REVIEW C PROGRAMING

Dựa trên slide của Khoa KTMT

Content

- Basic notations
- Data type
- Condition and Iteration
- Function
- Command line argument
- Pointer
- Structure
- Link listed
- I/O function

Tập ký tự

- Tập ký tự trong C
  - 26 chữ cái hoa:A B C ... X Y Z
  - 26 chữ cái thường:a b c … x y z.
  - 10 chữ số: 0 1 2 3 4 5 6 7 8 9.
  - Các kí hiệu toán học:+ - * / = < >
  - Các dấu ngăn cách: . ; , : space tab
  - Các dấu ngoặc:( ) [ ] { }
  - Các kí hiệu đặc biệt:_ ? $ & # ^ \ ! ‘ “ ~ .v.v.

Từ khóa

- Từ khóa hay dùng trong

break	case	char	const	continue	default
do	double	else	enum	float	for
goto	if	int	interrupt	long	return
short	signed	sizeof	static	struct	switch
typedef	union	unsigned	void	while	

Định danh

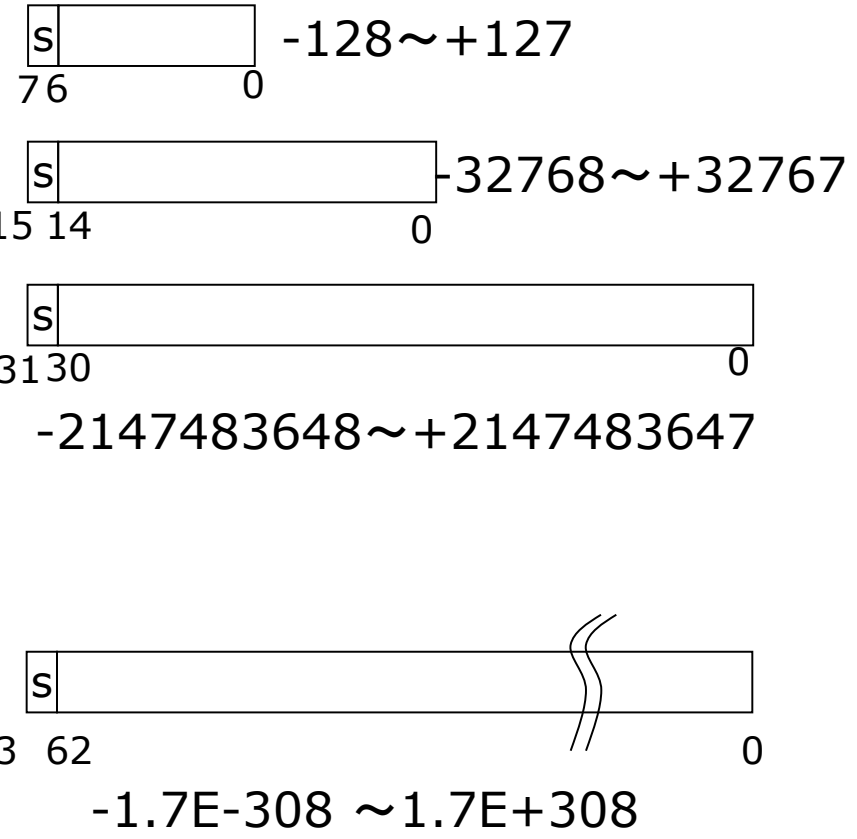
- Quy tắc đặt tên định danh trong C
  - Các kí tự được sử dụng: chữ cái, chữ số và dấu gạch dưới "_" (*underscore*)
  - Bắt đầu của định danh phải là chữ cái hoặc dấu gạch dưới "_", không được bắt đầu định danh bằng chữ số.
  - Định danh do người lập trình đặt không được trùng với các từ khóa của C
- Chú ý: *C là ngôn ngữ có phân biệt chữ hoa và chữ thường*

Data type

- Integer
  - int, char, short, long
- Floating
  - double, float
- Array
  - Collection of A data type
  - Declare : int a[10];

Size of Type

- size of char: 1 byte
- size of short: 2 bytes
- size of int: 4 bytes
- size of long: 4 bytes
- size of float: 4 bytes
- size of double: 8 bytes



