Foundations of C Programming (Structured Programming)

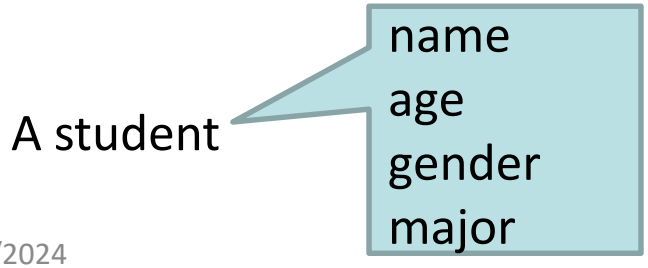
- Structure (结构), Enumeration(枚举)

Outline

- Structure definition
- Structure variables declaration
- Structure assignment
- Array of structures
- Enumeration

Basic Idea

- To represent one item, we can declare single variable
  - E.g., `int age;`
- To represent several items of the same type, we can declare an array
  - E.g., `int age[100];`
- To represent several items of same or different types, together for a particular object, we can declare a structure
  - E.g., we have 100 students, each student's information includes name, age, gender, major, how can we do?



An Example - birthday

- A birthday consists of 3 parts: year, month and day.
- We can define them in this way

```
int year = 2007;
int month = 11;
int day =13;
```

- These 3 variables are logically related, we cannot see that they are for one date with the above declarations.
- It would be better if they can be grouped together.
- The structure in C helps.

An Example - date

A structure called date

```
struct date {
      int year;     // 1st member variable
      int month;    // 2nd member variable
      int day;      // 3rd member variable
};      // don't forget the semicolon !
```

- date now is a new type that can be used like int, char, …
- date has three members (成员).

```
int i;  //i is an integer
struct date d; //d is a date with three members
```

struct and array

- A structure is a collection of related data items of same or different types, usually contribute to one object (关于同一个对象的若干信息)
  - E.g.,
  - Student: student id, name, major, gender, start year, …
  - Bank account: account number, name, currency, balance, …
  - Address book: name, address, telephone number, …
- Indicated by keyword struct
- An array contains only data of the same type, usually the data in an array do not have coherent relationship.

struct Variable Declarations

- There are three ways to declare a variable of struct type

```
struct date {
      int year;
      int month;
      int day;
};

struct date birthday;
```

Preferred

`birthday` is a variable, it is not part of structure declaration

```
struct date {
      int year;
      int month;
      int day;
} birthday;
```

```
typedef struct{
      int year;
      int month;
      int day;
} date;

date birthday;
```

Preferred

Accessing the Members of a Structure

- A member of a structure is accessed by specifying the variable name, followed by a period(英文句号), and then the member name

```
struct date today;

scanf("%d %d", &today.month, &today.day);
if(today.month == 1 && today.day == 1)
     printf("Happy new year!");
```

```
struct date {
     int year;
     int month;
     int day;
};
```

Initialization of structure variable：An Example

- An Employee record consists of three elements:
  - Age of integer
  - Name of 20 characters
  - Salary of float

```
struct employee
{
   int age;
   char name[20];
   float salary;
};
……
struct employee emp1 = {25, "Dave", 2500}, emp2;

strcpy(emp2.name, "John");
emp2.age = 30;
emp2.salary = 2000;
…
```

struct-to-struct Assignment

```
struct studentRecord{
    char name[15];
    int  id;
    char dept[5];
    char gender;
};
struct studentRecord student1, student2;

strcpy(student1.name, "Tom Hanks");
student1.id = 12345;
strcpy(student1.dept, "COMP");
student1.gender = 'M';

student2 = student1;
```

```
strcpy(student2.name, student1.name);
student2.id = student1.id;
strcpy(student2.dept, student1.dept);
student2.gender = student1.gender;
```

Class Exercises

- Can you define a struct called point (点) which has *x* coordinate (坐标) and *y* coordinate
- If a point is at (10, 3), how to express that?

Nested Structures

- We can nest (嵌套) structures inside structures.
- E.g.,

```
struct point{
  double x, y;
};

struct line{
  struct point p1, p2;
};

struct triangle{
  struct point p1, p2, p3;
};


struct point p;
struct line l;
struct triangle t;
```

Access the members:

