Python Workshop Series Session 2: *Functions & Logic*

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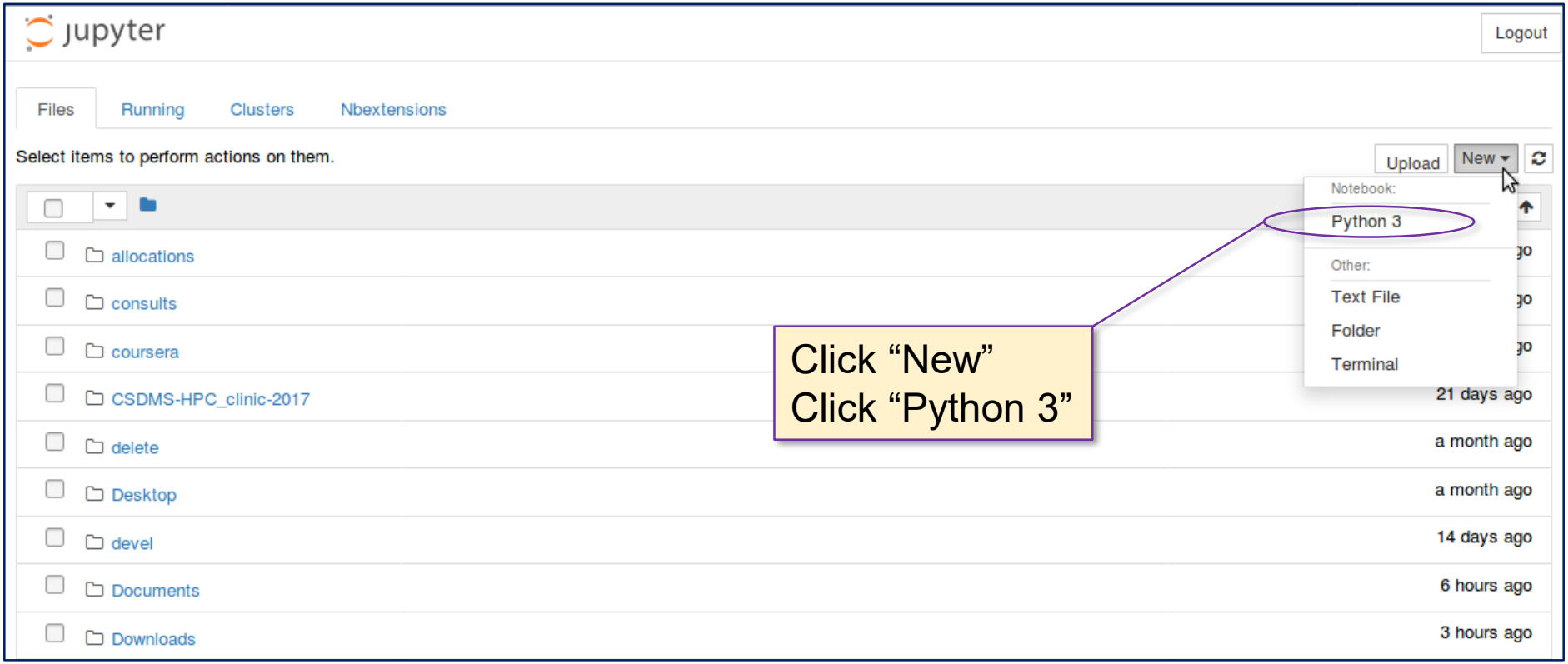
Slides: https://github.com/ResearchComputing/Python_Fall_2019

