ECE 220

Lecture x0009 - 02/13

Slides based on material originally by: Yuting Chen & Thomas Moon

Reminders

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  - Conceptual questions (including C)

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Swap function

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- The declaration syntax for a pointer is:

```
type *ptr-name;
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Pointers in C

Example declarations

```
int *ptr; // ptr is a pointer to an int

char *cptr; // cptr is a pointer to _____

double *dptr; // dptr is a pointer to _____
```

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Usefulness well become clear in later lectures.

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Curious? You can play with: https://cdecl.org/

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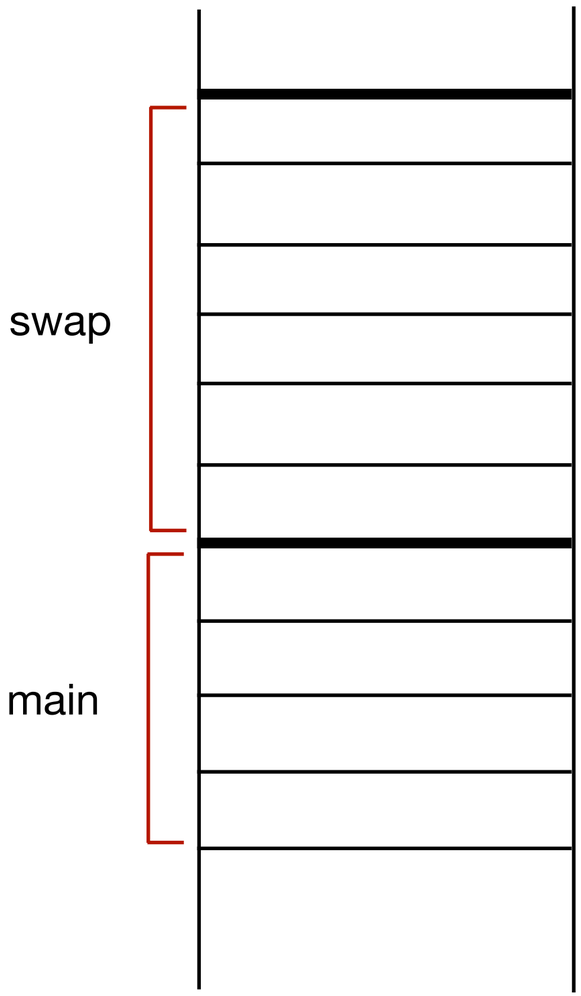

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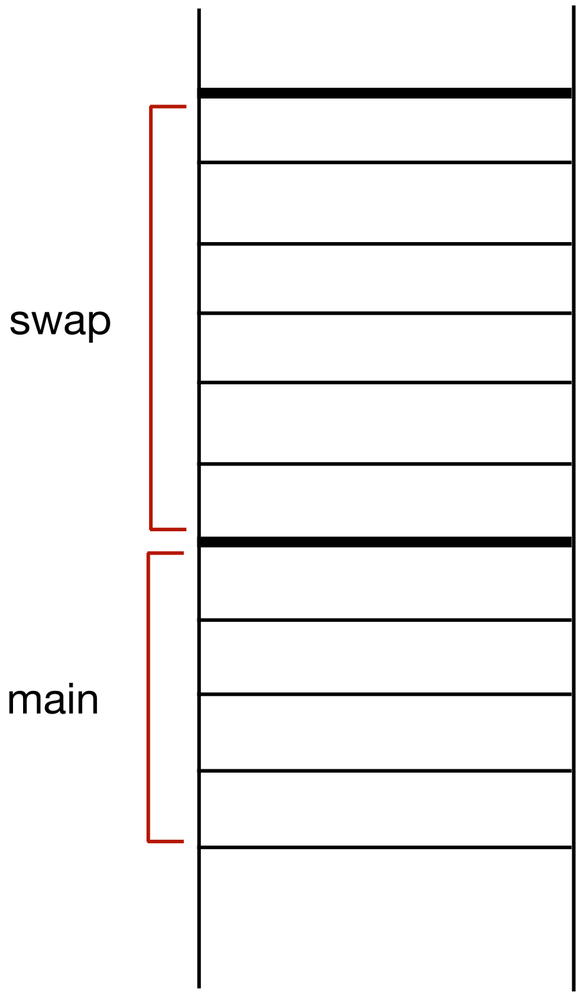


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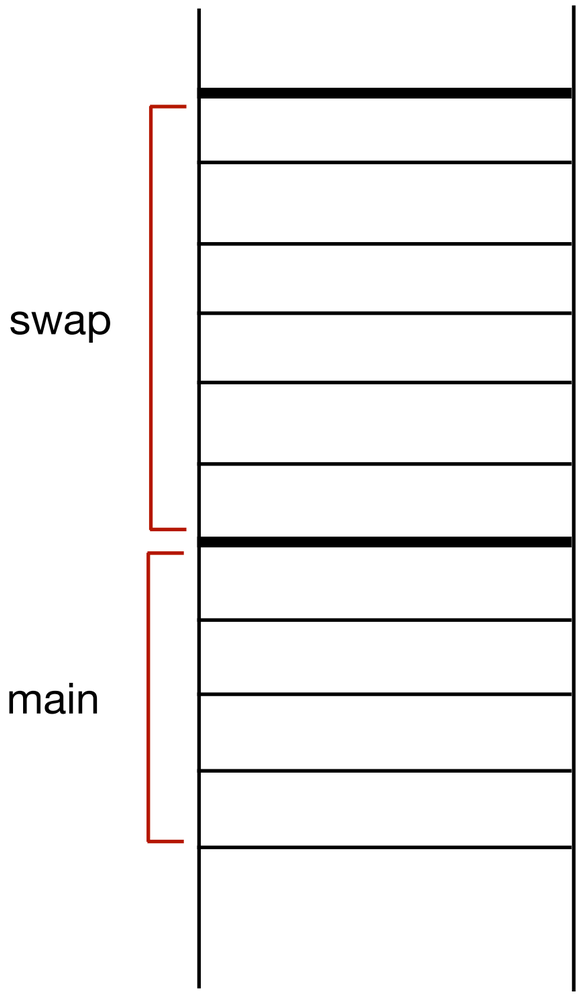


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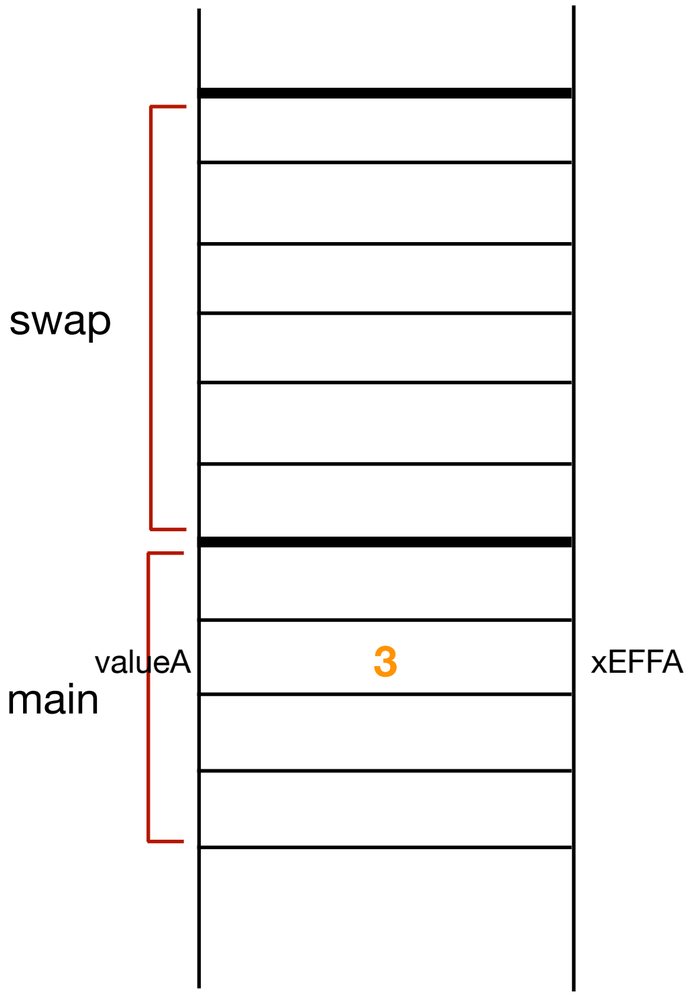


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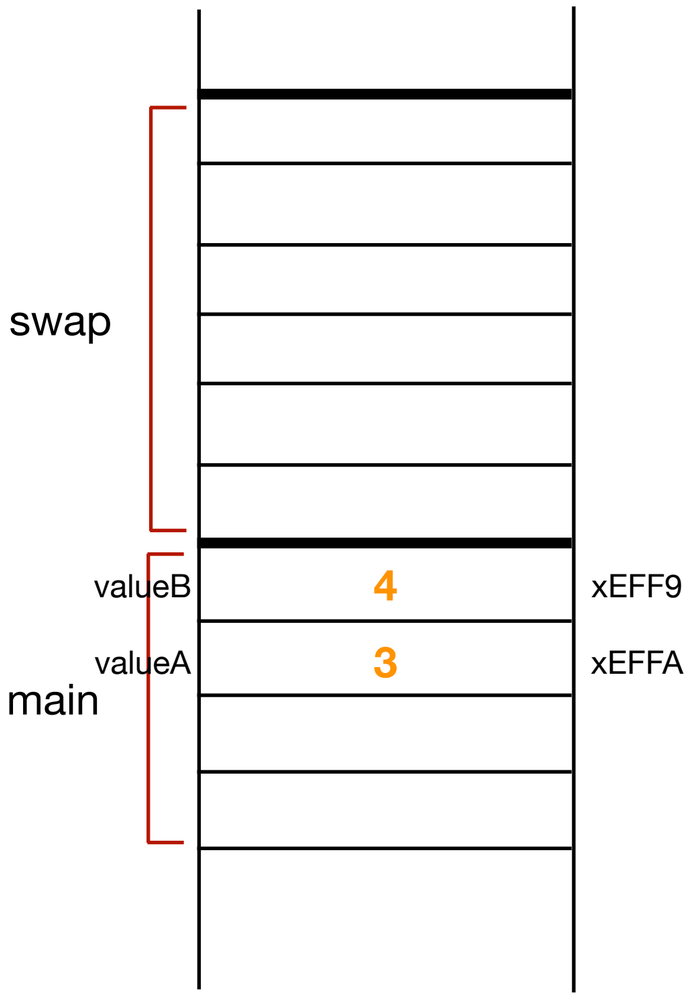


