FURTHER HAND-TRANSLATION HINTS

Q. What code should be generated for the following expression?

```
new int [<expr>] [] ... []
```

e.g., **new int** [2*x+1][][][]

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```
new int [<expr>] [] ... []
e.g., new int [2*x+1][][][]
```

ANSWER:

code that leaves value of <expr> on top of EXPRSTACK

HEAPALLOC

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new int [<expr>] [] ... []

e.g., **new int** [2*x+1][][][]

ANSWER:

code that leaves value of <expr> on top of EXPRSTACK

HEAPALLOC

Example Suppose a is declared as **static int** a[]; and the data memory address of a is 5.

Q. What code should be generated for the following expression?

new int [<expr>] [] ... []

e.g., **new int** [2*x+1][][][]

ANSWER:

code that leaves value of <expr> on top of EXPRSTACK

HEAPALLOC

Example Suppose a is declared as **static int** a[]; and the data memory address of a is 5.

What TinyJ VM instructions should

a = **new int**[100];

be translated to?

Q. What code should be generated for the following expression?

```
new int [<expr>] [] ... []
e.g., new int [2*x+1][][][]
```

ANSWER:

code that leaves value of <expr> on top of EXPRSTACK
HEAPALLOC

Example Suppose a is declared as **static int** a[]; and the data memory address of a is 5.

What TinyJ VM instructions should

```
a = new int[100];
```

be translated to?

ANSWER:

Q. What code should be generated for the following expression?

`new int [<expr>] [] ... []`

e.g., `new int [2*x+1][][][]`

ANSWER:

code that leaves value of <expr> on top of EXPRSTACK

HEAPALLOC

Example Suppose a is declared as **static int** a[]; and the data memory address of a is 5.

What TinyJ VM instructions should

```
a = new int[100];
```

be translated to?

ANSWER:

```
PUSHSTATADDR 5
    ⋮

SAVETOADDR
```

Q. What code should be generated for the following expression?

```
new int [<expr>] [] ... []
e.g., new int [2*x+1][][][]
```

ANSWER:

code that leaves value of <expr> on top of EXPRSTACK
HEAPALLOC

Example Suppose a is declared as **static int** a[]; and the data memory address of a is 5.

What TinyJ VM instructions should

```
a = new int[100];
```

be translated to?

ANSWER:

