macOS: Install OpenCV 3 and Python 2.7

by **Adrian Rosebrock** on November 28, 2016 in **OpenCV 3**, **Tutorials**

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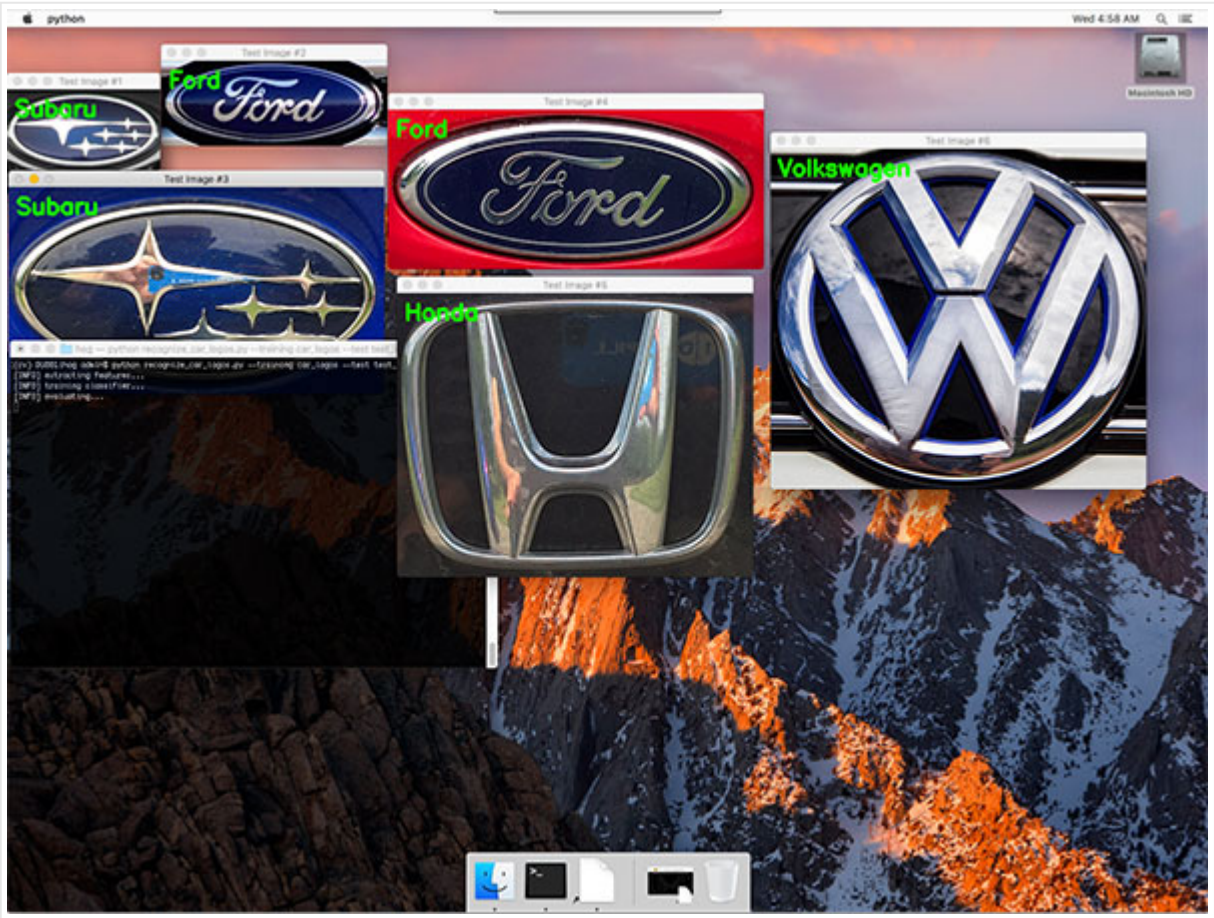

I'll admit it: Compiling and installing OpenCV 3 on macOS Sierra was ***a lot*** more of a challenge than I thought it would be, even for someone who has a compiled OpenCV on *hundreds* of machines over his lifetime.

If you've tried to use one of my previous tutorials on installing OpenCV on your freshly updated Mac (Sierra or greater) you likely ran into a few errors, specifically with the `QTKit.h` header files.

And even *if* you were able to resolve the QTKit problem, you likely ran into *more* issues trying to get your CMake command configured just right.

In order to help resolve any issues, problems, or confusion when installing OpenCV with Python bindings on macOS Sierra (or greater) I've decided to create two *hyper-detailed tutorials:*

1. This first tutorial covers how to install *OpenCV 3 with Python 2.7 bindings* on macOS.
2. My second tutorial will come next week where I'll demonstrate how to install *OpenCV 3 with Python 3.5 bindings* on macOS.

I decided to break these tutorials into two separate blog posts because they are quite lengthy.

Furthermore, tuning your CMake command to get it *exactly right* can be a bit of a challenge, especially if you're new to compiling from OpenCV from source, so I wanted to take the time to devise a foolproof method to help readers get OpenCV installed on macOS.

