CPSC 217, Loops In Python: Part 2

In this section of notes you will learn how to rerun parts of your program without duplicating instructions.

James Tam

Common Mistake #1

- Mixing up branches (`IF` and variations) vs. loops (`while`)
- Related (both employ a Boolean expression) but they are not identical
- Branches
  - General principle: If the Boolean evaluates to true then execute a statement or statements (**once**)
  - Example: display a popup message if the number of typographical errors exceeds a cutoff.
- Loops
  - General principle: As long as (or while) the Boolean evaluates to true then execute a statement or statements (**multiple times**)
  - Example: While there are documents in a folder that the program hasn't printed then continue to open another document and print it.

James Tam

Common Mistake #1: Example

- **Program name**: `11branchVsLoop.py`
  - Learning objective: knowing the difference between a branching vs. an iterative (solution).

```
age = int(input("Age positive only: "))
if (age < 0):
    age = int(input("Age positive only: "))
print("Branch:", age)
```

Vs.

```
age = int(input("Age positive only: "))
while (age < 0):
    age = int(input("Age positive only: "))
print("Loop:", age)
```

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Nesting

- Recall: Nested branches (one inside the other)
  - Nested branches:

```
If (Boolean):
    If (Boolean):
        ...
```

- Branches and loops (`for`, `while`) can be nested within each other

```
# Scenario 1
loop (Boolean):
    if (Boolean):
        ...
```

```
# Scenario 2
if (Boolean):
    loop (Boolean):
...
```

```
# Scenario 3
loop (Boolean):
    loop (Boolean):
        ...
```

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Recognizing When Looping & Nesting Is Needed

- **Scenario 1**: As long some condition is met a question will be asked (branch = question).
  - Example: As the question is asked if the answer is invalid then an error message will be displayed.
    - **Example**: While the user entered an invalid value for age (too high or too low) then if the age is too low an error message will be displayed.
    - Type of nesting: an IF-branch nested inside of a loop

```
loop (Boolean):
    if (Boolean):
        ...
```

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IF Nested Inside A While

- **Program name**: `12nestingIFinsideWHILE.py`
  - Learning objective: checking a condition during a repetitive process.

```
age = - 1
MIN_AGE = 1
MAX_AGE = 118
age = int(input("How old are you (1-118): "))
while ((age < MIN_AGE) or (age > MAX_AGE)):
    if (age < MIN_AGE):
        print("Age cannot be lower than", MIN_AGE, "years")
    #(Age for too high also possible (similar)
    age = int(input("How old are you (1-118): "))

print("Age=", age, "is age-okay")
```

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Recognizing When Looping & Nesting Is Needed

- **Scenario 2**: If a question (Boolean expression for a branch) answers true then check if a process should be repeated.
  - **Example**: If the user specified the country of residence as Canada then repeatedly prompt for the province of residence as long as the province is not valid.
  - Type of nesting: a loop nested inside of an IF-branch

```
If (Boolean):
    loop ():
        ...
```

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While Nested Inside An IF

- **Program name**: 13nestingWHILEinsideIF.py
  - A repetitive process that occurs given a condition has been met

```
country = ""
province = ""
VALID_PROVINCES = "BC, AB, SK, MB, ON, PQ,NL, NB, NS, PEI"
country = input("What is your country of citizenship: ")
if (country == "Canada"):
    province = input("What is your province of citizenship: ")
    while province not in (VALID_PROVINCES):
        print("Valid provinces: %s" %(VALID_PROVINCES))
        province = input("What is your province of citizenship: ")
    print("Country:", country, ", Province:",province)
```

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Recognizing When Looping & Nesting Is Needed

- **Scenario 3**: While one process is repeated, repeat another process.
  - More specifically: for each step in the first process repeat the second process from start to end
  - **Example:** While the user indicates that he/she wants to calculate another tax return prompt the user for income, while the income is invalid repeatedly prompt for income.
  - Type of nesting: a loop nested inside of an another loop

```
Loop():
    Loop():
        ...
```

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Pseudo Code

- A high level solution or algorithm that is not specified in a programming language.
- Instead English-like statements are used.
  - "A high-level description of the actions of a program or algorithm, using a mixture of English and informal programming language syntax" – Python for Everyone (Horstmann, Necaise)
- Benefits: it allows the programmer to focus on the solution without spending a lot time worrying about details such as syntax.

