2nd CCU Workshop on remote access

Today's Schedule

- 09:00 to 09:30 – Tmux
- 09:30 to 10:45 – SSH, SSH keys, SCP and rsync
- 10:45 to 11:00 – Intermission/Questions
- 11:00 to 11:45 – Tunneling and port forwarding
- 11:45 to 12:15 – Mosh
- 12:15 to 12:30 – remote text editors: vim and nano

You might remember me from ...

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Data analysis meetings began in 2022 with Jacob Davidson and myself as organizers

Jacob Davidson

Daniel S. Calovi

IMPRS – Introduction to Scientific Coding workshop

The Data Science Consultancy

Join our CASCB Slack channel

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Why are we offering this workshop?

- Most of the High Performance Computing (HPC) infrastructure available are only accessible through ssh/terminal
- We would like to remove this barrier that prevents users from fully using these solutions

Persistent terminals add macos shortcut

- tmux is a terminal multiplexer (multiple terminal sessions) that keeps them alive even after closing them, to create a new session write:
  - tmux new -s session_name #to start a new session
  - ctrl+b is the default “primer” shortcut to activate other commands
  - ctrl+b then : opens the command mode
  - To close (completely) a tmux session active command mode (ctr+b then :) and type
    - kill-session #the status bar is on the bottom by default
  - To go back to the terminal, without closing the session, you can detach it:
    - ctrl+b, then d
  - You can list any existing sessions by typing:
    - tmux ls
  - To go back to an existing session, you have to attach to it:
    - tmux attach -t session_name

Persistent terminals

- You can personalize tmux to your heart's content, here are a few examples:
- You can split terminals:
  - ctrl+b, then % - to split into 2 vertical panes
  - ctrl+b, then " - to split into 2 horizontal panes
  - ctrl+b, then arrow keys - to navigate the panes
  - ctrl+b, then x – to close a pane
- You can create new windows
  - ctrl+b, then c - to create a new window
  - ctrl+b, then n or p - to cycle through windows
- You can rename a window
  - ctrl+b, then , (comma) - check status to see the name
- You can list all open windows
  - ctrl+b, then w

Min maxing tmux

- Tmux is hyper customizeable
- It has a config file normally at ~/.ttmux.conf
- You can basically reset everything
  - Emacs shortcut mode
  - Vim shortcut mode
  - Colors
  - Default splits and windows
  - Enable mouse support

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  - Emacs shortcut mode
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  - Colors
  - Default splits and windows
  - Enable mouse support
  - Twitch integration!

Persistent terminals

- If you ssh into a remote machine through a tmux terminal, you are not guaranteed to keep the the ssh alive until reconnection
- The best practice is to ssh or mosh in to the remote machine, and then open a tmux session on the remote machine
- Similarly, tmux sessions are killed if the computer running it is shutdown

IP addresses

- Private and public IP addresses
  - Private IP addresses are the ones you have inside your own network
  - Public IP addresses is what the internet sees
- E.g. At home you usually have one router, and everyone connected to it. While accessing a website the website will register your public IP, but if you need to connect to a different computer in your home network, you will need their private IP
- Virtual Private Networks (VPNs)
  - A VPN creates a secure tunnel between your machine and a remote server, often assigning you a new public IP and/or providing you with a private IP within a different Network
    - Used for security reasons to make your connection opaque to your network manager
    - Used for security reasons to grant you access to a network so that you can access computers within

SSH security measures

- Normally your computer will only be able to make outgoing connections to other computers
- The next step is allowing you to receive incoming connections from the local network
  - This usually means installing/managing a firewall, in Linux ufw would be most common choice
    - apt install ufw ; ufw allow ssh; ufw enable

SSH security measures

- The third, and very unusual and unsafe step, would be to open your local machine to be accessible from outside your local network (internet-facing)
  - Usually this is not a problem, since most of the time we are behind routers, knowing your public IP would only allow them to see your router, not your local machine
  - Complicated steps would be necessary to make your local machine accessible from an external network → Network Address Translation (NATs, old school gamers will probably remember these)

Why I am explaining all this?

