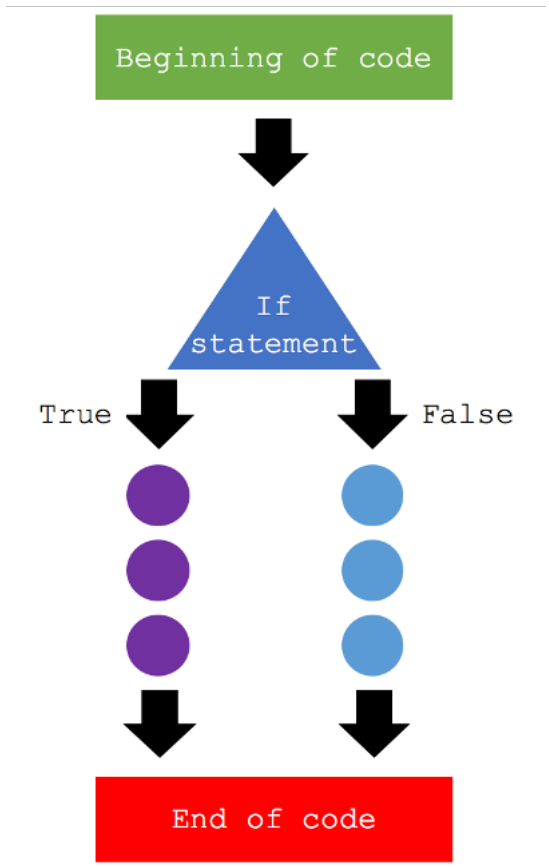
Lesson 3

July 16, 2020

1 Lesson 3: Introduction to Programming III

1.1 If Operations

While Booleans maybe didn't seem that important before, they can be really useful in constructs called If Statements. If Statements allow you to establish instructions throughout your code; they create decision points so that a block of code is only executed if a certain condition is true.



This is a flowchart of what happens in your code that contains an If Statement. Notice how it can execute two different paths, depending on whether a condition is true or false.

If Statements usually contain a conditional statement that can be evaluated as either True or False (Booleans!). There are six main operators used in the conditional parts of if statements: - >

Greater than - < Less than - >= Greater than or equal to - <= Less than or equal to - != Not equal to - == Equal to

Let's try a simple example. Can you predict the output of the following code? Type it below to check your answer!

[2]:
```
age = 16
if age >= 18: # Here ">=" means greater than or equal to
     print("You are eligible to vote in the United States")
if age < 18: # Here "<" means less than
     print("Sorry you cannot vote (yet)!")
```

```
Sorry you cannot vote (yet)!
```

Change your age to text (e.g. "Sixteen"). Can you predict the result?

[5]:
```
age = "Sixteen"
if age >= 18: # Here ">=" means greater than or equal to
     print("You are eligible to vote in the United States")
if age < 18: # Here "<" means less than
     print("Sorry you cannot vote (yet)!")

# NOTE: in Python 3, this would yeild an error, as you cannot
# compare strings and integers (as in line 3); however, this
# is possible in Python 2, where this is written!
```

```
You are eligible to vote in the United States
```

1.2 Checkpoint #1

So far, we've covered if statements. Test what you've learned with the following exercises:

What would you expect the output of the following code to be?

[14]:
```
handedness = "right"
if handedness == "left":
    print("You are left-handed")
if handedness == "right":
    print("You are right-handed")
```

```
You are right-handed
```

There is another way to write this same code! Try running the following code below:

[15]:
```
handedness = "right"
if handedness == "left":
    print("You are left-handed")
else:
    print("You are right-handed")
```

```
You are right-handed
```

Yup, that's right - "else" results in the same output!

Try making handedness a variable storing any string or integer (not "right"). See the difference between our first and second program?

[16]:
```
handedness = 3 # Could be anything
if handedness == "left":
    print("You are left-handed")
if handedness == "right": # No output!
    print("You are right-handed")
```

[17]:
```
handedness = 3
if handedness == "left":
    print("You are left-handed")
else:
    print("You are right-handed")
```

```
You are right-handed
```

[18]:
```
## Whitespace
```

You might have noticed that statements under the conditional are all indented. This is actually critical to the format of code in Python. See what happens when we don't include the whitespace:

[19]:
```
handedness = "right"
if handedness == "left": # Equal to
print("You are left-handed")
```

```
  File "<ipython-input-19-d5fcb71af447>", line 3
    print("You are left-handed")
        ^
IndentationError: expected an indented block
```

Notice that the error says "expected an indented block." In this case, Python is actually giving a very informative error message, because that is exactly the problem. Also note that the colon : is a critical part of the syntax of the if statement!

Whenever we have a conditional statement (if or else), the command executed below it must be indented. This tells Python which commands are dependent on the if statement and which are not.

Let's try another example. Can you fix the following code so that the output is "I have an apple!"

[22]:
```
myFruit = "apple"
if myFruit == "orange":
     print("I have an orange")
if myFruit == "grapefruit":
    print("I have a grapefruit") # Added indent
```

```
if myFruit == "apple":
     print("I have a apple")
if myFruit == "banana":
    print("I have a banana") # Added indent
```

```
I have a apple
```

Notice that there are two errors and they BOTH need to be fixed before the code will run without error.

[ ]:
```
## Elif
```

Sometimes it is better to have more than two conditions so that we can capture more possibilities. To do this, we can use another conditional command called "elif" (short for "else if"), which evaluates only if the preceding if statement is not true. This allows us to make more complicated flowcharts of commands. Take a look at the example below. Can you predict what the output of the following code would be?

