

Python Workshop Series Session 2: *Functions & Logic*

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Slides: https://github.com/ResearchComputing/Python_Fall_2018



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Be Boulder.

Official Python 3 Documentation: <https://docs.python.org/3/>

Please sign in: tinyurl.com/curc-name (use the python tab)

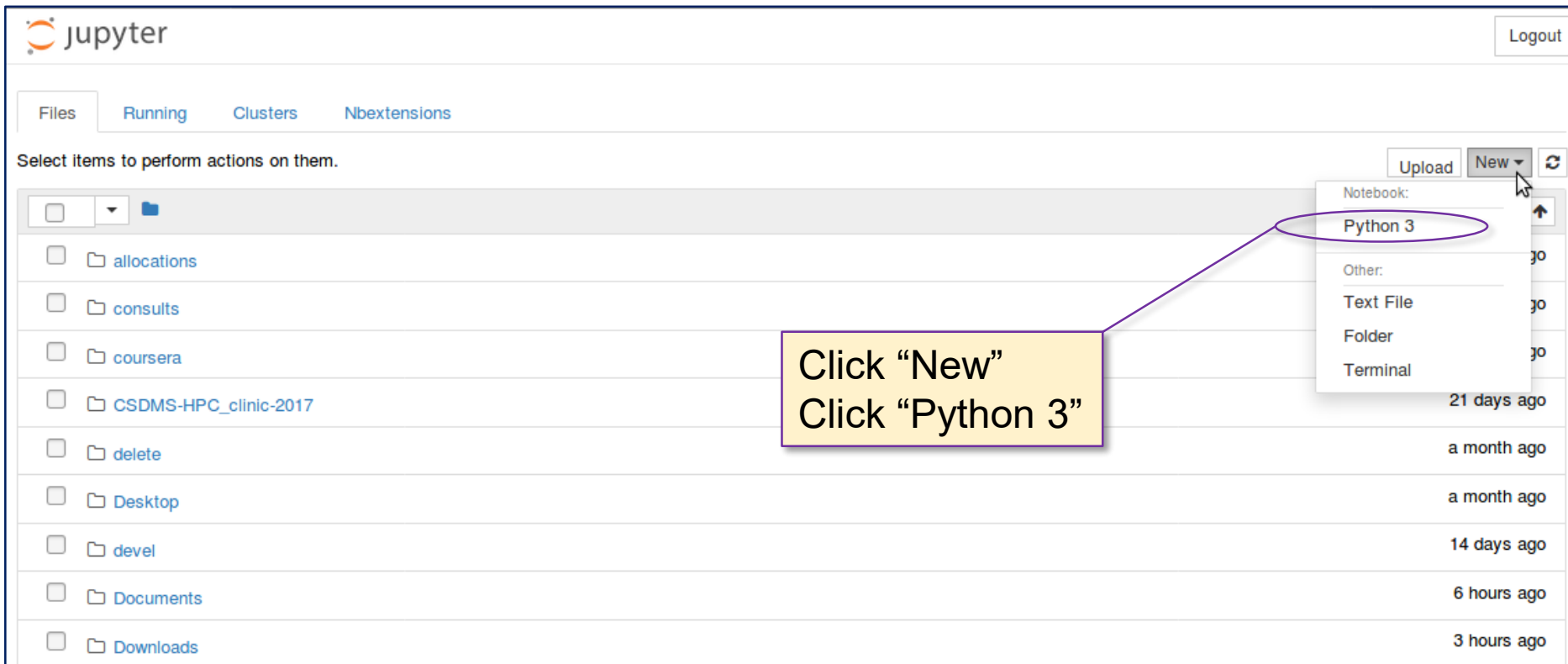


Jupyter Notebook

- Today's workshop has various code samples
- I suggest cutting and pasting them into the Jupyter notebook
- Recall that to open 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
- Note: to close the notebook, close your browser and then type `ctrl+c`



