11 – Advanced Bash Scripting

CS 2043: Unix Tools and Scripting, Spring 2019 [3]

Matthew Milano

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Cornell University

Table of Contents

As always: Everybody! ssh to wash.cs.cornell.edu

- Quiz time! Everybody! run `quiz-02-15-19`
- You can just explain a concept from last class, doesn't have to be a command this time.
- NOTE: demos for this lecture: `/course/cs2043/demos/11-demos`
    - the leading `/` is important!

More on Conditions

Case

- Just like a switch statement in other languages, only better.
- Does not carry on to all cases if you forget that **break** keyword.

```
case "$var" in
  "A" )
      cmds to execute for case "A"
      ;;
  "B" )
      cmds to execute for case "B"
      ;;
  * )
      cmds for DEFAULT (not matched) case
      ;;
```

- Sort of like shorthand for **if-elif-else** statements...
- ...only not quite the same!

Simple If and Case Examples

- Make a simple program to print between 0 and 2 **blarghs**
- Input is **$1**, explicit check not necessary (**else** or ***)** case)

```
#! /usr/bin/env bash
#
# (empty to fill space in minted)
# (empty to fill space in minted)
# (empty to fill space in minted)
#
if [[ "$1" == "0" ]]; then
    echo "0 blargh echoes..."
elif [[ "$1" == "1" ]]; then
    echo "1 blargh echoes..."
    echo " [1] blargh"
# number or string
elif [[ "$1" -eq 2 ]]; then
    echo "2 blargh echoes..."
    echo " [1] blargh"
    echo " [2] blargh"
else
    echo "Blarghs come in [0-2]."
    exit 1
fi
```

Demo file **simple/if.sh**.

```
#! /usr/bin/env bash
case "$1" in
    "0" )
        echo "0 blargh echoes..."
        ;;
    "1" )
        echo "1 blargh echoes..."
        echo " [1] blargh"
        ;;
    # number or string
    2 )
        echo "2 blargh echoes..."
        echo " [1] blargh"
        echo " [2] blargh"
        ;;
    * )
        echo "Blarghs come in [0-2]."
        exit 1
        ;;
esac
```

Demo file **simple/case.sh**.

Difference Between Case and If Comparisons

- The matching strategy is different for **`case`** than **`if`**.
- By default, **`case`** statements are comparing *patterns*.
  - Note that a single value e.g., `"A"` is just an explicit *pattern*.
  - Patterns are **NOT** regular expressions! Refer to [1].
- By default, **`if`** statements are comparing values.
  - To use *extended regular expresions* in **`if`** statements, you need to use the **`=~`** operator.
  - Use **`[[ double bracket expressions ]]`** for extended regular expressions in **`if`**
  - The **`=~`** operator not available for *all* `bash < 4.0`. Check `man bash` and search for `=~`.
    - Recall: after `man bash`, type `/expr` and hit `<enter>` to search. So type `/=~` and hit `<enter>`.
    - Cycle through results with `n` for next search result.

Using Sets with Case

- See demo file `sets/case.sh`.

```
#!/usr/bin/env bash
case "$1" in
    [[:digit:]] )
        echo "$1 blargh echoes..."
        for (( i = 1; i <= $1; i++ )); do
            echo " [$i] blargh"
        done
        ;;
    * )
        echo "Blarghs only come in [0-9]."
        exit 1
        ;;
esac
```

- Works on inputs `0-9`, as well as exit for everything else.
- Will **not** match `11` (sets only match one character, see [1]).
- So `*)` being **last** is *equivalent* to **`default`** in other languages
    - But only if `*  )` is *actually* last!

Using Sets with If Part 1

- See demo file `sets/if.sh`.

```
#!/usr/bin/env bash
if [[ "$1" =~ [[:digit:]] ]]; then
    echo "$1 blargh echoes..."
    for (( i = 1; i <= $1; i++ )); do
        echo " [$i] blargh"
    done
else
    echo "Blarghs only come in [0-9]."
    exit 1
fi
```

- Works on `[0-9]`.
- Cool! Works on `99`.
- Whoops! Works on `208a` – the `for` loop crashes!

Using Sets with If Part 2

- Option 1: negate a negation (read: *if not "not a number"*):

```
# +-----------+  +-----------------+
# | Negate if |  | Negate (invert) |
# | match     |  | set             |
# +-----------+  +-----------------+
#     |            |
if [[ ! "$1" =~ [^[:digit:]] ]]; then
```

- Option 2: use a complete *extended regular expression pattern*:

```
#   +----------------------+
#   | ^: beginning of line |
#   +----------------------+
#              |
if [[ "$1" =~ ^[[:digit:]]+$ ]]; then
# +--------------------+  ||  +------------------------+
# | +: 1 or more digit |--++--| $ matches end of line |
# +--------------------+      +------------------------+
```

Using Sets with If Part 3 (We're Finsihed, Right?!)

- The last example felt pretty bullet-proof, what can go wrong?
- Using demo file `eregex/if.sh`:

```
$ ./if.sh 08
./if.sh: line 4: ((: i <= 08: value too great for base
    (error token is "08")
```

- This is because of the leading **0** — `bash` treats this as *octal*:

```
$ ./if.sh 0111
0111 blargh echos...
  [1] blargh
  [2] blargh
  ...
  [72] blargh
  [73] blargh
```

- For now, we'll happily ignore this.

