INFDEV02-2 Homework 4

The DEV Team

Abstraction, functions, recursion, lambdas, and data structures.

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1 Lecture Homework 4 - Drawing with lambdas

1.1 Homework 4 - Grid

Fill in the missing code blocks.

```
def draw_grid (x_dim,y_dim,p):
 1
      res=""
 2
 3
      x = 0
 4
      y = 0
      while((y<y_dim)):
 5
        while((x<x_dim)):
 6
7
          if(
                        (x,y)):
 8
                       =(res+
9
          else:
10
                                         )
                       =(res+
11
          x = (x+1)
12
        res=(res+"\n")
13
                  =0
14
                   = (
                                           )
15
      return res
   print (draw_grid(3,3,lambda x,y:
                                                    ))
```

```
globals
stack
heap
definitions
              draw_grid (x_dim,y_dim,p) => ...
                       "###\n###\n##\n"
output
globals
stack
heap
definitions
              draw_grid (x_dim,y_dim,p) => ...
globals
                    ret
                           "###\n###\n###\n"
                                    3
                    x_dim
                    y_dim
                                    3
                              lambda -> @3
stack
                    р
                           "###\n###\n###\n"
                    res
                                    0
                    х
                                    3
heap
              draw_grid (x_dim, y_dim, p) => ...
definitions
```

globals		
	ret	null
	x_dim	3
	y_dim	3
stack	р	lambda -> @3
	res	"###\n###\n###\n"
	x	0
	у	3
heap		
definitions	draw_grid	(x_dim,y_dim,p) =>
globals		
	ret	null
	x_dim	3
	y_dim	3
stack	p _	lambda -> @3
	res	"###\n###\n##\n"
	x	0
	У	3
heap		
definitions	draw_grid	(x_dim,y_dim,p) =>
globals		
	ret	null
	x_dim	3
	y_dim	3
stack	p p	lambda -> @3
	res	"###\n###\n##\n"
	x	0
	у	2
heap		
definitions	draw_grid	(x_dim,y_dim,p) =>
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	res	"###\n###\n###"	
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              draw_grid (x_dim,y_dim,p) => ...
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heap
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              draw_grid (x_dim,y_dim,p) => ...
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	ret	null
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	res "##	#\n###\n##"
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definitions	draw_grid (x_dim	,y_dim,p) =>
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	x_dim	3
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stack	p la	mbda -> @3
	res "##	#\n###\n##"
	x	1
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stack	p la	mbda -> @3
	res "##	##\n###\n#"
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              draw_grid (x_dim,y_dim,p) => ...
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              draw_grid (x_dim,y_dim,p) => ...
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              draw_grid (x_dim, y_dim, p) => ...
definitions
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              draw_grid (x_dim,y_dim,p) => ...
definitions
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                       y_dim
                               lambda -> @3
                                    "#"
                       res
stack
                       х
                                     1
                                     0
                       у
                             ret
                                  null
                             х
                                    1
                                   0
                            У
heap
definitions
              draw_grid (x_dim,y_dim,p) => ...
globals
                       ret
                                   null
                       x_dim
                                     3
                       y_dim
                                     3
stack
                               lambda -> @3
                       р
                                    "#"
                       res
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                       у
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heap
definitions
              draw_grid (x_dim,y_dim,p) => ...
globals
                       ret
                                   null
                                     3
                       x_dim
                       y_dim
                                    3
                               lambda -> @3
stack
                       р
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                       res
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heap
definitions
               draw_grid (x_dim,y_dim,p) => ...
globals
                       ret
                                   null
                                     3
                       x_dim
                       y_dim
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stack
                       p
                               lambda -> @3
                                    "#"
                       res
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                       У
heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
```

```
globals
                       ret
                                   null
                       x_dim
                                     3
                                     3
                       y_dim
                               lambda -> @3
stack
                       res
                                     0
                       х
                                     0
heap
definitions
               draw_grid (x_dim,y_dim,p) => ...
globals
                                   null
                       ret
                                     3
                       x_dim
                                     3
                       y_dim
stack
                               lambda -> @3
                                    11 11
                       res
                                     0
                       х
                                     0
heap
definitions
               draw_grid (x_dim,y_dim,p) => ...
globals
                       ret
                                   null
                                     3
                       x_dim
                       y_dim
                                     3
                               lambda -> @3
                                    11 11
                       res
stack
                                     0
                       х
                       у
                             ret
                                 True
                                   0
                             х
                                   0
                            У
heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
```

