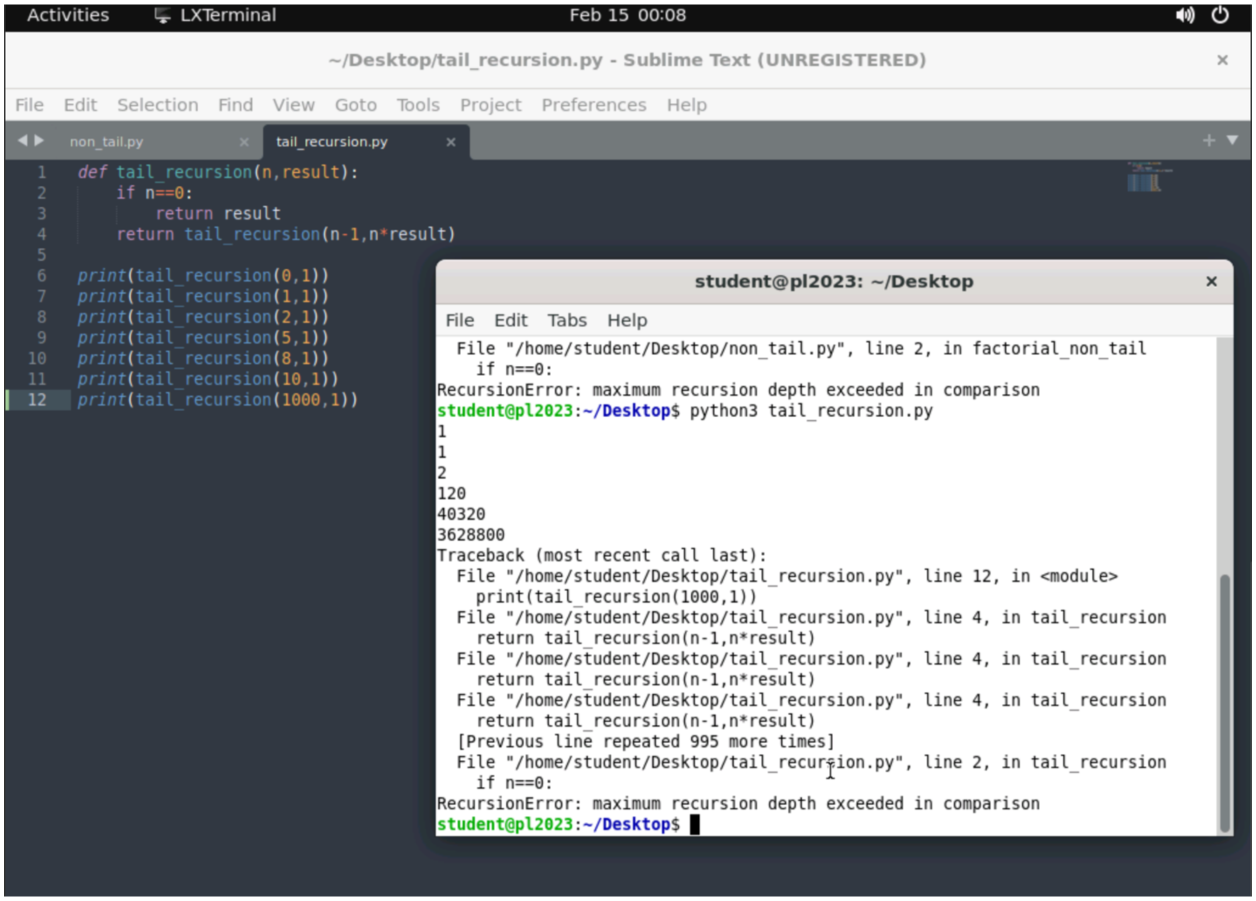
Tail Recursion

In SBCL tail-recursive and non-tail-recursive version were able to handle larger inputs as compared to Python because in python we eventually hit system limits on the stack size which depicts that SBCL supports tail recursive optimization whereas Python doesn't.

