http://www.cs.cornell.edu/courses/cs1110/2022sp

Lecture 3:
Functions & Modules
(Sections 3.1-3.3)

CS 1110
Introduction to Computing Using Python

Cornell Bowers C·IS
Computer Science

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Lecture 3:
Functions & Modules
(Sections 3.1-3.3)

Have these ready for today's lecture:
- Materials for note taking (e.g., lecture slides on paper or pdf)
- Terminal or Powershell, ready to start Python
- Atom Editor

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Lecture Afterthoughts

There were many questions about the math module function **`ceil()`**. Since it's not a commonly known function, we've replaced it with **`sqrt()`**, which takes the square root of a number (Recall: $\sqrt{9} = 3$ because 3^2 (or 3x3) = 9).

We hope this is a better example function!

This is not a math class! We just needed an example to work with. ☺

Announcements

Can’t see the zoom polls?

- Using zoom in web browser? It doesn't show polls
- It’s okay! Please still work out the answer.
- We aren't counting participation, so no credit is lost!

Lab Deadlines

- Lab 1: Feb 2
- Lab 2: Feb 3
- Lab 3: Feb 4
- Lab 4: Feb 7

extensions

New labs this week!

Common Python Gotcha

```
> 1+1
> Command not found: 1+1
>
```

What in the world?!?

Take a step back.

Where am I?

If you don't see **>>>**

you are not in python interactive mode!

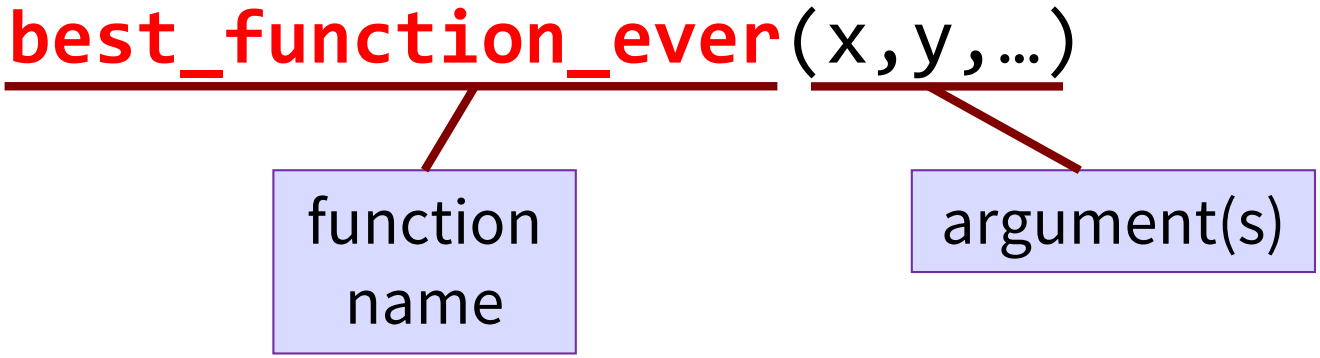
```
> python
>>> 1 + 1
2
>>>
```

Ahh, much better.

All is right in the world.

Function Calls

- Function expressions have the form:



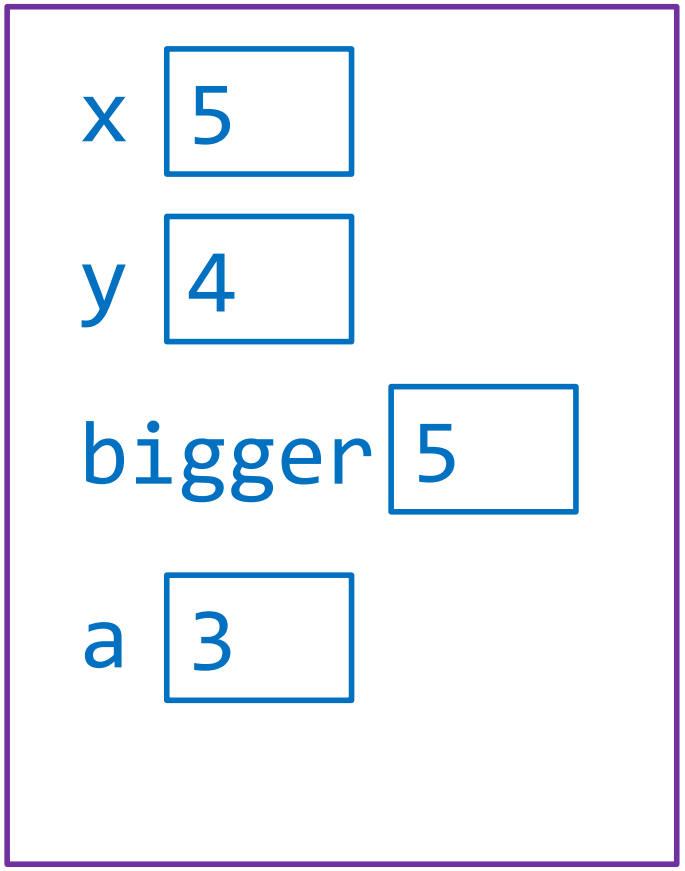
- Arguments
  - Separated by commas
  - Can be any expression

A function might have 0, 1, … or many arguments

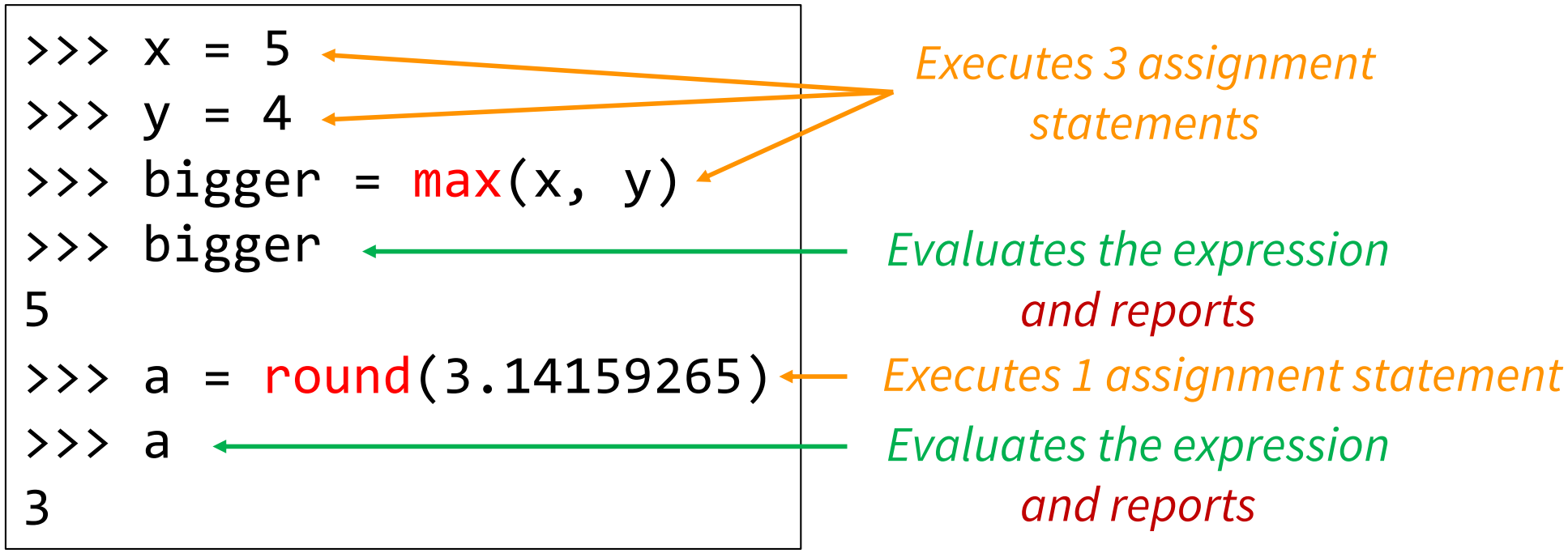
Two math functions built into Python

```
>>> x = 5
>>> y = 4
>>> bigger = max(x, y)
>>> bigger
5
>>> a = round(3.14159265)
>>> a
3
```

