12 – Awk / Gawk

CS 2043: Unix Tools and Scripting, Spring 2019 [1]

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

- Quiz time! Everybody! run `quiz-02-18-19`
- 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/12-demos`
    - the leading `/` is important!

AWK / GAWK

awk Introduction

- **awk** is a programming language designed for processing text-based data.
  - Allows easy operation on fields rather than full lines.
  - Works in a *pattern-action* manner, like `sed`.
  - Supports numerical types (and operations).
  - Supports control-flow (e.g., `if` - `else` statements).
- Created at Bell Labs in the 1970s.
  - Alfred **A**ho, Peter **W**einberger, and Brian **K**ernighan
  - An ancestor of `perl`, a *cousin* of `sed`.
  - **K**ernighan and **R**itchie also invent C
- **Very** powerful.
  - It's *Turing Complete*!
  - ... a lot of things are.

gawk

- **gawk** is the GNU implementation of the **awk** programming language.
- On BSD/OSX, it is just called **awk**.
- On GNU, it is technically **gawk**, but should reliably be *symlinked* as **awk**.
- There are many different implementations of the AWK programming language.
    - If you use C or C++, this is similar to how there are different compilers. The compiler is an "implementation" of the language (big quotes on that...).
    - If you use Python, it's like the difference between CPython, PyPy, Jython, etc.
    - Different implementations of the same programming language.

Basic Structure

- `awk` allows filters to handle text easily.
- The basic structure of an `awk` program is:

```
pattern1 { commands1 }
pattern2 { commands2 }
# ...
```

- Patterns can be regular expressions!
  - Proceeds line by line, checking each pattern one by one.
  - If the pattern is found, the `{ commands }` are executed.
  - So for the above:
    - First line of input grabbed.
    - `pattern1` checked, if match `{ commands1 }` executed.
    - `pattern2` checked, if match `{ commands2 }` executed.
    - Next line of input grabbed.
    - Check `pattern1`, then `pattern2`, so on and so forth...

Why use **awk** over **sed**?

- Processing numerical values in **awk** is much more convenient.
- Variables and control flow in the actions.
- Convenient way of accessing fields within a given line.
- Flexible printing.
- Built-in arithmetic and string functions.
- Traditionally, **awk** has been used a lot in the scientific community e.g., biologists would use **awk** as a way of processing data and creating new table entries or something.
    - Basically, **awk** used to be the only real good *and* convenient option to process a large amount of data while still needing to perform mathematical computations or transformations.
    - These days there are many other options, but if you join a lab you may very well find some **awk** scripts creeping around and need to maintain them.

Simple Examples

- Print all lines containing Monster or monster.

```
awk '/[Mm]onster/ {print}' frankenstein.txt
```

- If no action specified, default is to print the whole line.

```
awk '/[Mm]onster/' frankenstein.txt
```

- The **$0** variable in **awk** refers to the whole line.

```
awk '/[Mm]onster/ {print $0}' frankenstein.txt
```

- First field (delimited by whitespace, or change *field separator*).

```
awk '/[Mm]onster/ {print $1}' frankenstein.txt
```

- **awk** understands extended regular expressions by default :)
  - We don't need to escape **+**, **?**, etc!

awk Shebang and **BEGIN** / **END**

- **awk** allows us blocks of code to be executed only once, at the beginning / end.
- With demo file `monstrosity.awk` and data file `frankenstein.txt` in current directory:

```
#!/usr/bin/awk -f
BEGIN { print "Starting search for monster..." }
/[Mm]onster/{ count++ } # Increment if [Mm]onster found
END { print "Found " count " monsters in the book." }
```

- Use the `-f` in the shebang to tell **awk** it expects a script.

```
$ ./monstrosity.awk  # hangs... no input file
$ ./monstrosity.awk frankenstein.txt # yay!
# shebang '#!/usr/bin/awk -f' makes same as ...
$ awk -f monstrosity.awk frankenstein.txt
```

Using Variables in **awk**

- words are *variables by default*
  - opposite of `bash`, where words are strings by default
  - `word` is a variable (`$word` works too)
- actions separated by semicolon
  - `{x = 0; y = 3; z = x + y; print z}`
- Not particularly whitespace sensitive!

Important Variables

- `NF`: the number of fields in the current line.
- `NR`: the number of lines read so far.
  - You cannot change `NF` or `NR`
- `FILENAME`: the name of the input file.
- `FS`: the *field separator*.
  - Example: change `FS=","` for processing a comma-separated-value sheet.
  - Can also specify `-F` flag (capital!) to set the `FS`.

Pattern Matching with **awk**

- `awk` can match any of the following pattern types:
  - `/regular expression/`
  - `relational expression`
  - `pattern1 && pattern2`
  - `pattern1 || pattern2`
  - `pattern1 ? pattern2: pattern3`
    - If `pattern1`, then match `pattern2`. Otherwise, match `pattern3`
  - `(pattern)`: parenthesis to group / change order of operations.
  - `! pattern` to invert `pattern`
  - `pattern1, pattern2`: match `pattern1`, work on every line until matches `pattern2`
    - So you cannot combine this...

Match action in (match) action

- there are *many* match-action programming languages.
  - sed
  - iptables
  - firewalls
  - datalog/prolog
- usually has *precedence*
  - take first match, like `case`.
- awk does **not** have precedence

Much Much More...

- Regular expression usage / comparison available here.
- Many more comparison operations detailed here.
- A wealth of useful / powerful built-in functions:
  - **`toupper(x)`**: make string upper case
  - **`tolower(x)`**: make string lower case
  - **`exp(x)`**: exponential of `x`
  - **`rand()`**: random number between **`0`** and **`1`**
  - **`length(x)`**: the length of `x`
  - **`log(x)`**: returns the log of `x`
  - **`sin(x)`**: returns the sine of `x`
  - **`cos(x)`**: returns the cosine of `x`
  - **`int(x)`**: convert
  - etc.
- Much more information available here.

More about the filesystem

Inode the ultimate

- a data structure in a Unix-style file system that describes a file-system object such as a file or a directory.
- stores the attributes and disk block location(s) of the object's data.
- attributes may include metadata
    - (times of last change, access, modification)
    - owner and permission data.
- Directories are lists of names assigned to inodes.
- A directory contains an entry for itself, its parent, and each of its children.
- This was **all** cribbed straight from wikipedia. Go look!

Links in the filesystem

- When and `inode` for an object is in a directory, we say it's been **linked** into the filesystem tree
- the `ln` command makes and manages links.

link a filesystem obejct into the directory tree

```
ln [flags] <source> <target>
```

- works like `cp`; from `src` to `dst`
- creates a *peer* link; no notion of "original"
- only works on files

Symlinks in the filesystem

- A “soft” link or “symbolic” link isn’t a link at all
- works like a “shortcut” (really a `junction`) on Windows
- just a special file that contains a path in it
- looks light-blue under `ls`
    - you’ve seeen this before!

symlink a filesystem obejct into the directory tree

```
ln -s [flags] <source> <target>
```

- technically the same command as `ln`, but used very differently with the -s flag!
- creates a *subordinate* link; refers to the path.
- doesn’t check to see if the source path was sensible first!
- works on files or directories.

References

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