

1 Introduction

If you want to install Linux on your personal computer there are a couple ways to do it.

1. Remove the current operating system and install Linux as the only operating system on your computer.

Pros: Operating system runs on hardware and hence is faster. Uses less hard drive space since you are only storing one operating system.

Cons: Old operating system is completely removed, going back to it requires reinstallation of the operating system.

Only do this if you are sure that you want to change platforms.

2. Create a dual boot system that stores two or more operating systems on the same machine and select the operating system you wish to use each time you boot the system.

Pros: Operating system runs on hardware and hence is faster. You can use multiple operating systems.

Cons: Requires partitioning of the hard drive. Uses more hard drive space. Going back to one operating system requires more work. Need to reboot to change operating systems.

Only do this if you are sure that you are fine with dicing up the hard drive and realize that going back may require some work.

3. Install a virtual machine and load the operating system into it. Hence it would run like an application.

Pros: You can use multiple operating systems. You do not need to partition the hard drive. Removing the other operating system is as easy as deleting a file. If you have enough hard drive space and memory you can run as many operating systems as you would like, all at the same time. You can share files between operating systems. If you really mess something up, you can simply delete the virtual machine and start over, not as easy with the other methods.

Cons: Virtual machines are very slow in comparison to running the operating system directly on the hardware. They take up as much hard drive space as dual booting, since each operating system is stored on the heard drive. They take up more memory since two or more operating systems are running concurrently and hence sharing memory.

Only do this if your computer has a sufficient amount of memory, at least twice the recommended memory for a single machine.

Although virtual machines are by far the slowest and most memory intensive, they are more flexible and easier to manage.

2 Installing a Virtual Machine

2.1 Downloads

When working with virtual machines you install a virtual machine manager on your computer, download the iso image (essentially a single file that contains a DVD of the operating system) of the operating system, then install the operating system inside the manager. The virtual machine manager is a software version of a computer, so when you start one up you are running a virtual computer inside your physical computer. This virtual computer will have a virtual hard drive (simply a file or set of files containing all the programs and data for the virtual machine). It will also have a virtual CD/DVD drive for installing the operating system. Your keyboard, mouse, monitor, USB drives, ... will be shared between the virtual machine (called the Guest) and the computer (called the Host).

The two main free virtual machine managers are Oracle's VirtualBox and VMWare (specifically VMWare Workstation Player). VMWare has some features that VirtualBox does not (and vice-versa) but it is only available for Windows and Linux hosts, no version for the Mac. VirtualBox has versions for Windows, Mac, and Linux hosts, as well as having some features that VMWare does not. We will go through the process using VirtualBox.

- Download VirtualBox for your platform (Host). Links to the current version is on the MyClasses page for this class. You may use a different virtual machine if you would like but the configuration may be slightly different than the instructions below.
- Download the 64 bit version of Linux Mint. One of the big differences between Linux and either Windows or the Mac is that in Linux you have a choice of desktops and they are much more configurable. For Mint there are two main desktops that are common, Mate and Cinnamon. The Cinnamon desktop is more graphical and nicer to use but requires a lot of graphical processing overhead, and hence does not run well inside a virtual machine. Mate, while not as fancy, is a nice graphical user interface that is much faster and hence works better inside a virtual machine.

Note: some computer configurations will not install the 64 bit version without changing the system's virtualization settings in the BIOS. If your system is one of these and you do not want to alter the BIOS settings you can install the 32 bit version.

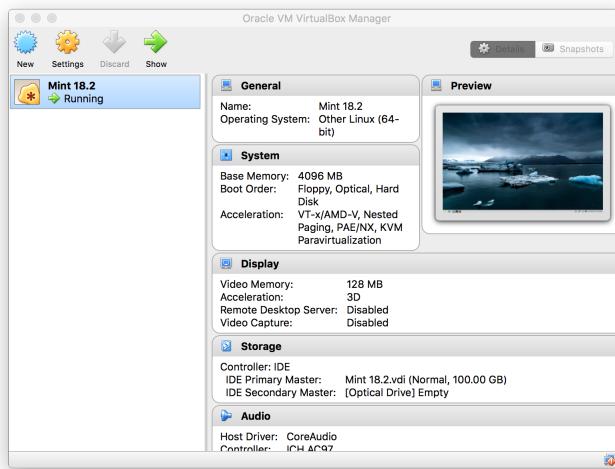
Note that you will need around 15 GB of hard drive space minimum to install Linux Mint as a virtual machine.

If you do some searches on Linux you will find that there are many (hundreds in fact) different versions of Linux. These versions are called distributions (or distros for short). They are grouped in branches of systems that start with base configurations and add on features further down the branch. Many versions have specific uses and others are more general. We have gone with Linux Mint for this handout. Mint is a very popular distribution along the Debian branch and has a look and feel close to Windows, and hence feels more natural to Windows users. Another very popular distribution is Ubuntu, which is also on the Debian

branch, and has a look and feel closer to the Mac. Either is a nice version of Linux to start out with to get the feel for the Linux operating system.

2.2 Setting Up VirtualBox for Linux Mint

1. Start VirtualBox, you will see the home screen that looks something like the image below. Note that the left panel will be blank for you since in the image below I already have a Mint virtual machine installed.