Visualize the execution!



Play-by-Play of Python interactive mode



Python interactive mode reports the value to be helpful

Always-available Built-in Functions

- You have seen many functions already
  - Type casting functions: `int()`, `float()`, `bool()`
  - Get type of a value: `type()`
  - Exit function: `exit()`

Empty parens are a human space-saving convention to indicate something is a function.

- Longer list:

http://docs.python.org/3/library/functions.html

Visualizing functions & variables **(1)**

Running Example:

1. Built-in functions

- Available as soon as you start python
- We don't usually draw them, but they are technically there

```
C:\> python
>>>
```

What Python can access directly

```
int()
float()
str()
type()
print()
…
```

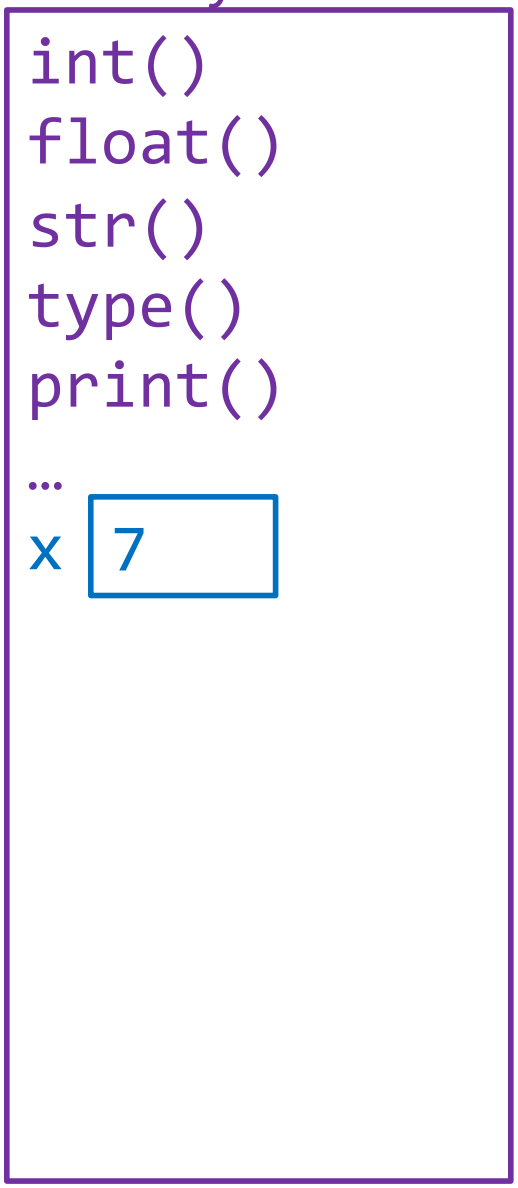
Visualizing functions & variables **(2)**

Running Example:

1. Built-in functions
2. Define a new variable

```
C:\> python
>>> x = 7
>>>
```

What Python can access directly



Modules: libraries and scripts

- Many more functions available via built-in ***modules***
  - "Libraries" of functions and variables
- To access a module in Python, use **`import`** command:

  `import` *<module name>*

  Can then access functions like this:

  <module name>.*<function name>*(*<arguments>*)

  Example:

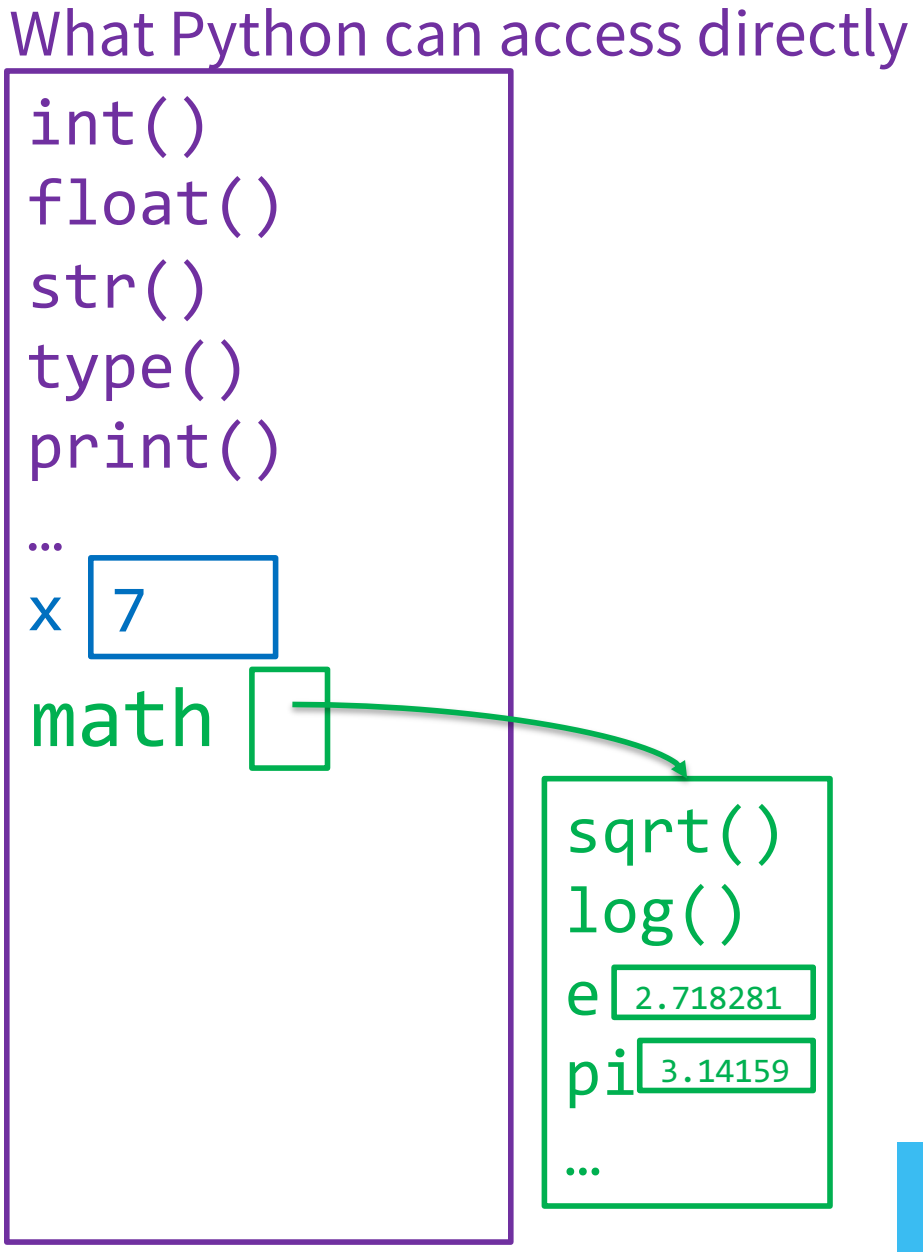
```
>>> import math
>>> p = math.sqrt(9.0)
>>> p
3.0
```