Condition and Loop Structure

- if … else
- switch
- for
- while, do … while

Condition

- a == b
  - b equals to a
- a != b
  - b is different to a
- a > b
  - b is smaller than a
- a >= b
  - b isn’t greater than a
- a < b
  - b is greater than a
- a <= b
  - b isn’t smaller than a

if … else

```
if(condition){
        statement1;
        …
}
else{
        statement2;
        …
}

Example :
if( x == 1){
        y = 3;
        z = 2;
}
else{
        y = 5;
        z = 4;
}
```

```
if (condition)
        task1;
else task 2;
```

is equivalent?

```
if (condition)
task1;
if (!condition)
task2;
```

switch

```
switch(condition){
        case value1: statement1;…; break;
        case value2: statement2;…; break;
        …
        default: statementn;…; break;
}

Example :
int monthday( int month ){
        switch(month){
        case 1: return 31;
        case 2: return 28;
        …
        case 12: return 31;
        }
}
```

for

- `expr1, expr3`: assignments or function calls
- `expr2`: relational expression
  Any of the three expression can be omitted
  - the semicolons must remain

```
for(expr1 ; expr2 ; expr3){
        statements ;
        …
}

Example :
for( x = 0; x < 10; x++){
        printf("%d\n", x);
}
```

while, do…while

- If there is no initialization or re-initialization, the `while` is most natural

```
while ((c = getchar()) == ' ' || c == '\n' || c = '\t')
        /* skip white space characters *
```

```
while(condition){
        statement ;
        …
}

Example :
x = 0;
while(x < 10){
        printf("%d\n",x);
        x = x + 1;
}
```

```
do{
        statement ;
        …
} while(condition)

Example :
x = 0;
do{
        printf("%d\n",x);
        x = x + 1;
} while(x < 10)
```

break

- `break`
  - Terminates the execution of the nearest enclosing loop or conditional statement in which it appears.
- `continue`
  - Pass to next iteration of nearest enclosing do, for, while statement in which it appears
- Example

```
/* trim: remove trailing blanks, tabs, newlines */
char s[MAX]
int n;
for (n = strlen(s)-1; n >= 0; n--)
   if (s[n] != ' ' && s[n] != '\t' && s[n] != '\n')
        break;
s[n+1] = '\0';
```

```
for (i = 0; i < n; i++)
   if (a[i] < 0) /* skip negative elements */
        continue;
... /* do positive elements */
```

Function

- A function is a group of statements that is executed when it is called from some point of the program. The following is its format:

```
type name ( parameter1, parameter2, ...) {
      statements;
}
```

- where:
  - `type` is the data type specifier of the data returned by the function.
  - `name` is the identifier by which it will be possible to call the function.
  - `parameters` (as many as needed): Each parameter consists of a data type specifier followed by an identifier
  - `statements` is the function's body. It is a block of statements surrounded by braces { }.

Example of function

```
#include <stdio.h>
int squaresub(int a)
{
    return a*a;
}

int main()
{
    int  b = 10;
    printf("%d\n", squaresub(5));
    return 0;
}
```

Data type of function

Return value statement

Use function

Usage of command line arguments

- `main( int argc, char **argv)`
- `main( int argc, char *argv[])`

- Argc : number of arguments
- argv[0] : argument 0
- argv[1] : argument 1
- argv[2] : argument 2

Example :

%./a.out 123 456 789

arg[0]: ./a.out

arg[1]: 123

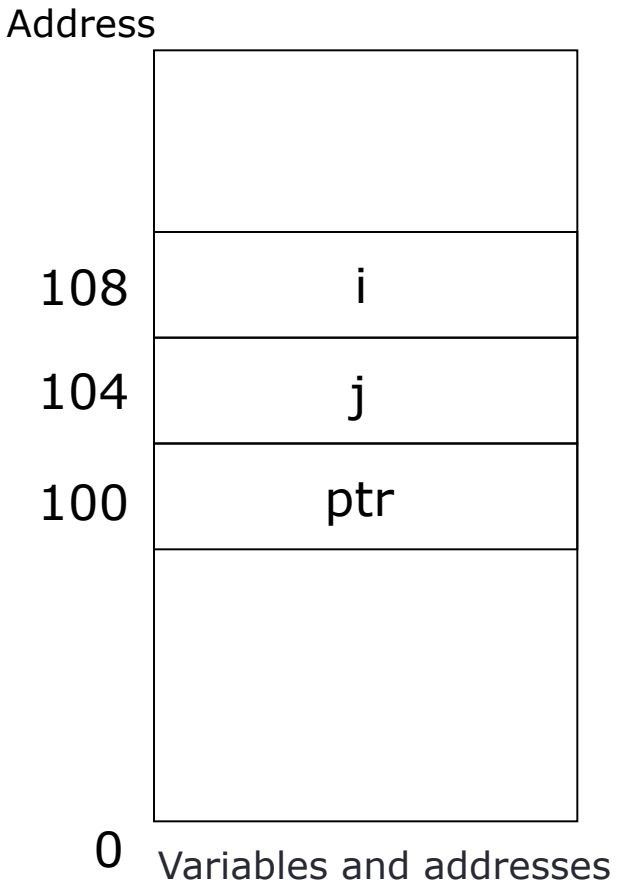
arg[2]: 456

arg[3]: 789

Pointer

- Pointer variable
  - "Variable" refers to variable
- int i = 10;
- int j = 20;
- int *ptr;
- Pointer to pointer:

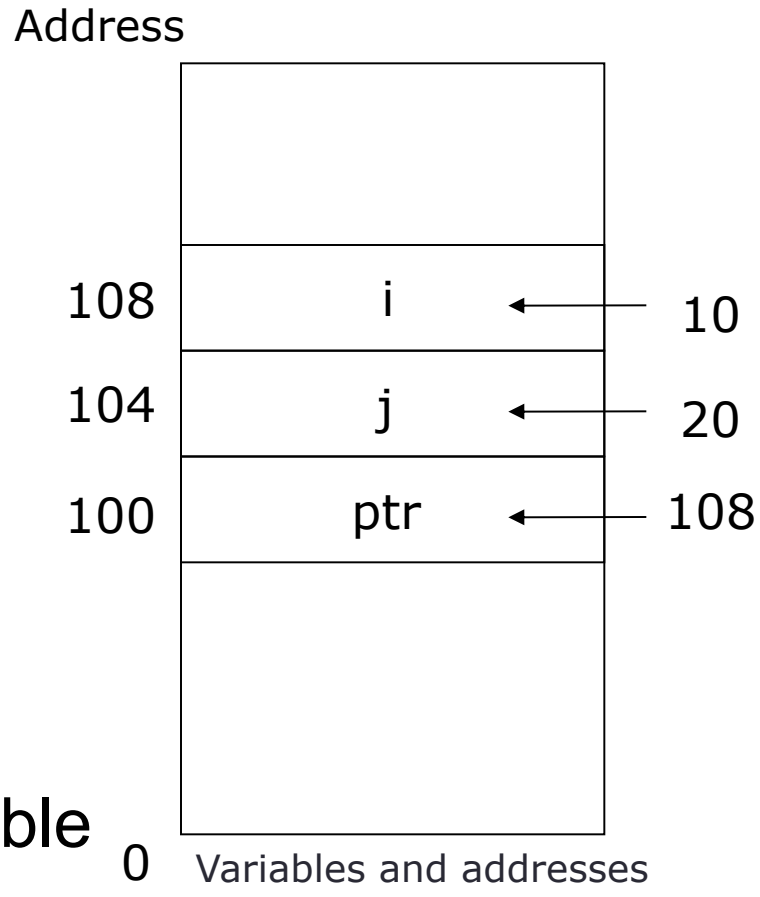
  int **p;



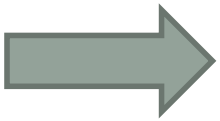
Pointer (cont)

- int i = 10;
- int j = 20;
- int *ptr = &i;

- printf("i=%d\n", &i)
- printf("ptr=%d\n", ptr)
- printf("i=%d\n", i)
- printf("*ptr=%d\n",*ptr)
- Ptr refers to the pointer variable



```c
#include <stdio.h>

int main ()
{
   int  var = 20;   /* actual variable declaration */
   int  *ip;        /* pointer variable declaration */

   ip = &var;  /* store address of var in pointer variable*/

   printf("Address of var variable: %x\n", &var  );

   /* address stored in pointer variable */
   printf("Address stored in ip variable: %x\n", ip );

   /* access the value using the pointer */
   printf("Value of *ip variable: %d\n", *ip );

   return 0;
}
```



```
Address of var variable: bffd8b3c
Address stored in ip variable: bffd8b3c
Value of *ip variable: 20
```

Pointer (cont)

- int x=1, y=5;
- int z[10];
- int *p;
- p=&x; /* p refers to x   */
- y=*p;   /*y is assigned the value of x*/
- *p = 0; /* x = 0   */
- p=&z[2]; /* p refer to z[2] */

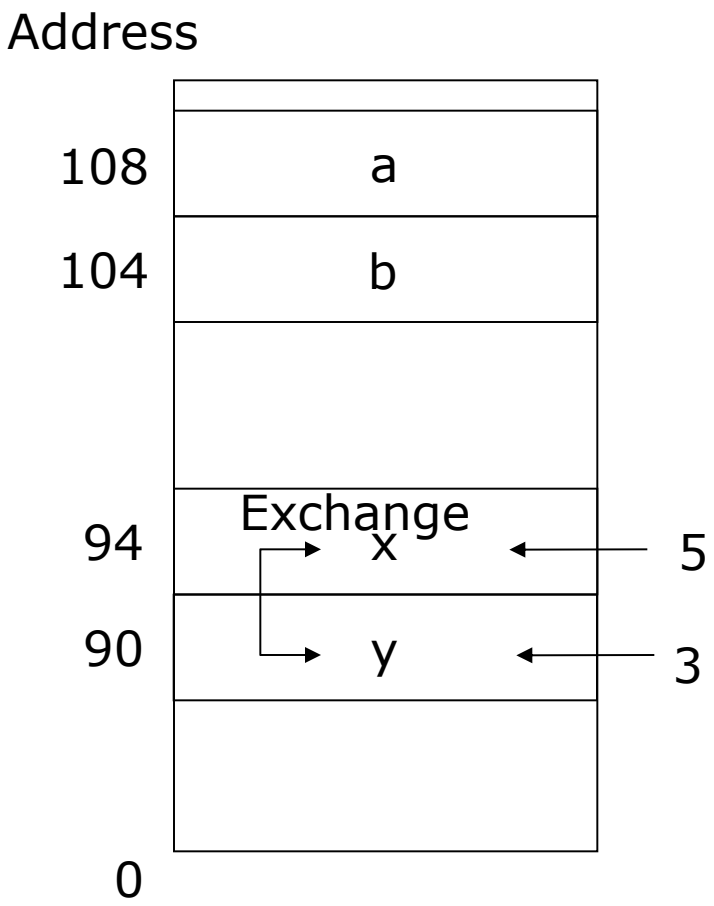
Pointer and function

```
#include <stdio.h>
void swap(int x, int y)
{
        int temp;
        temp = x;
        x = y;
        y = temp;
}

int main(){
        int a = 5;
        int b = 3;
        swap (a, b);
        printf("a=%d\n", a);
        printf("b=%d\n", b);
        return 0;
}
```