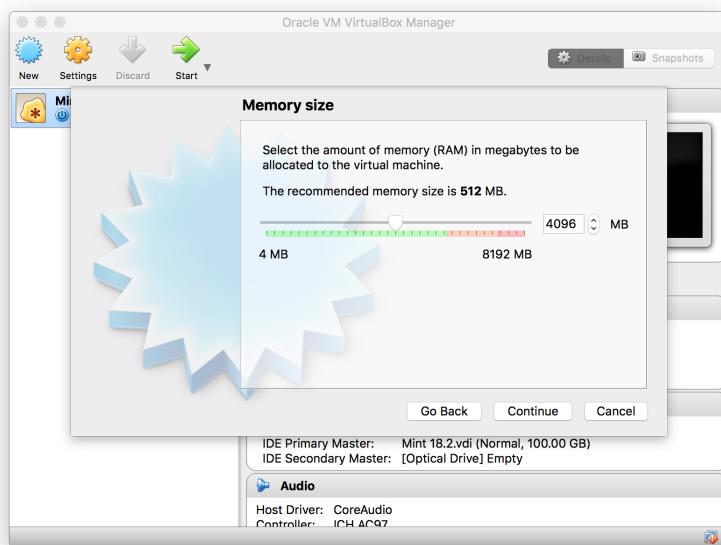
2. Click on the *New* toolbar button. The following dialog will appear. Give the virtual machine a name (such as Linux Mint 18.3), make sure that the type is set to Linux, and the version is set to Other Linux (32-bit) or Other Linux (64-bit), depending on what you will be installing. If you downloaded the 64-bit version and Other Linux (64-bit) is not an option the drop-down then you will either need to turn on virtualization in your BIOS or install a 32-bit version.



Once that is done click on the Continue button.



3. The next dialog will ask you for the amount of memory to dedicate to the virtual machine. Select something between 2 and 4 GB, but do not go over the Maximum recommended memory. A virtual machine is a virtualization of the computer hardware. So it is software that simulated hardware, hence it will be slower than running Linux directly on the computer hardware. Giving it more memory to work with is a good way to speed it up. As a rule of thumb, I do not give the virtual machine more than half my computer's memory. When you are done, click Continue.



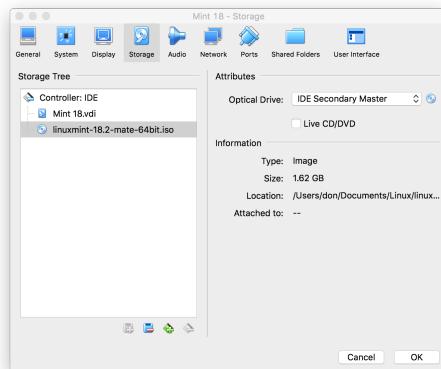
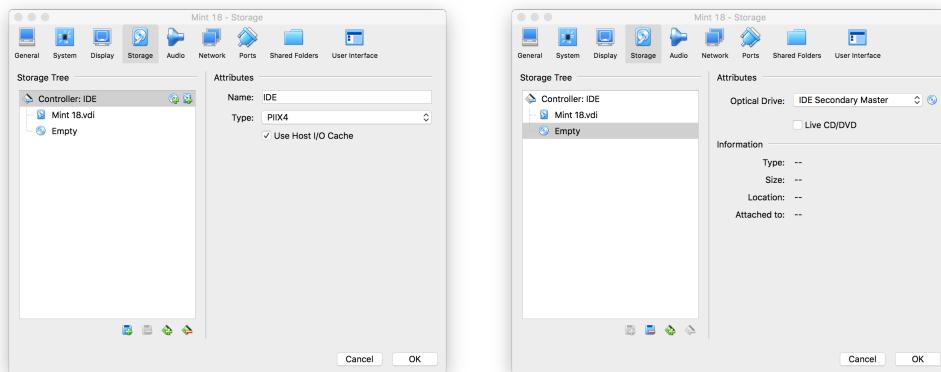
4. The next series of dialog boxes are options on the virtual hard drive, this is really just a file on your computer's hard drive, like a Word document, just much larger.
- The first dialog will ask if you want to create the disk now, select Create a virtual hard disk now, and click Continue.
 - The second is on what type of image you want, leave it as VDI and click Continue.
 - The third will ask if you want it to be a fixed size or dynamically allocated, select Dynamically allocated and click Continue.
 - The fourth will ask you the size of the disk, which is the maximum size the virtual machine will allow. The default of 8 GB is a bit too small, change this to at least 15 GB. If you are interested in testing out Linux beyond what we do in this class then you might want to make this larger, say 50–100 GB. Since you selected Dynamically allocated the disk size will be as small as possible, so it will not eat up 100 GB initially, only if you use that much.



5. At this point you should be taken back to the home screen and your new virtual machine should show up in the list in the left panel. This does not mean that Linux is ready to go, this just means that we are ready to install the operating system. Before we install the operating system we will make one more change that will help increase the speed of the virtual machine. On the right, click on Display. The following dialog will open, slide the Video Memory slider to 128 MB and click OK.