- Private IPs matter
- It is often the case that we want to transfer files to and from remote machines
- When machines aren't on the same network, it's usually easier to initiate a file transfer from the local machine — either by requesting files from the remote machine or by sending files to it.
- This approach generally simplifies the process compared to initiating the transfer from the remote machine (avoid setting up a NAT)

Learning by doing it

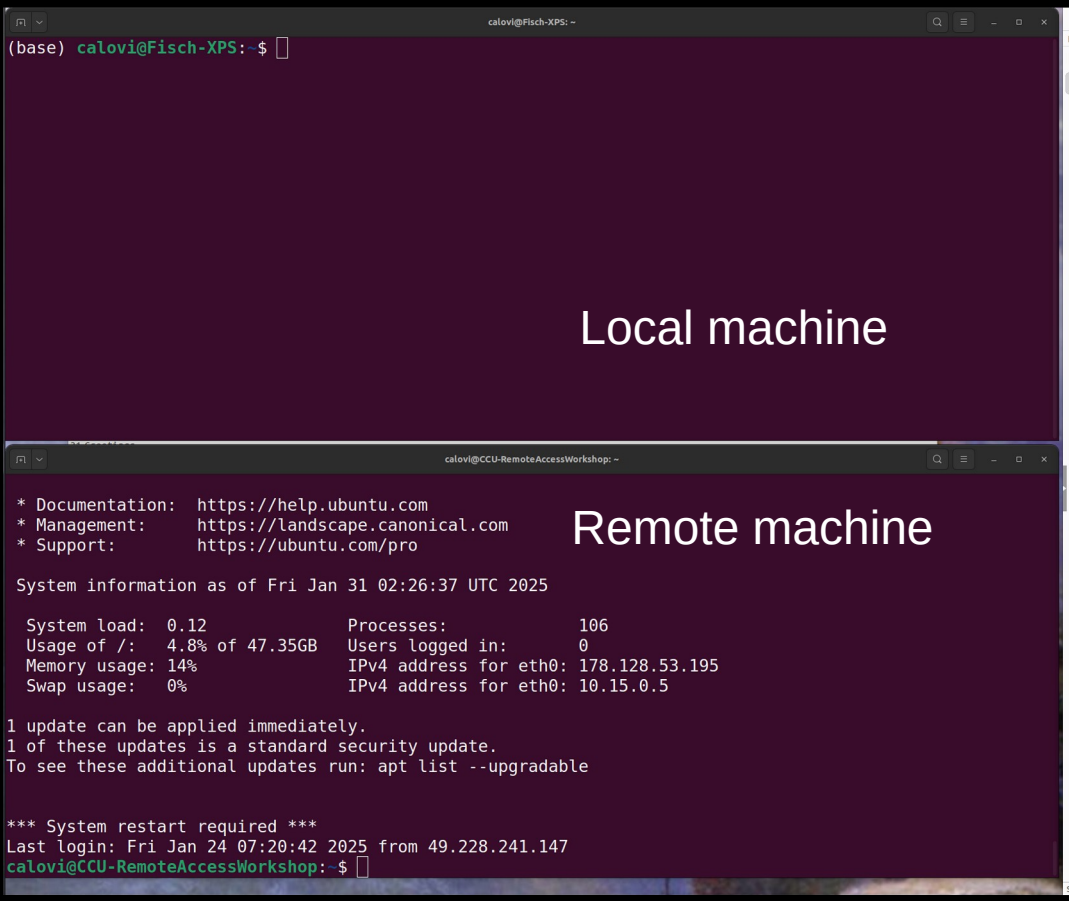
- MacOS and Linux users should open a terminal
- Windows users should open the Ubuntu installation mentioned in the e-mail last week
  - This is something similar to what Windows users should be seeing:

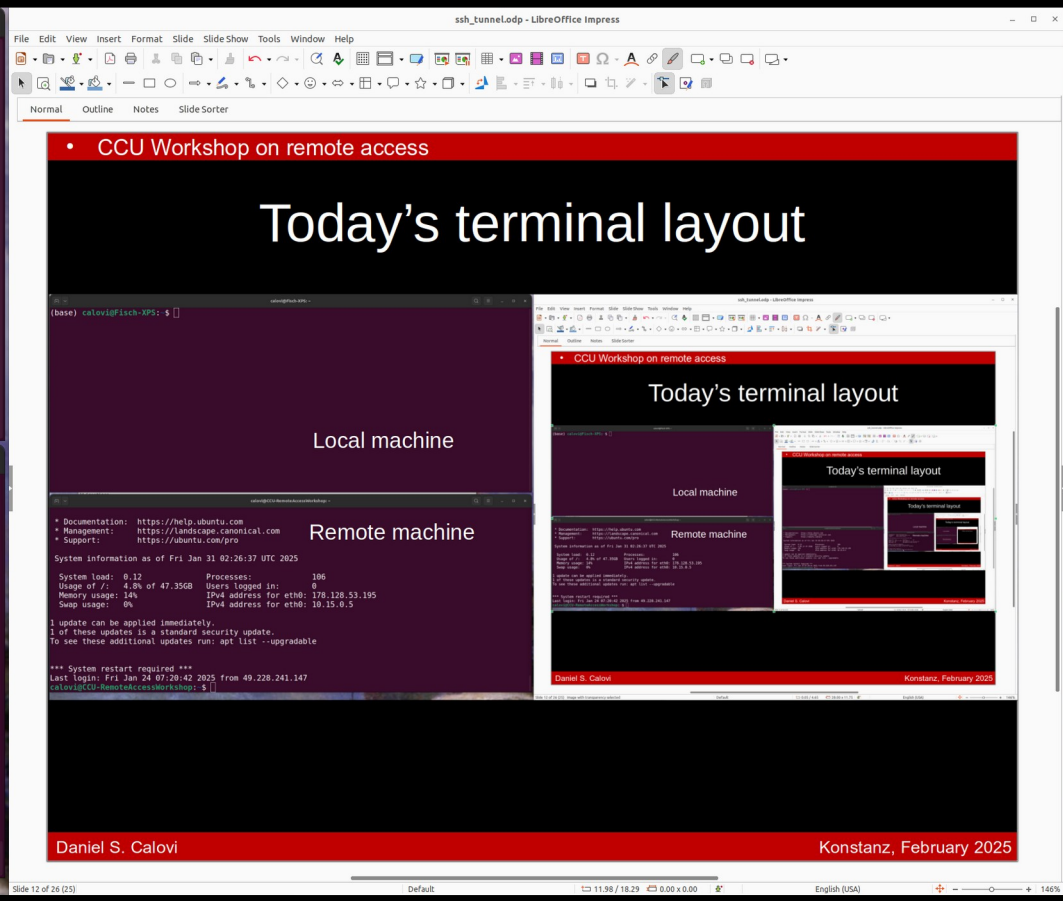
Learning by doing it

- Open a terminal
- In Windows, open the WSL terminal (Ubuntu most likely)
- Create a folder where we will work today
  - In Windows, open the file explorer and create the folder inside the Ubuntu/Linux icon on the left bar
- Unzip the file into the working directory you created
- In the terminal access the folder you are going to work on
  - In case you want to work inside the Windows folder structure, access normal windows folders in: **/mnt/c/**

```
calovi@DESKTOP-M1LE1C2:~$ cd /mnt/c/Users/Calovi/Downloads/
calovi@DESKTOP-M1LE1C2:/mnt/c/Users/Calovi/Downloads$ ls
 BoseUpdaterInstaller_7.1.13.5138.exe  'Docker Desktop Installer.exe'      SteamSetup.exe
 Cellects                              Example                             ZoomInstaller.exe
'ChromeSetup (1).exe'                  Example.zip                         ZoomInstallerFull.exe
 ChromeSetup.exe                       LibreOffice_24.8.4_Win_x86-64.msi   desktop.ini
calovi@DESKTOP-M1LE1C2:/mnt/c/Users/Calovi/Downloads$
```

Today’s terminal layout
Change this





Secure Shell (SSH) Protocol

- ssh-keygen
  - most of us use them to avoid having to type passwords later
- ssh localhost
  - Localhost is an abstraction to avoid using the private IP of the local machine
- Syntax of ssh is normally "ssh login@host"
  - Login can be omitted if they are the same between local and remote machines
- You can even ssh into your own machine, or a different user, you can try
  - ssh login@localhost
  - ssh different_login@localhost

Secure Shell (SSH) Protocol

- cd ~/.ssh/ #linux and wsl users
  - ~/ means /home/login/ in linux
- Cd /users/login/.ssh/ #macOS
- What are id_rsa and id_rsa.pub
  - Your identifiers besides a password, once your public key is copied to a remote machine, ***normally*** you don't need to use your password into it anymore
- authorized_keys file
  - These are keys from other computers that can access your machine without ***normally*** using a password
- known_hosts file
  - Every computer you access has some specific information (host key), to avoid spoofing (phishing, man-in-the-middle attacks), your ssh will always warn you if a remote computer has changed their host key

Secure copy (SCP) protocol

- Syntax
  - scp path/to/your/files login@host:path/at/the/remote/location
- Example time, considering the login each one of you have receive, in the local terminal type:
  - touch attendance.txt #creates an empty file
  - scp attendance.txt login@178.128.53.195:~/
- In the remote terminal (bottom) type:
  - ssh login@178.128.53.195
  - ls -l
- If you were copying a folder will subfolders you should use the recursive option
  - scp -r path/to/your/folder login@host:/path/at/the/remote/location
  - Question time, how would you transfer a file from that server to your computer?

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scp login@host:/path/at/the/remote/location/attendance.txt path/to/your/folder/

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scp login@178.128.53.195:~/attendance.txt ~/Workshop_Remote/

remote sync (rsync)

- Ever had a huge list of files in a folder and you wanted to only copy the ones that do not exist in the destination location?
- rsync is your friend (but a bit of a high maintenance one)
- rsync -azulv files/folder login@host:/path/at/remote/location/

remote sync (rsync)

- What is azulv? And what are the MANY options available?

