

Python Workshop Series Session 1: *Hello World!*

Nick Featherstone
Research Computing

Slides: https://github.com/ResearchComputing/Python_Spring_2018



Research Computing
UNIVERSITY OF COLORADO **BOULDER**

Be Boulder.

Nuts and Bolts Overview of Python Programming

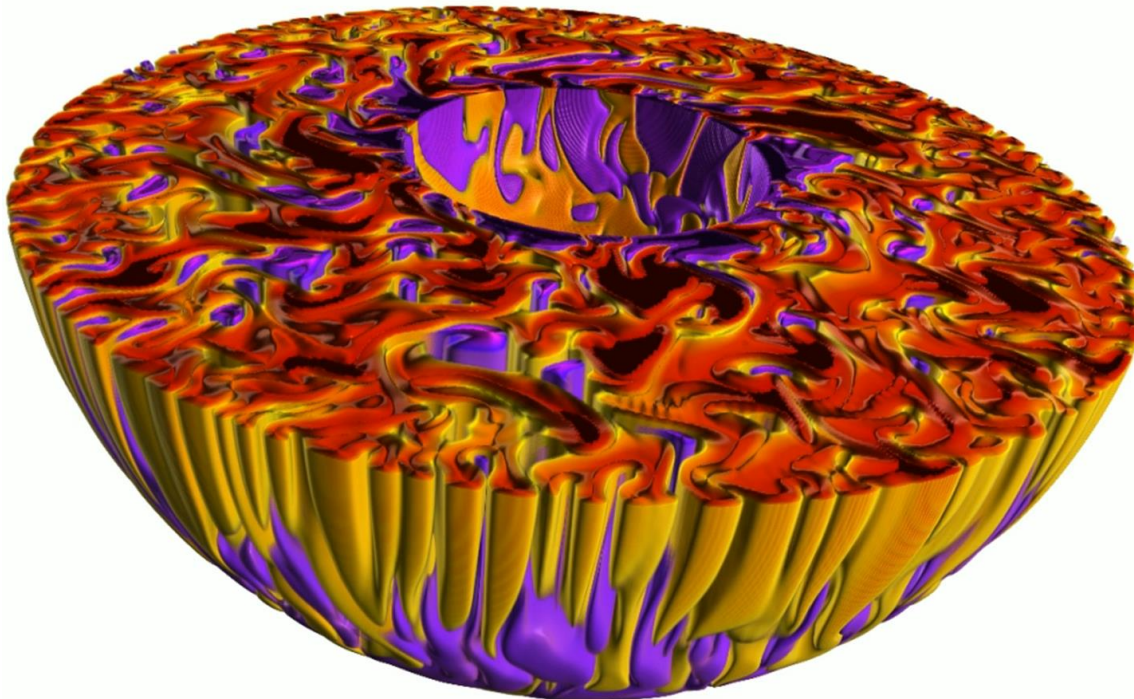


Who are we?



Why are we here?

My Background: Astro & Geophysical CFD



Should You Be Here?

Target Audience:

(minimally) experienced programmers

Preparation:

Is Intel's distribution for Python 3.x installed?

If not:

1. <https://jupyter.rc.colorado.edu>
2. start my server
3. virtual notebook server + “spawn”
4. “New” (upper right) + Python 3



Workshop Series Outline

Mar 14: overview, variables, I/O
Mar 21: conditionals, functions
Mar 28: loops, lists etc.
Apr 4: objects, methods, modules

