CSE 303
Concepts and Tools for Software Development

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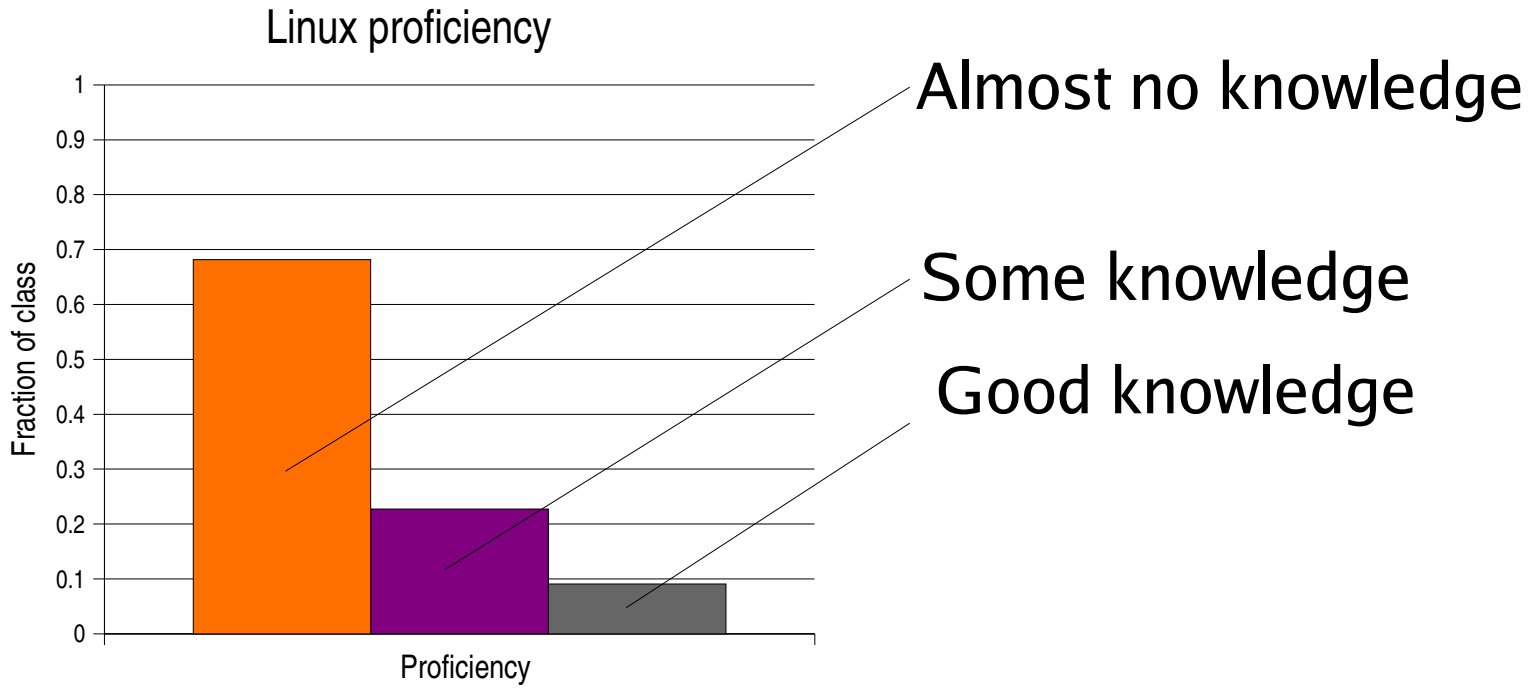
Lecture 2 – Filesystem, processes, users, and command line

