APS106

UNIVERSITY OF TORONTO

functions, input & output, importing modules.

Week 1 | Lecture 2 (1.2.1)

While waiting for class to start:

Download and open the Jupyter Notebook (.ipynb) for Lecture 1.2.1

You may also use this lecture's JupyterHub link instead (although opening it locally is encouraged).

Upcoming:

- Lab 1 released (Gradescope invites coming...)
- Reflection 1 released Friday
- PRA (Lab) on Friday @ 2PM this week

if nothing else, write #cleancode

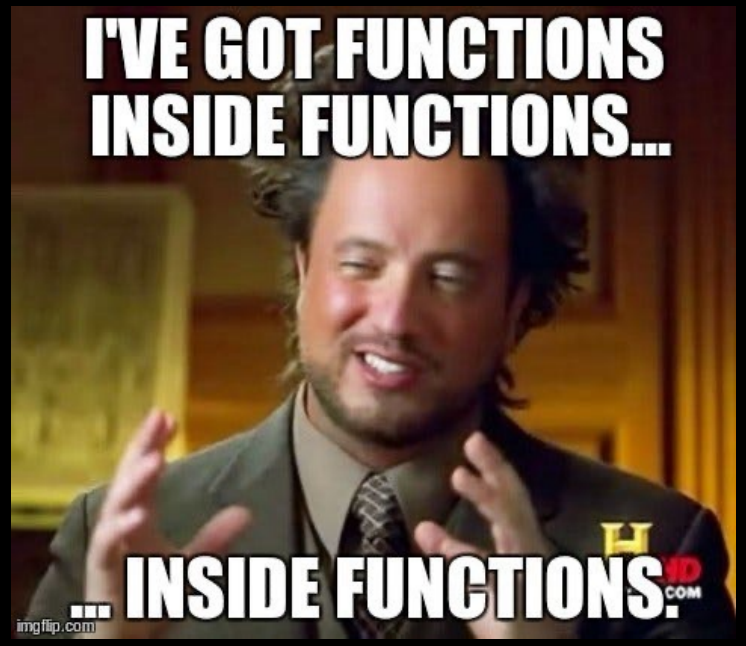
What you'll learn today

Lecture 2.1

- **Functions, input & output, importing modules**

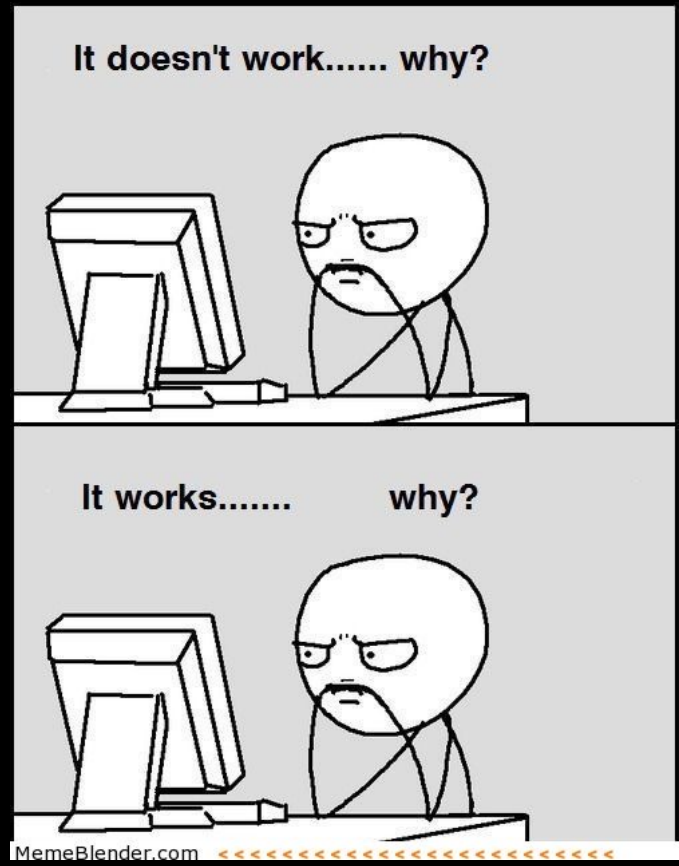
Lecture 2.2

- Writing your own functions



Programming Guide 101

- Readability
  - If nothing else, write #cleancode
- Comments
  - Save yourself from yourself
- Lots of testing!
  - Modular code (you will learn about functions next week)
  - Test often and with purpose
- Understanding errors
  - Types of errors
  - Error codes
- Always have a plan!



