

NC STATE UNIVERSITY

CROP AND SOIL SCIENCES

CS 590 Special Topics

Programming and Data Science for Applied Research

Course Concepts and Workflow

WHAT DO YOU HOPE TO LEARN IN THIS CLASS?

Underlying Course Concepts in R and Python

- Basic Programming Skills
- Advanced Programming Topics and Packages
- Data Visualizations and Interactive Packages
- Machine Learning (Supervised and Unsupervised) Algorithms
- Section Exercises and Capstone Project

Environment Setup – Anaconda (Prompt)

Objectives

- Install the Anaconda Working Environment
- Install R and Python3 Kernels for Jupyter Notebooks
- Open and Explore Jupyter Notebooks
- GitHub Exercise

Let's Browse the Syllabus!

Anaconda and Jupyter Notebooks

- Anaconda is a distributions of R and Python with working environments for many programming languages – via Jupyter Notebooks
- Jupyter Notebooks is an **I**ntegrated **W**orking **E**nvironment (IDE) that manages multiple programming languages (kernels) under one environment
- Jupyter Notebooks gives programmers the ability to write code, display images, and write markdown notes for future references all in one window
- Jupyter Notebooks is the most popular IDE in data science and it is a great learning tool

Disclaimer...

Jupyter Notebooks is not the only IDE available for R and Python programming

Feel free to use any IDE for R or Python
(e.g. Sublime, TextWrangler, R Studio, Vi/Vim, Visual Studio)

It won't hurt my feelings... much

Remote Desktop Connection (Recommended)

```
Command Prompt
Microsoft Windows [Version 10.0.17763.678]
(c) 2018 Microsoft Corporation. All rights reserved.

C:\Users\jcdunne>ipconfig

Windows IP Configuration

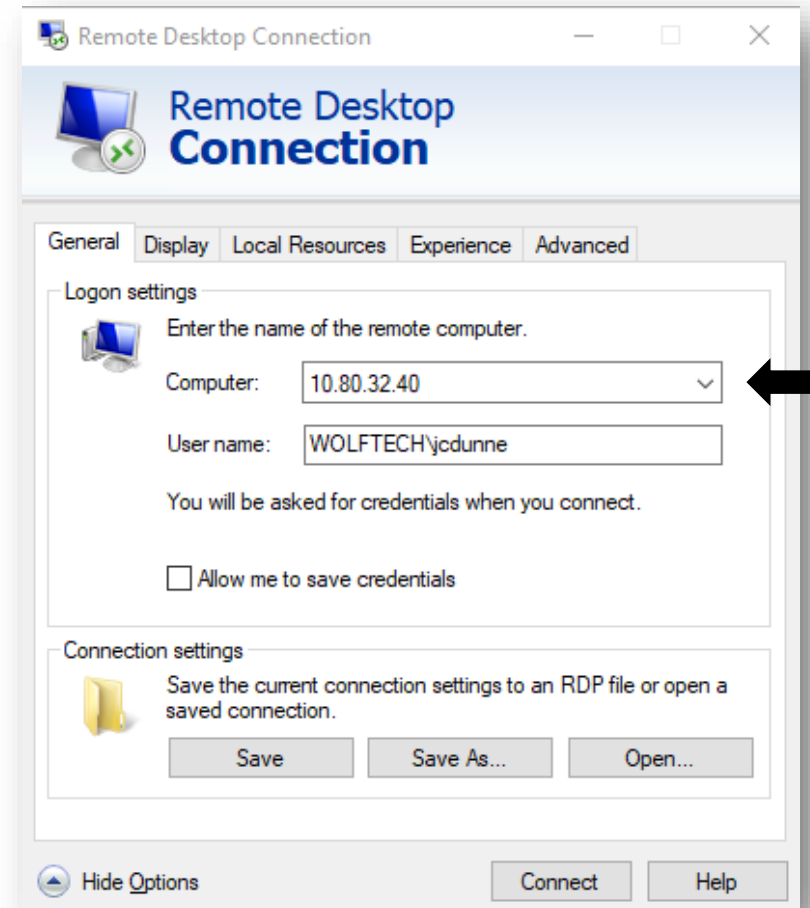
Ethernet adapter VirtualBox Host-Only Network:

    Connection-specific DNS Suffix  . : 
    Link-local IPv6 Address . . . . . : fe80::194b:7188:3cf9:d0d2%4
    IPv4 Address. . . . . : 192.168.56.1
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 

Ethernet adapter Ethernet:

    Connection-specific DNS Suffix  . : 
    Link-local IPv6 Address . . . . . : fe80::74a6:8495:b1d0:16de%16
    IPv4 Address. . . . . : 10.80.32.40
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 10.80.32.1

C:\Users\jcdunne>
```



Anaconda Setup and Installation

Determine the Computer for Setup and Installation

- Remote Desktop Connection (IP Address Required) – Recommended
- Local Machine (Lab Computer or Laptop)

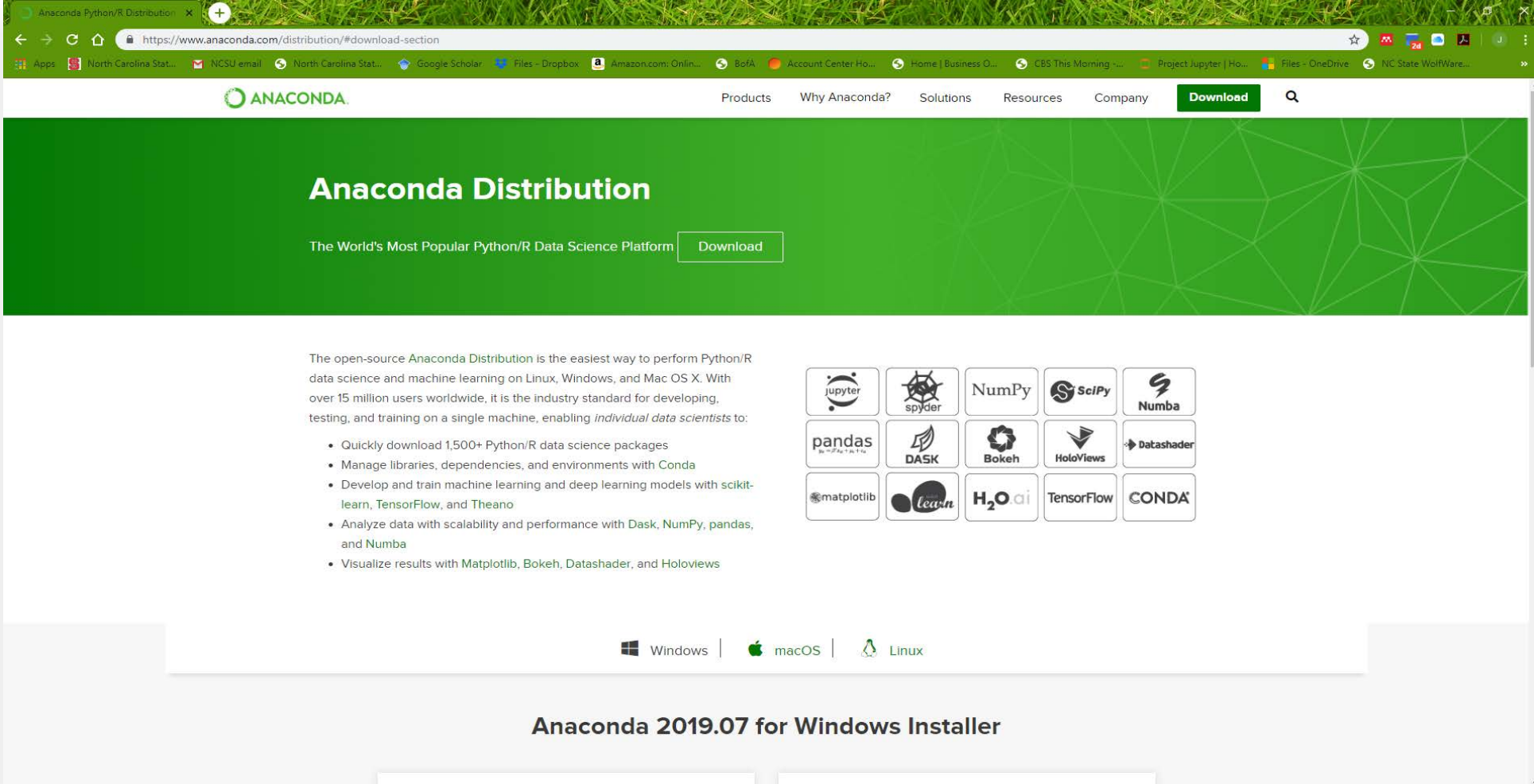
Binder Rendering

- Online Only (Binder/Docker Setup)

Let's Download Anaconda!

- Go To:
<https://www.anaconda.com/distribution/>
- Or Google Search
Anaconda 3 – Click the first link (Anaconda Python/R Distribution – Free Download)

Download Anaconda 3 – Home Page



The screenshot shows the Anaconda Distribution website. The browser's address bar displays `https://www.anaconda.com/distribution/#download-section`. The website has a green header with the Anaconda logo and navigation links: Products, Why Anaconda?, Solutions, Resources, Company, and a green Download button. Below the header is a large green banner with the text "Anaconda Distribution" and "The World's Most Popular Python/R Data Science Platform" followed by a Download button. The main content area features a paragraph about the open-source distribution and a list of benefits. To the right of the text is a grid of logos for various data science libraries and tools. At the bottom, there are links for Windows, macOS, and Linux, and a section for the Anaconda 2019.07 for Windows Installer.

ANACONDA

Products Why Anaconda? Solutions Resources Company **Download**

Anaconda Distribution

The World's Most Popular Python/R Data Science Platform **Download**

The open-source Anaconda Distribution is the easiest way to perform Python/R data science and machine learning on Linux, Windows, and Mac OS X. With over 15 million users worldwide, it is the industry standard for developing, testing, and training on a single machine, enabling *individual data scientists* to:

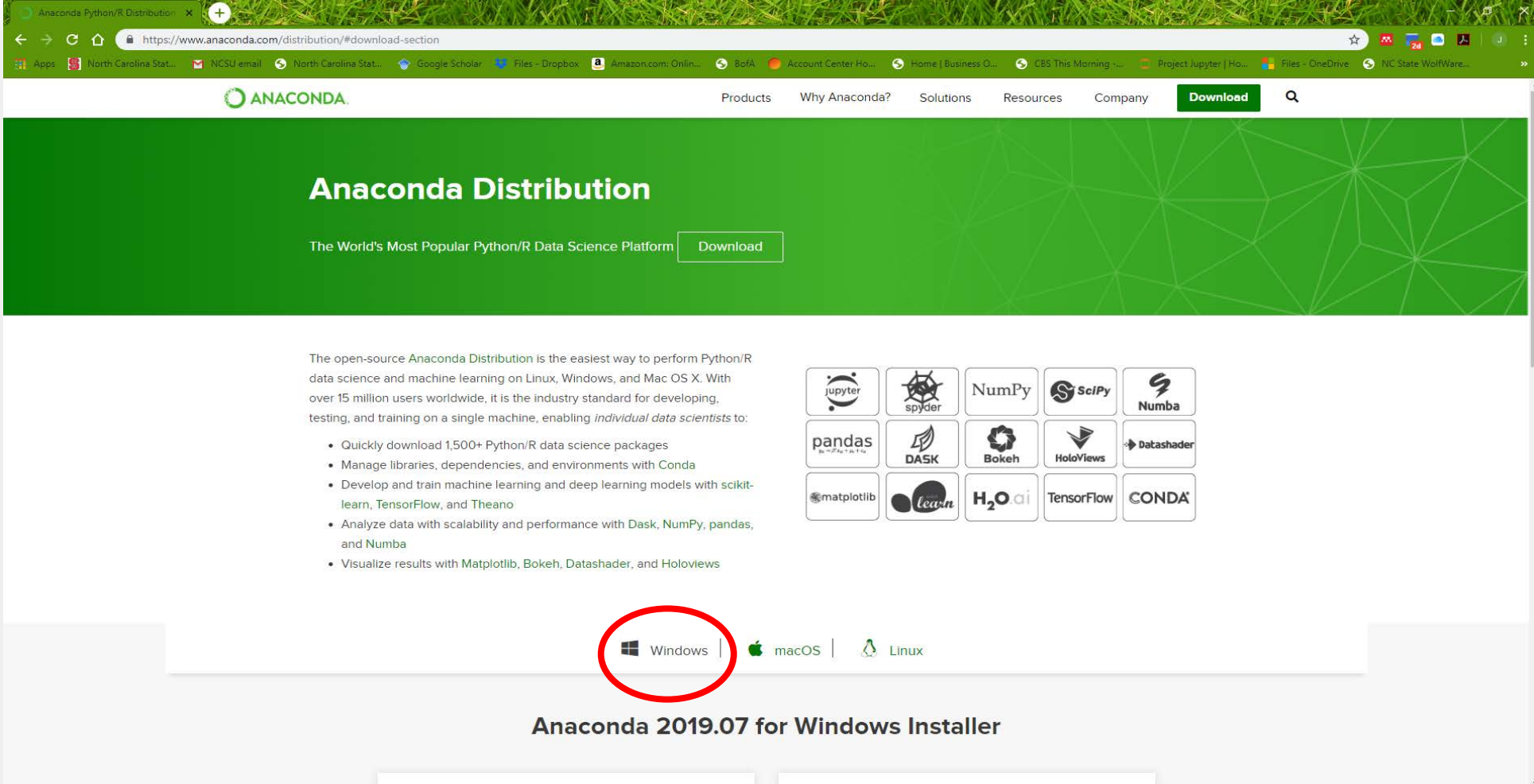
- Quickly download 1,500+ Python/R data science packages
- Manage libraries, dependencies, and environments with Conda
- Develop and train machine learning and deep learning models with *scikit-learn*, TensorFlow, and Theano
- Analyze data with scalability and performance with Dask, NumPy, pandas, and Numba
- Visualize results with Matplotlib, Bokeh, Datashtader, and Holoviews

jupyter	spyder	NumPy	SciPy	Numba
pandas	DASK	Bokeh	HoloViews	Datashader
matplotlib	learn	H2O.ai	TensorFlow	CONDA

Windows | macOS | Linux

Anaconda 2019.07 for Windows Installer

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ANACONDA





Products Why Anaconda? Solutions Resources Company **Download**






Anaconda Distribution



The World's Most Popular Python/R Data Science Platform [Download](#)




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- Visualize results with Matplotlib, Bokeh, Datashader, and HoloViews

  NumPy  

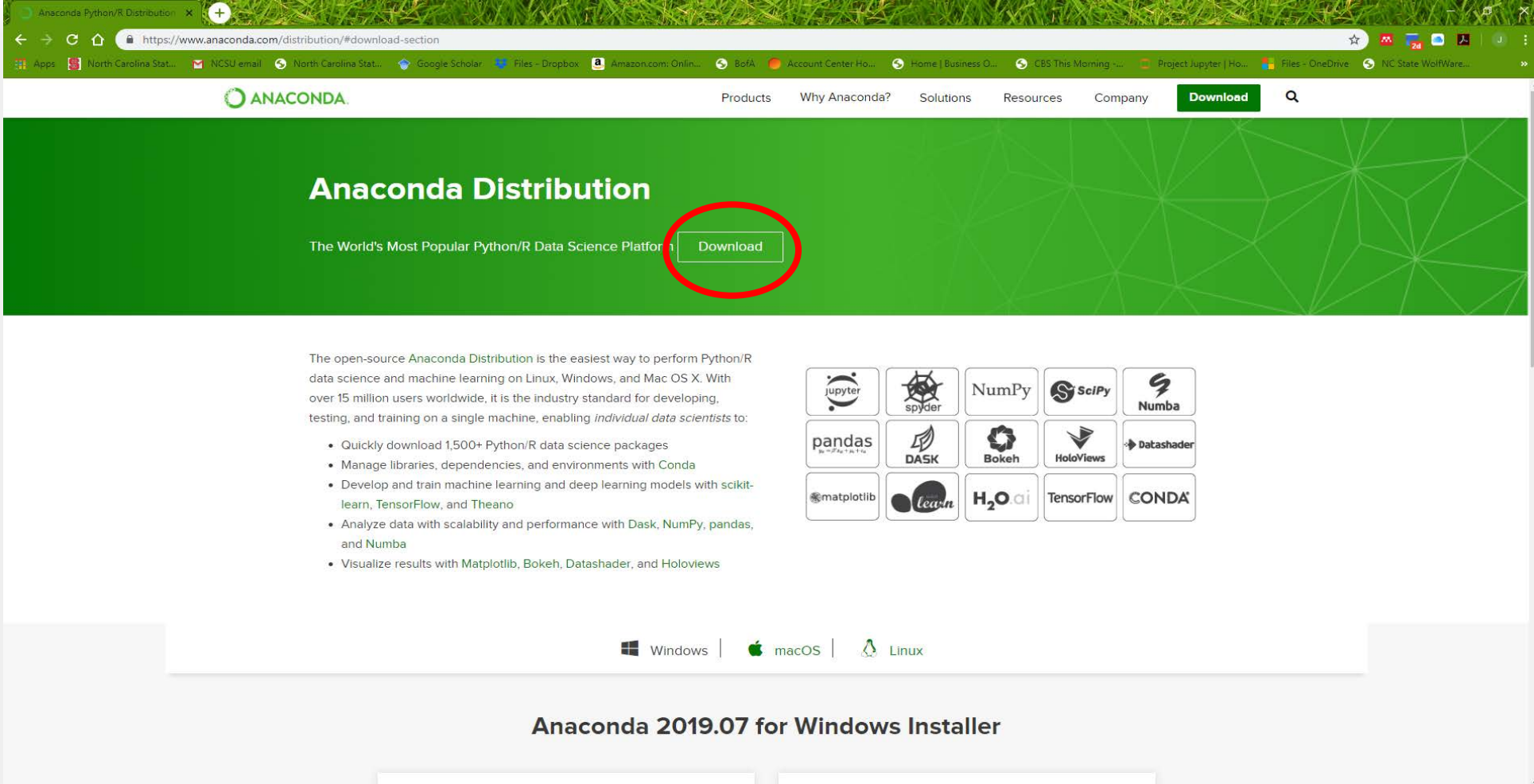
    

  TensorFlow CONDA

 Windows |  macOS |  Linux

Anaconda 2019.07 for Windows Installer

Download Anaconda 3 – Home Page



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ANACONDA

Products Why Anaconda? Solutions Resources Company **Download**

Anaconda Distribution

The World's Most Popular Python/R Data Science Platform **Download**

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jupyter spyder NumPy SciPy Numba

pandas DASK Bokeh HoloViews Datashader

matplotlib scikit-learn H2O.ai TensorFlow CONDA

Windows | macOS | Linux

Anaconda 2019.07 for Windows Installer

Download Anaconda 3 – Windows Installer

The screenshot shows the Anaconda website's download section for Windows. The browser's address bar displays the URL <https://www.anaconda.com/distribution/#download-section>. The page features a navigation bar with links for Windows, macOS, and Linux. The main heading is "Anaconda 2019.07 for Windows Installer". Below this, there are two columns of download options. The left column is for the "Python 3.7 version" and includes a green "Download" button, with links for "64-Bit Graphical Installer (486 MB)" and "32-Bit Graphical Installer (418 MB)". The right column is for the "Python 2.7 version" and also includes a green "Download" button, with links for "64-Bit Graphical Installer (427 MB)" and "32-Bit Graphical Installer (361 MB)". Below the download section, there is a "Get Started with Anaconda Distribution" section with five cards: "Documentation" (Installation and user guide for Anaconda Distribution 5, with a "Read More" link), "Anaconda Blog" (News, software releases, and developer best practices, with a "Read More" link), "Community Support" (Solutions and knowledge from the community, with a "Read More" link), "Anaconda Webinars" (Industry trends and tutorials from Anaconda, with a "Read More" link), and "Anaconda Training" (Learn Python for Data Science with DataCamp, with a "Start Learning" link). The browser's taskbar at the bottom shows an active window titled "Anaconda3-2019.0...exe" and a "Show all" button.

