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Lecture 20: While Loops (Sections 7.3, 7.4)

CS 1110

Introduction to Computing Using Python

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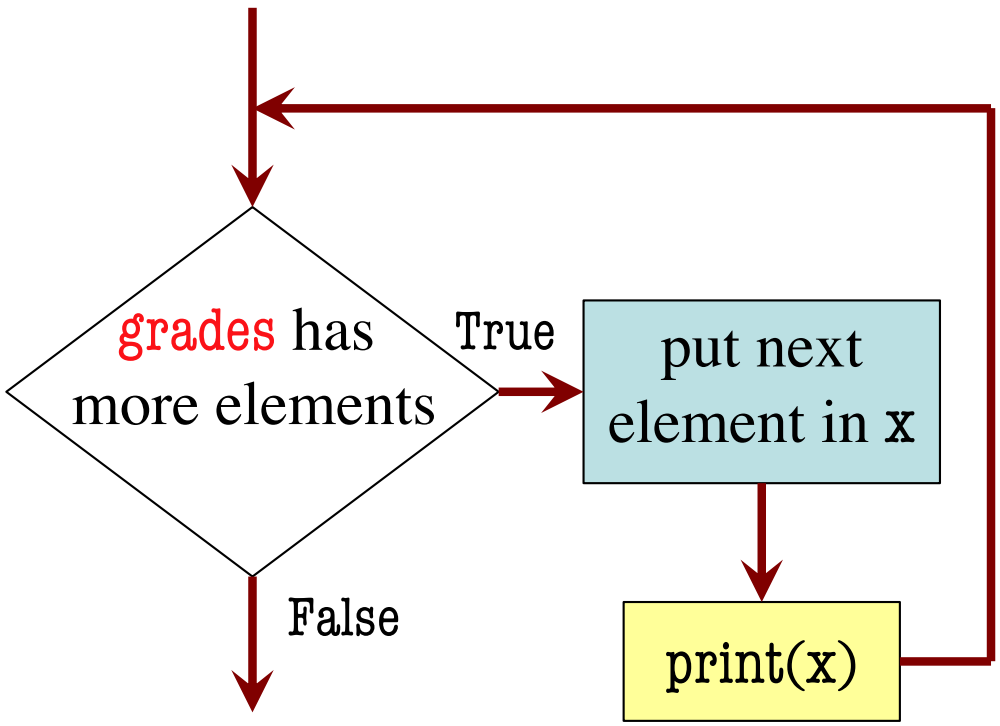
Announcements

- A3 is being graded this week
- A4 is out. Due next Thursday.
- Prelim 2
  - Tuesday, April 24th, 7:30-9:00pm
  - Please go to the same room you went for Prelim 1
  - Conflict assignment on CMS, due 11:59pm **Tonight**

Recall: For Loops

```
for x in grades:
    print(x)
```



- **loop sequence:** grades
- **loop variable**: x
- **body**: print(x)

To execute the for-loop:

1. Check if there is a "next" element of **loop sequence**
2. If so:
   - *assign* next sequence element to **loop variable**
   - Execute all of **the body**
   - Go back to Line 1
3. If not, terminate execution

Different types of Repetition

1. Process each item in a sequence
   - Compute statistics for a dataset.
   - Send all your contacts an email.

```
for x in sequence:
    process x
```

2. Do something *n* times
   - Draw a checkers board.
   - Run a protein-folding simulation for 10^6 time steps.

```
for x in range(n):
    do something
```

3. Do something an unknown number of times
   - Fly up until you're near the ceiling.
   - Play hangman until 6 strikes.

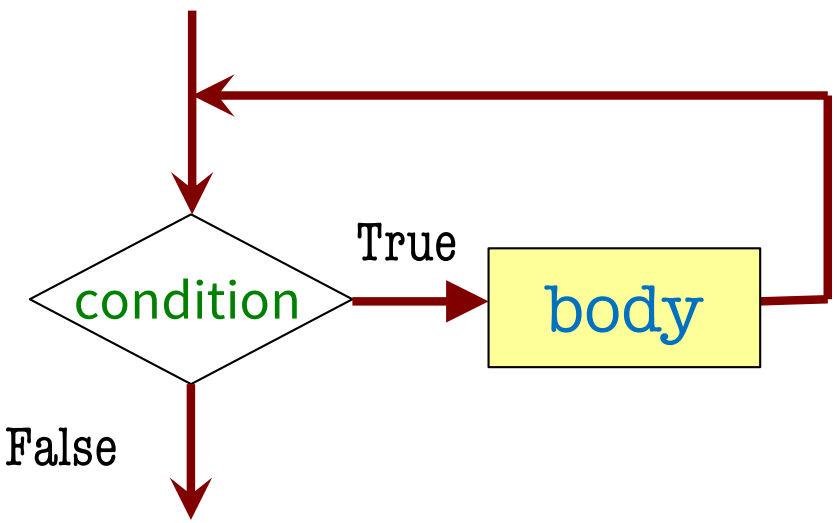
???

