MIDAS Python Workshop, 2023

Lesson 1: Data Types, Functions, and Conditionals

Arithmetic in Python

```
1 1+2
```

```
3
```

Use + to add numbers.

```
1 2*3
```

```
6
```

Use * to multiply.

```
1 2*3 - 1
```

```
5
```

Order of operations is just like you learned in elementary school.

```
1 2**7
```

```
128
```

Python is weird in that it uses ** for exponentiation instead of the more common ^.

/ for division.

```
1 6/3
```

```
2.0
```

```
1 8/3
```

```
2.6666666666666665
```

// performs division but rounds down.

```
1 8//3
```

```
2
```

% is modulo. x%y is remainder when x is divided by y.

```
1 8%3
```

```
2
```

Data Types

Programs work with **values**, which come with different **types**

Examples:

- The value `42` is an **integer**
- The value `2.71828` is a **floating point number** (i.e., decimal number)
- The value `"bird"` is a **string** (i.e., a *string of characters*)

Variable's type determines what operations we can and can't perform

- e.g., `2*3` makes sense, but what is `'cat'*'dog'`?
- (We'll come back to this in more detail in a few slides)

Variables in Python

Variable is a name that refers to a value

Assign a value to a variable via **variable assignment**

```
1 mystring = 'Die Welt ist alles was der Fall ist.'
2 approx_pi = 3.141592
3 number_of_planets = 9
```

Assign values to three variables

```
1 mystring
```

```
'Die Welt ist alles was der Fall ist.'
```

```
1 number_of_planets
```

```
9
```

```
1 number_of_planets = 8
2 number_of_planets
```

Change the value of `number_of_planets` via another assignment statement.

```
8
```

Variables in Python

Variable is a name that refers to a value

Note: unlike some languages (e.g., C/C++ and Java), you don't need to tell Python the type of a variable when you declare it. Instead, Python figures out the type of a variable automatically. Python uses what is called **duck typing**, which we will return to in a few lectures.

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1 mystring
```

```
'Die Welt ist alles was der Fall ist.'
```

```
1 number_of_planets
```

```
9
```

```
1 number_of_planets = 8
2 number_of_planets
```

```
8
```

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```
1 mystring
```

```
'Die Welt ist alles was der Fall ist.'
```

```
1 number_of_planets
```

```
9
```

```
1 number_of_planets = 8
2 number_of_planets
```

```
8
```

If it looks like a duck, swims like a duck, and quacks like a duck, then it probably is a duck.
https://en.wikipedia.org/wiki/Duck_test

Variables in Python

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Assign a value to a variable via **variable assignment**

```
1 mystring = 'Die Welt ist alles was der Fall ist.'
2 approx_pi = 3.141592
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```

```
1 mystring
```

```
'Die Welt ist alles was der Fall ist.'
```

```
1 number_of_planets
```

```
9
```

```
1 number_of_planets = 8
2 number_of_planets
```

```
8
```

Note: unlike some languages (e.g., C/C++ and Java), you don't need to tell Python the type of a variable when you declare it. Instead, Python figures out the type of a variable automatically. Python uses what is called **duck typing**, which we will return to in a few lectures.

Python variable names can be arbitrarily long, and may contain any letters, numbers and underscore (_), but may not start with a number. Variables can have any name, except for the Python 3 reserved keywords:

```
False      await      else       import     pass
None       break      except     in         raise
True       class      finally    is         return
and        continue   for        lambda     try
as         def        from       nonlocal   while
assert     del        global     not        with
async      elif       if         or         yield
```

Variables in Python

Sometimes we do need to know the type of a variable

Python `type()` function does this for us

```
1 mystring = 'Die Welt ist alles was der Fall ist.'
2 approx_pi = 3.141592
3 number_of_planets = 9
4 type(mystring)
```

```
str
```

```
1 type(approx_pi)
```

```
float
```

```
1 type(number_of_planets)
```

```
int
```

Recall that `type` is one of the Python reserved words. Syntax highlighting shows it as green, indicating that it is a special word in Python.

Variables in Python

Note: changing a variable to a different type is often called **casting** a variable to that type.

We can (sometimes) change the type of a Python variable

Convert a `float` to an `int`:

```
1 approx_pi = 3.141592
2 type(approx_pi)
```

```
float
```

```
1 pi_int = int(approx_pi)
2 type(pi_int)
```

```
int
```

```
1 pi_int
```

```
3
```

Convert a `string` to an `int`:

```
1 int_from_str = int('8675309')
2 type(int_from_str)
```

```
int
```

```
1 int_from_str
```

```
8675309
```

Variables in Python

Note: changing a variable to a different type is often called **casting** a variable to that type.

We can (sometimes) change the type of a Python variable

Convert a `float` to an `int`:

```
1 approx_pi = 3.141592
2 type(approx_pi)
```

```
float
```

```
1 pi_int = int(approx_pi)
2 type(pi_int)
```

```
int
```

```
1 pi_int
```

```
3
```

Test your understanding: what should be the value of `float_from_int`?

Convert a `string` to an `int`:

```
1 int_from_str = int('8675309')
2 type(int_from_str)
```

```
int
```

```
1 int_from_str
```

```
8675309
```

```
1 float_from_int = float(42)
2 type(float_from_int)
```

Variables in Python

Note: changing a variable to a different type is often called **casting** a variable to that type.

We can (sometimes) change the type of a Python variable

Convert a `float` to an `int`:

```
1 approx_pi = 3.141592
2 type(approx_pi)
```

```
float
```

```
1 pi_int = int(approx_pi)
2 type(pi_int)
```

```
int
```

```
1 pi_int
```

```
3
```

Test your understanding: what should be the value of `float_from_int`?

Convert a `string` to an `int`:

```
1 int_from_str = int('8675309')
2 type(int_from_str)
```

```
int
```

```
1 int_from_str
```

```
8675309
```

```
1 float_from_int = float(42)
2 type(float_from_int)
```

```
float
```

Variables in Python

We can (sometimes) change the type of a Python variable

But if we try to cast to a type that doesn't make sense...

```
1 goat_int = int('goat')
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
<ipython-input-72-6ee721a55259> in <module>()
----> 1 goat_int = int('goat')

ValueError: invalid literal for int() with base 10: 'goat'
```

`ValueError` signifies that the type of a variable is okay, but its value doesn't make sense for the operation that we are asking for.
https://docs.python.org/3/library/exceptions.html#ValueError

Variables in Python

Variables must be declared (i.e., must have a value) before we evaluate them

```
  1 answer = 2*does_not_exist
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-78-7576ff000ce0> in <module>()
----> 1 answer = 2*does_not_exist

NameError: name 'does_not_exist' is not defined
```

`NameError` signifies that Python can't find anything (variable, function, etc) matching a given name. https://docs.python.org/3/library/exceptions.html#NameError

String Operations

```
1 'one' * 'two'
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
<ipython-input-25-168e5aba40b3> in <module>()
----> 1 'one' * 'two'

TypeError: can't multiply sequence by non-int of type 'str'
```

Try to multiply two strings and Python throws an error.

`TypeError` signifies that one or more variables doesn't make sense for the operation you are trying to perform. https://docs.python.org/3/library/exceptions.html#TypeError

```
1 'cat' + 'dog'
```

```
'catdog'
```

```
1 'goat'*3
```

```
'goatgoatgoat'
```

Python uses + to mean **string concatenation**, and defines multiplication of a string by a scalar in the analogous way.

Comments in Python

Comments provide a way to document your code

- Good for when other people have to read your code
- But *also* good for you!

Comments explain to a reader (whether you or someone else) what your code is *meant* to do, which is not always obvious from reading the code itself!

```
1 # This is a comment.
2 # Python doesn't try to run code that is
3 # "commented out".
4 euler = 2.71828 # Euler's number
5 '''Triple quotes let you write a multi-line comment
6     like this one. Everything between the first
7     triple-quote and the second one will be ignored
8     by Python when you run your program'''
9 print(euler)
```

```
2.71828
```

Functions in Python

We've already seen examples of functions: e.g., `type()` and `print()`

Function calls take the form `function_name(function arguments)`

A function takes zero or more **arguments** and **returns** a value

Functions in Python

We've already seen examples of functions: e.g., `type()` and `print()`

Function calls take the form `function_name(function arguments)`

A function takes zero or more **arguments** and **returns** a value

