Inception with Mr C

ESC101: Fundamentals of Computing

Purushottam Kar

Announcements

- Replacement lab October 6 (Sat) 2-5PM at NCL for sections B4, B5, B6, B13,
- No replacement lecture since not a “DoAA Saturday”
- Extra doubt clearing session after extra lab on Sat i.e. Oct 06 (Sat) 5-6PM CC-02.

BODMAS table has more members

Operator Name	Symbol/Sign	Associativity
Brackets (**array subscript**), Post increment/decrement	(), [] ++, --	Left
Unary negation, Pre-increment/decrement, NOT, (de)reference, sizeof	-, ++, --, !, *, &, sizeof	Right
Multiplication/division/ remainder	*, /, %	Left
Addition/subtraction	+, -	Left
Relational	<, <=, >, >=	Left
Relational	==, !=	Left
AND	&&	Left
OR	||	Left
Ternary Conditional	? :	Right
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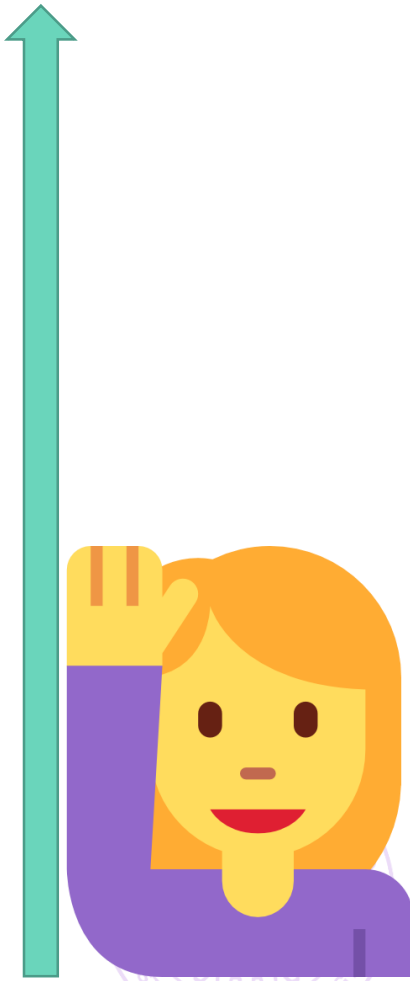

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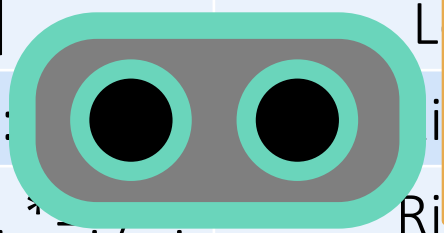

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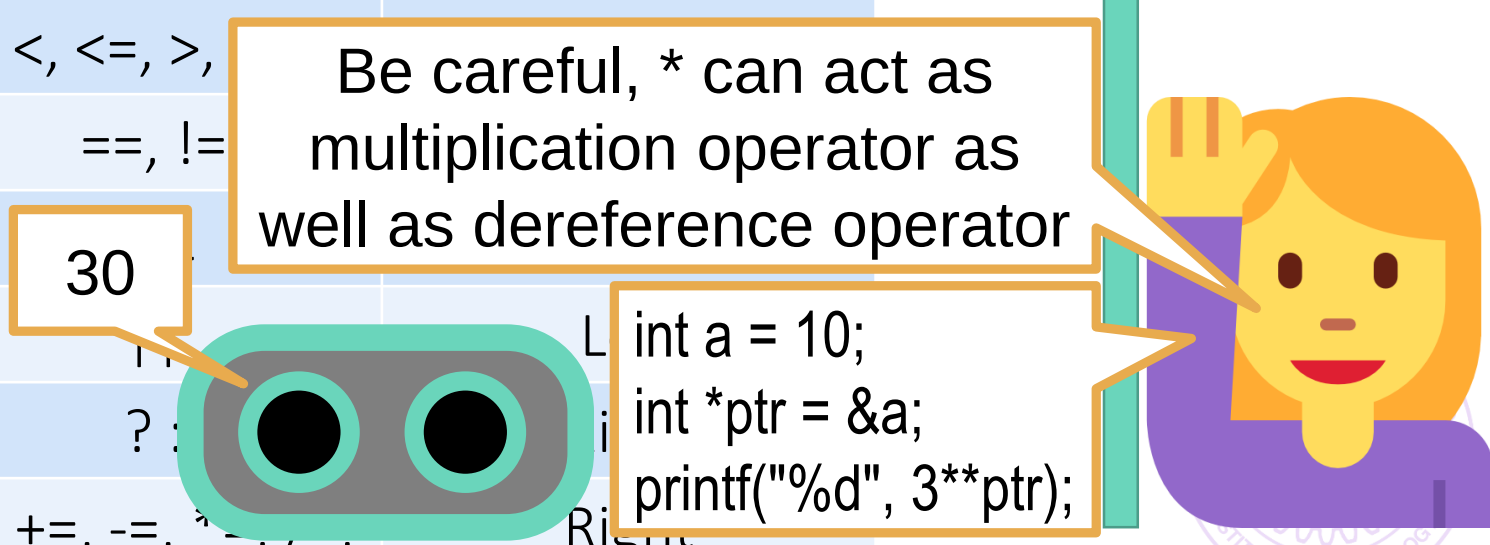

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- malloc(), calloc(), realloc(), free()

