Introduction to Linux

Michael C. Hackett

Computer Science Department

Community
College
*of* Philadelphia

Lecture Topics

- Open Source Philosophy
  - Open Source Software
  - Free Software
  - Free and Open Source Software

- The GNU Project and FSF

- The Unix Philosophy

- The Linux Operating System

- The Linux Kernel
  - Kernel Versions

- User Interfaces

Open Source Software

- **Open source software (OSS)** is computer software that gives anyone permission to:
  - View the program's source code.
  - Copy the program's source code.
  - Modify the program's source code.
  - Distribute any modifications to the program's source code.

- These rights are granted under one of several possible open source licenses.

- The opposite would be **closed source** (or **proprietary**) **software**.
  - Source code may not be freely viewed, copied, modified and/or distributed.
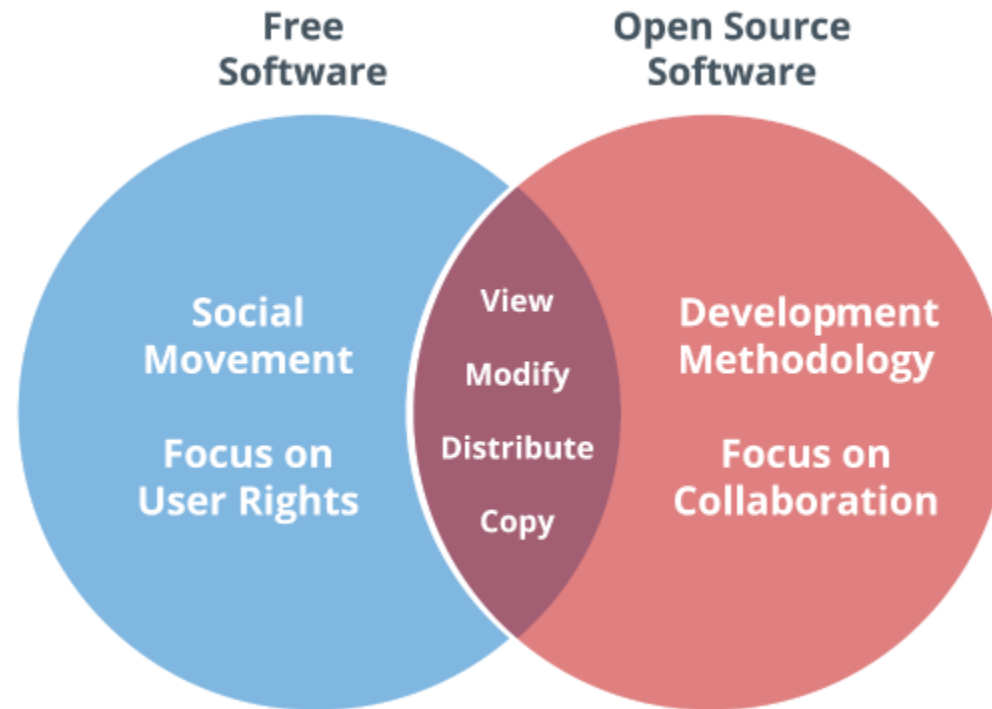
Open Source Software
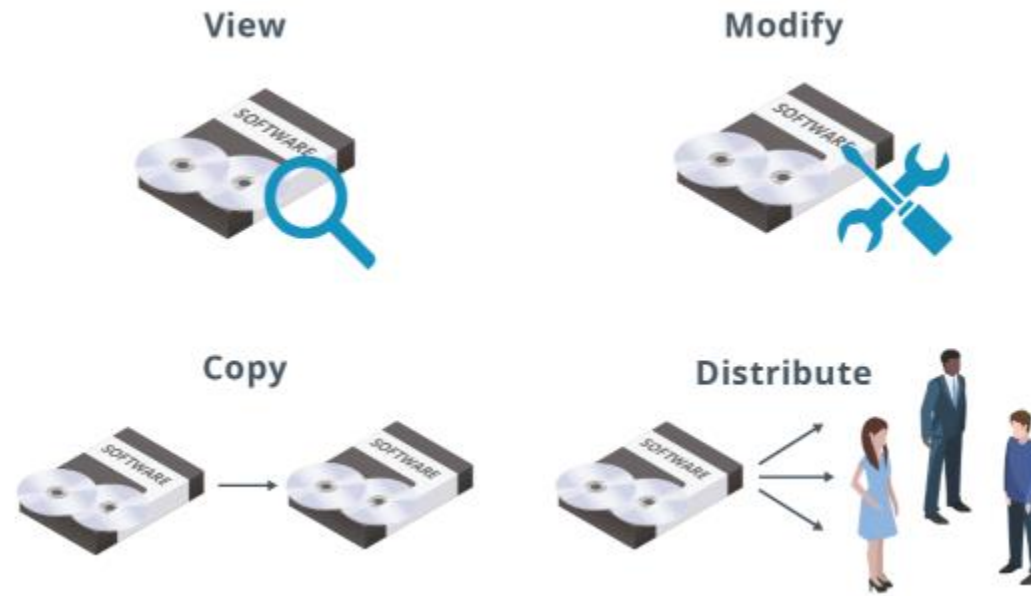
Permissions granted by open source software

