

//PART1

//a)

```
local B in
  thread      // S1
  B=true      // T1
  if B then   // S3
  skip Browse B // S3.1
  thread      // S2
  B=false     // T2
  end
end
end
end
end
```

/* Outputs:

1. S1 T1 S3 S2 T2 S3.1 --> Cant unify B in value creation.
2. S1 T1 S2 S3 S3.1 T2 --> B:True()
3. S1 T2 S2 S3 T2 S3.1 --> Cant unify B in value creation.
4. S1 T1 S2 T2 S3.1 S3 --> Error
- S2 S1 T1 S3 T2 S3.1 --> Cant unify B in value creation.
5. S2 T2 S3 S3.1 S1 T1 --> No Output.
6. S2 T2 S1 T1 S3 S3.1 --> Cant unify B in value creation.
7. S2 S1 T1 T2 S3 S3.1 --> Cant unify B in value creation.
8. S2 T2 S1 S3 T1 S3.1 --> No Output.
9. S2 T2 S1 S3.1 T1 S3 --> Error
10. S2 T2 S1 S3 S3.1 T1 --> No Output.
11. S2 T2 S1 T1 S3.1 S3 --> Error
12. S1 T1 S2 T2 S3 S3.1 --> Cant unify B in value creation.
13. S2 S1 T2 T1 S3 S3.1 --> Cant unify B in value creation.
14. S2 S1 S3 T1 T2 S3.1 --> Deadlocked statements.
15. S1 T1 S3 S2 T2 S3.1 --> Cant unify B in value creation.
16. S1 S2 T1 S3 T2 S3.1 --> Cant unify B in value creation.
17. S1 S2 T1 T2 S3 S3.1 --> Cant unify B in value creation.
18. S2 T2 S3.1 S3 S1 T1 --> B:False()
19. S1 T1 S3 S3.1 S2 T2 --> Cant unify B in value creation.

*/

//b)

```
local X Y T in
  thread Y = X end
  X = 3
  skip Browse Y
end
```

```
local T1 T2 in
  T2 = thread 3 end
  T1 = thread (4+3) end
  skip Browse T2
  skip Browse T1
end
```

/* Output: Finite 1

*Hoz> runFullT (Finite 1) "declarative threaded" "thread2.txt" "thread2.out"

Y : 3

T2 : 3

T1 : Unbound

*/

when finite =1 then T1 remain unbounded and Y=3 and T2=3 is assigned.

/* Output: Infinity

*Hoz> runFullT (Infinity) "declarative threaded" "thread2.txt" "thread2.out"

Y : Unbound

T2 : Unbound

T1 : Unbound

when quantum is infinity then T1 , Y and T2 remain unbounded

*/

//c)

```
local Z in
  Z = 3
  thread local X in
    X = 1
    skip Browse X
  skip Browse X
```

```

skip Basic
  skip Browse X
  skip Browse X
skip Basic
  skip Browse X
end
end
thread local Y in
  Y = 2
  skip Browse Y
skip Basic
  skip Browse Y
  skip Browse Y
  skip Browse Y
skip Basic
  skip Browse Y

```

```

end
skip Basic
end
  skip Browse Z
  skip Browse Z
  skip Browse Z
skip Basic
  skip Browse Z

```

```

skip Browse Z
skip Basic
end

```

```
//d)
```

```

local B in
  B = thread true end
  if B then skip Browse B end
end

```

```
/*Thread suspended at Finite 5
```

```
Output: Finite 5
```

```
*Hoz> runFullT (Finite 5) "declarative threaded" "thread4.txt" "thread4.out"
```

```

thread suspended: [(if EXU1 then [skip/BB] else
[skip],[("EXU1",9),("B",8),("IntPlus",1),("IntMinus",2),("Eq",3),("GT",4),("LT",5),("Mod",6),("IntMulti
ply",7)]]]
B : true()

```

if we look in kernal syntax suspension occur at Fninte 5 because in kernal version if condition is the 5th instructions and hence lead to suspension at Finite 5

```

*/

