

Pecos

Why use it?

With a study as important as this one, we want to ensure that our data is of the utmost quality. Pecos, a product of Sandia National Laboratories, is well renowned as a staple in the quality assurance sector of photovoltaic systems. In our study, large quantities of data are being collected every minute which means that it is highly impractical to manually assess every collection. That is where Pecos comes in. According to its documentation, “Pecos is an open-source Python package designed to conduct automated quality control and performance monitoring which can allow system operators to quickly detect performance issues.” This is exactly what we were looking for.

How to use it?

Reference “Pecos Guide” Below

How it works?

Pecos is a Python Package. That means that it is a large collection of various scripts and files that work together in order to accomplish a task. While Sandia Labs designed this code in order to conduct data quality control and panel efficiency, our primary concern is purely on data quality control. Therefore, large portions of the original script have been removed in order to only conduct necessary evaluations. Furthermore, its primary function is to serve as a quality assurance measure to flag erroneous data and generate easy to read reports.

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Pecos Guide

Step 1: Download and Install Oracle VM VirtualBox

Visit: <https://www.virtualbox.org/>

You should now be seeing a window like this:



VirtualBox

Welcome to VirtualBox.org!

VirtualBox is a powerful x86 and AMD64/Intel64 virtualization product for enterprise as well as home use. Not only is VirtualBox an extremely feature rich, high performance product for enterprise customers, it is also the only professional solution that is freely available as Open Source Software under the terms of the GNU General Public License (GPL) version 3. See "About VirtualBox" for an introduction.

Presently, VirtualBox runs on Windows, Linux, macOS, and Solaris hosts and supports a large number of guest operating systems including but not limited to Windows (NT 4.0, 2000, XP, Server 2003, Vista, Windows 7, Windows 8, Windows 10), DOS/Windows 3.x, Linux (2.4, 2.6, 3.x and 4.x), Solaris and OpenSolaris, OS/2, and OpenBSD.

VirtualBox is being actively developed with frequent releases and has an ever growing list of features: supported guest operating systems and platforms it runs on. VirtualBox is a community effort backed by a dedicated company: everyone is encouraged to contribute while Oracle ensures the product always meets professional quality criteria.

Download VirtualBox 7.0

Hot picks:

- Pre-built virtual machines for developers at [Oracle's Tech Network](#)
- [Hyperbox](#) Open-source Virtual Infrastructure Manager [project site](#)
- [phpVirtualBox](#) AJAX web interface [project site](#)

News Flash:

- New January 17th, 2023** [VirtualBox 7.0.6 released!](#)
Oracle today released a 7.0 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.
- New January 17th, 2023** [VirtualBox 6.1.4 released!](#)
Oracle today released a 6.1 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.
- New November 10th, 2022** [VirtualBox 7.0.4 released!](#)
Oracle today released a 7.0 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.
- New October 20th, 2022** [VirtualBox 7.0.2 released!](#)
Oracle today released a 7.0 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.
- New October 10th, 2022** [VirtualBox 6.1.6 released!](#)
Oracle today released a 6.1 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.
- New October 10th, 2022** [VirtualBox 6.1.4 released!](#)
Oracle today released a significant new version of Oracle VM VirtualBox, the highly popular open source virtualization software. Changelog for details.
- New September 2nd, 2022** [VirtualBox 6.1.3b released!](#)
Oracle today released a 6.1 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.
- New August 30th, 2022** [We're hiring!](#)
Looking for a challenge? We're hiring a VirtualBox Principal Software Developer (US, UK, Romania).
- New July 1st, 2022** [VirtualBox 6.1.3b released!](#)
Oracle today released a 6.1 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.

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Click the Download button to begin downloading VirtualBox:



VirtualBox

Welcome to VirtualBox.org!

VirtualBox is a powerful x86 and AMD64/Intel64 virtualization product for enterprise as well as home use. Not only is VirtualBox an extremely feature rich, high performance product for enterprise customers, it is also the only professional solution that is freely available as Open Source Software under the terms of the GNU General Public License (GPL) version 3. See "About VirtualBox" for an introduction.

Presently, VirtualBox runs on Windows, Linux, macOS, and Solaris hosts and supports a large number of guest operating systems including but not limited to Windows (NT 4.0, 2000, XP, Server 2003, Vista, Windows 7, Windows 8, Windows 10), DOS/Windows 3.x, Linux (2.4, 2.6, 3.x and 4.x), Solaris and OpenSolaris, OS/2, and OpenBSD.

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[Download VirtualBox 7.0](#)

Hot picks:

- Pre-built virtual machines for developers at [Oracle Tech Network](#).
- [Hyperbox](#) Open-source Virtual Infrastructure Manager [project site](#)
- [phpVirtualBox](#) AJAX web interface [project site](#)

News Flash

New January 17th, 2023
VirtualBox 7.0.6 released!
Oracle today released a 7.0 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.

New January 17th, 2023
VirtualBox 7.0.5 released!
Oracle today released a 7.0 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.

New November 18th, 2022
VirtualBox 7.0.4 released!
Oracle today released a 7.0 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.

New October 20th, 2022
VirtualBox 7.0.2 released!
Oracle today released a 7.0 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.

New October 11th, 2022
VirtualBox 6.1.40 released!
Oracle today released a 6.1 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.

New October 10th, 2022
VirtualBox 7.0.0 released!
Oracle today released a significant new version of Oracle VM VirtualBox, its high performance, multi-platform virtualization software. Choose for details.

New September 2nd, 2022
VirtualBox 6.1.38 released!
Oracle today released a 6.1 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.

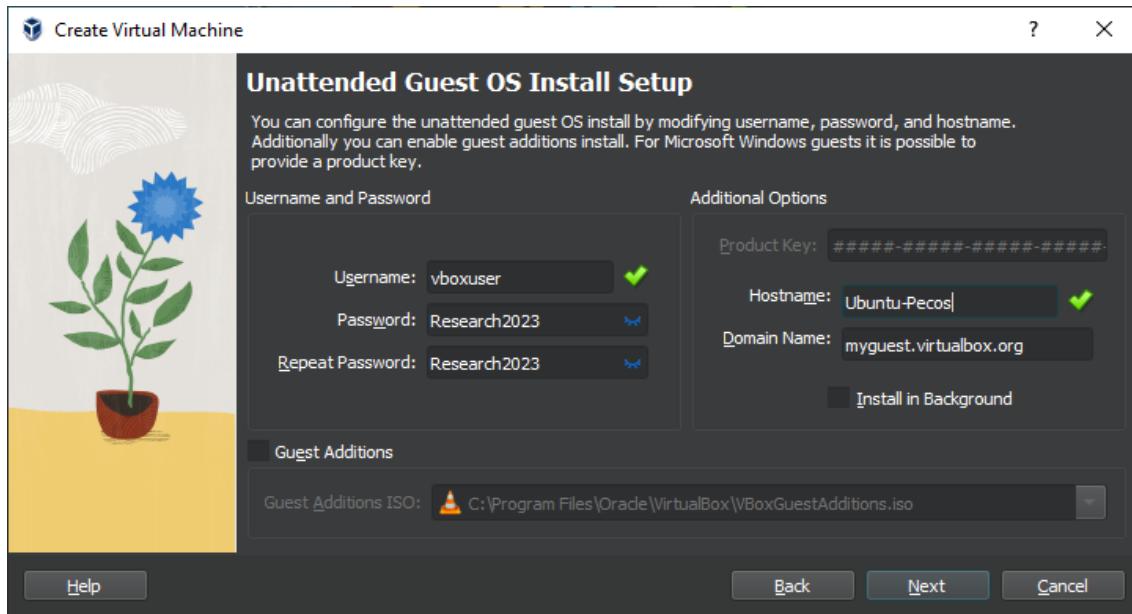
New August 30th, 2022
We're hiring! Looking for a new challenge? We're hiring! Join our team of Software Developers (US, UK, Romania).

New July 19th, 2022
VirtualBox 6.1.37 released!
Oracle today released a 6.1 maintenance release which improves stability and fixes regressions. See the [Changelog](#) for details.

Once the download has finished, allow the program to install.

(* If provided with VM Disk Image, Go to Launching VM section of Step 3 (Follow steps on how to launch the VM, skip to Step 5, and use login information below. *)

Login Information:

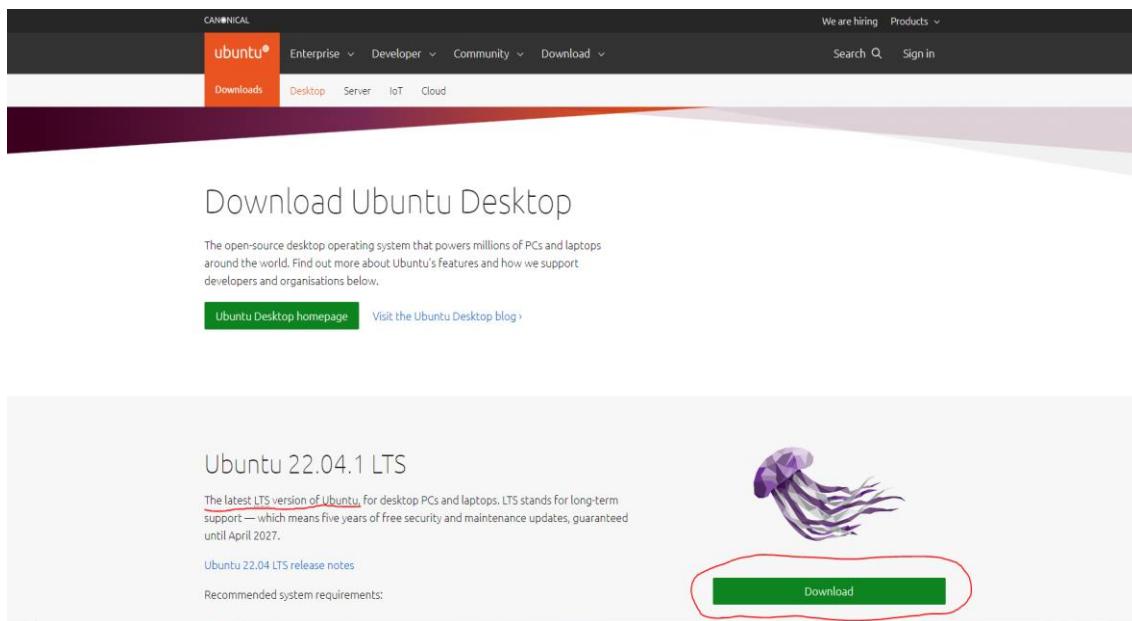


Step 2. Download Ubuntu Desktop

Visit: <https://ubuntu.com/download/desktop>

You should now be seeing a window like this:

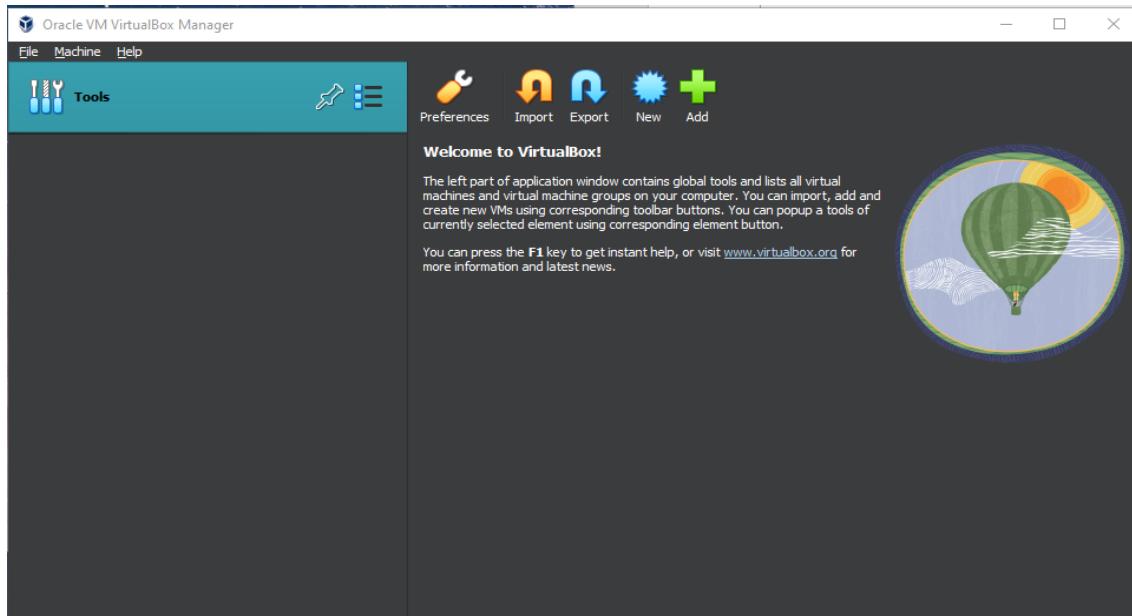
Click the Download button on the latest version to begin downloading Ubuntu Desktop:



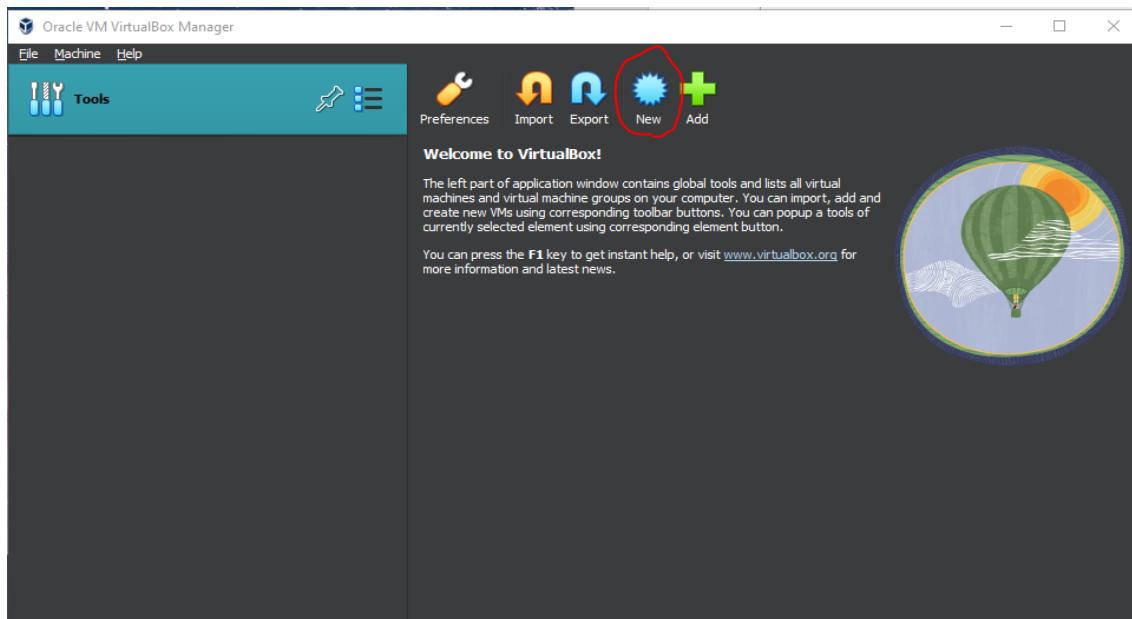
Once the download has finished, be sure to unzip the file. (Right click on zip folder and select *Extract All*.)

Step 3. Creating a New Virtual Machine

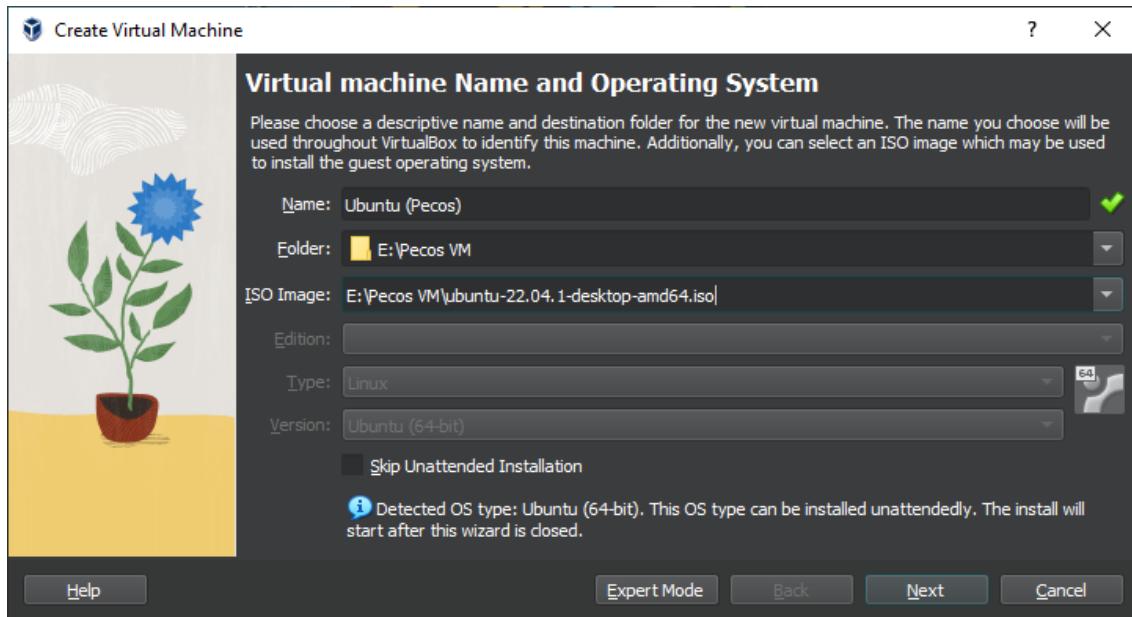
Launch Oracle VM VirtualBox. Once launched, you should see a window like the one below:



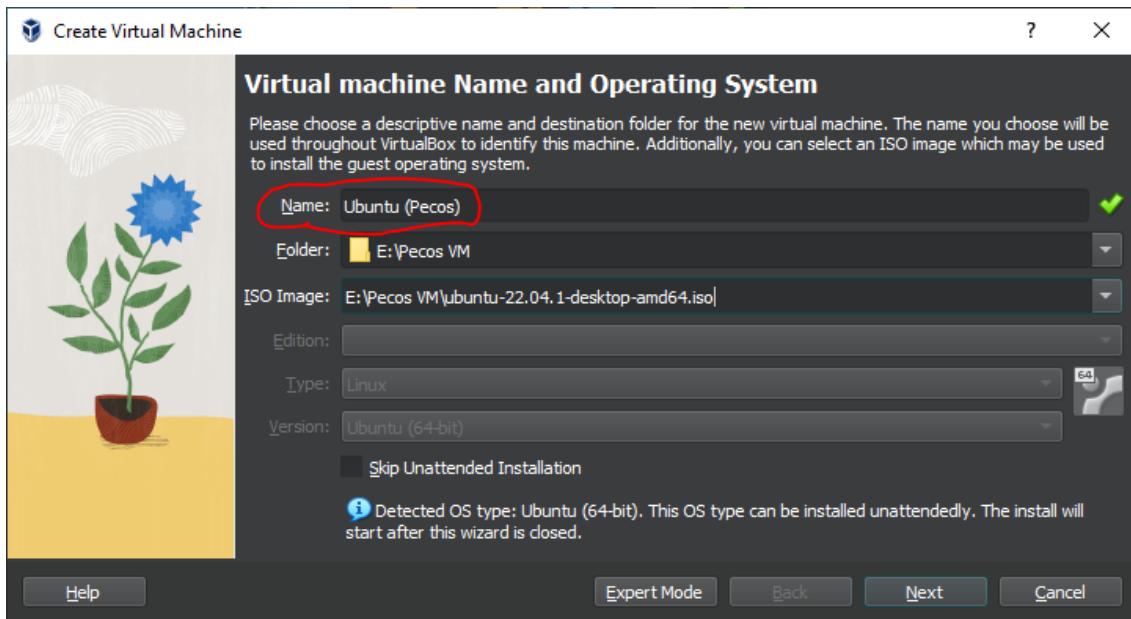
To create a new VM select NEW:



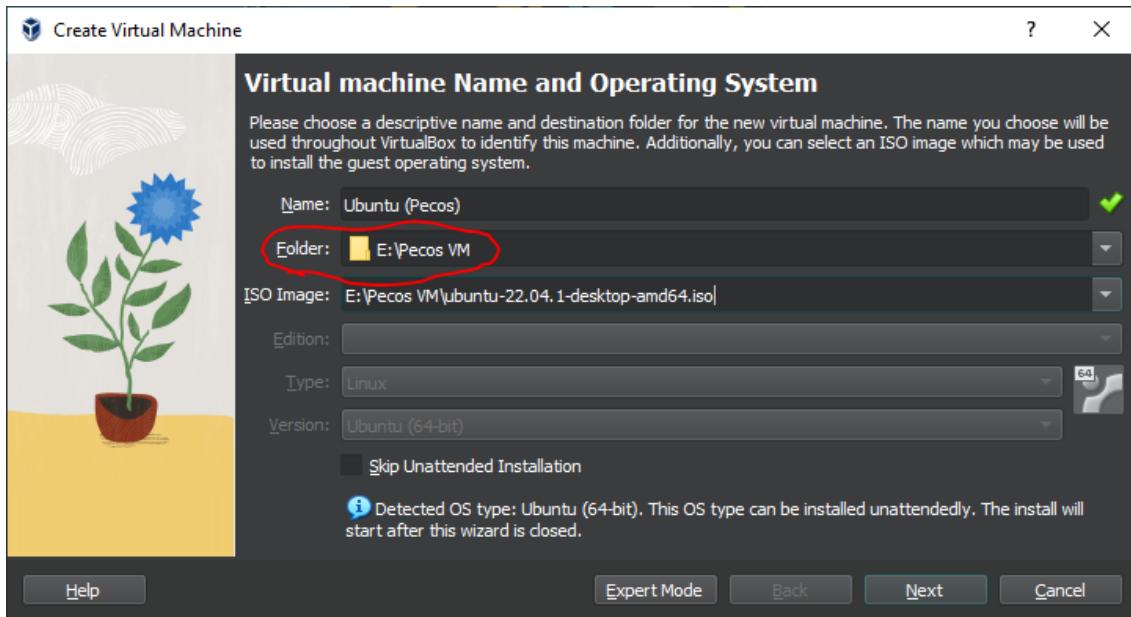
Now you should be seeing a window like the one below:



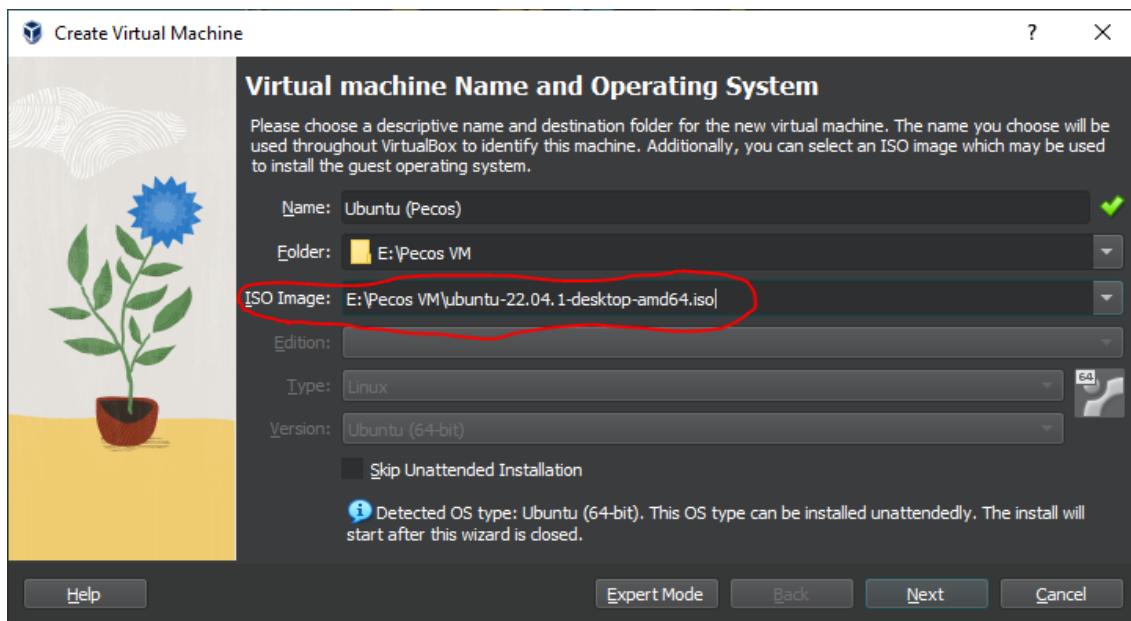
Input the name that you want to assign to the new VM:



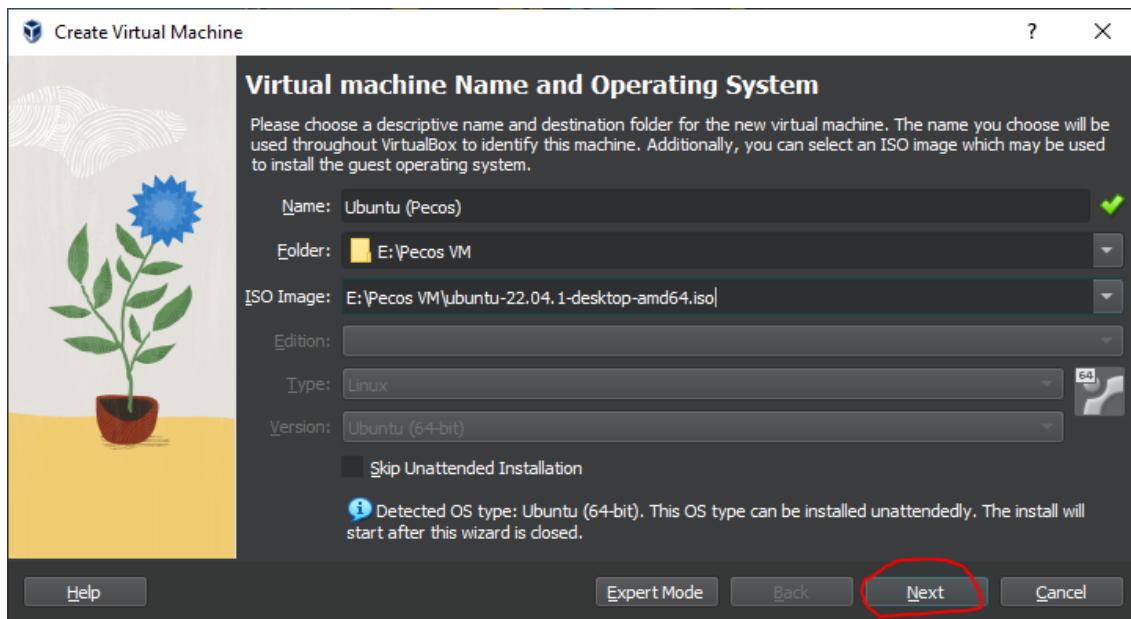
Designate the folder that you want the VM to reside within:



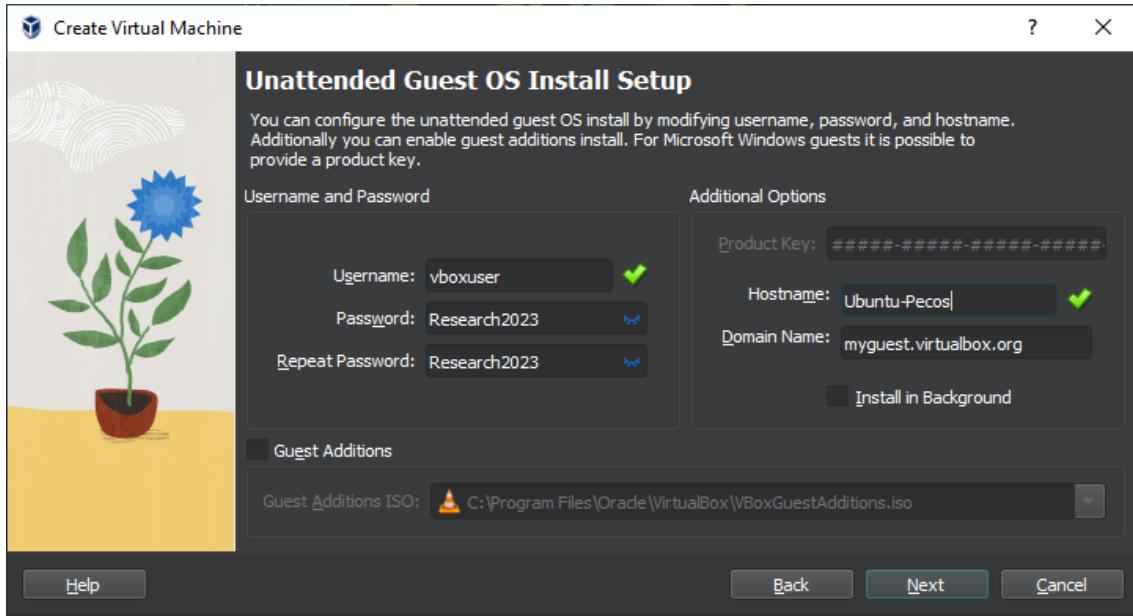
Select the ISO Image (*This is the Ubuntu Desktop that we downloaded in Step 2*):



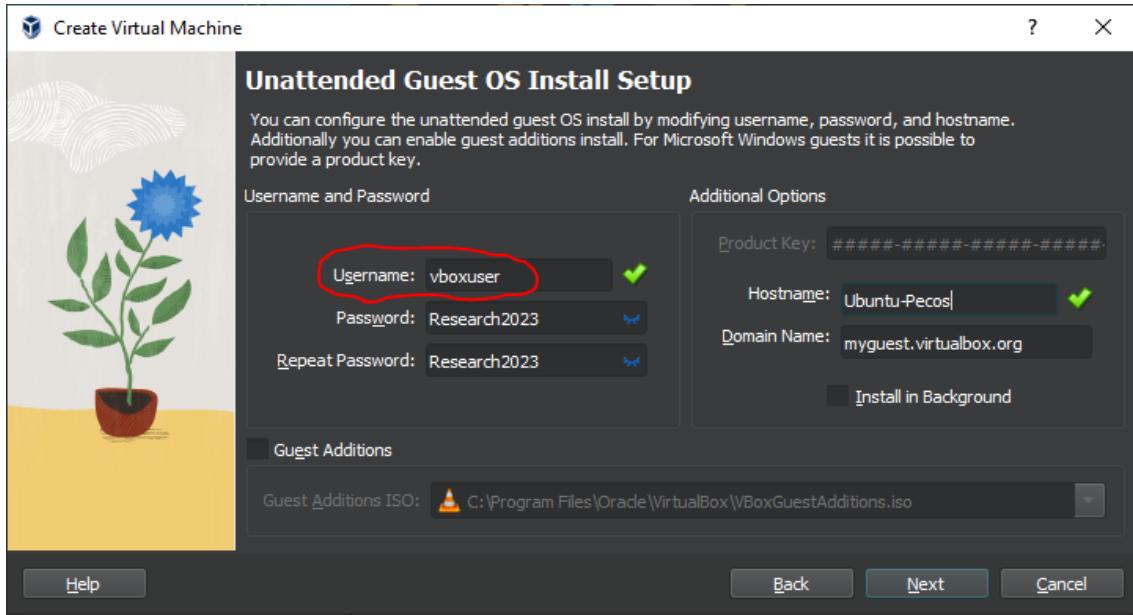
Now hit Next to go on to the next step:



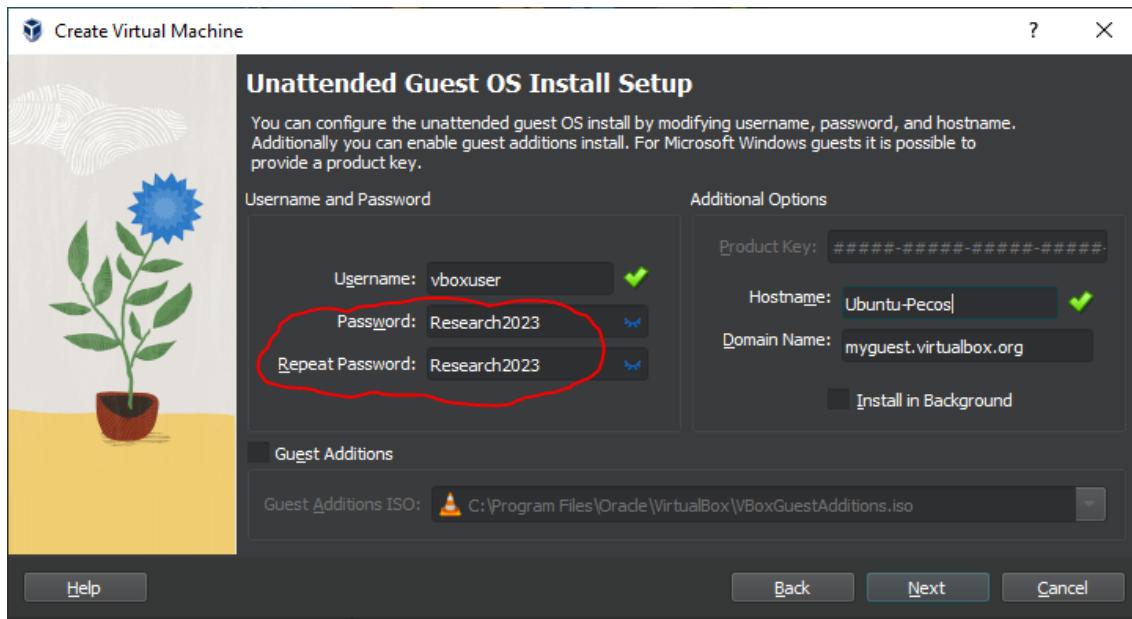
You should now be seeing a window like below:



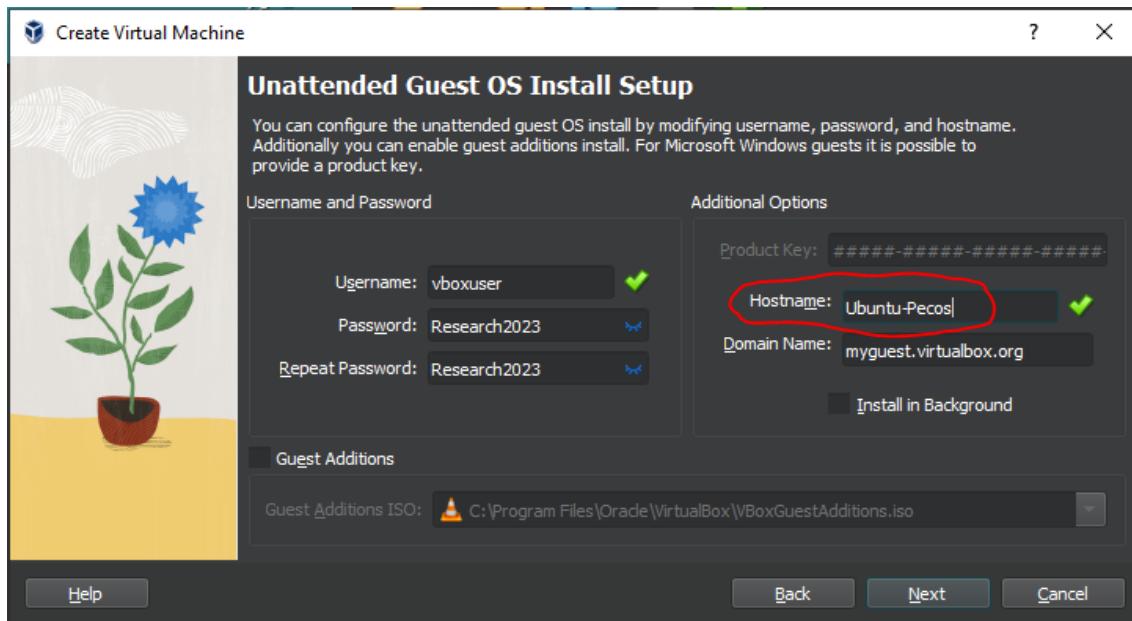
Here we can designate the Username that will be associated with the system:



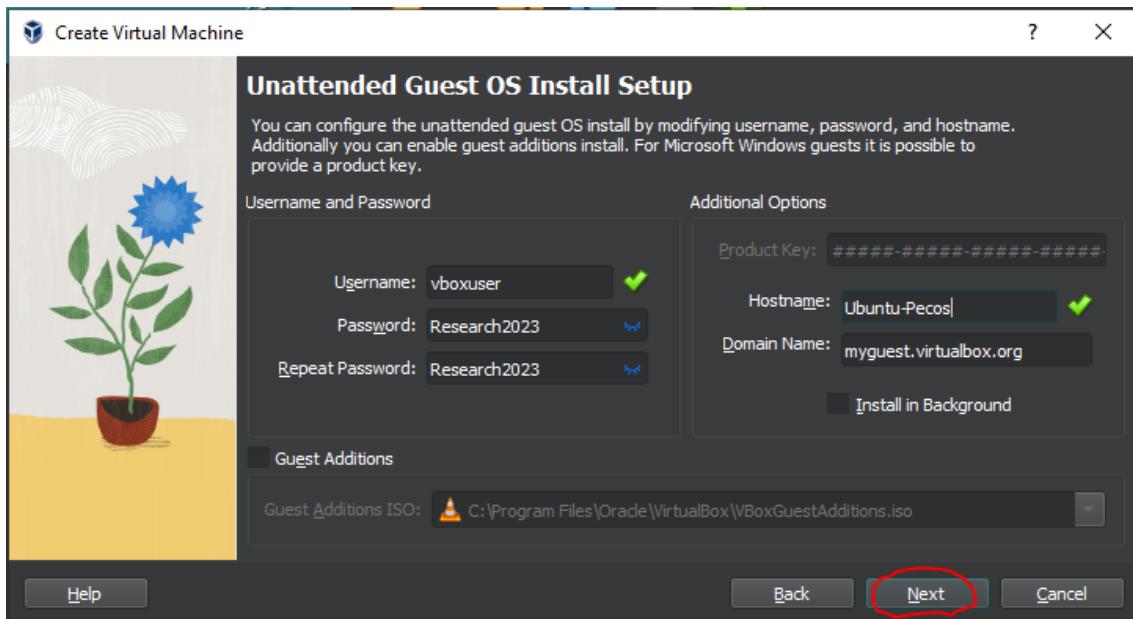
Setup the Password:



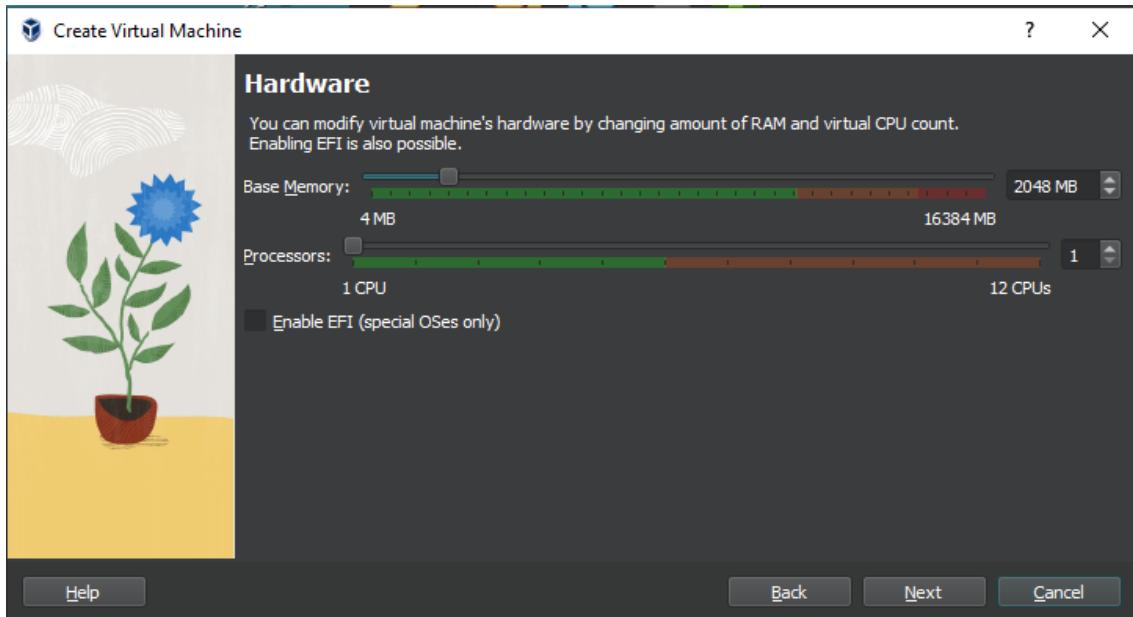
Setup the Host Name (*This will default to the name of the VM which may need to be changed due to the presence of invalid characters*):



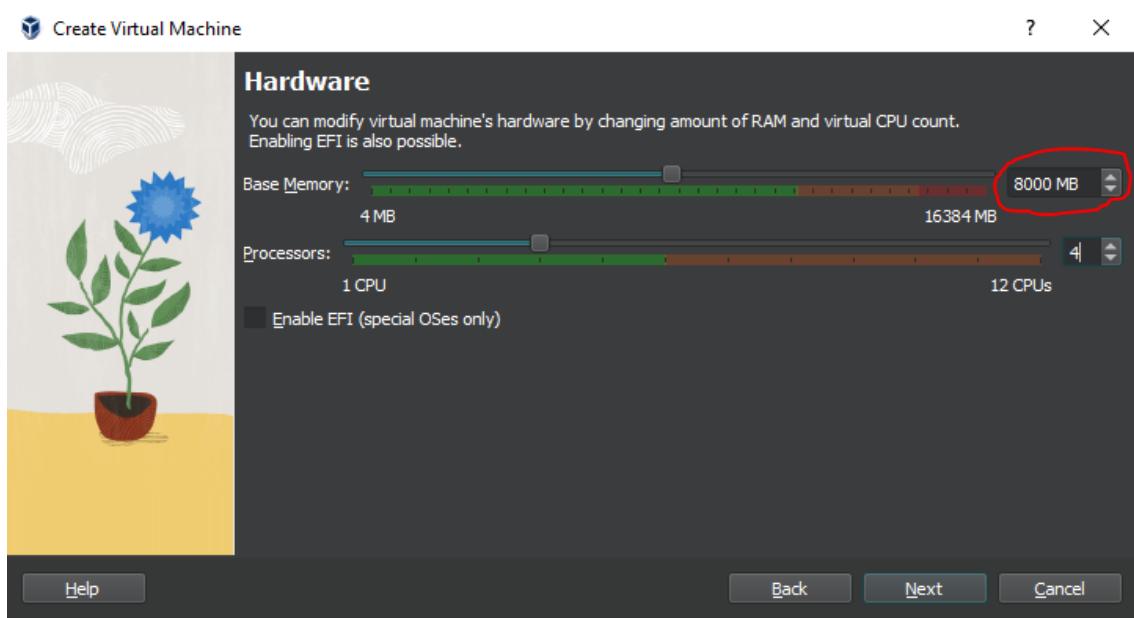
Now hit Next to go on to the next step:



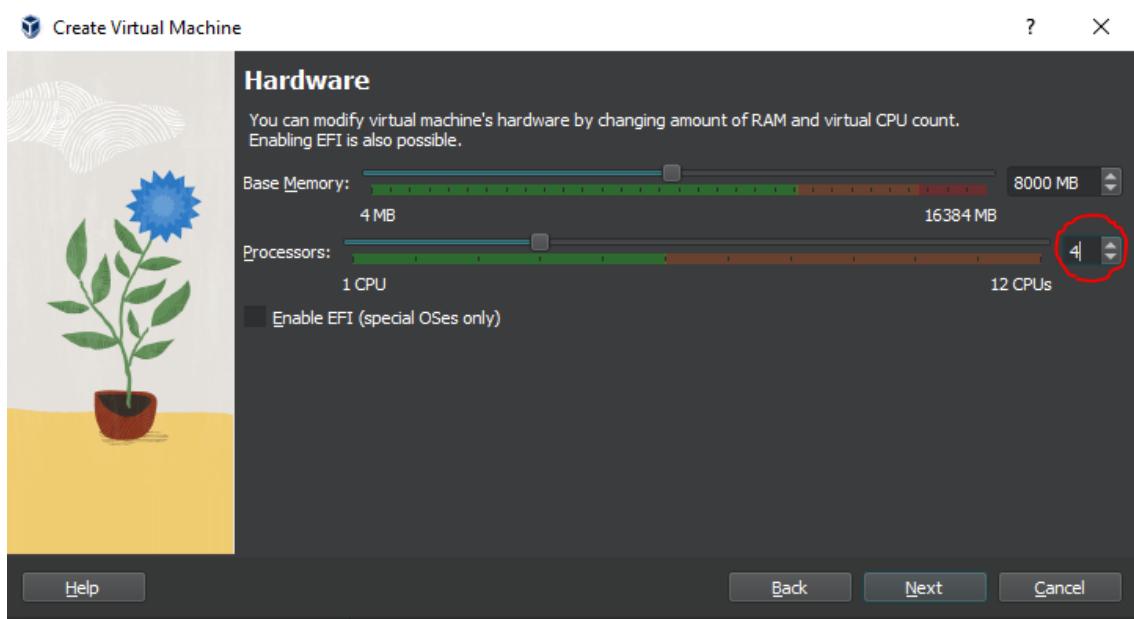
You should now have a window like the one shown below:



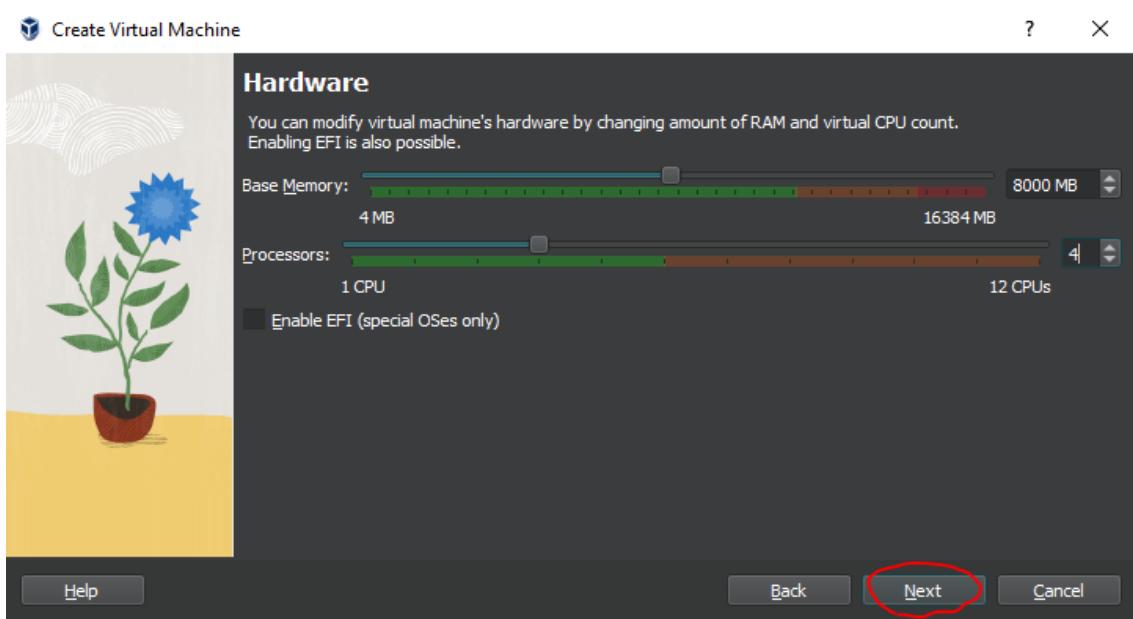
Here we can change the amount of RAM allocated to the system. I recommend using at least 8 GB (8000 MB) of RAM:



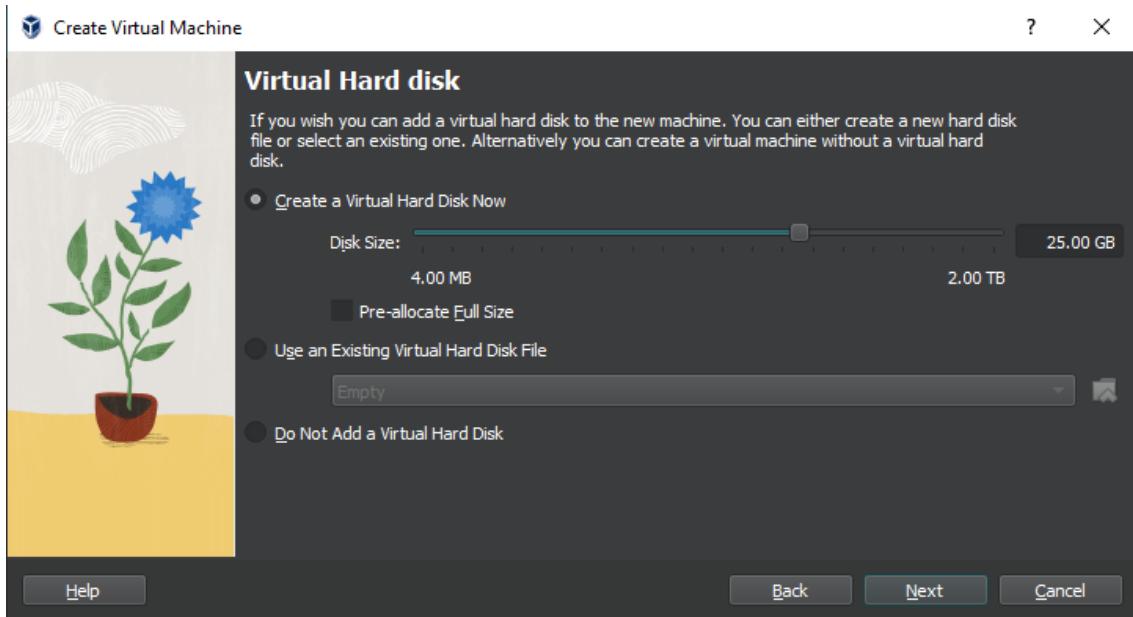
We can also designate the number of CPUs that we want to allocate to the VM. I recommend using 4 CPUs:



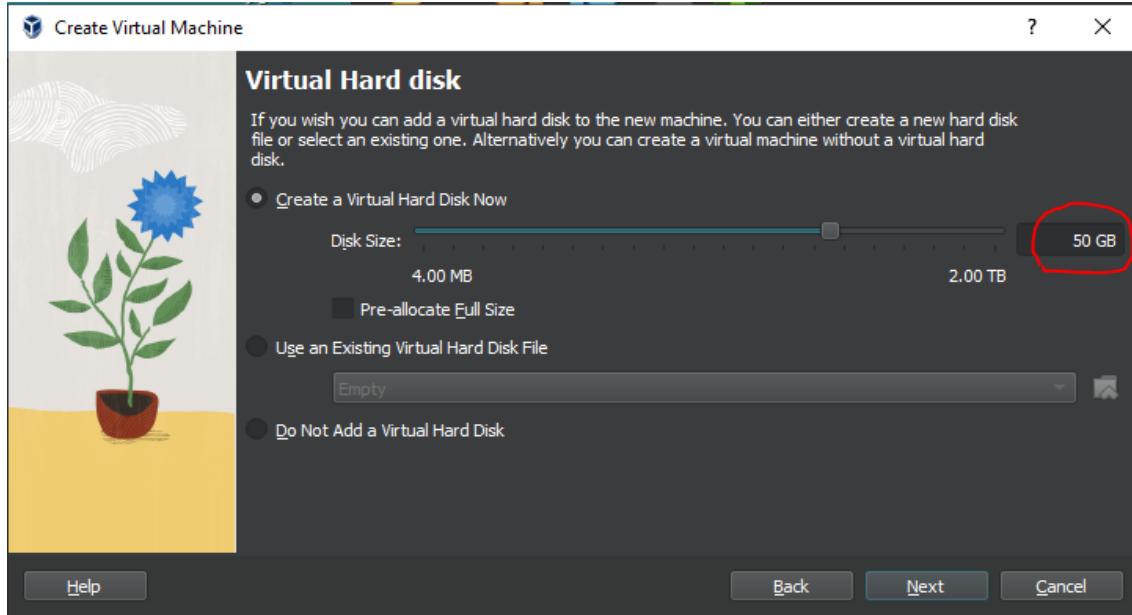
Now hit Next to go on to the next step:



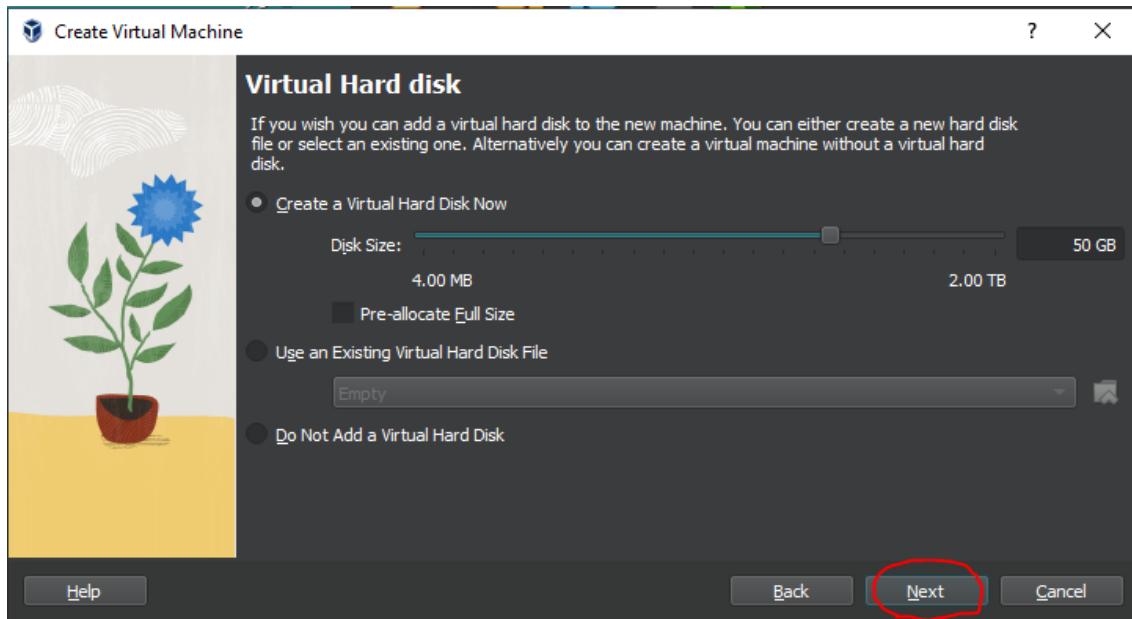
You should now have a window like the one shown below:



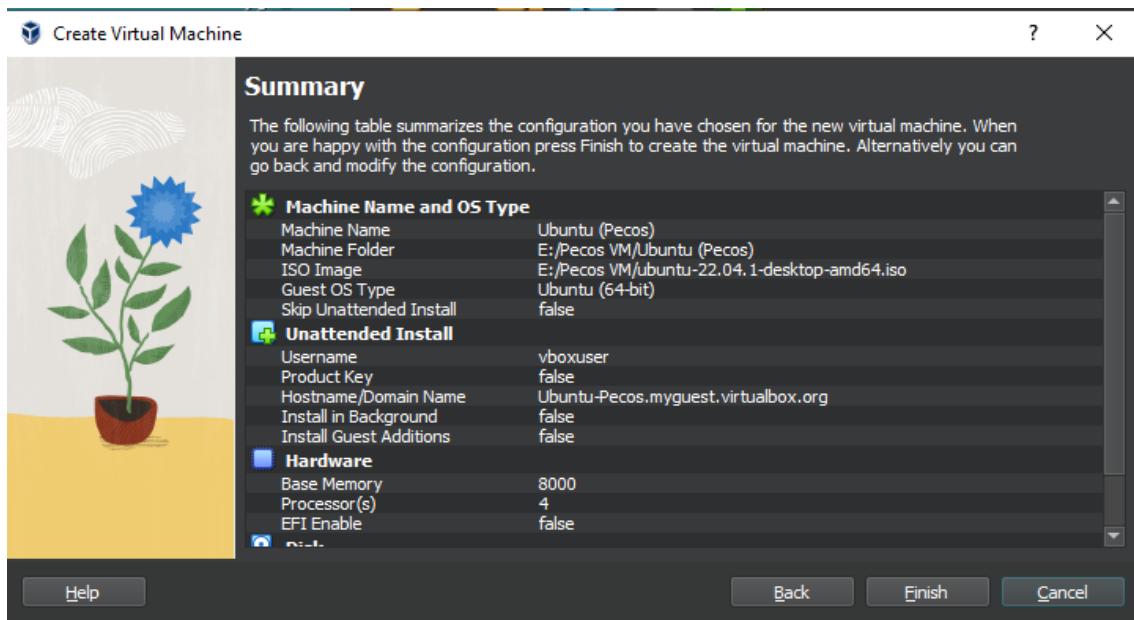
Here we can allocate the amount memory that we want available for the machine. The previously allocated 25 GB should be sufficient for our task, but I recommend allocating 50 GB or more if you are planning on doing anything else with the system:



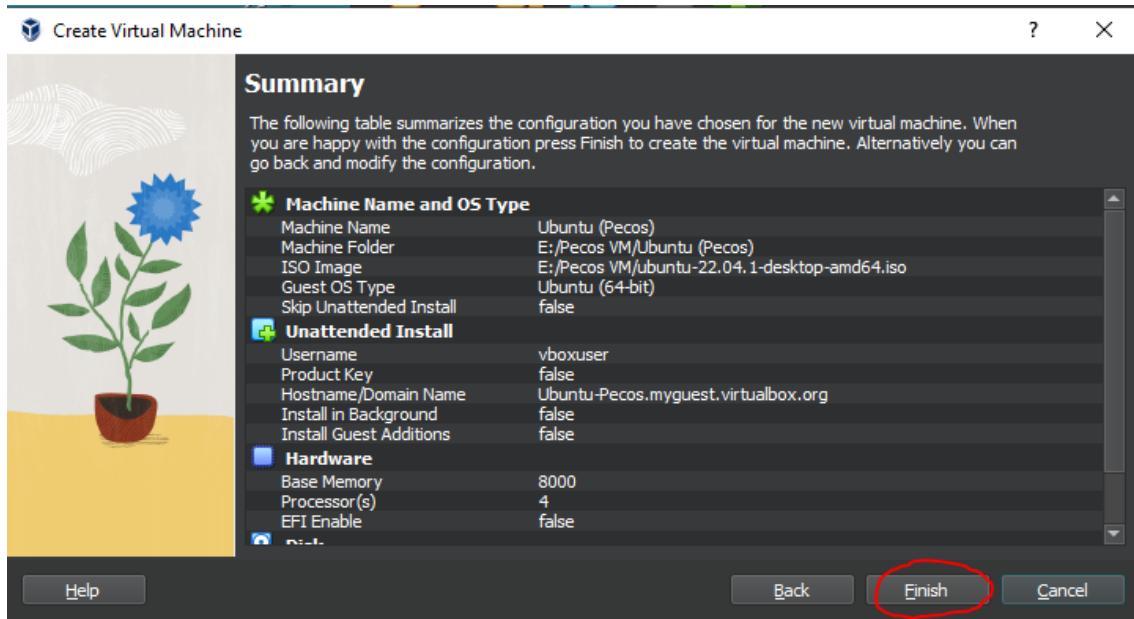
Now hit Next to go on to the next step:



You should now see a window like the one shown below. This allows you to scroll back through the configuration that you have selected. If any changes need to be made, do it now:



If no changes are needed, then hit finish to complete the creation of the VM:

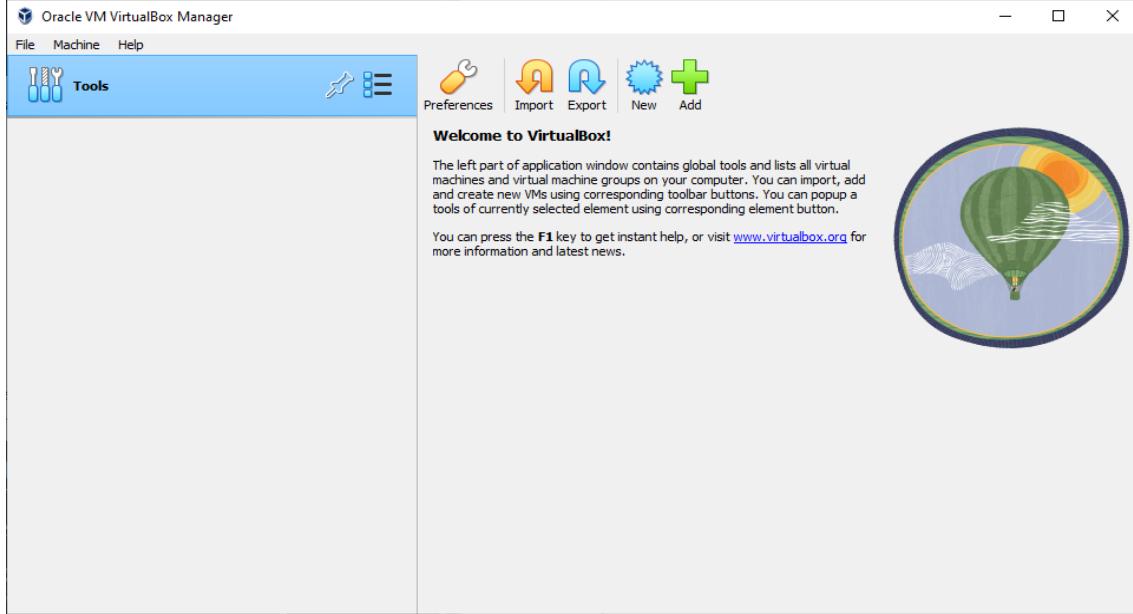


After clicking finish, the VM should automatically launch.

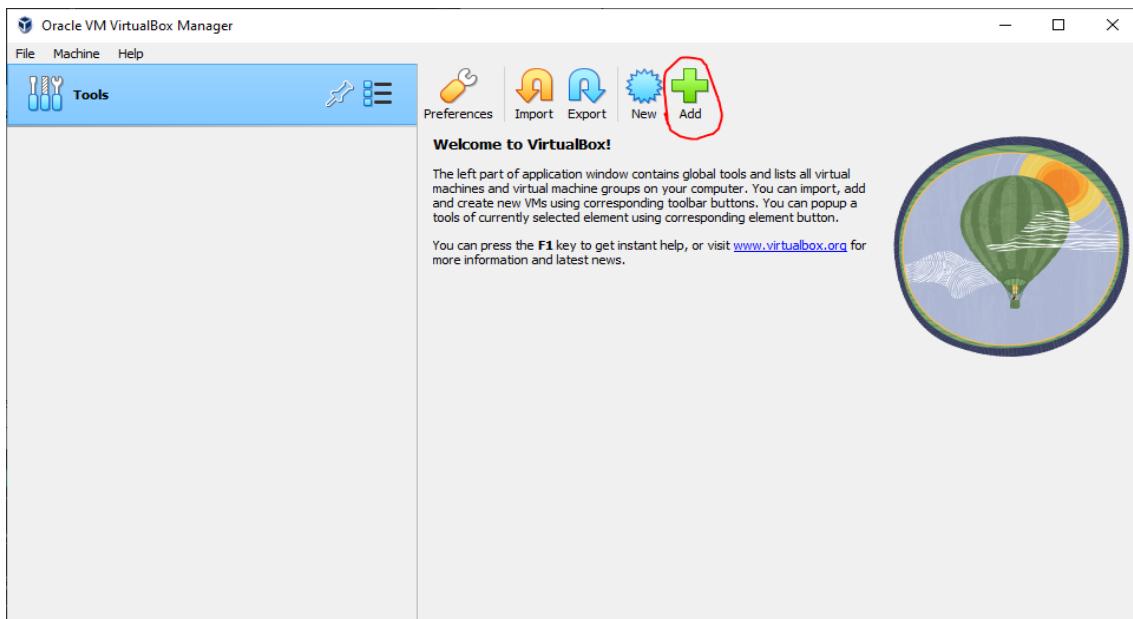
Adding a VM

If you already have a VM Disk Image, you can follow these steps to add it to your VM list in Oracle VirtualBox.

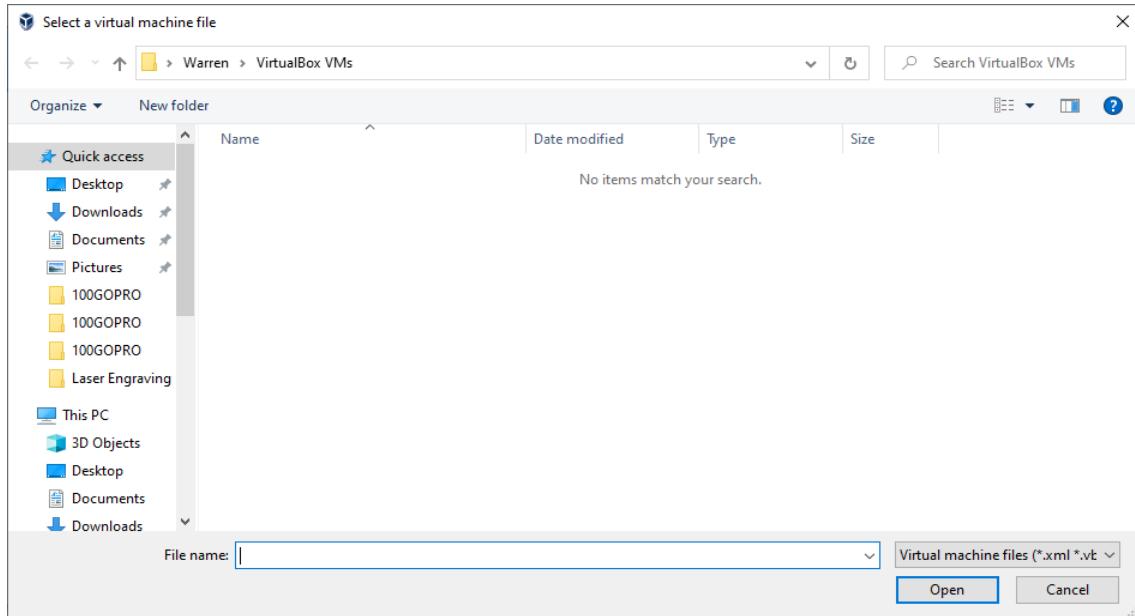
Open Oracle VirtualBox:



Click the green + sign to add a VM:

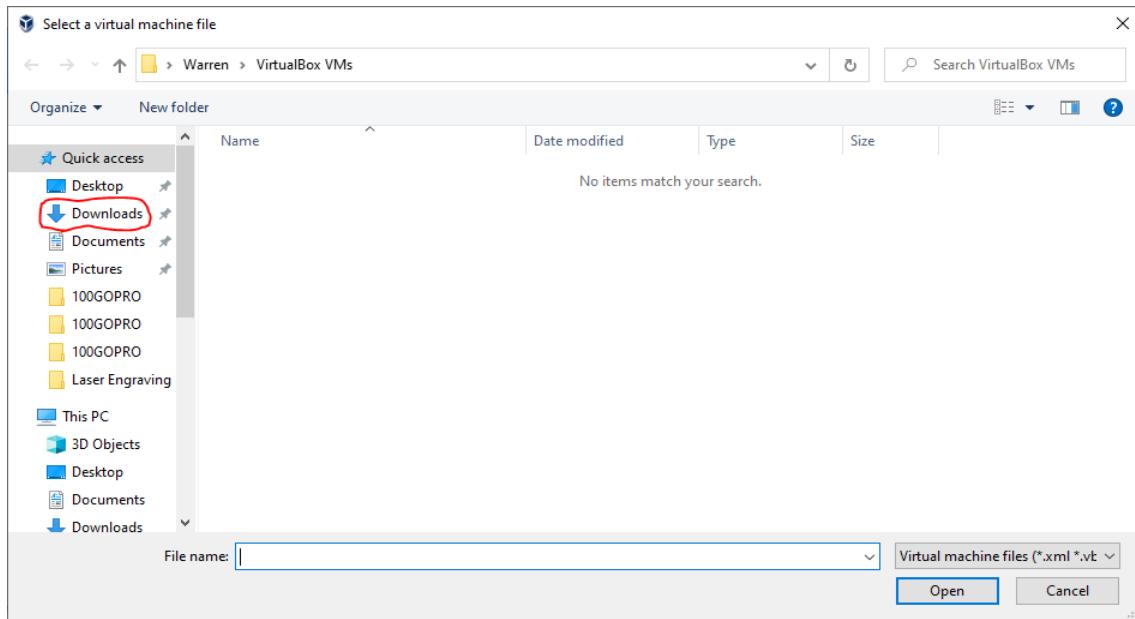


You will now be in the file explorer:

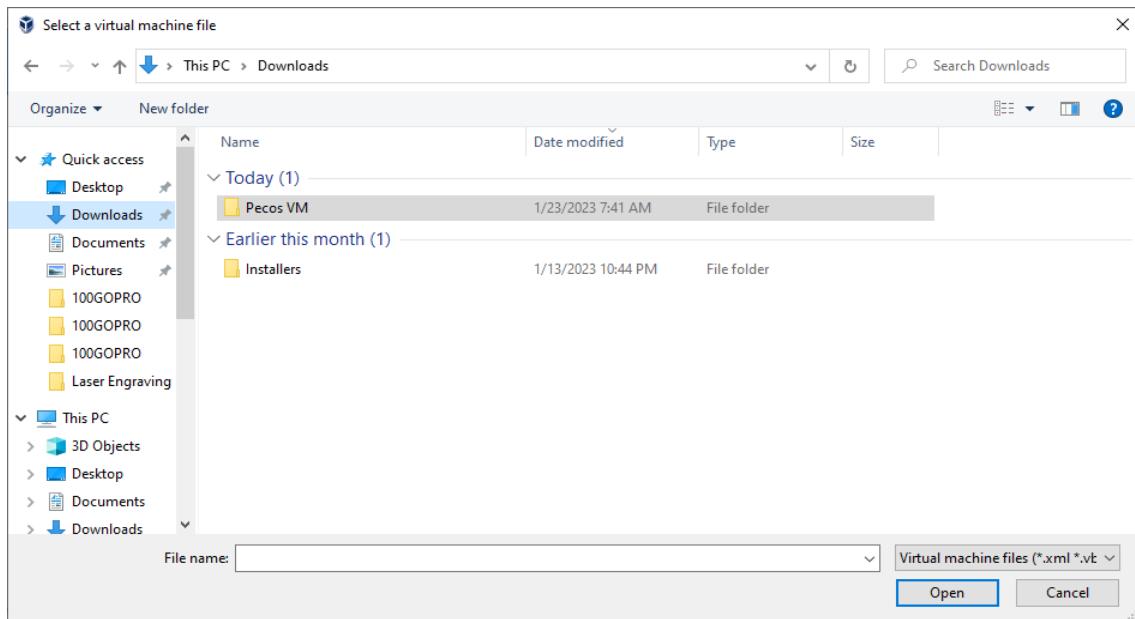


Locate the folder where your VM is located.

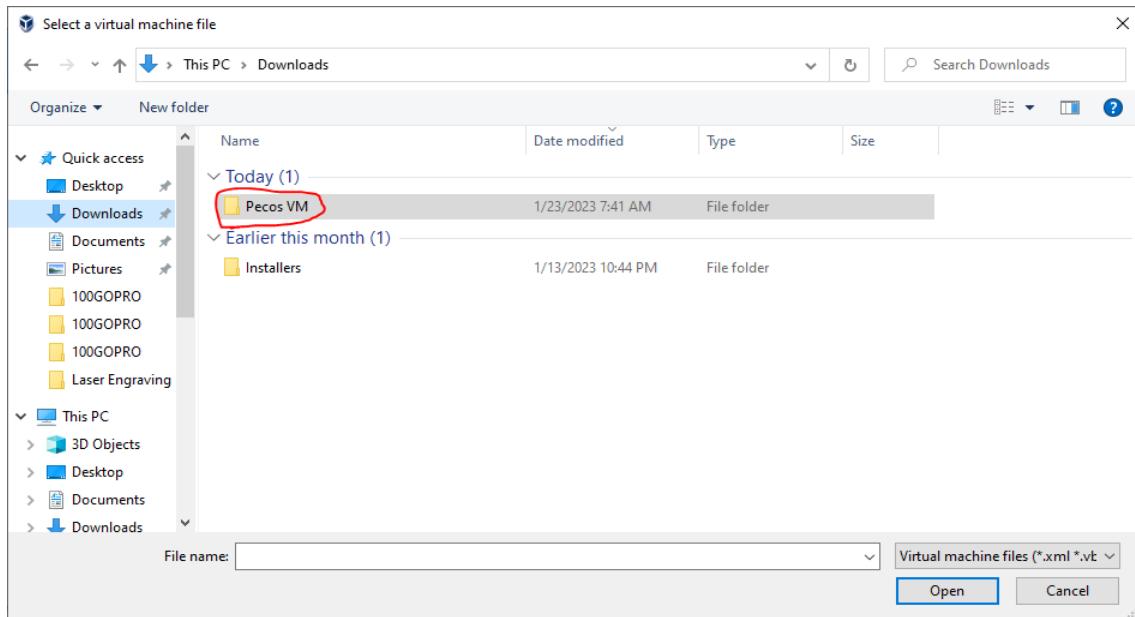
(In this instance, it is the Downloads folder):



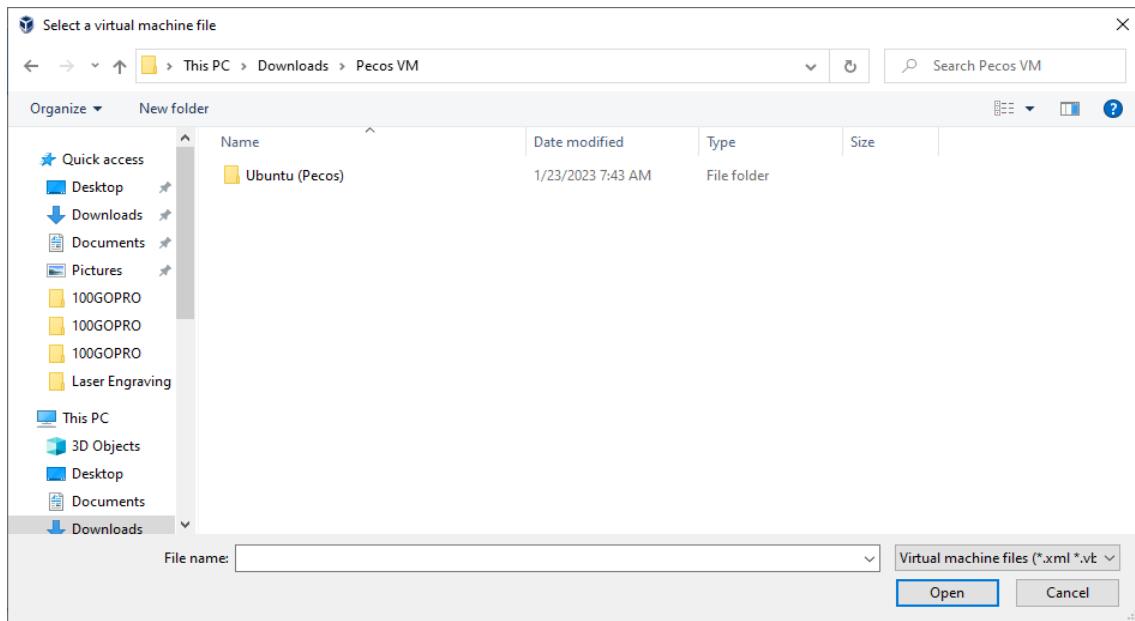
After clicking on the folder, you should now see the outer folder for the VM:



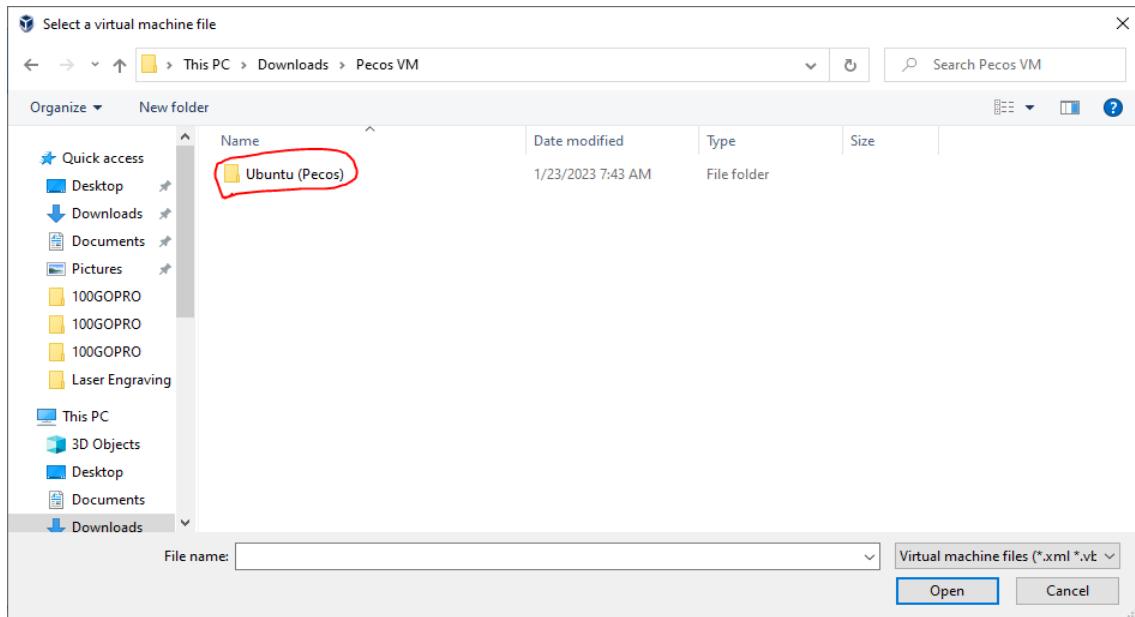
Double click this folder:



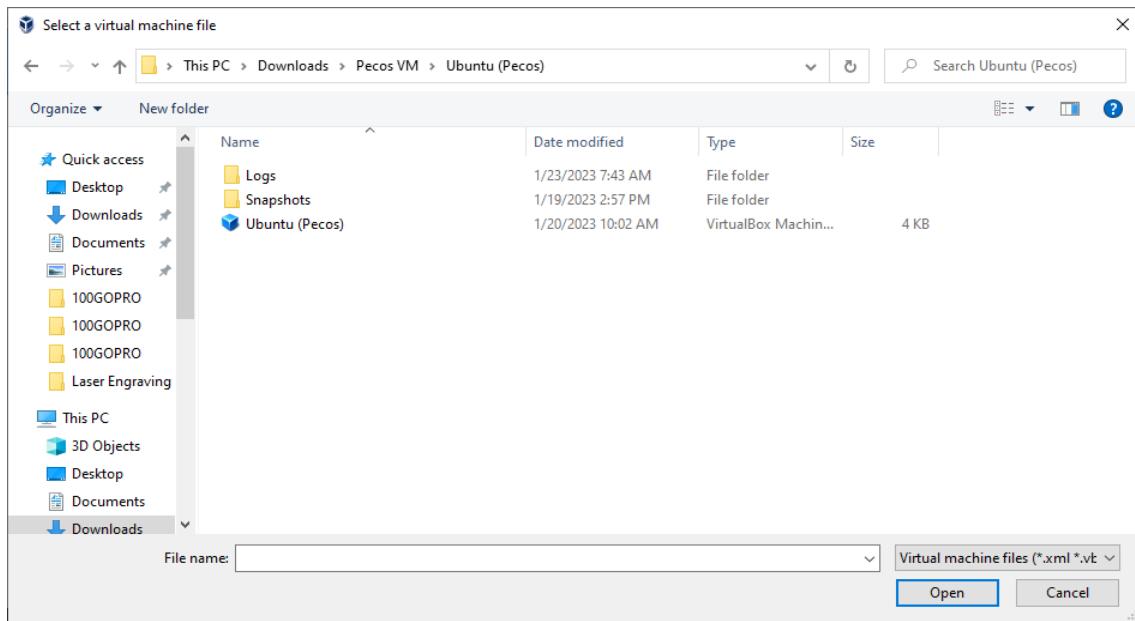
You will now see the inner folder with the name of the VM:



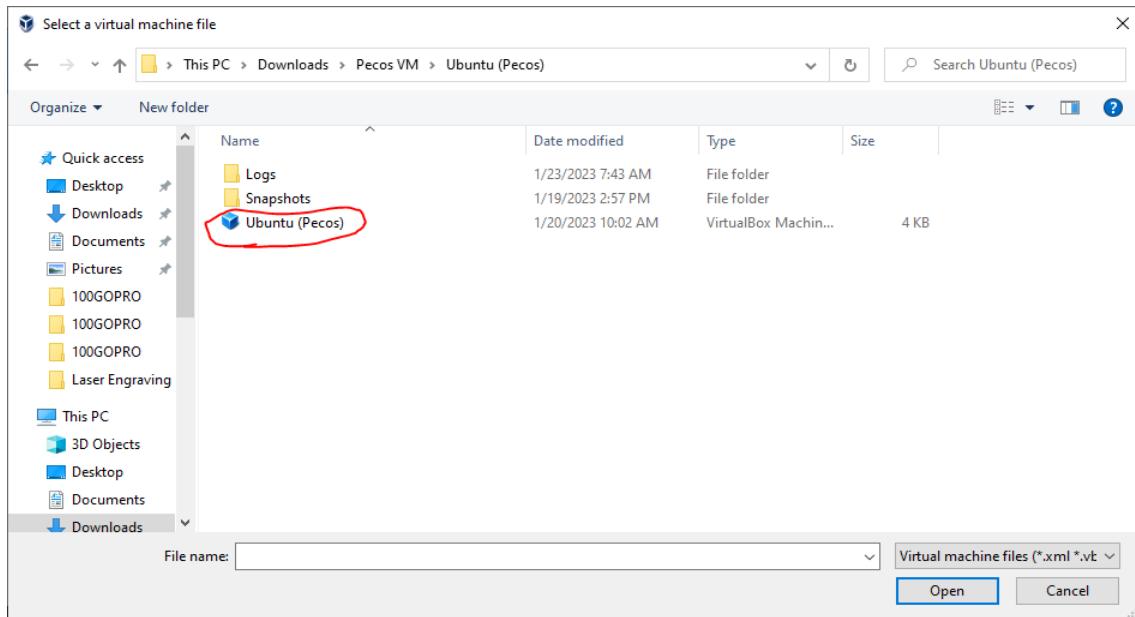
Double click this folder:



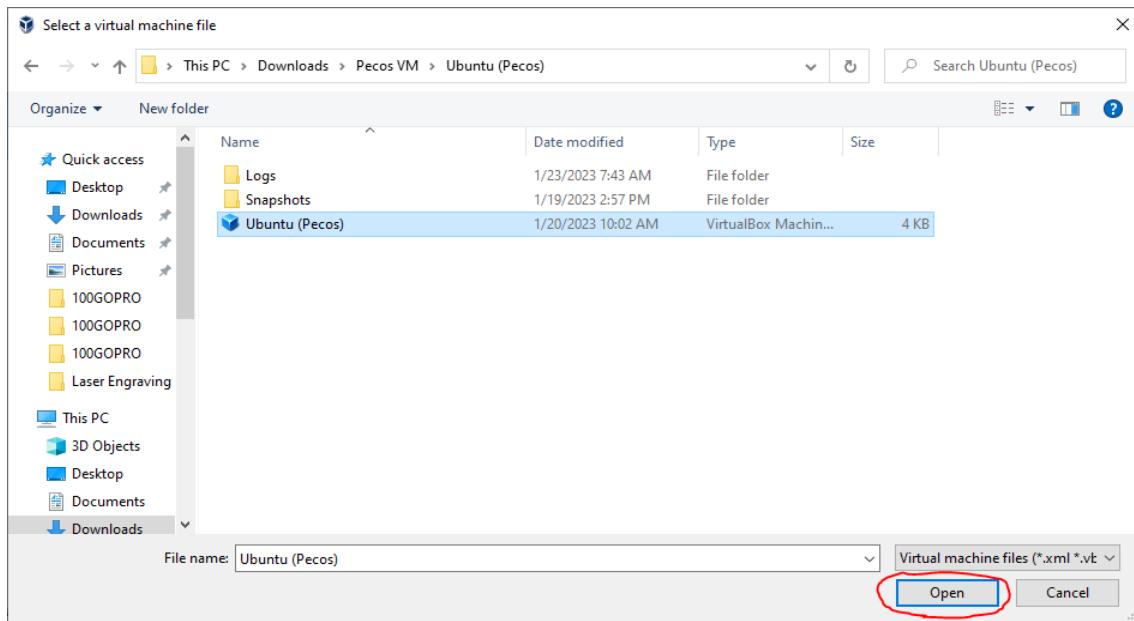
Now you will see a window like below:



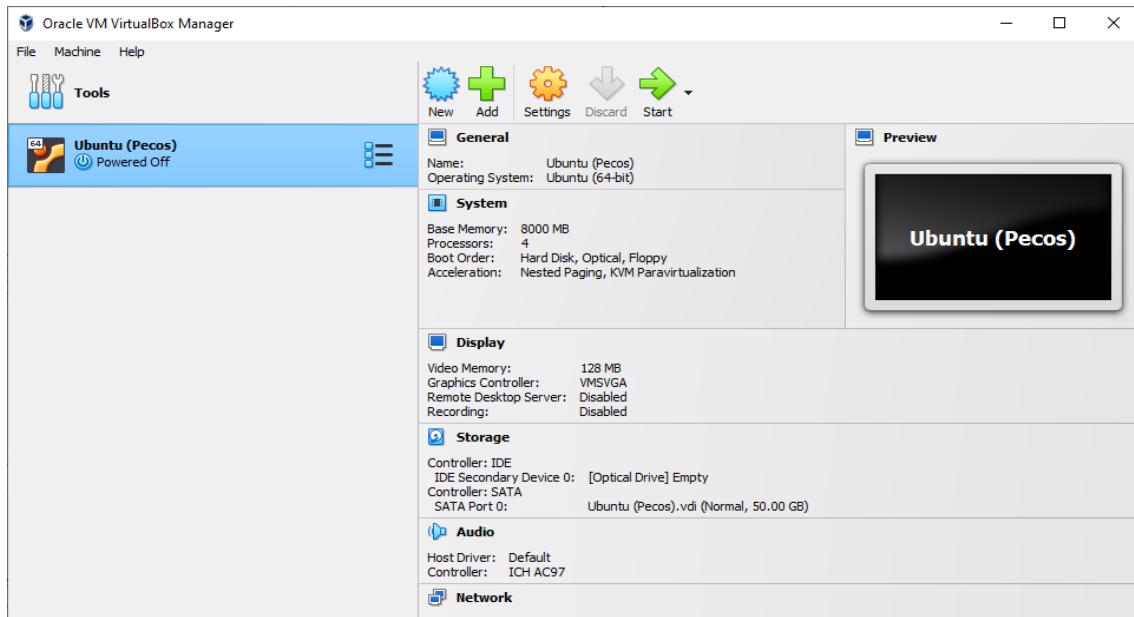
Select the VMD file:



Now hit open:

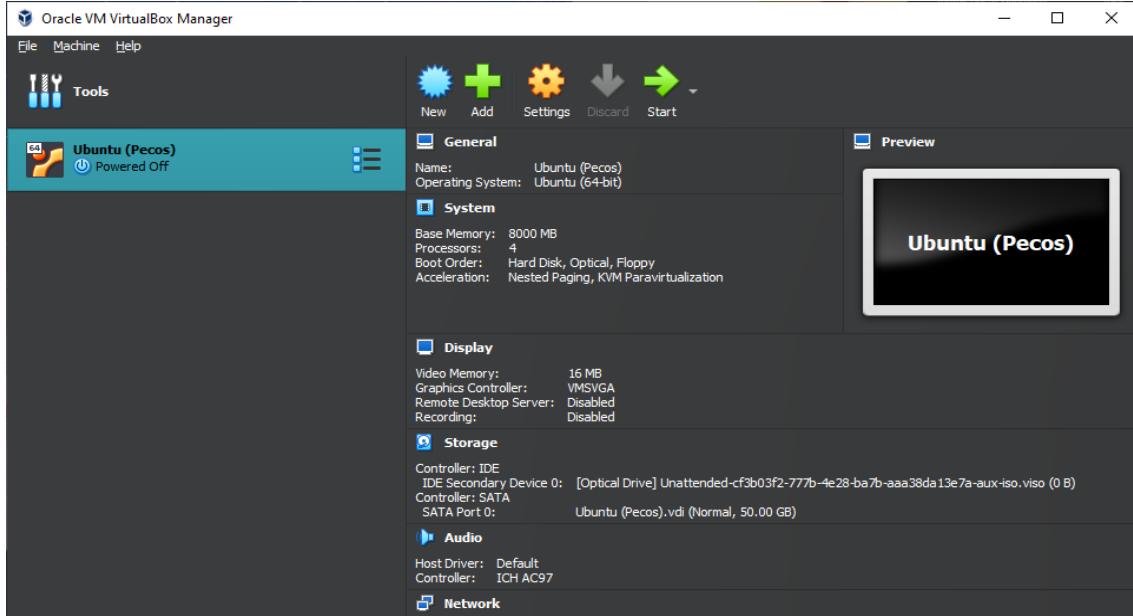


The VM should now show up on your VM list in Oracle VirtualBox:

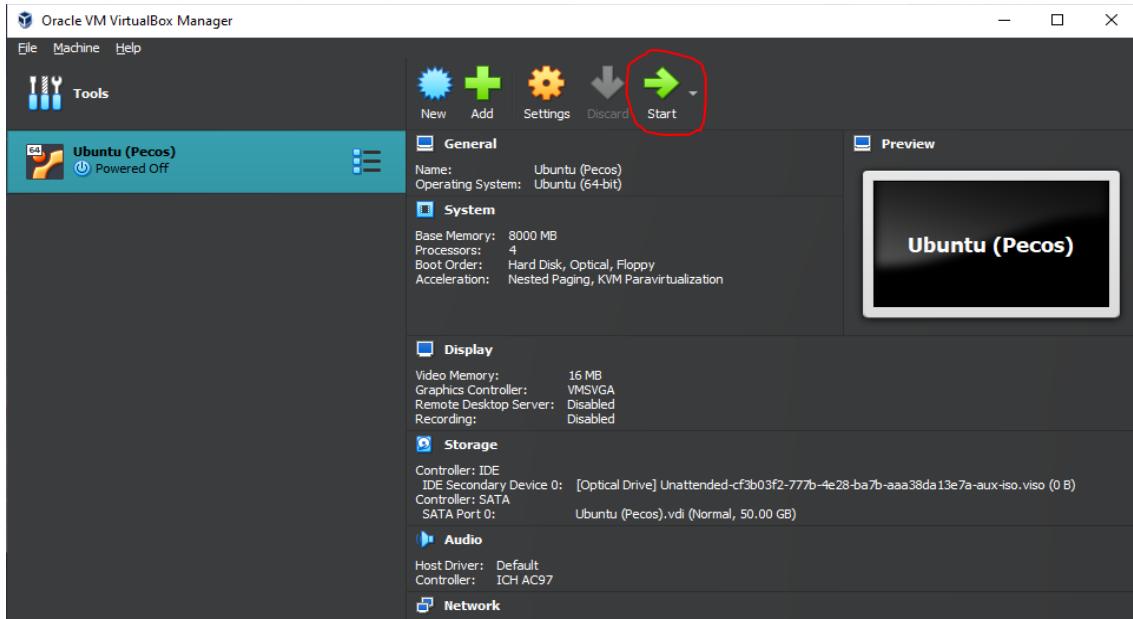


Launching a VM

If the VM does not launch automatically, select the newly created VM in the VM list:

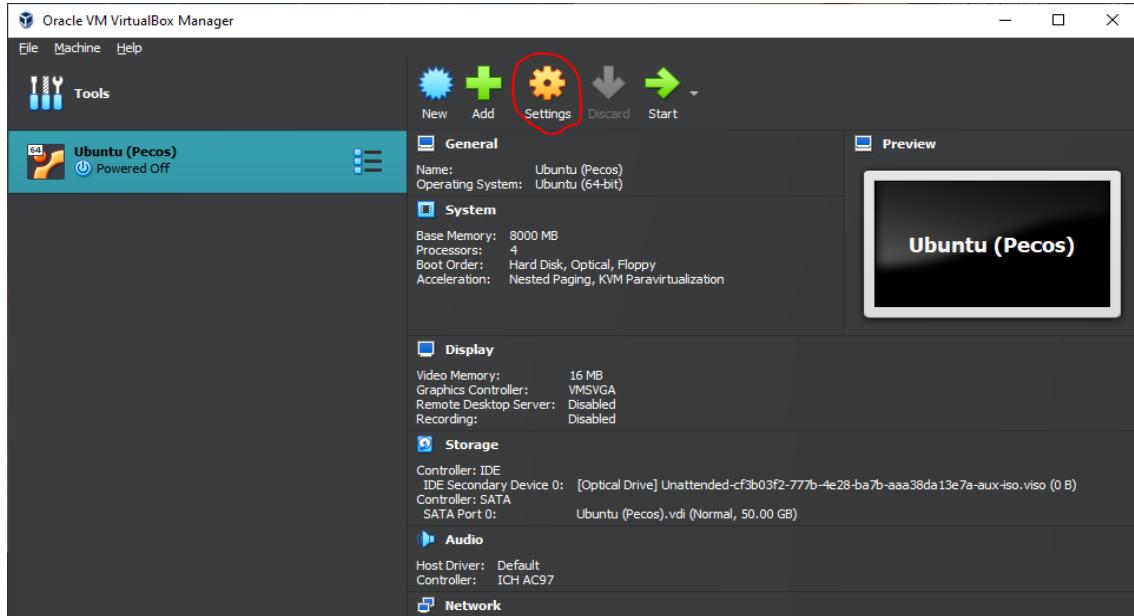


Then, click start:



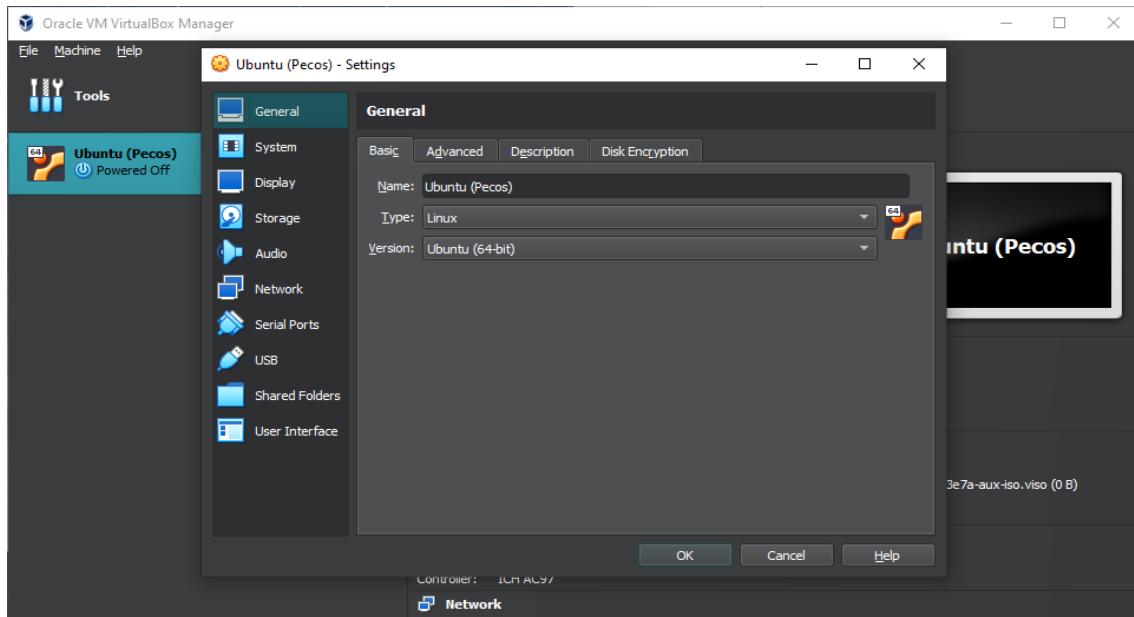
Changing a VM's Settings

If there are any changes that you need to make to the machine, go to settings:

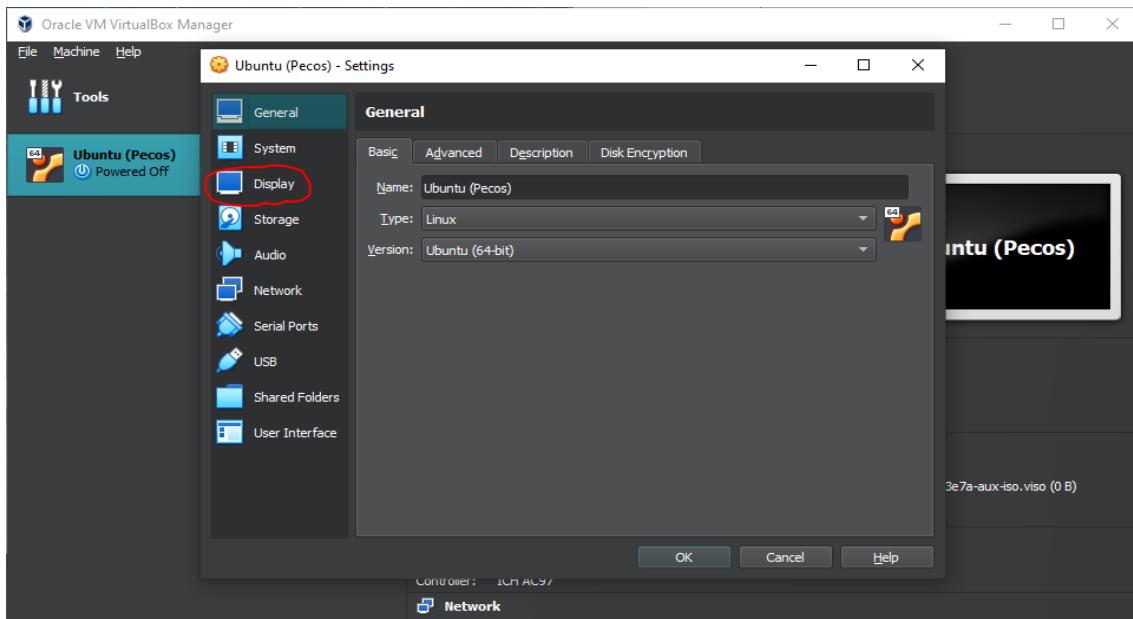


While we are here, we need to change one thing.

