Introduction à la programmation, lesson 3: cycles and functions

**While loop**

Using the while loop, we can repeat an instruction many times (while the value of a condition is True.)

```
while <condition>:
    instructions
```

The instructions are repeated while the value of the condition is True. When the value of the condition becomes False, the program exits the while loop.

**Example:** a program asks for an integer A, then for a non-zero integer B, and computes A/B.

```
A = input("Enter an integer A: ")
B = input("Enter an integer B: ")
while B == 0:
    B = input("B is zero. Give me another value: ")
print "A / B = ", float(A) / B
```

**Be careful with infinite loops!** If the value of the condition of the while loop never becomes False, the algorithm never stops. Here are two examples:

```
n = 5
while n < 10:
    print "n equals: ", n
print "The end."

while True:
    print "I continue…"
print "The end."
```

Sometimes, it is convenient to introduce a counter.

```
i = 0  #counter
while i < 10:
    print 2 ** i
    i = i + 1
print "The end."
```

**Important:** you must always initialize the counter. The step is the change of the counter at each loop. In the example above, the step is equal to 1, but we can choose the step differently:

```
i = 0  #counter
while i < 20:
    print i
    i = i + 2  #step equals 2
print "The end."

i = 10  #counter, here initialized with 10
while i > 0:
    print i
    i = i – 1  #step equals -1
print "The end."
```
Exercise 1. Write a program that asks to enter an integer n and then prints out the sum of integers from 1 to n (use the while loop).

The keyword **break** allows to exit the while loop immediately.

```python
i = 1
while i < 100:
    if i % 2 == 0: #if i is even
        print "%d " %i
    break
    i = i + 1
print "The end."
```

The keyword **continue** allows to restart the while loop immediately.

```python
i = 1
while i < 100:
    if i % 2 == 0:
        print "%d " %i
    continue
    i = i + 1
print "The end."
```

Try to avoid using **break** and **continue** as they make your code less readable.

Exercise 2. Define a list L of integers, and write a program that creates and prints out a list L' containing all the integers of L starting from the first one and until the first integer larger than 100. For example, if L = [1, 2, 1, 100, 5, 4], the program must create L' = [1, 2, 1, 100].

Functions

Exercise 3. Print out the table of multiplication by 3, 5, and 8.

We will now learn how to solve Exercise 3 in much more elegant way using functions. To create a function, we use the following syntax:

```python
def name_of_function(parameter1, parameter2, parameter3, parameterN):
    instructions
```

The first line contains:
- The keyword **def**, that stands for “define”
- The name of the function. It must be unique.
- A list of parameters separated with commas.

Here is a function that prints out the table of multiplication by an integer n.

```python
def multiplication_table(n):
    i = 0 #a counter
    while i < 10:
        print """%d * %d = %d" % (i + 1, n, (i + 1) * n)
        i = i + 1
```

We can now use this function to solve Exercise 3 by adding the following three lines:

```python
multiplication_table(3)
multiplication_table(5)
multiplication_table(7)
```
Some functions must compute a value that will be later used by the program, and in this case they need to communicate the computed value. To this end, we can use the keyword `return`. For example,

```python
def linear(a, b, n):
    return a * n + b
```

```python
a, b = 1, 1
i = 0
while i < 10:
    print "%d, %d" % (i, linear(a, b, i))
```

Attention: The `return` instruction must be the last one in the definition of the function.

**Exercise 4.** Write a function `add_prefix` that receives two strings, a word and a prefix, and returns the concatenation of the prefix and of the word. For example, if you give it “construction” and “re”, it must return “reconstruction”.

```python
def add_prefix(word, prefix):
    #add your code here

print add_prefix("construction", "re")
```

**Exercise 5.** Write a function that receives the voltage V in volts and the current I in amps, and returns the resistance R in ohms. As a reminder, $V = I \cdot R$.

```python
def resistance(V, I):
    #add your code here
    return R

print resistance(5.0, 2.0)
```

**Exercise 6.** Write a function `string_power` that receives a string S and a number n, and returns a string obtained by concatenating S n times. For example, if S = “bla” and n = 3, your function must return “blablabla”.

```python
def string_power(S, n):
    #add your code here

print string_power("bla", 3)
```

**Cycle for**

The for cycle allows iterating over lists, letters in a string, etc. Let us start with an example, and note the usage of the keyword `in`:

```python
list = [2,4,6,8,10, "toto"]
for element in list:
    print element
```

Take a look at how your text editor highlights the code, it will help understanding. Note also that the code below produces exactly the same result:

```python
list = [2,4,6,8,10, "toto"]
for x in list:
    print x
```
The **for** cycle can also be used to iterate over the characters of a string.

```python
name = "Felipe Juan Pablo Alfonso de Todos los Santos"
print "My name is spelled as: "
for letter in name:
    print letter
```

We will now consider another way of using the cycle **for**. This time, we will use one more keyword **range**.

```python
for x in range(1, 10, 3):
    print x
```

Execute this code and try to understand what it does. Formally:

**range**(start, end, step):

- is a function that takes three integer parameters
- and generates a list of integers between start and (end - 1) with the given step.

Here are two more examples:

```python
for x in range(12, 24, 5):
    print x

for x in range(20, 10, -2):
    print x
```

**Attention**: The list generated by the function range can be empty.

```python
for x in range(100, 110, -2):
    print x
```

**Attention**: parameters start and step are optional.

- **range**(a) generates a list of integers between 0 and (a - 1) with a step 1.
- **range**(b, c) generates a list of integers between b and (c - 1) with a step 1.

**Exercise 7**. In this exercise, you must write a function and then test it on an example.

- **sum_even**: receives a list of integers and returns the sum of all even integers in the list.
- **number_even**: receives a list of integers and returns the number of even integers in the list.
- **first_odd**: receives a list of integers and returns the first odd number in the list.
- **min_odd**: receives a list of integers and returns the smallest odd number in the list.
- **index_of_element**: receives a list of integers and an integer and returns the position of this integer in the list. If the integer does not appear in the list, return None.
- **extract_even**: receives a list of integers L and returns a list L' containing all even integers in L.
- **add_to_list**: receives a list of integers L and an integer d and returns a list L' such that L'[i] = L[i] + d.
- **cut**: receives a list of integers L and an integer d, and returns two lists, the first containing all elements of L smaller than d, and the second all elements of L equal or larger than d.