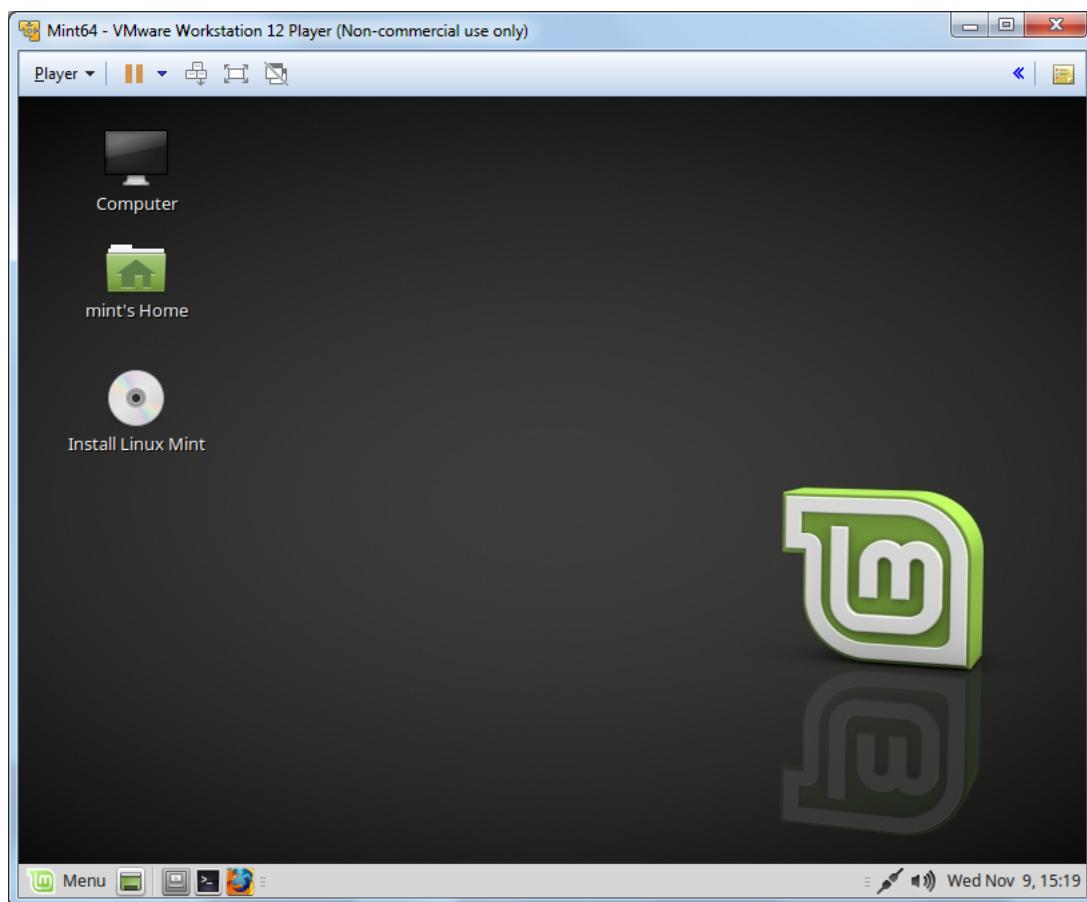
6. Before we install Mint we need to insert the virtual CD into the virtual CD player, sounds silly but that's what we are doing. Click on Storage and the following dialog will appear. Select the CD drive on the left, under Attributes, click on the CD icon on the far right, then Choose Virtual Optical Disk File... Navigate to the iso image of Linux Mint you downloaded and select it. The “disk” information should now appear in the area below. Click OK.



3 Installing Mint

Now that we have our virtual computer created we are ready to install the virtual operating system. In general I prefer to dedicate a machine to a single operating system, or do some type of multiple boot. The upside is that the operating system is running directly on the hardware. The downside is that if you want to revert the system back to its original state or if you irrevocably mess something up, it much harder to fix. With a virtual machine all you need to do is delete the machine and start over. It is also a nice way to test out different operating systems before committing to switching over or to dual boot what you have.

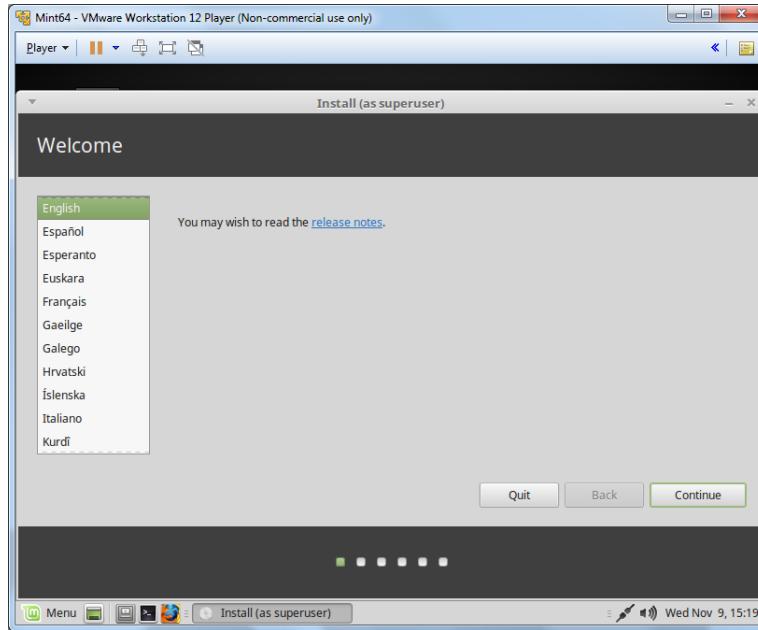
1. Go to the home screen of VirtualBox, select the machine and power it on. At this point the virtual machine will start, and it will run the iso image, i.e. start up the process of installing Linux Mint on the virtual machine. Keep in mind that if you mess up somewhere here it is no big deal, you are altering the operating system of the virtual machine, not the host computer.