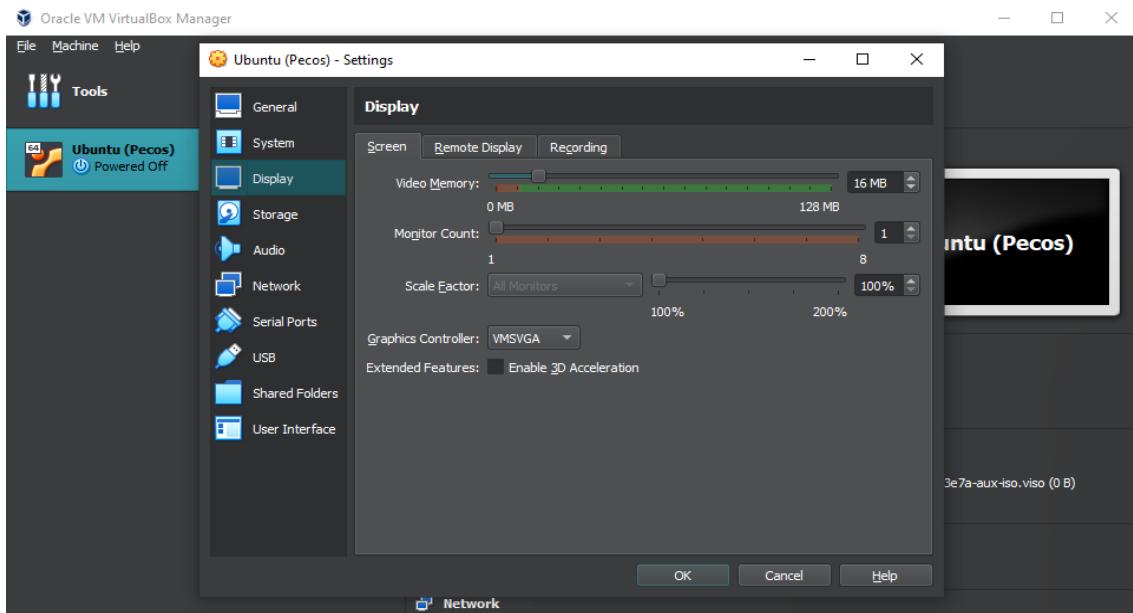
Click settings:



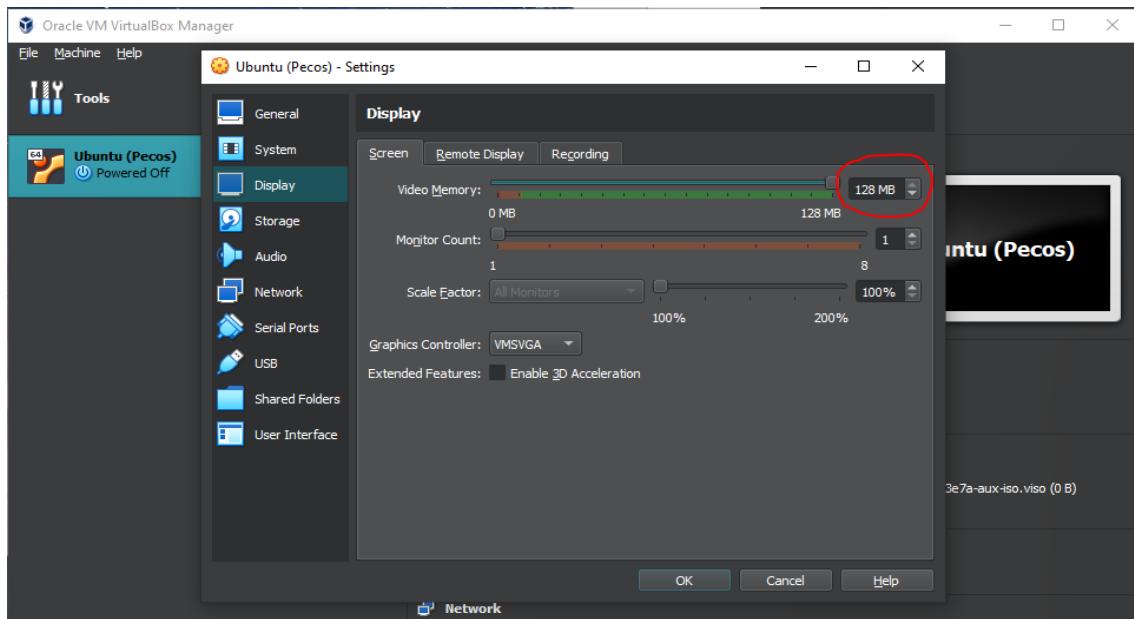
Select Display:



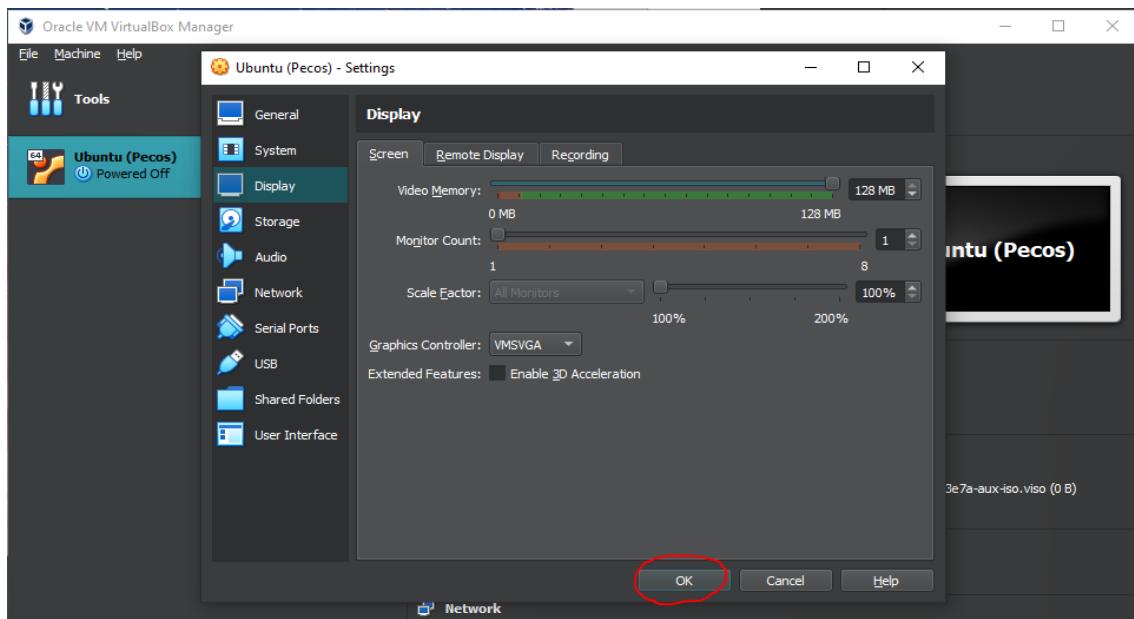
You should now be seeing a window like the one shown below:



Set Video Memory to max:



Now hit OK:

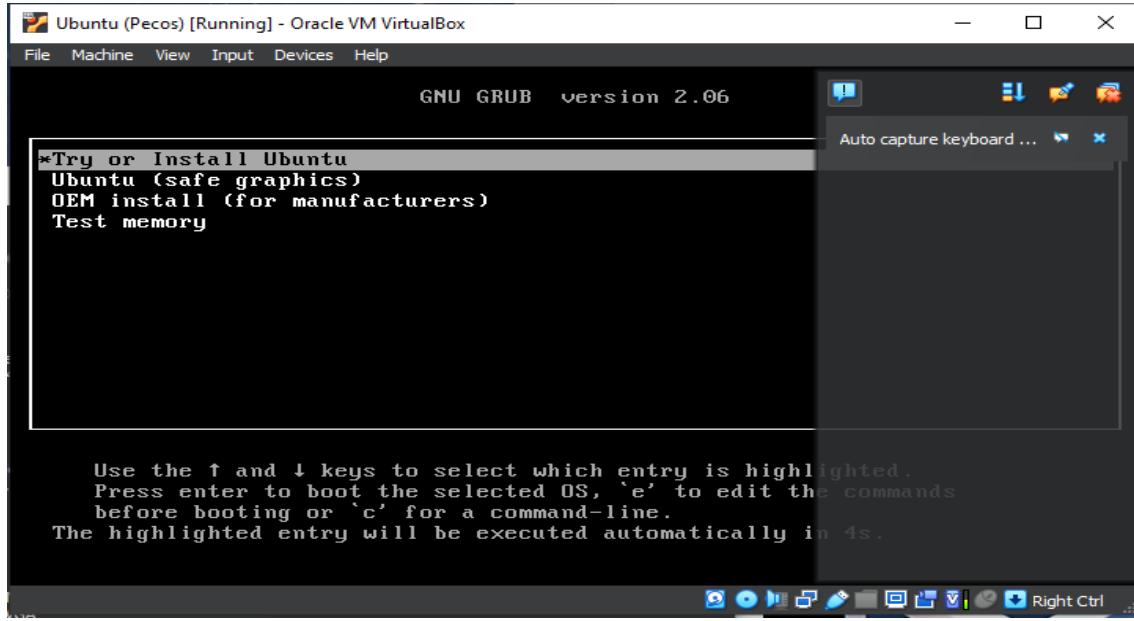


Step 4: Running Virtual Machine

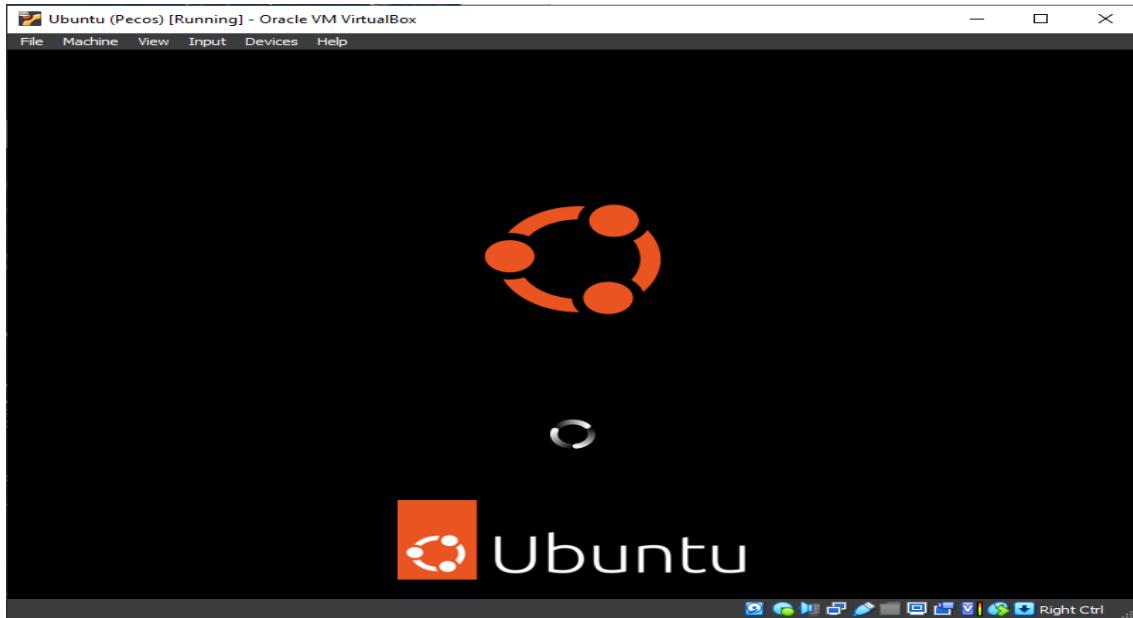
Once you launch the newly created VM, you will be greeted with the following window:



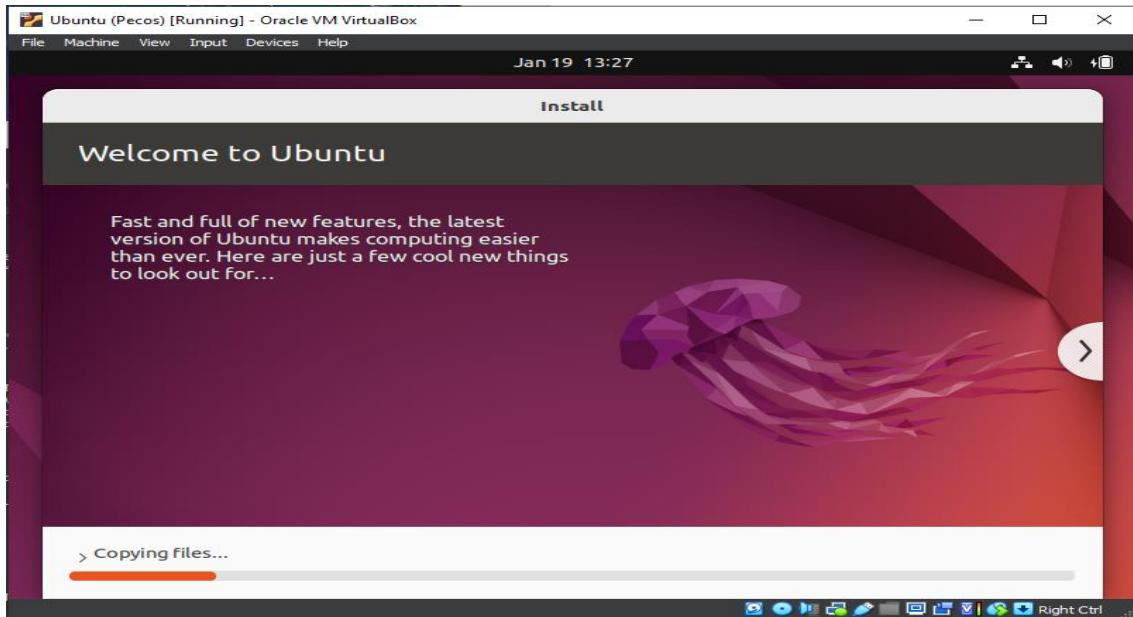
Hit Enter to begin Ubuntu Install. (If there is a delay, the VM will automatically do this.):



You should now see a window like the one below:

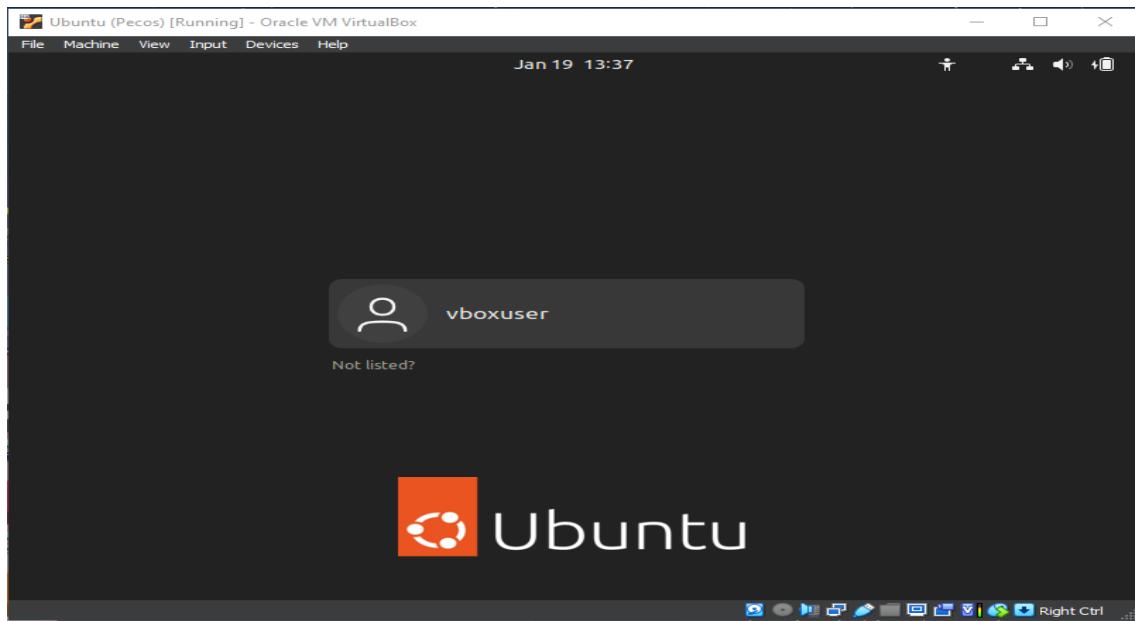


Then one like this:

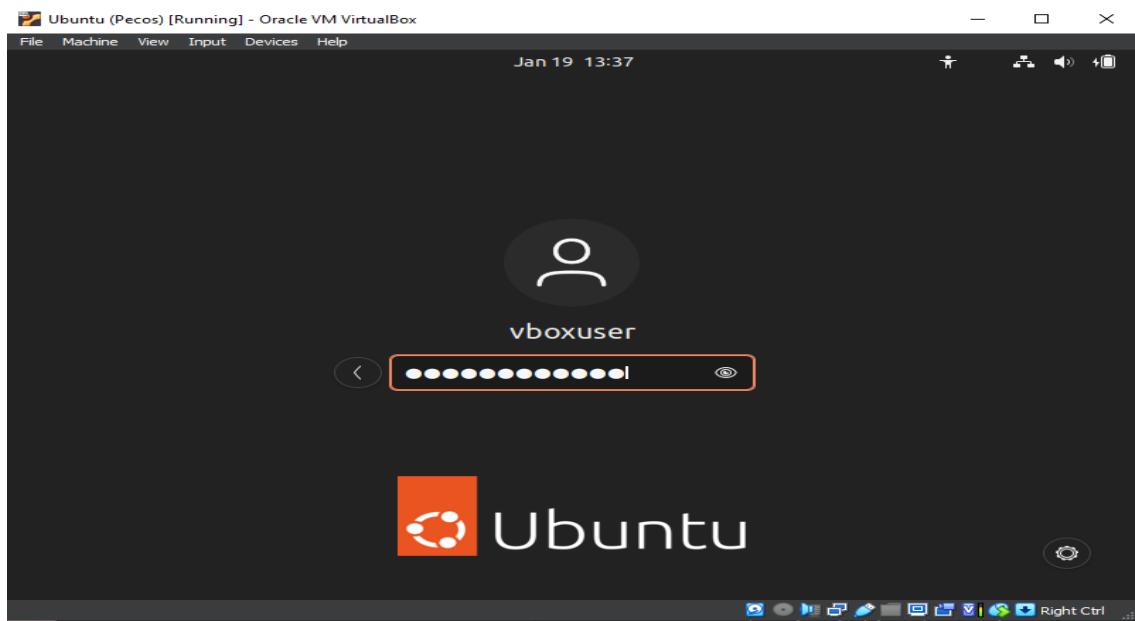


This process will take about 20 minutes, and once it is completed the machine will restart.

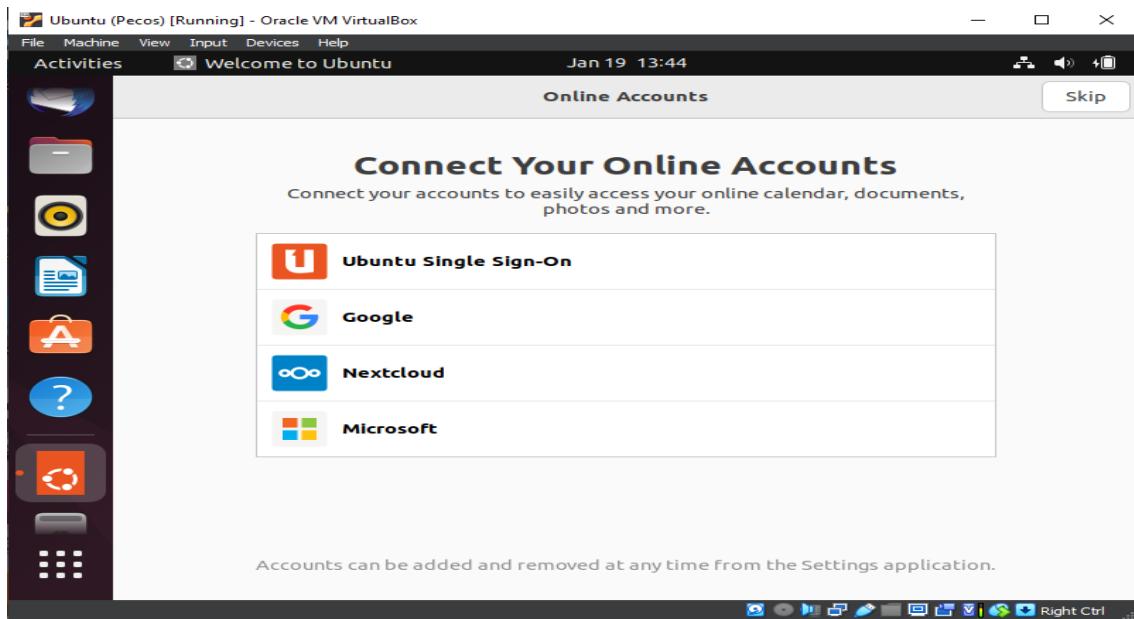
After restart, you will see a window like the one shown below:



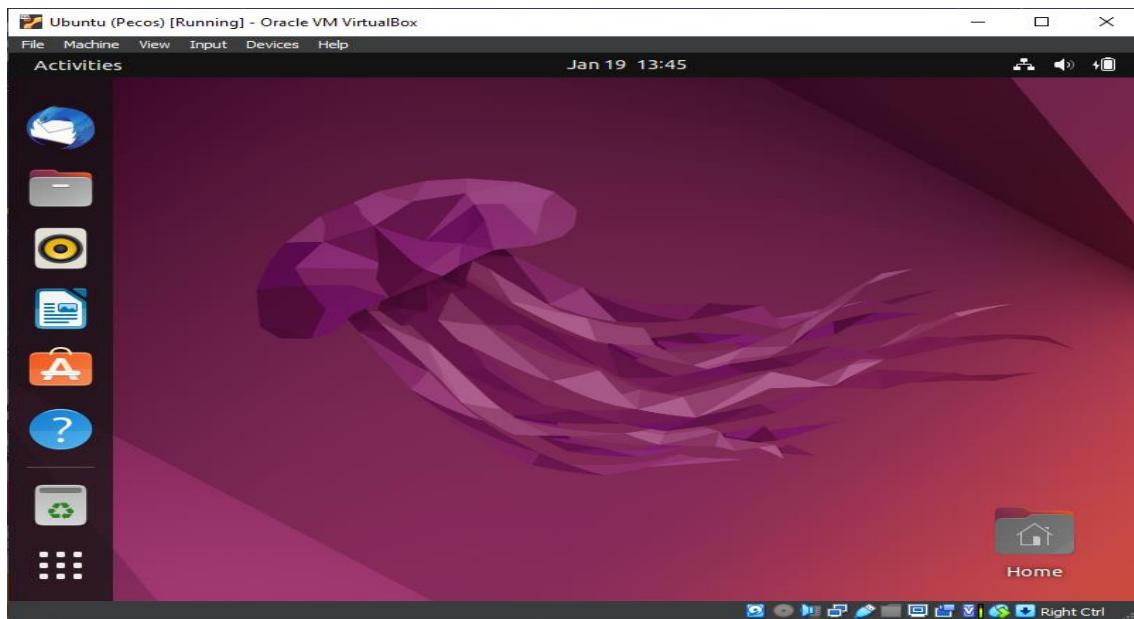
You'll need to login again:



I recommend skipping through this entire process. (Accounts can be added later, if needed):

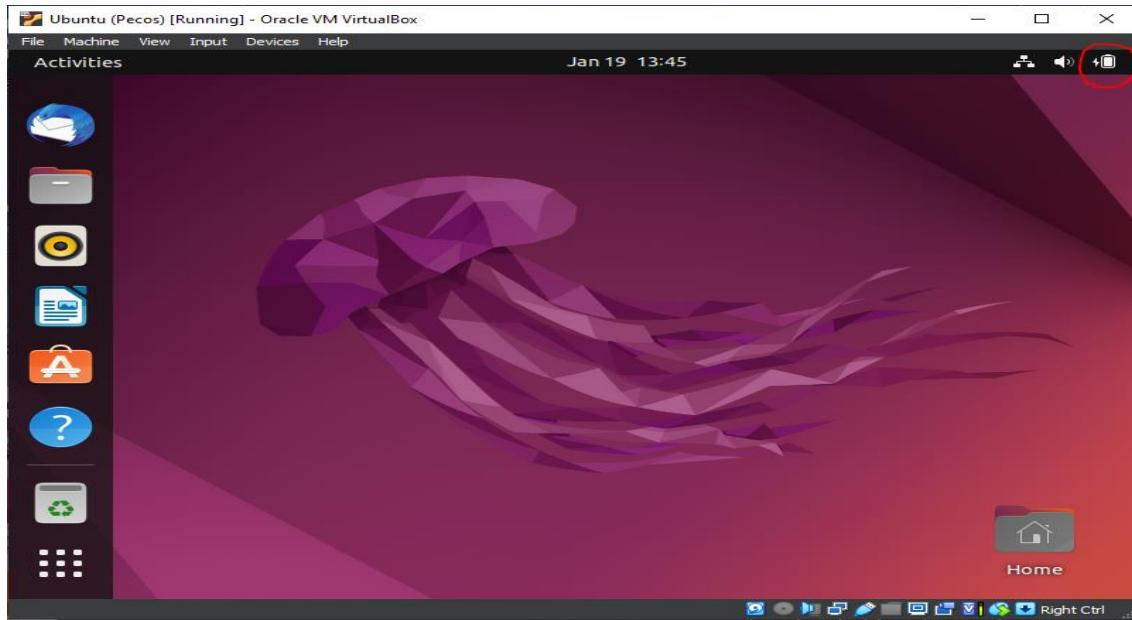


You should now be on your VM's desktop:

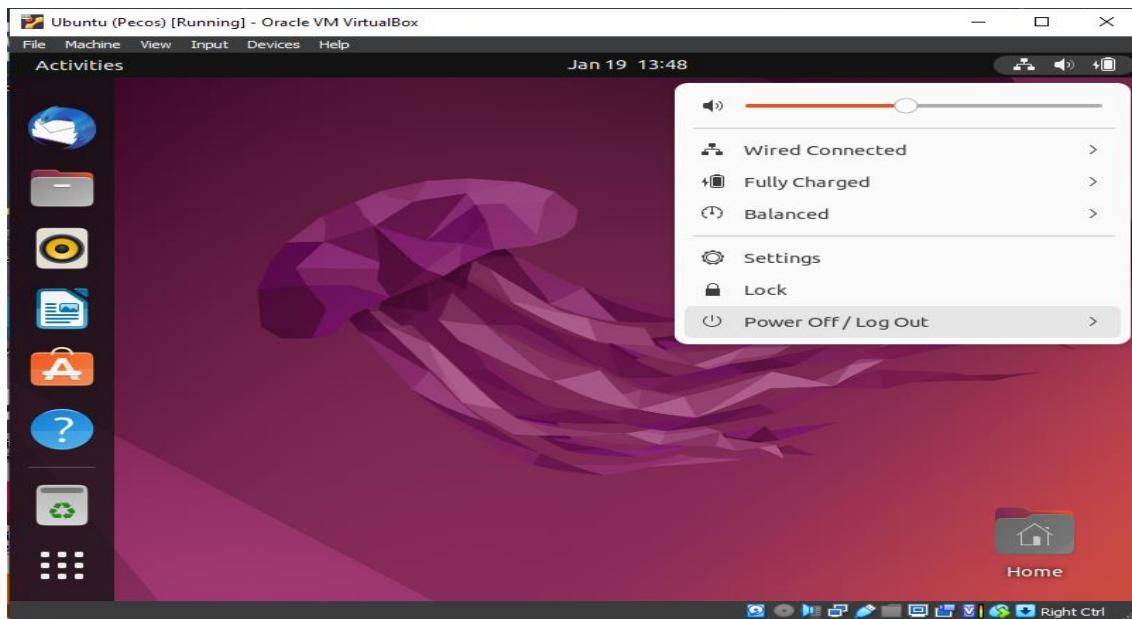


Powering Off/Restarting VM

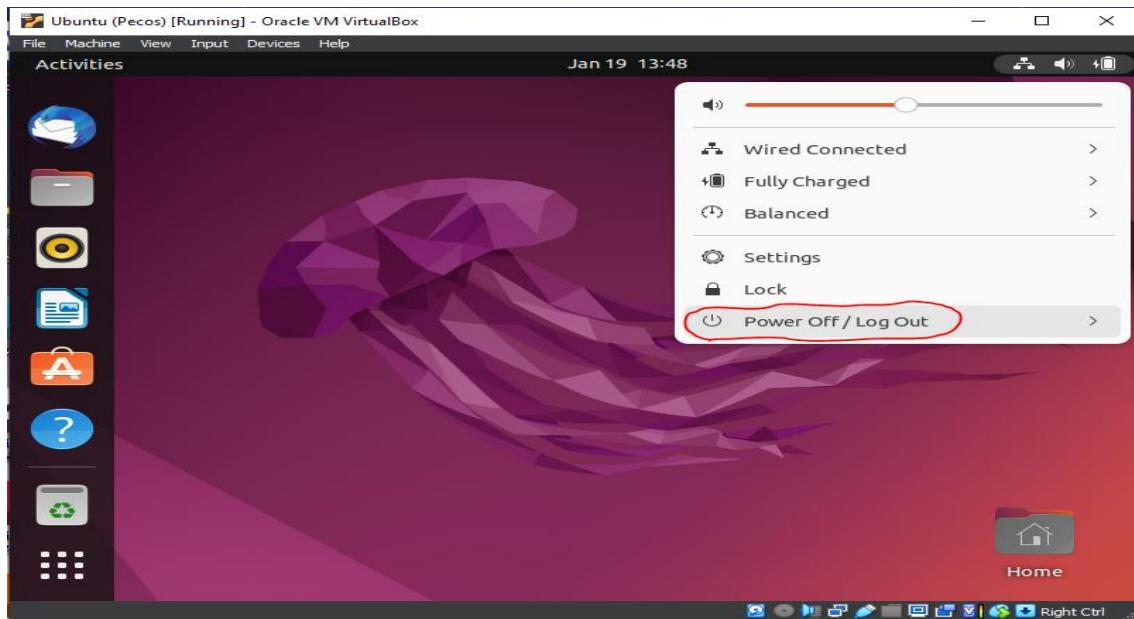
Select the power icon located to the top right



You will now see a window like the one below:



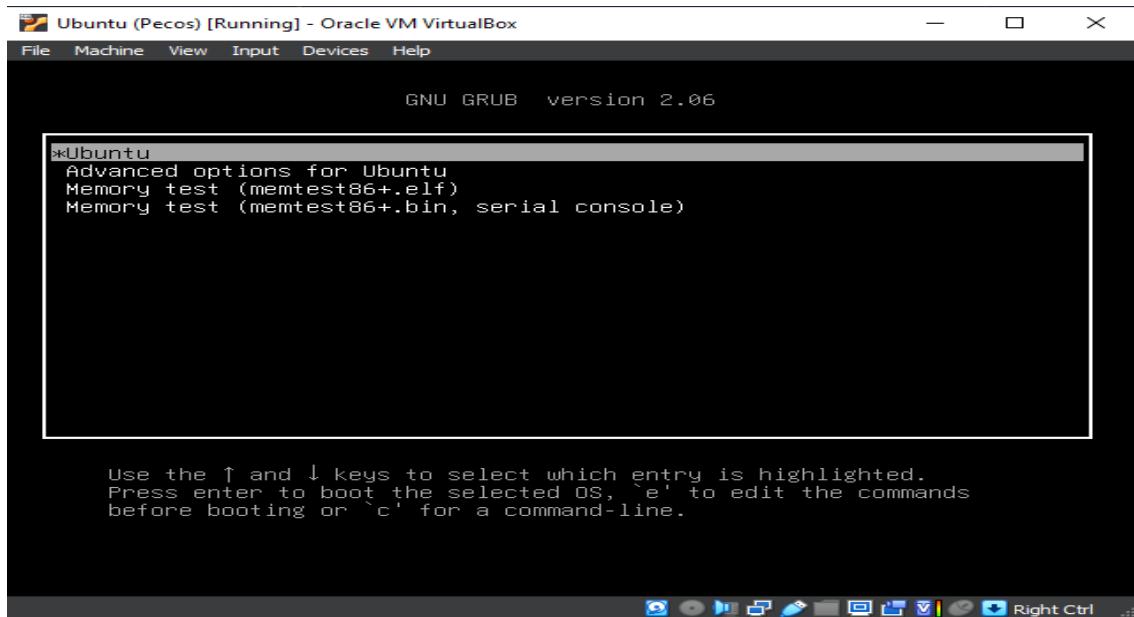
Select Power Off/Log Out:



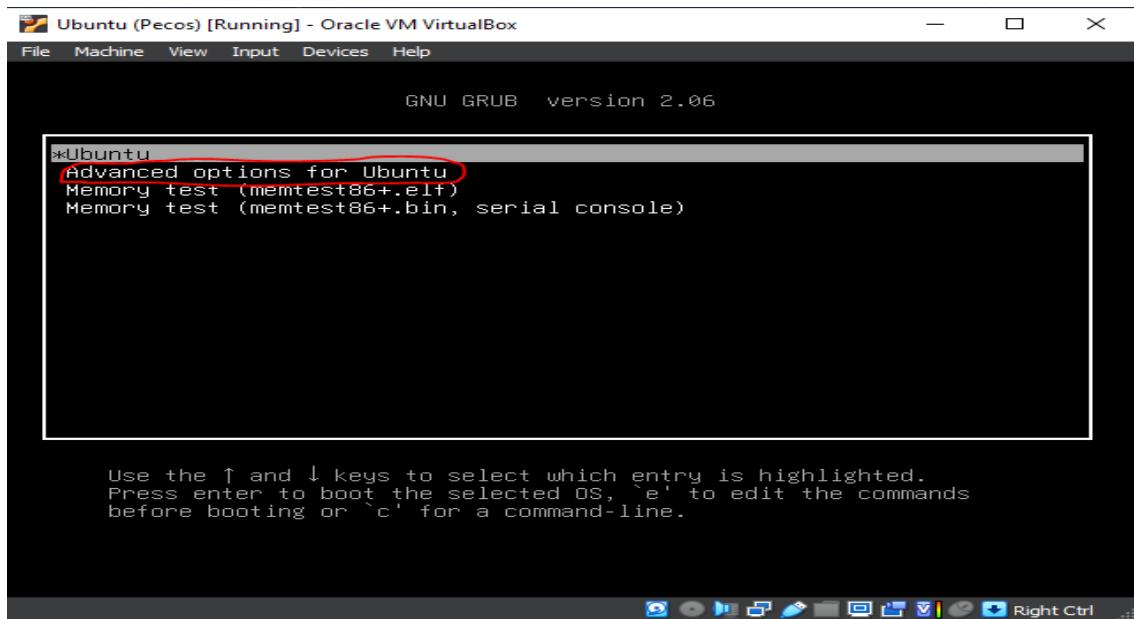
Adding Administrator Privileges

You must go through this process before installing Anaconda or adding packages

Restart VM using the steps described previously and hold down shift when the system begins to restart. You should now see a window like the one below:

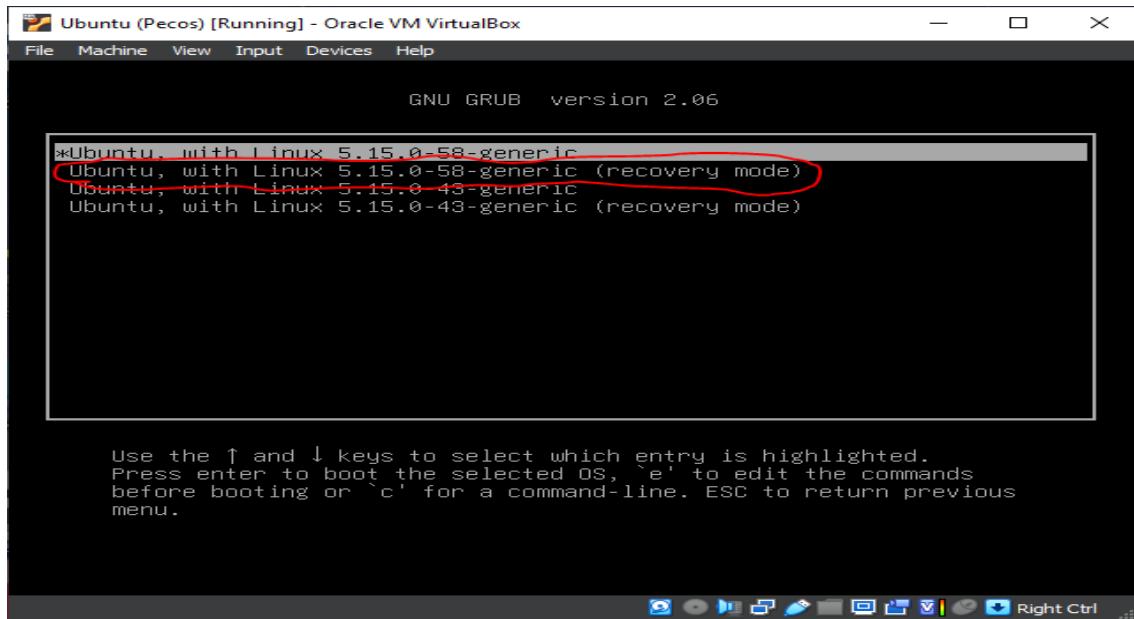


Select Advanced options for Ubuntu:



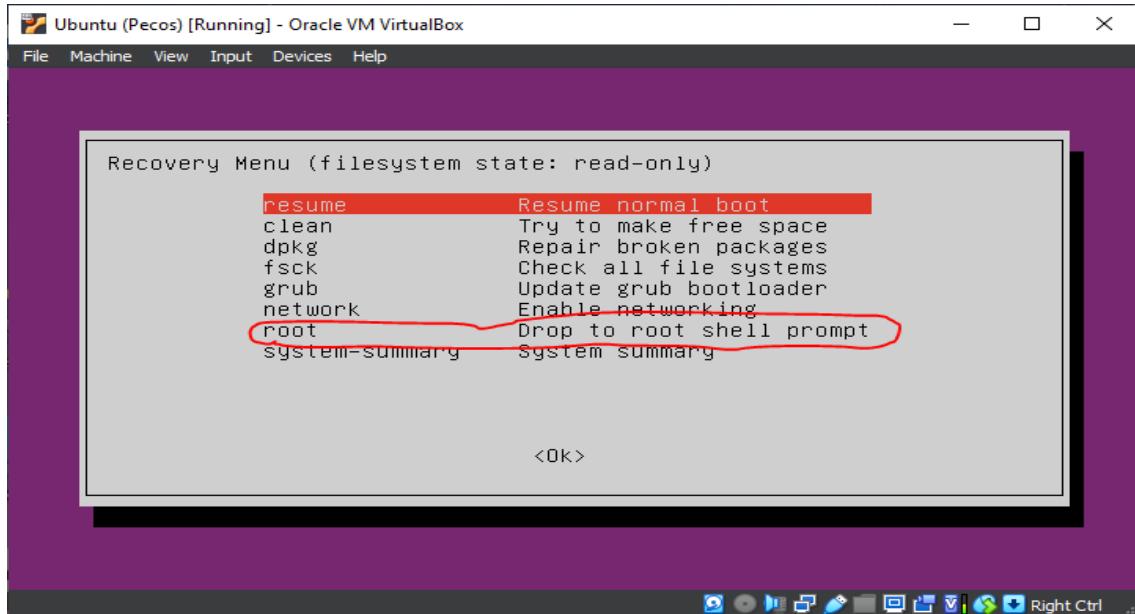
Select recovery mode for the most recent version of Linux.

(In this case it's Linux 5.15.0-58-generic):

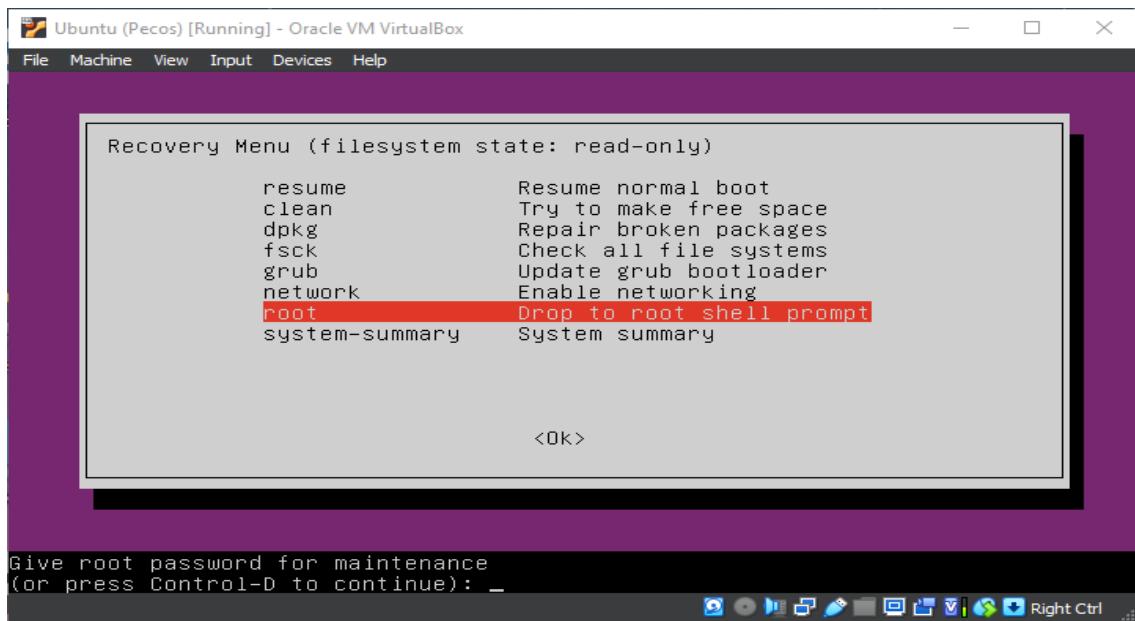


Now you should be looking at the window below.

We are interested in the root filesystem:



Arrow down to root and hit Enter:

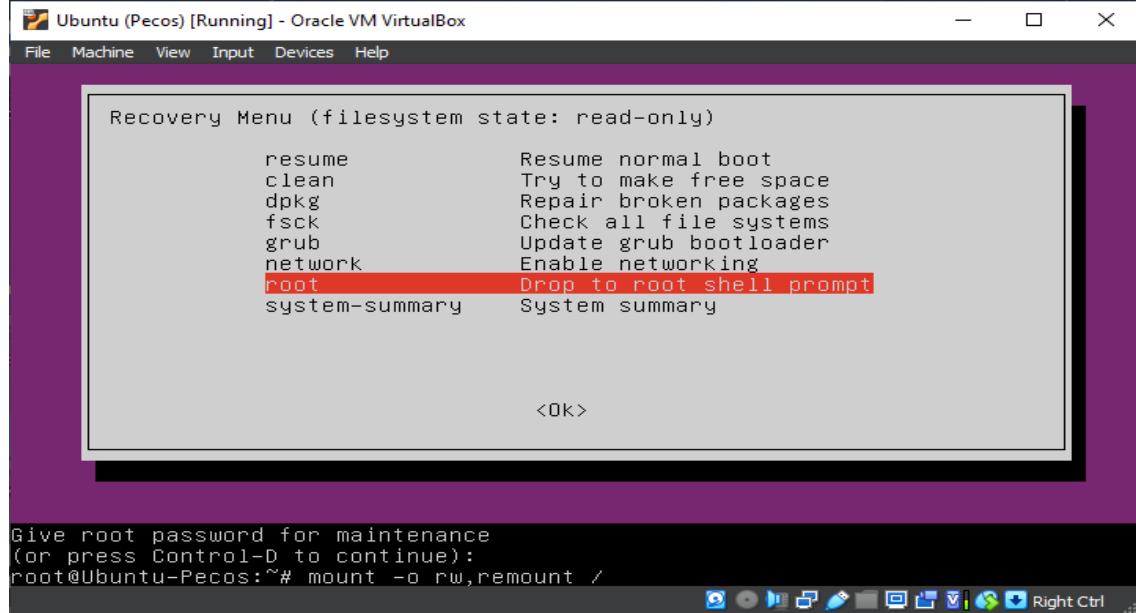


Input password and hit Enter once again.

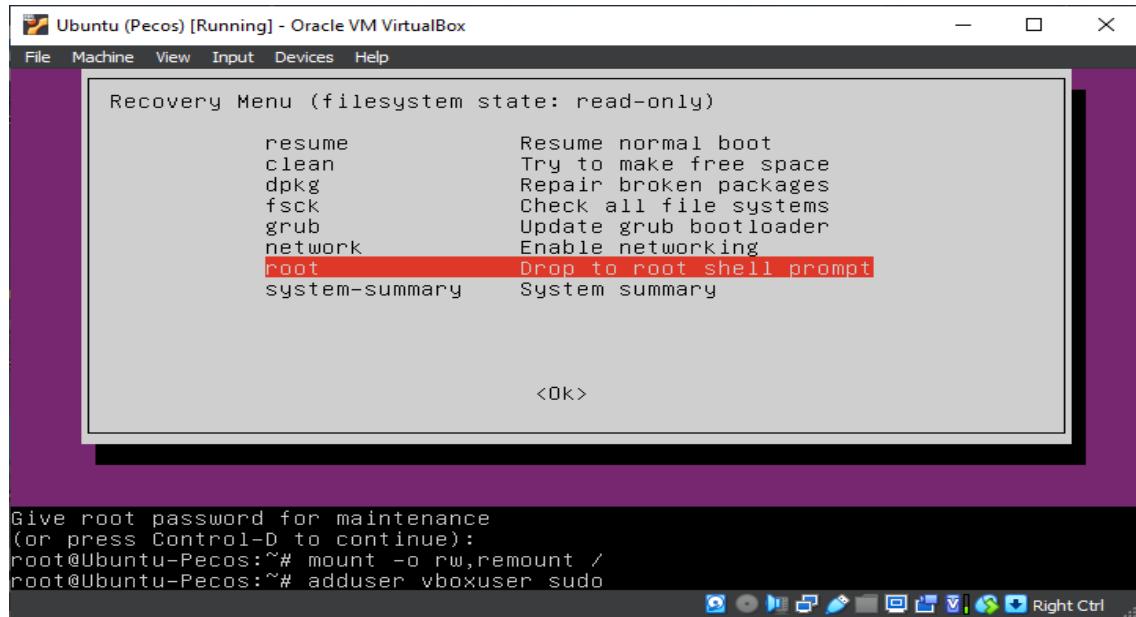
In terminals, passwords are invisible

Now you should be looking at the window below.

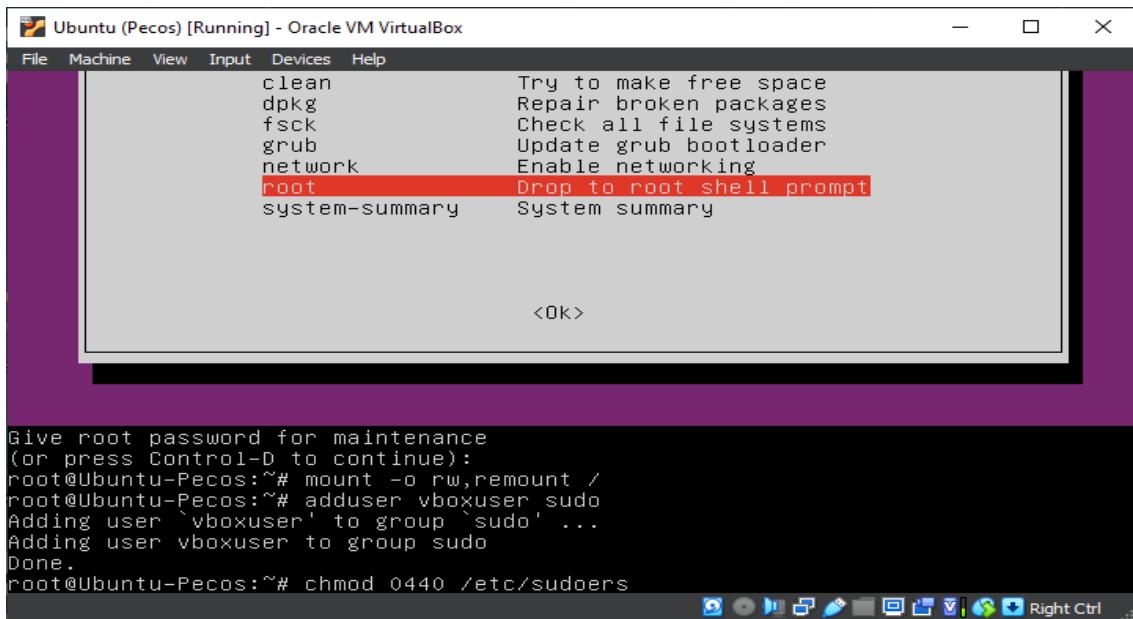
Type command `mount -o rw,remount /` and hit Enter:



After that, type command `adduser vboxuser sudo` and hit Enter:



Then, type command ***chmod 0440 /etc/sudoers*** and hit Enter:



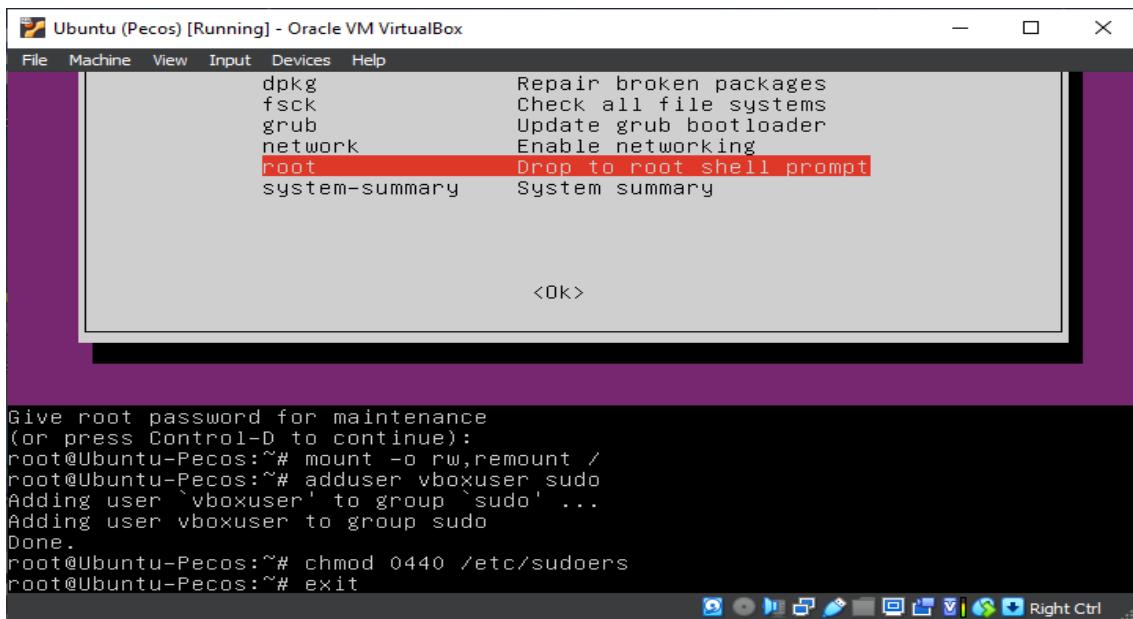
```
Ubuntu (Pecos) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
clean Try to make free space
dpkg Repair broken packages
fsck Check all file systems
grub Update grub bootloader
network Enable networking
root Drop to root shell prompt
system-summary System summary

<Ok>

Give root password for maintenance
(or press Control-D to continue):
root@Ubuntu-Pecos:~# mount -o rw,remount /
root@Ubuntu-Pecos:~# adduser vboxuser sudo
Adding user `vboxuser' to group `sudo' ...
Adding user vboxuser to group sudo
Done.
root@Ubuntu-Pecos:~# chmod 0440 /etc/sudoers

```

Finally, type command ***exit*** and hit Enter:



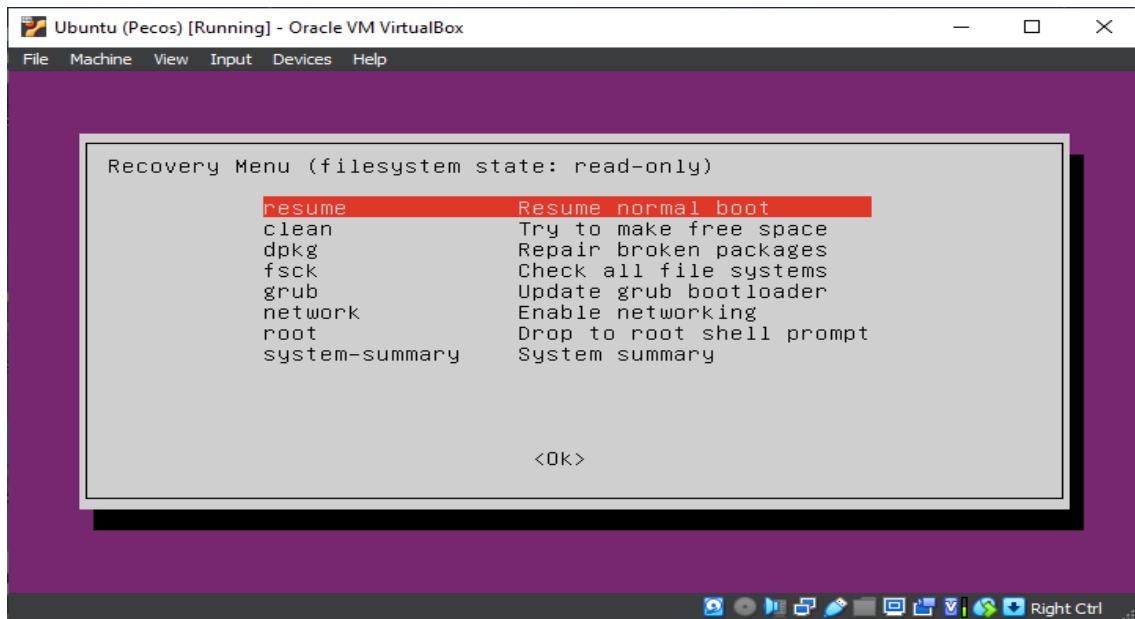
```
Ubuntu (Pecos) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
dpkg Repair broken packages
fsck Check all file systems
grub Update grub bootloader
network Enable networking
root Drop to root shell prompt
system-summary System summary

<Ok>

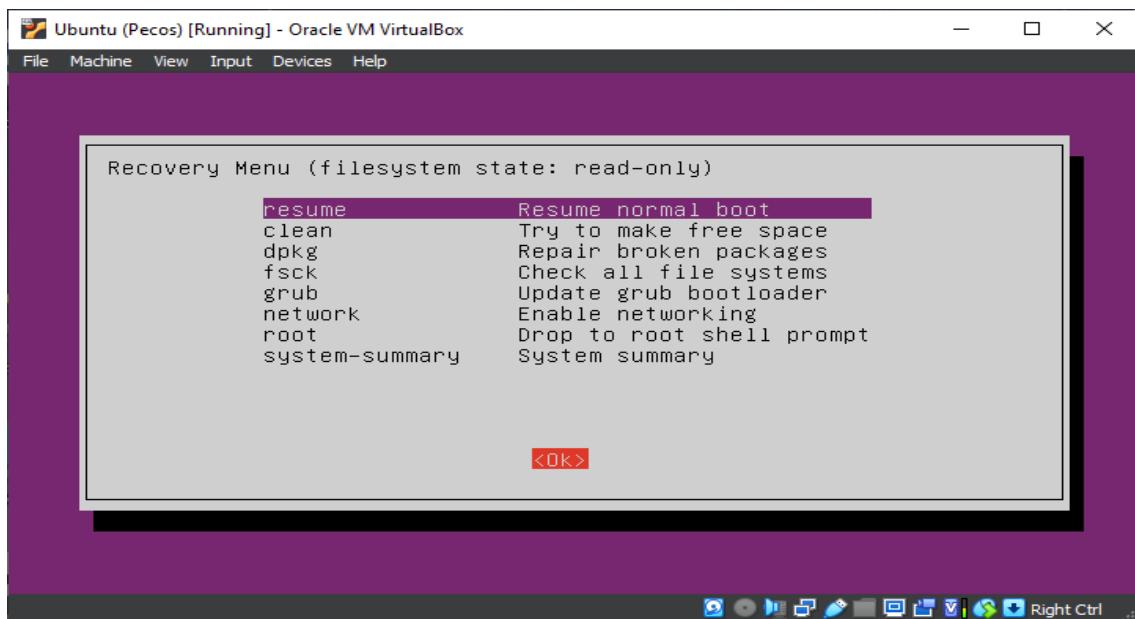
Give root password for maintenance
(or press Control-D to continue):
root@Ubuntu-Pecos:~# mount -o rw,remount /
root@Ubuntu-Pecos:~# adduser vboxuser sudo
Adding user `vboxuser' to group `sudo' ...
Adding user vboxuser to group sudo
Done.
root@Ubuntu-Pecos:~# chmod 0440 /etc/sudoers
root@Ubuntu-Pecos:~# exit

```

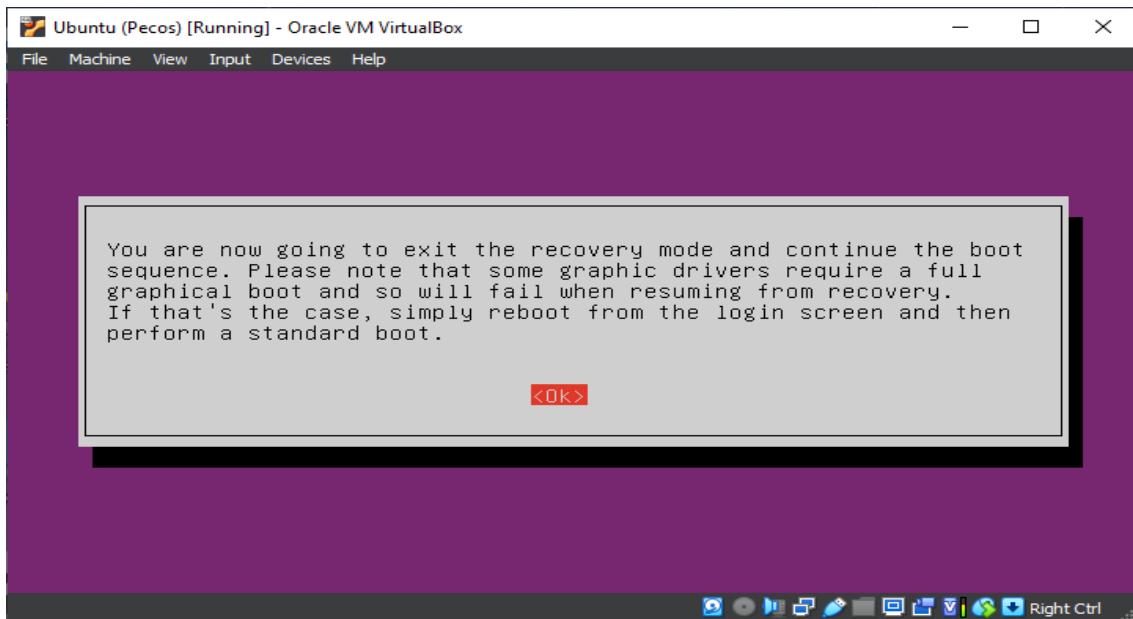
You should now be back in the normal Recovery Menu:



Hit the right arrow key:



Hit Enter:

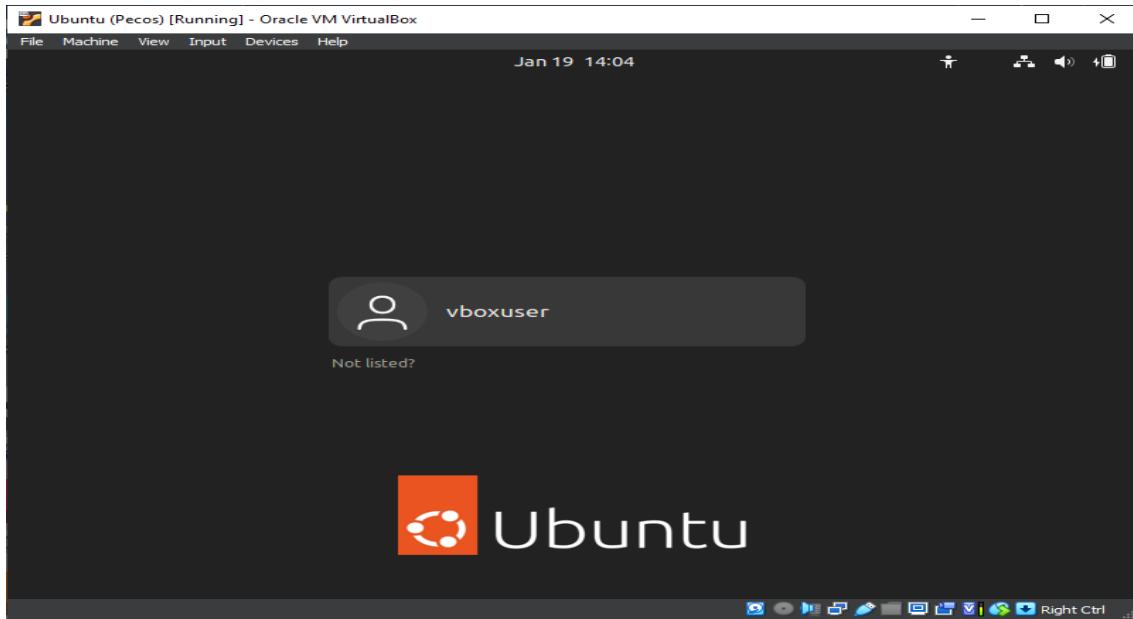


Now the system will restart to apply the changes.

