `"int main(argc, argv)"` – arguments of program
 - e.g. `ls -a ~`

Predefined shell variables

- Example:

- `ls -a ~`

sh	Description
<code>\$#</code>	<u>Number</u> of positional arguments (start from 0)
<code>\$0</code>	Command name (Ex: What command user exec your script)
<code>\$1, \$2, ..</code>	Positional <u>arguments</u>
<code>\$* / \$@</code>	<ul style="list-style-type: none">● List of <u>positional arguments</u> (useful in for loop)● <code>\${*:2}</code> : Get the list of argument after \$2
<code>\$?</code>	<u>Return code</u> from last command
<code>\$\$</code>	<u>Process number</u> of current command (pid)
<code>\$_</code>	<u>Process number</u> of last background command

Usage of \$* and \$@

- The difference between \$* and \$@
 - \$* : all arguments are formed into a long string
 - \$@ : all arguments are formed into separated strings
- Examples: test.sh

```
for i in "$*" ; do
    echo "In loop: $i"
done
```

```
% test.sh 1 2 3
In loop: 1 2 3
```

```
for i in "$@" ; do
    echo "In loop: $i"
done
```

```
% test.sh 1 2 3
In loop: 1
In loop: 2
In loop: 3
```


The "test" command

- Checking file status, string, numbers, etc
- test(1)
 - test expression
 - [expression]
- Test and **return 0 (true) or 1 (false)** in \$?
 - test -e News ; echo \$?
 - If there exist the file named "News"
 - test "haha" = "hehe" ; echo \$?
 - Whether "haha" **equal** "hehe"
 - test 10 -eq 11 ; echo \$?
 - Whether 10 **equal** 11

Test command – File test

- **-e file**
 - True if file exists (regardless of type)
- **-s file**
 - True if file exists and has a size greater than zero
- **-d file**
 - True if file exists and is a directory
- **-f file**
 - True if file exists and is a regular file

Test command – File test

- -L file
 - True if file exists and is a symbolic link
- -r file
 - True if file exists and is readable
- -w file
 - True if file exists and is writable
- -x file
 - True if file exists and is executable

Test command – File test

- `file1 -nt file2`
 - True if file1 exists and is newer than file2
- `file1 -ot file2`
 - True if file1 exists and is older than file2
- `file1 -ef file2`
 - True if file1 and file2 exist and refer to the same file

Test command – String test

- -z string
 - True if the length of string is zero
- -n string
 - True if the length of string is nonzero
- string
 - True if string is not the null string
- s1 = s2 (though some implementation recognize ==)
 - True if the strings s1 and s2 are identical
- s1 != s2
 - True if the strings s1 and s2 are not identical
- s1 < s2
 - True if string s1 comes before s2 based on the **binary value of their characters (lexicographical order)**
- s1 > s2
 - True if string s1 comes after s2 based on the **binary value of their characters**

Test command – Number comparison

- Number comparison with “>”

```
$ test 14 > 123 ; echo $?  
0 # True
```

- The correct way is to use “-gt” (greater-than)

```
$ test 14 -gt 123 ; echo $?  
1 # False
```

Test command – Number test

- `n1 -eq n2` **`==, !=, >, <, >=, <=` fashion does not apply here**
 - True if the integers `n1` and `n2` are algebraically equal
- `n1 -ne n2`
 - True if the integers `n1` and `n2` are not algebraically equal
- `n1 -gt n2`
 - True if the integer `n1` is algebraically greater than the integer `n2`
- `n1 -ge n2`
 - True if the integer `n1` is algebraically greater than or equal to the integer `n2`
- `n1 -lt n2`
 - True if the integer `n1` is algebraically less than the integer `n2`
- `n1 -le n2`
 - True if the integer `n1` is algebraically less than or equal to the integer `n2`

Test Command – Combination

- `! expression`
 - True if expression is false.
 - `$ [! A == B] =>` Test expression, invert the internal result
 - `$! [A == B] =>` Invert the whole test command result
- `expression1 -a expression2`
 - True if both expression1 and expression2 are true.
 - `$ [A == B -a C == D]`
- `expression1 -o expression2`
 - True if either expression1 or expression2 are true.
 - The `-a` operator has higher precedence than the `-o` operator.
 - `$ [A == B -o C == D]`

