NETWORK PROGRAMMING

Assoc. Prof. Truong Dieu Linh

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
  - 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-thread TCP server
  - 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

Truong Dieu Linh
SoICT, HUST

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

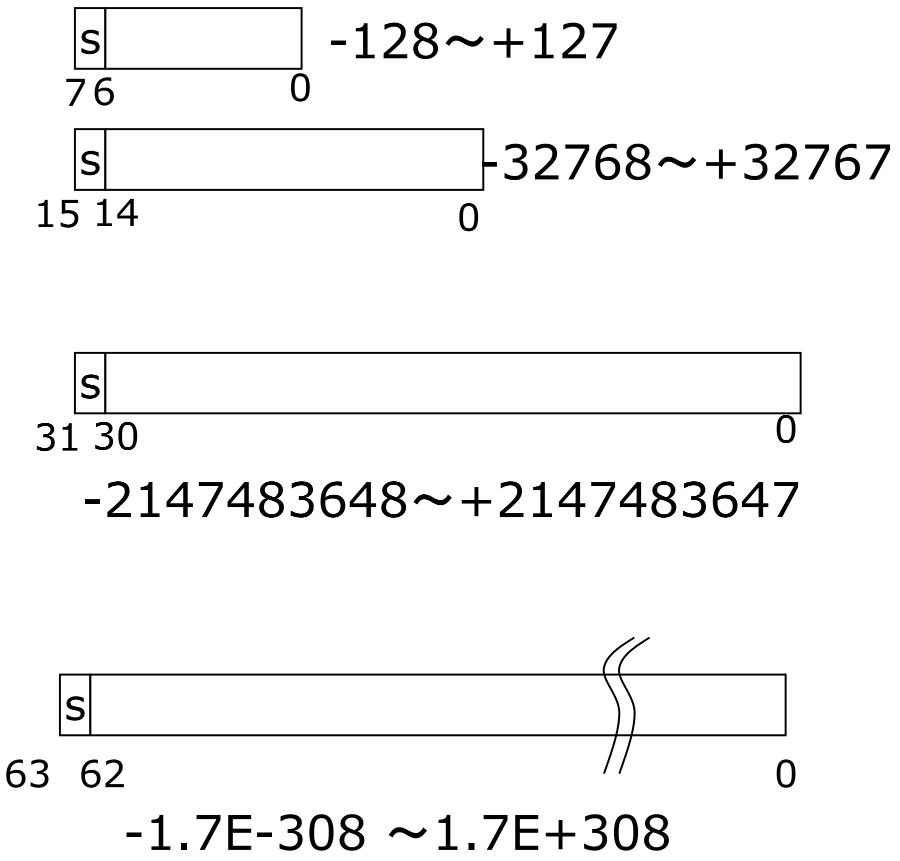
size of short: 2 bytes

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;
}

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[])

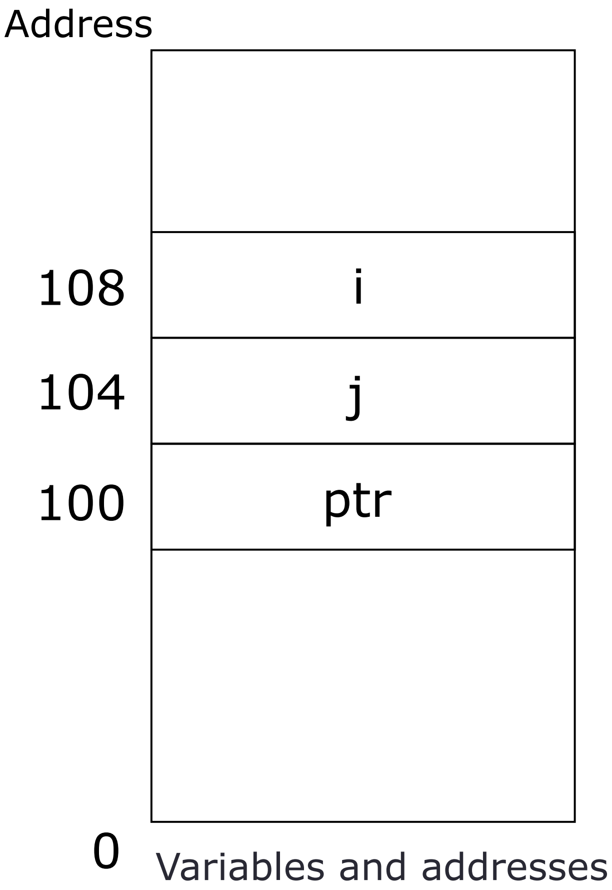
- Argc : number of arguments
- argv[0] : command name
- argv[1] : 1st argument
- argv[2] : 2nd argument

