

# NETWORK PROGRAMMING

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Data Communications & Computer Networks

SoICT, HUST

# Course information

- IT4062E: Network programming
- Webpage of the course
  - <https://users.soict.hust.edu.vn/linhtd/courses/NetworkProg/>
- Instructor email: [linhtd@soict.hust.edu.vn](mailto:linhtd@soict.hust.edu.vn)
  - For making appointment or brief discussion.
- What we study in this course
  - How to build network applications using socket programming paradigm.
  - Socket programming using C (in details)
  - Socket programming in Java (introduction and self study)
- Reference:
  - UNIX® Network Programming Volume 1, Third Edition: The Sockets Networking API, W. Richard Stevens, Bill Fenner, Andrew M. Rudoff
  - <https://notes.shichao.io/unp/ch7/>

# Course contents

- Lecture contents
  - Review of C programming language
  - Review of related concept in Computer Networks
  - Introduction to Socket API
  - Basic TCP socket: server side, client side
  - UDP socket
  - Multi-process TCP server
  - Application protocol
  - Socket programming with Java.
- Exercises in class
  - After each lecture
- Final project
  - Development of network applications in groups
  - 2-3 members/ group.
  - Used for mid-term and final evaluations

# REVIEW C PROGRAMMING

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# Content

- Data type
- Condition and Loop statement
- Function
- Command line argument
- Pointer
- Structure
- Link listed
- I/O function

# Data type

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

# Size of Type

size of char: 1 bytes

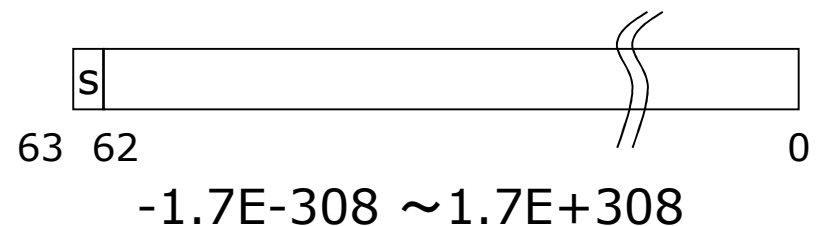
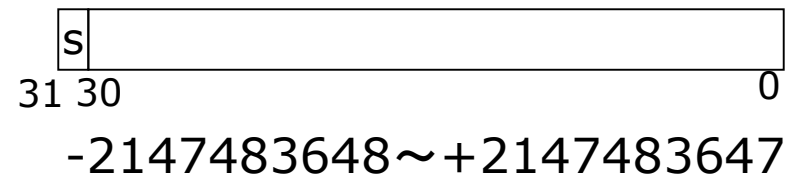
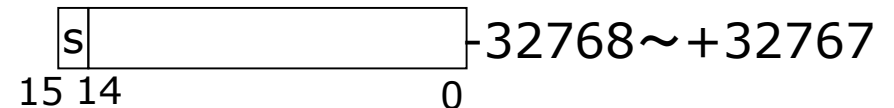
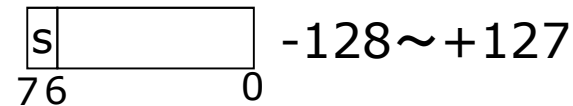
size of short: 2 bytes

size of int: 4 bytes

size of long: 4 bytes

size of float: 4 bytes

size of double: 8 bytes



# Condition and Loop statement

- 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;  
}
```

# 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

```
for (condition1 ; condition2 ; condition3)
{
    statements;
    ...
}
```

Example:

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

# while

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

Example:

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

# break and continue

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

- Example

```
for( i=0; i<100; i++ ){  
    statement 1;  
    if ( i==90 )    continue;  
    statement 2;  
}
```

```
for( i=0; i<100; i++ ){  
    statement 1;  
    if ( i==90 )    break;  
    statement 2;  
}
```

# Function

- A function is a group of statements that is executed when it is called from some point of the program.
- Function format:  
*type function\_name ( parameter1, parameter2, ...) {  
statements }*
- where:
  - *type* is the type of the data returned by the function.
  - *function\_name*.
  - *parameters*
  - Statements: function's body.

# Example of function