Result ?

Pointer and function (cont)

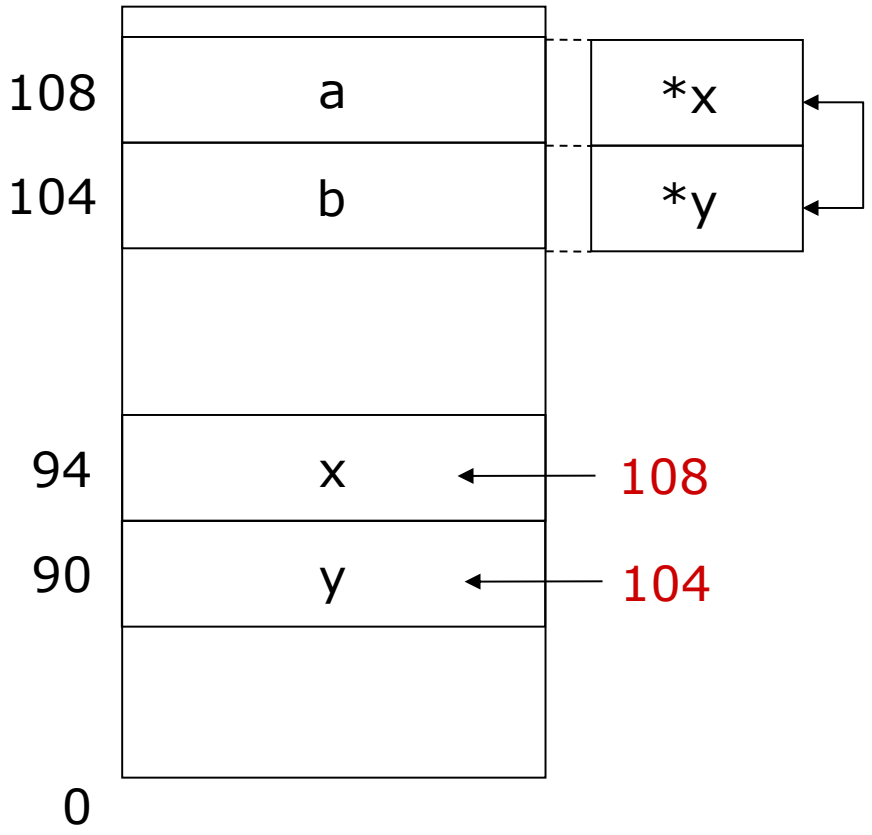
```
#include <stdio.h>
void swap(int x, int y)
{
        int temp;
        temp = x;
        x = y;
        y = temp;
}

int main(){
        int a = 5;
        int b = 3;
        swap (a, b);
        printf("a=%d\n", a);
        printf("b=%d\n", b);
        return 0;
}
```



Pointer and function (cont)

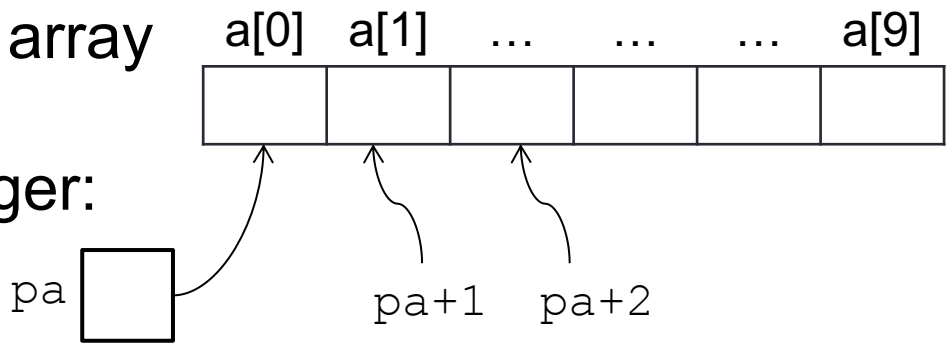
```
#include <stdio.h>
void swap(int *x, int *y)
{
        int temp;
        temp = *x;
        *x = *y;
        *y = temp;
}

int main(){
        int a = 5;
        int b = 3;
        swap (&a,&b);
        printf("a=%d\n", a);
        printf("b=%d\n",b);
        return 0;
}
```

