CS2043 - Unix Tools & Scripting
Lecture 11
`awk` and `gawk`

Spring 2015 [1]

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[1] based on slides by Hussam Abu-Libdeh, Bruno Abrahao and David Slater over the years

Announcements

- A3 (due 02/20)
- February break (No Monday lecture 02/16)
- OH resume on Wednesday

AWK introduction

- `AWK` is a programming language designed for processing text-based data
    - allows us to easily operate on fields rather than full lines
    - works in a *pattern-action* matter, like `sed`
    - supports numerical types (and operations) and control flow (`if-else` statements)
    - extensively uses string types and associative arrays
- Created at Bell Labs in the 1970s
    - by Alfred Aho, Peter Weinberger, and Brian Kernighan
- An ancestor of `Perl`
    - and a cousin of `sed` :-P
- Very powerful
    - actually *Turing Complete*

gawk

- gawk is the GNU implementation of the AWK programming language. On BSD/OS X the command is called awk.
- AWK allows us to setup filters to handle text as easily as numbers (and much more)
- The basic structure of a awk program is

```
pattern1 { commands }
pattern2 { commands }
...
```

- patterns can be regular expressions! Gawk goes line by line, checking each pattern one by one and if it's found, it performs the command.

Why gawk and not sed

- convenient numerical processing
- variables and control flow in the actions
- convenient way of accessing fields within lines
- flexible printing
- built-in arithmetic and string functions

Simple Examples

```
gawk '/[Mm]onster/ {print}' Frankenstein.txt
gawk '/[Mm]onster/' Frankenstein.txt
gawk '/[Mm]onster/ {print $0}' Frankenstein.txt
```

- All print lines of Frankenstein containing the word Monster or monster.
- If you do not specify an action, gawk will default to printing the line.
- $0 refers to the whole line.
- gawk understands **extended** regular expressions, so we do not need to escape +, ? etc

Begin and End

- Gawk allows blocks of code to be executed only once, at the beginning or the end.

```
gawk 'BEGIN {print "Starting search for a monster"}
     /[Mm]onster/ { count++}
END {print "Found " count " monsters in the book!}
' Frankenstein.txt
```

- gawk does not require variables to be initialized
- integer variables automatically initialized to 0, strings to "".

gawk and input fields

The real power of gawk is its ability to automatically separate each input line into fields, each referred to by a number.

```
gawk '
BEGIN {print "Beginning operation"; myval = 0}
/debt/ { myval -= $1}
/asset/ { myval += $1}
END { print myval}' infile
```

- $0 refers to the whole line
- $1, $2, ... $9, $(10) ... refer to each field
- The default Field Separator (FS) is white space.

gawk gawk gawk

- If no pattern is given, the code is executed for every line

```
gawk ' {print $3 }' infile
```

Prints the third field/word on every line.

Other gawk variables

- NF - # of fields in the current line
- NR - # of lines read so far
- FILENAME - the name of the input file

```
gawk '{for (i=1;i<=NF;i++) print $i }' infile
```

Prints all words in a file

- You **cannot** change NF or NR.

Simulation

Let's implement `wc -l` in awk!

The field separator

- FS - The field separator
- Default is " "

```
gawk 'BEGIN { FS = ","} {print $2 }' infile
```

- `gawk -F:` also allows us to set the field separator

Matching and gawk

gawk can match any of the following pattern types:

- /regular expression/
- relational expression
- exp && exp
- exp || exp
- condition ? statement1 : statement2 - if condition, then statement1, else statement2
- ! exp
- and more...

Relational Operators 2/2

```
gawk '($1 > .5){print $2 }' infile
```

Other relational operators

- `<, <=, >, >=, !=, ==`

Matching and gawk

gawk can match any of the following pattern types:

- /regular expression/
- relational expression
- pattern && pattern
- pattern || pattern
- patern1 ? pattern2 : pattern3 - if pattern1, then match pattern2, if not then match pattern3
- (pattern) - to change order of operations
- ! pattern
- pattern1, pattern2 - match pattern1, work on everyline until it matches pattern2 (cannot combine this one)

The field separator revisited

- FS - The field separator
- Default is " "

```
gawk 'BEGIN { FS = ":"}
toupper($1) ~ /FOO/ {print $2 } ' infile
```

- `gawk -F:` also allows us to set the field separator
- `toupper()`, `tolower()` - built in functions
- ~ - gawk matching command
- !~ - gawk not matching command

Other gawk functions

- `exp(x)` : exponential of x
- `rand()` : produces a random number between 0 and 1
- `length(x)` : returns the length of x
- `log(x)` : returns the log of x
- `sin(x)` : returns the sin of x
- `int(x)` : returns the integer part of x

What type of code can I use in gawk?

gawk coding is very similar to programming in c

- `for(i = ini; i <= end; increment i)` {`code`}
- `if (condition)` {`code`}
  (In both cases the { } can be removed if only one command is executed)
- and so on. See the gawk manual for more

www.gnu.org/software/gawk/manual

Variables and Associative Arrays

- gawk handles variable conversion automatically

`total = 2 + "3"` assigns 5

- Arrays are automatically created and resized
- Arrays are "associative", meaning the index can be any string:

`array["txt"] = value`
`array[50]` is equivalent to `array["50"]`.

