

Lecture 07

Cloud Computing

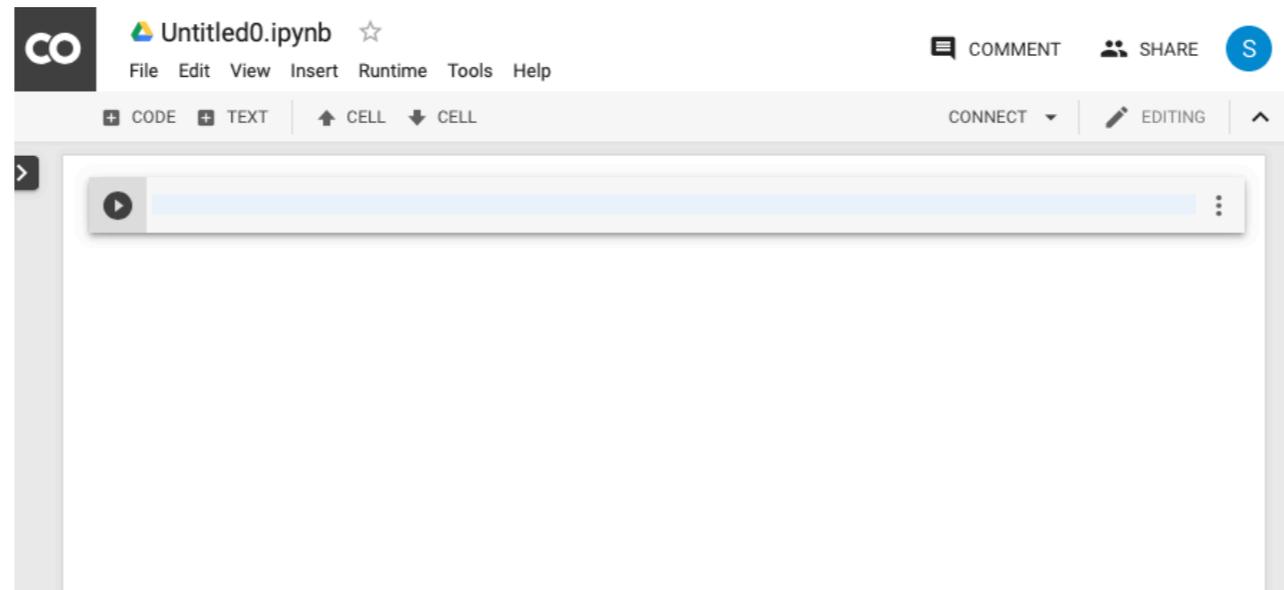
STAT 479: Deep Learning, Spring 2019

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<http://stat.wisc.edu/~sraschka/teaching/stat479-ss2019/>

Option 1: Google Colab

<https://colab.research.google.com>



- Free Google-flavored Jupyter Notebooks in the Cloud
- For each notebook, they spin up a custom (Linux-based) computing instance
- Computations limited to ~12 h though; you won't lose your notebook, but computations will be interrupted
- Maybe useful for quick testing/experimenting/sharing (but maybe tedious as you need to reinstall packages each time)

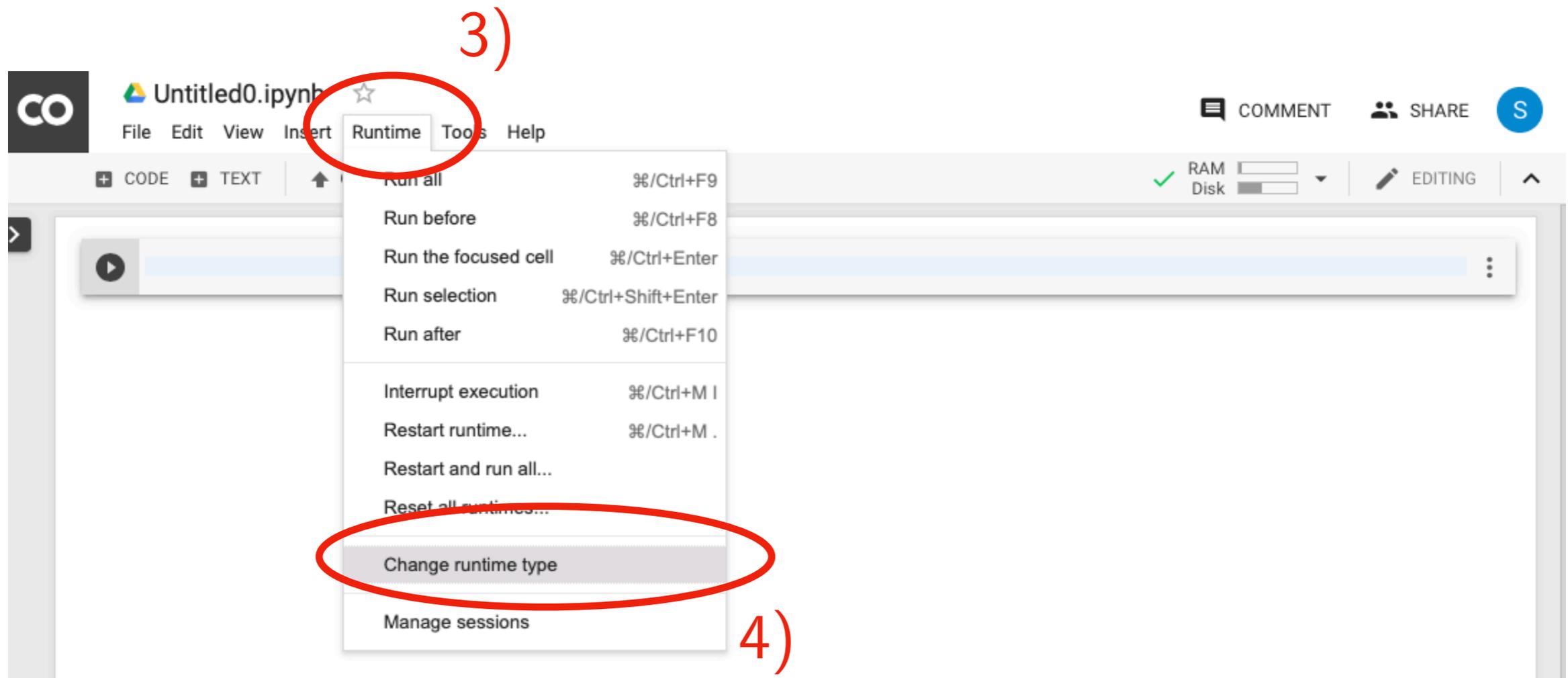
Option 1: Google Colab

The screenshot shows the Google Colab interface. At the top, there is a navigation bar with tabs: EXAMPLES, RECENT, GOOGLE DRIVE (circled in red), GITHUB, and UPLOAD. Below the navigation bar, there is a 'Filter notebooks' section with a search icon. A table lists several notebooks with columns for Title, Owner, Last modified, and Last opened. At the bottom right, there is a button labeled 'NEW PYTHON 3 NOTEBOOK' (circled in red) and a 'CANCEL' button. A red '1)' is next to the 'GOOGLE DRIVE' tab, and a red '2)' is next to the 'NEW PYTHON 3 NOTEBOOK' button.

Title	Owner	Last modified	Last opened
Untitled	Sebastian Raschka	3 days ago	3 days ago
Untitled7.ipynb	Sebastian Raschka	11 days ago	11 days ago
Untitled6.ipynb	Sebastian Raschka	Jan 12, 2019	Jan 12, 2019
Untitled5.ipynb	Sebastian Raschka	Dec 17, 2018	Dec 17, 2018
Untitled4.ipynb	Sebastian Raschka	Oct 12, 2018	Oct 12, 2018

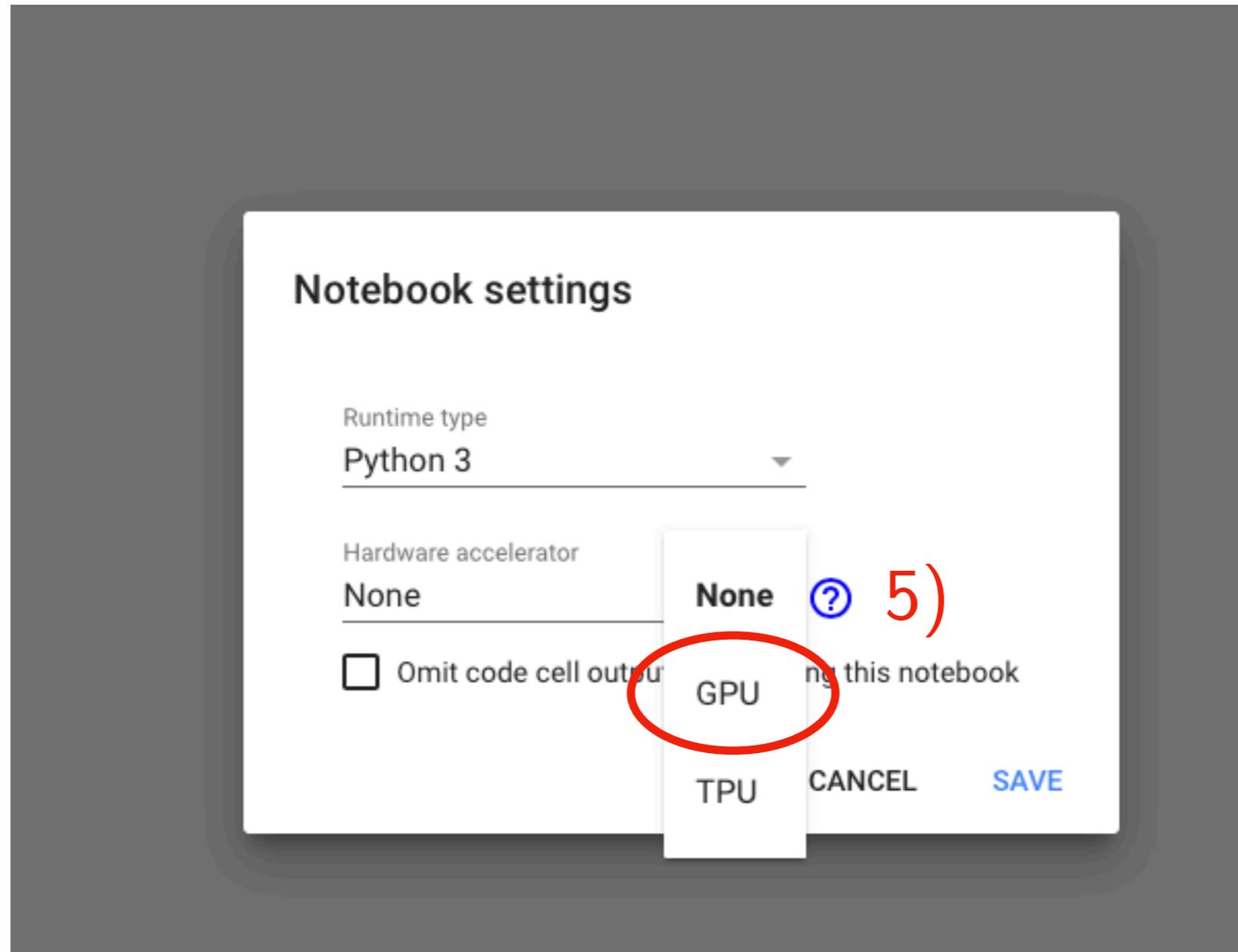
Menu appears if you visit <https://colab.research.google.com>

Option 1: Google Colab



Follow these steps for running code on GPU later (default is CPU)

Option 1: Google Colab



Follow these steps for running code on GPU later (default is CPU)

Option 1: Google Colab



The screenshot shows the Google Colab interface. At the top left is the Colab logo. The main header area contains the file name 'Untitled0.ipynb' with a star icon, and navigation menus for 'File', 'Edit', 'View', 'Insert', 'Runtime', 'Tools', and 'Help'. On the right side of the header are 'COMMENT', 'SHARE', and a user profile icon. Below the header is a toolbar with options for '+ CODE', '+ TEXT', '↑ CELL', and '↓ CELL'. On the far right of the toolbar are indicators for 'RAM' and 'Disk' usage, a green checkmark, and an 'EDITING' mode indicator. The main workspace contains a code cell with the following Python code:

```
[1] import torch
```

```
[2] torch.__version__
```

```
'1.0.1.post2'
```

Below the code cell is a blue progress bar with a play button icon on the left and a vertical ellipsis on the right.