Program to exchange 2 value of variables



Pointer and Array

- The declaration an integer array
  `int a[10];`
- If `pa` is a pointer to an integer:
  ```
  int *pa;
  pa = &a[0];
  ```
- Similarity: `pa` and `a` are pointers
- Difference: `pa` is a variable but `a` is not
  - legal: `pa ++; pa = a;`
  - Illegal: `a++; a = pa;`
- `a`: constant pointer



Constant pointer vs Pointer to constant

- Constant pointer: a pointer that cannot change the address its holding.
  - Declaration: `<type> *const <name of pointer>`
- Pointer to constant: a pointer through which one cannot change the value of variable it points
  - Declaration: `const <type>* <name of pointer>`
- Constant Pointer to a Constant: mixture of the above two types of pointers
  - Declaration:

```
const <type of pointer>* const <name of pointer>
```

Constant pointer

```c
#include <stdio.h>
int main(void)
{
    int var1 = 0, var2 = 0;
    int *const ptr = &var1;
    ptr = &var2;
    printf("%d\n", *ptr);

    return 0;
}
```

```
$ gcc -Wall constptr.c -o constptr
constptr.c: In function ‘main’:
constptr.c:7: error: assignment of read-only variable
‘ptr’
```

Pointer to constant

```
#include <stdio.h>
int main(void)
{
    int var1 = 0;
    const int* ptr = &var1;
    *ptr = 1;
    printf("%d\n", *ptr);

    return 0;
}
```

```
$ gcc -Wall constptr.c -o constptr
constptr.c: In function ‘main’:
constptr.c:7: error: assignment of read-only location
‘*ptr’
```

Constant Pointer to a Constant

```c
#include <stdio.h>
int main(void)
{
    int var1 = 0,var2 = 0;
    const int* const ptr = &var1;
    *ptr = 1;
    ptr = &var2;
    printf("%d\n", *ptr);

    return 0;
}
```

```
$ gcc -Wall constptr.c -o constptr
constptr.c: In function ‘main’:
constptr.c:7: error: assignment of read-only location
‘*ptr’
constptr.c:8: error: assignment of read-only variable
‘ptr’
```

Return pointer from functions vs Function pointer

- Return pointer from functions:

```
<type>* <name of function> (<types of parameter>)
```

- Function pointer: pointers to functions

```
<type> (*<name of function>) (<types of parameter>)
```

```c
int func (int a, int b)
{
   printf("\n a = %d\n",a);
   printf("\n b = %d\n",b);

   return 0;
}
```

```c
int main(void)
{
   // Function pointer
   int(*fptr)(int,int);
   // Assign address to
   // function pointer
   fptr = func;
   func(2,3);
   fptr(2,3);

   return 0;
}
```