To learn how to install OpenCV with Python 2.7 bindings on your macOS system, *keep reading.*

macOS: Install OpenCV 3 and Python 2.7

The first part of this blog post details why I am creating a new tutorial for installing OpenCV 3 with Python bindings on the Mac Operating System. In particular, I explain a common error you may have run across — the `QTKit.h` header issue from the now deprecated QTKit library.

From there, I provide super detailed instructions on how to install OpenCV 3 + Python 2.7 your macOS Sierra system or greater.

Avoiding the QTKit/QTKit.h file not found error

In the Mac OSX environment the QTKit (QuickTime Kit) Objective-C framework is used for manipulating, reading, and writing media. In OSX version 10.9 (Mavericks) QTKit was deprecated (source).

However, it wasn't until the release of macOS Sierra that much of QTKit was removed and instead replaced with AVFoundation, the successor to QTKit. AVFoundation is the new framework for working with audiovisual media in iOS and macOS.

This created a *big problem* when compiling OpenCV on Mac systems — the QTKit headers were *not found on the system* and were expected to exist.

Thus, if you tried to compile OpenCV on your Mac using my previous tutorials your compile likely bombed out and you ended up with an error message similar to this:

```
macOS: Install OpenCV 3 and Python 2.7                    Shell
fatal error:
      'QTKit/QTKit.h' file not found
#import <QTKit/QTKit.h>
         ^ 1 error generated. make[2]: *** [modules/videoio/CMakeF
Error 1 make[1]: ***
[modules/videoio/CMakeFiles/opencv_videoio.dir/all] Error 2 make:
[all] Error 2
```

Even more problematic, both the tagged releases of OpenCV v3.0 and v3.1 *do not* include fixes to this issue.

That said, the *latest commits* to the OpenCV GitHub repo *do address this issue*; however, a new tagged release of v3.2 has yet to be released.

That said, I'm happy to report that by using the latest commit to OpenCV's GitHub we *can* install OpenCV on macOS Sierra and greater.

The trick is that we need to use the `HEAD` of the repo as opposed to a tagged release.

Once OpenCV 3.2 is released I'm sure the QKit to AVFoundation migration will be included, but until then, if you want to install OpenCV 3 on your macOS system running Sierra or later, you'll need to avoid using tagged releases and instead compile and install the development version of OpenCV 3.

How do I check my Mac Operating System version?

To check your Mac OS version click the *Apple* icon at the very top-left corner of your screen in the menu then select *"About this Mac"*.

A window should then pop up, similar to the one below:

Figure 1: Checking your OS version on Mac. My machine is currently running macOS Sierra (10.12).

If you are running macOS Sierra or greater, you can use this tutorial to help you install OpenCV 3 with Python 2.7 bindings.

If you are using an older version of the Mac Operating System (Mavericks, Yosemite, etc.), please refer to my previous tutorials.

Step #1: Install Xcode

Before we can even *think* about compiling OpenCV, we first need to install Xcode, a full blown set of software development tools for the Mac Operating System.

Register for an Apple Developer account

Before downloading Xcode you'll want to register with the Apple Developer Program (it's free). If you have an existing Apple ID (i.e., what you use to sign in to iTunes with) this is even easier. Simply provide some basic information such as name, address, etc. and you'll be all set.

From there, the easiest way to download Xcode is via the App Store. Search for *"Xcode"* in the search bar, select it, and then click the *"Get"* button:

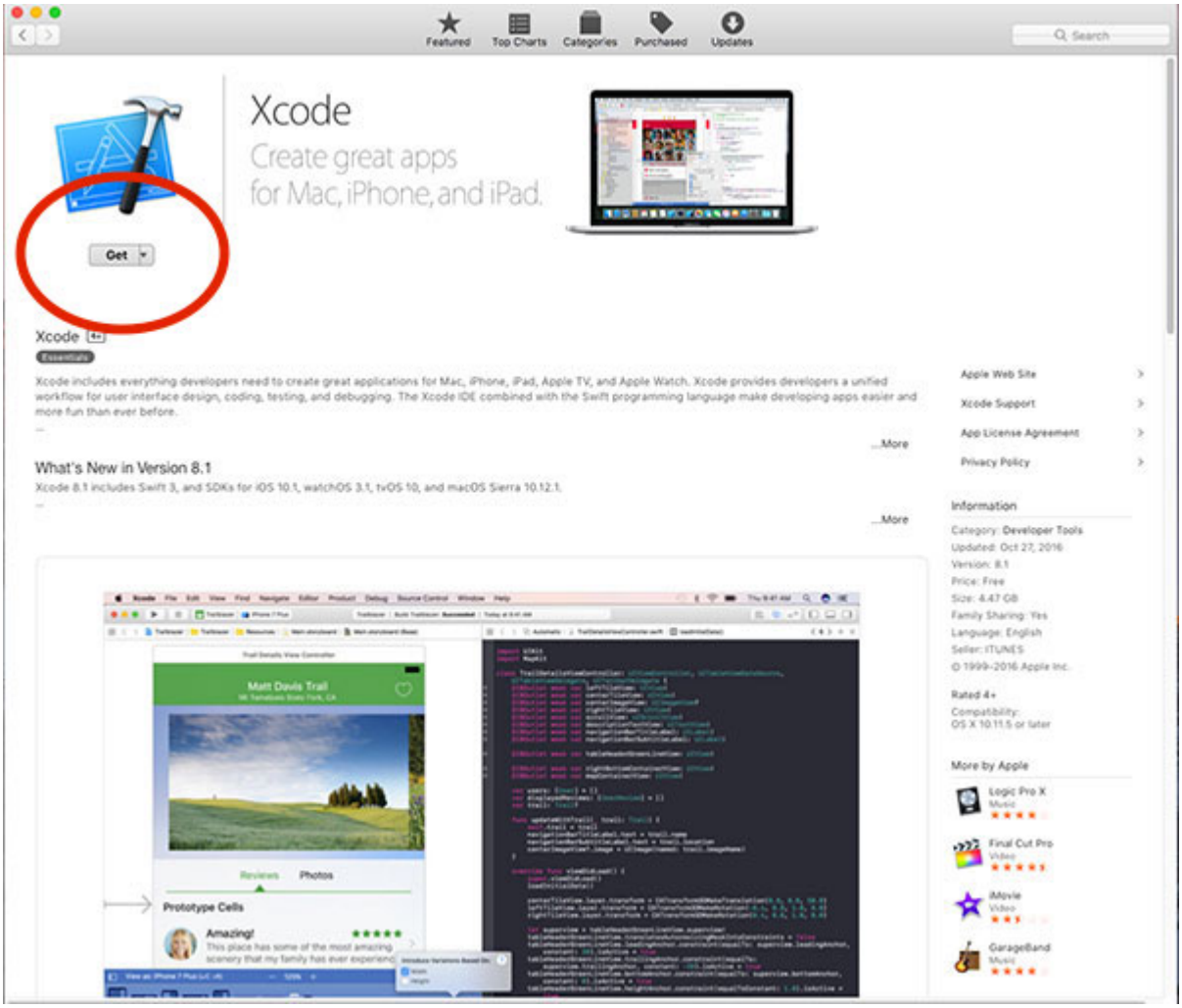

Figure 2: Selecting Xcode from the Apple App Store.

Xcode will then start to download and install. On my machine the download and install process took approximately 30 minutes.

Accept the Apple Developer license

Assuming this is the first time you've installed or used Xcode, you'll need to accept the developer license (otherwise, you can skip this step). I prefer using the terminal whenever possible. You can use the following command to accept the Apple Developer License:

```
macOS: Install OpenCV 3 and Python 2.7                    Shell
1 $ sudo xcodebuild -license
```

Scroll to the bottom of the license and accept it.

Install Apple Command Line Tools

Finally, we need to install the command line tools. These tools include packages such as make, GCC, clang, etc. **This is *absolutely* a required step**, so make sure you install the command line tools:

```
macOS: Install OpenCV 3 and Python 2.7                    Shell
1 $ sudo xcode-select --install
```

After you enter the command above a window will pop up confirming that you want to install the command line tools:

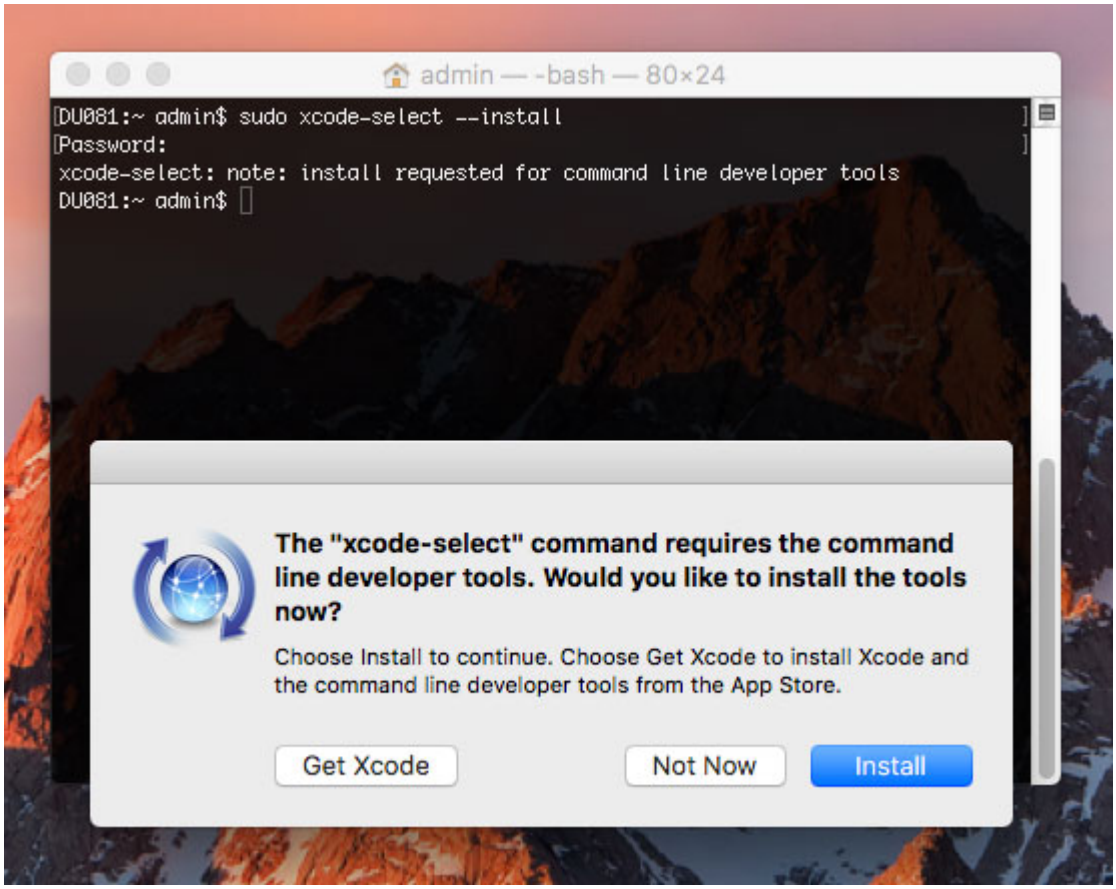

Figure 3: Installing the Apple Command Line Tools on macOS.

Click *"Install"* and the Apple Command Line Tools will be downloaded and installed on your system. This should take less than 5 minutes.

Step #2: Install Homebrew

We are now ready to install Homebrew, a package manager for macOS. Think of Homebrew as similar equivalent to *apt-get* for Ubuntu and Debian-based systems.

Installing Homebrew is simple. Simply copy and paste the command underneath the *"Install Homebrew"* section of the Homebrew website (make sure you copy and paste the *entire* command) into your terminal:

```
macOS: Install OpenCV 3 and Python 2.7                                Shell
1 $ /usr/bin/ruby -e "$(curl -fsSL https://raw.githubusercontent.cor
```

Once Homebrew is installed you should update it to ensure the most recent package definitions are downloaded:

```
macOS: Install OpenCV 3 and Python 2.7                                Shell
1 $ brew update
```

The last step is to update our `~/.bash_profile` file. This file may exist on your system already or it may not. In either case, open it with your favorite text editor (I'll use `nano` in this case):

```
macOS: Install OpenCV 3 and Python 2.7                                Shell
1 $ nano ~/.bash_profile
```

And insert the following lines at the bottom of the file (if `~/.bash_profile` does not exist the file will be empty, so simply insert the following lines):

```
macOS: Install OpenCV 3 and Python 2.7                          Shell
1 # Homebrew
2 export PATH=/usr/local/bin:$PATH
```

The above snippet updates your `PATH` variable to look for binaries/libraries along the Homebrew path before searching your system path.

After updating the file save and exit the editor. I have included a screenshot of my `~/.bash_profile` below:

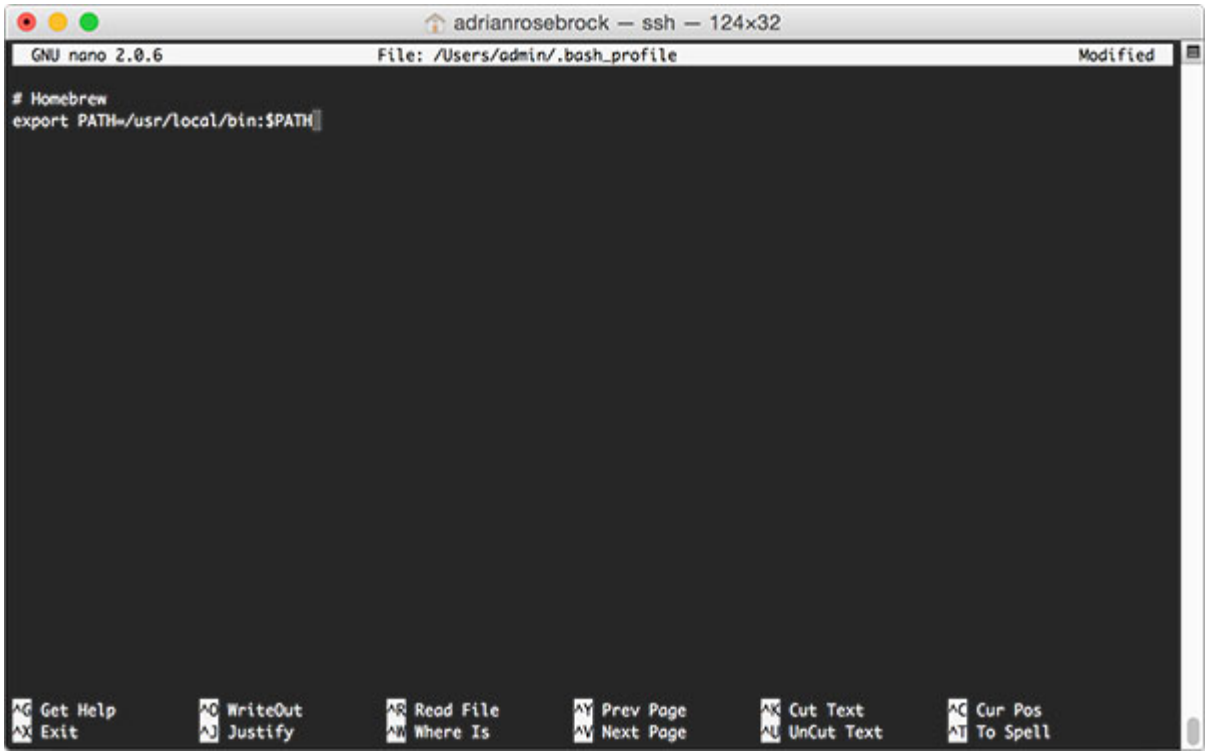

Figure 4: Updating my *.bash_profile* file to include Homebrew.

You should then use the `source` command to ensure the changes to your `~/.bash_profile` file are manually reloaded:

```
macOS: Install OpenCV 3 and Python 2.7                          Shell
1 $ source ~/.bash_profile
```

This command only needs to be executed *once*. Whenever you login, open up a new terminal, etc., your `.bash_profile` will will *automatically* be loaded and sourced for you.

Step #3: Setup Homebrew for Python 2.7 and macOS

In general, you *do not* want to develop against the system Python as your main interpreter. This is considered bad form. The system version of Python should (in an ideal world) serve only one purpose — *support system operations*.

Instead, you'll want to install your own version of Python that is *independent* of the system one. Installing Python via Homebrew is dead simple:

```
macOS: Install OpenCV 3 and Python 2.7                          Shell
1 $ brew install python
```

Note: *This tutorial covers how to install OpenCV 3 with* ***Python 2.7*** *bindings on macOS. Next week I'll be covering OpenCV 3 with Python 3 bindings — if you want to use* ***Python 3*** *with OpenCV on macOS, please refer to next week's blog post.*

After the install command finishes we just need to run the following command to complete the Python installation:

```
macOS: Install OpenCV 3 and Python 2.7                    Shell
1 $ brew linkapps python
```

To confirm that we are using the *Homebrew version of Python* rather than the *system version of Python* you should use the `which` command:

```
macOS: Install OpenCV 3 and Python 2.7                    Shell
1 $ which python
2 /usr/local/bin/python
```

Important: Be sure to inspect the output of the `which` command! If you see `/usr/local/bin/python` then you are correctly using the *Hombrew version of Python.*

However, if the output is `/usr/bin/python` then you are incorrectly using the *system version of Python*. If this is the case then you should ensure:

1. Homebrew installed without error.
2. The `brew install python` command completed successfully.
3. You have properly updated your `~/.bash_profile` file and reloaded the changes using `source` . This basically boils down to making sure your `~/.bash_profile` looks like mine above in **Figure 4**.

Step #4: Install virtualenv, virtualenvwrapper, and NumPy

We are now ready to install three Python packages: virtualenv and virtualenvwrapper, along with NumPy, used for numerical processing.

Installing virtualenv and virtualenvwrapper

The `virtualenv` and `virtualenvwrapper` packages allow us to create separate, independent Python environments for each project we are working on. I've mentioned Python virtual environments many times before, so I won't rehash what's already been said. Instead, if you are unfamiliar with Python virtual environments, how they work, and why we use them, please refer to the first half of this blog post. There is also an excellent tutorial on the RealPython.com blog that takes a deeper dive into Python virtual environments.

To install `virtualenv` and `virtualenvwrapper` , just use `pip` :

```
macOS: Install OpenCV 3 and Python 2.7                    Shell
1 $ pip install virtualenv virtualenvwrapper
```

After these packages have been installed we once again need to update our `~/.bash_profile` file:

```
macOS: Install OpenCV 3 and Python 2.7                    Shell
1 # Virtualenv/VirtualenvWrapper
2 source /usr/local/bin/virtualenvwrapper.sh
```

After updating, your `~/.bash_profile` should look similar to mine below:

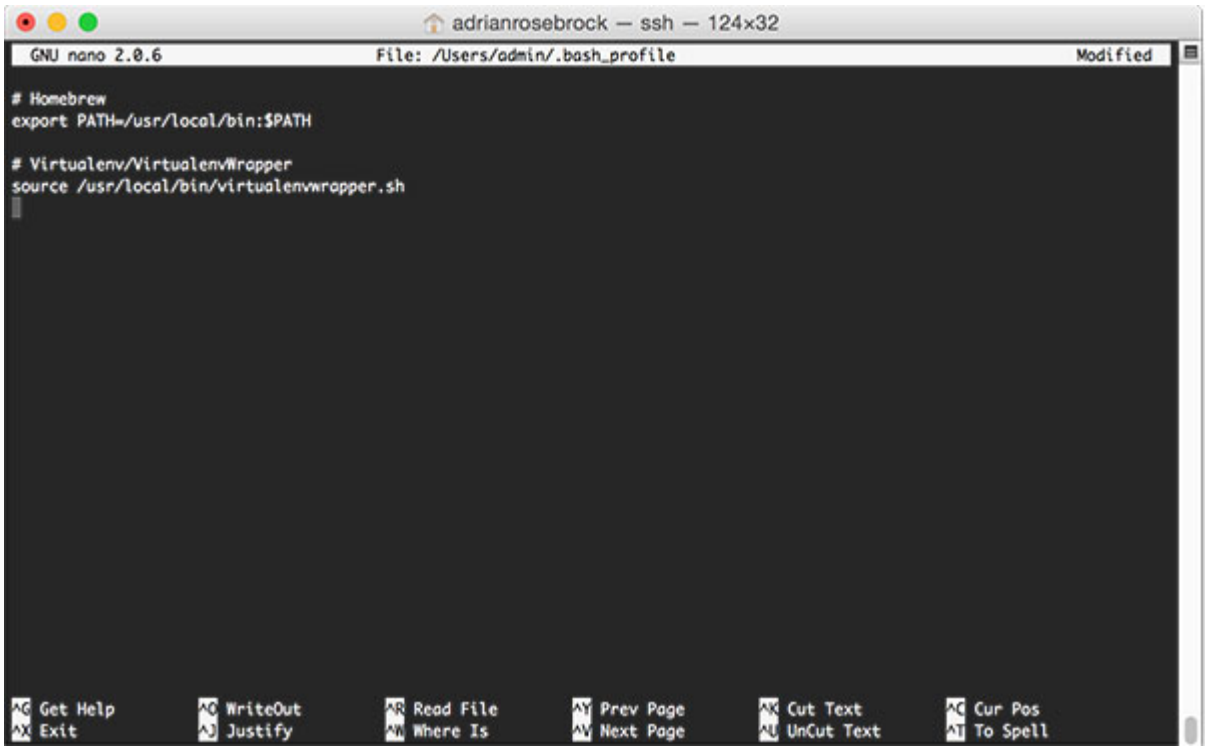

Figure 5: Update your *.bash_profile* file to include virtualenv/virtualenvwrapper.

Save and exit your text editor, followed by refreshing your environment using the `source` command:

```
macOS: Install OpenCV 3 and Python 2.7
1 $ source ~/.bash_profile
```

Again, this command only needs to be executed *once*. Whenever you open up a new terminal the contents of your `.bash_profile` file will be automatically loaded for you.

Creating your Python virtual environment

Assuming the above commands completed without error, we can now use the `mkvirtualenv` command to create our Python virtual environment. We'll name this Python virtual environent `cv` :

```
macOS: Install OpenCV 3 and Python 2.7                    Shell
1 $ mkvirtualenv cv
```

This command will create a Python environment that is *independent* from all other Python environments on the system (meaning this environment has its own separate `site-packages` directory, etc.). This is the virtual environment we will be using when compiling and installing OpenCV.

The `mkvirtualenv` command only needs to be executed once. If you ever need to access this virtual environment again, just use the `workon` command:

```
macOS: Install OpenCV 3 and Python 2.7                    Shell
1 $ workon cv
```

To validate that you are in the `cv` virtual environment, simply examine your command line — if you see the text `(cv)` preceding the prompt, then you ***are*** in the `cv` virtual environment:

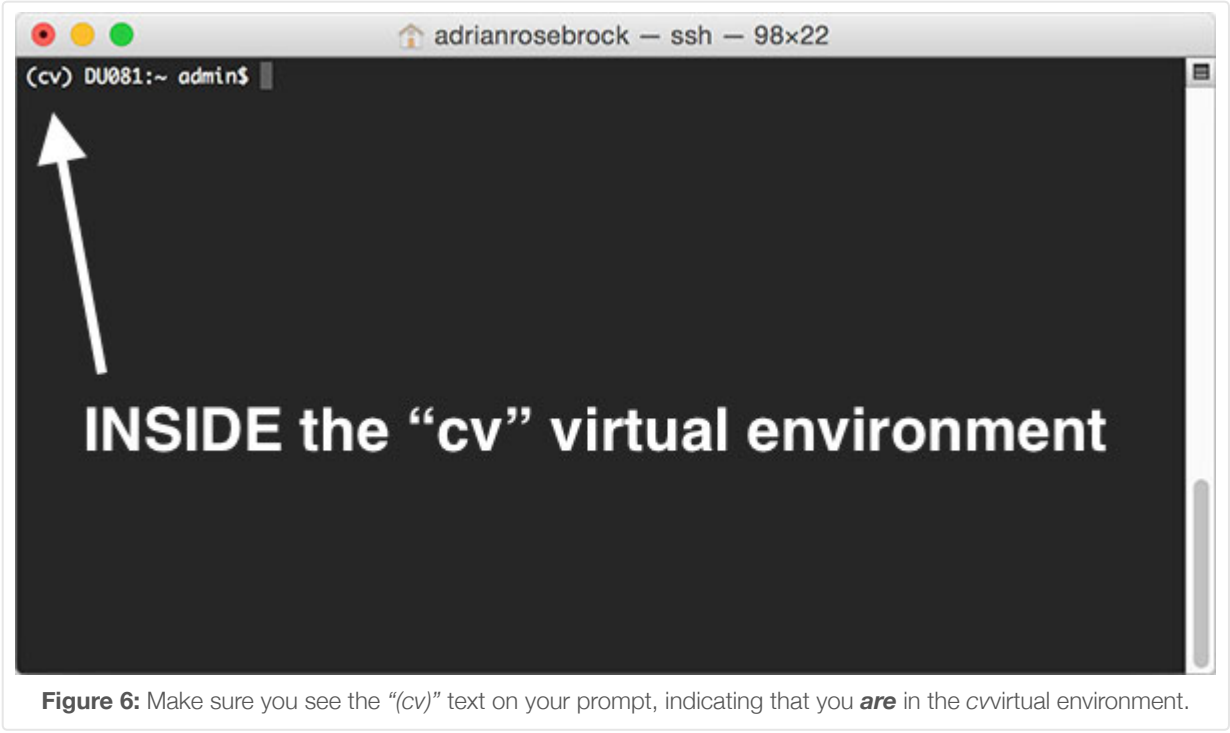

Figure 6: Make sure you see the *"(cv)"* text on your prompt, indicating that you ***are*** in the *cv*virtual environment.

Otherwise, if you ***do not*** see the `cv` text, then you ***are not*** in the `cv` virtual environment:

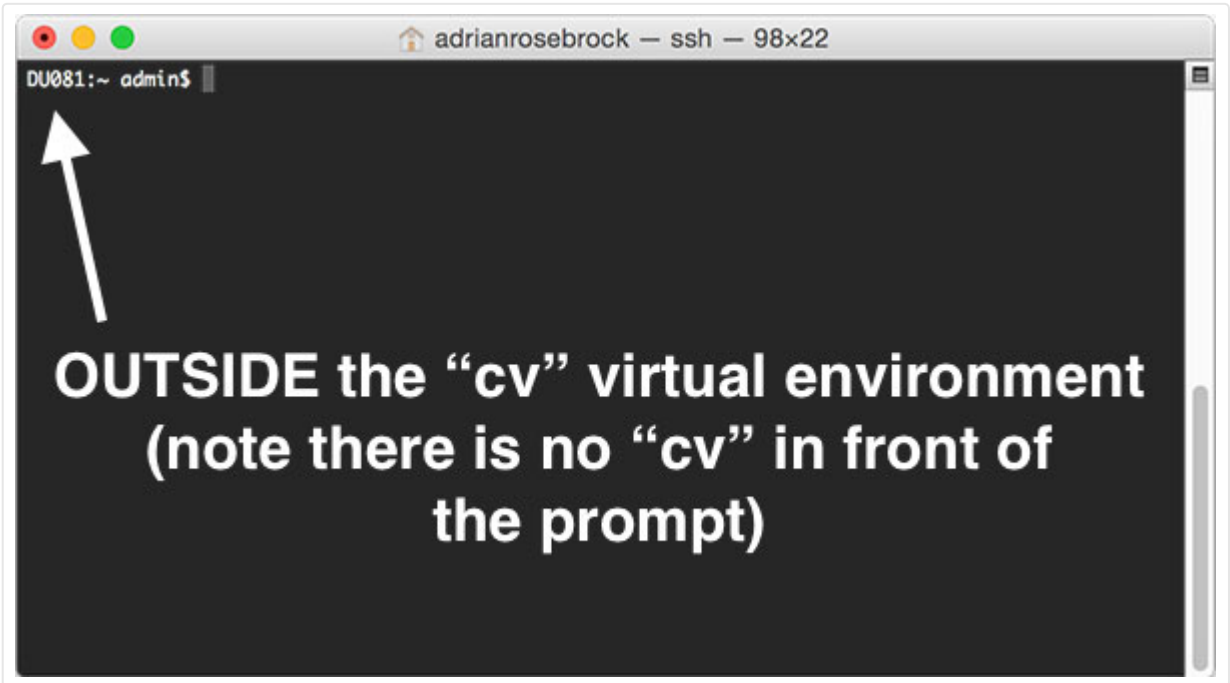

Figure 7: If you do not see the *"(cv)"* text on your prompt, then you ***are not*** in the *cv* virtual environment and you need to run the *"workon"* command to resolve this issue before continuing.

To access the `cv` virtual environment simply use the `workon` command mentioned above.

Install NumPy

The last step is to install NumPy, a scientific computing package for Python.

Ensure you are in the `cv` virtual environment (otherwise NumPy will be installed into the *system* version of Python rather than the `cv` environment) and then install NumPy using `pip` :

```
macOS: Install OpenCV 3 and Python 2.7                    Shell
1 $ pip install numpy
```

Step #5: Install OpenCV prerequisites using Homebrew

OpenCV requires a number of prerequisites, all of which can be installed easily using Homebrew.

Some of these packages are related to tools used to actually *build and compile* OpenCV while others are used for image I/O operations (i.e., loading various image file formats such as JPEG, PNG, TIFF, etc.)

