Basic Python Development & Virtual Machine Setup for Students

Authors: Emily Chen, Charlie Meng, Sander Shi, Jordan Tick
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Overview

College students who are studying computer science or related fields will often be taking classes that use Python and common Python libraries. Setting up a development environment for this is often a tedious and bothersome process, and students should be focused on learning to use Python and its associated libraries instead of spending too much time setting up the environment.

This guide will walk through the installation of a virtual machine -- an emulation of a computer operating system. This will help users using Windows or Mac OS host a Linux operating system within their own system. Then, the guide will explain how to load an Ubuntu virtual disk image and configure it on a virtual machine. Lastly, the guide will walk through Python installation as well as the installation of basic Python libraries like OpenCV and OpenGL.

Virtual Machine Installation Manual (VirtualBox)

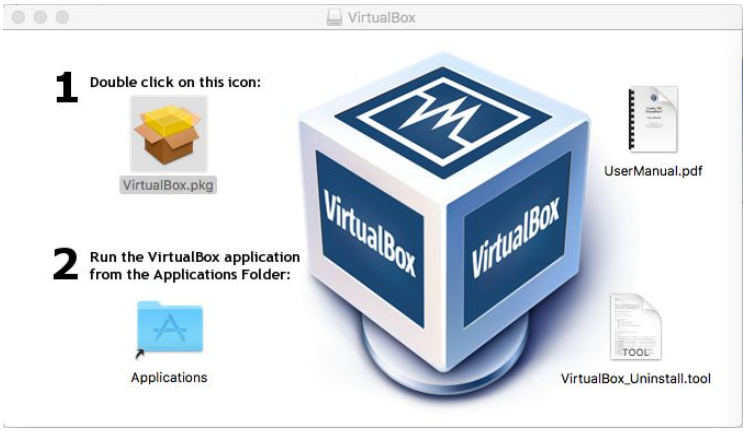
Mac OS X

Step 1:

Go to https://www.virtualbox.org/wiki/Downloads, then click “OS X hosts.” Make sure to choose a 64-bit installation if your computer is 64-bit.

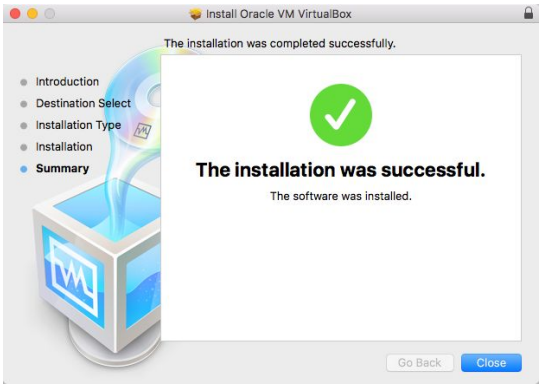
Step 2:

Now that you have the installation file. Click on the “.dmg” file, and open the “.pkg” file listed in the newly opened window.



Step 3:

Click “Continue,” on the first page in the installation. On the “Destination” page, click “Continue” again, then click “Install” on the installation type page. Wait for the installation to complete.



Windows

Step 1:

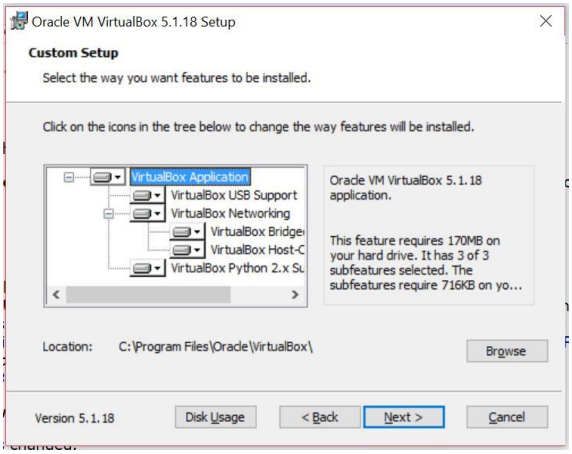
Go to https://www.virtualbox.org/wiki/Downloads, then click “Windows hosts.” Make sure to choose a 64-bit installation if your computer is 64-bit.

