



C PROGRAMING

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2-D array

- Logically 2-D array represents m x n matrix i.e. m rows and n columns.
 - `int arr[3][4] = { {1, 2, 3, 4}, {10, 20, 30, 40}, {11, 22, 33, 44} };`
- Array declaration:
 - `int arr[3][4] = { {1, 2, 3, 4}, {10, 20, 30, 40}, {11, 22, 33, 44} };`
 - `int arr[3][4] = { {1, 2 }, {10}, {11, 22, 33 } };`
 - `int arr[3][4] = { 1, 2, 10, 11, 22, 33 };`
 - `int arr[][4] = { 1, 2, 10, 11, 22, 33 };`

	0	1	2	3
0	1	2	3	4
1	10	20	30	40
2	11	22	33	44



2-D array

- 2-D array is collection of 1-D arrays in contiguous memory locations.
 - Each element is 1-D array.
- `int arr[3][4] = { {1, 2, 3, 4}, {10, 20, 30, 40}, {11, 22, 33, 44} };`

arr	0				1				2			
	0	1	2	3	0	1	2	3	0	1	2	4
	1	2	3	4	10	20	30	40	11	22	33	44
	400	404	408	412	416	420	424	428	432	436	440	444
400					416				432			



Passing 2-D array to Functions

- 2-D array is passed to function by address.
- It can be collected in formal argument using array notation or pointer notation.
- While using array notation, giving number of rows is optional. Even though mentioned, will be ignored by compiler.



void pointer

- Void pointer is generic pointer it can hold address of any data type (without casting).
- Scale factor of `void*` is not defined, so cannot perform pointer arithmetic.
- To retrieve value of the variable need type-casting.
- `void*` is used to implement generic algorithms.



Dynamic memory allocation

- Dynamic memory allocation allow allocation of memory at runtime as per requirement.
- This memory is allocated at runtime on Heap section of process.
- Library functions used for Dynamic memory allocation are
 - malloc() – allocated memory contains garbage values.
 - calloc() – allocated memory contains zero values.
 - realloc() – allocated memory block can be resized (grow or shrink).
- All these function returns base address of allocated block as void*.
- If function fails, it returns NULL pointer.



Memory leakage

- If memory is allocated dynamically, but not released is said to be "memory leakage".
 - Such memory is not used by OS or any other application as well, so it is wasted.
 - In modern OS, leaked memory gets auto released when program is terminated.
 - However for long running programs (like web-servers) this memory is not freed.
 - More memory leakage reduce available memory size in the system, and thus slow down whole system.
- In Linux, valgrind tool can be used to detect memory leakage.

```
int main() {  
    int *p = (int*) malloc(20);  
    int a = 10;  
    // ...  
    p = &a; // here addr of allocated block is  
lost, so this memory can never be freed.  
    // this is memory leakage  
    // ...  
    return 0;  
}
```



Dangling pointer

- Pointer keeping address of memory that is not valid for the application, is said to be "dangling pointer".
- Any read/write operation on this may abort the application. In Linux it is referred as "Segmentation Fault".
- Examples of dangling pointers
 - After releasing dynamically allocated memory, pointer still keeping the old address.
 - Uninitialized (local) pointer
 - Pointer holding address of local variable returned from the function.
- It is advised to assign NULL to the pointer instead of keeping it dangling.

```
int main() {  
    int *p = (int*) malloc(20);  
    // ...  
    free(p); // now p become dangling  
    // ...  
    return 0;  
}
```



Preprocessor Directives

- Preprocessor is part of C programming toolchain/SDK.
 - Removes comments from the source code.
 - Expand source code by processing all statements starting with #.
 - Executed before compiler
- All statements starting with # are called as preprocessor directives.
 - Header file include
 - #include
 - Symbolic constants & Macros
 - #define
 - Conditional compilation
 - #if, #else, #elif, #endif
 - #ifdef #ifndef
 - Miscellaneous
 - #pragma, #error



#include

- #include includes header files (.h) in the source code (.c).
- #include <file.h>
 - Find file in standard include directory.
 - If not found, raise error.
- #include "file.h"
 - File file in current source directory.
 - If not found, find file in standard include directory.
 - If not found, raise error.





Thank you!

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