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# CS051A

# INTRO TO COMPUTER SCIENCE WITH TOPICS IN AI

## 3: Turtle and for loops

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Lectures



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Labs

# Lecture 3: Turtle and for loops

- Administrative
- `print` function
- Multiline strings and docstrings
- Turtle module
- For loops

This week

- All course handouts can be found on the course website
  - https://cs.pomona.edu/classes/cs51a/
- First assignment due this coming Sunday.
- If you have any questions, join our office hours and mentor sessions.
  - Schedule is posted on website.

# Lecture 3: Turtle and for loops

- Administrative
- `print` function
- Multiline strings and docstrings
- Turtle module
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# `print` function

- Use it when you want to "print" (i.e. display on the screen) certain expressions (e.g., numbers, strings, contents of variables, messages, etc.).
- Extremely useful for figuring out how our code works.

```
def bbq_cost(angie, jasmine, num_people):

    soda_cost = 0.5
    hotdog_cost = 0.75

    num_hotdogs = hotdogs(angie, jasmine)
    num_sodas = soda(num_people)

    return num_sodas * soda_cost + num_hotdogs * hotdog_cost
```

# Using the `print` function to understand our code

```
>>> bbq_cost(1,2,6)
15.75
```

- If you wanted to figure out *why* it was that high, you could temporarily add some print statements in the code.

```
def bbq_cost(angie, jasmine, num_people):

    soda_cost = 0.5
    hotdog_cost = 0.75

    num_hotdogs = hotdogs(angie, jasmine)
    num_sodas = soda(num_people)

    print("hotdogs: " + str(num_hotdogs))
    print("sodas: " + str(num_sodas))

    return num_sodas * soda_cost + num_hotdogs * hotdog_cost
```

```
>>> bbq_cost(1,2,6)
hotdogs: 13
sodas: 12
15.75
```

# Don’t forget to remove unnecessary `print` statements

- We can dig further if we'd like by adding more print statements.
  - E.g., `print("total cost of hotdogs: " + str(num_hotdogs*hotdog_cost))`
- When you're done, don’t forget to *REMOVE ALL PRINT STATEMENTS!*
- In most cases, we're adding print statements to help us debug our program.
  - debugging: the process of finding and removing programming errors.

# `print` vs `return`

- `print`
  - the print function displays the value to the screen/shell.
- `return`
  - a `return` statement has two parts, `return [expression]`
  - When the program gets to this line, it evaluates the expression.
  - Whatever value this expression evaluates to then is "returned" from that function and represents the value at where the function was called.

# print_vs_return.py

- Similar calculations but VERY different behavior.

```python
def print_square(number):
    print(number * number)


def return_square(number):
    return number * number
```

```
>>> print_square(10)
100
>>> return_square(10)
100
>>> x = print_square(10)
100
>>> x
>>> y = return_square(10)
>>> y
100
```

# `print_vs_return.py`

- `print_square(10)` and `return_square(10)` *appear* to do the same thing, but they are different.
  - `print_square(10)` is actually printing to the shell *inside* the function.
  - `return_square(10)` evaluates to `100`, then that value is printed because the default behavior for the shell is to print the value.
- This difference is highlighted in the next 4 statements:
  - `x = print_square(10)` calls `print_square(10)` which prints but does NOT return a value. Therefore, `x` remains undefined.
  - `y = return_square(10)` calls `return_square(10)` which does NOT print out the value (100) but returns it, therefore y is assigned the value 100.

# print_vs_return.py

```
# what will happen if the following was included at the bottom
# of the code when we run this program?
print_square(5)
print("#")
return_square(5)
print("##")
print(print_square(5))
print("###")
print(return_square(5))
print("####")
```

- If you hit Run (green triangle), you get:

```
25
#
##
25
None
###
25
####
```

# print_vs_return.py

- When you run a file, it starts at the top and executes each statement/line one at a time.
- `print_square(5)` prints 25.
- `print("#")` prints #
- `return_square(5)` does NOTHING. It returns a value, but then we don't do anything with it (just as if we'd typed 5*5 there) so the result of the calculation is lost.
- `print("##")` prints ##
- `print(print_square(5))` calls `print_square(5)` which again prints 25. Then, when we return, we try and print out the value that was returned from `print_square(5)`. Since `print_square` does not return a value, we get “None”.
- `print("###")` prints ###
- `print(return_square(5))` prints 25 because `return_square(5)` returned it!
- `print("####")` prints ###

## `return` statement

- When the interpreter reaches a return statement the program indicates a disruption in flow.
- We have to leave that function.
- Therefore any code in a function body that directly follows a return statement cannot be reached.

# Lecture 3: Turtle and for loops

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# Multiline strings

- So far we've seen double quotes and single quotes to enclose strings.
- If we want a string to span over multiple lines we have a few options
  - there is a special character `'\n'` that represents the end of the line. E.g.,

```
print("This is a string\nthat spans over multiple\nlines")
```

```
This is a string
that spans over multiple
lines
```

# Multiline strings using triple quotes

- Previous approach has a few drawbacks:
  - hard to read as a human
  - hard to get formatting/alignment right
  - if it's a long string (e.g., a paragraph) it's going to go off the screen
  - pain to copy and paste multiline text from somewhere else
- Use triple quotes instead, e.g.,

multiline_strings.py

```
print("""This is a multiline string
I can continue to type
over many different lines
and it won't stop until
I close the strings""")
```

```
This is a multiline string
I can continue to type
over many different lines
and it won't stop until
I close the strings
This is a string
that spans over multiple
lines
```

# Docstrings

- Docstring: a string immediately following a definition.
  - Another form of commenting.

