CS-1004, Introduction to Programming for Non-Majors, A-Term 2014

Setting up Python 3.4, numpy, and matplotlib on your Macintosh or Linux computer

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Programming assignments in CS-1004 will be in the programming language *Python* — specifically, version 3.4 of *Python*. In addition, you will need several *Python* packages, including one called *numpy* (meaning "Numerical Python") and one called *matplotlib*, a *Python* version of the popular *Matlab* system. The first part of this document provides instructions for installing *Python 3.4* and packages such as *numpy* and *matplotlib* on Macintosh platforms.[1] Click here to skip forward to the Linux section of this document.

In general, it is expected that assignments will be compatible among Windows, Macintosh, and Linux systems, provided that they all use compatible versions of *Python* and *numpy*.

Note: There are two different, incompatible versions of *Python* in general use around the world — *Python 2.7* and *Python 3.4*. Significant changes to the *Python* language were made between *Python 2.x* and *Python 3.y* (for all values of *x* and *y*). The *Python 3* language is cleaner, more self-consistent, and more user-friendly. Programs written for versions of *Python 2* will not necessarily run on *Python 3* installations; if they do run, they may get different answers to the same problem.

That being said, a lot of legacy *Python 2* code is still in use, and new *Python 2.7* code is still being written and distributed by organizations that have not yet upgraded to *Python 3*. Not all *Python 2* packages have been ported to *Python 3*.

Note 2: Both Mac OS X and Linux come with *Python 2.7* already installed for their own needs. That version of *Python* must not be deleted or disturbed when installing *Python 3.4* and its packages.

Installing Python 3.4 on Macintosh[2, 3]

Installing *Python 3.4* on Mac OS X presents some challenges:–

[1] If you have a Windows computer or laptop, please refer to this documents instead:– docx, pdf

[2] It is useful to print out the relevant section of this document. If you read it on-screen, the dialog boxes of the installation tend to obscure the instructions of the document, just when you need them the most!

[3] These instructions have been tested on MacOS X 10.9.4. There may be slight differences with other versions of MacOS.

- Mac OS X has a very robust protection mechanism against malware, particularly the inadvertent installation of programs of unknown provenance. This protection must be overridden in order to install *Python 3.4*.
- Packages such as *numpy 1.8.1* and *matplotlib 1.3.1* are delivered in forms that require installation via commands in a *Terminal* window for installation.
- The *IDLE* tool of *Python 3.4* has a dependency on *Tcl/Tk*, an open-source toolkit for building user interfaces. However, *Python 3.4* requires a more recent version than is already installed on Mac OS X.

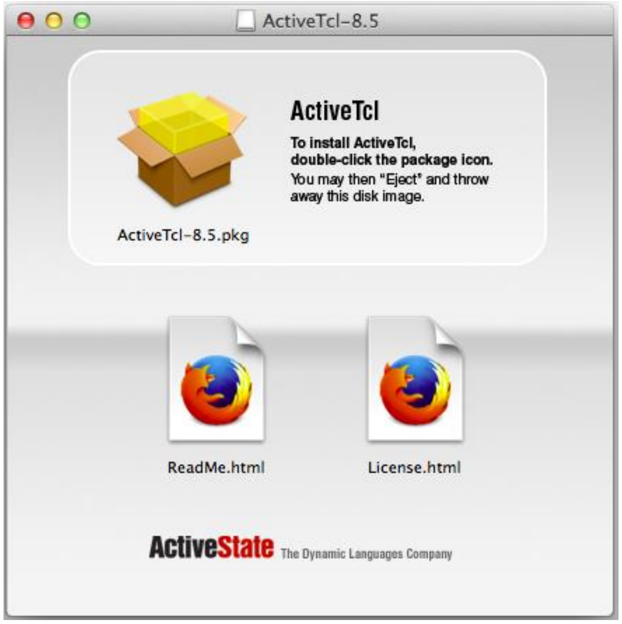
First, download the following two installers to a convenient folder or directory by clicking on these links:– ActiveTcl8.5.15.1, and python-3.4.1.macosx10.6. Alternatively, you may browse to

http://www.cs.wpi.edu/~cs1004/a14/Resources/

and download the files from there. Note that installations on the Macintosh require administrator privileges.

ActiveTcl 8.5.15.1

Open the **`ActiveTcl 8.5.15.1`** file that you just downloaded. You will be asked to confirm your action, and then it displays the following dialog box:–

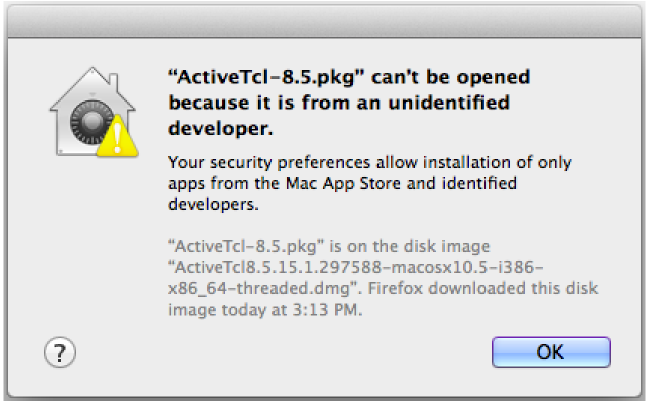


ActiveTcl

To install ActiveTcl, double-click the package icon. You may then "Eject" and throw away this disk image.

Figure 1

Double-click on the icon that looks like a shipping carton. Under most circumstances, you will next be presented with the following dialog box of the Macintosh *Gatekeeper*:–



"ActiveTcl-8.5.pkg" can't be opened because it is from an unidentified developer.

Your security preferences allow installation of only apps from the Mac App Store and identified developers.

"ActiveTcl-8.5.pkg" is on the disk image "ActiveTcl8.5.15.1.297588-macosx10.5-i386-x86_64-threaded.dmg". Firefox downloaded this disk image today at 3:13 PM.

Figure 2

Click *OK*, and then open *System Preferences* under the *Apple* menu. In the *System Preferences* folder, open the *Security and Privacy* icon, shown circled in Figure 3 to open the *Security & Privacy* control panel of Figure 4.

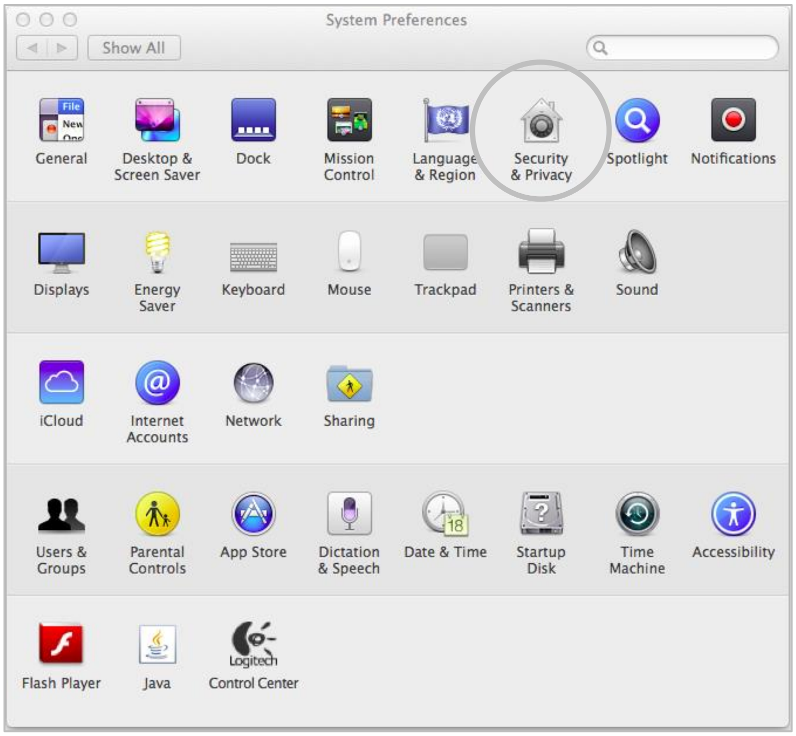
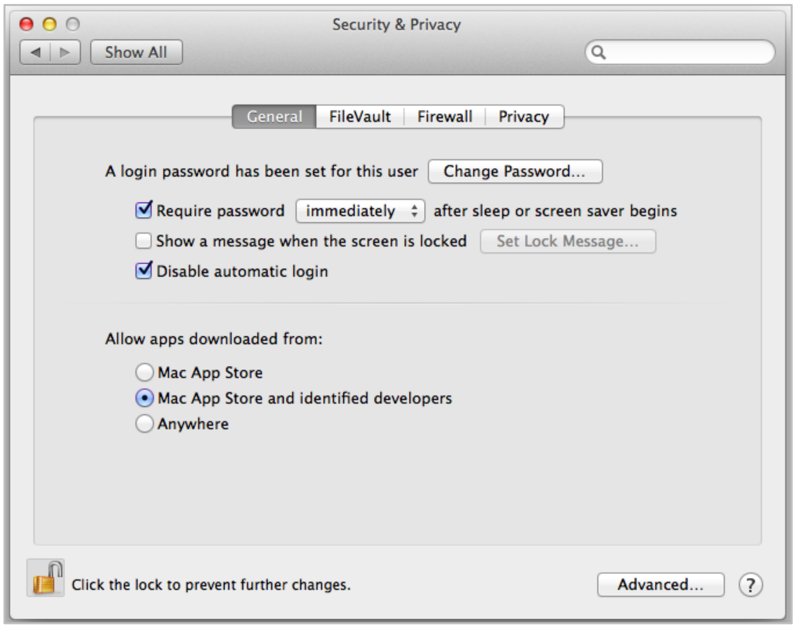


Figure 3



A login password has been set for this user

☑ Require password immediately after sleep or screen saver begins

□ Show a message when the screen is locked

☑ Disable automatic login

Allow apps downloaded from:

○ Mac App Store

● Mac App Store and identified developers

○ Anywhere

Click the lock to prevent further changes.

