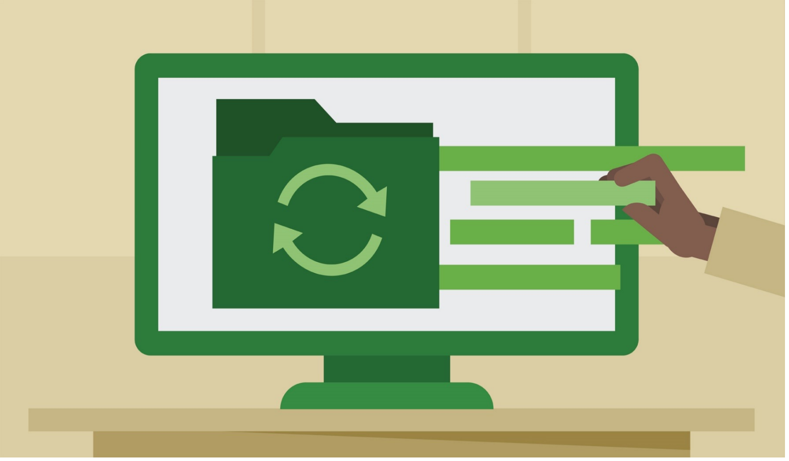
Memory Management



OBJECTIVES

1 Casting

2 C Program structure in memory

3 Allocate dynamic memory

4 Manipulate in memory

TYPE CASTING

❑ All objects in C have specified type

- ✓ Type variable char, int, float, double, …
- ✓ Pointers point to type char, int, float, double, …

❑ Expression with many types

- ✓ C language automatic cast the types (casting).
- ✓ User cast the types.

IMPLICIT CASTING

- Increase level (data type) in expression
  - ✓ Elements with the same type
    - The result is general type
    - int / int ➔ int, float / float ➔ float
    - Example: 2 / 4 ➔ 0, 2.0 / 4.0 ➔ 0.5
  - ✓ Elements with the diffirent type
    - The result is cover type
    - char < int < long < float < double
    - float / int ➔ float / float, …
    - Example: 2.0 / 4 ➔ 2.0 / 4.0 ➔ 0.5
    - Note: temporary casting

IMPLICIT CASTING – 1

❑ Assign <left expression> = <right expression>;

- ✓ The right expression is increased level (or reduced level) temporary as the same type with right expression type.

```
int i;
float f = 1.23;
i = f; // ➔ f temporary is int
f = i; // ➔ i temporary is float
```

- ✓ May be the accurate of real will be lost ➔ limited!

```
int i = 3;
float f;
f = i;   // ➔ f = 2.999995
```

EXPLICIT CASTING

❑ **Meaning**

Type casting to avoid wrong result.

❑ **Syntax**

```
(<new type>)<expression>
```

❑ **Example**

```
int x1 = 1, x2 = 2;
float f1 = x1/x2;           //➔ f1 = 0.0
float f2 = (float)x1/x2;    //➔ f2 = 0.5
float f3 = (float)(x1/x2);//➔ f3 = 0.0
```