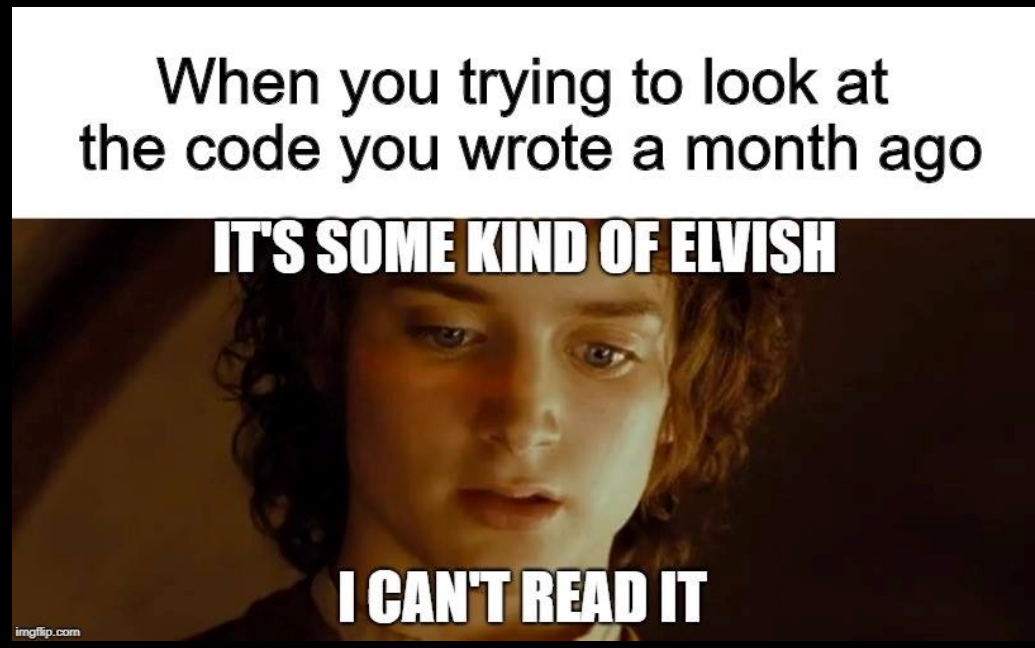
Readability Tips (#cleancode)

>>> canda = cat + panda

- Use whitespace to separate variables and operators
  - >>> canda=cat+panda
- Be consistent with spacing, too much whitespace can be bad
  - >>> canda = cat +panda
- Pick variable names that are easy to read and interpret
  - >>> canda = nom + nomnomnomnomnomnom
- Be consistent with naming schemes
  - >>> Canda = CAT + _panda42

Comments

- Comments are to help you, and anyone else who is reading/using your code, to remember or understand the purpose of a given variable or function in a program.
- A comment begins with the number sign (#) and goes until the end of the line.
- Python ignores any lines that start with the (#) character



```swift
// Sensor Values
var allSensorLabels : [String] = []
var allSensorValues : [Double] = []
var ambientTemperature : Double!
var objectTemperature : Double!
var accelerometerX : Double!
var accelerometerY : Double!
var accelerometerZ : Double!
var relativeHumidity : Double!
var magnetometerX : Double!
var magnetometerY : Double!
var magnetometerZ : Double!
var gyroscopeX : Double!
var gyroscopeY : Double!
var gyroscopeZ : Double!
```

```swift
func peripheral(_ peripheral: CBPeripheral, didDiscoverCharacteristicsFor service: CBService, error: Error?) {

    self.statusLabel.text = "Enabling sensors"

    for charateristic in service.characteristics! {
        let thisCharacteristic = charateristic as CBCharacteristic
        if SensorTag.validDataCharacteristic(characteristic: thisCharacteristic) {

            self.sensorTagPeripheral.setNotifyValue(true, for: thisCharacteristic)
        }
        if SensorTag.validConfigCharacteristic(characteristic: thisCharacteristic) {

            var enableValue = thisCharacteristic.uuid == MovementConfigUUID ? 0x7f : 1
            let enablyBytes = NSData(bytes: &enableValue, length: thisCharacteristic.uuid == MovementConfigUUID
                ? MemoryLayout<UInt16>.size : MemoryLayout<UInt8>.size)
            self.sensorTagPeripheral.writeValue(enablyBytes as Data, for: thisCharacteristic, type:
                CBCharacteristicWriteType.withResponse)
        }
    }

}
```

Warning! This is not Python! It is an example from one of my iOS apps I had to come back to after a few years. Comments are (//) in Swift instead of (#) in Python