Python

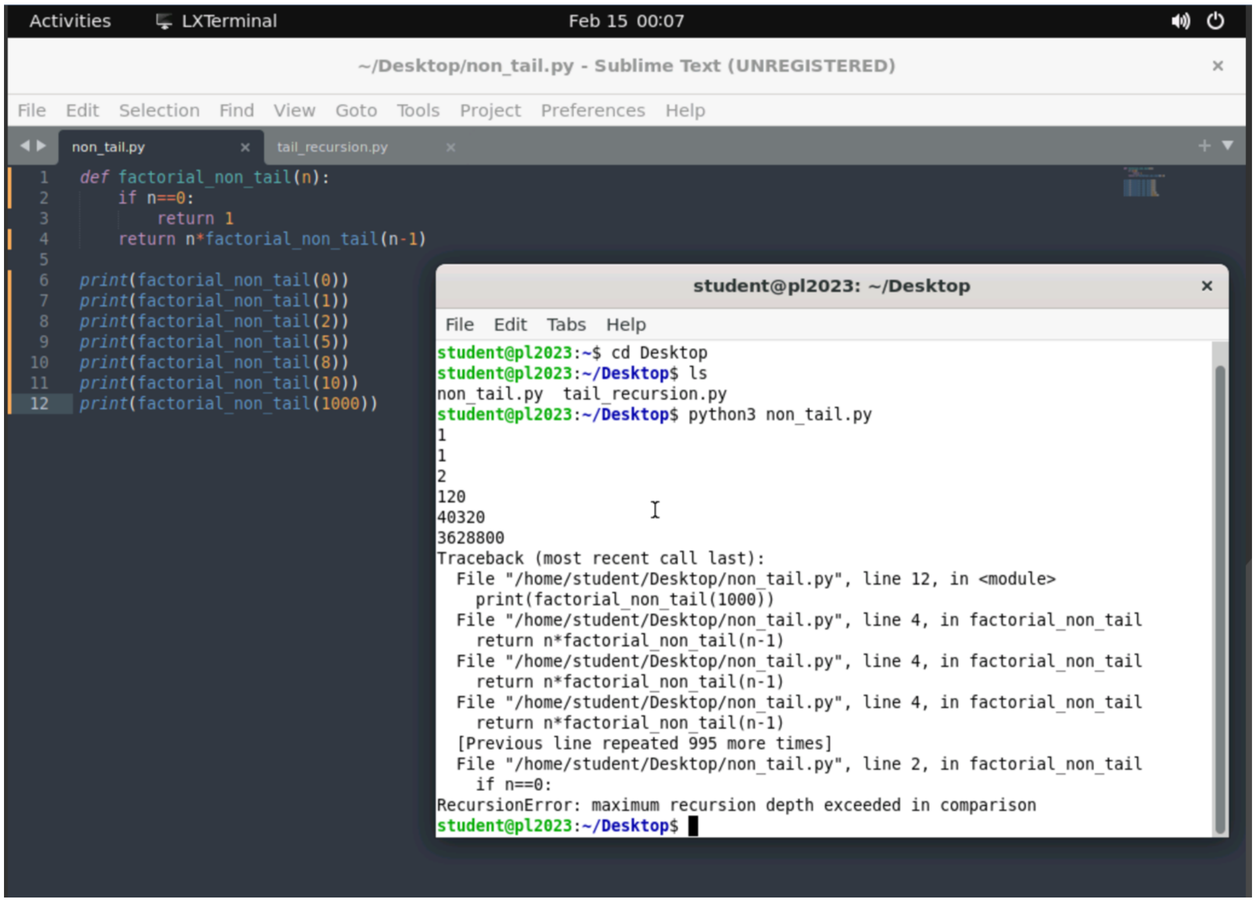
Tail recursion


Activities
LXTerminal
Feb 15 00:08
~/Desktop/tail_recursion.py - Sublime Text (UNREGISTERED)
File Edit Selection Find View Goto Tools Project Preferences Help
non_tail.py
tail_recursion.py
student@pl2023: ~/Desktop
File Edit Tabs Help

```python
def tail_recursion(n,result):
    if n==0:
        return result
    return tail_recursion(n-1,n*result)

print(tail_recursion(0,1))
print(tail_recursion(1,1))
print(tail_recursion(2,1))
print(tail_recursion(5,1))
print(tail_recursion(8,1))
print(tail_recursion(10,1))
print(tail_recursion(1000,1))
```

```
  File "/home/student/Desktop/non_tail.py", line 2, in factorial_non_tail
    if n==0:
RecursionError: maximum recursion depth exceeded in comparison
student@pl2023:~/Desktop$ python3 tail_recursion.py
1
1
2
120
40320
3628800
Traceback (most recent call last):
  File "/home/student/Desktop/tail_recursion.py", line 12, in <module>
    print(tail_recursion(1000,1))
  File "/home/student/Desktop/tail_recursion.py", line 4, in tail_recursion
    return tail_recursion(n-1,n*result)
  File "/home/student/Desktop/tail_recursion.py", line 4, in tail_recursion
    return tail_recursion(n-1,n*result)
  File "/home/student/Desktop/tail_recursion.py", line 4, in tail_recursion
    return tail_recursion(n-1,n*result)
  [Previous line repeated 995 more times]
  File "/home/student/Desktop/tail_recursion.py", line 2, in tail_recursion
    if n==0:
RecursionError: maximum recursion depth exceeded in comparison
student@pl2023:~/Desktop$
```