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int *ptr = (int*)malloc(10*sizeof(int));
*(ptr + 2) = 42; // *(ptr + 2) is the same as ptr[2]
printf("%d", ptr[2]); // prints 42
```

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Need to typecast the pointer returned by calloc too!

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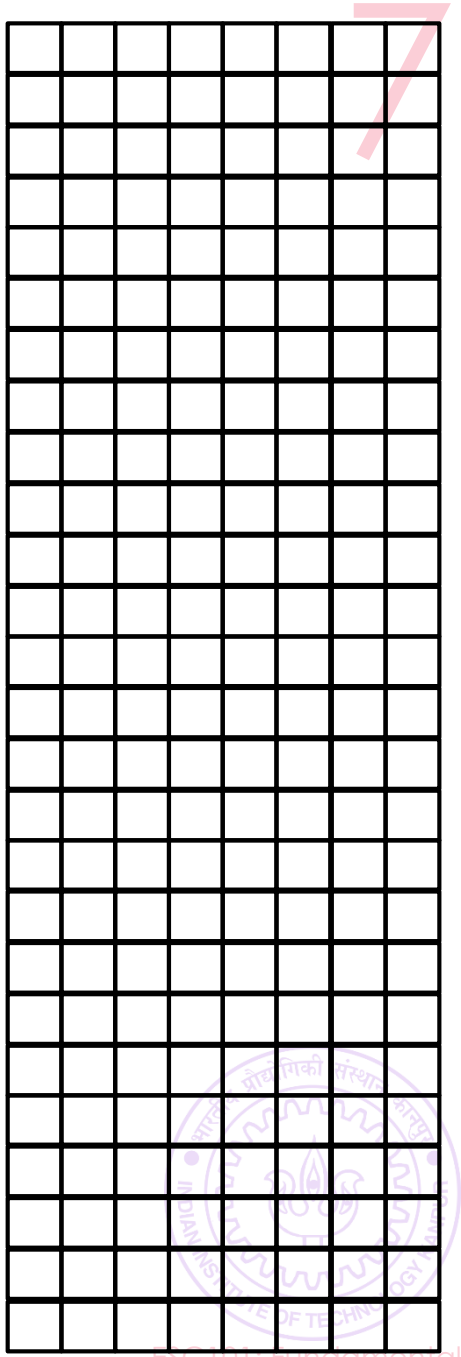

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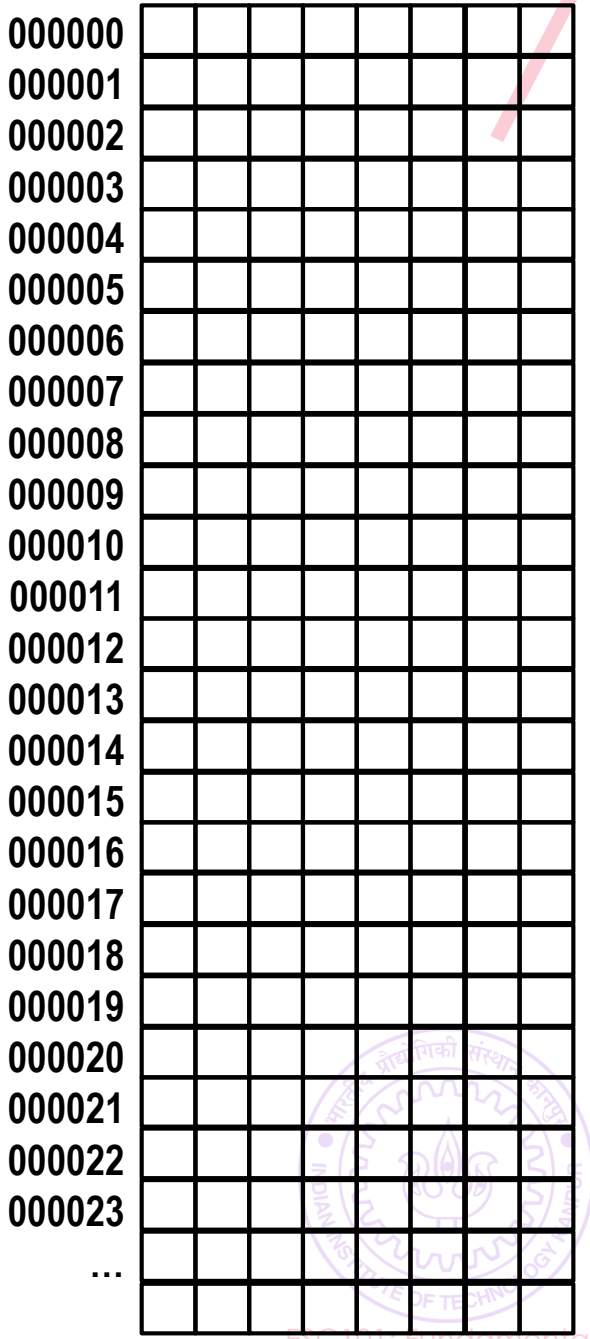

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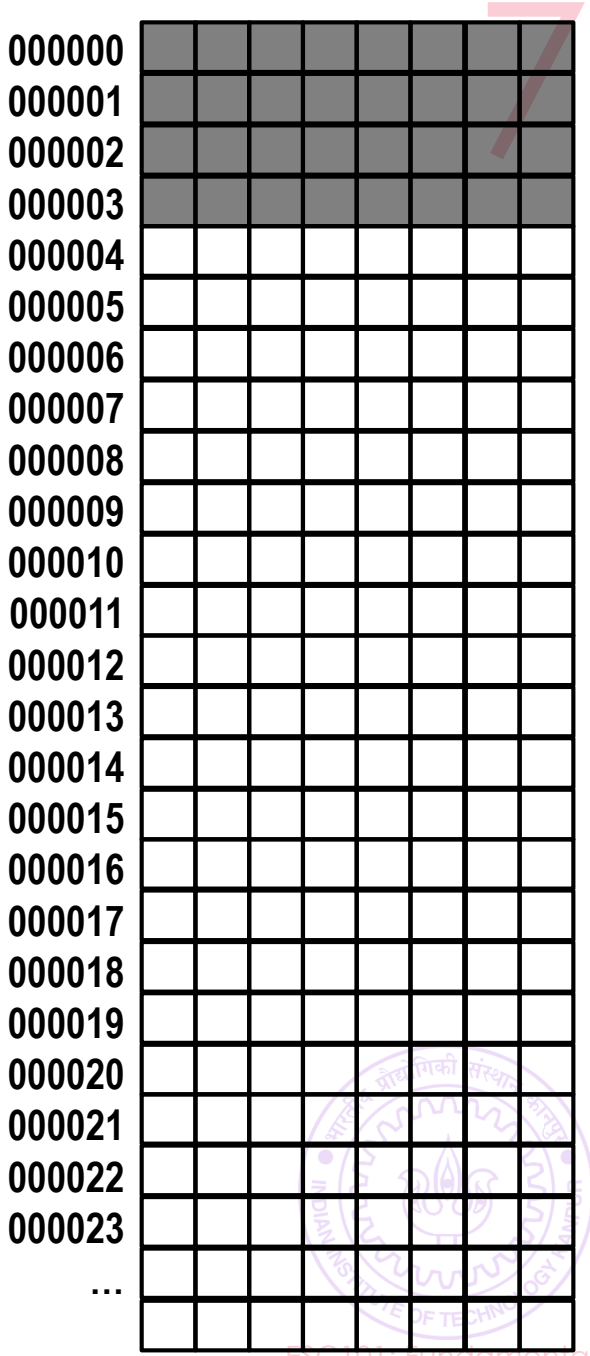

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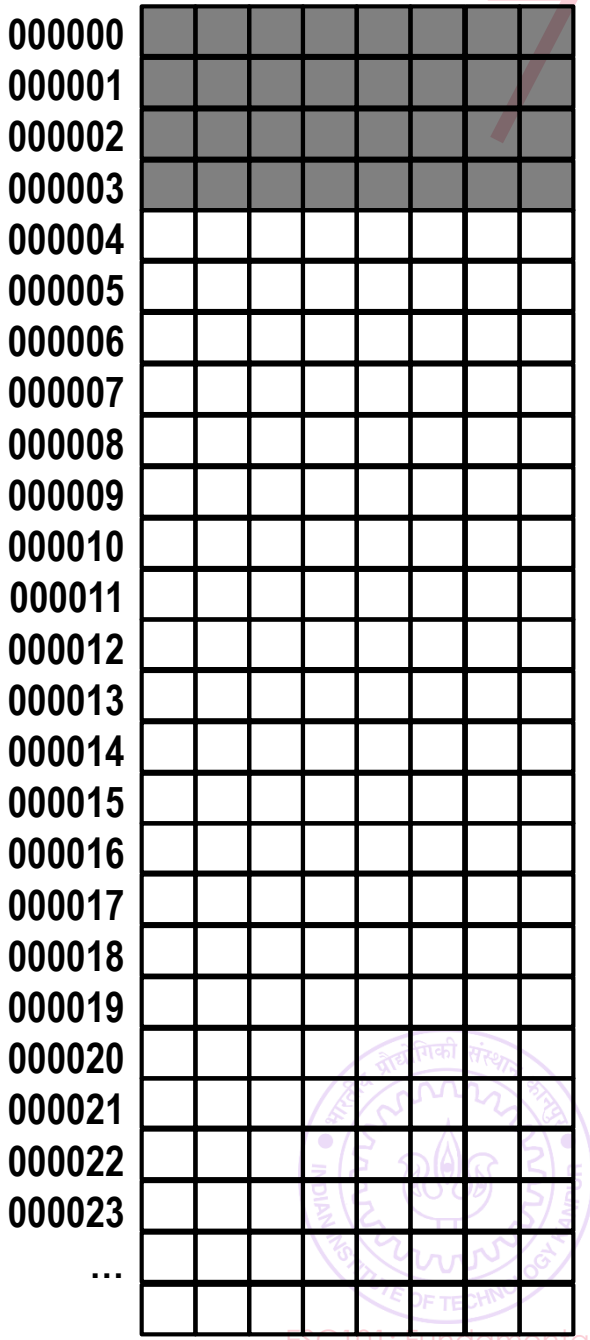

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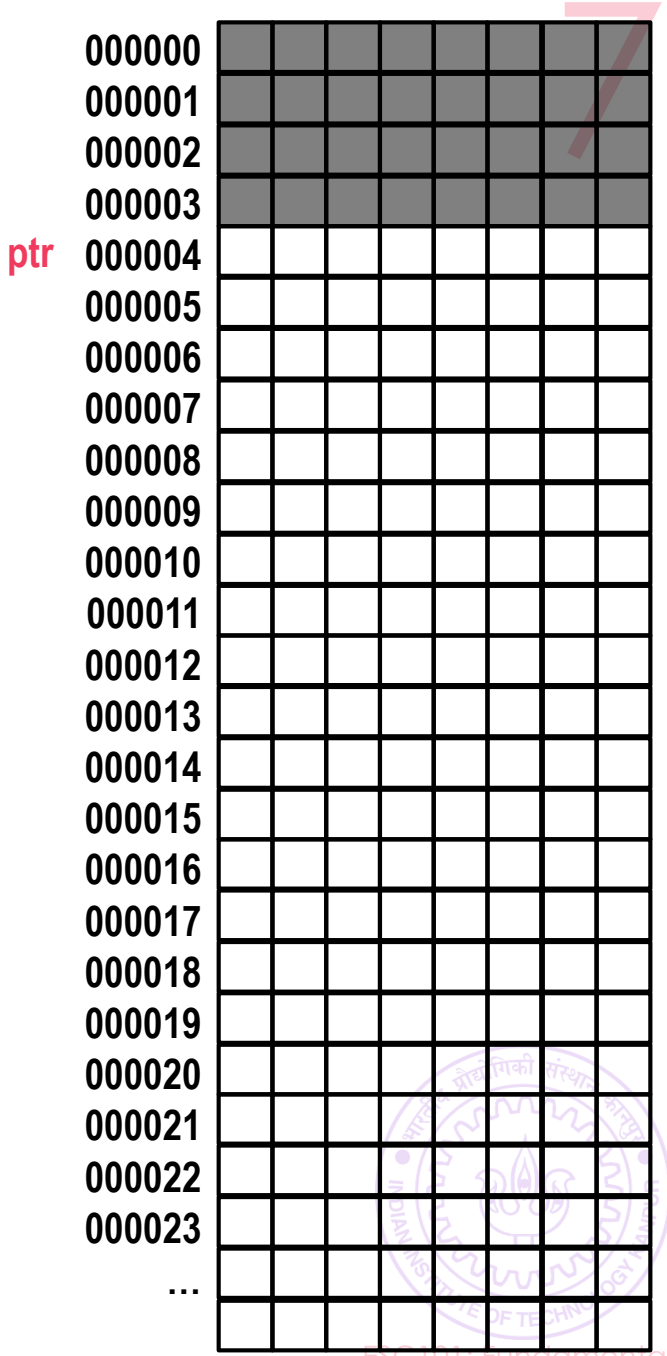

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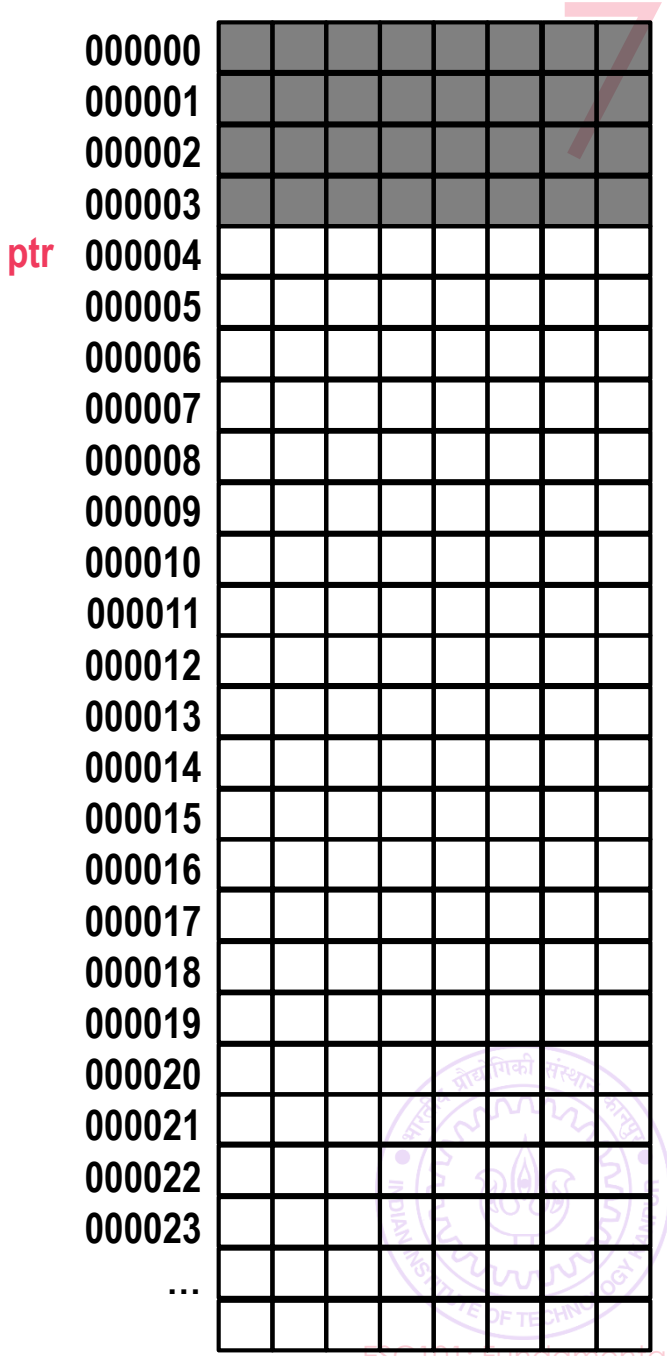

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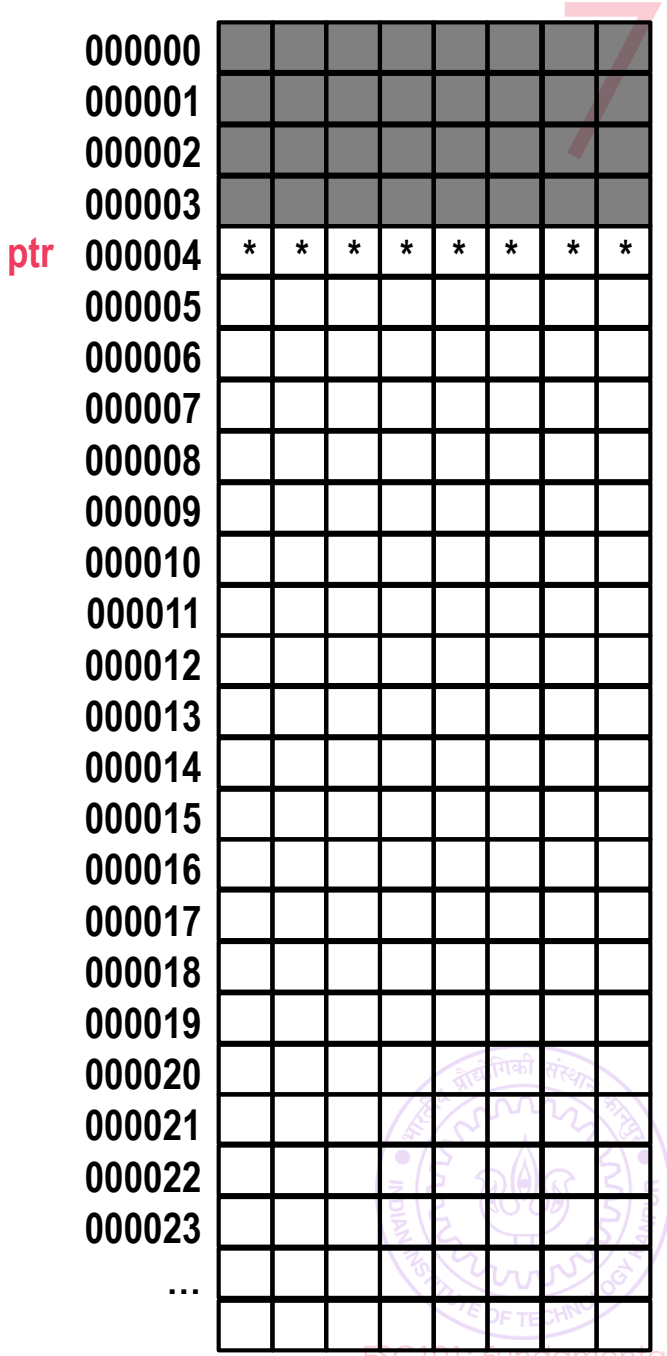

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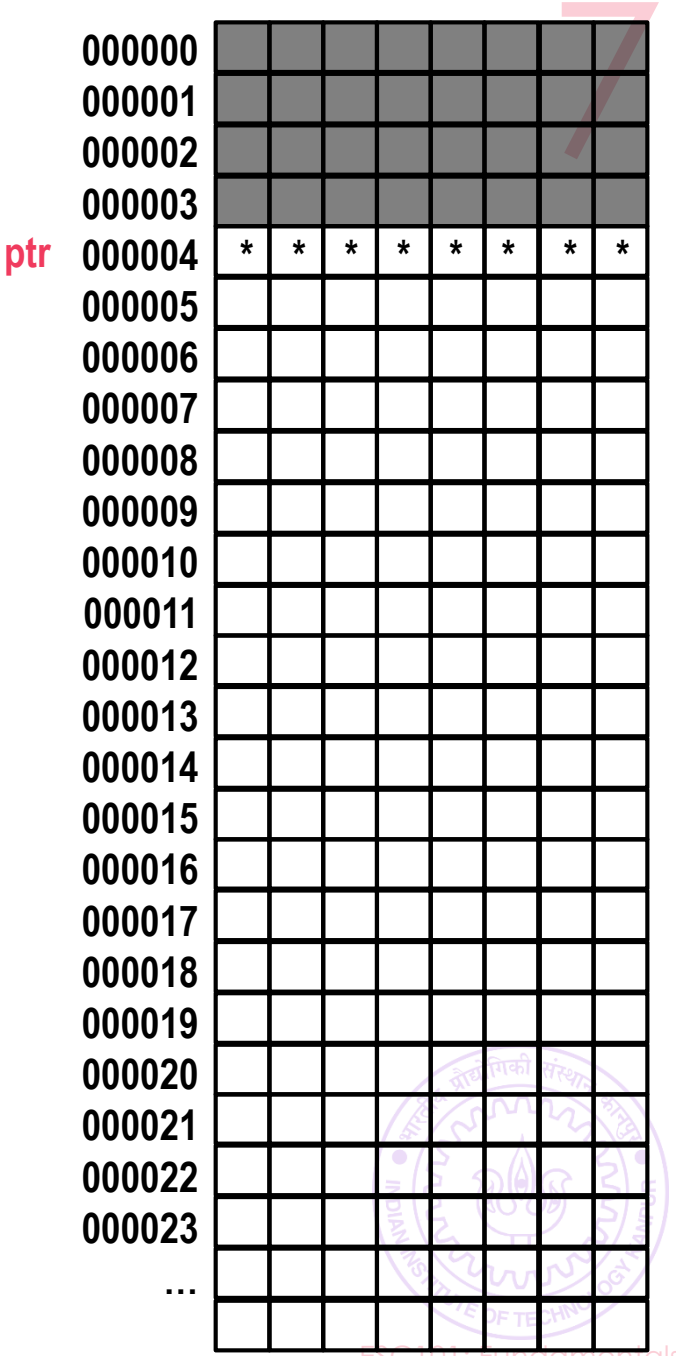

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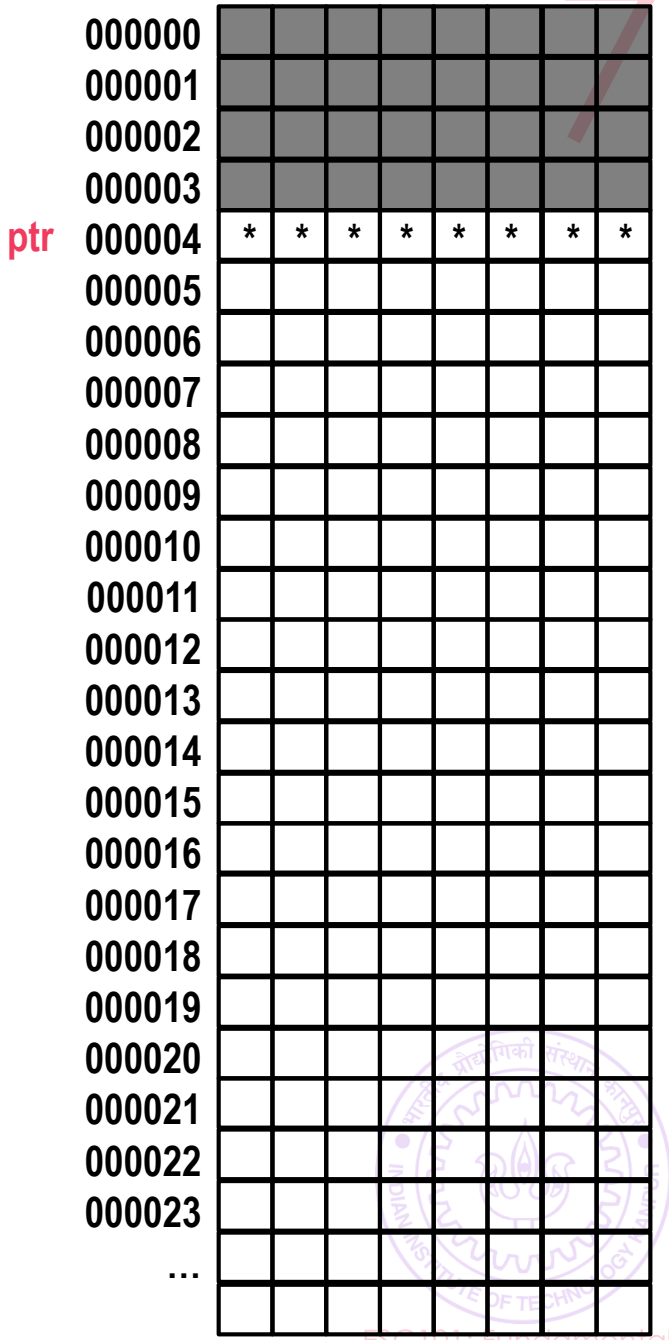

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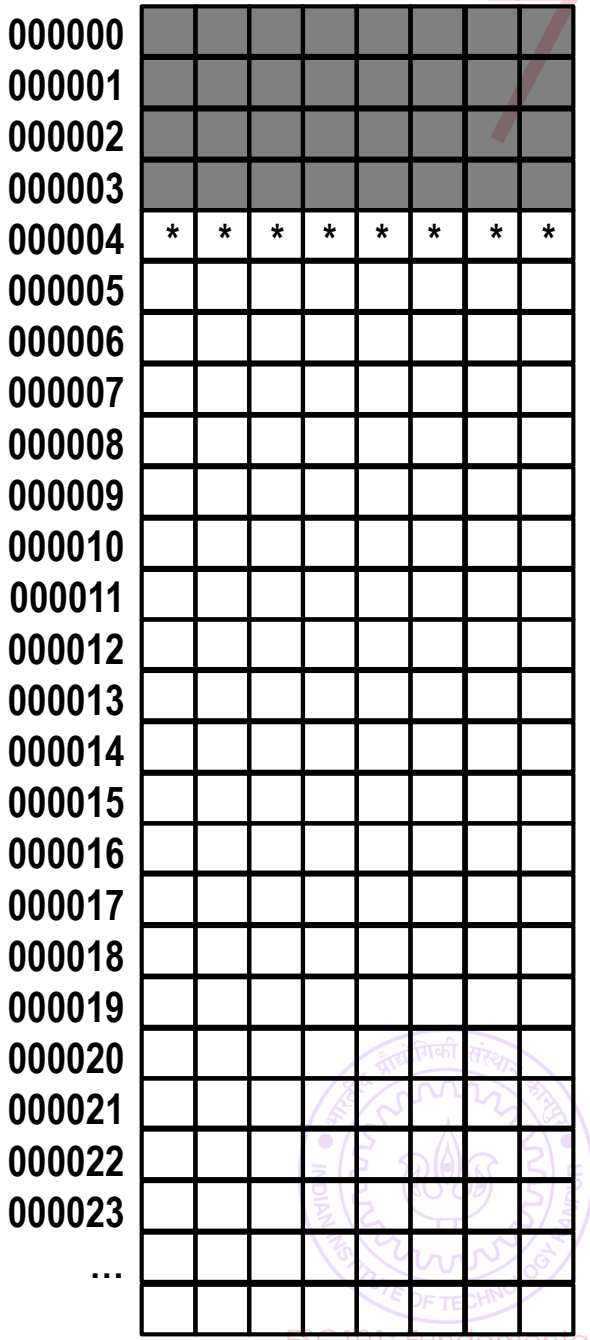

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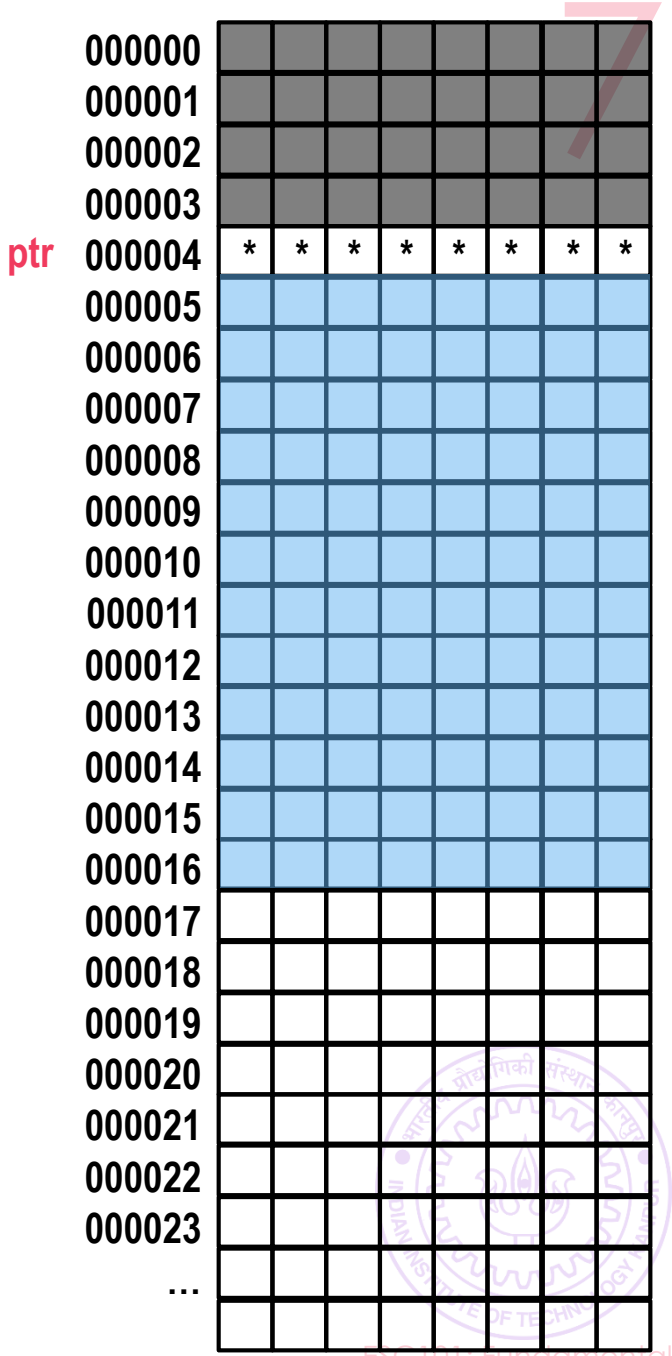

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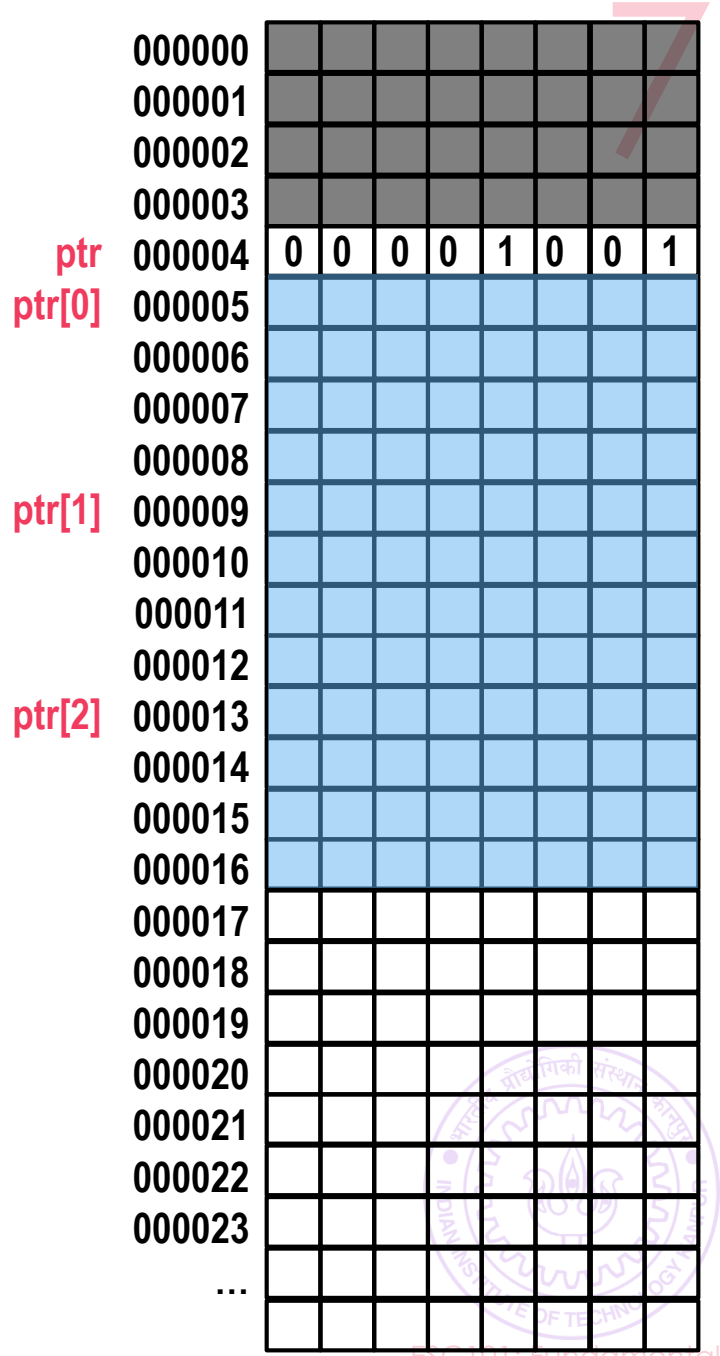

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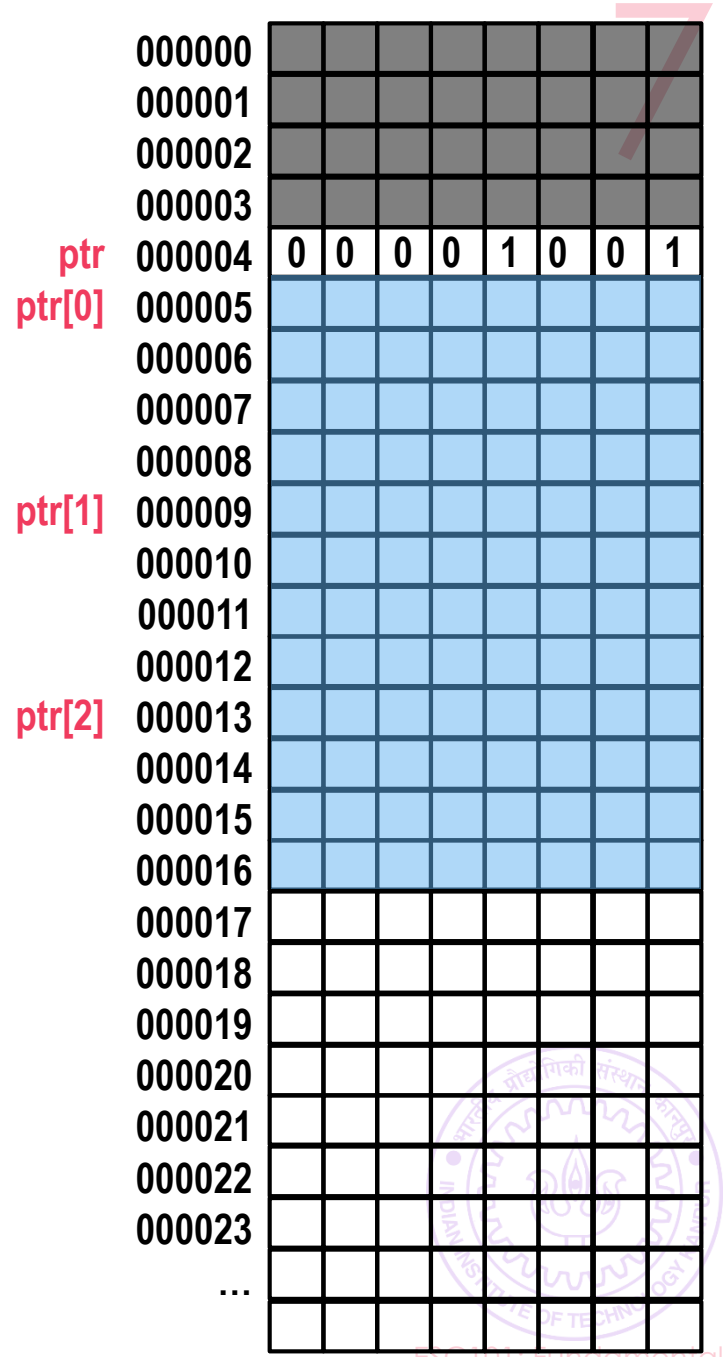

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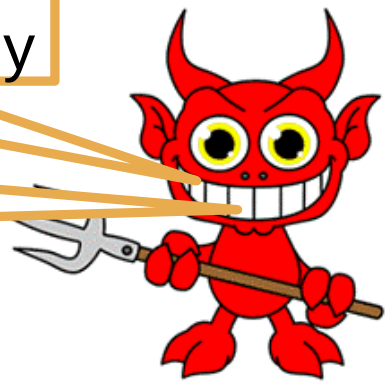

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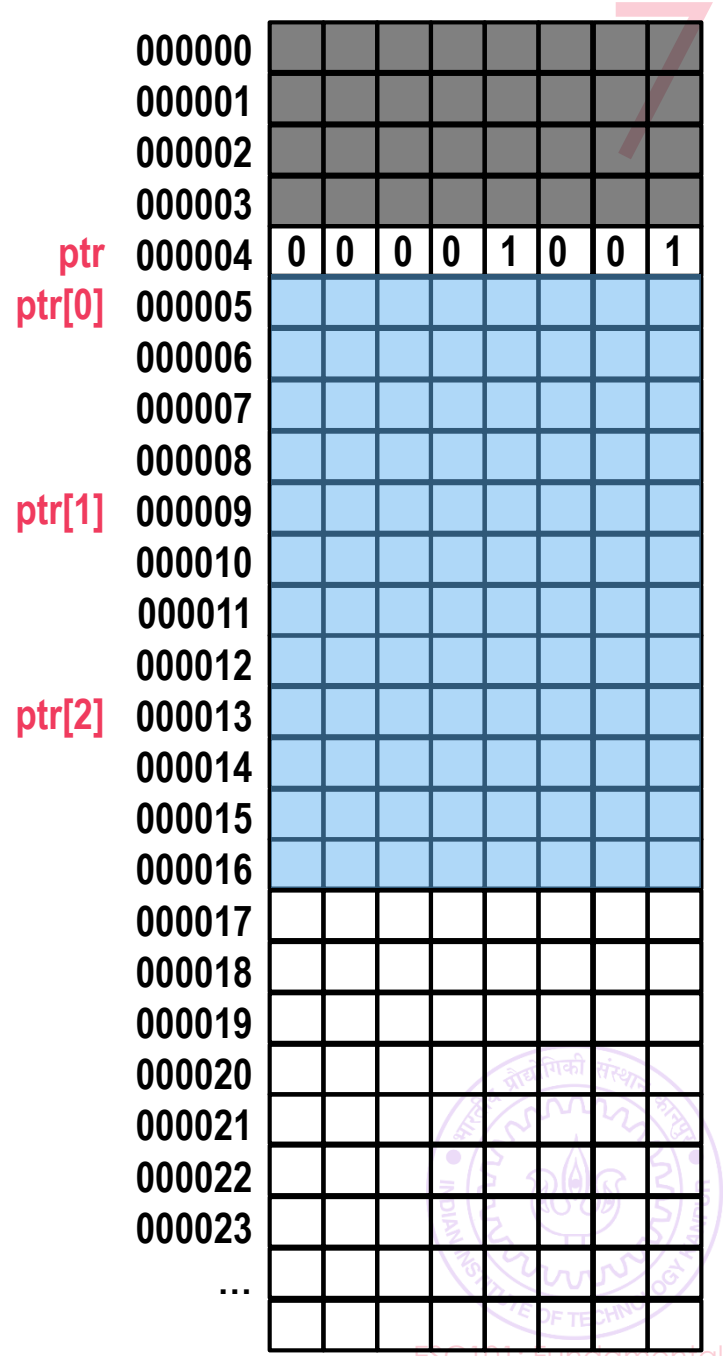

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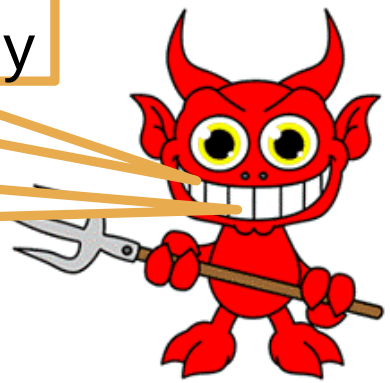

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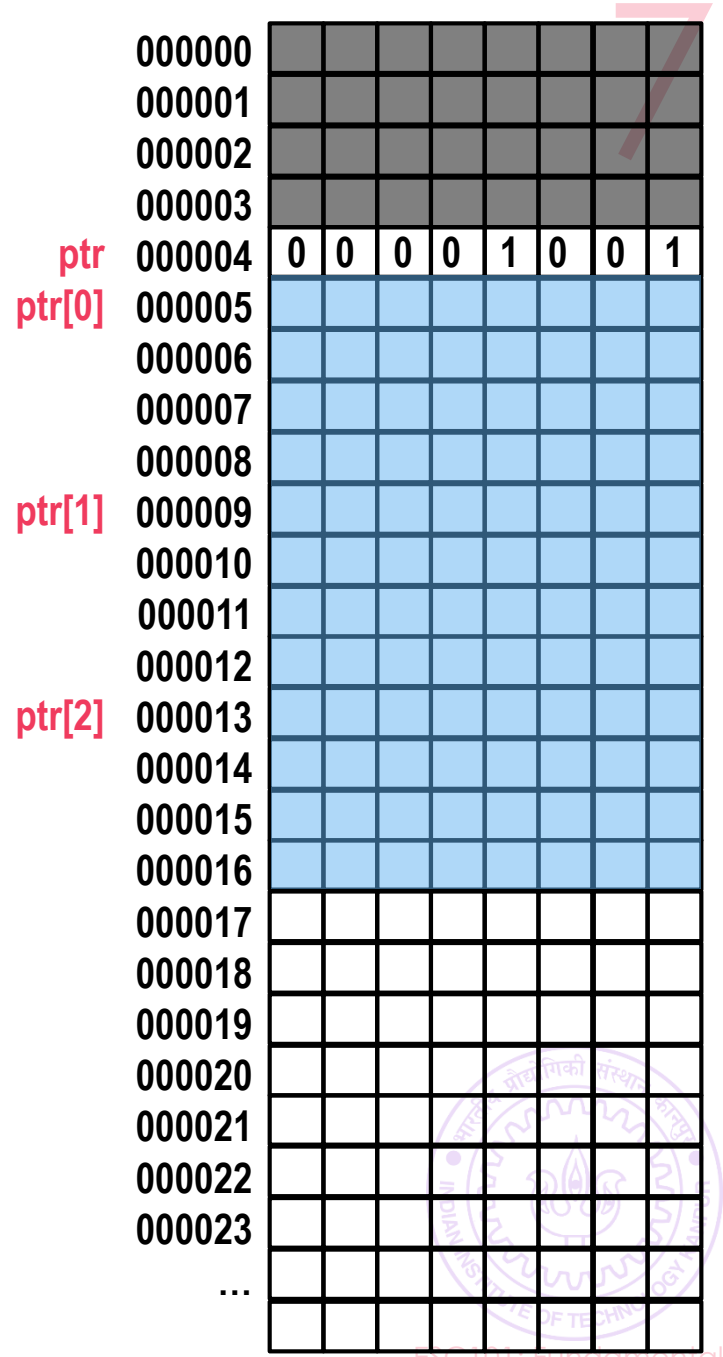

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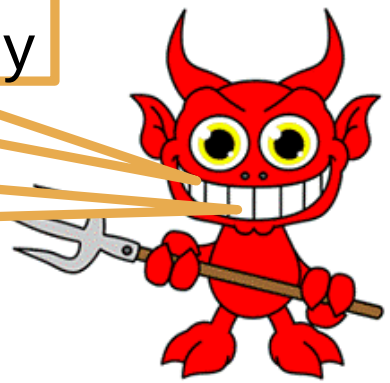

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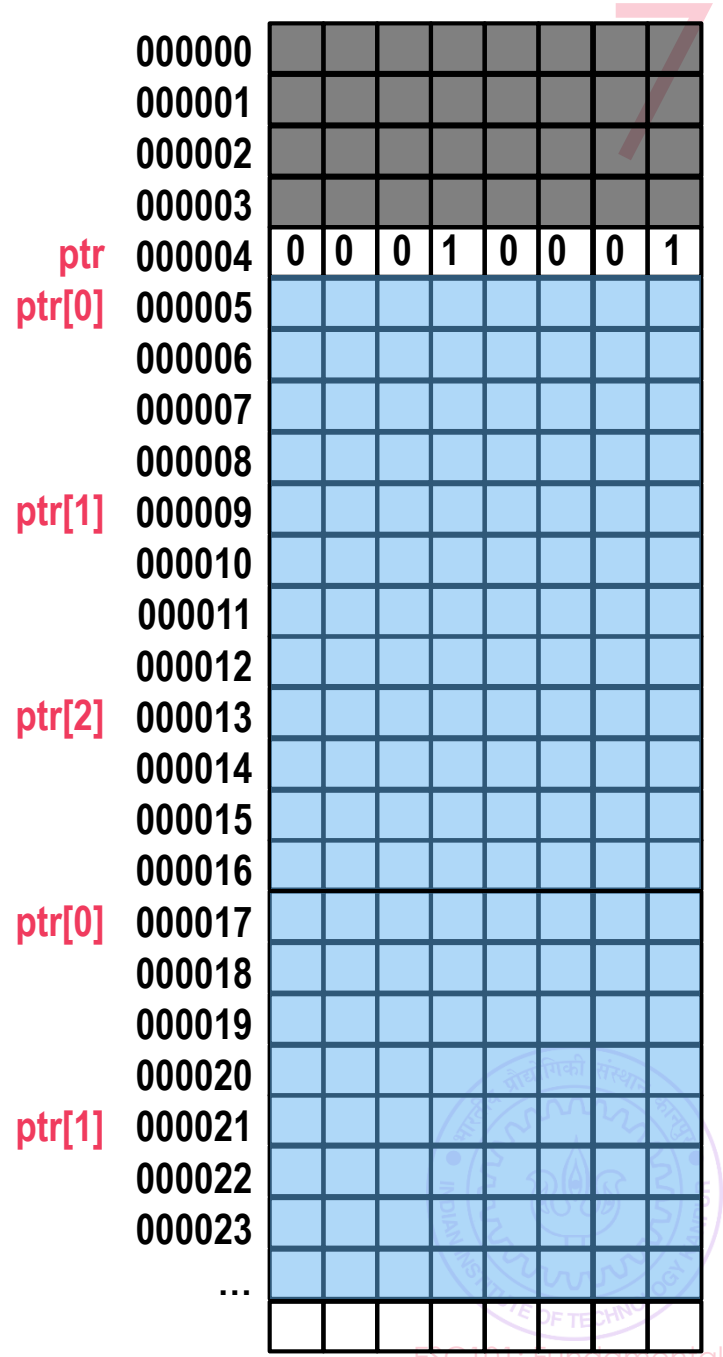

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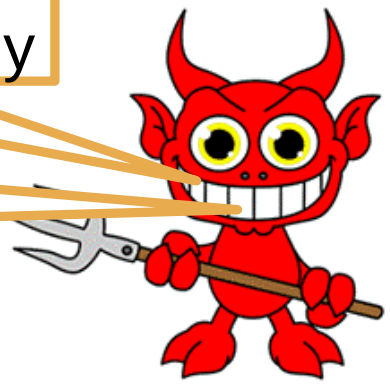

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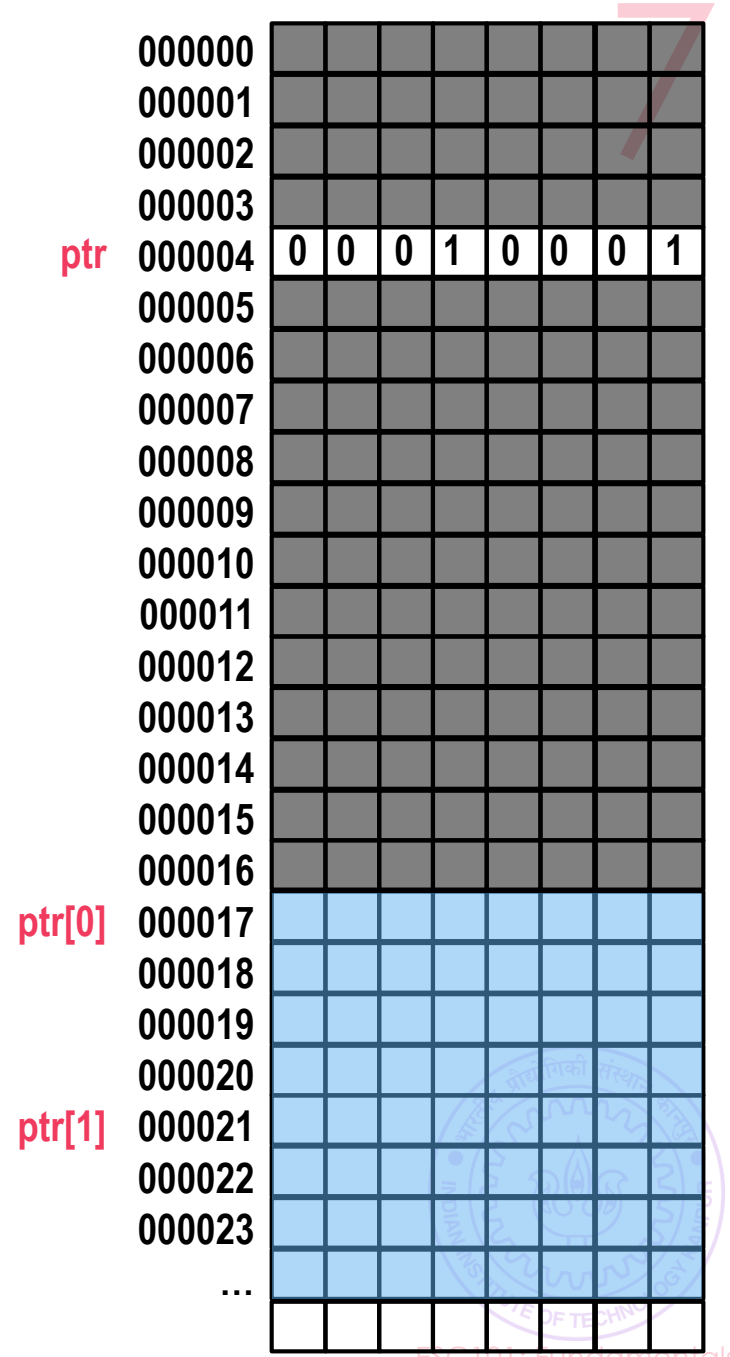

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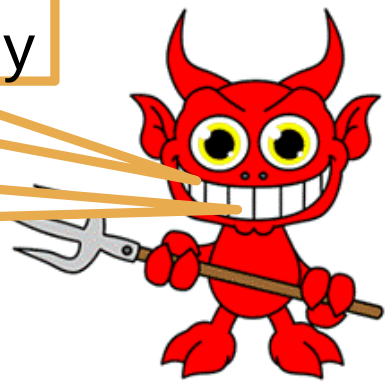

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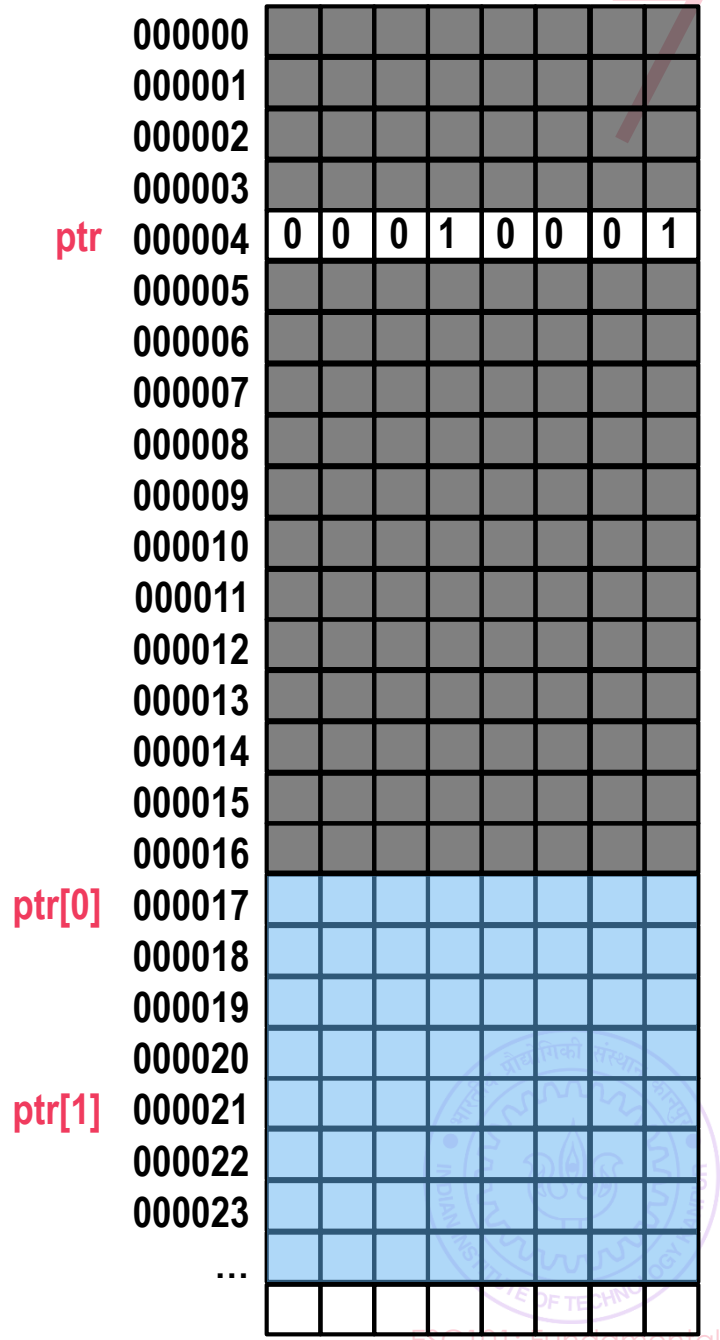
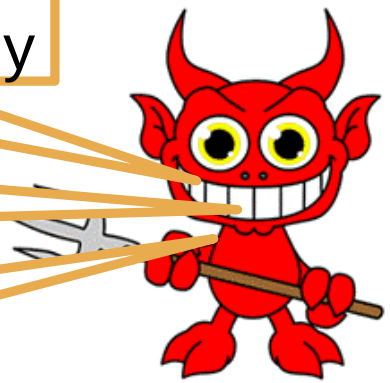


ptr will take 8 bytes to store – sorry for not drawing accurately

Actually even this is not accurate ☹ – details in CS220/330/335 ☺

If you keep losing memory like this, soon your program may crash!



free

भारतीय प्रौद्योगिकी संस्थान कानपुर
INDIAN INSTITUTE OF TECHNOLOGY KANPUR

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Used to deallocate memory allocated using malloc/calloc/realloc

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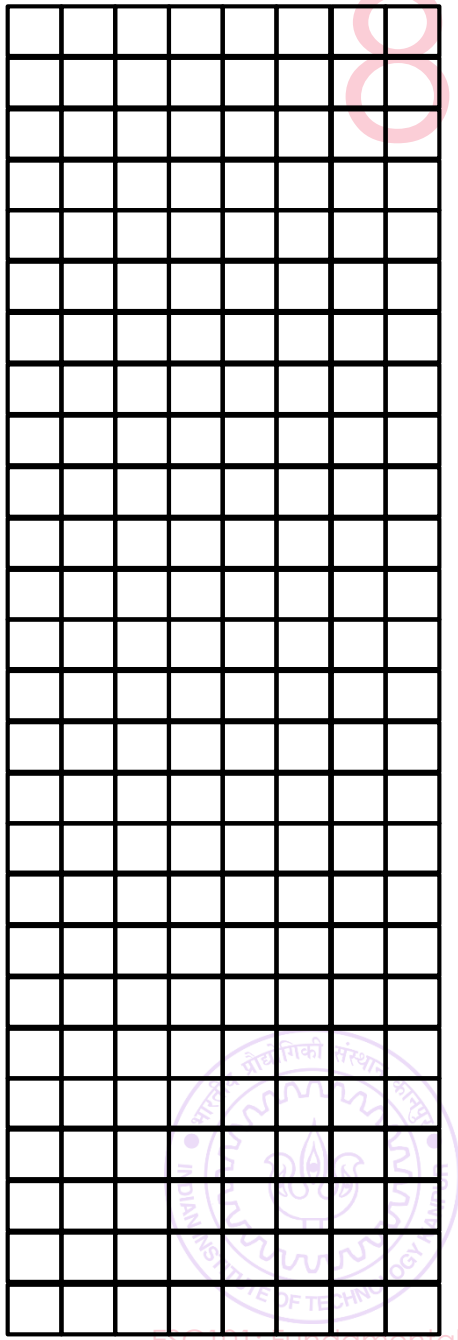

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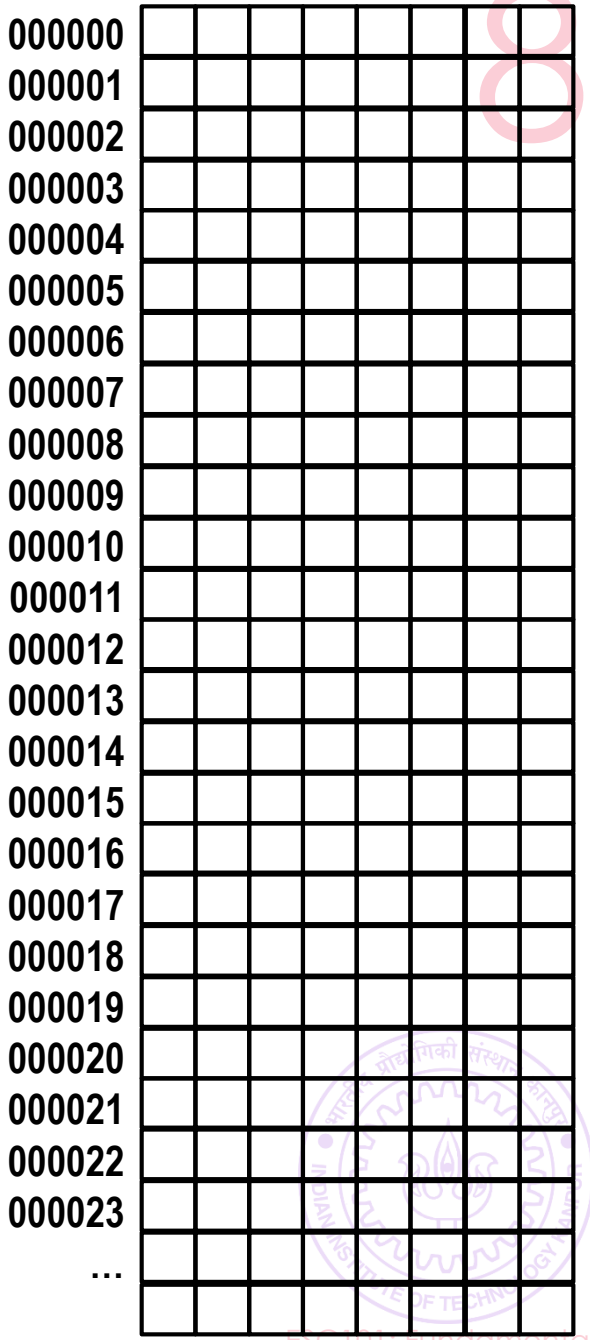

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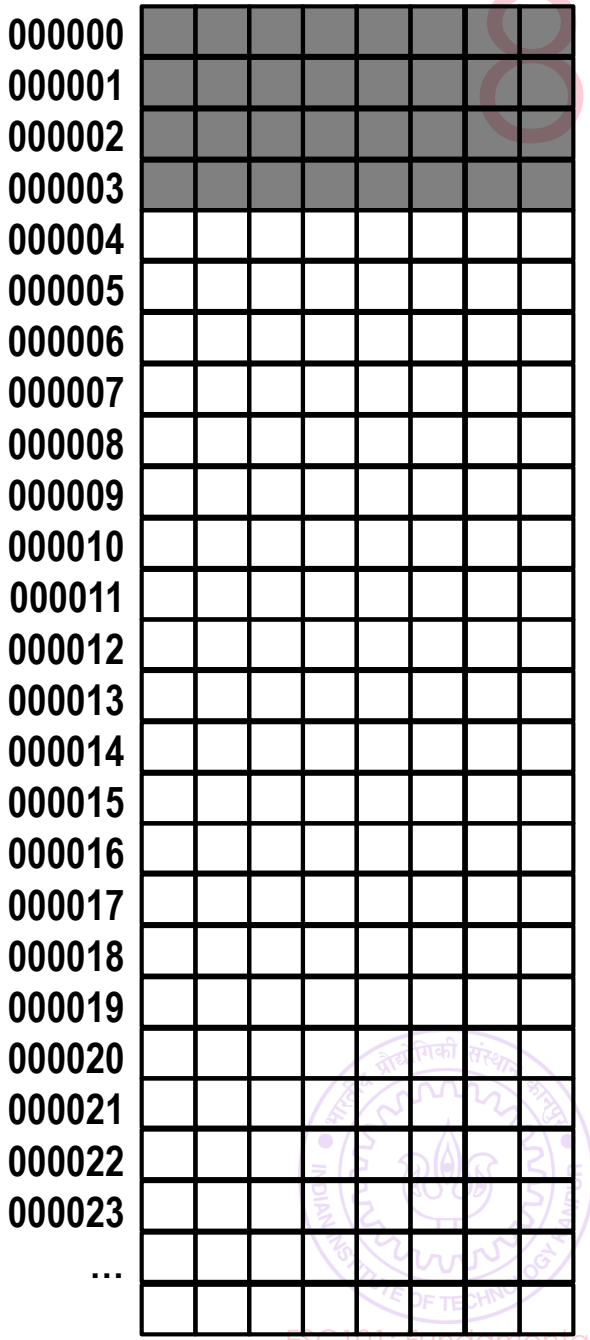

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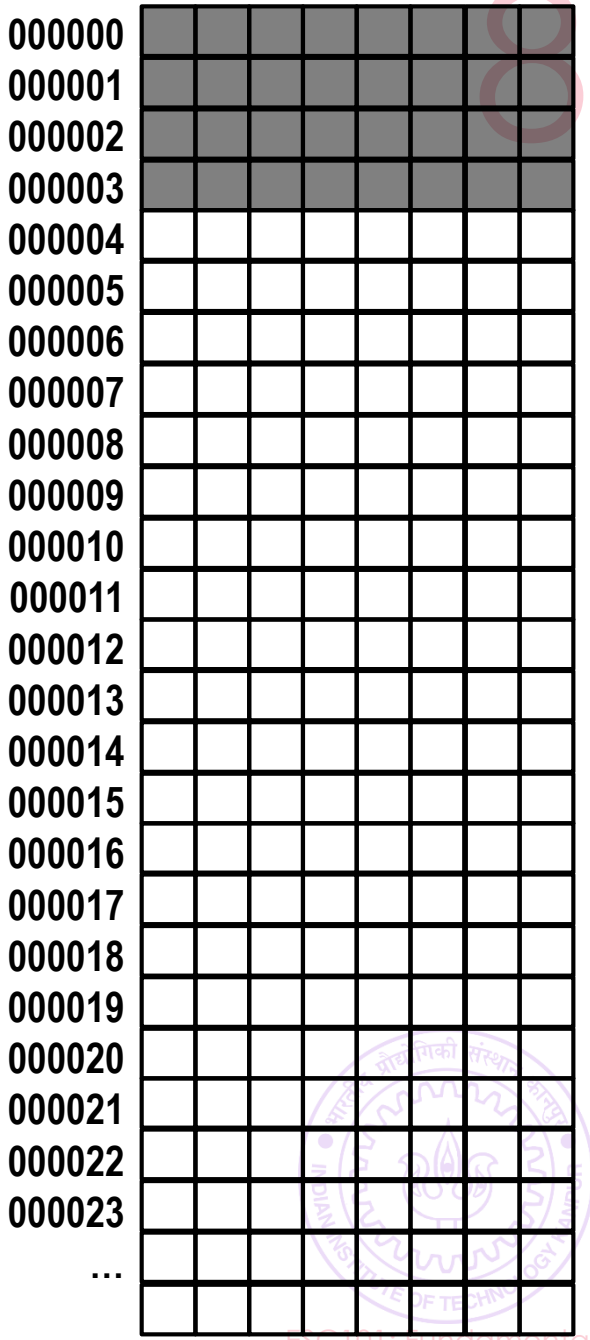

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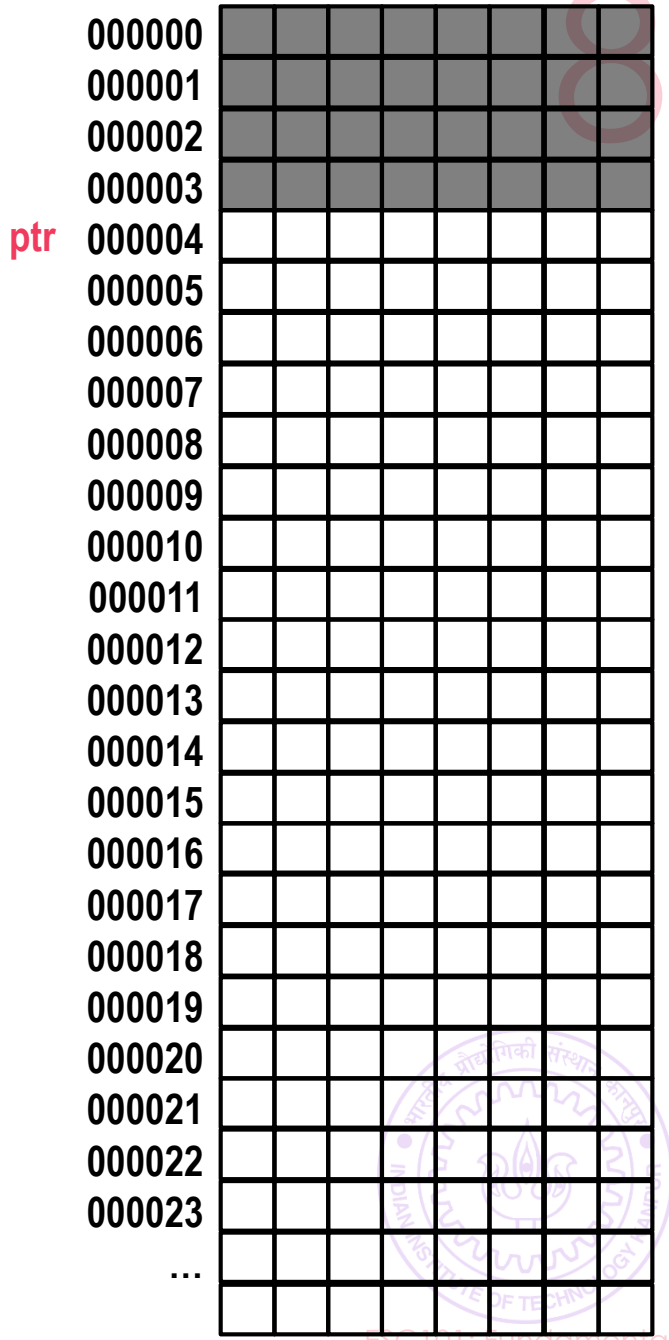

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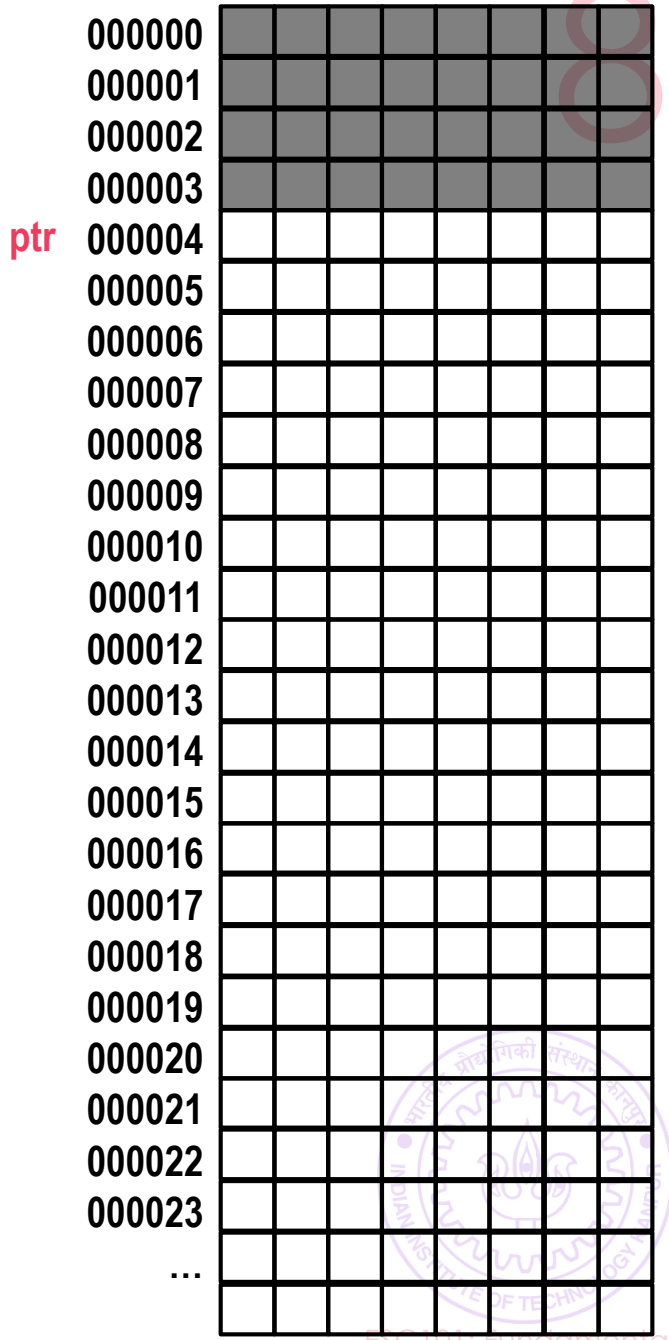
int *ptr; // may contain a junk address now



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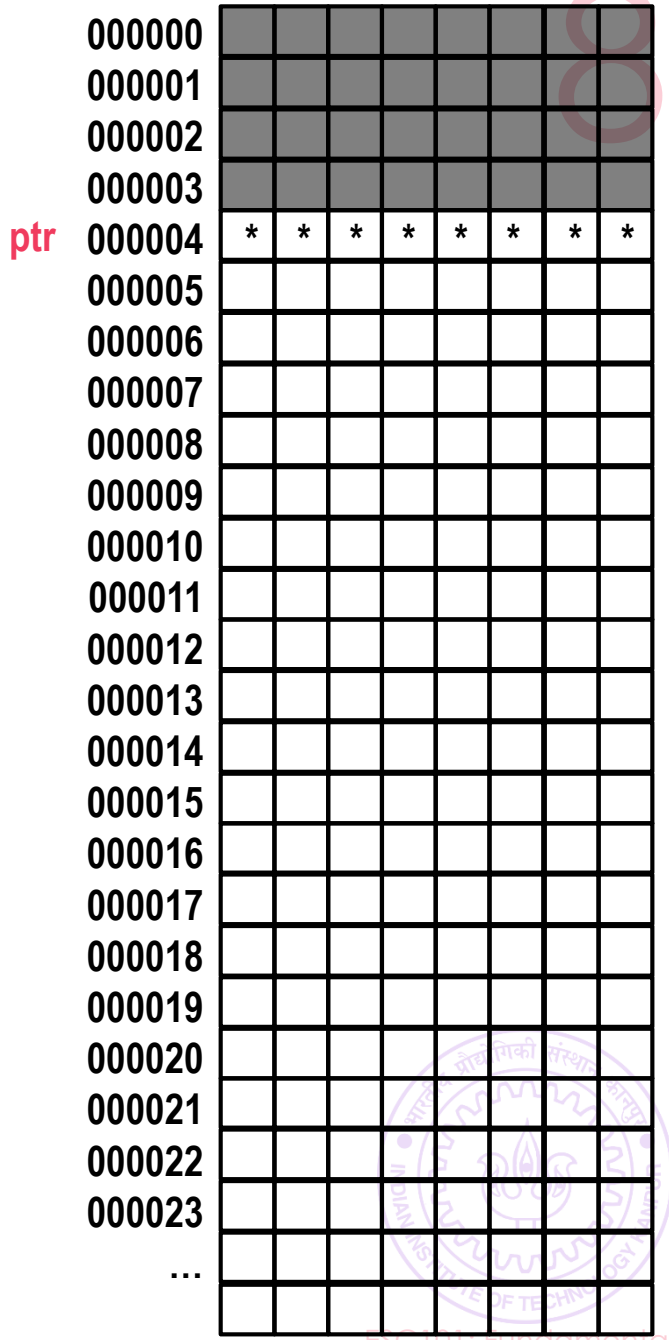

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int *ptr; // may contain a junk address now
char str[3];
```