Free Software

- ***Free software*** is often used interchangeably with OSS.
  - OSS – Primarily fosters open collaboration when developing software
  - Free software – Primarily focuses on upholding the rights of the user.

- Free, in this sense, means "freedom"
  - Not as in "having no monetary cost"- That's "*freeware*"

- **Free and Open Source Software (FOSS)**
  - Any software project that embodies both ideas.

Free Software and Open Source Software

Free software and open source software

FOSS Licenses

- Some FOSS licenses available to software developers:
  - Apache License
  - Berkeley Software Development (BSD) license family
  - Creative Commons Zero (CC0)
  - Eclipse Public License (EPL)
  - GNU General Public License (GPL)
  - Massachusetts Institute of Technology (MIT) License
  - Mozilla Public License (MPL)

The GNU Project

- **The GNU** ("guh-new") **Project** is a free software project led by Richard Stallman.
  - Considered to have launched the free software movement.
  - http://www.gnu.org
  - First announced in 1983
  - Goal was to create a complete operating system built using entirely free software.

The GNU Project

- GNU stands for "GNU's Not Unix"
  - Describes its similarity to the proprietary Unix operating system.
  - Would not contain any proprietary Unix code.

- By the early 1990's, the GNU Project didn't complete a full operating system.
  - Had created several programs that remain in use today, such as
    - GNU C Compiler (GCC)
    - Emacs text editor

The Free Software Foundation

- The Free Software Foundation (FSF) is a non-profit organization that promotes the philosophy of free software.
  - Founded by Richard Stallman
  - https://www.fsf.org

- **GNU General Public License (GPL)**
  - Created by the FSF and Stallman
  - One requirement of the GPL is that any derivative of software distributed under the GPL must also be distributed under that same license
    - *Copyleft* (as opposed to a copyright).

The Unix Philosophy

- GNU software is based on the design of Unix
- Tends to conform to the ***Unix philosophy***
  - A set of practices and approaches to software development
  - Emphasizes simplicity and modularity

- Several key points…

The Unix Philosophy

- Do one thing and do it well
  - Build smaller individual tools that perform a specific function
  - Don't build a single large program that performs numerous, unrelated tasks.

- Worse is better
  - Limited functionality is often superior to too much functionality.
  - Makes the program easier to use and maintain/update/modify.

The Unix Philosophy

- Support interactivity
  - Software tools should work well with other software tools

- Handle input/output streams
  - Allow the output of one tool to be the input to another tool.

The Linux Operating System

- Linux is a family of operating systems based on the Linux kernel.
  - Operating System: A set of software components that control a computer's hardware
  - Kernel: The OS's core software component that manages all components in the computer system.

- Created by Linus Torvalds in 1991.

The Linux Operating System

- Linux kernel was released under the GPL.

- Most distributions of Linux include GNU software.

- First full operating system to qualify as FOSS.

- The FSF calls the collective Linux OS family "**GNU/Linux**"

The Linux Operating System

Linux is a combination of the Linux kernel and GNU software

Linux Advantages

- FOSS nature promotes transparency
- Highly customizable
- Highly reliable
- Integration with major programming languages
- Security
- Most distributions are free of monetary cost

Linux Disadvantages

- Presents a steep learning curve from other operating systems like Windows or OSX.

- Less support than commercial operating systems.
  - Development (kernel and applications) is primarily based on community contributions.