Windows | macOS | Linux

Anaconda 2019.07 for Windows Installer

Python 3.7 version

[Download](#)

64-Bit Graphical Installer (486 MB)
32-Bit Graphical Installer (418 MB)

Python 2.7 version

[Download](#)

64-Bit Graphical Installer (427 MB)
32-Bit Graphical Installer (361 MB)

Get Started with Anaconda Distribution

Documentation

Installation and user guide for Anaconda Distribution 5

[Read More](#)

Anaconda Blog

News, software releases, and developer best practices

[Read More](#)

Community Support

Solutions and knowledge from the community

[Read More](#)

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Industry trends and tutorials from Anaconda

[Read More](#)

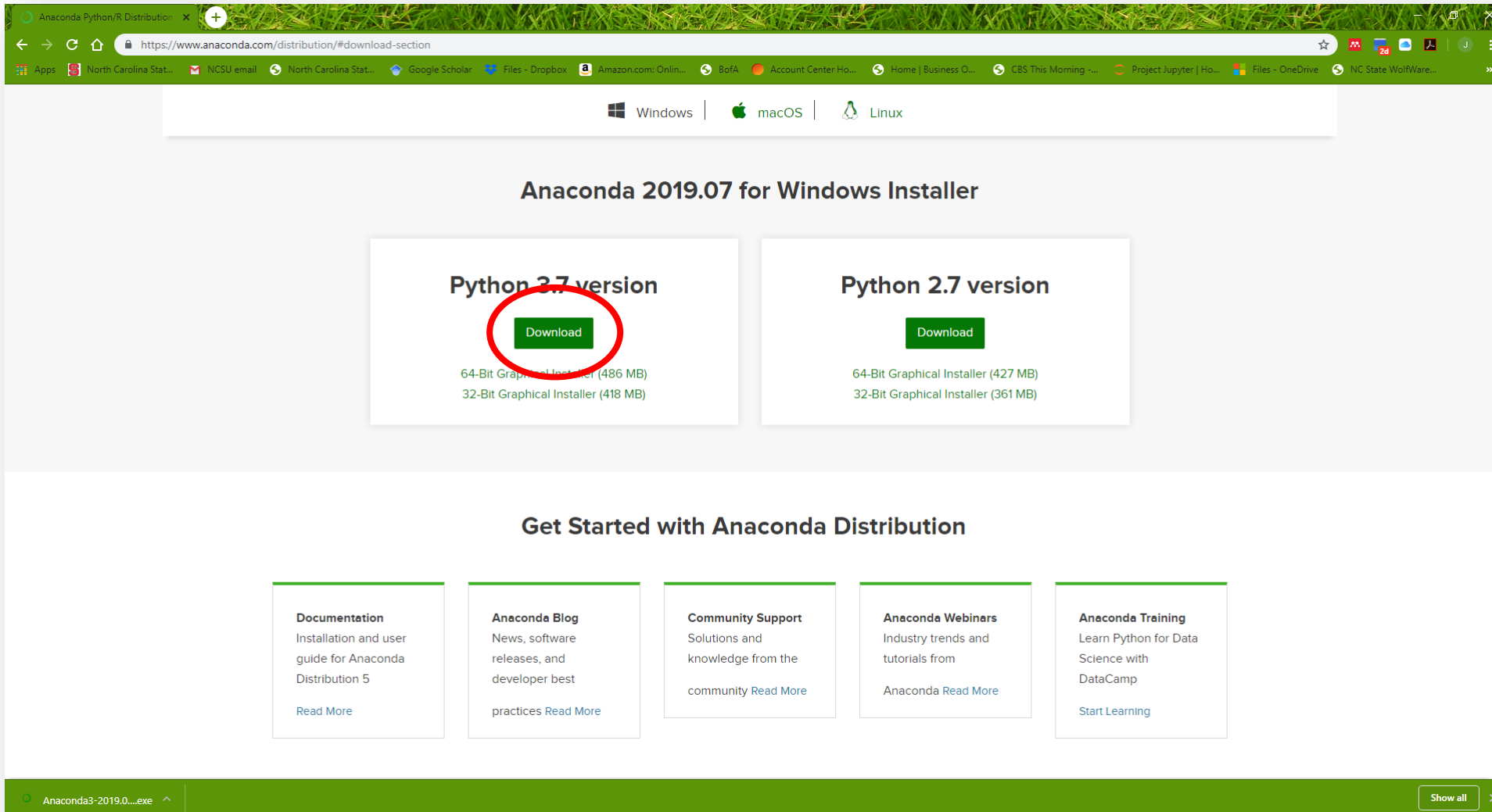
Anaconda Training

Learn Python for Data Science with DataCamp

[Start Learning](#)

Anaconda3-2019.0...exe Show all

Download Anaconda 3 – Python 3.7 Version



Download Anaconda 3 – Python 3.7 Version

Windows | macOS | Linux

Anaconda 2019.07 for Windows Installer

Python 3.7 version

[Download](#)

64-Bit Graphical Installer (486 MB)
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32-Bit Graphical Installer (361 MB)

Get Started with Anaconda Distribution

Documentation

Installation and user guide for Anaconda Distribution 5

[Read More](#)

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[Read More](#)

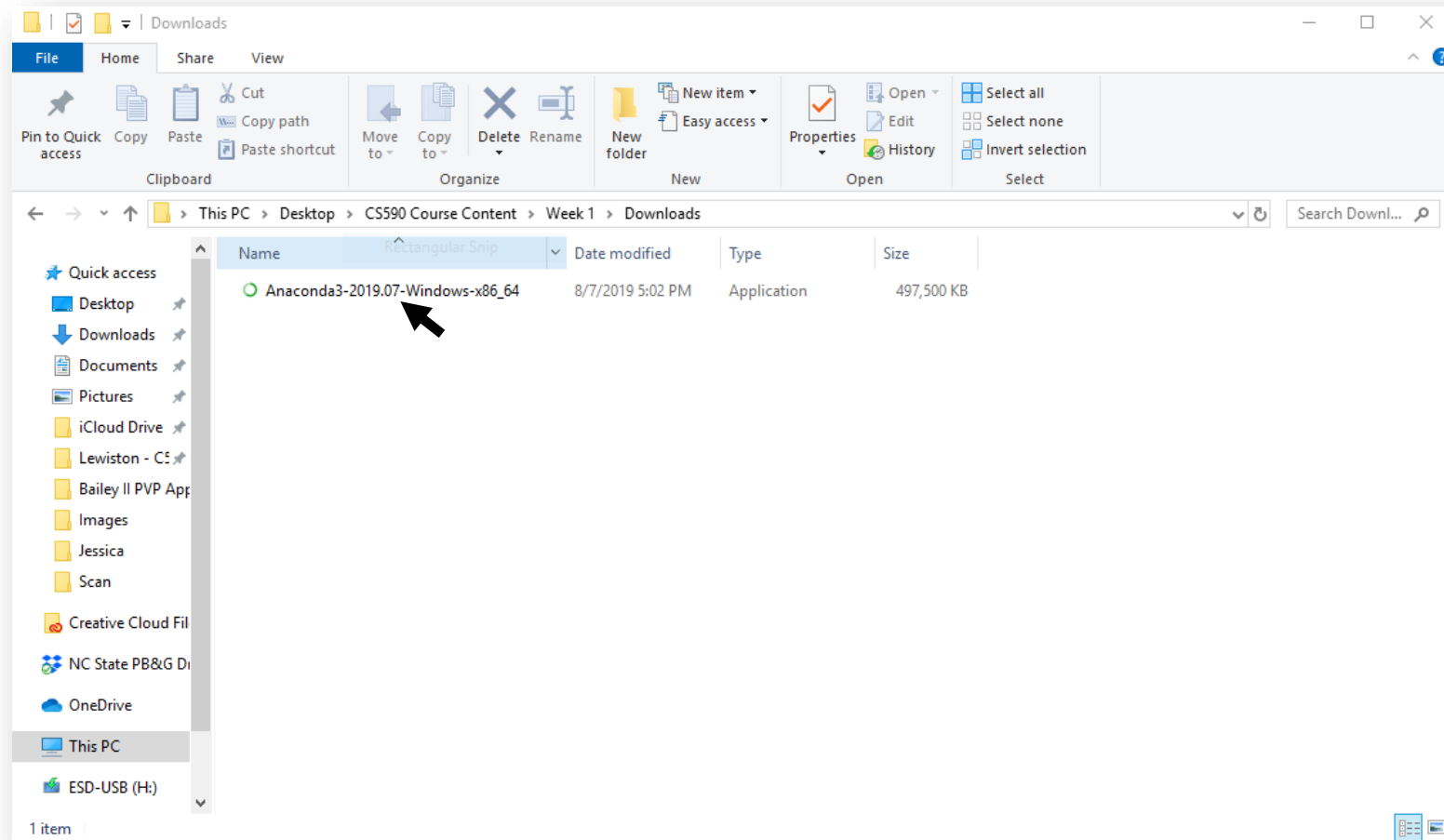
Anaconda Training

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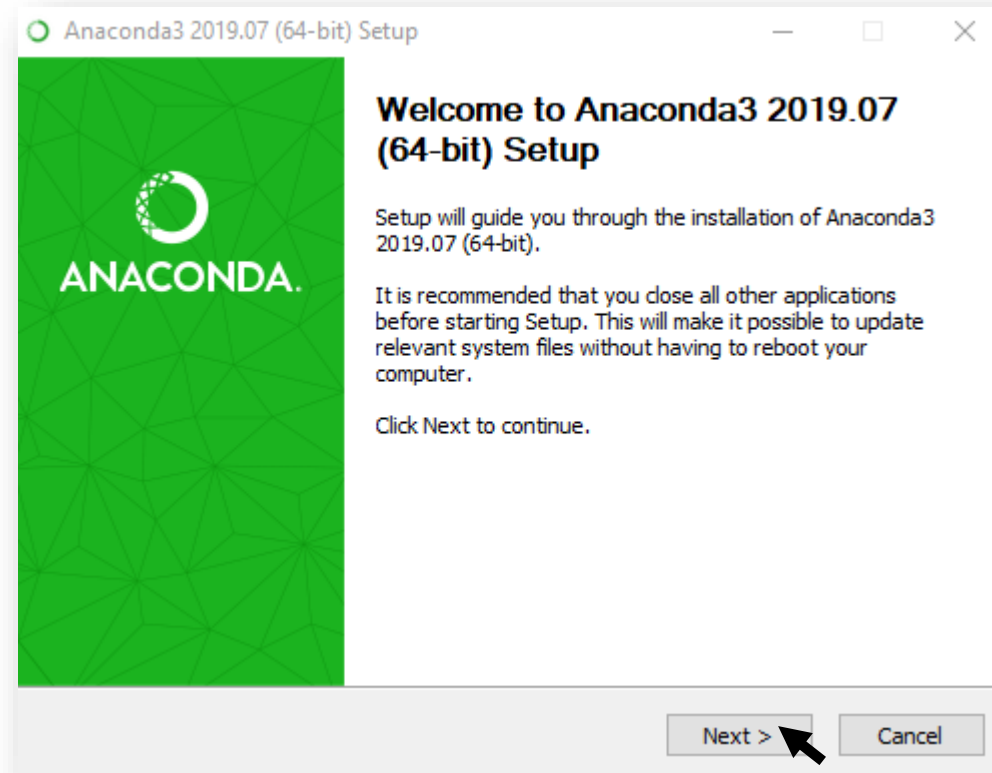
[Start Learning](#)

 Anaconda3-2019.0...exe ^ Double click or click ^, then show in folder [Show all](#)