Test Command – Combination Example

- `! ["A" = "A" -o 1 -eq 1]`
 - false
- `[! "A" = "A" -o 1 -eq 1]`
 - true

Test Command – In Script

- Add space beside = <= != []...
 - \$ [A=B] # error
 - \$ [A=B] # error
 - \$ [A = B] # error
- If the var may be null or may not be set, add ""
 - \$ [\$var = "A"] may be parsed to [= "A"] and cause syntax error!!
 - \$ ["\$var" = "A"] become ["" = "A"]

```
if [ "$var" = "hehe" ] ; then
    echo '$var equals hehe'
else
    echo '$var doesn't equal hehe'
fi
```

expr command (1)

- Another way to combine test results
- AND, OR, NOT (&&, ||, !)

```
[ 1 -eq 2 ] || [ 1 -eq 1 ] ; echo $?  
0  
[ 1 -eq 1 ] || [ 1 -eq 2 ] ; echo $?  
0  
[ 1 -eq 1 ] && [ 1 -eq 2 ] ; echo $?  
1
```

```
[ 1 -eq 2 ] && [ 1 -eq 1 ] ; echo $?  
1  
! [ 1 -eq 2 ] ; echo $?  
0  
[ ! 1 -eq 2 ] ; echo $?  
0
```

expr command (2)

- `$ expr1 && expr2`
 - if `expr1` is false then `expr2` won't be evaluate
- `$ expr1 || expr2`
 - if `expr1` is true then `expr2` won't be evaluate
- Ex:
 - `$ [-e SomeFile] && rm SomeFile`
 - `$ checkSomething || exit 1`

Arithmetic Expansion

```
echo $(( 1 + 2 ))  
a=8  
a=$(( $a + 9 ))  
a=$(( $a + 17 ))  
a=$(( $a + 9453 ))  
echo $a
```

```
3  
// a=8  
// a=17  
// a=34  
// a=9487  
9487
```

if-then-else structure

```
if [ test conditions ] ; then  
    command-list
```

```
elif [ test conditions ] ; then  
    command-list
```

```
else  
    command-list
```

```
fi
```

Or in one line

```
if [ a = a ] ; then echo "Yes" ; else echo "No" ; fi
```

switch-case structure (1)

```
case $var in
    value1)
        action1
    ;;
    value2)
        action2
    ;;
    value3|value4)
        action3
    ;;
    *)
        default-action
    ;;
esac
```

```
case $sshd_enable in
    [Yy][Ee][Ss])
        action1
    ;;
    [Nn][Oo])
        action2
    ;;
    *)
        ???
    ;;
esac
```

For loop

```
for var in var1 var2 ...; do  
    action  
done
```

```
a=""  
for var in `ls`; do  
    a="$a $var"  
done  
echo $a
```

```
for i in A B C D E F G; do  
    mkdir $i;  
done
```


While loop

```
while [ expression ] ; do  
    action
```

```
done
```

```
break
```

```
continue
```

```
while read name ; do  
    echo "Hi $name"
```

```
done
```

Read from `stdin`

```
#!/bin/sh
echo -n "Do you want to 'rm -rf /' (yes/no)? "
read answer # read from stdin and assign to variable
case $answer in
    [Yy][Ee][Ss])
        echo "Hahaha"
        ;;
    [Nn][Oo])
        echo "No~~~"
        ;;
    *)
        echo "removing..."
        ;;
esac
```

Create tmp file/dir

- `TMPDIR=`mktemp -d tmp.XXXXXXX``
- `TMPFILE=`mktemp ${TMPDIR}/tmp.XXXXXXX``
- `echo "program output" >> ${TMPFILE}`

functions (1)

- Define function

```
function_name ( ) {  
    command_list  
}
```

- Removing function definition

```
unset function_name
```

- Function execution

```
function_name
```

- Function definition is local to the current shell
- Define the function before first use

functions (2) - scoping

```
func() {  
    # global variable  
    echo $a  
    a="bar"  
}  
a="foo"  
func  
echo $a
```

```
foo  
bar
```

```
func() {  
    # local variable  
    local a="bar"  
    echo $a  
}  
a="foo"  
func  
echo $a
```

```
bar  
foo
```

functions (3) - arguments check

```
func() {  
    if [ $# -eq 2 ] ; then  
        echo $1 $2  
    else  
        echo "Wrong"  
    fi  
}  
func  
func hi  
func hello world
```

```
Wrong  
Wrong  
hello world
```

functions (4) - return value

```
func() {  
    if [ $# -eq 2 ] ; then  
        return 2  
    else  
        return 0  
    fi  
}  
func  
echo $?  
func hello world  
echo $?
```

```
0  
2
```

