PLTW COMPUTER SCIENCE

Activity 1.3.4

Nested Branching and Input

Introduction

Most useful programs have a way to get input from the user, make a decision, and do different things depending on the input. Programs usually have a way to communicate output back to the user.

Think of a program or app you've used. What was the input? What was the output? Did the program's behavior depend on the input?

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. 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_4.py`.

```
In []: %logstart -ort studentName_1_3_4.log
In []: # Jane Doe John Smith 1.3.4 IPython log
```

Part I. Nested `if` structures and testing

2. The `if–else` structures can be nested. The indentation tells the *Python*® interpreter what blocks of code should be skipped under what conditions. Paste the code below into your *Python* file. The line numbers will be different.

```
def food_id(food):
    ''' Returns categorization of food
```

```
    food is a string
    returns a string of categories
    '''
    # The data
    fruits = ['apple', 'banana', 'orange']
    citrus = ['orange']
    starchy = ['banana', 'potato']

    # Check the category and report
    if food in fruits:
        if food in citrus:
            return 'Citrus, Fruit'
        else:
            return 'NOT Citrus, Fruit'
    else:
        if food in starchy:
            return 'Starchy, NOT Fruit'
        else:
            return 'NOT Starchy, NOT Fruit'
```

Then, in IPython:

```
In []: food_id('apple')
'NOT Citrus, Fruit'
```

- Did this return value result from line 15, 17, 20, or 22 (refer to line numbers shown above)?
- Every input will cause only one of the following lines of code to be executed.
    - What input will cause line 15 to be executed?
    - What input will cause line 17 to be executed?
    - What input will cause line 20 to be executed?
    - What input will cause line 22 to be executed?
- Bananas are starchy, and the program “knows” it. Explain why line 20 will never result in bananas being reported as starchy.

3. The example in the previous step shows one reason bugs can be difficult to track down. Just the job of getting the program to “fall into” all the blocks of code can be difficult, and bugs can hide for years in a rarely executed line of code in a large program. To create code with fewer bugs, developers use **glass box testing**. That means they create a **test suite** that will run through every block of code. Some programmers write their test suite first, an approach called **test-driven design** or Extreme Programming (XP).

   Continuing in your *Python* file, complete this `food_id_test()` that calls `food_id()` several

times: once for each of the the `return` statements at lines 15, 17, 20, and 22 above.