The Jupyter Interface



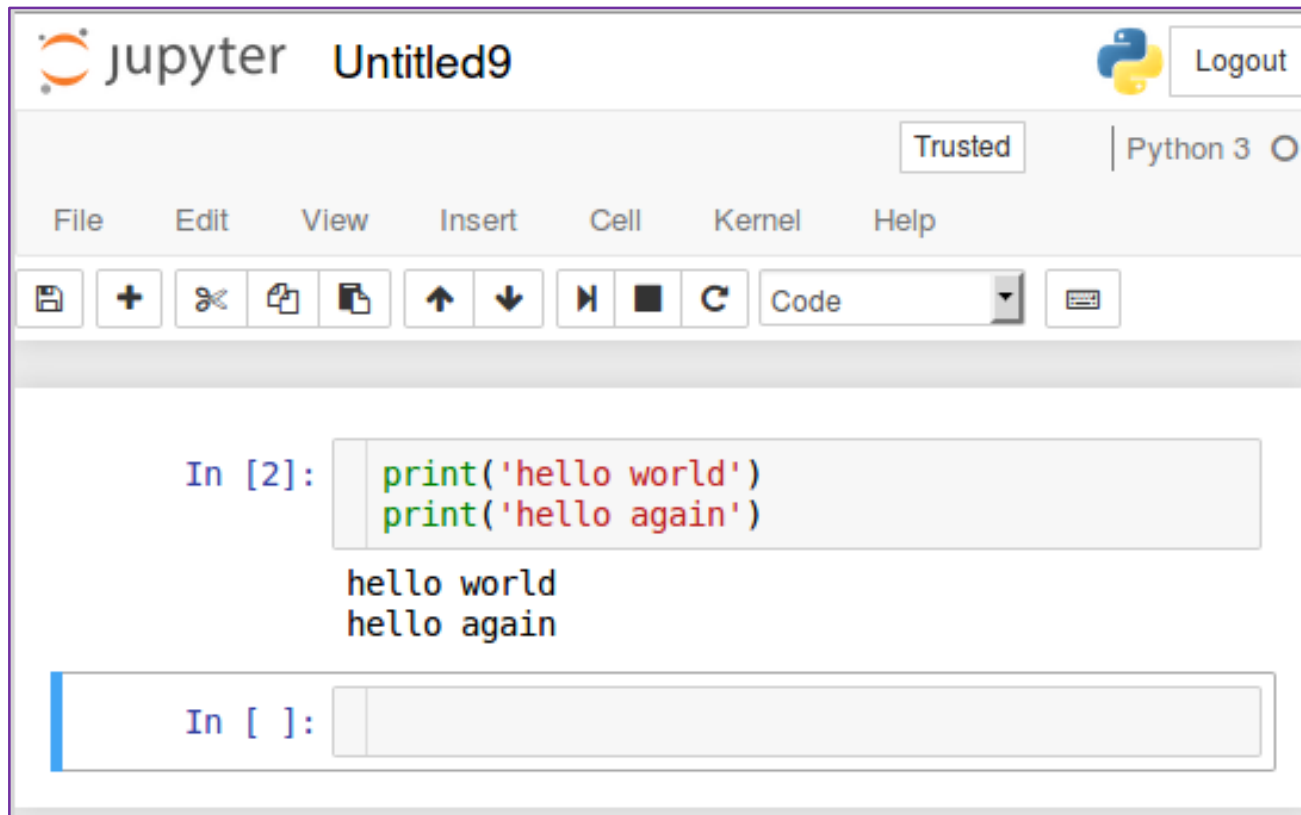
The screenshot shows the Jupyter web interface. At the top left is the Jupyter logo. To the right is a 'Logout' button. Below the logo are tabs for 'Files', 'Running', 'Clusters', and 'Nbextensions'. A message says 'Select items to perform actions on them.' Below this is a list of folders: 'allocations', '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