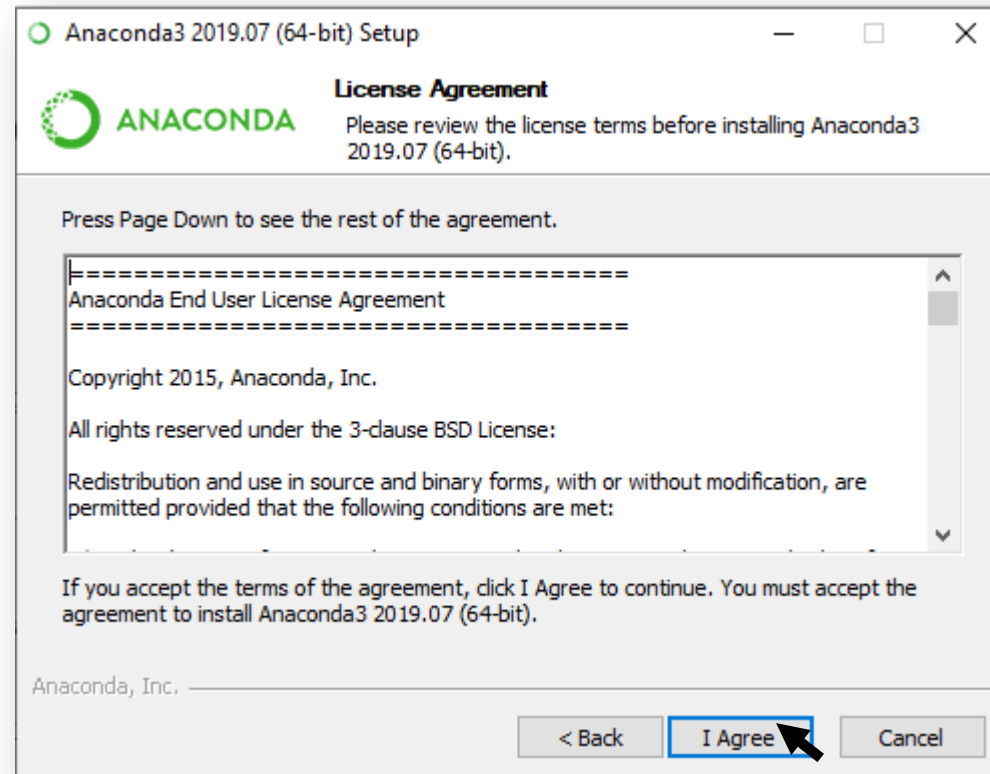
Anaconda 3 Executable File



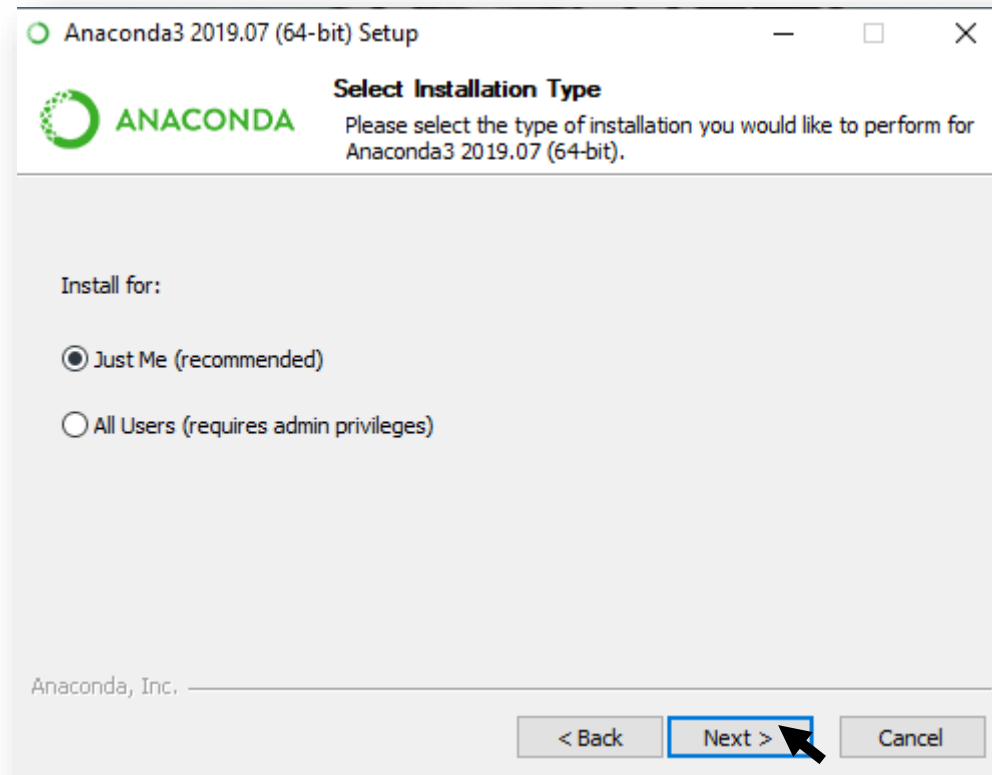
Anaconda 3 Installation and Setup



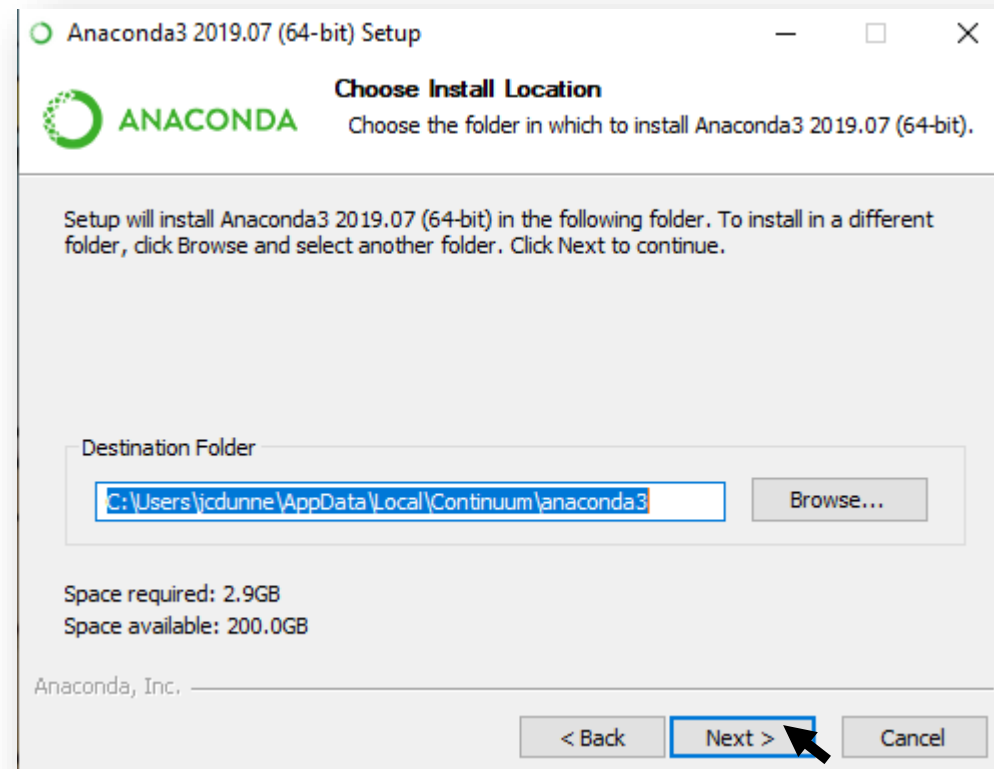
Anaconda 3 Installation and Setup



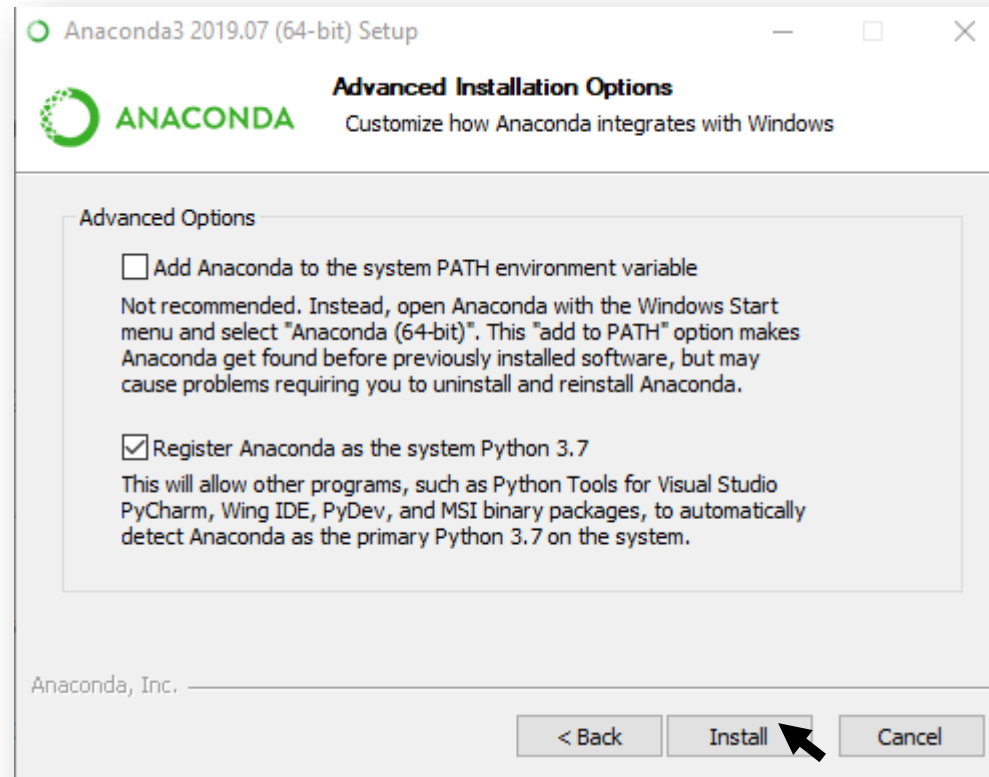
Anaconda 3 Installation and Setup



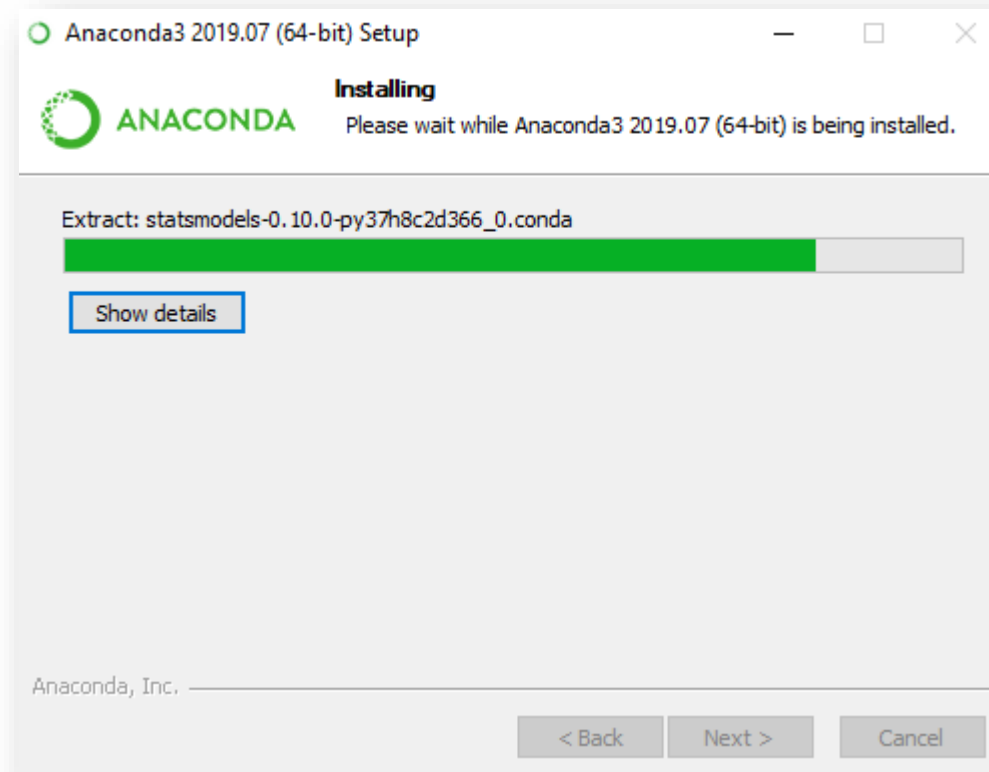
Anaconda 3 Installation and Setup



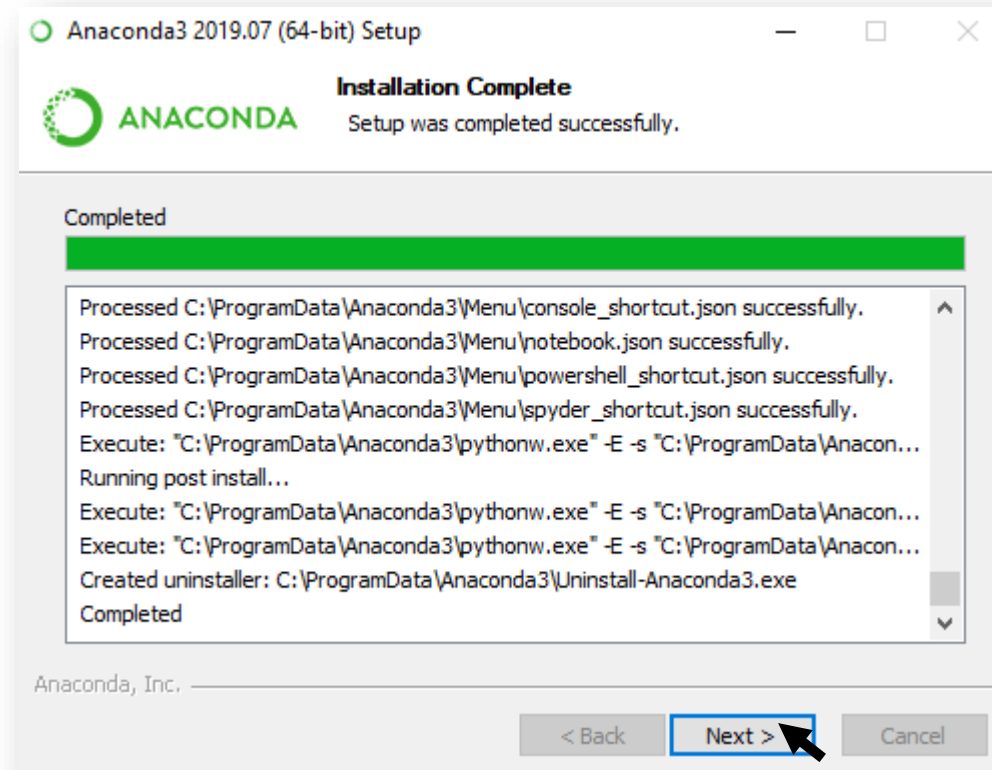
Anaconda 3 Installation and Setup



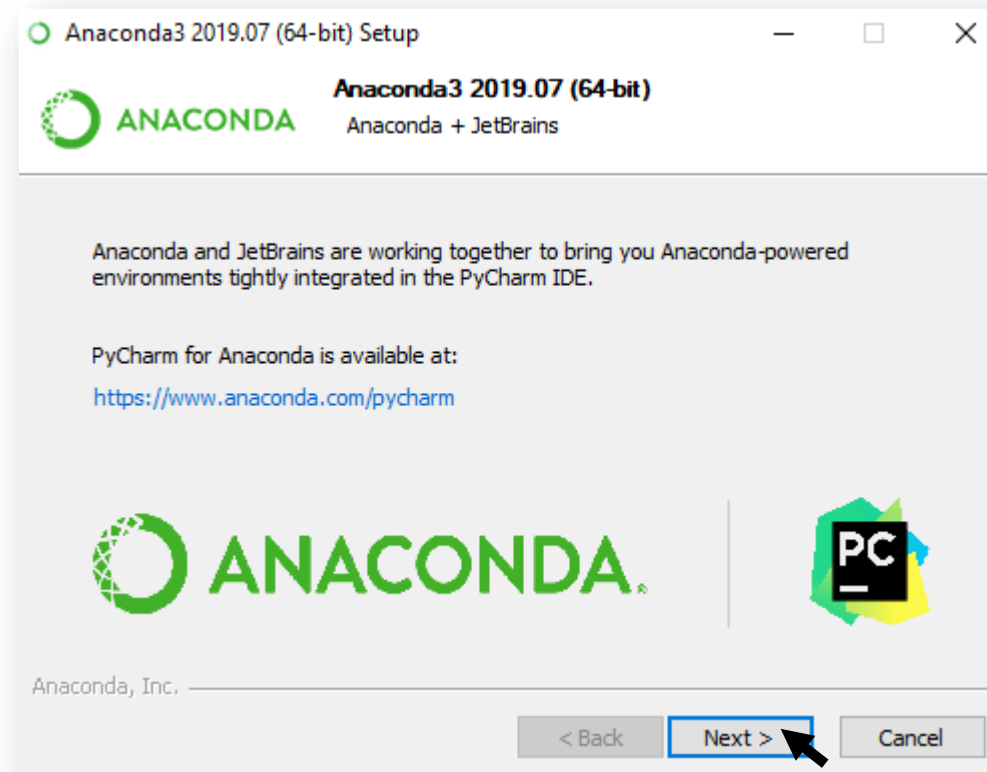
Anaconda 3 Installation and Setup



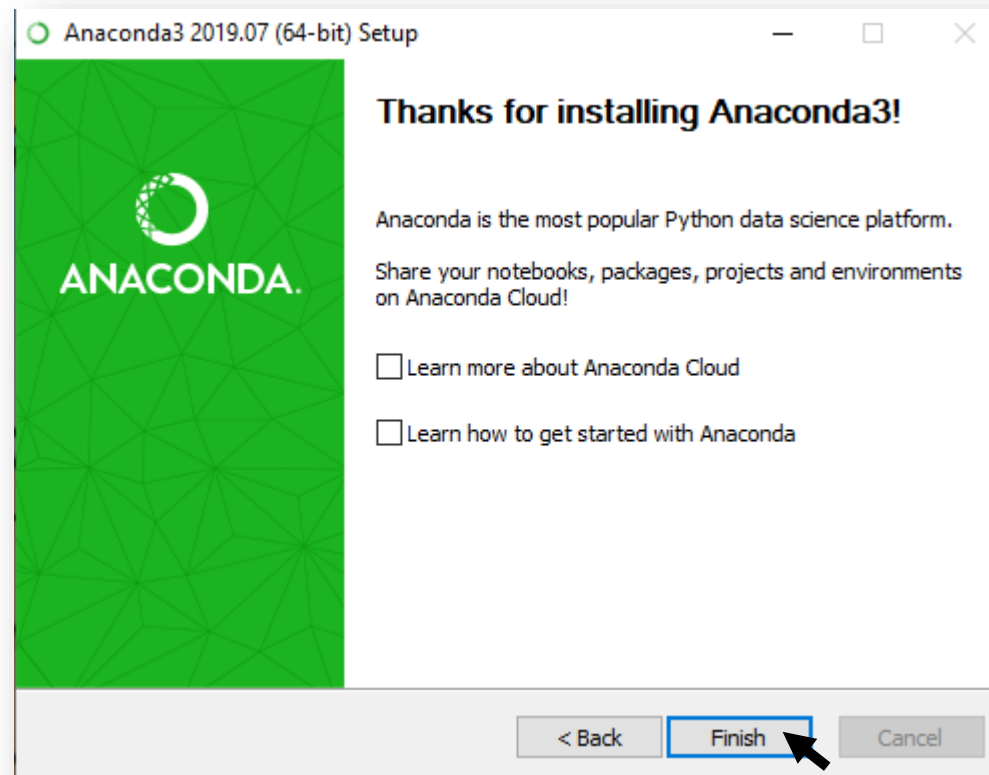
Anaconda 3 Installation and Setup



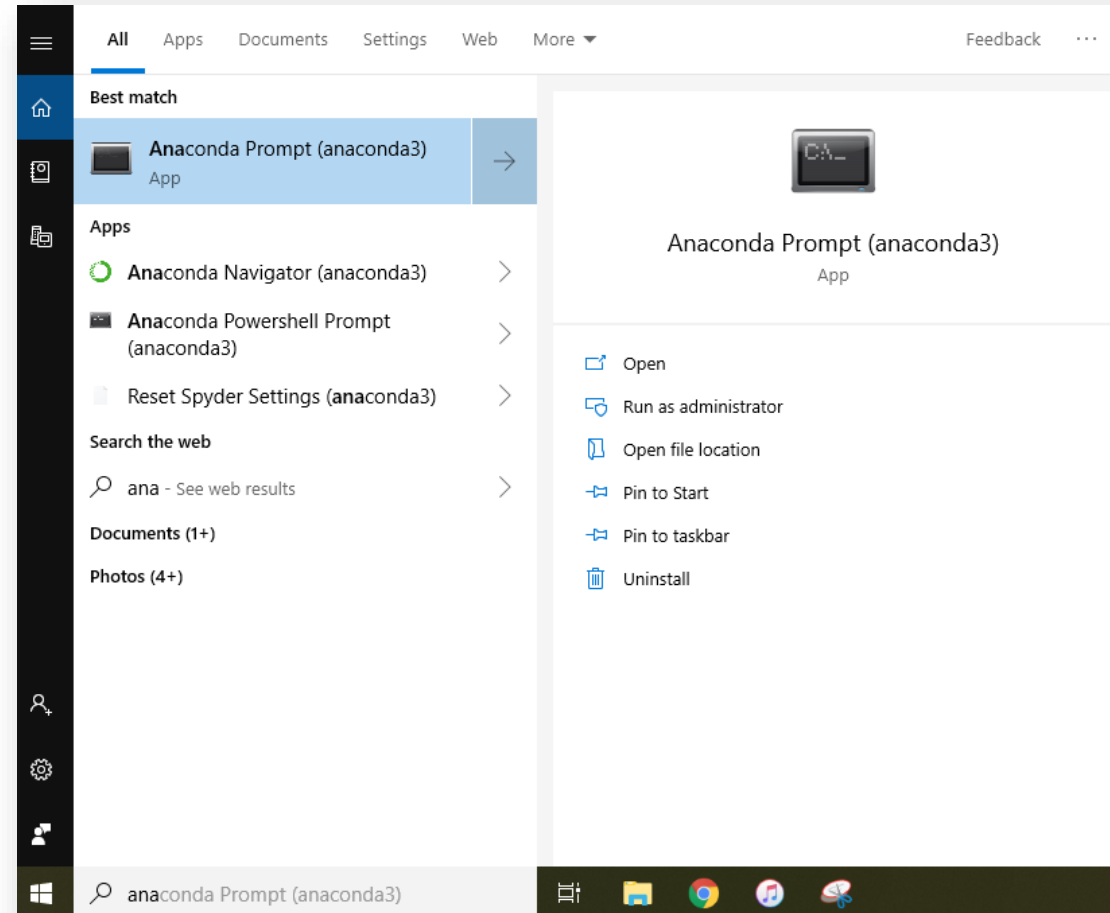
Anaconda 3 Installation and Setup



Anaconda 3 Installation and Setup



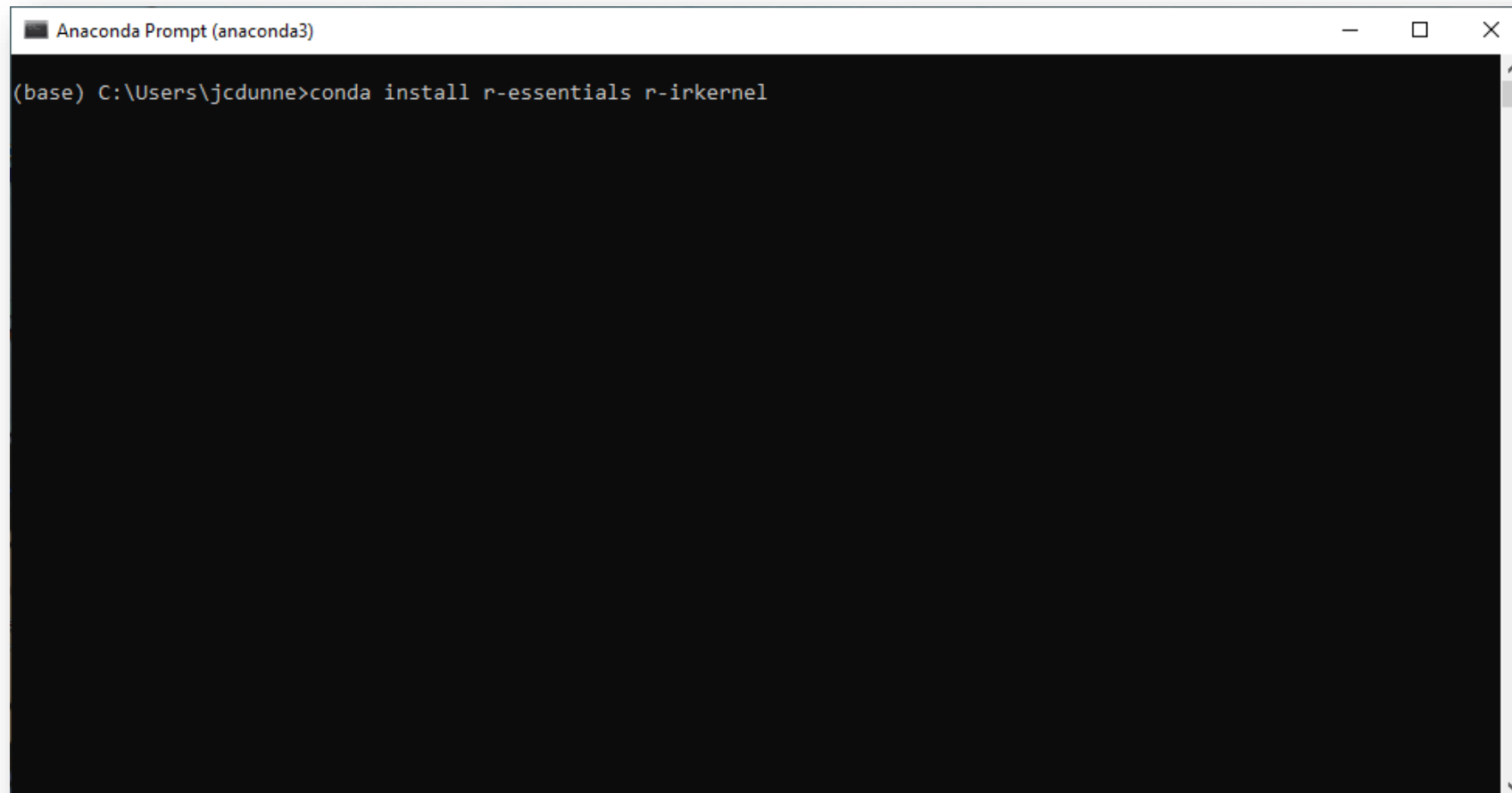
Installing R / R-Kernel for Jupyter Notebooks



*** MAC Users > Finder > Search “Terminal” > Open Terminal



Installing R / R-Kernel for Jupyter Notebooks

A screenshot of an Anaconda Prompt window. The title bar reads "Anaconda Prompt (anaconda3)". The command prompt shows the command `conda install r-essentials r-irkernel` being entered. The prompt is in a dark-themed environment with a black background and white text. The window has standard Windows window controls (minimize, maximize, close) in the top right corner.

```
Anaconda Prompt (anaconda3)
(base) C:\Users\jcdunne>conda install r-essentials r-irkernel
```

> conda install r-essentials r-irkernel

Installing R / R-Kernel for Jupyter Notebooks

```
Anaconda Prompt (anaconda3) - conda install r-essentials

r-tidyr                conda-forge/win-64::r-tidyr-0.8.3-r36h796a38f_1
r-tidysselect          conda-forge/win-64::r-tidysselect-0.2.5-r36h796a38f_1001
r-tidyverse            conda-forge/noarch::r-tidyverse-1.2.1-r36h6115d3f_1002
r-timedate             conda-forge/noarch::r-timedate-3043.102-r36h6115d3f_1001
r-tinytex              conda-forge/noarch::r-tinytex-0.14-r36h6115d3f_1
r-ttr                  conda-forge/win-64::r-ttr-0.23_4-r36h17dded8_1001
r-utf8                 conda-forge/win-64::r-utf8-1.1.4-r36hda5aaf8_1001
r-uuid                 conda-forge/win-64::r-uuid-0.1_2-r36hda5aaf8_1002
r-vctrs                conda-forge/win-64::r-vctrs-0.2.0-r36hda5aaf8_1