Non-tail recursion

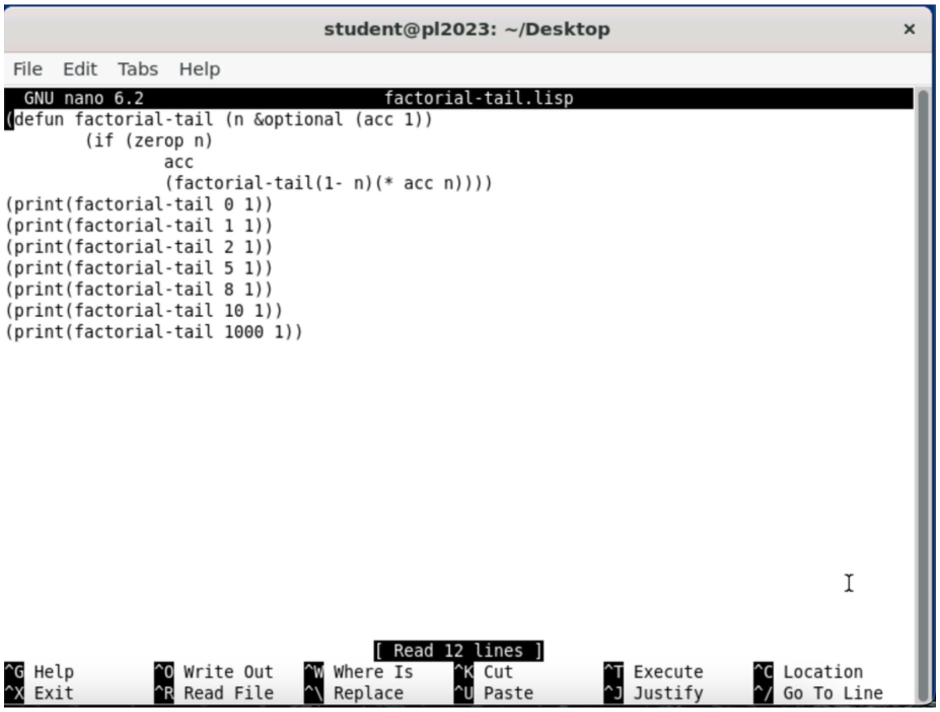


```
def factorial_non_tail(n):
    if n==0:
        return 1
    return n*factorial_non_tail(n-1)

print(factorial_non_tail(0))
print(factorial_non_tail(1))
print(factorial_non_tail(2))
print(factorial_non_tail(5))
print(factorial_non_tail(8))
print(factorial_non_tail(10))
print(factorial_non_tail(1000))
```