[26]:
```
tempInCelsius = 25
if tempInCelsius < 0:
     print("Your water is frozen")
elif tempInCelsius > 100:
     print("Your water is boiling")
else:
     print("Your water is liquid (not freezing or boiling)!")
```

```
Your water is liquid (not freezing or boiling)!
```

Given that the tempInCelsius is neither below 0 ˚ or above 100 ˚, the water is liquid.

Let's try another example. We have written a program that should print out a password depending on the size of the number. Try to select a "secretID" that would cause the program to print: "Your Pokemon is: MewTo"

[33]:
```
secretID = 40 # Put your answer here!
if secretID > 100:
    print("Your Pokemon is: Charizard!")
elif secretID > 70:
     print("Your Pokemon is: Pikachu!")
elif secretID > 40:
     print("Your Pokemon is: Rattata!")
elif secretID >= 40:
     print("Your Pokemon is: MewTo!")
else:
     print("Your Pokemon is: Wobbuffet!")
```

```
Your Pokemon is: MewTo!
```

The answer is 40!

For professional coders most of their time is spent checking and rechecking the logic

[34]:
```
## Checkpoint #2
```

Now it's your turn!

1. Store your eye color in a variable as a string. Then, write an if statement that prints "Your eyes are brown!" if they are brown and prints "Your eyes are not brown!" if they aren't.

[37]:
```
myEyeColor = "brown"
if myEyeColor == "brown":
    print("Your eyes are brown!")
else:
    print("Your eyes are not brown!")
```

```
Your eyes are brown!
```

2. There are lots of other eye colors besides brown, so let's make our solution more comprehensive. Now have an if statement for brown eyes, blue eyes, green eyes, and an "else" statement if none of those colors apply. For each if statement, print "Your eyes are" (the appropriate color).

[36]:
```
myEyeColor = "brown"
if myEyeColor == "brown":
    print("Your eyes are brown!")
elif myEyeColor == "blue":
    print("Your eyes are blue!")
elif myEyeColor == "green":
    print("Your eyes are green!")
else:
    print("Your eyes are not brown, blue, or green!")
```

```
Your eyes are brown!
```

[ ]:
```
## Nested If
```

If Statements can be stacked one after another as you have seen in previous examples, but it is also possible for If Statements to be nested within a parent If Statement. Let's look at an example below:

[39]:
```
operation = "division"
number1 = 9
number2 = 3
if operation == "division":
    if number2 == 0:
          print("You cannot divide by zero")
    else:
           print(number1 / number2)

elif operator == "multiplication":
    print(number1 * number2)
```

```
3
```

The first If Statement checks to determine if the operation is division. If so, then there is a secondary check to determine if the denominator (number2 in this case) is zero.

Now let's have you try. Let's complete this calculator by adding addition and subtraction. But our calculator has two special requirements:

The two variables (number1 and number 2) should always be positive

The result of any calculation should never be less than zero (HINT: watch out for subtraction)

If either of these rules are violated, the calculator should print: "This operation is not allowed"

[42]:
```
operation = "subtraction"
number1 = 9
number2 = 3
if operation == "subtraction":
    if number2 > number1:
        print("This operation is not allowed")
    else:
        print(number1 - number2)
elif operation == "addition":
    print(number1 + number2)
```

```
6
```

For this exercise, it's okay if you didn't reach exactly the same lines of code as we did - it's great if you found a new way to get to the same answers!

[ ]:
```
## Lesson 3 Summary
```

In Lesson 3 we have covered the following: - If Statements - Whitespace Issues - Elif Statements - Nested If Statements

Let's put together everything that we learned and try a real world example.

Review the table below - it shows the freezing and boiling temperatures for a few common substances. It is often important in science to know at what temperature certain substances change states of matter. Let's create a program that will tell us whether our substance is freezing, boiling or neither.

- Water /// Freezing point = 0 /// Boiling point = 100
- Carbon Dioxide /// Freezing point = -78 /// Boiling point = -57
- Mercury /// Freezing point = -39 /// Boiling point = 357
- Ethanol /// Freezing point = -114 /// Boiling point = 78
- Gold /// Freezing point = 1064 /// Boiling point = 2856

1. Start by creating two variables, one to contain our substance and one to contain our temperature.

2. Create a series of If Statements to check which substance we're dealing with (you can select two for simplicity)

3. Then within each If Statement, we should check to see if the temperature is above the boiling point, lower than the freezing point, or neither
4. The result should be a printed statement that says: [Substance] is [Solid, Liquid, or Gas]

[49]:
```
substance = "Mercury"
temperature = 25
if substance == "Water":
    if temperature > 100:
           print(substance + " is gas")
    elif temperature < 0:
           print(substance + " is solid")
    else:
           print(substance + " is liquid")
elif substance == "Mercury":
    if temperature > 357:
           print(substance + " is gas")
    elif temperature < -39:
           print(substance + " is solid")
    else:
           print(substance + " is liquid")
```

```
Mercury is liquid
```

For this exercise, it's okay if you didn't reach exactly the same lines of code as we did - it's great if you found a new way to get to the same answers!

Extend yourself: What state are each of these substances in at room temperature (25 C)?

- Water (liquid)
- Carbon dioxide (gas)
- Mercury (liquid)
- Ethanol (liquid)
- Gold (solid)