CS 332/532 Systems Programming

Lecture 5

- Pointers-

Professor : Mahmut Unan – UAB CS

Agenda

- Pointers
- Double Pointer
- Arrays & Pointers
- Passing Pointers to Functions
- Char
- Strings

Example - page 1/2

```c
#include <stdio.h>
int main()
{
    int *ptr, a;
    a = 25;
    /* without using a pointer */
    printf("Address of a: %p\n", &a);
    printf("Value of a: %d\n", a);

    /*let's use a pointer */
    ptr = &a;
    printf("Address of the pointer : %p\n", ptr);
    printf("Value of the pointer : %d\n", *ptr);

    /* how about if we change the value of int */
    a = 125;
    printf("Address of the pointer : %p\n", ptr);
    printf("Value of the pointer : %d\n", *ptr);

```

Example - page 2/2

```
20      /* let's change the value using pointer*/
21      *ptr = 250;
22      printf("Address of a: %p\n", &a);
23      printf("Value of a: %d\n", a);
24
25      /* we can reuse the pointer */
26      int b = 50;
27      ptr = &b;
28      printf("Address of the pointer : %p\n", ptr);
29      printf("Value of the pointer : %d\n", *ptr);
30      return 0;
31  }
```

Example - output

```
Address of a: 0x7ffeee56291c
Value of a: 25
Address of the pointer : 0x7ffeee56291c
Value of the pointer : 25
Address of the pointer : 0x7ffeee56291c
Value of the pointer : 125
Address of a: 0x7ffeee56291c
Value of a: 250
Address of the pointer : 0x7ffeee562918
Value of the pointer : 50
```

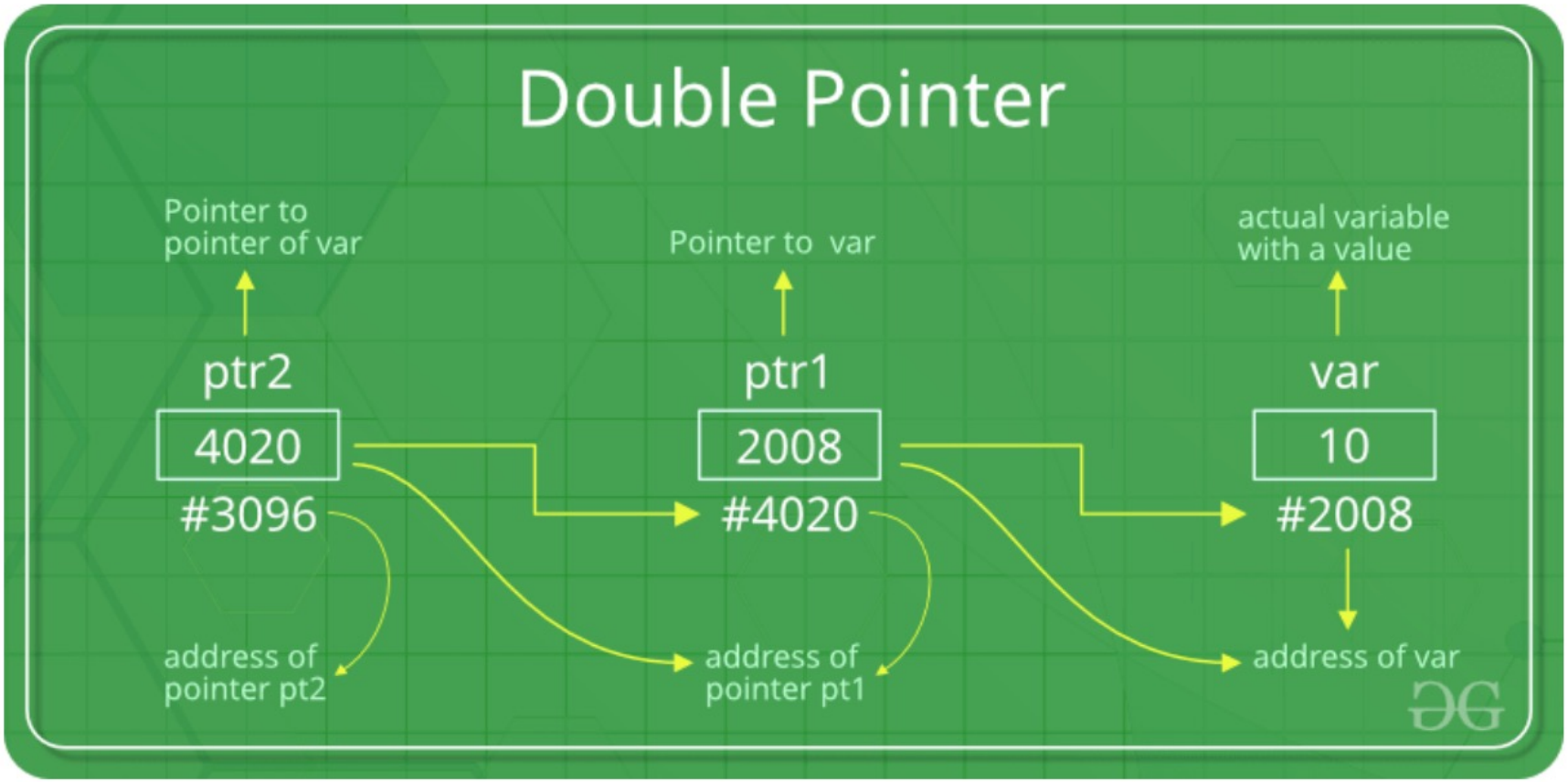
The * and & cancel each other when used together

```c
#include <stdio.h>

int main() {
    int *ptr, i=5;
    ptr = &i;
    printf("%p %p %p %d %p\n", &i, *&ptr, &*ptr, *ptr, &ptr);
    return 0;
}
```

```
0x7ffee636291c 0x7ffee636291c 0x7ffee636291c 5 0x7ffee6362920
```