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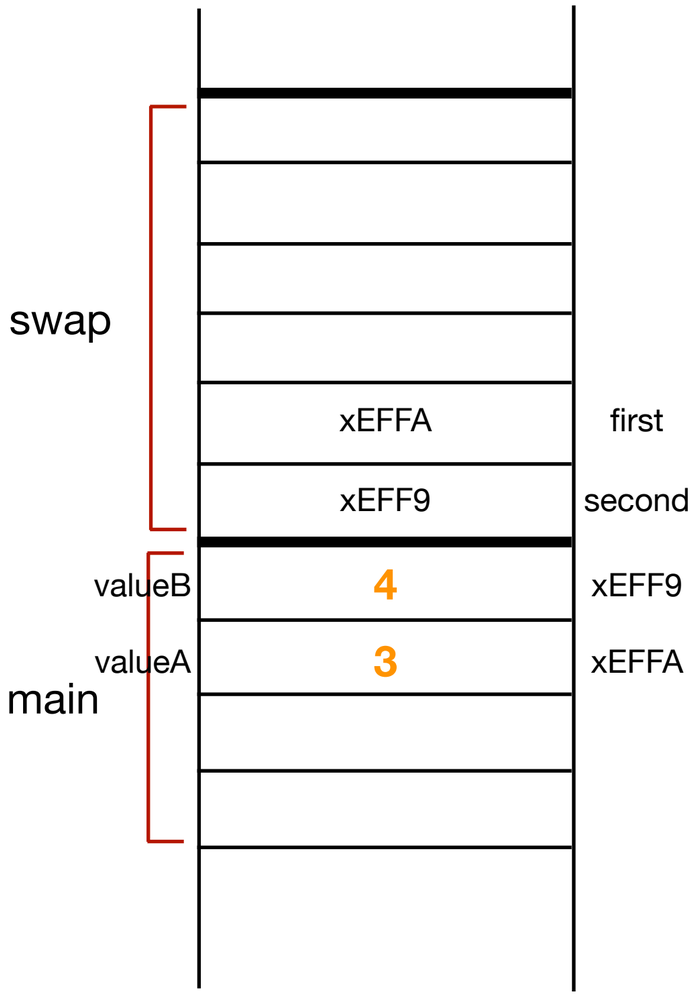


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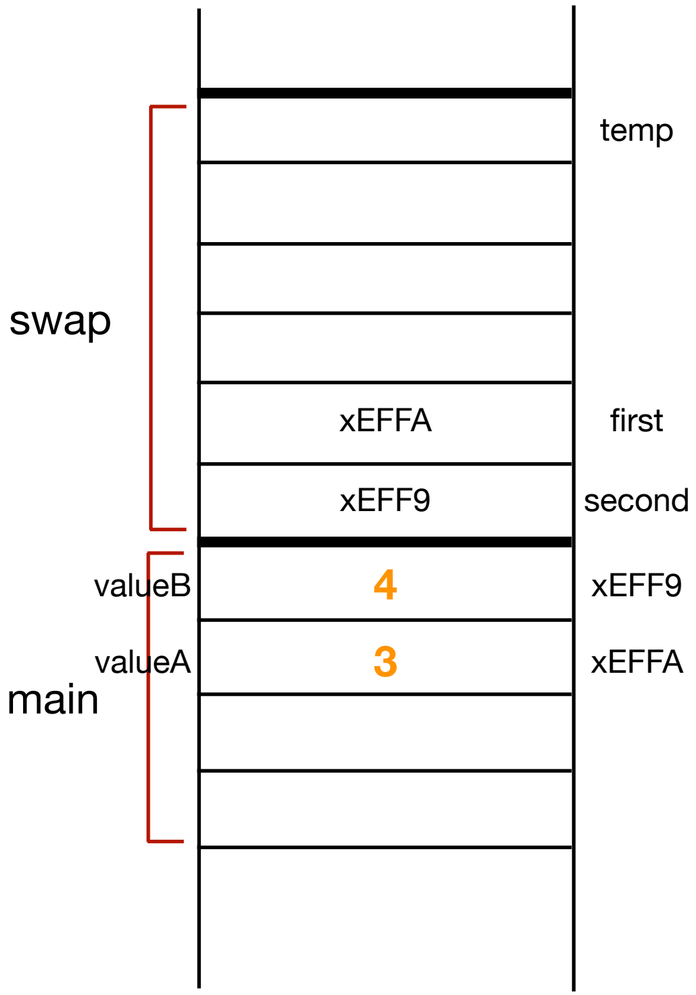


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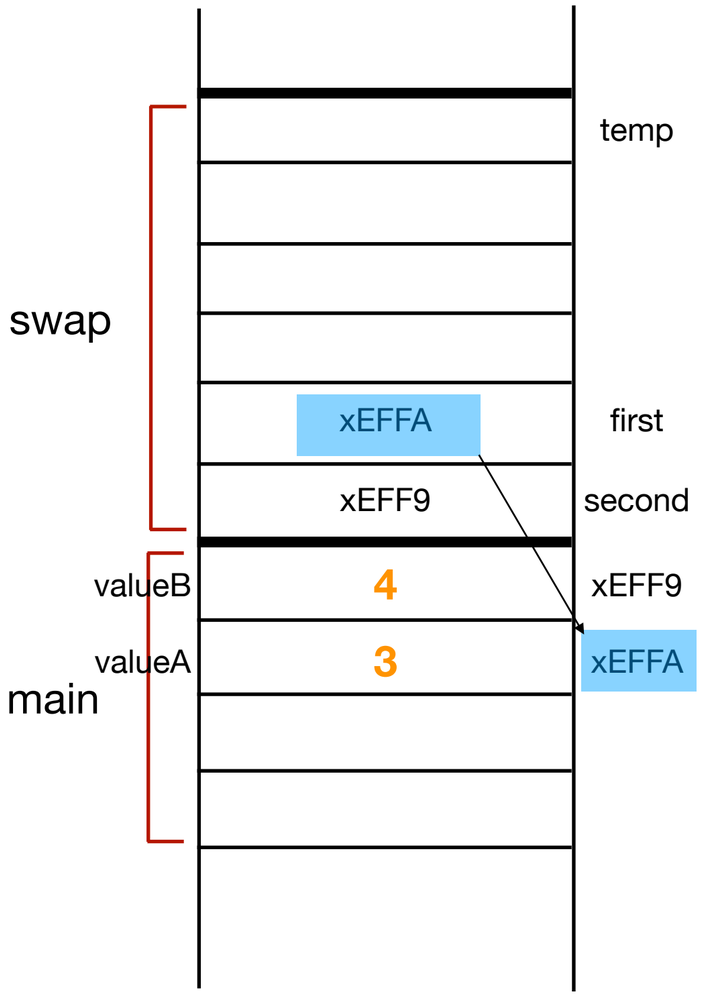


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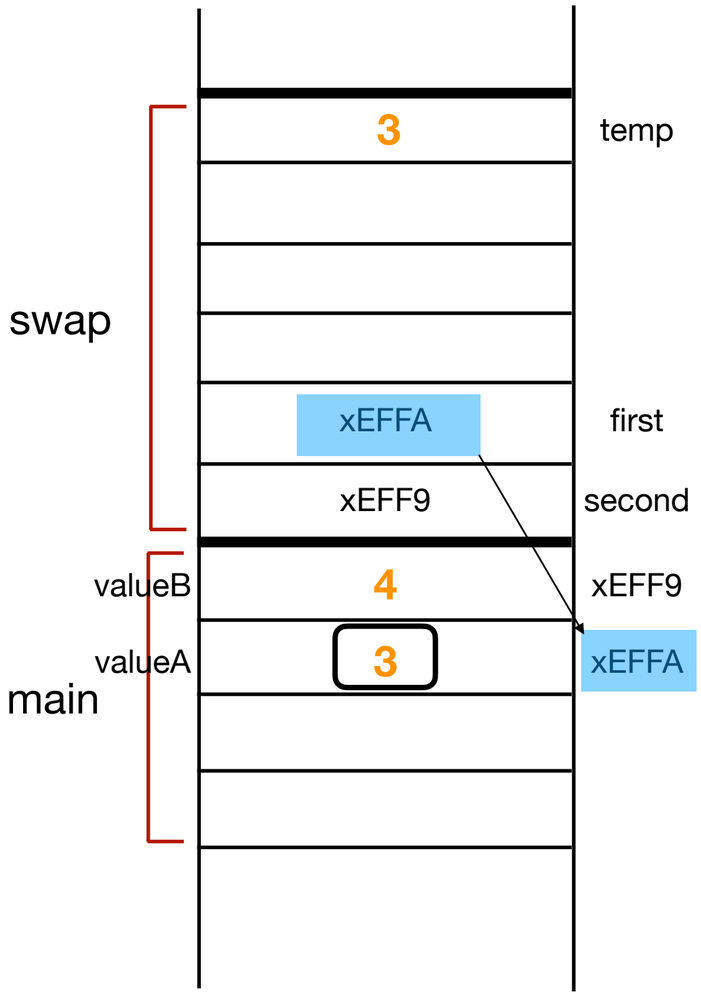


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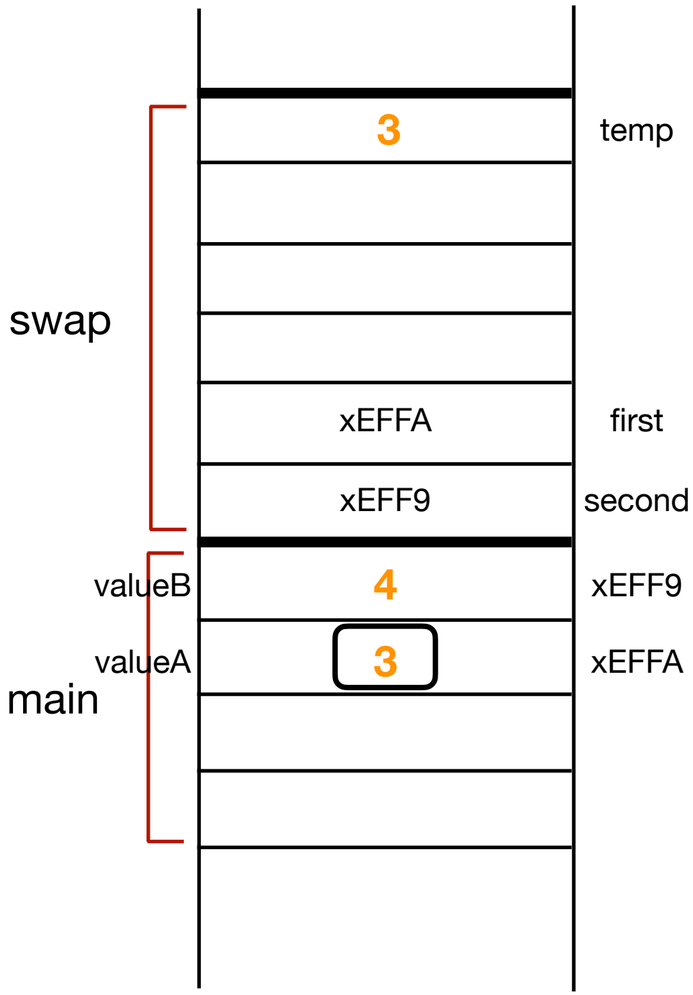


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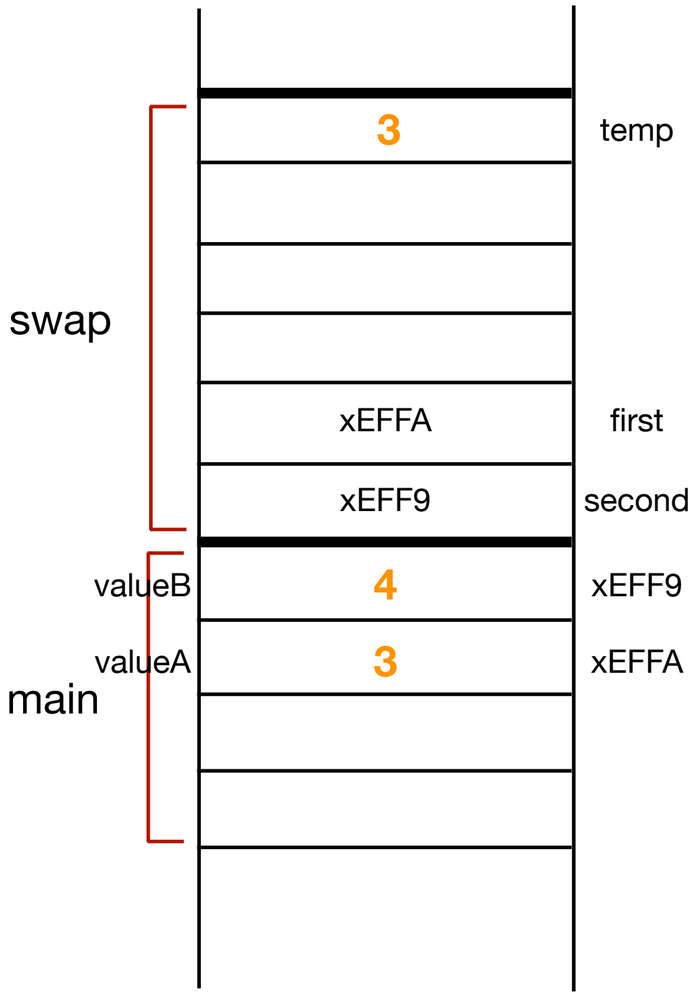


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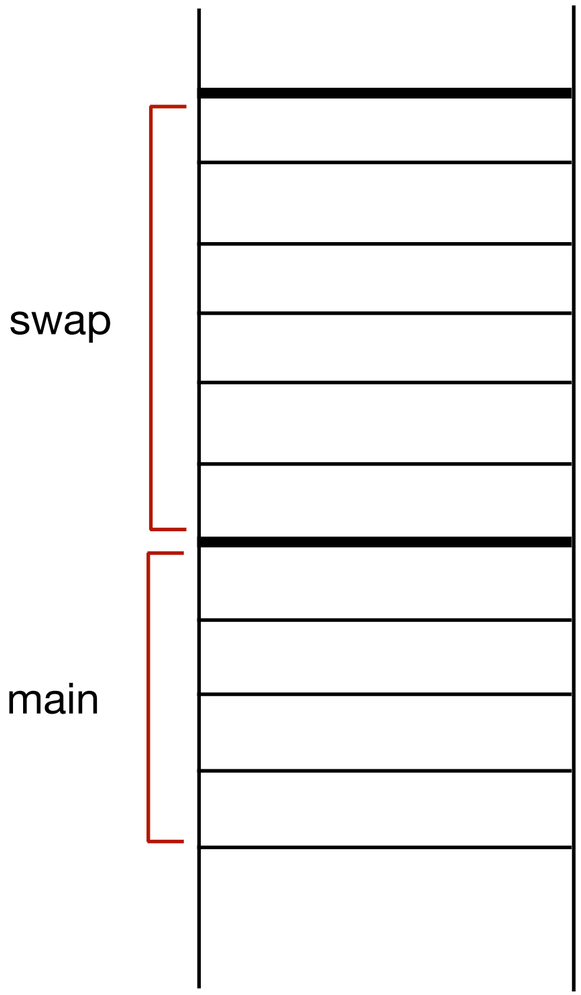

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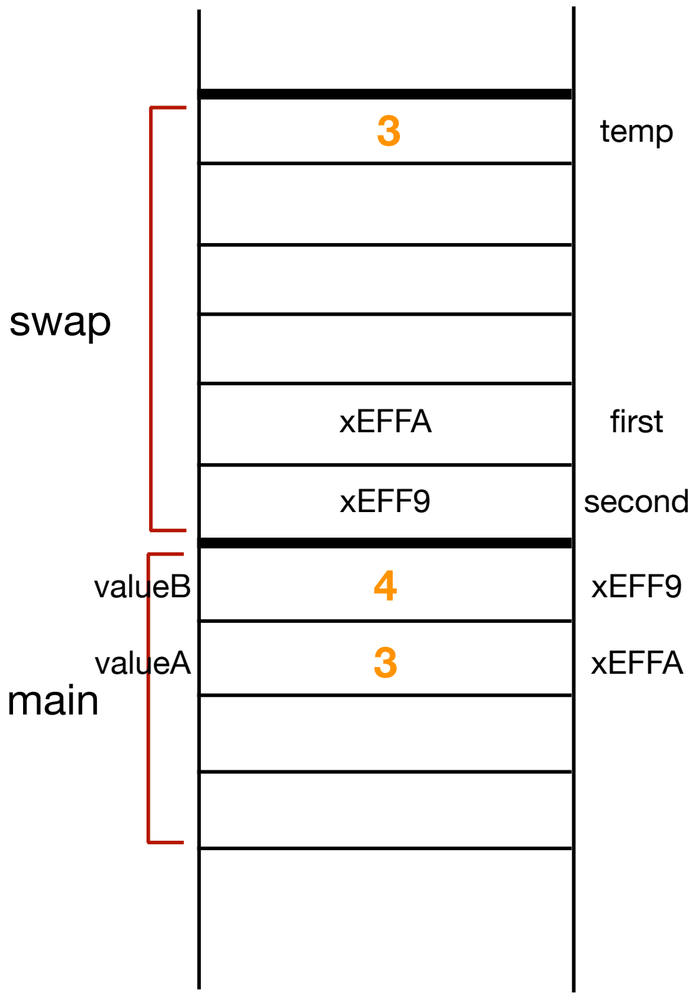

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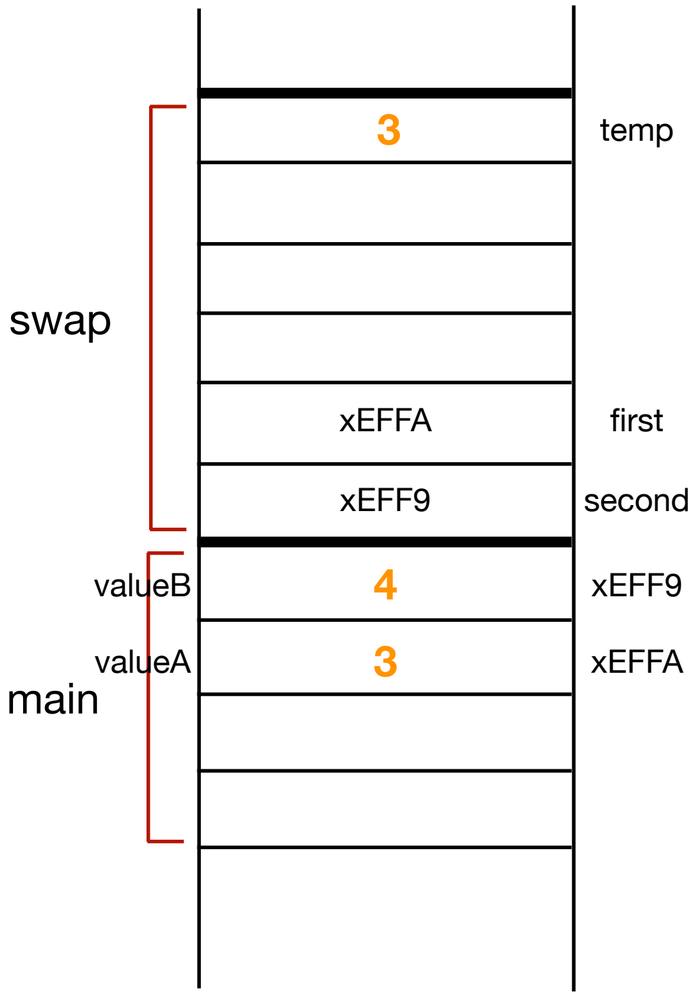


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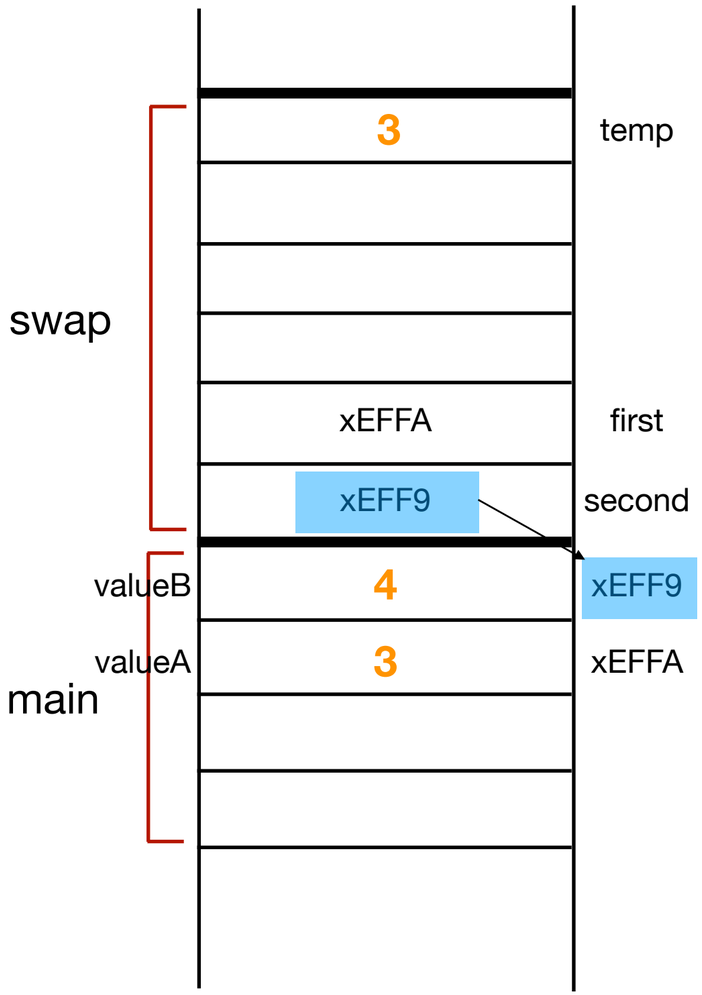


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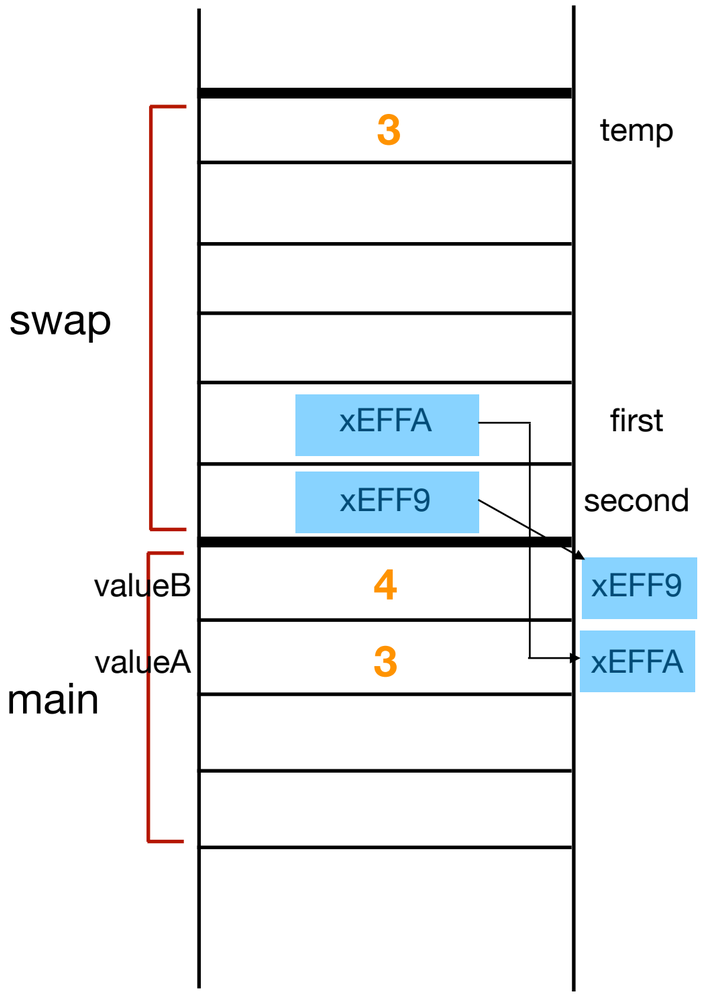


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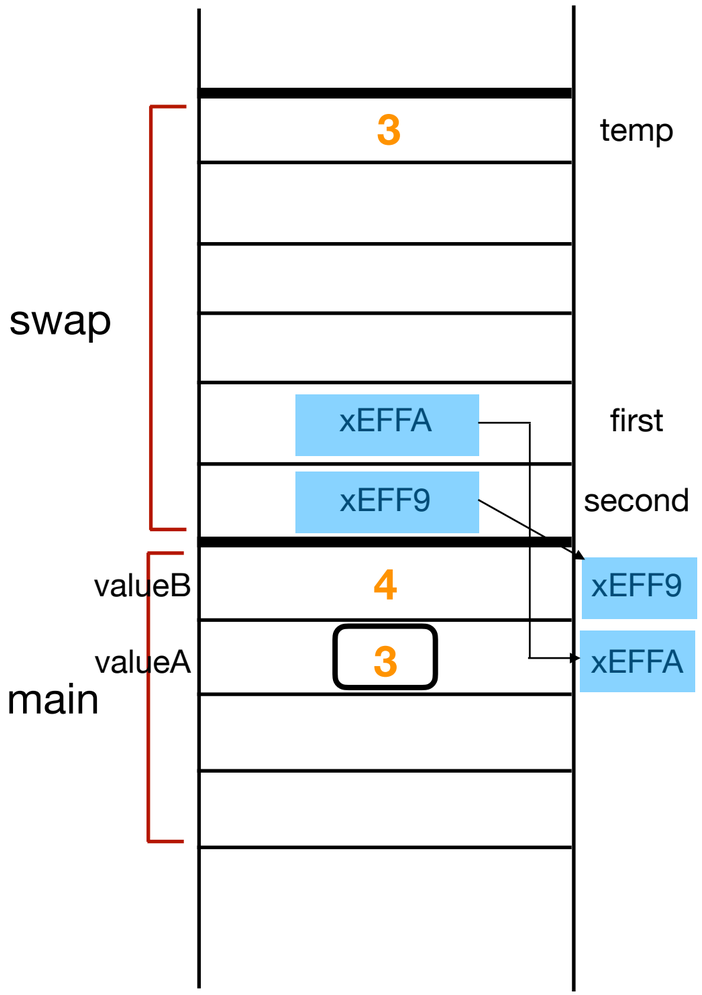


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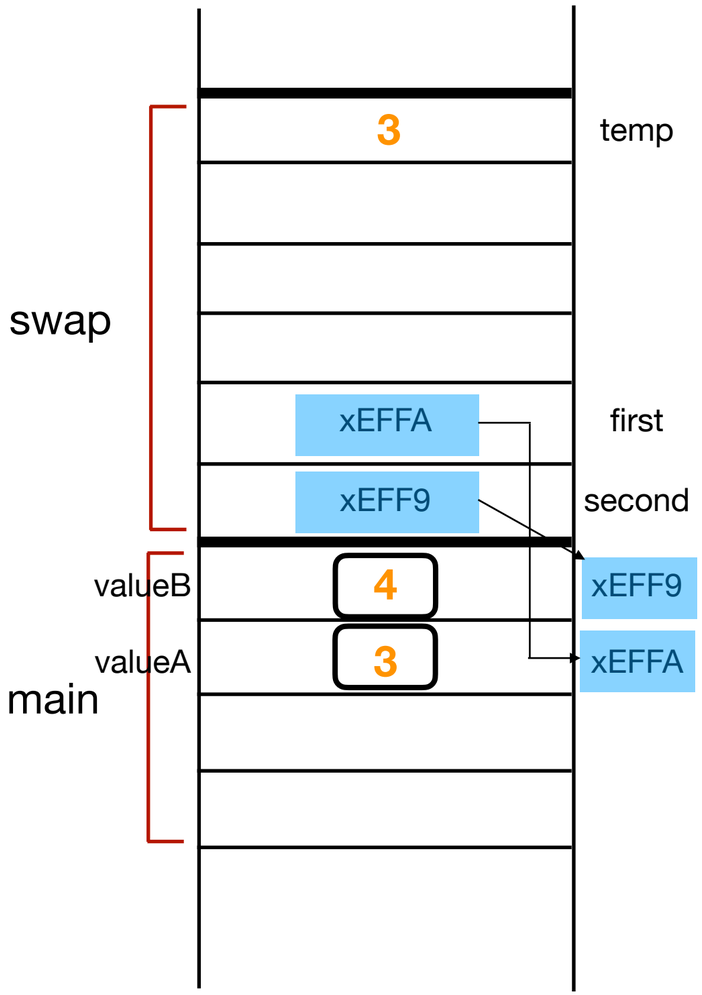


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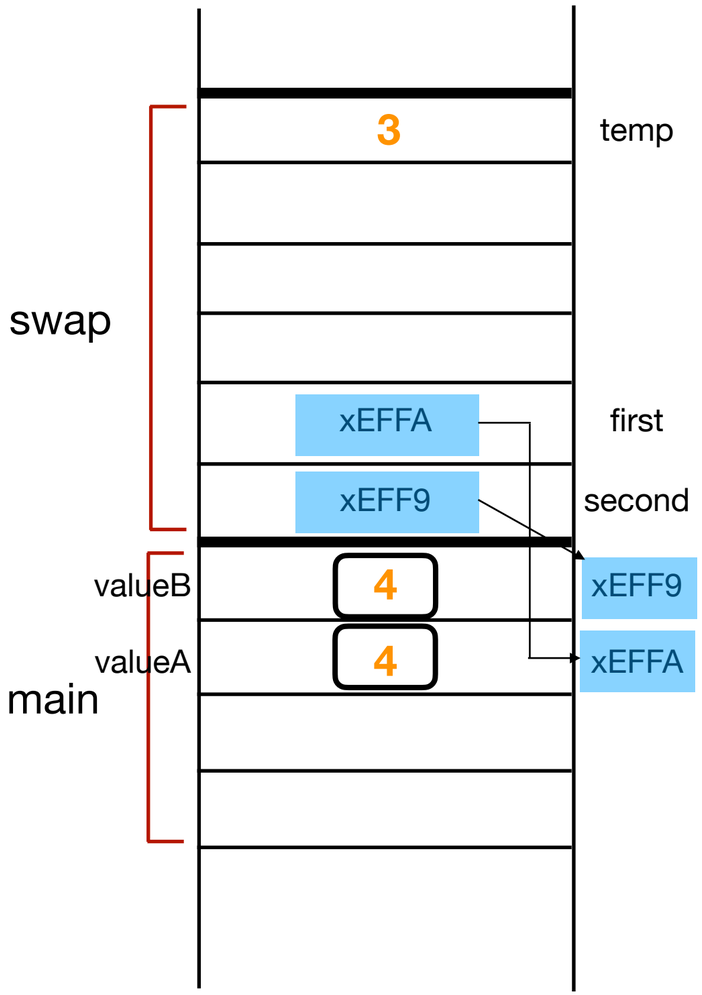


