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} };

	0				1				2			
	0	1	2	3	0	1	2	3	0	1	2	4
arr	**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.

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.

```
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;
}
```

- In Linux, valgrind tool can be used to detect memory leakage.

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;
}
```

Thank you!

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