CS2303 In Class Exercises

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Abstract

Today's goal is to introduce using Linux.

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It is usually possible to install a virtual machine on your computing platform, which will allow your machine to simulate a Linux machine. You can read about that at `https://www.virtualbox.org/wiki/Downloads`.

1 Linux

Linux is an operating system, an alternative to Windows, MacOS, and any other UNIX system.

1.1 History Leading to Linux

`https://web.stanford.edu/~learnest/nets/timesharing.htm`:
The first demonstration of timesharing feasibility was accomplished by an MIT group led by Prof. Fernando Corbato. Another timesharing system development was initiated by MIT Prof. Jack Dennis using a PDP-1 computer that had been donated to MIT by DEC.

The second generation began at MIT with the development of Multics, a cooperative project between MIT, General Electric (GE) and Bell Telephone Labs that was managed by Profs. Fernando Corbato, Jack Dennis and others. Bell Labs pulled out of the project in 1969.

Third generation timesharing. The next generation was started by some Bell Labs people who had been involved in the Multics project and wanted a much simpler and cleaner system. By keeping their project hidden from management for a time they were able to create a rather elegant system that came to be called Unix. It was initially created in 1969 and by 1973 was recoded in the C programming language. The principal people involved were Ken Thompson, Dennis Ritchie, Brian Kernighan, Douglas McIlroy, Michael Lesk and Joe Ossanna. Among its nice features, Unix allows users to link multiple processes, front-to-back, so that a wide range of things can be done in a single run. A somewhat more advanced version of Unix, called BSD, was developed at U.C.

Berkeley, initially by Bill Joy, who had earlier been involved with the SDS-940 project and would later adapt BSD to the Sun Microsystems workstations. This project ran from 1977 to 1995 and was mostly funded by IPTO.

Fourth generation timesharing. The GNU Project, started by Richard Stallman at MIT in 1983, set out to create free software mostly through the efforts of volunteers. Extending that effort, Linus Torvalds, created a Unix-like operating system called Linux beginning in 1991 that is widely used and still moving forward today.

1.2 Prevalence of Linux

`https://en.wikipedia.org/wiki/Linux` Linux a family of open source Unix-like operating systems based on the Linux kernel an operating system kernel first released on September 17, 1991, by Linus Torvalds. Linux is typically packaged in a Linux distribution.

Linux was originally developed for personal computers based on the Intel x86 architecture, but has since been ported to more platforms than any other operating system.

Linux is the leading operating system on servers and other big iron systems such as mainframe computers, and the only OS used on TOP500 supercomputers (since November 2017, having gradually eliminated all competitors).

It is used by around 2.3 percent of desktop computers. The Chromebook, which runs the Linux kernel-based Chrome OS, dominates the US K–12 education market and represents nearly 20 percent of sub-$300 notebook sales in the US.

Linux also runs on embedded systems, i.e. devices whose operating system is typically built into the firmware and is highly tailored to the system. This includes routers, automation controls, televisions, digital video recorders, video game consoles, and smartwatches. Many smartphones and tablet computers run Android and other Linux derivatives. Because of the dominance of Android on smartphones, Linux has the largest installed base of all general-purpose operating systems.

Linux is one of the most prominent examples of free and open-source software collaboration. The source code may be used, modified and distributed—commercially or non-commercially—by anyone under the terms of its respective licenses, such as the GNU General Public License.

1.3 Features of Linux

A Linux-based system is a modular Unix-like operating system, deriving much of its basic design from principles established in Unix during the 1970s and 1980s. Such a system uses a monolithic kernel, the Linux kernel, which handles process control, networking, access to the peripherals, and file systems. Device drivers are either integrated directly with the kernel, or added as modules that are loaded while the system is running.