Step 2:

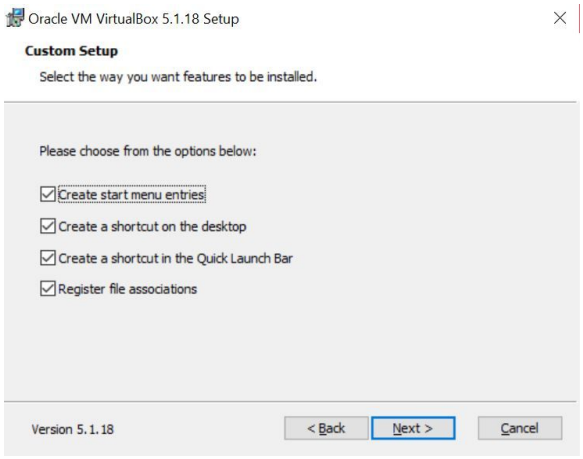
Now that you have an “.exe” file, double-click to open.

Step 3:

Clicking “Next” on each screen until the installation starts will use default settings. The first screen will ask you where you would like to save VirtualBox, the second will ask you what shortcuts you would like to create, and the remaining screens will load the installation.

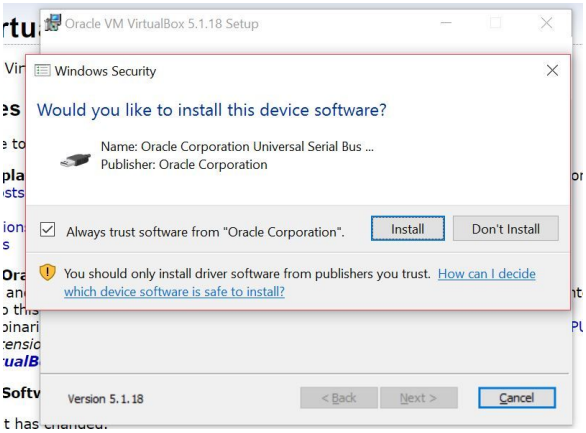


Step 1: Click ‘Next’

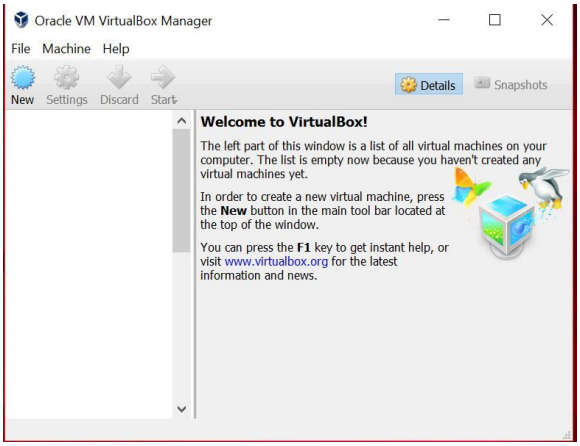


Step 2: Click ‘Next’

Step 3: Click ‘Yes’



Step 4: Click ‘Install’



If you have successfully installed VirtualBox, you should see this screen.

Ubuntu Installation on VirtualBox

Step 1:

Go to http://www.osboxes.org/ubuntu/ and download a VDI file for the version of Ubuntu that you are comfortable with (we recommend Ubuntu 16.10, nicknamed 'yakety yak'). **Once again, make sure that you download a 64-bit version if your computer is 64-bit.** OS Boxes is a company that specifically makes OS images for VirtualBox, meaning installing linux this way will make things easy for you. Although not required, it would be a good idea for you to download this file to the same location as your virtual machine so you know where it is later (your virtualbox folder actually has a folder in it named "images", which is what these files are called!).

When you download your linux image, you will be on a page that also tells you the default username and password for this virtual machine (most likely username "osboxes" and password "osboxes.org"). **Remember to keep track of these as you will need them later!**

Step 2:

Open the VirtualBox program and click the "new" button in the top left corner. This will start the process of linking your OS Boxes image file with VirtualBox.

Step 3:

In the screens that follow, you will be asked to enter a name for your virtual machine (any will do) as well as the name of the operating system you downloaded. You will then be asked how much RAM you would like to allocate for your virtual machine (1GB=1024MB is standard, but 2GB (2048MB) or 4GB (4096MB) will help your virtual machine run faster).

Step 4:

This step is important. You will be brought to a screen titled “Hard Disk” and asked how you wish to add your ‘virtual hard disk’ to your virtual machine. This is the image you downloaded from OS Boxes! Press the option that says “Use an existing virtual hard disk file” and then press the folder icon to the right which allows you to select your virtual hard disk file. Select the file you downloaded from OS Boxes and press create.

