# Introduction to Python 2.7

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# Course objectives

- Learn the basic building blocks of python
- Learn to scripting in python
- What are python packages?
- Astronomical packages

- **Disclosure:** This is not a comprehensive tour of Python 2.7. I will cover only what is necessary/useful for this workshop. See slide on "Further reading" for references.

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# What is python?

- Programming language
  - general purpose
  - interpreted
  - high-level
  - Created by Guido van Rossum almost 30 years ago

  - Widely used in astronomy
  - Numerous packages exist
    - ★ AstroPy - Common astronomy utilities
    - ★ SunPy - Solar data analysis
    - ★ GammaPy - Gamma-ray astronomy

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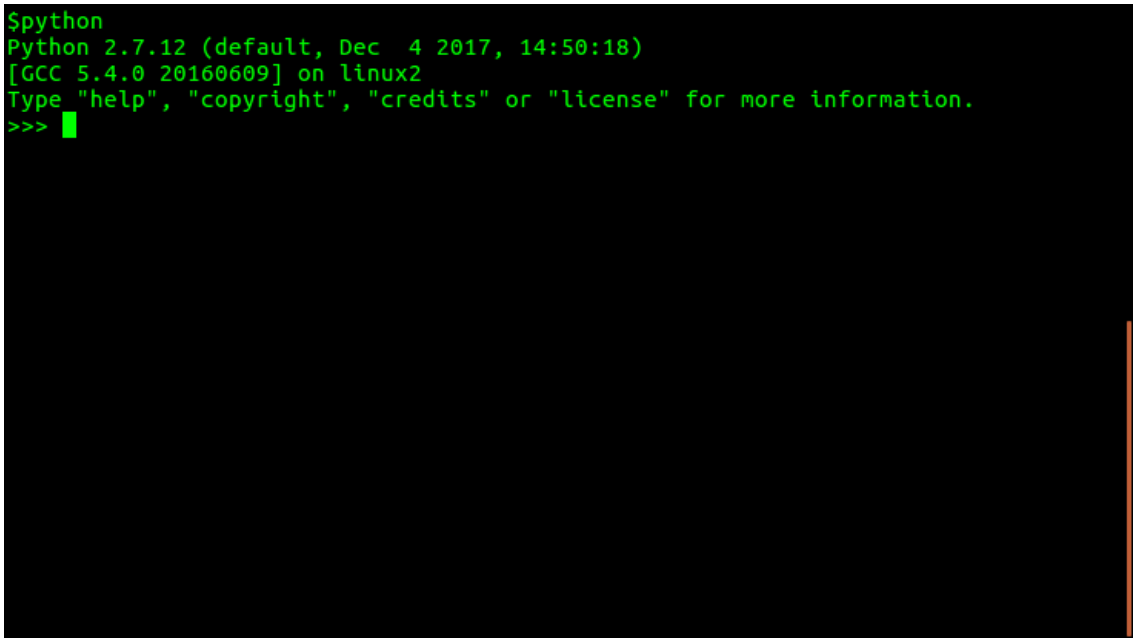
# Python interpreter

- Start the interpreter by typing **python** in your command prompt



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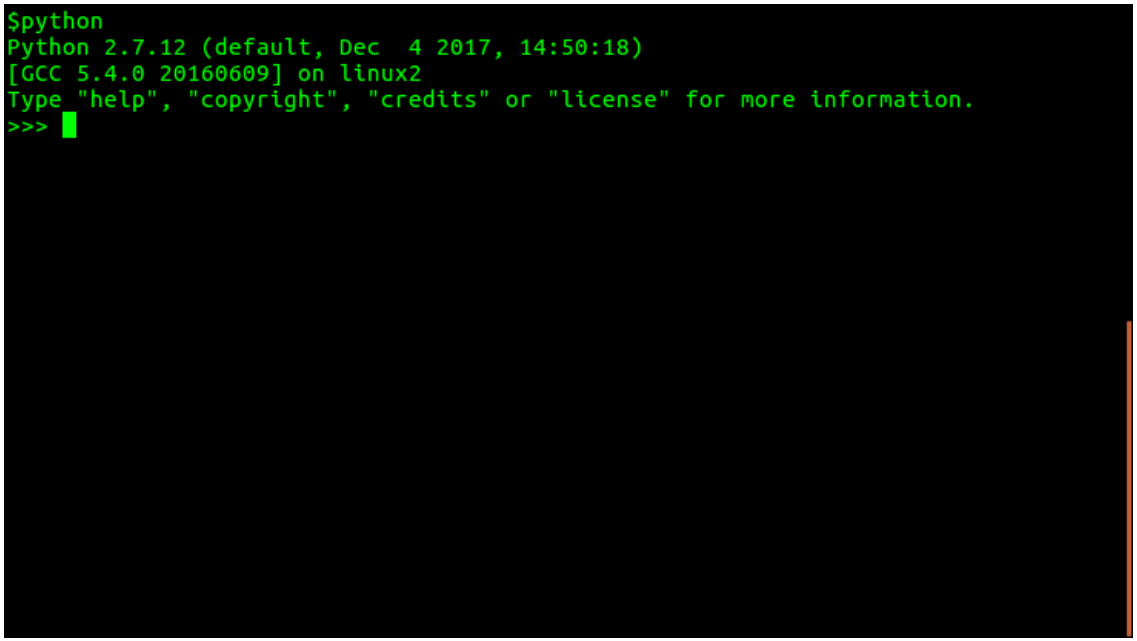