r-viridislite          conda-forge/noarch::r-viridislite-0.3.0-r36h6115d3f_1002
r-whisker              conda-forge/noarch::r-whisker-0.3_2-r36h6115d3f_1002
r-withr               conda-forge/noarch::r-withr-2.1.2-r36h6115d3f_1001
r-xfun                conda-forge/noarch::r-xfun-0.8-r36h6115d3f_1
r-xml2                 conda-forge/win-64::r-xml2-1.2.1-r36h796a38f_0
r-xtable              conda-forge/noarch::r-xtable-1.8_4-r36h6115d3f_2
r-xts                  conda-forge/win-64::r-xts-0.11_2-r36hda5aaf8_1
r-yaml                 conda-forge/win-64::r-yaml-2.2.0-r36hda5aaf8_1002
r-zeallot              conda-forge/noarch::r-zeallot-0.1.0-r36h6115d3f_1001
r-zoo                  conda-forge/win-64::r-zoo-1.8_6-r36hda5aaf8_1

The following packages will be UPDATED:

conda                pkgs/main::conda-4.7.10-py37_0 --> conda-forge::conda-4.7.11-py37_0

The following packages will be SUPERSEDED by a higher-priority channel:

certifi              pkgs/main --> conda-forge

Proceed ([y]/n)?
```

> Proceed ([y]/n)? y

Installing R / R-Kernel for Jupyter Notebooks

```
Anaconda Prompt (anaconda3)

r-utf8      conda-forge/win-64::r-utf8-1.1.4-r36hda5aaf8_1001
r-uuid      conda-forge/win-64::r-uuid-0.1_2-r36hda5aaf8_1002
r-vctrs      conda-forge/win-64::r-vctrs-0.2.0-r36hda5aaf8_1
r-iridis     conda-forge/noarch::r-iridis-0.3.0-r36h6115d3f_1002
r-whisker    conda-forge/noarch::r-whisker-0.3_2-r36h6115d3f_1002
r-withr      conda-forge/noarch::r-withr-2.1.2-r36h6115d3f_1001
r-xfun       conda-forge/noarch::r-xfun-0.8-r36h6115d3f_1
r-xml2       conda-forge/win-64::r-xml2-1.2.1-r36h796a38f_0
r-xtable     conda-forge/noarch::r-xtable-1.8_4-r36h6115d3f_2
r-xts        conda-forge/win-64::r-xts-0.11_2-r36hda5aaf8_1
r-yaml       conda-forge/win-64::r-yaml-2.2.0-r36hda5aaf8_1002
r-zeallot    conda-forge/noarch::r-zeallot-0.1.0-r36h6115d3f_1001
r-zoo        conda-forge/win-64::r-zoo-1.8_6-r36hda5aaf8_1

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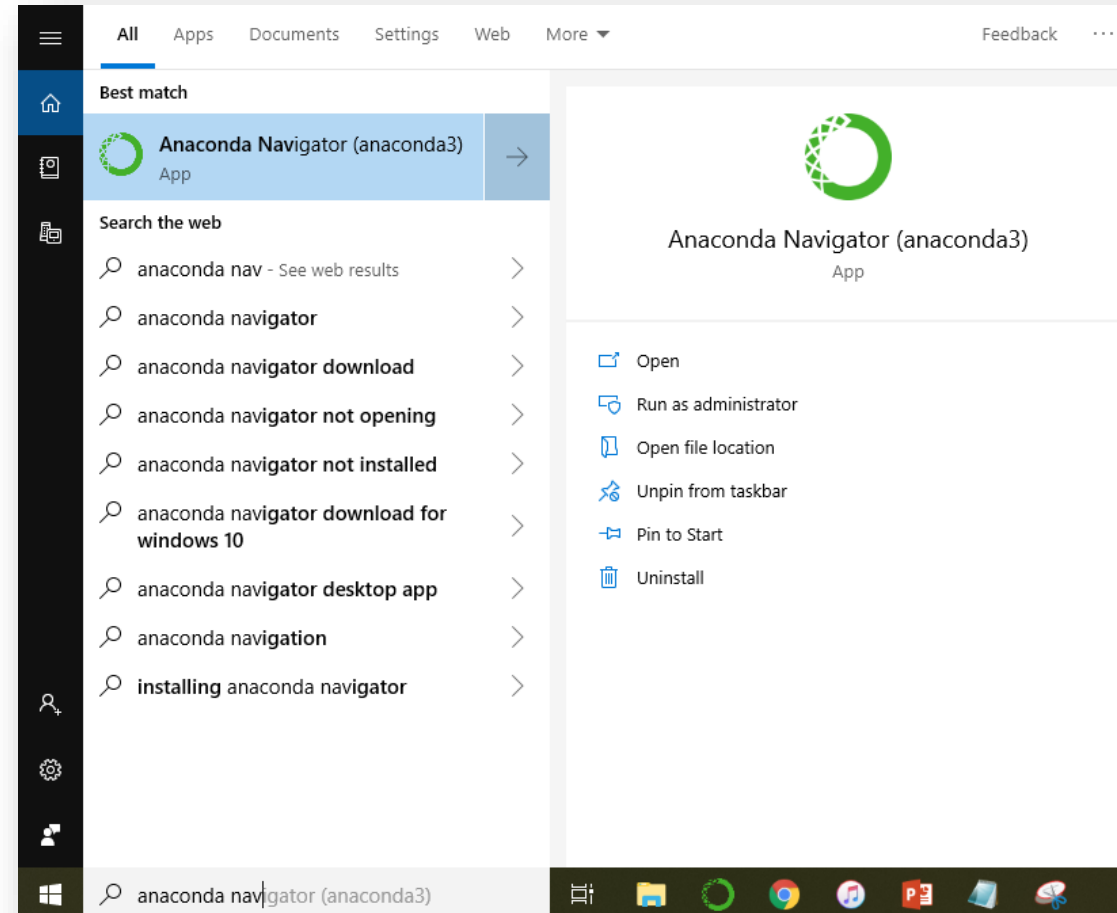
Proceed ([y]/n)? y

Preparing transaction: done
Verifying transaction: done
Executing transaction: done

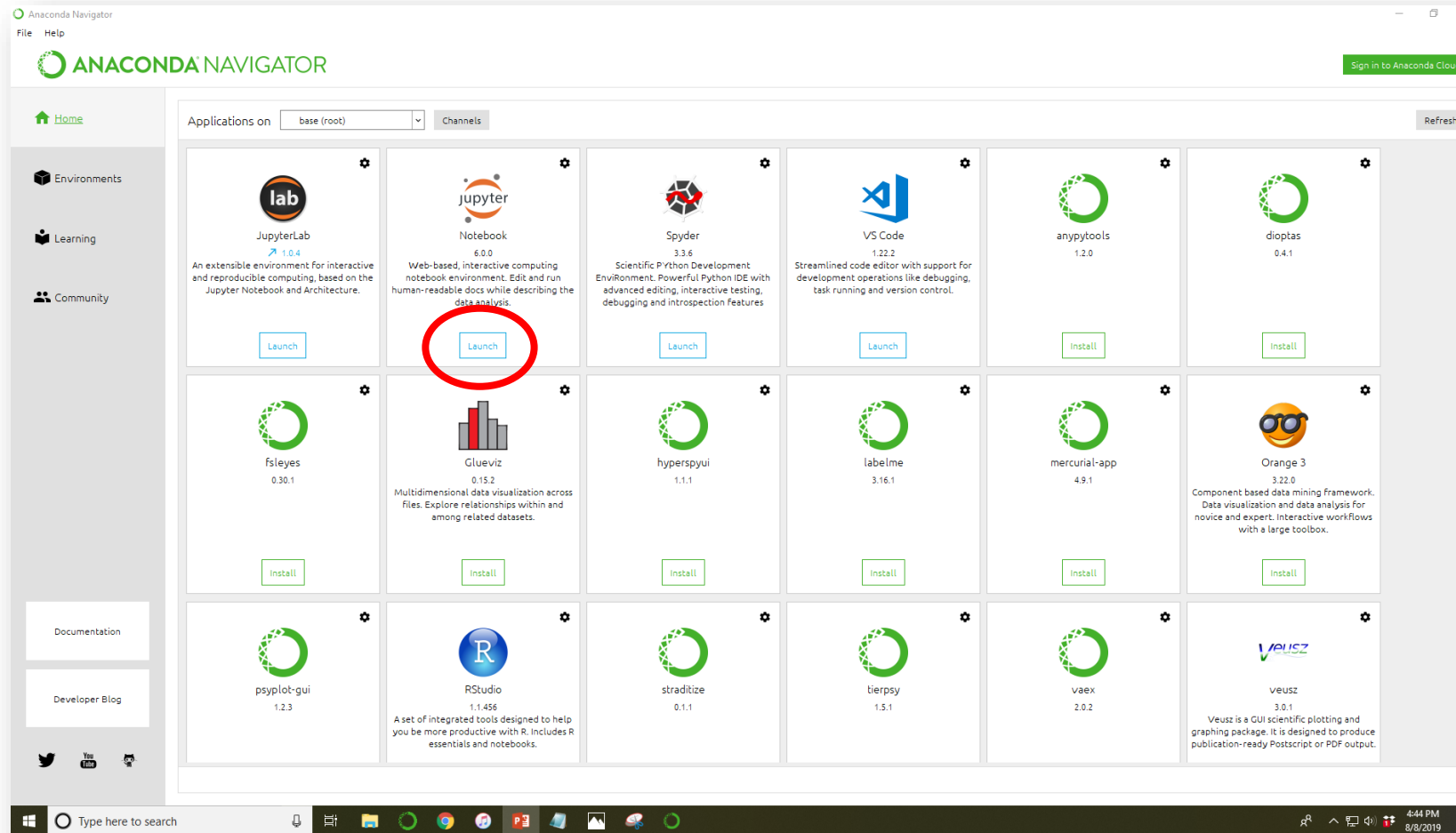
(base) C:\Users\jcdunne>
```