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Nested Loop: Example Process In Pseudo Code

```
Do While (user wants to calculate another return)

    Do While (salary invalid)
        Get salary information

    Do While (investment income invalid)
        Get investment income

    …
```

Each time we have a tax return to calculate

For each client as long as salary invalid repeatedly prompt

Complete each of these steps from start to end

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While Nested Inside Another While

- **Program name**: `14nestingWHILEinsideWHILE.py`
  - Learning objective: a repetitive process that repeats from start to end each time another repetitive process occurs.

```
MIN_INCOME = 0
runAgain = "yes"
while (runAgain == "yes"):
    print("CALCULATING A TAX RETURN")
    income = -1
    while (income < MIN_INCOME):
        income = int(input("Income $"))
    runAgain = input("To calculate another return enter 'yes': ")
```

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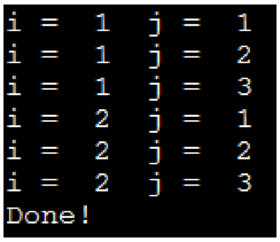
Analyzing Another Nested Loop

- One loop executes inside of another loop(s).
- **Example structure**:

```
Outer loop (runs n times)
    Inner loop (runs m times)
        Body of inner loop (runs n x m times)
```

- **Program name**: `15nested_nested_loop_repeats_start_end.py`
  - Learning objective: for each number in a sequence a second sequence counts from start to end.

```
i = 1
while (i <= 2):
    j = 1
    while (j <= 3):
        print("i = ", i, " j = ", j)
        j = j + 1
    i = i + 1
print("Done!")
```



```
i =  1  j =  1
i =  1  j =  2
i =  1  j =  3
i =  2  j =  1
i =  2  j =  2
i =  2  j =  3
Done!
```

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Practice Example #2: Nesting

1. Write a program that will count out all the numbers from one to six.
2. For each of the numbers in this sequence the program will determine if the current count (1 – 6) is odd or even.
   a) The program display the value of the current count as well an indication whether it is odd or even.

- Which Step (#1 or #2) should be completed first?

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Step #1 Completed: Now What?

- For each number in the sequence determine if it is odd or even.
- This can be done with the modulo (remainder) operator: %
  - An even number modulo 2 equals zero (2, 4, 6 etc. even divide into 2 and yield a remainder or modulo of zero).
  - `if (counter % 2 == 0): # Even`
  - An odd number modulo 2 does not equal zero (1, 3, 5, etc.)
- Pseudo code visualization of the problem

```
Loop to count from 1 to 6
    Determine if number is odd/even and display message
End Loop
```

  - Determining whether a number is odd/even is a part of counting through the sequence from 1 – 6, checking odd/even is nested within the loop

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The Break Instruction

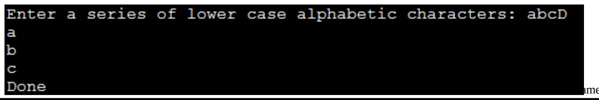
Q: What if the user just typed 'abc' and hit enter?

- It is used to terminate the repetition of a loop which is separate from the main Boolean expression (it's another, separate Boolean expression).
- **General structure**:

```
for (Condition 1):               while (Condition 1):
    if (Condition 2):                if (Condition 2):
       break                            break
```

- **Program name**: `16break_illustration_only_avoid.py`
  - Learning objective: early termination of a loop occurring any time in the loop body (most for illustration purposes).

```
str1 = input("Enter a series of lower case alphabetic characters: ")
for temp in str1:
    if ((temp < "a") or (temp > "z")):
        break
    print(temp)
print("Done")
```



```
Enter a series of lower case alphabetic characters: abcD
a
b
c
Done
```

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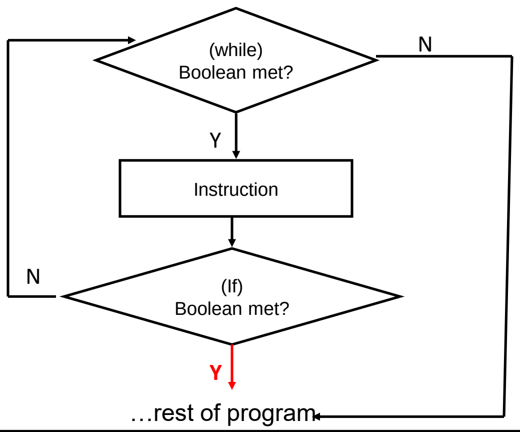
The Break Should Be Rarely Used

- Adding an extra exit point in a loop (aside from the Boolean expression in the while loop) may make it harder to trace execution (leads to 'spaghetti' programming).



JT: While adding a single break may not always result in 'spaghetti' it's the beginning of a bad habit that may result in difficult to trace programs

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An Alternate To Using A 'Break'

- **NO:** Instead of an 'if' and 'break' inside the body of the loop

```
while (BE1):
    if (BE2):
        break
```

- **YES**: Add the second Boolean expression as part of the loop's main Boolean expression

```
while ((BE1) and not (BE2)):
```

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Another Alternative To Using A 'Break'

- **YES**: If the multiple Boolean expressions become too complex consider using a 'flag'

```
flag = True
while (flag == True):
    if (BE1):
        flag = False
    if (BE2)
        flag = False
    # Otherwise the flag remains set to true
    # BE = A Boolean expression
```

- Both of these approaches (YES #1 & 2)still provide the advantage of a single exit point from the loop.