- Type the following commands in the prompt
  - a = 10
  - b = 20.5
  - c = a+b
  - type(a); type(b); type(c)
- Try out other basic math operations

# Scripting in python

- Create a new file called **mycode.py**
- Add the following code to the file:

```
a = 10
b = 20.5
# Add two numbers
c = a+b
# Now, print the number
print c
```

- Save the file and execute it as **python mycode.py**

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- Save the file and execute it as **python mycode.py**
- Or, you can add **#!/usr/bin/env python** as the first line in mycode.py
- Change the file permission with **chmod u+x mycode.py**
- Finally, execute as **./mycode.py**

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# Strings in python

- Strings, or a set of characters represented inside ' ', " ", or """ """.
- Create a string with

```
mystring = "Hello, Python!"
```

- **print mystring** will print the entire string.

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## Exercise:

- Can you print just 'Hello'?
- Can you print the string in reverse? That is, display '!nohtyP ,olleH'.

# Lists

- Lists are pretty useful components of Python
- It is a collection of items inside [] and separated by commas.
- Example:

```
list1 = [1, 2, 3, 4, 5]
list2 = [6, 7, 8, 9, 10]
print list1[1]
print list1[2:4]
print list1 + list2
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list3 = [1, 2.5, 'three']
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```
list3 = [1, 2.5, 'three']
```

## Exercise:

- Can you display the reverse of list3? That is ['three', 2.5, 1]
- Can you display the length/size of list3?

# Further reading

- There is more to python than what we just saw
- ... but this should get you started.

- `https://www.python.org/about/gettingstarted/`
- `https://www.learnpython.org/`
- `https://www.tutorialspoint.com/python/index.htm`
- ...

- Or, just google your problem!

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# Python packages

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- You need to install the libraries separately.
- We'll use **pip** to install some useful libraries.
- pip install "name" - -user
  - "name" is the name of the library to install
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  - "name" is the name of the library to install
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- Useful packages for this workshop:
  - NumPy - math operations on N-dimensional arrays
  - Matplotlib - plotting library
  - AstroPy
  - ApIPy - Plotting/visualizing images.

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# Brief overview of AplPy

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- Import the library in your script using

```
import aplpy as a
```