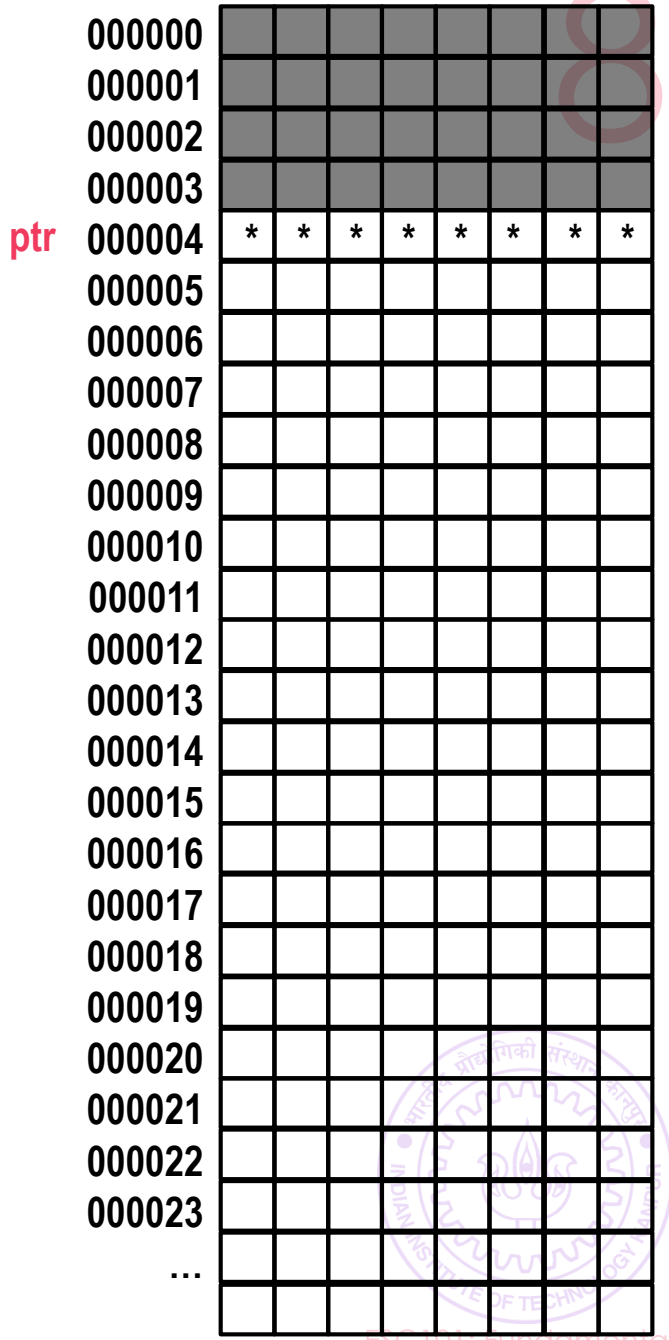

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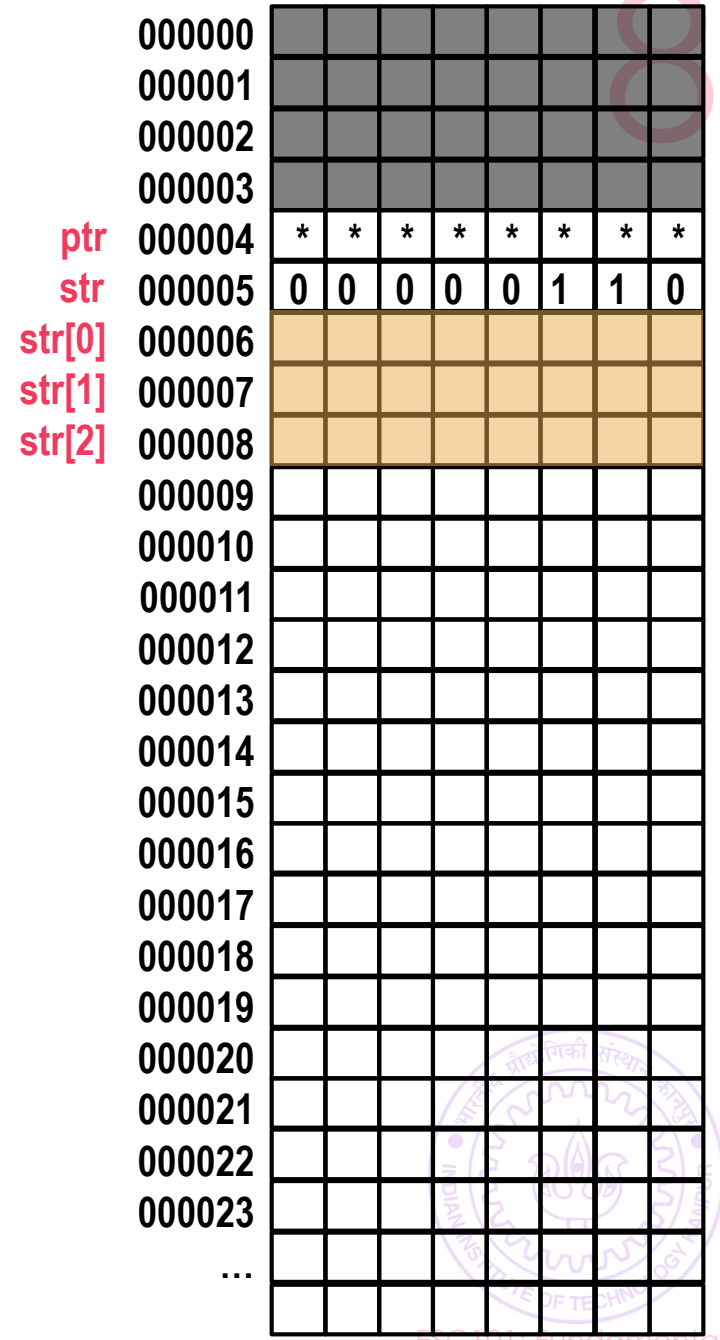

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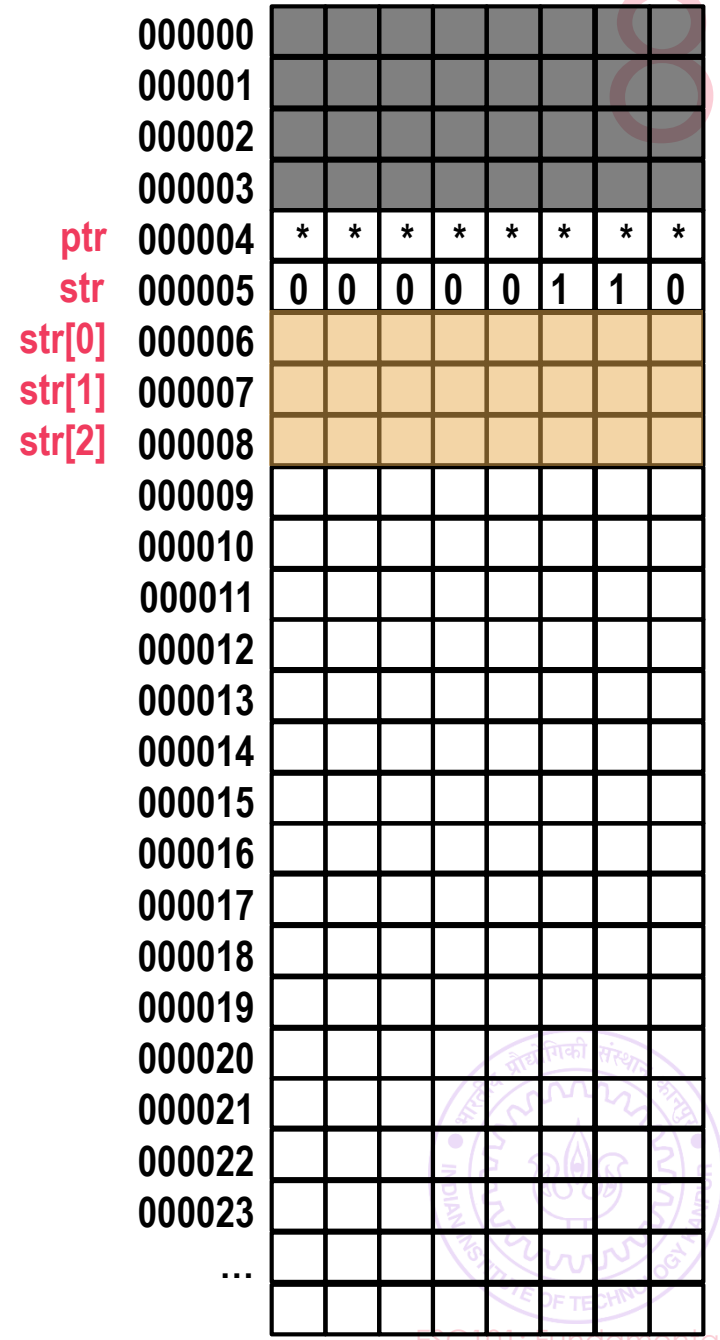

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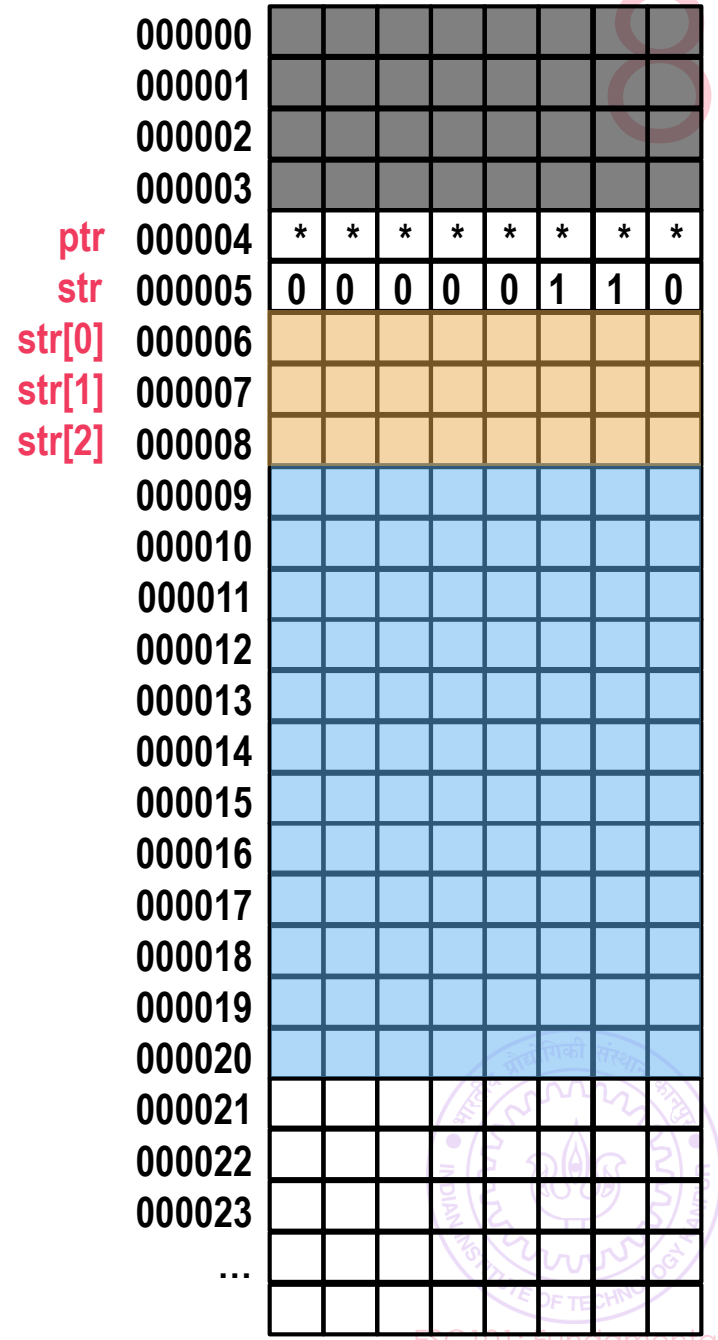

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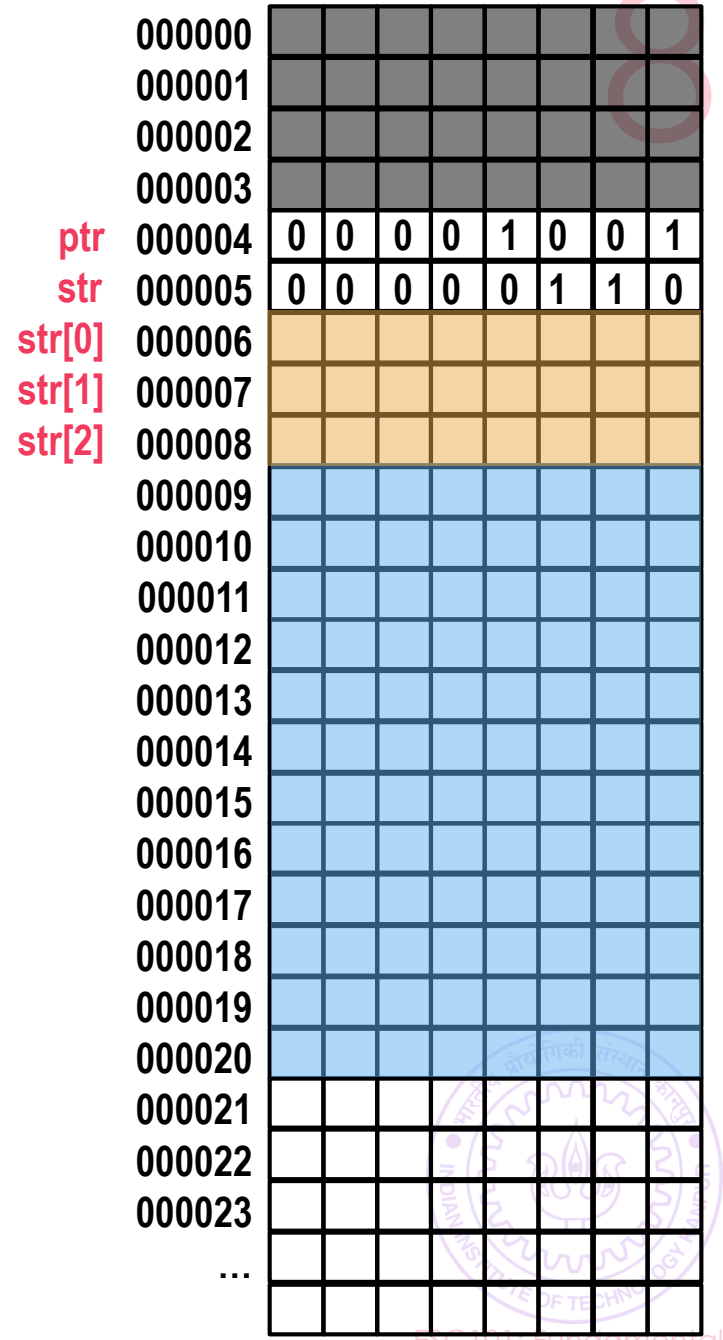

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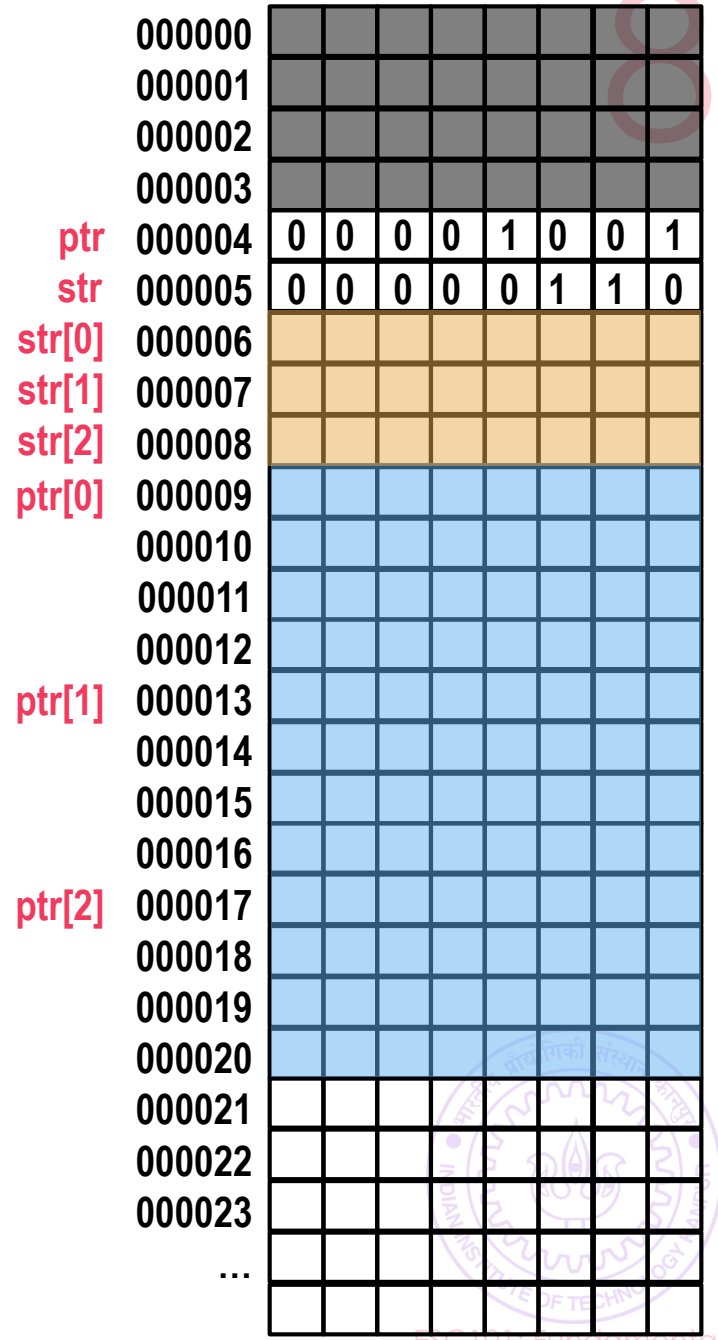

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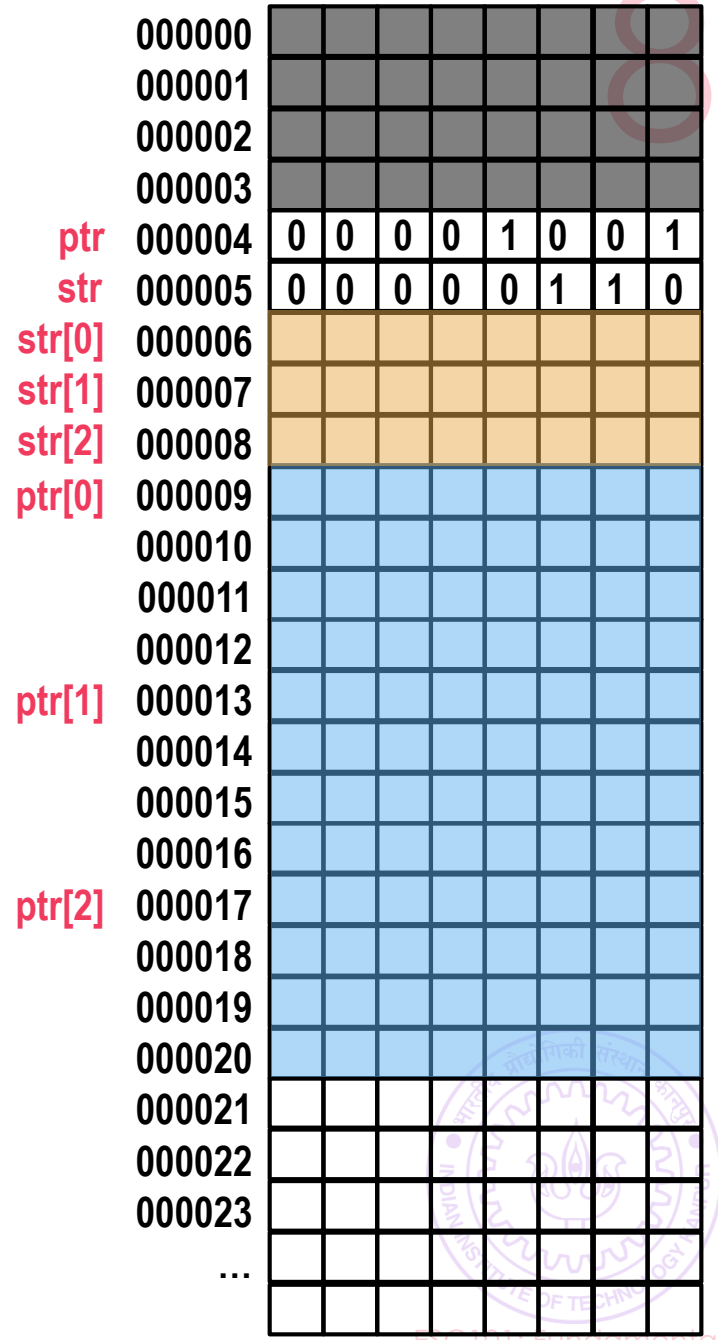

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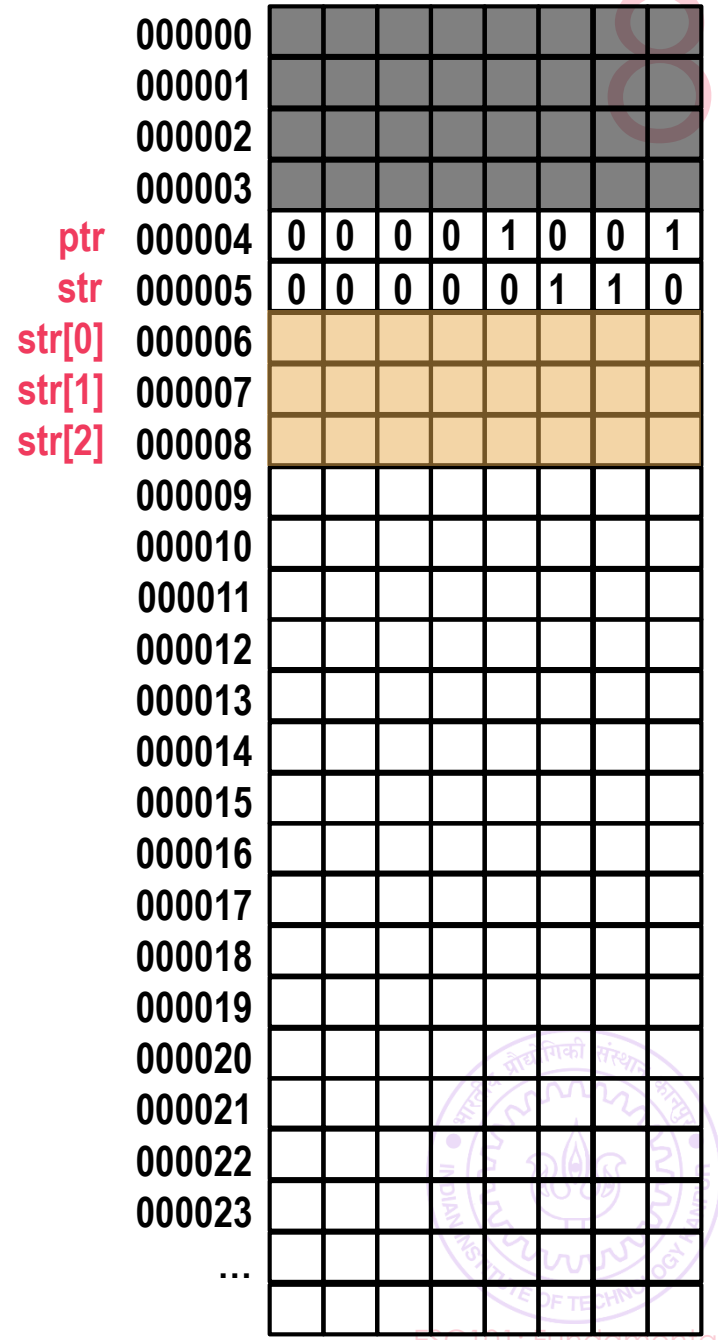

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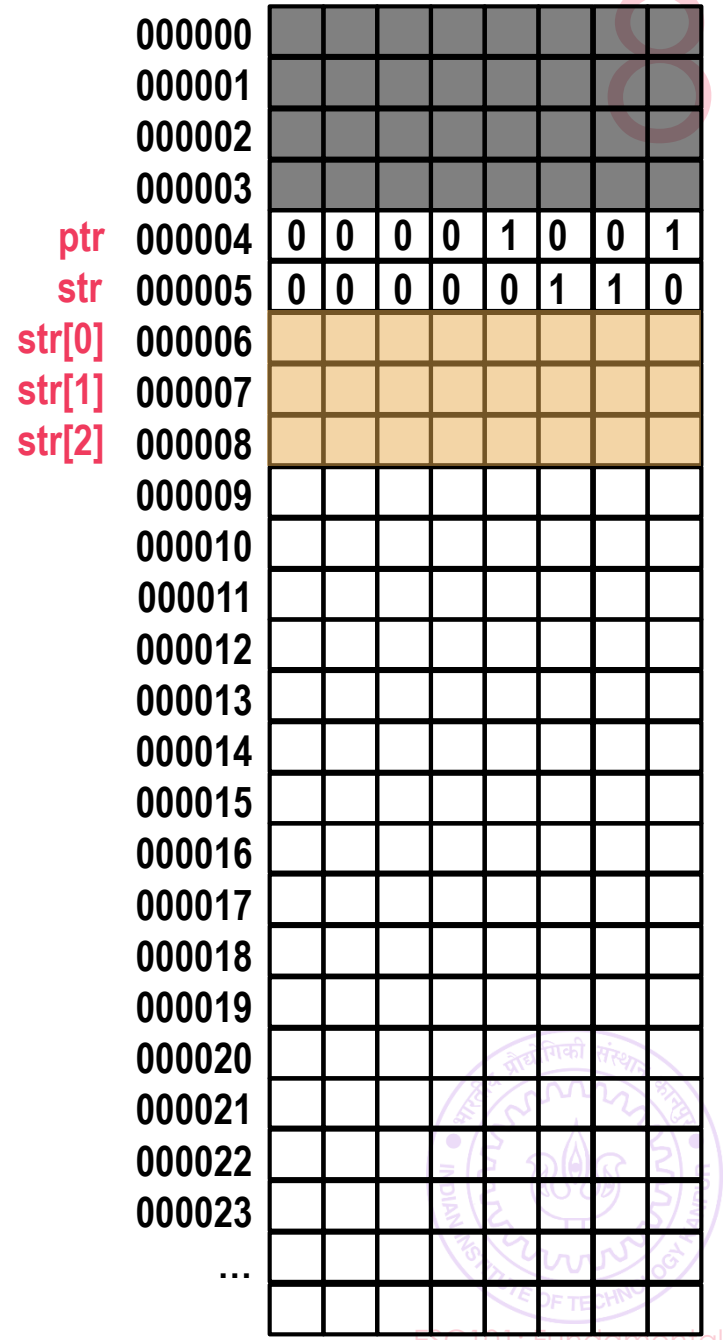

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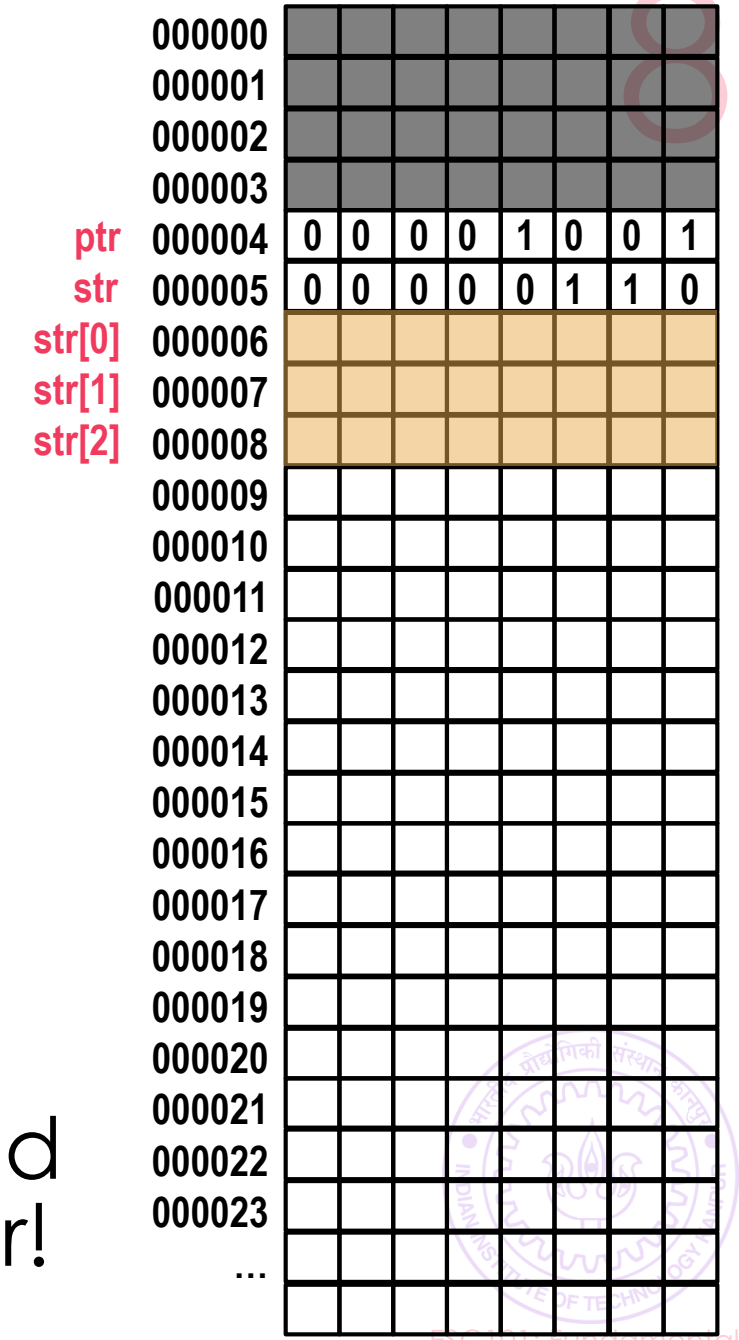
Don't use freed memory or free memory twice or free non-malloc/calloc/realloc-ed arrays – will cause segfault or runtime error!