Scope

- Local var can only be read and written inside the function.
- Subprocess can **only read** the environment variable, the modification of the variable will **NOT** be effective to the current process. (Subprocess may include some PIPE execution)
- If something wrong, try to print every variable.

```
#!/bin/sh
a=10
export b=20
cat test.sh | while read line; do
    echo "$a $b $line"
    b=$((b+1))
done
echo b is $b
```

test.sh

```
10 20 #!/bin/sh
10 21 a=10
10 22 export b=20
10 23 cat test.sh | while read line; do
10 24 echo "$a $b $line"
10 25 b=$((b+1))
10 26 done
10 27 echo b is $b
b is 20
```


Parsing arguments

- Use getopt

```
#!/bin/sh
echo "Initial OPTIND: $OPTIND"
while getopts abcf: op ; do
    echo "${OPTIND}-th arg"

    case $op in
        a|b|c)
            echo "one of ABC" ;;
        f)
            echo $OPTARG ;;
        *)
            echo "Default" ;;
    esac
done
```

```
$ ./test.sh -a -b -c -f hi
Initial OPTIND: 1
2-th arg
one of ABC
3-th arg
one of ABC
4-th arg
one of ABC
6-th arg
hi
```

- ":" means additional arg.
- \$OPTARG: content of additional arguments
- \$OPTIND: index of the **next** argument
 - Need **manually reset** for the second call

Handling Error Conditions

- Internal error
 - Program crash
 - Failing to perform sub commands
 - Invalid input
 - Syntax error
- External error
 - Signal from OS
 - The system telling you that some system-level event has occurred
 - Ctrl+C
 - SIGINT

Handling Error Conditions – Internal Error

- Example:
 - Handling the errors by yourself

```
#!/bin/sh
UsageString="Usage: $0 -man=val1 -woman=val2"

if [ $# != 2 ] ; then
    echo "$UsageString"
else
    echo "ok!"
    man=`echo $1 | cut -c 6-`
    woman=`echo $2 | cut -c 8-`
    echo "Man is ${man}"
    echo "Woman is ${woman}"
fi
```

program name

How about c but not -c?

Handling Error Conditions – External Error (1)

- Using trap in Bourne shell
 - To handle events like Ctrl+C (SIGINT, signal number is 2)
 - `trap [command-list] [signal-list]`
 - Perform command-list when receiving any signal in signal-list

```
trap "rm tmp*; exit 0" 1 2 3 14 15
trap "" 1 2 3 # Ignore signal 1 2 3
```

Handling Error Conditions – External Error (2)

Catch: perform something when trapped
Block: prevent system actions

#	Name	Description	Default	Catch	Block	Dump Core
1	SIGHUP	Hangup	Terminate	✓	✓	✗
2	SIGINT	Interrupt (^C)	Terminate	✓	✓	✗
3	SIGQUIT	Quit	Terminate	✓	✓	✓
9	SIGKILL	Kill	Terminate	✗	✗	✗
10	SIGBUS	Bus error	Terminate	✓	✓	✓
11	SIGSEGV	Segmentation fault	Terminate	✓	✓	✓
15	SIGTERM	Soft. termination	Terminate	✓	✓	✗
17	SIGSTOP	Stop	Stop	✗	✗	✗
18	SIGTSTP	Stop from tty (^Z)	Stop	✓	✓	✗
19	SIGCONT	Continue after stop	Ignore	✓	✗	✗

Debugging Shell Script

- Debug tools in sh

- Example:

Debug Mode

```
#!/bin/sh -x

var1="haha"
echo "01" ${var1:+ "hehe"}
echo "02" ${var1}
echo "03" ${var2:+ "hehe"}
echo "04" ${var2}
echo "05" ${var1:= "hehehe"}
echo "06" ${var1}
echo "07" ${var2:= "hehehe"}
echo "08" ${var2}
echo "09" ${var1:- "he"}
echo "10" ${var1}
echo "11" ${var3:- "he"}
echo "12" ${var3}
echo "13" ${var1:? "hoho"}
echo "14" ${var1}
echo "15" ${var3:? "hoho"}
echo "16" ${var3}
```