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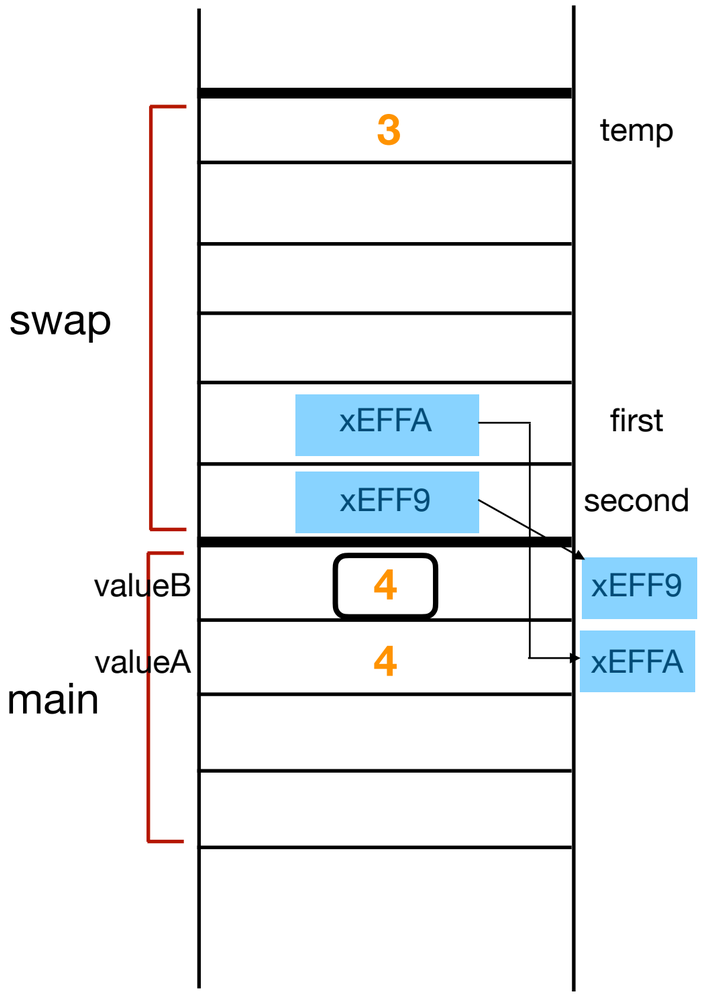


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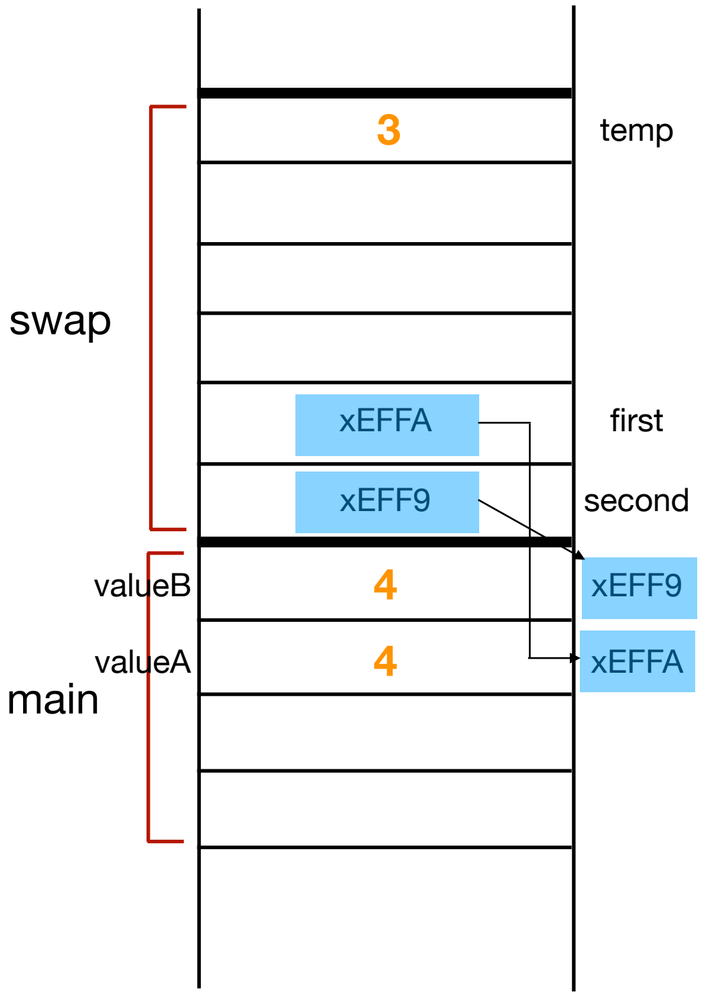


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int main(){
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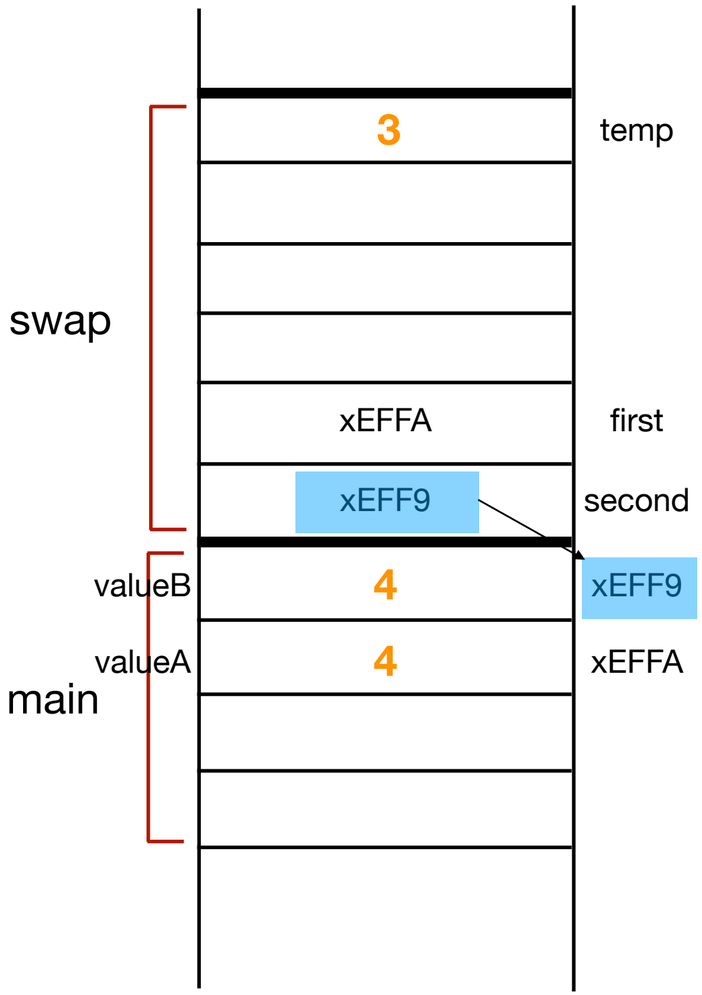
Using pointers in C

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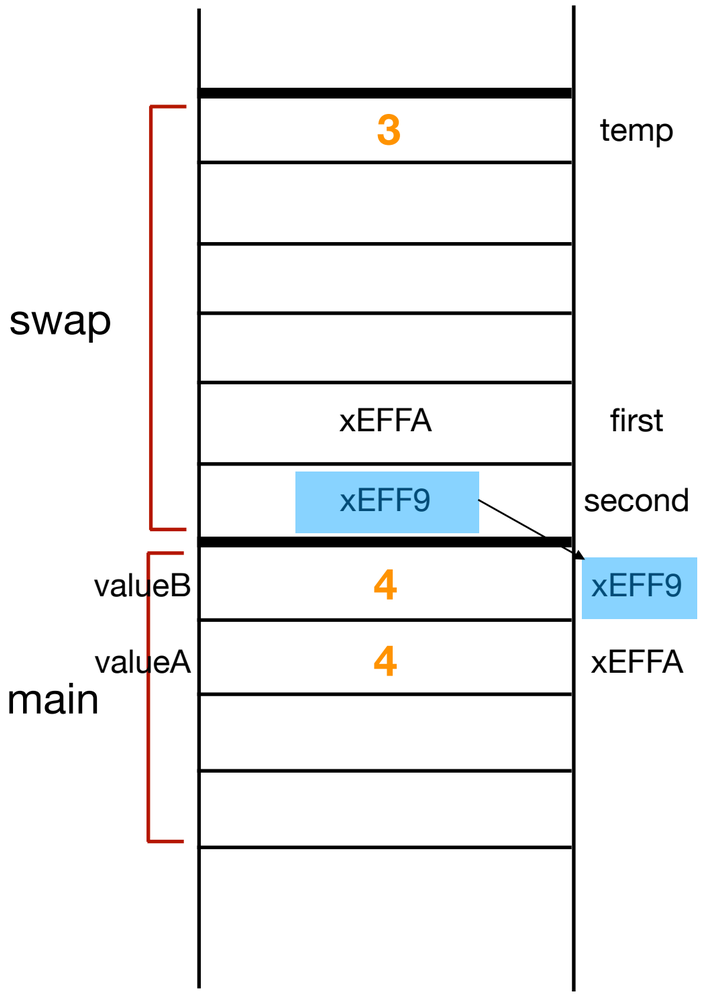


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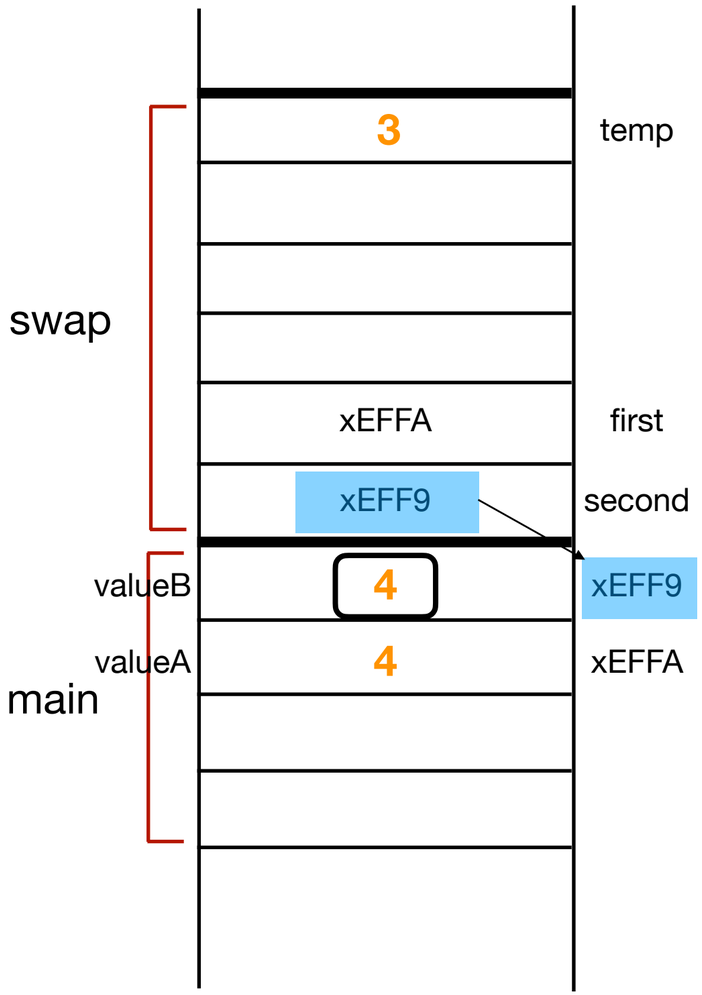


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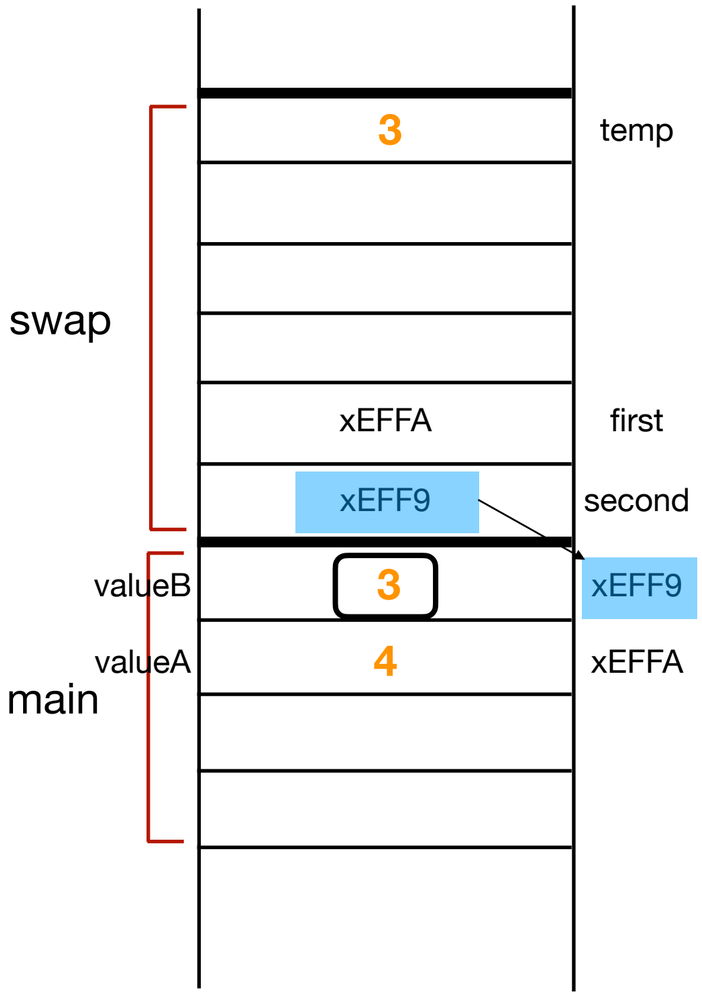


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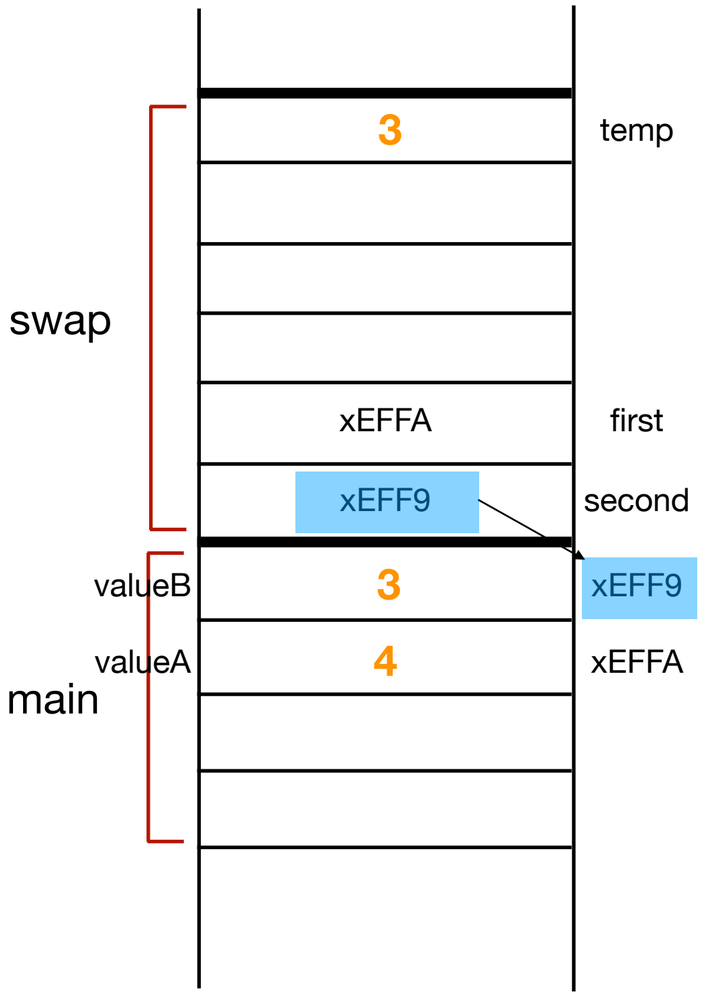


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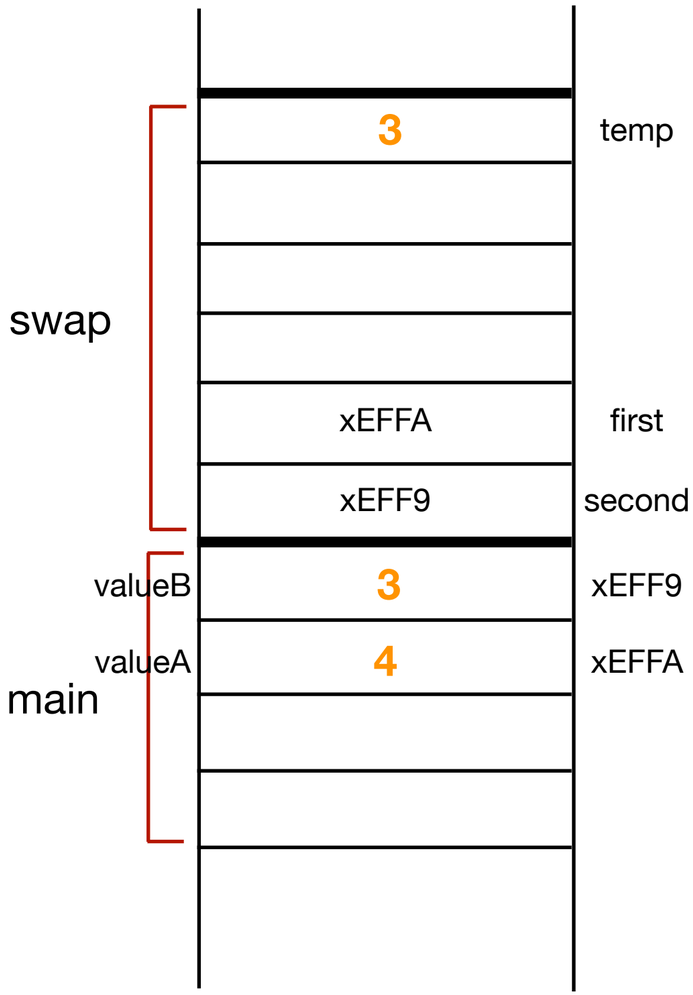


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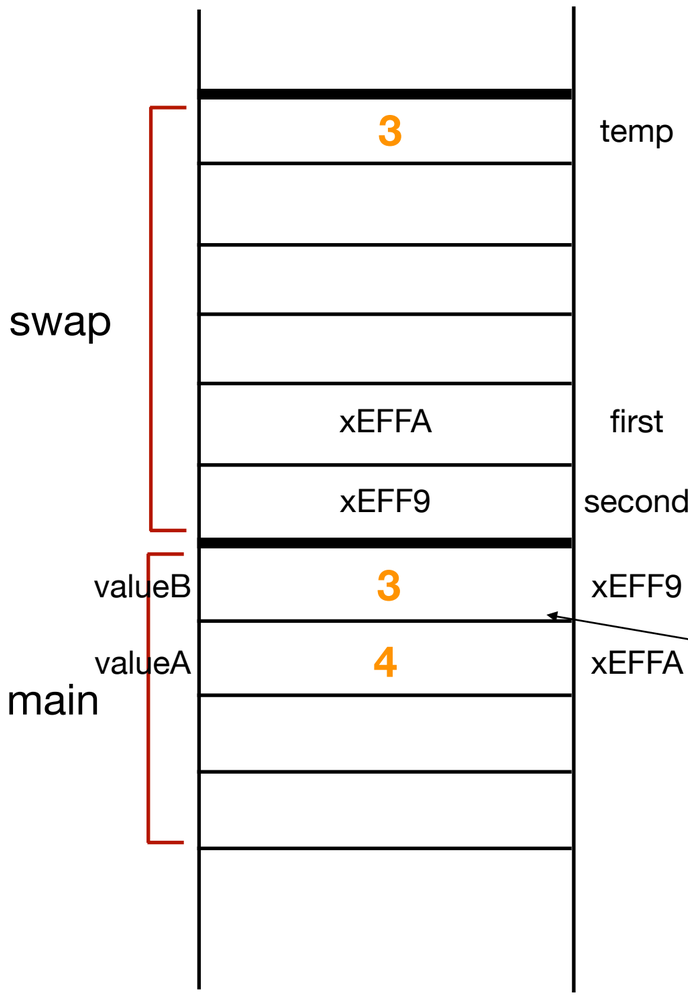

Compare

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- Pointers *need* to be indicated when making parameter declarations.

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`*ptr` → ***dereference operator***: returns the value pointed to by `ptr`

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```

Using pointers in C

- Which uses of * are *dereferencing* (not declarations) ?