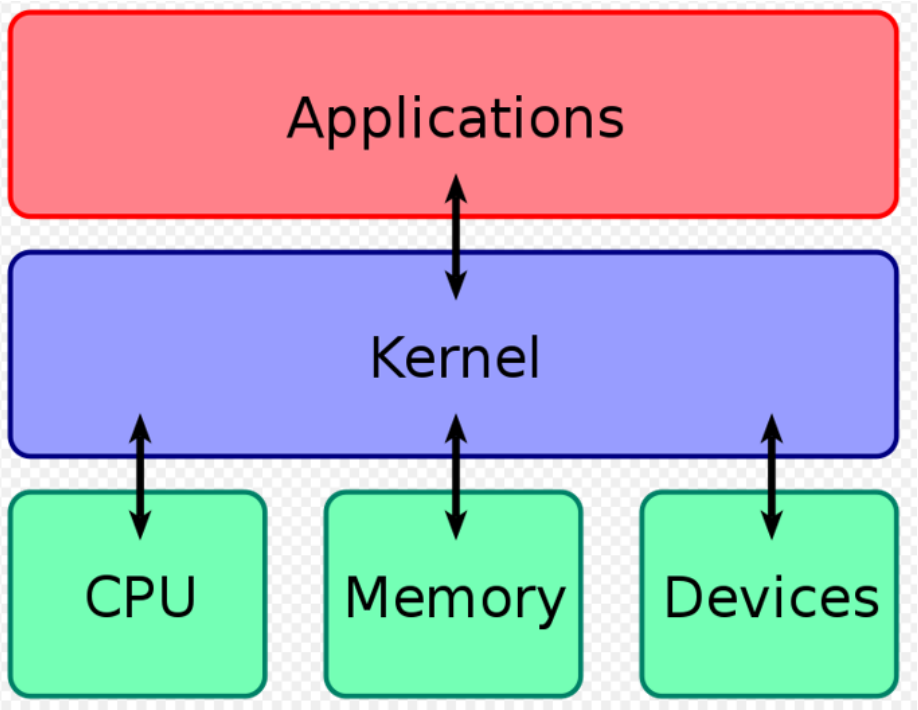

Figure 1: The kernel operates with devices and presents an interface to applications software, including executing, suspending and terminating processes.

1.3.1 Kernel

The kernel is defined as the portion of the operating system code that is always resident in memory.

A kernel is the foundational layer of an operating system (OS). It functions at a basic level, communicating with hardware and managing resources, such as RAM and the CPU.

Linux has its own kernel, and there are many other parts of Linux.

1.3.2 Applications

Many applications that can be run on Linux exist. Moreover, there are tools to help install such applications.

At `https://itsfoss.com/apt-get-linux-guide/` one can learn how to use apt-get.

There are manual pages (about which more later) for apt-get (in section 8 of the manual), see `https://linux.die.net/man/8/apt-get`.

Figure 2: Example of ASCII Art

1.3.3 Command Shell

Before graphical user interfaces, starting before there were screens, and instead people typed to the computer over a physical device called a terminal. Earlier terminals produced a paper record of what had been typed. Later terminals had screens, but the closest thing to a display was "ASCII Art", as in Figure 2.

When devices supporting more general graphics appeared, they were happily adopted, and of course many applications were built using them.

Now we have executables called "terminal emulator"s. Using a terminal emulator, one can re-experience, to some extent, the restriction of communicating by typing lines.

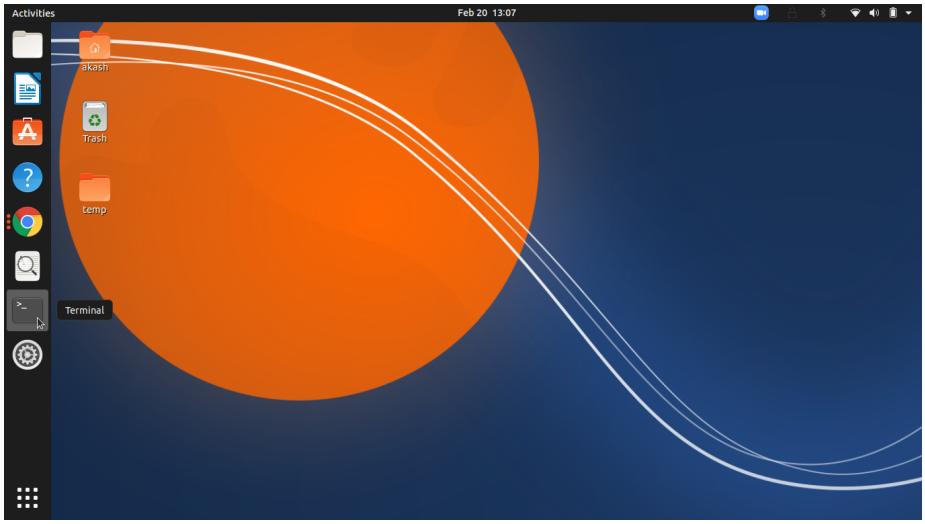

Figure 3: The terminal emulator is an application that can be started from the GUI (which appears at start up).