Step 5:

You should now be back to the main screen of VirtualBox with the name of your virtual machine appearing on the left. Double left-clicking its name will start your virtual machine. After it loads, you will be able to login using the username and password from step 1.

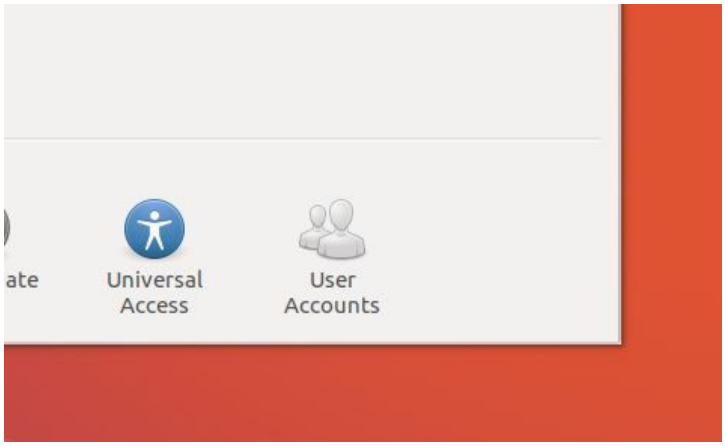
Basic VirtualBox Configurations

Username/Password/Super User Password

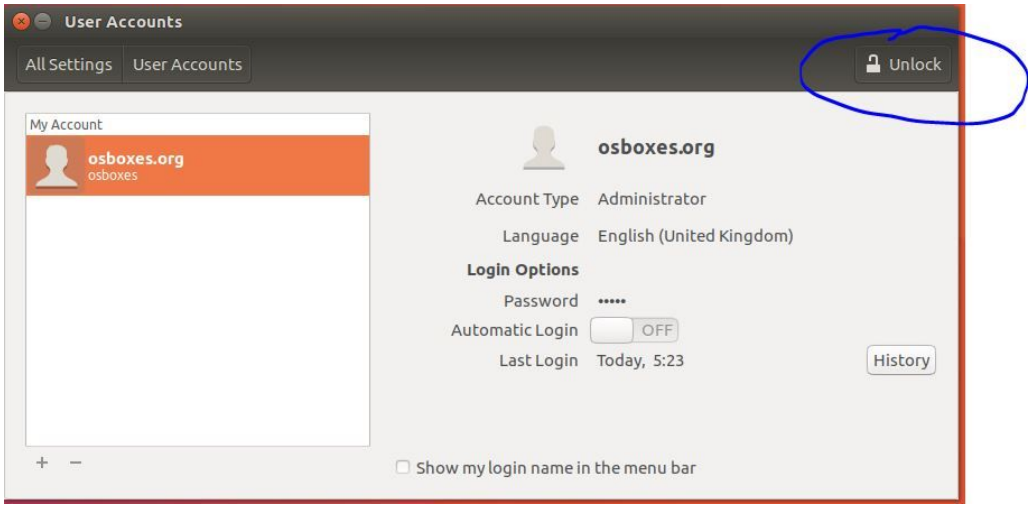
Using a virtual disk image has its benefits--you will not have to go through the tedious installation of installing an operating system yourself. Instead, you only have to load this image and run it. However, when you use OSBoxes, it will automatically set the username and password, which you might want to customize.

To do this, go to “System Settings”:

Then click “User Accounts”:



To make changes, you need to unlock the settings:



Then you can click on “osboxes.org” to change your username, and “password” to change your password.