```
#include <stdio.h>

                    1              2
void Swap(int *first, int *second){
int temp;
temp = *first;3
4*first = *second;5
6*second = temp;
}

int main(){
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}
```

Asides: … pointers *only* point to variables?

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```c
#include <stdio.h>

void fun(int a){
    printf("Value of a is %d\n", a);
}

int main(void){
    void (*fun_ptr)(int) = &fun;
    (*fun_ptr)(10);

    return 0;
}
```

Asides: … pointers *only* point to variables?

- No.
- They can point to functions, structs, *other pointers*, etc.
- Example on left shows a pointer to a function.
- We will learn about them on a **need-to-know** basis.

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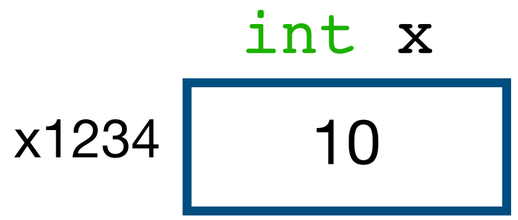

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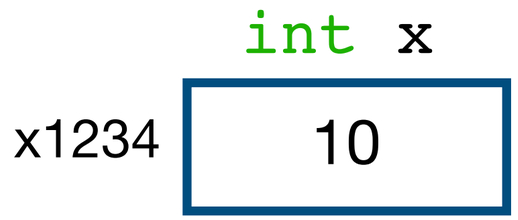

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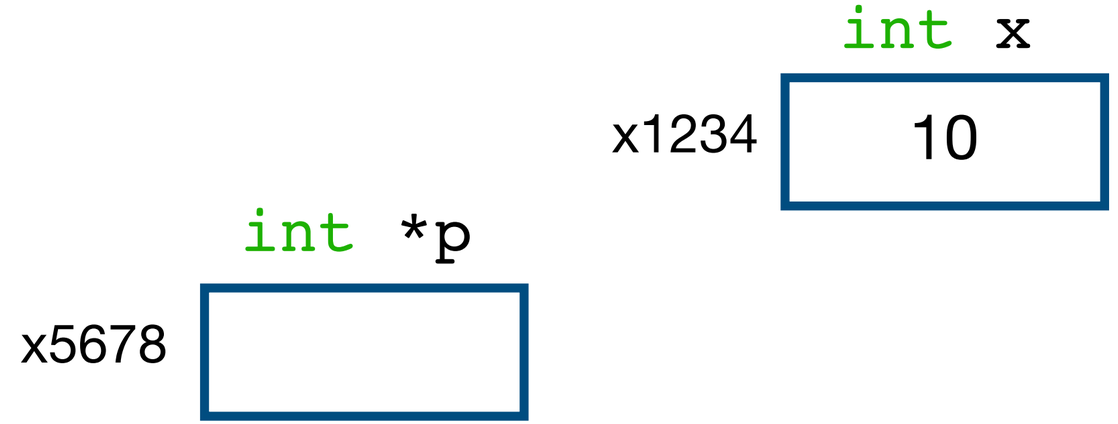