Outline

- Functions
- Conditionals
- Recursion
- Exception Handling



Defining a Function

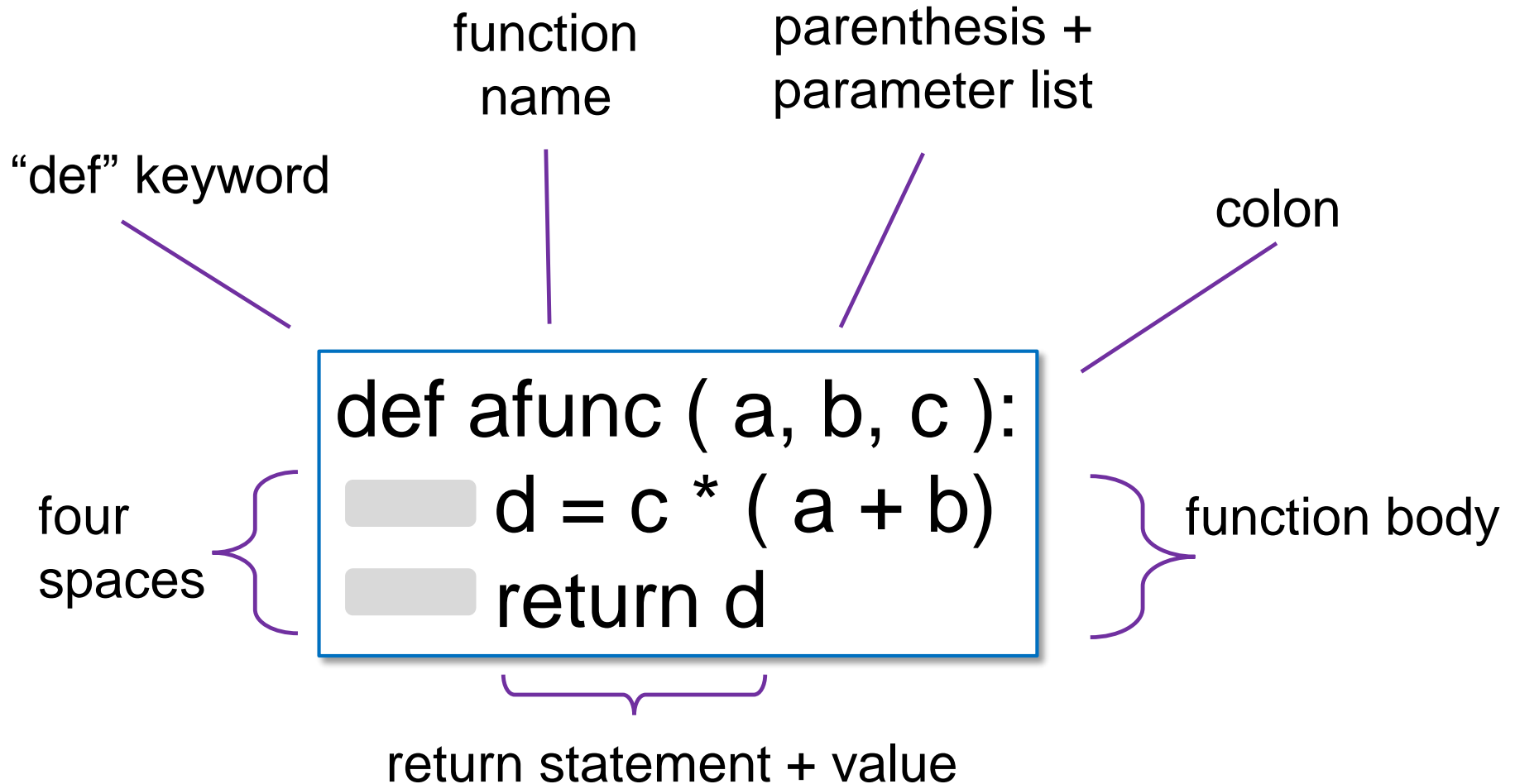
- Functions must be defined before they are called
- Definition example:

```
def afunc ( a , b , c = 1):  
    d = c * ( a + b)  
    return d
```

- Several things to note...



Defining a Function



Calling Functions

```
def afunc ( a , b , c ):
```

```
    d = c * ( a + b)
```

```
    return d
```

```
myval = afunc( 1 , 2 , 4 )
```

- Functions may be called once defined
- Value of *d* assigned to *myval* via return statement



Exercise 1

- Write a function that :
 1. accepts two parameters
 2. returns the difference of those two parameters.
- Test it out with various parameter combinations

```
def afunc ( a , b , c ):  
    d = c * ( a + b )  
    return d  
  
myval = afunc( 1 , 2, 4 )
```

function definition / calling syntax



Exercise 2

- Write a function that accepts two parameters:
 - name : a string value
 - age : an 'int' value

```
def afunc ( a , b , c ):  
    d = c * ( a + b )  
    return d  
  
myval = afunc( 1 , 2 , 4 )
```

function definition / calling syntax

- It should return:
 - msg : a string with value "{name} is {age} years old."
- Hint: use the "str" type conversion function



Multiple Return Values

```
def afunc ( a , b , c = 1):
```

```
    d = c * ( a + b)
```

```
    e = c * ( a - b)
```

```
    return d , e
```

```
myval1, myval2 = afunc( 1 , 2 )
```

