Start 8:05 am.

Please scan the attendance QR code

Welcome!

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Structure:

Revision / summary

Go through T Questions

introduce yourself and tell a bit about your major / favourite food / interest in CS/.......

Text/verbal

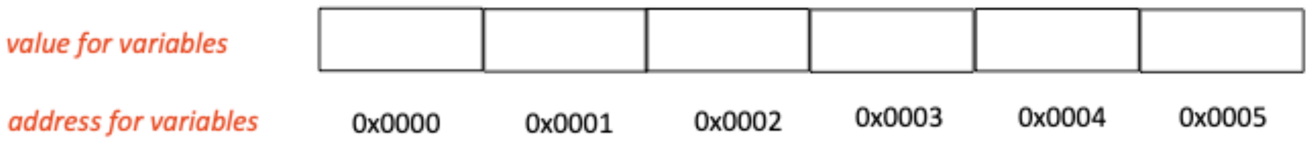
Attendance Link:

https://edstem.org/au/courses/7900/lessons/20189/slides/143881

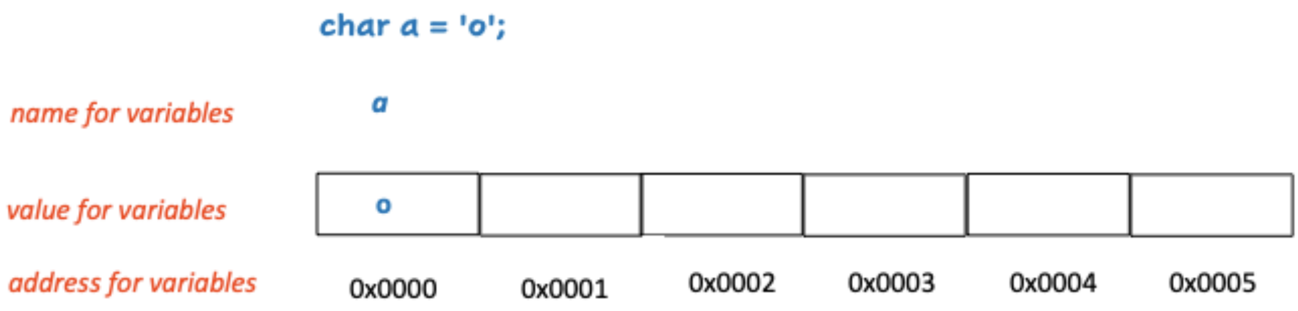
Week 2

Part1 : Pointer

Memory



```
Hexadecimal: with prefix 0x
```



(Notice: Different types need different number of bytes and this may varies in different OS)

How to get the address ?

```
char a = 'o';
printf("%p", &a);

// 0x0000, starting address for this variable
// virtual address => Week8
```

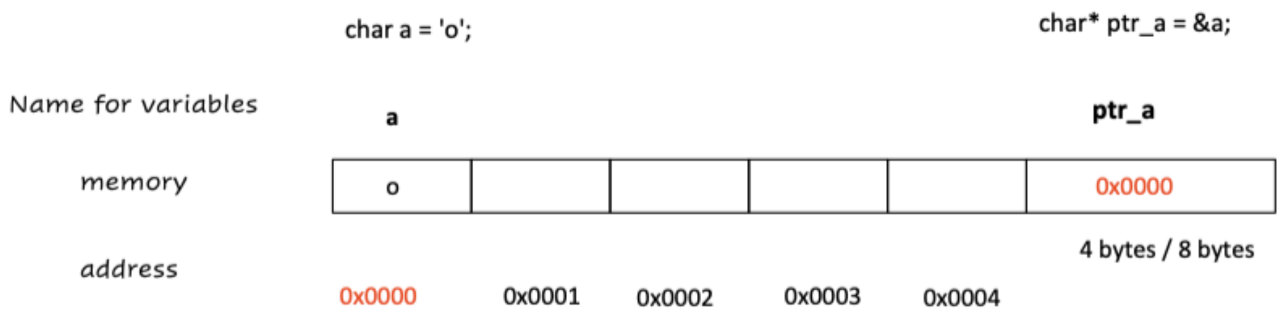
What's the pointer ?

