Matrix, Commands, File Systems

OPS102 Week 2 Class 1

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Seneca Polytechnic

Outline

Introduction and How This Course Works

Welcome to OPS102

- OPS102 – Operating Systems for Programmers
- An introduction to Linux and Windows
- For software developers
- First offered Fall 2023, replacing ULI101 for SDDS students
- See the official OPS102 course outline

Course and Mark Breakdown

- Labs – 20%
  - 10 labs throughout the term
  - You must submit all labs
- Quizzes – 25%
  - 7 quizzes throughout the term, top 5 results are used
- Mid-Term Test – 25%
  - Week 7, just before the study break
- Final Test – 30%
  - Final week of the term

Swapping Weeks 1 and 2

- For OPS102 section(s) NEE in fall 2024
- In calendar week one, I'll present course week two material
- In calendar week two, I'll present course week one material
- Why? Because I think the week two topics will help you in your other courses (e.g. IPC C Programming)

Recap From/Upcoming In Week One

Recap From/Upcoming In Week One

- Course introduction and overview
- Operating system basics, components, and interfaces
- A bit of history
- Command line basics
- A little bit about licensing

Connecting to matrix

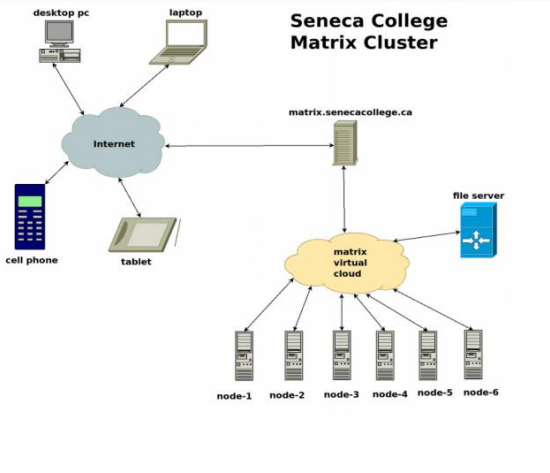
Connecting to matrix

- For your coursework, you will have access to machines running both Windows OS and Linux OS.
- Most (all?) lab computers have Windows 10 installed on them.
- Linux is available on a server cluster called “matrix”.
- All Seneca students get an account on matrix.
- You will connect with matrix and practice Linux commands.
- The matrix cluster has been configured to allow users to only interact with the Linux OS using a command line interface (CLI).
- In the next few slides, you will learn more about matrix and how to connect to it.

More About matrix

- The matrix server consists of several computers running “CentOS” (a version of Linux) all working together to form a cluster.
  - I think matrix is a set of virtual machines (VM’s) on HyperV, with a big disk partition on one node, shared via NFS, fronted by some sort of load balancer?
- A cluster is a cost effective alternative to larger servers.
- All registered students in this course have access to an account on Matrix. You will be using your matrix account for:
  - practicing Linux commands
  - performing Linux labs
  - reference during quizzes and tests

More About matrix - the Picture



To connect to matrix, You Must be “On Campus”

- The matrix cluster is at Seneca, on the Newnham campus
- Only very limited access to matrix is allowed from off campus
  - Web access is allowed, but not command line login
- To access matrix, you must be either
  - On campus, in a lab, or connected to SenecaNet
  - Or, off campus, and connected to the Seneca VPN
- For information about VPN access, see https://students.senecapolytechnic.ca/spaces/186/it-services/wiki/view/1024/vpn

Using SSH to Connect to matrix

- You can connect to matrix from any Seneca lab workstation, or from your personal computer.
- Since you will be connecting to a remote computer using your login and password, it is important that the connection is secure.
- We will use `ssh` (secure shell) to connect to matrix.
- SSH is a protocol for secure remote login/connection from one computer to another.
  - The `ssh` command implements the SSH protocol.
- Applications using SSH provide secure, encrypted communications over a network connection.
- More on SSH (link): Extra Topics - SSH - week 13

Accessing matrix from Windows

- If you are running Windows 10 or newer versions, you can use Windows CMD window to run the `ssh` command.
- Alternately you can download and install a third party SSH client program, such as:
  - SSH Secure Shell Client
  - PuTTY
  - Or see the list at: https://en.wikipedia.org/wiki/Comparison_of_SSH_clients
- The next two slides show connection to matrix using windows CMD and the third party tool `PuTTY`.
- You will use the same user and host names with any SSH client.

Connecting to matrix from Windows CMD

- Open a Windows CMD window, and then (in the terminal), type the following command and press the enter key:

  `ssh senecausername@matrix.senecapolytechnic.ca`

  Remember to replace `senecausername` with your actual username.
- Type yes and press the enter key for any questions it may ask.
  - On your first connection, it will ask you to confirm the "fingerprint" of matrix – enter `yes`.
- Type your Seneca password at the `password:` prompt and press the enter key.
- You should see a prompt from `bash` something like this:

  `[senecausername@mtrx-node01pd ~]$`

Oh oh! Something Didn't Work!