```
PUSHSTATADDR 5
PUSHNUM 100
HEAPALLOC
SAVETOADDR
```

BEFORE execution of: PUSHSTATADDR 5

address	Statically Allocated Data Memory
0	
1	
2	
3	
4	
a 5	

EXPRSTACK
???
⋮
???

address	HEAP (Part of Data memory)
⋮	already allocated for other purposes
13212	

address	CODE MEMORY
0	PUSHSTATADDR 5
1	PUSHNUM 100
⋮	HEAPALLOC
	SAVETOADDR
	These instructions execute:
	a = new int[100];

AFTER execution of: PUSHSTATADDR 5

address	Statically Allocated Data Memory
0	
1	
2	
3	
4	
a 5	

EXPRSTACK
???
⋮
???
PTR TO ADDR 5

address	HEAP (Part of Data memory)
⋮	already allocated for other purposes
13212	

address	CODE MEMORY
0	
1	
⋮	
	PUSHSTATADDR 5
	PUSHNUM 100
	HEAPALLOC
	SAVETOADDR
	These instructions execute:
	a = new int[100];

AFTER execution of: PUSHNUM 100

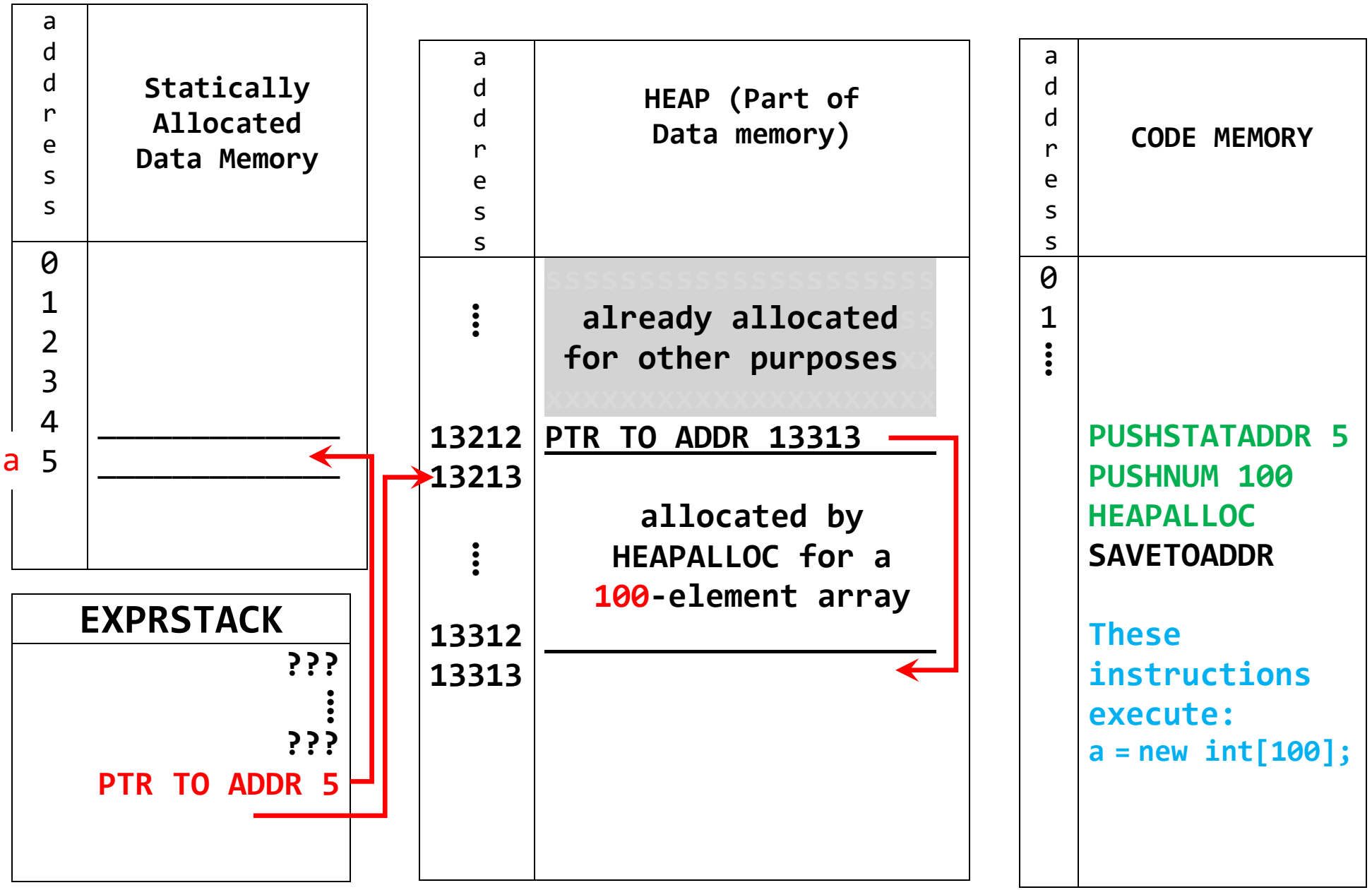
address	Statically Allocated Data Memory
0	
1	
2	
3	
4	
a 5	

address	HEAP (Part of Data memory)
⋮	already allocated for other purposes
13212	

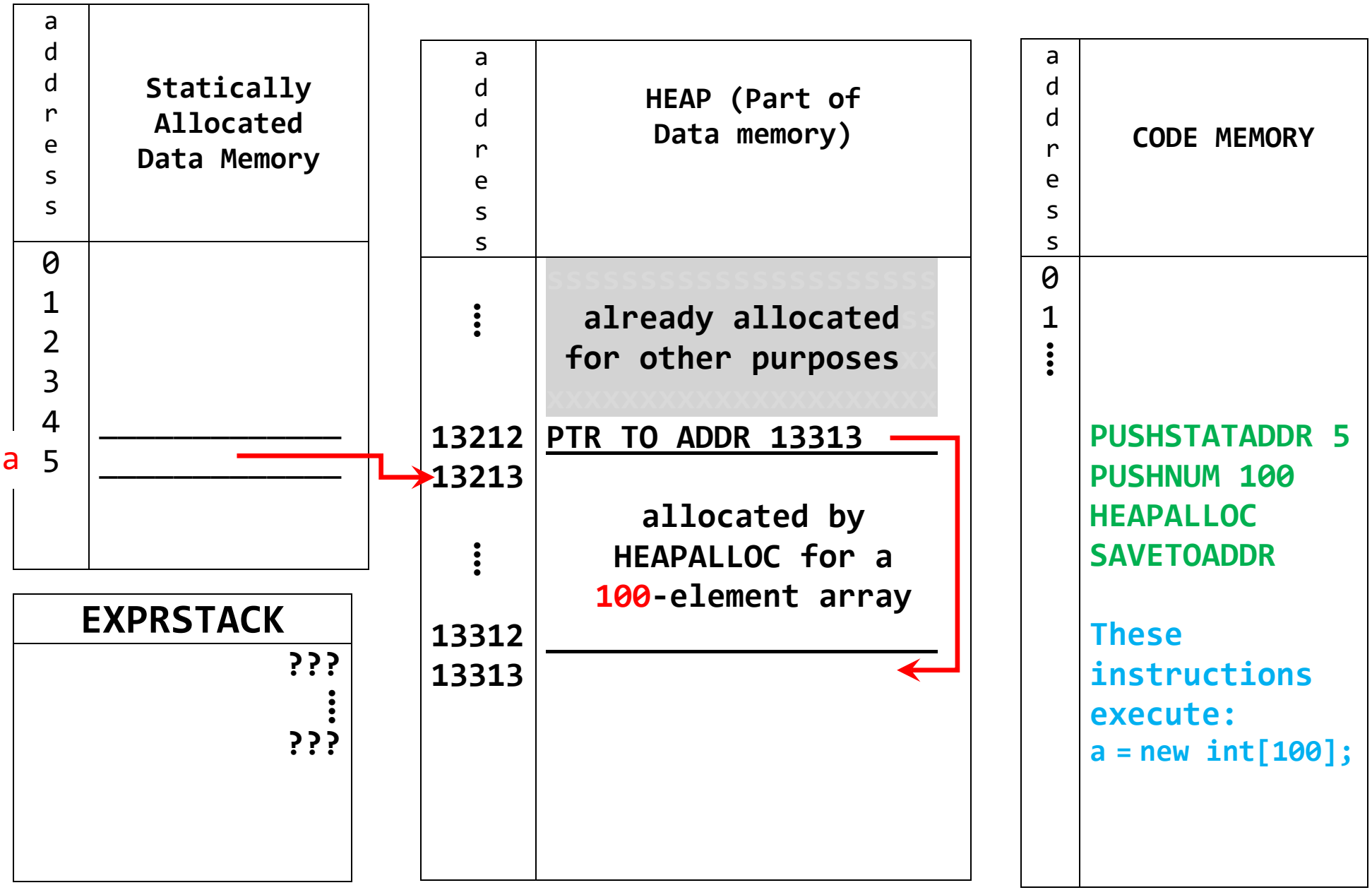
address	CODE MEMORY
0	PUSHSTATADDR 5
1	PUSHNUM 100
⋮	HEAPALLOC
	SAVETOADDR
	These instructions execute:
	a = new int[100];

EXPRSTACK
???
⋮
???
PTR TO ADDR 5
100

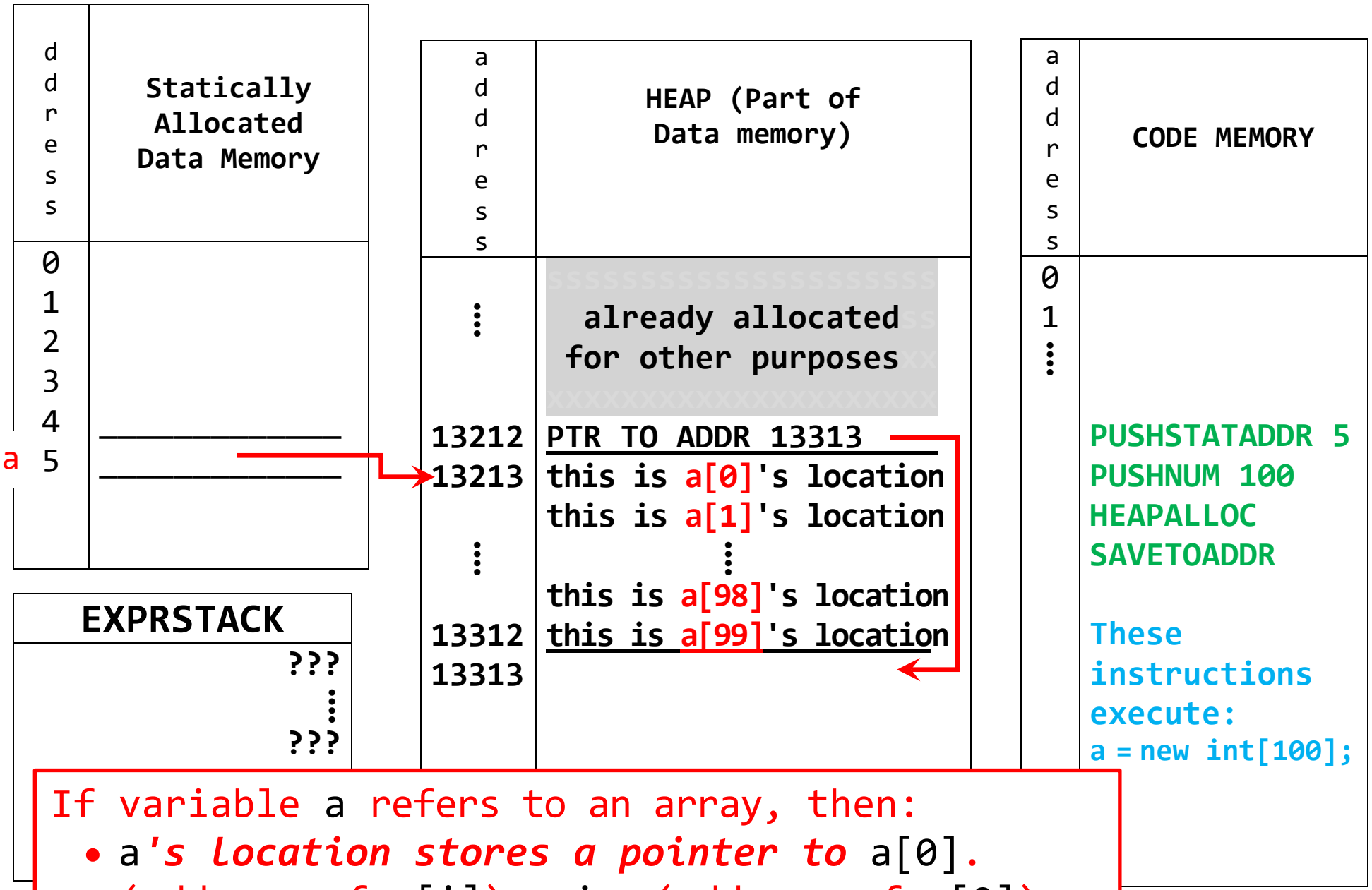
AFTER execution of: HEAPALLOC



AFTER execution of: SAVETOADDR



AFTER execution of: SAVETOADDR



If variable a refers to an array, then:

- a's location stores a pointer to a[0].
- (address of a[i]) = i + (address of a[0]).
- i + (pointer to a[0]) is a pointer to a[i].

Q. What code should be generated for the following assignment statement?

IDENTIFIER [<expr>] = <expr>$_R$;

e.g., a[9*x] = g(w) + y;

ANSWER:

Q. What code should be generated for the following assignment statement?

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ANSWER:

If variable a refers to an array, then a ***'s location stores a pointer to*** a[0].

Q. What code should be generated for the following assignment statement?

IDENTIFIER [<expr>] = <expr>$_R$;

e.g., a[9*x] = g(w) + y;

If variable a refers to an array, then a ***'s location stores a pointer to*** a[0].

ANSWER:

PUSHLOCADDR IDENTIFIER.stackframe_offset

or PUSHSTATADDR IDENTIFIER.static_address

Push ptr to IDENT's location

LOADFROMADDR **Replace ptr to IDENT's location with ptr to IDENT[0]**

code that leaves value of <expr> on top of EXPRSTACK

ADDTOPTR **Replace ptr to IDENT[0] with ptr to IDENT[<expr>]**

code that leaves value of <expr>$_R$ on top of EXPRSTACK

SAVETOADDR **Pop value of <expr>$_R$; pop ptr to IDENT[<expr>]**

Save value of <expr>$_R$ into IDENT[<expr>]'s location

Q. What code should be generated for the following assignment statement?

IDENTIFIER [<expr>] = <expr>$_R$;

e.g., a[9*x] = g(w) + y;

If variable a refers to an array, then a ***'s location stores a pointer to*** a[0].

ANSWER:

PUSHLOCADDR IDENTIFIER.stackframe_offset

or PUSHSTATADDR IDENTIFIER.static_address

Push ptr to IDENT's location

LOADFROMADDR Replace ptr to IDENT's location with ptr to IDENT[0]

code that leaves value of <expr> on top of EXPRSTACK

ADDTOPTR Replace ptr to IDENT[0] with ptr to IDENT[<expr>]

code that leaves value of <expr>$_R$ on top of EXPRSTACK

SAVETOADDR Pop value of <expr>$_R$; pop ptr to IDENT[<expr>]

Save value of <expr>$_R$ into IDENT[<expr>]'s location

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e.g., a[9*x] = g(w) + y;

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ANSWER:

PUSHLOCADDR IDENTIFIER.stackframe_offset

or PUSHSTATADDR IDENTIFIER.static_address

Push ptr to IDENT's location

LOADFROMADDR **Replace ptr to IDENT's location with ptr to IDENT[0]**

code that leaves value of <expr> on top of EXPRSTACK

ADDTOPTR **Replace ptr to IDENT[0] with ptr to IDENT[<expr>]**

code that leaves value of <expr>$_R$ on top of EXPRSTACK

SAVETOADDR **Pop value of <expr>$_R$; pop ptr to IDENT[<expr>]**