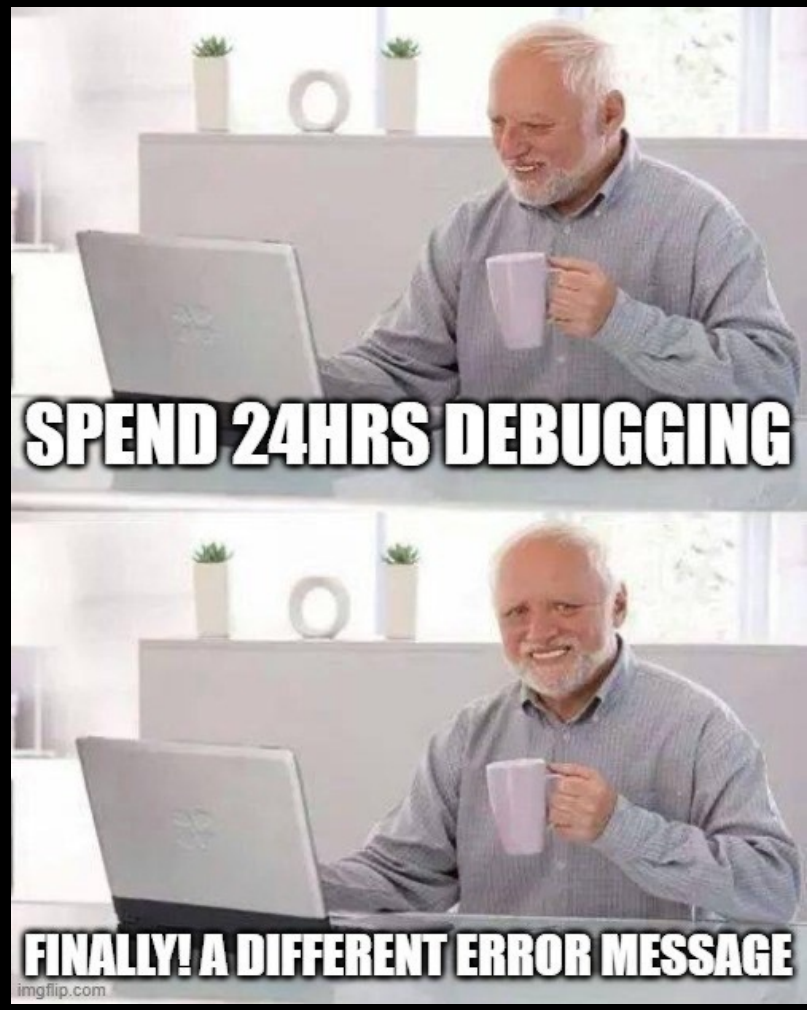
Testing!

- The more lines of code you write, the more likely it is that you will make a mistake and the harder it will be to find the mistake
  - "like finding a needle in a haystack"
- Test your code as you write it
  - Requires you understanding what specific output an input will provide
- "Modular code"
  - Test in small chunks or "modules"
  - Put a test input into the beginning where you know what the output is and see what you get!

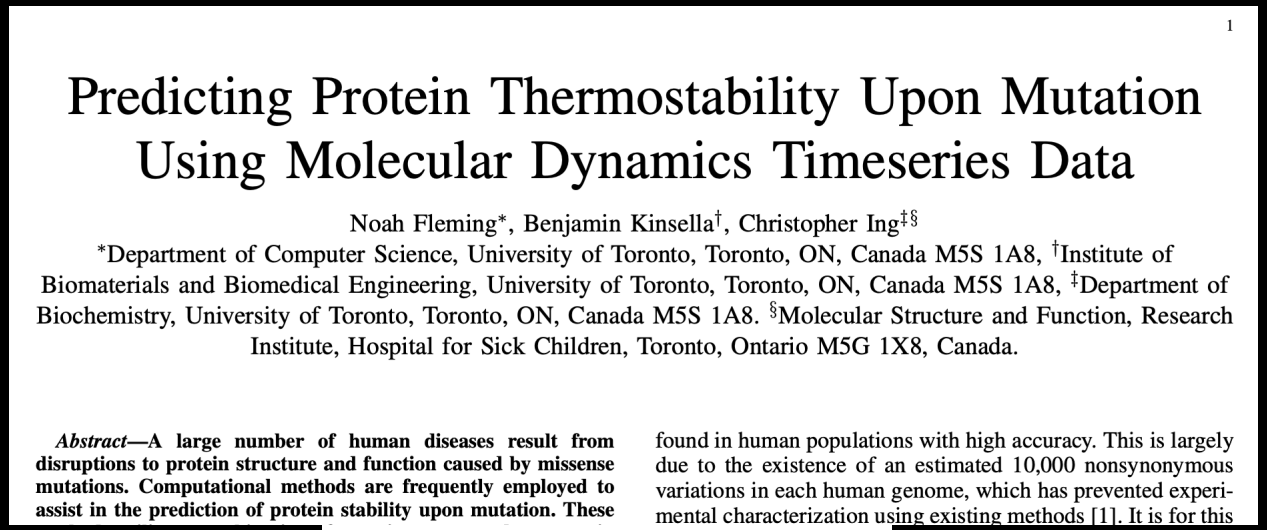
Golden Rule: Never spend more than 15 minutes programming without testing

Error Reduction vs Debugging

- It is pretty much impossible to write code without errors.
  - *Error Reduction*: techniques we can use to reduce the number and severity of errors.
  - *Debugging*: techniques for identifying and correcting errors



Code Efficiency



1

Predicting Protein Thermostability Upon Mutation Using Molecular Dynamics Timeseries Data

Noah Fleming*, Benjamin Kinsella†, Christopher Ing‡§
*Department of Computer Science, University of Toronto, Toronto, ON, Canada M5S 1A8, †Institute of Biomaterials and Biomedical Engineering, University of Toronto, Toronto, ON, Canada M5S 1A8, ‡Department of Biochemistry, University of Toronto, Toronto, ON, Canada M5S 1A8. §Molecular Structure and Function, Research Institute, Hospital for Sick Children, Toronto, Ontario M5G 1X8, Canada.