```
1 import math
2 rt2 = math.sqrt(2)
3 print(rt2)
```

```
1.41421356237
```

```
1 a=2
2 b=3
3 math.pow(a,b)
```

```
8.0
```

Python math **module** provides a number of math functions. We have to **import** (i.e., load) the module before we can use it.

`math.sqrt()` takes one argument, returns its square root.

`math.pow()` takes two arguments. Returns the value obtained by raising the first to the power of the second.

Functions in Python

Note: in the examples below, we write `math.sqrt()` to call the `sqrt()` function from the `math` module. This "dot" notation will show up a lot this semester, so get used to it!

We've already seen examples of functions: e.g., `type()` and `print()`

Function calls take the form `function_name(function arguments)`

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Python math **module** provides a number of math functions. We have to **import** (i.e., load) the module before we can use it.

`math.sqrt()` takes one argument, returns its square root.

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1 a=2
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3 math.pow(a,b)
```

```
8.0
```

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Functions in Python

Note: in the examples below, we write `math.sqrt()` to call the `sqrt()` function from the `math` module. This notation will show up a lot this semester, so get used to it!

We've already seen examples of functions: e.g., `type()` and `print()`

Function calls take the form `function_name(function arguments)`

A function takes zero or more **arguments** and **returns** a value

```
1 import math
2 rt2 = math.sqrt(2)
3 print(rt2)
```

```
1.41421356237
```

```
1 a=2
2 b=3
3 math.pow(a,b)
```

```
8.0
```

Documentation for the Python `math` module: https://docs.python.org/3/library/math.html

Functions in Python

Functions can be **composed**

- Supply an expression as the argument of a function
- Output of one function becomes input to another

```
1  a = 60
2  math.sin( (a/360)*2*math.pi )
```

```
0.8660254037844386
```

`math.sin()` has as its argument an expression, which has to be evaluated before we can compute the answer.

```
1  x = 1.71828
2  y = math.exp( -math.log(x+1))
3  y # approx'ly e^{-1}
```

```
0.36787968862663156
```

Functions can even have the outputs of other functions as their arguments.

Defining Functions

We can make new functions using **function definition**

Creates a new function, which we can then call whenever we need it

```
1  def print_wittgenstein():
2      print("Die Welt ist alles")
3      print("was der Fall ist")
```

```
1  print_wittgenstein()
```

```
Die Welt ist alles
was der Fall ist
```

Let's walk through this line by line.

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1 def print_wittgenstein():
2     print("Die Welt ist alles")
3     print("was der Fall ist")
```

```
1 print_wittgenstein()
```

```
Die Welt ist alles
was der Fall ist
```

This line (called the **header** in some documentation) says that we are defining a function called `print_wittgenstein`, and that the function takes no argument.

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```
1  print_wittgenstein()
```

```
Die Welt ist alles
was der Fall ist
```

The `def` keyword tells Python that we are defining a function.

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```

```
1  print_wittgenstein()
```

```
Die Welt ist alles
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```

Any arguments to the function are giving inside the parentheses. This function takes no arguments, so we just give empty parentheses. In a few slides, we'll see a function that takes arguments.

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3      print("was der Fall ist")
```

```
1  print_wittgenstein()
```

```
Die Welt ist alles
was der Fall ist
```

The colon (`:`) is required by Python's syntax. You'll see this symbol a lot, as it is commonly used in Python to signal the start of an indented block of code. (more on this in a few slides).

Defining Functions

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Creates a new function, which we can then call whenever we need it

```
1  def print_wittgenstein():
2      print("Die Welt ist alles")
3      print("was der Fall ist")
```

This is called the **body** of the function. This code is executed whenever the function is called.

```
1  print_wittgenstein()
```

```
Die Welt ist alles
was der Fall ist
```

Defining Functions

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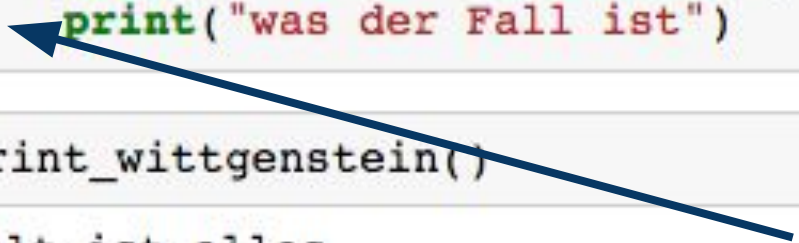
1  def print_wittgenstein():
2      print("Die Welt ist alles")
3      print("was der Fall ist")
```