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

Jupyter Notebook

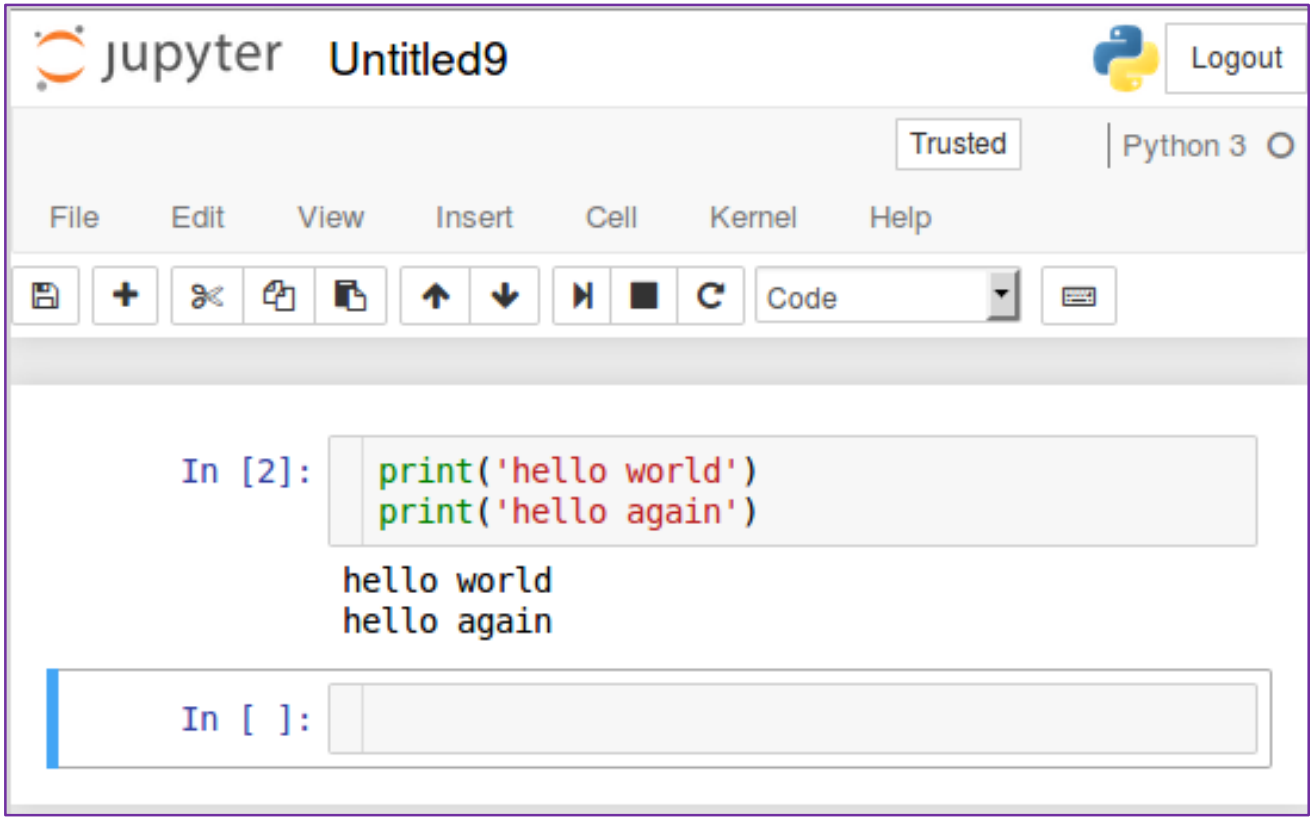
- Today's workshop has various code samples
- I suggest cutting and pasting them into the Jupyter notebook
- Recall that to open the notebook:
  - Access your shell ("anaconda prompt" in Windows)
  - Type: conda activate idp
  - Type: jupyter notebook ← note the "Y"
  - Follow along
- Note: to close the notebook, close your browser and then type ctrl+c