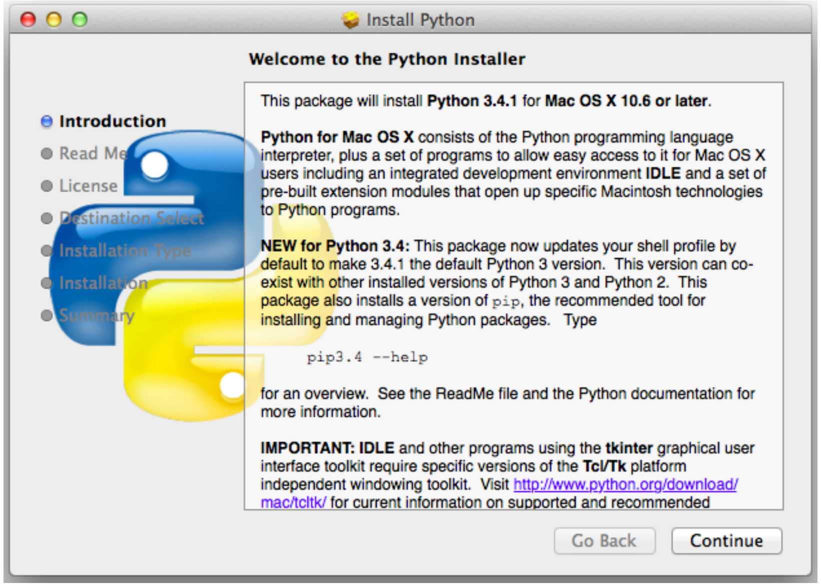
Figure 4

In the *Security & Privacy* panel, first click the padlock in the lower left to unlock the settings. (The padlock is shown already unlocked in the figure. In normal cases, it would be locked.) You probably need to supply the *Administrator's* login and password at this point. Next, select *Anywhere* for the option under *Allow apps downloaded from*.

Finally, go back to Figure 1 and double-click again on the package icon to install *ActiveTcl 8.5.15.1*. At this point, the installation of that package should proceed normally.

Installing Python 3.4

Next, you will install *Python 3.4*. Open the **`python-3.4.1-macosx10.6.dmg`** file that you downloaded on Page 2 above. This should bring up the dialog in Figure 5 below.



Welcome to the Python Installer

This package will install **Python 3.4.1** for **Mac OS X 10.6 or later**.

Python for Mac OS X consists of the Python programming language interpreter, plus a set of programs to allow easy access to it for Mac OS X users including an integrated development environment **IDLE** and a set of pre-built extension modules that open up specific Macintosh technologies to Python programs.

NEW for Python 3.4: This package now updates your shell profile by default to make 3.4.1 the default Python 3 version. This version can co-exist with other installed versions of Python 3 and Python 2. This package also installs a version of `pip`, the recommended tool for installing and managing Python packages. Type

```
pip3.4 --help
```

for an overview. See the ReadMe file and the Python documentation for more information.

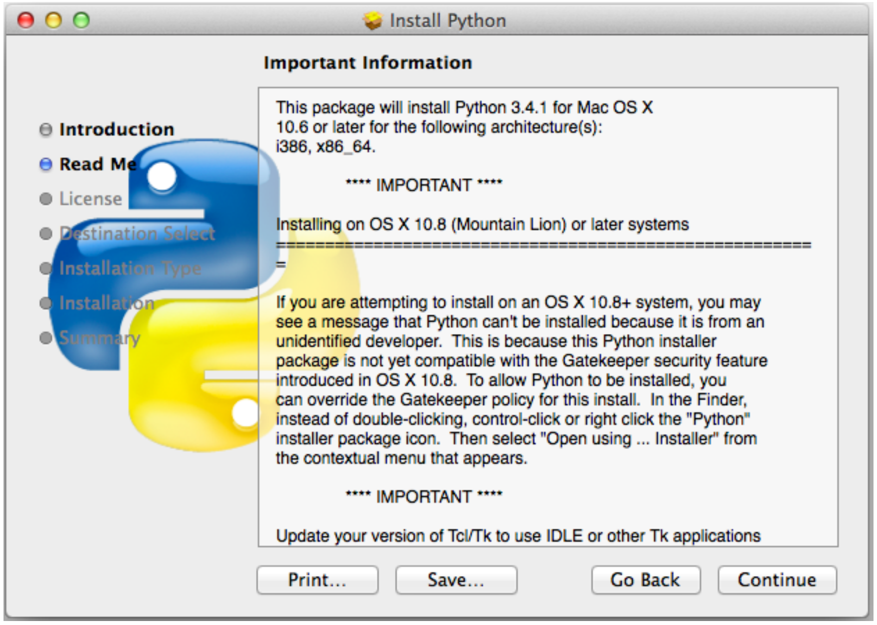
IMPORTANT: IDLE and other programs using the **tkinter** graphical user interface toolkit require specific versions of the **Tcl/Tk** platform independent windowing toolkit. Visit http://www.python.org/download/mac/tcltk/ for current information on supported and recommended

Figure 5

The message in the dialog box is scrollable and includes information about specific versions of *Tcl/Tk*. We have already addressed this issue with the installation of *ActiveTcl 8.5.15.1*.

If the installer complains that there is already a version of *Python 3* installed on your computer, please seek help or contact the Professor. You must have *Python 3.4.1* for this course. Earlier versions should be upgraded.

Click *Continue* to bring up another dialog:–



Important Information

This package will install Python 3.4.1 for Mac OS X 10.6 or later for the following architecture(s): i386, x86_64.

**** IMPORTANT ****

Installing on OS X 10.8 (Mountain Lion) or later systems
===
=

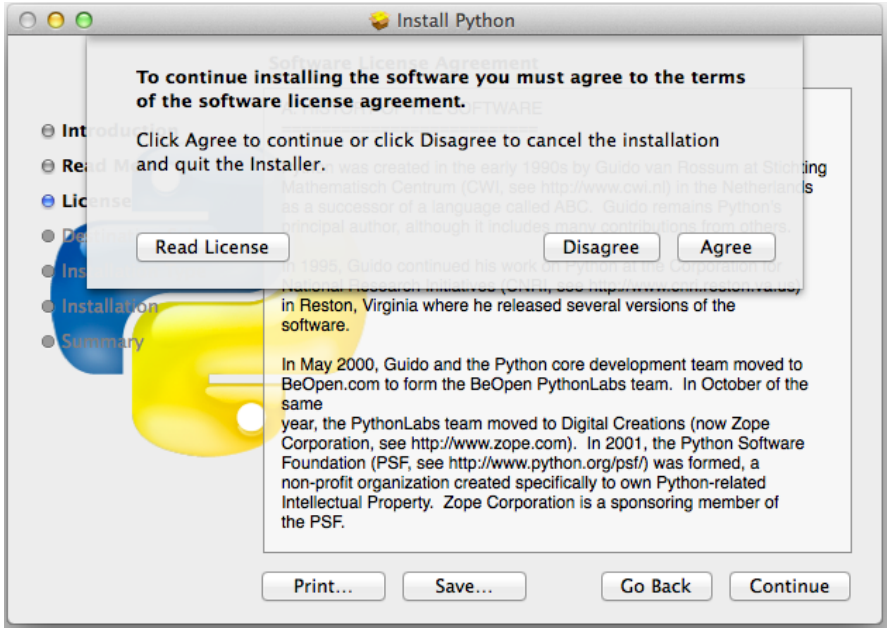
If you are attempting to install on an OS X 10.8+ system, you may see a message that Python can't be installed because it is from an unidentified developer. This is because this Python installer package is not yet compatible with the Gatekeeper security feature introduced in OS X 10.8. To allow Python to be installed, you can override the Gatekeeper policy for this install. In the Finder, instead of double-clicking, control-click or right click the "Python" installer package icon. Then select "Open using ... Installer" from the contextual menu that appears.