- This is NEW! It appears that PyTorch is already pre-installed now (it wasn't always the case)

Option 1: Google Colab



The screenshot shows the Google Colab interface for a notebook titled "Untitled0.ipynb". The top navigation bar includes "File", "Edit", "View", "Insert", "Runtime", "Tools", and "Help". On the right, there are "COMMENT", "SHARE", and a user profile icon. Below the navigation bar, there are controls for adding code or text cells, moving cells up or down, and a status bar showing "RAM", "Disk", and "EDITING" mode. The notebook content consists of four code cells:

```
[1] import torch
```

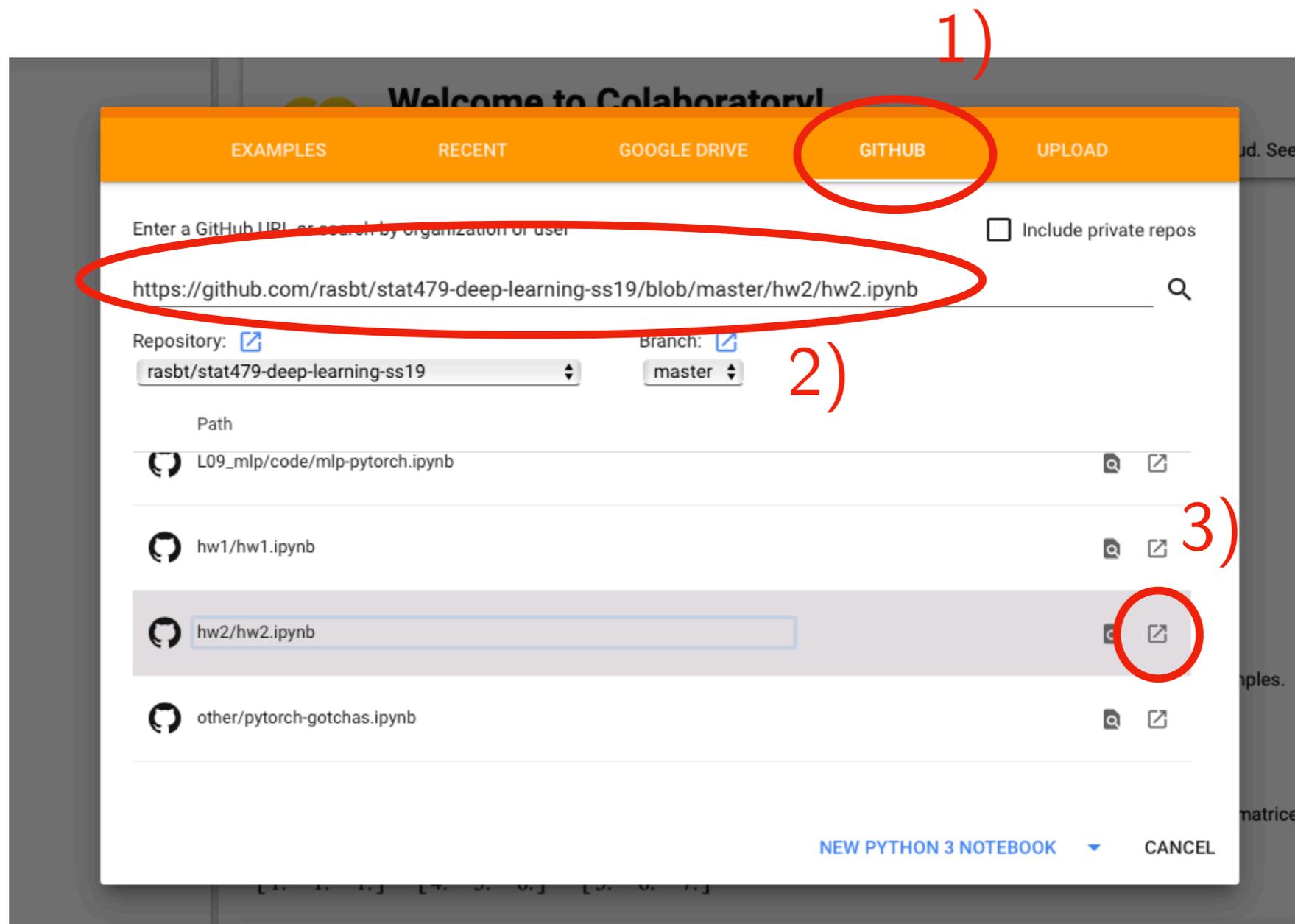
```
[2] torch.__version__
```

```
'1.0.1.post2'
```

```
!pip install numpy
```

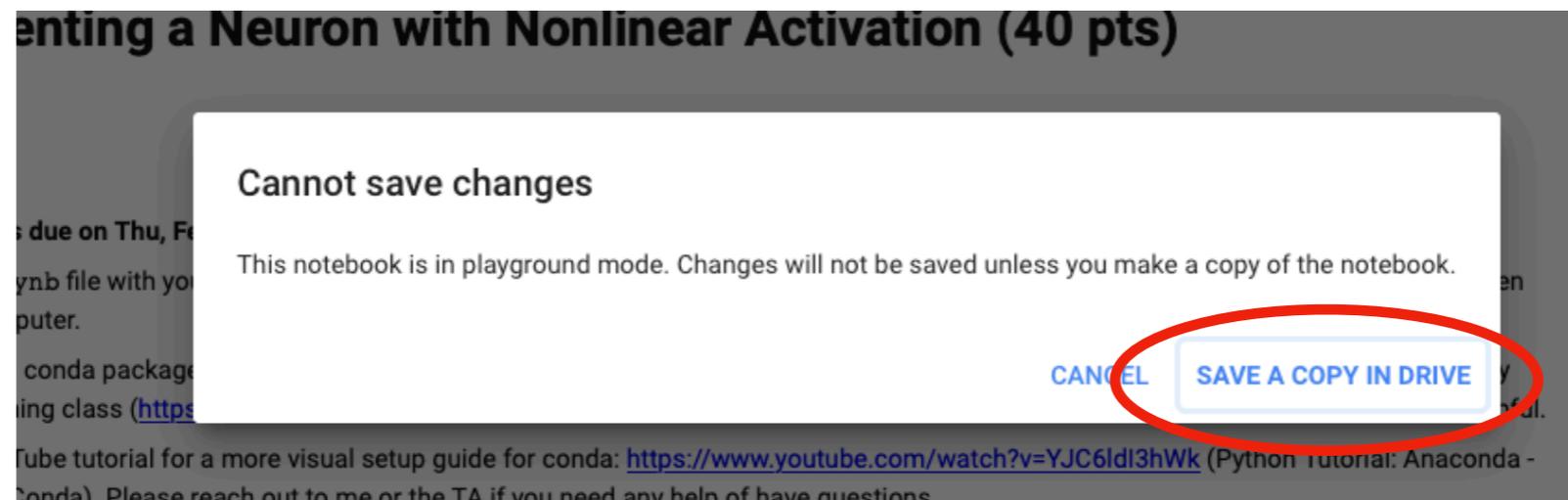
- In any case, if you'd like/need to install packages, you can do it as shown in the example above
- Note that in Jupyter Notebooks, the "!" indicates that what follows on that line is a "shell command" (you can think of a "shell" as the Linux & macOS command-line terminal, e.g., a Bash Shell)

Option 1: Google Colab



- You can also upload Notebooks or directly paste GitHub links to notebooks

Option 1: Google Colab



4)

When you import a Notebook from a GitHub link, make sure to save it in your Google Drive if you plan to make edits, otherwise it will be gone later

Option 1: Google Colab

```
/usr/local/lib/python3.6/dist-packages/pandas/io/parsers.py in __init__(self, f, engine, **kwds)
    816         self.options['has_index_names'] = kwds['has_index_names']
    817
--> 818         self._make_engine(self.engine)
    819
    820     def close(self):

/usr/local/lib/python3.6/dist-packages/pandas/io/parsers.py in _make_engine(self, engine)
    1047     def _make_engine(self, engine='c'):
    1048         if engine == 'c':
-> 1049             self._engine = CParserWrapper(self.f, **self.options)
    1050         else:
    1051             if engine == 'python':

/usr/local/lib/python3.6/dist-packages/pandas/io/parsers.py in __init__(self, src, **kwds)
    1693         kwds['allow_leading_cols'] = self.index_col is not False
    1694
-> 1695         self._reader = parsers.TextReader(src, **kwds)
    1696
    1697         # XXX

pandas/_libs/parsers.pyx in pandas._libs.parsers.TextReader._cinit__()

pandas/_libs/parsers.pyx in pandas._libs.parsers.TextReader._setup_parser_source()

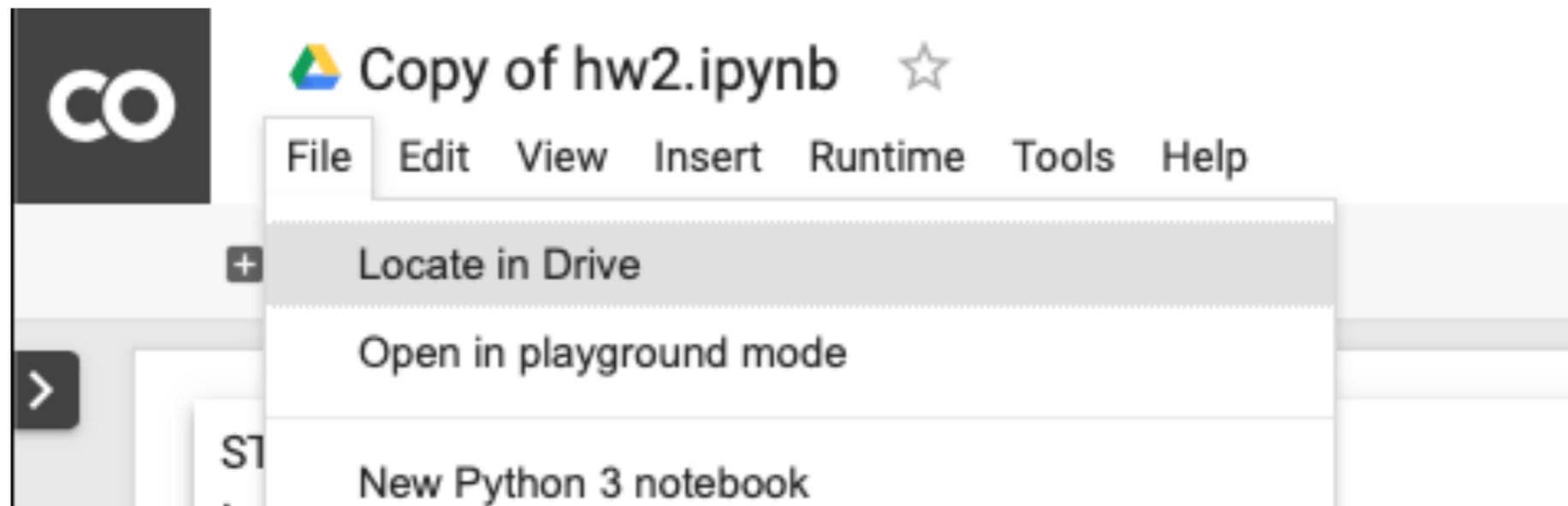
FileNotFoundError: File b'./datasets/iris.data' does not exist
```

SEARCH STACK OVERFLOW

If you'd run the HW2 notebook, you'd likely encounter this error. This is because it can't find the dataset via the specified, relative link ...

Option 1: Google Colab

... you'd need to get the datafile into the same location as the notebook*.
First, locate the position of the saved Notebook in your Google Drive:



*technically, it is also possible to load CSV files via `pandas.read_csv`, but getting the dataset onto Google Drive may be generally useful, e.g., for working with more complex datasets later.

Option 1: Google Colab

Notebooks are usually in a directory called "My Drive/Colab Notebooks"

The screenshot shows the Google Drive interface. On the left is a sidebar with navigation options: Drive, New, My Drive, Team Drives, Shared with me, Recent, Starred, Trash, and Storage (312.5 GB used). The main area shows a search bar and a breadcrumb path: My Drive > Colab Notebooks. Below this is a table of files and folders:

Name	Owner
hw2	me
Copy of hw2.ipynb	me
Untitled0.ipynb	me

Two arrows point to the 'hw2' folder and the 'Colab Notebooks' breadcrumb.