- No single official version of Linux, which can be confusing.

Linux Distributions

- Linux is a family of operating systems based on the Linux kernel

- A ***Linux Distribution*** ("**distro**") is a member of this family.

- All distros are based on the Linux kernel
  - The additional software and applications included with a distro will vary.

Linux Distributions

- Some common distributions and derivatives:
  - Debian
    - Ubuntu – Very popular general-use Linux OS
    - Kali Linux – Cybersecurity and penetration testing
  - Red Hat Enterprise Linux – Paid customer support
    - Fedora – Community version of RHEL
    - CentOS – RHEL without customer support
  - SUSE Linux Enterprise Server – Paid customer support
    - openSUSE – SLES without customer support

- https://www.distrowatch.com

Where Linux is Found

- Internet Servers
- File and Print Servers
- Application Servers
- Cloud Systems
- Supercomputers

- Scientific Workstations
- Office/Personal Workstations
- Cybersecurity Workstations
- Mobile Devices

Where Linux is Found

- Internet Servers
  - Web Servers
  - DNS Servers
  - DHCP Servers
  - Time Servers
  - Mail Servers
  - FTP Servers
  - Authentication and Certificate Servers
  - Routing Servers
  - Firewall and Proxy Servers

Where Linux is Found

- File and Print Servers
  - Network File Systems
  - Printer Server

- Application Servers
  - Database Servers and Database Management Systems

Where Linux is Found

- Cloud Systems
  - Software as a Service (SaaS) – Cloud server hosts the software and is accessed through the Internet (Facebook, Twitter, etc.)
  - Platform as a Service (PaaS) – Cloud provider hosts a company's web application. (Amazon Web Services, Microsoft Azure, etc.)
  - Infrastructure as a Service (IaaS) – Cloud provider hosts hardware and software; Customers install, manage, and access their own virtualized operating systems called **containers**.

Where Linux is Found

- Supercomputers
  - ***Clustering-*** Combining several smaller computers to function as one large supercomputer

  - Beowulf Cluster- Common Linux clustering where one master computer sends instructions to several slave computers to perform tasks concurrently.
  - Uses a Message Passing Interface (such as OpenMPI)

Where Linux is Found

- Scientific/Engineering Workstations
  - Many OSS programs available for many scientific disciplines such as:
    - Physics
    - Chemistry
    - Data Mining
    - Statistics and Modeling
    - Electrical Engineering
    - Artificial Intelligence

Where Linux is Found

- Office/Personal Workstations
  - Open Source Software for
    - Graphics editing
    - Desktop publishing
    - Media
    - Financial
    - Office productivity

Where Linux is Found

- Cybersecurity Workstations
  - Tools for vulnerability assessment and penetration testing.

- Mobile Devices (Smartphones and Tablets)
  - Android
  - AsteroidOS
  - Sailfish OS
  - Tizen
  - Ubuntu Touch

Linux Support

- HOWTO documents
  - Linux Documentation Project (LDP) – https://www.tldp.org

- Linux User Groups (LUGs)
  - Regional groups of Linux users who meet to discuss Linux-related topics, issues, and problems.
  - Philadelphia-area Linux User Group (PLUG) – http://www.phillylinux.org

- Online Forums
  - https://www.linuxquestions.org

The Linux Kernel

- The Linux Kernel is the core component of any Linux distribution.
  - https://www.kernel.org

- It (and much supporting software) was written in the C programming language.

- The Linux Kernel is developed and updated continuously.
  - You may need to update/upgrade the kernel to support new hardware or to fix problems and patch security vulnerabilities

Kernel Versions

- The different versions of the Linux kernel are identified by three numbers.
  - Major Number (Major version of the kernel)
  - Minor Number (A minor revision to the major version)
  - Revision Number (Most current change to the minor revision)

- For example, Linux Kernel with the version number 4.17.6 indicates:
  - Major Number: 4
  - Minor Number: 17
  - Revision Number: 6
  - This would be the sixth release of the 4.17 kernel, which is the seventeenth release of the version 4 kernel.

Kernel Versions

- Sometimes, a fourth number is added to indicate a critical security patch.

- ***Production kernels*** are versions of the Linux kernel that has been thoroughly tested and are considered stable.

- ***Development kernels*** are versions that are not fully tested and not yet stable.