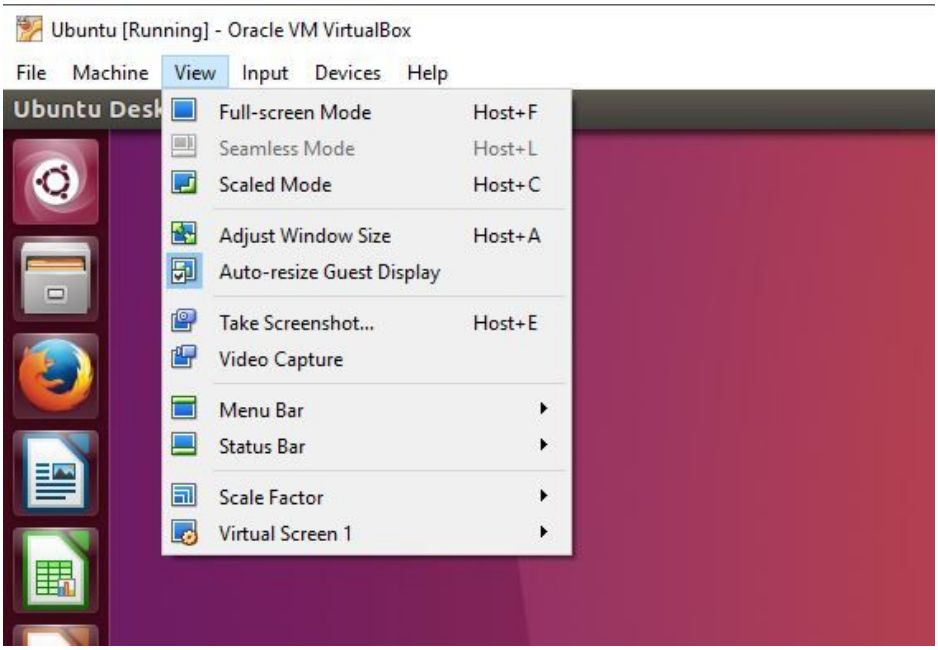
Lastly, Ubuntu keeps its user password separate from its administrative (“sudo”) password. To set this password, open up terminal (right click on your desktop and click on ‘open terminal’) and enter the command

```
sudo passwd root
```

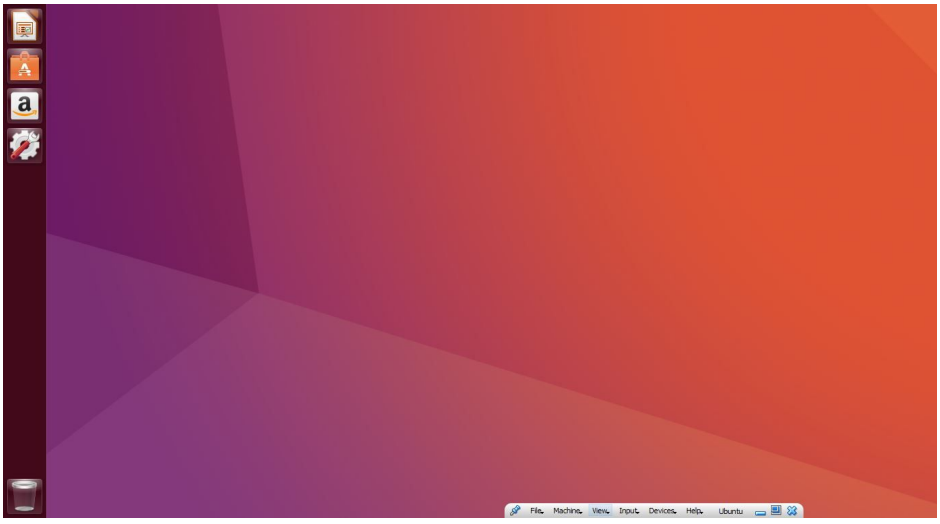
After you’ve done this you will be prompted to enter a new administrative password. We suggest making it the same as your user password so it is easy to remember!

Fullscreen

When you start your virtual machine, it will not be full screen at first. So in order to make it full-screen and function as if you are running Linux straight from your hard drive, you can go to the top bar, and click “view,” and then click “Full Screen Mode.”



And to return to window mode, click “view” at the bottom of the screen and unselect “Full-screen Mode.”

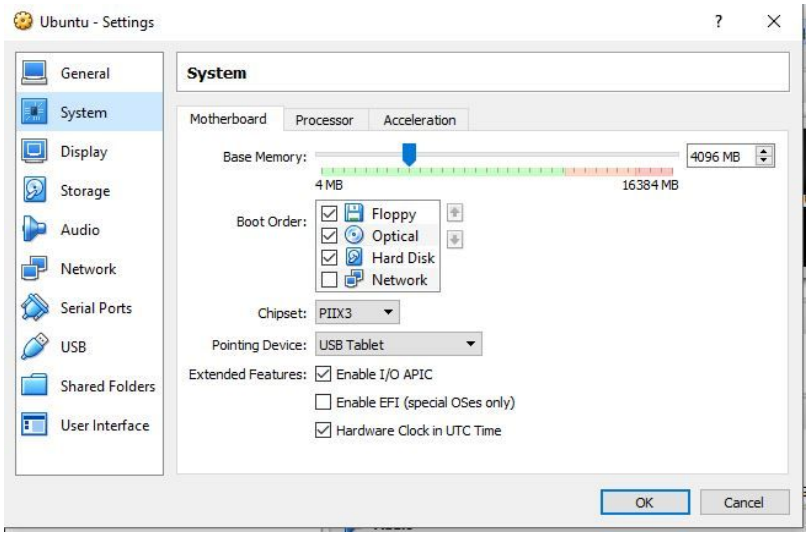


RAM

You may not have configured a good amount of RAM for your virtual machine. Depending on what tasks you are performing, you may want a different amount of RAM allocated for your virtual machine, and you are able to allocate any amount between 4MB and the total amount of memory you have installed in your machine.