> exit

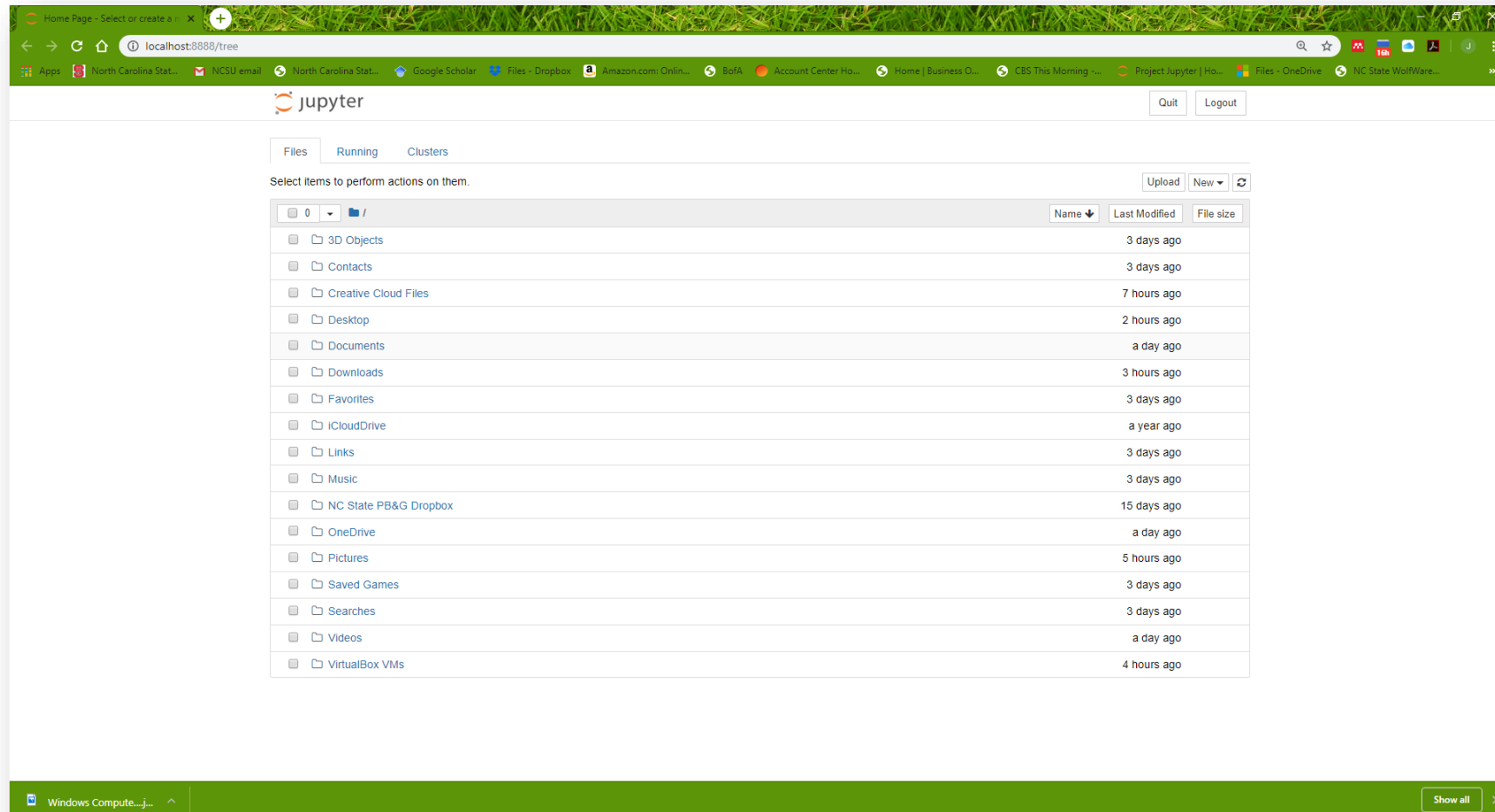
Launch Anaconda Navigator



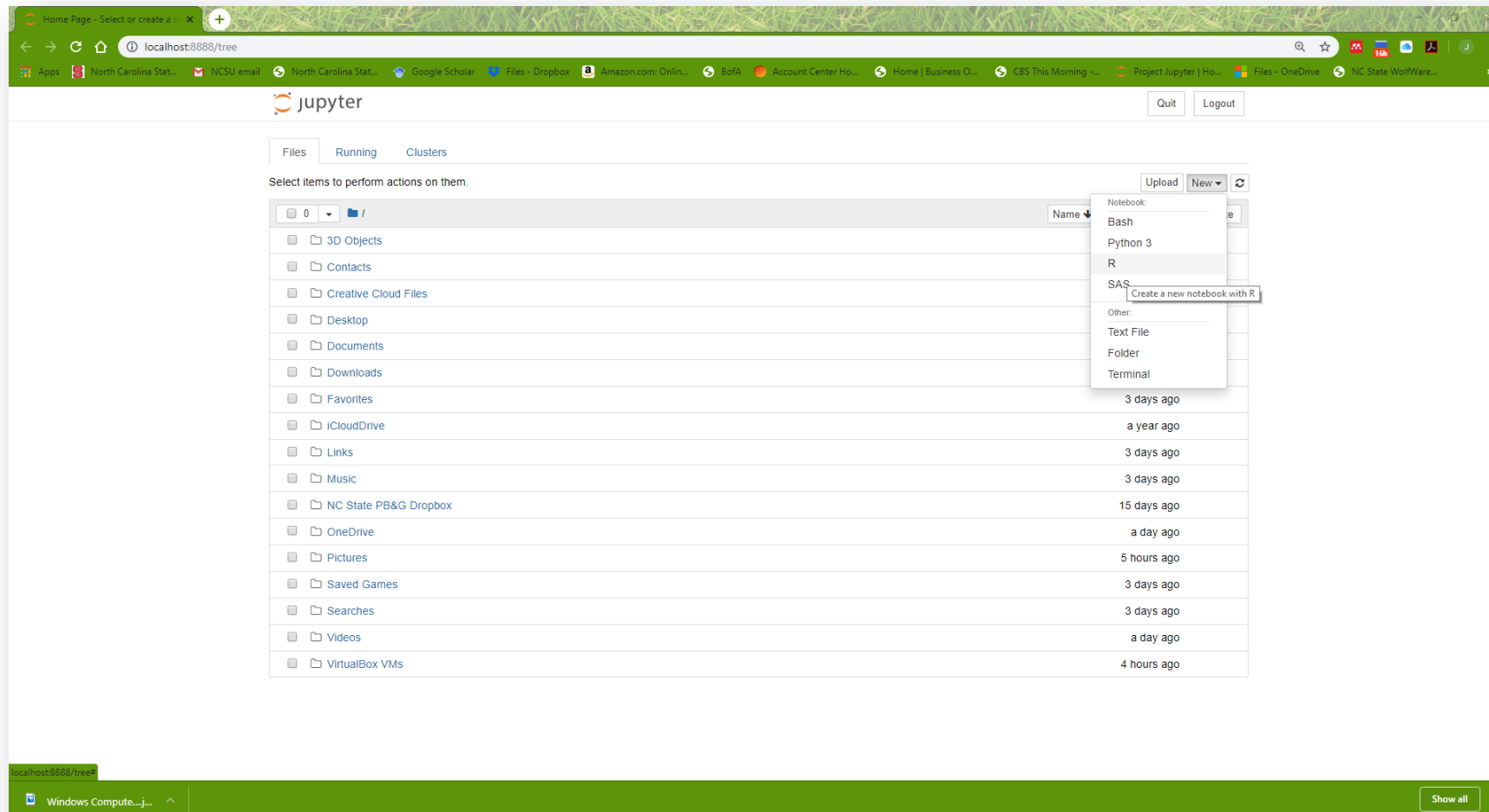
Launch Anaconda Navigator



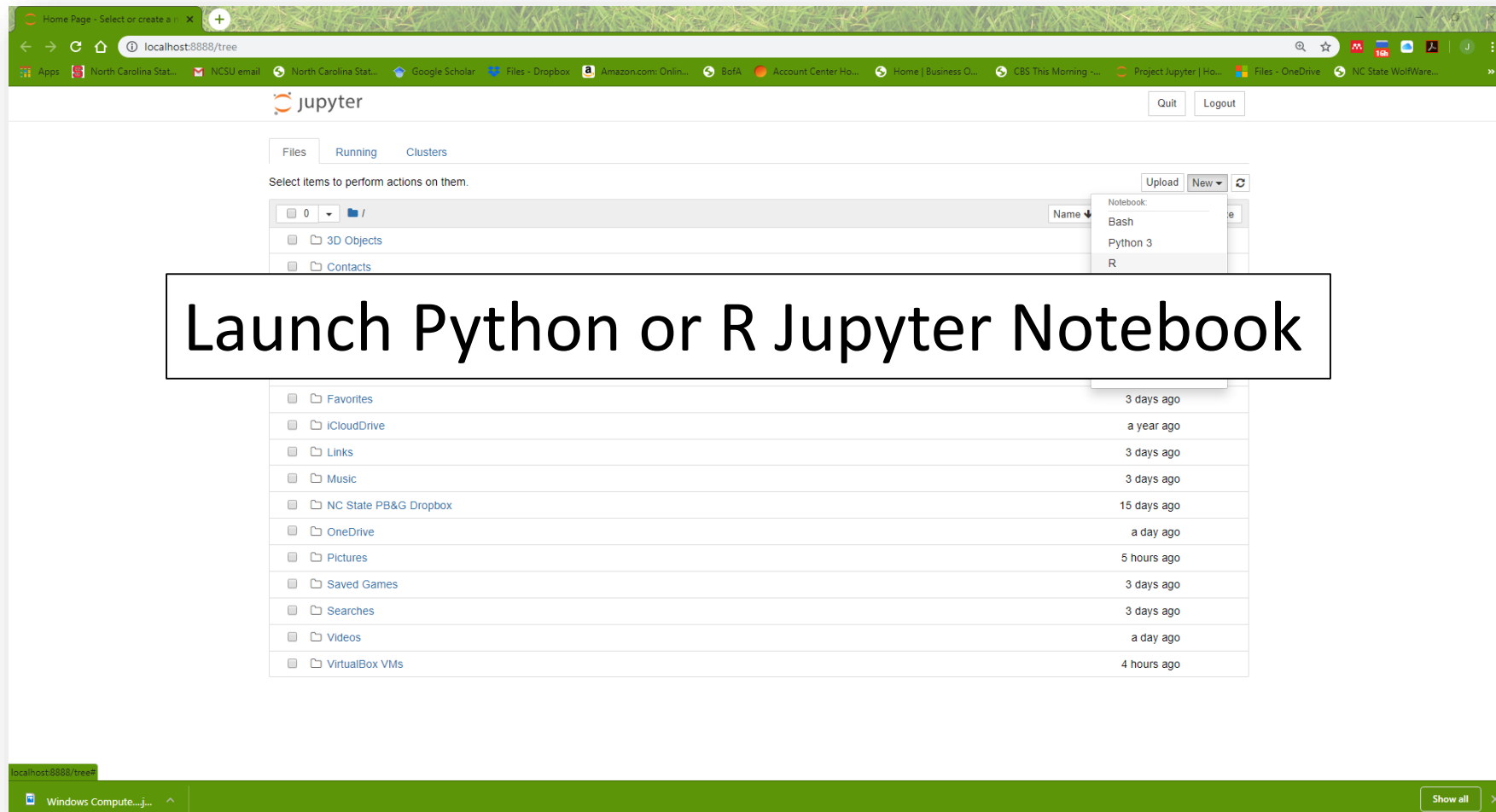
Launch Anaconda Navigator



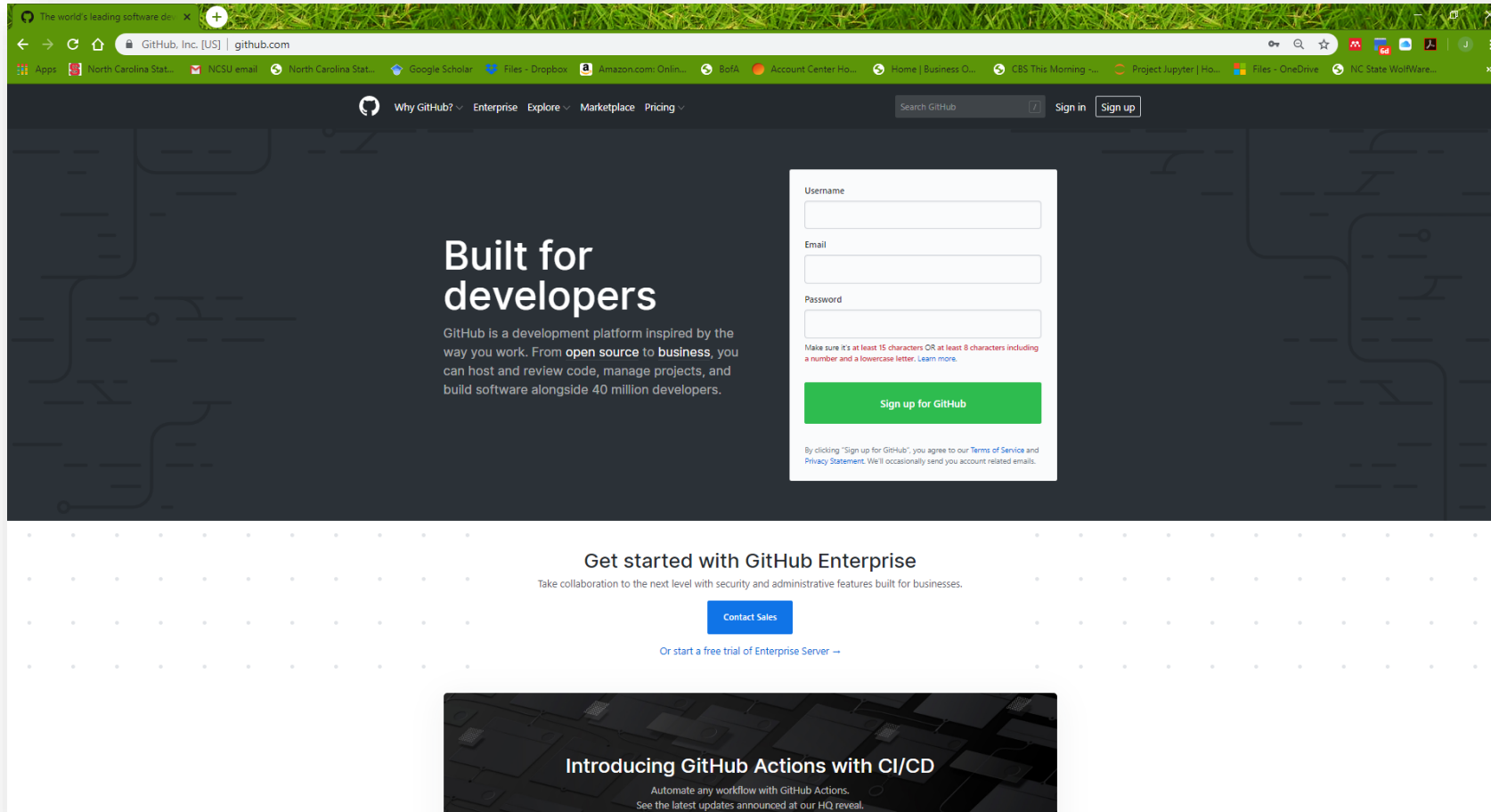
Launch Anaconda Navigator



Launch Anaconda Navigator



GitHub Exploration - Sign Up

A screenshot of the GitHub website's sign-up page. The browser's address bar shows 'github.com'. The page has a dark header with navigation links like 'Why GitHub?', 'Enterprise', 'Explore', 'Marketplace', and 'Pricing'. A search bar and 'Sign in'/'Sign up' buttons are on the right. The main content area features the text 'Built for developers' and a description of GitHub as a development platform. A sign-up form is centered, with fields for 'Username', 'Email', and 'Password'. Below the form is a green 'Sign up for GitHub' button. At the bottom, there are sections for 'Get started with GitHub Enterprise' and 'Introducing GitHub Actions with CI/CD'.

The world's leading software development platform

GitHub, Inc. [US] | github.com

Apps North Carolina Stat... NCSU email North Carolina Stat... Google Scholar Files - Dropbox Amazon.com: Onlin... BofA Account Center Ho... Home | Business O... CBS This Morning ~... Project Jupyter | Ho... Files - OneDrive NC State WolfWare...

Why GitHub? Enterprise Explore Marketplace Pricing Search GitHub Sign in Sign up

Built for developers

GitHub is a development platform inspired by the way you work. From **open source** to **business**, you can host and review code, manage projects, and build software alongside 40 million developers.

Username

Email

Password

Make sure it's at least 15 characters OR at least 8 characters including a number and a lowercase letter. [Learn more.](#)

Sign up for GitHub

By clicking "Sign up for GitHub", you agree to our [Terms of Service](#) and [Privacy Statement](#). We'll occasionally send you account related emails.

Get started with GitHub Enterprise

Take collaboration to the next level with security and administrative features built for businesses.