```

```

//e) fib1_sugar.txt

```

```

local Fib X Result in
  Fib = fun {$ In}
    if (In == 0) then
      1
    elseif (In == 1) then
      1
    else
      ({Fib (In-1)} + {Fib (In - 2)})
    end
  end
  X = 16
  Result = {Fib X}
  skip Browse Result
end

```

```

/* Output
X=12
*Hoz> runFullT (Finite 4) "declarative threaded" "lab6/fib1_sugar.txt" "lab6/fib1_sugar.out"
Result : 233

```

```

(2.02 secs, 796,340,704 bytes)

```

```

X=13
*Hoz> runFullT (Finite 4) "declarative threaded" "lab6/fib1_sugar.txt" "lab6/fib1_sugar.out"
Result : 377

```

```

(5.08 secs, 2,023,921,480 bytes)

```

```

X=14
*Hoz> runFullT (Finite 4) "declarative threaded" "lab6/fib1_sugar.txt" "lab6/fib1_sugar.out"

```

Result : 610

(13.02 secs, 5,199,275,136 bytes)

X=15

```
*Hoz> runFullT (Finite 3) "declarative threaded" "lab6/fib1_sugar.txt" "lab6/fib1_sugar.out"
Result : 987
```

(32.61 secs, 13,449,972,624 bytes)

X=16

```
*Hoz> runFullT (Finite 3) "declarative threaded" "lab6/fib1_sugar.txt" "lab6/fib1_sugar.out"
Result : 1597
```

(84.12 secs, 34,936,141,736 bytes)-----(>1min)

Explanation:

After observing the output we can say, for increasing value of X there is a pattern in output where sum of two consecutive outputs results in the third output
eg. $377+610=987$; $610+987=1597$

X	R	Time
12	233	35.52 sec
13	377	45.78 sec
14	610	57.85 sec
15	987	64.29 sec

at X=16 we get a time more than 1 min. here, at X=16 only we are above 1min and this is because there are two recursive call in the Fib which will be computing the values and will form like a binary threaded
each node will have two child nodes and return will result in more time consumptions
*/

```
// fib2_sugar.txt
```

```
local Fib Fib1 X R in
  Fib1 = fun {$ X N M}
    if (X == 0) then
      M
```

```

elseif (X == 1) then
  M
else
  {Fib1 (X-1) M (N+M)}
end
end
Fib = fun {$ X}
  {Fib1 X 1 1}
end
X = 1500
R = {Fib X}
skip Browse R
end

```

/* Outputs:

```

X=1500
*Hoz> runFullT (Finite 4) "declarative threaded" "lab6/fib2_sugar.txt" "lab6/fib2_sugar.out"
R : 1415338001064792265

```

(35.52 secs, 14,187,021,128 bytes)

```

X=1700
*Hoz> runFullT (Finite 4) "declarative threaded" "lab6/fib2_sugar.txt" "lab6/fib2_sugar.out"
R : 6191931358466575682

```

(45.78 secs, 18,191,957,976 bytes)

```

X=1800
*Hoz> runFullT (Finite 4) "declarative threaded" "lab6/fib2_sugar.txt" "lab6/fib2_sugar.out"
R : -7444749993583591759

```

(52.21 secs, 20,381,047,336 bytes)

```

X=1900
*Hoz> runFullT (Finite 4) "declarative threaded" "lab6/fib2_sugar.txt" "lab6/fib2_sugar.out"
R : 2141288501034094421

```

(57.85 secs, 22,694,424,816 bytes)

```

X=2000
*Hoz> runFullT (Finite 4) "declarative threaded" "lab6/fib2_sugar.txt" "lab6/fib2_sugar.out"
R : -820905900187520670

```

(64.29 secs, 25,130,954,888 bytes)---->(>1 min)

X	R	Time
1500	1415338001064792265	35.52 sec
1700	6191931358466575682	45.78 sec
1900	2141288501034094421	57.85 sec
2000	-820905900187520670	64.29 sec

as observed above for X=2000 time exceeds 1 minute with the more increase in X there will be more recursive calls to Fib1 and everytime we will be calculating the value for all smaller X.

