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by NUS Hackers

Hacker Tools: Part 1

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Where are we?

Introduction

Shell and Scripting

Data Wrangling

Conclusion

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Friday **Hacks**

Hack & Roll

NUS **Hacker**space

About Me

Hi! I'm Julius. My GitHub is `https://github.com/indocomsoft`

A Year 2 Computer Science Undergraduate who loves hacking and building systems.

I also enjoy Space Exploration, Music Theory and History.

(my favourite games are KSP and EU4 hit me up if you play those too)

About This Workshop

- No prior knowledge assumed
- Learning how to make the most of tools that productive programmers use.
- How to hack on Unix-like environment.

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Required Software

Unix-like environment, either one of these:

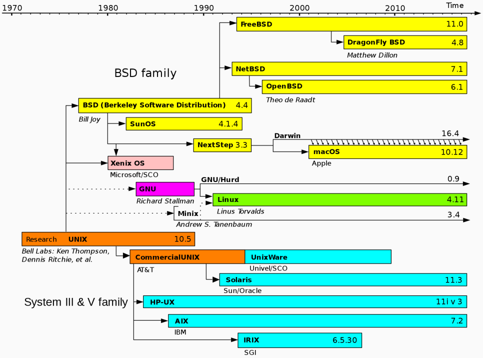
- Linux[1]
- macOS[2]
- BSD
- Other Unix-like OS'es (Minix, Solaris, AIX, HP-UX, etc.)

[1] For beginners, Ubuntu is recommended. Either dual-boot or install as virtual machine using VirtualBox

[2] Open Terminal, and run `xcode-select --install` first

Unix? Can I eat that?

- A family of multitasking, multiuser OS'es.
- First developed in the 1970's.
- Popularised the use of interactive command line.



The Unix Philosophy

1. Write programs that do one thing and do it well.
2. Write programs to work together.
3. Write programs to handle text streams, because that is a universal interface.

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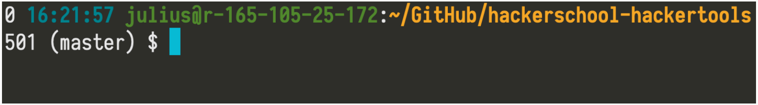
Introduction to Shell

- An efficient, textual interface to your computer.
- Provides an interactive programming language ("scripting").
- Many shells to choose from:
  - Standard ones: `sh` or `bash`
  - Shells that match languages: `csh`
  - "Better" shells: `fish`, `zsh`, `ksh`
- For this workshop, the focus is on the ubiquitous `sh` and `bash`.[3]

[3] Feel free to explore other shells. On macOS, many people prefer `fish` or `zsh`

The Shell Prompt

- What greets you when you open a terminal.



```
0 16:21:57 julius@r-165-105-25-172:~/GitHub/hackerschool-hackertools
501 (master) $
```

- Lets your run programmes and commands.
- Determined by the variable PS1. For example,

```
export PS1='> '
```

Common Commands

- `man` to get the **man**ual pages of a command
- `cd` to **c**hange **d**irectory
- `ls` to **l**i**s**t files and directories
- `mkdir` to **m**a**k**e **dir**ectory
- `rm` to **re**mo**v**e files and directories
- `cp` to **c**o**p**y file
- `mv` to **m**o**v**e file

Command Editing Shortcuts

`bash` has shortcuts based on `emacs` keybindings:

- Ctrl + a: beginning of line
- Ctrl + e: end of line
- Alt + b: move back one word
- Alt + f: move forward one word
- Ctrl + k: delete from cursor to the end of line

And some special ones:

- Ctrl + u: delete from cursor to the start of line
- Ctrl + w: delete from cursor to start of word

Command Control Shortcuts

- Ctrl + c: terminates the command
- Ctrl + z: suspends the command (`fg` to continue)
- Ctrl + l: clears the screen
- Ctrl + s: stops the output to the screen
- Ctrl + q: allows output to the screen

Script (1/2)

You can write programs directly at the prompt, or write into a file (writing scripts)

```sh
#!/bin/sh
echo something
```

- Open an editor (for beginner, `nano` is recommended), save the script as `example-script`
- On your shell, run `chmod +x example-script`
- You can run your script as `./example-script`

Script (2/2)

```
#!/bin/sh
echo something
```

Magic?