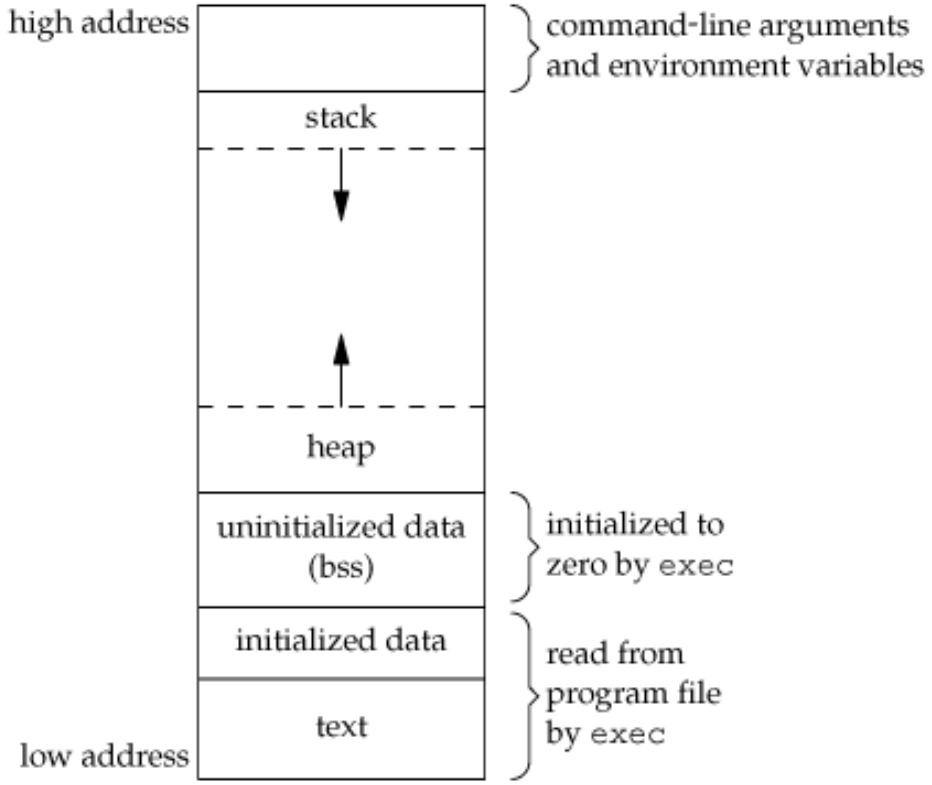
`void` pointer

- `void` pointer: a special a pointer that has no associated data type with it
  - Can hold address of any type and can be typcasted to any type.
  - Generic programming
- Declaration: `void *<name of pointer>;`
- The void pointer cannot be dereferenced directly
  - The void pointer must first be explicitly cast to another pointer type before it is dereferenced.

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

Dynamic Memory Allocation

- A typical memory representation of C program consists of following sections.
  1. Text segment: code segment
  2. Initialized data segment
  3. Uninitialized data segment
  4. Stack
  5. Heap: the segment where dynamic memory allocation usually takes place



Dynamic Memory Allocation

- `void * malloc( size_t size );`
  - Allocates requested size of bytes and returns a pointer first byte of allocated space
  - Doesn't initialize the allocated memory
  - Asigment: `ptr = (cast-type*) malloc(byte-size)`
- `void * calloc( size_t num, size_t size );`
  - Allocates space for an array elements, initializes to zero and then returns a pointer to memory
  - Initializes the allocates memory block to zero
  - Asigment: `ptr = (cast-type*)calloc(n, element-size);`
  - Equivalent:

```
ptr = malloc(size);
memset(ptr, 0, size);
```

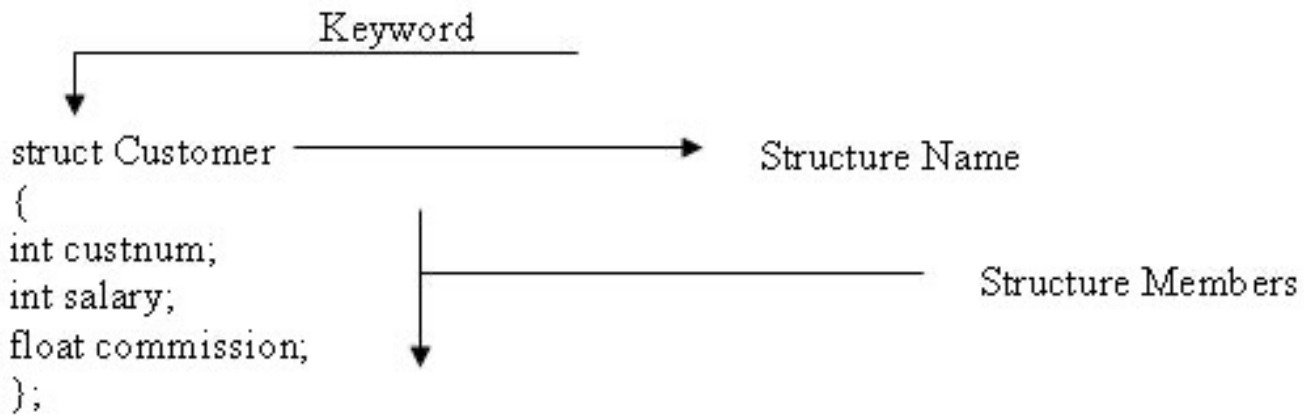
Dynamic Memory Allocation

- `void *realloc(void *ptr, size_t size);`
  - Deallocates the old object pointed to by ptr and returns a pointer to a new object that has the size specified by size
  - `ptr = realloc(ptr, newsize);`
- `void free(void *ptr);`
  - Deallocate the previously allocated space
- Memory Leak
  - Create a memory in heap and forget to delete it
  - To avoid memory leaks, memory allocated on heap should always be freed when no longer needed
- valgrind: suite of tools for debugging and profiling programs.

```
$ valgrind –leak-check=full <program>
```

Structure

- Structure is a collection of variables under a single name. Variables can be of any type: int, float, char etc.
- ***Declaring a Structure:***



Using variable structure

- Declare structure variable?
  - This is similar to variable declaration.
  - Example

```
int a;
struct Customer John;
```

- Access structure members: use the dot operator

```
<structure variable name>.<member name>
```