**** IMPORTANT ****

Update your version of Tcl/Tk to use IDLE or other Tk applications

Figure 6

This is a warning that the Macintosh *Gatekeeper* policy does not, by default, trust the *Python 3.4.1* installer. We have already addressed that issue in Figure 4 above. Click *Continue* to go forward with the installation. The next dialog is from *Python* itself:–



To continue installing the software you must agree to the terms of the software license agreement.

Click Agree to continue or click Disagree to cancel the installation and quit the Installer.

in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same
year, the PythonLabs team moved to Digital Creations (now Zope Corporation, see http://www.zope.com). In 2001, the Python Software Foundation (PSF, see http://www.python.org/psf/) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation is a sponsoring member of the PSF.

Figure 7

Click *Agree* to continue the installation. The installation itself will take several minutes. After it has completed, you should find a folder named *Python 3.4* in your *Applications* folder, as shown circled in solid black below.

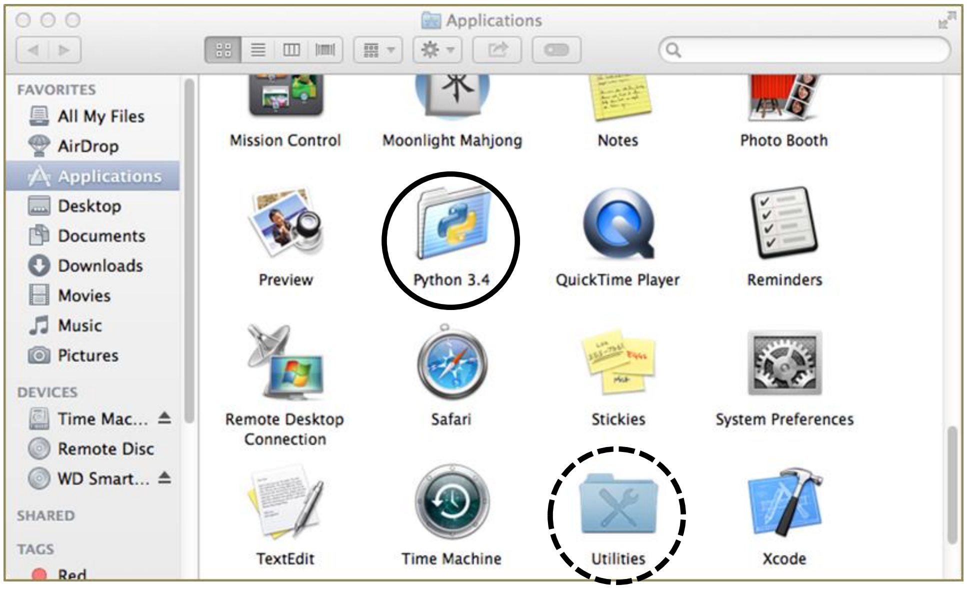


Figure 8

Open the *Python 3.4* folder to show the next figure:–

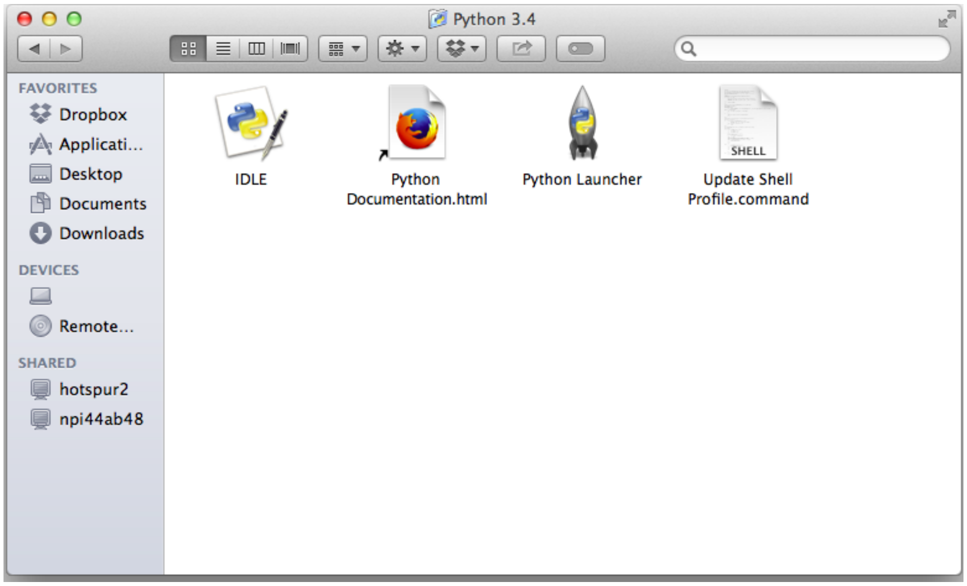
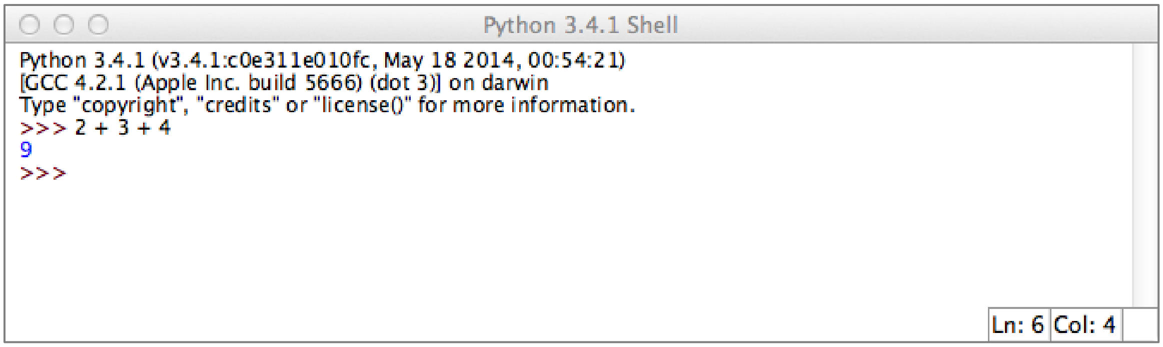


Figure 9

Create an *Alias* for *IDLE* and put it in a convenient place so that you can access it easily — for example, your desktop. Double-click this alias to bring up the following window:–



```
Python 3.4.1 (v3.4.1:c0e311e010fc, May 18 2014, 00:54:21)
[GCC 4.2.1 (Apple Inc. build 5666) (dot 3)] on darwin
Type "copyright", "credits" or "license()" for more information.
>>> 2 + 3 + 4
9
>>>
```

Figure 10

This is *IDLE*, the *Python* command prompt and graphical user interface. This is where we will start all programs and projects in this course. For now, simply type any *Python* statement or expression after the ">>>" prompt. For example, in Figure 10, the expression *2 + 3 + 4* was typed and *Python* responded with the value *9*. Continue testing by typing out the code on pages 10-11 of the textbook, just to make sure that your installation works as expected.

Note: IDLE is essentially the same across *Windows*, *Macintosh*, and *Linux* platforms. It is used the same way in all three.

Reminder: After you have completed the entire installation of *ActiveTcl 8.5.15.1* and *Python 3.4*, return to the *Security & Privacy* control panel of Figure 4 and restore the *Allow apps downloaded from* option to its original value (*Mac App Store and identified developers*). Then click on the padlock to *lock* it, thereby preventing further changes.

Installing *matplotlib*, *numpy*, and other packages

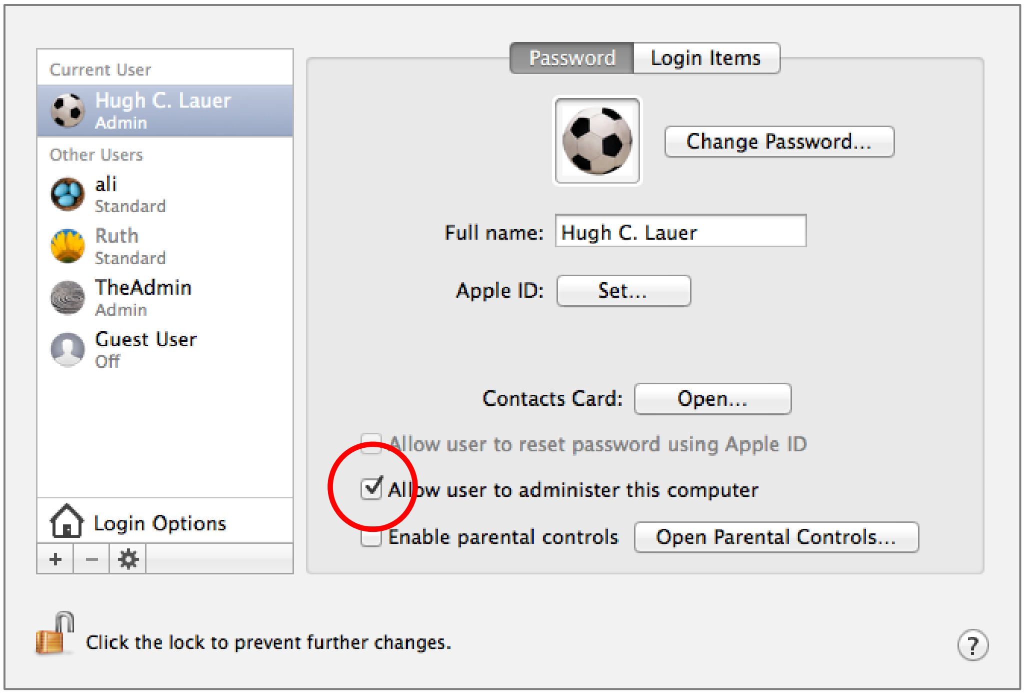
One of the many benefits of *Python* is the vast number of third-party packages that can be downloaded and used by your *Python* programs. Many of these are open-source and free. For this course, we will use at least the following:–

- *matplotlib* (a package for creating 2D plots and graphs similar to *Matlab*),
- *numpy* (meaning "Numerical Python," a package for efficient handling of large arrays of numerical data), and
- *graphics.py*, a simple tool written in *Python 3* and created by the textbook author for making simple drawings.