<u>Example</u> :

```
%./a.out 123 456 789
argv[0]: ./a.out
argv[1]: 123
argv[2]: 456
argv[3]: 789
```

Pointer

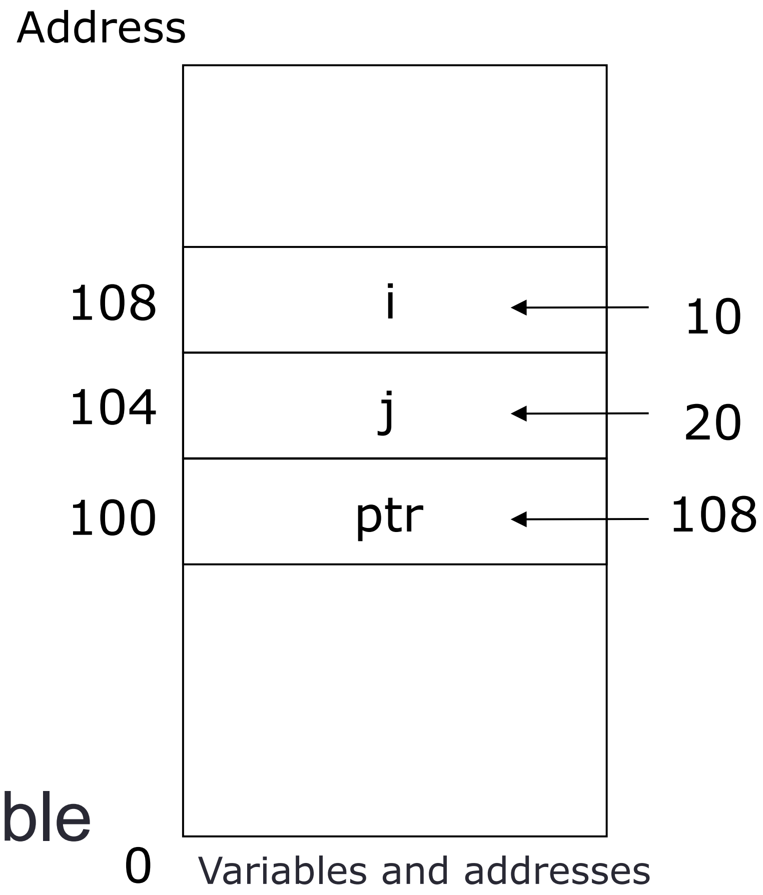
- Pointer variable
  - "Variable" refers to variable
  - Value of the pointer is the address of the variable in the memory
- int i = 10;
- int j = 20;
- int *ptr