*Python
Essentials*

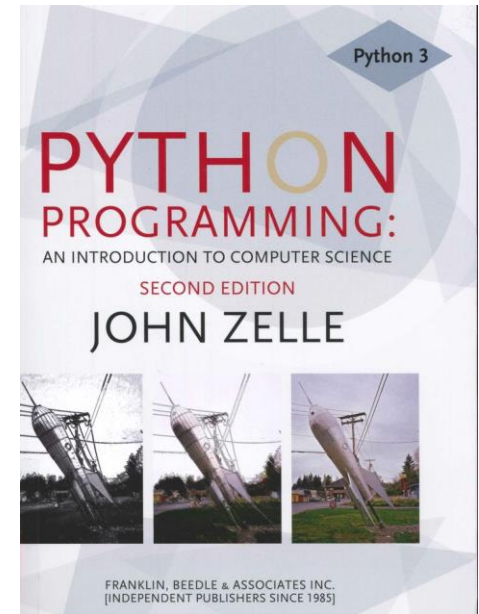
Apr 11: NumPy (efficiency tips)
Apr 18: Matplotlib (creating plots)
Apr 25: H5Py (portable file format)
May 2: custom package creation

*Python
for Research*



Useful References

- Free Online Text
 - How to Think Like a Computer Scientist (Wentworth et al.)
 - <http://openbookproject.net/thinkcs/python/english3e/index.html>
 - Highly recommended
- Textbook
 - Python Programming:
An Introduction to Computer Science (Zelle)