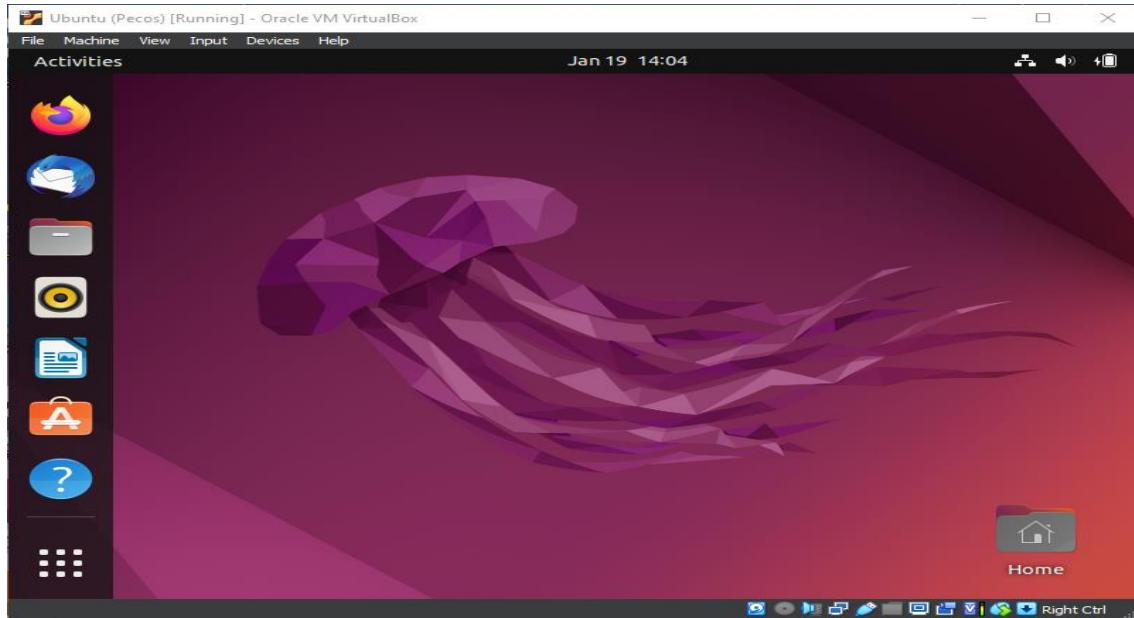
Step 5: Install Anaconda on Virtual Machine

Launch Oracle VM VirtualBox. Select virtual machine and hit start.

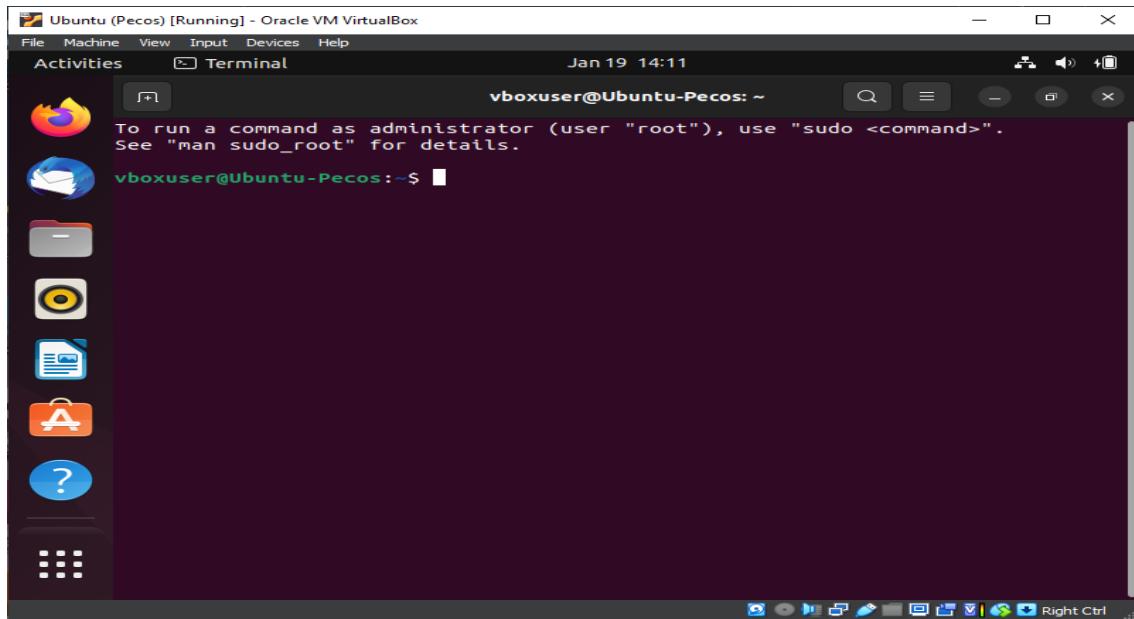
Select user and enter password:



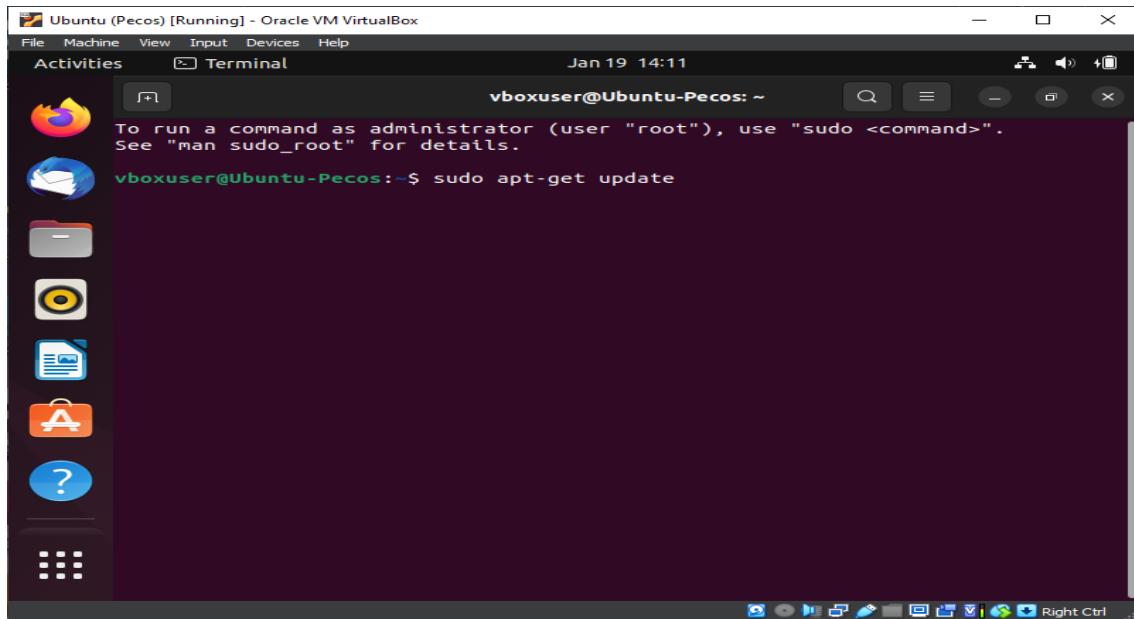
You should now be on the desktop of your VM:



Hit **ctrl+alt+t** to open the Terminal:

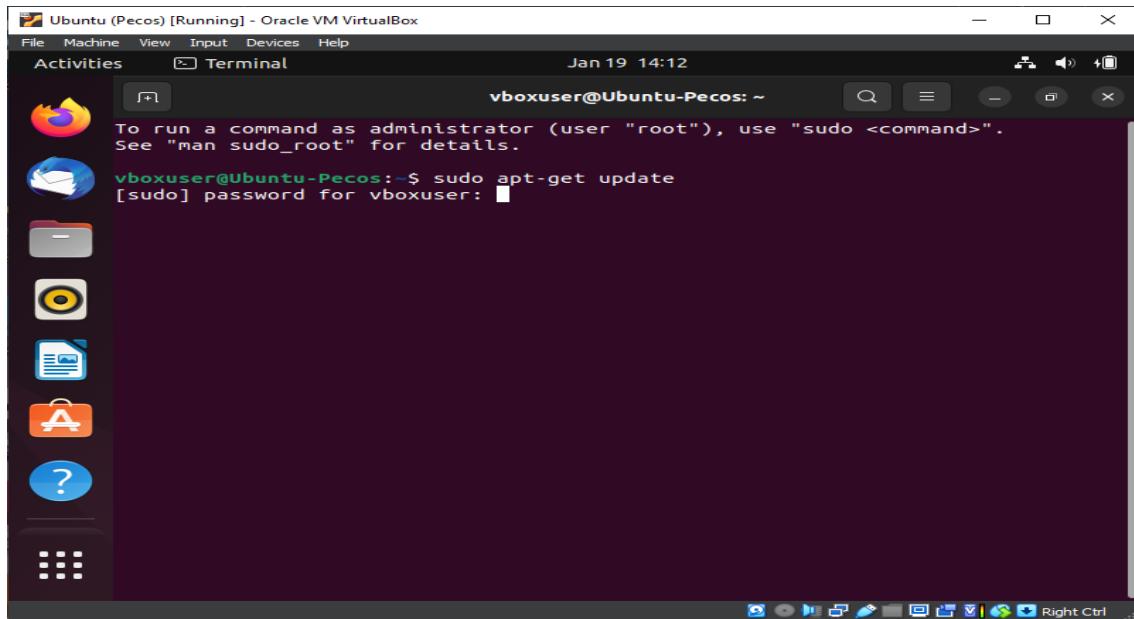


Type the command `sudo apt-get update` and hit Enter:



A screenshot of a Linux desktop environment, specifically Ubuntu, running in Oracle VM VirtualBox. The desktop has a dark theme with a dock at the bottom containing icons for various applications like a browser, file manager, and system settings. On the left, there's a vertical panel titled "Activities" with a "Terminal" icon highlighted. The main window is a terminal window titled "Ubuntu (Pecos) [Running] - Oracle VM VirtualBox". It shows the command `vboxuser@Ubuntu-Pecos: ~` and the output of the command `sudo apt-get update`, which includes a warning about running commands as root and the command itself.

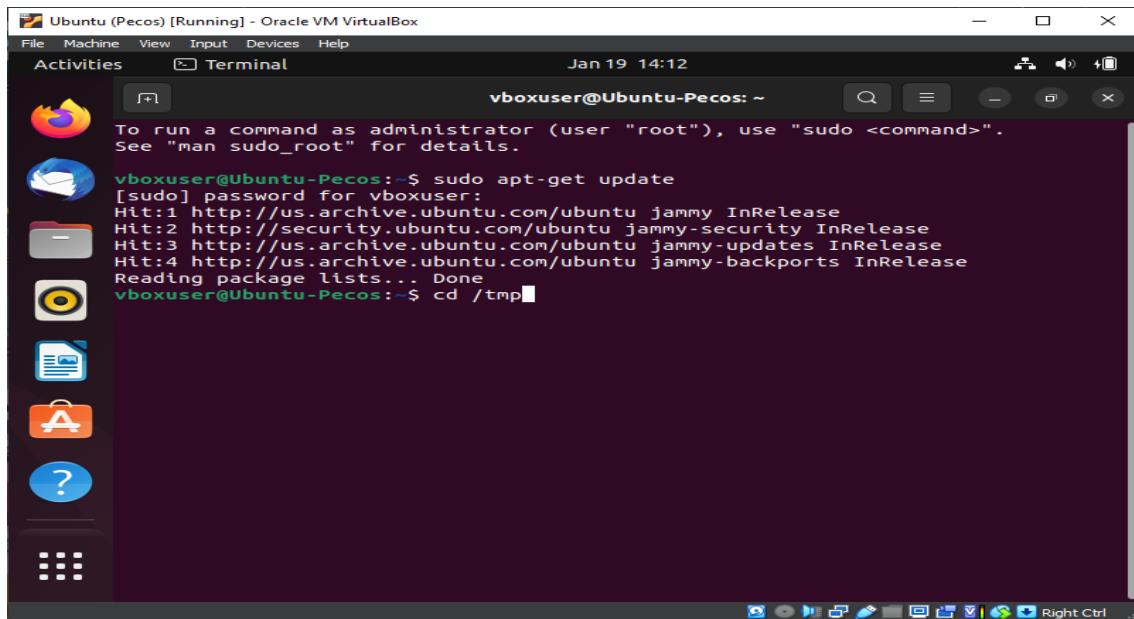
You will now need to enter your password and hit Enter:



A screenshot of the same Linux desktop environment. The terminal window now shows the command `vboxuser@Ubuntu-Pecos: ~` and the output of `sudo apt-get update`. After the command, it prompts for a password with the text "[sudo] password for vboxuser: " followed by a series of visible asterisks (****).

Remember passwords are invisible in the terminal

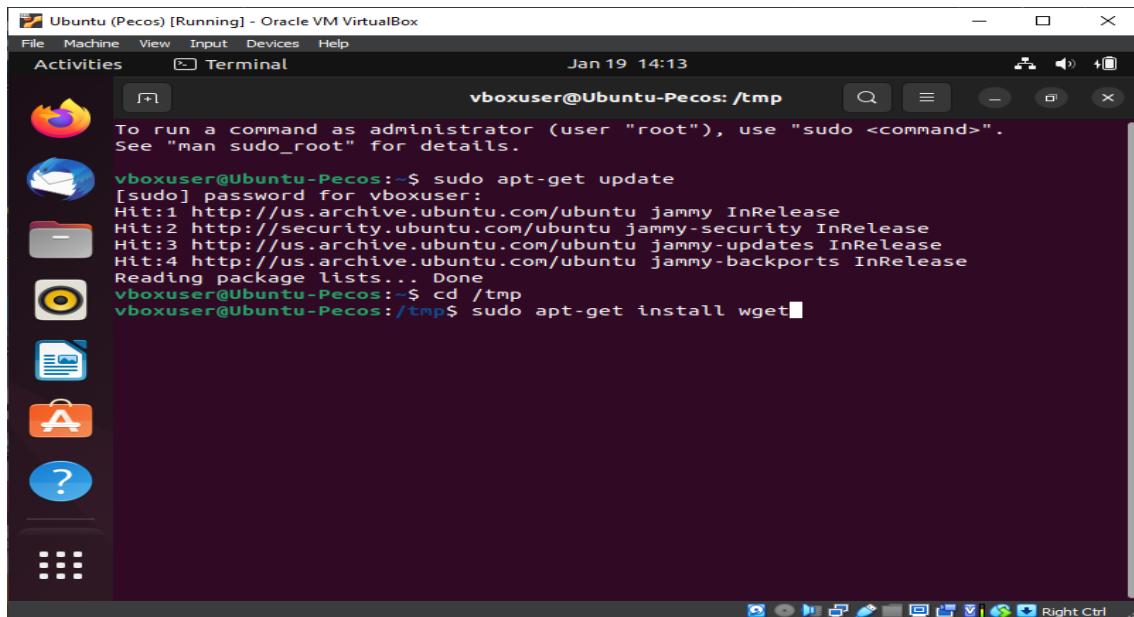
Now type `cd /tmp` and hit Enter:



A screenshot of a Linux desktop environment showing a terminal window titled "Ubuntu (Pecos) [Running] - Oracle VM VirtualBox". The terminal window has a dark background and contains the following text:

```
vboxuser@Ubuntu-Pecos:~$ sudo apt-get update
[sudo] password for vboxuser:
Hit:1 http://us.archive.ubuntu.com/ubuntu jammy InRelease
Hit:2 http://security.ubuntu.com/ubuntu jammy-security InRelease
Hit:3 http://us.archive.ubuntu.com/ubuntu jammy-updates InRelease
Hit:4 http://us.archive.ubuntu.com/ubuntu jammy-backports InRelease
Reading package lists... Done
vboxuser@Ubuntu-Pecos:~$ cd /tmp
```

Next, type command `sudo apt-get install wget` and hit Enter:

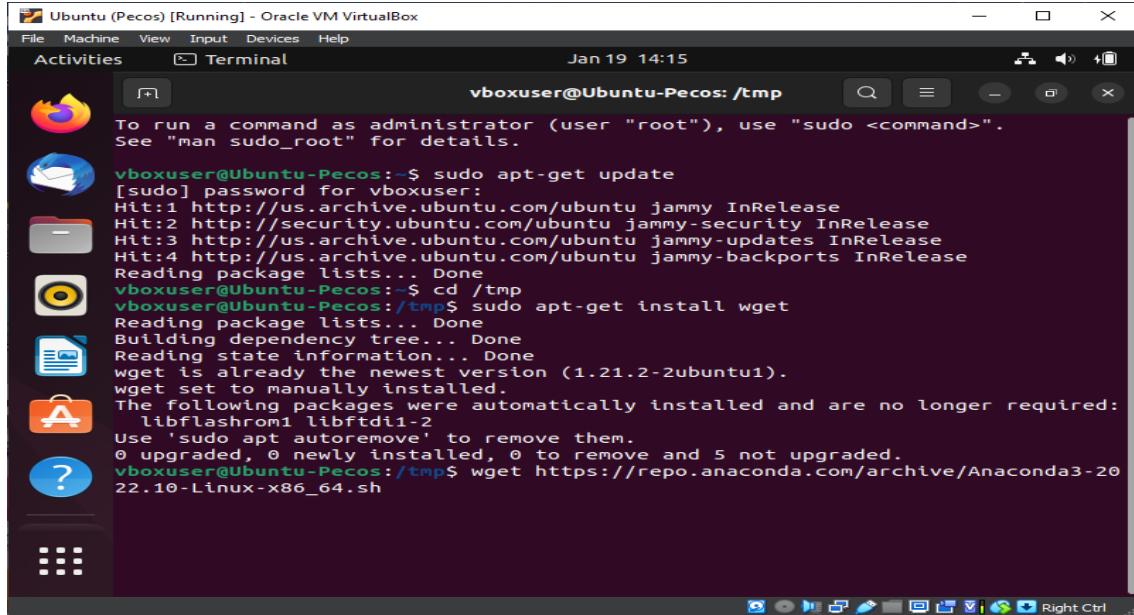


A screenshot of a Linux desktop environment showing a terminal window titled "Ubuntu (Pecos) [Running] - Oracle VM VirtualBox". The terminal window has a dark background and contains the following text:

```
vboxuser@Ubuntu-Pecos:~$ sudo apt-get update
[sudo] password for vboxuser:
Hit:1 http://us.archive.ubuntu.com/ubuntu jammy InRelease
Hit:2 http://security.ubuntu.com/ubuntu jammy-security InRelease
Hit:3 http://us.archive.ubuntu.com/ubuntu jammy-updates InRelease
Hit:4 http://us.archive.ubuntu.com/ubuntu jammy-backports InRelease
Reading package lists... Done
vboxuser@Ubuntu-Pecos:~$ cd /tmp
vboxuser@Ubuntu-Pecos:/tmp$ sudo apt-get install wget
```

Next, input [wget https://repo.anaconda.com/archive/Anaconda3-2022.10-Linux-x86_64.sh](https://repo.anaconda.com/archive/Anaconda3-2022.10-Linux-x86_64.sh)

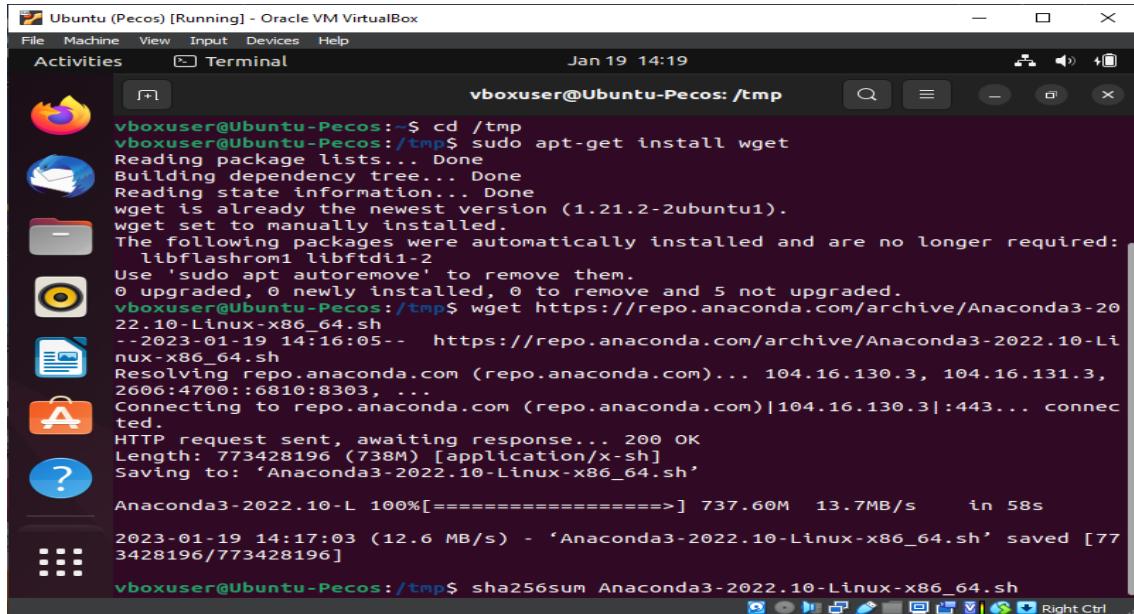
and hit Enter:



```
vboxuser@Ubuntu-Pecos:~$ sudo apt-get update
[sudo] password for vboxuser:
Hit:1 http://us.archive.ubuntu.com/ubuntu jammy InRelease
Hit:2 http://security.ubuntu.com/ubuntu jammy-security InRelease
Hit:3 http://us.archive.ubuntu.com/ubuntu jammy-updates InRelease
Hit:4 http://us.archive.ubuntu.com/ubuntu jammy-backports InRelease
Reading package lists... Done
vboxuser@Ubuntu-Pecos:~$ cd /tmp
vboxuser@Ubuntu-Pecos:/tmp$ sudo apt-get install wget
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
wget is already the newest version (1.21.2-2ubuntu1).
wget set to manually installed.
The following packages were automatically installed and are no longer required:
  libflashrom1 libftdi1-2
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 5 not upgraded.
vboxuser@Ubuntu-Pecos:/tmp$ wget https://repo.anaconda.com/archive/Anaconda3-2022.10-Linux-x86_64.sh
```

This line will differ depending on version number of Anaconda

Next, input [sha256sum Anaconda3-2022.10-Linux-x86_64.sh](https://repo.anaconda.com/archive/Anaconda3-2022.10-Linux-x86_64.sh) and hit Enter:

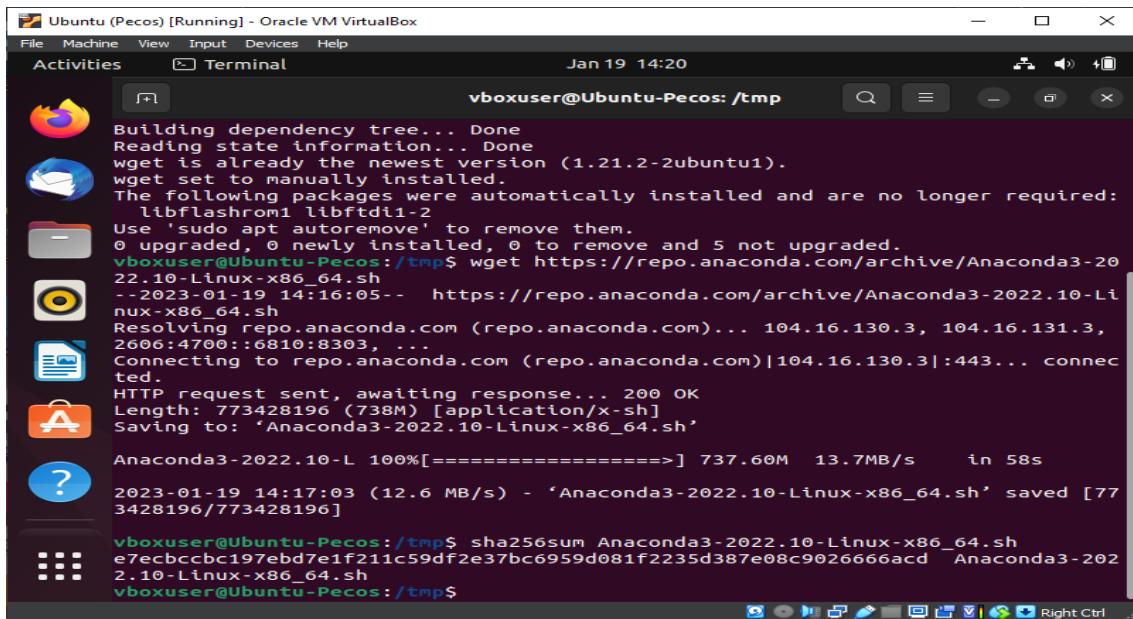


```
vboxuser@Ubuntu-Pecos:~$ cd /tmp
vboxuser@Ubuntu-Pecos:/tmp$ sudo apt-get install wget
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
wget is already the newest version (1.21.2-2ubuntu1).
wget set to manually installed.
The following packages were automatically installed and are no longer required:
  libflashrom1 libftdi1-2
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 5 not upgraded.
vboxuser@Ubuntu-Pecos:/tmp$ wget https://repo.anaconda.com/archive/Anaconda3-2022.10-Linux-x86_64.sh
--2023-01-19 14:16:05--  https://repo.anaconda.com/archive/Anaconda3-2022.10-Linux-x86_64.sh
Resolving repo.anaconda.com (repo.anaconda.com)... 104.16.130.3, 104.16.131.3,
2606:4700::6810:8303, ...
Connecting to repo.anaconda.com (repo.anaconda.com)|104.16.130.3|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 773428196 (738M) [application/x-sh]
Saving to: 'Anaconda3-2022.10-Linux-x86_64.sh'

Anaconda3-2022.10-L 100%[=====] 737.60M  13.7MB/s   in 58s
2023-01-19 14:17:03 (12.6 MB/s) - 'Anaconda3-2022.10-Linux-x86_64.sh' saved [773428196/773428196]
vboxuser@Ubuntu-Pecos:/tmp$ sha256sum Anaconda3-2022.10-Linux-x86_64.sh
```

This line will differ depending on version number of Anaconda

If there are no errors, then continue:

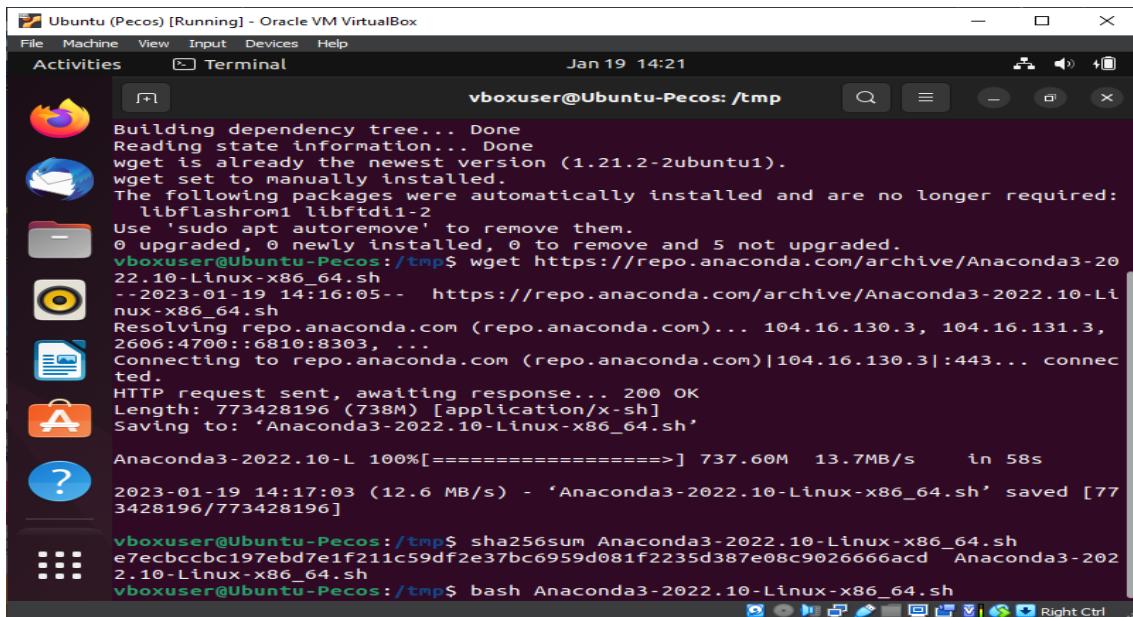


```
vboxuser@Ubuntu-Pecos:~/tmp$ wget https://repo.anaconda.com/archive/Anaconda3-2022.10-Linux-x86_64.sh
--2023-01-19 14:16:05-- https://repo.anaconda.com/archive/Anaconda3-2022.10-Linux-x86_64.sh
Resolving repo.anaconda.com (repo.anaconda.com)... 104.16.130.3, 104.16.131.3, 2606:4700::6810:8303, ...
Connecting to repo.anaconda.com (repo.anaconda.com)|104.16.130.3|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 773428196 (738M) [application/x-sh]
Saving to: 'Anaconda3-2022.10-Linux-x86_64.sh'

Anaconda3-2022.10-L 100%[=====] 737.60M 13.7MB/s in 58s
2023-01-19 14:17:03 (12.6 MB/s) - 'Anaconda3-2022.10-Linux-x86_64.sh' saved [773428196/773428196]

vboxuser@Ubuntu-Pecos:~/tmp$ sha256sum Anaconda3-2022.10-Linux-x86_64.sh
e7ecbccbc197ebd7e1f211c59df2e37bc6959d081f2235d387e08c9026666acd Anaconda3-2022.10-Linux-x86_64.sh
vboxuser@Ubuntu-Pecos:~/tmp$
```

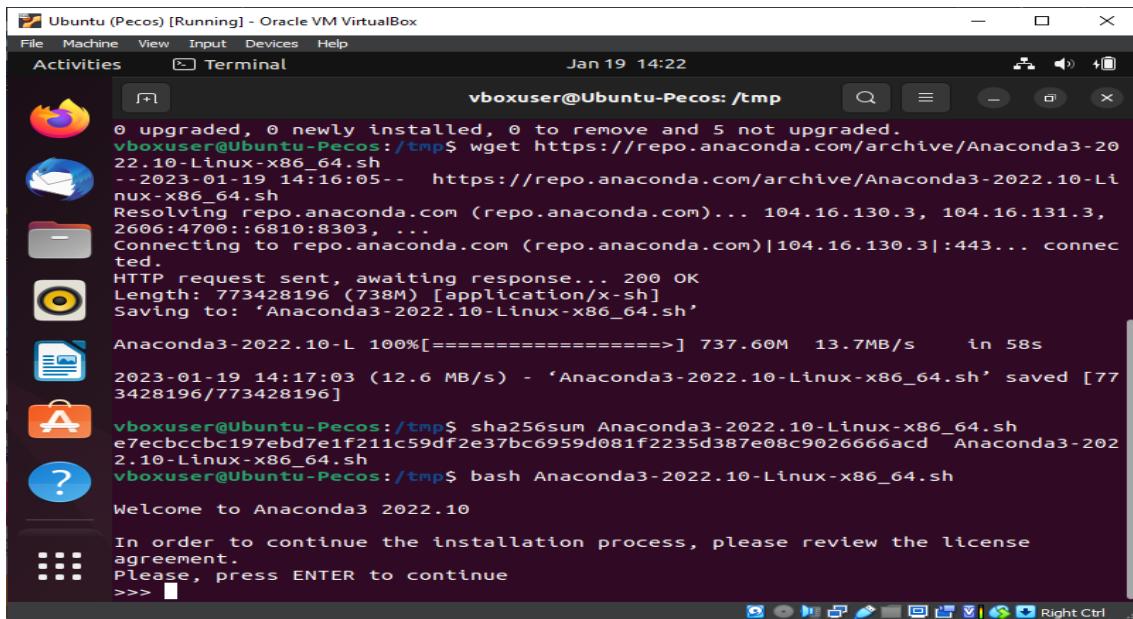
Type *bash Anaconda3-2022.10-Linux-x86_64.sh* and hit Enter:



```
vboxuser@Ubuntu-Pecos:~/tmp$ bash Anaconda3-2022.10-Linux-x86_64.sh
vboxuser@Ubuntu-Pecos:~/tmp$
```

This line will differ depending on version number of Anaconda

You should now see Anaconda's License Agreement:



```
vboxuser@Ubuntu-Pecos:~/tmp$ wget https://repo.anaconda.com/archive/Anaconda3-2022.10-Linux-x86_64.sh
--2023-01-19 14:16:05-- https://repo.anaconda.com/archive/Anaconda3-2022.10-Linux-x86_64.sh
Resolving repo.anaconda.com (repo.anaconda.com)... 104.16.130.3, 104.16.131.3, 2606:4700::6810:8303, ...
Connecting to repo.anaconda.com (repo.anaconda.com)|104.16.130.3|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 773428196 (738M) [application/x-sh]
Saving to: 'Anaconda3-2022.10-Linux-x86_64.sh'

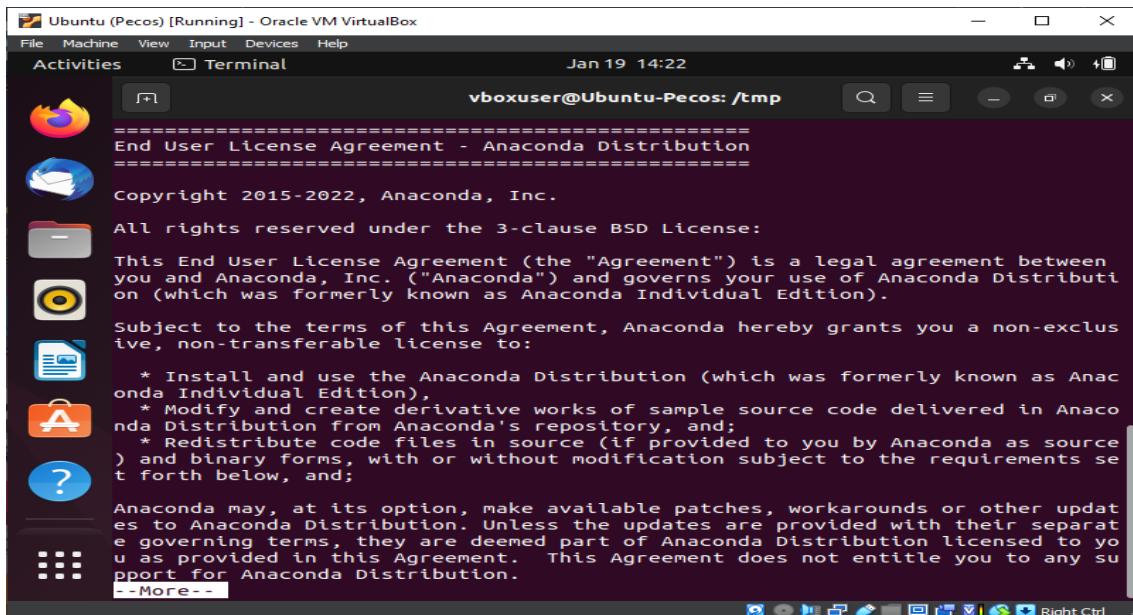
Anaconda3-2022.10-L 100%[=====] 737.60M 13.7MB/s in 58s
2023-01-19 14:17:03 (12.6 MB/s) - 'Anaconda3-2022.10-Linux-x86_64.sh' saved [773428196/773428196]

vboxuser@Ubuntu-Pecos:~/tmp$ sha256sum Anaconda3-2022.10-Linux-x86_64.sh
e7ecbccbc197ebd7e1f211c59df2e37bc6959d081f2235d387e08c9026666acd Anaconda3-2022.10-Linux-x86_64.sh
vboxuser@Ubuntu-Pecos:~/tmp$ bash Anaconda3-2022.10-Linux-x86_64.sh

Welcome to Anaconda3 2022.10

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

Hit enter until you make it through the agreement:



```
=====
End User License Agreement - Anaconda Distribution
=====

Copyright 2015-2022, Anaconda, Inc.

All rights reserved under the 3-clause BSD License:

This End User License Agreement (the "Agreement") is a legal agreement between
you and Anaconda, Inc. ("Anaconda") and governs your use of Anaconda Distributi
on (which was formerly known as Anaconda Individual Edition).

Subject to the terms of this Agreement, Anaconda hereby grants you a non-exclus
ive, non-transferable license to:

    * Install and use the Anaconda Distribution (which was formerly known as Anac
onda Individual Edition),
    * Modify and create derivative works of sample source code delivered in Anaco
nda Distribution from Anaconda's repository, and;
    * Redistribute code files in source (if provided to you by Anaconda as source
) and binary forms, with or without modification subject to the requirements se
t forth below, and;

Anaconda may, at its option, make available patches, workarounds or other updat
es to Anaconda Distribution. Unless the updates are provided with their separat
e governing terms, they are deemed part of Anaconda Distribution licensed to yo
u as provided in this Agreement. This Agreement does not entitle you to any su
pport for Anaconda Distribution.

--More--
```

When you get to the end of the Agreement you will need to type **yes** to agree to the terms and conditions and then hit Enter:

```
vboxuser@Ubuntu-Pecos: /tmp
You must comply with all domestic and international export laws and regulations
that apply to the software, which include restrictions on destinations, end users, and end use. Anaconda Distribution includes cryptographic software. The country in which you currently reside may have restrictions on the import, possession, use, and/or re-export to another country, of encryption software. BEFORE using any encryption software, please check your country's laws, regulations and policies concerning the import, possession, or use, and re-export of encryption software, to see if this is permitted. See the Wassenaar Arrangement http://www.wassenaar.org/ for more information.

Anaconda has self-classified this software as Export Commodity Control Number (ECCN) EAR99 which includes mass market information security software using or performing cryptographic functions with asymmetric algorithms. No license is required for export of this software to non-embargoed countries.

The Intel Math Kernel Library contained in Anaconda Distribution is classified by Intel as ECCN 5D992.c with no license required for export to non-embargoed countries.

The following packages listed on https://www.anaconda.com/cryptography are included in the repository accessible through Anaconda Distribution that relate to cryptography.

Last updated February 25, 2022

Do you accept the license terms? [yes|no]
[no] >>>
Please answer 'yes' or 'no':'
>>> yes
```

Next, you can choose where Anaconda will be installed. In our case, the specified install location is perfectly fine, so hit Enter:

```
vboxuser@Ubuntu-Pecos: /tmp
Anaconda has self-classified this software as Export Commodity Control Number (ECCN) EAR99 which includes mass market information security software using or performing cryptographic functions with asymmetric algorithms. No license is required for export of this software to non-embargoed countries.

The Intel Math Kernel Library contained in Anaconda Distribution is classified by Intel as ECCN 5D992.c with no license required for export to non-embargoed countries.

The following packages listed on https://www.anaconda.com/cryptography are included in the repository accessible through Anaconda Distribution that relate to cryptography.

Last updated February 25, 2022

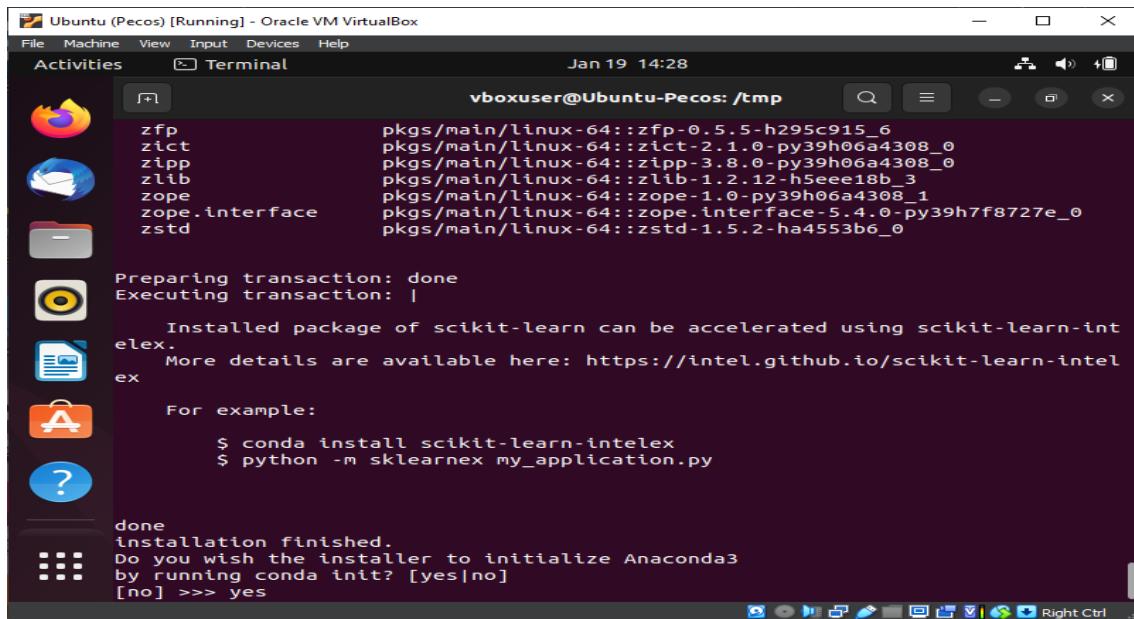
Do you accept the license terms? [yes|no]
[no] >>>
Please answer 'yes' or 'no':'
>>> yes

Anaconda3 will now be installed into this location:
/home/vboxuser/anaconda3

- Press ENTER to confirm the location
- Press CTRL-C to abort the installation
- Or specify a different location below

[/home/vboxuser/anaconda3] >>> 
```

The installation is now complete. Type **yes** and hit Enter to initialize Anaconda:



```
vboxuser@Ubuntu-Pecos: /tmp
File Machine View Input Devices Help
Activities Terminal Jan 19 14:28
vboxuser@Ubuntu-Pecos: /tmp
zfp      pkgs/main/linux-64::zfp-0.5.5-h295c915_6
zict     pkgs/main/linux-64::zict-2.1.0-py39h06a4308_0
zipp     pkgs/main/linux-64::zipp-3.8.0-py39h06a4308_0
zlib     pkgs/main/linux-64::zlib-1.2.12-h5eee18b_3
zope     pkgs/main/linux-64::zope-1.0-py39h06a4308_1
zope.interface pkgs/main/linux-64::zope.interface-5.4.0-py39h7f8727e_0
zstd     pkgs/main/linux-64::zstd-1.5.2-ha4553b6_0

Preparing transaction: done
Executing transaction: |

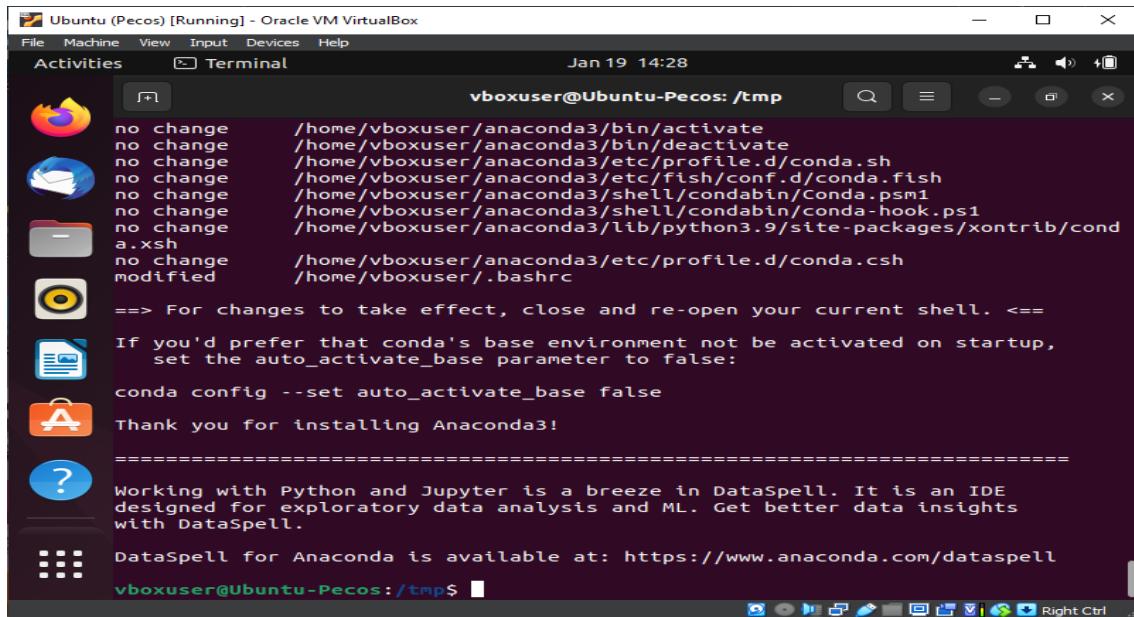
  Installed package of scikit-learn can be accelerated using scikit-learn-intel
  elex.
    More details are available here: https://intel.github.io/scikit-learn-intel
  ex

  For example:

    $ conda install scikit-learn-intel-elex
    $ python -m sklearnex my_application.py

done
installation finished.
Do you wish the installer to initialize Anaconda3
by running conda init? [yes|no]
[no] >>> yes
```

Finished, you should now be seeing a screen like the one below:



```
vboxuser@Ubuntu-Pecos: /tmp
File Machine View Input Devices Help
Activities Terminal Jan 19 14:28
vboxuser@Ubuntu-Pecos: /tmp
no change  /home/vboxuser/anaconda3/bin/activate
no change  /home/vboxuser/anaconda3/bin/deactivate
no change  /home/vboxuser/anaconda3/etc/profile.d/conda.sh
no change  /home/vboxuser/anaconda3/etc/fish/conf.d/conda.fish
no change  /home/vboxuser/anaconda3/shell/condabin/Conda.psm1
no change  /home/vboxuser/anaconda3/shell/condabin/conda-hook.ps1
no change  /home/vboxuser/anaconda3/lib/python3.9/site-packages/xontrib/condaxsh
no change  /home/vboxuser/anaconda3/etc/profile.d/conda.csh
modified   /home/vboxuser/.bashrc

==> For changes to take effect, close and re-open your current shell. <==

If you'd prefer that conda's base environment not be activated on startup,
set the auto_activate_base parameter to false:
conda config --set auto_activate_base false

Thank you for installing Anaconda3!
=====
Working with Python and Jupyter is a breeze in DataSpell. It is an IDE
designed for exploratory data analysis and ML. Get better data insights
with DataSpell.