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] */

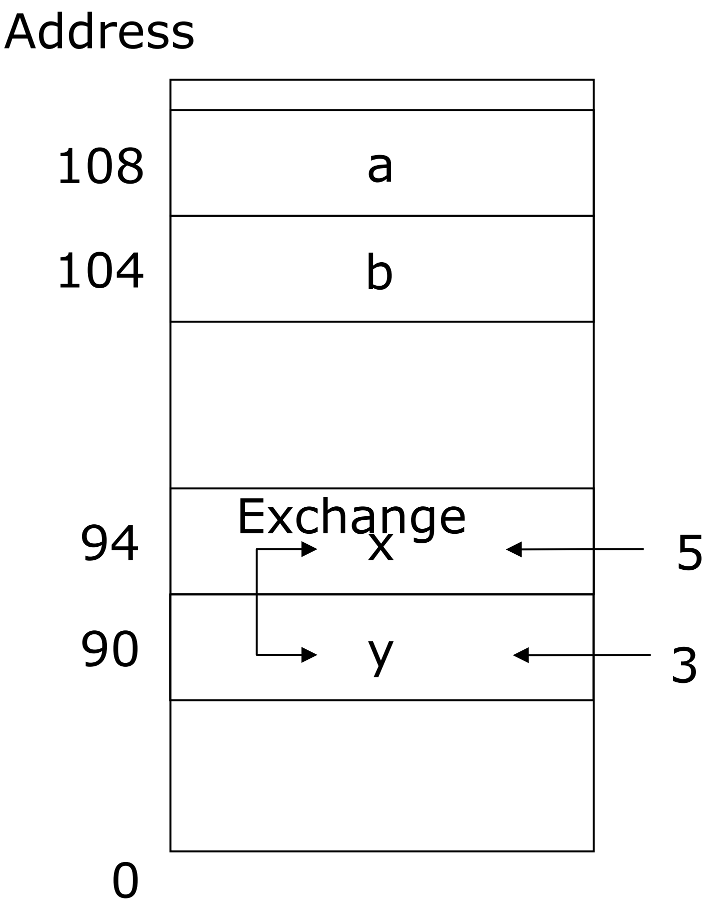
Pointer and function

```
#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 ?

Pointer and function (cont)

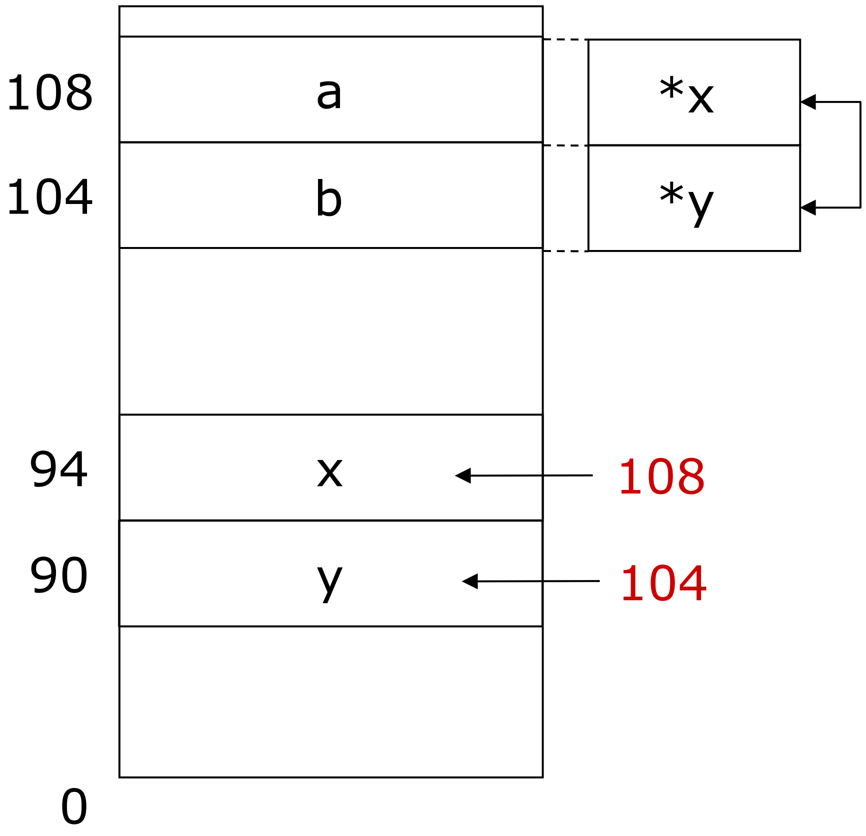
```
#include <stdio.h>
void swap(int x, int y)
{
        int temp;
        temp = x;
        x = y;
        y = temp;
}

