Python lab 2: Modules, arrays, and plotting

Dr Ben Dudson

Department of Physics, University of York

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`http://www-users.york.ac.uk/~bd512/teaching.shtml`

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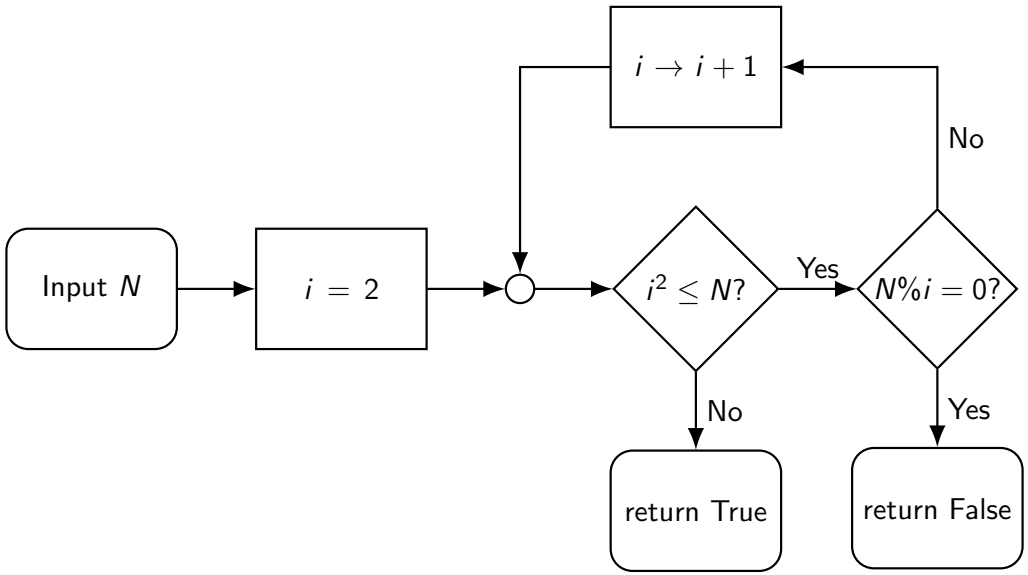
- Related functions are grouped together, say one for mathematical functions, one for network connections etc.
- These groups of functions go by different names in various languages: **libraries**, **packages** and **modules**. Python uses a hierarchical system where functions are grouped into modules, which in turn are grouped into packages.

Python modules

Say we write a function to test if a number is prime

```
def isPrime(N):
    i = 2
    while i**2 <= N:
        if N % i == 0:
            return False # Not a prime
        i = i + 1
    return True # Is a prime
```



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- Rather than copying and pasting the function, we can just **import** it

```
import prime

i = input("Enter a number:")
if prime.isPrime(i):
    print "Prime number"
else:
    print "Not a prime number"
```

Python modules

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- Later we might want to use this function in a second file
- Rather than copying and pasting the function, we can just **import** it
- This allows us to use huge collections of functions which people have written. On your CD are packages for scientific plotting, making 3D animations, interactive web pages, and writing games

Python modules

Two ways to import modules in Python. The simplest way is:

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```

Now we can use p.isPrime instead.
If we don't want this extra typing we can import the function

```
from prime import isPrime
```

This allows us to just use isPrime without the module name at the start.

NumPy

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  This is not encouraged for large programs since it can result in problems when names collide. For some modules, this is however the most convenient way
- The main module we're going to be using for scientific calculations is Numerical Python, or NumPy. To use these functions,

```
from numpy import *
```

Arrays

- So far this course we've been dealing with variables which store one number at a time.
- Particularly in scientific fields, we often want to deal with lots of numbers, such as tables of measurements
- If we had to use a different variable for each of these numbers it would be nearly impossible to write programs to handle thousands or millions of numbers

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- If we had to use a different variable for each of these numbers it would be nearly impossible to write programs to handle thousands or millions of numbers
- The solution to this is to store many numbers in a single variable. These are called **arrays**, and are like vectors in mathematics: Instead of x_i Python uses `x[i]`
- This is the main purpose of NumPy: to provide an efficient way to handle large arrays of numbers

Creating arrays

There are several ways to create arrays in Python, but the one you'll probably use most is the linspace function which is part of NumPy. To see how it works, here's an example

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from numpy import *
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This will print out

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The brackets at the beginning and end mean it's an array. It goes from 0 to 4, and contains 9 numbers.

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The brackets at the beginning and end mean it's an array. It goes from 0 to 4, and contains 9 numbers.
Therefore, linspace(min, max, n) creates an array which goes from min to max, and contains n numbers

Using arrays

Once we have an array, the big advantage is that we can treat it like we would a single number. For example, mathematical operations are done on each of the numbers in an array

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```

Looping over arrays

If we want to run a set of commands once for each element in an array, there are two main ways. The first is to use a **while** loop, using len to get the length of the array

```
from numpy import *
a = linspace(0, 1, 11)
i = 0
while i < len(a):
    print a[i]
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Alternatively, we can use a different form of loop called a **for** loop

```
from numpy import *
a = linspace(0, 1, 11)
for v in a:
    print v
```

Plotting

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- There are several different plotting modules for Python, but the one we'll be using is Matplotlib.

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import matplotlib.pyplot as plt
```

- This gives us the plot function (amongst others) which we can use to plot graphs. For example:

```
from numpy import *
import matplotlib.pyplot as plt

x = linspace(0, 5, 10)
plt.plot(x, x**2)
```

Summary

- To use arrays, first import the NumPy module using

  from numpy **import** $*$

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Getting help: Python includes lots of built in help for modules and functions. To see what a function does, there is the help() function. For example, to see how to use linspace works, run

```
help(linspace)
```

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