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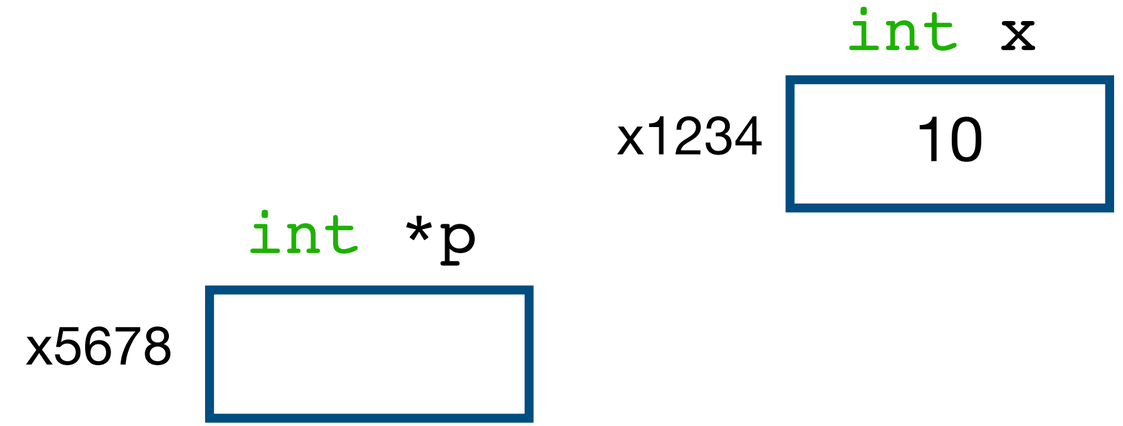

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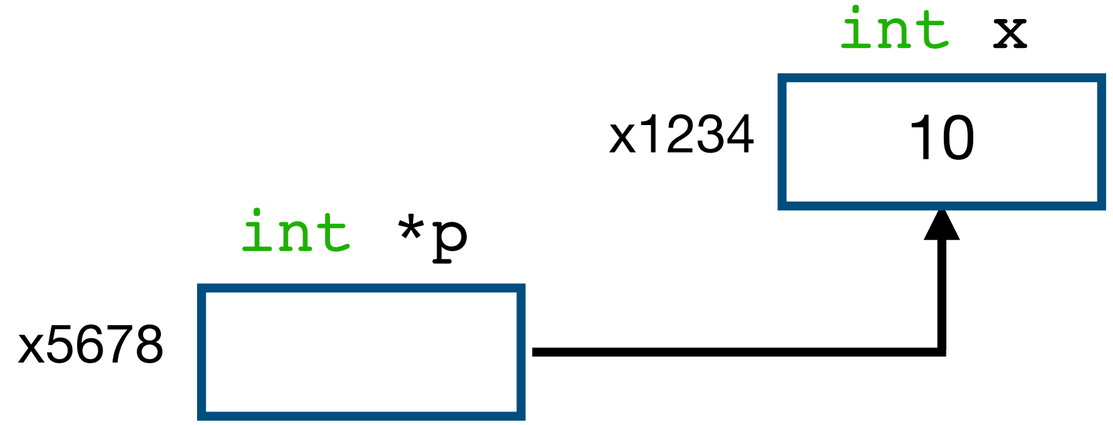

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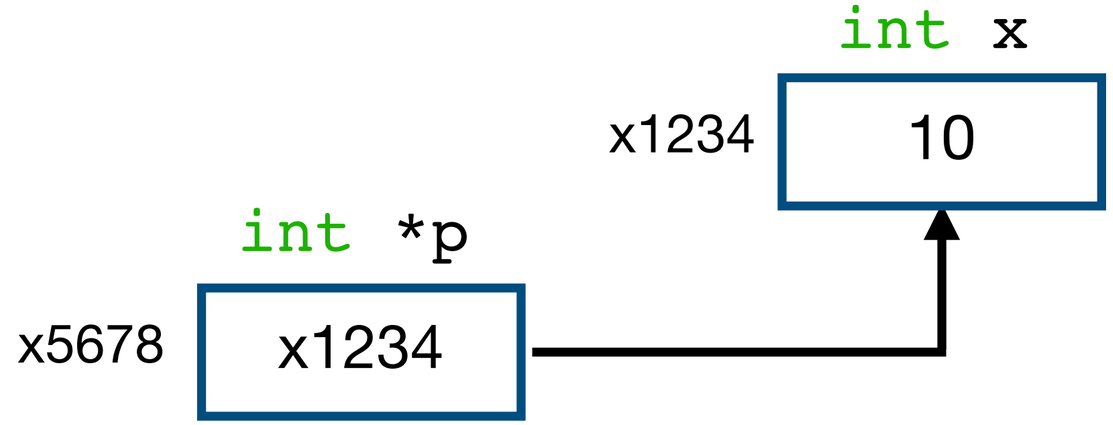
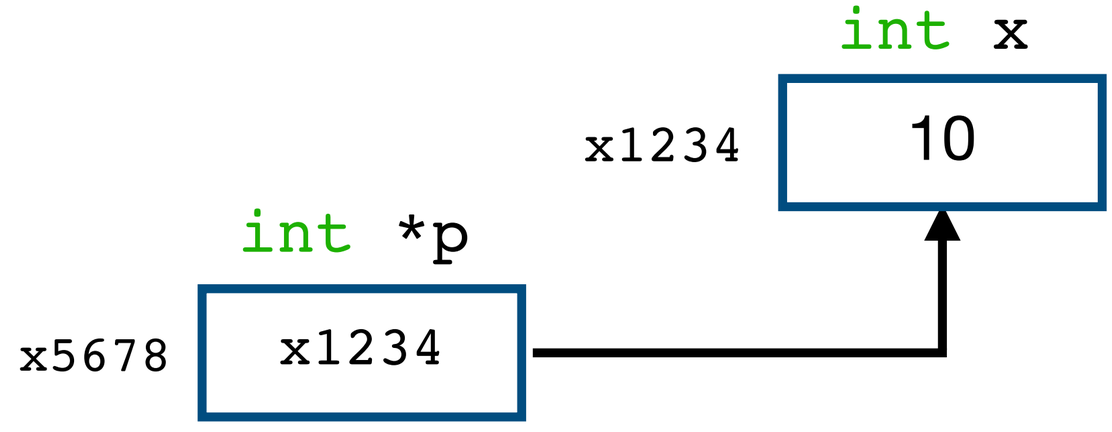


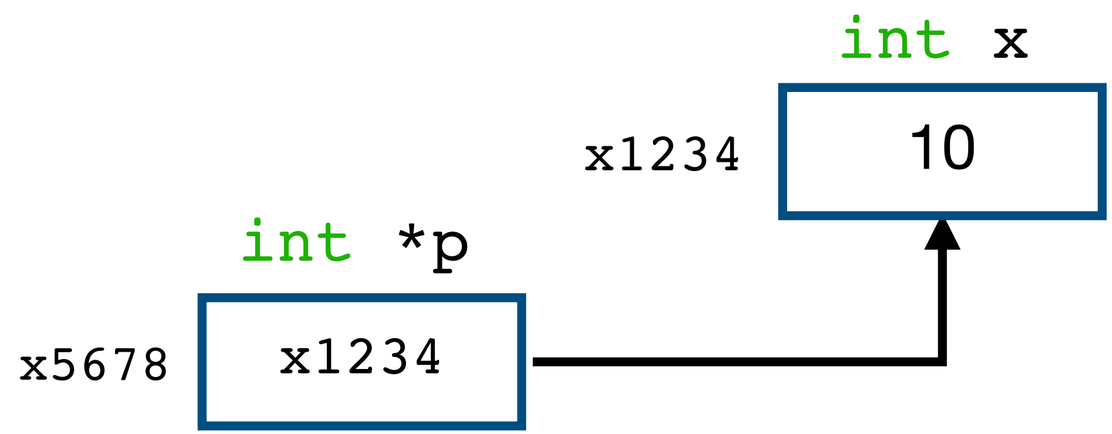
More pointers in C



More pointers in C

```
int x = 10;
int *p = &x;

/* Guess the outputs 1*/
```

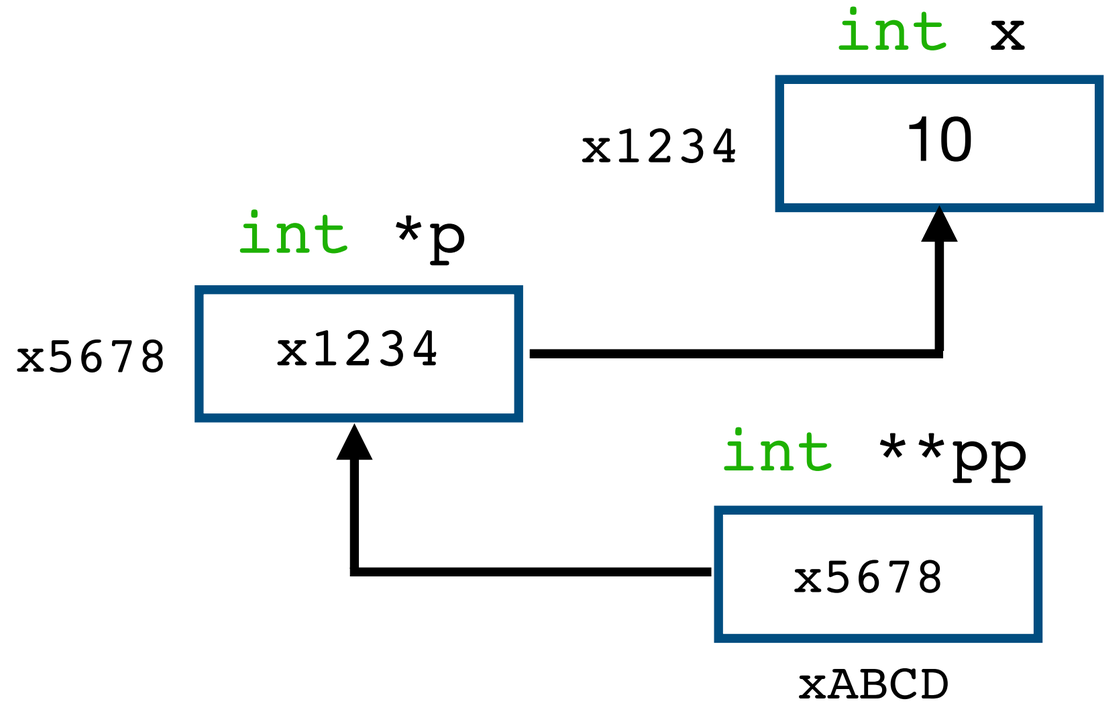



```
printf("x%X\n", &x);
printf("x%X\n", p);
printf("x%X\n", &p);
printf("%d\n", *p);

*p = *p + 10;

printf("%d\n", *p);
printf("%d\n", x);
```

Even more pointers in C

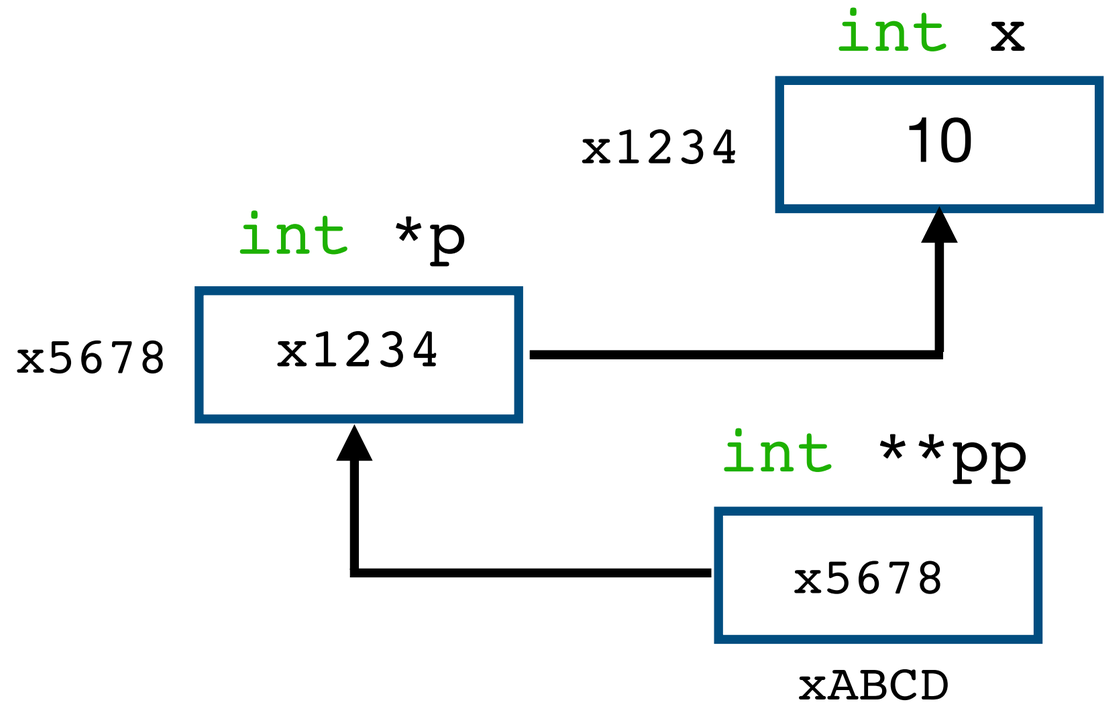


Even more pointers in C

```
int x = 10;
int *p = &x;
int **pp = &p;
```

```
/* Guess the outputs 2 */

printf("x%X\n", &pp);
printf("x%X\n", pp);
printf("x%X\n", *pp);
printf("%d\n", **pp);
```



Pointers in LC-3

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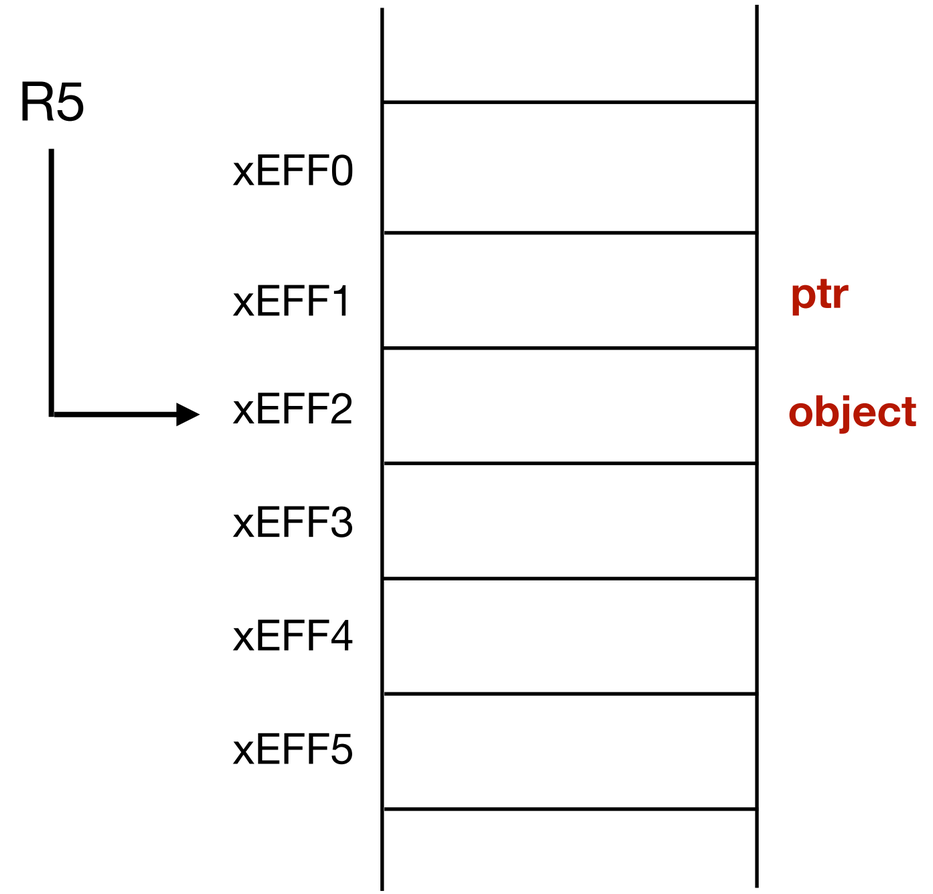