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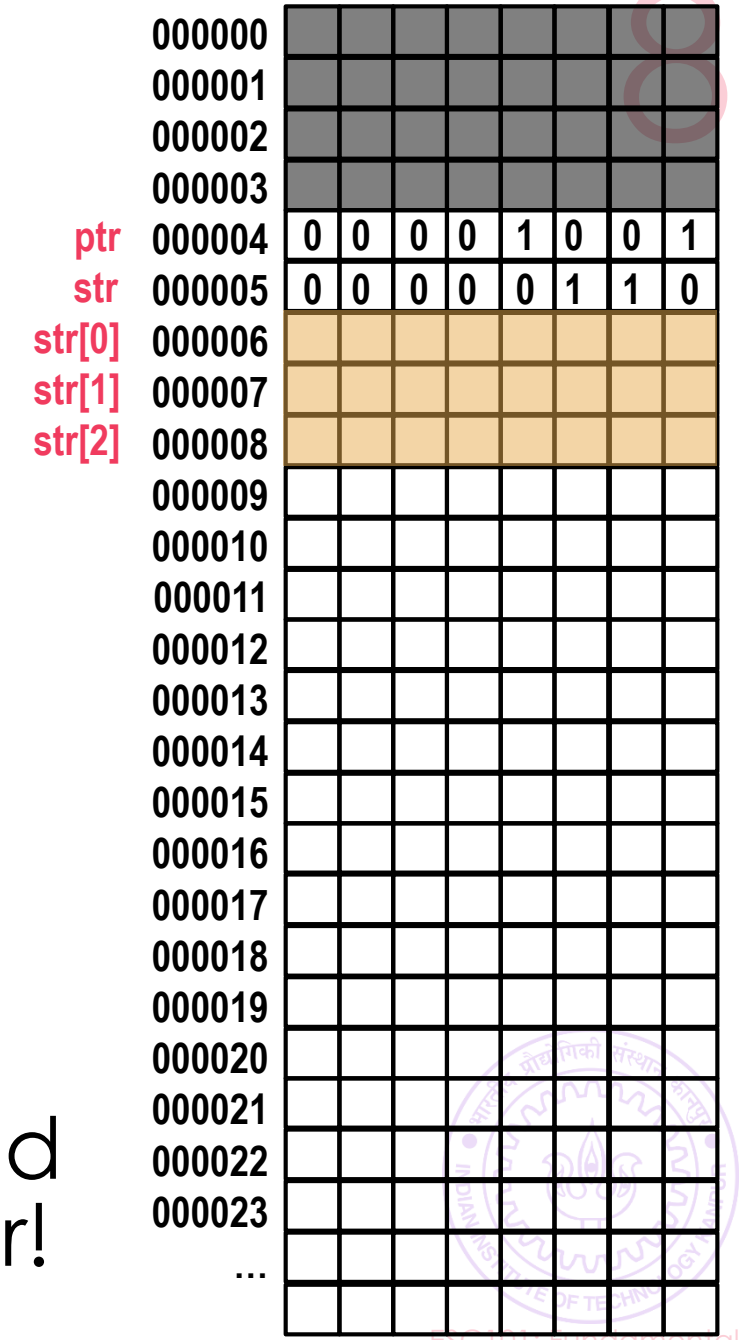

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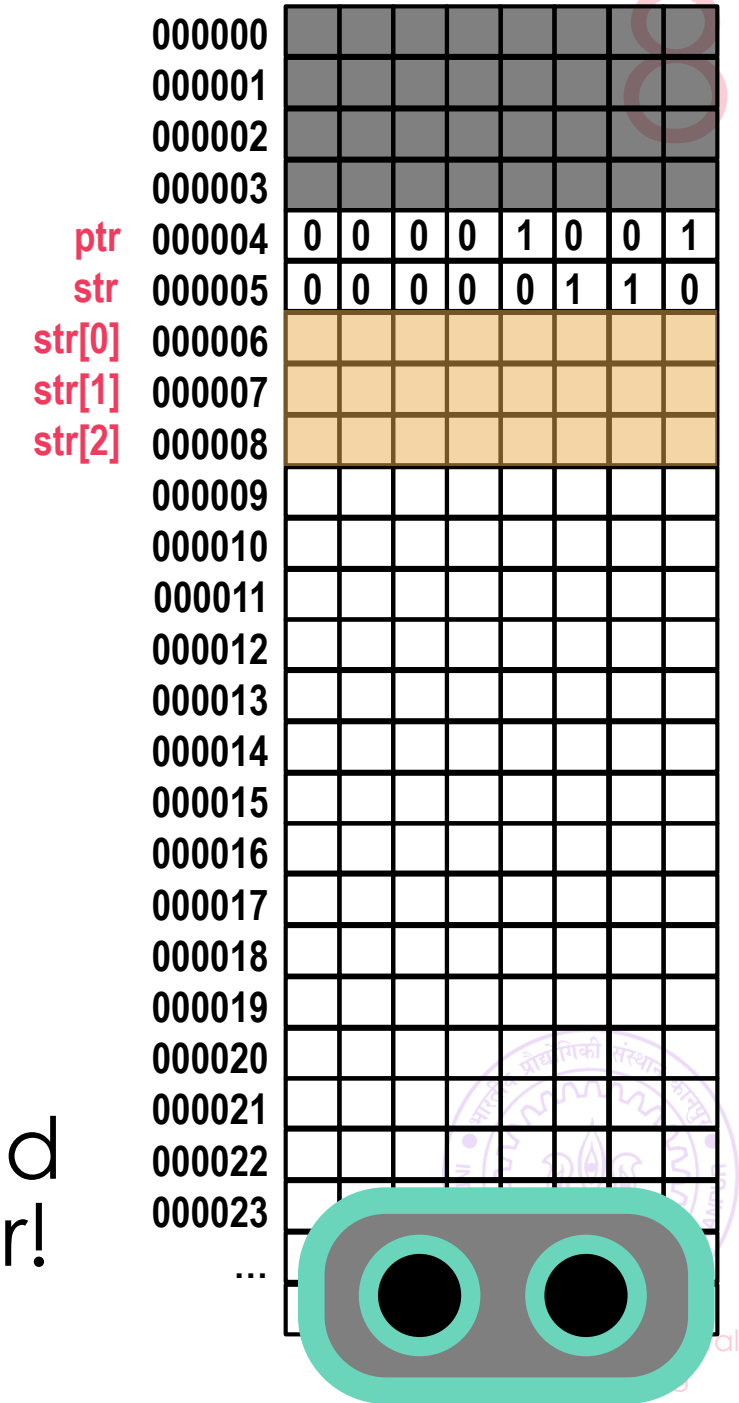

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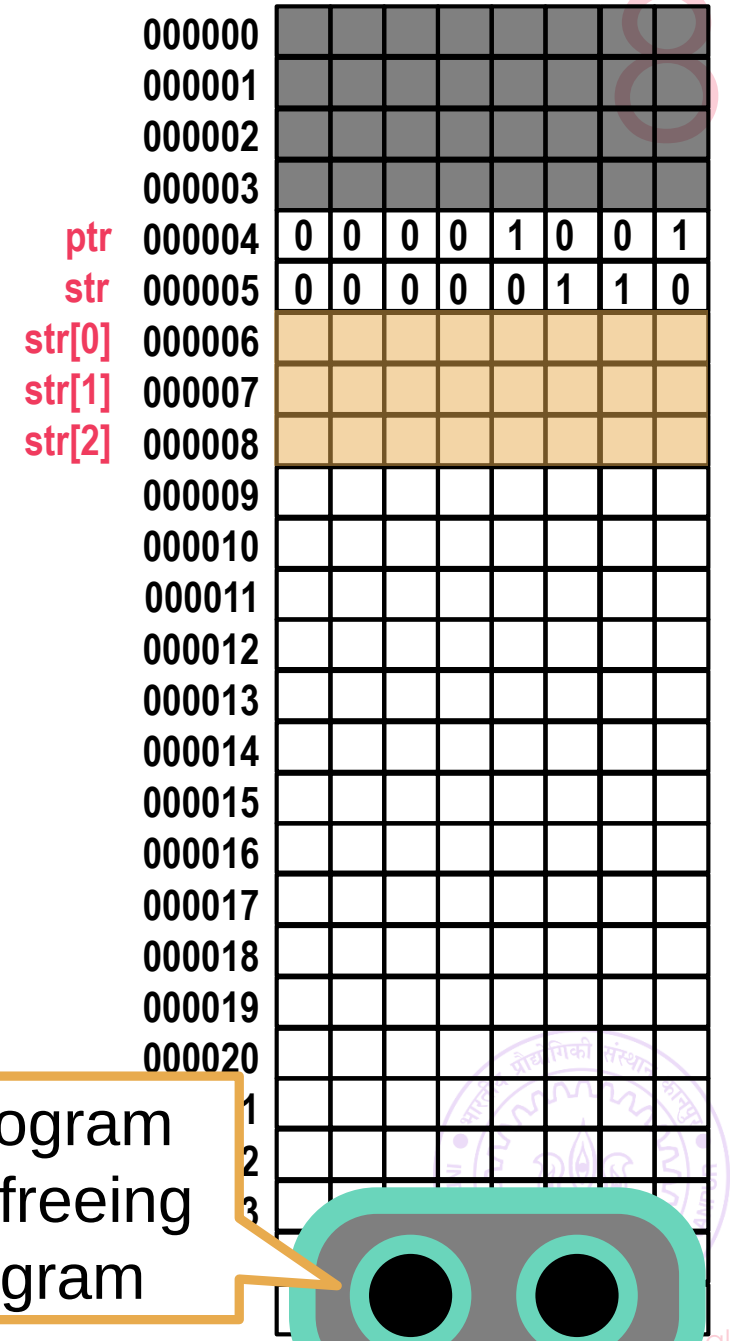

I always free all memory when a program ends. You only have to worry about freeing memory during the run of your program

Library analogy for malloc/free

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malloc/calloc is like borrowing a book from library

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Cannot use a book after returning it (cannot use an array variable after it has been freed)

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Of course, if you re-issue a book you can return it again

realloc – **re**vised **alloc**ation

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If you malloc-ed an array of 100 elements and suddenly find that you need an array of 200 elements ☹

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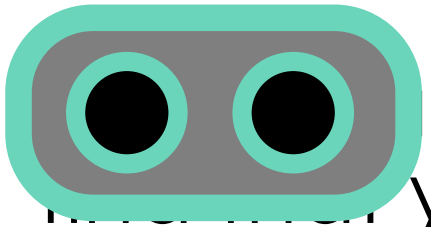

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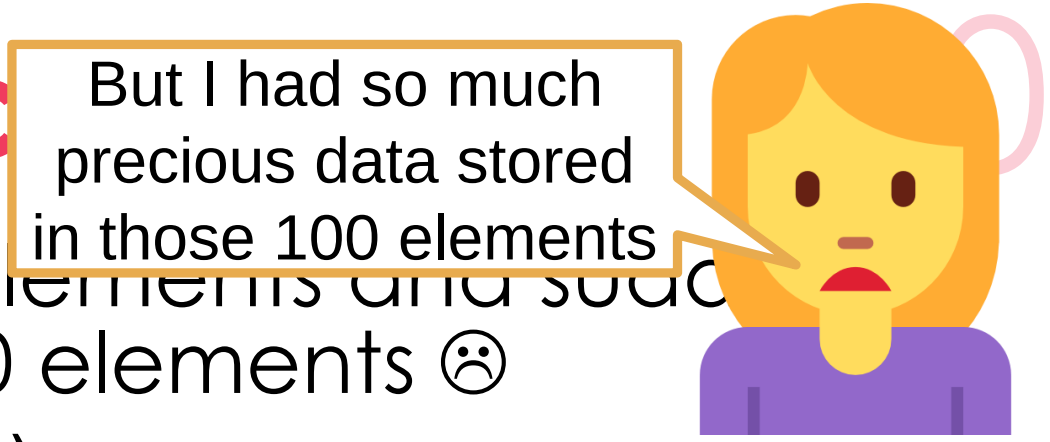


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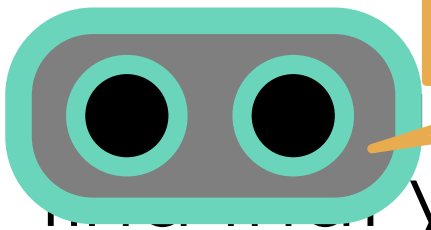

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But I had so much precious data stored in those 100 elements

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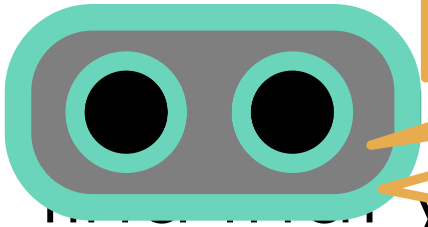
realloc ... c



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...llo... an array of 100 elements and sudd...

...find that yo... 200 elements ☹

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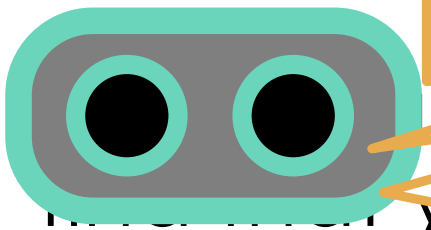

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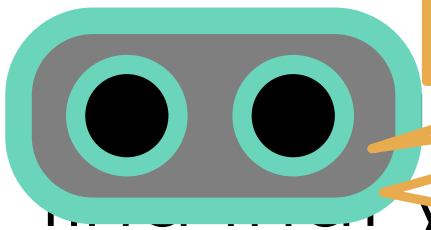

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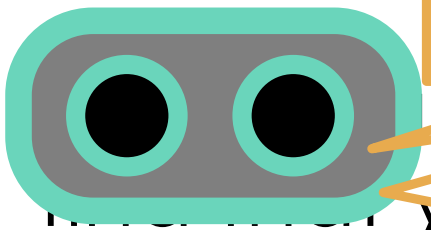

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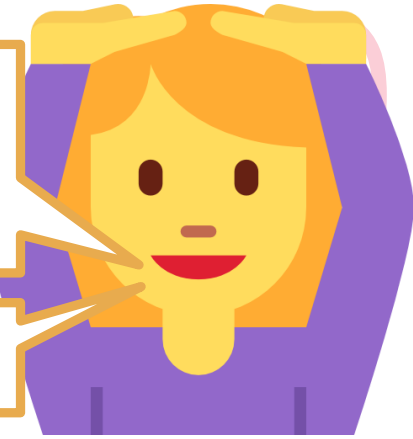

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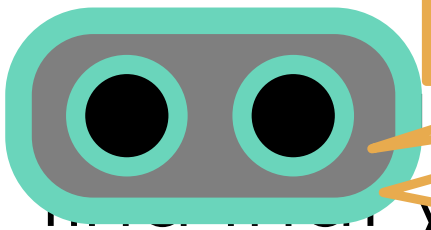

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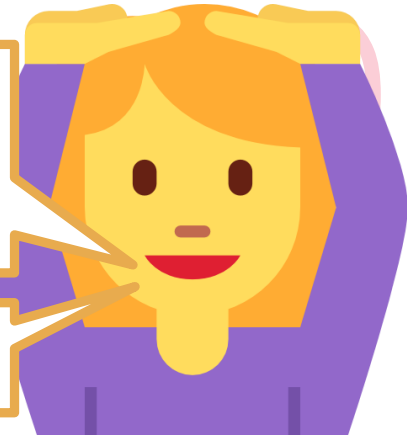

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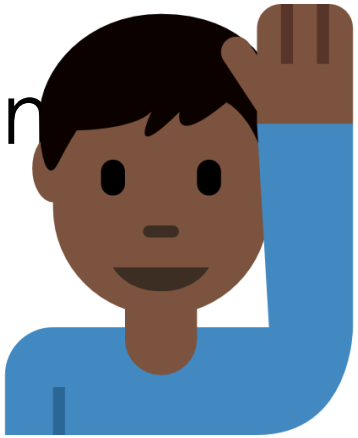

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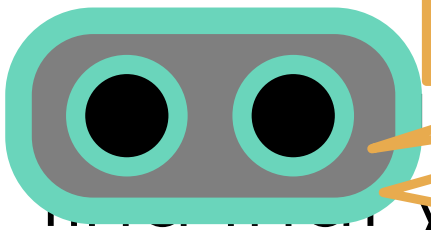

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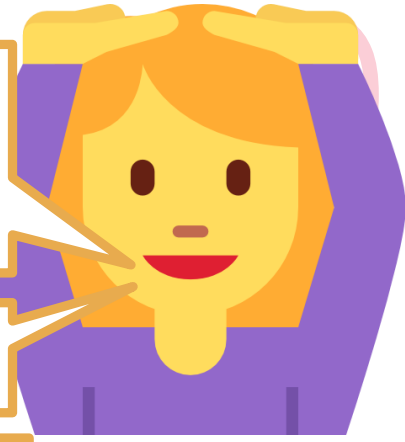

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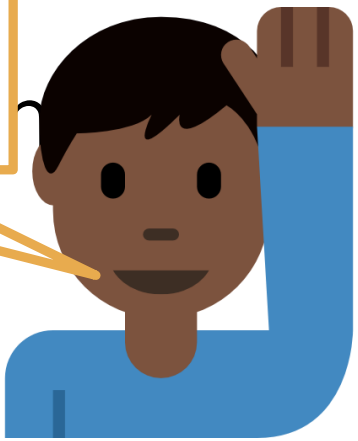
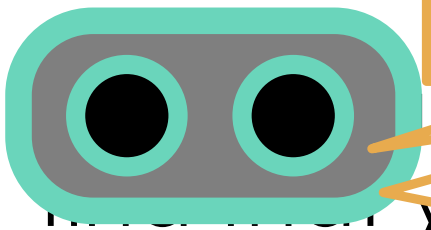


realloc



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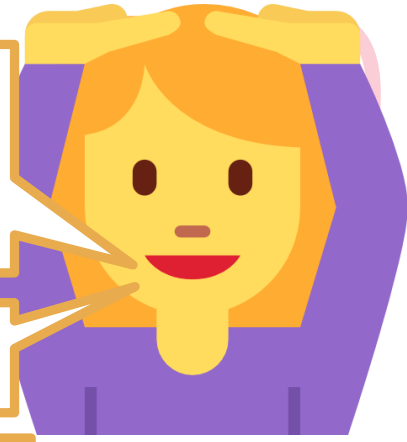

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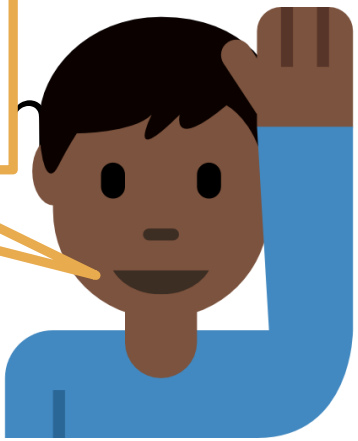

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Don't use realloc to resize of non-malloc arrays

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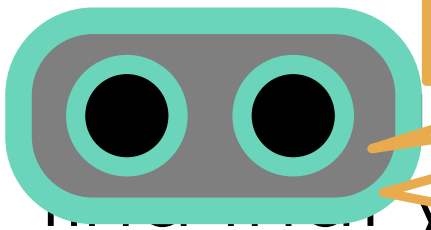

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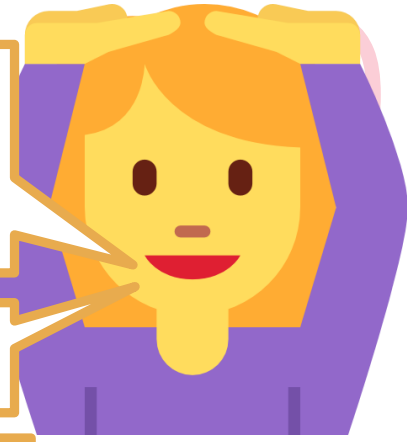

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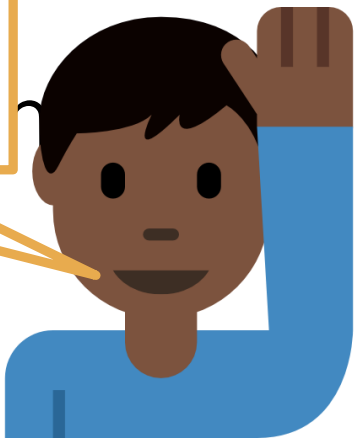

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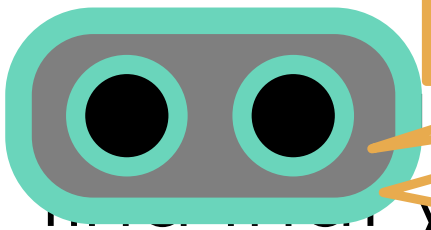

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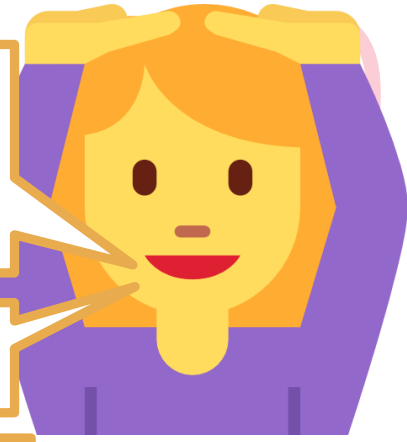

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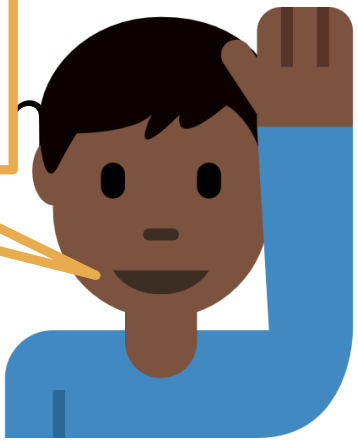

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Use realloc only to resize of calloc/malloc-ed arrays

getline

भारतीय प्रौद्योगिकी संस्थान कानपुर
INDIAN INSTITUTE OF TECHNOLOGY KANPUR

getline

Read a single line of text from input (i.e. till '\n')