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)

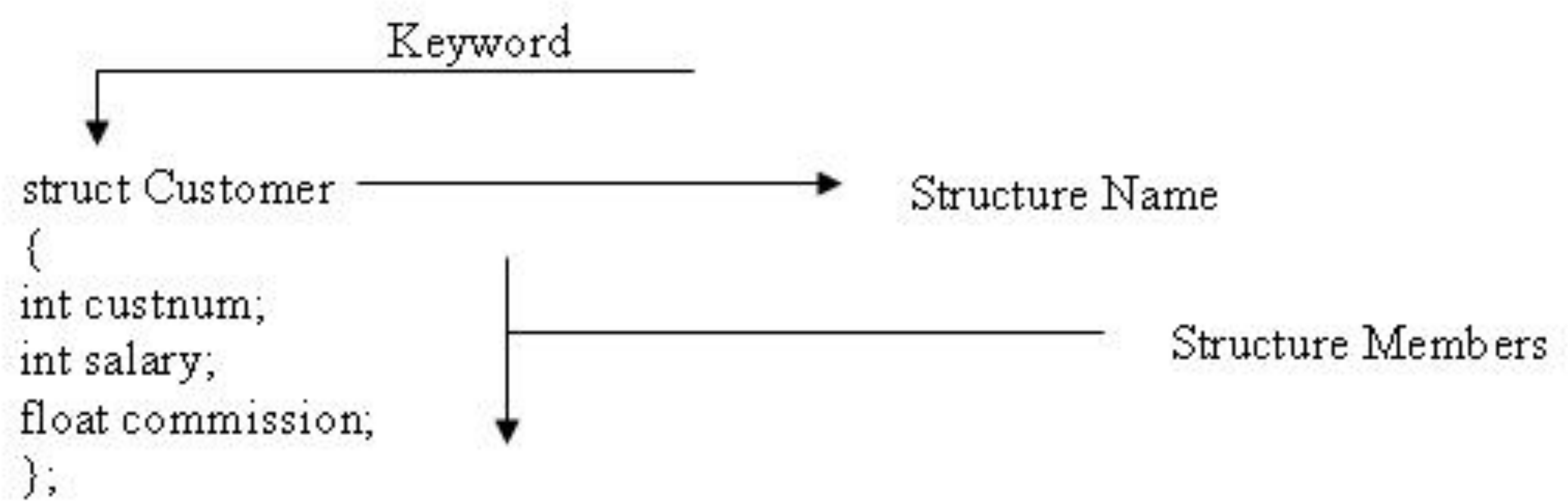
```
#include <stdio.h>
void swap(int *x, int *y)
{
      int temp;
      temp = *x;
      *x = *y;
      *y = temp;
}

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



Structure

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



```
struct Customer
{
int custnum;
int salary;
float commission;
};
```

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 = {70000000,70};
    struct student *c = &b;
    printf("Score of student : \n", c->score);

Example (Structure)

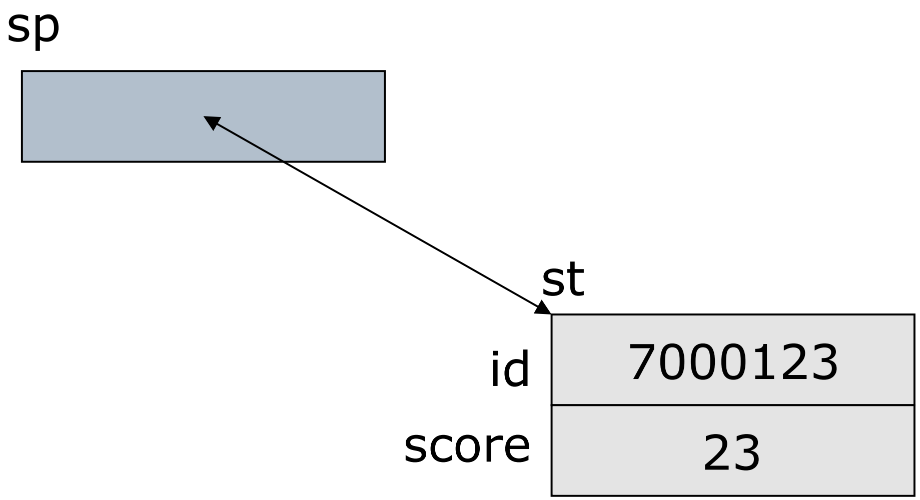
```
struct student{
    int id;
    int score;
};