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int object;
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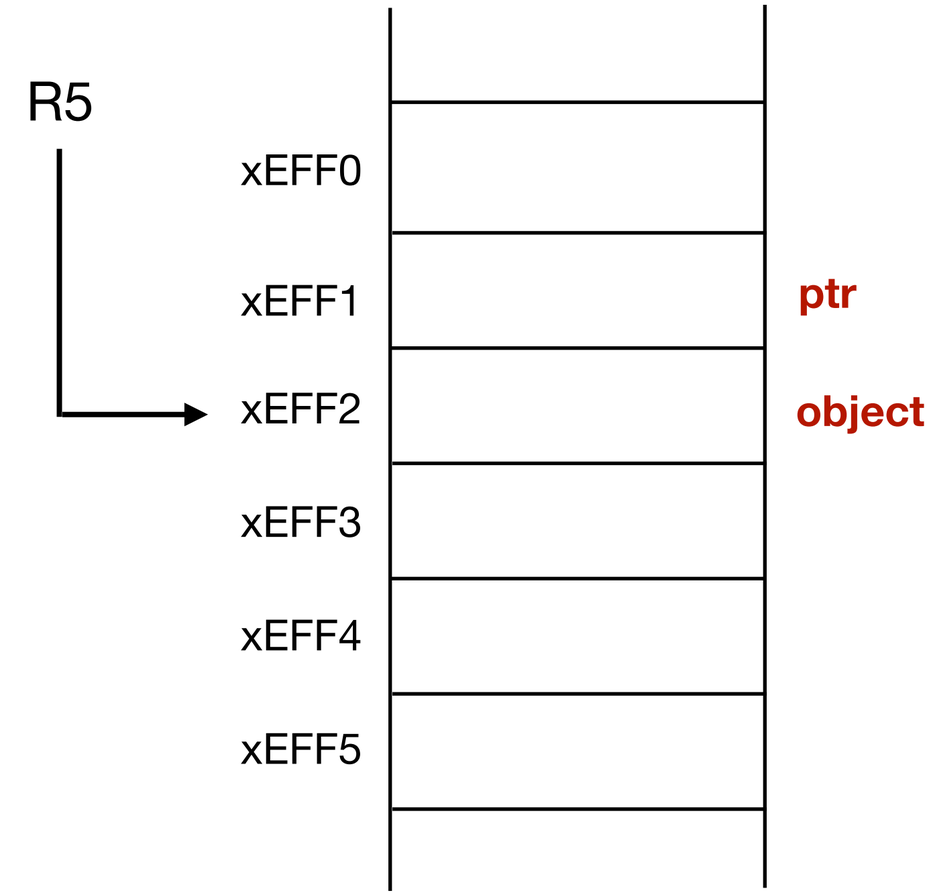

Pointers in LC-3

```
int object;
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object = 4;
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```
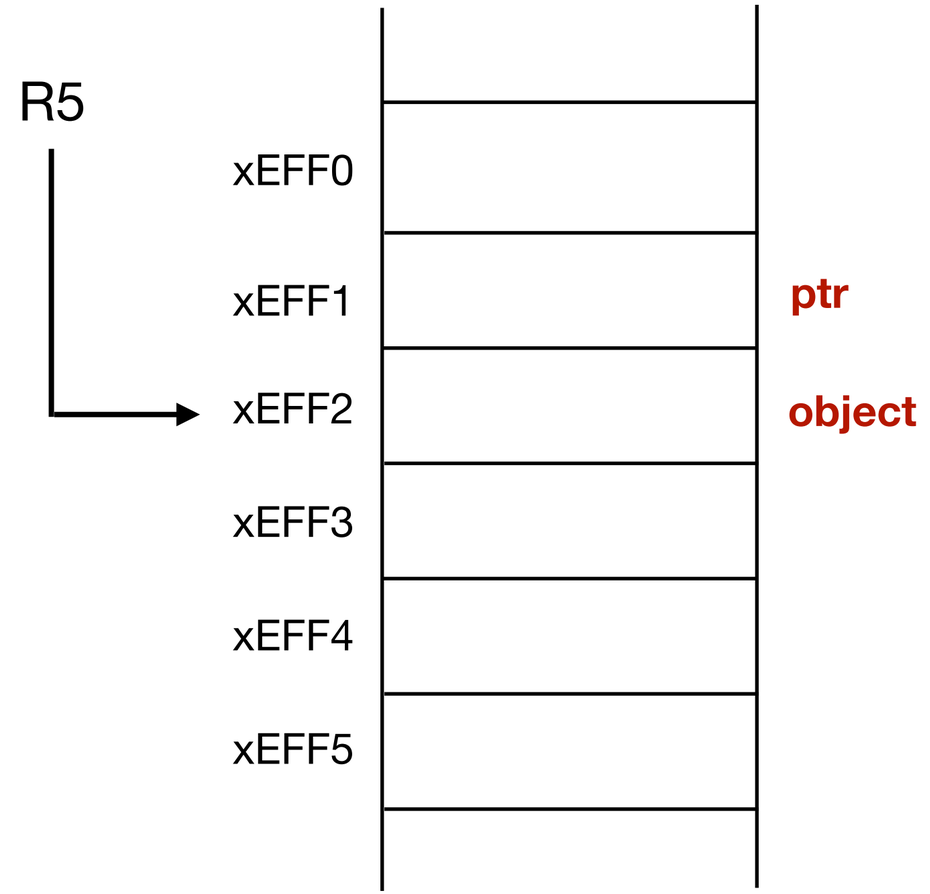

```
AND R0, R0, #0    ; Clear R0
```



Pointers in LC-3

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int object;
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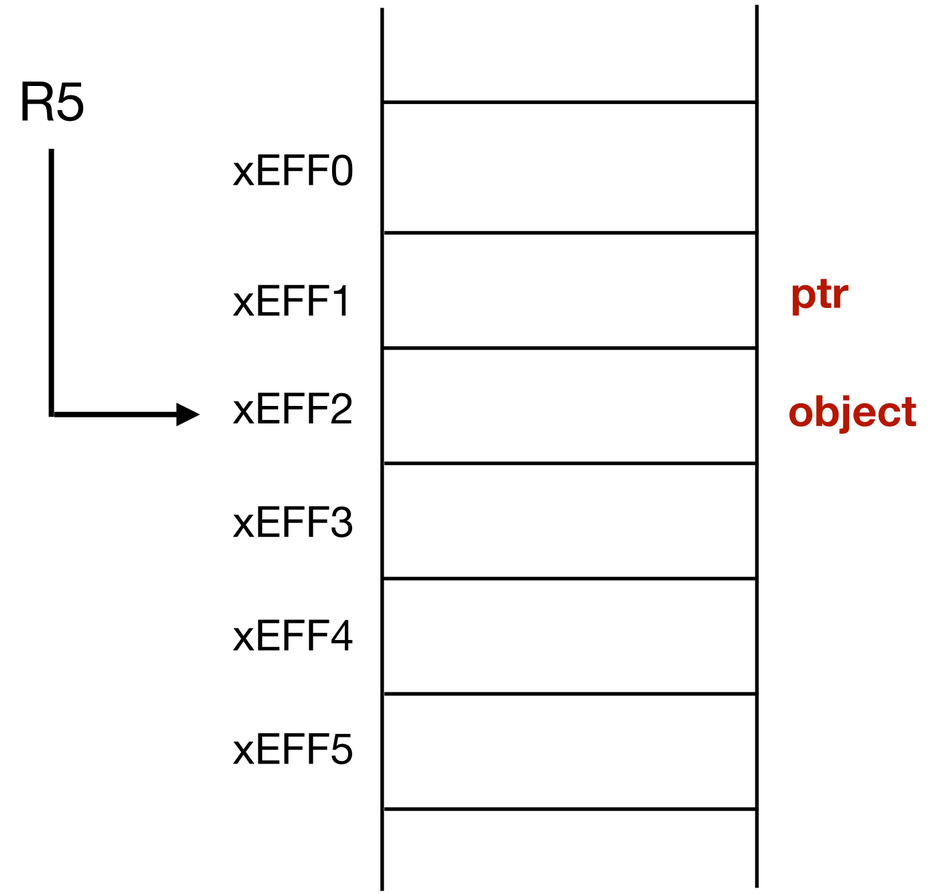
```
AND R0, R0, #0    ; Clear R0
ADD R0, R0, #4    ; R0 = 4
```



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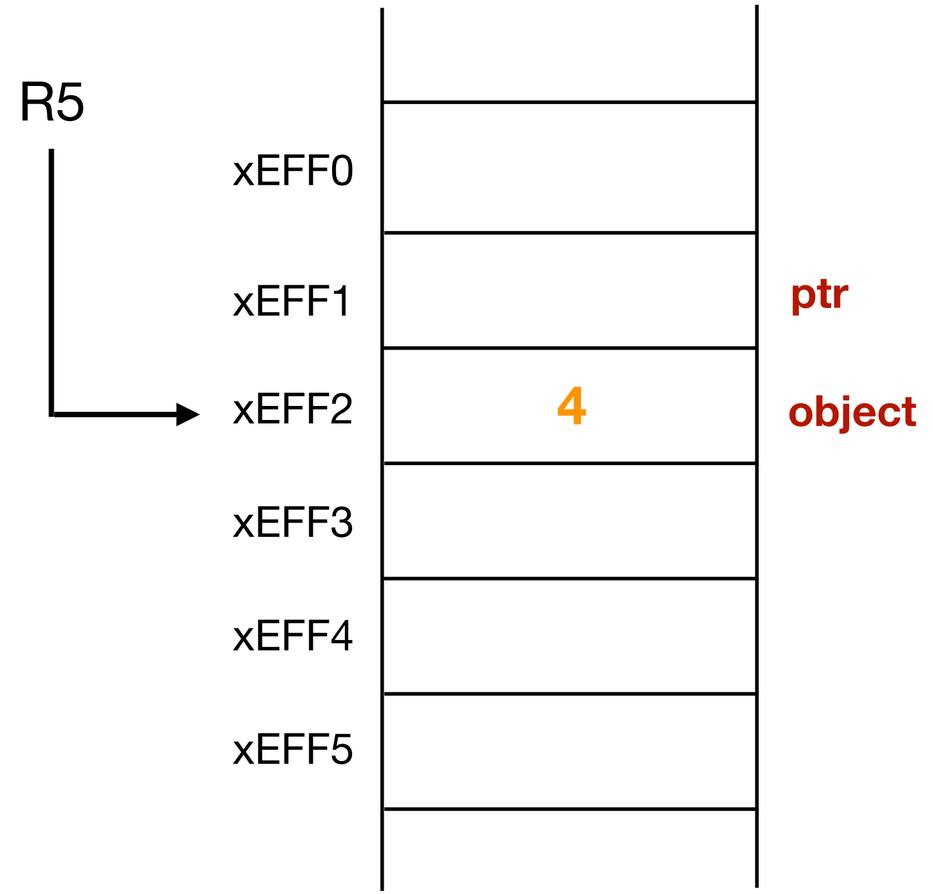


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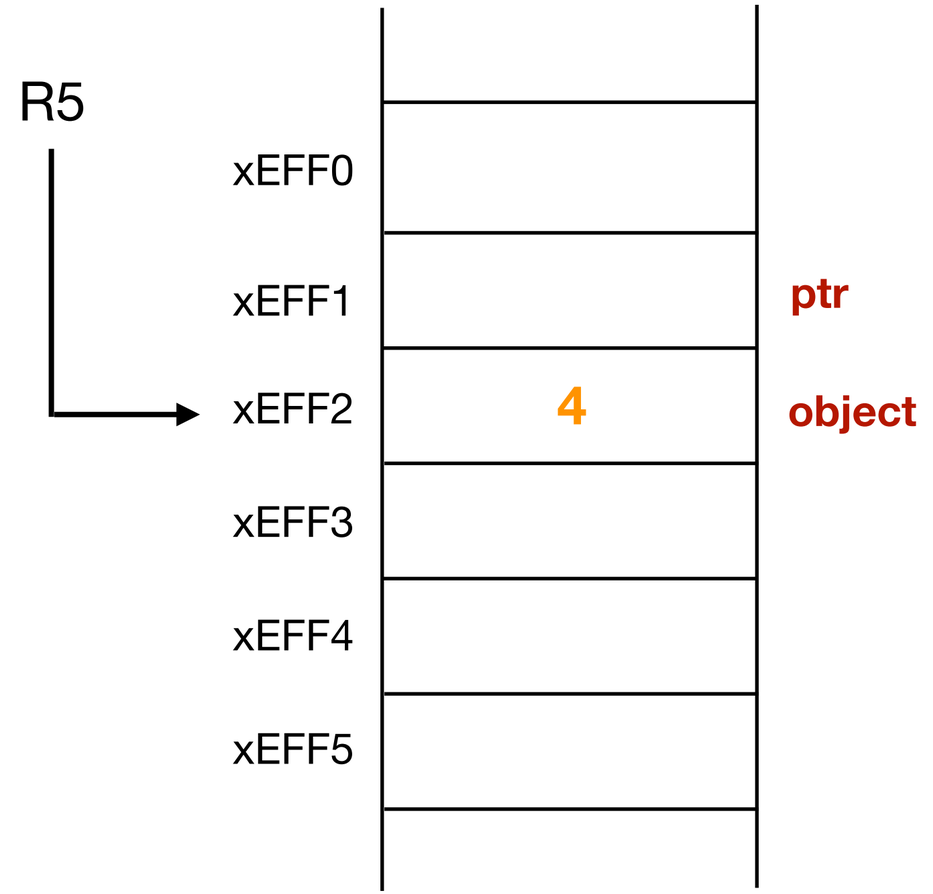


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ADD R0, R5, #0    ; Generate memory address of object
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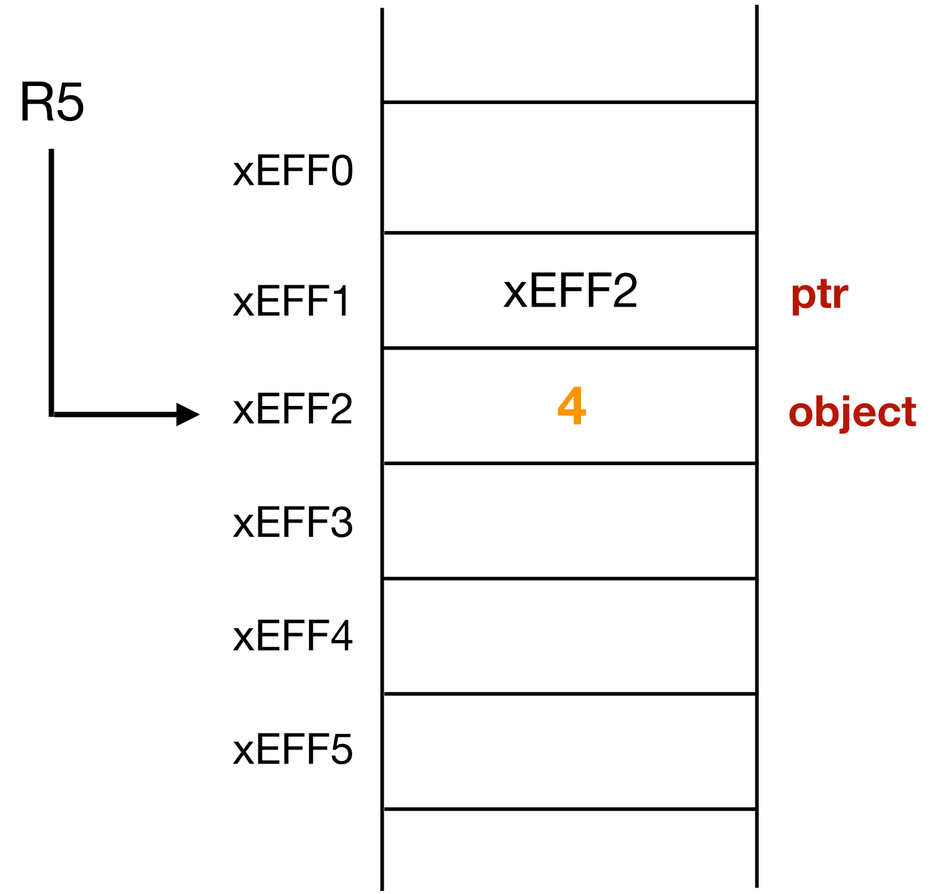


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STR R0, R5, #-1   ; ptr = &object
```