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int len = 11; // I only expect 10 characters to be entered
char *str = (char*)malloc(len * sizeof(char));
getline(&str, &len, stdin);
```

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char **ptrstr = &str;
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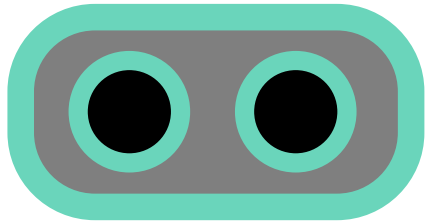

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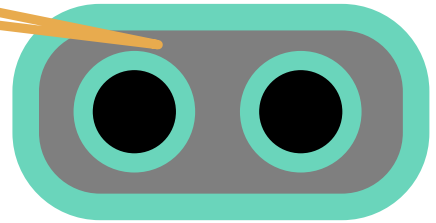

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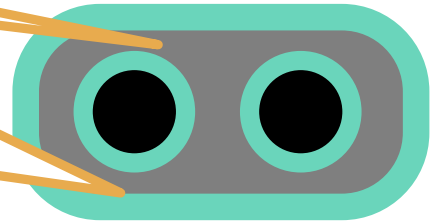

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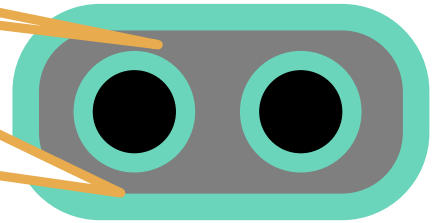

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WARNING: len may be larger than length of input + 1
Get actual length of input using strlen() from string.h

Array of pointers?

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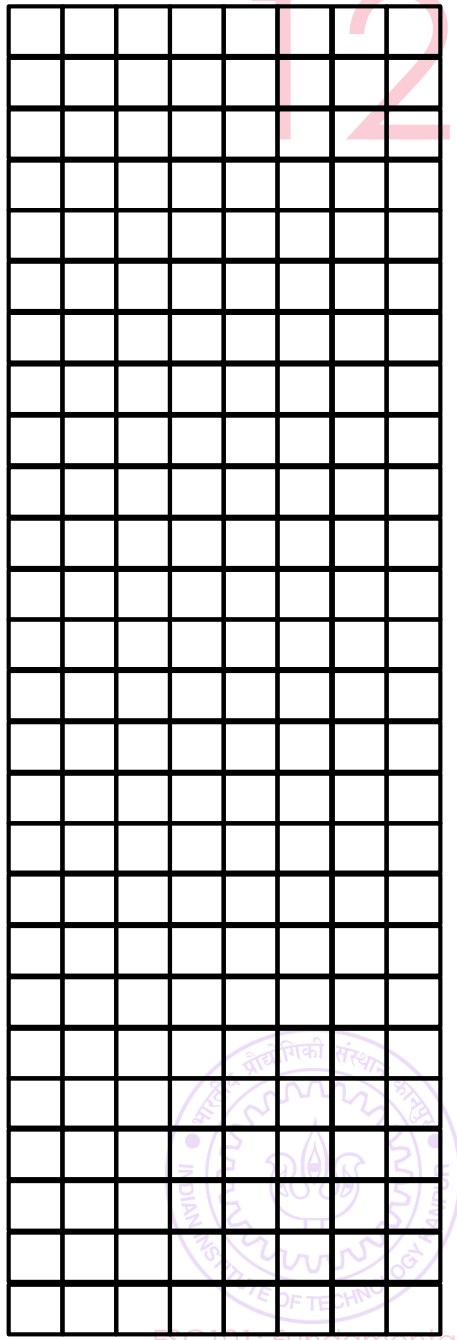

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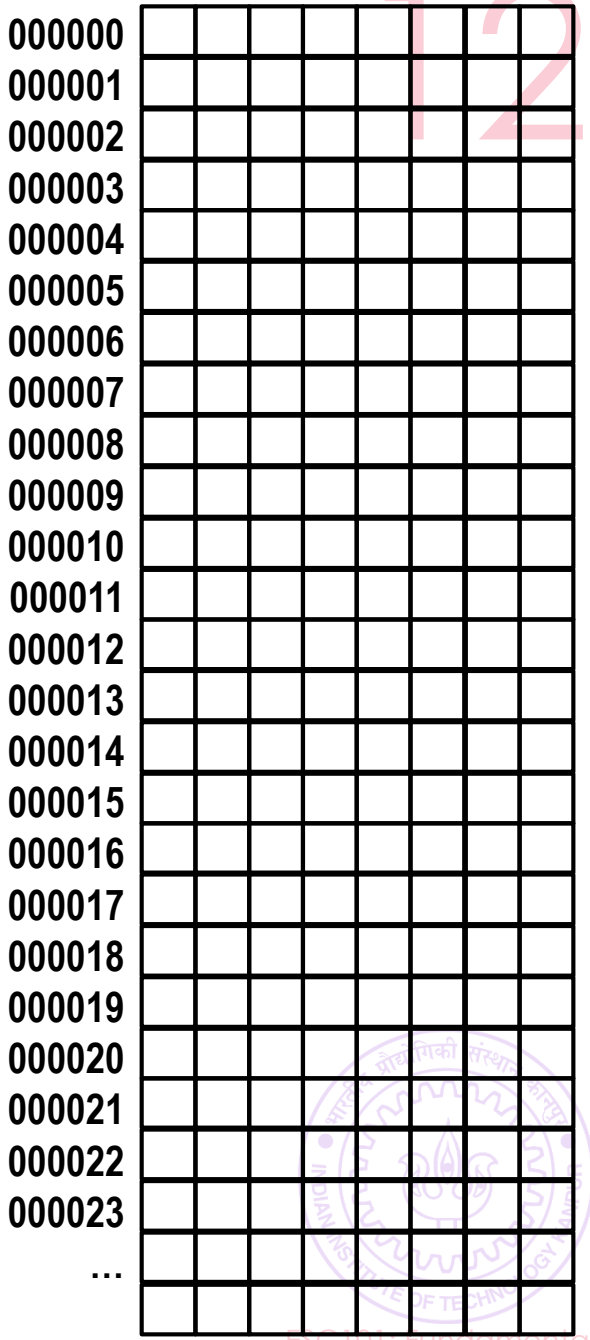

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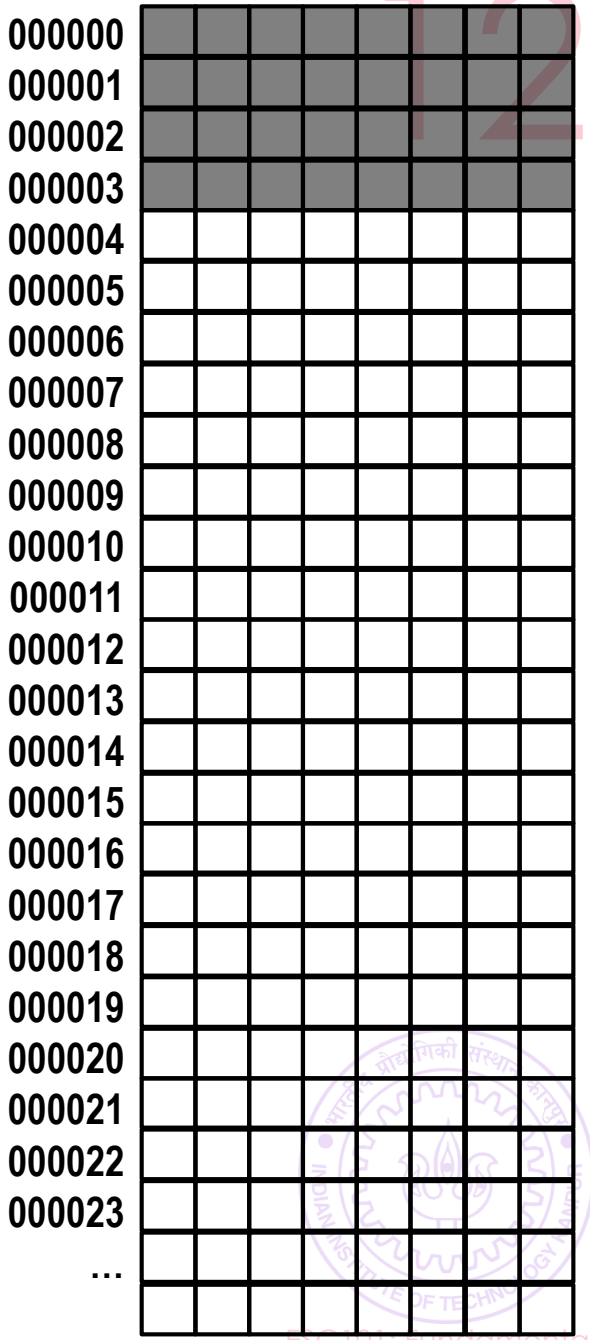
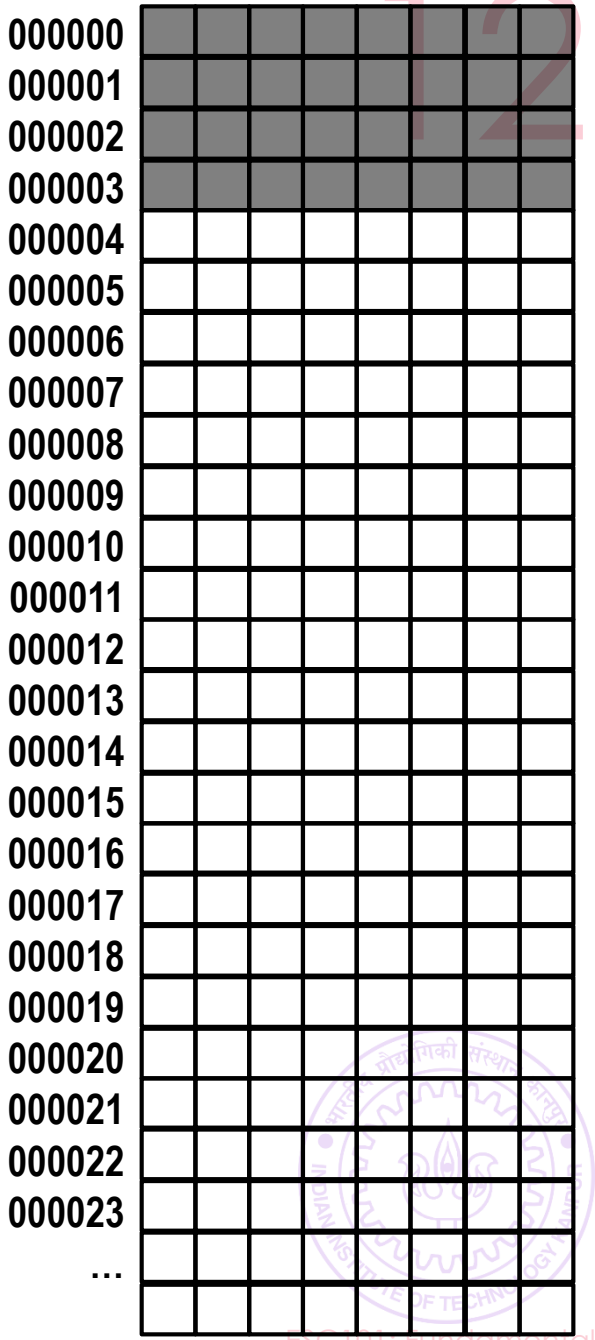


Array of pointers?

char *ptrArr[3];



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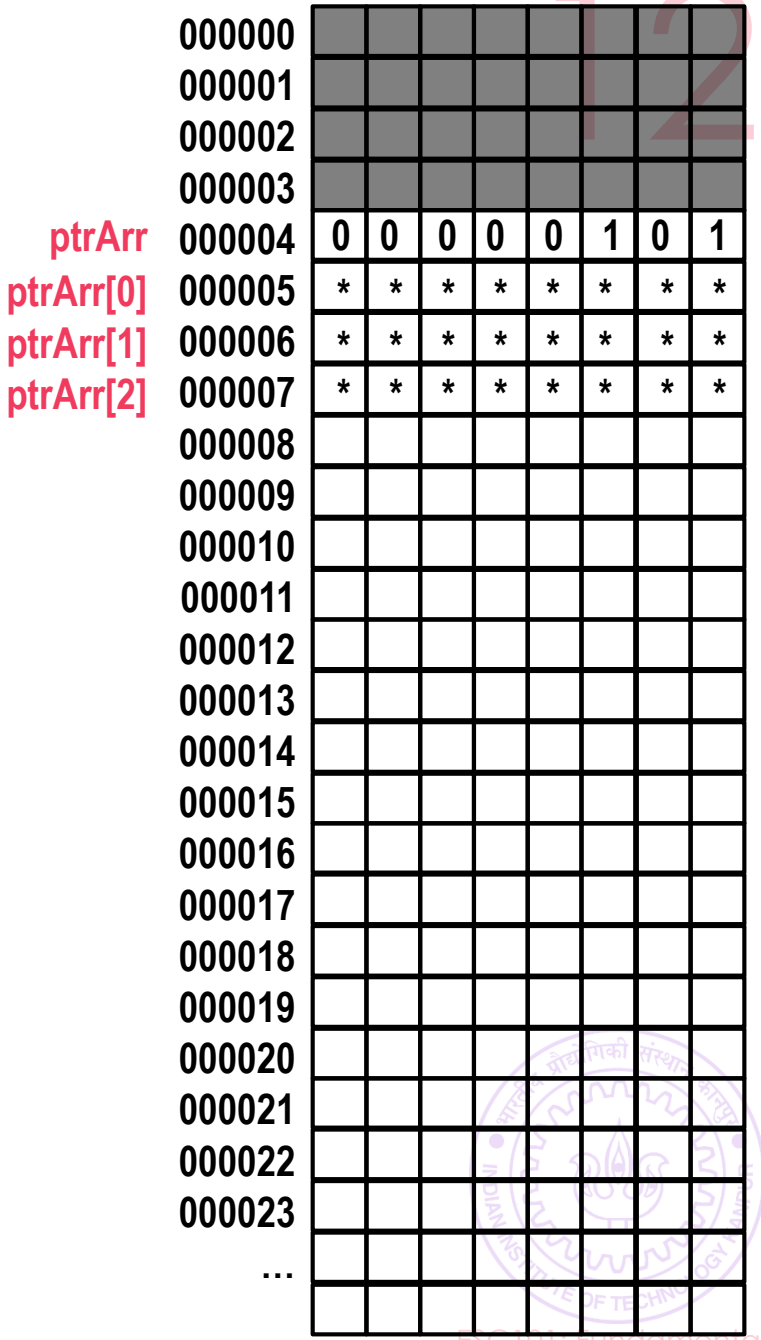

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	000000								
	000001								
	000002								
	000003								
ptrArr	000004	0	0	0	0	0	1	0	1
ptrArr[0]	000005	*	*	*	*	*	*	*	*
ptrArr[1]	000006	*	*	*	*	*	*	*	*
ptrArr[2]	000007	*	*	*	*	*	*	*	*
	000008								
	000009								
	000010								
	000011								
	000012								
	000013								
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All elements of ptrArr array will take 8 bytes to store – sorry for not drawing accurately

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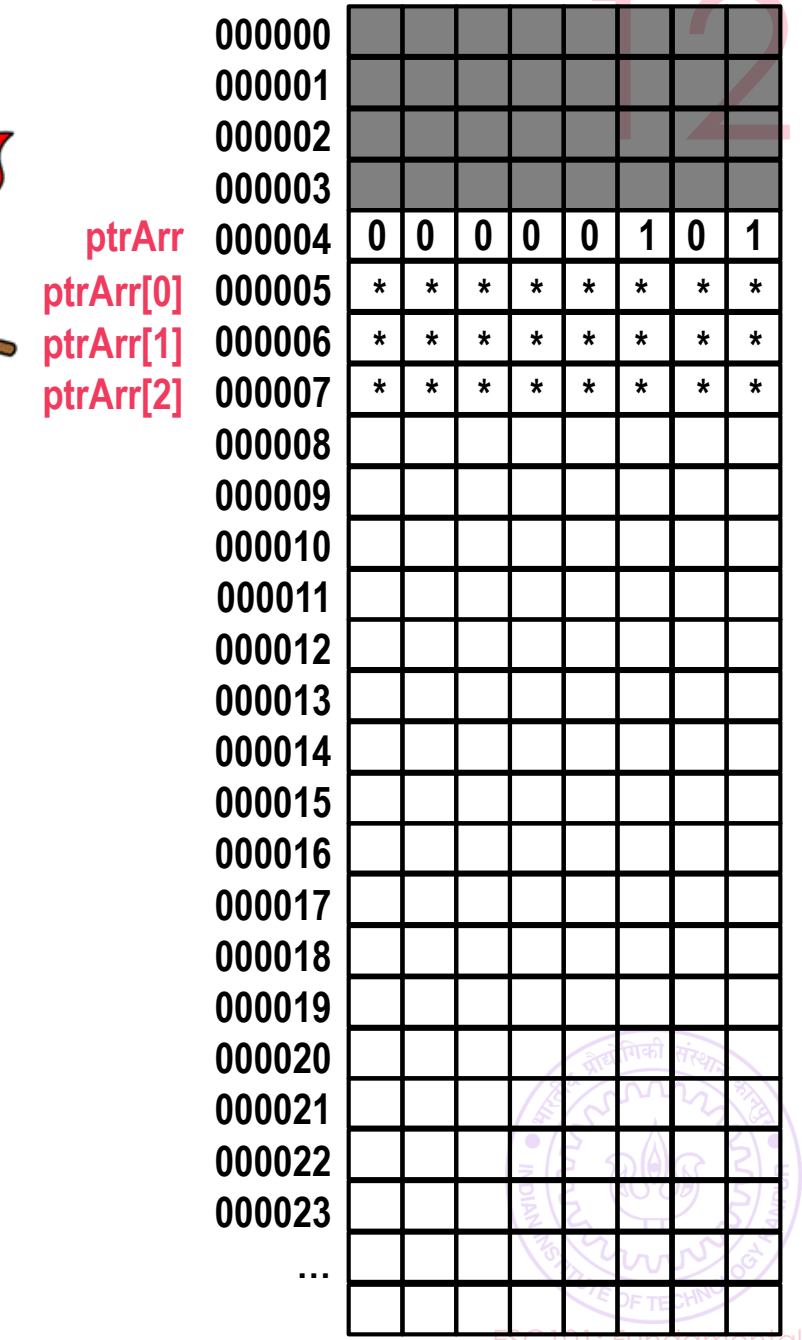

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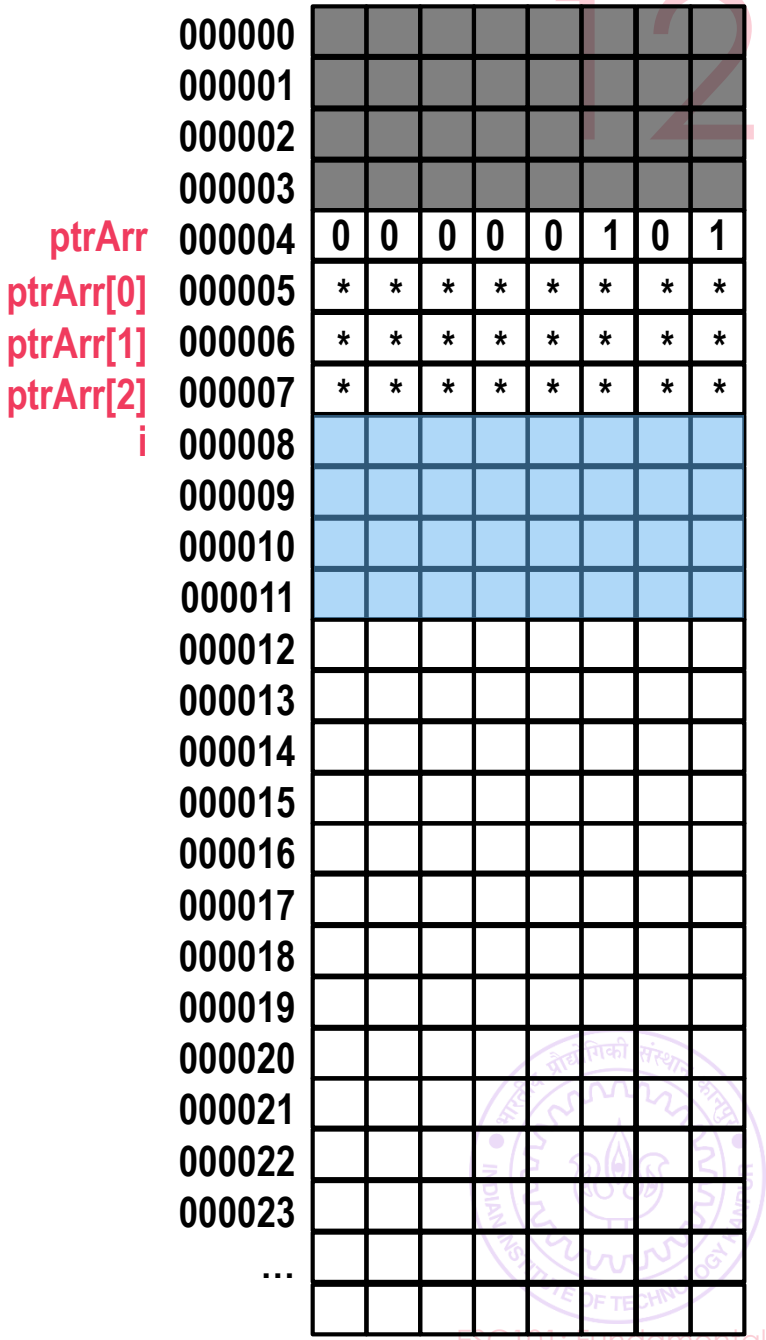

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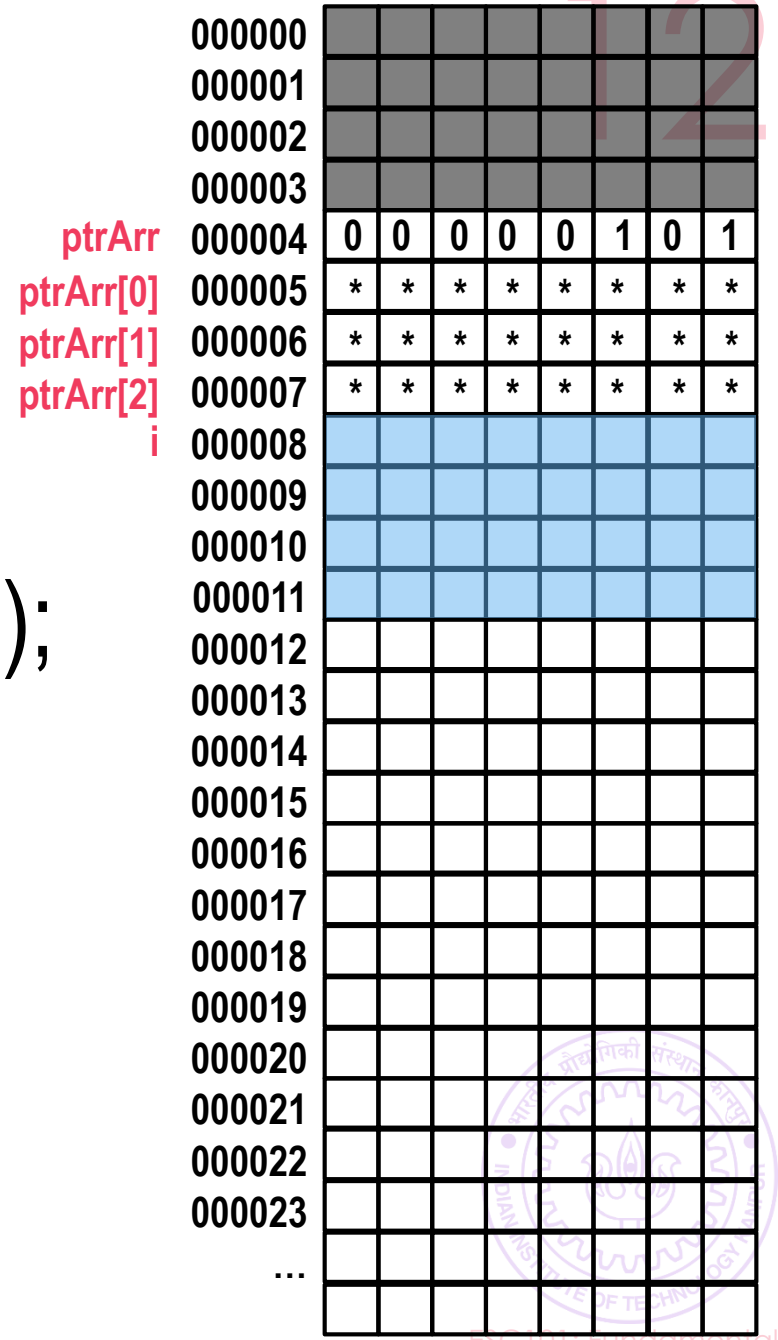

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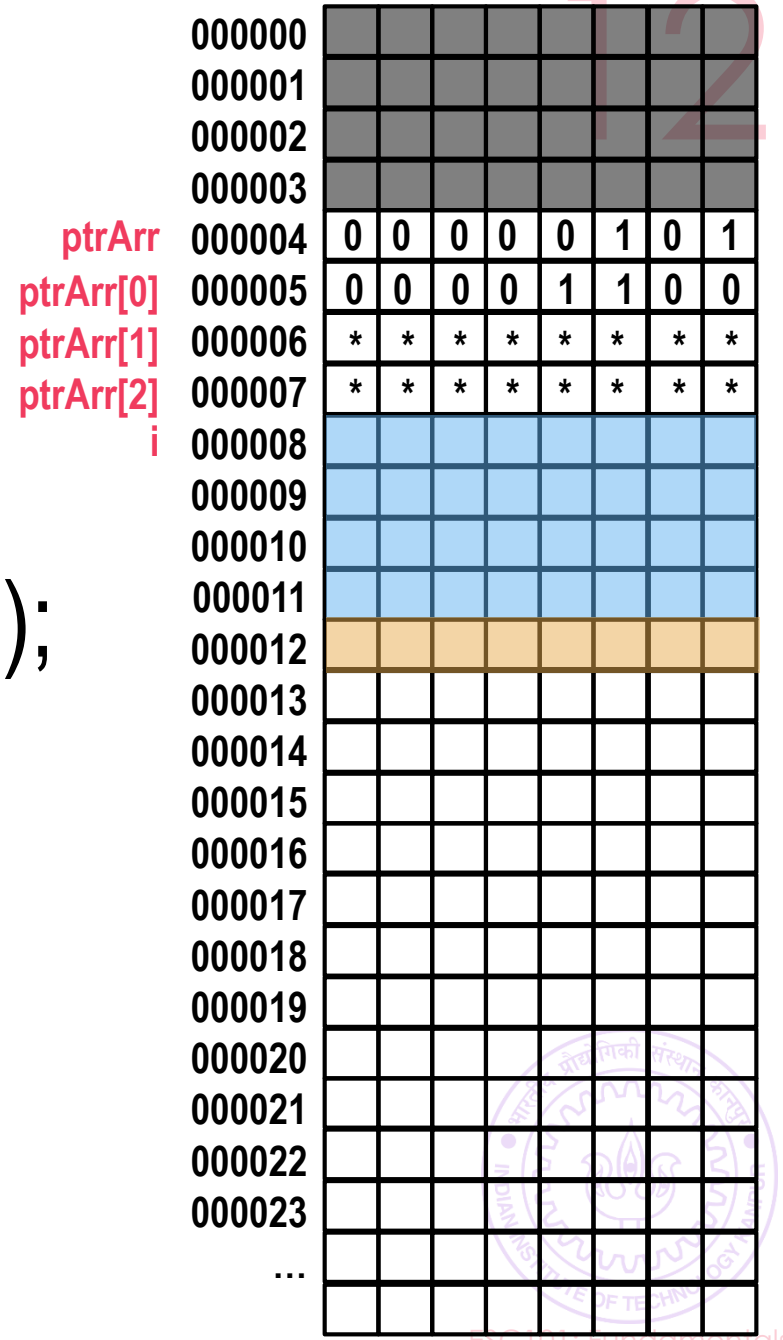

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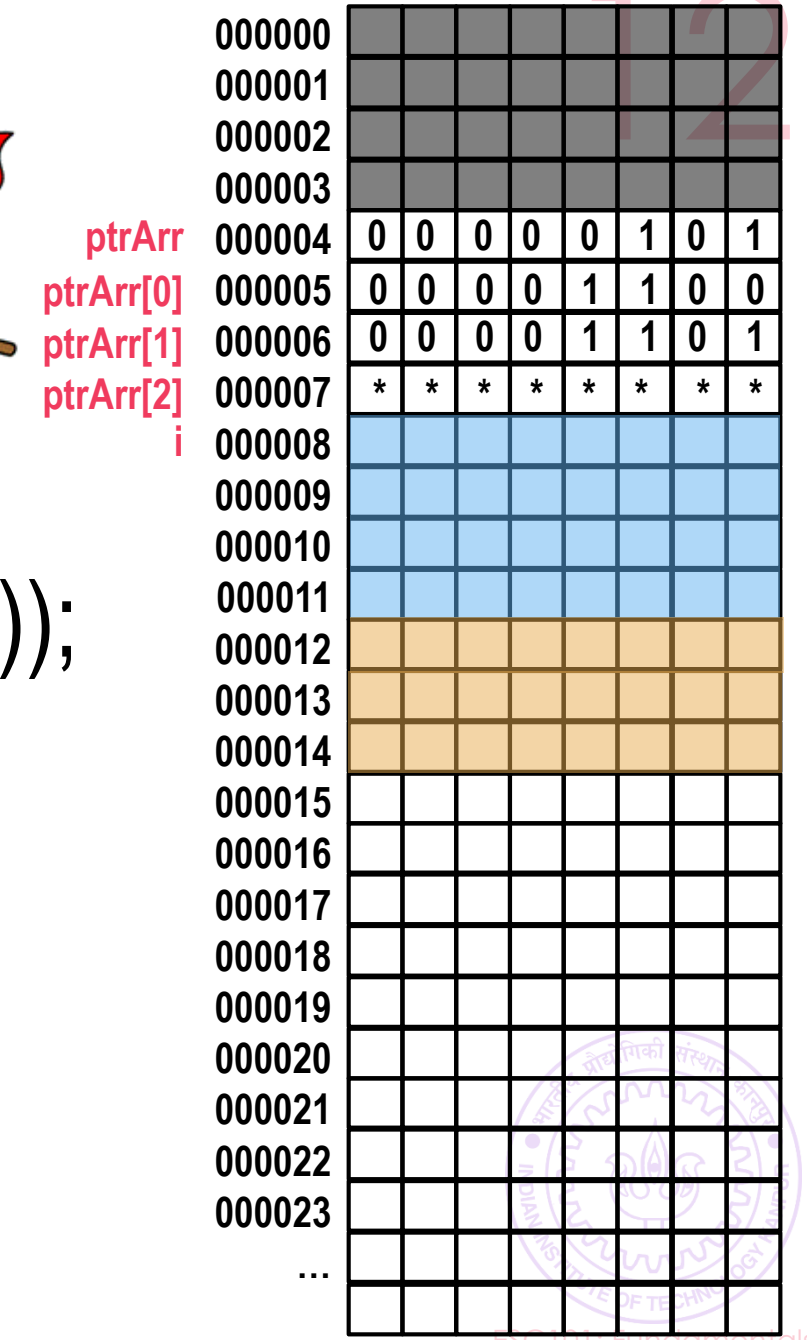

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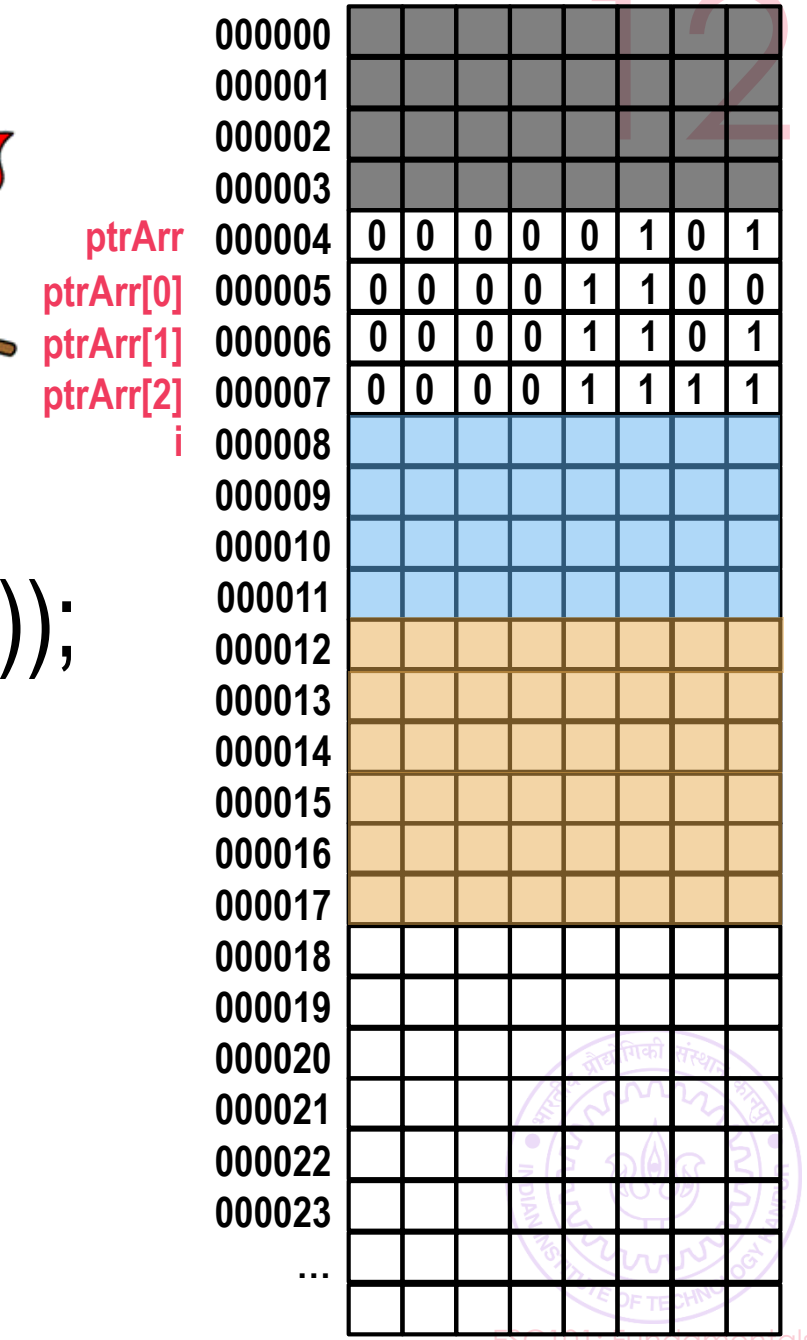

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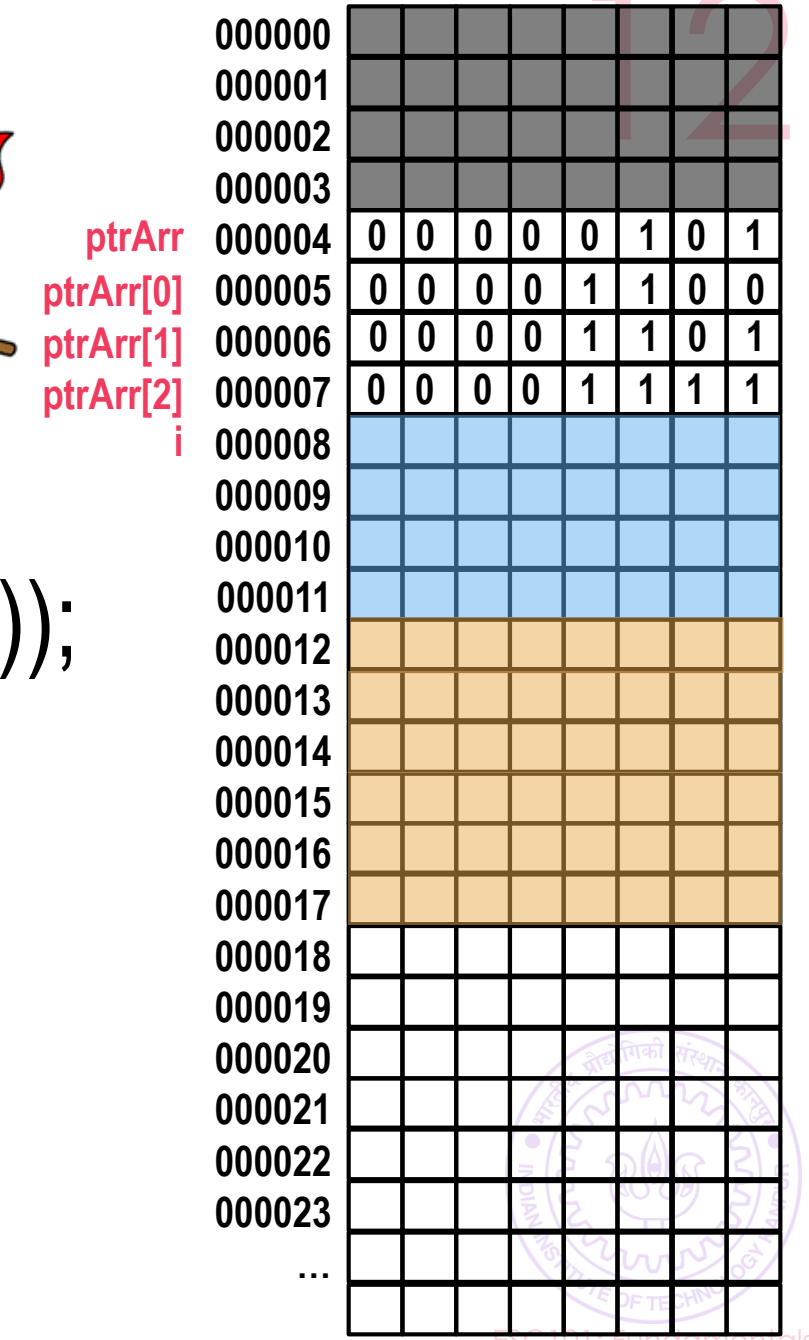

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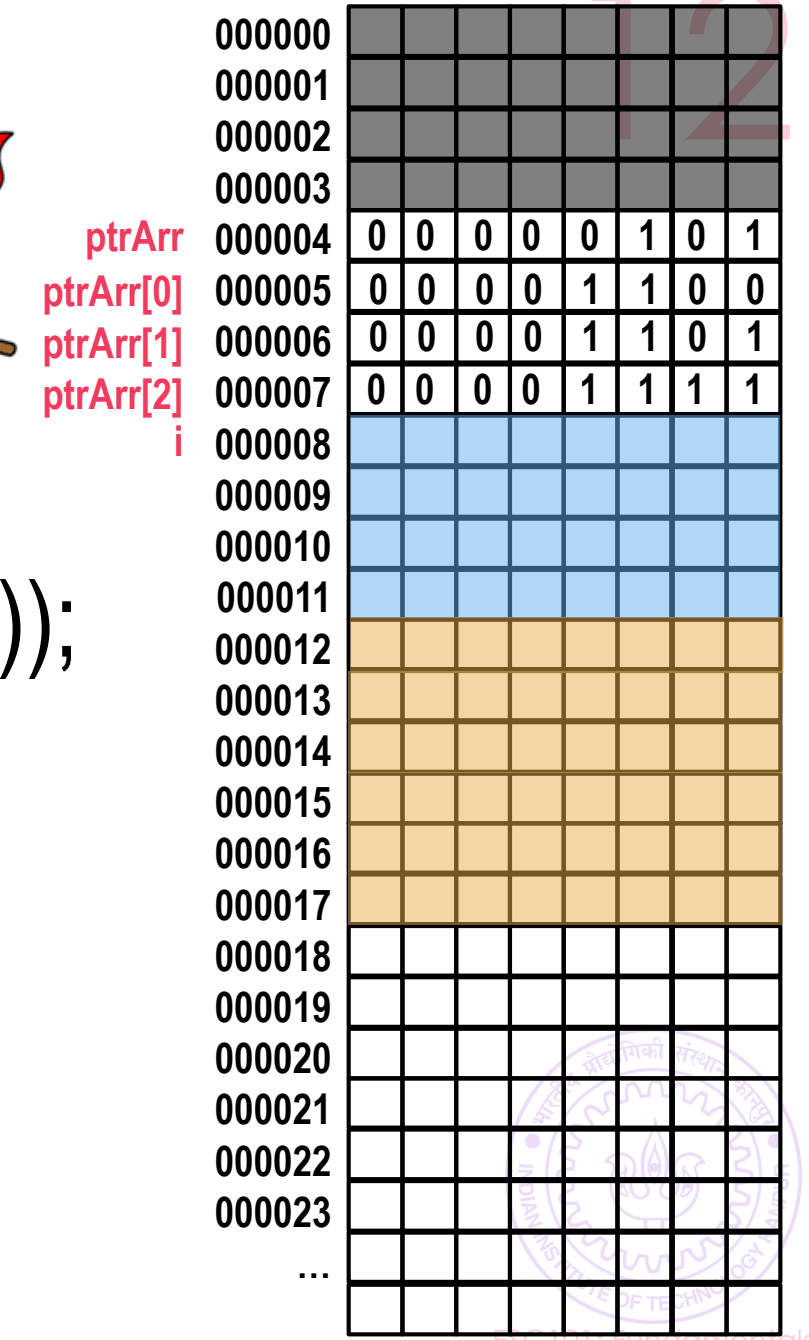

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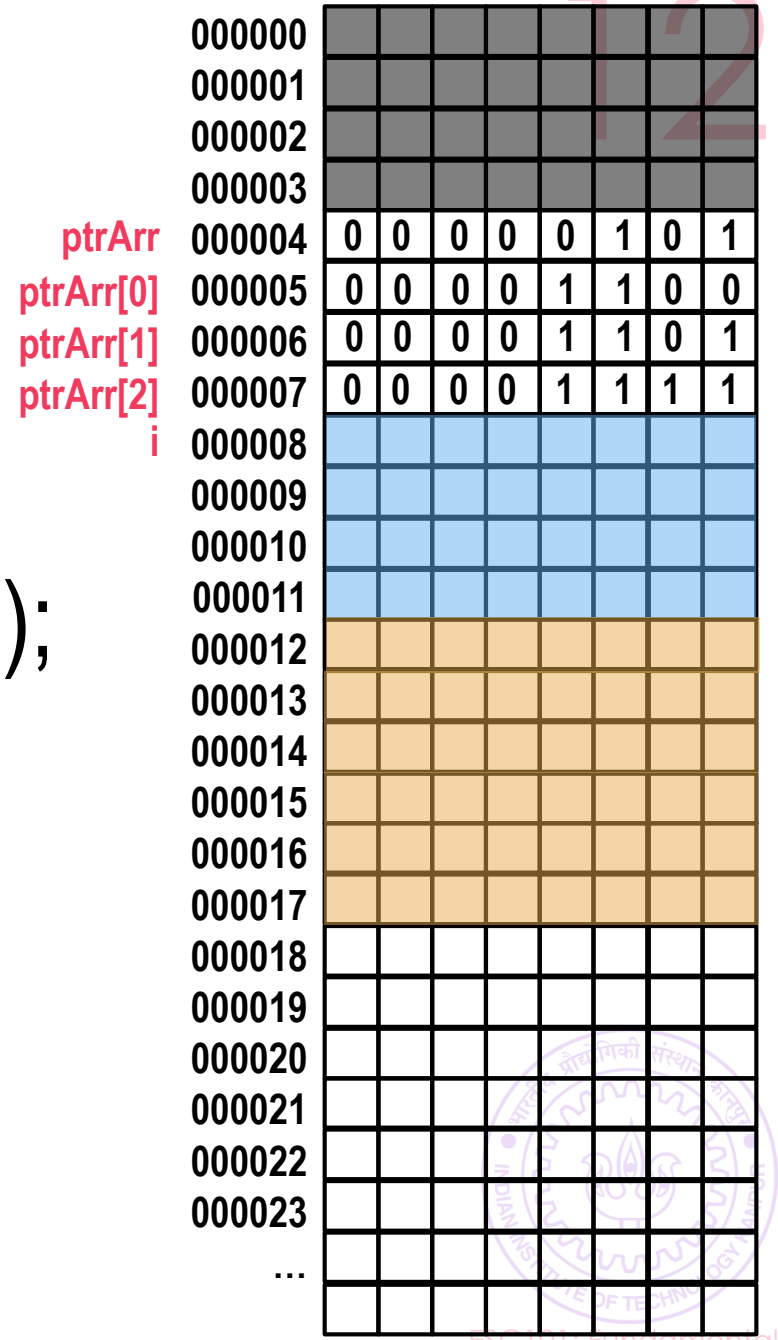

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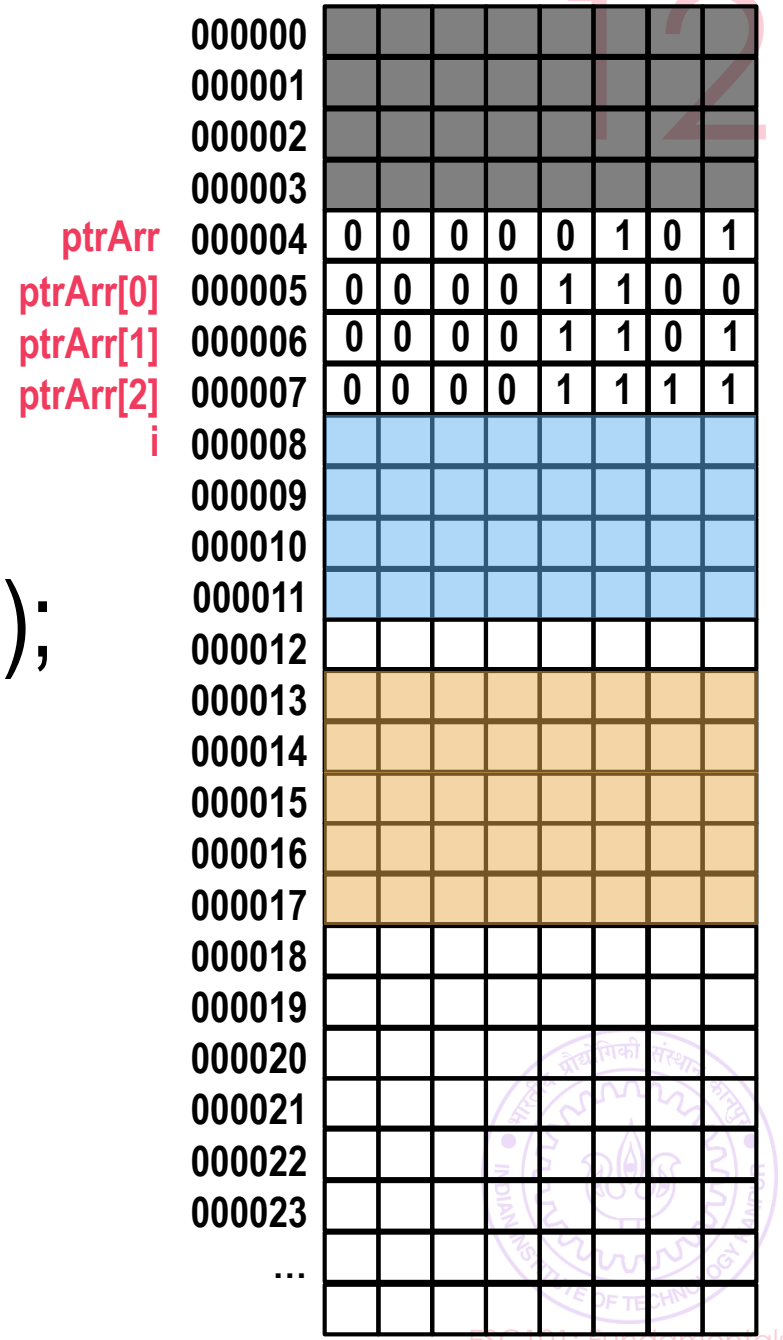

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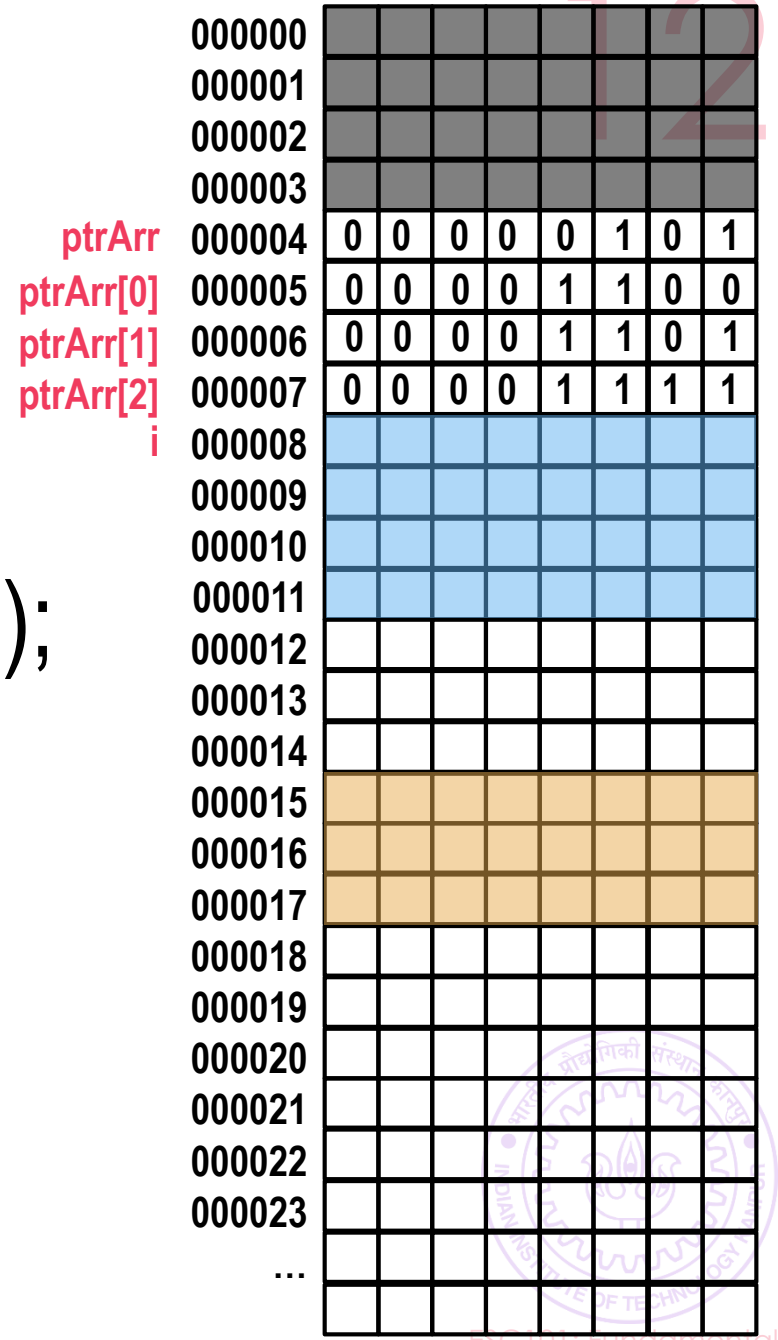

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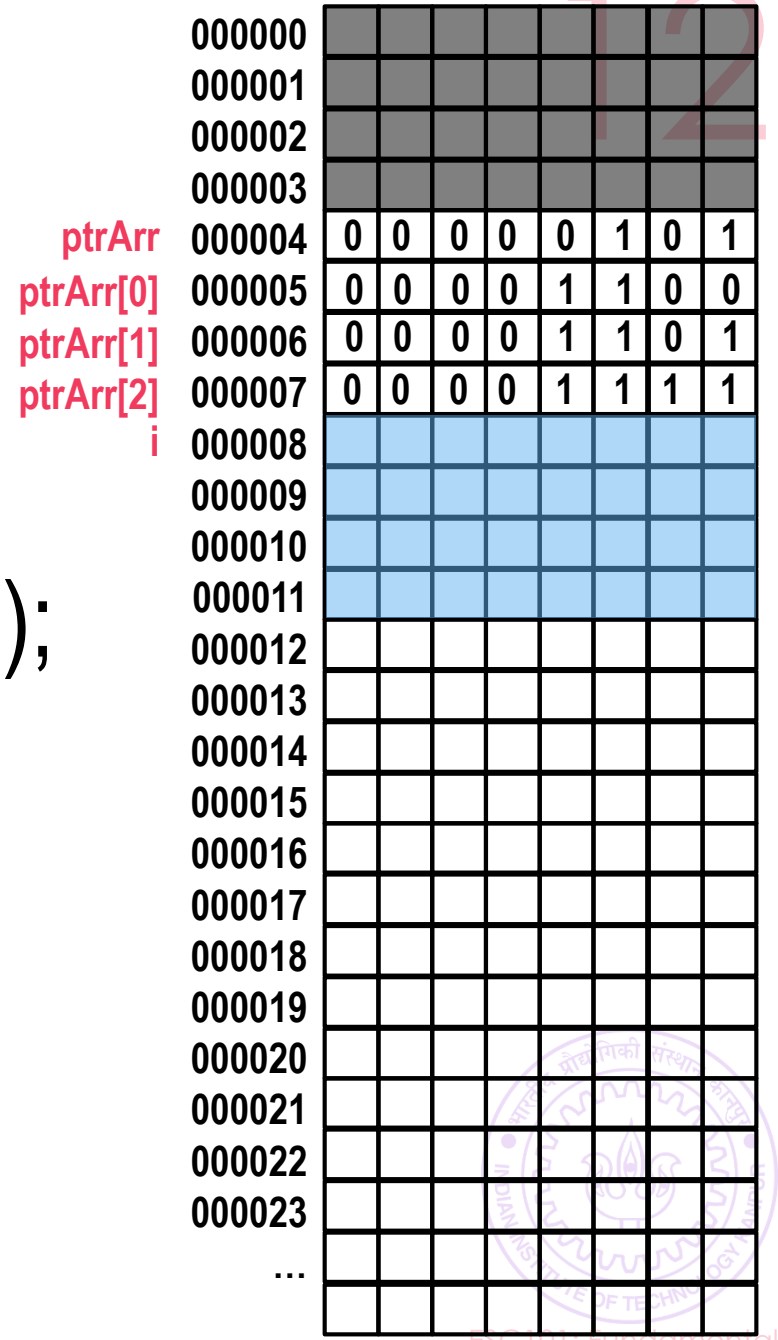

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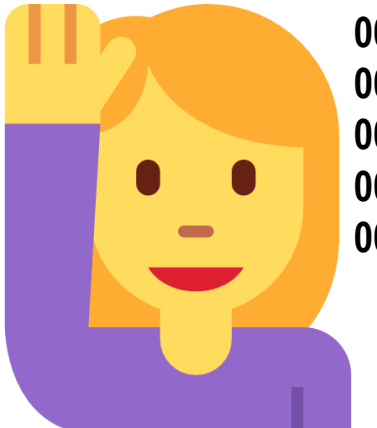

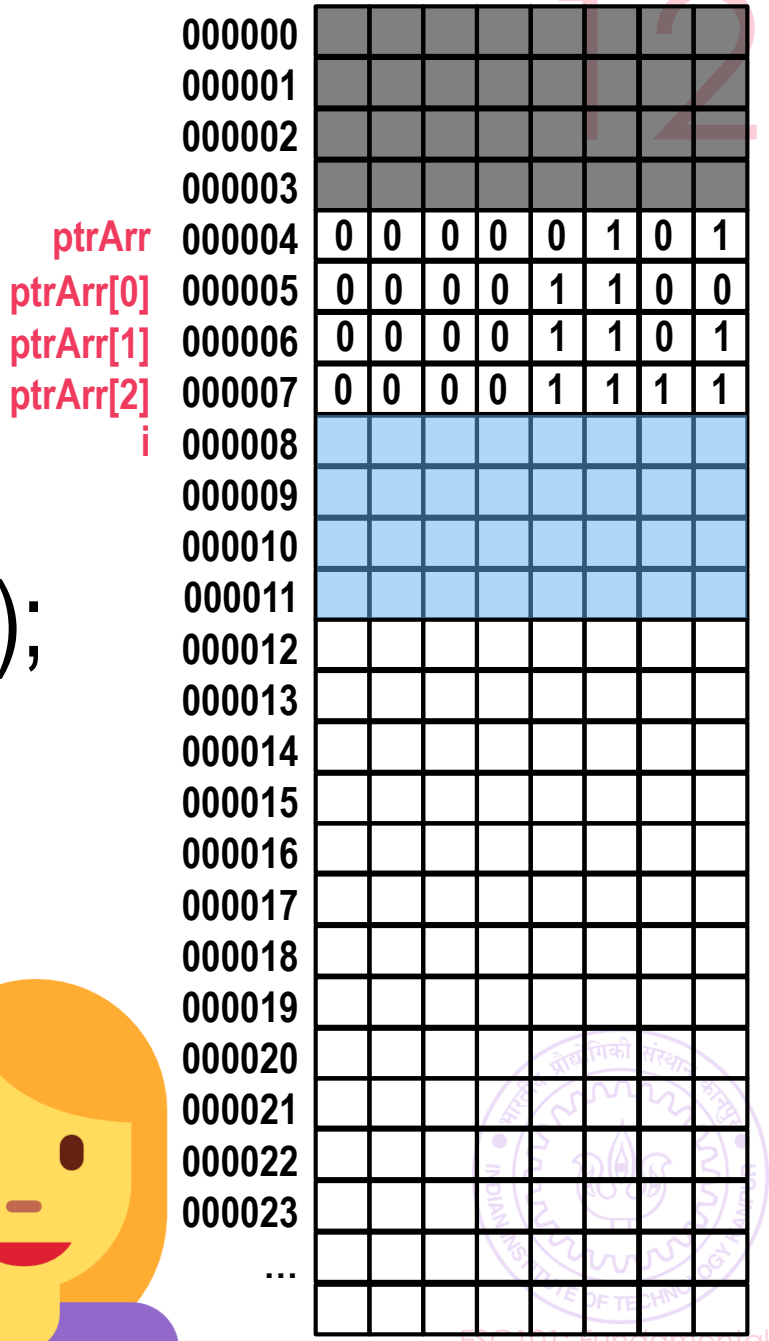

All elements of ptrArr array will take 8 bytes to store – sorry for not drawing accurately

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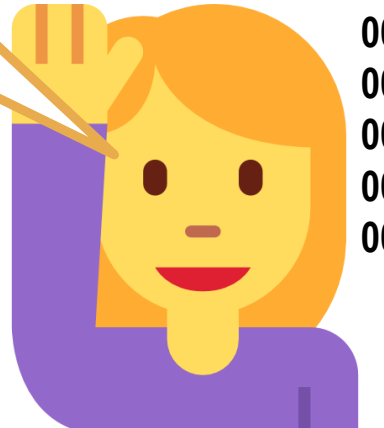
Very useful in programs where we have to create a known number of arrays of unknown length



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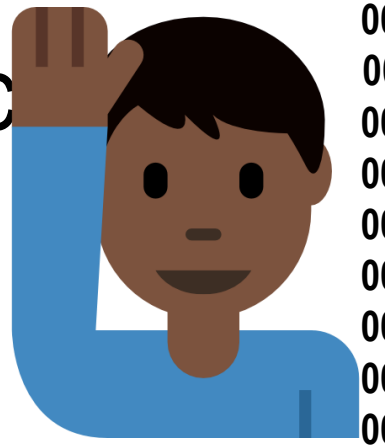

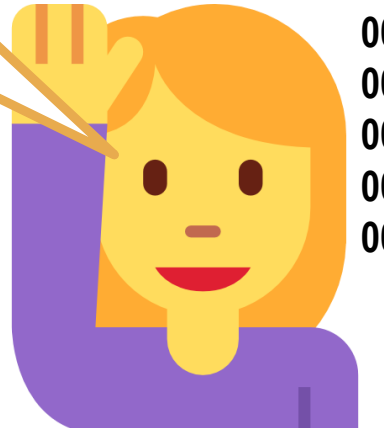

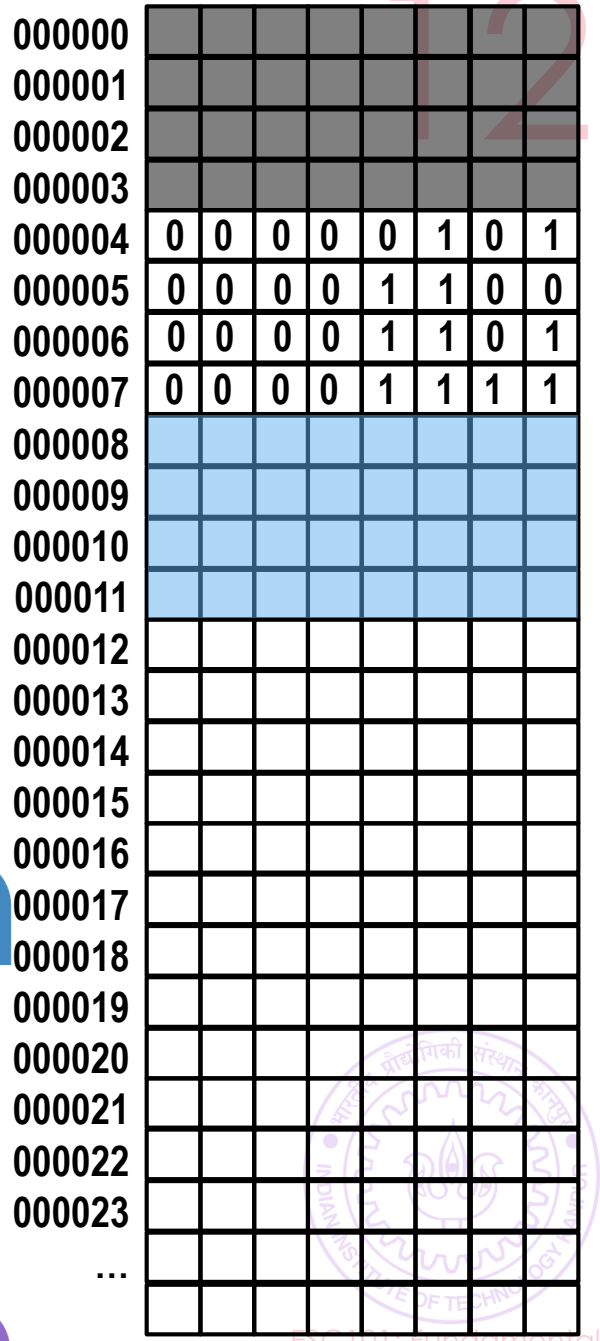

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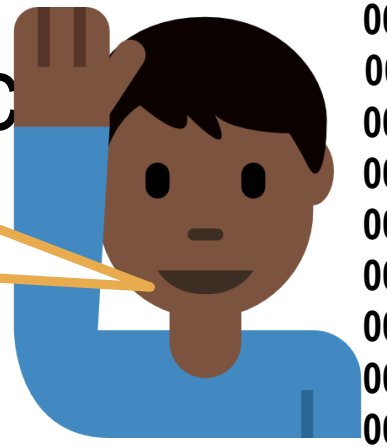

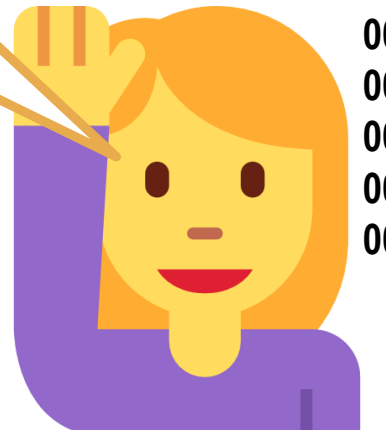