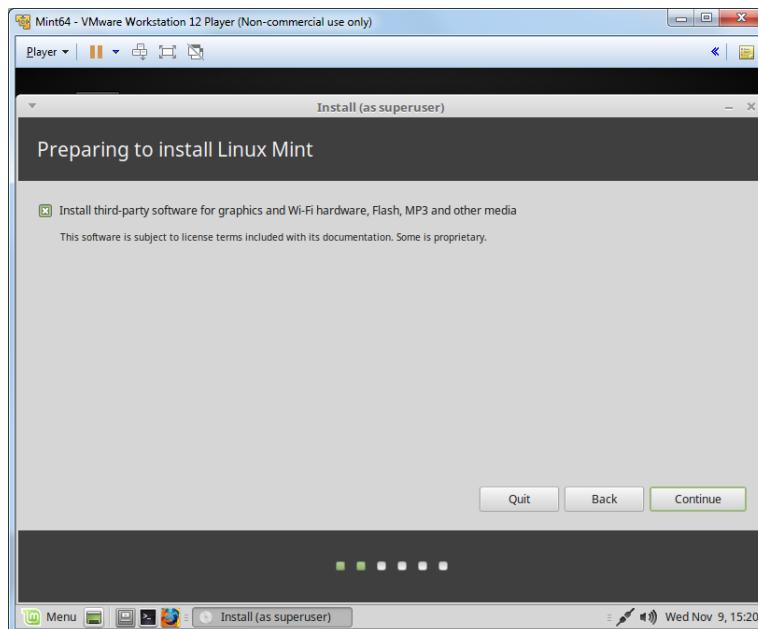
As this is starting up you will be able to click on the virtual machine window to enter that computer. This will lock the mouse and keyboard to the virtual machine. To escape from the virtual machine to the host press the right Alt key. When we are finished, we will have installed software that will seamlessly go from one machine to

the other, as if this was just another application. Once you see the above screen you are running Linux from the iso image (as if it were running from a CD or DVD). We need to install the system on the virtual machine. Double-click the Install Linux Mint icon.

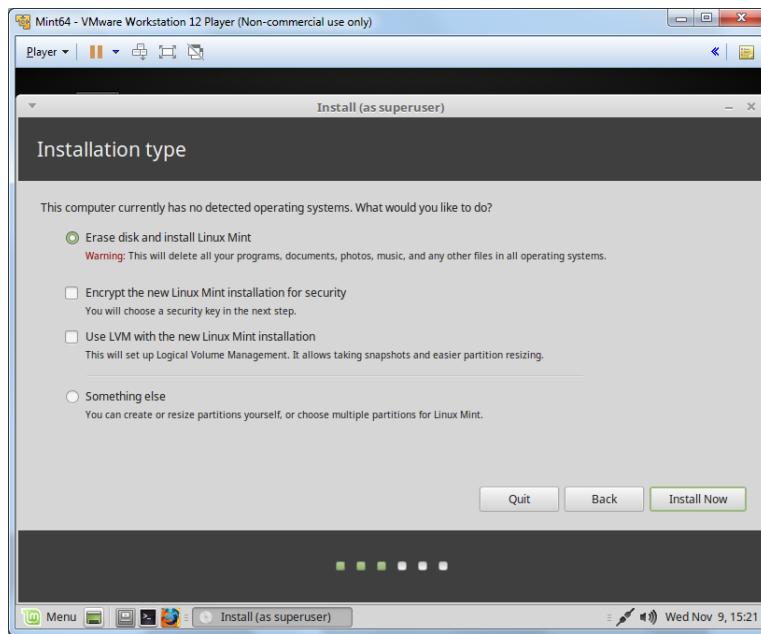
2. Select the language you want to use and click Continue.