If you encounter an error message, and don't get properly logged in to matrix – don't worry! Read the error message you received.

Problems can occur for several reasons:

- You mis-spelled `matrix.senecapolytechnic.ca`
- You mis-spelled your matrix username (same username that you connect to my.senecacollege.ca)
- You have CAPS LOCK on by mistake (your username should be lowercase only).
- You mis-spelled your password (same password that you use to connect to my.senecacollege.ca)

The Look of Success

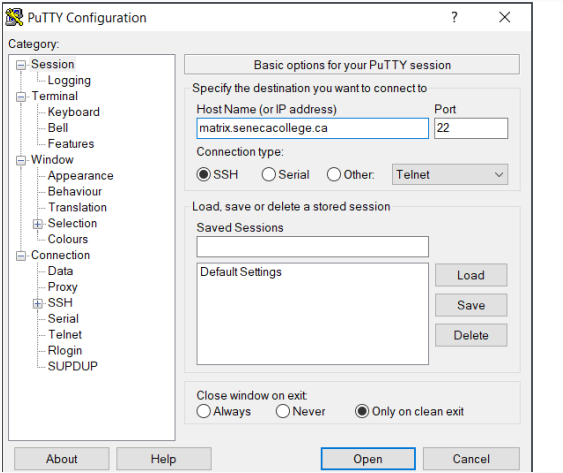
```
C:\Users\tiayyba.riaz>ssh tiayyba.riaz@matrix.senecacollege.ca
##############################################################################
#
# Welcome to Matrix
#
# You are accessing a private utility and information that is strictly
# confidential on a server owned by Seneca College and maintained by
# Information Technology Services
#
# All connection attempts are logged and strictly monitored.
# All unauthorized connection attempts will be fully investigated
# and dealt with appropriately.
#
# All activities on this system are governed by
# Seneca Information Technology Acceptable Use Policy
# For complete ITAU policy visit http://www.senecacollege.ca/policies/itau.html
#
##############################################################################
Starting September 1, 2020, Login to VPN will be required to SSH to matrix.

Students: studentvpn.senecacollege.ca
Faculty: senecavpn.senecacollege.ca

Instruction on using VPN: https://employees.senecacollege.ca/spaces/77/it-services/wiki/view/3716/vpn
tiayyba.riaz@matrix.senecacollege.ca's password:
```

Connecting to matrix Using **PuTTY**

- Download PuTTY for Windows from Download PuTTY and run the installer
- Run the PuTTY command and use the settings:
  - Host Name: matrix.senecapolytechnic.ca
  - Port: 22
  - Connection Type: SSH

  and click **Open**
- A terminal window should pop up, asking you to confirm the matrix signature, and then asking for who to login as (your username) and then your password.

The Look of PuTTY - Part 1



The Look of PuTTY - Part 2

Connecting to matrix from MacOS

- In Finder window, open Applications > Utilities > Terminal
- And then continue the same as in Windows CMD on slide 16

  `ssh senecausername@matrix.senecapolytechnic.ca`
- On a Linux machine? Same thing.

Remember to Log Out!

- When you're finished on matrix, remember to log out
- Don't just close your terminal window
- Use the `exit` or `logout` commands to disconnect from matrix
  - You can also use `ctrl-D` to exit – why?
  - Because `ctrl-D` means "end of file"
  - See the linux man page for ASCII: `man ascii`
- Why exit cleanly? To help make sure you haven't left anything running.

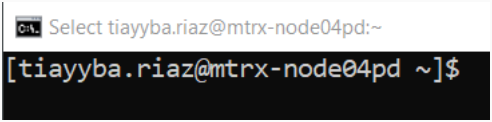
Simple Commands to Start With

The Command Prompt

- Command line interfaces almost always start each line with a “prompt string” before waiting for you to type a command.
- The prompt will often contain useful information
  - But usually in a terse format
  - So as not to use a lot of space on the line

Linux Default Command Prompt

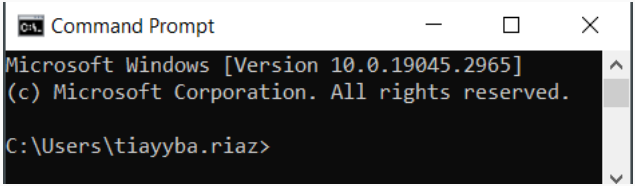
A common default **bash** shell prompt string:



- **tiayyba.riaz**: username of the current user
- **mtrx-node04pd**: local name of the computer
- **~**: shorthand for the user's home directory
  - Every user has a default "home directory" (default folder)
- **$**: a dollar (or percent) sign indicates a normal user
- **#**: a hash or number sign indicates administrator permissions ("root" permissions)

Windows CMD Default Command Prompt

The standard Windows CMD prompt string:



- C:\Users\tiayyba.riaz: Indicates the current directory
  - In this case, the home directory of the user "tiayyba.riaz"
- Home directories are usually named for the user's username
- Both Windows and Linux allow you to set your prompt to (almost) anything you want.

