Machine Learning at Scale: R and Python Notebooks for Data Science via Jupyter

Evolved from the IPython Project

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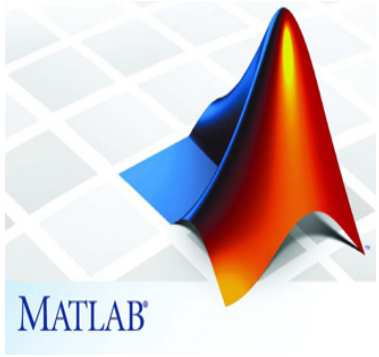
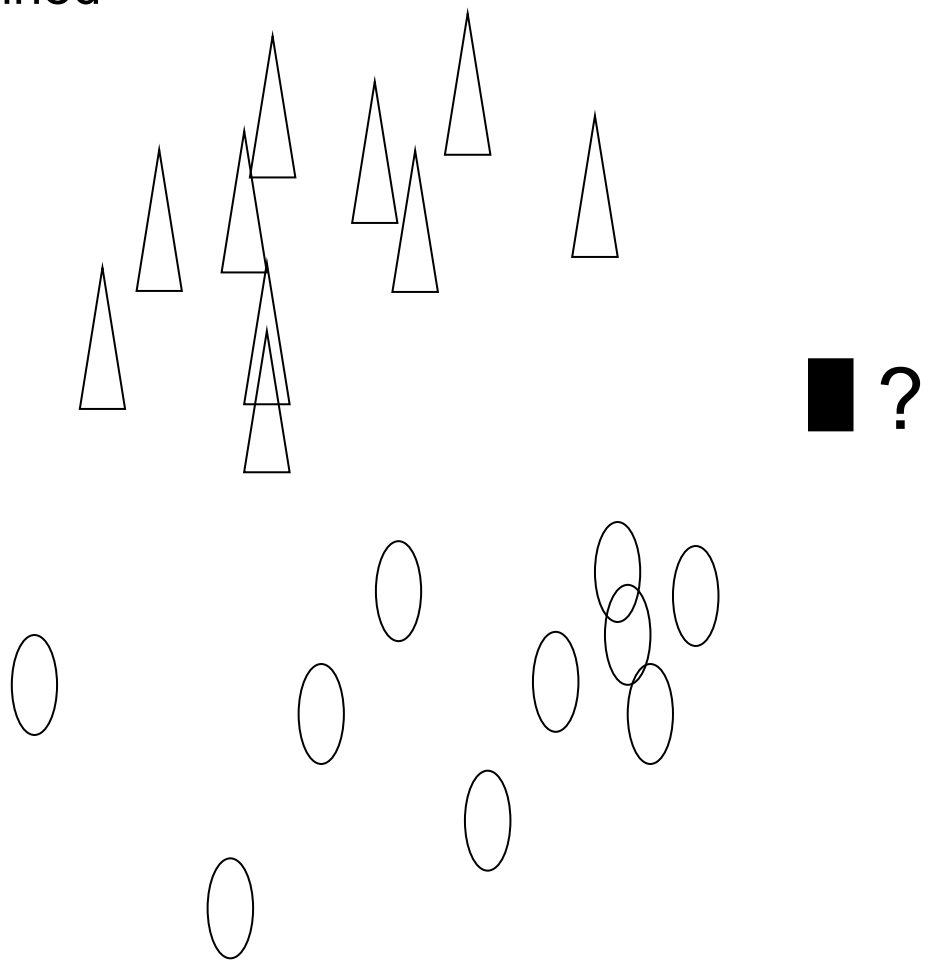
June 07, 2016

Python and R are trending for Data Science



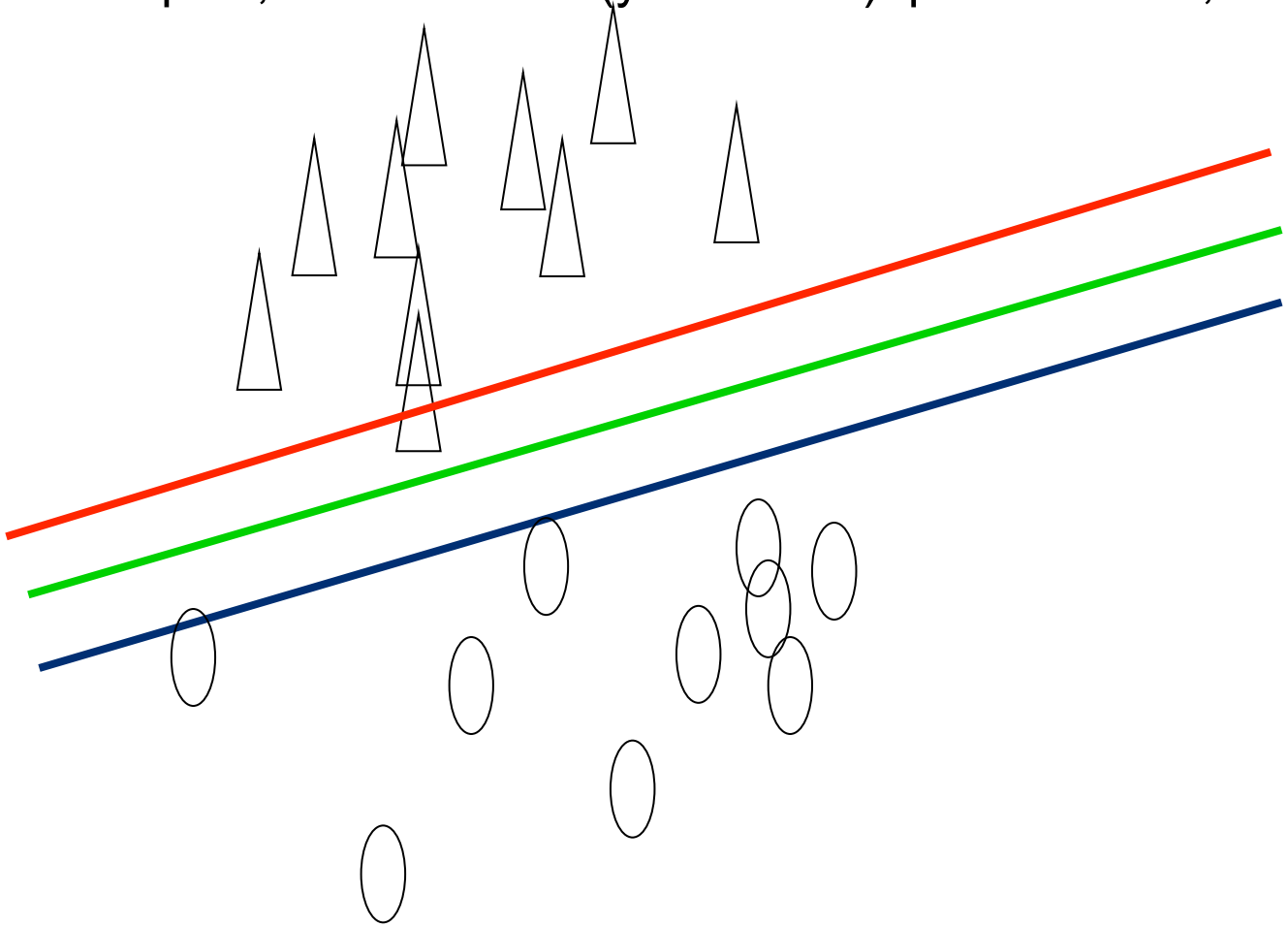
Example: Train an linear classifier

Problem explained



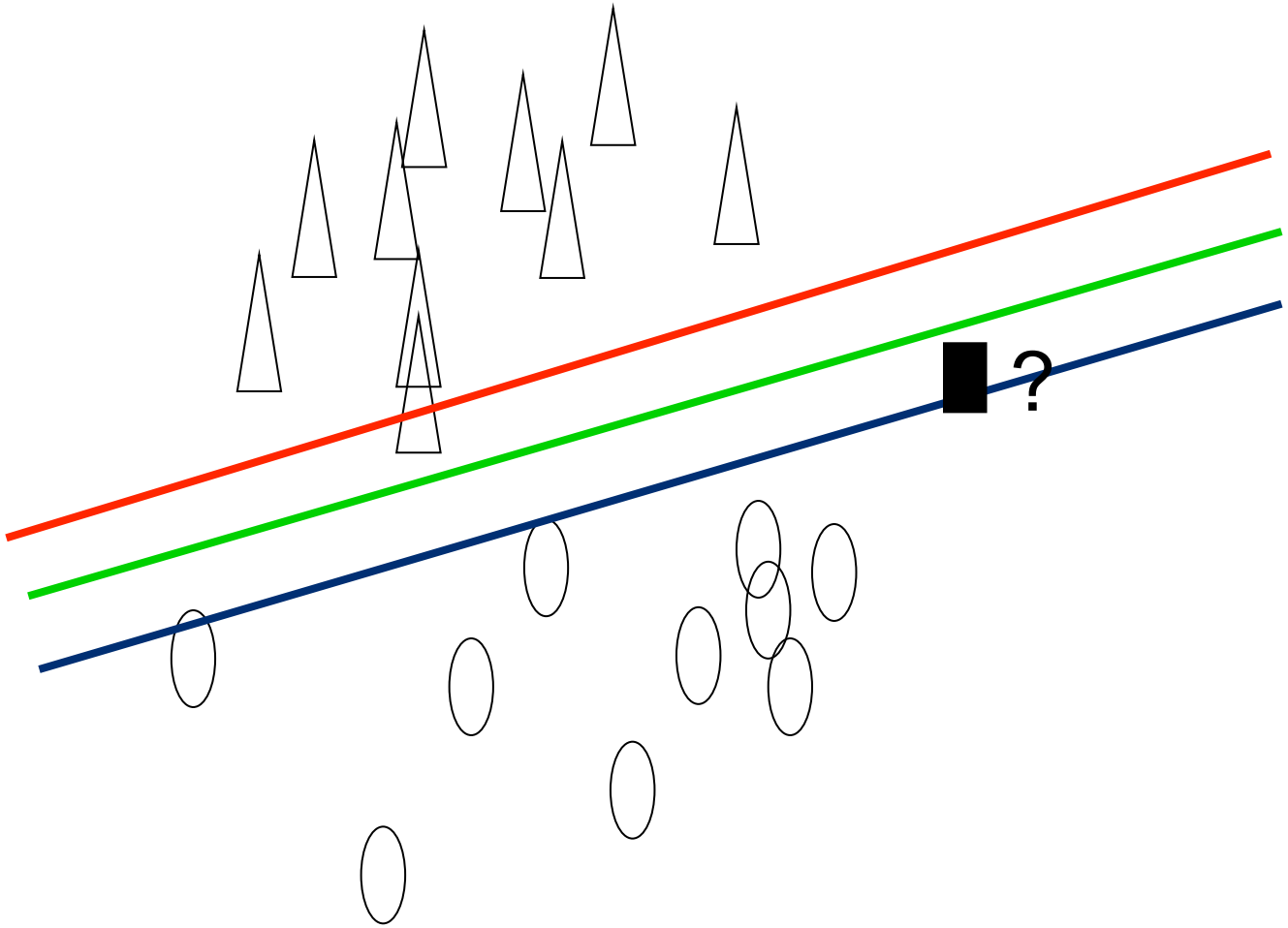
Example: Train an linear classifier

Based on samples, train a model (y = x*a + b) parameter: a, b



Example: Train an linear classifier

Which model is better ?



Example: Train an linear classifier

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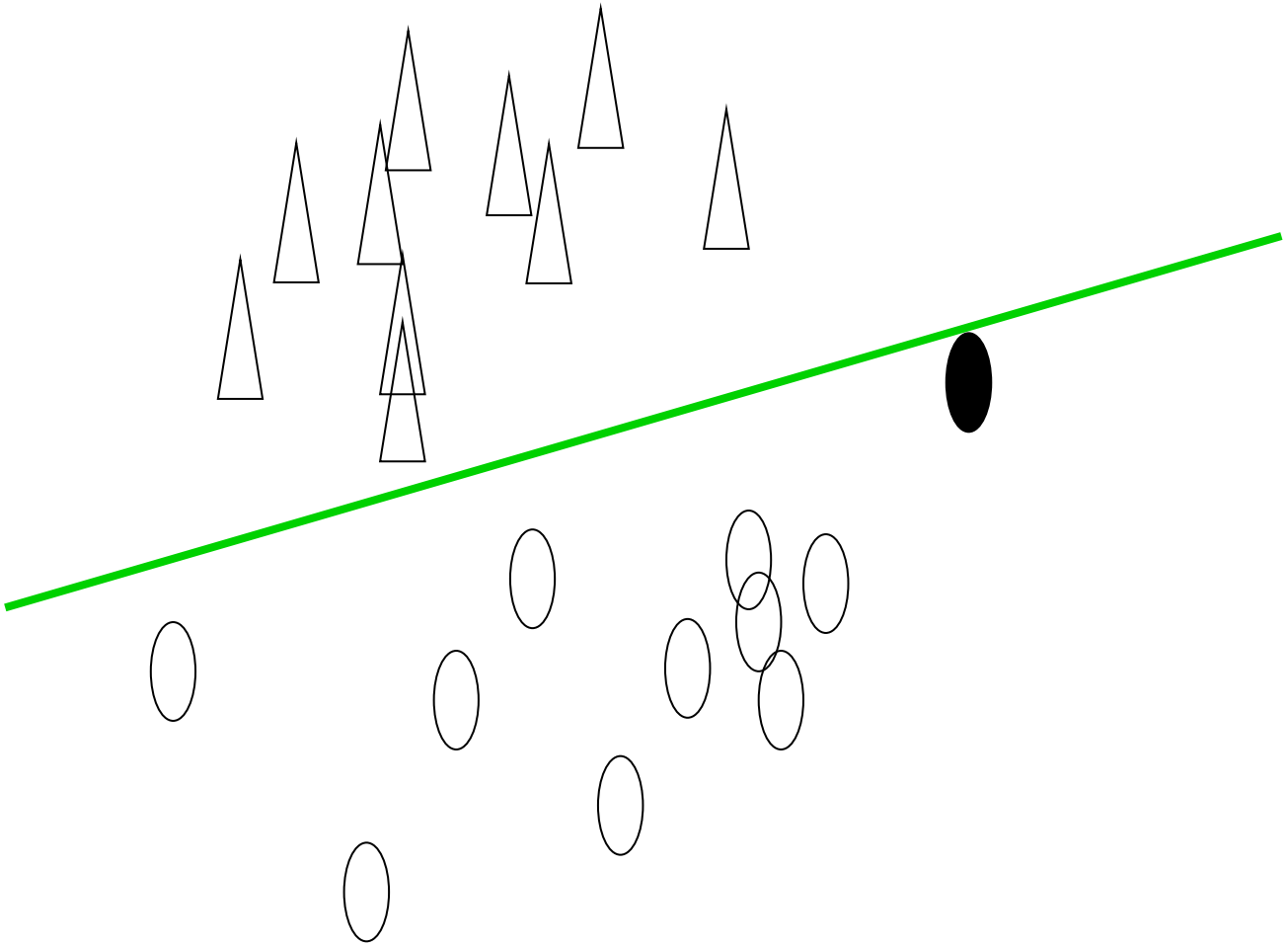
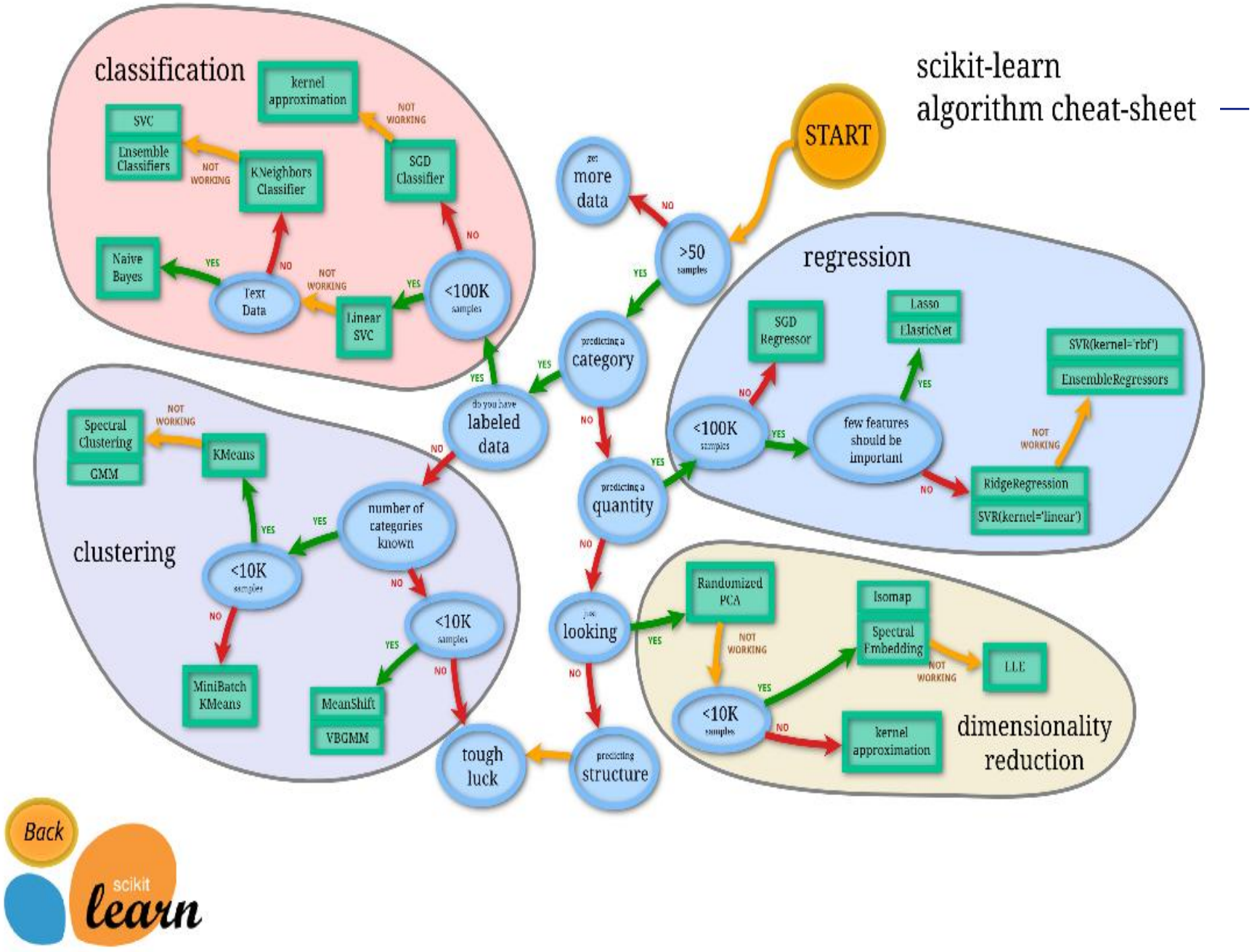
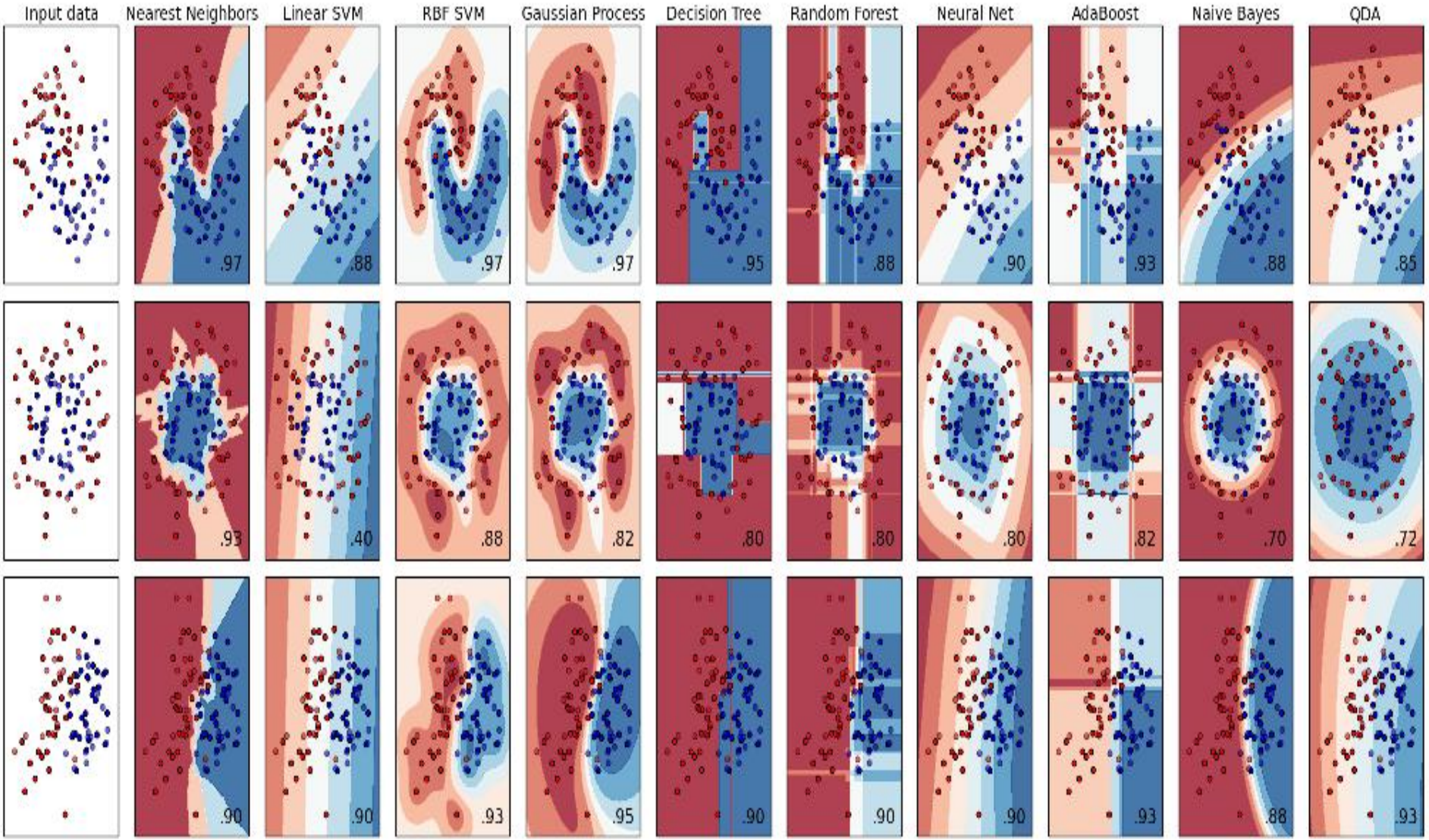



scikit-learn
algorithm cheat-sheet
START
get more data
NO
>50 samples
YES
classification
kernel approximation
NOT WORKING
SVC
Ensemble Classifiers
NOT WORKING
KNeighbors Classifier
SGD Classifier
NO
Naive Bayes
YES
Text Data
NO
NOT WORKING
Linear SVC
YES
<100K samples
NO
predicting a category
YES
regression
SGD Regressor
Lasso
ElasticNet
SVR(kernel='rbf')
EnsembleRegressors
NO
<100K samples
YES
few features should be important
YES
NOT WORKING
RidgeRegression
NO
SVR(kernel='linear')
do you have labeled data
YES
NO
predicting a quantity
YES
clustering
Spectral Clustering
GMM
NOT WORKING
KMeans
YES
number of categories known
YES
<10K samples
NO
NO
<10K samples
YES
MiniBatch KMeans
MeanShift
VBGMM
NO
looking
YES
Randomized PCA
NOT WORKING
Isomap
Spectral Embedding
NOT WORKING
LLE
YES
<10K samples
NO
kernel approximation
dimensionality reduction
NO
predicting structure
tough luck
Back
scikit learn


Input data
Nearest Neighbors
Linear SVM
RBF SVM
Gaussian Process
Decision Tree
Random Forest
Neural Net
AdaBoost
Naive Bayes
QDA
.97
.88
.97
.97
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.93

Jupyter's notebook enables R and Python notebooks

- **Jupyter's notebook interface enables mixing executable code with narrative text, equations, interactive visualizations**
  - Jupyter's notebook user interface enables mixing executable code with narrative text, equations, interactive visualizations, and images to enhance team collaboration and advance the state of reproducible research and training.
- **Jupyter began with Python and now has kernels for 50 different languages, including R**
- **The IRKernel is the native R kernel for Jupyter.**

PRP First Application: Distributed IPython/Jupyter Notebooks:

Cross-Platform, Browser-Based Application Interleaves Code, Text, & Images

Python and R

IJulia
IHaskell
IFSharp
IRuby
IGo
IScala
IMathics
Ialdor
LuaJIT/Torch
Lua Kernel
IRKernel (for the R language)
IErlang
IOCaml
IForth
IPerl
IPerl6
Ioctave
Calico Project
- kernels implemented in Mono, including Java, IronPython, Boo, Logo, BASIC, and many others

Evolved from the IPython Project

IScilab
IMatlab
ICSharp
Bash
Clojure Kernel
Hy Kernel
Redis Kernel
jove, a kernel for io.js
IJavascript
Calysto Scheme
Calysto Processing
idl_kernel
Mochi Kernel
Lua (used in Splash)
Spark Kernel
Skulpt Python Kernel
MetaKernel Bash
MetaKernel Python
Brython Kernel
IVisual VPython Kernel

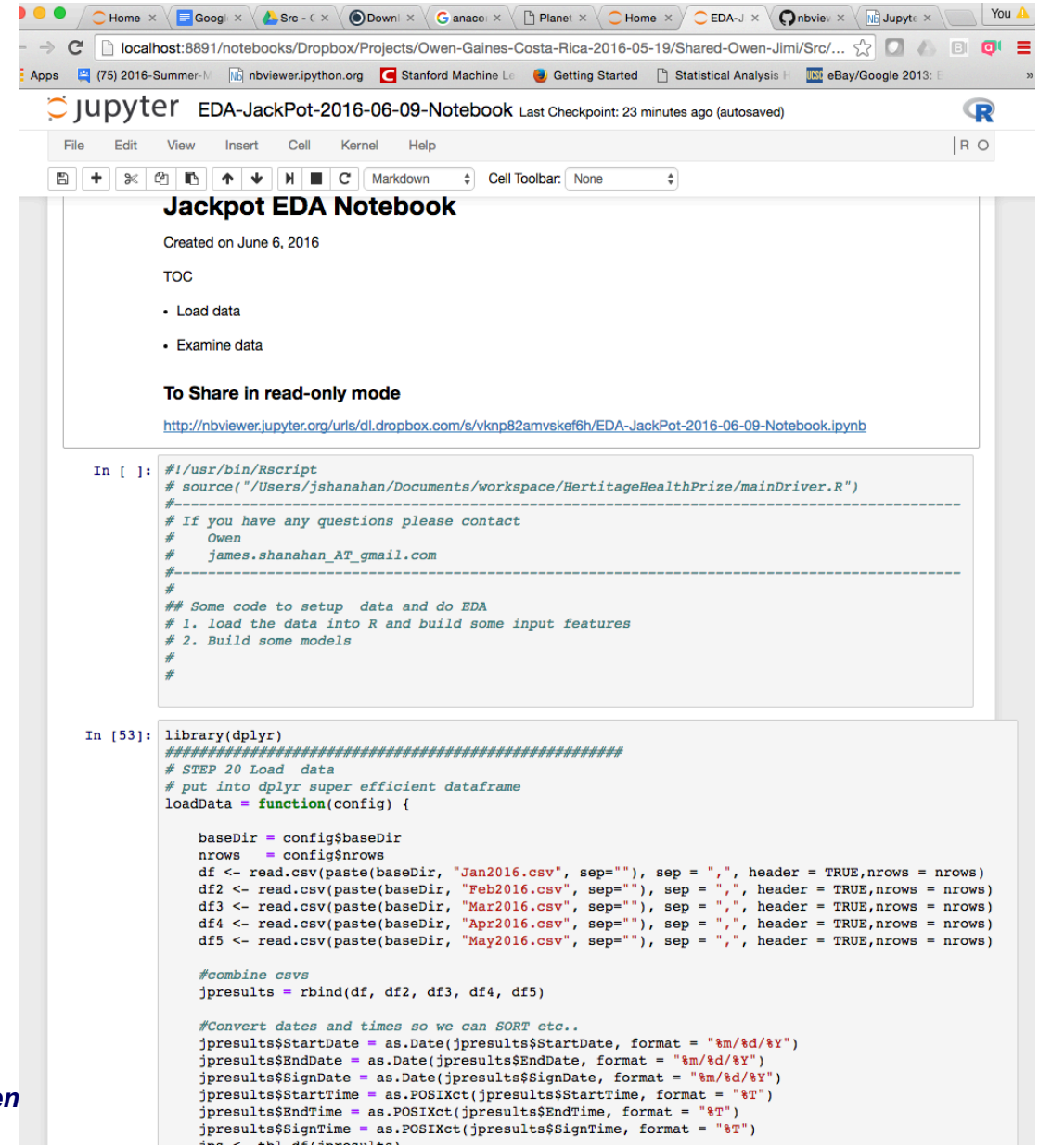
Source: John Graham, QI: 10/2015

Jupyter's notebook enables R and Python notebooks

- **To Install conda package manager to install and organize project dependencies**
  - Data scientists, researchers, and analysts use the conda package manager to install and organize project dependencies. With conda they can easily build and share metapackages, which are downloadable bundles of packages. Conda works with Linux, OS X, and Windows, and is language agnostic, so we can use it with any programming language and with projects that depend on multiple languages.
- **See slides below for installation instructions**

Jupyter Demo

- ..



INSTALL: R and Jupyter Notebooks

- **STEP 1: install Jupyter Notebook**
  - Install Anaconda (Python, Jupyter)
  - Follow slides included below
  - http://jupyter.readthedocs.io/en/latest/install.html
- **STEP 2: Install R Kernel**
  - Follow slides included below
  - https://www.continuum.io/blog/developer/jupyter-and-conda-r

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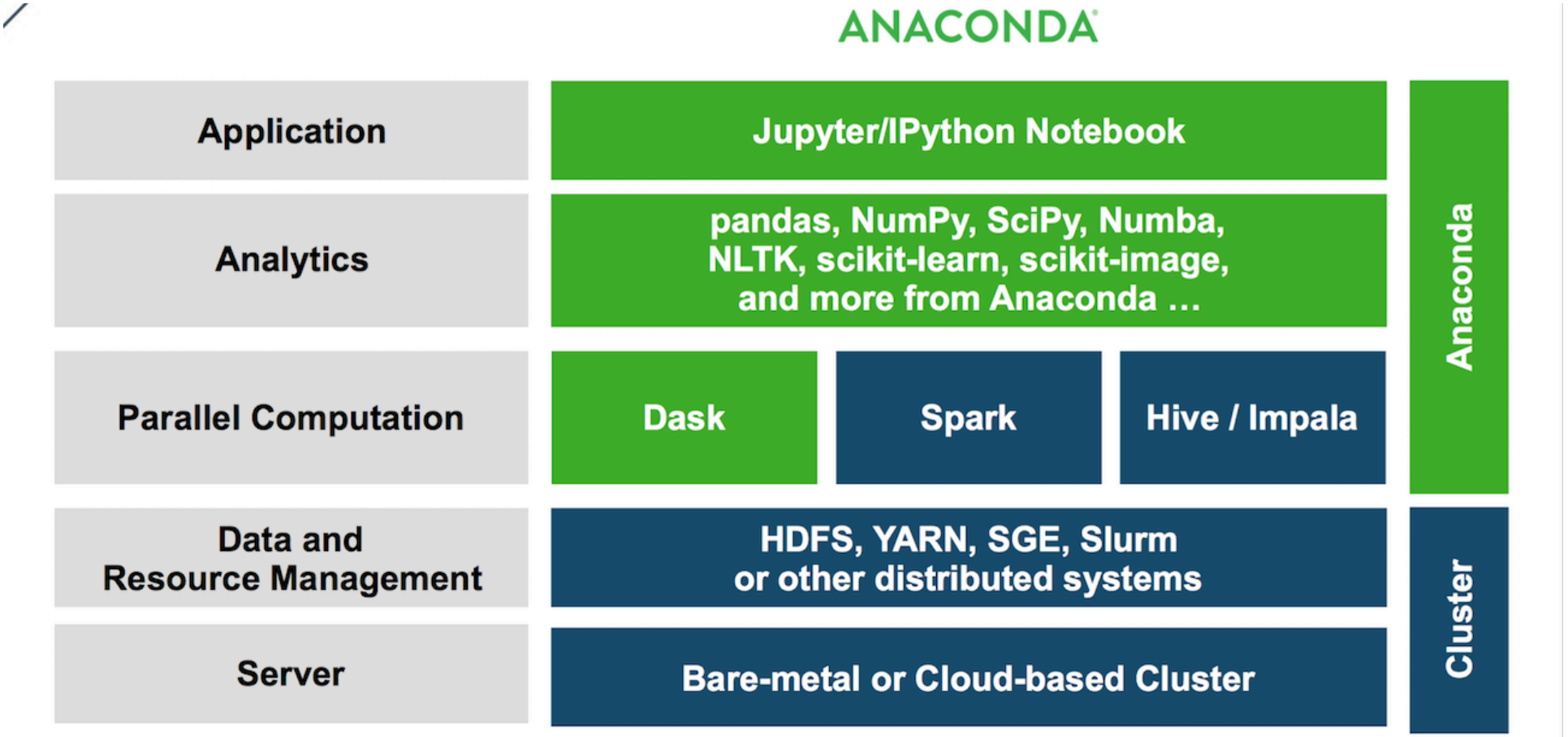
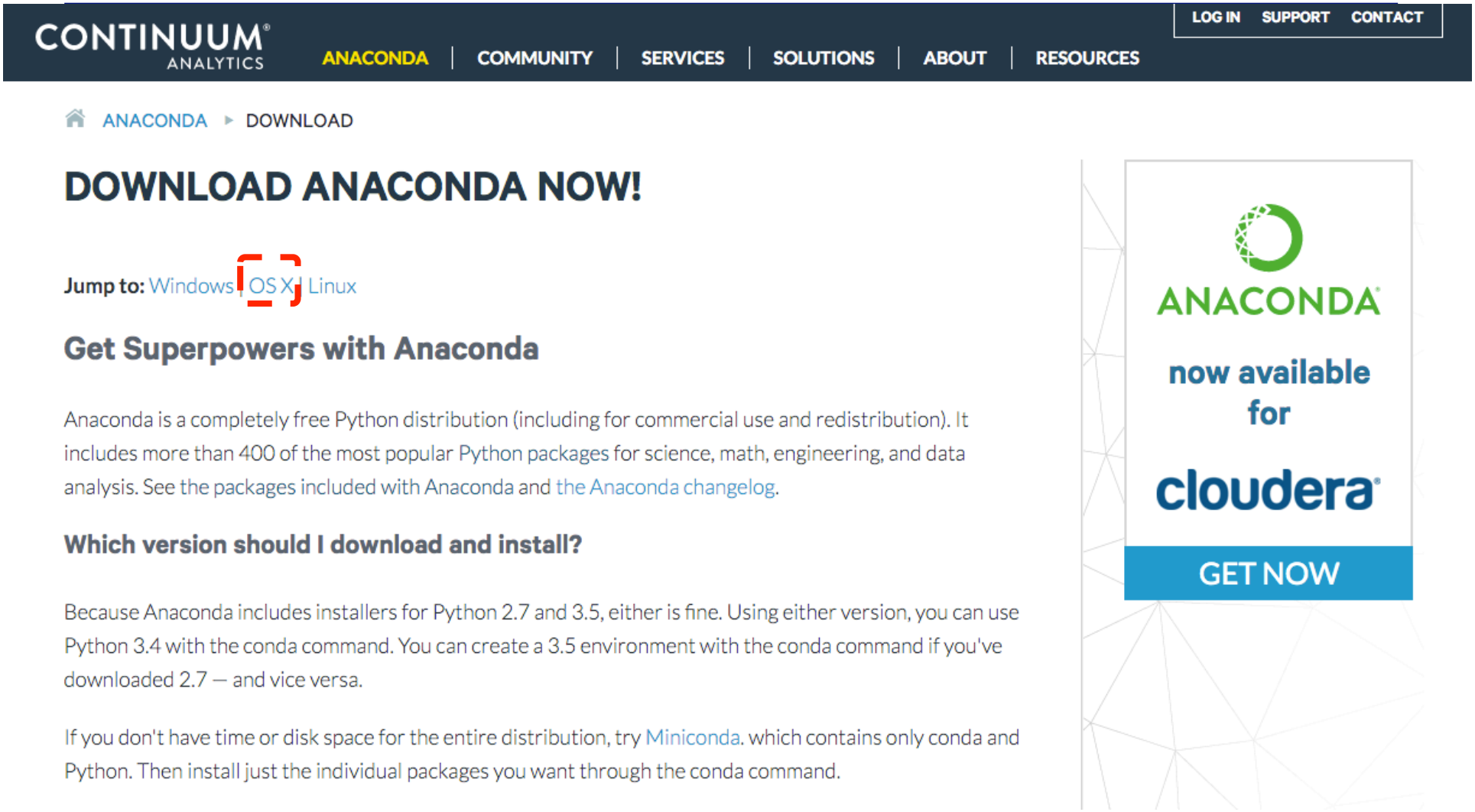
Anaconda

https://www.continuum.io/


ANACONDA
Application
Jupyter/IPython Notebook
Analytics
pandas, NumPy, SciPy, Numba,
NLTK, scikit-learn, scikit-image,
and more from Anaconda …
Parallel Computation
Dask
Spark
Hive / Impala
Data and
Resource Management
HDFS, YARN, SGE, Slurm
or other distributed systems
Server
Bare-metal or Cloud-based Cluster
Anaconda
Cluster

Download Anaconda



https://www.continuum.io/downloads

Anaconda for Windows

PYTHON 2.7	PYTHON 3.5
WINDOWS 64-BIT GRAPHICAL INSTALLER 335M	WINDOWS 64-BIT GRAPHICAL INSTALLER 345M
Windows 32-bit Graphical Installer 281M	**Windows 32-bit Graphical Installer** 283M
Behind a firewall? Use these **zipped Windows installers**.	

Windows

Windows Anaconda Installation

1. Download the graphical installer.
2. Double-click the .exe file to install Anaconda and follow the instructions on the screen.
3. Optional: **Verify data integrity with MD5**.

Anaconda for OS X

PYTHON 2.7	PYTHON 3.5
MAC OS X 64-BIT GRAPHICAL INSTALLER 339M (OS X 10.7 or higher)	MAC OS X 64-BIT GRAPHICAL INSTALLER 342M (OS X 10.7 or higher)
Mac OS X 64-bit Command-Line installer 290M (OS X 10.7 or higher)	**Mac OS X 64-bit Command-Line installer** 293M (OS X 10.7 or higher)

OS X

OS X Anaconda Installation

Choose either the graphical installer or the command line installer for OS X.

Graphical Installer:

1. Download the graphical installer.
2. Double-click the downloaded .pkg file and follow the instructions.

Anaconda Install

Download python+Notebook

Contents

- http://docs.continuum.io/anaconda/install

Download the Anaconda installer and double click it.

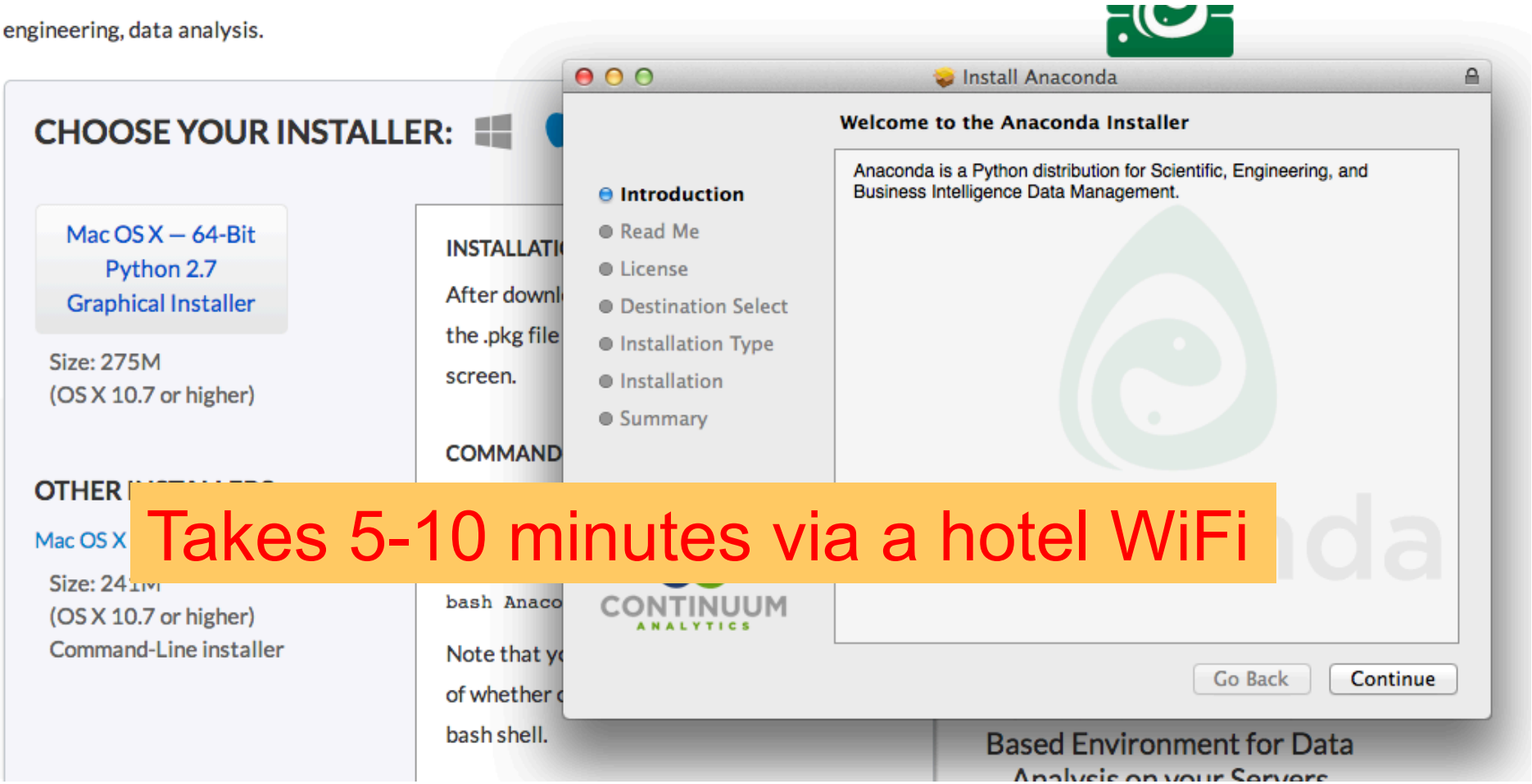
OS X Install

Download the Anaconda installer and double click it.

NOTE: You may see a screen that says "You cannot install Anaconda in this location. The Anaconda

300 Meg: Takes 5-10 minutes via a hotel WiF

Anaconda Installer



conda update --prefix /Users/jshanahan/anaconda anaconda

Download Anaconda Python 2.7

Anaconda for OS X

OS X Anaconda Installation

Choose either the graphical installer or the command line installer for OS X.

Graphical Installer:

1. Download the graphical installer.
2. Double-click the downloaded .pkg file and follow the instructions.

https://www.continuum.io/downloads

OS X Anaconda Installation

OS X Anaconda Installation

Choose either the graphical installer or the command line installer for OS X.

Graphical Installer:

1. Download the graphical installer.
2. Double-click the downloaded .pkg file and follow the instructions.

Command Line Installer:

1. Download the command line installer.
2. In your terminal window, type one of the below and follow the instructions:

   Python 2.7:

   ```
   bash Anaconda2-2.5.0-MacOSX-x86_64.sh
   ```

   Python 3.5:

   ```
   bash Anaconda3-2.5.0-MacOSX-x86_64.sh
   ```

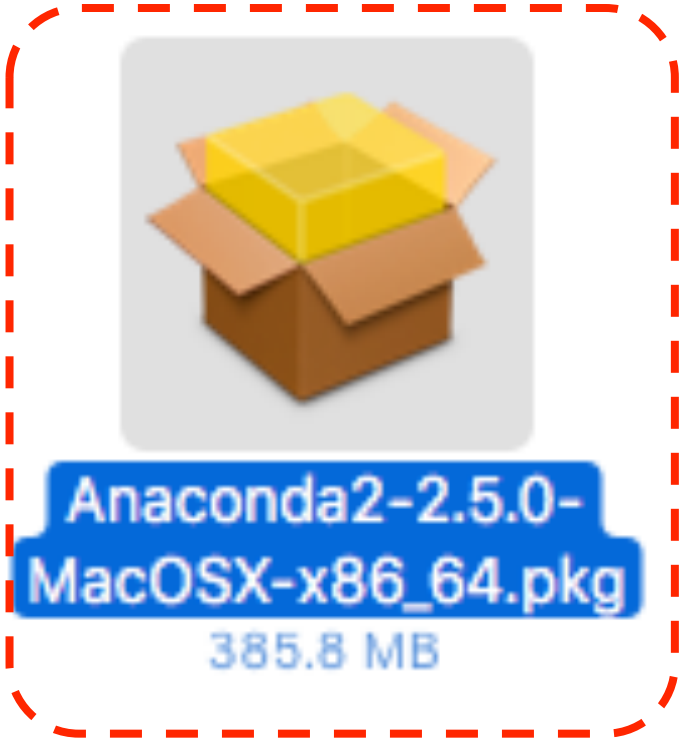
   NOTE: Include the "bash" command even if you are not using the bash shell.