```
globals
                                   null
                       ret
                       x_dim
                                     3
                                     3
                       y_dim
                               lambda -> @3
                       res
stack
                       х
                                     0
                                     0
                       у
                             ret
                                  null
                                    0
                             х
                                    0
                             У
heap
definitions
               draw_grid (x_dim,y_dim,p) => ...
globals
                       ret
                                   null
                       x_dim
                                     3
                       y_dim
                                     3
stack
                               lambda -> @3
                       р
                       res
                                     0
                       х
                       у
                                     0
heap
               draw_grid (x_dim,y_dim,p) => ...
definitions
globals
                       ret
                                   null
                                     3
                       x_dim
                       y_dim
                                     3
                               lambda -> @3
stack
                       р
                                     11 11
                       res
                                     0
                       х
                                     0
                       У
heap
definitions
               draw_grid (x_dim,y_dim,p) => ...
globals
                       ret
                                   null
                                     3
                       x_dim
                       y_dim
                                     3
stack
                       p
                               lambda -> @3
                                     11 11
                       res
                                     0
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                       У
heap
               draw_grid (x_dim,y_dim,p) => ...
definitions
```

```
globals
                                  null
                      ret
                      x_dim
                                   3
                                   3
                      y_dim
stack
                              lambda -> @3
                                   11 11
                      res
                      X
                                   0
heap
definitions
              draw_grid (x_dim,y_dim,p) => ...
globals
                                  null
                      ret
                      x_dim
                                   3
stack
                      y_dim
                                   3
                      p
                              lambda -> @3
                      res
heap
definitions
              draw_grid (x_dim,y_dim,p) => ...
globals
                                  null
                      ret
                                   3
                      x_dim
stack
                      y_dim
                                   3
                      р
                              lambda -> @3
heap
definitions
              draw_grid (x_dim,y_dim,p) => ...
globals
stack
heap
definitions
             draw_grid (x_dim,y_dim,p) => ...
globals
{\tt stack}
heap
definitions
```

2 Lecture Homework 4 - High order predicate combinators

2.1 Or

Fill in the missing code blocks.

```
up=lambda \quad x,y:(y==0)
   left=lambda x, y:(x==0)
  OR=lambda
          lambda
5
            (
                       (
                                              ) or
                                                              (
                                                                                     ))
6
7
8
                           (
   top_or_left=
                                                  )
9
   a=top_or_left(0,0)
10
11
  b=top_or_left(0,1)
  c=top_or_left(1,0)
12
  d=top_or_left(1,1)
13
```