ALLOCATE STATIC AND DYNAMIC MEMORY

❑ Static memory allocation

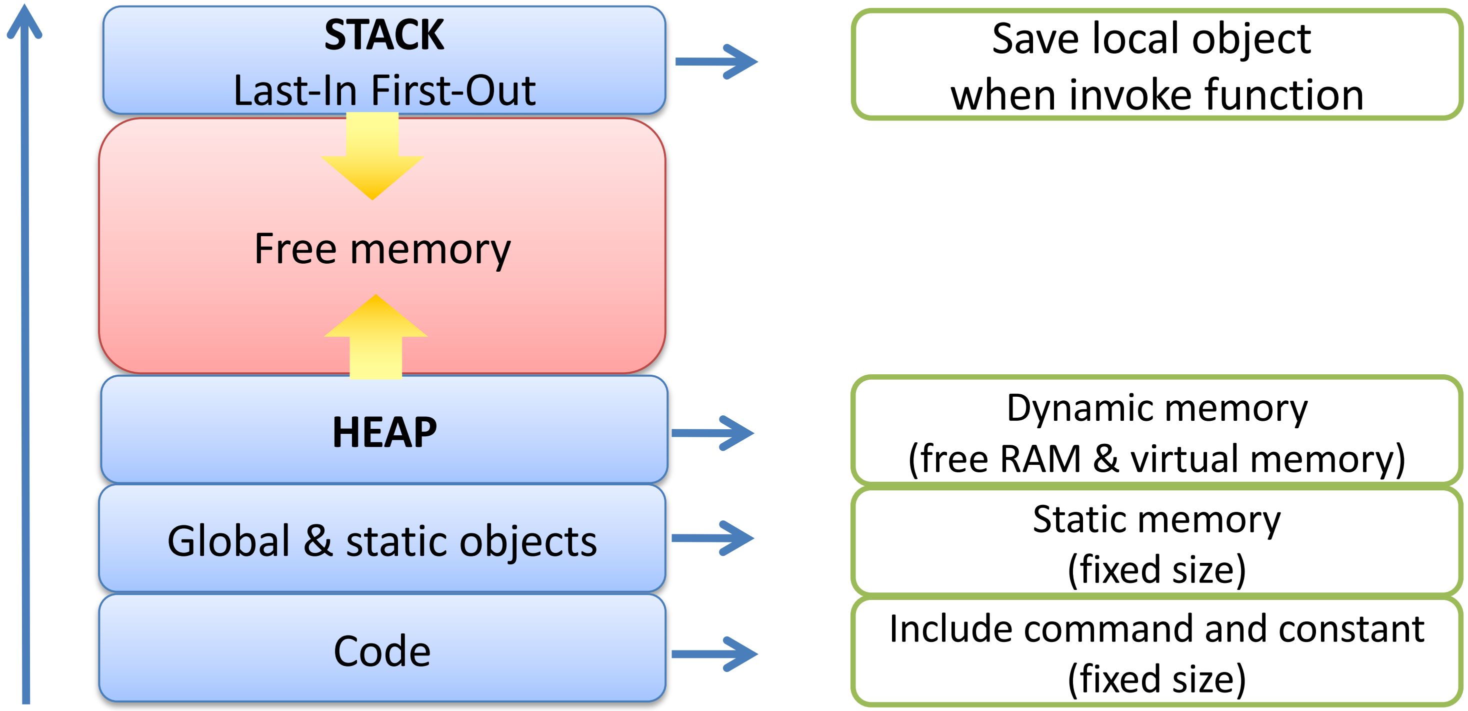
- ✓ Declare variable, struct, array …
- ✓ Must know how many memories to store ➔ waste memory, can not change size, …

❑ Dynamic memory allocation

- ✓ Allocate as required.
- ✓ Free the memory if not need.
- ✓ Use outside memory (include virtual memory).

C PROGRAM STRUCTURE IN MEMORY

- The whole of program will be loaded into memory which is free, with 4 parts:



STACK
Last-In First-Out

Free memory

HEAP

Global & static objects

Code

Save local object
when invoke function

Dynamic memory
(free RAM & virtual memory)

Static memory
(fixed size)

Include command and constant
(fixed size)

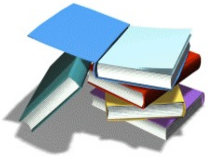
ALLOCATE DYNAMIC MEMORY

Library <stdlib.h> or <alloc.h>

- ✓malloc
- ✓calloc
- ✓realloc
- ✓free

ALLOCATE DYNAMIC MEMORY

void *malloc(size_t size)



Allocate in HEAP a memory size (bytes)
size_t instead of unsigned (in <stddef.h>)

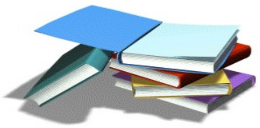
Return

- Success: The pointer point to allocated memory.
- Fail: NULL (not enough memory).

```
int *p = (int *)malloc(10*sizeof(int));
if (p == NULL)
        printf(“Not enough memory!”);
```

ALLOCATE DYNAMIC MEMORY

void *calloc(size_t num, size_t size)



Allocate memory include num elements in HEAP, each has size (bytes)

