IIT Madras
BSc Degree

Home Lesson-2.2

Lesson-2.1

Variables

Introduction

Variables are containers that are used to store values. Variables in Python are defined by using the assignment operator `=`. For example:

```
x = 1
y = 100.
z = "good"
```

Variables can also be updated using the assignment operator:

```
x = 1
print('The initial value of x is', x)
x = 2
print('The value after updating x is', x)
```

The output is:

```
The initial value of x is 1
The value after updating x is 2
```

Assignment Operator

The syntax of the assignment statement is as follows:

> <variable-name> = <expression>

The assignment operator works from right to left. That is, the expression on the right is evaluated first. The value of this expression is assigned to the variable on the left. For example:

```
x = 1 + 2 * 3 / 2
print(x)
```

The output is:

```
4.0
```

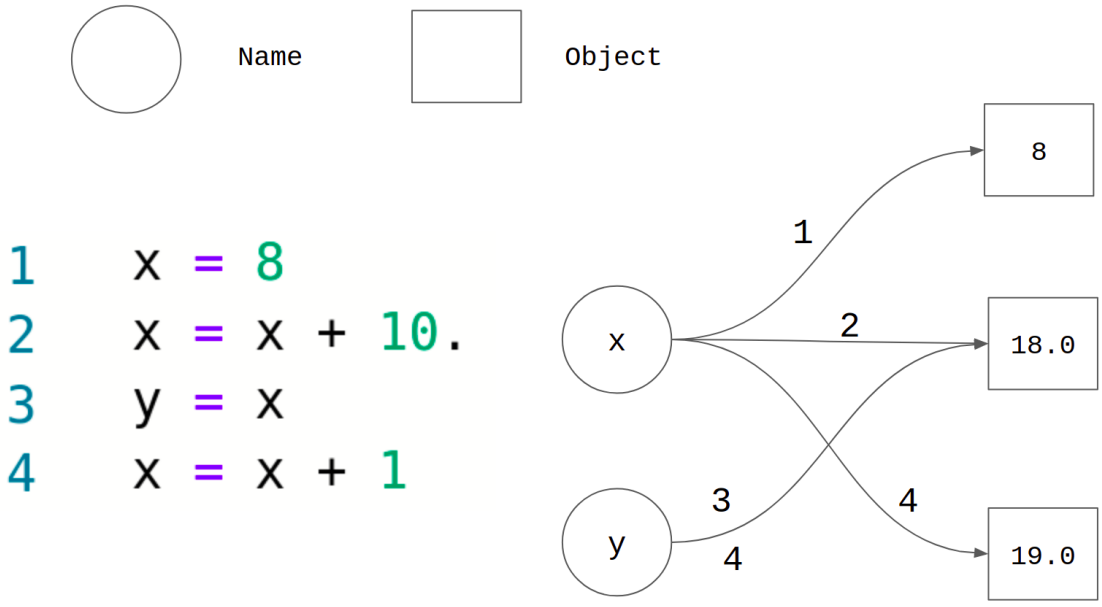
Having a literal to the left of the assignment operator will result in an error:

```
##### Alarm! Wrong code snippet! #####
3 = x
##### Alarm! Wrong code snippet! #####
```

This will throw the following error:

```
SyntaxError: cannot assign to literal
```

The assignment statement maps or binds the variable name on the left to an object on the right. A closer look at the anatomy of an assignment statement:



The number on any arrow represents the line number in the code. The variable on the left binds to the object on the right after the corresponding line is executed. For example, the variable `x` binds to the object `8` - in this case an `int` literal - after line-1 is executed. The interesting part is line-3. Note that `y = x` makes both `x` and `y` bind to the same object. When `x` is updated in line-4, it binds to a new object. However, the value of `y` is not disturbed by this operation. It continues to be bound to the object `18.0` even after line-4 is executed.

As a final point, the assignment operator should not be confused with the equality operator:

```
x = 2   # this is the assignment operator
x == 2  # this is the equality operator
```

The assignment operator must be used for creating or updating variables; the equality operator must be used when two expressions need to be compared. They cannot be used interchangeably!

Dynamic Typing

Python supports what is called dynamic typing. In a dynamically typed language, a variable is simply a value bound to a name; the value has a type — like `int` or `str` — but the variable itself doesn't [refer]. For example:

```
a = 1
print(type(a))
a = 1 / 2
print(type(a))
```

The output is:

```
<class 'int'>
<class 'float'>
```

In the above example, `a` was initially bound to a value of type `int`. After its update in line-3, it was bound to a value of type `float`. The image in the previous section will give a clearer picture of why this is the case.