Class Mailing List and HW1

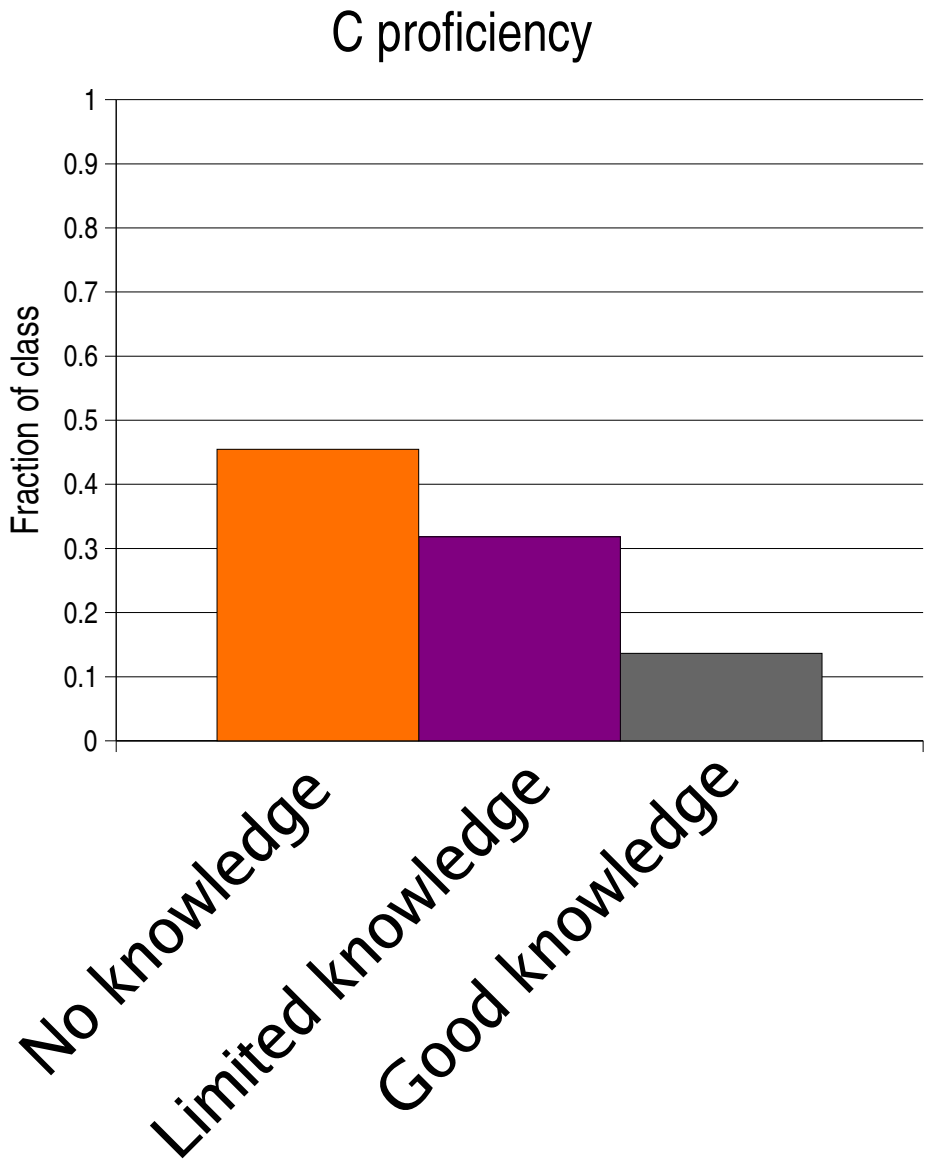
- You should have received an email from me yesterday about assignment 1
  - If you did not receive this email, let us know
- After today, you will know enough to get started on HW1
  - You will need next lecture to finish it