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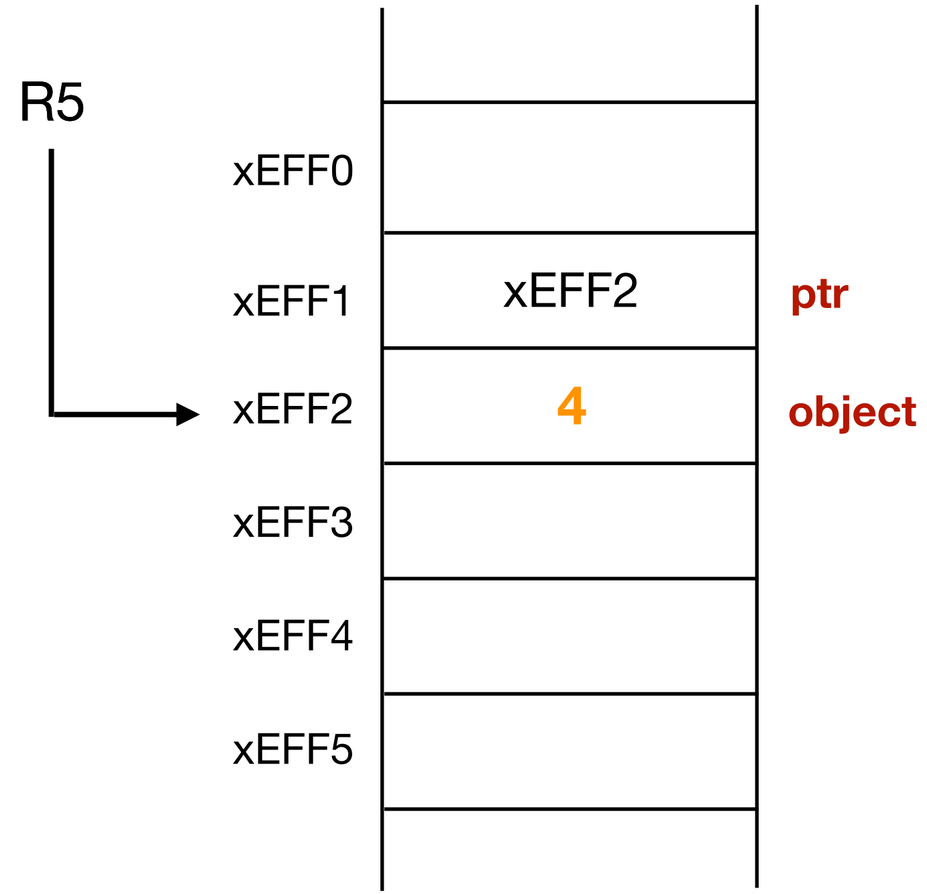

Pointers in LC-3

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*ptr = *ptr + 1;
```

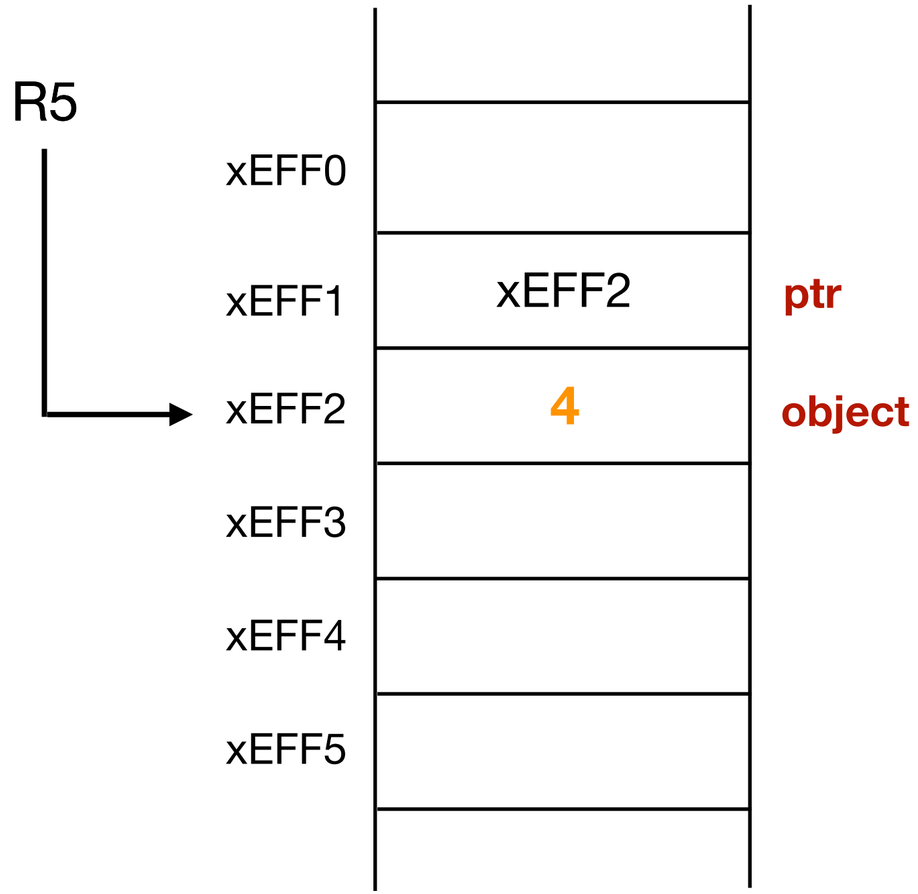

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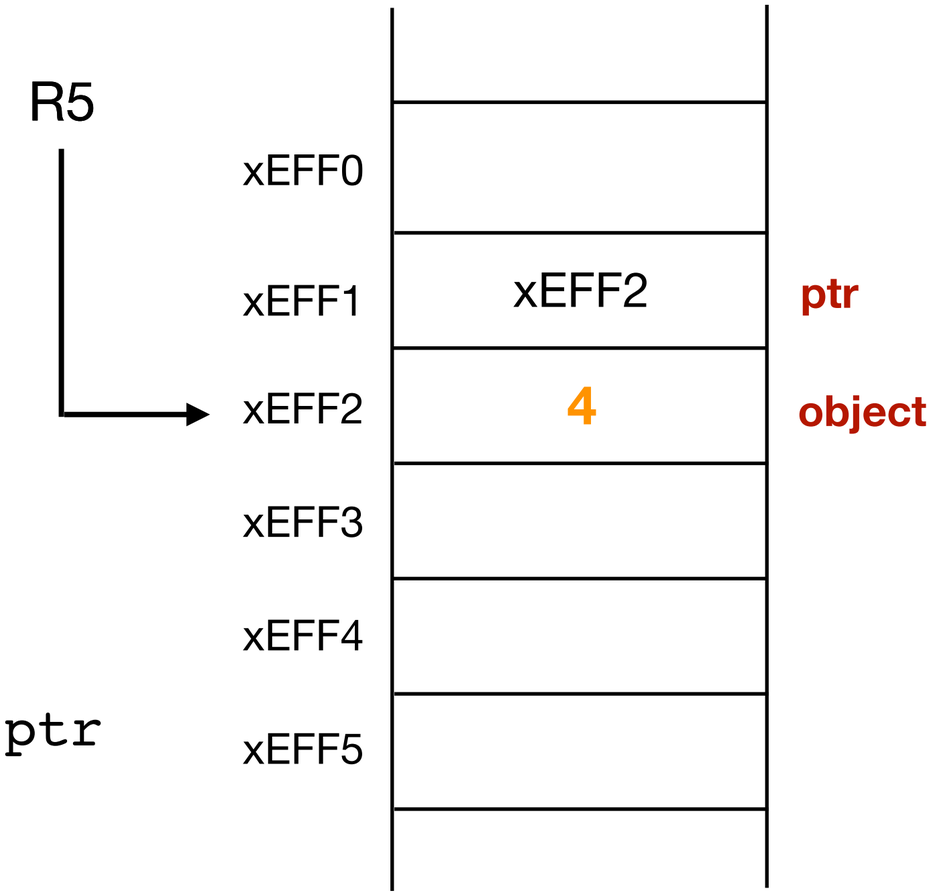


```
LDR R0, R5, #-1  ; R0 contains the value of ptr
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Pointers in LC-3

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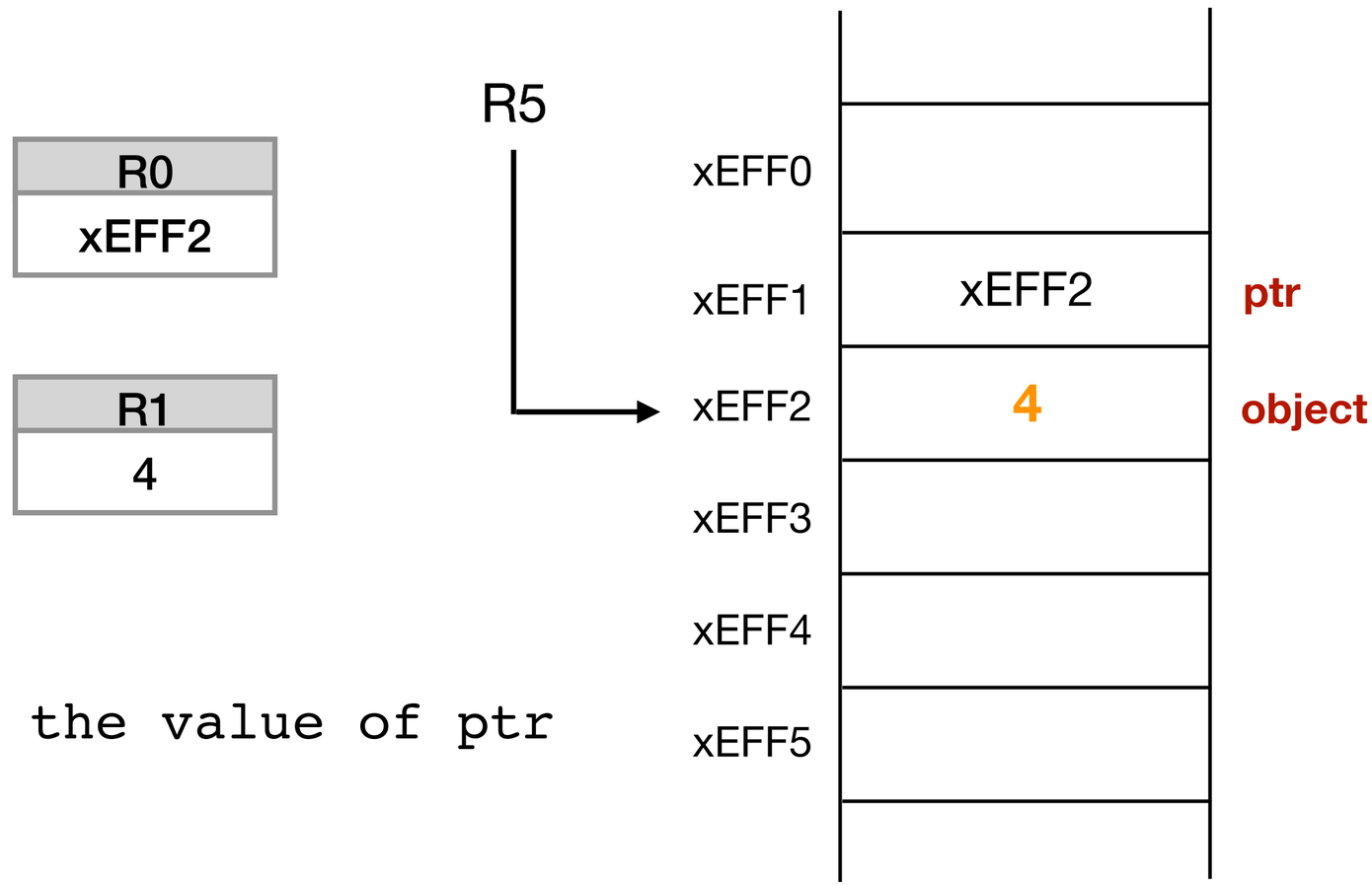


```
LDR R0, R5, #-1   ; R0 contains the value of ptr
LDR R1, R0, #0    ; R1 = *ptr
```

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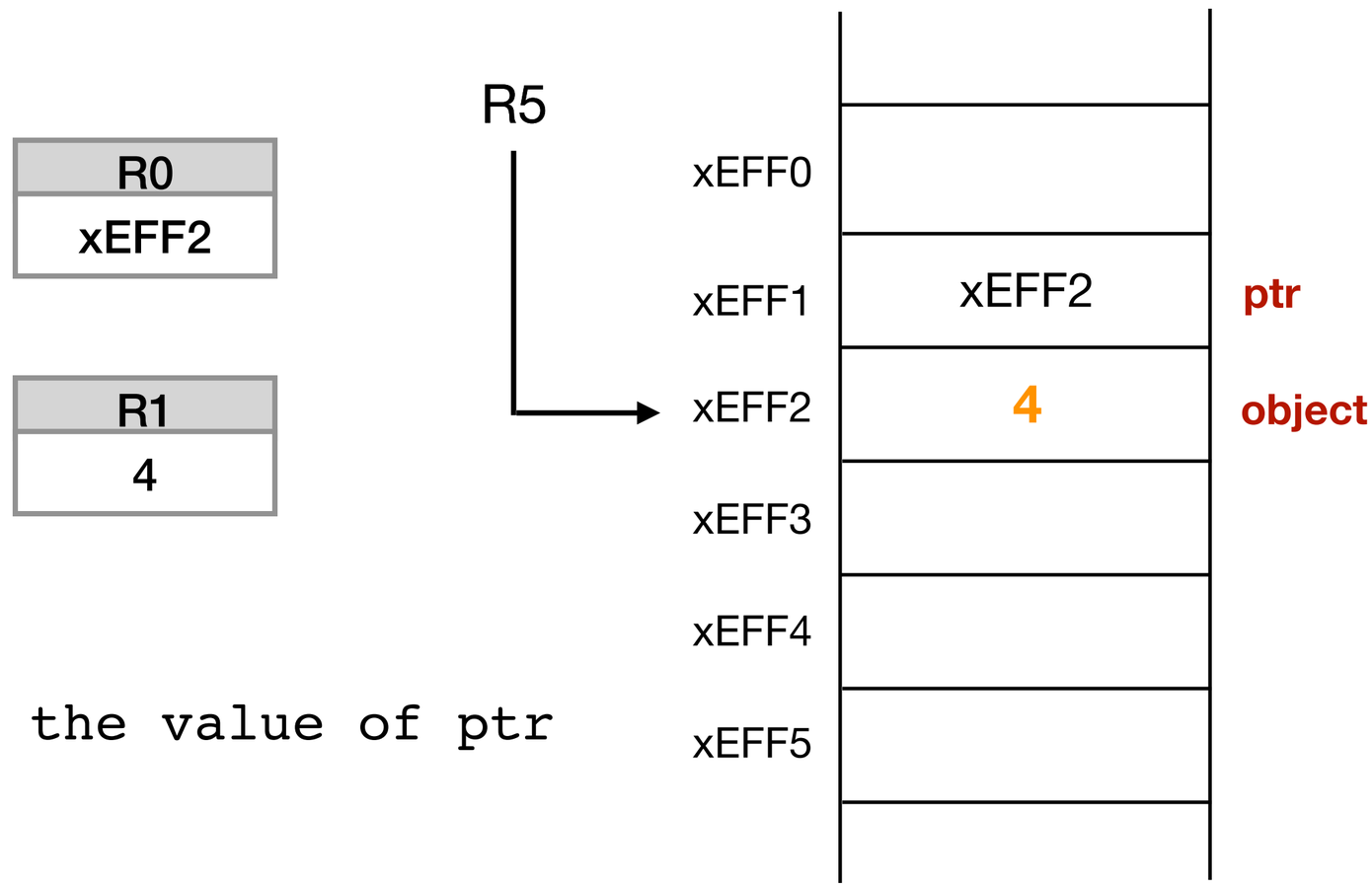