here there is a recursion with one fib call and hence we are able to calcute till X=1900 with time less than 1 min

*/

//fib1_thread.txt

local Fib X Result in

Fib = fun {\$ In}

if (In == 0) then

1

elseif (In == 1) then

1

else

(thread {Fib (In-1)} end + thread {Fib (In - 2)} end)

end

end

X = 2

Result = {Fib X}

skip Browse Result

end

/* Outputs:

X=0

*Hoz> runFullT (Finite 3) "declarative threaded" "lab6/fib1_thread.txt" "lab6/fib1_thread.out"

Result : 1

X=1

*Hoz> runFullT (Finite 3) "declarative threaded" "lab6/fib1_thread.txt" "lab6/fib1_thread.out"

Result : 1

X=2

```
*Hoz> runFullT (Finite 3) "declarative threaded" "lab6/fib1_thread.txt" "lab6/fib1_thread.out"
```

```
thread supsended: [("IntPlus" "EXU4" "EXU5"
```

```
"EXU1", [("EXU4", 18), ("EXU5", 19), ("EXU3", 15), ("EXU2", 12), ("In", 11), ("EXU1", 10), ("Eq", 3), ("IntMi  
nus", 2), ("Fib", 8), ("IntPlus", 1)]), (skip/BResult, [("Fib", 8), ("X", 9), ("Result", 10), ("IntPlus", 1), ("IntMinu  
s", 2), ("Eq", 3), ("GT", 4), ("LT", 5), ("Mod", 6), ("IntMultiply", 7)])]
```

```
thread supsended: [("IntPlus" "EXU4" "EXU5"
```

```
"EXU1", [("EXU4", 18), ("EXU5", 19), ("EXU3", 15), ("EXU2", 12), ("In", 11), ("EXU1", 10), ("Eq", 3), ("IntMi  
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```

```
thread supsended: [("IntPlus" "EXU4" "EXU5"
```

```
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nus", 2), ("Fib", 8), ("IntPlus", 1)]), (skip/BResult, [("Fib", 8), ("X", 9), ("Result", 10), ("IntPlus", 1), ("IntMinu  
s", 2), ("Eq", 3), ("GT", 4), ("LT", 5), ("Mod", 6), ("IntMultiply", 7)])]
```

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thread supsended: [("IntPlus" "EXU4" "EXU5"
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```

```
thread supsended: [("IntPlus" "EXU4" "EXU5"
```

```
"EXU1", [("EXU4", 18), ("EXU5", 19), ("EXU3", 15), ("EXU2", 12), ("In", 11), ("EXU1", 10), ("Eq", 3), ("IntMi  
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s", 2), ("Eq", 3), ("GT", 4), ("LT", 5), ("Mod", 6), ("IntMultiply", 7)])]
```

```
thread supsended: [("IntPlus" "EXU4" "EXU5"
```

```
"EXU1", [("EXU4", 18), ("EXU5", 19), ("EXU3", 15), ("EXU2", 12), ("In", 11), ("EXU1", 10), ("Eq", 3), ("IntMi  
nus", 2), ("Fib", 8), ("IntPlus", 1)]), (skip/BResult, [("Fib", 8), ("X", 9), ("Result", 10), ("IntPlus", 1), ("IntMinu  
s", 2), ("Eq", 3), ("GT", 4), ("LT", 5), ("Mod", 6), ("IntMultiply", 7)])]
```

Result : 2

X=3

```
*Hoz> runFullT (Finite 3) "declarative threaded" "lab6/fib1_thread.txt" "lab6/fib1_thread.out"
```