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;
```



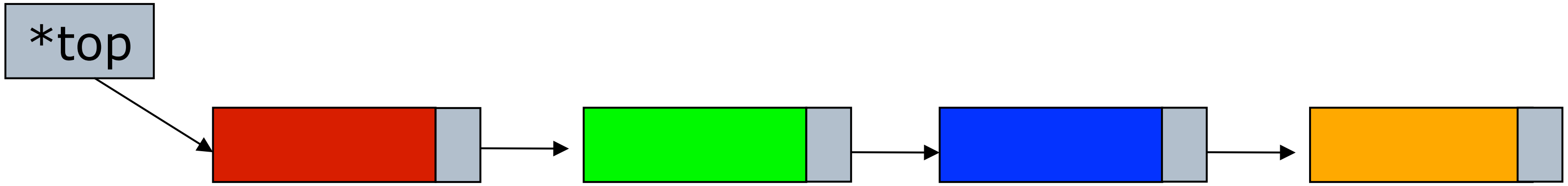
```
printf("%d\n", sp->score);
```

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）

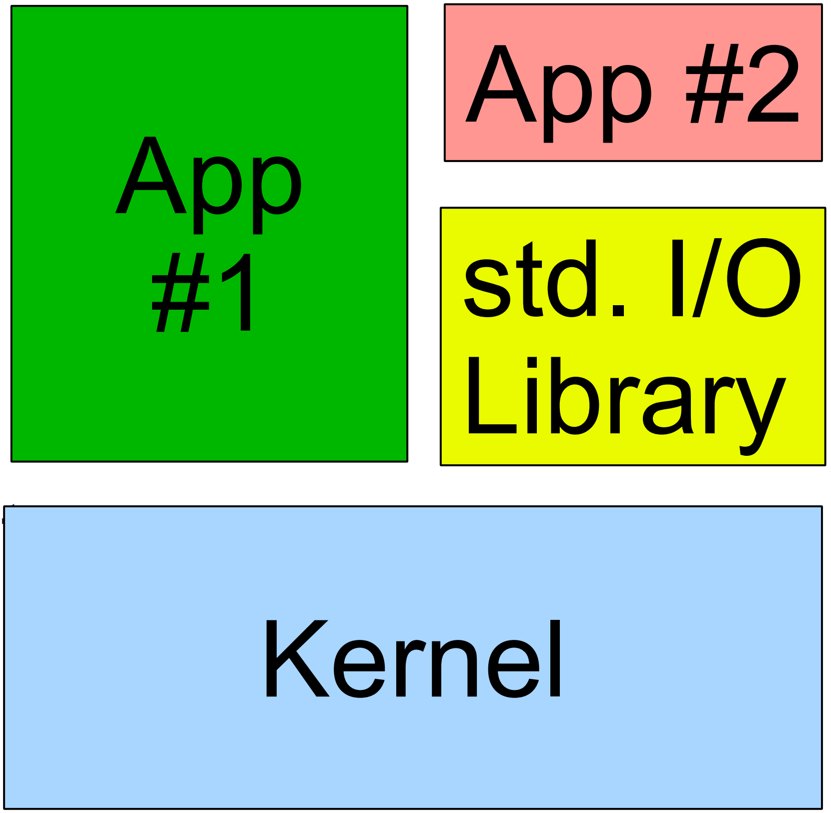
```
cp = (char *)malloc(64);
sp = (struct student *)malloc(64);
```

（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. tex 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;
```

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:

- 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   |
```