***Abstract*—A large number of human diseases result from disruptions to protein structure and function caused by missense mutations. Computational methods are frequently employed to assist in the prediction of protein stability upon mutation. These**

found in human populations with high accuracy. This is largely due to the existence of an estimated 10,000 nonsynonymous variations in each human genome, which has prevented experimental characterization using existing methods [1]. It is for this

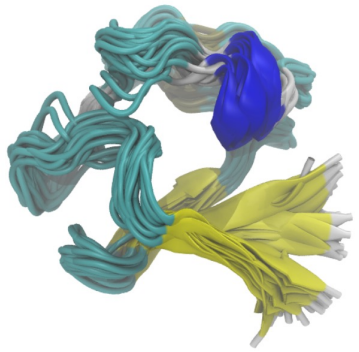
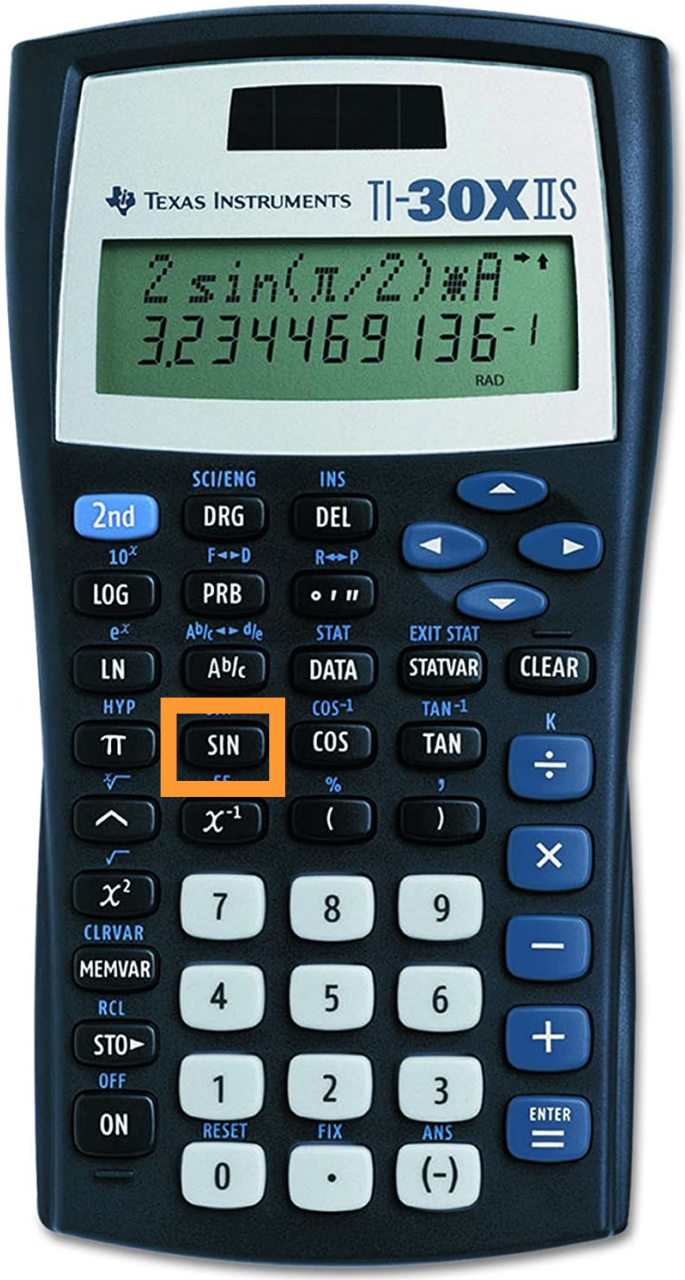


Fig. 1. Rendering of multiple time frames in simulations of the protein rubredoxin (PDB: 1BFY). Protein is colored based on secondary structure.

Supercomputer in Quebec

What is a function?

- A function is a piece of code that you can "call" repeatedly to do one thing.
- Think about the **sin** key on your calculator. It takes in an angle, does some calculations and returns the sine of that angle.
- Python has **built-in functions** (today), but programmers can also create their own **user-defined functions** (next lecture).




easy

Why do we write functions?

