Shell TUTORIAL

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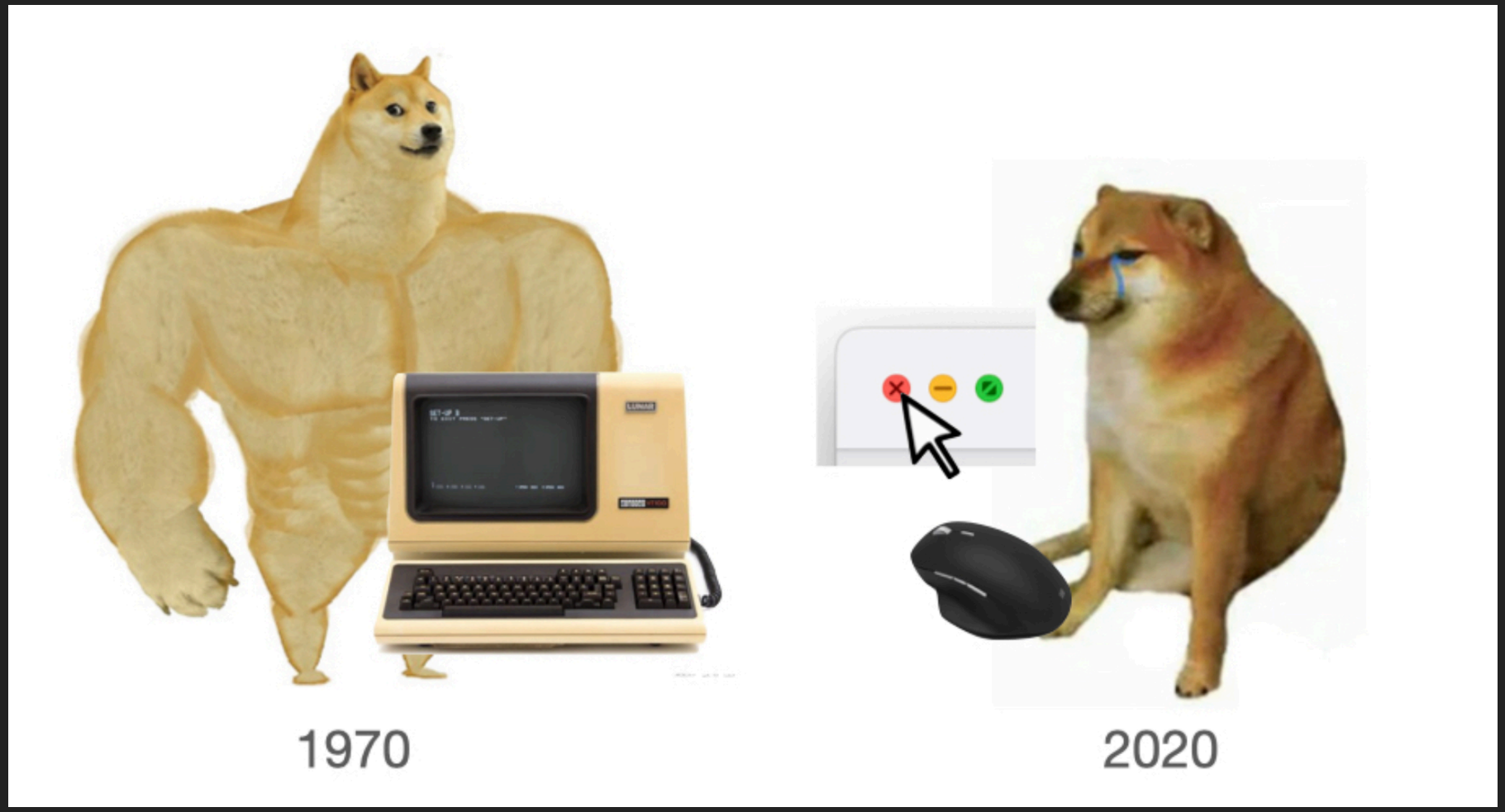
***A brief tutorial for beginners**, so feel free to absent if you are familiar with shell* 🙈🙈

INTERACTIVE WITH COMPUTER SYSTEM

As we all know, there are many ways to interact with a computer system: GUI, CLI, AR, VR, etc.



WHY SHOULD I USE CLI?