Installing *matplotlib*, *numpy*, and other packages on a Macintosh requires you to type Linux-like or Unix-like commands in a *Terminal* window. If you are comfortable doing this — including the use of the **sudo** command — skip forward to here. If not, it is a good idea to learn about this now.

Administrator privileges

First, give yourself *Administrator* permission at the command line level, so that you can use the **sudo** command with your own password. To get such permission, click on your user name in the upper right corner of the Macintosh desktop. This will open a pull-down menu of user names authorized to use your computer. Select the bottom item, entitled *Users and Groups Preferences*, to bring up a control panel similar to Figure 11 below.



Full name: Hugh C. Lauer

Apple ID: Set…

Contacts Card: Open…

□ Allow user to reset password using Apple ID

☑ Allow user to administer this computer

□ Enable parental controls

Click the lock to prevent further changes.

Figure 11

First, click on the padlock in the lower left corner to allow you to edit these settings. You will probably have to supply the *Administrator* user name and password.

Next, select your own user name from the left column. Check the circled option in Figure 11 that says "Allow user to administer this computer." Finally, click on the padlock in the lower left to prevent further (possibly accidental) changes.

Mac OS X will require you to reboot the computer to make these changes. **Do this now!**

After you have rebooted and logged in again, go back to Figure 8 and open the *Utilities* folder, which is indicated by the dashed circle in the figure. This will bring up the window of Figure 12. Select *Terminal* (highlighted with a red circle) and open it.

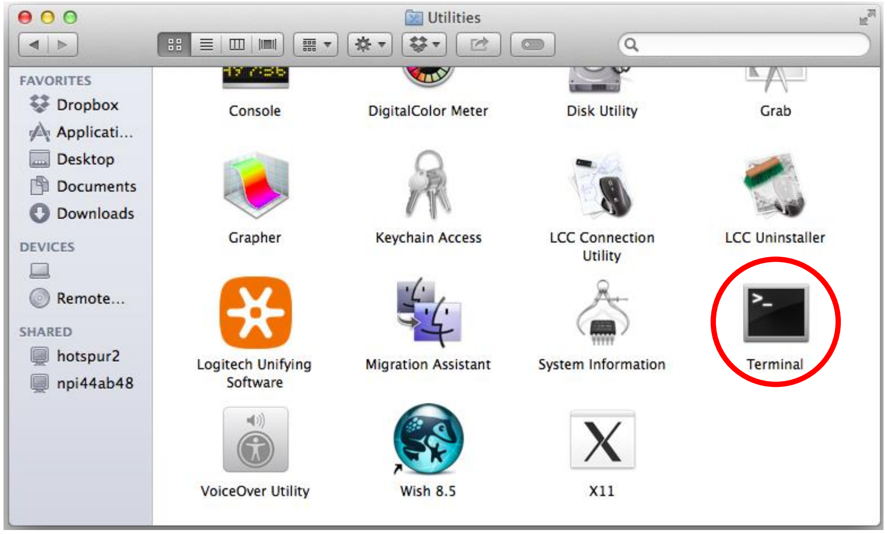


Figure 12

This will bring up a terminal window (also known as a *command shell* in Unix and Linux terminology). In this window, you will type *commands*, each one of which starts with a command name and is followed by zero or more *operands*, which control what the command does. A *command* may work silently and then type out its results in the same window, or it may engage in a textual conversation with you, requiring you to respond, or it may open its own window with its own graphical user interface.

An important command is **sudo**, which means **do** the command that follows on the rest of the line with **su** privileges (i.e., *super-user* priviliges, also known as *administrator* privileges). By checking the box in Figure 11, you have authorized yourself to use the **sudo** command. You need to supply your own password when you use **sudo** (not the administrator's password).

Installing *numpy* and *matplotlib*

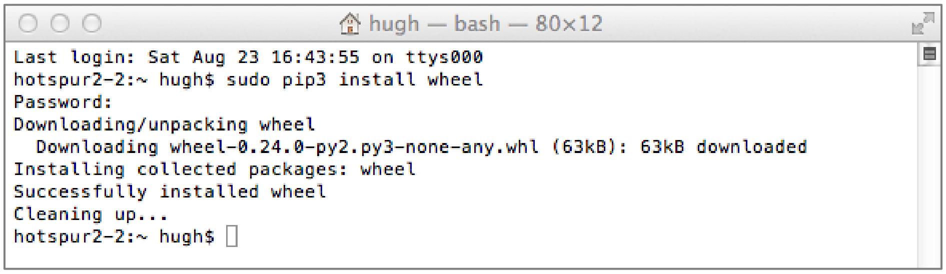
Click on the following links to download two files to a convenient folder:–

- Macintosh/numpy-1.8.1-cp34-cp34m-macosx_10_6_intel.macosx_10_9_intel.macosx_10_9_x86_64.whl
- Macintosh/matplotlib-1.3.1-cp34-cp34m-macosx_10_6_intel.macosx_10_9_intel.macosx_10_9_x86_64.whl

Before you can install *numpy 1.8.1*, you first need to install a *Python* utility that can interpret "wheel" files — i.e., files with the **.whl** suffix.[4] To do this, open a *Terminal* window and type the command

```
sudo pip3 install wheel
```
[5]

This is illustrated in Figure 13 starting in line 2:–



```
Last login: Sat Aug 23 16:43:55 on ttys000
hotspur2-2:~ hugh$ sudo pip3 install wheel
Password:
Downloading/unpacking wheel
  Downloading wheel-0.24.0-py2.py3-none-any.whl (63kB): 63kB downloaded
Installing collected packages: wheel
Successfully installed wheel
Cleaning up...
hotspur2-2:~ hugh$ 
```

Figure 13

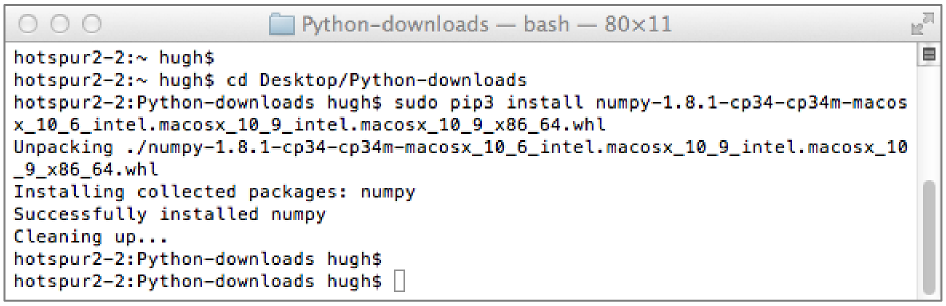
Next, use the **cd** command to change the working directory of the *Terminal* to the folder where you downloaded your files. This is shown on line 2 of Figure 14. Install *numpy* by typing or pasting the following command to the *Terminal* window (all on one line):–

```
sudo pip3 install numpy-1.8.1-cp34-cp34m-
    macosx_10_6_intel.macosx_10_9_intel.macosx_10_9_x86_64.whl
```

It is helpful to copy and paste the very long file name. The entire command should be typed or pasted onto one line, even though it overflows the line length of the terminal window. This command will install *numpy* and all of its dependencies, as shown in Figure 14 below.

[4] The original of the term **wheel** for this purpose is a mystery.

[5] **pip** denotes the *Python Installation Program*. **pip3** is the version of **pip** for *Python 3.x*.



