CS 1112: Introduction To Programming

Functions and Scope

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Spring 2024

Friendly Reminders

- Your ***safety*** and ***comfort*** is important!
  - If you choose to wear a mask you are welcome to do so
  - *We will interpret wearing a mask as being considerate and caring of others in the classroom (not that you are sick), and realize that some may choose to mask to remain distanced*
- Be an ***active*** participant in your learning!
  You're welcome and ***encouraged*** to ask questions during class!
- If you feel ***unwell***, or think you are, please stay home
  - *We will work with you!*
  - Get some rest ☺
  - View the recorded lectures – *please allow 24-48 hours to post*
  - *Contact us!*

Announcements

- **Quiz 3** is being graded
- **PA02** is due by 11:00pm on Wednesday (***tonight***)!
  - Submit on Gradescope: your .py file and a reflection file (PDF).
  - *Not sure how to create/submit a PDF? No problem! Ask one of the TAs for help!*

- Coming up…
  - **Exam 1** on February 28, 2024 (during class time)
  - If you have **SDAC accommodations**, please book an appointment at the SDAC facility to take the exam with your extended time and distraction-free environment.
    - You can book a testing time slot at any time on Feb. 28th but you must book on this day (not another day)

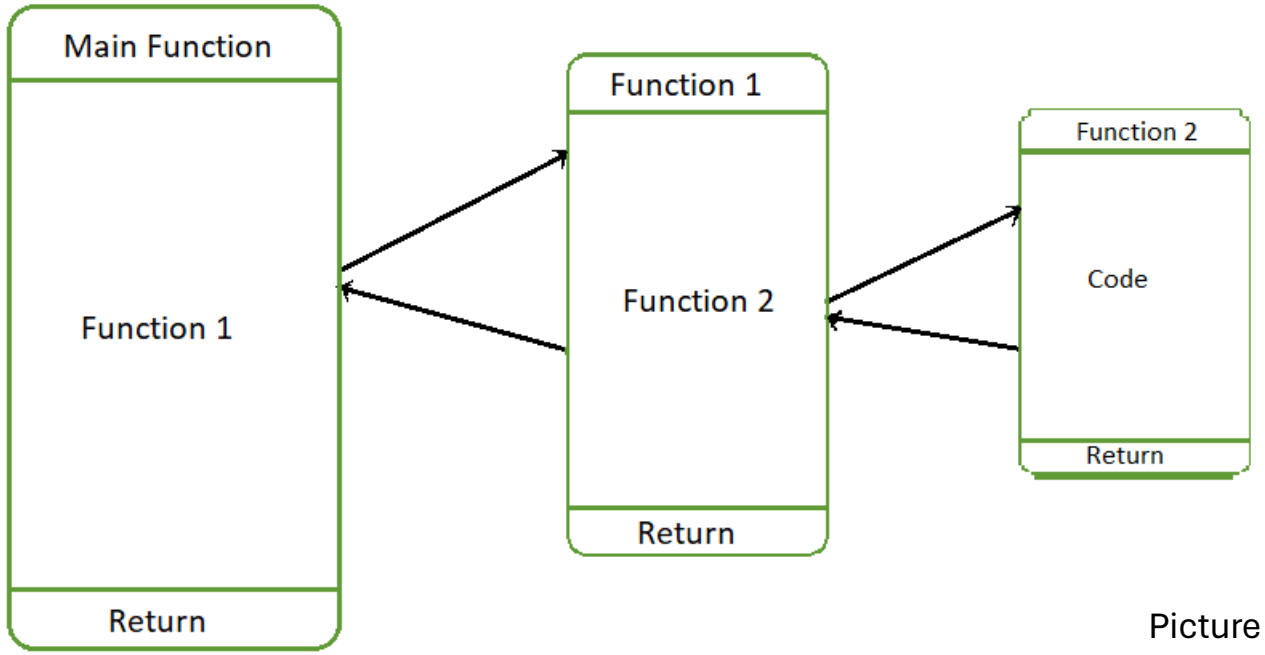
Functions calling Functions

Calling another function from inside a function

Visual: functions calling other functions…

In the below figure. The function call is made from the **Main function** to **Function1**. Now the state of the Main function is stored in Stack, and execution of the Main function is continued when Function 1 returns. When Function1 *c*alls **Function2**, the state of the Function1 is stored in the stack, and execution of Function 1 will be continued when Function 2 returns.