Print out the substitution results

- Result:

```
+ var1=haha
+ echo 01 hehe
01 hehe
+ echo 02 haha
02 haha
+ echo 03
03
+ echo 04
04
+ echo 05 haha
05 haha
+ echo 06 haha
06 haha
+ echo 07 hehehe
07 hehehe
+ echo 08 hehehe
08 hehehe
+ echo 09 haha
09 haha
+ echo 10 haha
10 haha
+ echo 11 he
11 he
+ echo 12
12
+ echo 13 haha
13 haha
+ echo 14 haha
14 haha
hoho
```

ShellCheck

- Find potential bugs in your shell scripts
 - <https://www.shellcheck.net/>
- In FreeBSD
 - devel/hs-ShellCheck
 - pkg install hs-ShellCheck

Regular Expression

Pattern Matching

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Regular Expression (1)

- Informal definition
 - Basis:
 - A single character "a" is a R.E.
 - Hypothesis
 - If r and s are R.E.
 - Inductive
 - Union: $r + s$ is R.E.
 - Ex: $a + b$
 - Concatenation: rs is R.E.
 - Ex: ab
 - Kleene closure: r^* is R.E.
 - Ex: a^*

Regular Expression (2)

- Pattern-matching
 - Special operators

operator	Description
.	Any single character
[]	Any character in []
[^]	Any character not in []
^	<u>start of a line</u>
\$	end of a line
*	zero or more
?	zero or one
+	one or more
{m,n}	At least m times and at most n times
{m,}	At least m times.
{m}	Exactly m times.
\	Escape character

Regular Expression (3)

- Examples

- `r.n`

- Any 3-character string that start with r and end with n

- `r1n`, `rxn`, `r&n` will match

- `r1xn`, `axn` will not match

- `..Z..`

- Any 5-character strings that have Z as 3rd character

- `aeZoo`, `12Zos` will match

- `aeooZ`, `aeZoom` will not match

- `r[a-z]n`

- Any 3-character string that start with r and end with n and the 2nd character is an alphabet

- `rxn` will match

- `r1n`, `r&n` will not match

Regular Expression (4)

- Examples
 - ^John
 - Any string starts with John
 - John Snow -> will match
 - Hi John -> will not match
 - [Ee][Nn][Dd]\$
 - Any string ends with any combination of "end"
 - [A-Za-z0-9]+
 - String of characters

Regular Expression (5)

- Utilities using RE
 - grep
 - awk
 - sed
 - find
- Different tools, different RE
 - BRE (Basic)
 - ERE (Extended)
 - PCRE (Perl Compatible)
 - https://en.wikipedia.org/wiki/Regular_expression#Standards

Advanced scripting

- sed and awk

Details on using sed and awk...

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sed – Stream EDitor (1)

- sed(1)
 - sed -e "command" -e "command"... file
 - sed -f script-file file
 - Sed will (1) read the file line by line and (2) do the commands, then (3) output to stdout
 - e.g. sed -e '1,10d' -e 's/yellow/black/g' yel.dat
- Command format
 - [address1[,address2]]function[argument]
 - From address 1 to address 2
 - Do what action
- Address format
 - n → line number
 - /R.E./ → the line that matches R.E

sed – Stream EDitor (2)

- Address format
 - Example of address format
 - sed -e 10d
 - sed -e /man/d
 - sed -e 10,100d
 - sed -e 10,/man/d
 - Delete line from line 10 to the line contain "man"

sed – Stream Editor

Function: **print** (1)

- **print**
 - Syntax:
 - [addr1, addr2]p
- **Ex:**
 - `sed -n -e '/^tsaimh/p'` # Print out the lines that begins with tsaimh

-n: By default, each line of input is echoed to the standard output after all of the commands have been applied to it. The -n option suppresses this behavior.

sed – Stream Editor

Function: **print** (2)

```
hello  
tsaimh  
world
```

input.txt

- `sed -e '/^tsaimh/p' input.txt`

```
hello  
tsaimh  
tsaimh  
world
```

Output

- `sed -n -e '/^tsaimh/p' input.txt`

```
tsaimh
```

Output

sed – Stream Editor

Function: substitution (1)