- `#!/bin/sh` is also known as the **shebang**, specifies the interpreter[4]
- `echo` is a command that prints its arguments to the standard output.

[4] You can use other interpreters too, e.g. `#!/usr/bin/env python` for a python script.

Flags (1/3)

- Most command line utilities take parameters using **flags**.
- They come in short form (`-h`) and long form (`--help`)
- Usually, running `COMMAND -h` or `man COMMAND` will give you a list of the flags the program takes.
- Short flags can be combined: `rm -r -f` is equivalent to `rm -rf` or `rm -fr`

Flags (2/3)

- A double dash `--` is used in to signify the end of command options, after which only positional parameters are accepted.
    - For example, to create a file called `-v`, Use `touch -- -v` instead of `touch -v`
    - For example, to grep a file called `-v`, `grep pattern -- -v` will work while `grep pattern -v` will not.

Flags (3/3)

Some common flags are a de facto standard:

- `-a` commonly refers to all files (i.e. also including those that start with a period[5])
- `-f` usually refers to forcing something, e.g. `rm -f`
- `-h` displays the help for most commands
- `-v` usually enables a verbose output
- `-V` usually prints the version of the command

[5] In Unix, by convention files whose names begin with a period is hidden

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Running a command

```
echo Hello
```

- `COMMAND ARG1 ARG2 ARG3`

Variables (1/3)

```
PS1='> '
echo location
name=Julius
echo $name
```

- Used to store text
- `name=value` to set variable
- `$name` to access variable

Variables (2/3)

There are also a number of special variables:

- `$?`: get exit code of the previous command
- `$1` to `$9`: arguments to a script
- `$0`: name of the script itself
- `$#`: number of arguments
- `$$`: process ID of current shell

Variables (3/3)

Create a script `variable-example` containing the code below, then try running it with various arguments.

```
#!/bin/sh
echo $0
echo $1
echo $2
echo $#
```

Loop (1/4)

Loop is used to run a command a bunch of times.

For example:

```
for i in $(seq 1 5); do echo hello; done
```

Loop (2/4)

```
for i in $(seq 1 5); do echo hello; done
```

Let’s unpack this!

```
for x in list; do BODY; done
```

- `;` terminates a command – equivalent to newline
- Split `list`, assign each to `x`, and run `BODY`
- Split by “whitespace” – we will get into it later
- Compared to C, no curly braces, instead `do` and `done`

Loop (3/4)

```
for i in $(seq 1 5); do echo hello; done
```

Let’s unpack this!

```
$(seq 1 5)
```

- Run the program `seq` with arguments `1` and `5`
- Substitute the `$(...)` block with the output of the program
- Equivalent to

  ```
  for i in 1 2 3 4 5; do echo hello; done
  ```

Loop (4/4)

```
for i in $(seq 1 5); do echo hello; done
```

Let's unpack this!

```
echo hello
```

- Everything in a shell script is a command
- Here, it means run the `echo` command, with argument `hello`.
- All commands are searched in `$PATH` (colon-separated)
- Find out where a command is located by running `which COMMAND`, e.g. `which ls`

Conditionals (1/2)

```
if test -d /bin; then echo true; else echo
↪  false; fi;
```

Let’s unpack this!

```
if CONDITION; then BODY; fi
```

- `CONDITION` is a command.
- If its exit code is `0` (success), then `BODY` is run.
- Optionally, you can also hook in an **`else`** or **`elif`**

Conditionals (2/2)

```
if test -d /bin; then echo true; else echo
 ↪  false; fi;
```

Let's unpack this!

```
test -d /bin
```

- `test` is a program that provides various checks and comparison which exits with exit code `0` if the condition is true[6].
- Alternate syntax: `[ condition ]`, e.g. `[ -d /bin ]`

[6] Remember, you can check exit code using `$?`

Everything Together

Let’s create a command like `ls` that only prints directories:

```sh
#!/bin/sh
for f in $(ls)
do
  if test -d $f
  then
    echo dir $f
  fi
done
```

Bug!