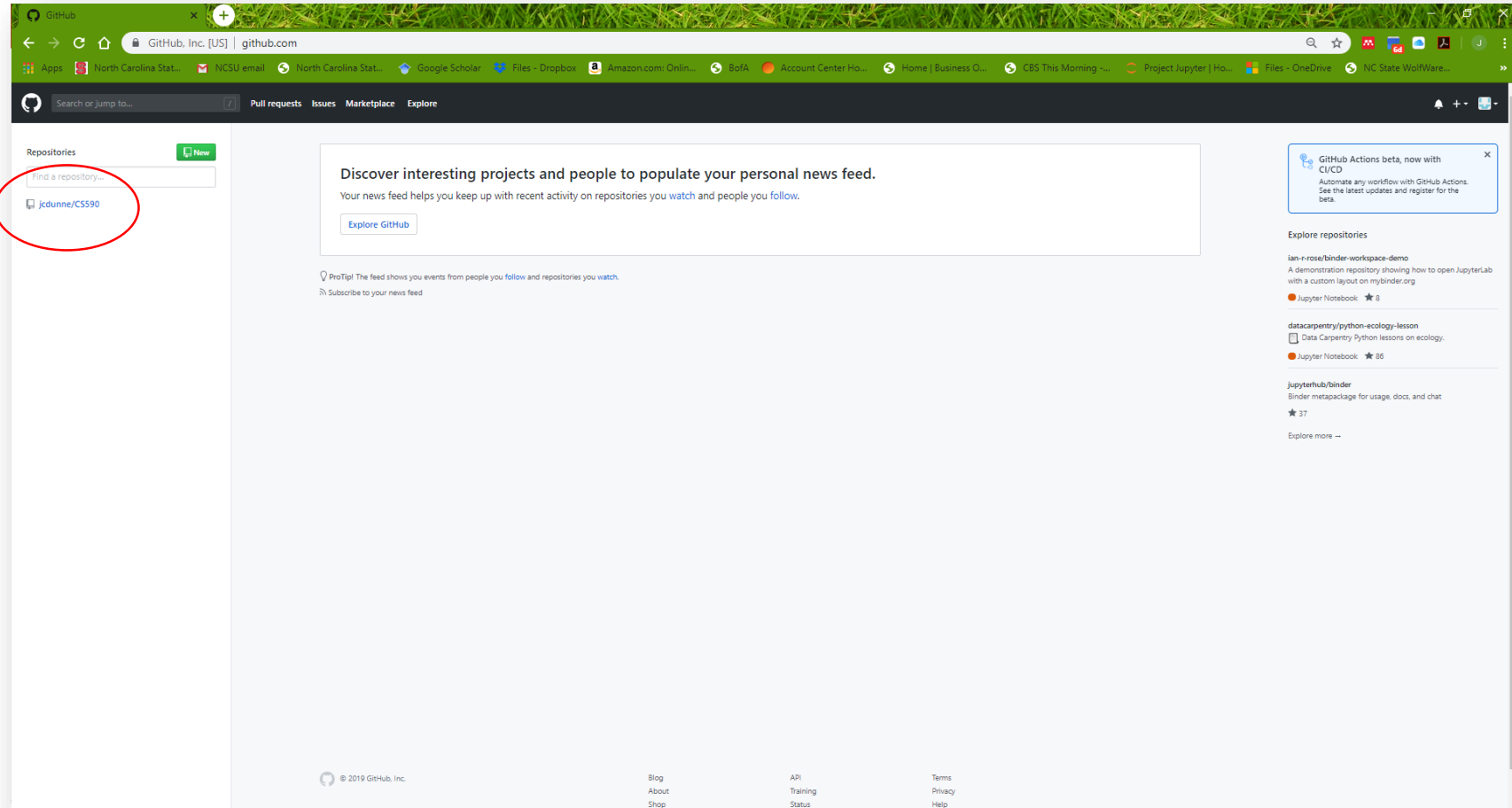
Contact Sales

Or start a free trial of Enterprise Server →

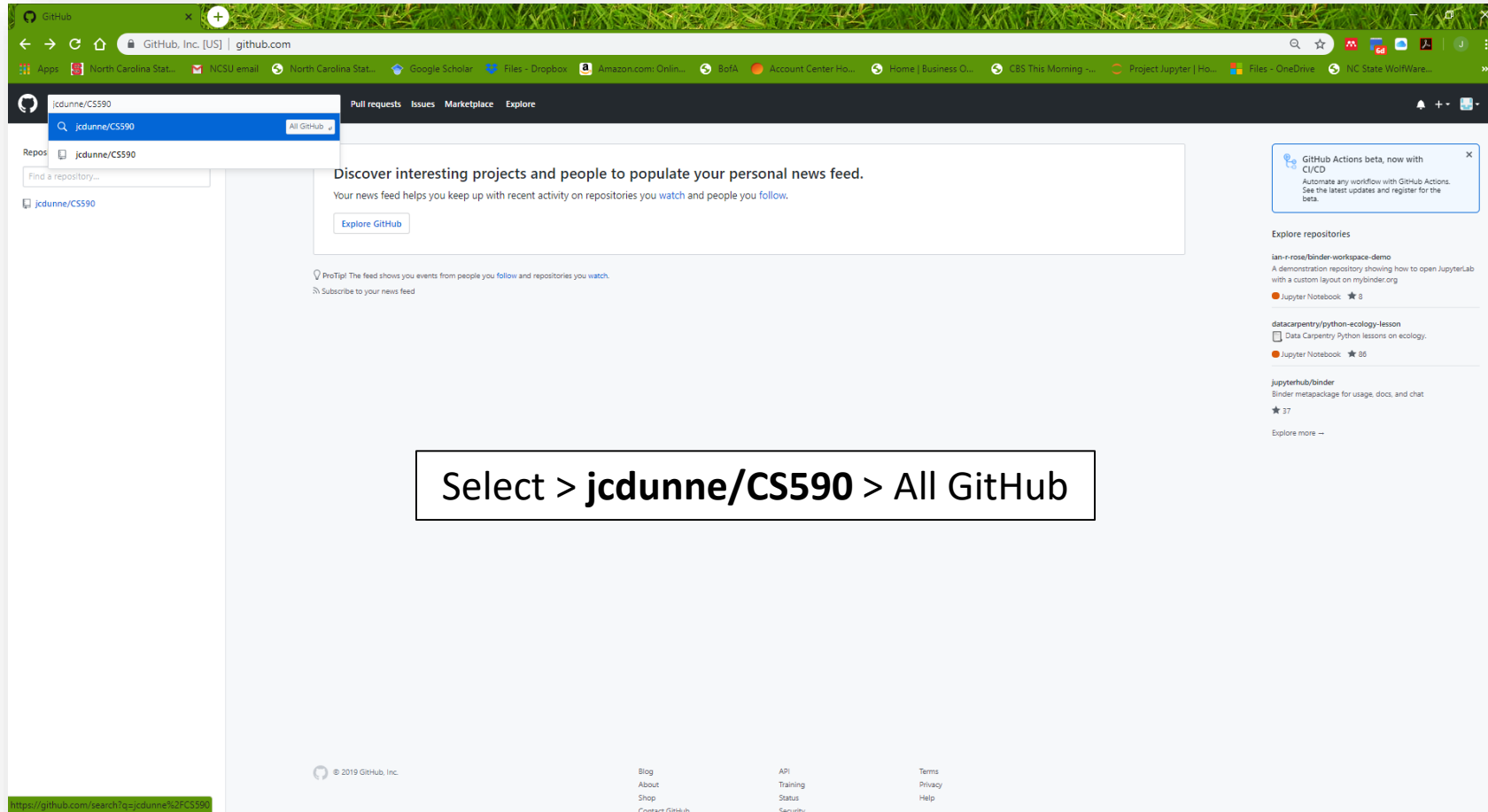
Introducing GitHub Actions with CI/CD

Automate any workflow with GitHub Actions. See the latest updates announced at our HQ reveal.

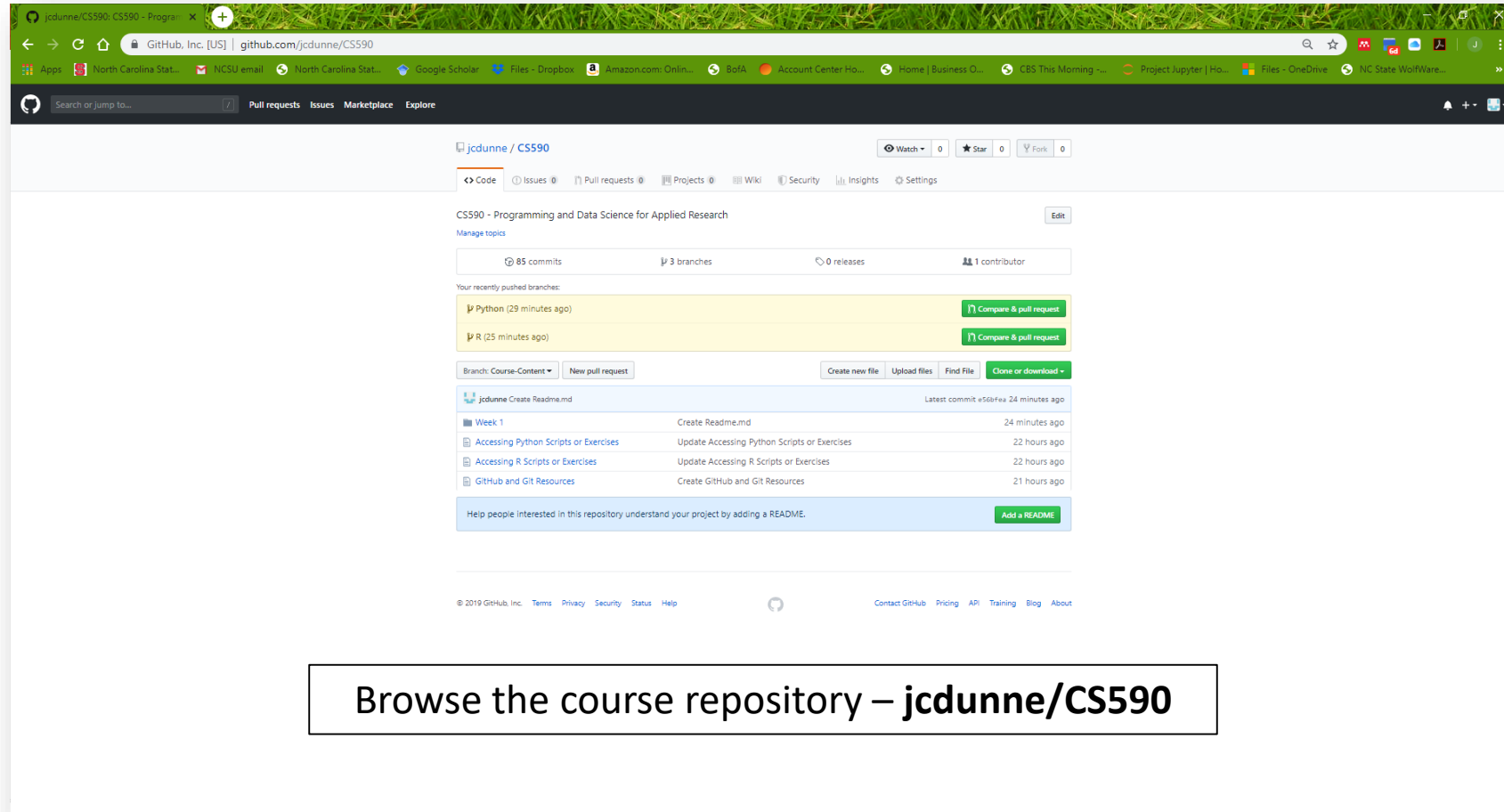
GitHub Repository – Course Content



GitHub Repository Search – jcdunne/CS590



GitHub Course Repository – jcdunne/CS590



Browse the course repository – `jcdunne/CS590`

Anaconda Setup and Installation

Determine the Computer for Setup and Installation

- Remote Desktop Connection (IP Address Required) – **Recommended**
- Local Machine (Lab Computer or Laptop)

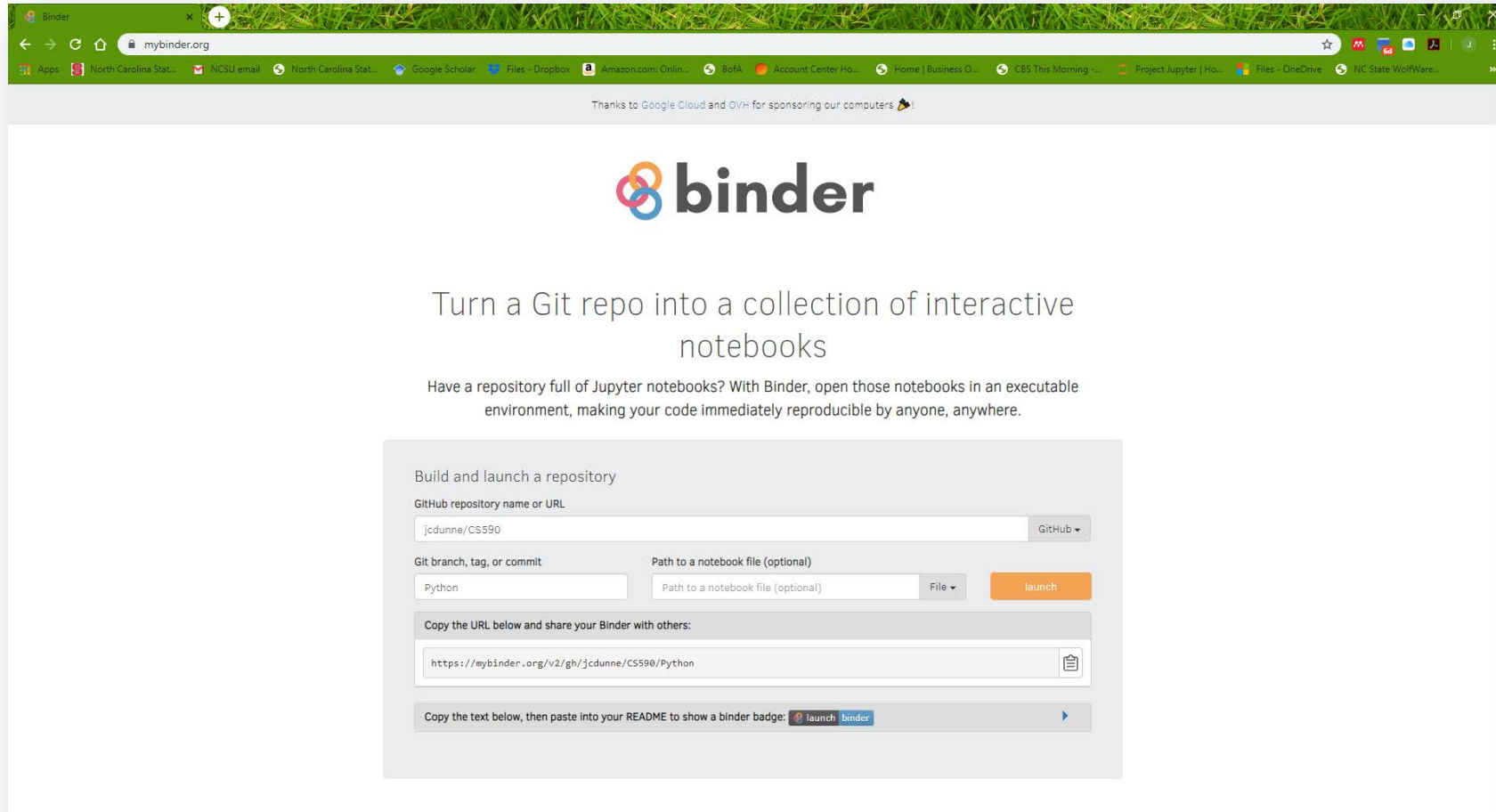
Binder Rendering

- Online Only (Binder/Docker Setup)

Let's Download Anaconda!

- Go To:
<https://www.anaconda.com/distribution/>
- Or Google Search
Anaconda 3 – Click the first link (Anaconda Python/R Distribution – Free Download)

Binder Exploration – GitHub Input



The screenshot shows the Binder website interface in a web browser. The browser's address bar displays `mybinder.org`. The page features the Binder logo at the top, followed by the heading "Turn a Git repo into a collection of interactive notebooks". Below this, a paragraph explains that Binder allows users to open Jupyter notebooks in an executable environment. The main section is a form titled "Build and launch a repository". It includes a text input for the "GitHub repository name or URL" containing `jcdunne/CS590`, a "GitHub" dropdown menu, a "Git branch, tag, or commit" input with `Python`, and an optional "Path to a notebook file" input. A "launch" button is positioned to the right of the optional path input. Below the form, a text box displays the generated URL: `https://mybinder.org/v2/gh/jcdunne/CS590/Python`. At the bottom, there is a section for creating a Binder badge, showing a "launch binder" button and a right-pointing arrow.

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binder

Turn a Git repo into a collection of interactive notebooks

Have a repository full of Jupyter notebooks? With Binder, open those notebooks in an executable environment, making your code immediately reproducible by anyone, anywhere.