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# Plotting with AplPy

```
#!/usr/bin/env python
import aplpy as a

filename = 'n1569.fits'
f = a.FITSFigure(filename)

f.show_grayscale()

f.save('n1569_orig.pdf', dpi=200)
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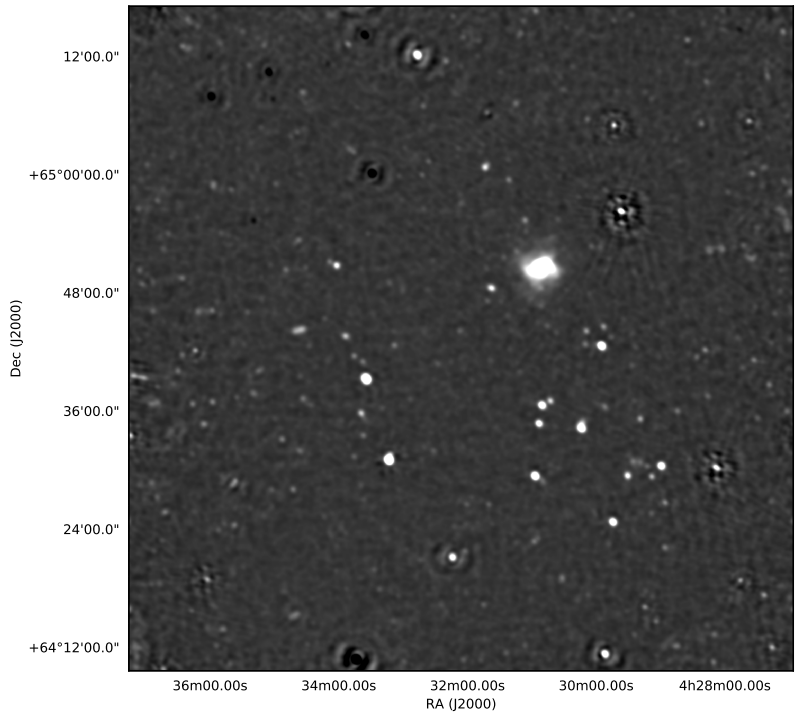

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filename = 'n1569.fits'
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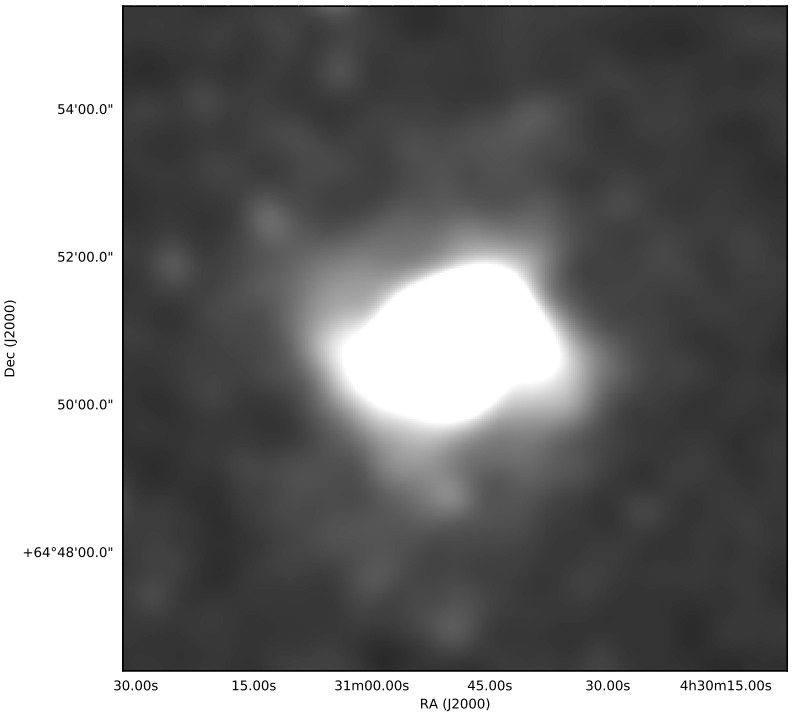

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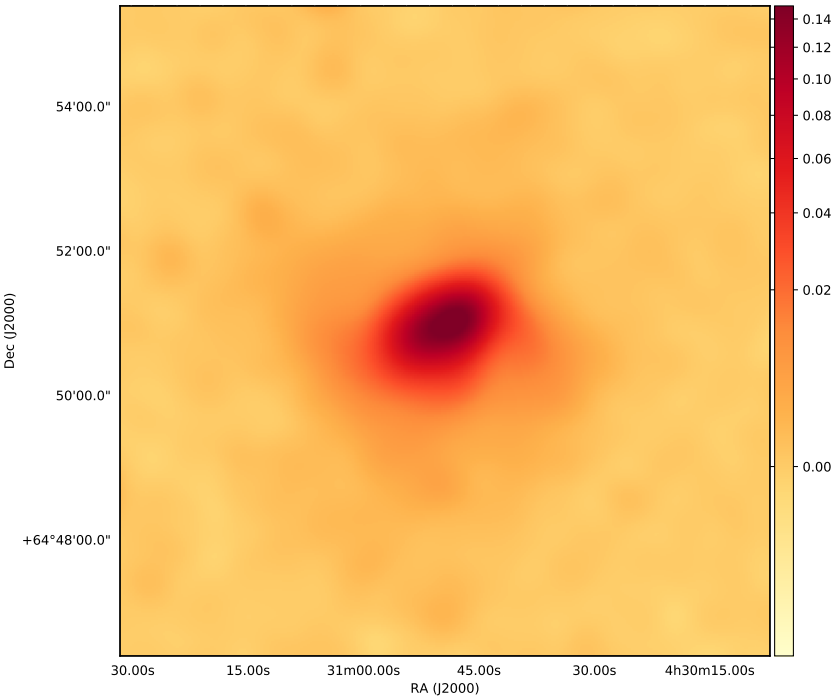

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    0.000315*16, 0.000315*32,\
    0.000315*64]
f.show_contour(filename, \
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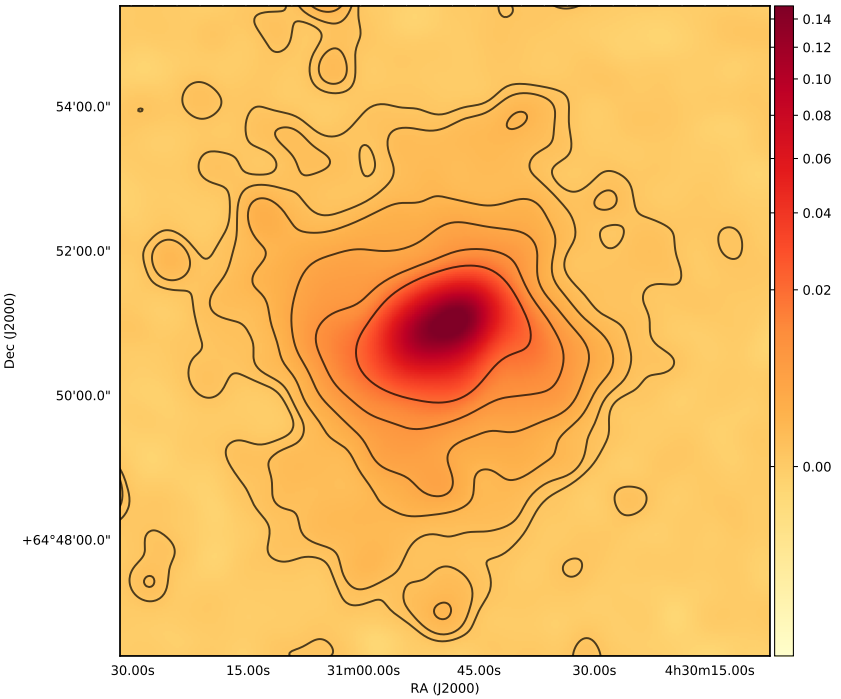

# Brief overview of NumPy

- NumPy is a wide-used python library for N-dim array manipulation
- Import NumPy with the line