Hold on! What if the directory is called ”My Documents”?

- `for f in $(ls)` expands to
  `for f in My Documents`
- Will first perform the test on `My`, then on `Documents`
- Not what we wanted!

Argument Splitting

- Bash splits arguments by whitespace (tab, newline, space)
- Same problem somewhere else: `test -d $f`
- If `$f` contains whitespace, `test` will error!
- Need to use quote to handle spaces in arguments `for f in "My Documents"`
- How do we fix our script?
- What do you think `for f in "$(ls)"` does?

Globbing (1/2)

- `bash` knows how to look for files using patterns:
  - `*`: any string of characters
  - `?`: any single character
  - `{a,b,c}`: any of these characters
- Thus, `for f in *` means all files in this directory
- When globbing, each matching file becomes its own argument
- However, still need to make sure to quote, e.g. `test -d "$f"`

Globbing (2/2)

You can make advanced patterns

- `for f in a*`:

Globbing (2/2)

You can make advanced patterns

- `for f in a*`: all files starting with `a` in the current directory
- `for f in foo/*.txt`:

Globbing (2/2)

You can make advanced patterns

- `for f in a*`: all files starting with `a` in the current directory
- `for f in foo/*.txt`: all `.txt` files in `foo`
- `for f in foo/*/p??.txt`:

Globbing (2/2)

You can make advanced patterns

- `for f in a*`: all files starting with `a` in the current directory
- `for f in foo/*.txt`: all `.txt` files in `foo`
- `for f in foo/*/p??.txt`: all three-letter text files, starting with p, in subdirectories of `foo`

Other whitespace issues

- `if [ $foo = "bar" ]; then`: What’s the issue?

Other whitespace issues

- `if [ $foo = "bar" ]; then`: What's the issue?
- What if `$foo` is empty? arguments to `[` are `=` and `bar`
- Possible workaround: `[ x$foo = "xbar" ]`, but very hacky

Other whitespace issues

- `if [ $foo = "bar" ]; then`: What's the issue?
- What if `$foo` is empty? arguments to `[` are `=` and `bar`
- Possible workaround: `[ x$foo = "xbar" ]`, but very hacky
- Instead, use `[[ CONDITION ]]`: `bash` built-in comparator that has special parsing
- Good news: it also allows `&&` instead of `-a`, `||` instead of `-o`, etc.

shellcheck

- The mentioned problems are the most common bugs in shell scripts.
- A good tool to check for these kinds of possible bugs in your shell script: `https://www.shellcheck.net/`

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Composability

- Shell is powerful, in part because of **Composability**
- You can chain multiple programs together, rather than one program that does everything
- Remember **The Unix Philosophy**:
    1. Write programs that do one thing and do it well.
    2. Write programs to work together.
    3. Write programs to handle text streams, because that is a universal interface.

Pipe (1/2)

```
dmesg | tail
```

Let’s unpack this!

```
a | b
```

- Means run both a and b, but send all the output of a as input to b, and then print the output of b

Pipe (2/2)

You can chain this even longer!

```
cat /var/log/sys*log | grep Mar 23 | tail
```

- `cat /var/log/sys*log` prints the system log
- This output is fed into `grep Mar 23`, which looks for all entries from today.
- This output is then further fed into `tail`, which prints only the last 10 lines.

Streams

- All programs launched have 3 streams:
  - `STDIN`: the program reads input from here
  - `STDOUT`: the program prints to here
  - `STDERR`: a second output that the program can choose to use.
- By default, `STDIN` is your keyboard, `STDOUT` and `STDERR` are both your terminal

Stream Redirection (1/2)

- However, this can be changed!
- `a | b`: makes `STDOUT` of `a` the `STDIN` of `b`.
- `a > foo`: `STDOUT` of `a` goes to the file `foo`
- `a 2> foo`: `STDERR` of `a` goes to the file `foo`
- `a < foo`: `STDIN` of `a` is read from the file `foo`
- `a <<< some text`: `STDIN` of `a` is read from what comes after `<<<`

Stream Redirection (2/2)

So why is this useful?