Referencing versus Defining

When a variable that has already been defined is used in an expression, we say that the variable is being referenced. For example:

```
x = 2
print(x * x, 'is the square of', x)
```

In line-2, we are referencing the variable `x` which was assigned a value in line-1. If a variable is referenced before it has been assigned a value, the interpreter throws an exception called `NameError`:

```
print(someVar)
```

This is the output:

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

Keywords and Naming Rules

Keywords are certain words in the Python language that have a special meaning. Some of them are listed below:

```
not, and, or, if, for, while, in, is, def, class
```

We have already seen some of them - `not, and, or`. We will come across all these keywords in upcoming chapters. Keywords cannot be used as names for variables. For example, the following line of code will throw a SyntaxError when executed:

```
##### Alarm! Wrong code snippet! #####
and = 2
##### Alarm! Wrong code snippet! #####
```

Along with this restriction, there are certain other rules which have to be followed while choosing the names of variables in Python [refer]:

- A variable name can only contain alpha-numeric (alphabets and numbers) characters and underscores:
  - `a - z`
  - `A - Z`
  - `0 - 9`
  - `_`
- A variable name must start with a letter or the underscore character.

Few observations that directly follow from the above rules:

- A variable name cannot start with a number.
- Variable names are case-sensitive (`age`, `Age` and `AGE` are three different variables).

Note that these are not merely conventions. Violating any one of these rules will result in a `SyntaxError`. As an example, the following code will throw a `SyntaxError` when executed:

```
##### Alarm! Wrong code snippet! #####
3a = 1
##### Alarm! Wrong code snippet! #####
```

Reusing Variables

Variables can be used in computing the value of other variables. This is something that will routinely come up in programming and data science. Consider the following sequence of mathematical equations. We wish to evaluate the value of `z` at `x = 10`:

$$y = x^2$$
$$z = (x+1)(y+1)$$

This can be computed as follows:

```
x = 10
y = x ** 2
z = (x + 1) * (y + 1)
```

Multiple Assignment

Consider the following statement that defines two variables `x` and `y`.

```
x = 1
y = 2
```

Python allows a compact way of writing this assignment on the same line. The following code assigns 1 to the variable `x` and 2 to the variable `y`:

```
x, y = 1, 2
```

Note that the order matters. The following code assigns 2 to the variable `x` and 1 to the variable `y`:

```
x, y = 2, 1
```

To understand how this works, we need to get into the concept of packing and unpacking tuples, which we will visit in chapter-5. Treat this as a useful feature for the time being. Another way of doing multiple assignments is to initialize multiple variables with the same value:

```
x = y = z = 10
print(x, y, z)
```

The output is:

```
10 10 10
```

Though `x`, `y` and `z` start off by being equal, the equality is broken the moment even one of the three variables is updated:

```
x = x * 1
y = y * 2
z = z * 3
print(x, y, z)
```

The output is:

```
10 20 30
```

Assignment Shortcuts

Execute the code given below and observe the output. What do you think is happening?

```
x = 1
x += 1
print(x)
```

`+=` is something that we haven't seen before.

> `x += a`
>
> Increment the value of `x` by `a`. In other words, add `a` to `x` and store the result in `x`. It is equivalent to the statement `x = x + a`.

This is not just limited to the addition operator. The following table gives a summary of the shortcuts for some of the arithmetic operators:

Shortcut	Meaning
`x += a`	`x = x + a`
`x -= a`	`x = x - a`
`x *= a`	`x = x * a`
`x /= a`	`x = x / a`
`x %= a`	`x = x % a`
`x **= a`	`x = x ** a`

Note that the arithmetic operator must always come before the assignment operator in a shortcut. Swapping them will not work:

```
x = 1
x =+ 1
print(x)
```

This will give `1` as the output. This is because `+` is treated as the unary operator here. Statements like `x =* 1` or `x =/ 2` will result in errors!

Deleting Variables

Variables can be deleted by using the `del` keyword:

```
x = 100
print('x is a variable whose value is', x)
print('we are now going to delete x')
del x
print(x)
```

When this code is executed, line-5 throws a `NameError`. This is because `x` was deleted in line-4 and we are trying to access a variable that is no longer defined at line-5.