Visualizing functions & variables **(3)**

Running Example:

1. Built-in functions
2. Define a new variable
3. **Import a module**

```
C:\> python
>>> x = 7
>>> import math
>>>
```



Module Variables

- Modules can have variables, too
- Can access them like this:

  <module name>.*<variable name>*

- **Example**:

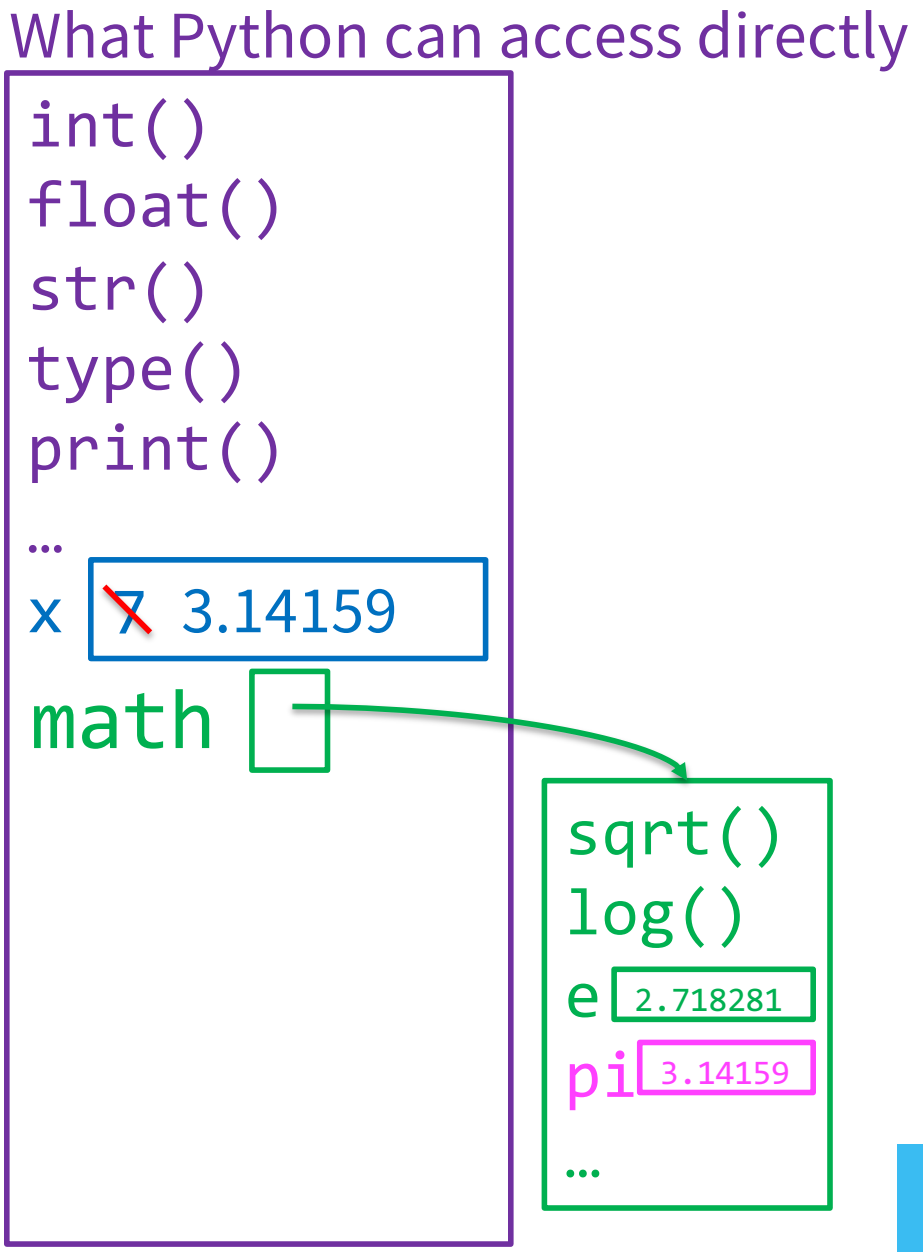
```
>>> import math
>>> math.pi
3.141592653589793
```

Visualizing functions & variables **(4)**

Running Example:

1. Built-in functions
2. Define a new variable
3. Import a module
4. Use a module variable

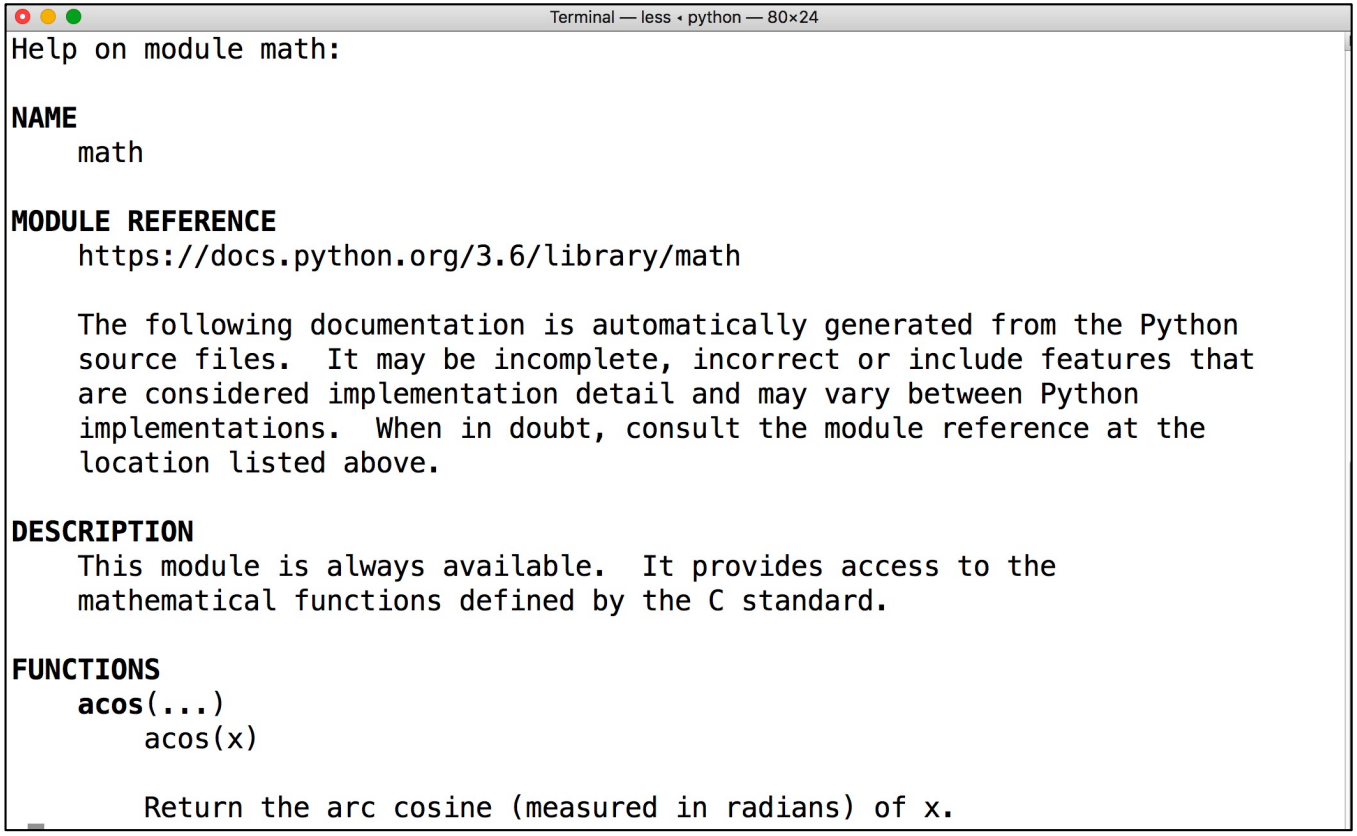
```
C:\> python
>>> x = 7
>>> import math
>>> x = math.pi
```



module help

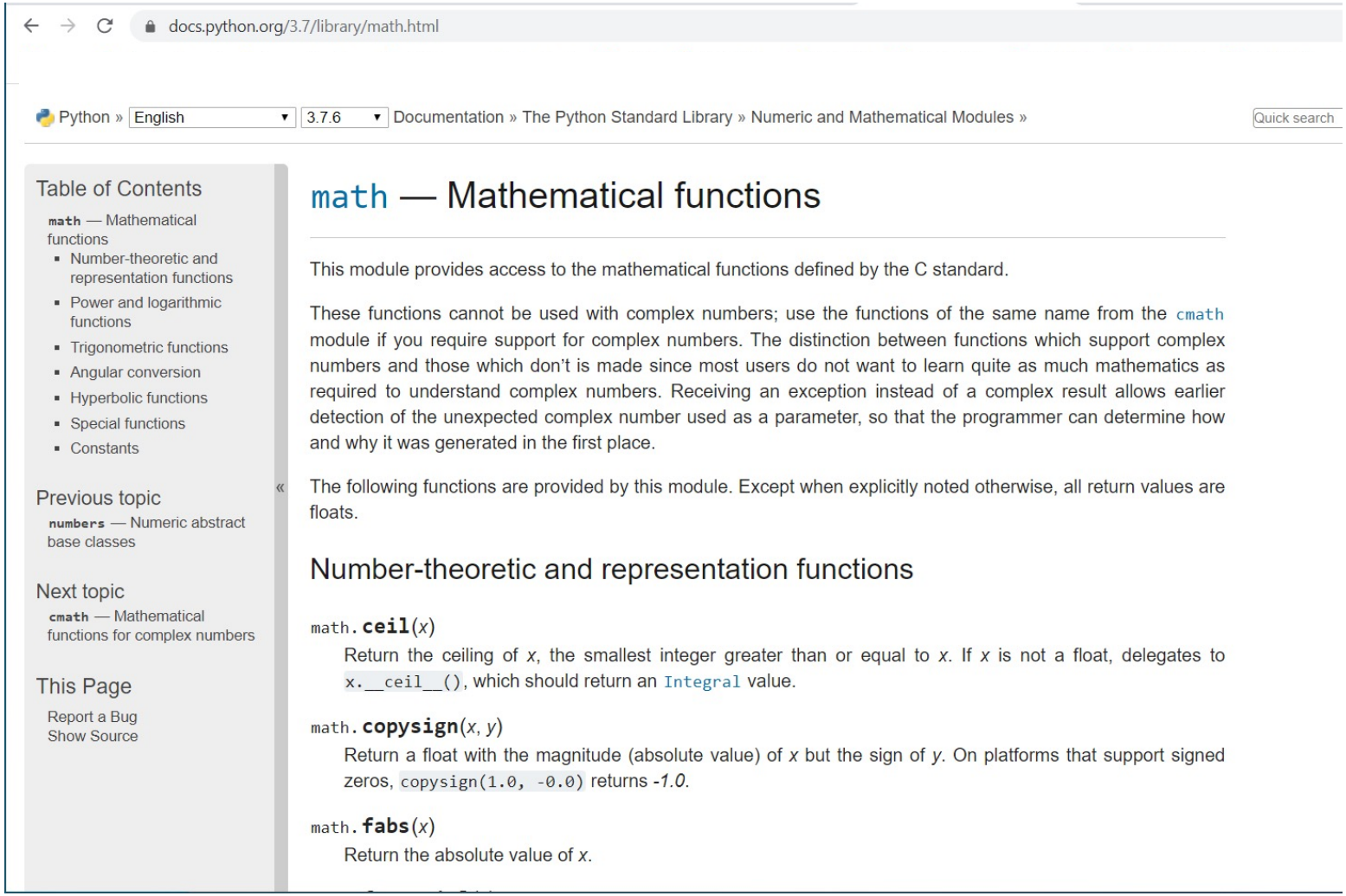
After importing a module, see what functions and variables are available:

```
>>>  help(<module name>)
```