- Access to members of a pointer to the variable structure: using operators →

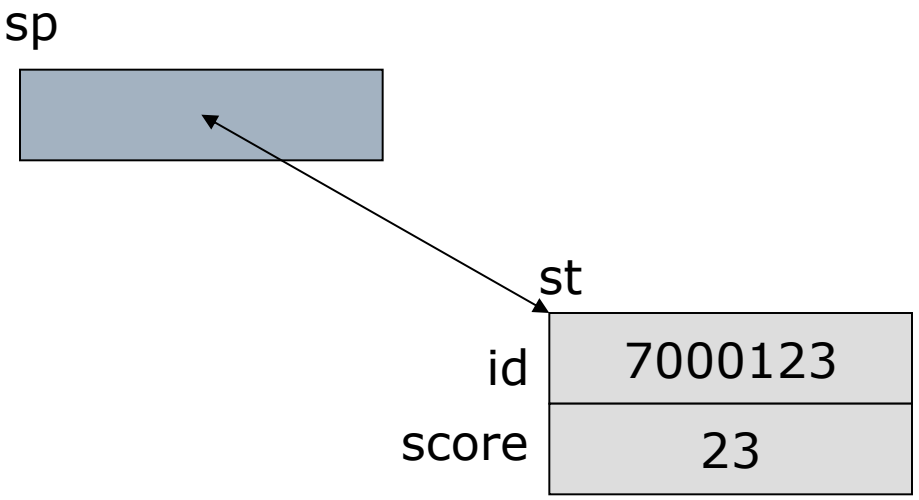
```
<structure variable name> -> <member name>
```

Example

```
struct student{
    int id;
    int score;
};

int main()
{
    int i;
    struct student students[5];
    for(i=0; i<5; i++){
        students[i].id = i;
        students[i].score = i;
    }
    for(i=0;i<5;i++){
        printf("student id:%d, score:%d\n",
             students[i].id, students[i].score);
    }
    return 0;
}
```

Structure and Pointer

```
struct student st;
struct student *sp;
sp = &st;
sp->id = 7000123;
(*sp).score = 23;
```



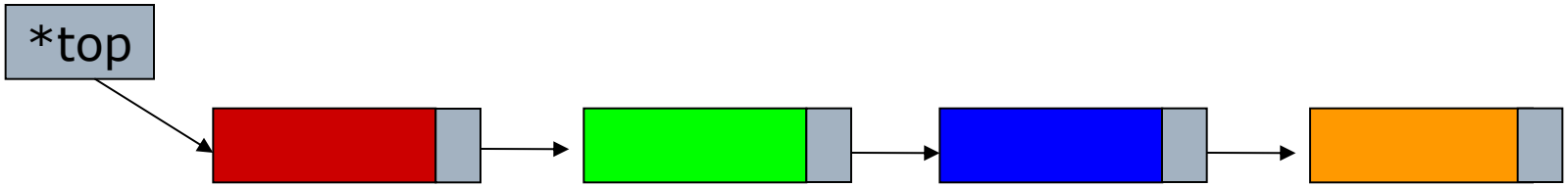
printf("%d\n", sp->score);

Link list

- Store a pointer to the next structure in the structure

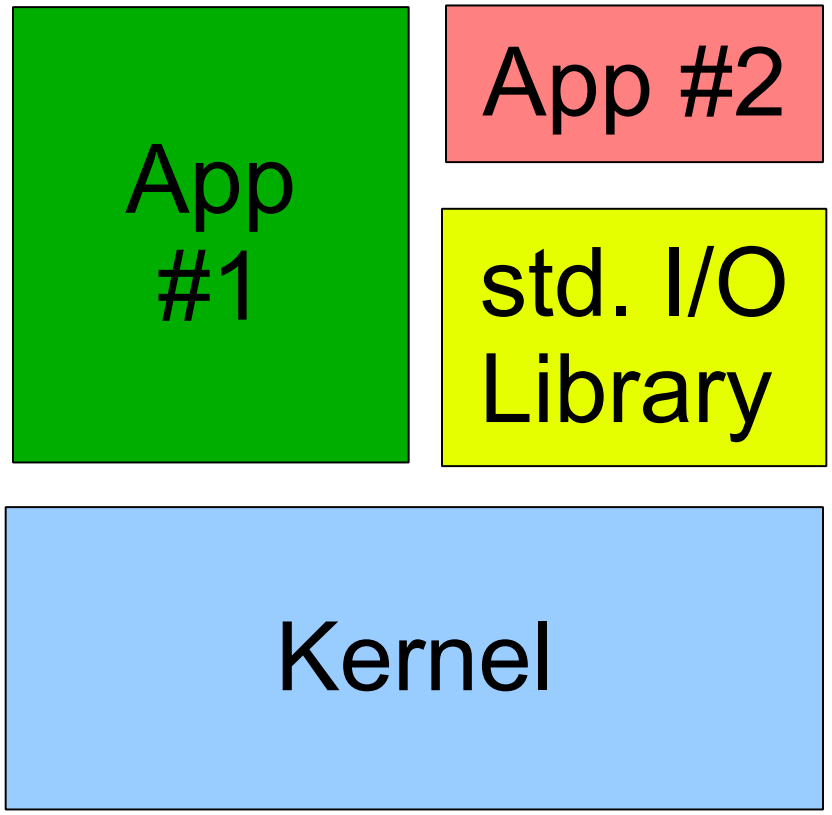
```
struct student {
   int id;
   int score;
   struct student *next;
}
```