Save value of <expr>$_R$ into IDENT[<expr>]'s location

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LOADFROMADDR **Replace ptr to IDENT's location with ptr to IDENT[0]**

code that leaves value of <expr> on top of EXPRSTACK

ADDTOPTR **Replace ptr to IDENT[0] with ptr to IDENT[<expr>]**

code that leaves value of <expr>$_R$ on top of EXPRSTACK

SAVETOADDR **Pop value of <expr>$_R$; pop ptr to IDENT[<expr>]**

Save value of <expr>$_R$ into IDENT[<expr>]'s location

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IDENTIFIER [<expr>] = <expr>$_R$;

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PUSHLOCADDR IDENTIFIER.stackframe_offset

or **PUSHSTATADDR** IDENTIFIER.static_address

LOADFROMADDR

code that leaves value of <expr> on top of EXPRSTACK

ADDTOPTR

code that leaves value of <expr>$_R$ on top of EXPRSTACK

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e.g., a[9*x] = g(w) + y;

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or PUSHSTATADDR IDENTIFIER.static_address

LOADFROMADDR

code that leaves value of <expr> on top of EXPRSTACK

ADDTOPTR

code that leaves value of <expr>$_R$ on top of EXPRSTACK

SAVETOADDR

Example Suppose a is a ***local*** **int**[] variable and the stackframe offset of a is 2.

Q. What code should be generated for the following assignment statement?

IDENTIFIER [<expr>] = <expr>$_R$;

e.g., a[9*x] = g(w) + y;

If variable a refers to an array, then a ***'s location stores a pointer to*** a[0].

ANSWER:

PUSHLOCADDR IDENTIFIER.stackframe_offset
or PUSHSTATADDR IDENTIFIER.static_address

LOADFROMADDR
code that leaves value of <expr> on top of EXPRSTACK
ADDTOPTR

code that leaves value of <expr>$_R$ on top of EXPRSTACK
SAVETOADDR

Example Suppose a is a ***local*** **int**[] variable and the stackframe offset of a is 2.

What TinyJ VM instructions should be generated for the assignment a[23] = 17;?

Q. What code should be generated for the following assignment statement?

IDENTIFIER [<expr>] = <expr>$_R$;

e.g., a[9*x] = g(w) + y;

If variable a refers to an array, then a***'s location stores a pointer to*** a[0].

ANSWER:

PUSHLOCADDR IDENTIFIER.stackframe_offset

or PUSHSTATADDR IDENTIFIER.static_address

LOADFROMADDR

code that leaves value of <expr> on top of EXPRSTACK

ADDTOPTR

code that leaves value of <expr>$_R$ on top of EXPRSTACK

SAVETOADDR

Example Suppose a is a ***local*** **int**[] variable and the stackframe offset of a is 2.

ANSWER:

What TinyJ VM instructions should be generated for the assignment a[23] = 17;?

Q. What code should be generated for the following assignment statement?

IDENTIFIER [<expr>] = <expr>$_R$;

e.g., a[9*x] = g(w) + y;

If variable a refers to an array, then a***'s location stores a pointer to*** a[0].

ANSWER:

PUSHLOCADDR IDENTIFIER.stackframe_offset
or PUSHSTATADDR IDENTIFIER.static_address

LOADFROMADDR
code that leaves value of <expr> on top of EXPRSTACK
ADDTOPTR

code that leaves value of <expr>$_R$ on top of EXPRSTACK
SAVETOADDR

Example Suppose a is a ***local*** **int**[] variable and the stackframe offset of a is 2.

ANSWER:
PUSHLOCADDR 2
⋮

What TinyJ VM instructions should be generated for the assignment a[23] = 17;?

Q. What code should be generated for the following assignment statement?

IDENTIFIER [<expr>] = <expr>$_R$;

e.g., a[9*x] = g(w) + y;

If variable a refers to an array, then a ***'s location stores a pointer to*** a[0].

ANSWER:

PUSHLOCADDR IDENTIFIER.stackframe_offset

or PUSHSTATADDR IDENTIFIER.static_address

LOADFROMADDR

code that leaves value of <expr> on top of EXPRSTACK

ADDTOPTR

code that leaves value of <expr>$_R$ on top of EXPRSTACK

SAVETOADDR

Example Suppose a is a ***local*** **int**[] variable and the stackframe offset of a is 2.

What TinyJ VM instructions should be generated for the assignment a[23] = 17;?

ANSWER:

```
PUSHLOCADDR 2
LOADFROMADDR
PUSHNUM 23
ADDTOPTR
   ⋮
```

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IDENTIFIER [<expr>] = <expr>$_R$;

e.g., a[9*x] = g(w) + y;

If variable a refers to an array, then a***'s location stores a pointer to*** a[0].

ANSWER:

PUSHLOCADDR IDENTIFIER.stackframe_offset
or PUSHSTATADDR IDENTIFIER.static_address

LOADFROMADDR
code that leaves value of <expr> on top of EXPRSTACK
ADDTOPTR

code that leaves value of <expr>$_R$ on top of EXPRSTACK
SAVETOADDR

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What TinyJ VM instructions should be generated for the assignment a[23] = 17;?

ANSWER:

```
PUSHLOCADDR 2
LOADFROMADDR
PUSHNUM 23
ADDTOPTR
PUSHNUM 17
SAVETOADDR
```

BEFORE execution of: PUSHLOCADDR 2

stkfrm offset	Stackframe of Currently Executing Method Activation
-3	
-2	
-1	
0	
1	
a 2	
3	
⋮	

EXPRSTACK

???
⋮
???

address	HEAP (Part of Data memory)
⋮	allocated for other purposes
13212	PTR TO ADDR 13313
13213	array of size ≥ 24 (size is 100 in this example)
⋮	
13236	
⋮	
13312	
13313	

address	CODE MEMORY
0	PUSHLOCADDR 2
1	LOADFROMADDR
⋮	PUSHNUM 23
	ADDTOPTR
	PUSHNUM 17
	SAVETOADDR

These instructions execute:
a[23] = 17;

BEFORE execution of: PUSHLOCADDR 2

offset from stkfrm	Stackframe of Currently Executing Method Activation
-3	
-2	
-1	
0	
1	
a 2	
3	
⋮	

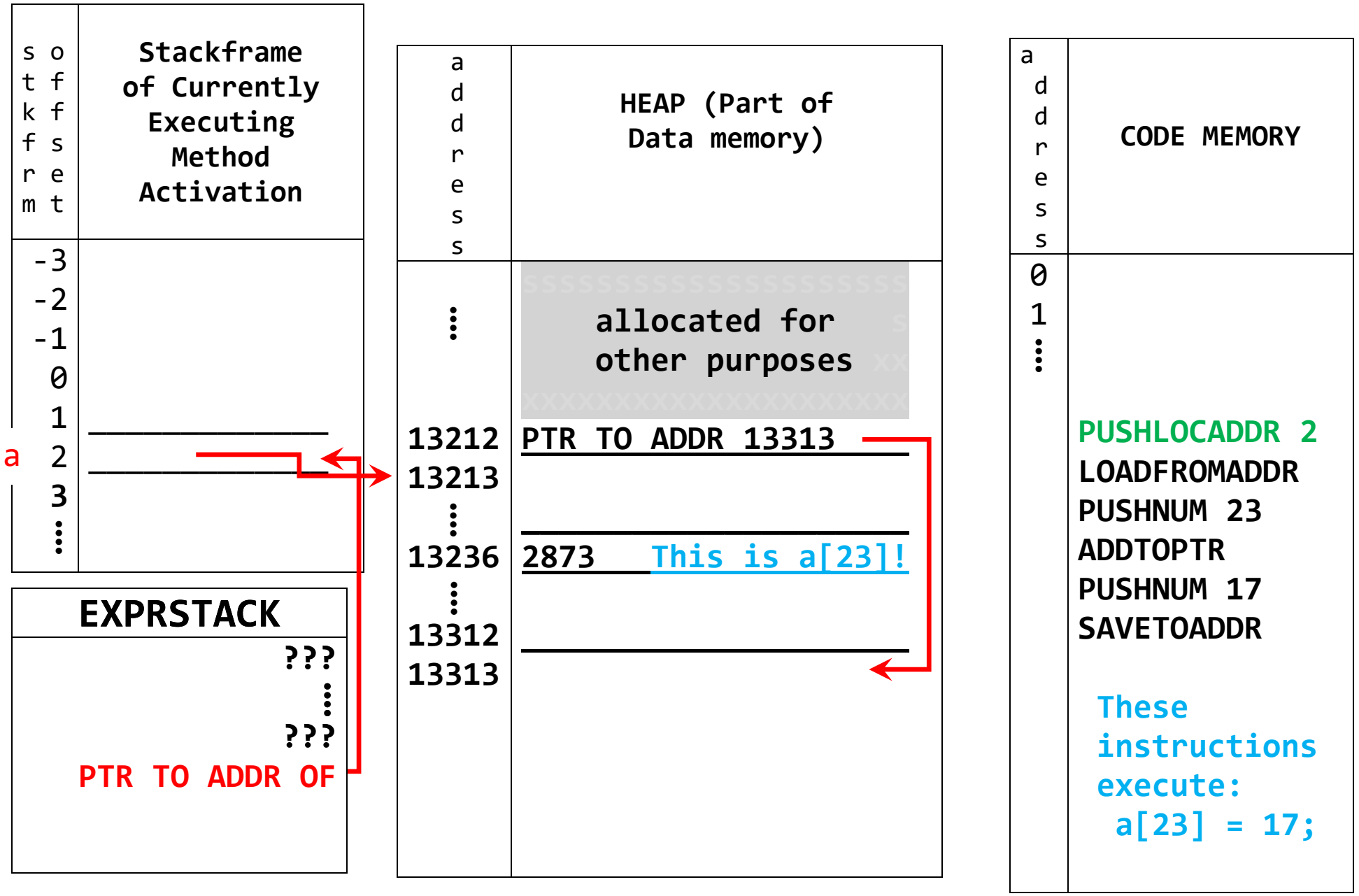
EXPRSTACK

???
 ⋮
 ???

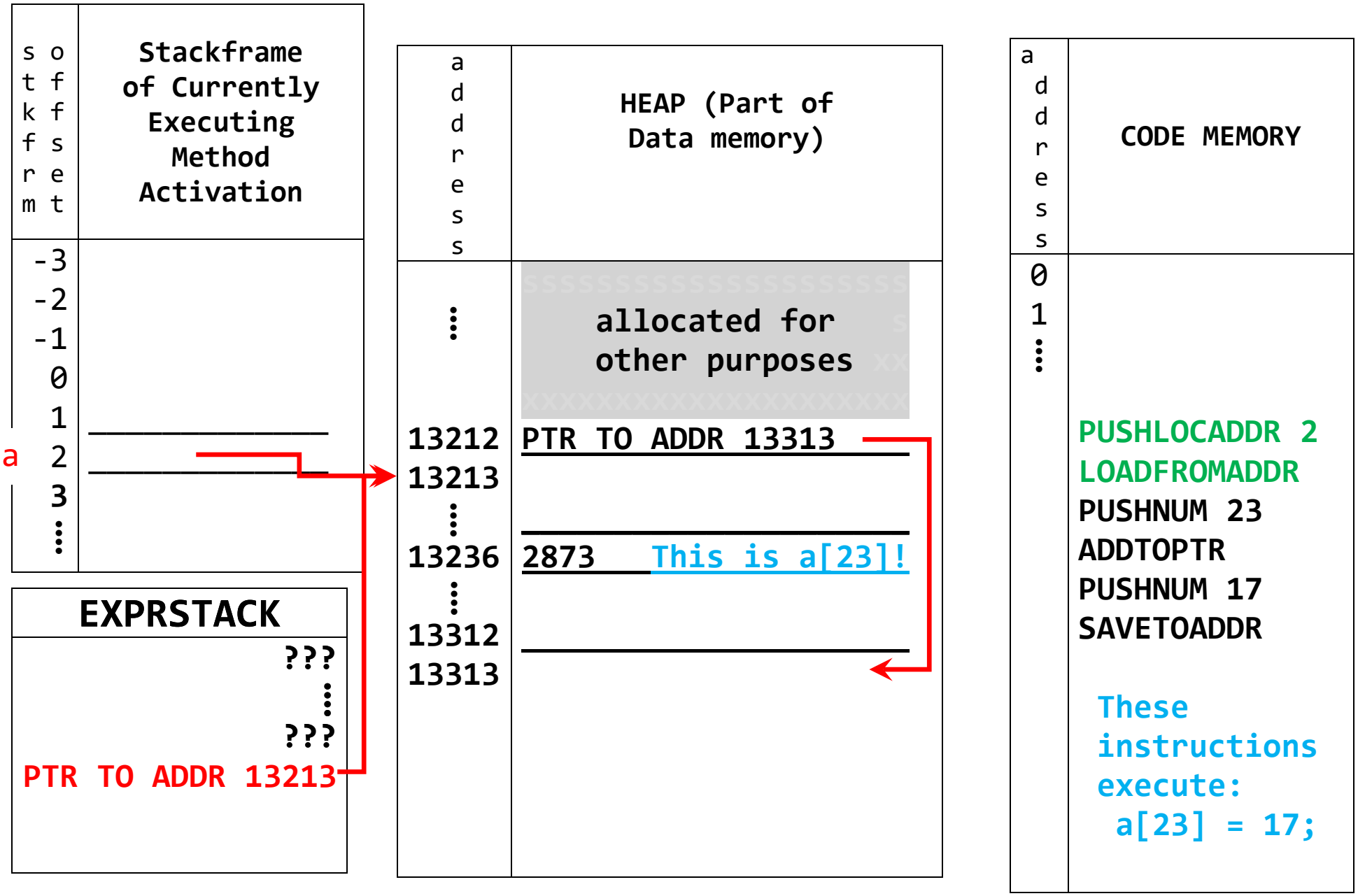
address	HEAP (Part of Data memory)
⋮	allocated for other purposes
13212	PTR TO ADDR 13313
13213	
⋮	
13236	2873 This is a[23]!
⋮	
13312	
13313	

address	CODE MEMORY
0	
1	
⋮	
	PUSHLOCADDR 2
	LOADFROMADDR
	PUSHNUM 23
	ADDTOPTR
	PUSHNUM 17
	SAVETOADDR
	These instructions execute: a[23] = 17;

AFTER execution of: PUSHLOCADDR 2



AFTER execution of: LOADFROMADDR



AFTER execution of: PUSHNUM 23

stkfrm offset	Stackframe of Currently Executing Method Activation
-3	
-2	
-1	
0	
1	
a 2	
3	
⋮	

address	HEAP (Part of Data memory)