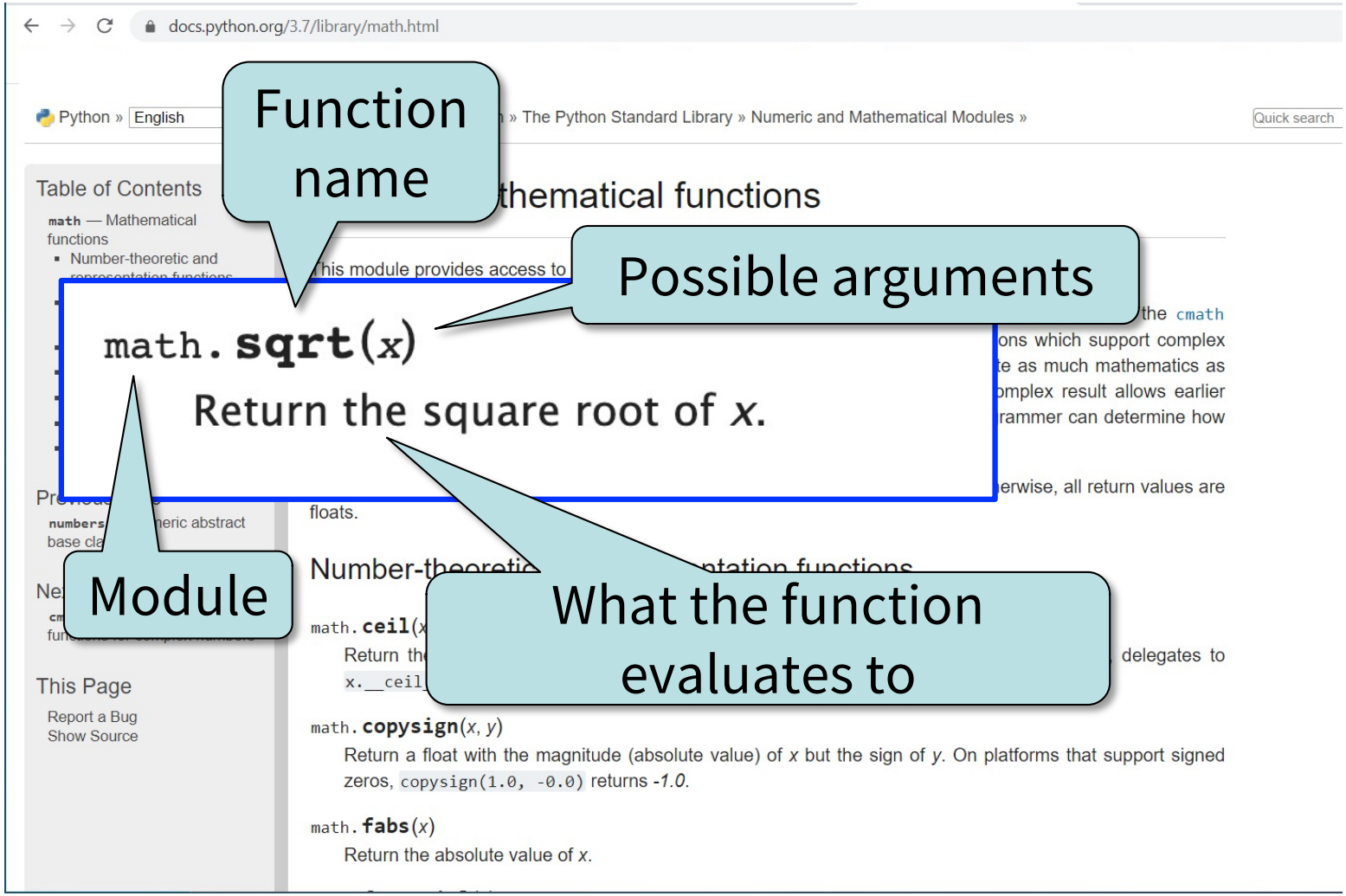
Reading the Python Documentation

https://docs.python.org/3/library/math.html



A Closer Reading of the Documentation

https://docs.python.org/3.7/library/math.html



Other Useful Modules

- `io`
  - Read/write from files
- `random`
  - Generate random numbers
  - Can pick any distribution
- `string`
  - Useful string functions
- `sys`
  - Information about your OS

We'll use these many of these this semester.

Make your Own Module!

Why?

Python Interactive Mode:

- Good for scratch work!
  - quickly testing something
- **Not** typically how we'll write programs.

We'll want to write our code in a text file using a text editor.

my_module.py

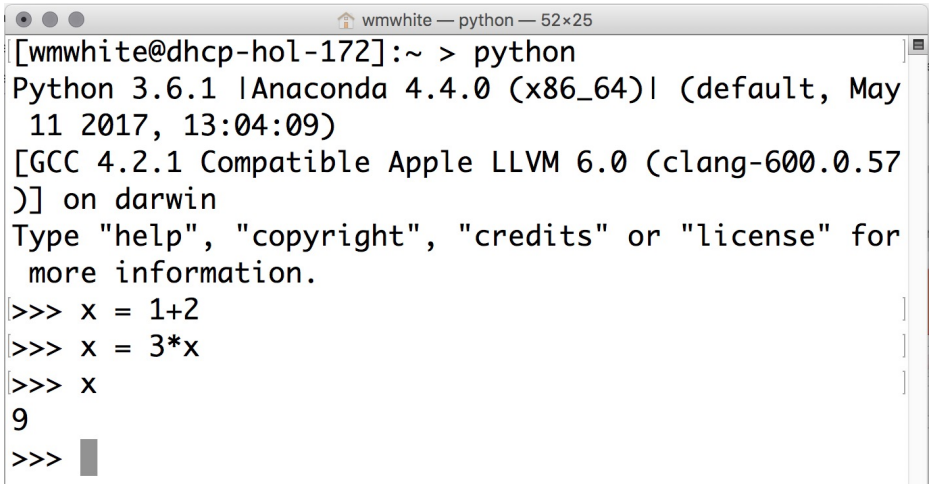
```
1  # my_module.py
2
3  """ This is a simple module.
4  It shows how modules work """
5
6  x = 1+2
7  x = 3*x
8
9
10
```

We recommend Atom…

…but any editor will work

Typing in Interactive Mode vs. Writing a Module

Python Interactive Mode



- Type python at command line
- Type commands after **>>>**
  - type line-by-line, again and again
- Python executes as you type

Module

my_module.py

```
1 # my_module.py
2
3 """ This is a simple module.
4 It shows how modules work """
5
6 x = 1+2
7 x = 3*x
```

- Written in text editor
  - write once, go back and edit
  - run repeatedly
- Can load with **`import`**
- Python executes statements when **`import`** is called

Section 2.4 in your textbook discusses a few differences

my_module.py

Module Text File

```
# my_module.py

"""This is a simple module.
It shows how modules work"""

x = 1+2
x = 3*x
```

Single line comment
starts with #
(not executed)

Docstring
(note the Triple Quotes)
A multi-line comment.
Useful for *code documentation.*

Commands
Executed on import

What does the docstring do?