```
thread supsended: [("IntPlus" "EXU4" "EXU5"
```

```
"EXU1", [("EXU4", 18), ("EXU5", 19), ("EXU3", 15), ("EXU2", 12), ("In", 11), ("EXU1", 10), ("Eq", 3), ("IntMi  
nus", 2), ("Fib", 8), ("IntPlus", 1)]), (skip/BResult, [("Fib", 8), ("X", 9), ("Result", 10), ("IntPlus", 1), ("IntMinu  
s", 2), ("Eq", 3), ("GT", 4), ("LT", 5), ("Mod", 6), ("IntMultiply", 7)])]
```

```
thread supsended: [("IntPlus" "EXU4" "EXU5"
```

```
"EXU1", [("EXU4", 18), ("EXU5", 19), ("EXU3", 15), ("EXU2", 12), ("In", 11), ("EXU1", 10), ("Eq", 3), ("IntMi  
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```

```
thread supsended: [("IntPlus" "EXU4" "EXU5"
```

```
"EXU1", [("EXU4", 18), ("EXU5", 19), ("EXU3", 15), ("EXU2", 12), ("In", 11), ("EXU1", 10), ("Eq", 3), ("IntMi  
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```



```
thread suspended: [{"IntPlus" "EXU4" "EXU5"  
"EXU1",[("EXU4",18),("EXU5",19),("EXU3",15),("EXU2",12),("In",11),("EXU1",10),("Eq",3),("IntMi  
nus",2),("Fib",8),("IntPlus",1)]),(skip/BResult,[("Fib",8),("X",9),("Result",10),("IntPlus",1),("IntMinu  
s",2),("Eq",3),("GT",4),("LT",5),("Mod",6),("IntMultiply",7))]]  
thread suspended: [{"IntPlus" "EXU4" "EXU5"  
"EXU1",[("EXU4",18),("EXU5",19),("EXU3",15),("EXU2",12),("In",11),("EXU1",10),("Eq",3),("IntMi  
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s",2),("Eq",3),("GT",4),("LT",5),("Mod",6),("IntMultiply",7))]]  
thread suspended: [{"IntPlus" "EXU4" "EXU5"  
"EXU1",[("EXU4",18),("EXU5",19),("EXU3",15),("EXU2",12),("In",11),("EXU1",10),("Eq",3),("IntMi  
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thread suspended: [{"IntPlus" "EXU4" "EXU5"  
"EXU1",[("EXU4",18),("EXU5",19),("EXU3",15),("EXU2",12),("In",11),("EXU1",10),("Eq",3),("IntMi  
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s",2),("Eq",3),("GT",4),("LT",5),("Mod",6),("IntMultiply",7))]]  
thread suspended: [{"IntPlus" "EXU4" "EXU5"  
"EXU1",[("EXU4",38),("EXU5",39),("EXU3",32),("EXU2",26),("In",20),("EXU1",18),("Eq",3),("IntM  
inus",2),("Fib",8),("IntPlus",1)]]]  
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"EXU1",[("EXU4",18),("EXU5",19),("EXU3",15),("EXU2",12),("In",11),("EXU1",10),("Eq",3),("IntMi  
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thread suspended: [{"IntPlus" "EXU4" "EXU5"  
"EXU1",[("EXU4",38),("EXU5",39),("EXU3",32),("EXU2",26),("In",20),("EXU1",18),("Eq",3),("IntM  
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"EXU1",[("EXU4",18),("EXU5",19),("EXU3",15),("EXU2",12),("In",11),("EXU1",10),("Eq",3),("IntMi  
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s",2),("Eq",3),("GT",4),("LT",5),("Mod",6),("IntMultiply",7))]]  
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"EXU1",[("EXU4",38),("EXU5",39),("EXU3",32),("EXU2",26),("In",20),("EXU1",18),("Eq",3),("IntM  
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"EXU1",[("EXU4",18),("EXU5",19),("EXU3",15),("EXU2",12),("In",11),("EXU1",10),("Eq",3),("IntMi  
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s",2),("Eq",3),("GT",4),("LT",5),("Mod",6),("IntMultiply",7))]]
```