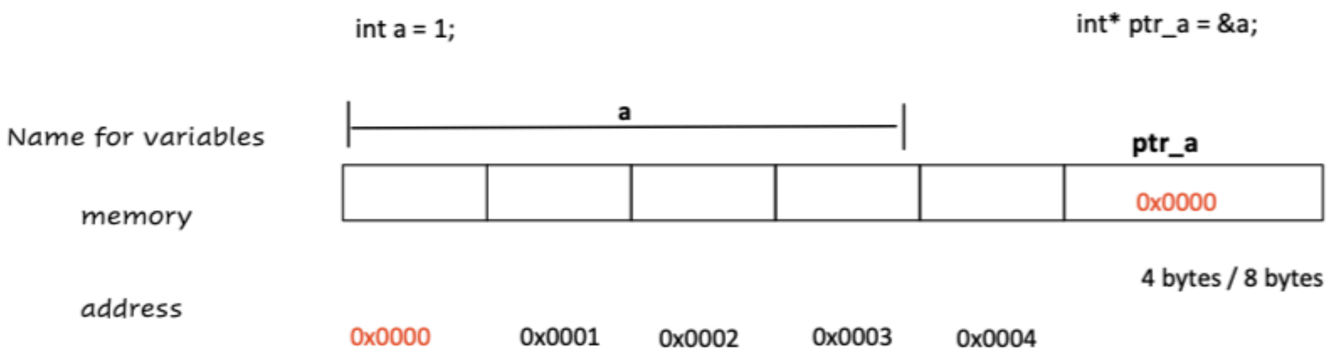
pointer is similar with address. To more specific, it is a variable stores the address (**starting address for some variable**).

```
/*
  variable name: pointer_a
  type: char* (a pointer/address to a char)
*/
char a = 'o';
char* ptr_a;       // the same as char *ptr_a;  * means it is pointer(variable stores address), char means the type of pointer is char (address stores char)
ptr_a = &a;
```

0x0000 is the address which stores the value 'o' whose type is char.

In 32-bit OS, address needs 4 bytes, in 64-bit OS, address needs 8 bytes





> Check address and value

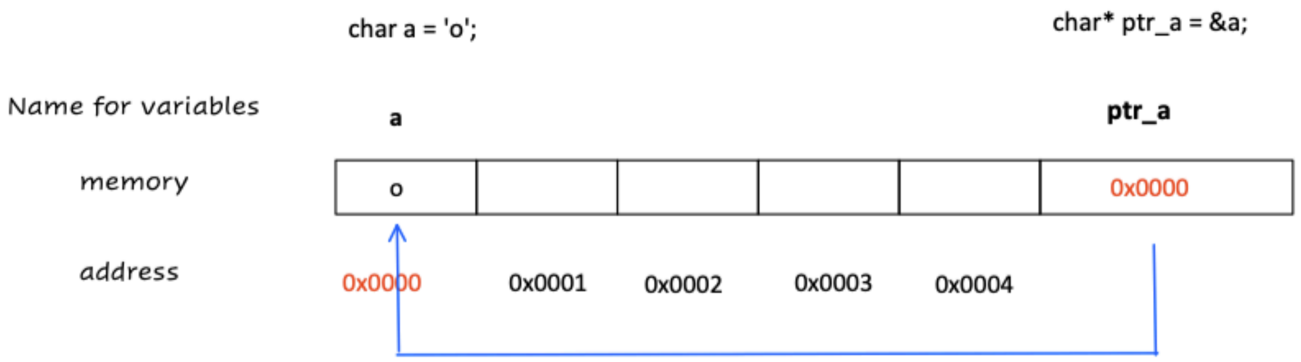
How to retrieve the value ?

```
// *ptr

printf("%c", *pointer_a);

// will print o
// since the type is char*, the computer only cares about 1 byte from statring address
//                           If the type is int*. It will do `from the starting address, let see 4 bytes`
```