double pointer? even triple…



https://www.geeksforgeeks.org/double-pointer-pointer-pointer-c/

```c
#include <stdio.h>
int main() {

    int a = 25;
    int *ptr = &a;//the first pointer

    printf("Address : %p\n", ptr);
    printf("Value : %i\n", *ptr);

    *ptr = 45;// change the value
    printf("Address : %p\n", ptr);
    printf("Value : %i\n", *ptr);

    int **ptr2 = &ptr;// second pointer
    printf("Address - First pointer: %p\n", ptr);
    printf("Value -First Pointer: %i\n", *ptr);
    printf("Address - First pointer: %p\n", ptr2);
    printf("Value -First Pointer: %i\n", **ptr2);
    return 0;
}
```

```c
#include <stdio.h>
int main() {

    int a = 25;
    int *ptr = &a;//the first pointer

    printf("Address : %p\n", ptr);
    printf("Value : %i\n", *ptr);

    *ptr = 45;// change the value
    printf("Address : %p\n", ptr);
    printf("Value : %i\n", *ptr);

    int **ptr2 = &ptr;// second pointer
    printf("Address - First pointer: %p\n", ptr);
    printf("Value -First Pointer: %i\n", *ptr);
    printf("Address - First pointer: %p\n", ptr2);
    printf("Value -First Pointer: %i\n", **ptr2);
    return 0;
}
```

```
Address : 0x7ffee76aa928
Value : 25
Address : 0x7ffee76aa928
Value : 45
Address - First pointer: 0x7ffee76aa928
Value -First Pointer: 45
Address - First pointer: 0x7ffee76aa920
Value -First Pointer: 45
```

Arrays & Pointers

```c
#include <stdio.h>
int main() {
    int i,arr[5];
    double arr2[5];

    for(i = 0; i <5; i++)
        printf("address of arr[%d] = %p\n", i, &arr[i]);

    for(i = 0; i <5; i++)
        printf("address of arr2[%d] = %p\n", i, &arr2[i]);
    return 0;
}
```

Arrays & Pointers

```
address of arr[0] = 0x7ffeeece0910
address of arr[1] = 0x7ffeeece0914
address of arr[2] = 0x7ffeeece0918
address of arr[3] = 0x7ffeeece091c
address of arr[4] = 0x7ffeeece0920
address of arr2[0] = 0x7ffeeece08e0
address of arr2[1] = 0x7ffeeece08e8
address of arr2[2] = 0x7ffeeece08f0
address of arr2[3] = 0x7ffeeece08f8
address of arr2[4] = 0x7ffeeece0900
```

Array Manipulation

```c
#include <stdio.h>
int main() {
    int arr[5] = {10, 20, 30, 40, 50};
    int *ptr;

    ptr = &arr[3]; // address of the fourth element

    printf("\n Pointer value : %d", *ptr);
    printf(" \n Next Value : %d", *(ptr+1));
    printf("\n Previous Value : %d", *(ptr-1));

    printf("\n Address of the Pointer : %p", &(*(ptr)));
    printf("\n Address of the Next Value : %p", &(*(ptr+1)));
    printf("\n Address of the Previous Value : %p", &(*(ptr-1)));
    return 0;
}
```

Array Manipulation

```
Pointer value : 40
Next Value : 50
Previous Value : 30
Address of the Pointer : 0x7ffeeb08e91c
Address of the Next Value : 0x7ffeeb08e920
Address of the Previous Value : 0x7ffeeb08e918
```

```
1
2
3
4
5
6
7
8       printf("\n Pointer value : %d", *ptr);
9       printf(" \n Next Value : %d", *(ptr+1));
10      printf("\n Previous Value : %d", *(ptr-1));
11
12      printf("\n Address of the Pointer : %p", &(*(ptr)));
13      printf("\n Address of the Next Value : %p", &(*(ptr+1)));
14      printf("\n Address of the Previous Value : %p", &(*(ptr-1)));
15      return 0;
16  }
```