3. Optional: Verify data integrity with MD5.

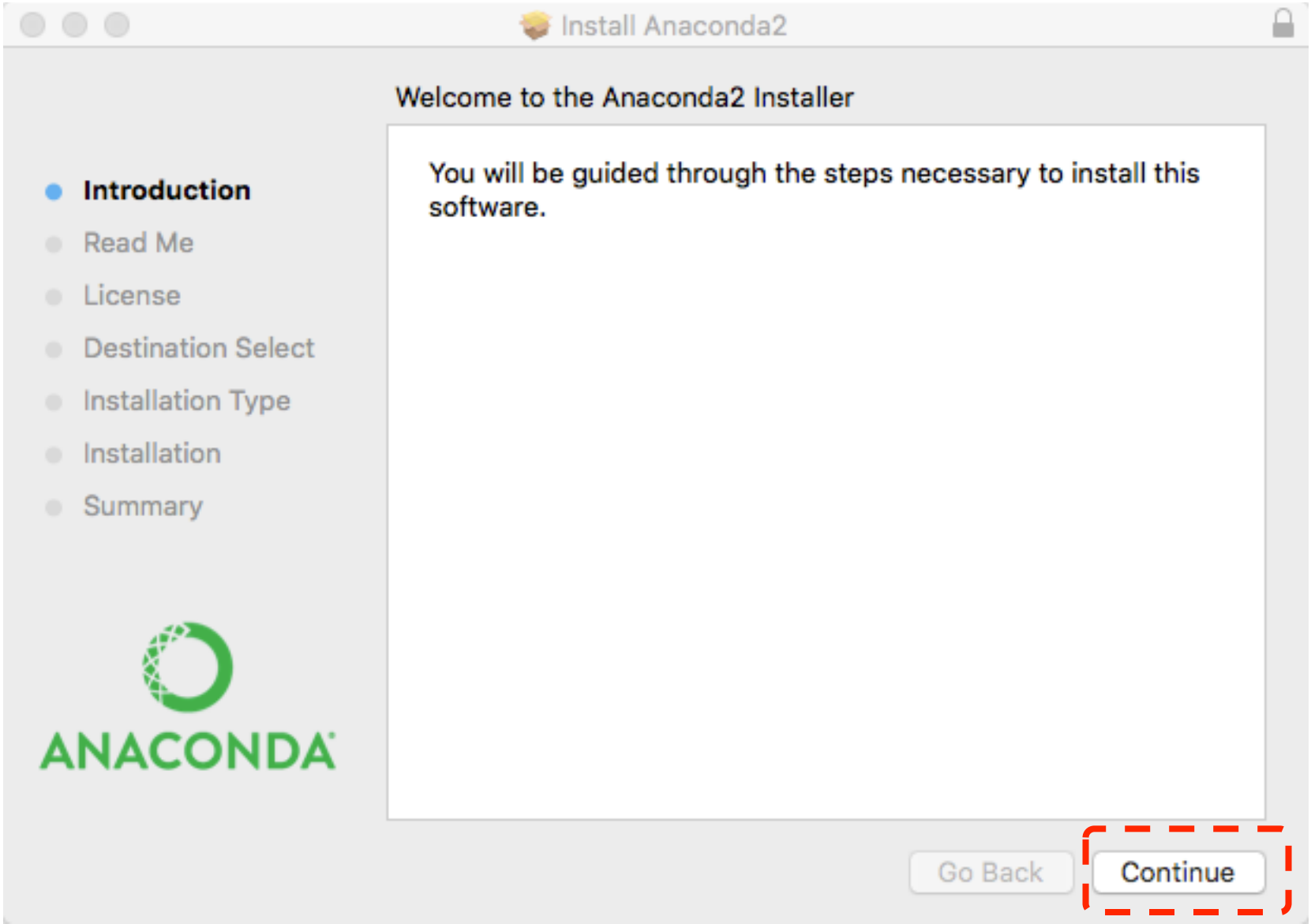
https://www.continuum.io/downloads

OS X Anaconda Installation

Anaconda2-2.5.0-MacOSX-x86_64.pkg



OS X Anaconda Installation



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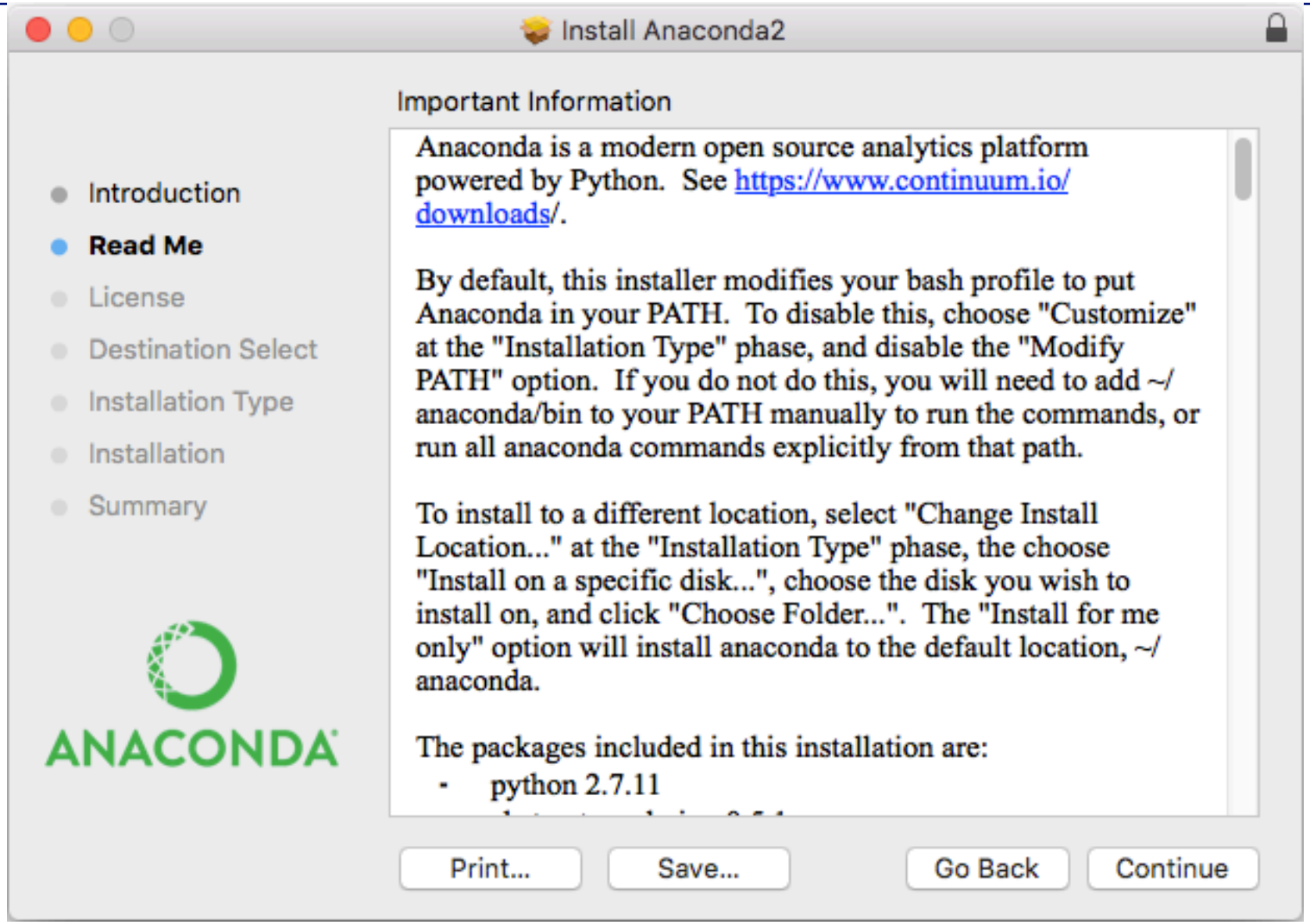

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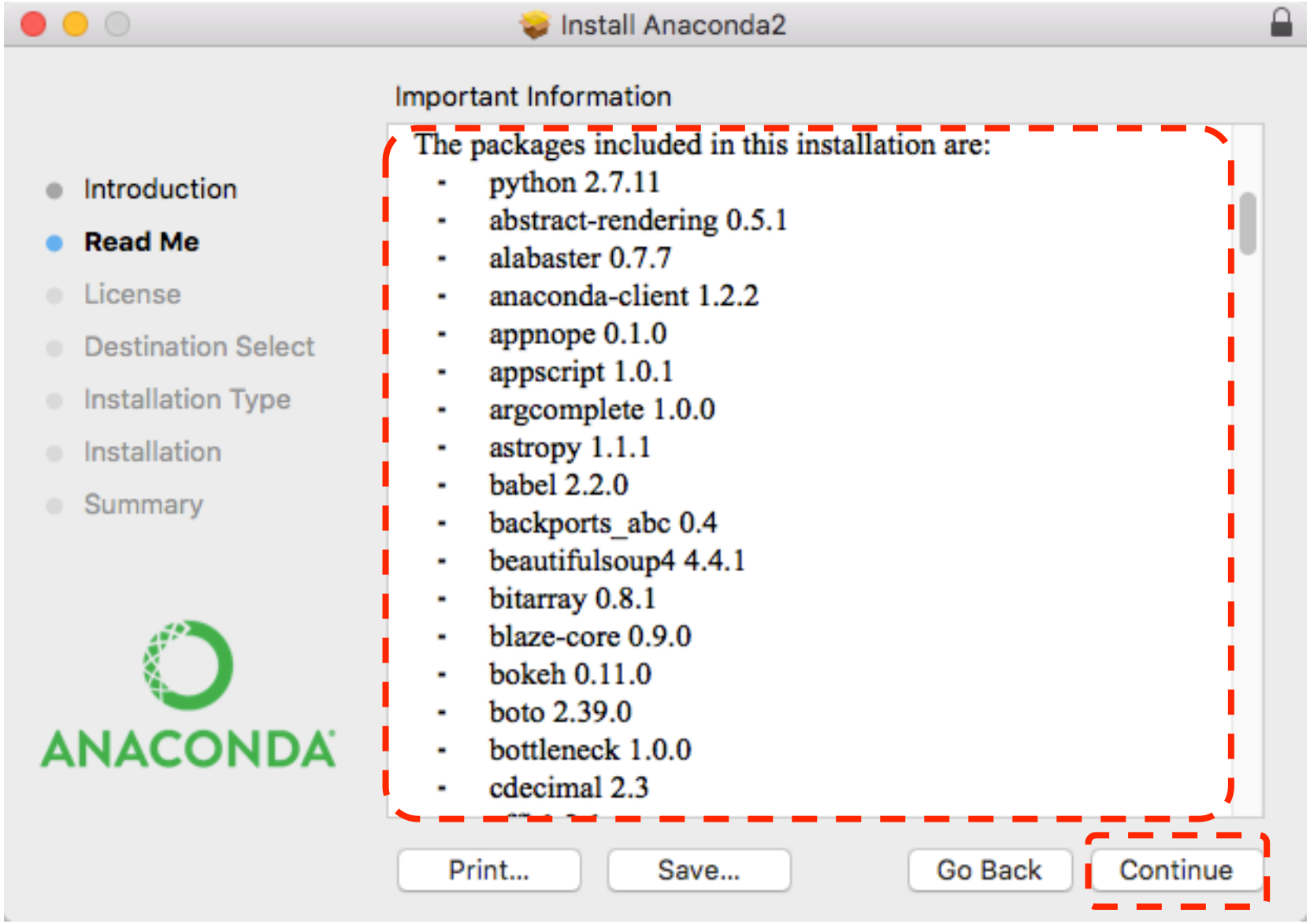
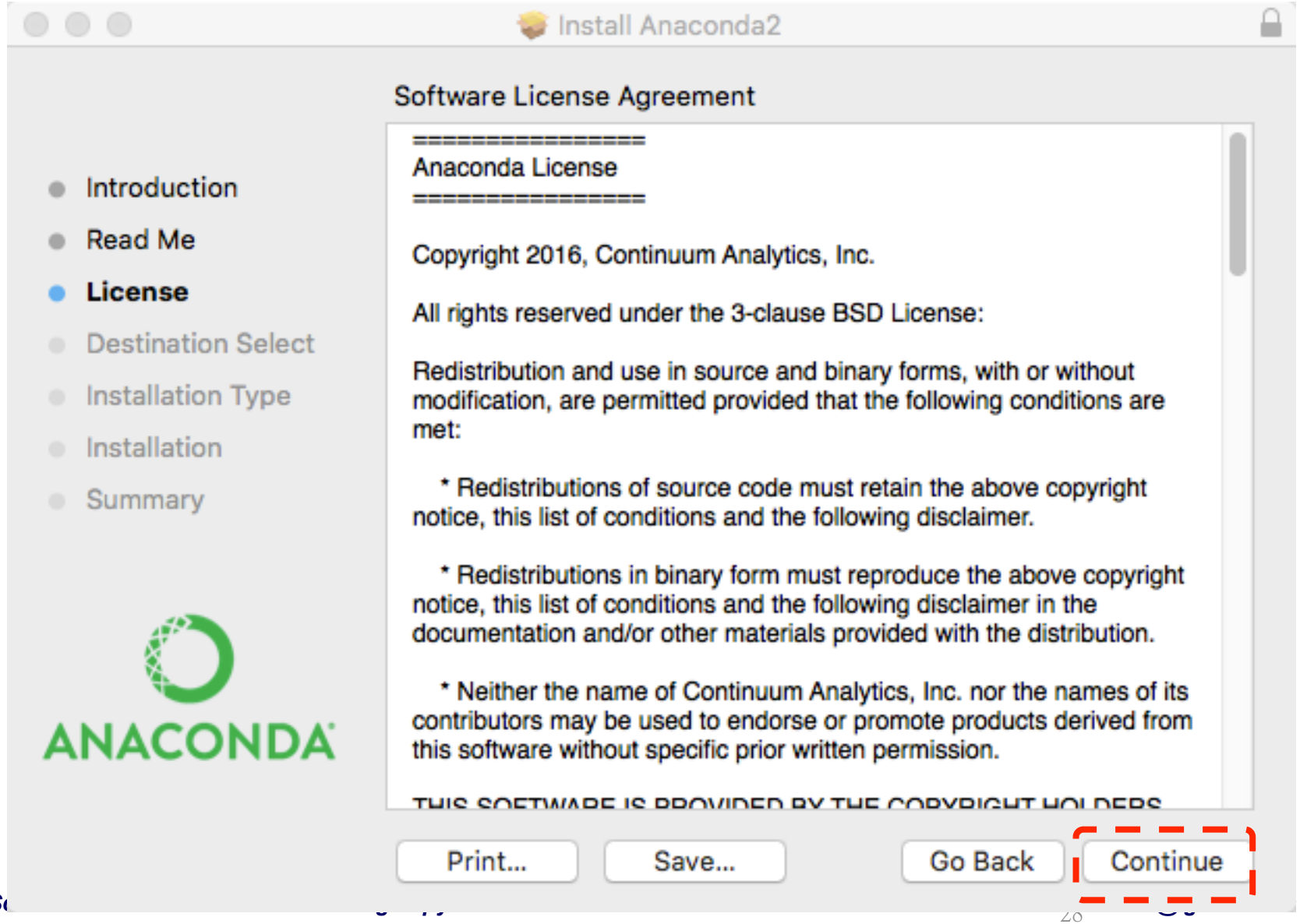


Install Anaconda 2: 165 packages included

```
- python 2.7.11
- abstract-rendering 0.5.1
- alabaster 0.7.7
- anaconda-client 1.2.2
- appnope 0.1.0
- appscript 1.0.1
- argcomplete 1.0.0
- astropy 1.1.1
- babel 2.2.0
- backports_abc 0.4
- beautifulsoup4 4.4.1
- bitarray 0.8.1
- blaze-core 0.9.0
- bokeh 0.11.0
- boto 2.39.0
- bottleneck 1.0.0
- cdecimal 2.3
- cffi 1.2.1
- clyent 1.2.0
- colorama 0.3.6
- configobj 5.0.6
- cryptography 1.0.2
- curl 7.45.0
- cycler 0.9.0
- cython 0.23.4
- cytoolz 0.7.5
- datashape 0.5.0
- decorator 4.0.6
- docutils 0.12
- dynd-python 0.7.1
- jupyter 1.0.0
- jupyter_client 4.1.1
- jupyter_console 4.1.0
- jupyter_core 4.0.6
- launcher 1.0.0
- libdynd 0.7.1
- libpng 1.6.17
- libtiff 4.0.6
- libxml2 2.9.2
- libxslt 1.1.28
- llvmlite 0.8.0
- lxml 3.5.0
- markupsafe 0.23
- matplotlib 1.5.1
- mistune 0.7.1
- mkl 11.3.1
- mkl-service 1.1.2
- multipledispatch 0.4.8
- nbconvert 4.1.0
- nbformat 4.0.1
- networkx 1.11
- nltk 3.1
- node-webkit 0.10.1
- nose 1.3.7
- notebook 4.1.0
- numba 0.23.1
- numexpr 2.4.6
- numpy 1.10.4
- odo 0.4.0
- openpyxl 2.3.2
- openssl 1.0.2f
- pandas 0.17.1
- path.py 8.1.2
- patsy 0.4.0
- pep8 1.7.0
- pexpect 3.3
- pickleshare 0.5
- scikit-learn 0.17
- scipy 0.17.0
- setuptools 19.6.2
- simplegeneric 0.8.1
- singledispatch 3.4.0.3
- sip 4.16.9
- six 1.10.0
- snowballstemmer 1.2.1
- sockjs-tornado 1.0.1
- sphinx 1.3.5
- sphinx_rtd_theme 0.1.9
- spyder 2.3.8
- spyder-app 2.3.8
- sqlalchemy 1.0.11
- sqlite 3.9.2
- ssl_match_hostname 3.4.0.2
- statsmodels 0.6.1
- sympy 0.7.6.1
- terminado 0.5
- tk 8.5.18
- toolz 0.7.4
- tornado 4.3
- traitlets 4.1.0
- unicodecsv 0.14.1
- werkzeug 0.11.3
- wheel 0.26.0
- xlrd 0.9.4
- xlsxwriter 0.8.4
- xlwings 0.6.4
- xlwt 1.0.0
- xz 5.0.5
- yaml 0.1.6
- zeromq 4.1.3
- zlib 1.2.8
- anaconda 2.5.0
- conda 3.19.1
- conda-build 1.19.0
- conda-env 2.4.5
```

OS X Anaconda Installation



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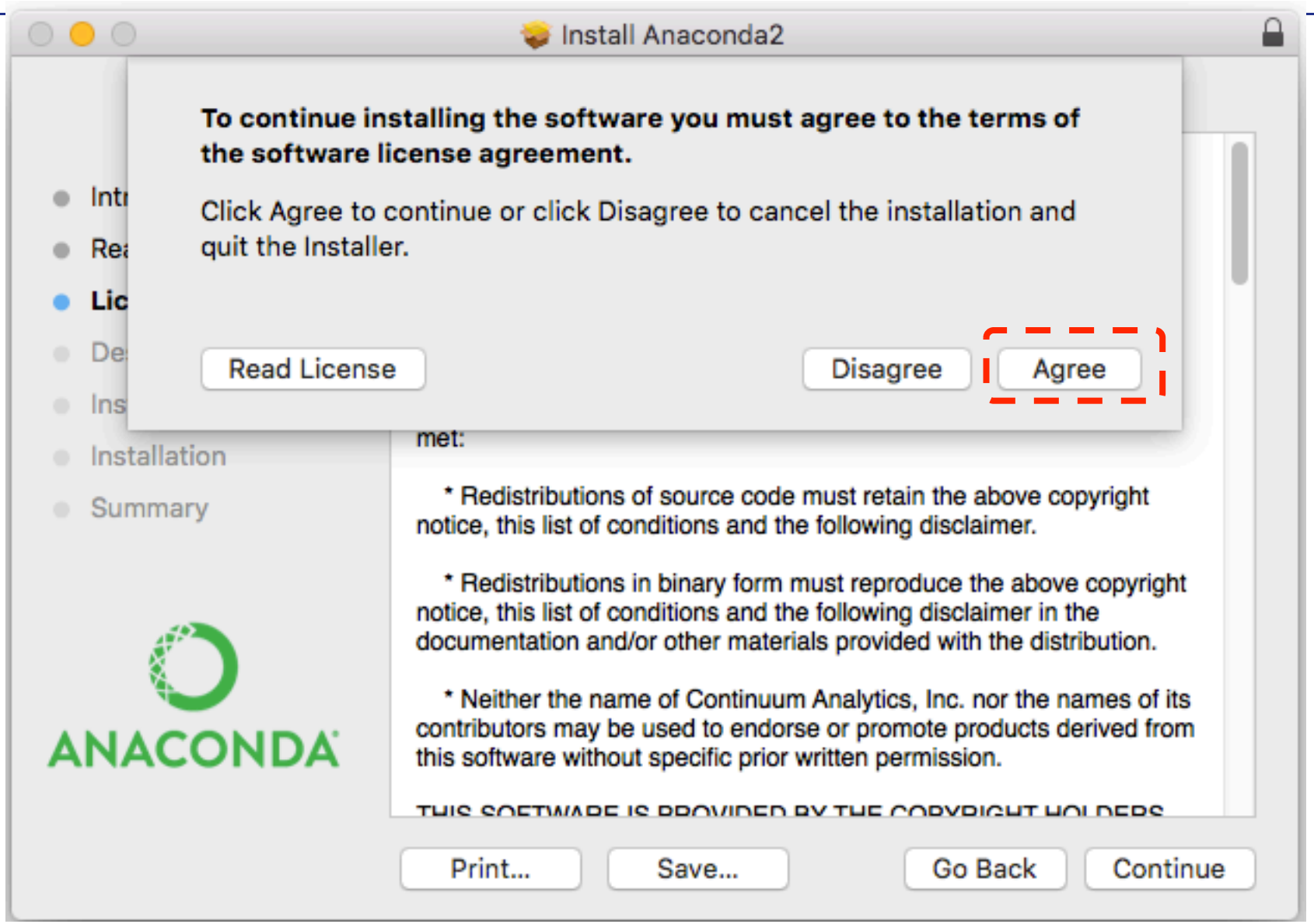

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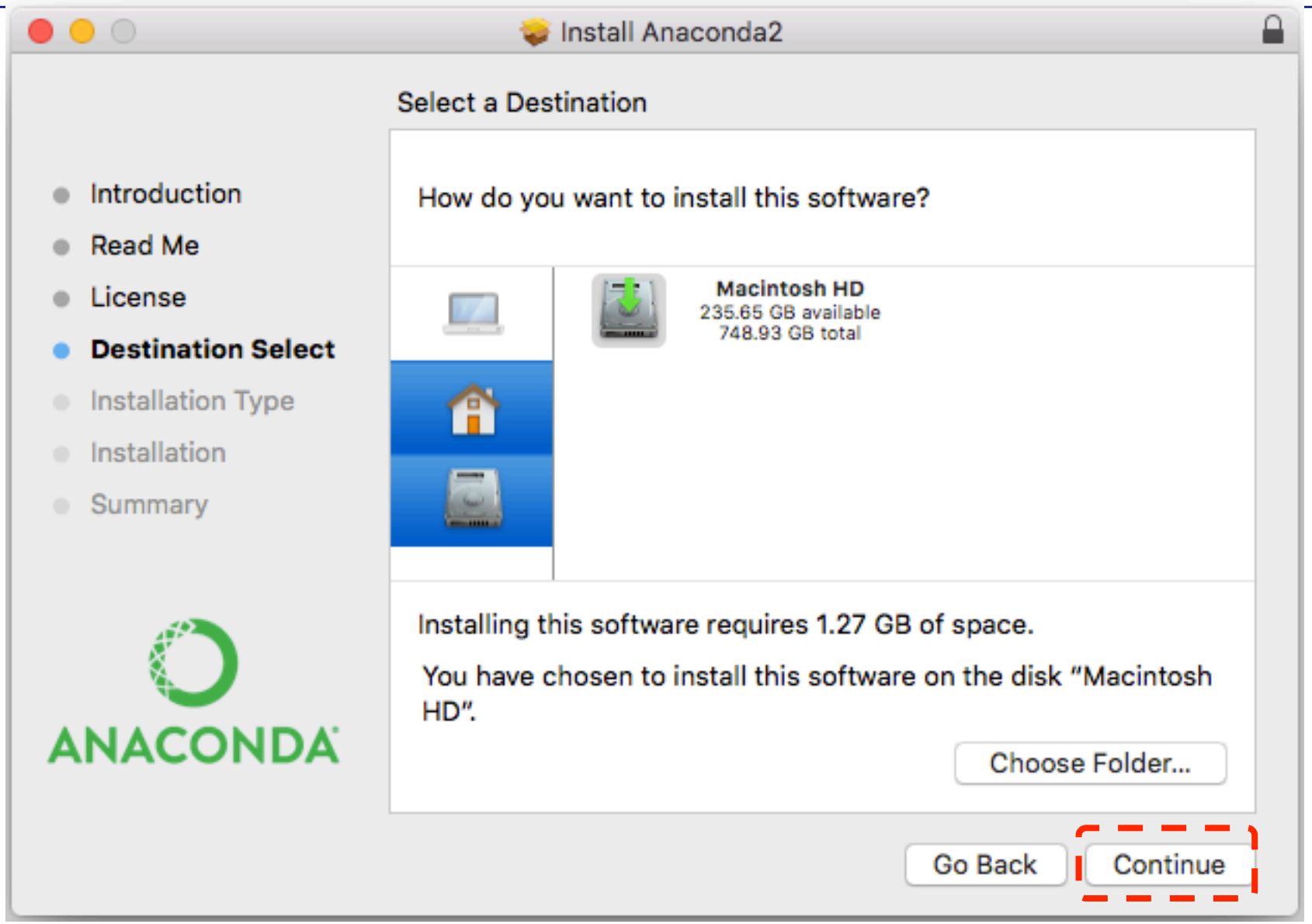

