

# 42-PROGR-recursiones

October 12, 2017

Fibonacci:

```
In [1]: def fibon(n):
        p,q = 0,1
        for int in xrange(n):
            p,q = q,p+q
        return q
```

```
In [2]: def fibon2(n):
        if n == 0:
            return 0
        elif n == 1:
            return 1
        else:
            return fibon2(n-1)+fibon2(n-2)
```

```
In [3]: time fibon(1000)
```

CPU times: user 0 ns, sys: 0 ns, total: 0 ns

Wall time: 393  $\mu$ s

```
Out[3]: 70330367711422815821835254877183549770181269836358732742604905087154537118196933579742
```

```
In [4]: fibon2(1000)
```

-----  
RuntimeError

Traceback (most recent call last)

```
<ipython-input-4-6ec515aad559> in <module>()
----> 1 fibon2(Integer(1000))
```

```
<ipython-input-2-23561b5bb1a5> in fibon2(n)
      5         return Integer(1)
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... last 1 frames repeated, from the frame below ...

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```

RuntimeError: maximum recursion depth exceeded while calling a Python object

```
In [5]: sys.setrecursionlimit(1000)
        fibon2(994)
```

-----

RuntimeError Traceback (most recent call last)

```
<ipython-input-5-59c828d2cfb3> in <module>()
      1 sys.setrecursionlimit(Integer(1000))
----> 2 fibon2(Integer(994))
```

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RuntimeError: maximum recursion depth exceeded while calling a Python object

```
In [7]: sys.setrecursionlimit(1500)
        %time fibon2(1000)
```

-----

KeyboardInterrupt

Traceback (most recent call last)

```
<ipython-input-7-6a2aea302e56> in <module>()
      1 sys.setrecursionlimit(Integer(1500))
----> 2 get_ipython().magic(u'time fibon2(1000)')
```

```
/usr/local/SageMath/local/lib/python2.7/site-packages/IPython/core/interactiveshell.py
2156         magic_name, _, magic_arg_s = arg_s.partition(' ')
2157         magic_name = magic_name.lstrip(prefilter.ESC_MAGIC)
-> 2158         return self.run_line_magic(magic_name, magic_arg_s)
2159
2160         #-----
```

```
/usr/local/SageMath/local/lib/python2.7/site-packages/IPython/core/interactiveshell.py
2077         kwargs['local_ns'] = sys._getframe(stack_depth).f_locals
2078         with self.builtin_trap:
-> 2079             result = fn(*args,**kwargs)
2080         return result
2081
```

```
<decorator-gen-59> in time(self, line, cell, local_ns)
```

```
/usr/local/SageMath/local/lib/python2.7/site-packages/IPython/core/magic.pyc in <lambda>
186     # but it's overkill for just that one bit of state.
187     def magic_deco(arg):
--> 188         call = lambda f, *a, **k: f(*a, **k)
189
190         if callable(arg):
```

```
/usr/local/SageMath/local/lib/python2.7/site-packages/IPython/core/magics/execution.py
1174         if mode=='eval':
1175             st = clock2()
-> 1176             out = eval(code, glob, local_ns)
1177             end = clock2()
1178         else:
```

```
<timed eval> in <module>()
```

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```

```

<ipython-input-2-23561b5bb1a5> in fibon2(n)
2         if n == Integer(0):
3             return Integer(0)
----> 4         elif n == Integer(1):
5             return Integer(1)
6         else:

```

```
src/cysignals/signals.pyx in cysignals.signals.python_check_interrupt (build/src/cysignals/signals.c:1000)
```

```
src/cysignals/signals.pyx in cysignals.signals.sig_raise_exception (build/src/cysignals/signals.c:1000)
```

```
KeyboardInterrupt:
```

Parado después de unas tres horas y media de cálculo. Es claro que no merece la pena, en muchas recursiones, aumentar el límite (mil niveles de profundidad del árbol de recursión) que tiene Sage.

## Fibonacci recursivo a iterativo

```
In [8]: def fibon3(n):  
        L = [1,1]  
        while len(L) <= n+1:  
            L.append(L[-2]+L[-1])  
        return L
```

```
In [9]: fibon3(10)
```

```
Out[9]: [1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144]
```

```
In [10]: time RES = fibon3(10^5)
```

```
CPU times: user 168 ms, sys: 228 ms, total: 396 ms  
Wall time: 345 ms
```

¿Por qué y cómo se puede transformar todo programa recursivo en iterativo?  
Suma de los cubos:

```
In [11]: def suma(n):  
        suma = 0  
        j = 1  
        while j < n+1:  
            suma += j^3  
            j += 1  
        return suma
```

```
In [12]: suma(100)
```

```
Out[12]: 25502500
```

```
In [13]: def suma2(n):  
        if n == 1:  
            return 1  
        else:  
            return suma2(n-1)+n^3
```

```
In [14]: suma2(100)
```

```
Out[14]: 25502500
```

```
In [15]: time suma(10^4)
```

```
CPU times: user 8 ms, sys: 4 ms, total: 12 ms  
Wall time: 7.33 ms
```

```
Out[15]: 2500500025000000
```

```
In [18]: sys.setrecursionlimit(104+100)
        %time suma2(104)
```

CPU times: user 12 ms, sys: 4 ms, total: 16 ms  
Wall time: 12.9 ms

Out[18]: 2500500025000000

Factorial:

```
In [19]: def fact(n):
        prod = 1
        for i in xrange(2,n+1):
            prod *= i
        return prod
```

```
In [20]: fact(5)
```

Out[20]: 120

```
In [21]: def fact2(n):
        if n == 0:
            return 1
        else:
            return factorial(n-1)*n
```

```
In [22]: fact2(5)
```

Out[22]: 120

```
In [23]: time N = fact(104)
```

CPU times: user 16 ms, sys: 4 ms, total: 20 ms  
Wall time: 19.6 ms

```
In [25]: sys.setrecursionlimit(104+100)
        %time NN = fact2(104)
```

CPU times: user 0 ns, sys: 0 ns, total: 0 ns  
Wall time: 665  $\mu$ s

¿No son un poco extraños estos tiempos? ¿A qué se pueden deber?  
Máximo Común Divisor:

```
In [26]: def mcd(n,m):
        while m > 0:
            n,m = m,n%m
        return n
```



```
In [27]: mcd(5*87665,77774*5)
```

```
Out[27]: 5
```

```
In [28]: def mcd2(n,m):  
    '''Maximo com\'un divisor de dos enteros positivos n,m con n>m'''  
    if m == 0:  
        return n  
    else:  
        return mcd(m,n%m)
```

```
In [29]: mcd2(5*87665,77774*5)
```

```
Out[29]: 5
```

Recursión e inducción

Una solución al primer ejercicio propuesto dentro del ejercicio 9 de la lista al final del capítulo 4 de las notas.

```
In [30]: def comprueba(N):  
    var('n')  
    L = []  
    S = 1  
    F(n) = n*(n+1)*(2*n+1)/6  
    if N == 1:  
        if F(n=1) == 1:  
            L.append(1)  
            return S,L  
        else:  
            L.append(0)  
            return S,L  
  
    else:  
        S,L= comprueba(N-1)  
        S += N^2  
        if S == F(n=N):  
            L.append(1)  
        else:  
            L.append(0)  
        return S,L
```

```
In [31]: comprueba(7)
```

```
Out[31]: (140, [1, 1, 1, 1, 1, 1, 1])
```

```
In [32]: comprueba(17)
```

```
Out[32]: (1785, [1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1])
```