I recommend uploading the whole folder though (simply drag&drop it from your computer into this window)

Option 1: Google Colab

The screenshot shows the Google Drive interface. On the left is a sidebar with navigation options: 'New', 'My Drive', 'Team Drives', 'Shared with me', 'Recent', 'Starred', 'Trash', and 'Storage' (312.5 GB used). The main area shows a breadcrumb path: 'My Drive > Colab Notebooks > hw2'. Below this is a table of files:

Name	Owner	Last modified	File size
datasets	me	10:08 PM me	—
images	me	10:08 PM me	—
hw2	me	10:08 PM me	18 KB

A context menu is open over the 'hw2' file, listing actions such as Preview, Open with, Share, Get shareable link, Move to, Add to Starred, Rename, Manage versions, Make a copy, Report abuse, Download, and Remove. The 'Open with' option is selected, and a sub-menu is displayed showing 'Colaboratory' as the chosen application, along with 'Connect more apps'.

Then, simply open the notebook in Colaboratory.

Option 1: Google Colab

Unfortunately, there's some extra step required: mounting your Google Drive to the computer that now runs the Notebook. You need to execute the following code:

1)

```
from google.colab import drive
drive.mount('/content/drive')
```

... Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client_id=9473189

Enter your authorization code:

Then, click on the link and enter it in the field above

2)

```
from google.colab import drive
drive.mount('/content/drive')
```

... Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client_id=9473189

Enter your authorization code:

.....

3)

```
from google.colab import drive
drive.mount('/content/drive')
```

Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client_id=9473189

Enter your authorization code:

.....

Mounted at /content/drive

Your Google Drive should now be finally mounted:

Option 1: Google Colab

Now, you simply need to provide the correct address to the dataset inside the Notebook and it should work:

```
[16] df = pd.read_csv('/content/drive/My Drive/Colab Notebooks/hw2/datasets/iris.data', index_col=None, header=None)
df.columns = ['x1', 'x2', 'x3', 'x4', 'y']
df = df.iloc[50:150]
df['y'] = df['y'].apply(lambda x: 0 if x == 'Iris-versicolor' else 1)
df.tail()
```

```
↳
```

	x1	x2	x3	x4	y
145	6.7	3.0	5.2	2.3	1
146	6.3	2.5	5.0	1.9	1
147	6.5	3.0	5.2	2.0	1
148	6.2	3.4	5.4	2.3	1
149	5.9	3.0	5.1	1.8	1

Option 2: Google Cloud Instances

This is trickier and you don't have to use it for this class, but it's a useful skill and experience!

<https://console.cloud.google.com/education>

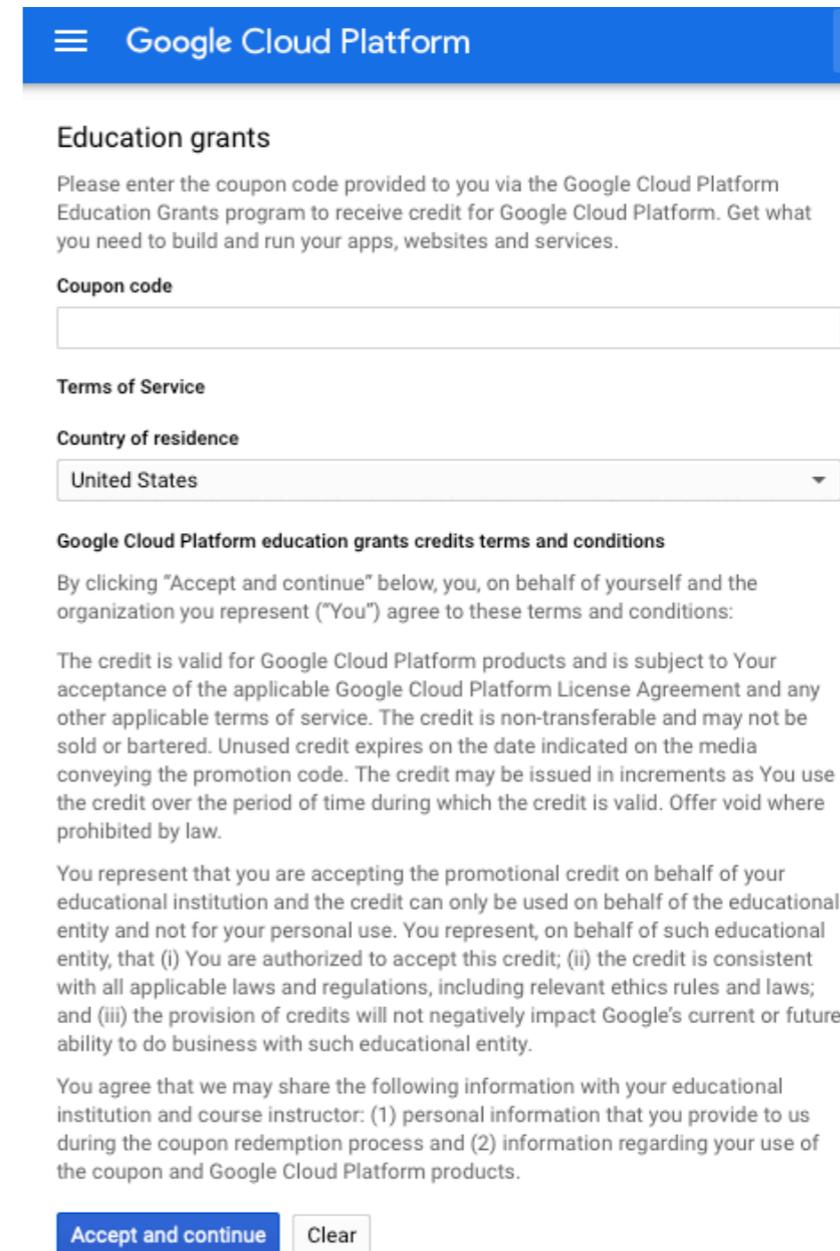
Will email a
\$50 coupon code (per student) after class

Option 2: Google Cloud Instances

Go to the website

<https://console.cloud.google.com/education>

Read the terms, and accept if you agree
(you don't have to use this platform for this class!)



Google Cloud Platform

Education grants

Please enter the coupon code provided to you via the Google Cloud Platform Education Grants program to receive credit for Google Cloud Platform. Get what you need to build and run your apps, websites and services.

Coupon code

Terms of Service

Country of residence

United States

Google Cloud Platform education grants credits terms and conditions

By clicking "Accept and continue" below, you, on behalf of yourself and the organization you represent ("You") agree to these terms and conditions:

The credit is valid for Google Cloud Platform products and is subject to Your acceptance of the applicable Google Cloud Platform License Agreement and any other applicable terms of service. The credit is non-transferable and may not be sold or bartered. Unused credit expires on the date indicated on the media conveying the promotion code. The credit may be issued in increments as You use the credit over the period of time during which the credit is valid. Offer void where prohibited by law.

You represent that you are accepting the promotional credit on behalf of your educational institution and the credit can only be used on behalf of the educational entity and not for your personal use. You represent, on behalf of such educational entity, that (i) You are authorized to accept this credit; (ii) the credit is consistent with all applicable laws and regulations, including relevant ethics rules and laws; and (iii) the provision of credits will not negatively impact Google's current or future ability to do business with such educational entity.

You agree that we may share the following information with your educational institution and course instructor: (1) personal information that you provide to us during the coupon redemption process and (2) information regarding your use of the coupon and Google Cloud Platform products.

Accept and continue

Option 2: Google Cloud Instances

Check your credits periodically, via the billings menu that can be accessed from the main menu

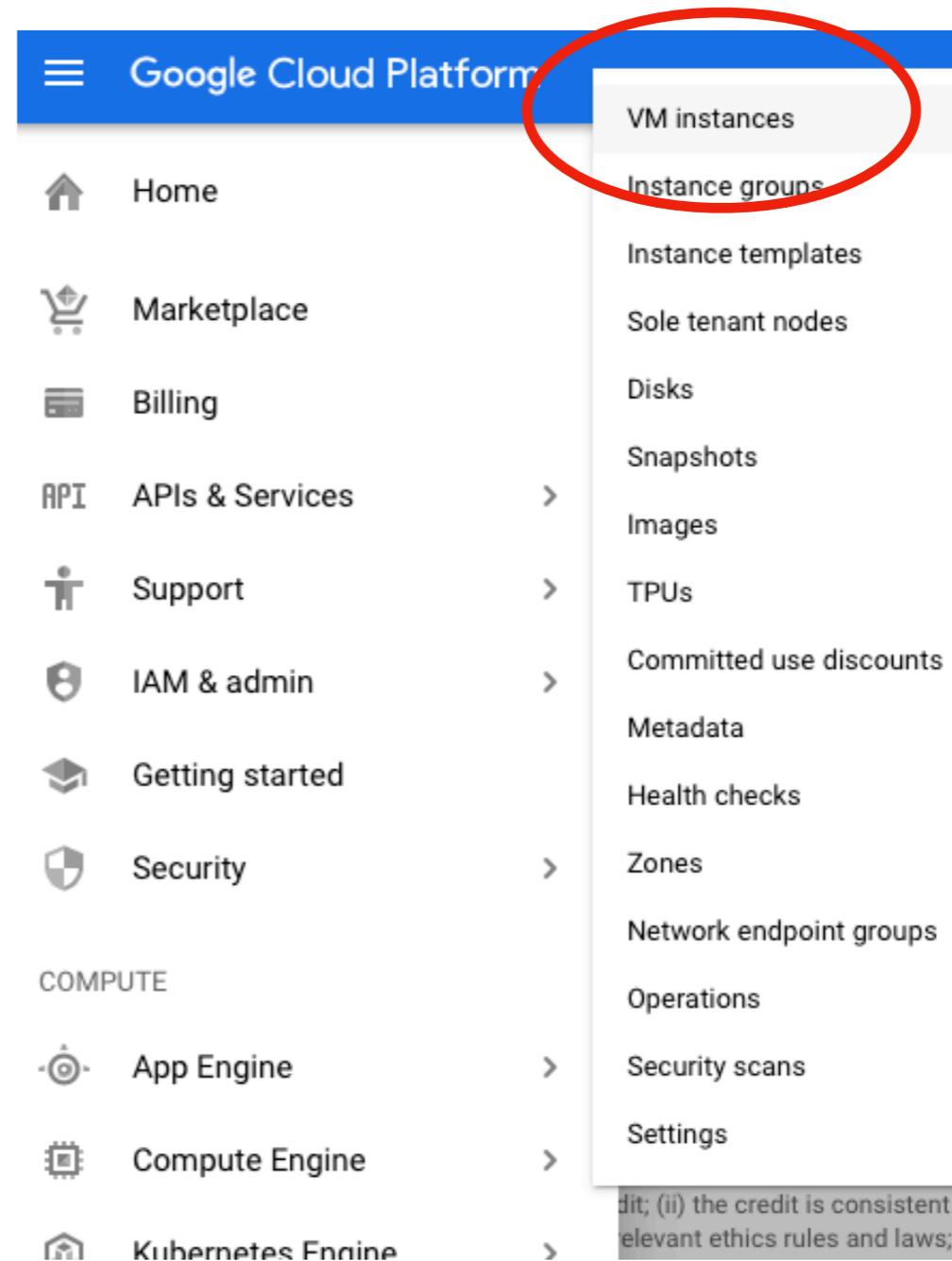
The screenshot displays the Google Cloud Platform interface. The top navigation bar is blue and contains the 'Google Cloud Platform' logo and a search icon. A red circle highlights the main menu icon (three horizontal lines) in the top left corner, with a red arrow pointing to it. Below the navigation bar, the 'Billing' section is active, showing an 'Overview' for account 'STAT479'. The page displays the following information:

- Billing account ID: 015F4C-ACA469-15800F
- Organization: wisc.edu
- Credits: \$100.00 (Credits remaining, Out of \$100.00)
- Days remaining: 337 (Ends Jan 23, 2020)
- Projects linked to this billing account:

Project name	Project ID
My First Project	stately-lyceum-229102

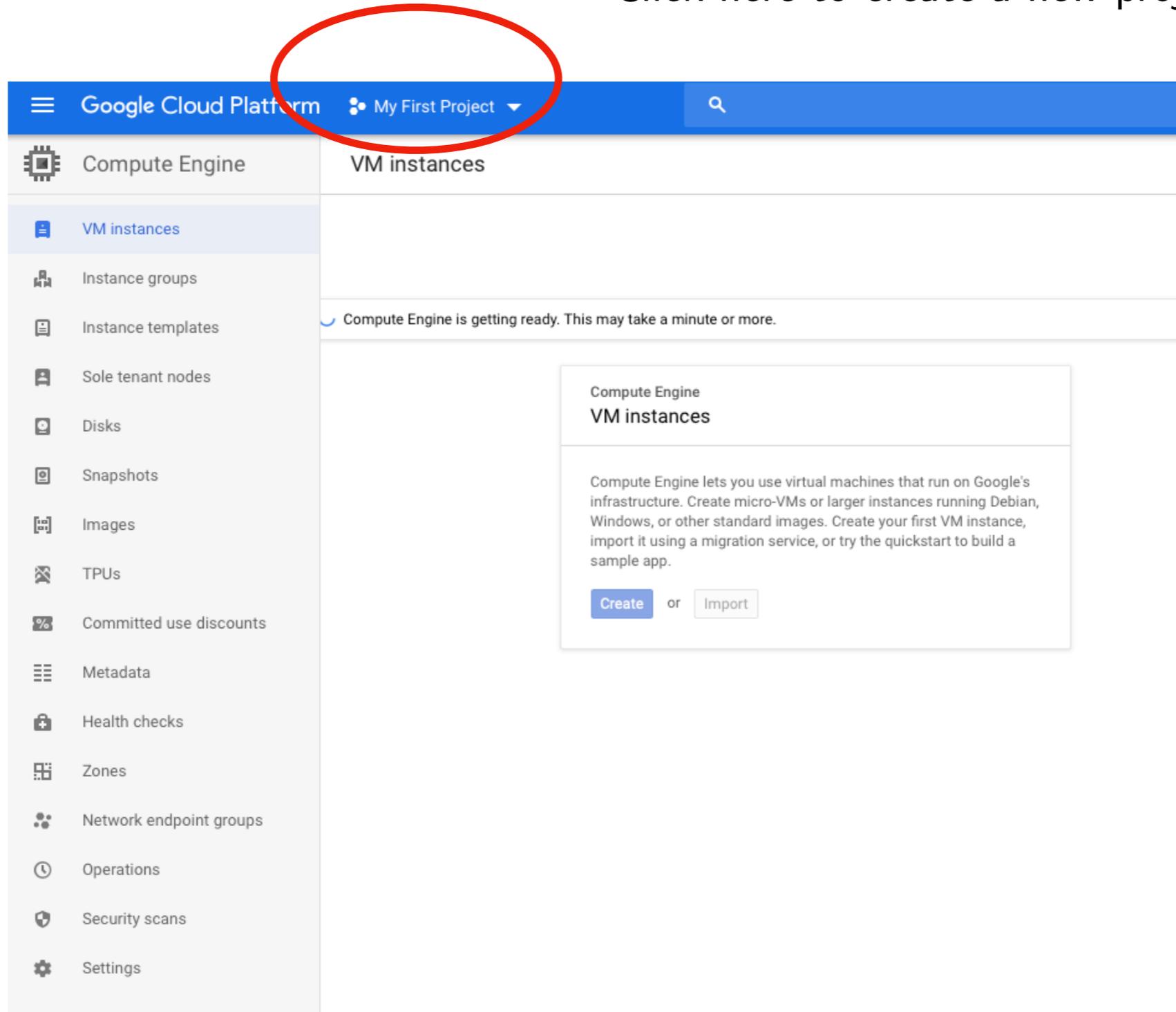
Option 2: Google Cloud Instances

To create a new computing instance, click on VM instances



Option 2: Google Cloud Instances

Click here to create a new project



The screenshot shows the Google Cloud Platform console interface. At the top, there is a blue navigation bar with the text 'Google Cloud Platform' and a dropdown menu labeled 'My First Project'. A red circle highlights this dropdown menu. Below the navigation bar, the left sidebar contains a list of navigation items: Compute Engine, VM instances, Instance groups, Instance templates, Sole tenant nodes, Disks, Snapshots, Images, TPUs, Committed use discounts, Metadata, Health checks, Zones, Network endpoint groups, Operations, Security scans, and Settings. The main content area is titled 'VM instances' and displays a message: 'Compute Engine is getting ready. This may take a minute or more.' Below this message is a card titled 'Compute Engine VM instances' with the following text: 'Compute Engine lets you use virtual machines that run on Google's infrastructure. Create micro-VMs or larger instances running Debian, Windows, or other standard images. Create your first VM instance, import it using a migration service, or try the quickstart to build a sample app.' At the bottom of the card are two buttons: 'Create' and 'Import'.

Option 2: Google Cloud Instances

The screenshot shows the Google Cloud Platform interface for VM instances. At the top, there is a blue header with 'My First Project' and a search icon. Below that, a grey bar shows 'VM instances' with a back arrow. A red warning banner states: 'You don't have permission to view the Compute project (compute.projects.get)'. The main content area has a white background with a 'Select from' dropdown menu set to 'WISC.EDU'. To the right of the dropdown, red text says 'Then click here to create a new project'. A 'NEW PROJECT' button is circled in red. Below this is a search bar labeled 'Search projects and folders'. Underneath are tabs for 'RECENT' and 'ALL'. A table lists projects:

Name	ID
✓ My First Project ?	stately-lyceum-229102
grid wisc.edu ?	532642321694

Option 2: Google Cloud Instances

Google Cloud Platform

New Project

You have 24 projects remaining in your quota. Request an increase or delete projects. [Learn more](#)

[MANAGE QUOTAS](#)

Project Name *
TestProject

Enter a name for your project

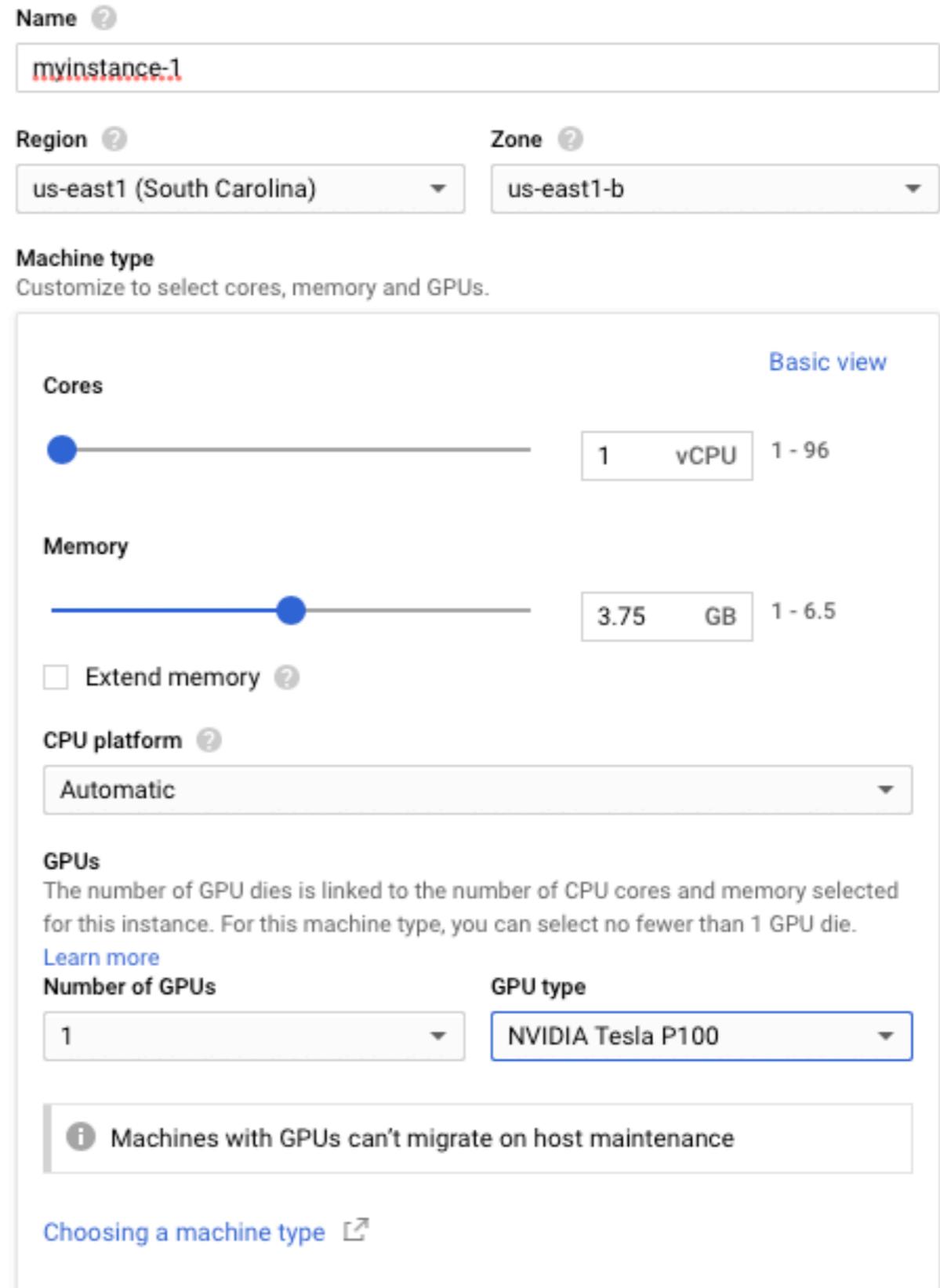
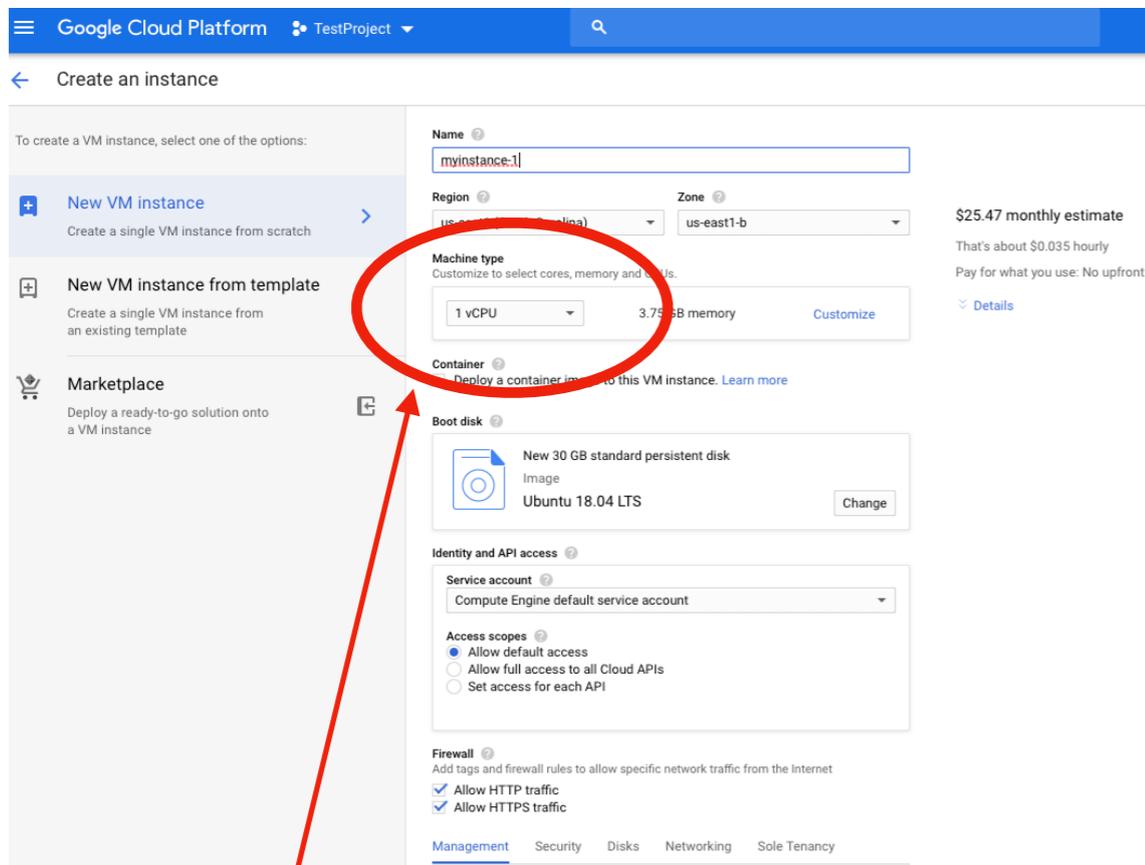
Option 2: Google Cloud Instances

The screenshot shows the Google Cloud Platform interface for creating a VM instance. The page is titled "Create an instance" and includes a navigation menu with "New VM instance", "New VM instance from template", and "Marketplace". The main configuration area includes fields for Name, Region, Zone, Machine type, Container, Boot disk, Identity and API access, and Firewall. The "Machine type" is set to "1 vCPU" and the "Boot disk" is set to "Ubuntu 18.04 LTS". A red circle highlights the "1 vCPU" option, and another red circle highlights the "Ubuntu 18.04 LTS" option. A red arrow points from the "Marketplace" section to the "1 vCPU" option. A red arrow points from the text "Choose Ubuntu 18.04 LTS" to the "Ubuntu 18.04 LTS" option. The "Firewall" section is checked for "Allow HTTP traffic" and "Allow HTTPS traffic". The "Management" tab is selected at the bottom.