Calling Function execution will be completed only when Called Function's execution is completed



Picture & text snippet from geeksforgeeks

Functions calling other Functions

- To call a function from another function in Python, you just have to **call the name of the function** and pass in any required arguments. See the following example:

```
def func1():
      print("This is function 1")

def func2():
      print("This is function 2")
      func1()  # call function 1

# Call function 2 –
func2()
```

Output:

```
This is function 2
This is function 1
```

In the above code, function 2 simply calls function 1 by invoking the **name** of the function. When you run the code, you'll see that function 2 executes first and then function 1 executes.

What happens when you invoke (call) a function?

1. Python creates *memory* for the function (*we don't see this*)
2. Argument values are assigned to parameter names
3. Lines of code in the body of the function are *executed*
4. When the function encounters a `return` statement, a value is *passed back* to the **caller**, and the function **ends**
5. Python removes the *memory* for the function (all values that existed *only in the function* are gone)

Python Demonstration

Let's jump on PyCharm!

functions_calling_functions.py

This raises the issue of Scope…

When writing functions, you will often be dealing with a lot of variables. It is important to understand variable scope…

This raises the issue of Scope…

- OK… maybe not that kind of Scope… ☺

Scope

- The area where a variable is recognized (or has meaning)
- **Global Variables -** declared outside of a function.
  - Have scope from where they are first created until the end of the program (or module/file)
- **Local Variables -** declared inside of a function.
  - Have scope from where they are first created until the end of the function definition
  - This includes parameters

- In this example, how would you describe the scope of the variable x?

  ???

- What about variable b?

  ???

```
def add_stuff(a):
  x = a + 5
  return x

b = 4
print("Statement 1: The value of b is", b)
y = add_stuff(7)
print("Statement 2: The value of y is", y)
print("Statement 3: The value of b is", b)
```

Note: Tools like pythontutor.com can be helpful is visualizing the concept of scope

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- In this example, how would you describe the scope of the variable x?
  a) x is a local variable
  b) It is local to function add_stuff
- What about variable b?

  ???

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  - Have scope from where they are first created until the end of the function definition
  - This includes parameters

- In this example, how would you describe the scope of the variable x?
  a) x is a local variable
  b) It is local to function add_stuff
- What about variable b?
  a) b is a global variable

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def add_stuff(a):
  x = a + 5
  return x