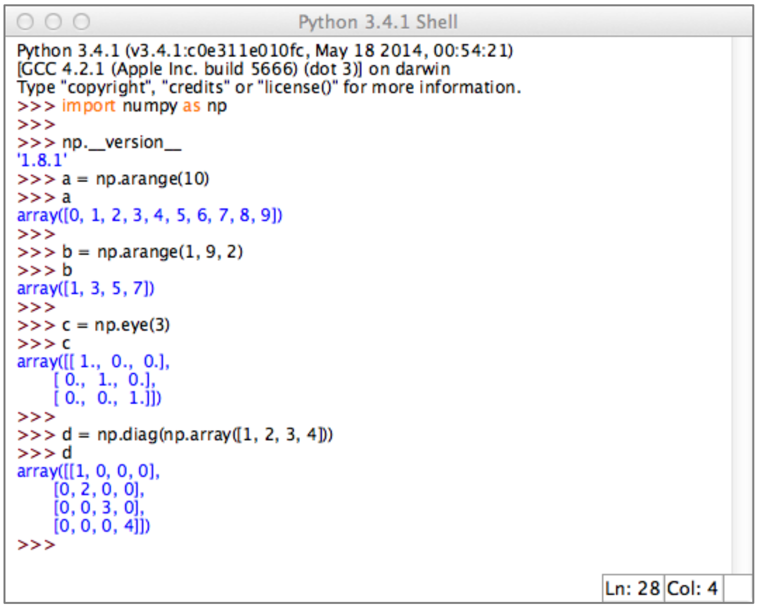
```
hotspur2-2:~ hugh$
hotspur2-2:~ hugh$ cd Desktop/Python-downloads
hotspur2-2:Python-downloads hugh$ sudo pip3 install numpy-1.8.1-cp34-cp34m-macos
x_10_6_intel.macosx_10_9_intel.macosx_10_9_x86_64.whl
Unpacking ./numpy-1.8.1-cp34-cp34m-macosx_10_6_intel.macosx_10_9_intel.macosx_10
_9_x86_64.whl
Installing collected packages: numpy
Successfully installed numpy
Cleaning up...
hotspur2-2:Python-downloads hugh$
hotspur2-2:Python-downloads hugh$
```

Figure 14

You can test your installation of *numpy* by opening an *IDLE* window, as in Figure 10. Type or paste the following commands into IDLE, one line at a time, exactly as written:–

```
import numpy as np
np.__version__ [6]
a = np.arange(10)
a
b = np.arange(1, 9, 2)
b
c = np.eye(3)
c
d = np.diag(np.array([1, 2, 3, 4]))
d
```

The result should resemble Figure 15 below:–



```
Python 3.4.1 (v3.4.1:c0e311e010fc, May 18 2014, 00:54:21)
[GCC 4.2.1 (Apple Inc. build 5666) (dot 3)] on darwin
Type "copyright", "credits" or "license()" for more information.
>>> import numpy as np
>>>
>>> np.__version__
'1.8.1'
>>> a = np.arange(10)
>>> a
array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
>>>
>>> b = np.arange(1, 9, 2)
>>> b
array([1, 3, 5, 7])
>>>
>>> c = np.eye(3)
>>> c
array([[ 1.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  0.,  1.]])
>>>
>>> d = np.diag(np.array([1, 2, 3, 4]))
>>> d
array([[1, 0, 0, 0],
       [0, 2, 0, 0],
       [0, 0, 3, 0],
       [0, 0, 0, 4]])
>>>
```

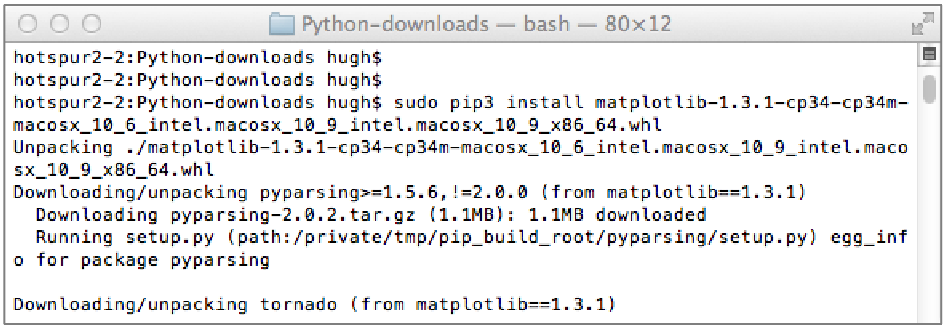
Figure 15

[6] Note that the word “**version**” is preceded by *two* underscore characters and followed by *two* more underscore characters.

Installation of *matplotlib* is done the same way. Type or paste the following command into the *Terminal* window, all on one line:–

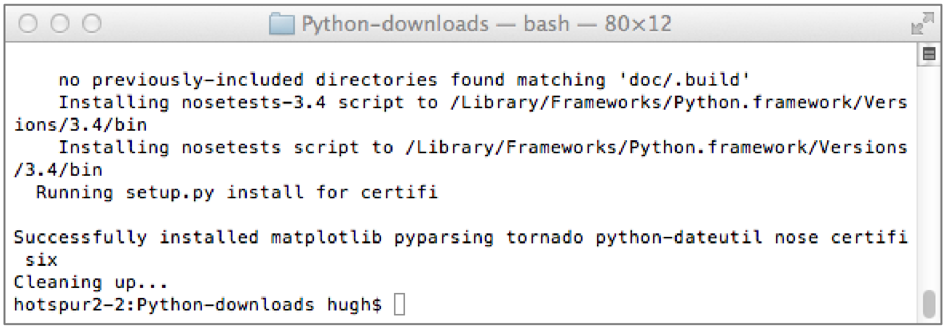
```
sudo pip3 install matplotlib-1.3.1-cp34-cp34m-
  macosx_10_6_intel.macosx_10_9_intel.macosx_10_9_x86_64.whl
```

This is shown in the highlighted area of Figure 16 below. However, *matplotlib* has many dependencies, and the **.whl** file instructs the **pip3 install** command to retrieve them from the network and install them, also. Therefore, the output continues for several screens full. The end is shown in Figure 17.



```
hotspur2-2:Python-downloads hugh$
hotspur2-2:Python-downloads hugh$
hotspur2-2:Python-downloads hugh$ sudo pip3 install matplotlib-1.3.1-cp34-cp34m-
macosx_10_6_intel.macosx_10_9_intel.macosx_10_9_x86_64.whl
Unpacking ./matplotlib-1.3.1-cp34-cp34m-macosx_10_6_intel.macosx_10_9_intel.maco
sx_10_9_x86_64.whl
Downloading/unpacking pyparsing>=1.5.6,!=2.0.0 (from matplotlib==1.3.1)
  Downloading pyparsing-2.0.2.tar.gz (1.1MB): 1.1MB downloaded
  Running setup.py (path:/private/tmp/pip_build_root/pyparsing/setup.py) egg_inf
o for package pyparsing

Downloading/unpacking tornado (from matplotlib==1.3.1)
```

Figure 16



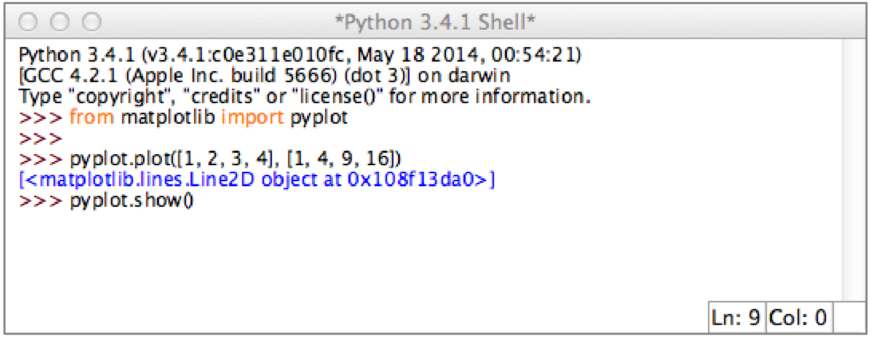
```

    no previously-included directories found matching 'doc/.build'
    Installing nosetests-3.4 script to /Library/Frameworks/Python.framework/Vers
ions/3.4/bin
    Installing nosetests script to /Library/Frameworks/Python.framework/Versions
/3.4/bin
  Running setup.py install for certifi

Successfully installed matplotlib pyparsing tornado python-dateutil nose certifi
 six
Cleaning up...
hotspur2-2:Python-downloads hugh$ 
```

Figure 17

To test your *matplotlib* installation, type or paste the following commands into IDLE, one line at a time, exactly as written:–

```
from matplotlib import pyplot
pyplot.plot([1, 2, 3, 4], [1, 4, 9, 16])
pyplot.show()
```

The IDLE window should look something like the following:–



```
Python 3.4.1 (v3.4.1:c0e311e010fc, May 18 2014, 00:54:21)
[GCC 4.2.1 (Apple Inc. build 5666) (dot 3)] on darwin
Type "copyright", "credits" or "license()" for more information.
>>> from matplotlib import pyplot
>>>
>>> pyplot.plot([1, 2, 3, 4], [1, 4, 9, 16])
[<matplotlib.lines.Line2D object at 0x108f13da0>]
>>> pyplot.show()
```