```
a
                                  True
               b
                                  True
               С
                                  True
               OR
                             lambda -> @10
globals
               d
                                  False
                              lambda -> 04
               left
                              lambda -> @9
               top_or_left
                              lambda -> @2
               up
stack
heap
definitions
               a
                                  True
               b
                                  True
               С
                                  True
               OR
                             lambda -> @10
globals
                              lambda -> 04
               left
                              lambda -> @9
               top_or_left
                              lambda -> @2
               uр
stack
heap
definitions
```

	a True
	b True
	c True
globals	OR lambda -> @10
	left lambda -> 04
	top_or_left lambda -> 09
	uplambda -> @2
	p2 lambda -> @4
	p1 lambda -> @2
stack	ret False
	x 1
	y 1
heap	
definitions	
	a True
	b True
	c True
globals	OR lambda -> @10
	left lambda -> @4
	top_or_left lambda -> @9
	up lambda -> @2
	p2 lambda -> @4
	p1 lambda -> @2
stack	ret null
	x 1
	y 1
heap	
definitions	
	a True
	b True
	c True
globals	OR lambda -> @10
	left lambda -> @4
	top_or_left lambda -> @9
	uplambda -> @2
	p2 lambda -> @4
	p1 lambda -> @2
	ret null
	x 1
stack	y 1
	ret False
	x 1
	y 1
	J

	a	True
	b	True
	С	True
globals	OR	lambda -> @10
	left	lambda -> @4
	top_or_left	lambda -> 09
	up	lambda -> @2
	p2 1	lambda -> @4
	p1 1	lambda -> @2
	ret	null
	x	1
stack	у	1
	re	et null
	x	1
	у	1
heap		
definitions		
	a	True
	b	True
	С	True
globals	OR	lambda -> @10
	left	lambda -> @4
	top_or_left	lambda -> @9
	up	lambda -> @2
	p2 1	lambda -> @4
	p1 1	lambda -> @2
stack	ret	null
	х	1
	21	-
	у	1
heap		

	a True
	b True
	c True
globals	OR lambda -> @1
	left lambda -> 04
	top_or_left lambda -> @9
	up lambda -> 02
	p2 lambda -> @4
	p1 lambda -> @2
	ret null
-+1-	x 1
stack	y 1
	ret False
	x 1
	y 1
heap	
definitions	
	a True
	b True
	c True
globals	OR lambda -> @1
	left lambda -> 04
	top_or_left lambda -> @9
	uplambda -> @2
	p2 lambda -> @4
	p1 lambda -> @2
	ret null
-+1-	x 1
stack	y 1
	ret null
	x 1
	у 1
heap	
-	

	a	True
	Ъ	True
	С	True
globals	OR	lambda -> @10
	left	lambda -> @4
	top_or_left	lambda -> @9
	up	lambda -> @2
	p2 1a	ambda -> @4
	p1 1a	ambda -> @2
stack	ret	null
	х	1
	у	1
heap		
definitions		
	a	True
	b	True
	С	True
globals	OR	lambda -> @10
	left	lambda -> @4
	top_or_left	lambda -> @9
	up	lambda -> @2
stack		
heap		
definitions		
	a	True
	b	True
	OR	lambda -> @10
globals	left	lambda -> @4
	top_or_left	lambda -> @9
	up	lambda -> @2
stack		
heap		
definitions		

	a	True
	b	True
	OR	lambda -> @10
globals	left	lambda -> @4
	top_or_left	lambda -> @9
	up	lambda -> @2
	p2 1	ambda -> @4
	p1 1	ambda -> @2
stack	ret	True
	x	1
	у	0
heap		
definitions		
	a	True
	b	True
globals	OR	lambda -> @10
giobais	left	lambda -> @4
	top_or_left	lambda -> @9
	up	lambda -> @2
	p2 1	ambda -> @4
	p1 1	ambda -> @2
stack	ret	null
	X	1
	у	0
heap		
definitions		
	a	True
	Ъ	True
globals	OR	lambda -> @10
8-020-2	left	lambda -> @4
	top_or_left	lambda -> @9
	up	lambda -> @2
	p2 1	ambda -> @4
	p1 1	ambda -> @2
	ret	null
stack	x	1
DUGUK	у	0
	re	t False
	x	1
	у	0
heap		
definitions		

	a	True
	b	True
	OR	lambda -> @1(
globals	left	lambda -> 04
	top_or_le	
	=	lambda -> @2
	up	lambda -> 04
	p2 p1	lambda -> @2
	ret	null
		1
stack	X	
	у	0
		ret null
		x 1
		у 0
heap		
definitions		True
	b	True
	OR	lambda -> @1(
globals	left	lambda -> @4
	top_or_le	
		lambda -> @2
	up	lambda -> @4
	p2	lambda -> @2
stack	p1 ret	null
Stack		1 1
	X	0
h a a n	у	
heap		
definitions		True
	b	True
	OR	lambda -> @10
globals	left	lambda -> @4
	top_or_le	
	_	lambda -> @2
	up	lambda -> 04
	p2 p1	lambda -> @2
	ret	null
	x	1
stack		0
	у	
		ret True
		x 1
		у 0
heap		

	a	True
	b	True
	OR	lambda -> @10
globals	left	lambda -> 04
	top_or_le	ft lambda -> 09
	up	lambda -> 02
	p2	lambda -> @4
	p1	lambda -> @2
	ret	null
	x	1
stack	у	0
		ret null
		x 1
		у О
heap		
definitions		
	a	True
	Ъ	True
	OR	lambda -> @10
globals	left	lambda -> 04
	top_or_le	ft lambda -> 09
	up	lambda -> @2
	p2	lambda -> @4
	p1	lambda -> @2
stack	ret	null
	x	1
	у	0
heap		
definitions		
	a	True
	b	True
mlohola	OR	lambda -> 010
globals	left	lambda -> 04