Stream Redirection (2/2)

So why is this useful?

It lets you manipulate output of a program!

Stream Redirection (2/2)

So why is this useful?

It lets you manipulate output of a program!

- `ls | grep foo`: all files that contain the word `foo`
- `ps | grep foo`: all processes that contain the word `foo`
- On Linux: `journalctl | grep -i intel | tail -n 5`: last 5 system log messages with the word `intel` (case-insensitive)
- Note that this forms the basis for **data-wrangling**, which will be covered later.

Grouping Commands

```
(a; b) | tac
```

- Run `a`, then `b`, and send all their output to `tac`[7]
- For example: `(echo qwe; echo asd; echo zxc) | tac`

[7] `tac` print in reverse

Process Substitution

```
b <(a)
```

- Run `a`, generate a temporary file name for its output stream, and pass that filename to `b`
- To demonstrate: `echo <(echo a) < (echo b)`
- On Linux: `diff <(journalctl -b -1 | head -n20) <(journalctl -b -2 | head -n20)`
- This shows the difference between the first 20 lines of the last boot log and the one before that.

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Job (1/2)

Used to run longer-term things in the background.

- Use the & suffix
  - It will give back your prompt immediately.
  - For example: `(for i in $(seq 1 100); do echo hi; sleep 1; done) &`
  - Note that the running program still has your terminal as `STDOUT`. Instead, can redirect `STDOUT` to file.
  - Handy especially to run 2 programs at the same time like a server and client: `server & client`
  - For example: `nc -l 1234 & nc localhost 1234 <<< test`

Job (2/2)

- `jobs`: see all jobs
- `fg %JOBS`: bring the job corresponding to the id to the foreground (with no argument, bring the latest job to foreground)
- You can also background the current program: `^Z`[8], then run `bg`
  - `^Z` stops the current process and makes it a job.
  - `bg` runs the last job in the background.
- `$!` is the PID of the last background process.

[8] Ctrl is usually denoted as ^, thus Ctrl + z is denoted as `^Z`

Process Control (1/2)

- `ps`: lists running processes
  - `ps -A`: lists processes from all users
  - Check out the man page for other arguments.
- `pgrep`: find processes by searching (like `ps -A | grep`)
  - `pgrep -f`: find processes with arguments
- `kill`: send a *signal* to a process by ID (`pkill` to search and run `kill`)
  - Signal tells a process to do something
  - `SIGKILL` (`-9` or `-KILL`): tell it to exit *right now* (equivalent to `^\`)
  - `SIGTERM` (`-15` or `-TERM`): tell it to exit gracefully (equivalent to `^C`)

Process Control (2/2)

- `kill`: send a *signal* to a process by ID (`pkill` to search and run `kill`)
  - Signal tells a process to do something
  - Most common[9]:
    - `SIGKILL` (`-9` or `-KILL`): tell it to exit *right now* (equivalent to `^\`)
    - `SIGTERM` (`-15` or `-TERM`): tell it to exit gracefully (equivalent to `^C`)

[9] Prefer `SIGTERM` over `SIGKILL`: `https://turnoff.us/geek/dont-sigkill/`

More Resources

- If you are completely new to the shell, you might want to read a comprehensive guide, such as BashGuide[10].
- For a more in-depth introduction, The Linux Command Line[11] is a good resource.

[10] http://mywiki.wooledge.org/BashGuide

[11] http://linuxcommand.org/tlcl.php

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xargs

- Sometimes piping doesn't quite work because the command being piped into does not expect the newline separated format.
- For example, `file` command tells you properties of the file.
- Try running `ls | file` and `ls | xargs file`
- What is `xargs` doing?

Other Exercises

- Try running `touch {a,b}{a,b}`, then `ls`. What appeared?
- Sometimes you want to keep `STDIN` and still output to a file. Try running `echo HELLO | tee hello.txt`
- Run `echo HELLO > hello.txt`, then `echo WORLD >> hello.txt`. What are the contents of `hello.txt`? How is > different from >>?