b = 4
print("Statement 1: The value of b is", b)
y = add_stuff(7)
print("Statement 2: The value of y is", y)
print("Statement 3: The value of b is", b)
```

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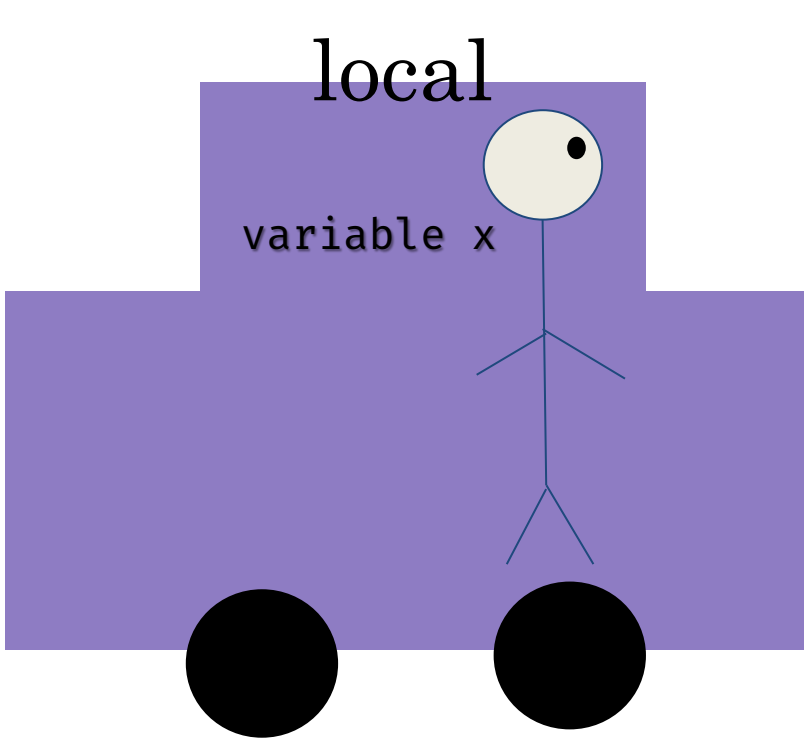
Variables with the same name but different scopes: Which variable will be used?

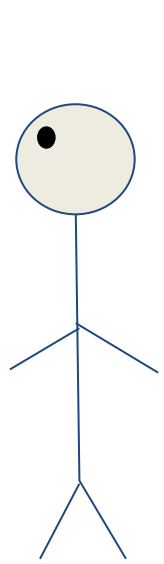
- If the **variable name** is on the left of an assignment operator (=) - **if** it *does not have a value yet:*
  - Python treats it as a local variable unless it has been *explicitly* declared with the **`global`** operator.
  - If the variable has been explicitly declared with the **`global`** operator, the global variable will be used.

- If the variable is assumed to *have a value already*:
  - If a local variable by that name exists, the **local variable** will be used