- Let's consider our sine function.
- In Python, this could take 10 or more line of code to compute.
- If you have to compute the sine of an angle multiple times in your code, this means you have to repeat the same 10 lines of code over and over and OVER again!
- This is both inefficient and it creates more opportunities to bugs (mistakes) to creep into your code.

Open your notebook

Click Link:
1. Why do we write functions?

Why do we write functions?

- **Reuse:**
  - The practice of using the same piece of code in multiple applications.
- **Abstraction:**
  - A technique for managing the complexity of the code (how much do we really need to know?).
  - **model.fit(X, y)** → This could train a deep neural network.
- **Collaboration:**
  - Easy to read, Easy to modify, Easy to maintain.

- **#cleancode**

Calling Functions

"snake case" or "pothole case"?

In Python names of variables and functions use low case and underscores.

- The general form of a function call:

```
function_name(arguments)
function_name()
function_name
```

Would not result in a function call.

```
function_name
Function_Name
FunctionName
```

- Terminology
  - *argument*: a value given to a function.
  - *pass*: to provide an argument to a function.
  - *call*: ask Python to execute a function (by name).
  - *return*: give a value back to where the function was called from.

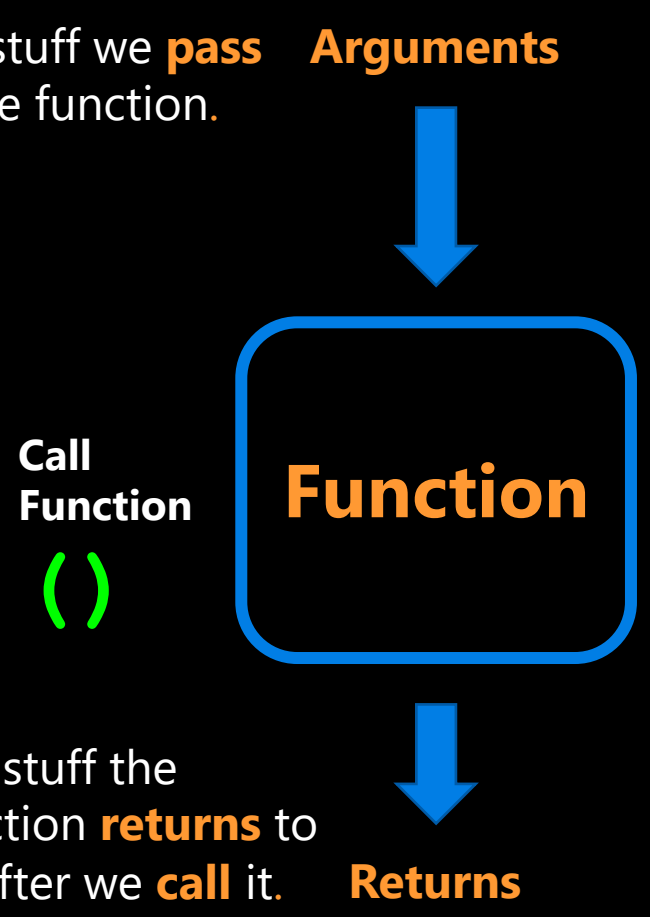
Calling Functions

- The general form of a function call:

```
function_name(arguments)
function_name()
function_name
```

Would not result in a function call.

- Terminology
  - *argument*: a value given to a function.
  - *pass*: to provide an argument to a function.
  - *call*: ask Python to execute a function (by name).
  - *return*: give a value back to where the function was called from.



Calling Functions

- The general form of a function call:

```
function_name(arguments)
```

- Terminology
  - *argument*: a value given to a function.
  - *pass*: to provide an argument to a function.
  - *call*: ask Python to execute a function (by name).
  - *return*: give a value back to where the function was called from.

Open your notebook

Click Link:
2. Function Call

Back to evaluation and expressions

- Last week we learned about the assignment statement (=).
- Remember, the value of the expression on the right-hand side (RHS) of the = sign is figured out first and then assigned to the variable on the left-hand side.
- This also applies if the thing on the RHS is a function!

First, the function is *called* while passing it an *argument*.

```
x = abs(-20+5)
```

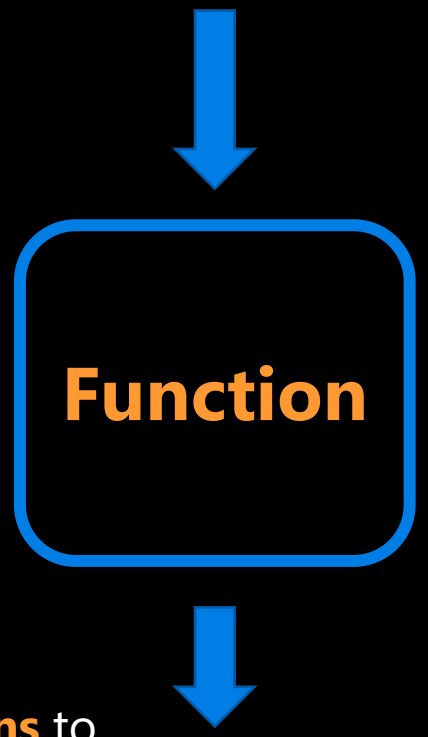
Then, what the function *returns* is assigned to *x*.