```

thread suspended: [("IntPlus" "EXU4" "EXU5"
"EXU1", [("EXU4",38),("EXU5",39),("EXU3",32),("EXU2",26),("In",20),("EXU1",18),("Eq",3),("IntMi
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s",2),("Eq",3),("GT",4),("LT",5),("Mod",6),("IntMultiply",7))])
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"EXU1", [("EXU4",18),("EXU5",19),("EXU3",15),("EXU2",12),("In",11),("EXU1",10),("Eq",3),("IntMi
nus",2),("Fib",8),("IntPlus",1))],(skip/BResult,[("Fib",8),("X",9),("Result",10),("IntPlus",1),("IntMinu
s",2),("Eq",3),("GT",4),("LT",5),("Mod",6),("IntMultiply",7))])
Result : 3

```

X=4

```
*Hoz> runFullT (Finite 3) "declarative threaded" "lab6/fib1_thread.txt" "lab6/fib1_thread.out"
```

```

thread suspended: [("IntPlus" "EXU4" "EXU5"
"EXU1", [("EXU4",18),("EXU5",19),("EXU3",15),("EXU2",12),("In",11),("EXU1",10),("Eq",3),("IntMi
nus",2),("Fib",8),("IntPlus",1))],(skip/BResult,[("Fib",8),("X",9),("Result",10),("IntPlus",1),("IntMinu
s",2),("Eq",3),("GT",4),("LT",5),("Mod",6),("IntMultiply",7))])
thread suspended: [("IntPlus" "EXU4" "EXU5"
"EXU1", [("EXU4",18),("EXU5",19),("EXU3",15),("EXU2",12),("In",11),("EXU1",10),("Eq",3),("IntMi
nus",2),("Fib",8),("IntPlus",1))],(skip/BResult,[("Fib",8),("X",9),("Result",10),("IntPlus",1),("IntMinu
s",2),("Eq",3),("GT",4),("LT",5),("Mod",6),("IntMultiply",7))])
thread suspended: [("IntPlus" "EXU4" "EXU5"
"EXU1", [("EXU4",18),("EXU5",19),("EXU3",15),("EXU2",12),("In",11),("EXU1",10),("Eq",3),("IntMi
nus",2),("Fib",8),("IntPlus",1))],(skip/BResult,[("Fib",8),("X",9),("Result",10),("IntPlus",1),("IntMinu
s",2),("Eq",3),("GT",4),("LT",5),("Mod",6),("IntMultiply",7))])
thread suspended: [("IntPlus" "EXU4" "EXU5"
"EXU1", [("EXU4",18),("EXU5",19),("EXU3",15),("EXU2",12),("In",11),("EXU1",10),("Eq",3),("IntMi
nus",2),("Fib",8),("IntPlus",1))],(skip/BResult,[("Fib",8),("X",9),("Result",10),("IntPlus",1),("IntMinu
s",2),("Eq",3),("GT",4),("LT",5),("Mod",6),("IntMultiply",7))])
thread suspended: [("IntPlus" "EXU4" "EXU5"
"EXU1", [("EXU4",18),("EXU5",19),("EXU3",15),("EXU2",12),("In",11),("EXU1",10),("Eq",3),("IntMi
nus",2),("Fib",8),("IntPlus",1))],(skip/BResult,[("Fib",8),("X",9),("Result",10),("IntPlus",1),("IntMinu
s",2),("Eq",3),("GT",4),("LT",5),("Mod",6),("IntMultiply",7))])
thread suspended: [("IntPlus" "EXU4" "EXU5"
"EXU1", [("EXU4",18),("EXU5",19),("EXU3",15),("EXU2",12),("In",11),("EXU1",10),("Eq",3),("IntMi
nus",2),("Fib",8),("IntPlus",1))],(skip/BResult,[("Fib",8),("X",9),("Result",10),("IntPlus",1),("IntMinu
s",2),("Eq",3),("GT",4),("LT",5),("Mod",6),("IntMultiply",7))])

```