Module Text File

```
# my_module.py

"""This is a simple modul
It shows how modules work

x = 1+2
x = 3*x
```

```
>>> import my_module
>>> help(my_module)
```

```
Help on module my_module:

NAME
    my_module

DESCRIPTION
    This is a simple module.
    It shows how modules work

DATA
    x = 9
```

Ways of Executing Python Code

1. running the Python Interactive Shell
2. NEW: importing a module

Importing a module from inside Python (1)

Module Text File

my_module.py

```
# my_module.py

"""This is a simple module.
It shows how modules work"""

x = 1+2
x = 3*x
```

Python Interactive Mode

```
C:\> python
>>> import my_module
```

Needs to be the same name as the file ***without the ".py"***

Importing a module from inside Python (2)

Module Text File

my_module.py

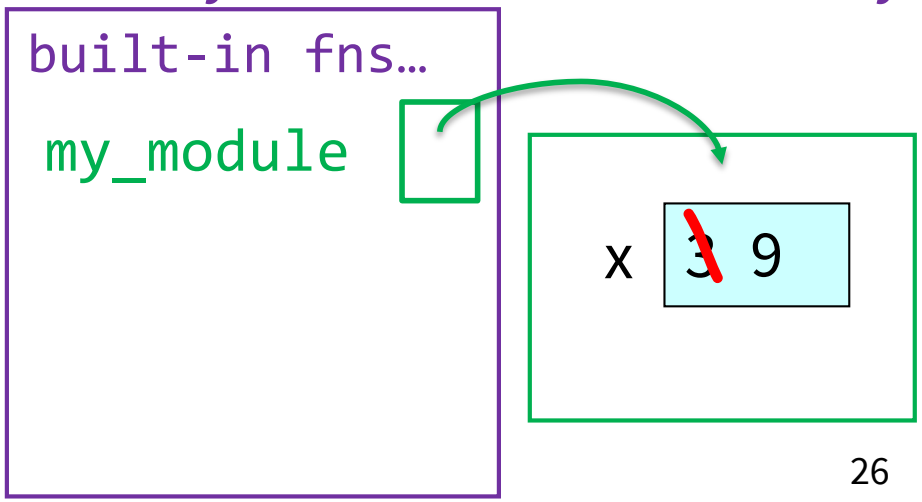
```
# my_module.py

"""This is a simple module.
It shows how modules work"""

x = 1+2
x = 3*x
```

variable x stays "within" the module

Python Interactive Mode

```
C:\> python
>>> import my_module
>>> my_module.x
9
```

What Python can access directly



Clicker Question!

Module Text File

```
# fah2cel.py


"""Convert 32 degrees
Fahrenheit to degrees
Celsius"""


f= 32.0
c= (f-32)*5/9
```

Python Interactive Mode

```
C:\> python
>>> import fah2cel
```

After you hit "Return" here what will python print next?

(A) >>>

(B) 0.0
>>>

(C) an error message

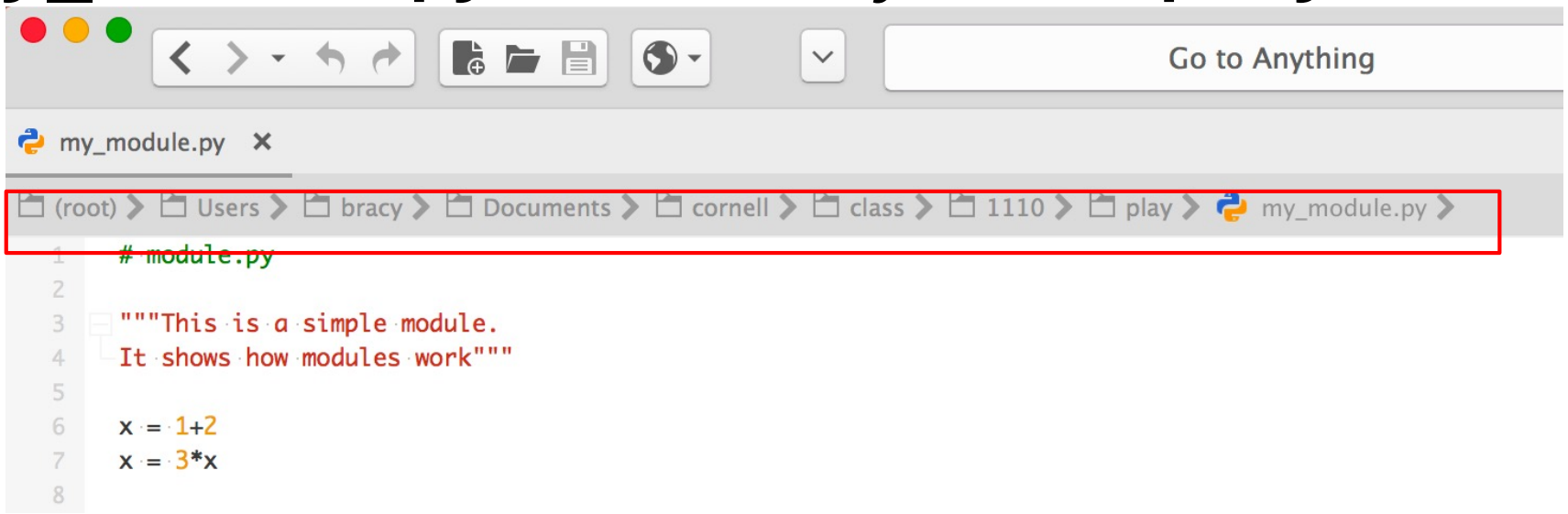
(D) The text of fah2cel.py

(E) Sorry, no clue.

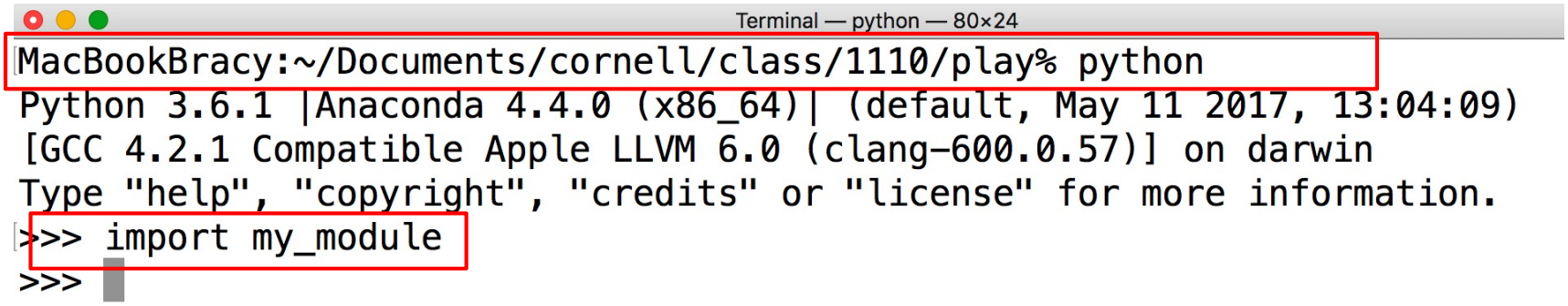
Rule #1: Modules must be in Working Directory*

*the directory where you typed “python”

If **my_module.py** in directory/folder **play**:



Then you must run **python** from the folder **play**:



Rule #2: You must **`import`**

Windows command line
(Mac looks different)