```
1  print_wittgenstein()
```

```
Die Welt ist alles
was der Fall ist
```



Note: in languages like R, C/C++ and Java, code is organized into **blocks** using curly braces ({ and }). Python is **whitespace delimited**. So we tell Python which lines of code are part of the function definition using indentation.

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1  def print_wittgenstein():
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```

```
1  print_wittgenstein()
```

```
Die Welt ist alles
was der Fall ist
```

This whitespace can be tabs, or spaces, so long as it's consistent. It is taken care of automatically by most IDEs.

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```
1  def print_wittgenstein():
2      print("Die Welt ist alles")
3      print("was der Fall ist")
```

```
1  print_wittgenstein()
```

```
Die Welt ist alles
was der Fall ist
```

We have defined our function. Now, any time we call it, Python executes the code in the definition, in order.

Defining Functions

After defining a function, we can use it anywhere, including in other functions

```
1 def wittgenstein_sandwich(bread):
2     print(bread)
3     print_wittgenstein()
4     print(bread)
5 wittgenstein_sandwich('here is a string')
```

```
here is a string
Die Welt ist Alles
was der Fall ist.
here is a string
```

This function takes one argument, prints it, then prints our Wittgenstein quote, then prints the argument again.

Defining Functions

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```
1 def wittgenstein_sandwich(bread):
2     print(bread)
3     print_wittgenstein()
4     print(bread)
5 wittgenstein_sandwich('here is a string')
```

```
here is a string
Die Welt ist Alles
was der Fall ist.
here is a string
```

This function takes one argument, which we call `bread`. All the arguments named here act like variables **within the body of the function**, but not outside the body. We'll return to this in a few slides.

Defining Functions

After defining a function, we can use it anywhere, including in other functions

```
1 def wittgenstein_sandwich(bread):
2     print(bread)
3     print_wittgenstein()
4     print(bread)
5 wittgenstein_sandwich('here is a string')
```

```
here is a string
Die Welt ist Alles
was der Fall ist.
here is a string
```

Body of the function specifies what to do with the argument(s). In this case, we print whatever the argument was, then print our Wittgenstein quote, and then print the argument again.

Defining Functions

After defining a function, we can use it anywhere, including in other functions

```
1 def wittgenstein_sandwich(bread):
2     print(bread)
3     print_wittgenstein()
4     print(bread)
5 wittgenstein_sandwich('here is a string')
```

```
here is a string
Die Welt ist Alles
was der Fall ist.
here is a string
```

Now that we've defined our function, we can call it. In this case, when we call our function, the variable bread in the definition gets the value `'here is a string'`, and then proceeds to run the code in the function body.

Defining Functions

After defining a function, we can use it anywhere, including in other functions

```
1 def wittgenstein_sandwich(bread):
2     print(bread)
3     print_wittgenstein()
4     print(bread)
5 wittgenstein_sandwich('here is a string')
```

```
here is a string
Die Welt ist Alles
was der Fall ist.
here is a string
```

Note: this last line is **not** part of the function body. We communicate this fact to Python by the indentation. Python knows that the function body is finished once it sees a line without indentation.

Now that we've defined our function, we can call it. In this case, when we call our function, the variable bread in the definition gets the value `'here is a string'`, and then proceeds to run the code in the function body.

Defining Functions

Using the `return` keyword, we can define functions that produce results

```
1 def double_string(string):
2     return 2*string
```

```
1 double_string('bird')
```

```
'birdbird'
```

```
1 twogoats = double_string('goat')
```

```
1 print(twogoats)
```

```
goatgoat
```

Defining Functions

Using the `return` keyword, we can define functions that produce results

```
1 def double_string(string):
2     return 2*string
```

`double_string` takes one argument, a string, and **returns** that string, concatenated with itself.