I recommend trying CPUs first (cheaper) when experimenting.

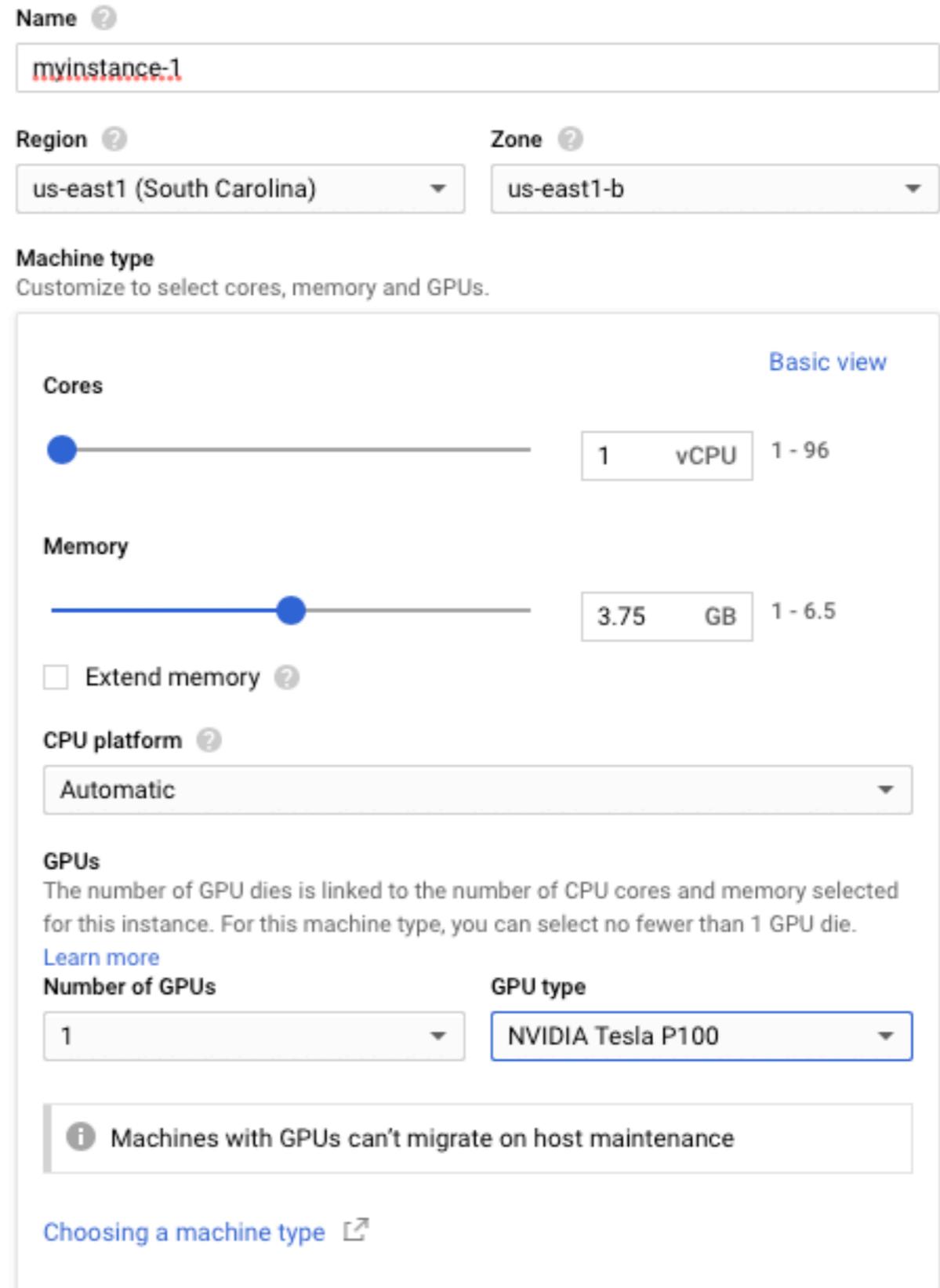
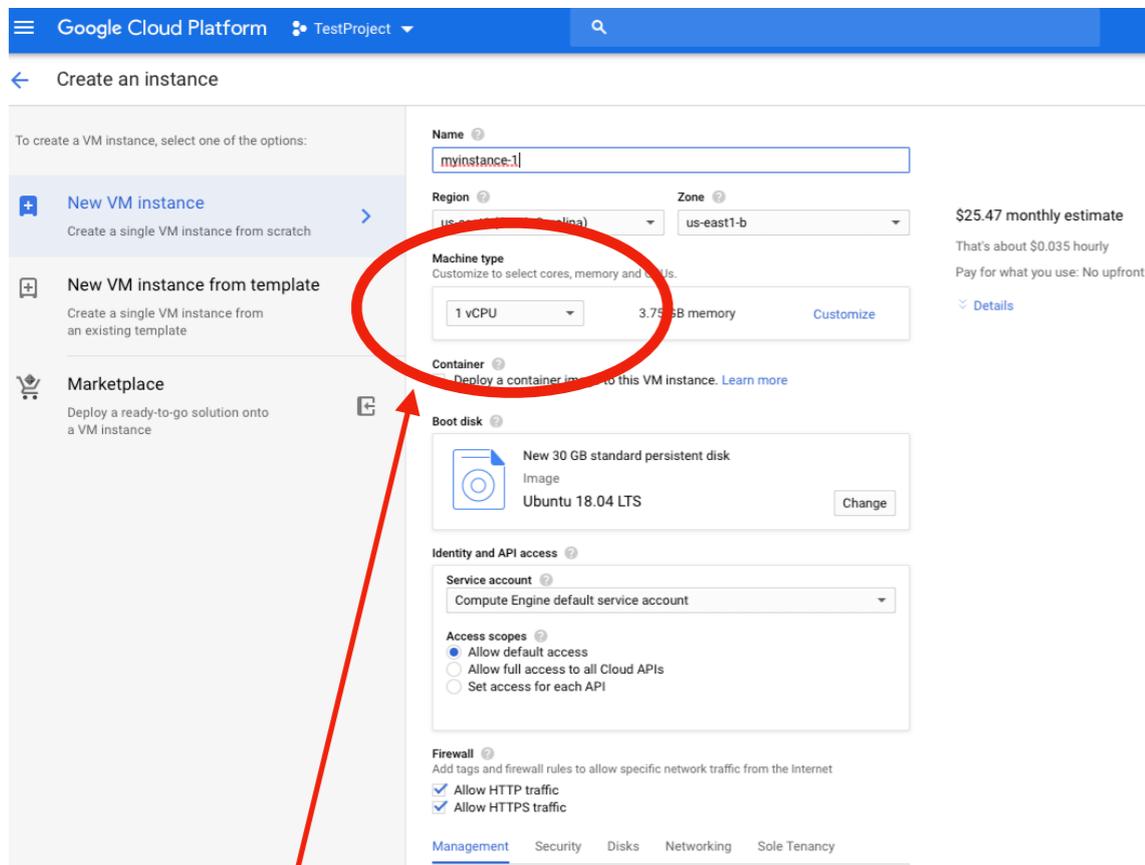
Choose Ubuntu 18.04 LTS

Option 2: Google Cloud Instances



Later, when you need it in the class, you can choose GPUs from here

Option 2: Google Cloud Instances



Later, when you need it in the class, you can choose GPUs from here

Option 2: Google Cloud Instances

Name [?]
myinstance-1

Region [?] us-east1 (South Carolina) Zone [?] us-east1-b

Machine type
Customize to select cores, memory and GPUs.

Basic view

Cores
1 vCPU 1 - 96

Memory
3.75 GB 1 - 6.5

Extend memory [?]

CPU platform [?]
Automatic

GPUs
The number of GPU dies is linked to the number of CPU cores and memory selected for this instance. For this machine type, you can select no fewer than 1 GPU die.
[Learn more](#)

Number of GPUs GPU type
1 NVIDIA Tesla P100

\$771.53 monthly estimate
That's about \$1.057 hourly
Pay for what you use: No upfront costs and per second billing
[Details](#)

Again, GPUs are expensive, be resourceful with your coupon!

Option 2: Google Cloud Instances

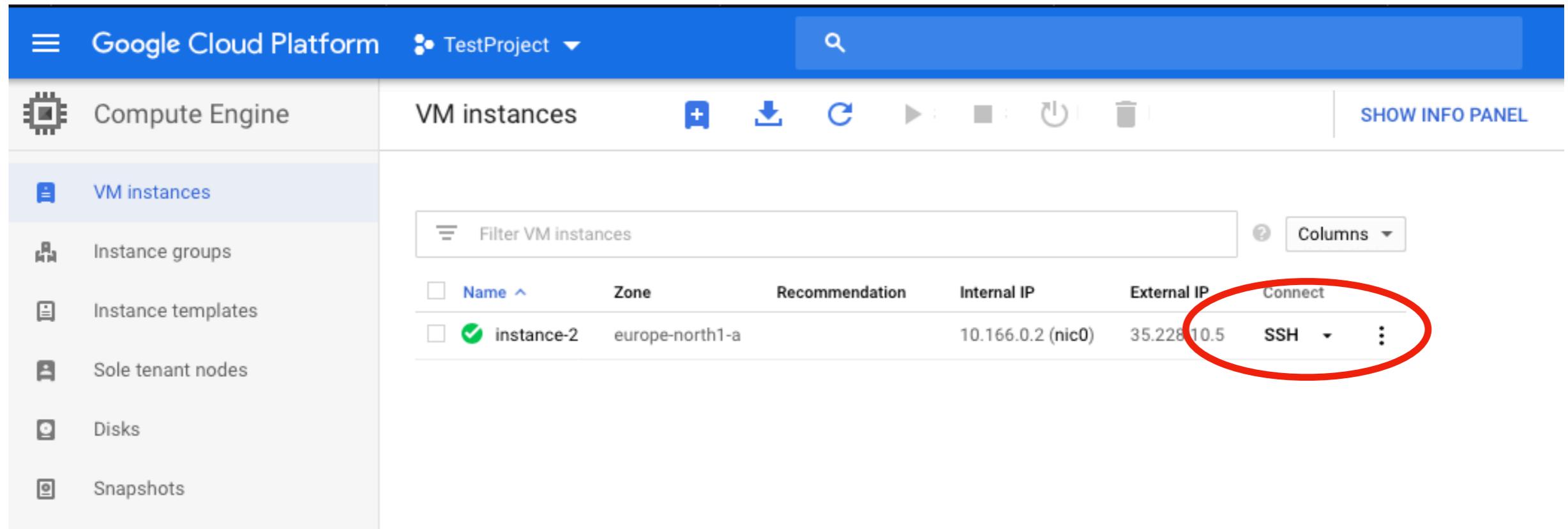


The screenshot shows a table of VM instances in Google Cloud. At the top, there is a search bar labeled "Filter VM instances" and a "Columns" dropdown menu. The table has columns for Name, Zone, Recommendation, Internal IP, External IP, and Connect. A tooltip is displayed over the "Recommendation" column of the first row, showing a red exclamation mark icon and the text "Quota 'GPUS_ALL_REGIONS' exceeded. Limit: 0.0 globally." The second row shows an instance named "myinstance-1" with a red exclamation mark icon in the "Recommendation" column, and "None" in the "External IP" column. The "Connect" column for both rows contains refresh and delete icons.