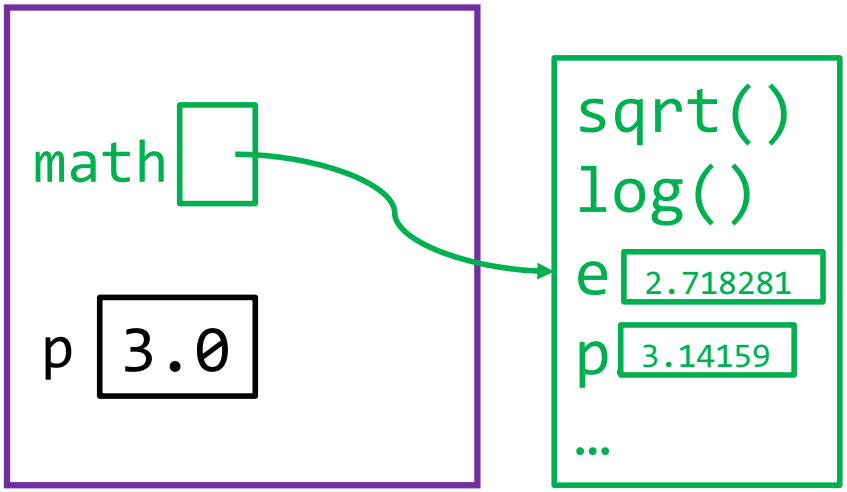
With `import`

```
C:\> python
>>> import math
>>> p = math.sqrt(9.0)
>>> p
3.0
```

Without `import`

```
C:\> python
>>> math.sqrt(9.0)
Traceback (most recent call
last):
  File "<stdin>", line 1,
in <module>
NameError: name 'math' is
not defined
```

What Python can access directly

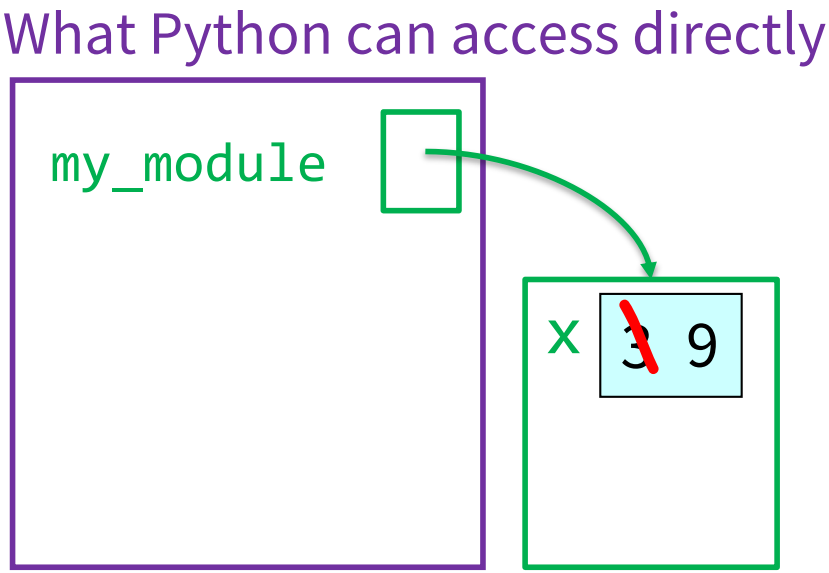


What Python can access directly

Python unaware of what "math" is

Rule #3: You Must Use the Module Name

```
C:\> python
>>> import my_module
>>> my_module.x
9
>>> x
Traceback (most recent call
last):
  File "<stdin>", line 1, in
<module>
NameError: name 'x' is not
defined
```



Python unaware of what "x" is (it cannot access it directly)

`from` command (1)

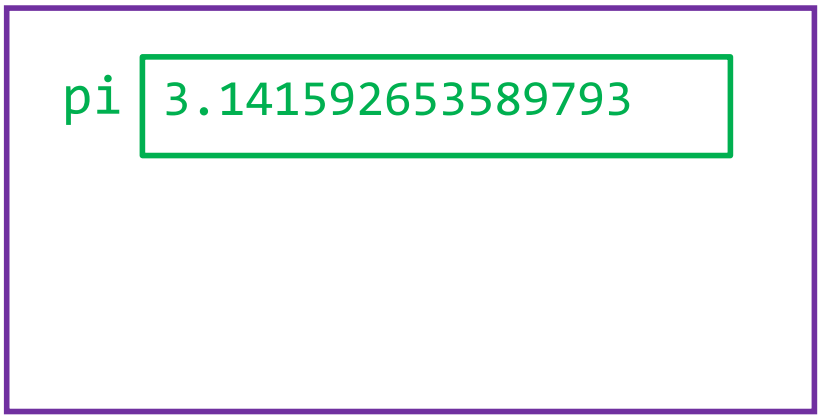
You can also import like this:

`from` <module> `import` <function name>

Example:

```
C:\> python
>>> from math import pi
>>> pi
3.141592653589793
```

What Python can access directly



No longer need the module name!

`from` command (2)

You can also import *everything* from a module:

```
from <module> import *
```

Example:

```
C:\> python
>>> from math import *
>>> pi
3.141592653589793
>>> sqrt(pi)
1.7724538509055159
```

What Python can access directly

```
sqrt()
log()
e   2.718281828459045
pi  3.141592653589793
…
```

Module functions now behave like built-in functions

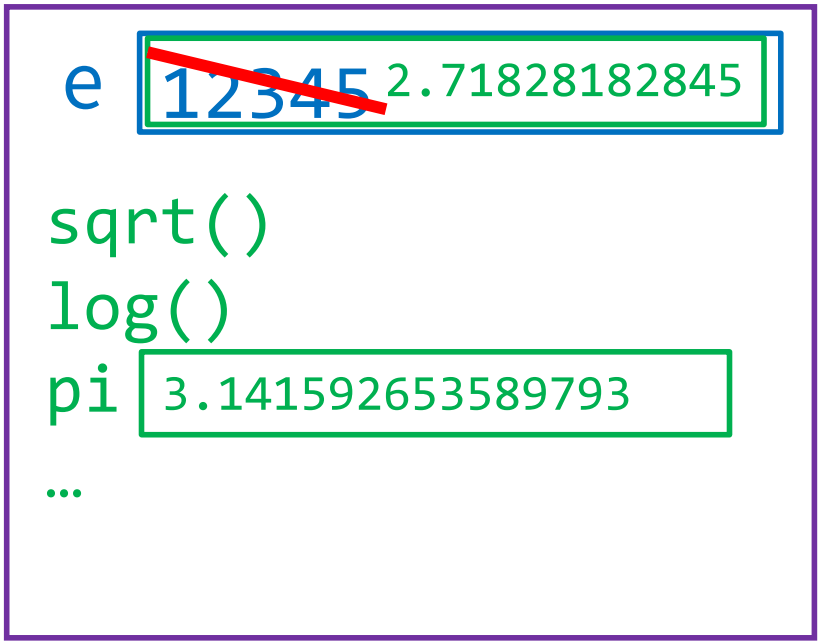
Dangers of Importing Everything

Example:

```
C:\> python
>>> e = 12345
>>> from math import *
>>> e
2.71828182845
```

e was overwritten!

