PLTW COMPUTER SCIENCE

Activity 1.3.3

Branching and Output

Introduction

Computers can sometimes appear intelligent because they can make a decision. A program that lets you text from a mobile device might decide to auto-correct your text. A program to provide driving directions might decide you've gone the wrong way. All programming languages have a way to branch, executing one set of instructions or another, depending on a condition.

How is this done in *Python*® programming language? And how can we get output from a program to know what the program has decided?

Materials

- Computer with Enthought Canopy distribution of *Python*® programming language

Procedure

1. Form pairs as directed by your teacher. Meet or greet each other to practice professional skills.

2. Launch Canopy and open an editor window. Set the working directory for the IPython session and turn on session logging. Open a new file in the code editor and save it as `JDoeJSmith_1_3_3.py`.

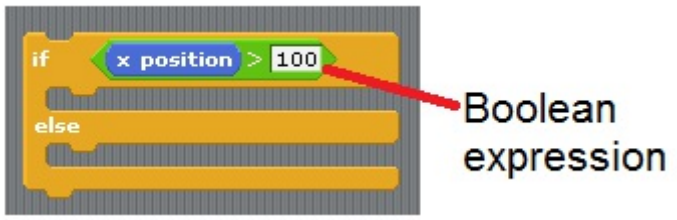
   ```
   In []: %logstart -ort studentName_1_3_3.log
   In []: # Jane Doe John Smith 1.3.3 IPython log
   ```

3. In the previous activity, you learned that you can assign values to variables of different types. You learned that you can evaluate expressions and can define functions that return a value.

   ```
   In []: a = 3
   In []: a**2
   Out[]: 9
   ```

Part I: Conditionals

3. As you saw in Scratch™ programming language, computer programs can use `if` structures to make decisions. In an `if` structure, what gets executed depends on whether a **Boolean expression**, also known as a **conditional**, is true.




```
In []: a == 3 # Boolean expression, also called a conditional
Out[]: True
```

Note that the single = is used for assignment, while the double == is used to compare two expressions to see if they are equal. Other comparison operators that can be used to create a Boolean expression include >= (for ≥) and != (for ≠).

You can make **compound conditionals** by connecting Boolean expressions with `and`, `or`, and `not`. In the following examples, remember that `a` is still 3.

```
In []: a+1 >= 2 and a**2 != 5 # compound conditional
Out[]: True
```

The only two Boolean values are `True` and `False`.

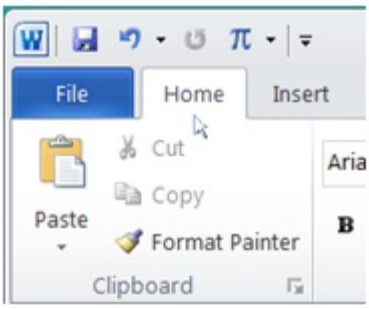
Predict, try, discuss, and explain the output:

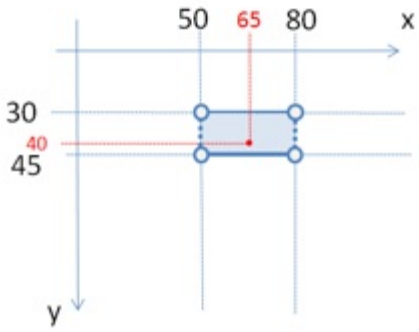
```
In []: # 3a. Prediction:
In []: a**2 >= 9 and not a>3


In []: # If prediction was wrong, discuss and explain
In []: # 3b. Prediction:
In []: a+2 == 5 or a-1 != 3


In []: # If prediction was wrong, discuss and explain
```

4. One situation where a programmer would use a compound conditional is when deciding whether a mouse click is within a certain region on the screen. For example, you might want your program to respond if a user clicks a rectangular shape, like a button or tab, as shown in the figure on the left.





Creating a program that uses mouse input is part of Lesson 1.5. For now, we'll just assign x and y arbitrary values–let's say (`65, 40`), using the **assignment operator** =. These coordinates are shown by the red dot in the figure above on the right.

Unlike most languages, *Python allows* **multiple assignment** in a single line of code, as shown here:

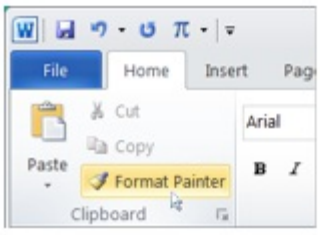
```
In []: x, y = (65, 40)
In []: x
Out[]: 65
```

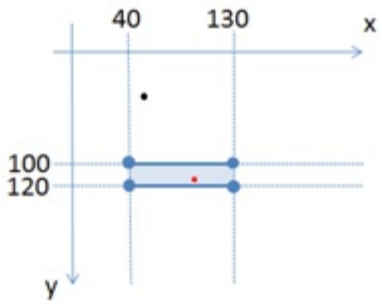
You might have noticed that the positive y-axis points down in the figure above. Computer graphics usually number the pixel rows from 0 at the top left and increase down and to the right across the screen.

The following expression is `True` when the red point ***(x, y)*** is in the blue area shown above.

```
In []: 50 < x and x < 80 and 30 <= y and y <= 45
Out[]: True
```

Write a compound conditional to test whether ***(x, y)*** is in the rectangle shown in the figures below. The conditional should be `False` since ***(x, y)*** is still bound to the values (`65, 40`) from before.






```
In []: # 4. Compound conditional
In []: (type your compound conditional here)
Out[]: False
```

5. Assign (`90, 115`) to ***x*** and ***y*** to match the figure above with the mouse cursor on the left and the red dot on the right. You can use the up arrow on your keyboard to go back in the IPython

session history and reuse the compound conditional you typed in Step 4. You can press enter to execute the command again or modify it before pressing enter.

```
In []: x, y = (90, 115)
In []: (arrow up to retrieve your compound conditional)
Out[]: True
```

Part II: `if-else` Structures and the `print()` Function

6. An `if` structure causes a program to execute a block of code only if a Boolean expression is True.

   Optionally, an `else` block can be included. The `else` block of code will be executed only if the Boolean expression was `False`.