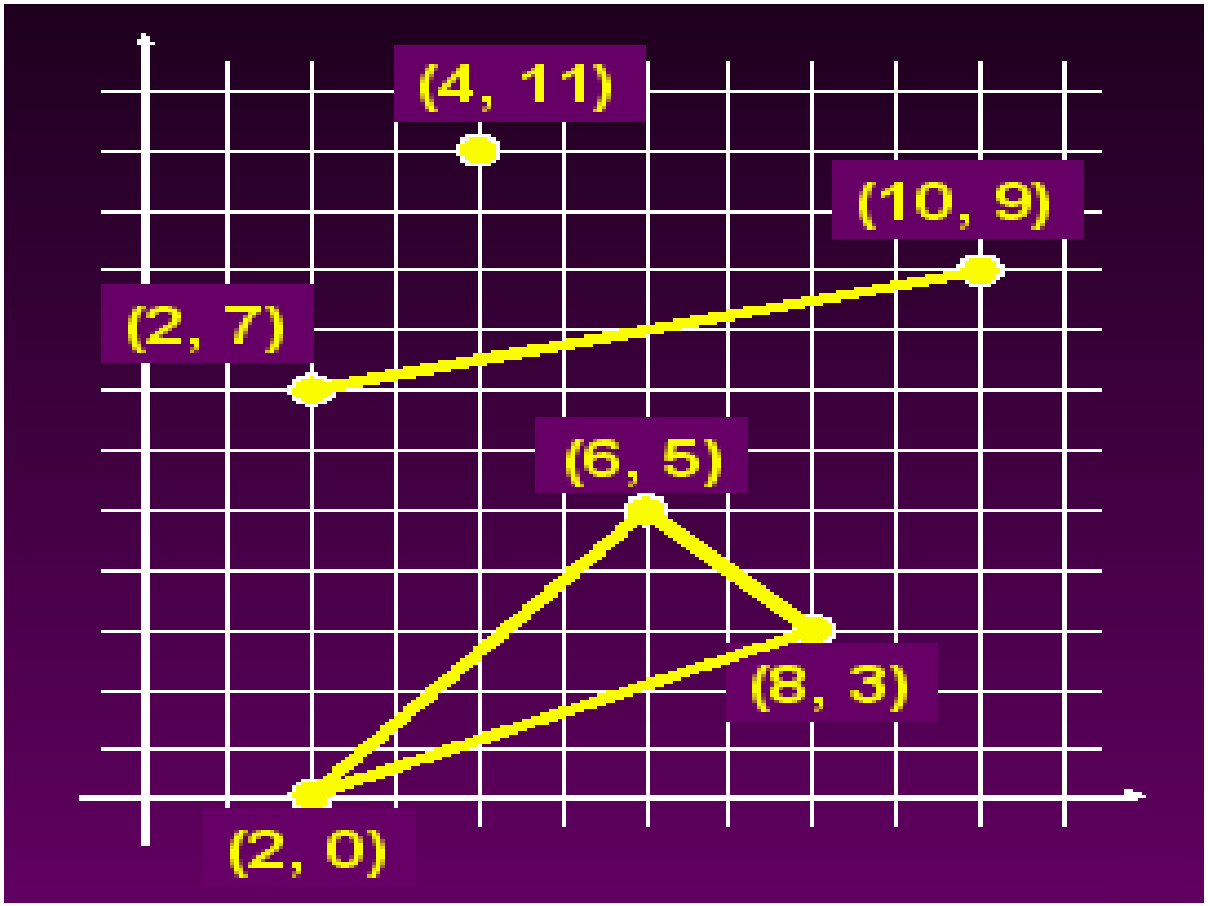
```
p.x
p.y          } A point p

l.p1.x
l.p1.y
l.p2.x       } A line l
l.p2.y

t.p1.x
t.p1.y
t.p2.x
t.p2.y       } A triangle t
t.p3.x
t.p3.y
```

Class Exercise

- Write code to give the following assignments.



Structure in A Function

- Parameters in a function can be of structure type
- The return value can be of structure type
- Usually the declaration of structure is put outside of function, so all the functions can use this declaration

Structure in A Function: An Example

```
struct date {
  int year;
  int month;
  int day;
};
struct date nextDay(struct date today);
int main(){
    struct date today, next;
    scanf("%d%d%d", &today.year, &today.month, &today.day);
    next = nextDay(today); //next=tomorrow
    printf("%d %d %d", next.year,next.month, next.day);
    return 0;
}
struct date nextDay(struct date today)
{
   struct date tomorrow;
   // Put code here to calculate the date of tomorrow
   return tomorrow;
}
```

```
today: 2021.11.17
today.year=2021;
today.month=11;
today.day=17;
```

```
tomorrow: 2021.11.18
tomorrow.year=2021;
tomorrow.month=11;
tomorrow.day=18;
```

Tips: It is better to put structure definition outside any function so all functions can use it.

Array of Structures

- If we have 100 students, each student's information includes name, id, how can we do?

```
typedef struct {
    char name[15];
    int  id;
} studentRecord;

int main(){
    studentRecord student[100];
    int i;
    for (i = 0; i < 100; i++)
        scanf("%s%d", student[i].name, &student[i].id);
    // Put code here to handle the inputted info
}
```

Tips: If the number of students is unknown, you can use scanf to read the number of students first.

Enumeration(枚举)

- An enumeration type (also called enum) is a data type that consists of integral constants.
- Use the keyword “enum”
  - Format: enum *enumName* {const1, const2, ……. };
- Examples

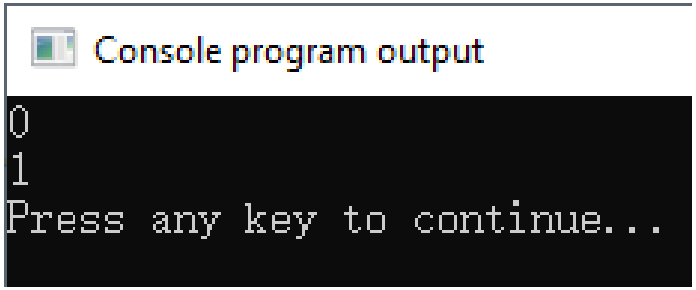
Declare an enumeration type week

```
#include <stdio.h>
enum week{Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday};
int main(){
   enum week day;

   day = Sunday;
   printf("%d\n", day);
   day = Monday;
   printf("%d\n", day);
}
```

Declare a variable day of the type week

Assign a value to day



Summary

- Struct can be used to group data of different types together.
- Struct can be defined in different ways.
- Struct makes the processing of information easier.