⋮	allocated for other purposes
13212	PTR TO ADDR 13313
13213	
⋮	
13236	2873 This is a[23]!
⋮	
13312	
13313	

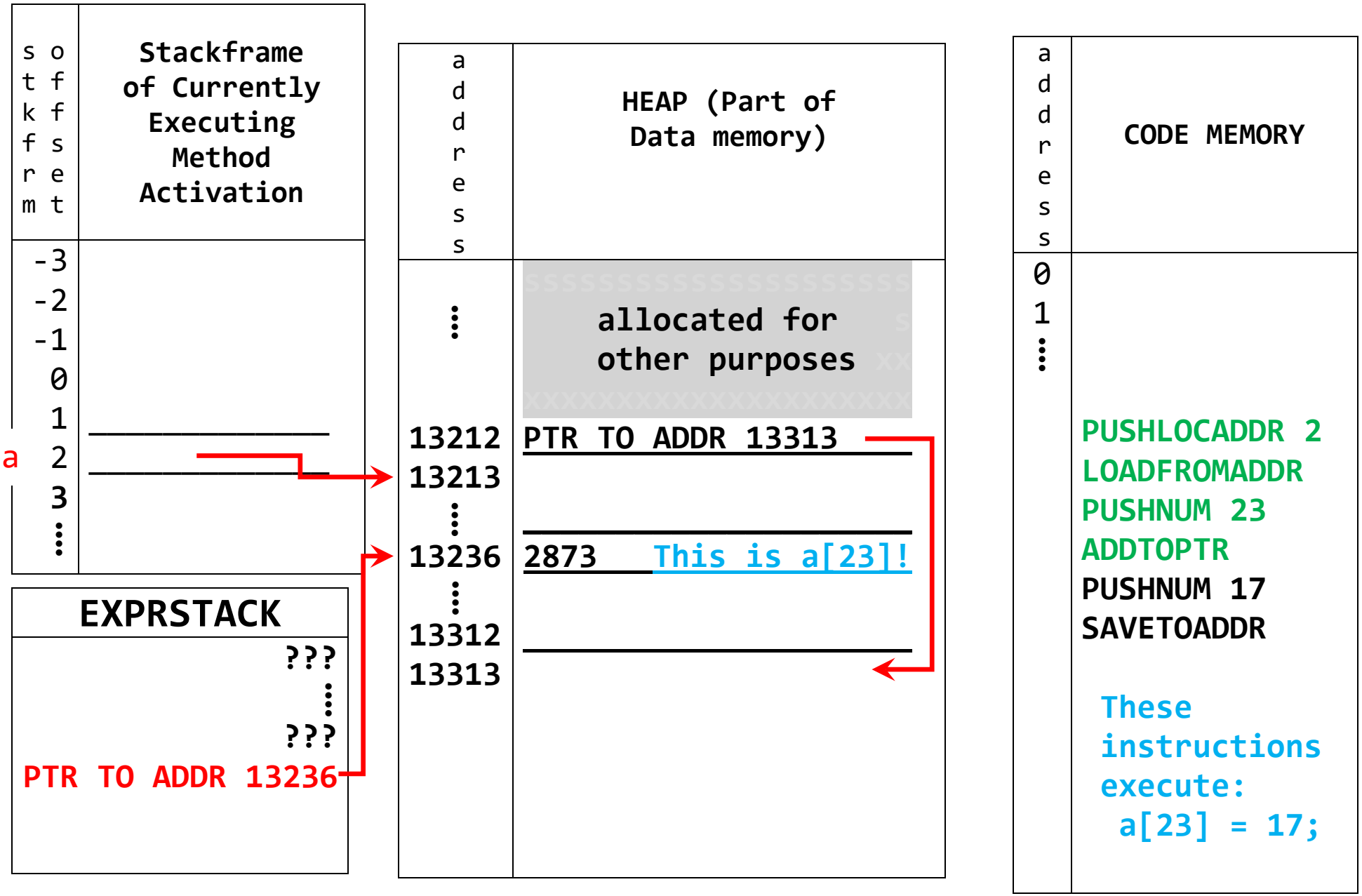
address	CODE MEMORY
0	
1	
⋮	
	PUSHLOCADDR 2
	LOADFROMADDR
	PUSHNUM 23
	ADDTOPTR
	PUSHNUM 17
	SAVETOADDR

These instructions execute:
a[23] = 17;

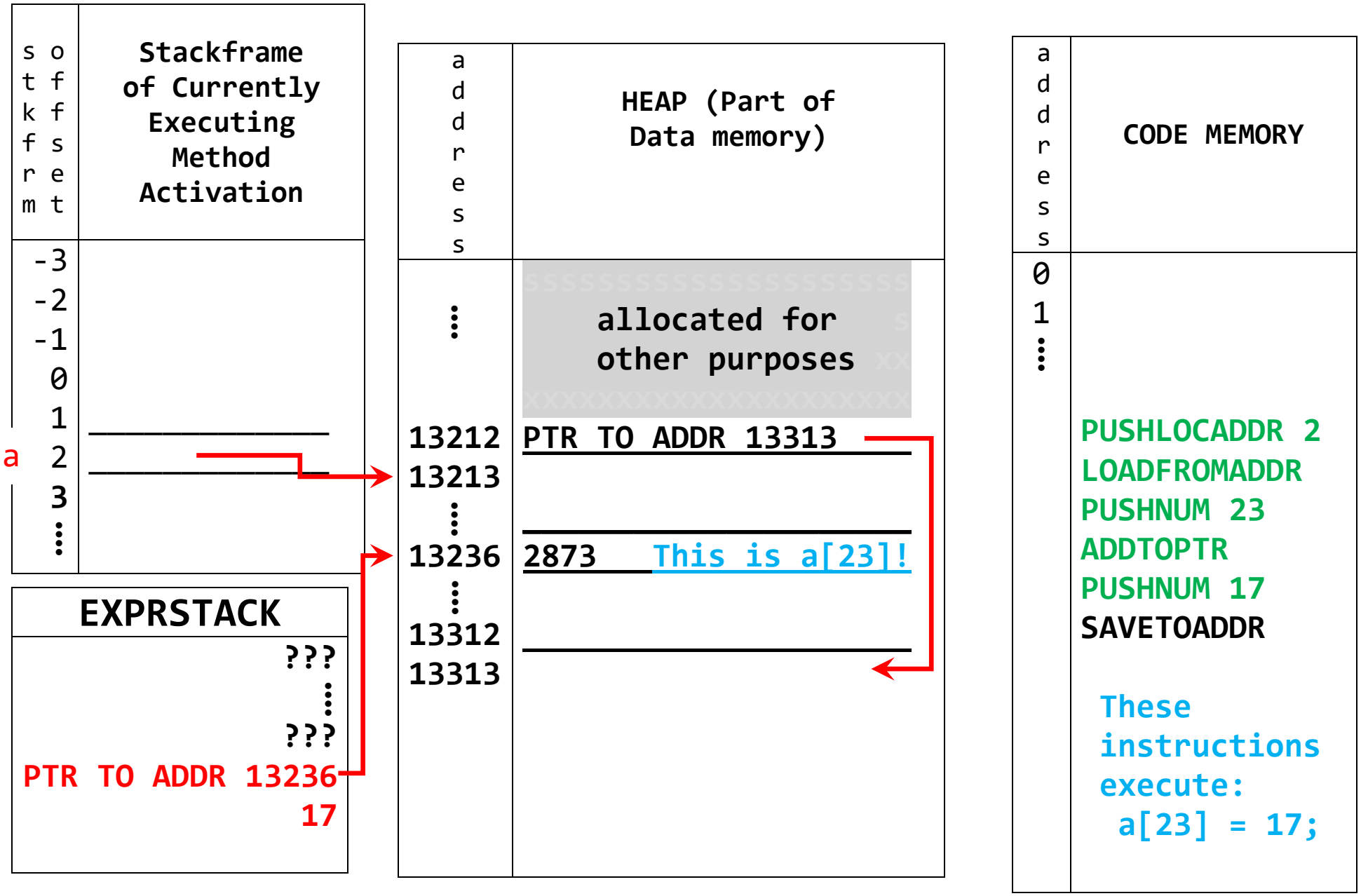
EXPRSTACK

???
⋮
???
PTR TO ADDR 13213
23

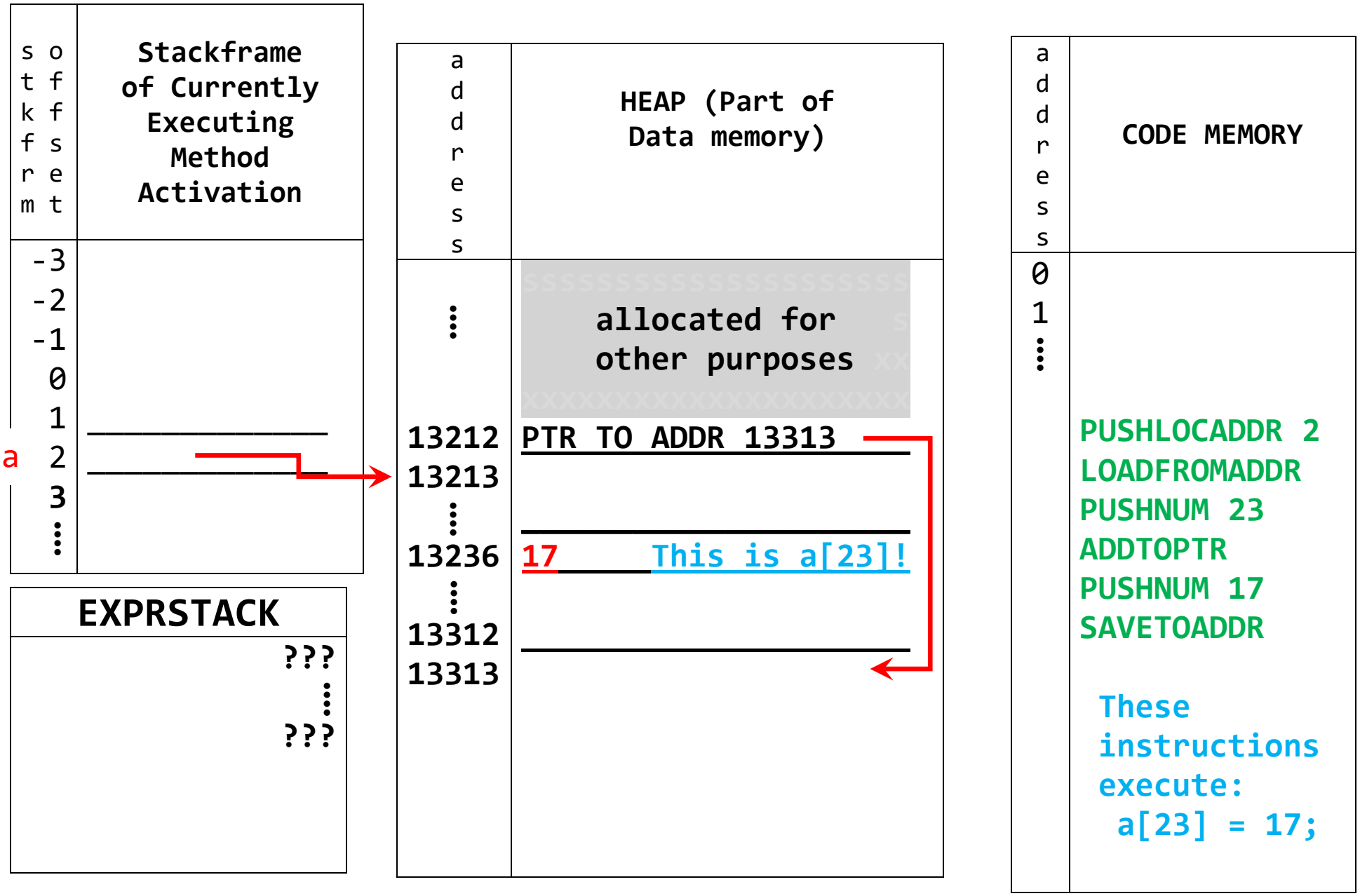
AFTER execution of: ADDTOPTR



AFTER *execution of*: PUSHNUM 17



AFTER execution of: SAVETOADDR



Q. What code should be generated to leave the value of the following indexed variable on top of EXPRSTACK?

IDENTIFIER [<expr>]

e.g., a[y-x]

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IDENTIFIER [<expr>]

e.g., a[y-x]

ANSWER:

PUSHLOCADDR IDENTIFIER.stackframe_offset

or **PUSHSTATADDR** IDENTIFIER.static_address

LOADFROMADDR

code that leaves value of <expr> on top of EXPRSTACK

ADDTOPTR

LOADFROMADDR

Q. What code should be generated to leave the value of the following indexed variable on top of EXPRSTACK?

IDENTIFIER [<expr>]

e.g., a[y-x]

ANSWER:

PUSHLOCADDR IDENTIFIER.stackframe_offset

or **PUSHSTATADDR** IDENTIFIER.static_address

LOADFROMADDR

code that leaves value of <expr> on top of EXPRSTACK

ADDTOPTR

LOADFROMADDR

Example Suppose a is declared as

static int a[];

and the data memory address of a is 5.

What TinyJ VM instructions should be generated to leave the value of a[23] on top of EXPRSTACK, assuming a will contain a reference to an array of size ≥ 24 when the instructions are executed?

ANSWER:

Q. What code should be generated to leave the value of the following indexed variable on top of EXPRSTACK?

IDENTIFIER [<expr>]

e.g., a[y-x]

ANSWER:

PUSHLOCADDR IDENTIFIER.stackframe_offset

or **PUSHSTATADDR** IDENTIFIER.static_address

LOADFROMADDR

code that leaves value of <expr> on top of EXPRSTACK

ADDTOPTR

LOADFROMADDR

Example Suppose a is declared as