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Introduction

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What is Data Wrangling?

- Have you ever had a bunch of text and wanted to do something with it?
- Great! That's **Data Wrangling**
- Adapting data from one format to another, until you end up with exactly what you wanted.

Basic Data Wrangling (1/2)

Linux:

```
journalctl | grep -i intel
```

- This is an example of basic data wrangling: finding all system log entries that mentions Intel
- Most of data wrangling is just about knowing what tools you have, and how to combine them.
- Remember **The Unix Philosophy**!

Basic Data Wrangling (2/2)

- Let’s start from the beginning:
  1. We need a data source
  2. Something to do with it.
- A good use case is for logs, because you often want to investigate them, but reading the whole thing is not feasible.

Data Wrangling Example (1/)

Let’s try to figure out who is trying to log into my server.

- First, I try to look into my server’s log:
  `cat log`
- That’s far too much stuffs!
- Let’s limit it to `ssh` stuffs:
  `cat log | grep sshd`
- That is still way more stuffs than what we wanted, and it’s pretty hard to read.

Data Wrangling Example (2/)

We can do better!

```
cat log
| grep sshd
| grep "Accepted publickey for"
```

There's still a lot of noise here.

There are *a lot* of ways to get rid of that, but let's look at one of the most powerful tools in your toolkit: `sed`.

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sed? Isn't that the adjective to describe my life?

- `sed` is a stream editor that builds on top of the old `ed`[12] editor
- In it, you basically give short commands for how to modify the file.
- If you use `vim`, you should be familiar with some of the commands (`ed` -> `vi` -> `vim`)
- There are tonnes of commands, but the most common one is `s` for substitution.

[12] If you're into lame computing jokes, here's a joke about `ed`: `https://www.gnu.org/fun/jokes/ed-msg.html`

Back to Our Example

```
cat log
| grep sshd
| grep "Accepted publickey for"
| sed 's/.*Accepted publickey for //'
```

- Wow! It's a lot cleaner.
- What we just wrote was a simple **Regular Expression**

The s Command in sed

Syntax: `s/REGEX/SUBSTITUTION/`

- `REGEX` is the regular expression you want to search for.
- `SUBSTITUTION` is the text you want to substitute matching text with.

What is Regular Expression

- It’s a powerful construct that lets you match text against patterns.
- They are common and useful enough that it’s worthwhile to take some time to understand how they work.
- Usually (though not always) surrounded by `/`
- Most ASCII characters just carry their normal meaning, but some characters have special matching behaviour.
- Exactly which characters do what vary somewhat between different implementations of regular expressions, which is a source of great frustration.

List of Regex Special Characters

Character	Meaning
`.`	Any single character except newline
`*`	Zero or more of the preceding match
`?`	One or more of the preceding match
`[abc]`	Any one character of `a`, `b`, and `c`
`(RX1|RX2)`	Either something that matches `RX1` or `RX2`
`^`	The start of the line
`$`	The end of the line

If you are unfamiliar with regex, there is a nice tutorial at `https://regexone.com/`

Obsolete vs Modern Regex

- Note that `sed`'s regex is somewhat weird and will require you to put a `\` before most of these to give them special meaning.
- This is because by default `sed` is using the *obsolete* regex format.
- You can avoid this problem by passing `-E` flag to `sed`, which tells it to switch to the *modern* regex format.
- You can explore the differences by running `man re_format`

Looking at our regex just now

```
/.*Accepted publickey for /
```

- It means any text that starts with any number of characters, followed by the literal string `"Accepted publickey for "`
- However, regexes are tricky.
- What if the username is also `"Accepted publickey for "`?
- Why? By default, `*` and `+` are “greedy” – they will match as much text as they can

Solution: Match the whole line

```
| sed -E 's/.*Accepted publickey for (.*) from
 ↪  ([0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}
 ↪  port ([0-9]+) ssh2: RSA SHA256:.*//'
```

Let’s look at what’s going on with a regex debugger[13]

[13] https://regex101.com/r/wPc8Ii/3

Explanation

- The start is still as before.
- Then on any string of characters (username).
- Then on `from` followed by an IP address[14]
- Then on `port` followed by a sequence of digits.
- Finally, we try to match on the suffix `ssh2: RSA SHA256:` followed by any string of characters.
- Notice that with this technique, a username of `Accepted publickey for` will not confuse us anymore. Can you see why?