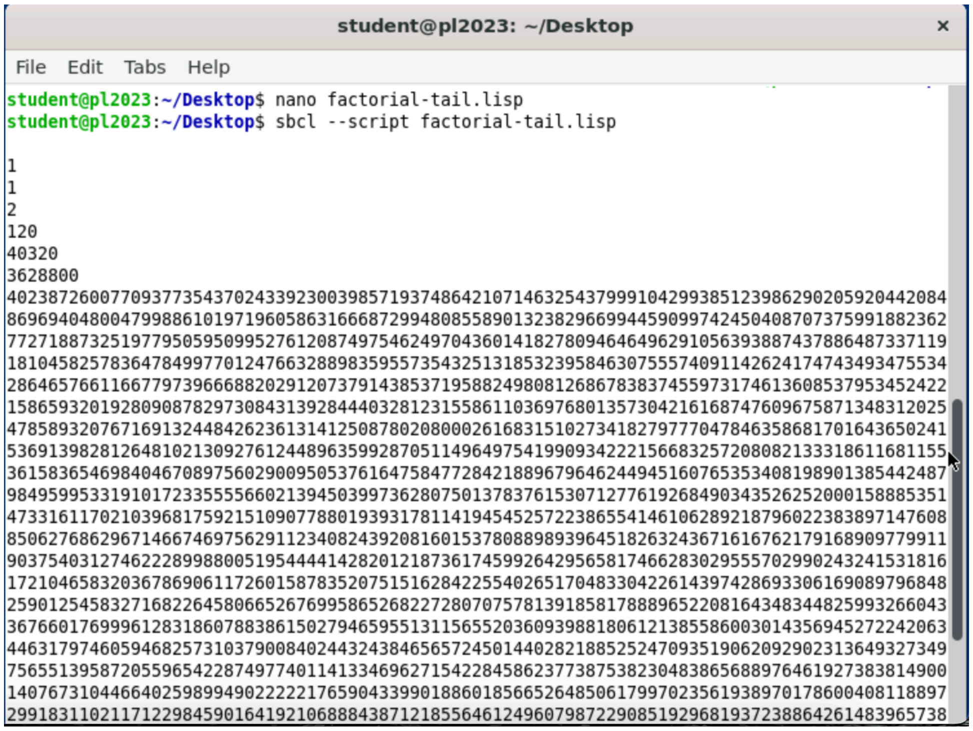
```
student@pl2023:~$ cd Desktop
student@pl2023:~/Desktop$ ls
non_tail.py  tail_recursion.py
student@pl2023:~/Desktop$ python3 non_tail.py
1
1
2
120
40320
3628800
Traceback (most recent call last):
  File "/home/student/Desktop/non_tail.py", line 12, in <module>
    print(factorial_non_tail(1000))
  File "/home/student/Desktop/non_tail.py", line 4, in factorial_non_tail
    return n*factorial_non_tail(n-1)
  File "/home/student/Desktop/non_tail.py", line 4, in factorial_non_tail
    return n*factorial_non_tail(n-1)
  File "/home/student/Desktop/non_tail.py", line 4, in factorial_non_tail
    return n*factorial_non_tail(n-1)
  [Previous line repeated 995 more times]
  File "/home/student/Desktop/non_tail.py", line 2, in factorial_non_tail
    if n==0:
RecursionError: maximum recursion depth exceeded in comparison
student@pl2023:~/Desktop$
```

Lisp

Tail recursion

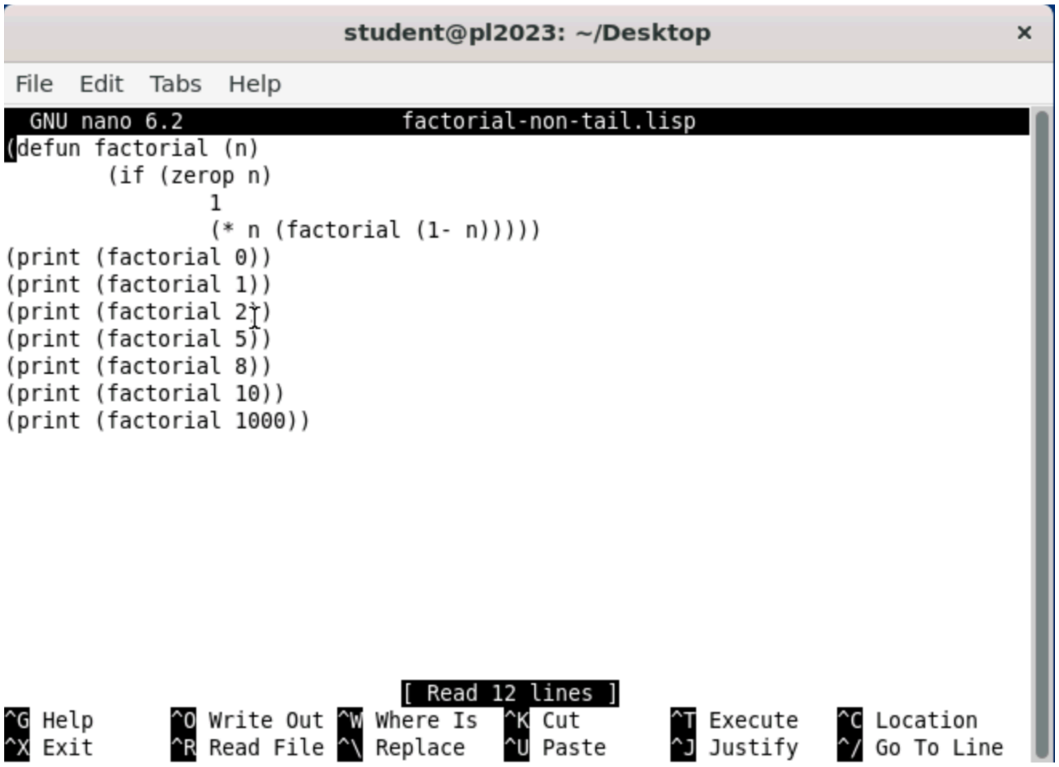


```
 GNU nano 6.2                          factorial-tail.lisp
(defun factorial-tail (n &optional (acc 1))
        (if (zerop n)
                acc
                (factorial-tail(1- n)(* acc n))))
(print(factorial-tail 0 1))
(print(factorial-tail 1 1))
(print(factorial-tail 2 1))
(print(factorial-tail 5 1))
(print(factorial-tail 8 1))
(print(factorial-tail 10 1))
(print(factorial-tail 1000 1))

                                     [ Read 12 lines ]
^G Help          ^O Write Out     ^W Where Is      ^K Cut           ^T Execute       ^C Location
^X Exit          ^R Read File     ^\ Replace       ^U Paste         ^J Justify       ^/ Go To Line
```