`*` : **define a pointer** VS **dereferencing**

The previous one is used to define a pointer. `int a = 10; int* ptr = &a;`

The * here is called **dereferencing** operations (*) which allows retrieval of the value stored at the address. `int num = *ptr;`



Notice

```
int* pointer;
// We can get access the memory, but we do not know what stores there (unknown)

int* pointer = NULL;
// we can check for as a default/uninitialized value
if (NULL != pointer){
// do something
}
```

Part2: Array and string

1. All the elements in the array should be the **same type**
2. the memory layout for the elements in array are **contiguous**.

```
/*
  Declaration
*/

// type name[constant] ==> the complier needs to know how many memory you need
int a[2];
char arr[5];


/*
  Initialisation
*/
int integers[2] = {1, 2};
```

```c
a[0] = 1;

// The compiler can determine the required size
int ignore_constant[] = {1, 2};

//############
// Do not use variable length array
//############
```

There is not `string` type in C, we can use char array to represent string.

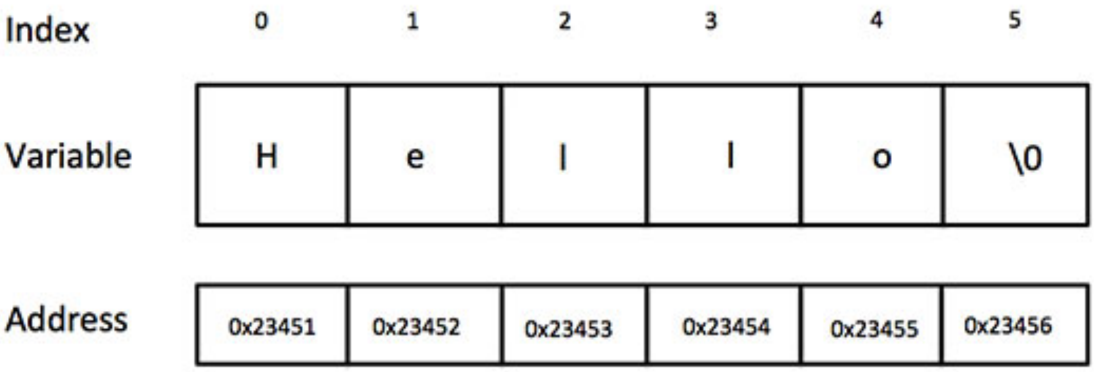
`Terminating character.`

```c
// string = char array end with '\0'
char myHobby[] = "rowing";    // size
char myHobby[] = {'r', 'o', 'w', 'i', 'n', 'g' , 0};
```

▶ Answer

```c
printf("%d\n", '\0'); // ==> 0 == '\0'
```

> Tutorial/Week2/Q3
>
> Tutorial/Week2/Q5.1



Index	0	1	2	3	4	5
Variable	H	e	l	l	o	\0
Address	0x23451	0x23452	0x23453	0x23454	0x23455	0x23456

- What happens ?

```
#include<stdio.h>
// part of Tutorial/Week2/Q5.1
int main(){

    char array2[] = {'H', 'e', 'l', 'l', 'o'};
    char array1[] = "hello";

    // check address
    printf("%p\n", array2 + 4);
    printf("%p\n", array1);

    printf("%s\n", array2);
    return 0;
}
```