Today's Session: Getting Around in Python

- Overview
- Running Python programs
- Variables and Assignment
- Basic I/O

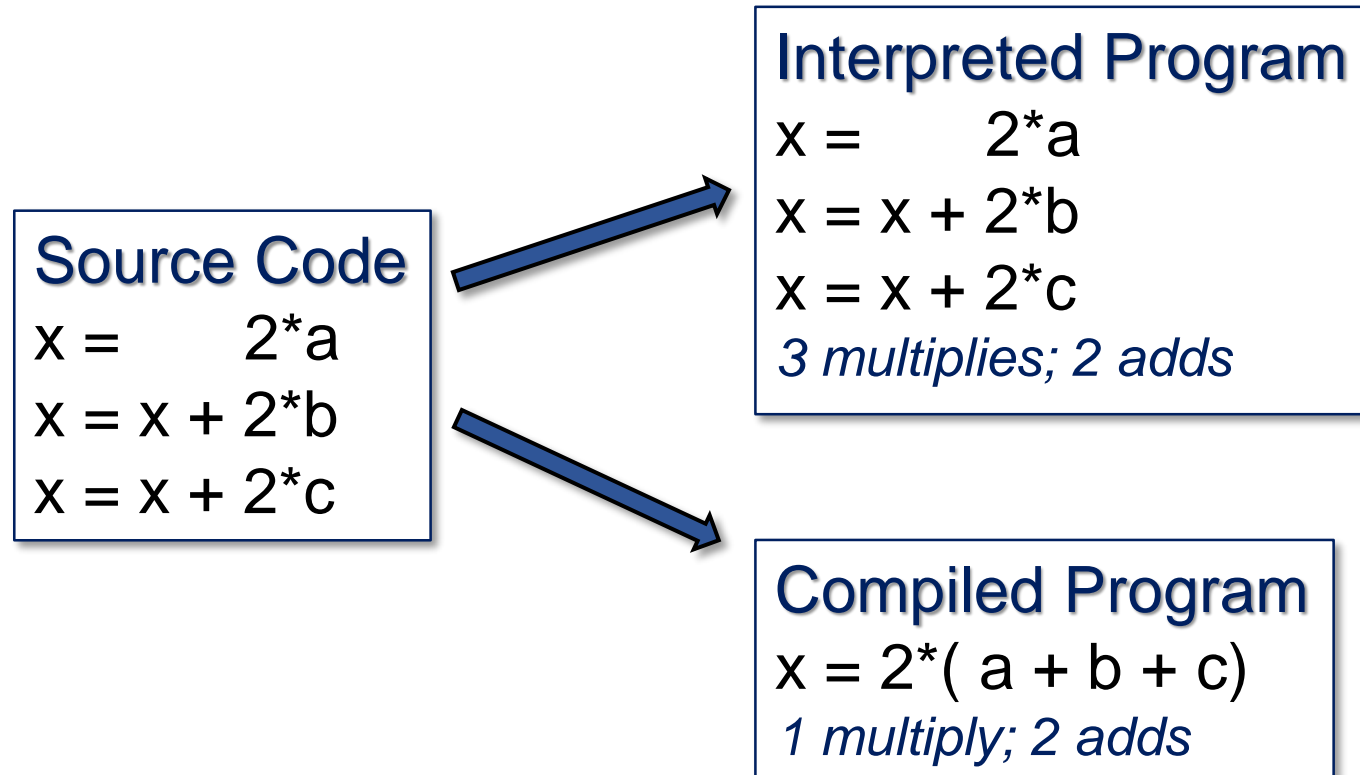


Python, an Interpreted Language

- Python is an *interpreted* language
- Separate program (the interpreter) runs Python code.
- Interpreters execute code “naively.” (line by line)
- Compilers take holistic approach. Interpreters do not.
- Efficiency losses when compared to compiled code.



Compilation vs. Interpretation



- The NumPy, Cython & F2Py packages help to overcome this limitation (weeks 5 and 8).



First Program

- Open a text editor and type:

```
print("hello world")
```

- Save the file as hello.py
- This is a complete Python program
 - ... no semicolons, no brackets
 - ... no “begin program,” no “end program,” etc.
 - .py extension customary (not required)



Running a Python Program

There are various ways to invoke the interpreter

- Command line (1): “*python hello.py*”
- Command line (2): *./hello.py* (similar to bash script)
- Interactive sessions
- Jupyter Notebook (or other IDE)

...follow along as we try a few...



Command Line (1)

- Typical method for running Python programs.
- To use this method:
 1. Open a shell (“anaconda prompt” in Windows)
 - Activate your conda environment:
source activate idp (no source in windows)
 1. Navigate to the folder containing hello.py
 2. Type: *python hello.py*



Command Line (2)

- Can execute code in fashion similar to a bash script
- Must add “shebang” sign **#!** and path to python interpreter:
- Try it (hello2.py):



```
#! path-to-python  
print("hello")
```

1. which python
2. chmod +x hello2.py
3. ./hello2.py



Running the Interpreter Directly

- Similar to IDL and R interpreters
 - Type `python` and enter statements one at a time
 - Type `exit()` when finished (exit is a function)
 - Let's try it out...
-
- To run existing program within interactive session:
 - `exec(open("hello.py").read())`
 - This is clunky and *nonstandard*



Checking the Python Version

- We can access the python version within a program

```
#!/usr/bin/python  
import sys  
print(sys.version)
```

- Save this as ./hello3.py
- `chmod + x hello3.py`
- `./hello3.py`
- *sys* is a *module* (collection of functions & variables)
- *version* is a variable within the sys module