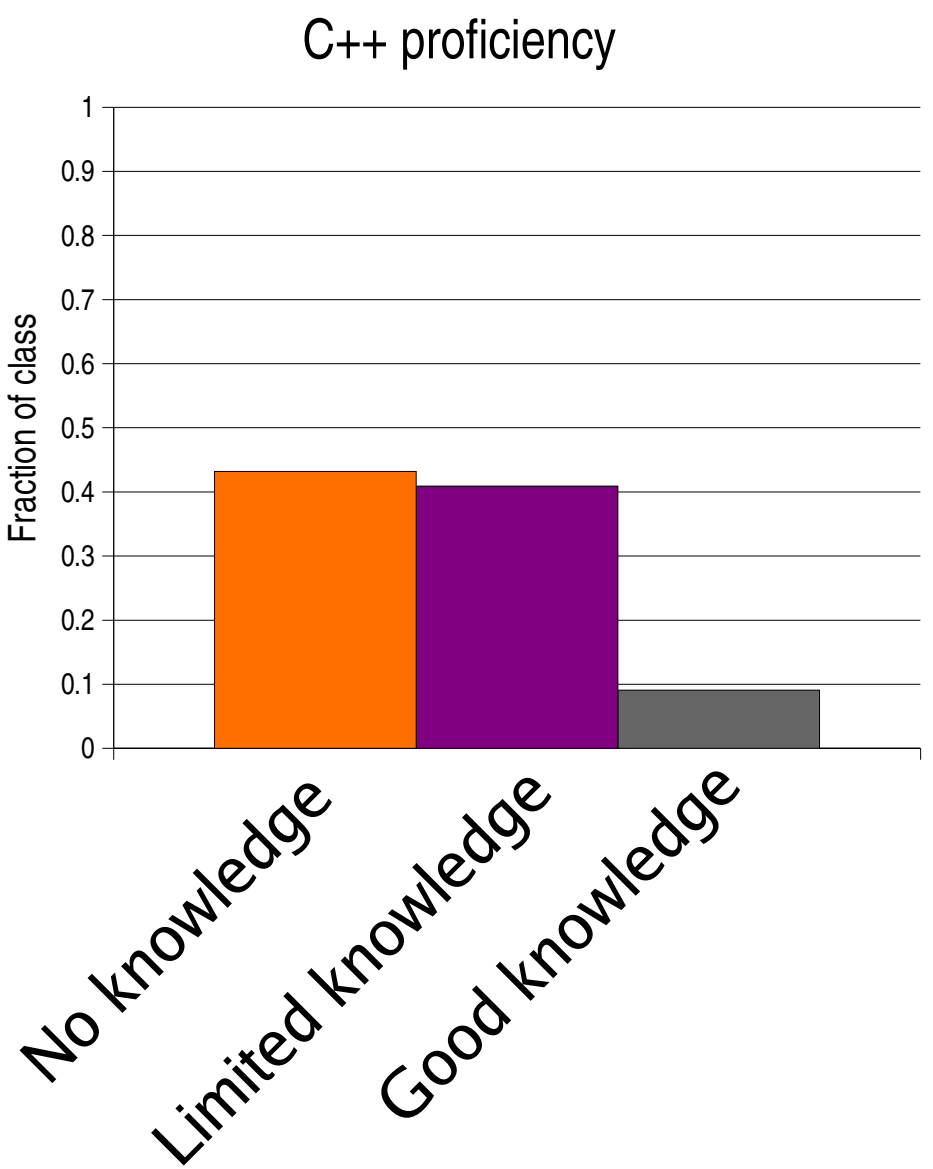
Survey Results



- **Our focus**: help **everyone** achieve a certain level of proficiency in Linux and C/C++
- **Extra credit questions** on assignments aimed at those who already have some background and want to learn more

Survey Results





Top Goals and Worries

- Top objectives
  - Learn C/C++, Linux, scripts, and tools
  - Deepen knowledge and increase confidence
  - Our advice: “An expert is a man who has made all the mistakes that can be made in a very narrow field.” (Niels Bohr)
- Top worries
  - Lack of background, lack of prior knowledge
  - Steep learning curve, potential difficulty
  - Amount of work

Where We Are

- It's like we started over using the computer from scratch
- And all we can do is run dinky programs at the command-line
- But we are learning
  - A model: filesystem, processes, users
  - A powerful way to control it: the shell
- Last time: filesystem and shell basics

Some Useful Commands

- Navigating directory structure: `cd`, `pwd`, `ls`
  - Relative path: `cd ../cse303`
  - Absolute path: `cd /home/username/cse303`
- Manipulating files: `mv`, `cp`, `rm`
- Manipulating directories:
  - `mkdir`, `rmdir`, `cp -r`, `rm -rf`
- Viewing file content: `cat`, `head`, `tail`, `less`
- Changing permissions: `chmod`
  - Example: `chmod -R go-rw .`

Outline for Today

- The rest of the model
  - Users
  - Programs and processes
- The power of the shell (just the beginning)
  - Special characters: file metacharacters