  - If no local variable by that name exists, the **global variable** will be used

- The keyword **`global`** can be used within a function to make scope explicit

Kind of like a car with tinted windows

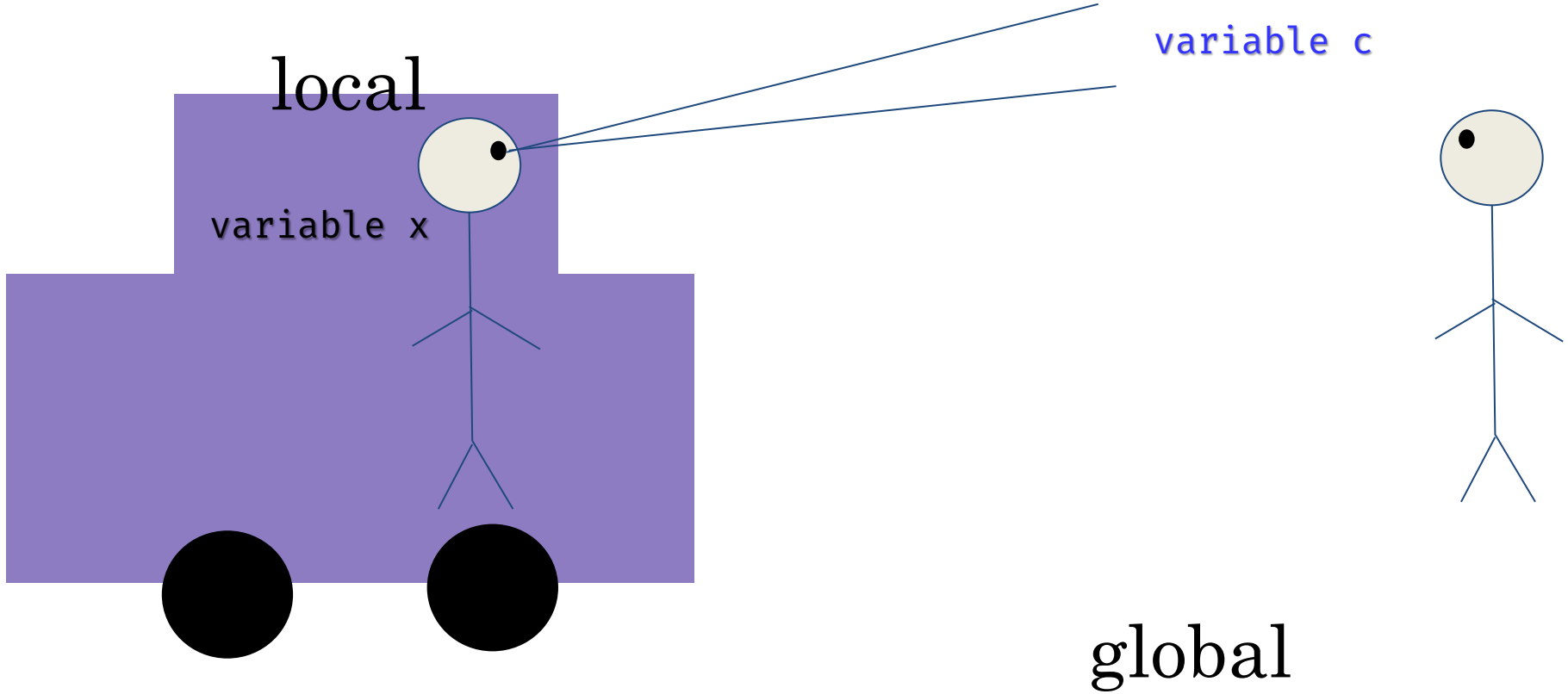




global

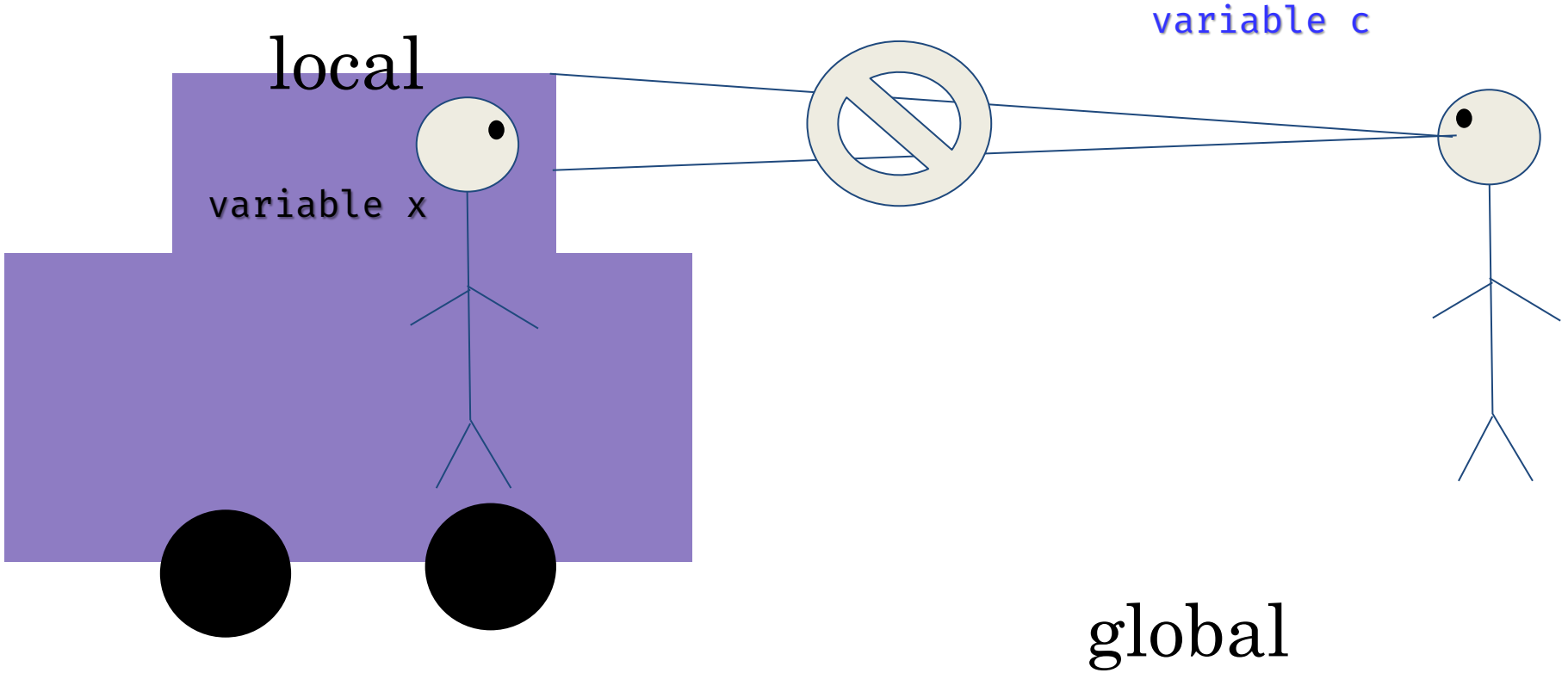
Kind of like a car with tinted windows

You can see variables (like c) outside the car from inside the car



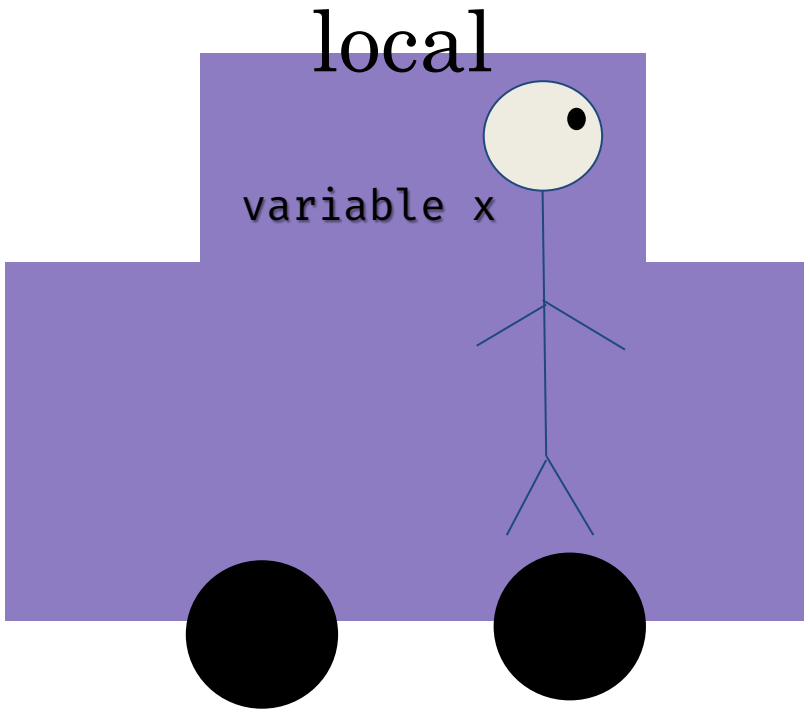
Kind of like a car with tinted windows

You cannot see variables inside the car (like x) from outside the car (tinted windows)

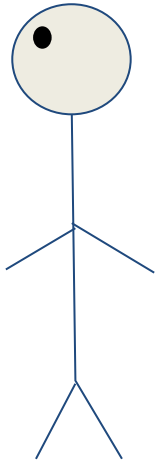


Kind of like a car with tinted windows

To modify variables outside the car, you must ask your friend to help you (calling global)



variable c



global

Which Variable is in Scope?

Q1: Variable **x** - Are these two different variables or are they the same variable?