```
#include <stdio.h>
```

```
int squaresub(int a)  
{  
    return a*a;  
}
```

Data type of function

Return value statement

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

Use function



# Usage of command line arguments

- `main( int argc, char **argv)`
- `main( int argc, char *argv[])`
- `Argc` : number of arguments
- `argv[0]` : command name
- `argv[1]` : 1<sup>st</sup> argument
- `argv[2]` : 2<sup>nd</sup> argument

Example :

```
$/a.out 123 456 789
```

```
argv[0]: ./a.out
```

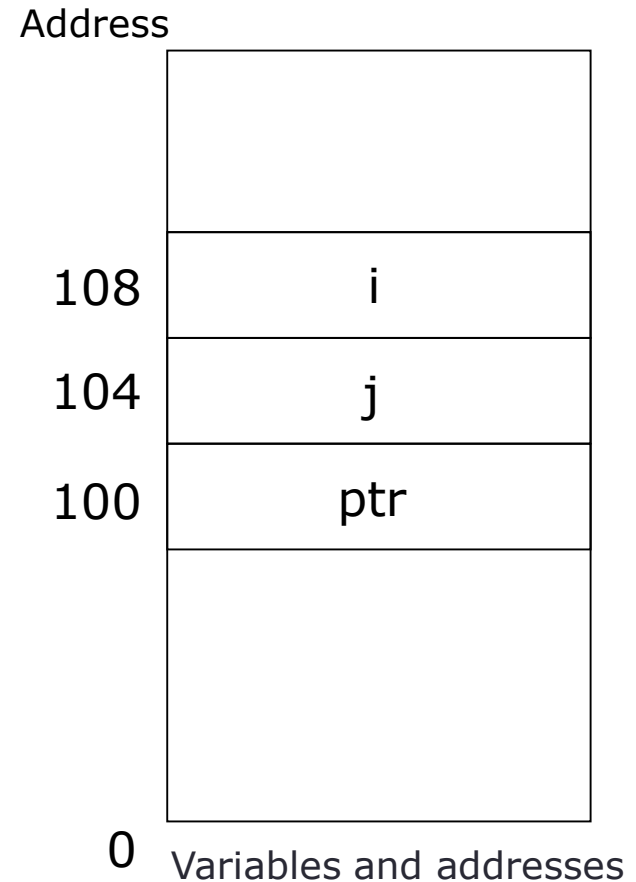
```
argv[1]: 123
```

```
argv[2]: 456
```

```
argv[3]: 789
```

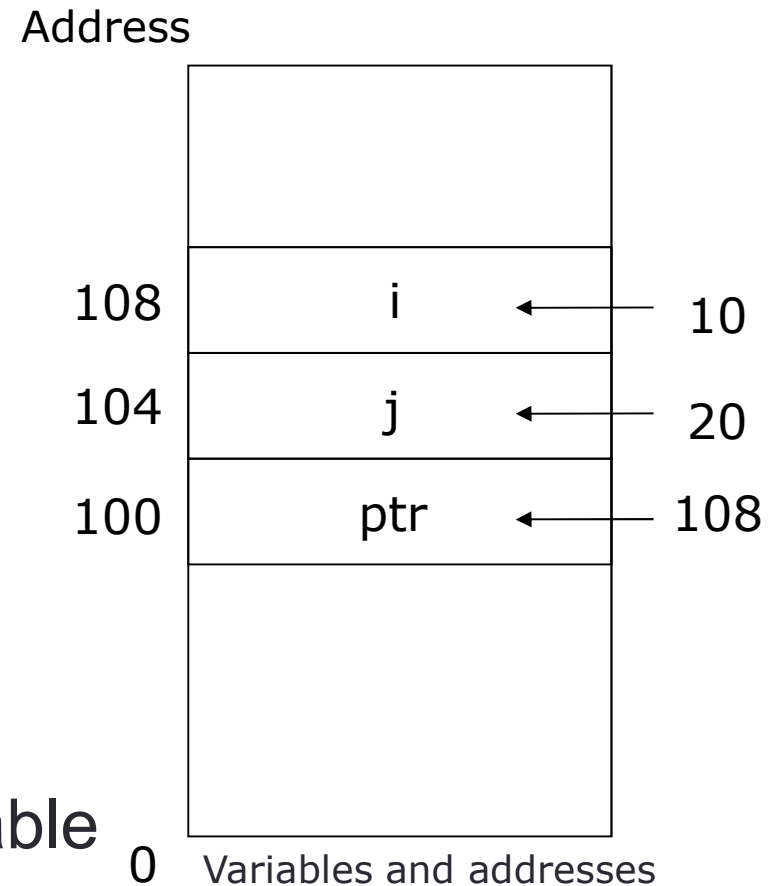
# Pointer

- Pointer variable
  - "Variable" refers to variable
  - Value of the pointer is the address of the variable in the memory
- `int i = 10;`
- `int j = 20;`
- `int *ptr`



## 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



## 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;
}
```