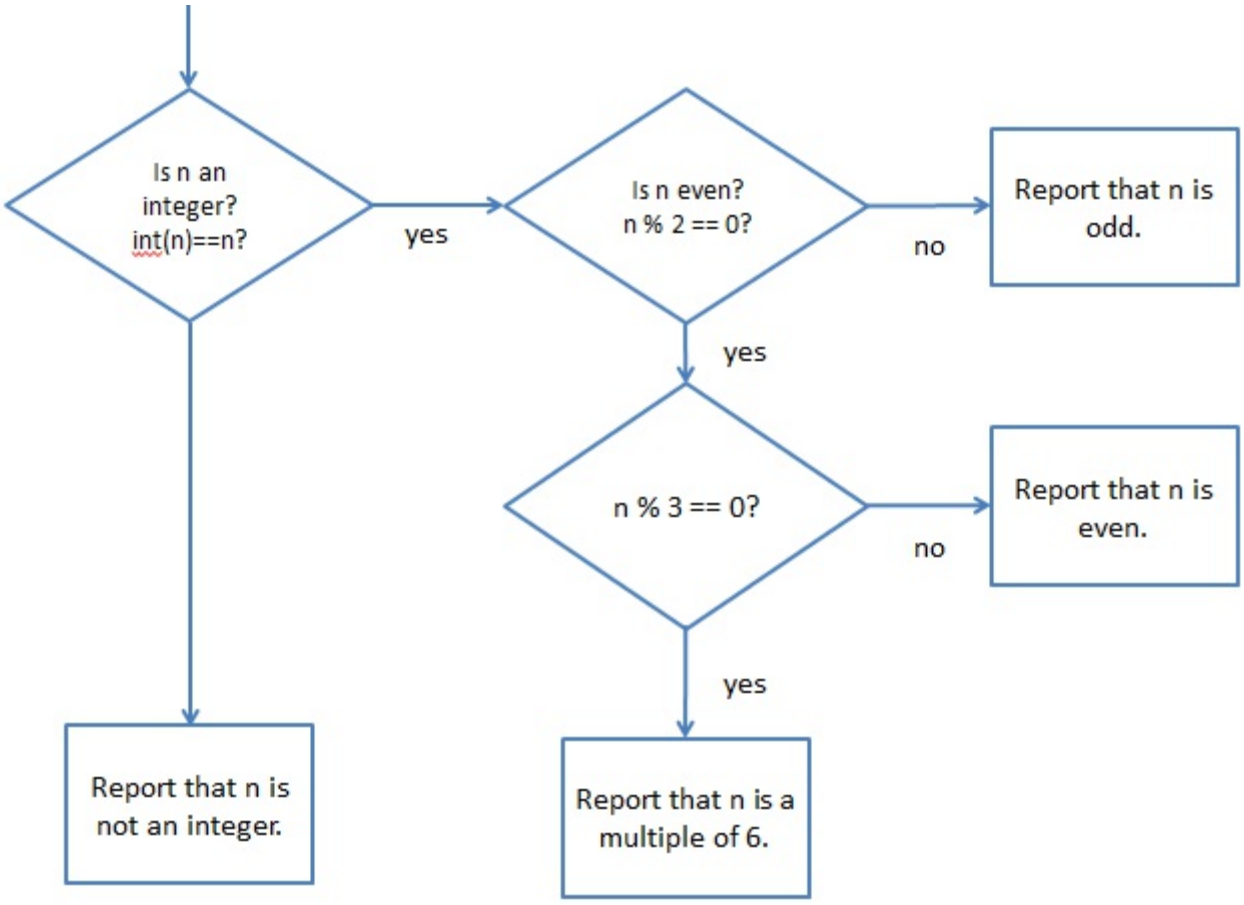
```
def food_id_test():
    ''' Unit test for food_id
    returns True if good, returns False and prints error if not
    good
    '''
    works = True
    if food_id('orange') != 'Citrus, Fruit':
        works = False
        print('orange bug in food id()')
    if food_id('banana') != 'NOT Citrus, Fruit':
        works = False
        print('banana bug in food_id()')
    # Add tests so that all lines of code are visited during test

    if works:
        print('food_id passed all tests')
        return works
```

In IPython,

```
In []: food_id_test()
food_id passed all tests!
Out[]: True
```

4. Define a function `f(x)` that implements the **flow chart** below. A flow chart is another way to represent an algorithm; input and output are in rectangles, and branching decisions are in diamonds. The exercise illustrates the `%` operator, called the modulo operator, which identifies the remainder after division. As an example, `13 % 4` is 1, since 13 ÷ 4 is 3 remainder 1.




```
In []: f(12)
Out[]: 'The number is a multiple of 6.'
```

5. What set of test cases could you use to visit all the code?

Part II: The `raw_input()` function, type casting, and print() from *Python* 3

6. To get input from the user of a program, we normally use a graphical user interface (GUI). That is the subject of Lesson 1.3. Beginners often want a simple way to obtain text input. *Python* uses the `raw_input(prompt)` command. It has some annoying behavior that we have to deal with for now — it always returns a string even when numeric type is appropriate. In addition IPython ignores Ctrl-C interrupts with raw_input(), so infinite loops will require restarting the *Python* kernel. Finally the prompt doesn't appear until the user starts typing. That said, here's how you use it:

   ```
   In []: a = raw_input('Give me a number between 5 and 6: ')
   Give me a number between 5 and 6: 5.5
   ```

   Even though the user typed a number, `raw_input()` returned a string. You can see that as follows.

```
In []: a
Out[]: '5.5'

In []: type(a)
Out[]: str
```

The variable `a` has a variable type that is a string. Keyboard input might be encoded as a `str` type, as shown above, or as a `unicode` type, but either way, it is a string of characters. (If you see `u'5.5',` it indicates Unicode. Unicode is a set of characters that includes all of the world's written languages. It is encoded with UTF-8, an extension of ASCII. The `u` in `u'5'` indicates that the string returned by the `raw_input()` command is a Unicode string.)