- Multiple scalar values may be returned.
- Separate values with commas
- $d \rightarrow \text{myval1}$ $e \rightarrow \text{myval2}$



The NoneType Class

```
def afunc ( a ):  
    print ( a )
```

```
afunc(2)  
g = afunc(2)  
print(g)
```

Open and run “nonetype.py”

- Functions need not return a value
- Even if no “return” statement, functions will return Nonetype
- Nonetype:
 - empty datatype
 - print() displays “None”



Optional Parameters

```
def afunc ( a, b, c = 1):  
    d = c * ( a + b )  
    return d
```

```
var  = afunc( 1, 2 )  
var2 = afunc( 1, 2 , c=2 )
```

- Optional parameters specified by indicating default value
- **c** does not have to be passed to *afunc*
- Defaults to value of 1



Optional Parameters

```
def afunc ( a , b = 1 , c = 1):  
    d = c * ( a + b)  
    return d
```

- Optional parameters can be specified implicitly by position (no “=” needed)

afunc(3,b=2) afunc(3,2,c=1) afunc(3,2,1)

afunc(3,2) afunc(3,b=2,c=1) *equivalent function calls*



Pass by Value or Reference?

- General rule of thumb
 - Scalar variables **behave** as though passed by value
 - Most everything else is passed by reference
- In reality, everything is passed by reference.
- Scoping rules dictate behavior of assignment etc.
- Open and run [pass_by_reference_or_value.py](#)



Scope

- Scope behaves more or less intuitively in Python.
- Variables defined within a function are invisible to the program unit that called the function.
- When a name is used in a function, it is resolved using the nearest enclosing scope...
- i.e., the block of code that defined the function – then on up the chain
- Open and run “scope.py”



Scoping Gotcha!

Try this...

```
def func():  
    print(a)
```

```
a = 1  
func( )
```

... and this...

```
def func():  
    a+=1
```

```
a = 1  
func( )
```

What gives?
Examine scope.py.
Think hard...
Talk to your neighbor...



Scoping Gotcha!

Python Documentation: If a *name binding operation* occurs anywhere within a code block, all uses of the name within the block are treated as references to the current block.

In other words, assignment always creates a new **local** variable.

```
def func():  
    a = a+1
```

equivalent



```
a = 1  
func( )
```

```
def func():  
    func_a = func_a+1
```

```
a = 1  
func( )
```

The problem: `func_a` is referenced before it has been assigned a value.



Global Variables

- Set variables you wish to be global in the top-level namespace (effectively the main-program area in our examples so far)
- If you want a function to modify a global variable, declare the variable as **global** inside the function
- The value from the top-level or *builtins* (technical) namespaces will be used.
- Unlike local variables, no other namespace (e.g. containing functions) will be searched.
- Examine **global_scope.py**

```
def func( ):
    global a
    a = a+1
a = 1
func( )
print(a)
```



Logical Operators

- Boolean expressions have value True or False
 - Note the capital 'T' and 'F'
 - true and false are not Boolean values in Python
- Boolean values can be combined to yield a Boolean expression via logical operators:
 - and
 - or
 - not
- Open and run logical_operators.py



Comparison operators

- Numeric values can be combined to yield a Boolean expression via comparison operators:
 - `==` “equals”
 - `!=` “not equal”
 - `>` “greater than”
 - `>=` “greater than or equal to”
 - `<` “less than”
 - `<=` “less than or equal to”
- Open and run `comparison_operators.py`
- The `==` and `!=` also work with string variables



Conditionals 1: if

- Syntax is similar to function definition syntax:

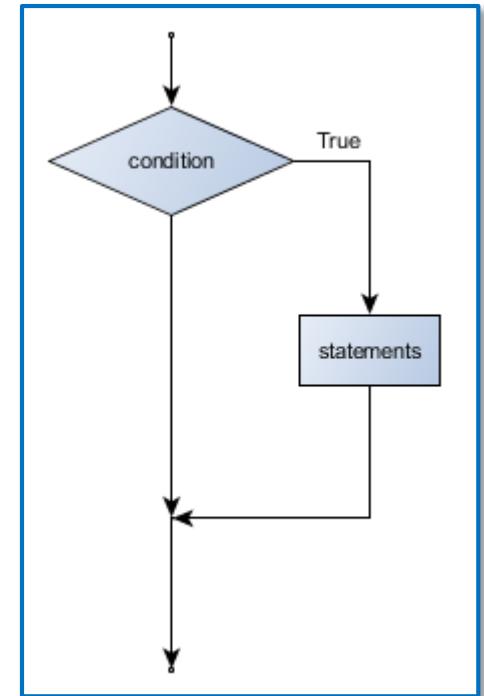
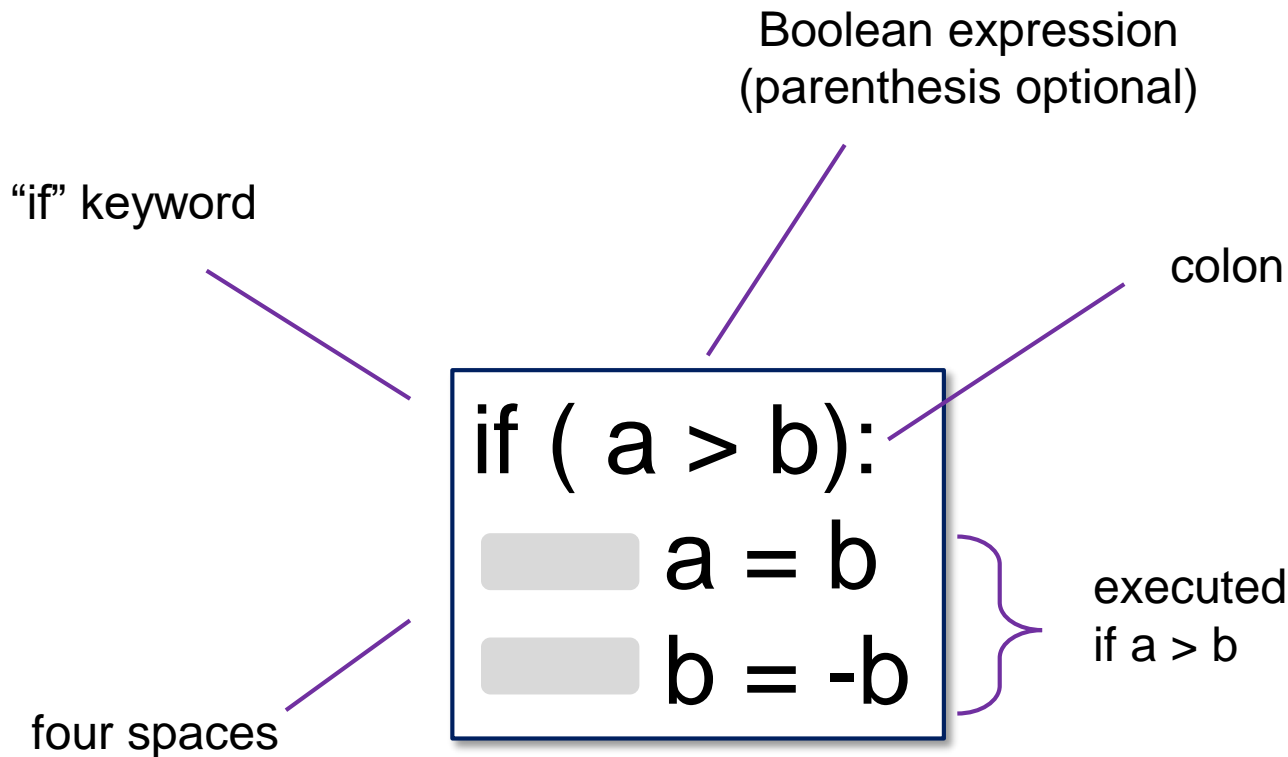


image credit: HTLCS



Exercise 3

- Write a function named *ispositive* that:
 - Accepts a single, numeric parameter
 - uses if (without else) to return:
 - True if the input parameter is positive.
 - False otherwise

```
def ispositive(a):  
     if ( expr ):  
          statement 1  
         statement 2
```