bbq-functions-commented.py

```
def hotdogs(angie, jasmine):
    """
    Returns the number of hotdogs required for the party.

    Parameters:
    angie  -- the number of hotdogs angie will eat
    jasmine -- the number of hotdogs jasmine will eat
    """
    chris = 2 * jasmine
    brenda = chris - 1
    wenting = (brenda + 1) // 2 + 1  # add 1 to brenda to round up

    total_hotdogs = angie + jasmine + chris + brenda + wenting
    return total_hotdogs
```

# Using the `help` function to read docstrings

- If you pass a method as an argument to the help function, you will get back the docstring of that method. E.g.,

```
>>> help(hotdogs)
Help on function hotdogs in module __main__:

hotdogs(angie, jasmine)
    Returns the number of hotdogs required for the party.

    Parameters:
    angie  -- the number of hotdogs angie will eat
    jasmine -- the number of hotdogs jasmine will eat
```

- This can be VERY useful when you're using code that you haven't written!

## Conventions

- We're going to be defining docstrings for ALL functions we write from here on out.
- We'll always use triple quotes for docstrings (even if they're just one line).
- For simple functions, a one line docstring is sufficient.
- For longer ones, first give a description of what it does, then describe what each of the parameters represents.

## Good style

- Use good variable/function names.
- Use whitespace (both vertical and horizontal) to make code more readable.
- Comment code, including both comments and docstrings.
- Try and write code as simply as possible (more on this as we go).

# Lecture 3: Turtle and for loops

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# Modules

- Module: a collection of functions and variables.
- Modules allow us to use code that other people have written.
- For example, there is a module called `math` that has many of the math functions you might want.
- We can look at the documentation for this module online by searching for "math python" or by going to https://docs.python.org/3/ and browsing searching there.
  - https://docs.python.org/3/library/math.html
    - logs
    - sqrt
    - trigonometric functions
    - constants

# Importing modules

- If we want to use a module, we need to tell the program to include it with our program. To do this, we need to "import" it.
- There are many ways of importing modules (some better than others).
- For now, we're going to import the functions and variables into our program as if they were local (i.e. just as if we'd written them in our program).
  - this is convenient for now, but in some situations there are better ways of doing it (more on this later)

```
>>> from math import *
```

- This statement has multiple components:
- `from` is a keyword,
- `math` is the name of the module,
- `import` loads the module into our program,
- * means everything, i.e. load everything included in the math module.

# `turtle` module

- The turtle module implements a set of commands similar to the Logo programming language
- The basic idea is that you control the movements of a turtle (in our case, it will be an arrow) through basic commands such as:
  - `forward(distance)`: Move the turtle forward by the specified distance, in the direction the turtle is headed.
  - `backward(distance)`: Move the turtle backward by distance, opposite to the direction the turtle is headed. Do not change the turtle's heading.
  - `right(angle)`: Turn turtle right by angle units.
  - `left(angle)`: Turn turtle left by angle units.
  - ...and many others
- As the turtle moves, it draws a line behind it, so by giving it different commands, we can draw things on the screen!
- Check the documentation for the turtle class online
- You'll be getting more comfortable with this documentation as part of next week's lab.

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# Let’s move our turtle!

- How would you create a square?
- `forward(some_length)`

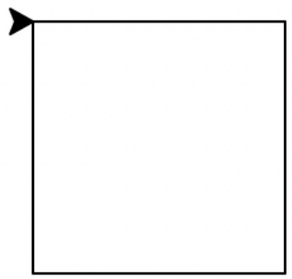
```
right(90)
forward(some_length)
right(90)
forward(some_length)
right(90)
forward(some_length)
```

# Let's move our turtle!

turtle-examples.py

```
1   from turtle import *
2   from random import randint
3
4
5   def square(length):
6       forward(length)
7       right(90)
8       forward(length)
9       right(90)
10      forward(length)
11      right(90)
12      forward(length)
13      right(90)
```

```
>>> square(100)
```



- This seems like a lot of repetitive typing. Let's say we can tell the turtle to repeat some statements, would there be a better way of creating a square?
- go forward some length and then turn right, repeat this 4 times

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# Python for loops

- Python has a number of different "loop" structures that allow us to do repetition (computers are really good at doing repetitive tasks!)
- The `for` loop is one way of doing this
- There are a number of ways we can use the for loop, but for now the basic structure we'll use is:

```
for some_variable in range(num_iterations):

    statement1

    statement2

    ...
```

# Python for loops syntaxes

```
for some_variable in range(num_iterations):
    statement1
    statement2
    …
```

- `for` is a keyword
- `in` is a keyword
- `range` is a function that we'll use to tell Python how many repetitions we want
- `num_iterations` is the number of iterations that we want the loop to do
- `some_variable` is a local variable whose scope (where it can be referred to) is only within the for loop
  - `some_variable` will take on the values from `0` to `num_iterations-1` as each iteration of the loop occurs
    - We’re computer scientists so we start counting at zero :)
  - for example, in the first iteration, it will be 0, the second time 1, the third time 2, etc.we're computer scientists so we start counting at zero :)
- Don't forget the ':' at the end!
- Like with defining functions, Python uses indenting to tell which statements belong in the for loop

# What would this code do?

```
>>> for i in range(10):
...     print(i)
... 
```

```
0
1
2
3
4
5
6
7
8
9
```

# An iterative square

turtle-examples.py

```
16  def iterative_square(length):
17      for i in range(4):
18          forward(length)
19          right(90)
20
```

## Resources

- Textbook: Continue reading Chapter 4.
- print_vs_return.txt
- multiline_strings.txt
- bbq-functions-commented.txt
- turtle-examples.txt

## Practice Problems

- Practice 1 (solution)

## Homework

- (Work in progress) - Assignment 1