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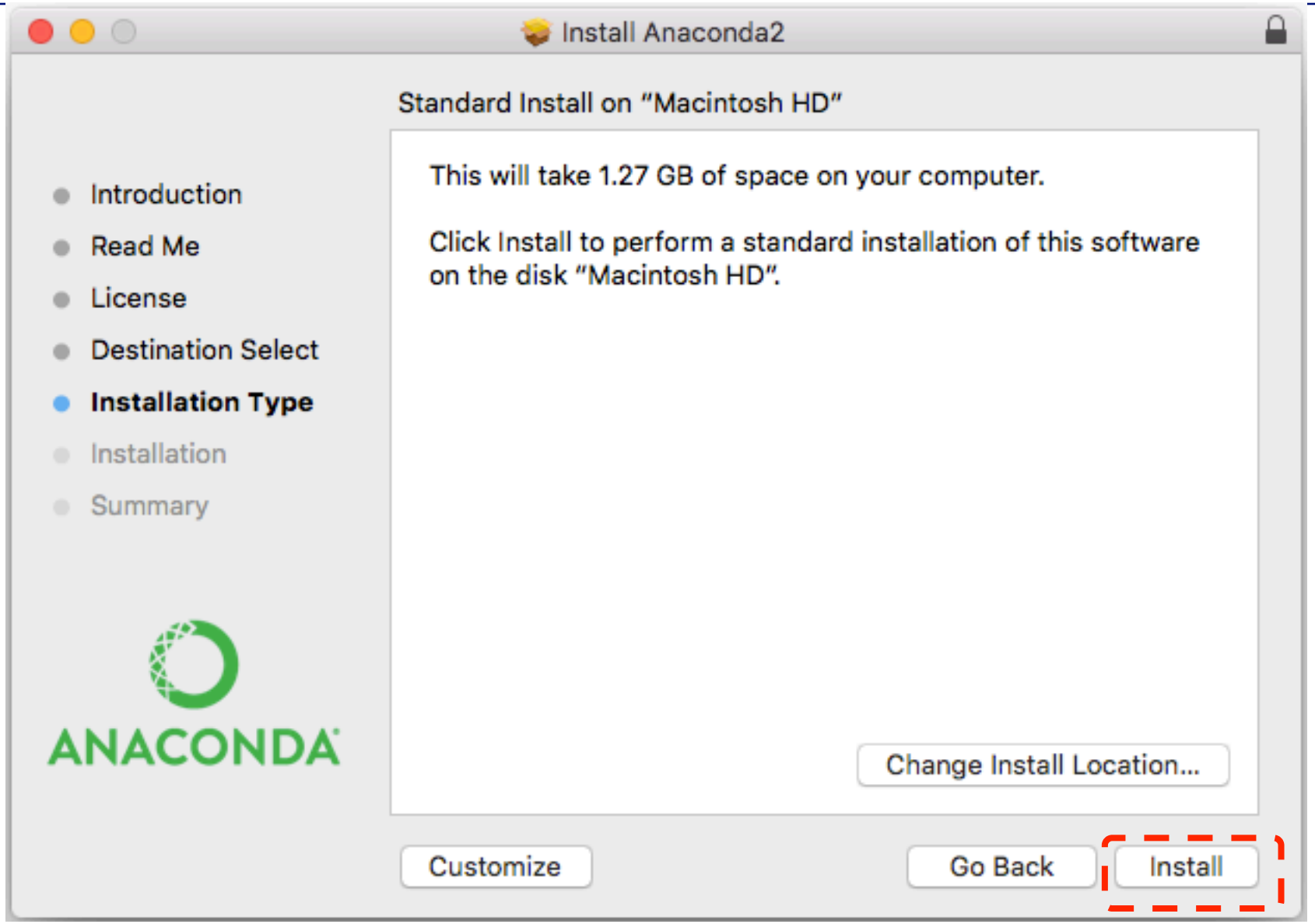

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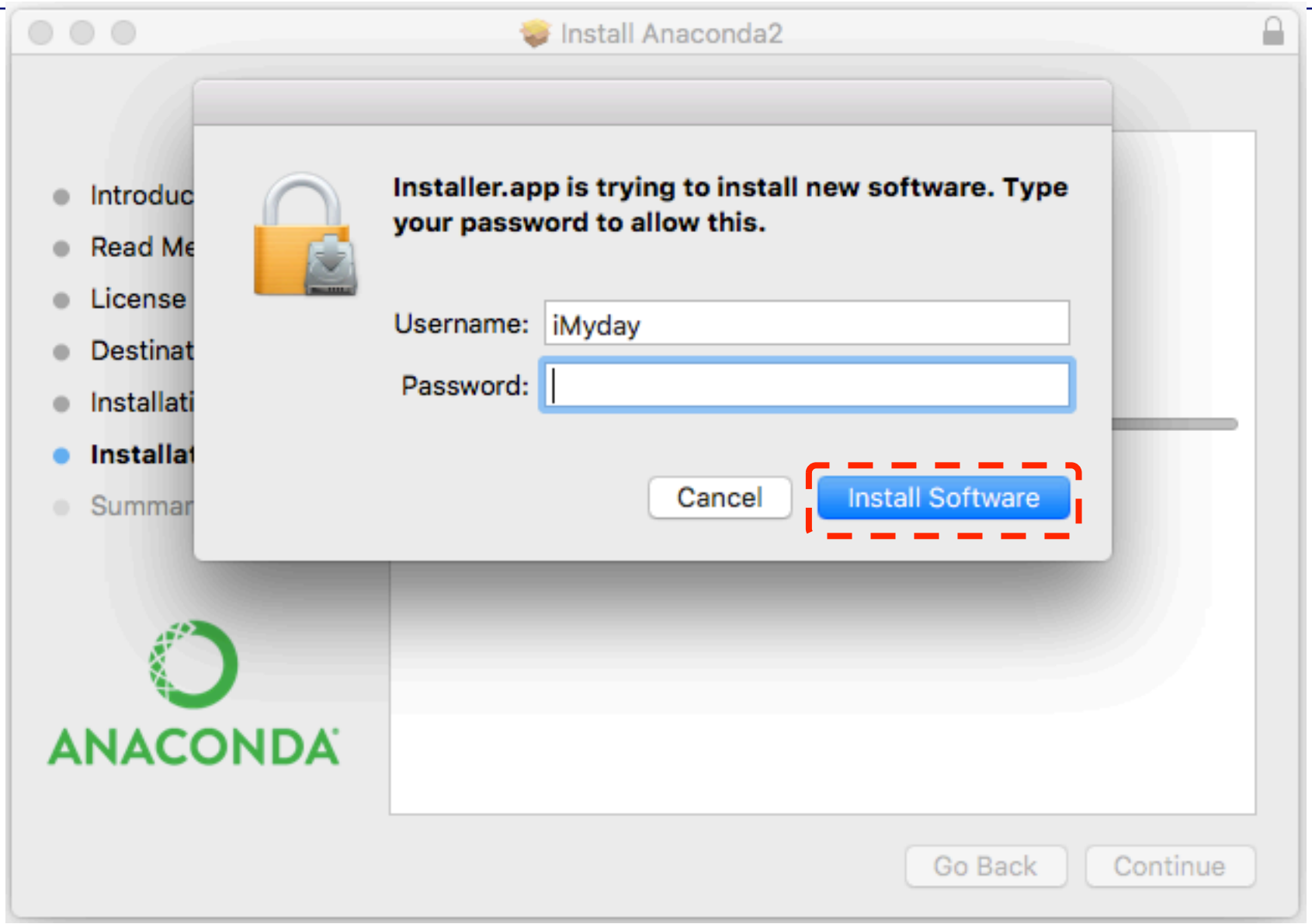

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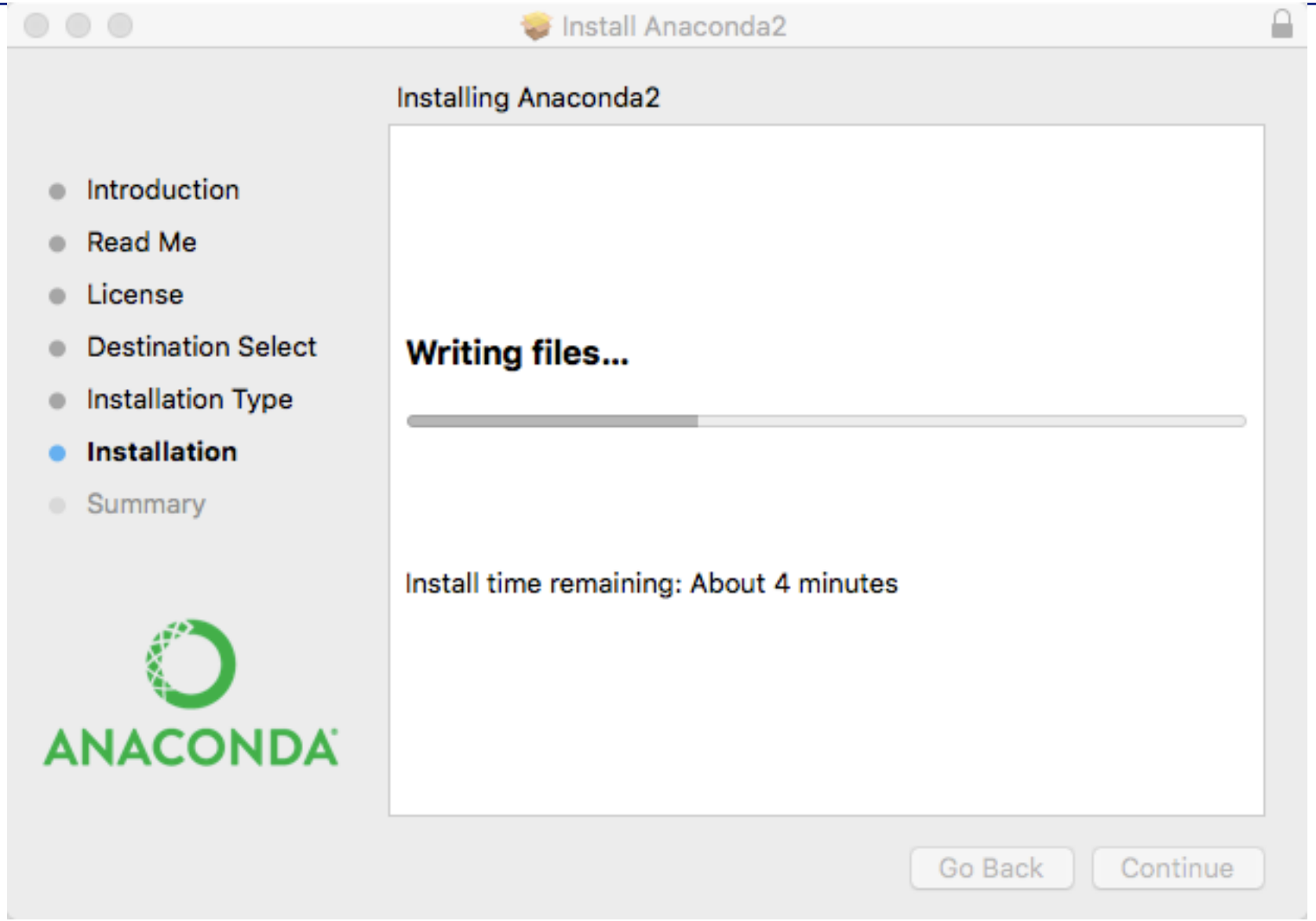

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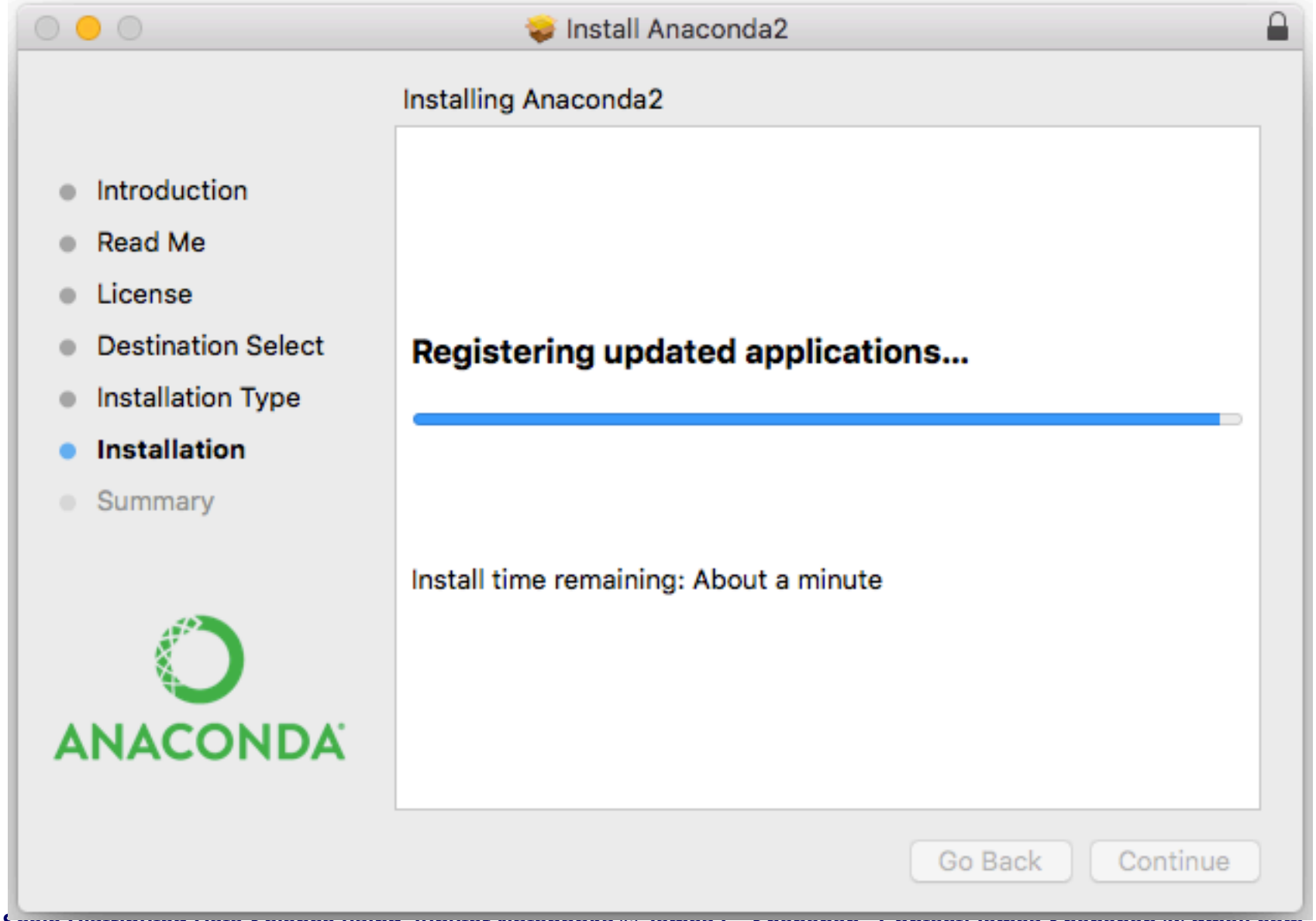

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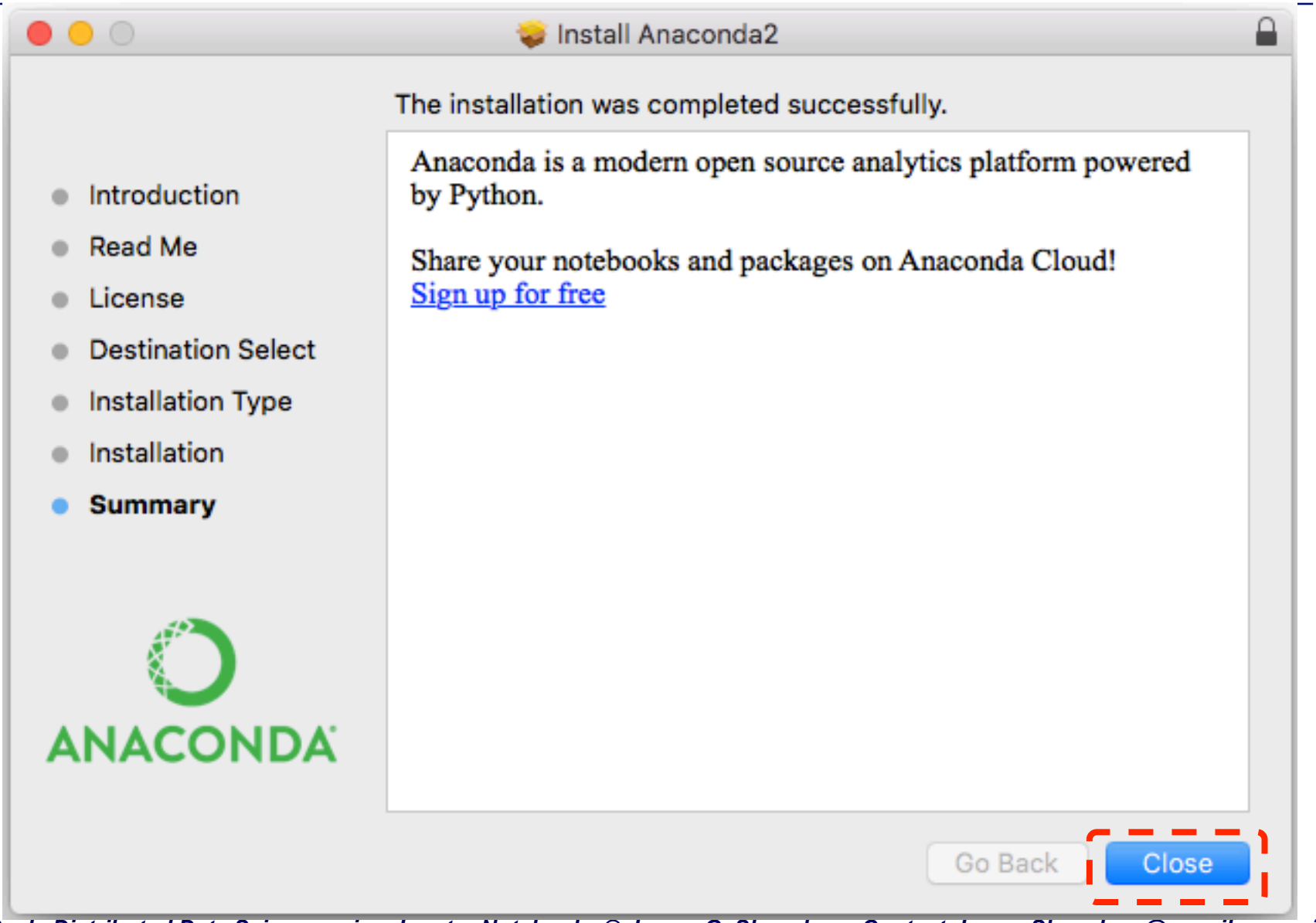
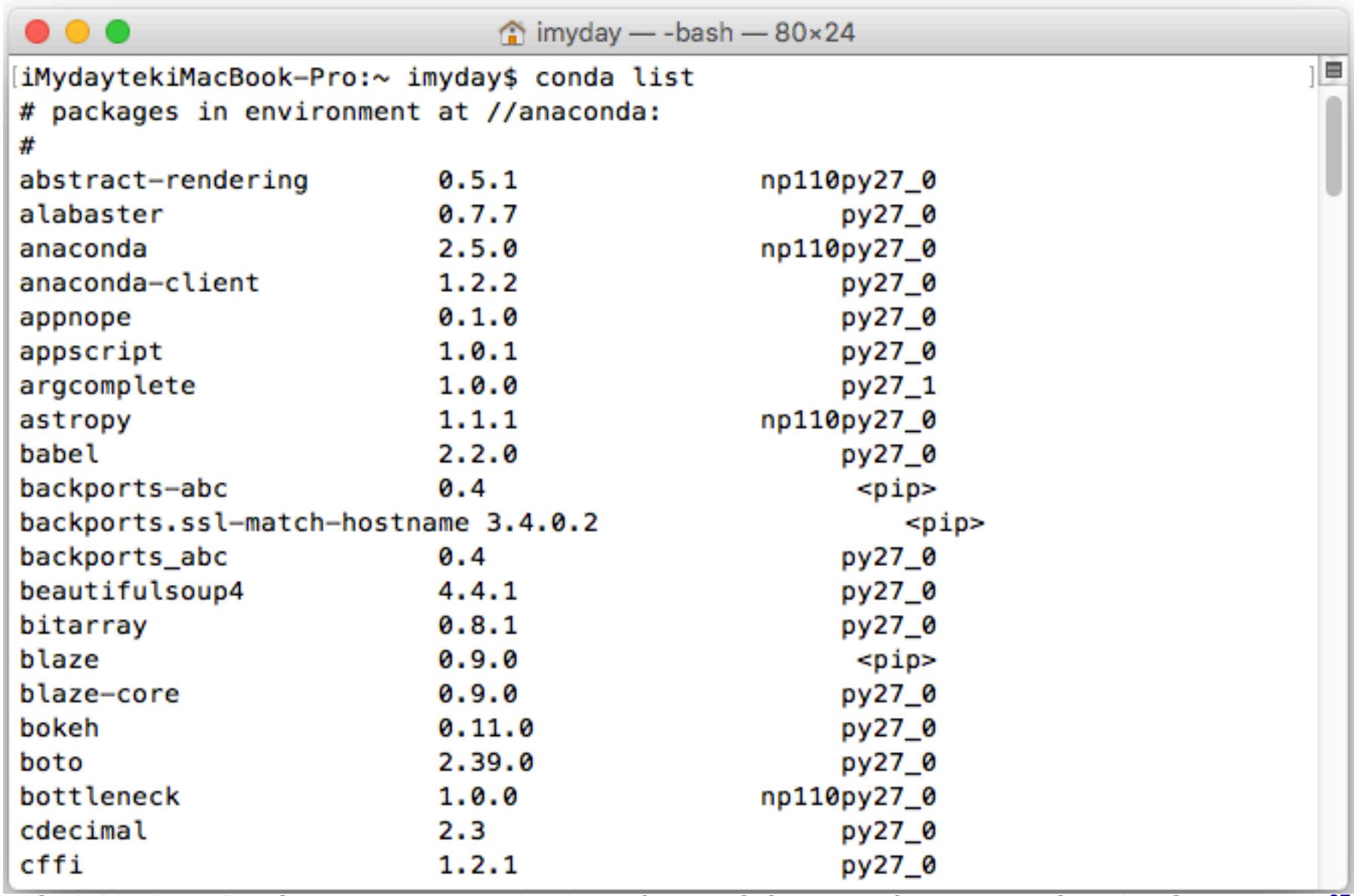