Beyond Sequences: The while-loop

while <*condition*>:

```
    statement 1
    ...
    statement n
```

body



- Relationship to for-loop
  - Broader notion of "keep working until done"
  - Must explicitly ensure condition becomes false
  - *You* explicitly manage what changes per iteration

While-Loops and Flow

```
import random

num = random.randint(0,10)
guessed_it = False
print('I'm thinking of a number.')

while not guessed_it:
    guess = int(input('Guess it: '))
    guessed_it = (num == guess)
print('Well done!')
```

```
I'm thinking of a number.
Guess it: 6
Guess it: 2
Guess it: 1
Guess it: 4
Well done!
```

Q1: What gets printed?

```
a = 0
while a < 1:
    a = a + 1

print(a)
```

```
a = 0
while a < 2:
    a = a + 1

print(a)
```

```
a = 0
while a > 2:
    a = a + 1

print(a)
```

A1: What gets printed?

```
a = 0
while a < 1:
    a = a + 1

print(a)
```

1

```
a = 0
while a < 2:
    a = a + 1

print(a)
```

2

```
a = 0
while a > 2:
    a = a + 1

print(a)
```

0

Q2: What gets printed?

```
a = 4
while a > 0:
    a = a - 1

print(a)
```

```
a = 0
while a < 3:
    if a < 2:
        a = a + 1

print(a)
```

A2: What gets printed?

```
a = 4
while a > 0:
    a = a - 1

print(a)
```

0

```
a = 0
while a < 3:
    if a < 2:
        a = a + 1

print(a)
```

Infinite loop!

Q3: What gets printed?

```
a = 8
b = 12
while a != b:
    if a > b:
        a = a - b
    else:
        b = b - a
print(a)
```

A: Infinite Loop!
B: 8
C: 12
D: 4
E: I don't know

A3: What gets printed?

```
a = 8
b = 12
while a != b:
    if a > b:
        a = a - b
    else:
        b = b - a
print(a)
```

A: Infinite Loop!
B: 8
C: 12
D: 4 **CORRECT**
E: I don't know

This is Euclid's Algorithm for finding the greatest common factor of two positive integers.
Trivia: It is one of the *oldest* recorded algorithms (~300 B.C.)

`for` vs. `while`

- You can almost always use either

- Sometimes **`for`** is better
- Sometimes **`while`** is better

for vs. while

do something n times

```
for k in range(n):
    # do something
```

```
k = 0
while k < n:
    # do something
    k = k+1
```

Must remember to increment

My preference? for-loop

for vs. while

do something an unknown number of times

```
for k in range(BIG_NUM):
    # do something
    if time to stop:
        break
```

??

```
while not time to stop:
    # do something
```

My preference? while-loop

for vs. while

do something to each element of a sequence

```
for k in range(len(seq)):
    seq[k] = seq[k]+1
```

```
k = 0
while k < len(seq):
    seq[k] = seq[k]+1
    k = k+1
```

while is more flexible, but often requires more code

My preference? for-loop

for vs. while

do something until a limit is reached

make a table of squares up to N

```
seq = []
n = math.floor(sqrt(N)) + 1
for k in range(n):
    seq.append(k*k)
```

```
seq = []
k = 0
while k*k < N:
    seq.append(k*k)
    k = k+1
```

for-loop requires you to know how many iterations you want **ahead of time**

can use complex expressions to check if a task is done

My preference? while-loop

for vs. while

change a sequence's length

remove all 3's for list nums

```
for i in list(range(len(nums))):
    if nums[i] == 3:
        del num[i]
```

```
while 3 in nums:
    nums.remove(3)
```

IndexError: list index out of range

is this not beautiful?

My preference? while-loop

for vs. while

Fibonacci numbers:

$$F_0 = 1$$
$$F_1 = 1$$
$$F_n = F_{n-1} + F_{n-2}$$

find 1st n Fibonacci numbers

```
fib = [1, 1]
for k in range(2,n):
    fib.append(fib[-1] + fib[-2])
```

```
fib = [1, 1]
while len(fib) < n:
    fib.append(fib[-1] + fib[-2])
```

loop variable not always **used**

loop variable not always **needed** at all

My preference? while-loop

Remember Hangman?

```
import random, hangman
word_list = [ ... words we want user to guess .. ]
N_GUESSES = 10
secret = hangman.SecretWord(random.choice(word_list))

for n in list(range(N_GUESSES)):
    secret.word_so_far()
    user_guess = input("Guess a letter: ")
    secret.apply_guess(user_guess):
    if secret.is_solved():
        print("YOU WIN!!!")
        break  #jumps out of the for-loop
secret.reveal()
```

Usually can keep guessing until you get some number wrong

Improving Hangman with while

```
import random, hangman
word_list = [ ... words we want user to guess .. ]
~~N_GUESSES = 10~~    MAX_STRIKES = 10
secret = hangman.SecretWord(random.choice(word_list))
n_strikes = 0
~~for n in list(range(N_GUESSES)):~~ while n_strikes < MAX_STRIKES:
    secret.word_so_far()
    user_guess = input("Guess a letter: ")
bad_guess =
    secret.apply_guess(user_guess)
    if secret.is_solved():
        print("YOU WIN!!!")
        break  #jumps out of the loop
secret.reveal()
```

```
if bad_guess:
    n_strikes = n_strikes + 1
```

Using while-loops Instead of for-loops

Advantages

- Better for **modifying data**
  - More natural than range
  - Works better with deletion
- Better for **convergent tasks**
  - Loop until calculation done
  - Exact steps are unknown
- Easier to **stop early**
  - Just set loop var to False

Disadvantages

- **Infinite loops** more likely
  - Easy to forget loop vars
  - Or get stop condition wrong
- **Require** more management
  - Initialize the condition?
  - Update the condition?