Users

- One filesystem and one operating system
- But many users
  - home directory, permissions, `whoami`, `quota`
  - change permissions with `chmod`
    - You can use it to make your homework unreadable by others ;-)
  - one “superuser”: `root` (administers machine)

At login

- `/etc/passwd` guides the *login* program
  - Verifies user name and password
  - Sets some environment variables: HOME, PATH
  - Launches the appropriate shell
  - The shell then takes over with startup scripts (`/etc/profile`, `~/.bash_profile`, etc.)
- But passwords are in `/etc/shadow`
  - Why? Hint: compare permissions on these files
- Extra: Use Linux Pocket Guide (LPG) to lookup difference between .bashrc and .bash_profile

Processes

- A running program is a process
- An application may run many processes
- The shell runs a program by
  - "Launching a process"
  - Waiting for the process to finish
  - Giving the prompt back
- A running shell is just a process that kills itself when interpreting the `exit` command
- GUIs are just a type of application

Program Options

- Most programs have options
- Single-letter preceded by a single hyphen

```
rm -r -f *
rm -rf *
```

- Or long options preceded by 2 (or 1) hyphens

```
ls --color
```

- Some commands support both

```
grep -c cat *.txt
grep --count cat *.txt
```

Discovering Available Options

- Program man takes a program name and displays the manual page or manpage
- Standard option `--help`
  - Prints usage and exits
  - Often programs print usage when given bad options
- Resources on the Web
  - Google is your friend

Controlling Processes

- Possible to run a program in the background
  - `C-Z, fg, bg, &`
- Viewing processes and killing them

  `jobs, ps, top, kill, ^C`

Summary of System Model

- Filesystem: tree of directories and files
- Users: home directory, permissions
- Processes that
  - Perform some useful work
  - Perform Input/Output (I/O)
  - Interact with devices: monitor, keyboard, network
  - Launch other processes
  - Create and modify files or directories
- The operating system manages all these

The Shell: What We Know So Far

- Program that interprets commands and initiates their execution
- Additionally, the shell has a state
  - Current working directory
  - Current user, her home directory, etc.
- Builtins: commands provided by the shell
  - `cd, exit, echo, source, alias`
  - Give directives to the shell
  - Change the state of the shell

File Metacharacters

- The shell performs various expansions and substitutions before invoking a program
- Example: `ls -l *.txt`
- Why file metacharacters?
  - On the command line: save typing
  - Inside scripts: flexibility (ex: email all pictures)

Expansions

- Brace expansion
  - Example: `mkdir hw1/{old,new,test}`
  - Creates: `hw1/old, hw1/new, hw1/test`
- Tilde expansion (expansion of ~ character)
  - Home directory of user bob: `~bob`
  - Current user's home directory: `~`
- Filename expansion: `*, ?, [`
  - Replace pattern with list of matching file names

Pattern Matching

- Any string, including null string: `*`
- Any single character: `?`
- Any character from set: `[ ]`
  - Example `[abc]` or `[a-c]`
- Any character not in set: `[!abc]` `[^abc]`
- Special case: "`.`" at beginning of a file name
- Examples:
  - `mv mytaxes*19* very-old`
  - `mv mytaxes*200[0-4]* old`

Special Characters

How to use them without special meaning?

- Escape: `\x` takes following character, x, literally
- Single quotes: `'xxx'` take everything literally
- Double quotes: "xxx" take everything literally except $, ``` (for command subst.), and \ if followed by special character

- Rules on what to escape or quote are arcane
  - When in doubt, just give it a try

Quoting and Escaping Examples

Directory contains three files: `a.txt`, `a*.txt`, `a?*.txt`

```
> ls a*.txt
> a?*.txt  a.txt  a*.txt
> ls a\*.txt
> a*.txt
> ls a\?\*.txt
> a?*.txt
> ls “a?*.txt”  or ls 'a?*.txt'
> a?*.txt
```

Aliases

- Shorthand for frequently used commands
  - Usually put them in your `~/.bashrc`
- Different from variables
- Syntax
  - Define alias: `alias ls="ls --color"`
  - View alias: `alias ls`
  - Remove alias: `unalias ls`

Readings

- Sections from the Linux Pocket Guide
  - Same sections as last lecture

- Class website lists additional resources