Previously installed: UPDATE ONLY

conda update --prefix /Users/jshanahan/anaconda anaconda

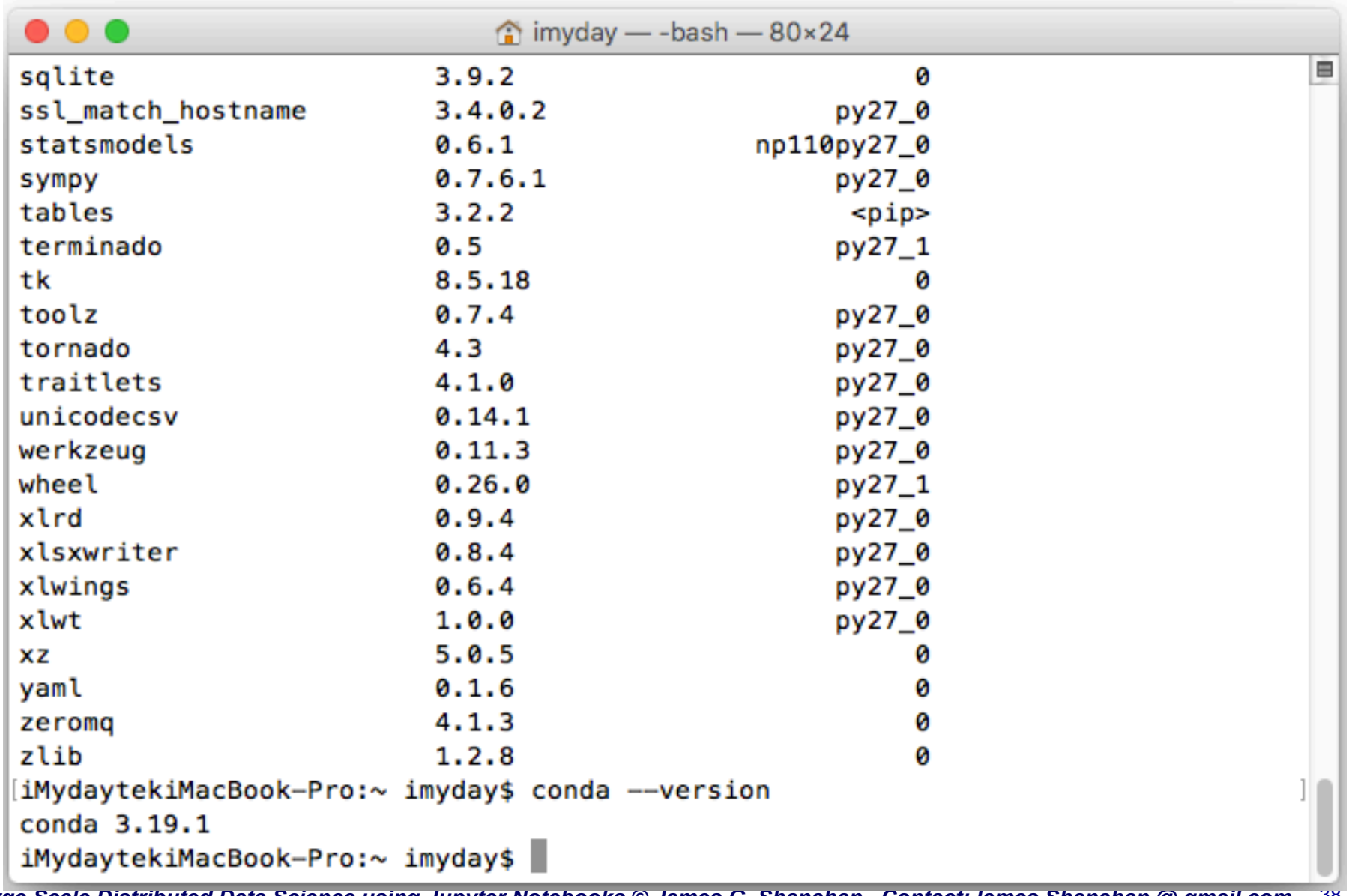
```
boto-2.38.0-py 100% |################################################################################| Time: 0:00:00  90.07 kB/s
conda-env-2.4. 100% |################################################################################| Time: 0:00:00  90.07 kB/s
cython-0.22.1- 100% |################################################################################| Time: 0:00:06 387.59 kB/s
cytoolz-0.7.3- 100% |################################################################################| Time: 0:00:01 202.66 kB/s
decorator-3.4. 100% |################################################################################| Time: 0:00:00   1.17 MB/s
greenlet-0.4.7 100% |################################################################################| Time: 0:00:00  55.86 kB/s
idna-2.0-py27_ 100% |################################################################################| Time: 0:00:00 145.75 kB/s
ipaddress-1.0. 100% |################################################################################| Time: 0:00:00  91.65 kB/s
llvmlite-0.5.0 100% |################################################################################| Time: 0:00:14 435.04 kB/s
lxml-3.4.4-py2 100% |################################################################################| Time: 0:00:04 220.90 kB/s
mistune-0.5.1- 100% |################################################################################| Time: 0:00:01 167.80 kB/s
nose-1.3.7-py2 100% |################################################################################| Time: 0:00:01 175.91 kB/s
astropy-1.0.3- 100% |################################################################################| Time: 0:00:14 369.05 kB/s
bcolz-0.9.0-np 100% |################################################################################| Time: 0:00:01 245.33 kB/s
bottleneck-1.0 100% |################################################################################| Time: 0:00:01 167.26 kB/s
numba-0.19.1-n 100% |################################################################################| Time: 0:00:04 230.86 kB/s
numexpr-2.4.3- 100% |################################################################################| Time: 0:00:00 128.90 kB/s
blz-0.6.2-np19 100% |################################################################################| Time: 0:00:01 221.19 kB/s
pillow-2.8.2-p 100% |################################################################################| Time: 0:00:01 269.09 kB/s
ply-3.6-py27_0 100% |################################################################################| Time: 0:00:00 124.84 kB/s
py-1.4.27-py27 100% |################################################################################| Time: 0:00:00 141.94 kB/s
pycparser-2.14 100% |################################################################################| Time: 0:00:01 145.17 kB/s
cffi-1.1.0-py2 100% |################################################################################| Time: 0:00:01 158.43 kB/s
pycurl-7.19.5. 100% |################################################################################| Time: 0:00:00  83.32 kB/s
pyflakes-0.9.2 100% |################################################################################| Time: 0:00:00  99.50 kB/s
pytest-2.7.1-p 100% |################################################################################| Time: 0:00:01 165.68 kB/s
python-2.7.10- 100% |################################################################################| Time: 0:00:28 412.67 kB/s
python.app-1.2 100% |################################################################################| Time: 0:00:00   3.96 MB/s
pytz-2015.4-py 100% |################################################################################| Time: 0:00:01 163.19 kB/s
pyyaml-3.11-py 100% |################################################################################| Time: 0:00:01 141.79 kB/s
```

conda list



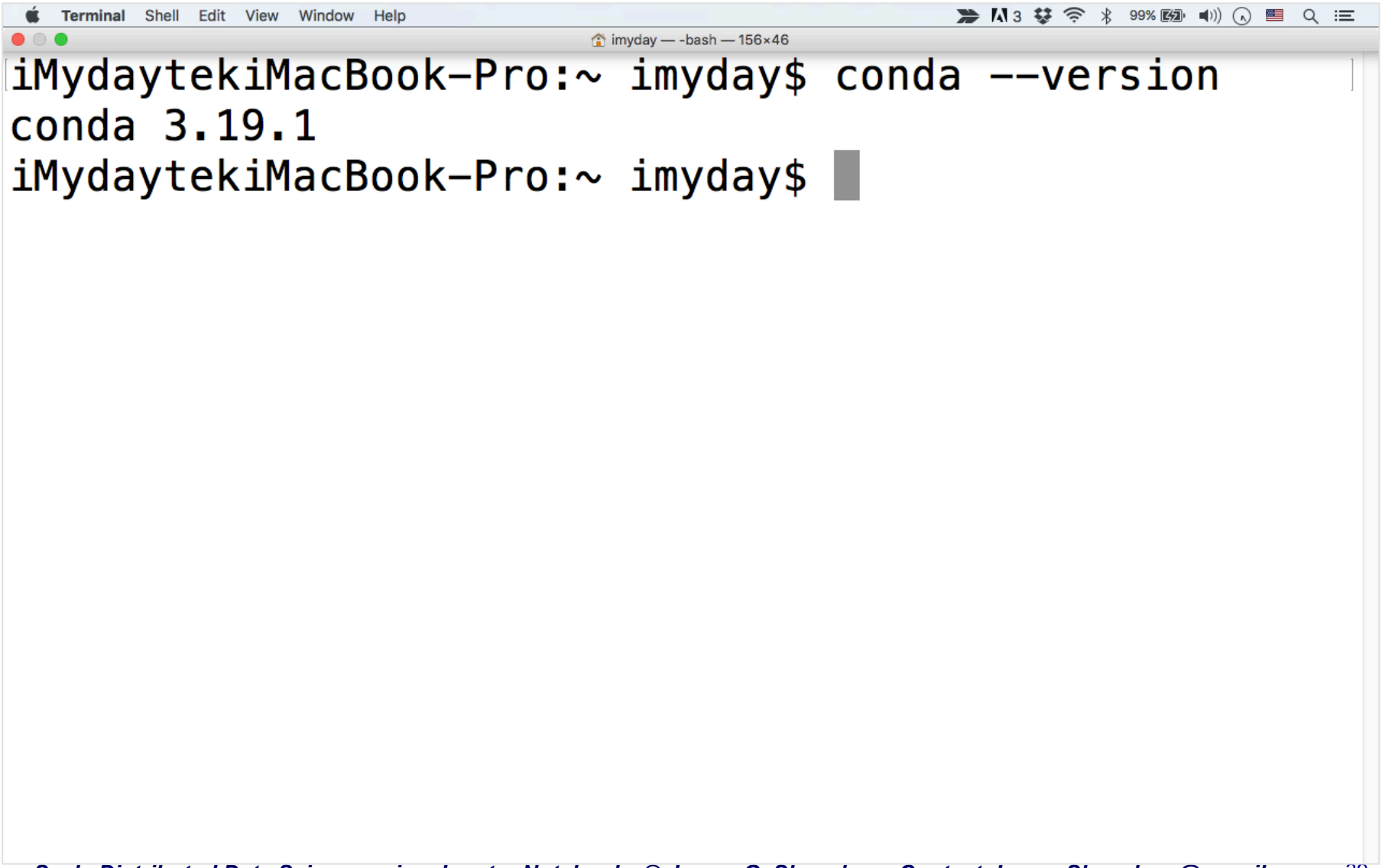
http://conda.pydata.org/docs/using/using.html#verify-that-conda-is-installed-check-current-conda-version

conda --version

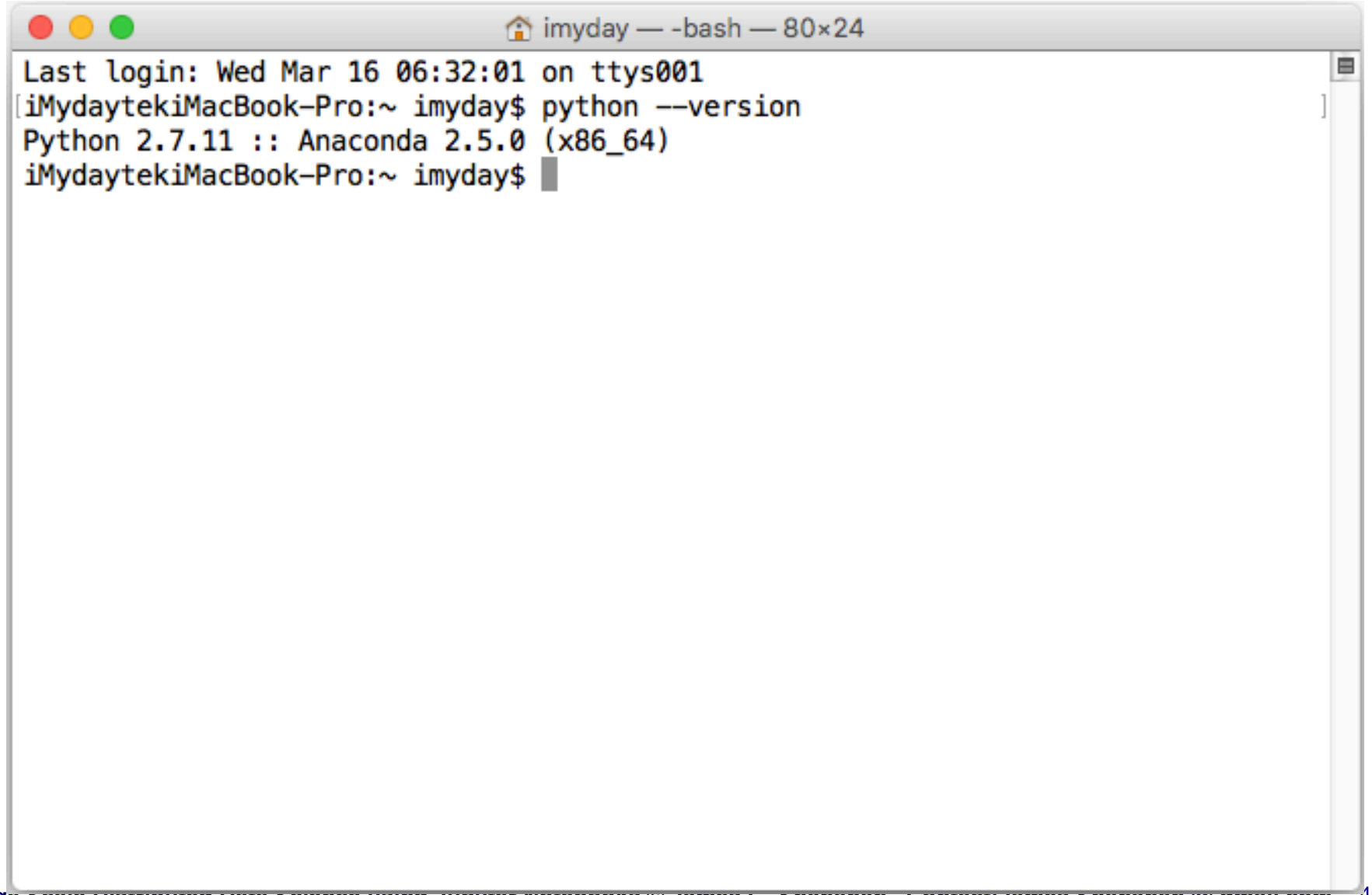


http://conda.pydata.org/docs/using/using.html#verify-that-conda-is-installed-check-current-conda-version

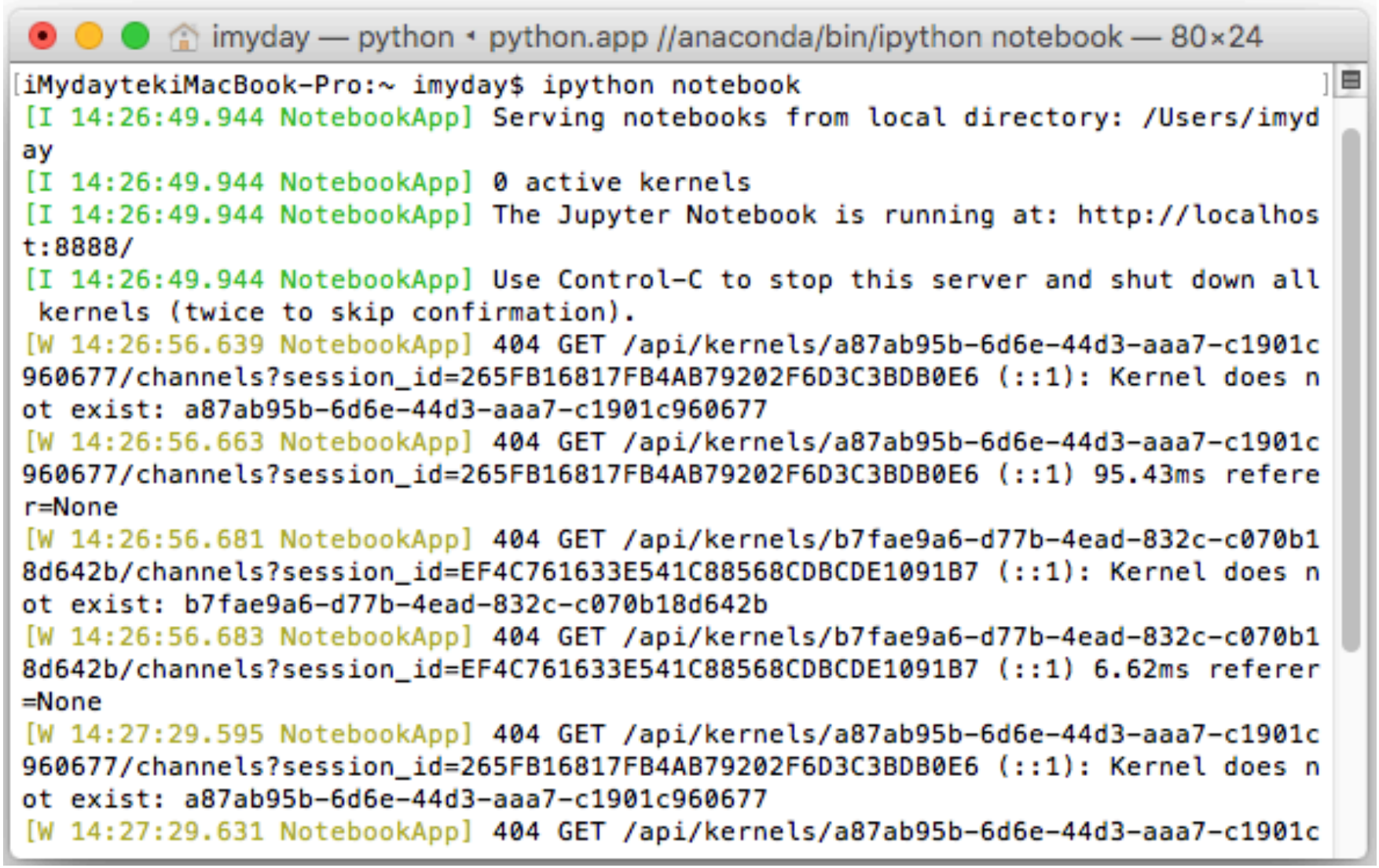
conda --version



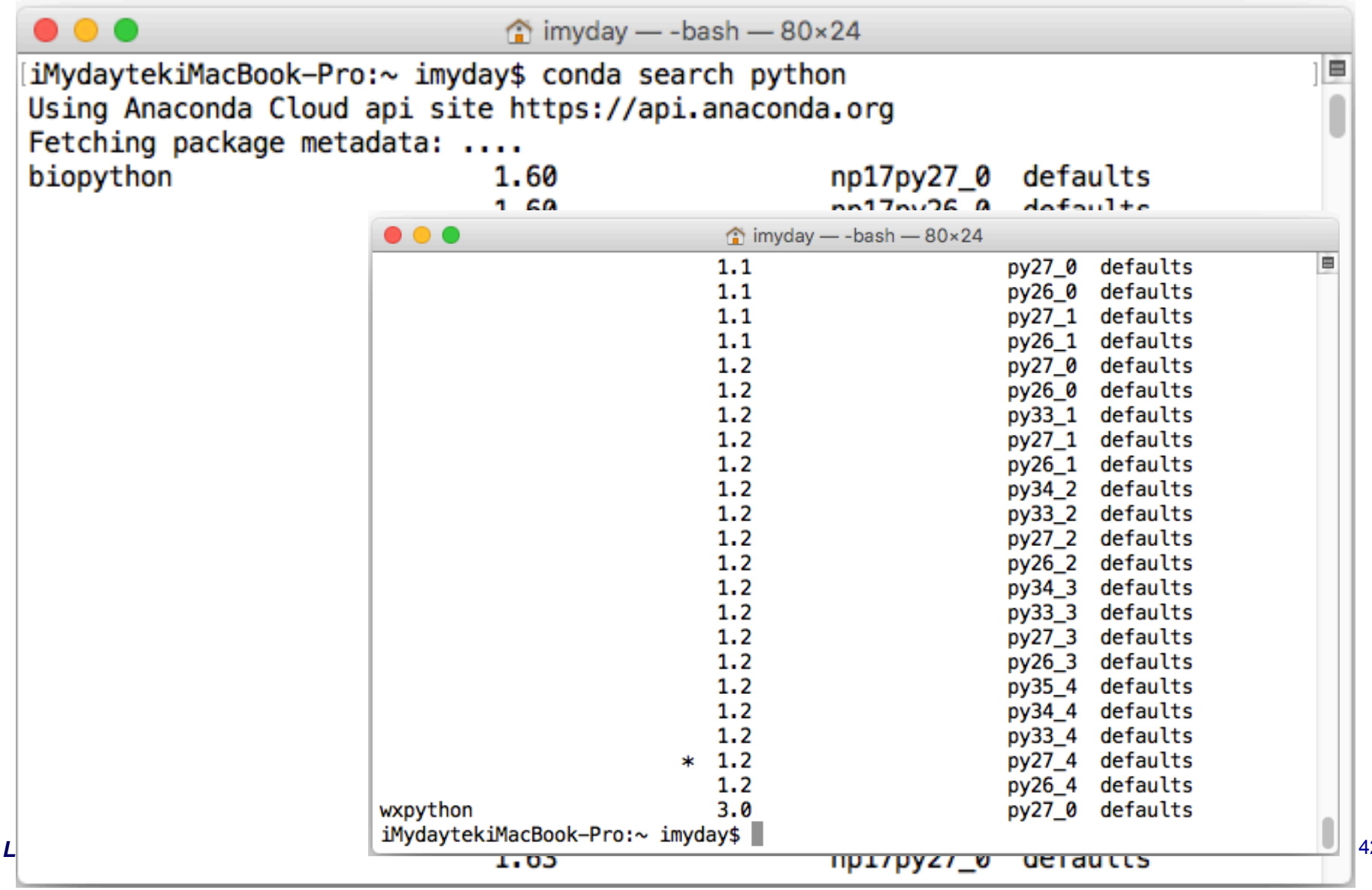
python --version



ipython notebook



conda search python



INSTALL: R and Jupyter Notebooks

- **STEP 1: install Jupyter**
  - Install Anaconda (Python, Jupyter)
  - http://jupyter.readthedocs.io/en/latest/install.html
- **STEP 2: Install R Kernel**
  - https://www.continuum.io/blog/developer/jupyter-and-conda-r

“R Essentials” setup

The Anaconda team has created an “R Essentials” bundle with the IRKernel and over 80 of the most used R packages for data science, including `dplyr`, `shiny`, `ggplot2`, `tidyr`, `caret` and `nnet`.

Downloading “R Essentials” requires conda. Miniconda includes conda, Python, and a few other necessary packages, while Anaconda includes all this and over 200 of the most popular Python packages for science, math, engineering, and data analysis. Users may install all of Anaconda at once, or they may install Miniconda at first and then use conda to install any other packages they need, including any of the packages in Anaconda.

Once you have conda, you may install “R Essentials” into the current environment:

On MAC or Windows got the shell/CMD and type
conda install -c r r-essentials

Might take 10-20 minutes

or create a new environment just for “R essentials”:

```
conda create -n my-r-env -c r r-essentials
```

Bash

Jupyter

Jupyter provides a great notebook interface to write your analysis and share it with your peers. Open a shell and run this command to start the Jupyter notebook interface in your browser:

```
jupyter notebook
```

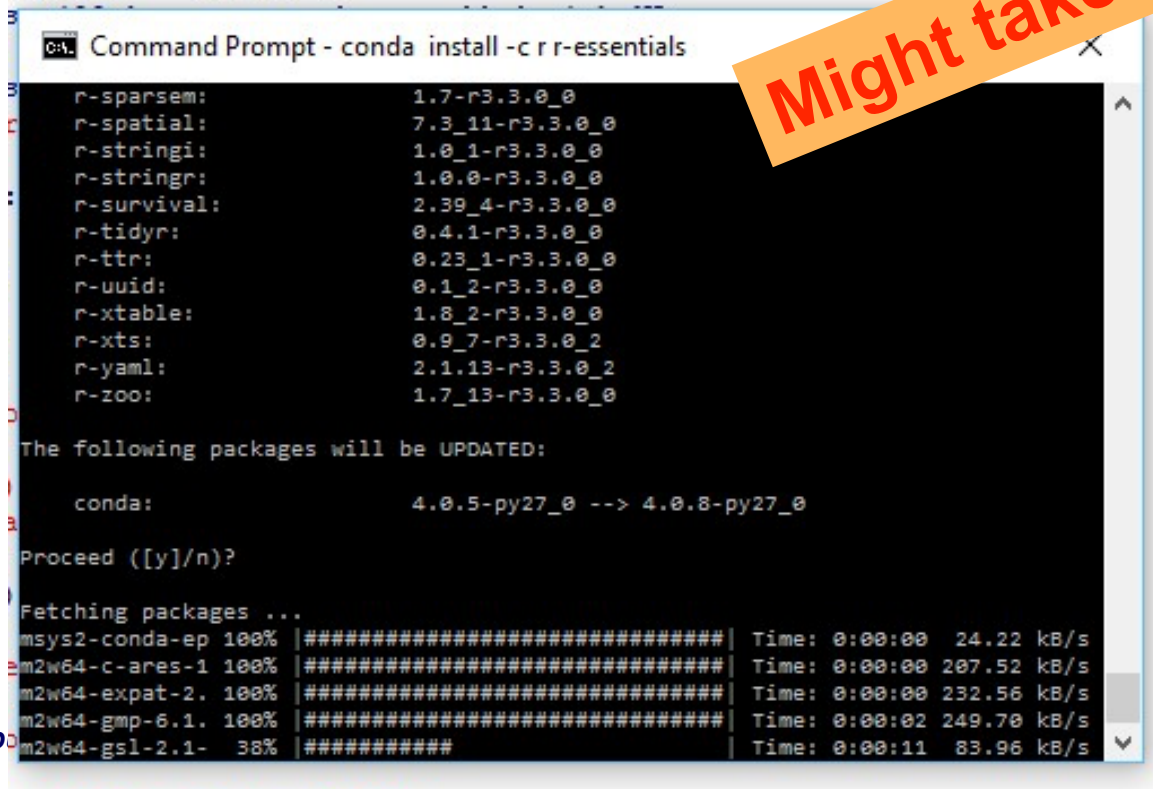
Bash

Install IRKernel for Jupyter

- **The Anaconda team has created an "R Essentials" bundle with the IRKernel and over 80 of the most used R packages for data science, including dplyr, shiny, ggplot2, tidyr,caret and nnet.**