Figure 18

After you type the **ENTER** key following the last line, the following window should appear:–

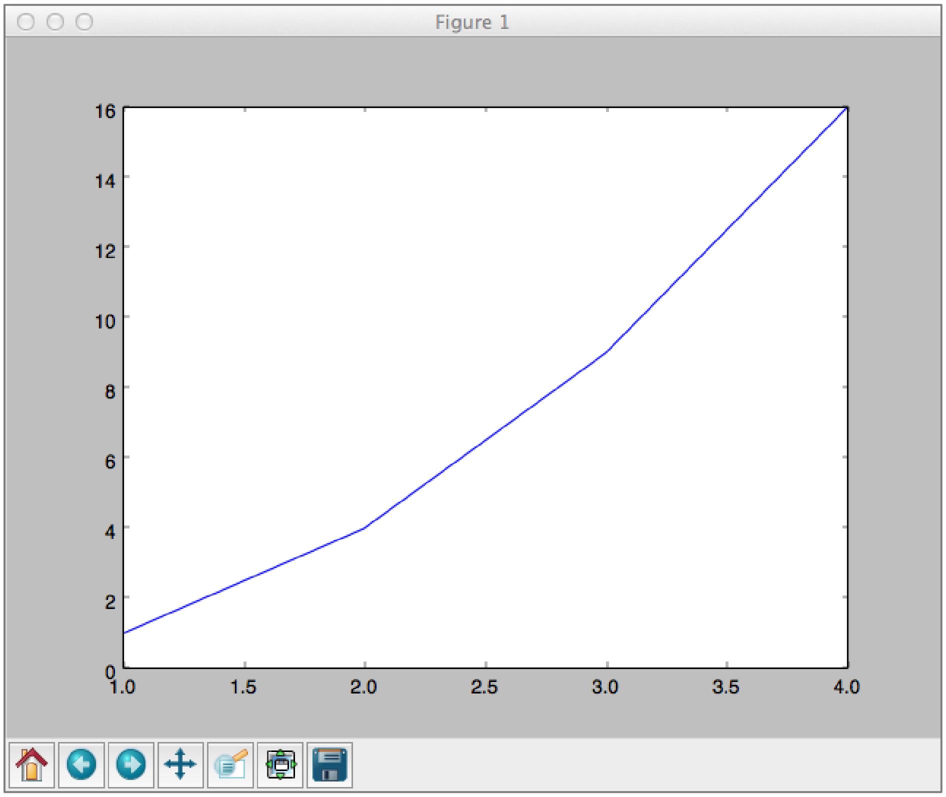


Figure 19

To close this window, click on the “close” button in the upper right.

Congratulations! You now have a working version of *matplotlib* installed.

Cleaning up

Remember to go back to the *Security and Privacy* settings *Figure 4* to restore the setting to *Allow apps downloaded from* only the *Mac App Store and identified developers.*

In addition, note that **dmg** files in Apple parlance are really virtual disk images. Opening the files to install *ActiveTcl 8.5.15.1* and *Python 3.4* causes two disk icons to be left on your desktop. You can remove these by right-clicking and selecting *Eject* for each one.

Installing Graphics.py

To install *graphics.py*, click on this link — graphics.py — and download the file to the folder where you keep your *Python* programs. Follow the instructions on p.488 of the textbook.

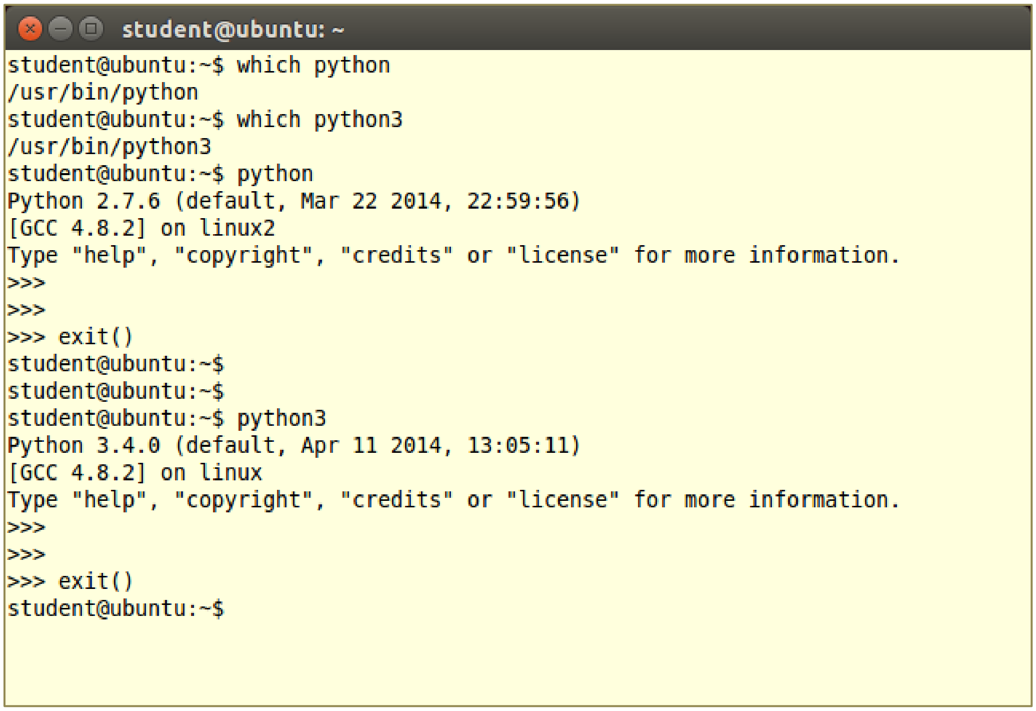
Installing Python 3.4 on Linux

Linux comes in many flavors supported by different organizations with different approaches to software installation. The desktop/laptop versions of Linux typically package the most common applications — including *Python* — in their automated download and installation systems. The following describes the installation on *Ubuntu 14.04*, a popular Linux version in use on the WPI campus, also known by the code name *Trusty Tahr.*[7, 8]

To determine whether or not *Python* is installed in your Linux (for any version or distribution of Linux), open a *Terminal Window* (also called a *Command Shell*) and type the following two commands (on separate lines):–

```
which python
which python3
```

If either returns the name of an executable file, then execute it to start that version of *Python*. The version number should be the first thing that *Python* says, as illustrated in the following figure for **python** (line 5) and **python3** (line 15):–



```
student@ubuntu:~$ which python
/usr/bin/python
student@ubuntu:~$ which python3
/usr/bin/python3
student@ubuntu:~$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>>
>>>
>>> exit()
student@ubuntu:~$
student@ubuntu:~$
student@ubuntu:~$ python3
Python 3.4.0 (default, Apr 11 2014, 13:05:11)
[GCC 4.8.2] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>>
>>>
>>> exit()
student@ubuntu:~$
```

Figure 20

The first two commands (lines 1 and 3) ask which file contains the programs *python* and *python3*, respectively. In this case, both programs are present in the indicated files. If either had not been present, the command would have reported nothing.

[7] It is not clear whether up-to-date versions of *Python* are available for download on older releases of *Ubuntu* or other versions of Linux. If you have an older Linux and are not able to upgrade, please see the Professor or Teaching Assistants for advice.

[8] The WPI Computer Science Department maintains a mirror distribution site for Ubuntu releases at http://ubuntu.cs.wpi.edu.