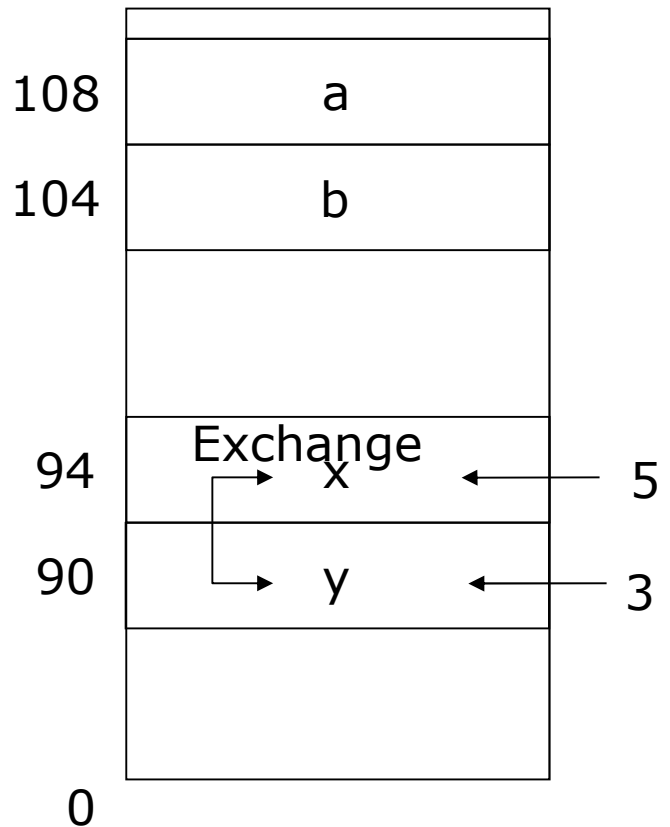
Result ?
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# Pointer and function (cont)

```
#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;
}
```

