Programming Tools

Most of the programming assignments will require using the C language.

We will use a current version of the GCC C compiler.

What's GCC?

- the Gnu Compiler Collection (see gcc.gnu.org)
- a collection of freeware software development tools, including support for C, C++, Objective-C, Fortran, Java, and Ada
- available as part of all Linux and most UNIX-derived operating systems

How do you get it?

- run Linux on your own computer
- use a remote Linux environment (rlogin cluster)

You will have to use the CS Department's rlogin cluster for some assignments in any case.

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Linux

Read Chapter 1 of the Sobell book for a history of Linux… really…

There are many Linux distributions (distros)… superiority is a matter of religion.

- the CS Department's rlogin cluster and other servers (more later) are running CentOS
- I use CentOS
- CentOS will be the official platform for testing your assignments
- If you run another distro, any difficulties that arise will be your problem

In any case, we require you to run 64-bit CentOS 8 on your own computer.

If you do not do so, expect to have problems.

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Linux Installation Choices

There are options for setting up CentOS as a virtual machine on your computer:

Using a software virtualization tool to run Linux concurrently with your host OS

- well-supported options are available; we recommend VirtualBox
- easy to back up your Linux installation in case of problems
- allows straightforward transfer of data between Linux and your host OS
- does not disrupt your current OS setup
- may suffer from conflict with Hyper-V

Creating a bootable flash drive installation of CentOS

- requires rebooting to change from Linux and your current OS
- cannot break your current OS setup (unless you REALLY mess up)
- should provide a fast CentOS installation (subject to your USB speed)

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Linux Installation Choices

There are options for setting up CentOS natively on your computer:

Running Linux as your only OS
- makes your current OS, and all its apps, unavailable on your computer
- provides the fullest and fastest runtime experience

Using Hyper-V virtualization support to run Linux concurrently with your host OS
- supported on most x86-64 processors
- enabled by default on some installations of Windows 8 and Windows 10
- tends to provide poor performance for CentOS
- does not disrupt your current OS setup

Creating a dual-boot environment for Linux and your current OS
- requires rebooting to change from Linux and your current OS
- fiddly, may break your current OS setup
- I do not recommend this; if you do this, do a full system backup of your computer in advance

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Creating a CentOS Virtual Machine I

Here's my advice:

Install VirtualBox (virtualbox.org).
- I'm using version 6.1.16, but more recent versions should be fine.
- follow the VirtualBox/CentOS Installation notes carefully.

Download a CD/DVD image for installing your chosen distro.
- I used CentOS-Stream-8-x86_64-latest-dvd1.iso.

Install CentOS 8 as a guest OS:
- follow the VirtualBox and CentOS Installation notes carefully.
- make sure you install the VirtualBox Guest Additions (these are essential)

Once you're done, you can boot and run CentOS within a virtual machine.

This minimizes your chances of disrupting your existing system setup.

This works best if your computer has at least 8GB of RAM.

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Dealing with Hyper-V

Hyper-V is a Microsoft technology for supporting virtual machines.

It's a Type-1 *hypervisor*: it runs directly on the hardware and prevents other hypervisors from doing the same

So, Hyper-V and VirtualBox do not coexist peacefully.

This is true despite Oracle's claim that VirtualBox 6 does so…

What to do…?

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Hyper-V

Hyper-V is not an issue if you are running:

OS-X
Linux
Windows 7 (most likely OK)
Windows 8 (most likely OK)
Windows 10 Home
(possibly other low-end versions of Windows 10)

If running these, I recommend just using VirtualBox.

Hyper-V may be an issue if you are running:

Windows 10 Pro, Business or Enterprise

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Avoiding Hyper-V

Hyper-V option 1:

Don't turn Hyper-V on
Use VirtualBox

Hyper-V can be turned off:

https://www.petri.com/how-to-disable-hyper-v-completely-in-windows-10

If you do this, read ALL of the discussion and follow it carefully.

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Living with Hyper-V

What if you need Hyper-V?

Why would you need Hyper-V?

- to use Docker
- to use some of an ever-expanding list of Windows 10 feature updates
  Device Guard, Credential Guard, Sandbox, . . .

Hyper-V option 2: switch back and forth

Turn Hyper-V off when you need to use VirtualBox
Turn Hyper-V back on when you need to use it

Note: disabling Hyper-V requires the steps described on the page linked from the previous slide, AND performing a hard reboot.

IOW, you must shutdown and then reboot your machine.

Simply doing a Windows restart will NOT be sufficient.

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Living with Hyper-V

Hyper-V option 3: set up a CentOS VM using Hyper-V

https://linuxhint.com/install_centos_hyperv/

Be warned:

- fiddly, IMO
- follow the instructions carefully!

- the CentOS VM seems to be slower when running this way, maybe much slower
- I've had display scaling issues with my attempts to do this… YMMV

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Installing CentOS on a Flash Drive

If you must live with Hyper-V, but a Hyper-V CentOS VM is too slow…

Create a bootable USB flash drive for installing CentOS 8:

https://www.how2shout.com/how-to/how-to-create-centos-8-linux-bootable-usb-drive.html#:~:text=%20Steps%20to%20make%20bootable%20USB%20of%20CentOS,just%20like%20any%20other%20Windows%20application...%20More%20

Needs a 16 GB flash drive (or larger) to prepare the installation drive.