Build and launch a repository

GitHub repository name or URL

GitHub

Git branch, tag, or commit

Path to a notebook file (optional)

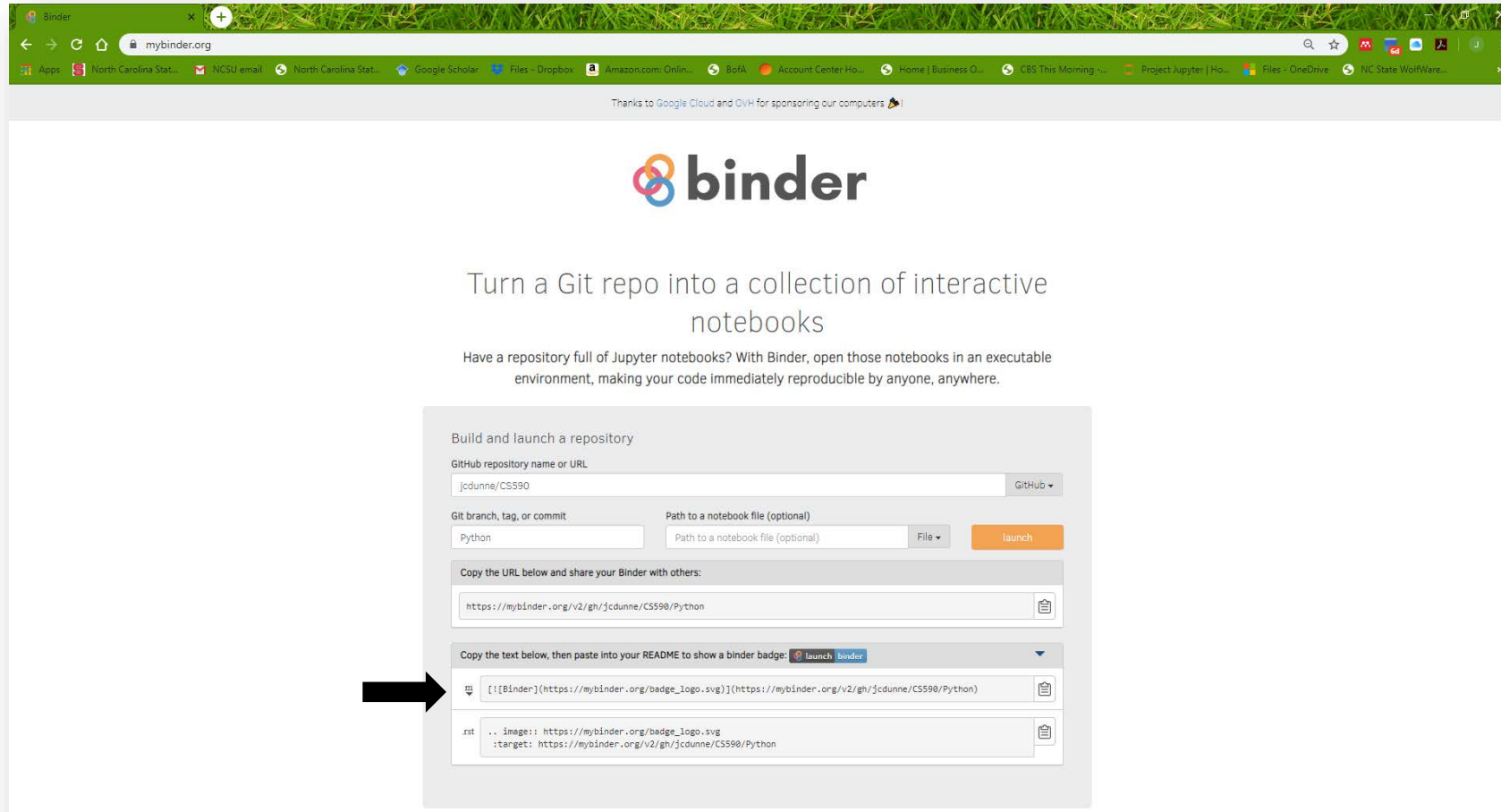
File launch

Copy the URL below and share your Binder with others:

📄

Copy the text below, then paste into your README to show a binder badge: launch binder ▶

Binder Exploration – GitHub Rendering



The screenshot shows the Binder website interface. At the top, there's a navigation bar with the Binder logo and the text "Turn a Git repo into a collection of interactive notebooks". Below this, a form titled "Build and launch a repository" is displayed. The form has several input fields: "GitHub repository name or URL" (containing "jcdunne/CS590"), "Git branch, tag, or commit" (containing "Python"), and "Path to a notebook file (optional)" (containing "Path to a notebook file (optional)"). There is a "launch" button next to the path field. Below the form, there's a section titled "Copy the URL below and share your Binder with others:" with a text box containing the URL "https://mybinder.org/v2/gh/jcdunne/CS590/Python". Below this, there's a section titled "Copy the text below, then paste into your README to show a binder badge:" with a text box containing the badge code: `[[Binder]](https://mybinder.org/badge_logo.svg)(https://mybinder.org/v2/gh/jcdunne/CS590/Python)`. A black arrow points to this section. Below the badge code, there's a section titled "rst" with a text box containing the RST code: `.. image:: https://mybinder.org/badge_logo.svg :target: https://mybinder.org/v2/gh/jcdunne/CS590/Python`.

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binder

Turn a Git repo into a collection of interactive notebooks

Have a repository full of Jupyter notebooks? With Binder, open those notebooks in an executable environment, making your code immediately reproducible by anyone, anywhere.

Build and launch a repository

GitHub repository name or URL

jcdunne/CS590

Git branch, tag, or commit

Python

Path to a notebook file (optional)

Path to a notebook file (optional)

File

launch

Copy the URL below and share your Binder with others:

https://mybinder.org/v2/gh/jcdunne/CS590/Python

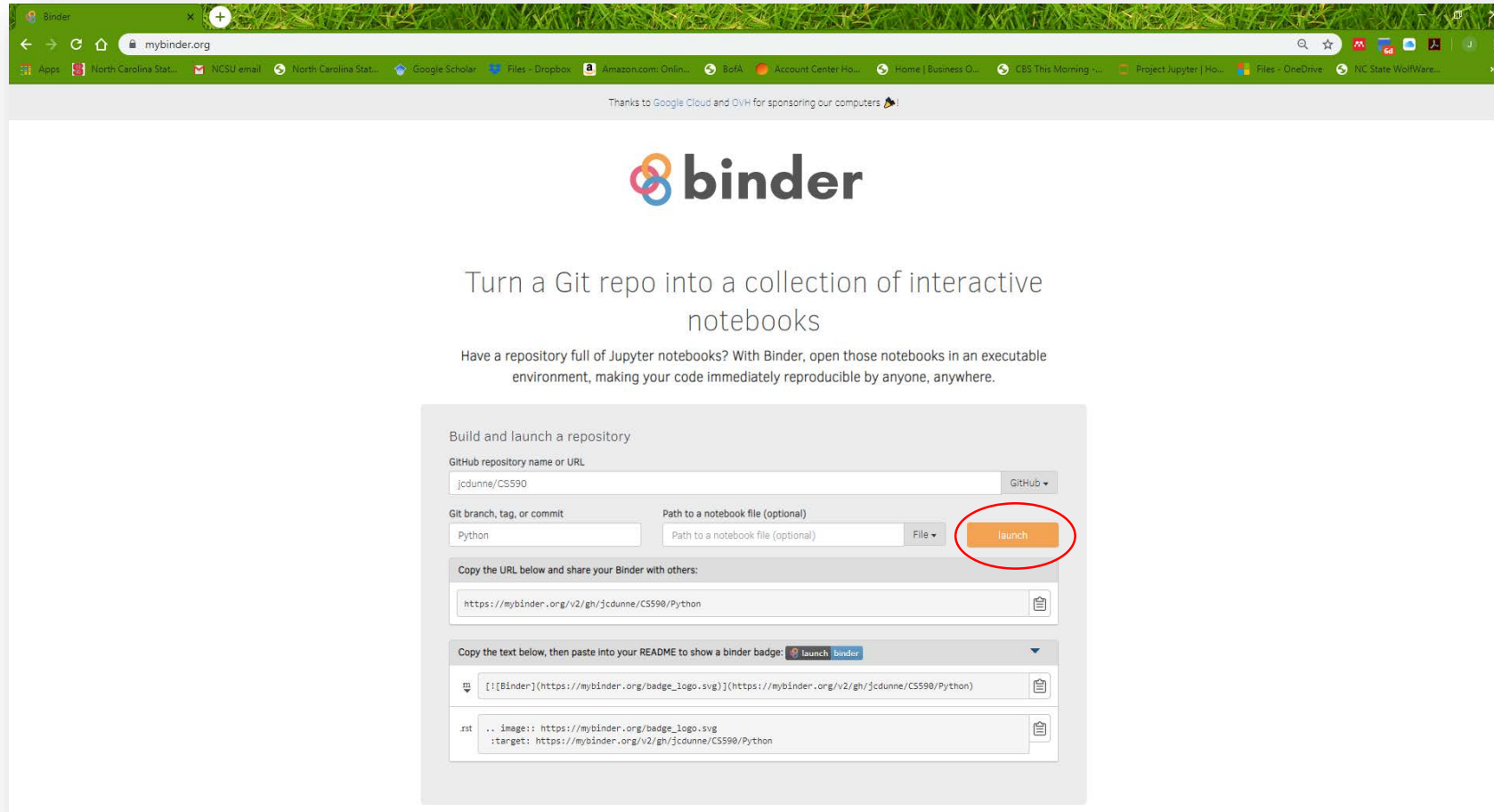
Copy the text below, then paste into your README to show a binder badge:

[[Binder]](https://mybinder.org/badge_logo.svg)(https://mybinder.org/v2/gh/jcdunne/CS590/Python)

rst

.. image:: https://mybinder.org/badge_logo.svg :target: https://mybinder.org/v2/gh/jcdunne/CS590/Python

Binder Launch – Accessing GitHub Repository



The screenshot shows the Binder website interface. At the top, there's a green header with the Binder logo and the text "Turn a Git repo into a collection of interactive notebooks". Below this, a section titled "Build and launch a repository" contains a form. The form has a text input for "GitHub repository name or URL" with the value "jcdunne/CS590" and a dropdown menu set to "GitHub". Below this, there are two rows of inputs: "Git branch, tag, or commit" with the value "Python", and "Path to a notebook file (optional)" with a dropdown menu set to "File". A red circle highlights the "launch" button. Below the form, there's a section "Copy the URL below and share your Binder with others:" with a text input containing the URL "https://mybinder.org/v2/gh/jcdunne/CS590/Python". Below this, there's a section "Copy the text below, then paste into your README to show a binder badge:" with a text input containing the badge code. At the bottom, there's a section "rst" with a text input containing the RST code.

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binder

Turn a Git repo into a collection of interactive notebooks

Have a repository full of Jupyter notebooks? With Binder, open those notebooks in an executable environment, making your code immediately reproducible by anyone, anywhere.

Build and launch a repository

GitHub repository name or URL

jcdunne/CS590 GitHub

Git branch, tag, or commit

Python

Path to a notebook file (optional)


Path to a notebook file (optional) File

launch

Copy the URL below and share your Binder with others:

<https://mybinder.org/v2/gh/jcdunne/CS590/Python>

Copy the text below, then paste into your README to show a binder badge:

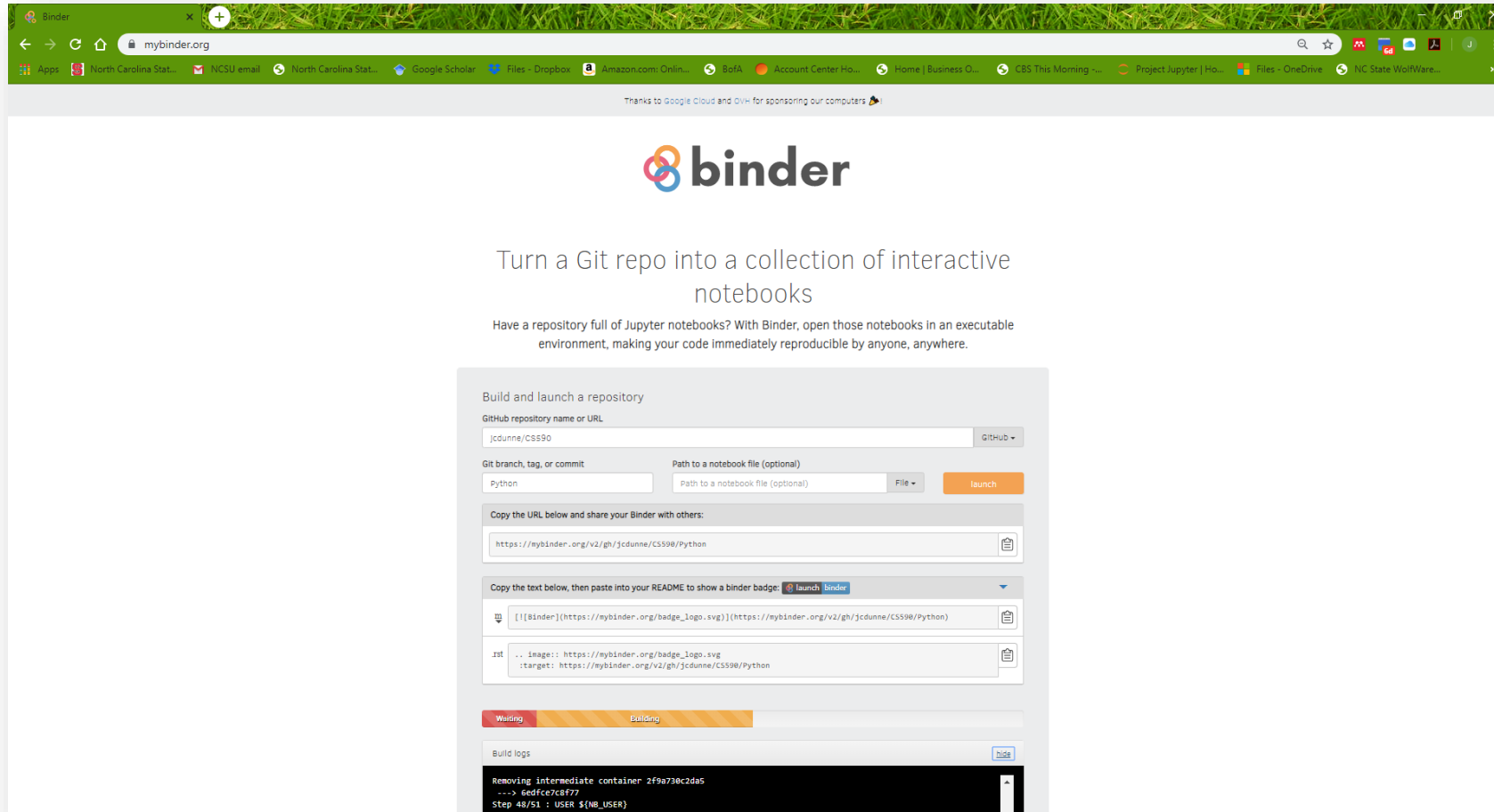
 [launch binder](#)

```
[[Binder]](https://mybinder.org/badge_logo.svg)(https://mybinder.org/v2/gh/jcdunne/CS590/Python)
```

rst

```
.. image:: https://mybinder.org/badge_logo.svg
   :target: https://mybinder.org/v2/gh/jcdunne/CS590/Python
```


Binder Build – Building the Environment



The screenshot shows the Binder website interface in a web browser. The browser's address bar displays "mybinder.org". The page features the Binder logo at the top, followed by the text "Turn a Git repo into a collection of interactive notebooks". Below this, a paragraph explains that Binder can open Jupyter notebooks in an executable environment. The main section, titled "Build and launch a repository", contains a form with the following fields: "GitHub repository name or URL" (filled with "jcdunne/CS590"), "Git branch, tag, or commit" (filled with "Python"), and "Path to a notebook file (optional)". A "launch" button is visible. Below the form, there is a section for sharing the URL and a section for copying text to use in a README. At the bottom, a "Build logs" section shows the progress of the build, with a status bar indicating "Working" and "Building".

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binder

Turn a Git repo into a collection of interactive notebooks

Have a repository full of Jupyter notebooks? With Binder, open those notebooks in an executable environment, making your code immediately reproducible by anyone, anywhere.

Build and launch a repository

GitHub repository name or URL
jcdunne/CS590

Git branch, tag, or commit
Python

Path to a notebook file (optional)
Path to a notebook file (optional)

launch

Copy the URL below and share your Binder with others:

<https://mybinder.org/v2/gh/jcdunne/CS590/Python>

Copy the text below, then paste into your README to show a binder badge:

`[[binder]](https://mybinder.org/badge_logo.svg)(https://mybinder.org/v2/gh/jcdunne/CS590/Python)`

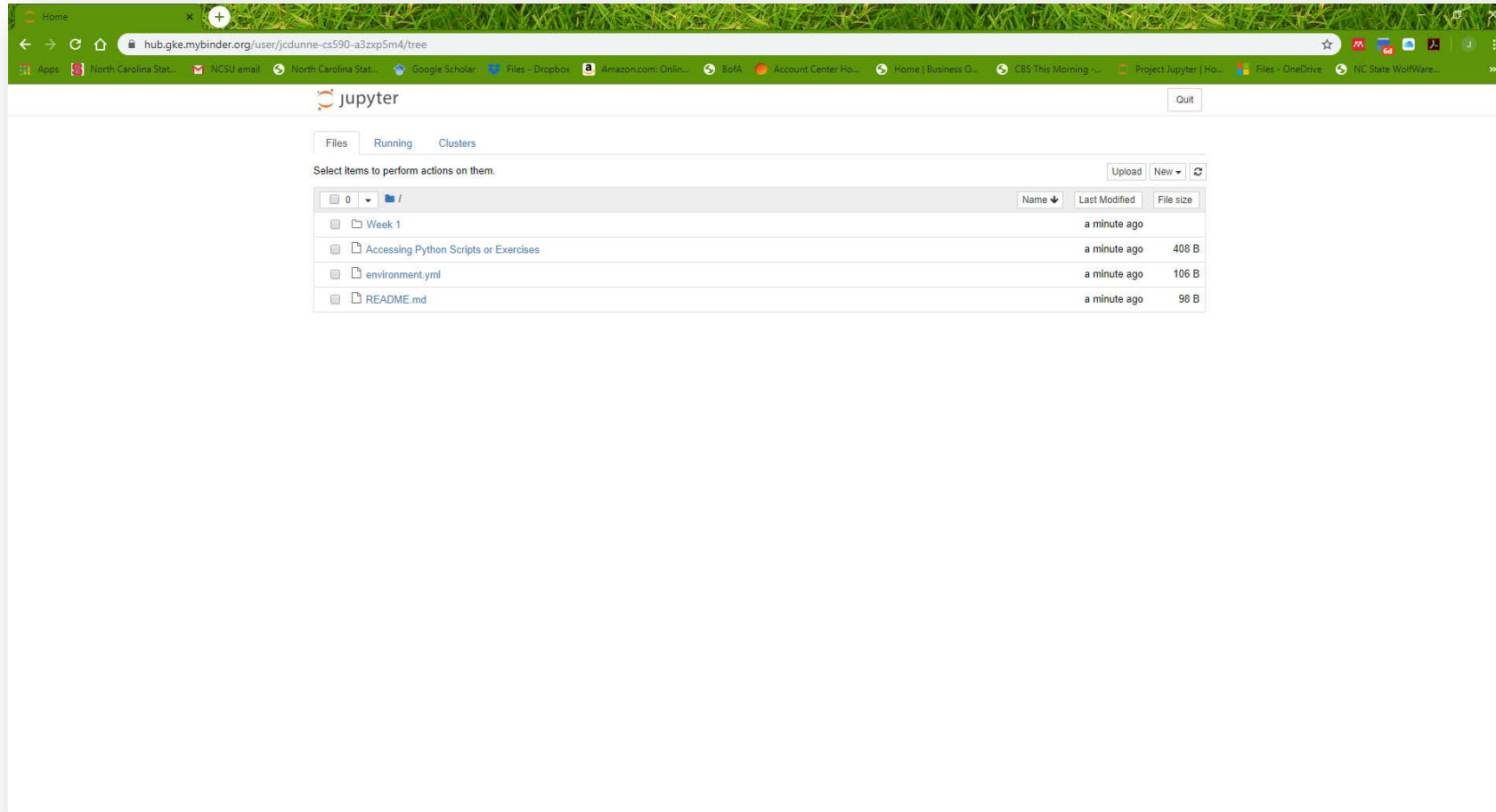
.. image:: https://mybinder.org/badge_logo.svg
:target: https://mybinder.org/v2/gh/jcdunne/CS590/Python