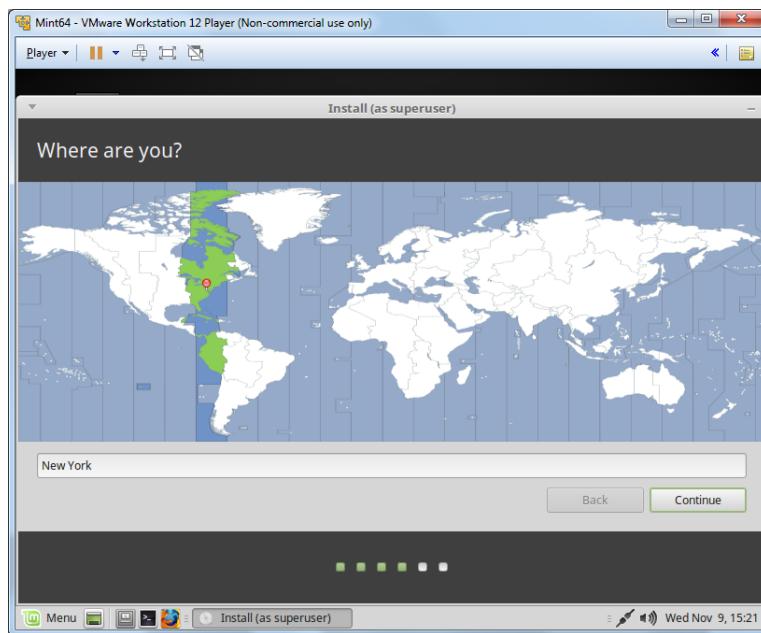
3. Select to install third-party software and click Continue. It probably not matter for our purposes if you do not select this.



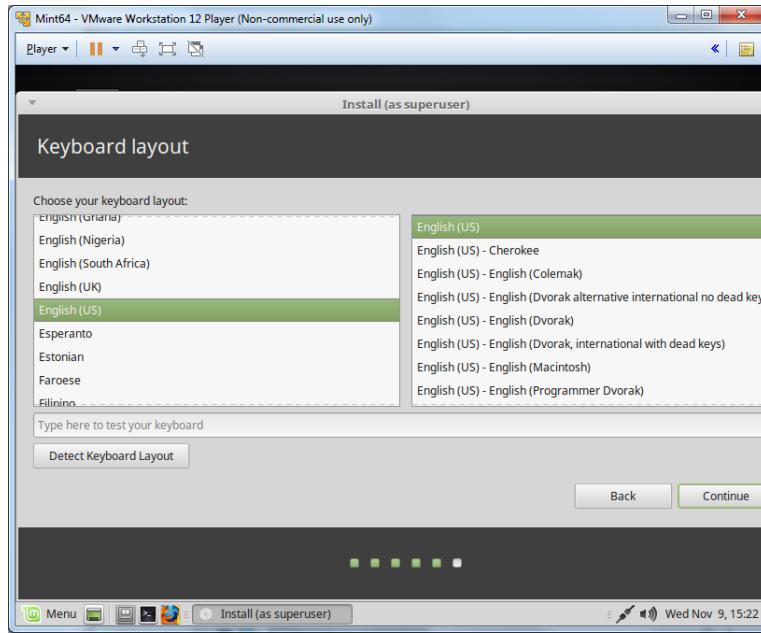
4. Select the installation type, use Erase disk and install Linux Mint. Remember this is the disk of the virtual machine, not your host machine.



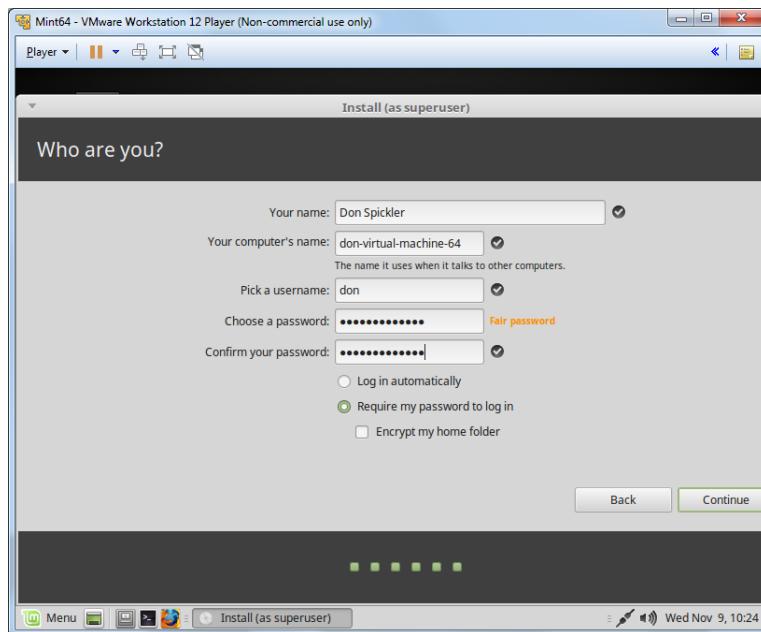
5. Select the location and click Continue.