Name ^	Zone	Recommendation	Internal IP	External IP	Connect
		Quota 'GPUS_ALL_REGIONS' exceeded. Limit: 0.0 globally.		None	Refresh Delete
myinstance-1				None	Refresh Delete

It may unfortunately happen that sometimes all GPUs are busy (used by other people)

Option 2: Google Cloud Instances



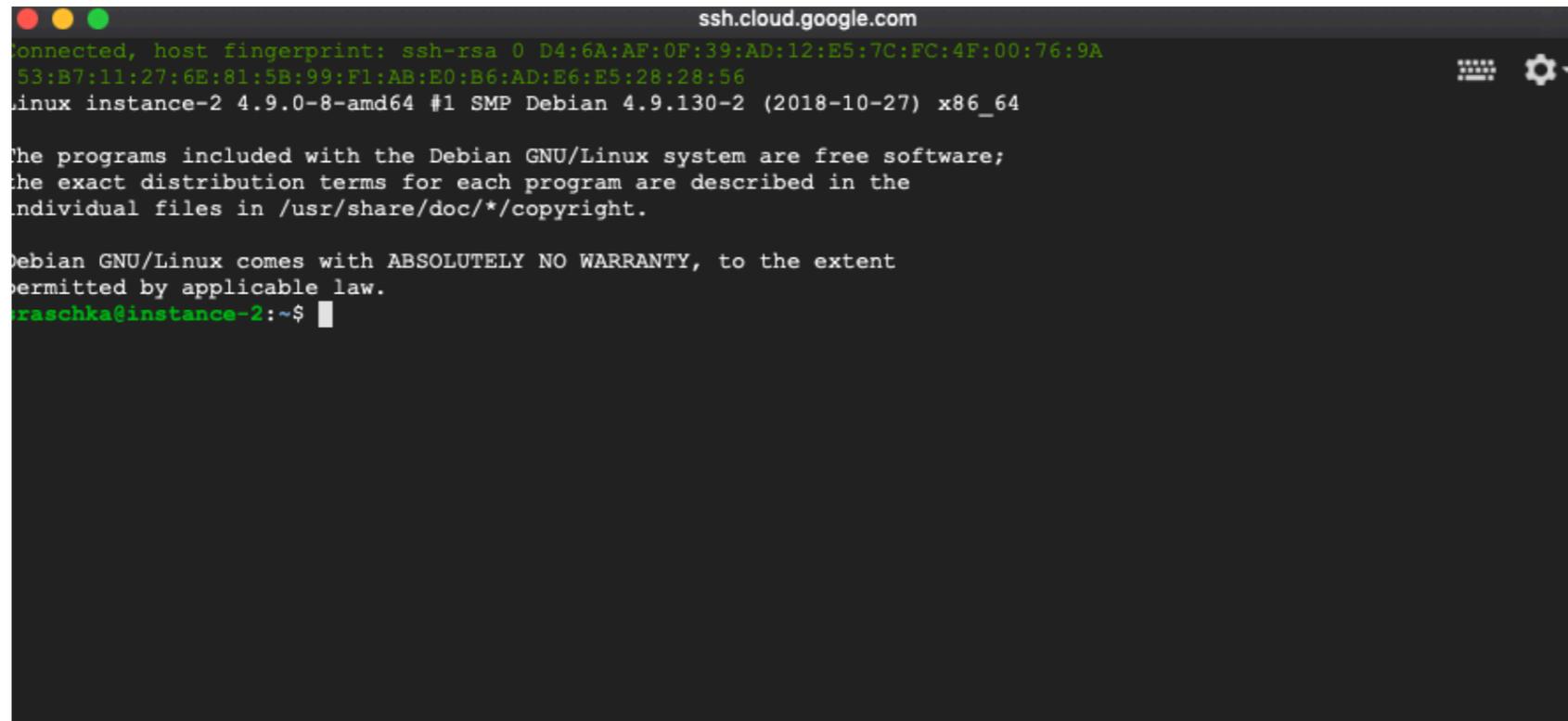
The screenshot shows the Google Cloud Platform console for a project named 'TestProject'. The left sidebar is set to 'Compute Engine' and 'VM instances'. The main area displays a table of VM instances. The table has columns for Name, Zone, Recommendation, Internal IP, External IP, and Connect. The 'Connect' column for the instance 'instance-2' is circled in red, showing the 'SSH' option.

Name	Zone	Recommendation	Internal IP	External IP	Connect
<input type="checkbox"/> instance-2	eu-west1-b	Standard	10.166.0.2 (nic0)	35.228.10.5	SSH

Anyways, once your instance runs, you can click in SSH to log in

However, note that the first time you are planning to use GPUs on Google Cloud Engine, you need to submit a Quota request. You can it at <https://console.cloud.google.com/iam-admin/quotas>

Option 2: Google Cloud Instances



```
ssh.cloud.google.com
connected, host fingerprint: ssh-rsa 0 D4:6A:AF:0F:39:AD:12:E5:7C:FC:4F:00:76:9A
53:B7:11:27:6E:81:5B:99:F1:AB:E0:B6:AD:E6:E5:28:28:56
linux instance-2 4.9.0-8-amd64 #1 SMP Debian 4.9.130-2 (2018-10-27) x86_64

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
sebastian@instance-2:~$
```

It will basically be a Linux terminal

Option 2: Google Cloud Instances

First, I recommend installing conda. In this step, we download it first

```
ssh.cloud.google.com
sraschka@instance-2:~$ wget https://repo.continuum.io/miniconda/Miniconda3-latest-Linux-x86_64.sh
--2019-02-20 07:02:13-- https://repo.continuum.io/miniconda/Miniconda3-latest-Linux-x86_64.sh
Resolving repo.continuum.io (repo.continuum.io)... 104.16.19.10, 104.16.18.10, 2606:4700::6810:130a, ...
Connecting to repo.continuum.io (repo.continuum.io)|104.16.19.10|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 69826864 (67M) [application/x-sh]
Saving to: 'Miniconda3-latest-Linux-x86_64.sh'

Miniconda3-latest-Linux-x86_ 100%[=====>] 66.59M 157MB/s in 0.4s

2019-02-20 07:02:14 (157 MB/s) - 'Miniconda3-latest-Linux-x86_64.sh' saved [69826864/69826864]

sraschka@instance-2:~$ █
```

Option 2: Google Cloud Instances

There is some package missing that we need for installing conda

```
sraschka@instance-2:~$ sudo apt-get install bzip2
Reading package lists... Done
Building dependency tree
Reading state information... Done
Suggested packages:
  bzip2-doc
The following NEW packages will be installed:
  bzip2
0 upgraded, 1 newly installed, 0 to remove and 0 not upgraded.
Need to get 47.5 kB of archives.
After this operation, 188 kB of additional disk space will be used.
Get:1 http://deb.debian.org/debian stretch/main amd64 bzip2 amd64 1.0.6-8.1 [47.5 kB]
Fetched 47.5 kB in 0s (761 kB/s)
Selecting previously unselected package bzip2.
(Reading database ... 34432 files and directories currently installed.)
Preparing to unpack .../bzip2_1.0.6-8.1_amd64.deb ...
Unpacking bzip2 (1.0.6-8.1) ...
Setting up bzip2 (1.0.6-8.1) ...
Processing triggers for man-db (2.7.6.1-2) ...
```

Option 2: Google Cloud Instances

After bzip2 is installed, you can run the installer for Miniconda:



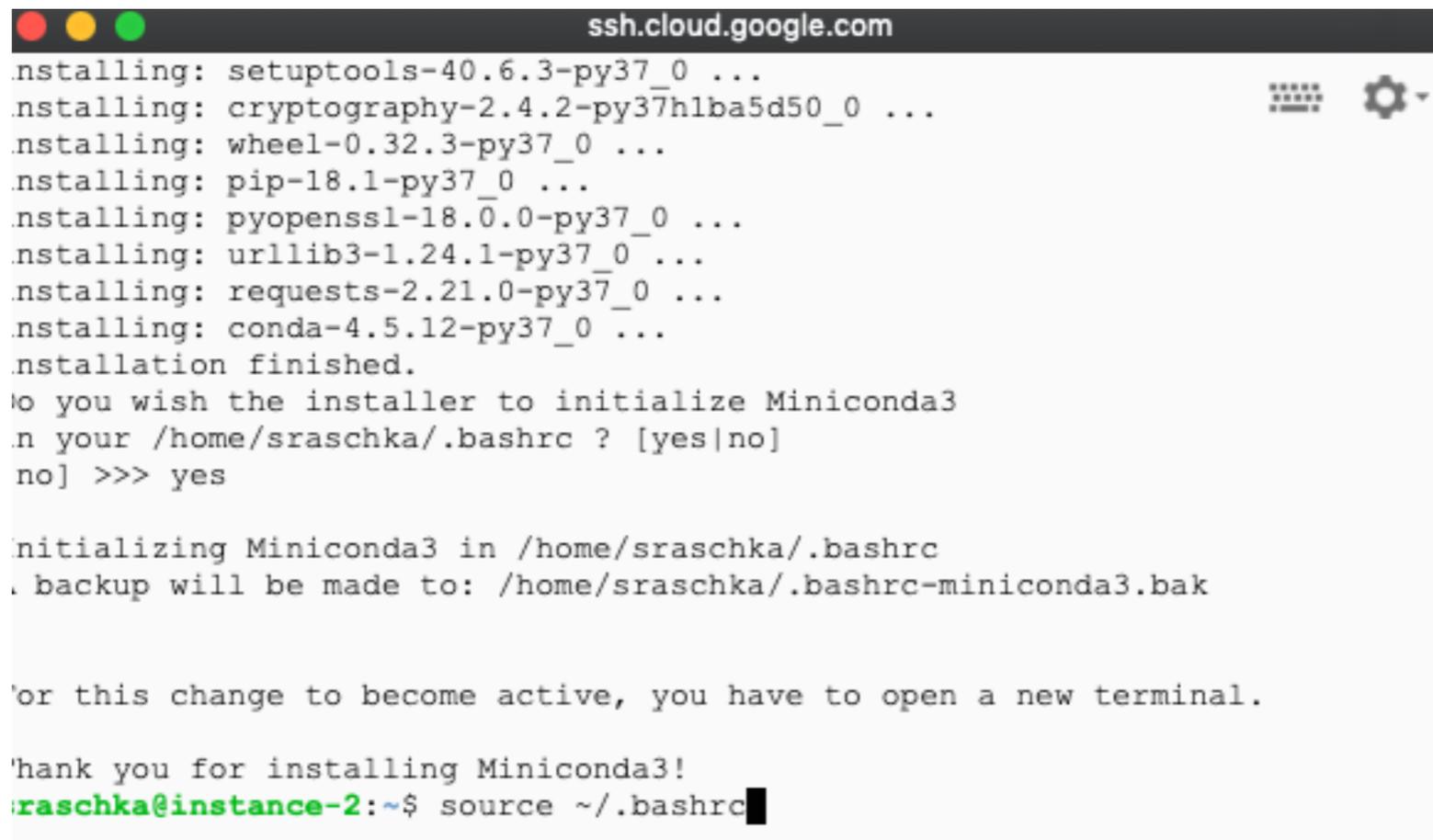
```
ssh.cloud.google.com
sraschka@instance-2:~$ bash Miniconda3-latest-Linux-x86_64.sh

Welcome to Miniconda3 4.5.12

In order to continue the installation process, please review the license
agreement.
Please, press ENTER to continue
>>> █
```

Option 2: Google Cloud Instances

After completing the installation, source your `~/ .bashrc` file

A terminal window titled 'ssh.cloud.google.com' showing the installation of Miniconda3. The output lists the installation of various dependencies: setuptools, cryptography, wheel, pip, pyopenssl, urllib3, requests, and conda. After the installation is finished, the user is prompted to initialize Miniconda3 in their .bashrc file. The user responds 'yes', and the terminal shows the initialization process, including a backup of the .bashrc file. The user is then prompted to open a new terminal for the changes to take effect. Finally, the user is thanked for installing Miniconda3, and the terminal prompt shows the user has successfully sourced the .bashrc file.

```
ssh.cloud.google.com
Installing: setuptools-40.6.3-py37_0 ...
Installing: cryptography-2.4.2-py37hlba5d50_0 ...
Installing: wheel-0.32.3-py37_0 ...
Installing: pip-18.1-py37_0 ...
Installing: pyopenssl-18.0.0-py37_0 ...
Installing: urllib3-1.24.1-py37_0 ...
Installing: requests-2.21.0-py37_0 ...
Installing: conda-4.5.12-py37_0 ...
Installation finished.
Do you wish the installer to initialize Miniconda3
in your /home/sraschka/.bashrc ? [yes|no]
no] >>> yes

initializing Miniconda3 in /home/sraschka/.bashrc
A backup will be made to: /home/sraschka/.bashrc-miniconda3.bak

For this change to become active, you have to open a new terminal.

Thank you for installing Miniconda3!
sraschka@instance-2:~$ source ~/.bashrc
```

Option 2: Google Cloud Instances

Next, you can conveniently install PyTorch via the command from PyTorch's main website <https://pytorch.org>

The image shows the PyTorch website's build configuration tool. On the left, there is a sidebar with the following options: PyTorch Build, Your OS, Package, Language, CUDA, and Run this Command. The main area displays a grid of options with the following selections highlighted in red:

Stable (1.0)	Preview (Nightly)			
Linux	Mac	Windows		
Conda	Pip	LibTorch	Source	
Python 2.7	Python 3.5	Python 3.6	Python 3.7	C++
8.0	9.0	10.0	None	

Below the grid, the command to run is displayed:

```
conda install pytorch torchvision cudatoolkit=10.0 -c pytorch
```

Below the website screenshot is a terminal window titled 'ssh.cloud.google.com'. The prompt is 'sraschka@instance-2:~\$' and the command 'conda install pytorch torchvision cudatoolkit=10.0 -c pytorch' is entered and executed.