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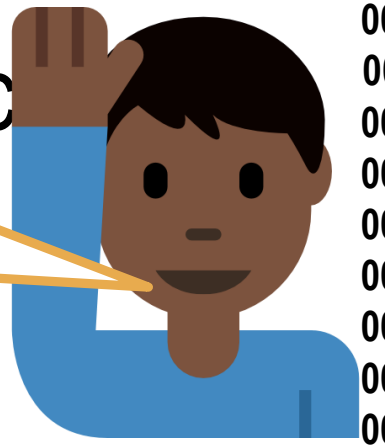

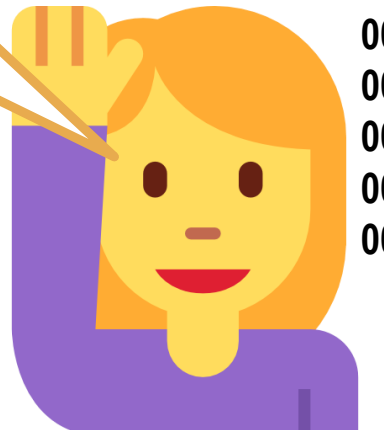

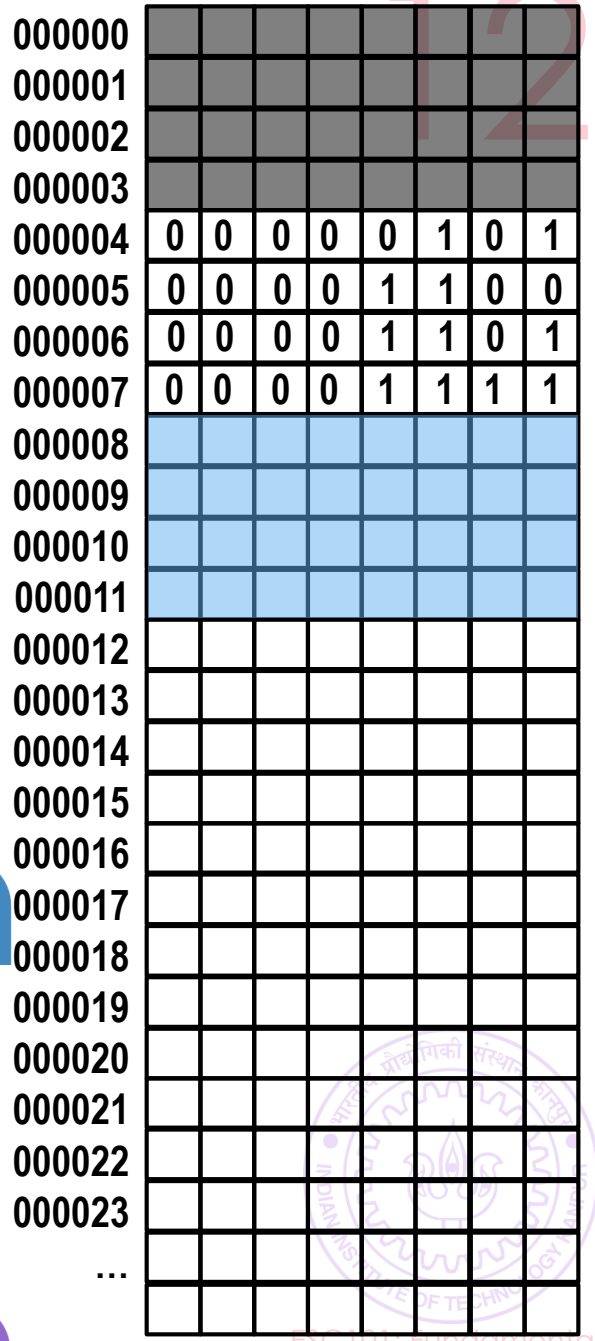

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	000000							
	000001							
	000002							
	000003							
ptrArr	000004	0	0	0	0	0	1	0	1
ptrArr[0]	000005	0	0	0	0	1	1	0	0
ptrArr[1]	000006	0	0	0	0	1	1	0	1
ptrArr[2]	000007	0	0	0	0	1	1	1	1
i	000008								
	000009								
	000010								
	000011								
	000012								
	000013								
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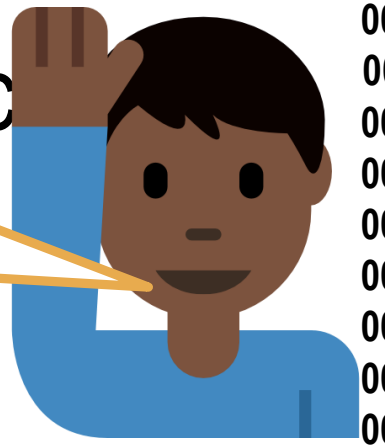

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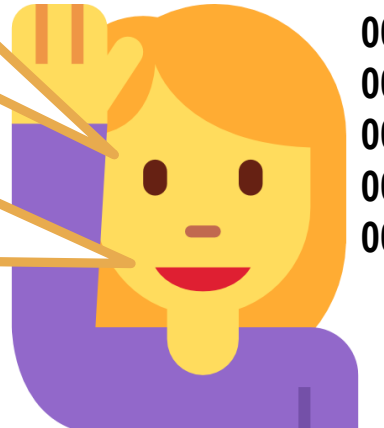

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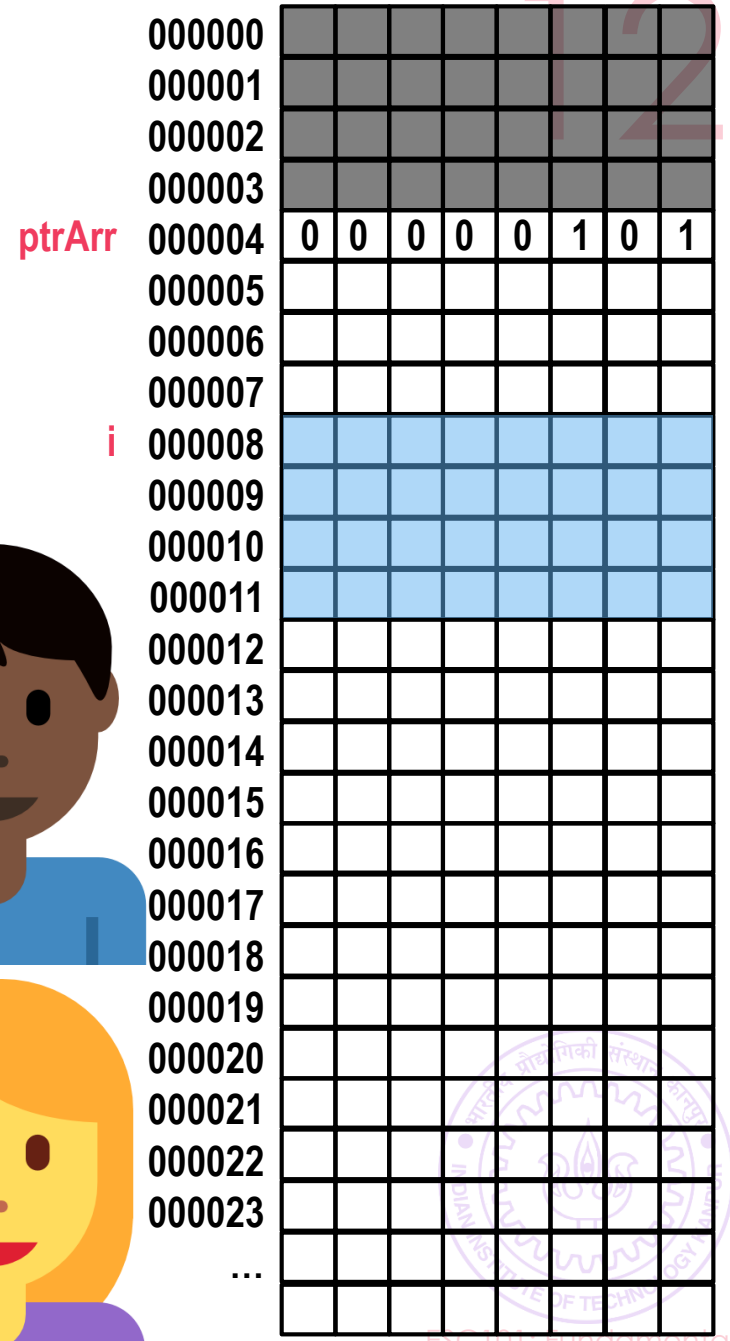

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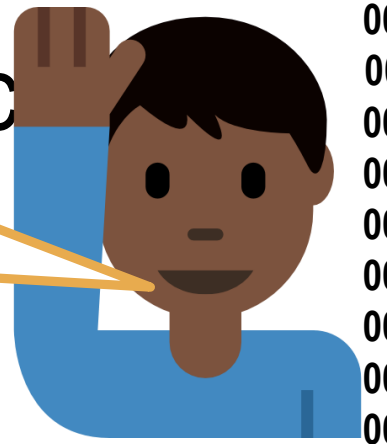

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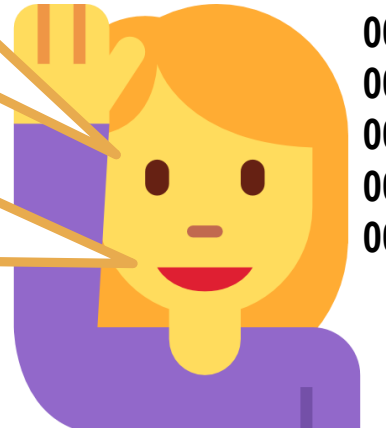

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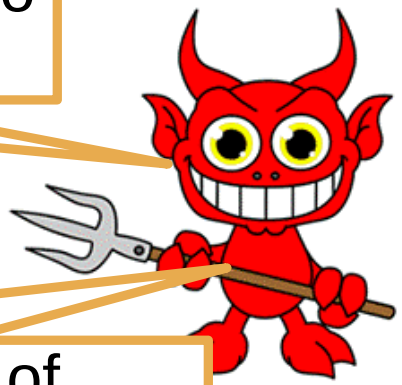

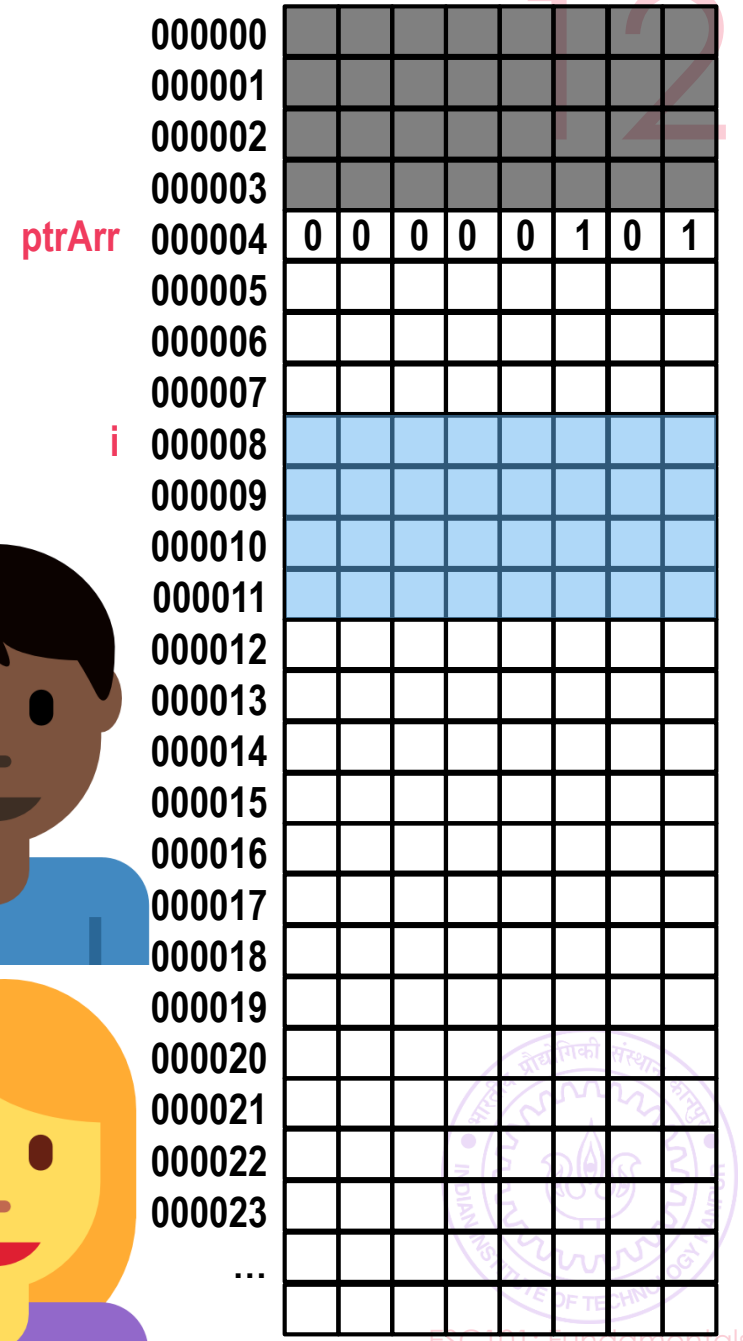

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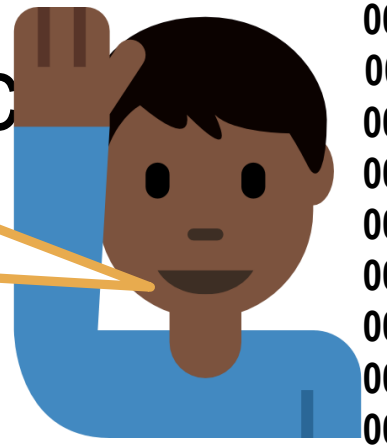

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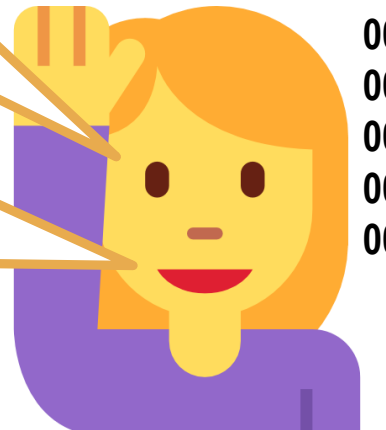

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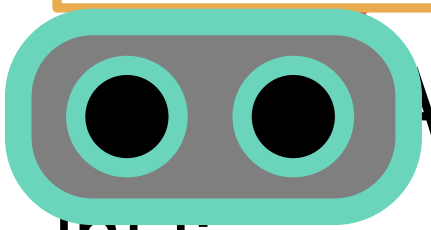

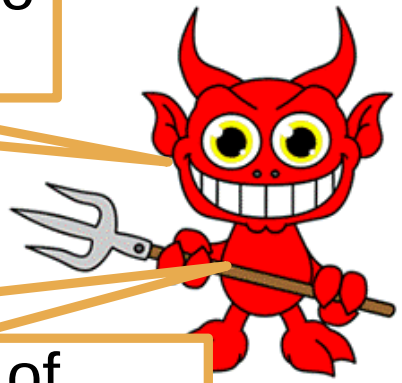

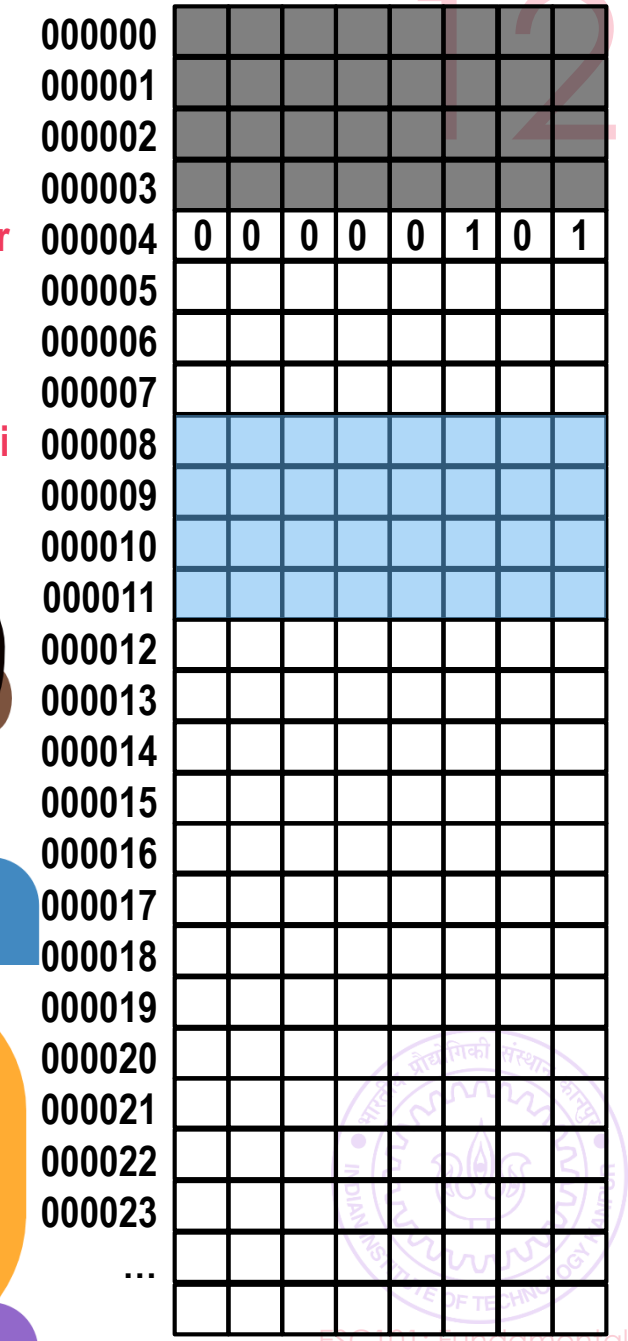

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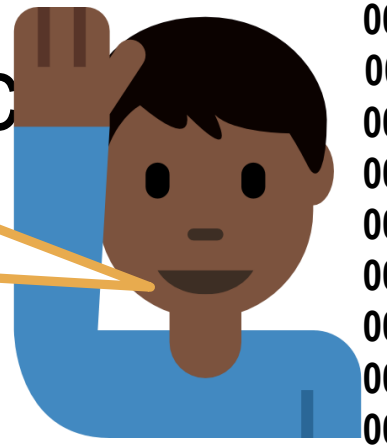

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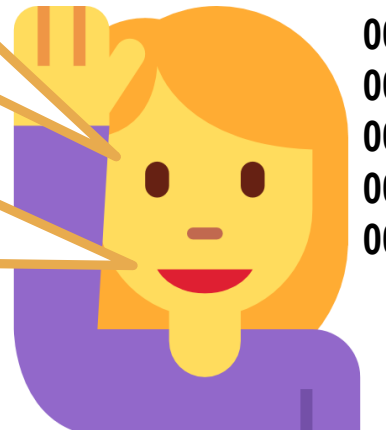

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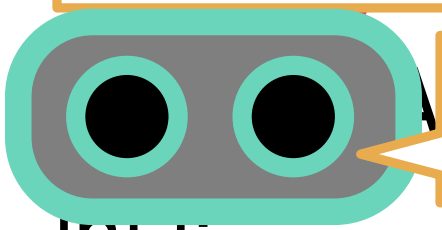

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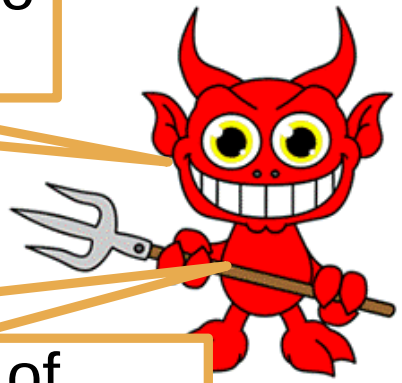

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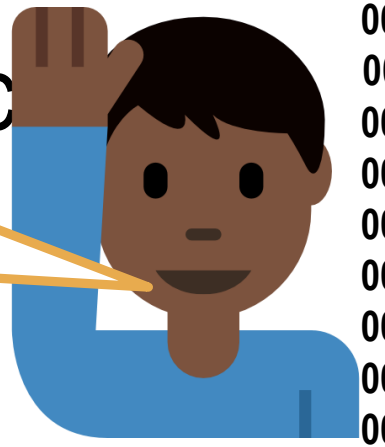

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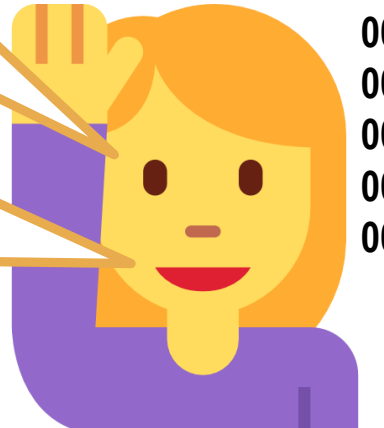

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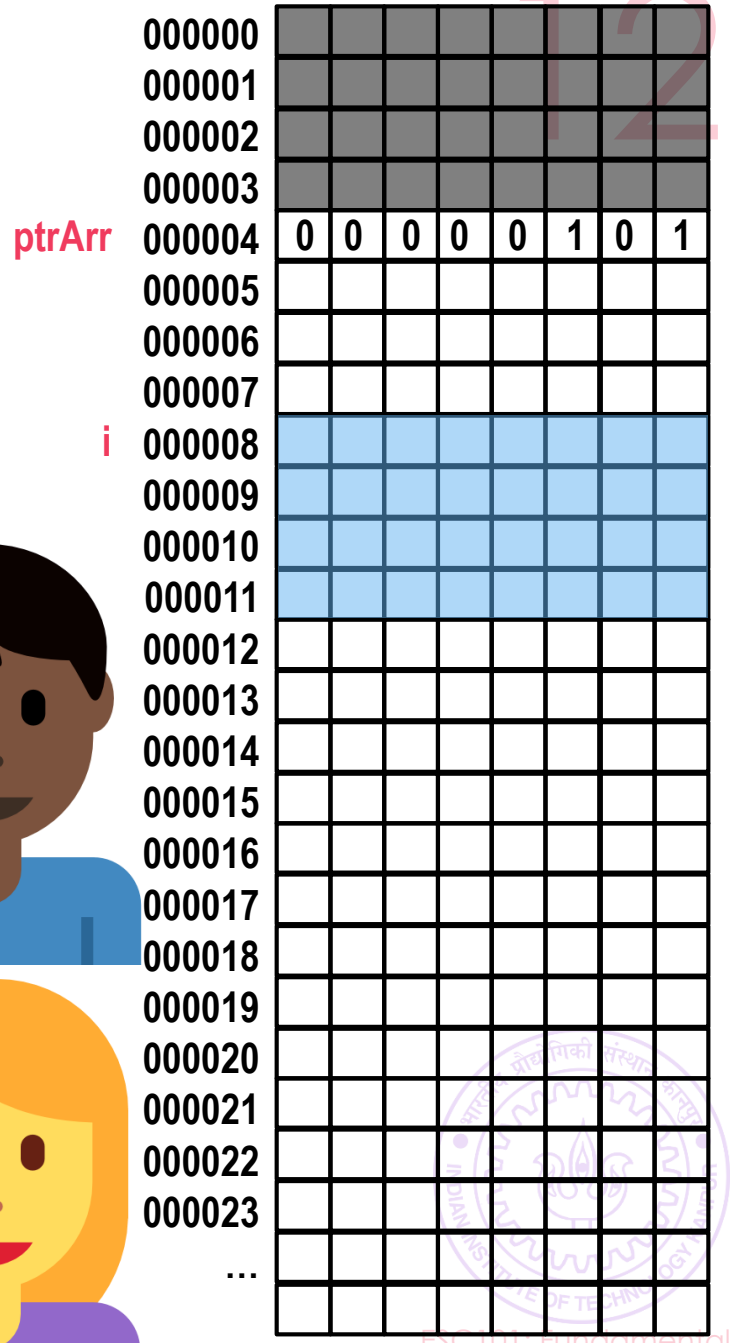

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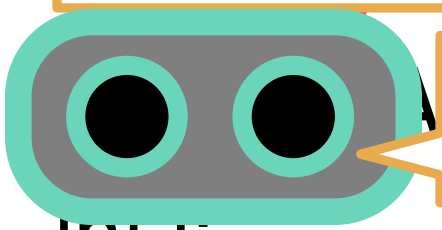

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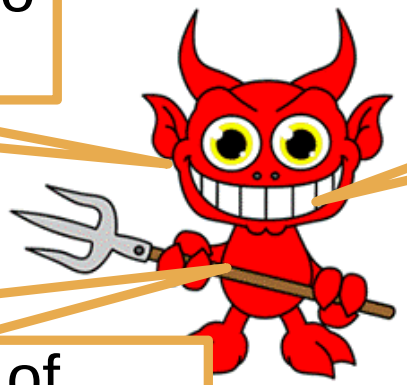

Anything for you, Mr C!

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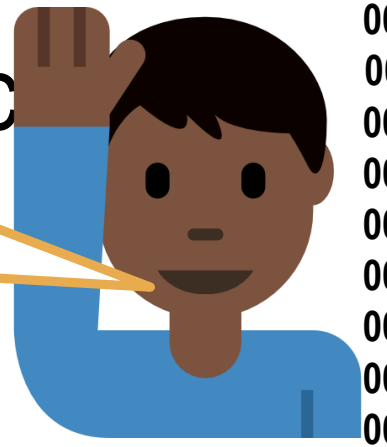

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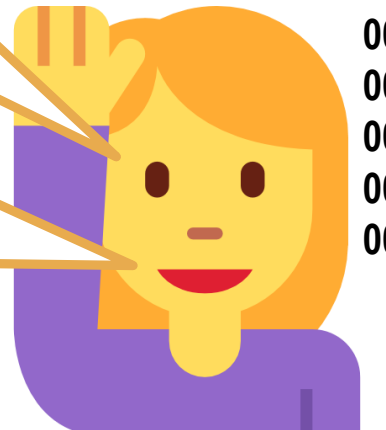

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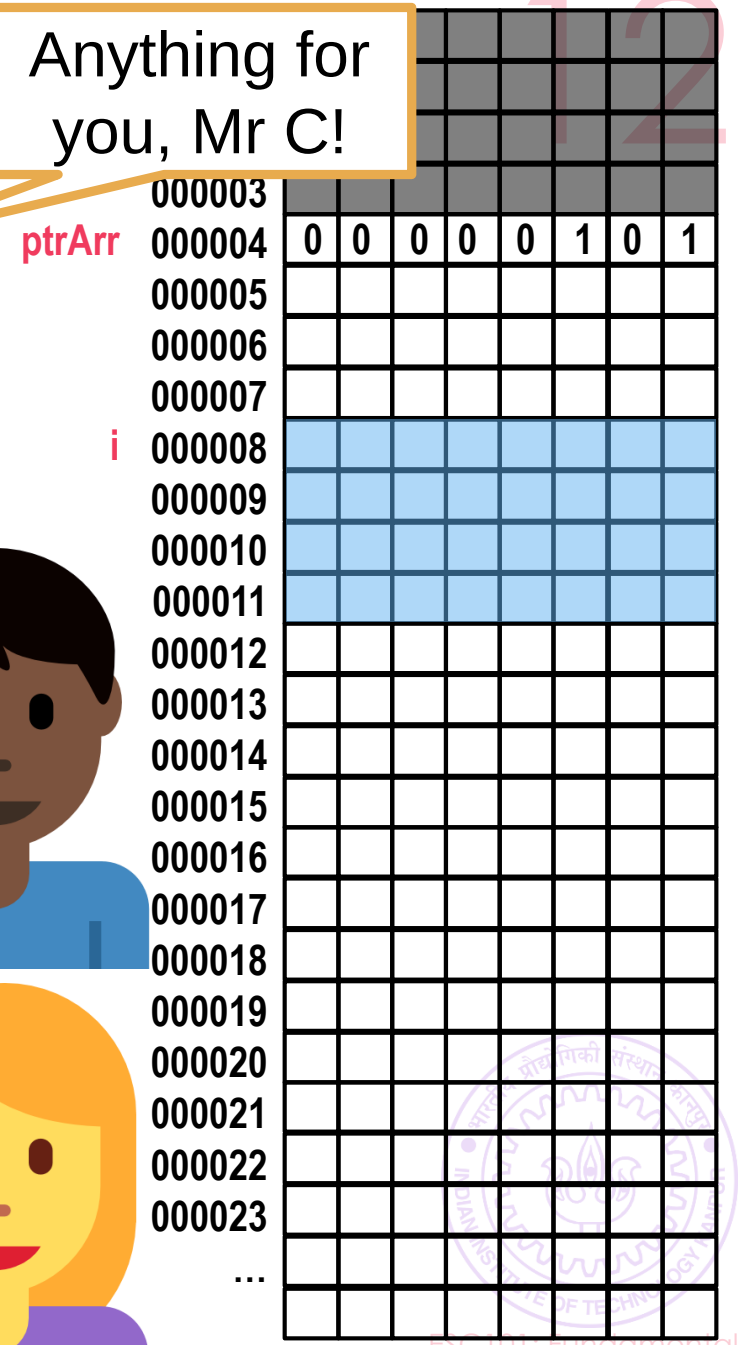

Array of Pointers ➔ Arrays of Arrays

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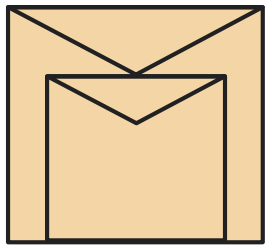

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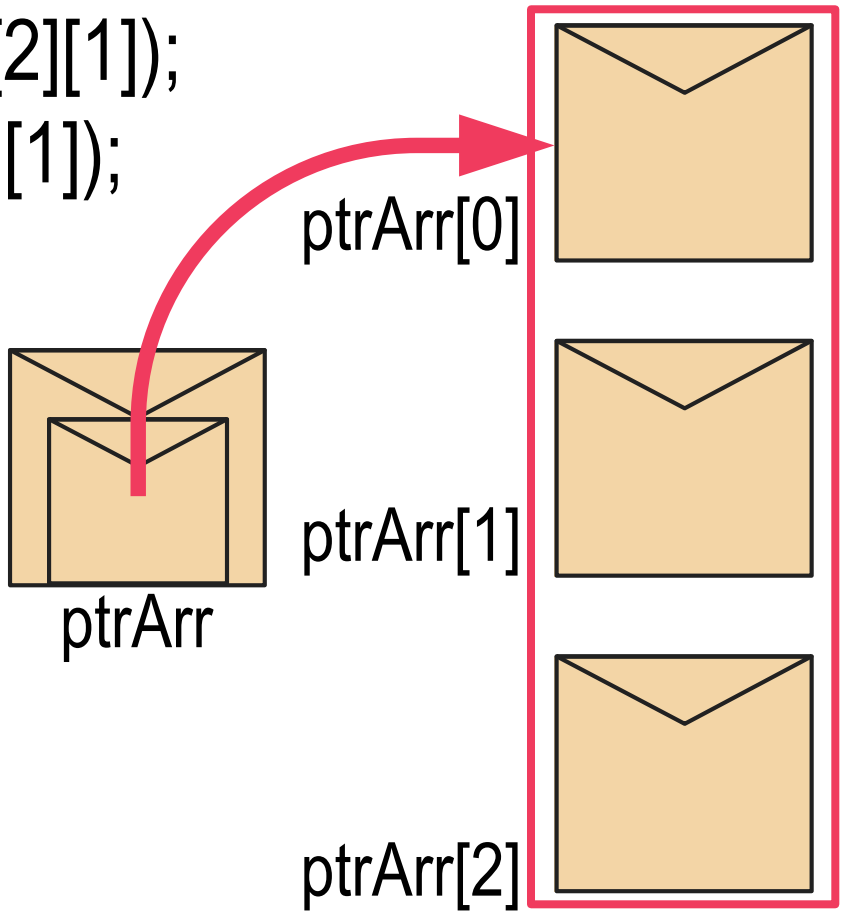

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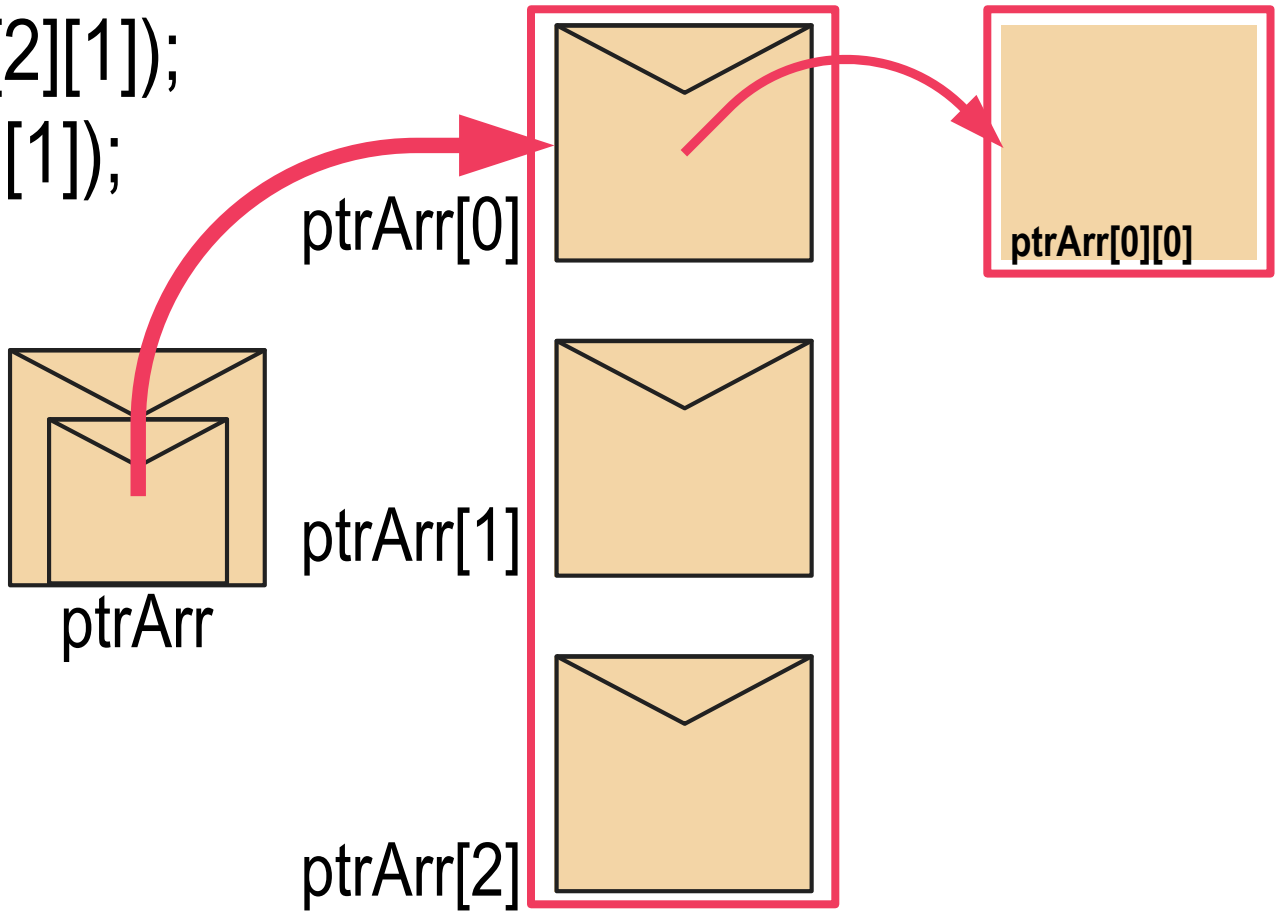

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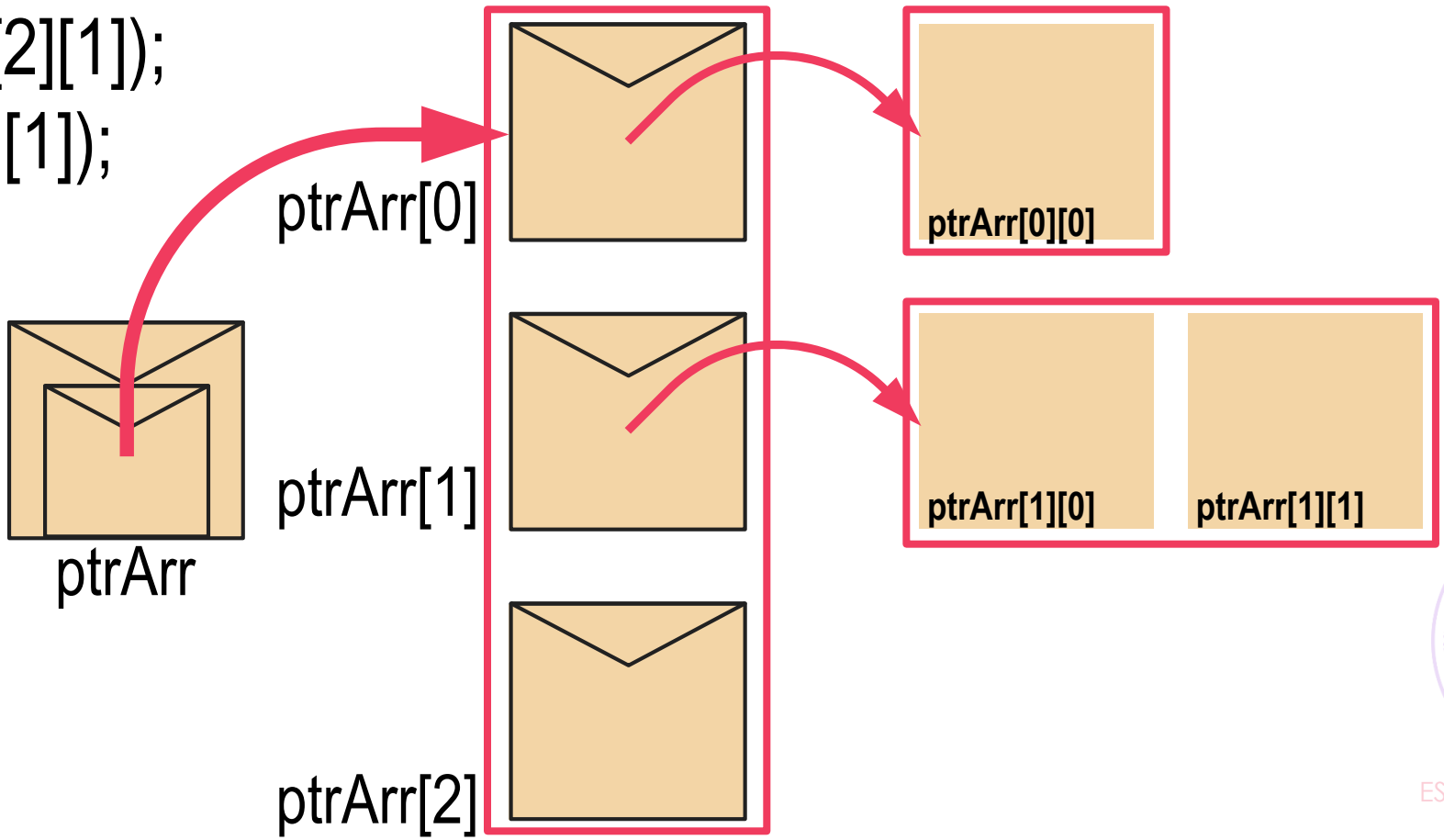

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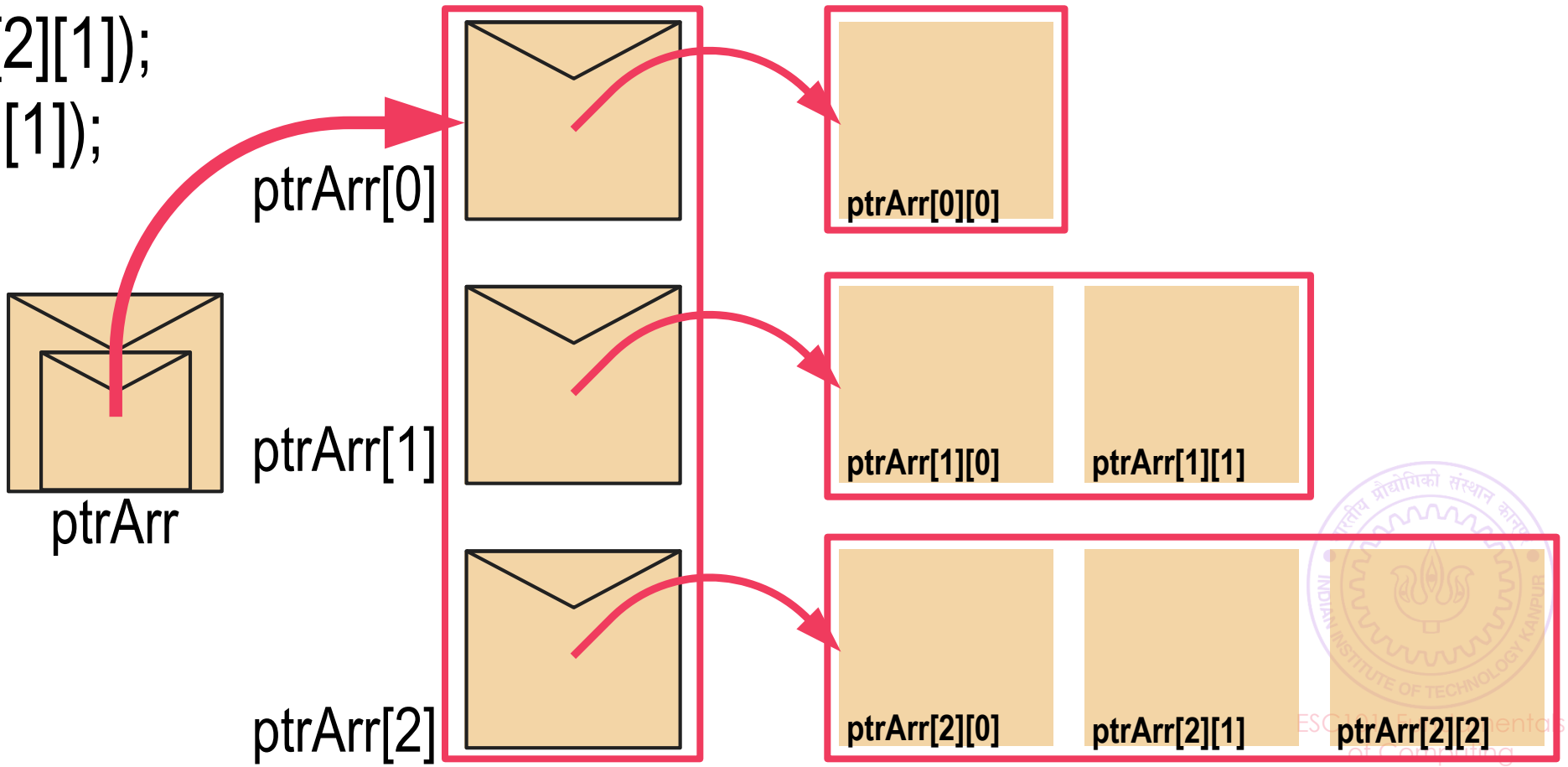

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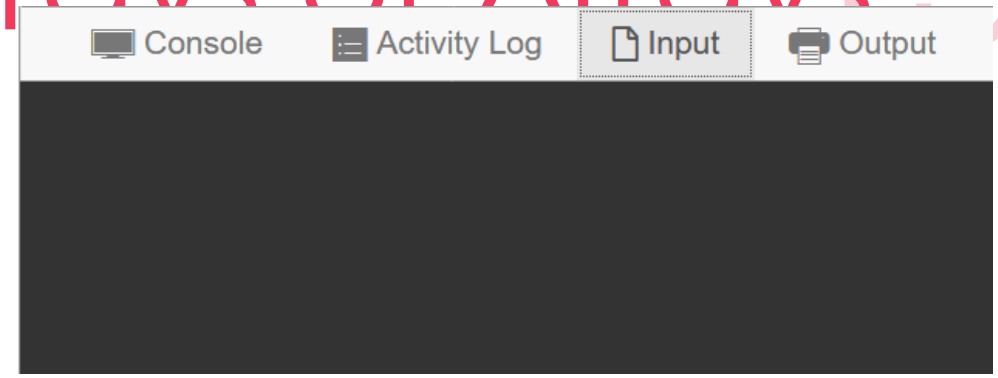

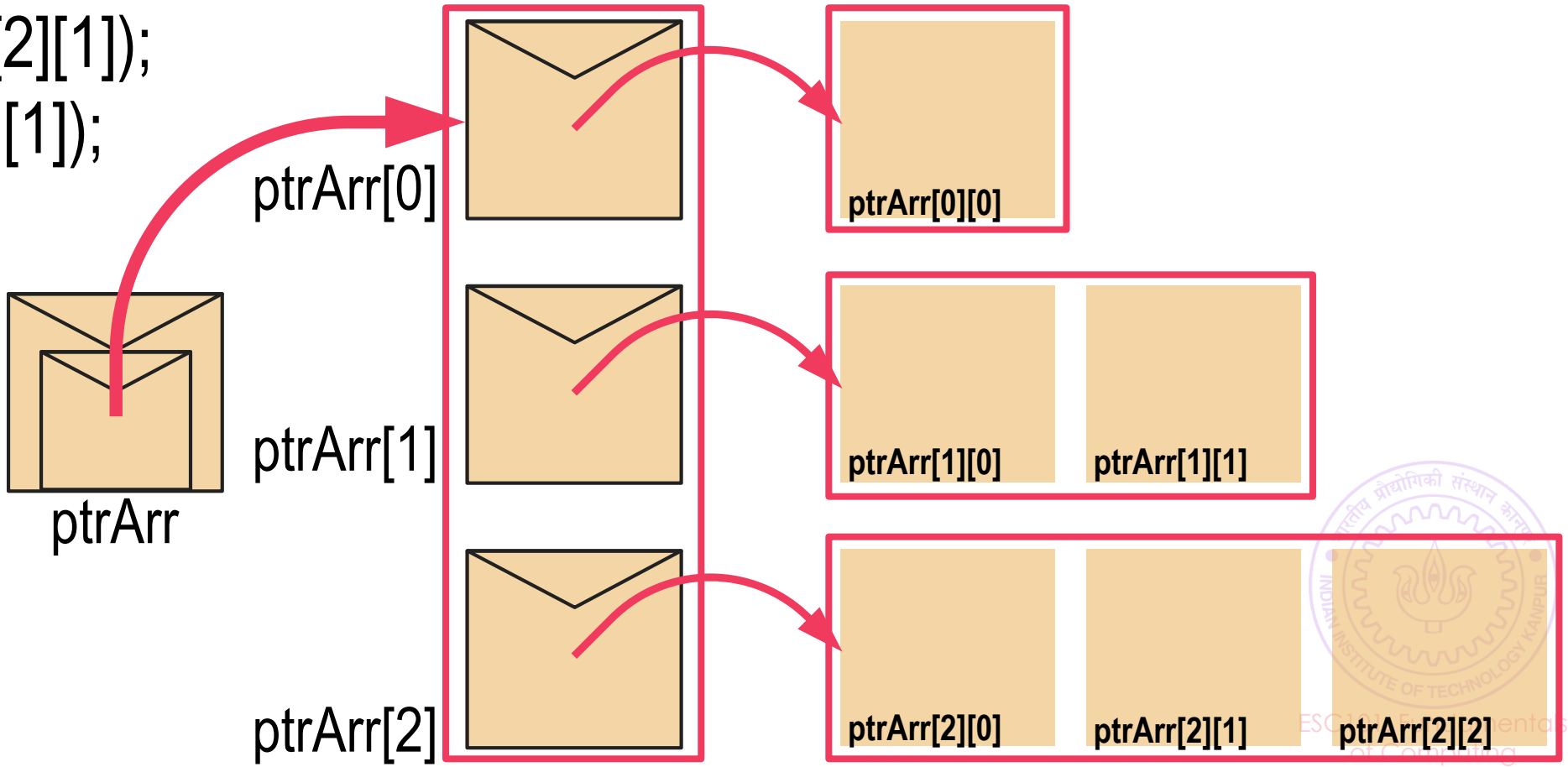

Array of Pointers ➔ Arrays of Arrays

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char **ptrArr = (char**)malloc(3*sizeof(char*));
for(i = 0; i < 3; i++)
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scanf("%c", &ptrArr[2][1]);
printf("%c", ptrArr[2][1]);
for(i = 0; i < 3; i++)
        free(ptrArr[i]);
free(ptrArr);
```
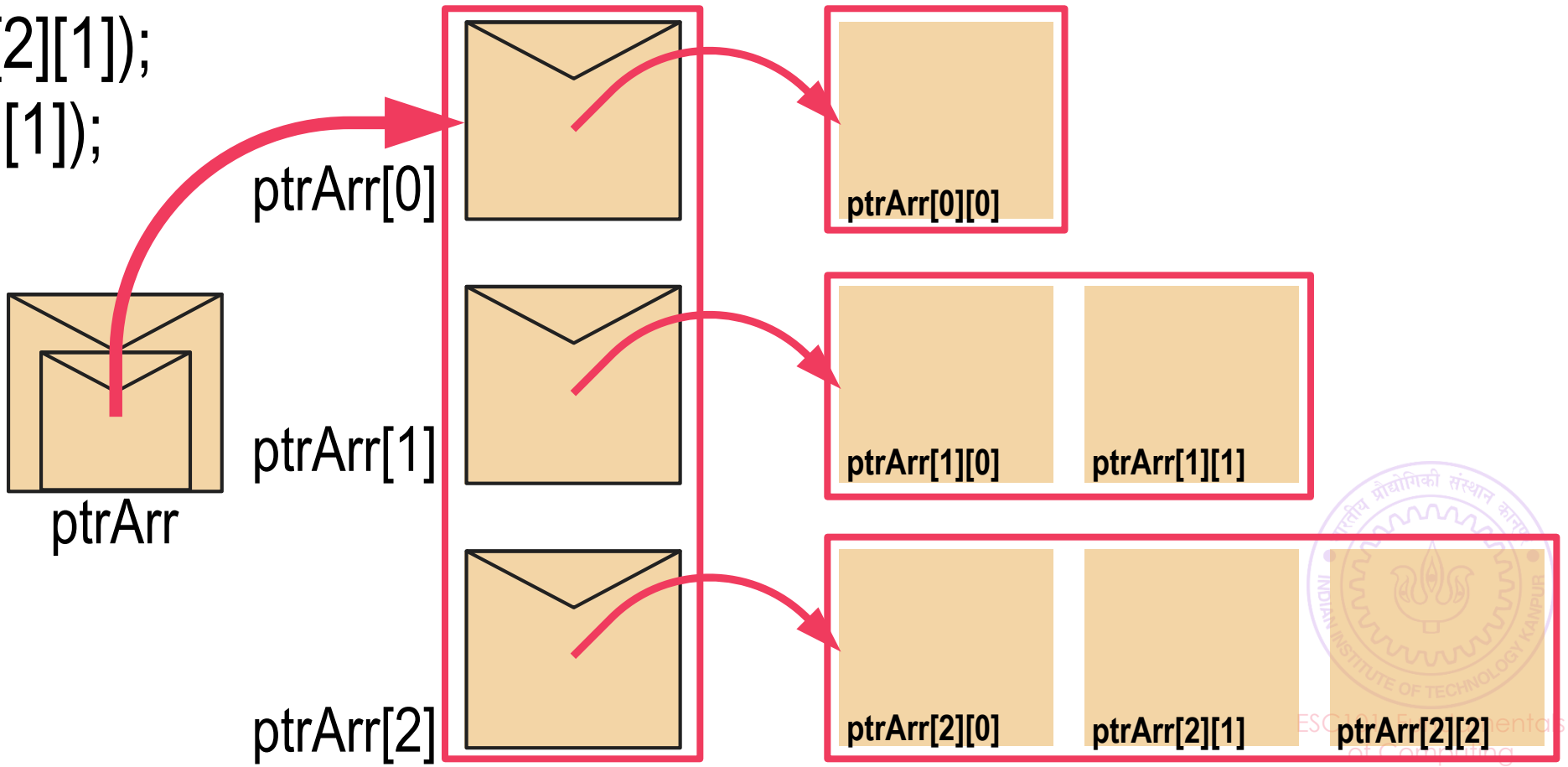