Variables

- gawk handles variable conversion automatically

```
total = 2 + "3" // assigns 5

total++ // total = total + 1

++total // returns current value, then total = total + 1

line = "foo" "bar" // concatenates two strings

line = var "bar" // concatenates the contents of var with bar
```

Variables

Operators

- ++ Add 1 to variable.
- -- Subtract 1 from variable.
- += Assign result of addition.
- -= Assign result of subtraction.
- *= Assign result of multiplication.
- /= Assign result of division.
- %= Assign result of modulo.
- **= Assign result of exponentiation

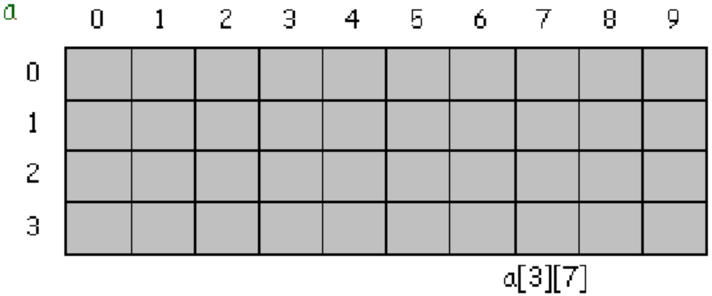
Another gawk function

- `substr(string, beg[, len])` : Return substring of string at beginning position beg (counting from 1), and the characters that follow to maximum specified length len. If no length is given, use the rest of the string.

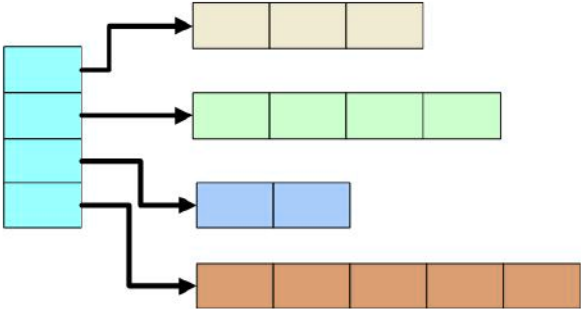
Fake Multidimensional Arrays!

```
array[key1, key2, ...]
```

This is not what AWK is doing



This is not what AWK is doing either



Fake Multidimensional Arrays!

```
array[3, 6]
```

- Multidimensional subscripts are individual strings concatenated.
- "3" and "6" in the example are concatenated together separated by the value of the system variable `SUBSEP`

Associative Arrays

`(key,value)` addition

- Arrays are automatically created and resized
- "associative" means that the index can be any string:

`array["txt"] = value`
`array[50]` is equivalent to `array["50"]`.

Associative Arrays

`(key,value)` modification

```
array["txt"]++
array["txt"]+= $1
array["txt"]+= $1 "bar"
```

Associative Arrays

`(key,value)` lookup

```
print array["txt"]
array["txt"]= array["txt"] "bar"
```

Associative Arrays

`(key,value)` deletion

```
delete array["txt"]
```

Array functions

The following are very helpful:

```
if (someValue in theArray) {
    action to take if somevalue is in theArray
} else {
    an alternate action if it is not present
}

for (i in theArray) print i
```

gawk examples

```
gawk ' {
     for(i=1;i<=NF;i++){
          for(j=length($i);j>0;j--) {
               char = substr($i,j,1)
               tmp = tmp char
          }
          $i = tmp
          tmp = ""


     } print
} ' infile
```

- Inverts all strings in the file

Associative Array Example

Suppose we have an iou file of the following form:

```
Who owes me what as of today
Name \tab Amount
Name \tab Amount
⋮
```

Lets write a gawk script to add up how much everyone owes us

Associative Array Example

```
gawk '
     BEGIN {FS = "\t" }
     NR > 1 { Names[$1]+=$2 }
     END { for(i in Names) print i " owes me " Names[i] " Dollars."}
' ioufile
```

(Can you spot the error?)

Formatter Printing

```
printf("Hello World\n")
```

```
printf("%d\t\%s\n", $5, $9)
```

where

- `%d`: decimal integer
- `%s`: string
- `\t`: tab
- `\n`: new line

Split

```
n = split(string, array, separator)
```

- Splits fields of `string` separated by `separator` and places them into `array`.
- `n` is the resulting number of fields
- default separator is whitespace

Tests

```
if ((i, j) in array)
```

- This tests whether the key i SUBSEP j exists in the array.

That makes life a little harder!

```
for (item in array)
```

- Each item has the form `i SUBSEP j`
- You must use `split()` to extract individual subscript components.

```
n= split(item, subscr, SUBSEP)

subscr[1] # first component
subscr[2] # second component
...
subscr[n] # n-th component
```

Length of an Array

- `awk 'BEGIN {A= "Ithaca is Gorges";print length(A)}'`

  prints "16"

- `awk 'BEGIN {split("Ithaca is Gorges",A);print length(A)}'`

  prints "3"

Last words on gawk

We have only touched on the very basic things you can do with gawk to give you a taste

Check the website for much more:

www.gnu.org/software/gawk/manual

Next Time

Reminder

No lecture on Monday
Have a good February break!