▶ Answer

Sizeof

```
/*
  return type: size_t => to represent the size of obejct
<stddef.h>

  1) sizeof( object );
  2) sizeof( type_name );
*/



#include <stdio.h>
#include <stddef.h>

int main(){
    printf("%zu\n", sizeof("abc"));
    printf("%zu\n", sizeof(char*)); // 8/4

    printf("%zu\n", sizeof(int*));
    printf("%zu\n", sizeof(int));

    printf("%zu\n", sizeof(void*));

    int arr[2];
    printf("%zu\n", sizeof(arr)); // 2 * 4 = 8
    // In general, void is a incomplete type, and you cannot use sizeof for incomplete types, but gcc get 1

}
```

> Tutorial/Week2/Q5.2

// 10mins Back at 51

Part3: Array and Pointer

1. We can get a pointer of the first element in a array through the name of array

   ```
   int arr[5] = {1, 2, 3, 4, 5}; // &arr[0]

   arr   // it is a pointer points to 1. type is int*
   &arr[0]


   arr[0] // *(arr)
   arr[1] // *(arr + 1), since the type is int*, the computer knows it need 4 bytes to get the next element
   ```

2. What about `&arr` ?

   The value of `arr` and `&arr` are the same, starting address for the array

   > Try

   type is different, `arr` is the pointer for the first element (type ?). `&arr` is a pointer for the whole array (type ?)

   When adding or subtracting an integer from a pointer, the former uses one element as one step(granularity), and the latter uses the entire array as the granularity.

3. Check

   ```c
   // 3 minutes
   #include <stdio.h>
   int main()
   {
     int  a[5] = {1, 2, 3, 4, 5};
     int *ptr =  (int*)(&a + 1);   // (int*)
     printf("%d %d" , *(a + 1), *(ptr - 1));
   }
   ```

   ▶ Answer

> Tutorial/Week2/Q5.3, Q6

> Tutorial/Week2/Q5

Difference

```c
#include <stdio.h>

int main(){
    char* ptr = "abcd";
    char array[] = "cdef";
```

```
    /*
        char a[] = "abcd"           char* p = "cdef"

        a is an array               p is a pointer

        sizeof(a) = 5              sizeof(p) = 8 / 4

        "abcd" in stack             p is in stack, "cdef" in code section (can not modify)

        value &a same with a        p not same with &p

        a = "hello" invalid         p = "hello" valid
        since a is address
        we can not change address

        a[0] = 'c'  valid           p[0] = 'c' invalid
        array stored in stack        code section read only
        during the runtime, writeable

    */

}
```

Part 4: char** argv

```
// ./a.out argv1 argv2  => how to represent string array
int main(int argc, char** argv){}
int main(int argc, char* argv[]){}

// ########## Tutorial Q4 #########
```

```
/*
    + char* p
      1. Address to a single char value
      2. Address to a single char value that is the first in an
array => starting address of one string, so  is the similar as
char p[]

      char p[]   char* p ==> so char* can represent string


    + char* (argv[])
      1. an array whose elements are char*  =>    printf("%s\n",
argv[1]); => string array
      |a1|a2|a3|

      |'a'|'r' |'g' |'v' |'1' | '\0'|
        a1

      |'a'|'r' |'g' |'v' |'2' | '\0'|
        a2

      |'a'|'r' |'g' |'v' |'3' | '\0'|
        a3
      Array of “the type” with unknown length
      - Type is char *


    // receive char*
    printf("%s\n", argv[1]);   ==> type is char*
    printf("%s\n", *(argv + 1)); ==> type of argv is char**,
deference it once

*/
```

> Tutorial/Week2/Q2, Q4

Back 9:52

> Tutorial/Week2/Q7, 8, 9, 10, 11

Parameters are passed by value in C

In the C language, when a one-dimensional array is used as a function parameter, the compiler always resolves it as a pointer to the first address of its first element.

