Linux for Radio Astronomy

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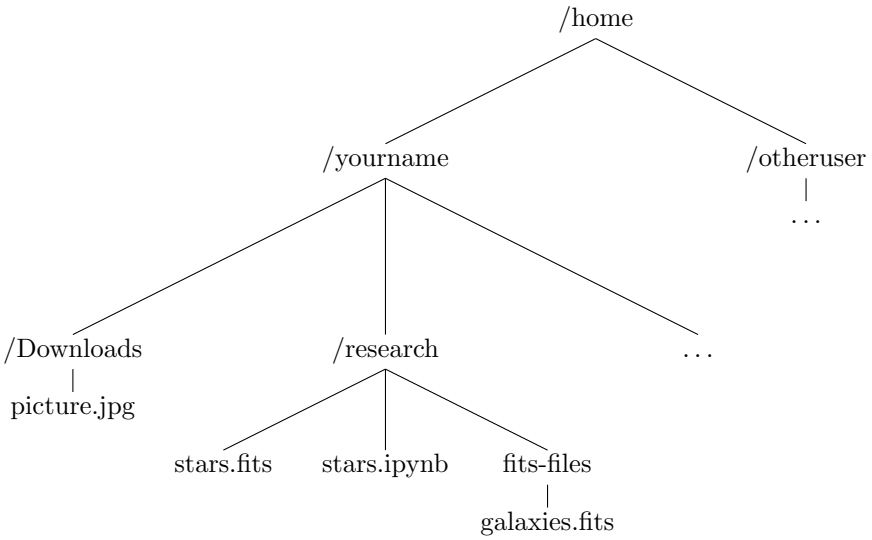
February 19, 2024

1 Using Linux

1.1 File Structure

Before you start your wonderful journey using Linux lets have a crash course on the basics of the Linux file structure. First of all we have directories. A directory is just a folder. A directory can have subdirectories, in fact almost everything you do will happen within your home directory (denoted as /home/user or often shortened to ∼/). When discussing the path to a file we can use the absolute path. The absolute path for picture.jpg would be /home/yourname/Downloads/picture.jpg. Alternatively you can use relative paths. Relative paths are very useful and come in handy when writing code. Let's say you're writing code in the Jupyter notebook stars.ipynb and you wanted to access the file stars.fits. Instead of writing out stars.fits absolute path you could just access that file as "stars.fits". If you wanted to access galaxies.fits you would have to write "fits-files/galaxies.fits" (I would recommend keeping all of your data files in the same directory as your Jupyter notebooks because in order to access galaxies.fits in this scenario you would need to import a specific python library called os, and, in my opinion, is not worth it). You can access files in directories further up by using "..". Lets say your present working directory was ∼/research and you wanted to access picture.jpg, its relative path would be "../Downloads/picture.jpg"



1.2 Terminal Commands[1]

Directories

mkdir NewDir	makes new directory (i.e., folder) /Users/username/NewDir/
rmdir NewDir	removes directory NewDir/
cd NewDir	change to new dir.
cd ..	go back ("up") one dir.
cd	return to home dir.
pwd	shows current dir.
ls	list contents of dir.
ls -la	verbose listing

All Files

cp SomeFile NewFile	copies file to another file
cp SomeFile NewDir/	copies file to new dir.
cp Dir/SomeFile .	copies file in Dir to current dir. (.)

[1] Taken from D.H.McIntosh "Basic Linux (Unix) Commands"

cp ../SomeFile .	copies file in one dir. up to current dir. (.)
mv SomeFile NewDir/	moves file to new dir.
mv SomeFile ../../	moves file up 2 dirs.
mv *.txt NewDir/	moves all files ending in .txt to new dir.
rm SomeFile	deletes file
rm *	deletes ALL files in dir. (Careful!)
locate SomeFile	finds dir. location for SomeFile
sudo	for commands that need superuser privileges
touch SomeFile	creates SomeFile

1.3 Installing Software[2]

Installing software on a Linux machine can be done through various methods. The first of which is using your package manager and the terminal.

Install through the terminal

The easiest and quickest way to install software is through the terminal. Using the following code snippet will allow you to install an application "package-name".

```
sudo apt-get install packagename
```

Install through software application

Many Linux distributions (such as Ubuntu) have an application pre-installed called "software". You can search through this app and install software this way.

Other Methods

Linux has many other ways to install software such as appimages, snaps, tarballs, etc. You will likely learn how to use these through necessity. A good google search will usually help to clear the confusion as to which method you should use as well. I will be going through how to install and use various relevant applications for radio astronomy.

[2]This tutorial is written with the assumption that you are using Ubuntu, if you are using a different distribution the methods for installing packages will be slightly different.

2 Astronomy Software

2.1 Python

Python should be installed on your system already. If you would like to install a specific version of python you can run a command like:

```
sudo apt-get python3.6
```

To update python the command apt-get update should do.

2.2 Anaconda

Installing Anaconda will install the software conda as well as several important python packages. Conda allows us to create python environment. I *strongly* suggest that you always work within a virtual environment. Virtual environments allow us to avoid "Dependency Hell". Often time software relies on other software to run. For example, if If you wanted to use the library Astropy, it would be necessary to actually have python to use Astropy. If I need one version of python to use a certain library and a different version of python to use another library, I can make two virtual environments, each with their own versions of python and libraries.

I will not go into depth about how to install Anaconda here. Please follow the Anaconda documentation of how to install in Linux here

To create an environment with the name myenv and python version 3.9 you would type the following command into the terminal:

```
conda create -n myenv python=3.9
```

To activate this environment you would type:

```
conda activate myenv
```

2.3 Jupyter Notebook

Jupyter notebook is an editor for python notebooks, something that we often use in the sciences. There is also Jupyter lab. Jupyter lab has a few more features than notebook and I personally like to use lab, but the differences are more or less trivial. After you launch Jupyter it will open in your browser and you can navigate to the .ipynb file you want to edit. You can create a new .ipynb file within Jupyter. Once you have closed the tab in which your notebook is running you *have not* closed the notebook itself. To close the notebook you can close the terminal window you are in or press control c to actually close the notebook.

To install Jupyter notebook:

```
pip install notebook
```

To install Jupyter lab:

```
pip install jupyterlab
```

To launch Jupyter notebook:

```
jupyter notebook
```

To launch Jupyter lab:

```
jupyter lab
```

2.4 CARTA

CARTA is a tool used for viewing data cubes. Data cubes are fits files that have 3-dimensions (x, y, and frequency).It is particularly useful within radio astronomy.
To install CARTA:

```
sudo add-apt-repository ppa:cartavis-team/carta
sudo apt-get update
sudo apt install carta
```

2.5 CASA

CASA, is a data processing software for radio telescopes. CASA has a kind of weird installation process. There is a good presentation on it that you can see here. If you plan to use XCLASS you have to download 5.1.1.

2.6 XCLASS

XCLASS is a tool that will fit synthetic spectra to your observational data. XCLASS operates within CASA. XCLASS has a somewhat complicated install process. There is a good tutorial for downloading XCLASS here. IMPORTANT: The install script is written in python 2 and needs to be run with python 2.

2.7 DS9

DS9 is a fits viewer for 2D images. We do not use DS9 as much in radio astronomy since we'll usually be using CARTA, but it is a good program to become acquainted with.

3 Challenges

After this tutorial you should be able to:

- Make a file with the location ∼/NewDir/SomeFile.txt
- Make a jupyter notebook with location ∼/research/FirstFile.ipynb
- Open a data cube in CARTA.