Conditionals 2: if / else

- Can add an “else” clause to our if statement

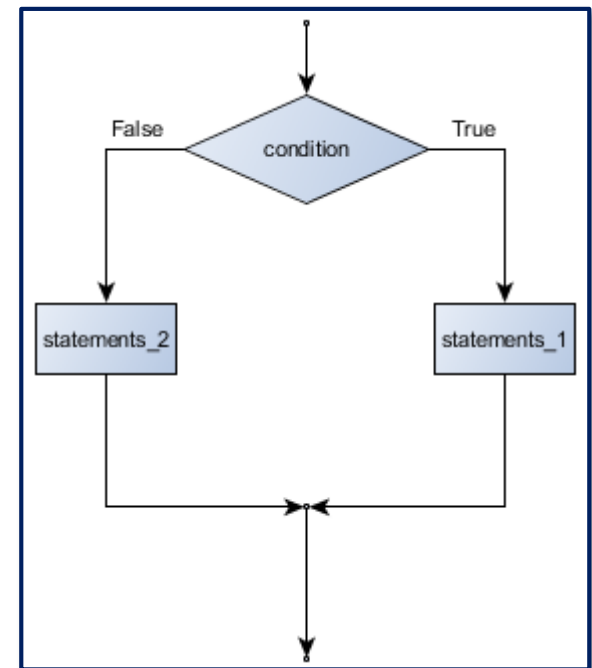
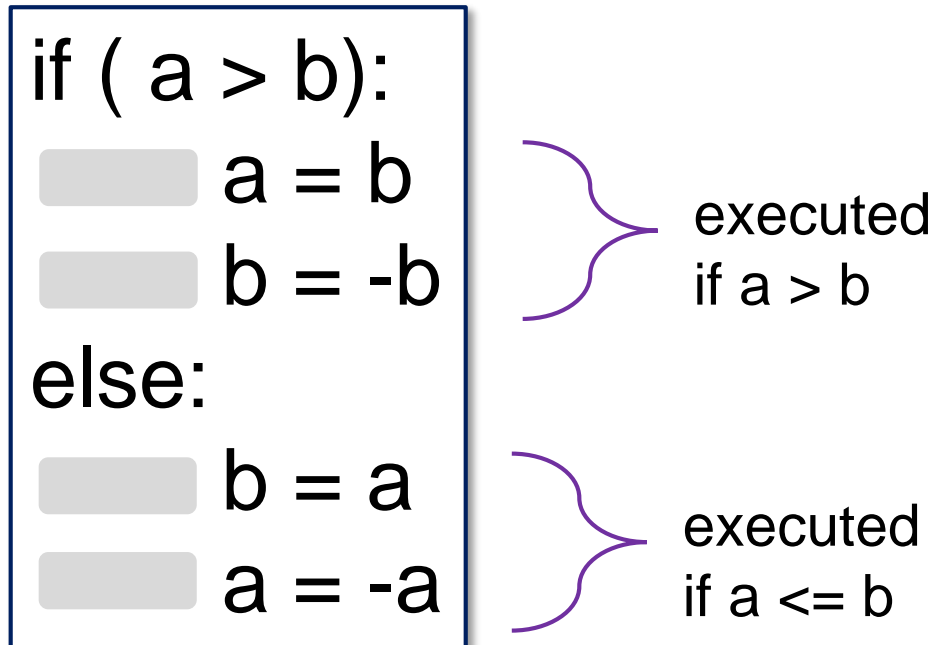


image credit: HTLCS



Conditionals 3: elif

- Can also add an else-if clause(s) via “elif”