- *Warning : allocate memory before use and release memory after use*



I/O function

- All I/O calls ultimately go to the kernel
- I/O library helps with buffering, formatting, interpreting (esp. text strings & conversions)



Input function (include in stdio.h)

- Functions
  - printf( )
    - Print formatted data to stdout
  - fprintf( )
    - Write formatted output to stream
  - gets( )
    - Read one line from standard input
    - **NEVER EVER USE THIS!**
  - fgets( )
    - Get string from stream, a newline character makes fgets stop reading
    - **USE THIS INSTEAD**
  - getc( )
    - Character read from standard input
  - putc( )
    - Export one character to standard output
- Deprecated functions
  - scanf( )
    - Read formatted data from stdin
  - fscanf( )
    - Read formatted data from stream

Input function (include in unistd.h)

- Function
  - read()
    - Argument : number of bytes read and target
  - write()
    - Argument : the number of bytes to write to output
  - open()
  - close()
  - start()

open()/read()/write()/close()

```
#include <fcntl.h>
#include <sys/types.h>
#include <sys/uio.h>
#include <unistd.h>
#define BUFSIZE 1024

int main()
{
    char buf[BUFSIZE];
    int fd;
    int nbyte;
    fd = open("test.txt", O_RDONLY, 0);
    while((nbyte = read(fd, buf, BUFSIZE)) > 0) {
        write(1, buf, nbyte);
    }
    close(fd);

    return 0;
}
```

File handling functions

- `fopen(char *filename, char *mode)`
  - `r,w,a,r+,w+,a+`
- `fgets(char *s,int length,FILE *fd)`
- `fgetc(FILE *fd)`
- `fclose(FILE *fd)`

Example

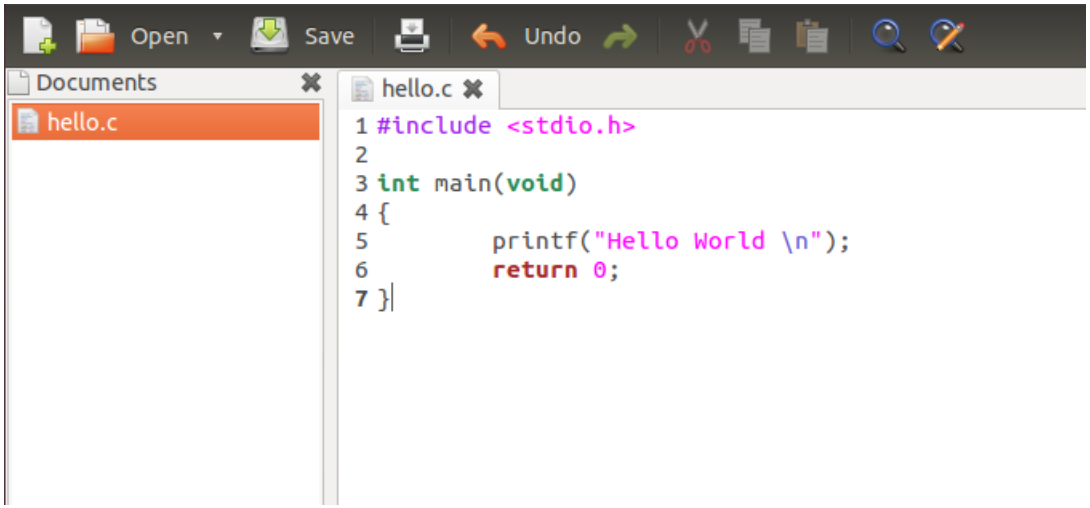
```
#include <stdio.h>

int main(int argc, char *argv[])
{
  FILE *fp;
  char buf[1024];
  int c;
  fp = fopen(argv[1],"r");
        while((fgets(buf, sizeof(buf),fp)) != NULL){
                    fputs(buf,stdout);
       }
  fclose(fp);

  return 0;
}
```

Chuẩn bị

- 3 thứ cần thiết để lập trình C trên Linux
  - Text editor
  - Compiler
  - C standard library

Text editor

- Vi
- nano
- gedit
- v.v…



Compiling & Running

- Cài đặt gcc

```
sudo apt-get install gcc
```

- Dịch

```
gcc -o hello hello.c
```

- Chạy

```
./hello
```

Make