	top_or_le	ft lambda -> 09
	up	lambda -> 02
stack		
heap		
definitions		

	up	lambda -> 02
	left	lambda -> 04
globals	OR	lambda -> 010
	top_or_left	lambda -> @9
	a	True
stack		
heap		
definitions		
globals	up	lambda -> 02
	left	lambda -> 04
	OR	lambda -> @10
	top_or_left	lambda -> @9
	a	True
	p2 1	Lambda -> @4
	p1 1	Lambda -> @2
stack	ret	True
	х	0
	у	1
heap		
definitions		
	up	lambda -> 02
	left	lambda -> 04
globals	OR	lambda -> @10
	top_or_left	lambda -> 09
	a	True
	p2 1	Lambda -> @4
	p1 1	Lambda -> @2
stack	ret	null
	x	0
	У	1
heap		
definitions		

	up lan	mbda -> @2
	left lam	mbda -> @4
globals	OR lam	ıbda -> @10
	top_or_left lar	mbda -> @9
	a	True
stack	p2 lambda	a -> @4
	p1 lambda	a -> @2
	ret ni	ull
	х	0
	У	1
	ret Ti	rue
	X	0
	у	1
heap		
definitions		
· · · · · ·	up lar	mbda -> @2
globals	•	mbda -> @4
		ıbda -> @10
	top_or_left lam	
	a	True
stack		a -> @4
	•	a -> @2
	-	ull
		0
	у	1
	ret ni	
	ret no	0
		1
hoon	у	
heap definitions		
GETTHICTORS	un 1	mbda -> @2
globals	1	
		mbda -> @4 ubda -> @10
	•	mbda -> @9 True
	aa	
	•	a -> 04
a+ > a l-	p1 lambda	
stack		ull O
	X 	0
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heap		
definitions		

globals	ир	lambda -> @2
	left	lambda -> 04
	OR	lambda -> @10
	top_or_left	lambda -> 09
	a	True
stack	p2 1	ambda -> @4
	p1 1	ambda -> @2
	ret	null
	x	0
	у	1
	ret	False
	х	0
	у	1
heap		
definitions		
	ир	lambda -> @2
globals	left	lambda -> @4
	OR	lambda -> @10
8100410	top_or_left	
	a	True
		ambda -> 04
	-	ambda -> @2
	p1 l ret	null
stack		0
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	re	t null
	Х	0
	у	1
heap		
definitions		
globals	up	lambda -> 02
	left	lambda -> 04
	OR	lambda -> @10
	top_or_left	lambda -> @9
	a	True
	p2 1	ambda -> @4
	p1 1	ambda -> @2
stack	ret	null
	x	0
	у	1
heap		
definitions		

	up	lambda -> @2
	left	lambda -> @4
globals	OR	lambda -> @10
	top_or_left	lambda -> @9
	a	True
stack		
heap		
definitions		
	up	lambda -> @2
	left	lambda -> @4
globals	OR	lambda -> @10
	top_or_left	lambda -> @9
stack		
heap		
definitions		
	up	lambda -> @2
	left	lambda -> @4
globals	OR	lambda -> @10
	top_or_left	lambda -> @9
		ambda -> @4
	-	ambda -> @2
stack	ret	True
	x	0
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heap		
definitions		
	ир	lambda -> @2
	left	lambda -> @4
globals	OR	lambda -> @10
		lambda -> @9
		ambda -> @4
	-	ambda -> @2
stack	ret	null
BUGUR		0
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haan	у	
heap		
definitions		

	up		lambda	->	@2
globals	left		lambda	->	04
giobaib	OR		lambda	->	@10
	top_or_	left	lambda	->	@9
	p2	2 la	mbda ->	04	
	p1	l la	mbda ->	@2	
	re	ŧ	null		
	x		0		
stack	у		0		
		ret	True		
		х	0		
		У	0		
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definitions					
	ир		lambda	->	@2
	left		lambda	->	@4
globals	OR		lambda	->	@10
	top_or_	left	lambda	->	@9
	p2	2 la	mbda ->	@4	
	p1	l la	mbda ->	@2	
	re	et	null		
	х		0		
stack	у		0		
		ret	null		
		х	0		
		у	0		
heap					
definitions					
	up		lambda	->	02
	left		lambda	->	04
globals	OR		lambda	->	@10
	top_or_	left	lambda	->	@9
	p2		mbda ->	@4	
	- p1		mbda ->	@2	
stack	re	et	null		
	х		0		
	У		0		
heap					
neah					

	up	lambda -> @
globals	left	lambda -> @
giobais	OR	lambda -> 0:
	top_or_le	eft lambda -> 0
	p2	lambda -> @4
	p1	lambda -> @2
	ret	null
	x	0
stack	у	0
		ret True
		x 0
		у О
heap		•
definitions		
	up	lambda -> @
	left	lambda -> @
globals	OR	lambda -> 0:
	top_or_le	eft lambda -> @
	p2	lambda -> @4
	p1	
	ret	
	x	0
stack		0
	у	
		_
		x 0
h		у 0
heap		
definitions		1
	up	lambda -> 0
globals	left	lambda -> 0
	OR	lambda -> 0:
		eft lambda -> @
	p2	lambda -> 04
	p1	
stack	ret	null
	X	0
	у	0
heap		
definitions		

	up lambda -> @2
globals	left lambda -> @4
_	OR lambda -> @10
	top_or_left lambda -> @9
stack	
heap	
definitions	
	up lambda -> @2
globals	left lambda -> @4
	OR lambda -> @10
stack	
heap	
definitions	
	up lambda -> @2
globals	left lambda -> @4
	OR lambda -> @10
	ret lambda -> @9
stack	p1 lambda -> @2
	p2 lambda -> @4
heap	
definitions	
	up lambda -> @2
globals	left lambda -> @4
	OR lambda -> @10
	ret null
stack	p1 lambda -> @2
	p2 lambda -> @4
heap	
definitions	
	up lambda -> @2
globals	left lambda -> @4
8	OR lambda -> @10
stack	
heap	
definitions	
uoliniolonb	up lambda -> @2
globals	left lambda -> @4
stack	1010 lambaa / G1
heap	
neap definitions	
	up lambda -> @2
globals	up lambda -> @2
stack	
heap	
definitions	

globals
stack
heap
definitions

2.2 And

Fill in the missing code blocks