To install the required prerequisites for OpenCV on macOS, just execute these commands:

macOS: Install OpenCV 3 and Python 2.7 — Shell

```
$ brew install cmake pkg-config
$ brew install jpeg libpng libtiff openexr
$ brew install eigen tbb
```

Step #6: Download the OpenCV 3 source from GitHub

As I mentioned at the top of this tutorial, we need to compile OpenCV from the latest commit, *not* a tagged release. This requires us to download the OpenCV GitHub repo:

macOS: Install OpenCV 3 and Python 2.7 — Shell

```
$ cd ~
$ git clone https://github.com/opencv/opencv
```

Along with the opencv_contrib repo:

macOS: Install OpenCV 3 and Python 2.7 — Shell

```
$ git clone https://github.com/opencv/opencv_contrib
```

Step #7: Configuring OpenCV 3 and Python 2.7 via CMake on macOS

In this section I detail how to configure your OpenCV 3 + Python 2.7 on macOS Sierra build using CMake.

First, I demonstrate how to setup your build by creating the `build` directory.

I then provide a CMake build template that you can use. This template requires you to fill in two values — the path to your `libpython2.7.dylib` file and the path to your `Python.h` headers.

I will help you find and determine the correct values for these two paths.

Finally, I provide an *example* of a fully completed CMake command. However, please take note that this command is specific to *my* machine. Your CMake command may be slightly different due to the paths specified. Please read the rest of this section for more details.

Setting up the build

In order to compile OpenCV 3 with Python 2.7 support for macOS we need to first set up the build. This simply amounts to changing directories into `opencv` and creating a `build` directory:

macOS: Install OpenCV 3 and Python 2.7 — Shell

```
$ cd ~/opencv
$ mkdir build
$ cd build
```

OpenCV 3 + Python 2.7 CMake template for macOS

In order to make the compile and install process easier, I have constructed the following template ***OpenCV 3 + Python 2.7 CMake template:***

```
macOS: Install OpenCV 3 and Python 2.7                                Shell
$ cmake -D CMAKE_BUILD_TYPE=RELEASE \
    -D CMAKE_INSTALL_PREFIX=/usr/local \
    -D OPENCV_EXTRA_MODULES_PATH=~/opencv_contrib/modules \
    -D PYTHON2_LIBRARY=YYY \
    -D PYTHON2_INCLUDE_DIR=ZZZ \
    -D PYTHON2_EXECUTABLE=$VIRTUAL_ENV/bin/python \
    -D BUILD_opencv_python2=ON \
    -D BUILD_opencv_python3=OFF \
    -D INSTALL_PYTHON_EXAMPLES=ON \
    -D INSTALL_C_EXAMPLES=OFF \
    -D BUILD_EXAMPLES=ON ..
```

Looking at this template I want to point out a few things to you:

1. `BUILD_opencv_python2=ON` : This indicates that we want to build Python 2.7 bindings for our OpenCV 3 install.
2. `BUILD_opencv_python3=OFF` : Since we are compiling Python 2.7 bindings we need to *explicitly state* that we do not want Python 3 bindings. Failure to include these two switches can cause problems in the CMake configuration process.
3. `PYTHON2_LIBRARY=YYY` : This is the ***first*** value you need to fill in yourself. You will need to replace `YYY` with the path to your `libpython2.7.dylib` file (I will help you find it in the next section).
4. `PYTHON2_INCLUDE_DIR` : This is the ***second*** value you will need to fill in. You need to replace `ZZZ` with the path to your `Python.h` headers (again, I'll help you determine this path).

Determining your Python 2.7 library and include directory

Let's start by configuring your `PYTHON2_LIBRARY` value. This switch should point to our `libpython2.7.dylib` file. You can find this file within *many* nested subdirectories of `/usr/local/Cellar/python/` . To find the *exact* path to the `libpython2.7.dylib` file, just use the `ls` command along with the wildcard asterisk:

```
macOS: Install OpenCV 3 and Python 2.7                                Shell
$ ls /usr/local/Cellar/python/2.7.*/Frameworks/Python.framework/Ve
/usr/local/Cellar/python/2.7.12_2/Frameworks/Python.framework/Vers
```

Take note of the output of this command — ***this is the full path to your*** `libpython2.7.dylib` ***file and will replace*** `YYY` ***in the CMake template above.***

Next, let's determine the `PYTHON2_INCLUDE_DIR` . This path should point to the `Python.h` headers used to generate our actual OpenCV + Python 2.7 bindings.

Again, we'll use the same `ls` and wildcard trick here to determine the proper path:

```
macOS: Install OpenCV 3 and Python 2.7                                Shell
$ ls -d /usr/local/Cellar/python/2.7.*/Frameworks/Python.framewor
/usr/local/Cellar/python/2.7.12_2/Frameworks/Python.framework/Vers
```

The output of the `ls -d` command is our full path to the `Python.h` headers. ***This value will replace*** `ZZZ` ***in the CMake template.***

Filling in the CMake template