What is the Result ?

```c
#include <stdio.h>
int main(void)
{
    int *ptr, totalSum, arr[5] = {10, 20, 30, 40, 50};
    totalSum = 0;
    for(ptr = arr; ptr < arr+5; ptr++)
    {
        --*ptr;
        totalSum += *ptr;
    }
    printf("Sum = %d\n", totalSum);
    return 0;
}
```

What is the Result ?

```c
#include <stdio.h>
int main(void)
{
    int *ptr, totalSum, arr[5] = {10, 20, 30, 40, 50};
    totalSum = 0;
    for(ptr = arr; ptr < arr+5; ptr++)
    {
        --*ptr;
        totalSum += *ptr;
    }
    printf("Sum = %d\n", totalSum);
    return 0;
}
```

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Passing Pointers to functions

```c
#include <stdio.h>
void test(int a);
int main(void)
{
    void (*ptr)(int a);
    ptr = test;
    (*ptr)(10);
    return 0;
}
void test(int a)
{
    printf("%d\n", 2*a);
}
```

```
20
```

```c
#include <stdio.h>
int addTwoNumbers(int a, int b);
int subtractTwoNumbers(int a, int b);

int main(void)
{
    int (*ptr[2])(int a, int b);
    int i, j, result;
    ptr[0] = addTwoNumbers;
    ptr[1] = subtractTwoNumbers;

    printf("Enter two integer numbers: ");
    scanf("%d %d", &i, &j);
    if(i > 0 && i < 25)
        result = ptr[0](i, j);
    else
        result = ptr[1](i, j);
    printf("Result  : %d\n", result);
    return 0;
}
int addTwoNumbers(int a, int b)
{   return a+b;  }
int subtractTwoNumbers(int a, int b)
{   return a-b;   }
```

```c
#include <stdio.h>
int addTwoNumbers(int a, int b);
int subtractTwoNumbers(int a, int b);

int main(void)
{
    int (*ptr[2])(int a, int b);
    int i, j, result;
    ptr[0] = addTwoNumbers;
    ptr[1] = subtractTwoNumbers;

    printf("Enter two integer numbers: ");
    scanf("%d %d", &i, &j);
    if(i > 0 && i < 25)
        result = ptr[0](i, j);
    else
        result = ptr
    printf("Result
    return 0;
}
int addTwoNumbers(int
{   return a+b;  }
int subtractTwoNumber
{   return a-b;   }
```

```
Enter two integer numbers: 20 30
Result   : 50
```

```
Enter two integer numbers: 45 20
Result   : 25
```

The `char` Type

- Since a character in the ASCII set is represented by an integer between 0 and 255, we can use the **char** type to store its value.
- Once a character is stored into a variable, it is the character's ASCII value that is actually stored.

```
char ch;
ch = 'c';
```

  - the value of `ch` becomes equal to the ASCII value of the character 'c'.
  - Therefore,
    - the statements `ch = 'c';` and `ch = 99;` are equivalent.
    - Of course, 'c' is preferable than 99; not only it is easier to read, but also your program won't depend on the character set as well.

```c
#include <stdio.h>
int main(void)
{
    char ch;
    ch = 'a';
    printf("Char = %c and its ASCII code is %d\n", ch, ch);
    return 0;
}

```

```
Char = a and its ASCII code is 97
```

- Since C treats the characters as integers, we can use them in numerical expressions. For example:

```
char ch = 'c’;
int i; ch++; /* ch becomes 'd'. */
ch = 68; /* ch becomes 'D'. */
i = ch-3; /* i becomes 'A',that is 65 */
```

`getchar()` and `putchar()`

- The `getchar()` function is used to read a character from stdin.
- The `putchar()` function writes a character in stdout, for example, `putchar('a')`

Strings

- A string literal is a sequence of characters enclosed in double quotes.
- C treats it as a nameless character array.
- To store a string in a variable, we use an array of characters.
- Because of the C convention that a string ends with the null character, to store a string of **N** characters, the size of the array should be **N+1** at least.

```
char str[8];
```

An array can be initialized with a string, when it is declared. For example, with the declaration:

```
char str[8] = "message";
```

the compiler copies the characters of the "message" into the str array and adds the null character. In particular, str[0] becomes 'm', str[1] becomes 'e', and the value of the last element str[7] becomes '\0'. In fact, this declaration is equivalent to:

```
char str[8] = {'m', 'e', 's',
's', 'a', 'g', 'e', '\0'};
```

puts()

```c
#include <stdio.h>
int main(void)
{
    char str[] = "UAB CS 330 Course";
    puts(str);
    puts(str);
    str[4] = '\0';
    printf("%s\n", str);
    return 0;
}
```

```
UAB CS 330 Course
UAB CS 330 Course
UAB
```

References

- C From Theory to Practice - 2nd edition, Nikolaos D. Tselikas and George S. Tselikis
- https://www.tutorialspoint.com/cprogramming/c_pointers.htm
- https://www.programiz.com/c-programming/c-pointers-arrays
- https://www.geeksforgeeks.org/function-pointer-in-c/