```
1
   left=lambda x, y:(x==0)
   top=lambda x, y:(y==0)
3
   AND=lambda
5
       lambda
          (
6
                     (
                                                                                  ))
                                           ) and
7
8
   left_and_top=AND(left,top)
9
10
   a=left_and_top(0,0)
   b=left_and_top(0,1)
11
   c=left_and_top(1,0)
12
   d=left_and_top(1,1)
13
```

```
True
               a
                                   False
               b
                                   False
               С
                                   False
               d
globals
               left
                               lambda -> @2
                               lambda -> @4
               top
               left_and_top
                               lambda -> @9
                              lambda -> @10
               AND
stack
heap
definitions
                                   True
               a
               b
                                   False
               С
                                   False
                               lambda -> @2
globals
               left
                               lambda -> 04
               top
               left_and_top
                               lambda -> @9
               AND
                              lambda -> @10
stack
heap
definitions
```

	a True
	b False
	c False
globals	left lambda -> @2
	top lambda -> @4
	left_and_top lambda -> @9
	AND lambda -> @10
	p2 lambda -> @4
	p1 lambda -> @2
stack	ret False
	x 1
	y 1
heap	
definitions	
	a True
	b False
	c False
globals	left lambda -> 02
	top lambda -> @4
	<pre>left_and_top lambda -> @9</pre>
	AND
	p2 lambda -> 04
	p1 lambda -> 02
stack	ret null
	x 1
	y1
heap	
definitions	
	a True
	b False
	c False
globals	left lambda -> @2
	top lambda -> @4
	left_and_top lambda -> @9
	AND lambda -> @10
	p2 lambda -> @4
	p1 lambda -> @2
	ret null
stack	x 1
	ret False
	x 1
	Α 1
heap	y 1

	a	True
	b	False
	С	False
globals	left	lambda -> @2
	top	lambda -> 04
	left_and_t	cop lambda -> 09
	AND	lambda -> @10
	p2	lambda -> @4
	p1	lambda -> @2
	ret	null
	x	1
stack	у	1
		ret null
		x 1
		y 1
heap		
definitions		
	a	True
	b	False
	С	False
globals	left	lambda -> @2
	top	lambda -> 04
	left_and_t	cop lambda -> @9
	AND	lambda -> 010
stack	p2	lambda -> @4
	p1	lambda -> @2
	ret	null
	x	1
	у	1
heap		
definitions		

	a True	
	b False	
	c False	
globals	left lambda -> @2	
	top lambda -> @4	
	left_and_top lambda -> @9	
	AND lambda -> @10	
	p2 lambda -> @4	
	p1 lambda -> @2	
	ret null	
-+1-	x 1	
stack	y 1	
	ret False	
	x 1	
	y 1	
heap		
definitions		
	a True	
	b False	
	c False	
globals	left lambda -> @2	
	top lambda -> @4	
	<pre>left_and_top lambda -> @9</pre>	
	AND lambda -> @10	
	p2 lambda -> @4	
stack	p1 lambda -> @2	
	ret null	
	x 1	
	y 1	
	ret null	
	x 1	
	y 1	
heap		
definitions		
		_

	a	True
	b	False
	С	False
globals	left	lambda -> @2
	top	lambda -> @4
	left_and_top	lambda -> @9
	AND	lambda -> @10
	p2 la	ambda -> @4
	p1 la	ambda -> @2
stack	ret	null
	x	1
	у	1
heap		
definitions		
	a	True
	Ъ	False
	С	False
globals	left	lambda -> @2
	top	lambda -> @4
	left_and_top	lambda -> @9
	AND	lambda -> @10
stack		
heap		
definitions		
	a	True
	b	False
globals	left	lambda -> @2
	top	lambda -> @4
	left_and_top	lambda -> @9
	AND	lambda -> @10
stack		
heap		
definitions		

	a True
	b False
	left lambda -> @2
globals	top lambda -> @4
	left_and_top lambda -> @9
	AND lambda -> @10
	p2 lambda -> 04
	p1 lambda -> 02
stack	ret False
	x 1
	у О
heap	
definitions	
	a True
	b False
	left lambda -> @2
globals	top lambda -> @4
	left_and_top lambda -> @9
	AND lambda -> @10
	p2 lambda -> @4
	p1 lambda -> @2
stack	ret null
	х 1
	у
heap	
definitions	
	a True
	b False
	left lambda -> @2
globals	top lambda -> @4
	left_and_top lambda -> @9
	AND lambda -> @10
	p2 lambda -> @4
	p1 lambda -> @2
stack	ret null
	x 1
	у О
	ret True
	x 1
	у 0
heap	
definitions	

	a True
	b False
	left lambda -> @2
globals	top lambda -> @4
	left_and_top lambda -> @9
	AND lambda -> @10
	p2 lambda -> @4
	p1 lambda -> @2
	ret null
. ,	x 1
stack	у
	ret null
	x 1
	у О
heap	
definitions	
	a True
	b False
-1-b-1-	left lambda -> @2
globals	top lambda -> @4
	left_and_top lambda -> @9
	AND lambda -> @10
	p2 lambda -> @4
	p1 lambda -> @2
stack	ret null
	x 1
heap	
definitions	
	a True
	b False
globals	left lambda -> @2
PTODATE	top lambda -> @4
	<pre>left_and_top lambda -> @9</pre>
	AND lambda -> @10
	p2 lambda -> @4
	p2 lambda -> @4 p1 lambda -> @2
	<u>.</u>
an al-	p1 lambda -> @2
stack	p1 lambda -> @2 ret null
stack	p1 lambda -> @2 ret null x 1
stack	p1 lambda -> @2 ret null x 1 y 0
stack	p1 lambda -> @2 ret null x 1 y 0 ret False
stack heap	p1 lambda -> @2 ret null x 1 y 0 ret False x 1

	a True	
	b False	
globals	left lambda -> @2	
8	top lambda -> @4	
	<pre>left_and_top lambda -> @9</pre>	
	AND lambda -> @10	
	p2 lambda -> @4	
	p1 lambda -> @2	
	ret null	
	x 1	
stack	о	
	ret null	
	x 1	
	у О	