In order to change the amount, you must go to the VirtualBox, then select your virtual machine, and click settings.

Then click “System” and change the base memory to your prefered amount:



A Note: Linux Terminology

From hereon out, this manual assumes you are working within your virtual machine on Ubuntu. If you see anything shown as `pip install -v pyopengl` this means you must run this specific line (verbatim in terminal). Terminal is the command prompt of Linux; you can run commands in here that allow you to install necessary software. To access terminal, simply search for the word “terminal” in the search box at the top left of your screen. If you are not working in Ubuntu, you may need to google equivalent commands in your VM (for instance, apt-get is Ubuntu’s package manager, but other versions of Linux use yum, pacman, etc).

Python 2 and Python 3 Installation on Ubuntu

Common Package Installation on Python

Almost all versions of linux come with both Python 2 and Python 3 nowadays. However, should either of these be missing, you can install Python 2 by running

```
sudo apt-get install python2.x
```

or

```
sudo apt-get install python 3.x
```

from the command terminal, where X is the version number you want to install (currently 2.7 and 3.4 at the time of writing this manual), assuming that you are working on Ubuntu.

Before we begin our tutorial on installing various Python packages, here is a short list of popular Python packages and their functionalities for a quick reference:

- Tkinter, Turtle, Pygame, OpenGL: These are graphics packages for python. By default, Tkinter is already installed in Python 2
- Panda3D, Blender: These libraries exist for 3D graphics
- Numpy, OpenCV, PIL: these are libraries for manipulating matrices and images.
- Matplotlib, scikit: these libraries are useful for graphing and making mathematical models

Pip

What is Pip?

Pip is a package management system that you can use to manage and install python libraries; the acronym PIP stands for “Pip Installs Packages.” If you have Python 2.7.9 or later (for Python 2) or Python 3.4 or later (for Python 3), Pip should already be installed.

To install Pip, download it from PyPi by running

```
wget https://bootstrap.pypa.io/get-pip.py
```

in your terminal. You can then run

```
sudo python get-pip.py; sudo python3 get-pip.py; rm get-pip.py
```

to install Pip for Python 2 and Pip3 for Python 3.

Installing Packages

Packages are most commonly installed from Python Package Index (PyPI).

To exemplify how PyPI is typically used, to download the popular graphics library OpenGL, one would simply run

```
sudo pip install PyOpenGL
```

PyOpenGL also has a companion library “PyOpenGL_accelerate”, which similarly is installed using

```
sudo pip install PyOpenGL_accelerate
```

Installing OpenCV

OpenCV ("Open Computer Vision") is a programming library made by Intel to help with Computer Vision. It was originally developed in C in 1999. As such, the library is not a part of Python and cannot be installed through pip. By downloading the proper 'connector' files, however, it is possible to run OpenCV in Python! The following section will discuss how to download OpenCV in both Python 2 and Python 3.

WARNING 1: All of the following steps require administrative privileges in terminal.

To become privileged (also known as gaining "root access"), run the command

```
su
```

This command will prompt you for your root password (which you set up earlier in the VirtualBox Configuration section) and, afterwards, you will have the administrative privileges necessary for downloading packages from the internet. Administrative privileges will only be valid for the current terminal window, and will end when you close this window.

Warning 2: This installation may take a while depending on what is already downloaded on your system. Steps 1 and 6 may take the longest -- upwards of twenty minutes each.

Step 1 – Update Package Manager

Apt-get is the package manager for Ubuntu, and is used to download and install certain packages. Since you created your Virtual Machine from scratch, you will have to update your apt-get to the newest version. To do this, run

```
apt-get update; apt-get upgrade
```

in terminal. You will now be able to download anything that is in the package manager (apt-get).