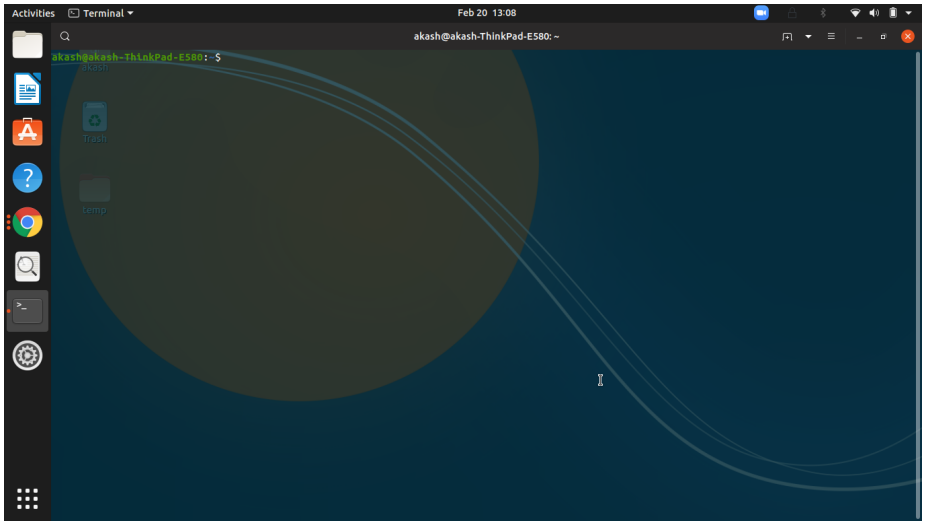

Figure 4: The terminal emulator provides a "prompt", after which, one types a command (or several commands).

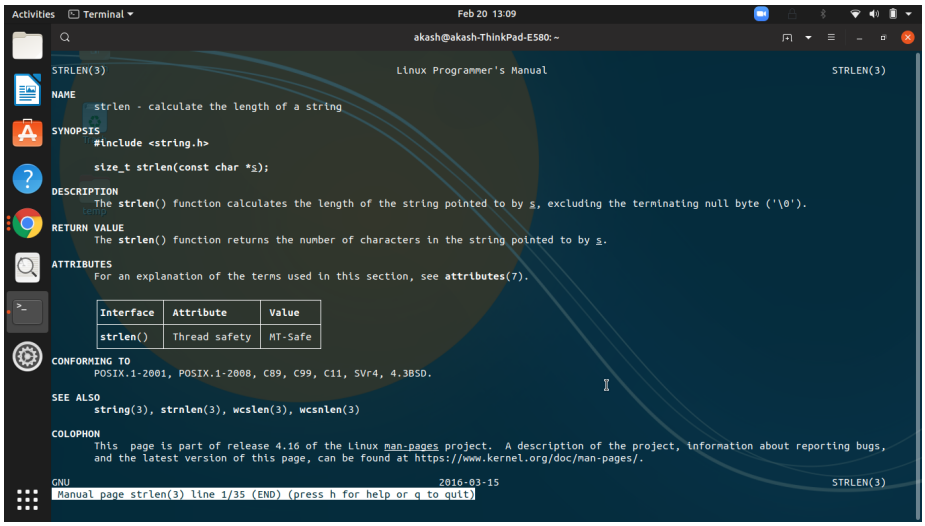

Figure 5: A typical man page, in this case, for strlen: Note that this is from section 3 of the man pages.

1.3.4 Man(ual) Pages

There are many commands, and while in early days there was a paper manual, into which one could insert new pages, corresponding to adding new commands, this manual became unwieldy, and is now replaced by an executable form, referred to as "man pages".

Once the name of a command is known, it usage can be discovered through accessing its man pages (sometimes there are several, from different sections of the manual). Note that, having abandoned a paper manual, we are not limited by any page size, so having multiple man pages implies having a man page in more than one section.

For example, we used the C function strlen in processing command line arguments. Suppose we wished to learn about strlen. We can request a man page for strlen within a terminal emulator.