```
1 double_string('bird')
```

```
'birdbird'
```

```
1 twogoats = double_string('goat')
```

```
1 print(twogoats)
```

```
goatgoat
```

Defining Functions

Using the `return` keyword, we can define functions that produce results

```
1 def double_string(string):
2     return 2*string
```

```
1 double_string('bird')
```

```
'birdbird'
```

```
1 twogoats = double_string('goat')
```

```
1 print(twogoats)
```

```
goatgoat
```

So when Python executes this line, it takes the string `'bird'`, which becomes the parameter `string` in the function `double_string`, and this line **evaluates** to the string `'birdbird'`.

Defining Functions

Using the `return` keyword, we can define functions that produce results

```
1 def double_string(string):
2     return 2*string
```

```
1 double_string('bird')
```

```
'birdbird'
```

```
1 twogoats = double_string('goat')
```

```
1 print(twogoats)
```

```
goatgoat
```

Alternatively, we can call the function and assign its result to a variable, just like we did with the functions in the `math` module.

Defining Functions

```
1 def wittgenstein_sandwich(bread):
2     local_var = 1 # define a useless variable, just as example.
3     print(bread)
4     print_wittgenstein()
5     print(bread)
6 print(bread)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-96-8745f5bed0d2> in <module>()
      4     print_wittgenstein()
      5     print(bread)
----> 6 print(bread)

NameError: name 'bread' is not defined
```

Variables are **local**. Variables defined inside a function body can't be referenced outside.

```
1 print(local_var)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-97-38c61bb47a8e> in <module>()
----> 1 print(local_var)

NameError: name 'local_var' is not defined
```

Defining Functions

When you define a function, you are actually creating a variable of type **function**

Functions are objects that you can treat just like other variables

```
1 type(print_wittgenstein)
```

```
function
```

```
1 print_wittgenstein
```

```
<function __main__.print_wittgenstein>
```

```
1 print(print_wittgenstein)
```

```
<function print_wittgenstein at 0x10aa0aaa0>
```

This number is the address in memory where `print_wittgenstein` is stored. It may be different on your computer.

Boolean Expressions

Boolean expressions evaluate the truth/falsity of a statement

Python supplies a special Boolean type, `bool`
variable of type `bool` can be either `True` or `False`

```
1 type(True)
```

```
bool
```

```
1 type(False)
```

```
bool
```

Boolean Expressions

Comparison operators available in Python:

```
1 x == y # x is equal to y
2 x != y # x is not equal to y
3 x > y # x is strictly greater than y
4 x < y # x is strictly less than y
5 x >= y # x is greater than or equal to y
6 x <= y # x is less than or equal to y
```

Expressions involving comparison operators evaluate to a Boolean.

```
1 x = 10
2 y = 20
3 x == y
```

```
False
```

```
1 x != y
```

```
True
```

```
1 x < x
```

```
False
```

```
1 x <= x
```

```
True
```

Note: In true Pythonic style, one can compare many types, not just numbers. Most obviously, strings can be compared, with ordering given alphabetically.

Boolean Expressions

Can combine Boolean expressions into larger expressions via **logical operators**

In Python: `and`, `or` and `not`

```
1 x = 10
2 x < 20 and x > 0
```

```
True
```

```
1 x > 100 and x > 0
```

```
False
```

```
1 x > 100 or x > 0
```

```
True
```

```
1 not x > 0
```

```
False
```

Note: technically, any nonzero number or any nonempty string will evaluate to `True`, but you should avoid comparing anything that isn't Boolean.

```
1 1 and x > 0
```

```
True
```

```
1 0 and x > 0
```

```
0
```

```
1 'cat' and x > 0
```

```
True
```

```
1 '' and x > 0
```

```
''
```

Boolean Expressions: Example

Let's see Boolean expressions in action

```
1 def is_even(n):
2     # Returns a boolean.
3     # Returns True if and only if
4     # n is an even number.
5     return n % 2 == 0
```

Reminder: `x % y` returns the remainder when `x` is divided by `y`.

Note: in practice, we would want to include some extra code to check that `n` is actually a number, and to "fail gracefully" if it isn't, e.g., by throwing an error with a useful error message. More about this in future lectures.

```
1 is_even(0)
```
```
True
```

```
1 is_even(1)
```
```
False
```

```
1 is_even(8675309)
```
```
False
```

```
1 is_even(-3)
```
```
False
```

```
1 is_even(12)
```
```
True
```

Conditional Expressions

Sometimes we want to do different things depending on certain conditions

```
x = 10
if x > 0:
    print('x is bigger than 0')
if x > 1:
    print('x is bigger than 1')
if x > 100:
    print('x is bigger than 100')
if x < 100:
    print('x is less than 100')
```

```
x is bigger than 0
x is bigger than 1
x is less than 100
```

Conditional Expressions

Sometimes we want to do different things depending on certain conditions

```
2 if x > 0:
3     print('x is bigger than 0')
5     print('x is bigger than 1')
6 if x > 100:
7     print('x is bigger than 100')
8 if x < 100:
9     print('x is less than 100')
```

This is an **if-statement**.