Address

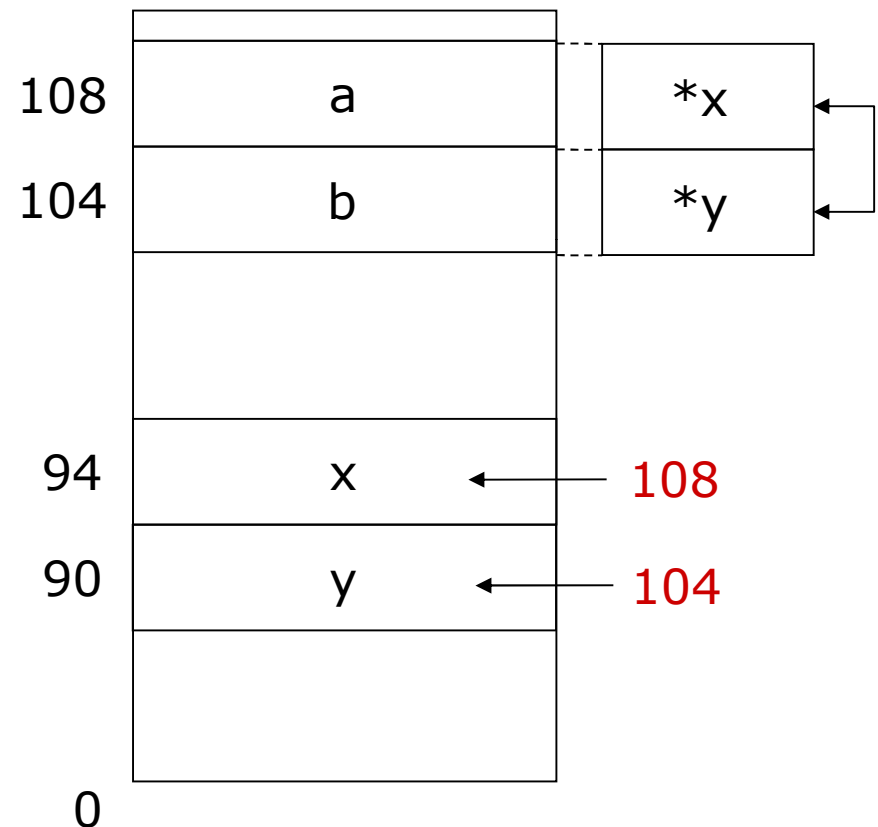


# Pointer and function (cont)

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

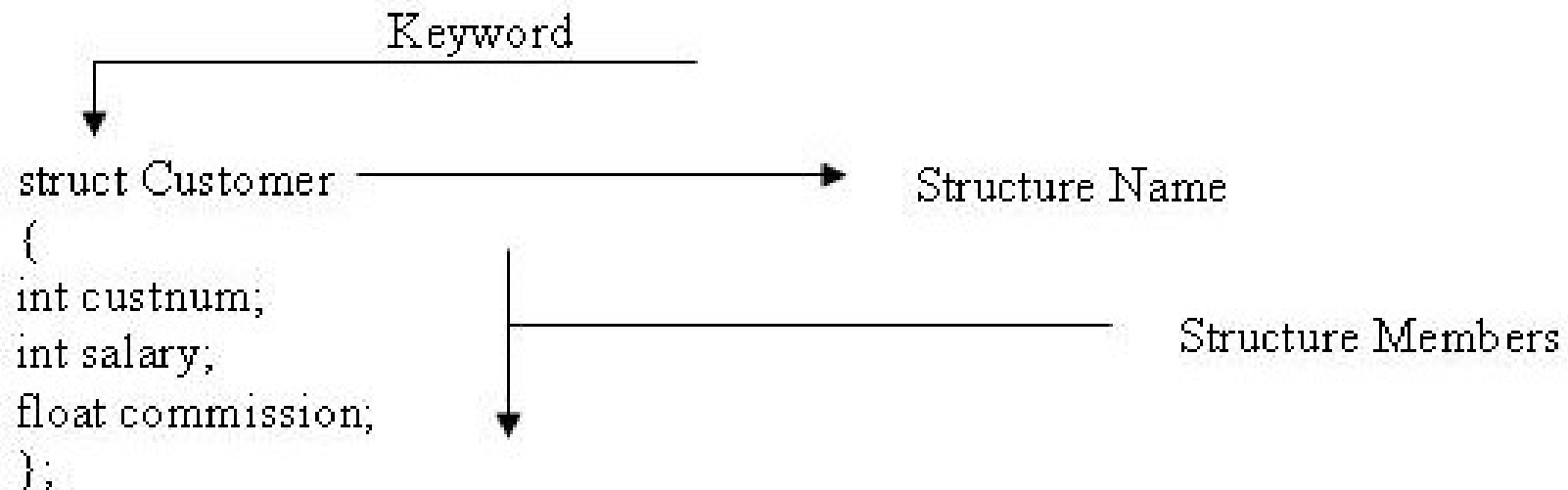
```
int main(){
    int a = 5;
    int b = 3;
    swap (&a,&b);
    printf("a=%d\n", a);
    printf("b=%d\n",b);
    return 0;
}
```

Program to exchange 2 value of variables



# 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

- **How to declare Structure Variable?**
  - This is similar to variable declaration.
- Example :

```
int a;
```

```
struct Customer John;
```

# Access structure members

- Use “dot” operator denoted by (.).
- Syntax:

*structure-variable-name.member-name*

*Ex:*

*John.salary;*

*John.commission;*

## Access structure members (cont)

- Access to members of a pointer to the variable structure  
→ using operators (→)
- Example :
  - `struct student b = {700000000,70};`  
`struct student *c = &b;`  
`printf("Score of student : \n", c->score);`