General Linux and Windows Commands

Now that you have successfully connected to matrix, and you also have access to Windows CMD, let's look at some basic commands:

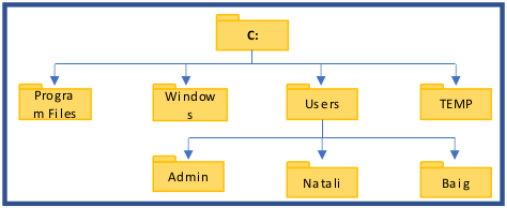
Windows	Linux	Description
echo	echo	Print something on the screen
	cal	Display calendar
date /t	date	The `date` command in Linux shows date and time.
quser	who	Prints information about the currently logged in user(s) (quser – Windows server only)
whoami	whoami	Prints name of current user
cls	clear	Clears the terminal screen and shows prompt in first line
tree	tree	Shows the folder (and file) hierarchy in tree format
dir	ls	List information about files/folders

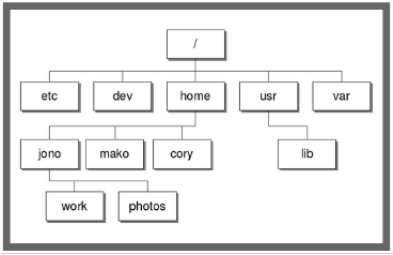
Hierarchical File Systems

File Systems

- A file system is a method of organizing and retrieving files efficiently from a storage medium e.g a hard disk.
- Both Linux and Windows use hierarchical file systems
- Files are organized in folders and subfolders
- The original (pre-GUI) name for folders is “directories”
- In Windows File System, the hierarchy starts from drives: C, D etc
- There are no drive letters like C, or D in Linux
- In Linux, The topmost directory is the root (/)
  - All files and directories appear under root
  - Windows has a per-drive root directory e.g. C:\

File Systems in Pictures





Files and Folders

Files and Folders (Directories)

- Virtually everything in a modern computer system is a file or a folder
- Folders, like their real-world counterparts, are containers that can have files and other folders (called sub-folders). Some Examples:
  - Home folder
  - Desktop folder
  - Root Folder
- Files are used to save user data (or any data) in them
- Files can be of many different types, for example:
  - Word DOC document file
  - C programming language source file
  - Compiled object code file
  - sqlite database file

Files and Folders (Directories) - cont'd

- Types of files are identified from their extensions – the 3 or 4 last characters after a period/dot. Examples:
  - `.docx` – Microsoft Word documents
  - `.exe` – an executable program on Windows
  - `.txt` – a text file
- You need a specific program or application to open each file. Windows examples:
  - Notepad program opens a `.txt` file
  - MS Word opens a `.docx` file
  - You can use an image viewer program (like MS Paint) to open `.png` or `.jpg` files
- If your system does not have a required program for a particular file type, you cannot open that file properly.
- File extensions are less important on Linux, and not used on MacOS.

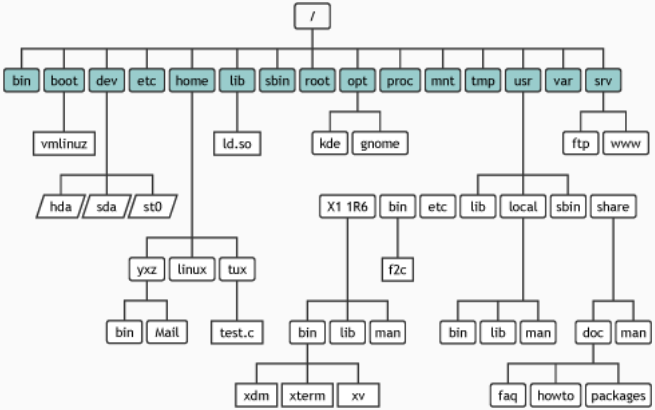
File and Folder Names

Before learning to create directories, it is important to understand what represents an appropriate filename. Here are some guidelines:

- Unix/Linux is case sensitive! Windows is not case sensitive for file names.
- Adopt a consistent file naming scheme – this will help you find your files later.
- Make your file and folder/directory names meaningful.
- Avoid non alphanumeric characters, as they may have a special meaning to the system that will make your work more difficult.
- Avoid using spaces in file names – consider periods, hyphens, and underscores instead, spaces in file names can lead to inconsistent results while working in command line interface.
    - More later about other special characters to avoid.