2 Popular Commands for the UNIX (and Linux) Command Line

From `https://www.ubuntupit.com/the-50-best-linux-commands-to-run-in-the-terminal/`

2.1 Linux Commands for Navigating the Filesystem

It might be worth mentioning that Linux has some common directories, and principles for where things are found. Recall that we discussed graphs, and a

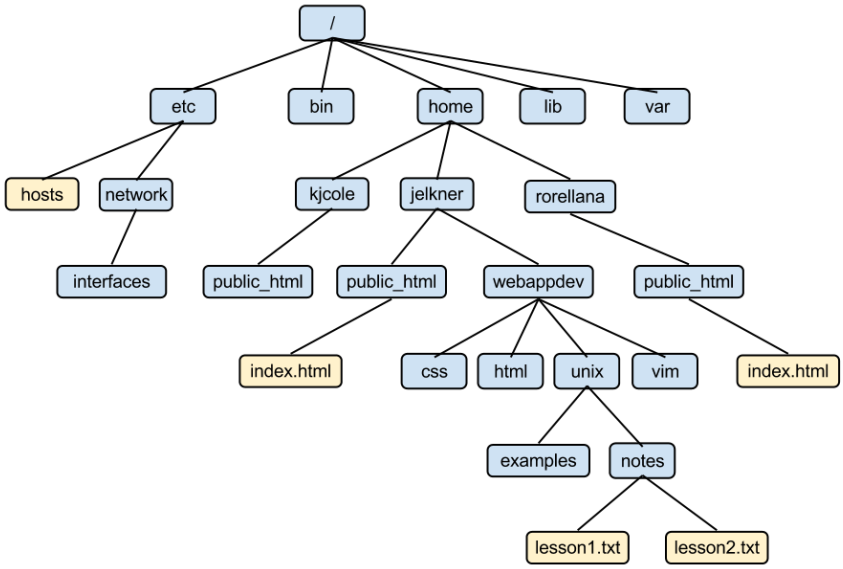

Figure 6: An example directory tree

distinguished node called the root. Linux's file system can be abstracted to a graph, in which files are nodes. A node can be a file, and can contain files. A node containing other nodes is called a directory. Thus a directory can contain a subdirectory. There is a notion of the location of a file in the file hierarchy. To designate where a file is, we use either relative or absolute naming. Absolute naming starts from the root directory (named root) and names each subdirectory encountered along the edges of the graph until the file's own node is reached, including the file's own "leaf" name. Relative naming by contrast starts in a designated directory, called the current directory, and navigate from there up and/or down within the directory tree, to find the file.

Besides the current directory, there is another special directory in the directory hierarchy, called the "home directory". This is the value taken on by the current directory on login. Each user has a home directory. There are commands for navigating the directory hierarchy, and there is a method to change the home directory.

There are also commands for adding to and subtracting from the directory hierarchy.

Command	Meaning
pwd	print the working directory: Because we can navigate through the filesystem hierarchy, (which changes the current directory), we can inquire what the current directory is.
ls	We can request a listing of the files (including subdirectories) in the current directory
cd	We can change the current directory, navigating by starting where we are and moving up (having one parent makes up unambiguous), or down in a designated direction
mkdir	create a directory, by default within the current directory
rmdir	remove a designated directory (be careful!)
mount	associates a device, such as a USB, to the file system
df	report on disk space

2.2 Linux Commands about Processes

Command	Meaning
kill	stop a process
uname	obtain some system specifics: name, bits per word
ps	obtain info on processes running on the machine
shutdown	stop all of the processes

2.3 Linux Commands for About Files

Files (including directories) have attributes, including date modified, and who is allowed to work with the file (in multiple ways). The ways to work with files include reading, writing and executing. The description of who has three parts: owner, group and everyone. The owner of a file can be changed. Who is a member of which group can be changed.

Command	Meaning
touch	update the date/time modified to be the current time, will create the file if it is not already present
cat	create new files, view file contents in the terminal, and redirect output to another command line tool or file.
head	print out the first part of a file
tail	print out the last part of a file
cp	copies a file
mv	moves a file
comm	compare two files for common and distinct lines
less	see content of a file, moving around in the file
cmp	compare two files and print the result to the standard output stream

Exercises: (As always, if you have questions, ask. After this occasion, this material becomes background knowledge.)

1. Describe how you would obtain information from the man pages on the function strncpy.

   in the terminal run "man strncpy"