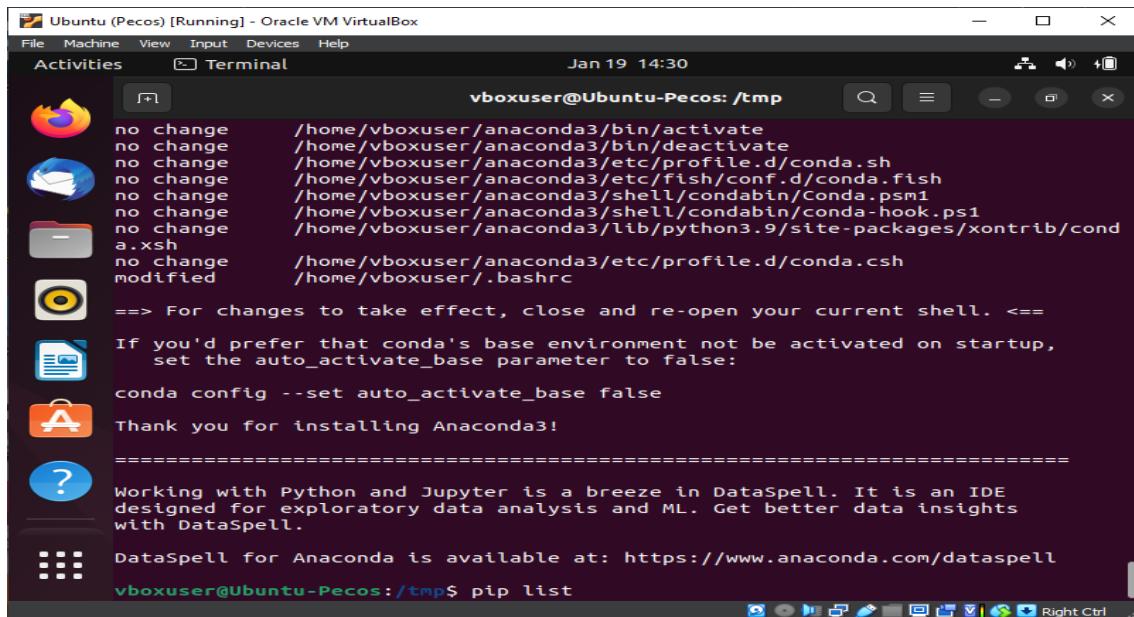
DataSpell for Anaconda is available at: https://www.anaconda.com/dataspell
vboxuser@Ubuntu-Pecos: /tmp$
```

Step 6: Install Needed Packages

- pandas
- matplotlib
- numpy
- jinja2
- nose
- pvlib
- plotly
- ephem
- sqlalchemy
- pecos

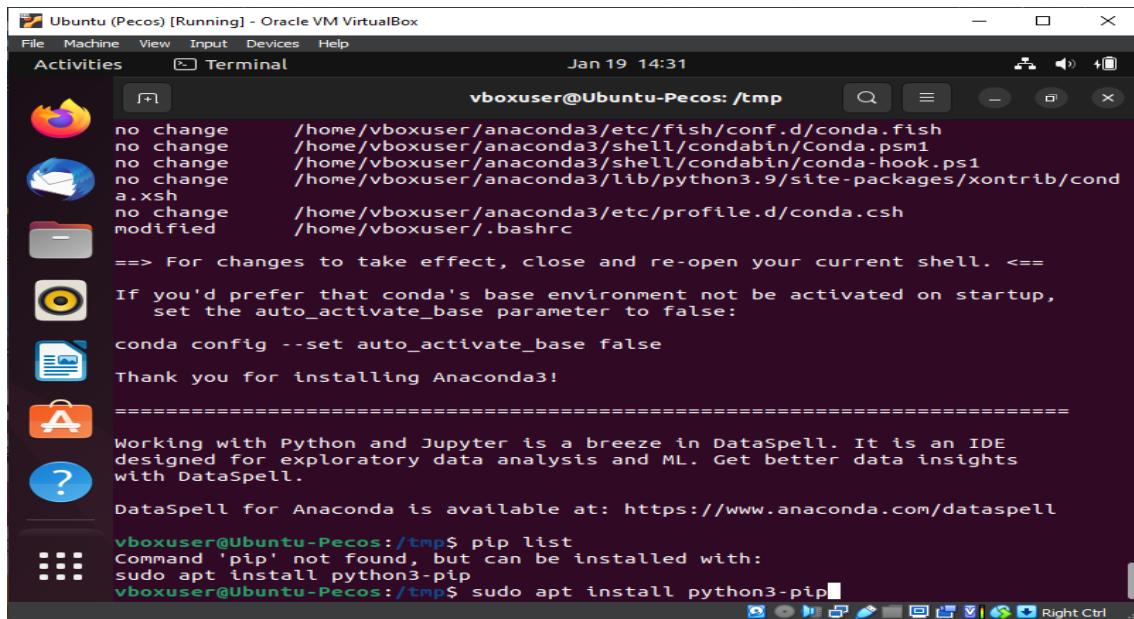
You can check what packages are installed by typing the command *pip list*. Some of these packages may already be installed with Anaconda, however most of these will need to be manually installed. If any packages are missing, use command *pip install* along with the name of the package needed.

Check for needed packages. Use command *pip list* and hit Enter:



```
vboxuser@Ubuntu-Pecos: /tmp
no change    /home/vboxuser/anaconda3/bin/activate
no change    /home/vboxuser/anaconda3/bin/deactivate
no change    /home/vboxuser/anaconda3/etc/profile.d/conda.sh
no change    /home/vboxuser/anaconda3/etc/fish/conf.d/conda.fish
no change    /home/vboxuser/anaconda3/shell/condabin/Conda.psm1
no change    /home/vboxuser/anaconda3/shell/condabin/conda-hook.ps1
no change    /home/vboxuser/anaconda3/lib/python3.9/site-packages/xontrib/conda.xsh
no change    /home/vboxuser/anaconda3/etc/profile.d/conda.csh
modified     /home/vboxuser/.bashrc
==> For changes to take effect, close and re-open your current shell. <==
If you'd prefer that conda's base environment not be activated on startup,
set the auto_activate_base parameter to false:
conda config --set auto_activate_base false
Thank you for installing Anaconda3!
=====
Working with Python and Jupyter is a breeze in DataSpell. It is an IDE
designed for exploratory data analysis and ML. Get better data insights
with DataSpell.
DataSpell for Anaconda is available at: https://www.anaconda.com/dataspell
vboxuser@Ubuntu-Pecos:/tmp$ pip list
```

If pip command is not installed, use command `sudo apt install python3-pip` and hit Enter:



```
vboxuser@Ubuntu-Pecos: /tmp
no change      /home/vboxuser/anaconda3/etc/fish/conf.d/conda.fish
no change      /home/vboxuser/anaconda3/shell/condabin/Conda.psm1
no change      /home/vboxuser/anaconda3/shell/condabin/conda-hook.ps1
no change      /home/vboxuser/anaconda3/lib/python3.9/site-packages/xontrib/conda.xsh
no change      /home/vboxuser/anaconda3/etc/profile.d/conda.csh
modified       /home/vboxuser/.bashrc

==> For changes to take effect, close and re-open your current shell. <==

If you'd prefer that conda's base environment not be activated on startup,
set the auto_activate_base parameter to false:

conda config --set auto_activate_base false

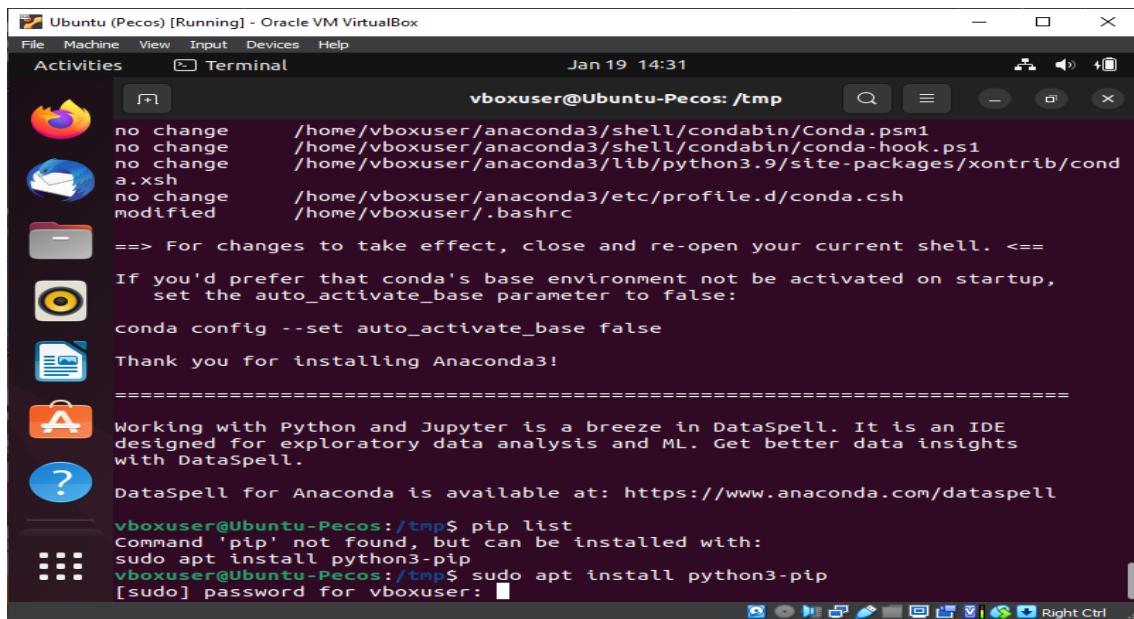
Thank you for installing Anaconda3!

=====
Working with Python and Jupyter is a breeze in DataSpell. It is an IDE
designed for exploratory data analysis and ML. Get better data insights
with DataSpell.

DataSpell for Anaconda is available at: https://www.anaconda.com/dataspell

vboxuser@Ubuntu-Pecos:/tmp$ pip list
Command 'pip' not found, but can be installed with:
sudo apt install python3-pip
vboxuser@Ubuntu-Pecos:/tmp$ sudo apt install python3-pip
```

Now, enter password and hit Enter:



```
vboxuser@Ubuntu-Pecos: /tmp
no change      /home/vboxuser/anaconda3/shell/condabin/Conda.psm1
no change      /home/vboxuser/anaconda3/shell/condabin/conda-hook.ps1
no change      /home/vboxuser/anaconda3/lib/python3.9/site-packages/xontrib/conda.xsh
modified       /home/vboxuser/.bashrc

==> For changes to take effect, close and re-open your current shell. <==

If you'd prefer that conda's base environment not be activated on startup,
set the auto_activate_base parameter to false:

conda config --set auto_activate_base false

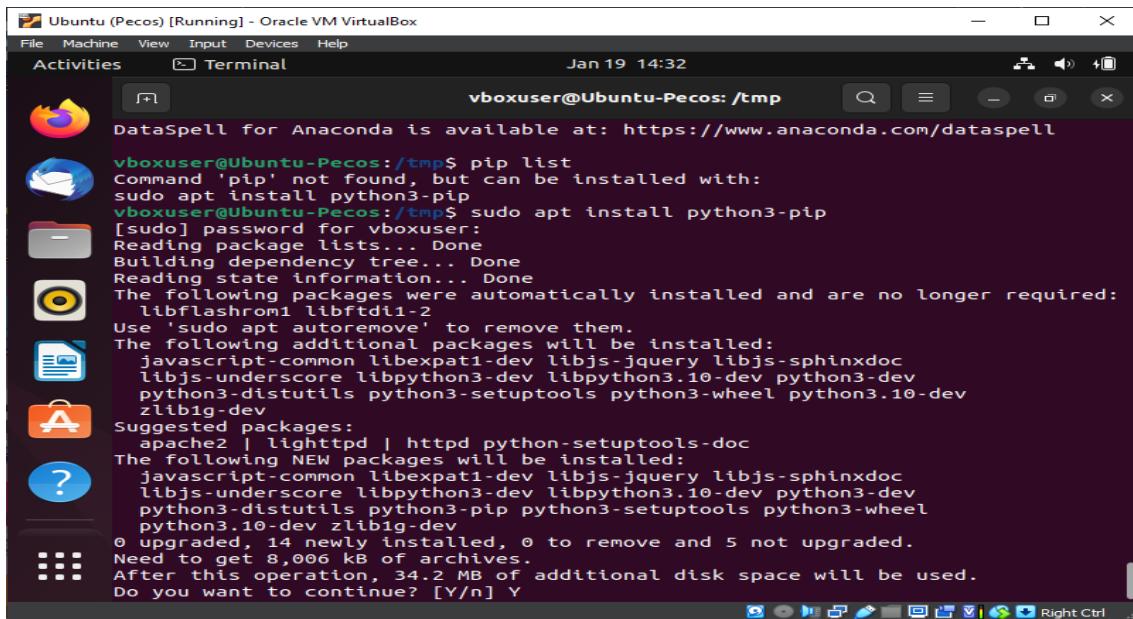
Thank you for installing Anaconda3!

=====
Working with Python and Jupyter is a breeze in DataSpell. It is an IDE
designed for exploratory data analysis and ML. Get better data insights
with DataSpell.

DataSpell for Anaconda is available at: https://www.anaconda.com/dataspell

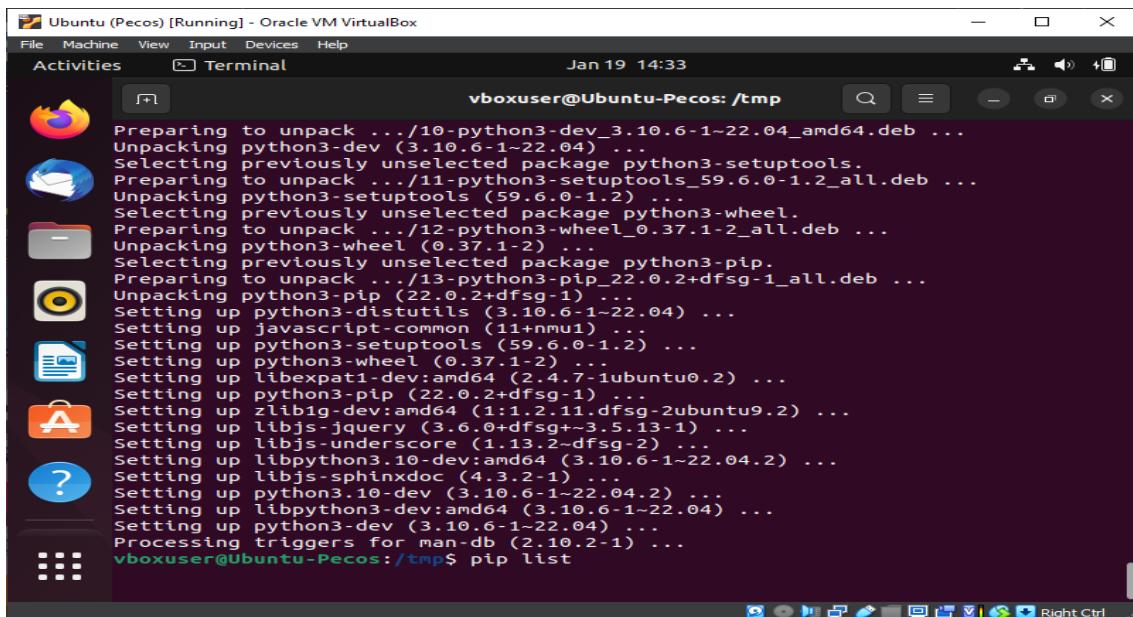
vboxuser@Ubuntu-Pecos:/tmp$ pip list
Command 'pip' not found, but can be installed with:
sudo apt install python3-pip
vboxuser@Ubuntu-Pecos:/tmp$ sudo apt install python3-pip
[sudo] password for vboxuser: [REDACTED]
```

Type **Y** to approve and hit Enter:



```
vboxuser@Ubuntu-Pecos:~/tmp$ pip list
Command 'pip' not found, but can be installed with:
sudo apt install python3-pip
[vboxuser@Ubuntu-Pecos:~/tmp$ sudo apt install python3-pip
[sudo] password for vboxuser:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following packages were automatically installed and are no longer required:
libflashrom1 libftdi1-2
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
javascript-common libexpat1-dev libjs-jquery libjs-sphinxdoc
libjs-underscore libpython3-dev libpython3.10-dev python3-dev
python3-distutils python3-setuptools python3-wheel python3.10-dev
zlib1g-dev
Suggested packages:
apache2 | lighttpd | httpd python-setuptools-doc
The following NEW packages will be installed:
javascript-common libexpat1-dev libjs-jquery libjs-sphinxdoc
libjs-underscore libpython3-dev libpython3.10-dev python3-dev
python3-distutils python3-pip python3-setuptools python3-wheel
python3.10-dev zlib1g-dev
0 upgraded, 14 newly installed, 0 to remove and 5 not upgraded.
Need to get 8,006 kB of archives.
After this operation, 34.2 MB of additional disk space will be used.
Do you want to continue? [Y/n] Y
```

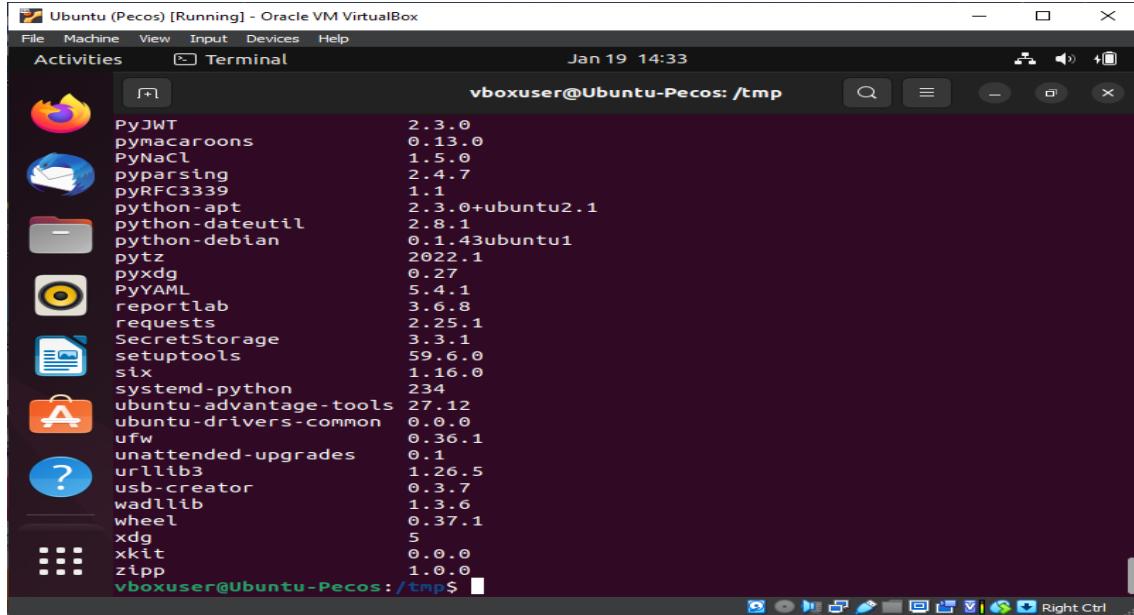
Now type **pip list** and hit Enter:



```
vboxuser@Ubuntu-Pecos:~/tmp$ pip list
Preparing to unpack .../10-python3-dev_3.10.6-1~22.04_amd64.deb ...
Unpacking python3-dev (3.10.6-1~22.04) ...
Selecting previously unselected package python3-setuptools.
Preparing to unpack .../11-python3-setuptools_59.6.0-1.2_all.deb ...
Unpacking python3-setuptools (59.6.0-1.2) ...
Selecting previously unselected package python3-wheel.
Preparing to unpack .../12-python3-wheel_0.37.1-2_all.deb ...
Unpacking python3-wheel (0.37.1-2) ...
Selecting previously unselected package python3-pip.
Preparing to unpack .../13-python3-pip_22.0.2+dfsg-1_all.deb ...
Unpacking python3-pip (22.0.2+dfsg-1) ...
Setting up python3-distutils (3.10.6-1~22.04) ...
Setting up javascript-common (11+nmui) ...
Setting up python3-setuptools (59.6.0-1.2) ...
Setting up python3-wheel (0.37.1-2) ...
Setting up libexpat1-dev:amd64 (2.4.7-1ubuntu0.2) ...
Setting up python3-pip (22.0.2+dfsg-1) ...
Setting up zlib1g-dev:amd64 (1:1.2.11.dfsg-2ubuntu9.2) ...
Setting up libjs-jquery (3.6.0+dfsg+-3.5.13-1) ...
Setting up libjs-underscore (1.13.2~dfsg-2) ...
Setting up libpython3.10-dev:amd64 (3.10.6-1~22.04.2) ...
Setting up libjs-sphinxdoc (4.3.2-1) ...
Setting up python3.10-dev (3.10.6-1~22.04.2) ...
Setting up libpython3-dev:amd64 (3.10.6-1~22.04) ...
Setting up python3-dev (3.10.6-1~22.04) ...
Processing triggers for man-db (2.10.2-1) ...
vboxuser@Ubuntu-Pecos:~/tmp$ pip list
```

A list of the installed packages should now be visible.

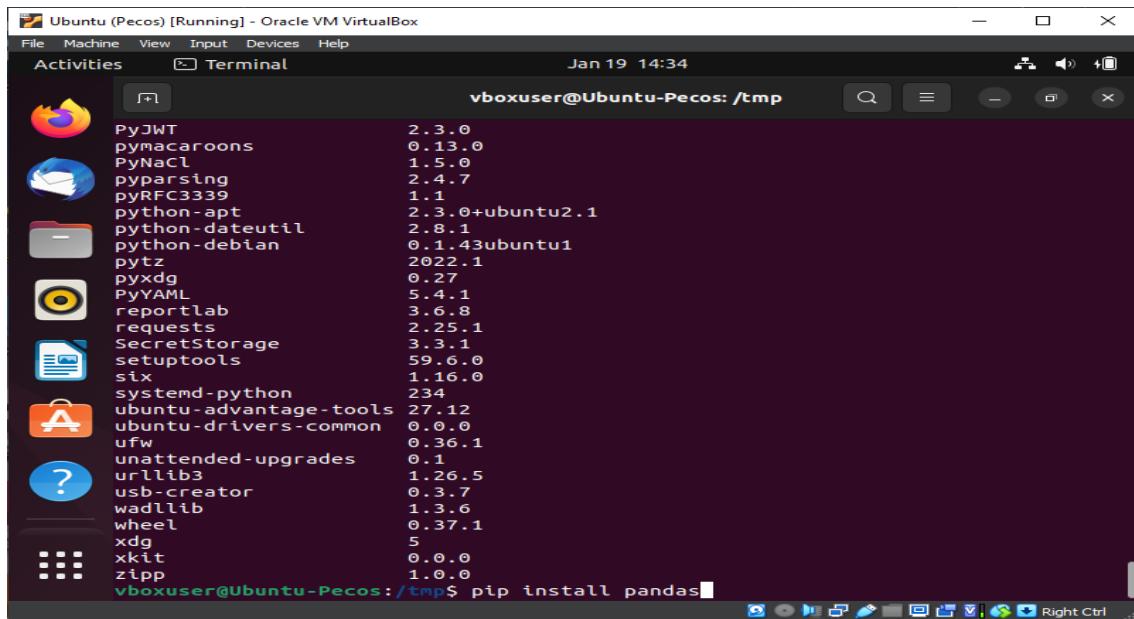
Scroll up and down to check installed packages:



```
vboxuser@Ubuntu-Pecos: /tmp$
```

The screenshot shows a terminal window titled "Ubuntu (Pecos) [Running] - Oracle VM VirtualBox". The window has a dark theme with white text. The title bar includes the machine name, running status, and the host OS. The terminal window has a header bar with tabs for "Activities" and "Terminal". The main area displays a list of installed Python packages and their versions. The packages listed include PyJWT, pymacaroons, PyNaCl, pyparsing, pyRFC3339, python-apt, python-dateutil, python-debian, pytz, pyxdg, PyYAML, reportlab, requests, SecretStorage, setuptools, six, systemd-python, ubuntu-advantage-tools, ubuntu-drivers-common, ufw, unattended-upgrades, urllib3, usb-creator, wadllib, wheel, xdg, xkit, and zipp. The versions range from 0.1.43ubuntu1 to 2.34. The prompt at the bottom is "vboxuser@Ubuntu-Pecos: /tmp\$".

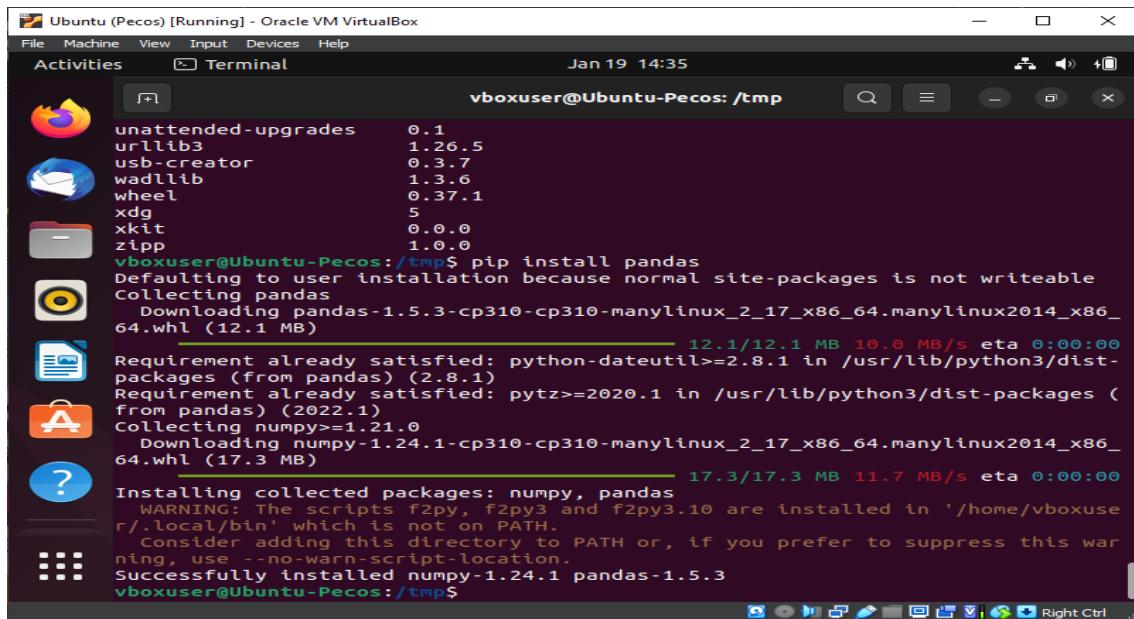
Install *pandas* by typing the command ***pip install pandas*** and hit Enter:



```
vboxuser@Ubuntu-Pecos: /tmp$ pip install pandas
```

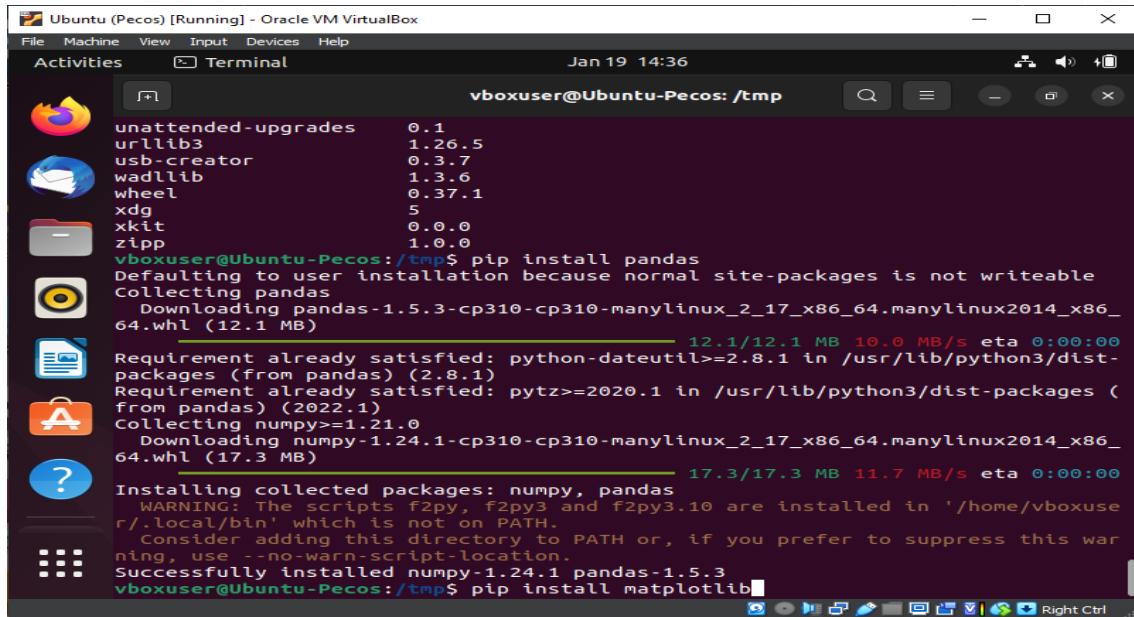
This screenshot is identical to the one above, showing the same terminal window and package list. However, the command "pip install pandas" is now typed into the terminal at the bottom. The prompt "vboxuser@Ubuntu-Pecos: /tmp\$" remains at the bottom of the screen.

Successful Install:



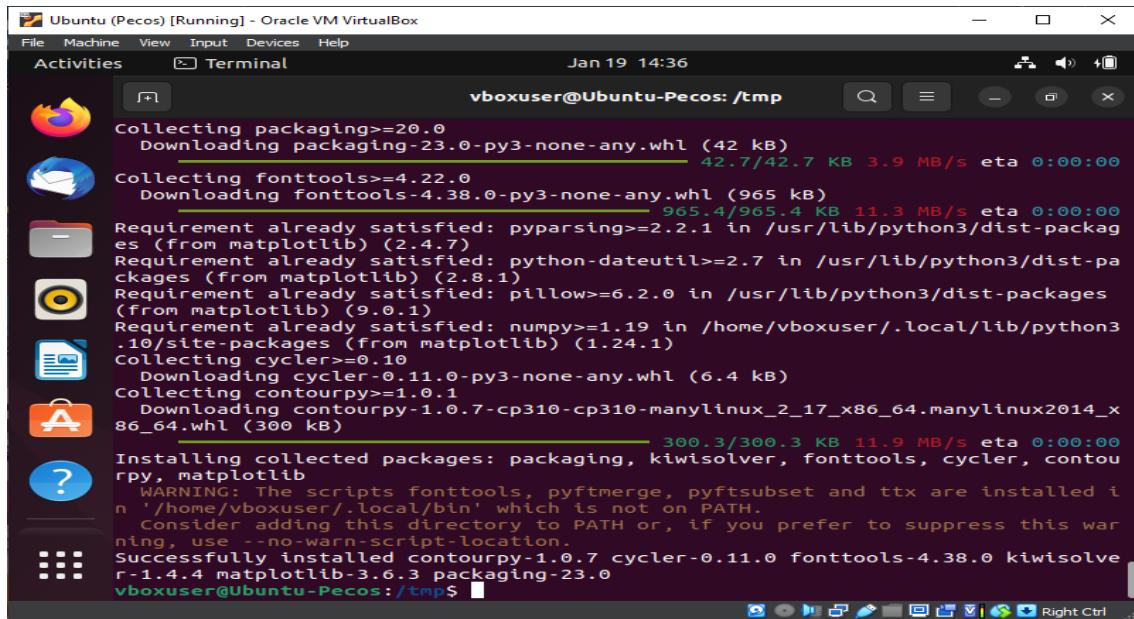
```
vboxuser@Ubuntu-Pecos:~/tmp$ pip install pandas
Defaulting to user installation because normal site-packages is not writeable
Collecting pandas
  Downloading pandas-1.5.3-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_
  64.whl (12.1 MB)
Requirement already satisfied: python-dateutil>=2.8.1 in /usr/lib/python3/dist-
packages (from pandas) (2.8.1)
Requirement already satisfied: pytz>=2020.1 in /usr/lib/python3/dist-packages (
from pandas) (2022.1)
Collecting numpy>=1.21.0
  Downloading numpy-1.24.1-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_
  64.whl (17.3 MB)
12.1/12.1 MB 10.0 MB/s eta 0:00:00
17.3/17.3 MB 11.7 MB/s eta 0:00:00
Installing collected packages: numpy, pandas
  WARNING: The scripts f2py, f2py3 and f2py3.10 are installed in '/home/vboxuse
r/.local/bin' which is not on PATH.
  Consider adding this directory to PATH or, if you prefer to suppress this war
ning, use --no-warn-script-location.
Successfully installed numpy-1.24.1 pandas-1.5.3
vboxuser@Ubuntu-Pecos:~/tmp$
```

Install *matplotlib* by typing the command *pip install matplotlib* and hit Enter:



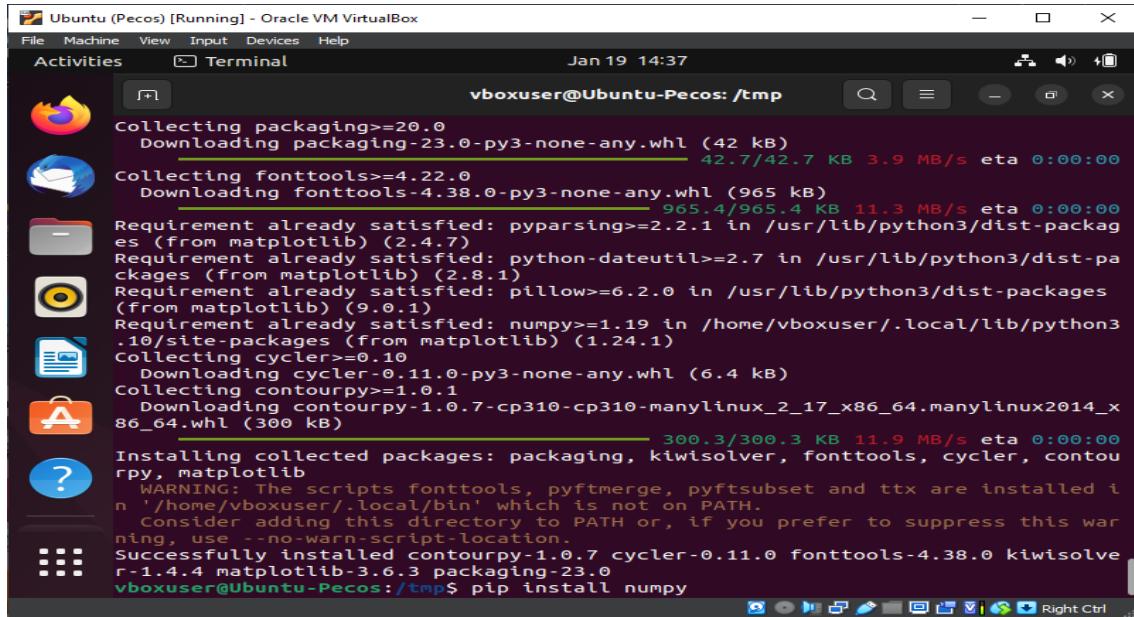
```
vboxuser@Ubuntu-Pecos:~/tmp$ pip install pandas
Defaulting to user installation because normal site-packages is not writeable
Collecting pandas
  Downloading pandas-1.5.3-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_
  64.whl (12.1 MB)
Requirement already satisfied: python-dateutil>=2.8.1 in /usr/lib/python3/dist-
packages (from pandas) (2.8.1)
Requirement already satisfied: pytz>=2020.1 in /usr/lib/python3/dist-packages (
from pandas) (2022.1)
Collecting numpy>=1.21.0
  Downloading numpy-1.24.1-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_
  64.whl (17.3 MB)
12.1/12.1 MB 10.0 MB/s eta 0:00:00
17.3/17.3 MB 11.7 MB/s eta 0:00:00
Installing collected packages: numpy, pandas
  WARNING: The scripts f2py, f2py3 and f2py3.10 are installed in '/home/vboxuse
r/.local/bin' which is not on PATH.
  Consider adding this directory to PATH or, if you prefer to suppress this war
ning, use --no-warn-script-location.
Successfully installed numpy-1.24.1 pandas-1.5.3
vboxuser@Ubuntu-Pecos:~/tmp$ pip install matplotlib
```

Successful Install:



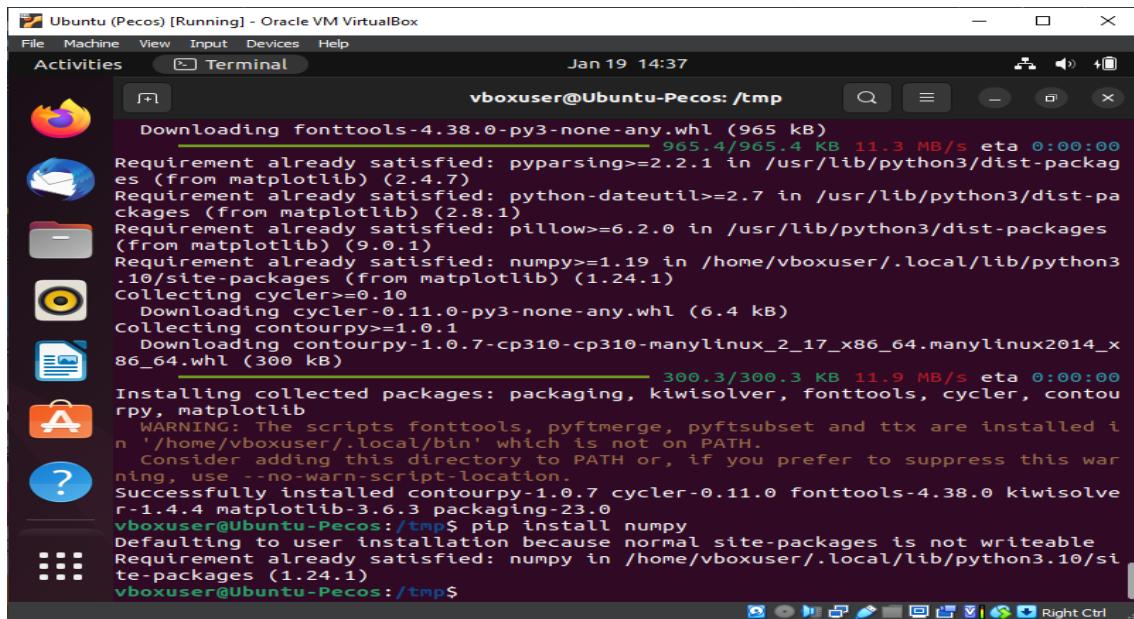
```
vboxuser@Ubuntu-Pecos: /tmp
Collecting packaging>=20.0
  Downloading packaging-23.0-py3-none-any.whl (42 kB)
Collecting fonttools>=4.22.0
  Downloading fonttools-4.38.0-py3-none-any.whl (965 kB)
Requirement already satisfied: pyparsing>=2.2.1 in /usr/lib/python3/dist-packages (from matplotlib) (2.4.7)
Requirement already satisfied: python-dateutil>=2.7 in /usr/lib/python3/dist-packages (from matplotlib) (2.8.1)
Requirement already satisfied: pillow>=6.2.0 in /usr/lib/python3/dist-packages (from matplotlib) (9.0.1)
Requirement already satisfied: numpy>=1.19 in /home/vboxuser/.local/lib/python3.10/site-packages (from matplotlib) (1.24.1)
Collecting cycler>=0.10
  Downloading cycler-0.11.0-py3-none-any.whl (6.4 kB)
Collecting contourpy>=1.0.1
  Downloading contourpy-1.0.7-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (300 kB)
Installing collected packages: packaging, kiwisolver, fonttools, cycler, contourpy, matplotlib
  WARNING: The scripts fonttools, pyftmerge, pyftsubset and ttx are installed in '/home/vboxuser/.local/bin' which is not on PATH.
    Consider adding this directory to PATH or, if you prefer to suppress this warning, use --no-warn-script-location.
Successfully installed contourpy-1.0.7 cycler-0.11.0 fonttools-4.38.0 kiwisolver-1.4.4 matplotlib-3.6.3 packaging-23.0
vboxuser@Ubuntu-Pecos:/tmp$
```

Install *numpy* by typing the command ***pip install numpy*** and hit Enter:



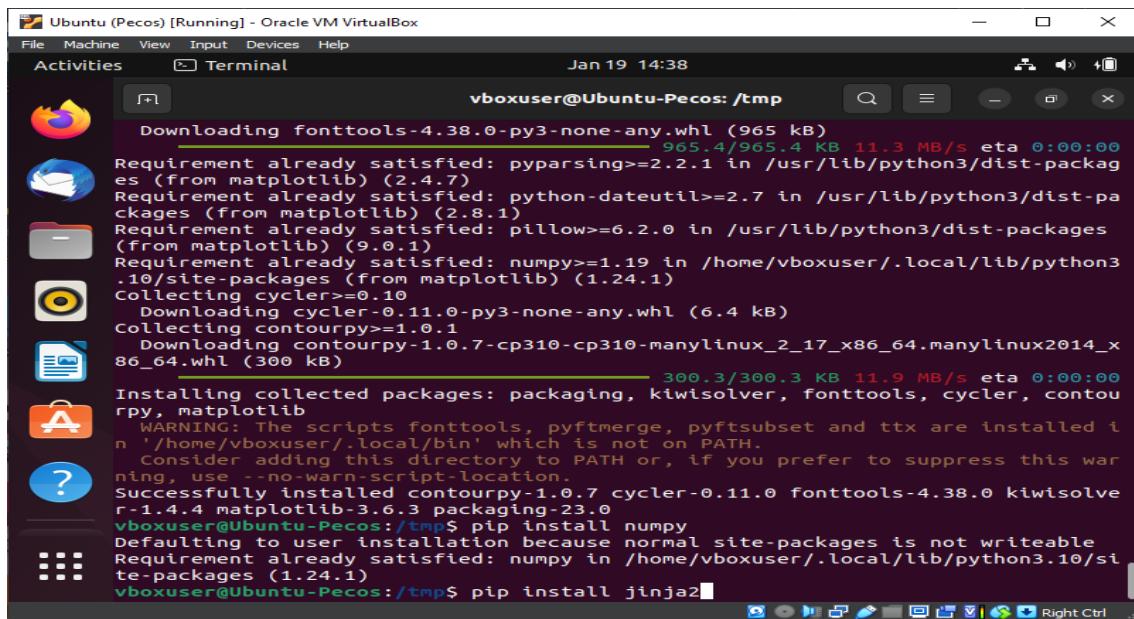
```
vboxuser@Ubuntu-Pecos: /tmp
Collecting packaging>=20.0
  Downloading packaging-23.0-py3-none-any.whl (42 kB)
Collecting fonttools>=4.22.0
  Downloading fonttools-4.38.0-py3-none-any.whl (965 kB)
Requirement already satisfied: pyparsing>=2.2.1 in /usr/lib/python3/dist-packages (from matplotlib) (2.4.7)
Requirement already satisfied: python-dateutil>=2.7 in /usr/lib/python3/dist-packages (from matplotlib) (2.8.1)
Requirement already satisfied: pillow>=6.2.0 in /usr/lib/python3/dist-packages (from matplotlib) (9.0.1)
Requirement already satisfied: numpy>=1.19 in /home/vboxuser/.local/lib/python3.10/site-packages (from matplotlib) (1.24.1)
Collecting cycler>=0.10
  Downloading cycler-0.11.0-py3-none-any.whl (6.4 kB)
Collecting contourpy>=1.0.1
  Downloading contourpy-1.0.7-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (300 kB)
Installing collected packages: packaging, kiwisolver, fonttools, cycler, contourpy, matplotlib
  WARNING: The scripts fonttools, pyftmerge, pyftsubset and ttx are installed in '/home/vboxuser/.local/bin' which is not on PATH.
    Consider adding this directory to PATH or, if you prefer to suppress this warning, use --no-warn-script-location.
Successfully installed contourpy-1.0.7 cycler-0.11.0 fonttools-4.38.0 kiwisolver-1.4.4 matplotlib-3.6.3 packaging-23.0
vboxuser@Ubuntu-Pecos:/tmp$ pip install numpy
```

Successful Install:



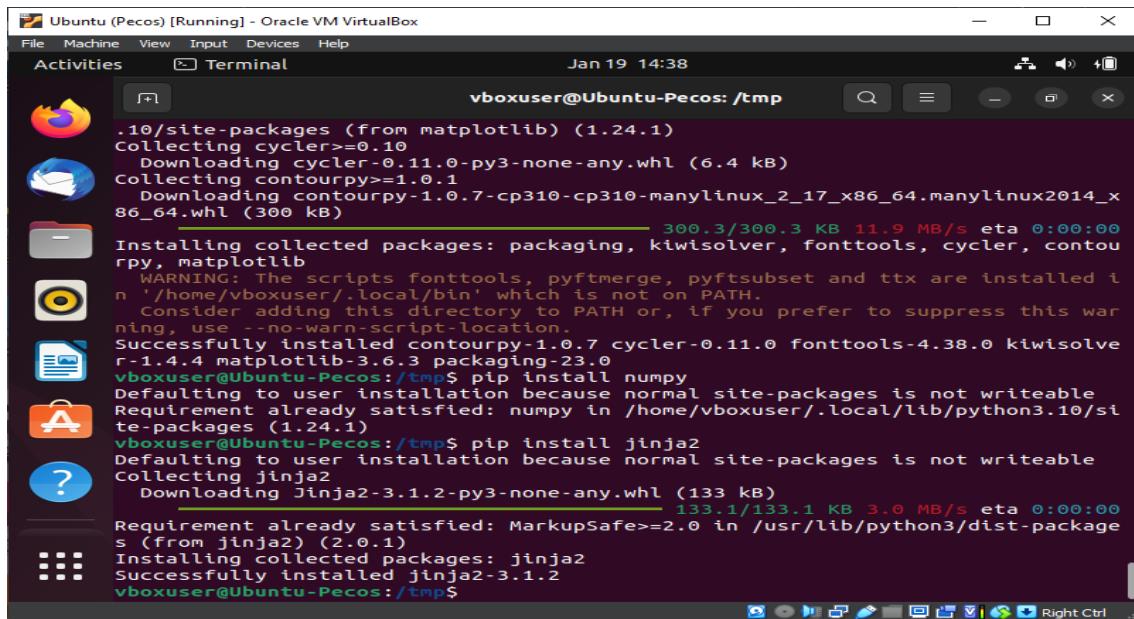
```
vboxuser@Ubuntu-Pecos: /tmp
  Downloading fonttools-4.38.0-py3-none-any.whl (965 kB)
    965.4/965.4 KB 11.3 MB/s eta 0:00:00
Requirement already satisfied: pyparsing>=2.2.1 in /usr/lib/python3/dist-packages (from matplotlib) (2.4.7)
Requirement already satisfied: python-dateutil>=2.7 in /usr/lib/python3/dist-packages (from matplotlib) (2.8.1)
Requirement already satisfied: pillow>=6.2.0 in /usr/lib/python3/dist-packages (from matplotlib) (9.0.1)
Requirement already satisfied: numpy>=1.19 in /home/vboxuser/.local/lib/python3.10/site-packages (from matplotlib) (1.24.1)
Collecting cycler>=0.10
  Downloading cycler-0.11.0-py3-none-any.whl (6.4 kB)
Collecting contourpy>=1.0.1
  Downloading contourpy-1.0.7-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (300 kB)
    300.3/300.3 KB 11.9 MB/s eta 0:00:00
Installing collected packages: packaging, kiwisolver, fonttools, cycler, contourpy, matplotlib
  WARNING: The scripts fonttools, pyftmerge, pyftsubset and ttx are installed in '/home/vboxuser/.local/bin' which is not on PATH.
  Consider adding this directory to PATH or, if you prefer to suppress this warning, use --no-warn-script-location.
Successfully installed contourpy-1.0.7 cycler-0.11.0 fonttools-4.38.0 kiwisolver-1.4.4 matplotlib-3.6.3 packaging-23.0
vboxuser@Ubuntu-Pecos:/tmp$ pip install numpy
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: numpy in /home/vboxuser/.local/lib/python3.10/site-packages (1.24.1)
vboxuser@Ubuntu-Pecos:/tmp$
```

Install *jinja2* by typing the command ***pip install jinja2*** and hit Enter:



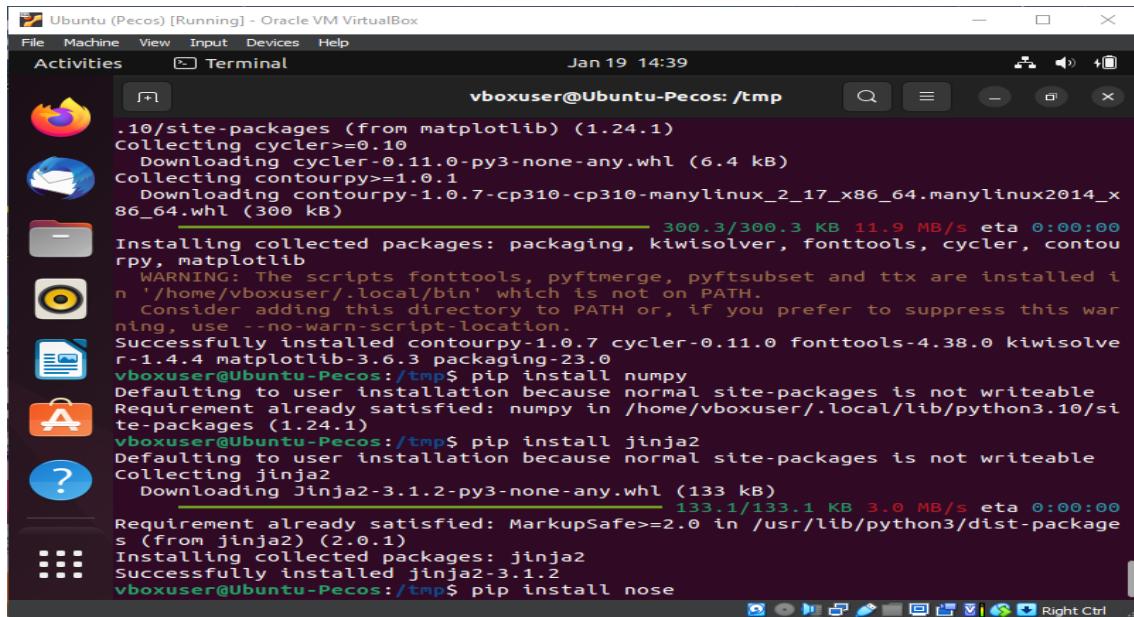
```
vboxuser@Ubuntu-Pecos: /tmp
  Downloading fonttools-4.38.0-py3-none-any.whl (965 kB)
    965.4/965.4 KB 11.3 MB/s eta 0:00:00
Requirement already satisfied: pyparsing>=2.2.1 in /usr/lib/python3/dist-packages (from matplotlib) (2.4.7)
Requirement already satisfied: python-dateutil>=2.7 in /usr/lib/python3/dist-packages (from matplotlib) (2.8.1)
Requirement already satisfied: pillow>=6.2.0 in /usr/lib/python3/dist-packages (from matplotlib) (9.0.1)
Requirement already satisfied: numpy>=1.19 in /home/vboxuser/.local/lib/python3.10/site-packages (from matplotlib) (1.24.1)
Collecting cycler>=0.10
  Downloading cycler-0.11.0-py3-none-any.whl (6.4 kB)
Collecting contourpy>=1.0.1
  Downloading contourpy-1.0.7-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (300 kB)
    300.3/300.3 KB 11.9 MB/s eta 0:00:00
Installing collected packages: packaging, kiwisolver, fonttools, cycler, contourpy, matplotlib
  WARNING: The scripts fonttools, pyftmerge, pyftsubset and ttx are installed in '/home/vboxuser/.local/bin' which is not on PATH.
  Consider adding this directory to PATH or, if you prefer to suppress this warning, use --no-warn-script-location.
Successfully installed contourpy-1.0.7 cycler-0.11.0 fonttools-4.38.0 kiwisolver-1.4.4 matplotlib-3.6.3 packaging-23.0
vboxuser@Ubuntu-Pecos:/tmp$ pip install jinja2
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: numpy in /home/vboxuser/.local/lib/python3.10/site-packages (1.24.1)
vboxuser@Ubuntu-Pecos:/tmp$ pip install jinja2■
```

Successful Install:



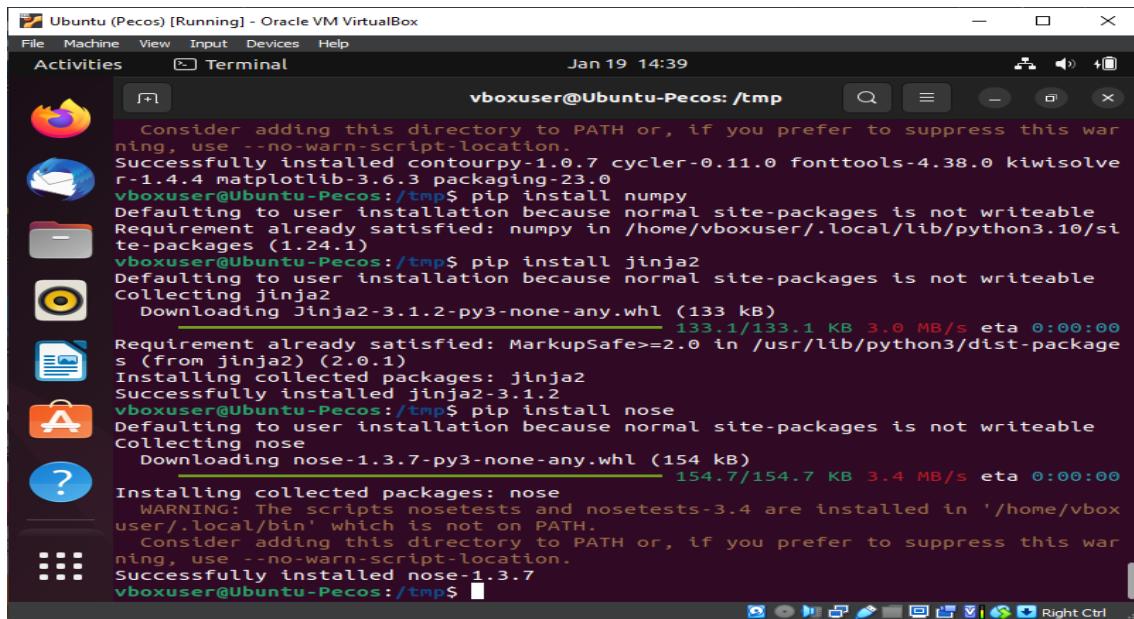
```
vboxuser@Ubuntu-Pecos: /tmp
.v0/site-packages (from matplotlib) (1.24.1)
Collecting cycler>=0.10
  Downloading cycler-0.11.0-py3-none-any.whl (6.4 kB)
Collecting contourpy>=1.0.1
  Downloading contourpy-1.0.7-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (300 kB)
    300.3/300.3 KB 11.9 MB/s eta 0:00:00
Installing collected packages: packaging, kiwisolver, fonttools, cycler, contourpy, matplotlib
  WARNING: The scripts fonttools, pyftmerge, pyftsubset and ttx are installed in '/home/vboxuser/.local/bin' which is not on PATH.
  Consider adding this directory to PATH or, if you prefer to suppress this warning, use --no-warn-script-location.
Successfully installed contourpy-1.0.7 cycler-0.11.0 fonttools-4.38.0 kiwisolver-1.4.4 matplotlib-3.6.3 packaging-23.0
vboxuser@Ubuntu-Pecos:/tmp$ pip install numpy
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: numpy in /home/vboxuser/.local/lib/python3.10/site-packages (1.24.1)
vboxuser@Ubuntu-Pecos:/tmp$ pip install jinja2
Defaulting to user installation because normal site-packages is not writeable
Collecting jinja2
  Downloading Jinja2-3.1.2-py3-none-any.whl (133 kB)
    133.1/133.1 KB 3.0 MB/s eta 0:00:00
Requirement already satisfied: MarkupSafe>=2.0 in /usr/lib/python3/dist-packages (from jinja2) (2.0.1)
Installing collected packages: jinja2
Successfully installed jinja2-3.1.2
vboxuser@Ubuntu-Pecos:/tmp$
```

Install *nose* by typing the command ***pip install nose*** and hit Enter:



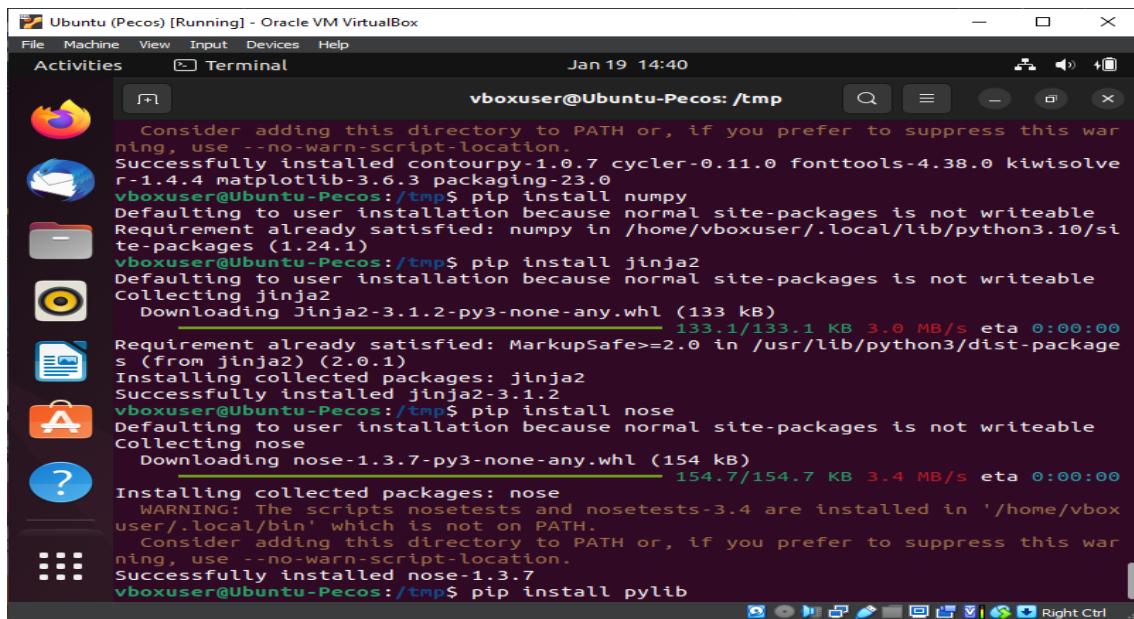
```
vboxuser@Ubuntu-Pecos: /tmp
.v0/site-packages (from matplotlib) (1.24.1)
Collecting cycler>=0.10
  Downloading cycler-0.11.0-py3-none-any.whl (6.4 kB)
Collecting contourpy>=1.0.1
  Downloading contourpy-1.0.7-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (300 kB)
    300.3/300.3 KB 11.9 MB/s eta 0:00:00
Installing collected packages: packaging, kiwisolver, fonttools, cycler, contourpy, matplotlib
  WARNING: The scripts fonttools, pyftmerge, pyftsubset and ttx are installed in '/home/vboxuser/.local/bin' which is not on PATH.
  Consider adding this directory to PATH or, if you prefer to suppress this warning, use --no-warn-script-location.
Successfully installed contourpy-1.0.7 cycler-0.11.0 fonttools-4.38.0 kiwisolver-1.4.4 matplotlib-3.6.3 packaging-23.0
vboxuser@Ubuntu-Pecos:/tmp$ pip install numpy
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: numpy in /home/vboxuser/.local/lib/python3.10/site-packages (1.24.1)
vboxuser@Ubuntu-Pecos:/tmp$ pip install jinja2
Defaulting to user installation because normal site-packages is not writeable
Collecting jinja2
  Downloading Jinja2-3.1.2-py3-none-any.whl (133 kB)
    133.1/133.1 KB 3.0 MB/s eta 0:00:00
Requirement already satisfied: MarkupSafe>=2.0 in /usr/lib/python3/dist-packages (from jinja2) (2.0.1)
Installing collected packages: jinja2
Successfully installed jinja2-3.1.2
vboxuser@Ubuntu-Pecos:/tmp$ pip install nose
Defaulting to user installation because normal site-packages is not writeable
Collecting nose
  Downloading nose-2.1.0-py3-none-any.whl (13 kB)
    13.1/13.1 KB 3.0 MB/s eta 0:00:00
Requirement already satisfied: importlib-metadata<5.0; python_version >= "3.8" in /usr/lib/python3/dist-packages (from nose) (5.0.1)
Requirement already satisfied: packaging in /usr/lib/python3/dist-packages (from nose) (42.1.0)
Requirement already satisfied: pbr in /usr/lib/python3/dist-packages (from nose) (6.0.0)
Requirement already satisfied: six in /usr/lib/python3/dist-packages (from nose) (1.16.0)
Requirement already satisfied: typed-ast in /usr/lib/python3/dist-packages (from nose) (2.0.0)
Requirement already satisfied: typeguard in /usr/lib/python3/dist-packages (from nose) (3.4.2)
Requirement already satisfied: zipp in /usr/lib/python3/dist-packages (from nose) (3.7.0)
Installing collected packages: nose
Successfully installed nose-2.1.0
vboxuser@Ubuntu-Pecos:/tmp$
```

Successful Install:



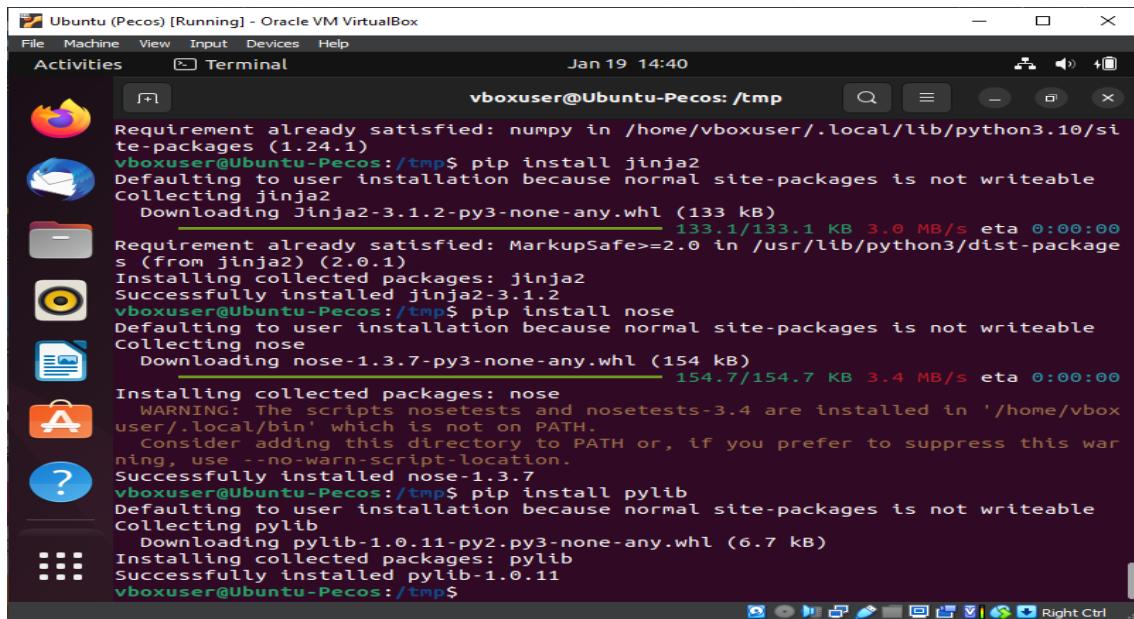
```
vboxuser@Ubuntu-Pecos:~/tmp$ pip install numpy
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: numpy in /home/vboxuser/.local/lib/python3.10/site-packages (1.24.1)
vboxuser@Ubuntu-Pecos:~/tmp$ pip install jinja2
Defaulting to user installation because normal site-packages is not writeable
Collecting jinja2
  Downloading Jinja2-3.1.2-py3-none-any.whl (133 kB)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/lib/python3/dist-packages (from jinja2) (2.0.1)
Installing collected packages: jinja2
Successfully installed jinja2-3.1.2
vboxuser@Ubuntu-Pecos:~/tmp$ pip install nose
Defaulting to user installation because normal site-packages is not writeable
Collecting nose
  Downloading nose-1.3.7-py3-none-any.whl (154 kB)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/lib/python3/dist-packages (from nose) (2.0.1)
Installing collected packages: nose
  WARNING: The scripts nosetests and nosetests-3.4 are installed in '/home/vboxuser/.local/bin' which is not on PATH.
  Consider adding this directory to PATH or, if you prefer to suppress this warning, use --no-warn-script-location.
Successfully installed nose-1.3.7
vboxuser@Ubuntu-Pecos:~/tmp$ pip install pylib
```

Install *pylib* by typing the command ***pip install pylib*** and hit Enter:



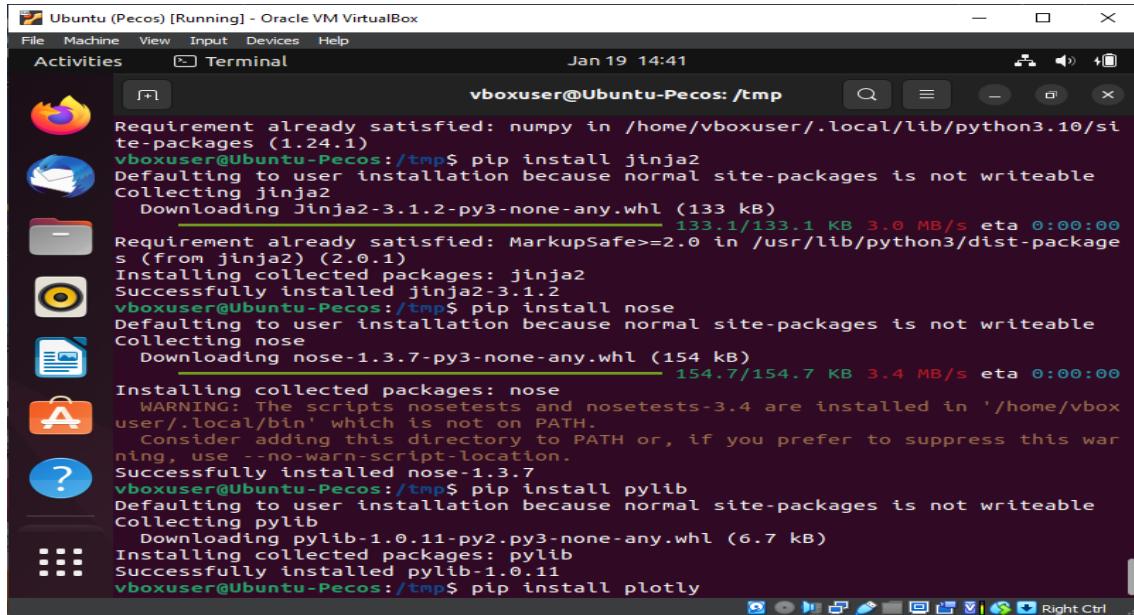
```
vboxuser@Ubuntu-Pecos:~/tmp$ pip install numpy
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: numpy in /home/vboxuser/.local/lib/python3.10/site-packages (1.24.1)
vboxuser@Ubuntu-Pecos:~/tmp$ pip install jinja2
Defaulting to user installation because normal site-packages is not writeable
Collecting jinja2
  Downloading Jinja2-3.1.2-py3-none-any.whl (133 kB)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/lib/python3/dist-packages (from jinja2) (2.0.1)
Installing collected packages: jinja2
Successfully installed jinja2-3.1.2
vboxuser@Ubuntu-Pecos:~/tmp$ pip install nose
Defaulting to user installation because normal site-packages is not writeable
Collecting nose
  Downloading nose-1.3.7-py3-none-any.whl (154 kB)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/lib/python3/dist-packages (from nose) (2.0.1)
Installing collected packages: nose
  WARNING: The scripts nosetests and nosetests-3.4 are installed in '/home/vboxuser/.local/bin' which is not on PATH.
  Consider adding this directory to PATH or, if you prefer to suppress this warning, use --no-warn-script-location.
Successfully installed nose-1.3.7
vboxuser@Ubuntu-Pecos:~/tmp$ pip install pylib
```

Successful Install:



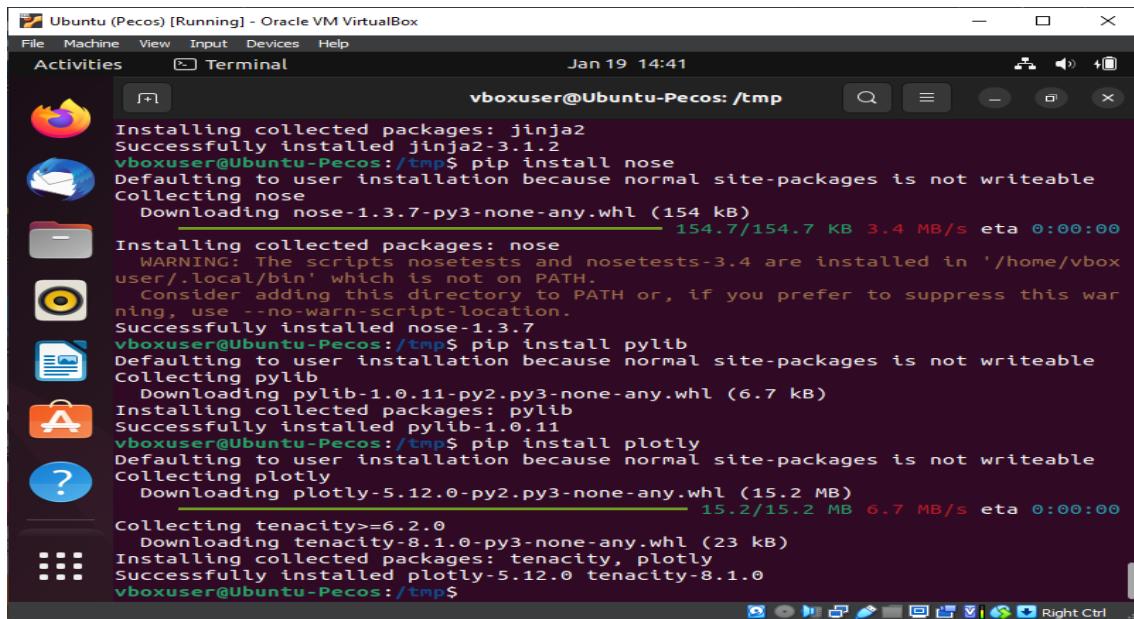
```
vboxuser@Ubuntu-Pecos:~/Desktop$ pip install numpy
Requirement already satisfied: numpy in /home/vboxuser/.local/lib/python3.10/site-packages (1.24.1)
vboxuser@Ubuntu-Pecos:~/Desktop$ pip install jinja2
Defaulting to user installation because normal site-packages is not writeable
Collecting jinja2
  Downloading Jinja2-3.1.2-py3-none-any.whl (133 kB)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/lib/python3/dist-packages (from jinja2) (2.0.1)
Installing collected packages: jinja2
Successfully installed jinja2-3.1.2
vboxuser@Ubuntu-Pecos:~/Desktop$ pip install nose
Defaulting to user installation because normal site-packages is not writeable
Collecting nose
  Downloading nose-1.3.7-py3-none-any.whl (154 kB)
Installing collected packages: nose
  WARNING: The scripts nosetests and nosetests-3.4 are installed in '/home/vboxuser/.local/bin' which is not on PATH.
    Consider adding this directory to PATH or, if you prefer to suppress this warning, use --no-warn-script-location.
Successfully installed nose-1.3.7
vboxuser@Ubuntu-Pecos:~/Desktop$ pip install pylib
Defaulting to user installation because normal site-packages is not writeable
Collecting pylib
  Downloading pylib-1.0.11-py2.py3-none-any.whl (6.7 kB)
Installing collected packages: pylib
Successfully installed pylib-1.0.11
vboxuser@Ubuntu-Pecos:~/Desktop$
```

Install *plotly* by typing the command ***pip install plotly*** and hit Enter:



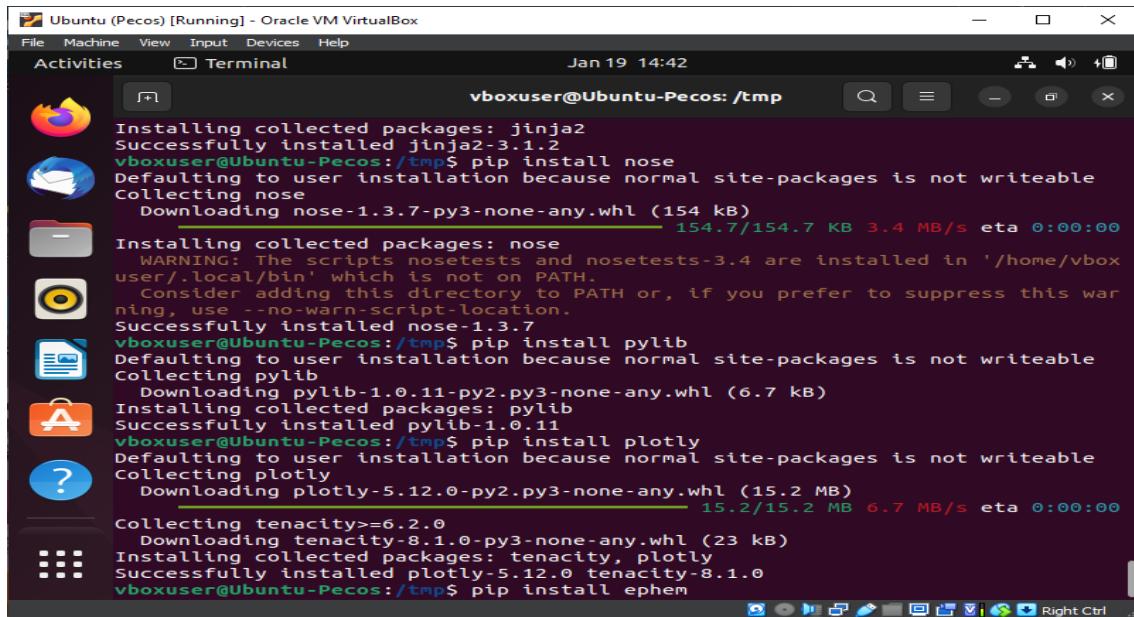
```
vboxuser@Ubuntu-Pecos:~/Desktop$ pip install numpy
Requirement already satisfied: numpy in /home/vboxuser/.local/lib/python3.10/site-packages (1.24.1)
vboxuser@Ubuntu-Pecos:~/Desktop$ pip install jinja2
Defaulting to user installation because normal site-packages is not writeable
Collecting jinja2
  Downloading Jinja2-3.1.2-py3-none-any.whl (133 kB)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/lib/python3/dist-packages (from jinja2) (2.0.1)
Installing collected packages: jinja2
Successfully installed jinja2-3.1.2
vboxuser@Ubuntu-Pecos:~/Desktop$ pip install nose
Defaulting to user installation because normal site-packages is not writeable
Collecting nose
  Downloading nose-1.3.7-py3-none-any.whl (154 kB)
Installing collected packages: nose
  WARNING: The scripts nosetests and nosetests-3.4 are installed in '/home/vboxuser/.local/bin' which is not on PATH.
    Consider adding this directory to PATH or, if you prefer to suppress this warning, use --no-warn-script-location.
Successfully installed nose-1.3.7
vboxuser@Ubuntu-Pecos:~/Desktop$ pip install pylib
Defaulting to user installation because normal site-packages is not writeable
Collecting pylib
  Downloading pylib-1.0.11-py2.py3-none-any.whl (6.7 kB)
Installing collected packages: pylib
Successfully installed pylib-1.0.11
vboxuser@Ubuntu-Pecos:~/Desktop$ pip install plotly
```

Successful Install:



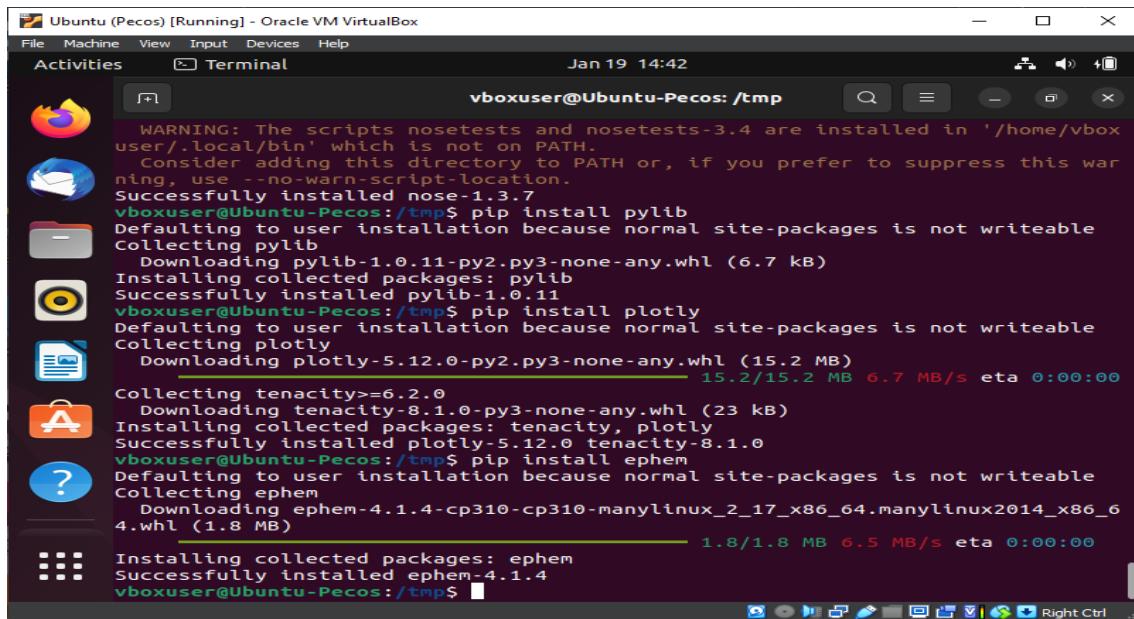
```
vboxuser@Ubuntu-Pecos:~/Desktop$ pip install nose
Collecting nose
  Downloading nose-1.3.7-py3-none-any.whl (154 kB)
Installing collected packages: nose
  WARNING: The scripts nosetests and nosetests-3.4 are installed in '/home/vbox
user/.local/bin' which is not on PATH.
  Consider adding this directory to PATH or, if you prefer to suppress this war
ning, use --no-warn-script-location.
Successfully installed nose-1.3.7
vboxuser@Ubuntu-Pecos:~/Desktop$ pip install pylib
Collecting pylib
  Downloading pylib-1.0.11-py2.py3-none-any.whl (6.7 kB)
Installing collected packages: pylib
  Successfully installed pylib-1.0.11
vboxuser@Ubuntu-Pecos:~/Desktop$ pip install plotly
Collecting plotly
  Downloading plotly-5.12.0-py2.py3-none-any.whl (15.2 MB)
Collecting tenacity>=6.2.0
  Downloading tenacity-8.1.0-py3-none-any.whl (23 kB)
Installing collected packages: tenacity, plotly
  Successfully installed plotly-5.12.0 tenacity-8.1.0
vboxuser@Ubuntu-Pecos:~/Desktop$
```

Install *ephem* by typing the command ***pip install ephem*** and hit Enter:



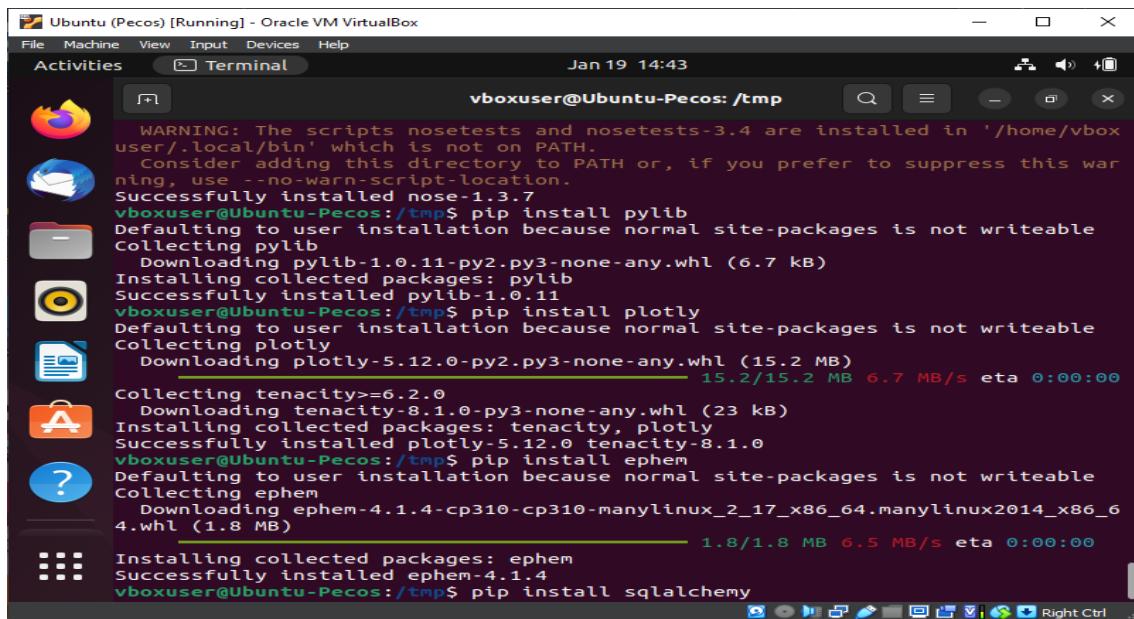
```
vboxuser@Ubuntu-Pecos:~/Desktop$ pip install ephem
Collecting ephem
  Downloading ephem-3.7.1-py3-none-any.whl (15 kB)
Installing collected packages: ephem
Successfully installed ephem-3.7.1
vboxuser@Ubuntu-Pecos:~/Desktop$
```

Successful Install:



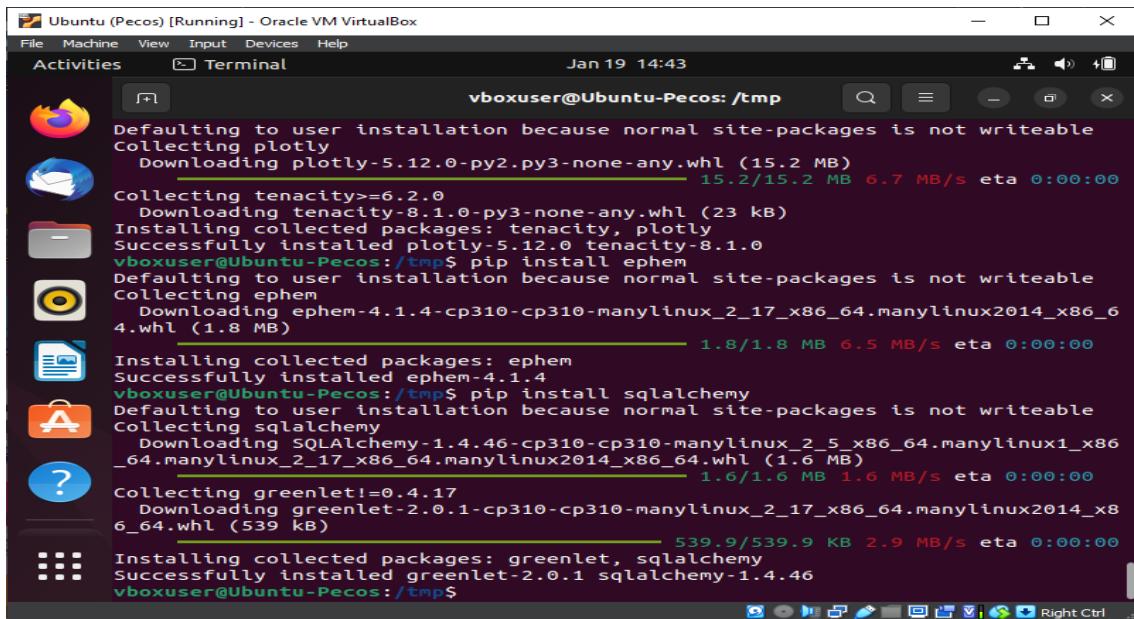
```
vboxuser@Ubuntu-Pecos:~$ pip install sqlalchemy
WARNING: The scripts nosetests and nosetests-3.4 are installed in '/home/vbox
user/.local/bin' which is not on PATH.
Consider adding this directory to PATH or, if you prefer to suppress this war
ning, use --no-warn-script-location.
Successfully installed nose-1.3.7
vboxuser@Ubuntu-Pecos:~$ pip install pylib
Defaulting to user installation because normal site-packages is not writeable
Collecting pylib
  Downloading pylib-1.0.11-py2.py3-none-any.whl (6.7 kB)
Installing collected packages: pylib
Successfully installed pylib-1.0.11
vboxuser@Ubuntu-Pecos:~$ pip install plotly
Defaulting to user installation because normal site-packages is not writeable
Collecting plotly
  Downloading plotly-5.12.0-py2.py3-none-any.whl (15.2 MB) 15.2/15.2 MB 6.7 MB/s eta 0:00:00
Collecting tenacity>=6.2.0
  Downloading tenacity-8.1.0-py3-none-any.whl (23 kB)
Installing collected packages: tenacity, plotly
Successfully installed plotly-5.12.0 tenacity-8.1.0
vboxuser@Ubuntu-Pecos:~$ pip install ephem
Defaulting to user installation because normal site-packages is not writeable
Collecting ephem
  Downloading ephem-4.1.4-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_6
4.whl (1.8 MB) 1.8/1.8 MB 6.5 MB/s eta 0:00:00
Installing collected packages: ephem
Successfully installed ephem-4.1.4
vboxuser@Ubuntu-Pecos:~$ pip install sqlalchemy
```

Install *sqlalchemy* by typing the command *pip install sqlalchemy* and hit Enter:



```
vboxuser@Ubuntu-Pecos:~$ pip install sqlalchemy
WARNING: The scripts nosetests and nosetests-3.4 are installed in '/home/vbox
user/.local/bin' which is not on PATH.
Consider adding this directory to PATH or, if you prefer to suppress this war
ning, use --no-warn-script-location.
Successfully installed nose-1.3.7
vboxuser@Ubuntu-Pecos:~$ pip install pylib
Defaulting to user installation because normal site-packages is not writeable
Collecting pylib
  Downloading pylib-1.0.11-py2.py3-none-any.whl (6.7 kB)
Installing collected packages: pylib
Successfully installed pylib-1.0.11
vboxuser@Ubuntu-Pecos:~$ pip install plotly
Defaulting to user installation because normal site-packages is not writeable
Collecting plotly
  Downloading plotly-5.12.0-py2.py3-none-any.whl (15.2 MB) 15.2/15.2 MB 6.7 MB/s eta 0:00:00
Collecting tenacity>=6.2.0
  Downloading tenacity-8.1.0-py3-none-any.whl (23 kB)
Installing collected packages: tenacity, plotly
Successfully installed plotly-5.12.0 tenacity-8.1.0
vboxuser@Ubuntu-Pecos:~$ pip install ephem
Defaulting to user installation because normal site-packages is not writeable
Collecting ephem
  Downloading ephem-4.1.4-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_6
4.whl (1.8 MB) 1.8/1.8 MB 6.5 MB/s eta 0:00:00
Installing collected packages: ephem
Successfully installed ephem-4.1.4
vboxuser@Ubuntu-Pecos:~$ pip install sqlalchemy
```

Successful Install:



```
vboxuser@Ubuntu-Pecos:~/tmp$ pip install plotly
Defaulting to user installation because normal site-packages is not writeable
Collecting plotly
  Downloading plotly-5.12.0-py2.py3-none-any.whl (15.2 MB)
    15.2/15.2 MB 6.7 MB/s eta 0:00:00

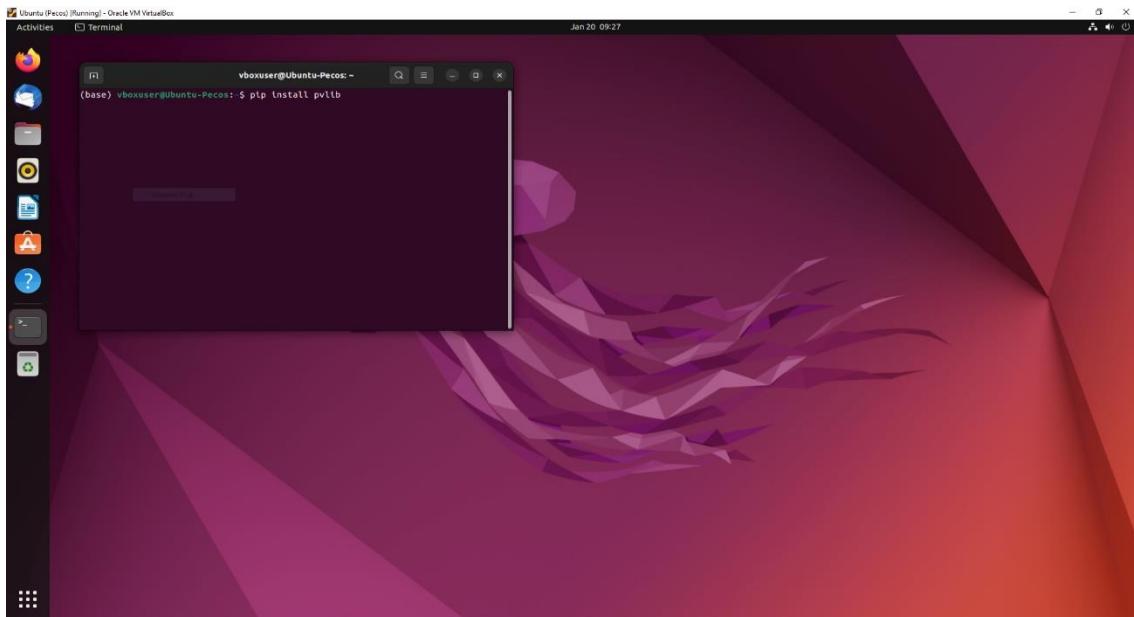
Collecting tenacity>=6.2.0
  Downloading tenacity-8.1.0-py3-none-any.whl (23 kB)
Installing collected packages: tenacity, plotly
Successfully installed plotly-5.12.0 tenacity-8.1.0
vboxuser@Ubuntu-Pecos:~/tmp$ pip install ephem
Defaulting to user installation because normal site-packages is not writeable
Collecting ephem
  Downloading ephem-4.1.4-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (1.8 MB)
    1.8/1.8 MB 6.5 MB/s eta 0:00:00

Installing collected packages: ephem
Successfully installed ephem-4.1.4
vboxuser@Ubuntu-Pecos:~/tmp$ pip install sqlalchemy
Defaulting to user installation because normal site-packages is not writeable
Collecting sqlalchemy
  Downloading SQLAlchemy-1.4.46-cp310-cp310-manylinux_2_5_x86_64.manylinux1_x86_64.manylinux_2_17_x86_64.manylinux2014_x86_64.whl (1.6 MB)
    1.6/1.6 MB 1.6 MB/s eta 0:00:00

Collecting greenlet!=0.4.17
  Downloading greenlet-2.0.1-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (539 kB)
    539.9/539.9 KB 2.9 MB/s eta 0:00:00

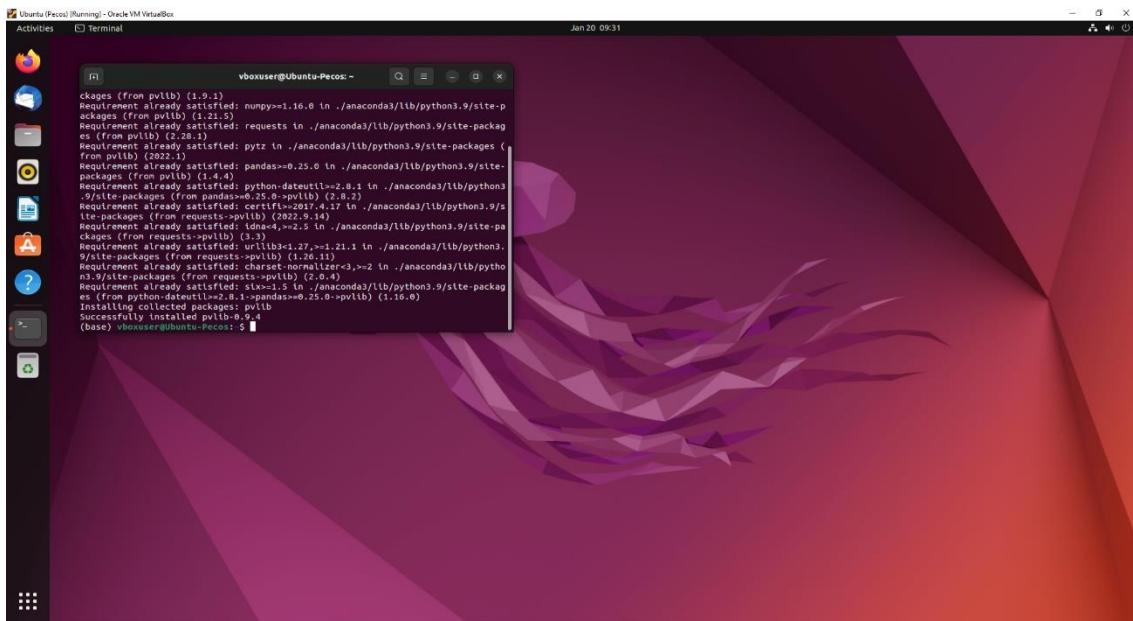
Installing collected packages: greenlet, sqlalchemy
Successfully installed greenlet-2.0.1 sqlalchemy-1.4.46
vboxuser@Ubuntu-Pecos:~/tmp$
```

Install *pvlib* by typing the command ***pip install pvlib*** and hit Enter:

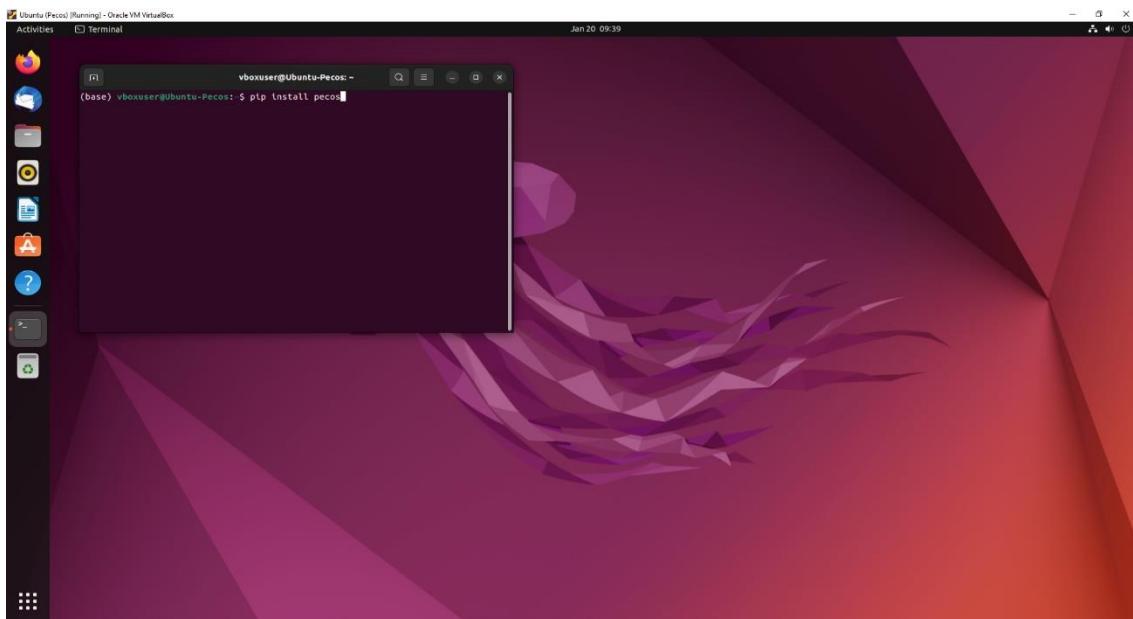