To use numeric values from the input, you have to turn the string into an `int` or a `float`. This will raise an error if the user didn't provide an `int` or a `float`. There are commands — not covered in this course — that **catch** the error so that it doesn't continue up to the *Python* interpreter and halt the program. For now, however, we can live with an error if the user does something unexpected.

To convert from a string to a number, you can use the `int()` function or the `float()` function. Forcing a value to be converted to a particular type is called **type casting**. Continuing from `a` being `'5.5'` above,

```
In []: int(a)
ValueError: invalid literal for int() with base 10: '5.5'

In []: float(a)
Out[]: 5.5

In []: int(float(a))
Out[]: 5
```

You can also type cast a number into a string:

```
In []: b = 6

In []: a + b
TypeError: cannot concatenate 'str' and 'int' objects

In []: a + str(b)
Out []: '5.56'

In []: float(a) + b
Out []: 11.5
```

Explain the difference between + as concatenation and + as numeric addition.

7. The following code picks a random number between 1 and 4 (inclusive**,** meaning it includes both 1 and 4) and lets the user guess once. In part b below, you will modify the program so that it indicates whether the user guessed too low, too high, or correctly.

```
from __future__ import print_function # must be first in file
import random
```

```
def guess_once():
    secret = random.randint(1, 4)
    print('I have a number between 1 and 4.')
    guess = int(raw_input('Guess: '))
    if guess != secret:
        print('Wrong, my number is ', secret, '.', sep='')
    else:
        print('Right, my number is', guess, end='!\n')
```

In IPython,

```
In []: guess_once()
I have a number between 1 and 4 inclusive.
Guess: 3
Right, my number is 3!

In []: guess_once()
I have a number between 1 and 4 inclusive.
Guess: 3
Wrong, my number is 4.
```

In line 9, `print('Wrong, my number is ', secret, '.', sep='')` has four arguments: three strings and a keyword=value pair. This is `print(s1, s2, s3, sep='')`. If the `sep=''` were not there, this would print the three strings separated by spaces. The separator is a space–by default–for the output of `print()`, but the function offers a keyword for setting the separator to a different value. The argument `sep=''` sets it to the **null string**, i.e., the empty string.

In the next activity, you'll learn about the random module and the related lines of code from your program.

```
import random
secret = random.randint(1, 4) # picks random number
```

- Explain how line 11 works, using the explanation of line 9 as a model.
- Modify the program to provide output as shown below.

```
In []: guess_once()
I have a number between 1 and 4 inclusive.
Guess: 3
Too low - my number was 4!

In []: guess_once()
I have a number between 1 and 4 inclusive.
Guess: 3
Too high, my number was 2!

In []: guess_once()
```

```
I have a number between 1 and 4 inclusive.
Guess: 1
Right on! I was number 1!
```

8. Create a function `quiz_decimal(low, high)` that asks the user for a number between `low` and `high` and tells them whether they succeeded.

```
In []: quiz_decimal(4, 4.1)
Type a number between 4 and 4.1:
4.5
No, 4.5 is greater than 4.1

In []: quiz_decimal(4, 4.1)
Type a number between 4 and 4.1:
4.05
Good! 4 < 4.05 < 4.1
```

Conclusion

1. What is the relationship between if-structures and glass box testing?
2. Nested if-else structures can contain many blocks of code. How many of those blocks of code might be executed?
3. What does a test suite do, and why do you think programmers often write test suites first, before they've even written the functions that will be tested?