On WINDOWS CMD Shell type
conda install -c r r-essentials

Might take 10-20 minutes

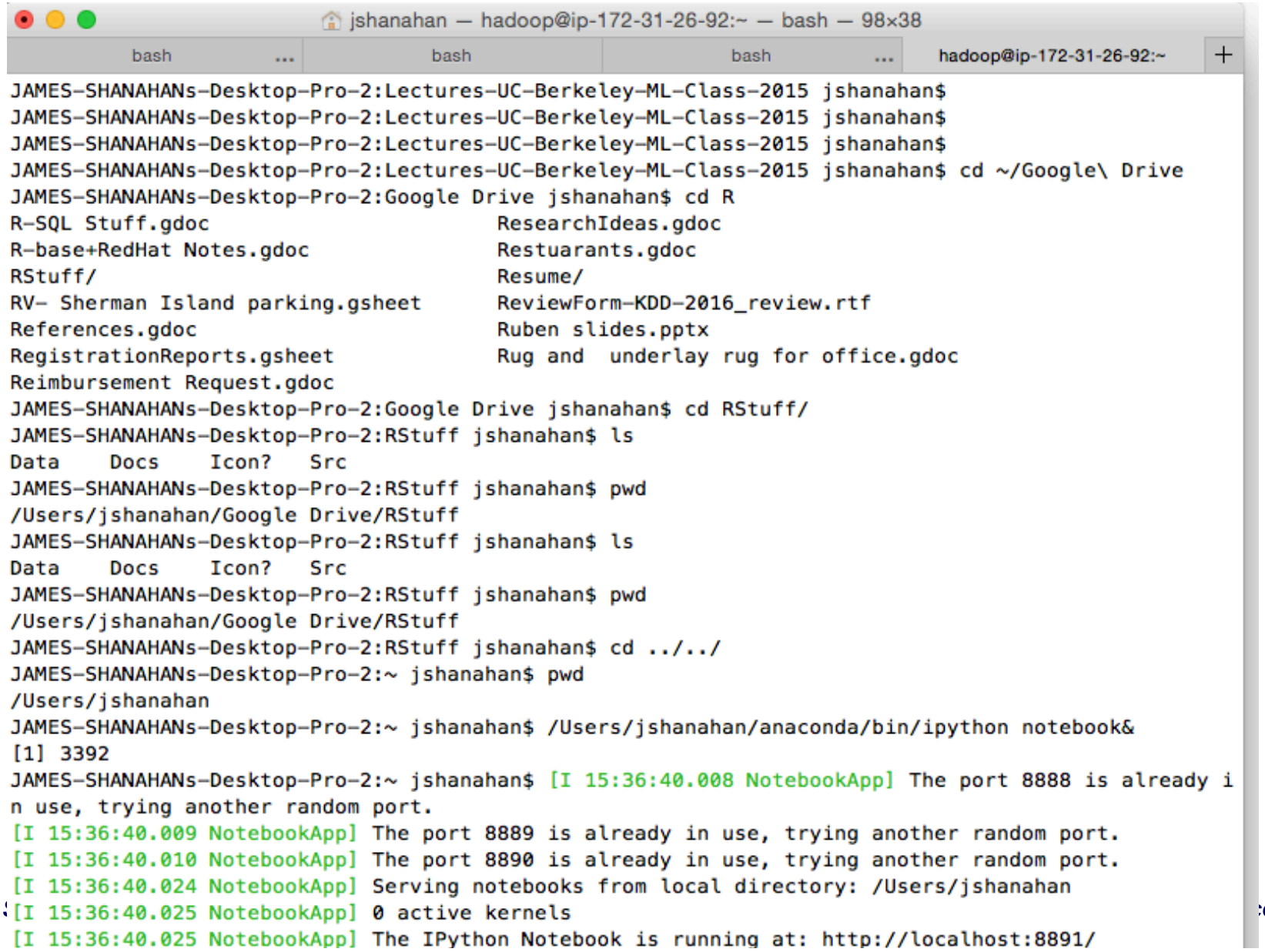


To start the Notebook on a MAC/Windows

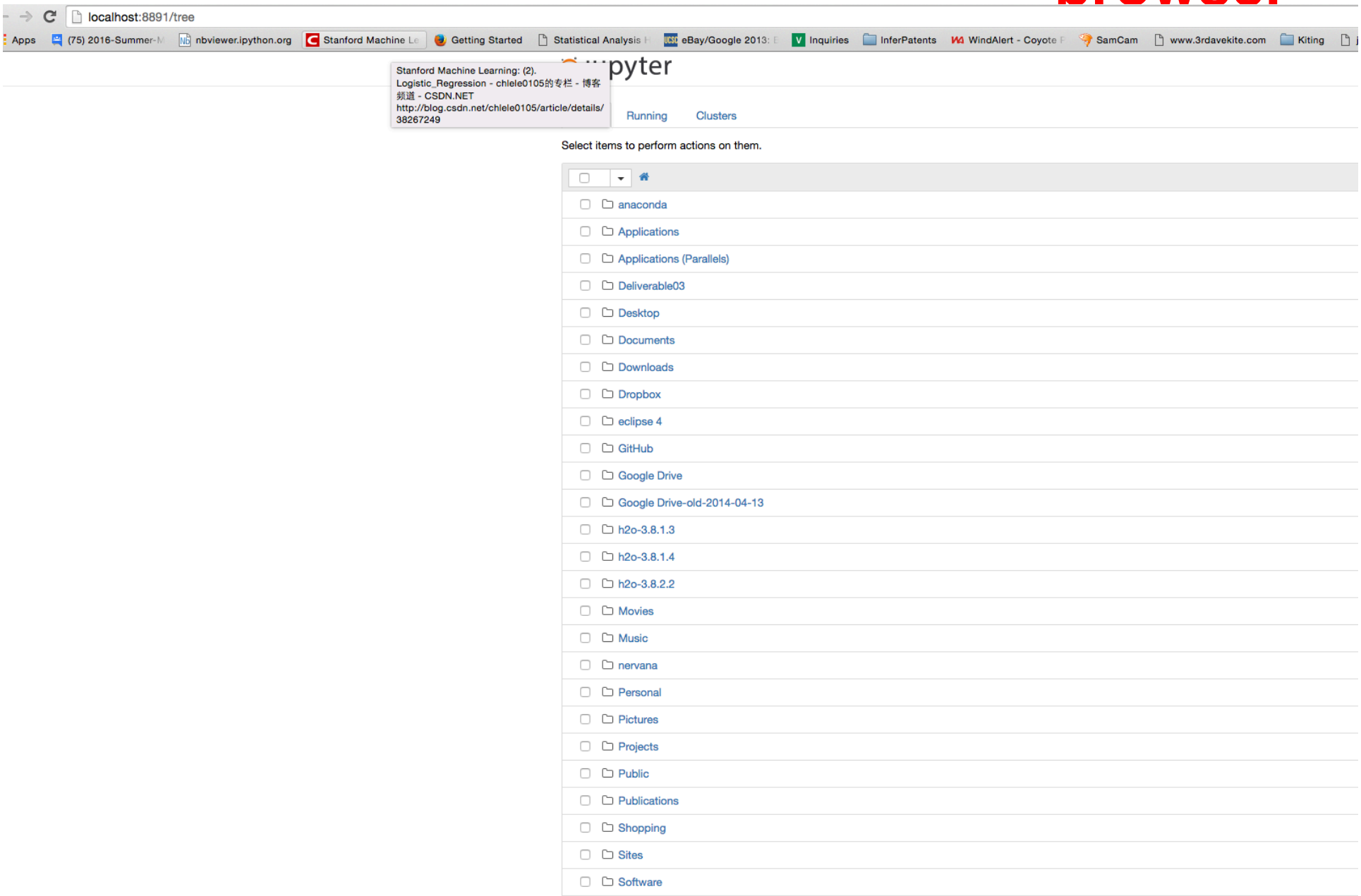
- **To start the Jupyter server on the MAC**
  - See next slide
  - /Users/jshanahan/anaconda/bin/ipython notebook&

- **To start the Jupyter server on WINDOWS**
  - See Slides below

To start the Notebook on a MAC



Opens a notebook window in your web browser



To start Juptyer Notebook on Windows

3. Running the Jupyter Notebook

3.1. Launching *Jupyter Notebook App*

Either

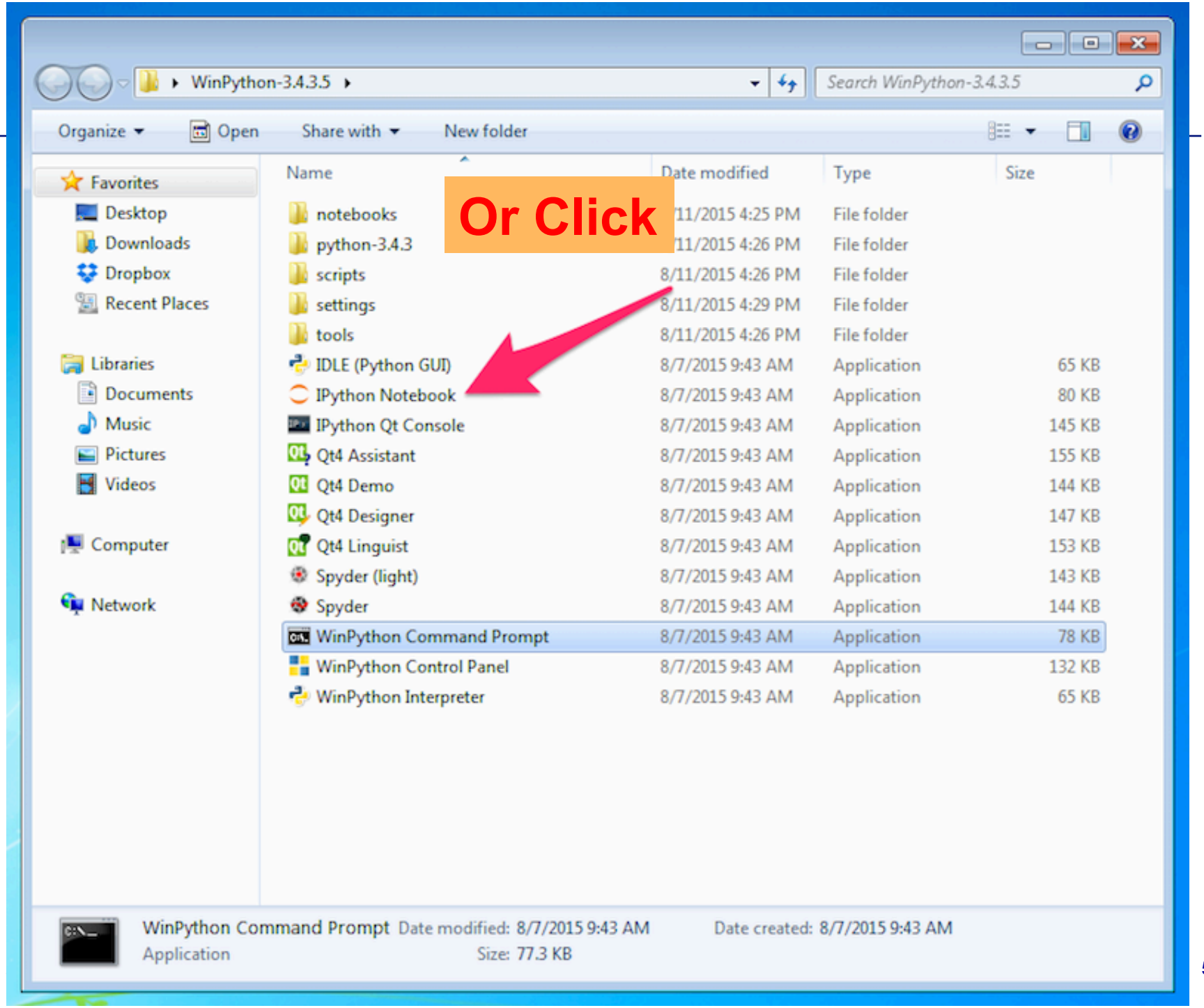
The Jupyter Notebook App can be launched by clicking on the *Jupyter Notebook* icon installed by Anaconda in the start menu (Windows) or by typing in a terminal (*cmd* on Windows):

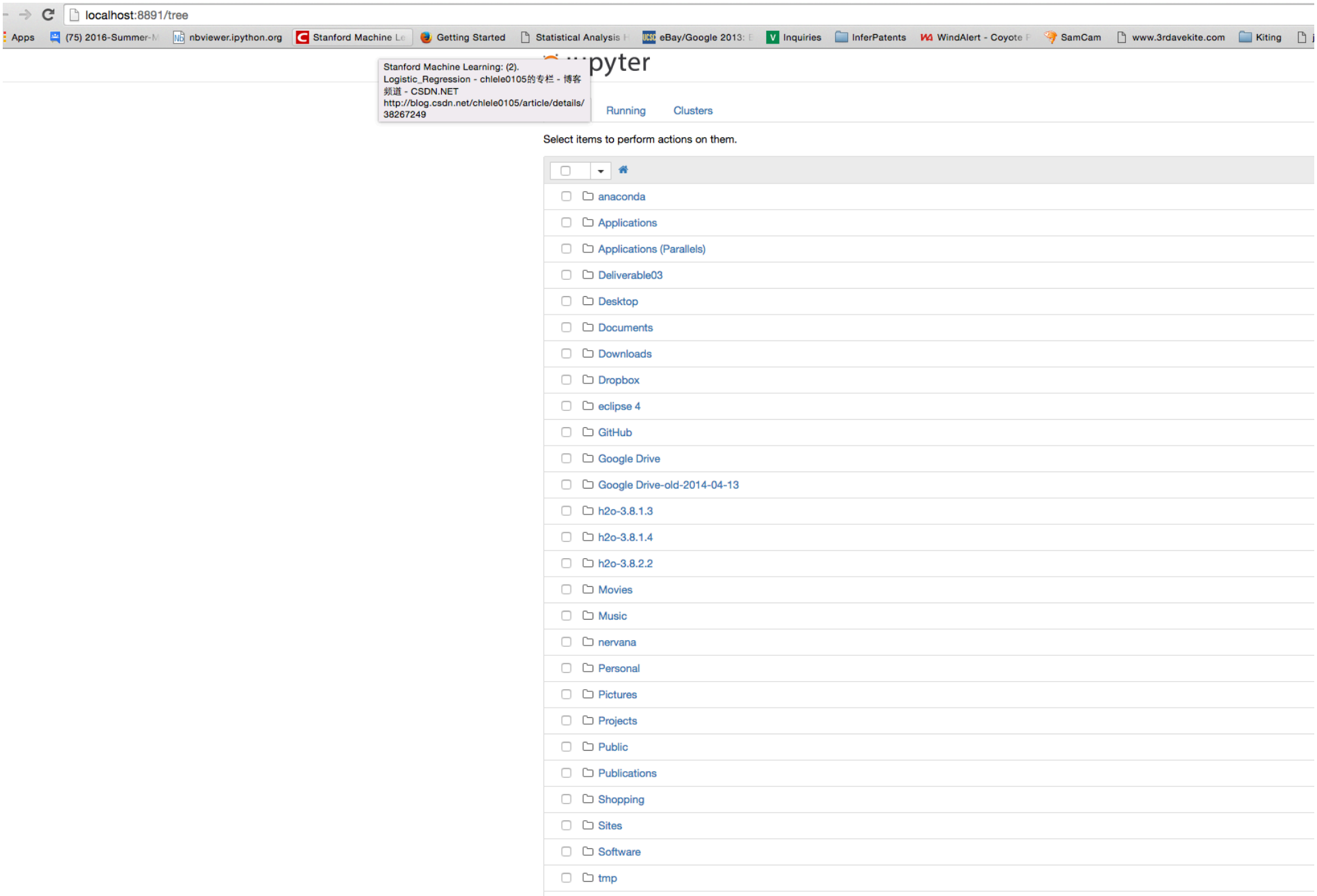
```
jupyter notebook
```

This will launch a new browser window (or a new tab) showing the Notebook Dashboard, a sort of control panel that allows (among other things) to select which notebook to open.

When started, the Jupyter Notebook App can access only files within its start-up folder (including any sub-folder). If you store the notebook documents in a subfolder of your user folder no configuration is necessary. Otherwise, you need to choose a folder which will contain all the notebooks and set this as the Jupyter Notebook App start-up folder.

See below for platform-specific instructions on how to start Jupyter Notebook App in a specific folder.


WinPython-3.4.3.5
Search WinPython-3.4.3.5
Organize
Open
Share with
New folder
Favorites
Desktop
Downloads
Dropbox
Recent Places
Libraries
Documents
Music
Pictures
Videos
Computer
Network
Name
Date modified
Type
Size
Or Click
notebooks
python-3.4.3
scripts
settings
tools
IDLE (Python GUI)
IPython Notebook
IPython Qt Console
Qt4 Assistant
Qt4 Demo
Qt4 Designer
Qt4 Linguist
Spyder (light)
Spyder
WinPython Command Prompt
WinPython Control Panel
WinPython Interpreter
File folder
Application
65 KB
80 KB
145 KB
155 KB
144 KB
147 KB
153 KB
143 KB
144 KB
78 KB
132 KB
65 KB
WinPython Command Prompt Date modified: 8/7/2015 9:43 AM
Date created: 8/7/2015 9:43 AM
Application
Size: 77.3 KB


localhost:8891/tree
Apps
(75) 2016-Summer-M
nbviewer.ipython.org
Stanford Machine Le
Getting Started
Statistical Analysis H
eBay/Google 2013: E
Inquiries
InferPatents
WindAlert - Coyote F
SamCam
www.3rdavekite.com
Kiting
Stanford Machine Learning: (2). Logistic_Regression - chlele0105的专栏 - 博客频道 - CSDN.NET http://blog.csdn.net/chlele0105/article/details/38267249
pyter
Running
Clusters
Select items to perform actions on them.
anaconda
Applications
Applications (Parallels)
Deliverable03
Desktop
Documents
Downloads
Dropbox
eclipse 4
GitHub
Google Drive
Google Drive-old-2014-04-13
h2o-3.8.1.3
h2o-3.8.1.4
h2o-3.8.2.2
Movies
Music
nervana
Personal
Pictures
Projects
Public
Publications
Shopping
Sites
Software
tmp

Jupyter

Jupyter provides a great notebook interface to write your analysis and share it with your peers. Open a shell and run this command to start the Jupyter notebook interface in your browser:

```
jupyter notebook
```

Bash

Start a new R notebook:

You can immediately write and run R code in the notebook cells.

An R notebook example

Now you can:

- import the data wrangling R package, dplyr:

```
In [1]: library(dplyr)
```

S

- import the data wrangling R package, dplyr:

```
In [1]: library(dplyr)
```

- explore one of the available datasets, such as the `iris`:

```
In [2]: iris

Out[2]:
    Sepal.Length    Sepal.Width     Petal.Length    Petal.Width     Species
1            5.1            3.5              1.4            0.2      setosa
2            4.9              3              1.4            0.2      setosa
...
```

- calculate the average sepal width by species:

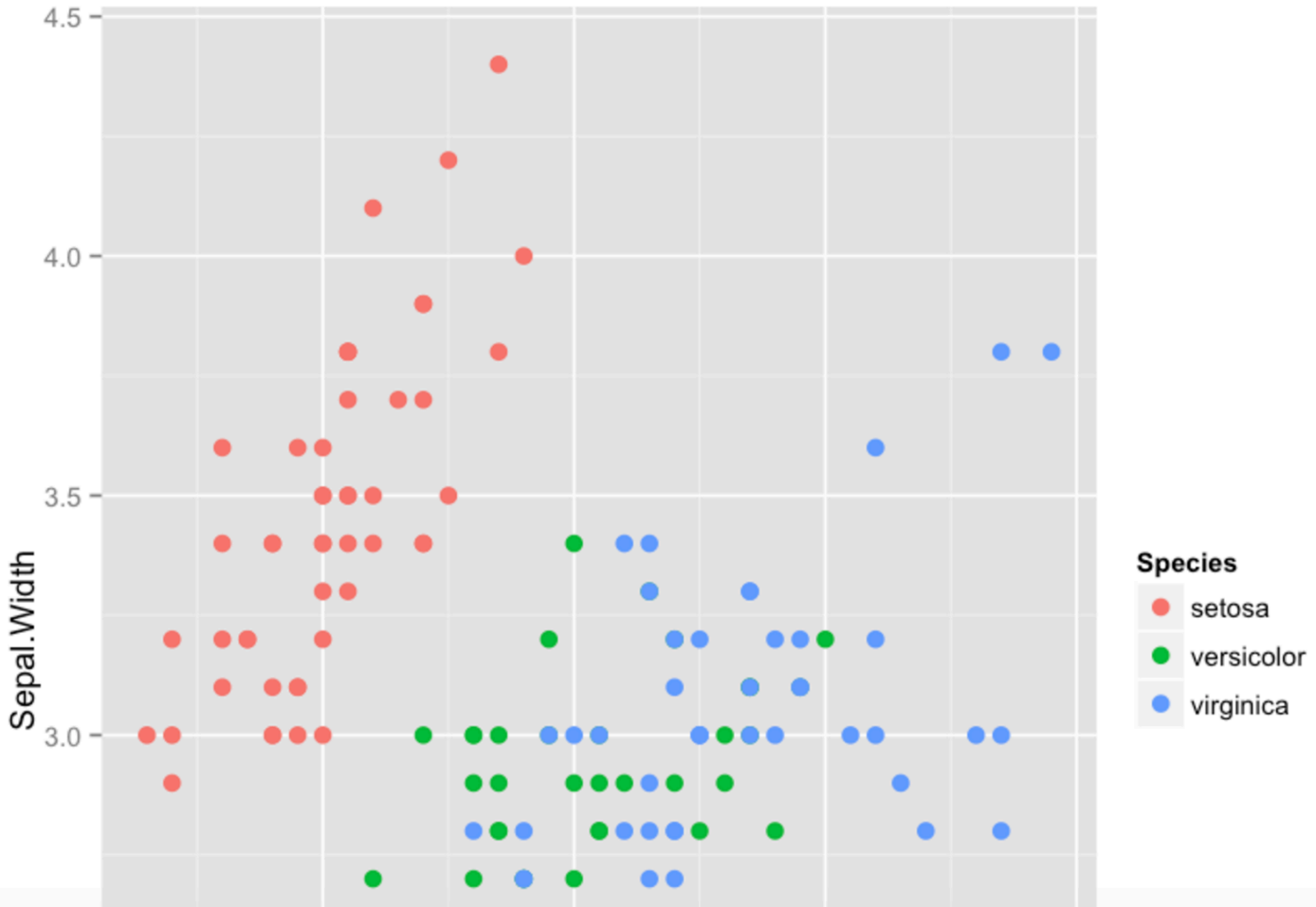
```
In [3]: iris %>%
 group_by(Species) %>%
 summarise(Sepal.Width.Avg = mean(Sepal.Width)) %>%
 arrange(Sepal.Width.Avg)

Out [3]:
        Species     Sepal.Width.Avg
1    versicolor                2.77
2     virginica               2.974
3        setosa               3.428
```