Step 2 – Get setup packages

To be able to download and compile your OpenCV files, you must first prepare your VM. Do this by running

```
apt-get install build-essential cmake git pkg-config
```

Git is needed to download the code, while Build-essential, cmake, and pkg-config are needed to compile it.

Step 3 – Download dependencies

Since OpenCV is a computer vision package, you need to download various libraries for image and video decompression. You will also need the “Tk” library which is used in OpenCV’s graphical windows. Lastly, libatlas and fortran are used to help optimize opencv. Run the following commands:

```
apt-get install libjpeg8-dev libtiff5-dev libjasper-dev libpng-dev
apt-get install libavcodec-dev libavformat-dev libswscale-dev
apt-get install libv41-dev libgtk2.0-dev libatlas-base-dev gfortran
```

The numbers in these filenames are version numbers; if you are reading this, it is quite possible these numbers have changed. If any of the above commands give you an error, pay attention to which files are out of date and search online to find what the newer version is. Or guess a higher number, maybe you’ll get lucky!

Step 4 – Download Python-relevant files

If you do not already have pip, Python’s package installer, then run

```
wget https://bootstrap.pypa.io/get-pip.py
python get-pip.py; python3 get-pip.py
rm get-pip.py
```

This will download the file ‘get-pip.py’ from the internet, then run it to install pip and remove the file afterwards.

Now, install python header files that will allow you to link OpenCV to python. Run

```
apt-get install python2.7-dev
```

Make sure you replace 2.7 with whatever version of python you are running!
OpenCV deals a lot with matrices, which python does not have on its own. Download numpy if you don't already have it by running

```
pip install numpy
```

or

```
apt-get install python-numpy
```

since OpenCV requires you have it.

Step 5 – Download OpenCV to the Home Directory

You finally made it to the step you've been waiting for – installing OpenCV! Git is a program you installed in step 2 for storing different versions of files, and as such we are going to download the OpenCV git repository.
Run the following command in your terminal:

```
cd; git clone https://github.com/Itseez/opencv.git; cd opencv
```

This will create a folder in your home directory named "opencv" and navigate into the folder.
You can now get whichever version of OpenCV that you want! Simply run "git checkout 3.x.x", where '3.x.x' is the version of opencv that you want, and git will retrieve that version for you. You don't have to do this if you want the most up-to-date version of opencv however, which will be in this git repository by default. As of now, the current version is '3.4.0'.
You will also need to download a helper package for OpenCV, do so by running the following command:

```
cd; git clone https://github.com/Itseez/opencv_contrib.git
```

Step 6 – Compile OpenCV & Link it to Python

Create a folder in the opencv folder, and navigate to it:

```
cd opencv; mkdir build; cd build
```

Then compile the code by running this:

```
cmake -D CMAKE_BUILD_TYPE=RELEASE \
      -D CMAKE_INSTALL_PREFIX=/usr/local \
      -D INSTALL_C_EXAMPLES=ON \
      -D INSTALL_PYTHON_EXAMPLES=ON \
      -D OPENCV_EXTRA_MODULES_PATH=~/opencv_contrib/modules \
      -D BUILD_EXAMPLES=ON ..
make -j4
make install; ldconfig
```

Cmake is a program that tells your computer how to compile code; ‘make’ is what actually compiles the code (“-j4” just means use four processes to make compiling faster). This step may take up to 30 minutes, or even an hour if your computer has a weaker CPU. After the commands finish running, you have successfully installed OpenCV!

With OpenCV installed, you can now delete the two git repositories you have downloaded (opencv and opencv_contrib). However, if you plan to update OpenCV at all in the future, you should keep these repositories. To update, you can simply run

```
git pull
```

within each repository, then delete your build folder (opencv/build) and repeat step 6.

Step 7 – Testing OpenCV

To make sure you actually have OpenCV installed, open python by entering the following line in the terminal:

```
python
```

This will start up the Python interpreter so that you can run one line of code at a time.
When you install OpenCV, it is automatically nicknamed ‘cv2’ by Python. Run

```
import cv2
```

to see if you have OpenCV properly installed. If nothing happens, then OpenCV is now installed!

```
cv2.__version__
```

To see which version of opencv you downloaded, run the above command. If you get an error, go through the previous steps and make sure each step is executed correctly.

This is the end of the instruction manual. We hope it was helpful!

For future VirtualBox, be sure to visit https://www.virtualbox.org/wiki/VirtualBox

For future Ubuntu help, be sure to visit https://www.ubuntu.com/

For future Python help, be sure to visit https://www.python.org/