# Example (Structure)

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

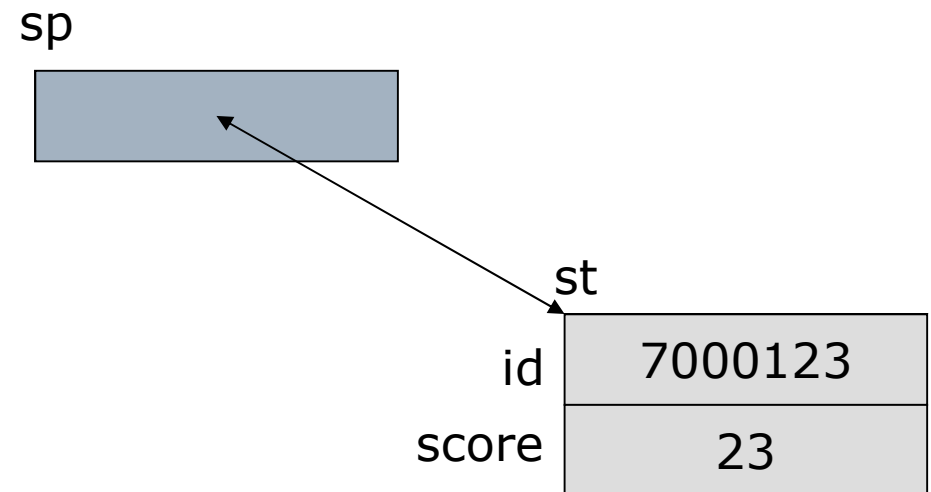
int main()
{
    int i;
    struct student students[5];
    for(i=0; i<5; i++){
        students[i].id = i;
        students[i].score = i;
    }
    for(i=0; i<5; i++){
        printf("student id:%d, score:%d\n",
            students[i].id, students[i].score);
    }
}
```

## Use 'typedef'

```
typedef struct student{  
    int id;  
    int score;  
} STUDENT;  
STUDENT students[5];
```

# Structure and Pointer

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



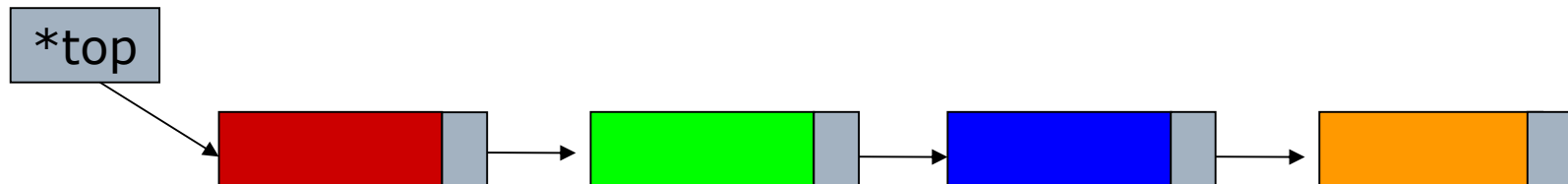
```
printf("%d\n", sp->score);
```

# 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*



## Link list (cont)

```
char *cp;  
struct student *sp;
```

(1)

```
cp = (char *)malloc(64);  
sp = (struct student *)malloc(64);
```

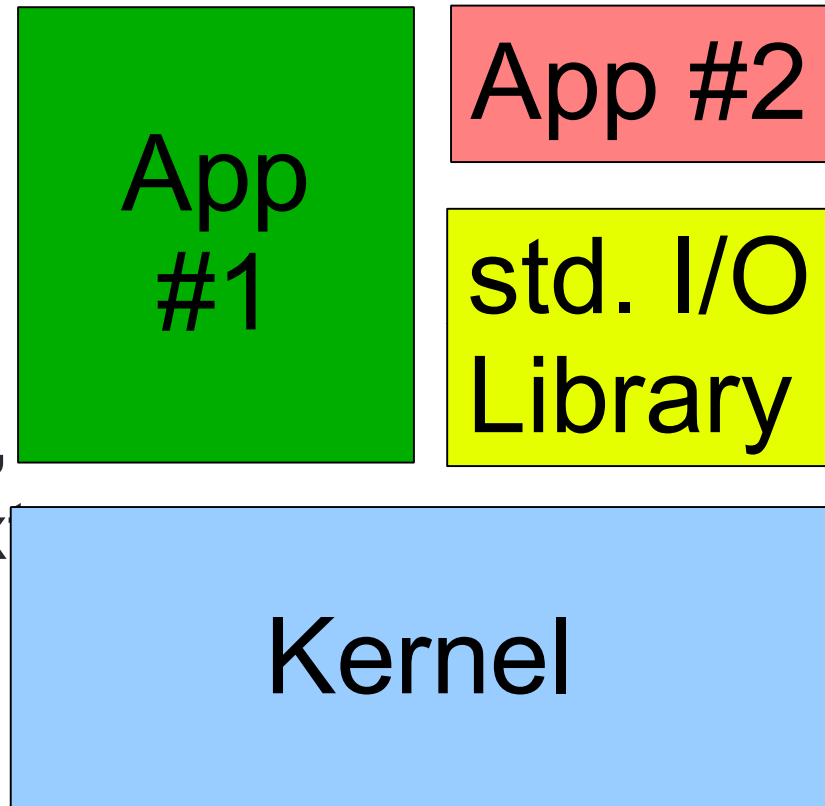
(2)