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Alternative To Using Break

- **Third, complete and executable example**: `17_break_alternative.py`
  - A fully working example for you to look through on your own if you need to see a fully working alternative to using a break.

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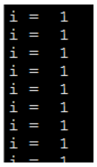
Infinite Loops

- Infinite loops never end (the stopping condition is never met).
- They can be caused by logical errors:
  - The loop control is never updated (Example 1 – below).
  - The updating of the loop control never brings it closer to the stopping condition (Example 2 – next slide).
- **Program name**: `18infinite1.py`
  - Learning objective: a loop that never ends.

```
i = 1
while (i <= 10):
     print("i = ", i)
i = i + 1
```



```
i =  1
i =  1
i =  1
i =  1
i =  1
i =  1
i =  1
i =  1
```

To stop a program with an infinite loop in Unix simultaneously press the <ctrl> and the <c> keys

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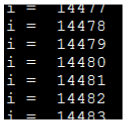
Infinite Loops (2)

- **Program name**: `19infinite2.py`
  - Learning objective: a loop that never ends.

```
i = 10
while (i > 0):
    print("i = ",  i)
    i = i + 1
print("Done!")
```



```
i =  14477
i =  14478
i =  14479
i =  14480
i =  14481
i =  14482
i =  14483
```

To stop a program with an infinite loop in Unix simultaneously press the <ctrl> and the <c> keys

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Testing Loops

- Make sure that the loop executes the proper number of times.
- Test conditions:
  1) Loop does not run
  2) Loop runs exactly once
  3) Loop runs exactly ‘n’ times

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Testing Loops: An Example

Program name: `20testing.py`

- Learning objective: minimum tests for a loop that steps through a sequence.

```
sum = 0
i = 1
last = 0

last = int(input("Enter the last number in the sequence to sum : "))
while (i <= last):
    sum = sum + i
    print("i = ", i)
    i = i + 1

print("sum =", sum)
```

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Extra Practice #3

- Write a loop that will continue repeating if the user enters a value that is negative.
- Write a program that will prompt the user for number and an exponent. Using a loop the program will calculate the value of the number raised to the exponent.
  - To keep it simple you can limit the program to non-negative exponents.

James Tam

After This Section You Should Now Know

- How/when to employ nested branches and loops
  - How to trace their execution
- The `break` instruction, why it should be avoided and alternatives to its use
- What is an infinite loop
- How to test loops

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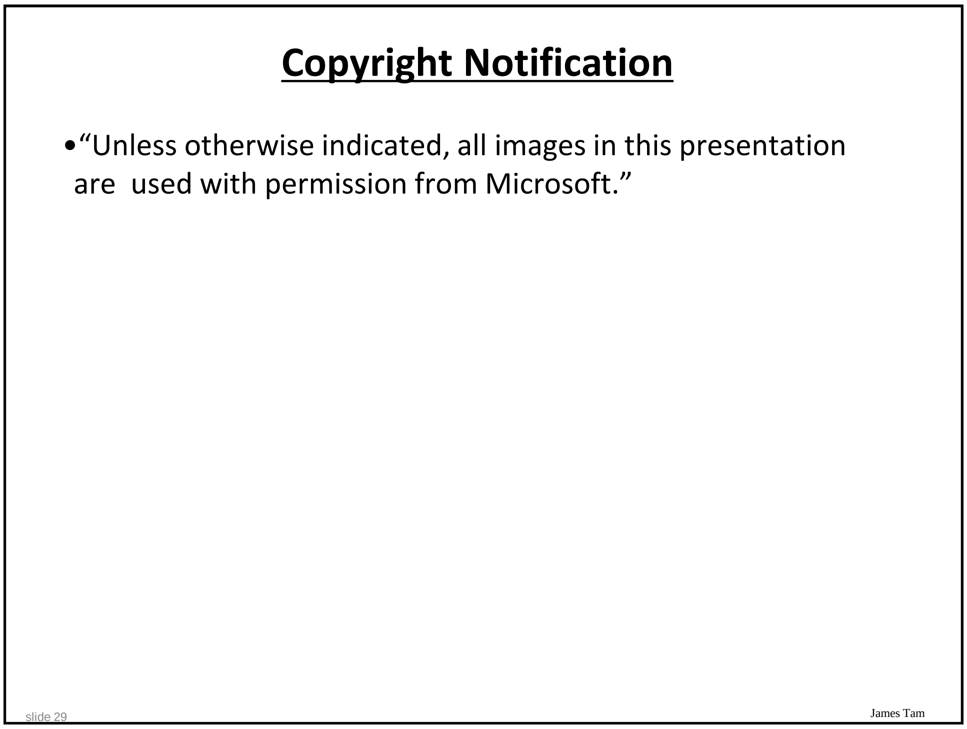

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