```
import numpy as np
```

# 1-D array

- Create an array with

```
a = np.array([1,2,3,4,5])
```

- **a.ndim** tells you the dimensions of the array
- **a.shape** tells you the shape of the array

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## Exercise

- Create an array with the **b=np.zeros((5,5))**. Try using the above-mentioned methods on **b**. What did **np.zeros** create?

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# Indexing and slicing

- Recall how we used indices while discussing Lists and Tuples.
- Now, create an array with **c=np.array([1,2,3,4,5])**.

**Exercise:**

- Using indexing on **c**, can you produce this array: [2,3,4]?
- Can you print the reverse of **c**?

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## Some useful functions

- np.arange() and np.linespace()
- np.ones(), np.ones_like(), np.zeros(), and np.zeros_like()
- np.eye()

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# More indexing and slicing

- Create an array with **d = np.random.randint(1,10,10)**
- Print the content of **d**. Can you guess what the above function did?

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- Create an array with **d = np.random.randint(1,10,10)**
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- Execute **d>3**. Can you interpret the result?

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- Execute **d[d>3]**. Can you interpret the result?

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# Simple plotting examples with Matplotlib

- Create an array with **x=np.linspace(0,10,1000)**
- Compute the sin of **x** with **y=np.sin(x)**

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- Now, let's plot this sin curve

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import matplotlib.pyplot as plt
plt.plot(x,y)
plt.show()
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- What happens if we replace the above plot with **plt.plot(x,y,'k−−')**?

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## Exercise:

- Can you plot the cosine of **x** on the above plot?
- What is the purpose of **plt.xlabel()** and **plt.ylabel()**? Use python help.

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# How to read FITS images using AstroPy?

- AstroPy is more than just a tool to read FITS images
- You can open a FITS image and create a new FITS image using

```
import astropy.io.fits as pf
data = pf.open('n1569.fits')[0].data
# Do something with the data
pf.PrimaryHDU(data=data)
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## Exercise:

- In the above code, can you find the size of **data**?
- What is the maximum value in **data**?
- What is the smallest values in **data**?
- Can you create a new array called **mask** that is **1** when **data**$>0.08$ and **0** everywhere?

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