```
static int a[];
```

and the data memory address of a is 5.

What TinyJ VM instructions should be generated to leave the value of a[23] on top of EXPRSTACK, assuming a will contain a reference to an array of size ≥ 24 when the instructions are executed?

ANSWER:

```
PUSHSTATADDR 5
      ⋮
```

Q. What code should be generated to leave the value of the following indexed variable on top of EXPRSTACK?

IDENTIFIER [<expr>]

e.g., a[y-x]

ANSWER:

PUSHLOCADDR IDENTIFIER.stackframe_offset

or PUSHSTATADDR IDENTIFIER.static_address

LOADFROMADDR

code that leaves value of <expr> on top of EXPRSTACK

ADDTOPTR

LOADFROMADDR

Example Suppose a is declared as

```
static int a[];
```

and the data memory address of a is 5. What TinyJ VM instructions should be generated to leave the value of a[23] on top of EXPRSTACK, assuming a will contain a reference to an array of size ≥ 24 when the instructions are executed?

ANSWER:

```
PUSHSTATADDR 5
LOADFROMADDR
PUSHNUM 23
ADDTOPTR
   ⋮
```

Q. What code should be generated to leave the value of the following indexed variable on top of EXPRSTACK?

IDENTIFIER [<expr>]

e.g., a[y-x]

ANSWER:

PUSHLOCADDR IDENTIFIER.stackframe_offset

or **PUSHSTATADDR** IDENTIFIER.static_address

LOADFROMADDR

code that leaves value of <expr> on top of EXPRSTACK

ADDTOPTR

LOADFROMADDR

Example Suppose a is declared as

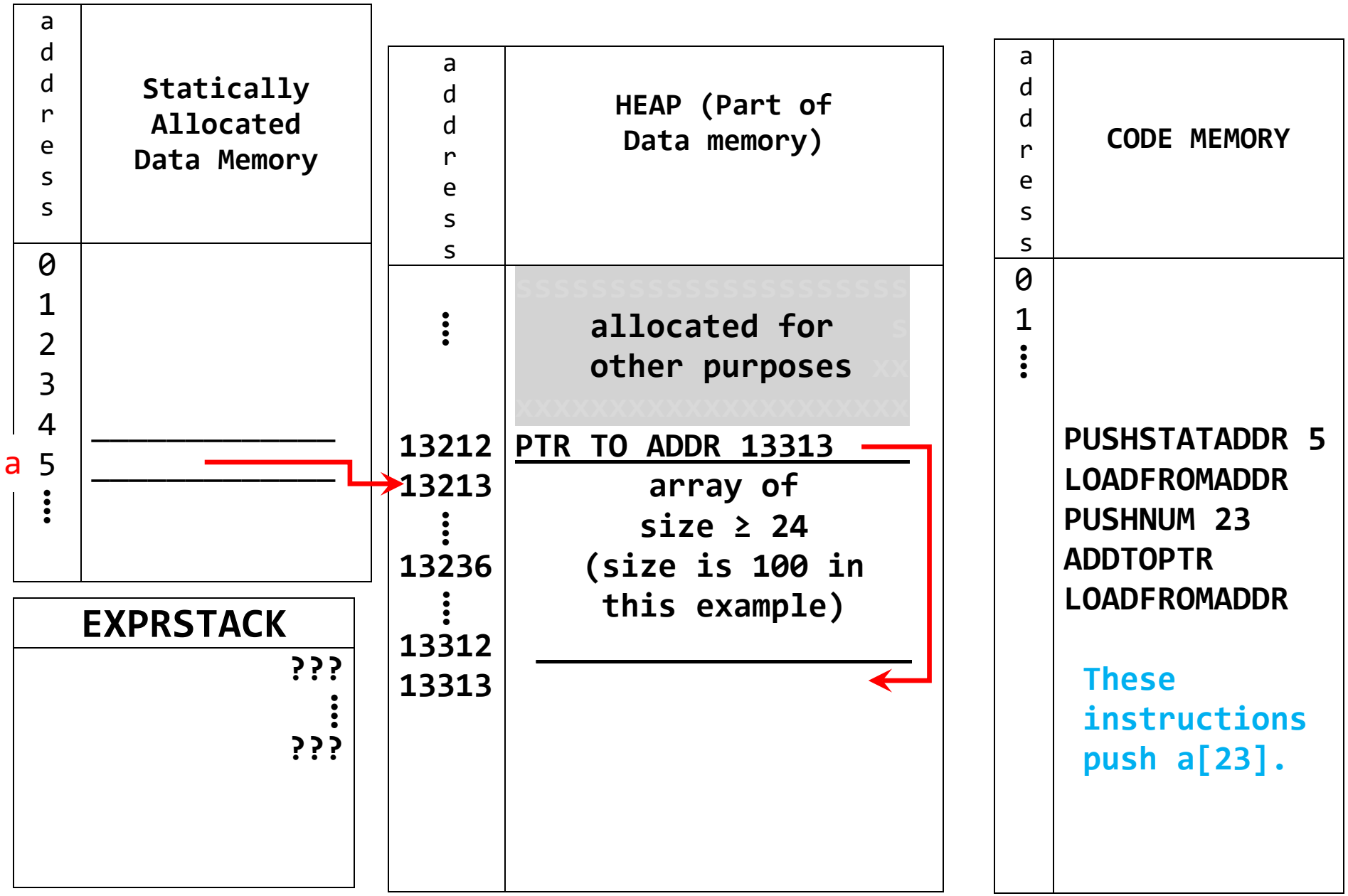
```
static int a[];
```

and the data memory address of a is 5. What TinyJ VM instructions should be generated to leave the value of a[23] on top of EXPRSTACK, assuming a will contain a reference to an array of size ≥ 24 when the instructions are executed?

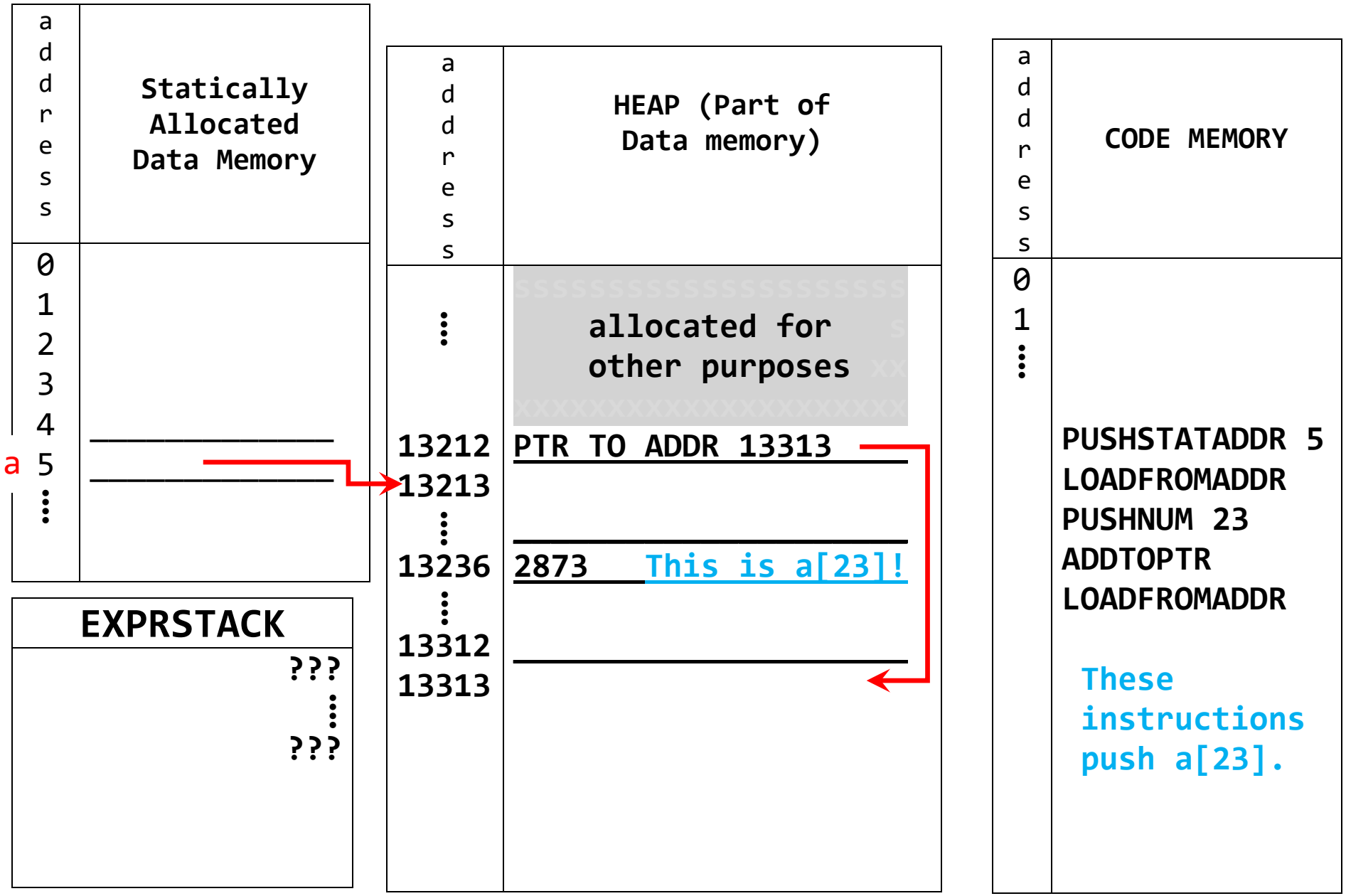
ANSWER:

```
PUSHSTATADDR 5
LOADFROMADDR
PUSHNUM 23
ADDTOPTR
LOADFROMADDR
```

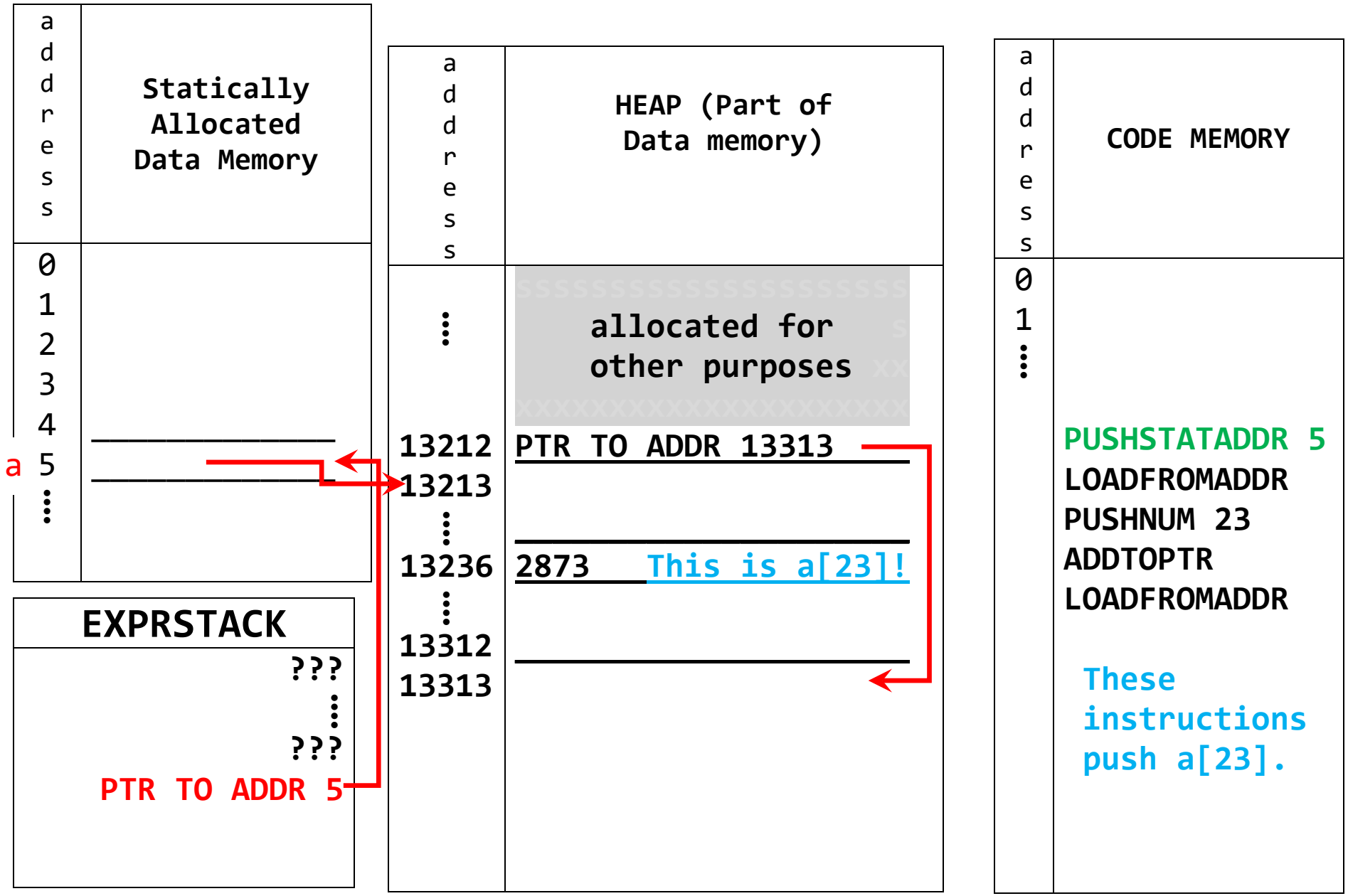
BEFORE execution of: PUSHSTATADDR 5



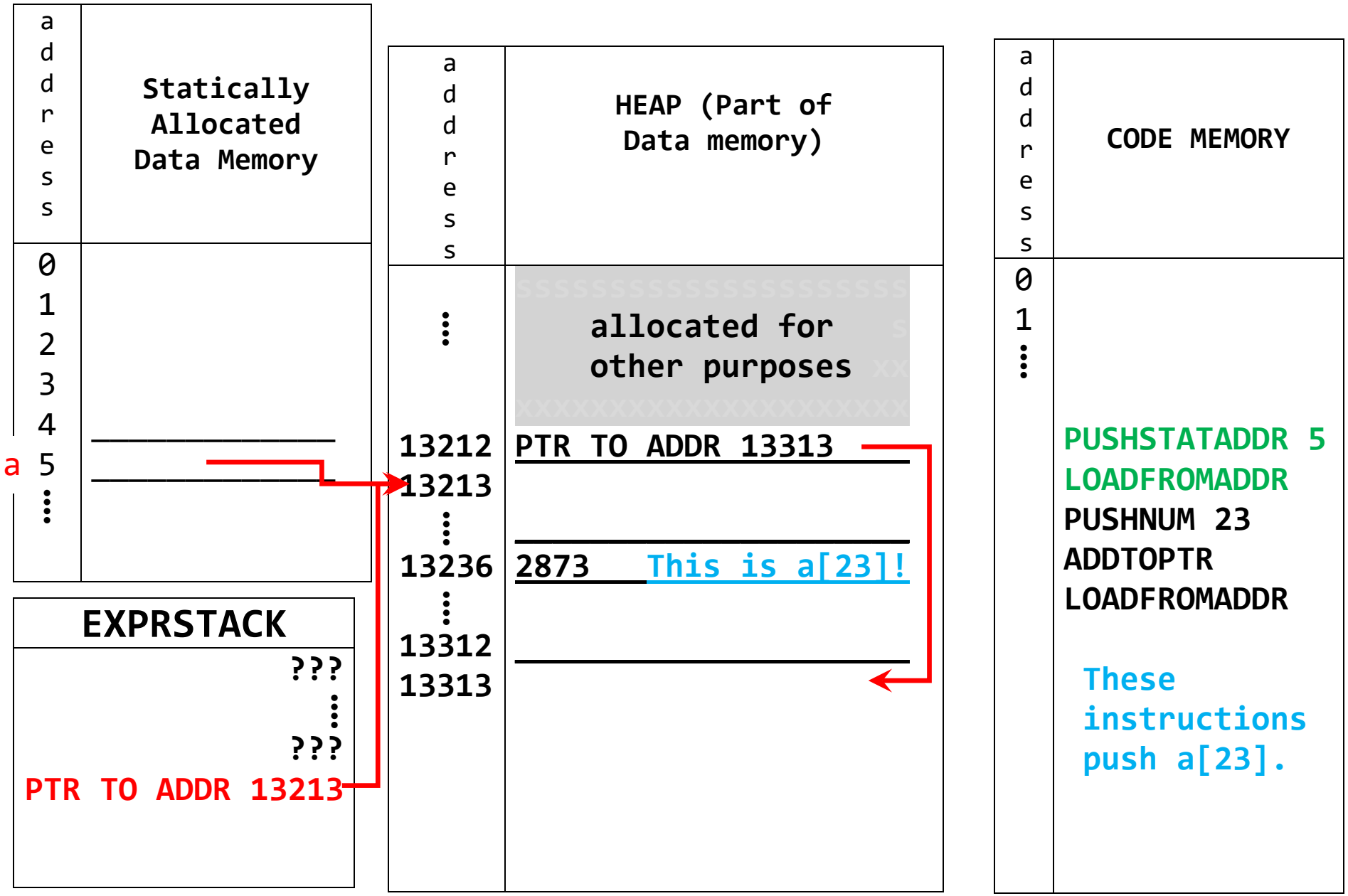
BEFORE execution of: PUSHSTATADDR 5



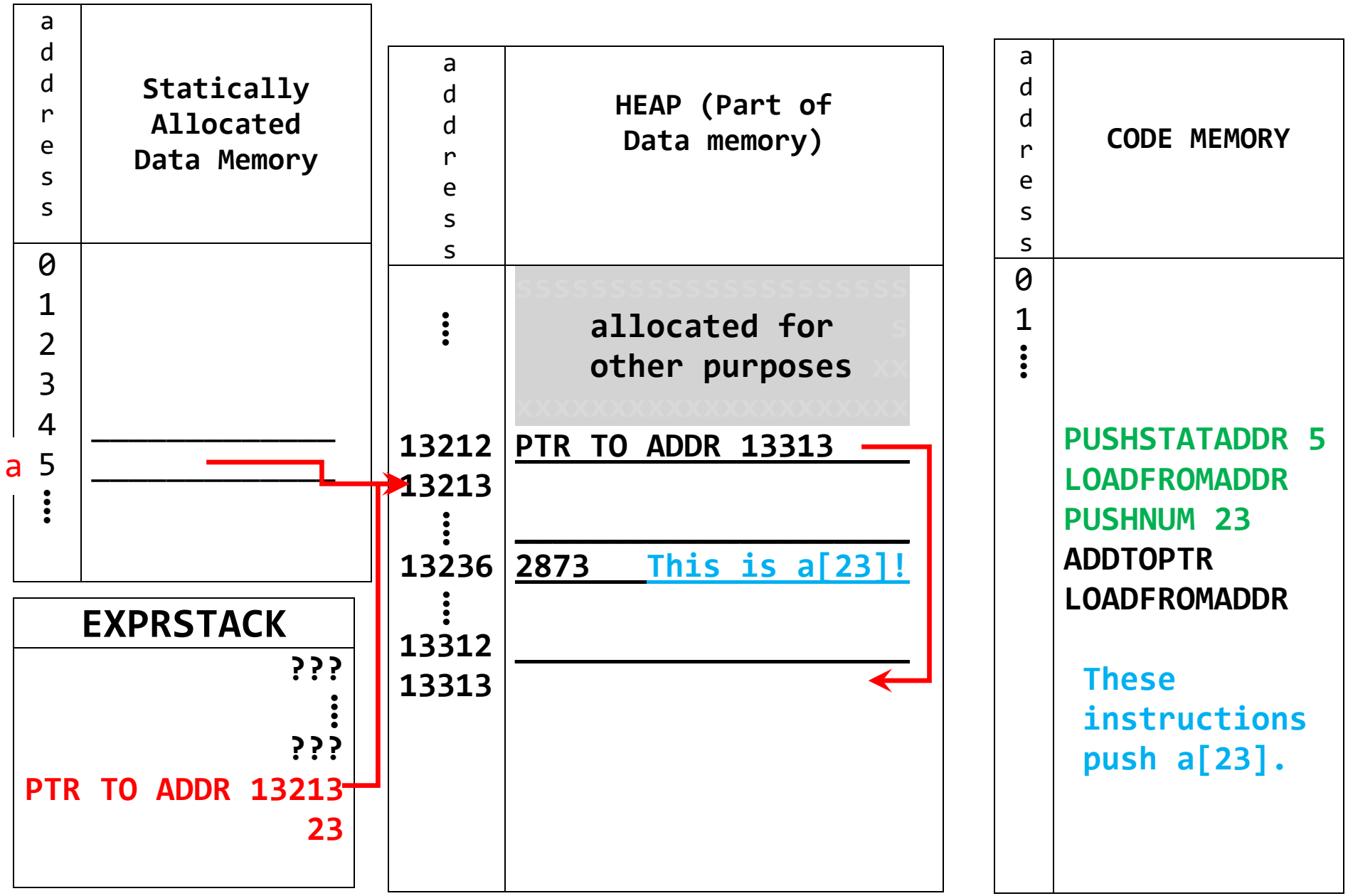