```
def add_stuff(a):
  result = x + 5
  return result

x = 4
y = x + 3
```

Q2: Variable **c** - Are these two different variables or are they the same variable?

```
def add_stuff(p):
  c = p + 5
  return c

c = 4
c = c + 3
```

Q3: The keyword **global** - Does this change anything?

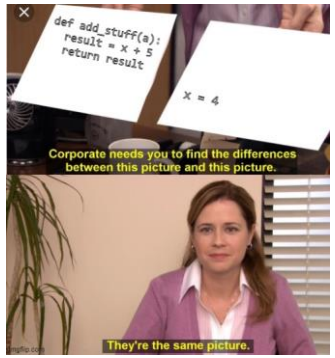
```
def add_stuff(p):
  global c
  c = p + 5
  return c

c = 4
c = c + 3
```

Which Variable is in Scope?

Q1: Variable **x** - Are these two different variables or are they the same variable?

These are the same variable




```
def add_stuff(a):
  result = x + 5
  return result

x = 4
y = x + 3
```

Q2: Variable **c** - Are these two different variables or are they the same variable?

```
def add_stuff(p):
  c = p + 5
  return c

c = 4
c = c + 3
```

Q3: The keyword **global** - Does this change anything?

```
def add_stuff(p):
  global c
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Which Variable is in Scope?

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def add_stuff(p):
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c = 4
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```

Q3: The keyword **global** - Does this change anything?

Now these are the same variable

```
def add_stuff(p):
  global c
  c = p + 5
  return c

c = 4
c = c + 3
```

Python Demonstration

Let's jump on PyCharm!

more_function_basics.py

In-Class "lab" Activity!

Activity on Scope

- In pairs or groups up to three work on the following activity.
- **Variable Scope In-Class Activity**
- *Practice identifying variable scope.*
  Practice tracing code in a function.

Remember to check-in with a TA before leaving class today!

```python
# goal of this function is to double a number
# input: the number that I want doubled
# output (return value): the doubled number
def my_function(x):  # this is assigning the value of the
  # passed-in argument to the variable x
  x_doubled = x + x
  return x_doubled


# remember to typecast input if you want something other than a string
my_num = input("Enter a number: ")
doubled_my_num = my_function(float(my_num))
print("When we double", my_num, "we get", doubled_my_num)

#
#
# in the computer's memory, this is what's going on when we create
# variables....
#
#  variable name   |   variable type  |     scope    |  variable address
# ------------------------------------------------------------------------
#   my_num         |       string     |    global    |     0xFA724B
#   doubled_my_num |       float      |    global    |     0xA73D91
#   x              |       float      | my_function  |     0x453AB1


# and example of a function that doesn't return anything
def silly_function():  # no parameters
  print("this is just a print line in the silly function")
  return
result = silly_function()
print("the silly function returned:", result)
# notice that the return is None
```

```python
# since we ask the user to enter an integer often, we could create a
# function that would allow us to put the call to input, the type
# casting, and more (in the future, we'll think about input validation)
# all in one place
def get_int(the_prompt):
  # ... we could have more code here to make sure the number is valid
  in_num = int(input(the_prompt))
  return in_num

large = get_int("Enter a large number: ")
print(large * 2, "is larger than", large)


# you can always experiment with Python to learn the language better
# In this example, we are experimenting with types and operators
# try various operators on different pairings and orderings of
# a string and an int
#
str1 = "hello"
int1 = 9
result = str1 * int1  # swap the order, use different operators, etc.
print(type(result))
print(result)


# in the future, we'll discuss putting a function like this in a
different # file than the one we are currently working on. Then we can
call it
# anytime we want by using import
```