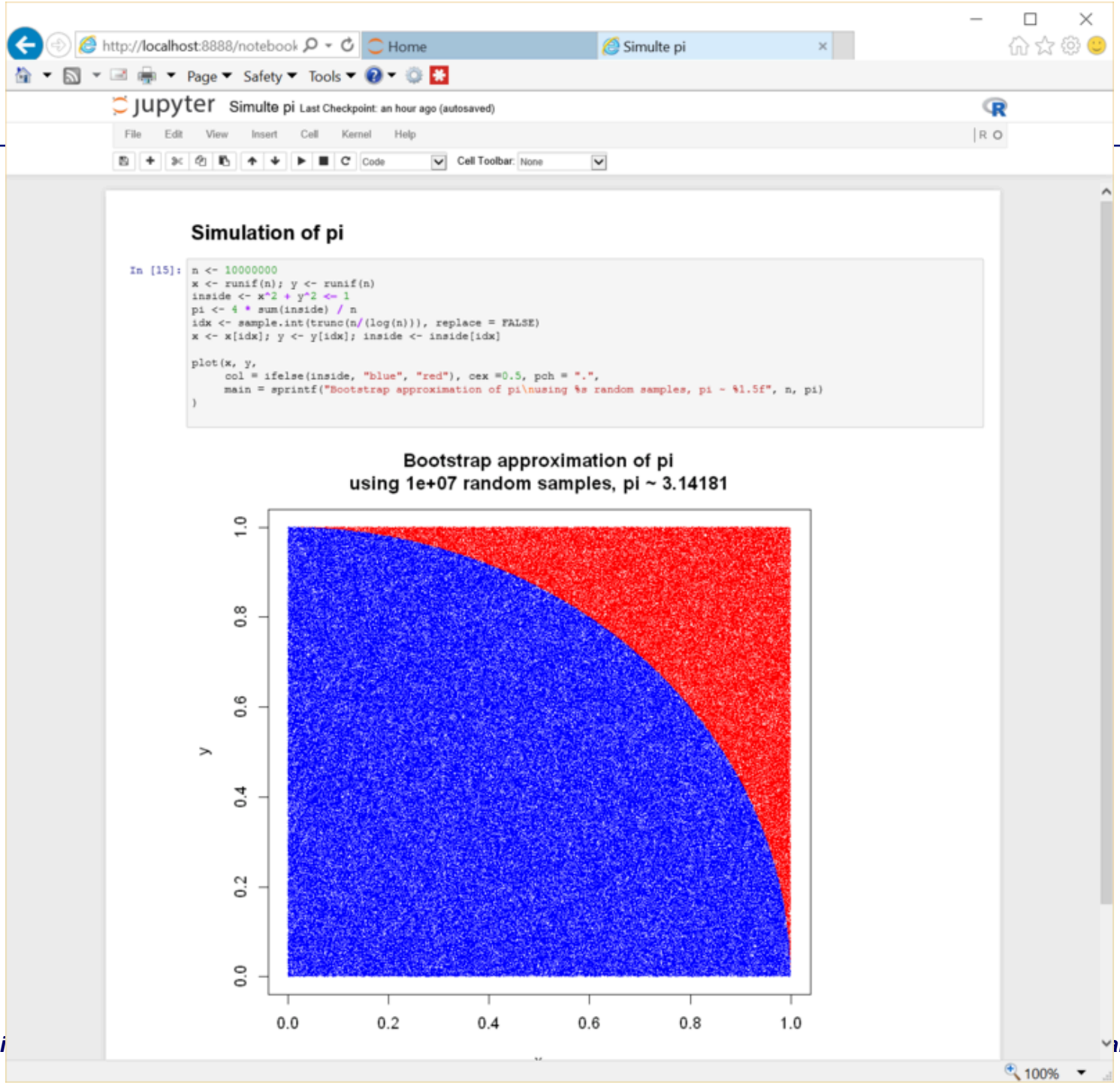
```
In [4]: library(ggplot2)
```

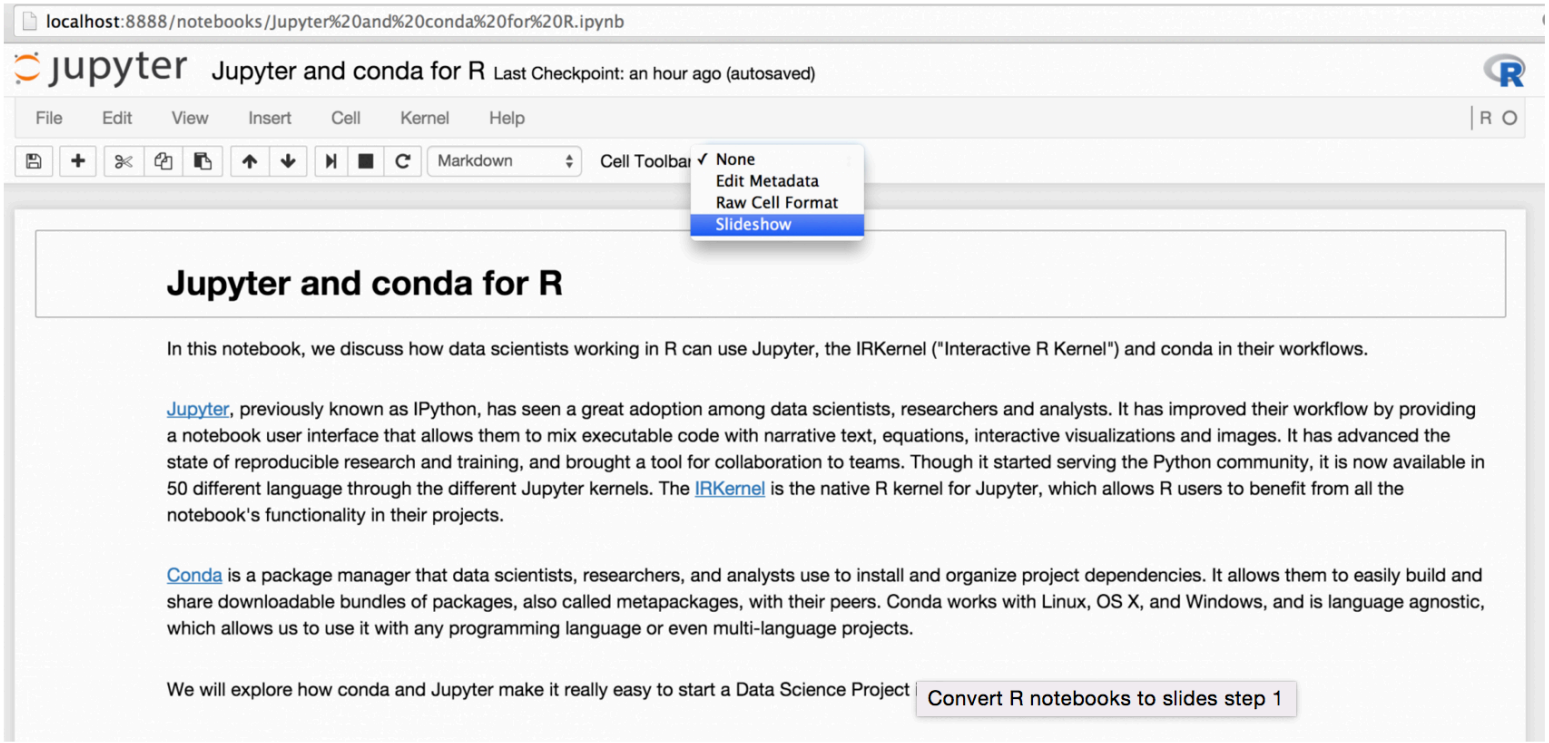
- plot the Sepal.Width vs. Sepal.Length

```
In [5]: ggplot(data=iris, aes(x=Sepal.Length, y=Sepal.Width, color=Species))
```

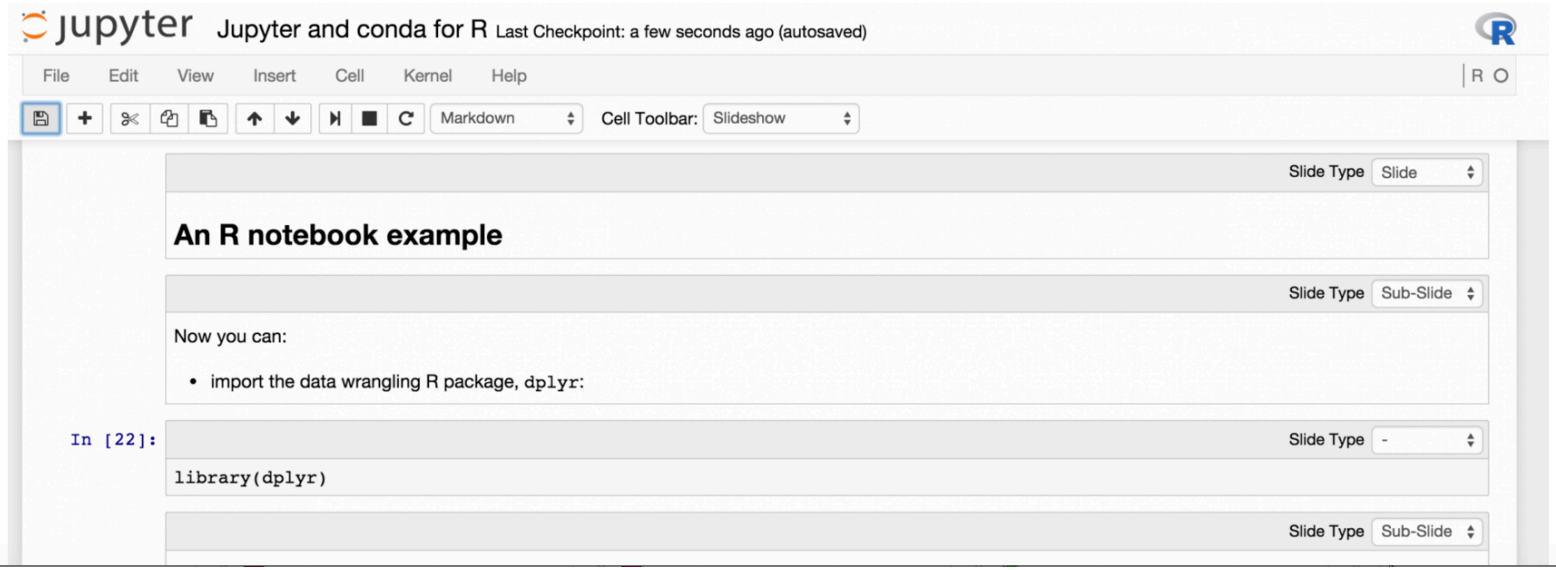


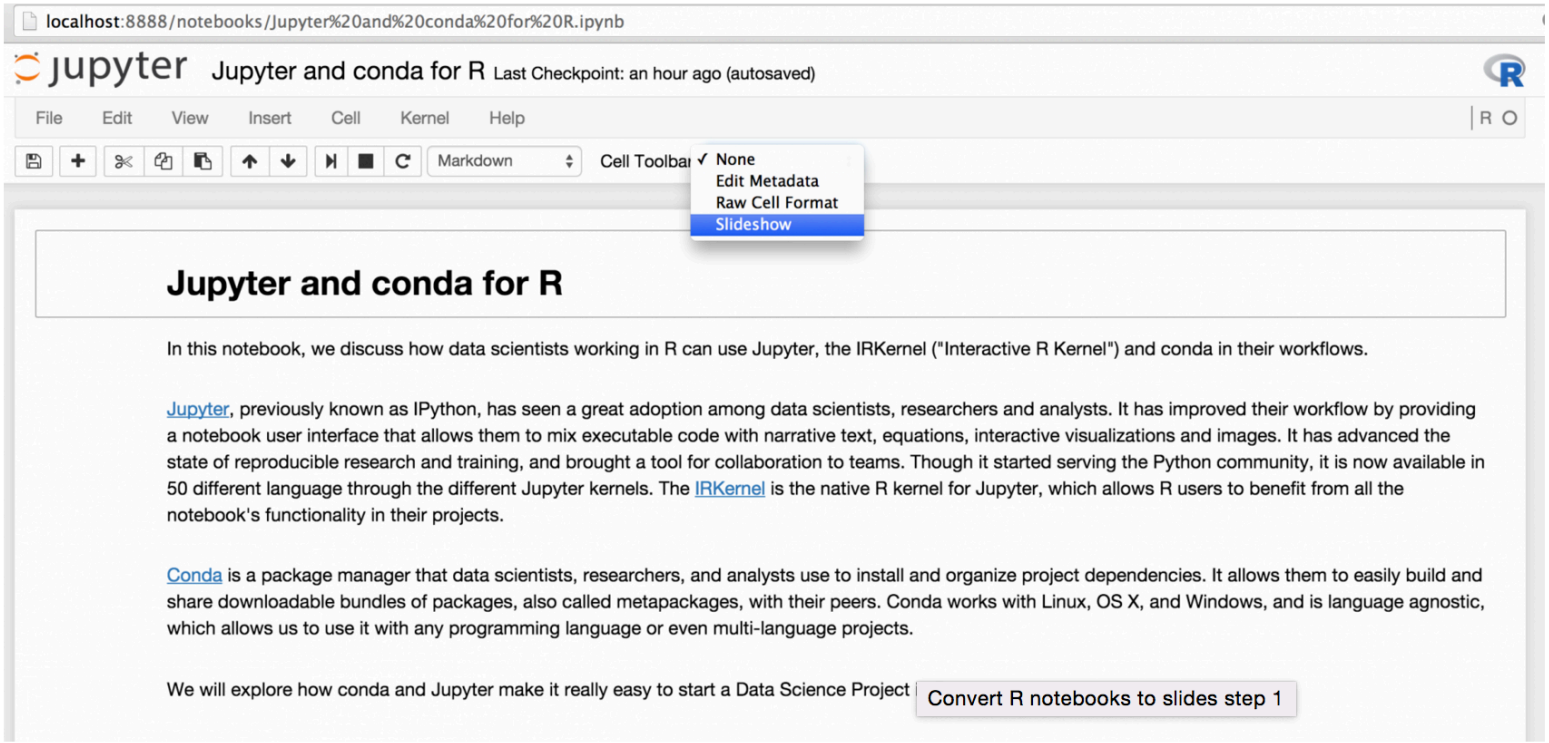
261-2015-....ipynb | Paper 482.pdf | WWW2019_San-Franc....pdf | iw3c2_budget_templ....xlsx | emr.zip


http://localhost:8888/notebook
Home
Simulte pi
Page
Safety
Tools
jupyter
Simulte pi Last Checkpoint: an hour ago (autosaved)
File
Edit
View
Insert
Cell
Kernel
Help
Code
Cell Toolbar:
None
Simulation of pi
In [15]:
n <- 10000000
x <- runif(n); y <- runif(n)
inside <- x^2 + y^2 <= 1
pi <- 4 * sum(inside) / n
idx <- sample.int(trunc(n/(log(n))), replace = FALSE)
x <- x[idx]; y <- y[idx]; inside <- inside[idx]
plot(x, y,
col = ifelse(inside, "blue", "red"), cex =0.5, pch = ".",
main = sprintf("Bootstrap approximation of pi\nusing %s random samples, pi ~ %1.5f", n, pi)
)
Bootstrap approximation of pi
using 1e+07 random samples, pi ~ 3.14181
y
0.0
0.2
0.4
0.6
0.8
1.0
100%

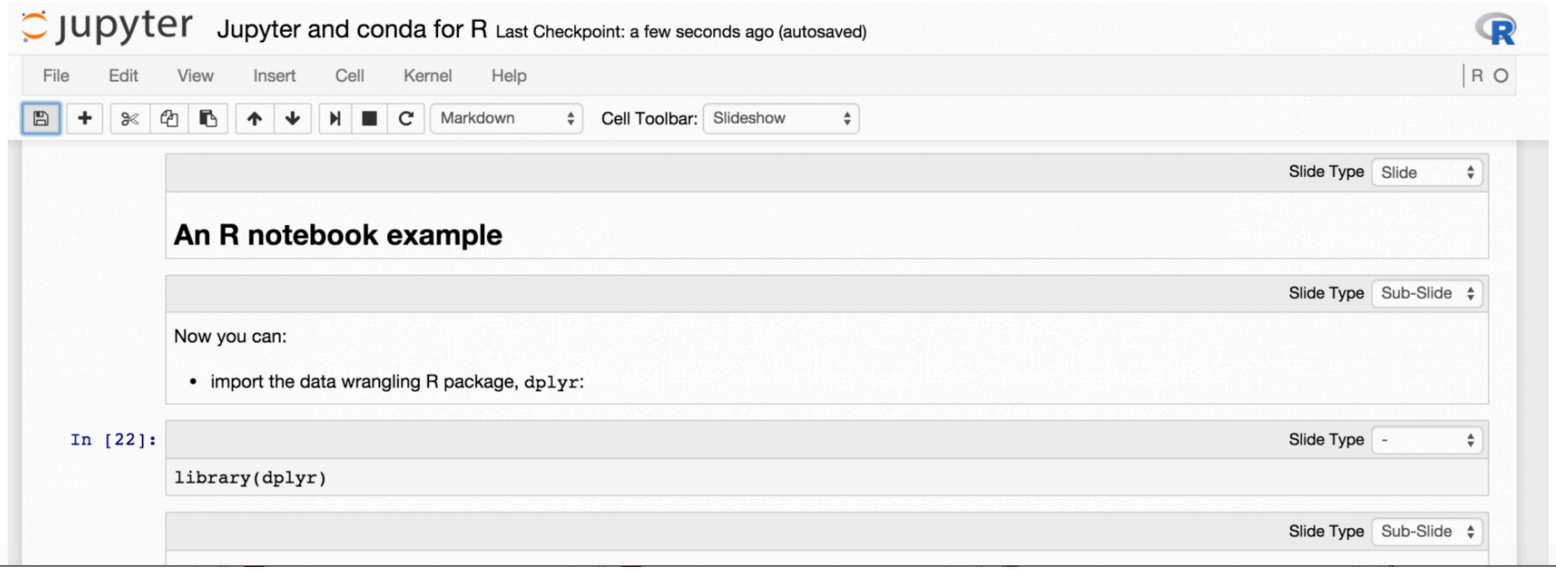


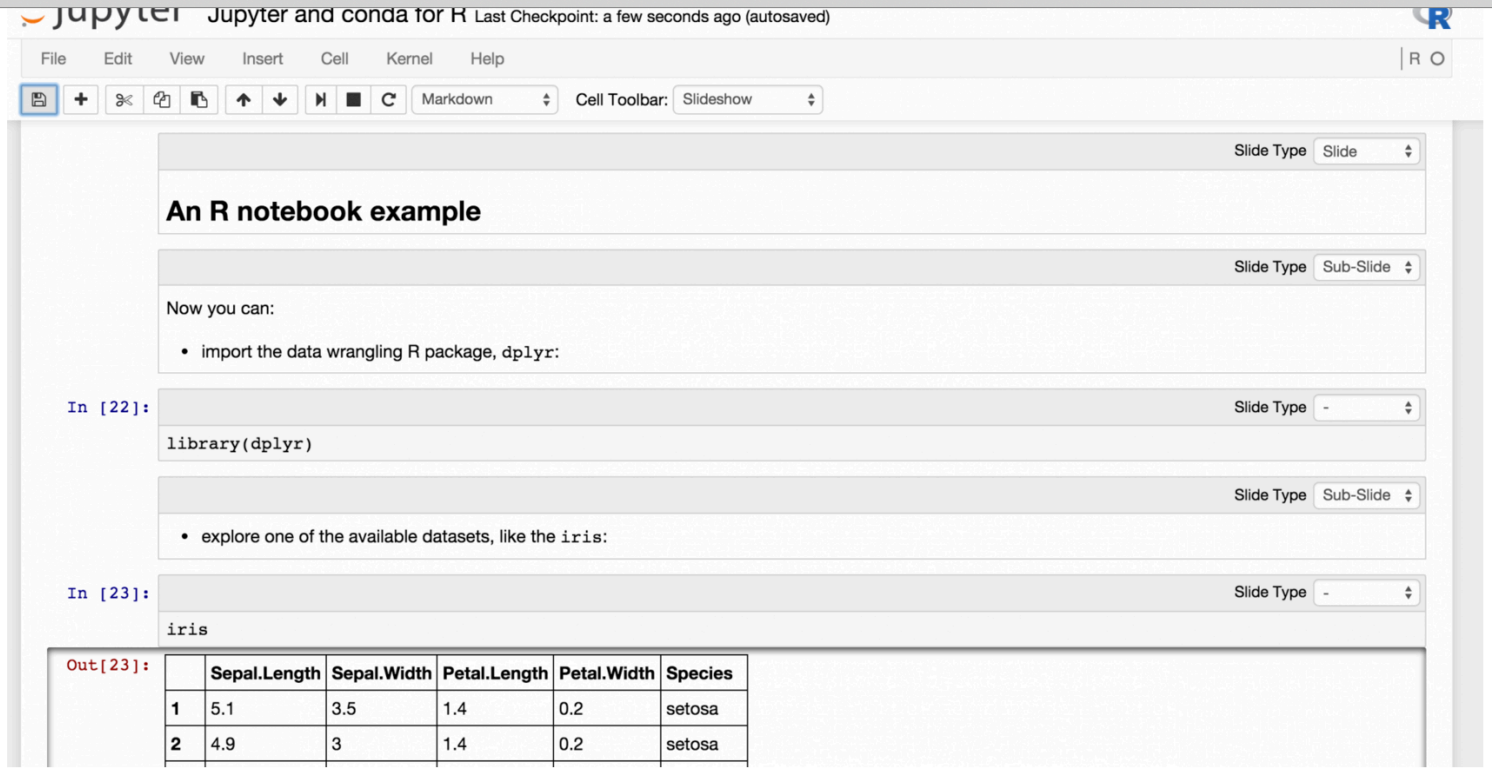
Organize the cells into slides and subslides:





Organize the cells into slides and subslides:





And convert:

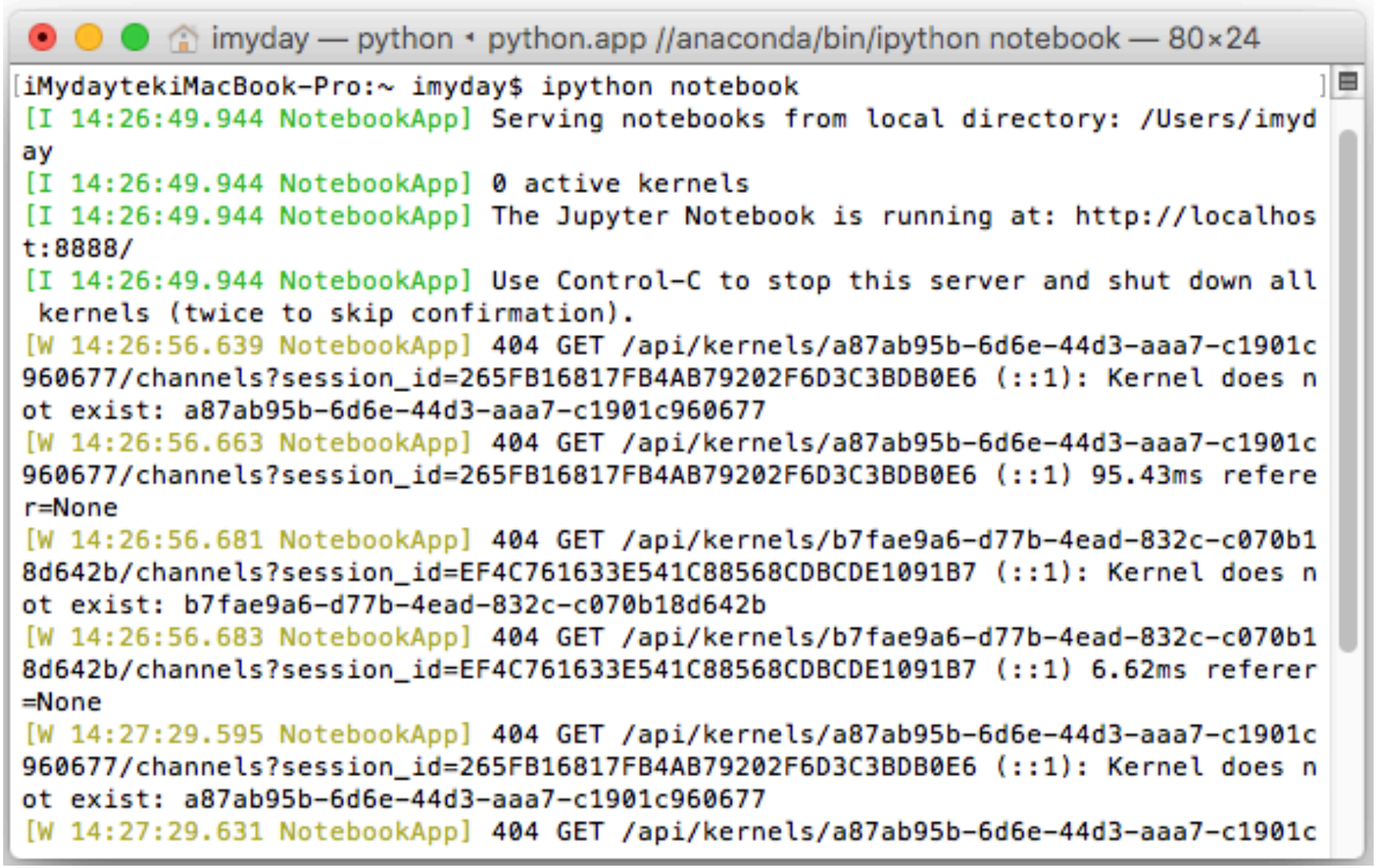
```
jupyter nbconvert my_r_notebook.ipynb --to slides --post serve
```