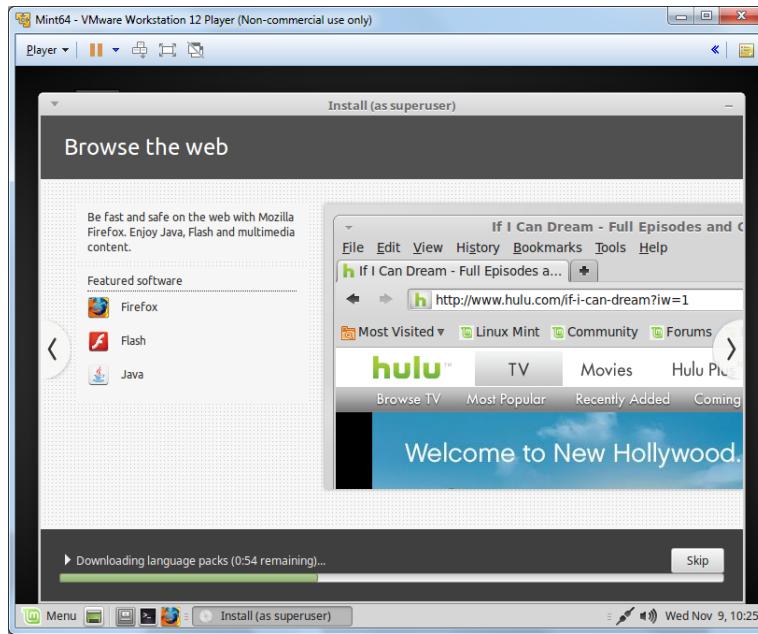
6. Select the keyboard layout and click Continue.



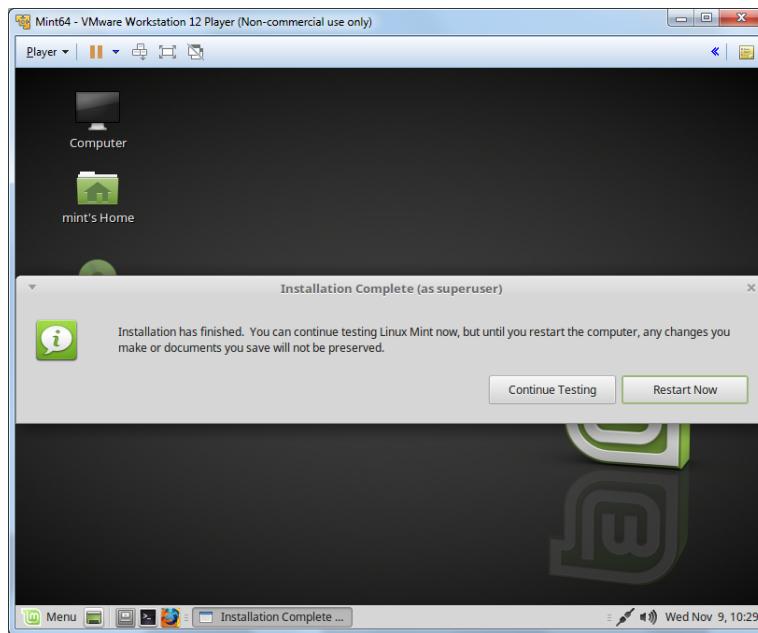
7. Type in your name, give the computer a name, pick a username and password. Do not forget this password, when you install anything on Linux that requires administrative rights you will need to use your password. You can choose to have the system log you in automatically, I personally do not do that. Click Continue.



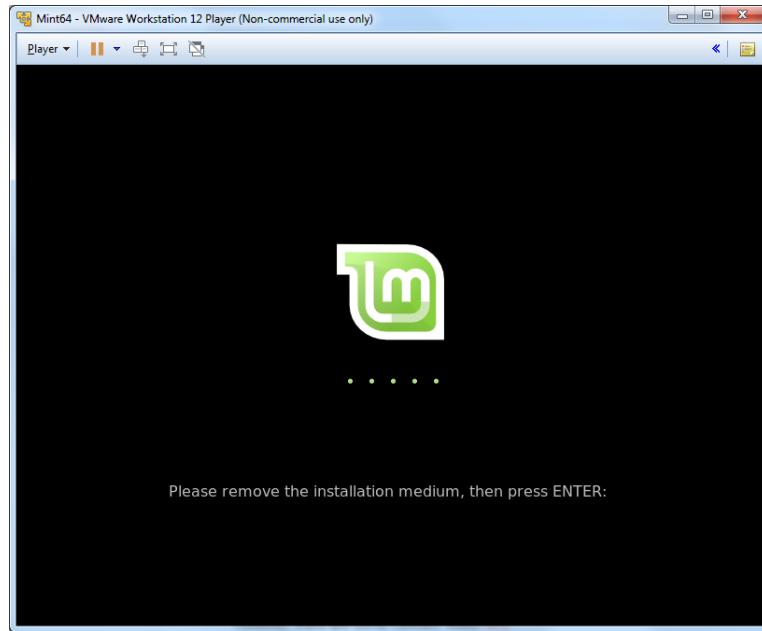
8. At this point the installation process will begin. It does take a while to install the system but it is much quicker than other distributions and far faster than installing Windows.