Option 2: Google Cloud Instances

Next, let's check that PyTorch works
(you also may want to install ipython via conda):

```
Executing transaction: done
(base) sraschka@instance-2:~$ ipython
Python 3.7.1 (default, Dec 14 2018, 19:28:38)
Type 'copyright', 'credits' or 'license' for more information
Python 7.3.0 -- An enhanced Interactive Python. Type '?' for help.

In [1]: import torch

In [2]: █
```

Note that GCE now also provides a tutorial and utilities for a more convenient use of PyTorch on their cloud instances. I recommend reading through the tutorial at https://cloud.google.com/deep-learning-vm/docs/pytorch_start_instance

Option 2: Google Cloud Instances

How can we get data onto that instance now? This is a bit tricky, you would maybe need some understanding of Linux or macOS's Unix.

There are some tips here:

<https://cloud.google.com/compute/docs/instances/connecting-to-instance>

And here:

<https://cloud.google.com/compute/docs/instances/transfer-files>

Option 2: Google Cloud Instances

There, you need to follow the instructions to create authentication files:

[SSH \(LINUX & MACOS\)](#) [PUTTY \(WINDOWS\)](#)

To connect to an instance using `ssh` :

1. [Provide your public SSH key to an instance](#) using one of the available options.
2. In the console, find the external IP address for the instance that you want to connect to. Go to the list of instances page.

[GO TO THE INSTANCES PAGE](#)

3. In a terminal, use the `ssh` command and your private SSH key file to connect to your instance. Specify the external IP address of the instance that you want to connect to.

```
ssh -i [PATH_TO_PRIVATE_KEY] [USERNAME]@[EXTERNAL_IP_ADDRESS]
```

where:

- `[PATH_TO_PRIVATE_KEY]` is [the path to your private SSH key file](#).
- `[USERNAME]` is the name of the user connecting to the instance. The username for your public key when the SSH key was created. You can connect to the instance as that user if the instance has that user and if you have the matching private SSH key.
- `[EXTERNAL_IP_ADDRESS]` is the external IP address for your instance.

If the connection is successful, you can use the terminal to run commands on your instance. When you are done, use the `exit` command to disconnect from the instance.

Option 2: Google Cloud Instances

n	Internal IP	External IP	Connect
	10.166.0.2 (nic0)	35.228.10.5	SSH <input type="button" value="v"/> ⋮

- Open in browser window
- Open in browser window on custom port
- View gcloud command
- Use another SSH client

You can see that without key files, there's no access from your own terminal:

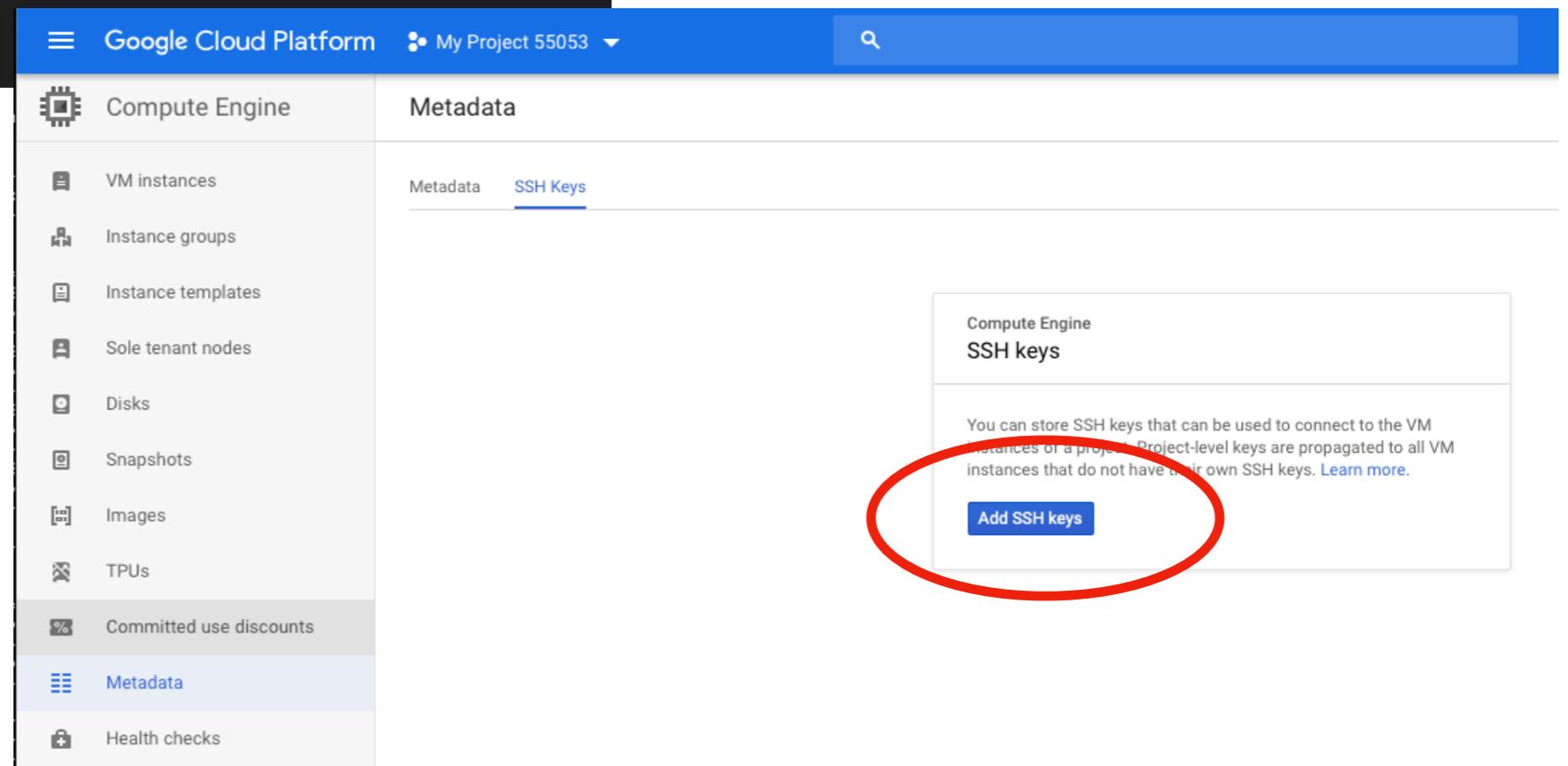
So, let's create a key pair:

```
sebastian — ssh-keygen -t rsa -f ~/.ssh/googlecloud -C sraschka — 80x24
Last login: Wed Feb 20 00:34:40 on ttys007
(base) sebastian@Sebastians-MacBook:~$ ssh sraschka@35.228.10.5
The authenticity of host '35.228.10.5 (35.228.10.5)' can't be established.
ECDSA key fingerprint is SHA256:E3SzAfk5pInnHdbnKkcAMNynaHvyzX5/UZN8OD4HExQ.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '35.228.10.5' (ECDSA) to the list of known hosts.
sraschka@35.228.10.5: Permission denied (publickey).
(base) sebastian@Sebastians-MacBook:~$ ssh-keygen -t rsa -f ~/.ssh/googlecloud -C sraschka
Generating public/private rsa key pair.
Enter passphrase (empty for no passphrase): ?
```

Option 2: Google Cloud Instances

The public key (it's contents) is what needs to be entered online in your account:

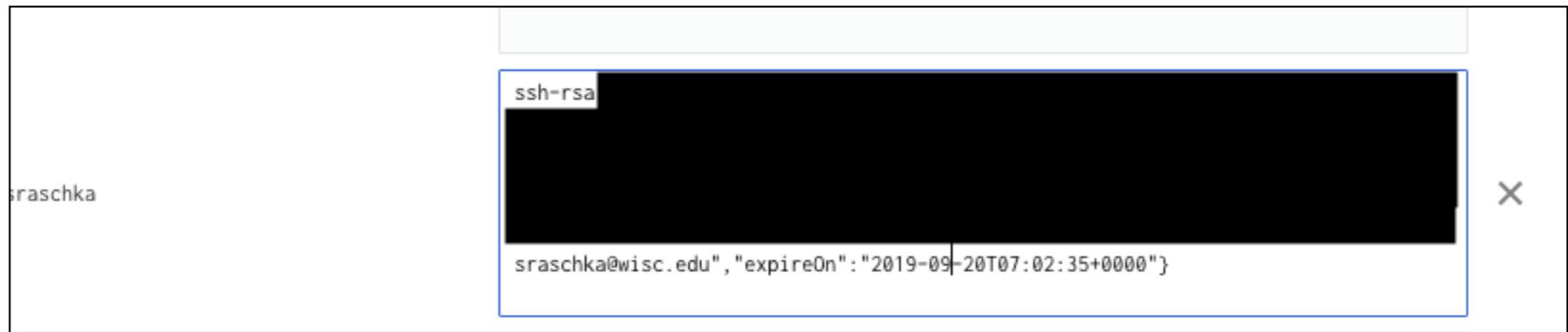
```
.ssh — -bash — 80x24
(base) sebastian@Sebastians-MacBook:~/ssh$ ls
googlecloud  googlecloud.pub  known_hosts
(base) sebastian@Sebastians-MacBook:~/ssh$
```



Option 2: Google Cloud Instances

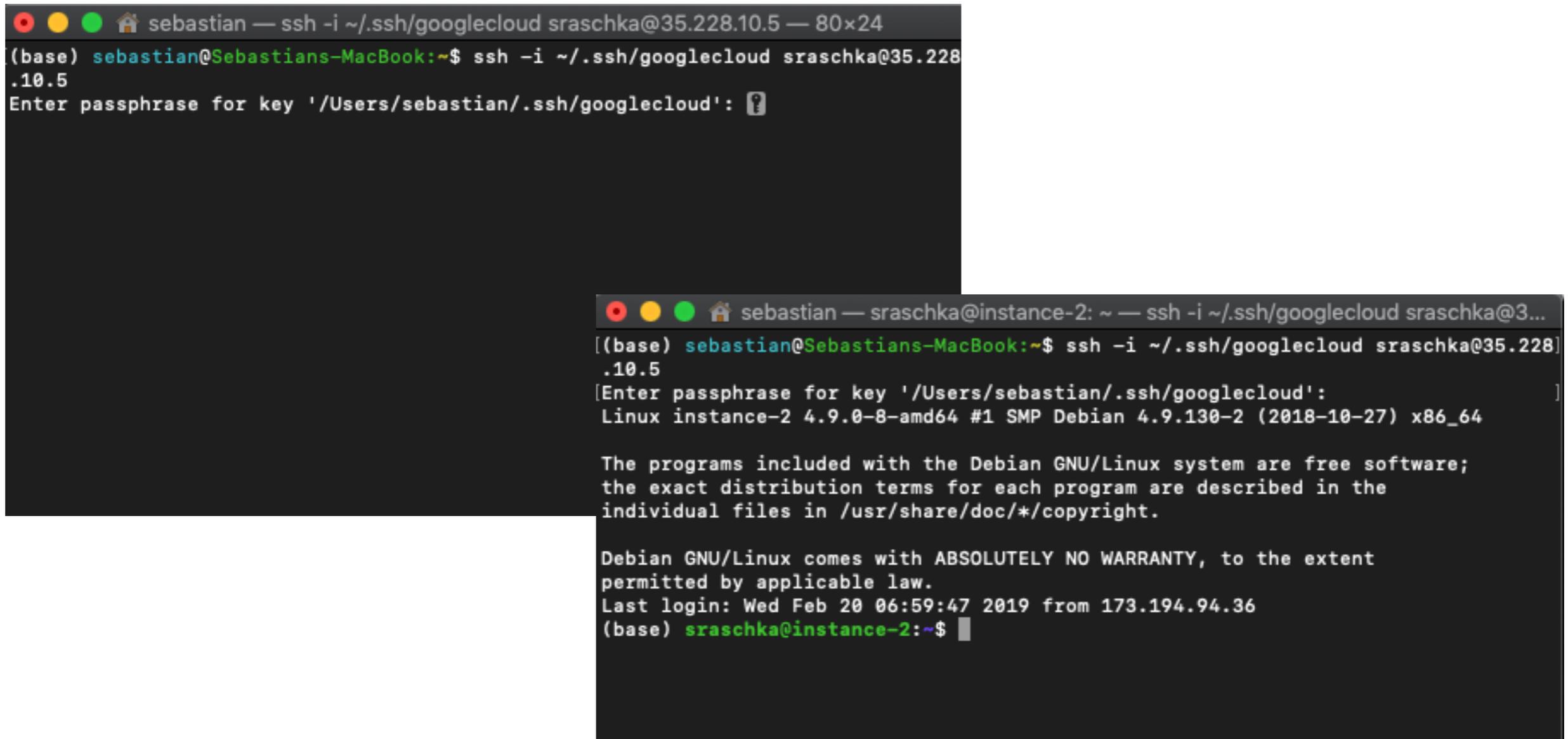
Note that I blacked out my key for security reasons ;)