1. Some times, **GUI is not available** (e.g. server, embedded system).
   And many powerful tools are CLI only (e.g. `git`, `ssh`, `vim`)
2. CLI is more **efficient** (e.g. `mv` v.s. drag and drop)
3. CLI is more **flexible** and **programmable** (e.g. `>`, `|`, `&&`)
4. ***ICS*** hopes you to use CLI 😂

OVERVIEW

1. **Brief Intro**: all you need to know about starting using shell.
2. **Recommend**: basic but useful command line tools.
3. **Automation**: write a bash scripts.

- ***RTFM***: *use `man` and `tldr`.*

1. BASIC SETUP

1. Terminal (emulator): emulate a (texted-based) terminal inside the GUI environment.
    - Linux: `kitty`, `gnome-terminal`, `konsole`, `xterm`, `terminator`, etc.
    - Windows: `Windows Terminal`
    - *Open `vscode` and `Ctrl + ~`*
2. SSH to server:
    - `ssh <your stuid>-ics@igw.dfshan.net -p2291`
3. ***Try the tty: `Ctrl + Alt + F1` (F1-F6, in some Linux distros)***

The TTY demystified

2. SHELL: THE "SHELL" OF THE KERNEL

We fouce on `bash shell`

- `echo $0`

```
command-name arg1 arg2 arg3 ... # Basic format
```

DO -	In GUI	In CLI (bash shell)
Create a file	Right click, New file	`touch filename`
Move a file	Drag and drop	`mv file1 file2`
Launch an app	Click icon	`./app`
Quit an app	Click close button	`Ctrl + C`
Suspend an app	Minimize	`Ctrl + Z`
Show background process	Task Manager	jobs

BASIC TOOLS (COMMANDS)

- Directories: `pwd`, `cd`, `mkdir`
- File: `touch`, `cp`, `mv`, `rm`, `cat`, `less`
- Simple functions: `sort`, `wc`, `echo`
- Others: `grep`, `chmod`
- Code Editor: `vim`
- monitor: `top`, `htop`
- Network: `ping`, `ssh`, `scp`

Tar

Usage Scenario: archive files in 1 bundle

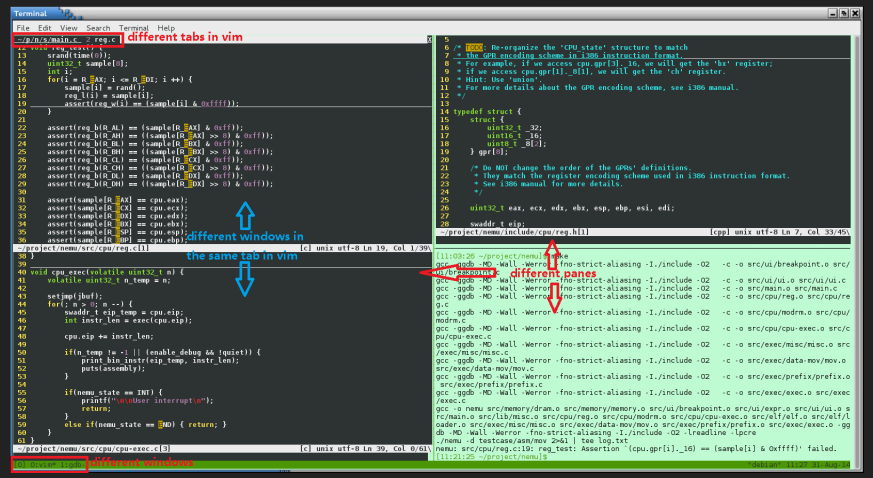
- `-c`: create a tarball
- `-x`: open a tarball
- `-v`: verbose mode [displays progress]
- `-t`: list files in a tarball
- `-f`: specify file name

`-f` is always the last option

```
0 tar -cf name-of-archive.tar /path/to/dir/ # compress directory
1 tar -cf name-of-archive.tar /path/to/filename # compress file
2 tar -cf name-of-archive.tar dir1 dir2 dir3 # compress multiple dirs
3 tar -xf name-of-archive.tar # open a tar file in current directory
```