[14] This matches `999.999.999.999` which is not a valid IPv4 address. A regex that only matches valid address is left as an exercise

Capture Groups

- Oh no, the entire log is now empty.
- We want to keep the username
- Use **Capture Groups**!
- Any text matched by a regex surrounded by parentheses is stored in a numbered capture group.
- Capture group 0 is special. It is the whole text matched by the regex.
- These are available in the `SUBSTITUTION`[15] as `\1`, `\2`, `\3`, etc.

[15] In some engines, even in the pattern itself!

Using Capture Groups in sed

```
| sed -E 's/.*Accepted publickey for (.*) from
↪  ([0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}
↪  port ([0-9]+) ssh2: RSA SHA256:.*/\1/'
```

- Note that in our current regex, capture group 1 is username, capture group 2 is IP address, capture group 3 is port number.
- You can try out using \2 and \3 instead of \1.

More on Regular Expressions

- As you can probably imagine, you can come up with *really* complicated regex.
- For example, there is an article on how you might match an email address[16]. It's not easy[17]. People have even written tests[18] and test matrices[19]
- Regular expressions are notoriously hard to get right, but they are also very handy to have in your toolbox!

[16] https://www.regular-expressions.info/email.html

[17] http://emailregex.com/

[18] https://fightingforalostcause.net/content/misc/2006/compare-email-regex.php

[19] https://mathiasbynens.be/demo/url-regex

More Regex Trivia

- You can check for prime numbers using regex[20]
- You can match `A B C` where $A + B = C$[21]
- You can match nested brackets, e.g. to parse Lisp's s-expressions using Regex[22]
- Note: these are more for curiosity purposes. There are usually better tools than regex, although for a quick and dirty script, regex is usually enough.

[20] `https://www.noulakaz.net/2007/03/18/a-regular-expression-to-check-for-prime-numbers/`

[21] `http://www.drregex.com/2018/11/how-to-match-b-c-where-abc-beast-reborn.html`

[22] `http://www.drregex.com/2017/11/match-nested-brackets-with-regex-new.html`

Back to Data Wrangling

So now we have

```
cat log
| grep sshd
| grep "Accepted publickey for"
| sed -E 's/.*Accepted publickey for (.*) from
 ↪  ([0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}
 ↪  port ([0-9]+) ssh2: RSA SHA256:.*/\1/'
```

sed All the Way!

But we can do everything just with sed!

```
cat log
| sed -E -e '/Accepted publickey for/!d' -e
 ↪  's/.*Accepted publickey for (.*) from
 ↪  ([0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}
 ↪  port ([0-9]+) ssh2: RSA SHA256:.*/\1/'
```

- d is to delete, `!` is to apply the function to the lines **not** selected by the pattern.
- Check out `man sed`!

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Let's look for common usernames

```
| sort | uniq -c
```

- `sort` will, well, sort its input.
- `uniq -c` will collapse consecutive lines that are the same into a single line, prefixed with a count of the number of occurrences.

How about the most common logins?

We probably want to sort that too and only keep the most common logins

```
| sort -nk1,1 | tail -n3
```

- `sort -n` sorts in numeric (instead of lexicographic) order, `-k1,1` means sort only by the first whitespace-separated column[23].
- Exercise: what if we wanted the least common ones?

[23] In this *particular* example, sorting by the whole line wouldn't matter, but we're here to learn!

How about the most common logins?

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- `sort -n` sorts in numeric (instead of lexicographic) order, `-k1,1` means sort only by the first whitespace-separated column[23].
- Exercise: what if we wanted the least common ones?
- Either use `head` instead of `tail` or use `sort -r` which sorts in reverse order.

[23] In this *particular* example, sorting by the whole line wouldn't matter, but we're here to learn!