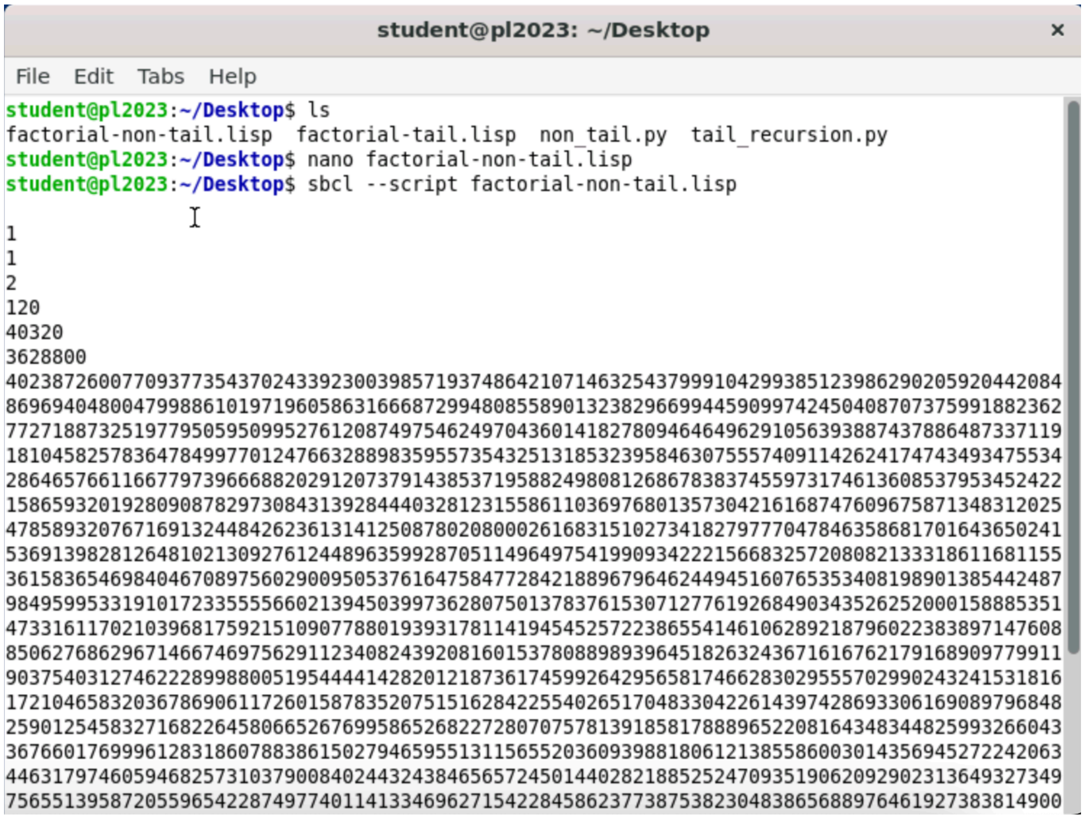


```
student@pl2023:~/Desktop$ nano factorial-tail.lisp
student@pl2023:~/Desktop$ sbcl --script factorial-tail.lisp

1
1
2
120
40320
3628800
402387260077093773543702433923003985719374864210714632543799910429938512398629020592044208
8696940480047998861019719605863166687299480855890132382966994459099742450408707375991882362
7727188732519779505950995276120874975462497043601418278094646496291056393887437886487337119
1810458257836478499770124766328898359557354325131853239584630755574091142624174743493475534
2864657661166779739666882029120737914385371958824980812686783837455973174613608537953452422
1586593201928090878297308431392844403281231558611036976801357304216168747609675871348312025
4785893207671691324484262361314125087802080002616831510273418279777047846358681701643650241
5369139828126481021309276124489635992870511496497541990934222156683257208082133318611681155
3615836546984046708975602900950537616475847728421889679646244945160765353408198901385442487
9849599533191017233555566021394503997362807501378376153071277619268490343526252000158885351
4733161170210396817592151090778801939317811419454525722386554146106289218796022383897147608
8506276862967146674697562911234082439208160153780889893964518263243671616762179168909779911
9037540312746222899880051954444142820121873617459926429565817466283029555702990243241531816
1721046583203678690611726015878352075151628422554026517048330422614397428693306169089796848
2590125458327168226458066526769958652682272807075781391858178889652208164348344825993266043
3676601769996128318607883861502794659551311565520360939881806121385586003014356945272242063
4463179746059468257310379008402443243846565724501440282188525247093519062092902313649327349
7565513958720559654228749774011413346962715422845862377387538230483865688976461927383814900
1407673104466402598994902222217659043399018860185665264850617997023561938970178600408118897
2991831102117122984590164192106888438712185564612496079872290851929681937238864261483965738
```