Linux Hierarchical File System

A standard Linux distribution follows a directory structure like this:



Linux – Standard Directories

Common top-level directories that you should be aware of:

Directory	Purpose
/	Root, top of file system hierarchy
/bin	Common system binaries (commands)
/home	Contains users' home directories
/usr	This is called "user", where user related programs live
/usr/bin	Common utilities (commands) for users
/usr/sbin	Common utilities for system administration
/etc	System configuration files (eg. passwd)
/var	Dynamic files (log and mail files)
/tmp /var/tmp	Temporary files for programs
/dev	Device driver files (terminals, printers, etc)
/opt	Additional installed application programs

Paths: Absolute, Relative, Relative to Home

File and Directory Paths

- A path specifies a unique location of a file or directory in the file system.
- The file system location is found by following the directory tree hierarchy.
- A path is written as a string of characters in which directories are separated by the path separator: a (forward) slash "/" in Linux and MacOS, or a backslash "\" in Windows.
- There are multiple ways of specifying pathnames
  - Absolute pathnames
  - Relative pathnames
  - Relative to home pathnames
- Examples
  - /home/cory
  - /home/jono/work
  - C:\Users\Natali

Pathname Types

- Absolute pathname: A full pathname that starts from the root of the hierarchy. Examples:
  - `/home/jones/Desktop/paris.jpg`
  - `D:\Trips\Paris\Louvers\`
- Relative pathname: A pathname that does not start with a slash is a relative pathname, and is interpreted relative to the current directory. Example (the argument to `cat` is relative to CWD):

  ```
  [jane@machine: /home/jane/Documents/]$ cat ./Math/marks.txt
  ```
- Relative to home pathname – on Linux/Unix a tilde (“∼”) is used as a shorthand for the user’s home directory. Example: from anywhere show the contents in Documents folder

  ```
  [jane@machine: /var/log/]$ ls ~/Documents/
  ```

Current Working Directory

Current Working Directory

- Current working directory is the folder/directory where you are working at a given time.
  - If you are viewing Documents folder in file explorer, then Documents is your current working directory
  - If you are viewing pictures from your Photos folder, then Photos folder is your current working directory
- Current working directory is a more important concept, when you are interacting with your system through a command line interface.
- Whenever a user opens a terminal, their home directory is their current working directory.
- We can navigate in the file system and change our current working directory any time using the `cd` (change directory) command (Linux and Windows).

Changing the Current Working Directory

- In a CLI, we use the command `cd` to change our current working directory.
- The argument can be any type of path (absolute, relative or relative to home).

Examples of cd in Linux	Examples of cd in Windows

`cd /bin`
change directory to `"/bin"`
	`cd D:\Courses\OPS102`
	change directory to
	`"D:\Courses\OPS102"`

`cd` change directory to your home directory	`cd` display current directory
`cd ~` change directory to your home directory	
`cd ..` Change to parent directory	`cd ..` Change to parent directory

Listing the Contents of a directory

- Often you would need to list the contents of a directory when you are working in CLI.
- In Linux, the command `ls` is the most commonly used command to display a list of files and subdirectories in the current directory or of any other directory.
- The equivalent command in Windows is `dir`

Examples of ls in Linux	Examples of dir in Windows
`ls` List the contents of current directory	`dir` List the contents of current directory
`ls /bin` List the contents of `/bin`	`dir D:\` List the contents of D drive

Checking File Types in Linux with ls

Use `ls -l` (detailed listing) and the first character indicates the file type:

```
tiayyba@ubuntu:~$ ls -l /dev/tty
crw-rw-rw- 1 root tty 5, 0 May  5 02:10 /dev/tty
tiayyba@ubuntu:~$ ls -l md5test.txt  sign.sh
-rw-rw-r-- 1 tiayyba tiayyba  21 Apr 14 11:09 md5test.txt
-rw-rw-r-- 1 tiayyba tiayyba 301 Apr  3 10:48 sign.sh
tiayyba@ubuntu:~$ ls -ld EncDec
drwxrwxr-x 2 tiayyba tiayyba 4096 Dec 17 23:46 EncDec
tiayyba@ubuntu:~$
```

Checking File Types in Linux with ls - cont'd

Character	Meaning
-	a regular file
b or c	a device special file
d	a directory
l	a symbolic link (like a Windows shortcut)
p	a named pipe, for inter-process communication (IPC)
s	a Unix domain socket, also for IPC

Summary

- Introduction to matrix and SSH
- Some simple commands
- Hierarchical file systems
- Files and folders (directories)
- Pathnames – absolute, relative, relative to home
- Current working directory, and directory contents