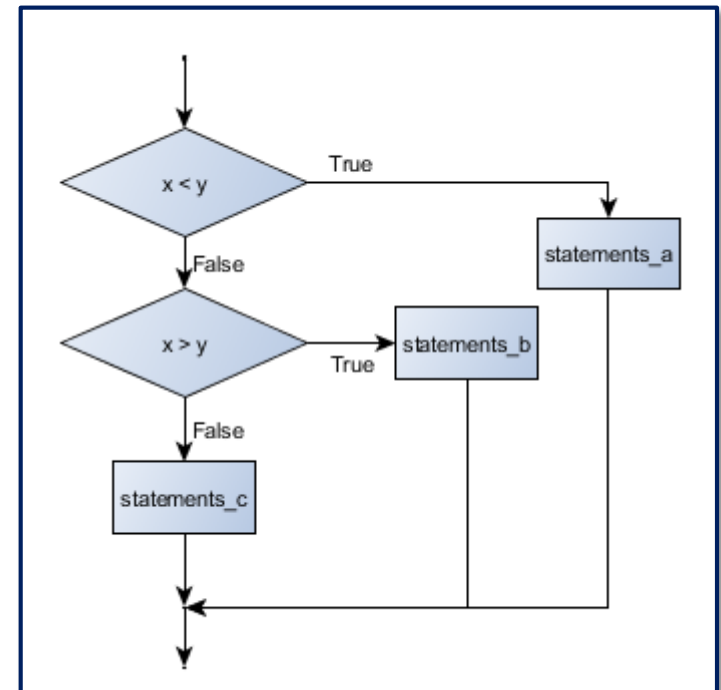
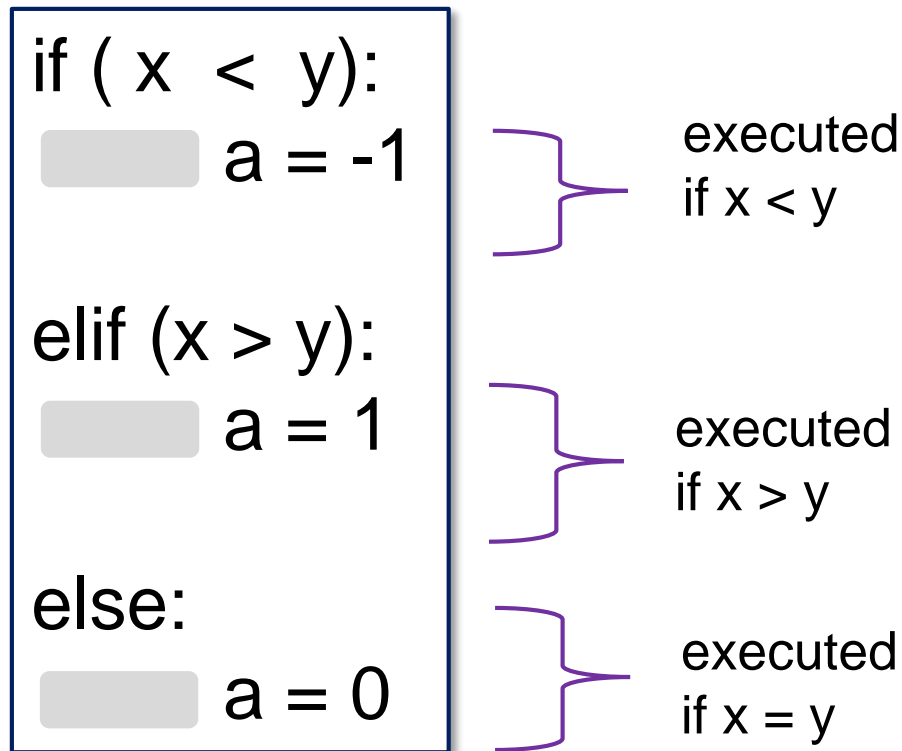


image credit: HTLCS



Exercise 4

- Using if / elif / else write a function that takes a number between 0 and 100 and returns the associated letter grade.
- e.g, grade(75) will return 'C'

```
def ispositive(a):  
    if ( expr ):  
        statement 1  
    statement 2
```

function definition syntax

```
if ( x < y):  
    a = -1  
elif (x > y):  
    a = 1  
else:  
    a = 0
```

elif syntax



Recursion in Python

- Python allows the user to define recursive functions.
- No extra keywords needed.
- The function is recursive by virtue of calling itself:

```
def afunc ( parameters):  
    if ( expr):  
        statement group 1  
        return something  
    else:  
        statement group 2  
        afunc(new parameters)
```



Recursion Example: Factorial

- Open factorial.py

```
def factorial(n):  
    if (n <= 1):  
        return 1  
    else:  
        return n*factorial(n-1)
```

- Quick exercise:
copy/modify to compute sum of numbers 1 through n
- Test these numbers:
 - 10
 - 100
 - 1000
 - 10000



Recursion Depth

- Python has a maximum recursion depth. Code will crash if reached.
- Can set via `sys.setrecursionlimit`
- Try it!
- Useful sometimes
- Generally inefficient; use loops

```
import sys
def factorial(n):
    if (n <= 1):
        return 1
    else:
        return n*factorial(n-1)

mstr = input("Enter a number: ")
m = int(mstr)
sys.setrecursionlimit(m+2)
print('m! is' , factorial(m) , '!')
```



Exception Handling

- Occasionally, you may get some wonky input.
- The program doesn't have crash: use try/except
- Open `exception_handling.py`

try:

 [] thing you want to do

except:

 [] thing to do if that fails
remainder of program



Next Time

- Lists, tuples, and dictionaries
- Iteration