   No matter whether the Boolean expression was **`True`** or **`False`**, the execution continues after the else block of the `if-else` structure. The function below illustrates the `if-else` structure.

   The function also shows the `print()` function, which will print its arguments on the screen. The text inside the single quotation marks is called a **string** of **characters** and will be printed as-is, without the quotes.

```
from __future__ import print_function # use Python 3.0 printing

def age_limit_output(age):
    '''Step 6a if-else example'''
    AGE_LIMIT = 13    # convention: use CAPS for constants
    if age < AGE_LIMIT:
      print (age, 'is below the age limit.')
    else:
      print(age, 'is old enough.')
    print(' Minimum age is ', AGE_LIMIT)
```

   The colons at the end of lines 3, 6, and 8 are required by `def`, `if`, and `else` key words. The indentation tells the *Python* interpreter which block of code belongs to that `def`, `if`, or `else` block. Just as Scratch grouped the code in if/else blocks, *Python* uses indentation to group code. Always use four spaces for each level of indentation. All such stylistic conventions can be found at http://www.python.org/dev/peps/pep-0008/#indentation.

When you try the code, notice that the output doesn't come after an `Out[]:`. This is because `print()` sends output to the system out, which by default is set to be the screen. The `print()` command returns a null value, however. The return value of a function or expression is what IPython displays (also on the screen) after the `Out[]`.

- Copy the code above to the code editor. Execute the code, and then try the following input. Discuss the output.

  ```
  In []: age_limit_output(10)
  In []: age_limit_output(16)
  ```

- Define a new function `report_grade(percent)` that reports mastery if the argument `percent` is 80 or more. You can write the function as an additional function in the same file of code as before. The beginning of the new code is shown here, and the required output is shown below. Pair program, strategizing first.

  ```
  def report_grade(percent):
      '''Step 6b if-else'''
  ```

  Then, in the IPython session,

  ```
  In []: report_grade(79)
  A grade of 79 does not indicate mastery.
  Seek extra practice or help.

  In []: report_grade(85)
  A grade of 85 percent indicates mastery.
  Keep up the good work!
  ```

Part III. The `in` operator and an introduction to collections

The `in` operator can also be used to create a Boolean expression, like `==`. The in operator will return True or False. You can use it to see if an **element** is `in` an **iterable**. Iterables are built out of zero or more elements and include strings as well as other variable types like tuples and lists that are the subject of the next activity. A string is an iterable that is made of elements that are characters.

Symbol Name	Looks Like	Iterable
Quotation marks	`'letters'` or `"spaces"`	string
Parentheses	`( e1, e2, e3 )`	tuple
Square brackets	`[e1, e2, e3 ]`	list
Curly braces	`{key1 : value1, key2 : value2}`	dictionary

7. Examine the following examples using the `in` operator:

```
In []: 't' in 'string' # includes lowercase t character
Out[]: True
In []: 'T' in 'string' # case matters
Out[]: False
In []: 3 in [1,2,3] # this list contains the int 3
Out[]: True
In []: ' in [1,2,3] # '3' is a string, different than 3
Out[]: False
```

8. The following function `vowel(letter)` returns `True` if the `letter` is `'a'`, `'e'`, `'i'`, `'o'`, `'u'`, or any of their uppercase counterparts and returns `False` otherwise.

```
def vowel(letter):
    vowels = 'aeiouAEIOU'
    if letter in vowels:
        return True
    else:
        return False
# should check len(letter)==1
```

   In your *Python* file for this activity, define a function `letter_in_word(guess, word)` that returns `True` if `guess` is a letter in `word` and returns `False` otherwise.

```
In []: letter_in_word ('t', 'secret hangman phrase')
Out[]: True
```

9. In MasterMind, one player has a secret sequence of colored pegs. Another player tries to guess the sequence.

   Define a function `hint(color, secret)` that takes two parameters: a string (representing a color) and a list of strings (representing a sequence of colors). The function should print a hint telling whether the color is in string.

```
In []: secret = ['red','red','yellow','yellow','black']
In []: hint('red', secret)
The color red IS in the secret sequence of colors.

In []: hint('green', secret)
The color green IS NOT in the secret sequence of colors.
```

Conclusion

1. Describe the relationship between blocks of code indented after the colon in `if`, `elif`, and `else` blocks.

2. There are many operators that can be used to create Boolean expressions. List the ones you have learned about and name one more that you learn about by searching for Boolean operators on the Internet.

3. Steve and Latisha wrote this code:

```
if check == 2:
   print('Code complete.')
else:
   print('Code complete.')
   print('Not all systems are ready')
```

   Ira, Jayla, and Kendra are all saying it would be better to move lines 22 and 24 to a single line executing `print ('Code complete.')` just before line 21. These three students have different reasons for their opinions. Their reasons are below. Do you think each of them is right, wrong, or somewhere in between? Explain.

   Ira: “It would be better to have a single print statement because that code is going to happen no matter what. The program will run slower by having it there twice.”

   Jayla: “It would be better to have a single print statement because that code is going to happen no matter what. Later, if you want to change your program, you're going to have to remember to change it in two places the way the code is now.”

   Kendra: “It would be better to have a single print statement because it is going to happen no matter what. That program would take up less memory if you just wrote it once.”