```
x is bigger than 0
x is bigger than 1
x is less than 100
```

Conditional Expressions

Sometimes we want to do different things depending on certain conditions

```
1  x = 10
2  if x > 0:
3      print('x is bigger than 0')
4  if x > 1:
5      print('x is bigger than 1')
6  if x > 100:
7      print('x is bigger than 100')
8  if x < 100:
9      print('x is less than 100')
```

This Boolean expression is called the **test condition**, or just the **condition**.

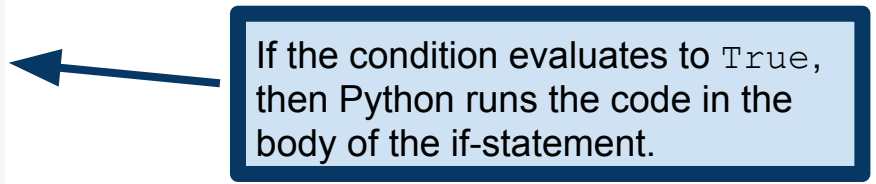
```
x is bigger than 0
x is bigger than 1
x is less than 100
```

Conditional Expressions

Sometimes we want to do different things depending on certain conditions

```
1  x = 10
2  if x > 0:
3      print('x is bigger than 0')
4  if x > 1:
5      print('x is bigger than 1')
6  if x > 100:
7      print('x is bigger than 100')
8  if x < 100:
9      print('x is less than 100')
```

```
x is bigger than 0
x is bigger than 1
x is less than 100
```



Conditional Expressions

Sometimes we want to do different things depending on certain conditions

```
1  x = 10
2  if x > 0:
3      print('x is bigger than 0')
4  if x > 1:
5      print('x is bigger than 1')
6  if x > 100:
7      print('x is bigger than 100')
8  if x < 100:
9      print('x is less than 100')
```

```
x is bigger than 0
x is bigger than 1
x is less than 100
```

If the condition evaluates to `False`, then Python skips the body and continues running code starting at the end of the if-statement.

Conditional Expressions

Sometimes we want to do different things depending on certain conditions

```
1  x = 10
2  if x > 0:
3      print('x is bigger than 0')
4  if x > 1:
5      print('x is bigger than 1')
6  if x > 100:
7      print('x is bigger than 100')
8  if x < 100:
9      print('x is less than 100')
```

```
x is bigger than 0
x is bigger than 1
x is less than 100
```

Note: the body of a conditional statement can have any number of lines in it, but it must have at least one line. To do nothing, use the `pass` keyword.

```
1  y = 20
2  if y > 0:
3      pass # TODO: handle positive numbers!
4  if y < 100:
5      print('y is less than 100')
```

```
y is less than 100
```

Conditional Expressions

More complicated logic can be handled with **chained conditionals**

```
1  def pos_neg_or_zero(x):
2      if x < 0:
3          print('That is negative')
4      elif x == 0:
5          print('That is zero.')
6      else:
7          print('That is positive')
8  pos_neg_or_zero(1)
```

```
That is positive
```

```
1  pos_neg_or_zero(0)
2  pos_neg_or_zero(-100)
3  pos_neg_or_zero(20)
```

```
That is zero.
That is negative
That is positive
```

Conditional Expressions

More complicated logic can be handled with **chained conditionals**

```
1  def pos_neg_or_zero(x):
2      if x < 0:
3          print('That is negative')
4      elif x == 0:
5          print('That is zero.')
6      else:
7          print('That is positive')
8  pos_neg_or_zero(1)
```

This is treated as a single if-statement.

```
That is positive
```

```
1  pos_neg_or_zero(0)
2  pos_neg_or_zero(-100)
3  pos_neg_or_zero(20)
```

```
That is zero.
That is negative
That is positive
```

Conditional Expressions

More complicated logic can be handled with **chained conditionals**

```
1  def pos_neg_or_zero(x):
2      if x < 0:
3          print('That is negative')
4      elif x == 0:
5          print('That is zero.')
6      else:
7          print('That is positive')
8  pos_neg_or_zero(1)
```

```
That is positive
```

If this expression evaluates to `True`...