AFTER *execution of*: PUSHSTATADDR 5



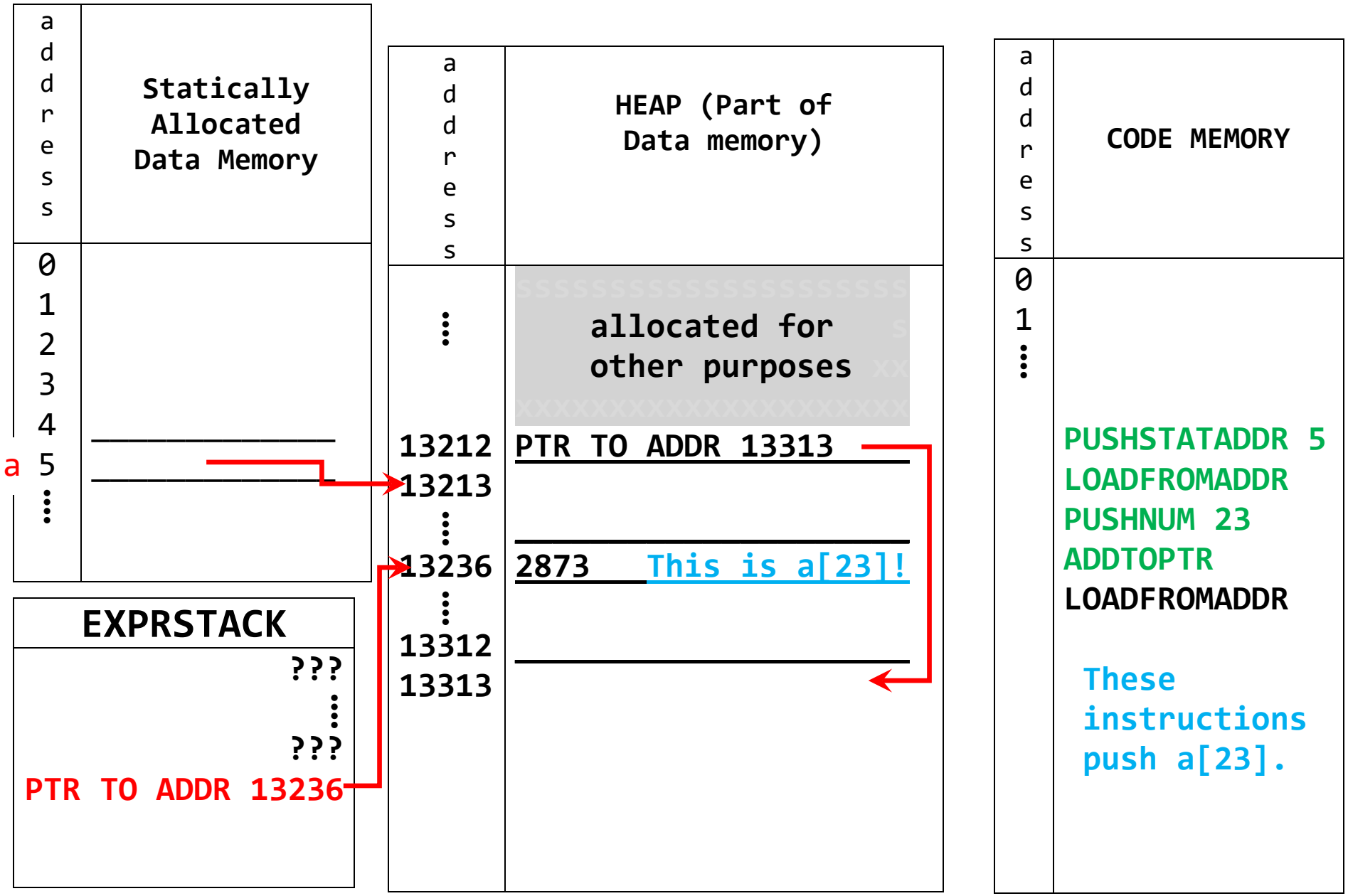
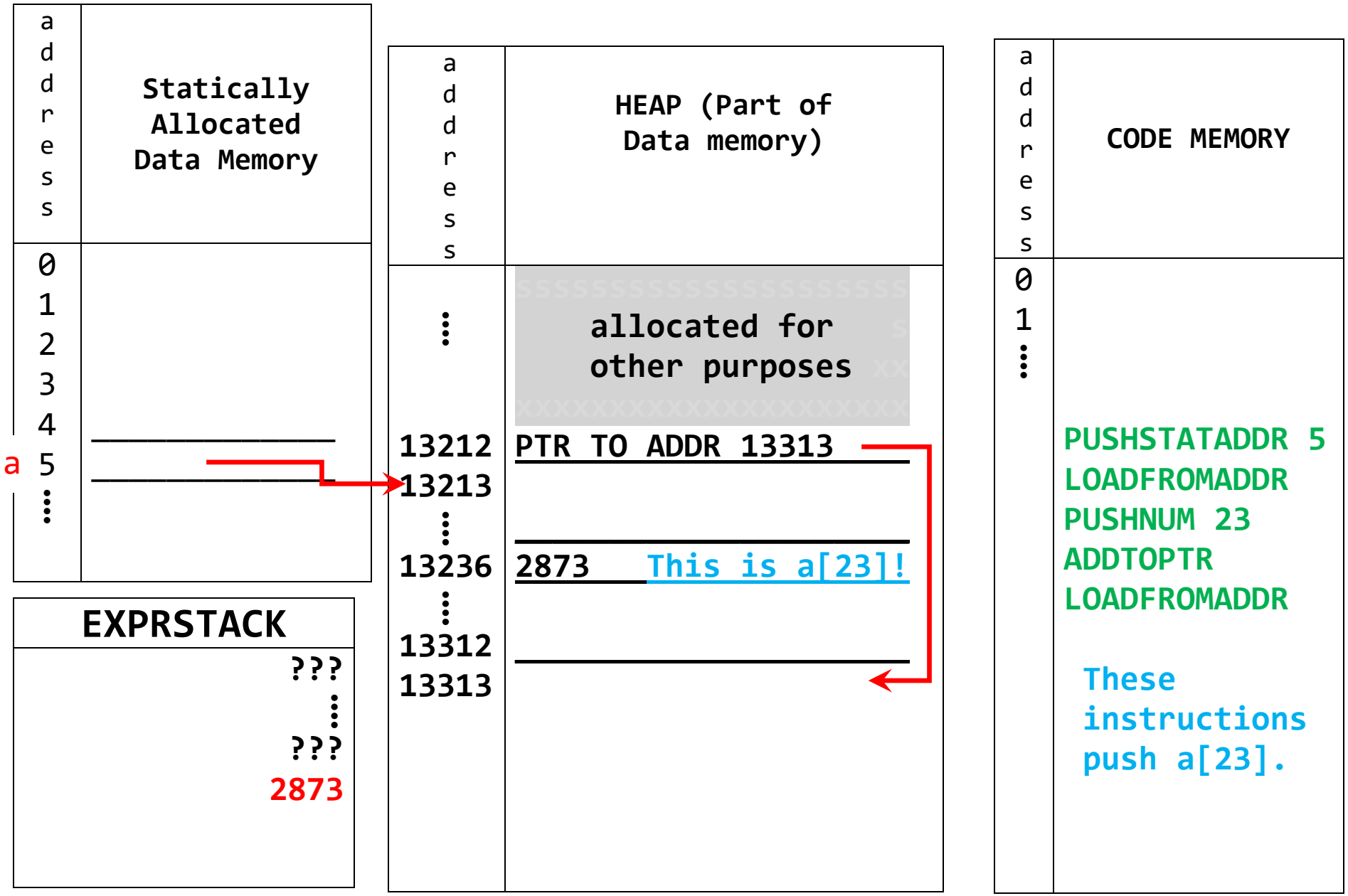
AFTER execution of: 1st LOADFROMADDR



AFTER execution of: PUSHNUM 23



AFTER execution of: ADDTOPTR



AFTER execution of: 2nd LOADFROMADDR