The Jupyter Interface



- 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

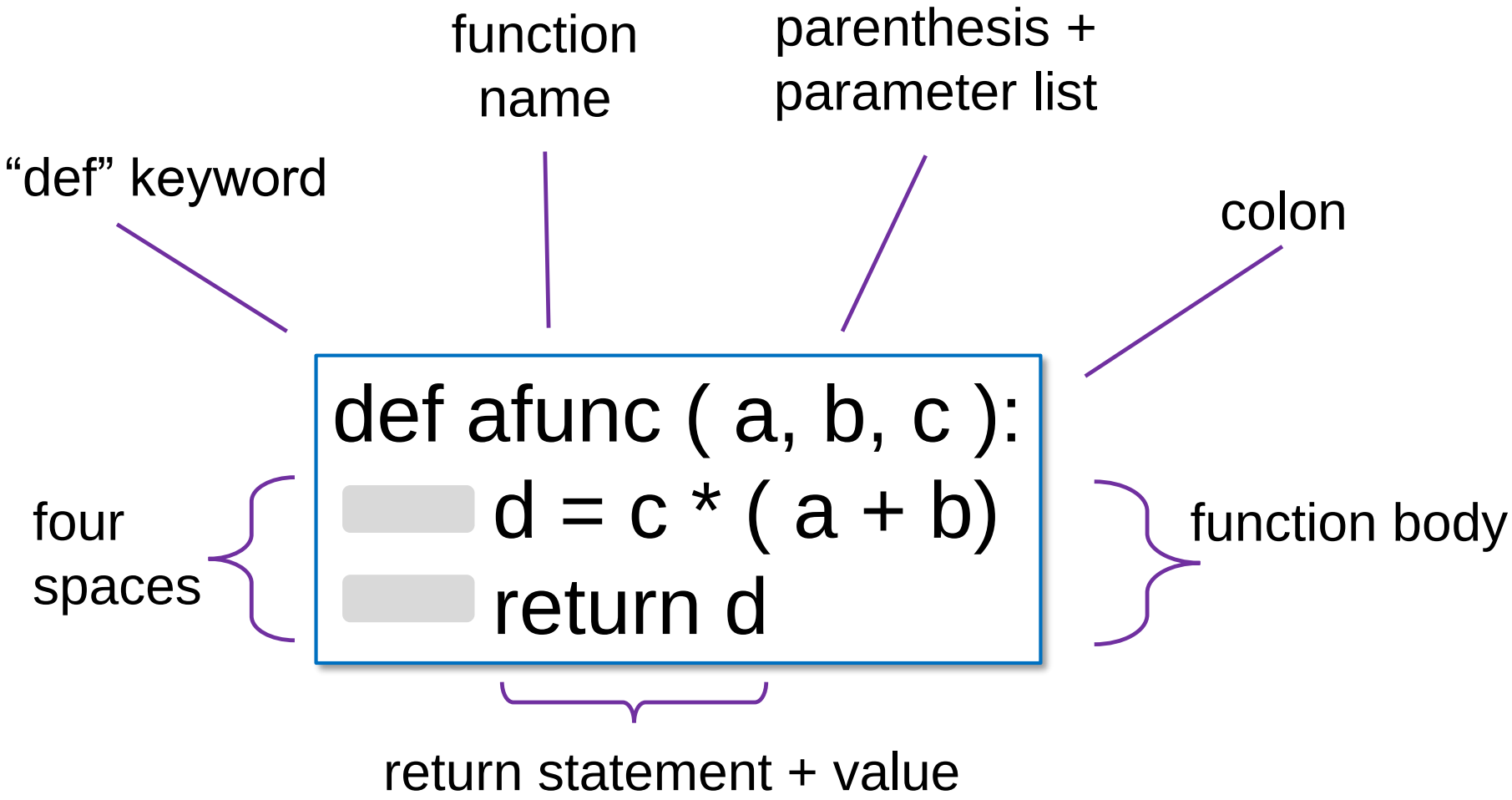
Defining a Function

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

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

Sample function definition and calling syntax

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

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

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 )
```

Sample 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 ):
    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 → myval1 e → 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.

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

a = 1
func( )
```

equivalent

```
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:

Boolean expression
(parenthesis optional)

"if" keyword

colon