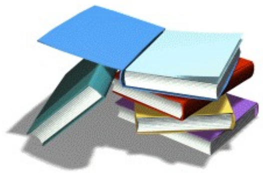
Return

- Success: The pointer point to allocated memory.
- Thất bại: NULL (not enough memory).

```
int *p = (int *)calloc(10, sizeof(int));
if (p == NULL)
        printf(“Not enough memory!”);
```

ALLOCATE DYNAMIC MEMORY

void *realloc(void *block, size_t size)



Reallocate memory with size that block point memory in HEAP.
block == NULL ➔ use malloc
size == 0 ➔ use free

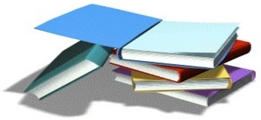
Return

- Success: The pointer point to allocated memory.
- Fail: NULL (not enough memory).

```
int *p = (int *)malloc(10*sizeof(int));
p = (int *)realloc(p, 20*sizeof(int));
if (p == NULL)
        printf(“Not enough memory!”);
```

ALLOCATE DYNAMIC MEMORY

void free(void *ptr)



Free memory pointed by ptr, that returned by malloc(), calloc(), realloc() functions.
If ptr is NULL -> do nothing.

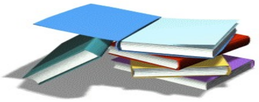
Return

- Nothing.

```
int *p = (int *)malloc(10*sizeof(int));
free(p);
```

ALLOCATE DYNAMIC MEMORY

<pointer_to_datatype> = new <datatype>[size]



Allocate memory with size = sizeof (<datatype>)* in HEAP

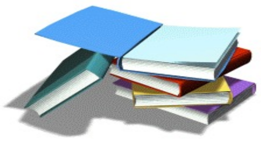
Return

- Success: The pointer point to allocated memory.
- Fai: NULL (not enough memory).

```
int *a1 = (int *)malloc(sizeof(int));
int *a2 = new int;
int *p1 = (int *)malloc(10*sizeof(int));
int *p2 = new int[10];
```

ALLOCATE DYNAMIC MEMORY

delete []<pointer_to_datatype>



Free the memory in HEAP pointed by <pointer_to_datatype> (allocated by new)

Return

- Nothing.

```
int *a = new int;
delete a;
int *p = new int[10];
delete []p;
```

Allocate dynamic memory

❑ Note:

- ✓ Not need check the pointer is NULL or not before free or delete.
- ✓ Allocate by malloc, calloc or realloc -> free the memory by free.

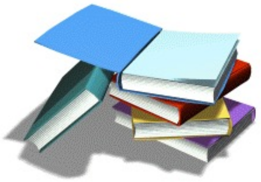
Manipulate in memory

❑ Library <string.h>

- ✓ **memset** : assign value to all bytes in memory.
- ✓ **memcpy** : copy memory.
- ✓ **memmove** : move information from memory to memory.

Manipulate in memory

void *memset(void *dest, int c, size_t count)



Assign first count (bytes) of memory pointed by dest with value c (from 0 to 255)
Use for char memory, with other type memory -> the value is zero .

Return

- pointer dest.

```
char buffer[] = “Hello world”;
printf(“Before memset: %s\n”, buffer);
memset(buffer, ‘*’, strlen(buffer));
printf(“After memset: %s\n”, buffer);
```

Manipulate in memory

void *memcpy(void *dest, void *src, size_t count)

Copy count byte from src memory into dest memory.

If 2 memories overlap, the function works **not** exactly.

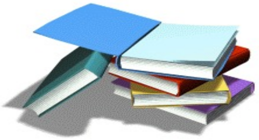
Return

- Pointer dest.

```
char src[] = “*****”;
char dest[] = “0123456789”;
memcpy(dest, src, 5);
memcpy(dest + 3, dest + 2, 5);
```

Manipulate in memory

void *memmove(void *dest, void *src, size_t count)



Copy count byte from src memory into dest memory.
If 2 memories overlap, the function works exactly.

- Pointer dest.

```
char src[] = “*****”;
char dest[] = “0123456789”;
memmove(dest, src, 5);
memmove(dest + 3, dest + 2, 5);
```

Thank you

Q&A