Non-tail recursion



```
  GNU nano 6.2                   factorial-non-tail.lisp
(defun factorial (n)
        (if (zerop n)
                1
                (* n (factorial (1- n)))))
(print (factorial 0))
(print (factorial 1))
(print (factorial 2))
(print (factorial 5))
(print (factorial 8))
(print (factorial 10))
(print (factorial 1000))

                                [ Read 12 lines ]
^G Help        ^O Write Out  ^W Where Is  ^K Cut         ^T Execute    ^C Location
^X Exit        ^R Read File  ^\ Replace   ^U Paste       ^J Justify    ^/ Go To Line
```



```
student@pl2023:~/Desktop$ ls
factorial-non-tail.lisp  factorial-tail.lisp  non_tail.py  tail_recursion.py
student@pl2023:~/Desktop$ nano factorial-non-tail.lisp
student@pl2023:~/Desktop$ sbcl --script factorial-non-tail.lisp

1
1
2
120
40320
3628800
4023872600770937735437024339230039857193748642107146325437999104299385123986290205920442084
8696940480047998861019719605863166687299480855890132382966994459099742450408707375991882362
7727188732519779505950995276120874975462497043601418278094646496291056393887437886487337119
1810458257836478499770124766328898359557354325131853239584630755574091142624174743493475534
2864657661166779739666882029120737914385371958824980812686783837455973174613608537953452422
1586593201928090878297308431392844403281231558611036976801357304216168747609675871348312025
4785893207671691324484262361314125087802080002616831510273418279777047846358681701643650241
5369139828126481021309276124489635992870511496497541990934222156683257208082133318611681155
3615836546984046708975602900950537616475847728421889679646244945160765353408198901385442487
9849599533191017233555566021394503997362807501378376153071277619268490343526252000158885351
4733161170210396817592151090778801939317811419454525722386554146106289218796022383897147608
8506276862967146674697562911234082439208160153780889893964518263243671616762179168909779911
9037540312746222899880051954444142820121873617459926429565817466283029555702990243241531816
1721046583203678690611726015878352075151628422554026517048330422614397428693306169089796848
2590125458327168226458066526769958652682272807075781391858178889652208164348344825993266043
3676601769996128318607883861502794659551311565520360939881806121385586003014356945272242063
4463179746059468257310379008402443243846565724501440282188525247093519062092902313649327349
7565513958720559654228749774011413346962715422845862377387538230483865688976461927383814900
```