Use the bootable CentOS 8 installer to install CentOS on another flash drive:

Needs a 32 GB flash drive (I recommend 64 GB) for the installation.
Plug both flash drives into your computer (use a hub if necessary).
Boot your computer from the installation flash drive created above.
(Probably requires entering your BIOS/EFI settings to change boot order.)
Follow the CentOS 8 installation notes…

Vital: when you choose the location for the installation **be sure** to pick your second flash drive, not your hard drive.

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Living with Hyper-V

Hyper-V option 4: forget running a CentOS VM and dual-boot instead

https://www.tecmint.com/install-centos-7-alongside-windows-10-dual-boot/

Be warned:

- raises specter of hosing your machine and having to reinstall everything
- therefore, backup all your files first!

- requires hard reboot to switch from your primary OS to CentOS

NOT recommended!

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The rlogin Cluster

rlogin

A cluster of 32 virtual machine nodes running CentOS 8

Dedicated for instructional use, primarily at undergraduate level

Be warned:

- less convenient than a local installation (network latency, no GUI tools)
- requires an SSH client if you are running Windows
  (see `software.cs.vt.edu` for SSH Secure Shell Client)
- will not fully satisfy the requirements for the first assignment in CS 2505

OTOH:

- you'll have to do some assignments on rlogin anyway
- CS 3214 requires using rlogin for more or less everything

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Running Linux on an OS X Host

Essentially, follow the instructions for a Windows Host, but install the version of VirtualBox for OS X.

Note:

- OS X is not Linux (or UNIX), and that prior students have experienced issues when trying to use the OS X native version of the GCC C compiler in this course.
- Those problems will go away if you run Linux.
- If you decline to do that, you may have to use the rlogin cluster (more later) for all of the UNIX-related and C programming assignments.

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SLO Accounts

The CS Department uses a single-logon system (SLO) for many of its resources:

- rlogin cluster
- CS software site (`software.cs.vt.edu`)
- CS Forum Board

If you are a CS major and have previously taken a CS course at VT, you should already have an account.

If not, or if you've forgotten your SLO password, go to the following link and rectify the problem:

https://admin.cs.vt.edu/

Note that you will need this to access some of the resources necessary for this course.

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SSH: secure shell for remote access

Secure shell is a network protocol for secure communication.

An SSH client is supplied with UNIX/Linux, and with OS X.

Windows users should Google for “SSH Secure Shell Client” or for “PuTTY”, which are freely available for non-commercial use.

See `software.cs.vt.edu` under Freeware/SSH client.

You will use an SSH client to access the rlogin cluster for certain assignments.

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rlogin Cluster

The rlogin cluster is a collection of computers, each running CentOS 8, that are available to for students taking CS courses at VT.

To access the cluster, open a Linux terminal and enter the following command using your VT email PID:

```
ssh <PID>@rlogin.cs.vt.edu
```

```
#768 wmcquain: ~> ssh wmcquain@rlogin.cs.vt.edu
wmcquain@rlogin.cs.vt.edu's password:

Welcome to the Computer Science remote login service.

This service is provided by instructional based money and is for instructional
use only. Research related work should be done on research provided machines.

Use of this system is regulated by the Virginia Tech acceptable use guidelines:
http://www.vt.edu/about/acceptable-use.html
. . .
```

Status and other information can be found at: http://rlogin.cs.vt.edu/

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SSH: login without a password

You can set up keys that allow you to ssh to your rlogin account without using a password.

From a Linux or Cygwin terminal on your machine, use the ssh-keygen command to create a key pair; the session will resemble this:

```
#769 wmcquain: ~> ssh-keygen
Generating public/private rsa key pair.
Enter file in which to save the key (/home/wmcquain/.ssh/id_rsa):
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/wmcquain/.ssh/id_rsa.
Your public key has been saved in /home/wmcquain/.ssh/id_rsa.pub.
The key fingerprint is:
SHA256:Fj546ZNotReallyMyKeyOfCoursekzJcZ6ptrKYXphM wmcquain@centos8
The key's randomart image is:
. . .
```

Convenient, not mandatory

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SSH: login without a password

Then, use the ssh-copy-id command to install the key on the remote system:

```
#770 wmcquain: ~> ssh-copy-id -i ~/.ssh/id_rsa.pub rlogin.cs.vt.edu
/usr/bin/ssh-copy-id: INFO: Source of key(s) to be installed:
"/home/wmcquain/.ssh/id_rsa.pub"
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter out any that
are already installed
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompted now it is
to install the new keys
wmcquain@rlogin.cs.vt.edu's password:

Number of key(s) added: 1

Now try logging into the machine, with:   "ssh 'rlogin.cs.vt.edu'"
and check to make sure that only the key(s) you wanted were added.
. . .
```

Convenient, not mandatory

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SSH: login without a password

You should now ssh to your rlogin account and see if your key file only contains what you would expect:

```
#774 wmcquain: .ssh> ssh wmcquain@rlogin.cs.vt.edu
. . .
#817 wmcquain@cedar:~> cd .ssh
#818 wmcquain@cedar:.ssh> ls
authorized_keys  id_rsa  id_rsa.pub  known_hosts
#819 wmcquain@cedar:.ssh> cat authorized_keys
ssh-rsa . . . wmcquain@centos8
#. . .
```

The only authorized key entry corresponds to my login from my local machine.