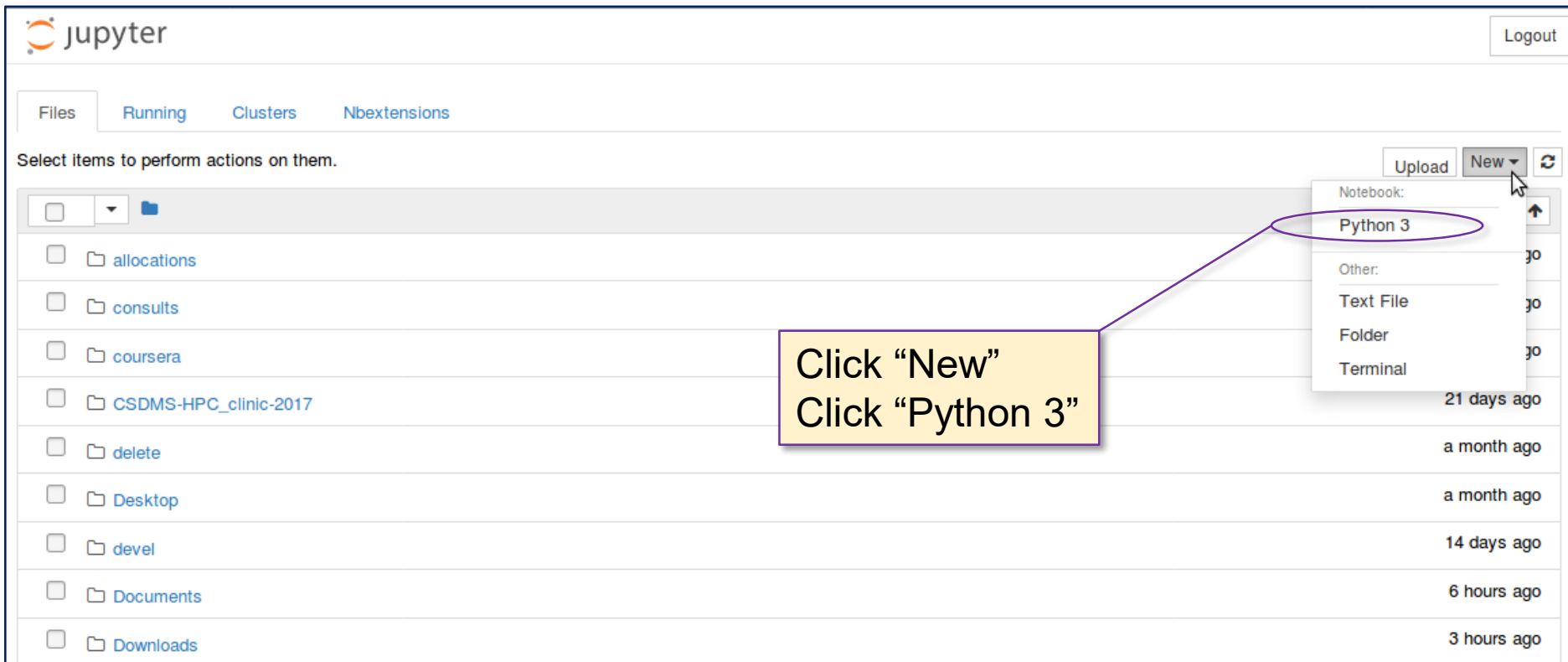


Jupyter Notebook

- Browser-integrated IDE
- Popular for interactive data-analysis
- I will use this throughout the workshop
- Let's try out the notebook
 - Access your shell (“anaconda prompt” in Windows)
 - Type: `source activate idp` (`conda activate` in Windows)
 - Type: `jupyter notebook` ← note the “Y”
 - Follow along