What Python can access directly

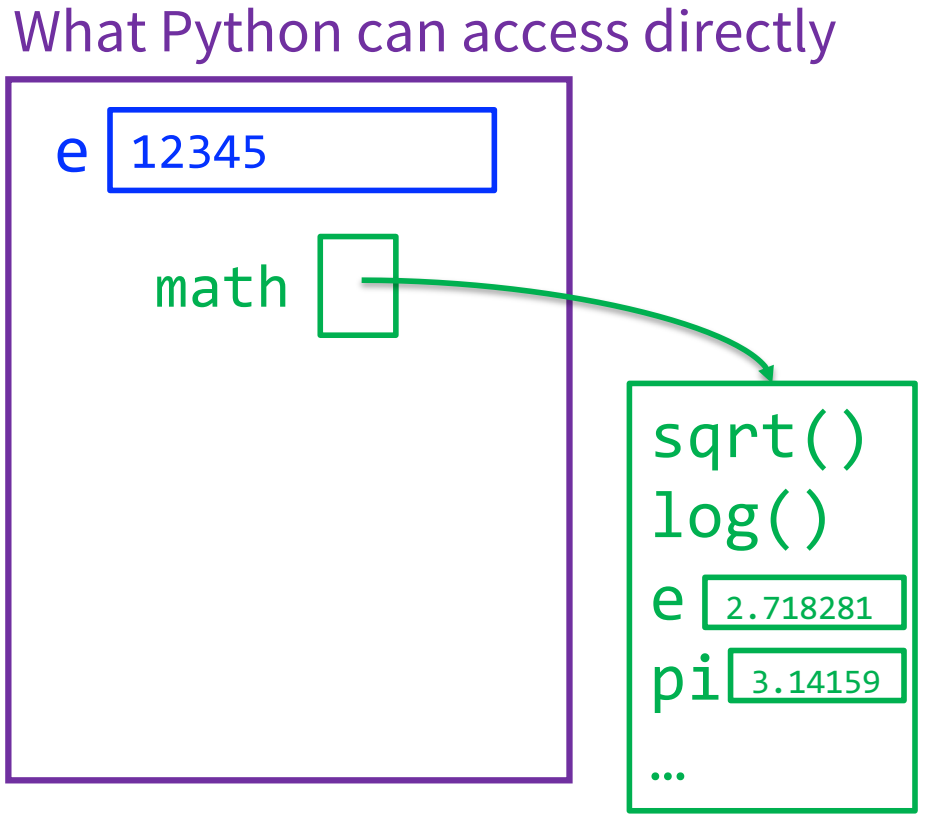


Do you know every mathematical constant?
Might not want to import them all.

Avoiding `from` keeps variables separate

Example:

```
C:\> python
>>> e = 12345
>>> import math
>>> math.e
2.718281828459045
>>> e
12345
```



Ways of Executing Python Code

1. running the Python Interactive Shell
2. importing a module
3. NEW: running a script (a different kind of module)

This is as far as we got in the Lecture on 2/1/22.

The following slides will be useful for and covered in this week's lab.

Running a Script

- From the command line, type:

  `python <script filename>`

- Example:

  C:\> python my_module.py

From the command line, use **full** filename, *with* ".py"

Common Command shell Gotcha

```
>>> python last_task.py
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'python' is not defined
>>>
```

Rule #1 of running a script from the command line is making sure you are in the command line!

If you see **>>>** *you are in* ***python interactive mode****, But you wanted to be* ***outside*** *of Python!*

```
>>> exit()
C:\> python last_task.py
[..some output…]
```

Running a Script

- From the command line, type:

  `python <script filename>`

- Example:

  C:\> python my_module.py

  C:\>

  looks like nothing happened!

- Actually, something did happen
  - Python executed all of my_module.py

From the command line, use **full** filename, *with* ".py"

Clicker Question

Module Text File

```
# my_module.py

"""This is a simple module.
It shows how modules work"""

x = 1+2
x = 3*x
```

Command Line

```
C:\> python my_module.py
C:\> my_module.x
```

After you hit "Return" here what will be printed next?

(A) >>>

(B) 9
>>>

(C) an error message

(D) The text of my_module.py

(E) Sorry, no clue.

Running my_module.py as a script

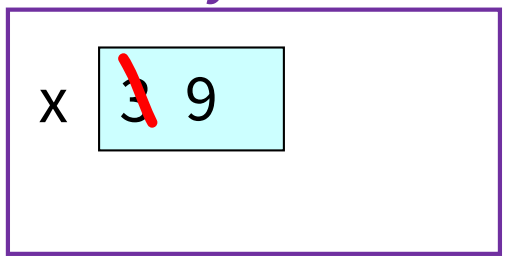
Module Text File

```
# my_module.py

"""This is a simple module.
It shows how modules work"""

x = 1+2
x = 3*x
```

Command Line

```
C:\> python my_module.py
C:\>
```

What Python can access directly



When the script ends:

- All memory used by `my_module.py` is deleted
  - Includes all variables
- There is no evidence that the script ran!

Creating Evidence that the Script Ran

- New (very useful!) command: `print`

  `print (``<expression>`**`)`**

- **`print`** evaluates the `<expression>` and writes the value to the console

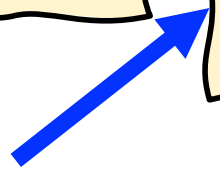
my_module.py vs. script.py

my_module.py

```
# my_module.py

"""This is a simple module.
It shows how modules work"""

x = 1+2
x = 3*x
```

script.py

```
# script.py

"""A simple script.
Shows why we use print"""

x = 1+2
x = 3*x
print(x)
```



Only difference!

Running script.py as a script

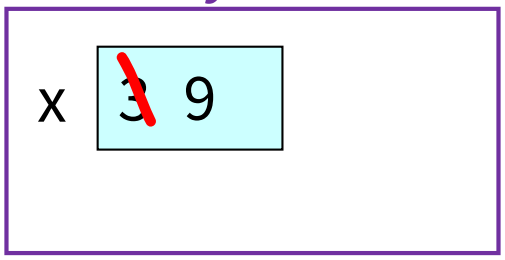
script.py

```
# script.py
"""A simple script.
Shows why we use print"""


x = 1+2
x = 3*x
print(x)
```

Command Line

```
C:\> python script.py
9
C:\>
```

What Python can access directly



When the script ends:

- All memory used by `script.py` is deleted
  - Includes all variables
- But the print statement leaves evidence that it ran

Interactive mode **evaluates & reports**
Script mode only **evaluates**

Python Interactive Mode

```
C:\> python
>>> x = 1+2
>>> x = 3*x
>>> x
9
>>>
```

Executes 2 assignment statements

Evaluates the expression and reports

script2.py

```
# script2.py


"""A simple script.
Shows why we use print"""


x = 1+2
x = 3*x
x
```

Executes 2 assignment statements

Evaluates the expression

Command Line

```
C:\> python script2.py
C:\>
```

No output!

Modules: Libraries vs. Scripts

Library

- Provides functions, variables
- **`import`** it into Python shell, don't include ".py"
- Within Python shell you have access to the functions and variables of the imported module

Script

- Behaves like an application
- At command line prompt, Tell python to run the file (use full filename, including ".py")
- After running the app you're back at the command line

Files look the same.
Difference is how you use them.