Tmux

Usage Scenario: manage multiple terminal sessions



- prefix key: `Ctrl + b`
- Client-Server model: `tmux` (server) + `tmux attach` (client)

grep

Usage Scenario: search for a specific string in a file

`grep + regex`

- `-i`: case insensitive
- `-r`: recursive search
- `-n`: show line number
- `-v`: invert match

```
0 grep -i "hello" file.txt # search for "hello" in file.txt
1 grep -r "hello" . # search for "hello" in all files in current directory
2 grep -r "hello" . -n # search for "hello" in all files in current directory and show
3 grep -r "hello" . -v # search for files that do not contain "hello" in current direct
```

INTERLUDE: SO MANY COMMAND 😭

- `-h`, `--help`
- `man`: man is the system's manual pager (Ask the man XD)
  - `man -k ipc`
  - `man man`
  - Some of the following command can be found their manpage, but how about `cd` ?
- `tldr`: https://github.com/tldr-pages/tldr
  - There is room for simpler help pages focused on practical examples.
  - `man tar` v.s. `tldr tar`

Find

Usage Scenario: search files in a directory

- `-name`: search by name
- `-type`: search by type
- `-exec`: execute command on each file found

```
0 find . -type f -name "*.txt" # find all txt files in current directory
1 find . -type f -name "*.txt" -exec cat {} \; # cat all txt files in current directory
```

MORE TOOLS

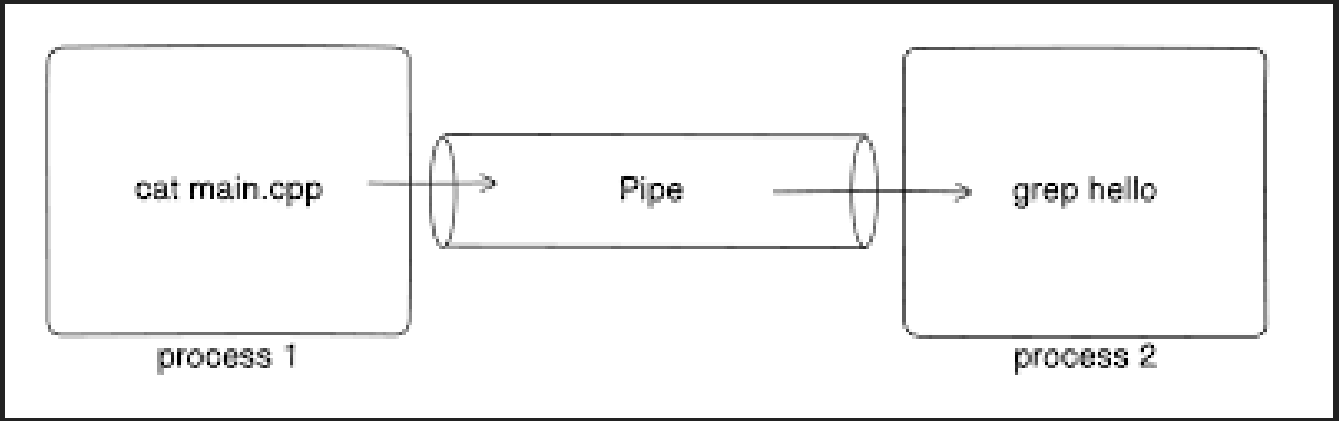
- `awk`: a powerful pattern scanning and processing language
- `sed`: a stream editor for filtering and transforming text
- `curl`: transfer data from or to a server
- `ag`: a code-searching tool similar to `grep`
- `tree`: list contents of directories in a tree-like format
- `htop`: an interactive process viewer for Unix
- `cmatrix`: a program that simulates the display from "The Matrix"
- `sl`: a steam locomotive runs across your terminal

INSTALL SOFTWARE IN CLI

1. Package manager: `apt` (ubuntu, Debian), `brew`(macOS), `dnf`(fedora), `pacman`(arch)
    - Search (e.g. `apt search`)
    - https://command-not-found.com/
2. Build from source
    - README/INSTALL doc
    - configure and make install