Now, I can ssh to the cluster without having to provide a password.

Convenient, not mandatory

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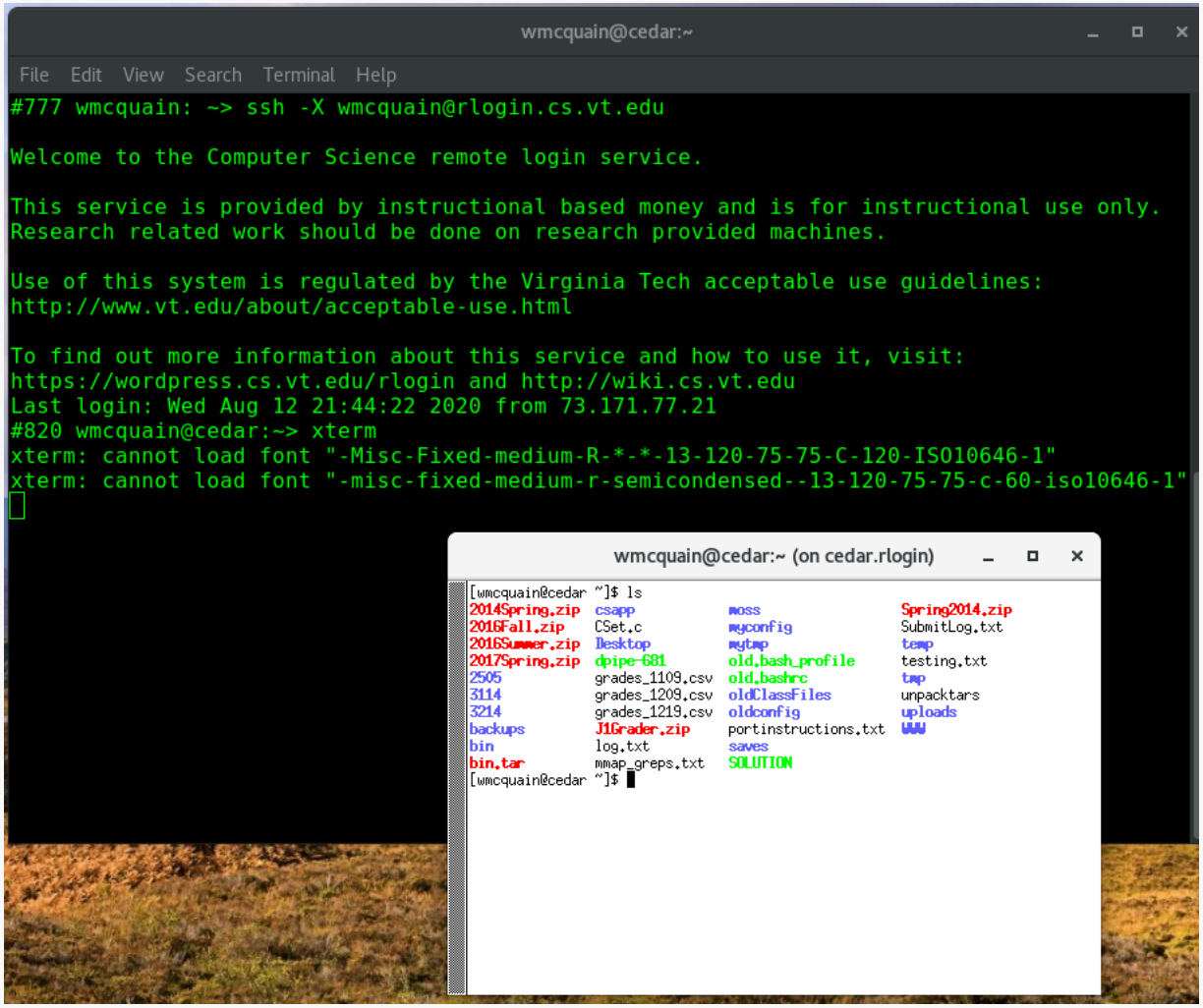
SSH: opening an X tunnel

Many Linux applications have a graphical user interface; you can execute those on the server (rlogin cluster machine) by using the `-X` switch when you invoke `ssh`:

Warning

This will be slow.



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So…

Get to work!

Create an installation of Linux on your laptop/tablet.

- Use VirtualBox or not, your choice.
- Use CentOS 8

Get an SLO account (if you don't already have one) and make sure you know your password.

If you like, set up password-free login (via ssh) to your `rlogin.cs.vt.edu` account.

See the first assignment on the course website!!

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