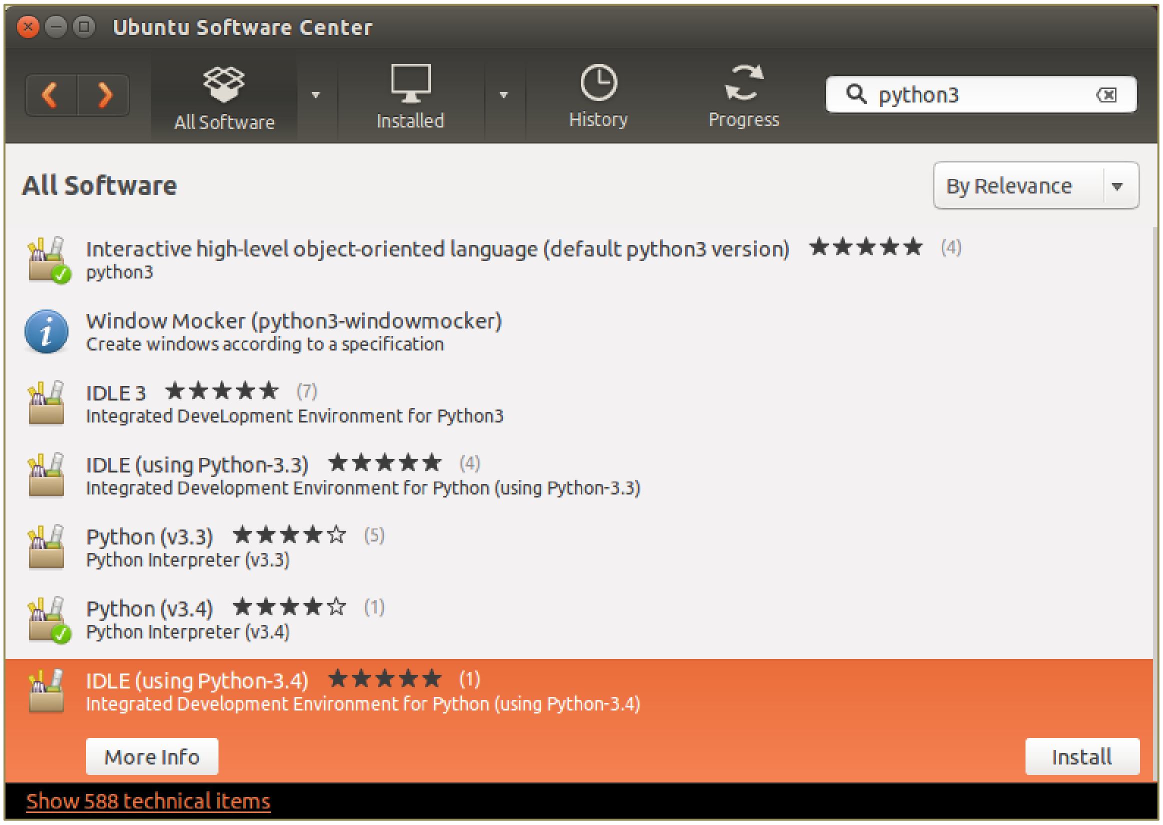
In line 5, the *python* program is run. Its first action is to print a preamble announcing its version and other (possibly useful) information; in this case, it is *Python 2.7.6*. The *exit()* command following the traditional *Python* prompt of “>>>” merely tells *Python 2.7.6* to finish what it is doing and to quit.

In line 14, the *python3* program is run. You can see from its preamble that it is *Python 3.4.0*.[9]

Installing IDLE

Figure 20 applies to any version Linux from any distributor to determine whether or not *Python* is installed and, if so, what version it is.

The following is specific to *Ubuntu* Linux. Users of other Linux distributions should carry out similar actions on those distributions. Select and open the *Ubuntu Software Center* icon in the toolbar on the left of the *Ubuntu* desktop. In the upper right, enter the term “Python3” in the search box. A search should produce the results shown in the figure below.



Interactive high-level object-oriented language (default python3 version) ★★★★★ (4)
python3

Window Mocker (python3-windowmocker)
Create windows according to a specification

IDLE 3 ★★★★★ (7)
Integrated DeveLopment Environment for Python3

IDLE (using Python-3.3) ★★★★★ (4)
Integrated Development Environment for Python (using Python-3.3)

Python (v3.3) ★★★★☆ (5)
Python Interpreter (v3.3)

Python (v3.4) ★★★★☆ (1)
Python Interpreter (v3.4)

IDLE (using Python-3.4) ★★★★★ (1)
Integrated Development Environment for Python (using Python-3.4)

Figure 21

This shows that the *Ubuntu Software Center* knows about several versions of *Python 3* and several versions of *IDLE*. The last line is highlighted and shows an *Install* button for “IDLE using Python 3.4). Click on this *Install* button to cause IDLE to be downloaded installed.

[9] This is one minor release older than the versions that we have installed on Windows or the Macintosh. However, we will live with that difference for CS-1004.

When the installation has completed, a new icon will have been added to the toolbar on the left, namely, the IDLE icon . *IDLE* has now been installed.

Testing your Linux installation of Python 3.4

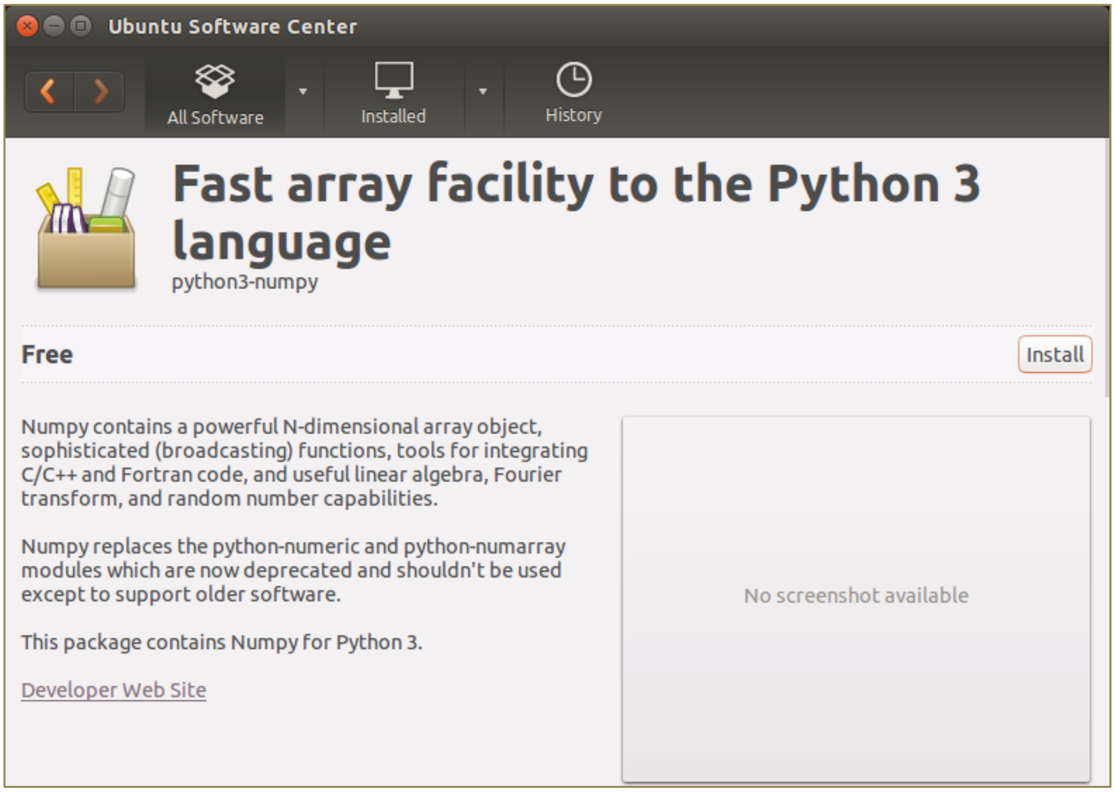
Follow the same instructions as with Figure 10 in order to validate that you can run *Python*.

Installing *numpy* on Linux

In *Ubuntu 14.04*, open the *Ubuntu Software Center* again and search for the term "python3-numpy". This will bring up one or more results, including the *numpy* package for *Python 3*.

> **Note:** Be sure that you specified "python3" as part of the search term. Otherwise, the search will return information about numpy for *Python 2.7*.
>
> **Note2:** If you use a different version of Linux, the search term in your software installation system should still be "python3-numpy."

Select on the *More Info* button to bring up the following window:–



Fast array facility to the Python 3 language

python3-numpy

Free

Numpy contains a powerful N-dimensional array object, sophisticated (broadcasting) functions, tools for integrating C/C++ and Fortran code, and useful linear algebra, Fourier transform, and random number capabilities.

Numpy replaces the python-numeric and python-numarray modules which are now deprecated and shouldn't be used except to support older software.

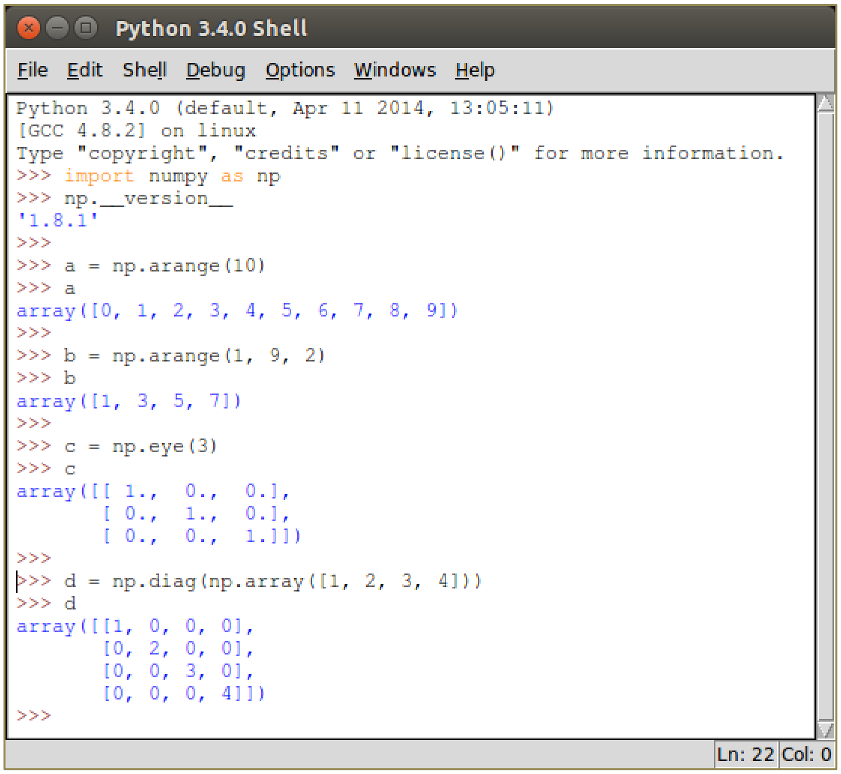
This package contains Numpy for Python 3.