Back to evaluation and expressions

```
x = abs(-20+5)
```

- Last week we learned about the assignment statement (=).
- Remember, the value of the expression on the right-hand side (RHS) of the = sign is figured out first and then assigned to the variable on the left-hand side.
- This also applies if the thing on the RHS is a function!

The stuff we **pass** to the function. **Arguments** ?



?

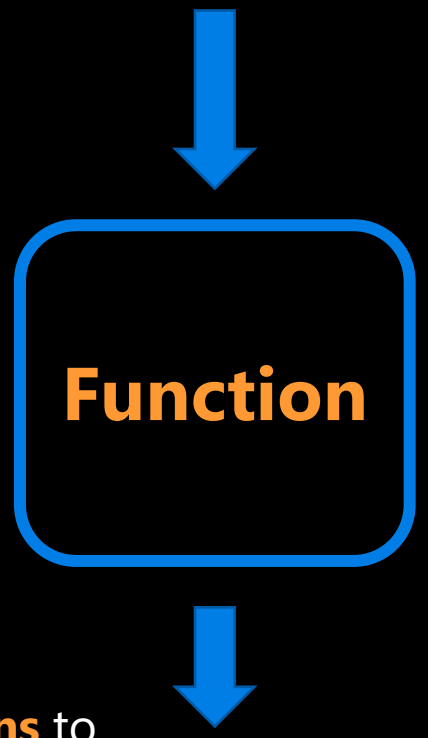
The stuff the function **returns** to us after we **call** it. **Returns** ?

Back to evaluation and expressions

- Last week we learned about the assignment statement (=).
- Remember, the value of the expression on the right-hand side (RHS) of the = sign is figured out first and then assigned to the variable on the left-hand side.
- This also applies if the thing on the RHS is a function!

```
x = abs(-20+5)
```

The stuff we **pass** to the function. **Arguments** -15



abs

The stuff the function **returns** to us after we **call** it. **Returns** 15

Back to evaluation and expressions

- Last week we learned about the assignment statement (=).
- Remember, the value of the expression on the right-hand side (RHS) of the = sign is figured out first and then assigned to the variable on the left-hand side.
- This also applies if the thing on the RHS is a function!

Open your notebook

Click Link:
3. Back to Evaluation and Expressions

Breakout Session 1

- $x = \dfrac{|y + z| + |y * z|}{y^{\alpha}}$
- where,
  - $y = -20$
  - $z = -100$
  - $\alpha = 2$
- What is x ?

Open your notebook

Click Link:
4. Breakout Session 1

Built-in Functions

- The *function_name* is the name of the function (like sin or print).
- Python has many built-in functions. Learn more about them here.

Built-in Functions

A
abs()
aiter()
all()
any()
anext()
ascii()

B
bin()
bool()
breakpoint()
bytearray()
bytes()

C
callable()
chr()
classmethod()
compile()
complex()

D
delattr()
dict()
dir()
divmod()

E
enumerate()
eval()
exec()

F
filter()
float()
format()
frozenset()

G
getattr()
globals()

H
hasattr()
hash()
help()
hex()

I
id()
input()
int()
isinstance()
issubclass()
iter()

L
len()
list()
locals()

M
map()
max()
memoryview()
min()

N
next()

O
object()
oct()
open()
ord()

P
pow()
print()
property()

R
range()
repr()
reversed()
round()

S
set()
setattr()
slice()
sorted()
staticmethod()
str()
sum()
super()

T
tuple()
type()

V
vars()

Z
zip()

_
__import__()

Built-in Functions

- The *function_name* is the name of the function (like sin or print).
- Python has many built-in functions. Learn more about them here.

Open your notebook

Click Link:
5. Built-in Functions

Function Help

- To get information about a particular function, call **help** and pass the function as the argument.
- **help** is one of Python's built-in functions.

- `help(abs)`
- `help(abs())`

Notice how we're not calling the function.

Open your notebook

Click Link:
6. Function Help

Output

- Python has a built-in function named **print** for displaying messages to the user.
- The general form of a **print** function call:

```
print(arguments)
```

- The arguments can be of type `int`, `float`, `strings` and others we will discuss next week.

Open your notebook

Click Link:
7. Output

Input

- Python has a built-in function named **input** for reading inputs from the user.
- The general form of an **input** function call:

```
input(argument)
```

- The argument is the text you want displayed to the user.
  - *"What is your name?"*
- The value returned by the **input** function is always a string.

Open your notebook

Click Link:
8. Input

Breakout Session 2

- Write code to print out the following text:

```
"Hello, my name is {} and I'm hoping to get a grade of {} in APS106 this term."
```

- Where you see curly brackets {} you need to use the **input** function to prompt the user to enter that information.