heap		
definitions		
	a True	
	b False	
	left lambda -> @2	
globals	top lambda -> 04	
	left_and_top lambda -> @9	
	AND lambda -> @10	
	p2 lambda -> @4	
	p1 lambda -> 02	
stack	ret null	
	x 1	
	у О	
heap		
definitions		
	a True	
	b False	
globals	left lambda -> @2	
	top lambda -> @4	
	left_and_top lambda -> @9	
	AND lambda -> @10	
stack		
heap		
definitions		

	left	lambda -> @2
	top	lambda -> 04
globals	AND	lambda -> @10
	left_and_top	lambda -> 09
	a	True
stack		
heap		
definitions		
	left	lambda -> 02
	top	lambda -> 04
globals	AND	lambda -> @10
	left_and_top	lambda -> 09
	a	True
	p2 1a	ambda -> @4
	p1 1a	ambda -> @2
stack	ret	False
	x	0
	у	1
heap		
definitions		
	left	lambda -> @2
	top	lambda -> @4
globals	AND	lambda -> @10
	left_and_top	lambda -> @9
	a	True
	p2 1a	ambda -> @4
	p1 la	ambda -> @2
stack	ret	null
	x	0
	У	1
heap		
definitions		

	left	lambda -> @2
	top	lambda -> @4
globals	AND	lambda -> @10
	left_and_top	lambda -> @9
	a	True
	p2 1	ambda -> @4
	-	ambda -> @2
	ret	null
	x	0
stack	У	1
		False
	x	0
	у	1
heap		
definitions		
	left	lambda -> @2
	top	lambda -> @4
globals	AND	lambda -> @10
	left_and_top	lambda -> @9
	a a	True
	-	ambda -> @4
	-	ambda -> @2
	ret	null
	x	0
stack	У	1
	re	t null
	x	0
	у	1
heap		
definitions		
	left	lambda -> @2
	top	lambda -> @4
globals	AND	lambda -> @10
	left_and_top	lambda -> @9
	a	True
	p2 1	ambda -> @4
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stack	ret	null
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heap		
definitions		

	left	lambda -> @2
	top	lambda -> @4
globals	AND	lambda -> @10
	left_and_top	lambda -> @9
	a	True
	p2 1	ambda -> 04
	p1 1	ambda -> @2
	ret	null
	x	0
stack	у	1
	re	t True
	x	0
	у	1
heap		
definitions		
	left	lambda -> @2
	top	lambda -> @4
globals	AND	lambda -> @10
	left_and_top	lambda -> 09
	a	True
	p2 1	ambda -> 04
	p1 1	ambda -> @2
	ret	null
stack	х	0
Stack	у	1
	re	t null
	x	0
	у	1
heap		
definitions		
	left	lambda -> @2
	top	lambda -> @4
globals	AND	lambda -> @10
	left_and_top	lambda -> 09
	a	True
	p2 1	ambda -> 04
	p1 1	ambda -> @2
stack	ret	null
	x	0
	у	1
heap		
definitions		

	left	lambda -> 02
	top	lambda -> @4
globals	AND	lambda -> @10
	left_and_top	lambda -> @9
	a	True
stack		
heap		
definitions		
	left	lambda -> @2
	top	lambda -> @4
globals	AND	lambda -> @10
	left_and_top	lambda -> @9
stack		
heap		
definitions		
	left	lambda -> 02
-1-b-1-	top	lambda -> @4
globals	AND	lambda -> @10
	left_and_top	lambda -> @9
	p2 1a	ambda -> @4
	p1 la	ambda -> @2
stack	ret	True
	x	0
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heap		
definitions		
	left	lambda -> 02
	top	lambda -> @4
globals	AND	lambda -> @10
	left_and_top	lambda -> 09
	p2 la	ambda -> @4
	p1 la	ambda -> @2
stack	ret	null
	x	0
	у	0
heap		

	left lambda -> 02	
globals	top lambda -> 04	
0-00010	AND lambda -> @1	0
	left_and_top lambda -> @9)
	p2 lambda -> @4	
	p1 lambda -> @2	
	ret null	
	x 0	
stack	у О	
	ret True	
	х 0	
	у О	
heap		
definitions		
	left lambda -> 02	2
	top lambda -> @4	Ŀ
globals	AND lambda -> @1	
	left_and_top lambda -> @9	
	p2 lambda -> @4	
	p1 lambda -> @2	
	ret null	
	х 0	
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heap		
definitions		
	left lambda -> @2	 ?
	top lambda -> @4	
globals	AND lambda -> @1	
	left_and_top lambda -> @9	
	p2 lambda -> @4	
	p1 lambda -> @2	
stack	ret null	
stack		
Stack	x 0	
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heap	x 0 y 0	

	left lambda -> @2
globals	top lambda -> 04
8100010	AND lambda -> @10
	left_and_top lambda -> @9
	p2 lambda -> @4
	p1 lambda -> @2
	ret null
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heap	
definitions	
	left lambda -> @2
	top lambda -> @4
globals	AND lambda -> @10
	left_and_top lambda -> @9
	p2 lambda -> @4
	p1 lambda -> @2
	ret null
	x 0
stack	у О
	ret null
	x 0
	у 0
heap	
definitions	
	left lambda -> @2
	top lambda -> @4
globals	AND lambda -> @10
	left_and_top lambda -> @9
	p2 lambda -> @4
	p1 lambda -> @2
stack	ret null
	x 0
	у 0
heap	
definitions	
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	left lambda -> @2
globals	top lambda -> @4
0	AND lambda -> @10
	left_and_top lambda -> @9
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heap	
definitions	
	left lambda -> @2
globals	top lambda -> @4
	AND lambda -> @10
stack	
heap	
definitions	
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globals	top lambda -> @4
giobais	AND lambda -> @10
	ret lambda -> @9
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stack	p1 lambda -> @2
	p2 lambda -> @4
heap	
definitions	
	left lambda -> @2
globals	top lambda -> @4
	AND lambda -> @10
	ret null
stack	p1 lambda -> @2
	p2 lambda -> @4
heap	
definitions	
	left lambda -> @2
globals	top lambda -> @4
J	AND lambda -> @10
stack	
heap	
definitions	
	left lambda -> @2
globals	top lambda -> @4
stack	1
heap	
definitions	
globals	left lambda -> @2
stack	ICIC Idmbud / WZ
heap	
definitions	

globals
stack
heap
definitions

2.3 Not

Fill in the missing state blocks.