Kernel Versions

- Development kernels end with -rc (**release candidate**) and a number indicating the version.

- For example, 4.18-rc3 would be the third release candidate for the 4.18 kernel.
  - Once it is tested and declared stable, it will become the 4.18.0 production kernel.

- Be sure to only use production kernels on essential servers.
  - Development kernels are untested and may cause issues.

Kernel Versions

- ***Distribution kernels*** are versions of the Linux kernel produced by a specific distribution.

- Typically will list a patch number, distribution identifier, and architecture after the major, minor, and revision number.

- For example: 4.17.6-100.fc28.x86_64
  - 100th *distribution* release of the 4.17.6 production kernel
  - 64-bit version (x86_64) of the Fedora Linux 28 distribution (fc28)

User Interfaces

- Users typically interact with an operating system through a user interface.
  - **Command Line Interface (CLI)** – Computer users enter commands into a prompt to interact with the operating system and use applications.
  - **Graphical User Interface (GUI)** – Computer users interact with the OS and applications by clicking buttons, menus, and icons.
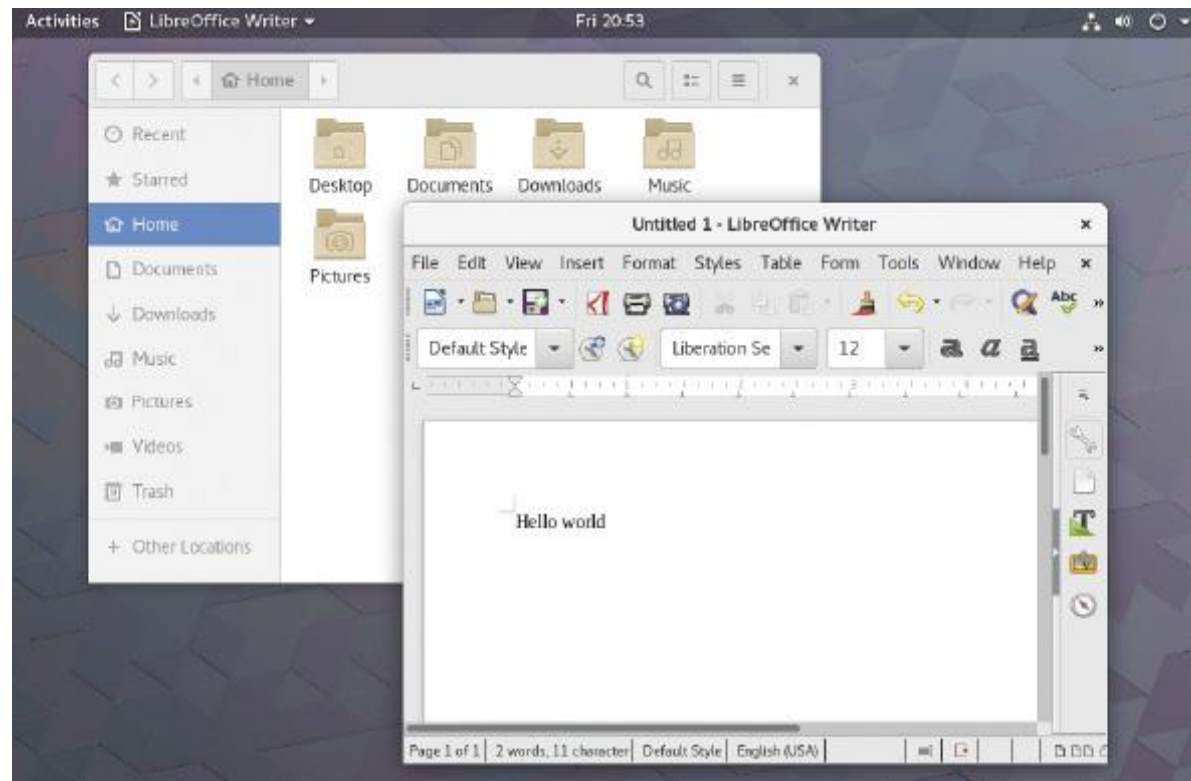
User Interfaces