```
(base) vboxuser@Ubuntu-Pecos:~$ pip install pvlib
```

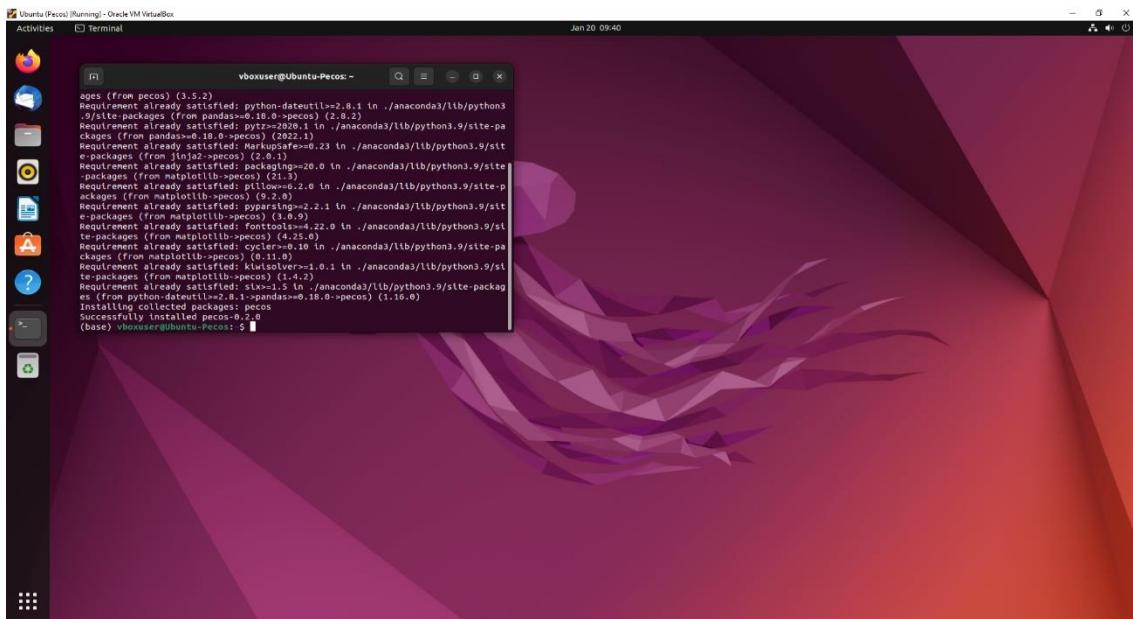
Successful Install:



Install *pecos* by typing the command `pip install pecos` and hit Enter:



Successful Install:



Step 7: Download Modified Pecos zip file on Virtual Machine

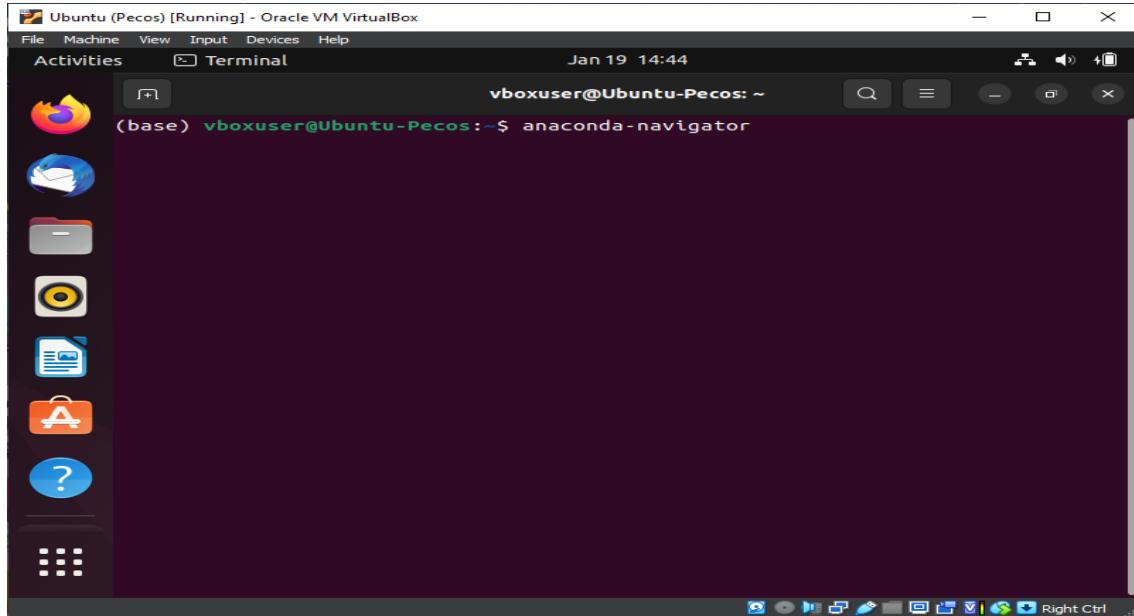
Visit: <https://github.com/wcsims42/Quality-Assurance.git>

Original Source Files: <https://github.com/sandialabs/pecos>

Source files will not work without being altered. Use first source

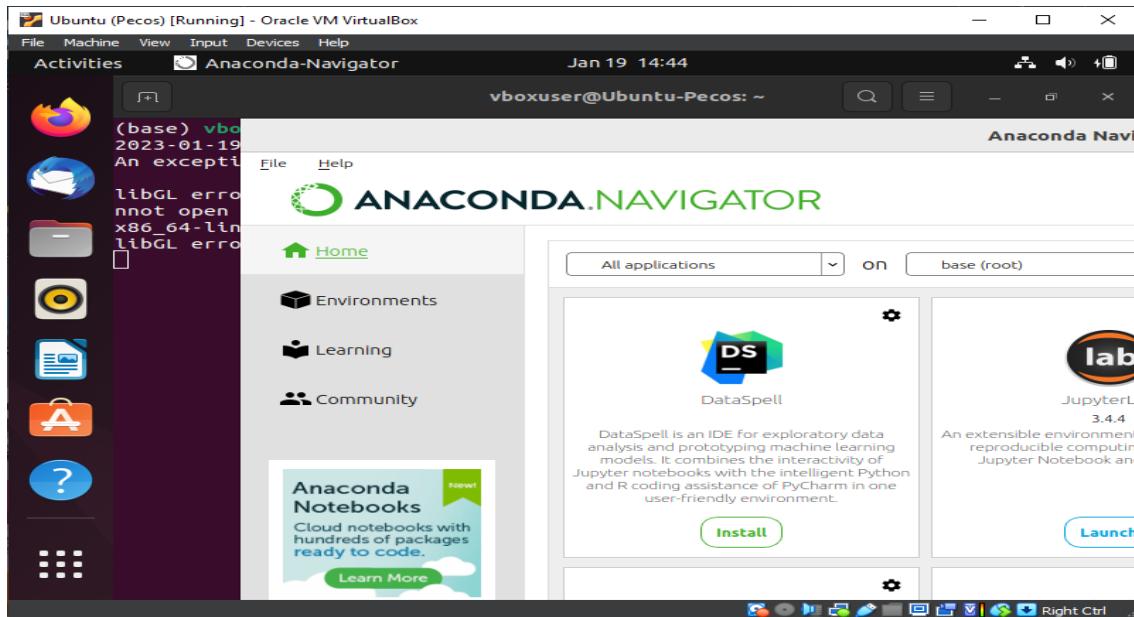
Step 8: Launch Anaconda Navigator

Open Terminal, type `anaconda-navigator` and hit Enter:



Anaconda Navigator should then begin loading.

An array of applications should now be available to you like shown below:

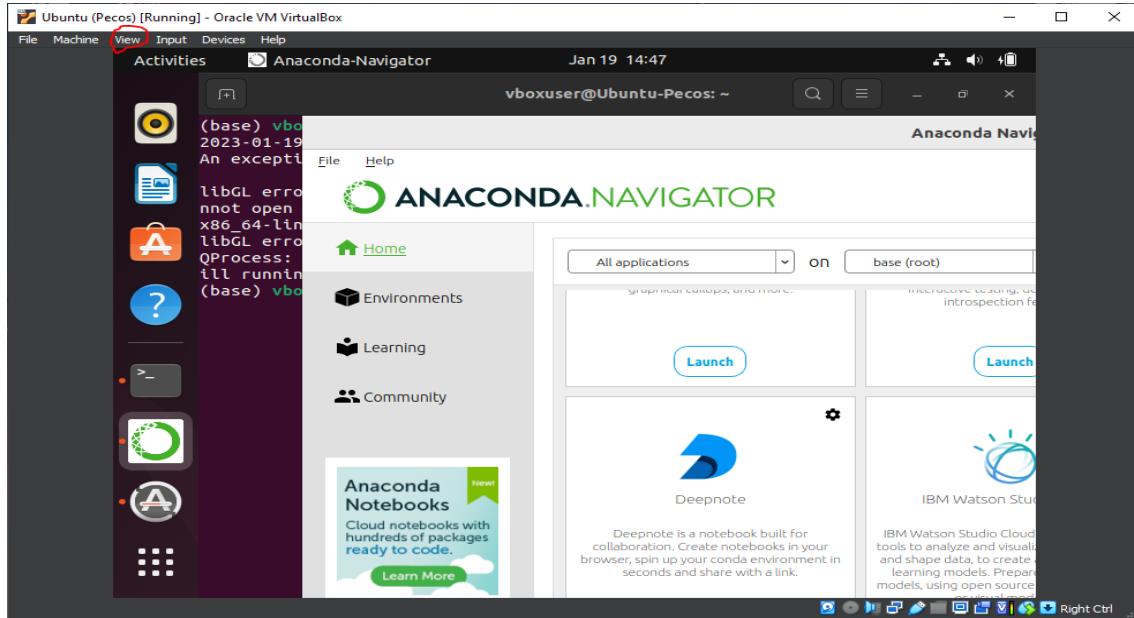


As you can probably tell, the scale and resolution of the VM is all wrong.

This will be fixed in the following step.

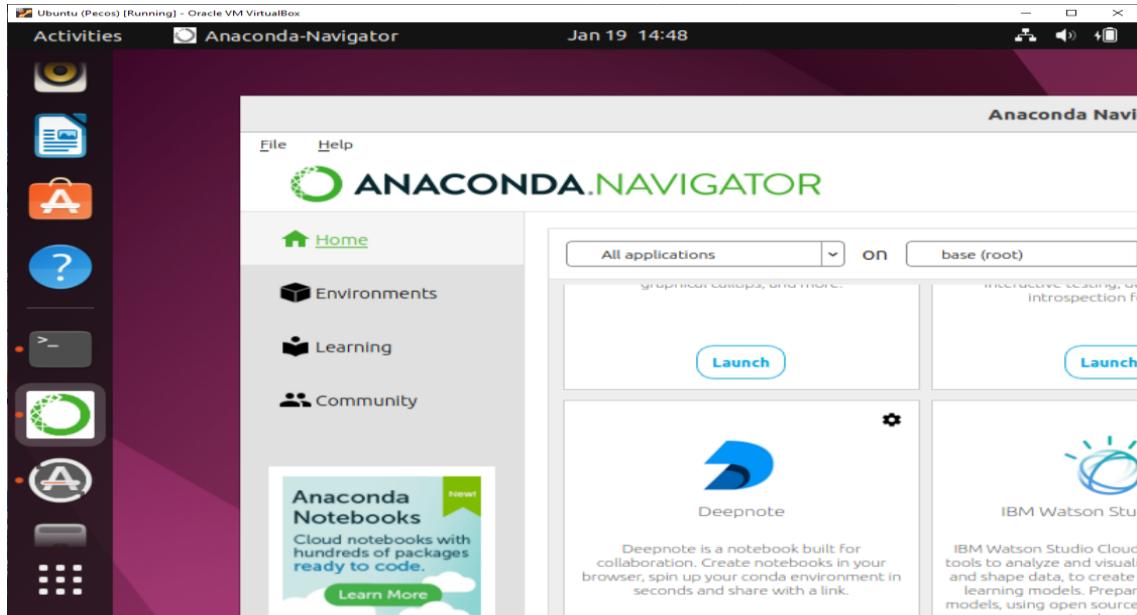
Step 9: Change View and Resolution of VM

Click on View in the top left corner of the VM window and select Scaled Mode:

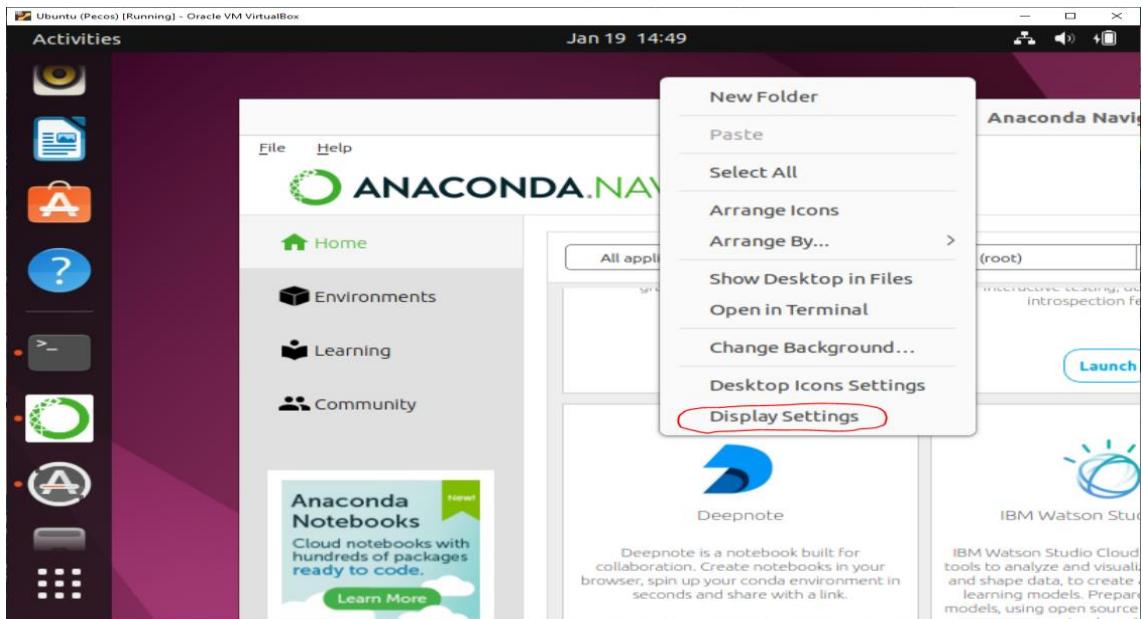


The VM should now be full screen

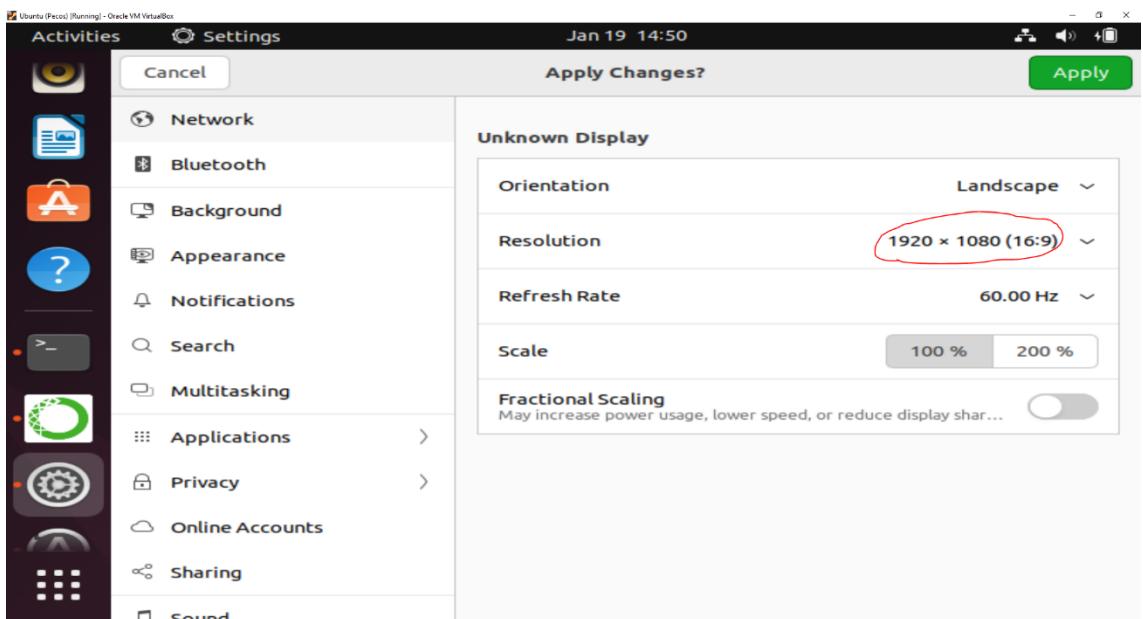
Right click on desktop:



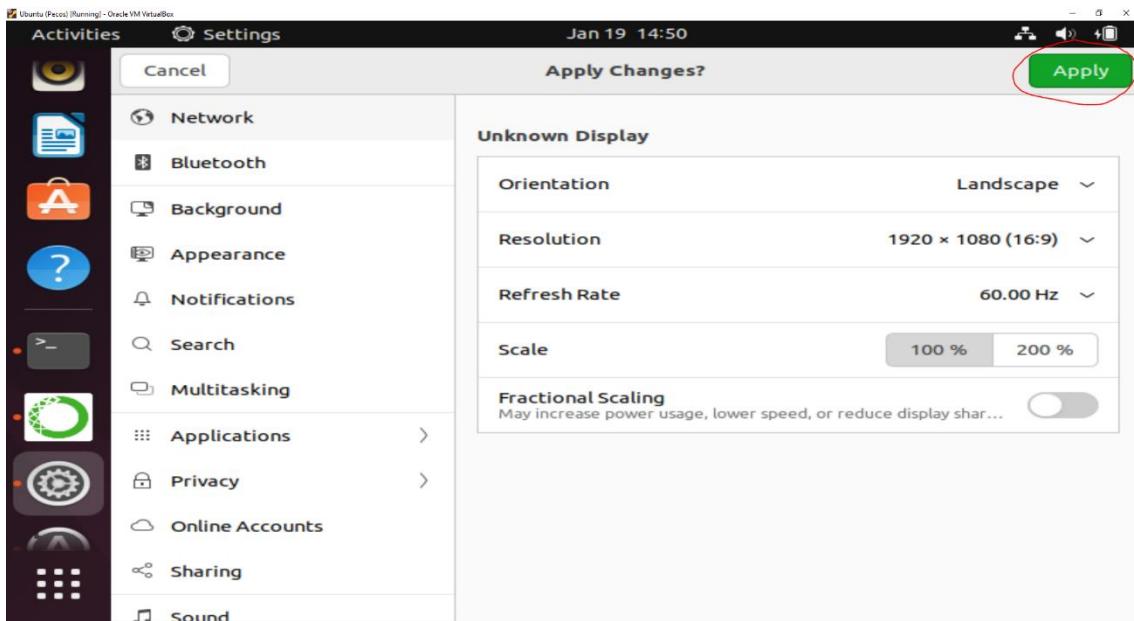
Select Display Settings:



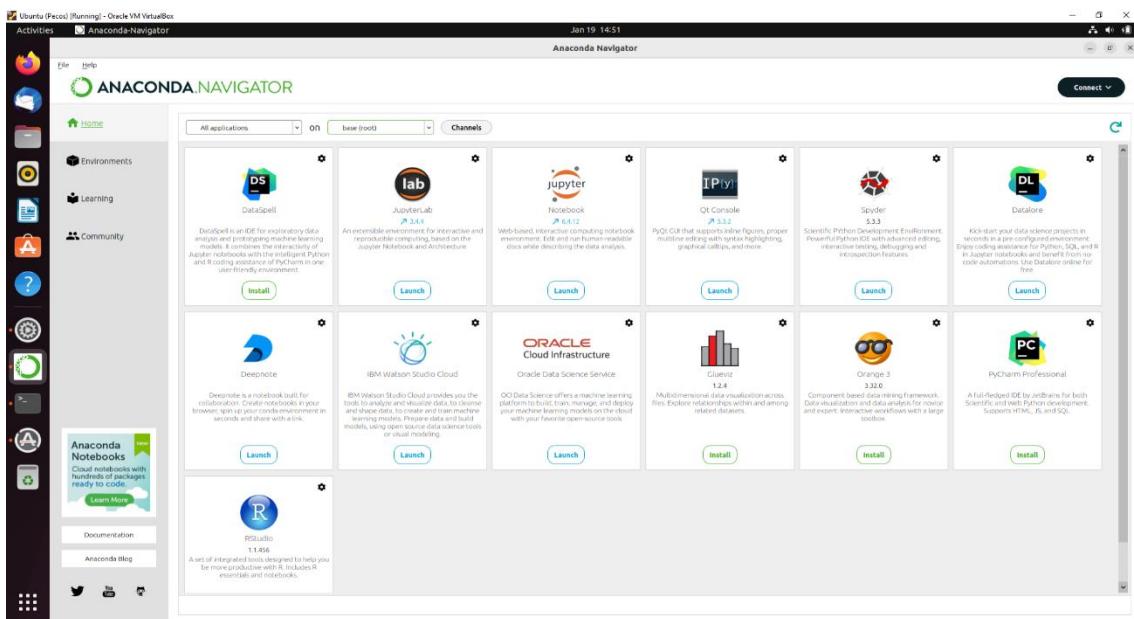
Select the Resolution of your monitor:



Hit Apply:



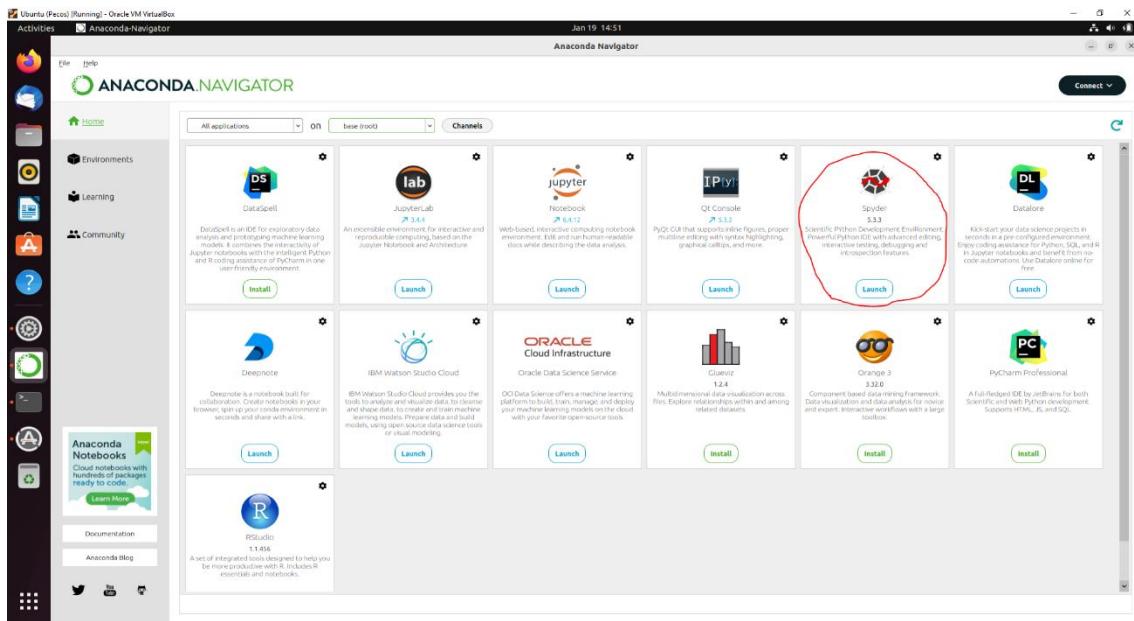
The resolution of the VM should now be significantly better and user-friendly:



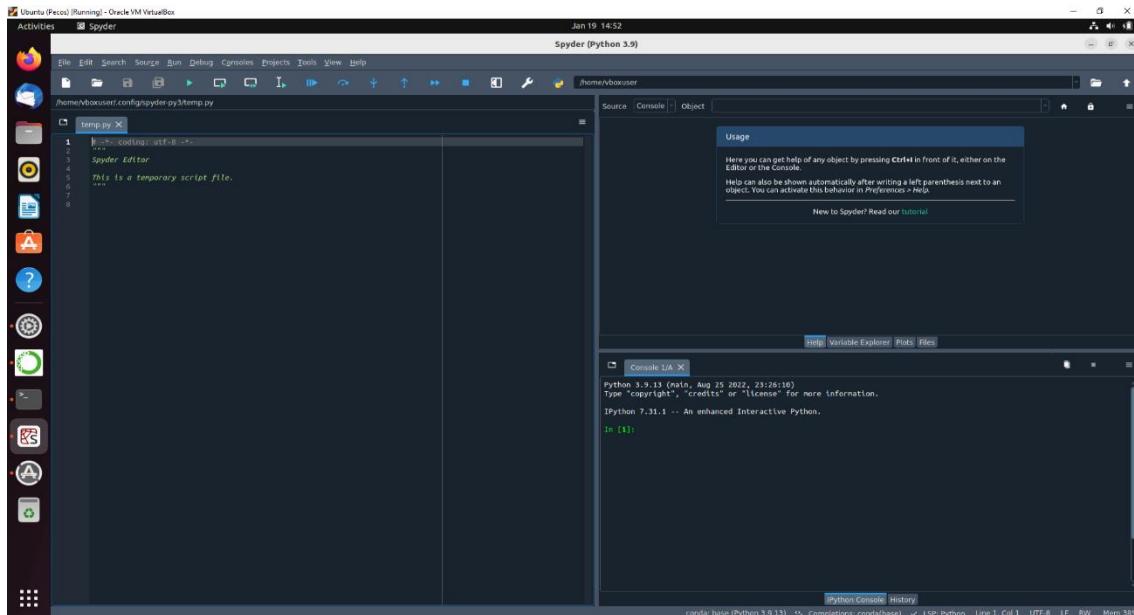
Step 10: Launch Spyder

Locate the Spyder application on the Anaconda Navigator Home page.

Click Launch:



You should now be seeing a window like the one below:

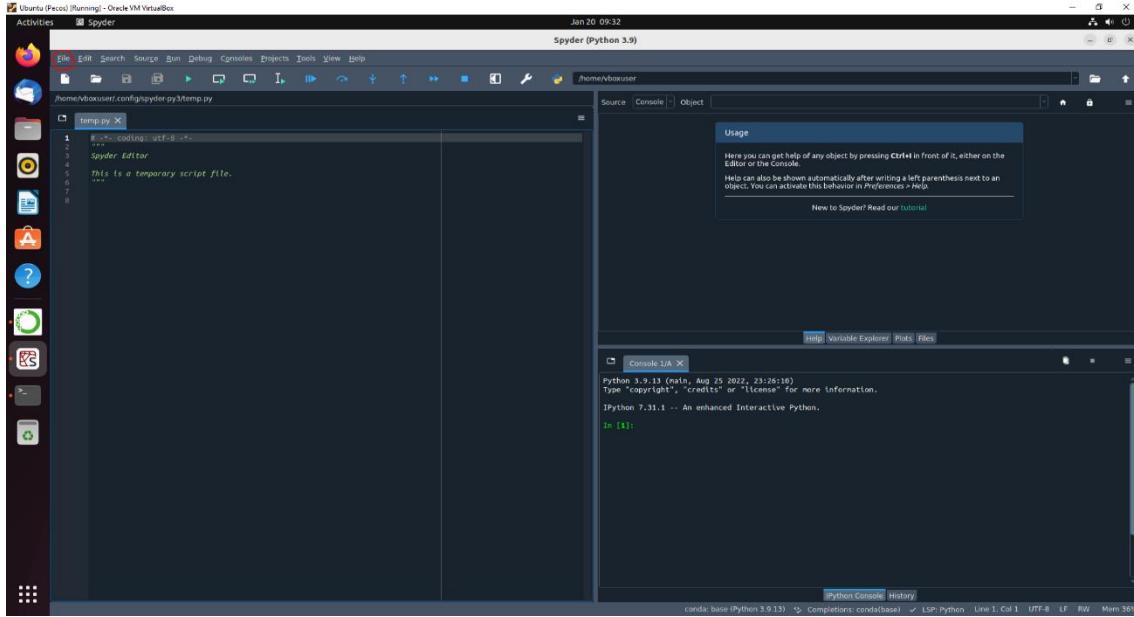


This tool provides an excellent platform for editing, testing, and running python scripts.

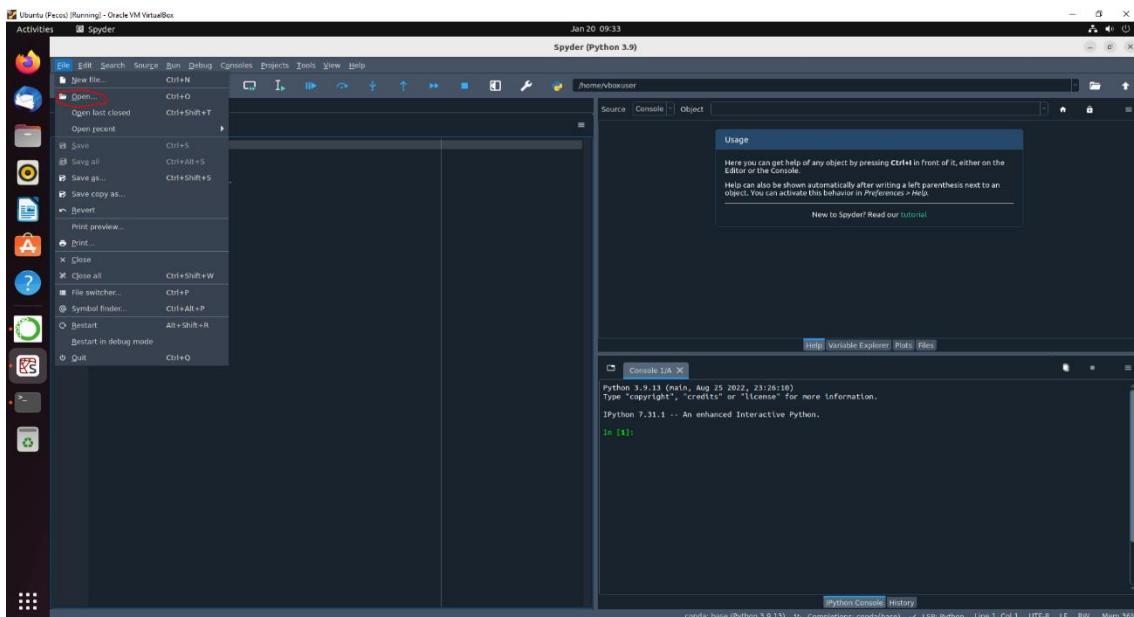
(Very similar to MATLAB)

Step 11: Opening Quality Control Script

In the Spyder window, locate the File table located to the top left and click on it:

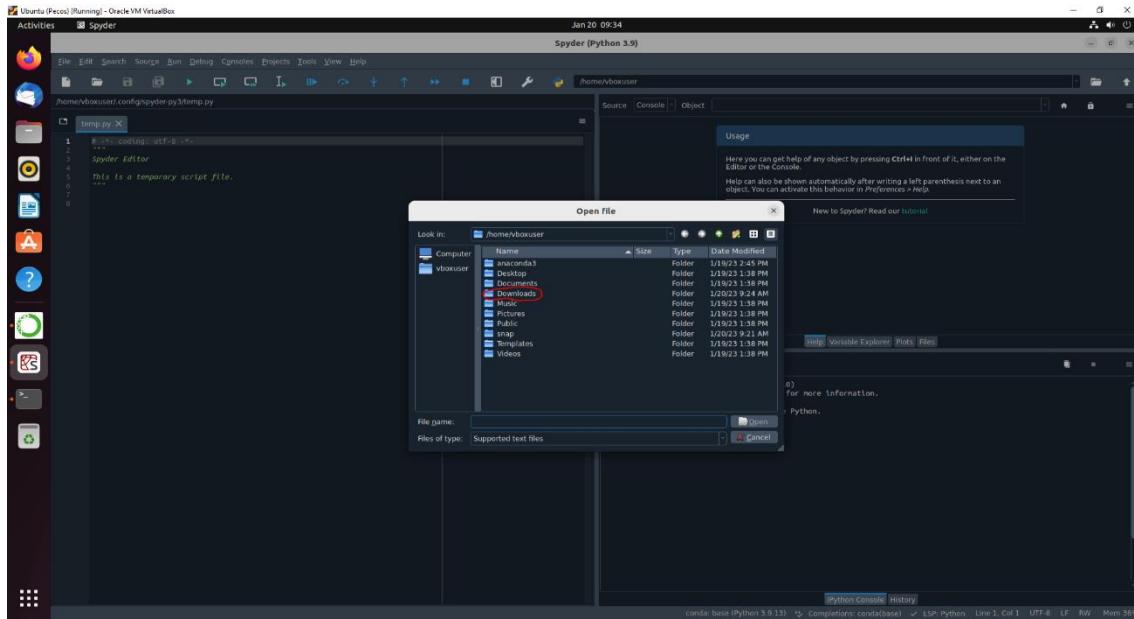


Now, select Open from the drop-down menu:



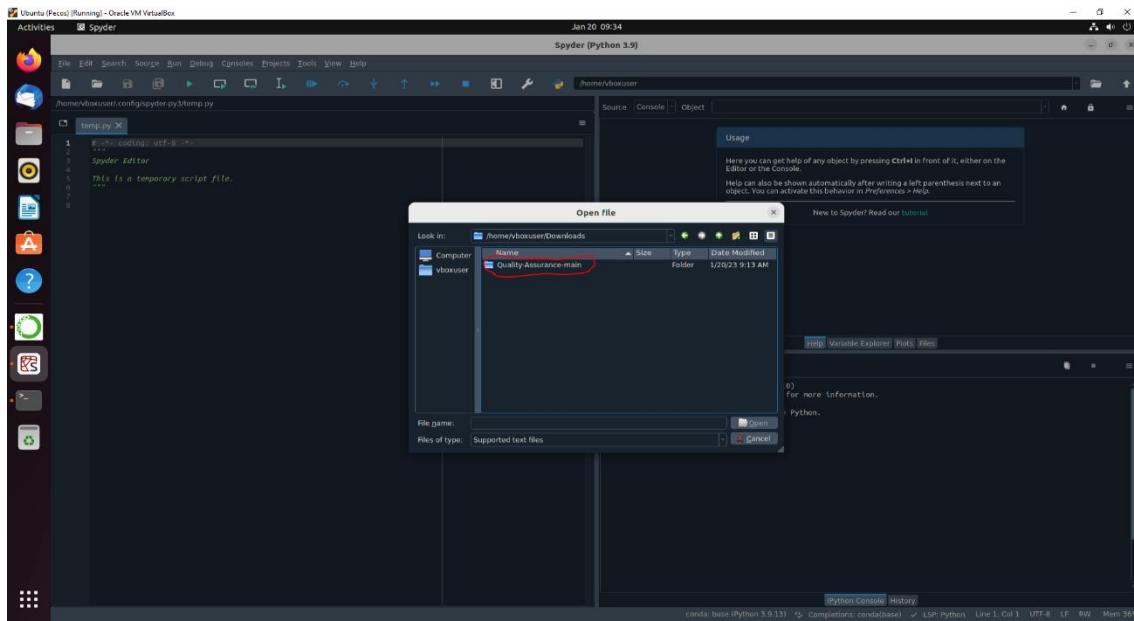
Now, locate the folder where your Pecos files are stored. (In our case, it is the Downloads folder.)

Double click the folder:

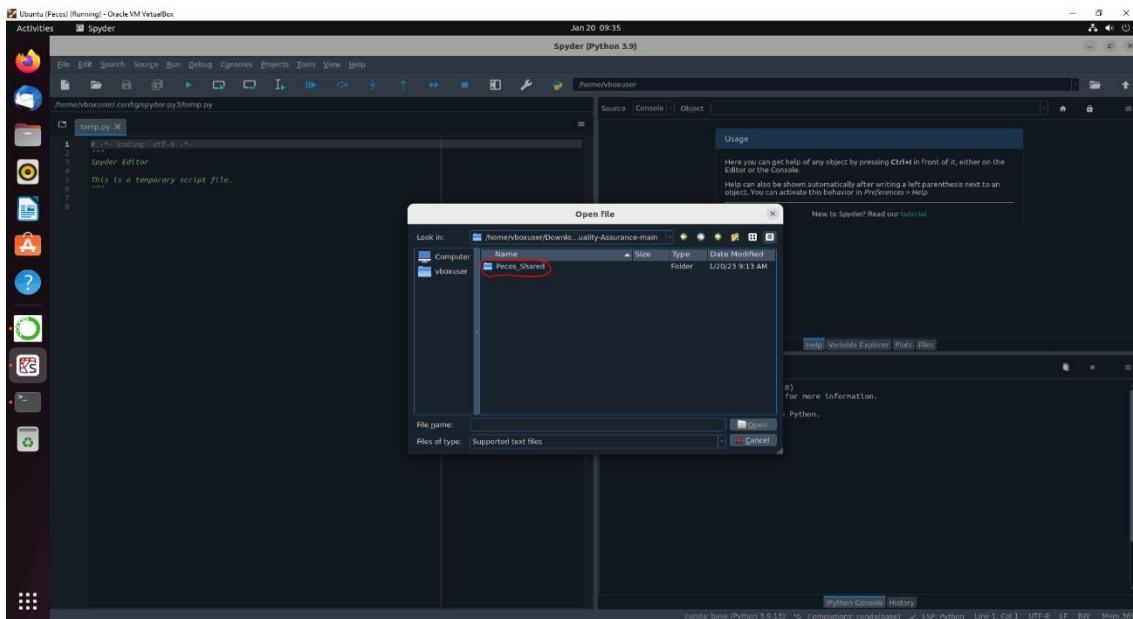


You should now see the downloaded folder from Step 7.

Double click it:

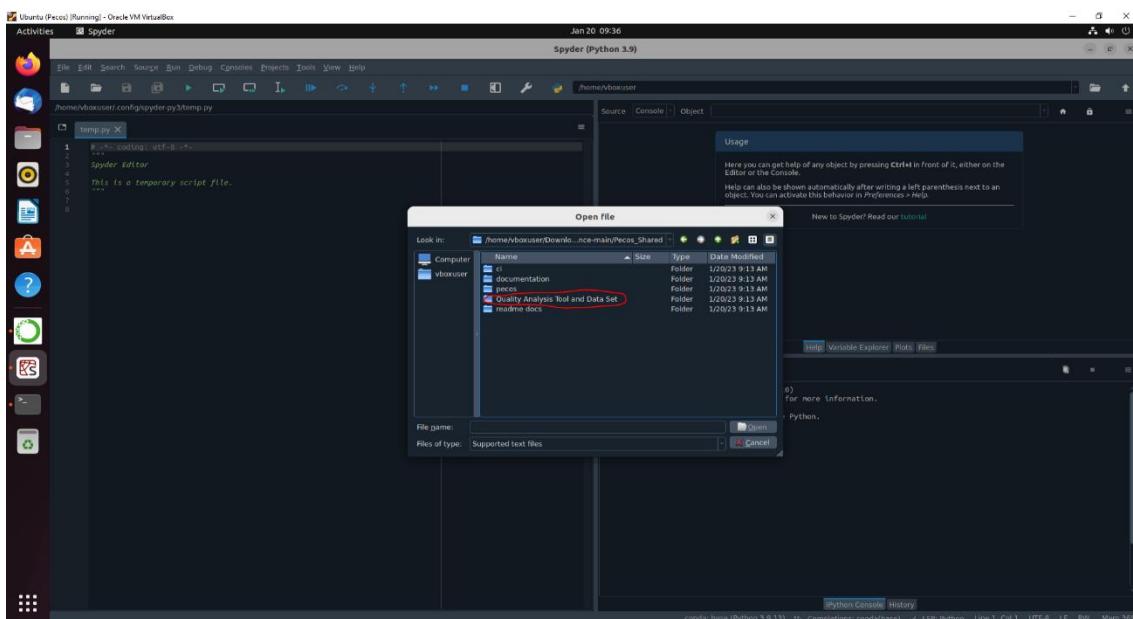


There is another nested folder. Go ahead and double click it as well:



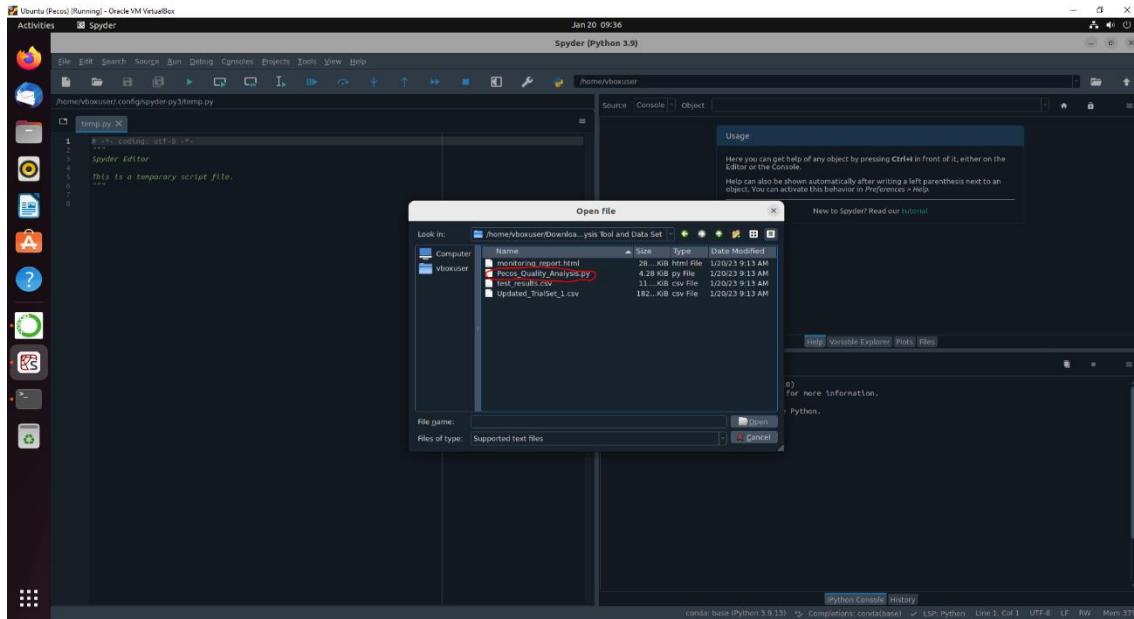
Now you should see multiple folders.

Locate the *Quality Analysis Tool and Data Set Folder* and double click it:



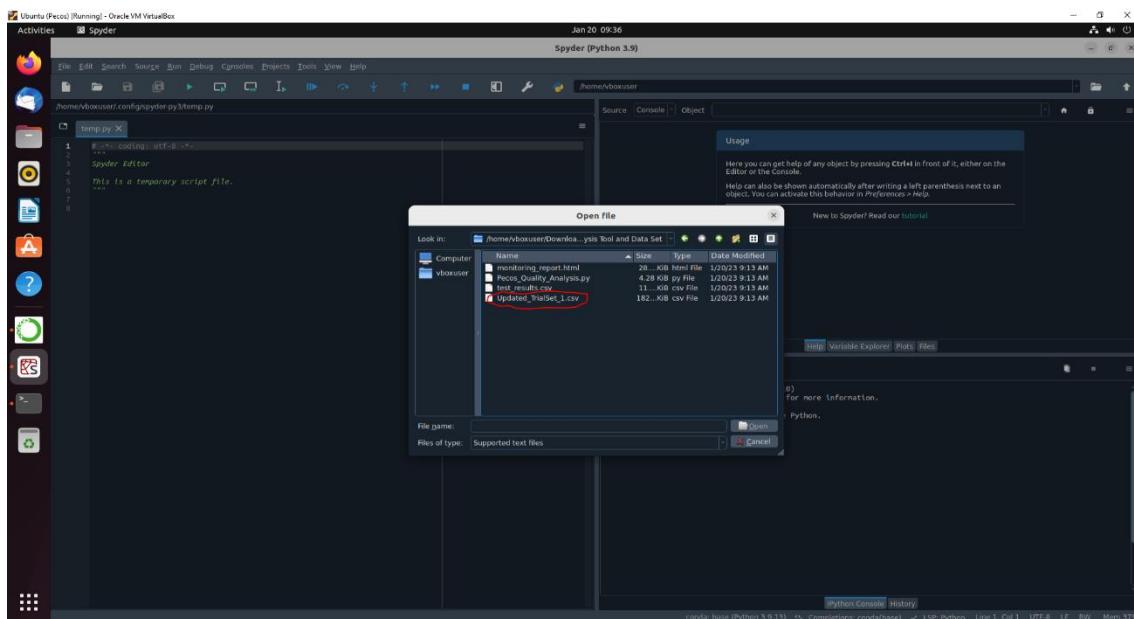
Now, Locate the *Pecos_Quality_Analysis.py* file.

This is the script that you need to run, so double click it:



This script can run a quality check on measured data when provided with a csv file containing the data of interest as well as user established parameters. (This is a simplified Pecos analysis that only focuses on quality control.)

Also, in this folder, is the data file that will be analyzed:



Make sure before running the script that the data file that you are wanting to evaluate is in this folder

Step 12: Specify Data File of Interest

Locate Code Block 1:

Type file name inside of single quotes:

data_file = 'Filename.csv'

The screenshot shows the Spyder IDE interface with a Python script named `temp.py` open in the editor. The script demonstrates basic file operations, data loading, and filtering. It also imports various modules like `yaml`, `pandas`, `matplotlib`, `pecos`, and `numpy`. A specific section of the code uses `CodeBlocks` annotations to highlight parts of the code.

Below the editor, a Jupyter Notebook cell is visible with the title "Pecos Quality Analysis". The cell contains a single line of code: `In [2]:`

```
In [2]:
```

The Spyder interface includes a top navigation bar with tabs for Activities, Spyder, File, Edit, Search, Source, Run, Debug, Consoles, Projects, Tools, View, Help, and Spyder (Python 3.9). On the right side, there are panes for Source, Console, Object, Usage, Help, Variable Explorer, Plots, and Files. A status bar at the bottom indicates the current date and time as Jan 20 09:49.

This command designates the file that will be evaluated. This file must be formatted as a csv file. Also, ensure that the file is saved in the same folder as the python script being run.

* Timestamp must be in form *month/day/year 24-hour:minutes* *

Example: 01/12/2023 14:28

Step 13: Add and/or Remove Grouped Sensors

Locate Code Block 2:

```

# In this example, simple time series data is used to demonstrate basic functions
# Data is loaded from a CSV file which contains four columns of values that
# are expected to follow linear, random, and sine models.
# A translation dictionary is defined to map and group the raw data into
# common names for analysis.
# A time filter is established to screen out data between 6 AM and 8 PM
# The data is loaded into a Pecos PerformanceMonitoring object and a series of
# quality control tests are run, including range tests and increment tests
# The results are printed to CSV and HTML reports
# Only edit filenames and values in specified codeblocks (Codeblocks 1-8) +
# Code Block 2 +
# Code Block 3 +
# Code Block 4 +
# Check the expected frequency of the timestamp
# Check the timestamp(60)
# Generate a time filter to exclude data points early and late in the day
# clock_time = pecos.utils.datetime_to_clocktime(pd.data_index)
# time_filter = pd.Series((clock_time > st*3600) & (clock_time < et*3600),
#                         index=pd.data_index)

# Initialize logger
pecos.logger.initialize()

# Create a Pecos PerformanceMonitoring data object
pn = pecos.monitoring.PerformanceMonitoring()

# Code Block 1 +
# Populate the object with a DataFrame and translation dictionary
data_file = 'Updated_FieldSet_1.csv'
df = pd.read_csv(data_file, index_col=0, parse_dates=True)
pn.add_dataframe(df)

# add_translation_dictionary() groups same types of sensors (Avoids setting up checks for each sensor.)
pn.add_translation_dictionary({'Heat Flux': ['HFT - Unshaded (W/m2)', 'HFT - Shaded (W/m2)', 'HFT - Front Panel (degC)']})
pn.add_translation_dictionary({'Temp': ['T1 - Unshaded (degC)', 'T2 - Shaded (degC)', 'T3 - Front Panel (degC)']})

# Code Block 2 +
# pn.add_translation_dictionary() groups same types of sensors (Avoids setting up checks for each sensor.)
# If any Heat Flux or Temperature Sensors are added or removed, change below
pn.add_translation_dictionary({'Temp': ['T1 - Unshaded (degC)', 'T2 - Shaded (degC)', 'T3 - Front Panel (degC)']})

# Code Block 3 +
# Specify timestamp of interest below
st = 6 # Start Time
et = 20 # End Time

# Code Block 4 +
# Check the expected frequency of the timestamp
pn.check_timestamp(60)

# Generate a time filter to exclude data points early and late in the day
clock_time = pecos.utils.datetime_to_clocktime(pd.data_index)
time_filter = pd.Series((clock_time > st*3600) & (clock_time < et*3600),
                         index=pd.data_index)

```

Add and/or remove grouped sensors:

`pn.add_translation_dictionary({'Groupname': ['Sensor1', 'Sensor2', 'etc']})`

```

# In this example, simple time series data is used to demonstrate basic functions
# Data is loaded from a CSV file which contains four columns of values that
# are expected to follow linear, random, and sine models.
# A translation dictionary is defined to map and group the raw data into
# common names for analysis.
# A time filter is established to screen out data between 6 AM and 8 PM
# The data is loaded into a Pecos PerformanceMonitoring object and a series of
# quality control tests are run, including range tests and increment tests
# The results are printed to CSV and HTML reports
# Only edit filenames and values in specified codeblocks (Codeblocks 1-8) +
# Code Block 2 +
# Code Block 3 +
# Code Block 4 +
# Check the expected frequency of the timestamp
# Check the timestamp(60)
# Generate a time filter to exclude data points early and late in the day
# clock_time = pecos.utils.datetime_to_clocktime(pd.data_index)
# time_filter = pd.Series((clock_time > st*3600) & (clock_time < et*3600),
#                         index=pd.data_index)

# Initialize logger
pecos.logger.initialize()

# Create a Pecos PerformanceMonitoring data object
pn = pecos.monitoring.PerformanceMonitoring()

# Code Block 1 +
# Populate the object with a DataFrame and translation dictionary
data_file = 'Updated_FieldSet_1.csv'
df = pd.read_csv(data_file, index_col=0, parse_dates=True)
pn.add_dataframe(df)

# add_translation_dictionary() groups same types of sensors (Avoids setting up checks for each sensor.)
pn.add_translation_dictionary({'Heat Flux': ['HFT - Unshaded (W/m2)', 'HFT - Shaded (W/m2)', 'HFT - Front Panel (degC)']})
pn.add_translation_dictionary({'Temp': ['T1 - Unshaded (degC)', 'T2 - Shaded (degC)', 'T3 - Front Panel (degC)']})

# Code Block 2 +
# pn.add_translation_dictionary() groups same types of sensors (Avoids setting up checks for each sensor.)
# If any Heat Flux or Temperature Sensors are added or removed, change below
pn.add_translation_dictionary({'Temp': ['T1 - Unshaded (degC)', 'T2 - Shaded (degC)', 'T3 - Front Panel (degC)']})

# Code Block 3 +
# Specify timestamp of interest below
st = 6 # Start Time
et = 20 # End Time

# Code Block 4 +
# Check the expected frequency of the timestamp
pn.check_timestamp(60)

# Generate a time filter to exclude data points early and late in the day
clock_time = pecos.utils.datetime_to_clocktime(pd.data_index)
time_filter = pd.Series((clock_time > st*3600) & (clock_time < et*3600),
                         index=pd.data_index)

```

These lines of code group similar sensors together that can be evaluated using the same metrics. In our case, it groups all the heat flux sensors together under the name ‘Heat Flux’ and groups all the temperature sensors under the name ‘Temp’.

Step 14: Change Hours of Interest

Locate Code Block 3:

The screenshot shows the Spyder IDE interface with the following details:

- Title Bar:** Ubuntu (Pecos) (Running) - Oracle VM VirtualBox
- Top Bar:** Activities, Spyder, Date: Jan 20 09:56, Spyder (Python 3.9)
- Toolbar:** File, Edit, Search, Source, Run, Debug, Consoles, Projects, Tools, View, Help.
- File Path:** /home/boxuser/Downloads/Quality Assurance-main/Pecos_Shared/Quality Analysis Tool and Data Set
- Code Editor:** The main window displays a Python script named `temp.py` under the file `Pecos_Quality_Analysis.py`. The code implements a quality analysis tool for temperature data, including reading CSV files, filtering data, and generating plots and reports. A specific section of the code is highlighted with a red oval, showing the creation of a timestamp filter and its application to the data frame.
- Console:** Shows the output of the code execution, including logs from the `logger` and the creation of various plots like `T1 - Unshaded (degC)`, `T2 - Shaded (degC)`, and `T3 - Front Panel (degC)`.
- Help:** A tooltip provides information about using the Spyder editor.
- Bottom Status Bar:** Python Console, History, Line 1 Col 1, ASCII, LF, RW, Mem 39M.

Designate hours of interest:

* Use 24-hour format*

$st = \textcolor{blue}{a}$ (Start Time)

et = b (End Time)

The screenshot shows the Spyder IDE interface with the following details:

- Title Bar:** Jupyter (Faro) [Running] - Oracle VM VirtualBox
- Toolbar:** Activities, Spyder
- File Menu:** File, Edit, Search, Source, Run, Debug, Consoles, Projects, Tools, View, Help
- Code Editor:** temp.py X Pecos_Quality_Analysis.py X
- Code Content (temp.py):**

```
1 In this example, simple time series data is used to demonstrate basic functions
2 In pecos.
3
4 The data is loaded from a CSV file which contains four columns of values that
5 are expected to follow linear, random, and sine models.
6
7 A translation dictionary is defined to map and group the raw data into
8 categories.
9
10 A time filter is established to screen out data between 6 AM and 6 PM
11
12 The data is loaded into a pecos.PerformanceMonitoring object and a series of
13 tests are run to check the data for trends, seasonality, and increments tests.
14
15 The results are printed to CSV and HTML reports
16
17
18 *** Only edit filenames and values in specified codeblocks (Codeblocks 1-8) ***
19
20
21 # Import yaml
22 import yaml
23 import pandas as pd
24 import matplotlib.pyplot as plt
25 import numpy as np
26 import pecos
27
28 # Initialize logger
29 pecos.logger.initialize()
30
31 # Create a Pecos PerformanceMonitoring data object
32 pm = pecos.monitoring.PerformanceMonitoring()
33
34 # Code Block 1
35
36 # Create a data object with a DataFrame and translation dictionary
37 data_file = "Updated_TrialSet1.csv"
38 df = pd.read_csv(data_file, index_col=0, parse_date=True)
39 pm.add_data(df=df)
40
41 # Code Block 2
42
43 # If no add translation dictionary() groups same types of sensors (Avoids setting up checks for each sensor.)
44 # If any Heat Flux or Temperature parameters are added or removed change below.
45 pm.add_translation_dictionary([{"West_Flux": "H1" - Unshaded (H1/2), "H2" - Shaded (H2/2), "H3" - Front Panel (H3/2)}, {"T1": "T1" - Unshaded (degC), "T2": "T2" - Shaded (degC), "T3": "T3" - Front Panel (degC)}])
46
47 # Code Block 3
48
49 # Specify timestamp of interest below
50 st = 6 # Start Time
51 et = 12 # End Time
52
53 # Code Block 4
54
55 # Check the expected frequency of the timestamp
56 pm.check_timestamp(60)
57
58 # Generate a time filter to exclude data points early and late in the day
59 clock_time = pecos.utils.datetime_to_clocktime(pd.date.today())
60 time_filter = pd.Series((clock_time > st) & (clock_time < et)) & (6000,
```
- Console Tab:** /home/farouser/Downloads/Quality-Assurance-main/Pecos_Shared/Quality Analysis Tool and Data Set
- Console Output:**

```
Jan 20 09:49
Spyder (Python 3.9)
```
- Plot Tab:** Usage, Help, Variable Explorer, Plots, Files
- Plot Results:** A scatter plot titled "Check for data increment outside expected range" showing data points for various sensors over time.
- Warning:** Figures now render in the Plots pane by default. To make them also appear inline in the Console, uncheck "Note Inline Plotting" under the Plots pane options menu.

The above establishes a timespan of interest. Other data will still be evaluated, but the report will only report flagged data within the timespan of interest.

Step 15: Specify Frequency of Timestamp

Locate Code Block 4:

The screenshot shows the Spyder IDE interface with a Python script titled 'temp.py' open. The script contains code for reading data from a CSV file, defining a translation dictionary, creating a PerformanceMonitoring object, and generating reports. A red box highlights the line 'pn.check_timestamp(60)'. The Spyder interface includes a top menu bar, a toolbar, and several panes for code editing, console output, and help.

```
1 # In this example, simple time series data is used to demonstrate basic functions
2 # in pecos.
3 # Data is loaded from a CSV file which contains four columns of values that
4 # are expected to follow linear, random, and sine models.
5 # A translation dictionary is defined to map and group the raw data into
6 # categories.
7 # A time filter is established to screen out data between 6 AM and 8 PM
8 # The data is loaded into a pecos PerformanceMonitoring object and a series of
9 # plots are generated. The plots include time series plots and increment tests
10 # The results are printed to CSV and HTML reports
11
12 # Only edit filenames and values in specified codeblocks (Codeblocks 1-8)
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```

Specify Timestamp Frequency:

*pm.check_timestamp(**t**)*

t: Time value (in seconds) of how often we are sampling data. * Report in seconds*

The above establishes the frequency of your measurements. For example, in our current setup, we are sampling once every 60 seconds. It is crucial that the value specified here and the frequency of the measurements in the data file are the same.

Step 16: (Filter 1) Change Expected Ranges for Sensors

Locate Code Block 5.

Change expected ranges for each sensor:

```
pm.check_range([a, b], 'Sensor1')
```

a: Lower bound of the expected range of the sensor.

b: Upper bound of the expected range of the sensor.

Ensure values are reported in the same units as in data file

The screenshot shows the Spyder IDE interface with the following details:

- Title Bar:** Ubuntu (Picos) [Running] - Oracle VM VirtualBox
- File Menu:** File Edit Search Source Run Debug Environments Projects Tools View Help
- Code Editor:** /home/vboxuser/Downloads/Quality-Assurance-main/Picos_Shared/Quality Analysis Tool and Data Set/Picos_Quality_Analysis.py
- Code Content:** The code performs various checks on data, including time filters, missing data, corrupt data, and moving windows. It also generates plots for Air Temperature, Wind Speed, and Wind Direction.
- Console:** Displays a warning message about the `append` method in `pd.concat` and suggests using `pandas.concat instead.`
- Plots:** A warning message indicates that plots now render in the Plots pane by default, and users can uncheck "Note Inline Plotting" under the Plots pane options menu.
- Bottom Status:** Python Console History

The above establishes a reasonable range for the sensor indicated. If a value exceeds the specified range (Higher than the upper bound or lower than the lower bound), then it will be flagged and indicated in the report.