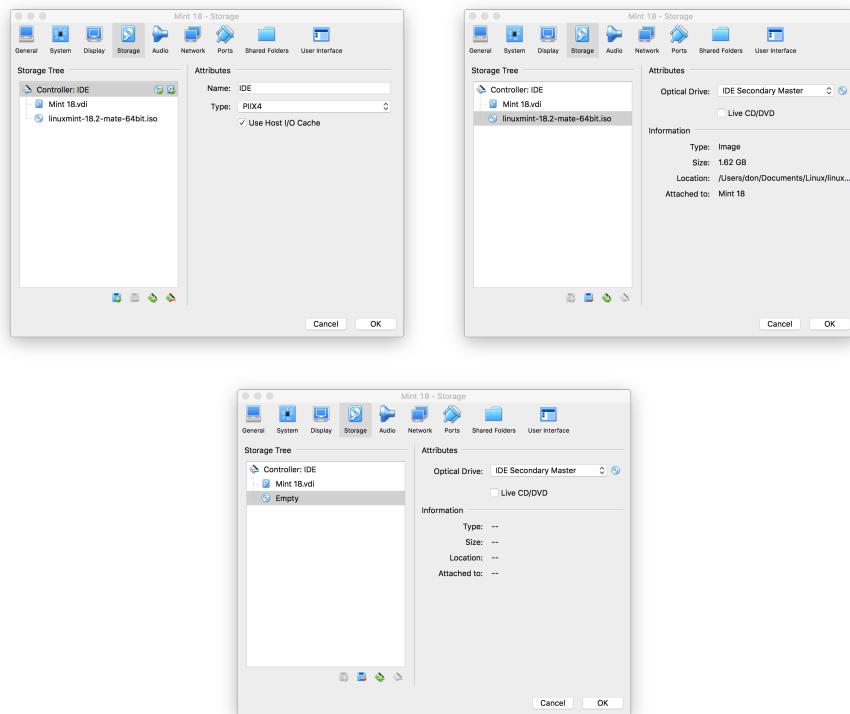
9. When the installation is finished you will get a prompt to restart the virtual machine, click the Restart Now button.



10. The machine will shut down and give you a message to remove the install media.



11. If VirtualBox does not automatically remove the virtual CD, it probably will, do the following. Click Storage, select the CD drive on the left, click the CD icon on the far right, select Remove Disk from Virtual Drive.



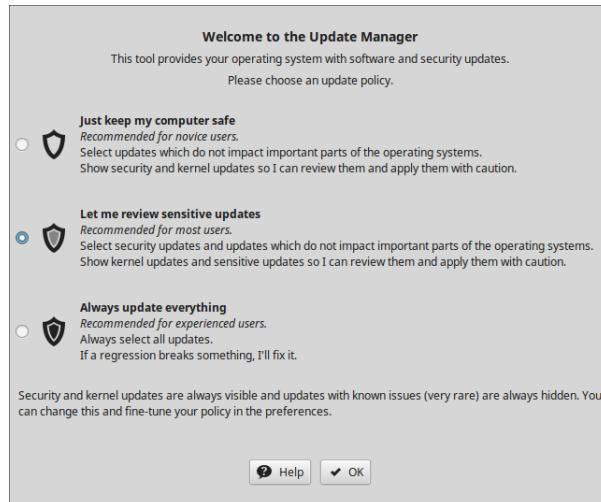
The virtual machine will now restart. Enter your username and password to log in.

4 A Few Notes

1. For Mac users, the keyboard shortcuts for Linux are like Windows in that they use the Control key and not the Command key. So to copy it is Control+C instead of Command+C. So if you are on the Mac side then use Command and when you switch to the Linux VM use Control.
2. The virtual machine will connect to the Internet if your computer's host operating system is connected. The virtual machine uses an internal network local to your computer to connect. So if the VM is not connected to the Internet, check your computer's connection.
3. A virtual machine is like a real computer and should be shut down in the same manner. So to shut down Linux Mint go to the menu button in the taskbar and select Quit. A small dialog will open asking if you want to shut down, restart, etc. click the shut down button. Clicking the close (x) titlebar icon is like unplugging the machine, not always the best thing to do.
4. For computers with high resolution screens you will notice that everything, especially the fonts, are very small. In Mint there is a quick way to make everything more readable. In the settings, select General, and there should be a Desktop Scaling feature, select Double (Hi-DPI).

5 Installing Updates

You should install updates before we start downloading and installing more software. This is a little different in Linux than it is in Windows, but it is easy to do. In the task bar on the right you will see a small shield probably with a blue information icon inside it. Click it. The Update Manager will open and ask you for the level of update notifications you wish, you will see a dialog like the one below.



I would recommend using the default setting and clicking OK. You will only need to make this selection one time. Once this is selected, the Update Manager will display a list of updates, the first one is usually an update to the operating system, click Install Updates. You will be prompted for your password again. When the install is finished you may see other updates that need to be installed, install those as well.

Unlike Windows, updates are not installed automatically nor are you forced to update packages you do not wish to update. In Linux you are free to select the updates you want and deselect those you do not. Furthermore, you are notified about updates, the shield will have a blue information icon in it, but you are the one who initiates the update. In addition, you need to type in your password for any updates to be installed, this adds a level of security to your system.

6 Installing Applications on Linux Mint

At this point we have the basic virtual machine installed. Now we need to install some programs. There are a lot of different ways to install programs in Linux but the main two are through the terminal window and through the Software Manager. Note that different flavors of Linux have different types of software managers but all incorporate the terminal in one way or another.