Developer Web Site

Figure 22

Although it does not specify which version of *numpy* is provided, click on the *Install* button to install it. It will automatically install any required dependencies. You do not need to select other options for this course.

Finally, open an *IDLE* window by clicking on the *IDLE* icon and carry out the tests of Figure 15. Results of these tests are shown in Figure 23 below. Fortunately, the version of *numpy* is 1.8.1, as indicated by line 5 of this window.

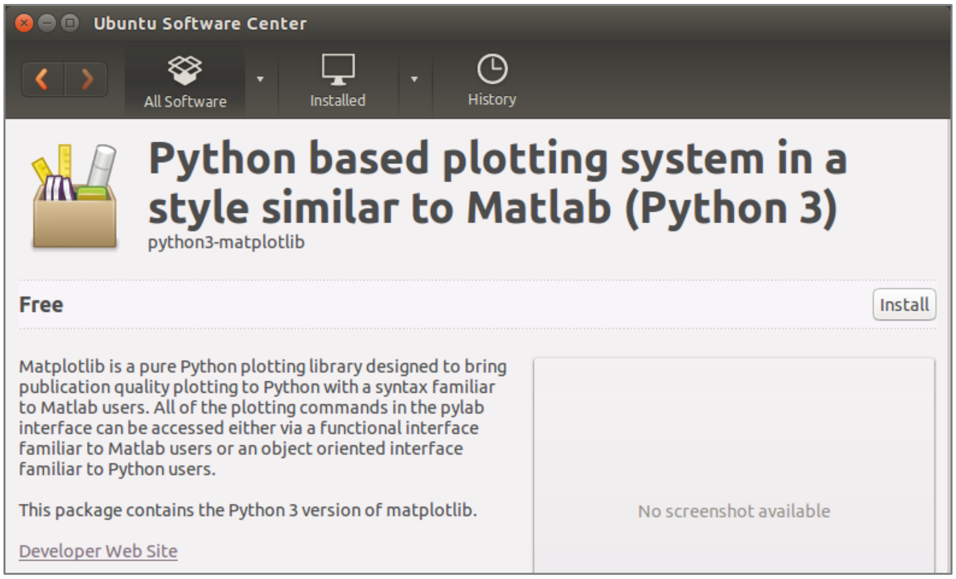


```
Python 3.4.0 (default, Apr 11 2014, 13:05:11)
[GCC 4.8.2] on linux
Type "copyright", "credits" or "license()" for more information.
>>> import numpy as np
>>> np.__version__
'1.8.1'
>>>
>>> a = np.arange(10)
>>> a
array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
>>>
>>> b = np.arange(1, 9, 2)
>>> b
array([1, 3, 5, 7])
>>>
>>> c = np.eye(3)
>>> c
array([[ 1.,  0.,  0.],
       [ 0.,  1.,  0.],
       [ 0.,  0.,  1.]])
>>>
>>> d = np.diag(np.array([1, 2, 3, 4]))
>>> d
array([[1, 0, 0, 0],
       [0, 2, 0, 0],
       [0, 0, 3, 0],
       [0, 0, 0, 4]])
>>>
```

Figure 23

Installing *matplotlib* on Linux

To install *matplotlib* on your version of Linux, repeat the same steps as you used for *numpy* but search instead for "python3-matplotlib." In *Ubuntu* , you would see the following:–



Python based plotting system in a style similar to Matlab (Python 3)

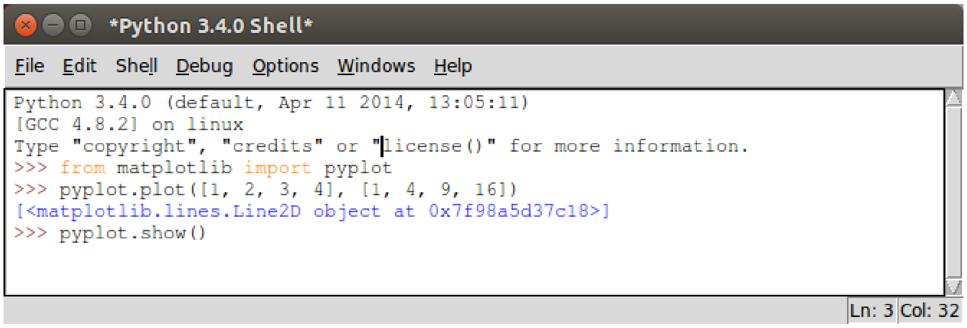
python3-matplotlib

Matplotlib is a pure Python plotting library designed to bring publication quality plotting to Python with a syntax familiar to Matlab users. All of the plotting commands in the pylab interface can be accessed either via a functional interface familiar to Matlab users or an object oriented interface familiar to Python users.

This package contains the Python 3 version of matplotlib.

Figure 24

Install this, just as you installed *numpy*. To test your installation, carry out the test of Figure 18. This should produce the *IDLE* window of Figure 25 and the plot of Figure 26



```
Python 3.4.0 (default, Apr 11 2014, 13:05:11)
[GCC 4.8.2] on linux
Type "copyright", "credits" or "license()" for more information.
>>> from matplotlib import pyplot
>>> pyplot.plot([1, 2, 3, 4], [1, 4, 9, 16])
[<matplotlib.lines.Line2D object at 0x7f98a5d37c18>]
>>> pyplot.show()
```

Figure 25

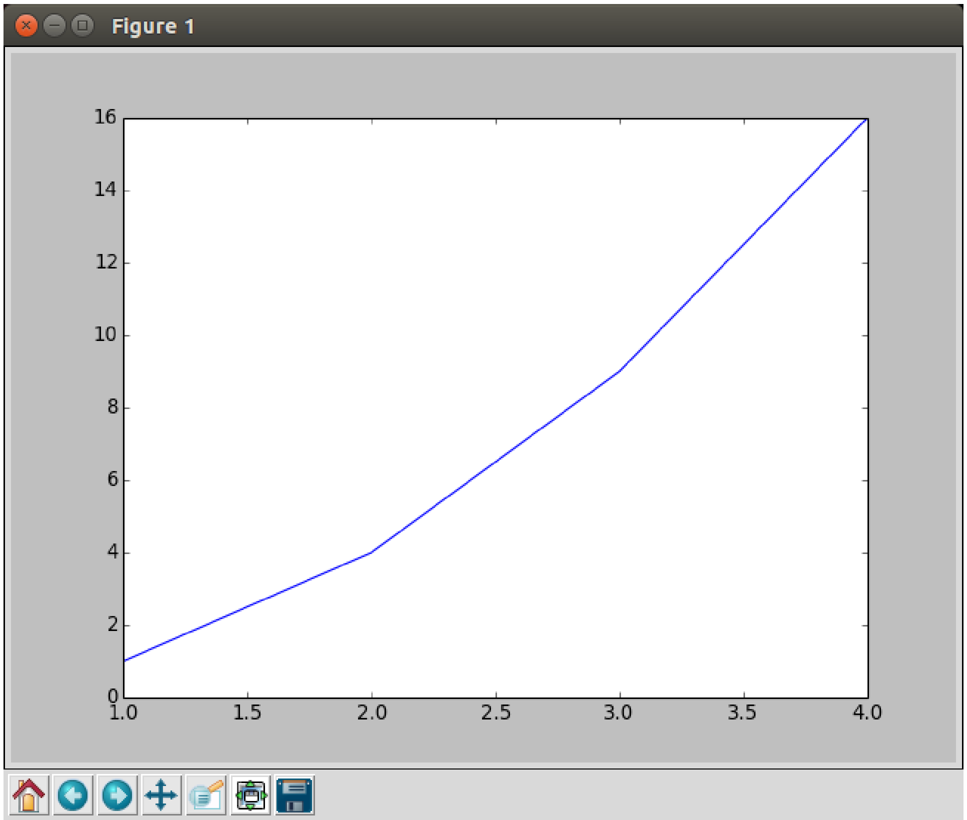


Figure 26

Conclusion

Congratuations! You have successfully used *Python 3.4* as already installed and have added *IDLE*, *numpy*, and *matplotlib*.

If you are brave enough (and savvy enough) to use another distribution of *Linux*, good luck. The guidance here should help you get started. The official *Python* download page is at

https://www.python.org/download/

Source "tarballs" are available to compile for your own environment. Alternatively, a list of other *Python* distributors is also provided. Good luck!