Bash

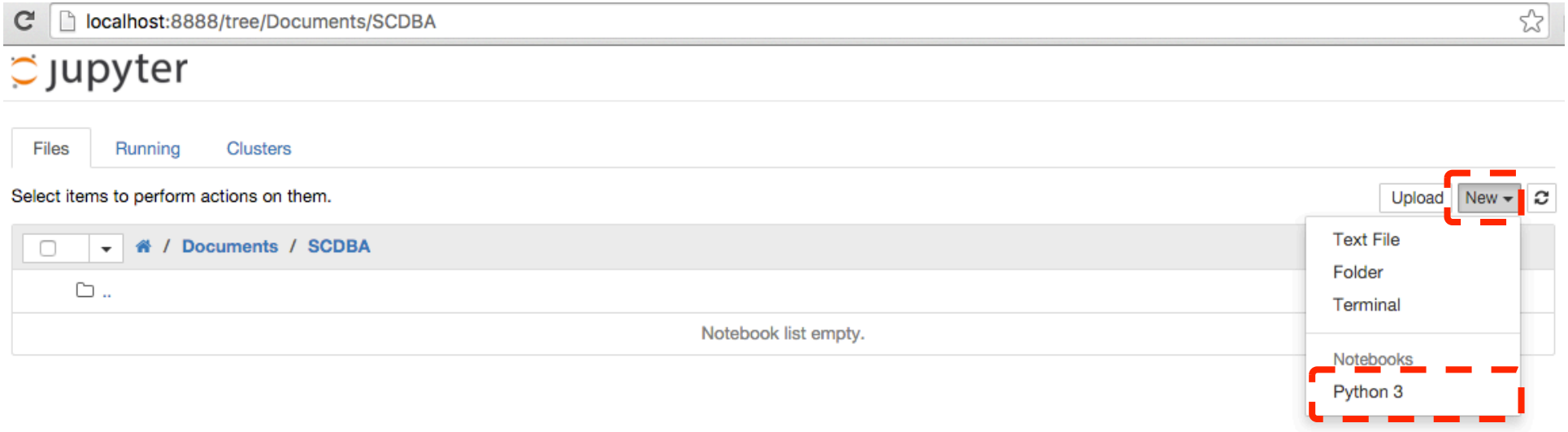
This opens a browser showing the slidedeck:

ipython notebook

ipython notebook

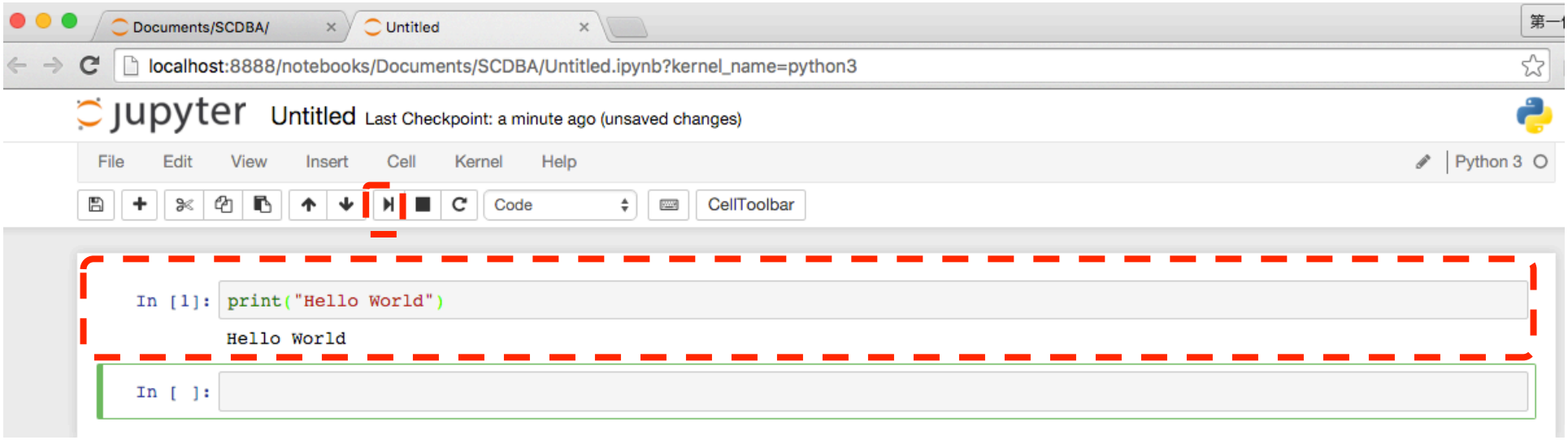


jupyter notebook
Python 3



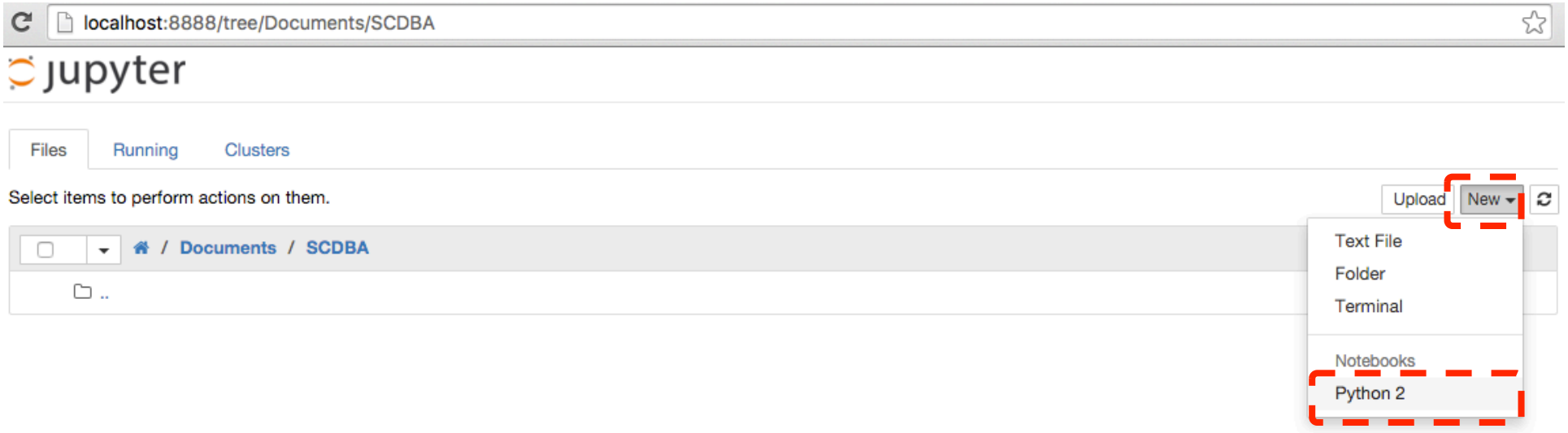
jupyter notebook

Python 3



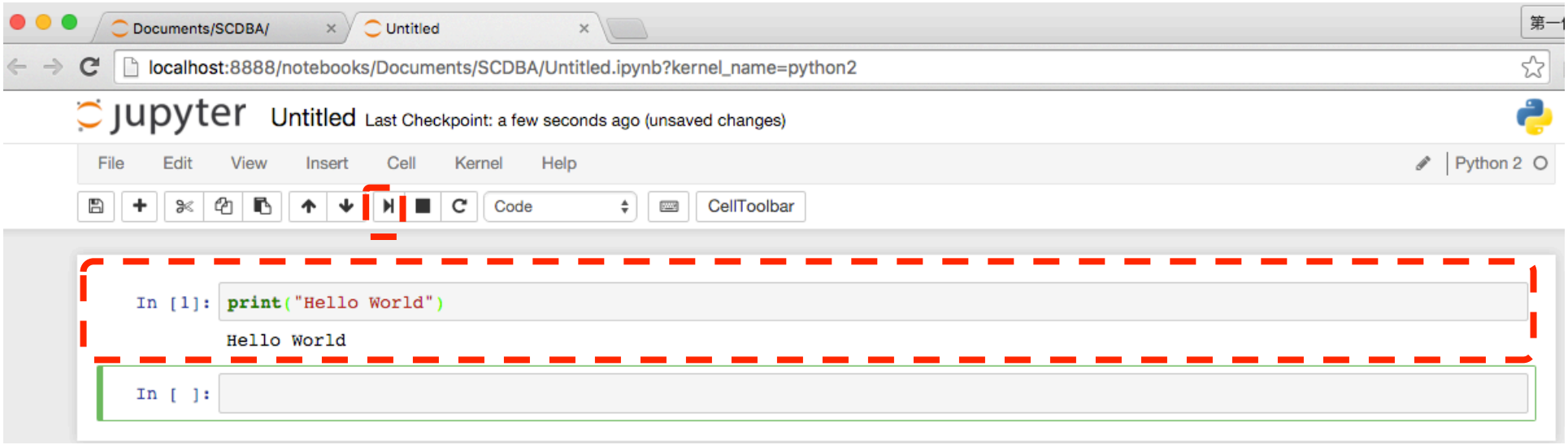
jupyter notebook

Python 2

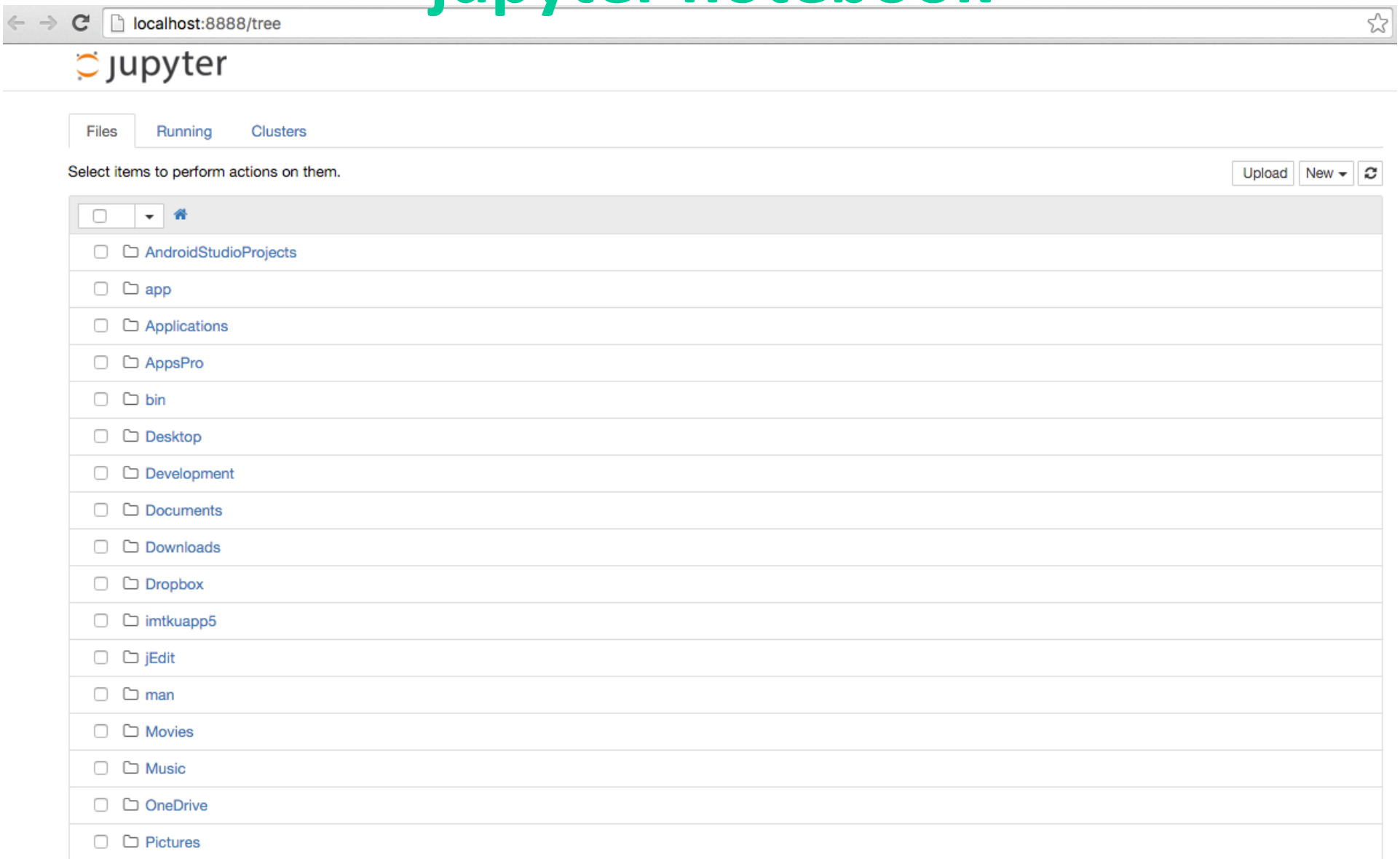


jupyter notebook

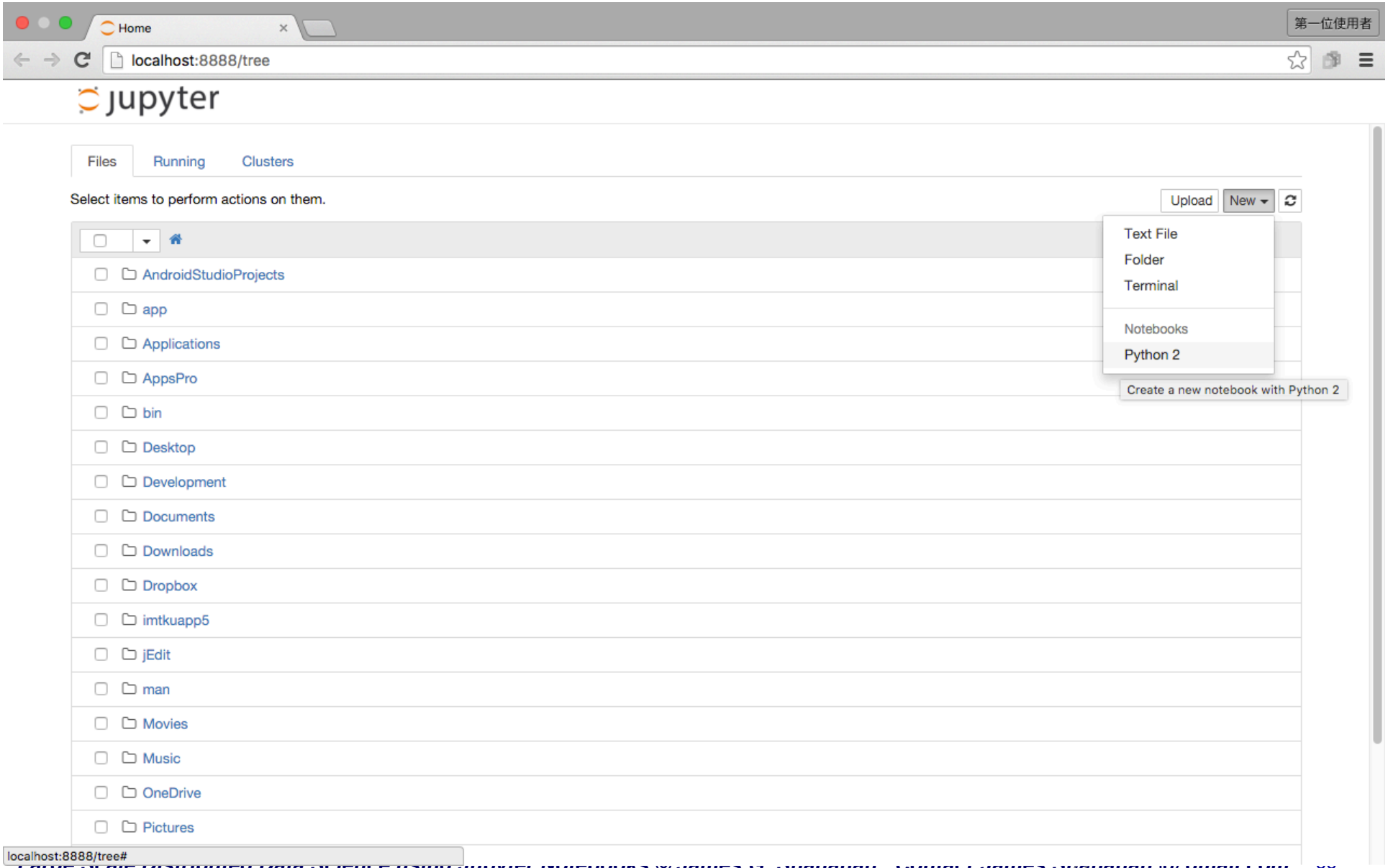
Python 2



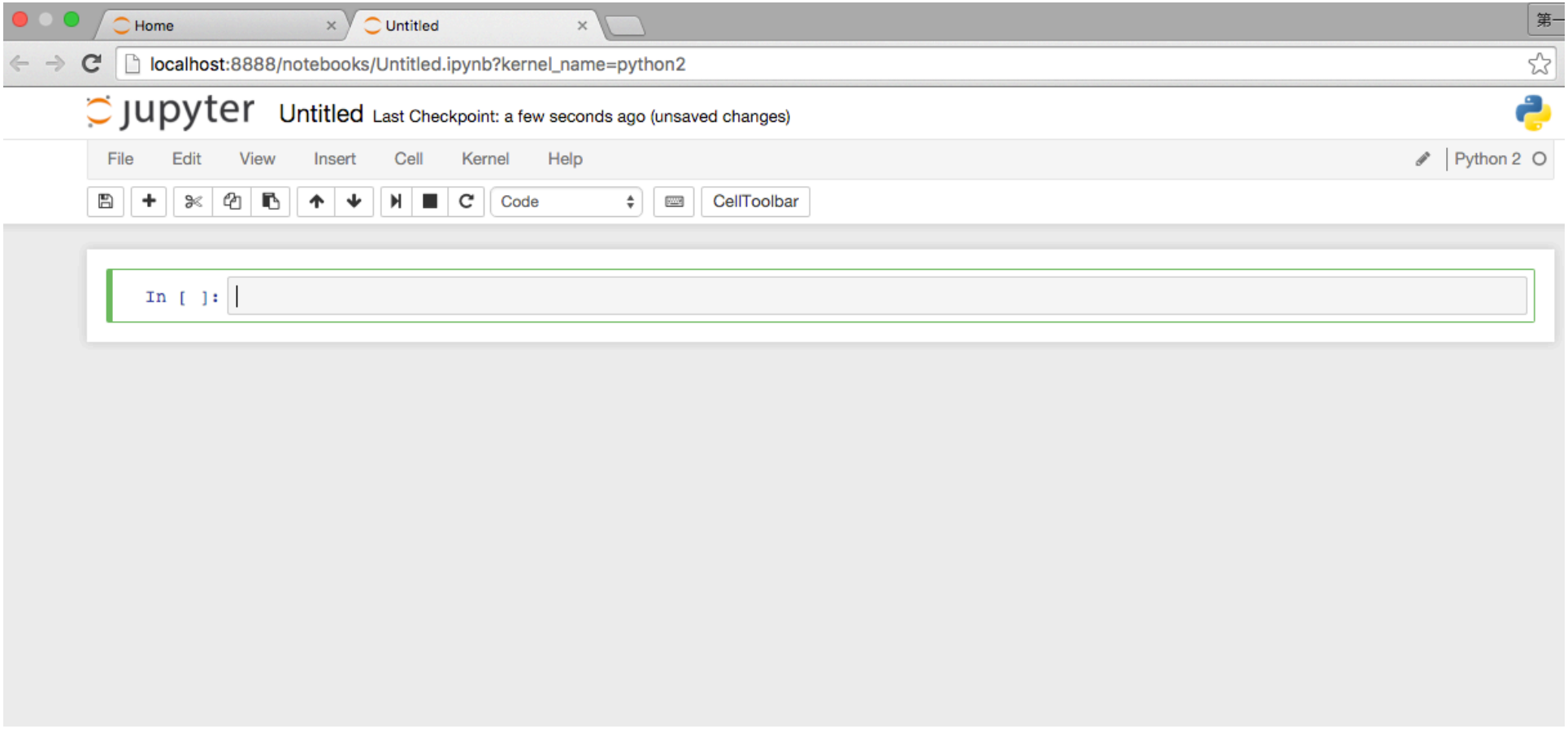
ipython notebook
jupyter notebook



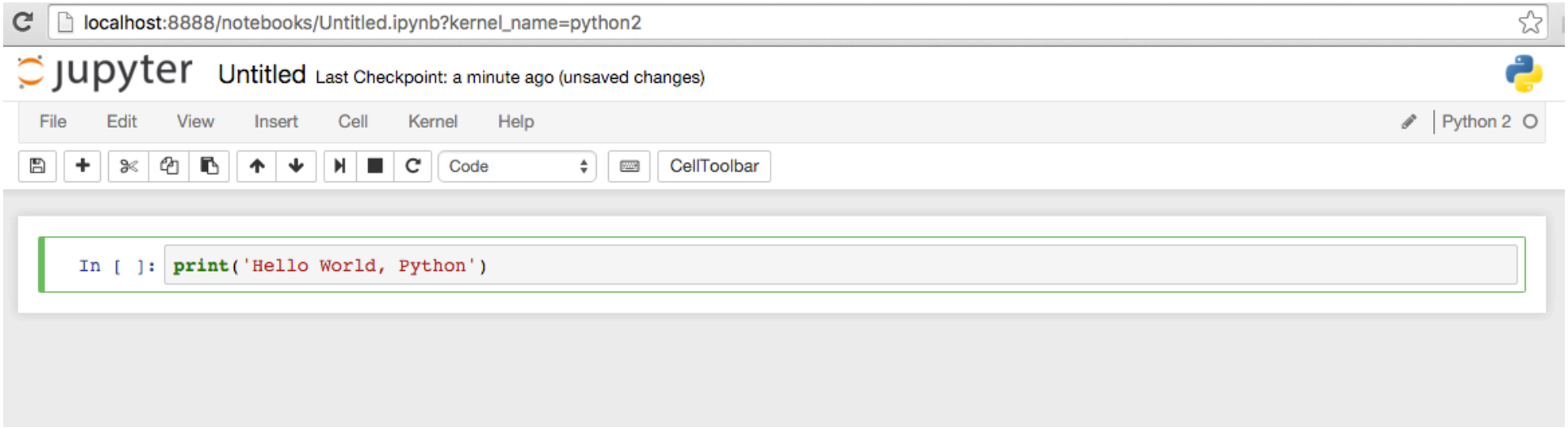
jupyter notebook



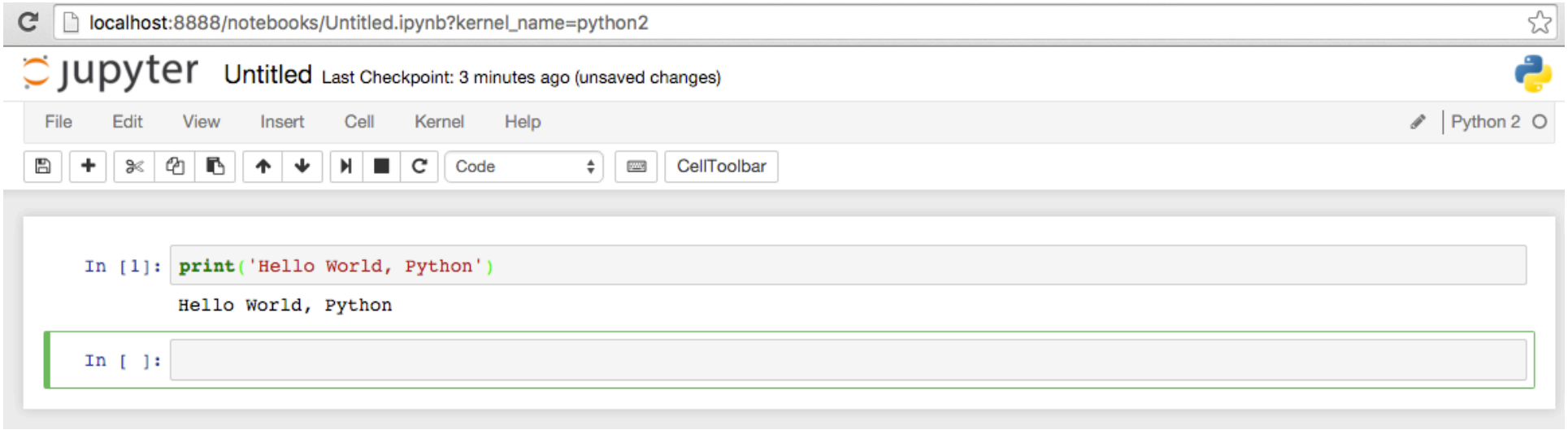
jupyter notebook



```
print('Hello World, Python')
```



print('Hello World, Python')



Rstudio Versus R in Jupyter

rmp · 7 months ago

the Jupyter notebook seems to be rather ignored by the larger R community. Any idea why that might be? Maybe its because Rmarkdown has been around for quite some time now and offers more options to write full reports and have more control over the output.

Reply · Share ›

anarcho-chossid ➚ rmp · 6 months ago

Because Jupyter still doesn't provide the basic functionality in terms of working with code that RStudio does. It doesn't even do all of the syntax highlighting. (When I asked them for a way to change syntax highlighting for IRKernel, their response was basically "whatever".)

Also, while working in Jupyter is ok for quick prototyping, most of my time is spent building actual code for a pipeline. And RStudio is best/better for that.

Not to mention integration with Shiny.

Reply · Share ›

Joris Meys ➚ rmp · 6 months ago

To my knowledge, big part of the R community isn't even fully aware of the capabilities of Jupyter. I also found out rather recently.

The reason for me to stay with RStudio for now, is simply because I use a lot more packages than the one mentioned there (including the Bioconductor set), and having them available is far less hassle in RStudio compared to jupyter.

Reply · Share ›

- That's it

- See you all on Monday, June 20 at 9AM