- Command Line Interface

```
root@cd6a623ef493:/# useradd jdoe1
root@cd6a623ef493:/# adduser jdoe2
Adding user `jdoe2' ...
Adding new group `jdoe2' (1001) ...
Adding new user `jdoe2' (1001) with group `jdoe2' ...
Creating home directory `/home/jdoe2' ...
Copying files from `/etc/skel' ...
Enter new UNIX password:
Retype new UNIX password:
passwd: password updated successfully
Changing the user information for jdoe2
Enter the new value, or press ENTER for the default
        Full Name []: Jane
        Room Number []: Doe
        Work Phone []: 3034421345
        Home Phone []:
        Other []:
Is the information correct? [Y/n] Y
root@cd6a623ef493:/#
```

User Interfaces

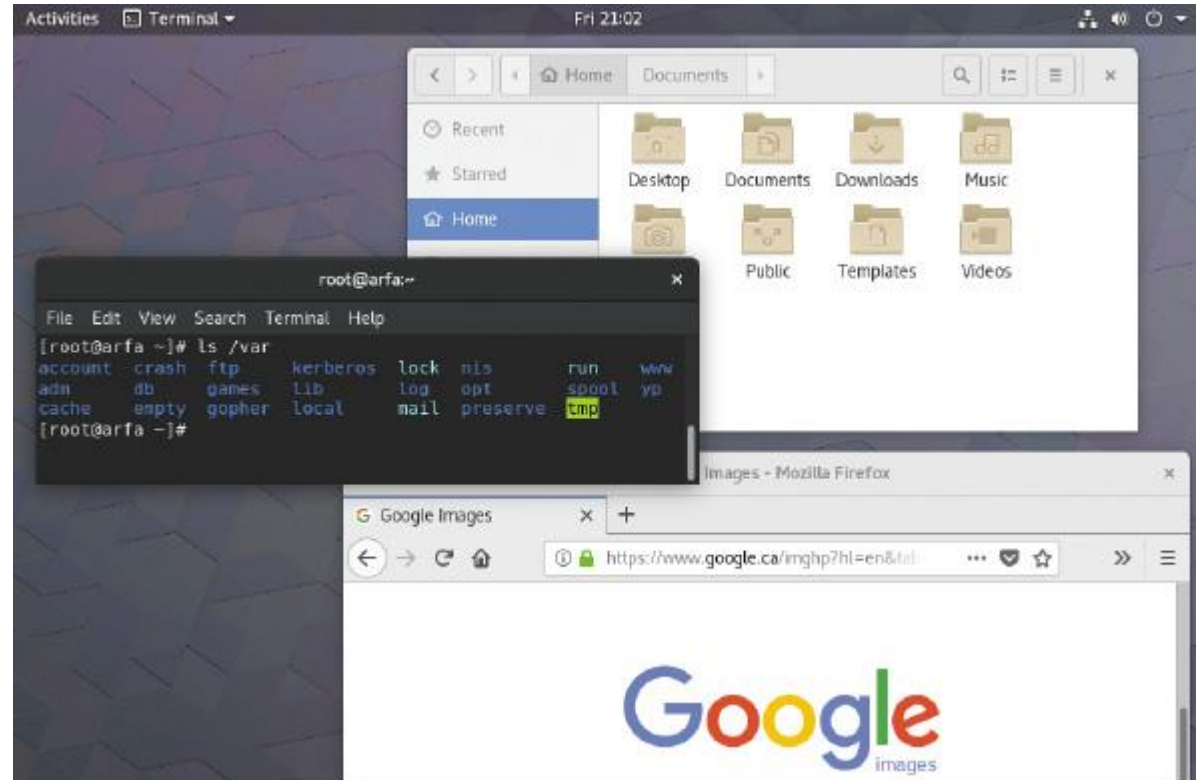- Graphical User Interface

User Interfaces

- A core component of the Linux GUI is **X Windows**
  - Displays graphics/windows.
  - **X.org** – Latest implementation of X Windows based on the original MIT X Windows project
  - **Wayland** – Alternative to X.org designed to be easier to develop and maintain.

- X Windows in combination with window managers and desktop environments create the look and feel of the Linux GUI.

User Interfaces

- Two primary Linux Desktop Environments:
  - GNU Network Object Model Environment (GNOME)
  - K Desktop Environment (KDE)

- Usually comes down to preference.

- Graphical toolkits
  - GNOME uses the gtk toolkit for creating windowed applications
  - KDE uses the qt toolkit

User Interfaces

- GNOME Desktop

User Interfaces

- KDE Desktop