Step 17: (Filter 2) Check for Stagnant Data

Locate Code Block 6.

Change stagnation check for each sensor:

```
pm.check_delta([a, None], b, 'Sensor1')
```

a: Small increment of change

b: Time interval (in seconds) that is being evaluated for stagnant data

```

# Line of Interest: Missing Data Filter +
# Check for missing data
pm.check_missing()

# Line of Interest: Corrupt Data Filter +
# Check for corrupt data values
# pm.check_corrupt([-1.999])
pm.check_corrupt([-1.999])

# Check for expected ranges
pm.check_range([-150, 150], 'West Flux')
pm.check_range([-180, 180], 'Pyranometer (W/m²)')
pm.check_range([0, 360], 'Wind Direction (Degrees)')
pm.check_range([0, 100], 'Wind Speed (m/s)')

# Check for changes between consecutive time steps
# pm.check_increment([None, 50], 'West Flux') # Do we need this?
pm.check_increment([None, 100], 'Pyranometer (W/m²)')
pm.check_increment([None, 360], 'Wind Direction (Degrees)')
pm.check_increment([None, 35], 'Wind Speed (m/s)')

# Code Block 6
# Check for quality control index for HFI-HS, T1-T5, Pyranometer, Wind Direction, and Wind Speed
mask = pm.mask[['HFI - Unshaded (W/m²)', 'HFI - Shaded (W/m²)', 'HF3 - Front Panel (W/m²)', 'HF4 - Back Panel (W/m²)']]
QCI = pecos.Metrics.QCI(mask, pn.tfilter)

# Generate graphics
# pm.generate_graphics(pecos_graphics.plot_test_results(pm.data, pm.test_results, pn.tfilter))
df.plot(ylim=[-1.5, 1.5], figsize=(7.0, 5.5))
plt.savefig('custom.png', format='png', dpi=300)
pm.test_results['QCI'] = QCI

# Write test results and report files
pm.write_test_results(pm.test_results)
pecos.io.write_test_results(pm.test_results, pm.test_results, test_results_graphics,
                           [custom.png], QCI)

```

The above runs a check for stagnant data. If the sensor does not output a value differing by 0.0001 for 1 hour (3600 s), then it will be flagged. This is useful, because it also indicates that we may be dealing with a faulty sensor.

Step 18: (Filter 3) Change Abrupt Data Spike Parameters

Locate Code Block 7.

Change abrupt increment for each sensor:

```
pm.check_increment([None, a], 'Sensor1')
```

a: Largest reasonable change in value expected to occur from one timestamp to the next

```

Ubuntu (Pecos) [Running] - Oracle VM VirtualBox
Activities Spyder
File Edit Search Source Run Debug Consoles Projects Tools View Help
/home/vbouser/Downloads/Quality Assurance-main/Pecos_Shared/Quality Analysis Tool and Data Set/Pecos_Quality_Analysis.py
temp.py Pecos_Quality_Analysis.py
1 #!/usr/bin/python
2 # Line of Interest: Missing Data Filter
3 # Check for missing data
4 pm.check_missing()
5
6 # Line of Interest: Corrupt Data Filter
7 # Check for corrupt data values
8 pm.check_corrupt([999])
9
10 # Line of Interest: Out of Range
11 # Check data is within expected ranges
12 pm.check_range([-100, 100], 'Heat Flux')
13 pm.check_range([0, 3600], 'Temp (C)')
14 pm.check_range([0, 1380], 'Pyranometer (W/m²)')
15 pm.check_range([0, 360], 'Wind Direction (Degrees)')
16 pm.check_range([0, 360], 'Wind Speed (m/s)')
17
18 # Code Block 6
19 # Check for corrupt data within a 1 hour moving window
20 pm.check_delta([0, 6000], None, 3600, 'Heat Flux')
21 pm.check_delta([0, 6000], None, 3600, 'Temp (C)')
22 pm.check_delta([0, 6000], None, 3600, 'Pyranometer (W/m²)')
23 pm.check_delta([0, 6000], None, 3600, 'Wind Direction (Degrees)')
24 pm.check_delta([0, 6000], None, 3600, 'Wind Speed (m/s)')
25
26 # Code Block 7
27 # Check for abrupt changes between consecutive time steps
28 # pm.check_increment(None, 50) # Do we need this?
29 pm.check_increment(None, 100, 'Heat Flux')
30 pm.check_increment(None, 100, 'Temp (C)')
31 pm.check_increment(None, 100, 'Pyranometer (W/m²)')
32 pm.check_increment(None, 360), 'Wind Direction (Degrees)')
33 pm.check_increment(None, 28), 'Wind Speed (m/s)')
34
35 # + Code Block 8
36 # Quality control index for HFS-HFS, T1-T5, Parameter, Wind Direction, and Wind Speed
37 mask = pn.mask[['HFS - Unshaded (W/m²)', 'HFS - Shaded (W/m²)', 'HFS - Front Panel (W/m²)', 'HFS - Back Panel']]
38 QCI = pecos.metrics.QCI(mask, pn.filter)
39
40 # Generate graphics
41 #pecos.graphics.plot_test_results(pm.data, pm.test_results, pm.tfilter)
42 #df.plot(ylim=[-1.5,1.5], position=(7,0,1))
43 plt.savefig('custom.png', format='png', dpi=300)
44
45 # Write test results and report files
46 pecos.io.write_test_results(pm.test_results)
47 pecos.io.write_monitoring_report(pm.data, pm.test_results, test_results_graphics,
48     ['custom.png'], QCI)
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```

Usage
Here you can get help of any object by pressing Ctrl+I in front of it, either on the Editor or the Console.
Help can also be shown automatically after writing a left parenthesis next to an object name. To activate this behavior in Preferences > Help.

New to Spyder? Read our tutorial

Console I/A

```

/home/vbouser/Downloads/Quality Assurance-main/Pecos_Shared/Quality Analysis Tool and Data Set/Pecos_Quality_Analysis.py
/home/vbouser/anaconda3/lib/python3.9/site-packages/pecos/monitoring.py:215: FutureWarning: The frame.append method is deprecated and will be removed from pandas in a future version. Use pandas.concat instead.
  self._test_results = pd.concat([self._test_results, df], ignore_index=True)
2023-01-20 09:41:18 : Check for data increment outside expected range
2023-01-20 09:41:18 : Check for data increment outside expected range
2023-01-20 09:41:18 : Creating graphic For HFS - Structure (degC)
2023-01-20 09:41:18 : Creating graphic For Pyranometer (W/m²)
2023-01-20 09:41:19 : Creating graphic For T1 - Shaded (degC)
2023-01-20 09:41:19 : Creating graphic For T2 - Shaded (degC)
2023-01-20 09:41:20 : Writing test results csv file test_results.csv
2023-01-20 09:41:20 : Writing QCI report

```

Warning
Figures now render in the Plots pane by default. To make them also appear inline in the Console, unCheck "Mute Inline Plotting" under the Plots pane options menu.

In [2]:

Python Console History LSP: Python Line 1 Col 1 ASCII LF RW Mem 39%

The above runs a check to ensure that any immediate spikes in the data are flagged. This could be indicative of a spontaneous environmental event or a slight hiccup with either the sensor or the data logger.

Step 19: Quality Control Index

Locate Code Block 8.

Ensure every sensor being evaluated is listed:

```
mask = pm.mask[['Sensor1','Sensor2','Sensor3','etc']]
```

* All sensors must be listed individually; group names cannot be used. *

```

# Line of Interest: Missing Data Filter
pm.add_time_filter(time='filter')

# Line of Interest: Corrupt Data Filter
# Check for corrupt values
pm.check_corrupt(['HFS'])

# Check data is within expected ranges
pm.check_range([-150, 150], 'Heat Flux')
pm.check_range([0, 360], 'Temp')
pm.check_range([0, 1380], 'Pyranometer (W/m2)')
pm.check_range([0, 360], 'Wind Direction (Degrees)')
pm.check_range([0, 360], 'Wind Speed (m/s)')

# Check for redundant data within a 1 hour moving window
pm.check_delta([0, 6000, None], 3600, 'Heat Flux')
pm.check_delta([0, 6000, None], 3600, 'Temp')
pm.check_delta([0, 6000, None], 3600, 'Pyranometer (W/m2)')
pm.check_delta([0, 6000, None], 3600, 'Wind Direction (Degrees)')
pm.check_delta([0, 6000, None], 3600, 'Wind Speed (m/s)')

# Code Block 8
# Check for abrupt changes between consecutive time steps
# pm.check_increment([None, 50], 'Heat Flux') # Do we need this?
pm.check_increment([None, 50], 'Temp')
pm.check_increment([None, 360], 'Pyranometer (W/m2)')
pm.check_increment([None, 360], 'Wind Direction (Degrees)')
pm.check_increment([None, 28], 'Wind Speed (m/s)')

# Code Block 9
# Compute quality control index for HFS-HFS-TS-TS_Pyranometer, Wind Direction, and Wind Speed
mask = pm.mask[['HFS - Unshaded (W/m2)', 'HFS - Shaded (W/m2)', 'HFS - Front Panel (W/m2)', 'HFS - Back Panel']]

# Generate graphics
pm.metrics.plot_test_results(pm.data, pm.test_results, pm.filter)
df.plot(ylim=[-1.5,1.5], position=(7,0,1))
plt.savefig('custom.png', format='png', dpi=300)

# Write test results and report files
pecos.io.write_test_results(pm.test_results)
pecos.io.write_monitoring_report(pm.data, pm.test_results, test_results_graphics,
                               ['custom.png'], QCI)

```

The above lines compute a quality control index for the sensors being evaluated. This serves as a good indicator of which sensors are performing well and which sensors are exhibiting persistent issues.

Step 20: Running Script

To run, click the green play button located above the script window.

The screenshot shows the Spyder IDE interface running on a Linux desktop. The title bar indicates "Ubuntu (Pecos) [Running] - Oracle VM VirtualBox". The main window displays a Python script named "temp.py" under the "Pecos_Quality_Analysis.py" file. The code uses pandas to read a CSV file, applies a timestamp filter, and then performs various data processing steps. A "Usage" pane on the right provides help for the selected object. The bottom navigation bar includes "Python Console", "History", "File", "Edit", "Search", "Source", "Run", "Debug", "Console", "Projects", "Tools", and "Help".

```
1 # In this example, simple time series data is used to demonstrate basic functions
2 # present in Pecos.
3 # Data is loaded from a CSV file which contains four columns of values that
4 # are expected to follow linear, random, and sine trends.
5 # A translation dictionary is defined to map and group the raw data into
6 # more meaningful categories.
7 # A time filter is established to screen out data between 6 AM and 8 PM
8 # The data is loaded into a pecos PerformanceMonitoring object and a series of
9 # analysis methods are applied to the data to calculate metrics and identify trends.
10 # The results are printed to CSV and HTML reports
11
12 # *only edit filenames and values in specified codeblocks (Codeblocks 1-8) *
13
14 # Import packages
15 import pandas as pd
16 import numpy as np
17 import matplotlib.pyplot as plt
18 import os
19 import time
20 import pecos
21
22 # Initialize logger
23 pecos.logger.initialize()
24
25 # Create a Pecos PerformanceMonitoring data object
26 pm = pecos.monitoring.PerformanceMonitoring()
27
28 # Code Block 1
29 # Load the data object with a DataFrame and translation dictionary
30 data_file = "Updated_TriadSet1.csv"
31 df = pd.read_csv(data_file, index_col=0, parse_dates=True)
32 pm.add_dataframe(df)
33
34 # Code Block 2
35 # pm.add_translation_dictionary() groups same types of sensors (Avoids setting up checks for each sensor.)
36 # If any Heat Flux or Temperature Sensors are added or removed change below.
37 pm.add_translation_dictionary([{"West_Flux": "MP2 - Unshaded (W/02)", "WF2 - Shaded (W/02)", "WF3 - Front Panel": "MP3 - Unshaded (F/03)", "WF4 - Shaded (F/04)", "WF5 - Top": "MP5 - Unshaded (T/05)", "WF6 - Shaded (T/06)", "WF7 - Left": "MP7 - Unshaded (L/07)", "WF8 - Shaded (L/08)", "WF9 - Right": "MP9 - Unshaded (R/09)", "WF10 - Shaded (R/10)", "WF11 - Bottom": "MP11 - Unshaded (B/11)", "WF12 - Shaded (B/12)", "WF13 - Back": "MP13 - Unshaded (B/13)", "WF14 - Shaded (B/14)", "WF15 - Middle": "MP15 - Unshaded (M/15)", "WF16 - Shaded (M/16)", "WF17 - Center": "MP17 - Unshaded (C/17)", "WF18 - Shaded (C/18)", "WF19 - Top": "MP19 - Unshaded (T/19)", "WF20 - Shaded (T/20)", "WF21 - Left": "MP21 - Unshaded (L/21)", "WF22 - Shaded (L/22)", "WF23 - Right": "MP23 - Unshaded (R/23)", "WF24 - Shaded (R/24)", "WF25 - Bottom": "MP25 - Unshaded (B/25)", "WF26 - Shaded (B/26)", "WF27 - Back": "MP27 - Unshaded (B/27)", "WF28 - Shaded (B/28)", "WF29 - Middle": "MP29 - Unshaded (M/29)", "WF30 - Shaded (M/30)", "WF31 - 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Shaded (C/494)", "WF495 - Top": "MP495 - Unshaded (T/495)", "WF496 - Shaded (T/496)", "WF497 - Left": "MP497 - Unshaded (L/497)", "WF498 - Shaded (L/498)", "WF499 - Right": "MP499 - Unshaded (R/499)", "WF500 - Shaded (R/500)", "WF501 - Bottom": "MP501 - Unshaded (B/501)", "WF502 - Shaded (B/502)", "WF503 - Back": "MP503 - Unshaded (B/503)", "WF504 - Shaded (B/504)", "WF505 - Middle": "MP505 - Unshaded (M/505)", "WF506 - Shaded (M/506)", "WF507 - Center": "MP507 - Unshaded (C/507)", "WF508 - Shaded (C/508)", "WF509 - Top": "MP509 - Unshaded (T/509)", "WF510 - Shaded (T/510)", "WF511 - Left": "MP511 - Unshaded (L/511)", "WF512 - Shaded (L/512)", "WF513 - Right": "MP513 - Unshaded (R/513)", "WF514 - Shaded (R/514)", "WF515 - Bottom": "MP515 - Unshaded (B/515)", "WF516 - Shaded (B/516)", "WF517 - Back": "MP517 - Unshaded (B/517)", "WF518 - Shaded (B/518)", "WF519 - Middle": "MP519 - Unshaded (M/519)", "WF520 - Shaded (M/520)", "WF521 - Center": "MP521 - Unshaded (C/521)", "WF522 - Shaded (C/522)", "WF523 - Top": "MP523 - Unshaded (T/523)", "WF524 - Shaded (T/524)", "WF525 - Left": "MP525 - Unshaded (L/525)", "WF526 - Shaded (L/526)", "WF527 - Right": "MP527 - Unshaded (R/527)", "WF528 - Shaded (R/528)", "WF529 - Bottom": "MP529 - Unshaded (B/529)", "WF530 - Shaded (B/530)", "WF531 - Back": "MP531 - Unshaded (B/531)", "WF532 - Shaded (B/532)", "WF533 - Middle": "MP533 - Unshaded (M/533)", "WF534 - Shaded (M/534)", "WF535 - Center": "MP535 - Unshaded (C/535)", "WF536 - Shaded (C/536)", "WF537 - Top": "MP537 - Unshaded (T/537)", "WF538 - Shaded (T/538)", "WF539 - Left": "MP539 - Unshaded (L/539)", "WF540 - Shaded (L/540)", "WF541 - Right": "MP541 - Unshaded (R/541)", "WF542 - Shaded (R/542)", "WF543 - Bottom": "MP543 - Unshaded (B/543)", "WF544 - Shaded (B/544)", "WF545 - Back": "MP545 - Unshaded (B/545)", "WF546 - Shaded (B/546)", "WF547 - Middle": "MP547 - Unshaded (M/547)", "WF548 - Shaded (M/548)", "WF549 - Center": "MP549 - Unshaded (C/549)", "WF550 - Shaded (C/550)", "WF551 - Top": "MP551 - Unshaded (T/551)", "WF552 - Shaded (T/552)", "WF553 - Left": "MP553 - Unshaded (L/553)", "WF554 - Shaded (L/554)", "WF555 - Right": "MP555 - Unshaded (R/555)", "WF556 - Shaded (R/556)", "WF557 - Bottom": "MP557 - Unshaded (B/557)", "WF558 - Shaded (B/558)", "WF559 - Back": "MP559 - Unshaded (B/559)", "WF560 - Shaded (B/560)", "WF561 - Middle": "MP561 - Unshaded (M/561)", "WF562 - Shaded (M/562)", "WF563 - Center": "MP563 - Unshaded (C/563)", "WF564 - Shaded (C/564)", "WF565 - Top": "MP565 - Unshaded (T/565)", "WF566 - Shaded (T/566)", "WF567 - Left": "MP567 - Unshaded (L/567)", "WF568 - Shaded (L/568)", "WF569 - Right": "MP569 - Unshaded (R/569)", "WF570 - Shaded (R/570)", "WF571 - Bottom": "MP571 - Unshaded (B/571)", "WF572 - Shaded (B/572)", "WF573 - Back": "MP573 - Unshaded (B/573)", "WF574 - Shaded (B/574)", "WF575 - Middle": "MP575 - Unshaded (M/575)", "WF576 - Shaded (M/576)", "WF577 - Center": "MP577 - Unshaded (C/577)", "WF578 - Shaded (C/578)", "WF579 - Top": "MP579 - Unshaded (T/579)", "WF580 - Shaded (T/580)", "WF581 - Left": "MP581 - Unshaded (L/581)", "WF582 - Shaded (L/582)", "WF583 - Right": "MP583 - Unshaded (R/583)", "WF584 - Shaded (R/584)", "WF585 - Bottom": "MP585 - Unshaded (B/585)", "WF586 - Shaded (B/586)", "WF587 - Back": "MP587 - Unshaded (B/587)", "WF588 - Shaded (B/588)", "WF589 - Middle": "MP589 - Unshaded (M/589)", "WF590 - Shaded (M/590)", "WF591 - Center": "MP591 - Unshaded (C/591)", "WF592 - Shaded (C/592)", "WF593 - Top": "MP593 - Unshaded (T/593)", "WF594 - Shaded (T/594)", "WF595 - Left": "MP595 - Unshaded (L/595)", "WF596 - Shaded (L/596)", "WF597 - Right": "MP597 - Unshaded (R/597)", "WF598 - Shaded (R/598)", "WF599 - Bottom": "MP599 - Unshaded (B/599)", "WF600 - Shaded (B/600)", "WF601 - Back": "MP601 - Unshaded (B/601)", "WF602 - Shaded (B/602)", "WF603 - Middle": "MP603 - Unshaded (M/603)", "WF604 - Shaded (M/604)", "WF605 - Center": "MP605 - Unshaded (C/605)", "WF606 - Shaded (C/606)", "WF607 - Top": "MP607 - Unshaded (T/607)", "WF608 - Shaded (T/608)", "WF609 - Left": "MP609 - Unshaded (L/609)", "WF610 - Shaded (L/610)", "WF611 - Right": "MP611 - Unshaded (R/611)", "WF612 - Shaded (R/612)", "WF613 - Bottom": "MP613 - Unshaded (B/613)", "WF614 - Shaded (B/614)", "WF615 - Back": "MP615 - Unshaded (B/615)", "WF616 - Shaded (B/616)", "WF617 - Middle": "MP617 - Unshaded (M/617)", "WF618 - Shaded (M/618)", "WF619 - Center": "MP619 - Unshaded (C
```

Run with default configuration.

Looking at the bottom right window, we can see that the script has successfully run.

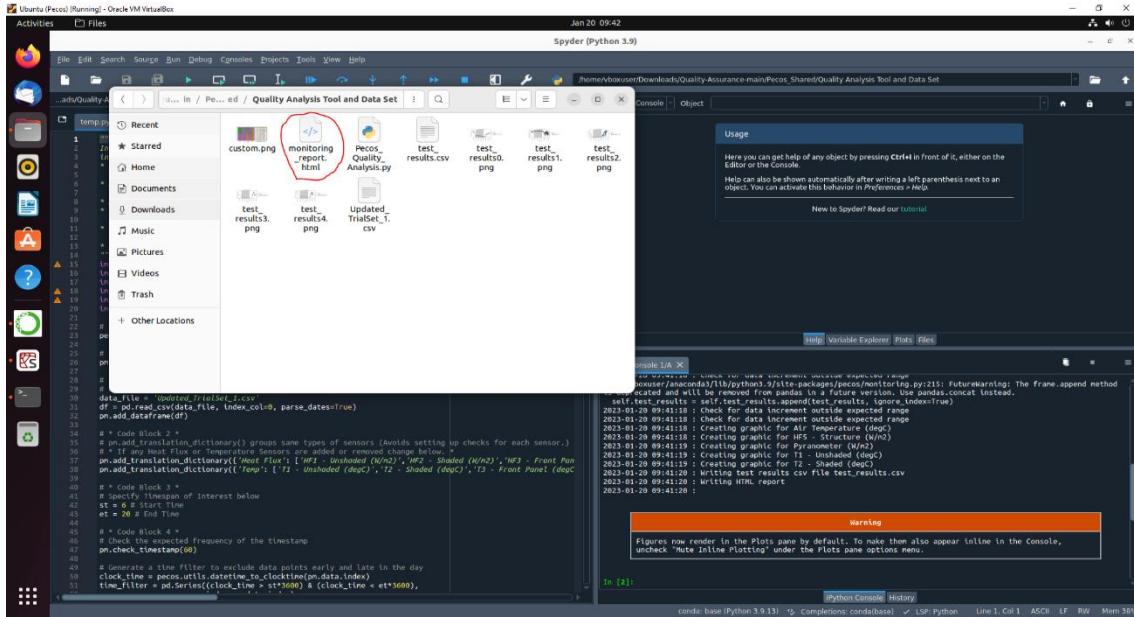
There are no errors, and the Report has been successfully generated:

The screenshot shows the Spyder IDE interface with the following details:

- Title Bar:** Ubuntu (Pecos) [Running] - Oracle VM VirtualBox
- Toolbar:** File Edit Search Source Run Debug Cythonics Projects Tools View Help
- Code Editor:** /home/vboxuser/Downloads/Quality-Assurance-main/Pecos_Shared/Quality Analysis Tool and Data Set/Quality_Analysis.py
- Code Content:** A Python script named `temp.py` demonstrating basic functions for time series data. It includes imports for `pandas`, `matplotlib.pyplot`, `pytz`, `pecos`, and `logging`. It initializes a logger, creates a `PecosPerformanceMonitoring` object, and processes a CSV file named `Updated_TrialSet1.csv` using a translation dictionary. The script then generates plots for various sensors like `H1`, `H2`, `H3`, `T1`, and `T2`.
- Console:** Shows command-line output from running the script.
- Help:** Usage information and a link to the Spyder tutorial.
- Plots:** A preview of the generated plots.

Step 21: Evaluate Report

Locate the document titled “monitoring_report.html”. (*This document should be in the same folder as the one that you are running the script from*):



The screenshot shows the Spyder Python IDE interface. In the top navigation bar, it says "Ubuntu (Pecos) [Running] - Oracle VM VirtualBox". The main window displays a file browser with several files listed. One file, "monitoring_report.html", is highlighted with a red oval. The code editor pane on the left shows a Python script with various imports and data processing logic. The bottom right pane shows a terminal window with some log output.

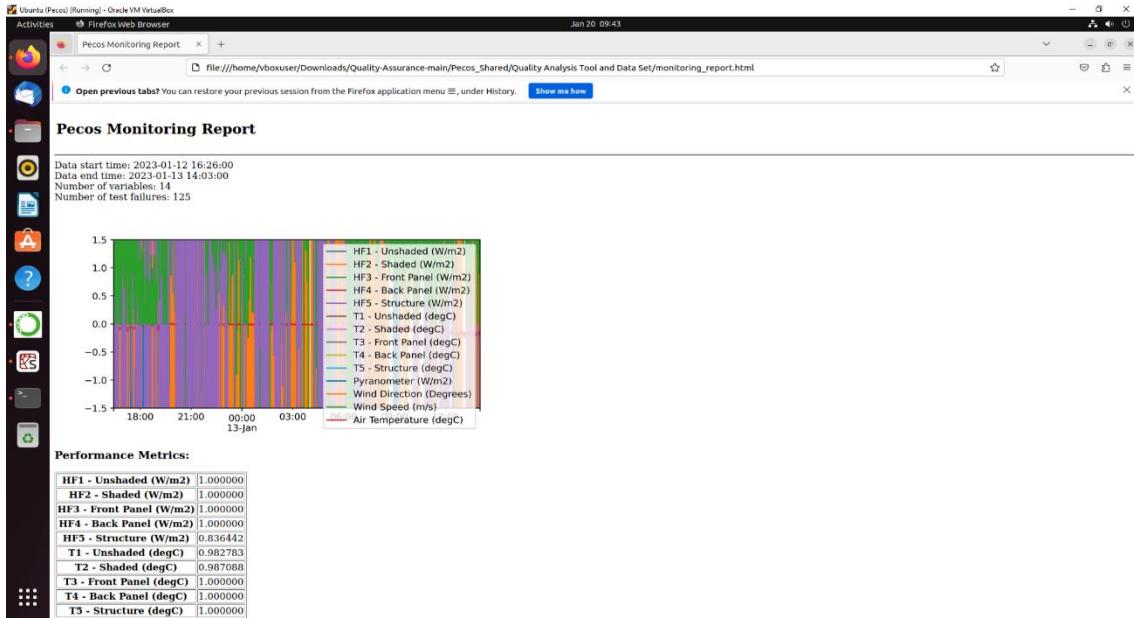
```

# Data analysis
df = pd.read_csv('test_results.csv', index_col=0, parse_dates=True)
pn.add_dataframe(df)

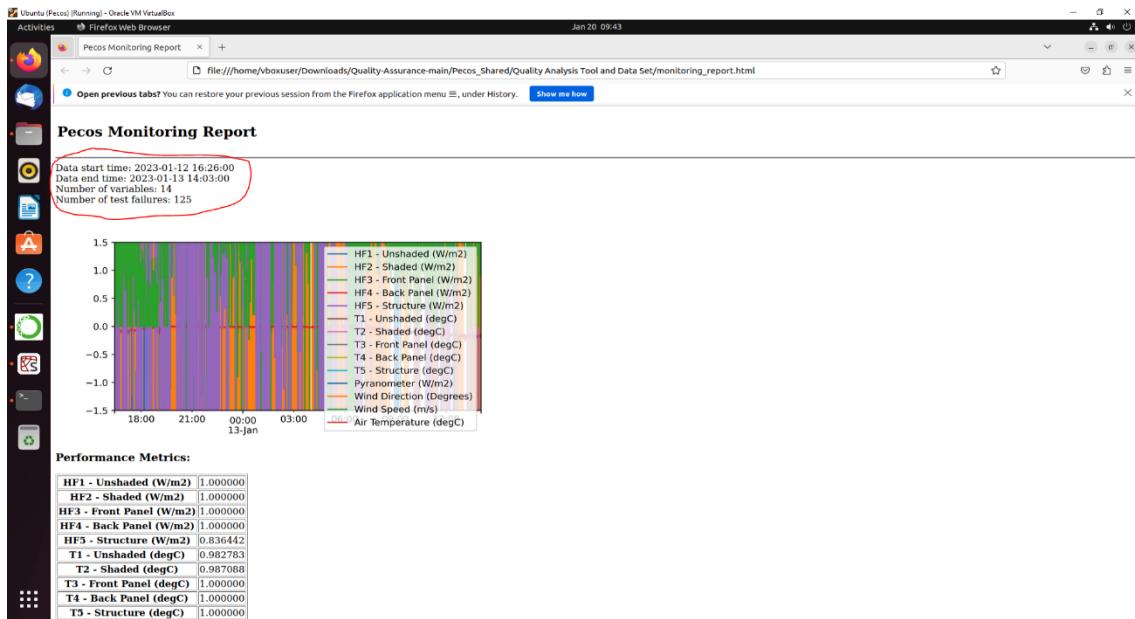
# + Code Block 1 +
# Create a dictionary of groups same type of sensors (devices), setting up checks for each sensor.
# Temperature Sensors are added or removed change below.
pn.add_translation_dictionary({'Heat Flux': ['HF1 - Unshaded (W/m2)', 'HF2 - Shaded (W/m2)', 'HF3 - Front Panel (W/m2)', 'HF4 - Back Panel (W/m2)', 'HF5 - Structure (W/m2)'], 'Temperature Sensors': ['T1 - Unshaded (degC)', 'T2 - Shaded (degC)', 'T3 - Front Panel (degC)', 'T4 - Back Panel (degC)', 'T5 - Structure (degC)'], 'Pyranometer': ['Wm2'], 'Wind Direction (Degrees)': ['WindDir'], 'Wind Speed (m/s)': ['WindSpeed'], 'Air Temperature (degC)': ['Temp']})


# + Code Block 2 +
# Check if there are any new types of sensors (devices) added or removed.
# Temperature Sensors are added or removed change below.
pn.add_translation_dictionary({'Temp': ['T1 - Unshaded (degC)', 'T2 - Shaded (degC)', 'T3 - Front Panel (degC)', 'T4 - Back Panel (degC)', 'T5 - Structure (degC)'], 'HF1 - Unshaded (W/m2)': ['HF1 - Unshaded (W/m2)', 'HF2 - Shaded (W/m2)', 'HF3 - Front Panel (W/m2)', 'HF4 - Back Panel (W/m2)', 'HF5 - Structure (W/m2)'], 'HF2 - Shaded (W/m2)': ['HF1 - Unshaded (W/m2)', 'HF2 - Shaded (W/m2)', 'HF3 - Front Panel (W/m2)', 'HF4 - Back Panel (W/m2)', 'HF5 - Structure (W/m2)'], 'HF3 - Front Panel (W/m2)': ['HF1 - Unshaded (W/m2)', 'HF2 - Shaded (W/m2)', 'HF3 - Front Panel (W/m2)', 'HF4 - Back Panel (W/m2)', 'HF5 - Structure (W/m2)'], 'HF4 - Back Panel (W/m2)': ['HF1 - Unshaded (W/m2)', 'HF2 - Shaded (W/m2)', 'HF3 - Front Panel (W/m2)', 'HF4 - Back Panel (W/m2)', 'HF5 - Structure (W/m2)'], 'HF5 - Structure (W/m2)': ['HF1 - Unshaded (W/m2)', 'HF2 - Shaded (W/m2)', 'HF3 - Front Panel (W/m2)', 'HF4 - Back Panel (W/m2)', 'HF5 - Structure (W/m2)]})
pn.add_translation_dictionary({'Temp': ['T1 - Unshaded (degC)', 'T2 - Shaded (degC)', 'T3 - Front Panel (degC)', 'T4 - Back Panel (degC)', 'T5 - Structure (degC)'], 'HF1 - Unshaded (W/m2)': ['HF1 - Unshaded (W/m2)', 'HF2 - Shaded (W/m2)', 'HF3 - Front Panel (W/m2)', 'HF4 - Back Panel (W/m2)', 'HF5 - Structure (W/m2)'], 'HF2 - Shaded (W/m2)': ['HF1 - Unshaded (W/m2)', 'HF2 - Shaded (W/m2)', 'HF3 - Front Panel (W/m2)', 'HF4 - Back Panel (W/m2)', 'HF5 - Structure (W/m2)'], 'HF3 - Front Panel (W/m2)': ['HF1 - Unshaded (W/m2)', 'HF2 - Shaded (W/m2)', 'HF3 - Front Panel (W/m2)', 'HF4 - Back Panel (W/m2)', 'HF5 - Structure (W/m2)'], 'HF4 - Back Panel (W/m2)': ['HF1 - Unshaded (W/m2)', 'HF2 - Shaded (W/m2)', 'HF3 - Front Panel (W/m2)', 'HF4 - Back Panel (W/m2)', 'HF5 - Structure (W/m2)'], 'HF5 - Structure (W/m2)': ['HF1 - Unshaded (W/m2)', 'HF2 - Shaded (W/m2)', 'HF3 - Front Panel (W/m2)', 'HF4 - Back Panel (W/m2)', 'HF5 - Structure (W/m2)]})
```

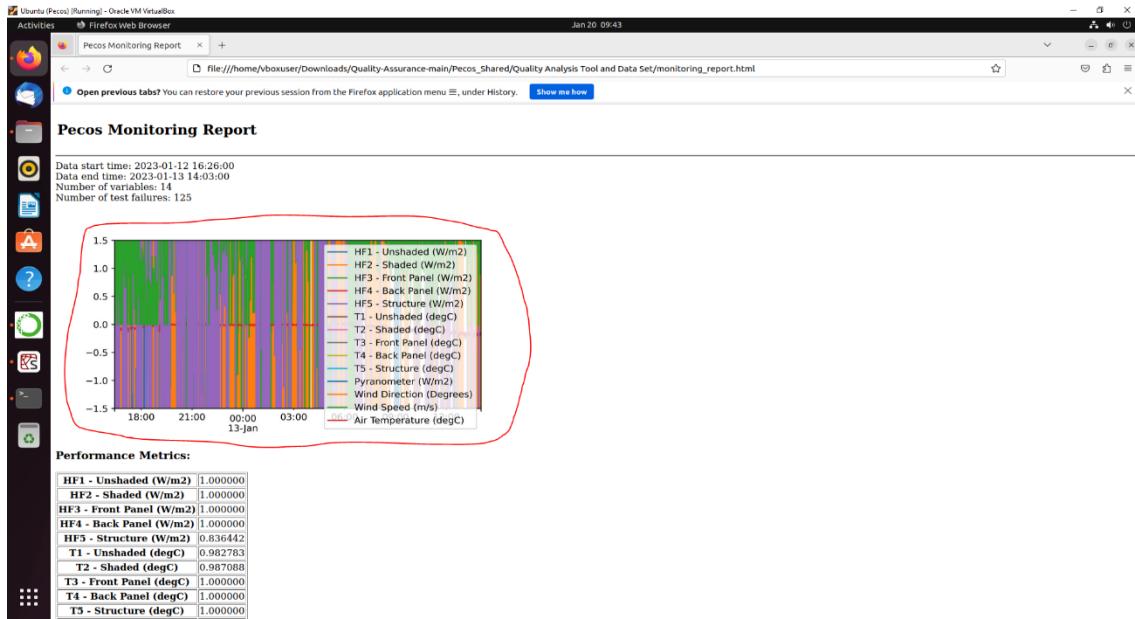
Once opened, you should see a report like the one below:



At the top of the document, below the title, is a summary of the data analyzed. It lists the window of time that the data was recorded for, as well as the number of sensors being evaluated and the number of test failures that were experienced:

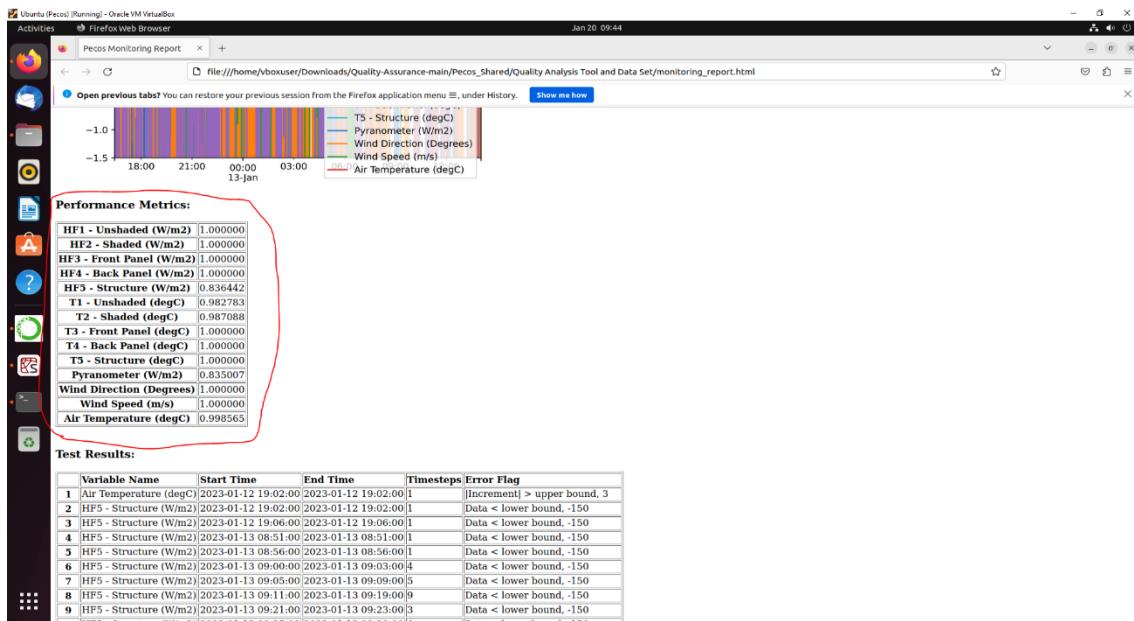


This graphic at the top depicts a comparison of data quality for each sensor:



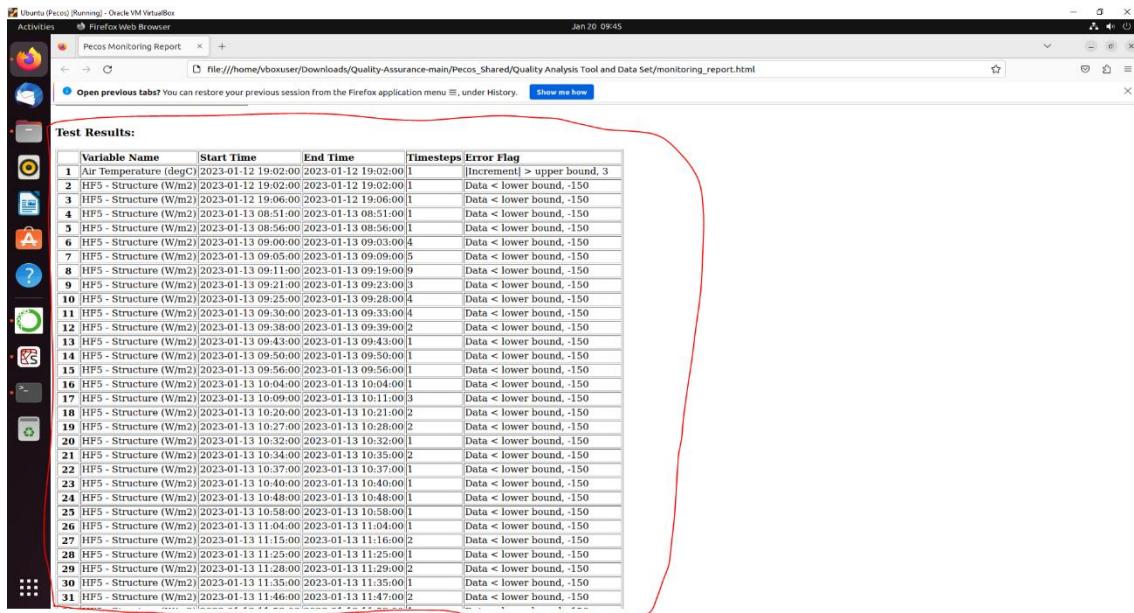
The quality index of each sensor is a good indicator of if a sensor is beginning to fail.

A table of these performance metrics can be viewed immediately below the figure:



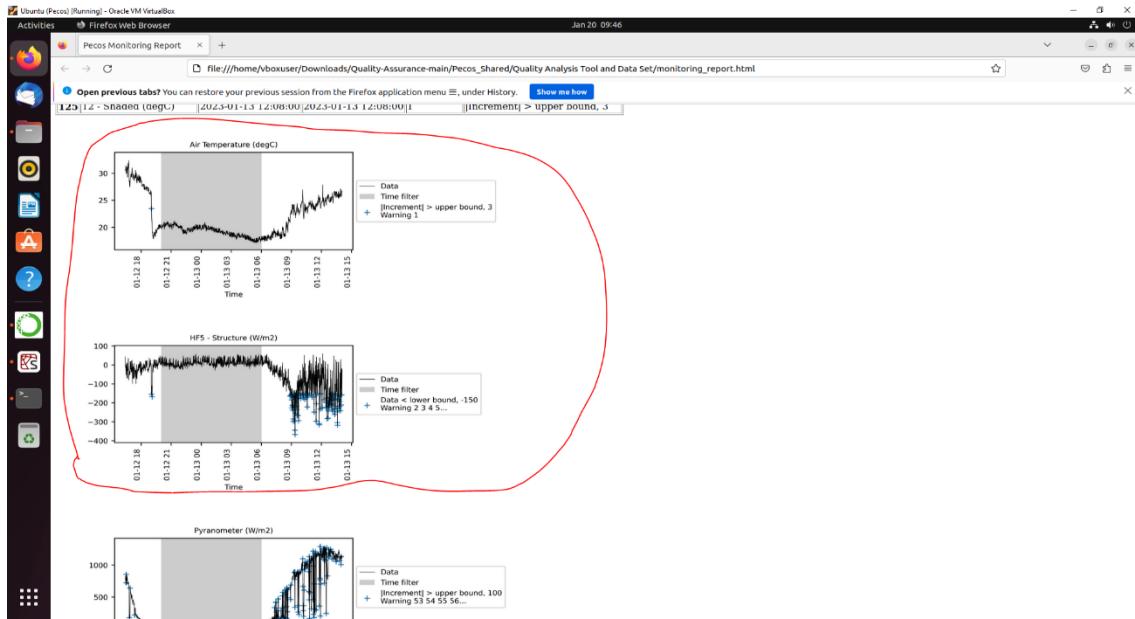
The closer to 1 that a sensor scores, the less issues it experienced. Therefore, if a sensor scores high, then it is in good operating condition. However, if it scores low, then it will need to be checked immediately.

Under "Test Results" every flagged data point is listed along with which test(s) it failed:



This allows the user to immediately locate at which timestamp the error occurred.

Immediately below the table of test results is a set of graphs for each sensor that was flagged during the analysis:



This provides for an easy visual analysis of the data, where the user can readily identify any gaps and/or spontaneous spikes in the data.

Step 22: Address any Issues (Maintenance)

- Why did we get these values?
 - Faulty Sensor
 - Replace Sensor
 - Faulty Datalogger
 - Bad Connection
 - Loose Wire
 - Compromised Connection
 - Irregular Conditions
 - Weather
 - Temporary Shading
 - Animal Tampering
 - Other Environmental Factors

Regularly scheduled maintenance is crucial to the success of a system such as this. Pecos serves as a wonderful indicator of issues within the system, but the user is responsible for maintaining the normal operational conditions of the system.

Areas for Improvement (Literature Suggestions)

- Automatic data retrieval
 - Multiple file analysis and report generation

Other Lines of Interest in Code

pm.check_missing()

The screenshot shows the Spyder IDE interface with a Python script named `temp.py` open. The script performs various checks on sensor data, including timestamp validation, missing data detection, and range validation for heat flux, pyranometer, and wind parameters. It also handles time windows and generates reports. A terminal window below the IDE shows the execution of the script and its output, which includes a warning about the use of `append` and `concat` methods.

```
temp.py | Proc: Quality Analysis.py | Spyder (Python 3.9)
```

```
df = pd.read_csv(data_file, index_col=0, parse_dates=True)
pn.add_dataframe(df)

# * Code Block 2 *
# pn.add_translation_dictionary() groups same types of sensors (Avoids setting up checks for each sensor.)
pn.add_translation_dictionary(['Heat Flux', 'Unshaded (W/m²)', 'W2 - Shaded (W/m²)', 'W3 - Front Panel (W/m²)', 'W4 - Back Panel (W/m²)'])
pn.add_translation_dictionary(['temp': 'T1 - Unshaded (degC)', 'T2 - Shaded (degC)', 'T3 - Front Panel (degC)', 'T4 - Back Panel (degC)'])

# * Code Block 3 *
# Specify Timestamp of Interest below
st = '2023-01-20T00:00:00Z'
et = '2023-01-20T01:00:00Z'

# * Code Block 4 *
# Check the expected frequency of the timestamp
pn.check_timestamp(60)

# Generate a time filter to exclude data points early and late in the day
time_filter = pn.series.all_data_time_to_clockTime(pd.date_range(st, et+pd.Timedelta('1H')), clock_time=et+pd.Timedelta('3000H')) & (clock_time < et+pd.Timedelta('3600H'))
pn.add_time_filter(time_filter)

# Line of Interest: Missing Data Filter *
# Check for missing data
pn.check_missing()

# Line of Interest: Corrupt Data Filter *
# Check for corrupt data values
pn.check_corrupt({999})

# Check data for expected ranges
pn.check_range([-10, 190], 'Heat Flux')
pn.check_range([0, 13000], 'Pyranometer (W/m²)')
pn.check_range([0, 360], 'Wind Direction (Degrees)')
pn.check_range([0, 30], 'Wind Speed (m/s)')

# * Code Block 5 *
# Check if statement data within a 1 hour moving window
pn.check_delta(0.0001, None, 3600, 'Heat Flux')
pn.check_delta(0.0001, None, 3600, 'Pyranometer (W/m²)')
pn.check_delta(0.0001, None, 3600, 'Wind Direction (Degrees)')
pn.check_delta(0.0001, None, 3600, 'Wind Speed (m/s)')

# * Code Block 7 *
# Check if value changes between consecutive time steps
pn.check_increment(100, 'Heat Flux') # Do we need this?
pn.check_increment(100, 'Temp')

# Figures now render in the Plots pane by default. To make them also appear inline in the Console, uncheck "Note: Inline Plotting" under the Plots pane options menu.
```

```
Jan 20 10:00
```

```
/home/vboxuser/Downloads/Quality-Assurance-main/Pecos_Shared/Quality Analysis Tool and Data Set
```

```
Source | Console | Object |
```

```
Usage
```

```
Here you can get help of any object by pressing Ctrl+q in front of it, either on the left or on the code pane.  
Help can also be shown automatically after writing a left parenthesis next to an object. You can activate this behavior in Preferences > Help.
```

```
New to Spyder? Read our tutorial
```

```
Console | Help | Variable Explorer | Plots | Files
```

```
2023-01-20 09:41:18 : CHECK FOR DATA INCREMENT EXCEEDED OR EQUAL
```

```
/home/vboxuser/.anaconda/lib/python/3.9/site-packages/pecos/monitoring.py:215: FutureWarning: The frame.append method is deprecated and will be removed in a future version. Use frame.extend or pd.concat instead.
```

```
self.test_results = self._test_results.append(test_results, ignore_infinity=True)
```

```
2023-01-20 09:41:18 : Check for data increment outside expected range
```

```
2023-01-20 09:41:18 : Creating graphic for Air Temperature (degC)
```

```
2023-01-20 09:41:18 : Creating graphic for Air Pressure (hPa)
```

```
2023-01-20 09:41:18 : Creating graphic for Air Structure (W/m²)
```

```
2023-01-20 09:41:18 : Creating graphic for Pyranometer (W/m²)
```

```
2023-01-20 09:41:19 : Creating graphic For T1 - Unshaded (degC)
```

```
2023-01-20 09:41:19 : Creating graphic For T2 - Shaded (degC)
```

```
2023-01-20 09:41:20 : Writing test results csv file test_results.csv
```

```
2023-01-20 09:41:20 : Writing HTML report
```

```
Warning
```

```
In [2]:
```

```
Python Console | History |
```

The line above was not included in the guide above due to it never needing to be changed. It acts as an additional filter by flagging any occurrences of missing data. This is extremely helpful because it can be indicative of a failing sensor or a fault in the system that needs to be addressed.

```
pm.check_corrupt([-999])
```

Ubuntu (Pecos) [Running] - Oracle VM VirtualBox

Activities Spyder

File Edit Search Source Run Debug Consoles Projects Tools View Help

/home/boxuser/Downloads/Quality-Assurance-main/Pecos_Shared/Quality Analysis Tool and Data Set

temp.py | Pecos Quality Analysis.py x

```
df = pd.read_csv(data_file, index_col=0, parse_dates=True)
pn.add_dataframe(df)

# Code Block 1
# Check for missing data
pn.check_missing()

# Code Block 2
# Check for corrupt data values
pn.check_corrupt(**{999})

# Code Block 3
# Check for missing data
pn.check_missing()

# Code Block 4
# Check for corrupt data values
pn.check_corrupt(**{999})

# Code Block 5
# Check for missing ranges
pn.check_range([-150, 180], 'Heat Flux')
pn.check_range([0, 180], 'Parameter: (W/m2)')
pn.check_range([0, 180], 'Wind Direction (Degrees)')
pn.check_range([0, 30], 'Wind Speed (m/s)')

# Code Block 6
# Check for corrupt data within a 1 hour moving window
pn.check_delta([0.0001], None, 3600, 'Heat Flux')
pn.check_delta([0.0001], None, 3600, 'Temp')
pn.check_delta([0.0001], None, 3600, 'Parameter: (W/m2)')
pn.check_delta([0.0001], None, 3600, 'Wind Direction (Degrees)')
pn.check_delta([0.0001], None, 3600, 'Wind Speed (m/s)')

# Code Block 7
# Check for repeat changes between consecutive time steps
# If pn.check_increments(**{'None': 50}, 'Heat Flux') # Do we need this?
pn.check_increments(**{'None': 50}, 'Temp')
```

Source Console Object

Usage

Here you can get help of any object by pressing Ctrl+ in front of it, either on the Editor or the Console.

Help can also be shown automatically after writing a left parenthesis next to an object. You can activate this behavior in Preferences -> Help

New to Spyder? Read our tutorial

Console [A] x

```
2023-01-20 09:41:18: Welcome to Spyder 4.2.0! Your configuration is up-to-date.
2023-01-20 09:41:18: Python 3.9.13 | Spyder Jupyter Notebook | IPython 8.1.0
2023-01-20 09:41:18: IPython kernel 3.9.13 | Jupyter core 2.10.0 | qtconsole 5.10.0
2023-01-20 09:41:18: qtconsole 5.10.0 | qtconsole 5.10.0 | qtconsole 5.10.0
2023-01-20 09:41:18: Creating graphic for Air Temperature (W/m2)
2023-01-20 09:41:18: Creating graphic for Air Temperature (W/m2)
2023-01-20 09:41:18: Creating graphic for T1 - Unshaded (degC)
2023-01-20 09:41:18: Creating graphic for T2 - Shaded (degC)
2023-01-20 09:41:18: Writing HTML report
2023-01-20 09:41:20 : Writing HTML report
```

Variable Explorer Plots Files

Warnings

Figures now render in the Plots pane by default. To change this, make them appear inline in the Console, uncheck "In-line Plotting" under the Plots pane options menu.

In [2]:

[Python Console History]

The above line of code runs as a check for any corrupt data values. This is also a great indicator of a failing sensor.

References

K.A. Klise and J.S. Stein (2016), Performance Monitoring using Pecos, Technical Report SAND2016-3583, Sandia National Laboratories, Albuquerque, NM.

K.A. Klise and J.S. Stein (2016), Automated Performance Monitoring for PV Systems using Pecos, 43rd IEEE Photovoltaic Specialists Conference (PVSC), Portland, OR, June 5-10. [pdf](#)

Latest Link: <https://pecos.readthedocs.io/en/latest/>

Sturtevant, C., Metzger, S., Nehr, S., Foken, T. (2021). Quality Assurance and Control. In: Foken, T. (eds) Springer Handbook of Atmospheric Measurements. Springer Handbooks. Springer, Cham. https://doi.org/10.1007/978-3-030-52171-4_3