Working Building

Build logs

```
Removing intermediate container 2f9a730c2da5  
--> 6edfce7c8f77  
Step 48/51 : USER $(NB_USER)  
--> Running in b6b6d6d6b6d4
```

Binder Rendering – CS590/Python Repository



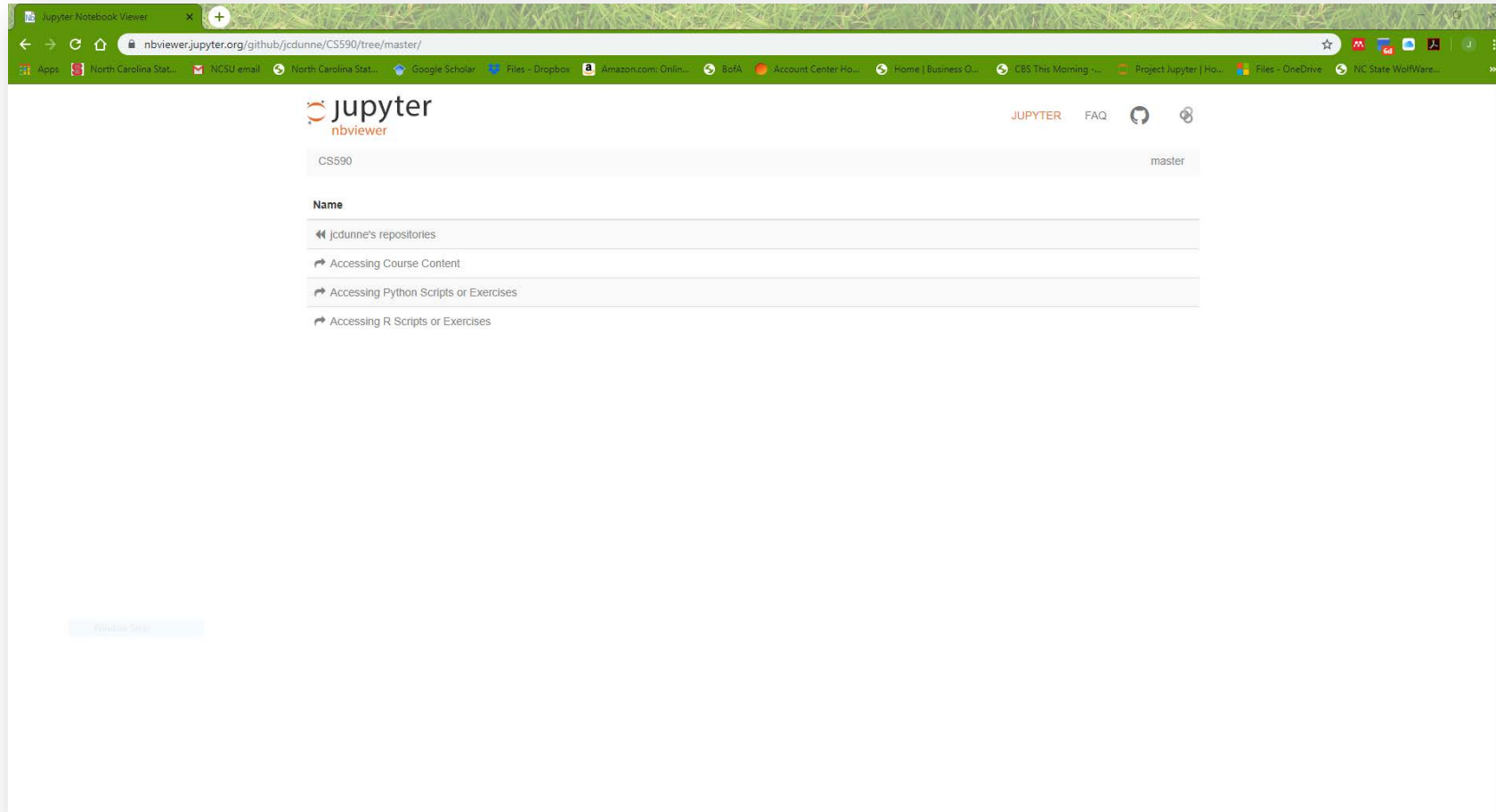
Jupyter NBViewer Exploration - Recommended



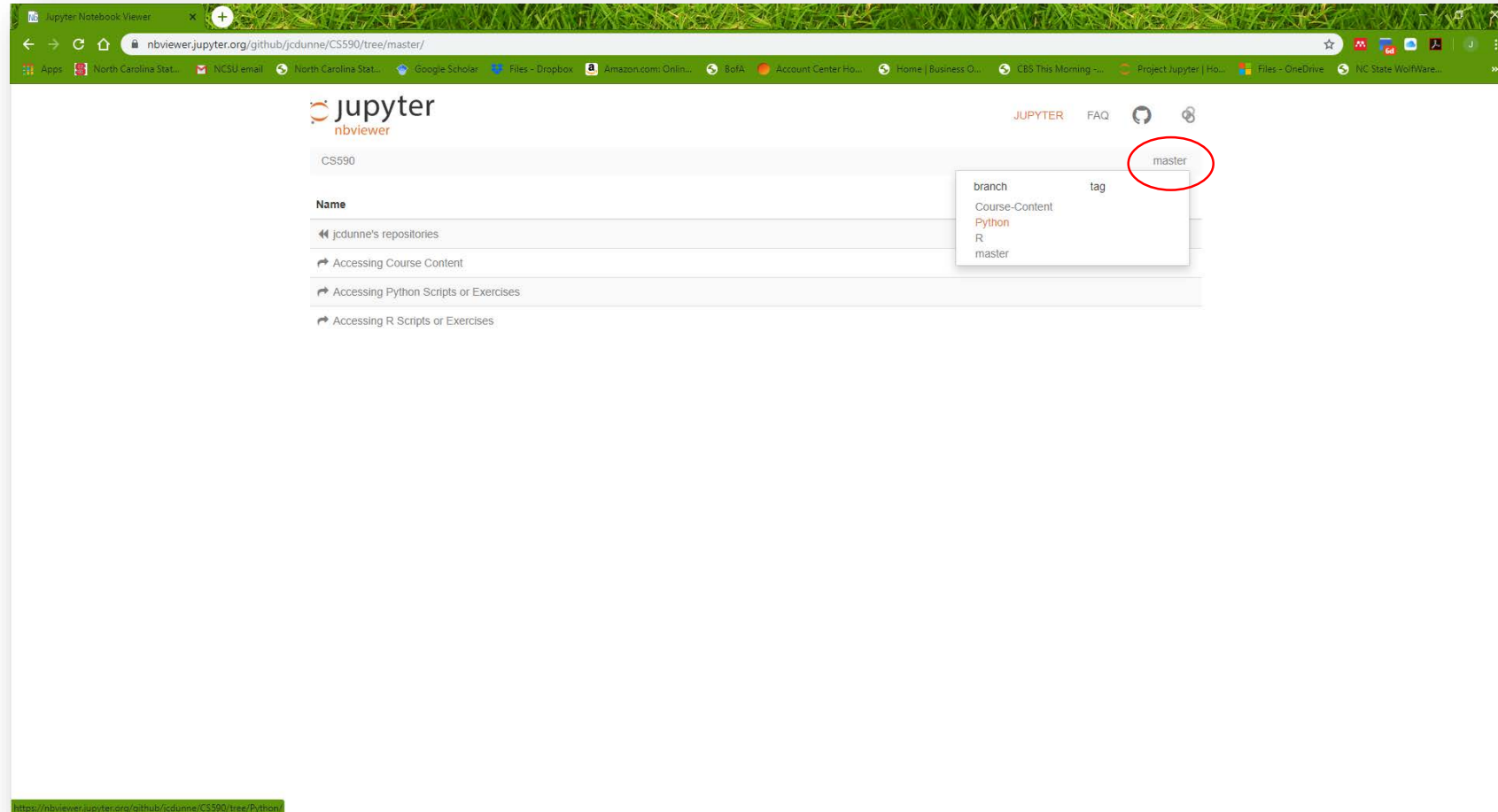
Jupyter NBViewer Search



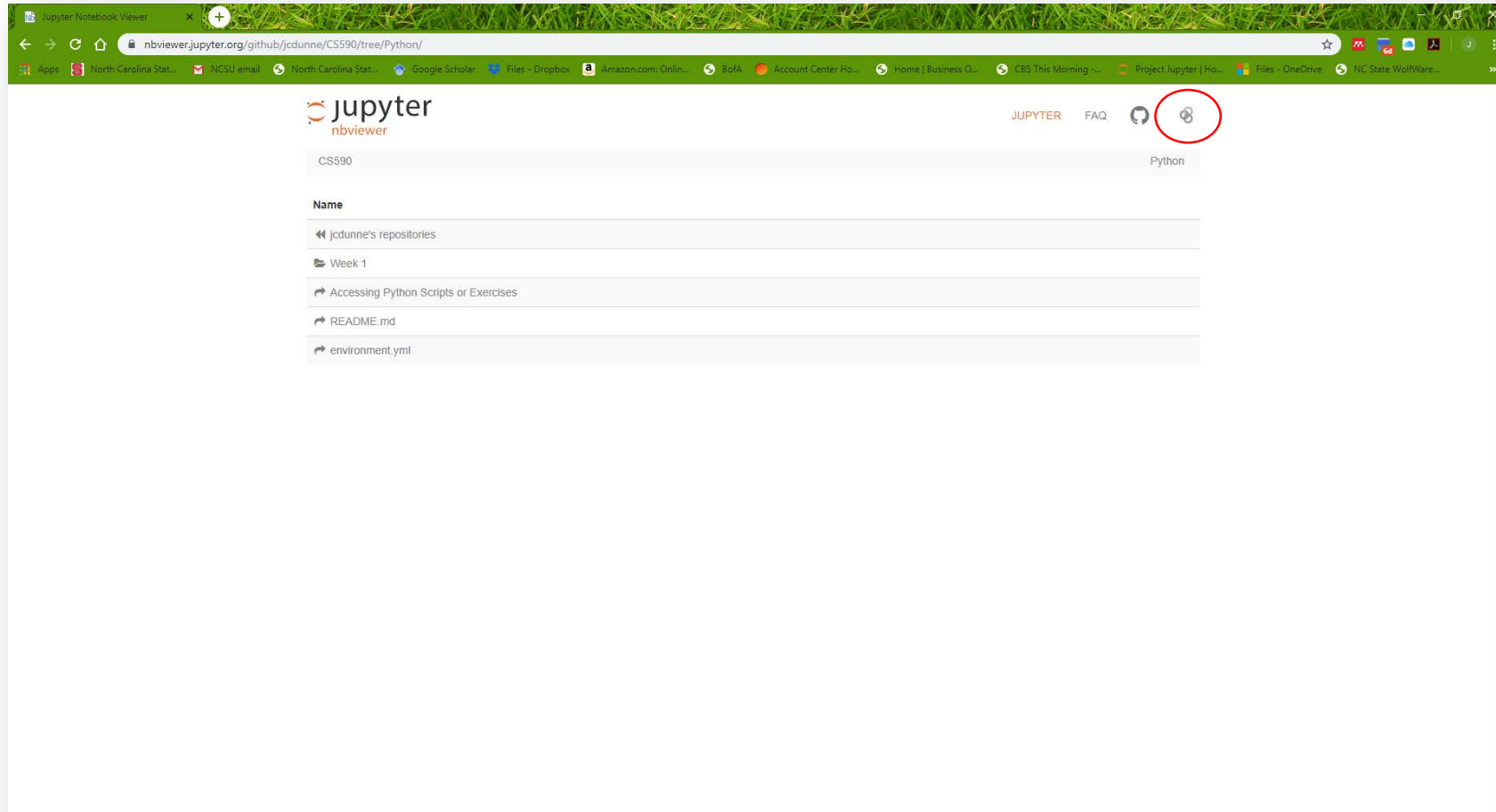
Jupyter NBViewer – CS590



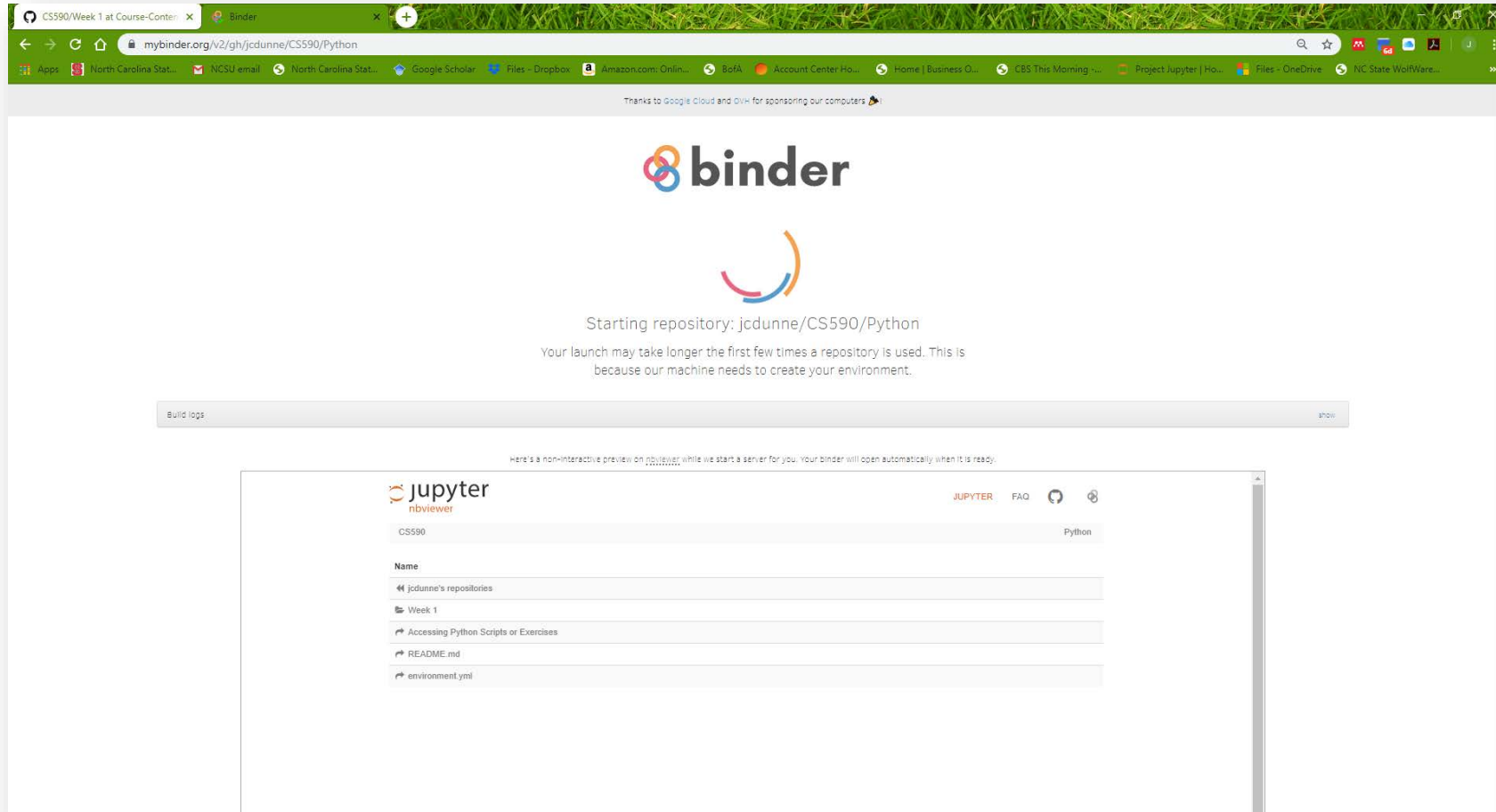
Jupyter NBViewer – Branch Selection



Jupyter NBViewer – Binder Build



Jupyter NBViewer – Binder Build



Jupyter NBViewer – Navigation Page