Be aware of Google's special key formatting requirements (i.e., the contents you see in the curly braces; you may have to add that manually)



Option 2: Google Cloud Instances

Finally, we should be able to log in:



```
sebastian — ssh -i ~/.ssh/googlecloud sraschka@35.228.10.5 — 80x24
(base) sebastian@Sebastians-MacBook:~$ ssh -i ~/.ssh/googlecloud sraschka@35.228.10.5
Enter passphrase for key '/Users/sebastian/.ssh/googlecloud': [?]

sebastian — sraschka@instance-2: ~ — ssh -i ~/.ssh/googlecloud sraschka@3...
[(base) sebastian@Sebastians-MacBook:~$ ssh -i ~/.ssh/googlecloud sraschka@35.228.10.5
[Enter passphrase for key '/Users/sebastian/.ssh/googlecloud':
Linux instance-2 4.9.0-8-amd64 #1 SMP Debian 4.9.130-2 (2018-10-27) x86_64

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

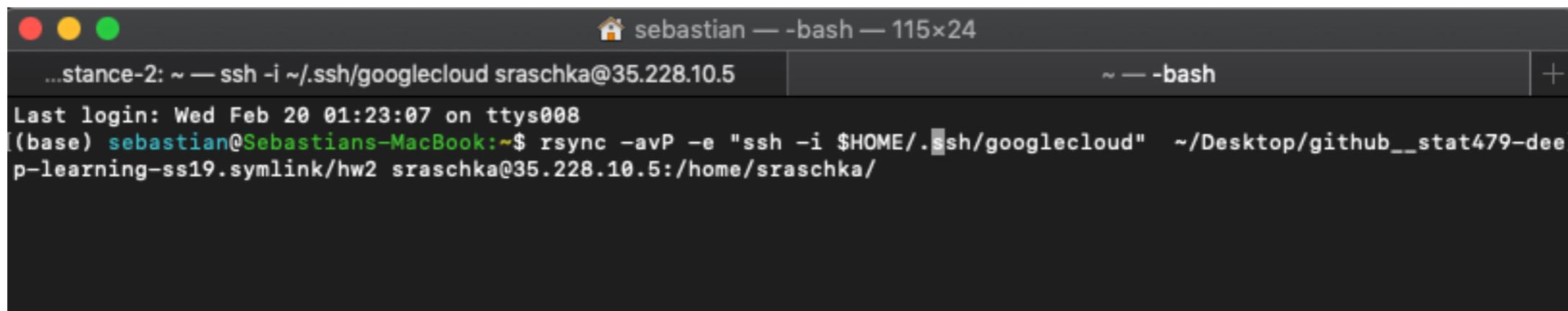
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Wed Feb 20 06:59:47 2019 from 173.194.94.36
(base) sraschka@instance-2:~$
```

Option 2: Google Cloud Instances

Next, you need to install rsync on the Google instance:

```
(base) sraschka@instance-2:~$ pwd
/home/sraschka
(base) sraschka@instance-2:~$ sudo apt-get install rsync
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following NEW packages will be installed:
  rsync
0 upgraded, 1 newly installed, 0 to remove and 0 not upgraded.
Need to get 393 kB of archives.
After this operation, 703 kB of additional disk space will be used.
Get:1 http://deb.debian.org/debian stretch/main amd64 rsync amd64 3.1.2-1+deb9u1 [393 kB]
Fetched 393 kB in 0s (2,976 kB/s)
Selecting previously unselected package rsync.
(Reading database ... 34460 files and directories currently installed.)
Preparing to unpack .../rsync_3.1.2-1+deb9u1_amd64.deb ...
Unpacking rsync (3.1.2-1+deb9u1) ...
Setting up rsync (3.1.2-1+deb9u1) ...
Created symlink /etc/systemd/system/multi-user.target.wants/rsync.service → /lib/systemd/system/rsync.service.
Processing triggers for systemd (232-25+deb9u8) ...
Processing triggers for man-db (2.7.6.1-2) ...
(base) sraschka@instance-2:~$
```

And after that, I can transfer files from my local machine to the Google instance:

A terminal window titled 'sebastian' with a window size of '115x24'. The terminal shows a shell prompt '(base) sebastian@Sebastians-MacBook:~\$' followed by the command 'rsync -avP -e "ssh -i \$HOME/.ssh/googlecloud" ~/Desktop/github__stat479-deep-learning-ss19.symlink/hw2 sraschka@35.228.10.5:/home/sraschka/'. The output of the command is not visible in the image.

```
sebastian — -bash — 115x24
...stance-2: ~ — ssh -i ~/.ssh/googlecloud sraschka@35.228.10.5
Last login: Wed Feb 20 01:23:07 on ttys008
(base) sebastian@Sebastians-MacBook:~$ rsync -avP -e "ssh -i $HOME/.ssh/googlecloud" ~/Desktop/github__stat479-deep-learning-ss19.symlink/hw2 sraschka@35.228.10.5:/home/sraschka/
```

Option 2: Google Cloud Instances

```
sebastian — -bash — 115x24
stance-2: ~ — ssh -i ~/.ssh/googlecloud sraschka@35.228.10.5
~/rsync-52.200.1/rsync/io.c(453) [sender=2.6.9]
(base) sebastian@Sebastians-MacBook:~$ rsync -Pav -e "ssh -i $HOME/.ssh/googlecloud" ~/Desktop/github__stat479-dee
p-learning-ss19.symlink/hw2 sraschka@35.228.10.5:/home/sraschka/
[Enter passphrase for key '/Users/sebastian/.ssh/googlecloud':
building file list ...
9 files to consider
hw2/
hw2/.DS_Store
  6148 100%  0.00kB/s   0:00:00 (xfer#1, to-check=7/9)
hw2/hw2.ipynb
 18637 100% 17.77MB/s   0:00:00 (xfer#2, to-check=6/9)
hw2/.ipynb_checkpoints/
hw2/.ipynb_checkpoints/hw2-checkpoint.ipynb
 18637 100%  5.92MB/s   0:00:00 (xfer#3, to-check=4/9)
hw2/datasets/
hw2/datasets/iris.data
  4551 100% 493.82kB/s   0:00:00 (xfer#4, to-check=2/9)
hw2/images/
hw2/images/neuron.png
 47842 100%  4.15MB/s   0:00:00 (xfer#5, to-check=0/9)

sent 96376 bytes  received 154 bytes  9193.33 bytes/sec
total size is 95815  speedup is 0.99
(base) sebastian@Sebastians-MacBook:~$
```

As we can see, everything is on the Google instance now:

```
sebastian — sraschka@instance-2: ~/hw2 — ssh -i ~/.ssh/googlecloud sraschka@35.228.10.5 — 115x24
ce-2: ~/hw2 — ssh -i ~/.ssh/googlecloud sraschka@35.228.10.5
(base) sraschka@instance-2:~$ ls
hw2  miniconda3  Miniconda3-latest-Linux-x86_64.sh  Miniconda3-latest-Linux-x86_64.sh.1
(base) sraschka@instance-2:~$ cd hw2/
(base) sraschka@instance-2:~/hw2$ ls
datasets  hw2.ipynb  images
(base) sraschka@instance-2:~/hw2$
```

Option 2: Google Cloud Instances

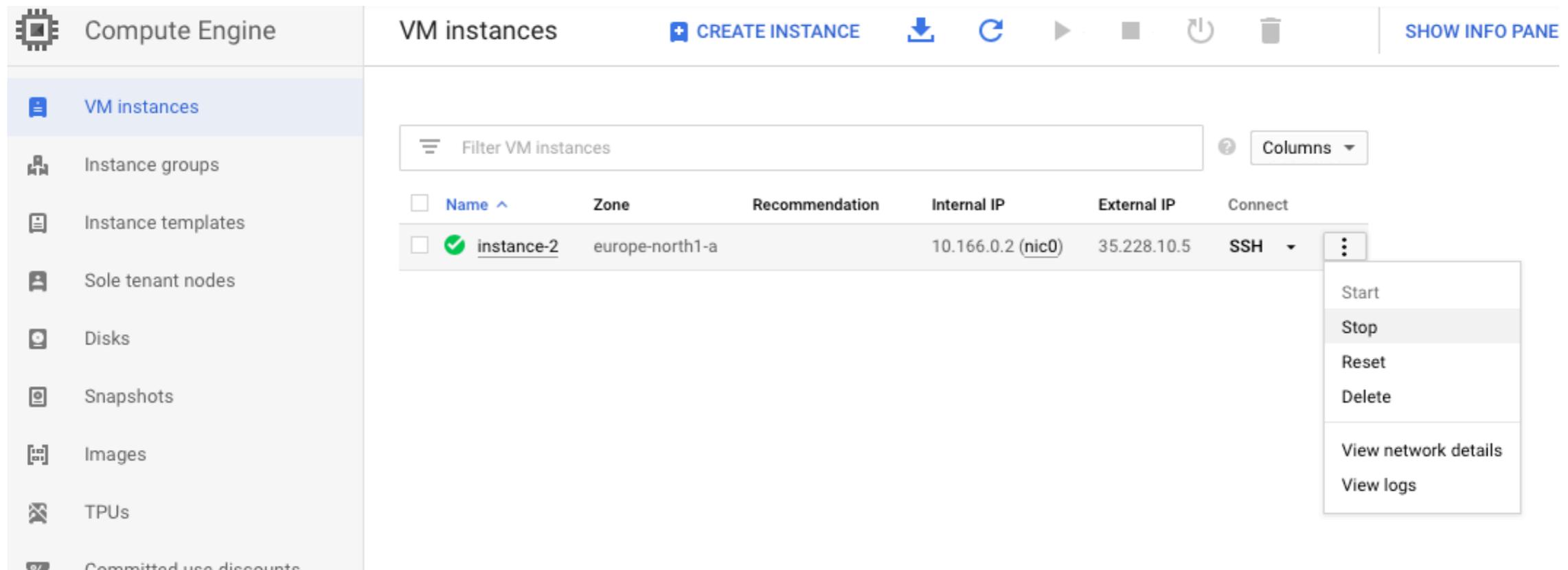
Setting up Jupyter Notebook access is also tricky. I uploaded some instructions here, which also apply to Google Cloud:

Section H.10 (pp. 25-27)

https://github.com/rasbt/stat479-deep-learning-ss19/blob/master/other/appendix__cloud-computing.pdf

Option 2: Google Cloud Instances

Very Important: When you are done, stop or delete your instances!



The screenshot displays the Google Cloud Platform interface for VM instances. The left sidebar shows the 'Compute Engine' menu with 'VM instances' selected. The main area shows a table of VM instances. The table has the following columns: Name, Zone, Recommendation, Internal IP, External IP, and Connect. The table contains one instance named 'instance-2' in the 'europe-north1-a' zone. The 'Internal IP' is '10.166.0.2 (nic0)' and the 'External IP' is '35.228.10.5'. The 'Connect' column shows 'SSH'. A context menu is open over the 'instance-2' row, showing options: Start, Stop, Reset, Delete, View network details, and View logs.

Name	Zone	Recommendation	Internal IP	External IP	Connect
instance-2	europe-north1-a		10.166.0.2 (nic0)	35.228.10.5	SSH

Once you are done, either stop or delete the instances. Stopped instances will cost some minor amount for storage, but you won't have to redo all the steps. Deleted instances are gone forever. I recommend stopping the instance until the end of the class if you like to reuse it.