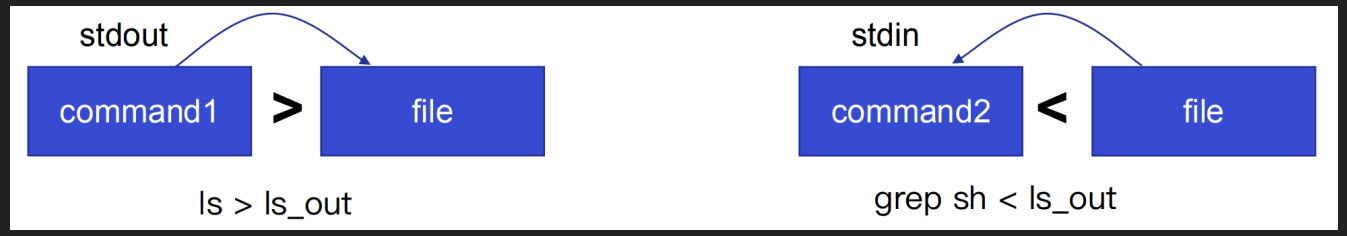
COMMUNICATION: PIPE

- A lot of CLI tools, communication is required to do complex jobs.
- Pipe: | use the `stdout` of previous command as the `stdin` of the next.



COMMUNICATION: REDIRECT 1

- A lot of CLI tools, communication is required to do complex jobs.
- Redirect: > & <, `stdout` to file or file to `stdin` (normally).



COMMUNICATION: REDIRECT 2

- A lot of CLI tools, communication is required to do complex jobs.
  - 0 - `stdin`, the standard input stream.
  - 1 - `stdout`, the standard outr55.,mjyput stream.
  - 2 - `stderr`, the standard error stream.

COMBINING COMMANDS (FURTHER MORE)

1. Count students number in server
2. fetch all include file
3. diff between two directories
4. check the disk usage of all files in /usr/bin

- *`xargs`*
- *`<()`: temporary file*
- *`$()`: command substitution*

- Build a temporary tools combination
- We a programming
  - a "Natural programming language"
  - Cooprate tools togather

3. SHELL SCRIPTS

Shell is also a programming language, which allows you to combine a series of commands and execute

VARIABLES

In `bash`, the syntax for assigning a value to a variable is `foo=bar`, and to access the value stored in a variable, the syntax is `$foo`.

Notes:

1. `foo = bar` (with spaces around =) will not work: the interpreter will try to run a program `foo` with = and `bar` as arguments.
2. **In `shell` scripts, spaces are used to separate arguments.**

STRINGS

In Bash, strings can be defined using `'` and `"`, but they have different meanings:

- Strings defined with `'` are literal strings, where variables are not replaced.
- Strings defined with `"` are strings where variables are replaced with their values.
- read more in Official Bash Manual

```
foo=bar
echo "$foo" # print bar
echo '$foo' # print $foo
```

CONTROL STRUCTURES

```
if [ expression ]; then
    # do something
elif [ expression ]; then
    # do something
else
    # do something
fi
```

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

```
while [ expression ]; do
    # do something
done
```

TEST

```
test expression

[ expression ]

[[ expression ]]
```

- [-e file]：if file exists, then true.
- [string]：if string is not empty (length > 0), then true.
- [string1 != string2]：if string1 and string2 are different, then true.
- [integer1 -eq integer2]：if integer1 equals to integer2, then true.
  - **do not confuse with numeric and string comparison**

FUNCTIONS

```
mcd () {
  mkdir -p "$1"
  cd "$1"
}
```

SPECIAL VARIABLES

Different from other scripting languages, bash uses many special variables to represent parameters, error codes, and related variables

- `$0` : script name
- `$1` ~ `$9` : script parameters. `$1` is the first parameter, and so on.
- `$@` : all parameters
- `$#` : number of parameters
- `$?` : return value of the previous command
- `$$` : process ID of the current script
- `!!` : the last command, including parameters. Common usage: when you fail to execute a command due to insufficient permissions, you can use `sudo !!` to try again.
- `$_` : the last parameter of the last command

SHABANG

- shabang (#!) is a special comment that tells the system which interpreter to use to execute the script
- #! + <Path of interpreter>

```
#!/bin/bash
echo "Hello, World!"
```

```
#!/usr/bin/env python3
# use env to find python3 in PATH
print("Hello, World!")
```

`builtin`

- `source` or `.`: run commands in the current shell
- `cd`: change directory
- ..., read more in `man bash-builtins`

$. THE BEST WAY TO LEARN IT , IS TO USE IT.

"Unix is user-friendly; it's just choosy about who its friends are."

- MIT - The Missing Semester
- USTC - Linux101
- The Art of Command Line