Review this code on your own.
Don't hesitate to ask the TAs or the professor questions if you have any!

```
# The goal of this function is to double a number.
# input: the number that I want doubled
# output (return value): the doubled number

# Think: my_function(9) -> implicit assignment x = 9
def my_function(x): # function header: my_function is the function
name,
  # and x is the only parameter.
  # This is the function body (note code is indented), executed when
  # function is called. This code does NOT get executed until the
  # function is called/invoked.
  y = x+x
  return y # control of the program will return to wherever we called
         # this function from, and 'return' y to tell that part of
         # the code.
         # When a function returns a value, think:
         # "replace the function call with the returned value"

# When you are done with the function definition, just
# de-indent(un-indent?). You Can use backspace or shift+tab.

my_num = input("give me a number! ") # input() is a function too, and
  # "give me a number" is its argument here. The input function always
  # returns a string. For example, if the user only types in digits,
  # those digits are returned as a string.

my_num = int(my_num) # int() is a function that takes in one argument
               # and returns a value of type int

print(my_function(my_num)) # my_function() gets called with a number
  # passed in (an argument). When the function returns, the function
  # call becomes that returned value.
```

Review this code on your own.
Don't hesitate to ask the TAs or the professor questions if you have any!

Review/Practice: Writing Functions

Practice writing a function. Do this activity on your own or find a friend in the class to work with. There is nothing to submit, and you do not need to check-in with a TA (this particular activity is *not* an in-class "lab" activity.)

You are welcome to discuss this function with TAs or your professor during office hours, or ask about it on Piazza)

Review: Writing Functions

- Write a **function** called `calculate_meal_cost` that has in three (3) parameters
  - 1 parameter for the original cost of the meal
  - 1 parameter for the amount of tip (pre-tax) (a percentage)
  - 1 parameter for the amount of tax (a percentage)

- What would the function header look like?

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- What would the function header look like?

```
def calculate_meal_cost(orig_cost, tip_pct, tax_pct):
```

Review: Writing Functions

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  - 1 parameter for the original cost of the meal
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  - 1 parameter for the amount of tax (a percentage)

- What would the function body look like?
  - The tax amount will be the tax percent multiplied by the original cost
  - The tip amount will be the tip percent multiplied by the original cost
  - Then we should add all three of them together (original cost + tax amount + tip amount)

Header

```
def calculate_meal_cost(orig_cost, tip_pct, tax_pct):
```

Function call

```
calculate_meal_cost(90, 15, 10)
```

Output: 112.5

Review: Writing Functions (Possible Solution)

- The function body may look something like the following:

```
def calculate_meal_cost(orig_cost, tip_pct, tax_pct):
    tip_amount = tip_pct / 100 * orig_cost
    tax_amount = tax_pct / 100 * orig_cost
    total_cost = orig_cost + tip_amount + tax_amount
    return total_cost
```

- (*Don't forget to*: add comments including a multi-line function docstring)

Reminder: CS Laptop Loaner Program

- This course requires students to have a **laptop**
- I realize that not everybody might have one (nor necessarily need one for their desired major / path…)
- If you do not have a laptop for any reason… ***not to worry!***
- The CS department's Systems staff has a notebook / laptop loaner program and will be able to loan you a notebook / laptop computer for the duration of the semester if you don't have one or if you cannot afford one.
  - Also available if your laptop is broken and under repair, we can arrange for you to receive a loaner laptop for a week or two until your own laptop is fixed

Interested? Link: https://www.cs.virginia.edu/wiki/doku.php?id=cs_laptop_loaner

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