1. Open up the terminal, this is like the command prompt in Windows. Unlike Windows the terminal in Linux is actually useful. It is in the application bar at the bottom, it is the black icon beside the firefox icon. When it opens up type in the following command,

```
sudo apt-get update
```

The sudo gives the command administrative rights and hence requires a your password. **Note that when you type in your password, nothing will be shown on the terminal screen, no password or even stars.**

2. In VirtualBox, go to the menu and select Install Guest Additions. This will load the guest additions virtual cd into the virtual cd drive. The autorun should run the installation. You will be asked for your password and then it will install the software. This will make the transition between the host and guest smoother.

Make sure that under View the Auto-Resize Guest Display option is checked and that under Devices the Shared Clipboard and Drag and Drop are both set to Bidirectional.

3. For the majority of our classes that use Linux we use C++ as well. Most Linux distributions will automatically install gcc (which is a C compiler), we would also like to use C++ in the class so we need to install g++,

- (a) Select Menu > Software Manager.

- (b) In the search bar, search for g++. Scroll down to the g++ button.
 - (c) Click g++ and the information window will appear, click the Install button.
4. For some classes, like our hardware courses, we need to install an assembler. This is for the installation of the NASM (Netwide) assembler. From the terminal type in,

```
sudo apt install nasm
```

Again, you will be asked for your password. When this finishes you will have the netwide assembler installed.

5. There is a simple text editor called xed that you can use to type in your programs and you can use the terminal to compile and run your programs. One editor I personally like is Kate, it has syntax highlighting, automatic reindentation, and you can link in a terminal window into the editor. This is optional but if you want to set this up here is what you do.
- (a) In the Software Manager search bar, search for Kate. It will come up as the first hit.
 - (b) Click Kate and the information window will appear, click the Install button.
 - (c) In the search bar, search for Konsole. It will come up close to the top.
 - (d) Click Konsole and the information window will appear, click the Install button.
 - (e) When these are finished, select Menu > All Applications > Kate. Note that if you right-click on Kate you will get an option to show it in your favorites window, directly from the Menu.
 - (f) Go to Settings > Configure Kate.
 - (g) Select Plugins.
 - (h) Check the Terminal tool view and then Apply.
 - (i) Now click on the Terminal in the application list, and check Automatically synchronize ... option and click OK.
 - (j) At this point, there will be a terminal option at the bottom. If selected, a terminal window will appear inside the editor.
 - (k) One strange thing is that the toolbar icons are not loaded automatically, there is a reason for this, but if you like to have icons here is what you do,
 - i. Close Kate.
 - ii. Go back to the Software Manager.
 - iii. In the search bar, search for libqt5libqgtk2. It should have only one hit.
 - iv. Install it.
 - v. When that is finished. Go back to the terminal and type in,
- ```
sudo apt-get install oxygen-icon-theme*
```

and then

```
sudo apt-get install kdelibs-bin kdelibs5-data kdelibs5-plugins
```

vi. Open Kate back up and you should now have nifty little icons.

- (l) If you want spell checking as you type you may also need to install sonnet, this can be done through the software manager.
6. Another nice editor is Gedit. You can put a terminal window at the bottom of its layout as well but it does not have all the editing options that Kate does. In addition, some very powerful editors, which are text-screen based and a little more difficult to use, are emacs, vi, and vim.
7. If you will be doing Java development on the VM you should install OpenJDK, this can be done through the software manager.
8. There are many applications that are cross platform, for example Code::Blocks, Eclipse, Chrome, Firefox, Gimp, Blender, Mathematica, Maxima, Octave, Python (Spyder), ... Many of these are free and available through the software manager. In addition, most Linux distributions include LibreOffice, a complete, and free, office suite with word processor, spreadsheet, presentations, and data base.

## 7 Shared Folders

A shared folder is a way that you can transfer files between the host computer and your virtual machine. In general, what you do is tell the VM software (VirtualBox) that you want to set up a shared folder and then you need to tell the virtual machine (guest OS) that it is there and link it up. As with anything on virtual machines, there may be troubleshooting on a case by case basis.

In general, you should be careful with shared folders, this will allow you to save and delete files on your host system from your VM. If you delete a file on the host through the VM, the file will not be sent to the trash on either the host or the VM.

1. Start up VirtualBox but do not start the VM yet.
2. Go to the VM properties and select Shared Folders.
3. Click on the folder with a + sign icon on the right.
4. At this point a dialog will open.
  - (a) In the Folder Path box, put in the folder path of the folder you want to share. Inside the VM, the shared folder will be linked to this physical folder.
  - (b) In the Folder Name box put in the name of the folder you want to use. It can be anything you want, I would keep it at a single word like Share or PC or Mac.

- (c) Make sure the Read-only check box is unchecked and that the Auto-mount check box is checked.
5. Click OK and start up the VM.
  6. When the VM is started open the file manager and look on the left at the Places. You should see a place that is the Folder Name but with `sf_` in front of it. Click on this place and then you should see the contents of that folder on your host machine.

**Note:** You may get a permission error when you select the place, if so this is usually caused by not being in the right group. Open the terminal and run the command,

```
sudo usermod -aG vboxsf $(whoami)
```

Restart the VM and see if you now have access.