```
1
   def draw_grid (x_dim,y_dim,p):
2
      res=""
3
     x = 0
     y = 0
4
5
      while((y<y_dim)):
6
        while((x < x_dim)):
7
          if(p(x,y)):
8
            res=(res+"#")
9
          else:
10
            res=(res+" ")
11
          x = (x+1)
        res=(res+"\n")
12
13
        0 = x
14
        y = (y+1)
15
      return res
16
17
   NOT=lambda p:lambda x,y:(not p(x,y))
18
19
   left=lambda x, y:(x==0)
20
   right=NOT(left)
   res=draw_grid(2,2,right)
```

```
NOT
                              lambda -> @6
                       left
                              lambda -> @8
 globals
                              lambda -> @5
                       right
                                " #\n #\n"
                       res
stack
heap
definitions
               draw_grid (x_dim,y_dim,p) => ...
res=" #\n #\n"
                       NOT
                              lambda -> @6
                       left
                              lambda -> @8
globals
                       right
                              lambda -> @5
stack
heap
 definitions
               draw_grid (x_dim,y_dim,p) => ...
                       NOT
                              lambda -> @6
globals
                       left
                              lambda -> @8
                       right
                              lambda -> @5
                                " #\n #\n"
                        ret
                                     2
                        x_dim
                                     2
                        y_dim
 stack
                               lambda -> @5
                                " #\n #\n"
                        res
                                     0
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heap
               draw_grid (x_dim,y_dim,p) => ...
 definitions
```

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                             lambda -> @6
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                             lambda -> @8
                     right
                             lambda -> @5
                      ret
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                      x_dim
                      y_dim
                                   2
stack
                              lambda -> 05
                               " #\n #\n"
                      res
                                    0
                      х
                                    2
heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
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                             lambda -> @8
globals
                     right lambda -> 05
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                              lambda -> @5
stack
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heap
              draw_grid (x_dim,y_dim,p) => ...
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heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
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                              lambda -> 05
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heap
              draw_grid (x_dim,y_dim,p) => ...
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                             lambda -> @8
globals
                     right lambda -> 05
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stack
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heap
              draw_grid (x_dim,y_dim,p) => ...
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heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
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                             lambda -> @5
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                      res
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heap
              draw_grid (x_dim, y_dim, p) => ...
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                             lambda -> @8
                     right lambda -> 05
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heap
              draw_grid (x_dim,y_dim,p) => ...
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                             lambda -> @8
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                              lambda -> @5
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heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
```