Bash Arrays

Bash Arrays

- Arrays in **bash** are extraordinarily flexible in some senses...
- ...and particularly fickle in other senses.
- Short version:

```
arr=( use parentheses and separate items by spaces )
```

- Mixed "types": `my_arr=( "a string" 1 twelve "33" )`
- Question: what are the types of **twelve** and "33"
  - **twelve** would be interpreted as a **string**.
  - "33" can be either a **string** or a number!
  - **bash** doesn't really have a "type system".

```
my_arr=( "a string" 1 twelve "33" )
echo "Index '3' with '44' added: $(( ${my_arr[3]} + 44 ))"
# Prints:
# Index '3' with '44' added: 77
```

Citation Matters!

- The majority of the remaining examples are either copied or modified from [2].
  - A truly excellent resource, worth reading on your own!
  - We do not have time to cover all of the cool and obscure things you can do with arrays.
- We'll be going through chunks of demo file `slide_arrays.sh`.

Alternative Initialization

- `arr=( parentheses enumerations )` gives indices in range `0`, up to *but not including* `length` of array.
- Custom indices are allowed!

```
arr[11]=11
arr[22]=22
arr[33]=33
arr[51]="a string value"
arr[52]="different string value"
```

- Indices do **not** need to be integers:

```
some_array=( zero one two ) # Indices: 0, 1, 2
some_array[11]=11           # Indices: 0, 1, 2, 11
some_array["hi"]="there"    # Indices: 0, 1, 2, 11, "hi"
```

- You **cannot** have an `array` of `array`s.

Array Functions

- You perform an `array` operation with `${expr}`
  - Works on non-arrays too; mandatory for arrays
- You use the name of the variable followed by the operation:

```
echo "Index 11: ${arr[11]}" # prints: Index 11: 11
echo "Index 51: ${arr[51]}" # prints: Index 51: a string value
echo "Index 0: ${arr[0]}"   # DOES NOT EXIST! (aka nothing)
```

- Like loops, `@` and * expand differently:

```
echo "Individual: ${arr[@]}"
# Individual: 11 22 33 a string value different string value
echo "Joined::::: ${arr[*]}"
# Joined::::: 11 22 33 a string value different string value
```

- Differently how?

```
echo "Length of Individual: ${#arr[@]}"
# Length of Individual: 5
echo "Length of Joined::::: ${#arr[*]}"
# Length of Joined::::: 5
```

Differently HOW?!!!

- Easier to compare with loops
  - Remember that `;` allows you to continue on the same line.
- Individual expansion (@):

```
for x in "${arr[@]}"; do echo "$x"; done
# 11
# 22
# 33
# a string value
# different string value
```

- Joined expansion (*):

```
for x in "${arr[*]}"; do echo "$x"; done
# 11 22 33 a string value different string value
```

- The * loop only executes once (everything is *globbed* together).
- The @ loop iterates over each element in the array.

Even More Initialization Options

- Evaluate expressions and initialize at once:

```
arr[44]=$((arr[11] + arr[33]))
echo "Index 44: ${arr[44]}"    # Index 44: 44
arr[55]=$((arr[11] + arr[44]))
echo "Index 55: ${arr[55]}"    # Index 55: 55
```

- Alternative index specifications:

```
new_arr=([17]="seventeen" [24]="twenty-four")
new_arr[99]="ninety nine" # may as well, not new
for x in "${new_arr[@]}"; do echo "$x"; done
# seventeen
# twenty-four
# ninety nine
```

- Get the list of indices:

```
for idx in "${!new_arr[@]}"; do echo "$idx"; done
# 17
# 24
# 99
```

Array Slicing

- You can just as easily *slice* your arrays.
- Use `@` to get whole array, then specify indices to *slice*
  - Syntax: `${array_var[@]:start_index:slice_size}`
  - If `end index` is not specified, takes until last index

```
zed=( zero one two three four )
echo "From start: ${zed[@]:0}"
# From start: zero one two three four
echo "From 2: ${zed[@]:2}"
# From 2: two three four
echo "Indices [2-4]: ${zed[@]:2:3}"
# Indices [2-4]: two three four
for x in "${zed[@]:2:3}"; do echo "$x"; done
# two
# three
# four
for x in "${zed[*]:2:3}"; do echo "$x"; done
# two three four
```

More...

- This was a *small subset* of what can be done with **`bash`** arrays.
- I highly suggest you go through the examples listed in [2] in.
    - Search for **`Substring Removal`** for some insanely cool tricks!

Bash functions and local variables

can define *functions* in bash

declare a new function (bash builtin)

```
function <name> {
body...
}
```

line breaks are essential!

```
function hello {
  echo "hello world!"
}
```

- functions take arguments, just like scripts!
  - arguments to script are hidden within the function

```
function print_an_arg {
  echo "$*"
}
```

Variables defined in functions

- Reminder: *environment* variables inherited by sub-scripts
- Reminder: *local* variables only in current script
- Variables defined in functions are visible outside!

```
function define_a_variable {
  x='words!'
}
define_a_variable
echo $x
#prints words!
```

- invoke a function just like a command

Very-local variables

- the `local` keyword keeps variables within the function only
  - a terrible name; `local` variables and "local" (as in not environment) variables are different.
- *opposite* of **`global`** keyword in python

```
function define_a_variable {
  local x='words!'
}
define_a_variable
echo $x
#prints nothing
```

References

[1] Bash Reference Manual. *Bash Reference Manual: Pattern Matching*. 2017. URL: http://www.gnu.org/software/bash/manual/bashref.html#Pattern-Matching.

[2] Bash Reference Manual. *Bash Reference Manual: Shell Parameter Expansion*. 2017. URL: https://www.gnu.org/software/bash/manual/html_node/Shell-Parameter-Expansion.html.

[3] Stephen McDowell, Bruno Abrahao, Hussam Abu-Libdeh, Nicolas Savva, David Slater, and others over the years. “Previous Cornell CS 2043 Course Slides”.