```
1  pos_neg_or_zero(0)
2  pos_neg_or_zero(-100)
3  pos_neg_or_zero(20)
```

```
That is zero.
That is negative
That is positive
```

Conditional Expressions

More complicated logic can be handled with **chained conditionals**

```
1  def pos_neg_or_zero(x):
2      if x < 0:
3          print('That is negative')
4      elif x == 0:
5          print('That is zero.')
6      else:
7          print('That is positive')
8  pos_neg_or_zero(1)
```

```
That is positive
```

...then this block of code is executed...

```
1  pos_neg_or_zero(0)
2  pos_neg_or_zero(-100)
3  pos_neg_or_zero(20)
```

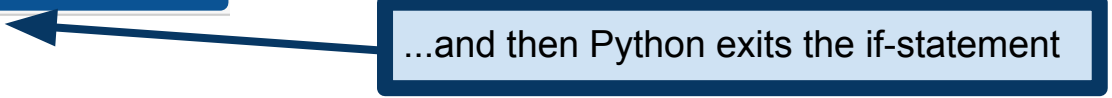
```
That is zero.
That is negative
That is positive
```

Conditional Expressions

More complicated logic can be handled with **chained conditionals**

```
1  def pos_neg_or_zero(x):
2      if x < 0:
3          print('That is negative')
4      elif x == 0:
5          print('That is zero.')
6      else:
7          print('That is positive')
8  pos_neg_or_zero(1)
```

```
That is positive
```




```
1  pos_neg_or_zero(0)
2  pos_neg_or_zero(-100)
3  pos_neg_or_zero(20)
```

```
That is zero.
That is negative
That is positive
```

Conditional Expressions

More complicated logic can be handled with **chained conditionals**

```
1  def pos_neg_or_zero(x):
2      if x < 0:
3          print('That is negative')
4      elif x == 0:
5          print('That is zero.')
6      else:
7          print('That is positive')
8  pos_neg_or_zero(1)
```

If this expression evaluates to `False`...

```
That is positive
```

```
1  pos_neg_or_zero(0)
2  pos_neg_or_zero(-100)
3  pos_neg_or_zero(20)
```

```
That is zero.
That is negative
That is positive
```

Conditional Expressions

More complicated logic can be handled with **chained conditionals**

```
1  def pos_neg_or_zero(x):
2      if x < 0:
3          print('That is negative')
4      elif x == 0:
5          print('That is zero.')
6      else:
7          print('That is positive')
8  pos_neg_or_zero(1)
```

```
That is positive
```

Note: `elif` is short for **else if**.

...then we go to the condition. If this condition fails, we go to the next condition, etc.

```
1  pos_neg_or_zero(0)
2  pos_neg_or_zero(-100)
3  pos_neg_or_zero(20)
```

```
That is zero.
That is negative
That is positive
```

Conditional Expressions

More complicated logic can be handled with **chained conditionals**

```
1  def pos_neg_or_zero(x):
2      if x < 0:
3          print('That is negative')
4      elif x == 0:
5          print('That is zero.')
6      else:
7          print('That is positive')
8  pos_neg_or_zero(1)
```

```
That is positive
```

If all the other tests fail, we execute the block in the `else` part of the statement.

```
1  pos_neg_or_zero(0)
2  pos_neg_or_zero(-100)
3  pos_neg_or_zero(20)
```

```
That is zero.
That is negative
That is positive
```

Conditional Expressions

Conditionals can also be nested

```
if x == y:
    print('x is equal to y')
else:
    if x > y:
        print('x is greater than y')
    else:
        print('y is greater than x')
```

This if-statement...

Conditional Expressions

Conditionals can also be nested

```
if x == y:
    print('x is equal to y')
else:
    if x > y:
        print('x is greater than y')
    else:
        print('y is greater than x')
```

This if-statement...

...contains another if-statement.

Conditional Expressions

Often, a nested conditional can be simplified

When this is possible, I recommend it for the sake of your sanity, because debugging complicated nested conditionals is tricky!

These two if-statements are equivalent, in that they do the same thing!

```
1  if x > 0:
2      if x < 10:
3          print('x is a positive single-digit number.')
```

But the second one is (arguably) preferable, as it is simpler to read.

```
1  if 0 < x and x < 10:
2      print('x is a positive single-digit number.')
```