```

thread suspended: [("IntPlus" "EXU4" "EXU5"
"EXU1",[("EXU4",18),("EXU5",19),("EXU3",15),("EXU2",12),("In",11),("EXU1",10),("Eq",3),("IntMi
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s",2),("Eq",3),("GT",4),("LT",5),("Mod",6),("IntMultiply",7)])])
thread suspended: [("IntPlus" "EXU4" "EXU5"
"EXU1",[("EXU4",38),("EXU5",39),("EXU3",32),("EXU2",26),("In",20),("EXU1",18),("Eq",3),("IntM
inus",2),("Fib",8),("IntPlus",1)])])
thread suspended: [("IntPlus" "EXU4" "EXU5"
"EXU1",[("EXU4",40),("EXU5",41),("EXU3",35),("EXU2",29),("In",23),("EXU1",19),("Eq",3),("IntM
inus",2),("Fib",8),("IntPlus",1)])])
thread suspended: [("IntPlus" "EXU4" "EXU5"
"EXU1",[("EXU4",18),("EXU5",19),("EXU3",15),("EXU2",12),("In",11),("EXU1",10),("Eq",3),("IntMi
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thread suspended: [("IntPlus" "EXU4" "EXU5"
"EXU1",[("EXU4",38),("EXU5",39),("EXU3",32),("EXU2",26),("In",20),("EXU1",18),("Eq",3),("IntM
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thread suspended: [("IntPlus" "EXU4" "EXU5"
"EXU1",[("EXU4",40),("EXU5",41),("EXU3",35),("EXU2",29),("In",23),("EXU1",19),("Eq",3),("IntM
inus",2),("Fib",8),("IntPlus",1)])])
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thread supsended: [("IntPlus" "EXU4" "EXU5"
"EXU1",[("EXU4",75),("EXU5",76),("EXU3",66),("EXU2",54),("In",42),("EXU1",38),("Eq",3),("IntM
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```

```

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s",2),("Eq",3),("GT",4),("LT",5),("Mod",6),("IntMultiply",7)])])

```

Result : 5

*/

//PART2

//both a and b part

local Producer N Limit Out OddFilter P L F T Consumer Xs Ys Accumulator NotEqual in

Producer = proc {\$ N Limit Out}

if (N<Limit) then T N1 in

Out = (N|T)

N1 = (N + 1)

{Producer N1 Limit T}

else Out = nil

end

end

//odd filter

OddFilter = fun {\$ P}

case P

of nil then nil

[] '!(1:X 2:Xr) then in

if((X mod 2) == 0) then

(X|{OddFilter Xr})

else

{OddFilter Xr}

end

end

end

//consumer

Consumer = fun {\$ Xs Accumulator}

case Xs

of nil then Accumulator

[] '!(1:X 2:Xr) then {Consumer Xr (X+Accumulator)}

end

//Accumulator

end

// Example Testing

N = 0

L = 100

```
{Producer N L P} // [0 1 2 .. 100]
skip Browse P
Accumulator = {Consumer P 0}
skip Browse Accumulator
F= {OddFilter P} // [0 2 4 .. 100]
skip Browse F
```

end

/*

*Hoz> runFull "declarative" "lab6/part2.txt" "lab6/part2.out"

```
P : [ 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52
53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 ]
```

```
//Consumer Output
Accumulator : 4950
```

```
//OddFilter output
F : [ 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50
52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 ]
```

*/

//c question:

local Generate N Limit Out Sum in

```
fun {Generate N Limit}
  if (N<Limit) then
    (N){Generate (N+1) Limit}
  else nil
  end
end
```

```

fun {Sum Xs A}
  case Xs
  of nil then A
  [] (X|Xr) then {Sum Xr (A+X)}
  end
end
end

```

```

local Xs S in
  thread Xs={Generate 0 100}
  skip Browse Xs end
  thread S={Sum Xs 0}
  skip Browse S end
end
end

```

```

/*
output

```

```

*Hoz> runFullT (Finite 4) "declarative threaded" "lab6/part2_1.txt" "lab6/part2_1.out"
Xs : [0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51
52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76
77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99]

```

```

S : 4950

```

```

*/

```