- -a → Archive mode, makes an exact copy
- -z → Compression, compresses the data during transmission, high CPU usage, good for text files, bad for videos or binaries
- -u → Update, skip files that are newer at the destination
- -l → Copy symlinks as symlinks, copies links as links and not the files they are pointing to (maybe too complex for most)
- -v → Verbose, provides detailed output of the process

Test time

- Copy the folder “useless_but_plentifull_files” and all contents inside it to the server in your home

Test time

- Copy the folder “useless_but_plentifull_files” and all contents inside it to the server in your home
  - rsync -azulv useless_but_plentifull_files calovi@178.128.53.195:~/

Add a synchronization issue in rsync

- Script to create a new folder there, and change one of the files
- Then rsync them to get it back
- Look up rsync to check if file was damaged
  - --checksum for checking if corrupted files, but it’s slow

Tunnels and port forwarding

- Sometimes it is useful to create a tunnel between your local machine and a remote one
- Test case scenario: running a jupyternotebook in your office desktop, but accessing it at home
  - ssh -L 8080:localhost:80xx user@178.128.53.195
    - This will create a port forwarding between your remote machine and your local one. Change xx for your password number (1-17)
    - It is exposing the remote machine port 80xx to your local machine port 8080
- We can open a python webserver by typing:
  - python3 -m http.server 80xx
- And then in a browser we can open the URL
  - localhost:8080

ssh -L vs ssh -R

- These tunnels can be incoming or outgoing
- The previous example with ssh -L was requesting a port from the remote machine
- If we want to offer a port to the remote machine, we can use ssh -R

Add a reverse port forward example

- Maybe something that requires them to create files

Tunnels as a means to increase security

- In HPC systems, it is common to have a Frontdoor machine.
- This frontdoor is internet facing (dangerous), and controls access to the powerful computers inside (internal machine)
- Instead of doing two normal ssh connections (one to the frontdoor, and then one to the internal machine) it is worth defining a tunnel for easier access:
- ssh -L 9090:internal_machine_ip:22 user@frontdoor-ip
  - Where 9090 is the port where you are routing the ssh connections (port 22)
- Now you can access that internal machine or copy files to it by using:
  - ssh -p 9090 internal_user@localhost
  - scp -P 9090 /path/to/local/file internal_user@localhost:/path/to/remote/destination

Example of tunnel

- Maybe create 2 servers, one that can only be accessed through tunneling?

Advanced uses of ssh

- You can execute commands directly through the ssh by adding a command after the address:
  - ssh login@178.128.53.195 'mkdir test; ls -lth'
- You can enable graphical interface forwarding by using:
  - ssh -X login@host
    - This is very slow, and should only be used sparingly

Words of caution

- Different administrators can change ssh configurations to disable some of this features
- The root only accessible file /etc/ssh/sshd_config contains a list of several services that can be enabled or disabled
- e.g some remote machines can only be accessed by pre-authorized machines (authorized_keys file), some tunnel features might not work as intended in this scenario
- Xforwarding – allowing access to a remote graphical interface might be disabled, only allowing you to use the terminal

Intermission/Questions

Modifying text files remotely: VIM

- VIM has three basic modes
  - Normal mode, where you can only move the cursor but not edit the text
    - Used to enter the two other modes
  - Insert mode, if pressing “i” or “a” or “o” in normal mode you enter insert mode where you can edit your file
  - Command-line mode, if pressing “:” you activate command-line mode
    - It is in command mode that you can save and quit
      - :q to quit
      - :q! to quit while not saving changes
      - :w to save
      - :wq or :x to save and quit

Modifying text files remotely: Nano

- Nano is a friendlier version of terminal text editing.
- Editing is straightforward, and the shortcuts for the menus appear in the bottom
- Most necessary ones are ctrl-o for saving and ctrl-x for exiting
- nano -c enables line and column counter, useful for debugging indented files like python

Intermittent connections

- Unfortunately SSH is pretty slow, and very sensitive to disconnections
- A very straightforward tool to help with this is mosh
- If you have installed mosh in your computer, use it like a normal ssh and type:
  - mosh login@178.128.53.195
  - Most likely it didn't work by default (waiting for connection on port 60000+)
- To enable the udp connection required for mosh, you can create a rule on your firewall
  - sudo apt install ufw
  - sudo ufw allow 60000:60030/udp
  - sudo ufw reload
- Besides the firewall port additions (one required for each connection), mosh is very simple and straightforward

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Thank you, and questions time