We can do better

Okay, so that's pretty cool, but we'd sort of like to only give the usernames, and maybe not one per line?

```
| awk '{print $2}' | paste -sd, -
```

Let's start with `paste`

- It lets you combine lines (`-s`) by a given single-character delimiter (`-d`), and ask it to to read from `STDIN` (`-`)[24]
- You can also emulate this using `tr '\n' ','`, but this results in a trailing comma.

[24] Using GNU paste, the `-` can be omitted, but this is not POSIX compliant.

awk

- A programming language that happens to be really good at processing text streams.
- There is *a lot* to say about `awk` if you were to learn it properly, but as with many other things here, we'll just go through the basics.

awk Syntax

- Basic `awk` syntax: `pattern { block }`
- `awk` takes in an optional pattern plus a block saying what to do if the pattern matches a given line.
- The default pattern (if no pattern is provided) matches all lines.
- Inside the block, `$0` is set to the entire line's content, and `$1` to `$n` is set to the n-th field of that line, when separated by `awk` field separator[25].

[25] whitespace by default, can be changed with `-F`

Our Use of awk

```
| awk '{print $2}'
```

- So in this case, we're saying that, for every line, print the contents of the second field, which happens to be the username.

More fancy awk

Let’s compute the number of single-use usernames that start with `r` and end with `t`:

```
| awk '$1 == 1 && $2 ~ /^r[^ ]*t$/ { print $2
↪  }' | wc -l
```

Let’s unpack this!

- The pattern means the first field of the line should be equal to `1` (the count from `uniq -c`), and the second field should match the regex.
- The block says to print the second field (username)
- Finally, we count the number of lines in the output with `wc -l`.

awk as a Programming Language

Remember that **awk** is a programming language, so we can actually not use **wc -l** at all:

```
BEGIN { rows = 0 }
$1 == 1 && $2 ~ /^c[^ ]*e$/ { rows += $1 }
END { print rows }
```

- BEGIN is a pattern that matches the start of the input, and END matches the end.
- First we initialise the count to 0. The per-line block just adds the count from the first field. Then we print it out at the end.

Advanced awk

- In fact, we could get rid of `grep` and `sed` entirely, because `awk` can do it all, but that is left as an exercise.
- A good resource to read is `https://backreference.org/2010/02/10/idiomatic-awk/`

We can do Maths too!

```
| awk '{print $1}'
| paste -sd+ -
| bc
```

- bc is actually a calculator language.
- You can even run it straight from your shell and use it as a normal calculator.
- In this case, we are piping a mathematical expression to bc

Data Wrangling to Make Arguments (1/2)

- Remember the `xargs` tool from the exercise just now?
- Since we can pipe data to it, we can use data wrangling to make arguments too.
- Say we want to delete all files that matches the regex `asd.a [0-9]{2}`

```
ls | grep -E 'asd.a [0-9]{2}' | xargs rm
```

What happened?

Data Wrangling to Make Arguments (2/2)

- It's the annoying whitespace splitting again.
- A workaround is to use the null character (`\0`) as delimiter instead

```
ls
| grep -E 'asd.a [0-9]{2}'
| tr '\n' '\0'
| xargs -0 rm
```

Where are we?

Introduction

Shell and Scripting

Data Wrangling

- Introduction
- sed and Regular Expression (regex)
- More Advanced Data Wrangling
- Exercises

Conclusion

Exercises (1/2)

- How is `sed s/REGEX/SUBSTITUTION/g` different from regular `sed`? What about `/textbackslash I` or `/textbackslash m`?
- To do in-place substitution it is quite tempting to do something like `sed s/REGEX/SUBSTITUTION/ input.txt > input.txt`. However this is a bad idea, why? Is this particular to `sed`?

Exercises (2/2)

- Find the number of words (in `/usr/share/dict/words`) that contain at least three `a`s and don't have `'s` ending.
- What are the three most common last two letters of those words?
- How many of those two-letter combinations are there?
- And for a challenge: which combinations do not occur?

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Conclusion

Talk to us!

- Feedback form: `https://tinyurl.com/hs2019-hackertools-1`
- Upcoming hackerschool:
  - Hackertools Part Two