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LDR R0, R5, #-1   ; R0 contains the value of ptr
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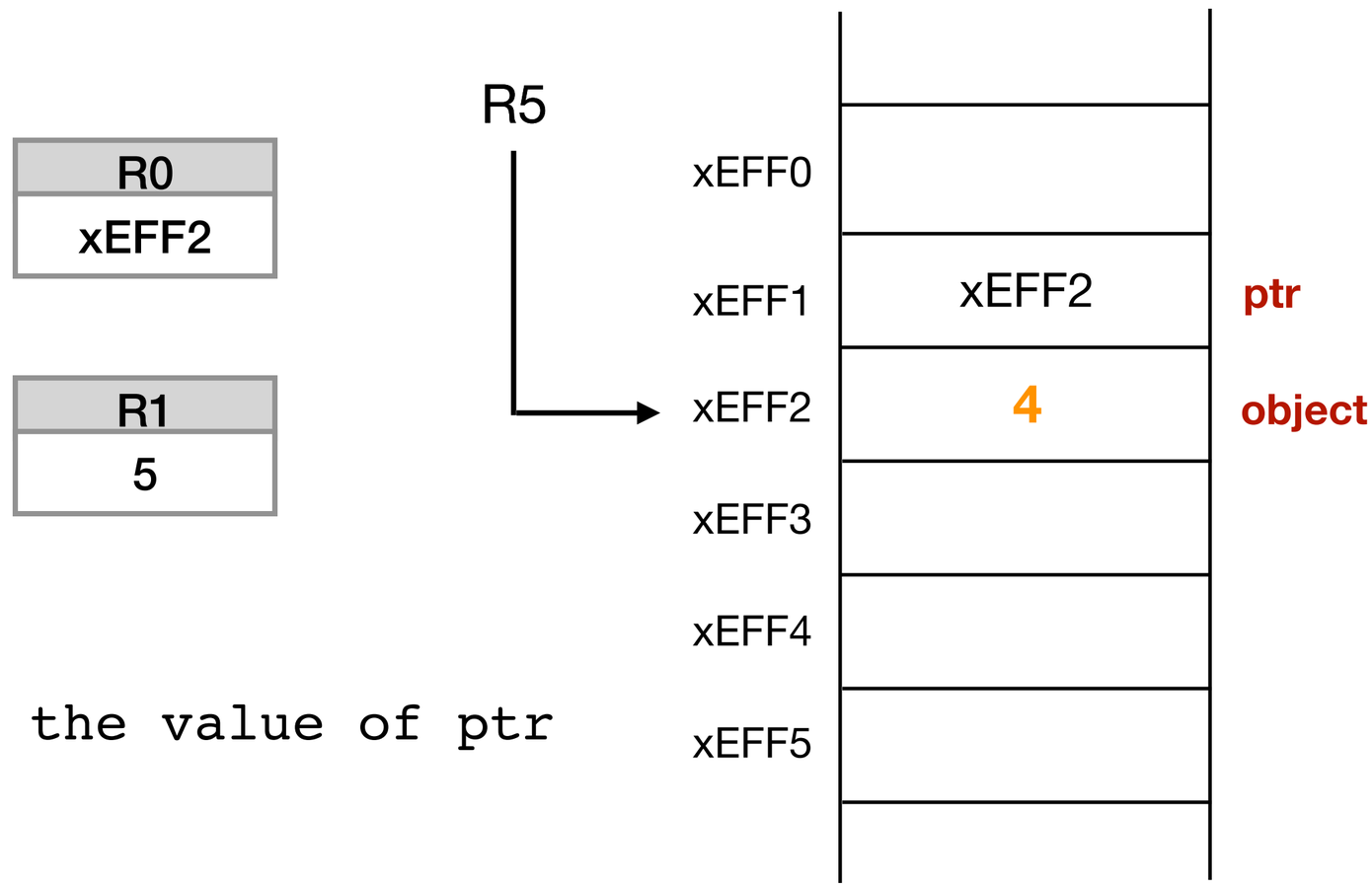


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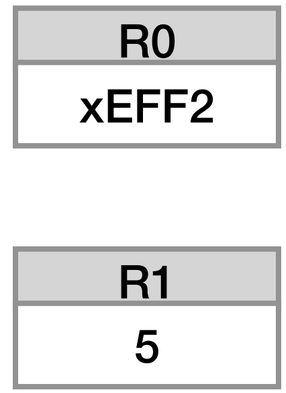

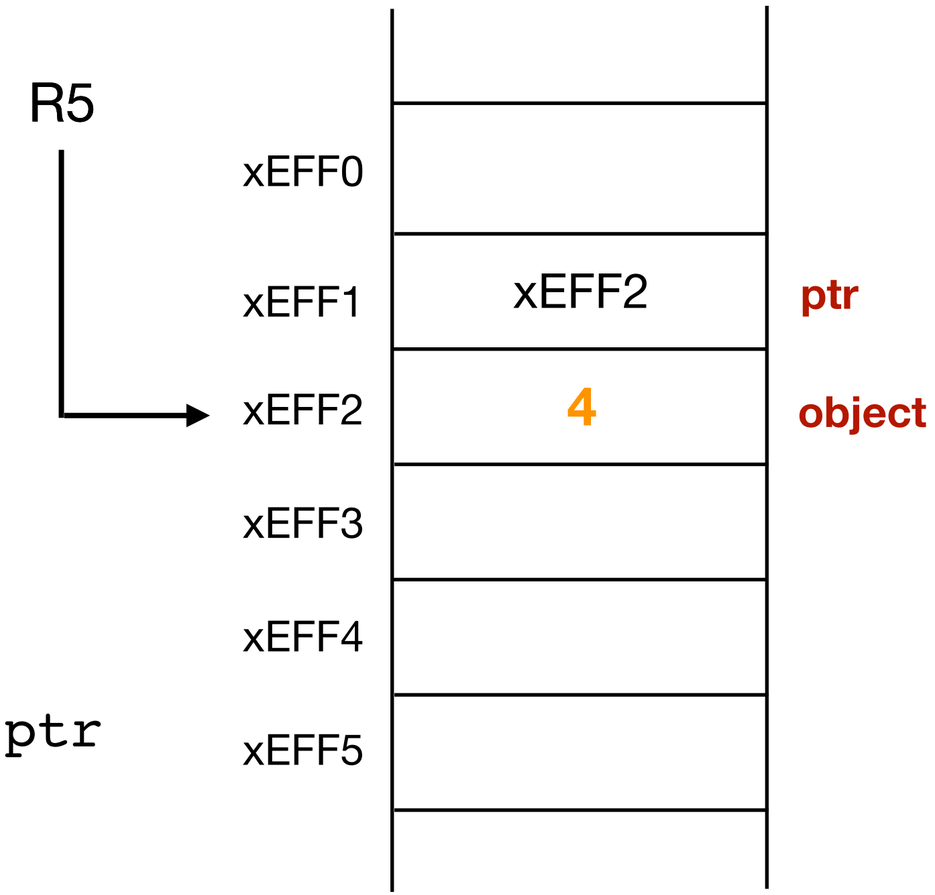


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```
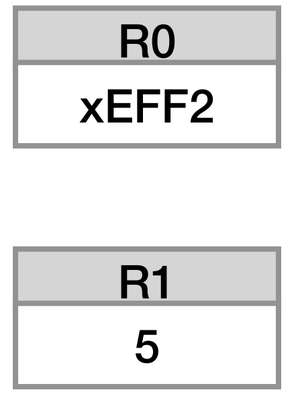
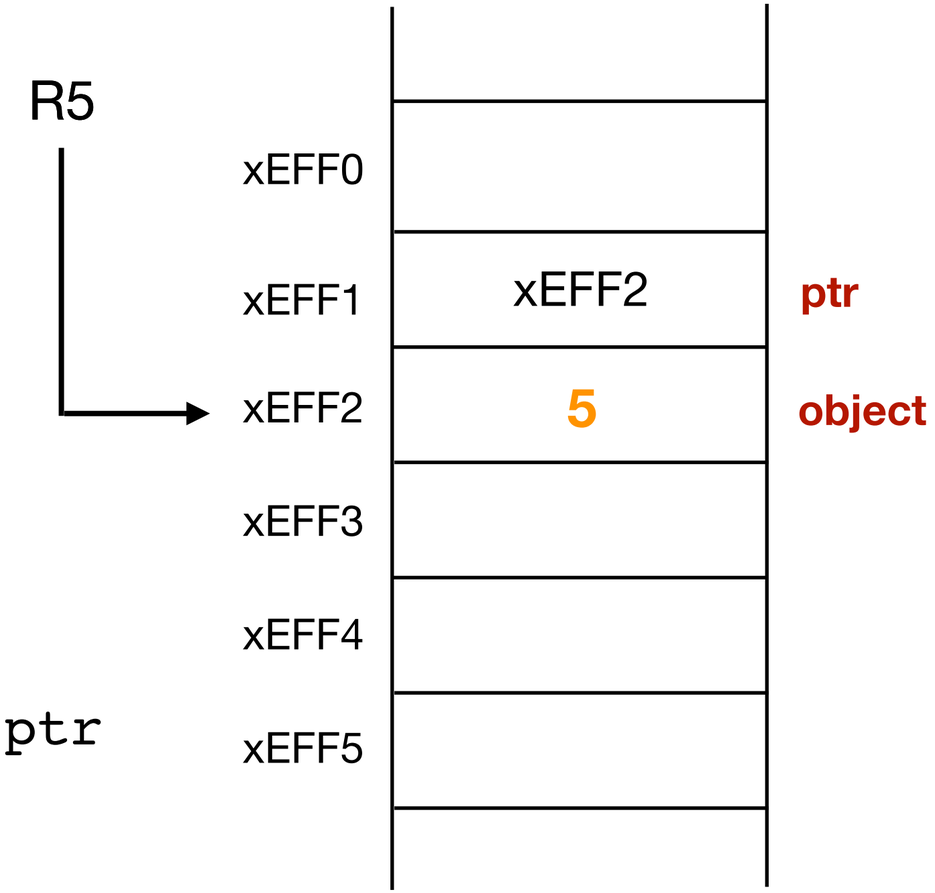
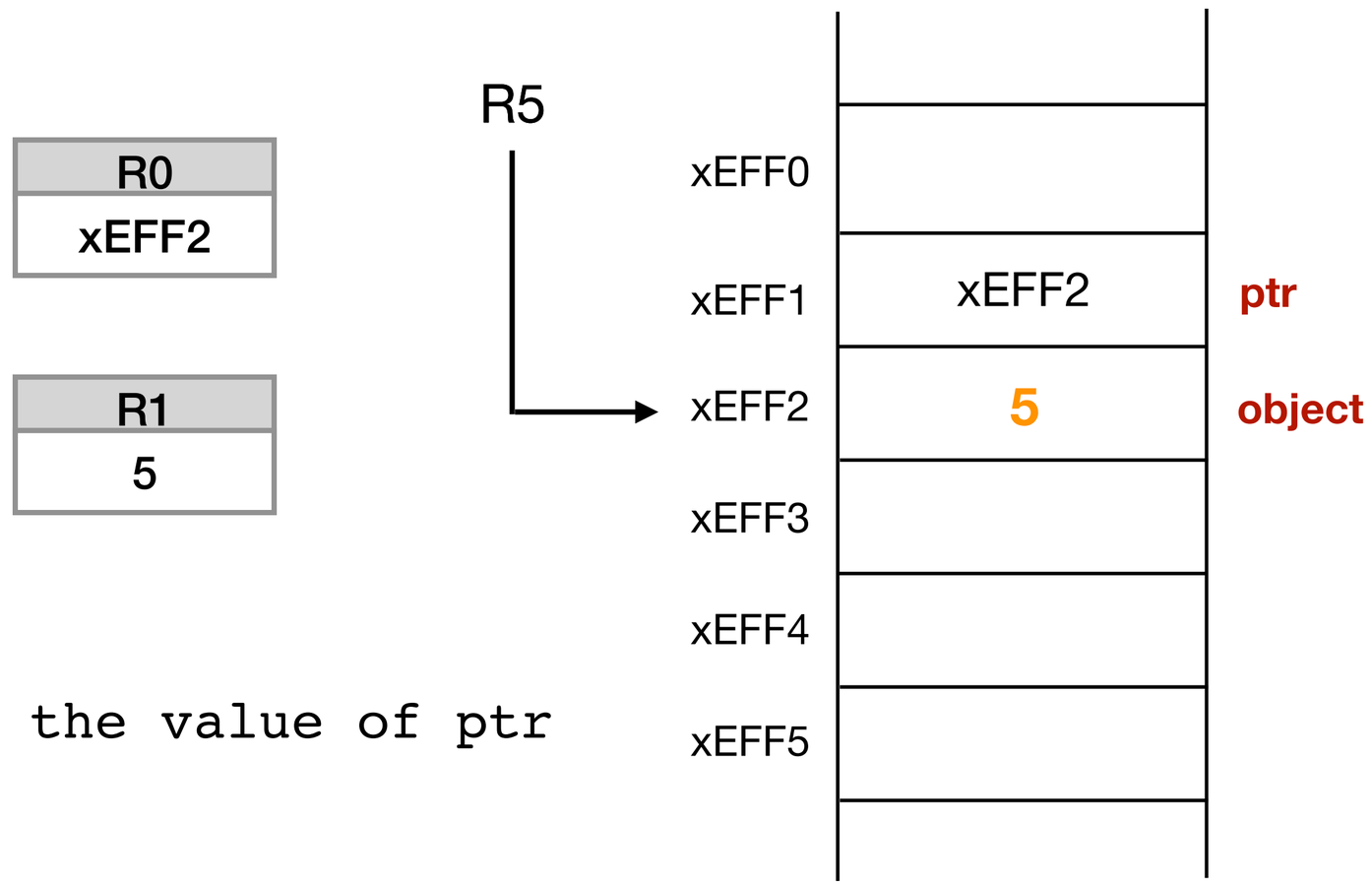






```
LDR R0, R5, #-1   ; R0 contains the value of ptr
LDR R1, R0, #0    ; R1 = *ptr


ADD R1, R1, #1    ; *ptr + 1
STR R1, R0, #0    ; *ptr = *ptr +1
```

Pointers in LC-3

```
*ptr = *ptr + 1;
```

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```

Why not?

```
STR R1, R5, #0
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Arrays

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```
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```

- `arraySize` has to be positive, nonzero and integer values
- `type` is any valid C type

Arrays

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double balance[5] = {1000.0, 2.0, 3.4, 7.0, 50.0};
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double balance[5] = {1000.0, 2.0, 3.4, 7.0, 50.0};

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- Accessing elements?
  - Expression **`a[4]`** refers to the 5th element of the array **`a`** (index starts from 0)

Arrays

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Arrays

- How do we calculate the length of an array? `sizeof` function

Arrays

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```c
#include <stdio.h>

int main() {
  //simple array
  int arr[] = {19, 25, 8,  22, 17, 7,  84, 9,  19, 25, 10, 3,  1,
               7,  84, 9,  19, 25, 10, 3,  1,  8,  22, 17, 19, 25,
               10, 3,  1,  8,  22, 17, 7,  84, 9,  33, 1,  8,  22,
               17, 7,  84, 9,  19, 25, 10, 22, 17, 7,  84, 9,  19,
               25, 10, 3,  1,  8,  84, 9,  11, 23, 45, 5,  3};

  // using sizeof() operator to get length of array
  int len = sizeof(arr) / sizeof(arr[0]);

  printf("The length of int array is : %d ", len);
}
```

Arrays

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Gives memory occupied by `arr[0]`

Exercise

Using loops, write a C program that prompts the user for *five* integers one by one and stores them into an array `arr`. Then print out the five integers in a single line but in reverse order.

Exercise

Add a function `int my_first_sum` to the previous program which will take the list of five numbers and return their sum. Use this function to display the sum to the console instead of the numbers in reverse order.

Passing arrays

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```
int my_first_sum(int array[]){
  int i, sum=0;
  for (i=0; i<5; i++)
    sum = sum + array[i];
  return sum;
}
```

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- How did we pass the parameter `arr` to the function `my_first_sum` ?

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- How did we pass the parameter `arr` to the function `my_first_sum` ?

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  for (i=0; i<5; i++)
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  return sum;
}
```

Fact: The name of the array is *pointer* to the array!

Not convinced?

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- Replace the previous function with this one instead and try it out!

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```
int my_second_sum(int *array){
  int i, sum=0;
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  return sum;
}
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- The parameter declaration `int array[]` in the function definition is *syntactic sugar* for `int *array`.

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This is called pointer/array duality in C.

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- In fact `arr[3]` is syntactic sugar for `*(arr + 3)` !!

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```
int my_third_sum(int *arr){
  int i, sum=0;
  for (i=0; i<5; i++)
    sum = sum + *(arr + i);
  return sum;
}
```

would also work just fine!

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- So is there a difference between `cptr` and `arr` in the below?

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char arr[10];
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cptr = arr;
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- Try doing:

```
cptr = cptr + 1;
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What gives?

Next time

- More pointer/array duality
- Arrays in LC3
- Variable length arrays
- Strings
- Multi-dimensional arrays

Good luck on the exam!