Question 7: Swap

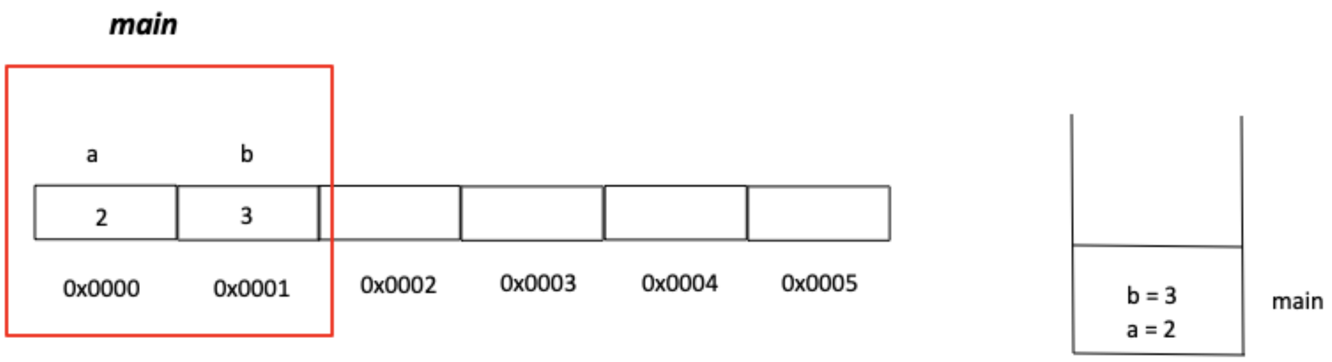
```
void swap(int* a, int* b) {
  //
  // TODO
  //
}

int main(void) {
  int a = 2;
  int b = 3;
  swap(?, ?); //Specify the variables to swap
  printf("%d %d\n", a, b); // should print 3 2
  return 0;
}
```

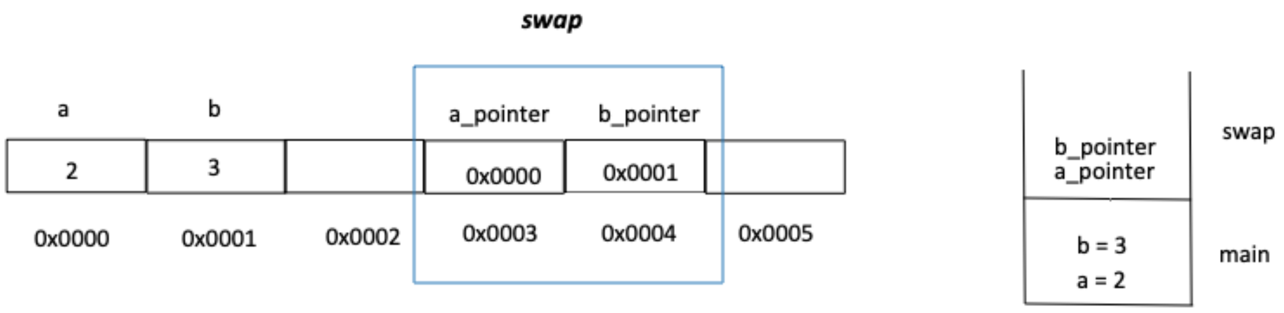
// 10 minutes for discussing

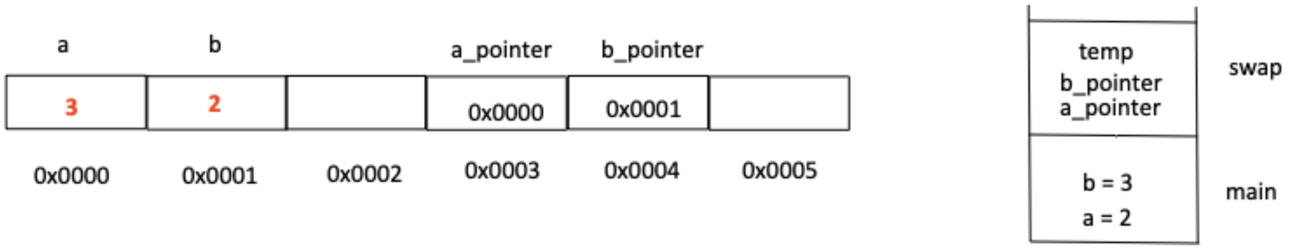
Answer:

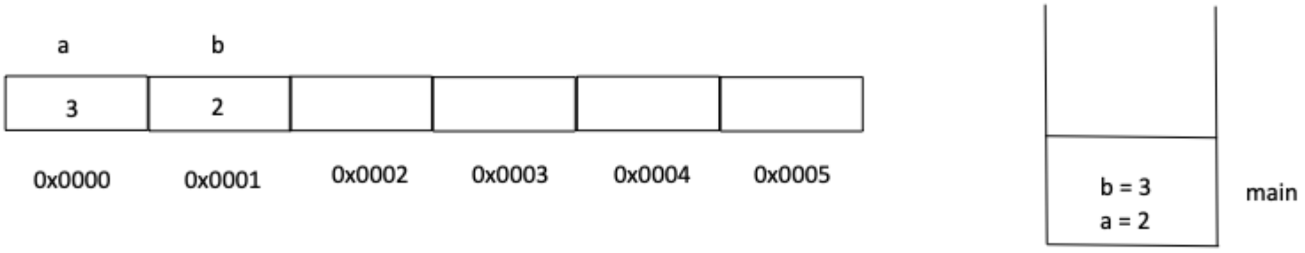
```
#include <stdio.h>

void swap(int* a_pointer, int* b_pointer) {
    int temp = *a_pointer;
    *a_pointer = *b_pointer;
    *b_pointer = temp;
}

int main(void) {
    int a = 2;
    int b = 3;
    swap(&a, &b); //Specify the variables to swap
    printf("%d %d\n", a, b); // should print 3 2
    return 0;
}
```

Just for the convenience to explain, the reality is `int` usually needs 4 bytes, and address takes 8 bytes.


main
a
b
2
3
0x0000
0x0001
0x0002
0x0003
0x0004
0x0005
b = 3
a = 2
main


swap
a
b
a_pointer
b_pointer
2
3
0x0000
0x0001
0x0000
0x0001
0x0002
0x0003
0x0004
0x0005
b_pointer
a_pointer
swap
b = 3
a = 2
main


a
b
a_pointer
b_pointer
3
2
0x0000
0x0001
0x0000
0x0001
0x0002
0x0003
0x0004
0x0005
temp
b_pointer
a_pointer
swap
b = 3
a = 2
main


a
b
3
2
0x0000
0x0001
0x0002
0x0003
0x0004
0x0005
b = 3
a = 2
main

Extra

Void*

A special pointer, "no type pointer"

Usage of `void*`

If the parameter of the function can be any type of pointer, its parameter should be declared as `void*`

```
void *get_address( sometype *data , int n) {
  unsigned char *ptr = (unsigned char*)data;
  return (void*)(ptr + n);
}
// avoid do +/- in void*, some complier does not accept

/*
  Why we use unsigned char as a type of BYTE ?
  size
  Generally unsigned chars are used when you don't want a sign.
This will make a difference when doing things like shifting bits
(shift extends the sign).

*/
```

```
#include <stdio.h>

int main(){

    int a = 123456;
    int* ptr_a = &a;
    unsigned char* byte_ptr = (unsigned char*)ptr_a;
    printf("%x, %x, %x , %x", *byte_ptr, *(byte_ptr + 1), *
(byte_ptr + 2), *(byte_ptr + 3));
}

>> 40, e2, 1 , 0
  // 123456 = 1 E2 40
```

a++ VS ++a

```c
#include <stdio.h>
int main()
{
    int a = 12, b = 1;
    int c = a - (b--);
    int d = (++a) - (--b);
    printf("c=%d, d=%d\n", c, d);
    return 0;
}
```

```
c=11, d=14
```

There may be some errors! If you find it, please contact me by the email. Thanks