Console | Activity Log | Input | Output

X



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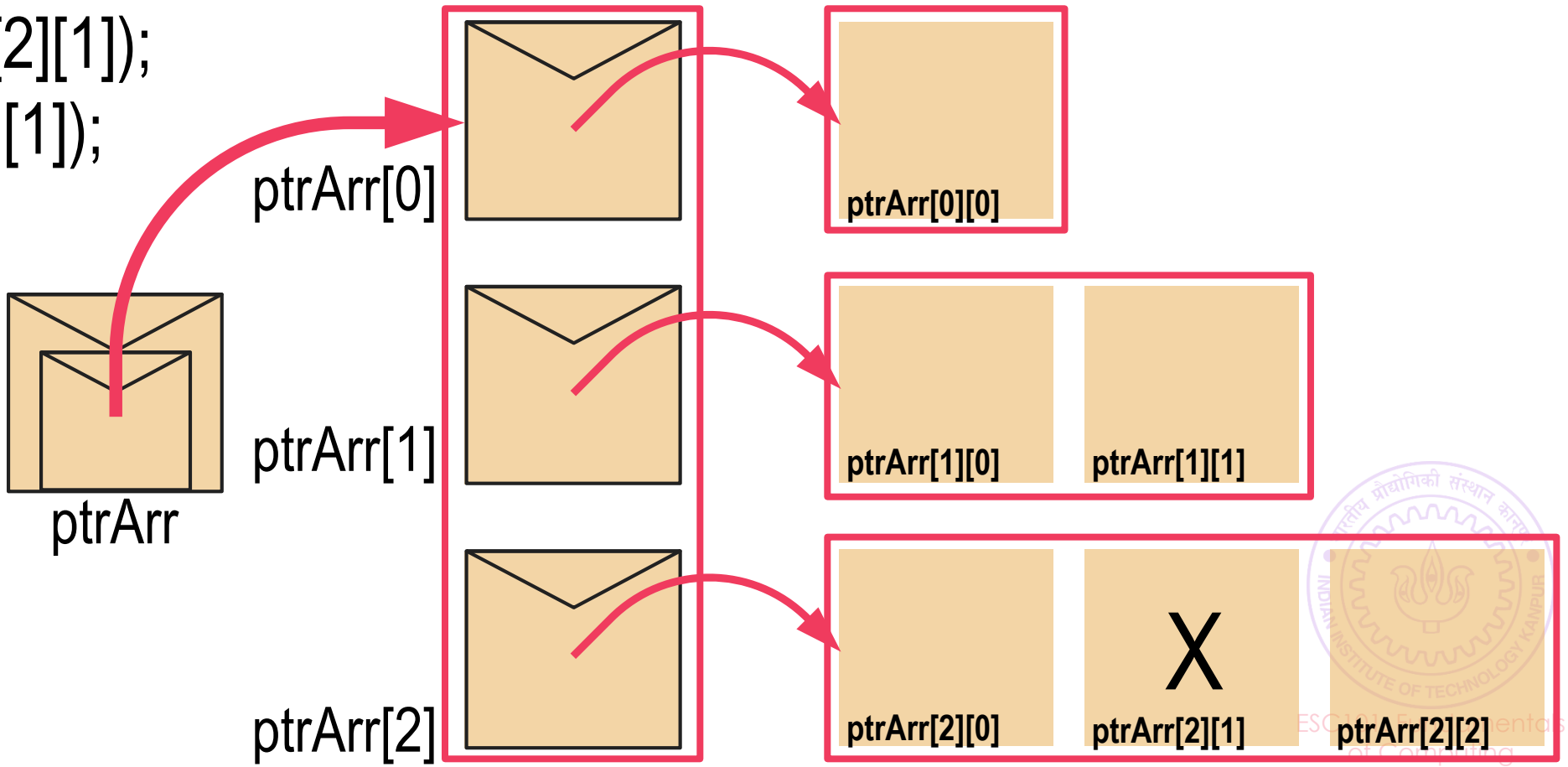

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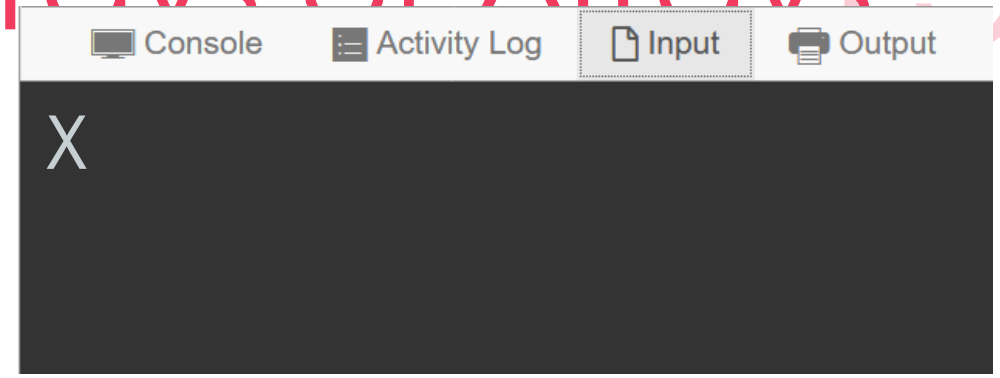

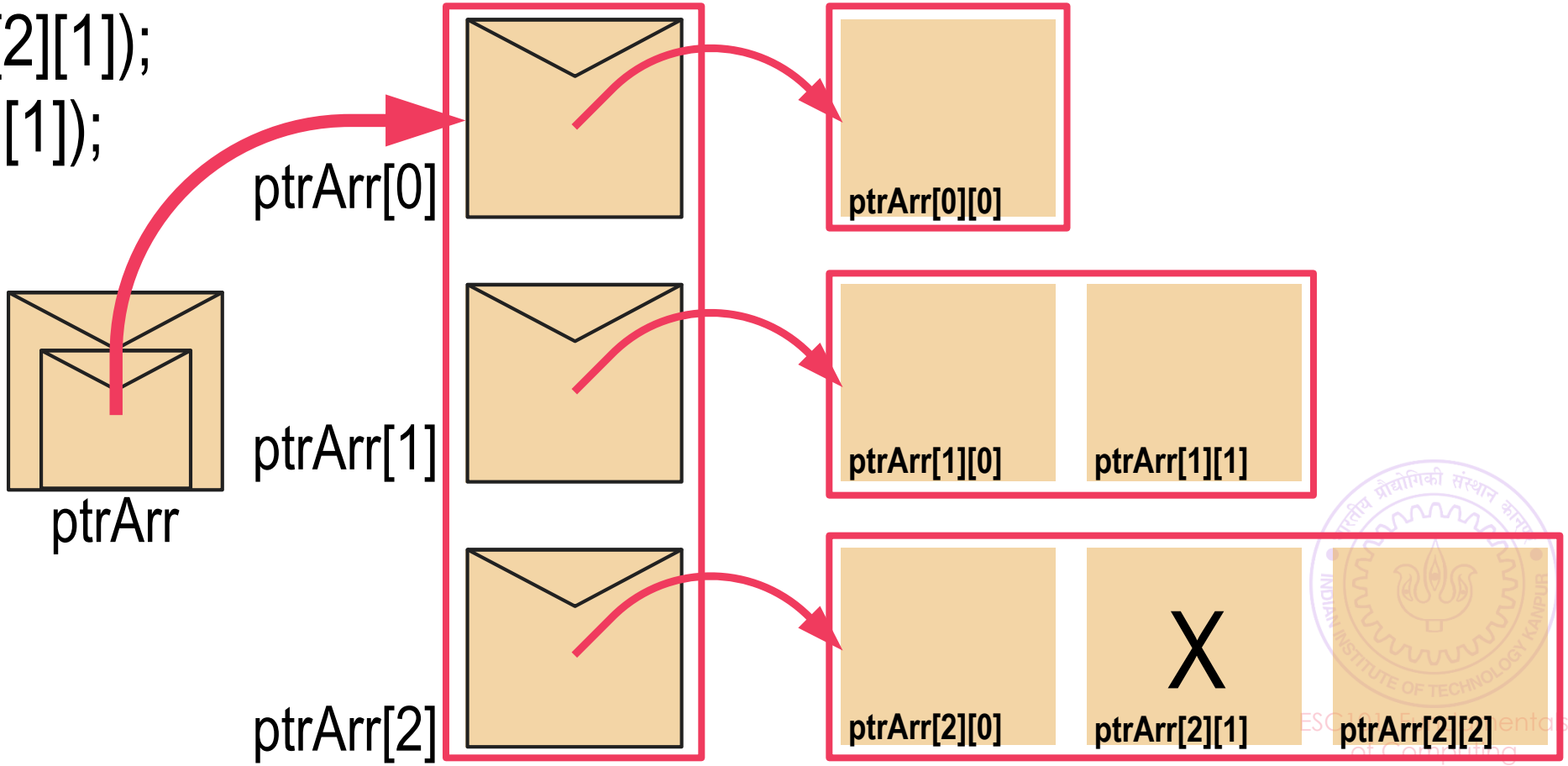

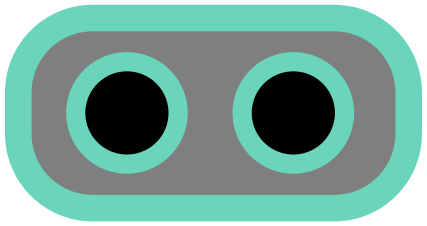

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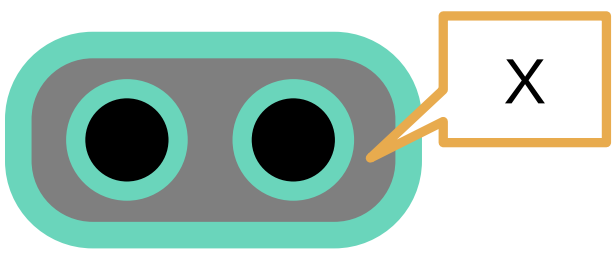

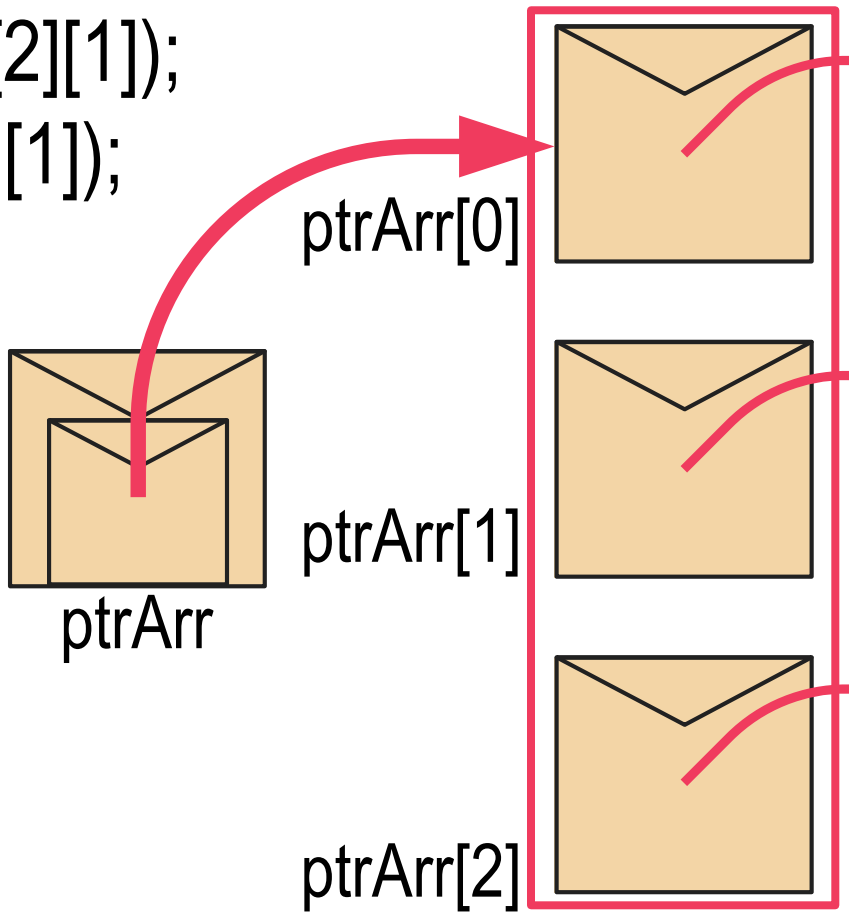

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Note that ptrArr[1] does not have 3 elements so ptrArr[1][2] may cause segfault!