```
if ( a > b):
    a = b
    b = -b
```

executed
if a > b

four spaces

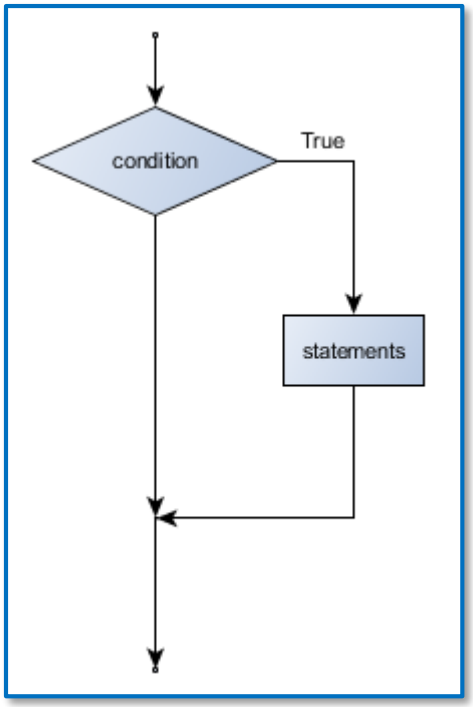


image credit: HTLCS

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

```
if ( a > b):
    a = b
    b = -b
else:
    b = a
    a = -a
```

executed if a > b

executed if a <= b

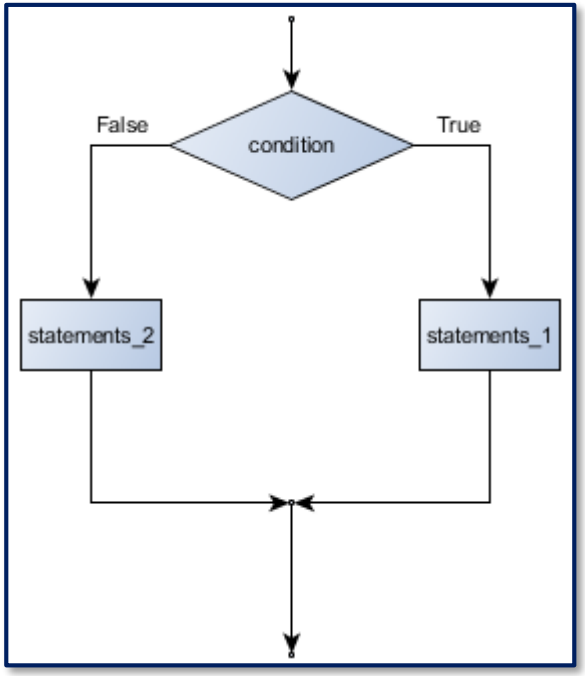


image credit: HTLCS

Conditionals 3: elif

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

```
if ( x  <  y):
    a = -1

elif (x > y):
    a = 1

else:
    a = 0
```

executed if x < y

executed if x > y

executed if x = y

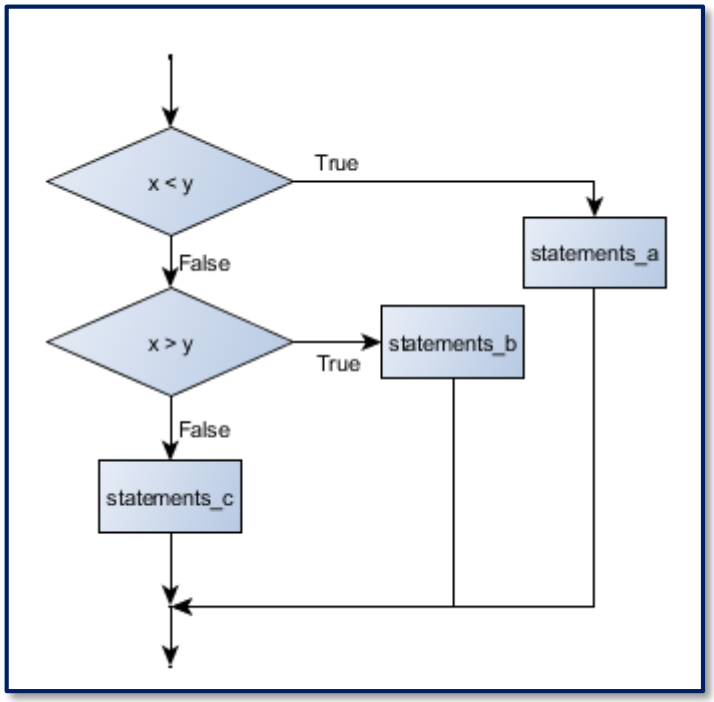


image credit: HTLCS

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
- Also: sys.getrecursionlimit

```
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