The Jupyter Interface

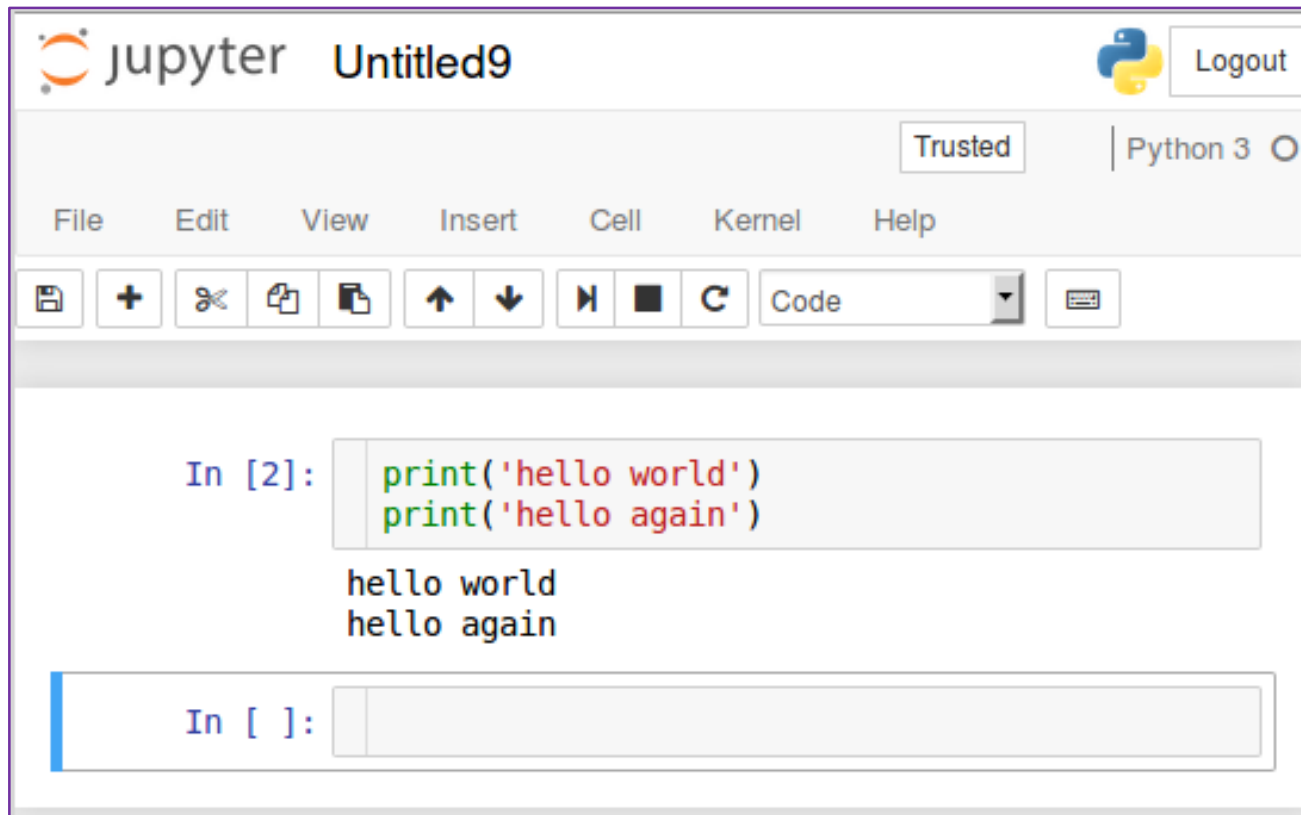


The screenshot shows the Jupyter web interface. At the top left is the Jupyter logo. To the right is a 'Logout' button. Below the logo are tabs for 'Files', 'Running', 'Clusters', and 'Nbextensions'. A message says 'Select items to perform actions on them.' Below this is a list of folders: 'allocations', 'consults', 'coursera', 'CSDMS-HPC_clinic-2017', 'delete', 'Desktop', 'devel', 'Documents', and 'Downloads'. On the right side, there are buttons for 'Upload', 'New', and a refresh icon. The 'New' button is clicked, and a dropdown menu is shown with the following options: 'Notebook:', 'Python 3', 'Other:', 'Text File', 'Folder', and 'Terminal'. The 'Python 3' option is circled in purple. A yellow box with a purple border contains the text 'Click "New" Click "Python 3"' with a line pointing to the 'Python 3' option in the dropdown menu.

Click "New"
Click "Python 3"

- Jupyter supports different interactive notebook types (e.g., R, Python 2.x etc.)
- Start a Python 3 notebook

The Jupyter Interface



- Pressing 'enter' starts a new line
- Pressing 'shift' + 'enter' executes all lines of code within a cell



NOTE: Typical Program Structure

- Customary to include main program inside function
- Very helpful for complex and/or production codes

```
def main( ):
    print("hello world")

if __name__ == "__main__":
    main( )
```

- Program is a function definition + function call
- Not necessary for our short exercises



Print Function: Call Syntax

```
print( item1, item2, item3, ..., sep = ' ', end= '\n')
```

- item1, item2, item3
 - Comma-separated list of variables whose values you wish to display
- sep:
 - optional keyword parameter
 - separation string inserted between displayed values (defaults to whitespace)
- end:
 - optional keyword parameter
 - string appended to end of printed values (defaults to newline)



Calling Print

- Start with this:

```
name = 'John'  
age = 30  
name2 = 'Mary'  
age2 = 31
```

- Then try these different print combinations:

```
print(name, 'is', age, 'years old.')
```

```
print(name2, 'is', age2, 'years old.')
```

```
print(name, 'is', age, 'years old.', end = ' ; ' )  
print(name2, 'is', age2, 'years old.')
```

```
print(name, age, sep= ' : ' )  
print(name2, age2, sep = ' : ' )
```