```
cp = (char *)malloc(sizeof(ch));  
sp = (struct student *)malloc(sizeof(struct student)*10);  
→ struct student sp[10]
```



## 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
  - Get warning by compilers
- fgets( )
  - Get string from stream, a newline character makes fgets stop reading
  - **USE THIS INSTEAD of gets()**

- 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

# File handling functions

- `FILE * fopen(char *filename, char *mode)`
  - `r,w,a,r+,w+,a+`
- `char * fgets(char *s,int length,FILE *fd)`
- `int fgetc(FILE *fd)`
- `fclose(FILE *fd)`
  
- `<fstream.h>`
  - `fread`
  - `fwrite`

# 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);
    exit(0);
}
```

# Exercise

**Notice:** *It is important to do this exercise properly. The program produced by this exercise will be used for subsequent lectures.*

We need a small **Study Schedule Management program** for students in the university. The program works should allow students to:

- login (using student ID and password)
- Read schedule of one weekday by providing the weekday. For example: student provides “Thursday” and the program return list of all courses and schedule of the courses of the day.

Internally, the program store the list of registered courses (by students) and their schedules in 3 text files. The structure of the file is as following:

## **course\_schedule.txt**

119747	IT3080	Computer Network	523,526,22,25-31,33-40,TC-502;
119748	IT4560	Computer Literacy	221,224,22,25-31,33-40,TC-211;
119749	IT4590	Database	524,526,22,25-31,33-40,D6-101;
119750	IT4935	Database Lab	615,616,22,25-31,D6-303;

Ví dụ với môn Computer Network, buổi học diễn ra vào thứ 5, buổi chiều, bắt đầu từ tiết 3, kết thúc ở tiết 6, môn học kéo dài các tuần 22, 25-31, 33-40, Địa điểm TC-502

## **student\_registration.txt**

20191121	119747
20191121	119750
20191121	119748
20203121	119748
20191121	119747

## **User-account.txt**

20203121	passwd1
20191121	passwd2

# Exercise

Required functionalities:

Internal:

- Represent courses by structures,
- Represent relationship student -registered classes by structures.
- Once the program starts, read study schedule from files and represent the information under the form of a list of courses (structure), list of registration (structure).

Human interface:

- Login
- Read schedule:
  - Read week day from student
  - Return schedule of the day to students as in the following:

=====

Code	Course	Week Day  AM/PM	Period	Week	Room
IT3080	Computer Network	Thursday  Afternoon	3-6	22,25-31, 33-40	TC-502

# Exercise

- Read week schedule (when user enter "ALL"):
- Display the busy schedule in the following format for a given student.

```

• =====
  • |Monday      | Tuesday          |Wednesday        |Thursday |Friday
  • -----
  • 1 |          |          |          |          |
  • 2 |          |          |          |          |
  • 3 |          |          |          |          |
  • 4 |          |          |          |          |
  • 5 |          |          |          |          |
  • 6 |          |          |          |          |
  • 7 |          | TC-201   |          |          |
  • 8 |          | TC-201   |          |          |
  • 9 |          | TC-201   |          |          | TC-502 |
  • 10 |         | TC-201   |          |          | TC-502 |
  • 11 |          |          |          |          | TC-502 |
  • 12 |          |          |          |          | TC-502 |

```