- substitution
 - Syntax
 - s/pattern/replace/flags
 - Flags
 - **N**: Make the substitution only for the N'th occurrence
 - g: replace all matches
 - p: print the matched and replaced line
 - w: write the matched and replaced line to a file

sed – Stream Editor

Function: substitution (2)

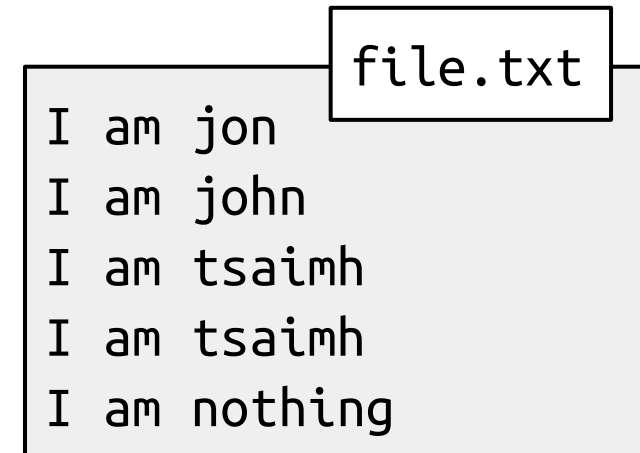
- Example:

- `sed -e 's/tsaimh/TSAIMH/2' file.txt`

```
I am jon  
I am john  
I am tsaimh  
I am tsaimh  
I am tsaimh  
I am nothing
```

- `sed -e 's/tsaimh/TSAIMH/g' file.txt`

```
I am jon  
I am john  
I am TSAIMH  
I am TSAIMH  
I am nothing
```

A diagram showing a file named 'file.txt' with its contents. The file is represented as a light gray rectangle with a black border. The text 'file.txt' is written in a black box at the top right of the rectangle. The contents of the file are listed inside the rectangle:

```
I am jon  
I am john  
I am tsaimh  
I am tsaimh  
I am nothing
```

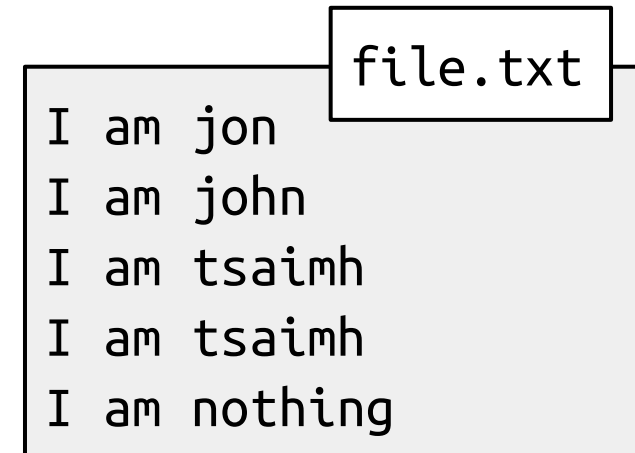
file.txt

sed – Stream Editor

Function: substitution (3)

- Example:

- `sed -e 's/tsaimh/TSAIMH/p' file.txt`
I am jon
I am john
I am tsaimh
I am TSAIMH
I am TSAIMH
I am TSAIMH
I am TSAIMH
I am nothing
- `sed -n -e 's/tsaimh/TSAIMH/p' file.txt`
I am TSAIMH
I am TSAIMH
- `sed -e 's/tsaimh/TSAIMH/w wfile' file.txt`
- `cat wfile`
I am TSAIMH
I am TSAIMH

A diagram showing a file named 'file.txt' with its contents. The file is represented as a light gray rectangle with a black border. A small white box with a black border is attached to the top right corner, containing the text 'file.txt'. The main rectangle contains the following text:

I am jon
I am john
I am tsaimh
I am tsaimh
I am nothing

sed – Stream Editor

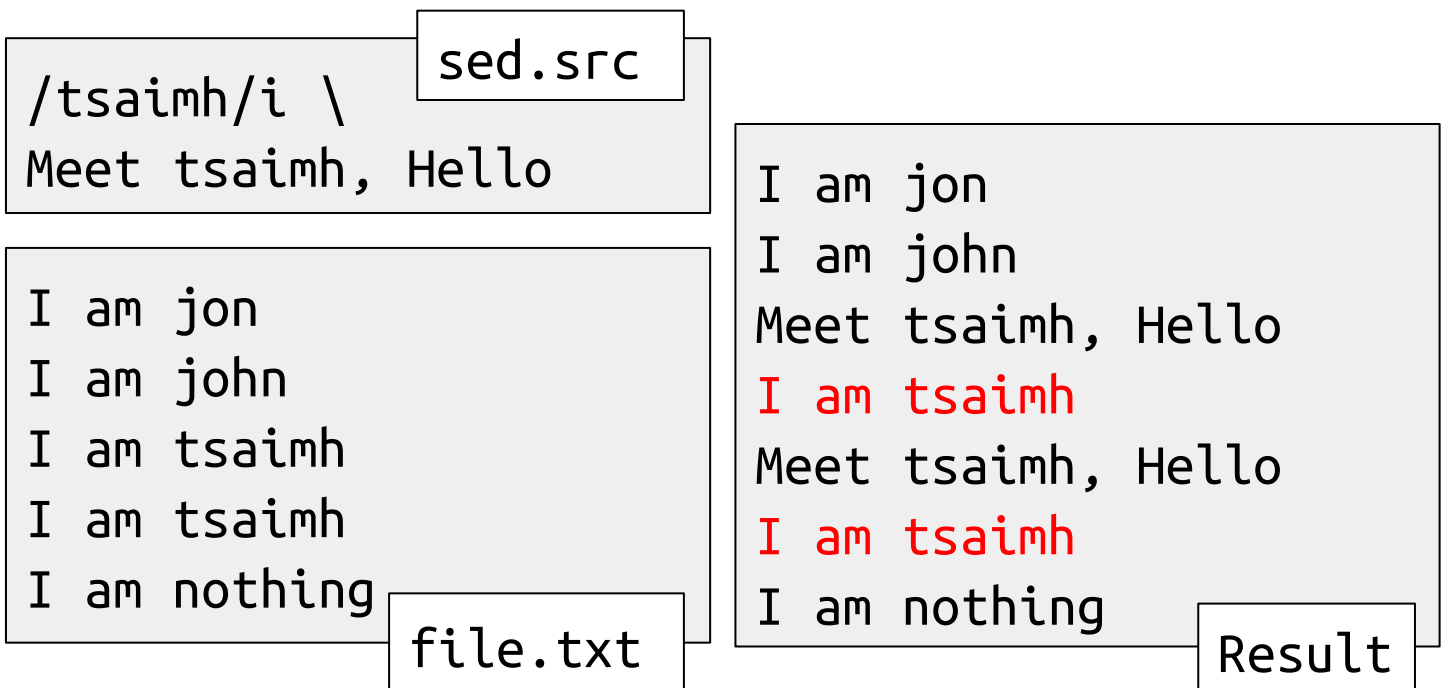
Function: delete

- delete
 - Syntax:
 - [address]d
- Ex:
 - `sed -e 10d`
 - `sed -e /man/d`
 - `sed -e 10,100d`
 - `sed -e 10,/man/d`

sed – Stream EDiTOr

Function: append, insert, change

- Function
 - append
 - append after the line
 - insert
 - insert before the line
 - change
 - replace whole line
- Example:
 - `sed -f sed.src file.txt`



sed – Stream EEditor

Example: split lines into multiple files

- `cat host.txt | sed -e '/cs/w cs_host.txt' -e '/google/w google_host.txt'`

www.google.com
bsd1.cs.nctu.edu.tw
linux3.cs.nctu.edu.tw
store.google.com
cs.nctu.edu.tw

host.txt

bsd1.cs.nctu.edu.tw
linux3.cs.nctu.edu.tw
cs.nctu.edu.tw

cs_host.txt

www.google.com
store.google.com

google_host.txt

awk

- awk(1)

- awk [-F fs] ['awk_program' | -f program_file] [data_file]

- awk will read the file line by line and evaluate the pattern, then do the action if the test is true

- Ex:

- awk '{print "Hello World"}' file

- awk '{print \$1}' file

- Program structure

- pattern { action }

- missing pattern means always matches

- missing { action } means print the line

Amy	32	0800995995	nctu.csie
\$1	\$2	\$3	\$4

awk – Pattern formats

- pattern formats
 - Regular expression
 - `awk '/[0-9]+/ {print "This is an integer" }'`
 - `awk '/[A-Za-z]+/ {print "This is a string" }'`
 - `awk '/^$/ {print "this is a blank line."}'`
 - BEGIN
 - before reading any data
 - `awk ' BEGIN {print "Nice to meet you"}'`
 - END
 - after the last line is read
 - `awk ' END {print "Bye Bye"}'`

awk – action format

- Actions

- Print

- Assignment

- if(expression) statement [; else statement2]

- awk ' { if(\$2 ~ /am/) print \$1 }' file

- while(expression) statement

- awk 'BEGIN {count=0} /tsaimh/ {while (count < 3) {print count;count++}}' file

- awk 'BEGIN {count=0} /tsaimh/ {while (count < 3) {print count;count++;count=0}}' file

variable usage: no need for "\$"

- for (init ; test ; incr) action

- awk '{for (i=0;i<3;i++) print i}' file

reset count after printing

awk – built-in variables (1)

- \$0, \$1, \$2, ...
 - Column variables
- NF
 - Number of fields in current line
- NR
 - Number of line processed
- FILENAME
 - the name of the file being processed
- FS
 - Field separator, set by **-F**
- OFS
 - Output field separator

awk – built-in variables (2)

- Ex:
 - `awk 'BEGIN {FS=":"} /tsaimh/ {print $3}' /etc/passwd`
 - 1002
 - `awk 'BEGIN {FS=":"} /^tsaimh/{print $3 $6}' /etc/passwd`
 - 1002/home/tsaimh
 - `awk 'BEGIN {FS=":"} /^tsaimh/{print $3 " " $6}' /etc/passwd`
 - 1002 /home/tsaimh
 - `awk 'BEGIN {FS=":" ;OFS="==" } /^tsaimh/{print $3 ,$6}' /etc/passwd`
 - 1002==/home/tsaimh

```
tsaimh:*:1002:20:Meng-Hsun Tsai:/home/tsaimh:/bin/tcsh
```

Shell Script Examples

國立陽明交通大學資工系資訊中心

Information Technology Center, Department of Computer Science, NYCU

check alive(1)

- ping

```
$ /sbin/ping -c 3 bsd1.cs.nctu.edu.tw
```

```
PING bsd1.cs.nctu.edu.tw (140.113.235.131): 56 data bytes
```

```
64 bytes from 140.113.235.131: icmp_seq=0 ttl=64 time=0.044 ms
```

```
64 bytes from 140.113.235.131: icmp_seq=1 ttl=64 time=0.068 ms
```

```
64 bytes from 140.113.235.131: icmp_seq=2 ttl=64 time=0.056 ms
```

```
--- bsd1.cs.nctu.edu.tw ping statistics ---
```

```
3 packets transmitted, 3 packets received, 0.0% packet loss
```

```
round-trip min/avg/max/stddev = 0.044/0.056/0.068/0.010 ms
```

check alive(2)

```
#!/bin/sh
# [Usage] isAlive.sh bsd1.cs.nctu.edu.tw
```

```
Usage="[Usage] $0 host"
temp="$1.ping"
Admin="tsaimh fs"
count="3"
```

```
if [ $# != 1 ] ; then
    echo $Usage
else
```

default 10 times

```
/sbin/ping -c ${count:=10} $1 | /usr/bin/grep 'transmitted' > $temp
Lost=`awk -F" " '{print $7}' $temp | awk -F"." '{print $1}' `
```

Grep "tran..."
write to the temp file

```
if [ ${Lost:=0} -ge 50 ] ; then
    mail -s "$1 failed" $Admin < $temp
fi
/bin/rm $temp
fi
```

Mail and del. \$temp

- awk on \$temp using space as delimiter
- How many % packet loss?

Reference

- [awk\(1\)](#)
- [sed\(1\)](#)
- <http://www.grymoire.com/Unix/Awk.html>
- <http://www.grymoire.com/Unix/Sed.html>
- https://en.wikipedia.org/wiki/Regular_expression