Open your notebook

Click Link:
9. Breakout Session 2

Importing Functions and Modules

- Not all useful functions are built-in and they must be imported.
- Groups of functions are stored in separate Python files, which are called **modules**.
- Some modules come pre-installed with Python and other need to be installed separately.
  - For example, there are a lot of machine learning methods implemented in the scikit-learn modules.
- To get access to the functions in a module, you need to **import** the module.

Importing Functions and Modules

- The general for of an import statement is:
  - `import module_name`
- To access a function within a module:
  - `module_name.function_name`
- The dot is an operator:
  1. Look up the object that the variable to the left of the dot refers to.
  2. In that object, find the name that occurs to the right of the dot.

```
import math
math.sqrt(16)
```

Importing Functions and Modules

- The general for of an import statement is:
  - `import module_name`
- To access a function within a module:
  - `module_name.function_name`

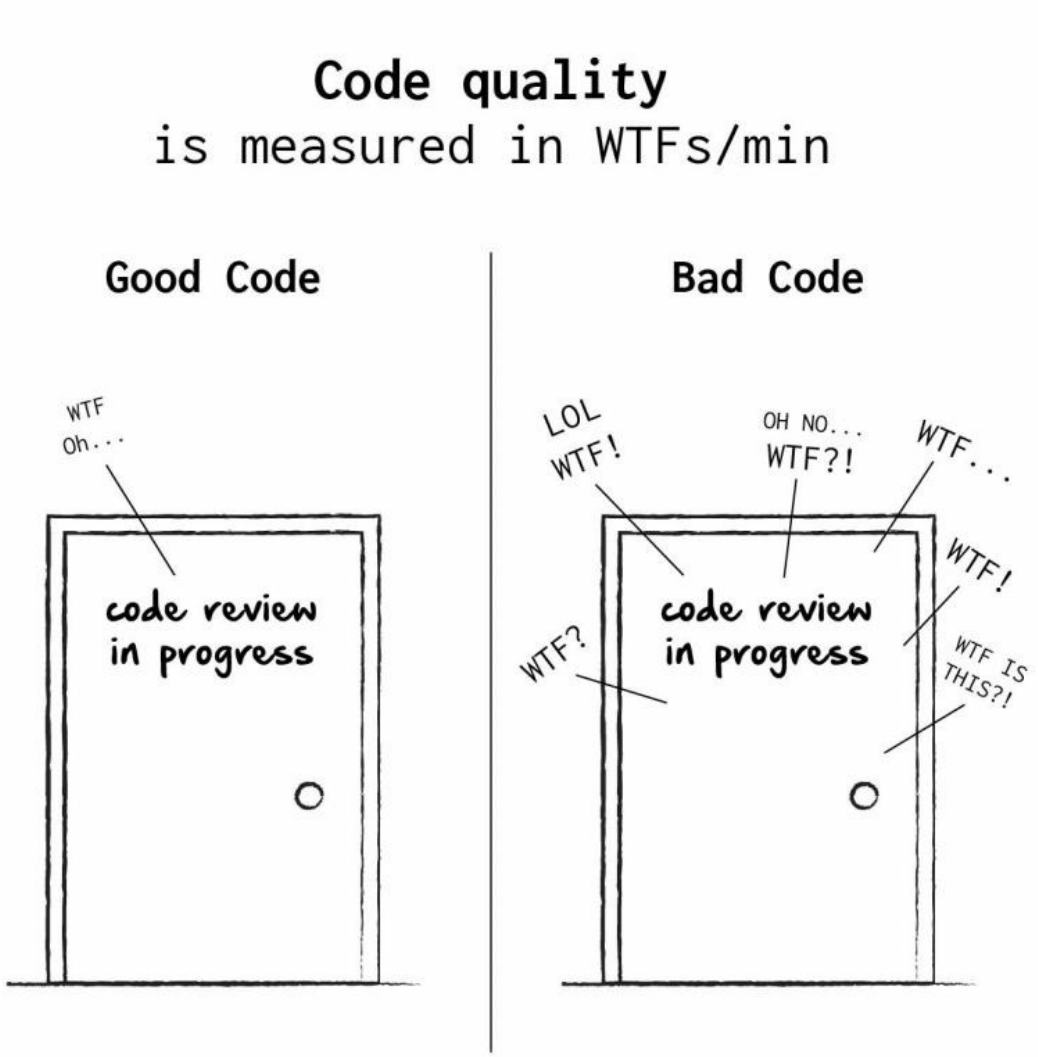
Open your notebook

Click Link:

10. Importing Function and Modules

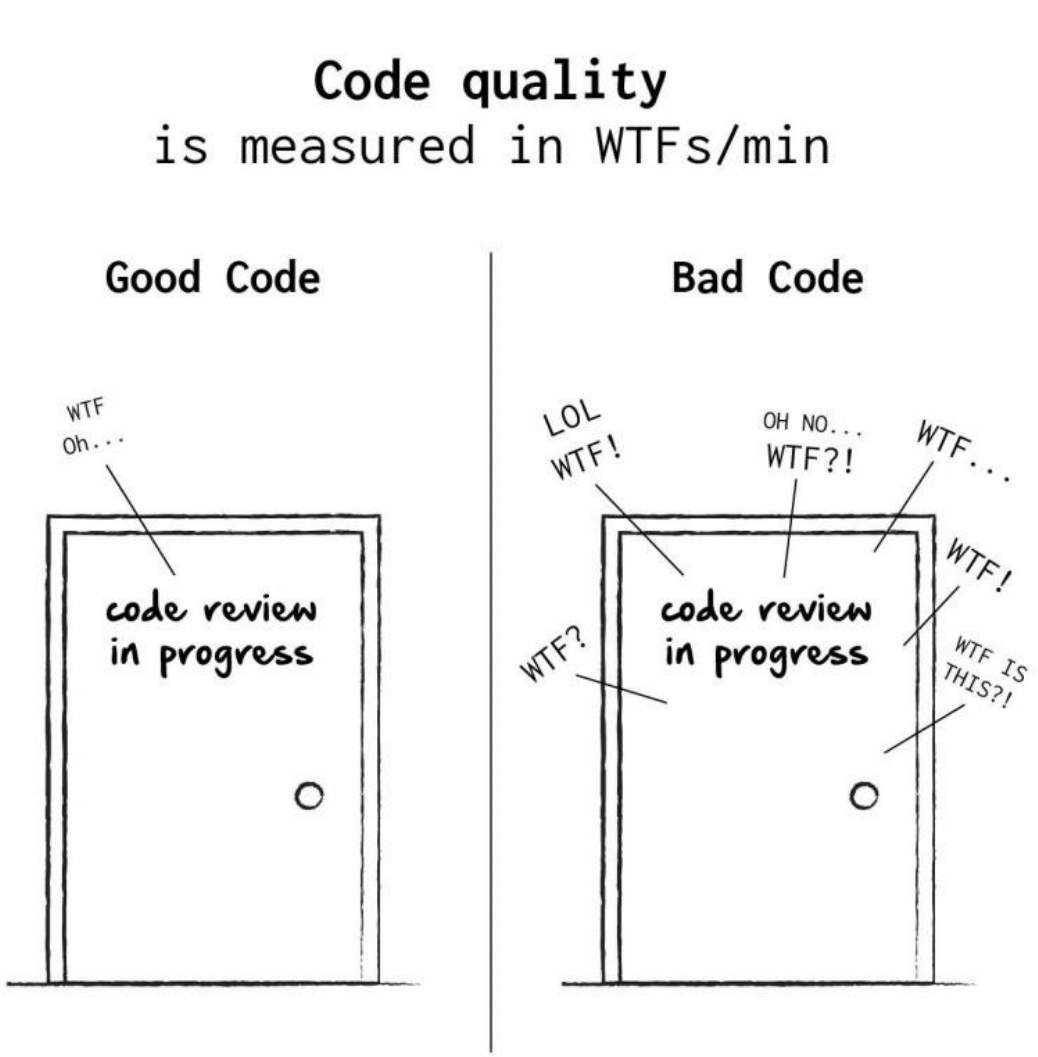
Defining Your Own Functions

- The real power of functions is in defining your own.
- Good programs typically consist of many small functions that call each other.
- If you have a function that does **only one thing** (like calculate the sine of an angle), it is likely not too large.
- If its not too large, it will be easy to test and maintain.



Defining Your Own Functions

- As a general rule, you should not write functions more than a 30 or 40 lines.
- Smaller is better: 10 or less is good.
- If you need something bigger, break it up into multiple functions.
- **#cleancode**



Function Definitions

- The general form of a function definition is:

```
def function_name(parameters):
    body
```

Colon

Indent

(parameter1, parameter2, ...)

- **def** is a keyword, standing for **definition**. All function definitions must begin with def. The def statement must end with a colon.
- **function_name** is the name you will use to call the function (like sin, abs but you need to create your own name).
- **parameters** are the variables that get values when you call the function. You can have 0 or more parameters, separated by commas. Must be in parenthesis.
- **body** is a sequence of commands like we've already seen (assignment, multiplication, function calls).
- **Important:** all the lines of body must be indented. That is how Python knows that they are part of the function.

Function Definitions

- The general form of a function definition is:

Definition

Function Name

Colon

```
def function_body(parameters):
    body
```

Indent

(parameter1, parameter2, ...)

Open your notebook

Click Link:
11. Defining Your Own Functions

APS106

UNIVERSITY OF TORONTO

functions, input & output, importing modules.

Week 1 | Lecture 2 (1.2.1)

if nothing else, write #cleancode