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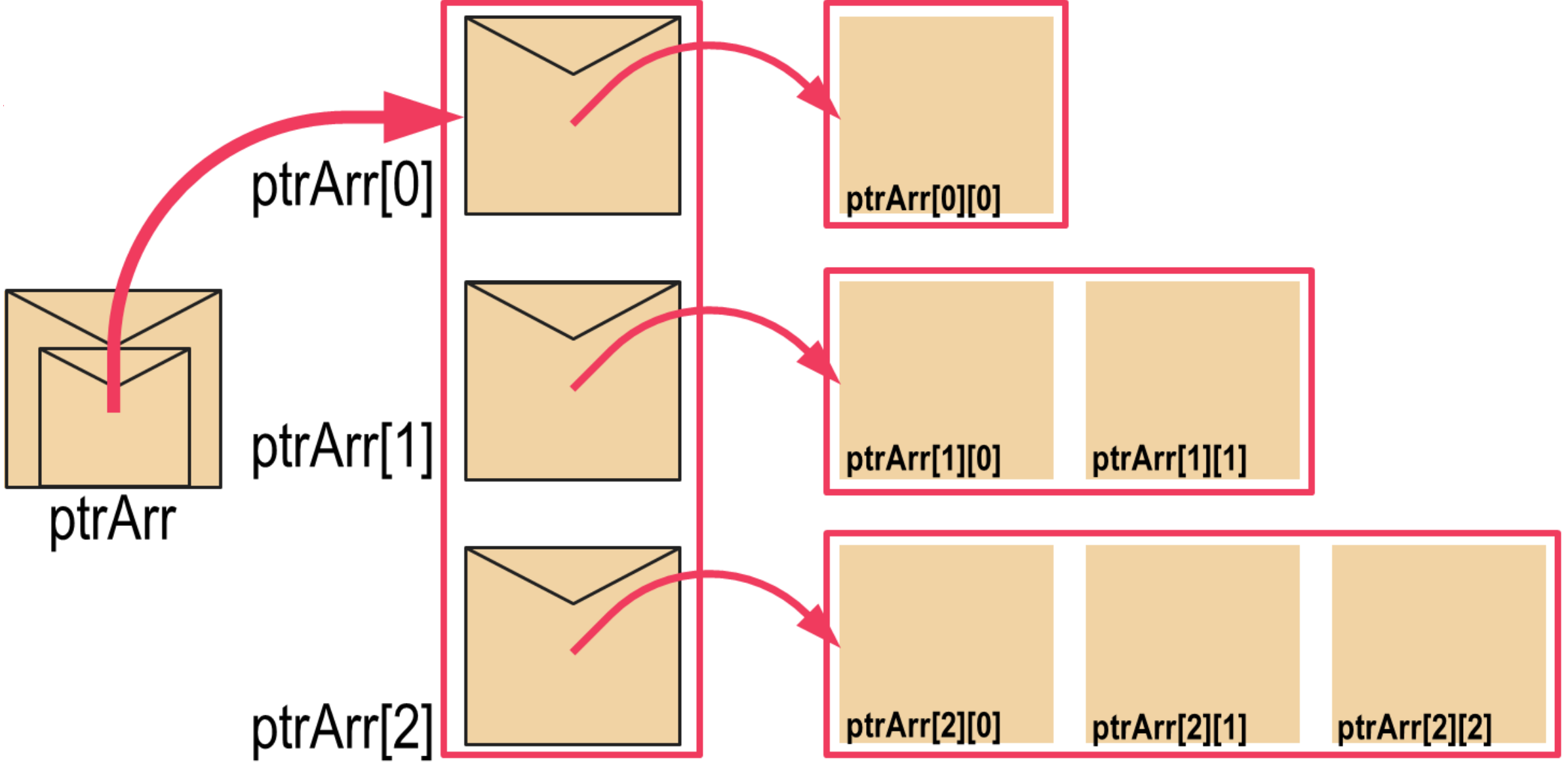

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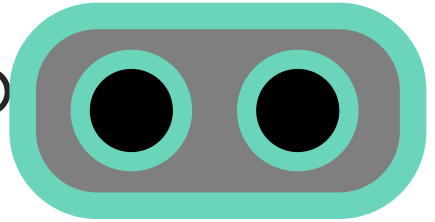

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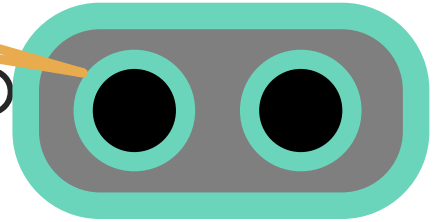

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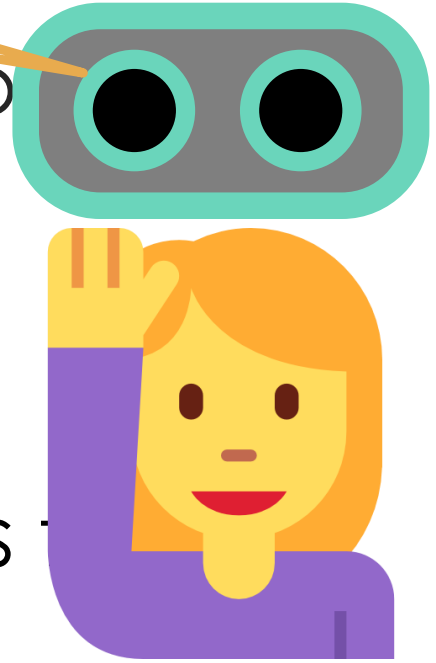

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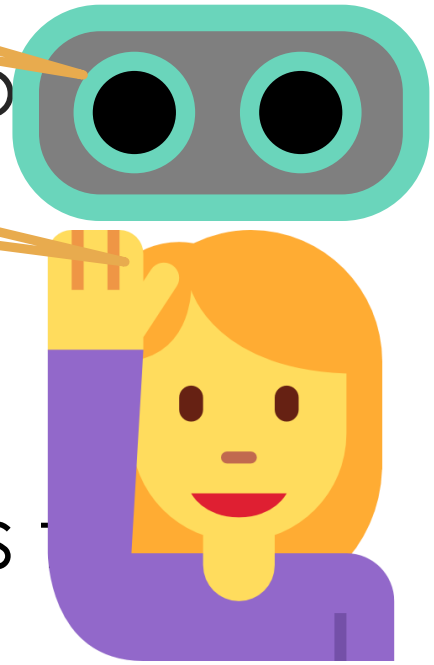

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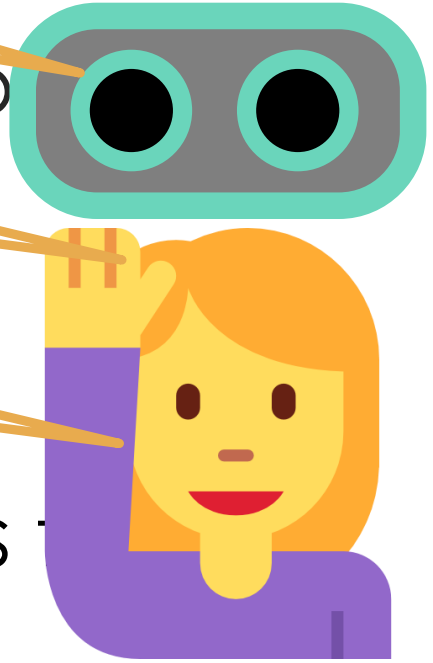

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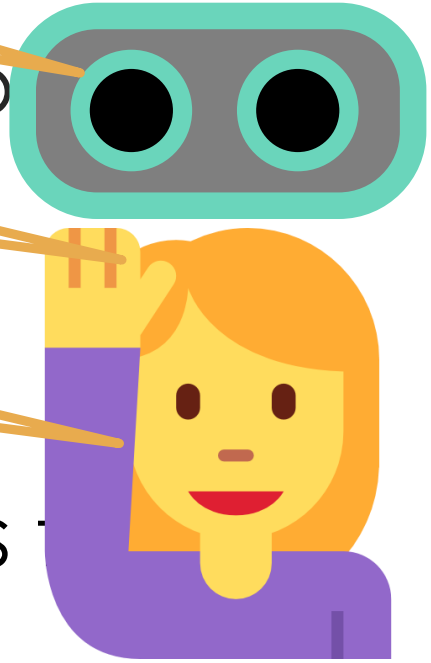

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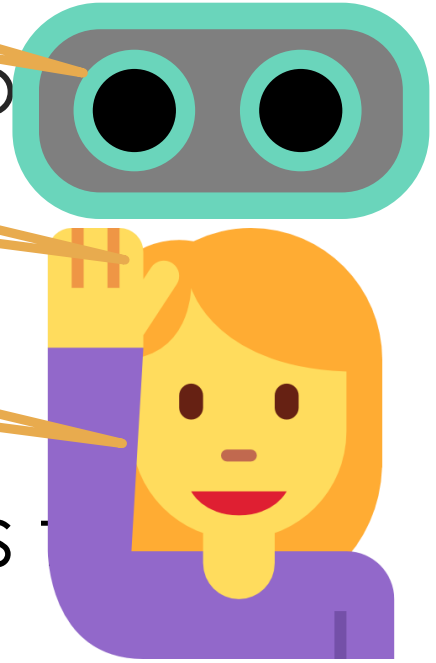

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int *ptr[5]; is an array of 5 pointers to int but
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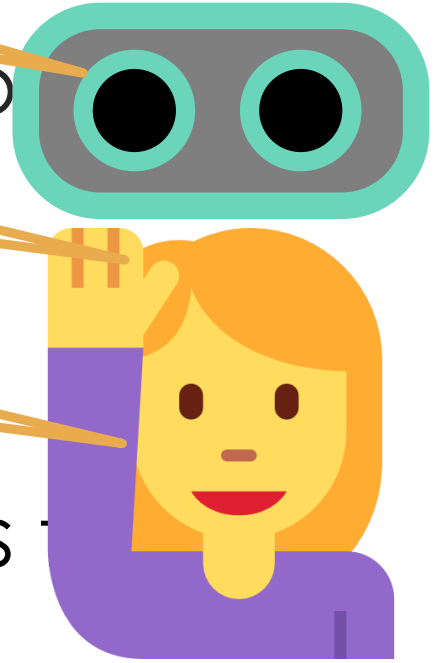

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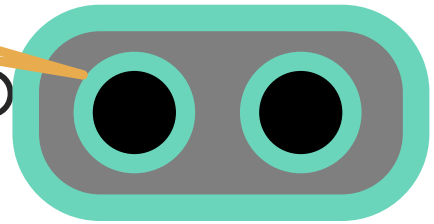

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access

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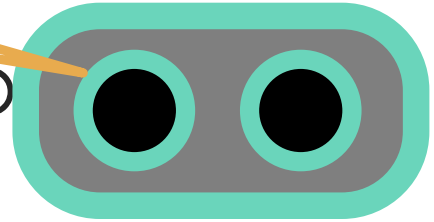

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I will ask questions on pointers to pointers, array of pointers, etc though

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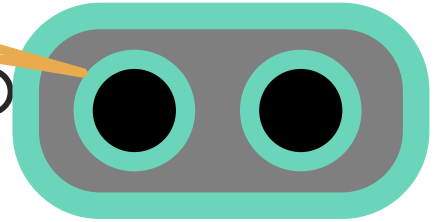
However, I can write char* qtr = str;
qtr++; Now qtr points to str[1]



I can also write char** rtr = ptrArr;
rtr++; Now rtr points to ptrArr[1]

Don't worry. I won't ask exam questions on int (*ptr)[5];

I will ask questions on pointers to pointers, array of pointers, etc though

Just one potentially confusing notation in C
int *ptr[5]; is an array of 5 pointers to int but
int (*ptr)[5] is a single pointer to an array of 5 ints ☹

Your avatar befits you ☺

2D Arrays in C

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int mat[3][5];
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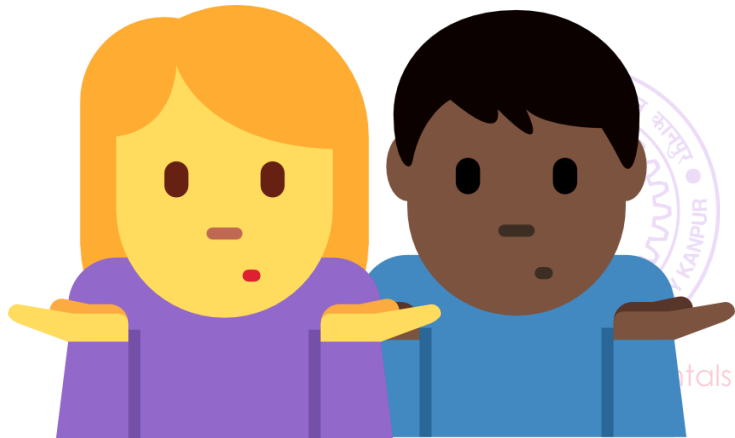

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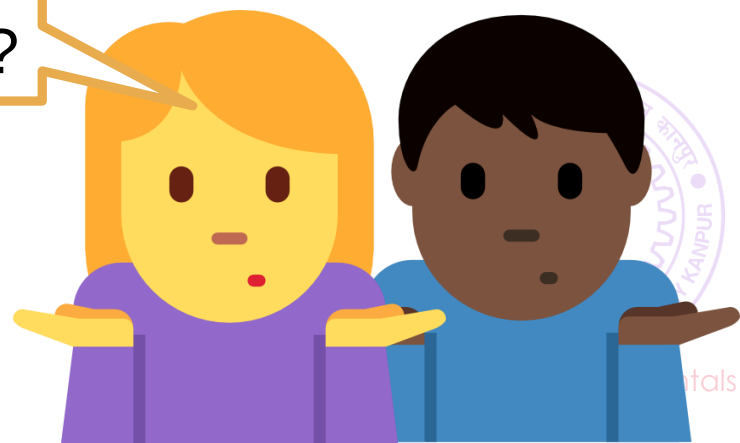

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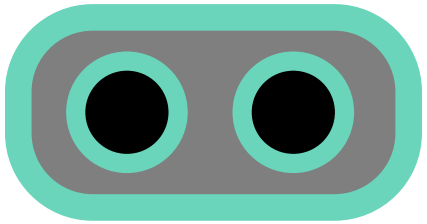

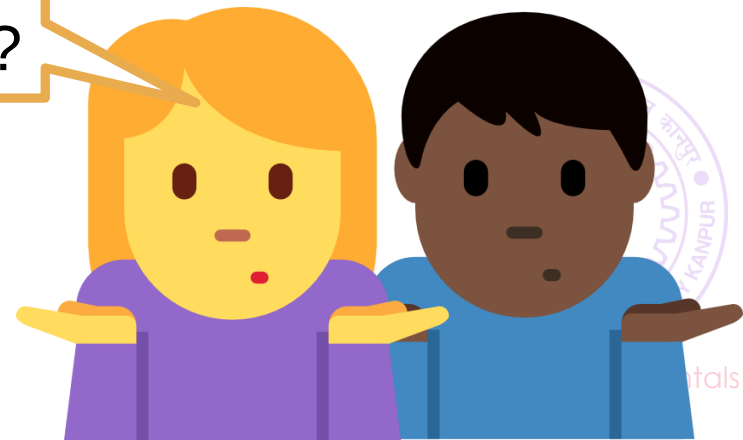

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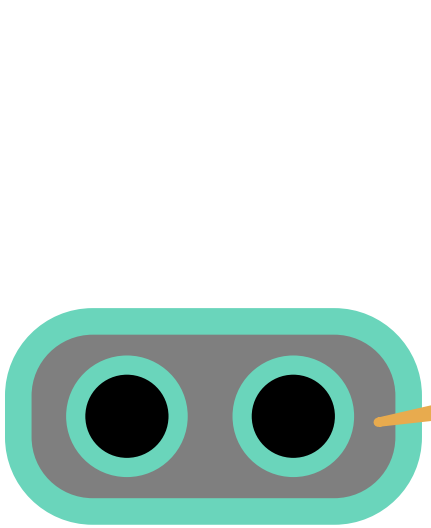

Not that much actually – let me show you the differences

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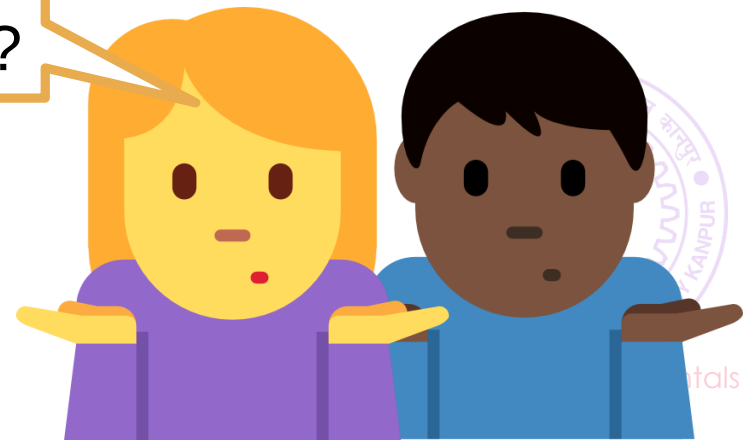

2D arrays vs Array of arrays

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Number of elements in each row is the same

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Elements of a single array are contiguous but different arrays could be located far off in memory

2D arrays vs Array of arrays

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- Number of elements in each row is the same
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- Easier to initialize

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int mat[3][5] = { {1,2}, {3},
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More power, responsibility

Memory layout of 2D arrays

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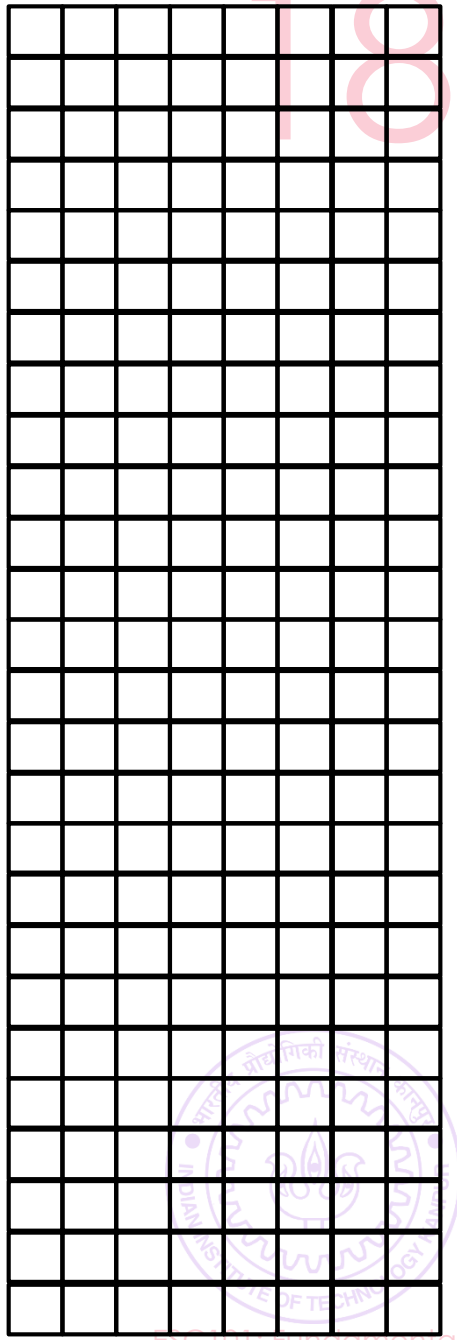

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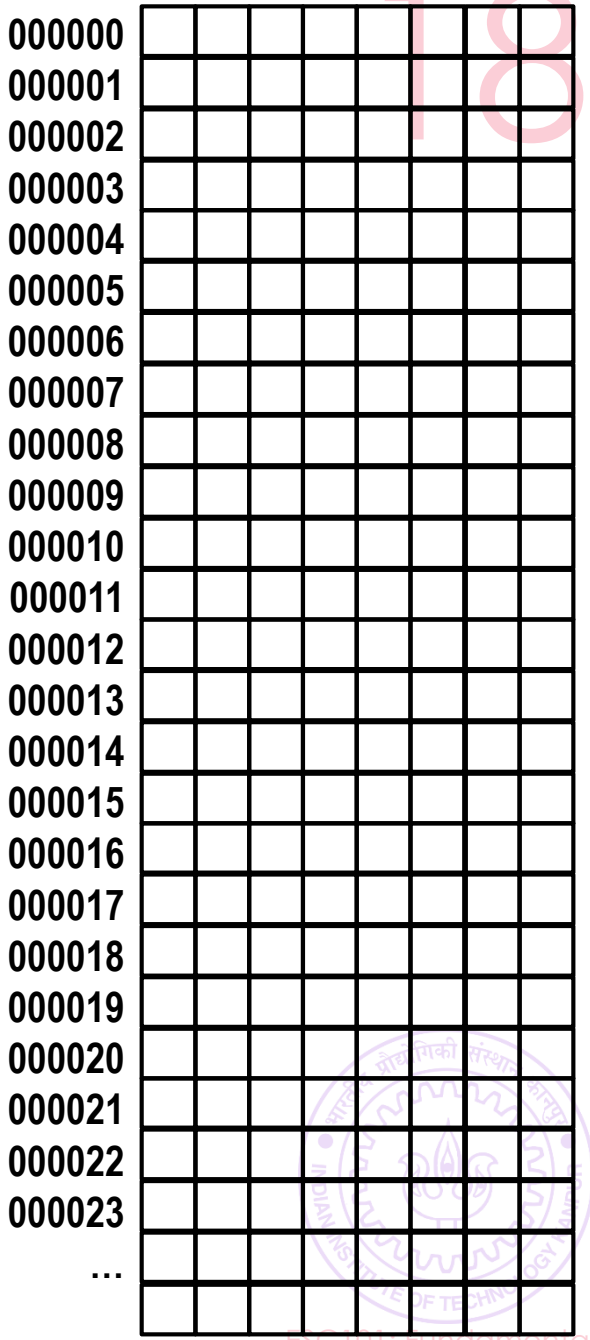

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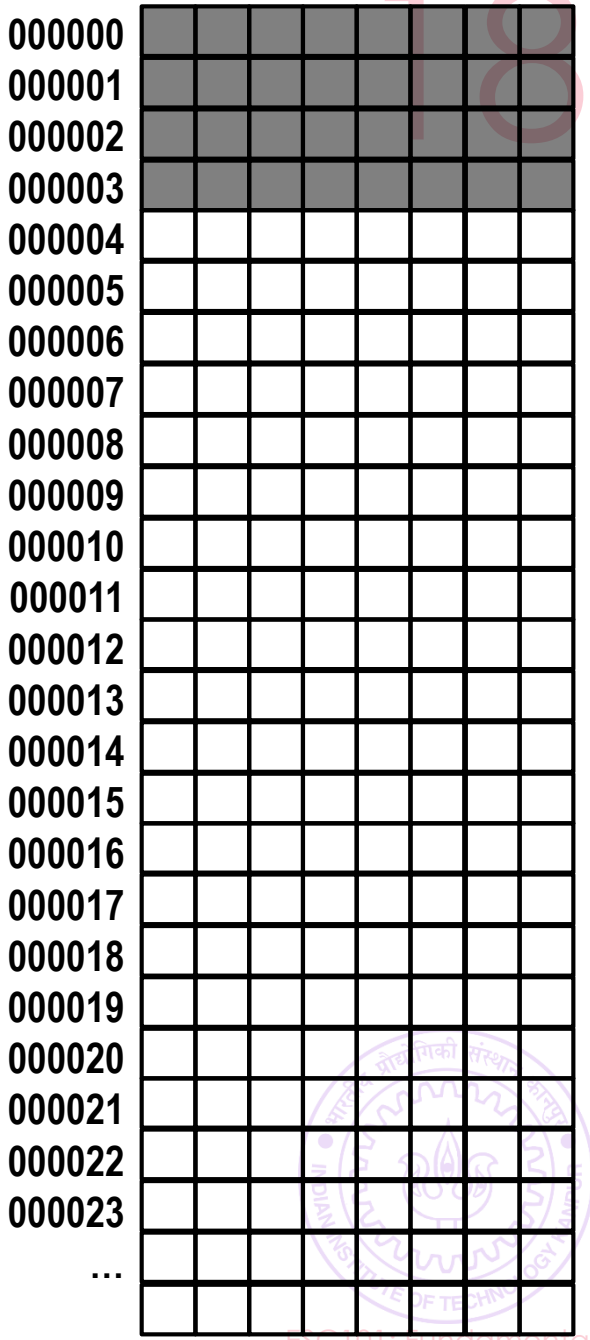

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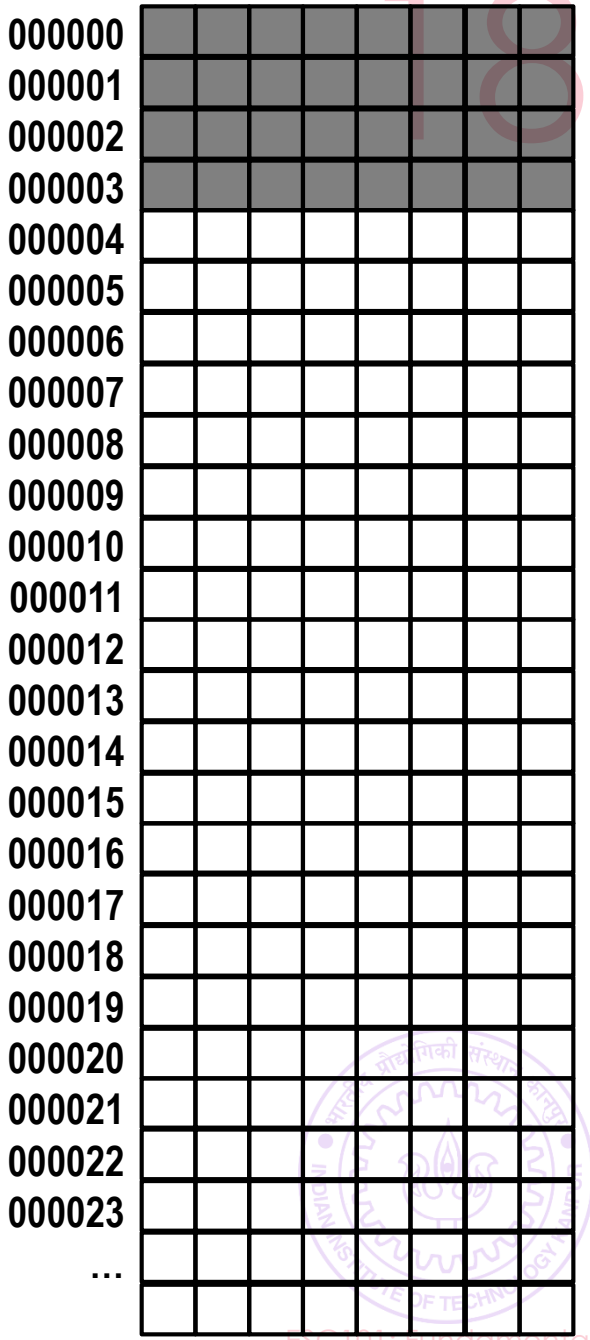
char str[3][5];



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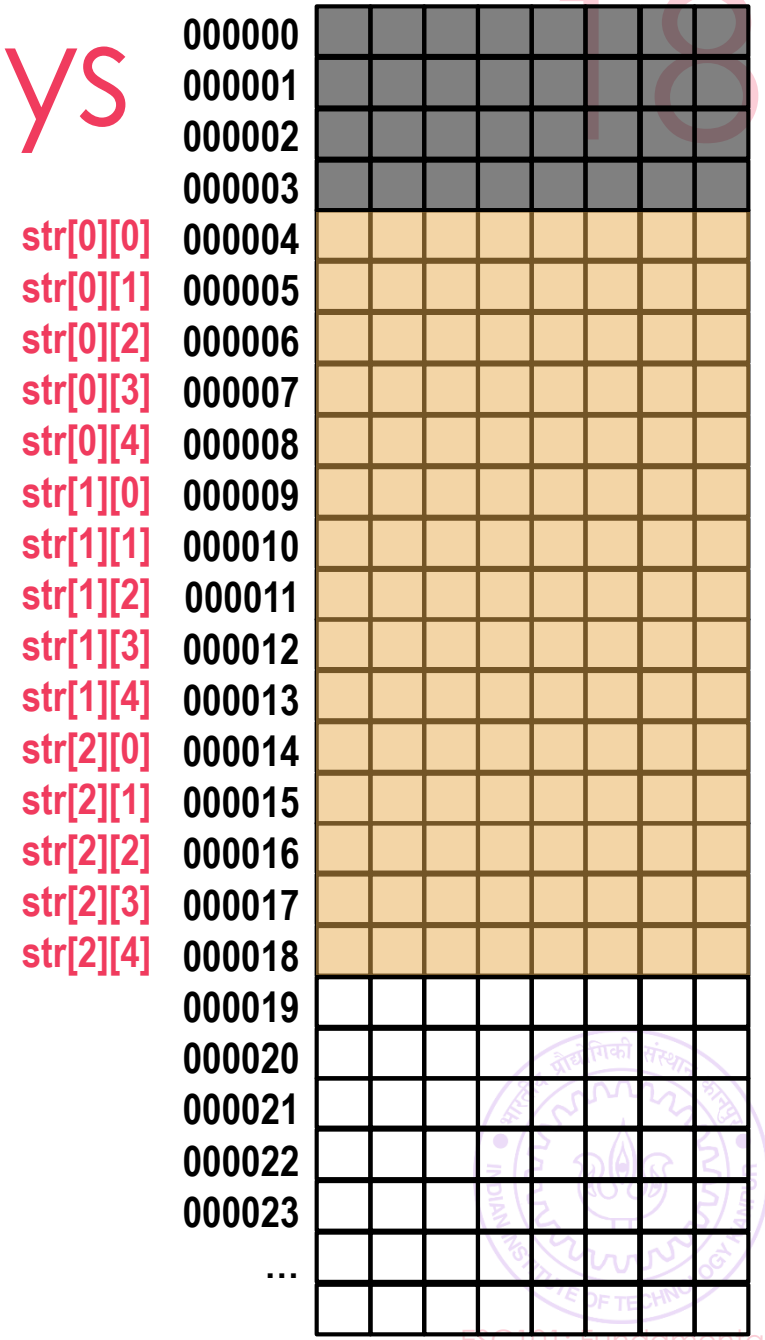

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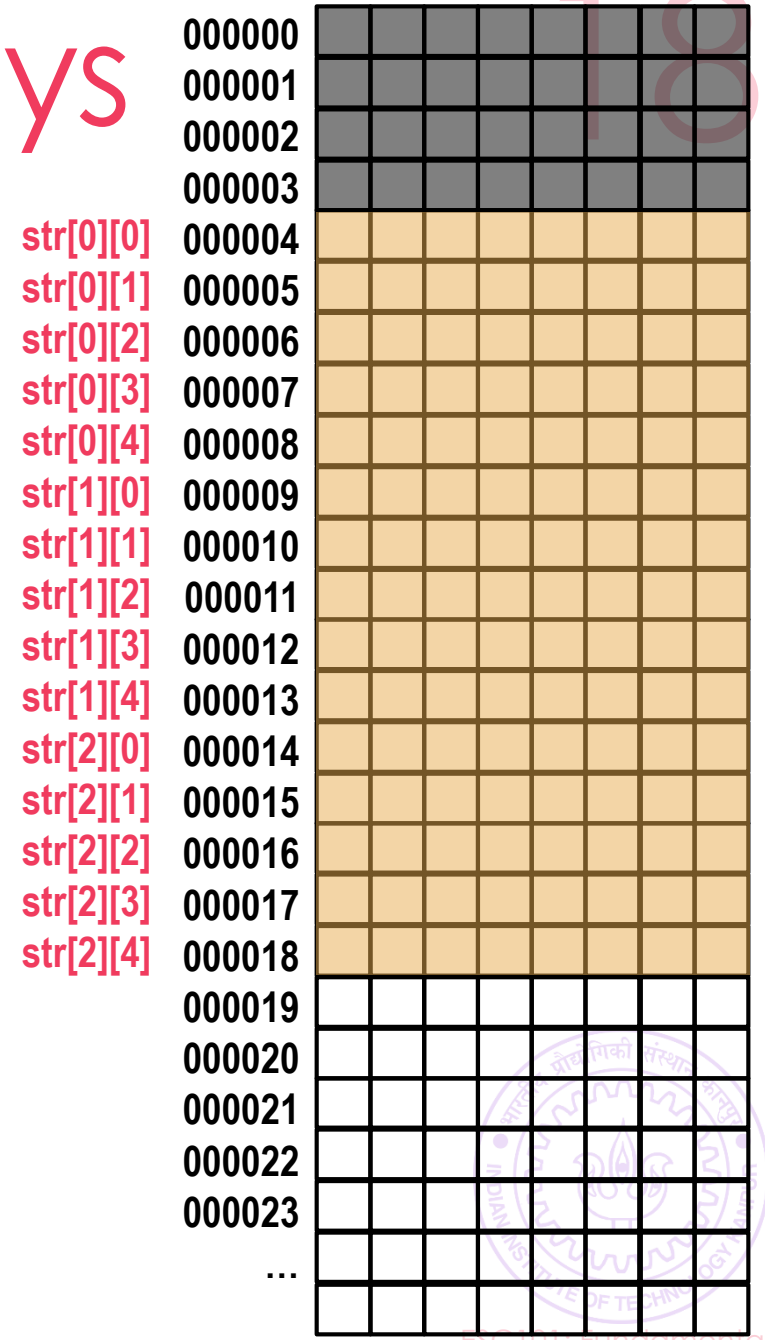
char str[3][5];

Location of the str pointer not shown



Memory layout of 2D arrays

char str[3][5];

- Location of the str pointer not shown
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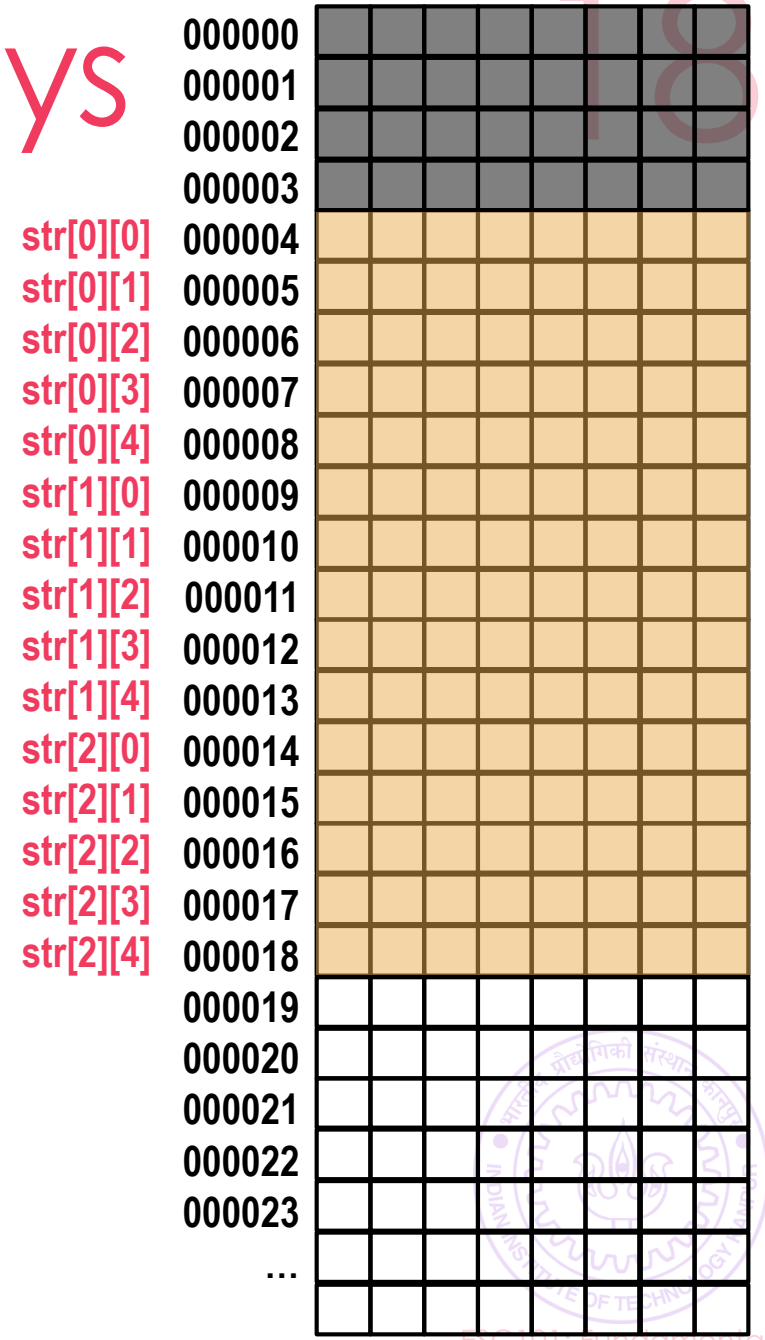
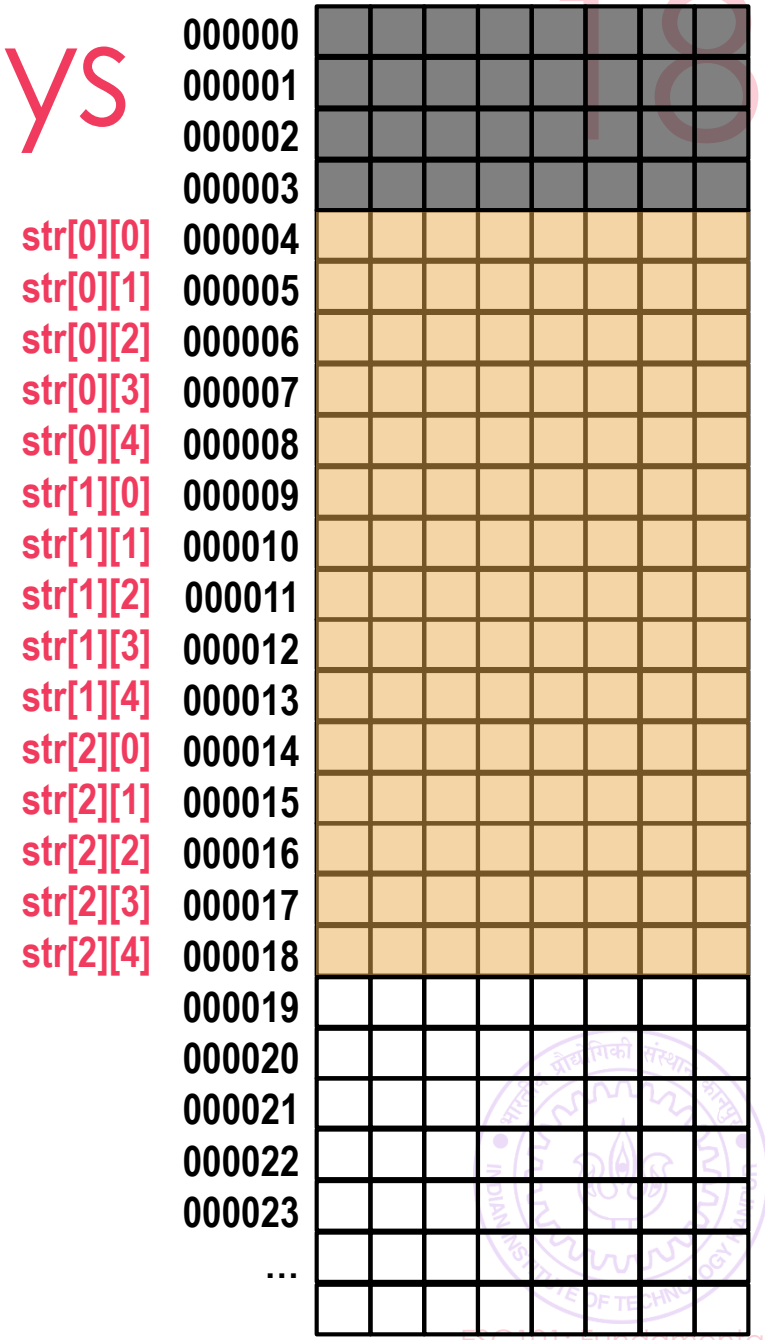


Memory layout of 2D arrays

char str[3][5];

- Location of the str pointer not shown
- First all elements of row 0 stored in continuous sequence
- Then without breaking sequence, all elements of row 1 stored and so on



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```
char* ptr = *str; // ptr points to str[0][0]
ptr += 5; // ptr now points to str[1][0]
ptr += 5; // ptr now points to str[2][0]
ptr += 3; // ptr now points to str[2][3]
```