Variables in Python

- Variables are not declared (implicitly typed)
- Variables are created via an assignment statement
- Variable type determined implicitly via assignment
 - `x = 2` `int`
 - `y = 3.0` `float`
 - `Z = "hello"` `str` double or single quotes
 - `z = True` `Bool` note capital "T" , "F" in False
- **Beware:** Python is CASE SENSITIVE (z is not Z)
- Check variable type using `type` function:
 - `print('z is: ', type(z))`



Arithmetic in Python

- Arithmetic in Python respects order of operations
- Addition: `+`
- Subtraction: `-`
- Multiplication: `*`
- Division: `/` (**beware:** returns float result)
- Floor Division : `//` (returns int or float; rounds down)
- Mod Division : `%` `3%2 → 1`
- Exponentiation: `**` `2**4 → 16`
- Can concatenate strings using `“+”`
 - `x = 'hello' + ' there'`
 - `print (x) → displays 'hello there'`



Type Conversion

- Variables can be recast using type conversion functions
- `x = int (43.4)` \rightarrow `x = 43`
- `y = float (x)` \rightarrow `y = 43.0`
- `z = str (x)` \rightarrow `z = "43"`
- `n = bool (0)` \rightarrow `n = False`
- `m = bool (x)` \rightarrow `m = True`



Simple User Input

- The `input` function can be used to grab simple input from the user:

```
num_str = input( "Enter a number: " )  
cat_name = input ( "What is your cat's name?" )
```

- Accepts one string argument that contains the prompt seen by the user.
- Note that it ALWAYS returns a string.
- Recast as int or float to do math...



Exercise

Write a short program that asks the user their age.

Have the program print a message indicating how old the user will be in 10 years.



Variables and Memory

- Memory in python is a bit non-intuitive (to me at least)
- Characters and integers exist in one place in memory
- Can explore this using the “is” operator
 - True if variables point to *same memory location*
 - False otherwise
 - DOES NOT compare VALUES
- Try these:

```
a = 1  
b = 1  
print (a is b)
```

```
a = 1.0  
b = 1.0  
print (a is b)
```

```
a = 'T'  
b = 'T'  
print (a is b)
```



Variables and Memory

- Intrinsic variables, like 'int' don't occupy a set amount of RAM
- e.g., all 'ints' are not 4 bytes...
- Can explore this using the `getsizeof` function
 - part of the `sys` module
 - returns size of an object in bytes
- Try these:

```
import sys  
print( sys.getsizeof ( 2**30))
```

```
import sys  
print( sys.getsizeof ( 2**60))
```

- Standard X-byte datatypes available via NumPy package (week 5)



Lists in Python

- Multiple values can be grouped into a list
 - `mylist = [1, 2, 10]`
- List elements accessed with `[]` notation
- Element numbering starts at 0
- `print (mylist [1])` → displays 2
- Lists can contain different variable types
 - `mylist = [1, 'two' , 10.0]`
- Strings can be accessed element-wise like a list
 - `mystring = 'John'`
 - `print (mystring[1])` → displays 'o'
- More on lists in two weeks...



Simple File I/O (writing)

```
# generate some data
```

```
line1 = "This is the first line"
```

```
line2 = "This is the second line"
```

```
# write data to a file
```

```
filename = 'myfile.txt'
```

```
filemode = 'w'    use 'w' when writing; 'r' when reading
```

```
file = open ( filename, filemode)
```

```
file.write(line1)
```

```
file.write(line2)
```

```
file.close( )
```



Simple File I/O (reading)

```
# read data from a file (use readline)
filename = 'myfile.txt'
filemode = 'r'   use 'w' when writing; 'r' when reading
file = open ( filename , filemode)
file.readline(line1)
file.readline(line2)
file.close( )
print( line1)
print( line2)
```

NOTE: `file.read()` will read entire file into single string