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heap
              draw_grid (x_dim,y_dim,p) => ...
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definitions
              draw_grid (x_dim,y_dim,p) => ...
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definitions
              draw_grid (x_dim,y_dim,p) => ...
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definitions
              draw_grid (x_dim,y_dim,p) => ...
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              draw_grid (x_dim,y_dim,p) => ...
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              draw_grid (x_dim,y_dim,p) => ...
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              draw_grid (x_dim,y_dim,p) => ...
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heap
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heap
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              draw_grid (x_dim,y_dim,p) => ...
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              draw_grid (x_dim,y_dim,p) => ...
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                              lambda -> @5
                                   11 11
                       res
                                    1
                       X
stack
                                    0
                             lambda -> @8
                        р
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heap
definitions
              draw_grid (x_dim,y_dim,p) => ...
```

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NOT
                             lambda -> @6
globals
                      left
                             lambda -> @8
                      right
                             lambda -> @5
                      ret
                                  null
                      x_dim
                                    2
                                    2
                      y_dim
                              lambda -> 05
                       res
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stack
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                             lambda -> @8
                       p
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                                 null
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                        х
                                   0
heap
definitions
              draw_grid (x_dim,y_dim,p) => ...
                     NOT
                             lambda -> @6
globals
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                             lambda -> @8
                     right lambda -> 05
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                                  null
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                      x_dim
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                              lambda -> @5
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stack
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heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
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globals
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                             lambda -> @8
                      right
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                       ret
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                       res
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stack
                             lambda -> @8
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heap
              draw_grid (x_dim, y_dim, p) => ...
definitions
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globals
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                             lambda -> @8
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                                  null
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                       x_dim
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stack
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heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
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                             lambda -> 06
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                       x_dim
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                       res
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heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
                             lambda -> @6
                      NOT
globals
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                             lambda -> @8
                      right
                             lambda -> @5
                       ret
                                  null
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                       x_dim
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stack
                              lambda -> @5
                                   11 11
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heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
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globals
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                             lambda -> @8
                             lambda -> @5
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heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
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heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
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globals
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heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
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heap
definitions
              draw_grid (x_dim,y_dim,p) => ...
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                               lambda -> @6
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heap
               draw_grid (x_dim,y_dim,p) => ...
definitions
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heap
               draw_grid (x_dim, y_dim, p) => ...
definitions
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               draw_grid (x_dim, y_dim, p) => ...
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heap
               draw_grid (x_dim,y_dim,p) => ...
definitions
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heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
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heap
              draw_grid (x_dim,y_dim,p) => ...
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heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
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heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
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globals
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                             lambda -> @8
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definitions
              draw_grid (x_dim,y_dim,p) => ...
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globals
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                      right lambda -> @5
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stack
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                              lambda \rightarrow @5
heap
definitions
              draw_grid (x_dim,y_dim,p) => ...
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                             lambda -> @8
globals
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                      right lambda -> @5
stack
heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
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globals
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stack
heap
              draw_grid (x_dim,y_dim,p) => ...
definitions
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NOT
                           lambda -> @6
globals
                     left lambda -> @8
                       ret
                            lambda -> @5
stack
                            lambda -> @8
                       p
heap
definitions
              draw_grid (x_dim,y_dim,p) => ...
                     NOT
                           lambda -> @6
globals
                           lambda -> @8
                     left
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                            lambda -> @8
                       p
heap
definitions
              draw_grid (x_dim,y_dim,p) => ...
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globals
                     left lambda -> @8
stack
heap
definitions
             draw_grid (x_dim,y_dim,p) => ...
                      NOT lambda -> @6
globals
stack
heap
definitions
             draw_grid (x_dim,y_dim,p) => ...
globals
stack
heap
definitions
             draw_grid (x_dim,y_dim,p) => ...
globals
stack
heap
definitions
```